Part II

Macro Gravitation

Proposition: Einstein's General Theory of Relativity (GTR) is not applicable to the entire universe.
Proof: Let us assume the opposite, that Einstein's GTR is applicable to the entire universe. Under the assumption that gravitation is the only significant large-scale interaction Einstein's GTR is then the appropriate theoretical tool for attaining a model of the universe. A cosmological model which assumes that Einstein's GTR is applicable to the entire universe has already been developed; it is the expanding-universe model. The expanding-universe model essentially contradicts three principles embodied in the theory that has been applied for its development:

1. The starting point of physics is the tacit postulate that physical reality can be described quantitatively, and that this reality is governed by principles. Contrary to this postulate, it is proven by Hawking's singularity theorem that if Einstein's GTR is universally valid then there necessarily was a "beginning of time" in which the entire universe was in a state of singularity. In a state of singularity physics breaks down and an adequate description of physical reality is impossible. A description of physical reality as singularity essentially contradicts the starting point of physics. [1] Therefore, a consistent physical verification which leads to a picture of space-time singularity indicates nothing but the existence of at least one misleading underlying supposition. [2] Clues to what that supposition might be are provided by the following contradictory results.

2. According to Einstein's Relativity massive matter is always slower than light that is propagated at the massive matter's empty space vicinity. It is possible for massive matter to move at the velocity of light in vacuum and faster ***only if*** the gravitational potential at its vicinity is higher than the gravitational potential at the light vicinity. But under the assumption that Einstein's GTR is applicable to

[1] Instead of facing the fact that his theorem proves that Einstein's great theory is limited, Hawking later tried to "avoid" singularity by the introduction of an ad-hoc hypothesis.
[2] Gravitational collapse as well, no matter how much mass is involved, ***never*** ends up in singularity. The principal anti-singularity measure is introduced hereafter; the auxiliary measure is introduced in Part III.

the entire universe, contradictory results are obtained: massive matter that is at sufficient distance from the observer recedes at the velocity of light and faster in spite of the low gravitational potential which is attributed to the past by the expanding-universe picture due to higher density of gravitational mass then. The massive substance that, with respect to some reference frames is faster than light is slower than light with respect to other reference frames, so it is not tachyon-matter but a severe contradiction to Relativity. A "solution" to that contradiction has been worked out: "…the galaxies are encrusted in space and therefore are not moving relative to space; however, space itself is in motion, expanding and creating more and more room between any two given points as time goes by…" (Magueijo, 2003, p. 87). The expression "relative to space" is of no physical significance, as *only* a material frame can be used as a frame of reference. It was due to that fundamental principle that the "luminiferous ether" was abandoned. Reviving the superfluous ether in the form of "expanding ether" contradicts the foundations of Relativity.

3. Einstein's General Relativity embodies the supposition that time is homogeneous, that practically means that all the fundamental parameters of nature are universal constants. Contrary to this tacit assumption, the expanding-universe model has "discovered" a new fundamental parameter whose value is not constant. This parameter, which has no local significance whatsoever, is called, ironically, Hubble constant (Walker, 1988).

Conclusion: The expanding-universe model contradicts the theoretical tool that has been employed for its development. Therefore, this model, even if not intentionally developed as such, is a proof by contradiction that ***Einstein's General Relativity is not applicable to the entire universe.***

The above three contradictory results are but a few of the inherent contradictions of the expanding-universe model. This model results from the dogmatic application of a limited theory outside the limited domain where it is useful. Consequently, the expanding-universe model is inherently contradictory and superfluous. The expanding universe is essentially similar to the geocentric celestial spheres and to the luminiferous ether. Like them, it should be abandoned.

The expanding-universe cosmology is guided by the question: "What is the solution of Einstein's field equations for the entire universe?" The key question is rather: "Are Einstein's field equations applicable to the entire universe?" The answer to this key question is definitely negative. Einstein's insightful theory is based on a narrow data base—observations of the solar system and nothing more. Under the

assumption that Einstein's theory is of universal applicability, central observations—of kinds that were not even guessed when Einstein's theory had been formulated—are interpreted as evidence of the existence of invisible, gigantic "physical realities" ("expanding universe", "dark matter", "dark energy", and their byproducts). When the relevant principles of Nature are revealed, these invisible, gigantic "physical realities" are found superfluous, essentially analogous to the "celestial spheres" and to the "luminiferous ether". It is shown in Part I that Einstein's Special Relativity is a simplification of Time-Asymmetric Special Relativity. In this part it is shown that Newton's Universal Law of Gravitation is a simplification of the Magnitude-Controlled Law of Macro Gravitation, a law that approximates macro gravitation to a force whose magnitude is controlled by Nature and can be magnified from the minimal magnitude given by Newton's law. A universally applicable theory of gravitation should be based on the above two non-simplified elementary theories and not, as Einstein's GTR is, on their simplifications.

1. The Large-Scale Structure of the Cosmos

The assumptions that time is homogeneous and that Einstein's GTR is applicable to large-scale cosmology are misleading assumptions. The abandonment of these assumptions leads to time-asymmetric physics that essentially changes the interpretation of the extra-galactic observations. The observations that are wrongly interpreted as demonstrations of a universal expansion are instead interpreted as demonstrations of the non-homogeneity of time. They indicate that during our observable past the value of the variant speed of light with respect to Earth has decreased continuously (this is explained hereafter in chapter 4). The time-asymmetric interpretation of the cosmological red-shift is the starting point for the understanding of the structure of the cosmos. That structure is the necessary starting point for a universal theory of macro gravitation, in the same way that the heliocentric kinematics of the solar system was the necessary starting point for Newton's theory of gravitation and for its geometrical modification by Einstein.

The magnitude of the red shift in the spectra of galaxies increases, in general, with their distances. This empirical rule, however, does not hold true for galaxies of the local cluster, in which even a violet-shifted spectrum appears. The time-asymmetric interpretation of this empirical phenomenon is that the observable shift in the spectra of galaxies is due to two separate effects: the time-effect, and the Doppler Effect. (A third effect, which reinforced the red shift of quasars and of cosmological

radio sources, is introduced later in this part.) In our observable past, the magnitude of the red-shift due to the time-effect increases monotonously as the distance of the emission event. The shift due to the Doppler Effect, however, can equally be red or violet and its magnitude (except of supernovas and relativistic jets) lies in the non-relativistic domain. For members of the local cluster, the time-effect is still of the same order of magnitude as the Doppler Effect, and the resultant shift reveals no clear relation to the distance of the emission event. For observations of other clusters, the magnitude of the Doppler Effect is negligible in comparison with the magnitude of the time-effect. In that domain, the time-effect dominants, and consequently the observable red-shift monotonously increase with distance. This interpretation, by which the magnitude of the Doppler Effect is non-relativistic, implies that ***the relative velocities between galaxies are non-relativistic.***

It is commonly believed at the present time that no macroscopic amounts of antimatter exist. This view is based on the fact that no antiparticles was found in the primary cosmic rays—would there be significant macroscopic amounts of antimatter in the universe, this would (as commonly understood today) have its representation in the cosmic rays. [3] This view when combined with the fictitious realm of the big bang leads to the belief in "breaking the matter-antimatter symmetry at the beginning of the universe"—which is nothing but one of the false byproducts of the expanding universe model.

Central in Periodic Physics is the Principle of Supreme Design; it is, among the other things, crucial for understanding why there is no significant amount of antimatter in the primary cosmic rays.

Principle of Supreme Design
The universe is supremely designed, inspected, and controlled, such that at any epoch there are numerous solar systems that host life and less numerous solar systems at recycling processes preparing to host life.

