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E. SZÁDECZKY-KARDOSS

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STUDIES ON THE UNIVERSAL CYCLICITY RELATION

PREFACE

Since 1969 various interrelations of the material and energy flows of the planet Earth have been systematically studied at the Department of Earth and Mining Sciences of the Hungarian Academy of Sciences. Throughout these processes a kind of rhythmicity or cyclicity could be recognized.

A universal cyclicity relation controlling generally the material and energy flows on the Earth and in the Universe was discovered by the author (1973) and has been discussed since 1974 by a continuously increasing interdisciplinary team of physicists, astronomers, geoscientists, biologists, philosophers, educationalists, etc. The main discussions took place at the 5th and 6th Symposia on the Earth's Material and Energy Flows (Budapest, 1975 and 1978) and at sessions of the Commission on Geonomy of the Hungarian Academy of Sciences since 1976.

The results of these investigations on the universal cyclicity relation — found mainly by Hungarian scientists — are summarized in this volume. The wide range of the topics originating in essence from geosciences shows a new aspect of these sciences to other disciplines.

Accordingly, this survey on the universal cyclicity relation appears in the geological periodical of the Hungarian Academy of Sciences.

E. Szádeczky-Kardoss

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THE UNIVERSAL CYCLICITY RELATION

By

E. SZÁDECZKY-KARDOSS

LABORATORY FOR GEOCHEMICAL RESEARCH OF THE HUNGARIAN ACADEMY OF SCIENCE, BUDAPEST

Contents

1. Phenomena of the Universe are repeated mostly rhythmically or cyclically The rhythmic and cyclic motion can be uniformly quantified by means of velocity values. Based on these velocity values four forms of motion can be distinguished. They appear as linear strips in the logarithmic space-time diagram. The known durable inorganic processes of the Universe are concentrated in these strips (Fig. 1, p. 7.)

2. The separation of the four forms of motion is determined by the dispersity of the medium of motion. Strip *A* includes the electromagnetic oscillations proceeding in the dispersion-free medium. In the strip *B* the oscillations, rotations and revolutions of the so-called mechanical matter proceeding in simple disperse medium appear. Strip C contains the basic processes of the near-surface geological, *ptc*-depending chemical and biological motions of the simple disperse systems containing other particles (dispersion in dispersion). (Fig. 4, p. 26) Strip D involves the nuclear processes in the non-disperse medium of the elementary particles

Velocity differences of few orders of magnitude within each strip are also due to differences in dispersity. These are determined, however, by physical conditions and do not affect the type of dispersion.

3. The four forms of motion characterized by velocities express in quantitative form the dialectic principle of the antagonistic motions ("motion in contrast"). Analysing in time antagonistic motions represent rhythms and cycles. The continuous repetition of the rhythms and cycles generates the main lasting phenomena.

4. The quantitative transformations, i.e. chemical and nuclear reactions and the reaction series of the biological and social transformations generate the relatively quick transformations of the cycles into one another. They are mostly characterized by definite space or time parameters, forming bridges between the four velocity strips. Narrow bridges nearly parallel to the time axis are formed by the chemical and nuclear reactions, while wider bridges bordered by lines parallel to the space axis are formed by the biological and social processes between the strips *B* and *C*. (Fig. 1, p. 7.)

5. The main difficulty of the wide ranging correlation of different knowledges — i.e. the application of different terms and parameter-systems — may be eliminated by the cycle discipline. It applies a uniform bilogarithmic space-time representation extending from the space and time quanta 10^{-13} cm and 10^{-23} sec up to the Hubble space of 10^{28} cm and Hubble time of 10^{18} sec. Space quanta represent the smallest individually oscillating part of the space. The quotient of the space and time quanta is the light velocity.

6. Interactions between the four forms of motion is maximum in case of the similar parameters of their cycle resp. rhythms ("principle of commensurability"). It exists a) time resonance according to the similar frequencies; b) space resonances generated by the similarity of the space dimensions, e.g. wavelength and body diameter; c) resonance between the different hierarchic levels of organic, inorganic and artificial systems within the strips of motion ("hierarchic resonance"); d) resonance between the velocities of the four strips; e) resonances of the particles and the cosmic objects with space parameters differing by 5 to 6 order of magnitude ("universal resonance").

Thus the Universe represents a unique resonating system.

7. The particular behaviour of the heat energy (second law of thermodynamics) is due to a coupled time- and space resonance between strips *A* and *B*. Heat energy generated by the oscillation of the atoms and molecules at about 10^{-8} cm (1 Å) in strip *A* is in space resonance with the lower end of strip *B*, which react by time resonance upon the infrared portion of strip *A* appearing in form of heat. In this way a part of the electromagnetic energy increasing with the temperature will be irreversibly consumed. This part of the thermal energy is the bound energy which cannot be converted in work.

The thesis of commensurability is manifested also by a lot of other phenomena. The components of 6600 and 6400 Å of daylight are commensurable with the dimensions of the chloroplast grana of plants containing chlorophyl and thus these optimize the mechanism of photosynthesis. Matters emitting radiation commensurable with the space and time dimensions of the organella of mythotic cell division, highly disturb the cell division, i.e. these are cancer-generating. Researches of pharmacological application of this commensurability are in progress.

8. Cycle processes are conspicuous mainly in gas or liquid state but operate also in solid state (thermal oscillation, oscillation and rotation of the molecule). Thus, the cycle and rhythm processes are universal forms of motion, though especially in case of superhuman dimensions these remain hidden due to the multiplied hierarchic superpositions. Objects are processes, too.

9. In the space-time diagram including 41 space and time orders of magnitude from the space and time quanta up to the Hubble-dimensions theoretically each object can be plotted as a projection point of its space dimension and average life-time. This brings new aspects concerning the quantitative relations of phenomena.

10. Joining the prolonged water-clay-life system (strip *C*) evolved near the Earth's surface the cycle view extends over the biological and social systems, as well. The assignment of consciousness and social processes to the velocity system of the universal motion processes provides new perspectives for the quantitative drawing of relationships between the natural and social sciences (see the paper entitled Cycle Parameters and System Theory, in this volume).

1. The Main Types of Motion

Correlating the space: time data of the different anorganic *rhythms* and *cycles* a surprising regularity has been discovered.[1] In spite of the extraordinary variability of these motions, their distribution in space and time is not at random. On the contrary, they appear mainly in four discrete groups sharply separated from each other:

1. electromagnetic oscillation (strip *A* in Fig. 1),

2. oscillations and cyclic movements of the so-called mechanical matter (strip *B*),

3. *ptc*-depending chemical, geological and the main biological cycles at Earth's near-surface (strip *C*) and

4. rotations of the particles (strip *D*).

[1] Oscillatory and wave-like motions are denoted in the cycle-concept as *rhythms*. Periodic or quasi-periodic rotations, recurrences and revolutions are called *cycles*, independently of their forms and of their continuous or regularly interrupted nature.

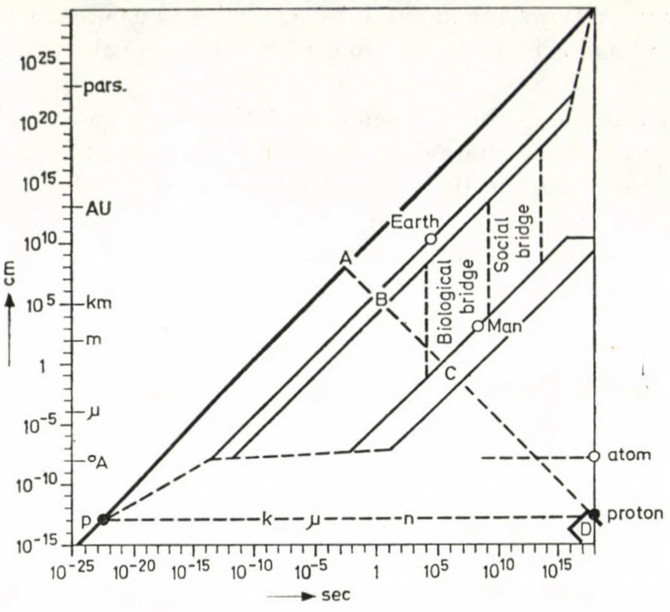


Fig. 1

The four permanent forms of motions and bridges of the transient movements

Each group joins apparently very different phenomena, which are, however, unified by a defined space : time relation, i.e. by an „*eigen-speed*"[2] and determined by the four main types of matter-distribution.

The electromagnetic waves (strip *A*) are characterized by the well-known rate of roughly 300 000 km/sec. Strip *A* represents motions independent of attractive forces.

Strip *B* unifies the supersound, sound, infra-sound, and seismic waves on the one hand, and the revolution and the unimpeded rotations of celestial bodies, on the other. All these motions are joined by their velocities of about 0.01 km/sec to 1 km/sec on the average. They represent the motion controlled by gravitation and influenced at short distances by chemical bonding forces, too. Strip *B* deviates at its both ends towards strip *A*. The average dispersities of the galactic systems are extremely low, [PAÁL 7, I] thus their velocities are greater than the norm of *B*-strip.

Motions such as the propagation of sound 0.33 km/s in air, 1.4 km/s in water, 3.2 and 5.8 km/s in steel for transversal, resp. longitudinal waves and of seismic waves (about 4—13 km/s) as well as average air-, marine and river-

[2] Eigen-speed of the cycle motion means its *peripheral velocity* $v = 2\ r/t$ being roughly constant for a given strip, whereas angular velocity $\omega = v/r$ decreases with the space and time parameter within the strip.

system current or flows (of about 0.1—0.004 km/s, 0.001 km/s and 1 km/s velocities resp.) and even the 4—5 km/s orbit velocity of the planets belong to strip *B*.

Strip *C* containing the geological and the *ptc*-depending chemical and biochemical processes is characterized by the eigen-speed of about 10^{-10} to 10^{-14} km/sec, i.e. of 10^{-5} to 10^{-9} cm/sec. The main geological phenomena, such as the formation and decomposition of clay minerals, the geomorphological cycle, the denudation and sedimentation, the drift connected with plate tectonics including geosynclinal, orogenic and rock forming processes as well as the basic biochemical processes determined by the main lifetime-bodysize relations of the living systems[3] belong to this strip (see GÁNTI in this volume).

Strip *C* represents the motion of systems generated partly by diffusion, partly by different kinds of plastic deformation, e.g. as drift of continental and oceanic plates. These motions are ruled by the VAN DER WAALS and hydrogen bonding forces and by some special cases of the normal valency bonds. The junction of these different phenomena is due to the common "three-phase dispersion" of the systems described in the next chapter.

Strip *D* contains the nuclear phenomena characterized by a nearly zero translative eigen-speed, according to the minimum space dimensions but by light velocity of rotation. Strip *D* represents the marginal case of motions controlled by nuclear forces, attributed to the symmetric high velocity rotation of the space quanta (see the next paper).

The four motion types represent a coherent series in which the motion of the strip *D* is added to that of the strip *B* and strip *C*.

The appearance of motions in four main velocity types is called "universal cyclicty relation". It describes all the known durable main types of motions except the dilatation of the Universe.

The relatively quick transformations into new cycles often due to explosion like collisions are characterized mostly by slow starting stages before the new cycle mostion.

The picture of the universal motion system in the bilogarithmic representation (Fig. 1) is surprisingly simple (in contrast to those represented by non-logarithmic, e.g. arithmetic scales). Thus, the cyclicity relation reveals the logarithmic appearance of the structure of the Universe in the mind.

The mean velocity value of point *D*: v_D 10^{-30} cm/s,
The mean velocity value of strip *C*: v_C 10^{-7} cm/s,

[3] The velocity of the permanent motion of *zoological individuals* belongs to the biological bridge (chapter 3.). Their own velocity relative to the Earth surface is mostly near to the lower limit of strip *B* (man about 0.001 km/s, birds about 0.01 km/s), but depends on their own measure, too. "Own measure velocities" are determined by the distances travelled in the measure of the average diameter of the objects. For this description all phenomena and processes need a special space-scale. The result is a one-dimensional velocity value. In this paper the problem of the "own measure velocities" will not be dealt with.

The mean velocity value of strip B: v_B 10^5 cm/s,
The mean velocity value of strip A: v_A $3 \cdot 10^{10}$ cm/s,
i.e. the light velocity.

The velocity difference between strip A and the proton projection-point of strip D, i.e. between the motion in the vacuum and of the pure mechanical matter is of 10^{-39}—10^{40} order. This value characterizes the energy difference between electromagnetic oscillations of strip A and the gravitation due mainly by the proton strip D. By means of energy computation DIRAC (1978) found the same energy difference. (Concerning the cosmologic relations of this difference see the next second paper of this volume).

The strips represent the peaks of the GAUSS-like frequency distribution of natural velocities.

The frequency relations of the motions described by the four strips may be shown only in a logarithmic scale. If the frequency volume of the phenomena of the biological bridge (see below) would be delineated arithmetically by a height say of 2 mm, the frequency maximum of strip C would be 10 m high and that of the strip B greater than the galactic diameter.

At the border of two media belonging to different strips (different dispersity types) intermediate cycle velocities appear. An example is the periodic temperature changes at the surface of the ocean water, as ocean belongs to strip C and the atmosphere — determining the temperature of the ocean water — to strip B. Such marginal cases are obviously rare. For this example I am indepted to Professor B. BÉLL and Professor Z. DOBOSI.

Strips B and C include almost the totality of the independent natural and artifical "*solid objects*", too, e.g. many parts of the planets and satellites, i.e. rock masses, minerals, as well as artifical objects such as buildings, instruments, furnitures. Solid objects are formed by the freezing in of the cycle motion by chemical forces in a restricted hierarchic level. Except this level solid objects participate also in the cyclic motion systems. They move together with the higher system to which they belong and include lower cyclic motion systems, by which they are built up. Solid objects can be quantitatively characterized by space-time parameters, i.e. by their main diameters and average lifetimes, too, and in this way, they may be projected also in the general space-time system of motions (Fig. 1 in the paper: "Cycle parameters and System Theory" in this volume). These projection points fit mostly into the strips B or C as solid objects come into being by the preponderance of the strengths mainly by chemical bonds and gravitation belonging to the cyclic processes of strips B and C or by human activity. The liquidation of the solid objects is also due to the cyclic processes of strips B and C. Thus, their connection with these strips is a genetic one.

2. Motion and Dispersity. Some General Pecularities of the Cycles

The separation of the four types of motion is due to four different kinds of dispersity. Dispersity is a fundamental particularity of the matter. It determines almost all other pecularities.

There are four main types of matter differing in dispersity: the two extreme kinds of the non-disperse one-phase systems (i.e. the pure vacuum and the pure dense matter, of the elementary particles) and the two disperse kinds of matter i.e. the two-phase systems and the complex more-phase systems. The motions of these four kinds of matter are represented by the velocities described by strips A, B, C and D in the universal bilogarithmic space-time system.

Strip A represents the motion of the quasi-homogeneous "vacuum" i.e. of the *non-disperse one-phase field.*

Strip B unites the motion of the *simple two-phase disperse systems* consisting of particles and of intraatomic and intramolecular vacuum.

Strip C represents the motion of the *three or more phase complex disperse (heterodisperse) systems*, i.e. of disperse systems in simple dispersions e.g. fluid and solid solutions, colloid and coarse dispersed suspensions and emulsion formed in large mass by the accumulation of the liquid water exceptionally accumulated at Earth's (near) surface. Motions called plastic deformation are also processes within strip C representing three-phase disperse systems.

Strip D represents the motions of the *non-disperse one-phase dense matter sistems* concentrated in the nuclei, and in other elementary particles.

Thus, the different media or kinds of matter represent always a determined grade of dispersity characterized by a main velocity (mobility) v of the system depending on the "viscosity" (η) in a larger sense of the medium:

$$v = D/kT$$

(D diffusion constant, T temperature).

In first approximation it may be admitted that in the simple two-phase disperse systems of strip B roughly the (extended) Einstein relation $\eta_{\mathrm{rel}\,B} = 1 + k_B \varphi_B$ is valid (φ the volume of the disperse phase in the volume-unit of the system, k_B the material constant depending on the intensity of the interaction between disperse phase and disperging medium). Then the three-phase systems of strip C may be described in first approximation by the relation $\eta_C = 1 + k_B \varphi_B + k_C \varphi_C$. The constant k_C depends on the interaction of the second disperse phase from the simple disperse medium, e.g. from the "liophil or liophob" nature of particles in the colloid systems according to the Ostwald—Buzágh continuity theory. Thus, the velocity of motion may be modified by different "stabilizing" materials similarly to those used in colloid-chemistry.

The differences in velocity within each strip i.e. the widening of velocity lines to strips can be also related to the differences in dispersity, i.e. to the changes of distribution of particles in vacuum:

the (optical) density changing the light velocity within strip *A*;

the pressure, temperature and state of the particles and disperging media within the strip *B*;

the state, pressure, temperature, as well as the concentration of particles in the disperging media within strip *C*;[5]

All these factors are in close relationship within dispersity "sensu lato". The kind of dispersity influences even the morphology of the moving disperse matter. The space quanta of strip *A* are deformable; the disperse elements of strip *B* are mainly three dimensional, i.e. quasi-isodimensional. The second disperse phase of the complex three-phase dimension of strip *C* are partly anisometric sensitive two- and unidimensional elements, e.g. clay minerals and spiral biological macromolecules, mainly joined by weak hidrogen-bonds and stabilized only under the slow motion systems of strip *C*.

The question may be raised whether continuous transitions in dispersity are existing in the Universe between strips *A* and *B*. Such systems may realize some intermediate (interzonal) velocity realms between strips *A* and *B*. *Magnetosphere* seems not to represent a transition of this kind. The about 3 to 8 minute, i.e. in average 300 sec oscillation of magnetosphere corresponds to an about 10^6 km space parameter in strip *B*. The length of the magnetosphere is in fact 10^5 km at least and presumably not far from 10^6 km.

Rhythmic and cyclic motions are much more common than one percepts it. They are present everywhere and controll all movements of the Universe. They represent the permanent and the most efficient processes. The energy dispersion by entropy represents the complementary disordering process of the system forming, ordering effect of cycle motions. Thus, energy dispersion is also not an unidirectional flow.

Most of the cycles are, however, hidden from our everyday activity. Cyclicity regulates the Universe imperceptibly. Systematic investigation from the viewpoint of cyclicities reveal a complete, quantitative, homogeneous and vivid concept about things.

Different rhythmic or cyclic movements belong presumably to all points of the four strips and to the time and space parameters from the subatomic to the hypergalactic one.

In the field of a rotating body — e.g. at the surface of the Earth — all movements become automatically cyclic.

[5] The substrips of living systems (GÁNTI, 1979, in this volume) may also be related to the annual rhythm of temperature values coded in the DNA-molecule affecting the dispersity, thus the cyclic activity.

The so-called "*flows*" are parts of great cyclic processes mainly of the strip *B*. Regarding the individual flows, they are irreversible processes, but putting the flow into the greater cycle to which it belongs, the quasi-cyclic reiterating nature of it becomes obvious (see also the paper of HORVÁTH in this volume).

The laws of thermodynamics are valid of the different parts of the cycle described as flows. E.g. velocity of flux (I) of the flow is propotionate to the E thermodynamic force (e.g. the heat flow to temperature, electric current to the potential difference, diffusion to concentration, generally to the gradient of the free enthalpy): $I = LE$, where the proportionality factor L is the conductivity coefficient. Changes in time of the extensive factor mass, volume, entropy (depending on the quantity of matter) are equal to the product of L and of the difference $Y - Y_0$ of the intense factor (pressure, temperature, chemical potential) tending to equalization:

$$\frac{dx}{dt} = L(Y - Y_0)\,.$$

The *diffusion* and other chemical transport phenomena represent parts of mostly hidden cycles of strip *C*.

Cycles are often *anisometric*, one-or two-dimensional, e.g. most areal extended phenomena at the Earth's surface. Processes in the elongated structures of biological systems, and much phenomena described as the mentioned flows are quasi-one-dimensional. In these cases the decisive space parameter is the longest diameter, since the cycle process is extended up to this diameter during all rotations of the cycle.

In the hierarchy of the continuous system of cycles some cycles appear regularly *interrupted*. E.g. the main petrological metamorphism appears at a defined section of the Earth's tectonic evolution returning once in all galactic-solar-terrestrial cycles.

Cycles and rhythms have also limits, as the Universe is also limited. At the lower limit the time parameter attains roughly 10^{-23} sec and the space parameter 10^{-13} cm. These values represent *quanta of time and space*, i.e. the admitted theoretical minimal values of time and space[6] performing independent motion within the oscillating vacuum. Quanta represent the wavelength and the inverse frequency of the strip *A* corresponding to the dimension 10^{-13} cm and to the pressumable maximum energy quanta of electromagnetic waves.

It is possible to find an upper limit of cyclicity space and time, too. Strip *A* correlated with the time value corresponding to the Hubble-time of about 10^{18} sec determines the maximum space value of 10^{28} cm.

[6] Mathematically even smaller inferable time and space values can be, however, imagined. Adequate space energy, and mass values may by computed, too. Thus "substructural" world is drafted in this volume by MÁRFÖLDI.

Following the Big-Bang model, it may be roughly admitted that groups and kinds of cycles and dimensions of movements increase parallel to the Hubble-dilatation since the Big-Bang. In this case the origo of the diagram presents the initial first moment of the heat world existed before about 16 to 20×10^9 years. The subsequent phases of the development may be schematically represented by the gradual expansion of the area of the diagram. The present limits of the world are determined by the Hubble-time and the corresponding space value. First strip D and A, then strip B, finally strip C came into being. According to the geochemical, data the youngest strip C may exist since about 4×10^9 years.

The cycle diagram Fig. 1. is a physical picture of the known Universe demonstrating it by the basic parameters of perception, *viz.* space and time. It represents a many-sided universal "map" of the processes and objects (see the next chapter) showing different hidden interactions and relations.

Universal constants of physics appear to determine the geometrial structure the Fig. 1. cycle diagram. The r_0 and t_0 origo of the diagram are the derivatives of the PLANCK-constant h. The quotient of the space and time quantum gives the light velocity. The endpoint of the time axis is determined by the Hubble-constant, H. The 5 to 6 order of magnitude distance between strips A and B is due to the space-quanta number of about 10^6 (presumably $8^3 \cdot 12^3$, see the next paper) of the proton, and to the difference between the atomic and nuclear differences, 10^{-8} cm and 10^{-13} cm. The two endpoints of the main (linear) section of strip B are determined by the space dimension of about 1 Å of the atoms and that of the Galactics of about 10^{20} cm expressing the dependence of strip B on the chemical and gravitation forces. The position of strip C is determined by the logarithmic distance $BC = 2\,AB$. Weak physical interactions appear in some form in almost all chemical reactions. Therefore, it may be admitted that strip C is in some correlation with the weak Fermi-constant. The position of the cardinal point of strip D is determined by the space dimension and lifetime (until now) of the proton. At the same time the velocity difference A/D of about 39 order of magnitude is the quotient of the electromagnetic and gravitation energies.

All these coincidences are due to the general resonance of the cyclic motion-system of the Universe, expressed by the universal cyclicity relation.

In the language of philosophy universal cyclicity represents the *quantitative and differentiated form of the* dialectic concept "*motion in contrasts*". In function of time the motion in contrasts (or antagonistic motion) results in oscillations (i.e. rhythms) and (regular or irregular) cyclic movements. Four and only four main types of durable inorganic motion determined by the dispersity of matter in the space is possible.

Theoretically all phenomena may be plotted in this diagram.

This suggests the possibility of a *comparative quantitative multidisciplinary research of different sciences* and may serve the general survey of knowledges.

The logarithmic space-time picture of the Universe may express also acceleration and other terms of motion containing space or time values on different powers. In these cases the appropriate power value may be prescribed to the axis in question.

The representation of the Universe by the space-time picture extends over 41 time and space orders of magnitude. Thus all values of cyclicities influenced permanently by different resonating and non-resonating factors are principally only approaches and represent obviously stochastic phenomena.

3. Formation of the Cycles. The Bridges of Chemical and Nuclear Reactions

The conversions of the cyclic phenomena into each other, i.e. the *chemical and nuclear reactions* are also not random processes. These are characterized also by definite space-time relations and velocities. The nuclear and chemical reactions are determined by the dimensions of the particles, atoms and molecules and by the reaction times; the biochemical and social ones mostly by the dimensions and time parameters of the biological individuals or social units (see the paper by ONDVÁRY in this volume). In the universal space-time system the sites of reactions appear along some definite lines forming characteristic non-continuous "interzonal bridges" between the strips *A*, *B*, *C*, *D*. At present we know five such bridges: that of the instable particles along the line 10^{-13} cm, that of the instable radioactive and transuran atoms about the line 10^{-8} cm, that of the main chemical reactions also about the line 10^{-8} cm, that of the biochemical, biological reactions and finally that of the social phenomena both between about 10^{3}—10^{13} sec. The first three bridges are nearly parallel to the time axis, the last two are roughly parallel to the space axis. (Fig. 1.)

Strips and bridges differ principally. Strips represent the realms of the inorganic and organic, quasi-permanent cyclic motions. Bridges represent the realm of the non-cyclic, i.e. principally transient short-time reactions transforming cycles into each other, i.e. forming new cycles from the older ones.

Between strips *B* and *C* the broad bridge of the biochemical metabolism and of the neurophysiologic processes of multicellular organisms is due to the accelerated quasi-one-dimensional structures, i.e. vascular metabolic flow system, and the elongated neuron cells. The acceleration works in the metabolism by catalysts (it is a system of enzymatic ruled biochemical reactions), in the neurophysiologic processes by joined electron transfer and K—Na ionic diffusion through the cell membranes. The rate of mammalian (i.e. human) metabolism is about 10^{3} cm/s, that of the stimuli conduction in plants (e.g. Mimosa) about 1.5 cm/s and that of the neurophysiologic processes in mammals maximum about 10 000 cm/s = 360 km/hour. The last rate represents already B strip velocity, according to the two-phase disperse system motion of these individuals relative to the Earth. The velocity of some man-made instruments (the cosmic rocket) surpasses even the average of strip B. In this way, these instruments become cyclic rotating members of strip B, i.e. satellites. High pressure and high temperature experiments producing e.g. accelerated diffusion of the aquaeous vapor in amorphous substances realize, man-made transient motions in the interzonal realm between strips C and B.

The second bridge between strips B and C, i.e. that of the social organizations — described by ONDVÁRY (1978 and in this volume) — overlaps partly the biological one but is shifted according to the greater space parameters of these systems to the side of greater time-space values.

The third bridge — discovered by B. GULYÁS (1978 and in this volume) — contains the space-time parameters of molecular and partly prebiological phenomena. Thus it describes the elementary subvital development, too. This bridge connects the average 10^{-8} cm/s B-strip value and the starting 10^{-6} cm/s C-strip value.

Two bridges exist between strips C, D and the origo, i.e. that of the unstable radioactive and transuranic atoms and of the unstable elementary particles. Both lead to stable systems: the first one to the stable atoms, the second one to the protons.

Thus, we live in a world characterized by infinite possibilities of the (cyclic) processes, but limited by strongly defined space-time relations.

4. Strips *A* and *B*. Cycle and Rhythm. Symmetry

Electromagnetic oscillations propagating with light velocity in vacuum, i.e. the strip A is practically realized where the distribution of the "mechanical" mass is sporadic, thus practically no interaction exists between space and particles. Strip A contains the one-phase oscillations of the vacuum space quanta, representing a boson-field, where infinite number of particles may be in the same quantum state. According to the next paper, the propagation of the gravitation belongs also to the A-strip motions representing the longitudinal oscillations of the vacuum space quanta in contrast to the transversal oscillations of the electromagnetic waves.

Motions of the strip B are connected with the separation of the two stable particle groups nucleons and electrons of opposite charge. The strip B is essentially a half spin fermion field interpreted by the cycle motion in the next paper. The equilibrium distance of the two particle type of opposite charge is represented by the average atomic radius of about 1 Å $= 10^{-8}$ cm. Thus, the starting point of the straight section of strip B is determined by the atomic dimension of about 1 Å. The time dimension of strip *B*, i.e. its continuation to the time axis is about 10^{-18}. This differs from the parameter 10^{-23} s of strip *A* by 5 to 6 orders of magnitude, according to the difference between the space-quanta moving as solitary units in strip *A*, and the protons (i.e. the main constituents of strip *B*) containing about 10^5 to 10^6 space-quanta, as mentioned before. This difference is one of the harmonics of the logarithmic 40 order difference between strips *A* and D.

Strip *B* represents the unimpeded motions of the simple two-phase systems. It contains the oscillations of the mechanical material: ultrasound, sound, hypersound, seismic waves, as well as the average current systems of the atmosphere and hydrosphere, and the unimpeded rotations and revolutions of celestial bodies[7]. Even such motion as the geophysical west drift of about 1800 years period corresponds to the *B*-strip motions as it represents the displacement of the lithosphere against the main Earth's mass modifyed only slightly by a $1800 \times 365 = 660\,000$ part, i.e. by 0.1 sec the daily rotation cycle.

Velocities of systems influenced by the forced strengths, such as friction are diminished. These appear at the border of strip *B* facing strip *C*. Such impeded systems are, e.g. the atmospheric micro-turbulences (described in this volume by B. BÉLL) at the vicinity of the solid Earth surfaces, as well as most river systems and especially marine currents. The width of strip *B* is practically broadened to about 4 orders of magnitude by these impeded motions, i.e. by the friction at the solid Earth's surface.

The revolutions of planets and satellites determined by the second power of the time parameter and by the third one of the space parameter appear all within the strip *B*. The equation of the third law of KEPLER is connected with the cyclicity relation, since the rotation of planets is spatial, revolutions' however, plane processes, thus the energy of the three-dimensional rotation converted into the two-dimensional revolution are increased by a rate of 3/2. The $\lambda : T$ — or considering the 3 spatial dimensions the λ^3/T^3 relation of the rotation converted into the revolution appears as λ^3/T^2 according the third law of KEPLER. Thus, the linear cyclicity relation implicit contains higher grade motions, too.

Cycle is related always to rhytms, since rhyhthms are generated by cycles. Two main kinds of rhyhtms shall be discerned. Rhythms of strip *A* and those of the minor parameter part of strip *B* are quasi-independent "primary" oscillations. On the contrary, rhythms observed at defined point of a cycle depend spatially and temporally on the cycle, e.g. changing of day and night at a given point of the planets, the pulse at some definite points of the artery system. These kinds of rhythms are secondary oscillations. The primary rhythms of strip A are products of the atomic electron shell cycle strip *B*.

[7] The rotation of the celestial bodies near their central bodies is impeded by the strong mutual gravity and become synchronous with their revolution (e.g. Mercur, Moon).

The true rhythm works mostly in *thin media*, i.e. in vacuum or in media rich in vacuum characterized by small even "zero" density and relatively great distance between the particles. Thus, the particles of the thin media are not joined by attractive forces and oscillate unrestricted, expanding principally unlimited in the thin medium. Thin medium surrounds as dispersing phase the particles and systems of the dense one. However, intense source force, e.g. earthquake, produces oscillations in dense media, too.

The *superposition* of the different hierarchy levels of motion changes the resultant motion of the lower level of the hierarchy.

All peripheral points of a cycle of the radius r moving together with the superposed next higher hierarchic level by the translation distance d describe spiral line if $d < 4r$, but cycloid turning into sinusoidal wave line with increasing d if $d > 4r$, e.g. $d = 47r$ for the Moon's revolution around the Earth, and $d = 417r$ for the Earth's revolution around the Sun (Fig. 2).

The hierarchy produces transitions between cycles and rhythms. Depending on the velocity of the superposed neighbouring motion (e.g. revolution of rotating planets) cycle may pass gradually into wave motion, i.e. rhythms.

Acceleration of the lower level cycle of hierarchy promotes system development and strengthens the structure. Acceleration of the higher level cycle of hierarchy promotes the wave nature of the lower one and strengthens its expansion and extensivity. (These relations allow wide practical use. E.g. industrial systems may be governed by changing velocity of the different levels.)

According to the cycle conception(the space quanta of the particles are rotating and the directions of the rotation, their *symmetry* or their *parallelism*

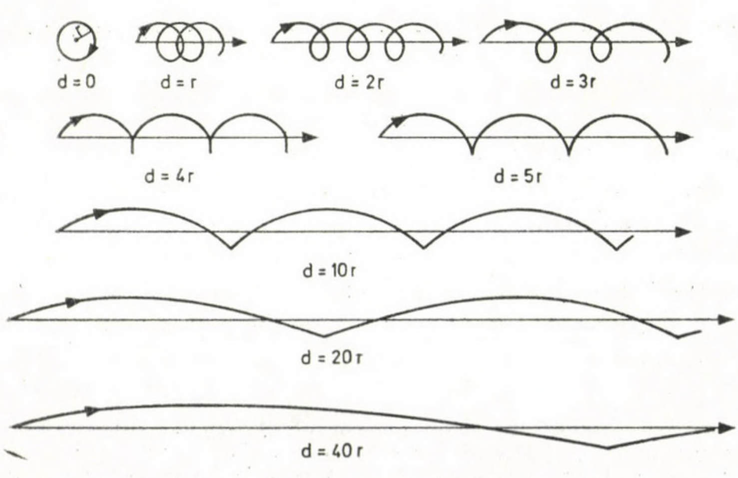


Fig. 2. Relation between rotation and translation

controls mainly the attractive or repulsive forces. The main nuclear forces are products of the symmetric rotation of the space-quanta particles (see the next paper in this volume).

Mostly the cycle freezing appears mainly as crystal symmetry. Regular cycles in human mind appear as scientific law. Thus, scientific law may be described by symmetry. Both symmetry and law express regular repetition of phenomena.[8]

According to the cycle concept conservation laws and the invariance of physical laws are not static manifestations, they represent dynamic phenomena. The macrosymmetry may be described, too — as dynamism. The concept of "time reflexion" (WIGNER) expresses the dynamism of elementary particles.

In this chapter symmetry problem is discussed on the example of the crystal symmetry.

A two-dimensional plane cycle represents right or left rotation, it is "enantiomorphic". The interrelation of two parallel rotating cycles in contact is unstable. The stable configuration is the dissymmetry with symmetric rotation (Fig. 3).

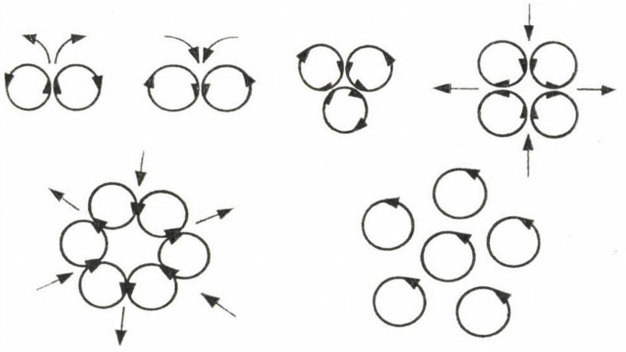


Fig. 3 **Repulsion, attraction and symmetry. In the first figure the direction of rotation must be reversed in one of the circles**

The addition to these a third cycle produces one asymmetric pair and thus a new unstability which tends to form a fourth intermediate whirl producing the tetragonal plane symmetry. As in the tetragonal plane symmetry a conjunctive and a disjunctive pair of forces appears, the hexagonal symmetry characterized by a conjuctive and two connective translative forces is more stable (Fig. 3). Most stable is the cubic space symmetry characterized by four tetragyres. It represents quasi-perfect three-dimensionality and maximum symmetry dynamism.

[8] According to NOETHER, the conservation of energy (weight constancy) represents symmetry of gravity concerning time translation, conservation of the impulse momentum represents symmetry by rotation. Elementary particles are characterized also by other (internal) symmetries, e.g. conservation of barion number (WIGNER) and lepton number (GY. MARX).

Cyclicity dynamism allows to discuss some problems of the chemical bond and of the crystalline field and the ligand field theory, too, related to the Pauli spin principle. The state of the whole spin number of elementary particles ("bozon") is symmetric, that of the half spin numbers (fermion) is asymmetric, i.e. the signs of their functions are changed when particles are changed (see the next paper in this volume).

In this way crystals represent frozen systems of active symmetries. On the contrary *symmetries of biological systems* are not frozen. The frequent left rotation of biomolecules loosens contacts, therefore one of the elements of hexasymmetry receives central position producing peripheral pentasymmetry. Biological pentasymmetry is probably correlated with the role of five-valency elements P and N in their macromolecules, too. The close relation of pentasymmetry with the *Fibonacci row* and with the *golden section* predominant in arts and expressing vital relations are often described. New adaptation of these relations was found by LENDVAI in musicology, too.

5. Strip C. Bond of Geologic-Chemical-Biological and Social Phenomena

Strip C is characterized by the complex three-phase dispersions. Thus the velocity within these dispersions is decreased by about further 10 orders of magnitude as compared with strip B. In addition to the common chemical valency bonds the weaker van der Waals and hydrogen bonds also appear in strip C. The continuously changing assemblage of water molecules, the joining of scales of clay minerals and other phyllosilicates, the double spiral structure of many living organic molecule-systems are all characterized by hydrogen or/and van der Waals bonds. These bonds generate the sensitive structures of all the three members of the water-clay-life system characterizing strip C. The contrast of the weak bonds existing beside the strong ones is reflected in the two- and one-dimensional crystals of large specific surfaces increasing the sensitivity of the C-strip structures.

In strip C the most complex and at the same time the most infrequent phenomena in the Universe interrelated with Earth and Man appear. Strip C phenomena are at present known only at the nearsurface zone of the Earth. These are generated by accumulation of a highly particular material at the Earth's surface, that of the *liquid* H_2O. Water combines two extremely opposite elements: the most typical volatile hydrogen and the oxygen forming more than 70% volume per cent of the inert solid phases, i.e. rocks. Consequently, water is one of the most efficient solvent, the mighty presence of which enables the steady formation and cyclic rejuvenation of different terrestrial solutions (sea-water, mineral water). Water is characterized by the lowest boiling point among the main volatile components of the planets and by extremely high heat capacity moderating the changes of temperature at the Earth's surface. The mighty liquid sphere and consequently the mainly horizontal flow system are specially characteristic for the Earth's surface, too.

Gravity, surface temperature and the molecular weights of the compounds of the outer spheres of planets prescribe mainly the changes in mass and composition of planets. The accumulation of water is a consequence of the gravity potential and of the surface temperature of the Earth the last being determined mainly by the solar distance.

The water-rock interactions create the afore-mentioned special terrestrial phases, clay and related minerals characterized by high absorbing capacity. The fine dispersed system of clay or related minerals and the solutions form the three or even more phase dispersions where the velocity of the disperse phase is decreased by about 10 order of magnitude as compared with strip *B*.

This slow motion, mostly diffusion, enable reactions even with changes of the molecular structure depending not only on temperature and pressure, but chiefly also on concentration of the components.

Clay minerals as lubricant and as steadily changing, transforming, decomposing and rejuvenating phases produce a softened and uninterrupted cycle system at the Earth's surface.

Subsequently to the accumulation of water and the formation of the clay cycle, a third great step of terrestrial development is induced, that of the continuous presence of one-dimensional organic macromolecules. Sensitive C—C—C bond aliphatic chain structures are frequent in other celestial bodies, too. Similar molecules and their derivatives, however, may be continuously preserved only in the low velocity complex disperse water system under the softened radiation and motion system of the Earth's surface. Cyclic changes of energy mainly of solar origin and of the related anorganic chemical reactions at the Earth' surface produce reaction-series within these macromolecules, too. Their reactions are, however, accelerated by the extremely high specific surface of the sensitive unidimensional structure and become even more accelerated by their bends at certain critical places, producing the catalyst-enzym mechanism. The reaction-series of the very long molecules reflect regular environmental changes by molecular coding and then automatically as a system already quasi-independent of the slight momentary effects.

In this way the self-governed biochemical system is produced. The biological systems emerge from the slow realm of strip *C*, forming a velocity bridge between strips *C* and *B*. Living systems gradually invade the interzonal area between the strips *B*—*C*, quite "impassable" so far for anorganic phenomena.

Many new reactions appear in the multicellular organism since about one billion years and on the continents since about 400 million years. Further velocity increase was produced by the development of the vascular flow system of the primary metabolism and by the conductivity of the elongated cells of the neuron system. Conductivity by electron transfer in the neurons represents a new far-reaching biological invention. Velocity was increased so far by morphological changes using *C*-strip chemical attractive force. Now a pecularity of strip *A*, the electric conductivity is joined to the biochemical processes avoiding the attractive gravity forces of strip *B*. The maximum velocity of neural conduction in high mammals attains about 100 m/sec.

Shrinking of time or/and augmentation of space parameters are the most particular abilities of biological systems. Life is characterized by the dialectic unity of two opposite processes: the maintenance of the biological cycle system and the acceleration of internal reactions.

The unidimensional fibre structure of the organic macromolecules combined with ATP results in a very active high energy level. It is suitable for accomodation, even for changing environment. Life extracts CO_2 from the $(NH_4)_2CO_3$ of the primary ocean water and produces $CaCO_3$ since more than three and a half billion years. The fine laminated organosediment, stromatolite, a product mainly of filamentous blue-green algae is known already from 2.6×10^9 years old limestones). The synchronously released ammonia forms N_2 and together with the bioproduct O_2 it produce gradually the special recent terrestrial atmosphere. A consequence of this atmosphere is the evolution of the continental life and the high grade information systems of Man.

Thus evolution processes are especially significant in strip *C*.

Biological evolution represents new adaptations to the environments by improving automatism and abilities. It is connected with the increase of the expedient codes in the chromosomes, and due to ever new informative automatisms.

Social evolution is a result of the differentation of works (trades) and their relations, discussed in the paper "*System theory and cyclicity relation*" of this volume.

These main *grades of evolution* may be characterized by the following additive pecularities to the former ones:

- Common celestial bodies: gravitative differentiation,
- Earth's near-surface: diffusion chemistry,
- Living systems: self-reproduction, accelerated and coded reaction-series, with $\pm$ feed-back, information, distinction of values,
- Human society: differentiation of trades, collective code systems of information, e.g. languages.

The *spiral line of evolution* is the resultant of reversible cyclic and translature forces of higher hierarchic levels. (J. Horváth and T. Jermy in this volume.) Evolution may be characterized quantitatively in the space-time diagram describing rotation around a given point of the strip *B* or *C* and synchronous shift quasi-parallel to the strip.

Evolution is an increase of the complexity of a cycle process characterized by slow energy increase, and internal space and time changes. Simple phase transformation, e.g. a polymorphic transition according mostly to *pt*-changes does not represent evolution. Evolution is mostly — perhaps even always — connected with the chemical change of the system, i.e. with a change in concentration of the components. It is not a change at random. It depends on the past of the system, too, which takes active part in the evolution. If changes exceed a definite limiting value, new cycles are formed from the old ones (transformation) and the evolution may eventually pass into revolution (see also the mentioned paper in this volume).

6. Interactions of Different Motion Systems. Commensurability and Resonance

Interactions *within the same strip* are represented by the hierarchic intrapositions and superpositions of rhythms and cycles discussed mainly in the paper "*System theory and cyclicity relation*" of this volume.

Interaction and unilateral effect between *different* strips are maximum if their motions are spatially or temporally commensurable, i.e. in the case of resonance sensu lato. Unilateral effect appears if energies commensurable in space or time are not commensurable in intensity (e.g. radiation energy of Sun at chloroplasts).

Interactions between strips *B* and *C* are especially complex if objects are in direct contact, e.g. at borders of the atmosphere, hydrosphere, biosphere and lithosphere. These interactions are topics of different geosciences, especially of the geonomy. In the remote interactions between different strips the temporal and spatial resonance phenomena are specially unambiguous. Examples for temporal (frequency) resonances *sensu stribto* are well known. Maximum and mostly complex spatial resonance appears if the strip *A* wavelengths and the strip *B* body measures are commensurable. Interactions already are known between very hard X-rays and nuclei (MÖSSBAUER, effect). Strip *A* oscillations of greater wavelength are also mainly generated by strip *B* mechanical objects with space dimensions of similar order of magnitude. E.g. radiochemistry and photochemistry represent mostly interactions of similar space dimensions between strips *A* and *B*. Between strips *A* and *C* are also clear resonances depending on the approximate commensurability of the strip *A* wavelength and the strip *C* dimensions of biological objects. E.g. assimilation is due to the roughly commensurable wavelength of solar radiation with the structure elements of chlorophyll. Commensurability is supposed between biological rhythms of animals' pulse, respiration and the terrestrial micropulsations (DRISCHELL 1974, Author 1974, reservation against: VERŐ in this volume). The sensory structures of the eye is commensurable with the most intense wavelength of solar radiation at the Earth's surface. Cancer may be produced by radiation comprising wavelength from 3000 to 3200 Å and 2500—2600 Å, emitted by many carcynogen foods and chemicals (ILLINGWORTH 1976) and commensurable with the chromatide and the mithotic apparatus, i.e. with the organella related to the carcynogenic hyperactivity. Moreover, the carcynoma is related by a temporal resonance to the mentioned ultraviolet radiation, too. The carcynogenic wavelength corresponds in strip *C* to 10^2 to 10^4 sec, i.e. some minutes to 180 minutes and this time intervals corresponds to that of the main phases of the mitogenesis (prophase 90 min, metaphase 20 min, anaphase 5 to 10 min, telophase 40 min). Carcynogene are, however, e.g. hard X-rays, too, commensurable with the fine components of the chromatides.

Commensurability exists between strip *B* and *C*, too, e.g. audibile are sounds roughly commensurable with the dimensions of mammal organism and organs.

Commensurability rule may be established as a guiding principle for purposeful selection of biological irradiations. They are influenced, however, by physical absorption, by dependence on speed relation — as in the case of sound explosion and Tserenkov radiation — and by many other factors, too.

The wavelength to body measure commensurabilities are a quite new and significant territory of researches.

There are at least five kinds of resonance: 1. the well-known *time resonance* characterized by the commensurability of the frequencies, appearing in the time-space diagram by directions parallel to the space axis. 2. *Space resonance* characterized by the commensurability of space measures (mainly wavelengths and body diameters), appearing in the diagram along parallels to the time axis. 3. The *hierarchy resonance* maintaining the cooperation between the different hierarchic levels of systems and functioning parallel to the four motion strips *A*, *B*, *C*, *D*. 4. The *velocity resonance* between the four strips expressed by their velocity relation of 1 : 2 : 4 : 8 order of magnitude. This resonance appears in the space-time diagram in the direction perpendicular to the strips. 5. The *"five order" space parameter resonance* expressed by the five to six order of magnitude space and time coincidences of the main cosmic systems (see the next chapter).

Resonances are governed by the law of the harmonics which by means of simple whole number relation of the frequencies quantifies not only the wave motions, but also the formation of micro-particles, the functions of macro-objects, the systems of human and cosmic measures. The details for particles, and for cosmic and human systems are discussed in the next three papers, for geological phenomena and their cosmic relations in the book by BENKŐ.

Thus, Universe is a uniform motion system governed by resonance relations. Since the intensities (amplitudo) of resonance phenomena are, however, described by Gaussian curves of different shapes and synchronously countless factor are working, the correspondence of the cycles and rhythms is not exact. There are discrepancies — distortions, postponements, different kinds of hysteresis, omissions — both in time and space, obscuring the function of the universal resonance relations.

The resonance structure of the elementary particles is determined by the ($m\,8^n$) relation ($m = 1 \ldots 7$, $n = 1 \ldots 6$) according to the next paper of this volume. With the increase of the space quanta (i.e. the "elements" of the particles) the number of the resonances increases decreasing their intensities. Thus, the ($m\,8^n$) relation does not appear in macrosystems.

Presumably the physical interactions are also governed by the universal resonance relation. Physical interactions represent changes of energies, impulses and moments between different kinds of matter, i.e. between cyclic and rhythmic motions of the strips and bridges (For their interpretation see the two next papers of this volume.)

In strip C occur mainly chemical phenomena. Physical effects are transmitted to strip C mainly by the commensurability relation.

According to the classic view in the Universe, the total mass of matter is constant, masses of each level in the most simple case being also constant: $M = N(2r)^3\varrho$, though the number and the masses of the elements within the level may change. In quantum-mechanics this is not valid, particles are emitted or absorbed by nuclear reactions, photons by electromagnetic interactions, etc. Therefore, the vacuum of different levels is exchangeable, it is collective for the Universe. According to the new cosmology of DIRAC even the number of the protons thus the mass of the matter of the Universe increase by the dilatation This is corrobated also by the cycle conception, see p. 83. "Cyclicity and Cosmology"). In this way, the mass of the hierarchic levels, or at least that of certain levels also increases: it is submitted to a cosmological evolution.

In this view the law of the indestructability ("stability") of matter is valid *within* the Universe, too, but at the surface of the dilatating Universe new material is formed by the transformation of inactive space quanta into rotating ones (see the next paper).

Gravity, chemical forces, nuclear forces characterizing strips B, C and D represent attractive forces. These strips are characterized by rotating space quanta forming generally the particles of the mechanical matter. Their symmetric or parallel rotation produces attractive or repulsive forces. Electromagnetic oscillations, especially the heat of the strip A realize mainly repulsive forces. The opposite forces create one another.

At the scale of the Universe mutual creation may be delineated by the Big-Bang model. First at maximum heat repulsive force prevails. By differentation of matter into positive- and negative-charged particles the attractive forces, are strengthened, too. Thus, the joining of matter and the formation of celestial bodies are enabled. Strips B and C appear and the realms of all four strips expand. Repulsive forces function, however, below a characteristic minimum space dimension within these strips, except black holes. Concerning further development of the Universe, two main kinds of possibilities may be postulated: 1) the permanent continuation of the expansion, i.e. a non-cyclic Universe in the universal cyclicity discussed by GY. PAÁL in this volume, 2) the turn back of the expansion into contraction, i.e. an ever pulsating Universe discussed in the papers p. 83. and by CLUBE in this volume.

7. Hierarchy and Interdisciplinarity

Superimposed minor and major cycles represent successive "organization levels" according to the hierarchic sequences (see the paper by DUDICH in this volume). The sequence cell-tissue-organ-organism-life community-biosphere represent the hierarchy of living systems. Atom-molecule-crystal-rock-planetary sphere-planet forms one of the organic hierarchies.

Four main stages of the hierarchic evolution in stript *B* may be discerned:

1. *Cosmic nebulae* consist of "plasma" according to the extremely low pressure, dispersity and density at 2.7° to 20° K.

2. *Stars* according to their very high temperature of million degrees are mainly in plasma state.

3. *Heavy stars* (white dwarfs, neutron stars, black holes) with extremely high pressures, densities and different temperature values are assumed to consist partly of neutrons, formed from protons and electrons under high pressure, even of collapsed particles.

4. *Planets and satellites* consist of (sub)nuclear particles forming atoms, molecules, crystals, rocks, finally complex (fluid + solid) planetary bodies, according to their temperature between about 20° to 10 000° K.

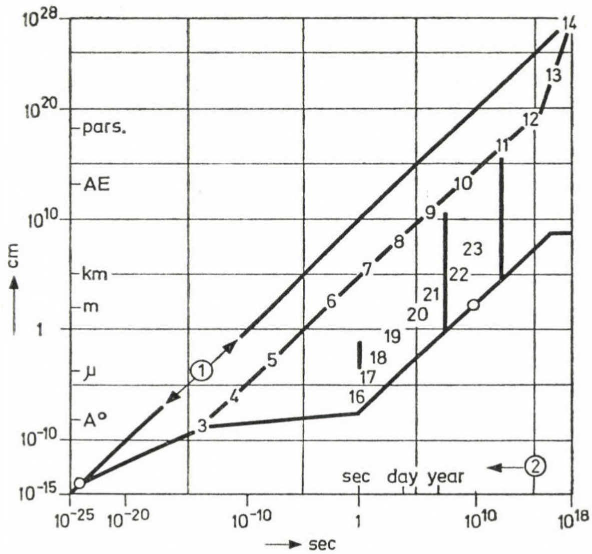
The *biological systems* together with their particularly highly differentiated hierarchy roughly delineated by the presence of the liquid H_2O are incomparably less in mass and in temperature range. The hierarchic structures of the biological system appears in strip *C*.

The old and always reviving aspiration to synthetize knowledges by interdisciplinary researches may be furthered by systematic investigations of all systems of hierarchies.

By the explosion of information new necessities for interdisciplinary surveys are born. It is believed that without such a survey science may grow too confused and the value of many specialized researches will become questionable. System theory is regarded as a possible method for the general corroboration of interdisciplinary researches. This volume contains a paper (by E, Szűcs) discussing the limits of these aspirations, too. However, not alone the research of system theory, but that of the hierarchy of systems require elucidation.

First, let us enumerate an approximate sequence of the anorganic and biological hierarchic levels or systems (Fig. 4) and characterize these levels and their elements by the most decisive parameters.

Pecularities of macrosystems may be described by 12 independent groups of parameters, called cycle parameters (see the paper "System-theory and Cyclicity" in this volume). Four of these parameters describe the main particularities of the lower level of hierarchy of which the system consists, 2 parameters characterize the own motions within the system and 6 parameters those of the



o space quantum; ① electromagn. oscillation; ② particle: 3 atom; 4 molecule; 5 crystal; 6 rock; 7 planetary sphere, satellite; 8 planet; 9 star. 10 planetary system; 11 star clusters; 12 Galaxy; 13 Metagalaxy; 14 Universe; 15—16 organic megamolecule; 17 organellum; 18 cell; 19 tissue; 20 organ; 21 organism; 22 population; 23 state

Fig. 4. The main objects and movements. Objects and systems being motions (processes) are also represented by the space and time parameters diameter and average life time (i.e. reciprocal frequency). The description of a hierarchic level requires 5 independent cycle parameters at least (see the text). But systems belong to the same higher level and consist of similar elements (i.e. lower levels), thus are sufficiently represented by their own space- and time-parameters

next higher levels influencing directly the system and the dispersity. Thus, the minimum number of motions increases additively by 6 units advancing to the next lower level (see table p. 28).

The collateral biological sequence branches off from the main anorganic sequence at the level of the molecule and "returns" at the level of planet (Earth) to the main sequence.

Already a first approximate description of the universal hierarchic structure by orders of magnitude requires 5 independent parameters for each level at least: the minimum number of motion N_m, the number of the elements (systems) of the levels: N_e, their average diameter $2r$, their average densities ϱ, and the average free place of each elements ϑ_e.[9]

Table 1. contains these 5 independent cycle parameters from the 12 ones.[10] (The 6th parameter: mass (M) is not independent $M = N_m(2r)^3\varrho$). Some parameters are correlated, however, with the neighbouring levels. The average volume of the free place ϑ is dependent, e.g. also from the volume parameters of the next lower ($i-1$) level, beside the own average diameter and number of elements:

$$\vartheta = (2r)^3 - N_e[(2r_{i-1})^3 + \vartheta_{i-1}]\,.$$

Theoretically all levels, i.e. systems are formed by the multiplication of the next lower level — becoming sub-systems or elements of the next higher one — with a synchronous qualitative change characterized by a new set of additive motions, beside those of the elements.

Systems represent developing units and the twelve cycle parameters describe the state of the system in a given moment of the R rotation number. An exhaustive description of a system contains that of its development, too, by the continuous curves of cycle parameters in the function of time. The right planning of artificial systems is a model construction of the 12 cycle parameter curves.

In the last million years man and hierarchy of *artificial systems* are developed by the mighty growth of the human observing-transforming-reflecting systems. This trinity of abilities pruduces the systems of instruments (technics) and of the reflection (religions → arts → sciences), i.e. the duality of the human artificial and transforming-reflecting power. The hierarchies of this artificial duality differ from the preceding "natural systems" mainly by the smaller number of R and by the appearance of the highly specialized differentiation of the self-conserving property of the cycles: "purpose" ("aim") and "value" (see the paper "System theory and Cyclicity" in this volume.)

According to the presence or absence of free space (e.g. vacuum) within the level, the universal anorganic hierarchy sequence is divided into four main parts: two *tight* groups of levels without significant free place and two *wide* ones with predominating free space. Microparticles form six *tight* levels, chem-

[9] The determination of these parameters for elementary particles is enabled by the model of the progressive setting up of the particles according to the next paper. Each element forms a system consisting, of elements i.e. "sub-systems" which represent the systems of the next lower level.

[10] The N_e parameter appears in a more comprehensive description (System theory and cyclicity in this volume) regarding the form types of elements, too, as $(n + u)$ parameters and the N_m parameter as the q co-ordinates of the elements.

The main inorganic hierarchy

Level (i)	All numbers represent approximative values m ± 10^1					$M = N_{\varrho}(2r)^3 \varrho$
	N_m Minimum number of additive motion types	N_ϱ Average number of the elements (subsystems)	2 r (cm) Average diameter of the level	ϱ (g/cm³) Average density of the level	ϑ (cm³) Average volume of the free space	(g) Average mass of the level
15 Universe	6	10^4	10^{28}	10^{-31}	10^{84}	10^{54}
14 Supergalaxies	12	10^5	10^{27}	?	10^{54}	10^{50}
13 Galaxies	18	10^{11}	10^{22} to 10^{23}	$3.5 \cdot 10^{-21}$	10^{22}	10^{45}
12 Stars planet systems*	24	$2 \cdot 10^1$	$10^{11}-10^{13}$	$2 \cdot 10^{-12}$	10^{12}	$2 \cdot 10^{33}$
11 Planets	30	10^1	$\sim 10^{10}$	$0.7-5.5$	0	$6 \cdot 10^{27}$ (Earth)
10 Satellites	36	10^1	10^7 to 10^8	$\sim 0.7-5.5$	0	10^{21}
9 Planetal spheres (groups of rocks, etc.)	(36–)42	10^1	10^6	(0.7) 2.5 – 8.0 (<)	0	$10^{10}-10^{20}$
8 Rocks and fluid units (e.g. rivers, flows, magma masses)	–48	10^{18}	10^4	$(\sim 1) 2.7-8.0$	0	$3 \cdot 10^5$
7 Phases, fluid or solid (e.g micromin-erals, subflows, macromolecules)	–54	10^{19}	10^{-1} to 10^{-3}	$\sim (1.2)-20$	0	$1-10 \cdot 10^3$
6 Molecules	60	10^2	$\sim 10^{-7}$	~ 1	10^{-21}	$1-10 \cdot 10^{-22}$
5 Atoms	66	10^1	10^{-8}	~ 1	$(10^{-8})^3$	$1-100 \cdot (1.67 \cdot 10^{-24})$
4 Nucleons	72	$12^3 \cdot 8^3$	10^{-13}	$1.67 \cdot 10^{15}$	0	$1.67 \cdot 10^{-24}$
3 Electrons	78	8^3	$\leq 10^{-13}$ (rest mass)		0	$0.91 \cdot 10^{-27}$
2 Neutrino	84	8	$2 \cdot 10^{-13}$ (rest mass)		0	
1 Space quantum	90		$\sim 10^{-13}$		0	

* Solar diameter = $1.39 \cdot 10^6$ km, Solar volume $\sim 10^{33}$ cm³. Comets, meteorites (unifying the levels 8 and 9), etc. are omitted.

The 10^{-13} cm diameter represents the vacuum space quantum. The rotating space quanta forming the "elementary" particles are diminished by about 5 order of magnitude in consequence of the nuclear force produced by their symmetric rotations. In this volume, however, this problem is not dealt with.

ical unit appears in 2 *wide*, the macrosystems including celestial bodies in 5 *tight*, cosmic systems at least in 4 *wide* levels. (See the Table.)

These four hierarchic levels are correlated with the 4 universal motion types: strip *D* characterizes the motion types of the 6 levels of the microparticles, the mainly diffusive motions of the 2 open chemical levels atoms and molecules in one another are joined to strip *C*, the 5 closed levels of the macrosystems move according to the strip *B*, and the oscillations of strip *A* occur mainly in the free places between the elements of the at least 4 levels of the cosmic systems.

Considering the hieararchic levels of the main universal systems a space parameter difference of about 5 to 6 order of magnitude is observable, in which also the man (and other living systems) can be fitted: nucleon 10^{-13} cm, atom 10^{-8} cm, macromolecule-micromineral 10^{-3} cm, man 10^{2} cm, satellites 10^{7} cm, stars 10^{12} cm, galaxies $10^{22}-10^{23}$ cm, Universe 10^{28} cm. (Similar results by GY. PAÁL)

The bilogarithmic *space-time picture* is a unique method for description of the Universe's different phenomena, for reveal their essential, but often hidden pecularities and relations. It allows to quantitatively compare and synthetite the different phenomena of our biological, social and cosmic environment, since it is based on the two parameters space and time of motion. i.e. on the essence of things. Thus the space-time picture is an instrument of *multidisciplinary and interdisciplinary researches.*

The hierarchy of the different known systems represents the current scientific view of the knowledges. Different sciences are represented by the different parts of the hierarchies. Starting from the cycle conception even a *quantified system of the sciences* may be given by the consistent pattern of the hierarchies in the function of space and time. This description differs from the normal cycle velocity diagram only by the historical human-centric interpretation of the time by the reversion of the physical time parameter.

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СИСТЕМА СВЯЗИ УНИВЕРСАЛЬНОЙ ЦИКЛИЧНОСТИ

Э. САДЕЦКИ-КАРДОШШ

Резюме

1. Явления Вселенной в своем большинстве — ритмично или циклично — повторяются. Ритмичные и цикличные явления движений могут быть едино количественно определены значениями скоростей. На основании этих значений скоростей могут быть выделены *4. формы движения*, которые на логарифмических диаграммах пространства— времени проявляются в форме линейных *полос*. В этих полосах сгущены основные процессы и явления Вселенной (рис. 1).

2. Выделение этих четырех форм движения обосновывается *дисперсностью* среды движения. Полоса *A* объединяет электромегнитные колебания, происходящие в бездисперсной среде; полоса *B* — колебания, вращения и орбитальные движения так называемых механических материй, проходящие в простой дисперсной среде; полоса *C* — приповерхностные геологические, химические и биологические основные процессы, обусловленные рис, (комплексных) дисперсных систем, содержащих частицы различной подвижности; полоса *D* — ядерные процессы элементарных частиц, проходящие в недисперсной среде.

Различия скоростей, сохраняющиеся внутри небольшого количества порядка величин, явлений внутри некоторых полос также могут указывать на дисперсные отличия, но они обусловлены состоянием и не касаются типа дисперсий.

3. Характеризуемые скоростями 4 формы движений в количественной форме выражают диалектическое основное положение *движения в условиях противоречия*. Дело в том, что движения в условиях противоречия точно также во времени подразделяются на

ритмы и циклы. Непрерывное повторение ритмов и циклов создает и пророждает заново множество переменных явлений Вселенной.

4. Точно также определенные размеры пространства — времени характеризуют качественные *скачки*, завершающие преобразования циклов друг в друга: химические и ядерные реакции, затем биологические и социальные скачки, представляющие серии реакций биологических процессов. Химические и ядерные реакции образуют узкие *мосты* между 4 полосами циклично-ритмичных движений, почти параллельные оси времени; биологические и социальные процессы — более широкие мосты, ограниченные линиями более-менее параллельными оси пространства (рис. 1).

5. Трудность широкой увязки друг с другом энаний, выражающуюся в применении в различных науках различных систем координат и разных «точек зрения», данный цикличный подход исключает тем, что определяет выведенные из квантовой энергии *количества пространства и времени*, отправляясь от которых, как от общего начала координат, применяет единую систему логарифмических вычислений, распространяющуюся до размеров пространства и времени Хоббла. Квант времени — порядка 10^{25} сек, квант пространства — порядка 10^{-25}см. Частное от деления кванта пространства на квант времени дает скорость света. Квант пространства представляет собою наименьшую самостоятельно движущуюся (колеблющуюся) часть пространства.

6. Взаимное влияние 4 форм движений является максимальным при *соизмеримости* размеров циклов и ритмов. Явление резонанса времени, известное по частотам, таким образом распространимо также и на резонансы пространства, происходящие из совпадения по длинам волн.

Одним из проявлений данного положения является термический эффект. Атомной размерности порядка 1 Å (полоса *B*) соответствует частота, выраженная в 10^{14} гц. Таким образом электромагнитные колебания такой частоты (полоса *A*) приводят в колебание атомы (термическая вибрация), благодаря чему часть данного отрезка электромагнитной энергии, возрастающая с температурой тепла, необратимо расходуется в форме тепла. Отсюда вытекает 2-е основное положение термодинамики, согласно которому одна часть количества тепла представляет собою связанную энергию, которую нельзя обратить в работу.

Положение соразмерности сказываются и в ряде других явлений. Компоненты солнечного света с длиной волн в 6600 и 6400 Å соответствуют по размерам хлоропластовым гранумам растений, содержащих хлорофили, и таким образом оптимизируют механизм фотосинтеза. Материи, испускающие лучи с длиной волн, соответствующей размерностям времени и пространства митотических органеллов деления клеток, мешают делению клеток, и тем самым, вызывают раковые заболевания. (Начаты исследования относительно лекарственного применения этих соразмерностей. Дальнейшие примеры в тексте.)

7. Цикличные процессы особенно заметны главным образом при газовом и жидком состояниях материи, но присутствуют и в тревдых телах (тепловые колебания, молекулярные колебания и молекулярная ротация). Цикличные и ритмичные процессы, таким образом, являются *универсальной формой движения*, хотя вследствие многочисленных иерархических наложений — особенно в случае размеров, превышающих человека — часто скрыты. В диаграмме пространства — времени, заключающей в себе 43 порядка величин пространства и 43 порядка величин времени, распространяющихся от квантов пространства и времени и до системы вычислений Хаббла, любой предмет и явление могут быть принципиально изображены проекциями точек размеров пространства и средней долговечности. Таким образом исследование количественных связей явлений освещается с новых точек зрения.

8. Цикличный подход, привязываясь к установившейся системе (полоса *C*) вода-глина-жизнь, сформировавшейся вблизи поверхности Земли, распространяется также и на биологические и социальные системы. Принадлежность знании и общественных процессов к универсальной системе скоростей процессов движений дает перспективу для количественного выражения связей между естественными и общественными науками (см. статью в этом сборнике «Параметры циклов и теория систем»).

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SPACE AND MATTER IN THE CYCLE VIEW (PRELIMINARY REPORT)

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Contents

According to the cycle relation the smallest unit of space capable to independent motion is the three-dimensional vacuum space quantum of 10^{-13} cm order of magnitude. Its oscillation expands with light velocity. On the basis of the elasticity of space (SAKHAROV, ZELDOVICH, NOVIKOV, WHEELER) elasticity and compressibility are postulated also for space quanta. These postulates lead to the assumption of the mechanisms discussed below.

Three main types of motion of space quanta are possible: oscillation, rotation and revolution. Simple transversal (complex) oscillations are done by the space quanta propagating with the velocity of light and filling the "vacuum" space between the particles. These are the electromagnetic oscillations, belonging to the strip A. (fig. 1. p. 7.)

In the case of high concentration of energy the space quanta rotate with light velocity. The mainly 1/2 spin particles of the mechanical matter are built up by rotating space quanta. As a result of the parallel direction of their coupling points the space quanta rotating in opposite direction (i.e. symmetric) by light velocity are coupled with considerable forces representing permanent nuclear forces. Thus the rotating space quanta combined into groups form "elementary" particles. (See Fig. 3, p. 18. in this volume.). Matter consist of rotating —, space of oscillating space quanta.

The smallest isometric particle consists of eight space quanta in which four co-rotating space quantum pairs are coupled by symmetric rotation. They form two kinds of the neutrino.

The greater particles are the harmonic multiples of the smallest structures the basic formula of which is $N = m8^n$ according to the theory of space quantum, where $m = 1, \dots 6$; $n = 1, \dots 7$. The electron is a structure consisting of $N = 8^3 =$ $= 512$ space quanta, i.e. of 64 directly coupled columns of 8 units, while the proton is a structure of $N = (12^3)(8^3) = 884736$ space quanta (Figs 2—6, p. 40—49).

From the rules of the rotation of the space quanta and of the electronoids the masses, electric charge, and other pecularities of the particles can be directly deduced.

The joint velocity of the particles is determined by the resonance-like interaction of the space quanta. Due to the elasticity of space quanta the smallest space quantum group consisting of eight space quanta propagates pratically without inter-

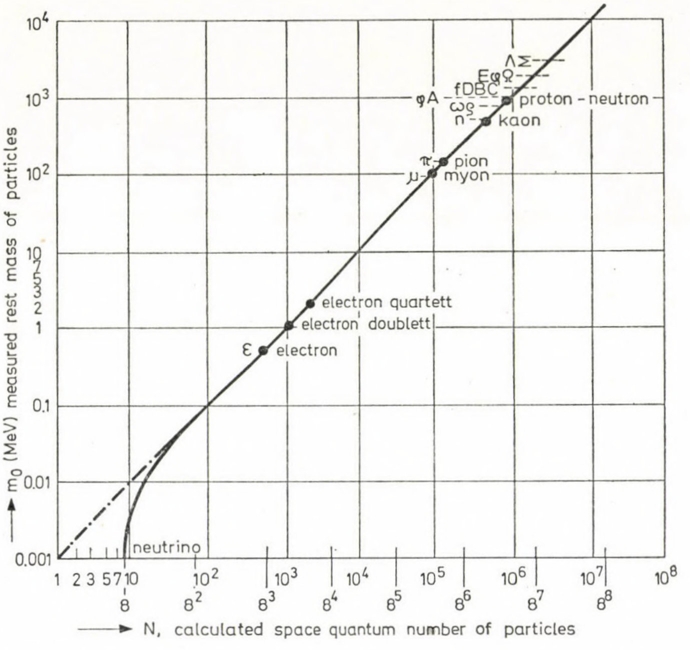

Fig. 1 Rest masses and the number of rotating space quanta

action, i.e. with light velocity. Parallel to the increase of particles the interaction between the oscillating space quanta and the rotating space quanta grows stronger, and the rest masses of particles increases linearly with the number of space quanta: $M_{\mathrm{MeV}} \sim \sim 10^{-3} (m8^n)$ (Fig. 1). At about 8 space quantum width it reaches the threshold value from which on the increase is linear between interaction and number of the rotating quanta. According to the difference of space quantum and atomic measures, the speed of the particles is uniformly lower by about 5 orders of magnitude than the light velocity.

The parallel rotating space quanta repel each other. From this fact the PAULI-principle can be directly deduced.

The atomic nucleus forces the intraatomic space quanta of the surrounding vacuum to join revolution. The potentials between the space quanta around the equatorial plane and the poles of the nucleus produces electric field and in relative motion magnetic field, respectively. This problem shall be treated in a special paper.

The dualism of matter and anti-matter is due to the two possible opposite directions of the rotation of the complex particles.

This model interprets all the main motions — spin, parity, charge, mass — of the nuclear physics. It creates a contradiction-free basis for the ABRAHAM's electron theory and joins the considerations of the FERMI—YANG model to the theory of quarks.

The reality content of the new model might be checked by direct measurement of the morphological and other dimensions deduced from it.

I. Motion Types of Space Quanta

By means of analysis of the space quantum motion a uniform model can be established on the relationship of space and matter. This model represents a graphic picture of the abstract mathematical formalism of the knowledges discovered by nuclear physics, resp. quantum mechanics and quantum space theory. It advances from the smallest independent space quantum units obtained from the cyclicity relation to the structurally more complicated ones, in contrast to the model of experimental nuclear physics, which moves from the measurable world down to smaller units.

Some basic principles of the interpretation of the space matter relationship deduced from the cyclicity relation is based essentially on the postulate of space quanta, i.e. of the smallest independently oscillating space particles, in connection with the PLANCK's quantum notion. According to the previous studies (SZÁDECZKY-KARDOSS, 1974, 1978), the space quantum is the smallest three-dimensional part of the "empty vacuum" characterized by the volume of about $(10^{-13})^3$ cm^3, i.e. by the diameter of about 10^{-13} cm. It corresponds to the $E_0 \sim 10^{10}$ eV quantum energy, which is presumably the maximum one particle energy value[1]).

In harmony with the cycle view all phenomena of the Universe are of motion type. Thus matter and space themselves are also motion phenomena. The space theory of Maxwell interprets the electromagnetic oscillation as the relatively displacement of parts of space related to each other. These relatively "isolated" parts of space correspond to the smallest independently moving space quanta of the cycle view. According to the cyclicity model, the space parts taking part in the electromagnetic oscillations can be identified with the space quanta corresponding to the energy quanta.

The space quanta may move, oscillate, revolve or rotate independently or united in groups, but are possibly in relatively inactive state, "outside" of the Hubble Universe. "Within" this active Universe the natural state of space quanta is the oscillating or rotational motion of light velocity.

1. The space quanta of the empty space, i.e. of the vacuum when they oscillate related to each other transmit the oscillations to their neighbours with the velocity of the light. The carrier of the electromagnetic oscillation, i.e. the photon is represented by the oscillation of the space quanta. According to our model, the photon is not a particle propagating with great velocity, but rather a series of oscillating space quanta. During the electromagnetic oscillations, the space quanta are not translated just like the particles undulating water. Certain translation of the space quanta of vacuum, more precisely their revolution appears only around the rotating space quanta.

The physical concept started once from the consideration that "something" = matter, and "nothing" = vacuum. According to the cycle view, however, only

[1] The diameter 10^{-13} cm of the oscillating vacuum space quanta diminishes when it transforms to the rotating ones in the elementary particles by the attactive nuclear force exerced by the symmetric rotation coupling. In this volume, however, it will be not dealt with this phenomenon.

the motion exists, thus the antagonism of vacuum and matter appears as two basic forms of motion, i.e. as oscillation and rotation. Vacuum is not the absolute "nothing", but rather the totality of space quanta oscillating with different intensity. Matter is the in site rotation of the space quantum groups characterized thus by the quasi-impermeable "site". As a result of the limited elasticity of space quanta the "in situ" rotation with light velocity represents the concentration of great energy quantities which cannot be more transmitted by means of oscillation.

The oscillation of space quanta is possible only in case of their elasticity and compressibility. The elasticity of space in relation with the curved space was assumed by Sakharov (1967) and was taken into account also by Zeldovich and Novikov (1977). (From this point of view gravity is the metric elasticity of the space; Wheeler, 1978).

Due to the continuity of space the basic form of space quanta is not the rigid sphere (in that case the space would not be continuous, in case of even the densest spherical packing it would contain 26% of space-free cavities) but the elastically deformable unit determined by hexahedron-like forms or compacting to rotation forms. It is a compressible unit of a slightly changing "density".

Because of the elastic deformability of space quanta and the relation of indeterminacy, the considerations, preliminary outlined here are of semi-quantitative nature.

2. The groups of space quanta rotating with light velocity are the components of the *mechanical* matter. The space quantum group rotating with great velocity, e.g. the nucleon of 10^{-13} cm^3 and consisting of about ($8^3.12^3$) space quanta, picks up gyroscope-like "relative inertia".

The relative inertia according to the rotation axis does not produce real (translation) inertia even if several space quanta of different directions of the rotations are coupled. (Mass is a scalar property while spin and impulse momentum are vectorial quantities.)

Thus, the mass-character is defined not by the impulse itself. In first approximation the real inertia against the translation is produced by the resonance-like interaction of the rotating space quantum groups and of the surrounding vacuum space quanta. The interaction depends on the eigen-frequency, i.e. mostlyo n the degree of freedom of the particle and at the same time on the number of space quanta.

Unlike the e.g. neutrino-like space quantum groups propagating with light velocity the elastic vacuum space quanta do not exert measurable interaction. Parallel with the growth of the particles, however, the interaction is ever increasing as a function of space quantum elasticity. At about the electron dimension the resistance of these vacuum space quanta reach the threshold value against the translation of the particles at which the constant mass-like inertia occurs. From that point the (translational) inertia is proportional to the number (N) of space quanta of the particle (Fig. 1)[3]. Thus between the space quanta of the vacuum and of the particles there is a resonance-like interaction depending on the number of the rotating space quanta. The linear proportionality of mass and number of space quanta does not exist for the smallest particles, since the resonance between their rotating space quanta and the oscillating vacuum space quanta is incomplete. If the resonance of the neutrino would be complete its mass would be the $8^3 : 8 = 64$ part of the mass of electron, i.e. 512 000 eV : 64 = 8000 eV. But the N = 8 neutrino contains only two space quanta in all direction instead of 8. So this value is diminished three times by 4. The mass of the neutrino would be thus roughly about 8000 : 4 : 4 : 4 = 12.5 eV.

Consequently, some force is required to displace the greater space quantum groups. Thus, in presence of other masses the complex rotating space quantum group possesses a weight which depends on the number of space quanta. Systems of lower velocity can hardly penetrate the space quantum groups rotating with light velocity, these are impermeable for other "bodies". Since the inertia, the weight and certain impermeability are the main characteristics of the matter (of the "mechanical matter"). The complexes of space quantum groups rotating with light velocity correspond to the notion of particles.

While the oscillation propagating with light velocity denotes the independent motion of each space quantum transferred to each other, the fermion-like particle is the rotation of the group consisting of $(8^3) \leq$ space quanta. Because of the interaction of the rotating and oscillating space quanta no individual space quantum remains in the state of constant rotation, the rotation is transformed into oscillating motion again due to the neighbouring oscillations.

The smallest space quantum group required for the continuous rotation of space quanta consists of eight space quanta. However, because of its propagation with light velocity it possesses no measurable interaction with the neighbouring space quanta just due to the short-time coupling, and no magnetic field (see below); this smallest rotating space quantum group is the neutrino.

The energy-centre-like space quanta rotating with light velocity possess two basic features. First, the space quanta of the directly coupled systems, i.e. of the particles of the mechanical matter, are in strong resonance-like relationship with each other. In the particles the space quanta are coupled by

[3] The approximately linear relationship between the space quantum number and the m rest mass is obtained due to the c light velocity of the rotation of space quanta. The relationship is, of course, a first approximation since it has been deduced only on the basis of elementary rotation relations, e.g. the internal interactions between the electronoid shells. The elasticity of space quanta, the translation velocity within the nucleus, further the mass defect as well as the members of the semi-empiric formula for binding energy, i.e. the volumetric, surficial, Coulomb, symmetric and pair energies were neglected here.

pairs in all three directions of the space with extreme energy (i.e. symmetric coupling by rotation, see the next chapter), thus these closely corotating assemblages consist of $2^3 = 8$, resp. 8^3, 8^6 . . . space quanta. Further, the smaller groups of the rotating space quanta, e.g. the electrons are characterized by extremely rapid and considerable variation of forms corresponding to the voltage of the medium. The quasi-isometric shape in the state of rest of the rotating space quantum may be elongated by several orders of magnitude (at approximate constant volume) and in the resonant one-dimensional chains of the elongated space quanta the individual space quantum rotation is transformed to mutual spiral whirling (Fig. 3). The extreme elasticity, the unity of the extremely elongated "unbroken" space quanta, are assured by the energy concentration of space quanta of the rotation with light velocity and by the joint spiral rotation system.

