

A Revolution in the Structure and Meaning of Relativity through Nakaza's New Relativity Theory (NNRT)

—Reconstructing Observational Spacetime through Electromagnetic and Matter Waves on the Basis of Universal Spacetime, Galilean Transformations, and Newtonian Mechanics—

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Abstract

Nakaza's New Relativity Theory (NNRT) takes universal time and universal space, the physical equivalence of all inertial frames, the Galilean transformation (GT), and Newton's laws of motion as the basis of real motion. The existence of time and space belongs to a different level from the values measured by clocks, length standards, and electromagnetic waves. By giving this distinction explicit axiomatic and operational form, NNRT constructs the Lorentz transformation (LT) as an electromagnetic observation map between two inertial frames and a gravitational observational metric as a set of observation relations for electromagnetic waves, matter waves, and clocks under the action of gravitational sources and accelerated motion. Building on the first paper [6], which developed the mathematical structures of round-trip light measurements, normalization of the wave operator, phase transport, observational coframes, and matter waves, the present paper focuses on a transformation of the foundational principles by which relativity is constructed, placing those principles within NNRT. Specifically, Newton's laws, the composition of real and observed velocities, relativistic effective interactions, GPS atomic clocks, Mercury's perihelion advance, gravitational redshift, light deflection, and propagation delay are reorganized into a coherent NNRT framework. Equations that have the same mathematical form as those of conventional theories are assigned to measurement relations derived from NNRT's independent construction conditions, rather than treated as grounds for retaining the conventional ontology of real spacetime. A comprehensive change in theoretical direction is proposed: observational spacetime is constructed from motion and the action of sources in universal spacetime, without adopting the principle that the only real spacetime contracts under LT and curves under gravity.

Keywords: *Nakaza's New Relativity Theory (NNRT), universal spacetime, Galilean transformation, Lorentz observation map, Newtonian mechanics, electromagnetic waves, matter waves, observational metric, phase transport, GPS, Mercury's perihelion advance*

1. Introduction—From Conventional Construction Principles to NNRT

The passage of time and the extension of space are recognized through the order and duration of phenomena, positions, and distances. Human beings cannot, however, directly grasp time and space themselves and measure their substance with instruments. A clock indicates the number of repetitions of a selected periodic phenomenon, whereas a ruler or optical ranging system indicates a comparison with a selected length standard. Observational times and distances are physical quantities dependent on the standards and operations adopted for measurement.

Conventional relativity establishes the time–space relations of LT and the four-dimensional geometry of general relativity (GR) as the structure of physical spacetime itself. NNRT fundamentally changes this

starting point. The four-dimensional geometry obtained through clocks and ranging is observational spacetime, which organizes measurement results; it is not identical with the real spacetime shared by all inertial frames. NNRT therefore rejects the constructive order that places the geometry of measured spacetime in advance as the cause of real motion, and instead constructs observables from universal spacetime, GT, and the action of forces. This is not the addition of another interpretation permitted within an existing theory, but a replacement of the starting axioms and of the direction of causal explanation.

The NNRT transformation does not consist in superimposing a supplementary theory on the foundations of conventional relativity. It consists in describing measured objects—light-arrival events, phase, frequency, wavenumber, clock readout, and planetary orbits—from NNRT's own axioms and rederiving experimentally established quantitative relations as its consequences. Building on NNRT studies since 2015 [1]–[5], the first paper [6] systematized the empirical route from round-trip light measurements to LT, its rigorous derivation through normalization of the same wave operator, observational coframes, gravitational fields, GPS, and the mathematics of Mercury's perihelion advance.

The role of the present paper is not to repeat the mathematical derivations of the first paper, but to clarify, on the basis of their results, why the construction order of relativity must be transformed and what this means physically. The laws of real motion, the electromagnetic observation map between two inertial frames, and the common observational scale field arising from gravitational sources are distinguished. The mathematical content of LT and GR is constructed within NNRT without adopting conventional four-dimensional spacetime realism as a foundational principle. The principal equations are given in sufficient detail for the argument to be followed independently.

By “transformation” this paper means assigning the mathematical expressions of relativity entirely to NNRT's own axioms and deductive order. Even when the equations are mathematically isomorphic, their governing axioms, the direction of cause and effect in wave propagation, and the quantities actually read by measuring instruments are brought together within NNRT. The theoretical center moves from “curved real spacetime” to “motion and the action of sources in universal spacetime, together with the observed phases of electromagnetic and matter waves.”

2. Universal Spacetime and the Definition of Physical Measurement Standards

2.1 Real Spacetime and the Time Shared by All Inertial Frames

NNRT defines real spacetime as the following Cartesian product:

$$\mathcal{M}_{\text{real}} = \mathbb{R}_T \times \mathbb{R}_{\mathbf{X}}^3.$$

Here, T is universal time, $\mathbf{X}$ is the position in real three-dimensional space, and the subscript real denotes the real layer. The equivalence of all inertial frames does not mean choosing a privileged frame of absolute rest; it means using a common real time and common dynamical laws for all frames. If frame S' moves relative to frame S at constant velocity $\mathbf{v}$, the coordinate relation for real quantities is GT:

$$T' = T, \quad \mathbf{X}' = \mathbf{X} - \mathbf{v}T.$$

This relation, $T' = T$, is not an approximation but a postulate of NNRT concerning real spacetime. The real reference time of equivalent inertial clocks does not run more slowly because of their relative velocity. Corrections to displayed clock values or recorded atomic cycles, when present, are addressed separately as issues of measurement scales.