The expression "the universe at a certain epoch" is of absolute significance (absolute simultaneity is introduced hereafter in page 39). "Supremely" here means done in supreme quality and by principles only (without any material tool). Due to the Principle of Supreme Design, the universe is eternally active and full of life. Contrary to Modern Physics' accidental universe, that is analogous to a projectile, Periodic Physics' universe is analogous to a modern aircraft; there is a careful flight plan, the flight is continuously inspected and controlled such that the plan is exactly

[3] Eventually, some tiny number of antiparticles has been found in the primary cosmic rays.

executed. The fact that humans can design or destroy a certain, extremely tiny, part of the physical universe does not mean that everything else is accidental. The origin and the role of cosmic rays are explained in the third and the fourth parts of this book. Cosmic rays maintain the high temperature of Earth's core that is one of the crucial conditions for life. Significant amounts of antimatter cosmic rays would generate mighty gamma rays that can severely harm life. Cosmic rays are designed, inspected, and controlled to support life; therefore, no significant amount of antimatter cosmic rays approaches a matter living-planet.

In reality (not only in physical reality) there are plenty of complementary pairs. That many things are complementary pairs is a fundamental pattern of nature. Matter and antimatter constitute a complementary pair, and due to symmetrical considerations, gravitation-dynamics considerations, and observations of extremely red-shifted spectrums, the two kinds appear evenly in the universe.

The conclusion that relative velocities between galaxies are non-relativistic, and the fact that the observable large-scale distribution of galaxies in the universe seems to be practically constant, suggests that the universe, on the very large-scale, is static. A static and finite universe, which is impossible according to Modern Physics' theory of gravitation, is possible according to its modification by Periodic Physics. This modification also requires a thorough reconsideration of Modern Physics' view of gravitational mass. The universe is then analogous to a crystal: the galaxies behave like ions in a crystal; they are bound to their vicinities by instantaneous restoring gravitation.

The spatial volume where any physical substance can be found is finite; matter galaxies and antimatter galaxies occur evenly; the galaxies are arranged in a solid gravitational crystal, and each galaxy oscillates in its vicinity.

2. Observations on Einstein's Theory of Gravitation

Einstein's theory of gravitation, while useful when applied to the solar system and to various kinds of stars, totally fails when applied to the entire universe. The expanding universe cosmology is based on the false deduction by which the limited success of Einstein's theory guarantees its universal validity. The application of this theory to the entire universe is not perceived as it should be, a test of the validity-domain of the theory, but as an operation revealing facts of reality.

The universal validity of Einstein's theory is usually believed to be beyond doubt. Consequently, central observations that cannot be explained by Modern Physics and are the keys for its modification are, instead, regarded as evidence of the existence of invisible, gigantic "physical realities". Current modern cosmology is in a dead end where rich and highly significant observations, achieved by highly advanced technology, are digested into a fairy tale. In this fairy tale, the observable matter is a marginal 4% character, while the main roles are played by gigantic ghosts. The primal father, "Expanding universe", gives virtual birth to its own "Inflation", to its own "Accelerated expansion", and to the biggest invisible 74% giant, "Dark energy". Misunderstanding of the large-scale propagation of light and partial understanding of gravitation, give virtual birth to the secondary big giant, the invisible 22% "Dark matter".

"Expanding universe", "Dark matter", and "Dark energy" possess the unmistakable properties of superfluous concepts. They ultimately result from treating both the correct and the misleading assumptions of Modern Physics as a final set of dogmas, while ignoring the facts that ***physics develops in stages*** and that ***the cosmological red-shift, the cosmological background radiation, glowing nebulas, globular clusters, elliptical galaxies, quasars, cosmic rays, cosmological jets, and the fact that the universe does not collapse, among other phenomena, lie outside the applicability-domain of Modern Physics.*** Contrary to the officially declared scientific methods and principles, discrepancies in modern cosmology are regarded as only apparent discrepancies and are "explained" by false rationalizations. The following is an amusing example of how a chain of contemporary cosmological fictions is used to serve very practical interests. "Dark energy" accelerates the "expansion of the universe" such that the "horizon", that prevents observations of violations of physics, gets closer in an increasing rate. [4] Thus, there is an urgent demand for large budget intensive observations to record these parts of the universe that are going to "disappear" soon... The expanding universe model, together with all its byproducts, is essentially similar to the geocentric model and its byproducts. Both models demonstrate that when misleading assumptions are dogmatically applied to physical domain in which they are not useful, ridiculous mixture of science and myth results.

Can physical reality at a certain event be instantaneously affected by physical reality at another event that lies outside its past cone? Does instantaneous influence that is not propagated exist? Einstein believed that Special Relativity excludes

[4] Under the misleading assumption that the universe is expanding, certain observations are interpreted as evidence that the expansion is accelerated… Mistakes reproduce more mistakes.

instantaneous influence. Special Relativity, however, is concerned with massive particles, light and electromagnetic fields. In other words, Special Relativity is concerned with all kinds of particles: massive particles, photons, virtual field mediators and even tachyons. [5] Thus, Special Relativity is of no use regarding the question: "Does instantaneous influence exist?" Instantaneous influence, if it exists, does not involve mediators, so this topic is not in the domain of Special Relativity.

When the Einstein-Podolsky-Rosen paradox was experimentally tested, it was found that with respect to the collapse of wave-functions, Einstein's conviction about the impossibility of instantaneous transfer of signals was false. Wave-functions collapse instantaneously; this phenomenon is not a propagated one. That empirical fact, however, was not known in Einstein's time. Fascinated with his great discovery that no observable particle is faster than light, and in light of his quest for unification of gravitation and electromagnetism, Einstein inserted a term into his field equations which converts Newton's instantaneous gravitation into a wavy gravitation that is propagated at the velocity of light. According to Einstein's GTR, physical reality at a certain event is affected gravitationally by the gravitational mass at the surface of its past cone.

The intensive and prolonged efforts to directly detect gravitational waves eventually yielded a positive result on September 14th, 2015. Appling Einstein's theory to the observation yields: the gravitational waves observed in LIGO150914 were produced in a merging event of two black holes during which about three solar masses had abruptly converted to gravitational waves. Gravitational waves, however, are geometrical waves—ripples in the geometry of space time; unlike electromagnetic waves they do not carry energy. The solution to this discrepancy is: whenever Einstein's equations predict gravitational waves, physical substance is converted to its orthogonal form (tachyons) and disappears to the unobservable orthogonal universe at the rate predicted by Einstein's theory. [6] From the events of conversion, gravitational waves propagate "in memorial" for the lost physical substance. When black holes are involved, part of the involved physical substance is converted and disappears to the orthogonal universe. When black holes are not involved, virtual photon-antiphoton pairs and/or virtual fermion-antifermion fundamental pairs are produced from the system's energy and become real as their analogous tachyon-form in the unobservable universe. Antiphotons are photons emitted by antimatter (see chapter 4 hereafter). The fundamental fermions are the

[5] Tachyons move faster than light and their mass is imaginary, which means that they are unobservable in principle and cannot transfer any influence; a new view of tachyons is introduced in Part III.

[6] The orthogonal universe is introduced in Part III.

electron neutrino, the electron, the up-quark, and their three antiparticles (see Part IV).

Binary pulsars provide an indirect experimental confirmation for the existence of gravitational waves. The reduction in the orbital energy of the binary pulsar PSR 1913+16 is the first observation of this kind; this observation corresponds to emission of gravitational waves. In this case, according to Periodic Physics, photons pairs and/or fundamental-fermion pairs are virtually produced and appear at the unobservable universe in their analogous tachyon-form. In the solar system virtual pairs are produced and disappear to the orthogonal universe at energy rate of about five kilo-joual per second (about 3.12x10^16 Mev per second). That energy loss is compensated by controlled gravitation.

Einstein misinterpreted his field equations. He believed that his field equations were a complete description of gravitation, that gravitation was always propagated, and that gravitational waves carried energy. These three assertions are misleading. Einstein's field equations are useful for gravitational waves and for those limited cases where the "propagated term" of the equations is negligible. These equations do not describe the maintenance of the universe. The universe is maintained by instantaneous controlled gravitation. Gravitation is a complementary pair, instantaneous gravitation and gravitational waves.

Conversion of physical substance to its orthogonal form results in two gravitational outcomes:

1. Instantaneous change of the gravitational field that is affected by the event of conversion.
2. Gravitational waves are propagated away from the event of conversion at the speed of light.

