Basic Ideas of Burkhard Heim's Unified Field Theory

by

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Abstract – Heim's theory is defined in a 6–dimensional world. Two of the 6 dimensions measure and guide organizational processes in the 4 dimensions of our experience. A very small natural constant, called a "metron", is derived, representing the smallest area existing in nature. This leads to the conclusion that space must be composed of a 6–dimensional geometric lattice of very small cells bounded on all sides by metrons. The existence of metrons requires our usual infinitesimal calculus to be replaced by one of finite areas.

The unperturbed lattice represents empty space. Local deformations of the lattice indicate the presence of something other than emptiness. If the deformation is of the right form and complexity, it acquires the property of mass and inertia. Elementary particles are complex dynamical systems of locally confined interacting lattice distortions. Thus, the theory geometricises the world by viewing it as a huge assemblage of very small geometric deformations of a 6–dimensional lattice in vacuum. The theory results in a very precise determination of the experimental masses of elementary particles. It also has significant consequences for cosmology.

Using a method of multivalued logic, Heim is able to extend the purely physical theory into the non–material, transcendental domain and to describe in a formal way the properties of life and related processes. Only a brief summary of the ideas underlying the transcendental theory is presented. This forms the basis of a projector theory, which describes a possible way of exchanging information between points lying far apart and to cover interstellar distances without the need of physically traversing space.

1. Introduction

Heim's theory encompasses the entire field of physics as well as aspects not generally accessible to precise treatment, such as life and all higher processes associated with it. The purely physical part of the theory is contained in two volumes (Heim, 1984, 1989) and concentrates in particular on the structure of elementary particles and cosmology. This work culminates in the derivation of formulas for calculating the mass spectrum of elementary particles. Numerical results are in excellent agreement with measured values. The theory also provides a highly accurate value of the quantum mechanical fine structure constant α (alpha). A third volume about particle interactions is presently in preparation (Heim, private communication). Heim published three resumés of his theory (Heim, 1977, 1985, 1990a), one of them in cooperation with W. Dröscher. In addition, one of the authors has written a number of summary articles describing the essential features of Heim's work (v. Ludwiger, 1976, 1979a, 1979b, 1981, 1983).

A brief survey of the difficulties encountered by past and present physical theories will serve to illustrate the significance of Heim's contribution to our understanding of nature.

Till the end of the last century, Newtonian mechanics and Maxwell's theory of electromagnetism dominated the field of physics. The small precession of Mercury's orbit about the sun did not fit into the picture, but it was thought to be the result of some essentially unimportant exterior disturbance. However, when the atomic structure was slowly unraveled and showed that, contrary to theory, atomic electrons could revolve about the central nucleus only in certain, predetermined orbits, in which they did not radiate, it became evident that some deep-seated fault was inherent in classical Newtonian theory.

During the first quarter of this century physics underwent two very fundamental modifications: Einstein developed first his special and then his general theory of relativity (the special theory is a simplified version of the general theory), and De Broglie, Bohr, Schrödinger, and Heisenberg worked out the principles of quantum mechanics applicable to atomic configurations. In the thirties and forties further development of this work resulted in quantum field theory, describing the characteristics of elementary particles. Efforts to improve and generalize quantum field theory are still in progress.

Classical physics was shown to be a special case of both relativity and quantum theory, valid when dimensions, speeds, and masses are "normal", i.e. within the range of human experience. It loses its validity beyond these limits and does not apply, for instance, to atomic or intergalactic dimensions, or when velocities approach the speed of light. This is due to the omission in Newton's theory of some very fundamental aspects. New concepts included in relativity but neglected by Newton are the constancy of the speed of light and the effect of masses on the geometry of space. Quantum theory involves the novel concepts of wave-particle duality, uncertainty, probability distributions, and others.

In the normal range mentioned above, both relativity and quantum theory reduce to classical physics. This proves the latter to be a special case of the former. Strangely enough, though, the two modern theories seem to be incompatible with each other. While special relativity and quantum theory go over into each other in their respective ranges of validity, heroic efforts during the past half century have failed to unite general relativity and quantum theory. This was the first hint that even these theories may not represent the ultimate approach to physics.

Meanwhile, there appeared a few additional discrepancies. The origin of the universe in a "big bang" explosion is a notion about which many physicists feel uncomfortable (Van Flandern, 1993), although the theory has been able to explain many experimentally confirmed phenomena. More serious is the fact that the application of quantum field theory to elementary particles and their mutual interactions in many instances yields only very approximate numerical results, especially for the more exotic members of the particle spectrum. In addition, theories about the internal particle structure require matter to have a surprisingly large number of very special properties. This is hard to believe, for nature may be complex mathematically, but conceptually it should exhibit the aspect of unity and simplicity. Finally, quantum theory gives rise to some paradoxical situations, as was already pointed out by Einstein and collaborators (Einstein et al. 1935). To this day, these have not found a satisfactory explanation.

The difficulties mentioned above, as in the case of classical physics, appear to indicate that even the advanced modern theories are still subject to certain limitations. They do not seem to apply to the very distant past of the universe or to the interior of elementary particles. Apparently, in the hierarchy of physical theories, relativity and quantum field theory are themselves only special cases of a still more general and all-inclusive approach to physics, which considers certain fundamental aspects of nature ignored by existing methods.

It is Heim's privilege to have recognized life and related phenomena as the feature being disregarded in today's theories. The meaning of this statement will presently be explained.

Life processes themselves are too complex to be expressible in terms of precise mathematical formulations. In order to describe them, Heim has had to develop a new formal language of multivalued mathematical logic. In this view life does not result from the mechanistic extension of conventional physics and chemistry to very complex organic systems, nor is it an ethereal quantity incapable of exercising any influence on pure physics.

Heim's theory may be divided into two parts: A purely mathematical section, treating all aspects of classical and modern physics, and a second part, termed the "transcendental" theory, dealing with life and related phenomena by means of the specially developed method of multivalued logic.

The two parts of Heim's theory satisfy an essential correspondence principle, requiring the two parts to be compatible. The laws of nature form a single unit, and hence the laws of pure physics must go over into those governing transcendental processes in the appropriate domain, just as the laws of relativistic quantum mechanics go over into those of special relativity in the classical limit of large masses and high velocities. In order to satisfy the correspondence principle, Heim's theory, designed to encompass both non-living and living matter, has to share certain basic concepts in both areas, even though the two forms of existence may require different mathematical formalisms to describe them.

In addition to the 6-dimensionality of space (extended to 12 dimensions in the latest version of the theory), Heim introduces several other new concepts into physics. These will be discussed in the following sections.

Heim's theory, as far as it applies to events in pure physics, ranging from cosmology to internal particle structures, has an existence of its own, independently of the presence or absence of life. But the important point to note is that life is known to exist and to form an essential and inseparable part of this universe. Therefore, any physical description of the cosmos *must* obey the principle mentioned above. Heim's theory satisfies this criterion, while other theories do not. This line of reasoning is behind the assertion that the neglect of life phenomena is indirectly responsible for the limitations exhibited by relativity and quantum field theory. The very good agreement with experiment of Heim's calculated mass spectrum of elementary particles may be regarded as verification of his physical theory. Since it joins smoothly to the theory of life processes, by inference his description of the latter in terms of a multivalued logic should also be correct.

Due to the inclusion of life, Heim's theory is more comprehensive than conventional descriptions of nature and sheds some light on phenomena which so far have resisted efforts to accommodate them in today's world view. This is particularly true of the whole range of paranormal effects, whose very existence is doubted by many because they do not fit into the picture of modern science. As it turns out, what appears to be "paranormal" when perceived by our senses, limited to register processes in only 4 dimensions, is perfectly normal in 6 dimensions.

Until now, no satisfactory explanation has existed for the phenomenon of life, consciousness, and intelligence. It is more than doubtful that chemical and physical reactions alone are responsible for the development of a single cell into a human being of incredible structural complexity and with a brain capable of creating the most inspired and ingenious works of art, literature, science, and technology. The mystery of paranormal effects is no greater than that of "normal" life, and we should not be surprised that the interpretation of one automatically leads to an interpretation of the other. Thus, Heim's theory quite naturally covers not only the world of non-living and living matter, but also the domain of pure ideas and transcendental phenomena.

Unfortunately, the transcendental part of Heim's theory, describing processes beyond the purely physical realm, only exists in the form of an unpublished manuscript, but several of its main features have been published by Heim in the form of small booklets (Heim 1980, 1982, 1990b). Additional summaries are published by one of the authors (v. Ludwiger, 1979c, 1992), and Senkowski (1983).

Sections 2–11, covering the theory's basic philosophy and its application to the structure of elementary particles, are based to a large extent on a paper published in the *Journal of Scientific Exploration* (Auerbach and v. Ludwiger, 1992). A few formulas are included in the main text, but the reader may skip them, since they are not essential for an understanding of the article. Most technical details are deferred to the appendices. Sections 12 and 13 briefly describe the extension of Heim's theory to the transcendental domain and the projector theory of one of the authors (v.L.) about the exchange of information across interstellar distances and a possible mode of transportation for spacecraft.

2. Field Mass and Heim's Modified Law of Gravitation

It is well known in physics that energy is stored in the gravitational field surrounding any material object. Heim concludes that in accordance with Einstein's relation $E = mc^2$ (E = energy, m = mass, c = velocity of light = 300'000 km/s) this field energy must have associated with it a field mass, whose gravitation modifies the total gravitational attraction of an object. Einstein realized this, too, but ignored the field mass because of its small magnitude.

The existence of field mass leads to a modification of Newton's simple law of gravitation. Newton's law specifies the force F between two masses in terms of the distance r separating them. If one mass is equal to 1 kg and the other is denoted by M, then the force between them is,

$$\text{Newton's law:} \qquad F = \gamma \frac{M}{r^2}\ , \tag{1}$$

where γ (gamma) $= 6.67221 \times 10^{-11}$ m^3/kg s^2 is the gravitational constant.

Due to the existence of field mass, the gravitational force in Heim's theory is the solution of a so-called "transcendental" equation, i.e. an algebraic equation having no simple solution (cf. Appendix B). Nevertheless, approximate analytical solutions, i.e. formulas, can be derived for various ranges of the distance between two masses. According to Heim, the gravitational force in the normal, macroscopic range, which a mass M exerts on a mass of 1 kg, is given approximately by the expression,

$$\text{Heim's law:} \qquad F \approx \gamma \frac{M}{r^2}\left(1 - \frac{r^2}{\rho^2}\right)\ , \tag{2}$$

the value of ρ (rho) being about 150 million light years or 1.42×10^{21} km (1 light year = 9.46 trillion (10^{12}) km).

As is to be expected, the force given by Eq. (2) is virtually indistinguishable from that of Eq. (1) out to distances of many light years. Thereafter, the force of Eq. (2) begins to weaken more rapidly than Newton's law and goes to zero when $r = \rho$. At still greater distances it becomes weakly repulsive. The repulsion is of a special kind: Objects moving towards M are repelled, but objects moving away from it are not. Finally, at very large distances the approximation of Eq. (2) becomes invalid. It can be shown, however, that the gravitational force at a very great maximum distance goes to zero and stays zero, because at distances exceeding it the force becomes unphysical. This is further discussed in Appendix B. The greatest possible distance in 3 dimensions, denoted by D, is the diameter of the universe.

3. The 6–Dimensionality of the World

In addition to the normal gravitational field described by Eq. (2) the field mass gives rise to a second gravitational field, whose relation to the first is very similar to the relation between magnetic and electric fields. In the literature the second field sometimes is referred to as the "mesofield". In free space the two fields are orthogonal to each other.

The result of this is a set of equations governing the two dissimilar gravitational fields quite analogous to those describing the electromagnetic fields (Maxwell's equations). The main difference is the appearance of the field mass in the gravitational equations in the place where zero appears in Maxwell's equations. The zero in the latter is due to the non–existence of magnetic monopoles.

This difference renders Heim's gravitational equations less symmetric than the electromagnetic ones. The same lack of symmetry also applies to a unified field theory, combining electromagnetism and gravitation, which cannot be more symmetric than its parts.

In the macroscopic world the general theory of relativity has introduced a new concept into physics. It assumes that the properties of space itself are modified in the presence of masses. However, the equations of relativity are restricted in the sense that they only govern gravitation. In addition, they are too symmetric to satisfy the above asymmetry criterion, and they cannot be extended to the microscopic world of quantum theory. For this reason Heim regards relativity as an incomplete description of nature. He does, however, accept its basic philosophy of space being capable of deformation.

On passing from the macrocosm to the microcosm of elementary particles, Heim relates quantities describing the deformation of space to the energy states of the system responsible for the deformation, in analogy to general relativity. Energy states are known to occur in discrete, so–called "quantum" steps, like the discrete energy levels of hydrogen atoms. These considerations determine the general form of equation describing the microscopic states of a system in Heim's theory.

Einstein's general relativity results in a set of 16 coupled equations (6 of which occur twice). The figure 16 is equal to the square of the number of dimensions. Hence, according to relativity, our world appears to be 4–dimensional (because $16 = 4^2$) and consists of 3 genuine dimensions and one dimension proportional to time.

In contrast, Heim finds at least 36 equations describing the microcosm. Again, this must equal the square of the number of dimensions, so that the microscopic world appears to be at least 6–dimensional. Since there can exist only one set of laws in nature, it must be possible by appropriate transformations to carry the microscopic equations over into the macroscopic domain. The conclusion, therefore, is that the universe we live in is at least 6–dimensional and not 4–dimensional. *All 6 coordinates are orthogonal to each other*, i.e. the angle between all coordinate axes is 90°. Some details of the concepts discussed above are presented in Appendix A.

The macroscopic equations of unified field theory, coupling together the fields of electromagnetism and gravitation, could be derived if a 6 by 6 array of 36 quantities, known as the 6–dimensional "field tensor" of the unified field theory were known. The resulting equations would show how gravitation (or antigravitation) could artificially be produced from magnetic fields. Unfortunately, the field tensor is not known. Heim's published version of a unified field theory is confined almost exclusively to the microscopic domain of elementary particles. An attempt to derive a macroscopic 4–dimensional set of equations is presented in the article *The Generation of Antigravity* in this volume, where a 4–dimensional field tensor is shown in Eq. (A40). However, the tensor and the equations derived from it are only approximations of the true situation.

4. The 5th and 6th Dimensions

It can be shown that the number of genuine dimensions, i.e. those measurable with yardsticks, is limited to 3. A space of more than 3 true dimensions leads to unstable atomic and planetary orbits. For this reason higher dimensions cannot be genuine. The 4th dimension, for example, is proportional to time, which is measured with clocks and not yardsticks. The 5th and 6th dimensions have to be something different again, because more than a single time dimension again leads to unphysical results (Cole, 1980). According to Heim, the two higher dimensions are associated with organizational properties. They will be called "transdimensions" or "transcoordinates", to distinguish them from the four dimensions with which we are all familiar. For brevity, they are denoted by x_5 and x_6.

