Time-Asymmetric Relativity*

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Universally valid physics should be time-asymmetric at all levels. This is attained by introducing an additional time whose rate with respect to oscillations, unlike that of the familiar time, is directionally periodic. This modification involves the introduction of an additional fundamental parameter: the variant speed of light. It leads to time-asymmetric physical laws, to time-asymmetric description of time-like physical quantities, and to a new picture of the universe.
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Introduction

The poor cosmological picture that results from applying Einstein's Relativity on the entire universe indicates the limitations of Einstein's Relativity. Clearly, Einstein's Relativity is a simplified theory which is not applicable on the entire universe. In order to attain a universally

* The time-coordinate reversal operation on that scheme is an asymmetric operation.

applicable Relativity, Einstein's method of modification should be applied on his own theory.

In his lecture "Symmetry in Physical Laws" Richard Feynman notes "a very interesting symmetry which is obviously false, i.e., *reversibility in time*" [1]. That false symmetry should not be present in a universally applicable theory.

It is known that the fundamental invariant quantity, a linear element of space-time, is preserved under many different, homogeneous *and non-homogeneous*, definitions of the unit of time. It is fashionable to interpret this fact as evidence that time is a human fiction which has no physical significance [2]. But an application of Einstein's method on his own work yields a different interpretation: in addition to the familiar time, there necessarily exists a second kind of time, which unlike the familiar time, does not flow in step with the w-coordinate. The flow of that time is directional, which justifies the name "true time." The observable consequences of the true time are the cosmological red-shift, glowing nebulas and new-born stars rich in hydrogen.

1. The principle of time

There are three fundamental physical quantities: length, mass and time. There are two different kinds of length: spatial length and four-dimensional length. There are two different kinds of mass: inertial mass and gravitational mass. Time-Asymmetric Relativity is founded on the view that there are also two different kinds of time. In addition to the familiar time, which can be called "oscillation-time,"† there also flows the *true time*. The flow of oscillation-time is homogeneous

† It is accumulated number of oscillations expressed in units of time.

with respect to oscillations; the flow of the true time is directionally periodic with respect to oscillations.

Time-Asymmetric Relativity is based on the following three postulates (the additional third postulate is crucially necessary for a universally applicable relativity):

Principle of Relativity

> The postulates of physics and the essential part of the laws of physics do not depend on space-time and are not altered by any transition from one reference frame to another. Space-time is equally curved in all the mutually non-accelerated reference frames which are found in the same vicinity.

Principle of Space

> The speed of light in vacuum with respect to oscillation-time is a universal constant.

Principle of Time

> The speed of light in vacuum with respect to the true time is a fundamental variant. The variant speed of light is a directionally periodic function of the w-coordinate.

The graph of the variant speed of light versus the time-coordinate resembles a “saw tooth” type: it decreases very gradually along extremely large intervals and increases along shorter intervals. The increasing phase and the decreasing phase are distinguished from each other by definite characteristic features such that the time-coordinate reversal operation on that function is an asymmetric operation. The variant speed of light, as will be shown, is intrinsically present in the correct laws of physics and in the correct description of time-like quantities. Thus, the presence of the variant speed of light implies time-asymmetric physics.

2. Time-asymmetric kinematics

The time-asymmetric observer uses a quadruple-display device. The device consists of:

1. A SI chronometer displaying the elapsing oscillation-time, τ, measured since an arbitrarily chosen zero event. The SI time, which is the most accurately defined oscillation-time, is displayed in accordance with

$$d\tau = \frac{dN}{N_{SI}} \tag{1}$$

N denotes the number of counted cycles of the resonance vibration of the cesium-133 atom (cycles of the radiation corresponding to the transition between two hyperfine levels of the ground state of that atom), $N_{SI} \equiv 9{,}192{,}631{,}770$ cycles (of the same radiation) per SI second [3].

2. A display of the time-coordinate, w, measured from the same zero event. This quantity is displayed in accordance with

$$dw = c\,d\tau \tag{2}$$

Where c denotes the constant speed of light.

