Observational Relativity:
A New Theory with New Discoveries and New Insights

Xiaogang Ruan[1*]

1 Beijing University of Technology, Beijing 100124, China
* E-mail: adrxg@bjut.edu.cn

Abstract: Physics has had a new theory: the theory of Observational Relativity (OR). The theory of OR has discovered that all theories or spacetime models in human being's physics must be branded with observation. The theory of OR has uncovered the root and essence of the relativistic effects of matter motion and matter interactions presented in spacetime: all relativistic effects are observational effects and apparent phenomena -- the speed of light is not really invariant; spacetime is not really curved. Newton's classical mechanics is a theory of idealized observation with the idealized observation agent OA_∞, presenting us with the true reflection of the objective physical world; Einstein's relativity theory is a theory of optical observation with the optical observation agent OA(c), presenting us with only an optical image of the objective physics world, not exactly the physical reality. The theory of OR is a theory of the general observation agent OA(η) ($0<\eta<\infty$; $\eta\to\infty$), which has genralized and unified Newton's classical mechanics and Einstein's relativity theory: as $\eta\to\infty$, the theory of OR strictly reduces to Newton's classical mechanics; as $\eta\to c$, the theory of OR strictly reduces to Einstein's relativity theory. In the theory of OR, Newton's classical mechanics and Einstein's relativity theory are just two special cases, i.e., what Hawking called 'partial theories'. Now, the theory of OR has become what Hawking called a 'complete theory'. The theory of OR would inject fresh blood and new ideas into physics. Mankind must re-examine his physics and reshape his view of nature.

Key Words: relativity theory, the invariance of light speed, spacetime curvature, the principle of correspondence, the principle of locality, observational locality, observatioal relativity

1 Introduction

Hawking remarked in his book **A Brief History of Time** [1]: **"*If we discover a complete theory, it would be the ultimate triumph of human reason -- for then we should know the mind of God.*"**

What this paper presents to the readers, the theory of **Observational Relativity** (OR), is exactly Hawking's so-called **Complete Theory**, the theory of OR for short.

In 1887, following Maxwell's proposal [2], American physicists Michelson and Morley performed an experiment to search for the ether [3]. They failed to capture the ether and encountered a problem: Galileo's speed-addition law appeared to be invalid.

The Michelson-Morley experiment showed that the speed of light c plus the orbital speed v of the earth remained the speed of light c. To explain the Michelson-Morley experiment, FitzGerald proposed a hypothesis that the space of a moving object would contract by a factor of $\sqrt{(1-v^2/c^2)}$ along the line of motion [4]. Afterwards, Lorentz added a hypothesis that the time of a moving object would dilate by a factor of $1/\sqrt{(1-v^2/c^2)}$ [5-7]. Thus, the Lorentz transformation, or the FitzGerald-Lorentz transformation, was born.

In 1905, Einstein seemed to have grasped the true meaning of the Michelson-Morley experiment, and proposed the principle of the invariance of light speed. It is based on the principle of the invariance of light speed that Einstein theoretically deduced the Lorentz transformation and established his theory of special relativity [8], revealing the relativistic effects of inertial spacetime and inertial motion, among which the most talked is the effect of **time dilation and length contraction**. The principle of the invariance of light speed is not only the cornerstone of Einstein's theory of special relativity, but also the logical premise of Einstein's theory of general relativity. In 1915, on the basis of special relativity, in other words, still taking the principle of the invariance of light speed as a logical premise or an axiom, with the help of the principle of equivalence and the principle of general covariance, Einstein established his theory of general relativity [9], revealing the relativistic effects of gravitational spacetime and gravitational interaction, among which the most talked is the effect of **spacetime curvature**.

Einstein's theory of relativity, both the special and the general theories, has been established for over a century. However, even today, we still do not know why the speed of light is invariant and why spacetime is curved.

The principle of the invariance of light speed is an indispensable logical premise of both Einstein special relativity and Einstein general relativity. The principles of simplicity and relativity are merely auxiliary logical premises of Einstein special relativity, the principles of equivalence and covariance are merely auxiliary logical premises of Einstein general relativity. The principle of the invariance of light speed is the root of all relativistic effects in Einstein's theory of relativity, including the special and the general, including the effect of **time dilation and length contraction** and the effect of **spacetime curvature**.

According to the incompleteness theorem proposed by the great logician Gödel [10,11], an axiom of a theoretical system is a logical proposition that cannot be proven or disproven by the theoretical system itself. As a logical premise or an axiom, the principle of the invariance of light speed cannot be proven or disproven by Einstein's theory of relativity. Therefore, Einstein's theory of relativity cannot explain why spacetime as well as matter motion and matter interactions would exhibit relativistic effects or relativistic phenomena, including why the speed of light was invariant and why spacetime was curved.

From the perspective of cause-and-effect or causal logic, **the Invariance of Light Speed** (ILS), as a principle or a fundamental logical premise of Einstein's theory of relativity, is indeed puzzling:

(1) ILS is not self-evident and lacks the logically basic features as a principle or an axiom;

(2) ILS does not have any connection with other theories or principles in physics and cannot be mutually confirmed;

(3) ILS is not like a logical premise, but more like a logical consequence, a causal inversion.

It was such logical speciousness that led to Einstein knowing what the relativistic effects were, but not knowing why they presented in observation, so that Einstein and human being's physics formed numerous misconceptions, and even erroneous doctrines and theories.

The theory of OR, the new theory, brings physics new discoveries, new understandings and new ideas.

The theory of OR has revealed the root and essence of the relativistic effects of spacetime as well as matter motion and matter interactions: all relativistic effects are observational effects and apparent phenomena: the speed of light is not really invariant; spacetime is not really curved.

The theory of OR has discovered that all theories or spacetime models in physics must be branded with observation. The Galilean transformation and Newtonian mechanics are theories of idealized observation, i.e., that of the idealized observation agent OA_∞, represent the objective and real physical world; the Lorentz transformation and Einstein relativity are theories of optical observation, i.e., that of the optical observation agent OA(c), present us with only an optical image of the objective physics world, not exactly the objective physical existence.

The theory of OR originates from more basic logical premises and is a theory of the general observational agent OA(η) ($0<\eta<\infty$; $\eta\to\infty$). So, it possesses a broader perspective, and therefore, has generalized and unified Newton's classical mechanics and Einstein's theory of relativity: as $\eta\to\infty$, the theory of OR strictly reduces to Newton's classic mechanics; as $\eta\to c$, the theory of OR strictly reduces to Einstein's theory of relativity. In the theory of OR, both Newton's mechanics and Einstein's relativity are only two special cases, what Hawking referred to as **partial theories**. Whereas the theory of OR has become what Hawking referred to as a **complete theory**.

Thus, Newton's classical mechanics and Einstein's theory of relativity, the two great theoretical systems of human being's physics, have been generalized and unified by the theory of OR within the same theoretical system under the same axiom system.

The theory of OR, as a scientific research report [12-15], has already formed a complete theoretical system, consisting of two parts: Volume I, **Inertially Observational Relativity** (IOR); Volume II, **Gravitationally Observational Relativity** (GOR). The theory of OR is voluminous, and it is impossible for this article to list the whole theoretical system of OR. In order to help readers understand the theory of OR, this article focuses on discussing: (1) the basic idea of logical deduction in the theory of OR; (2) the scientific discoveries of the theory of OR; (3) the unification of Newton's classical mechanics and Einstein's theory of relativity in the theory of OR.

And then, this article will clarify the logical self-consistency and theoretical correctness of OR theory.

2 The Original Intention of OR

The theory of OR is not manufactured, nor is it deliberately designed to challenge or criticize a certain theory or doctrine. It is merely an inadvertent scientific discovery, in a sense, an accident.

However, in the final analysis, the theory of OR is a product of logic and theory, and a product of empiricism and speculation.

The author of OR holds a dialectical materialist view of nature. The author believes that the universe has two attributes: spacetime and matter, which are a pair of contradictory unity, depending on each other, and under certain conditions, transforming into each other; that spacetime has two attributes: space and time, which are a pair of contradictory unity, depending on each other, and under certain conditions, transforming into each other; and that matter has two attributes: mass and energy, which are a pair of contradictory unity, depending on each other, and under certain conditions, transforming into each other.

In a certain sense, Einstein's theory of relativity is an excellent interpretation of the dialectics of nature and the dialectical materialist view of nature.

As the fundamental premise of Einstein's theory of relativity, however, Einstein's principle of the invariance of light speed leads to two specious inferences:

(i) The speed of light is the ultimate speed of the universe that cannot be exceeded; and

(ii) Photons have no rest mass.

According to Einstein's mass-speed relation:

$$m=\frac{m_o}{\sqrt{1-v^2/c^2}}\quad\left(\lim_{v\to c}m_o=0\ \text{ or }\ \lim_{v\to c}m=\infty\right),$$

if an object P or m travels at the speed of light c, then its rest mass m_o is zero or its relativistic mass m is infinite.

According to the principle of physical observability, an infinite physical quantity is unreal. So, Einstein had to set the rest mass m_o of photons to zero.

It is puzzling that, according to Einstein's mass-speed relation, the same observed object P appears to have various relativistic mass m to different observers. Therefore, people subconsciously believe that the relativistic mass m is unreal, and only the rest mass m_o is the objective and real mass of P, that is, the intrinsic mass of matter.

So, the absence of rest mass in photons is tantamount to the absence of mass in photons. Without mass, what would the energy of a photon depend on?

It is unacceptable to the author's dialectical materialist view of nature that matter or a material object possesses only energy but no mass.

So, it became the original intention for the theory of OR to give photons a little bit of mass.

Originating from the innate view of nature, great physicists such as Feynman [16], De Broglie [17,18], and Schrödinger [19,20] also did not accept the absence of rest mass in photons, and ever spent much time and effort attempting to determine the rest mass of photons through observations or experiments. Until today, many experimental physicists still attempt to determine the rest mass of photons through observations and experiments.

Unlike measuring the rest mass of photons by observation or experiment, the author of OR attempts to theoretically give photons a little bit of rest mass and establish a theoretical model of photons having rest mass.

The author of OR thought that the ultimate speed of the universe was perhaps not the speed of light c. **The Ultimate Speed of the Universe** should be defined as Λ: the speed at which the matter-wave frequency of a material particle tends to infinity. Although the frequency of light is very high, it is still limited. According to the definition of Λ, the speed of light c should be lower than Λ: $c<\Lambda$. So, a photon could obtain its own rest mass:

$$m_o = m\sqrt{1-c^2/\Lambda^2} > 0 \quad \left(c<\Lambda,\ 0<m<\infty\right).$$

So, what would be exactly the ultimate speed Λ?

The author of OR originally thought that Λ, not c, would be the invariant speed, that is, the true ultimate speed of the universe, and could not be surpassed or reached by any material particles, even light or photons.

Based on this idea, the author of OR set out to establish an axiom system, expecting to derive a model of spacetime transformation that could give photons rest mass.

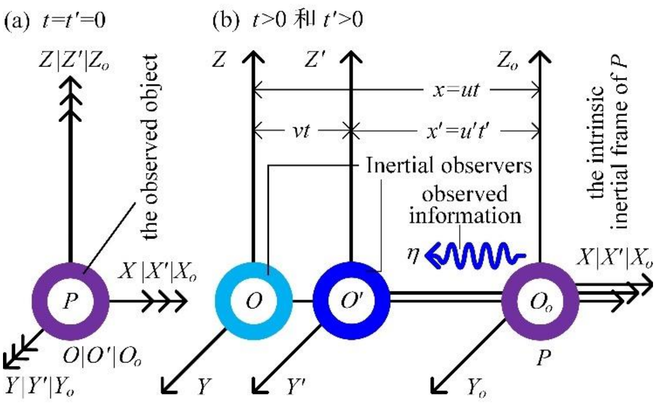

Figure 1 The Spacetime Transformation of $O'\to O$ and Observation

(1) P: the observed object; (2) O and O': inertial observers; (3) (X,Y,Z), (X',Y',Z'), and (X_o,Y_o,Z_o): the coordinate systms of O, O', and P (or P's intrinsic observer O_o), respectively; (4) (x,t,u) and (x',t',u'): the information on P's space, time and speed observed by O and O', respectively; (5) η: the intrinsic transmitting speed of observed information; (6) A problem: How would the observed information on P be transmitted from P to O and O'?

As depicted in Fig. 1, the author's logical deduction and theoretical derivation needed a physical quantity which possessed clear and definite physical significance: the speed of the information on the observed object relative to the observer, being denoted as η for the time.

3 Observation and Observational Locality

The theory of OR discovers that all theoretical systems or spacetime models in human being's physics are linked to certain observation media or certain observation systems, and must be branded with observation. This is the origin of the name of **Observational Relativity** (OR).

Throughout history, however, human being's physics has never clarified the indispensable role and status of observation in physical theories or spacetime models.

3.1 Three Important Concepts of OR

Observation is to perceive the objective world and obtain the information about it.

The information about the observed object P must be transmitted from the observed object P to the observer O at a certain speed by a certain observation medium, so that the observer O can perceive the observed object P.

However, physicists, including Newton and Einstein, do not seem to be aware of such problems involved in physical theories and spacetime models (see Fig. 1):

(i) Who is transmitting the information about the observed object P to the observer O?

(ii) At what speed is the observed information about P transmitted from P to O?

In order to clarify the role or status of observation and observation media in physical theories and spacetime models, the theory of OR has coined three important concepts related to observation and observation media.

(i) **Observation Agent**: An observation system (P, $M(\eta)$,O) that employs the specific observation medium $M(\eta)$ with the specific speed η to transmit the information about the observed object P to the observer O, denoted as OA(η).

(ii) **Information Wave**: the matter wave of the observation medium of OA(η) that transmits the observed information.

(iii) **Informon**: the material particles that consist of the information wave of OA(η).

Železnikar once employed **Informon** to refer to an information entity and analogized it with an electron [21].

In theory, all forms of matter motion, not just light or photons, can serve as observation media to transmit the information on observed objects for observers.

All matter waves, including sound wave, light wave, electric wave, water wave, seismic wave, and gravitational wave, can serve as information waves; all matter particles, including photons, electrons, neutrons, protons, atoms, molecules, and even a rock, can serve as informons.

The ear is the acoustic observation agent for mankind; the eye is the optical observation agent for mankind. Human perception of the objective world requires various observation agents.

All theories and spacetime models of human being's physics, including Galileo's doctrine and Newton's mechanics, as well as Einstein's theory of relativity, imply their respective specific observation agents.

Table 1. Mankind could perceive the objective world through different observation agents

Observation Agents OA(η) ($0<\eta<\infty;\eta\to\infty$)	Information Waves (Medium $M(\eta)$)	IW Speeds (η (m/s))
OA(v_S): bat agent	air ultrasonic wave	$\eta=v_S\approx340$
OA(v_U): dolphin agent	underwater ultrasonic	$\eta=v_U\approx1450$
OA(c): optical agent	light or EM interaction	$\eta=c\approx3\times10^8$
OA(κ): gravity agent	gravitational wave	$\eta=\kappa>7\times10^6c$
OA_∞: idealized agent	Idealized IW	$\eta\to\infty$

Note: (1) OA(η) ($0<\eta<\infty;\eta\to\infty$): the general observation agent including the realistic and the idealized; (2) All realistic observation agents have the observational locality ($\eta<\infty$), leading to the delay of observed information -- the lower the IW speed η, the more significant the observational locality of OA(η) and the relativistic effects it exhibits in observation are; (3) the idealized observation agent OA_∞ has no observation locality, and therefore, no relativistic effects or apparent phenomena.

3.2 The Observational Locality of Mankind

Locality, or the locality principle, plays an important role in modern physics. both Newton and Einstein believed that there was no action at a distance in the universe.

Einstein's concept of locality is linked to his hypothesis of the invariance of light speed: matter cannot move faster than the speed of light. In 1935, based on his concept of locality, Einstein and his colleagues Podolsky and Rosen conceived a famous thought experiment called the **EPR Paradox** [22] to question the completeness of quantum mechanics.

However, an increasing number of EPR experiments have shown [23,24] that quantum entanglements do exist in the physical world. This indicates that there indeed exists the forms of matter motion that exceeds the speed of light in the physical world, but this does not means that there exists **spooky action at a distance** in the universe.

Under the principle of physical observability, locality, or the principle of locality, is beyond doubt.

The Principle of Physical Observability (PPO): In short, infinite physical quantities are unobservable -- the universe have no infinite physical quantity.

Actually, the principle of locality is just a logical inference from the principle of physical observability: the speed of any form of matter motion must be finite or limited; it takes time for matter or information to cross space. However, this does not mean that the speed of light cannot be surpassed. It only means that there is no matter motion with infinite speed in the universe.

Since the speed of matter motion is limited, the transmitting speed of observed information must also be limited. This can be expressed as an observation principle.

The Principle of Observational Locality (POL): According to the principle of locality, the information-wave speed η of a realistic observation agent OA(η) must be finite or limited ($\eta<\infty$), and it takes time for the information wave of OA(η) to cross space.

The principle of observational locality means that all realistic observation agents must have the observational locality: $\forall$OA(η) $\eta<\infty$.

Human perception of the objective world is constrained by the observational locality: when you hear a bird chirping as it flies across the sky, it is no longer in the place where it was chirping; when you see its image, it is no longer in the place where it was flying.

The theory of OR has discovered that all relativistic effects are observational effects and apparent phenomena: the root and essence of relativistic effects lie in the observational locality ($\eta<\infty$) of the observation agent OA(η).

3.3 The Principle of General Correspondence

In 1920, Bohr formally established the principle of correspondence, commonly known as **Bohr Correspondence Principle** [25]. Actually, the basic idea of Bohr correspondence principle can be traced back to 1913. Based on the basic idea of his correspondence principle, Bohr established his atomic model and atomic theory [26-28].

The Basic Idea of Bohr correspondence principle: There must be an intrinsic corresponding relationship between quantum mechanics and classical mechanics, and under certain conditions, quantum mechanics and classical mechanics can be transformed into each other.

There are various interpretations of Bohr correspondence principle. The most common are two limiting forms:

(i) The limit of Bohr quantum number n: $n\to\infty$;

(ii) The limit of Planck constant h: $h\to0$.

Actually, Galilean relativity principle is also a type of correspondence principle.

The Basic Idea of Galilean Relativity Principle: Spacetime is symmetrical, and therefore, all observers are equal or have equal rights, in other words, a physical law or a spacetime model must take the same form in different reference frames [29,30].

The principle of relativity implies an intrinsic corresponding relationship between different reference frames: a physical law or a spacetime model of physics in different reference frames has the same form or structure, being **isomorphic** or **isomorphically consistent**, possessing **the corresponding relationship of isomorphic consistency**.

Galileo's principle of relativity implies the equality of observers of different reference frames; whereas Bohr's principle of correspondence implies the equality of observers of different observation agents, the optical agent OA(c) and the idealized agent OA_∞.

Now, the theory of OR further clarifies that **All Observation Agents are Equal**.

The Principle of General Correspondence (PGC): Spacetime is symmetrical, and therefore, all observers, regardless of reference frames or observation agents, are equal or have equal rights, in other words, a physical law or a spacetime model must take the same form in different reference frames with different observation agents, being **isomorphic** or **isomorphically consistent**, possessing the corresponding relationship of **isomorphic consistency**.

Based on the PGC principle, the theoretical systems of different observation agents OA(η_1) and OA(η_2) can be isomorphically and uniformly transformed into each other by following PGC logical paths as below.