Modern superstring theory, describing the interactions between elementary particles, also involves the use of more than 4 dimensions. However, following a suggestion by Kaluza and Klein, all but 4 of them curl up in such a manner that they exist only in dimensions of the order of 10^{-35} m. Thus they are hidden and do not manifest themselves in the macroscopic world.

x_5 is a coordinate designating the degree of organization of a system. It is known in physics that entropy, which is a measure of *dis*organization, can be expressed in terms of a logarithm of the probability that the system is in a certain organizational state. The 5th coordinate expresses the opposite of disorganization, hence it is measured in units of the *negative* logarithm of a probability, multiplied by a constant giving it the dimension of length.

The function of x_5 can be demonstrated by using the living cell as example. Its interior consists of various regions having very different degrees of organization. The liquid cell plasma consists mainly of water having a low order of organization, unless one goes down to the atomic level, which we shall not do here. Cell nucleus and organelles, on the other hand, are complex, highly organized structures. If we had a mathematical expression for the material density of the cell's interior, it would yield a fairly constant value throughout the cell volume, since most cell constituents have the approximate density of water (actually, the cell is much too complex to allow a mathematical description).

Quite a different answer is obtained if we ask for the density of *organized* matter inside the cell. This would require a revision of our hypothetical formula and the introduction into it of x_5, the organizational coordinate. Choosing a numerical value for x_5 specifies the organizational state of the material whose density throughout the cell volume is given by the formula. Suppose we choose a low value for x_5. By so doing, we ask the formula to give us the distribution of matter inside the cell having a low degree of order. As a consequence, the formula will yield normal density in the cell plasma only. In the cell nucleus and the organelles the density will turn out to be close to zero, because these are not regions of low organizational order. Conversely, if x_5 is given a large numerical value, implying high structural organization, the *same* formula will give normal density in the nucleus and the other structured regions of the cell, but very low density in the plasma.

The structure of an elementary particle has a whole range of organizational features in various localities in its interior. Specifying a numerical value for x_5 each time isolates the density of that portion of the internal particle structure whose organization corresponds to the chosen value of x_5.

Many material objects have the tendency to change their structure and hence their organization as a function of time until they reach a final, stationary state. The dependence on x_5 of the mathematical expressions describing such configurations is a measure of the degree of organizational order prevailing in a system during the various phases of its evolution in time until it reaches the final state of stability. Organizational states evolving in time towards a final goal were defined already in antiquity as "entelechial" systems. Accordingly, Heim calls x_5 the *entelechial* coordinate.

The above interpretation of x_5 is valid in the purely physical domain. Highly complex systems such as living beings, which cannot be described in mathematical terms, require a different interpretation of x_5. This will be discussed in Section 12.

The 5th and 6th coordinates work together as a team and always appear in combination. The task of x_6 in this team is to guide the structure evolving in time, whose organizational condition is specified by x_5, towards the stationary, dynamically stable configuration.

Most physical systems are guided by x_6 towards a state of maximum disorder. A house, for example, is a highly organized structure, but if left alone it eventually ends up as a disordered pile of rubble. In this example, x_6 guides states of high order towards those of low organizational order. *Life processes, on the other hand, are guided in the opposite direction, i.e. from disorder to order!*

Due to its function of directing the development in time of each individual system, x_6 fulfills the important task of guiding the evolution of the entire universe. This is illustrated by the following example: Let each picture of a film strip show an instantaneous state of a 3–dimensional world. Then the film as a whole represents the development in time of a possible universe. Now imagine a great number of other films stacked up all around the first one. Each of them again pictures the world, but with at least one single change compared to its neighboring strips. A line drawn arbitrarily through the block of films is called a "world line". Each film strip represents a possible sequence of uniquely determined events in our universe, and a world line intersects the pictures corresponding to the actual development of the universe in time. If there exists no intention, usually on the part of intelligent beings, of providing some guidance to world events, then the world line is confined to a single film strip, indicating a world history that is determinate. However, if intelligent guidance is provided, the line "jumps" from film strip to film strip. The actual world line is guided by the 6th coordinate through the block of films, intersecting the pictures corresponding to the true temporal development of the cosmos. At each time step the 6th coordinate determines which state of the universe is to become reality.

Both transdimensions always act together, no event of any kind can involve only one of them. In fact, every event *must* involve both dimensions. All structures existing in the 3–dimensional world of our experience (4 if time is included) extend into the two transdimensions.

x_6 is called the *aeonic* coordinate for reasons to be explained in Section 9.

It should be noted that the meaning of x_5 and x_6 is by no means obvious, but has had to be deduced by Heim from his formalism on the basis of circumstantial evidence. For this reason the definition of both transdimensions is not as sharp and clear–cut as that of, for instance, length and time. This is especially true with respect to higher than purely physical structures, for there the transcoordinates appear as qualities and not as quantities. Qualities are always difficult to define in precise terms.

5. Minimum Distance and Metron

Heim's gravitational law differs from Newton's not only at very large distances but also at very small ones. There exists a very small minimum distance, R_-, below which the force again becomes unphysical. An approximate expression for this distance is (cf. Appendix B),

$$R_- \approx \left(\frac{3\,e}{16}\right)\frac{\gamma M_0}{c^2}\ , \quad e = 2.71828...\ , \tag{3}$$

where M_0 is the mass confined within R_-. The subscript 0 indicates that the field mass is not included in M_0. R_- is about 4 times smaller than the so–called Schwarzschild radius of general relativity, R_S,

$$R_S = 2\frac{\gamma M_0}{c^2}\ , \tag{4}$$

closely related to the formation of black holes.

Even more significant than the maximum and minimum distances is a third distance relation derived from Heim's gravitational law. In the limit of vanishing mass, i.e. in empty space, a non–vanishing relation can be derived, involving the product of the minimum distance R_- and another small length, known in quantum theory as the Compton wavelength λ (lambda), given by,

$$\lambda = \frac{h}{M_0\,c}\ . \tag{5}$$

Here h is Planck's constant equal to 6.62608×10^{-34} kg m^2/s. The product cannot be obtained by simply multiplying Eq. (3) by Eq. (5), because the former is an approximation. Using the exact formula and letting M_0 go to zero, results in a quantity which Heim calls a "metron" and designates by the symbol τ (tau),

$$\tau = \frac{3\,\gamma\,h}{8\,c^3} \; . \qquad (6)$$

Being the product of two lengths, τ clearly is an area measured in square meters (m^2). It is composed of natural constants only and, therefore, is itself a constant of nature. The expressions above are derived in Appendix B. The present size of a metron, according to Eq. (6), is

$$\tau = 6.15\times10^{-70}\ m^2 \; . \qquad (7)$$

(The figure 6.15×10^{-70} has 69 zeros behind the decimal point, followed by the number 615), The significance of a metron is the fact that it exists in empty, 6–dimensional space. This leads to the conclusion that space is subdivided into a 6–dimensional lattice of metronic cells. Each cell is finite in size and bounded on all sides by metron–sized areas. This is a radical departure from the generally held view that space is divisible into infinitely small cells. Independently of Heim, other authors in an attempt to quantize gravitation have found elementary areas of dimensions similar to that of a metron (Ashtekar et al. 1989).

The sense in which a 6–dimensional cell is surrounded on all sides by 2–dimensional metrons may require some further explanation. A 3–dimensional cube will serve as example. It is bounded by six 2–dimensional surfaces. Each surface in turn is bounded by 4 edges or lines, forming what may be called 1–dimensional surfaces having length as their only dimension. Finally, each edge is bounded at its ends by two point–like corners or surfaces of dimension 0. This illustrates the fact that a cube may be bounded by "surfaces" of dimensionality 2, 1, or 0. The model of a cube made from solid material will emphasize its 2–dimensional surfaces, but a wire model displaying only the edges represents the cube just as well. The cube size is determined either by the size of its 6 surfaces or, alternatively, by the length of its 12 1–dimensional sides.

The example above shows that surfaces always have one dimension less than the volume they bound. A 4–dimensional cube, for instance, is bounded by 3–dimensional surfaces, which to us would appear as cubes. Clearly, it is impossible to visualize a cube as a 3–dimensional surface. This demonstrates the characteristic difficulty of trying to form a mental picture of configurations having more than 3 dimensions.

Nevertheless, the example above can now be generalized to a 6–dimensional cube. It is bounded on all sides by 5–dimensional "surfaces". These in turn have surface–like boundaries of dimensionalities 4, 3, $\underline{2}$, 1, and 0. The 2 is underlined to indicate that 2–dimensional metrons clearly belong to the areas bounding a 6–dimensional cell. Just like a 3–dimensional cube can be constructed from 1–dimensional wires, so a 6–dimensional volume can be built up from 2–dimensional metrons, and just like the side lengths limit the volume size in the 3–dimensional case, so the very small metronic size limits the volume of 6–dimen–

sional cells bounded by them.

It should be borne in mind that a 6–dimensional cube is very different from a 3–dimensional one. In the most general case, if the cube is n–dimensional and N is the number of k–dimensional surfaces bounding it, then N is given by the formula,

$$N = 2^{n-k} \frac{n!}{(n-k)!\,k!} \,. \tag{8}$$

(The quantity n! is called n–factorial and equals the product of all integers from 1 to n. For example, $5! = 1 \cdot 2 \cdot 3 \cdot 4 \cdot 5$). For $n = 6$ and $k = 2$ one finds 240 metrons bounding a 6–dimensional metronic cube!

6. Metronic Mathematics

The result that no area in Heim's 6–dimensional universe can be smaller than a metron requires a revision of some branches of mathematics. Differentiation, for example, assumes that a line can be decomposed into an infinite number of infinitely small segments. Conversely, integration recomposes the infinitely small segments back into a line of finite length.

In Heim's theory, differentiation and integration must be changed to comply with the metronic requirements mentioned above. A line cannot be subdivided into infinitely small segments, because an infinitesimal length normally is not part of an area of finite, metronic size. Similarly, integration is changed into a summation of finite lengths. While the mathematics of finite lengths has been developed in the literature (Nörlund, 1924; Gelfond, 1958), the novel feature of Heim's metronic theory is that it is a mathematics of finite *areas*.

Obviously, the metronic area of 6.15×10^{-70} m^2 is exceedingly small. To get an idea of the smallness of τ, consider a sphere whose surface area is just equal to one metron, making its radius equal to 7×10^{-36} m. If the radius of this metronic sphere were enlarged to one meter, then a proton to the same scale would have a radius of 23'000 light years, or half the radius of our Milky Way galaxy! Just for comparison, if the radius of a proton at the center of a hydrogen atom were enlarged to one meter, then the atomic electron would revolve about it at an approximate distance of "only" 35 kilometers.

A metron is so tiny that for many applications it may be regarded as infinitesimal in the mathematical sense. In such cases Heim's metronic mathematics goes over into regular mathematics. There are instances, however, when it becomes obligatory to use metronic differentiation and integration.

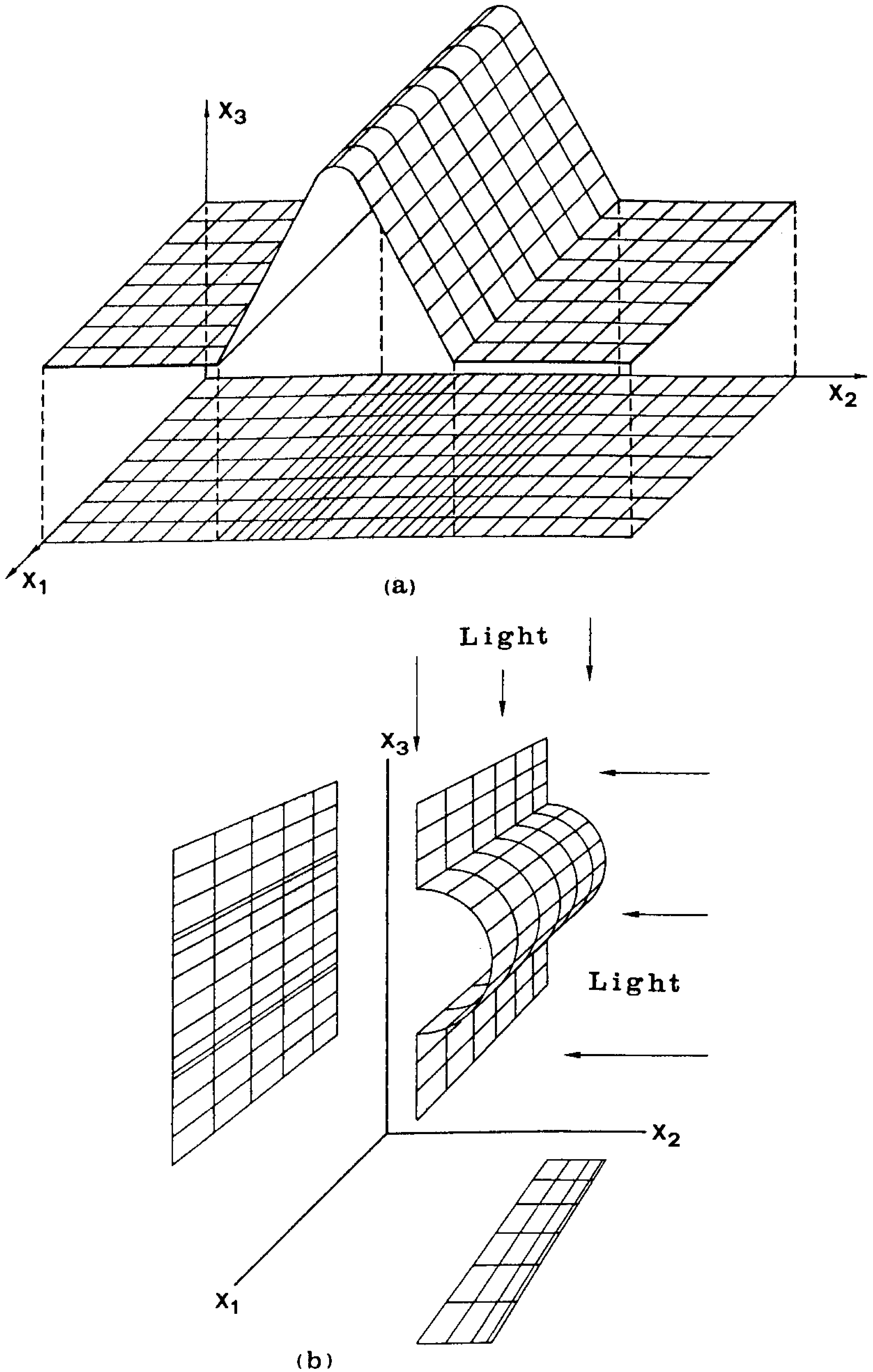


Fig. 1. Two–dimensional condensations (projections) of 3–dimensional met–ronic sheets.

7. The Building Material of Elementary Particles

Empty space has been shown to consist of an invisible lattice of metronic cells. One can visualize them as little volumes, whose walls are metrons, touching each other and filling all of space. The orientation of the areas is related to the quantum mechanical concept of spin.

Uniformity of the lattice signifies emptiness. Conversely, if the lattice is locally deformed or distorted, this deformation signifies the presence of something other than emptiness. If the deformation is complicated enough it might, for example, indicate the presence of matter. This implies that there really is no separate substance of which particles are composed. What we call "matter" is nothing but a locally confined geometric structure in vacuum. Pure vacuum has the ability to deform its 6–dimensional lattice structure into geometrical shapes. That portion of it, which extends into the 3–dimensional space perceived by our senses, is interpreted by us as matter.