3. A display of the variant speed of light $\mathrm{v}_{(w)}$. As explained in the gravitational part of my proposal which is introduced in a subsequent article, the gravitational potential depends on the variant speed of light. Since light is detached from the flow of time, it preserves the gravitational potential of its emission event. By applying the theory of macro gravitation on the extra-galactic observations, the evolution of the variant speed of light during the observable past can be evaluated. ‡

‡ The third display shows, therefore, an extrapolation of the function that is obtained from the extra galactic observations. This function varies continuously,

4. A display of the true time, t. The true magnitude of a time-interval equals to the distance traveled by light during that time-interval divided by the quasi-constant value of the variant speed of light in the region under consideration. Thus

$$dt = \frac{c}{\mathrm{v}_{(w)}} d\tau \tag{3}$$

Equation (3) demonstrates that a correct description of the evolution of the variant speed of light is essentially the same thing as a correct description of the flow of the true time and vice versa. Let $N_{(w)}$, the number of cycles (of the radiation mentioned above) per true second, be a correct description of the flow of the true time (it is convenient to define $N_{(0)} = N_{SI}$). Then

$$\mathrm{v}_{(w)} = \frac{N_{(w)}}{N_{SI}} c \tag{4}$$

After an unlimited number of identical quadruple-display devices have been prepared, a local inertial frame[§] will be chosen whose Cartesian system of coordinates is calibrated according to the SI definition of the length-unit. The devices will be distributed within this system such that all the SI chronometers are mutually synchronized according to Einstein's definition of synchronization [4]. Since there is a one-to-one mapping between each of the

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quasi-monotonously, and very gradually, such that for local measurements it is practically constant.

[§] In an inertial frame a particle which is affected only by gravitation moves along a straight line at a velocity whose magnitude is a fixed fraction of the speed of light.

quantities w, t, v and τ, then all the other displays will also be synchronized.

The above system can be treated as two inertial frames which share a common system of spatial coordinates: one frame provides an approximate description of the flow of the true time, and will be called the "true frame;" the other frame provides the customary description of the flow of oscillation-time, and will be called the "customary frame."

The magnitude of a squared four-dimensional interval between two infinitesimally close events with respect to the true frame is $\mathrm{v}^2 dt^2 - dr^2$, where dt and dr are the time interval and the spatial interval, respectively, and v is the quasi-constant value of the speed of light assigned by this frame to the tiny region under consideration. The same squared interval with respect to the customary frame is $c^2 d\tau^2 - d\sigma^2$, where $d\tau$ and $d\sigma$ are the time interval and the spatial interval, respectively. Due to the absence of relative motion, and since all the true clocks, like all the SI chronometers, are synchronized, there is complete agreement between the two frames about simultaneity. Events are simultaneous with respect to one frame if and only if they are simultaneous with respect to the other. And since both frames share a common system of spatial coordinates, there is also complete agreement about spatial intervals, therefore

$$dr = d\sigma \tag{5}$$

The quantities $\mathrm{v}\,dt$ and $c\,d\tau$ are the radius of the light sphere emitted at the first event simultaneously to the second event with respect to the true frame and the customary frame, respectively. This physical reality is described in both frames by equal quantities, thus

$$\mathrm{v}\,dt = c\,d\tau \tag{6}$$

The combination of (5) and (6) yields

$$\mathrm{v}^2\, dt^2 - dr^2 = c^2 d\tau^2 - d\sigma^2 \tag{7}$$

A four-dimensional interval evaluated in a true inertial frame is preserved in a moving-together customary frame.

A four-dimensional interval evaluated in a true inertial frame is preserved in all the true frames that move at uniform motion relative to that frame. This fact is the actual mathematical content of the Principle of Relativity (the velocity of a free particle is proportional to the variant speed of light. The term uniform in this context refers to the fractional magnitude of the velocity). To any of those true frames, a non-true frame can be attached in which the speed of light is an arbitrary, very gradual or constant function of w. This operation leaves the four-dimensional interval preserved. This is true because equation (7) is also valid when the constant speed of light is replaced with other arbitrary descriptions of the speed of light. The four-dimensional interval is, therefore, preserved in all systems that rest or move at uniform motion with respect to a true inertial frame under any constant or very gradually evolving definition of the variant speed of light. This crucial fact is guaranteed by the following transformation:

$$\begin{gathered} d\tau = \frac{\mathrm{v}}{\mathrm{v}'}\gamma\left(dt - \beta\frac{dx}{\mathrm{v}}\right) \\ d\xi = \gamma\left(dx - \beta\,\mathrm{v}\,dt\right) \\ d\eta = dy \quad , \quad d\zeta = dz \end{gathered} \tag{8}$$

Where $0 \le \beta < 1 \quad , \quad \gamma \equiv \left(1-\beta^2\right)^{-\frac{1}{2}} \quad , \quad 0 < \mathrm{v}, \mathrm{v}' < \infty$