PGC Logical Path 1:

Based on the PGC principle, by directly replacing the η_1 of OA(η_1) with the η_2 of OA(η_2), the observed physical quantities of OA(η_1) will be correspondingly transformed into the observed physical quantities of OA(η_2), the physical models of OA(η_1) will be isomorphically and uniformly transformed into the physical models of OA(η_2).

PGC Logic Path 2:

Firstly, based on the PGC principle, transform the logical premises of the theoretical system of OA(η_1) isomorphically and uniformly into that of OA(η_2). Secondly, based on the logical premises of OA(η_2) transformed from that of OA(η_1), following or analogizing the logic of the theoretical system of OA(η_1), deduce the theoretical system of OA(η_2) that must be isomorphically consistent with the theoretical system of OA(η_1).

The principle of general correspondence, PGC for short, is based on the fundamental idea: **One physical world, One logical system**.

The PGC principle is originally a logical shortcut developed by the theory of OR specifically for the theory of GOR. In fact, the PGC principle provides a universal logical law for the entire physics, providing an important ideological foundation and guiding principles for development of new theories and the unification of old theories in physics, as well as, for the test of the logical consistency and self-consistency of theoretical systems in physics.

4 The Establishment of OR Theory

A theory in physics could make us know both the physical phenomena and the physical essence, only if it could be built on the most basic logical premises or the most basic axiom system,

However, cause and effect constitute a contradictory unity, which are both mutually opposed and interdependent, and can be transformed into each other under certain conditions: any cause must be an effect of other causes; and any effect must be a cause of other effects. So, the cause-and-effect chain of logic has no beginning and no end, and there is no absolute the first principle or most basic logical premise.

Nevertheless, compared to Einstein's theory of relativity, the theory of OR possesses more basic logical premises and a more basic axiom system.

4.1 The Axiom System of IOR and the Logical Deduction of IOR

As everyone knows, Einstein's theory of special relativity has two major logical premises: the second, the principle of relativity; the third, the principle of the invariance of light speed. However, there is also the first that is little known: the principle of simplicity. Such **Three Principles** constitute the axiom system of Einstein special relativity. Among them, only the principle of the invariance of light speed is indispensable, whereas the principle of simplicity and the principle of relativity are only two auxiliary logical premises.

Up to today, however, the principle of the invariance of light speed as the logical premise of Einstein's theory of special relativity remains merely a specious hypothesis that is rather baffling.

So, Einstein's theory of special relativity based on the principle of the invariance of light speed has led to many misconceptions in physics regarding the relativistic effects of inertial spacetime and inertial motion, including **the principle of the invariance of light speed** itself and the effect of **time dilation and length contraction**.

4.1.1 The Axiom System of IOR

Compared to Einstein's theory of special relativity, the theory of IOR has more basic logical premises and a basic axiom system.

IOR Axiom System

The First: The Principle of Physical Observability

The Second: The Conditions of Wave-Particle Duality

(1) The Principle of Frequency-Speed Relation
(2) The Definition of the Ultimate Speed
(3) The Principle of OR Speed Addition

The Third: The Definition of Time

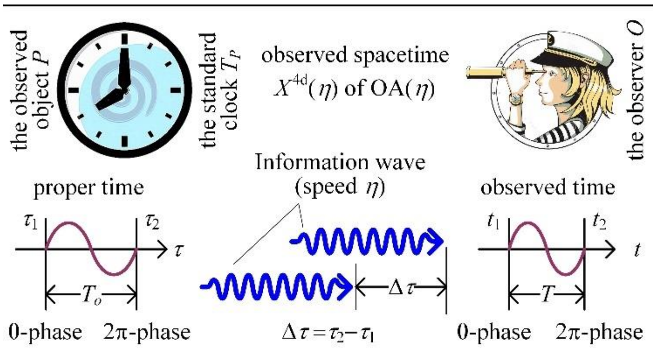

Figure 2 The Standard Clock: Proper Time τ and Observed Time t

(1) The standard clock: Let a periodic signal source T_P be the observed object P, define the intrinsic period T_o and intrinsic frequency f_o of P or T_P as the basic units for measuring time; if P is stationary in free spacetime S_F, then T_P is the standard clock. (2) The intrinsic time (proper time) τ: According to the definition of OR time, it is the time observed by the intrinsic observer O_o of P or by the idealized agent OA_∞ -- Einstein called it the standard time; (3) Observational or observed time t: Constrained by the observational locality of the realistic observation agent OA(η) ($0<\eta<\infty$), the observed time t of a realistic observer O is not the objective and real time τ (proper time) -- Einstein called it the coordinate time.

Definition 1. Time: Suppose there are a periodic signal source T_P and an observer O armed with a specific observation agent OA(η); T_o and f_o are respectively the intrinsic period and frequency of T_P. If O observes N periods of T_P in the duration of Δt with OA(η), then $\Delta t=NT_o=N/f_o$, and Δt is referred to as **the observed time** of T_P relative to O or OA(η); in particular, if Δt is the observed value if O and T_P are relatively stationary in the free spacetime S_F or if OA(η) is the idealized agent OA_∞, then Δt is referred to as **the intrinsic time** and denoted as $\Delta\tau$ $(=N_oT_o=N_o/f_o)$, where N_o is the period number in the duration of the intrinsic $\Delta\tau$ when P is stationary in the free spacetime S_F.

The definition of time is the fundamental and indispensable logical premise of OR theory, including IOR and GOR, whereas the principle of physical observability and the conditions of wave-particle duality merely are only auxiliary logical premises for the theory of IOR.

Time is the most basic physical quantity in physics. In a certain sense, the definition of OR time in the theory of OR could be regarded as the first principle or the most basic logical premise.

4.1.2 The Logical Deduction of IOR

As shown in Fig. 1 and Fig. 2, based on the axiom system of IOR, starting from the definition of OR time as the first principle, OR came into deducing the inertial-spacetime transformation, attempting to build a theoretical model that could give photons rest mass.

The logical deduction and theoretical derivation of IOR theory have produced an interesting conclusion (omitting the lengthy logical deduction of IOR [12-15]): $\Lambda=\eta$!

This means that the so-called **Ultimate Speed** Λ of the universe is actually the speed η at which the observation medium transmits observed information, it depends on the observation medium (not necessarily be light) due to the observational locality of observers ($\eta<\infty$) of the observation agent OA(η)..

Thus, the theory of OR has discovered that there is no really **invariant** or **insurmountable** ultimate speed in the objective physical world. The so-called ultimate speed of the universe is only a sort of observational limitation of observers. When bats perceive the physical world through air ultrasound as the observation medium, the speed of air ultrasound would be the ultimate speed that bats could not surpass observationally; when Einstein observed the physical world through light as the observation medium, the speed of light would be the ultimate speed that Einstein's theory of relativity could not surpass observationally.

The theory of IOR has proven an important theorem:

The Invariance of Information-Wave Speeds --
$\forall u\in(-\eta,\eta)\ \eta\oplus u=\eta$.

In theory, all forms of matter motion or matter waves, not just light or electromagnetic interaction, could serve as observation media or information waves to transmit information about observed objects for observers.

Then, the author of OR seemed to understand why the Lorentz transformation and Einstein's theory of relativity are linked to the speed of light c: it turns out that the invariance of light speed is only a special case of the invariance of information-wave speeds, which could be effective and valid only if the observer observes the physical world through light; it turns out that Einstein's theory of relativity is just a theory of human perceiving the objective physical world through light, that is, a product of optical observation, and what Hawking called a partial theory.

In this way, the theory of IOR has discovered that the speed of light is not really invariance.

Starting from the definition of OR time, under the general observation agent OA(η) ($0<\eta<\infty$; $\eta\to\infty$), based on the invariance of information-wave speeds, the theory of OR deduces a more general differential form of the transformation equation of OR inertial spacetime:

$$\begin{array}{ll} O'\to O: & O'\to O: \\ \mathrm{d}x=\Gamma(\mathrm{d}x'+v\mathrm{d}t') & \mathrm{d}x'=\Gamma(\mathrm{d}x-v\mathrm{d}t) \\ \mathrm{d}y=\mathrm{d}y' & \mathrm{d}y'=\mathrm{d}y \\ \mathrm{d}z=\mathrm{d}z' & \mathrm{d}z'=\mathrm{d}z \\ \mathrm{d}t=\Gamma\left(\mathrm{d}t'+\dfrac{v\mathrm{d}x'}{\eta^2}\right) & \mathrm{d}t'=\Gamma\left(\mathrm{d}t-\dfrac{v\mathrm{d}x}{\eta^2}\right) \end{array} \tag{1}$$

where $\Gamma=\Gamma(\eta,v)$ is the spacetime-transformation factor of the general observation OA(η) agent:

$$\Gamma(\eta,v)=\left(\sqrt{1-v^2/\eta^2}\right)^{-1}. \tag{2}$$

By setting the initial conditions for Eq. (1), we can obtain the algebraic form of the transformation equation of OR inertial spacetime, which can be referred to as **the general Lorentz transformation** that not only generalizes the Lorentz transformation but also the Galilean transformation, unifying the two great spacetime transformation in human being's physics.

In a sense, the Lorentz transformation represents Einstein's theory of special relativity, whereas the general Lorentz transformation represents the theory of IOR.

Just as Einstein deduced the whole theoretical system of his special relativity based on the invariance of light speed and the Lorentz transformation [8], the theory of OR theoretically deduced the whole theoretical system of **Inertially Observational Relativity** (IOR) based on the invariance of information-wave speeds and the general Lorentz transformation [12-15].

Eventually, the whole theoretical system of IOR has generalized and unified Newton's inertial mechanics and Einstein's special relativity, and moreover, has integrated de Broglie's theory of matter waves in it, moving towards the unification of relativity theory and quantum theory.

4.2 The Axiom System of GOR and the Logical Deduction of GOR

Einstein's theory of general relativity also has **Three Principles**: (1) the principle of equivalence; (2) the principle of general covariance; and (3) the principle of the invariance of light speed. However, it is strange that physicists are fond of discussing the equivalence principle and the covariance principle, yet often forget the principle of the invariance of light speed. Actually, the principles of equivalence and general covariance are only two auxiliary logical premises of Einstein general relativity, whereas the principle of the invariance of light speed is its fundamental and indispensable logical premise.

The speciousness of the principle of the invariance of light speed has further been amplified in Einstein's theory of general relativity, leading to numerous misconceptions about the relativistic effects of gravitational spacetime and gravitational interactions, including the relativistic effect of **spacetime curvature** and Einstein's prediction of **gravitational waves**.

In particular, based on Einstein's theory of general relativity, modern physics has further developed a few specious doctrine, including the **Big Bang** theory.

4.2.1 The Axiom System of GOR

Based on the principle of general correspondence (PGC), the theory of GOR can be deduced through either PGC logical path 1 or PGC logical path 2.

Compared to PGC logical path 1, deducing the theory of GOR through PGC logical path 2 is more conducive to our understanding of Einstein general relativity and its curvature of gravitational spacetime, and even to our comprehension of the root and essence of all gravitational relativistic phenomena. Meanwhile, it is more helpful for us to elucidate the logical thought of GOR theory.

Under the PGC principle, following PGC logical path 2, the theory of OR transforms the three principles of Einstein general relativity into the three principles of GOR.

GOR Axiom System

The First: The Principle of GOR equivalence
The Second: The Principle of GOR covariance
The Third: The Principle of Information-Wave Speeds

This constitutes the axiom system of GOR.

In the axiom system of GOR, the principles of equivalence and covariance proposed by Einstein remains valid. Furthermore, they acquire a more universal significance under the PGC principle: the observers could not only be those in different reference frames but also those in different observation agents. Under the PGC principle, Einstein's principle of the invariance of light speed has been transformed into the principle of the invariance of information-wave speeds, where the information-wave speed η of the general observation agent OA(η) replaces the speed of light c of the optical observation agent OA(c).

It should be pointed out that the principle of the invariance of information-wave speeds was originally a logical consequence of IOR theory, i.e., the theorem of the invariance of information-wave speeds. This implies that the theory of IOR is the foundation of GOR theory. In other words, the axiom system of IOR is also that of GOR; whereas the axiom system of GOR, in essence, just adds two auxiliary logical premises, the principles of equivalence and covariance, to the axiom system of IOR.

So, for the theory of GOR, only the principle of the invariance of information-wave speeds is fundamental and indispensable. All in all, for the theory of OR including IOR and GOR, only the definition of OR time is the fundamental and indispensable logical premise.

4.2.2 The Logical Deduction of GOR

Now, you can understand that, under the PGC principle, through PGC logical path 2, based on the three principles of GOR, following or analogizing the logic of Einstein general relativity, OR must be able to deduce the theory of **Gravitationally Observational Relativity** (GOR) of the general observation agent OA(η) ($0<\eta<\infty$; $\eta\to\infty$), and ultimately, to establish the whole theoretical system of GOR that must be isomorphically consistent with Einstein's theory of general relativity.

Under the PGC principle, combining PGC logical path 1 and PGC logical path 2, OR extends the theory of IOR from inertial spacetime to gravitational spacetime, and extends Einstein's theory of general relativity from the optical agent OA(c) to the general agent OA(η). In this way, the theory of GOR could be established.

However, both PGC logical path 1 and PGC logical path 2 are logical shortcuts built on the basis of the principle of general correspondence.

It's worth noting that taking shortcuts comes at a cost.

It is because of following the logical shortcuts paved by Einstein specially for his theory of relativity that we still cannot understand why the speed of light is invariant and why spacetime is curved. Similarly, simply and directly applying the PGC principle may lead us to miss the correct understanding of the root and essence of gravitational relativistic phenomena.

Therefore, the logical deduction of GOR theory does not follow the logic of Einstein general relativity. In particular, the theory of GOR has abandoned Einstein's logic of **weak-field approximation** designed specially for his theory of general relativity, the so-called way of weak-field approximation. While applying the PGC principle, OR strives to deduce the theory of GOR from the most basic physical concepts and logical premises, elucidating the root and essence of gravitational relativistic effects or gravitational relativistic phenomena.

GOR Basic Way of Logical Deduction

Step 1: Starting from the three principles of GOR
Step 2: Analogizing the logic of Einstein's theory of general relativity
Step 3: Applying the GOR logical way of idealized convergence

Firstly, by analogizing the logic of Einstein's spacetime theory of general relativity, OR deduces the corresponding spacetime models of GOR and derives the GOR measuring formula of gravitational spacetime.

The Measurement of GOR Standard Time dτ:

$$\mathrm{d}\tau=\frac{\mathrm{d}s}{\eta}=\sqrt{g_{00}(\eta)}\mathrm{d}t=\sqrt{1+\frac{2\chi}{\eta^2}}\mathrm{d}t \tag{3}$$

where dt is the observed time of OA(η), χ is the Newtonian gravitational potential.

The Measurement of GOR Physical Space dl:

$$\mathrm{d}l^2=\gamma_{ik}(\eta)\mathrm{d}x^i\mathrm{d}x^k\quad\left(\gamma_{ik}(\eta)=\frac{g_{0i}g_{0k}}{g_{00}}-g_{ik}\right) \tag{4}$$

Then, by analogizing the logic of Einstein's gravitational field equation and motion equation of general theory, taking advantage of the GOR logical way of idealized convergence, OR deduces the gravitational field equation and motion equation of GOR.

The Gravitational-Field Equation of GOR:

$$R_{\mu\nu}(\eta)-\frac{1}{2}g_{\mu\nu}(\eta)R(\eta)=-\kappa_{\mathrm{GOR}}(\eta)T_{\mu\nu}(\eta) \tag{5}$$

where $R_{\mu\nu}(\eta)$ and $R(\eta)$ are respectively the Ricci tensor and Gaussian curvature of OA(η), $g_{\mu\nu}(\eta)$ and $T_{\mu\nu}(\eta)$ are respectively the spacetime metric and energy-momentum tensor of OA(η), and $\kappa_{\mathrm{GOR}}(\eta)$ is the coefficient of GOR field equation.

The Gravitational-Motion Equation of GOR:

$$\frac{\mathrm{d}^2 x^\mu}{\mathrm{d}\tau^2} + \Gamma^\mu_{\alpha\beta}(\eta)\frac{\mathrm{d}x^\alpha}{\mathrm{d}\tau}\frac{\mathrm{d}x^\beta}{\mathrm{d}\tau} = 0 \quad (\mu = 0,1,2,3)$$
$$\Gamma^\mu_{\alpha\beta}(\eta) = \frac{1}{2} g^{\mu\nu}(\eta)\left(g_{\alpha\nu,\beta}(\eta) + g_{\nu\beta,\alpha}(\eta) - g_{\beta\alpha,\nu}(\eta)\right) \tag{6}$$

where x^μ (μ=0,1,2,3) is the 4d coordinates of the observed spacetime $X^{4d}(\eta)$ of OA(η), $x^0=\eta t$ is the time axis and x^i (k=1,2,3) are the space axes, in the form of Cartesian coordinates, $x^1=x$, $x^2=y$, and $x^3=z$.

In a sense, Einstein field equation represent Einstein's theory of general relativity, whereas the GOR field equations represent the theory of GOR.

Just as Einstein deduced the whole theoretical system of his general theory based on the invariance of light speed as well as his field equation and motion equation [9], OR theoretically deduces the whole theoretical system of **Gravitationally Observational Relativity** (GOR) based on the invariance of information-wave speeds as well as the GOR field equation and motion equation [12-15].

It should be pointed out that there is still one issue unaddressed here: How is the coefficient $\kappa_{\text{GOR}}(\eta)$ of the gravitational-field equation of GOR calibrated?

4.2.3 The GOR Idealized Convergence vs Einstein's Weak-Field Approximation

Einstein was adept at constructing logical shortcuts leading to the grand edifices of physics: To reach the theory of special relativity, he designed the principle of the invariance of light speed; To reach the theory of general relativity, he designed the principles of equivalence and general covariance.

In general relativity, in order to calibrate the coefficient κ_E of his field equation, Einstein needed to match his gravitational-field equation with Newton's law of universal gravitation in the form of Poisson equation. To this end, Einstein specifically constructed a logical shortcut: the way of **weak-field approximation**.

Actually, Einstein's way of weak-field approximation not just implies the hypothesis of weak-field approximation, but a set of five hypothetical logical premises:

(i) Weak Gravitational Field: Metric $g_{\mu\nu}=\eta_{\mu\nu}+h_{\mu\nu}$ ($|h_{\mu\nu}|<<|\eta_{\mu\nu}|$), spacetime is approximately flat;

(ii) Slow Speed: $|v|<<c$, the speed v of the observed object P is much lower than the speed of light c;

(iii) Static Field: The spacetime metric $g_{\mu\nu}$ or $h_{\mu\nu}$ does not change over time;

(iv) Spacetime Orthogonality: $g_{i0}=g_{0i}=0$, the time axis x^0 is perpendicular to the space axes x_i (i=1,2,3);

(v) Harmonic Coordinates: $\Box x^\mu = 0$ (μ=0,1,2,3).

By taking advantage of his way of weak-field approximation, Einstein successfully calibrated the coefficient of his field equation: $\kappa_E=8\pi G/c^4$ where G is the gravitational constant in Newton's law of universal gravitation.

Thus, physicists mistakenly believe that Newton's theory of universal gravitation is only an approximation of Einstein's theory of general relativity under the conditions of low speed and weak field.

However, why is Einstein's field-equation coefficient κ_E associated with the speed of light c?