With the increase of the number of eigen-frequencies the relative intensity of the individual eigen-frequencies and thus the intensity of resonance and of the mono-serial chain joining decrease. This decrease of resonance limits at the same time the dimensions of the stable particles.

3. The space quantum group reaching the limiting velocity of light is sharply separated from its environs by its peripheral speed. By means of the superposition of space quantum layers the space quantum group cannot increase when it reached the light velocity (its peripheral speed would surpass the limiting velocity). In case of the intra-atomic translation-free rotation the space quantum group, i.e. the atomic nucleus of inert mass affects its neighbourhood so that the belts of the neighbouring atomic space quanta jointly revolve with a speed decreasing inwards, and to the poles of the group.

The revolving system is able to displace the particles, to exert a "force" effect. This jointly revolving space quantum system generates the electric field. In this field the centrifugal force of the revolving space quanta generates symmetric potentials, i.e. magnetic forces in the system, as compared to the rotation axis. (Around the neutrino of only two space quanta in diameter no difference between the equatorial and polar environs appears. This is also hampered by the propagation of the neutrino by light velocity. Consequently, the magnetic momentum of the neutrino equals zero.)

The additive oscillation energy penetrating the atomic system repels the electron to higher quantified orbits and in this way it is absorbed. On the contrary, in the atomic system the jump of electrons to deeper orbits generates new electromagnetic oscillations in the surrounding vacuum.

From the interpretation of particles as groups of rotating space quanta follows the chemical bonding forces and the electrostatic attractive forces.

The atom does not contain oscillating vacuum space quanta. Thus the oscillating vacuum exert resistance linearly proportional to the diameter of the atom. The velocity of the mechanical matter being less by about 5 to 6 orders of magnitude than the light velocity, i.e. the velocity difference between the strips A and B of the cycle diagram, can be traced back to this decelerating resistance. Thus, in case of the individually oscillating space quanta of the vacuum the propagation velocity of the nucleons consisting of about 10^6 times more rotating space quanta is less by 10^5—10^6 than the light velocity (strip A). In fact, the velocity of the mechanical matter consisting by mass mostly of nucleons (strip B) is only 10^5—10^6th of the A-strip velocity. (See p. 43, footnote.)

On the basis of the rotating space quantum number and particle mass resp. of the relationship between them (Fig. 1) and by means of the coupling rules the number of space quanta can be calculated from the mass of the particles known by nuclear-physics (See also Table I, p. 46.)

II. Coupling Rules of Space Quanta. The Main Structural Types of the Particles

The coupling of the directly contacting rotating space quanta can be summarized by the following 6 theoretical assumptions:

1. *The symmetric coupling.* Within the rotating space quantum groups constituting the particles of the mechanical matter the directly contacting space quanta of symmetric rotation are coupled by great forces corresponding to their great velocities. This coupling is considered to be the main source of the permanent nuclear forces. In case of symmetric (i.e. opposite) rotation the direction of motion in the contacting surfaces of the two space quanta is parallel, strengthening each other. (Fig. 3. p. 18. in the foregoing paper of this volume.) At the contacting sides, i.e. in the equatorial planes the edges of space quanta become straightened. Two space quantum groups coupled in this manner are elongated. Thus, the deuteron-nucleus becomes cigar-shaped.

When the number of space quanta, i.e. of the radius of the particle increases, the centrifugal forces is increased, too, by the square of the radius. Thus within the particle the space quanta are elongated perpendicularly to the rotation axis. Due to the joint effect of the coupling and of the centrifugal force the space quanta coupled in three directions of space are distorted to flattened hexahedra, while their assemblage takes the shape of a rotation ellipsoid.

One side of the coupled space quantum pair exerts attractive, the other of repelling effect. In the greater particles the space quanta outwards, resp. the space quantum groups are coupled to the attractive side with a rotation axis partly parallel, partly perpendicular to the direction of rotation (e.g. the nucleus of helium, (Fig. 8, p. 53).

If, however, the rotation of space quanta is parallel, the directions of motions would be opposite in the neighbouring sides of two space quanta, i.e. repelling force would be generated. Consequently, space quanta of parallel direction of rotation cannot approach each other. The mutual repelling of the parallel rotating electrons excluding each other is defined by the Pauli-principle.

2. *Columnar coupling and coupling value.* Two or more space quanta can be coupled also parallel with the rotation axis elongating each other in the direction of rotation. Due to the rotation the hexahedron-shaped equatorially flattened space quanta of the space quantum groups are coupled by their widened surfaces and jointly rotating. In this way space quantum columns of 2—8 members can be generated.

The coupling of co-rotating columns is less strong than the simple symmetric (equatorial) coupling, since the centre of coupling lies at the rotation pole of least rotation velocity. Thus the increase of the columns is limited by the resonance number $8 = N_a$.

When coupled by the symmetric rotation, two two-membered columns generate the smallest viable particle, i.e. the neutrino consisting of 8 space quanta ($N = 8$ = space quantum number. The equilibrated basic number 8 determines also the structures of the quasi-isometric greater particles: when adding a new space quantum layer the circumference of the marginal boundary layer is increased by 8 space quanta, i.e. by the N_a-value. The increase of circumference is: $\Delta = N_a = 8$). In general, the decisive coupling value of the particles is $N_a = 8$ (the rule of upper harmonics, see below)[4].

Complete resonance structure is represented by the columnar assemblage consisting of $N = 8^3 = 512$ space quanta, i.e. of 64 octette space quantum column (See Fig. 2). In this case the D length of edge equals the spatial-

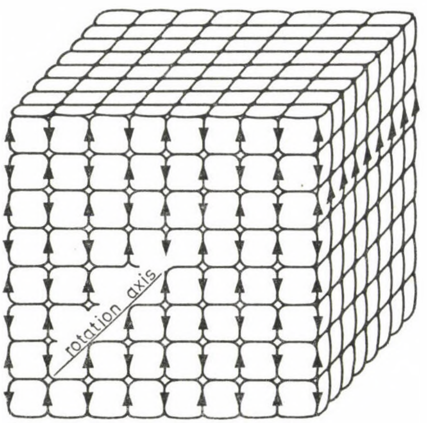

Fig. 2. Model of the electronoid

[4] During the superposition of space quanta the space quantum number of the boundary layer of the isometric particles is increased as follows: $4 \rightarrow 12 \rightarrow 20 \rightarrow 28 \rightarrow 36 \ldots$, their difference is thus a constant value, i.e. $\Delta = 8$.

structural Nr coupling number, including also the H height of the co-rotating columns. According to the mass measured in MeV this structure is the *electron* (Fig. 4/a). The equality

$$N = \Delta = D = H = 8$$

is valid in the rest state of the electron.

According to this model the rest state diameter of the electron would be $\sim 8 \cdot 10^{-13}$ cm. This is however a fictitious value, since it concerns the non-moving electron which does not exist (the computation of the real dimensions of the electrons will be dealt with in a next paper). The value of $N_e = 512$ can be corroborated indirectly from nuclear physical measurement data. It is known that the mass of the electron is 1/1836 part of the proton mass and the space dimension of 10^{-13} cm of the proton is also known (this value will be determined more precisely below). Thus the electron contains 1836-times less space quanta, i.e. $N \sim 10^6/1836 \sim 545$ space quanta which in this first approximation corresponds to the $N_e = 512$ model deduced from thet heoretically most stable structure.

3. *The rule of the resonances and the matter-wave dualism.* The number of space quanta of the particles is more precisely determined by the "rule of the resonances". Accordingly, in the stable forms of the co-rotating space quanta, the number of space quanta is $N = m\,8^n$, where $n = 1, 2, 3, 4, \ldots 7$ and $m = 1$—8.

Particles are resistant to the mechanical and other effects[5] when the number of their space quanta is proportional by simple integer numbers in all the three directions (i.e. logarithmically and similarly to the relationship between the tonic and harmonic).

This rule is correlated to the resonance and to the energies of the harmonic oscillator.

The axis of the rotating space quanta is decreased due to the great energy of rotation with light velocity. The rotating space quantum groups of the particles interacting with the oscillating vacuum space quanta behave as systems characterized by eigen-frequencies. The maximal number of eigen-frequencies is determined by the degree of freedom depending onthe (N) number of the material pointsof the system, i.e. of the number of space quanta of the particles. (In the state free of repelling force the number of degree of freedom equals $3N$). The basic frequency of the particles is given by the inverse of the time quantum, i.e. 10^{23} Hz. The upper harmonics are the multiples of integer number

[5] Since "thermodynamic probability" is the number of micro-states of the systems by means of which a given macro-state of the system can be realized, it can be said that in nature those processes are of highest W thermodynamic probability which can be expressed by the formula: $W = (N_a)^n = 8^n$. This relationship is in connection with the S entropy and with the k BOLTZMANN-constant, according to the formula: $S = k \ln W$.

of this from which, taking into account the number of space quanta $N = 8$ of the smallest independent space quantum group, the neutrino, the basic formula $m\,8^n$ is deduced.

From the $N = 8$ neutrino two — with their antiparticles four — kinds of neutrino may be deduced: the columnar and laminar ones. Electron and positron may be built up from the columnar, myon from the laminar neutrino-structure.

Because of the elasticity of space quanta the small structures are deformed by the rapid translation movements and by the revolution of quanta of the atomic space: they become elongated or flattened. In such cases the strong symmetric coupling (binding) force of the flattened sides of space quanta increases, that of the shortened sides decreases.

In the atom, the whole electron is curved parallel with its revolution orbit[6]. The eletron is squashed to a wave-packet. In the case of translation at velocity approaching the light velocity it is distorted to one pearl-like space quantum series (Fig. 3.).

Neither the shape nor the dimension of space quanta are constant due to their elasticity and compressibility. The dimension of $\sim 10^{-13}$ cm computed from the energy quanta concerns the space quanta participating in the electromagnetic oscillations.

This correspondence relates to the fact that the electron takes the wave-character by means of complet spreading to one space quantum series. Thus, in the space quantum model the matter-wave-dualism may be interpreted mechanically: the isometric space quantum group behaves as "matter" and when spreading gradually to a pearl necklace-like space quantum series, it takes wave-features (Fig. 3).

Necklace "fibrous" series of electrons may occur in the electric current which may be transferred also between the atoms, resp. non-prohibited electron shells of the electric conductors without obstacles. The diameter of such an

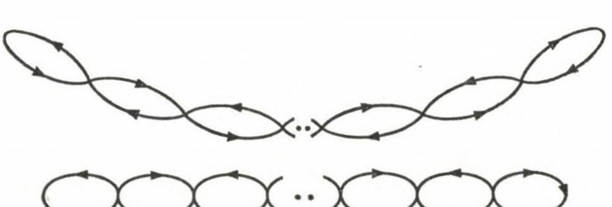

Fig. 3. The necklace structure of particles

[6] In extreme case, i.e. in nuclear reactions, the electron is disintegrated into columns, moreover, to parts of columns (see later in case of neutron), but if the external effect is stopped the space quanta return to their normal equilibrium structure.

electron fibre could not be measured so far since the more the accelerating voltage and the "resolution capacity" are increased, the more thinner will be the double spiral of the electron.[7] Thus neither the most up-to-date accelerations of 100—1000 GeV have shown measure of the electron.

4. *Structure and shape of particles. Pairing and reflection. Quarks.* Particles are built up by the (quasi)-stable structures which can be deduced from the formula: ($m\ 8^n$). The basic condition of stability is the symmetric rotation of a resonating number of space quanta.

The formula of ($m\ 8^n$) type expresses not only the number of space quanta but also the morphology, i.e. the isometric, lamellar or columnar shape of the structure. The (8^3) structure remains isometric as a component of greater particles, this will be called below *electronoid.* The structures of $m = 2, 3, \ldots 8$ are gradually elongating individually instable configurations which appear as electron doublett-triplett . . . octett of the atomic-electron shells under the influence of the atomic nucleus. Thus, their formula-like description is a follows: $([1 + 1])8^3$, $[(1 + 1 + 1)]8^3$, etc. (Table, p. 46.)

The structure of $(8 \cdot 8^3) = (8^4)$ denotes a long, thin thus instable column consisting of 8 electronoid adhered by columnar coupling. In case of ($m\ 8^4$) the column becomes thicker. The structure $(8 \cdot 8^4) = (8^5)$ denotes a plate consisting of one plate, that of ($m\ 8^5$) a plate thickening by m. The structure $(8 \cdot 8^5) = (8^6)$ describes an isometric shape again, the ($m\ 8^6$) an elongating column, while the $(8 \cdot 8^6) = 8^7$ denotes a one-layer plate, the structure ($m\ 8^7$) a thickening plate. (Fig. 4). The $(3 \cdot 8^5)$ sandwich structure suitable to squashing is the *myon* which produces the myon atom when squashing similarly to the electrons of the electron shell. The structure $(4 \cdot 8^5)$ is represented by the pion, the thicker lamellar structures of which are continuously exchanged around the equatorial planes of nucleons (according to Chapter II/5) producing in this way the nuclear force within the nucleus characterized by the continous exchange of protons and neutrons, according to the Yukawa-model.

A parallel four-member column pair consisting of 4096 space quanta oorresponds to the eight-member (8^4) structure (flat column or band) which

[7] The basic speed of the universal motion represented by the strips A and D is the light velocity. The five order velocity difference between the A and B strips is interpreted by the difference between the 10^{-8} cm average atomic and the 10^{-13} cm space quantum measures. The A-strip electromagnetic field ("vacuum") does not brake the propagation of electromagnetic oscillations since all movements in the homogeneous electromagnetic field are compensated by opposite oscillatory movements. But translating particles are affected only by the resistance of the frontal space quanta, the compensating effect of the quanta pushed aside is missing. Thus the B-strip systems consisting of atoms or protons are influenced by the brake force proportional to the five order difference 10^{-8}—10^{-13} cm. Protons are surrounded by a belt of revoluting space quanta determining the atomic radii, the width of which is proportional to the $(8^3 \cdot 8^{12} = 884\ 736)$ number of their rotating space quanta. Thus plasma stars are of B-strip velocity.

is expressed by the formula: $(2 \cdot 4 \cdot 8^3)$. This structure is not realized in the nuclear reactions due to the smaller degree of its resistance. The increasing resistance growing with the circular frequency generates, however, the more stable $(2 \cdot 8^6)$ structure of two types, i.e. the kaons elongated perpendicularly to the equatorial plane and the η mesons coupling within this plane. The latter type of the kaon described by the formula $[(1 + 1)]8^6$. Similarly, beside the $(4 \cdot 8^6)$ structures the structure $(2 \cdot 2 \cdot 8^6)$ of the same space quanta number

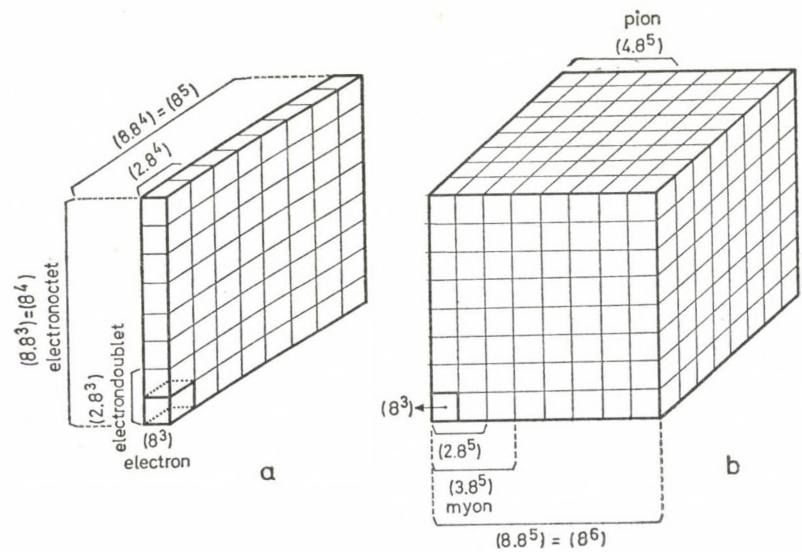

Fig. 4. The schematized structures of the electron, myon and pion

also exists. The structure $[(1 + 1 + 1 + 1)]8^6$ structure coupling each other in the equatorial plane correspond to the Λ and the Σ hyperons, as well as the φ-meson (Fig. 5).

Thus, mesons are partly columnar partly lamellar structures of $m = 2$—4 value, while hyperons are rather lamellar structures of $m = 4$—6.

The N space quantum number approximately corresponds to the thousand-fold of the MeV unit used in the nuclear-physical practice: $N \cdot 10^{-3} \sim m_0$ (MeV). (The threshold value of the photon energy is 1.02 MeV and in case of collision of positron and electron two photons of 0.56 MeV energy are generated.)

The particle structures and features deduced from the space quantum number, i.e. from the rest mass are shown in the Table I.

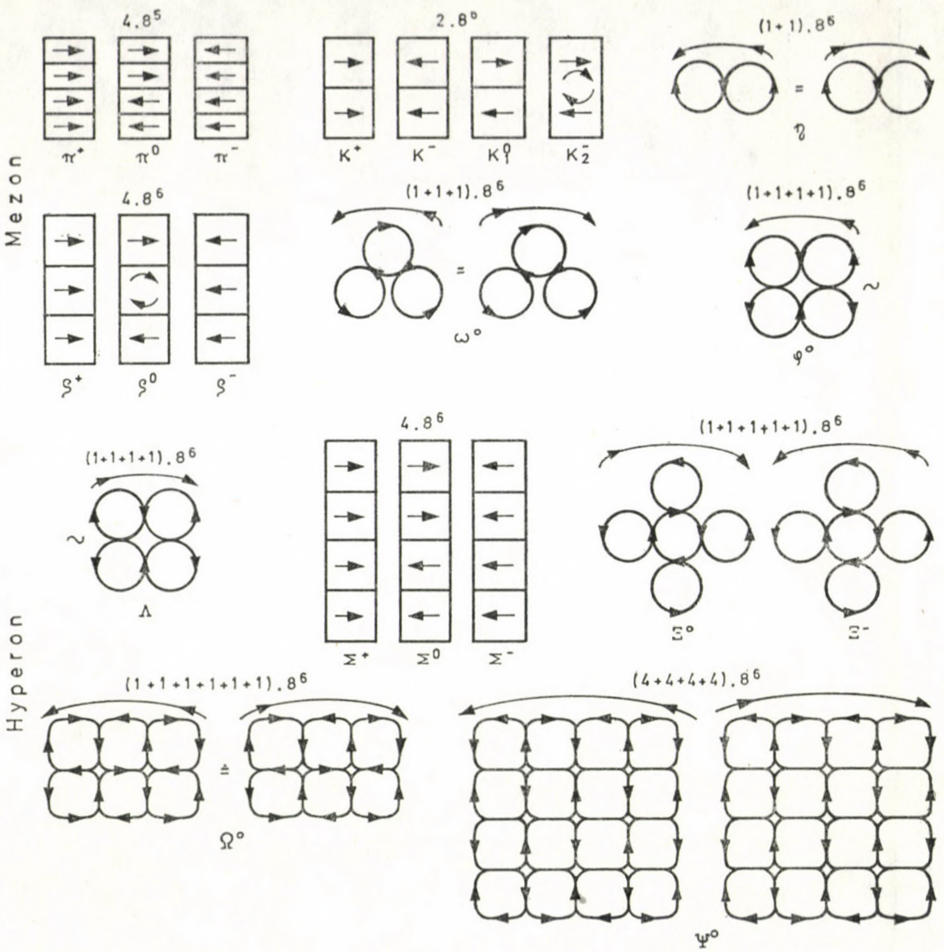

Fig. 5. The schematized structures of the mesons and hyperons

The rest mass of particles is determined by the number of space quanta. Since the rotations of particles approach the light velocity the relativistic change of mass is of about the same measure in the different particles.

It is an important result of the space quantum model that from the structures deduced from the rest mass their peculiarly changing electric charges as well as some other quantum-mechanically determined quantities can be concluded (Fig. 5).

The q electric charge is also in relation with the relativistic change of mass. The opposite ro-tation of the proton and electron reinforcing, i.e. accelerating each other means the positive and negative charges of the proton and

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Table I

Space quantum structure of particles and data of multiplett differences

Particle		Mass (M) (MeV)	Number of space quanta (N)	Structure	Difference		Lifetime (sec)
sign	name				$\Delta = M - \frac{N}{1000}$	$\Delta\% = 100\,\Delta/M$	
ν	Neutrino	~ 0	8	8			∞
	—	—	64	8^2			instable
e	electron	0.511	512	8^3	-0.001	-0.19	$\sim\infty$
	electrondublet-, triplet-, octet	1.02–4.088	1024–4096	$2 \cdot 8^3 - 8 \cdot 8^3 = 8^4$			
	4 f suborbit of the atom-structural N electron shell			$2 \cdot 8^4 - 6 \cdot 8^4$			(instable thin plates)
			32 768	8^5			(instable thin plates)
			65 536	$2 \cdot 8^5$			
μ	myon	105.6	98 304	$3 \cdot 8^5$	$+7.3$	$+6.9$	$2.2 \cdot 10^{-6}$
$\Xi - \Sigma$	difference	126	131 072	$4 \cdot 8^5$	$+8.5$	$+6.4$	$2.6 \cdot 10^{-8}$
π	pion	139.6					
	less stable thick plates			$5 \cdot 8^5 - 7 \cdot 8^5$			$0.8 - 10^{-10}$
$\Sigma - p$	difference	254	262 144	8^6	-8.0	-3.1	
$\varkappa - \pi$	difference	350.7					
$\varkappa$	meson (kaon)	495	524 288	$2 \cdot 8^6$	-29	-5.8	
η	meson	549			$+25$	$+4.6$	
ϱ	meson	765	786 432	$3 \cdot 8^6$	-21	$+2.7$	$\sim 10^{-23}$
ω	meson	783		$3 \cdot 8^6$			
p	proton	938.3	884 736	$(12^3)(8^3)$	$+53.5$	$+5.6$	$\sim\infty$
n	neutron	939.6	885 248	$(12^3)(8^3) + 8^3$	$+54$	$+5.8$	918
φ	meson	1019.5	1 048 576	$4 \cdot 8^6$	-29	-2.8	$2.5 \cdot 10^{-10}$
Λ	baryon	1115.6		$4 \cdot 8^6$	$+67$	$+6.9$	$0.8 - 10^{-10}$
Σ	baryon	1189.4–1197.4		$4 \cdot 8^6$	$+141$	$+11.9$	$1.4 \cdot 10^{-16}$
Ξ	baryon	1315–1321	1 310 720	$5 \cdot 8^6$	$+5$	-0.4	$1.6 \cdot 3 \cdot 10^{-10}$
ω	baryon	1672.2	1 572 864	$6 \cdot 8^6$	$+99.4$	$+5.9$	$1.3 \cdot 10^{-10}$
			1 835 008	$7 \cdot 8^6$			
			2 097 152	8^7			
ψ	particle ψ_1	3095	3 145 724	$1.5 \cdot 8^7$			
	ψ_2	3700	4 194 304	$2 \cdot 8^7$			
	theoretical limit	104	10 485 760	$5 \cdot 8^6$	-486	-4.86	
			16 777 216	8^8			

of the electron, respectively. The rotation of the other particles being parallel with that of the proton (i.e. the positive charge) restrains the velocity and makes the relativistic mass decrease. This is true inversely, as well: the increase of mass is "advantageous" for the negative charge.

Three relationships can be concluded for baryons on the basis of this: α) By means of increasing mass the electric charge of baryons is displaced from the positive dominancy towards the negative one (in case of nucleons + and 0, in that of Λ-particles 2+, 1+, 0, −; in that of Σ+, 0, −; in that of Ξ 0 and −; in case of the Ω-hyperon only modification. β) Within the same baryon species the mass increases (moving from the positive-charge towards modification of negative charge, through zero). γ) The increase of relativistic velocity displaces this state towards the negative electric charge.

The distribution of the electric charges can be summarized in four rules (a, b, c, d) related to the morphology of particles.

Two types of the structures exist: elongated structures of columnar coupling situated parallel with the rotation axis, and lamellar structures coupled along the equatorial plane and perpendicularly of the rotation axis. In case of columnar coupling:

a) the particles rotating in the same direction as the proton rotation are of positive electric charge, and those rotating in opposite direction, i.e. in that of the electron, are of negative charge;

b) the 8^n components consisting of the same number of opposite rotating particles are of zero electric charge

In case of equatorial coupling:

c) the opposite rotation directions of the components are compensated by any possible join rotation direction of the whole particle, i.e. zero electric charge is produced;

d) in case of the part of $m = 5$ the rotation directions of the external components are the same, thus this is either compensated to zero by the join rotation of the particle, or in sense of the γ-rule it is transformed to a particle of negative charge.

According to the rule c, the decelerated psi-particle of $2 \cdot 8^7$ structure is of 0 electric charge. The similarities in most of the quantum mechanical values of the φ-meson and Λ-hyperon correspond to their similar structures. In the ω-meson two of the three components rotate parallel, i.e. repel each other. The spin of this structure is 3/2.

The (m 8^n) resonance functions also in the powerful and space quantum multiplicating particle collisions, resp. in the nuclear reactions. The photon colliding the proton may generate two (8^3) structures of opposite rotation in this way, i.e. the positron and electron (Chapter III). The transitional generation of the psi-particles during the the powerful electron-positron and proton-proton collision, as well as that of the (8^3) structures splitting from the proton may be also related to the multiplication of the resonant space quanta. These collisions generate structures of about $(2 \cdot 8^7)$, more exactly $(4 + 4 + 4 + +4)\ 8^6$, but this structure is somewhat decelerated just due to its great mass (as compared to the light velocity), consequently this would provide a relativistically deficient mass value (about $7\ 1/2 \cdot 8^7$).

Parallel with the further increase of the number of coupling electronoids the number of eigen-frequencies also increases, its intensity and also the symmetry decrease, thus the electron deformation and due to this the repelling effect becomes predominant. Thus, the number of coupling electronoids does not exceed the value of $2 \cdot 8^4$ (i.e. concerning space quanta that of $2 \cdot 8^7$).

Great number of non-zero spin mesons and non-1/2spin baryons exist. Most of this type of particles occur between the space quantum numbers $N = 6\ (8^6) = 1\ 572\ 864$ and $N = 120^3 = 1\ 728\ 000$. The space quantum number $N = 8^7 = 2\ 097\ 752$ is exceeded only by a few particles.

The energy quantum corresponding to the space quanta (the product of the Planck-constant and of the frequency: $E_0 = h\nu = 10^{10}$ eV, or expressed by the τ_0 time quantum $E_0 = \frac{h}{\tau_0}$) seems to represent the possible greatest energy quantity which is assigned to one space-time quantum. By means of the strong symmetric rotation of space quanta this enormous energy of space quanta is balanced when accumulating in the particles. The E_0-value would be reached by a particle of 10^4 MeVmass and of about $N = 5 \cdot 8^7$ space quantum number, and in form of the rotation energy of the space quantum group assemblage. One wonders whether this is the theoretical limit to the growth of particles by means of random fetting, over which only the equilibrium proton (neutron) structures may couple each other to atomic nuclei?

In case of the mesons of smaller mass the decelerating effect of opposite rotation is more considerable, thus the mass of pion modification of 0 electric charge is also smaller than that of the positive and negative modifications (+ and − pion 139.6 MeV, pion^0 134.97 MeV). Consequently, the stability and the lifetime of the modification of 0 electric charge is shorter (+ and − pion $2.6 \cdot 10^{-8}$ s, pion^0 $0.8 \cdot 10^{-16}$ s).

In the kaon of greater mass different effect are acting (masses of + and − kaon, resp. kaon^0; 493.7, resp. 497.8 MeV; lifetimes of + and − resp. 0-kaon: $1.23 \cdot 10^{-8}$ s, resp. $0.89 \cdot 10^{-10}$ s, that of K* 10^{-23} s in order of magnitude, but a long-living modification also exists: K^0, : $5.2 \cdot 10^{-8}$ s). In case of the troublesome kaons quantum mechanics should take into account the special features of their components, i.e. of the two (8^6) structures. In the (8^6) structure 8^3 electronoids each consisting of 512 space quanta couple each other re-inforcing the rotation of nearly light velocity with complete resonance. It means in itself a state over the light velocity, which therefore cannot be realized. Consequently, the 8^6 structure does not appear individually, but some of them together generate "rare" particles in associated generations. This may prove the relativistically increased greater mass of kaons of 0 charge, among others the occurrence of the long-living modification which decomposes to three pions. In the equatorial plane of the kaon the increased velocity may generate a third phase of diagonal electronoid rotation being the resultant of the opposite direction of rotation of the two 8^6 structures which seems to smooth the decelerating fluctuation of the original two opposite rotations and preforms the three-pion decomposition.

As a result of the over-resonant state it is not unexpected that the isometric 8^6 structure of high resonance value is not known as an individual particle and instead of this so-called joint generation occurs the critical limit of which is drawn just at the mass value of the 8^6 structure. The rare particles (kaons and hyperons) are generated at this value, i.e. the structures of non-zero scarcity which are generated only together within a relatively very short time (about 10^{-23} *s*) and which are of very high threshold energy. Their generation should be sharply distinguished e.g. from the non-assemblage-like decomposition of the rare particles proceeding more slowly and by means of weak interaction. It is assumed that in case of joint particle generation the 8^6 structures representing the equilibrium are consumed to generate the more complex particles, moreover in this process certain particles, i.e. the kaons only approach the *m* (8^5) structure in lack of sufficient number of rotating space quanta.

By means of loose, low coordination number or random fitting and of generating space quantum parts of different density the greater number of electronoids (8^3 structures) deform the space quanta and the resulting potentials cut down the stability of particles. In case of the densest fitting and abso-

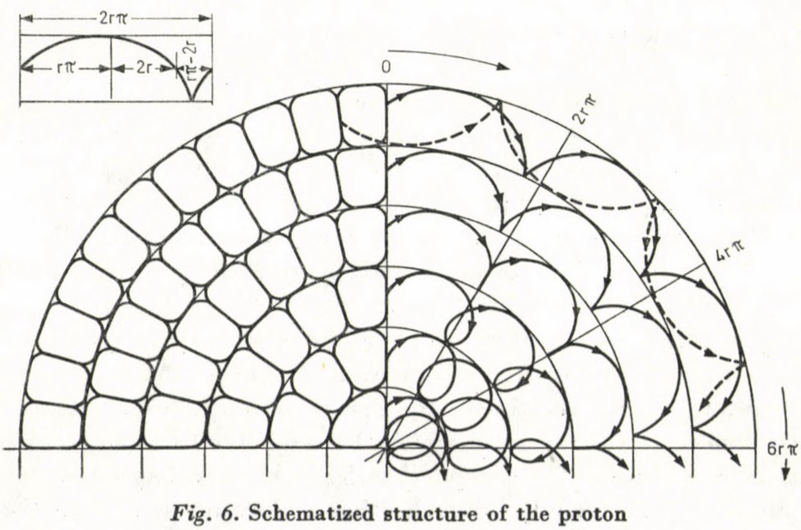

Fig. 6. Schematized structure of the proton

lutely uniform density distribution the potential is restricted to minimum. Uniform solid spheres produce the densest space fitting in case of the densest most uniform coordination number of 12 (12 direct contact for each sphere). Among the space quantum groups of particles the possible greatest stability, and at the same time, the longest lifetime is produced by structure consisting of electronoids showing uniformly a coordination number of 12 in three directions of the space, i.e. $12^3 = 1728$, that is consisting of $N = (12^3)\ (8^3) = 884\ 736$ space quanta. This corresponds fairly well ($10^{-3}\ N \sim 938.3$ MeV) to the known most stable particle, i.e. to the *proton* (Fig. 6).

In the about two thousand times greater proton the rotation axes of electronoids are slightly diverging around the common rotation axis generating in this way the resistance against the displacement of rotation axis.

The $12^3 = 1728$ electronoids of the proton are arranged in 6 layers. In the equatorial plane, 4, 12, 20, 28, 36, 44, i.e. 1.4, 3.4, 5.4, 7.4, 9.4, 11.4 (altogether 144) electronoids occur.

The determination of complex rotation of the structure and of its elementary parts may contribute to the knowledge of the particles. Here, this will be carried out for the proton.

According to the indeterminacy principle, the visualization of structures below 10^{-13} cm seems to be inadmissible. However, indeterminacy concerns only the canonic conjugated values. The rotation axis Z perpendicular to the drawing plain is not conjugated to the place and impulse axis X and Y. Thus the figure does not represent neither places and impulses, nor times and energies, but the means of the relative rotation of the electronoids. At least a rough delineations of the protonic dynamism yield already a model — approach of the proton.

According to its triple hierarchy level, the proton is characterized by three rotations and two counter-rotations: two kinds of rotation of the space quanta $\pm v_r$, those of electronoids $\pm v_e$, as well as the rotation of v_p velocity of the whole proton; their limiting value is the light velocity in all cases.

Here, only the complex rotation of electronoids within the proton will be dealt with. No general regularities can be mentioned in relation with the rotation of space quanta within the electron due to the large-scale deformability of the individual electrons. In the solid proton, however, fixed in a complex manner, the rotations of electronoids and spherical shells consisting of electronoids can be unambiguously established (Fig. 6).

The angular velocities of electronoids and of their space quanta within the proton are inversely proportional to the radii. While proton rotates one times, the electronoid rotates six times, the space quantum $6 \times 4 = 24$-times. The peripheral speed of the layers in which the component is found are added to the angular velocities of the components. The peripheral speed of the electronoid spherical shells underlying each other and co-rotating with the proton decrease directly proportionally with the radii of the shells. As compared to the unit velocity of the proton the peripheral speed of the six shells are (Fig. 7) $V_1 = 0.17$, $V_2 = 0.33$, $V_3 = 0.50$, $V_4 = 0.67$, $V_5 = 0.83$ and $V_6 = 1.0$. In the centres of the shells, resp. of the electronoids the velocities are $v_1 = 0.08$, $v_2 = 0.25$, $v_3 = 0.41$, $v_4 = 0.58$, $v_5 = 0.75$ and $v_6 = 0.91$. The velocity increases, resp. decreases in the normal, resp. opposite rotating phases of the electronoid-edges (Fig. 6). In each shell the v_i average velocities, resp. the proportional pathways of the electronoids are given by the

$$d_i = (\pi r_i + 2 r_i) + (\pi r_i - 2 r_i)$$

relationship, where $r_i = v_i/\pi$. In this way, each given point of the electronoid-edges describes an asymmetric wave-curve in the three external shells, resp. asymmetric spiral in the internal three shells being parallel with the shells within the proton. Within one shell the wave, resp. spiral curves of the electronoids rotating in different way are the half-displaced images of each other.

The total propagation of one circumferential point of the electronoid in the shell is, too:

$$D_i = (\pi r_i + 2 r_i) + (\pi r_i - 2 r_i) = 2 r_i \pi .$$

Consequently, the three external shells differ from the three internal ones: on the one hand, in the shape of path of the electronoid-edges (wave-curve, resp. spiral-like), and in the propagation velocity of electronoid circumferences, on the other. In the three external shells the electronoid circumferences propagate continuously forward together with the shell, in the three internal ones, however, these possess backward propagating sections, too.

The rotation of the three external and three internal electronoid shell produces opposite electric charge. According to the cycle view, the electric charge is the attracting, resp. repelling interaction of the parallel, resp. opposite rotation of the proton and electron. Such interaction occurs also within the proton consisting of electronoids. In the three external shells positive charge is produced by the parallel propagation direction of the proton and of the electronoids while the partly opposite propagation direction of the electronoids in the three internal shells generates negative charge. The interlying level separating these is a secondary surface of zero charge which is similar to the most external primarily zero-charged electronoid shell representing the proton surface. The magnitudes of charges are determined by the afore-mentioned $V_1 \ldots V_6$ circumferential velocities of each shell (Fig. 7). Thus, the following charge values are obtained: the level of 0.17 velocity represents $-1/3$ charge as compared to the secondary zero-surface; the level of 0.33 represents $-1/3$ charge as compared to the primary one; the level of 0.67 is $+2/3$ as compared to the primary one; while the level of 0.83 represents $+5/6$ charge as compared to the primary one, resp. within the two zero-surfaces $+2/3$ charge. Obviously the three lower levels compensate each other $(+2/3 + (-1/3) + (-1/3) = 0)$. The level of 5/6 charge represents a separate unit.

The system of the internal shells of one $+2/3$ and two $-1/3$ charge may correspond to the basic quark deduced by Gell Mann and also characterized by SU(3) symmetry, while the external shell of $+5/6$ charge may be correlated to the so-called charming-quark of SU(2) symmetry. It is possible thus that

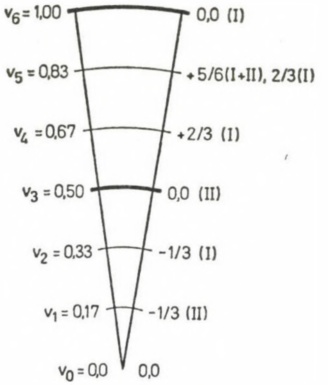

Fig. 7. Velocities and charges of the electronoid shells of proton

the electronoid shells are in direct connection with or represent the different types of quarks.

The sine-line of the electron rotation at the proton's margin produces $12 \times 44 = 528$ fluctuations per 10^{-23} s. According to Chapter IV. this is considered as the source of gravitation.

According to the quark model, the mesons are built up by one quark and one anti-quark which in harmony with our model can be related to the one-dimensional structure of the mesons. (When interpreting the relativistically growing mass of quarks being greater than that of the proton it is to be taken into account that in our model the relativistic increase of mass occurs in the space quantum of light velocity)

5. *Joint direction of rotation. Proton-neutron iso-doublet. Matter and anti-matter*. On the basis of the coupling rules not only the simple particles but also the structure of the *atomic nuclei* can be deduced (Fig. 8). The structures obtained in this manner reflect not only the stability of nuclei, the isobar rule of the paired, resp. impaired mass numbers, i.e. the cosmic frequency of elements as well as their magic numbers, but also interprete the schemes of the related electron shells. In the figure the double of the width of the deuteron nucleus is demonstrated as longer diameters. The diagram extends up to the

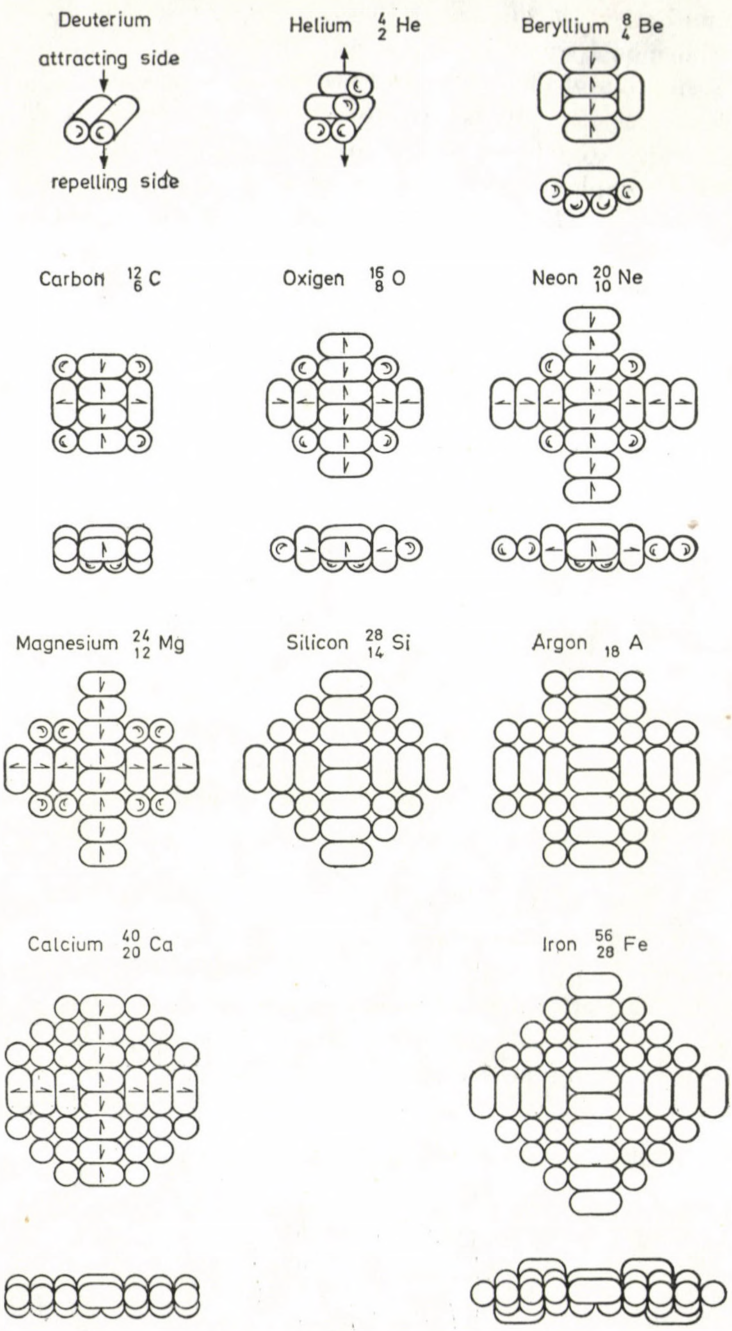

Fig. 8. **Models of atomic nuclei**

Fe-mass number. Over this range the structure cannot be demonstrated in plane, spatial model would be required.

The formation of the neutron and the coupling of neutron and proton in the complex nucleons follows directly from the cycle view. Two protons — rotating necessarily in the same directions, thus repelling each other — can join to a complex nucleon (e.g. deuterium) forming a space quantum whirl between them, which rotates in the opposite direction and have opposite charge. Already $N = (8^3)$ space quanta, i.e. the electron is sufficient to compensate the charge of one of the protons which is so transformed into a neutron. All complex nucleons of higher atomic number contains such proton—neutron pairs, above the atomic number 40 even more electronized neutrons than protons. According to the deformability of the electron, it may form an equatorial belt around the neutronized proton (Fig. 9). The circumference of the equator is 300 space quantum long, the diameter of the proton is 12 electronoid, i.e. 12.8 space quantum long. This is 40 space quanta more than the pearl-like elongated neutronizing electron (512 : 2 = 256) plus the likewise elongated neutrino (8 : 2). (13.8% difference by the imperfecness of the pearl-like structure?)

If the neutron of a similar structure enters nuclear reaction by collision, its velocity will transitionally decrease to zero, the space quanta of the balancing ring depart and are coupled to the corresponding equilibrium systems, i.e. one electron and neutrino, the neutron itself transforming into a charge-bearing proton. This is the well-known $n \rightarrow p^+ + e^- + \nu$ reaction.

The pion and from it the myon are formed mainly in the equatorial plane of the proton-neutron iso-doublet, thus also these are of lamellar shape.

The joint rotation does not represent energy surplus, but is the resultant of rotation energies of every second space quantum of the same direction. At the same time, the rotation of the space quanta of opposite rotation also exists. Due to the uniform environs, however, only one rotation direction is manifested outwards in our world, namely which produces the negative charge of the electron and the positive charge of the proton. The particles of opposite rotation, i.e. the positron (antielectron) and the antiproton can be produced only artificially. From the two kinds of rotation direction of the particles, the

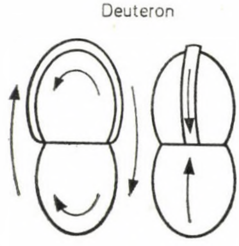

Fig. 9

duality as well as the charge parity and charge conjugation of the particle and anti-particle, i.e. of the matter and anti—matter can be directly deduced.

Both possible rotation direction of the whole of the particle represent nearly equilibrium state, thus the rotation and revolution of the surrounding space quanta can be transformed into the opposite without resistance, depending on the environment.

The relation between the rotation of the particle as a whole and that of its individual space quanta can be interpreted in two ways. It is most simple to assume that the velocity of space quanta of same direction is added to the total rotation of light velocity. But in this case the velocity of the marginal space quanta would be 2c, i.e. it would exceed the light velocity[8]. (The assumption of velocities greater than the light velocity was made in cosmology several times after EINSTEIN.). Further it can be assumed that the velocity of the space quanta of particles decrease towards the margins in such an extent that the sum of the joint and eigen velocities equals always the light velocity, i.e. the eigen velocity of the marginal space quanta is zero.

The direction of rotation (apparently) becomes opposite even rotating the rotation axis by 180°. Thus, the position of the northern or southern pole of the rotation axis should also be given, according to the DIRAC quadruple matrix [↑ ↓ + —] replacing the double matrix of SCHRÖDINGER—PAULI.

6. *Remote effects: atom and molecule. Summary of the coupling. Decomposition of particles.* Energetically the formation of the atom can be followed in the simplest case, i.e. in the conditions of the orbit of one main quantum number, i.e. of the orbit of 1—2 electrons. In the space quanta of the vacuum volume of the atom a simple proton or deuteron generates a revolution being of the same direction as its own rotation direction at least up to the first electron shell, the $v \leq c$ velocity of which decreases from the equatorial plane towards the poles. The direction of rotation of the elongated electron moving in the electron orbit delimiting the revolving space quantum system is opposite to the rotation direction of the nucleus. Thus, the true symmetric coupling is valid also in the simplest atomic structure, howerer in correspondence with the greater distance only to decreased extent. The rotation direction characterizing the positive charge of the proton is opposite to the rotation direction determining the negative charge of the electron. According to our model, in the antimatter these directions of rotation are opposite.

Consequently, the electric charge is the interaction of systems consisting of rotating particles and acting through the revolving or oscillating space quanta. According to the rule of symmetric rotation, within the revolving atomic system the particles of opposite rotation direction attract, those of the same rotation direction repel each other. If the rotation direction of the nucleus

[8] This double light velocity seems to be apparent since velocities are always relative, measured by the differences to the neighbouring systems.

is called positive, the charge of the parts rotating in opposite direction will be negative. If the rotation axis would be opposite, the rotation direction would also turn to opposite. Nevertheless, according to the spin inertia the relation of rotation axes is stable within the system even if the system as a whole is rotated in any direction.

Now, let us summarize the structural effects of space quantum coupling. In all cases 1. the fundamental phenomenon is the symmetric coupling bound to parallel rotation axes. In general, this produces lamellar structures coupled in the joint equatorial plane. 2. Due to the smaller strength of the lamellar form as compared to the isometric one, the rest masses of the smallest structures (neutrino, electron) enduring a specific environmental effect are stable only if the symmetric coupling of rotation is accompanied by the columnar coupling elongating the rotation axis which transforms the lamellae to (nearly) isometric structures. Presumably, in the case of nucleons also some kind of complicated columnar coupling is acting. 3. In case of strongly oriented field of force the symmetric rotation coupling is transformed to linear coupling. In extreme case instead of the symmetric rotation returning into itself by space quanta, a flow undulating through the space quanta develops, e.g. in case of the electrons of high velocity (Fig. 3.) and in the external shells of the electronoids of the proton (Fig. 6), as well in the equatorial plane of the neutron.

Unambiguous correlation can be presumed between structures of particles of the space quantum model and the decomposition of the particles. The particles of shorter lifetime are already decomposition products and derive generally from nucleons. By means of release of one or more particle components the relatively stable and better resoning structures are decomposed to pions and to several smaller baryons (e.g. to nucleons again). In a second step these particles, resp. the originally smaller ones decompose to myons and finally through these or indirectly to the smallest particles, i.e. electrons and neutrinoes, resp. neutretto. The weakly resoning structures, i.e. of zero electric charge and consisting of two opposite rotating elements, e.g. the zero-pions, the η-mesons of $[(1+1)8^6]$ structure and the parts of opposite rotation of the Σ^0-hyperons destroy each other and are decomposed partly or totally to "γ" particles, photons.

III. Interpretation of the Quantities of Quantum Mechanics. Relations to Other Theories

The quantum theory characterizes the particles by physical quantities determined by (partly conventional) integer numbers. Most of them have been mentioned earlier. Now their interpretation according to the space quantum model (cycle view) will be summarized in a simplified form.

These interpretations cannot be always free of contradictions since neither the quantum theory nor the interpretation according to the cycle view are completely elaborated and their result differ in some aspect.

In both views the main starting points are the mass and the electric charge. Having discussed them it is superfluous to analyze these two parameters. Only one fact will be mentioned, namely that the electric charge (Q) is in relationship to the baryon-charge (B), to the scarcity (S) and to the isospin component (I_3) but is not interpreted hitherto by the space quantum model.

$$Q = I_3 + \frac{B+S}{2},$$

One of the fundamental notion in quantum theory is the spin. This is the impulse momentum of the particle which expresses the fact that it behaves "as if" it rotated around its axis. Thus, in quantum mechanics the origin of the impulse momentum is unknown. According to the cycle view, however, this rotation is an objective reality. The positive or negative value of the spin indicates parallel or opposite orientation as related to the external field. In the cycle view the determination of the spin by the expression $\hbar = \frac{h}{2\pi}$ denotes the value of energy quantum by one rotation, resp. oscillation during one time quantum. Since

$$h = E_0/\nu = E_0(10^{-23}\ \text{sec}), \text{ thus } \hbar = \frac{E_0\, 10^{-23}\ \text{sec}}{360^\circ}.$$

The moment of momentum of the particles — i.e. the J spin — expresses the energy per frequency by the Planck-constant h per 360° $\left(\hbar = \frac{h}{2\pi}\right)$. The dimensions of the energy per frequency and the moment of momentum are the same, e.g. in the *cgs* system J [g cm^2/s]. The value 1/2 or of it integer multiplex of the *fermions*, i.e. of the "atomforming" particles characterized by definite place-coordinates within the atom — corresponds to the one half of the two kinds of particles forming the atomic unit. The distributions of the fermions described by the Fermi—Dirac statistics is valid also for the rigid state with similarly definite place-coordinates. On the contrary the *bosons*, e.g. photons, pions, alpha-particles without definite place-coordinates in the phase field are characterized by the spin unity (:photon) or by zero-spin (short living mesons), resp. 2, 3, 4 . . . spin (mesons mainly of greater masses). Their Bose—Einstein statistics is valid also for the gas-like distribution of particles, being similar to the indefinite place-coordinates of the bosons.

The limit value of the zero-spin mesons and half-spin baryons is represented by the ($4 \cdot 8^6$) critical structure. The critical time needed to the complete rotation of this structure of about $8 \cdot 10^{-13}$ cm circumference is $8 \cdot 10^{-23}$ sec.

This time separates the real particles from the numerous elementary resonances which will not be dealt with here.

Quantum mechanics expresses the differences between the baryon and meson by the $+1$ resp. -1 baryon number of the baryons and by the baryon number of zero ($B = 0$) of the mesons .Baryons and anti-baryons are characterized by the $B = +1$ resp. $B = -1$. The baryon number is conserved, i.e. in physical processes the difference of the number of baryons and anti-baryons is constant. This can be deduced from the fact that the rotation direction of the baryon particles rotating by about light velocity can be changed only simultaneously. Meson does not possess baryon-charge since for its components the two opposite spin-orientation, resp. rotation directions are equally provided, thus the change of the rotation direction cannot produce change, either.

The leptons characterized by the zero-spin, form also a peculiar system, i.e. a special lepton charge does exist. The lepton number is also conserved this conservation of the lepton charge means that in case of transformation of the particle the difference of the number of leptons is constant and this suggests the simultaneous formation of lepton and anti-leptons.

Scarcity (S) is a value occurring in the joint generation of particles, the particle takes S-values differing from zero in these processes. These particles of non-zero scarcity are called scarce particles, such are the kaons and the hyperons baryons. The scarcity is also a conserved value not only in case of strong but also in case of the electromagnetic interaction which according to the space quantum model, resp. to the cycle view expresses that during these interactions the $m \gtrless 4$ ($m\ 8^6$) structures are constant and are stabilized by the symmetric rotation coupling. The S scarcity is related to the electric charge, to baryon and to the third component of the isospin as it has been mentioned having discussed the electric charge. Its numerical value changes parallel with the increasing m-value of the ($m\ 8^6$) structure:

Λ and Σ baryons of $4 \cdot 8^6$ structure:	$S = -1$
Σ baryons of $5 \cdot 8^6$ structure:	$S = -2$
Ω baryons of $6 \cdot 8^6$ structure:	$S = -3$

That is, the scarcity of baryon is inversely proportional to the mass, i.e. to the number of components.

The value of isospin (I) gives the number of modifications of different electric charge occurring in the isomultipletts of nearly the same mass. $I = 1$ means that the isomultiplet consists of three particles, i.e. of $+$, 0 and $-$ charge, i.e. it is of triplet character. In case of $I = 1/2$ the isomultiplet is of isodoublet character, i.e. it possesses two electrically different modifications; in case of $I = 0$ it has one modification with singulet character. Thus, the value of the $(2\ I + 1)$ formula is 3, 2 and 1 in these cases. (The kaon consists of two isodoublets, K^+ and K^-, resp. K_S^0 and K_L^0, thus in both cases $I = 1/2$.)

It follows unambiguously from the space quantum model of the particles (Fig. 5) that the two possible rotation directions of the differect components of structures may produce three resultants with the join rotation direction, i.e. the proton-directional (+), the electron-directional (—) and the (0) isospin rotation eliminating each other.

Isospin is a peculiarity being preserved only in strong interaction, thus it is characteristic of the vector-like particles, i.e. mesons and baryons (together hadrons or warm particles) taking part only in strong interactions. The third isospin component express the difference of the electric charge and the half hyper-charge $\left(I_3 = Q - Y/2 = Q - \frac{B+S}{2}\right)$.

Within the frame determined by the $Y = 2(Q - I_3)$ hyper-charge the I_3 value of the isospin changes proportionally to the electric charge: at 0 hyper-charge $I_3 = Q$; at $+1$ hyper-charge $I_3 = Q - 1/2$; at -1 hyper-charge (i.e. at the relatively small mass of the baryion) $I_3 = Q + 1/2$.

Similarly to the positive and negative electric charges, the matter and antimatter are the result of two opposite rotations. Nevertheless, matter-antimatter and positive-negative charges are not synonymous notion pairs. The electric charge is a scalar quantity related to the great number of differently oriented particles while the matter-antimatter charge reflection concerning the given particle is a vectorial value. In addition to this there is a zero electric charge, too, which is generated in the simplest case by a particle coupled by two particle components of + and — rotation directions along the equatorial plane.

Parity (P own parity) expresses the preservation of the mirror symmetry of the particle: it changes to opposite the sign of the space coordinates but does not affect the sign of charges. This is the symmetry of the strong and electromagnetic interactions, i.e. that of the unchanged particles. It is called also weak space reflection. The + parity means that the sign of the wave function does not change if the direction of coordinate axes is changed to the opposite; this occurs e.g. in case of proton and neutron, and of the baryons, in general. On the contrary, the value of parity is -1 when the wave function changes its sign; this is characteristic of the π and other mesons, i.e. usually the structures of zero-spin. Thus, at the formation of mesons the change of spins is accompanied by the change of directions. In case of the electric beta-decay and in general of weak interaction, i.e. during the intra-nuclear transformation the (own) parity is not preserved.

Charge parity (C) is the operator which carries out the charge reflection (charge conjugation), i.e. changes the sign of electric and other charges and the direction of the fields.

The product of these two parities, $P \cdot C$ is the strong reflection or the combined parity which changes both the space coordinates and the sign of charges and is preserved also in weak interactions except the $K_2^0 \to \pi + \pi$ decay. Consequently, the parity characterizing the symmetry of wave functions of the particles, circumscribes the symmetric rotation coupling of the space quantum model, resp. its relation to the other two couplings.

IV. Space-Matter Interactions

The transversal oscillations of the vacuum space quanta, i.e. the electromagnetic oscillations are emitted when the atomic electrons get to a lower energy level. According to our model, an external ring of space quanta of the atomic space is released and transformed to transversal oscillation. Revolution cannot be continued between the relatively fixed space quanta thus the energy is transformed into oscillation. Inversely, when electromagnetic energy is absorbed the oscillation (photon) penetrating the atom repels the electrons to a higher orbit, generating by revolution a quantified space quantum ring. The velocity distribution of revolution can be computed from the photon energies.

On the basis of the space quantum model the so-called "annihilation" $e^+ + e^- \to \gamma$ as well as its opposite, i.e. the electron + positron pair formation from the photon can also be circumscribed. The pair formation needs a photon of such a large energy $E = hv$, which exceeds the energy of two electrons of individually $N = 521$ space quantum number, i.e. of 0.511 MeV rest mass. This is the threshold energy. In case of pair formation, dissimilarly of the normal propagation of the electromagnetic oscillation, the space quantum series flying back from the proton has no supply from the back-scattering proton. The supply of this "lack of space quanta" is carried out from lateral direction, from the space quanta in transversal oscillation by means of their gradual whirling. This is promoted also by the lateral movement of the neighbouring space quanta. When the photon-oscillation gets to the opposite phase, i.e. the oscillating space quanta move towards their original position, each space quantum of the generated neighbouring rotation system gets separately a rotation of light velocity by means of the new collision. Since each space quantum has 8 cross section neighbours, around the oscillating photon also eight rotating space quantum column will be generated. In case of sufficient photon energy and corresponding to the rule of upper harmonics the length of the column series equals 8 space quanta, too. In this manner the first eight rotating space quantum columns of the electron separated by a central channel are generated. Due to the photon energy exceeding the threshold energy each of the columns generates the rotation of further eight columns when rotating in the loosing space thus it forms the equilibrium electron structure of $N = 8^3 = 512$ as well as its antisymmetric pair, the positron. Depending upon the relative position of the rotating proton and on the photon-energy these are ejected from the reaction space.

The interpretation of *gravity* according to the cycle view should be briefly touched. Since the elastic space quanta are in different interactions with one another, the shape and volume of rotating space quanta and of their revolving surroundings represented mostly by protons and neutrons are in an equilibrated change. The nucleons are fluctuating according to the 10^{23} Hz frequency of space quanta. The fluctuating space quantum groups of nucleons generate longitudinal oscillation of 512×10^{23} Hz in the vacuum. The intensity of this longitudinal oscillation is directly proportional to the number of rotating space quanta, i.e. to the mass and inversely to the square of distance. The synchronous and non-isolated system of the oscillations deriving from masses lying at different distances tries to approach these masses. Therefore, it may be admitted that this longitudinal oscillation represents the gravity oscillation. The progress of the longitudinal oscillation is due to the energy of its forward moving component, the gravity attraction to that of the backward component. (See also the paper by MÁRFÖLDI in this volume.)

The question may arise whether vacuum can be converted to matter, in other words, the electromagnetic oscillations may be converted to proton, resp. atom and vica versa. The investigation of the very low temperature supra-liquid supra-conductivity and the very high temperature processes is suggested for solution of this problem.

Since the static interpretation of the electric and other charges is replaced by a dynamic process in the space quantum model, the stability of the "homogeneous", i.e. self-repelling charge distribution does not cause any trouble. Charge is not a static feature here, but it is a state of rotation which repels the particles of the same rotation direction and attracts those of opposite rotation direction.

The space quantum model is a kind of a "resurrection" of the theory proposed by MAX ABRAHAM which was strongly opposed by nuclear physicists and rejected in its original form. According to this the electron would be a "charge pattern" generating electric (and during motion also magnetic) field around it, in which the mc^2 rest energy equals the $e^2/2r_0$ electrostatic energy. Thus, r_0 is a finite value, the classical radius of the electron $r_0 = e^2/2mc^2 = 1.4 \cdot 10^{-13}$ cm. Thus, according to Abraham, the whole observed m_e mass of the electron should be traced back to the electromagnetic mass without assuming a special mechanical mass.

The theory of Abraham was rejected since it violate the relativistic invariancy; the impulse and energy of the electromagnetic field does not form a quadruple-vector,[9] it cannot equal the quadruple impulse of the particles. In addition to this, the "spherical electron" is not cohered by the repelling

[9] Mass vector is a quadruple vector with three space-like and one time-like components. The space-like components are the impulse vectors, the time-like component is the energy vector.

Coulomb-force. Consequently, instead of the Abraham-model other but also questionable models have been introduced: the electron has been regarded to be point-like and the infinite large own energy obtained in this manner was tried to be compensated by infinite "negative" mechanical mass(!). This assumption, however, produce new difficulties being unsolved so far.

These difficulties are eliminated by the principles of rotational coupling discussed above according to which the electron is cohered by the multiple symmetric coupling greater than the Coulomb-force and the electron is not point-like but similarly to the Abraham-theory a structure possessing extension, the electrostatic attraction and repelling is not separate matter and neither a "charge pattern" but it is the dynamic effect corresponding to the two possible directions of the rotation.

On the basis of the relationship between the mass and the number of rotating space quanta the computation of the impulses and energies is simplified. If the energy of the space quantum rotating with light velocity is considered to be the unit ($E_0 = 1$) in the greater particles, then the impulse of the particle of v translation velocity and N space quantum number will be $I_N = vNr$ while its energy will be $E_N = \frac{1}{2}(NE_0)v^2$.

Thus, progressing on the basis of the space quantum postulate a graphic model may be constructed without any mathematical formalism which describes our knowledge on the space-matter relations uniformly and (so far) without contradictions.

This model is, thus, an attempt to formulate the "ocular demonstration" ofthe space-matter relation, at the same time also some fundamental problems of quantum mechanics. In numerous items it leads to the same results as quantum mechanics but differs from it just in some debated statements. According to our model, the permanent nuclear forces are deduced from the coupling of the directly contacting space quanta rotating with great velocity while the pion-proton replacement is considered to be valid only in the continuous transitional rapid changes of the proton and neutron bound in the nucleus. There is a difference also in the interpretation of photons.

In the space quantum model, the distinction between space and matter as two separate principles as well as the artificial theoretical construction, e.g. the "etheric wind" become superfluous. E.g. the matter-space concept of the physical vacuum and the zero-point oscillation obtain a direct sense.

According to the new model the physical quantities determined by quantum mechanics as decisive values (spin, charge, parity, mass, scarcity, whirling, chirality, etc.) are simply the fundamental features of the rotating space quantum groups. Consequently, many basic principles of the quantum theory can be deduced also from the space quantum model and the quantum mechanical notions of the particles are geometrically interpreted. Moreover, the new model provides a graphic picture on the structure of the particles, on their make-up in detail, on the morphological peculiarities, i.e. on such characteristics which could not be approximated so far. A particular "beauty" of this model is that in contrast to the attempts of the past which reduced the particles to more types of particles, it reduces the particles to only one "final" or "primary" component, i.e. to the space quantum while it preserves some marvellous results of the deductions of three or more particles, resp. of the quarks. Probably, it is also advantageous in this model that it avoids some labyrinths of the theoretical physics based on mathematical speculations.

This paper is the first rough approximation requiring corrections and supplements.

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МАТЕРИЯ И ПРОСТРАНСТВО В КОНЦЕПЦИИ ЦИКЛИЧНОСТИ (ПРЕДВАРИТЕЛЬНОЕ СООБЩЕНИЕ)

Э. САДЕЦКИ-КАРДОШШ

Содержание

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CYCLE PARAMETERS AND SYSTEM THEORY

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1. Cycle motion generates systems. The system in everyday sense are the products of the cyclic motion of the two intermediate forms of motion, i.e. of the strips B and C.

2. To describe the physical cycles 6 pairs of parameters are needed characterizing the substantial and the functional pecularities of the hierarchic levels and dispersity of the system. Four parameters denote the own and the next lower hierarchy level: the space and time parameter of the cycle (r and t), the number of the different cycle elements, i.e. system elements $(n + u + \dots)$ and their site coordinates $(q_n + q_u + \dots)$. The dependence of the cycle on the internal level is characterized by the density $(\varrho_n + \varrho_u + + \dots)$ and temperature $(\tau_n + \tau_u)$ of the elements. In systems belonging to low hierarchic levels the parameter ϱ characterizing the lowest $(n - x)$ level refers already to the atoms, thus to the the chemical constitution.

Four parameters describe the relationship of the cycle with the external higher hierarchy levels: the relative velocity of the system (translation, D), the number of systems being in direct contact with the system in question (N), the age of the system, i.e. the number of cycle rotations (R), and the exchange of matter and energy with the environment (input, i and output, o). Finally, the dispersity of the system is characterized by the free volume of the dispersing medium (ϑ) and the forced strength (σ) exerced by the particles of the matter.

Substantial parameters are described by spatial coordinates, functional ones by time coordinates (Fig. 1):

Hierarchy level	Substantial parameter	Functional parameter
Strip A and D	ϑ	σ
(n + 1)	N	D
between (n + 1) and n	(i, o)	R
n	r	t
(n − 1)	(n + u + ...)	$(q_n + q_u + \dots)$
(n − x)	ϱ	τ

3. By means of the cycle parameters all physical notions can be expressed, e.g. volume $V \sim r^3$, mass $M \sim r^3\varrho$, kinetic energy $E_{\mathrm{kin}} \sim \frac{1}{2} r^3 \varrho \left(\frac{r}{t}\right)^2$, entropy $S \sim \frac{1}{\log R}$, chemical potential $\mu \sim \frac{V - \vartheta}{V}$, etc.

4. Among the systems grades can be distinguished according to the degree of complexity, in which the physical cycle parameters are gradually transformed. In this paper the following grades are discussed: electromagnetic oscillations (strip A), inorganic systems of strip B; inorganic systems of strip C; biological individuals; animal populations; psychological cycle; social cycle, e.g. economic, artistic and scientific systems.

5. The gradually changing form of the cycle parameters may serve as a basis to create the mutually recomputable network of notions. This possibility may realize a widespread quantified survey of knowledges.

It is possible to trace back all cycles and rhythms to the two parameters of the motion: space and time. In this way principally the quantitative projection of all phenomena is enabled.

A. The 12 Cycle Parameters

The shortest way to the multidisciplinary join of natural and social sciences by the cyclicity concept leads through the hierarchy of systems, as discussed in the first paper of this volume. According to the founder of system theory, L. BERTALANFFY: "system is a set of elements standing in interrelations". "Unity of sciences is granted not by utopian deductions of all sciences to physics and chemistry, but by the structural uniformities of the different levels of reality". A consequence of the existence of general system properties is the appearance of *structural similarities or isomorphism* in different fields. — An experimental law of growths applies to certain bacterial cells, to populations of bacteria of animals, men, books are completely different and so are the causal mechanisms involved. Nevertheless the mathematical law is the same". "The unifying principle is that we find organization at all levels".

The method of BERTALANFFY is essentially empirical and inductive. Another method elaborated by ASHBY 1958 and 1962 is deductive. It states a number of system principles such as wholeness, sum, centralization, differentiation, leading part, closed and open system, finality, equifinality (i.e. the reaching of final state of the open system from different intial conditions and in different ways), growth in time, relative growth, competition. The fundamental concept of Ashby is the "machine with input" the internal state of which and of its surroundings defining uniquely the next state. It is supplanted by the cybernetic model, i.e. a system open to information but closed with respect to entropy transfer. This led to "systems organizing themselves by way of progressive differentiation, evolving from states of lower to states of higher complexity". System theory found introduction already in many sciences, e.g. biology, linguistics, psychiatry, behavioural science, demography, sociology, economics, political science, history and other social sciences, philosophy.

Attempts to unite sciences by e.g. the general system theory were based on the reduction of complex terms to simple ones. According to RUSSELL ACKOFF and others, this is erroneus since complex terms are not synthetized from simple ones, on the contrary simple terms are abstracted from the complex ones.

This problem is no more relevant. By the discovery of the common quantitative generating process of phenomena the unification of sciences must be based on the hierarchy of cycle processes. The problem is now to find the final characteristics of the generating process, i.e. of the cyclic-rhythmic motions, and to deduce from these the scientific terms.

The most important addition of the cyclicity relation to the system theory is the statement that systems are formed by cyclic motions. This allows to detect new general and particular properties of systems, and to follow the development of system from the primitive anorganic grades to the complex social ones. Cyclicity allows to find isomorphism and hidden pecularities at different levels of systems, too.

In the former and the next papers of this volume the micro- and mega-systems of the Universe were discussed. In the human practice, however, both groups of extreme measures are not considered as objects of the system theory. System theory in practice dealt with social and related terrestrial systems of about human measures and of direct human interest. The present paper discusses mainly the basic relations of the systems in order to further the most common generalized interdisciplinary researches.

One of the most far reaching peculiarity of the cycle motion is its system generating function. Cycle motion transforms unordered sets into ordered systems.

The highly simplified scheme of this process is as follows. The elements of an unordered set are ordered by the cyclic motion into quasi-concentric belts according to their densities, dimensions, viscosities and other peculiarities. The differences between belts and realms represent the gradients of the intense factors introducing regular and permanent mechanical and/or thermal, chemical, electric and other interactions, mostly flows and diffusions. Flows sensu lato produce the active structural pattern, characteristic for the systems.

The universal motion diagram (Fig. 1 and 4 of the first paper of this volume) summarizes quantitatively the fundamental peculiarities and relations of the systems, by demonstrating the types and kinds of cyclic and rhythmic motions and by this the system of systems, too. Since systems are determined — like all phenomena of the Universe — by different motions, the decisive common peculiarities of the systems are to be deduced from this diagram.

The main features of the system-like phenomena are their time and space parameters (r and t) or the quotient of these parameters i.e. the velocity (Fig. 1). The different kinds of the system-elements are characterized by the number $n + u$, and by their site coordinates $(q_n + q_u)$ and densities $(\varrho_n + \varrho_u)$. Number n denotes the isometric and u the anisometric elements. The density depends already on the "elements of the elements", i.e. on the particles in the lowest cycle level. Similarly the temperature τ representing the oscillating and rotating impulses of the particles, e.g. average velocity of the molecules, depends also on lower hierarchic levels.

The system depends, however, on the higher hierarchic levels of the systems to which it belongs, too. The description of a system thus requires also the

characterization of the relation between the systems and the sequence of the higher hierarchic levels. The system being practically always open in some measures receives elements ("products") from and gives to other systems: input and output ($i + o$). The system translates (moves) with a relative velocity D in the higher level and iterates its cycle motion R times since its existence as a

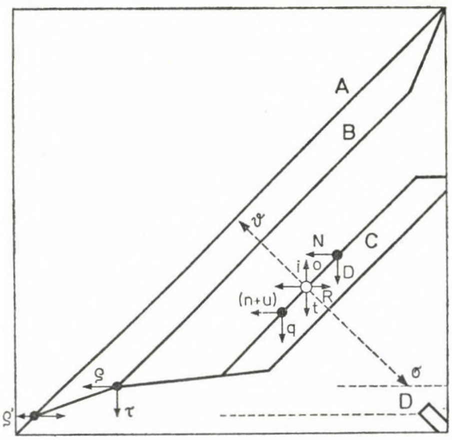

Fig. 1. The 12 cycle parameters of the systems

new system. In a given time it contacts with N number of systems of the higher level. It is influenced by the forces of its and by farther systems: forced strengths σ. The free place, e.g. vacuum (ϑ) is a common parameter of the different hierarchical levels. Free place ϑ and the forced strengths σ describe the dispersity of the system.

In this way the system is characterized by two parameters (ϱ and τ) of the lowest, by the parameters $(n + u)$, q of the neighbouring level, by the own parameters r, t, and by the six parameters ϑ, D, R, N, σ, and $(i + o)$ describing its relations to the higher levels. Thus a total of 12 groups of parameters are required for the exact quantitative description of a system. The 12 parameters form 6 pairs, from which one represents always a substantial, the other a functional peculiarity (Fig. 1, see also the table of the abstract).

It is possible to use instead of the enumerated parameters some other ones for the description (e.g. mass instead of density and volume) but the number 12 of the independent parameters will not change.

Let us describe more exactly the above 12 parameters.

In case of anisometric bodies three space parameters $r_1 > r_2 > r_3$ are distinguished. The volume of the system is determined in first approximation by the value $(r_2)^3$, or by $\left[\frac{r_1 + r_2 + r_3}{3}\right]^3$.

The reciprocal values of the time parameter t is frequency. The changes in time parameter, i.e. in cycle velocity due mainly to external forces (forced strengths σ) is mostly periodical, too.

Four fundamental kinds of system *elements* of number n may be distinguished in the chemical industry:

- energy sources (n_e)
- anorganic substances (n_i)
- organic, even living (and mostly cycle controlling) elements (n_u) consisting mainly of unidimensional molecules
- tools (n_t), remaining relatively unchanged during the cycle activity.

The current state of motion of the subsystems, resp. system elements is described by the change of the $q_1, q_2, q_3 \ldots$ vectorial site-coordinates. They express flow directions or paths of elements and at the same time the sequence of motion, the algorithm of it. Elements and subsystems are connected by these paths, which forward the information, too. Often they break through the theoretical ringstructure of the system forming path shortenings.[1]

The density and the energy density of the elements ϱ is required often to be differentiated for the different elements by data $\varrho_1, \varrho_2, \varrho_3 \ldots$ The mass M of the system is obviously $M \sim \varrho(nr)^3$.

The motion of the final particles is represented by the thermal oscillation determined by τ temperature. ($\tau = \dfrac{Mv^2}{3\,kL}$, where M is the molecular weight depending on ϱ of a one-atomic gas, v^2 is the mean value of the velocity square of the individual molecules and kL is the product of the Boltzmann—constant and Loschmidt-number, i.e. the universal gas constant.)

The parameters τ and q accomplish essentially the transformation process in the system, i.e. the transformation of input into output.

The momentary state of the (whole) system is described by the rotation number (R) providing the degree of maturity of the system.

The velocity and direction of the cycle within the surrounding higher level cycle as compared with the own velocity and direction is given by the D vectorial value of translation.

The number of the other cycles joining the cycle and influencing it directly is given by N. The N-value describes the equilibrium conditions and degree of homogeneity of the cycle and its environment in the planar (surficial) cycle system (e.g. a country). Each cycle has five to six neighbours at least if the cycles are of the same size. If a cycle is greater than the neighbouring ones,

[1] The impulse coordinates (mv) do not figure as independent cycle parameter as it may described by the parameters r^3, ϱ and r/t. The r/t velocity being a vectorial value, require the data of the direction, too, which is induced in parameters q_1, q_2, q_3. For most "human" systems the direction is an angle within the Earth's surface, depending on the Earth's rotation axis.

than $N > 6$, if it is smaller than $N < 6$. Thus N is a rough indicator of the space dimension of the neighbours relative to the own dimension r.

The material and energy quantities exchanged by the cycles are determined by the input and output (i and o) values. Useful (u) and harmful (p: pollution-like) output should be distinguished (o_u and o_p). The $i : o$ analysis promotes the determination of the q-values (*black-box* method). The switch of the o output to the i input signal means the basis of control, i.e. the *feed-back*.

The freedom of the system is depending first of all on the volume of the free places (e.g. vacuum[2]) between the elements. The forced strength σ exerced by the particles of the matter, decreases the degree of freedom of the system.

Any feature of the cycles i.e. of the systems can be reduced to these 12 parameters. Let us enumerate some most common physical notions by the proposed 12 parameters. Volume: $V \sim r^3$; Mass: $M \sim r^3\varrho$; Kinetic energy: $E_{\mathrm{kin}} = 1/2\, mv^2 = \frac{1}{2} r^3 \varrho \left(\frac{r}{t}\right)^2$; Force: $F = mrt^{-2}$; Viscosity: $\eta_{\mathrm{rel}} = 1 + k\frac{(V - \vartheta)}{V}$ (where k is different constant to the liophile and liophobe systems); Frequency: $\nu = \frac{1}{\tau}$.

The three intensive and three extensive factors of thermodynamics, p pressure, τ temperature, μ chemical potential and V volume, S entropy and m mass, as well as their products, i.e. the $P \cdot V$ mechanical, the $\tau \cdot S$ thermal and $\mu \cdot S$ chemical energies can be expressed as cycle parameters as follows:

Intensive factors	*Extensive factors*
pressure: $p \sim hg\varrho$	volume: $V \sim r^3$
temperature: $\tau \sim \frac{mv^2}{3kL}$	entropy: $S \sim \frac{1}{\log R}$
chemical potential: $\mu \sim \frac{V - \vartheta}{V}$	mass: $m \sim r^3\varrho$.

In first approximation pressure depends on the h depth, ϱ density and g gravitation. The chemical potential depends mostly on the $\frac{V_{n,u}}{V} = \frac{V - \vartheta}{V}$ concentration which expresses approximately also the degree of dispersity.

[2] Theoretically vacuum occurs within the atoms and molecules, too, but this kind of the free places appears in the term density ϱ, thus it is disregarded in the parameter ϑ. The value ϑ refers to the density of the system, in contrast to ϱ which represents the density of its elements in the lowest level. Both values are determined by the distance of their projection points from the rim of strips B or C. With increasing ϑ it is shifted towards strip A.

On the contrary, the forced strength σ mostly decreases the speed of rotation, shifting the system towards the opposite side of the strip B or C, i.e. in the direction of strip D. If, however, forced strength increases the motion of the system, this means stimulation and shifts the system towards strip A, like the increasing of ϑ.

Symmetry representing the opposite directions of rotation of the elements can be described by the values $+v$ and $-v$ of velocities.

In this way a wide range of notions can be deduced from the 6 pairs of cycle parameters. However, the network of uniform notions does not mean the realization of a sole uniform science though the succesful initiations of e.g. ONSAGER, PRIGOGINE and CARNAP.

The wide range of a comparative network of notions of different sciences provides a tool for some uniform systematic review of many knowledges.

The system concept deduced genetically from the cyclicity relations seems to be suitable by the 12 cycle-parameters to elucidate new connections between laws of motions, thermodynamics, biology and social phenomena — even micro- and megaworld. In the followings it will be tried to establish some basic methodological questions to this aim.