Einstein's principle of equivalence refers to two different states of reference frame in the instantaneous gravitational field; it is reformulated to the following:

First Principle of Equivalence
Free fall of a purely-matter system or of a purely-antimatter system in a uniformly operated gravitational field is infinitesimally equivalent to uniform motion in a hypothetical universe free of gravitation; stationary state of a purely-matter system or of a purely-antimatter system in a uniformly operated gravitational field is infinitesimally equivalent to uniform acceleration in a hypothetical universe free of gravitation.

The gravitational field might be different for different particles at the same infinitesimal vicinity; but at the default choice of the governing programs, it is uniformly operated—it is uniform for all the physical substance in the same infinitesimal vicinity. Another restriction on the validity domain of the first principle of equivalence is that the frames under consideration should not be mixture of matter and antimatter but purely constituted of matter or purely constituted of antimatter. Due to the first principle of equivalence, observations inside an infinitesimal free-falling frame (in a uniformly operated gravitational field) cannot, in principle, distinguish this frame from a frame that hovers at uniform motion in a hypothetical universe free of gravitation. The free fall creates in the free-falling frame an inverse gravitational field that counteracts the gravitational field that generates the free fall. For non-infinitesimal free-falling frames, like planet Earth, the principle implies that the curvature due to the external field is constantly zero. Consequently, the weight of objects in a free-falling frame is determined only by the gravitational mass of the frame. Tidal effects can be caused by the gravitational field that generates the free-fall and by objects (moons) that fall freely in the field of a large free-falling frame, but all the exterior gravitational fields have no effect on the weight of objects in the frame. The universal field, that determines the positions of galaxies, vanishes in them; the galactic field, that determines the kinematics of the galaxy's members, vanish in them; the Sun and the Moon do not affect the weight of objects on Earth (otherwise, objects would weigh more at midnight, less at noon). Detection of gravitational waves can be used for the distinction of a free-falling frame from a frame in uniform motion in hypothetical universe free of gravitation. Thus, Einstein's principle of equivalence does not include gravitational waves and is valid only for the instantaneous length-dependent gravitation, that instantaneously determine the geometry of space-time and is referred here as **macro gravitation**.

Gravitation is geometry; geometry, even propagated geometry does not require mediators. Gravitons do not exist.

Macro gravitation and length-dependent electricity constitute a complementary pair of two entirely different interactions. [7]

[7] Inside atoms and inside composite subatomic particles, gravitation and electricity are not length-dependent (see Part IV).

Principle of Difference
Gravitation differs from electricity in all respects [8]**.**

This postulate conflicts with the contemporary view of gravitation, that includes the knowledge that macro gravitation is geometry while macro electricity is forcefield but is not aware of the full implications of this fact. According to contemporary view, macro gravitation, like length-dependent electricity, is governed by equations and its magnitude is also a function of the variant distance of the affecting event from the affected event. Also, according to Einstein's view, the gravitational influence on an origin has been propagated from the surface of its past-cone at the velocity of light. The principle of difference, however, asserts that macro gravitation differs from length-dependent electricity also in these respects. Macro gravitation is governed by programs, not by equations, and its magnitude is a function of the additional distance (in space-time) of the affecting event from the affected event. The gravitational affecting space is definitely not the surface of the past-cone, macro gravitation is not propagated but instantaneous. Newton's third law of action and reaction holds true for macro gravitation when it is operated at its default mode; this law is not applicable to electricity because it is a propagated interaction. Length dependent electricity involve mediators, macro gravitation do not involve them.

Internal observations of the solar system can detect only the mutual gravitational interaction between the system's members. In this local domain gravitation currently behaves as if it is governed by equations (this is the default choice of the governing programs), and the gravitationally simultaneous space practically coincides with the electromagnetically simultaneous space, and consequently the modulus of the distance in space-time is numerically equal to the spatial distance. The principle of difference implies, of course, that the unification of gravitation and electricity under one set of equations is impossible in principle; Einstein's idea of unification is one of his few misleading ideas.

Applying his principle of equivalence to photons in a conservative gravitational field, Einstein found that the wavelengths of photons evolve *as if* they possessed gravitational mass that equals their total relativistic energy (which is kinetic energy only) divided by the squared speed of light (Einstein, 1952, 99-108). This result has been confirmed experimentally, and its contemporary common interpretation is that photons possess gravitational mass. From that point, and since it has been found before that the inertial mass of a massive particle stands in the same

[8] It hold true at all the three modes of the two interactions.

proportion to its total relativistic energy (Einstein, 1952, 67-71), and in light of the classical idea that the gravitational mass of a particle is proportional to its inertial mass, Einstein concluded that every particle, including zero-mass particles, has gravitational mass that is proportional to its total relativistic energy. According to Einstein's scheme every particle has gravitational mass and massive particles also have inertial mass which is proportional to their gravitational mass.
Particles are influenced by an electromagnetic field only if they possess electric charge. Gravitation, unlike electromagnetism, is not a forcefield; it is the geometry of space-time. Particles conform to that geometry regardless of whether or not they contribute to it (possesses gravitational mass). The idea that photons possess gravitational mass originates from a false deduction; the fact that the gravitational potential energy of photons is proportional to their kinetic energy does not prove that photons possess gravitational mass.

According to Einstein's scheme, any particle possesses gravitational mass which is proportional to its total relativistic energy (rest energy + kinetic energy). As is explained above, regarding photons, the fact that particles obey the geometry of space-time only confirm the validity of the first principle of equivalence (and of Hamilton principle), this fact tells nothing of the gravitational mass of particles. Experimental tests of gravitational mass of particles should measure their gravitational influence; such tests have been performed only for macroscopic bodies, and they prove nothing more than that the gravitational mass of a massive body is proportional to its time-symmetric rest-mass. The other facts about gravitational mass will be known through tests of the gravitational influence of moving bodies, of relativistic particles (plasma beams), of photons, and through tests of the influence of Earth's gravity on antiparticles.

There exists, however, a reason to believe that the gravitational mass of a particle is invariant; it is the pattern of the fundamental quantities. Each of the four quantities: length, time, mass, and charge, is a complementary pair of two different fundamental quantities, a true quantity, and an additional quantity: length of rigid rods and length of linear elements in space-time; variant-rate time and invariant-rate time; inertial mass and gravitational mass; variable charge [9] and electric charge. Ignoring Modern Physics' view of gravitational mass [10] a pattern can be noticed by which the true quantities are characteristically variant/variable quantities, and the additional quantities are characteristically invariant quantities. This pattern of the

[9] The variable charge is introduced in Part IV; it is crucially required for a consistent model of subatomic substance.

[10] This view involves a logical flaw and has not yet been experimentally tested.

eight fundamental quantities is assumed to be a principle of Nature, and it suggests also that when a particle is replaced by its antiparticle the gravitational mass is transformed like the electric charge, which implies a crucially important consequence: ***gravitational repulsion between matter and antimatter***. Thus, the principle of gravitational mass is introduced:

Principle of Gravitational Mass
The magnitude of the gravitational mass of physical substance is proportional to its time-symmetric rest-mass; the sign of antimatter's gravitational mass is opposite to the sign of matter's gravitational mass.

With respect to attraction-repulsion, macro gravitation differs from length-dependent electricity not in being only attractive. In this respect, it differs in that equal-sign gravitational masses, unlike equal-sign electric charges, attract each other; and in that opposite-sign gravitational masses, unlike opposite-sign electric charges, repel each other. Another difference: due to the invariant nature of instantaneous gravitational interaction, nothing in instantaneous gravitation is analogous to magnetism.

Particles whose speed, with respect to the invariant-rate time in their immediate vacuum vicinity, can be changed—possess inertial mass. Particles whose speed, with respect to the invariant-rate time in their immediate vacuum vicinity, is invariant—have no inertial mass. The rest-mass of a massive particle is defined as the inferior limit of its inertial mass when its velocity approaches zero. The inertial mass of photons is zero; consequently, their rest-mass is defined as zero. The magnitude of the gravitational mass of a particle is proportional to its time-symmetric rest-mass. The time-symmetric rest-mass of a particle is its rest-mass in the time-symmetric description (when only the invariant-rate time is used). According to the principle of gravitational mass the gravitational mass of a particle is independent on its energy content and on the reference frame, light does not contribute to the gravitational field, and antimatter is repelled by matter's gravity.