2.2 Operational Definitions of Clocks and Distances

Select a periodic phenomenon of reference frequency ν_0 , and use the number N of its repetitions to normalize the common reference time interval as

$$\Delta T = \frac{N}{\nu_0}$$

Likewise, using a reference round-trip light-travel time ΔT_{rt} and a reference vacuum electromagnetic propagation constant c , define the one-way optical reference length as

$$L_0 = \frac{c\Delta T_{\text{rt}}}{2}$$

To relate an optical ranging quantity to the distance between particular material bodies, the reflection point, receiving point, and clock configuration must be specified. If the measured frequency is $\nu_{\text{obs}} = D_{\text{obs}}\nu_0$, its conversion to the common reference is $\nu_0 = \nu_{\text{obs}}/D_{\text{obs}}$. The correction factor D_{obs} is determined from phase transport and the observation map for the relative motion, gravitational source, and measuring arrangement; it is not an arbitrarily adjustable number.

The postulate of universal time is distinct from counting and calibrating cycles with physical clocks. In NNRT, the former provides the universal basis of real motion, while observational spacetime constructed from the latter constitutes a system of measurement results. No step is included in NNRT that reinterprets a mathematical change in observational spacetime as a transformation of real spacetime.

3. NNRT Reconstruction of Newton's Laws of Motion

3.1 The First Law—Unaccelerated Motion and the Choice of a Rest Frame

For a body on which no external force acts, unaccelerated motion is expressed in any inertial frame by $d\mathbf{v}/dT = \mathbf{0}$. Choose the origin and velocity so that the body is at rest in frame S ; then $\mathbf{v} = \mathbf{0}$. At relative velocity $\mathbf{V}$, frame S' describes the same motion by $\mathbf{v}' = -\mathbf{V}$. Rest and uniform rectilinear motion are not two independent forms of inertial action, but coordinate descriptions of the same unaccelerated motion. Consequently, constructing dynamics by taking a freely resting body as a reference does not imply a privileged space of absolute rest.

3.2 The Second Law—Inertial Mass and Infinitesimal Velocity Increments

Let the real momentum with respect to universal time be $\mathbf{p}_{\text{real}} = m\mathbf{v}_{\text{real}}$. For constant mass m , the real force is defined by

$$\mathbf{F}_{\text{real}} = \frac{d\mathbf{p}_{\text{real}}}{dT} = m \frac{d\mathbf{v}_{\text{real}}}{dT}.$$

Consider the momentum increment over an infinitesimal interval of universal time ΔT :

$$\Delta \mathbf{p} = \mathbf{F}\Delta T, \quad \Delta \mathbf{v} = \frac{\mathbf{F}}{m}\Delta T + o(\Delta T),$$

$$m = \lim_{\Delta T \rightarrow 0} \frac{|\mathbf{F}|\Delta T}{|\Delta \mathbf{v}|} \quad (\mathbf{F} \parallel \Delta \mathbf{v}, m > 0).$$

Here inertial mass is operationally defined as the physical quantity governing the acceleration response to an external force. The force must be measured independently, and this definition by itself does not determine the microscopic origin of mass. Under GT, $\mathbf{v}' = \mathbf{v} - \mathbf{V}$ and $d\mathbf{v}'/dT = d\mathbf{v}/dT$; accordingly, the form of the second law is preserved in all inertial frames.

NNRT adopts Newton's laws as primary laws of real motion in universal time. Corrections required for precise gravitational orbits are separately constructed from matter-wave phase transport and the action of sources, and then related to effective interactions in real motion. The task of this framework is to account for orbital corrections absent from the inverse-square law alone through the relationship between real motion and observed phase, rather than attributing them to the curvature of real four-dimensional spacetime.

4. Independent Construction of Relativity in Three Stages under NNRT

NNRT independently constructs relativity in three stages according to the physical conditions of measurement. The first stage establishes the scales of universal spacetime by clock, ranging, and phase measurements completed within one inertial frame. The second constructs an LT-type observation map through electromagnetic transmission and reception between two relatively moving inertial frames. The third constructs a common observational coframe unifying the phase responses of electromagnetic waves, matter waves, and clocks under gravitational sources and acceleration conditions. SR and GR within NNRT are redefined as the observational laws of the second and third stages, respectively; they are not categories preserving an independent conventional theory of real spacetime alongside NNRT.

Table 1. Three-stage structure of relativity under NNRT

Measurement condition	Theoretical role within NNRT	Principal quantities and construction
Measurement completed within one inertial frame	Operational establishment of universal spacetime scales	Clock cycle count, reference length, local phase
Measurement between two inertial frames in relative motion	NNRT SR: LT as an electromagnetic observation map	Wavefront arrival time, frequency and wavenumber, LT-type coordinates
Measurement involving a gravitational source or acceleration	NNRT GR: source action and observational scale field	Phases of light and matter waves, atomic clocks, observational metric

These three stages reverse the order in which the theory is constructed. First, motion and the action of sources in universal spacetime are specified; next, phase propagation and measurement procedures for electromagnetic and matter waves are defined; finally, a four-dimensional observational geometry is obtained. The order that explains changes in waves and clocks from contraction and curvature of real spacetime is excluded from NNRT. The names SR and GR here refer to laws of interframe and gravitational observation constructed from NNRT's axioms.