The situation is somewhat analogous to the formation of a vortex in air. Still air corresponds to complete emptiness, having no recognizable geometric properties. A tornado, on the other hand, is a fairly well defined geometric structure in air. Its funnel–like shape clearly differentiates it from the surrounding atmosphere, which is not in rotation, but it still consists of air only and not of any separate material.

The same is true of geometrical structures in space. They clearly differ from complete emptiness, but their "construction material" nevertheless is vacuum. It should be emphasized, however, that a mere deviation from uniformity of the metronic lattice does not automatically constitute matter.

The metronic lattice should be viewed as a dynamic structure. It is in a state of constant pulsation and vibration, forming regions of greater and lesser density. This dynamic activity gives rise, among other things, to the well–known phenomenon of vacuum fluctuations.

8. Metronic Condensations

The term metronic "condensation" is frequently used by Heim in connection with the structure of elementary particles. Since the concept cannot be visualized in 6 dimensions, it will be explained with the aid of a 3–dimensional model.

Figures 1a and 1b illustrate transparent sheets, each having a central bulge. The sheets are covered with a square lattice of straight lines. Each of the many squares formed in this manner is supposed to represent a metron, so that each figure illustrates what may be called a "metronic sheet". Note that the metrons are not deformed, although the sheets are. Three rectangular coordinate axes are drawn in Fig. 1, denoted respectively by x_1, x_2, and x_3. They may be thought of as marking three corners of a room, whose floor is the x_1–x_2–plane, and two of whose vertical walls are the x_1–x_3– and x_2–x_3–planes.

If the sheets are illuminated from above, the grid lines will cast shadows on the floor, as shown in the drawings. Illumination from the right in Fig. 1b also casts a shadow on the left wall. In technical language these shadows are called projections of the grid on the respective walls. It is immediately evident that the square metrons in certain regions of the projected images become narrow rectangles. These regions' are the metronic condensations referred to in the heading, because the squares are compressed, or condensed, in one direction.

There exist areas of maximum condensation, where the projected metrons are compressed into thin rectangles, and other areas, where they project essentially as uncompressed squares. Note that some areas on the metronic sheet in Fig. 1b, showing minimum condensation in the x_1–x_3–plane, show maximum condensation in the x_1–x_2–plane.

Actually, Figs. 1a and 1b even in 3 dimensions are convenient simplifications of the true situation. The unperturbed metronic lattice, as mentioned in Section 7, is a network of cells. A disturbance would create a distorted *volume*, which might be pictured as a sequence of distorted parallel metronic sheets, the most deformed of which are pictured in the drawings. The distortion diminishes with increasing distance of the sheets from the ones drawn, until the undisturbed cubic lattice is re–established.

According to general relativity, a material object distorts space. This is illustrated in Fig. 2 for the earth–moon system. Space is pictured as a rubber sheet into which the heavy earth and the much lighter moon sink in to different depths. In Heim's theory the sheet is covered with a net of metronic squares. This enables one to express the space curvature, as the distortion is called in general relativity, by examining the density of compressed metrons in the projection of the sheet on a 2–dimensional plane, as shown in Fig. 2. Again, the distortion affects a large volume and not just a single sheet.

The deformations need not be static. They can rotate or pulsate or change shape in some other dynamical way, with the projections following suit.

This picture can now be generalized to a 6–dimensional lattice with a localized static or dynamic deformation, forming a condensation in our space, i.e. projecting a 3–dimensional pattern into our world. The 3–dimensional projections in 6–space are the generalizations of the 2–dimensional projections in 3–space illustrated in Figs. 1 and 2. Such condensations form the basis of matter and elementary particles. A

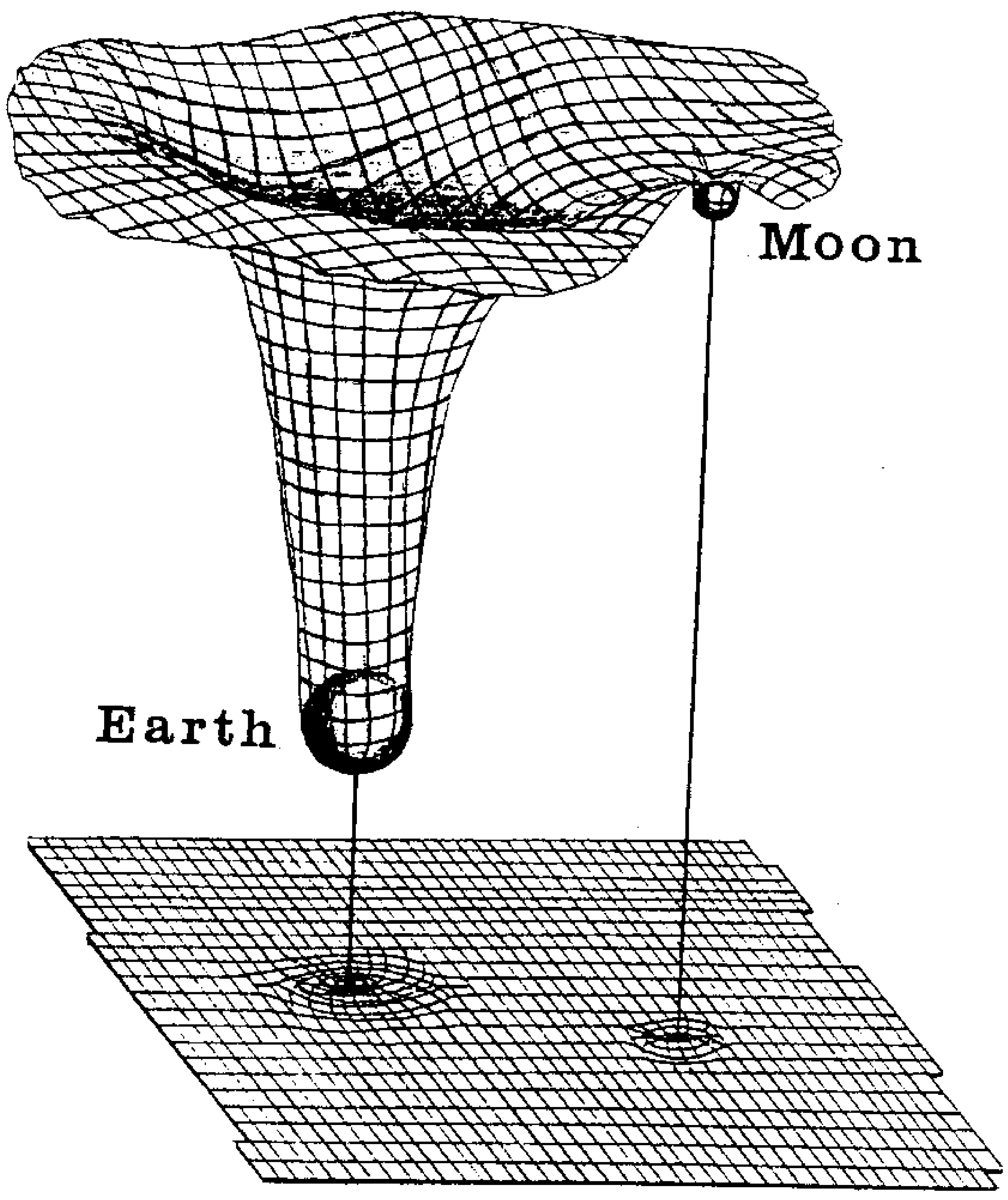


Fig. 2. 3–dimensional space curvature caused by the earth–moon system and its 2–dimensional projection.

piece of matter that can be seen, touched, and weighed is merely the projection into our 3–dimensional space of the true, 6–dimensional lattice deformation, just as the shadow of a tree is the 2–dimensional projection of its true 3–dimensional shape.

9. Cosmology

In Heim's theory, both the cosmic diameter D and the metronic size τ depend on the age of the universe, T. The dependence is such that D is presently expanding and τ is contracting, so that D was smaller in the past and τ was larger. It stands to reason that at one time in the distant past the area πD^2 of a sphere of diameter D in our 3–dimensional world was equal to the metronic area τ. This instant marks the origin of the universe and the beginning of time.

The mathematical relation between D and τ is not simple. If the surface of diameter D is much greater than τ, the relation is given approximately by (cf. Appendix C)

$$D \approx \frac{\pi}{e}\left(\frac{3}{32}\sqrt{\frac{3}{2}}\,\frac{\pi}{e}\right)^{\frac{4}{3}}\frac{E^{7/3}}{\tau^{11/6}}\,, \qquad e = 2.71828\ldots\,. \tag{9}$$

In the equation above, $E = 1\ \mathrm{m}^2$. In numerical calculations, E may simply be set to unity, but it is important to keep it in the formula for dimensional reasons, since without it D would not have the dimension of length.

When πD^2 is equal to τ, the relation between D and τ is much more complicated and involves the solution of a seventh order algebraic e–quation. Three different values of D are found to satisfy this equation at the beginning of time. It follows that the universe started out as a trinity of spheres, whose diameters turn out to be (in meters),

$$D_1 = 0.90992\ \mathrm{m}\,, \qquad D_2 = 1.06426\ \mathrm{m}\,, \qquad D_3 = 3.70121\ \mathrm{m}\,. \tag{10}$$

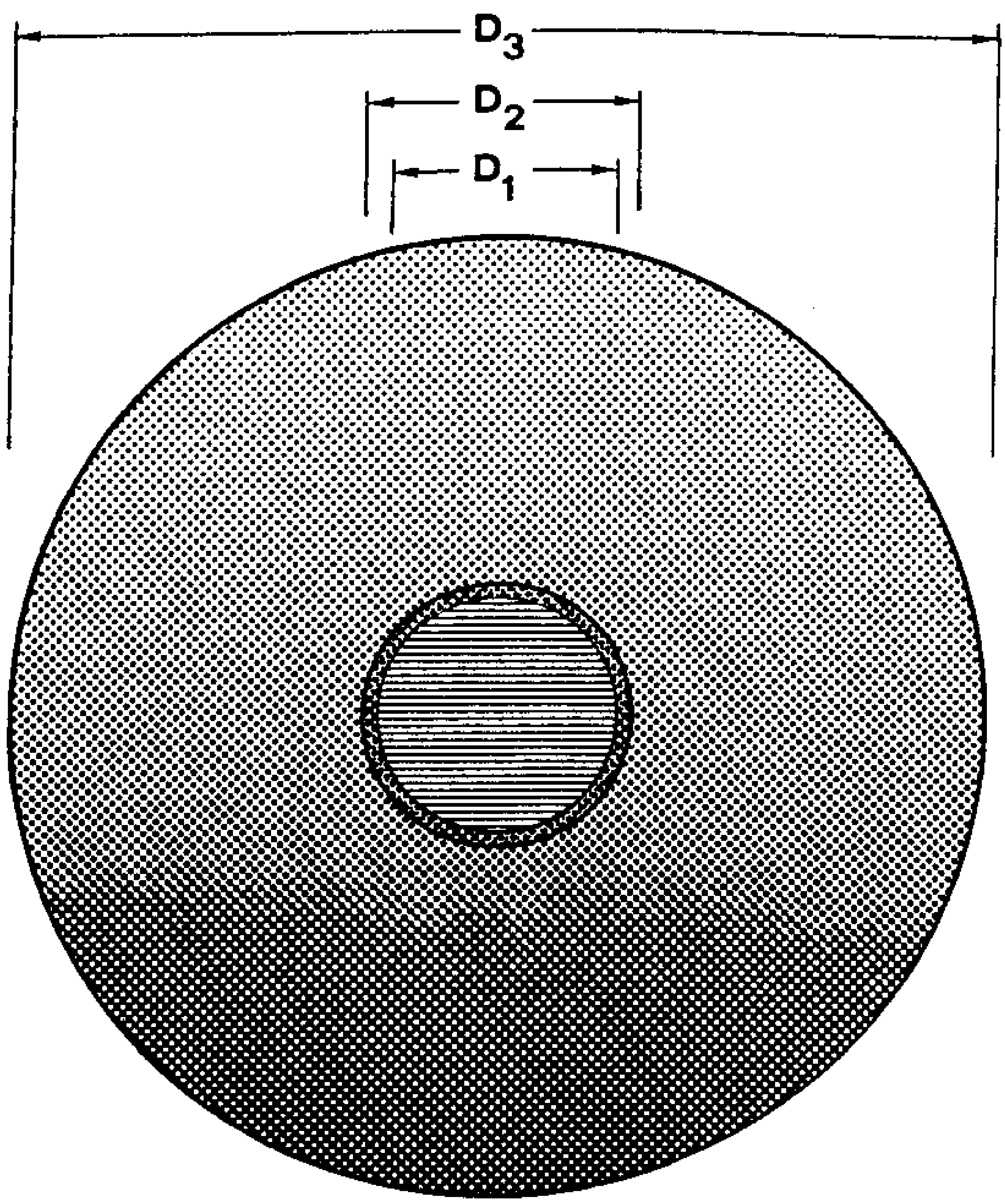


Fig. 3. Diameters of the initial trinity of spheres drawn to scale. $D_1 : D_2 : D_3 = 0.91 : 1.06 : 3.70$.