3. Controlled Gravitation

In order to describe the operation of macro gravitation, we first have to define the different regions of space-time. With respect to any arbitrary event as origin space-time is primarily divided into three regions: [11]

1. The **past of an origin** is the set of all events from which massive substances or light can in principle immerge to the origin. It is called the "past-cone" of that origin. The invariant distance of a past event from its origin along any possible connecting world-line is of a negative real value (this distance is minus zero when the connecting substances is light).
2. The **future of an origin** is the set of all events to which massive substances or light from the origin can in principle immerge. It is called the "future-cone" of that origin. The invariant distance of a future event from the origin along any possible connecting world-line is of a positive real value (this distance is plus zero when the connecting substance is light).
3. The **extended present of an origin** is the set of all events which in principle cannot be connected to that origin by world-lines of massive substances or of light. It is the region outside the past and the future cones. The invariant distance of an extended present event from the origin along the geodesic between them is of non-vanishing imaginary value (its sign is discussed in the following).

In the extended present region, there exists the **absolute present of the origin**. It is the set of all events that happen together with the origin (this absolute simultaneity is not known to Modern Physics). All the events of a collapse of a wave-function occur at one absolute present. The electromagnetic simultaneity, as defined by Einstein, is of local physical significance. For non-local physics the absolute present, which can be called also the **absolute simultaneity**, is relevant. When at a certain event the variant speed of light, with respect to a certain reference system, assumes a certain value, it assumes the same value, with respect to that system, at the entire absolute present of that event. Different cosmological regions can assign different time-densities to the same absolute present, but for each of them the time-density there is uniform.

The absolute coordinate

The variant speed of light is a function of the absolute coordinate; the absolute coordinate is the w-coordinate in a virtual frame whose electromagnetic simultaneity continuously coincides with the absolute simultaneity. All the

[11] This division is absolute; it does not depend on the frame of reference.

members of a cosmological region experience the same variant speed of light. The phase and the function of the fundamental variant can be different for different cosmological systems, but for all the members of a cosmological system it is the same for each absolute present.

The absolute present of an origin separates between its **past-present** and its **future-present**. The past-present is the region between the past-cone and the absolute present. [12] The imaginary invariant distance of a past-present event from the origin along the geodesic between them is designated by a minus sign. The future present is the region between the absolute present and the future cone. [13] The imaginary invariant distance of a future-present event from the origin along the geodesic between them is designated by a plus sign.

The minus sign of an invariant distance from the origin designates an event which happened before the origin. The origin, therefore, cannot in principle affect any event of minus-sign distance. ***Every*** event of minus-sign distance, however, can in principle affect the origin. Past events (negative real distances) can affect the origin by massive particles, by mass-less particles, and by gravitational waves. ***When gravitation is operated out of the default choice mode, past-present events (negative imaginary distances) can, if chosen, gravitationally affect the origin***.

The plus sign of an invariant distance designates an event which is yet to occur when the origin takes place. The origin, therefore, can in principle affect ***any*** plus-sign event. A plus-sign event, however, cannot in principle affect the origin. The origin can affect future events (positive real distance) by massive particles, by mass-less particles, and by gravitational waves. ***When gravitation is operated out of the default choice mode, future-present events (positive imaginary distances) when they occur can be gravitationally affected by the origin because the origin is in their past-present***.

The origin can affect absolute present events gravitationally, or by causing collapses of wave-functions. Absolute present events can affect the origin in the same two ways (the origin is also in their absolute present). An absolute present event can affect the origin and can be affected by it. That property is designated by assigning

[12] For any world-line the past-present interval takes place after the past cone event and before the absolute present event.

[13] For any world-line the future-present interval takes place after the absolute present event and before the future cone event.

a plus-minus sign to the non-vanishing imaginary distances of absolute present events.

Thus when, in addition to world-lines of particles, collapse of wave-functions and instantaneous gravitation are also considered, the four-dimensional continuum with respect to any arbitrary origin is absolutely divided into ***five regions***: past, past-present, absolute present, future-present, and future.

In the unified region of the past-present and the absolute present a **gravitationally simultaneous space** (GSS) exists. A gravitationally simultaneous space is the set of events which are gravitationally simultaneous to the origin and instantaneously affect it. The gravitationally simultaneous space of each event is determined by Nature such that the supreme design of the universe is executed, and such that when gravitation is uniformly operated the first principle of equivalent holds true. Unlike the electromagnetic simultaneous space, the gravitationally simultaneous space is absolute. Note that no observable substance moves along geodesics of imaginary lengths (space-like intervals). Instantaneous gravitation is not propagated; when the origin is gravitationally affected by a certain event, this is not done through any propagation of mediators, it is the immediate consequence of the fact that that event is at the GSS of the origin. At the default choice of the governing programs the GSS of an event coincides with its absolute present. Deviations of the GSS from the absolute present and operation of non-uniform gravitation are required for the maintenance of elliptical galaxies, for the maintenance of globular clusters, for the maintenance of crystal-like systems of stares, during the construction of young cosmological systems, for preventing total gravitational collapse of black holes, and more.

Let us apply the time-asymmetric modification to Newton's law of gravitation (it is the first approximation of gravitation). In the absence of relative motion, a force is proportional to the variant speed of light at the event of observation (I.18). Let us consider point-like gravitational masses m_1 and m_2, according to the principle of gravitational mass and Equation I.10, gravitational mass and length are invariants under a time-transformation. Thus, the gravitational force $\vec{F}_{1,2}$ exerted by m_2 on m_1 satisfies the above law of transformation when it is given by:

$$\vec{F}_{1,2} = -\frac{\mathrm{v}}{c} G \frac{m_1 m_2}{\vec{r}_{1,2}^{\,2}} \hat{r}_{1,2} \qquad \text{(II.1)}$$

Where G denotes the gravitational universal constant, $\vec{r}_{1,2}$ denotes the position of m_1 with respect to m_2, and $\hat{r}_{1,2}$ is the corresponding unit vector. The gravitational fundamental parameter is a **dependent variant** whose value is $\frac{\mathrm{v}}{c}G$ where the value of the variant speed of light is v. It is assumed that ***the relevant value of the gravitational dependent-variant depends only on the time-density at the affected event with respect to the affected substance and does not depend at all on the time-density at the affecting event***. Thus, even when the affected event and the affecting event are at different time-densities (they are not in the same absolute present), only the time-density at the affected event matters.

We proceed in considering the factors that constitute the original Newtonian law. The gravitational fundamental parameter, G, is a universal constant; its physical units in the time-asymmetric description are different from its physical units in the familiar, simplified description; otherwise, its constant numerical value is the same in both descriptions. The gravitational masses of the two bodies, m_1 and m_2, are proportional correspondingly to the time-symmetric rest-masses of the bodies. By the principle of difference, ***the squared spatial distance is modified into the squared gravitational distance of the gravitationally affecting event from the gravitationally affected event; it is the modulus of the connecting geodesic between the two events***. The invariant distance of an affecting event from an affected event is denoted "s", and its modulus is the gravitational distance. The gravitational distance of a certain affecting body from a certain affected event has a maximal value and it can assume any positive value which is smaller than that maximum, depending on the controlled choice of the affective event (the gravitational distance approaches zero as the gravitationally affecting event approaches the past cone of the affected event). $\hat{r}_{1,2}$ denotes the unit vector of the position of m_1 at the affected event with respect to m_2 at the affecting event. We have the following **law of controlled gravitation;** description of macro gravitation approximated to force:

$$\vec{F}_{1,2} = -\frac{\mathrm{v}}{c} G \frac{m_1 m_2}{s s^*} \hat{r}_{1,2} \qquad \text{(II.2)}$$

Or, in a more elegant way:

$$\vec{F}_{1,2} = \frac{V}{c} G \frac{m_1 m_2}{s^2} \hat{r}_{1,2} \qquad \text{(II.3)}$$

The minus sign is contained in the squared imaginary term.