It is unnecessary to invoke conventional SR or GR as an explanatory principle at any intermediate stage. The mathematical relations previously addressed by SR and GR are reassigned as deductive results of NNRT's second and third stages. Even when the names of the relativistic theories remain unchanged, their foundations and physical subjects are redefined in their entirety within NNRT.

5. From GT to the LT-Type Electromagnetic Observation Map—Principal Relations and Their Meaning

5.1 Conditions for Constructing the Observation Map

When the two ends of a moving rod and the round trip of electromagnetic waves are tracked with a common universal clock, the outbound and inbound propagation times are asymmetric. For a rod of length L moving at velocity v , the two one-way travel times are

$$T_+ = \frac{L}{c - v}, \quad T_- = \frac{L}{c + v}, \quad \sqrt{T_+ T_-} = \gamma \frac{L}{c},$$

$$\gamma = (1 - v^2/c^2)^{-1/2}.$$

The final geometric mean is a constructed, optically symmetric scale; it does not mean that the two directly recorded one-way times are equal. The first paper [6] distinguished an empirical measurement construction based on round-trip events from a rigorous derivation based on normalization of the wave operator. The map to observed coordinates is uniquely fixed not by GT alone but by adding the electromagnetic measurement

conditions: correspondence of observation origins, linearity of the map, equality of the normalized coefficients of the same wave operator, and preservation of orientation.

The one-dimensional LT-type observation map is thus

$$t'_{\text{obs}} = \gamma \left(T - \frac{vX}{c^2} \right), \quad x'_{\text{obs}} = \gamma(X - vT).$$

By contrast, GT for real spacetime remains $T' = T$, $X' = X - vT$; the two must not be interpreted as the same coordinate transformation. For the observed origin $X = vT$, the relation $t'_{\text{obs}} = T/\gamma$ does not imply that a real clock records T/γ .

5.2 Phase Invariance and the Theorem of Observed Velocity

For events on the same phase of an electromagnetic wave, impose

$$\theta = \omega T - kX = \omega' t'_{\text{obs}} - k' x'_{\text{obs}}$$

Comparison of the coefficients yields

$$\omega' = \gamma(\omega - vk), \quad k' = \gamma \left(k - \frac{v\omega}{c^2} \right)$$

and hence the following dispersion invariant:

$$\omega'^2 - c^2 k'^2 = \omega^2 - c^2 k^2.$$

For a propagating vacuum wave with $\omega = ck$, it follows that $\omega'/k' = c$. Within NNRT, the invariance of observed light speed is not adopted as an independent axiom about real spacetime but is a mathematical consequence of the adopted electromagnetic observation normalization and phase correspondence.

Setting $\beta = v/c$, the observed frequency ratio for recession from the source is

$$\frac{\nu_B}{\nu_A} = \sqrt{\frac{1 - \beta}{1 + \beta}}$$

Thus, in NNRT, the relativistic Doppler shift follows from the observation map specifying which phase event of an electromagnetic wave in universal time is received by relatively moving transmitters and receivers. LT is not taken as a law of real-clock retardation or real-length contraction; the explanatory principle of SR is instead replaced by relations among phase, wavenumber, and frequency.

6. Distinguishing the Composition Laws for Real and Observed Velocities

For a relative velocity v of frame S' , let the real velocity of a body be u_{real} , and its real velocity in reference frame S be w_{real} . Differentiating the GT position equation with respect to universal time gives

$$w_{\text{real}} = u_{\text{real}} + v_{\text{real}}$$

This composition law expresses positional changes in universal spacetime. On the other hand, using the ratio $u'_{\text{obs}} = dx'_{\text{obs}}/dt'_{\text{obs}}$ of observed coordinates gives

$$u'_{\text{obs}} = \frac{dX/dT - v}{1 - (v/c^2)(dX/dT)},$$

and the inverse relation gives

$$w_{\text{obs}} = \frac{u'_{\text{obs}} + v}{1 + u'_{\text{obs}}v/c^2}$$

These relations concern velocities defined with different scales of time and distance, and therefore do not conflict. In particular, for an electromagnetic wave with $u'_{\text{obs}} = c$, one has $w_{\text{obs}} = c$. The common light speed in this context is a velocity normalized through the observation map and cannot simply be substituted into the GT composition rule for real motion.

Although both are called “velocities,” a GT velocity is the change of real position with respect to universal time, whereas an LT-type velocity is a measured ratio constructed from electromagnetic observed

coordinates. Confusion arises when the two are treated as competing transformations of the same real motion; NNRT eliminates that duplication. Assigning real motion to GT and observational correspondence to LT constitutes a transformation of the theoretical framework itself.