The theory of OR has discovered that Einstein's theory of general relativity is also a theory of the optical observation agent OA(c), and there is no direct corresponding relationship between Einstein's field equation of the optical agent OA(c) and Newton's law of universal gravitation of the idealized agent OA$_\infty$. Einstein's way of weak-field approximation has misled physics.

In order to calibrate the coefficient κ_{GOR}, the GOR gravitational-field equation also needs matching with Newton's law of universal gravitation in the form of Poisson equation.

However, as a gravitational theory of the general observation agent OA(η) ($0<\eta<\infty$; $\eta\to\infty$), the theory of GOR does not require the way of weak-field approximation.

The theory of GOR has proven an important theorem:

The Theorem of Cartesian Spacetime -- $h_{\mu\nu}\to 0$ as $\eta\to\infty$.

The theorem of Cartesian spacetime clarifies that the curved metric $h_{\mu\nu}$ of gravitational spacetime is zero under the idealized observation scene of OA$_\infty$ ($\eta\to\infty$). This suggests that the objective and real gravitational spacetime is flat, rather than curved. The so-called spacetime curvature is only an observational effect or an apparent phenomenon, caused by the observational locality ($\eta<\infty$) of the realistic observation agent OA(η).

In this way, the theory of GOR has discovered that spacetime is not really curved.

So, the correspondence between the gravitational-field equation of GOR and Newton's law of universal gravitation does not require the so-called logic of weak-field approximation, but the logic of idealized convergence.

The GOR Way of Idealized Convergence: Let the information-wave speed η of the observation agent OA(η) be large enough, then the gravitational spacetime tends to be flat, and it holds that

$$g_{\mu\nu}(x^\alpha,\eta) = \eta_{\mu\nu} + h_{\mu\nu}(x^\alpha,\eta)$$
$$\left(|h_{\mu\nu}| \ll |\eta_{\mu\nu}| \text{ and } \lim_{\eta\to\infty} h_{\mu\nu}(x^\alpha,\eta) = \mathbf{0}\right), \tag{7}$$

particularly, as $\eta\to\infty$, $g_{\mu\nu}\to\eta_{\mu\nu}$, where $\eta_{\mu\nu}$ is the Minkowski metric: $\eta_{\mu\nu}$=diag(+1,–1,–1,–1).

It can be proven [12-15] that, under the GOR logic of idealized convergence, the five conditions in Einstein's way of weak-field approximation must be satisfied.

Thus, the corresponding relationship between the GOR field equation and the Poisson equation of Newton's law of universal gravitation is no longer approximate but logically in the strict sense.

By taking advantage of the GOR way of idealized convergence, as the information-wave speed η of the observation agent OA(η) is large enough, the GOR gravitational-field equation reduces to:

$$\nabla^2 h_{00} = \kappa_{\text{GOR}}\rho\eta^2 \quad \left(h_{00} = 2\chi/\eta^2\right) \tag{8}$$

where h_{00} is the 00-element of the curved metric $h_{\mu\nu}$.

By comparing Eq. (8) with the Poisson equation $\nabla^2\chi=4\pi G\rho$ of Newton's universal-gravitation law, the GOR field-equation coefficient κ_{GOR} can be calibrated:

$$\kappa_{\text{GOR}}(\eta) = \frac{8\pi G}{\eta^4}. \quad (9)$$

The calibration of GOR field-equation coefficient marks the formal establishment of GOR theory, that is, the so-called **Gravitationally Observational Relativity** or **General Observational Relativity**.

Eventually, the whole theoretical system of GOR has generalized and unified Newton's theory of universal gravitation and Einstein's theory of general relativity.

4.3 The Different Logical Paths Leading to the Theory of OR

The of OR theory is a product of logic and theory, originating from the definition of OR time as the first principle, and has a more basic axiom system than Newton's classical mechanics and Einstein's relativity theory. It is based on more basic logical premises that the theory of OR has acquired a broader perspective, so that it has revealed the root and essence of relativistic phenomena, and has generalized and unified Newton's classical mechanics and Einstein's relativity theory.

If you could not understand the logical deduction of OR theory based on the axiom system of OR, you could choose the following more concise logical paths. The different logical paths leading to the same theory of OR could confirm the theory of OR and help you understand OR.

4.3.1 From Time Definition to OR

As previously stated, in the axiom system of OR, only the definition of OR time is a fundamental and indispensable logical premise.

Actually, the principle of physical observability is implicitly taken as the logical premise underlying all theoretical systems in physics, including Galileo's doctrine, Newton's mechanics, Einstein's theory of relativity, and even quantum theory. Hence, the principle of physical observability could be regarded as a fundamental principle universally followed by all theoretical systems in physics. Meanwhile, the conditions of wave-particle duality in the axiom system of OR could be substituted with the principle of simplicity or the principle of relativity.

Even if you could not understand the OR conditions of wave-particle duality, based on the definition of OR time and the principle of relativity, or based on the definition of OR time and the principle of simplicity, you could also prove the theorem of the invariance of information-wave speeds (see 3.2.4-5 in Chapter 3 of the 1st volume IOR in [12-15]), deduce the transformation of OR inertial spacetime, and establish the whole theoretical system of OR, including the theory of IOR and the theory of GOR.

4.3.2 From Observational-Limit Principle to OR

Perhaps you also could understand the definition of OR time and the invariance of time-frequency ratio. But you could definitely understand that: the speed of moving objects that bats can observe through their ears cannot exceed the air ultrasonic speed of 340 m/s; the speed of moving objects that dolphins can observe through their ears cannot exceed the water ultrasonic speed of 1450 m/s; the speed of moving objects that humans can observe through their eyes cannot exceed the speed of light of 3×10^8 m/s.

This is what OR calls **Observational Locality** or **Observational Limit**. Different observation agents have different degrees of observational limit.

You could express it as an observation principle.

The Principle of Observational Limit (POL): For an observation system $(P, M(\eta), O)$ or an observation agent OA(η), the information-wave speed η of OA(η), i.e., the speed of the observation medium $M(\eta)$ transmitting the information on the observed object P, is the observational upper limit of the observer O armed with OA(η): $|u| \le \eta$, that is, the observed O could not perceive or observe the object P if the moving speed u of P is larger than the transmit speed η of observed information.

In fact, the principle of observational limit is equivalent to the principle of observational locality.

Since the speed η of the medium M transmitting information cannot exceeded observationally by the observer O with OA(η), the information-wave speed η of OA(η) must exhibit the invariance relative to the observer O.

Thus, based on the POL principle, you can also prove the theorem of invariance of information-wave speeds, and furthermore, by following the logic of Einstein's theory of relativity, you can also deduce the whole theoretical system of OR, including IOR and GOR.

4.3.3 From the Principle of the Invariance of Information-Wave Speeds to OR

More simply, you can directly express the invariance of information-wave speeds as a basic principle of physics, an observation principle.

In the Michelson-Morley experiment [3], the speed of light exhibited the invariant phenomenon. It was based on the Michelson-Morley experiment that Einstein proposed the principle of the invariance of light speed, and consequently, established his theory of relativity, including the special [8] and the general [9]. Up to today, the mainstream school of physics still believe that the Michelson-Morley experiment is the empirical basis of the principle of the invariance of light speed.

However, in fact, the Michelson-Morley experiment is not the support for the principle of the invariance of light speed proposed by Einstein, but the support for the theorem of the invariance of information-wave speeds proved by the theory of OR.

In the Michelson-Morley experiment, light or photons serve as both the observed object of Michelson and Morley and the observation medium transmitting observed information to Michelson and Morley. In other words, the observation agent OA(η) of Michelson and Morley was the optical observation agent OA(c), and naturally, the information-wave speed η of OA(c) is the speed of light c. In the Michelson-Morley experiment, the invariance of light speed is merely a phenomenon, whereas the invariance of information-wave speeds is the essence.

So, you have every reason to express the invariance of information-wave speeds as a principle.

Thus, based on the principle of the invariance of information-wave speeds and by following Einstein's logic of relativity theory, you could also deduce the whole theoretical system of OR, including IOR and GOR.

4.3.4 Following PGC Logical Path 1 to OR

The simplest and most direct approach to extend Einstein's theory of relativity, including the special and the general, from the optical agent OA(c) to general observation agent OA(η) ($0<\eta<\infty$; $\eta\to\infty$) is through PGC logical path 1 under the principle of general correspondence.

PGC logical path 1 paved by the PGC principle is the most convenient logical pathway from Einstein's theory of relativity to the theory of OR: directly replacing the speed of light c in all the principles or axioms as well as all the theoretical models or formulae of Einstein relativity theory (including the special and the general) with the information-wave speed η of the general observation agent OA(η) ($0<\eta<\infty$; $\eta\to\infty$), you could also obtain the whole theoretical system of OR, including IOR and GOR.

Naturally, the theory of OR obtained in this way must be isomorphically consistent with Einstein theory of relativity: IOR must be isomorphically consistent with Einstein special relativity; GOR must be isomorphically consistent with Einstein general theory.

Whether you understand the PGC principle or not, this corresponding transformation of isomorphic consistency must be within your grasp.

Now, you must be able to understand that Einstein's theory of relativity, including the special and the general, must be the theory of the optical agent OA(c), which is only a special case of OR theory. You must be able to predicted that, as $\eta\to c$, the whole theoretical system of OR would strictly reduce to Einstein theory of relativity: IOR strictly reduces to Einstein special relativity; GOR strictly reduces to Einstein general relativity.

However, you might not be able to foresee and understand that: as $\eta\to\infty$, the whole theoretical system of OR would strictly reduce to Galileo-Newtonian classical mechanics: IOR strictly reduces to Galileo-Newtonian inertial mechanics (see Table A1 in Appendix A); GOR strictly reduces to Newton's theory of universal gravitation (see Tables A2 in Appendix A).

Perhaps, this could give you some insights into OR.

Mankind needs to re-examine Galileo's doctrine and Newton's mechanics. Mankind needs to re-evaluate Einstein's theory of relativity, both the special and the general.

5 The Unite of Newton and Einstein in OR

In the theoretical system of OR, Newton's classical mechanics and Einstein's relativity theory are only two special cases representing different observation agents: Newton's mechanics is the theory of the idealized agent OA_∞; Einstein's relativity theory is the theory of the optical agent OA(c). Both are what Hawking called **partial theories**, whereas the theory of OR has become what Hawking called a **complete theory**.

The theory of OR is the theory of the general observation agent OA(η) ($0<\eta<\infty$; $\eta\to\infty$), which has generalized and unified Newton's classic mechanics and Einstein's theory of relativity: as $\eta\to\infty$, the theory of OR strictly reduce to Newton's classical mechanics; as $\eta\to c$, the theory of OR strictly reduce to Einstein's relativity theory. Thus, the theory of OR has unified the two great theories in the same theoretical system under the same axiom system.

One physical world, One logical system.

Tables A1 and A2 in Appendix A list the basic relations of OR theory as well as the corresponding relations in Einstein's relativity theory and in Galileo-Newtonian mechanics, demonstrating the corresponding relationships of strictly isomorphic consistency between the theory of OR and Einstein relativity theory (see Table A1), and that between the theory of OR and Galileo-Newtonian mechanics (see Table A2).

5.1 OR vs Einstein's Relativity Theory

Based on the principle of general correspondence and PGC logical path 1, you could understand the isomorphic consistency between the theory of OR and Einstein's theory of relativity. Furthermore, you could anticipate that: as $\eta\to c$, the theory of OR strictly reduces to Einstein's theory of relativity. In other words, as $\eta\to c$, all relations in the theory of IOR converge isomorphically and uniformly to the corresponding relations in Einstein's theory of special relativity; as $\eta\to c$, all relations in the theory of GOR converge isomorphically and uniformly to the corresponding relations in Einstein's theory of general relativity.

5.1.1 IOR vs Einstein's Special Relativity

In Appendix A, the first column of Table A1 lists 10 basic relations in the theory of IOR, and the second column lists the corresponding 10 basic relations in Einstein's theory of special relativity, demonstrating the corresponding relationship of strictly isomorphic and logical consistency between the theory of IOR and Einstein's special relativity (see Chapter 8 of the 1st volume IOR in [12-15]).

The following IOR formulae are demonstrated as a few examples, where the corresponding formulae in Einstein's theory of special relativity are familiar to everyone.

(I) The IOR Factor vs the Lorentz Factor

The IOR factor $\Gamma(\eta,v)=1/\sqrt{(1-v^2/\eta^2)}$ (Eq. 2) of spacetime transformation is the OR factor of inertial-spacetime transformation, also called **the inertially-relativistic factor**: the larger the value of Γ, the more significant the inertial relativistic effects exhibited by the observed object P in inertial spacetime would be.

The IOR factor of spacetime transformation $\Gamma(\eta,v)$ can be decomposed in terms of Taylor series:

$$\Gamma(\eta,v)=\Gamma_\infty+\Delta\Gamma(\eta,v)\quad(v<\eta)\tag{10a}$$

where Γ_∞ is the Galilean factor, and $\Delta\Gamma(\eta,v)$ is the observational-effect factor of IOR:

$$\begin{cases}\Gamma_\infty=\lim\limits_{\eta\to\infty}\Gamma(\eta,v)=1\\ \Delta\Gamma(\eta,v)=\dfrac{1}{2}\dfrac{v^2}{\eta^2}+\dfrac{1\cdot3}{2\cdot4}\dfrac{v^4}{\eta^4}+\dfrac{1\cdot3\cdot5}{2\cdot4\cdot6}\dfrac{v^6}{\eta^6}+\cdots\end{cases}\tag{10b}$$

Where $\Gamma_\infty\equiv1$ represents the objective and real physical existence; $\Delta\Gamma(\eta,v)\geq0$ represents purely apparent phenomena of OA(η). The larger the value of $\Delta\Gamma(\eta,v)$, the larger the

IOR factor $\Gamma(\eta,v)$ is, and the more significant the apparent phenomena of inertially relativistic effects are.

The factor $\gamma=1/\sqrt{(1-v^2/c^2)}$ of spacetime transformation in Einstein's special relativity can be referred to as the Lorentz factor [5-8], where the speed of light c is an invariant, so the value of γ depends on the speed v of P. Based on this, Einstein believed that the relativistic effects of inertial spacetime is objective and real natural phenomena and the root and essence lie in matter motion.

However, the IOR factor $\Gamma=\Gamma(\eta,v)$ of spacetime transformation indicates that the value of Γ essentially depends on the information-wave speed η of the OA(η): given the moving speed v of P, the larger the value of η, the weaker the inertially-relativistic effects exhibited by P would be; if η is infinite, then the inertial spacetime would have no relativistic phenomena. Thus, the theory of IOR discovered that the relativistic effects of matter motion in inertial spacetime are not the objective and real physical reality, but rather the observational effects and apparent phenomena caused by the observational locality ($\eta<\infty$) of the observation agent OA(η).

The IOR factor Γ has generalizes the Lorentz factor γ. As $\eta\to c$, the IOR factor $\Gamma(\eta,v)$ strictly converges to the Lorentz factor γ:

$$\Gamma(c,v)=\lim_{\eta\to c}\frac{1}{\sqrt{1-v^2/\eta^2}}=\frac{1}{\sqrt{1-v^2/c^2}}=\gamma(c,v). \quad (11)$$

(II) The IOR Spacetime Transformation vs the Lorentz Transformation

As shown in Eq. (1), the transformation equation of IOR inertial spacetime deduced based on the definition of OR time is originally in differential form. Integrating it, the algebraic form of it can be obtained, which is called **the general Lorentz transformation**.

$$O'\to O: \begin{cases} x=\Gamma(x'+vt') \\ y=y' \\ z=z' \\ t=\Gamma\left(t'+vx/\eta^2\right) \end{cases} \qquad O'\to O: \begin{cases} x'=\Gamma(x-vt) \\ y'=y \\ z'=z \\ t'=\Gamma\left(t-vx/\eta^2\right). \end{cases} \quad (12)$$

As the Lorentz transformation represents Einstein's theory of special relativity, the general Lorentz transformation represents the theory of IOR.

The general Lorentz transformation has generalized the Lorentz transformation. As $\eta\to c$, the spacetime transformation of IOR strictly converges to the Lorentz transformation:

$$\lim_{\eta\to c}\begin{cases} x=\Gamma\left(x'+vt'\right) \\ y=y' \\ z=z' \\ t=\Gamma\left(t'+vx'/\eta^2\right) \end{cases} = \begin{cases} x=\gamma\left(x'+vt'\right) \\ y=y' \\ z=z' \\ t=\gamma\left(t'+vx'/c^2\right). \end{cases} \quad (13)$$

(III) The IOR Speed-Addition Law vs Einstein's Speed-Addition Law

Originally, human being's physics believed in Galileo's law of speed-addition. However, after the birth of Einstein theory of special relativity, physics turned to believe in Einstein's rule of relativistic speed-addition.

The theory of IOR can also deduce the relativistic relation of speed addition: based on the differential form of IOR spacetime transformation (Eq. (1)), one can directly derive the IOR speed-addition formula:

$$u=\frac{dx}{dt}=\frac{u'+v}{1+vu'/\eta^2} \quad \text{or} \quad u'=\frac{dx'}{dt'}=\frac{u-v}{1-vu/\eta^2}. \quad (14)$$

The IOR relativistic rule of speed-addition has generalized Einstein's relativistic of speed-addition. As $\eta\to c$, the IOR speed-addition formula strictly converges to Einstein's speed-addition formula:

$$u=\lim_{\eta\to c}\frac{u'+v}{1+vu'/\eta^2}=\frac{u'+v}{1+vu'/c^2}. \quad (15)$$

(IV) IOR Observed Mass vs Einstein's Inertial Mass

In Einstein's theory of special theory, the matter of inertial spacetime has two types of mass: the rest mass m_o and the moving mass m. According to Einstein's mass-speed relation: $m=m_o/\sqrt{(1-v^2/c^2)}$ where m also known as relativistic mass.

The theory of IOR deduces the relativistic mass-speed relation of the general observation agent OA(η):

$$m(\eta)=\frac{m_o}{\sqrt{1+v^2/\eta^2}}=\Gamma_\infty m_o+\Delta\Gamma(\eta)m_o. \quad (16)$$

where the IOR mass also has two types: the rest mass m_o and the moving mass m.

However, according to Eq. (16), the IOR mass $m=m(\eta)$ depends on the observation agent OA(η) and on the information-wave speed η of OA(η). This suggests that the so-called relativistic mass, whether it is the IOR $m(\eta)$ or Einstein's $m(c)$, is actually an observational or observed mass that includes observational effect and is not the entirely objective and real mass.

The mass-speed relation of IOR has generalized Einstein's mass-speed relation. As $\eta\to c$, the mass-speed relation $m=m(\eta)$ of IOR strictly converges to Einstein's mass-speed relation $m=m(c)$:

$$m(c)=\lim_{\eta\to c}\frac{m_o}{\sqrt{1+v^2/\eta^2}}=\frac{m_o}{\sqrt{1+v^2/c^2}}. \quad (17)$$

(V) IOR Observed Momentum vs Einstein's Relativistic Momentum

In his special relativity, Einstein defined the momentum of a material particle as the product of its relativistic mass m and its speed v: $p=mv$, that is, Einstein's relativistic momentum.