B. Grades of Systems

Let us try to characterize the *mutual features* of physical systems and cycles by the twelwe cycle parameters. The cycle parameters were distinguished on double basis: by the analysis of the cycle diagram and by the model of a simplified (idealized) mechanical system belonging theoretically to the strip B. This model gradually leads through subsequent qualitative leaps to the terrestrial inorganic, then biological and finally to the social and human-made artificial systems. In this way the analogies of the twelwe cycle parameters was found also in other systems by "periodically gradual" increase in complexity. This method is supported also by the fact that theoretically all systems are generated in the same way, i.e. by the cyclic motion mechanism.

The main phases and cycle parameters of the series are as follows:

1. To characterize *strip A* mostly the parameters r, t and D are needed: $4r = \lambda$, and $r/D \sim$ amplitude. The velocity of strip A, i.e. the light velocity c is obtained directly from the space- and time-quantum parameters: $c = r_0/t_0$. Strip A representing the realm of electromagnetic oscillations does not include systems sensu stricto due to cycle rotation. Yet, the periodicity and the existence of a kind of hierarchic superpositions in this realm, too, provide some relations with the formation of systems.

2. In the *inorganic grades of strip B* the twelve cycle parameters can be applied in unchanged form. At the beginning of the cycle process, at the formation of the system the q displacement of the material means arrangements according to density, grain-size and/or viscosity. Later in the evolved system mainly the processes characterized by the entropy step forward, therefore the equalization of concentrations and heat-exchanges become pre-dominating.

These processes represent already a primitive form of "communication" between the system and its environment, resp. between the system and its elements.

3. In the *inorganic grade of strip C* complex three- or more phase dispersion appear instead of the simple two-phase dispersion in strip *B*. Thus in the formation of strip *C*, practically in the near-surface systems of the Earth the liquid H_2O — which is essentially a simple two-phase dispersion of H and O ions in the intermolecular and interatomic quasi-vacuum — dissolves other ions and molecules moving by diffusion with a velocity considerably lower than the water's flow. The diffusion sensu lato velocity lower by about ten orders of magnitude in average than the flow velocities of strip *B* is a main characteristic of strip *C*. It is an additive phenomena to the cyclic motion types of strip *B* and becomes also cyclic being actually a subsystem of the strip *B*. In the system of strip *C* the number of elements increases according to the number of species of the dissolved ions. By means of diffusion and related chemical transport phenomena the intensity of "communication" is somewhat widened in strip *C*.

4. The individuals of the *biological grade* may already distinguish and choose between input materials and energies. By means of work and with the aid of code, resp. memory the highest biological grade, man produce consumable objects and phenomena, i.e. *values*. The value is represented in this grade by the useful input (i_u) needed to maintain the own cycle, i.e. the life of the individual and of the species. When making distinction between the useful (i_u) and harmfull i_p inputs certain primitive "critics" is developed already in the lower biological grades.

In the biological systems the transition of the former primitive communication processing into a *feed-back information system* is a new feature. Information also makes the entropy S decrease and depends exponentially but in inverse ratio on the R number of the system creating cycle rotations: $S = 1/\log R$.

The accuracy of the ε information increases parallel with the number of the observed repetitions R', but decreases with the Δ difference of the extreme values of the space and time parameters: $\varepsilon = R' \dfrac{1}{\Delta}$, where $\Delta = (r_{\max} - r_{\min}) + (t_{\max} - t_{\min})$. The I intensity (significance) of the information depends on its accuracy, rate and U unexpectedness, increasing parallel with the number of rotations: $I_i = \varepsilon U v = 2R \left(\dfrac{1}{\Delta}\right) Uv$.

The E_i intensity of information and at the same time the measure of information content is also connected to the entropy S, to the $W_1, W_2, W_3, \ldots$ thermodynamic probabilities of the system's different possible states: $S = k \ln W$ (k is the Boltzmann-constant). Accordingly, $E_i = W_1^2 + W_2^2 + \ldots +$

$+ W_n^2 = \sum_1^n W_i$ (ONICESCU, 1966), or in terms of the cycle parameters:

$$E_i = \sum_1^n \left(\frac{1}{R}\right)_i^2.$$

Information makes possible the control, i.e. the feed-back of the input of metabolism maintaining the biological system.[3]

5. The *animal "society"* (correctly: family), e.g. the states of ants and bees, and the *population* represent the higher level of the biological hierarchy system overlying the level of individuals. Here the individual becomes subsystem, i.e. one u element of the animal family, resp. population. The animal "society" is a social race-preserving system of mutual aid. In these organizations co-existence is controlled by *habits*. Habit is a preferred form of motion, the basis of attitude systems which can be expressed by the mutual and conventional site coordinates of the individuals and populations ($q_a, q_b, q_c \ldots$, e.g path, track). (See also the paper by T. JERMY in this volume.)

6. *The psychological cycle* located mainly in the nervous system represents the great leap between the inorganic and the biological world. It means the appearance of the reflection of environment by the formation of the system of information. The development of it is due to the increased metabolic and conductive (nervous) velocities, i.e. to the extended space and time resonance between the biological system and the strips A, B, and C. Interactions between the own hierarchic levels — i.e. between the cycle parameters of the biological system — are also increased by the extended resonances.

Tentatively the identification of the human psychological cycle parameters will be investigated below in a first approximation. The space parameter r of the nervous system depends on the dimension of the body. The time parameter t of it is a function of the sum of irritations. The $(n + u)$ number of the system elements is determined by the about 10^9—10^{10} neurons and their synapses. They represent the fixed tracks of the bioelectric currents produced by the irritations and measured by the velocity of the activity potentials. (Maximum velocity in the primitive vertebrates 25—30 m/s and 100 m/s in the

[3] The response started by the information is elucidated by the *operon-theory* of JACOB and MONOD elaborated at the level of bacteria. According to this, in case of the appearance of nutriment (lactose) a section of the DNA molecule of the chromosome consisting of several parts becomes activated. The inductor produced due to the nutriment's effect provisionally joins the continuously present inhibitory repressor-protein, and bonds it. Thus, the reproducing mechanism of the RNA molecules is released and by means of the operator and structure genes the formation of a new RNA molecules is started. Expressed in terms of cycle parameters this means that the i system element of the input nutriment switches off the function of the u inhibitory system element and at the same time it initiates the production mechanism of the useful o_u output.

mammals. The velocities are positively correlated with the thickness of the myelin-cover of the neurons.) The bioelectric currents thus represent the cycle motions, i.e. the q space coordinates of the elements.

The number of the external i_e and internal *irritations* i_i mediated by the sensor and afferent system represents the input, while the decisions and actions produced by the irritations and mediated by the motoric afferent system correspond to the o output.[4] According to the so-called "nothing or all" principle of the irritations (stimulus threshold !), the N number of the external impulses is always greater than i_e. The intensity of impulses below the stimulus threshold measured by the chronaxia number corresponds to the cycle parameter D (translation). The number of the reiterations of the irritations decisive for the *memory* and *learning*[5] is expressed in the cycle system by the R cycle rotation value. The complex pattern of imitations and behaviour — influenced by customs, fashions, persuasion, advertising, propaganda, convincing and time-spirit — represents the forced strength σ in the psychological systems. At the beginning it is an economic support for the information system. On the contrary, the deliberations and free choices between different possibilities represent the freedom of the psychological system. It corresponds to the ϑ volume of free places in the physical systems. The psychological freedom depends on the knowledge and wealth of the individual. (Similarly the freedom of the states is mainly also the function of its technical knowledge and wealth.) Both forced strength and freedom are correlated with i, o and R, but represents change in dispersity and not exchange of materials. — According to the high hierarchic level of the psychological system, the parameters ϱ density and τ temperature describing the lowest hierarchic levels are no more significant for the nervous system.

According to the engram-model of R. Senon new experiences "fixed" as remembrances do not produce new structures, new nervous cells. (The nervous system network is completed in man essentially already at the age of three years). New excitations only deepen the structure of the neuron network. The repetition, the learning make easier to run again excitations.

The nervous system operates by active selection and differentiation. While in the metabolism the nutriments are transformed chemically into sub-

[4] In sleeping the metabolism and its reactions inside the body prevail, while at the wakefulness the perception of the outside world by the nervous system predominate. By electroencephalography low-frequence sleeping ϑ (less than 7/sec) and high frequency wakeful and attentive (more than 7/sec) α and β action currents are distinguished, representing presumably the "echo" of the continuous and many-sided communication between the neurons.

[5] The reflex of orientation (Pavlov) responding to the new foreign stimuli is also learnt reaction (Grastyán et al., 1959). Consequently, reflection is also the result of learning. Intuition is not the acceleration of the process of consciousness (Katona, 1978), it is rather the conductive coupling of distant engrams. The appearance of "intuitive ideas" is promoted by sleeping ("dream") uncontrolled by the everyday common processes (Sellye, 1967).

stances ever approaching the DNA—RNA norms, the excitations run through the nervous systems almost without forming new chemical compounds. In addition to the electric (physical) conduction, however, simultaneous chemical electrolytic processes occur, too, characterized by oxygen consumption and concentration differences of the Na and K ions between the nervous cells and membrans, opposite to the common electric network which operates by a flow of only one material, i.e. of the electrons, thus is unable to active selection. According to the Hodgkin—Huxley model, the nervous current intensity I_m is the sum of the I_C capacitive current intensity and of the ionic current capacity depending first of all on the ionic currents of Na and K.

The classification by KARL POPPER (1971) spreading over the whole Universe corresponds essentially to his psychical triple classification. POPPER makes distinction between the "first world" (physical objects and living creatures as well as of the artificial objects produced by them), the "second world" (states of mind, experiences and "subjective knowledge"), and the "third world" ("objective knowledge" including the material carriers and theoretical systems of cultural inheritance). C. ECCLES (1975) tried to localize the three worlds in the brain: the first world gets into the cerebrum through the receptors and sensor crustal parts. This is transformed into the second world (self-consciousness) in the dynamic hemisphere of the brain, then it is transformed into the third world and in the outside world through the motoric nervous system and muscles.

The system analysis by cycle parameters gives a simple reply to the (apparent) contradictions raised in the philosophical dispute with regard to the *reflexion theory* (LEONTIEV, 1969; RUBINSTEIN, 1969; TYKHTIN, 1971; KEDROV, 1973, 1978; etc., KATONA), e.g. "the reflecting mind cannot be productive"). The first step of reflexion is the impulse system of different current density indicated by the input i_e in the neurons, which during the arrangement q is transformed into consciousness and after a run of R number it may develop eventually to a productive output o, too.

7. As against the animal family-like "society" the *(human) society* is at present more a self-preserving, competing—fighting system serving individual aims. To restrain the fight and to control the co-existence the *moral values* and the law have developed, stimulated knowledge (ordered information), by beauty, and seek for comfort. Similarly to health, in first approximation the "formal" beauty (see below) can be described by the *optimum relation* $\dfrac{n+u}{q}$.

In this sense comfort is an increased efficiency, the possible maximum of the quotient of the result (or useful o_u output) and of the $(mrt^{-2})\,r^3$ invested $=$ $= mr^4t^{-2}$ labour:

$$\frac{o_u}{(m r^4 t^{-2})} \rightarrow \max .$$

The *language* and other kinds of communication as well as the intellectual energy increasing with them take main part in the creation of the human social systems. All these result in the development of useful output (o_u), i.e. of production and the creation of artificial systems.

The need for information aiming at the recognition and application of new cycles is considerably increased and differentiated in the human society. Desire for knowledges, curiousity, excitement for sensation and even the fashion can be traced back to the increasing need of information aiming at the intensification of the own life cycle.

At a human and social level information is the ordered sequence of symbols and conventional, partly "numeric" signals suitable to store the information. At the same time, from the point of view of system control the information is a selected, resp. valuable fact, the raw material of data processing, the processed and researchable output of previous outputs. Thus, its scheme is: data $\rightarrow$ data processing $\rightarrow$ information.

8. *The artificial system* (e.g. plant, enterprise, state apparatus) differs from the natural systems in its consciousness, in the organized control to definite aims by decisions, further in the foundations to the n_t tools (implements, equipments, instruments and n_i input) and to the o_u outputs produced by them. The units of higher hierarchy level of these systems and organizations operating collectively in favour of a social aim try to realize continuous production in order to increase their efficiency (plants, cultural organizations, e.g. libraries, sport establishments). Therefore the q site coordinates develop to traffic (road, railroad, water ways) and to information network.

Artificial systems promote the conquest of *interzonal velocity ranges* between velocities of the strips A, B, C and D. The indirect aim of artificial systems is the changing of the nature, while the direct aim is to produce useful output. The useful output, o_u, i.e. approximately the brutto production is the product of the working hours needed by production (number of workers u multiplied by the working process, $u \cdot R'$), of the accuracy of knowledges needed by production $\left[\frac{R}{\Delta}(\vartheta + n + u)\right]$ and of the required material supplies $(n + i)$:

$$o_u = \left[\frac{R}{\Delta}(\vartheta + n + u)(uR')(n + i)\right].$$

The value of the netto production is obtained in first approximation from the brutto production by subtracting the "accident"-like Dx factor being characterized mostly by extreme translation values:

$$o_{u\,\mathrm{netto}} = \left[\frac{R}{\Delta}(\vartheta + n + u)(uR')(n + i)\right] - Dx.$$

In the artificial social systems the unified exchange value of different products, i.e. the *money* has developed. Money is a storing and comparative value representing a k "constant"-like multiplier by means of which the social products may be ordered into relatively uniform coordinate system. In this way the $n_k + n_l + u$ number of elements and the working process accompanying the changes by site coordinates, as well as the useful input and output values (i_u, o_u) can be mutually converted in form of equations.

As the monetary values are too instable subjects of manipulations, a more stable unit for the economic values is wanted in science. The exchange value of the minimum subsistence (M) measured by area seems to represent a more objective unit for the economic values.

The two kinds of the useful input and output value i_u and o_u are related to two kinds of economic categories, the *demand* characterized mainly by i_u and the *supply* depending mainly on o_u.

In addition to the monetary value of the product, i.e. to the *price* it is required the determination of the dimension-like unit, e.g. piece, weight (m), volume, etc. to which the price refers. Thus, price is the quotient of two parameters, i.e. of the monetary value and of the dimension (k/dim). Nevertheless, in the system of cycle parameters money and price do not mean new parameters; these are determined also by the cycle parameters, e.g.

$$\frac{i_u}{m}, \quad \frac{i_u}{r}, \quad \frac{i_u}{r^3} \quad \text{resp.} \quad \frac{o_u}{m}, \quad \frac{o_u}{r}, \quad \frac{o_u}{r^3}.$$

In the determination of optimal functioning of the artificial systems, the transport costs, the price of q, i.e. the distance of subsystems from each other and from the input source, as well as the ϑ_2, ϑ_3 free places play important role.

In the artificial economic system a new optimum relation, the maximal *profit* appears. In first approximation the profit can be described by the expression: $(o_u - i)$.

Artificial system differs from the biological ones by the fact, too that the choice of information is carried out not only by coded molecules, biologically "prefabricated" n_k system-elements, but in the course of production the system produces new n_i elements by means of improvable technologies and of changing q site- coordinates. The technological optimum relation can be approximated by the expression: $\frac{n + u}{q} \sim \max$. The operating control and response to the demands is influenced also by fashion.[6] The N number of the external cycles represents by their i_A, i_B, i_C demands and o_A, o_B, o_C productions the market and rivalry. The relative evolution of them is expressed by the D

[6] *Fashion* is an externally controlled demand influencing also the o_u useful output of economic plants.

translation value. These as well as σ forced strength as taxation, customs, embargo, need complex information. *Control* is the gradual realization of a definite cycle system expressed by the rotation number R.

The time parameter t of a plant represents the transition time during which the input becomes saled goods (o_u). The efficiency of production increases with shortening t-time. The shortening of t means the increase of the $v = r/t$ production velocity.

Similarly to other durations of life, the duration of a plant can be determined as probability values based on the plant average curves. The tR "probable duration" of life is influenced mostly by external factors (i and o, D, N, σ) and can be improved by means of specialization of a plant, resp. by change of product structure as well as by the parallel increase of the r-value by means of fusion of several plant units to a larger system, e.g. trust.

Inaugurators of economic mathematics, ARROW and DEBREU and others elaborated a "general equilibrium analysis" and assumed the Bentham's homo oeconomicus, i.e. economic rentability. A critics of this was given by KORNAI.

9. *The artistic and scientific productions* and other abstracted systems, — e.g. the system of numeration, that of knowledges as well as the religions mingling the early knowledges of mankind with dualistic mysticism — represent also some kind of artificial information systems.

Out of the systems of knowledges here only the distinction between the basic psychological types of knowledges is tried to carry out in the spheres of creation, resp. reception of knowledges:

Sphere of creation. 1. The relations of constant quantitative difference-type repeated in the same way in the outside world thus running in the same nerve path are fixed in the DNA molecule in form of genes. These can be partly inherited, therefore, the professions based on such relations, e.g. acoustic intervals, relations of numbers, are successfully improvable already in young ages ("infant prodigies" in music and mathematics). In this field the creation is bound essentially to the analytic elements of quantitative differences.

2. The phenomena running in mixed, i.e. in different nerve path systems and not or hardly repeated in the environment, are based mainly on individual experiences. Being not fixed in genes, lead to knowledges which cannot inherited. To improve these at a creative level needs more maturity, i.e. ever older ages. In this case the creation is rather a synthesis.

Sphere of reception. 1. The products of fine arts and fiction concern mostly the man, the human sphere, i.e. certain parts of the bridge between the strip C and B. The enjoyment in such products runs in afferent nerve paths of somatic endogene origin being active also in physical tranquillity. Their perception needs less the stress of projection to external nerve regions, thus their products are at least to certain degree easier intelligible and can be "consumed" in form of a general relaxation.

2. The scientific products deal with different forms of motion of the strips A, B, C and D and even in case of the biological motion of strip C these can be approached from the outside world. Thus, the understanding and study of such kinds of works need greater excitation, the concentration in the external regions of the nervous system. Their recreative character is more restricted.

There exist a usual aversion to the measurement of works of art, resp. of their value, e.g. of aesthetics. Valuable results against this aversion have been achieved e.g. by HANKISS, E. It can be hardly debated that a work of art tries to give different information. Thus the conciseness of a work of art is characterized by the quotient of its information content E_i and of the volume (r^3) resp. time dimension (t) of the work. Arts use countless kinds of periodic phenomena as well as symmetry (in the symmetric rotation of cycles) to express different aspects of *aesthetic values.*

One of the most important category of the aesthetics is *beauty* and *ugliness.* The "elementary" formal beauty is in correlation with the $n + u$ elements of the composition as well as with the ratio of their spatial and temporal arrangement, i.e. with that of the q site-coordinates, i.e. with the $\frac{n+u}{q}$ optimum relation (proportionality, regularity, rhythm, symmetry). At the same time, beauty represents also a value, thus it is connected to the i_u and o_u parameters. Decisive is the ϑ freedom, i.e. the possible lack of σ forced strengths which can be interpreted as a harmony based on the recognition of the natural and social regularities: "Beauty is the sensuously appearing freedom" (BARNA J.).

One of the most frequent topics of literary works is the conflict of the individual or community produced by the simultaneous connection to several systems. The intensity of this conflict, the dramatic character of the topic is expressed by the sum of the mostly opposite non-conform forced strengths, without sign (i.e. their non-algebraic sum):

$$\Sigma = \sigma_1 + \sigma_2 \ldots \sigma_n .$$

The *style* of the work, the exquisite elegance of the motion of the system of work of art or its heavy ponderous monumentality are determined mainly by the ratio ϱ/ϑ. Beauty is of human dimension. If it exceeds this measure it passes into the majestic. Thus, the space dimension, r, the time dimension t as well as the living-space-temperature determined by the abstract form of τ are also assigned to the concept of beauty. Beauty, as an information, depends also on the environment, on the number N determining the relative dimensions and interactions of the joining cycles and on the D translation velocities compared to the cycle. The more exact role of translation D can be interpreted by the changing distance between the author and the audience, and between the author and the described cycle, i.e. by the *viewpoint.* The viewpoint is expressed by the relation of the coordinate systems of the author, of the described object and of the audience, i.e. by the D_1, D_2 and D_3 translation values.

Thus, beauty is a rather complex phenomenon being assigned to all the twelve cycle parameters: it is the unity of diversity, the totality of truth, moral benefit, labour and of other factors.

C. Outlook

The swing-like *rhythms* occurring at the surface of *history* have been studied since Vico by numerous historians and philosophers (Spengler, Toynbee, etc.). According to the recognition of Marx, in the background of these changes the production cycle processes, determining for the most part the social systems, are active. By means of the cycle parameters the formation and decomposition of these systems can be quantitatively interpreted.

At a higher level of complexity factors occur which cannot be predicted at lower levels. Thus, history is usually interpreted as a stochastic system influenced mostly by random elements. However, governing systems consciously starting from the concept of value of global character of laws, UNO, peace-organizations, Roman Club, etc. are already active, e. g. international code, too. Now, a concrete and uniform method of research is needed which takes into account all the theoretically possible groups of factors. The system analysis according to the twelve cycle parameters tries to develop such a method. Its aims are:

— to promote the quantification of systems

— to unite the systems into a mutually fertile comparable uniform system

— to distinguish the parts of complicated systems

— to control the efficiency

— to create prognostics of different kinds

— to make careful suggestions to planning, experiments, simulations, modelling, computerized and automatized simulation, algorithm, operation research, optimalization and choice the preferences

— to promote the systematic, rapid and optimal transformation of production structures

— to improve the more exact concept-building, to disclose the hidden sense and relations of words (e.g. metaphors), to approach to each other the scientific jargons and to make it more unambiguous

— and as a farther aim to elaborate a uniformly interpreted wide network of concepts.

When these aims seem to be Utopian one has to remember that a lot of ideas of the "Utopia" by Thomas Morus have already been realized.

In favour of the fundamental elucidation of the possible method here only a few system types were analyzed in first approximation neglecting consciously the details. A more exact interpretation needs wide and interdisciplinary cooperation of different professions.

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ПАРАМЕТРЫ ЦИКЛОВ И ТЕОРИЯ СИСТЕМ

Э. САДЕЦКИ-КАРДОШШ

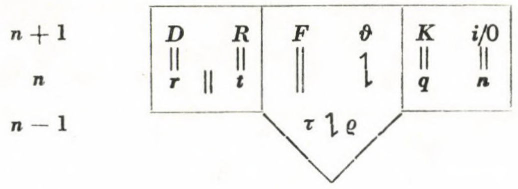
Резюме

1. Цикличные движения создают системы. В повседневном понимании данные системы являются продуктами цикличных движений двух промежуточных форм — полос *B* и *C*.

2. Для однозначного описания физических циклов необходимы 12 (рядов) параметров, которые в то же время являются общими характеристиками этих систем. Среди них 4 обозначают собственный уровень иерархии цикла: размерность пространства и времени (r и t) цикла, число сгруппированных по видам элементов (элементов системы) цикла ($n + u + \ldots$) и их координаты местонахождения ($q_n + q_u + \ldots$). Зависимость циклов от внутренней и внешней среды характеризуют параметры, относящиеся к двум соседним уровням иерархии. Внутренние параметры представляют собою густоту элементов ($\varrho_n + + \varrho_u + \ldots$) и температуру ($\tau_n + \tau_u + \ldots$). Соответствующие этим 6 параметрам дальнейшие 6 параметров содержат связь циклов с внешними, более высокими уровнями иерархии: относительную скорость системы (трансляция, D), долговечность системы (число R ротаций цикла), количество по видам полученных от среды и переданных обратно элементов (вход i и выход o), количество других систем, находящихся в непосредственной контакте с данной системой (N), свободный объем диспергирующей среды (ϑ) и (внешние) принудительные силы (F' — внешняя принудительная сила — температура!).

Структуру систем дает связь 3 групп, состоящих из четырех параметров цикла:

Уровень иерархии



3. Для параметров цикла можно также выразить и физическое содержание (например, объем $V \sim r^3$, масса $M \sim r^3\varrho$, кинетическая энергия $E_{\text{кин}} \sim \frac{1}{2} r^3\varrho \left(\frac{r}{t}\right)^2$, энтропия $S \sim \frac{1}{\log R}$, химический потенциал $\mu \sim \frac{K - \vartheta}{v}$).

4. Среди систем согласно комплексности могут быть выделены разряды, в которых свойства 12 физических параметров цикла абстрагируются постепенно. Данная работа выделяет следующие разряды: электромагнитные колебания полосы A; неорганические системы полосы B; неорганические системы полосы C; системы биологических индивидов; системы животного мира, психологических циклов, (гуманных) общественных, экономических и искусствоведческих наук.

5. Форма 12 параметров цикла, изменяющихся по разрядам, может служить основой для создания единой взаимно пересчитываемой системы понятий, вместе с тем для широкого квантированного обзора знаний. Чтобы разобраться в хаосе понятий и знаний, возросших в потоке информации и взаимосвязей нашего времени, необходим такой обзор. Хаос приводит к формированию новой системы циклов, смене эпох, где теория преобразования циклов может дать информацию.

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CYCLE VIEW AND COSMOLOGY

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The velocity of the four basic motion types are logarithmically doubled when moving from the strip D toward strip A: $v_A/v_B \sim 10^5$, $v_B/v_C \sim 10^{10}$, $v_C/v_D \sim 10^{20}$ thus $v_A/v_D \sim 10^{40}$. This relation is interpreted as a resonance of the cyclic motion phenomena.

The structure of the cycle diagram is correlated with the universal constants. The extension of the space: time diagram, however, increases according to the dilatation of the Universe. This is possible if the gravity constant changes as a function of time and the mass of the matter was smaller at the Big-Bang.

The spherical surface of the Universe measured by the Hubble-radius may be just covered by 10^{80} protons. This is the number of the protons in the Universe computed by Jordan. Thus it is assumed that the matter — mainly the protons — are generated at the Hubble boundary-surfaces of the expanding world, when the oscillating active space quanta of this world collide with the inactive ones outside the expanding world. Space quanta get rotating by the collision thus are joined to particles (mainly protons) by a mechanism principially similar to the electron-positron pair-forming generated by high energy photons or other types of collision described in a preceding paper of this volume.

This model is supported by the assumption of Dirac concerning the parallel generation of space and matter. Not only the difference of the smallest and greatest velocities but — according to Dirac — the proportion of the electromagnetic and gravitative energies, and the age of the Universe expressed in atomic units are of the order of 10^{39}—10^{40}. Since this is the square root of the number of the protons 10^{78}—10^{80}, mass may increase proportionally with the square of the lifetime of the Universe.

The cycle view concerns fundamentally the "real" facts of the present world which can be directly observed. It looks primarily for the uniform quantitative bases of natural and social relationships. Its interests are assigned primarily to the human problems. Nevertheless, since these spread over the whole Universe the consideration of the relationships of cycle investigations cannot be avoided from the point of view of the nowadays extensively evolving speculative branches of sciences, i.e. of the space-matter relationships and of cosmology. The second paper and this one deal with such kinds of problems. These speculative considerations and their validity, however, are independent of the cycle velocity relations.

In the up-to-date cosmology the theory of expansion predominates. The Big-Bang-state before 10^{18} sec, more exactly $1{,}6{,}10^9$ years and the preceding universal black-hole-state may be interpreted by the quantum-mechanical tunnel-effect, the initially slow photon-dissipation, then by the accelerating material flow affecting other particles, and finally by the Big-Bang according to HAWKING. The universal cyclicity relation support the idea that the generation of the universal black hole is a result of a former contraction complementing the expansion but essentially opposite to it.

According to FRIEDMAN the mass of the Universe may be estimated to 10^{52} tons and the duration of expansion to $40 \cdot 10^9$ years (i.e. still plus $24 \cdot 10^9$ years). If, however, the material quantity is considerably less, the gravitation will be too small to produce the re-contraction of the material. Consequently, the assumption of an eternally expanding world, opposite to pulsation must be also considered. This possibility is investigated by PAÁL in this volume.

Any model can hardly avoid the new concept of DIRAC on the parallel generation of space and matter. The basis of this is provided by the peculiar relationship between the proportion of the electromagnetic and gravitation energy of 10^{39}—10^{40} (supported also by the A—D velocity difference, see below) and the number of protons of 10^{78}—10^{80} being the square of the former values.

DIRAC pointed out that the ratio of the electric force of e^2/r^2 and of the gravitation force of $\gamma m_e m_p/r^2$ results in $e^2/\gamma m_e m_p \sim 10^{39}$, and that the approximate age of the Universe of about $20 \cdot 10^9$ years is also 10^{39} expressed in atomic units. Assuming that the coincidence is not accidental, parallel with the increasing age of the Universe the γ-value should also increase. Since the totality of matter in the Universe amounts to about 10^{78} proton mass which is roughly square of the age of the Universe in atomic units, DIRAC assumed that the mass increases proportionally with the square of the lifetime. New particles are probably generated where matter already exists. When modifying the DIRAC's assumption, i.e. that the nuclei of not all the elements but only those of hydrogen are considered to be able of multiplication — the new elements of greater atomic weight are produced by the joining of these —, it can be understood that in the ancient minerals no traces of proton formation can be observed.

The results of the universal cycle relation support this concept. The difference between the greatest and smallest cycle velocities is of 10^{39}—10^{40} orders of magnitude: $v_A/v_D \sim 10^{40}$. This conformity is not accidental: the electromagnetic oscillations are represented by the strip A, while gravitation can be traced back to the motion system of the strip D (to the oscillation of particles, see p. 61. of this volume). Thus, the difference of 10^{39}—10^{40} exists not only between the electromagnetic and gravitation energies, but also between the corresponding velocity values.

Relationship can be determined not only between the two extreme velocities but also between the velocities of the four basic cyclic types of motion. Accordingly, the subsequent velocities can be logarithmically halved or in other words when moving from the strip D towards strip A the values of velocities are logarithmically doubled:

$$v_A/v_B \sim 10^5, \quad v_B/v_C \sim 10^{10}, \quad v_C/v_D \sim 10^{20}.$$

The logarithmic halving of velocities should be interpreted as a resonance-like universal hierarchic phenomenon reflecting the law of upper harmonics of wave-length., resp. frequencies. This relationship includes the energies, moments, dispersities and a lot of other phenomena of the Universe. Considering the structure of particles and other aspects the introductory study discussed the general problems of the resonance.

The study of BENKŐ (separate volume) deals with the temporal arithmetic doubling, resp. halving of the geological and galactic processes.

According to the recognition of PAÁL (this volume), in case of celestial bodies and systems of celestial bodies the logarithmic doubling (halving) also appears. Having halved logarithmically the proton mass of about 10^{78}—10^{80} of the Universe, resp. the $A-D$ velocity of 10^{39}—10^{40}, the logarithmic halving can be continued in details in the next logarithmic doubling. At the $10^{58.5}$ proton value the mass of the greatest star is obtained, the subsequent logarithmic halving produces the mass of the greatest galaxy at $10^{68.5}$ proton mass, and the mass of the greatest super-galaxy at 10^{73} proton mass.

PAÁL's proton-star-galaxy-mass relationship expresses the mutual quantitative determination of the hierarchic systems of strip B. Consequently, the Big-Bang explosion is an oscillation-like energy effect which can be described by wave equations.

Thus, according to the cycle view the Universe can be considered as an unbroken system of rhythmic-oscillating and cyclic-revolving motions which can be essentially described by wave equations.

The cycle diagram interpreted in sense of the upper harmonics provides fundamental information on the problems of universal constants. The structure of the cycle diagram (Fig. 1 in the first paper of this volume) reflects some universal constants. The strip D is displaced towards the right-increasing time parameters in the course of the expansion of the Universe. This results in the increase of the cycle diagram in proportion with time, but the distances between the strips does not increase. This is possible if certain universal constants, first of all the gravity constant change as a function of the time. In this case, at the beginning all the celestial bodies and systems of celestial bodies were of smaller mass and have increased parallel with the expansion (DIRAC).

In the changing Universe many dimensionless values remain unchanged but the basic units outside the strip A will change, i.e. the absolute quantities of the matter and energy will also alter. According to the upper-harmonic hierarchy structure, the conservation of matter and energy means not the conservation of their absolute value, but the conservation of their logarithmic ratios and some basic relationships. The measurement produces the constant value, the sum when starting from a constant. In fact, it is not the absolute values and conservation of the matter and energy what is measured but the conservation of their ratio. According to this interpretation, the absolute values of the matter's quantity increase in the expanding world, thus the proportions of velocities and dispersities are changing, in the sense that they become differentiated. This may be shown by the temporal increase of the units of space- and time axes of the cycle diagram.

The light velocity, i.e. the vacuum character of strip A should be, however, considered to be unchanged. Moving backwards in time the velocities of strips B and C approach the A light velocity, i.e. they increase. Finally (in the obviously unrealizable extreme case), only one velocity, the light velocity and the corresponding one D nucleon would remain as the abstracted starting point of the Big-Bang. Thus, the initial nucleon-poor state is characterized by a minimum-density vacuum ratio, i.e. by an extreme ϱ/ϑ degree of dispersion, (see the former paper of this volume) i.e. great velocity approaching the light velocity.

The types of dispersion (and not the absolute values) of the matter imbedded in vacuum are unchanged. The basic scheme of the cycle diagram and the involved natural laws are unchanged.

The constancy of all universal constants can be assumed only if the law of upper harmonics would not extend also over the strip D. In this case, parallel with the temporal displacement to the right of the strip D only the great-dimensional part of the strips A and B would be elongated without the change of the distance between strips A, B and C, resp. of the absolute value of their velocity.

The principle of upper harmonics should be reflected also by the temporal character of the processes. It is important, however, that as a function of the historic-geological times the upper harmonics appear not in logarithmic but in nearly arithmetic units though slightly accelerating in time. This follows from the relation that time is one-dimensional, space is three-dimensional.

The cycle relation allows to interpret the difference of velocities, resp. energies of $10^{39}-10^{40}$ order of magnitude, resp. its relationship with the proton number of $10^{78}-10^{80}$. It has been found that the protons of about 10^{80} number would cover the spherical surface of Hubble-radius as a unistratal envelop.

The n_p proton number is a linear function of the expansion and is in proportion with the sum of the circle section surface of the particles n, first of all of the protons of r radius of the prevailing Hubble spherical surface of R radius: The number $n_{(p+x)}$ of the protons and other primary particles will be determined by the equation: (r and R in cm-s):

$$n_{(p+x)} = \frac{4R^2}{r_p^2} = \frac{(4 \cdot 10^{28})^2}{(10^{-13})^2} = 4 \cdot 10^{82}.$$

The $n_{(p+x)}$number including other particles may be greater by about two order of magnitude than the n_p proton number. Thus the about 10^{78}—10^{80} proton number computed by JORDAN and others sufficiently corresponds to the theoretically calculated value. Better agreement is found when instead of the 10^{80} protons $= 1.67 \cdot 10^{50}$ tons matter the most up-to-date value of 10^{52} tons of HERBERT is taken into account.

According to this new relationship in the Universe, there is a material mass (essentially proton) which just cover the Hubble-surface. This relationship also supports the cosmology of DIRAC and the enlargement of the modified conservation theses. Accordingly, the space/matter ratio, as well as the density of the Universe, further the ratio of the electromagnetic and gravitation forces are constant, but the quantity of matter and among others the value of the gravity constant is changing, i.e. increasing.

This relationship is valid independently of the cycle view and of the interpretation of the space-quantum model and supports the interpretation of the generation of particles mostly as a surficial frontal process connected with the expansion.

According to this connection, it may be assumed that protons are generated at the prevailing Hubble-boundary of the expanding world and proceeds at this surface. Here the active space quanta of the expanding world collide with the inactive space quanta outside the Hubble-volume. The hereby rotating space quanta are jointed to particles. The sine waves of the oscillating space quanta whirling backwards produce the rotation. This process is similar to the pair forming mechanism of the photon-proton collision described in the second paper of this volume (p. 60.).

However the process at the Hubble-surface differs from the common pair-formation that not the photons of great velocity but on the contrary, particles of great velocity collide with relatively inactive space quanta. Each particle produces in front of it symmetrically rotating space quantum groups which join their neighbours of opposite rotation and produce stable particles. Thus, the quantity of the generated particles is proportional to the prevailing value of expansion at the Hubble-surface.

The particles generating at the Hubble-surface lag ever behind the front expanding with light velocity as a result of their inertia and their initial A-velocity decreases to B-velocity. In the course of decreasing temperature the initially uniformly distributed particles are joined to atoms and molecule groups, then by means of gravitation to celestial bodies.

As a result of the appearance of particles in the expansion front a magnetic field affecting the motion of particles will occur.

In this way the modelling of the pulsating Universe seems to be possible.

Parallel with the further decrease of energy the vacuum temperature (2.7 K) of the Universe approaching the absolute zero, the equilibrium between

the expansion, and proton formation will be broken and a marginal proton accumulation with the increase of gravitation will begin. Thus expansion is replaced by contraction.

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ЦИКЛИЧНЫЙ ПОДХОД И КОСМОЛОГИЯ

Э. САДЕЦКИ-КАРДОШШ

Резюме

Скорости четырех основных типов движения логарифмически удваиваются, если продвигаются от полосы D в сторону полосу A: $v_A/v_B \sim 10^5$, $v_B/v_C \sim 10^{10}$, $v_C/v_D \sim 10^{20}$ и $v_A/v_D \sim 10^{40}$. Эта зависимость толкуется как резонанс явления цикличного движения. Структура диаграммы циклов отражает универсальные константы. Протяженность диаграммы пространство; время, однако, увеличивается согласно дилатации космоса. Это возможно при условии, если константа гравитации изменяется в функции времени и масса материи была бы меньше при Биг Бенге.

Сферическая поверхность Вселенной, измеряемая радиусом Хаббла, покрывается как раз 10^{80} протонами. Это — количество протонов во Вселенной, вычисленное Джорданом. Таким образом, можно допустить, что материя — главным образом протоны — создаются поверхностями границы Хоббла растягивающегося мира тогда, когда осциллирующиеся активные пространственные кванты этого мира столкиваются с неактивными пространственными квантами, находящимися за пределами растягивающегося мира. Таким образом, пространственные кванты, введенные во вращение в результате столкновения квантов, присоединяются к частицам (главным образом — протонам), посредством механизма, в основном аналогичного фотонам высокой энергии, образующим электроно-позитроновые пары или других типов столкновения, описанных в предыдущей стате.

Эту модель поддерживает предположение Дирака относительно параллельного образования пространства и вещества. Не только разница наименьших и наибольших скоростей, но — по мнению Дирака — также и электромагнитная и гравитационная энергии и даже возраст космоса выраженный атомными единицами, имеют величину порядка 10^{39}—10^{40}. Поскольку это квадратичный корень числа протонов 10^{78}—10^{80}, масса изменяется, по-видимому, пропорционально квадрату ее продолжительности существования.

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FUNCTION RELATIONS AND CONFIDENCE INTERVALS OF CYCLIC RELATIONSHIPS

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The shape and confidence limits of the functions expressing the velocity relations of the electromagnetic (strip *A*), cosmogonic and mechanical cosmogonic (strip *B*) and of the chemical, biological and geological (strip *C*) motions lying in three parallel strips in the diagram of universal cyclicity relation of SZÁDECZKY-KARDOSS. The confidence intervals of the functions are taken as $\pm 1/2$, ± 1 and ± 2 orders of magnitude.

The interaction of strips is assumed to be one-sided: the motion of greater velocity affects that of lower velocity but inversely this is not true.

When moving from the strip *A* towards strip *C* the motion cycles are repeated similarly but less regularly than ever. Thus, to more obvious characterization of the cycles of biological and geological character in strip *C* the logarithmic spiral is suggested. Instead of the life-time of the individual, the time necessary for reproduction (i.e. for sexual maturity) is suggested to describe the biological cycle.

To investigate the social and economic cycles is troublesome and is caused by the fact that the number of repetitions is small while the factors influencing the cycle are numerous and their interaction is not always cleared.

According to the ever progressing and advancing universal cyclicity relationship established by E. SZÁDECZKY-KARDOSS in 1975 the cyclic natural phenomena known so far plotted in a rectangular diagramm (on the basis of their space and time parameters) are the electromagnetic, mechanical and chemical, or rather biochemical and biological cycles of motion. These appear arranged along three parallel straight lines (*A*, *B*, *C*). The recognition of this regular arrangement was possible thanks to the necessary and logical mode of representation which demonstrated the parameters in question in logarithmic scale just due to their wide range of orders of magnitude [10 11, 12].

The fact that the numeric relationship of data was transformed into a logarithmic one has the advantage, in addition to the suggestive graphs, that the recognition of relationships as well as their mathematical-geometric treatment became easier.

1. Expression of the Universal Cyclicity Relationship in Form of Function Relations

In the space-time diagram the arrangement of points is no strikingly regular that it nearly compels to express the interrelations between the individual factors in form of functions. Moreover, it is desirable in all cases and efforts will be made to express the relations between phenomena most simply, i.e. possibly in form of a function relation. This requirement can easily be satisfied just due to the double logarithmic plotting.

1.1 *Function Forms of the Strips*

1 11. The relationship between the logarithms of the plotted values can be considered numerical because of the linear arrangement and can be simply expressed by the equation of the straight line.

Assuming that the corresponding value pairs are obviously in a close correlation with each other (which is made probable by the arrangement of the empiric data in the figure and by the studies of different branches of science) the relationships can be expressed by the following ***logarithmic functions:***

$$\log y_A = \log x_A + \log 3 \cdot 10^{10}$$

$$\log y_B = \log x_B + \log 10^5$$

$$\log y_C = \log x_C + \log 10^{-7}$$

where $y = \mathrm{cm}$; $x = \mathrm{sec}$

1.12. The three parallel straight lines marked by A, B and C in the figure are, in fact, not parallel with each another. This becomes evident when the function relations represented by the three strips designing the order of cyclic motion ***are expressed*** in delogarithmized form, i.e. ***numerically.*** In this case:

$$y_A = 10^{10} \cdot x_A$$

$$y_B = 10^5 \cdot x_B$$

$$y_C = 10^{-7} \cdot x_C = \frac{x_C}{10^7}$$

When expressing the three lines numerically, also straight lines result, but these are not parallel with each other and starting from the origo they are extremely divergent. The lines A and B are very steep as this is indicated by their rise: 10^{10} resp. 10^5, while the line C is very flat, its rise is 10^{-7}. Thus, the lines A and B can be considered to be vertical and the line C to be practically horizontal. In this way the relationships may lose one of their most important advantage, i.e. their suggestivness. On the other hand, plotting requires a logarithmic scale due to practical reasons, as well.

1.2. The ***function relations*** outlined above ***are valid*** not between infinite limits. This can be deduced also from the figure. They are valid in the ranges determined by limits based on real data and some theoretical considerations. These can be determined according to two assumptions:

— the straight lines *A*, *B* and *C* reflect real correlations;

— the Hubble-limit is valid for all the three cyclic motions.

1.21. The lower limit of *the line* "*A*" was fixed by E. Szádeczky-Kardoss at $2 \cdot 10^{-14}$ cm as deduced from the Planck's energy values of the vibration quantums assigned to this range (11). This unambiguously determines the corresponding time value, as well.

In the figure the origo is 10^{-15} sec for x, and 10^{-25} cm for y.

Though the choice of origo of the coordinate system is arbitrary, the value chosen (being less by an order of magnitude than that deduced theoretically) seems to be well founded. The minimum of space parameter, 10^{-15} cm, is less by three orders of magnitude than that of electron, but is greater than that of the zero-massed particles, i.e. photon, electron-neutrino, myon-neutrino, resp. their anti-neutrino and graviton.

On the basis of the assumption of Gy. Paál [8], i.e. that as deduced from the theory of relativity the upper limit lies at about 10^{10} parsec ($= 3.1 \cdot 10^{28}$ cm), this value, 10^{28} cm has been accepted by E. Szádeczky-Kardoss [11]. The corresponding time parameter, i.e. 10^{18} sec coincides with the Hubble-time. This might be the "Big-Bang" cycle of the (known) universe [8]. The upper limit of the time parameter would correspond to $0.98 \cdot 10^{11}$ years. This is in good correlation with the cycle time of about $0.86 \cdot 10^{11}$ years concluded by Fridmann to the expansion-contraction cycles of the Universe. Thus, this would correspond to the stability limit of the Universe but would not mean the boundary of it, only the boundary of matter being capable of stable motion. Consequently, this does not mean the end of the Universe but means the space and time limits of matter in cyclic motion [9].

1.22. The upper *limit of the function B* expressing the cycles of the mechanical motion of matter may surpass in no case the range valid for *A*. It is very likely even less by an order of magnitude at least. Thus $x_{B_{\max}} \leq 10^{17}$ sec this is somewhat less than the value in the figure.

To determine the lower limit seems to be somewhat more problematic. On the figure the lower limit point of the straight line is indicated at $x = 10^{-13}$ sec, and from here the line is connected with the origo, i.e. with the starting point of *A*. In this case the lower limit would be determined both for y as well as for the upper value of x.

It is to be considered, however, whether is it necessary to derive the two lines from the same starting point. In lack of concrete data, resp. knowledges on a purely theoretical basis a speculative model can be made up which derives the start of line *B* not from that of *A*, but from elsewhere and connects them in another manner. The lower limit value of the line *B* can be approached also as follows:

Based on the figure, the $y = 10^{-8}$ space dimension corresponding to the electron shell of hydrogen does not fall to the line *B*. Thus, this point can be considered as a transition to the curve A. To take this value as the lower limit of the straight section is, of course, arbitrary. Nevertheless, this expresses the principle that matter can pass from electromagnetic to mechanical motion, resp. to exert mechanical or more exactly such motion which can be described by the NEWTON's axioms, only after having attained a certain order of magnitude.

Assuming that in end cases the transition from one curve into the other is abrupt, this is indicated in the figure by horizontal, resp. vertical displacement. In the variety of the diagram modified in this manner (Fig. 1) the final sections of the curves are without rounding in order to emphasize the abrupt character of the transition. This, however, does not exclude transitions of other kind, e.g. incidentally non-horizontal joining.

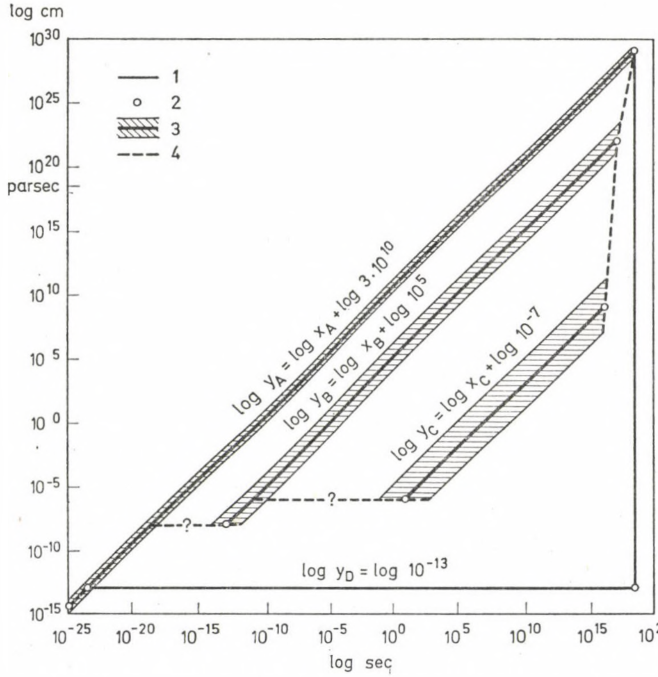

Fig. 1. Functions, limits and ranges of validity of the cyclic relationships. 1. Lines of cyclic functions; 2. validity limits; 3. intervals ranges; 4. possible (probable) transitions between the strips

It is to be noted that according to GY. PAÁL the motions falling to the upper end zone of strip B leave the strip at the time dimension of 10^{14} sec, and tend to join the final point of strip A along an ever rising line and reach it in a distance of about 10^{15} light-year, i.e. of about 10^{23} cm.

1.23. The upper limit of *strip C* was determined by E. SZÁDECZKY-KARDOSS by the Earth's diameter ($1.3 \cdot 10^9$ cm) and by the corresponding time parameter (10^{14} sec). If the Earth cycle is considered to be not an individual phenomenon, this limit can be somewhat elongated.

In favour of a more exact delimitation the following consideration is suggested. The condition should be valid of both strips C and B that their upper limit can not exceed that of A, moreover, logically that of strip C cannot exceed that of B.

The age of the Earth as a geological object is 5 to $6 \cdot 10^9$ years (i.e. 1.6 to $1.9 \cdot 10^{17}$ sec) as to our recent knowledge. Considered, however, as a geological object possessing also biological cycles, it must be younger. Since the difference does not exceed 50 per cent of the whole age, more probably it is only 25 to 40 per cent of it, this does not cause change in the order of magnitude. Thus, this can be neglected.

The total time interval of the Earth cycle is unknown. When, however, the stringent statement of the universal cyclicity relation is valid, that the space dimension of the cycle determines also its time parameter, in possession of the space parameter this can be determined in the figure. Further, considering the recent dimension of the cycle, this determines the remaining time with a high accuracy.

When assuming that the half of the cycles has been reached, this would mean 10 to $12 \cdot 10^9$ years, i.e. 3.15 to $3.78 \cdot 10^{17}$ sec. If the length of the Earth's total cycle would be taken as 20 billion years, which may be hardly longer, the upper limit would be only $6.3 \cdot 10^{17}$ sec and this is less by an order of magnitude than that of A. Consequently, the curve C would pass through B into A at about 10^{17} sec.

A cycle longer than 10^{17} sec may be hardly assigned to the field of geology. It seems to be probable that the Earth's cycles, especially the biological ones are earlier completed than those of the universe. Consequently, the assumption seems to be acceptable that the upper limit of the cycles characterized by biological motion are of minor values.

In the original figure [10] the lower limit should be below the dimension determined by the point 9 indicating the bacterial cycle (10^{-4} cm) but above the minimum of B. A further approximation is promoted by the data of H. MOROWITZ who, as to the communication of B. GULYÁS [5] determined the smallest dimension on thermodynamic bases in 10^{-5} cm which a living organism should possess in favour to be able for the minimal biological functions being qualified as "life". When not the totality of these biological functions but only some elements of them are taken into account, the minimum of space dimension would be smaller, as well.

Accordingly, $y_{C_{\min}}$ is the matter of smallest dimension which preserves its stability at the given velocity and is able to move according to the strip C.

1.24. Based on the considerations explained previously the validity fields of the functions expressing the three strips of motion can be *summarized* as follows:

Strip	Time dimension (= x)		Space dimension (= y)	
	min.	max.	min.	max.
A	10^{-25}	10^{18}	10^{-15}	10^{28}
B	10^{-13}	10^{17}	10^{-8}	10^{22}
C	10^{1} (10^{0})	10^{17} (10^{16})	10^{-6} (10^{-7})	10^{10} (10^{9})

1.3. *The confidence interval of the functions*, i.e. the maximal deviation from the axes of strips within which the given phenomena can be assigned to the corresponding cycle strips, has been indicated by E. SZÁDECZKY-KARDOSS in ± 1 order of magnitude [11, 12]. It is more probable, however, that this value is different for the different strips. This is also mentioned by the author, i.e.

— the velocity values of the strips *A* and *B* are given as 10^5, resp. 10^0 km/sec while that of strip *C* this is $10^{-11} \ldots 10^{-13}$ km/sec (roughly the mean value of this was taken into account to express the strip *C* as a function);

— in the figure original the width of each strip is shown in increasing manner (according to the figure, the width of the strips *A*, *B* and *C* would correspond to 0.75, 1.5 and 3 orders of magnitude).

The figure fairly reflects the regularity based on empiric data that the strictness of belonging to the given strip decreases from *A* to *C*.

This fact is, however, supported also by theoretical considerations.

The velocity differences between the strips are attributed by E. SZÁDECZKY-KARDOSS rather plausibly to the fact that the dispersity degree of the medium of motion increases from *A* to *C*, to an ever growing extent [12]. This means, however, that the motions of strip *A* to be expressed by physical formulae and controlled by strict causal regularities are substituted by the forms of motion in which rather the stochastic regularities appear or become predominant.

The stochastic regularities, however, are characterized by greater deviation. The strip comprised in the same confidence interval widens. To express this only the formulation by words of the plotted regularity is needed, resp. it is to be interpreted. Without any particular objective evidence the following approach is suggested:

The width of strip *C* is originally two orders of magnitude according to the velocities of 10^{-11} and 10^{-13} km/sec. When two further orders of magnitude are assigned to this and the characteristic velocity as 10^{-12} km/sec in the strip *C* is accepted, the confidence interval conform to the other strips will be ± 2

orders of magnitude, i.e. the velocity values will vary between 10^{-10} and 10^{-14} km/sec.

Strip B can be characterized by ± 1 order of magnitude, i.e. taking the mean value in 10^0 km/sec the motions of 10^1—10^{-1} km/sec velocity can be assigned to this strip.

In strip A those forms of motion are found the regularities of which can be described by causal relationships. In this case it would be expected that the points demonstrating the motions would coincide with the line of the function A. Even if the strip of confidence interval is not taken zero, which would be probably expected theoretically, it is true that the closeness of individual data to the function will be very high, much higher than either in the B-or in the C-strips. Consequently, it is suggested to take the width of the strip belonging to the function A to be of ± 0.5 order of magnitude as the respective confidence interval.

Referring this to the velocity of $3.0 \cdot 10^5$ km/sec accepted to the strip A this would correspond to limiting values of of $9.5 \cdot 10^4$, resp. $9.5 \cdot 10^5$ km/sec.*

If one expresses the confidence intervals, belonging to each strips and including the same percentual cases (80 per cent at least) in terms of velocities characteristic of the strip the following values are obtained:

Strip	Standard velocity cm/sec	Velocities belonging to the maximal permissible		Confidence interval
		negative	positive	
		deviation		
A	$3 \cdot 10^{10}$	$9.5 \cdot 10^9$	$9.5 \cdot 10^{10}$	10^1
B	10^5	10^4	10^6	10^2
C	10^{-12}	10^{-14}	10^{-10}	10^4

The values reflect the empirical regularity mentioned above that the more the occurrence of forms of motion characterized by regularities expressible by stochastic relations can be expected in the subsequent strips, the more wider will be zone of the confidence interval concerning the same frequency.

It is to be emphasized, however, that these limits are based only on a small number of concrete data but are in harmony both with the empirical facts and with the theoretical considerations. Later, in possession of more de facto data (and present author will contribute to this in the field of geology)**

* Concerning this value greater than light velocity see the paper by G. MÁRFÖLDI [14].

** BENKŐ, F.: Geological and Cosmogonic Cyclic Phenomenia Reflected by the New Universal Cyclicity Relation (In press) both the average velocities characteristic of the strip and the limiting values assigned to a given confidence would be more exactly determined.

1.4. The newly developed *strip D* seems to be practically horizontal in the double logarithmic scale. Accordingly, its value is expressed

$$\log y_D = \log 10^{-13}$$

or in delogarithmized form

$$y_D = 10^{-13}$$

function (i.e. both y and $\log y$ can be considered constant).

This and the horizontal run of the strip, i.e. that it is parallel with the x axis suggest that the basic conditions of the universal cyclicity relations, i.e. that in case of cyclic motion a definite space parameter is accompanied by a definite time parameter and vica versa, is not valid of this strip.

Thus, in this graph the strip D seems to represent a non-cyclic motion, resp. only those points may be cyclic motions simultaneously which cross the cycle strips. On the basis of the confidence intervals of the strips outlined above (see 1.2) this is a real value only in the case of strip A. Consequently, the strip D requires an interpretation somewhat different from the others.

2. Some Considerations Concerning the Universal Cyclicity Relation

The three i.e. electromagnetic, mechanical as well as chemical and biochemical kinds of cycles of matter being fairly separated in the diagram correspond to the three fundamental forms of motion. Strip C represents (also) the highest organization forms of matter, at least to our inevitably anthropocentric concept. Strip B represents the cosmogonic matter, the motion of which can be described by the mechanical axioms of NEWTON. Strip A represents the zone where matter does not occur in the everyday sense of the word but reveals itself only in form of radiations.

2.1. For the sake of simplicity, the cyclic motion is usually considered to be of circular orbit. This may be distorted to a smaller or greater extent [12] as it is expressed by the grade of divergency, and may become more or less regular elliptic- or circle-shaped.

The biological and geological, and in general the motion cycles in strip C are of the peculiarity that these motions are never repeated exactly in the same manner as are the physical or chemical cycles of the strips A and B, resp. C. This is especially valid in case of the social motions.

Repetition is similar but not the same or identical; certain changes took also place. This change generates the evolution characteristic of the social, biological, geological, etc. cycles. This introduces the historical view into the research of cyclic motions. History and the evolution itself indicate the irreversibility of the change.

In physics only those motions are considered to be cyclic which are repeated exactly in the same manner. However, the periodically repeated motions expressing unidirectional evolution (and therefore irreversible) within the strips *B* and *C* should also be considered to be cyclic.

To investigate its regularities and in favour of its numerical expression it would be more expedient to consider the *logarithmic spiral* instead of the circle. Further, demonstrating the temporal evolution the planar expression ought to be supplemented with a spatial component. In this way this type of cyclic motion could be numerically characterized by a function.

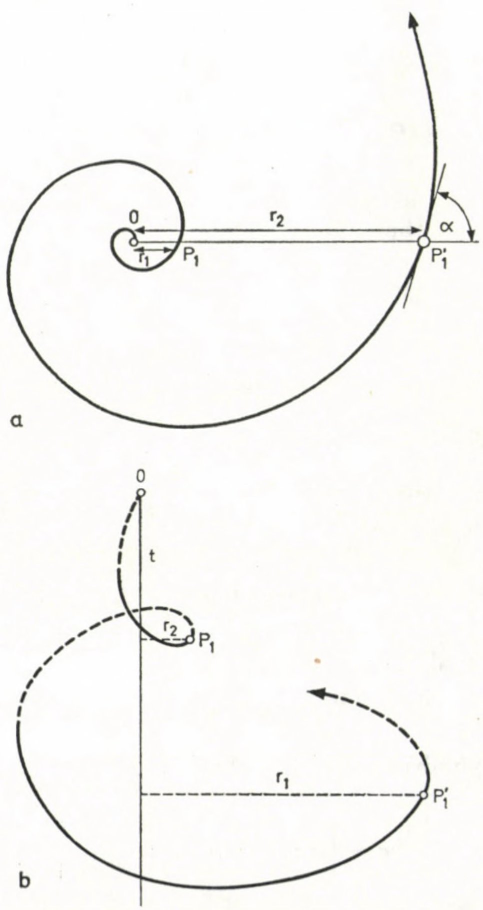

Fig. 2. The logarithmic spiral. a = in plane; b = in space; O = origo; r_1, r_2: radii; α = angle of tangent; P_1, P_1' = points of the cycle of the same position in case of one period difference; t = time axis

This would be the model of the "coiled line" [10], i.e. of the spiral evolution (Fig. 2). Its planar equation is:

$$r = a e^{k\varphi}$$

where

r = radius vector of some optional point of the logarithmic spiral (= the distance of point from the origo taking into account the direction),

a = constant,

e = exponential (base of natural logarithm = 2.7182818),

k = cot α, where

α = the angle between the logarithmic spiral and the half-line connecting the origo with any of its point (concerning the same spiral curve it is constant),

φ = the angle between any point of the logarithmic spiral drawn to the origo and the starting direction (in rectangle coordinate system: x-axis).

The only question is whether this function can be and how transformed into a spatial one, i.e. introducing the vertical in addition to x and y dimensions and displacing vertically the origo, is it possible to pull up the provisionally planar spiral into the space.

This removes at the same time the difficulties of interpretation of the time period arising from the irreversibility of biological and geological cycles.

The equation of such a "cone-like" (i.e. swirled to the envelop of the cone) spiral is as follows:

$$\bar{r} = \left\{ e^{at} \cos \omega,\ e^{at} \sin \omega t,\ b\, e^{at} \right\}$$

where

$\bar{r}$ = distance of the cone-like spiral's point from a fixed point of the space (radius vector),

e = exponential,

a, b = constants,

ω = angular velocity of the spiral motion (= the angle taken during 1 sec by any point of the spiral, projected to x, y plane)

t = time, expressed in optional time units (when e.g. the duration is the unit during which the point gets upward or downward by one spiral, then $t = 2\pi$).

In case of cylindric spiral (= spiral line)

$$r = \left\{ a \cos t;\ a \sin t;\ \frac{h}{2\pi} t \right\}$$

where

a = radius of the basic circle of cylinder,

h = lead (= rise of axial direction corresponding to one circumvolution).

2.2. The duration of the *biological cycle* is at present interpreted as fixed to the duration of life [10]. It is to be considered, however, whether this is the real (characteristic) time parameter of the cycle of living beings. The end of life does not mean the beginning of a new cycle referring to the given individual.

It seems theoretically more exact to define the duration of the cycle by the time needed to the biological "reproduction" of the individual. This can be most simply expressed by the time interval between fecundation and sexual maturity of the nascent individual. (N. B.: Similar values are used by Ondvári [7] in studying the social motions.) This is really a rejuvenation cycle and concerns the same individual. The difference between the results obtained by the two definitions is, of course, within one order of magnitude, thus the position of strip *C* will not be changed.

2.3. The possibility of investigation, resp. exact determination of the *social and economic cycles* would be of extraordinary significance. It is questionable, however, whether such a cycle can be determined fairly enough for being accepted as a scientifically convincing argument. The number of repetitions is small and these do not take place in the same manner. The periods are rather long and the divergencies are also high.

Furthermore, the social motion is constituted and influenced by numerous factors. The individual effects of these cannot be determined, neither their participation in generating the cycle, nor their interaction. Thus, it is questionable that at the beginning at least the investigations carried out in this manner would be convincing enough or not.

The investigation is especially aggravated by the fact that the space and time parameters of the cycle highly depend on the measure of independency of the production process of the natural cycles. E.g. in agriculture cycles corresponding to the seasonal changes could be expected. The more the techniques, and first of all physics enter into the production processes rendering them gradually independent of the cyclicity of biological processes, the more it can be expected that the cycle will be accelerated though its time parameter grows simultaneously. In this sense, however, it is without doubt that the investigation of cycles concerning the same branch of production may provide a new approach to the exact determination of the industrial, resp. in general the production (economic) level of development.

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ФУНКЦИОНАЛЬНЫЕ СВЯЗИ ЦИКЛИЧНЫХ ЗАВИСИМОСТЕЙ И ПЕРЕДЕЛЫ ИХ ДЕЙСТВИЯ

Ф. БЕНКЕ

Резюме

В работе определяются формы и пределы действия функций, выражающих скоростные условия электромагнитных (A), космогонных или механических (B) и химических, биологических, а также геологических (C) движений, располагающихся в трех параллельных полосах диаграммы установленного Э. Садецки-Кардошшом универсальной зависимости цикличности. Ширины полос, соответствующие диапазонам надежности (интервалам конфиденции) функций, принимаются за величины порядков $\pm 1/2$, ± 1 и ± 2, соответственно.

Автор предполагает односторонность взаимодействия полос: движения большей скорости влияют на движения меньшей скорости, но наоборот это видимо не проявляется.

В направлении от полосы A к полосе B циклы движений повторяются все менее и менее одинаково, но все же аналогично. Поэтому для более наглядной характеристики биологических и геологических циклов полосы C автор рекомендует применять логарифмическую спираль. Вместо продолжительности жизни особя в качестве объема биологического цикла предлагается принимать время до воспроизведения особя (достижения им возраста половой зрелости).

Трудности изучения общественных и экономических циклов обусловлены главным образом тем, что количество повторений обычно невелико, в то время число факторов, влияющих на цикл велико, и взаимодействие этих факторов, в свою очередь, не всегда ясно.

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SOME THEORETICAL AND PRACTICAL CONSIDERATIONS CONNECTED WITH THE CYCLICITY RELATIONS

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The theoretical significance of the universal cyclicity relation is manifested by the facts that

— a quantitatively expressible regular relationship is determined between the space and time dimensions of cyclic motions;

— based on the aforementioned fact it provides the possibility to the most comprehensive classification of natural phenomena;

— it has established a relation between the inorganic and organic world and the natural and social-economic phenomena, thus it is able to establish new relationships;

— it indicates the predominating character of the main motion type of matter: the forms of motion being assigned to the inter-strip velocity ranges are rare and usually these are only transitional;

— consequently, it supports the possibility of conversion of quantity into quality and the fixation of this conversion to limit values;

— it indicates the main phases and forms of the arrangement and evolution of the matter and motion, respectively.

The practical significance of the cycle relation is reflected by the facts that

— by means of the space-time relationship it promotes the consciousness of research if only one dimension of the cycle is known;

— in case of motion between the strips it refers to the transitional character of motion;

— it promotes the development of prognostics related to the natural resources;

— within certain limits it provides the possibility to the human influence of certain cyclic phenomena;

— it promotes the elucidation of economic and risk problems connected to the corresponding phenomena.

Reference is made to the determinative role of geonomy in the discovery of the universal cyclicity relation as well as to the tasks which can be forecasted in connection with the cycle relation.

Though the construction of the comprehensive diagrams of the opening lecture [10] is based on a relatively small number of data, the regularity is so conspicuous and high-grade and is in harmony with the statements of different branches of science. Accordingly, the forwarded ordering principle and therefore the most important conclusions can be considered to be of general validity.

This concept gives the most complete comprehension of natural cyclic phenomena known so far. When one accepts the fundamental statement, i.e. that cyclicity is a fundamental pecularity of natural phenomena, in other words that cyclicity is the most common natural relation, it would be justified to state that an overall systematization possibility of all the natural phenomena known up to now is presented.

This bears great importance both from the theoretical and from the practical points of view.

1. Theoretical Significance of the Universal Cyclicity Relation

1.1. The greatest theoretical significance of the universal relation of cyclicity is its existence itself, i.e. that *between the space and time parameters* of continuous, cyclic motions of organic and inorganic matter a regular relationship can be determined which can be *expressed quantitatively*, too. This provides a possibility of the uniform quantitative view of natural phenomena [10, 11]. Concerning the whole universe, resp. its part which is known by us it deals with the electromagnetic, mechanical, chemical, biological and geological cycles with a uniform concept. Moreover, it renders possible to investigate the social and economic phenomena on a scale comparable with the natural ones.

The cycle relations promote to enclose physics, chemistry, earth sciences and biology in a higher-grade unit and allow the mutual computations of their relations. As a uniform systematization principle, they provide a quantitative basis to systematize the sciences and to investigate their evolution trends [10, 11, 12].

The biological and geological as well as principally the social laws are beyond doubt of stochastic character. When investigating, however, either the chemical or the physical motions are studied in the time-ranges assigned to their space parameters these also turn out to be stochastic regularities as it is evidenced ever stringently by modern physics and chemistry. In this manner the cycles of apparently most different dimensions become commensurable. This is the other great epistemological importance of the universal relation of cyclicity in the natural, moreover probably also in the social sciences.

Consequently, the recognition of the universal relation of cyclicity ensures that investigations do not stop necessarily at the natural phenomena but may include the social and economic motions of mankind creating a relation of the widest sense between the organic and inorganic world, between phenomena and their history, as well as between the natural-scientific and social-economic phenomena. In this way research becomes an activity of universal character.

The analysis of relations from this point of view may produce new statements and by means of their synthesis — expressed most commonly by the universal relation of cyclicity — it is of fruitful influence also in each particular science, opens new vistas, and may initiate new research trends in different sciences, resp. science branches.

1.2. The universal relation of cyclicity contributes to the enrichment of ***natural phylosophy*** and epistemology corroborating their fundamental statements from a new viewpoint.

Based on the regular relationship, plotted in double logarithmic scale the cyclic motions of matter are arranged in three parallel strips of 45° rise. The strips represent the electromagnetic, the mechanical characterized by the Newtonian axioms and the chemical-biochemical-biological forms of motion, i.e. the fundamental motion forms of matter.

The three strips can be interpreted as three velocity fields, too. In this case the strips A, B and C represent the motions of average velocity of 10^5, $10°$, resp. 10^{-12} km/s. As it is indicated by the empirically plotted data grouped along these three strips, most of the material forms of motion known so far are characterized by these three velocities, resp. velocity ranges. This fact, however, results in significant conclusions in the field of natural philosophy.

The only question is that whether only these three velocity kinds of motion of matter exist, as stable motions at least. The fact that data are grouped around the velocity ranges characteristic of the three kinds of motion seems to support this assumption. This does not exclude, however, the possibility of existence of cyclic motions of other velocities (see later).

1.21. The circumstance that a sudden decreases occur at function-likely determinable limit values (strips B, resp. C) explains also the fact that *between the individual strips no transitional cycle forms are known so far*, resp. these are less frequent. Further, this provides an explanation the fact that the astonishing but conspicuous concentration of distribution can be observed along these three strips and that the individual strips are separated from each other by field characterized by no or very few data. The zones between the three strips are the transitional zones through which matter changing its form of motion passes suddenly; and if there is a motion, it is rapid and transitional, moreover not cyclic, but unidirectional. E.g. based on the data of GY. PAÁL [9] the planets get into the strip A from the strip B subparallelly with the y-axis during their collapse.

Accordingly, the motions being already or still not cyclic may be assigned to the fields between the strips.

If there is a relationship between the strips, and certainly there is a cyclic form of motion characterized by velocity ranges falling between the strips, would be expected. If it does not exist or appears but exceptionally or episodically, this is due to the facts that either it is really absent, or it is so transitional that cannot be practically observed. Consequently, the cyclic and, therefore, stable motions are concentrated in the strips, and the transitional, resp. acyclic motions fall in the fields between the strips. Some of the complex cycles can be assumed to fall also in the fields between the strips.

According to GY. PAÁL [9], the "black holes" lie above the A-strip, i.e. in the velocity range greater than $3 \cdot 10^{10}$ cm/sec. Beyond the C-strip, however, no further concentration zone can be probably expected. When extrapolating the differences of velocity between the strips, i.e. 5, resp. 12 orders of magnitude, the new strip ought to follow by a distance of 17 orders of magnitude at least. This would mean, however, a velocity of 10^{-24} cm/sec. Accepting the maximal space and time dimensions determined to the A-strip, over the C-strip a parallel stright line would fall out of the really representable range.

1.22. Investigating the strips A, B and C, it can be stated that in the range where real x-values are assigned to each strip, an ever growing time parameter (x-value) is assigned to the same space parameter (y-value) when moving from A to C. E.g. in case of $y = 1$ (i.e. $= 10^0$), the corresponding x-values are as follows: $x_A = 10^{-10}$, $x_B = 10^{-5}$ and $x_C = 10^7$ sec. In reverse terms: the velocity of the cyclic motion assigned to the same space parameter rapidly but not uniformly decreases from A through B down to C. This decrase shows differences in orders of magnitude of 5, resp. 12. In other words: the energy of motion of matter characterized by the same or given space parameter is highest in strip A and decreases towards strip C.

Forces are generated by the consumption of the kinetic energy of matter. Gravitation, chemical energy, etc. consume the motion to an increasing extent using the kinetic energy represented by velocity to their formation. Accordingly, strip A can be considered to be a basic energy level. A part of this basic energy is consumed by gravitation, resp. chemical energy in favour to produce new forces.

This statement does not contradict the explanation which attributes the velocity differences within each strips to changes of the degree of dispersity in the medium of motion [12].

The transition into another quality of form of motion characterized by a new type of force is possible only by reaching certain threshold values. The considerable orders of magnitude of limits indicate that as it can be deduced also from the universal cyclicity relation considerable *quantitative changes* should be followed in order to generate *qualitative changes*, i.e. the new material form of motion.

1.23. According to the Marxist philosophy the *matter is the motion itself*. Since the velocity of motion is greatest along strip A, i.e. $3 \cdot 10^{10}$ cm/sec, it would be a plausible conclusion that the real, most unlimited forms of existence and motion are represented by the cycles determined by the strip A. The matter of given dimensions is able to move with the greatest velocity in this strip. Consequently, the motion which is the most peculiar of matter is expressed most property significantly by the strip A. The representative of strip A is the matter, the inert mass of which equals zero [2].

This bears, however, the consequence that beyond the strip *C* theoretically further strips might exist till the matter would lose all its kinetic energy. This is, however, only a theoretical possibility since the non-moving matter can not be called as matter.

The same consideration enforces us to question the cyclic nature of motion represented by the nuclear forces in strip *D*, on the basis of the present diagram. Talking into account either the function or the graphic form of strip *D*, velocities are assigned to this strip which forces us to make some considerations.

On the basis of the diagram one of the limit velocities of the strip is about 10^9 cm/s corresponding to the time parameter of 10^{-23} sec. The other extreme value of the strip is about 10^{18} sec (i.e. about 10^{10-11} years) which produces a velocity of about 10^{-31} cm/sec, i.e. a velocity denoting cyclic motion of 1 cm during about 10^{23-24} years. In this case the material may take the motion corresponding to its own space parameter during about 10^{11} years, i.e. during a time interval which has been accepted as the complete cycle of the universe, resp. as the upper temporal value of the strip *A*. Though certainly not from the philosophical but yes from the human viewpoint this can be regarded to be in tranquillity, resp. in quasi-tranquillity, in other words its very material nature could be questioned.

1.24. The assumption that the three curves start not from the same point supposes the different forms of motion to be a process of historical (temporal) character. It is thus assumed that matter gets into the mechanical state from the electromagnetic one after having reached certain limit values of orders of magnitude; similar event would be the transition into the chemical-biochemical state.

This concept of transitions reflects also the cosmic evolution grades of the material and globally corresponds to the geological, resp. cosmogonic grades developed on the *evolution of the universe*, i.e. the mechanical forces develop from the electromagnetic motion and these generate the chemical-biochemical forces.

The same statement is valid of the upper section of the curves: At the end of the processes, the same change is repeated but in opposite direction and in strongly accelerated manner, as the natural cycles are characterized by the acceleration of the terminating phases. Accordingly, the evolution path of all transitions of the forms of motion shows the following trend: electromagnetic → mechanical → chemical-biochemical → mechanical → electromagnetic.

(The statement, i.e. the upper completing phase of the curves is rapid is true only in a relative sense. Here the time difference is one or at least two orders of magnitude as against the lower section of the curves where this may attain 3 to 8 orders of magnitude. This, however, concerns the range between 10^{16} and 10^{17} sec, i.e. it represents $9 \cdot 10^{16}$ sec, or $3 \cdot 10^9$ years. The change is rapid here when comparing only with the size; at the opposite ends of the curves these orders of magnitude of the distance would correspond to a split of seconds. There, however, the space parameter is very small, too.)

In the diagram the transition between the strips would be theoretically possible parallel with both axes and in both directions. Based on logical considerations, however, it seems to be probable that transition is possible only in the lower and upper sections of the strips. The organization, resp. degradation of moving matter of intermediate position take place up to these points within the strips.

1.3. For the earth-sciences it is of great importance (and this is our proper pride) since *the recognition of the universal cyclicity relation started* from the field of geology, or rather *from that of geonomy*. This is by no means accidental: geonomy is the only science which just due to its topics is enforced to deal with the forms and types of motion of most different kinds and orders of magnitude. And when a science, such as geonomy can reach the state to determine regularities and beyond qualitative statements it can quantify them it will inevitably discover the universal relationships of phenomena.

This recognition inspires the researchers of small countries: the recognition of universal regularities does not need the expensive instruments, tools and procedures which are allowed nowadays to the rich countries only. It is enough to have the "highly educated human mind" the production of which is more troublesome than that of the most complicated device.

2. Practical Significance of the Universal Cyclicity Relation

The universal cyclicity relation is of great importance also from the practical point of view. It contributes considerably to the theoretical-scientific investigation of cyclic phenomena and to the scientific forecasting based on them.

2.1. It is a common *case in scientific research* that e.g. due to any reasons only one element of a relationship could be detected, resp. fixed. If its dimensions determine the range where the other element of the relationship should be find, this can direct the research conveniently a lot of otherwise unavoidable and unproductive investigations could be omitted.

For instance, the incompleteness of terrestrial sedimentation cycles is often only apparent since only the preserved parts can be evaluated. Due to geological reasons, i.e. to theoretically random effects, more or less of them may be missing. In possession of the cycle regularities the lacking part can be reliably reconstructed.

The infrequency of the completely symmetric geological cycles follows from the logarithmic system of cycles. The initial or final phases of geological processes are often characterized either by enormous energies causing rapid changes or by the slow change caused by the low energy level. However, when the values would be plotted in logarithmic scale, in several cases a more or less regularity, resp. more symmetric arrangement could be observed. In the case of fossil sedimentary cycles not the cycles themselves but only their products are observable and they are practically always incomplete [1, 13]. Consequently, the geological sedimentary cycles are often only apparently incomplete since these can be judged only or their remnants. Now, due to geological reasons, i.e. to theoretically random effects (see: accumulation and erosion) smaller-greater parts of them may be absent. In possession of the cycle regularities, however, the lacking part can be reconstructed at a high level of probability.

Certain cosmogonic effects prevail not only in the Earth but also in other planets, in the internal planets at least. These cannot be detected after all since they cannot be observed. On the basis of the terrestrial cycles of cosmic origin it can be predicted in which space and time range the cosmic cycles of other planets can be expected. These (may) considerably contribute to the purposeful control of the exploration of the solar system.

2.2. As it has been emphasized by E. Szádeczky-Kardoss [10] the investigations of cyclicity can well applied in *the long-term prognostics*. Based on the extrapolation of data of the last decades the recent long-term forecasts take into account the monotonous trends instead of the more probable spirally cyclic development. On the basis of the determined cycles of water table fluctuation, there is a possibility to make long-term meteorological forecast, further the application in agrogeology, water supplies management, flood control, engineering geology and hydrocarbon prospection may also be taken into account.

Cyclicity, however, may play an important role in the forecasting not only of natural but also of social processes, e.g. of predicting economic prosperity. The statistic correlation of the annual agricultural production of areal units with hydrological, resp. meteorological cycles may improve not only the prediction of agricultural production but also the protection against the processes endangering the production itself [10].