7. Relativistic Effective Interaction, Inertial Mass, Energy, and Matter Waves

7.1 Decomposition of Effective Force with Respect to Universal Time

In NNRT, let the fundamental quantity of real motion be $\mathbf{p}_{\text{real}} = m_0 \mathbf{v}$. To describe the effective interaction corresponding to relativistic observational momentum, define a force in universal time associated with $\mathbf{p}_{\text{eff}} = \gamma m_0 \mathbf{v}$:

$$\mathbf{F}_{\text{eff}} = \frac{d}{dT} (\gamma m_0 \mathbf{v}).$$

Taking the derivative of the product and using $\mathbf{a} = d\mathbf{v}/dT$ and $d\gamma/dT = \gamma^3 (\mathbf{v} \cdot \mathbf{a})/c^2$ gives

$$\mathbf{F}_{\text{eff}} = \gamma m_0 \mathbf{a} + \frac{\gamma^3 m_0}{c^2} (\mathbf{v} \cdot \mathbf{a}) \mathbf{v}.$$

When acceleration is parallel to velocity, $F_{\parallel} = \gamma^3 m_0 a_{\parallel}$; when perpendicular, $F_{\perp} = \gamma m_0 a_{\perp}$. Here $\mathbf{F}_{\text{eff}}$ is a mathematical definition of the corrective interaction described using universal time. Its microscopic mechanism must be determined by linking it to the relevant physical interaction. Retardation of real clocks through relative velocity has not been assumed as a starting point of this calculation.

Separately, there are quantities $\mathbf{p}_{\text{obs}} = \gamma m_0 \mathbf{v}_{\text{obs}}$ and $\mathbf{F}_{\text{obs}} = d\mathbf{p}_{\text{obs}}/dt_{\text{obs}}$ defined using observational time. The definitions of time and velocity used in $\mathbf{F}_{\text{eff}}$ and $\mathbf{F}_{\text{obs}}$ differ. The gravitational orbital correction discussed below must not be represented as resulting from a mere substitution between these relationships.

7.2 Physical Meaning of the Relativistic Energy Equation

Define observed energy and observed momentum by $E_{\text{obs}} = \gamma m_0 c^2$ and $p_{\text{obs}} = \gamma m_0 v$. Then

$$E_{\text{obs}}^2 = p_{\text{obs}}^2 c^2 + m_0^2 c^4$$

For the matter-wave relations $E = \hbar\omega$ and $p = \hbar k$, this becomes

$$\omega^2 = c^2 k^2 + \omega_0^2, \quad \omega_0 = \frac{m_0 c^2}{\hbar}.$$

Consequently, in NNRT $m_0 c^2$ is the quantity connecting the intrinsic angular frequency of matter waves to the scale of observed energy. An ontological explanation in which matter itself physically turns into energy is not needed. The expansion of observed kinetic energy at finite velocity is

$$K = (\gamma - 1)m_0 c^2 = \frac{1}{2} m_0 v^2 + \frac{3m_0 v^4}{8c^2} + O(v^6/c^4)$$

The leading term is the classical kinetic energy corresponding to work during acceleration in universal time. The higher-order terms are finite-velocity corrections specified through the scales of matter waves and observed momentum. NNRT builds this relation between the dynamics of real motion and observed energy, rather than explaining the formula through a retardation of real time.

8. Observational Coframe and the Measurement-Scale Field Produced by Gravitational Sources

8.1 Construction of a Common Observational Metric

The responses of electromagnetic waves, matter waves, and clocks in the presence of a gravitational source are unified through one observational scale field. Rather than assign a physically curved metric to universal spacetime, construct a metric for measurement from the observational coframe e^a_{μ} :

$$g_{\mu\nu}^{\text{obs}} = \eta_{ab} e^a_{\mu} e^b_{\nu}.$$

Here η_{ab} is the local orthonormal form of the observational coframe and $g_{\mu\nu}^{\text{obs}}$ is the observational metric. The gravitational action constructed in the first paper [6] may be written schematically as

$$S_G = \Lambda_G \int e (c_1 I_1 + c_2 I_2 + c_3 I_3) d^4 x, \quad c_1 : c_2 : c_3 = 1 : 2 : -4.$$

With appropriate normalization and boundary terms, the relationship $R[g_{\text{obs}}] = -\mathcal{T} + B$ between the curvature scalar and coframe invariants allows Einstein-type field equations to be constructed for the observational metric:

$$G_{\mu\nu}[g_{\text{obs}}] = \frac{8\pi G}{c^4} T_{\mu\nu}^{\text{obs}}.$$

The geometric left-hand side of the observational field equations expresses relationships formed by clocks, ranging, and wave phases. The right-hand side expresses, at the observational level, sources acting on these relationships. In NNRT, the real action of sources comes first, while the observational metric is constructed to systematize their phase responses. Hence, even if the field equations take the mathematical form of Einstein-type equations, this does not restore a constructive principle in which curved four-dimensional spacetime is the real cause.

This formulation clearly distinguishes mathematical agreement of the observational metric from the real physical meaning of the field. NNRT does not posit the observational metric as a substitute for real spacetime; it constructs it as a distinct mathematical object describing how the physical action of sources and wave propagation appear in measuring scales.

8.2 Distinct Couplings of Electromagnetic Waves, Matter Waves, and Clocks

The light phase θ and covariant wavevector $K_{\mu} = \partial_{\mu}\theta$ satisfy, in the geometric-optics approximation, the massless characteristic condition

$$g_{\text{obs}}^{\mu\nu} K_{\mu} K_{\nu} = 0$$

For the short-wavelength limit of a matter wave $\psi = A \exp(iS/\hbar)$, by contrast, the condition containing a mass term is employed:

$$g_{\text{obs}}^{\mu\nu} \partial_{\mu} S \partial_{\nu} S + m^2 c^2 = 0$$

For atomic clocks, distinguish the number N of oscillations from the phase-readout correction factor C , and construct the observational record through $dN/dT = \nu_0 C$. The condition that all three couple to the same observational coframe is explicitly adopted as a constructive condition for NNRT's gravitational observation framework. Electromagnetic and matter waves are therefore not forced into an identical wave equation; they are treated as distinct responses to a common scale field.