These figures are derived in Appendix C. The ratio $D_1 : D_2 : D_3$ is il– lustrated in Fig. 3. It is a strange coincidence that the size of the uni–

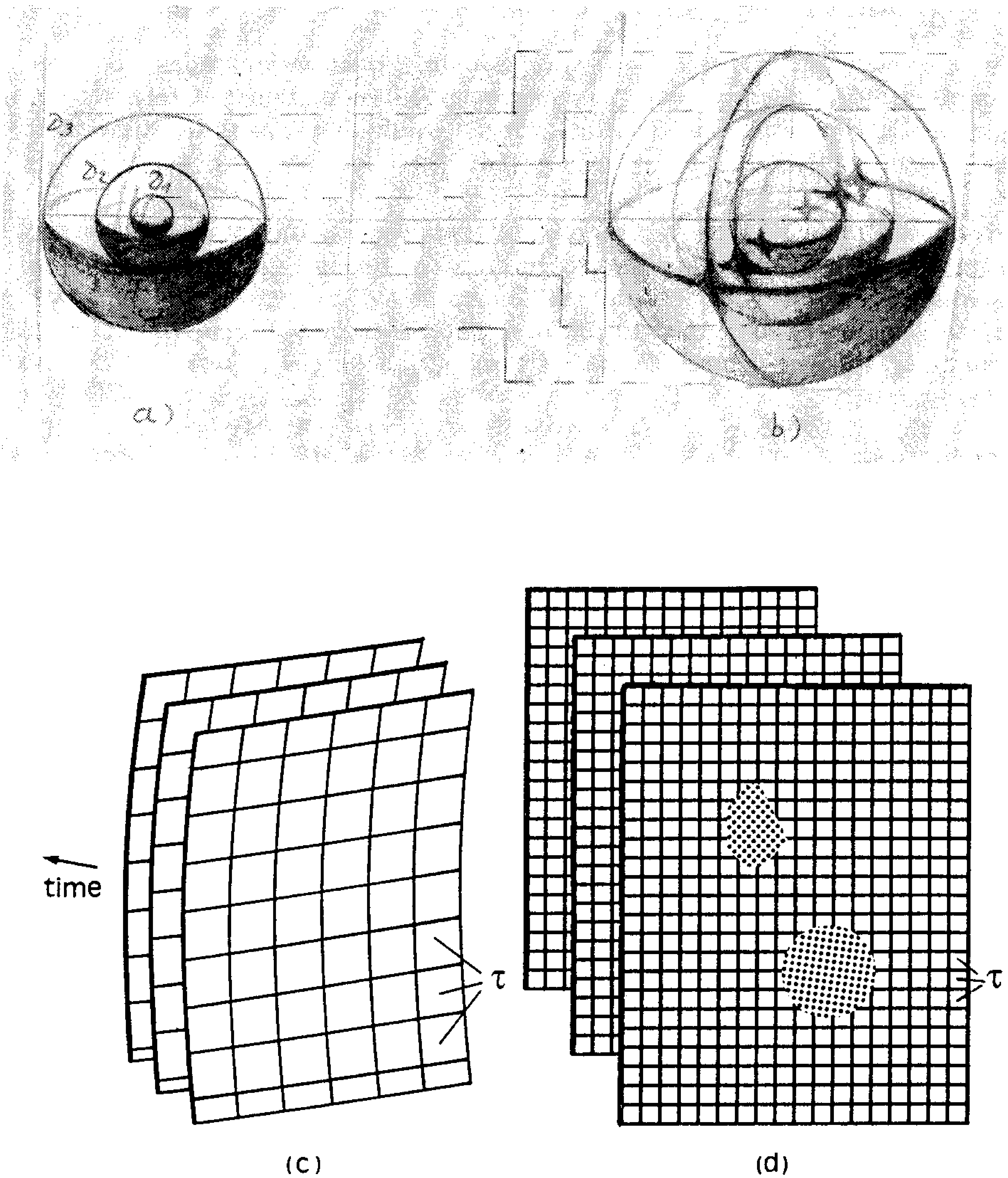


Fig. 4. Development of the original trinity of spheres in time. (a) The initial configuration at time $T = 0$ with $\pi D_3^2 = \tau$. (b) One chronon later. The spheres have expanded and the outer one is subdivided into metrons, symbolized by quadrants. (c) A portion of the expanding metron–covered spheres at a much later time. The metrons have grown smaller. (d) A part of the 3 expanding spheres at a time when met–rons are small enough to form condensations and matter.

verse at the start, according to theory, has had dimensions easily visualized by us.

The magnitude of τ at the beginning of time, $T = 0$, $D = D_3$, was 43.04 m^2. Since then it has shrunk to 6.15×10^{-70} m^2, and, since all constants of nature are functions of the metronic size, they too have changed in accordance with their dependence on τ.

The development of the universe may be followed from the original trinity of spheres to its greatest diameter and back to the origin. In Heim's theory time is quantized, i.e. time proceeds in finite steps. Each step corresponds to a smallest time interval, called a "chronon", δ (delta), given by the relation,

$$\delta = \frac{3}{4} \frac{e \, \tau^{5/6}}{2^{1/3} \, \pi^{1/4} \, E^{1/3} \, c} \, . \tag{11}$$

The initial steps in the development of the cosmos are expressed in terms of chronons. The first chronon at the beginning of time, when τ had a magnitude of 43.04 m^2, lasted 9.32×10^{-8} seconds according to Eq. (11). Nowadays, with τ having grown so small, its duration is reduced to 8.55×10^{-67} seconds.

Figure 4 illustrates the initial phases in the development of the universe and some of the later ones. The 3 spheres of diameters D_1 to D_3 are shown in Fig. 4a at time $T = 0$. The surface area of the outermost sphere is $\tau = \pi D_3^2$. After the first time step δ the outermost sphere expands and enters time, the middle sphere expands to diameter D_3, and the inner sphere expands to diameter D_2. This situation is shown in Fig. 4b. The surface of the outer sphere, which originally had an area equal to τ, now is subdivided into a number of metrons. This is indicated schematically by the quadrants in Fig. 4b. The exact shape of the metrons is unimportant and may differ from the one shown. After a further chronon has elapsed, the inner sphere expands to diameter D_3 and the two outer ones expand further and are covered with an increasing number of metrons. Finally, another chronon later, the inner sphere expands one more step and it, too, enters time. The last two stages are not shown in the drawing.

From this moment on, the three spherical shells expand together, the inner one always a chronon behind the middle sphere and the outer one always a chronon ahead. At the same time the number of metrons on each spherical shell multiplies and each metron becomes smaller as time goes on. The situation after a long period of time is illustrated in Fig. 4c. It shows a section of the 3 spherical shells, each a chronon apart and covered with a great number of small metrons. The final drawing, Fig. 4d, pictures the situation at the time matter begins to appear. The spheres are so large that parts of them resemble planes, and the metrons have become so small that condensations are able to form. This is discussed in more detail further down.

It may be surprising that the visible universe should be confined to the surfaces of 3 concentric spherical shells. Actually, as we all know, the universe occupies a huge volume of many cubic light years. What happens, however, is that as soon as time enters the picture the 3–dimensional spheres of Fig. 4 become 4–dimensional, time being the 4th dimension. In reality, the visible universe is confined to the surfaces of three 4–dimensional spheres. The 3–dimensional projection of a 4–dimensional spherical surface is a 3–dimensional volume, and the corresponding projections of the square metrons in Figs. 3b to 3d become 3–dimensional cubes. Each sphere is truly 3–dimensional only during the short time its diamter is equal to D_3 and its surface area is equal to a single τ.

The three spheres are to be interpreted in the sense that the middle sphere is the present, the inner sphere is one chronon behind in the past, and the outer shell is one chronon ahead in the future. Since the 3 spheres always stay together, they have an important bearing on the structure of elementary particles.

Heim's theory results in a present age of the universe approximately equal to 5.45×10^{107} years, and a diameter D of about 6.37×10^{109} light years. This latter figure is obtained by substituting numerical values into Eq. (9).

During most of its existence the universe consisted of an empty metronic lattice, whose metrons kept getting smaller as the universe grew larger. Eventually, metrons became small enough for matter to come into existence. This may have occurred some 15–20 billion (10^9) years ago, at which time matter was created throughout the cosmic volume. Hence, according to Heim, matter did not originate very soon after a big bang explosion but more uniformly in scattered "fire–cracker" like bursts, perhaps of galactic proportions. In this way, Heim's cosmology combines the advantages of the big bang theory with those of the steady state hypothesis developed by Bondi, Gold, and Hoyle.

Spontaneous creation of matter, coupled with the partly attractive and partly repulsive force of gravity mentioned in Section 2, resulted in the observed large–scale structure of the universe.

Creation of matter continues to this day, though on a very much reduced scale. It may, for example, occur in the form of small amounts of matter, as bursts of gamma rays (very hard X–rays), as vortex motions in air, or as balls of light in our atmosphere. These lights may be responsible for UFOs of class B (cf. the introductory article *Are UFOs a New Kind of Natural Phenomenon?* in this volume).

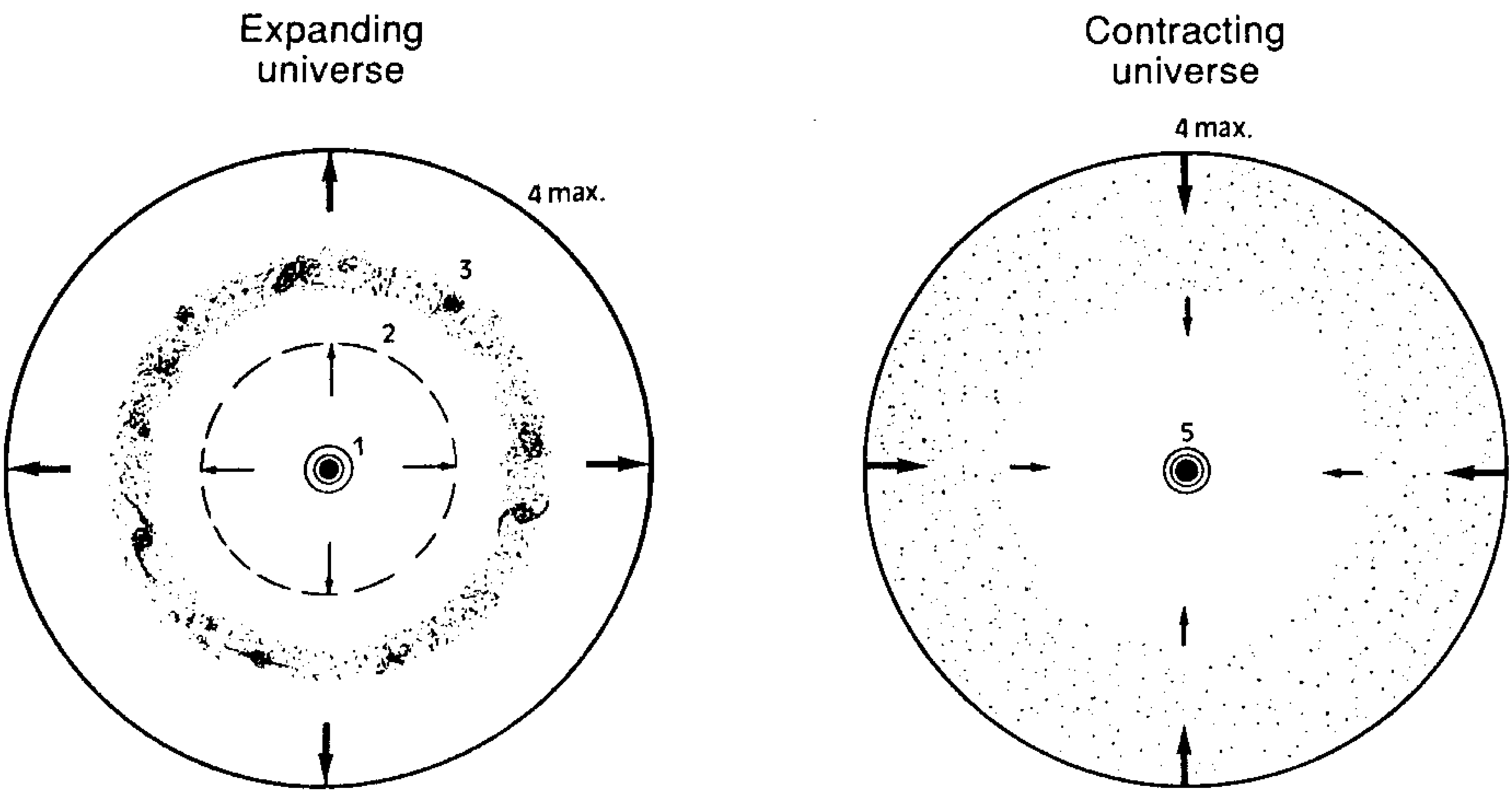


Fig. 5. History of the universe. (1) The trinity of spheres at $T = 0$. (2) The universe at the time matter comes into being. (3) The present universe at $T_{present} = 5.45 \times 10^{107}$ years and diameter $D_{present} = 6.37 \times 10^{109}$ light years. (4) Maximum expansion of the universe at $T_{max} = 8.733 \times 10^{109}$ years with $D_{max} = 1.651 \times 10^{110}$ light years. (5) The final trinity of spheres.

Figure 5 represents the history of the universe from the beginning to the end. It starts at $T = 0$ with the 3 spheres mentioned above. Expanding continuously, it reaches the present size of $D_{present} = 6.37 \times 10^{109}$ light years after the long period of $T_{present} = 5.45 \times 10^{107}$ years. Halfway through its history the universe reaches a maximum diameter, D_{max}. According to Heim's calculations, $D_{max} = 1.651 \times 10^{110}$ light years. This is only 2.6 times larger than the present size, but due to the very low rate of expansion it will take another 8.68×10^{109} years to get there. The age of the universe at the time of its greatest expanse will be $T_{max} = 8.733 \times 10^{109}$ years. This stage is indicated by the largest circle in Fig. 5. Thereafter, the universe contracts again until it reaches the final trinity of spheres after another 8.733×10^{109} years. The trinity of spheres into which the universe collapses at the end of a life cycle is smaller than the original spheres of Eq (10), as shown in Appendix C.

Heim calls the total life span of the cosmos an "aeon". The fact that x_6 guides the destiny of the cosmos throughout this time is the reason for calling it the *aeonic* coordinate.

From the first moment on the universe began to expand, but at a lower rate than is presently predicted on the basis of the red shift of distant galaxies. In Heim's theory, light traveling through space meets more repulsive regions than attractive ones due to the special nature of the repulsive force mentioned in Section 2. This results in a net loss of energy and a shift of the spectrum towards the red. According to Heim, this accounts for the entire observed red shift, the contribution of the expanding diameter D of the universe being insignificant. His calculation of the Hubble radius is in good agreement with observation if use is made of the somewhat uncertain average density of matter in space.

10. The Structure and Masses of Elementary Particles

More than three quarters of Heim's second volume are devoted to the derivation of his final formula for the masses of elementary particles in the ground state and in all excited states. Only the barest outline of the structural complexity of elementary particles can be presented here.

The interior of an elementary particle consists of a number of correlating metronic condensations in various subspaces. The meaning of this is illustrated in Fig. 6. The drawing shows a flexible sphere, or a rubber ball. In 3 of the 4 separate drawings of Fig. 6 the ball is squeezed together in different directions. In each case two of the projections on the walls or the floor are narrow ellipses, while the third projection is undistorted. In each case, therefore, the maximum distortions in the form of narrow ellipses are correlated with the minimum distortion having the form of a circle (foreshortened to a fat ellipse). The ball itself is 3-dimensional, while the walls and the floor are only 2-dimensional. A 2-dimensional space is called a subspace of a 3-dimensional one. In general, any space having fewer than 6 dimensions is a subspace of 6-space. Technically speaking, therefore, Fig. 6 illustrates three 2-dimensional subspaces of 3-space and the way in which the distortion in each subspace, or the condensation if the ball were covered with a grid of squares, correlates with the condensations in the other two. Figure 1b shows a similar type of correlation.