2.3. It is probably not an exaggeration attribute further *potential practical* significance to the universal cyclicity relation. If there is a possibility to be acquainted with the most important time-space parameters of the cycle, this inevitably leads to make clear the factors that generate and influence the cycle. However, if it can be determined that how at what degree do the individual factors contribute to the appearance of the cycle in the given characteristics, the fact can also be established how these individual factors affect (qualitatively and quantitatively) the cycle itself.

The knowledge of direct or indirect effects of the individual factors (may) necessarily provide the possibility (or at least contribute to it)) that by modifying certain biological, chemical, geological and environmental, even of certain physical phenomena the cycle could be governed in a direction being (more) advantageous to mankind.

By means of modification of the ratio of each factors generating the cycle the duration and intensity of the cycle may also be modified, i.e. the cycle can be affected (controlled), accelerated or decelerated, enforced or attenuated. This has or may have great significance in biology (agriculture, food production, medical science, genetics, etc.).

If the determinant factors of the cycle are known there is the theoretical possibility to influence the cycle in a direction favourable to us, i.e. within the limits of repetition divergency of the cycle to increase the frequency of repetitions of advantageous effect. To increase, however, the deviation it is restricted by the natural limits. Exceeding this the cycle will be destroyed, resp. will be transformed into an other cycle.

2.4. The function-like expression of the relationships provides the possibility that assuming any general distribution the confidence intervals of each curve could be designated, e.g. the boundaries of the probability fields of 90, 75, etc. per cent. The knowledge of the cycle's dispersion field may contribute to determine or better approximate the measure of economic risk connected with given industrial or agricultural production cycles. This problem is scarcely studied also on a global scale and has not been unambiguously and satisfactorily solved, yet.

It is obvious that apparently it is not considered to be direct research task to *investigate the rentability*. This is, in fact, the task of other sciences.

The theories supported by a restricted number of data or elaborated only on a theoretical way and the different data series measured by independent methods and supported by many-sided data are fused into a uniform synthesis in geonomy. It is, however, an important feature of geonomy that it is not satisfied with the recognition of the qualitative relationships between different phenomena but highly enforces itself to throw light upon the quantitative side of the relations.

The need for quantification, however, means a concrete and indispensable basis to determine the possibility and rentability of utilization. The quantified relations, on their turn, may serve as a basis to decide the rational utilization in the future.

2.5. If there is a close relation between the two factors (space and time) taken as the basis characterizing the cyclic motion, as it is expressed by the universal cyclicity relation, their dimensionless relative number (ratio) can be used in graphic representation; thus *the plotting of* only *one dimension can be sufficient*, respectively.

This, however,

— renders possible the graphic representation of new parameters, e.g. p, t, etc., which produces better visual

— and indicates that the effort exposed by GY. MARX, i.e. to express phenomena by one value, can be approached also in this way [6].

3. Tasks to be Done

3.1. In harmony with the statements and sense of the first lecture [12] the tasks to be done are first of all as follows:

— the number of data in the diagram should be by all means increased;

— systematic efforts are to be made to allocate further very different natural phenomena in the diagram. This may allow the doubtless verification of the universal validity of the cycle relations.

In this occasion not only the arrangement of point-like data is required. Major part of natural phenomena will appear as lines or moreover as fields, since:

— the geological and biological phenomena reflect rather statistic (stochastic) than causal regularities,

— as it has been emphasized by E. SZÁDECZKY-KARDOSS the complex cycles are very frequent in nature.

3.2. The experiences of the universal cyclicity relation obtained so far demonstrate that if exists and is active. In favour of further development the period or research characterized by the efforts to support this relation should be followed by the period in which the researchers looks as an "advocatus diaboli" for phenomena which contradict to or cannot be interpreted by the cyclicity relation.

This is of double advantage:

— for the cyclicity relation the fields would be determined in which especially intense research is required to solve the contradictions and by means of differences to refine, particularize and improve the relation itself;

— it provides valuable basis to the science branches in question which make possible to design conveniently the fields, direction and tasks of further partial researches.

REFERENCES

See the paper of author entitled: "Function Relations and Validity Limits of Cyclic Relations" in this volume (p. 99—100).

НЕКОТОРЫЕ ПРИНЦИПИАЛЬНЫЕ И ПРАКТИЧЕСКИЕ СООБРАЖЕНИЯ ПО ЗАВИСИМОСТЯМ ЦИКЛИЧНОСТИ

Ф. БЕНКЕ

Резюме

Теоретическое значение универсального соотношения циклов заключается
— в установлении количественно выражаемой закономерной связи между пространственными и временными размерами цикличных движений;
— в возможности благодаря вышеупомянутому соотношению всеобъемлющей систематизации и классификации ныне известных природных явлений;
— в создании связи между органическим-неорганическим миром с одной стороны и закономерностями естественных наук и общественно-экономическими явлениями, с другой, и тем самым, оно может привести к открытию новых закономерностей;
— в том, что оно указывает на преобладание тех или других главных видов движения вещества: формы движения, относящиеся к межполосным диапазонам скоростей, являются редкими и как правило они только переходные;
— в том, что в связи с этим оно подтверждает возможность перехода количественных изменений в качественные и его приуроченность к предельным величинам;
— в том, что оно отражает основные фазы и формы упорядочения и эволюци« вещества и движения.

Практическое значение зависимости цикличности состоит в том, что
— он с помощью связи размеров пространства и времени подчеркивает целеустремленность исследований, если только один из размеров цикла известен;
— при движении между полосами он указывает на переходной характер явления;
— он способствует развитию прогностики природных ресурсов;
— потенциально дает возможность на то, чтобы — в определенных пределах — искусственно повлиять на отдельные цикличные явления;
— он способствует выяснению вопросов экономики и возможных рисков.

В работе указывается на определяющую роль геномии в открытии универсального зависимости цикла, а также на дальнейшезадачи исследований соотношения циклов.

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CYCLIC PROCESSES AND THE STABILITY OF SYSTEMS

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The hypothesis of the general system theory and the theory on cycles is expounded and an attempt is made at formulating the general, universal principles to be accepted as a basis. In the domain of philosophy this can be done on the basis of two methodological principles of dialectics, as a new paradigm for formulating theories, namely on the basis of the synthesis of universal relationships and on that of the principles of universal changes. Accordingly, the world is a totality of processes and process-based complexes of relationships.

The concrete task of the implementation of such a synthesis consists in expressing the phenomena of order in terms of interactions of the processes involved. Treating a system as a peculiar kind of stacking, the author defines it as the stability of the order. Expressed in terms of motion, the order is, on the one hand, a repetition, on the other hand, a specific superposition of different states. The existence of order, the preservation of a system and the consecutiveness of its existence are controlled by a specifically oriented form of motion—a cycle. Accordingly, the final conclusion of the paper is the following: a system is a cyclic process expressed in terms of process interactions.

The many-sided interdisciplinary approach to problems and the expansion of complex research are conspicuous features of the scientific evolution in the 20th century. The investigations starting from very different fields converge in peculiar foci, in so-called generalization points and throw light upon the unity of natural phenomena and processes by means of new methods and at higher levels. The idea of the unity of nature is one of the fundamental principles of Marxist philosophy. It can be, therefore, accepted that to follow with keen attention the new scientific trends and to support them by own activity, these provide grand experience to the representative of this philosophy. Both my research field and a long-term fruitful cooperation with experts in natural science offered me the possibility to be not only the beholder but also an active participant of a complex research trend based fundamentally on Hungarian results, the generalization focus of which consists of the cyclic processes. In 1975 joining in to the fundamental paper of E. SZÁDECZKY-KARDOSS I had the opportunity to deal with the position of rotation as a philosophical generalization of cyclic processes in the universal dialectics of motion, and to touch the relation of rotation to evolution. Already at that occasion the following thesis concerning the role of rotation was emphasized: rotation is the fundamental form of motion of self-sustaining processes. Now, this thought will be progressed to arrive at the probably somewhat audacious conclusion which states the *necessity of a synthesis of the cyclicity and universal system theories.*

I.

Historical Review

In its modern form system theory as a complex research direction and generalization theory has evolved from biology. Its first general formulation was done by L. von BERTALANFFY in the fourties and fifties. Its influence and productivity incontestable and it is ever widely applied nearly in all branches of research.

Cyclicity theory evolves from geology; its generalized form was elaborated in the fifties and sixties by E. SZÁDECZKY-KARDOSS.

Both theories exceed their field of origin and develop to generalization theories and universal methodological principles. These influence our world concept and touch the general philosophical bases of our ideology.

The two theories were conceived independently of each other, their evolution, however, is necessarily convergent. Once L. von BERTALANFFY writes: "The general theory of periodicity would be desirable in many fields." E. SZÁDECZKY-KARDOSS formulates the following concept: "A set becomes a system through cyclicity".

As to L. von BERTALANFFY "the guiding principle of system theory is the dynamic concept which tries to explain the phenomena of order in terms of interactions between processes". As to our judgement this can be carried out by system theory only on the basis of cyclicity theory. The "feed-back", control and self-regulation expressed in the "terms of interactions between processes" are nothing else than a peculiarly complex and complicated cyclic process. In a dynamic concept, order is nothing else than a specific type of motion, a directional form of motion which is called rotation in the broadest sense. Thus, it has already been stated that the cyclicity theory opens a new perspective of development for system theory.

General Theoretical Considerations

Before all, it is necessary to recall to the general philosophical bases of synthesis of the two generalization theories.

In the first decade of our century, at the very beginning of the revolution of physics, V. I. LENIN came to the statement that the physics of the 20th century generates dialectic materialism. In other words, the new way of thinking called dialectics by K. MARX and F. ENGELS after HEGEL, breaks through. This new way of thinking, this new paradigm of creating theories is based on the synthesis of two basic principles of methodological concepts. *Dialectics realizes the synthesis of universal relationships and of the principle of universal changes.* With regards to ontology this means that the world is the totality of processes and of the relationship complexes based on the processes.

The objective dialectics of nature is ever more comprehensively disclosed by the new scientific efforts and directions of the 20th century. The generalization trends of theoretical research such as the system theory and cyclicity theory testify to this fact. Not only the necessity of their generation but also that of their synthesis are direct consequences of the dialectic form of thinking, of the dialectic view expressing the general theoretical and methodological essence of the 20th century scientific revolution.

II.

Now, let us investigate what does it mean to express the phenomena of order in terms of interactions between processes.

1. The terms "process" and "interaction" both express motion. In most general sense, *motion* comprises all processes taking place in space and time. Already in the last century, F. ENGELS called the attention to the inseparable relationship of "relationship" and "motion". He wrote: "The whole nature accessible to us consists of a system and universal relationship of bodies. The fact that these bodies are interrelated includes their interaction and this mutual interaction is motion itself." This thought of F. ENGELS widens the interpretation of motion as process and leads to the conclusion that all processes are really interactions, motion is the interaction of processes. By means of this we possess the key to disclose the *system as a process*. The system as a process exists as a complex of interactions.

The results of our consideration can be summarized as follows:

— motion is a process,
— motion is an interaction,
— system is the interaction of processes.

2. One of the basic problems of system theory is how to define the *system*. The most widespread, essentially equivalent models of system definitions are as follows:

Part + Totality = System
Element + Structure = System

These and similar models provide, of course, applicable phenomenological descriptions, resp. functional schemes. However, such certain types of supplement, e.g. that totality predominates over the parts do not belong to the general conceptual discovery of the nature of system, but characterize the specific features of the different types of systems.

The concepts of order and system are rather frequently confused. It is true that order is characteristic of all systems but the order of states and processes alone cannot be considered to be a system. Consequently, disorder is opposed to order and not to the system. The correct relation is as follows:

Disorder $\rightarrow$ Order $\rightarrow$ System

System is a peculiar kind of order. System is the *discontinuous, stable and reproductable form of order.* Stability and reproductibility are in close relation, and essentially express the identity of the system, the identity with itself, its survival and continuity of its existence. The discontinuous character denotes the specificity the quality and the diversity. The relation of discontinuity and reproductibility expresses also the momentum of identity. In other words, the stability of systems is the preservation of their identity. The basis of stability of the systems is the order expressed by them and by their activity. The basis of every system is the order determining its structure and functions. In this way the common essential characteristics of all systems are attained by means of which the abstract general concept of the system can be described. The essence of any system is given by the stability of order expressed in it. *Each system is the stability of the given order characteristic of it.*

3. In the foregoing two definitions of the system were given:

(α) system is the interaction of processes

(β) system is the stability of order.

These two definitions characterize the system from two different sides, e.g. from those of structure and of process. A more concrete approach will be given by disclosing the unity of the two aspects.

Our aim is to present a synthesis of cyclicity theory and system theory. Thus, the remaining task to be solved is to express the order and stability in terms of processes, resp. in those of interactions between processes.

Trying to explore the essence of system as interaction of processes, the direction of processes should be emphasized and the directional form of motion should be taken into account.

In terms of motion stability is the repetition of order. In the repetition as in directional form of motion identity occurs as a change of state and exists as a process. Repetition is the progressing of the same processes, the continuation of the same states. The basic function of repetition is the creation and maintenance of identity and continuity. By means of repetition *per definitionem* a given state is reproduced. Its formula is: $A \rightarrow \acute{A}$. Thus, repetition makes possible the reconstruction of definite states. It reproduces given possibilities and provides a possibility to recommence.

The integrated structures and systems, e.g. nucleus, atom, molecule studied by physics are specific forms of order and stability. Let us deal with the atom. The qualitative diversity and stability of atoms cannot be explained by classical mechanics. As to HEISENBERG, the quantum theory gives account of the stability of atoms and of the possibility of their continuous reformation. As it is emphasized by WEISSKOPF quantum theory introduced the idea of identity into physics and explored the reasons of different atomic forms and of their reproductibility. The specificity of different atoms derives from the stability of order, i.e. from the forms of vibration taken by the electron wave bound by the attractive force of the nucleus. The different forms depend on the strength and symmetry of the field. E.g. the specificity of the bases participating in the constitution of nucleic acide shows an analogous connection with molecule.

The stable states and preservation of objects can be explained by the equilibrium of the forces (forces and counterforces) generating them and compensating the effects of each other. We should agree, however, with BOULDING that all equilibrium systems should be regarded as the marginal case of a dynamic system and stability can be determined from the original dynamic system only. In case of the system it is to be emphasized that the basis of equilibrium and stability is the order expressing the essence of the system. Now order is an interaction of definite processes which shows a specific trend.

By saying that stability is the repetition of order, it was also stated that the basis of stability is the order itself. Further, it is also obvious that stability is produced only by an interaction in which repetition predominates. Repetition alone, however, does not produce order. Order is a specific succession of different states. Consequently, expressed in terms of motion order is the interaction of different directional forms of motion. Since order is the basis of the unbroken existence of the system, in term of motion it is a complex directional form of motion which renders possible the preservation and continuity of the system. Rotation is such a complex form of motion.

Rotation is the peculiar interaction and unity of two simple directional forms of motion. Rotation is the interaction of repetition (expressing the identity) and of the irreversible change (expressing the diversity), in which repetition predominates.* Its formula is: $A \rightarrow B \rightarrow A'$. On the one hand, in case of rotation the interactions being realized by the periodical succession of irreversible changes generate the order. As a result of predominance of repetition, however, the changes of state return to the starting point. In this way a definite and closed cycle of changes of states develops. The structural characteristics of rotation are: the so-called progressing, ascending ($A \rightarrow B$), and the returning ($B \rightarrow A'$) branches, further on this basis the $A \rightarrow A'$ moment. It is to be emphasized that rotation is closed only "outwards", and it is opened

* The term "irreversible change" is used here in specific sense. It denotes a motion process during which a state differing from a given state is generated. The formula is: $A \rightarrow B$. In this sense the irreversible change is opposed to repetition. Accordingly, reversibility is considered one of the special cases of repetition. A process, e.g. $a \rightarrow b$, can be reversed if there is the possibility of $b \rightarrow a$. In case of repeatability of a process the possibility of $(a \rightarrow b) \rightarrow \rightarrow (a \rightarrow b)$ exists or there is a possibility to $(b \rightarrow a) \rightarrow (b \rightarrow a)$. In case of rotation the condition of repetition is the recurrence (reditus) and not categorically the "reversal" (reversis). For the correct interpretation of rotation the distinction between recurrence and reversal is a significant element.

"inwards". The return to the starting point is a final point which is at the same time the starting point, as well. By means of this rotation becomes the fundamental form of motion of the self-sustaining process, i.e. the basis of the stability of order and the order of stability.

Thus, the final conclusion is as follows:

(γ) *expressed in terms of interaction of processes system is a cyclic process, i.e. rotation.*

In this way the necessity of the synthesis of system theory and cyclicity theory has been demonstrated.

ЦИКЛИЧНЫЕ ПРОЦЕССЫ И СТАБИЛЬНОСТЬ СИСТЕМ

Й. ХОРВАТ

Резюме

Автор выдвигает гипотезу синтеза общих теорий систем и циклов, проделав опыт их обоснования на общепринципиальном уровне. В области философии это положение автор видит в синтезе их *диалектик* как в двух методологических принципах новой парадигмы построения теорий, а именно в синтезе универсальных зависимостей, а также принципов универсальных изменений. В соответствии с этим мир представляет собою тотальность процессов и основанных на них комплексов взаимосвязей.

Конкретная задача осуществления такого синтеза состоит в отражении явлений порядка вещей в терминах взаимодействия между процессами. Рассматривая систему, как своеобразную упорядоченность, автор свою работу определяет в качестве стабильности порядка. Порядок, выраженный в терминах движений, представляет собою, с одной стороны, повторение, с другой, — специфичную смену друг друга различных состояний. Эгзистенцию порядка, сохранение системы, последовательность ее существования обеспечивает некоторая форма движения особого сложного направления, то есть циркуляции. В соответствии с вышесказанным окончательный вывод статьи: *система представляет собою отраженные в своих терминах цикличные процессы, криговорот, то есть циркуляцию взаимных влияний процессов.*

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NECESSITY AND DRAWBACKS OF INTERDISCIPLINARITY

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The comment outlines the benefits of the system approach and calls for cooperation between the isolating, branching disciplines which model the phenomena according to their own well-worked ordering principles; but it shows the failures of the superficial analogies.

I was delighted to participate at this symposium which demonstrated that the interdisciplinary approach to problems, the mutual approach of experts stimulates the development of all scientific branches. The lectures and the participants, the musician and mathematician, the philosopher and physicist, the mechanical engineer and the geologist, etc. were essentially looking for a strengthening of the interdisciplinary communication a transfer of the achievements obtained in certain fields into others and their utilization in other fields.

Neither the available time nor the topics of the symposium would permit a long-lasting science-historical discussion but I think this is not needed. It is obvious for all of us that the development of professional branches of science is a natural and irreversible process. Further it is also well known that the individual disciplines differ from each other first of all not in the objects of investigation but in their particular approach to it. The complex world (or a part of it) cannot be studied in detail, phenomena and regularities cannot be discovered if some of the characteristics significant from the professional point of view are not emphasized neglecting those being insignificant from the given point of view. The more complex are the phenomena and/or the more essential are the relationships studied, all the more the investigation should be focussed. Essentially, this is why the individual sciences became ever more polarized.

This would do no harm if the polarization of sciences were not be accompanied by the isolation of sciences in some cases; if the limitation of the investigation aspects were not lead to a restriction of horizon. When an expert accepts only his investigation aspects to be valid, when he regards his model the only image of the modelled phenomenon, when he does not know (or consciously neglects) the approaches and methods of other sciences, not only the solution but even the setting up of complex problems become impossible.

Taking into consideration that each science is in a certain sense, a model of the objective world the process of polarization can be characterized so that to become acquainted with the complex world and to make acquainted somebody with it, this needs even more models, each of which reflects the reality from an other side, i.e. it resembles the model according to other aspects. One has to remember, however, that the restriction of aspects concerns only the model and not the modelled phenomenon; the latter one remains a complex system independently of our mind.

The properties are closely interrelated. If somebody wants not only to explain, but also to forecast or even more, to utilize the phenomena, the investigation according to a narrow professional viewpoint is insufficient. In other words: the investigation of complex systems needs such a view which takes into account most of the possible viewpoints. Such an effort is meant by the twelve-cycle parameters introduced by E. SZÁDECZKY-KARDOSS. A specialist of our days knowing (and recognizing) only his particular profession can neither to solve nor to formulate the up-to-date practical and scientific problems.

In our century even more scientists recognize the dangers of isolation of sciences and several tendencies have arisen which "intersecting" the science branches try to find out suitable methods by means of which the terms, aspects and results of special sciences can be integrated. Such efforts have been e.g. cybernetics, system theory, etc. The arranging principle of this symposium, i.e. the cycle view should be regarded also as such an effort.

I believe that all these are useful and may produce new thoughts and results in the fields of individual sciences. It is far of me to be trouble-feast when I call the attention to phenomena which may bring these fundamentally correct efforts to a deadlock. My notions concern first of all not the present representatives of the cycle view because it is my own experience that they avoid the entrancement of false analogies. Nevertheless, it often happens with great ideas that epigons use them and this may heavily damage the idea itself, too. Some dangers (the harmful distortion of ideas) are sketched in the following.

Generalists: who are giddy with the organizing force of a tought and try to apply it to all phenomena without control. They seek only for generalizations, for similarities and neglect the special features and differences. Such a view may easily become dilettantism which deprives the human being of the wonderful ability to discover the world of extremely large and extremely small, to explore its relationships and laws, and to utilize them consciously for its own purposes.

Annexionists: people who believe that any kind of theory may exist as a super-theory, i.e. as a discipline which includes all the other disciplines. "*Religious*" *authority*: people who *do not understand* but only profess a theory (or rather admire a sciencist representing it). Instead of their own thoughts they argue with citations and instead of persuasion refer to authoritarian arguments.

Harmful analogy: people who, on the basis of some kind of apparent-similarity draw conclusions for beyond validity of similarity. The more help is provided by the recognition of similarity in the knowledge of phenomena, the more harmful is it when the differences are neglected.

All extremes restrict the most valuable ideas of the system view: the mutual approach and exchange of experiences of the representatives of different scientific branches.

In favour to generate the really interdisciplinary relations first of all the experts, the representatives of different sciences ought to transform their view.

Instead of the unnatural common language such a "translator" has to be developed which promotes interdisciplinary communication. First of all the kindred fields have to make clear the mutual fundamental concepts and to harmonize (and to correct if needed) their terminologies.

Within sciences no hierarchic order, no sciences subordinated to each other are found; but within the tasks there is a hierarchy: the tasks of a lower hierarchic position should be subordinated to those of a higher one. In other words: the scale of values is to be known within the frame of which the tasks should be drawn (and solved), i.e. the "higher" interest which means restrictions, condition system from the point of view of our solution. In other terms it can be said that studying any kind of tasks it should be regarded a "partial-system problem", the solution of which should meet (first of all) the requirements of the whole system.

The method of similarities should be known and applied by means of which the necessary and sufficient conditions of the similarity of two systems can be unambiguously established and in addition to the similarity the differences can also be determined.

It is especially necessary in education that instead of a "subject particularism" the view of integration should prevail, which demonstrates that the individual "professional laws" are only special cases of the universally valid natural laws.

The experts of the age of the scientific-technical revolution should not be only specialists but should possess wide general education, openness and modesty towards other science branches and experts.

In favour (and in the sense) of this the efforts should be promoted which improve the joiút activity of different experts. From this point of view I believe the cycle view may be very important and promoting not only for the intercommunication of experts but also for the systematization and review of phenomena according to the given aspect.

НЕОБХОДИМОСТЬ И ОПАСНОСТЬ СИСТЕМНОГО ПОДХОДА

Э. СЮЧ

Резюме

Добавление подчеркивает необходимость системного подхода в объединении все более изолированных наук, моделирующих явления по своим принципам, но также указывает на опасность поверхностных аналогий.

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UNIVERSAL CYCLICITY IN A NON-CYCLIC UNIVERSE

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Physical principles behind cyclic phenomena are reviewed. The conditions of cyclic behaviour of objects are reduced to equilibrium conditions, which in turn depend on geometrical sizes and matter densities. Cyclicity is shown to be an inherent property of cosmic systems, unless they are too large to be stable (e.g. the Universe itself). Thus, the size versus cycle time relation of cosmic objects is limited by the Hubble-time, the Hubble length and the light velocity.

I. Cyclicity, Equilibrium and Entropy

— Local Conditions for Individual Cosmic Objects —

Stable equilibrium of opposite forces is responsible for the permanent existence of different cosmic bodies ranging from interstellar dust and meteorites to planets and stars. The cyclic motions and oscillations near their stable equilibrium states are due to the very same forces. Thus, one can say, in a sense, that cosmic bodies typically show cyclic behaviour "simply because they exist".

All systems of cosmic bodies (e.g. solar system, stellar systems, clusters of galaxies, etc.) are commonly regarded to be products of a strong gravitational condensation process starting from small density perturbations of the almost homogeneous cosmic matter of the early Universe. The formation of stars and their systems is governed by the law of thermodynamics according to which entropy cannot decrease [1]. Complete systems are, therefore, bound to tend towards more and more probable — i.e. less and less ordered — configurations in *phase space*, an abstract six dimensional space describing both the geometrical positions (three dimensions) and the momenta — or velocities — of the constituents of the system (other three dimensions). The gravitational condensation is a transition from a featureless, almost evenly distributed substance to a wide variety of rather compact objects with high degrees of spherical or axial symmetries. This is a clearly "anti-entropic" tendency towards a very improbable and well-ordered situation — at least in the three dimensions of the geometrical configurations. It follows that in order to make star and galaxy formation compatible with thermodynamics the "velocity component" of the entropy should change towards "disorder" at a rate strong enough to overcompensate the opposite tendency of the "space component". This requirement of principle is actually satisfied in cosmogonic processes. The cosmic substance in the volume of, say, a galaxy is known to have been in an almost unique state of motion (corresponding to a single point or a small spot in the velocity space) before gravitational condensation, i.e. in the photon era of the hot Universe. Later the same matter evolves towards large velocity dispersions of its constituents during the epochs of the gravitational collapse and the subsequent relaxation processes. Thus, in a standard Big-Bang cosmology more or less point-like objects appear in the geometrical space on account of the disappearance of a single point-like distribution in the velocity space. The objects that move with the resulting large relative velocities are, however, confined to some minor geometrical domains of cosmic condensations (groups and clusters of stars, galaxies, etc.) spread over in an enormous, practically empty interstellar or intergalactic space. The long-lasting existence of densely populated small stable clusterings without rapid escape of high velocity members is mathematically feasible only if the members of clusterings have strongly curved orbits, they suffer intensive accelerations and their motions show repetitions either in a regular way (circular motion), or at least in a statistical sense (irregular quasi-periodic motion). — Thus, both equilibrium and entropy considerations make it clear that cyclic motion (sensu lato) should be a practically universal property of all stable individual cosmic objects.

The underlying forces, responsible for the long-lasting existence of stable cosmic objects, can be understood simply by studying the inner motions o objects [2]. In case of cyclic mechanical motions the simplest possible kinematic parameter, the size to cycle time ratio (of dimension of velocity), already ensures a deep insight into the physics of objects. To see this we write equilibrium conditions for gravitationally bound systems

$$E_{\text{pot}} = 2 \cdot E_{\text{kin}} \qquad \text{(the so-called VIRIAL theorem)}$$

and

$$\frac{v^2_{\text{therm}}}{c^2} \simeq \frac{v^2_{\text{esc}}}{c^2} \simeq \frac{v^2_{\text{sound}}}{c^2} \simeq \frac{v^2_{\text{puls}}}{c^2} \simeq \frac{v^2_{\text{orb}}}{c^2} \simeq \frac{\mathcal{R}}{R} \simeq \frac{p}{\varrho c^2}\,.$$

Here and below E_{kin} and E_{pot} mean the kinetic and (gravitational) potential energy of the object, respectively, v_{therm} denotes the average velocity of thermal motion of particles in the object, v_{esc} the escape velocity at the surface of the object, v_{sound} the sound velocity within the object, v_{puls} the propagation velocity of pulsational or vibrational motions of the object, v_{orb} the orbital velocity of a (possibly fictitious) satellite revolving close to the surface of the object, c the light velocity, p the average pressure and ϱ the average density of the object, R the radius of the object, $\mathcal{R} \equiv 2GM/c^2$ the Schwarzschild-radius of the object, M the mass of the object and G the Newtonian constant of gravity. We find that very different velocities give essentially the same information about objects in equilibrium. Let us examine now the information content of one suitably chosen representative velocity: $v_{\mathrm{orb}} = v$. If T, the cycle time of orbital motion, and R are given, one can calculate v. Furthermore, according to the well-known formula for circular motion-the ratio v^2/R is equal to the acceleration, a, of the satellite, which in turn measures the force, F, "felt" by the satellite due to the gravitational influence of the central object. In addition to these data, the above chain of approximate equations permits us to calculate M and p/ϱ for the object. Thus, in case of cyclic motions near equilibrium the simplest purely kinematic data on cycle time and size already contain far reaching physical (dynamic and even thermodynamic) information about the system in question. Although a superficial view of Newtonian physics might well suggest that velocities cannot be expected to provide essential insight into the processes, the average velocities of cyclic motions serve now as a convincing counterexample.

The size versus cycle time relation of SZÁDECZKY-KARDOSS [3] describes not only mechanical motions (his strip B), but electromagnetic oscillations (strip A) and chemical-biological cyclic motions, as well (strip C) [4]. It is interesting to note that some velocities are important parameters for these non-mechanical phenomena, too: electromagnetic waves can be characterized by the velocity of light — a fundamental constant of physics — while chemical cycles by chemical reaction rates — i.e. speeds of thermodynamic processes. Thus, we are fully justified in regarding the size versus cycle time relation, $R(T)$, as a really physical diagram characteristic of typical motions of individual objects in equilibrium.

Data of the relation $R(T)$ reveal the curious fact that the overwhelming majority of mechanical (mostly astronomical) motions have velocities in a relatively narrow range of orders of magnitude. Still the above equilibrium equations make it clear that stable objects might in principle exist also with completely different velocities. The laws of Nature would equally permit the presence or absence of strip B. Its obvious existence is thus essentially unexplained by current theory. We have to accept strip B as being equivalent to some properly chosen cosmological initial conditions. This circumstance makes the diagram $R(T)$ — and its possible transformed version — very informative and valuable from a cosmological point of view. One cannot help being very much impressed, if Nature shows prominent regularities in such cases when known laws of physics do not guarantee them! The diagram $R(T)$ is, of course, not only a great surprise for scientists, but also a possible key of further developments towards finding "better laws" of Nature that may clarify the theoretical background of these regularities. Really, it was already a century and a half ago that Laplace dramatized so strongly the difference between initial conditions and dynamic laws and today the dream of explaining initial conditions is as far from realization as ever [5].

Let us consider briefly the consequences of the existence of strip B, i.e. an almost linear dependence between log R and log T for mechanical motions. From the diagram $R(T)$ we can easily construct the diagrams $v(R)$ or $v(T)$ and $a(R)$ and even diagrams describing time derivatives higher than the first (v) or the second (a). In the idealized case of strictly circular satellite orbits the following formula gives all time derivatives as functions of R

$$\lg R^{(n)} = (1 - n) \cdot \lg R + \text{const}_n ,$$

where $R^{(n)}$ stands for the n-th time derivative of R and the additive constant depends on the number of differentiations. The above formula can be transcribed using T as independent variable without any essential change of the functional form because log $R \sim$ log T. Putting $n = 0, 1, 2, \ldots$ into our expression we see that strip B of the relation $R(T)$ is given approximately by a linear section with a slope of 45 degrees (except for the slightly bending top of the curve), the relation $v(R)$ is given by a horizontal line corresponding to a constant velocity, the diagrams $a(T)$ and $F(T)$ are again linear ones but with a slope of -45 degrees, while all the higher derivatives are described also by descending linear sections with larger and larger absolute values of the slope as the number of differentiations increases. Possible violations of this simple rule can only be due to deviations of the satellite orbit from the strictly circular one — which is of course necessary, if the central object itself is not exactly spherical. These connections are so simple as far as we restrict ourselves to the transformations of the linear part of the original strip B.

We conclude that strip B describes physically important but unexplained regularities not only in the velocities of mechanical objects, but in their accelerations and stabilizing forces, as well.

II. Disequilibrium and Entropy

— Global Conditions for the Universe —

According to the General Theory of Relativity gravitational and inertial effects (described as space-time effects) become dominant over and above a well-defined critical threshold size and exclude any equilibrium or repeated cyclic motion near equilibrium in those ranges of sizes. In such cases either a gravitational collapse in the future, or — its time reversed phenomenon — a Big-Bang in the past are required by the theory. Using a suitable measure of radial distance, r, the threshold — the so-called "trapping length" — can be expressed as [6]

$$r \approx (8\,\pi G \varrho / 3c^2)^{-1/2}.$$

The disequilibrium condition is, therefore, an inequality between the linear size and the matter density of the object or domain considered. Disregarding the minor effects due to non-Euclidean geometry one may simply write

$$\frac{4\pi}{3} r^3 \varrho = M$$

and

$$r \approx \mathfrak{R} \equiv \frac{2GM}{c^2} .$$

Thus, we have shown that the disequilibrium condition can intuitively be interpreted as excluding objects or domains in steady state, if they are inside their "Schwarzschild radii". It is to be noted that the above condition holds true in the same mathematical form both for isolated objects surrounded by an empty outer space and for any arbitrarily chosen domain embedded in a boundless Universe.

The present average density of the Universe is about 10^{-30} g/cm^3. The trapping length that corresponds to this density is of the order of 10^{28} cm, which is close to the so-called Hubble-radius, $R_H = \frac{c}{H}$, where H is the Hubble-constant. This means that the Universe cannot rest in static equilibrium, or oscillate around it, if its extensions exceed the above order of magnitude. Even if there were arbitrarily large cosmic repulsive forces, they could not suffice to counterbalance gravitation and establish equilibrium in large enough regions. Taking into consideration that the actual large-scale repulsive forces in the Universe are negligibly small, and observations indicate an increasing degree of uniformity in the distribution of gravitating cosmic matter in larger and larger distances up to the order of the Hubble-radius, we may be fairly sure to live in a non-static Universe that started expanding from a Big-Bang. The observed expansion of the Universe is only an independent corroboration of the theoretical prediction. One may add to the above estimates that the observed microwave background radiation is known to change its energy density and gravitational effect very rapidly during the expansion of our cosmic neighbourhood, so that at the time of emission of that radiation (which is directly observed now !) the trapping length was considerably smaller than the region scanned by our modern radio telescopes. Further evidences which come from the observed abundance of the relic helium (and other chemical elements) produced by the cosmological nucleogenesis in the hot early Universe strongly suggest that in those times even the matter of a single present galaxy should have been situated inside a gravitationally trapped region, i.e. could not have been in stable state or in oscillatory motion around it. This is almost equivalent to saying that each individual galaxy — a stationary object nowadays — should have originated from the cosmological Big-Bang, a singular primordial state of the non-stationary Universe.

One can calculate from EINSTEIN's equations that this globally singular state took place about 15 billion years ago. The "expansion age" so obtained is not much shorter than the HUBBLE-time, $T_H = \frac{1}{H}$. No cyclic phenomena with a characteristic cycle time longer than this age could have developed in our Universe so far, and no objects larger than about 15 billion light years might have reached their approximate equilibrium states by now. This is to be accepted as *an absolute theoretical space and time limitation for cosmic cyclicities at present* [2]. The sizes of the largest actual equilibrium configurations (clusters of galaxies) are "subcritical" by several orders of magnitude, while their cycle times (orbital periods of their member galaxies) are below the HUBBLE-time by one order. This agreement between what is required and observed, can be regarded as another indirect evidence in favour of the logical consistency and reliability of our cosmological picture and the theory behind it, the General Relativity.

On the basis of all the facts said above one can mark out upper boundaries for the size versus cycle time relation, $R(T)$, at the values of the HUBBLE length and HUBBLE time. It is, however, obvious that one more dividing line can be prescribed for this diagram, if one takes into account the equilibrium conditions presented in the previous Section. In view of the fact that no object can stabilize itself by a velocity larger than that of the light, and no stable equilibrium configuration can occur inside its Schwarzschild-radius, therefore the region of the diagram $R(T)$ above strip A that corresponds to light velocity is also forbidden for stable or oscillating objects [2]. Note that this new (diagonal) critical line is just fitted to the intersection point of the horizontal and vertical boundaries, because the HUBBLE length and-time are related to each other by light signals.

General Relativity requires the occurence of a singular cosmological situation with infinite values of the space-time curvature and energy density. There has been much speculation whether this surprising conclusion is not merely due to some oversimplification of the mathematical equations or inapplicability of the theoretical basis in such extreme cases. In this connection it is important to know that the gravitational "trapping" deduced in the last decades is a conclusion practically independent of all feasible simplifying conditions used in the earlier studies [7]. On the other hand, it is generally agreed that the almost singular states are only poorly treated because of the absence of a consequent quantum theory of gravity. Nevertheless, a most general thermodynamic principle, that of the increase of entropy in irreversible processes, can properly be used to demonstrate that no more than a final number of increasing cycles are feasible, even if we reject General Relativity in the immediate vicinity of the singular Big-Bang [1].

While our current global theory of the Universe appears to be incompatible with the supposition of an infinite number of cycles of all domains extending beyond their trapping length, including the Universe as a whole, the same laws permit — or even require — a practically or strictly infinite number of cycles for individual local objects that do not reach the critical sizes corresponding to their densities. To prove this one can combine the statement of the previous Section on the necessity of quasi-cyclic behaviour of individual cosmic systems with the results of HAWKING [8], according to which the Universe should be very similar to the simplest possible indefinitely expanding world model with Euclidean space, the so-called EINSTEIN—DE SITTER model, otherwise gravitational condensation could not have produced the astronomical objects (of strip *B*) and the biological objects (of strip *C*). For these objects to become possible, the Universe should be closely isotropic, homogeneous and should be expanding almost exactly at the critical rate, so that the "kinetic energy of expansion" and the "gravitational potential energy of the cosmic matter" be in an almost perfect balance. (Here pre-relativistic notions have been used for visualization.) In accordance with HAWKING's requirement the present day astronomical observations seem to favour very strongly an ever expanding Universe with a negative space curvature quite close to zero. However, much strange it may sound, all evidences indicate that negligibly small and short-living objects of strip *C* can only be reasonably situated in a spatially infinite Universe with an infinite future and very special and regular initial conditions near the past Big-Bang! ("There is no room for us in a smaller cosmos"). Substantial irregularities, like cluster, planets and people might have appeared only during the late evolution of an almost regular early world.

A slightly perturbed boundless "imbedding" Universe without permanent oscillations around some equilibrium state, and negligibly small spatially and temporally limited individuals ("inhabitants") with equilibria and oscillations seem to be in a "quasi-dialectic" interdependence — being mutually conditional upon each other in a logical sense, according to contemporary physics.

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УНИВЕРСАЛЬНАЯ ЦИКЛИЧНОСТЬ В НЕЦИКЛИЧНОЙ ВСЕЛЕННОЙ

Г. ПААЛ

Резюме

Рассматриваются физические принципы, обусловливающие цикличные явления. Условия цикличного поведения предметов, объектов ограничиваются до условий равновесия, от которых зависят геометрические размеры и плотности вещества. Автор статьи указывает на то, что цикличность является свойством, присущим космическим системам, если они не слишком велики для того, чтобы быть стабильными (например, сама вселенная). Таким образом, соотношение размеров космических объектов с периодом их цикличности лимитируется временем Хаббла, расстоянием Хаббла и скоростью распространения света.

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LARGE NUMBER COINCIDENCES AND THE COSMIC EVOLUTION[1]

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A "large number of dimensionless large numbers" are found to appear in Nature in conformity with a non-random pattern. Some regularities in their distribution are discussed in the framework of both the standard Einstein–Friedmann type world models and of Dirac's cosmology. Physical, astronomical, geological and biological consequences are noticed.

I. Basic Data and their Connections

In the present communication some considerations are made concerning the hierarchy of cosmic structures and their cosmologically expected evolution. To start with we sketch a few diagrams illustrating some remarkable empirical correlations between various observable parameters of these structures. Relations and numerical coincidences, prominent in these diagrams but unexplained by current theories, will be regarded as guides to plausible improvements or extensions of our theoretical picture.

Figure 1. shows the schematic graphical representation of the following empirical correlations: the statistical relation between cycle time, T, and linear size, R, for very different objects, including astronomical, geological and biological ones, as given in [1] (upper right quarter), the size-mass relation, $R(M)$, of the same objects on the basis of [2, 3] (upper left quarter), the angular momentum to mass relation, $P(M)$, for astronomical objects and elementary particles following [4, 5] (lower left quarter), and — to close formally the cycle of diagrams — the angular momentum versus cycle time relation determined by the former relations (lower right quarter).

The relation $R(T)$ is limited by the Hubble time $T_H = \frac{1}{H}$ (H being the Hubble constant) and the Hubble distance $R_H = c \cdot T_H$, approximately equal to the radius of the gravitationally "trapped surface" in the expanding Universe, $R_U \simeq (8\pi G\varrho/3c^2)^{-1/2}$ [6, 7]. Throughout this paper c is the light veloc-

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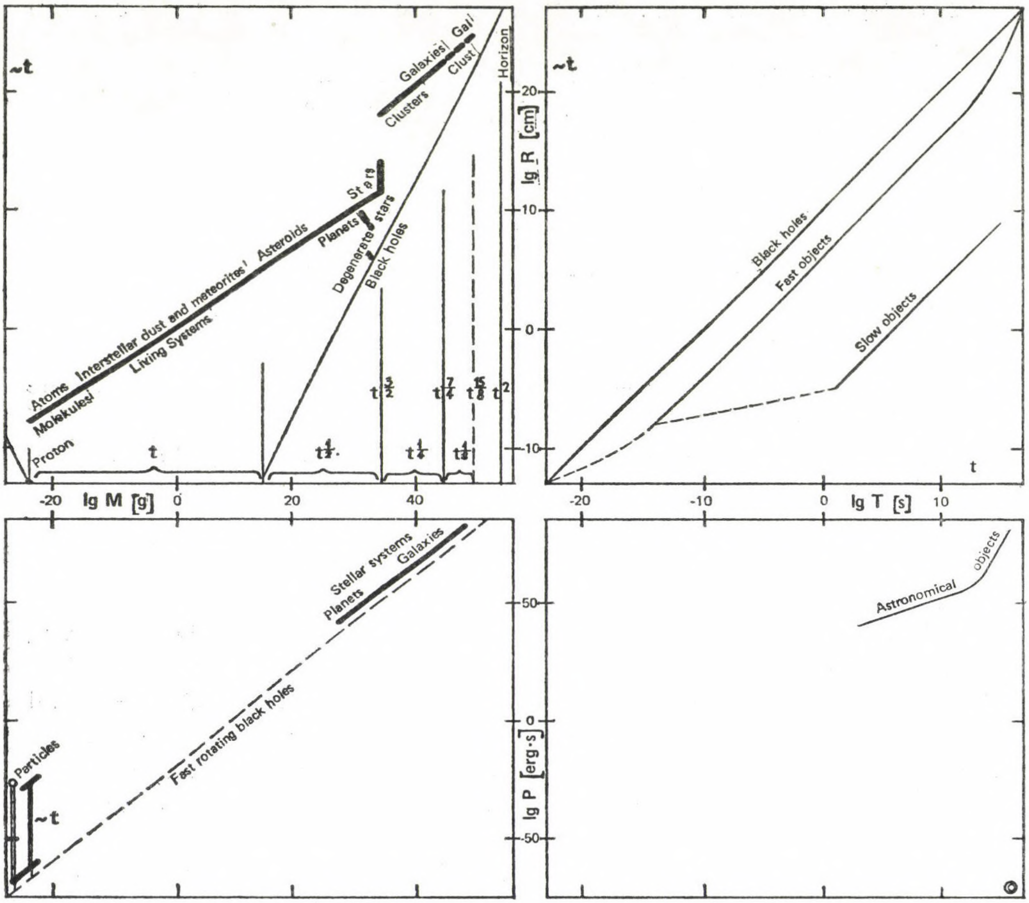

Fig. 1. Four empirical relations of cosmic objects (described in the 2[nd] paragraph of Section I). Some dimensionless numbers depicted in these diagrams are marked by t, if they are close to 10^{39} or 10^{40} in order of magnitude, or by another power of t, if they strongly deviate from this order

ity, G the Newtonian constant of gravity and ϱ the average mass density of the Universe. Another limit for the relation $R(T)$ is, of course, the diagonal line corresponding to the velocity of light $\left(\frac{R}{T} \simeq c\right)$. Any object collapses to form a black hole, if its representative point on the diagram $R(T)$ crosses this critical line by moving from right to left. In this diagram points describing stable objects align themselves around two distinct quasi-parallel line ("fast" and "slow") separated from the critical line by a distance roughly corresponding to 4 and 16 orders of magnitude in velocity. The position of the "fast" line is completely unexplained by any theory accepted in physics [7].

Contrary to the plot $R(T)$, the diagram $R(M)$ does not distinguish between "fast" (mostly astronomical) and "slow" (mostly geological and biological) objects, it unifies their graphical representation in a remarkably narrow and long line extending from the hydrogen atom to giant stars and covering a mass range of about 59 orders of magnitude. This line corresponds to an approximately constant density of the order of 1 g/cm^3, or slightly more. The slope of this line on the logarithmic diagram follows from the relation $M \sim R^3$. Note a striking contrast between the former diagram and the present one: the astronomical branch of the former is smooth up to the representative points of the largest systems, while the only branch of the latter shows an apparent discontinuity with a jump of several orders of magnitude, as we pass from stars stabilized by immediate particle interaction to stellar systems "stabilized" by orbital motions. The reason for the existence of this jump lies in the facts that larger stars cannot be stable [3] and individual stars of unit density in a cluster need much "empty" interstellar space for prolonged free orbital motion. Current theories are capable of explaining the majority of the data on the diagram $M(R)$, except for the exact positions of the stellar systems [3, 6]. Two critical lines appear in the relation $R(M)$. One of them corresponds to the Schwarzschild-radius $R_S = 2GM/c^2$ delineating the region of black holes from that of stable objects, whereas the other one corresponds to the equation $h \cdot c/\lambda = m_0 \cdot c^2$ applicable to atomic nuclei. (Here and below h denotes the PLANCK-constant, λ the wavelength and m_0 the rest mass of the particle.)

The empirical diagram $P(M)$ reveals the theoretically unexplained fact that most astronomical objects (from planets to galaxies and their clusters) obey a unique relation that can be expressed in CGS units as $P \cong 2.4 \cdot 10^{-15} M^2$ with a statistical uncertainty not exceeding one order of magnitude [5, 8]. The values of angular momentum and mass for the proton, the electron and some families of elementary particles are also shown in the diagram according to [4]. (Here the notation $P = \hbar/2 = h/4\pi$ is used.) In addition to this the diagram presents the theoretically found limiting value of P for extremely fast rotating black holes, too, as a function of the mass of the object (dashed line). This line is determined by the formula $P/M^2 = G/c = 2.23 \cdot 10^{-18}\ cm^2 \cdot g \cdot s^{-1}$ [6, 9]. The expressions

$$P/M^2 = RV/M = G/V > G/c$$

make it clear that these astronomical data are essentially equivalent to those of the astronomical branch of the relation $R(T)$.

In the following we shall identify in our diagrams the famous large dimensionless numbers, the so-called EDDINGTON—DIRAC numbers, that are known to appear in several relations of Nature and serve as a basis for DIRAC's cosmological considerations [10, 11]

The horizontal and vertical contour lines limiting the physically permitted region of the diagram $R(T)$ cover about 40 orders of magnitude. These lengths on the logarithmic plot can be interpreted as expressing the ratio of the expansion time of the Universe to an atomic time unit, $e^2/mc^3 = 0.95 \cdot 10^{-23}$ s, and the HUBBLE length divided by the classical radius of the electron, $e^2/mc^2 = 2.8 \cdot 10^{-13}$ cm. (Here e and m are the charge and mass of the electron.) Obviously, the size of the permitted region of the diagram $R(T)$ increases with the atomic time according both to the standard relativistic cosmology and to the DIRAC model.

Several simple expressions of DIRAC's large numbers appear in the diagram $R(M)$. One can again consider horizontal and vertical contour lines defined, e.g. by the mass and size of the proton and those of the "observable Universe", i.e. the causally connected part of the Universe within our momentary horizon. The mass range depicted in this way is about 10^{80}, while the range of sizes is close to the square root of this quantity: 10^{40}. Instead of the number of protons (or baryons) within the horizon, one can also consider their number within another closely related characteristic distance of the Universe, the HUBBLE distance defined above. The result is about 10^{78}. The critical line corresponding to the Schwarzschild-radius intersects the horizontal line of the proton at about 10^{39}, which is surprisingly close not only to the characteristic "age and size" of the expanding Universe, but also to the ratio of the electrostatic and gravitational forces between the electron and the proton in a hydrogen atom: $e^2/G \cdot m_e \cdot m_p = 2 \cdot 10^{39}$, the basic number in DIRAC's considerations. (m_e and m_p denote the mass of the electron and the proton.) Thus, it can be seen that taking the number of protons within a characteristic distance of the Universe at large scales and dividing its logarithm by 2, we arrive at the order of magnitude of other characteristic numbers of both the Universe and the proton and even the simplest atom, i.e. the smallest stable non-nuclear configuration that can be built up of elementary particles by long range forces. We can now proceed in a quite similar way to obtain further characteristic numbers for the largest stable configurations by further divisions of the remaining intervals on the log M axis of our diagram. The first new division gives approximately $10^{58.5}$, i.e. the maximum number of protons (and other nuclei) in the largest possible giant stars [12, 13]. Atoms are stabilized by the stronger long range force, the electric force, while stars by the weaker long range force, the gravity. We have, therefore, small atoms, as "electric stars", and large stars, as "gravitational atoms", representing two basic extreme configurations in the Universe. The "constant density branch" of the diagram $R(M)$ covers just that 59 orders of magnitude which separate the simplest atom from the largest object stabilized by immediate particle interactions. — Dividing again our horizontal interval (that remains from the largest stars up to the HUBBLE distance) into further two equal parts, we arrive at a value of $10^{68.25}$, which is just about the order of magnitude of the number of protons in the largest individual galaxies. The fourth division of the basic interval leads to the value 10^{73}, typical for the number of baryons in the largest superclusters of galaxies. No larger configurations seem to exist at all. *All the above characteristic orders of magnitude for basic cosmic structures have been "deduced" by a unique method of divisions into two equal parts of the logarithmic diagram* $R(M)$. The starting value of the above procedure was a number characteristic of the Universe at large scales.

Turning now to the relation $P(M)$ one finds again more than one candidates on it for further occurences of DIRAC's large numbers in the dimensionless ratios of physically important quantities of Nature. The vertical distances between the critical line of maximum possible ratio of P/M^2 for extremely fast rotating black holes and the points representing the proton, some typical families of elementary particles and the electron give the following dimensionless numbers (cp. [4, 5])

$$\frac{P_p/m_p^2}{G/c} = 0.8 \cdot 10^{38}, \quad \frac{P_{\text{typ}}/m_{\text{typ.}}^2}{G/c} \simeq 10^{38}, \quad \frac{P_e/m_e^2}{G/c} = 3 \cdot 10^{44}.$$

If the same particles are related to the astronomical objects according to the diagram $P(M)$, the following quantities appear

$$\frac{P_p/m_p^2}{P_{\text{astr.}}/M_{\text{astr.}}^2} \simeq 0.7 \cdot 10^{35}, \quad \frac{P_{\text{typ.}}/m_{\text{typ.}}^2}{P_{\text{astr.}}/M_{\text{astr.}}^2} \simeq 10^{35}, \quad \frac{P_e/m_e^2}{P_{\text{astr.}}/M_{\text{astr.}}^2} \simeq 3 \cdot 10^{41}.$$

II. Interpretations and Results

In the standard physical theory all the above numerical coincidences are due to mere chance, although mathematically some of them are, of course, not independent of each other. The major difficulty of interpreting the data is, however, that the numbers determining the outer frame of the physically connected part of the diagram $R(M)$ are clearly changing — as the horizon and the HUBBLE distance are growing in the expanding space of a Big-Bang cosmology — while several inner parts of this diagram describe objects and relations depending on the basic physical constants only and, as a consequence, are to be regarded as eternal constants in the standard physical picture. Nevertheless, there appears to be a prominent connection between the frame and the "content" with such an accuracy that the inner lines can even be "deduced" or "constructed" partially from the outer frame. The coincidences become perhaps less surprising, if we accept the approach proposed often recently by several authors saying that "the regularities are simply consequences of our own existence". There are no such regularities in other cosmological eras, but there are no intelligent observers in those times to find irregularities. Thus, we cannot see anything else, but a regular Universe, even though natural laws do not guarantee all the observed regularities and permit them only in a limited time interval [14, 15].

One can, however, avoid such conclusions in an unconventional theory — in DIRAC's cosmology [10, 11] — where the basic relations and regularities similar to those found above on the diagram $R(M)$ are *postulated* to be permanent features of Nature. Such a "principle of conservation of relations" is a consequence of DIRAC's well-known "Large Number Hypothesis" and imposes severe restrictions on the new unconventional physics and cosmology. In this logical frame some of the "constants" of Nature should in fact be varying with the cosmic time and the curious large numbers are as large as we find them, because the Universe is just about 10^{40} atomic time unit old when we observe it. The diagram $R(M)$ populated from elementary particles up to the whole causally connected domain of the Universe is expanding, the line of constant density connecting the atoms and the stars is increasing together with the line of stellar systems, while the critical line of black holes is being displaced parallelly to the right. In earlier epochs the stars were smaller and in the very early Universe they even ought to have been "similar" to the atoms. Formally the whole picture becomes feasible near an atomic time of the order of unity, when the causally connected Universe was just above a single proton and the proton was just outside the critical line of black holes. Of course, some of these formal conclusions might be overinterpretations of DIRAC's approach, but one has to go back with this picture at least to the time when no very large numbers occured in Nature, otherwise one cannot possibly succeed in explaining the laws of Nature in a simple way without very complicated basic postulates in accordance with DIRAC's original aim [10, 11].

In the recent version of DIRAC's cosmological theory [11] the dimensionless ratios of velocities defined by the distances of parallel lines of the diagram $R(T)$ are *not* connected with the aforementioned large varying numbers: the velocities are conserved, but the radii of celestial objects are changing. In case of all planetary and stellar systems this change leads to a shift of the astronomical branch of the diagram $\mathrm{R}(T)$ in its own direction without modifying its distance from the critical line of light velocity.

Let us study now the large dimensionless numbers identifiable on the diagram $R(M)$. They will be used to demonstrate that even the recent version of DIRAC's cosmology is to be modified or refined to some extent. For this purpose let us consider a well-defined type of astronomical objects that are conserved practically "for ever", once they were formed: pairs of collapsed stars, former close binaries (with mass transfer from one component to the other in an earlier period of their evolution), which suffered two collapses later to form two white dwarfs. Such objects are known to exist. They have fairly well defined masses and orbital radii, i.e. positions on the diagram $R(M)$ at the time of their formation. Applying DIRAC's formula for the orbital motions [11], it is found that all these binaries have a common law of further evolution (mass creation and orbital evolution). The narrow domain of the newly formed collapsed binaries on the diagram $R(M)$ coincides with that of the collapsed binaries formed earlier. The position of this common domain should evolve together with the whole pattern of the diagram $R(M)$ in order to maintain the numerical relations of Nature unaltered (and also to avoid selecting particular epochs with their changing relations [16]). The maximum and minimum separations of these binaries are close to each other in order of magnitude. Near the time of collapse both extreme radii are of the order of momentary radii of giant stars (the predecessors of collapsed objects), which is about 10^{24} atomic distance units at present. This order of magnitude can be expressed roughly as $t^{3/5}$, where t is the present "atomic age of the expanding Universe", i.e. about 10^{40}. The 5/3 power of the former quantity gives the expansion age, consequently this power should vary in proportion with it according to the Large Number Hypothesis [10, 11] and the radii themselves should increase approximately as $t^{3/5}$ [13], otherwise the momentarily widest (or narrowest) collapsed binary would expand much faster (or slower) than the maximum (or minimum) of all orbital radii of collapsed binaries turning up in the Universe at a given time, and this would clearly be a self-contradiction. Our conclusion concerning the power law of orbital radii seems inescapable, if the collapsed objects continue to exist for a cosmologically considerable time. Now we quote DIRAC's formula in an explicit form to describe the orbital motion of binaries in atomic units of length and time:

$$G \cdot M = v^2 \cdot r \, .$$

(Here G is the momentary value of the Newtonian constant of gravity, M the mass of the star, v the orbital velocity and r the radius of the orbit — supposed to be circular for simplicity). Considering that G is known to vary like t^{-1} and v is independent of time in the recent version of DIRAC's cosmology, it follows that M should vary approximately as $t^{1.6}$! (Note that if M were proportional to $t^{1.5}$, degenerate collapsed stars might remain as such for ever [3, 9]. If, however, $M \sim t^{1.6}$, they are destined to approach slowly a situation leading to a further collapse to a black hole. On the other hand, one can easily see that black holes cannot get out of the horizon owing to the decrease of G in the modern version of DIRAC's cosmology, irrespective of the law of particle creation. Collapsed objects are therefore expected to remain as such for ever. A possible evaporation of black holes is far too slow to essentially modify these conclusions.) Our above example of applying the Large Number Hypothesis to new large numbers of Nature seems to necessitate the acceptance of an exponent close to 1.6 to describe the law of particle creation, in a minor, but definite disagreement with DIRAC's original proposal regarding "multiplicative creation". (According to the latter the formula $M \sim t^2$ would apply.)

Accepting the law $M \sim t^{1.6}$ leads to the following immediate consequences and practical predictions in the field of cosmology, physics, astronomy, geology and biology. The world model satisfying DIRAC's postulates becomes essentially uniquely defined (cp. [16]). The scale factor of the expansion of the Universe, as a function of atomic time, is approximately proportional to $t^{13/15}$, where t i the time reconed from the Big-Bang. The cosmological scale factor, as a function of macroscopic time, τ, is *exactly* proportional to $\tau^{2/3}$. This is the well-known "Einstein- de Sitter cosmos". As a consequence the three dimensional expanding space of the world model is of zero curvature. (Strictly Euclidean space section.) Thus, the selection of proper initial conditions is automatic and is just in agreement with HAWKING's requirement [14]. The luminosity of a typical star (e.g. the Sun) varies in proportion to t, while the effective temperature of a planet (e.g. the Earth) around it varies as $t^{-0.05}$, i.e. extremely slowly. This is a very good reconciliation of DIRAC's cosmology and physics with the requirements of *geology*, *climatology*, and *biology*. Here we have excellent examples of how a cosmological theory can be tested by results of other disciplines! — The expansion time scale of the Universe calculated in this model is as long as $\frac{13}{15} \cdot T_H$, in good agreement with the requirements of astronomy and astrophysics. (Here T_H denotes the HUBBLE-time as above.) The cosmological deceleration parameter measured by the use of atomic time is $q_0 = 0.15$, if we take photon multiplication to be zero, otherwise $q = 0.85$ [16]. Both values are quite acceptable. The bound stellar and planetary systems turn out to be expanding at a rate of $\frac{9}{13}$ part of the free extragalactic HUBBLE expansion rate, whereas in the usual version of DIRAC's recent cosmology the expansion law of all bound astronomical systems coincides exactly with that of the Universe itself, both of them being described by the power law t^1 or τ^0 in atomic and dynamic units, respectively. The observational tests of the model described here are to be elaborated more particularly by repeating the works of MAEDER [17] and CANUTO et al. [18] for our case. It is, however, clear that all the predictions of this model will be closer to the predictions for $M \sim t^2$, than to those for $M \sim t^0$ — and this is rather promising. A further inference worth of note is that since the expansion rate of the Earth—Moon system expected in the present model is also only about $\frac{9}{13}$ part of that predicted by DIRAC, therefore, our model is somewhat more difficult to disprove by direct laser measurements of the upper limit of change of the Moon's distance, than the model usually considered [19].

Applying Dirac's Large Number Hypothesis to the diagram $P(M)$ implies that cosmic objects should have had a typical angular momentum to mass square ratio nearer to that of elementary particles in earlier cosmic times (as originally suggested by Brosche [4]). This statement is, however, in strict contradiction with the early formulation of Dirac's cosmology and the view expressed in [5], according to which angular momenta ought to be conserved. The need of rejecting the original version of Dirac's cosmology is thus once again corroborated on the basis of the diagram $P(M)$! Note that the latter conclusion is quite independent of our previous considerations regarding the law of particle creation to be accepted. This new argument, however, does not help us to distinguish between the recent Dirac's model with a scale factor proportional to t (the expansion time of the Universe) and particle creation proportional to t^2 on the one hand, and our present model, on the other. The proper change of angular momenta is automatically ensured in both recent models.

Summing up it can be said that taking duly into account the large dimensionless numbers of Nature identified in our diagrams we may hope to have improved some details of Dirac's cosmology together with our understanding of the cosmic hierarchy and its evolution with the cosmic time within the framework of this theory. One should, however, bear in mind that a uniquely defined world model is very vulnerable and Dirac's whole cosmological concept might easily clash with the first new data.

A further remark worthy of mention is that according to the relation $P(M)$ there seems to be a deep connection between the famous extreme Kerr metric [6] for fast rotating black holes in General Relativity and the *spin* of proton ! The connection is exactly of the same type as that between the well-known Schwarzschild metric [6] for black holes and the *mass* of proton: both of them give the same ratio as dimensionless Dirac number. Thus, exact but exotic mathematical consequences of General Relativity (a macroscopic theory !) appear to contain indirect but reliable information on elementary particles. This can be regarded as an indirect "test" of the validity of the General Theory of Relativity even at 10^{-13} cm, i.e. the proton size ! — The above numerical coincidence is to be compared also with the fact that a rotating charged black hole is known to have a magnetic dipole moment d related to the angular momentum P so that the gyromagnetic ratio of black holes is exactly 2, just as for electrons. — All these should increase one's confidence in black hole physics often regarded — by outsiders — as a merely speculative theory avoid of any immediate and realistic physical significance.

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СОВПАДЕНИЯ КРУПНЫХ ЧИСЕЛ В СВЕТЕ ЭВОЛЮЦИИ КОСМОСА

Г. ПААЛ

Резюме

В природе наблюдается появление «большого количества безразмерных больших чисел» в полном согласии с выраженным неслучайным характером. Некоторые закономерности в их распределении рассматриваются как по стандартным моделям мира типа Эйнштейн—Фридманн, так и согласно космологии Дирака. Отмечаются физические, астрономические, геологические и биологические последствия рассматриваемых явлений.

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LARGE-SCALE CYCLIC PROCESSES IN THE GALAXY

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Large-scale cyclic processes in the Galaxy are: a) the free oscillations in the gravitational potential field of the Galaxy (rotation and epicyclic movement); b) the quasi-stationary gravitational density wave producing the spiral structure (LIN, 1964); c) the oscillation due to the cyclic activity of the nucleus of the Galaxy.

The (*b*) density wave is rotating as a rigid body around the centre of the Galaxy (period: $5 \cdot 10^8$ years). The stars are moving at a considerably higher angular velocity, accordingly in the spiral arms one finds stars of ever increasing age in the direction of the galactic rotation. The spiral arms are so conspicuous not because of being richer in matter, but because much more energy is liberated in them by young objects of high luminosity.

The well-developed spiral structure of a galaxy implies low specific angular momentum and high central mass concentration.

The nucleus of our Galaxy is comparatively quiet. However, there are signs of its having been periodically active, with intense infrared and radio wave emission and matter ejection (*c*).

Oscillation is maintained by a 500 million year explosion cycle resulting in periodical Seyfert character of our Galaxy. These explosions are probably due to a supermassive star (of about 10^8 solar masses in the centre of the Galaxy).

The galactic level of organization is characterized by the undisturbed predominance of the gravitational interaction. Corresponding speed data are remarkably superior by about two orders of magnitude to the 1 km/sec average of strip *B*. It is possible that it is a manifestation of the convergence of strips *A* and *B* on a metagalactic scale.

The perpentuance of cosmic objects can be explained by the equilibrium of the forces generating them and approximately compensating the effect of each other. The same forces generate the characteristic forms of motion of each object as well as the fluctuations near the equalibrium. Thus, cyclicity is practically a universal feature of the partially separated stable cosmic objects.

Among the large-scale cyclic processes in the Galaxy the most significant ones are:

a) the free oscillating motions in the gravitational potential field of the Galaxy, i.e. rotation and the so-called epicyclic motion;

b) the gravitational density wave producting the spiral structure;

c) the oscillation generated by the cyclic activity of the Galaxy centre.

According to the organization level of the Galaxy and its position on the structural scale, in these processes — being in close interaction with each other — the common gravitation plays the predominant role.

It is well known, that similarly to the other spiral galaxie (constituting about 65 per cent of all the stellar systems) also the rotational angular velocity of our Milky Way is a function of the distance from the centre. If the spiral arms were material tubes they would be subjected to permanent deformation and after a few rotations they would wind up and disappeare. As it has been recognized, the winding up could not be obstructed even by the magnetic field in the spiral arms since the field power measured either from the FARADAY-rotation of polarized radiation of pulsars and other radio sources, or from the ZEEMAN-effect of the 21 cm interstellar hydrogen line, is only about 3 μgauss. Thus, the magnetic energy density falls to the order of magnitude of the energy density of the turbulent motion of interstellar gas and this is considerably lower than the energy density derived from the galactic rotation of the gas. Consequently, the magnetic field is unable to influence systematically the large-scale motion of the gas.

The same conclusion can be drawn on a purely heuristic way through the general consideration that according to the organizational level of the Galaxy and its position on the structural scale, in the formation of its main morphological pecularities from among the main physical interactions gravitation has to be predominant. Surely, from the Metagalaxy possessing the characteristic scale of 10^{28} cm through the clusters of galaxies, galaxies, nuclei of galaxies, stars down to the planetary bodies of 10^{8} cm, the predominating form of interaction of the objects is the gravitation and, moving towards the small dimensions, the electromagnetic interaction becomes important only on a much smaller scale. Taking this into consideration the problem of the winding up can be avoided by assuming that the material of the spiral arms is not constant but the spiral structure is produced by the local maximum of a quasi-stationary large-scale density wave in the Galaxy. The density wave affects the distribution of both the stars and the gas and it moves relative to the material of the stellar system, thus is not necessarily exposed to the deforming effect of the differential rotation. It is to be emphasized that the density wave is quasi-stationary; its progression and survival is assured by the wave-like disturbance which is caused by the density fluctuation in the gravitational field of the Galaxy.

After the early attempts of B. LINDBLAD, which were only partly successful, the significance of density waves on the galactic scale has been emphasized by C. C. LIN and his co-workers (LIN, 1964). According to the concept of LIN, the characteristic structure of the spiral galaxies is generated by the quasi-stationary density wave rigidly rotating around the nucleus of the stellar system. In accordance with the equations of mass conservation and continuity of gas dynamics the presence of the density wave is accompanied by the perturbation of a simple circular or elliptic motion of the stars and the interstellar gas. Near the density maxima the motion becomes necessarily slower and the galactocentric orbital velocity will periodically fluctuate.

The cosmic objects generally revolve around the Galaxy's centre in an elliptic orbit of more or less excentricity. According to LINDBLAD their motion can be described also by elliptic epicycles (Fig. 1). The epicyclic frequency $\varkappa(\mathrm{R})$ shows the following relation with the other basic factors of the galactic rotation:

$$\varkappa(R) = 2\sqrt{-B(A-B)} \tag{1}$$

where A and B, the so-called OORT's constants depend on the rotation velocity $\Omega(\mathrm{R})$ as follows:

$$A(R) = -\frac{1}{2} R \frac{d\Omega}{dR}; \quad B(R) = A - \Omega. \tag{2, 3}$$

$\Omega(R)$ and $\varkappa(R)$ can be regarded as the eigen-frequencies of the free oscillations in the R galactocentric distance. It is obvious that resonances may appear between the above eigen-values and the Ω_p angular velocity of the rigidly rotating density wave. Out of them the following ones the most important are:

a) corotation $\quad \Omega - \Omega_p = 0;$ (4)

b) inner LINDBLAD-resonance:

$$\Omega - \Omega_p = \varkappa/2 \tag{5}$$

c) outer LINDBLAD-resonance:

$$\Omega - \Omega_p = -\varkappa/2. \tag{6}$$

The corresponding non-perturbated orbits are shown in Fig. 1 in a coordinate system rotating with an angular velocity Ω_p, i.e. resting as compared to the spiral pattern. The resonance radii corresponding to the angular velocity of resonance depend on Ω_p and the shape of the $\Omega(R)$ function, i.e. on the distribution of mass in the stellar system. (The model being rotation-symmetric to the mass distribution can be deduced from the shape of the rotation velocity function $V_{\mathrm{rot}}(R) = R\Omega(R)$ changing with the distance from the centre.

According to W. LOHMANN (1974), the total mass can be estimated as $M_G = 0{,}75\ V_0^3/AG$, where V_0 is the orbital velocity of the Sun, G is the gravitational constant expressed in the corresponding units. Already the original theory of LINDBLAD made use of the fact that within the Milky Way $\Omega - \varkappa/2$ is practically wide annular range.

Thus, in the whole range the corresponding value of Ω_p produces resonance. In the LIN-theory the inner and outer LINDBLAD-resonances determine the limits of the radial extension of the denisty wave.

Since the spiral structure of the majority of the galaxies is stationary during long periods of time (and these are systems highly isolated from their

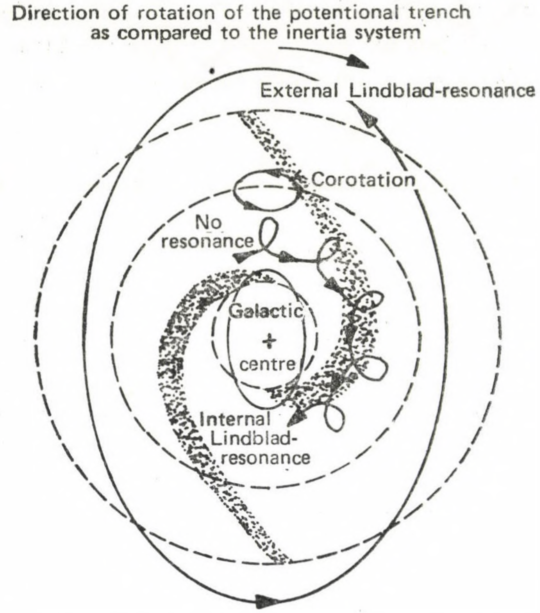

Fig. 1. LINDBLAD's epicyclic orbits and resonances in the galactocentric coordinate system rotating with an angular velocity Ω_p

environment) the presence of spiral arms can be explained only by a "self-preserving" neutral density wave.

In a galaxy, however, neutral density waves may survive only if the system is not inclined to produce local gravitational collapses (the so-called JEANS-instabilities). Already in 1964 it was demonstrated by A. TOOMRE that in a stellar system of mathematically negligible thickness JEANS-instabilities do not occur when the inequality below is valid for the local dispersion of peculiar velocities of the individual members in radial direction:

$$(\overline{v_{\mathrm{rad}}^2})^{1/2} > 3.36 \; G\sigma/\varkappa \tag{7}$$

(where σ is the surface density projected on to the main plane, $\varkappa$ is the epicyclic frequency and G is the gravitational constant). On the basis of the critical values this is 52 km/sec in the Sun's neighbourhood, while taking into account the real thickness of the galactic disc, this is 37 km/sec. This latter value is nearly the same as the R-directed velocity dispersion of late-type dwarf stars constituting the main mass of the Milky Way. If at the beginning the dispersion remains below the critical value in a galaxy, owing to the collapses it will increase until this value is reached, i.e. the situation is stabilized. With the disappearance of the JEANS-instabilities the increase of velocity dispersion will stop. This is of great significance from the point of view of the LIN-theory since in case of dispersion considerably surpassing the critical value the propagation conditions of the neutral density wave become less favourable.

The density wave propagating in the Galaxy's material otherwise moves together with the fluctuation generated in the gravitational potential field: the sites of maximal density coincide with the "potential trenches". In accordance with TOOMRE's result mentioned above, the smaller is the velocity dispersion of the objects belonging to the system, the greater is the amplitude of the density wave (thus, in the interstellar medium disturbances are considerably stronger than those among the stars.) The observer moving together with the material detects the transition of the potential trenches rotating as rigid bodies with an angular velocity generally differing from that of the Galaxy's material, with the frequency of

$$\mu = m[\Omega_p - \Omega(R)]/\varkappa . \quad (8)$$

Suitable stationary solution exists only when the condition is fulfilled, i.e. the inequality

$$\Omega - \varkappa/m < \Omega_p < \Omega + \varkappa/m \quad (9)$$

is to be valid. Consequently, in accordance with the observations as well as with the facts mentioned in connection with the LINDBLAD-resonances, the spiral arms around the centre of the stellar system can survive only within a definite ring. Fig. 2 based on the mass distribution of the Schmidt model, describes the run of the rotation and epicyclic frequencies in the Milky Way. It is obvious that in case of $m = 2$ the range suitable for the formation of spiral arms is much wider than in case of $m > 2$. (The same refers to the majority of those normal spiral galaxies which can be analyzed dinamically). Thus, the number of spiral arms is two and further arms can appear only at the edges of the stellar

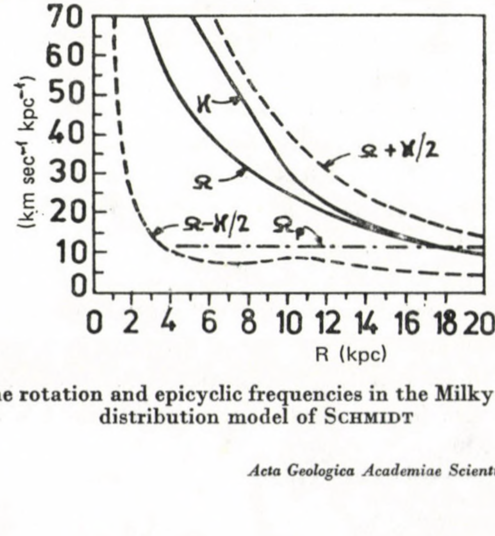

Fig. 2. The shape of the rotation and epicyclic frequencies in the Milky Way based on the mass distribution model of SCHMIDT

system where $\varkappa$ and Ω only slightly differ from each other, and their change is slow as compared to the galactocentric distance.

Consequently, the density wave front, as a double-armed spiral pattern rotates around the centre of the Galaxy as a rigid body with a period of 500 million years in the galactocentric distance of the Sun with an angular velocity considerably lower than that of the material.

The LIN-conception considerably affects also our ideas of stellar cosmogony. According to the linear approach discussed above, the density wave disturbing the "tranquillity" distribution of the stars and that of the interstellar material differ only in their relative amplitude. (Since the interstellar medium amounts only to 10 per cent of the mass of the whole system, a 5 per cent increase of the total density needs a much greater relative amplitude than in case of stars). The non-linear solutions describing the behaviour of the galactic density wave in a better way show qualitative differences: in the interstellar gas the transition through the potential trenches generates shock waves.

According to W. W. ROBERTS (1969), in our stellar system the maximal density generated in the shock wave front at a galactocentric distance of $R = 10$ *kpc*, is five times as much as that in tranquillity, when the relative depth of the potential trench is 5 per cent. In the coordinate system rotating with an angular velocity of Ω_p the streamlines of the gas are such (nearly circular) closed curves which possess break-points in the shock wave fronts. In the gas moving with an angular velocity greater than that of the potential trench when reaching the shock wave front considerable compression also occurs in addition to the sudden increase in density, thus the conditions of formation of new stars are greatly improved. (At the same time, the formation of the interstellar dust particles is also accelerated and this explains the fact that the light-absorbing cosmic nebulae show the spiral structure, too). A typical HI-nebula stays in an interval favourable for star formation generally for $3 \cdot 10^7$ years. Since the shock front lies within the inner edges of the spiral arms, the young O-stars and the HII-fields generated by them can be observed also here, strongly emphasizing the internal contours. Taking into account the fact that stars move with considerably greater angular valocities than the density wave does, in the spiral arms ever older stars are found in the direction of galactic rotation. The distribution of open clusters of different ages is consistent with the above concept (R. WIELEN, 1971) as it has been verified also by the researches carried out at the Department of Astronomy of the Eötvös University, Budapest (B. BALÁZS, 1978).

To reveal the age stratification of the spiral arms and generally the galactic disc, i.e. in an abstract sense their "annual rings", is one of the most important tasks of galactic astronomy at present. In this field not only the spatial distribution, but also the kinematic features of the stars of different ages may provide significant assistance. It is known, that the valocity dispersion of the interstellar gas is considerably smaller than that of the stars in general, and the newly born stars preserve the kinematic properties of the medium in which they were generated. Nevertheless, as it has been emphasized by R. WOOLEY and M. P. CANDY (1968) and since the "stellar gas" does not posses cooling mechanisms similar to that of the interstellar material, due to the interactions with the irregularities of the galactic gravitational field it shows increasing velocity dispersion perpendicular to the main plane. Thus, the older is some sub-system of stars, the greater is its velocity dispersion. As it has been proved by the researches carried out at the Department of Stellar-statistics of the Observatory of the Hungarian Academy of Sciences (L. BALÁZS, 1975), in a given neighbourhood of the Solar system the stars can be divided into kinematically fairly distinguishable, discrete sub-systems. This can be explained by their large-scale periodic formation, in accordance with the density wave theory.

Thus, the LIN-theory proves to be a reliable guide also in this field, and it is not accidental that in the past years the theory of conceiving the spiral structure as a wave phenomenon has become predominant. The spiral arms are conspicious not because they are much more abundant in matter but because much more energy is released in them by time — and mass units than in the fainter parts of the Galaxy. Since, similarly to the normal spiral galaxies the majority of the mass of the Milky Way is represented by old faint stars, the striking contrast of the spiral arms is caused by the apparent brightness of young objects. The formation and distribution of the young objects are determined by the cyclic, quasi-stationary perturbation of the gravitational field generated by their dwarf fellow-stars constituting the "grey mass" in the Galaxy.

