

# Reconstruction of Strong-Gravity Astrophysics, Gravitational Waves, and Cosmology in Nakaza's New Relativity Theory (NNRT) —A Unified Mapping from Real-Source Dynamics to Observational Spacetime—

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## Abstract

Nakaza's New Relativity Theory (NNRT) is not an auxiliary interpretive scheme that merely changes the interpretation of the equations of conventional relativity while leaving their foundations intact. NNRT reverses the very basis on which relativity is constructed. It places universal time and universal three-dimensional space at the foundation of physical reality and assigns real inertial motion to the Galilean transformation (GT). By contrast, the Lorentz transformation (LT) and general-relativistic metric structures are positioned as observational mappings formed through the phase, frequency, wave number, clocks, distances, and related electromagnetic observables. Under this reversal, relativistic effects that have conventionally been understood as the deformation or curvature of real spacetime acquire a different physical meaning: they are phenomena observed through the transport of electromagnetic and matter-wave phases, generated from real-source dynamics through gravitational response.

In this paper, this principle is applied consistently to strong-gravity objects, neutron-star compactness and tidal disruption, gravitational waves, black-hole shadows, observational horizons, cosmological redshift, the cosmic microwave background (CMB), baryon acoustic oscillations (BAO), and luminosity distance. The central structure is a mapping in which the real state generates the observational propagation structure  $C^{\mu\nu}$ , through which the phase four-wavevector  $K_\mu$  and the ray-bundle Jacobian  $D_B^A$  are transported, ultimately producing observables such as  $z$ ,  $\Delta\theta$ ,  $D_A$ ,  $D_L$ , and  $I_\nu$ . NNRT does not retain the conventional theory as a parallel framework. It relocates relativistic mathematics to the observational layer and restores universal spacetime, GT, and real matter dynamics to the foundation. This foundational reversal changes the formulation of problems from strong gravity to cosmology and reconstructs the physical meaning of relativity as a whole.

More specifically, NNRT replaces the black-hole horizon as a boundary of real spacetime with an output of phase connectivity; replaces the singularity as an endpoint of spacetime with a stability problem of real matter; replaces gravitational waves as distortions of real space with dynamical gravity-phase coupling; replaces cosmic expansion as the stretching of real space with the real motion of the matter distribution plus observational mapping; and separates observational acceleration from acceleration of real space. In this way, NNRT absorbs the empirically successful mathematics of conventional relativity into the observational layer while leaving none of its ontological foundation intact, thereby reconstructing both the physical meaning of relativity and the research questions built upon it.

**Keywords:** *Nakaza's New Relativity Theory (NNRT), universal spacetime, Galilean transformation, Lorentz mapping, observational spacetime, phase transport, strong-gravity objects, gravitational waves, black holes, cosmology*

## 1. Introduction

The experimental success of relativity has been established by the high-precision agreement between its theoretical formulas and observed values such as optical redshift, perihelion advance, light deflection, clock comparisons, and gravitational-wave signals. What experiments directly acquire, however, are readings of clocks, electromagnetic phase, frequency, wave number, interference signals, angles, fluxes,

and related observables. Identifying a metric constructed from observations with real spacetime itself is not an observational fact; it is an ontology assigned to those observables. NNRT treats precisely this point as a foundational problem of relativity [1-4].

### 1.1 What NNRT Changes

NNRT is not a theory that discards the successful equations and experimental values of conventional relativity and replaces them with a new numerical system. What it changes is the physical location of what those equations describe. NNRT places universal time and universal three-dimensional space at the foundation of reality and restores GT as the transformation governing real inertial motion. LT is positioned as an observational mapping arising from phase invariance in the exchange of light [1-4]. Accordingly, relativistic time and relativistic length are not defined as properties of real spacetime itself.

This change is not a terminological substitution. In the conventional structure, four-dimensional spacetime geometry is given first, and light, clocks, and matter are required to follow that geometry. In NNRT, real sources and real motion are placed first; they act on the phase transport of electromagnetic and matter waves, and observational spacetime is constructed from the resulting observations. The direction of causality itself is reversed.

### 1.2 Purpose of This Paper

The purpose of this paper is to develop this foundational reversal of NNRT consistently beyond the repositioning of special relativity, extending it to strong-gravity objects, black holes, neutron stars, gravitational waves, and cosmology. Particular attention is given to the relation between compactness and the gravitational-wave cutoff frequency, phase readout in LIGO-type interferometers, black-hole shadows, cosmological redshift, CMB, BAO, and luminosity distance, all within the same structure of “real physics to observational mapping.”

If this method is valid, matter motion, gravitational response, light propagation, and observational distance—quantities conventionally subsumed into a single four-dimensional spacetime geometry—can be separated into their respective physical processes. Relativity then changes in meaning from “a theory describing deformation of real spacetime” into “a theory describing how physical processes on universal real spacetime are mapped into phase and beam observations.” In this sense, NNRT is not an auxiliary theory running alongside the conventional framework; it replaces the foundations of relativity with their opposite ordering.