Each one of the fundamental quantities: length, time, and mass is a variant-invariant complementary pair:

Variant length (of rigid rods)
Invariant length (of linear elements in space-time)
Variant-rate time (time-asymmetric magnitude of time-intervals)
Invariant-rate time (time-symmetric magnitude of time-intervals)
Variant mass (inertial mass of particles)
Invariant mass (gravitational mass of particles)

Let's introduce notations of their units correspondingly:

$$[L_{VA}] \quad [L_{IV}] \qquad [T_{VR}] \quad [T_{IR}] \qquad [M_{VA}] \quad [M_{IV}]$$

It can be inferred from equation II.2 that the units of the gravitational universal constant in time-asymmetric physics are:

$$[G_{TA}] = \frac{[M_{VA}][L_{VA}]}{[T_{IR}]^2} \frac{[L_{IV}]^2}{[M_{IV}]^2} \qquad \text{(II.4)}$$

Time-symmetric physics uses the same unit for the two different kinds of mass and the same unit for the two different kinds of length. In addition, time-symmetric physics is not aware of the variant-rate time. Thus, the units of the gravitational universal constant in time-symmetric physics (SI system) are:

$$[G_{SI}] = \frac{[L]^3}{[M][T]^2}$$

A direct consequence of the fact that macro gravitation is not mediated by particles is that ***in general Newton's third law (action and reaction) is not valid in the gravitational case.*** The fact that body *A* at event *a,* is gravitationally affected by body *B* at event *b*, does not necessarily mean that body *B* at event *b* is gravitationally affected by body *A* at event *a*. That Newton's third law is useful in the solar system, is due to the fact that, in general, during the life-conditions phase of a system, macro gravitation operates at its default mode (the gravitational simultaneity coincide with the absolute simultaneity), and due to the fact that macro gravitation is instantaneous.

According to Periodic Physics, the conservation of the angular momentum of the planets in the solar system is due to the instantaneous operation of macro gravitation; only instantaneous central force is of zero torque. However, there exists a sophisticated way to explain the conservation of the planets' angular momentum in the reality of propagated gravitation. Does macro gravitation a propagated phenomenon like gravitational waves, or is it an instantaneous phenomenon? It is highly desired to answer this question by decisive experimental tests.

Let us describe the gravitational interaction from the largest level, the intergalactic level, to the level of a solar system. At each level the interaction is between the relevant members. And, by the first principle of equivalence, the internal interactions inside each member are not affected at all by the interactions at the upper level(s).

The intergalactic interaction: Matter galaxies and antimatter galaxies are evenly distributed in the universe (total symmetry between matter and antimatter; the total gravitational mass of the universe is zero). Gravitation between galaxies operates mostly at its default choice mode (the gravitational simultaneity coincides with the absolute simultaneity). Matter galaxies and antimatter galaxies are distributed such that the universe is a **gravitational crystal**, and each galaxy rotates in its region due to **restoring gravitation.** Unlike an electric crystal, in the gravitational crystal there are two kinds of attractions and one kind of repulsion. Light emitted in quantum energy transitions of antimatter has higher possibility to be annihilated inside a matter galaxy than cyclotron/synchrotron light of antimatter. Cyclotron/synchrotron radiation consists of virtual field-mediators that have turned to real photons while accelerating/decelerating charged particles/antiparticles by electromagnetic fields. Antimatter galaxies can be observed mainly by their cyclotron/synchrotron radiation. ***This suggests that cosmological radio sources might be antimatter objects, and that quasars are active nuclei of antimatter galaxies.*** Another relevant rule, that is also explained in the next chapter, is that the gravitational potential of light emitted by antimatter (antiphotons) is generated only by the gravitational mass of antimatter. Thus, when we observe quasars, we observe antiphotons that were emitted at the immediate proximity of super massive antimatter black holes and are observed at a matter galaxy very far from any antimatter galaxy. That practically maximal potential difference reinforced the red-shift due to the non-homogeneity of time and results in the extreme red-shift of the quasars. An antimatter galaxy around a quasar looks faint because the emission of cyclotron/synchrotron radiation is faint relative to the hardly observed quantum transition emission, and due to the reinforced red shift. Quasars' distances are not essentially different from those of matter galaxies; quasars of the lowest red shift

are probably members of the local cluster. In his book *Seeing Red: Redshifts, Cosmology and Academic Science*, Halton Arp presents observations of quasars which are aligned along two straight lines from both sides of a galaxy (Arp, 1998). Probability calculations indicate that that straight alignment is not accidental. The smaller the angle between the quasar and the galaxy, the higher its red shift (the farther it is). This means that there are two lines of antimatter galaxies from both sides of the central matter galaxy, and probably a line of matter galaxies hidden behind that central galaxy. Such observations provide important information about the structure of the gravitational crystal.

Internal interaction in spiral galaxies: In spiral galaxies the gravitational attraction is balanced by angular momentum (centrifugal "force"). A lot of matter which does not emit light (dense dying stars, planets, asteroids, and dust) contributes to the galaxy's gravitational mass. Due to the large-scale propagation of light (see next chapter), this "dark matter" does not significantly block the propagation of light. The rest of the "missing mass", if needed, is virtually created by shortening of gravitational distances inside the spiral galaxy.

Internal interaction in elliptical galaxies: An elliptical galaxy is held up by controlled restoring gravitation. Any escape attempt of a member from its proximity is immediately balanced by shorting of gravitational distances to other members which are in the opposite direction. In order to hold the members of the outside shell in place, shorting of gravitational distances of external objects is required. In this case the external gravitational field is not uniformly operated but is reinforced for the outside shell.

Internal interaction in globular clusters: Globular clusters are compact spheres of hundreds of thousands of stars. These objects are stannic demonstrations of controlled restoring gravitation; they are miniatures of elliptical galaxies.

Internal interaction in solar systems: In solar systems during the life-condition phase, gravitation operates at its default choice mode, and the systems are stable due to their angular momentum.

Creation of new systems from recycled materials: In systems under construction gravitation operate at the non-uniform mode. Things like the chemical composition of planets, their orbits, their spins and so on are executed according to the supreme design.

In maintaining the solar system, macro gravitation operates mainly in its default-choice mode**.** The observable consequences of operation in the uniform mode are that relative motions inside a system result only from interior gravitational influence, and that influence is such that all the interior GASs practically coincide with the corresponding absolute presents. Gravitation is also the tool to carry out special tasks. Special tasks demand operation in the **non-uniform mode** of gravitation**.** The creation of our planet, for example, involved many special tasks. Not one of the typical features of Earth is accidental. Things like the chemical constitution, the geometrical dimensions, the average distance from the sun, the angel which Earth's axis creates with the ecliptic plane, the angular velocity about its axis, and many other details, are all supremely designed, inspected and controlled with the intention of providing adequate conditions for life. The tool for executing the supreme designing plan is macro gravitation, which, when required, operates in its non-uniform mode.

The maintenance of a living planet involves mainly uniform gravitation, but also here there is room for special tasks. Due to tidal effects, the calendar day becomes longer. That process is under supreme inspection. When danger of a too-long calendar day approaches, Nature exerts an adequate torque along an adequate time interval such that in spite of the tidal effect the calendar day does not get too long.

Some cosmological features do not play an essential role in the physical operations of nature. They function as learning aids to help improve human knowledge. The non-living planets of the solar system, for instance, do not have a crucial physical function. In their absence, however, it would have been much harder to take the first step in solving the riddle of gravitation. There may also be some local clues to the non-uniform mode of gravitation. Some observers, starting with Maurice Allais in 1954, claim to observe that pendulums swing in unusual ways during eclipses (Schilling, 28). These observations cannot be explained by the current theory of gravitation. My view is that, if they are indeed observed, these anomalies exist as clues to help humans understand that gravitation is governed by Nature and can be operated also at a non-uniform mode. Non-uniform gravitation is applied mainly during the recycling and reconstructing phase which is discussed in chapter 6. During eclipses, which are out-of-routine events, human beings are provided with hints about the ability of Nature to create a state in which the gravitational influence on a certain body is different from the gravitational influence on its vicinity. That ability is not usually applied in the solar system during the life-conditions phase, and the unusual event of an eclipse provides a "stage" for tuitional demonstrations of its existence.