Transformation (8) deals with two frames: a true inertial frame, frame **1,** and a non-true inertial frame, frame **2**. In Frame **1** the true description of the variant speed of light v is applied, while frame **2** assigns to space-time some arbitrary description of the variant speed of light v', which is a gradually evolving or a constant function of its time-coordinate. Frame **2,** whose Cartesian coordinates are parallel to the corresponding coordinates of frame **1,** moves with respect to the latter at a uniform velocity $\beta \mathrm{v} \hat{x}$, where $\hat{x}$ is the unit vector in the positive direction of the X-axis. At the common zero event, the origins of the two frames coincide. The differential four-vector under consideration is (dt, dx, dy, dz) with respect to frame **1** and $(d\tau, d\xi, d\eta, d\zeta)$ with respect to frame **2**.

Let us consider an infinitesimally small element on the world-line of a moving point-like body. From (3) and (5) it follows that for moving-together frames the ratio between the speed of a body and the speed of light is invariant under any gradually evolving (or constant) definition of the variant speed of light. Consequently, by symmetry considerations, since the velocity of **2** as viewed from **1** is $\beta \mathrm{v} \hat{x}$, the velocity of **1** as viewed from **2** is $-\beta \mathrm{v}' \hat{\xi}$. From here, the inverse transformation follows:

$$dt = \frac{\mathrm{v}'}{\mathrm{v}} \gamma \left(d\tau + \beta \frac{d\xi}{\mathrm{v}'} \right)$$

$$dx = \gamma \left(d\xi + \beta \mathrm{v}' d\tau \right) \tag{8'}$$

$$dy = d\eta \quad , \quad dz = d\zeta$$

Transformation (8) guarantees the preservation of a four-dimensional interval not only under uniform motion, but also under any gradually evolving (or constant) arbitrary definition of the variant speed of light.

$$\mathrm{v}'^2 d\tau^2 - d\xi^2 - d\eta^2 - d\zeta^2 = \mathrm{v}^2 dt^2 - dx^2 - dy^2 - dz^2 \tag{9}$$

Equation (9) demonstrates that the metrics of space-time is invariant under arbitrary substitutions of the variant speed of light. This is the ultimate reason for the success of Time-Symmetric Special Relativity, which substitutes the variant speed of light with the universal constant speed of light. The metrics of space-time do not depend on the true description of the flow of time. Consequently the flow of the true time can be observed only where the non-homogeneity of time has observable consequences. In the domain where such consequences are too tiny to be observed, the customary description of the flow of time is useful despite its essential falseness.

Equation (9) raises an interesting possibility. It is hypothetically possible that for different systems the evolution of the variant speed of light in the same region is different. This possibility cannot *a priori* be dismissed. We shall see in a subsequent article that it will help to explain certain observations which otherwise have no satisfactory explanation.

3. Time-asymmetric electrodynamics

The time-asymmetric physical laws can be systematically derived from their familiar time-symmetric simplifications. A time-symmetric law should be invariant under transformation (8), which is the case if and only if this law satisfies the following two requirements:

1. It reduces *exactly* to the corresponding time-symmetric law under the substitution $\mathrm{v} = c$.

2. It is invariant under a **time-transformation**, the special case of (8′) when $\beta = 0$ (and consequently $\gamma = 1$), and $\mathrm{v}' = c$.

A time-transformation transforms a familiar customary description of physical reality in an inertial frame into the true time-asymmetric description of the same reality. The time transformation of space-time is

$$dt = \frac{c}{\mathrm{v}} d\tau \,, \tag{10}$$

$$dx = d\xi \quad , \quad dy = d\eta \quad , \quad dz = d\zeta \, .$$

The true description of space is identical to the customary description of space. This is also true for the time-coordinate. The true magnitude of a time-interval, however, is inverse proportional to the variant speed of light. The quantity v^{-1} can be called **time-density**. The time-density along world-lines evolves continuously.