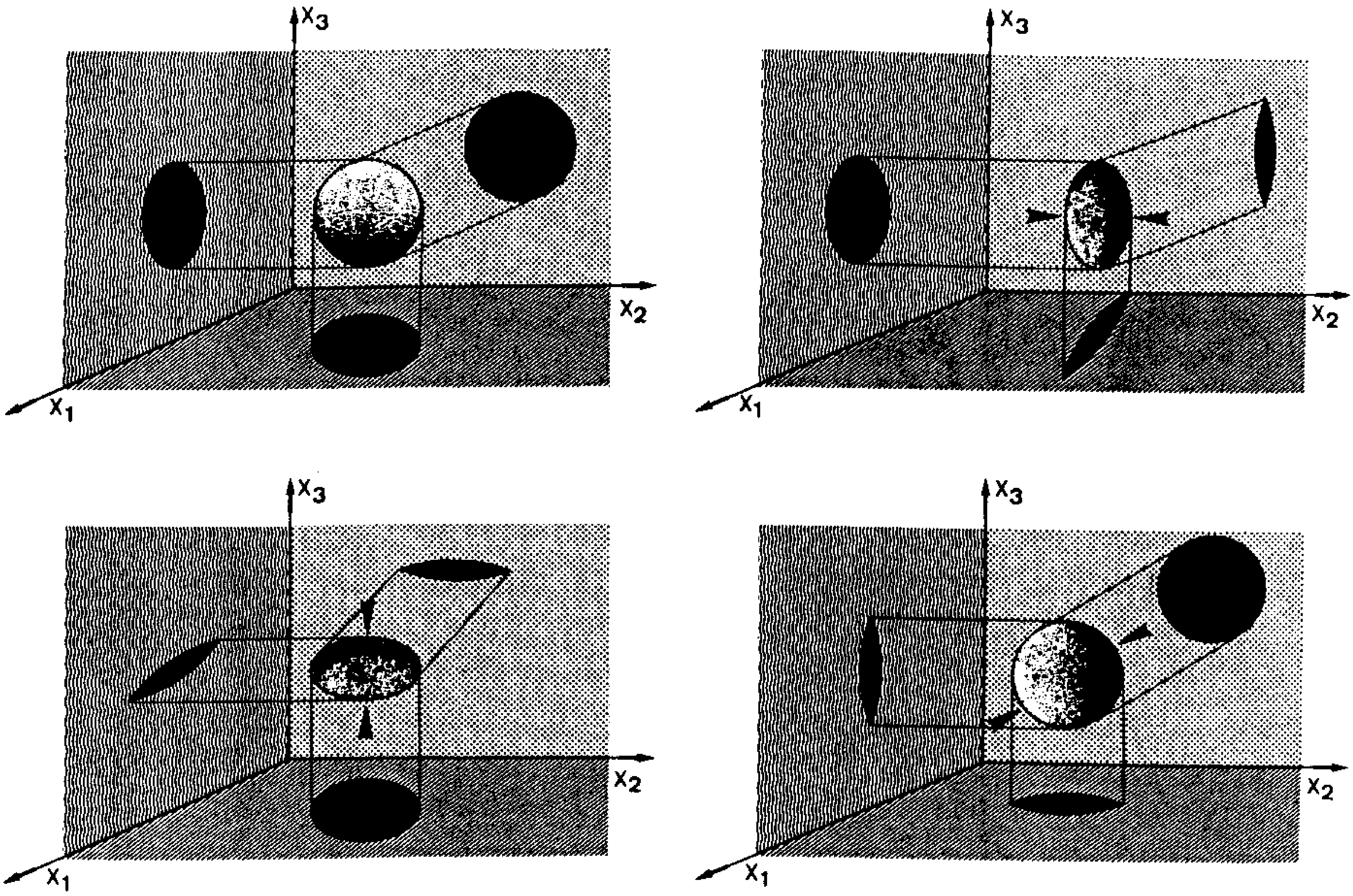


Fig. 6. Correlation of 2–dimensional projections (condensations) on 3 mutually perpendicular walls due to the compression of a flexible sphere in different directions.

The elementary particle configuration projecting into our 3–dimensional subspace of the 6–dimensional physical world consists of 4 concentric zones occupied by structural elements. The subdivision into 4 zones is a consequence of the trinity of spheres characterizing the universe from the first moment of its existence. Maxima and minima of the condensations in the sense of Fig. 6 participate in a rapid sequence of periodic, cyclic exchanges. The internal structures undergo continuous modifications during this process until, after a certain short period of time, the original configuration is re–established. This period is the shortest lifetime a particle possessing mass and inertia can have. In general, a lifetime consists of several cycles. If the initial configuration is not regained after the last period, the particle decays. A particle is stable only if its structure *always* returns to its original form. The cyclic exchanges define a spin which, in this case, is not the result of rotation.

All states of an elementary particle are characterized by 4 genuine quantum numbers. The first 3 are the baryonic number k (k = 1 or 2), the isotopic spin P, and the spin Q. The fourth number can only be either 0 or 1. In addition, there is a number +1 or −1 characterizing particle or antiparticle, a number indicating whether a particle is charged or not, and a number N=1,2,... specifying the state of excitation. Four more quantum numbers refer to the 4 internal structural zones. These, however, cannot be chosen at will but are derived from the numbers listed above.

The actual mass and inertia of particles are not a property of the 3-dimensional structures themselves, as might be thought. Instead, they are the secondary effect of exchange processes between the 4 internal zones described above. These processes are the actual sources of mass and inertia. For this reason, Heim's elementary particles definitely are not composed of particle subconstituents such as quarks. Nevertheless, there exist certain analogies to the quark model, because each elementary particle contains $k+1$ (k = baryonic quantum number) structural units. These, however, are not individual particles such as quarks, but integral components of the internal particle structure. As such they cannot possibly exist outside the configuration they compose. This explains why quarks have never experimentally been observed outside an elementary particle.

For protons and other baryons $k=2$, so that one expects protons to contain 3 pseudo-corpuscular subconstituents. Scattering experiments would be affected by such a triple structure. This may explain why a proton is thought in modern physics to be composed of 3 quarks. Moreover, Heim's formula for the electric charge of a proton, the so-called "elementary" charge e, contains the factor 3, so that phenomenologically one could allocate one-third of the total elementary charge to each of the 3 subconstituents, corresponding to the charge of e/3 generally associated with each quark. This is further explained in Appendix E. The same arguments apply to mesons with $k=1$. They contain 2 substructures in analogy to the two quarks thought to exist in their interior.

Results for the ground states of particles are in excellent agreement with experiment. In addition to the known nuclear particles Heim predicts the existence of a stable, electrically neutral electron, e_0, and its antiparticle. Their mass of $m_{e_0} = 0.5068833$ MeV is about 1% smaller than the mass of their charged counterparts (1 electron Volt (eV) is the mass equivalent of 1.7826×10^{-36} kg, 1 keV = 1'000 eV, 1MeV = 1'000'000 eV). Furthermore, Heim predicts 6 neutrinos, denoted by ν (nu). In the traditional notation their masses are: $\nu_R = 2.003$ eV, $\nu_P = 2.03$ eV, $\nu_\beta = 4.006$ eV, $\nu_\pi = 1.441793$ keV, $\nu(e_0) = 5.375675$ keV, and $\nu_\mu = 11.28781$ keV. On the other hand, the number of excited states each particle can have turns out to be much too large. So far Heim has not succeeded in finding a criterion which would limit the number of excited states to those actually observed.

11. The 4 Types of Elementary Structures

The uniform metronic lattice characterizing empty space can be distorted in several fundamental ways, all but one of which involve fewer than 6 coordinates. Heim finds that there exist 4 basic types of deformation in 6–space. He calls them "hermetry forms" or "hermetric" forms (*hermetry* is a condensation of "*herme*neutics [science of interpretation] of a possible world geome*try*").

a) The first type is a lattice deformation involving only the 5th and 6th coordinates. It is not a projection, but, in order to stay within our terminology, it may be called a self–condensation. In the 4 remaining dimensions the metronic lattice remains undisturbed. Physically, this may be interpreted as a structure existing in the two transdimensions. This is difficult to visualize, because our senses do not recognize x_5 and x_6 as dimensions. For this reason hermetry form (a) will be discussed more fully in Section 12.

Although the deformation exists in the transcoordinates only and does not project directly into our 3 dimensions, its effect may be felt in 3–dimensional space. Under certain conditions it will send quantized gravitational waves, so–called gravitons, into our 3 dimensions. This may be visualized by considering the example of a bell. The bell itself is confined to a small volume, but it sends sound waves through the atmosphere out to very great distances. The equations show that gravitons should propagate with 4/3 the speed of light. Thus, according to Heim, gravitational waves have a speed of 400'000 km/second. They do not correspond to the gravity waves predicted by general relativity.

b) The second type of deformation again involves x_5 and x_6, and in addition time, the 4th dimension, denoted by x_4. Again, this structure does not project directly into our 3–dimensional world but is felt here only in the form of waves. Heim derives the property of these waves and shows that they are identical to those of electromagnetic waves or photons. It follows that case (b) describes a structure in x_4, x_5, and x_6, extending into the remaining 3 dimensions in the form of electromagnetic waves, including light waves.

c) The third possible deformation involves 5 dimensions, i.e. all coordinates except time. This 5–dimensional structure projects into the 3–

dimensional space of our experience, i.e. it forms a condensation here, and it is reasonable to assume that we are sensitive to such condensations. This is indeed the case, and Heim shows that they give rise to uncharged particles with gravitational mass and inertia.

d) The final deformation involves all 6 coordinates. This again leads to 3–dimensional condensations giving rise to particles, but, as in case (b), the inclusion of time leads to electric phenomena as well. Heim can show that 6–dimensional condensations lead to charged particles.

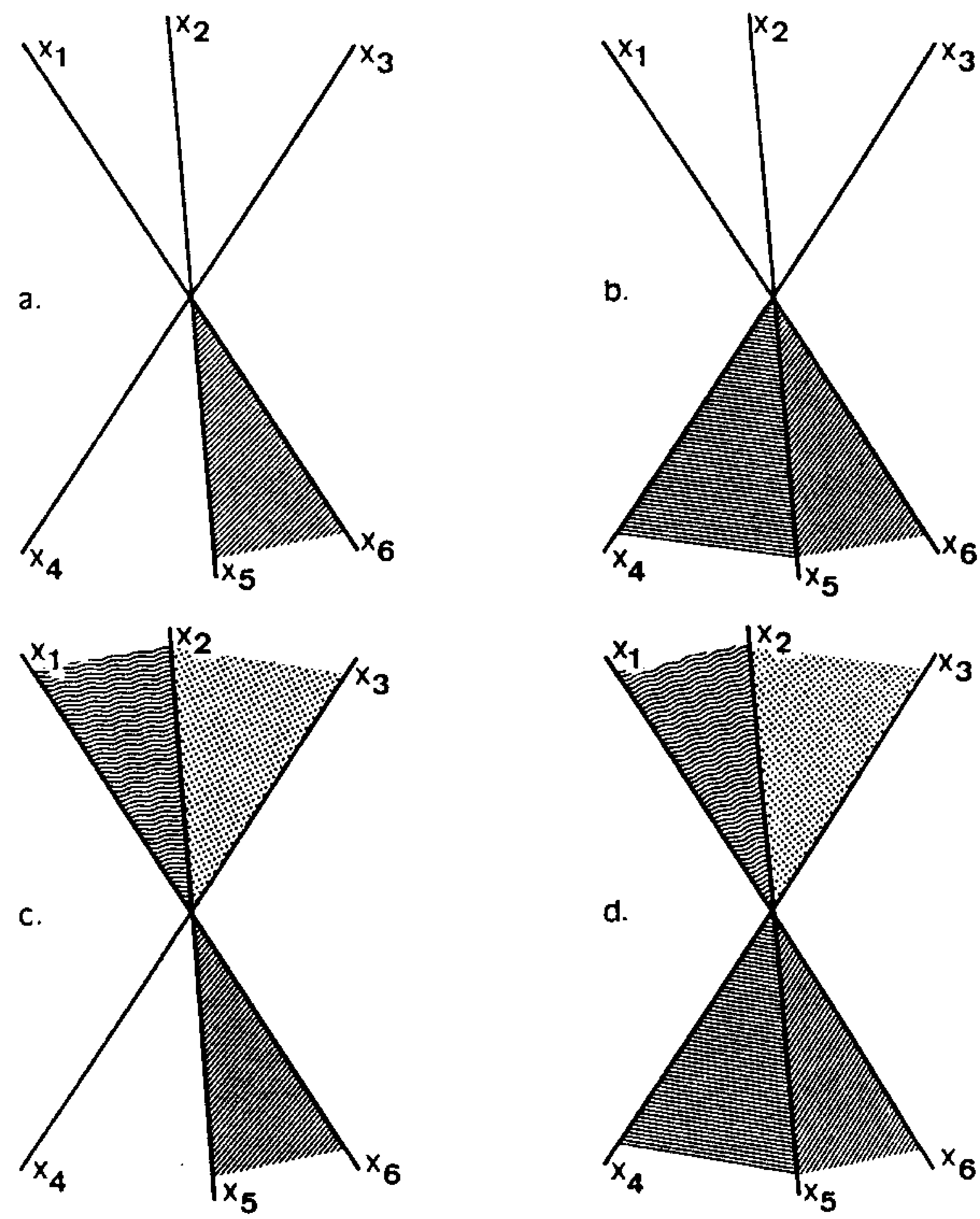


Fig. 7. Schematic representation of the coordinates involved in hermetry forms a–d. x_1, x_2, x_3 = space coordinates, x_4 = time coordinate, x_5 = entelechial (organizational) coordinate, x_6 = aeonic coordinate.

Figure 7 is a graphical representation of the 4 hermetry forms. In reality, the 6 coordinates form 90^0 angles with each other, as mentioned in Section 3, but graphically only 3 coordinates can be drawn at right angles. For this reason a compromise representation due to R. Keller is chosen, where all 6 coordinate axes are shown but with angles of less than 90^0 between them.

A limited, but more quantitative discussion of the 4 forms of condensation is contained in Appendix E.

12. The Meaning of Self–Condensations in the Transdimensions

While hermetry forms (b), (c), and (d) in Section 11 represent respectively photons, uncharged and charged particles, the meaning of hermetry form (a) is not so clear, because it only involves the 5th and 6th coordinates, which our senses do not recognize as such. Physically, i.e. in terms of length, weight, and time, the processes in these dimensions are not measurable. However, all material structures extend into the 5th and 6th dimensions, and these extensions should, in turn, have qualitative effects on the organized states of matter in our 3 dimensions. Although such effects are not measurable, it should nevertheless be possible to observe them.

The transcendental domain is characterized by the appearance of qualities in addition to quantities. The beauty of a Beethoven symphony cannot be expressed in terms of numbers: it is a quality and not a quantity. "Quality" is a non–mathematical concept and requires a modification of our common Aristotelian logic in order to describe quantities and qualities in a formal, unified language. This is the reasoning which led Heim to develop a complete system of formal multivalued logic.

Complex configurations like macromolecules and all structures involved in life processes require a new interpretation of the 5th coordinate. Again, the new interpretation is not self–evident but has had to be deduced from the way x_5 appears in Heim's formalism.

According to the new definition, x_5 is a measure of the *significance* or *usefulness* of a complex physical structure for achieving a certain objective. To the molecule of an amino acid, for example, there corresponds a certain pattern of x_5, signifying the usefulness of its composition for the living cell. Protein molecules are composed of amino acids. Their x_5–patterns generally are higher up on the x_5–scale, because they are more useful to the cell than the amino acids alone. Different patterns of x_5 specify the significance and type of organization (and complexity) relevant to each individual structure. A garage, for example, has a different significance and complexity from a private house or a cathedral.

In general, the extension of a very complex material object into the transdimensions is the pattern of usefulness, evaluated along x_5, of its physical configuration. In this section the terms usefulness and significance will be used interchangeably. The task in nature fulfilled by the two transdimensions is similar to that of Sheldrake's morphogenetic field (Sheldrake, 1985).

There is no absolute usefulness or significance. Both are relative concepts, since their magnitude depends on the question: For whom or for what is a certain object useful or significant? A fine painting, for example, has a great deal of significance for humans, but none whatsoever for animals.