4. The Cosmic Odyssey

Due to the even distribution of matter and antimatter, the large-scale average curvature of space-time is zero. Despite this fact, no massive substance and no massless substance can escape a certain finite vicinity of the universal solid crystal. The gravitational potential of massive substance is generated by the gravitational mass of matter and by the gravitational mass of antimatter. Due to the repulsion between massive matter and massive antimatter and the attraction between equal-sign gravitational masses, massive particles cannot penetrate antimatter galaxies, and massive antiparticles cannot penetrate matter galaxies. Only high-energy massive substance from the surface of the universal crystal is at risk of escaping the universal crystal. But outside the universal crystal, the gravitational field is not uniformly operated; massive particles experience inward attraction due to shortening of the gravitational distances to their matter galaxies, and massive antiparticles experience inward attraction due to the shortening of the gravitational distances to their antimatter galaxies. Thus, every massive substance is attracted to its galaxy, and escape is impossible.

Non-virtual massless substance is bound by the following principle:

Principle of Cosmic Odyssey
Most light in empty space eventually returns to its emitting system in converging superpositions that are evenly distributed over the whole solid angle.

How most photons/antiphotons avoid absorption along that longest voyage is explained hereafter.

Non-virtual massless substance is of seven types:

1. **Transition-photons** (produced in matter's quantum energy-transitions)
2. **Transition-antiphotons** (produced in antimatter's quantum energy-transitions)
3. **Transition-mixedphotons** (produced in mixed atoms' quantum energy-transitions) [14]
4. **Exmediation-photons** (virtual field-mediators of pure matter origin that became real)
5. **Exmediation-antiphotons** (virtual field-mediators of pure antimatter origin that became real)

[14] Two examples of mixed atoms are positronium and antiprotonic-helium.

6. **Exmediation-mixedphotons** (virtual field-mediators of mixed origin that became real)
7. **Annihilation-photons** (produced in matter-antimatter annihilations)

The gravitational potential of transition-photons and of exmediation-photons is generated solely by the gravitational mass of matter. The gravitational potential of transition-antiphotons and of exmediation-antiphotons is generated solely by the gravitational mass of antimatter. Thus, for transition photons/antiphotons and for exmediation photons/antiphotons the universe is closed and, when not absorbed by other systems, they return to their free-falling emitting system (every cosmological system is a free-falling system). A transition-mixedphoton is a superposition of a transition-photon and a transition-antiphoton. Thus, also most of the transition-mixedphotons return to their free-falling cosmological sources. An exmediation-mixedphoton is a superposition of an exmediation-photon and an exmediation-antiphoton. Thus, also most of the exmediation-mixedphotons return to their free-falling cosmological sources. Due to quantum entanglement, the sign of the pseudo gravitational mass of annihilation-photons evenly alternate between positive and negative. Each annihilation product is a superposition of a photon and an antiphoton; thus, also most of the annihilation photons return to their free-falling cosmological sources.

A photon/antiphoton emitted from a star has no definite linear momentum, it's wavefunction is a superposition of many linear momentums that are evenly distributed over the whole solid angle. It is a sphere whose radius expands at the speed of light. At each absolute present only one component is capable of interaction, and this is the reason that most light avoids absorption outside its cosmological emitting system. Outside the universal solid crystal, the superposition attains its maximal size, and it start to shrink at the speed of light and eventually returns back to its free falling cosmological source. That returning radiation is the background radiation. At the rapidly increasing phase of the variant speed of light (it takes place after the system runs out of hydrogen) the background radiation is extremely blue shifted, and it recycles helium back to hydrogen. The principle of cosmic odyssey should be taken in account for estimations of cosmological distances. Cosmological distances are, in general, smaller than those estimated by Modern Physics.

In most matter-antimatter annihilations, two photons are created. The entangled wave-function of a pair of annihilation-photons is a superposition of two states. In one state the pseudo gravitational mass of photon A is positive, and the pseudo gravitational mass of photon B is negative. In the other state the pseudo

gravitational mass of photon A is negative, and the pseudo gravitational mass of photon B is positive. Thus, if one photon is emitted toward Earth and the other away from Earth and an interaction occurs, there is 50% chance that both gain kinetic energy and 50% chance that both lose kinetic energy.

GM_{1x2}, the gravitational-mass discrete-vector of a photon/antiphoton, tells by which substance its gravitational potential is generated as well as the sign of its pseudo gravitational mass:

GM_1 —the gravitational mass with respect to matter
GM_2 —the gravitational mass with respect to antimatter

The gravitational mass of a photon/antiphoton with respect to matter/antimatter can assume one of three different zeroes:

- No-sign zero—the relevant substance does not contribute to the gravitational potential of the photon/antiphoton.
- Plus-zero—the relevant substance contributes to the gravitational potential of the photon (positive pseudo gravitational mass).
- Minus-zero—the relevant substance contributes to the gravitational potential of the antiphoton (negative pseudo gravitational mass).

The gravitational-mass vectors of the seven types of non-virtual photons are

$$GM(\#1) = \begin{pmatrix} +0 \\ 0 \end{pmatrix}$$

$$GM(\#2) = \begin{pmatrix} 0 \\ -0 \end{pmatrix}$$

$$GM(\#3) = \left(\begin{pmatrix} +0 \\ 0 \end{pmatrix} \quad S.P. \quad \begin{pmatrix} 0 \\ -0 \end{pmatrix}\right) \quad \text{(II.5)}$$

$$GM(\#4) = \begin{pmatrix} +0 \\ 0 \end{pmatrix}$$

$$GM(\#5) = \begin{pmatrix} 0 \\ -0 \end{pmatrix}$$

$$GM(\#6) = \left(\begin{pmatrix} +0 \\ 0 \end{pmatrix} \quad S.P. \quad \begin{pmatrix} 0 \\ -0 \end{pmatrix}\right)$$

$$GM(\#7) = \left(\left(A\binom{+0}{0}B\binom{0}{-0}\right) \quad S.P. \quad \left(A\binom{0}{-0}B\binom{+0}{0}\right)\right)$$

While the potential energy of light is generated by matter **or** by antimatter, its kinetic energy is affected by matter and by antimatter.
The antiparticles of transition-photons are transition-antiphotons. The antiparticles of exmediation-photons are exmediation-antiphotons. The antiparticles of transition-mixedphotons are transition-mixedphotons of the opposite-sign pseudo gravitational-mass. The antiparticles of exmediation-mixedphotons are exmediation-mixedphotons of the opposite-sign pseudo gravitational-mass. The antiparticles of annihilation-photons are annihilation-photons of the opposite-sign pseudo gravitational-mass. The inverse process of matter-antimatter total annihilation exists, i.e., when a photon collides with its antiphoton, a fundamental pair of lepton-antilepton is produced (the fundamental leptons are the electron and the electron-neutrino; see Part IV).[15] The main radiation inside matter galaxies are transition photons. Thus, most of the antiphotons that are annihilated inside matter galaxies are transition antiphotons. Consequently, antimatter galaxies look dimmer than matter galaxies that otherwise are of the same circumstances. An antimatter cosmological object can be observed mainly by its exmediation radiation. Thus, cosmic radio sources are most likely antimatter objects. According to Periodic Physics' interpretation, quasars are active nuclei of antimatter galaxies; from their radiation, we observe mainly the exmediation-radiation part, which is known to be intensive from galaxies' nuclei. In the quasars' case, the red-shift due to the time-effect is intensively reinforced because the emission takes place at the immediate proximity of super massive antimatter black holes, while the absorption is at a matter galaxy very far from any antimatter galaxy. Thus, in general, the red shift of all antiphotons that are absorbed by a matter galaxy is reinforced. The exmediation radiation and the faint transition-radiation from the rest of an antimatter galaxy are so faint that when wrongly interpreted as matter radiation, they are attributed imaginary-large distances.