In the theory of IOR, the momentum p of the observed object P is also defined as the product of the relativistic mass m and its speed v of P:

$$p(\eta)=m(\eta)v=\frac{m_o v}{\sqrt{1+v^2/\eta^2}}. \quad (18)$$

However, according to Eq. (16), the IOR momentum $p=p(\eta)$ depends on the observation agent OA(η) and on the information-wave speed η of OA(η). This suggests that the so-called relativistic momentum, whether it is the IOR $p(\eta)$ or Einstein's $p(c)$, is actually an observational or observed momentum that includes observational effect and is not the entirely objective and real momentum.

The momentum formula of IOR has generalized Einstein's momentum formula. As $\eta\to c$, the momentum formula $p=p(\eta)$ of IOR strictly converges to Einstein's momentum formula $p=p(c)$:

$$p(c)=\lim_{\eta\to c}\frac{m_o v}{\sqrt{1+v^2/\eta^2}}=\frac{m_o v}{\sqrt{1+v^2/c^2}}. \tag{19}$$

(VI) IOR Observed Energy vs Einstein's Relativistic Energy

People always take delight in talking about Einstein's mass-energy relation, that is, the famous Einstein formula $E=mc^2$. However, $E=mc^2$ is only an integral constant in Einstein's derivation of kinetic-energy formula, and does not represent the objective energy of matter particles. Einstein's rest energy $E_o=m_oc^2$ is also an integral constant and not the objective physical existence. What really has physical significance is the kinetic energy of the material particle P: $K=E-E_o$.

During the derivation of the kinetic-energy formula, the theory of IOR also involves two integral constants: (1) the total energy $E=m\eta^2$ of P which could be described as the mass-energy relation of IOR; (2) the rest energy $E_o=m_o\eta^2$ of P.

It is worth noting that: the mass-energy relation $E=m\eta^2$ of IOR has generalized Einstein formula $E=mc^2$; the rest energy $E_o=m_o\eta^2$ of IOR has generalized Einstein's rest energy $E_o=m_oc^2$.

In the inertial spacetime of IOR, the energy formula with the objective and real physical significance is only the kinetic-energy formula of IOR:

$$K=E-E_o=\left(\Gamma(\eta,v)-1\right)m_o\eta^2$$
$$\left(\Gamma=1\Big/\sqrt{1-v^2/\eta^2},\ E=m\eta^2,\ E_o=m_o\eta^2\right). \tag{20}$$

where $K=K(\eta)$ is the observed kinetic-energy of the general observation agent OA(η).

The kinetic-energy formula $K=K(\eta)$ of IOR has generalized Einstein's kinetic-energy formula $K=K(c)$. As $\eta\to c$, the observed kinetic-energy $K=K(\eta)$ of IOR strictly converges to Einstein's relativistic kinetic-energy $K=K(c)$:

$$\begin{aligned}K(c)&=\lim_{\eta\to c}\left(\left(\sqrt{1-v^2/\eta^2}\right)^{-1}-1\right)m_o\eta^2\\&=\left(\left(\sqrt{1-v^2/c^2}\right)^{-1}-1\right)m_oc^2.\end{aligned} \tag{21}$$

Section 5.1.1 demonstrates that the theory of IOR is logically consistent with Einstein's theory of special relativity. This confirms from one aspect that the theory of IOR is logically self-consistent.

5.1.2 GOR vs Einstein's General Relativity

In Appendix A, the first column of Table A2 lists 14 basic relations in the theory of GOR, and the second column lists the corresponding 14 basic relations in Einstein's theory of general relativity, demonstrating the corresponding relationship of strictly isomorphic and logical consistency between the theory of GOR and Einstein's general relativity (see Chapter 20 of the 2nd volume in [12-15]).

The following GOR formulae are demonstrated as a few examples, where the corresponding formulae in Einstein's theory of general relativity are familiar to everyone.

(I) The GOR Factor vs the Einstein Factor

The GOR factor of spacetime transformation is the gravitational-spacetime transformation factor of OR:

$$\Gamma(\eta,v,\chi)=\frac{1}{\sqrt{1-v^2/\eta^2+2\chi/\eta^2}} \tag{22}$$

where v is the moving speed of the observed object P in gravitational spacetime, χ is the Newtonian gravitational potential of P.

$\Gamma=\Gamma(\eta,v,\chi)$ is also referred to as the relativistic gravitational factor: the larger the value of Γ, the more significant the observational effects of P exhibited in gravitational spacetime would be, which can be decomposed in terms of Taylor series:

$$\Gamma(\eta,v)=\Gamma_\infty+\Delta\Gamma(\eta,v,\chi) \tag{23a}$$

where the GOR factor $\Gamma(\eta,v,\chi)$ generalizes the IOR factor $\Gamma(\eta,v)$; Γ_∞ remains the Galilean factor, and $\Delta\Gamma(\eta,v,\chi)$ (≥ 0) is the observational-effect factor of GOR:

$$\begin{cases}\Gamma_\infty=\lim\limits_{\eta\to\infty}\Gamma(\eta,v,\chi)=1\\ \Delta\Gamma(\eta,v,\chi)=\dfrac{1}{2}\dfrac{\alpha^2}{\eta^2}+\dfrac{1\cdot 3}{2\cdot 4}\dfrac{\alpha^4}{\eta^4}+\dfrac{1\cdot 3\cdot 5}{2\cdot 4\cdot 6}\dfrac{\alpha^6}{\eta^6}+\cdots\end{cases} \tag{23b}$$
$$\left(\alpha<\eta,\ \alpha=\sqrt{v^2-2\chi}\right)$$

Where the Galilean factor $\Gamma_\infty\equiv 1$ represents the objective and real physical reality; $\Delta\Gamma(\eta,v,\chi)\geq 0$ represents purely apparent phenomena of OA(η). The larger the value of $\Delta\Gamma(\eta,v,\chi)$, the larger the GOR factor $\Gamma(\eta,v,\chi)$ is, and the more significant the apparent phenomena of gravitationally-relativistic effects would be.

The Einstein factor of gravitational-spacetime transformation in general relativity [9] is $\gamma=1/\sqrt{(1-v^2/c^2+2\chi/c^2)}$. Without considering the moving speed v of P, then $\gamma=1/\sqrt{(1+2\chi/c^2)}$, where the speed of light c is an invariant, so the value of γ depends on the gravitational potential χ of P. Based on this, Einstein believed that the relativistic effects of gravitational spacetime is objective and real natural phenomena and the root and essence lie in gravitational interaction.

However, the GOR factor $\Gamma=\Gamma(\eta,\chi)$ (Eqs. 22-23) of spacetime transformation indicates that the value of Γ essentially depends on the information-wave speed η of the OA(η): given the gravitational potential χ of P, the larger the value of η, the weaker the gravitationally-relativistic effects exhibited by P would be; if η is infinite, then the gravitational spacetime would have no relativistic phenomena. Thus, the theory of GOR discovered that the relativistic effects of matter interaction in gravitational spacetime are not the objective and real physical reality, but rather the observational effects and apparent phenomena caused by the observational locality ($\eta<\infty$) of the observation agent OA(η).

The GOR factor $\Gamma=\Gamma(\eta,v,\chi)$ has generalizes Einstein factor $\gamma=1/\sqrt{(1-v^2/c^2+2\chi/c^2)}$. As $\eta\to c$, the GOR factor Γ strictly converges to Einstein factor γ:

$$\begin{aligned}\Gamma(c,v,\chi)&=\lim_{\eta\to c}\frac{1}{\sqrt{1-v^2/\eta^2+2\chi/\eta^2}}\\&=\frac{1}{\sqrt{1-v^2/c^2+2\chi/c^2}}=\gamma(c,v,\chi).\end{aligned}\tag{24}$$

(II) GOR Spacetime vs Einstein's Gravitational Spacetime

The measure equation (3) of GOR standard time $\mathrm{d}\tau$ has generalized that of Einstein's standard time in general relativity; whereas the measure equation (4) of GOR physical space $\mathrm{d}l$ has generalized that of Einstein's physical space in general relativity.

The GOR Standard Time vs Einstein's Standard Time

As $\eta\to c$, the measure equation (3) of GOR standard time strictly converges to the measure equation of Einstein's standard time:

$$\mathrm{d}\tau=\lim_{\eta\to c}\sqrt{1+\frac{2\chi}{\eta^2}}\mathrm{d}t(\eta)=\sqrt{1+\frac{2\chi}{c^2}}\mathrm{d}t(c).\tag{25}$$

where $\mathrm{d}t=\mathrm{d}t(c)$ of the optical agent OA(c) is only a special case of $\mathrm{d}t=\mathrm{d}t(\eta)$ of the general agent OA(η). The theory of OR calls $\mathrm{d}t=\mathrm{d}t(\eta)$ the observed time of P; whereas Einstein called $\mathrm{d}t=\mathrm{d}t(c)$ the coordinate time of P.

The GOR Physical Space vs Einstein's Physical Space

As $\eta\to c$, the measure equation (4) of GOR physical space strictly converges to the measure equation of Einstein's physical space:

$$\mathrm{d}l^2=\lim_{\eta\to c}\gamma_{ik}(\eta)\mathrm{d}x^i\mathrm{d}x^k=\gamma_{ik}(c)\mathrm{d}x^i\mathrm{d}x^k.\tag{26}$$

(III) GOR vs Einstein: Field Equations and Motion Equations

As Einstein field equation represents Einstein's theory of general relativity, the GOR gravitational-field equation represents the theory of GOR.

Einstein once supposed that his general relativity should consist of two fundamental equations: the first is a gravitational-field equation that describes how gravitational spacetime is curved; the second is a gravitational-motion equation that describes how an object moves in the curved gravitational spacetime. Later, Einstein et al. [31] and Fock [32] independently proved that Einstein's field equation and Einstein's motion equation are equivalent.

The GOR gravitational-field equation and the GOR gravitational-motion equation more clearly demonstrate the equivalence between the field equation and the motion equation in gravitational spacetime.

However, this does not deny the independent value of the GOR field equation or GOR motion equation. The calibration of the GOR field-equation coefficient κ_{GOR} not only needs the GOR field equation but also needs the GOR motion equation [12-15].

The GOR Field Equation ve Einstein's Field Equation

The GOR gravitational-field equation has generalized Einstein gravitational-field equation.

As $\eta\to c$, the GOR field equation (5) strictly converges to Einstein field equation:

$$\begin{cases}R_{\mu\nu}(c)-\dfrac{1}{2}g_{\mu\nu}(c)R(c)=-\kappa_E(c)T_{\mu\nu}(c)\\ \kappa_E(c)=8\pi G/c^2.\end{cases}\tag{27}$$

The GOR Motion Equation vs Einstein's Motion Equation

The GOR gravitational-motion equation has generalized Einstein gravitational-motion equation.

As $\eta\to c$, the GOR motion equation (6) strictly converges to Einstein motion equation:

$$\begin{cases}\dfrac{\mathrm{d}^2x^\mu}{\mathrm{d}\tau^2}+\Gamma^\mu_{\alpha\beta}(c)\dfrac{\mathrm{d}x^\alpha}{\mathrm{d}\tau}\dfrac{\mathrm{d}x^\beta}{\mathrm{d}\tau}=0\quad(\mu=0,1,2,3)\\ \Gamma^\mu_{\alpha\beta}(c)=\dfrac{1}{2}g^{\mu\nu}(c)\left(g_{\alpha\nu,\beta}(c)+g_{\nu\beta,\alpha}(c)-g_{\beta\alpha,\nu}(c)\right).\end{cases}\tag{28}$$

Actually, the GOR gravitational-field equation is an extended form of the Poisson equation of Newton's universal-gravitation law under the general observational agent OA(η); the GOR gravitational-motion equation is an extended form of the inverse-square formula of Newton's universal-motion law under the general observational agent OA(η).

(IV) GOR Observed Mass vs Einstein's Gravitational Mass

Based on the GOR relativistic factor $\Gamma=\Gamma(\eta,v,\chi)$ (Eq. (22)), we have had the general mass-speed relation:

$$m(\eta,v,\chi)=\frac{m_o}{\sqrt{1-v^2/\eta^2+2\chi/\eta^2}}\tag{29}$$

where m_o is still the intrinsic rest mass of the observed object P, $m(\eta,v,\chi)$ is the general relativistic mass observed with of OA(η), which is related to both the speed v and Newtonian gravitational potential χ of P. But essentially, m depends on the information-wave speed of OA(η). Therefore, $m(\eta,v,\chi)$ contains observational effects and is not entirely objective and real.

Based on the GOR mass-speed relation (Eq. (29)), under the general observation agent OA(η), the theory of OR defines the following two concepts for matter mass.

OA(η) Observed Inertial Mass $m_I(\eta)$:

$$m_I(\eta)=\Gamma(\eta,v,\chi)\big|_{\chi=0}m_o=\frac{m_o}{\sqrt{1-v^2/\eta^2}}.\tag{30}$$

OA(η) Observed Gravitational Mass $m_G(\eta)$:

$$m_G(\eta)=\Gamma(\eta,v,\chi)\big|_{v=0}m_o=\frac{m_o}{\sqrt{1+2\chi/\eta^2}}.\tag{31}$$

Obviously, the inertial mass $m_I(\eta)$ in Eq. (30) of OA(η) is exactly the IOR moving mass $m(\eta)$ in Eq. (16).

As $\eta\to c$, the inertia-mass $m_I(\eta)$ observed by OA(η) strictly converges to the inertia-mass $m_I(c)$ observed by Einstein's optical agent OA(c), equivalent to Einstein's relativistic inertia-mass $m(c)$ in Eq. (17):

$$m_I(c)=\lim_{\eta\to c}\Gamma(\eta,v,\chi)\big|_{\chi=0}m_o=\frac{m_o}{\sqrt{1-v^2/c^2}}.\tag{32}$$

As $\eta\to c$, the gravitational-mass $m_G(\eta)$ in Eq. (31)

observed by OA(η) strictly converges to the gravitational-mass $m_G(c)$ observed by Einstein's optical agent OA(c), that is, Einstein's gravitational-mass of general relativity:

$$m_G(c)=\lim_{\eta\to c}\Gamma(\eta,v,\chi)\big|_{v=0}m_o=\frac{m_o}{\sqrt{1+2\chi/c^2}}. \qquad (33)$$

(V) GOR Observed Energy vs Einstein's Relativistic Energy

In gravitational spacetime, the observed object P has both the kinetic energy K and the potential energy V, and its total energy $H=K+V$ must be conserved.

Under the general observation agent OA(η), based on the GOR factor $\Gamma(\eta,v,\chi)$ of spacetime transformation (Eq. (22)), the theory of OR defines the kinetic energy $K(\eta)$ and the potential energy $V(\eta)$ for the observed object P.

OA(η) Observed Kinetic Energy $K(\eta)$:

$$K=K(\eta)=\left(\Gamma(\eta,v,\chi)\big|_{\chi=0}-1\right)m_o\eta^2. \qquad (34)$$

OA(η) Observed Potential Energy $V(\eta)$:

$$V=V(\eta)=\left(1-\Gamma(\eta,v,\chi)\big|_{v=0}\right)m_o\eta^2. \qquad (35)$$

Thus, the total energy of the observed object P moving in the GOR gravitational spacetime is

$$\begin{aligned}H&=H(\eta)=K(\eta)+V(\eta)\\&=\left(\Gamma(\eta,v,\chi)\big|_{\chi=0}-\Gamma(\eta,v,\chi)\big|_{v=0}\right)m_o\eta^2.\end{aligned} \qquad (36)$$

As $\eta\to c$, the kinetic-energy $K(\eta)$ in Eq. (34) observed by OA(η) strictly converges to the kinetic-energy $K(c)$ observed by Einstein's optical agent OA(c), equivalent to Einstein's relativistic kinetic-energy $K(c)$ in Eq. (21):

$$K(c)=\lim_{\eta\to c}K(\eta)=\left(\Gamma(c,v,\chi)\big|_{\chi=0}-1\right)m_oc^2. \qquad (37)$$

As $\eta\to c$, the potential-energy $V(\eta)$ in Eq. (35) observed by OA(η) strictly converges to the potential-energy $V(c)$ observed by Einstein's optical agent OA(c), that is, Einstein's potential-energy of general relativity:

$$V(c)=\lim_{\eta\to c}V(\eta)=\left(1-\Gamma(c,v,\chi)\big|_{v=0}\right)m_oc^2. \qquad (38)$$

Naturally, as $\eta\to c$, the total energy $H(\eta)=K(\eta)+V(\eta)$ of the observed object P moving in the GOR gravitational spacetime observed by the general observation agent OA(η) strictly converges to that observed by Einstein's optical agent OA(c): $H(c)=K(c)+V(c)$.

(VI) GOR Celestial-Motion Equation vs Einstein's Celestial-Motion Equation

Based on the GOR field equation (5) and the GOR motion equation (6), the theory of GOR establishes a model of the celestial two-body system (M,m) in the form of Binet equation:

$$\mathrm{OA}(\eta):\quad \frac{\mathrm{d}^2u}{\mathrm{d}\varphi^2}+u=\frac{GM}{h_K^2}\left(1+\frac{3h_K^2}{\eta^2}u^2\right) \qquad (39)$$

where M is the massive celestial body acting as the gravitational source; m is a small celestial body acting as the observed object P moving in the gravitational field of M, and could be a planet or a satellite, or even a photon of starlight; $h_K\equiv r^2\mathrm{d}\varphi/\mathrm{d}\tau$ is the velocity moment of m, r is the radius vector of m, φ is the angle of the radius vector r, and $u=1/r$ is the reciprocal of r.

The GOR celestial-motion equation (39) has generalized Einstein's celestial-motion equation.

As $\eta\to c$, the GOR celestial-motion equation under OA(η) strictly converges to Einstein's celestial-motion equation of OA(c):

$$\mathrm{OA}(c):\quad \frac{\mathrm{d}^2u}{\mathrm{d}\varphi^2}+u=\frac{GM}{h_K^2}\left(1+\frac{3h_K^2}{c^2}u^2\right). \qquad (40)$$

It is worth noting that, compared to Newton's celestial-motion equation, Einstein's celestial-motion equation (40) has an additional item: $3h_Ku^2/c^2$, that is, the orbital precession term. With it, Einstein made a prediction for the orbit precession of Mercury: Mercury's perihelion would precess 43.03″ every 100 years.

However, it is puzzling that the data of astronomical observation indicates that Mercury's perihelion actually precesses 5600.73 arcseconds every 100 years, of which Einstein's predicted value is less than 8‰. Why could not Einstein predict the rest 99.2%?

The GOR celestial-motion equation (39) also has an orbital precession term: $3h_Ku^2/\eta^2$. However, the GOR celestial-motion equation indicates that such orbital precession depends on the observation agent OA(η) and the information-wave speed η of OA(η), being an observational effect or an apparent phenomenon caused by the observational locality ($\eta<\infty$) of OA(η). The Mercury's data of 5600.73 arcseconds is sourced from the optical astronomical observation, and the observation agent OA(η) is the optical agent OA(c). If the data of 5600.73 arcseconds does indeed contain the 43.03″ predicted by Einstein, then it just means that the Mercury's data does indeed record the observational effects and apparent phenomena of the optical agent OA(c) caused by the observational locality ($c<\infty$) of OA(c).

So, the Mercury's data of astronomical observation is not the support for Einstein's theory of general relativity, but rather the support for the theory of GOR.

Section 5.1.2 demonstrates that the theory of GOR is logically consistent with Einstein's theory of general relativity. This confirms from one aspect that the theory of GOR is logically self-consistent.