The differential operator $m_{(c,0)} \frac{d}{d\tau}$ will be applied to the four-vector $(t, x, y, z,)_{(t')}$ which describes the world-line of a particle with respect to a true inertial frame. $m_{(c,0)}$ denotes the customary rest-mass of the particle, and τ denotes the customary time in an inertial frame which initially moves together with the particle. This operation will result in a contravariant four-vector whose components transform as the components of a space-time four-vector. From (8′) it is deduced that $dt = \frac{c}{\mathrm{v}} \gamma d\tau$, where $\beta \mathrm{v}$ is the initial speed of the particle and $\gamma \equiv \left(1 - \beta^2\right)^{-\frac{1}{2}}$. It therefore follows that $m_{(c,0)} \frac{d}{d\tau} = \frac{c}{\mathrm{v}} m_{(c,0)} \gamma \frac{d}{dt}$ and the contravariant four-vector created is

$$\left(\frac{c}{\mathrm{v}} m_{(c,0)} \gamma \quad , \quad \frac{c}{\mathrm{v}} m_{(c,0)} \gamma \frac{dx}{dt} \quad , \quad \frac{c}{\mathrm{v}} m_{(c,0)} \gamma \frac{dy}{dt} \quad , \quad \frac{c}{\mathrm{v}} m_{(c,0)} \gamma \frac{dz}{dt} \right) \tag{11}$$

Generalizing the concept of relativistic mass we shall define

$$m_{(\mathrm{v},\beta)} = \frac{c}{\mathrm{v}} m_{(c,0)} \gamma \tag{12}$$

$m_{(\mathrm{v},\beta)}$, the relativistic mass, depends not only on the particle itself and on its fractional velocity β, but also on the observer's time-density. We have thus obtained a momentum-mass four-vector $\left(m, \vec{p}\right)$

Generalizing the concept of total relativistic energy we get

$$E_{(\mathrm{v},\beta)} = m_{(\mathrm{v},\beta)}\,\mathrm{v}^2 \tag{13}$$

Equation (13) apparently resembles E. Bakhoum's hypothesis [5], but note that here v denotes a fundamental parameter, while in Bakhoum υ denotes velocity. Our new four-vector can be represented also as a momentum-energy four-vector $\left(\frac{E}{\mathrm{v}^2}, \vec{p}\right)$.

Let $\left(\frac{H}{\mathrm{v}^2}, p_x, p_y, p_z\right)$ and $\left(\frac{\Omega}{\mathrm{v}'^2}, p_\xi, p_\eta, p_\zeta\right)$ be the momentum-energy four-vectors assigned to a particle by frames **1** and **2** respectively. Being a contravariant four-vector, this vector is transformed like a space-time four-vector, thus

$$\Omega = \frac{\mathrm{v}'}{\mathrm{v}} \gamma\left(H - \beta\,\mathrm{v}_1\, p_x\right) \quad H = \frac{\mathrm{v}}{\mathrm{v}'}\gamma\left(\Omega + \beta\,\mathrm{v}'\, p_\xi\right)$$

$$p_\xi = \gamma\left(p_x - \beta\frac{H}{\mathrm{v}}\right) \quad (14) \qquad p_x = \gamma\left(p_\xi + \beta\frac{\Omega}{\mathrm{v}'}\right) \quad (14')$$

$$p_\eta = p_y \quad , \quad p_\zeta = p_z \qquad p_y = p_\eta \quad , \quad p_z = p_\zeta$$

From (9), the invariant quantity which is preserved under transformation of momentum-energy is

$$\frac{\Omega^2}{\mathrm{v}'^2} - p_\xi^{\ 2} - p_\eta^{\ 2} - p_\zeta^{\ 2} = \frac{H^2}{\mathrm{v}^2} - p_x^{\ 2} - p_y^{\ 2} - p_z^{\ 2} \tag{15}$$

Equation (15) is multiplied by c^2 to get the following invariant quantity, the particle's squared rest-energy as viewed from a standard time-density

$$\frac{c^2}{\mathrm{v}^2}E^2 - c^2\vec{p}^2 = c^4 m_{(c,0)}^{\ \ 2} \tag{16}$$

Where E and $\vec{p}$ denote the particle's total relativistic energy and its linear momentum as viewed from the time-density v^{-1}.

The time transformation of momentum-energy is

$$H = \frac{\mathrm{v}}{c}\Omega \tag{17}$$

$$p_x = p_\xi \quad , \quad p_y = p_\eta \quad , \quad p_z = p_\zeta$$

Under time-transformation, the momentum of a particle is invariant, while its energy is proportional to the variant speed of light. The particle's mass is transformed like time and is, therefore, proportional to the observer's time-density (12). The customary description of space-like quantities is correct, while the customary description of time-like quantities does not provide a correct description of physical reality.** Under the assumption that time is homogeneous, rest mass and rest energy are constants, and the law of conservation of energy holds true. Time, however, is non-homogeneous. Rest masses and rest energies evolve continuously. Consequently the true energy of a closed system, unlike its customary energy, is not conserved. The

** The terms space-like and time-like are also used to distinguish between two different kinds of intervals in space-time. It is important to realize that space-like intervals as well as time-like intervals are space-like quantities.

continuous directional evolution of rest masses and rest energies and the continuous evolution of the time-periods of apparently periodic oscillators, among other facts, rule out the customary idea that the arrow of time is not present where entropy is not defined. The arrow of time is intrinsically present in the correct description of physical reality from the very elementary level, and, as is shown hereafter, it is intrinsically present in the laws of physics from the very elementary level.