Usefulness and information are related concepts, because the usefulness of any object may depend on the information received from it. A Chinese newspaper is not useful for someone unable to read the language, because he cannot derive any information from it. This shows that information may, among other things, be a carrier of usefulness and vice versa. The close connection between information and x_5–related activities is of paramount importance for the development of the transcendental theory, as will be seen later on.

Most objects are composed of a hierarchy of structures, displaying an increasing complexity and an increasing significance. Consider the example of a living cell: At the bottom of the hierarchy are structural condensations of metronic size. These combine to form elementary particles like protons, neutrons, and electrons. The next higher ranks are occupied by atoms, followed by a great variety of molecules. These in turn combine into organelles, and all of it together finally evolves into a cell. This model is further discussed in connection with Fig. 8.

The patterns of significance relative to the finished cell, arising from the complicated hierarchical structures making up the cell, are called *metroplexes* by Heim (*metroplex* is short for *metrophoric complex*, meaning a system of basic concepts in Heim's multivalued logic). Very generally speaking, a metroplex describes an assemblage of extensions into the transdimension x_5 of some material object. The object itself is called a *metroplex carrier*. The relative significances of hierarchical structures composing the object are measured along x_5.

It should be remembered that x_5 and x_6 are independent of distance, because the transcoordinates are not genuine dimensions. Instead of calling them dimensions in the range where they become qualities, it is

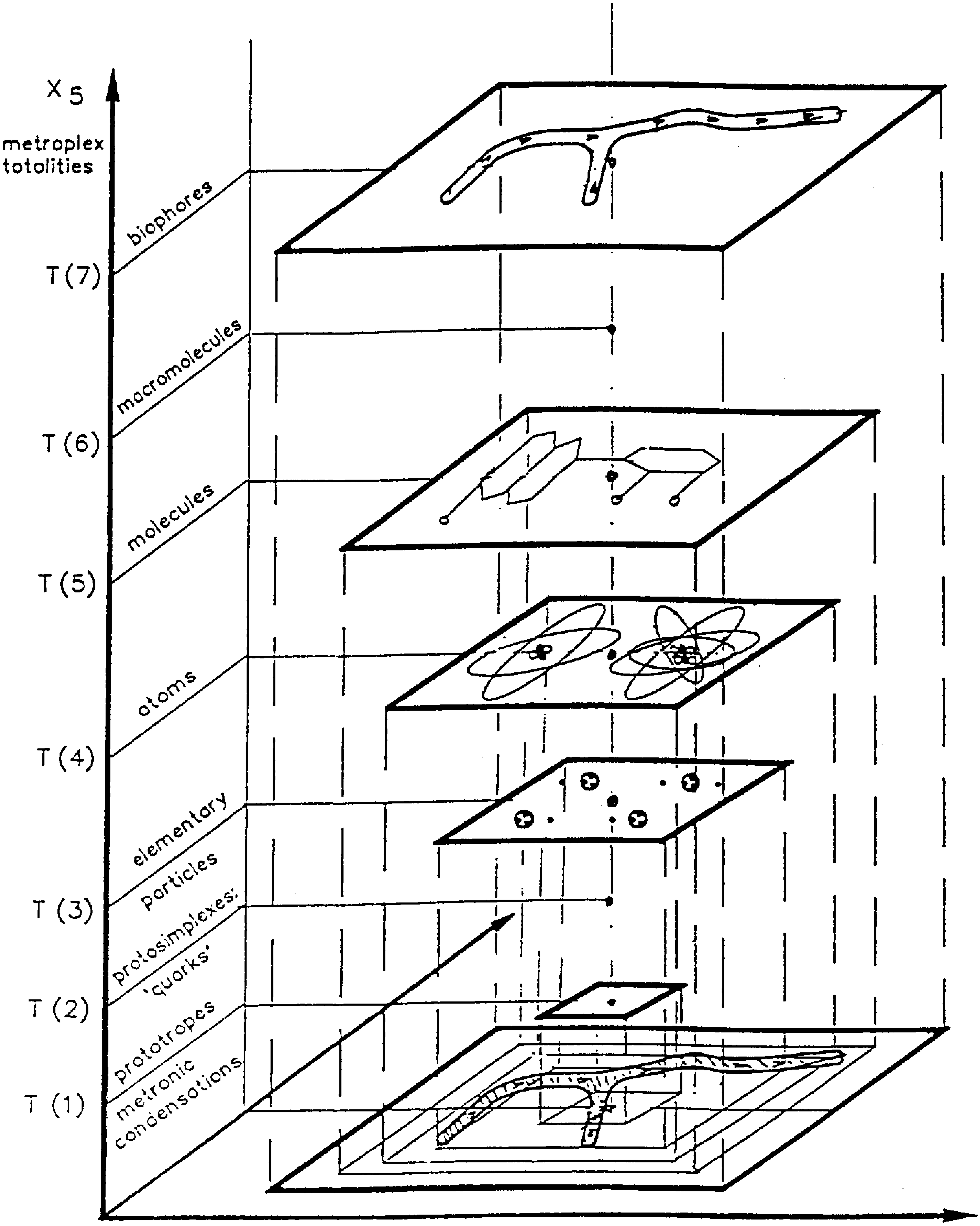


Fig. 8. Sequence of metroplexes at organizational levels T(1) – T(7) composing a biological structure.

better to simply call them stores of values that cannot be measured with yardsticks or clocks. Metroplexes, on the other hand, are bound to physical structures and events, and extend no farther out in space than they do.

Many things on earth, particularly living systems, are organized into closed, or finished, structures. A house is such a closed and finished structure, so is a flower, a mouse, a human being, etc. To every closed structure there corresponds a closed metroplex, i.e. a pattern of significances composed of the significances of the structure's various subconstituents, which together form a closed system. The usefulness of the closed system clearly is greater than that of its components. A cathedral is more useful than the bricks from which it is built, an animal is more significant than its cells or its organs, etc. A closed metroplex can be viewed as a very complex geometrical pattern of condensations in the transdimensions.

Figure 8 illustrates a system of closed metroplexes belonging to a biological system, a "biophore", as Heim calls it (a biophore is located somewhere between a virus and a microbe). Closed metroplexes are called *metroplex totalities* by him, and for this reason the vertical x_5–scale is marked T(1), T(2),...,T(7), signifying closed metroplexes, or metroplex totalities, of increasingly higher order.

The hierarchy of biological structures in Fig. 8 begins at T(1) with the simplest forms of metronic condensations ("prototropes"). These combine at T(2) into structural internal subconstituents ("protosimplexes") of elementary particles, analogous to quarks. Complete elementary particles form at (T3), still very low on the x_5–scale. When they combine into atoms they rise up to T(4). The next higher stage in the hierarchy at T(5) is occupied by simple molecules. They in turn unite to form macromolecules, thereby increasing their significance to T(6). Finally, the finished biological structure occupies the relatively highest position on the x_5–scale at T(7). The dashed vertical lines indicate that physically all components are combined into a single organism pictured in the bottom square.

An important concept involving metroplexes is that of information bridges. Two animals, say, two mice, are closed systems with two closed and very similar metroplexes. Being patterns of significance, metroplexes of a given species tend to be more similar than the purely physical body structures. This is particularly true of the lower species, while metroplexes of higher ones, especially of humans, may be more diversified.

When two closed metroplexes high up in x_5 are very similar, there occurs what may be called a "resonance reaction". It is the analog of Sheldrake's "morphic resonance". A type of morphic information bridge is established between the metroplex carriers, for instance between two animals of the same species, across which information can flow. While this effect may be more pronounced in the lower species, information bridges may be established even between humans. Resonance effects make themselves felt mainly through weak or strong telepathic interactions. Quite often both partners of a long married couple simultaneously but independently think of the same topic. A mother, whose son is involved in an accident far away, sometimes feels telepathically that something has happened to her son. This is due to the similarity of their metroplex structures or the fact that their metroplexes are in close x_5–proximity to each other. "Distance" in the transdimensions does not refer to the physical separation between metroplex carriers. Instead, it is a measure of the difference between their closed metroplexes.

The highest closed metroplexes formed are associated with humans, at least as far as we know. Their significance is represented by the highest points on the x_5–scale and lies far above the point T(7) of Fig. 8. Theoretically, the x_5–scale extends to infinity. The question naturally arises, whether anything exists beyond the highest x_5–level reached by man, something no longer tied to any existing physical structure.

This is actually the case. Not only beyond the very highest metroplex structures, but, in fact, all along the x_5–scale from zero upwards there exist free quanta of significance. They are free in the sense that they do not represent the extension into x_5 and x_6 of any material object. They are also free in the sense that they can move up and down the x_5–scale, changing their significance but without losing their informational content. While they are confined to the transdimensions and do not directly appear in our space, they do possess the important property of being able to make themselves felt in our world by means of gravitational waves, or gravitons, as mentioned under hermetry form (a) in Section 11. In fact, they *are* the hermetry forms (a).

The quanta of significance just described practically exist as ideas in the transdimensions. When they are able to couple information into gravitational waves Heim calls them *activities*, and when they move up and down the x_5–scale he calls them rising and falling activities.

The amount of information coupled into gravitational waves by hermetry form (a) depends on the location along x_5 from which the latter originates. Activities originating in metroplex regions high up on the

x_5–scale carry a great deal of information, while those coming from regions around T(1) in Fig. 8 carry very little. This is important, because gravitational waves, moderated by information, are able to interact with matter, thereby changing the probability state of a material system in accordance with the information they contain. This can be seen as follows:

In quantum theory an observable is always represented by the sum of all possible states of the quantity to be observed, each multiplied by a factor related to the probability of observing this particular state. When an experiment is performed to determine the actual state of the observable, for instance the energy of an atom, all probability factors collapse to zero except the one multiplying the state experimentally found to exist. Its factor increases to unity, i.e. certainty. Often, though not always, the factor which turns to unity was relatively large to begin with.

It is this distribution of probability factors with which gravitons are able to interact, thereby changing their distribution. As a result, some very likely states with large factors may be reduced to insignificance, while others, which are much less likely, are enhanced.

As an example, consider the simple case of an object lying on a table. Let all distances x be measured from one edge of the table and let the object rest at $x = x_1$. Quantum mechanically, the root of the probability of finding the object at an arbitrary point x is characterized by a smooth function of x, whose amplitude has a very sharp peak at x_1. Even far away from x_1, according to quantum theory, this amplitude is not zero, although it is extremely small. Now consider a falling activity, whose information content requires the object to be present at x_2 instead of x_1. If the activity is strong enough, it will be able to send gravitons into our 3–dimensional space, interacting with the probability function mentioned above and moving the peak from x_1 to x_2. Now the probability of finding the object at x_2 becomes very large and that of finding it at x_1 becomes very small. What we observe is a sudden shift of the object from x_1 to x_2. This is the somewhat complicated path along which the idea of a person may be transformed into telekinetic action.

Gravitational waves modulated by information are the analog of modulated electromagnetic waves and sound waves. Modulation, after all, is just the encoding of information in a manner suitable for its transmission by waves. Visible light waves, for example, are modulated by the surfaces from which they are reflected and carry a wealth of information regarding shape, color, and texture of the latter. Radio and televi–

sion waves prior to being broadcast or televised are similarly modulated by voices and actions in the studios of their respective stations. Sound waves may be modulated by speech or music.

Light and sound waves are able to interact with matter, for our eyes react to light and our ears to sound. Light can modify the chemical composition of photographic emulsions, and powerful radiation produced in the interior of stars is even strong enough to prevent their gravitational collapse, despite the weakness of the interaction between light and matter. Gravity waves, on the other hand, always react with matter, although the interaction is not very strong either. The prediction of Heim's theory that strong gravitational waves charged with information are able to produce very special and even unexpected results, therefore merely expresses the fact that gravity waves, too, conform to the general information–carrying ability and the interaction principle shared alike by all wave phenomena.

The purely physical constituents of a living organism correspond to organizational schemes whose values go up to T(15) on the vertical x_5–coordinate axis of Fig. 8 (not shown). The organization of the innumerable separate components of a living being down to the atomic level into a functioning whole is of such high degree of complexity and significance that it occupies the positions between T(15) and T(24) on the x_5–scale. *Activity currents* are currents of information–carrying activities flowing between metroplexes of all orders and forming a network through which the various components of a living system are interconnected. This is necessary in order for a living structure to function as a unit and not as a collection of disconnected parts.

The next higher metroplex totality, T(25), is a transition region. Beyond it one finally encounters the realm of mental and spiritual experiences, the domain of consciousness, thought, ideas, and inspiration, which are not localized in our 4–dimensional world, although they certainly have a decisive influence on us. From here, our free will issues directions to x_6, which in turn guides the action of a living entity at each moment of its existence. Our personality, residing in regions beyond T(25), leads a semi–autonomous existence, as pointed out further down. For this reason, it is given the special designation of *persona*.

In principle, the x_5–coordinate axis extends from zero to infinity. It is, therefore, entirely possible that x_5 is subdivided into many discrete levels separated by large x_5–distances, each of them representing a world parallel to our own. The condition parallel worlds have to satisfy is to occupy the same space we do and yet to be out of our reach. Consider, for example, a universe whose clocks are always a few hours ahead of our time. It exists in our 3 dimensions, but we never notice it, because whenever we reach a certain instant in time, the other universe has already passed it. It is like a runner who always is a few steps ahead of us, so we can never catch up to him.

While parallel universes separated from us in time are unlikely to exist because they might lead to violations of causality, parallel worlds separated from us and from each other by very great distances along x_5 are entirely conceivable. Their respective organizations would be so different from ours that we would not perceive them, although they utilize the same 4 dimensions in which we, too, are at home. Such parallel worlds may be filled with higher spirituality.

The process of learning and of assimilating the many experiences we go through in life leaves an imprint on the persona mentioned above. On the one hand, the persona is connected via activity currents to the rest of our individual metroplex patterns. On the other, its semi-autonomous character manifests itself when we sleep, for then the activity currents emanating from it are gradually reduced and finally decoupled altogether, resulting first in tiredness and then in sleep. During this period the persona has an existence of its own. The process is reversible, and when the activity currents are restored we wake up again. In the event of a person's death, his persona, composed of his character and the entire wealth of mental structures accumulated during a lifetime, permanently and irreversibly decouples from the body and is withdrawn into one of the parallel worlds in a high region of x_5.

The discussion in this section is an abbreviated version of Heim's complete transcendental theory. It is sufficient, however, for an understanding of the projector theory to follow.

13. The Projector Theory

The projector theory was first developed and published in 1979 by one of the authors (v. Ludwiger, 1979c). It is a consequence of Heim's theory discussed in Sections 2–12. This fact at least removes it from the category of pure speculations.

The purpose of the theory is to point out ways of transmitting information or even objects across large distances without the need of physically traversing the intervening space.

Let us assume that information is to be exchanged between position A, where the source is located in the form of a projecting device, and a target area B. A and B may be situated on the same planet or on different planets. Since the transmission is independent of distance, the separation in miles or light years between A and B is not important.

The first step towards the realization of a projection from A to B requires a decision regarding the type and shape of the target area B with which A wishes to exchange information. The location of B need not be known, it suffices to know the specific features the target is supposed to have. B could, for example, be a certain type of landscape assumed to exist somewhere either on the home planet or on a planet elsewhere in the galaxy.