5.2 OR vs Newton's Classical Mechanics

Perhaps, based on the principle of general correspondence and PGC logical path 1, you could understand that the theory of OR is isomorphically consistent with Einstein's relativity theory. However, you might not understand that the of theory OR is also isomorhically consistent with Newton's classical mechanics. You must be surprised that: as $\eta\to\infty$, the theory of OR strictly reduces to Newton's classical mechanics. In fact, as $\eta\to\infty$, all relations in the theory of IOR converge isomorphically and uniformly to the corresponding relations in Galileo-Newtonian inertial mechanics; as $\eta\to\infty$, all relations in the theory of GOR converge isomorphically and uniformly to the corresponding relations in Newton's theory of universal gravitation.

5.2.1 IOR vs Newton's Inertial Mechanics

In Appendix A, the first column of Table A1 lists 10 basic relations in the theory of IOR, and the third column lists the corresponding 10 basic relations in Galileo-Newtonian inertial mechanic, demonstrating the corresponding relationship of strictly isomorphic and logical consistency between the theory of IOR and Galileo-Newtonian inertial mechanics (see in Chapter 8 of the 1st volume in [12-15]).

The following IOR formulae are demonstrated as a few examples, where the corresponding formulae in Galileo-Newtonian inertial mechanics are familiar to everyone.

(I) The IOR Factor vs the Galilean Factor

The Galilean factor $\Gamma_\infty\equiv1$ is also a special case of the IOR factor $\Gamma(\eta,v)$ of spacetime transformation.

The IOR factor $\Gamma(\eta,v)$ not only has generalized the Lorentz factor γ, but also has generalized the Galilean factor Γ_∞. As $\eta\to\infty$, $\Delta\Gamma(\eta,v)\to0$, and the IOR factor $\Gamma(\eta,v)$ strictly converges to the Galilean factor Γ_∞:

$$\Gamma_\infty=\Gamma(\infty,v)=\lim_{\eta\to\infty}\frac{1}{\sqrt{1-v^2/\eta^2}}=1. \qquad (41)$$

It is thus clear that the Galilean factor $\Gamma_\infty\equiv1$ is the spacetime-transformation factor of the idealized observational agent OA_∞.

So, OA_∞ might be referred to as **the God's Eye**.

(II) The IOR Spacetime Transformation vs the Galilean Transformation

In the theory of IOR, **the general Lorentz transformation** (Eq. (12)) not only has generalized the Lorentz transformation, but also has generalized the Galilean transformation. As $\eta\to\infty$, $\Gamma(\eta,v)\to\Gamma_\infty\equiv1$, and the spacetime transformation of IOR strictly converges to the Galilean transformation:

$$\lim_{\eta\to\infty}\begin{cases}x=\Gamma(x'+vt')\\ y=y'\\ z=z'\\ t=\Gamma(t'+vx'/\eta^2)\end{cases}=\begin{cases}x=x'+vt'\\ y=y'\\ z=z'\\ t=t'=\tau.\end{cases} \qquad (42)$$

In the IOR 4d spacetime-transformation equation (12) of the general observation agent $OA(\eta)$, space and time are originally interdependent. But under the idealized agent OA_∞, 4d spacetime has been split into independent 3d space and 1d time. The general Lorentz transformation split into two independent equations: (1) the 3d space equation $\{x=x'+vt'; y=y'; z=z'\}$, which is exactly the Galilean transformation; (2) the 1d time equation $t=t'=\tau$, where different observers O and O' have the same observed time ($t=t'$), that is, the objective and real time τ.

This suggests that, in the objective and real physical world, space and time are independent of each other, just like Newton's statement [33]: Space exists immutably; Time flows silently.

(III) The IOR Speed-Addition Law vs Galileo's Speed-Addition Law

The IOR law of speed addition (Eq. (14)) not only has generalized Einstein's rule of speed addition (Eq. (15)), but also has generalized Galileo's law of speed addition.

As $\eta\to\infty$, the IOR equation (14) of speed addition strictly converges to Galileo's equation of speed addition:

$$u=\lim_{\eta\to\infty}\frac{u'+v}{1+vu'/\eta^2}=u'+v. \qquad (43)$$

As a physical model of the idealized observational agent OA_∞, Galileo's law of speed addition is the true natural law. Actually, Galileo's law of speed addition is more in line with human reason and intuition.

(IV) IOR Observed Mass vs Newton's Inertial Mass

The concept of **Inertial Mass** originated from Newton. As the physical quantity of the idealized observation agent OA_∞, according to the definition of the inertial mass observed with $OA(\eta)$ in Eq. (30), Newton's inertial mass m_I should be the IOR observed mass $m_\infty=m(\infty)$ as $\eta\to\infty$, i.e., the IOR mass observed with OA_∞:

$$m_I=m_\infty=m(\infty)=\lim_{\eta\to\infty}\frac{m_o}{\sqrt{1+v^2/\eta^2}}=m_o. \qquad (44)$$

Equation (44) has important enlightening significance:

Newton's inertia mass m_I is exactly Einstein's rest mass m_o; whereas m_o has been proven by the theory of OR to be the true mass of matter. And m_∞ in Eq. (44) may be referred to as Newtonian classical mass.

It turns out that mass is mass: $m_I=m_o=m_\infty$.

(V) IOR Observed Momentum vs Newton's Classical Momentum

In Newton's inertial mechanics, the momentum of a material particle is defined as the product of the inertial mass m_I or classical mass m_∞ of it and the moving speed v of it: $p_\infty=m_Iv=m_\infty v$, that is, Newton's classical momentum.

The momentum formula $p=p(\eta)$ (Eq. (18)) of IOR not only has generalized Einstein's relativistic momentum formula $p=p(c)$ (Eq. (19)), but also has generalized Newton's classical momentum formula $p=p(\infty)$.

As $\eta\to\infty$, the momentum formula $p=p(\eta)$ of IOR strictly converges to Newton's momentum formula:

$$p_\infty=p(\infty)=\lim_{\eta\to\infty}\frac{m_ov}{\sqrt{1+v^2/\eta^2}}=m_ov=m_Iv=m_\infty v \qquad (45)$$

(VI) IOR Observed Kinetic-Energy vs Newton's Classical Kinetic-Energy

In Newton's inertial mechanics, a matter particle has neither the mass energy E nor the rest energy E_o, but only kinetic energy: $K=m_Iv^2/2=m_\infty v^2/2$.

Actually, as $\eta\to\infty$, the IOR mass-energy formula $E=m\eta^2\to\infty$ and the IOR rest-energy formula $E_o=m_o\eta^2\to\infty$. According to the principle of physical observability, E and E_o are not observable. In other words, both mass energy and rest energy are not the objectively physical existence.

However, you may be a bit surprised: the IOR kinetic-energy formula (Eq. (20)) not only has generalized Einstein's relativistic kinetic-energy formula (Eq. (21)) in special relativity, but also has generalized Newton's kinetic-energy formula in classical mechanics $K_\infty=m_Iv^2/2$.

As $\eta\to\infty$, the kinetic-energy formula $K=K(\eta)$ of IOR strictly converges to Newton's classical kinetic-energy:

$$K_\infty = K(\infty) = \lim_{\eta\to\infty}\left(\left(\sqrt{1-v^2/\eta^2}\right)^{-1} - 1\right)m_o\eta^2 \\ = \frac{1}{2}m_o v^2 = \frac{1}{2}m_I v^2 = \frac{1}{2}m_\infty v^2. \tag{46}$$

Section 5.2.1 demonstrates that the theory of IOR is logically consistent with Galileo-Newtonian inertial mechanic. This confirms from another aspect that the theory of IOR is logically self-consistent.

5.2.2 GOR vs Newton's Gravitational Theory

In Appendix A, the first column of Table A2 lists 14 basic relations in the theory of GOR, and the third column lists the corresponding 14 basic relations in Newton's theory of universal gravitation, demonstrating the corresponding relationship of strictly isomorphic and logical consistency between the theory of GOR and Newton's universal gravitation (see in Chapter 20 of the 2nd volume GOR in [12-15]).

The following GOR formulae are demonstrated as a few examples, where the corresponding formulae in Newton's universal-gravitation theory are familiar to everyone.

(I) The GOR Factor vs the Galilean Factor

The Galilean factor $\varGamma_\infty\equiv1$ is not only a special case of the IOR spacetime-transformation factor $\varGamma(\eta,v)$, but also a special case of the GOR factor $\varGamma(\eta,v,\chi)$.

The spacetime-transformation factor $\varGamma=\varGamma(\eta,v,\chi)$ (Eq. (22)) of GOR not only has generalized Einstein's factor $\gamma=\gamma(\eta,v,\chi)$ (Eq. (21)) of general relativity, but also has generalized the Galilean factor $\varGamma_\infty$.

As $\eta\to\infty$, $\Delta\varGamma(\eta,v,\chi)\to0$, and the GOR factor strictly converges to the Galilean factor:

$$\varGamma_\infty = \varGamma(\infty,v) = \lim_{\eta\to\infty}\frac{1}{\sqrt{1-v^2/\eta^2+2\chi/\eta^2}} = 1. \tag{47}$$

It is thus clear that the Galilean factor $\varGamma_\infty\equiv1$ is the spacetime-transformation factor of the idealized observational agent OA_∞, as the God's Eye, representing the true spacetime and the objective physical world.

(II) GOR Spacetime vs Newton's Gravitational Spacetime

The measure equation (3) of GOR standard time $\mathrm{d}\tau$ in gravitational spacetime not only has generalized that of Einstein's standard time, but also has generalized that of Newton's classical time; whereas the measure equation (4) of GOR physical space $\mathrm{d}l$ in gravitational spacetime not only has generalized that of Einstein's physical space, but also has generalized that of Newton's physical space.

The GOR Standard Time vs Newton's Classical Time

As $\eta\to\infty$, the measure equation (3) of GOR standard time strictly converges to the measure equation of Newton's classical time:

$$\mathrm{d}\tau = \lim_{\eta\to\infty}\sqrt{1+\frac{2\chi}{\eta^2}}\mathrm{d}t(\eta) = \mathrm{d}t(\infty) = \mathrm{d}t_\infty. \tag{48}$$

where $\mathrm{d}t_\infty=\mathrm{d}t(\infty)$ of the idealized agent OA_∞, i.e., Newton's classical time, is also a special case of $\mathrm{d}t=\mathrm{d}t(\eta)$ observed with the general agent $OA(\eta)$.

It is thus clear that, as the observed time of the idealized agent OA_∞, Newton's classical time $\mathrm{d}t_\infty$ is exactly the standard time $\mathrm{d}\tau$, i.e., the objective and real proper time.

The GOR Physical Space vs Newton's Physical Space

As $\eta\to\infty$, the gravitational-spacetime metric converges to the Minkowski metric $\eta_{\mu\nu}$=diag(+1,–1,–1,–1), the physical-space metric $\gamma_{ik}(\eta)\to$diag(1,1,1), and the measure equation (4) of GOR physical space strictly converges to the classical measure equation of Newton's physical space:

$$\mathrm{d}l^2 = \lim_{\eta\to\infty}\gamma_{ik}(\eta)\mathrm{d}x^i\mathrm{d}x^k = (\mathrm{d}x^i)^2 \\ = \mathrm{d}x^2+\mathrm{d}y^2+\mathrm{d}z^2 \quad (\gamma_{ik} = g_{0i}g_{0k}/g_{00} - g_{ik}) \tag{49}$$

It is thus clear that, as the observed space of the idealized agent OA_∞, Newton's classical space $\mathrm{d}l_\infty$ is exactly Cartesian space, i.e., the objective and real proper space.

(III) GOR vs Newton: Field Equations and Motion Equations

As Einstein field equation represents Einstein's theory of general relativity, Newtonian field equation, the Poisson equation of Newton's universal-gravitation law, represents Newton's theory of universal gravitation.

In Einstein's theory of general relativity, by taking advantage of the way of weak-field approximation, Einstein field equation (27) corresponds approximately to Newton's gravitational-field equation; Einstein motion equation (28) corresponds approximately to Newton's gravitational-motion equation.

However, the GOR gravitational-field equation (5) not only corresponds strictly to Einstein field equation, but also corresponds strictly to Newton's gravitational-field equation; the GOR gravitational-motion equation (6) not only corresponds strictly to Einstein equation of motion, but also corresponds strictly to Newton's gravitational-motion equation. This demonstrates the strictly isomorphic and logical consistency between the GOR field equation and Newtonian field equation, and that between the GOR motion equation and Newtonian motion equation. Furthermore, it suggests that the GOR field equation and the GOR motion equation are equivalent.

The GOR Field Equation vs Newton's Law of Universal Gravitation

The GOR gravitational-field equation (5) not only has generalized Einstein field equation (27), but also has generalized Newtonian field equation.

Defining the extended Newtonian gravitational potential $\chi_{\mu\nu}$, the GOR field equation can be rewritten as:

$$\Box\chi_{\mu\nu} \equiv \frac{\eta^2}{2}\left(R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R\right) = -\frac{\eta^2}{2}\kappa_{\mathrm{GOR}}T_{\mu\nu}. \tag{50}$$

As $\eta\to\infty$, the GOR field equation (5) strictly reduces to Newtonian field equation, that is, the Poisson equation of Newton's universal gravitation law.

$$\nabla^2\chi = 4\pi G\rho \quad \begin{cases}\Box\chi_{\mu\nu} = 0 \quad (\mu\nu\neq00) \\ \Box\chi_{00} = \Box\chi = -\nabla^2\chi\end{cases} \tag{51}$$

where the only non-trivial term is the Poisson equation.

The GOR Motion Equation vs Newton's Law of Universal Gravitation

The GOR gravitational-motion equation (6) not only has generalized Einstein motion equation (28), but also has generalized Newtonian motion equation.

As $\eta\to\infty$, as in the Galilean transformation, the GOR 4d motion equation (6), in which space and time originally interdependent, splits into two independent equations of space and time:

$$\begin{cases} \dfrac{\mathrm{d}^2 t}{\mathrm{d}\tau^2}=0 \\ \dfrac{\mathrm{d}^2 x^i}{\mathrm{d}\tau^2}=-\dfrac{\partial\chi}{\partial x^i} \quad (i=1,2,3) \end{cases} \tag{52}$$

where the 1d time equation suggests that the observed time dt in Newton's gravitational spacetime is exactly the standard time (proper time) dτ, consistent with the Galilean transformation; the 3d space equation strictly reduces to Newtonian motion equation, that is, the inverse-square formula of Newton's universal-gravitation law:

$$F^i=-m\frac{\partial\chi}{\partial x^i} \quad (i=1,2,3;\ \chi=-GM/r) \quad \text{or} \quad |F|=\frac{GMm}{r^2} \tag{53}$$

(IV) GOR Observed Mass vs Newton's Gravitational Mass

The concept of **Gravitational Mass** also originated from Newton. Intuitively, people believe that Newton's gravitational mass m_G should be equal to his inertial mass m_I, i.e., $m_G=m_I$, and may also be referred to as Newtonian classical mass.

As the physical quantity of the idealized observation agent OA$_\infty$, according to the definition (Eq. (31)) of gravitational mass observed with OA(η), Newton's gravitational mass m_G should be the GOR observed mass $m_\infty=m(\infty)$ as $\eta\to\infty$:

$$m_G=m_\infty=m(\infty)=\lim_{\eta\to\infty}\frac{m_o}{\sqrt{1+2\chi/\eta^2}}=m_o \tag{54}$$

Like Eq. (44), Eq. (54) also has important enlightening significance. Combining Eqs. (44) and (54), the theory of OR has discovered that:

(i) Newton's classical mass m_∞ is exactly Einstein's rest mass m_o, both the inertia m_I and the gravitational m_G;

(ii) Newton's inertial mass m_I and gravitational mass m_G are equal -- no need to distinguish the inertia m_I and the gravitational m_G;

(iii) Newton's classical mass $m_\infty=m_o$ is the objective and real mass, i.e., the intrinsic mass of matter, whereas Einstein's relativistic mass $m=m_o+\Delta m(c)$ contains the untrue part of $\Delta m(c)$.

(V) GOR Observed Energy vs Newton's Classical Energy

The GOR observed kinetic-energy $K(\eta)$ of the general observational agent OA(η) defined by Eq. (34) not only has generalized Einstein's relativistic kinetic-energy $K(c)$ of the optical agent OA(c) in Eq. (37), but also has generalized Newton's classical kinetic-energy K_∞ of the idealized agent OA$_\infty$.

You may be a bit surprised that, as $\eta\to\infty$, the GOR kinetic-energy formula (Eq. (34)) of OA(η) strictly converges to Newton's classical kinetic-energy formula of the idealized agent OA$_\infty$:

$$\begin{aligned} K_\infty &= K(\infty)=\lim_{\eta\to\infty}K(\eta) \\ &= \lim_{\eta\to\infty}\left(\Gamma(\eta,v,\chi)\big|_{\chi=0}-1\right)m_o\eta^2=\frac{1}{2}m_\infty v^2. \end{aligned} \tag{55}$$

Equation (55) for gravitational spacetime is consistent with Eq. (46) for inertial spacetime.

The GOR observed potential-energy $V(\eta)$ of the general observational agent OA(η) defined by Eq. (35) not only has generalized Einstein's relativistic potential-energy $V(c)$ of the optical agent OA(c) in Eq. (38), but also has generalized Newton's classical potential-energy V_∞ of the idealized agent OA$_\infty$.

You may be a bit surprised that, as $\eta\to\infty$, the GOR potential-energy formula (Eq. (35)) of OA(η) strictly converges to Newton's classical potential-energy formula of the idealized agent OA$_\infty$:

$$\begin{aligned} V_\infty &= V(\infty)=\lim_{\eta\to\infty}V(\eta) \\ &= \lim_{\eta\to\infty}\left(1-\Gamma(\eta,v,\chi)\big|_{v=0}\right)m_o\eta^2=-\frac{GMm_o}{r} \end{aligned} \tag{56}$$

Equation (55) is exactly Newton's classical kinetic-energy formula: $K_\infty=m_\infty v^2/2$; Equation (56) is exactly Newton's classical potential-energy formula: $V_\infty=-GMm_\infty/r$. According to Eqs. (44) and (54), Newton's classical mass $m_\infty=m_o=m_I=m_G$.

Thus, as $\eta\to\infty$, the total energy $H(\eta)=K(\eta)+V(\eta)$ of the object P moving in the GOR gravitational spacetime observed with OA(η) converges to the total classical energy $H_\infty=K_\infty+V_\infty$ of the idealized agent OA$_\infty$:

$$H_\infty=K_\infty+V_\infty=\frac{1}{2}m_\infty v^2-\frac{GMm_\infty}{r} \tag{57}$$

(VI) GOR Celestial-Motion Equation vs Newton's Celestial-Motion Equation

The GOR celestial-motion equation (39) not only has generalized Einstein's celestial-motion equation (40), but also has generalized Newton's celestial-motion equation.

As $\eta\to\infty$, the GOR celestial-motion equation (39) strictly converges to Newton's celestial-motion equation in the classical form of Binet equation:

$$\frac{\mathrm{d}^2u}{\mathrm{d}\varphi^2}+u=\lim_{\eta\to\infty}\frac{GM}{h_K^2}\left(1+\frac{3h_K^2}{\eta^2}u^2\right)=\frac{GM}{h_K^2} \tag{58}$$

Section 5.2.2 demonstrates that the theory of GOR is logically consistent with Newton's theory of universal gravitation. This confirms from another aspect that the theory of GOR is logically self-consistent.