Be the conditions howsoever favourable for the survival of a Galaxy-sized neutral density wave, some energy dissipation should be taken into account. As it has been pointed out by J. H. OORT and co-workers (1972) the density wave should transfer annually about 10^{46} erg through the galactocentric circle drawn in the resonance field. According to D. LYNDEN-BELL (1970), the density wave makes up its energy loss first of all from the rotation energy of the Galaxy and it does so possibly in the following way.

In the corotation resonance region the stars, the epicentres of which are at a slightly shorter distance from the Galaxy's centre than the R_k corotation distance, i.e. for which $\Omega(R_k) = \Omega_p$ with:

$$0 < R_k - R \ll R_k \tag{10}$$

posses a circular velocity somewhat greater than that of the density wave and accelerate it (i.e. transfer angular momentum). The stars, however, the epicentres of which lie slightly outside the corotation circle, i.e. for which the relation

$$0 < R - R_k \ll R_k \tag{11}$$

holds, and they rotate with an angular speed somewhat smaller than that of the density wave, drawing off angular momentum from it. As a final conclusion, the issue whether the density wave gains or loses energy during the interactions mentioned above depends on the question how fast the density of the material decreases with the increase of the galactocentric radius in the corotation zone of the galactic disc. It can be a selection rule that from among the Ω_p rotation periods satisfying [9] the one will be realized at which corotation occurs with an efficiently high density gradient. Since the orbital angular momentum of the stars possessing epicentres satisfying [10] will decrease due to the interaction with the density wave, the diameter of the orbit of these stars will gradually decrease. Based on analogue considerations, since the galactocentric distance of the stars satisfying [11] will increase, the density of the corotation range decrease. According to the LYNDEN—BELL calculations, the corotation zone moves inward after a while pushing also the interstellar material ahead of it. Thus, as a result of the interaction of the density wave, the galactic rotation as well as the epicyclic motion, the specific angular momentum of the stellar system decreases and its central mass concentration increases at the same time.

Consequently, if a Galaxy possess a highly developed spiral structure, a relatively low specific angular momentum and a great central mass concentration can be expected. Since above certain mass limit the Galaxy's nucleus becomes instable, the question arises whether a large-scale cycle exists in the course of which the periodic activity of the Galaxy's nucleus "regenerates" the galactic density wave (which, on the basis of the aforementioned affects the activity of the core). This type of regeneration is necessary even because of the damping phenomena (K. ROHLFS, 1978).

Concerning our Galaxy, it can be stated that it was only in the past twenty years, when the observation techniques by means of which we are able to "see" deep into the Galaxy's centre have developed. As a result of the observations made at different wavelengths a striking similarity between the nucleus of the Milky Way and that of the so-called SEYFERT-galaxies (i.e. galaxies with very active nucleus) has been revealed.

At present the nucleus of our Galaxy is relatively at rest. Its energy release is only 10^{-4} times as much as that of the SEYFERT-galaxies and less than 10^{-7} times of that of the quasars. More and more evidences accumulate, however, to support the fact that also in the history of our Galaxy there are very active periods. In these periods the SEYFERT-character manifests itself by the strong infrared and radio emission as well as by the high-speed material outflow.

J. H. OORT and co-workers (G. W. ROUGOOR, 1964) were the first to state that at a distance of 3 kpc from the Galaxy's centre an expanding arm can be found both on the facing and the opposite side. (On the side facing us the radial velocity is about 50 km/sec). Both the outward-directed gas motion and the synchroton radiation observed from the centre relate to an explosion in the nucleus. Since the kinetic energy of the expanding arms is 10^{53} erg, in case of isotropic explosion about $3 \cdot 10^{58}$ erg energy must have been released (this is equal to the mass of 10^4 suns). If the mass ejected during explosion is equal to 10^8 solar masses, the above situation will occur 10 million years after the explosion. As to estimations, during the life of the Galaxy up to now 10^{60} erg energy has been released in its nucleus and the material that has flown out of it is about 10^9 solar mass. These data are characteristic right for the SEYFERT-galaxies and comparing them with the observations, we are justified in supposing that the nucleus of our Galaxy becomes of SEYFERT-character periodically, (by 500 million years) and supports the more and more verified hypothesis that the SEYFERT-galaxies are not peculiar objects but represent an excited state of the normal spiral galaxies recurring periodically.

(In 1970 analogue considerations made L. M. OZERNOY assume that the strong radiogalaxies, the N-type compact galaxies and the quasars are not different galaxy types but are rather the strongly excited forms of the elliptic, compact and supercompact galaxies.)

Let us return, however, to our Galaxy. According to recent assumptions, the supermassive star (perhaps black-hole) of at least 10^8 solar masses, periodically formed in the centre of the Milky Way is responsible for the repeated explosions in the nucleus, and its activity also contributes to the long-term persistence of the galactic density wave. The formation and regeneration of the object are based first of all on the gravitational accretion of the interstellar (or intergalactic) gas. Here some problems arise connection with the rate of accretion, since the gas quantity deriving from the evolutionary mass loss of the near-centre ($R < 100$ pc) stars amounts annually only to $2 \cdot 10^5$ $M_\odot$ (VAN DER KRUIT et al., 1972) and the inflow of the intergalactic gas, observed in the forms of high-speed hydrogen clouds and mainly at great galactic latitudes gives a value smaller by an order of magnitude than expected. Most of the researchers, however, incline to accept the explanation on the formation of the central superstar by accretion, because on the one hand, it is possible that only a fraction of the gas inflowing at high latitudes has been observed so far and the LYNDEN—BELL mechanism mentioned above may transport gas of sufficient quantity into the centre along the galactic plane. On the other hand, on the basis of the accretion hypothesis the structure of the spiral galaxies can be considered as the product of a large-scale cycle, in which the quasi-stationary density wave generating the spiral arms regains its slowly dissipating energy through the recurring explosions of a central supermassive object facilitating its cyclic formation through its sheer existence.

In conclusion, it may be said that the large-scale morphological features of our Galaxy are the results of cyclic processes governed by its gravitational field. At the organizational level of the Galaxy it also proves to be true that the

Table I

Core activities of different galaxies

Object	Luminosity (erg/s)	Duration of life (years)	Total emitted energy (erg)	Total observed kinetic energy (erg)
Quasars	$10^{47}-10^{48}$	10^{6}	10^{62}	10^{60}
SEYFERT	$10^{44}-10^{45}$	10^{8}	10^{61}	$10^{55}-10^{60}$
Milky Way	$10^{39}-10^{40}$	10^{10}	10^{58}	$10^{53}-10^{54}$

system-character of a higher level is not determined by the entry of new kinds of energy, but rather by a familiar form of interaction (in our case the gravitational one) which is not conspicuous at small dimensions but has a long action radius free of interference due to the elimination of shorter range interactions.

We have seen that large-scale cylic processes in the Galaxy — most probably — are closely connected with one another, and the space dimension of the density wave propagating in the Galaxy disc is commesurable with that of the whole system (which, on the other hand, can be demonstrated in the universal time-space diagram, attached to the rotation period). Since the velocity values of the processes discussed above exceed by about two orders of magnitude the average 1 km/sec characteristic for the main strip *B*, it seems to be possible that the tendency occurring in metagalactic dimensions appears already at the level of the Galaxy, i.e. the strip of mechanical rhythms converges towards the range of electromagnetic phenomena.

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КРУПНОМАСШТАБНЫЕ ЦИКЛИЧНЫЕ ПРОЦЕССЫ В ПРЕДЕЛАХ ГАЛАКТИКИ

Б. БАЛАЖ

Резюме

Крупномасштаные цикличные процессы в пределах Галактики сводятся к следующему:

а) свободные осциляции в поле силы тяжести Галактики (вращение и эпицикличное движение),

б) волна квазистационарной гравитационной густоты, создающая спиральные структуры (Лин, 1964),

в) осцилляция, вызванная цикличной деятельностью ядря Галактики.

Волна густоты (б) вращается как жесткое тело вокруг центра Галактики (период — $5 \cdot 10^8$ лет). Соответвенно этому, звезды перемещаются с гораздо большей угловой скоростью, на стрелах спиралей находятся звезды с возрастом, увеличивающимся в направлении вращения Галактики. Стрелы спиралей являются такими показательными не потому, что они богаче веществами, а в связи с освобождением в них большего количества энергии под действием молодых объектов, характеризующихся повышенной светимостью.

Ввиду хорошо развитой, выраженной спиральной структуры галактик можно судить о наличии низкого значения удельного момента импульсов и повышенной концентрации массы.

Ядро нашей Галактики относительно спокойное. Однако, есть признаки свидетельствующие о том, что оно было периодически активным с интенсивными эмиссиями инфракрасной радиации и радиоволн, а также с выбросами веществ. (в).

Осцилляция контролируется эксплозионным циклом продолжительностью в 500 миллионов лет, чем и обусловлен периодический характер Зейферт нашей Галактики. Эксплозии обусловлены, по-видимому, присутствием в центре Галактики супермассивной звезды (с примерно 10^8-кратной величиной солярной массы).

Галактический уровень организации материи характеризуется ненарушенным преобладанием гравитационного взаимодействия масс. Соответствующие данные скоростей заметно, примерно на два порядка больше средней скорости полосы B, составляющей 1 км в сек. Вполне возможно, что это обусловлено конвергенцией полос *A* и *B* в метагалактических масштабах.

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COSMOLOGY WITH A MATERIAL VACUUM[1]

By

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Some of the observational evidence favouring a new kind of steady state cosmology are described. Different types of galaxies as well as their evolution phases and the effects generating these phases are discussed.

In Big-Bang cosmology, primaeval inhomogeneities of some kind lead to galaxy formation. Possible theories are severely restricted [1], however, by the observation of isotropy in the microwave background and the need to identify some factors (e.g. angular momenta) responsible for evolution into different types of galaxy. No such theory, however, successful in these respects, accounts for the structural differences between clusters containing elliptical galaxies and those containing spiral galaxies [2].

This paper describes some of the observational evidence favouring a new kind of steady state cosmology which avoids these problems. According to this theory [3], a cluster of galaxies is a quasi-independent cell in an infinite universe with a material content of $\sim 10^{14} - 10^{15}\ M_0$ undergoing a quasi-cyclic evolution on a timescale of $\sim 5 \cdot 10^{10}$ years. In the collapse phase ($\sim 10^{10} y$), aggregates of stars and gas dissipated by the previous cycle, form a compact cluster of E-type galaxies. In the expansion phase, they evolve into S-type and I-type galaxies as the cluster takes on an enlarged and much more ragged structure.[2]

This process is basically due to the evolution of stars in the spheroidal components of galaxies which thereby tend to diminish in size along the (Hubble) sequence $E \rightarrow SO/IO \rightarrow S/I$. Mass loss from stars periodically ($\sim 10^8 y$) leads to the construction of successive galactic nuclei [4] which become supermassive in the gravitationally collapsed state associated with relatively brief active quasar and Seyfert phases. Rotational instability of these nuclei gives rise to symmetrical ejecta, initially recognised as double radio sources in the early massive E-state, and then as successive sets of relatively short-lived spiral

[1] Paper also presented at Meeting of Irish Astronomical Science Group at Dublin, November, 1978.

[2] M_0 denotes the solar mass, E, S, I and SO mean elliptical, spiral, irregular and lenticular galaxies, resp.

arms feeding into a bound disc in the subsequent S/I-state. According to this scheme, the mass-energy content of gravitationally collapsed nuclei formed at intervals of $\sim 10^8 y$ is $> 10^{13} M_0$ and is essentially the "missing mass", but immediately before collapse and after disruption, the mass-energy is so widely dispersed as to be locally unobservable. This property explains why quasars have large gravitational redshifts and spiral arms remain bound in spite of their initially relativistic ejection. It is, of course, implicit, in this scheme that galactic nuclei are *not* powered by black holes.

In this theory, the spheroidal component is considered to have an approximately constant specific angular momentum. Essentially similar nuclei which ultimately rotate with uniform angular velocity redistribute the angular momentum in such a way that the central high temperature ($\sim 5 \cdot 10^9 K$), low angular momentum part gives rise, on disruption, to the galactic halo, while the outer, high angular momentum part generates the disc. Such a model, as Unsold has shown [5], is in very good agreement with observations of chemical abundances in the Galaxy. Suppose we idealise this scheme, assuming an initial mass of spheroidal component M and specific angular momentum (*s.a.m.*) $= h$, and we suppose there is formed a disc of mass m with *s.a.m.* $= kh$ [3] and a halo of mass km with *s.a.m.* $= h/k$, then it follows that

$$m \leq M/k$$

(N.B. The commonly expressed view that the disc and halo have identical mean s.a.m. is based on KINMAN's rather artificial comparison [6] of essentially *nearby* globular clusters with gas much closer to the centre of our Galaxy. In the one place where the comparison can be made with certainty, the solar neighbourhood, the s.a.m. differ by a factor of 3 or 4). Thus, if the initial galactic mass is $\sim 10^{11} - 10^{12} M_0$ and the structure of galactic nuclei gives $k \sim 10$ (say) them $m < 10^{10} - 10^{11} M_0$. If $\sim 10^2$ nuclei are built in the lifetime of one galaxy, the mass of any one set of spiral arms is on the order of $10^8 - 10^9 M_0$, in adequate agreement with observations.

It is a plausible assumption that the "missing energy" is usually located in a *material* vacuum. The energy, however, intermittently transfers to gravitationally collapsed bodies giving rise to a supermassive, relativistic, regime, i.e. $m_0 \rightarrow \gamma\, m_0$.[4] The vacuum may be considered to exist ordinarily in the form of a cold, low density superfluid, itself giving rise to the smooth microwave background. According to this picture, the material vacuum is the source of all potential energy and those effects attributed to "fields" are a manifestation of action by the material vacuum. This is contrary to the view of Nature which

[3] Where k is a suitably chosen empirical constant, describing the structure of the given galaxy.

[4] γ is a numerical factor describing the relativistic mass increment.

ascribes to fields a more fundamental role. It seems that it is not possible to accept this pattern of galactic evolution, therefore, without also questioning some of the current fundamental concepts of physics.[7, 8].

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КОСМОЛОГИЯ С ВЕЩЕСТВЕННЫМ ВАКУУМОМ

С. В. М. КЛЮБЕ

Резюме

Рассматриваются некоторые факты наблюдений, благоприятствующих разработкам направленным на создание новой концепции космологии в условиях постоянства состояния вещей. При этом автор останавливается на различных типах галактик, а также на и, эволюционных фазах и на эффектах, вызывающих эти фазы.

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GEOMAGNETIC PULSATIONS. A POSSIBLE LINK BETWEEN INTERPLANETARY MEDIUM AND SURFACE

By

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Pulsations with periods of 1 to 100 s exist in the electric field of the air. The fields having amplitudes of 1 Vm^{-1} of order of magnitude have an effect both on microorganisms and on warmblooded animals. The estimation of the measure of this effect seems to be troublesome and it is expected that the international cooperation of Soviet and Hungarian experts will promote to solve this problem.

1. In recent times, the effect of the geomagnetic field and its variations on the human environment has been much discussed. The meteorological effect could be statistically confirmed, though the mechanism of the influence is not cleared, yet. In addition to an indirect biological influence through meteorological factors, the immediate effect of the geomagnetic activity on living organisms is also much discussed. Such an effect, however, could not be statistically proved, at least in published material, although interesting cases are known. As the interest is quickly increasing for the problem, it can be expected that positive or negative significant results will be soon available.

2. In the framework of possible biological effects of geomagnetic variations, the short-period part of the spectrum may play the major role. It includes a great variety of variations from different physical sources. Here only a limited part of the spectrum, the so-called geomagnetic pulsations will be treated. These are variations with periods between some tenths of seconds and several tens of minutes. The most prominent ones are the continuous pulsations, *Pc*, with the important subgroups *Pc1* (pearl pulsations, period around 1 s) and *Pc* 3–4 (periods 15–150 s), and impulsive or irregular pulsations, *Pi*.

The excitation mechanism of the pulsations has not been sufficiently dleared yet. *Pi*-type pulsations constitute a part of the so-called substorm complex which includes aurora, geomagnetic bays, ionospheric disturbances, etc. Accordingly, these appear at moderate latitudes during the night for some minutes on a rather quiet background with periods around 1 minute.

The name "Pearl-type" pulsations is due to their particular appearance on analogous records, where the envelop of the extrema has a beating period of about 1 min, thus the series of pulsations appears similarly to a pearl necklace. These are connected with wave packages or particles travelling along geomagnetic field lines, and reflected at the surface-near part of the field line (mirroring). The mirroring period is the period of beating. These are connected with instabilities in the inner part of the magnetosphere, in the plasmasphere, and also with particles coming into the lower zones of the atmosphere after geomagnetic storms.

Pcl-pulsations are at moderate latitudes a night-time phenomenon, appearing only in a few per cents of all time.

Some years ago the magnetospheric origin of the *Pc* 3—4 type (Fig. 1). pulsations has been generally accepted. Recent results show, however, that a significant part is of interplanetary origin.

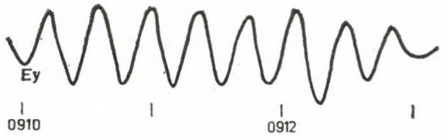

Fig. 1. **Example of Pc 3 pulsations in the electric field (period about 23 s)**

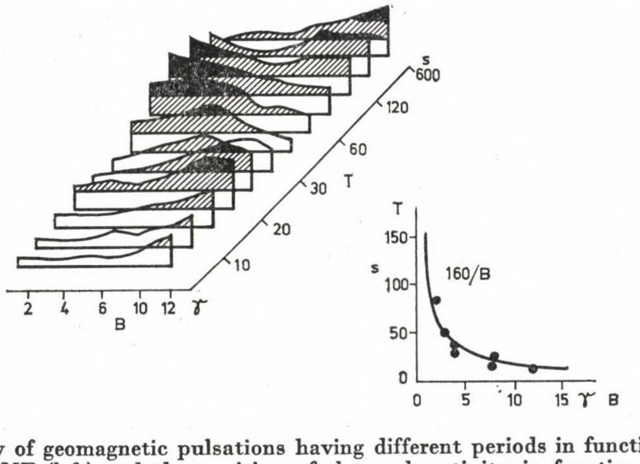

Fig. 2. **Activity of geomagnetic pulsations having different periods in function of the scalar magnitude of IMF (left) and the position of the peak activity in function of IMF (right), The curve 160/B is also drawn**

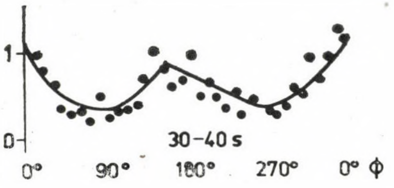

Fig. 3. **Dependence of the activity of 30—40 s period Pc 3 on the direction of the IMF; the angle is measured from the Sun-Earth direction in the equatorial plane**

Investigations carried out on the material of the Nagycenk observatory in W-Hungary [5, 8] have also proved connections existing between the parameters of the pulsations and of the interplanetary medium or of the solar wind. The scalar magnitude of the interplanetary magnetic field (*IMF*) determines the period of the pulsations ($T = 160/B$, where T is the period in s, B the magnitude of the IMF) (Fig. 2), the direction of the IMF influences their amplitude (Fig. 3), but the latter is determined mainly by the velocity of the solar wind (Fig. 4). These results are valid for the shorter period part of the *Pc* 3—4 pulsations up to periods of about 40 s (Fig. 5). Above this limit, the connections

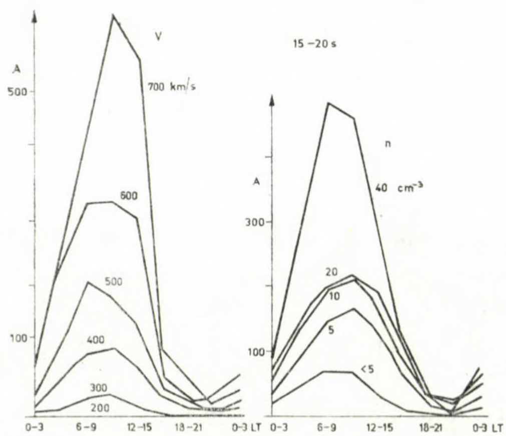

Fig. 4. **Diurnal change of the activity of 15—20 s pulsations in dependence on the solar wind velocity and the particle density (values indicated are lower limits of the parameters in the groups)**

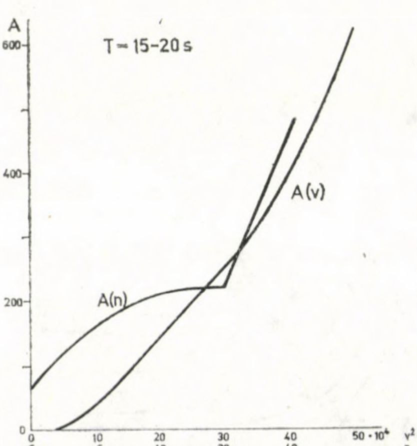

Fig. 5. **Change of the daily maximum level of amplitudes in function of the solar wind velocity and particle density (the A values in Figs 4 and 5 are in arbitrary units)**

are less significant or even they have different character. It is possible that the longer period part (*Pc* 4) originates from magnetospheric sources.

It is known from satellite measurements that in the space before the magnetopause (in direction of the Sun) particles can be detected which came from the direction of the Earth, i.e. which are reflected (Fig. 6). Even magnetohydrodynamic waves with periods similar to those of the pulsations could be observed. According to theoretical studies, reflection is possible on unordered magnetic fields in the magnetosheath, the area between the magnetopause and the bow shock. The reflected solar protons and the particles of the solar wind excite waves with the correct period $160/B$ due to a two-beam instability. The propagation of the waves to the surface of the Earth is unclear.

It is to be mentioned that the time of propagation of the solar wind from the Sun (2—3 days, area 1 in Fig. 7) and the period of the pulsations if they are identified with standing waves along geomagnetic field lines (area 2) lie between strips A and B in the general law of cyclicity, as they correspond to velocities around 100 km/s.

4. The sensitivity of living organisms to magnetic variations is not proved [9]. Therefore, magnetic pulsations be of any origin can or cannot influence them directly. The possibility of an other mechanism which could create an influence, emerged some years ago in a different area of geophysics. Namely, in magnetotelluric soundings of the Earth, the pulsations are used. Supposing plane waves with vertical incidence, the electric conductivity of a part of the Earth's crust can be determined from the ratio of the corresponding electric and magnetic variations. These values have sometimes rather great scatter.

Several Soviet geophysicists [2] suppose that the cause of this scatter is the non-vertical incidence of the pulsation waves. If pulsations have a propa-

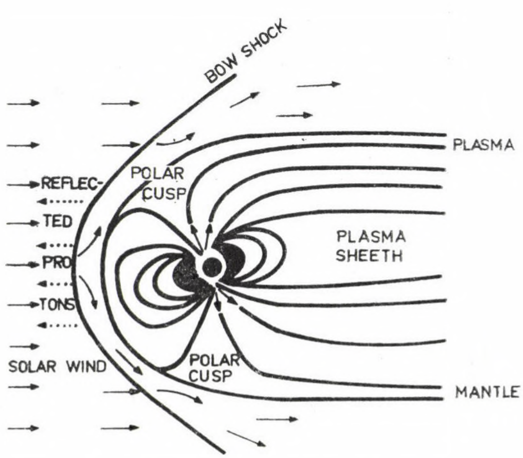

Fig. 6. Structure of the magnetosphere

gation velocity on the surface, then the non-vertical incidence is probable. Pulsation propagations with velocities 40—70 km/s have been really measured in the Soviet Union [7] (Fig. 8).

A consequence of this supposition may be the existence of an electric field in the air. Atmospheric electricity has been measured in many observatories for a long time, but the time-resolution of these records was not great enough to enable a study of such pulsation fields. Recently CHETAIEV's group [1, 3, 6] carried out measurements of the atmospheric electric field, and they found pulsation-like variations which seemed to be coherent with geomagnetic pulsations. Both *Pc* 1 and *Pc* 3—4 types were identified (Fig. 9). In some cases a doubling of the period in the vertical electric field was found.

By the help of IFZ, measurements of the short-period variations of the vertical electric current in the air have been started in fall 1978 in the Nagycenk observatory. Results of similar measurements have not been published

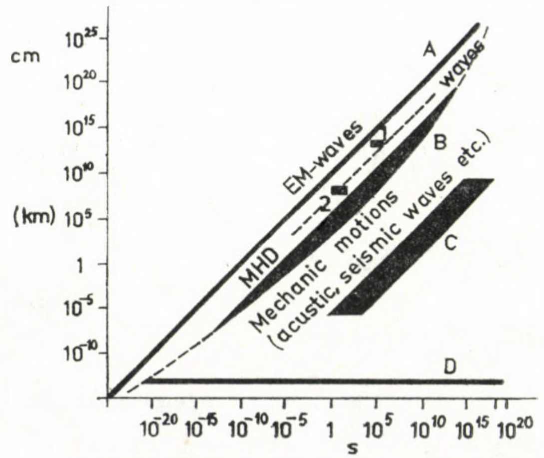

Fig. 7. The place of MHD-waves in the Earth-near space in the general law of cyclicity (area 1: :length dimension is the length of the corresponding field line)

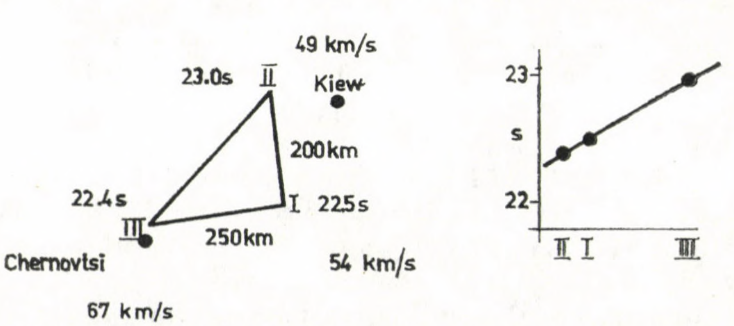

Fig. 8. The Ukrainian network for the determination of pulsation propagation; propagation velocities and average periods at each station (left); and the change of the average periods along the profile (right) are indicated

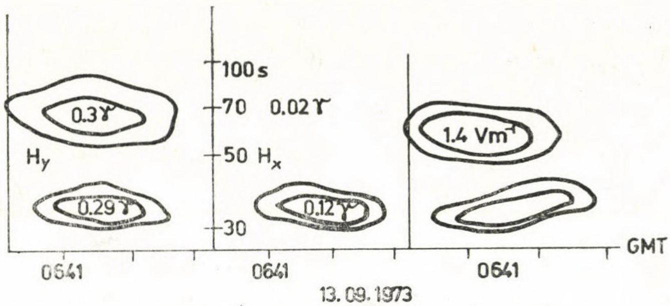

Fig. 9. **Time-frequency-amplitude displays of coherent geomagnetic and vertical electric gradient pulsations from the material of CHETAIEV's group**

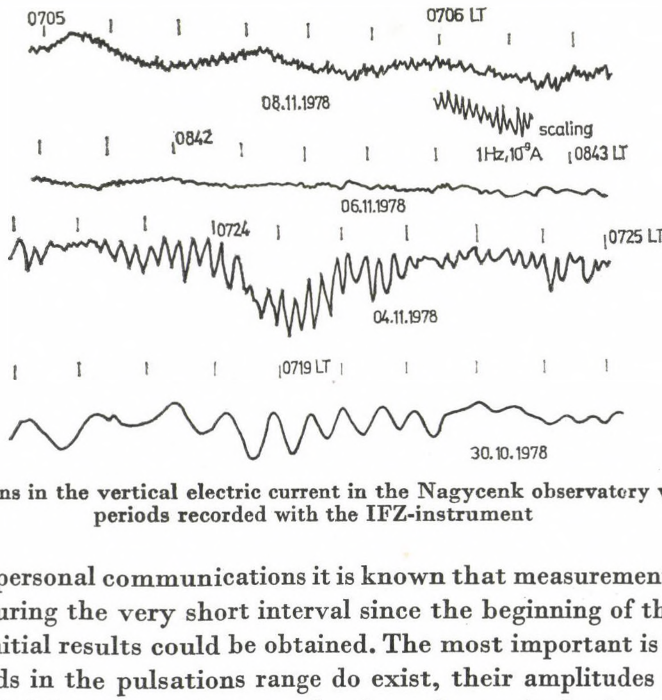

Fig. 10. **Variations in the vertical electric current in the Nagycenk observatory with different periods recorded with the IFZ-instrument**

yet, but from personal communications it is known that measurements are made in Georgia. During the very short interval since the beginning of the measurements, only initial results could be obtained. The most important is that variations of periods in the pulsations range do exist, their amplitudes are around 10^{-8}—10^{-9} A/m^2, i.e. greater by several orders of magnitude than the vertical current itself (10^{-11}—10^{-12} $A(m^2)$ [7] (Fig. 10) In agreement with the Soviet results, the amplitude of the pulsations decreases very rapidly in the morning hours, e.g. between 7 and 9 h *LT* by a factor of 3. Nevertheless, no unambiguous correlation was found between pulsations in the vertical current and geomagnetic pulsations, but this may be due to the mentioned period changes (doubling).

5. On the basis of all these it seems that a continuous chain of information transmission is known between interplanetary media and the surface of the Earth through the pulsations. Such a statement would be, however, too early.

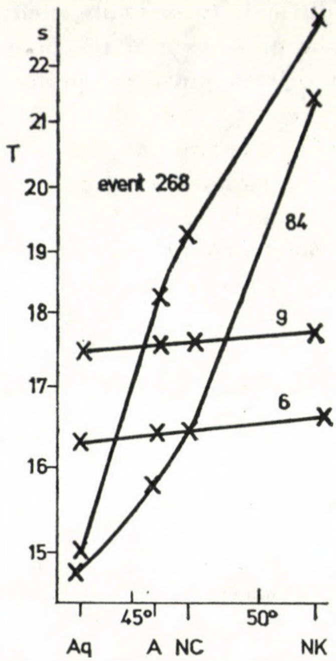

Fig. 11. The change of the pulsation period in function of the latitude (events investigated by J. Cz. MILETITS)

There are basic contradictions in connection with the latitude dependence of pulsation periods. According to recent investigations made in the Geodetic and Geophysical Research Institute of the Hungarian Academy of Sciences, the period of geomagnetic pulsations changes in most cases with the latitude, the rate of the change being highly variable between 0 and 15 per cent for a degree of latitude (Fig. 11). Such a change can be found even in the material from Ukraina [7] and Fig. 7, too, on a distance of 200 km/s. The dependence on latitude of periods is in contradiction with the formula 160/B which yields a certain period for a certain IMF all over the Earth, but also with the propagative character of the pulsations.

6. As a conclusion, pulsations with periods of 1—100 s exist without doubt in the electric field in the air. VLADIMIRSKY et al [9] found that fields having frequencies near those treated here and amplitudes of the order 1 Vm^{-1} have effects both on microorganisms and warmblooded animals. At the same time, magnetic fields proved to be ineffective. It can be, therefore, supposed that a part of the solar effects experienced by living organisms can be through pulsations.[1]

[1] See: E. SZÁDECZKY-KARDOSS: Cyclicity, Theory and Practice. Comission on Geonomy of the Hung. Acad. Sci. and the Hung. Astronautical Society, Budapest, 1978.

It is, however, very difficult to estimate such an effect. The possibility has been mentioned that the pulse-rate of the human heart and the rate of respiration can be connected with pulsation periods as coded paleo-periods. Such a connection seems at present not very probable; the *Pc* 1 pulsations have the correct period of the pulse, but they appear at moderate latitudes too seldom (some per cent of the time); *Pc* 3—4 are more continuous, last sometimes many hours, but have periods much longer than the rate of respiration. According to the formula $160/B$, a much (4—5 times) stronger interplanetary magnetic field would be needed for sufficiently small-period pulsations. Thus, neither hypothesis seems to be very realistic.

It is hoped that the Soviet—Hungarian co-operation will promote an understanding of in this interesting field of biological influences.

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ГЕОМАГНИТНЫЕ ПУЛЬСАЦИИ КАК ВОЗМОЖНОЕ ЗВЕНО СВЯЗИ МЕЖДУ МЕЖПЛАНЕТНОЙ СРЕДОЙ И ЗЕМНОЙ ПОВЕРХНОСТЬЮ

Й. ВЕРЕ

Резюме

В электрическом поле воздуха существуют пульсации с периодом от 1 до 100 сек. Электрические поля с амплитудами порядка 1 Vm^{-1} оказывают влияние как на микроорганизмы, так и на теплокровных животных. Вычисление размеров этого эффекта будет, повидимому, затруднено, но есть надежда на то, что в рамках международного сотрудничества советских и венгерских специалистов можно будет подойти ближе к решению этой проблемы.

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CYCLICITY IN THE HISTORY OF MATTER AND ITS APPLICATION TO THE ELEMENTARY STRUCTURE-BUILDING PROCESSES OF THE SOLAR SYSTEM

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Starting from a basic theorem of dialectics and that of history of matter this work made attempts to construct a uniform natural-philosophical principle for the elementary structures and structure-building processes. A conclusion that the history of matter is an alternating sequence of structuralization (crystallization) and gas periods has been deduced. The principle has been applied to understand a general view of the two elementary structure-building processes of Solar System evolution: chemical crystallization and gravitational crystallization.

Starting from two axioms an attempt can be made to create a uniform natural-philosophical principle of material structures and processes. The roots of both axioms derive from the last century. One of them was formulated in the dialectic philosophy as a general principle: the qualitative changes turn into quantitative ones. The other is the material-historical principle composed of the part-results of professional sciences: the changes of matter can be arranged into an evolution sequence. Our aim is to investigate a model which satisfies simultaneously both axioms. Such a model has been first developed in quantitative form by SZÁDECZKY-KARDOSS (1977).

Instead of a historic review references are made to the results of HUBBLE (1929), GAMOW (1948), PENZIAS and WILSON (1964; radiation of the background), and regarding the petrological differentiation to those of BOWEN.

In the research of natural phenomena it is an old viewpoint to group them into two associations: i.e. structures being temporally stable equilibrium structures and processes in which the temporal change means the essence of the phenomenon. Both of them are extreme models and throw light upon an essential feature of the human perception of Nature: the peculiar separation of space and time.

Between structure and process the structure-building process means the connection.* If the given structure is a crystal, then the formation of the structure is preceded in time by the crystallization process. The alternating sequence of structure-building processes and structures produces the construction of the

* This is the system-building cycle process itself (note of the editor).

chain of material history. The basic unit of this cyclic structure is the "structure formation — structure" period pair. This produces a sequence of processes of structure — structure-formation which bears the essence of each chain-loop of material history falling to the fields of different disciplines. Essentially, the structure-formation proceeds in the cluster of the same particles (structures) being in statistic motion ("gas-like" behaviour). The structure formation assumes the existence of a former "gas-forming" structure the condensation of which produces the structure of the basic unit. Nevertheless, if the structure, produced by the structure-formation — structure period-pair regarded as basic unit of the material-historic chain, appears in sufficiently great number, it may also be the starting matter (particle) of the next largescale structure-formation.

The large-scale structure-formation process has to be preceded by the accumulation of a great number of previous structures. It is not inevitable,

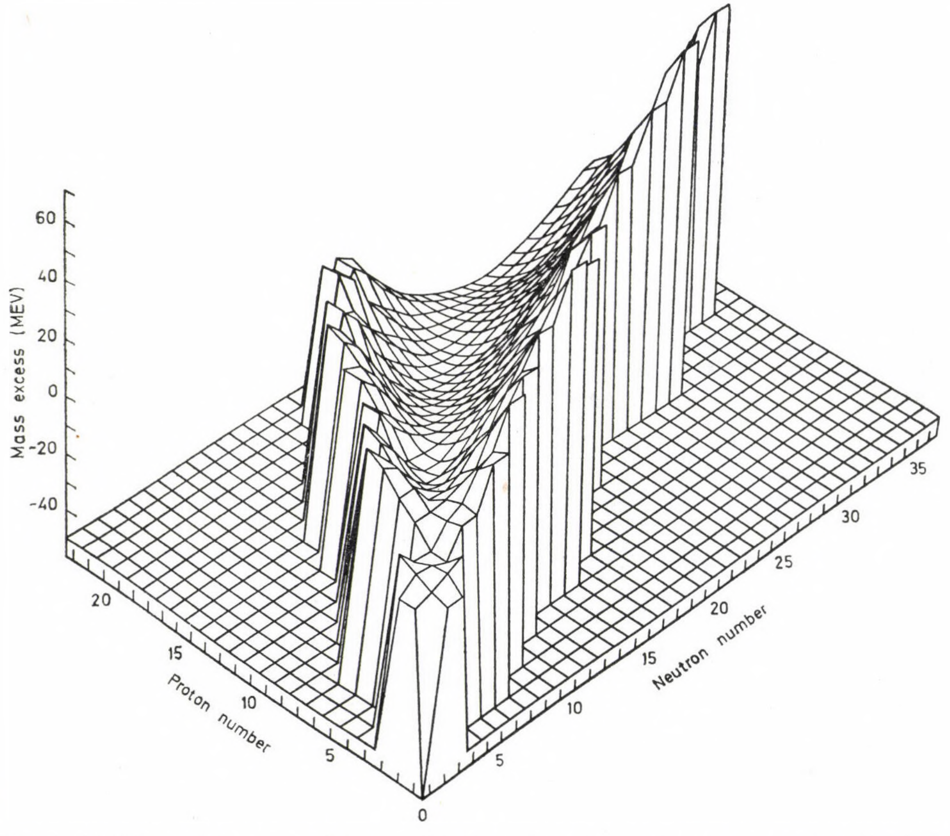


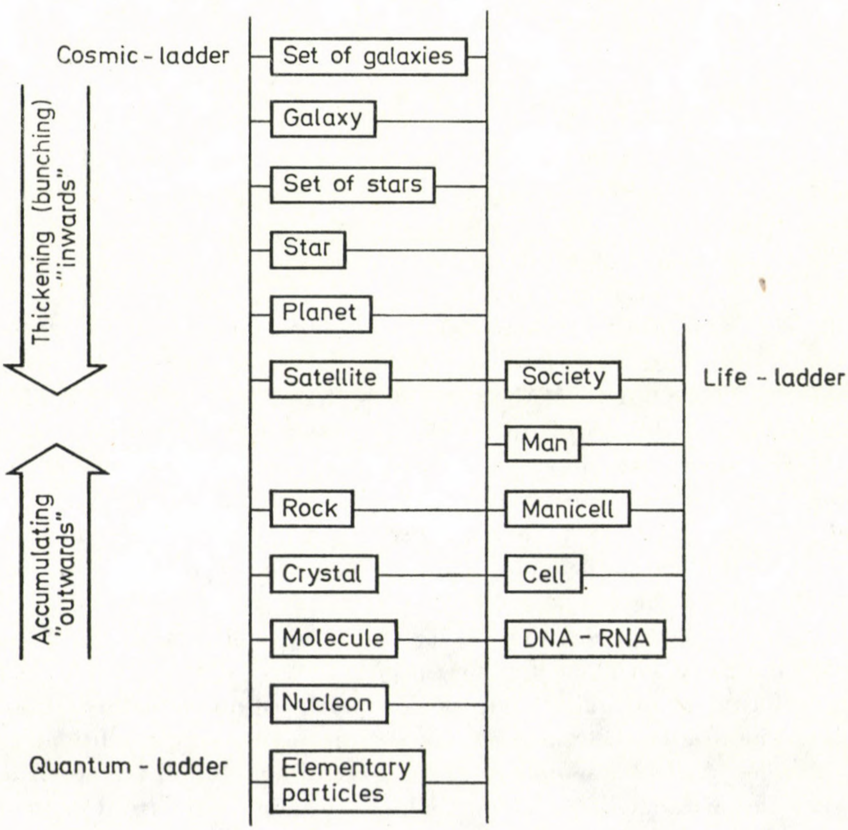
Fig. 1. Stability of atomic nuclei as a function of proton and neutron number (from JEF POSKANZER, Sci. Am. Sept. 1978). Stable atomic nuclei lie in the bottom of the energy valley. Isotopes lying in the slopes (realizing the evolution) get to the favoured stable states, i.e. the valley's bottom by means of radioactive decomposition

however, that the developed structure should pass into a structure-formation process even if it was generated in great number. This is only a possibility and in these cases the trials of evolution come to the front selecting (e.g. by means of some economic principles) the optimal variety, i.e. the basis of further evolution out of the varied structures of essentially the same construction generated during the structure formation (Fig. 1).

The most common process of structure formation is chemical crystallization. (The stable structures are denominated as "crystals" as general term, while structure formation will be called "crystallization".) The face of the observable world has been developed by different "crystallization", i.e. structure-formation processes through the hierarchy of the recently known "crystals" (Table I), i.e. stable structures (Szádeczky-Kardoss: Cyclicity, etc., 15—16, 1977.). In first approximation it can be said that the *history of matter is the*

Table I

The hierarchy of stable-structures involves the evolutionary stages of matter



history of "crystallizations". Taking into consideration also the "gas" periods separating the individual stable structures the history of matter displays the alternation of the crystallization and gas periods.

In the construction of structures the sequence of structures realizes at the same time the mutual "interbedding". In the reality, however, overlapping may occur between the different steps of crystallization, branches may appear in the chain of material history and not subsequently condensed structures may also take part in the make-up of further structures. In the evolution history of material the following aspects can be emphasized.

1. The individual structure types are of very different dimensions and the ranges of dimensions are separated from each other by a "void" of several orders of magnitude) this is really a very sparse space of gas).

2. In each dimension range the type which will be preponderant is selected from several possible varieties: the most economic structure becomes predominating.

3. The most successful variety is generated in such a quantity that it suppresses the increase of the others.

4. The cluster of particles of the predominating type follows statistic physical laws in its evolution (motion).

5. The evolution of the gas-like material cluster turns by and by into crystallization process (e.g. by the changing p, c, T conditions). The elements of new structures are the particles crystallized till that time.

6. In harmony with the law of mass effect after the crystallization process usually considerably quantity of gas(phase) remains due to the decrease in concentration.

7. The sequence of crystallizations represents an evolution because of the spontaneous irreversibility of the process.

8. The structure types separated by orders of magnitude in space and time cannot be transformed into each other. The types preserve their structure as inclusions characteristic of the previous period. A consequence of this is the hierarchic "interbedding" of the stable structures of the Universe.

9. The crystallization steps of material history are the steps of crystallization differentiation. The crystals of the past period are often preserved also in the new crystallization periods in form of non-equilibrium inclusions. The imperfect crystallization provides a possibility to the cognition of Nature, and to decipher its history.

10. In the gas period the interaction is especially intense between the particles. Paralelly with "cooling" of the gas the force deriving from this interaction performs labour building up the gas particles into structure.

11. The stable structures satisfy definite symmetry condition.

12. The shell-like sequence and different ages of different structures represent the distance-like presence of time-coordinates in the Universe. *The*

past of matter is within and around us. In this manner are united the time-and space-coordinates which are highly separated in our traditional world.

The model can be demonstrated in one dimension (Fig. 2) by the alternation of the crystallization and gas periods. Let the chain of history of matter known in a given moment be symbolized by the uniform covering of a line:

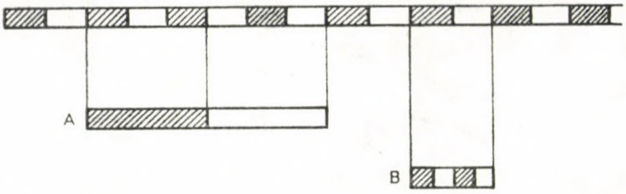


Fig. 2. The model of history of matter based on the alternation of crystallization and gas period can be restricted *(A)*, resp. enlarged *(B)* conserving the feature of cyclicity

then the period consisting of several structures — formation steps can be contracted into one period (*A*), or one period can be divided into several periods (*B*) by means of fitting rarefication (*A*) or compression (*B*) of the covering. The structure of history-model remains unchanged during this transformation.

The model is based on the chain of stable structures and interprets the "gas-spaces" separating the structures, too. Each stable structure is preserved in the "gas-space" preceding its generation. Similarly, in the atom the average energy level of plasma preceding its formation is preserved, and the same is valid of the nucleus and of its structure. The DNA preserved the conditions of the primitive ocean in the cell (Gy. MARX). The background radiation of 2.7 °K of the photon period of the Hot Universe is the most universal. Spherical clusters are the remnants of the past still spherical-symmetric loose and diffusive range of galaxies.

Let us apply this model to the evolution of the planetary system around the sun, i.e. to that of the shell around the central star. In addition to the atomic and molecular remnant materials of the contraction to star, two basic stable structures build up this shell: the crystal and the planet. Both of them possess a special structure, "lattice". The crystal lattice is an Euclidean-lattice, that of the planets (taking into consideration the belts disseminated according to density) is spherical-shelled. Symmetry conditions indicate also two considerably differing structures.

On the basis of the two structures the evolution of the planetary system can be divided into two periods. The smaller, earlier structures are the crystals: the first phase of the process is the chemical crystallization. The second phase is a gravitational "crystallization" of "gases of the crystals" generated by the first crystallization.

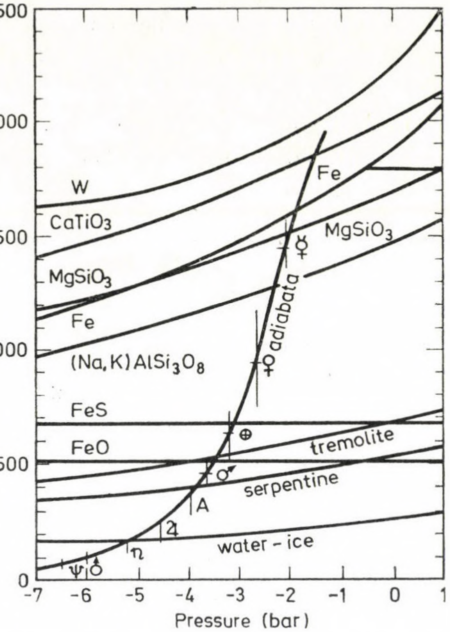


Fig. 3. **Theoretical model of chemical crystallization of the solar nebula (after LEWIS and BARSHAY, 1975). The most important crystals precipitating at the given pressure and temperature (resp. in the joining range around the sun) can be read off along the adiabate of the solar nebula. (From the top downwards the symbols indicate the planetary series Mercury, Venus, Earth, etc.)**

The chemical crystallization is initiated by the hot gas material of the solar nebula surrounding the protostar, after having become detached taking away the spin of the protostar and thus staing out from the subsequent contraction. The sequence of minerals precipitating from the gas nebula of cosmic element abundance has been deduced as a function of temperature and (since the gas temperature decreases when moving off the proto-star) of the distance from the proto-star (LARIMER, LEWIS and BARSHAY, GROSSMAN; Fig. 3). When cutting the gas-crystal phase boundaries in the p—T diagram by the adiabate given by CAMERON approaching most fairly the conditions of solar nebula, the most important crystal constituents belonging to the given space and temperature interval can be obtained.

In the space around the proto-star the crystals are growing and accumulate by means of inelastic collisions. This "crystal-gas" period can be characterized by the temporal change of dimension-spectra of the crystal clusters (HARTMANN, 1975). The gravitational crystallization is shown by the snapshots of dimension-spectra of the planetary system (Fig. 4). The initially precipitated micron-size particles are amassed to bodies of metre, later of kilometre dimension, i.e. to planetesimals by means of inelastic collisions. These planetesimals,

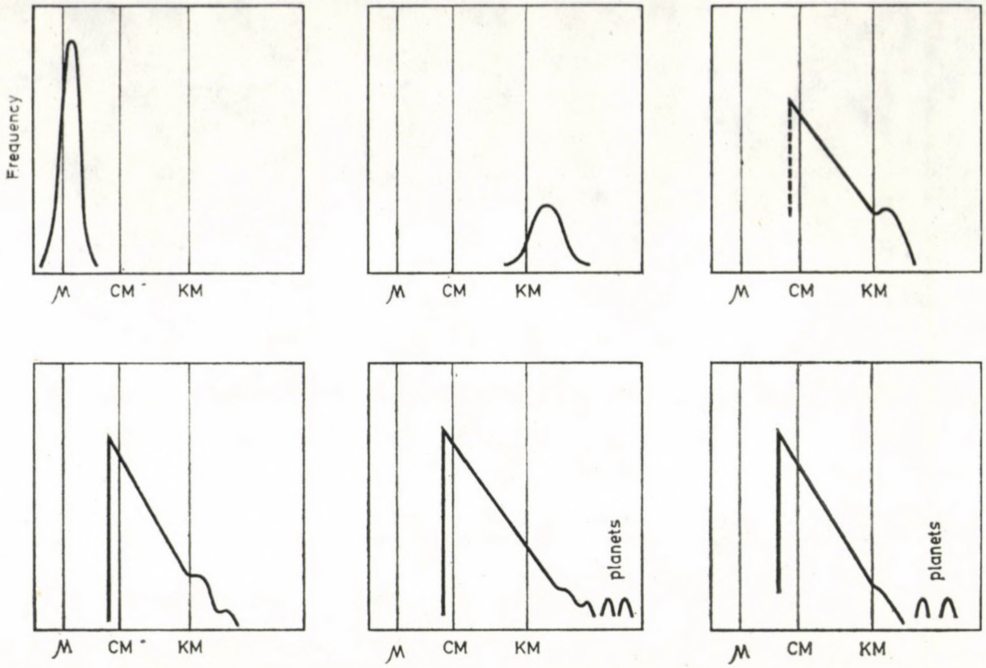


Fig. 4. **Gravitational crystallization in the solar nebula. The accumulation process of crystal grains, their compaction-crumbling equilibrium and the "precipitation" of planets from the crystals' gas by means of gravitation labour can be followed in the dimension-spectra of snapshots during the evolution of the solar system (applying the data of Hartmann 1975)**

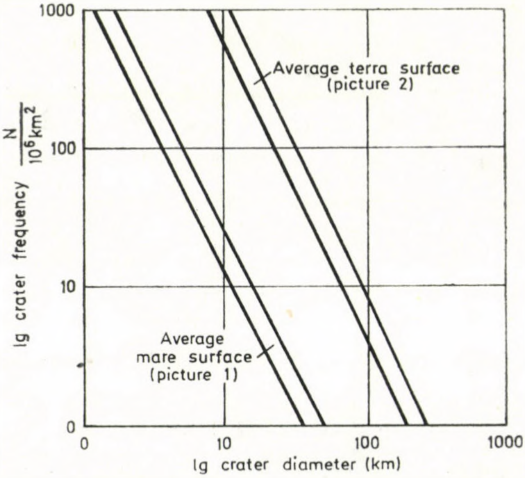
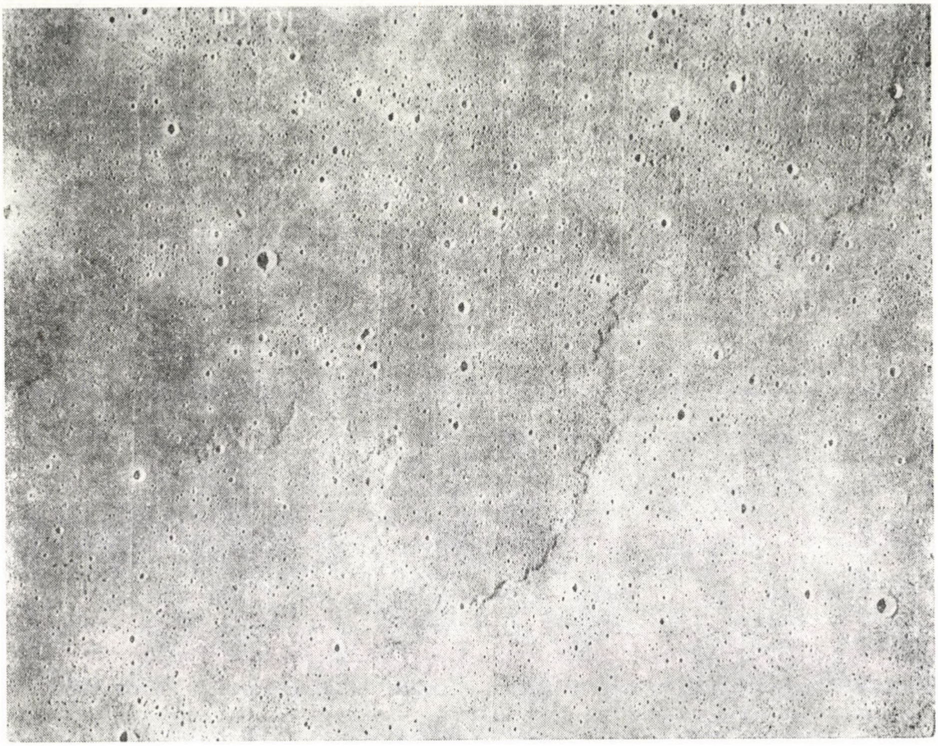
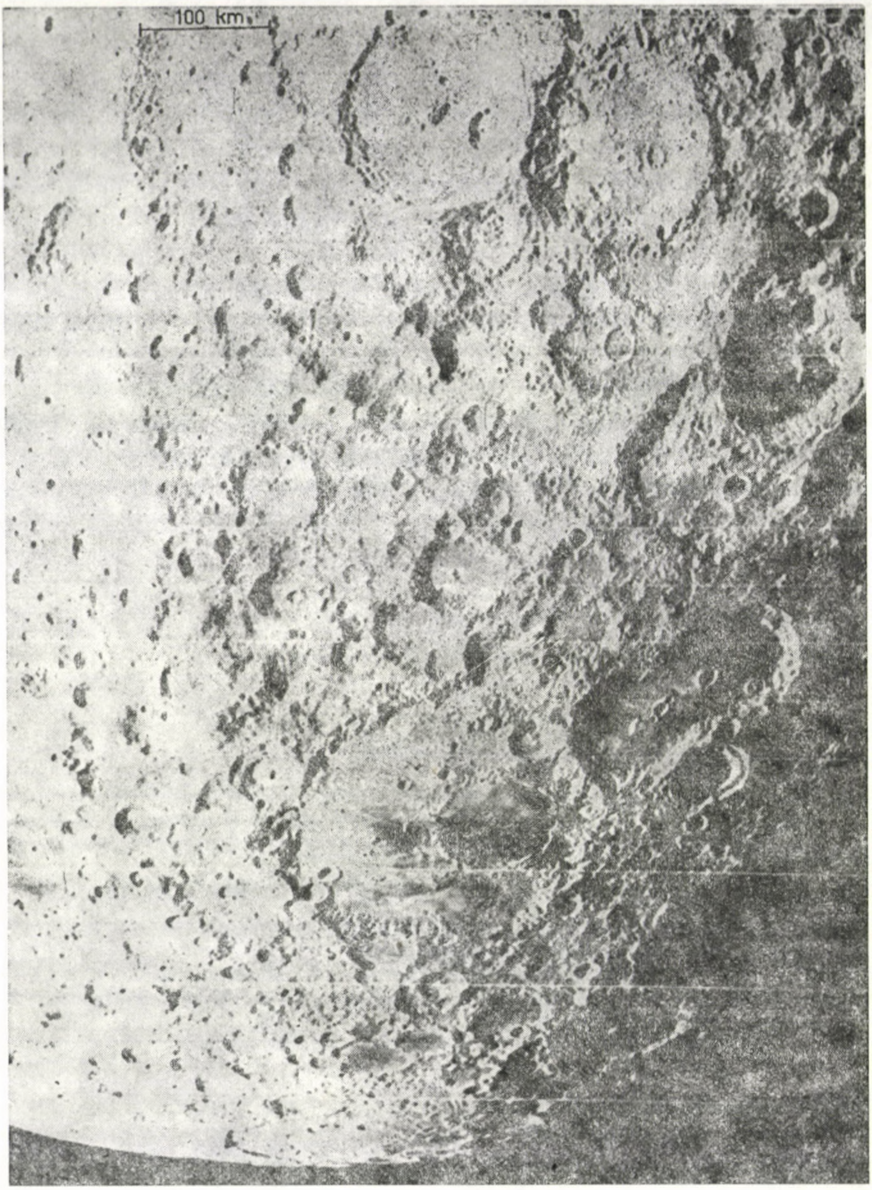


Fig. 5. **Diagram of crater density of two sharply differing regions of the lunar surface (pictures 1 and 2). The spectrum-range of crumbling of the average "terra"-surfaces nearly saturated with craters preserves the print of the large-scale detritus-accumulation period started by the appearance of planetesimals (picture 2). The "mare"-surfaces younger in average by about half a billion years preserved the print of a cleared rock-gas accompanied with smaller detritus (picture 1)**



Picture 1. Mare surface with a flow front from the Imbrium Basin (NASA, photo of Lunar Orbiter)

however, perturbate the orbits of each other generating in this way destroying and crumbling collisions, too. In the dimension-spectrum the cutting line occurring in the third diagram is a section of the dimension-spectrum which can be read also from the primitive planetary surfaces of the solar system. The diagrams of crater density of the surfaces scattered by old craters show this cutting line deriving from different periods of the solar system (Fig. 5). To illustrate the "cooling" and "diluting" of the crystals' gas two fairly distinguishable surfaces are shown in the Pictures 1 and 2. Similarly to other solid planetary surfaces, on the strata deriving from different planetary periods, the Moon bears the dimension-spectrum of crystal-gas permeating the solar system in the given period and thus printing its dimension-spectrum on the considerable crosssection of the planetary bodies. The recognition and identification of this crystal-gas period at the non-eroded planetary surfaces is the most important result of research concerning the solar system.



Picture 2. Primitive terra around Mare Ingenii at the back-side of the Moon (NASA, photo of Lunar Orbiter)

Conclusions

In the model of material history the stable structures are the milestones of the evolution series, these milestones are connected by the "crystallization periods". A stable structure is simultaneously a station of material evolution and the component of a manifold consisting of particles similar to it. Keeping the structure of the model the known evolution sequence can be enlarged or restricted.

The model of material history concluding to the alternation of the crystallization and gas periods has been applied to the formation of our planetary system. The planetary system, the two fundamental structures evolved parallel with the formation of the sun: the crystal and planet got its recent arrangement in two structure-formation, crystallization processes: by means of chemical crystallization and of "gravitational" crystallization. The print of dimension-spectrum of the "crystal-gas" period separating the two crystallization periods were recognized in the diagram of crater density of the primitive planetary surfaces.

ACKNOWLEDGEMENT

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ЦИКЛИЧНОСТЬ В ИСТОРИИ МАТЕРИИ И ЕЕ ПРИМЕНЕНИЕ В ПРОЦЕССАХ, СТРОЯЩИХ ЭЛЕМЕНТАРНЫЕ СТРУКТУРЫ СОЛНЕЧНОЙ СИСТЕМЫ

С. БЭРЦЗИ

Резюме

Статья, исходя из двух аксиом, — одного из основных принципов диалектики и, принципа исторического развития материи — делает попытку к созданию единого естественно-философского принципа, распространяющегося на элементарные материальные структуры и на строящие структуру процессы. Результат работы можно резюмировать следующим образом: история материи — это чередование структурализационной (кристаллизационной) и газовой эпох. Полученной общий принцип находит применение в двух основных структурализационных процессах Солнечной системы: в химической и «гравитационной» кристаллизации.

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PERIODICITY OF EXTREMAL GEOMETRIC ARRANGEMENTS (DENSEST PACKINGS, THINNEST COVERINGS, TESSELLATIONS)

By

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It is an experience of modern discrete geometry that an extremal-value property may induce order in a chaotic figure-system. The first part of the paper deals with different "levels" — lattice-likeness, regularity and block-regularity — of the periodicity of extremal geometric arrangements (packings with maximal density and coverings with minimal density). A counter-example for the following conjecture is given: the density of any kind of packing in the whole plane for an infinite system of arbitrary congruent convex discs cannot exceed the density of the densest regular packing formed by the same discs; but probably this will be true when the densest block-regular packing is considered instead of the regular one.

In the second part of the paper the most regular figures the Platonic and Archimedean solids and tesselations are reviewed and ordered. Starting from the regular polyhedra and tesselations and using the truncation as an ordering operation the Platonic and Archimedean solids and tesselations have been arranged into a periodic table. By the extension and generalization of truncation, higher dimensional cases — e.g. the table of four-dimensional solids and three-dimensional tessellations — are also constructed.

The stiffening of cycles generates structures possessing certain geometric regularities (SZÁDECZKY-KARDOSS, 1978). These structures are fundamental also from the point of view of material structure (e.g. studies are known which try to discover the relationship between geometric regularity and permeability). The problem of geometrically regular structures will be discussed from two aspects: first, the different types of periodicity will be dealt with (Part 1), then the most regular arrangements will be classified (Part 2).

1. Lattice-like, Regular and Block-regular Periodicity of Extremal Arrangements

(D. NAGY)

1.1 *An extremal-value property may induce order in a chaotic figure-system*

In this part geometric problems will be discussed from the aspect of periodicity which may be significant when studying structures of organic or inorganic nature (e.g. in structural biology, stereochemistry, geometrical crystallography). The arrangements of figures satisfying certain extremal property should be studied since, on the one hand, inclination of nature to create extremal configurations can be observed and, on the other, similar problems can be found in practical optimalization problems. These problems are assigned to the topics of discrete geometry which is for the study of non-continuous geometric sets. From the point of view of this branch of geometry the activity of L. FEJES-TÓTH and of his geometric school are of decisive importance (FEJES-TÓTH, 1953, 1964).

According to the experience of modern dicrete geometry, a disordered figure-system may take on certain regularity automatically if some kind of extremal-value (extremity, optimum, economy) is required. Consequently, in a chaotic set an extremal-value property may induce order. To what an extent this takes place, might be investigated in the densest packings of figures in the plane (or space) and in the thinnest coverings of the plane (or space). First of all, however, some notions must be explained.

1.2 *Density of packings and coverings*

It is said that a figure-system (a set of figures) forms a *packing in a given figure* in the plane (or in space) if the figures of the system are contained in the given figure, and they do not intersect each other by pairs, i.e. each point of the given figure is an interior point of at most one figure of the system. The problem is how the densest configuration can be realized (e.g. to cut off the maximum number of discs from a plate, to store the maximum number of balls in a box). A figure-system forms a *covering of a given figure* in the plane (or in space) if each point of the given figure belongs to at least one figure of the system. Here the problem is in general how to arrange the figures in the thinnest way (e.g. to cover a hole with minimum number of discs). Mainly packings in the whole plane (or space) and coverings of the whole plane (or space) will be discussed for infinit figure-systems (packing on a great plate or in box, covering of a great hole).

In a given finite figure the density of a packing is determined by the quotient of the total area (volume) of the arranged figures and of the area (volume) of the given figure. Similarly, the density of a covering of a given finite figure is determined by the quotient of the total area (volume) of the arranged figures and of the area (volume) of the given figure. In the whole plane (or space) density can be interpreted as follows: Around an arbitrary chosen point O ever greater circles (or spheres) are drawn and the corresponding densities are determined in them; then, tending to infinity with the radius of the circle (or sphere) the limiting value of the densities is considered. In the following let us assume that all figures in question possess a positive area (or volume). The definition of (upper) *density of a packing* in the whole plane (or space) is:

$$d = \limsup_{R \to \infty} \frac{A(R)}{B(R)}$$

where $A(R)$ = total area (or total volume) of the figures falling inside the circle (or sphere) of R radius and O centre, while $B(R)$ = area (or volume) of the circle (or sphere) of R radius and O centre.

The definition of (lower) ***density of a covering*** of the whole plane (or space) is:

$$D = \liminf_{R \to \infty} \frac{A(R)}{B(R)}$$

where the values of $A(R)$ and $B(R)$ are the same as above in case of covering.

It can be proved that none of them depend on the choice of O. In the definition it is practical to use "lim sup" or "lim inf" instead of the limiting values because these always exist. Following from the definition of packing and covering $d \leq 1$ and $D \geq 1$ is always true.

1.3 *Packings and coverings with congruent circles or spheres*

Since the notion of density is rather complicated for the whole plane (or space) and is difficult to treat, often the proof of a visually evident conjecture is also troublesome. E.g. it can be easily imagined but hardly proved that congruent (equal) circles can be packed in the plane by the density at most $\pi/\sqrt{12} = 0.9069\ldots$ where the given value is the density of the hexagonal circle-system shown in Fig. 1.1 (all circles have tangential points with six other; THUE, 1892). This means that at most 90.69... per cent of the plane can be filled up by congruent circles which do not intersect each other. The configuration shown in Fig. 1.1 is a so-called *lattice-like* system, i.e. the figures are in parallel position and their analogous (equivalent) points (e.g. the centres of circles) form a lattice which can be described by a linearly independent vector-pair.[1] The maximal density-value — mentioned above — can be attained, however, not only by means of the lattice-like circle-system shown in Fig. 1.1, but also by its "distortion" in a total area of zero density (e.g. omitting one row of circles) since the defined notion of density is insensitive to this. It is true, how-

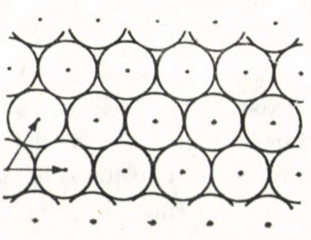


Fig. 1.1

[1] The notion "lattice" in geometry is not that of crystallography. The set of all points $\alpha\mathbf{a} + \beta\mathbf{b}\,(+\gamma\mathbf{c})$ in the plane (or in space) is called lattice, where $\mathbf{a}$, $\mathbf{b}$ (and $\mathbf{c}$) are given, linearly independent vectors and α, β (and γ) are arbitarry integers.

ever, that no denser system exists than that lattice-like system shown in Fig. 1.1, and the other systems of maximal density are nearly the same.

When covering the plane by congruent circles the density will be at least $2\pi/\sqrt{27} = 1.209\ldots$ (KERSHNER, 1939). This smallest density can also be attained by a lattice-like hexagonal circle-system (each circle is intersected by six others, see Fig. 1.2), but can be attained also by distortion, e.g. when adding superfluous circle). The lattice shown in Figs 1.1 and 1.2 are both regular triangle-lattices. Consequently, when magnifying in $2\sqrt{3}/3$ ratio each circle of

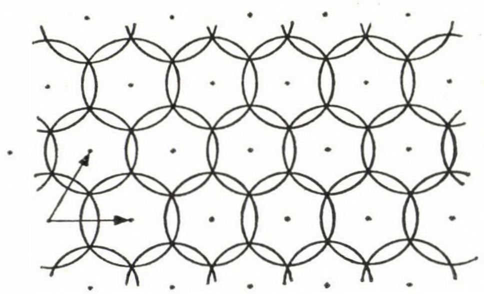


Fig. 1.2

the densest congruent lattice-like packing from its centre, a thinnest lattice-like covering will be obtained and vica versa.

The problem of densest packing of congruent spheres (balls) in space is mathematically unsolved as of yet. According to C. A. ROGERS "all physicists know and all mathematicians assume" the solution. Now, let us make horizontal layers with spheres the centres of which are in a plane and intersect it in a hexagonal circle-system as shown in Fig. 1.1. Then the layers should be put onto each other so that the spheres of each layer would slip in the depressions between the spheres of the previous layers as deep as possible. The density of this packing obtained in this manner will be $\pi/\sqrt{18} = 0.7404\ldots$ The conjecture is that a denser packing cannot be made. This value can be obtained also by a lattice-like sphere-system (the centres of spheres form a spatial lattice determined by a linearly independent vector-triplet). Nevertheless, not only "slightly distorted" lattice-like constructions, but fundamentally different (non-lattice-like) ones also exist. This derives from the fact that the fitting of horizontal layers consisting of spheres onto each other is not unambiguous: the third layer can be fitted onto the two previous ones so that the system has to be continued as a lattice, and so that this condition does not follow. (It is emphasized again that the notion of lattice in geometry is different form that of crystallography.)

Though the conjecture mentioned above (i.e. in case of spatial packing of congruent spheres $d \leq 0.7404\ldots$ is always satisfied for density) could not be proved as of yet, rather good density estimations are available: ROGERS (1958) proved that $d \leq 0.7797\ldots$, moreover he gave an estimation in arbitary n-dimensional Euclidean space,[2] while analogous results were obtained by BÖRÖCZKY (1974, 1975) in spaces of constant curvature (in addition to the Euclidean spaces spherical and hyperbolic spaces are of this type). The problem of the densest congruent sphere-packing in three-dimensional Euclidean space was solved in the case when not arbitrary sphere-systems, but only lattice-like ones were studied (GAUSS, 1831). A similar situation is when covering the space by congruent spheres (BAMBAH, 1954).

1.4 *Regularity of densest packing of certain discs*

In the following, packing problems in the whole plane will be dealt with. Finite (bounded) and connected figure in the plane (having positive area) are called *discs*. (Let us assume for packing or covering that the discs are open or closed, i.e. the discs do not contain or contain the boundary points, respectively.) Convex figures will also be often mentioned. A geometric figure (or a set of points) is called *convex* if the line segment joining any two points of the figure is contained in the figure (Fig. 1.3). A polygon (polygonal disc) is convex if and only if all its angles are no more than 180°.

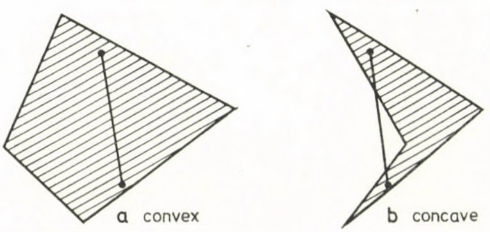


Fig. 1.3

FEJES-TÓTH (1950) proved that the density of any kind of packing with arbitrary congruent centro-symmetric convex discs cannot exceed the density of the densest lattice-like packing formed by the same discs. The maximal density, however, can be reached not only by lattice-like construction, but by distorted lattice-like packings, moreover, in some cases by fundamentally different way, as well. E.g. in Fig. 1.4 rectangles of maximal density (1) are shown (*a* and *b* are lattice-like, *c* and *d* derive from case *a*, while *e* is of a different structure).

A similar statement was proved by ROGERS (1951) for congruent convex discs in parallel position, i.e. the density of any kind of packing with these discs (e.g. the density of the congruent-triangles in parallel position of Fig. 1.5*a*) cannot exceed the density of the densest lattice-like packing (Fig. 1.5*b*, density here is

[2] In n-dimensional Euclidean space the density of a packing of congruent spheres cannot exceed the density of the packing with $n + 1$ congruent and by pair-touching spheres, considered in the simplex formed by their centres.

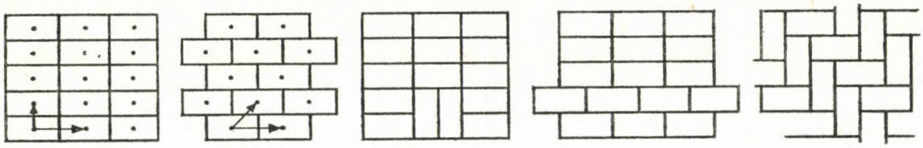


Fig. 1.4

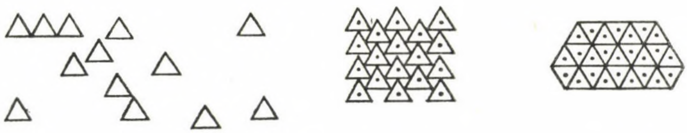


Fig. 1.5

2/3). Thus, ROGERS limited the position of the discs, did not start out from an incompletely chaotic system; but less was required concerning the quality of figures. It is true that the maximal density can be attained also by a non-lattice-like construction as it is shown by the parallel-lying rectangles of Fig. 1.4*d*. The requirement of parallel position of the discs cannot be neglected since in case of e.g. congruent triangles the density of densest lattice-like packing is 2/3 (see Fig. 1.5*b*) while allowing arbitrary position these may fill up the whole plane, i.e. density will be 1 (Fig. 1.5*c*).

In spite of the fact that neither Fig. 1.4*e* nor Fig. 1.5*c* are lattice-like, these cannot be considered by all means to be irregular. Both arrangements possess the property that applying congruency (isometry) their arbitary figure can be transformed into any other so that the whole system transforms into itself (covering the original position), as well. Such arrangements are called *regular* systems, the terms *homogeneous*, *uniform*, *transitive* or *crystallographic* are also used. The last term is reasonable since a planar crystallographic space group can be unambiguously assigned to all regular systems (the number of these groups is 17). Regularity is an enlargement of the notion of lattice-likeness in a sense that each lattice-like arrangement is regular, too, but as it is shown by Figs 1.4*e* and 1.5*c* inversely this is not true. The facts stated in connection with the densest packing of congruent triangles can be reformulated: the density of any kind of packing with arbitrary congruent triangles cannot exceed the density of the densest regular packing formed by the same triangles (which equals 1). The same density can be reached of course, also by non-regular packings, too (e.g. omitting certain triangles or displacing the triangles in a parallel strip, etc.).

Presumably similar observations might have lead FEJES-TÓTH (1953, p. 95) to formulate the following conjecture: the density of any kind of packing (in the whole plane for an infinite system) of arbitrary congruent convex discs cannot exceed the density of the densest regular packing formed by the same discs.

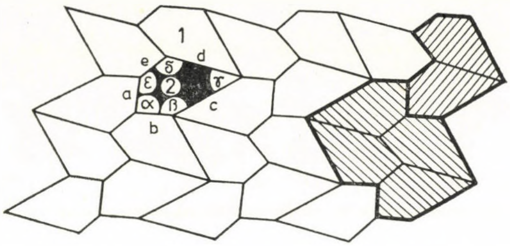
In connection with this conjecture certain doubts have been later expressed. FEJES-TÓTH called our attention to the problem whether certain convex pentagons forming a *tessellation*, i.e. filling up the plane without gaps and overlappings, and the non-regular system of which is well known, may be rearranged into a tessellation with a regular system. In the opposite case the refutation of this conjecture may be obtained. Following this way it will be shown that the conjecture in question is in general not true.

1.5 *There exists a convex disc with congruent replicas giving a packing denser than the densest regular one*

KERSHNER (1968) in his paper when having comprehended some previous results and having given three new types of pentagons considered a classical chapter of mathematics as being solved: with congruent replicas of what kind of convex polygons is it possible to produce a tessellation.[3] According to a statement of KERSHNER he was successful to prove circumstantially enough that in addition to those given by him no suitable convex polygons exist. Nevertheless, the proof was not published even in outlines. (By the way this is an evergreen topic of popular articles since it can be understood also by outsiders, moreover it can be enriched occasionally by new constructions of theirs.) It is known recently, partly with the aid of amateur researchers, that the enumeration of KERSHNER has been incomplete (see e.g. the remarks of KERSHNER, 1977 and SCHATTSCHNEIDER, 1977).

To each of the new pentagon types given by KERSHNER (1968) a tessellation was given which was non-regular system in its concrete form. Now let us study in detail one of them (Fig. 1.6). This arrangement is in fact non-regular since e.g. the pentagon No. 1 can be transformed into No. 2 only by positive rotation of γ angle around the corresponding vertex so that the tessellation will not cover itself (e.g. the pentagon No. 2 gets a position that it does not coincide with any of the previous pentagons). This, however, does not exclude the possibility that a regularly arranged tessellation can be made with the pentagons belonging to the given type by a different way. As a demonstration the example of pentagon of Fig. 1.7 is shown which is belonging to the given type (this can be easily controlled, because here $\alpha = \beta = \delta = \varepsilon = 120°$, $\gamma = 60°$, $a = b = e$, $c = d$) and a regularly arranged tessellation can be formed with it even in two different ways.

[3] Such enumeration settles the analogous problem concerning arbitrary convex discs because it can be easily shown that a tessellation can be produced by no means with convex but non polygon-shaped congruent discs. When allowing to apply concave discs, the problem is more troublesome.



$\alpha + \beta + \delta = 360°, \ \alpha = 2\gamma, \ a = b = e, \ c = d$

Fig. 1.6 After KERSHNER (1968)

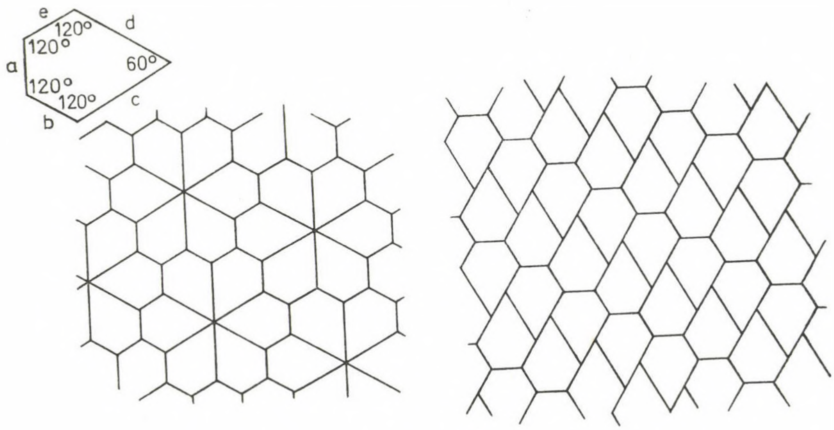


Fig. 1.7

In favour of a further study of the type of pentagons in question the defining relationships of KERSHNER will be transformed into easier forms. (The definition of KERSHNER is suitable rather to easily see that the corresponding tessellation can be produced really without gaps and overlapping. Now relationships are sought which throw light upon the fact how the pentagons belonging to the given type can be derived.) By means of ε the other angles will be expressed. When comparing the relationship $\alpha + \beta + \delta = 360°$ with the fact that the sum of angles of a pentagon is 540°, $\gamma + \varepsilon = 180°$ is obtained. Thus, $\gamma = 180° - \varepsilon$, and using the relationship $\alpha = 2\gamma$ it is true that $\alpha = 360° - 2\varepsilon$. Based on simple elementary, resp. trigonometric considerations

$$\beta = \frac{3}{2}\varepsilon - \text{arc}^* \operatorname{tg}(2 \sin \varepsilon) \quad \text{and} \quad \delta = \frac{\varepsilon}{2} + \text{arc}^* \operatorname{tg}(2 \sin \varepsilon)$$

where the asterisk refers to the aim that when relooking for the tangent, the so-called main value between 0° and 180° should be taken into account. It is also easily derived that if

$$a = b = e = 1, \text{ then } c = d = \frac{\sqrt{1 + 4 \sin^2 \varepsilon}}{2 \cos \frac{\varepsilon}{2}}.$$

It can be also easily seen that really a convex pentagon was produced if and only if $90° < \varepsilon < 150°$. In the opposite case, the pentagon will be deformed to a tetragon ($\varepsilon = 90°$ resp. $150°$) or an angle will be concave. In case $90° < \varepsilon < 150°$ we have always $a < c$.