Newton's Second Law, $\vec{F} = \frac{d\vec{p}}{dt}$, is the principal postulate of mechanics. This postulate equates the force acting on a particle and the derivative of the particle's momentum with respect to time. Under time-transformation, momentum is invariant (17) and time is proportional to the time-density (10). It therefore follows that

$$\vec{F}_{(\mathrm{v})} = \frac{\mathrm{v}}{c}\vec{F}_{(c)} \tag{18}$$

$\vec{F}_{(c)}$ is a force for a customary inertial observer and $\vec{F}_{(\mathrm{v})}$ is this same force for a moving-together true observer.

Electric charge, unlike rest mass, is an absolute quantity. This and the manner in which the electromagnetic field is defined in the c.g.s unit-system and (18) lead to the conclusion that in this unit-system, under a time-transformation, the magnitude of the electromagnetic field is proportional to the variant speed of light

$$\vec{E}_{(\mathrm{v})} = \frac{\mathrm{v}}{c}\vec{E}_{(c)} \tag{19}$$

$$\vec{B}_{(\mathrm{v})} = \frac{\mathrm{v}}{c}\vec{B}_{(c)} \tag{20}$$

Where $\vec{E}$ denotes the electric field, and $\vec{B}$ denotes the magnetic field. From here, keeping in mind that velocity magnitudes are proportional to v, the following time-asymmetric Lorentz force can be obtained

$$\vec{F}_{em} = q\left(\vec{E} + \frac{\vec{\upsilon}}{\mathrm{v}} \times \vec{B}\right) \tag{21}$$

$\vec{F}_{em}$ denotes the electromagnetic force exerted on a particle whose charge is q which moves in an electromagnetic field at velocity $\vec{\upsilon}$.

Under a time-transformation, the spatial derivative operation is invariant, whereas the time derivative operation is proportional to the variant speed of light. At the same time, an electric charge has an absolute value. These facts in combination with the two requirements mentioned in the beginning of this section lead to the following time-asymmetric modification of Maxwell's equations

$$\begin{aligned}
\vec{\nabla} \times \vec{E} &= -\frac{1}{\mathrm{v}}\frac{\partial \vec{B}}{\partial t} \\
\vec{\nabla} \times \vec{B} &= \frac{1}{\mathrm{v}}\frac{\partial \vec{E}}{\partial t} + \frac{4\pi\rho}{c}\vec{\upsilon} \\
\vec{\nabla} \cdot \vec{E} &= \frac{\mathrm{v}}{c} 4\pi\rho \\
\vec{\nabla} \cdot \vec{B} &= 0
\end{aligned} \tag{22}$$

Where $\vec{E}$ and $\vec{B}$ denote the electromagnetic field, and ρ and $\vec{\upsilon}$ denote the electric charge density and its velocity, respectively. Each term of equations (22) is proportional to the variant speed of light, and thus they hold true also under the customary substitution $\mathrm{v} = c$.

For the SI version of the time-asymmetric Maxwell's equations the universal constants ε_0 and μ_0, which appear in the customary equations, are replaced by the dependent variants $\varepsilon_{(\mathrm{v})} \equiv \frac{c\varepsilon_0}{\mathrm{v}}$ and $\mu_{(\mathrm{v})} \equiv \frac{c\mu_0}{\mathrm{v}}$, respectively

$$\begin{aligned}
\vec{\nabla} \times \vec{\mathrm{E}} &= -\frac{\partial \vec{\mathrm{B}}}{\partial \mathrm{t}} \\
\vec{\nabla} \times \vec{\mathrm{B}} &= \frac{1}{\mathrm{v}^2}\frac{\partial \vec{\mathrm{E}}}{\partial \mathrm{t}} + \frac{c}{\mathrm{v}}\mu_0 \rho \vec{\upsilon} \\
\vec{\nabla} \cdot \vec{\mathrm{E}} &= \frac{\mathrm{v}}{\mathrm{c}\varepsilon_0}\rho \\
\vec{\nabla} \cdot \vec{\mathrm{B}} &= 0
\end{aligned} \tag{23}$$

Due to the definition of the magnetic field in SI units, this vector is invariant under time transformation. Consequently each term of the second and the fourth equations is invariant under time transformation.