In the fifth Section, Sec. 5.1 demonstrates that Einstein's theory of relativity, both the special and the general, is theory the of optical observation: the observation agent of it is the optical agent OA(c); Sec. 5.2 demonstrates that Newton's mechanics, both the Galileo-Newtonian inertial mechanics and Newton's theory of universal gravitation is the theory of idealized observation: the observation agent of it is the idealized agent OA_∞.

According to the fifth Section 5 (see Tables A1 and A2 in Appendix A), it can be concluded that the theory of OR not only has generalized Einstein's theory of relativity, but also has generalized Newton's classical mechanics, and ultimately has unified Newton's mechanics and Einstein's theory of relativity in the same theoretical system under the same axiom system.

So, logically, the theory of OR is not only isomorphically consistent with Einstein's theory of relativity but also isomorphically consistent with Newton's classical mechanics. This fully confirms the logical self-consistency and theoretical validity of the theory of OR.

6 A Complete Theory: New Discoveries and New Ideas

The theory of OR is based on a more basic axiom system with more basic premises. As a theory of the general observation agent OA(η) ($0<\eta<\infty$; $\eta\to\infty$), it possesses a more broader perspective, and therefore, shows the high degree of generalization and unification.

The theory of OR has revealed the essence of the relativistic phenomena of matter motion and matter interactions presented in spacetime, and even has revealed the essence of quantum effects. In particular, the theory of OR has generalized and unified Newton's classical mechanics and Einstein's relativity theory, becoming what Hawking called **Complete Theory**, and marching towards the unification of relativity theory the and quantum theory.

The theory of OR has brought new discoveries, new insights, and new ideas into human being's physics, rather than a mechanical repetition of old theories.

Theory of OR Clears Galileo's Name:

The Galilean transformation is not an approximation of the Lorentz transformation, but a natural law of the objective physical world; whereas the Lorentz transformation is just an optical observation model of the physical world. Galileo's law of speed addition is not an approximation of Einstein's law of relativistic speed addition, but a fundamental principle of the objective physical world; whereas Einstein's law of speed addition is only an observational rule that could only be effective and valid under the optical agent OA(c).

Theory of OR Clears Newton's Name:

Newton's mechanics is not an approximation of Einstein's theory of relativity, but a true portrayal of the physical world; whereas Einstein's theory of relativity, both the special and the general, is only an optical image of the physical world, not entirely objective and true.

The Discoveries of OR

The theory of OR has discovered that: Mankind's perception of the objective world not only depends on but also is restricted by observation; All the theoretical systems in physics, including Galileo's doctrine, Newton's mechanics, Einstein's relativity theory, and even quantum theory, must be branded with observations.

Einstein's theory of relativity, including the special and the general, is the theory of optical observation that is effective and valid only in optical observation armed with the optical agent OA(c). The information-wave speed of OA(c) transmitting observed information is the speed of light c and is limited ($c<\infty$). Therefore, the optical observation agent OA (c) has the observational locality, so that matter motion and gravitational interaction exhibit relativistic effects in Einstein's observational spacetime.

Galileo's doctrine and Newton's mechanics are that of idealized observation armed with the idealized agent OA_∞. The information-wave speed of OA_∞ transmitting observed information is idealized as infinite, and therefore, OA_∞ has no observational locality and could be referred to as **the God's Eye**. So, Galileo's doctrine and Newton's mechanics represent the objective and real natural world.

However, there is no the idealized observation agent OA_∞ in reality. The objective and real natural world could only be touched by human reason.

The theory of OR has discovered that: In essence, all relativistic effects or relativistic phenomena of matter motion and matter interactions presented in spacetime are observational effects and apparent phenomena, rooted from the observation locality of the human observation agent OA(η) ($\eta<\infty$).

The speed of light is not really invariant; Spacetime is not really curved.

The theory of OR has discovered that: In essence, the quantum effects or quantum uncertainty presented in microscopic spacetime are observational effects, rooted from the observational perturbation of the human observation agent OA(η) ($h_\eta>0$: $h_\eta\eta\equiv hc$) (see Chapter 6 of the 1st volume IOR in [12-15]).

Heisenberg's uncertainty is only the perturbation effects of the informons (photons) the optical agent OA(c).

The OR Interpretations for Big Puzzles in Physics

BP-02: On Photon Mass

Photons have the rest mass m_o of their own, that is, the objective and real mass of matter. According to the theoretical calculation of OR theory, a photon with the frequency f weighs $m_o=m=hf/c^2$.

BP-04: On Planck Constant

Planck constant h is the energy-frequency ratio of photons, or to be more exact, is the energy-frequency ratio of the informons of the optical agent OA(c); whereas the energy-frequency ratio of the informons of the general observation agent OA(η) can be called **the general Planck constant** and denoted as h_η: $h_\eta=hc/\eta$.

BP-06: On Uncertainty Principle

In the theory of OR, Heisenberg's principle of uncertainty, that is, $\sigma_x\sigma_p\geq\hbar/2$ is just a special case of the principle of general uncertainty principle: $\sigma_x\sigma_p\geq\hbar_\eta/2$.

BP-07: On De Broglie Wave

De Broglie wave is not the inherent wave of matter, but rather the information wave of the optical observation agents OA(c).

BP-10: On Mercury Precession

Based his theory of general Relativity, Einstein predicted that Mercury's perihelion around the sun precesses 43″ every 100 years. However, Einstein's prediction is not the objective and real precession of Mercury orbit, but rather the observational effect and apparent phenomenon of the optical agent OA(c).

BP-13: On Gravitational Waves

The gravitational waves predicted by Einstein based on his theory of general relativity is not the objective and real gravitational radiation, but the information wave of the optical agent OA(c); the speed κ of gravitational waves is not equal to the speed of light c.

LIGO, the Laser Interferometer Gravitational-Wave Observatory in the United States, claimed that they had detected gravitational waves came from deep space [34,35]. However, what detected by LIGO did not the gravitational waves came from the distant deep space of the universe, but rather from the gravitational field carried by the electromagnetic matter system that passed over the earth and invaded the spacetime around the LIGO detector at close quarters. It was not that the speed of gravitational radiation was the speed of light, but rather that the gravitational field of the electromagnetic matter system itself moved at the speed of light with the electromagnetic system.

The theory of OR does not doubt the existence of gravitational waves and gravitons. In the theory of OR, **Gravitational Wave** is regarded as the equivalent concept of gravity or gravitational radiation.

According to Laplace's theoretical calculation, the speed κ of gravitational waves is much greater than the speed of light c: $\kappa > 7\times10^6 c$ [36]; whereas Flandern's calculation is $\kappa = 2\times10^{10} c$ [37]. This is reasonable, otherwise it would be difficult for us to imagine how photons could interact with gravitons, or as Flanders put it: the universe would lose its existing stable structure.

BP-14: On Black Holes

The theory of OR cannot deny the existence of black holes. In fact, the theory of GOR and Newton's theory of universal gravitation can also deduce the theory of black holes. However, the black-hole theory in modern physics derived from Einstein's theory of general relativity is only that of the optical agent OA(c) and cannot represent the objective reality of massive celestial bodies.

Based on the theory of GOR, from the perspective of the general observation agent OA(η), black hole scholars, including Hawking, would definitely find that black holes are different from what they imagined.

BP-15: On the Big Bang

Cosmological redshift does not imply cosmic expansion or Big Bang; Human being's physics needs to re-examine the theory of Big Bang in modern physics derived from Einstein's theory of general relativity, that is, the theory of Big Bang of the optical agent OA(c).

In fact, the universe may never have had a big bang.

For more detailed statements about the 15 big puzzles (from BP-01 to BP-15) in physics, please see Chapter 9 of the 1st volume IOR and Chapter 21 of the 2nd GOR in the monograph titled **Observational Relativity: The Unity of Newton and Einstein** [12-15].

7 The Theoretical Validity and Empirical Basis of the Theory of OR

Physics is both empirical and speculative.

The theory of OR is not only a product of logic and theory, but also is supported by observations and experiments, and has important practical application value. In particular, the theory of OR conforms to human experience and intuition, to human reason and logic, and to what Swedish physicist Alfvén called **Common Sense** [38].

7.1 Is the Theory of OR Right?

Actually, the theory of OR, including IOR and GOR, is logically concise and easy to understand.

As demonstrated in Sec. 5 as well as Tables A1 and A2 of Appendix A, the theory of OR is isomorphically consistent not only with Einstein's relativity theory but also with Newton's classical mechanics. As the theory of the general observation agent OA(η) ($0<\eta<\infty$; $\eta\to\infty$), the theory of OR has generalized Newton's classical mechanics of the idealized agent OA_∞ and Einstein's relativity theory of the optical agent OA(c), unifying the two great theoretical systems of human being's physics in the same theoretical system under the same axiom system.

This isomorphic consistency, as well as generalization and unification, confirms the logical self-consistency and theoretical validity of the theory of OR including IOR and GOR from one aspect.

In this way, the theory of OR has revealed the essence of the relativistic phenomena of matter motion and matter interactions presented in spacetime. This seemingly fulfill Hawking's statement that we are beginning to understand the mind of God.

Perhaps, you could not understand the logical deduction of OR theory based on the definition of OR time as the first principle. In this regard, Sec. 4.3 of this article specifically depicts for readers the different logical paths that the theory of OR could follow. Different logical paths could lead to the same destination of OR, which from one more aspect confirms the logical self-consistence and theoretical validity of the theory of OR.

In particularly, based on the principle of general correspondence, Sec. 4.3.4 of this article describes a logical shortcut, i.e., PGC logic path 1, leading to the theory of OR. You only need to replace the light speed c of the optical agent OA(c) in Einstein's theory of relativity with the information-wave speed η of the general observation agent OA(η), and you could directly obtain the whole theoretical system of OR, including IOR and GOR. Thus, you could certainly foresee the isomorphic consistency between the theory of OR and Einstein's theory of relativity, and that the theory of OR would generalized Einstein's theory of relativity, include the special and the general.

However, you might not necessarily understand the isomorphic consistency between the theory of OR and Galileo-Newtonian mechanics, and that the theory of OR would generalize classical mechanics, including Galileo's doctrine and Newton's theory.

Actually, it is an accident for the theory of OR to generalize and unify Galileo-Newtonian mechanics and Einstein's theory of relativity. In a sense, this further confirms the logical self-consistency and theoretical validity of the theory of OR including IOR and GOR.

7.2 Does the Theory of OR Have Empirical Basis?

Einstein's theory of relativity, including the special and the general, is revered as the Bible of human being's physics for it has empirical evidence, supported by most observations and experiments.

So, what about the theory of OR?

7.2.1 Why do Observations and Experiments Mostly Support Einstein?

The theory of OR repeatedly emphasizes that: Galileo's doctrine and Newton's mechanics are that of idealized observation that are the true reflection of the objective physical world; Einstein's theory of relativity, both the special and the general, is that of optical observation that presents us with only an optical image of the physical world, and is not entirely objective and true.

Then since Galileo is more right than Lorentz and Newton is more right than Einstein, why do human observations and experiments mostly tend to support Einstein?

The reason is simple: most of human observations and experiments currently take use of optical observation systems, that is, the optical agent OA(c), which naturally tend to support Einstein.

However, this does not mean that Einstein was more right than Newton. It only means that Einstein's theory of relativity is just a theory of optical observation.

Actually, it is not so much that these observations and experiments support Einstein, but rather they support the theory of OR. With the advancement of science and technology, mankind will master superluminal observation techniques, possess superluminal observation agents, and observe the more objective and real physical world. At that time, human observations and experiments will be more inclined to support Galileo and Newton.

7.2.2 Is the Theory of OR Supported by Observations or Experiments?

As a matter of fact, an observation or experiment that supports Einstein must be a support for the theory of OR, such as the Michelson-Morley experiment; an observation or experiment that supports Galileo or Newton must also be a support for the theory of OR, such as Galileo's principle of speed addition.

(I) The Theory of OR and the Michelson-Morley Experiment [3]

As elucidated in Sec. 4.3.3, the so-called invariance of light speed in the Michelson-Morley experiment is only an apparent phenomenon, the essence of it is the invariance of information-wave speeds. So, the Michelson-Morley experiment is not a support for Einstein's theory of relativity, but rather a support for the theorem of the invariance of information-wave speeds and the theory of OR.

(II) The Theory of OR and Galileo's Law of Speed Addition [39]

Originally, mankind believed in Galileo's principle of speed addition, which is rooted in people's daily observations and human reason.

Relative to the observer on the platform, the speed u of a passenger on the train is equal to the speed v of the train plus the speed u' of the passenger walking on the train: $u=u'+v$, that is, Galileo's law of speed addition, conforming to Alfvén's common sense, to human intuition, and to human rationality.

Now, however, people believe that Galileo's law of speed addition is only an approximation of Einstein's law of relativistic speed addition in the case of low speeds.

The theory of OR has discovered that Einstein's rule of speed addition is the product of the optical agent OA(c) and optical observation. The optical agent OA(c) has the observational locality: $c<\infty$. Therefore, Einstein's rule of speed addition contains the observational effect and apparent phenomenon of OA(c), and is not entirely objective and real. The higher the speed v of the observed object, the more significant the observational effect or apparent phenomenon becomes. Conversely, the lower the speed v of the observed object, the weaker the observational effect or apparent phenomenon becomes.

According to the theory of OR, the higher the information-wave speed η of the observation agent OA(η) or the lower the moving speed v of the observed object, the weaker the observation effect and apparent phenomenon of OA(η) becomes. In this way, under the condition of macroscopic speed or low speed, people's daily observations would be closer to the objective truth and physical reality observed by the idealized agent OA_∞.

The speed addition we observe in daily life in a macroscopic low-speed case conforms to Galileo's principle of speed addition, which confirms the logical conclusion of OR theory: Galileo's principle of speed addition is the product of the idealized agent OA_∞, and it is the true law of speed addition, an objective natural law.

It is thus clear that human daily observations, human common sense, and human rationality, are more in line with the idealized observation of OA_∞, supporting Galileo's principle of speed addition. This exactly demonstrates that Galileo's principle of speed addition and human daily observations support the theory of OR.

7.3 Does the Theory of OR Have the Value and Significance of It?

Short answer: Yes. The theory of OR not only has theoretical significance, but also practical value, including the realistic and the potential.

7.3.1 The Theoretical Significance of OR

The theory of OR is not only the inheritance and development of Galileo-Newtonian mechanics and Einstein theory of relativity, but also the development and progress of contemporary physics.

The theory of OR not only has revealed the root and essence of relativistic effects, unifying Newton's mechanics and Einstein's theory of relativity in the same theoretical system under the same axiom system, but also has revealed the root and essence of quantum effects, towards the unity of relativity theory and quantum theory.

The theory of OR will inject fresh blood and new ideas into physics, reshaping human view of nature.

7.3.2 The Practical Value of OR

Actually, Einstein's theory of relativity, as a special case of the theory of OR with the optical agent OA(c), has achieved significant applications, such as the GPS positioning system. In addition to the OR of the optical agent OA(c), both the OR of the subluminal agent OA(η) ($\eta<c$) and the OR of the superluminal agent OA(η) ($\eta>c$) also hold the potential practical applications.

Furthermore, the theory of OR has the great guiding significance for experimental physics.

(I) Luminous OR: for the GPS System

As a special case of OR theory with the optical agent OA(c), the best-known application of Einstein theory of relativity is that in GPS positioning system: for determining and calibrating the time of GPS satellites.

In the GPS system, the satellites orbit the earth at a speed (v) of over 7.9 k/s in the gravitational field (χ), and therefore, both the inertial and gravitational relativistic effects have to be taken into account. So, the determination and calibration of GPS time have employed Einstein theory of relativity: $d\tau=dt(c)\sqrt{(1-v^2/c^2+2\chi/c^2)}$, where the speed c of light or electromagnetic radiation is the information-wave speed c of the optical agent OA(c).

Actually, in GPS system, the satellites communicate between each other by radio. Naturally, the observation agent of GPS system is the optical agent OA(c), and the determination and calibration of GPS time must rely on the theory of OR with the optical agent OA(c), that is, Einstein's theory of relativity.

So, the GPS system is an applied example of OR theory in the case of the optical agent OA(c).

Of course, the practical applications of OR theory are not limited to the optical agent OA(c). According to the theory of OR, Einstein's theory of relativity would inevitably become invalid under the non-optical observation agent OA(η) ($\eta\neq c$). In that case, we would have to adopt the theory of OR with non-optical agents: either the subluminal ($\eta<c$) or the superluminal ($\eta>c$).

(II) Subluminal OR: for the Multi-Robot System Operating Collaboratively in Deep Sea

In the future, the deep sea will be the important exploring areas of mankind, and the exploration for deep sea will be the important scientific activity of mankind.

The robot Jiaolong of China has already been able to dive down to 10,000 meters underwater. As multi robots work collaboratively in deep sea, they will face the same problems as GPS satellites: how to calibrate time; how to determine space.

Underwater communication cannot rely on light or electromagnetic wave. Underwater robots, like dolphins, must rely on underwater ultrasonic wave, employing the dolphin agent OA(v_U): $\eta=v_U\approx1450$ m/s, much lower than the speed of light c. Particularly, the speed ratio underwater robots to underwater ultrasound is much greater than that of GPS satellites to the speed of light, and the gravitational field in deep sea is much stronger than that where GPS satellites are. Therefore, the dolphin agent OA(v_U) must present more significant relativistic effects than the optical agent OA(c).

So, the collaborative operation of multi robots in deep sea requires the subluminal theory of OR, that is, the dolphin theory of OR ($\eta=v_U$) listed in Table 1.

This is the potential practical value of OR theory.

(III) Superluminal OR: for Gravitational Wave Astronomy

As shown in an increasing number of quantum entanglement experiments [23,24], the physical world indeed has the superluminal forms of matter motion. In the future, with the development of science and technology, mankind will discover the superluminal forms of matter motion and invent the superluminal observation agent OA(η) ($\eta>c$). At that time, mankind must take use of the superluminal theory of observational relativity (OR).

LIGO's exploration [34,35] for gravitational waves has led to a new concept [40]: **Gravitational Wave Astronomy**. Of course, as the theory of OR has already clarified, the speed κ of real gravitational waves is more in line with the calculations of Laplace [36] and Flandern [37], much higher than the speed of light ($\kappa>>c$) -- It is definitely not the speed of light envisioned by Einstein and LIGO.

In order to develop gravitational wave astronomy in the true sense, physics requires the gravitational-wave observation agent OA(κ), employing gravitational radiation as the observation medium and following the gravitational theory of observational relativity, that is, the superluminal theory of OR. To this end, the primary task of experimental physics is to measure and determine the speed κ of gravitational radiation or gravitational waves.

By the way, there is a question worth pondering: experimental physicists have long mastered the technology for measuring the speed of light c, so why cannot they measure the speed κ of gravitational radiation to this day?

With the help of the superluminal theory of OR and superluminal agents, mankind will "**see**" or observe a more objective and real physical world.

(IV) The Guiding Significance of OR for Experimental Physics

The theory of OR tells us: What we perceive or observe may not necessarily be the objective reality; Phenomena may not necessarily be the essence.

However, experimental physics and experimental physicists believe that observation represents the reality; phenomena represent the essence. Such Mach-Einstein style view of nature has misled human being's physics.

The theory of OR has important guiding significance for experimental physics.