Under the assumption that the universe is accidental, the fact that the primary cosmic rays that approach Earth contain practically no antimatter is interpreted as proof that no macroscopic antimatter exists. But actually, the cosmic rays are the wonderful way to supply energy to Earth' core without harming life; the cosmic

[15] The production of an electron and a positron from one photon is not the inverse process of matter-antimatter total annihilation.

rays are the reason that our planet is blue due to plenty of liquid water. Mars is an example of a planet that receives less supply of cosmic rays than Earth. This prediction can be tested by measuring cosmic rays outside of Mars's atmosphere. Quasars are sources of antiphotons, most of them exmediation-antiphotons; it may be that by radiating quasars' light with exmediation-photons it will be possible to determine whether photon-antiphoton annihilations occur. Detection of photon-antiphoton annihilations is the way to identify antimatter-galaxies.

5. Second Principle of Equivalence

The non-homogeneity of time generates time-effects that can be detected by **interacting with the past**. Interactions with the past are only apparently impossible. A unique property of light is that it moves along identically vanishing world-lines. Massive substances move along world-lines of positive real lengths; they move continuously into their future. Light move along identically vanishing world-lines. The facts that the invariant real distance of light from its emission event is identically zero and that it does not assign any individual universal function to the four-dimensional continuum make it a "frozen record" of its emission event. Absorbed light tells the value of the variant speed of light at its emission event *with respect to the absorbing frame of reference*. An interaction between massive substance and light is an interaction with the past of that massive substance. Due to the gradual evolution of the variant speed of light and due to Doppler effects, this fact has significant empirical consequences only for light from the remote past.

The gravitational dependent variant evolves continuously, that evolution implies that the gravitational field is not a conservative field. But since light is propagated along identically vanishing world-lines, it is not subject to the gradual evolution of the gravitational potential and preserves its gravitational potential-energy at its emission event (in the frame of the absorbing substance). This unique property of light is the origin of the following postulate:

Second Principle of Equivalence
Exclusively for light and only in the reference frame of its absorbing substance the time-asymmetric gravitational field is equivalent to a conservative field.

According to the second principle of equivalence, the time-effect can be correctly described in light of the assertion that the total energy of a photon (kinetic energy +

gravitational potential-energy) is conserved. The evaluation of the gravitational potential-energy of a photon/antiphoton requires ascribing *pseudo* gravitational mass to that mass-less particle. For that purpose, the direct result of Einstein's principle of equivalence (the first principle of equivalence) is applied. Due to this result the magnitude of the pseudo gravitational mass of a photon/antiphoton equals its time-symmetric kinetic energy divided by the squared constant speed of light. The pseudo gravitational mass of photons is positive, and it is negative for antiphotons.

Let us consider the absorption of transition-photons and of exmediation-photons from another cluster, such that any effect other than the time-effect is negligible. Let λ_a denote the absorbed wavelength from a spectrum line of which the natural wavelength is λ_e (by the principle of space, that wavelength is a universal constant). The value of the variant speed of light at the absorption event with respect to the absorbing matter is denoted V_a, and the value of the variant speed of light at the emission event with respect to the absorbing matter is denoted V_e. By the second principle of equivalence the following equation holds true: (II.6)

$$\frac{hc}{\lambda_e}+\frac{hc}{\lambda_e}\frac{1}{c^2}\left[-\frac{V_e}{c^*}G\int_e^\infty\frac{\rho^+}{r}dx^3\right]=\frac{hc}{\lambda_a}+\frac{hc}{\lambda_a}\frac{1}{c^2}\left[-\frac{V_a}{c^*}G\int_a^\infty\frac{\rho^+}{r}dx^3\right]$$

Where h denotes the Plank constant, c denotes the constant speed of light, c^* is of the numerical value of the constant speed of light and the units of the variant speed of light, and ρ^+ is the density of matter gravitational mass, and the integrals are evaluated over the absolute presents of the relevant events.

When antiphotons are observed at a matter galaxy, the magnitude of their time-symmetric absorption potential is very small due to incredible distances to antimatter galaxies. This fact generates a **reinforced red-shift**; antiphotons observed in a matter galaxy are more red-shifted compared to photons that are otherwise of the same circumstances. On the other hand, the same fact generates **reduced blueshift** when antiphotons are observed at a matter galaxy by a system that experience the increasing phase of the variant speed of light. Thus, for absorption of antiphotons, the integrals are evaluated only over the gravitational mass of antimatter and the pseudo gravitational mass of antiphotons is negative.

$$\frac{hc}{\lambda_e}-\frac{hc}{\lambda_e}\frac{1}{c^2}\left[-\frac{V_e}{c^*}G\int_e^\infty\frac{\rho^-}{r}dx^3\right]=\frac{hc}{\lambda_a}-\frac{hc}{\lambda_a}\frac{1}{c^2}\left[-\frac{V_a}{c^*}G\int_a^\infty\frac{\rho^-}{r}dx^3\right] \quad \text{(II.6')}$$

6. The Hydrogen Cycle

The universe is designed such that most of the light emitted by a cosmological body eventually returns to it. That returning light appears as cosmic background radiation—the cosmic background radiation that is observed now has been emitted from our solar system. The cosmic background radiation (or odyssey-radiation) is extremely blurred, and its spectrum is extremely shifted. Due to the way that long-traveling wave-functions evolve, no image of the source, and no track of the original spectrum, can be obtained from the returning light. It is postulated that:

Third Principle of Equivalence
The spectrum of odyssey-radiation is equivalent to the spectrum of black-body radiation.

When, during the observable past, the variant speed of light decreases, the past shift is red, and the "black body" temperature is very low. And when during the observable past the variant speed of light rapidly increases, the past shift is violent violet, and the "black body" temperature is extremely high. The directional nature of the universal function is such that the evolution of the variant speed of light during the increasing phase is much faster than its evolution during the decreasing phase. Consequently, the violet-shifted background radiation takes the form of mighty high-energy gamma rays that recycle heavy nuclei back to hydrogen. The "black body" temperature in this case is incredibly high.

The red and violet past-shifts are reinforced by their corresponding nuclear processes. When the past shift is red the region's gravitational potential continuously increases, and the dominant process in the region is the thermonuclear fusion. This process reduces the gravitational mass of the region. That reduction of gravitational mass reinforces the increase of the region's gravitational potential, and thus reinforces the cosmological red shift. The opposite happens when the past shift is violet. Then the region's gravitational potential continuously and very rapidly decreases and the dominant process in the region is the recycling of heavy nuclei back to hydrogen, this process adds gravitational mass to the region. That addition of gravitational mass reinforces the decrease of the region's gravitational potential, and thus reinforces the cosmological violet-shift. The gravitational potential created by antimatter is always positive, but since antimatter gravitational mass and pseudo gravitational mass of antiphotons are always negative, the results are the same as described regarding light emitted by matter.

Many and various glowing nebulas are observed in the Milky Way and in neighboring galaxies. [16] It is beyond the current power of observation to directly confirm the existence of nebulas in very remote galaxies, but according to the assumption that the local cluster of galaxies does not differ significantly from other clusters, nebulas are common in the universe, no matter what epoch is considered. Nebulas are constituted of defused gas; they are several light-years across to about a hundred light-years across and they glow light that can be observed easily (in some cases by the unaided eye) from distances of thousands of light-years. Nebulas are often stellar nurseries; newborn stars are generated there.

Contemporary astronomers use only time-symmetric effects to explain the nebulas. A typical example is the Rosette Nebula, NGC 2237, that spans about 100 light-years, lies approximately 5,000 light-years away, and can be seen with a small telescope (Nemiroff/Bonnell, 2003). The time-symmetric explanation of the tremendous emission of red light from that large, defused object is the following: "…an open cluster of bright young stars, NGC 2244, which lies at a hole in the nebula's center, emits ultraviolet light which causes the surrounding nebula (hydrogen) to glow." What fantastic illumination of ultraviolet light is required to penetrate a huge cloud of tens light-years and to excite hydrogen molecules so intensively that it can be seen 5,000 light-years away with a small telescope!

A **cosmological region** includes all the massive substances that is at the same phase of the universal function and is at one continuous spatial region. A galaxy is not one cosmological region. In a galaxy, at the same absolute present, there intermittently appear regions which experience red past-shift and regions which experience violet past-shift.