4. On the time-asymmetric origin of Modern Physics

In the former section a simple algorithm has been used to reveal the time-asymmetric origin of macroscopic electrodynamics. The time-asymmetric origin of any other partial theory can be revealed by applying the same simple algorithm. Large-scale modern cosmology and modern nuclear theory are exceptions. These partial theories are spoiled not only by being time-symmetric, and thus require a more radical treatment. The time-asymmetric modification is applicable on any time-symmetric physical law which has been experimentally verified under the customary description of physical quantities. The process is executed by taking the following steps:

1. According to the physical units of the law, determine whether each term of this law is invariant under a time-transformation or proportional to some power of the variant speed of light.
2. Time-transform all the variable quantities which appear in the law (do not touch any fundamental parameter yet).
3. A term that after the time-transformation satisfies requirement 1 appears unaltered in the time-asymmetric law (but here, the true description of physical quantities is required).
4. A term that does not satisfy requirement 1 after the time-transformation should be examined further:
5. If the constant speed of light appears in this term, then in the time-asymmetric origin of this law it is replaced by the variant speed of light.
6. If the constant speed of light does not appear in this term, then in the time-asymmetric origin of this law a factor of $\frac{\mathrm{v}}{c}$ risen to an appropriate power appears in this term.

Conclusion

Time-Asymmetric Physics is based on the view that time is a complementary pair. The familiar homogeneous time, which flows in step with oscillations and describes the time-coordinate, is complemented by the non-homogeneous time. The introduction of the non-homogeneous time, whose rate with respect to oscillations is directionally periodic, is crucially necessary for the correct, time-asymmetric description of the physical principles of nature that govern physical reality. The introduction of the non-homogeneous time is in particular crucially necessary for the correct description of the observable consequence of the non-homogeneity of time; it is the time-effect which occurs in any interaction between massive matter and light. Due to the non-homogeneity of time, massive matter undergoes a continuous evolution, to which light is not subject. Since light travels along world-lines of identically vanishing length it carries the "frozen" value of the variant speed of light at its emission event. Consequently, in any interaction between massive matter and light, a time-effect takes place. The non-homogeneity of time, however, is very gradual. Consequently, we clearly observe the time-effect only where it predominates, namely only when light from the very remote past is observed.

The time-coordinate, like the other three coordinates of the four-dimensional continuum is homogeneous with respect to oscillations. The homogeneous time is actually spatial in nature. Also, any other description of time-like quantities by Time-Symmetric Physics is spatial in nature. The true description of time and of time-like quantities is non-homogeneous with respect to oscillations. The time-periods of apparently periodic oscillators, as well as the rest-masses and rest-energies of particles, continuously undergo a common directional evolution (3), (11) and (13). The speed of light with respect to the non-homogeneous time is a fundamental variant whose evolution is directionally periodic (the crucial significance of that directionally periodic evolution is discussed in a subsequent article). The fundamental invariant quantity, the four-dimensional interval, is preserved under many different descriptions of the variant speed of light. Consequently, many different descriptions of the variant speed of light, including the simplified description that it is a universal constant, satisfy the laws of physics. As a result, a direct observation of time and time-like quantities is impossible in principle. Time-Asymmetric Physics is experimentally confirmed wherever the time-symmetric theory is confirmed, but unlike the time-symmetric theory, it corresponds to the intrinsic time-irreversibility of physical reality. The puzzling question: "How can the time-irreversible reality be governed by laws that are time-symmetric?" is finally really solved. Physical reality, at all levels, is governed by time-asymmetric laws. The time-symmetric physics does not provide a correct description of the physical principles of nature and of physical reality, but provides a simplified convenient and misleading description of them. This description is useful only where the observable consequences of the non-homogeneity of time are negligible. In large-scale cosmology the non-homogeneity of time is crucial and has significant observable consequences, which are misinterpreted by Time-Symmetric Physics. This subject is discussed in a subsequent article.

The assumption that time flows in step with oscillations is one of the five misleading assumptions accepted in Modern Physics. We know now how to systematically expose the time-asymmetric origin of Modern Physics, so we can attain an improved physics in which the arrow of time is intrinsically present at all levels. We shall proceed from this starting point and will examine the difficulties that cosmology encounters at the present in subsequent articles.

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