In the next step, a metroplex structure corresponding as closely as possible to that of the desired destination B is artificially generated by the projector at A. In a technologically advanced society the problem of constructing a device able to create such metroplex patterns will have been solved.

Next, a search is made for a target area B displaying the desired characteristics and hence possessing a metroplex structure similar to the one produced artificially by the projector. The search is carried out by generating a free activity in the form of a tentacle reaching out to look for a natural metroplex resembling the artificial one. If a suitable candidate B is found, the artificial metroplex is modified until nearly perfect correspondence is attained between the natural and the artificial metroplexes. This results in a resonance reaction between them and establishes an information bridge linking source A to target B. Once A and B are connected, activities carrying information can flow across the bridge in both directions.

Now the projector can proceed to modulate rising activities with information, sending them across the morphic bridge to B. Upon descending and entering normal 3–dimensional space they transfer their information to gravitational waves able to modify the probability distribution of matter in conformity with the information they carry. This way of transmitting information is instantaneous and independent of the distance between A and B.

The entry of gravity waves from high x_5–regions into our space is accompanied by a variety of phenomena.

When a morphic bridge is established between the projector device and its own immediate neighborhood, which should be particularly easy, the descending gravitational waves will dissipate their energy near the source in the form of light bundles, fingers of light of finite length, or balls of light.

If, upon entry into 3–dimensional space, falling activities from very high metroplex regions meet a material structure, they can interact with it, raising it into a high x_5–region. This elevates it into a parallel spacetime which is displaced from the original one by the distance along x_5 by which the structure was raised. In the course of the transition its density is altered, making the structure become transparent. The luminous head of the activity tentacle will then appear to shine through the object.

The entry region in B of gravitational waves may vary in size, or it may pulsate and increase or decrease in brightness, depending on the intensity of the projected activities, or on the amount of energy needed to reorganize the surrounding matter. Luminous volumes of air may disappear in one place and reappear in another, or they might quickly move across the landscape.

Since an exchange of information and physical interactions can proceed from A to B as well as from B to A, the projector in A can be made to operate as a receiver of signals from B. Modulation of the activities connecting A and B may be programmed so as to feed only optical and acoustic signals from B to the source at A. The projector at A will then act as a passive eye and ear, spying, as it were, on the target at B. However, the action will not go unnoticed at B, because activities descending in a limited area of B in the form of gravitational waves liberate energy, ionizing the air and causing it to emit light.

Falling activities are not without danger. When they pass through x_5–regions above T(25), where the persona is located, they may interact with the latter and create entirely new levels of consciousness. This may lead to paranormal experiences or intense feelings of anxiety and fear, or it may lead to a personality split. Strong activities can affect us physically by causing paralysis or, on the more positive side, cure injuries and lead to recovery from illness. Energetic activities will liberate heat and may cause burns if not carefully handled. A medium may be a person sensitive to gravitational waves entering our space from higher x_5–regions. For this reason it would be interesting to perform an experiment in which gravitational effects are measured near a medium in trance.

Modulation of activities rising from the source in A can be employed for projecting more substantial information into the target site. Pictorial information generated in the projector may be raised by activity currents into high x_5–regions, where they are charged with effective ideas.

Upon re–entering 3–dimensional space at the target location they can condense or regroup physical structures and by so doing materialize the ideas. The requirement for this to happen is that the effective ideas in the form of information originate from an x_5–position *above* the morphic bridge. The items projected into the target area are able to produce substantial physical effects, in contrast to purely optical projections. At the same time, the target region in B into which the activity head descends is projected back and becomes visible in A. This is the ideal type of projection and almost eliminates the need for travel between A and B.

Since the projection works both ways, an observer in A is visible in B, and his picture in turn is projected back and becomes visible in A. The observer can see himself moving like a phantom in the target landscape B. Everything he does in A becomes reality in B. If, for example, he makes a depression in the ground near the source, the depression will appear in the ground at B.

An information bridge is independent of distance. Two well separated regions in space appear to be superimposed upon each other when a bridge between them is established.

When descending gravitational waves reorganize matter they can either absorb or emit energy. In the first case they absorb heat energy from their surroundings, producing a cooling–off effect. Actually, they are more likely to dissipate energy in the form of light. An observer at B may, for example, see a metallic object surrounded by a halo of light.

As the result of a projection from A, an individual at B will observe the following sequence of events: Luminous, transparent spherical or non–spherical forms appear out of nowhere. Occasionally, they may become optically more dense, and they may pulsate and extend fingers of light or separate into two balls, uniting again a few moments later. Their appearance may be metallic, and they can depress the soil while dissolving the next instant into a diffuse mist or disappearing altogether. A variety of humanoid shapes such as giants, dwarfs, astronauts, roboters and others may emerge. However, if one tries to catch them, they will dissolve into thin air. In reality, the seemingly solid objects are nothing but phantom–like images without substance.

Gravity waves accompanying the appearance in B may give rise to mechanical effects or to plasma phenomena. They can also cause strong electric and magnetic disturbances as a result of the coupling between gravitational and electromagnetic fields. Such a coupling is predicted by unified field theories. One should expect psychological ef–

fects on humans, whose emotional balance may become totally upset. Direct transfer of information in telepathic form is also possible. Moreover, paranormal phenomena may make themselves felt.

A very important class of problems concerns the possibility of space travel. The projector theory discussed so far is able to explain the transmission of images and physical effects, but this is not enough to account for travel through space, which obviously requires the transmission of solid objects. Conventional space travel is an inefficient and costly affair. If the spaceship travels at a low speed of, say, 1/10th the velocity of light, a round trip even to the nearest star will take a lifetime. If the speed is high, say, 9/10th of the speed of light, the trip will become very expensive in terms of energy, and friction between the interstellar gas and the spacecraft will heat the latter to incandescence. For interstellar travel to be quick and easy, physical passage through space must be avoided.

The projector theory points out a possible solution, although nothing is known about the technology required for its realization.

In order to make use of information bridges forming a link between two planets regardless of distance, the spacecraft itself has to be a projector. Before the journey can begin, the metroplex pattern of a suitable planetary environment must be created by technical means, just as in the cases discussed previously. If the spaceship intends to land, the surface features of the target planet will have to be reasonably similar to those of the home planet. In order to locate a suitable object, a tentacle of activities is extended to search for a matching planetary metroplex structure. A high degree of similarity is required, but perfect identity down to the last atom is not necessary. A resonance reaction between the two metroplex configurations then establishes the morphic bridge between both planets across which free activities can flow in both directions.

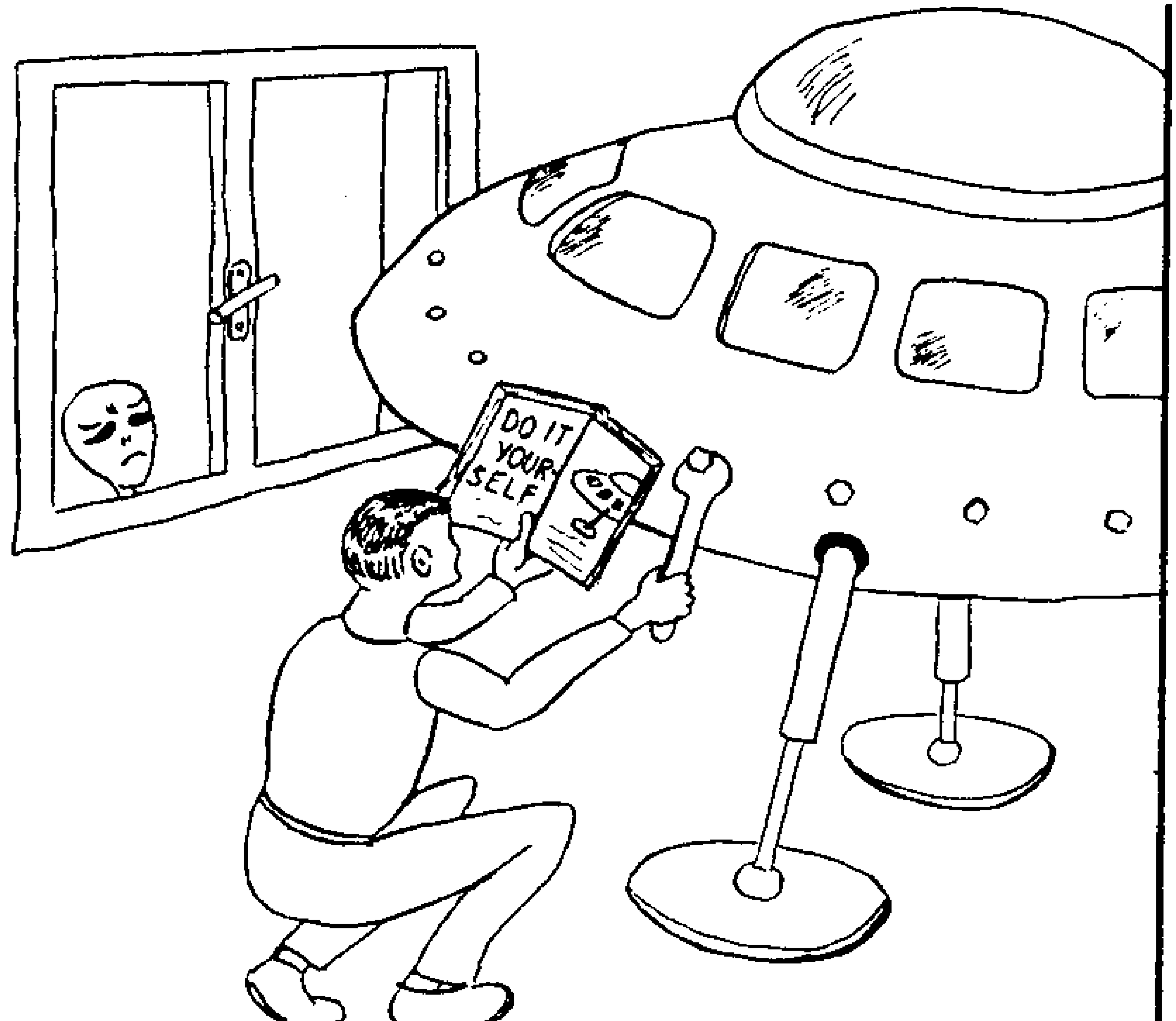
Only ideas in the form of activity currents can cross the bridge. The next step, therefore, is to transform the craft into a free activity. Technically, this might require a gravity generator inside the spaceship, producing waves which, upon passage through the craft and its crew, are modulated with full information about all of their structural details. The gravity waves transform the information gathered in their passage through the spacecraft into free activity currents rising up into very high metroplex regions. As a result, the physical objects disappear from 3-dimensional space and change into a pure idea, i.e. the craft dematerializes.

The activity with its encoded information can now, metaphorically speaking, "cross" the morphic bridge built up in the previous step. Having done so, it descends and again enters 3–dimensional space, where it transforms back into gravitational waves or activity currents and transmits to them its informational content. The gravity waves in turn modify the probability distribution of their environment at the point of entry – usually the metronic space grid some distance above the target planet's surface – in accordance with the impressed information about the spacecraft. As a result, the latter rematerializes. The same procedure is employed when the spacecraft wants to return home. In order to travel in the target planet's atmosphere and to land on its surface the craft has to use a second, more conventional means of propulsion.

The possibility of dematerialization and rematerialization of physical objects is considered in scientific parapsychology as an empirical fact. The most convincing experiments on dematerialization and rematerialization of miniature transmitters enclosed in small, sealed boxes were carried out in Peking (Lin Shuhuang et al. 1983).

The projector theory accounts for the sudden appearance and disappearance of UFOs, and for their apparently effortless way of covering interstellar distances. In summary, it shows the UFO to be a device with the ability to change itself into a free activity in high regions of x_5 and x_6, to artificially create a planetary metroplex structure similar to an existing one, to cross the resulting information bridge, and to rematerialize on earth.

The task of constructing an apparatus able to accomplish all this is left as an exercise to the reader.



14. Summary and Outlook

The essence of Heim's theory is its complete geometrization of physics. By this is meant the fact that the universe is pictured as consisting of innumerable small, locally confined geometric deformations of an otherwise unperturbed 6–dimensional metronic lattice. The influence these deformations have on our 4–dimensional world constitute the structures we interpret as gravitons, photons, charged particles, and uncharged ones. The theory ultimately results in a formula from which the masses of all known elementary particles and a few unknown ones may be derived. In addition, it provides a picture of cosmology differing substantially from the established one.

Despite the insight gained into particle physics, Heim's approach is not entirely equivalent to modern quantum field theory. For this reason he has extended the theory to 12 dimensions. Only this extension allows full quantization, and as a consequence it becomes possible to unite general relativity and quantum theory. Even 6 dimensions are not sufficient to accomplish this. The 7th and 8th dimensions can be identified with informational processes, but no interpretation can be given to dimensions 9–12. In a humorous vein, Heim, quoting Goethe, calls them the location of the "Webstuhl der Zeit" (loom of time). It may be the seat of a supreme guiding agency, but this, of course, is speculation. A more detailed account of these new developments will be published in the forthcoming 3rd volume.

While the organization of elementary particles still lends itself to mathematical treatment, higher structures, in particular living beings, are far too complex to be dealt with in this manner. Nevertheless, parallel to the metron theory for calculating the masses of elementary particles, Heim has developed a completely general system of formal multivalued logic capable of making statements about both quantitative relations (i.e. mathematical aspects) and qualitative ones (organizational patterns and information). A small segment of this theory is presented in Section 12.

Based on Heim's concept of processes in the transcendental domain, a projector theory is outlined, enabling the projector device to transmit information between points far apart, or to traverse arbitrary distances in very short times without having to physically travel through space. It is conjectured that UFOs are such projectors reaching us from distant planets.

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Appendix A. *The Correspondence Between Relativity and Heim's Theory*

Einstein's field equations of general relativity have the form,

$$G_{ik} = \kappa T_{ik}$$

$$G_{ik} \equiv R_{ik} - \frac{1}{2} g_{ik} R \qquad \text{(A1)}$$

$$i,k = 1,2,3,4,$$

where G_{ik} is the (divergenceless) Ricci tensor, R_{ik} is the contracted Riemann curvature tensor, R is the Riemann scalar, g_{ik} is the metric tensor, T_{ik} is the energy–momentum density tensor, and κ is a constant. Since both i and k run from 1 to 4 the equation above actually represents a set of $4^2 = 16$ coupled equations. Due to the symmetry of all tensors involved, i.e. because $G_{ik} = G_{ki}$ and $T_{ik} = T_{ki}$, the number of independent equations is reduced to 10.

R_{ik} is a given function of the metric tensor g_{ik} and its first and second derivatives, so that Eq. (A1) may be regarded as the equation which, together with appropriate boundary conditions, determines the important metric of space, i.e. its geometric properties.