Due to the current level of science and technology, human observations and experiments mostly rely on the optical agent OA(c). This is why most of observations and experiments support Einstein. Actually, in many cases, experimental physicists are not sure or concerned about what their observation agents are or who is transmitting the observed information for them.

According to the theory of OR, an experimental physicists conducting a physical experiment must first give a definite answer to the questions: what the observation agent OA(η) for his experiment is; what the information-wave speed η of OA(η) is.

In the theory of OR, the OR factor of spacetime-transformation $\Gamma(\eta)=1/\sqrt{(1-v^2/\eta^2+2\chi/\eta^2)}$ can be decomposed into Γ_∞ and $\Delta\Gamma(\eta)$: $\Gamma(\eta)=\Gamma_\infty+\Delta\Gamma(\eta)$, in which $\Gamma_\infty\equiv1$ is the Galilean factor representing the objective and real physical world; $\Delta\Gamma(\eta)$ is the relativistic factor representing the pure observational effects and apparent phenomena exhibited in observations and experiments, depending on the information-wave speed η of the observation agent OA(η), rooted from the observational locality ($\eta<\infty$) of OA(η). So, in order to determine the objective and real physical quantities of observed objects, experimental physicists must manage to remove $\Delta\Gamma(\eta)$ from $\Gamma(\eta)$.

If experimental physicists could introduce the observation-agent concept of OR theory into experimental physics, then they would definitely have new insights and new discoveries.

Conclusion

Human being's physics has had a new theory: **Observational Relativity** (OR), the theory of OR.

The theory of OR has generalized and unified the two great theoretical systems of human being's physics, Newton's mechanics and Einstein's theory of relativity, in the same theoretical system under the same axiom system. The theory of OR is not only the inheritance and development of Einstein's theory of relativity, both the special and the general, but also the inheritance and development of Galileo's doctrine and Newton's mechanics.

The theory of OR has already formed a complete theoretical system [12-15]: The 1st volume, **Inertially Observation Theory** (IOR), has generalized and unified Galileo-Newtonian inertial mechanics and Einstein's theory of special relativity; The 2nd volume, **Gravitationally Observation and Relativity** (GOR), has generalized and unified Newton's theory of universal gravitation and Einstein's theory of general relativity.

In order to clarify the logical self-consistency and theoretical validity of OR theory, as well as, to clarify the empirical basis and scientific value of OR theory, this article condenses the theory of OR, focusing on the logical deduction of OR theory, the new discoveries and new ideas of OR theory, and the unity of Galileo-Newtonian mechanics and Einstein's theory of relativity in the theory of OR.

In fact, the theory of OR is logically concise and easy to understand, which is in line with Alfvén's common sense [38], with human experience and intuition, with human rationality and logic, and at the same time, with human plain and simple views of nature.

The unity of Newton and Einstein in the theory of OR confirms the logical self-consistency and theoretical validity of the theory of OR. Section 4 of this article clarifies that the theory of OR originates from the definition of OR time as the first principle, based on a more basic axioma system with more basic logical premises, so that it has acquired the broader perspective of the general observation agent OA(η) ($0<\eta<\infty$; $\eta\to\infty$). Perhaps, you could not understand the logical deduction of OR derived from the definition of OR time. In order to help readers to understand the theory of OR, Sec. 4.3 depicts for readers a few more concise logical paths let to the theory of OR, including PGC logical path 1 based on the principle of general correspondence in Secs. 3.3 and 4.3.4. It further clarifies the logical and theoretical correctness of OR theory that different logical paths could lead to the same destination of OR theory. As shown in Tables A1 and A2 in Appendix A, Secs. 5 and 7.1 demonstrate that the theory of OR is logically isomorphic and consistent with both Galileo-Newtonian mechanics and Einstein's theory of relativity, both the special and the general. This isomorphic consistency also provides a strong support for the logical self-consistency and theoretical correctness of OR theory.

As stated in Sec. 6, the new discoveries and new ideas of OR, as the products of logic and theory, has the great scientific value and theoretical significance of it. For more details, please refer to references [12-15].

Furthermore, the theory of OR is not a castle in the air. As clarified in Secs. 7.2 and 7.3, the theory of OR has solid empirical basis, supported by observations and experiments. In addition to the practical value for the optical observation agent OA(c), the theory of OR has the potential value for both subluminal agents and superluminal agents, and also would provide important guiding significance for experimental physics.

We have reason to believe that the theory of OR is the scientific truth that can withstand empirical testing, withstand rational reasoning, withstand questioning and criticizing, and withstand the test of time and history. The theory of OR will inject fresh blood and new ideas into human being's physics. mankind will re-examine his physics and reshape his view of nature.

However, as a new doctrine of physics, the theory of OR must inevitably face questioning and criticizing.

The statements in the theory of OR may not necessarily be very rigorous. So, the theory of OR welcomes questioning and criticizing.

As the great German philosopher Arthur Schopenhauer ever remarked: ***"All truth passes through three stages: first, it is ridiculed; second, it is vehemently opposed; third, it is accepted as being self-evident."***

Reference

[1] Hawking S., A Brief History of Time: From the Big Bang to Black Holes. New York: Bantam Dell Publishing Group, 1988.

[2] Maxwell J. C., On a possible mode of detecting a motion of the solar system through the luminiferous ether. Proceedings of the Royal Society of London, 1880, 30: 108-110.

[3] Michelson A. A., and Morley E. W., On the relative motion of the earth and the luminiferous ether. American Journal of Science. 1887, 34: 333-345.

[4] FitzGerald G. F., The ether and the earth's atmosphere. Science, 1889, 13: 390.

[5] Lorentz H. A., The relative motion of the earth and the aether. Zittingsverlag Akad. V. Wet. 1892, 1: 74-79.

[6] Lorentz H. A., Simplified theory of electrical and optical phenomena in moving systems. In Proceedings of the Royal Netherlands Academy of Arts and Sciences, 1899, 1: 427-442.

[7] Lorentz H A., Electromagnetic phenomena in a system moving with any velocity smaller than that of light. In Proceedings of the Royal Netherlands Academy of Arts and Sciences, 1904, 6: 809-831.

[8] Einstein A., Zur Elektrodynamik bewegter Körper. Annalen der Physik, 1905, 17: 891-921.

[9] Einstein A. Grundlage der allgemeinen Relativitätstheorie. Annalen der Physik, 1916, 49: 769-822.

[10] Gödel K., Die Vollständigkeit der Axiome des logischen Funktionenkalküls. Monatshefte für Mathematik Physik, 1930, 37: 349-360.

[11] Gödel K., Über formal unentscheidbare Sätze der Principia Mathematica und verwandter Systeme I. Monatshefte für Mathematik Physik, 1931, 38: 173-198.

[12] Ruan X. G., Observation and relativity: why is the speed of light invariant in Einstein's special relativity? (in both Chinese and English) Journal of Beijing University of Technology, 2020, 46: 82-124.

[13] Ruan X. G., General observational relativity: why is spacetime curved in Einstein's general relativity? (in both Chinese and English) Journal of Beijing University of Technology, 2023, 49: 1-100; 101-200.

[14] Ruan X. G., The Theory of Observational Relativity: The Unity of Newton and Einstein (Chinese version: ISBN 978-7-5639-8668-2). Beijing University of Technology Press, 2024.

[15] Ruan X. G., Observational Relativity: The Unity of Newton and Einstein. Figshare DOI 10.6084/m9.figshare.24793032; The First Volume_Inertially Observational Relativity (IOR), ResearchGate DOI 10.13140/RG.2.2.12337.29289, viXra: 2312.0033; The Second Volume_Gtavitationally Observational Relativity (GOR). ResearchGate DOI 10.13140/RG.2.2.27436.78720, viXra: 2312.0031; 2025.

[16] Feynman R. P., Space-time approach to quantum electrodynamic. Phys. Rev., 1949, 76: 769-789.

[17] De Broglie L., Une novelle théorie de la lumière, La mécanique ondulatoire du photon I. Hermann, Paris, 1940, tome I: La lumière dans le vide.

[18] De Broglie L., Une nouvelle théorie de la lumière, la mécanique ondulatoire du photon II, Hermann, Paris, 1942, tome II: L'interaction entre les photons et la matière.

[19] Schrödinger E., The general unitary theory of the physical fields. Proc. R. Ir. Acad. A, 1943, 49: 43-58.

[20] Schrödinger E., The Earth's and the Sun's permanent magnetic fields in the unitary field theory. Proc. R. Ir. Acad. A, 1943, 49: 135-148.

[21] Železnikar A. P., Informon -- An emergent conscious component. Informatica, 2002, 26: 431-419.

[22] Einstein A., Podolsky B, Rosen N. Can quantum-mechanical description of physical reality be considered complete? Physical Review, 1935, 47: 777-780.

[23] Rosenfeld W., Weber M., Volz J. and et al., Towards a loophole-free test of Bell's inequality with entangled pairs of neutral atoms Advanced Science Letter, 2009, 2: 469-474.

[24] Hensen B., Bernien H., Dréau A. E. and et al., Experimental loophole-free violation of a Bell inequality using entangled electron spins separated by 1.3 km. 2015, arXiv: 1508.05949.

[25] Bohr N., Über die Serienspektra der Element. Zeitschrift für Physik, 1920, 2: 423-478.

[26] Bohr N., On the constitution of atoms and molecules, part I. Philosophical Magazine, 1913, 26: 1-24.

[27] Bohr N., On the constitution of atoms and molecules, part II systems containing only a single nucleus. Philosophical Magazine, 1913, 26: 476-502.

[28] Bohr N., On the constitution of atoms and molecules, part III systems containing several nuclei. Philosophical Magazine, 1913, 26: 857-875.

[29] Ajaltouni Z. J., Symmetry and relativity: from classical mechanics to modern particle physics. Natural Science, 2014, 6: 191-197.

[30] Ricci L. Dante's insight into Galilean invariance. Nature, 2005, 434: 717.

[31] Einstein A, Infled L, and Hoffmann B. The gravitational equation and the problem of motion. Annals of Mathematics, 1938, 39: 65-100.

[32] Fock V. A., On the motion of finite masses in the General Relativity Theory. Zhurnal Eksperimental'noi I Teoreticheskoi Fiziki (in Russian), 1939, 9: 375.

[33] Newton I., The Mathematical Principles of Natural Philosophy (1687). Dawsons of Pall Mall, 1968.

[34] Tushna Commissariat, LIGO detects first ever gravitational waves — from two merging black holes. IPO Physics World (physicsworld.com), Feb. 11, 2016.

[35] Chu J., For second time, LIGO detects gravitational waves. MIT News, June 15, 2016.

[36] Laplace P. S., A Treatise in Celestial Mechanics. Vol. IV, Book X, Chapter VII (1805). (Translated by N. Browditch), Chelsea, New York, 1966.

[37] Van Flandern T., The speed of gravity — What the experiments say. Physics Letters A, 1998, 250: 1–11.

[38] Alfvén H., Cosmology: Myth or science? Journal of Astrophysics and Astronomy, 1984, 5: 79-98.

[39] Galilei G., (1632) Dialogue Concerning the Two Chief World Systems, Ptolemaic and Copernican. (Transl. S. Drake) Berkeley: University of California Press, 1967.

[40] Blair D., Ju L., Zhao C., and et al., Gravitational wave astronomy: the current status. SCIENCE CHINA: Physics, Mechanics & Astronomy, 2015, 58: 120402.

Appendix A: The Corresponding Relationships between OR and Newton as well as between OR and Einstein

Table A1 lists the fundamental relations of Inertially Observational Relativity (IOR) as well as the corresponding relations of Galileo-Newtonian Inertial Mechanics and Einstein's theory of special relativity. Table A2 lists the fundamental relations of Gravitationally Observation Relativity (GOR) as well as the corresponding relations of Newton's theory of universal gravitation and Einstein's theory of general relativity.

Table A1. The Unity of Newton and Einstein in the Theory of IOR
(See Chapter 8 of the 1st Volume IOR in OR References [12-15])

	The Theory of IOR (the general observation agent OA(η))	Einstein Special Relativity (the optical agent OA(c): $\eta\to c$)	Galileo-Newtonian Inertial Mechanics (the idealized agent OA$_\infty$: $\eta\to\infty$)
IOR-01	OA(η) and IOR spacetime $X^{4d}(\eta)$: $\mathrm{OA}(\eta)=\left\{\begin{matrix} X^{4d}(\eta):\begin{Bmatrix} x^0=\eta t \\ x^1=x \\ x^2=y \\ x^3=z \end{Bmatrix} \\ \mathrm{d}s^2=\eta^2\mathrm{d}t^2-\mathrm{d}x^2-\mathrm{d}y^2-\mathrm{d}z^2 \end{matrix}\right\}$	OA(c) and Minkowski spacetime $X^{4d}(c)$: $\mathrm{OA}(c)=\lim_{\eta\to c}\mathrm{OA}(\eta)$ $=\left\{\begin{matrix} X^{4d}(c):\begin{Bmatrix} x^0=ct \\ x^1=x \\ x^2=y \\ x^3=z \end{Bmatrix} \\ \mathrm{d}s^2=c^2\mathrm{d}t^2-\mathrm{d}x^2-\mathrm{d}y^2-\mathrm{d}z^2 \end{matrix}\right\}$	OA$_\infty$ and Cartesian spacetime X^{4d}_∞: $\mathrm{OA}_\infty=\lim_{\eta\to\infty}\mathrm{OA}(\eta)$ $=\left\{\begin{matrix} X^{4d}_\infty:\begin{Bmatrix} x^0=\infty t \\ x^1=x, x^2=y, x^3=z \end{Bmatrix} \\ \mathrm{d}t=\mathrm{d}\tau \\ \mathrm{d}l=\sqrt{\mathrm{d}x^2+\mathrm{d}y^2+\mathrm{d}z^2} \end{matrix}\right\}$
IOR-02	IOR invariance of information-wave speeds: $\mathrm{OA}(\eta):\ \forall v\in(-\eta,\eta)\ \ \eta\oplus v=\eta$ The information-wave speed η of OA(η) is observationally invariant.	Einstein invariance of light speed: $\mathrm{OA}(c):\ \forall v\in(-c,c)\ \ c\oplus v=c$ If OA(η) is the optical agent OA(c), then the speed of light c is observationally invariant.	Cartesian invariance: $\mathrm{OA}_\infty:\ \forall v\in(-\infty,\infty)\ \ \infty\oplus v=\infty$ The information-wave speed of the idealized agent OA$_\infty$ is infinite, and so naturally invariant.
IOR-03	The IOR factor: $\Gamma=\Gamma(\eta)$ $\Gamma=\Gamma(\eta)=\dfrac{1}{\sqrt{1-v^2/\eta^2}}$	The Lorentz factor: $\gamma=\Gamma(c)$ $\gamma=\Gamma(c)=\lim_{\eta\to c}\Gamma(\eta)=\dfrac{1}{\sqrt{1-v^2/c^2}}$	The Galilean factor: $\Gamma_\infty=\Gamma(\infty)$ $\Gamma_\infty=\lim_{\eta\to\infty}\Gamma(\eta)=\lim_{\eta\to\infty}\dfrac{1}{\sqrt{1-v^2/\eta^2}}=1$
IOR-04	The general Lorentz transformation: $O'(\eta)\to O(\eta)$ $\mathrm{OA}(\eta):\ \begin{cases} x=\Gamma(\eta)(x'+vt') \\ y=y' \\ z=z' \\ t=\Gamma(\eta)\left(t'+\dfrac{vx'}{\eta^2}\right) \end{cases}$	The Lorentz transformation: $\mathrm{OA}(c):\ \ \{x\ \ y\ \ z\ \ t\}^T$ $=\lim_{\eta\to c}\begin{Bmatrix} \Gamma(\eta)(x'+vt') \\ y' \\ z' \\ \Gamma(\eta)\left(t'+\dfrac{vx'}{\eta^2}\right) \end{Bmatrix}=\begin{Bmatrix} \gamma(x'+vt') \\ y' \\ z' \\ \gamma\left(t'+\dfrac{vx'}{c^2}\right) \end{Bmatrix}$	The Galilean transformation: $\mathrm{OA}_\infty:\ \ \{x\ \ y\ \ z\ \ t\}^T$ $=\lim_{\eta\to\infty}\begin{Bmatrix} \Gamma(\eta)(x'+vt') \\ y' \\ z' \\ \Gamma(\eta)\left(t'+\dfrac{vx'}{\eta^2}\right) \end{Bmatrix}=\begin{Bmatrix} x'+vt' \\ y' \\ z' \\ t' \end{Bmatrix}$
IOR-05	IOR law of speed addition: $u(\eta)=\dfrac{u'+v}{1+u'v/\eta^2}$	Einstein's law of speed addition: $u(c)=\lim_{\eta\to c}\dfrac{u'+v}{1+u'v/\eta^2}=\dfrac{u'+v}{1+u'v/c^2}$	Galileo's law of speed-addition: $u_\infty=\lim_{\eta\to\infty}\dfrac{u'+v}{1+u'v/\eta^2}=u'+v$
IOR-06	IOR observational mass: $m=m(\eta)=\dfrac{m_o}{\sqrt{1-v^2/\eta^2}}$	Einstein's relativistic mass: $m(c)=\lim_{\eta\to c}\dfrac{m_o}{\sqrt{1-v^2/\eta^2}}=\dfrac{m_o}{\sqrt{1-v^2/c^2}}$	Newton's classical mass: $m_\infty=\lim_{\eta\to\infty}\dfrac{m_o}{\sqrt{1-v^2/\eta^2}}=m_o$
IOR-07	IOR observational momentum: $p=p(\eta)=m(\eta)v=\dfrac{m_o v}{\sqrt{1-v^2/\eta^2}}$	Einstein's relativistic momentum: $p(c)=\lim_{\eta\to c}\dfrac{m_o v}{\sqrt{1-v^2/\eta^2}}=\dfrac{m_o v}{\sqrt{1-v^2/c^2}}$	Newton's classical momentum: $p_\infty=\lim_{\eta\to\infty}\dfrac{m_o v}{\sqrt{1-v^2/\eta^2}}=m_o v=m_\infty v$
IOR-08	IOR mass-energy relation: $E=E(\eta)=m\eta^2=\dfrac{m_o\eta^2}{\sqrt{1-v^2/\eta^2}}$	Einstein's mass-energy relation: $E(c)=\lim_{\eta\to c}\dfrac{m_o\eta^2}{\sqrt{1-v^2/\eta^2}}$ $=\dfrac{m_o c^2}{\sqrt{1-v^2/c^2}}=mc^2$	Newton's mass-energy relation: $E_\infty=\lim_{\eta\to\infty}E(\eta)$ $=\lim_{\eta\to\infty}\dfrac{m_o\eta^2}{\sqrt{1-v^2/\eta^2}}=\infty$
IOR-09	IOR rest energy: $E_o=E_o(\eta)=m_o\eta^2$	Einstein's rest energy: $E_o(c)=\lim_{\eta\to c}E_o(\eta)=\lim_{\eta\to c}m_o\eta^2=m_o c^2$	Newton's rest energy: $E_{o\infty}=\lim_{\eta\to\infty}E_o(\eta)=\lim_{\eta\to\infty}m_o\eta^2=\infty$

	The Theory of IOR (the general observation agent OA(η))	Einstein Special Relativity (the optical agent OA(c): $\eta\to c$)	Galileo-Newtonian Inertial Mechanics (the idealized agent OA∞: $\eta\to\infty$)
IOR-10	IOR observational kinetic energy: $K=K(\eta)=E(\eta)-E_o(\eta)$ $=(\Gamma(\eta)-1)m_o\eta^2$	Einstein's relativistic kinetic energy: $K(c)=\lim\limits_{\eta\to c}K(\eta)=\lim\limits_{\eta\to c}(E(\eta)-E_o(\eta))$ $=(\Gamma(c)-1)m_oc^2=(\gamma-1)m_oc^2$	Newton's classical kinetic energy: $K_\infty=\lim\limits_{\eta\to\infty}K(\eta)=\lim\limits_{\eta\to\infty}(E(\eta)-E_o(\eta))$ $=\lim\limits_{\eta\to\infty}(\Gamma(\eta)-1)m_o\eta^2=\frac{1}{2}m_\infty v^2$

Notes: The theory of IOR has generalized and unified Einstein's theory of special relativity and Galileo-Newtonian Inertial Mechanics. All formulae or relationships in the theory of IOR, as $\eta\to c$, strictly converge to that of Einstein's special relativity; as $\eta\to\infty$, strictly converge to that of Galileo-Newtonian inertial mechanics. It is thus clear that the theory of IOR is logically consistent not only with Einstein's special relativity, but also with Galileo-Newtonian inertial mechanics. Moreover, such strict corresponding relationship between different theoretical systems, from one aspect, confirms the logical self-consistency and theoretical validity of the theory of IOR and even OR.