Now, from the pentagons belonging to the given type let us consider the following: $\varepsilon = 130°$, $\gamma = 50°$, $\alpha = 100°$, $\beta \sim 138.13°$, $\delta \sim 121.87°$, $a = b = e = 1$, $c = d \sim 2.16$. Out of these relationships only the fact is used that no combination (neither repetition) of the angles of the pentagon will produce in sum 180°, except the always satisfied $\gamma + \varepsilon = 180°$. (This is not valid for the pentagon shown in Fig. 1.7 since here: $\alpha + \gamma = \beta + \gamma = \delta + \gamma = 3\gamma = 180°$).*

Statement 1: By means of the pentagon described above only such tessellation can be produced where the pentagons join along their complete sides.

Proof: Let us assume (indirectly) that with congruent replicas of pentagon described above a tessellations can be constructed in which a vertex of a pentagon is an interior point of a side of an another pentagon (Fig. 1.8). According to our condition, a sum of certain angles of the pentagon which is equal to 180° is of the form $\gamma + \varepsilon$; at the vertex in question only these angles may occur. Since we have $a < c$ a vertex with angles α or δ (neighbouring to ε) will be an interior point of an other pentagon-side. According to our conditions, however, in the "bend" neither α nor δ can be supplemented

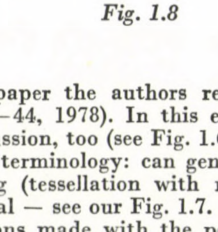


Fig. 1.8

* After completing this paper the authors recognized SCHATTSCHNEIDER's detailed paper (Math. Magazine, **51**, 29—44, 1978). In this excellent survey that type of pentagons — which is involved in our discussion, too (see Fig. 1.6) — is mentioned in the collection of such types vhich tiles (with our terminology: can generate a tessellation), but for which no tile-transitive or isohedral tiling (tessellation with regular system) exists. However, this statement is not correct in general — see our Fig. 1.7.

True, the most tessellations made with the pentagons belonging to the given type cannot be rearranged into a tessellation with regular system. For this "unrearrangebility" a sufficient condition has been given in our present paper: no combination (neither repetition) of the angles of the pentagon will produce in sum 180°, except the always satisfied $\gamma + \varepsilon = 180°$.

with some of the suitable angle (or angles) of the pentagon to 180°. Our tessellation is thus interrupted (contradiction).

Statement 2: By means of the described pentagon only tessellation with non-regular system can be created.

Proof: Based on Statement 1 it is known that only the cases are dealt with in which pentagons join by complete sides. Our aim is to produce in each possible case a part of the plane by means of joining pentagons where the proof of non-regularity of the tessellation shown in Fig. 1. 6 can be analogously carried out. When reviewing the limited number of joining possibilities (if angular relations are considered numerous arrangements can be excluded since joinings are interrupted) this can be easily reached.

Similarly, it can also be easily seen that by means of the described pentagon fundamentally only the tessellation shown in Fig. 1.6 can be created.

In this manner, by means of the pentagon in question a tessellation of a non-regular system can be created, i.e. a packing with 1-density, but regularly arranged tessellation not. This, however, is not yet a counter-example to the conjecture since packing creating no tessellation may be of 1-density in limiting value, so that the total area of the gaps is of zero-density. (E.g. omitting a disc from any of the tessellations the obtained system is no tessellation any more since it is not gap-free, its density, however, remains 1.) In case of regular systems, however, this is impossible to imagine. If one has a regular packing which is not a tessellation then somewhere a gap must exist. Due to regularity this gap is repeated, and the total area of the gaps, therefore, cannot be of zero-density.

Since the tessellation is a special case not only of packing but also of covering, our example is suitable to refute the analogous (dual) statement of covering, too. Namely, it is also not true that the density of any kind of covering with arbitrary congruent convex discs cannot be less than the density of the thinnest regular covering formed by the same discs.

In Fig. 1.6 the discs can be caught into congruent double blocks so that these blocks could form a tessellation of regular system (the blocks are not convex any more). Moreover, quadruple blocks which are lattice-like can also be formed. (This is less astonishing since a planar crystallographic space group has always a subgroup which can be generated by two translations.) Thus, it can be said about the tessellation shown in Fig. 1.6 that though it is non-regular system, but it is regular in finite (number of elements) blocks or *block-regular*. At least this property (in most of cases even more, i.e. regularity) is satisfied by all KERSHNER's tessellations (1968).

1.6 *Conjecture*

Instead of the refuted conjecture possibly the following can be stated: the density of any kind of packing (in the whole plane for an infinite system) of arbitrary congruent convex discs cannot exceed the density of the densest block-ragular packing formed by the same discs. An analogous conjecture can be formulated for covering (here also instead of regular, block-regular is to be said).

A convex polygon would be a counter-example to these conjectures with the congruent pieces of which only a "nowhere periodic" tessellation, more exactly a tessellation non-regular even in finite blocks (non-block-regular) can be created. A concrete tessellation which in a given form is non-block-regular, of course, can be given. This is the case in Fig. 1.4*d*, but with these rectangles regular, moreover lattice-like tesselation can also be created.

In recent times quite a number of papers deal with certain non-periodic tessellations (GARDNER, 1977). It is not probable, however, that a convex disc of the property in question producing a "nowhere periodic" tessellation would exist (if yes, this may only be a pentagon). Nevertheless, the occasional proof, that such a disc does not exist, indeed, would by no means prove that our conjecture is true, but would make it more probable.

1.7 *Conclusion*

In case of certain geometric density problems some kind of extremal-value requirements induce order. The order, the periodicity has different "levels": strongest is lattice-likeness, then comes regularity and weakest is the block-regularity of a figure-system. In case of problems discussed above not only one extremal arrangement (i.e. totally accomplished, rigid order) exists. In most cases there is a possibility to obtain a configuration of the same density deviating more or less from the ideal solution. At the same time, the perfectly lattice-like, completely regular, ideal solutions in themselves give a fair picture on the characteristics of extremal arrangements. In many cases, it is easy to imagine other extremal configurations when deriving them just from these (by means of distorting them). The same can be observed also in nature: no perfect lattices, ideal crystals and no unambiguous structures exist, lattice defects, imperfections and different deteriorating cases should be always taken into account. It is fruitful, however, many times to think in ideal, perfect arrangements or to accept this as a model or working hypothesis, and to obtain overview in this way about the problems. There is a "harmony" between these discrete geometric results and the natural structures. This demonstrates also the fact that our notions, e.g. the rather complicated formulation of density, have been aptly chosen.

We have dealt with tessellations which are at the "boundary" of packing and covering problems. It seems that this "transitional field" is especially suitable to check the debated questions of general packing or covering problems, to support or refute conjectures.

In the next part of our paper the most regular tessellations known from oldest times will be reviewed and classified.

2. The Periodic System of Platonic and Archimedean Solids and Tessellations
(Sz. Bérczi)

On particular polyhedra and tessellations regularities, repetitions can be observed. When regular polygons of uniform side length are joined along their edges convex polyhedra and planar tessellations possessing a special order will be obtained. Infinite number of solids, but only a finite number of tessellations show conspicuous regularities, symmetry features. Symmetry denotes the feature of solids and tessellations that applying definite motions, e.g. rotation with a given angle or in case of mosaics displacement with a given distance, these can be got in covering position (congruence position) to themselves. It must be noted, that the symmetry restrictions alone divide regular patterns into two types: local patterns (i.e. point groups) and infinite patterns (tessellations). From another (our) point of view local and infinite patterns — as shown later — can be connected by symmetry and an operation (here truncation) (see Fig. 2.2). The most symmetric ones are the simplest: these are the regular polyhedra and tessellations. They are built up by one kind of (congruent) regular polygons and their vertices are also regular and congruent. This must not be confounded with the regularly arranged mosaics discussed earlier, which had a wider notion. The semi-regular polyhedra and tessellations are more complex: these are built up by regular polygons of two or three kinds with equal edge lengths and their vertices though being congruent are not regular. The features of regular and semi-regular solids and tessellations are summarized in Table I:

Table I

The solid or tessellation	Faces	Vertices
Regular	uniform regular polygons	congruent, regular
Semi-regular	different regular polygons	congruent, not regular

Among the semi-regular bodies infinite number of them are found which are of one distinguished rotation axis. These are covered by two congruent n-sided regular polygon pedion and by n squares or $2n$ regular triangles connecting the two pedions. The former are called *prisms*, the latter *antiprisms*. In case of both types the rotation axis is the line connecting the centres of the regular n-polygons. (Fig. 2.1).

Discarding the prisms and antiprisms the remaining regular and semi-regular polyhedra and mosaics are the *Platonic and Archimedean solids and tessellations* investigated in our work. *The polyhedra to be put into the periodic table have no favoured rotation axis.* Some of them were known already by the

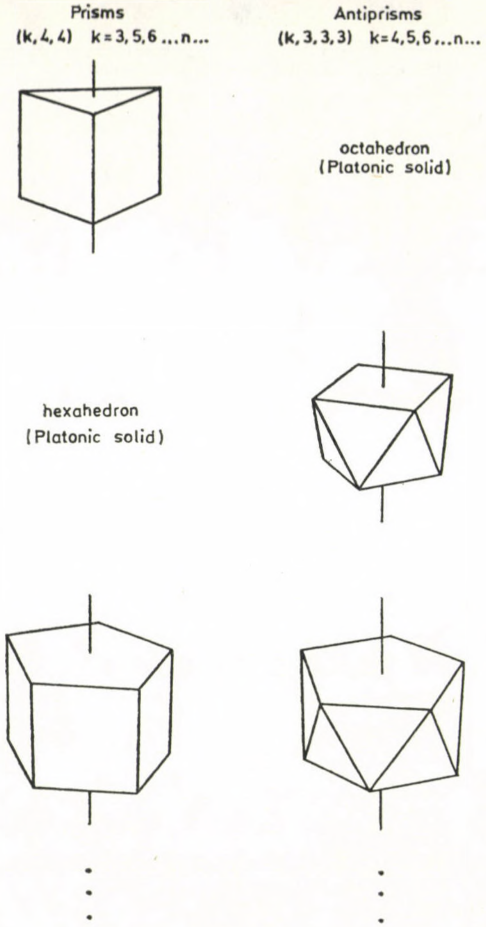


Fig. 2.1

PYTHAGOREANS. PLATON used the five regular bodies in his philosophy while ARCHIMEDES made complete the assemblage of semi-regular bodies (with one exception). KEPLER discussed the connection between solids and tessellations.

It is to be seen in Table I that the regular and semi-regular solids and tessellations are unambiguously characterized by their vertex figure. The Platonic and Archimedean solids and tessellations will be given by the STEINER-symbols based on the unambiguous determinative role of vertices of regular and semi-regular polyhedra and tessellations. In brackets the regular polygons joining in a vertex will be enumerated and the polygons will be marked only by one number, i.e. by that of their sides (vertices). E.g. the symbol of the prisms shown is $(k, 4, 4)$, that of the antiprisms is $(k, 3, 3, 3)$ where k denotes any cardinal number greater than 2. Table II. demonstrates the solids and tessellations to be investigated.

Table II

Platonic and Archimedean solids and tessellations	
Platonic tessellations	(3,3,3,3,3,3) (4,4,4,4) (6,6,6)
Platonic solids	(3,3,3,3,3) (3,3,3,3) (3,3,3) (4,4,4) (5,5,5)
Archimedean tessellations	(3,3,3,3.6) (3,4,6,4) (3,6,3,6) (4,6,12) (3,3,4,3,4) (3,12,12) (4,8,8)
Archimedean solids	(3,3,3,3,5) (3,4,5,4) (3,5,3,5) (5,6,6) (3,3.3,3,4) (3,4,4,4) (3,4,3,4) (4,6,6) (3,6,6) (3,8,8) (3,10,10) (4,6,8) (4,6,10)

Fejes-Tóth (1964) referred to the fact that some of the regular and semi-regular polyhedra and tessellations can be deduced from each other by means of truncation. This paper demonstrates that by means of truncation these solids and tessellations can be uniformly comprehended into our periodic table.[4]

Truncation is the operation by means of which new faces are generated in the direction of and on the place of vertices so that applying planes intersecting the polyhedron the smaller-greater environment of the vertices are removed (shortly: the vertices are cut off). This can be carried out in two ways. 1. If the size of the pyramid to be removed is known, having measured the required pyramid edge lengths onto the edges joining in the vertex, the contours of the basis of pyramid will be obtained; intersecting the body along this plane the sorner of the body can be removed. 2. When the surface of the face substituting the vertex will be continuously changed then starting from the vertex parallel layers are removed from the polyhedron by means of planes perpendicular to the symmetry axis of the vertex. This is the continuous truncation, thus the vertex is truncated only in the first moment, the further removal changes the size of the face appearing on the place of the vertex.

Three kinds of truncations will produce all the Archimedean bodies: simple, complex and snub truncations. Applying *simple truncation* to regular polyhedra the Archimedean solids are obtained by continuous truncation. Since the vertices of regular polyhedra are regular, intersecting the vertices by planes perpendicular to the symmetry axes penetrating the polyhedron's axes regular polygons are obtained in the site of intersection. The continuous truncation of vertices by planes (removal by layers) is unbroken till the edge length of the new and old truncated faces will be equal, the Archimedean solids of the simple truncation sequence will be obtained. When the simple truncation reached the state where only one point of original faces of the original Platonic solid remained (i.e. the centre of these faces), the reciprocal of the Platonic solid is attained (Fig. 2.2). Thus, the simple truncation sequence consists of two Platonic solids

[4] Moreover: hyperbolic tessellations also obbey this regularity as referred in the bottom series in Fig. 2.2.

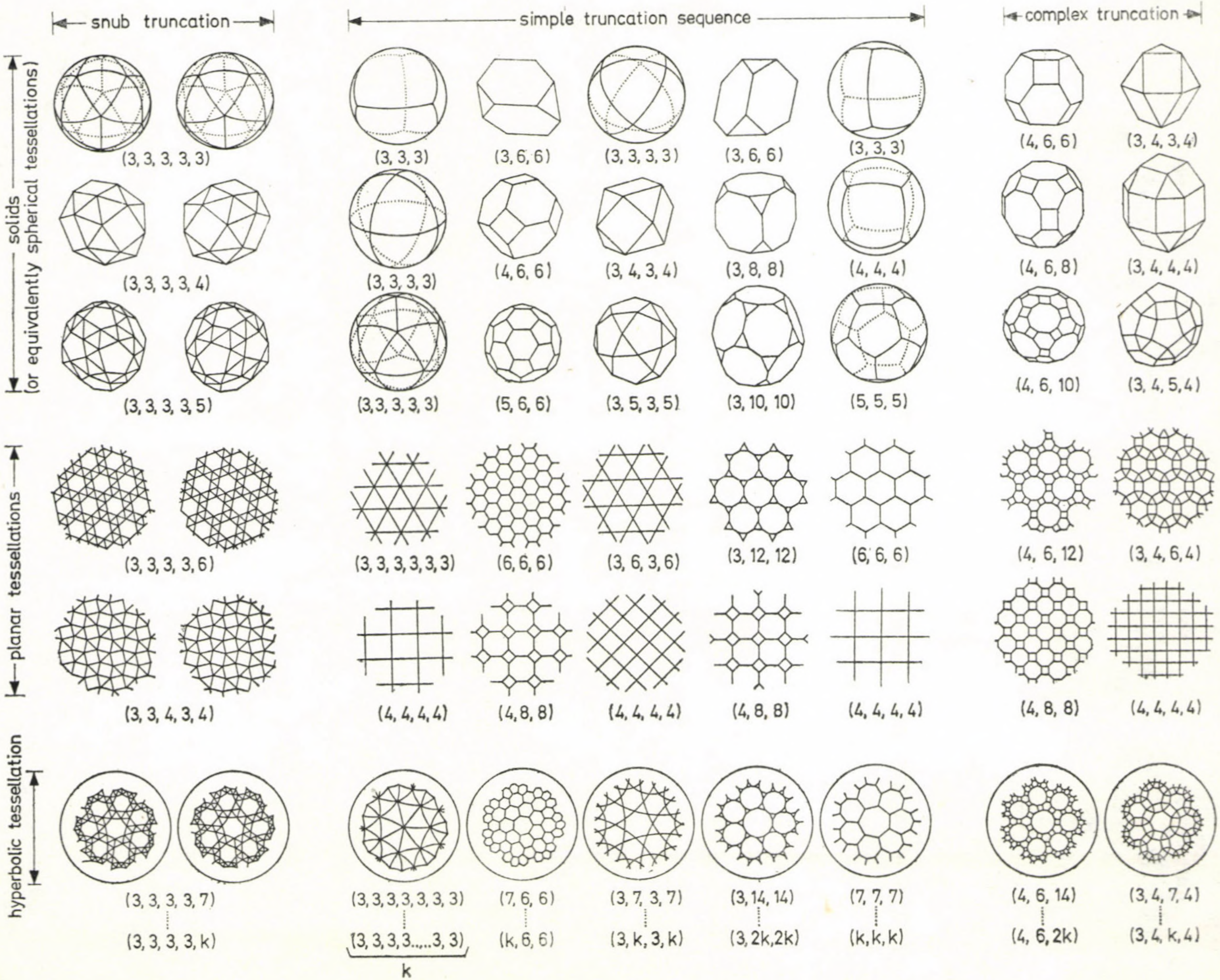


Fig. 2.2 **The periodic table of Platonic and Archimedean solids and tessellations supplemented by the sequence of one of the infinite numbers of two-dimensional hyperbolic tessellations. In order to emerge, the regular solids are given in their projected-onto-sphere form**

(being the reciprocals of each other) and of three Archimedean solids obtained by the simple truncation of Platonic ones. In a peculiar sequence, i.e. in the sequence of tetrahedra, however, in the midway of simple truncation a Platonic solid being "more regular" than the Archimedean ones emerges: the octahedron. The sequence of tetrahedra bears other interesting features, too, e.g. the icosahedron occurring in connection with snub truncation. Similarly to the sequence of tetrahedron, in the square lattice sequence also a Platonic square lattice occurs at midway among the lattices which is twice "denser" than the original Platonic tessellations.

New Archimedean solids can be created from the one being the middle member of simple truncation sequences and lying in the midway of and thus bearing the faces of the two extreme reciprocal Platonic solids. These bodies are, however, semi-regular — except the octahedron of the sequence of tetrahedra — and truncating their vertices non-regular polygons are obtained. If, however, thin removal is carried out also from the triangle faces of the $(3,k,3,k)$ polyhedra ($k = 4,5$ and also in case of the planar tessellation where $k = 6$), i.e. when removing both from the vertices of the midway polyhedron and from the triangular faces and this removal is done simultaneously and continuously, (this is the *complex truncation*), positions will be obtained when only regular faces cover the body. By means of the continuous complex truncation on the $(3,k,3,k)$ bodies mentioned above two new Archimedean solids can be derived: $(4,6,2k)$ and $(3,4,k,4)$.

By means of *snub truncation* the Archimedean solids $(3,3,3,3,k)$ can be derived also from the $(3,k,3,k)$ polyhedra. In case of snub truncation the fact is used that the plane truncating the vertex is determined by its three points. Thus truncation can be given also by the sections which are intersected by the truncating plane from the edges of the polyhedron. Let us divide the edges of the starting solids by golden section: the slightly misfashioned varieties of the

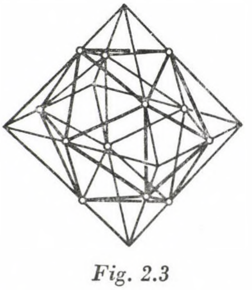


Fig. 2.3

ideal $(3,3,3,3,k)$ solids will be obtained. The case of octahedron is an exception since dividing its edges by golden section (Fig. 2.3) i.e. intersecting its vertices truncating planes determined by the dividing points the icosahedron will be obtained. By means of snub truncation two varieties of a snub-polyhedron

Table III

The infinite matrix of symbols of the regular solids, the regular planar tessellations and the regular hyperbolic tessellations

(3,3,3)	(3,3,3,3)	(3,3,3,3,3)	(3,3,3,3,3,3)	(3,3,3,3,3,3,3)	....
(4,4,4)	(4,4,4,4)	(4,4,4,4,4)	(4,4,4,4,4,4)	(4,4,4,4,4,4,4)	....
(5,5,5)	(5,5,5,5)	(5,5,5,5,5)	(5,5,5,5,5,5)	(5,5,5,5,5,5,5)	....
(6,6,6)	(6,6,6,6)	(6,6,6,6,6)	(6,6,6,6,6,6)	(6,6,6,6,6,6,6)	....
(7,7,7)	(7,7,7,7)	(7,7,7,7,7)	(7,7,7,7,7,7)	(7,7,7,7,7,7,7)	....
.....	......	....	....	....	....
.....	......	....	....	....	....

can be created which cannot be transferred into each other: a right-hand and a left-hand one (enantiomorphic pairs). (In the course of snub truncation two regular triangle faces develop on the place of vertices of the $(3,k,3,k)$ solid.)

In case of planar tessellations the truncation of vertices can be most easily imagined by the method applied previously to solids that is starting from the vertices sections are measured to the edges joining in the vertices (e.g. equal sections in case of simple truncation) and connecting the end-points of them the regular polygon substituting the vertex will be obtained. The same procedure is carried out in all vertices of the tessellation. The truncation steps described at the solids can also be carried out on tessellations.

By means of the truncation procedures enumerated above five truncation sequences can be deduced of the Platonic and Archimedean solids and tessellations: three of them are assigned to solids, two to tessellations.[5] Each sequence is generated by a Platonic pair consisting of the reciprocals of each other, thus these sequences are denominated after them: tetrahedron, octahedron-hexahedron, icosahedron-dodecahedron, regular triangle lattice — regular hexagonal lattice and square lattice sequences.

Those solids or tessellations which belong to the a_{ik} and a_{ki} matrix elements in Table III. are reciprocal to each other. Between these reciprocal pairs the following simple truncation sequence build the connection:

$$\underbrace{(k,k,k,\ldots k)} \quad (l,2k,2k) \quad (l,k,l,k) \quad (k,2l,2l) \quad \underbrace{(l,l,l,\ldots l)}_{k}$$

(As the solids can be considered equivalent — according to symmetry characteristics — with the spherical tessellations, this is the general form of the simple truncation sequence of tessellations of two-dimensional surfaces: on spherical, planar and hyperbolic surfaces.)

By means of the described truncation operations the same number of solids and tessellations will be obtained in the five sequences. (Occasionally, a polyhedron or a tessellation occurs several times but these cases of same pat-

[5] It must be noted, that the similar truncation steps can be accomplished on the infinite number of hyperbolic tessellations (Table III. Fig. 2.2).

tern are of different positions in the truncation sequence.) Drawing the truncation sequences below one another so that the solids and tessellations obtained in the same truncation step get the position below each other, i.e. in the same column, the periodic system of the Platonic and Archimedean solids and tessellations is obtained.

Each series of the periodic table is generated by a pair of regular solids or mosaics tessellations (i.e. the reciprocals of each other). From this point of view each series is independent. Some of the solids may occur in several sequences in different positions. This fact suggests a close relationship between the sequences tetrahedron, octahedron-hexahedron and icosahedron-dodecahedron which is manifested in the symmetry of these solids. No relationship of this kind exists between the two planar tessellation sequences!

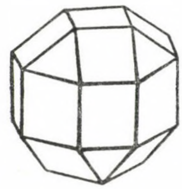


Fig. 2.4

The table is complete in itself. All the Platonic and Archimedean solids and tessellations occur in it once at least. Nevertheless, a solid or tessellation has been omitted which was believed to be Archimedean. The solid is the "scalped" (3,4,4,4) which can be derived from the Archimedean (3,4,4,4) by cutting of one of its caps then rotating by 45° the solid and then readjusted it again (Fig. 2.4). The vertex configurations do not change due to the prism zone lying below the cap but the rotation with 45° accentuates one of the symmetry axes of the solid, thus the "scalped" polyhedron (3,4,4,4) is a hybrid one lying between the tabulated Archimedean solids and the prisms (though it keeps its STEINER-symbol (3,4,4,4), too). For similar reasons, i.e. distinguishing one direction, the mosaic (3,3,3,4,4) is also removed from the circle of tabulated tessellations: this is the only prism-antiprism mosaic of the plane, the unity of the planar "absolute prism", of the square lattice and "absolute antiprism" of the regular triangular lattice, i.e. their "crested sum" (Fig. 2.5).

In our periodic system the two-dimensional tessellations and three-dimensional solids are truncated in the same steps. (By means of the outlined steps the same statements are valid of the one-dimensional "Tessellation", i.e. of the straight line covered by equal sections, as well as of the regular polygons.) A periodic table similar to that of the Platonic and Archimedean solids and tessellations can be created for the three-dimensional tessellations and four-dimensional solids. (The four- (and higher)-dimensional solids are called polytopes.) The truncation steps can be visualized on the tessellations of the

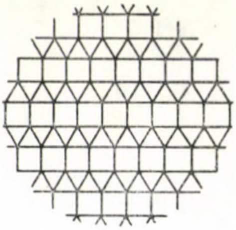


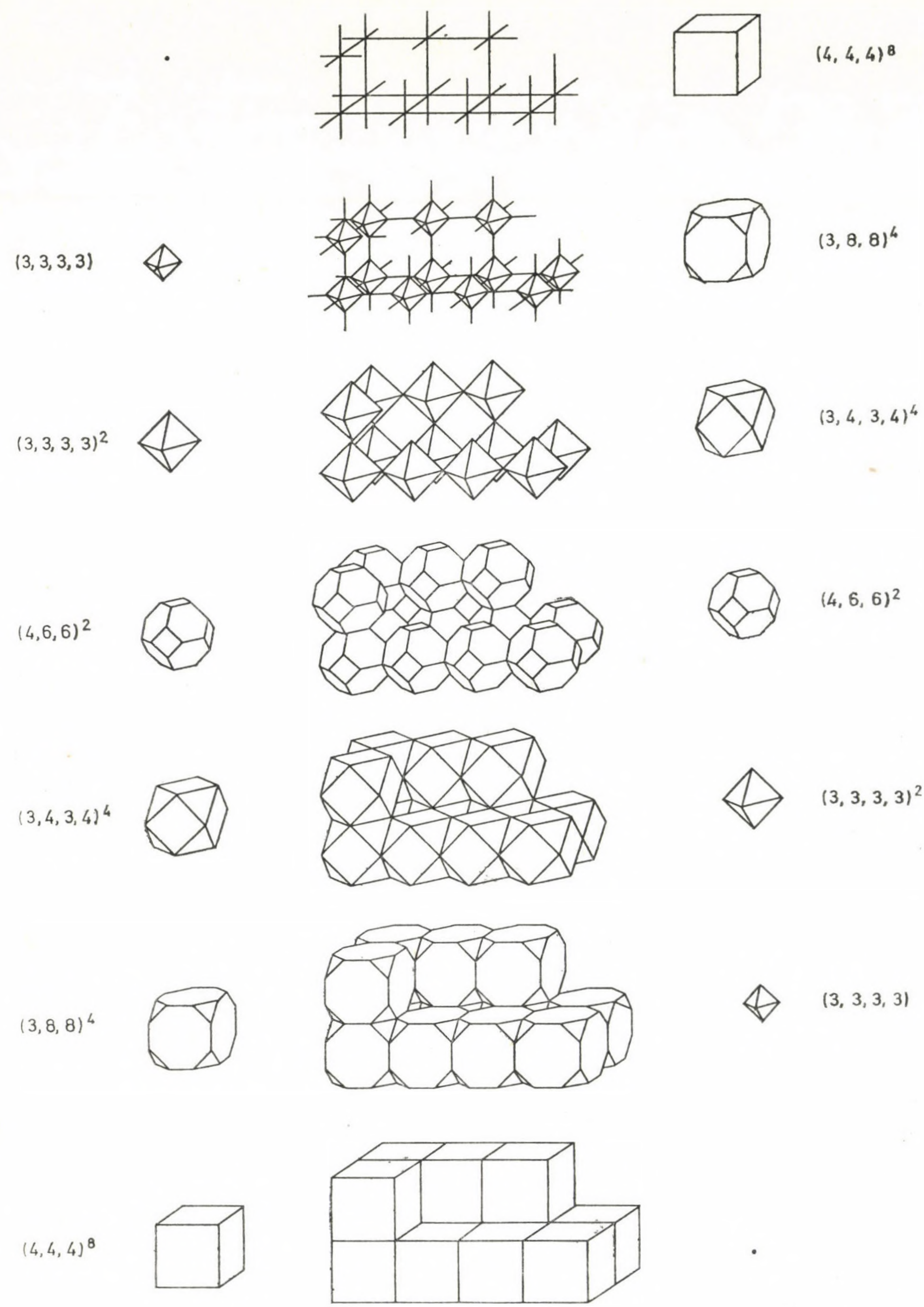
Fig. 2.5

three-dimensional space. This only link which can be demonstrated, i.e. the truncation sequence of the regular tessellation of 3-space, of the spatial hexahedron-lattice, will be enough when generalizing the STEINER-symbol and the truncation itself to obtain such a formal method by means of which applying only symbols and starting from the regular polytopes the reciprocal of the regular polytopes will be obtained through the truncation steps.

The spatial tessellations and the four-dimensional polytopes are built up by three-dimensional solids. They can be classified by the enumeration of the regular or semi-regular solids joining in one vertex (as the Platonic and Archimedean solids and tessellations were classified by the enumeration of regular polygons joining in one vertex.) The hexahedron-tessellation packing regularly the space will be $(4,4,4)^8$ described by the generalized STEINER-symbol. (The repetition of identical solids is indicated by power-numbers.)

The definition of truncation is repeated as said in the case of planar tessellations but in a generalized form. Starting from one vertex the same sections are measured to the edges. The end-points of sections will give the vertices of the environment around the vertex, the vertices of a regular or semi-regular solid determined by the vertex figure. When truncating, this environment will be removed.

The simple truncation sequence of the spatial hexahedron lattice is as follows (Fig. 2.6): starting from the vertices of the regular spatial tessellation, of the hexahedron lattice the environment of the hexahedron vertices will be removed layer by layer (it is more expressive to imagine that the environment of vertices — in harmony with the vertex figure — will be blown up). One should be stopped at positions in which the circumvertex environments (which are themselves also regular or semi-regular solids) and the truncated spatial-mosaic-forming solids are of the same edge length. Now the states of the simple truncation sequence consist of seven elements (as against the five elements of simple truncation sequence of the two-dimensional tessellations (Fig. 2.2). Since the spatial hexahedron lattice is the reciprocal of itself, the simple truncation sequence is symmetrical concerning the tessellation lying in the midway of the two hexahedron lattices. In Fig. 2.6 *the elements drawn as solids* in the spatial tessellation *are shown on the left*, the spatial tessellation *elements*


(4, 4, 4)⁸
(3, 3, 3, 3)
(3, 8, 8)⁴
(3, 3, 3, 3)²
(3, 4, 3, 4)⁴
(4,6,6)²
(4, 6, 6)²
(3,4,3,4)⁴
(3, 3, 3, 3)²
(3,8,8)⁴
(3, 3, 3, 3)
(4,4,4)⁸

remained empty are shown on the right, and by means of the STEINER-symbol the number of joining elements is also indicated. Both the left column consisting of truncating solids and the right one consisting of solids being blown up are the simple truncation sequence of the octahedron-hexahedron series (Fig. 2.2). Consequently, the truncation sequence of the spatial hexahedron lattice will be formally obtained by the peculiar self combination, superposition of the truncation sequence of the octahedron-hexahedron sequence. This formal combination is expressed also by the symbols of simple truncation sequence of the spatial lattice. This will be used when describing the simple truncation sequence of four-dimensional regular-polytopes.

In the four-dimensional space there are six regular-polytopes (COXETER, 1963). The simplex is built up by tetrahedra, its symbol is $(3,3,3)^4$ and it is the reciprocal of itself. The form built up by octahedra $(3,3,3,3)^6$ is also the reciprocal of itself. The reciprocal of the four-dimensional hexahedron $(4,4,4)^4$, i.e. of the measure-polytope is the $(3,3,3)^8$ cross-polytope. The reciprocal

Fig. 2.6 Interpretation of the simple truncation sequence of the spatial hexahedron lattice by symbols

$(4,4,4)^8$	In the hexahedron lattice 8 hexahedron vertices join in each vertex;
$(3,3,3,3)$ $(3,8,8)^4$	First station: the vertex figure of $(4,4,4)^8$ is an octahedron, thus this regular solid occurs in this space lattice. Here four (3,8,8) neighbouring along one edge and the (3,3,3,3) representing the vertex figure are joined;
$(3,3,3,3)^2$ $(3,4,3,4)^4$	Second station: the vertex figures are blown up so they touch themselves by their vertices. Thus, in each vertex two octahedra are joined. Further the four (3,4,3,4) obtained by the truncation of (3,8,8) and neighbouring themselves in the edges join also each vertex;
$(4,6,6)^2$ $(4,6,6)^2$	Third station: the whole space lattice is built up by only one semi-regular solid. Nevertheless, not the simple $(4,6,6)^4$ was used because it could not express the significant feature of this lattice configuration that half of the bodies derives from the truncation of hexahedra of the starting hexahedron lattice, the other half derives from the "blowing up" vertex figure holes enlarging by truncation. The blowing vertex figures fit one another and this results in the square face among them. These square faces were generated perpendicularly of the edges of the former hexahedron lattice and their square form proves the fact that along an edge four hexahedra were joined.
$(3,4,3,4)^4$ $(3,3,3,3)^2$	The truncating (4,6,6) solids were shrunken to octahedra which when joining in their vertices repeat the lattice of the second station so that in the vertices of the lattice the four solids enlarged from (4,6,6) to (3,4,3,4) are joined in addition to the two octahedra.
$(3,8,8)^4$ $(3,3,3,3)$	The truncating solids the octahedra join each other no more. This is analogous to the lattice of the first station.
$(4,4,4)^8$	The truncating bodies are shrunken to points and the remaining edges connecting the points draw the skeleton of the spatial hexahedron lattice. The reciprocal of the starting hexahedron lattice was obtained. All vertices of this lattice are the centres of the starting hexahedron lattice and inversely, all the centres of the new hexahedron lattice are the vertices of the starting lattice

Table IV

Truncation sequences of the four-dimensional regular polytopes, the three-dimensional

	Snub truncation	Simple truncation sequence				
Sequence of the octahedral faced measure-polytope		$(3,3,3,3)^6$	$(4,4,4)$ $(4,6,6)^3$	$(4,4,4)^2$ $(3,4,3,4)^3$	$(3,8,8)^2$ $(3,8,8)^2$	$(3,4,3,4)^3$ $(4,4,4)^2$
Sequence of the four-dimensional regular simplex		$(3,3,3)^4$	$(3,3,3)$ $(3,6,6)^3$	$(3,3,3)^2$ $(3,3,3,3)^3$	$(3,6,6)^2$ $(3,6,6)^2$	$(3,3,3,3)^3$ $(3,3,3)^2$
Measure-polytop-cross polytope sequence	$(3,3,3)^4$ $(3,3,3,3,3)^3$	$(3,3,3)^8$	$(3,3,3,3)$ $(3,6,6)^4$	$(3,3,3,3)^2$ $(3,3,3,3)^4$	$(4,6,6)^2$ $(3,6,6)^2$	$(3,4,3,4)^3$ $(3,3,3)^2$
Sequence of the 120 cell—600 cell		$(3,3,3)^{20}$	$(3,3,3,3,3)$ $(3,6,6)^5$	$(3,3,3,3,3)^2$ $(3,3,3,3)^5$	$(5,6,6)^2$ $(3,6,6)^2$	$(3,5,3,5)^3$ $(3,3,3)^2$
Sequence of the spatial hexahedron tessellation		$(4,4,4)^8$	$(3,3,3,3)$ $(3,8,8)^4$	$(3,3,3,3)^2$ $(3,4,3,4)^4$	$(4,6,6)^2$ $(4,6,6)^2$	$(3,4,3,4)^4$ $(3,3,3,3)^2$
Sequence of the three-dimensional hyperbolic regular tessellations		$(5,5,5)^{20}$	$(3,3,3,3,3)$ $(3,10,10)^5$	$(3,3,3,3,3)^2$ $(3,5,3,5)^5$	$(5,6,6)^2$ $(5,6,6)^2$	$(3,5,3,5)^5$ $(3,3,3,3,3)^2$
		$(3,3,3,3,3)^{12}$	$(5,5,5)$ $(5,6,)^3$	$(5,5,5)^2$ $(3,5,3,5)^3$	$(3,10,10)^2$ $(3,10,10)^2$	$(3,5,3,5)^3$ $(5,5,5)^2$

of the 120-cell $(5,5,5)^4$ consisting of regular dodecahedra is the 600-cell $(3,3,3)^{20}$. Out of the six enumerated regular polytopes two are the reciprocals of themselves; the simple truncation sequence of these two regular polytopes is "symmetric" similar to the space lattice. The truncation sequences of $(3,3,3)^4$ or $(3,3,3,3)^6$ can be built up from the tetrahedron or from the octahedron-hexahedron sequences. (The significance of the octahedron—hexahedron sequence is emphasized by the fact that unifying with itself from the directions of its both generators, i.e. from the octahedron and from the hexahedron, it generates a four-dimensional truncation sequence: the sequence of the $(3,3,3,3)^6$ polytope mentioned above and that of the particularly studied $(4,4,4)^8$ space lattice.)

In the further four-dimensional truncation sequences generated by two reciprocal pairs the combination of two-two three-dimensional truncation sequences are found. As it is excepted on the basis of the examples above, the $(3,3,3)^8$—$(4,4,4)^4$ truncation sequence is built up by the tetrahedron and octahedron-hexahedron sequences, while the $(3,3,3)^{20}$—$(5,5,5)^4$ sequence will be built up by the combination of the tetrahedron and the regular dodecahedron-icosahedron sequences. In the Table IV. of simple truncation sequences of poly-

regular tessellation and the three-dimensional hyperbolic regular tessellations

Simple truncation sequence		Complex truncation		Partial truncation		
$(4,6,6)^3$ $(4,4,4)$	$(3,3,3,3)^6$					
$(3,6,6)^3$ $(3,3,3)$	$(3,3,3)^4$					
$(3,8,8)^3$ $(3,3,3)$	$(4,4,4)^4$	$(4,4,4)$ $(4,6,6)^2$ $(4,6,6)$	$(4,4,4)^2$ $(3,4,3,4)^2$ $(3,4,3,4)$	$(3,6,6)^2$ $(4,6,6)^2$	$(3,3,3)^2$ $(3,4,3,4)^3$	"solids"
$(3,10,10)^3$ $(3,3,3)$	$(5,5,5)^4$					
$(3,8,8)^4$ $(3,3,3,3)$	$(4,4,4)^8$	$(4,4,4)$ $(4,6,8)^2$ $(4,6,6)$	$(4,4,4)^2$ $(3,4,4,4)^2$ $(3,4,3,4)$	$(3,6,6)^2$ $(4,6,6)^2$ $(3,4,3,4)$	$(3,3,3)^8$ $(3,3,3,3)^6$	"planar" tessellations
$(2,10,10)^5$ $(3,3,3,3,3)$	$(5,5,5)^{20}$					hyperbolic tessellations
$(5,6,6)^3$ $(5,5,5)$	$(3,3,3,3,3)^{12}$					

topes the relationships, regularities having demonstrated in the previous periodic system can also be observed.

Further four-dimensional polytopes can be derived from those which are built up by the starting bodies of the complex truncation sequences of the previous periodic system. Nevertheless, only one polytope or space-tessellation of such characteristics is found; i.e. the $(3,3,3,3)^6$ in the truncation sequence of $(3,3,3)^8$—$(4,4,4)^4$ and the $(3,3,3,3)^2$ $(3,4,3,4)^4$ in that of the hexahedron lattice. Fig. 2.7 shows the complex truncation sequence and partial truncation sequence and their two tessellations which can be derived from the latter one. At the end of the partial truncation sequence the known space lattice built up by octahedra and tetrahedra in the three-dimensional space is found. In the partial truncation sequence every second of the (3,4,3,4) will be blown up while the others endure the truncation accompanied by the extension of (3,4,3,4). (Partial truncation can be carried out also with $(3,3,3,3)^6$).

Snub truncation is successful only on the $(3,3,3,3)^6$: the octahedra building up the polytope will be deformed into icosahedra and on the place of vertices of the polytope tetrahedra will develop.

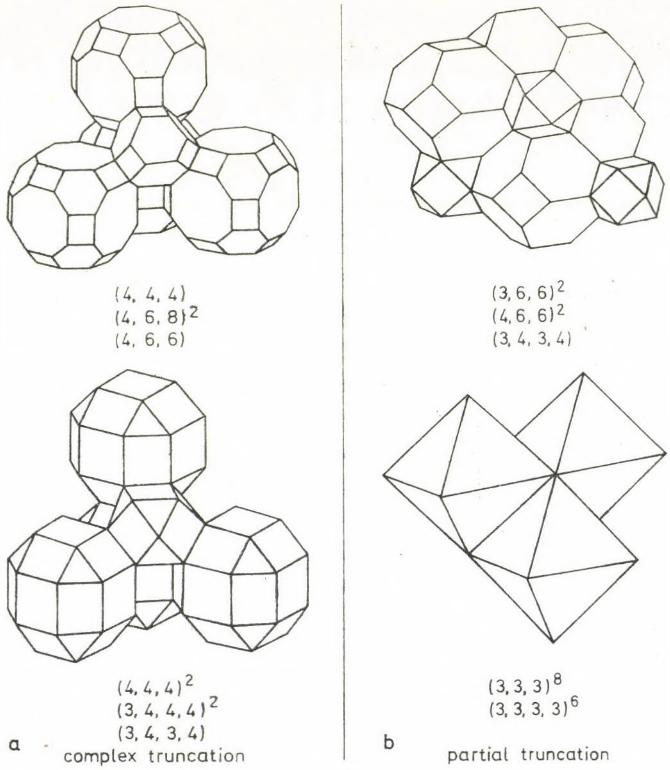


Fig. 2.7

According to the definition among the polytopes obtained by truncation from the regular four-dimensional polytopes, those are semi-regular which are built up by various three-dimensional solids and their vertex configurations are congruent. (The latter condition is satisfied by all bodies and mosaics of the truncation sequences.) Since by means of adjusting of faces of five three-dimensional bodies only three may join each other, i.e. the tetrahedron, the octahedron and the icosahedron, thus the four-dimensional semi-regular polytopes and three-dimensional tessellations should be built up by the pairs of them. Disregarding the sequence of the octahedral-faced measure-polytope one semi-regular-polytope or tessellation is found in each truncation sequence: in that of the regular simplex the $(3,3,3)^2$ $(3,3,3,3)^3$; in the sequence of measure-polytope the $(3,3,3)^5$ $(3,3,3,3,3)^3$ produced by snub truncation; in the sequence of the 120 and 600 cells the $(3,3,3,3,3)^2$ $(3,3,3,3)^5$; in that of the spatial hexahedron lattice the $(3,3,3)^8$ $(3,3,3,3)^6$.

Finally, the simple truncation sequence of the four-dimensional "cubical" lattice will be shown which can be built up by four-dimensional measure-polytopes and the simple truncation sequence of another four-dimensional regular space lattice produced in the cubical truncation sequence, will be derived, as well. The STEINER-symbols of the "cubical lattices" built up by measure-polytopes are: section-lattice on the straight line: $(\text{section})^2$ (two section join in one vertex); square lattice in the plane: $(4,4,4,4) = (\text{square})^4$; hexahedron lattice in the space: $(4,4,4)^8$; and following the sequence the STEINER-symbol of the four-dimensional cubical lattice will be $[(4,4,4)^4]^{16}$. Since the cubical lattices are always the reciprocals of themselves, the simple truncation sequence of the four-dimensional cubical lattice is the superposition with itself of the simple truncation sequence of the four-dimensional cube (the measure-polytope) — four-dimensional cross-polytope, similarly to those recognized at the spatial hexahedron lattice. In the truncation sequence of the four-dimensional cubical lattice, i.e. in that of the cross polytope — measure-polytope, the $(3,3,3,3)^6$ also occurs, as follows:

$[(4,4,4)^4]^{16}$	$\begin{bmatrix}(3,8,8)^3 \\ (3,3,3)\end{bmatrix}^8$	$\begin{bmatrix}(3,4,3,4)^3 \\ (3,3,3)^2\end{bmatrix}^8$	$\begin{bmatrix}(4,6,6)^2 \\ (3,6,6)^2\end{bmatrix}^4$
	$[(3,3,3)^8]$	$[(3,3,3)^8]^2$	$\begin{bmatrix}(3,3,3,3) \\ (3,6,6)^4\end{bmatrix}^2$

$[(3,3,3,3)^6]^4$	$\begin{bmatrix}(3,3,3,3) \\ (3,6,6)^4\end{bmatrix}^2$	$[(3,3,3)^8]^2$	$[(3,3,3)^8]$	
$[(3,3,3,3)^6]^4$	$\begin{bmatrix}(4,6,6)^2 \\ (3,6,6)^2\end{bmatrix}^4$	$\begin{bmatrix}(3,4,3,4)^3 \\ (3,3,3)^2\end{bmatrix}^8$	$\begin{bmatrix}(3,8,8)^3 \\ (3,3,3)\end{bmatrix}^8$	$[(4,4,4)^4]^{16}$

The $[(3,3,3,3)^6]^8$ itself is a regular space lattice of the four-dimensional space, too. Since in all vertices eight polytopes are joined, its vertex figure is the $(4,4,4)^4$ covered by eight "solid" "faces", thus its simple truncation sequence is the superposition of the simèle truncation sequences of the octahedron-faced measure-polytope and of the measure-polytope — cross-polytope. By means of the $(4,4,4)^4$ vertex figure the latter sequence induces a reciprocal lattice, i.e. the $[(3,3,3)^8]^{24}$ built up by the $(3,3,3)^8$ cross-polytope ,the vertex figure of which will be the $(3,3,3,3)^6$ enclosed by 24 octahedral solid "faces".

$[(3,3,3,3)^6]^8$	$\begin{bmatrix}(4,6,6)^3 \\ (4,4,4)\end{bmatrix}^4$	$\begin{bmatrix}(3,4,3,4)^3 \\ (4,4,4)^2\end{bmatrix}^4$	$\begin{bmatrix}(3,8,8)^2 \\ (3,8,8)^2\end{bmatrix}^3$
	$[(4,4,4)^4]$	$[(4,4,4)^4]^2$	$\begin{bmatrix}(3,8,8)^3 \\ (3,3,3)\end{bmatrix}^2$

$\begin{bmatrix}(4,4,4)^2 \\ (3,4,3,4)^3\end{bmatrix}^3$	$\begin{bmatrix}(4,4,4) \\ (4,6,6)^3\end{bmatrix}^2$	$(3,3,3,3)^6]^2$	$[(3,3,3,3)^6]$	
$\begin{bmatrix}(3,4,3,4)^3 \\ (3,3,3)^2\end{bmatrix}^3$	$\begin{bmatrix}(4,6,6)^2 \\ (3,6,6)^2\end{bmatrix}^3$	$[(3,3,3,3)^6]^6$	$\begin{bmatrix}(3,3,3,3) \\ (3,6,6)^4\end{bmatrix}^6$	$[(3,3,3)^8]^{24}$

Table V

Simple truncation sequences of the five-dimensional regular solids

Sequence of the regular simplex	$[(3,3,3)^4]^5$	$\begin{bmatrix}(3,3,3)\\(3,6,6)^3\end{bmatrix}^4$ $[(3,3,3)^4]$	$\begin{bmatrix}(3,3,3)^2\\(3,3,3,3)^3\end{bmatrix}^4$ $[(3,3,3)^4]^2$	$\begin{bmatrix}(3,6,6)^2\\(3,6,6)^2\end{bmatrix}^3$ $\begin{bmatrix}(3,3,3)^2\\(3,6,6)\end{bmatrix}^2$
Sequence of the measure-polytope — crosspolytope	$[(3,3,3)^4]^{16}$	$\begin{bmatrix}(3,3,3)\\(3,6,6)^3\end{bmatrix}^8$ $[(3,3,3)^8]$	$\begin{bmatrix}(3,3,3)^2\\(3,3,3,3)^3\end{bmatrix}^8$ $[(3,3,3)^8]^2$	$[(3,6,6)^4]^4$ $\begin{bmatrix}(3,3,3,3)\\(3,6,6)^4\end{bmatrix}^2$
Measure-polytope generated regular tessellations	$[(4,4,4)^4]^{16}$	$\begin{bmatrix}(3,8,8)^3\\(3,3,3)\end{bmatrix}^8$ $[(3,3,3)^8]$	$\begin{bmatrix}(3,4,3,4)^3\\(3,3,3)^2\end{bmatrix}^8$ $[(3,3,3)^8]^2$	$\begin{bmatrix}(4,6,6)^2\\(3,6,6)^2\end{bmatrix}^4$ $\begin{bmatrix}(3,3,3,3)\\(3,6,6)^4\end{bmatrix}^2$
Octahedron-faced measure-polytope generated regular tessellations	$[(3,3,3,3)^6]^8$	$\begin{bmatrix}(4,6,6)^3\\(4,4,4)\end{bmatrix}^4$ $[(4,4,4)^4]$	$\begin{bmatrix}(3,4,3,4)^3\\(4,4,4)^2\end{bmatrix}^4$ $[(4,4,4)^4]^2$	$[(3,8,8)^4]^3$ $\begin{bmatrix}(3,8,8)^3\\(3,3,3)\end{bmatrix}^2$
Dodecahedron generated hyperbolic tessellations	$[(3,3,3)^4]^{600}$	$\begin{bmatrix}(3,3,3)\\(3,6,6)^3\end{bmatrix}^{20}$ $[(3,3,3)^{20}]$	$\begin{bmatrix}(3,3,3)^2\\(3,3,3,3)^3\end{bmatrix}^{20}$ $[(3,3,3)^{20}]^2$	$[(3,6,6)^4]^5$ $\begin{bmatrix}(3,3,3,3,3)\\(3,6,6)^5\end{bmatrix}^2$

In the truncation sequence of (6,6,6), the (6,6,6) appears again before its reciprocal. The space lattice of the octahedron-faced measure-polytope shows a similar behaviour. The fact, however, that three kinds of regular space lattices are found in four dimensions also resembles to the two-dimensional „abundance". (The five-dimensional simple truncation sequences are listed in Table V.)

The method shown above can be generalized also to regular-polytopes of more than four dimensions. This produces existence-like results, but no unicity. (It can be demonstrated by means of other methods on the bodies occurring in the periodic table of the Platonic and Archimedean solids and tessellations that those, and only those are the regular and semi-regular bodies with no distinguished rotation axis.) The analogy between oscillatory motion and the simple truncation sequences is also significant. Though in the nature no body-oscillation between the reciprocal regular solids is known, this oscillation-comparison increases the relationship between the regular and semi-regular solids and demonstrates the common origin of the symmetry of them.

and the four-dimensional regular planar and hyperbolic tessellations

$\begin{bmatrix}(3,3,3,3)^3\\(3,3,3)^2\end{bmatrix}^3$ $\begin{bmatrix}(3,3,3)^2\\(3,3,3,3)^3\end{bmatrix}^3$	$\begin{bmatrix}(3,6,6)^3\\(3,3,3)\end{bmatrix}^2$ $\begin{bmatrix}(3,6,6)^2\\(3,6,6)^5\end{bmatrix}^3$	$[(3,3,3)^4]^2$ $\begin{bmatrix}(3,3,3,3)^3\\(3,3,3)^2\end{bmatrix}^4$	$[(3,3,3)^4]$ $\begin{bmatrix}(3,6,6)^3\\(3,3,3)\end{bmatrix}^4$	$[(3,3,3)^4]^5$	Solids
$\begin{bmatrix}(3,3,3,3)^3\\(3,3,3)^2\end{bmatrix}^4$ $[(3,3,3,3)^6]^3$	$\begin{bmatrix}(3,6,6)^3\\(3,3,3)\end{bmatrix}^2$ $\begin{bmatrix}(4,6,6)^2\\(3,6,6)^2\end{bmatrix}^3$	$[(3,3,3)^4]^2$ $\begin{bmatrix}(3,4,3,4)^3\\(3,3,3)^2\end{bmatrix}^4$	$[(3,3,3)^4]$ $\begin{bmatrix}(3,8,8)^3\\(3,3,3)\end{bmatrix}^4$	$[(4,4,4)^4]^5$	
$[(3,3,3,3)^6]^4$ $[(3,3,3,3)^6]^4$	$\begin{bmatrix}(3,3,3,3)\\(3,6,6)^4\end{bmatrix}^2$ $\begin{bmatrix}(4,6,6)^2\\(3,6,6)^2\end{bmatrix}^4$	$[(3,3,3)^8]^2$ $\begin{bmatrix}(3,4,3,4)^3\\(3,3,3)^2\end{bmatrix}^8$	$[(3,3,3)^8]$ $\begin{bmatrix}(3,8,8)^3\\(3,3,3)\end{bmatrix}^8$	$[(4,4,4)^4]^{16}$	Planar Tessellations
$\begin{bmatrix}(4,4,4)^2\\(3,4,3,4)^3\end{bmatrix}^3$ $\begin{bmatrix}(3,4,3,4)^3\\(3,3,3)^2\end{bmatrix}^3$	$\begin{bmatrix}(4,4,4)\\(4,6,6)^3\end{bmatrix}^2$ $\begin{bmatrix}(4,6,6)^2\\(3,6,6)^2\end{bmatrix}^3$	$[(3,3,3,3)^6]^2$ $[(3,3,3,3)^6]^6$	$[(3,3,3,3)^6]$ $\begin{bmatrix}(3,3,3,3)\\(3,6,6)^4\end{bmatrix}^6$	$[(3,3,3)^8]^{24}$	
$\begin{bmatrix}(3,3,3,3)^3\\(3,3,3)^2\end{bmatrix}^5$ $\begin{bmatrix}(3,3,3,3,3)^2\\(3,3,3,3)^5\end{bmatrix}^3$	$\begin{bmatrix}(3,6,6)^3\\(3,3,3)\end{bmatrix}^2$ $\begin{bmatrix}(5,6,6)^2\\(3,6,6)^2\end{bmatrix}^3$	$[(3,3,3)^4]^2$ $\begin{bmatrix}(3,5,3,5)^3\\(3,3,3)^2\end{bmatrix}^4$	$[(3,3,3)^4]$ $\begin{bmatrix}(3,10,10)^3\\(3,3,3)\end{bmatrix}^4$	$[(5,5,5)^4]^5$	Hyperbolic Tesellation

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ПЕРИОДИЧНОСТЬ ЭКСТРЕМАЛЬНЫХ ГЕОМЕТРИЧЕСКИХ РАСПОЛОЖЕНИЙ ПЛОТНЕЙШИЕ УПАКОВКИ, РЕДЧАЙШИЕ ПОКРЫТИЯ, РАЗБИЕНИЯ)

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Резюме

Опыт современной дискретной геометрии показывает, что свойство экстремальной величины может создать порядок в хаотической системе фигур. Первая часть статьи посвящена различным «уровням» периодичности — решётчатости, регулярности и блок-регулярности — экстремальных геометрических расположений (упаковок с максимальной плотностью и покрытий с минимальной плотностью). Даётся контрпример на следующую гипотезу: плотность любой упаковки на плоскости для бесконечной системы произвольных равных выпуклых фигур не превосходит плотности плотнейшей регулярной упаковки, построенной из тех же фигур; но, вероятно, это правильно в том случае, если мы рассматриваем плотнейшую блок-регулярную упаковку вместо регулярной.

Вторая часть статьи охватывает и систематизирует самые правильные фигуры: платоновы и архимедовы тела и разбиения. Исходя из правильных тел и разбиений и используя усечение, как систематизирующую операцию, платоновы и архимедовы тела и разбиения располагаются в периодическую таблицу. С распространением усечения также сконструированы многомерные случаи, напр. таблица 4-мерных тел и 3-мерных разбиений.

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GRAVITY AND SUBSTUCTURE IN THE SYSTEM OF THE UNIVERSAL CYCLICITY RELATION

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The SZÁDECZKY-KARDOSS *Universal Cyclicity Relation* is in excellent compatibility with the quite recently developing theory of the quantum-gravity. The cycle parameters; space- and time-coordinates of the elementary structure can be derived as postdetermined values from the energy and motion (rhythm parameters) of the substructure. Thus, the basic data for determining the parameters of the substructure are provided by the cycle parameters (the laws of motion) of the elementary particles, as it will be shown below.

On the basis of NEWTON's gravity equation, expressed (1) for a space of density ϱ, the acceleration becomes:

$$\frac{dx_\mu}{dt^2} = k\,\frac{\partial}{\partial x_\mu}\left[\int \frac{\varrho\, dV_0}{r_0}\right] = \frac{Kc^2}{8\pi}\cdot\frac{\partial}{\partial x_\mu}\left[\int\frac{\varrho\, dV_0}{r_0}\right] = \frac{\partial\varphi_0}{\partial r_0}\,. \tag{1}$$

Providing the directly measurable length and time measures in their connection with the values of time and space coordinates; and separating the expression (of GR) into its pure space and time components:

$$dS^2 = \left(1 + k/c^2\int\frac{\varrho\, dV_0}{r_0}\right) x\,(dx_1^2 + dx_2^2 + dx_3^2)^{1/2} \tag{2}$$

$$dT = \left(1 - k/c^2\int\frac{\varrho\, dV_0}{r_0}\right) dl = (1-\varphi_0/c^2)\,dl\,. \quad \text{Thus: } 1 \geq \frac{\varphi_0}{c^2}\,. \tag{3}$$

In terms of energy, the time-coordinate becomes:

$$dT = \left(1 - \frac{k}{c^4}\int\frac{\varrho_E\, dV_0}{r_0}\right) dl\,. \tag{4}$$

As a limiting condition for time-dilatation, in order to exclude the directional change:

$$\frac{1\ \text{sec}}{t_{\text{MIN}}} = \left|\frac{k}{c^4}\right| = 1{,}21\cdot 10^{44}\,. \tag{5}$$

The greatest gravity force (at Schwartschild-radius)

$$P_{\mathrm{MAX}} = \frac{\varphi_{\mathrm{MAX}}}{r_{\mathrm{MIN}}} m_{\mathrm{Sch}} = \frac{c^2 m_{\mathrm{Sch}}}{k m_{\mathrm{Sch}}/c^2} = \frac{c^4}{k} [N] = 1{,}21 \cdot 10^{44} [k_g m s^{-2}]$$

$$P_{\mathrm{MAX}} = \left(\frac{c^2 \int \varrho V_0}{r_0}\right)_{\mathrm{MAX}} = \left(\frac{E}{r_0}\right)_{\mathrm{MAX}} = \frac{c^4}{k} [J/m] \,. \tag{6}$$

The maximum value of the relativistic change:

$$\frac{1 \sec}{t_{\mathrm{MIN}}} = \frac{c^{[m]}}{r_{\mathrm{MIN}}} = \frac{(m/r)_{\mathrm{MAX}}}{(m/r)_{\mathrm{MIN}}} = \frac{|c^2/k|}{|1/c^2|} = \left|\frac{c^4}{k}\right| = \frac{\varphi_{\mathrm{MAX}}}{\varphi_{\mathrm{MIN}}} = M_G =$$
$$= |P_{\mathrm{MAX}}| = 1{,}21 \cdot 10^{44} \,. \tag{7}$$

The constant M_G — the constant of gravity metaporphism — can be considered as the third universal constant of physics, in addition the velocity of light c and the quantum constant h.

The raising of the limiting condition of gravity, derived from the basic relationships of relativity theory to the rank of a postulate can be justified as follows.

By the introduction of the postulate of limit potential ($\Phi_{\mathrm{MAX}} = c^2$ and $\Phi_{\mathrm{MIN}} = \left|\frac{k}{c^2}\right|$), the quotient of the highest and lowest gravity potential marks out, at the same time, the largest interpretable dynamic range of the change of the mass or spatial radius of the system:

$$M_G = \frac{\varphi_{\mathrm{MAX}}}{\varphi_{\mathrm{MIN}}} = \left|\frac{c^4}{k}\right| = 1{,}21 \cdot 10^{44} \,. \tag{8}$$

The constant M_G provides the maximum value of the dynamics of energy variation — determined by the limits of gravity potential — of the inertia systems. Thus, M_G the "gravity metamorphism constant" provides the required third universal constant. Together with the values of limit velocity and energy quantum (c, h, M_G), it is suitable to co-ordinate the parameters of mass-space-time (in their natural internal connection) and makes interpretable the discrete-valued minima of mass, space and time determinable as well. It has been shown, that $M_G = |P_{\mathrm{MAX}}|$ and P_{MAX} $[kg\ m\ s^{-2}]$ is of the dimensions of force, c and h are those of $[m\ s^{-1}]$, resp. $[Js]$.

The Quantum-consequences of the Gravity-limit Postulate

The basic consequence of the postulate of gravity limit potential is that an accelerated system can only finitely approach the light velocity (e.g. a proton up to an accuracy of appr. $10^{-10}\ m\ s^{-1}$) depending on its static gravity potential level Φ_0. By further energy transfer, the system exceeds the range of interpretability, i.e. it becomes a black hole.

$$v_{\max} = c(1 - \Phi_0/c^2)^{1/2} = c(1 - 1/M_0)^{1/2} \tag{9}$$

For a proton:

$$v_{\max, p} = c(1 - 1/3{,}47 \cdot 10^{19})\,[m\,s^{-1}]$$

On the basis of the postulate of gravity-limit potential, the relativistic characteristics are the mass/space radius quotient and its limit values

$$(m/r)_{\mathrm{MAX}} = c^2/k = 1{,}35 \cdot 10^{27} [kg\,m^{-1}] \tag{10}$$

$$(m/r)_{\mathrm{MIN}} = |1/c^2| = 1{,}11 \cdot 10^{-17}\ [kg\,m^{-1}] \tag{11}$$

instead of the ambiguous geometric concept of the "curvature of space". (Farwell geometry — proposed also by WHEELER).

The M_G gravity metamorphism constant also determines the discrete structure of space and time.

Thus, the lowest interpretable value of distance (space radius) is:

$$r_{\mathrm{MIN}} = \frac{c^{[m]}}{M_G} = \left|\frac{k}{c^3}\right| = 2{,}47 \cdot 10^{-36}\,[m] = \frac{1}{2\pi}\left(\frac{\hbar k}{c^3}\right)^{1/2} \tag{12}$$

the shortest interpretable time interval being:

$$t_{\mathrm{MIN}} = \frac{r_{\mathrm{MIN}}}{c} = \frac{1\ \mathrm{sec}}{M_G} = 8{,}23 \cdot 10^{-45}\,[s]\,. \tag{13}$$

The mass to be concentrated on the smallest radius — which can be considered as the mass-quantum (m_g) gravitationally expanded $m_{\max, e} = M_g m_g$: this is the smallest Schwartschild mass —

$$m_{\max, e} = \frac{c^2 r_{\mathrm{MIN}}}{k} = \left|\frac{1}{c}\right|^{[k_g]} = 3{,}33 \cdot 10^{-9}\,[kg] = \frac{1}{2\pi}\left(\frac{\hbar c}{k}\right)^{1/2} [kg]\,. \tag{14}$$

(This value agrees fairly well with the results of Howking and Narlikar)

The value of the smallest interpretable mass (the graviton) is given by Eq.

$$m_{\mathrm{MIN}} = \frac{m_{\max, e}}{M_G} = 2{,}73 \cdot 10^{-53}\,[kg] = m_g\,.$$

So:

$$E_{\mathrm{MIN}} = m_g c^2 = 2{,}47 \cdot 10^{-36}\,[J] = \frac{|h|^{[J]}}{\Theta} \quad \text{where } \Theta \approx \frac{8\pi^4}{3}$$

and

$$m_f = \frac{h^{[J]}}{c^2} = \Theta\, m_g = 7{,}37 \cdot 10^{-51}\,[kg]\,. \tag{15}$$

The discrete space structure thus defined is in accordance with the requirements of relation of indeterminacy ($m_g c_g c^{[m]} = h$, and $\Delta xp \geqq h$).

Thus, we have arrived at a consistent formulation of space structure required by the general theory of relativity with continuity being imposed only up to the limits of interpretability.

The Material Parameters of Space

In the general theory of relativity the concept of space has still preserved, to a certain extent, its Kantian character (Ding an sich selbst). The space "bends" as a result of the gravity of matter and thus controls the geodetic path of the matter (e.g. of the photon). Matter effects the space and the space — practically transmitting the material influence — effects the matter. On the basis of the general theory of relativity — and by introducing the gravity limit postulate — space can really be considered as an attribute of matter. One can define the lowest energy level which is the material equivalent of the space, and the material phenomena can be described as certain given states of energy of this basic energy level of the material vacuum (similarly interpreted by S. V. M. CLUBE and P. K. BISWAS). Thus, as against the geometric interpretation of relativity theory, where the geodetic line "bends" in the vicinity of the Sun, the relativistic refraction of light can be interpreted by assuming that, as a result of the transfer of gravitational energy of the Sun, the density of the vacuum energy increases in the vicinity of the Sun. Thus, the velocity of light decreases as a function of density, and the gravitational refraction of light can be attributed to the change of light velocity due to the change of energy density as a function of gravity potential, i.e. to a "continuous" change of the "refractive index".

Similarly, the special relativity and the LORENTZ transformation itself are correct as far as these are based on the general relativity. The relativistic transformations have to be interpreted, based on the relative energy densities of the (near to light-velocity) accelerated material systems, related to the minimum energy-level of the vacuum.

On the basis of the gravitational limit postulate, and by means of the fine-structure constant, the material parameters of the vacuum can be obtained. In possession of the parameters of substructure, the material density of vacuum can be determined as

$$\varrho_1 = \frac{m_{\mathrm{MIN}} M_G}{4\pi/3\,|c^3|^{[m^3]}} = \frac{3\,[kg]}{4\pi\,|c^4|^{[m^3]}} = 2{,}59 \cdot 10^{-35}[kg\,m^{-3}]\,. \tag{16}$$

So the mass of the vacuum in a sphere with $r = |c| = 3 \cdot 10^8\,[m]$ is: $\frac{1\,[kg]}{|c|} =$ $= 3{,}33 \cdot 10^{-9}\,[kg]$.

The above result can be proved as follows.

The constant $\varkappa$ determined in EINSTEIN's gravity equation is

$$\varkappa = \frac{8\pi k}{c^2} = 1{,}86 \cdot 10^{-26}\,[kg^{-1}\,m]\,. \tag{17}$$

So:

$$|k/c^2| = 7{,}4 \cdot 10^{-28} = |\varphi_{\mathrm{MIN}}| = |\varkappa/8\pi| \tag{18}$$

i.e.:

$$\left|\frac{\varkappa}{8\pi\,c^2}\cdot\right| = \left|\frac{1}{M_G}\right|$$

$$\frac{\varkappa}{8\pi\,c^2} = 8{,}23 \cdot 10^{-45}\,[kg^{-1}\,m^3\,s^{-2}]\,. \tag{19}$$

Knowing of the structure of vacuum its motion phenomena can also be examined if it is considered as an ideal gas.

Expressing the fine-structure constant as the ratio of the energy threshold values:

$$|E_f/2/3\,k_\beta| = \frac{7{,}42 \cdot 10^{-36}}{2/3 \cdot 1{,}38 \cdot 10^{-23}} = 8{,}09 \cdot 10^{-13} \tag{20}$$

the average energy content of a unit volume of vacuum becomes, in terms of the fine-structure constant:

$$E_{v,k} = \frac{m_{v,k} \cdot a_f}{k_\beta}\,\delta = \frac{2{,}95 \cdot 10^{-35} \cdot 1{,}24 \cdot 10^{12}}{1{,}38 \cdot 10^{-23}}\,1{,}027 = 2{,}7\,[\mathrm{K}^0] \tag{21}$$

$$m_{v,k} = \varrho_1 \cdot 1\,m^3\,.$$

The vacuum, considered as energy radiated by the black body (in good agreement with the results of S. V. M. CLUBE) is

$$T_v = \sqrt[4]{\frac{m_g/\delta \cdot a_f \cdot 1/v_f \cdot c^2}{\sigma}} = \left(\frac{9{,}86 \cdot 10^{-41} \cdot 3{,}57 \cdot 10^{17} \cdot 9 \cdot 10^{16}}{5{,}61 \cdot 10^{-8}}\right)^{1/4} = 2{,}7[\mathrm{K}^0]\,. \tag{22}$$

Thus, the fine-structure constant can also be interpreted as the relativistic (gravity expansion) quotient of the substructural motion. The energy of radiation corresponds to the level of PENSIAS—WILSON's background radiation which has been interpreted so far — quantitatively — as an electron radiation "cooled down", resp. infrashifted following the "Big-Bang".

The wavelength of the radiation of the vacuum itself — as a black body — is:

$$\lambda_v = \frac{h\delta^3}{m_g a_f c} = \frac{6{,}63 \cdot 10^{-34} \cdot 1{,}027^3}{3{,}3 \cdot 10^{-41} \cdot 3 \cdot 10^8} = 7{,}3 \cdot 10^{-2}\,[m]. \tag{23}$$

This is in good agreement with the measured wavelength of background radiation, verifying the values concerning the structure of vacuum derived on the basis of the gravity expansion theory.

Space and Time-limitatons of the Electromagnetic Energy, the Criterium of Overdeterminacy.

The gravity potential which can be attributed to the photon of a mass-volume quotient $m_f/r_f = |1/c^2| = 1{,}11 \cdot 10^{-17}$ determined the lowest known potential level:

$$\varphi_f = |k/c^2|\ [m^2 s^{-2}] = 7{,}4 \cdot 10^{-28}\,[m^2\,s^{-2}]. \tag{24}$$

Elementary particles represent higher gravitational potentials; the gravity potential of an electron is 27-times, that of a proton, 10^5-times higher.

Thus, the gravity potential which can be attributed to the photon determines the minimum level:

$$\varphi_f = \varphi_{\mathrm{MIN}} = \left|\frac{k}{c^2}\right| = k\,\frac{\nu\,h}{r_f\,c^2}$$

$$r_f = |\nu|\,h^{[m]} = \nu\Theta\,r_{\mathrm{MIN}}. \tag{25}$$

EINSTEIN — having realized the uniform nature of the complete electromagnetic wave spectrum — connected his energy equation to Planck's energy-quantum equation (worked out in the course of examining the radiation of black bodies). This equation determines the energy-content of an electromagnetic wave of frequency ν and through this, the mass equivalent of the photon (as the mass equivalent of the energy of the light wave) as $m_f = \nu \cdot h/c^2$.

PLANCK's quantum constant has been raised to the rank of a universal constant by Heisenberg's principle of indeterminacy which — in addition to the numerical value of light velocity — is the other basic point of the system of physical laws.

The lowest mass equivalent belonging to a single period (PLANCK-mass):

$$m_{f\,\mathrm{MIN}} = h^{[J]}/c^2 = 7{,}37 \cdot 10^{-51}\,kg \tag{26}$$

as the lowest photon mass equivalent, can be localized, according to Heisenberg's principle of indeterminacy, ($m_{f\,\mathrm{MIN}} \cdot c \cdot \lambda_{\mathrm{MAX}} \simeq h$) up to an accuracy of $\lambda_{\mathrm{MAX}} \cong |c|^{[m]}$ only. In each period of the electromagnetic wave of frequency ν the $m_f = |\nu|\, m_{f\,\mathrm{MIN}}$ mass equivalent (photon) can be considered as realized on the space radius of $r_f = |\nu| \cdot |h^{[m]}|$. Its place can only be marked out within the limit of indeterminacy $\lambda = c/\nu$ that is within a wavelength. A constant gravity potential, independent of frequency, can be attributed to the mass equivalent of the photon (i.e. its velocity of propagation is frequency-independent)

$$\varphi_f = k\,\frac{m_f}{r_f} = k\,\frac{\nu\, m_{f\,\mathrm{MIN}}}{\nu\, r_{f\,\mathrm{MIN}}} = \left|\frac{k}{c^2}\right| [m^2 s^{-2}] = \varphi_\nu = \varphi_{\mathrm{MIN}}\,. \tag{27}$$

The upper limit of frequency of the electromagnetic wave is:

$$r_{f\,\mathrm{MAX}} = \frac{|h|\,\nu_{\mathrm{MAX}}}{2\pi} = \frac{\lambda_{\mathrm{MIN}}}{2\pi}$$

$$\nu_{\mathrm{MAX}} = \left(\frac{c}{2\pi\, h^{[m]}}\right)^{1/2} = 2{,}69 \cdot 10^{20}\,[s^{-1}]\,. \tag{28}$$

This condition can be defined as a "criterion of overdeterminacy". At the critical wavelength, electron-positron pairs can be derived.

$$m_{el} = \sqrt{M_g} \cdot m_g, \qquad r_{el} = \frac{r_{\mathrm{MIN}}\sqrt{M_g}}{9}\,. \tag{29}$$

The $m_{f\,\mathrm{min}} = 7{,}37 \cdot 10^{-51}$ $[kg]$ mass corresponding to $h^{[J]}$ energy quantum, according to the relation of indeterminacy, can be delimited within a wavelength of $\lambda_{\mathrm{max}} = 3 \cdot 10^8$ $[m]$, while for increasing frequencies within wavelengths

$$\lambda = c/\nu$$

The space radius corresponding to the photon linearly increases with the frequency ($r_f = \nu \cdot |h^{[m]}|$), as it was shown:

When the space radius corresponding to the photon reaches the half wavelength (this happens just around the numerical value of the fine-structure constant (α_f), the photon so to say gets closed into the "space prison" determined by the wavelength, thus its translational motion with light velocity stops. Thus, we have arrived at the concept of the electromagnetic limiting frequency defined by the criterion of overdeterminacy. The mass equivalent of the photon belonging to that frequency should be interpreted as representing the energy-level of electron-positron pair generation, thus, at the critical wavelength, the generation of "stationary" matter. Thus, stationary matter appears as space-time localized rotating (turbulent) movement of the substructure. (In anti-matter this rotation of the substructure is complementary phase-shifted — so "Dirac see" appears in space-time).

Gravity as a Quantified Wave-phenomenon

When examining the gravity effect, we should start from the condition that gravity energy — like electromagnetic energy by means of photons — is a means of transmission of the "stationary matter". As a result of the radiation of gravity energy, the stationary mass of the bodies decreases. (Ref. 2) Any mass "lifted" by effecting work in a gravity potential field increases (MÖSSBAUER effect), that of a free falling body decreases. This phenomenon can be accounted for by the exchange of gravity mass quanta — similarly to the exchange of the electromagnetic quanta of action.

It should be taken into consideration that the gravity effect is still fully exerted even when the electromagnetic effect is hardly or not at all (neutron stars, black holes; $\Phi \to c^2$). The concept of the gravity trap rules out in advance that it should have only an effect on itself, therefore, it is reasonable to assume that the velocity of propagation of gravity action is higher than that of the light.

The gravity mass quantum — due to its nature — can escape from the so-called gravity graves which behave like traps for the light quantum. The assumption of the existence of particles with higher velocity than light have been proved to be compatible with the general theory of relativity in FEINBERG's theoretical considerations about tachions (since the gravity mass quantum, the "graviton", is a particle without electric charge, it cannot be indicated by the CHERENKOV radiation).

The velocity of propagation of gravity action in vacuum can be defined as having a value higher than light velocity ($c_g > c$); in a medium of $\varrho > \varrho_1$ density its velocity decreases and approaches light velocity.

Due to the interaction between the electromagnetic and gravity energy as well as to the conservation of momentum, the smallest impulses are the same:

$$P_{\mathrm{MIN}\,el} = P_{\mathrm{MIN}\,g} = h/c = 2{,}22 \cdot 10^{-42} \, [k_g \, m \, s^{-1}] . \tag{30}$$

Thus, the velocity of propagation of gravity as well as the maximum wave-length in vacuum are about 260-times greater than that of the light:

$$c_g/c = \frac{m_f}{m_g} = \frac{(h^{[J]}/c^2)}{2{,}73 \cdot 10^{-53}} \cong 260 = \frac{8\pi^4}{3}, \quad \lambda_{g\,\mathrm{MAX}} \simeq 7{,}9 \cdot 10^{10} \, [m] . \tag{31}$$

On the basis of the overdeterminacy criterion applied to the longitudinal propagation, exactly the proton mass is realized on the proton radius at the limiting frequency. From the rhythm strip of the gravity, the energy passes over to the "static" mass-strip (D), in which the rotational cyclic motion of the substructure provides the determined value of mass and radius of the elementary structure (proton)

$$\nu_{MAX} = \frac{m_p}{m_g} \approx 6 \cdot 10^{25}, \quad \lambda_{g\,MIN} = \frac{c_g}{\nu_{MAX}} = \frac{7{,}9 \cdot 10^{10}}{6 \cdot 10^{25}} \approx r_p . \tag{32}$$

Thus, the limit wavelength generated by the matter-energy concentrated on the Schwartzschield radius, that is, on the maximum gravity potential (c^2), generates proton mass on the proton radius. It gives a causal and quantitative explanation (as indicated by AMBARTZUMIAN and ZELDOVICH) of the positive energy state of the matter. On the basis of the facts above, the cycle parameters of the substructure verify origo-parameters as well as the dynamic range of space and time-coordinates of the SZÁDECZKY-KARDOSS cycle diagram.

СИЛА ТЯЖЕСТИ И СУБСТРУКТУРА В СИСТЕМЕ УНИВЕРСАЛЬНОГО ЗАКОНА ЦИКЛИЧНОСТИ

Г. МАРФЕЛЬДИ

Резюме

Универсальный закон цикличности, предложенный Э. Садецки-Кардошшом, совершенно совместим с теорией силы тяжести квантов, развиваемой учеными в последнее время. Параметры циклов, то есть пространственно-временные координаты элементарной структуры могут, в конечном счете, рассматриваться как величины, определенные дополнительно (впоследствии) исходя из энергии и движения (параметры ритмов) субструктуры. Таким образом, основными данными для определения параметров субструктуры служат параметры циклов (законы движения) элементарных частиц, как это будет показано ниже.