For an isolated static spherically symmetric source, the observational metric can be expressed, using $f(r) = 1 - 2GM/(rc^2)$, as

$$ds_{\text{obs}}^2 = -f(r)c^2 dt_{\text{obs}}^2 + f(r)^{-1} dr^2 + r^2 d\Omega^2$$

This metric is the spherically symmetric solution for the observational scale field in NNRT and jointly governs clock-phase readout, light paths and arrival times, and matter-wave orbital phases. Its mathematical Schwarzschild form does not imply introducing conventional real four-dimensional spacetime into the foundations of NNRT.

9. GPS Atomic Clocks—Gravitational Action and the Dynamics of Circular Orbits

A GPS satellite continues to orbit while freely falling toward the central gravitating source; it is not an inertial body moving uniformly along a straight line. On a circular orbit, the direction of tangential velocity changes and there is an inward coordinate acceleration $a_c = r\Omega^2 = v^2/r$. If the condition for a free circular

orbit is $\Omega^2 = GM/r^3$, then $ra_c = GM/r$. Here a_c is the magnitude of coordinate acceleration, not the proper acceleration registered by an accelerometer carried by the freely falling satellite.

Substituting the circular-orbit conditions $dr = d\theta = 0$ and $d\phi = \Omega dt_{\text{obs}}$ into the preceding observational metric, the dimensionless ratio q_{clock} for the observed time scale of the orbiting clock is

$$q_{\text{clock}} = \sqrt{1 - \frac{2GM}{rc^2} - \frac{r^2\Omega^2}{c^2}} = \sqrt{1 - \frac{2GM}{rc^2} - \frac{ra_c}{c^2}},$$

$$q_{\text{clock}} = \sqrt{1 - \frac{3GM}{rc^2}} \quad (\Omega^2 = GM/r^3).$$

NNRT interprets this not as a decrease in universal time T but as a relation between observed clock oscillation phase and readout scale, referenced to the same universal time. Expressing the orbital term by the centripetal-acceleration condition does not mean adding gravity and centripetal force separately, nor does it prove that atomic transitions couple directly to centripetal acceleration. The relation results from describing the gravitational source and orbital conditions within a common observational metric.

When the frequencies of a rotating ground clock and a satellite clock are converted to a common reference, the weak-field correction for a representative GPS orbit is approximately $+45.7 \mu\text{s/day}$ from the gravitational source, $-7.1 \mu\text{s/day}$ from the satellite's orbital term, and $+38.6 \mu\text{s/day}$ in total. The onboard oscillator is preadjusted to account for this observed frequency difference. NNRT treats the possibility of frequency preadjustment as a concrete example of distinguishing real time from the observed oscillation scale.

10. Mercury's Perihelion Advance—Correspondence between Corrected Central Force and Matter-Wave Phase

10.1 Effective Potential of the Observed Phase and the Orbital Equation

Separate the matter-wave action function on the equatorial plane of the spherically symmetric observational metric as

$$S = -\mathcal{E}t_{\text{obs}} + J\phi + W(r)$$

Here J is the conserved angular momentum of the observed phase, and $h = J/m$ is the corresponding specific angular momentum. Substitution into the Hamilton–Jacobi equation gives

$$-\frac{\mathcal{E}^2}{f(r)c^2} + f(r)\left(\frac{dW}{dr}\right)^2 + \frac{J^2}{r^2} + m^2c^2 = 0.$$

Writing the parameter along a phase characteristic as σ , its radial first integral yields

$$\frac{m}{2}\left(\frac{dr}{d\sigma}\right)^2 + U_{\text{eff}}(r) = \frac{mc^2}{2}(\mathcal{E}^2 - 1),$$

$$U_{\text{eff}}(r) = \frac{mh^2}{2r^2} - \frac{GMm}{r} - \frac{GMmh^2}{c^2r^3}, \quad \mathcal{E} = \frac{\mathcal{E}}{mc^2}$$

The radial terms corresponding to the corrected potential $U_{\text{corr}} = -GMmh^2/(c^2r^3)$ are

$$F_{\text{corr}}(r) = -\frac{dU_{\text{corr}}}{dr} = -\frac{3GMmh^2}{c^2r^4}.$$

On introducing the inverse radius $u = 1/r$, the spatial form of the phase characteristic satisfies

$$\frac{d^2u}{d\phi^2} + u = \frac{GM}{h^2} + \frac{3GM}{c^2}u^2$$

Taking the ellipse of semilatus rectum $p = h^2/(GM) = a(1 - e^2)$ as the zeroth-order solution, a perturbative expansion gives

$$\Delta\varpi = \frac{6\pi GM}{a(1-e^2)c^2}$$

This produces approximately 43 arcseconds per century as Mercury's anomalous perihelion advance. It is the correction attributable to the Sun, rather than the entire observed perihelion motion including perturbations from other planets.