In the absence of masses, $g_{11} = g_{22} = g_{33} = 1$, $g_{44} = -1$, and all other g_{ik}'s are zero. This set of metric tensor components signifies so–called "flat", or empty, space, in which unperturbed objects propagate along straight lines. In the presence of a single spherical mass space becomes curved, and the trajectories of unperturbed objects are curved orbits in a plane. This results from the fact that the 4 tensor components g_{11} – g_{44} now become functions of r and an angle θ. All other g_{ik}'s are again zero. The solution of the resulting equation of orbital motion about the central mass closely resembles the result obtained from classical Newtonian physics, except that it contains a small additional term. This term is responsible for the slow rotation of elliptical orbits about the central object. In the solar system the term is significant only in the case of the innermost planetary orbit, where it leads to the well–known precession of Mercury.

Heim establishes a general correspondence between Einstein's macroscopic field equations (A1) and his own equations in the microscopic domain. The Riemann tensor is conveniently written as a combination of Christoffel symbols, Γ^i_{km}, and their first derivatives, which are functions of the g'_{ik}s and their first derivatives. The correspondence is as follows (summation convention):

$$\begin{array}{ccc} \text{Einstein} & & \text{Heim} \\ \text{(macrocosmic)} & & \text{(microscopic)} \\ \Gamma^i_{km} & \rightarrow & \varphi^i_{km} \\ R_{km} & \rightarrow & C_p\,\varphi^p_{km} \\ G_{ik} = T_{ik} & \rightarrow & C_p\,\varphi^p_{ik} = \lambda_p(ik)\,\varphi^p_{ik} \end{array} \tag{A2}$$

$$i,\ k,\ m = 1,\ 2,\ 3,\ 4,$$

C_p, φ, and $\lambda_p(ik)$ respectively being an operator, an eigenfunction, and an eigenvalue. Equation (A2) indicates that a transition from the microcosm to the macrocosm implies a reduction of Heim's equations to those of general relativity. However, in conformity with the requirements of a unified field theory, Heim's microscopic equations must be written,

$$C_{(p)}\,\varphi^{(p)}_{ik} = \lambda_{(p)}(ik)\,\varphi^{(p)}_{ik} = \varepsilon^p_{ik}\ , \tag{A3}$$

where the parantheses around p signify suspension of the summation convention. The right–hand side of Eq. (A3) represents an energy density, denoted by ε^p_{ik}. Now, i, k, and p independently run from 1 to 4, so that Eq. (A3) represents a set of $4^3 = 64$ eigenvalue equations. The corresponding space is 8–dimensional. An appropriate energy density tensor, ε, can be constructed if i and k are allowed to vary from 1 to 8. The tensor turns out to be,

$$\varepsilon = \begin{pmatrix} \varepsilon_{11} & \varepsilon_{12} & \varepsilon_{13} & \varepsilon_{14} & \varepsilon_{15} & \varepsilon_{16} & 0 & 0 \\ \varepsilon_{21} & \varepsilon_{22} & \varepsilon_{23} & \varepsilon_{24} & \varepsilon_{25} & \varepsilon_{26} & 0 & 0 \\ \varepsilon_{31} & \varepsilon_{32} & \varepsilon_{33} & \varepsilon_{34} & \varepsilon_{35} & \varepsilon_{36} & 0 & 0 \\ \varepsilon_{41} & \varepsilon_{42} & \varepsilon_{43} & \varepsilon_{44} & \varepsilon_{45} & \varepsilon_{46} & 0 & 0 \\ \varepsilon_{51} & \varepsilon_{52} & \varepsilon_{53} & \varepsilon_{54} & \varepsilon_{55} & \varepsilon_{66} & 0 & 0 \\ \varepsilon_{61} & \varepsilon_{62} & \varepsilon_{63} & \varepsilon_{64} & \varepsilon_{65} & \varepsilon_{66} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} . \tag{A4}$$

Relation (A4) above shows that 28 out of the 64 ε'_{ik}s are zero, i.e. 28 equations of the type of Eq. (A3) describe situations in which nothing of importance happens. The remaining 36 equations imply that the im–portant space is 6–dimensional. If 6–space is denoted by R_6 and the 6 dimensions by x_1, x_2, ..., x_6, then

$$R_6 = R_6(x_1,\ x_2,\ x_3,\ x_4,\ x_5,\ x_6) \quad , \tag{A5}$$

where

$$\begin{aligned} x_1,\ x_2,\ x_3 &= \text{space coordinates} \\ x_4 = ict &= \text{time coordinate} \\ x_5 = i\varepsilon &= \text{entelechial coordinate} \\ x_6 = i\eta &= \text{aeonic coordinate} . \end{aligned}$$

Appendix B. *The Smallest Distance and the Metron*

In the macroscopic domain Heim finds the following expression for the gravitational potential $\varphi(r)$ due to a mass $M(r)$, including the r–de–pendent field mass:

$$\begin{aligned} \varphi(r) &= \frac{\gamma M(r)}{r}\left(1 - \frac{r}{\rho}\right)^2 \\ \rho &= \frac{h^2}{\gamma m_0^3} , \end{aligned} \tag{B1}$$

m_0 being the mass of a single nucleon composing the nuclei of $M(r)$. $M(r)$ is determined from the transcendental equation,

$$
\begin{aligned}
r\,q\,e^{-q} &= A\left(1-\frac{r}{\rho}\right)^2 \\
q &= 1-\sqrt{1-\varepsilon\,\varphi(r)} \\
\varepsilon &= \frac{3}{8\,c^2} \\
A &= \frac{3\,\gamma\,M_0}{16\,c^2}\,,
\end{aligned}
\tag{B2}
$$

where M_0 is the central mass, i.e. M(r) minus the total field mass. For $\varepsilon\,\varphi(r)>1$, q in Eq. (B2) becomes unphysical, and hence the solution of

$$\varepsilon\,\varphi(R) = 1 \tag{B3}$$

results in the largest and smallest radii, R_+ and R_-, between which Eq. (B1) is valid. Substituting Eq. (B3) into Eq. (B1) gives,

$$\frac{1}{\varepsilon} = \frac{\gamma\,M(R)}{R}\left(1-\frac{R}{\rho}\right)^2\,, \tag{B4}$$

and from the first line of Eq. (B2),

$$\frac{R}{e} = A\left(1-\frac{R}{\rho}\right)^2\,, \tag{B5}$$

because $q=1$. Dividing Eq. (B4) by Eq. (B5) and substituting for ε and A from Eq. (B2) results in the following formula for M(R):

$$M(R) = \frac{e}{2}\,M_0\,. \tag{B6}$$

With $\varphi(R)$ and M(R) given by Eqs. (B3) and (B6), respectively, one can now proceed to solve Eq. (B1) for $r=R$,

$$\frac{1}{\varepsilon} = \frac{\gamma\,e\,M_0}{2\,R}\left(1-\frac{R}{\rho}\right)^2\,. \tag{B7}$$

When R is the smallest possible radius, R_-, evidently $\frac{R_-}{\rho} \ll 1$, and to a very good approximation R_-, resulting from Eq. (B7), is,

$$R_- \approx \left(\frac{3\,e}{16}\right)\frac{\gamma\,M_0}{c^2}\,, \tag{B8}$$

which is Eq. (3), Section 5, of the main text.

In order to derive an expression for the magnitude of the metron, consider again Eq. (B4) for a single small quantum of mass $m(R_-)$, including the field mass contained within R_-. Replacing R by R_- and substituting for ε Eq. (B4) can be written,

$$R_- = \frac{3\gamma M(R_-)}{8c^2}\left(1 - \frac{R_-}{\rho}\right)^2 . \qquad \text{(B9)}$$

The Compton wavelength λ of $M(R_-)$ is defined as,

$$\lambda = \frac{h}{M(R_-)\,c} . \qquad \text{(B10)}$$

Multiplying Eq. (B9) by Eq. (B10) gives,

$$\lambda R_- = \frac{3\gamma h}{8c^3}\left(1 - \frac{R_-}{\rho}\right)^2 . \qquad \text{(B11)}$$

The condition for space to be empty is $\lambda \to \infty$. In this limit the right–hand side of Eq. (B11) stays finite because $\lim_{\lambda\to\infty}\frac{R_-}{\rho} = 0$. Identifying the left–hand side in the limit with the metronic area τ, Eq. (B11) becomes,

$$\tau = \frac{3\gamma h}{8c^3} , \qquad \text{(B12)}$$

which is Eq. (6), Section 5, of the main text.

Appendix C. *Origin and Size of the Universe*

The diameter D of the universe and the metronic area τ are related through the expressions,

$$\sqrt{\frac{3}{2}}\,f\left(\frac{1}{4}\sqrt{\frac{3}{2}}\frac{D f^3}{\sqrt{\tau}} - 1\right)^2 = \frac{D}{\sqrt{\tau}} \qquad \text{(C1.1)}$$

$$\left(\frac{e D\sqrt{\tau}}{\pi E} - 1\right) f^2 = \sqrt{\frac{e D\sqrt{\tau}}{\pi E}} . \qquad \text{(C1.2)}$$

The diameter $D = D_0$ at the beginning of time and the corresponding metronic size $\tau = \tau_0$ are characterized by the relation,

$$\pi D_0^2 = \tau_0 . \qquad \text{(C2)}$$

Substituting for τ_0 from Eq. (C2) into Eq. (C1) results in the following expressions, in which f has been replaced by f_0:

$$f_0 \left(\frac{1}{4} \sqrt{\frac{3}{2\pi}}\, f_0^3 - 1 \right)^2 = \sqrt{\frac{2}{3\pi}} \tag{C3.1}$$

$$D_0^2 - \frac{\pi^{\frac{1}{4}} \sqrt{E}}{\sqrt{e}\, f_0^2}\, D_0 - \frac{\sqrt{\pi}\, E}{e} = 0 \quad . \tag{C3.2}$$

Equation (C3.1) is of 7th order in f_0 and has 3 real roots:

$$\begin{aligned} f_{01} &= 2.043791516 \\ f_{02} &= 1.337222089 \\ f_{03} &= 0.478616983 \ . \end{aligned} \tag{C4}$$

When each of these values in turn is substituted into Eq. (C3.2) there result 3 positive and 3 negative roots of D_0,

$$\begin{aligned} D_{01}^+ &= 0.909917980 \text{ m} , & D_{01}^- &= -0.716602317 \text{ m} \\ D_{02}^+ &= 1.064258088 \text{ m} , & D_{02}^- &= -0.612679705 \text{ m} \\ D_{03}^+ &= 3.701211603 \text{ m} , & D_{03}^- &= -0.176171860 \text{ m} \ . \end{aligned} \tag{C5}$$

The positive values of D correspond to the initial trinity of spheres listed in Eq. (10), Section 9, of the main text. At the end of its life cycle the universe collapses into a trinity of spheres whose diamters are given by the negative values of D.

Equation (C1) can be used to calculate the present diameter D of the universe. Due to the presently very small size of τ (6.15×10^{-70} m^2) and the correspondingly large size of D, to a very good approximation,

$$\frac{D\, f^3}{\sqrt{\tau}} \gg 1 \qquad \text{and} \qquad D\sqrt{\tau} \gg 1 \ . \tag{C6}$$

This reduces Eq. (C1) to,

$$\frac{3}{32} \sqrt{\frac{3}{2}}\, \frac{D^2}{\tau}\, f^7 = \frac{D}{\sqrt{\tau}} \tag{C7.1}$$

$$\frac{e\, D \sqrt{\tau}}{\pi\, E}\, f^2 = \sqrt{\frac{e\, D \sqrt{\tau}}{\pi\, E}} \ . \tag{C7.2}$$

Solving Eq. (C7.2) for f and substituting into Eq. (C7.1) results in the expression,

$$D = \frac{\pi}{e}\left(\frac{3}{32}\sqrt{\frac{3}{2}}\,\frac{\pi}{e}\right)^{\frac{4}{3}}\frac{E^{7/3}}{\tau^{11/6}} \tag{C8}$$

for the size of the universe. This is Eq. (9), Section 9, of the main text.

Appendix D. *The Elementary Charge*

Heim's formula for the elementary charge, $e_{\pm}$, is,

$$\begin{aligned} e_{\pm} &= \pm\, 3\left(\frac{1}{4\pi^2}\sqrt{\frac{\theta\, h}{\pi\,\mu_0\, c}}\right) \\ \theta &= 5\,\eta + 2\sqrt{\eta} + 1 \\ \eta &= \frac{\pi}{(4+\pi)^{1/4}}\,, \end{aligned} \tag{D1}$$

where $\mu_0 = 4\,\pi\times10^{-7}$ henry/m is the permeability of free space. The factor 3 in Eq. (D1) gives the impression of $e_{\pm}$ being composed of 3 subcharges, each of them equal to e/3. Substituting numbers results in an elementary charge of

Heim: $\quad e_{\pm} = \pm\ 1.60216\times10^{-19}$ Coul.

Experimentally, one has,

Experiment: $\quad e_{\pm} = \pm\ 1.60211\times10^{-19}$ Coul.

Appendix E. *The 4 Hermetric Forms*

Einstein's 4–dimensional space is described by a single metric tensor, g_{ik} (cf. Appendix A). In contrast, Heim requires 3 metrics: One for the two transcoordinates, one for time, and one for the three space coordinates. They depend on x_1–x_6 as follows:

$$g_{ik}^{(1)} = g_{ik}^{(1)}(x_5,\ x_6)$$

$$g_{ik}^{(2)} = g_{ik}^{(2)}(x_4) \tag{E1}$$

$$g_{ik}^{(3)} = g_{ik}^{(3)}(x_1, x_2, x_3) .$$

The g_{ik} are elements of 6 by 6 matrices, which will be denoted by $g^{(\mu)}$ or $g^{(\nu)}$. From the general product of matrices $g^{(\mu)}$ and $g^{(\nu)}$ Heim constructs a basic metric tensor, $\gamma^{(\mu\nu)}$, valid in 6–dimensional hyperspace:

$$\gamma^{(\mu\nu)} = g^{(\mu)} g^{(\nu)} . \tag{E2}$$

Finally, 4 correlation tensors, $\hat{\gamma}_a - \hat{\gamma}_d$, representing the 4 hermetric condensations (a)–(d) of Section 11, are built up from the matrices γ and g. They are,

$$\hat{\gamma}_a = \begin{pmatrix} \gamma^{(11)} & g^{(1)} & g^{(1)} \\ g^{(1)} & E & E \\ g^{(1)} & E & E \end{pmatrix}$$

$$\hat{\gamma}_b = \begin{pmatrix} \gamma^{(11)} & \gamma^{(12)} & g^{(1)} \\ \gamma^{(21)} & \gamma^{(22)} & g^{(2)} \\ g^{(1)} & g^{(2)} & E \end{pmatrix}$$

$$\hat{\gamma}_c = \begin{pmatrix} \gamma^{(11)} & g^{(1)} & \gamma^{(13)} \\ g^{(1)} & E & g^{(3)} \\ \gamma^{(31)} & g^{(3)} & \gamma^{(33)} \end{pmatrix} \tag{E3}$$

$$\hat{\gamma}_d = \begin{pmatrix} \gamma^{(11)} & \gamma^{(21)} & \gamma^{(31)} \\ \gamma^{(12)} & \gamma^{(22)} & \gamma^{(32)} \\ \gamma^{(13)} & \gamma^{(23)} & \gamma^{(33)} \end{pmatrix} ,$$

where E is the unit tensor. Equation (E3) shows that only certain ones of the 6 coordinates are included in each of the 4 hermetry forms.

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