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ADDITIONAL BRIDGES IN THE UNIVERSAL CYCLICITY RELATION

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In the time-space diagram of the Universal Cyclicity Relation bridges representing constant density and mass can also be established. These bridges can be described by the relationships $t = mr^2/\hbar = \varrho r^5/\hbar$. Taking into account two typical density values in the Universe (ϱ_{proton}, ϱ_{atom}) two fairly interpretable bridges are obtained which comprise the time-space relationships of processes proceeding partly in the atomic (molecular) orbit, partly in the atomic nucleus orbit.

Some bridges characterizing single reactions also exist in addition to the strips A, B, C and point D which represent the cyclic and rhythmic motions in the diagram of the Universal Cyclicity Relation [1]. These possess an exact mathematical form and a physical meaning as well.

These bridges play an important role in the interpretation of some relations of the cyclicity law.

I

First of all, between the lower poles of strips *B* and *C* there is a "bridge". The space parameter of this bridge extends from several Ångström units to several hundred Ångström units, while its time parameters extend from 10^{-13} seconds to several seconds.

The angle of inclination of this bridge to the abscissa is about 11 to 13°.

The bridge in question comprises the space-time parameters of molecular — macromolecular, chemical — biochemical — biological reactions.

It includes intra- and intermolecular phenomena, e.g. conformational changes, proton and electron transfer, formation of bonds, formation of H-bridges, hydrophile and hydrophob interactions, the enzym-substratum and antigen-antibody reactions, the nuclein-acid and protein synthesis, the formation of patterns on the cell surface, etc. (Fig. 1)

In favour to interpret the time-space data mentioned above an attempt was made to apply an equation calculated from the SCHRÖDINGER-equation describing the spatial spreading of a substance package:

$$t = \frac{m r^2}{\hbar} = \frac{\varrho r^5}{\hbar} = \frac{\sqrt[3]{\dfrac{m^5}{\varrho^2}}}{\hbar} \qquad \left(\varrho = \frac{m}{r^3}\right) \tag{1}$$

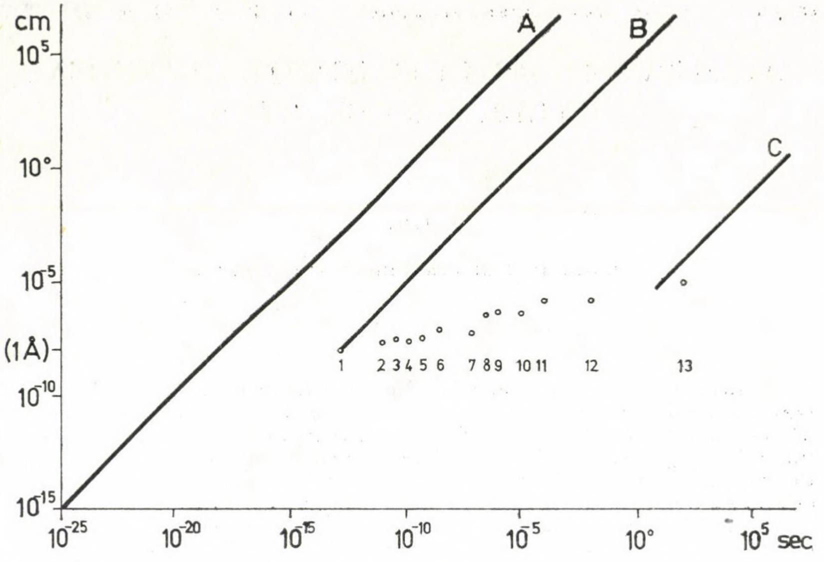

Fig. 1. **Some points of the transitional bridge between strips B and C of the Universal Cyclicity Relation. Legend see in Table I**

where t is the typical time parameter of the system, r is the typical space parameter, m denotes the mass, ϱ is the density, $\hbar = h/2\pi = 1.054 \cdot 10^{-27}$ g cm^2 sec^{-1}, where h is the PLANCK-constant.

(Different forms of the relation above are well known in physics. In its original form

$$t' = \frac{\sqrt{3}}{4} \frac{m r_0^2}{\hbar} \tag{2}$$

it describes the spatial spreading of a particle package defined by a fairly localized r_0 parameter. Here t' is the time during which the r space parameter of the particle will become doubled as compared to the original r_0 value [2].

The above relation is suggested also by other basic equations of microphysics, e.g. the energy equation of PLANCK, the principle of mass-energy equivalence of EINSTEIN:

$$E = mc^2 = h\nu \tag{3}$$

the velocity of electron around the nucleus

$$v = \hbar/mr \tag{4}$$

the impulse moment of the electron

$$rmv = k\hbar \tag{5}$$

Table I

Typical (calculated and measured space and time parameters of phenomena belonging to the transitional bridge between the strips B and C[see references: 3, 4, 5, 6, 7, 8]

Number on the Fig. 1.	Phenomenon	Space parameter in Å units	$t_{measured}$	$t_{calculated}$
			in seconds	
1	H-atom[1]	1.06	$\sim 10^{-13}$	$1.78 \cdot 10^{-13}$
2	$H_2O \rightleftharpoons HO^- + H^+$	~ 2	$7.71 \cdot 10^{-12}$	$1.14 \cdot 10^{-11}$
4	H-bridge formation	2.7–3.4	10^{-11}–10^{-9}	10^{-11}–10^{-9}
5	Ionic interaction[2]	$\sim 2-5$	10^{-11}–10^{-9}	$8 \cdot 10^{-12}$–$8 \cdot 10^{-10}$
7	Hydrophobic interaction	>4	10^{-8}	$>3 \cdot 10^{-10}$
	$H_2SO_4 \rightleftharpoons HSO_4^- + H^+$	~ 4	10^{-11}	$2.48 \cdot 10^{-10}$
3	$NH_4OH \rightleftharpoons NH_4^+ + OH^-$	~ 4	$3.3 \cdot 10^{-11}$	$8.88 \cdot 10^{-11}$
	$CH_3CH_2OH \rightleftharpoons$[3]	~ 5	$2.2 \cdot 10^{-11}$	$1.82 \cdot 10^{-10}$
6	malein acid $+ OH^- \rightleftharpoons$	~ 8	$3.3 \cdot 10^{-9}$	$1.17 \cdot 10^{-9}$
	Adenin $+ OH^- \rightleftharpoons$	~ 7	10^{-10}	$1.05 \cdot 10^{-10}$
	$ATP \cdot H + OH^- \rightleftharpoons$	~ 15	$8.3 \cdot 10^{-10}$	$1.86 \cdot 10^{-8}$
8	Polypeptide conformational change ($n_{aminoacids} = 100$)	~ 30	10^{-7}–10^{-6}	$6 \cdot 10^{-7}$
9	Polynucleotide conformational change ($n_{nucleotides} = 100$)	~ 50	10^{-6}	10^{-5}
10	Enzym-substrate[4] and Antigen-Antibody reactions:	$\sim 25-250$		
	complex formation:		10^{-8}–10^{-7}	
	complex dissociation:		10^{-6}	
	Catalase (H_2O_2)	30	(f) $6.6 \cdot 10^{-8}$ (d) $1.7 \cdot 10^{-7}$	$6 \cdot 10^{-7}$
	β-Amylase (Amylose)	40	(f) $1.7 \cdot 10^{-8}$ (d) $9.1 \cdot 10^{-7}$	$2 \cdot 10^{-5}$
	Acetylcholinesterase (Ach)	50	(f) 10^{-9} (d) $1.1 \cdot 10^{-5}$	$8 \cdot 10^{-5}$
	Hexokinase (Mg-ATP)	80	(f) $2.5 \cdot 10^{-7}$ (d) $1.6 \cdot 10^{-3}$	$8 \cdot 10^{-4}$
11	DNA, RNA synthesis	several hundred	10^{-4}/nucleotide	—
12	Protein-synthesis	several hundred	10^{-2}/aminoacid	—
13	the smallest living cells (PPLO elementary body)[5]	1000	? (several ten to hundred)	100

Remarks: [1] Based on the classical formula $v = \hbar/mr$ (4) the time of revolution of the electron around the nucleus is $1.27 \cdot 10^{-13}$ sec in the H-atom. Otherwise, according to different measurements the ionization time of the electron $\leq 10^{-13}$ sec. [2] $t_{calculated}$ derives from the formula $t = \varrho \frac{r^5}{\hbar}$ taking the molecular density. Similar is the value of the previous and in some of the subsequent cases. [3] In the following the reaction is not indicated. [4] Approximate space parameters. Substrate is in brackets. (f) = complex formation, (d) = complex dissociation. [5] $t_{measured}$ is approximate value (due to the special cell cycle).

the COMPTON wavelength of the electron

$$\lambda = \frac{h}{m_e c} \tag{6}$$

the DE BROGLIE wavelength

$$\lambda = \frac{\hbar}{mv}. \tag{7}$$

The uncertainty relation of HEISENBERG is also in connection with the above-presented relation.

$$\Delta x\, \Delta v \geq h/m$$

$$\Delta E\, \Delta t \geq h \tag{8}$$

or

$$\Delta p\, \Delta x \geq h, \quad \text{etc.}$$

Using equation (1) to calculate the typical time data of the mentioned phenomena and replacing the known space, density or mass parameters the obtained time parameters will be close to the typical measured time data.

To account for the linear correlation between the time and space data within the double logarithmic coordinate system, the density values of the systems (phenomena) fitting into this bridge will be investigated.

The density-values of the investigated systems remain within one order of magnitude ($10^0-10^1\ \mathrm{g/cm^3}$). This density-value is not only that of the chemical-biochemical-biological systems in restricted sense, its significance is more general: this is one of the typical density-values occurring in the Universe [9—15].

Table II

Density-values of chemical-biochemical systems

Density of Hydrogen-atom[1]	$2.70\ \frac{\mathrm{g}}{\mathrm{cm^3}}$
Density of H_2O molecule	$11.91\ \frac{\mathrm{g}}{\mathrm{cm^3}}$
Density of an aminoacid (glycin)	$13.16\ \frac{\mathrm{g}}{\mathrm{cm^3}}$
Density of a protein (human serum albumin)[2]	$1.79\ \frac{\mathrm{g}}{\mathrm{cm^3}}$
Average density of living systems $\sim$ density of water =	$1.00\ \frac{\mathrm{g}}{\mathrm{cm^3}}$

[1] $$\mathrm{H} = \frac{m_H}{V_H} = \frac{1.672 \cdot 10^{-24}\ \mathrm{g}}{\frac{4\pi}{3}(0.53\ \text{Å})^3} = 2.70\ \frac{\mathrm{g}}{\mathrm{cm^3}}.$$

[2] Tertier structure.

By introducing the typical density-value ($1\ g/cm^3 = \varrho_{water}$) in equation (1) an additional bridge in the diagram of the cyclicity relation will be obtained. The angle of this (and other similar) additional bridges to the abscissa is $11°\,19'$.

This and other similar bridges may be called isodensa because they do correspond to given density-values (Fig. 2).

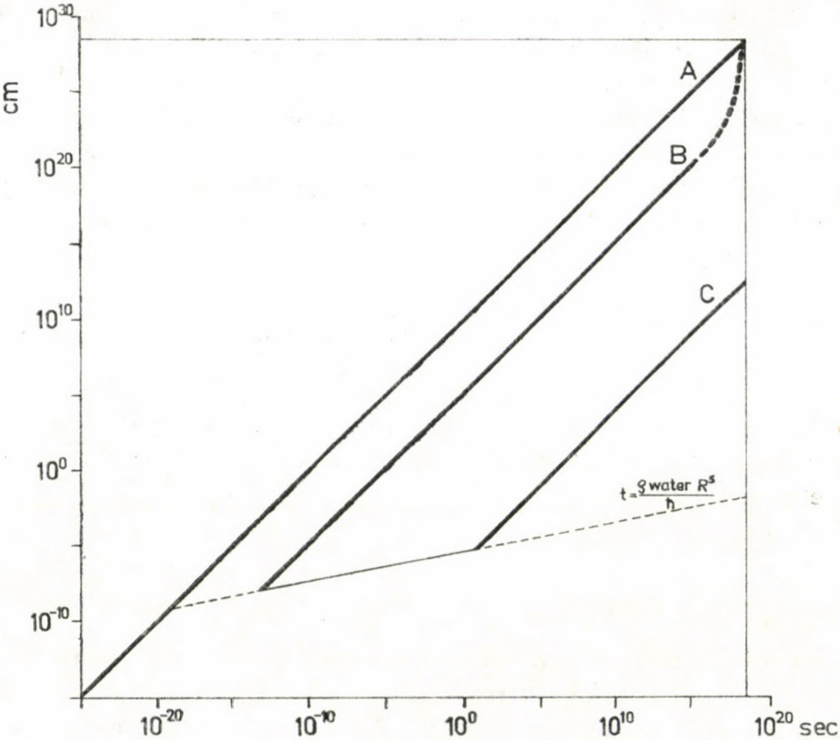

Fig. 2. The $t = \varrho_{water} \cdot r^5/\hbar$ line

The isodensa intersects the strips *B* and *C*. Their intersections correspond to the lower poles of these strips and represent significant physical points: the point of intersection of strip *B* with the isodensa marks the time and space data of the hydrogen-atom (1 Å, 10^{-13} sec.).

The intersection of strip *C* and of the isodensa marks the time and space data of the smallest living cells (the elementary body of the *P*leuro-*P*neumonia—*L*ike-*O*rganism, i.e. PPLO is known as the smallest living cell). Its diameter is about 10^{-5} cm, the cycle-time related to this cell-diameter is about 10 to 100 sec. The diameter of the theorically smallest cell is $5 \cdot 10^{-6}$ cm (MOROWITZ, [16].) The diameters of other smallest bacteria (e.g. Micrococcae, Rickettsiae, etc.) are also close to these space data.

The section of the isodensa comprehended between the lower poles of strips B and C is identical with the bridge mentioned above containing the time and space data of the phenomena proceeding in the orbits of atoms or molecules.

Above the point of the "minimal cell" the isodensa has not been interpreted, yet. Within a section below the intersection of the strip B and of the isodensa (i.e. hydrogen-atom), however, the bridge seems to be interpretable.

In the course of exciting the atoms the maximal time values of energy absorption vary between 10^{-18} and 10^{-20} sec. As space parameters those of quantum jumps, i.e. the differences of the individual electron orbits can be assigned to these. These values are of about 10^{-9} cm. Replacing the known density and distance parameters into equation (1) the excitation (absorption) time values known also from experiments will be obtained. E.g. in case of the hydrogen-atom [17, 18, 19, 20]:

$$t = \frac{\varrho_H \cdot (10^{-9}\,\mathrm{cm})^5}{\hbar} = 10^{-18}\,\mathrm{sec}\,. \tag{9}$$

The time value determined by the water isodensa and by the strip A, resp. by their intersection corresponds to the characteristic time (reaction time) of the electromagnetic interactions [21].

II

In addition to the density-value dealt with above, the other typical density-value realized in the Universe is the density of proton $(7.8 \cdot 10^{14}\ \mathrm{g/cm^3})$. The neutrons and atomic nuclei $(\varrho > 3 \cdot 10^{14}\ \mathrm{g/cm^3})$ as well as the neutron stars $(\varrho > 10^{14}\ \mathrm{g/cm^3})$ are of similar density [22].

Thus, the density-values 1 to 10 $\mathrm{g/cm^3}$ resp. $7.8 \cdot 10^{14}\ \mathrm{g/cm^3}$ are of special significance in the Universe. (The average density of the Universe decreases in harmony with the expansion, the density of young stars can be considered only to be a transitional state while the density of the interstellar space cannot be evaluated.) The density-value of about $\varrho = 1\ \mathrm{g/cm^3}$ is that of atoms and of major part of stars, while the proton density-value of about $10^{15}\ \mathrm{g/cm^3}$ is that of atomic nuclei and astronomic objects and this can be regarded as the final state the stellar evolution.

A bridge characterized by the $\varrho = \varrho_{\mathrm{proton}} \sim 10^{15}\ \mathrm{g/cm^3}$ density can also be plotted in the diagram. (The isodensa taken with the density-values of water, resp. proton may be called water, resp. proton isodensa) (Fig. 3).

The intersection of strip A with the proton isodensa produces the space and time parameters of proton (10^{-13} cm, resp. 10^{-23} sec).

Table III

Typical density-values in physics, planetology and astronomy

Density of the atoms: $2.7 \frac{g}{cm^3}$ (H) — $26.52 \frac{g}{cm^3}$ (U)

Atomic density of the elements: $0.07 \frac{g}{cm^3}$ (H, -253 °K) — $22.5 \frac{g}{cm^3}$ (Os)

Average density of the Earth-surface: $2.0-2.8 \frac{g}{cm^3}$

Average density of the Earth: $5.52 \frac{g}{cm^3}$

Density of the Planets: $0.7 \frac{g}{cm^3}$ (Saturn) — $5.52 \frac{g}{cm^3}$ (Earth)

Density of the Sun: $1.41 \frac{g}{cm^3}$

Density of the Stars:

main sequence stars (V) of the Hertzsprung-Russel diagram: $0.01 \frac{g}{cm^3}$ (O5) — $2.82 \frac{g}{cm^3}$ (MO)

(The young forms: giants, sub-, bright- and supergiants' densities are: $10^{-2} \frac{g}{cm^3}$ $-10^{-7} \frac{g}{cm^3}$

the white dwarfs are extremely dense objects $\varrho_{\text{dwarfs}} > 10^5 \frac{g}{cm^3}$; the neutron stars see later !)

Though only a few data were available it seems so that the (initial) section of the proton isodensa near the strip A is of similar importance as the initial section, resp. that falling between the $(A-B)$ and $(B-C)$ strips of the water isodensa. Namely, the space and time parameters of nuclear reactions fall to the orders of magnitude of 10^{-13} cm, resp. 10^{-23} to 10^{-21} sec. The prompt decomposition reactions of nuclei proceed during 10^{-22} to 10^{-21} sec. (The equation

$$t = R/v \tag{10}$$

can be applied to these processes where t is the duration of the process, $R = R_{\text{nucleus}}$, and $v = v_{\text{part.}} \sim 0.1\ c$). Nuclei excited by relatively less energy (<0.65 MeV) get an excited state (bound state) of longer duration. These processes will not be dealt with here [23, 24].

The space and time parameters of the so-called elementary resonances fall to the range of 10^{-13} cm, resp. 10^{-23} sec. The time value marked by the intersection of the proton isodensa with strip A corresponds to the time parameter of strong interactions, of the so-called rapid processes: 10^{-23} to 10^{-22} sec. This resembles to the relations of characteristic times of the strip A and water isodensa as well as of the electromagnetic interactions [21].

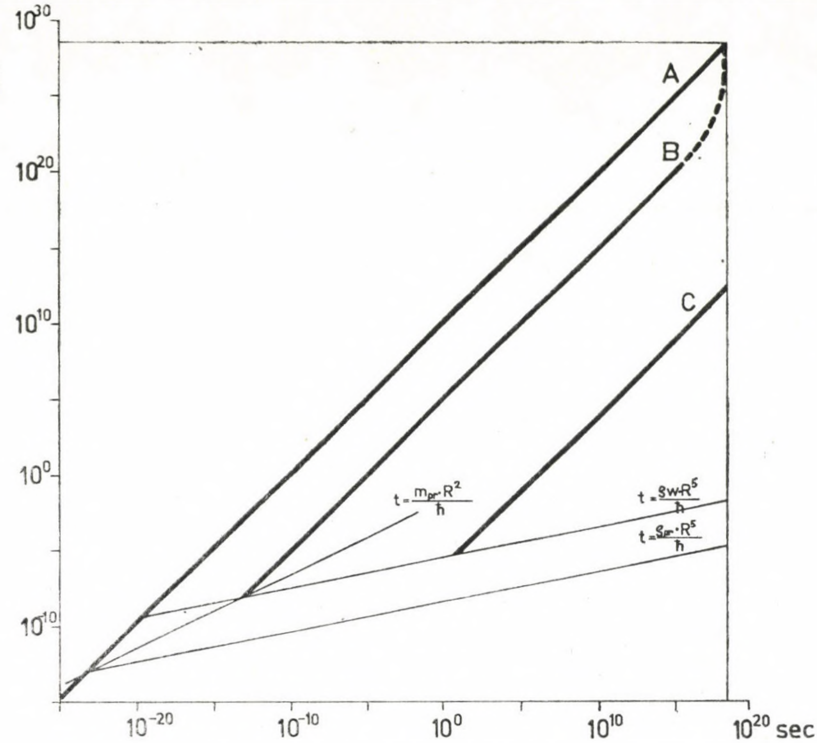

Fig. 3. **Bridges in the cyclicity diagram. (As a comparison in the diagram the isodensa drawn with the recent density-value of the Universe is also shown; which practically equals to the so-called critical density, i.e. $\varrho_{univ} = \varrho_{crit} \cong \cdot 10^{-30}$ g/cm³. The distance of isomasses from each other is 2 : 1)**

III

When taking the equation (1), resp. its form $t = \frac{mr^2}{\hbar}$ and calculations are made by means of $m = m_{proton}$ a transitional strip of tg $\alpha = 1/2$ rise will be obtained in the diagram (Fig. 3) which passes through the intersections of the proton isodensa with strip *A* (proton) as well as of the water isodensa with strip *B* (Hydrogen-atom). The bridges taken by such a constant mass are called isomass.

The feature of the proton isomass mentioned above seems to be trivial since the mass of the hydrogen-atom can be considered to be equal to the mass of the proton. The proton isomass, however, is of extraordinary significance: on one hand, it gives the regularity of changes of the space and time parameters of the particles possessing the proton mass, and by means of this it connects strip *A* and the proton isodensa, resp. strip *B* and the water isodensa, on the

other. (This relation is that of not only the proton—hydrogen-atom but in more general sense that of the nucleus — atom as it will be discussed in chapter V.)

IV

The three significant points of the diagram (i.e. proton, hydrogen-atom, minimal cell) can also be obtained by means of the following procedure:

As a consequence of equation (1) constant velocity will be obtained if the following condition is fulfilled:

$$v = r/t = \text{const.} \quad \text{if}$$

$$\frac{t}{r} \cdot \hbar = \frac{\hbar}{v} = \sqrt[3]{\frac{m^4}{\varrho}} = mr = \text{conts.} \tag{11}$$

In the Universe, however, this is usually not the case, but this shape of equation indicates three constants (because of the three real velocities of strips A, B and C) and which can be thus interpreted at three significant points of the cyclicity relation.

It is to be noted that the term mentioned above can be realized in case of electromagnetic waves, when $v = c$. In this case more interesting points will be obtained: the electron, the π-meson, etc. in the strip A close to the proton. Strip A:

$$\frac{\hbar}{v_A} = \frac{\hbar}{c} = k_A = 10^{-37}\,\text{g cm}. \tag{12}$$

(One has to remember:

$$E = mc^2 = h\nu = h\frac{c}{\lambda} \quad (3)$$

$$m\lambda = \frac{h}{c} = \frac{2\pi\hbar}{c}\Bigg).$$

It will be realized if

$$m = m_{\text{proton}} = 10^{-24}\,\text{g};\; r = r_{\text{proton}} = 10^{-13}\,\text{cm}.$$

Strip B:

$$\frac{\hbar}{v_B} = 10^{-32}\,\text{g cm} = k_B. \tag{13}$$

It will be realized if

$$m = m_{\text{H-atom}} = 10^{-24}\,\text{g};\; r = r_{\text{H-atom}} = 10^{-8}\,\text{cm}.$$

Strip C:

$$\frac{\hbar}{v_C} = 10^{-20}\,\mathrm{g\,cm} = k_C\,.$$

It will be realized if

$$m = m_{\mathrm{cell_{min}}} = 10^{-15}\ \mathrm{g};\ r = r_{\mathrm{cell_{min}}} = 10^{-5}\ \mathrm{cm}\,.$$

The mass of the smallest living cells is $5 \cdot 10^{-16}$ g, the mass of the hypothetical minimal cell of Morowitz is $6 \cdot 10^{-17}$ g; their diameters are 10^{-5} cm, resp. $5 \cdot 10^{-6}$ cm (16).

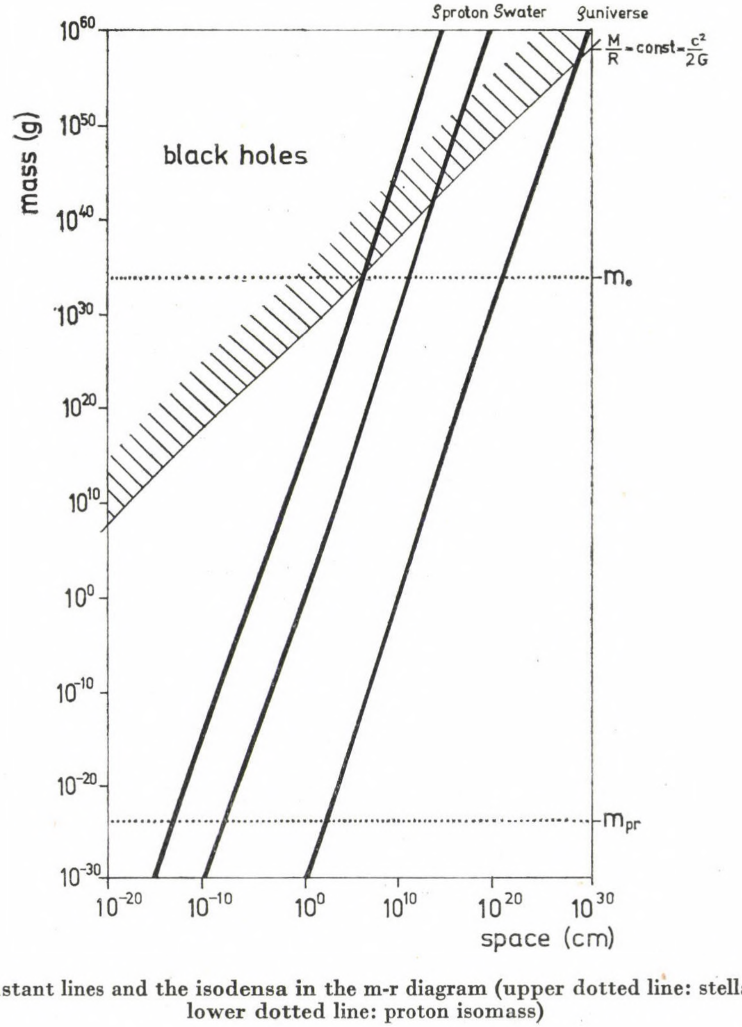

Fig. 4. Constant lines and the isodensa in the m-r diagram (upper dotted line: stellar isomass; lower dotted line: proton isomass)

In Figure 4 these points occur as the intersecting points of the lines of constants, i.e. of the proton and water isodensae (the thick dotted line is the recent density of the Universe, the thin dotted line represents the proton isomass) (Fig. 4).

V

Let us have some words on two interesting coincidences:

The mass of the Universe amounts to about 10^{81} proton masses, its average density is about 10^{-30} g/cm³, and its diameter is about $1.7 \cdot 10^{28}$ cm.

What would be the space parameter of the Universe if its average density would be equal to the proton density?

Cosmologists suggest a non-linear correlation between the space and time parameters of expansion. If it is supposed, however, that the strip *A* points out the history of the expanding Universe and the distance value is assigned to strip *A* (when $\varrho_{\text{Universe}} = \varrho_{\text{proton}}$) and the corresponding time parameter, resp. space parameter are required. these parameters will be about 10^{13} to 10^{14} cm

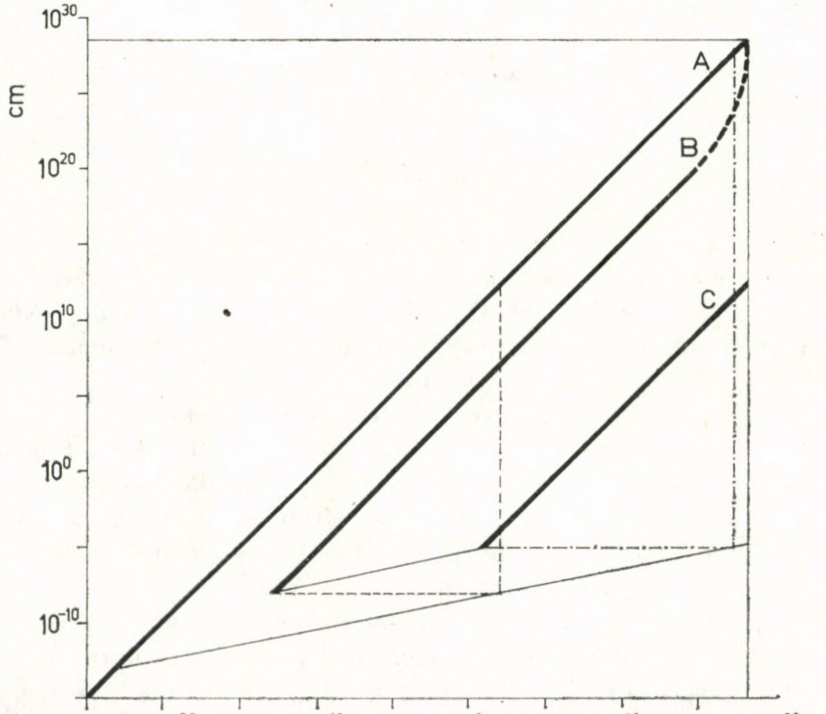

Fig. 5. Diagram and space-data of the hydrogen-atom and of the minimal-cell (Pecked line denotes the hydrogen-atom, pecked-dotted line the minimal-cell)

resp. about 10^3 seconds. Taking the intersection point of this line and of the proton isodensa a space value of 1 to 2 Å units will be obtained: a typical parameter, of the hydrogen-atom and of other atoms! It is unlikely an accidental coincidence.

The possible interpretation is as follows: when the expanding Universe reached the density of proton, it indicates a typical distance which lies close to the diameter of the Hydrogen-atom and of other atoms.

Developing this idea, an interesting relation will be obtained. Let us determine what may denote the time value in the diagram when the first living systems known so far were developed. This took place about 3.5 to 4 billion years ago which corresponds to $2.5 \cdot 10^{17}$ sec in the time scale of the Universe. In the diagram the intersection point of the corresponding "time-line" (Fig. 5 pecked-dotted line) marks the distance value of 10^{-5} cm. This, however, equals to the space parameter of the intersection point of the strip C and of the water isodensa, i.e. to the diameter of the smallest living cell!

The first developed co-acervate cells and protocells may have been of this diameter.

On the basis of our recent knowledge this coincidence can be regarded accidental in contrast to the previous one since it is not probable that the first developing cells would have had any idea about the structure of the Universe. Nevertheless, both coincidences are worth of attention and further studies (Fig. 5).

VI

In the diagram of the Universal Cyclicity Relation the demand of an isomass similar to the proton isomass emerges, in connection with the stars. The mass of stars varies within two orders of magnitude by a fair approximation $M_\odot \pm 1$ order of magnitude ($10^{33\pm1}$ g). The corresponding isomass (Fig. 4) is the "life-line" describing the evolution of the stars.

In general, during their evolution the stars are shrunken from a very diluted large-volume into a dense small-volume body (this is the typical case but other possibilities also exist). Their density may increase from $\varrho = 10^{-7}$ g/cm^3 up to 10^{15} g/cm^3, their radii decrease within the orders of magnitude of 10^{13} cm to 10^6 cm and during this process their mass remains essentially constant.

The question arises whether time parameters may be assigned to these data, resp. the $M = 10^{33}$ g isomass shown in Fig. 4 may be drawn in the diagram of the universal cyclicity similarly to the proton isomass. When substituting the known mass, density and space parameters in the equation (1), extreme high values will be obtained which can not be interpreted though the stars and astronomic objects ought to be located in the space-time diagram.

Taking into account the parameters being characteristic of certain stars, however, the idea is forwarded that analogously to the PLANCK-constant, a "star-evolution constant" of the same dimension may exist. This can be called "Stellar Evolution Constant" and can be marked with J. Assuming a consequent analogy it can be calculated as follows:

in case of proton:

$$\hbar \left(= \frac{\varrho r^5}{t} = \frac{mr^2}{t} = mrc\right) = \frac{\varrho_{pr} r_{pr}^5}{t_{pr}} = \frac{m_{pr} r_{pr}^2}{t_{pr}} = m_{pr} r_{pr} c \tag{15}$$

in case of a neutron star of proton density and before gravitational collapse:

$$J = \frac{\varrho r^5}{t} = \frac{mr^2}{t} = mrc \tag{16}$$

where t denotes the smallest time value which can be assigned to the neutron star, i.e. the duration during which the beam of light passes the distance corresponding to the half of the star's diameter: $t = r/c$; or t may be the shortest rotation time, too. The reason of these rough simplifications is one of the basic principles of the Universal Cyclicity Relation: when computing the relations in the large-scale Universe no special attention is paid to the extreme mathematical accuracy. In the foregoing formula m denotes the mass of the star, r is its characteristic space parameter (diameter or radius), ϱ refers to the density, while v is the characteristic possible greatest velocity of the star, in our case $v \to c$.

In this case the value of the constant:

$$J \sim 10^{50} \text{ g cm}^2 \text{ sec}^{-1}. \tag{17}$$

If somebody wants to compute this value for a highly evoluted star of atomic density, analogously for an atom:

to the atom: $\hbar = mrv$ (see (4))

to the star: $J = mrv$, (see (16))

where in addition to the m mass and r space parameter, be v the rotation velocity characteristic of a star.

In case of a typical star, i.e. of the Sun:

$$J \sim 10^{50} \text{ g cm}^2/\text{sec}.$$

On the basis of other considerations a constant value of $J \sim 10^{50}$ g cm^2 sec^{-1} will be obtained.[1]

The *star-isomass* taken with this constant is interpreted between strips *A* and *B* of the universal cyclicity diagram. (This isomass corresponds to the star-isomass of Fig. 4) (Fig. 6).

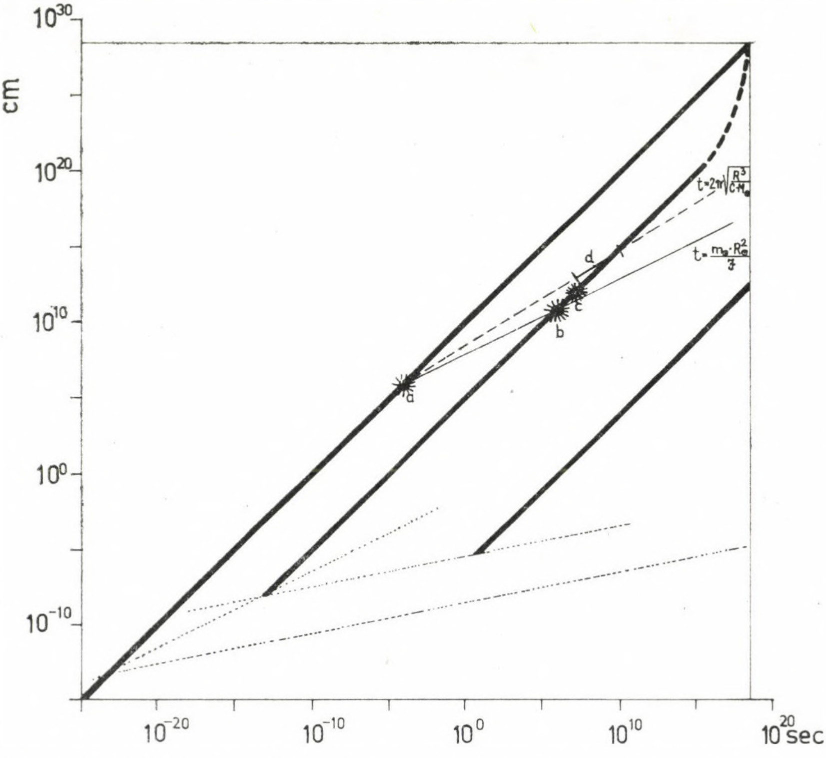

Fig. 6. **Transitional bridges of the universal cyclicity diagram and the stellar isomass. Signs: a = smallest neutron star; b = typical evoluted star-form; c = the Sun; d = the planetar system**

By means of the equation above a relationship of general validity was obtained to compute the space-time-mass-density-(rotation)velocity parameters of stars and other astronomic objects.

In connection with this relationship several interesting ones are referred to:

[1] See also the calculations of OSTRIKER J. P. in his paper: "White Dwarfs" (in: H. CHIU: Stellar Evolution, MIT, 1972 [22]), (where $J = 10^{49}-10^{50}$ gcm^2/sec, the Total Angular Momentum).

On the basis of the SCHWARTZSCHILD-formula the characteristic space parameter of the smallest neutron star is:

$$R = \frac{2MG}{c^2} = 10^6 \text{ cm.} \tag{18}$$

After the above formula, too:

$$r = J/mc = 10^6 \text{ cm.} \tag{19}$$

In the diagram the intersection point of strip A and of the star-isomass corresponds to this which marks the coordinates of a typical neutron star (just before the gravitational collapse), (point a (10^6 cm, 10^{-4} sec). (On the other hand, the relationship above and the previous relations suggest further relations between J (thus probably $\hbar$), the $m_{\text{astronomic}}$, the c and the G values !)

The intersection point of strip B with the stellar isomass mark the space and time parameters of a developed typical star (in the figure point c, 10^{12} cm, 10^7 sec).

Or in case of the Sun:

$$t = \frac{m_\odot r_\odot^2}{J} = 25.5 \text{ days} = t_{\text{rot}\odot} \tag{20}$$

(in the figure point b: 10^{11} cm, 10^6 sec).

VII

Summary and Conclusions

1. In the diagram of space and time of the Universal Cyclicity Relation density- and mass values can also be indicated.

2. In the Universe there are two typical density-values (ϱ_{proton}, ϱ_{atom}) and these correspond in the diagram to two fairly interpretable bridges (isodensa).

To describe the isodensa the formula $t = \dfrac{\varrho r^5}{\hbar}$ is suitable.

3. Similarly to the isodensa, isomass curves taken with the same density can also be drawn in the diagram and to describe these the formula $t = \dfrac{mr^2}{\hbar}$ is suitable. Out of the isomasses that of the proton is of special significance.

4. Isodensa mentioned above (resp. relationships) can be relatively fairly interpreted in the space-time range investigated so far.

The so-called water-isodensa (which may be called atom-isodensa, too, since it has be calculated from the density, values of atoms) interprets the processes proceeding in the atomic orbits (molecular orbits; e.g. excitation, revolution of the electron around the nucleus, reactions, bonds, phenomena proceeding in molecular orbits (biology !), etc.).

The so-called proton-isodensa (which may be called also nucleus-isodensa since computation is carried out by densities of nucleus) comprises the phenomena proceeding in the nucleus orbit (nuclear reactions, nuclear fission, excitation, etc.). The interpretation of this is a further task. The proton isomass shows the relationships of the space-time parameters of phenomena proceeding in the atomic and nuclear orbits.

5. The diagram of the universal cyclicity of E. SZÁDECZKY-KARDOSS is really the space-time diagram of the Universe. The bridges carry asymmetry into the symmetric system of the main strips of the diagram (i.e. these describe the scale-dependence of the Universe).

6. The cyclicity diagram supplemented with the bridges suggest a model to the evolution and structure of the Universe. The accurate and expressive elaboration of this, however, is the task of future.

7. As an analogy to the PLANCK--constant, a stellar evolution constant of the same dimension may also exist $\left(J = \frac{\varrho r^5}{t} = \frac{mr^2}{t} = mrc \sim 10^{50}\,\mathrm{g\,cm^2/sec}\right)$. This provides the relationship of the space-time-mass-density-rotation-velocity parameters of the stars and other celestial bodies. This relation corresponds to the notion of "total angular momentum" (OSTRIKER, 1972) known also in astronomy.

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ДОПОЛНИТЕЛЬНЫЕ МОСТЫ В УНИВЕРСАЛЬНОЙ СВЯЗИ ЦИКЛИЧНОСТИ

Б. ГУЛЯШ

Резюме

В диаграмме пространства и времени универсального закона цикличности можно установить мосты, представляющие собою постоянные густоту и массу. Эти мосты могут быть описаны в виде связи $t = mr^2/\hbar = \varrho r^5/\hbar$. Принимая во внимание два типичных значения густоты во вселенной ($\varrho_{\text{протон}}$, $\varrho_{\text{атом}}$) можно получить два довольно хорошо интерпретируемых моста, включающие в себя пространственно-временные связи процессов, происходящих частично на атомных (молекулярных) орбитах, частично же на орбитах атомных ядер.

Кроме полос **A**, **B**, **C** и **D** существуют также и мосты, характеризующие единичные реакции [1], представляющие собою цикличные и ритмичные движения в диаграмме универсального закона цикличности. Они располагают как точной математической формулировкой, так и физическим толкованием.

Эти мосты играют важную роль в интерпретации некоторых взаимосвязей закона цикличности.

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CLIMATIC CHANGE: A RATIONAL THEORY AND ITS HUMAN IMPLICATIONS

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Author postulated, that an Ice Age is caused by continental drift and plate tectonics which have resulted in highlands and large landmasses in polar and subpolar latitudes. These decrease global temperatures sufficiently for periodic variations in the Earth's orbital geometry to trigger off ice advances and retreats, the nature and extent of which depend on icesheet mechanics, the broad topography, and ocean temperatures.

Controversy over the causes of climatic change has raged for more than 300 years; the literature is enormous and the causes suggested vary with the scientific knowledge of the day. In 1842 J. F. ADHÉMAR of Paris used variations in the Earth's orbital geometry as the main cause of an Ice Age and in 1873 JAMES CROLL in his *Climate and Time in their Geological Relations* extended this theory. During this period CHARLES LYELL in his *Principles of Geology* used a uniformitarian approach and explained climatic change by changes in the latitudinal distribution of land and sea (Fig. 1).

In the early twentieth century there was a great outburst of meteorological suggestions concerning climatic change. Among the general works were *Die Klimate der geologischen Vorzeit* (1924) by W. KÖPPEN and A. WEGENER, *Climate Through the Ages* (1926. 2nd ed. 1949) by C. E. P. BROOKS and various accounts by MILUTIN MILANKOVITCH of the temperature effect on the global atmosphere of variations in the orbital geometry of the Earth [1]. These partly or largely theoretical expositions were aided by the publication of detailed field studies such as those by A. PENCK and E. BRÜCKNER in the Alps (*Die Alpen im Eiszeitalter*. 3 Vols. Leipzig, 1901–1909).

Recent decades have brought more elaborate methods of field research and analysis including isotopic dating of various kinds, palaeomagnetic measurements, and boring for cores in ocean-floor deposits and ice-caps. These scientific advances have made the problem of climate change more complex and have involved research scholars in so many branches of science that an International Quaternary Association (INQUA) has been formed and the formulation of a generally acceptable solution to the cause of climatic change seems more and more remote.

The difficulty of proposing a reasonably adequate solution may be seen in the major works published since 1950 on the Pleistocene climatic changes.

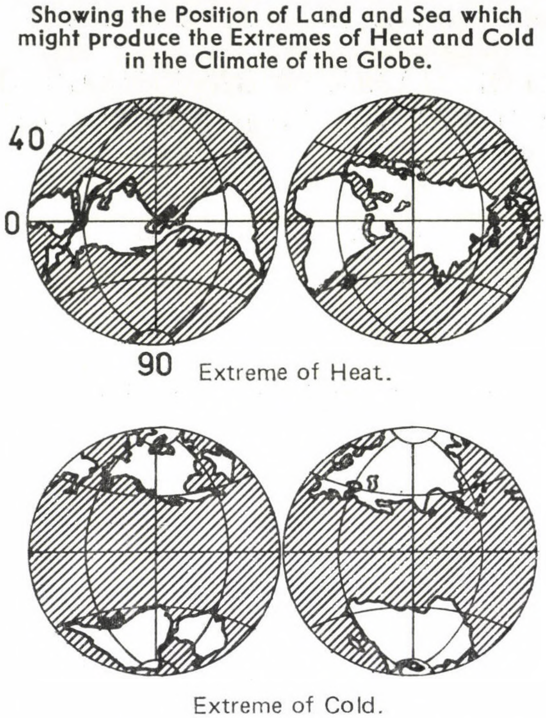

Fig. 1. **Popular explanation of hot and cold climates on continents, based on lateral shift of landmasses (LYELL, 1872)**

Several authors postulate a solar-topographic or solar-relief concept based on decreased solar radiation and the presence of extensive highlands or a configuration of land and sea favourable for the formation of ice sheets [2]. Some authors avoid generaliting on broad causes and confine their conclusion to the last cold period on which most evidence is available [3].

Much of the vast modern literature on climatic change uses a wide variety of field evidence on the local environment (paleoecology or paleogeography) to deduce and compile climatic maps of the more recent Quaternary phases. For example, analyses of ocean-floor sediment cores are used to deduce isothermal maps of North Atlantic surface waters [4] Or to take another example. the geographical distribution of ice-wedge polygons, pingos, fossil soil involutions and other periglacial phenomena is used to deduce the minimum drop in mean annual air temperatures [5]. The CLIMAPROJECT aims at reproducing graphically "The surface of the ice-age earth" [6], and meteorologists hope that eventually "synchronous pictures of the climate of the whole world at selected epochs in the past" may be available (J. S. SAWYER, in ref. 4, 105, 1977.). The broad meteorological view has been recently summarized by B. J.

MASON who deals also with numerical modelling of climate and possible perturbations of climate [7].

Recent advances in geophysics and geology have made the compilation of maps of global paleogeography less inexact although such maps are far from perfect for most periods in the past. Geologists have shown that continents move long distances, sometimes in unpredictable directions, that ocean basins expand on each side of medial submarine ridges and that the collision of crustal plates may create great mountain ranges as well as great oceanic deeps. This fluid crustal state may well cause meteorologists to hesitate before compiling paleoclimatic maps for some geological periods. But plate tectonics with continental drift and ocean-floor spreading may help geologists to explain broad paleoclimatic changes and some other environmental changes exhibited in geological phenomena. Both meteorologists and geologists will benefit from the notable efforts now being made to assess and map the former relative positions of the continents (paleocontinental maps) [8]. Once some agreement is reached on the global positions of the continents paleoclimatologists and paleogeographers will superimpose other geographical details with more confidence.

Probably for the first time broad climatic change can be satisfactorily explained in a purely geological way such as was attempted by CHARLES LYELL a century ago. When migratory landmasses congregate in polar and subpolar latitudes the world climate becomes cool; when there is a great preponderance of land in tropical and subtropical latitudes global climates tend to be warm. Surely the time has come when geologists can accept the contention that the onset of the Pleistocene climatic change was due to the movement of continental masses into polar and subpolar latitudes and to the elevation of high mountain ranges associated with those crustal tectonics.

But whereas the general lowering of global climate can be attributed to this cause, it cannot explain the short-termchanges of climate, with ice-advances and retreats, that occurred during the Pleistocene and have been studied in detail for the Quaternary. Although much mountain building has taken place in the last three million years the extent of continental drift must be small, and repetitive short-term changes of global climate cannot be attributed directly to any form of plate tectonics. The postulated causes of climatic change other than continental drift must now be discussed.

Possible Causes of Climatic Change

More than 20 main causes for climatic change have been postulated. Six of these deal with changes in the quantity or/and quality of solar emission or radiation. All lack observational testing and a satisfactory causal correlation with surface climate and weather phenomena. In practice solar radiation changes seem to be very small and it seems best to regard solar emission as reasonably constant.

Four other main theories are based on variations in the transparency of the atmosphere due to one or more of the following:

variations in the carbon dioxide content of the atmosphere;

the presence of volcanic aerosols or dust;

variations in the ozone layer; and

variations in the water vapour content of the atmosphere.

The author has already argued that none of these could account for a major change of climate such as occurred during the Pleistocene [10]. It seems reasonable to regard the atmosphere as a self-regulating mechanism insulated by the ozone layer from fluctuations in solar emission; and consisting of complex circulations that fluctuate in extent but cannot in themselves generate climatic change.

We come now to

Theories Based on Changes in the Earth's Geometry

Today many variables in the Earth's orbital geometry are recognized but by far the three chief are

(1) the eccentricity of the Earth's orbit, with a periodicity of about 96 800 years and a mainly tropical effect on the Earth's temperature system.

(2) the precession of the Equinoxes, with a periodicity of about 21 000 years (Fig. 2); and

(3) variations in the obliquity of the plane of the ecliptic, with a significant periodicity of about 40 000 years and a strongly polar climatic effect. Today the obliquity is about 23 1/2° but in the past it has changed periodically about 1° each way.

Their combined effect was calculated by M. MILANKOVITCH and has been recalculated many times since [11]. Most meteorologists have long agreed that the direct effect on global temperatures would be small (of the order of 1° or 2° C) and in themselves could not cause a major change in global climate. In warm periods of geologic history they are not significant; in cool periods they may trigger off the expansion of snow cover and ice (Fig. 3). In 1976 B. J. MASON considered the orbital-induced "variations in isolation, producing temperature changes of 4—5 deg C could well be responsible for initiating the advance and retreat of the ice sheets" (op. cit., 486). For lands poleward of 45°N the maximum of ice cover was nearly coincidental with the minimum of insolation or received radiation at intervals of 40 000 years (Fig. 4). Similarly the last maximum of obliquity of the Earth's axes and maximum insolation in high latitudes coincided closely with the last main ice-retreat about 10 000 BP.

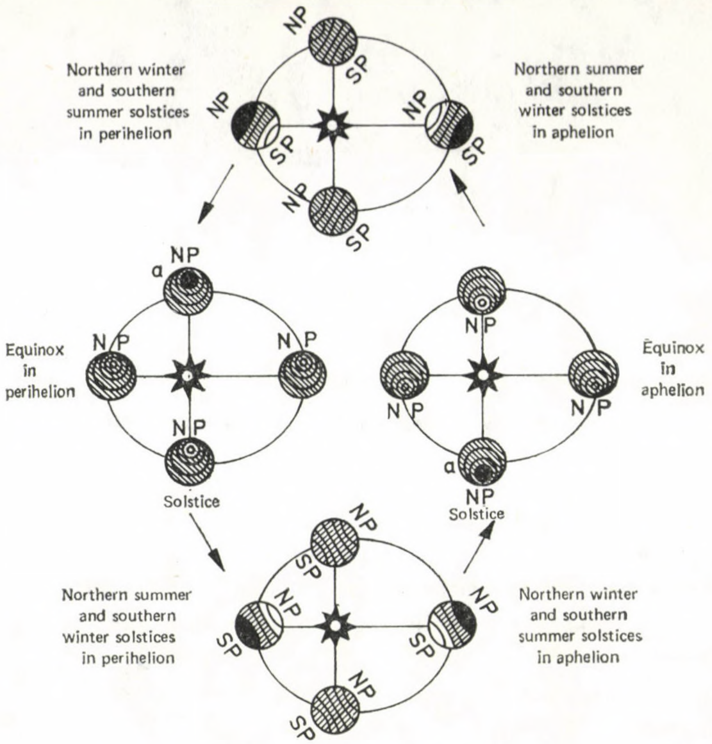

Fig. 2. **Diagram to illustrate the precession of the equinoxes (LYELL, 1872). Here the difference between aphelion (152 million km) and perihelion (147 million km) is greatly exaggerated. This exaggeration still persists in modern textbooks**

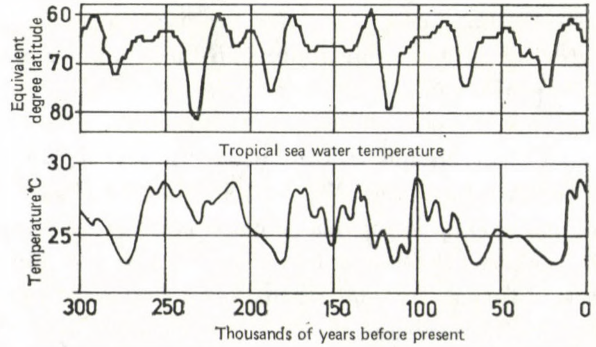

Fig. 3. **Curves of summer solar radiation at 65° N. latitude and of tropical sea-water temperature. The solar radiation is expressed as apparent shifts in latitude; thus a poleward extension of the curve indicates a relative drop in summer solar radiation to the amount experienced today at the latitude indicated (after EMILIANI (1958) and WOERKOM)**

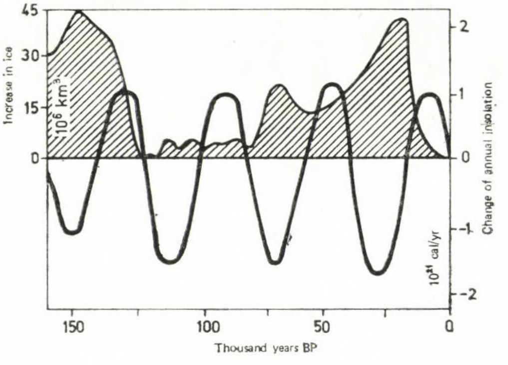

Fig. 4. **Changes in global ice cover and total annual insolation or radiation in latitudes 45°—90° N during the last 150000 years. Line O—O represents present values. The radiation curve is the mean of values given by MILANKOVITCH and VERNEKAR. After MASON (1976)**

It is interesting to notice that in 1957 C. EMILIANI and J. GEISS devised an elaborate climatic-change theory based mainly on topographic uplift and the temperature effects of variations in the Earth's orbital geometry coupled with a varying heat exchange between the oceans and continental ice sheets and with certain retardation or time-lag surface effects such as ice-cap plasticity, crustal warping and so on [12]. This ingenious hypothesis serves to remind us that climatic change is imposed on an Earth with a varied and changeable surface geography.

We will now turn to theories of climatic change based mainly on

Changes in Terrestrial Geography or Paleogeography

These are excessively complex as combinations, known and possible, of changes in the horizontal and vertical pattern of paleogeography are numerous. Continental continuity giving continental climates with abnormal winter cold in high latitudes has been postulated. A rival popular concept based on orogenic uplift during catastrophic mountain-building periods has now been largely replaced by prolonged orogenesis associated with slow crustal plate movements. As already noted many geologists combine the effects of orogenesis in high latitudes with some change in insolation due either to variations in solar emission and/or to periodic changes in the Earth's orbital geometry.

One geological theory is especially controversial unless linked with continental drift. It concerns the concept of a shift in the position of the pole. This theory takes several forms. In 1908 H. SIMROTH postulated a "pendulum oscillation" of the Poles with resultant changes in the oceans and in global climates. Fifty years later M. EWING and W. DONN formulated a theory of ice-advances and -retreats in the Pleistocene and suggested that the Quaternary began when the Poles moved to their present positions [13].

Polar wandering during the last few million years remains a problem, especially if Antarctic ice sheets are involved. Sea-level would be affected. The concept that if the Earth developed surface imbalance shifting of the Pole would result lacks of empirical proof or disproof. Recently an attempt has been made to relate possible Pole movement to the height of old shorelines to try to find some meaningful correlation between the two [14]. In this article it was assumed that as pole slippage occurs "the geographical point where the meridians converge spirals away from the axis, circuiting it with each daily rotation of the Earth" (p. 18). This geophysical problem excites mathematicians but at present it must be placed in a non-proven category.

At least two other phenomena of terrestrial geography are being increasingly incorporated into theories of the cause of climatic change in the Quaternary. Ice surges in Antarctica, especially western Antarctica, have attracted a growing literature, both concerning temperature change and sea-level variations [15]. Secondly, some theories incorporate ideas on the climatic effects of heat storage in the oceans. Recently variations in the meridional heat transport of the oceans has been used to devise a mechanism to explain the alternate advance and retreat of the global ice cover [16]. The suggestion is that during ice sheet advances the ocean warms up and eventually terminates the glacial phase; during interglacials the oceans cool slowly and eventually further glaciation occurs. But it seems that the mechanism is in all senses secondary and depends for its onset upon a primary factor.

Before discussing the last Ice Age (Pleistocene/Quaternary) it seems desirable to glance at the *Permo-Carboniferous Ice Age* and the possible climatic trends in global temperatures *since then*. Geological evidence points to the following sequence:

1. In Permo-Carboniferous times a great glaciation occurred in what was apparently a vast Antarctic polar continent. This glaciation lasted at least from Lower Carboniferous to Lower Permian times or 80 to over 100 million years.

2. Since early Cretaceous times or in the last 150 million years Gondwana or Pangaea has split up and the continental blocks on crustal plates have moved apart in various directions.

3. Associated with these crustal movements there was extensive and prolonged orogenesis at convergent plate margins.

4. Throughout Tertiary times there appears to have been a gradual decrease in global temperatures.

5. In late Miocene and during the Pliocene and the early Pleistocene periods glaciations occurred in Antarctica.

6. Eventually and relatively suddenly extensive glaciation occurred in highlands in subpolar regions in the Arctic of the northern hemisphere. The Quaternary proper may now be said to have begun.

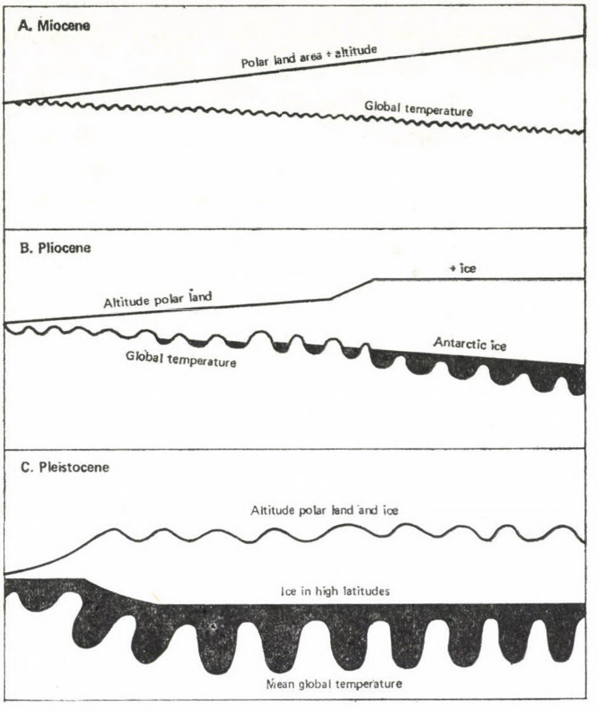

Fig. 5. **General scheme for the geological lowering of global air temperatures and their response to orbital temperature influences. In the bottom diagram an approximate time-scale would be 20 million years for *A*, 10 million years for *B*, and 2 million years for *C*. The glacial advances shown are entirely schematic. A more realistic and detailed time-scale for the late Quaternary changes is shown in Figs 3 & 4. Shading denotes persistent ice cover**

If these broad contentions are accepted we can explain on solely geological grounds the decrease of global atmospheric temperature sufficient to allow the temperature effect of changes in the Earth's orbital geometry to trigger off extensive glaciation in the northern hemisphere (Fig. 5). The gradual drift of the Antarctica block into a south polar position and the uplift of mountains at its edge caused extensive glaciations there which would lower global temperatures. No doubt many complicated changes in the paleogeography of that continent took place but eventually it was elevated and buckled sufficiently at its periphery to permit the accumulation of a deep ice-basin or ice-cup. With the development of a lofty and thick ice-cap the atmospheric chill of Antarctica becomes a virtually permanent factor in subsequent climatic change.

The distinction between a *glaciophile* and *glaciophobe topography* is important. The glaciophile topography allows the weight of the ice to depress the base of the ice sheet to a low level or even below sea-level while the mountain rim of the landmass retains the ice in the basin so that the ice accumulates to a great depth before overflowing the rim or discharging as broad ice-tongues or

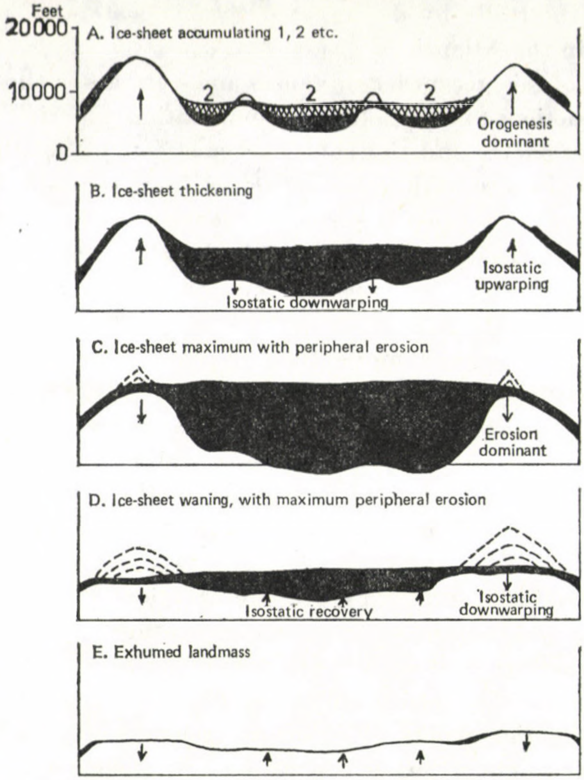

Fig. 6. Diagram of possible ice-advance and -retreat in a polar glaciophile topography. In *C* and *D* prolonged erosion breaches and lowers the peripheral mountains so facilitating ice-drainage and the reduction of altitude and concavity. Time- scale of the order of over 1 million years

glaciers through the rim. This condition is very different from that of a glaciophobe topography with dome-shaped relief from which ice sheets expand freely outward from high-level snow accumulation regions (Fig. 6).

Glaciations during the Quaternary

Let us take the last main glacial period, or the best investigated period of the Quaternary. It is characterized by glacial advances and retreats during interstadials and so-called interglacials.

Periodic insolation changes due to changes in the Earth's orbital geometry will persist. Some of these will affect more strongly the northern and southern hemisphere alternately but owing to the persistency of the chill of the Antarctica ice-cup their direct effect will be greatest in the northern hemisphere.

But Antarctica is not a constant factor. Its ice sheet-advances and -retreats mainly over the ocean. It must have some sort of expansion regime and it is connected thermally by deep-seated oceanic waters to north sub polar regions at least in the Atlantic.

As a result of this, recent ice-advances and -retreats in the northern hemisphere are the reactions to a complicated combination of periodic changes in the Earth's orbital geometry and the cold storage effects of an Antarctic regime, coupled presumably also with some influence from Greenland and the heat storage capacity of the oceans. It seems irrational to expect a simple temperature response to orbital influences during the Pleistocene because of the retardation effect of persistent ice-cups and the slow warmth mechanism of the oceans.

Assuming appreciable complications in the time scale and the degree of effect, let us study one ice advance and retreat in the northern hemisphere during what may be presumed to be a typical glacial period.

1. A cool phase in the Earth's orbital influence occurs, coincidental with weak or maybe with relatively strong Antarctic influence.

2. Snow accumulates and ice sheets gradually form and expand upon the snowier high-lands.

3. The new albedo, and temperature retardation of melting in the warmer season, cause a rapid drop in surface air temperatures.

4. The ice sheet heightens and expands under gravity flow.

5. At the same time sea-level drops.

6. Gradually the weight of ice causes isostatic depression beneath the ice sheets especially under the maximum ice-accumulation areas.

7. Eventually the expanded ice-sheet invades lower levels and lower latitudes at which its periphery thins and melts.

8. A warmer phase in the Earth's orbital influence causes the main ice sheet to retreat and thin or disappear on the highlands.

9. With the ice-retreat sea-level rises rapidly.

10. The glaciated landmass undergoes a slow isostatic recovery (Fig. 7).

The relative slowness of isostatic response compared with sea-level rise explains why an individual glacial advance and retreat is followed by or ends in a short relatively warm period. At the rapid rise in sea-level, the ocean covers a relatively large area of shallow coastal seas which provide relatively warm airmasses. Thereafter the landmass begins to rise and emerge as is happening today around the Baltic Sea and Hudson Bay. However, it must be stressed that it is unreasonable to expect a highland mass to recover the altitude it had before the ice-sheet formed upon it. The highland has been scraped clean of most loose surface material and compensatory isostatic rebound could only offset a fraction of this loss of surface height. In addition it is possible that regions peripheral to the main ice-accumulation region would rise slightly during glacial advances and perhaps sink slightly after ice-retreats in antiphase to the rise and fall beneath the centre of the ice-sheet. These considerations,

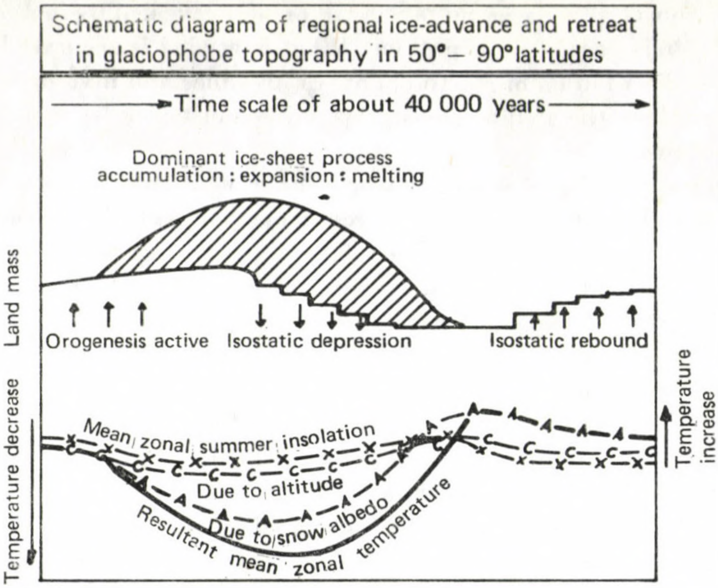

Fig. 7. Schematic diagram of single major ice-advance and -retreat in a glaciophobe topography in 50°—90° latitudes. The effect of altitude also includes increase of continentality. Shading denotes ice-sheet

however, are subsidiary to the important facts that the change from ice-or snow-cover to land cover causes a large sudden rise in temperature and that the land-sea distribution at the close of an ice-retreat will favour a relatively short-lived "warm" period.

So we postulate an Ice Age caused by continental drift and plate tectonics which have resulted in highlands and large landmasses in polar and subpolar latitudes. These decrease global temperatures sufficiently for periodic variations in the Earth's orbital geometry to trigger off ice-advances and -retreats, the nature and extent of which depend on ice-sheet mechanics, the broad topography, and ocean temperatures.

The Implications for Mankind

The following suggestions seem reasonable with regard to the prediction or forecasting of future climate in cool and cold areas.

1. The present fluctuations of climate with short cold spells and some hot dry spells are the complicated variations of very complex circulations in what is probably a cool interstadial. They might be regarded as the norm.

2. Any climatic change from cool to colder will be gradual until snow- and ice-cover begins to expand when the climate locally will deteriorate rapidly.

3. The onset of a glacial advance will be best revealed by increases in the extent and persistence of snow and ice. What is needed is accurate knowledge of the global distribution of ice and snow in nivolines and nivo-days. This has become possible with satellite photography but must also be observed in the southern oceans.

4. The possibility of a return to pre-Pliocene climates seems negligible. Greenland may be vulnerable but the great ice-cup of Antarctica seems beyond destruction on climatic grounds alone. These great ice-cups will persist until erosion of their peripheral mountain ramparts has lowered their surfaces almost to sea-level. This may mean also until erosion overcomes any effects of orogenesis due to crustal plate convergence; or until Antarctica (? or the pole) moves out of a polar continental position.

5. In any event the time-scale involved is of the order of tens of millions of years. The time-scale is geological or erosional and the Pleistocene or Quaternary might well persist for 50 million or 80 million years.

6. In the northern hemisphere individual ice-advances and- retreats are of the order of 20 000 and 40 000 years. If, as seems not improbable a main ice-advance occurs in 10 000 or 15 000 years hence it will be disastrous for most lands poleward of about 45° latitude North and South and those within about one thousand metres of the present permanent snowline. But it may well be beneficial climatically for lands nearer the tropics because of a slightly cooler climate and in all coastal states because of the exposure of shallow sub-marine coastal flats. The human need in subpolar civilizations is to conserve all natural fuels or to develop new power resources.

7. A problem with regard to the prediction of future climate in cool and cold regions is whether the present climate is considered to be an interstadial — or less cool phase in a glacial period — or the beginning of an interglacial or slightly warmer phase. Some scientists regard the present as an interglacial and predict an unusually long duration for what they describe as "the present interglacial period in the northern hemisphere" [17]. Their reasons are that the Earth is entering a 120 k a (120 000 year) long interval of exceptionally low orbital eccentricity during which summer insolation minima will be less extreme and that this condition coincides with "one of the quite infrequent and otherwise normally short Pleistocene interglacial periods when little continental ice is present" [17]. However, probably the majority of scientists would consider the present an interstadial because of the existence of vast ice-shelves at sea-level in the Arctic and Antarctic and the strength of the Greenland and South Polar ice-cups.

8. An interstadial would be slowly terminated by the onset of periglacial weather and the gradual re-appearance of ice sheets and permafrost in sub-polar regions. A developing interglacial period would presumably be accompanied by only a small rise in sea level because, as said, the great ice-cups of Ant-

arctica and Greenland seem largely indestructible. If a most unlikely catastrophe such as a large shift of Antarctica or of the poles caused those ice-cups to melt, sea level would rise by about 65 metres and nearly one third of the world's total population would be either displaced or defended by seawalls [18].

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РАЦИОНАЛЬНАЯ ТЕОРИЯ ОБ ИЗМЕНЕНИЯХ КЛИМАТА И СДЕЛАННЫЕ ВЫВОДЫ

Р. П. БЕКИНСЕЙЛ

Резюме

Автор выдвинул гипотезу оледения, вызванного миграцией материков и тектоникой плит, в результате которых на полярных и субполярных широтах формировались горные массивы и крупные материковые массы. В связи с этим произошло уменьшение глобальных температур до степени, достаточной для периодических изменений в орбитальной геометрии земного шара. Этим изменениями и были обусловлены продвижения вперед и отступления ледников, но характер и величина этих движений зависели от механики ледяных покровов, от топографической обстановки и от температур океанических вод.

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APPLICATION OF CYCLICITY AND RHYTHM IN EARTH STRUCTURAL RESEARCH

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Secular magnetic variations weaken and strengthen simultaneously on a global scale. The global validity of this variation can be demonstrated only in a suitable coordinate system since the data of observatories are valid only of the restricted neighbourhood of the observatories themselves. Thus, a coordinate system free of anthropogenic errors is needed.

On the occasion of previous Conferences on Material and Energy Flows I reported on a few results of research concerning the structure of the Earth and I pointed out that special human views developed owing to the continuous mutual interaction between man and nature as well as owing to the dimension of man may significantly mislead the research. We have known for ages that the Earth is spherical, nevertheless it, happens frequently that even during our scientific researches our considerations are fixed to two dimensional charts. We make correspondences, e.g. to the six big anomalies of the geoid figure, we assign six density inhomogeneities, since we have not even thought that these would be brought about by large-scale global anomalies reaching all points of the Earth's surface, so that we have to take into account the effect of the anomalies on the antipodal points, too. Thus, instead of a real interpretation of the globe we try to explain our observational results on sheets of charts and so we distort the material background of phenomena.

The same erroneous view point is represented in the investigation of secular magnetic variation by the method of which we try to draw conclusions concerning the physical features of the secular variation based on the pictures of the singular magnetic components. And the same is the case with the distribution or with the general properties of that variation. Namely, the phenomena are not produced within the singular components, but it is the total magnetic field vector which changes its direction and magnitude, and the decomposition into components and the representation on maps is only a technical necessity of measuring and representation.

Thus, the variation should not be represented by its singular components on maps, but rather we should look at the physical phenomena taking place in the interior of the Earth in a coordinate system valid for the whole Earth, if we want to get an answer of general validity for the questions rising during the research. Therefore, we have to be careful in defining our problems so that we could obtain the answer of the nature in an understandable manner and we should be able to minimize the pitfalls being inherent in anthropomorphic manner of thinking.

An ideal, fully objective thinking can be only approximated and it cannot be fully realized, since we are men and not ants with their fully mechanized way of thinking. But the recognition of the restrictions on our thinking due to our nature as human beings is already a great step forwards and the history of surmounting the delimitations is in reality the history of man's scientific development.

Phenomena of natural sciences take place in space and time; in the course of them one can encounter spatial and temporal repetitions, which can be called cycles and rhythms, respectively. In the system of mathematical notations these are generally expressed in the form of periodic functions. In order to eliminate the anthropomorphic errors of the research it is worthwhile to have recourse to these descriptions which reflect the nature based on observational data and perhaps the hidden connections of phenomena can be better revealed in this manner.

In the course of my investigations of more than three decades, I became first of all attentive to an oscillation with a period of half a century in the secular variation of the terrestrial magnetic field. The phenomenon could be well detected in the data series of various observatories, but no regularity valid for the entire Earth could be found. The difficulty — as stated later on — had been caused by the inaptitude of the coordinate system applied. The observatories namely are carrying out their magnetic measurements in the frame of their own coordinate systems (with axes towards N, E and in the vertical). These are valid of course only in the localities of observatories and data of observatories situated at great distances one from another cannot be compared (Fig. 1).

But if we look at the oscillation presenting itself in all components in a three-dimensional way, it becomes immediately obvious that this period will be brought about by a helical movement of the end-point of the magnetic vector carried out in the course of the secular variation. And if we study the phenomenon in a coordinate system determined by the space curve described by the end-point of the magnetic vectors of the various observatories (the axes of which are: the tangent, normal and binormal of the curve), we soon become aware of the general character of the phenomenon; the direction of circulation on the helix is clockwise and the secular magnetic variation is weakening and strengthening simultaneously on the whole Earth.

When applying the new coordinate system we could state — in addioton to the simple statement of the existence of a rhythm presenting itself in the various components — also the simultaneous weakening and strengthening of the secular magnetic variation on the whole Earth. The same period could be detected

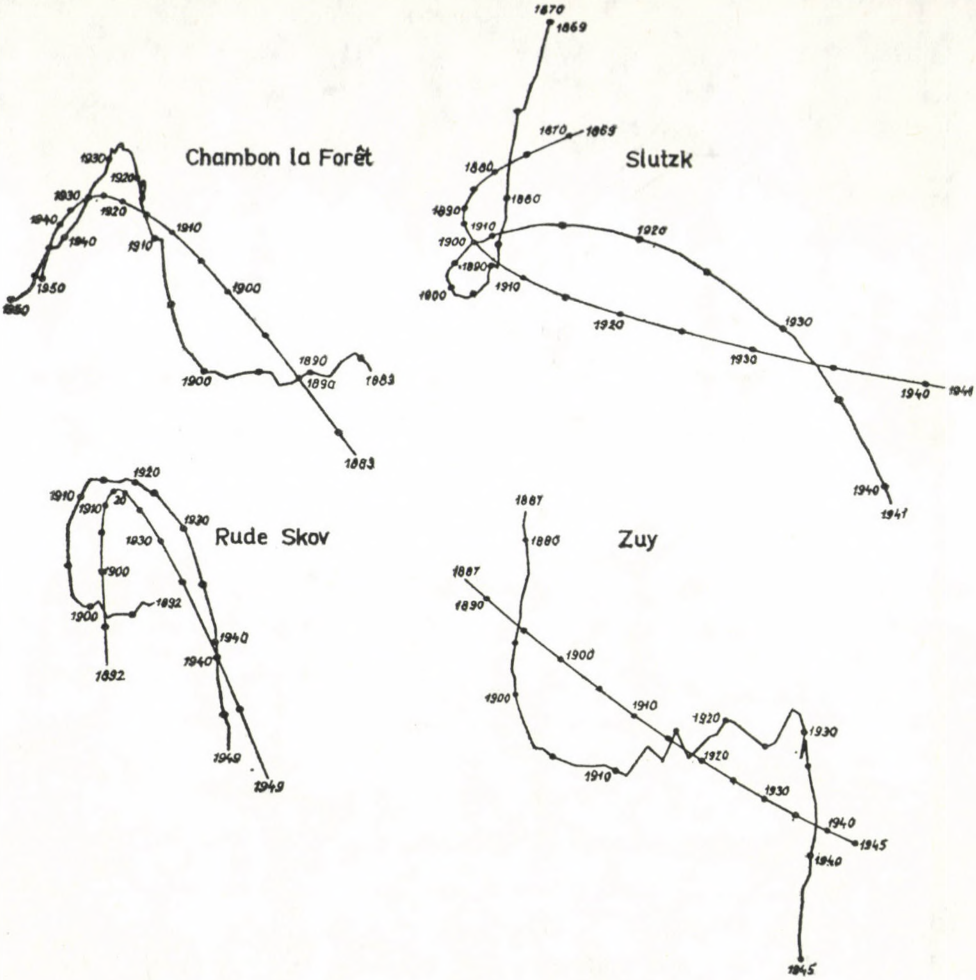


Fig. 1

also in the rotation phenomena of the globe (in the variation of the rotational speed and in the oscillation of the polar height), and we have here also phenomena valid for the whole of the Earth (Fig. 2). This coincidence of periods suggests the supposition that the secular variation of the terrestrial magnetic field might be connected with large-scale mass movements taking place in the Earth's interior.