Table A2. The Unity of Newton and Einstein in the Theory of GOR (See Chapter 20 of the 2nd Volume GOR in OR References [12-15])

	The Theory of GOR (the general observation agent OA(η))	Einstein's General Relativity (the optical agent OA(c): $\eta\to c$)	Newton's Gravitational Theory (the idealized agent OA∞: $\eta\to\infty$)
GOR-01	OA(η) and GOR spacetime $X^{4\text{d}}(\eta)$: $\mathrm{OA}(\eta)=\left\{\begin{array}{l}X^{4\text{d}}(\eta):\left\{\begin{array}{l}x^0=\eta t\\x^1=x\\x^2=y\\x^3=z\end{array}\right\}\\\mathrm{d}s^2=g_{\mu\nu}\mathrm{d}x^\mu\mathrm{d}x^\nu\\\left(g_{\mu\nu}=g_{\mu\nu}(x^\alpha,\eta)\right)\end{array}\right\}$	OA(c) and Minkowski spacetime $X^{4\text{d}}(c)$: $\mathrm{OA}(c)=\lim\limits_{\eta\to c}\mathrm{OA}(\eta)$ $=\left\{\begin{array}{l}X^{4\text{d}}(c):\left\{\begin{array}{l}x^0=ct\\x^1=x\\x^2=y\\x^3=z\end{array}\right\}\\\mathrm{d}s^2=g_{\mu\nu}\mathrm{d}x^\mu\mathrm{d}x^\nu\\\left(g_{\mu\nu}=g_{\mu\nu}(x^\alpha,c)\right)\end{array}\right\}$	OA∞ and Cartesian spacetime $X^{4\text{d}}_\infty$: $\mathrm{OA}_\infty=\lim\limits_{\eta\to\infty}\mathrm{OA}(\eta)$ $=\left\{\begin{array}{l}X^{4\text{d}}_\infty:\left\{\begin{array}{l}x^0=\infty t\\x^1=x,x^2=y,x^3=z\end{array}\right\}\\\mathrm{d}t=\mathrm{d}\tau\\\mathrm{d}l=\sqrt{\mathrm{d}x^2+\mathrm{d}y^2+\mathrm{d}z^2}\end{array}\right\}$
GOR-02	The GOR factor of spacetime transformation: $\Gamma=\Gamma(\eta)$ $\Gamma=\Gamma(\eta)=\dfrac{1}{\sqrt{\left(\sqrt{1+\frac{2\chi}{\eta^2}}-\gamma_i\frac{v^i}{\eta}\right)^2-\frac{v^2}{\eta^2}}}$	The Einstein factor: $\gamma=\Gamma(c)$ $\gamma=\Gamma(c)=\lim\limits_{\eta\to c}\Gamma(\eta)$ $=\dfrac{1}{\sqrt{\left(\sqrt{1+2\chi/c}-\gamma_iv^i/c\right)^2-v^2/c^2}}$	The Newtonian factor: Γ_∞ $\Gamma_\infty=\lim\limits_{\eta\to\infty}\Gamma(\eta)=1$
GOR-03	The determination of GOR standard time: OA(η): $\mathrm{d}\tau=\dfrac{\mathrm{d}s(\eta)}{\eta}=\sqrt{g_{00}(\eta)}\mathrm{d}t(\eta)$ $=\sqrt{1+\frac{2\chi}{\eta^2}}\mathrm{d}t(\eta)$	The determination of Einstein's standard time: OA(c): $\mathrm{d}\tau=\dfrac{\mathrm{d}s(c)}{c}=\sqrt{g_{00}(c)}\mathrm{d}t(c)$ $=\sqrt{1+\frac{2\chi}{c^2}}\mathrm{d}t(c)$	The determination of Newton's classic time: OA_∞: $\mathrm{d}\tau=\lim\limits_{\eta\to\infty}\sqrt{1+\frac{2\chi}{\eta^2}}\mathrm{d}t(\eta)=\mathrm{d}t_\infty$ Newton's clasical time dt_∞ is exactly the objective and real time dτ.
GOR-04	The determination of GOR physical space: OA(η): $\mathrm{d}l^2=\gamma_{ik}(\eta)\mathrm{d}x^i\mathrm{d}x^k$	The determination of Einstein's physical space: OA(c): $\mathrm{d}l^2=\gamma_{ik}(c)\mathrm{d}x^i\mathrm{d}x^k$	The determination of Newton's physical space: OA(c): $\mathrm{d}l^2=\lim\limits_{\eta\to\infty}\gamma_{ik}(\eta)\mathrm{d}x^i\mathrm{d}x^k$ $=x^2+y^2+z^2$ Newton's phyaical space is exactly the objective and real Cartesian space.
GOR-05	The GOR field equation: $\Box\chi_{\mu\nu}(\eta)=-\frac{\eta^2}{2}\kappa_{\text{GOR}}T_{\mu\nu}(\eta)$ $\left\{\begin{array}{l}\Box\chi_{\mu\nu}\equiv\frac{\eta^2}{2}\left(R_{\mu\nu}-\frac{1}{2}g_{\mu\nu}R\right)\\\kappa_{\text{GOR}}=8\pi G/\eta^4\end{array}\right.$	Einstein's field equation: $\Box\chi_{\mu\nu}(c)=\frac{c^2}{2}\left(R_{\mu\nu}-\frac{1}{2}g_{\mu\nu}R\right)$ $=-\frac{c^2}{2}\kappa_ET_{\mu\nu}(c)\quad\left(\kappa_E=\frac{8\pi G}{c^4}\right)$ As $\eta\to c$, the GOR field equation reduces to Einstein's field equation.	Newton's field equation: $\nabla^2\chi=4\pi G\rho$ $\left\{\begin{array}{l}\Box\chi_{\mu\nu}=0\quad(\mu\nu\neq00)\\\Box\chi_{00}=-\nabla^2\chi=-4\pi G\rho\end{array}\right.$ As $\eta\to\infty$, the GOR field equation reduces to Newton's law of universal gravitation in the form of Poisson equation.

	The Theory of GOR (the general observation agent OA(η))	Einstein's General Relativity (the optical agent OA(c): $\eta\to c$)	Newton's Gravitational Theory (the idealized agent OA_∞: $\eta\to\infty$)
GOR-06	The GOR motion equation: (i.e., the GOR geodesic equation) $\frac{\mathrm{d}^2x^\mu}{\mathrm{d}s^2}+\Gamma^\mu_{\alpha\beta}(\eta)\frac{\mathrm{d}x^\alpha}{\mathrm{d}s}\frac{\mathrm{d}x^\beta}{\mathrm{d}s}=0$ $(\mu=0,1,2,3)$	Einstein's motion equation: $\frac{\mathrm{d}^2x^\mu}{\mathrm{d}s^2}+\Gamma^\mu_{\alpha\beta}(c)\frac{\mathrm{d}x^\alpha}{\mathrm{d}s}\frac{\mathrm{d}x^\beta}{\mathrm{d}s}=0$ $(\mu=0,1,2,3)$ As $\eta\to c$, the GOR motion equation reduces to Einstein's motion equation.	Newton's motion equation: $\begin{cases}\frac{\mathrm{d}^2t}{\mathrm{d}\tau^2}=0\\ \frac{\mathrm{d}^2x^i}{\mathrm{d}\tau^2}=-\frac{\partial\chi}{\partial x^i}\end{cases}\quad\left(F^i=-m\frac{\partial\chi}{\partial x^i};\ i=1,2,3\right)$ As $\eta\to\infty$, the GOR motion equation splits into two independent relations: the 1d temporal (dt) and the 3d spatial (dr) that is exactly Newton's law of universal gravitation $\lvert F\rvert=GMm/r^2$.
GOR-07	The GOR spacetime metric: $g_{\mu\nu}(\eta):\begin{cases}g_{00}(\eta)=1+2\chi/\eta^2\\ g_{11}(\eta)=-\left(1+2\chi/\eta^2\right)^{-1}\\ g_{22}(\eta)=-r^2\\ g_{33}(\eta)=-r^2\sin^2\theta\\ g_{\mu\nu}(\eta)=0\quad(\mu\neq\nu)\end{cases}$	Einstein's spacetime metric: $\underset{\eta\to c}{g_{\mu\nu}(c)}:\begin{cases}g_{00}(c)=1+2\chi/c^2\\ g_{11}(c)=-\left(1+2\chi/c^2\right)^{-1}\\ g_{22}(c)=-r^2\\ g_{33}(c)=-r^2\sin^2\theta\\ g_{\mu\nu}(c)=0\quad(\mu\neq\nu)\end{cases}$	Newton's spacetime metric: $g_{\mu\nu}=\lim_{\eta\to\infty}g_{\mu\nu}(\eta)=\eta_{\mu\nu}$ $=\mathrm{diag}\left(+1,-1,-r^2,-r^2\sin^2\theta\right)$ As $\eta\to\infty$, the GOR metric $g_{\mu\nu}$. converges to the Minkowski metric $\eta_{\mu\nu}$.=diag(+1,–1,–1,–1).
GOR-08	The GOR spacetime line-element: $\mathrm{d}s^2=\left(1+2\chi/\eta^2\right)\eta^2\mathrm{d}t^2$ $-\left(1+2\chi/\eta^2\right)^{-1}\mathrm{d}r^2$ $-r^2\mathrm{d}\theta^2-r^2\sin^2\theta\mathrm{d}\varphi^2$	Einstein's spacetime line-element: $\mathrm{d}s^2=\left(1+2\chi/c^2\right)c^2\mathrm{d}t^2$ $-\left(1+2\chi/c^2\right)^{-1}\mathrm{d}r^2$ $-r^2\mathrm{d}\theta^2-r^2\sin^2\theta\mathrm{d}\varphi^2$	Newton's spacetime line-element: $\begin{cases}\mathrm{d}t=\mathrm{d}\tau\\ \mathrm{d}r^2=\mathrm{d}x^2+\mathrm{d}y^2+\mathrm{d}z^2\end{cases}$ As $\eta\to\infty$, the GOR line-element ds splits into two independent relation: 1d time-element dt and 3d space-element dr.
GOR-09	The GOR observed energy: Kinetic energy $K(\eta)$ of the object P: $K=K(\eta)=\left(\Gamma(\eta)\big\rvert_{\chi=0}-1\right)m_o\eta^2$ Potential energy $V(\eta)$ of the object P: $V=V(\eta)=\left(1-\Gamma(\eta)\big\rvert_{v=0}\right)m_o\eta$ Total energy $H(\eta)$ of the object P: $H=H(\eta)=K(\eta)+V(\eta)$ $=\left(\Gamma(\eta)\big\rvert_{\chi=0}-\Gamma(\eta)\big\rvert_{v=0}\right)m_o\eta^2$	Einstein's relativistic energy: Kinetic energy $K(c)$ of the object P: $K=K(c)=\left(\Gamma(c)\big\rvert_{\chi=0}-1\right)m_oc^2$ Potential energy $V(c)$ of the object P: $V=V(c)=\left(1-\Gamma(c)\big\rvert_{v=0}\right)m_oc$ Total energy $H(c)$ of the object P: $H=H(c)=\lim_{\eta\to c}H(\eta)=K(c)+V(c)$ $=\left(\Gamma(c)\big\rvert_{\chi=0}-\Gamma(c)\big\rvert_{v=0}\right)m_oc^2$	Newton's classical energy: Kinetic energy K_∞ of the object P: $K=\lim_{\eta\to\infty}K(\eta)=\frac{1}{2}m_\infty v^2=K_\infty$ Potential energy V_∞ of the object P: $V=\lim_{\eta\to\infty}V(\eta)=\chi m_\infty=V_\infty$ Potential energy H_∞ of the object P: $H=H_\infty=\lim_{\eta\to\infty}H(\eta)=K_\infty+V_\infty$ $=\frac{1}{2}m_\infty v^2-\frac{GMm_\infty}{r^2}$
GOR-10	The GOR motion equation of celestial two-body system (M,m): $\mathrm{OA}(\eta):\ \frac{\mathrm{d}^2u}{\mathrm{d}\varphi^2}+u=\frac{GM}{h_K^2}\left(1+\frac{3h_K^2}{\eta^2}u^2\right)$	Einstein's motion equation of celestial two-body system (M,m): $\mathrm{OA}(c):\ \frac{\mathrm{d}^2u}{\mathrm{d}\varphi^2}+u=\frac{GM}{h_K^2}\left(1+\frac{3h_K^2}{c^2}u^2\right)$	Newton's motion equation of celestial two-body system (M,m): $\mathrm{OA}_\infty:\ \frac{\mathrm{d}^2u}{\mathrm{d}\varphi^2}+u=\frac{GM}{h_K^2}$
GOR-11	The GOR precession-angle equation of planet orbits: $\Delta\varphi_{\mathrm{GOR}}$ $\Delta\varphi_{\mathrm{GOR}}=\Delta\varphi_{\mathrm{OA}(\eta)}=\frac{6\pi G^2M^2}{\eta^2h_K^2}$	Einstein's precession-angle equation of planet orbits: $\Delta\varphi_E$ $\Delta\varphi_E=\Delta\varphi_{\mathrm{OA}(c)}=\lim_{\eta\to c}\Delta\varphi_{\mathrm{OA}(\eta)}=\frac{6\pi G^2M^2}{c^2h_K^2}$	Newton's precession-angle equation of planet orbits: $\Delta\varphi_N$ $\Delta\varphi_N=\Delta\varphi_{\mathrm{OA}_\infty}=\lim_{\eta\to\infty}\varphi_{\mathrm{OA}(\eta)}=0$
GOR-12	The GOR gravitational-deflection angle of light sweeping over the sun: δ_{GOR} The optical agent OA(c): $\eta=c$ $\delta_{\mathrm{GOR}}=\delta_{\mathrm{OA}(\eta)}=\frac{4GM}{R_Sc^2}\quad(\eta\to c)$ The the superluminal agent OA(η): $\eta>>c$ $\delta_{\mathrm{GOR}}=\delta_{\mathrm{OA}(\eta)}=\frac{2GM}{R_Sc^2}\left(1+\frac{c^2}{3c^2+2\eta^2}\right)$	Einstein's gravitational-deflection angle of light sweeping over the sun: δ_E ($\eta=c$) $\delta_E=\delta_{\mathrm{OA}(c)}=\lim_{\eta\to c}\delta_{\mathrm{OA}(\eta)}=\frac{4GM}{R_Sc^2}$	Newton's gravitational-deflection angle of light sweeping over the sun: δ_N ($\eta>>c$) $\delta_N=\delta_{\mathrm{OA}_\infty}=\lim_{\eta\to\infty}\delta_{\mathrm{OA}(\eta)}$ $=\lim_{\eta\to\infty}\frac{2GM}{R_Sc^2}\left(1+\frac{c^2}{3c^2+2\eta^2}\right)=\frac{2GM}{R_Sc^2}$

	The Theory of GOR (the general observation agent OA(η))	Einstein's General Relativity (the optical agent OA(c): $\eta \to c$)	Newton's Gravitational Theory (the idealized agent OA_∞: $\eta \to \infty$)
GOR-13	The GOR gravitational-redshift equation of light: Z_{GOR} $Z_{GOR} = Z_{OA(\eta)} = \dfrac{1/\sqrt{g_{00}(r_B)} - 1/\sqrt{g_{00}(r_A)}}{K_{F\eta}/m_o\eta^2 - \left(1 - 1/\sqrt{g_{00}(r_B)}\right)}$ $\begin{pmatrix} K_{F\eta} = \left(\Gamma\vert_{\chi=0} - 1\right) m_o \eta^2 \\ \Gamma\vert_{\chi=0} = 1/\sqrt{1 - c^2/\eta^2} \\ g_{00}(r) = 1 + \dfrac{2\chi}{\eta^2};\ \chi(r) = -\dfrac{GM}{r} \end{pmatrix}$ where $\eta\,(\geq c)$ is the information-wave speed of the general observation agent OA(η); the speed of light c is the speed of the photon m as the observed object P.	Einstein's gravitational-redshift equation of light: Z_E $Z_E = Z_{OA(c)} = \lim_{\eta \to c} Z_{OA(\eta)} = 1 - \dfrac{\sqrt{g_{00}(r_B)}}{\sqrt{g_{00}(r_A)}}$ $\left(g_{00}(r) = 1 + \dfrac{2\chi}{c^2};\ \chi(r) = -\dfrac{GM}{r}\right)$	Newton's gravitational-redshift equation of light: Z_N $Z_N = Z_{OA_\infty} = \lim_{\eta \to \infty} Z_{OA(\eta)} = \dfrac{2GMr_B}{r_B c^2 + 2GM}\left(\dfrac{1}{r_B} - \dfrac{1}{r_A}\right)$
GOR-14	The GOR information-wave equation: $\nabla^2 h^-_{\mu\nu}(\eta) - \dfrac{1}{\eta^2}\dfrac{\partial^2}{\partial t^2} h^-_{\mu\nu}(\eta) = 0$ where the wave function $h^-_{\mu\nu}(\eta)$ is the metric-perturbation tensor under OA(η).	Einstein's information-wave equation: $\nabla^2 h^-_{\mu\nu}(c) - \dfrac{1}{c^2}\dfrac{\partial^2}{\partial t^2} h^-_{\mu\nu}(c) = 0$ As $\eta \to c$, the GOR wave equation reduces to Einstein's wave equation.	Newton's information-wave equation: $\nabla^2 h^-_{\mu\nu} = 0$ or $\nabla^2 \chi = 0$ As $\eta \to \infty$, the GOR wave equation reduces to Newton's wave equation.

Notes: The theory of GOR has generalized and unified Einstein's theory of general relativity and Newton's theory of universal gravitation. All formulae or relationships in the theory of GOR, as $\eta \to c$, strictly converge to that of Einstein's theory of general relativity; $\eta \to \infty$, strictly converge to that of Newton's theory of universal gravitation. It is thus clear that the theory of GOR is logically consistent not only with Einstein's theory of general relativity, but also with Newton's theory of universal gravitation. Moreover, such strict corresponding relationship between different theoretical systems, from one aspect, confirms the logical self-consistency and theoretical validity of the theory of GOR and even OR.