It is possible, in principle, that the universal function with respect to two different particles is different (see Part I p. 17). It seems that this is not the case for particles at the same spatial vicinity. However, the observations of glowing nebulas are actual evidence of regions that experience violet past-shift. ***The universal function is a function of the absolute time-coordinate, such that all substances of the same astronomical region experiences the same past-shift, and at any absolute present there are regions in each galaxy which experience red past-shift, while other regions of the galaxy experience violet past-shift.*** In any absolute present, all the various phases of the universal function appear in different regions of the universe and in different regions of a galaxy. A certain value of the variant speed of light with

[16] When first observed, galaxies were called nebulas. In this book, however, the meaning of "nebula" is distinguishably different from the meaning of "galaxy".

respect to a certain region at a certain event implies that with respect to this region at this event the value of the variant speed of light in the absolute present of the above event is the above certain value. Note that with respect to different regions the value of the variant speed of light in a certain absolute present can be different and even entirely different. Light from the same emission event that is observed in a certain absolute present can be red-shifted in one region and violet-shifted in the other.

Nature continuously governs all gravitational distances according to the supreme design such that an eternally stable universal structure is guaranteed. Danger of a universal gravitational collapse never exist, and also, as explained in Part III, each individual star, no matter how big its mass is, is never in a state of singularity. The flow of time never and anywhere stops.

Modern cosmology, due to misleading assumptions, is preoccupied with "the beginning of time." But in fact, as mentioned before, this issue is outside the domain of physics; physics is concerned with the way the universe functions. Physics can say nothing about "the beginning of the universe" or about "the beginning of time".

Let us crudely describe the evolution of a cosmological region through the different phases of the universal function it experiences. At the end of the phase of decreasing variant speed of light, the activity level of the region is very low. The region is out of nuclear fuel; the stars are at various stages of gravitational collapse and most of their emission is long-wave radiation. [17] Then the variant speed of light turns to its increasing phase. Gradually the past shift turns to a violet shift. The process starts with the light from the close galaxies and finally the cosmological background radiation turns to extremely high-energy gamma rays. The violet shifted light defused stars to red giants that are defused later to nebulas. The slope of the universal function at the increasing phase is much steeper than its slope at the decreasing phase. Therefore, the time-effect at that phase is so intensive that originally emitted infrared radiation is converted to mighty gamma rays background radiation. The wave-function of a returning-home photon is a huge ellipsoid far bigger than any nebula, that explains the incredible penetration ability of the Odyssey radiation. This wave-function converges at the emitting system where the photon is certainly absorbed. Those rays provide the binding energy to nuclei, and the inverse process of nuclear fusion occurs—***heavy nuclei are disintegrated back to hydrogen—light from the past is converted to mass.*** Light from other galaxies is less shifted than the background radiation. The light that is

[17] As explained in Part III, no gravitational collapse ends up in singularity.

not enough energetic to recycle nuclei, excite them, and that process results in intensive emission of observable light, x-rays, and gamma rays. Most of that radiation, however, returns to its emitting cosmological system and, when absorbed by it, recycle helium back to hydrogen. The same returning-home light, when absorbed by regions for which the observable past is at the decreasing phase of the variant speed of light, is long waves radiation.

When the universal function starts to decrease the bombardment by gamma rays gradually stops and gradually the past-shift turns to red-shift. The region is rich in hydrogen and, by means of controlled gravitation, is driven to create young stars, a process that begins already at the phase of increasing variant speed of light. Some of the young stars are very massive; they consume their nuclear fuel rapidly, and their rapid gravitational collapses trigger supernovas. Supernovas create and distribute a variety of heavy chemical elements, and thus prepare the chemical ground for the creation of planets, in particular of living planets.

The phase of decreasing variant speed of light is the phase of life-conditions. In addition to the abundance of nuclear fuel, the night sky at that phase is dark—two crucially necessary conditions for life. Life gradually appears on planets in the region. It does not result from a rare blind coincidence; it is supremely designed inspected and controlled.

A **closed cosmological system** is a cosmological system (together with the radiation emitted by this system) such that the universal function with respect to all the system's members is the same. The region's radiation that is absorbed by other regions is negligible compared with the region's total energy. In addition, that loss of energy is compensated for by absorption of radiation from other systems, so the region is practically closed. The same is true for the region's physical substance converted to its orthogonal form. During the phase of decreasing variant speed of light, mass is converted to photons and the wavelengths of those photons, when absorbed as odyssey-radiation, is red-shifted; these processes increase the entropy of the system. During the phase of increasing variant speed of light the wavelengths of odyssey-radiation are extremely short, and light is converted to mass—the entropy of the system decreases. Independently of the universal phase, there always exist local processes of conversion of energy to higher entropy forms. In the virtual time-homogeneous universe the time-symmetric second law of thermodynamics is universally true, and the entropy of that universe never decreases. Fortunately, and not accidentally, time is non-homogeneous, and each cosmological system experiences also a phase of dramatic decrease in its entropy

due to a violet past-shift which is incredibly more intensive than any local increase in entropy.

Time-Asymmetric Second Law of Thermodynamics
The entropy of a closed cosmological system increases during the decrease of the variant speed of light; and decreases during the increase of the variant speed of light. Due to controlled gravitation and conversion of physical substance to its orthogonal form, no gravitational collapse ends up in infinite entropy. The total entropy of a closed cosmological system always lies within a certain finite interval.

The universe is ***eternally active*** either in processes of thermonuclear fusion and biological processes or in processes of recycling heavy elements back to hydrogen and in creation of newborn systems. All the large-scale physical details are carefully designed and continuously inspected and controlled. Entropy never increases without a limit nor decreases without a limit. It is a marvelous universe designed for eternal life.

Relativistic plasma
Particle accelerators which generate highly dense beams (plasma beams) might enable a test of the principle of gravitational mass. According to Einstein's Relativity, the gravitational mass of a particle, like its inertial mass, depends on its energy content. Contrary to this view, the principle of gravitational mass asserts that the gravitational mass of a particle is proportional to its time-symmetric rest-mass and does not depend at all on its energy content. It might be possible to create relativistic plasma such that its gravity according to Einstein's Relativity could be detected by a highly sensitive Cavendish device. If gravitational mass does not depend on energy content, the gravity of the relativistic beam would be smaller than the error of measurement.

After-glow of gamma ray bursts
Estimations of distance based on Hubble Law are misleading; they are particularly misleading when the radiation under discussion is emitted by antimatter. In this case the red shift is reinforced since the gravitational potential of antiphotons is generated exclusively by the gravitational mass of antimatter. Thus, the case of high red-shifted after-glow of GRB is similar to the case of quasars and to the case of antimatter galaxies. In these cases, we deal with antiphotons, and the reinforced red shift effect takes place. Consequently, applying Hubble law to these observations is extremely misleading (for the correct description of the reinforced red shift see Equation II.8 and Equation II.8' above at chapter 5).

Mars—what makes the difference?

There is strong evidence that in the past there was plenty of liquid water on Mars's surface. But for the last 3.5 billion years, Mars has been a dry cold desert with icy poles and frozen underground lakes. "Unlike Earth, Mars has no tectonic plates; its crust is instead like one giant plate. But faults, or rock fractures, still form in the Martian crust due to stresses caused by the slight shrinking of the planet as it continues to cool."[18] The current state of Mars results from a gradual cooling of Mars's core, a process that fortunately does not happen in Earth's core. The difference ultimately results from different supplies of energy by cosmic rays, which results also in a weak magnetic field that does not protect Mars' atmosphere and Mars' water from the solar wind. It is not an accident that a living planet has a reliable continuous flow of cosmic rays, and a planet that is not designed to host life does not have them. Mars, despite its close similarity to Earth, is a strong demonstration that life does not result from a rare accidental coincidence. Periodic Physics predicts that the activity of primary cosmic rays toward Mars's core is significantly less intensive than this activity toward Earth's core. It is interesting also to conduct ongoing measurements of the intensity of cosmic rays above volcanos in order to determine whether cosmic rays have a role in volcanic eruptions.

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