If the half-a-century long rhythm of the secular magnetic variation while being only a partial phenomenon possesses features of such a general validity, then we must conclude that the entire variation be also an even more general phenomenon. Introducing a general coordinate system valid for the entire Earth, we are indeed able to detect that the magnetic secular variation has a

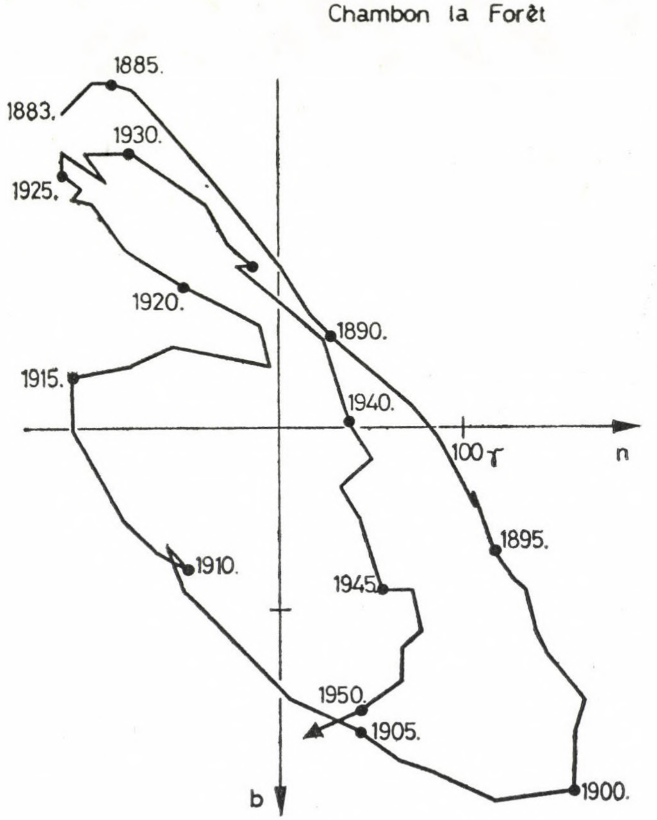


Fig. 2

high order symmetry around a point in India. It is remarkable that the magnetic dipole of the Earth is eccentric towards Australia and this dipole is drifting westwards, i.e. towards India in the course of the secular variation. By this the general consideration given above concerning a mass movement connected with the secular magnetic variation obtains a real meaning; namely, the eccentric inner core of the Earth is moving within the material of the outer core towards India bringing about flows there in the plasma-like material causing thus the secular magnetic variation (Fig. 3).

The shifting of the mass-asymmetry influences also the shape and processes of the Earth and the anomaly system of the geoidal figure consisting of 6 members is, as a matter of fact, due to two large-scale anomalies each of which deforming the whole body of the Earth. The geoidal anomalies of the temperate latitudes are consequences direct of these two anomalies. Thus, by separation of spatial cycles we are able to state the essentially simple physical background of an apparently complex anomaly system (Fig. 4).

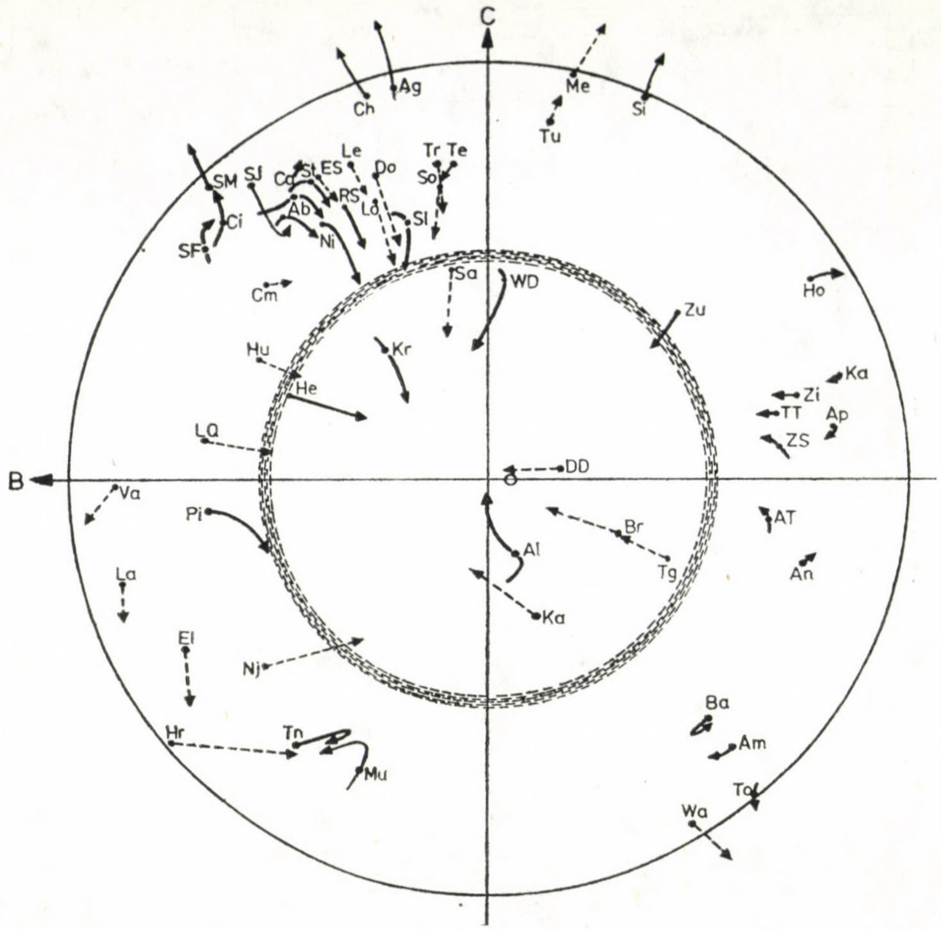
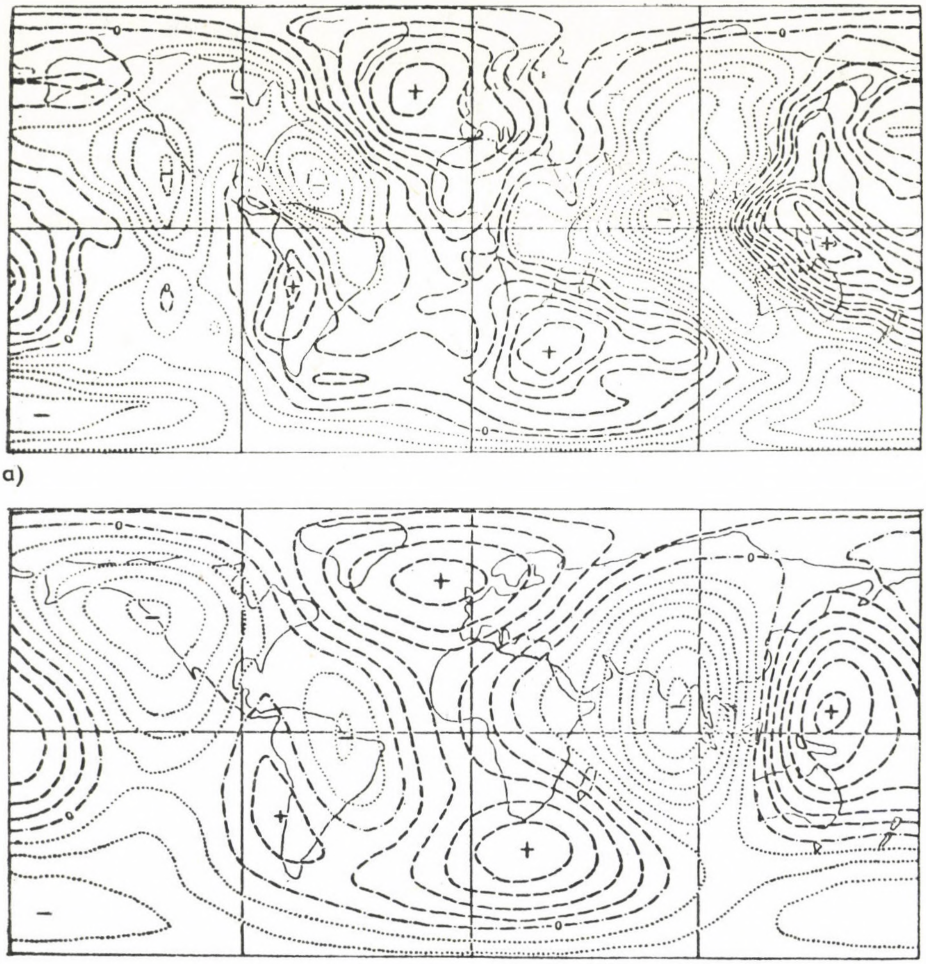


Fig. 3

Thus, we can see that in the course of the research interpretation can be based on the separation of cycles interconnected with and superposed on each other. A suitable choice of the coordinate system is of course an important basis of a fruitful research.

Our considerations have not been supported — of course — solely by the coincidence of periods, this having served only as a guide for starting and developing them. A powerful argument for the supposition can be taken, e.g. the fact that it provides a background in a uniform manner concerning both the structure of magnetic as well as gravity fields, pointing to the asymmetric structure of the Earth's core. It is also an essential argument of principle that the main forms of the geoidal figure represented on the charts could be computed by basing the calculation merely on the equatorial data system (i.e. on a



a)

b)

Fig. 4

data system taken along one single great circle). This argumentation is somewhat related to the proving method used frequently in scientific research, according to which a phenomenon forecast on the basis of a hypothesis will then be observed.

Our supposition is supported by a further series of formal arguments. The pointed end of the rotation-symmetric geoid anomaly on the Australian side is directed towards Australia on all the geoidal charts computed by any approximating method. If we compute the potential surface of a spherical mass having an asymmetric inner core of higher density, then the obtained (nearly elliptical) rotation-symmetic form has a pointed end in the direction of the asymmetry of the same directional features as the magnetic one.

The axes of positive and negative anomaly pairs of the temperate latitudes are converging towards N, indicating that the source of gravity anomalies is situated northward from the equatorial plane in the same manner as it is shown by magnetic measurements.

Also the explanation of special features of the individual fields becomes simpler on the basis of our considerations. By the application of rotation-symmetric anomalies of a general position the deviation of the forms of northern and southern hemispheres will disappear. In the same manner the polar flattening of the Earth of asymmetric structure is nearer to the state of hydrostatic equilibrium, than the central-symmetric one.

Thus, we can see that the confirming arguments present themselves in the form of mutual multiple correspondences, but the starting and directing idea is the agreement of periods and rhythms, in particular the possibility of attributing them to most simple physical facts. The dimensions of cycles and rhythms may be taken as characteristic of single science groups; the recognition of this fact may support individual research and can serve to eliminate restrictions posed by a possibly incorrect anthropomorphic viewpoint.

К ПРИМЕНЕНИЮ ЦИКЛИЧНОСТИ И РИТМОВ В ИССЛЕДОВАНИЯХ СТРУКТУРЫ ЗЕМЛИ

ДЬ. БАРТА

Резюме

Долговечные изменения магнитного поля представляют собою ослабления и усиливания, происходящие одновременно в глобальных масштабах. Справедливость этой закономерности в глобальных масштабах можно доказать графическим путем только при наличии соответствующей системы координат, так как данные обсерваторий справедливы только для ограниченного района, окружающего обсерваторию. Таким образом, необходимо иметь систему координат, лишеную антропогенных погрешностей.

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MASS AND ENERGY FLOW IN SOIL FORMATION

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Most of the substances and energy produced by living organism are stored in the soils. Annual climatic and biological cycles play an important part in soil formation. However, the period of the complete development of a soil profile is much longer, by about two orders of magnitude.

The bulk of the required energy is needed for biological, resp. biogeocenological processes. The main source of energy is solar irradiation, which is a function of climate.

An overwhelming part of the total mass of vegetation is represented by the roots.

The soil cover retains a number of vitally important elements, preventing their transportation into the ocean.

Human activity influences considerably the matter and energy exchange of soils. In the future, this should be done in a more conscious way, in view of environment protection. This scientific approach justifies a more detailed study of the cyclic processes.

The processes of soil formation take place in the thin upper layer of the Earth's crust. During these processes the crust undergoes substancial changes due to the activities of a great number of both biotical and non-biotical factors. In the course of above processes the complex effect of biological and non-biological factors develop the soil as a specific formation of nature.

The weathered rocks and sediments are the parent materials of soil formation, however, biological processes are essential when constituting soils jointly with abiotical factors.

In wider sense, including seashores also among the soil forming materials the advent of soil formation is quite close in time to the appearance of life in our Globe. As soon as life appeared on the Earth the biological processes resulted in products which are fundamental in the soil formation. Practically, the development of soils started with the beginning of life. Since then the biological processes have been in the closest connection with soil formation.

In the system of soil-living organisms the role of the soils is to supply the plants and certain micro-organisms with nutrient elements and water. This capability constitutes the fertility of soils. During the vegetation of plants a certain quality and quantity of substances and energy are transferred from the soil to the plant roots. Most part of the mass and energy which nurishes the whole living world after transformation are stored in the soil or on the surface of soils in plants and crops.

The soils themselves — in spite of their close relation with the biosphere — are regarded as non-living substances for the lack of significant peculiarities of living organisms (birth, death, growing, etc.). The soil together with living substances constitute a limited ecosystem, in which all the livings and soils have their own functions and correlations with the others. As a consequence, the soils and living organisms turn out to be in a close, mutual interaction during their processes of metabolism. It is clear that the possible destruction of either of them has a substantial influence on the other components of the ecosystem. In Table 1. the chemical composition of the litosphere and that of the soils are demonstrated (after VINOGRADOV).

It shows that the soils, which is partly a product of weathering of rocks, often reminds of the lithosphere as to its chemistry. Actually, soils contain more silicon and less sexquioxids, than rocks. However, concerning the carbon and nitrogen contents of soils the percentage of these elements are found to have surpassed those of the litosphere with at least one order of magnitude. This is one of the results of biological processes that plays an important role in soil formation. The biomassa in soils also explains this phenomenon. Though the content of inorganical substances in soils exceeds that of organic ones, still the latter ones are indispensable parts of soils.

In Table 2 the average chemistry of the atmosphere, hydrosphere, litosphere and some living organisms is demonstrated (after LOTKA).

The data of Table 2 show the differences between lito-, hydro- and atmosphere from one side and the living organisms from the other.

Comparing Table 1 and Table 2, it comes to light that soils, regarding their chemical composition, are in a transitional position between living and non-living world. Whenever the cyclicity of soil forming processes is studied

Table 1

Chemical composition of rocks and soils (VINOGRADOV, 1959)

Element	Rocks %	Soils %	Element	Rocks %	Soils %
O	47.2	49.0	C	(0.1)	2.0
Si	27.6	33.0	S	0.09	0.085
Al	8.8	7.13	Mn	0.09	0.085
Fe	5.1	3.8	P	0.08	0.08
Ca	3.6	1.37	N	0.01	0.1
Na	2.64	0.63	Cu	0.01	0.002
K	2.6	1.36	Zn	0.005	0.005
Mg	2.1	0.6	Co	0.003	0.008
Ti	0.6	0.46	N	0.0003	0.001
H	(0.15)	?	Mo	0.0003	0.0003

Table 2

The average chemistry of terrestrial matter, corn and human body

Chemical element	Average composition of terrestrial matter, in per cent, including atmosphere, litosphere and hydrosphere (the soil mass)	Average composition of a corn plant, in per cent (dry weight)	Average composition of the human body, in per cent (dry weight)
O	46.48	44.57	29.13
Si	27.60	1.17	0.00
Al	8.05	0.11	0.00
Fe	5.03	0.88	0.01
Ca	3.63	0.20	3.75
Na	2.72	0.10	0.40
K	2.56	0.92	0.90
Mg	2.07	0.18	0.10
H	0.145	6.26	8.40
Ti	0.696	0.00	0.00
Cl	0.095	0.14	0.40
P	0.152	0.18	2.50
C	0.149	43.70	45.00
Mn	0.116	0.00	0.00
S	0.100	0.17	0.60
F	0.030	....	0.14

these processes must be placed close to the living organisms. The same rule exists as to the situation of soils in the hierarchy of natural formations.

The periodicity of soil forming processes is similar to that of living substances. Evidently, a great part of potential energy in the soils is bound to lattic layers of soil minerals or other non-organic substances. The energy of hydratation plays a decisive role in this aspect.

In order to supply the plants with the necessary nutrient elements and with water the soil has to accumulate mass and energy through the photosynthetic processes of plants. As it is well-known plants are capable of the transformation of solar energy sintetizing carbohydrats. After the vegetation period a great part of the biomassa remains in the soil. The biological and non-biological transformations of plant tissues are followed by the formation of humus substances constituting the organic part of soils. Substantially, the mass and energy of this material are the sources of soil fertility. In Table 3 the organic matter content of different ecosystems is demonstrated.

Table 3 shows that a large quantity of humus can be found in the soils of different ecosystems, that surpasses with at least one order of magnitude that of overground phytomass.

Table 3

Organic matter content in different ecosystems, t/ha

Type	Overground phytomass	Humus
Coastal Marshes and terrestrial swamps	10—20	128
Tundra	3—10	320
Taiga	270	100
Grasslands	16	355

Table 4

Ratio of biomass of the overground parts of plants to the roots (V. A. KOVDA; I. SZABOLCS, 1971)

Vegetation	Ratio
Tundra	1 : 8, 1 : 6
Taiga	4 : 1
Forest steppe	3 : 1
Chernozem Grasslands	1 : 9
Association of chernozems and meadow soils	1 : 6
Solonetz soils	1 : 20

In Table 4 the ratio of the biomass of the overground parts of plants to the roots is demonstrated.

The data of Table 4 make it clear that in most ecosystems the ratio between the biomass of the overground parts of plants and that of the roots shift to the favour of the latter one.

The principles of soil science were described about a hundred years ago by DOKUCHAEV, who distinguished the major factors of soil formation as follows:

1. Parent material
2. Climate
3. Plants and other organisms
4. Relief
5. The age of soil

The five factors listed above play an equally important role in the development of soils. The mentioned factors cannot be substituted by one another. The principles described by DOKUCHAEV are basically true even at present. They can be applied for studies if investigating the mass and energy flow of soil formation.

Under the expression "parent material" those litological processes are understood which take part in the mass and energy system of soil forming processes. These effects are particularly due to the weathering of minerals and to the transport of weathering products as it was explained and illustrated previously in this paper. The effect of plants and other living materials are interpreted as the overall influence of biological processes in soil development.

Climate is a decisive factor in the formation of soils. It influences not only on the velocity of mass and energy flow but by determining the temperature and moisture regime it often has an effect on the soil forming process as well including its direction and design, too. When talking about climate it must be emphasized that the limit values of the temperature and moisture in soil formation are similar to those of life processes.

As a consequence of the fact that soil formation is going on at the surface of the Earth, topography exercises a great influence on this process. The shape of geomorphological patterns of the land determines the direction and velocity of the mass and energy flow not only on the surface but also in some upper layers of the soils. This is in full accordance with DOKUCHAEV's statements on the importance of topography.

The age of soils determines the time factor of soil formation processes. It is very difficult to ordinate exact figures as to the age of soils, but no difficulty arises when talking about the absolute age of soils. With the help of up-to-date methods (for instance with radiocarbon) it can be identified. It is much more difficult to determine the relative age of soils with more or less exact figures. The term "relative age" is ment for the sequence of the series of soil transformation.

The yearly cyclicity of climate plays a considerable role in soil formation as well as the cyclicity of biological processes. For the development of a soil profile even longer time is necessary than the changes of time interwalls of climatical and biological processes affecting on soils.

Table 5

Aridity — humidity conditions

Hydrothermical zone	Index	$K_n = \frac{\text{precipitation}}{\text{evaporation}}$
Extremely arid	A, AB	0.20
Arid	B, BC	0.20—0.40
Semi-arid	C, CD	0.40—0.75
Semi-humid	D, DE	0.75—1.20
Moderately humid	E, EF	1.20—1.95
Humid	F, FG	1.95—2.90
Extremely humid	G	2.90

Fig. 1. **Thermical belts and bioclimatical regions of the world. 1. Arctic; 2. Boreal; 3. Sub-Boreal, Humid; 4. Sub-Boreal, Semi-Arid; 5. Sub-Boreal, Arid; 6. Sub-Tropical, Humid; 7. Sub-Tropical, Semi-Arid; 8. Sub-Tropical, Arid; 9. Tropical, Humid; 10. Tropical, Semi-Arid; 11. Tropical, Arid; 12. Cryogen**

According to the above-described the climatical conditions expressively determine the mass and energy flow in soils. In Table 5 the different aridity-humidity conditions are reflected in different hydrothermal zones.

The K_n factor in Table 5 is named by VOLOBUYEV as aridity quotient that has a dominant influence on weathering and on soil-forming processes as well as on the ecosystem as a whole.

The global distribution of thermical belts and biochemical regions are reflected on Fig. 1.

The map of Figure 1 shows that the thermical and bioclimatical regions are characteristic of different parts of the continents. It can be concluded that the soil cover in the case of similar parent materials and other factors more or less corresponds to the belts and regions of this map.

Studying the various soil-plant ecosystems in different thermical and bioclimatical areas considerable differences are found between the climatical belts as is shown by the figures. The phytomass and territory of soil-plant ecosystems are demonstrated in Fig. 2 in different areas.

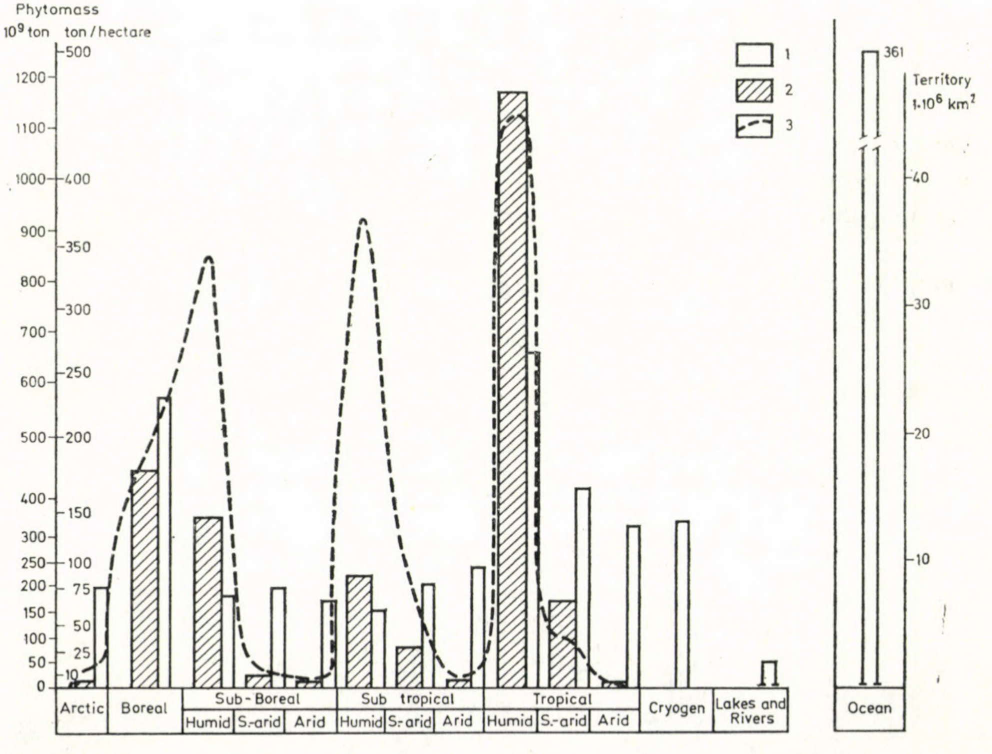

Fig. 2. Phytomass in ton and territory of soil-plant ecosystems in different thermical- and bioclimatical areas. 1. Territory in 10^9 km^2; 2. Phytomass in 10^9 ton; 3. Phytomass (ton/hectare)

Figure 2 demonstrates that in different ecosystems the amount of phytomass will be diverse. The figure shows the productivity of practically all climatical belts in comparison with the total bioproductivity of the Ocean. The produced phytomass in various ecosystems are in different proportion with the total radiation energy and with the moisture conditions during the vegetation period.

It is well known that the plants utilize only a part of the radiation energy even under optimal conditions. In Figure 3 the rate of exploitation of radiation energy in the ecosystems of Azerbaijan steppe is reflected (after VOLOBUYEV).

Fig. 3 demonstates that only a part of the solar energy is utilized, mainly in the vegetation period that is between March and August in the mentioned territory. A second peak of energy consumption can be found in November, December in spite of the low radiation mainly due to the increase in energy consumption during the soil biological processes.

The processes of soil formation and the mass and energy flow in soils are in a close relation with the respective values of the quantity and quality of the biomass. In Fig. 4 the schematical pattern of these interrelations is demonstrated.

Figure 4. gives a picture of the appearance of various soil associations remarkably dependent on the radiation balance of the surface, on one hand and on the quantity of energy consumed by soil forming processes on the other.

A great diversity can be found in the quantity of potential energy of various soils. This phenomenon is due to the different soil-forming processes associated with a certain pattern of mass and energy flow. In Fig. 5 the energy consumption in soil formation is demonstrated.

The data of Fig. 5 confirm the statements that the percentage of consumption of the total radiation energy in biological processes varies with the

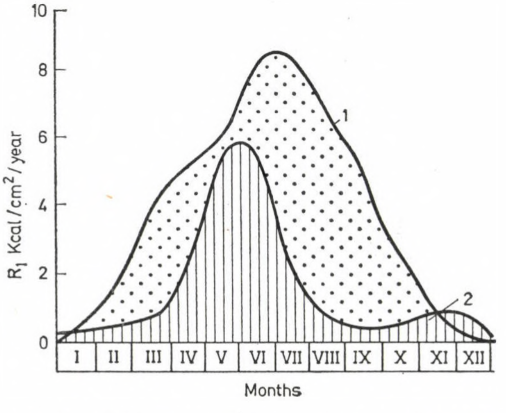

Fig. 3. Rate of exploitation of radiation energy in ecosystems of steppe in Azerbaijan (USSR). 1. Balance of radiation of the soil surface; 2. Energy consumed by ecosystems

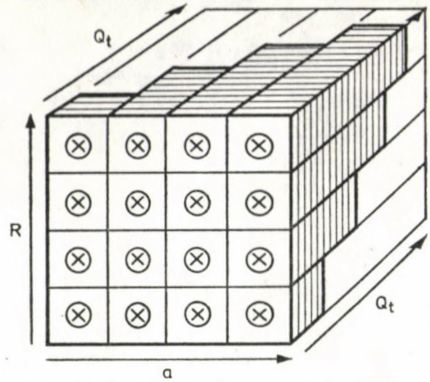

Fig. 4. Schematical pattern of soil-forming processes. R = Radiation balance on the surface; a = Ratio of radiation energy consumed for soil-forming processes; Q_t = Sum of energy consumed by different soil formation/time; x = Soil associations

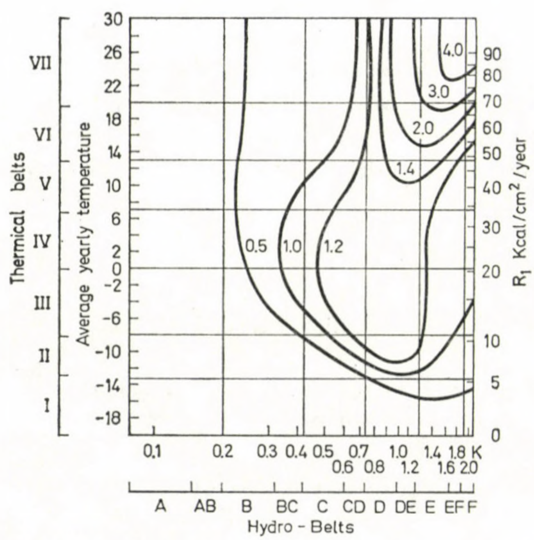

Fig. 5. The rate of energy consumption for biological processes in soil formation. The figures indicate the percentage of this value total energy from of soil forming processes

change of thermical and hydro belts. In general, even under the most advantageous hydro- and thermical conditions only a small part of the radiation energy can be utilized by photosynthesis.

In Table 6 the potential energy of different soils can be seen calculated on the basis of their humus content.

The data of Table 6 confirm the findings that chernozem soils have the highest natural productivity. It is remarkable that despite the high quantity of

Table 6

Potential energy in the organic materials of different soil types

Soil type	Energy in a soil column with a basic area of 1 cm² (cal)			Participation of solar energy in soil formation per year cal/cm² Q	Q/g
	0–20 cm	20–100 cm	0–100 cm (g)		
Grey desert soil	1 200	2 200	3 400	8 000	2.34
Chestnut soil	2 900	5 700	8 600	12 000	1.39
Chernozem soil	7 200	15 800	23 000	15 000	0.66
Chernozem soil	9.500	28 500	38 000	16 000	0.42
Sod podzolic soil	3 900	1 500	5 400	10 000	1.85
Brown forest soil	5 400	6 300	11 800	30 000	2.54
Yellow soil	4 700	5 000	9 700	41 000	4.23
Cinnamonic soil	6 400	8 900	15 300	30 000	1.94
Smolnica soil	2 000	6 800	8 800	28 000	3.18

solar energy available, the desert soils and those of semi-arid regions can take up only a small part of this source of energy as a poor plant cover. The ratio $Q : g$ serves as a starting point for estimating the "efficiency" of the transformation of solar energy into potential energy through the plants in soils. This ratio is related to the yearly periodicity of mass and energy flow in soils.

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ОБМЕН МАТЕРИЕЙ И ЭНЕРГИЕЙ В ПРОЦЕССЕ ПОЧВООБРАЗОВАНИЯ

И. САБОЛЧ

Резюме

Большинство веществ и энергии, созданных живыми организмами, хранится в почвах. Важную роль в образовании почв играют годичные климатические и биологические циклы. Однако, период полного развития и образования почвенного разреза намного длиннее, примерно на два порядка величин.

Основная масса необходимой энергии требуется для биологических или точное биоценологических процессов. Основным источником энергии является солнечное излучение, являющееся в свою очередь функцией климата.

Подавляющая часть общей массы растительности представлена корнями растений.

Почвенный покров сохраняет в себе определенное число важных для жизни элементов, не допуская их переноса в океан.

Человеческая деятельность значительно влияет на обмен материей и энергией почв. В будущем эту деятельность следует вести болеес ознательно с учетом охраны окружающей среды. Такой научный подход требует более детального изучения цикличных процессов.

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CYCLIC PHENOMENA IN RECEPTOR GENERATION BY THE CELL MEMBRANE

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The animal cell comprises a stable linear programme and a set of highly dynamic functional structures controlled by that programme. The cytoplasmic membrane furnishes the boundary separating the cell interior from the environment and through which environmental information is mediated to the cell interior and to the central programme. Some theoretical considerations on these cell membrane functions are discussed.

As an entity the animal cell is like a robot. It comprises a stable, linear programme (the double-stranded DNA) and a set of highly dynamic functional structures controlled by the programme. The cytoplasmic membrane furnishes the boundary which separates the cell interior from the environment, and through which environmental information is mediated to the cell interior and to the central programme. Some theoretical considerations of these functions of the cell membrane are reported in this paper.

The cytoplasmic membrane is a fluid mosaic structure composed essentially of lipids, proteins and water. As a boundary, it separates the highly ordered complex system of automata representing the cell, from a relatively disordered environment.

In addition to its boundary function, the cytoplasmic membrane acts as a receiver of all kinds of environmental information. The sub-structures in charge of this function have been termed as *receptors*. The receptors had been originally — and occasionally still are — interpreted as preformed static structures. Recently information has increasingly been accumulated in support of the implication that the cell surface might be far too small to accommodate all receptors required for the cell's normal function and survival, let alone those involved in special functions, such as virion reception, antigen recognition, contact inhibition, signal recognition, etc.

As experimental facts have thrown little light upon the apparent contradiction between the qualitative and quantitative aspects of receptors, a theoretical approach to the receptor problem was attempted to obtain more information on the problem. The theory of dynamic receptors has been advanced as a working hypothesis.

According to the dynamic receptor theory, practically all receptors more complex than e.g. a single chemical radical are metastable patterns produced at different probabilities by the movements and dynamic transitions of the microscopic states of membrane components. Since, as a fluid, the membrane exhibits the average viscosity of a light motor oil at biological temperatures, the freedom of rotational and translational movements may be considerable even in a constant average condition of the macroscopic structure. The great freedom of movements makes possible the appearance of transitory "combinations", which may represent a wide variety of receptor patterns. As the cytoplasmic membrane is essentially a self-assembled structure, only the types and relative counts of the molecules involved in pattern generation require a genetic coding. In other words, for most receptors only the possibility of generation is coded, while the actual manifestation of the pattern is probability-controlled.

This hypothetical interpretation of the receptor has emerged from an analysis of the following aspects:

1. Strength of the intermolecular interactions involved;
2. measured velocities of rotational and translational movements of different molecules within and across the membrane;
3. possible mechanisms of signal reception.

ad 1.

The average thermal energy of a fluid is about 0.6 kcal · mol^{-1} at 25—35 C°. This implies that the particles of the fluid are held together mainly by VAN der WAALS type forces (0.5 kcal · mol^{-1}). The average bond energy between two dipoles is about 3.5 kcal · mol^{-1}, while that between two ions is about 10 kcal · mol^{-1}.

Let us consider the possible role of the above intermolecular interactions in the formation of a large-scale metastable structure. The time required for the formation (and/or splitting) of a chemical bond under given conditions, the so-called time of expectation (t) can be calculated by the formula of POLÁNYI and WIGNER

$$t = \tau e^{W/kT}$$

where τ is the order of molecular orbital oscillations ($\simeq 10^{14}$ sec^{-1}, W the characteristic energy of interaction, and kT the average thermal energy of the system (k is the BOLTZMANN-constant). The values of t for formation (and splitting) of the different bond types are shown in Table 1, which also includes the value for a covalent bond of average ($\simeq$ 80 kcal · mol^{-1}) energy.

The data clearly indicate that at so-called physiological temperatures, spontaneous changes can occur only at the weak bond level. However, such bonds permit a marked dynamism of events at the microscopic level of membrane structure. The additiveness of the weak interactions and the re-inforcing effect of certain divalent cations account for the maintenance of the fluid mosaic membrane's average macroscopic structure.

Table 1

*Characteristic mean expectation time (t) for the formation (or splitting) of certain bond types**

Bond type	t
VAN der WAALS	$\sim 2 \cdot 10^{-14}$ sec
dipole—dipole	$\sim 2 \cdot 10^{-12}$ sec
—H—	$\sim 6 \cdot 10^{-9}$ sec
ionic	$\sim 2 \cdot 10^{-7}$ sec
covalent	$2.5 \cdot 10^{36}$ years
	(1 year $\sim 3.2 \cdot 10^{7}$ sec)

* The values were calculated for 25—35 °C ambient temperature in a fluid system using the POLÁNYI—WIGNER equation.

ad 2

The individual lipid molecule components rotate within the membrane structure at a frequency of $5 \cdot 10^{8}$—$5 \cdot 10^{11} \cdot \text{sec}^{-1}$. In structures consisting of many lipid molecules, the average frequency of phase transitions in $6 \cdot 10^{4} \cdot \cdot \text{sec}^{-1}$. The velocity of lateral translation of a lipid molecule in the plane of the membrane is about $5 \cdot 10^{4}$ Å $\cdot \text{sec}^{-1}$. Since the average diameter of a hydrophilic lipid head-group is about 50 Å, the path covered in one second corresponds to a length of 10^{3} diameters (e.g. for a 3 m long car this would mean a speed of $10.8 \cdot 10^{3}$ km $\cdot \text{h}^{-1}$). The rotation frequency of membrane proteins is in the range of 4 to $50 \cdot 10^{6} \cdot \text{sec}^{-1}$, while their lateral translation in the plane occurs at a velocity of 0.02—0.33 diameters $\cdot \text{sec}^{-1}$. Thus, the translational movements of membrane proteins are very slow as compared to those of membrane lipids.

It deserves mention that turning of the lipid molecule's apolar tail towards the polar bulk phase (the so-called flip-flop movement) occurs only once in 10^{3} seconds. Thus, this event can be regarded as very rare compared to the other molecular events considered here.

ad 3

A scrutiny of the data presented strongly suggests that the still prevailing interpretation of receptors as preformed stable structures is disputable if not untenable, at least in the case of the more complex receptors. I believe that the "static receptor" concept stems not only from the innate conservativism of human thinking, but also from the circumstance that measurements of receptor-ligand interactions usually cover only the diffusion controlled step. This being the slowest process in the interaction, it may well mask all microscopic events. Moreover, receptor-ligand interactions are as a rule observed in systems with at least 10^{3} receptors per cell, and a considerable excess of the ligand added

(10^5 molecules per cell for 10^6 cell s in 0.5 ml represent only about $4 \cdot 10^{-9}$ M final concentration).

Under such conditions about 100 molecules are presented for each receptor; it is thus not surprising that even "fast moving" (oscillating) receptors (targets) are hit by the ligand at a fairly high probability. This generally masks the probability parameters which would "spoil" the pseudo-first-order kinetics of the interaction and deprive the observer of the very convenient phenomenological interpretation of the event.

In reality, however, the probability of the hit (succesful collision) depends less on the velocity of diffusion than on the frequency, length and direction of the Brownian "jumps" performed by the ligand molecule, as well as on the frequency of oscillation of the appropriate membrane area between its receptor $\rightarrow$ non-receptor states.

The frequency of succesful receptor — ligand interaction was studied earlier in my laboratory in a polio virion $\rightarrow$ cultured monkey kidney cell system. We found that there was a lag phase between the net (reversible) attachment of virions and their irreversible interaction with the receptor proper, resulting in a full viral cycle. The lag phase was identified as a kind of "mating flight", characterized by the virion's Brownian "jumps" and by the flimmering (oscillation) of the receptor pattern. Reduction of the fluidity of the membrane's lipid phase by addition of saturated fatty (behenic) acid, or stabilization of the Mg^{++} K^+ Na^+-ATPase by addition of cardioactive glycosides resulted in a constant ratio between the rates of attachment and infection (i.e. "hit"). In this case, and only in this case, did the receptors behave as if they had been stable structures (fixed target).

It follows that under the usual conditions the virions "falling" towards the surface of a cell which carries many potential receptor sites can successfully collide with the cell only if so permitted by the Poissonian distribution and by the actual configuration of the receptors involved. In this light the receptors represent a statistical rather than a static structural category. Reception of a ligand depends equally on the probability of its presence in an appropriate orientation at the appropriate site, and on the actual, momentary assembly of an appropriate receptor pattern. If both probabilities are close to 1, the phenomenological delusion of the "constant receptor" will emerge.

The parameters of the hypothetical dynamic receptor were modeled in a computer. Constant average counts of different elements and the rules of their possible interactions were programmed. In the 100 consecutive pattern generation cycles run, a wide variety of sub-patterns (receptors) appeared at different probabilities, while the average composition of the system as a whole remained unchanged.

Stabilization of given sub-patterns in the system very soon resulted in modification of the frequency of some or all other sub-patterns. In certain cases some sub-patterns disappeared altogether, or "new" ones emerged quite suddenly. None of these changes had, however, any measurable effect on the system's average composition. This phenomenon has been regarded as the possible model of the modification of the cell's function in consequence of certain irreversible cell-cell or cell-ligand (e.g. hormone) interaction.

The experimental observations referred to in this paper and the computerized model equally support the validity of the dynamic receptor concept. In this interpretation the receptors (at least those larger than a single chemical group) seem to be "accidental" electrostatic (or quantum-chemical) patterns arisen through the relatively free rotational, translational and oscillatory movements of the compounds forming the cell's boundary. Thus, receptors would continuously appear and disappear, regardless of the presence or absence of the appropriate ligand. It follows that one can reasonably speak of a receptor only if the simultaneous presence of both proper pattern and ligand permits an interaction which results in a signal to the cell.

ЦИКЛИЧНЫЕ ЯВЛЕНИЯ В ВОЗБУЖДЕНИИ РЕЦЕПТОРНЫХ ИНФОРМАЦИЙ МЕМБРАНАМИ КЛЕТОК ЖИВОТНЫХ

А. С. КОХ

Резюме

Клетки животного включают в себя стабильную линейную программу и ряд высокодинамических функциональных структур, контолируемых той программой. Мембрана цитоплазмы представляет собой границу, разделяющую внутреннюю часть клетки от ее окружения и осуществляющую передачу информаций окружающей среды во внутрь клетки и к центральной программе. Рассматриваются некоторые теоретические соображения по поводу этих функций мембран клеток животных.

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COMPLEX EDUCATION AND THE UNIVERSAL CYCLIC RELATION

By

E. Tusa

Complex education aims at restoring the unity between recognition, intuition and spiritual elements in a higher unity of science, art and moral. Music is especially suitable for underlining the motion system, i.e. we can say that "music is the sounding motion".

According to the interdisciplinary tendency of our days, the complex education can be a tool to understand the relations between various sciences and arts, moreover as far as possible, between all the manifestations of the being, — by this means developing the human personality and moral forces, too. My complex model of education can be considered a descendant of the ancient Greek education. It is based on the elaboration of the so-called "key" problems, which are suitable — also in sense of the General System Theory — to demonstrate the structural analogies and hidden relations beyond various things. In this way we acquire a certain amount of qualitative "key" knowledge — which are able to open the doors to other values as well — rather than accumulate quantitative data. My conception had developed spontaneously and earlier than I became acquainted with the general system theory. This accidental, or perhaps not really accidental coincidence supports the actual necessity of this idea.

Let me demonstrate this method by an example. Choose the problem of the unity of *thesis-antithesis-synthesis*, because it is present in the primary subject-matter of musical education, namely in the very first piece of Bartók's Mikrokosmos.

This piece consists of three units: the first of them represents the thesis making three steps upwards, the second one the antithesis making three steps downwards, and finally the synthesis unites the two elements by making three steps both up- and downwards. This form is called "*Bar-Form*" in music, wherein two little units are followed by a longer one. The little units are called "Stollen", the longer one "Abgesang", hence the whole form: "Stollen, Stollen, Abgesang" emerges.

Working on this problem, the content, the message of this melody with the students have been examined together. This line of melody can be viewed both from below and from above. Both exist, both are true, and so we can see that truth has many faces. We call this statue-view. As a statue can be photographed from several stand-points (and each of them is true), the whole truth, however, is the totality of all the possible pictures. This view, for example that the convex is concave from an other side, inspired one of my twelve-year-old pupils to recognize our responsibility for the effects caused by words and acts in other persons. All we do or say, leave an impression in other persons, — and this recognition in itself is a moral success.

According to the line of melody one and the same note may adopt different roles. It can serve either as the starting note or the final note, or else it can be an organic element of a scale leading upwards or downwards. Depending on the role it actually fulfils, it may have various characters. It can be a goal or a start, a support or an obstacle, and so on. In the same way, it depends on the individual, that a given event in his life will turn to be a support or an obstacle. And this recognition is also a moral success.

The above-mentioned order of interrelations of ideas can also be expressed by *visual* representation. It is interesting, that the majority of the students and teachers — including myself — independently of each other drew the relation thesis-antithesis by sine curves, the synthesis by circles around the sine curves (Fig. 1). This coincides with the yin-yang symbol of eastern philosophies.

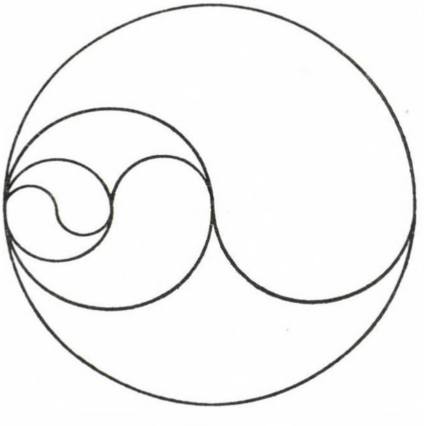

Fig. 1

Most students did not know this figure before, therefore I would suggest that this symbol of the eternal recurrence of existence may be a psychological archetype.

The general validity of this scheme is supported by the cyclicity relation. In the *B*-strip of the cyclicity diagram, the sound and earthquake waves are gradually transformed into the rotation and revolution of celestial bodies. The process can be continued: considering the rotation a new base-wave complementing with its counterpart produces a new rotation, which is characterized by a double diameter of the former rotation. In this way the system of hierarchies — being manifested in the cyclicity concept — gradually develops from a given base-wave of alternating phase in all orders of magnitude. It fairly shows the infinite but not unlimited character of the Universe (because it can be continued ad inf. to macro- and microdirection, but never oversteps the point of Origo) (Fig. 1).

Let us see now the *mathematical* aspect of this problem. The interrelation between music and mathematics is well known. I have always believed that this problem may also be formulated in terms of mathematics. But how? First I tried to put it down in the additive way (e.g. $2 + 2 = 4$). But soon I recognized that this was not the proper solution, because I felt that the connection of the two little parts is not an addition but rather a proportion. On the other hand, I also found that the relationship between the two little parts is not an identity but a reciprocity. I was happy to realize that in this way I came to the same result, which reflects the character of synthesis:

$$2 : 1/2 = 4$$

expressed algebraically:

$$x : 1/x = x^2$$

Incidentally, numerous other *geometric* analogies can be mentioned, which were collected by my students, thus first of all the PYTHAGORAS-theorem. Now, we have collected such hierarchic systems in which the series can be continued ad inf. in both macro- and microdirection, without loosing its character: so e.g. the periodic alternation of pentagons and pentagrams as well as the division of the right triangle by means of diagonals drawn on the hypotenuse (Fig. 2), the golden section and the FIBONACCI sequence.

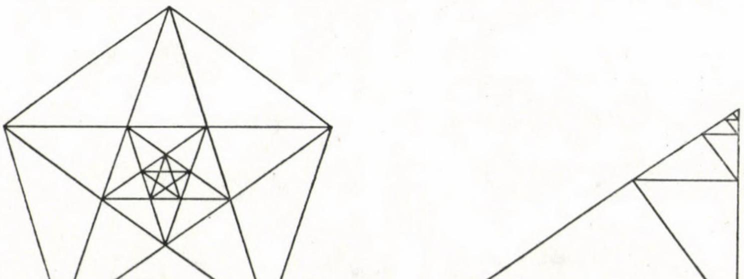

Fig. 2

Hierarchic order appears in all closed regular polygons of any side-number, if the vertices of the next smaller polygon are placed at the half-sides of the former one. In this case the hierarchic motion system is realized by turning the polygon. It is clear that when increasing the number of sides we more and more approach to the circle. The side-length of the next member in the hierarchic series can be defined by the following formula:

$$a_2 = a_1 \cdot \cos \frac{180°}{n}$$

where a_1 is the original length and n the number of sides. In the subsequent members cos^2, cos^3, cos^4, etc. are to be applied. As the number of sides of the poly-

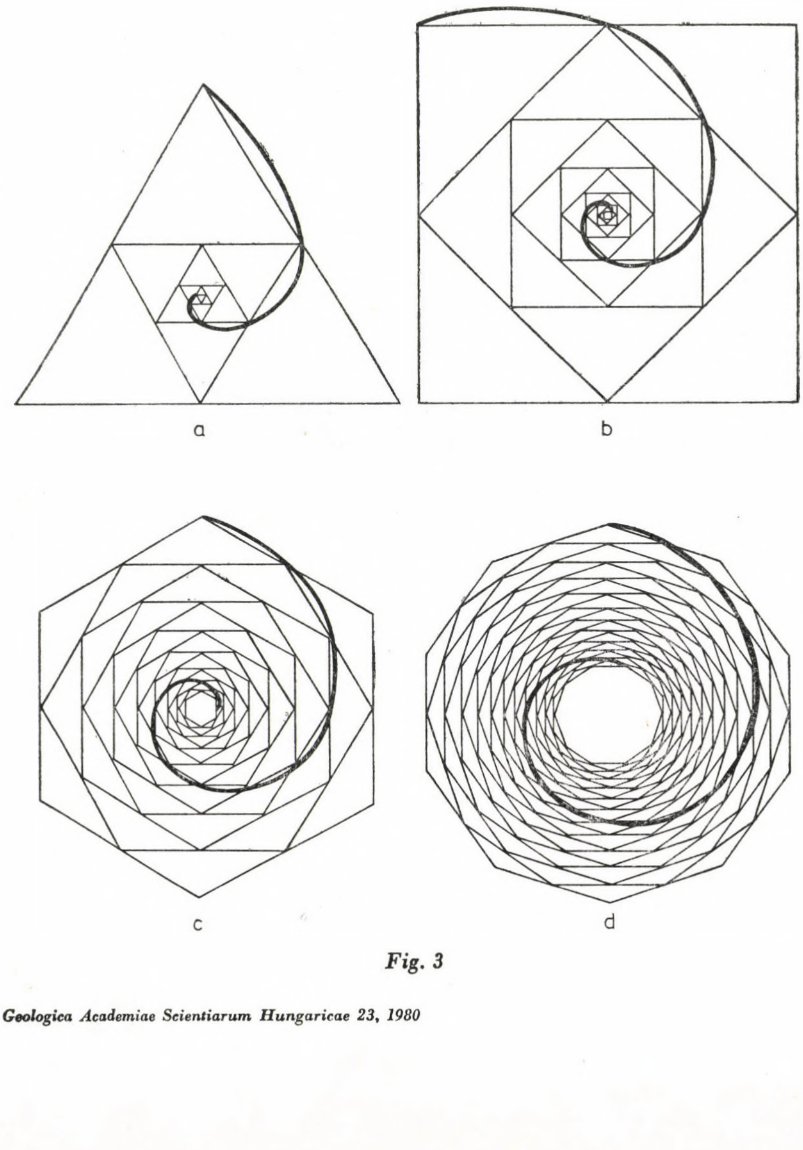

Fig. 3

gon increases, the side-length of the next member approaches more and more the previous one. If the side-length of the starting side is 10, the next side-lengths will be for a triangle 5, for a quadrangle 7.07, for a heptagon 9.026, for a decagon 9.511, for a 30-sided polygon 9.945, for a 90-sided polygon 9.994 and for a 180-sided polygon 9.998.

Connecting the intersections of the subsequent members a spiral can be drawn approaching gradually the circle with increasing the number of sides (Fig. 3).

Biological analogies can be easily found as well. Let us take the simplest example: the genes of the parents, as thesis and antithesis result in the child as a synthesis, similarly to the "Meistersinger von Nürnberg" where DAVID teaches WALTER von STOLZING how to construct the right music Bar-form: "Ob euch gelang ein rechtes Paar zu finden, das zeigt sich an den Kinden" (The child will tell, if true and fitly mated, the pair by you created.)

It can be demonstrated that *history* itself is nothing else than a synthesis of dialectic oppositions, forces and counter-forces.

It is very important to us to express these relations by motions, by primeval *gestures*. So we have evolved a series of motions reflecting the idea of thesis-antithesis-synthesis, we called this exercise "picking of flowers". In the first phase, in the thesis, we gather flowers, symbolizing the values on the border of our path, the path of Life. In the second phase, we embrace and enrich them by our own values. Finally, we do not keep them in order to decorate ourselves, but instead of this we offer them for serving higher purposes.

All the three gestures have special *moral* impacts.

1. The admission and gathering of experience indicate: do not pass indifferently the values of the environment (flowers).

2. The second phase helps the student to realize the dignity of his own personality. He will recognize that the special colour which he adds to the experience, cannot be replaced by anybody else.

3. The third phase helps to supply universal purpuses instead of egoistic ambitions.

Let us summarize our goals: complex education aims at restoring the unity between recognition, intuition and spiritual elements (having primarily formed an inseparable organic unity) now in a higher unity of science, art and moral.

Music is especially suitable for underlining the motion system. It is motion even if it takes place in our inner hearing: in this case it is the motion of thoughts; on the other hand, it is motion necessarily if it is realized on an instrument or by human voice. Not only motion, but also cyclicity and periodicity are its essential elements: breathing in and out, tension and relaxation of muscles, pulsation of rhythm, peaks and deep-points of formal arcs, etc. We could say that music is the "sounding motion".

КОМПЛЕКСНОЕ ВЫСЩЕЕ ОБРАЗОВАНИЕ И УНИВЕРСАЛЬНАЯ ЦИКЛИЧНАЯ СВЯЗЬ

Е. ТУША

Резюме

Комплексное образование предназначено для того, чтобы восстановить единство познания, интуиции и умственных элементов, воплощая их в более высокую единицу наук, искусств и морали. Музыка особенно пригодна к тому, чтобы лечь в основе системы движений. Другими словами, можно сказать, что «музыка — это звучащее движение».

DATA CONCERNING THE UNIVERSAL CYCLICITY RELATION

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THE OBJECT AND SYSTEM OF EARTH SCIENCES AND THE "UNIVERSAL CYCLE RELATION"

T. PÓKA

Accelerated differentiation and specialization of science requires the scientific definition of the scope, object and social functions of the individual branches of science. Nowadays, the system theory approach is the most up-to-date one.

The cycle law diagram set up by E. SZÁDECZKY-KARDOSS assigns the respective fields to the branches (disciplines) within the different sciences.

In the past decades, scientific research revealed a series of relationships which justify to range the Earth Sciences as a category equivalent to physics, chemistry and biology.

Earth science disciplines are called those fields of science, which investigate material systems suitable to develop or to support living material systems in a determined discrete space-time-energy range. They deal with the analysis of the Earth, as a relatively closed system, including its structural constituents (elements) and interrelations (functional relationships) as well as its historical development (evolution). The laws of the Earth sciences are applicable in the social practice, too. It becomes possible to forecast the processes and properties of the now still inaccessible spheres of the Earth, the short- and long-term changes of the Earth, and the occurrence, quality and workability of mineral raw materials and energy resources.

Earth sciences, along with Biology and Astronomy, may be called Sciences of Natural History, as opposed to Physics and Chemistry, which are essentially structural sciences.

At present, no system of the Earth Sciences is generally accepted. In the most widespread classifications "material testing" disciplines such as mineralogy, petrography, geochemistry, geophysics are contrasted to historical-genetical disciplines (dynamic geology, historical geology, tectonics, paleontology, etc.). This distinction, however, is a priori incorrect, because the material testing and the historical point of view are always present in all of them, only with varying importance.

Accordingly, the author proposes a coordinate system with the succession of organization levels (elements) of the object of science on one axis and with the degrees of successive progress in knowledge (description-quantification-discovery of universal regularities) on the other.

CYCLES AND RHYTHMS IN THE ATMOSPHERIC MOTION SYSTEM

B. BÉLL

The most important causes of the atmospheric cycles are:

1. Sun-Earth gravity interaction (in the atmospheric tides). Wavelength cca 20 000 km, period 12 hours. 2. Atmospheric gravitational waves of very varying wavelength. The usually stable and quasi-horizontal orographic gravitational waves (e.g. above Lake Balaton). 3. Influence of the Earth's rotation, generating inertial waves. Wavelength 100 km, period: (some) day(s). 4. Hydrostatic lability of the vertical air column resulting in the formation of thermic convection cells. Space parameter: 1—10 km, time parameter: some hours. 5. Vertical changes in the wind vector, giving rise to boundary surface waves. Space parameter: 10^2—10^3 m, time parameter: minutes, resp. hours. 6. Barotropic and baroclinal instability, responsible for the cyclons. Wavelength increasing from a few kms to several thousand of kms, with periods from a few minutes to 15—40 hours.

The atmospheric part of the hydrological cycle is characterized by the average time of about 10 days spent by a water particle in the atmosphere. The same order of magnitude is valid for the atmospheric part of the sulphur and carbonium cycles as well.

According to the above data the atmospheric motion systems fit well into the cycle-rhythm pattern of the Universe described by SZÁDECZKY-KARDOSS.

The energy scale is discontinuous, while the space and time parameters seem to be continuous. This apparent contradiction may be due to the gradual dissipation of macro-motion system into meso- and micro- ones. (Meso-motion systems would have parameters as 20—500 kms and 1—48 hours.)

PALEOCLIMATOLOGICAL AND PALEONTOLOGICAL IMPLICATIONS OF RADIATION MEASUREMENTS BY SATELLITES

Z. DOBOSI and B. GÉCZY

Relying on the data obtained by the satellites NIMBUS-2 and NIMBUS-3, RASCHKE et al. have plotted a radiation balance map of the system Earth-Atmosphere, the first one based on measurements. (A significant difference as compared to the former maps based on Simpson's calculation is that in the subtropical zone the balance is negative above the continents while positive above the oceans.)

This permitted to construct models of ocean-continent distribution in view of their respective radiation balances.

If continents form a ring about the Equator (ranging from 17°*N* to 17°*S*), a somewhat cooler, but more uniform climate than the present one results (model 1).

An "ocean ring" around the equator between the latitudes 45°N and 45°S would produce a somewhat warmer, but also more uniform climate than the present one (model II).

For a less uniform climate more continental surfaces would be needed in the subtropical and the polar regions.

These considerations shed new light on the problem of the uniform and relatively warm climate of the Jurassic and Cretaceous testified to by innumerable paleontological data and by oxygen isotope studies, as well. Jurassic and Cretaceous represent transition between models I. and II.

A decisive role may be attributed to the opening up to the Tethys Sea of equatorial position, separating northern Laurasia from southern Gondwana. This favourable situation ended with the closing of the Tethys by moving continental plates into the subtropical zone.

CYCLIC FLUCTUATIONS OF PRESSURE IN THE PANNONIAN BASIN AND THEIR HYDROCHEMICAL IMPLICATIONS

A. Rónai

In earlier papers the author reported on a 14—16-year cycle and a 28-year cycle observed in groundwater wells in Hungary.

During the years 1967—75, regular observation and automated recording were done in a series of wells (depth range 232—1060 m) in the Great Hungarian Plain, disclosing the 46 best aquifers of the area.

Along with the annual fluctuation of the static water table another cycle of several years could be recognized. This is due to the propagation of pressure waves in the aquifers, controlled by some climatic cycles of the Carpathian Basin. A first minimum was observed in 1968 and a maximum in 1970, followed by a gradual sinking resulting in an absolute minimum in the first half of 1974. In fact, those years were extremely poor in precipitation.

Daily changes in atmospheric pressure as well as the tidal ones are promptly reflected by water level oscillations. It should be noted that this effect is much more expressed in greather depth than near the surface.

Infiltrating water contains calcium, magnesium and hydrocarbonate ions while ascending waters are rich in sodium, accompanied by hydrogen carbonate and sulfate ions.

The impact of earthquakes was recorded in some wells (the induced "swing" varying between 9 and 93 mm) while other remained completely unaffected. Post-seismic water level is situated consequently deeper than the preseismic one.

PLACE AND ROLE OF THE BIOSPHERE IN THE MATERIAL AND ENERGY FLOWS

E. Dudich

The biosphere, a very disperse system, is essentially a biosol of global dimensions, characterized by very high values of specific active surface and of matter and energy exchange.

The level of molecular biology in strip *C* corresponds to the electron and proton exchange reactions and H bonds in organic macromolecules in strip *B* and to UV and X-radiation (of mutagenic effect) in strip *A*.

There are two hierarchies in the Biosphere. One of them (phylogenesis) ranges from primitive unicellulars to Man. The other (organization levels) ranges from organic macromolecules through cellular organs, cells, tissues, organs, organisms to complex life communities.

Taxa and life communities fit into strip *C*, their space-time parameters being commensurable with those of the geological processes. (This fact serves as the basis for biostratigraphy.) In the two other strips *B* and *A*, the corresponding phenomena are the seismic and the radio waves, respectively.

The biosphere played a very important part in the development of the geospheres of the Earth, being decisive in the circulation of several elements (C, N, O, P and others). This active interaction can and should be approached by computer simulation and modelling.

ON THE CYCLIC AND PERIODICAL PHENOMENA OF LIVING SYSTEM

T. Gánti

One part of the widely different periodical phenomena to be observed in the living organisms is directly controlled by the cyclic processes of environments, through oscillatory autocatalytic biochemical processes. Their frequency is a function of concentration and temperature and their spatial dimensions are limited by the diffusion and the information transfer.

Life times and body dimensions fit fairly well into strip C of SZÁDECZKY-KARDOSS' time-space diagram, ranging from 1.0×10^{-4} to 6.0×10^{3} cm and 1.2×10^{3} to 1.5×10^{9} sec, respectively. Strip C can be split up into "substripes" $C_1 - C_4$, from short-living corns through mammals and insects, birds and fishes to particularly long-living forms of insects, e.g. the bee queen.

It is imaginable that human life could still considerably prolongated by studying and applying the decisive mechanisms of bio-chemical inhibition suitable to produce low "life-speed".

HIERARCHICAL CLASSIFICATION OF THE LANDFORMS

AN INTERPRETATION OF THE PERIODICITY OF RELIEF DEVELOPMENT

M. PÉCSI

Microforms

1. Daily rhythm: frost heaving, sand ripples, etc. (Dimensions $>$ m^2).
2. Seasonal rhythm: snow forms, dunes, bank-slide ($<$ m^2).
3. Episodic periodicity: rock- slide, land-slide ($\sim$ 10 years $>$ km^2).
4. Forms due to periodic disequilibrium stages: meander cutoffs, intrazonal soil formations ($\sim 10^2$ years; < 10 km^2).

Mesoforms

5. Secular (cyclic) periodic formations: zonal soils, floodplain, cirque, etc. $\sim 10^3 - 10^4$ years: $10^2 - 10^3$ km^2.
6. Terraced or stepped formations: multi-terrace river valleys, abrasion terraces (polycyclic terrace formations)^2 $\sim 10^6$ years, $10^3 - 10^4$ km^2; local relief, pediments, or single terrace may form $\sim 10^4 - 10^5$ years $10 - 10^3$ km^2.

Macro- and Megaforms

7. Areal, stepped, planation, surfaces: peneplanation on a regional scale, pedimentation; one "denudational cycle" lasts $\sim 10^7$ years; $10^3 - 10^5$ km^2 (dimensions widely differ),
8. Subcontinental peneplanatation (polycyclic peneplain): (ancient shields, continental platforms, massives in ancient subduction belts) $\sim 10^8$ years; 10^6 km^2.
9. Continents or ocean basins ($5 \cdot 10^8 - 10^9$ years; 10^7 km^2).

The rate at which landforms develop is a function of the efficiency of the endogenic and exogenic forces. Fast developing forms may coexist with formations that are altered at a slow rate.

CYCLES AND RHYTHM IN THE TRIASSIC OF HUNGARY

E. VÉGH-NEUBRANDT

The hierarchy of sedimentation cycles may be summed up as follows (after KRUMBEIN 1965):

	Dimensions of the sed. basin km^2	Thickness of the sediments m	Time of formation million years
Sedimentary megacycle	10^2—10^4	10^2—10^3	10^6—10^8
Local complete cycle partial cycle, semi-cycle	10^2—10^3	10^1—10^2	10^6—10^7
Cyclothem group within one lithologic unit	10^2—10^3	10^1—10^2	10^6—10^7
Cyclothem	10^1—10^2	10^{-1}—10^1	10^4—10^5
Cyclothem member	10^{-1}—10^1	10^{-1}—10^1	10^3—10^4
Microlayer within one cyclothem member	10^{-3}—10^2	10^{-3}—10^{-2}	10^{-1}—10^2

The Tethys megacycle culminating in the Triassic has started in the Permian and ended in the Cretaceous. It comprises numerous minor semi-cycles partial and local cycles.

The Triassic represents no ideal cycle in Hungary. In the Transdanubian Central Mountains, the Mecsek Mountains and in the Gömör Karst it begins with continental sediments passing into near-shore, shallow-water, clastic marine sediments, while in the Bükk Mountains Permian marine sedimentation was continued.

The deepest basin conditions prevailed in the Bakony Mountains from the Middle Anisian through the Middle Karnian, in the Mecsek Mountains in the Anisian only, and in the Bükk Mts. from the Ladinian through the Norian.

The regressive sediments are well developed in the Mecsek Mts, while in the Transdanubian Central Mountains the sequence grades into the Jurassic with sub-marine dissolution phenomena only.

Cyclothems have been most thoroughly studied in the Transdanubian lagoonal facies from the Ladinian through the Rhaetian. They may eventually correspond to 25 800 year climatic cycles.

Faunal cycles turned out to be much shorter in the basin facies than in the platform one (34 Ammonites and 30 Conodont zones opposed to 9 Megalodontidae and 5 Dasycladaceae Zones.)

RELATIONSHIP BETWEEN THE STRUCTURE OF THE INNER PLANETS AND THE HIERARCHY OF THEIR SURFICIAL PROCESSES

A. KŐHÁTI

The hierarchy of the main processes known to occur at the surface of the Earth-type bodies of the solar system is presented in:

Table I

Sphere	Process	Earth	Venus	Mars	Mercury	Luna (Moon)	Phobos Deimos
Hydrosphere	Biogenic sedimentation	+					
	Aqueous sedimentation	+		+			
	Glacial sedimentation	+		+			
Atmosphere	Aeolian sedimentation	+	?	+			
	Chemical wathering	+	+	+			
Lithosphere	Tectonism	+	+	+			
	Volcanism	+	+	+	+	+	
	Impact crater formation	+	+	+	+	+	+
	Physical decomposition of rocks	+	+	+	+	+	+

Some of the characteristic structural parameters are given in:

Table II (*after:* KUSKOV)

	Pressure (kbar)	Temperature (K°)	Diameter ratio (Planet/core)
	at the mantle core boudnary		
Earth	1400	4000	1.8
Venus	1400	4000	2.0
Mars	250–300	1000–1500	3.4
Mercury	100	1400–2000	1.2
Luna	50	1000–1500	4.3

The "imbrian event" (big asteroid impact) can be traced in all the bodies under consideration.

The resulting (decreasing) succession of planetological development is the following: Earth, Mars, Venus, Mercury, Luna, Deimos, Phobos.

PERIODICAL CHANGES IN THE RADIATION OF STARS

B. SZEIDL

During the life of a star long stages of nuclear fusion (10^{-5}—10^{10} years) alternate with much shorter stages of gravitational contraction. The dimension, effective temperature of the surface (T_e) and luminosity (L) of the star vary accordingly. The physical properties of a star are correlated with its position on the log L—log T_e plane, i.e. on the theoretical Hertzsprung—Russell diagram (HRD).

Certain combinations of parameters (depth of HeII ionization zone, opacity depending on pressure) make stellar atmospheres pulsationally unstable. The range of parameters that allows this instability is limited, therefore, the pulsating stars are located in a narrow strip of the HRD (so-called instability strip). Stars crossing this strip in the course of their evolution become variable stars.

Actually more than 10 000 stars of periodically changing luminosity are known, with periods ranging from 0.01 to 300 days.

Multiple periodicity is also common, making possible to determine the dimension and the mass of the stars in question.

The characteristic basic periods of the stars fit into strip *B* of SZÁDECZKY-KARDOSS' diagram.

CYCLES OF SUPRAINDIVIDUAL BIOLOGICAL SYSTEMS AND THE SPIRAL CHARACTER OF BIOLOGICAL CYCLES

T. JERMY

Animal *species* exist in nature as series of *populations*. The population is the totality of individuals between which regular exchange of genetic informations occur. Therefore, the population is the unit carrying the genetic changes of the species.

The space parameter of animal populations depends on the size of the individuals as well as on their ability of dispersal. It varies between 10^2 and 10^7 cm.

The most important cyclic process determining the persistence as well as the genetic changes (adaptation, evolution) of the species, is the *generation cycle*. Its time parameter varies within the limits of 10^6 and 10^8 sec. These two parameters put the animal populations on the system of space/time coordinates between the strips B and C adjacent to the latter.

Generation cycles of animal populations can be regarded also as fundamental processes of *zoocenoses* since they represent cyclic changes in the age structure of populations, i.e. in the relationship of populations and consequently in the flow of matter and energy within and between the populations. As the zoocenoses are built up of populations, their space and time parameters are equal to those of the populations. Thus, animal populations, animal species, and zoocenoses can be placed on the same area in the system of space/time coordinates.

It has been pointed out by J. Horváth (in this volume p. 111) that biological systems are characterized by irreversible changes. Such changes are the following: *aging* on the individual level, *evolution* (in species), and *succession* (in biocenoses) on the supraindividual level. Thus, all cyclic biological processes are in reality *spiral* ones.

The spiral is the steeper the more irreversible changes occur in the system within one cycle. E.g. "spirality" of physiological cycles (respiration, heart rhythm, etc.) is negligible while cycles of supraindividual biological systems (generations in populations, etc.) have a much more pronounced spiral character. The degree of "spirality" can be determined by the quality and quantity of *changes in the information content* of the system during one cycle. E. g. one generation of a microbe or of an insect population means approximately a circular cycle because during it little changes occur in the information content harboured in these biological systems. On the contrary, one generation in human populations containing a huge amount of biological, cultural, social, etc. informations, means a very steep spiral unit.

THE UNIVERSAL RELATION OF CYCLICITY AND THE SOCIAL ORGANIZATIONS

Á. ONDVÁRI

According to the universal relation of cyclicity (in the following ULC), the natural cycles and rhythms are linear functions of the logarithms of space and time. In the CGS coordinate system the different anorganic phenomena appear along parallel lines.[1]
Our aim is to outline whether the statements of the ULG concerning the anorganic phenomena are valid also for the social phenomena or not and what is their relation to the biological bridge of the ULC. In this paper a sketch from

[1] SZÁDECZKY-KARDOSS E.: Az univerzális ciklustörvény (The Universal Law of Cyclicity) MTA X. Oszt. Közl. **8**, 1—2, 1975.

this viewpoints will be given concerning the organization-like social phenomena.

According to R. L. ACKOFF.[2]

— "An organization is a purposeful system that contains at least two purposeful elements which have a common purpose.

— An organization consists of elements that have and can exercise their own wills . . .

— An organization has a functional division of labor in pursuit of the common purpose(s) of its elements that define it . . .

— The functionally distinct subsets (part of the system) can respond to each other's behavior through observation or communication . . .

— At least one subset of the system has a system-control function".

In the case of social organization man is directly or indirectly the basic element of the organization as a purposive system. At the same time, man seems to be one of the cycle and rhythm phenomena of nature. As the first step it is to be investigated to what extent can be the man interpreted as a continuous (reversible) i.e. rhythmic and/or cyclic movement.

The alternation of man's awake (conscious) and sleeping (subconscious) states is a rhythmic phenomenon. In the evolution of this rhythm as well as in its alternation the axial rotation of the Earth and its revolution around the Sun have great significance.

The joint effect of birth and death represents an other rhythmic motion tendency that is irreversible from the point of view of the individual but is reversible when considering the human species.

Regarding the cycles of the individual the space and time parameters of the human body and of the human activity should be distinguished. The *human body* can be characterized by its height and by the age of fertile women. The parameters of *human activity* can be most simply determined by the daily "walking distance" of man (Table 1).

The space and time parameters of the rhythmic motion of different social organization can be explained by their forming and ceasing as follows.

Table 1

Sign in the figure and terms	Space parameter	Time
Human activity M'	5–20 km	24 hours
Human body[3]	0.8–2.2 m	12–55 years

[2] R. L. ACKOFF: Towards a system of systems concepts. Management Science, 17, 1971.

[3] The space parameters change during the individual evolution, the data of baby- and ch idhood are not considered.

Table 2

Denomination of the social organization	Time parameter (estimated)			Space parameter (estimated)		
	minimum	maximum	interval	minimum	maximum	interval
	values		(sec)	values		(cm)
a. Family-like	several days	several centuries	10^6-10^{10}	several metres	1000–2000 km	10^3-10^8
b. Enterprise-like	several weeks	several centuries	10^6-10^{10}	several hundred m	several thousand km	10^4-10^9
c. Party-like	several days	several centuries	10^5-10^{10}	several hundred m	several thousand km	10^5-10^9
d. Church-like	several years	several millennia	10^8-10^{11}	several hundred m	several thousand km	10^5-10^9
e. "Maffia"-like	several years	several centuries	10^8-10^{10}	several m	several thousand km	10^3-10^9
f. Nation-like	several centuries	1–2 millennia	$10^{10}-10^{11}$	several km	1–2 thousand km	10^6-10^8
g. Empire-like	several years	several thousand years	10^8-10^{11}	several hundred km	several thousand km	$5 \cdot 10^7-10^9$
h. Social systems	several centuries	several thousand years	$10^{10}-10^{11}$	several ten —	thousand km	$10^9-2 \cdot 10^9$
i. Social organizations resulted by the evolution of the terrestrial life	several days	ten-thousand years	$10^5-3 \cdot 10^{11}$	several m	40 000 km	$10^3-4 \cdot 10^9$

The *formation* of social organization is the date when the essential features have developed and the realization of the goal has started.

Ceasing of the social organization is the duration when those new organizations are already developed within the old one that are going to replace the recently primarily predominating organization.

The spatial extension of the social organization is represented by the region in which the members of the organization are active in an organized form to reach the goal. The space parameter of a social organization equals to the maximal longitudinal length of the predominating primary epoch of the social organization.[4]

Because of the small number of the repetition of time parameters the continuous (reversible, i.e. rhythmic and cyclic) character of social organizations should be accepted with reservations. Since the ULC is, however, demonstrated in a log-log co-ordinate system, this allows estimations within rather wide limits.

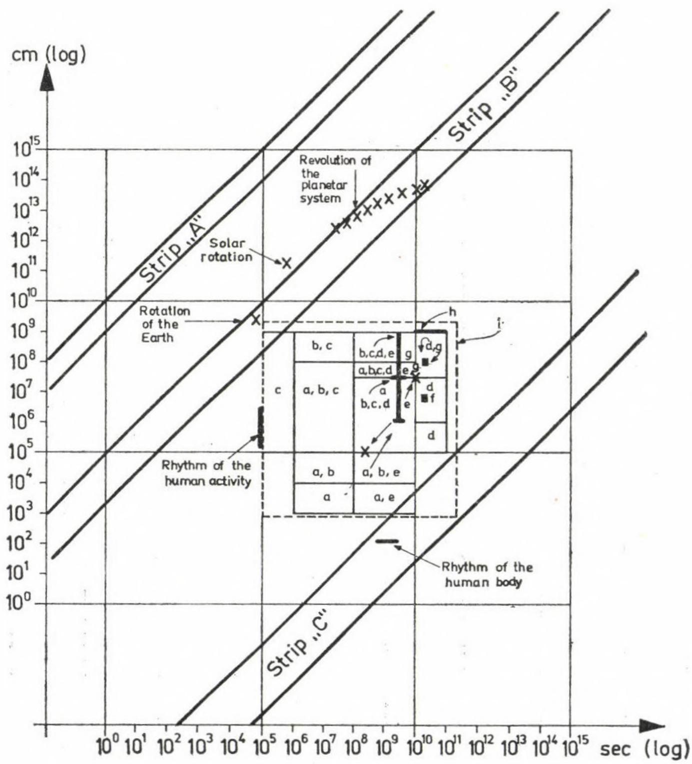

Fig. 1. **Location of social organizations in the diagram of the universal law of cyclicity. (For signs /letters/ see Table 2)**

[4] The spatial extension changes during the evolution of organization. Within the same spatial extension there are organizations of different "density".

In Table 2 the minimal and maximal values of the space and the time parameters of social organizations experienced so far are comprehended. These parameters intervals are represented in the ULC-diagram, too (Fig. 1). It can be stated from this figure that the general *i* frame of the space and time parameters of social organizations (dotted lines) is enclosed by a semicircular line determined by the parameters of the revolution of the planetar system, of the solar rotation, of the terrestrial rotation, of the human activity and of the human body.

In Figure 1 the sites of each social organizations signed by a—h (see Table 2) are indicated by rectangular fields. They overlap each other to certain extent. The figure demonstrates also the estimated most frequent space and time parameters of social organizations (marked by arrows). The estimated most frequent space and time parameters of real social organizations are united within the field "T" (Fig. 2).

Special attention should be attributed to the organization of "maffia" character demonstrated in Fig. 2 by the two points: maffia of Sicilian type *e* and maffia characterized by small number of elements *e*. The latter one calls

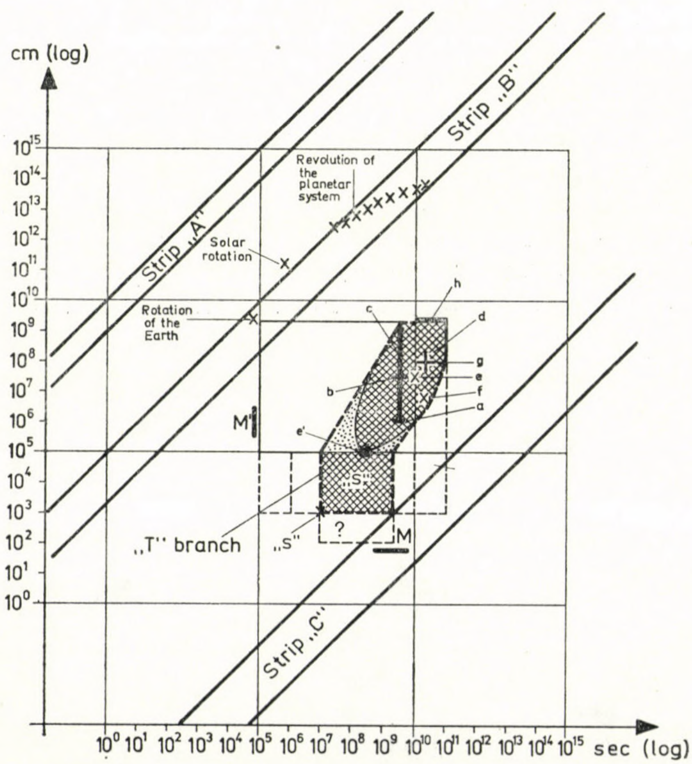

Fig. 2. "T" branch of the universal law of cyclicity

the attention to the significance of the organizations characterized by the least number of elements, i.e. to the human pairs, love, friendship, marriage. They are decisive in the evolution of the social organizations. The shortest "passing affairs" of human pairs being very frequent during the human evolution can be characterized by 10^7 sec and 10^3 cm parameters (point *s* in Fig. 2). The measures of organizations of small number of elements are seen in Table 3.

Table 3

Sign in the figure and term	Time	Space
	parameters	
Human pair (s)	several months to 70 years, i. e. 10^7 to $2 \cdot 10^9$ sec	10—1000 m i. e. 10^3—10^5 cm

Figure 2 shows all the estimated space and time parameters of the most frequent social organizations. Assuming continuous evolution the "*T*" social branch of the estimated most frequent space and time parameters of *real social organizations* is obtained by complementing the "*T*" field with the areas marked by dotted line and uniting with the "*S*" range. This branch joins the *C*-strip of the ULC as an individual section. The social branch partly overlaps the range of greater time parameters of the biological bridge even surpassing it at the side of greater time parameters.

In favour of a more exact picture it would be worth while to deal with the relationship of space parameters and elementary density of social organizations, with the "fine-structure' 'of "T" branch, and with the explanation of the inclination of "T"-branch into the main strike of the strips *A*, *B* and *C*.

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