10.2 Independent Confirmation through Radial Action and Phase Difference

The matter-wave phase is $\theta_m = S/\hbar$. Define the radial action J_r in the observational metric by

$$J_r(\mathcal{E}, J) = \oint p_r dr, \quad p_r = \frac{1}{f(r)} \sqrt{\frac{\mathcal{E}^2}{c^2} - f(r) \left(m^2 c^2 + \frac{J^2}{r^2} \right)}$$

For the first-order weak-field correction δJ_r , not only the r^{-3} -type effective-potential term but also the term arising from the radial component $f(r)^{-1}$ of the observational metric contributes at the same order. Including these terms, integration of the action over one cycle yields

$$\Delta\theta_{m,r} = \frac{\delta J_r}{\hbar}, \quad \Delta\varpi = - \left. \frac{\partial(\delta J_r)}{\partial J} \right|_{\mathcal{E}} = \frac{6\pi GM}{a(1-e^2)c^2}$$

The integral cross-check presented in the first paper [6] shows that the matter-wave phase accumulated over one cycle and the corrected orbital equation lead to the same coefficient of perihelion advance. Within NNRT, this agreement is not returned to an explanation presupposing geodesic motion in real four-dimensional spacetime; instead, it forms part of the chain of reasoning from the action of the source and matter-wave phase to the orbital correction.

10.3 Time Parametrization of the Phase Orbit in Universal Time and Its Correspondence to a Central-Force Representation

The specific angular momentum $h = J/m$ derived from the observed phase must be distinguished from the real-orbit quantity defined with universal time T , namely $h_T = r^2 d\phi/dT$; the two are generally not identical. Along an observed phase characteristic, $dt_{\text{obs}}/d\sigma = \varepsilon/f(r)$; its characteristic parameter cannot simply be relabeled as universal time.

In NNRT, when the spatial orbit $r(\phi)$ obtained from observed phase is related to a real central-force motion in universal time, an additional equation is used:

$$m \frac{d^2 \mathbf{X}}{dT^2} = - \frac{GMm}{r^2} \left(1 + \frac{3h_T^2}{c^2 r^2} \right) \hat{\mathbf{r}}, \quad h_T = r^2 \frac{d\phi}{dT}$$

This corrected central-force equation provides an effective representation yielding a spatial orbit of the same mathematical form as the phase characteristic $r(\phi)$. To make the time-parametrized path $r(T), \phi(T)$ explicit, use the conserved quantities and first integrals of the phase characteristic.

In a spherically symmetric observational scale field, the dimensionless energy constant and angular-momentum conservation determine the following first integrals for time, azimuth, and radius along the phase characteristic:

$$\frac{dt_{\text{obs}}}{d\sigma} = \frac{\varepsilon}{f(r)}, \quad \frac{d\phi}{d\sigma} = \frac{h}{r^2}, \quad \left(\frac{dr}{d\sigma} \right)^2 = \mathcal{R}(r).$$

$$\mathcal{R}(r) = c^2(\varepsilon^2 - 1) + \frac{2GM}{r} - \frac{h^2}{r^2} + \frac{2GMh^2}{c^2 r^3}, \quad f(r) = 1 - \frac{2GM}{rc^2}.$$

The time coordinate of the static observational chart is here associated with the common time label of universal spacetime in NNRT. This does not identify the phase-readout of a local atomic clock with universal time. With this time-label correspondence, the preceding equations can be rewritten exactly in terms of derivatives with respect to universal time, yielding the following equations of motion:

$$\frac{d\phi}{dT} = \frac{f(r)h}{\varepsilon r^2}, \quad \frac{dr}{dT} = \pm \frac{f(r)}{\varepsilon} \sqrt{\mathcal{R}(r)}.$$

Given initial conditions, integration can be carried out on each interval of monotonic radius with an appropriate choice of sign. The time and azimuth are specified by the respective integrals

$$T - T_0 = \pm \int_{r_0}^r \frac{\varepsilon d\rho}{f(\rho)\sqrt{\mathcal{R}(\rho)}}, \quad \phi - \phi_0 = \pm \int_{r_0}^r \frac{h d\rho}{\rho^2 \sqrt{\mathcal{R}(\rho)}}.$$

The integration intervals are joined at turning points. In this way, a time-parametrized orbit is constructed from the phase characteristic, specifying position and azimuth as functions of time as well as the spatial orbit. The corrected central-force equation above is an effective representation of the spatial orbit, while the time parametrization along universal time is determined by the first integrals displayed here. There is therefore no need to confuse the parameter of the phase characteristic with universal time.

11. Electromagnetic Redshift and Blueshift, Light Deflection, and Propagation Delay

11.1 Phase Gradients and Locally Observed Frequencies

The relativistic Doppler effect is described by the observation map between two inertial frames, whereas in the presence of a gravitational source the same phase is transported in the observational metric. Set $K_\mu = \partial_\mu \theta$ and apply the massless condition $g_{\text{obs}}^{\mu\nu} K_\mu K_\nu = 0$. For a static spherically symmetric source, time-translation symmetry conserves the angular frequency ω_∞ conjugate to the observational time at a sufficiently large distance. For a local observer at rest at radius r , the value is

$$\omega_{\text{loc}}(r) = \frac{\omega_\infty}{\sqrt{1 - 2GM/(rc^2)}}, \quad k_{\text{loc}}(r) = \frac{\omega_{\text{loc}}(r)}{c}$$

For the same light signal transmitted from a source at radius r_e and received at radius r_o ,

$$\frac{\omega_o}{\omega_e} = \sqrt{\frac{1 - 2GM/(r_e c^2)}{1 - 2GM/(r_o c^2)}}$$

so outward-going light is redshifted and inward-going light is blueshifted. This ratio compares the scales of two local static observers; an arbitrary frequency near the source must not be confused with the reference frequency at infinity. NNRT explains gravitational redshift and blueshift from the action of the gravitational source on phase gradients and local measurement scales.

11.2 Observed Optical Length, Deflection, and Delay

In a weak gravitational field, put $\Phi = -GM/r$ and employ isotropic spatial coordinates. To first order, the observed line element is

$$ds_{\text{obs}}^2 \simeq -\left(1 + \frac{2\Phi}{c^2}\right) c^2 dt_{\text{obs}}^2 + \left(1 - \frac{2\Phi}{c^2}\right) d\ell^2.$$

Writing the propagation time along the null phase characteristic as $dt_{\text{obs}} = n_{\text{obs}}(r) d\ell/c$, one obtains

$$n_{\text{obs}}(r) \simeq 1 - \frac{2\Phi(r)}{c^2} = 1 + \frac{2GM}{rc^2}.$$

The effective refractive index n_{obs} is a coefficient expressing the observational metric as an optical path length; it does not mean that the vacuum becomes a material medium or that the speed of light in universal spacetime is itself reduced by this factor. From the transverse gradient and path integral,

$$\alpha \simeq \left| \int_{-\infty}^{\infty} \frac{\partial n_{\text{obs}}}{\partial b} dz \right| = \frac{4GM}{bc^2},$$

$$\Delta t_{\text{obs}} \simeq \frac{1}{c} \int_{\Gamma} (n_{\text{obs}}(r) - 1) d\ell$$

The former result is light deflection and the latter is Shapiro-type propagation delay. NNRT does not collect redshift, deflection, and delay as unrelated geometrical phenomena; it describes them together through transport of the same electromagnetic phase under the source's action and the resulting change in observed optical length.

12. Transformation of the Principles of Relativity—Mathematical Isomorphism and Replacement of the Theoretical Framework

The consequences of NNRT's axioms and observational construction conditions extend to the Doppler shift of light, the universality of observed light speed, GPS frequency calibration, gravitational redshift and blueshift, light deflection, propagation delay, and Mercury's anomalous perihelion advance. Equations of the same form as those conventionally used are reassigned, within NNRT, to equations derived through the electromagnetic observation map, observational scale field, and matter-wave phase. Agreement with experiments tests the mathematics of measured spacetime; it does not require retaining the conventional construction principle for real spacetime.

Table 2. Correspondence between the NNRT Framework and Observational Subjects

Subject	NNRT theoretical structure	Observational correspondence
Real time and space	Common universal time and three-dimensional space	Sharing of real motion across inertial frames through GT
Inertial mass and force	Newtonian mechanics in universal time and phase-based effective interactions	Acceleration response and finite-velocity observation relations
Mathematics of SR in NNRT	Observation map for electromagnetic phase between two inertial frames	LT-type relations, Doppler shift, observed velocity
Mathematics of GR in NNRT	Gravitational sources and common observational coframe	Clock scales, matter waves, electromagnetic phase transport
GPS clocks	Phase readout affected by gravitational sources and orbital motion	Frequency preadjustment and calibration to a common reference
Precise planetary orbits	Matter-wave phase correction and its correspondence to real orbits	Mercury's anomalous perihelion advance
Gravitational observations of light	Measured changes in local frequency and optical length	Redshift, deflection, and Shapiro-type delay

The point goes beyond the general observation that a mathematically identical equation can admit different ontological interpretations. NNRT actually replaces the starting point of theory: universal spacetime, GT, and Newton's laws of motion are fixed as axioms of the real layer, while LT and the gravitational metric are defined as maps and scale fields of the measurement layer. The conventional construction order—"postulate curved real spacetime first, then explain changes in motion, phase, and clocks"—is thereby reversed into the order "derive phase transport and clock/ranging measurements from motion and the action of sources in universal spacetime, then construct the observational geometry."

As an analogy, this change recalls the transition from geocentrism to heliocentrism, which changed the reference frame and order of construction used to describe celestial phenomena. In NNRT, what is transformed is the very scheme that takes observationally obtained geometry as the starting reality. The explanatory focus of physics moves toward the construction of phase and observables from motion and the action of sources in universal spacetime.

In this framework, conventional relativity is not retained as a separate auxiliary theory, nor is its mathematics borrowed only where convenient. LT, the metric form of the gravitational field, clock-correction formulas, and orbital perturbation equations are organized into one system through NNRT's own axioms, observational conditions, and matter-wave action. The construction of mathematics that explains experimental results without presupposing conventional real-spacetime ontology is the concrete content of NNRT's proposed transformation. The basis for the transformation lies in the continuity between NNRT's axioms and its deductions, not in adopting conventional real-spacetime concepts as the standard of explanation.

This change in explanatory priority cannot be achieved merely by redescribing conventional geometrical metrics in negative terms. It becomes a distinctive NNRT theoretical framework only by maintaining the actual order of derivation: universal-clock time, real motion under GT, observed LT coordinates based on phase invariance, and the observational metric constructed from gravitational sources.

13. From the NNRT Transformation to Cosmology and Quantum Mechanics

The theoretical transformation proposed by NNRT extends beyond measurement relations within the Solar System. For photon reachability near black holes, shadows, gravitational lensing, phase records of gravitational-wave interferometers, cosmological redshift, distance scales, and the interpretation of expansion, the primary question becomes what phase responses are produced by gravitational sources and real motion, and what electromagnetic measurement systems record, rather than taking curvature of real spacetime as an initial condition. This establishes a direction for reconstructing cosmological observational equations from NNRT conditions through explicit treatment of source dynamics, propagation equations, and instrumental calibration.

In connecting NNRT to quantum mechanics, the action phase of matter waves in universal time is likewise distinguished from amplitudes, wavenumbers, and frequencies extracted by measurement. While recognizing the mathematical expressive power of Hilbert space, NNRT does not identify that space itself with real physical spacetime. Instead, it reexamines the meanings of projection, inner product, phase record, and probability amplitude through the NNRT observation map. This direction is not simply a selection among existing quantum interpretations: it offers construction principles for reconsidering the quantum measurement problem from the relationship between real motion and observational information.

The first paper [6] established the mathematical route from universal spacetime and GT to the LT-type observation map, the gravitational observational scale field, matter-wave phase, and observational formulas. Based on that mathematics, the present paper places Newtonian mechanics, observational momentum, gravitational sources, clocks, and ranging within a unified new theory of relativity, and declares the replacement of the conventional construction principles. The paper on mathematical foundations and the present paper on the transformation of the theoretical framework do not constitute two parallel theories; they present two complementary levels of one NNRT.

14. Conclusion—NNRT Replaces the Conventional Principle of Real Spacetime

Beginning with universal time and universal three-dimensional space as real spacetime, and with the equivalence of all inertial frames, GT, and Newton's laws of motion as its basic laws, this paper reconstructed relativity within NNRT. LT arises as an observation map of electromagnetic transmission and reception events, phase, and normalized clock and distance readings. The geometrical mathematics of GR is constructed through the coupling of electromagnetic waves, matter waves, and atomic clocks to a common

observational coframe under gravitational sources and acceleration conditions. These mathematical relations need not be subordinated to a theory that posits a single curved real spacetime.

The composition laws of real and observed velocities, the fundamental force and effective interaction of real motion, universal time and clock phase readout, and the angular momenta of phase characteristics and real orbits defined in universal time have been distinguished. GPS frequency corrections have been formulated as relations of observed phase associated with gravitational sources and orbital motion; Mercury's anomalous perihelion advance has been represented through the matter-wave radial action and the spatial correspondence of a corrected central force. For Mercury in particular, the phase-characteristic parameter was not identified with universal time; the isomorphism of spatial orbits and the motion along a time label derived from conserved quantities were expressed separately. The correspondence between observed phase and real motion has thereby been made explicit down to the specification of the time label.

The “revolution in structure and meaning” advanced by NNRT does not consist in leaving conventional relativity intact and adding a new interpretation to it. It redefines the physical roles from first principles: GT governs the coordinate transformation of real motion; the LT-type observation map governs electromagnetic measurements between relatively moving inertial frames; and the observational metric governs measurement relations among gravitational sources, waves, and clocks. Consequently, the same mathematical forms and experimentally established quantitative relations arise as NNRT's own observational laws. The construction order that explains physical phenomena from conventional real four-dimensional spacetime is removed, and universal spacetime, Newtonian mechanics, the action of sources, and phase transport of electromagnetic and matter waves are placed at the consistent starting point. This reversal of explanatory priority between the real and observational layers is precisely the transformation of relativity proposed in this paper.

The central proposition reached here is clear. Relativity is constructed not as laws by which a unique four-dimensional real spacetime deforms time and distance, but as laws by which the dynamics of universal spacetime and the phase events of electromagnetic and matter waves appear in the observational scales of clocks and ranging. Changing the roles of GT, LT, and the gravitational observational metric is not a peripheral revision of commentary; it replaces the structure of relativity itself.

Acknowledgments: This paper supplements and systematizes the studies by Eizo Nakaza from 2015 and 2023, particularly the explanations presented in Refs. [2] and [3], together with the mathematical construction developed in the first paper [6]. Accordingly, the discussions in Refs. [2] and [3] should be read in conjunction with the subsequent mathematical refinements presented here and in the first paper. This manuscript was prepared with AI assistance in textual organization and structuring, following sustained theoretical dialogue with the author. Responsibility for its theoretical claims, adoption of mathematical constructions, and physical interpretations rests with the author.

Appendix A. Definitions of Principal Symbols and Scales

T : universal time shared in real spacetime. $\mathbf{X}$: real position in universal three-dimensional space. S, S' : relatively moving inertial frames. $v, \mathbf{v}$: real velocities of bodies or between inertial frames. $t_{\text{obs}}, x_{\text{obs}}$: observed coordinates constructed from electromagnetic measurement. γ : observational Lorentz factor. θ, ω, k : electromagnetic phase, angular frequency, and wavenumber. ν_0 : reference frequency before correction. e^a_μ : observational coframe. $g_{\mu\nu}^{\text{obs}}$: observational metric. C, q_{clock} : clock oscillation phase and observed scale ratio. S, θ_m : matter-wave action and phase. J, h : conserved angular momentum of the observed phase and its value per unit mass. h_T : specific angular momentum of the real orbit defined with universal time. σ : parameter of a phase characteristic. $J_r, \delta J_r$: one-cycle matter-wave radial action and its

correction. $\mu = GM$: gravitational parameter of the central source. a, e, p : semimajor axis, eccentricity, and semilatus rectum of an elliptic orbit. $\Delta\varpi$: perihelion advance angle. Φ : weak-field gravitational potential. n_{obs} : optical effective refractive index of observation.

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