The concrete transformation extends continuously from strong-gravity objects to the universe as a whole. For black holes, a horizon changes from a boundary postulated in advance as real geometry into an observational boundary obtained only after phase connectivity has been solved, while the singularity moves from an endpoint of spacetime to a problem of matter density and stability. For gravitational waves, the meaning of strain in real space is rejected and replaced by a phenomenon in which laser phase reads out the dynamical gravitational response generated by a binary source. In cosmology, the scale factor is not treated as the scale of real space itself; the real evolution of the matter distribution is separated from the observational scale constructed by light. As a result, the Big Bang, the Hubble law, CMB, BAO, and observational acceleration are redefined not as a history of spacetime geometry, but as problems concerning the history of matter and radiation on universal spacetime together with phase and beam transport.

## 2. Minimal Foundation of NNRT

To discuss the full NNRT framework, it is necessary first to fix what is a real quantity and what is an observational quantity. This section states the minimal foundational structure used throughout this paper.

### 2.1 Universal Real Spacetime and GT

The foundation of physical reality is taken to be

$$M_{\text{real}} = R_t \times R_x^3$$

where  $t$  denotes universal time and  $\vec{x}$  denotes position in universal three-dimensional space. The real motion between two inertial coordinate systems is related by

$$t' = t, \quad \vec{x}' = \vec{x} - \vec{v} t$$

[1-4]. Introducing universal spacetime does not imply an absolute rest frame or an ether. Under GT, what has physical meaning is the relative velocity between inertial systems; the universality of the real foundation and the existence of an absolute rest frame are distinct issues.

## 2.2 Role of LT

The phase of an electromagnetic wave is written as

$$\theta = \vec{k} \cdot \vec{x} - \omega t$$

and the four-wavevector as

$$K_\mu = \partial_\mu \theta$$

In NNRT, LT is not a transformation of real coordinates themselves. It is an electromagnetic observational transformation by which  $\omega$  and  $\vec{k}$  are mapped between a source and an observer in different states of motion while preserving phase. If the magnitude of the wavevector is  $k = |\vec{k}|$ , the vacuum dispersion relation

$$\omega^2 - c^2 k^2 = 0$$

is preserved simultaneously, yielding invariance of the observed speed of light. Thus, invariance of  $c$  is not an assumption that light has an ether velocity relative to real three-dimensional space; it is an observational theorem arising from phase and dispersion invariance [1-4].

## 2.3 Observational Propagation Structure

Observational propagation including gravity is represented using the symmetric tensor  $C^{\mu\nu}$  and the Hamiltonian

$$H = \frac{1}{2} C^{\mu\nu} K_\mu K_\nu$$

The phase characteristics are

$$\frac{dx^\mu}{d\lambda} = C^{\mu\nu} K_\nu$$

and

$$\frac{dK_\mu}{d\lambda} = -\frac{1}{2} \partial_\mu C^{\alpha\beta} K_\alpha K_\beta$$

In this paper,  $C^{\mu\nu}$ , or an equivalent  $g_{\mu\nu}^{\text{obs}}$ , is treated as an observational-propagation structure and is not identified with the metric of  $M_{\text{real}}$  itself.

## 2.4 Real Layer and Observational Layer

The two-layer structure of NNRT is summarized in Table 1.

**Table 1. Real and observational layers in NNRT**

| Category                | Basic quantities                                   | Role                                                          |
|-------------------------|----------------------------------------------------|---------------------------------------------------------------|
| Real layer              | $M_{\text{real}}, \rho, P, \vec{v}, M, J, \vec{B}$ | Real states and motions of matter and fields                  |
| Gravitational response  | $e_\mu^a, C^{\mu\nu}$                              | Observational propagation structure generated by real sources |
| Observational transport | $K_\mu, D_B^A$                                     | Transport of phase, frequency, and ray bundles                |
| Observational layer     | $z, \Delta\theta, D_A, D_L, I_\nu$                 | Quantities constructed by measurement                         |

This separation is introduced not to discard successful relativistic mathematics, but to clarify its physical carrier. In NNRT, metric mathematics is retained in the observational layer, while real motion is returned to matter dynamics based on GT. Through this foundational reversal, the physical explanation of relativistic effects is relocated from spacetime geometry itself to source, field, phase, and measurement.

### 3. Real Sources and Observational Images in Strong-Gravity Astrophysics

The necessity of separating real sources from observational images becomes most evident for strong-gravity objects. In NNRT, a compact object is first defined as a material system, and redshift, shadow, waveform, and related observables are derived through the observational propagation structure generated by that material state.

#### 3.1 Real Compact Source

The basic quantities on the real side are written as

$$X_{\text{real}} = \{M, J, R_m, \rho, P, \vec{B}, \vec{v}, \text{EOS}, \dots\}$$

Here  $R_m$  is the real material surface. Therefore, an observationally defined critical radius  $R_{\text{obs}}$  is not identified with  $R_m$  from the outset.

The empirical success of Schwarzschild- or Kerr-type mathematics is retained in NNRT. Those structures, however, are used as  $g_{\mu\nu}^{\text{obs}}$ . For example, if a static, spherically symmetric observational structure is written as

$$ds_{\text{obs}}^2 = -\left(1 - \frac{2GM}{rc^2}\right)c^2 dt^2 + \left(1 - \frac{2GM}{rc^2}\right)^{-1} dr^2 + r^2 d\Omega^2$$

this metric describes correlations among external observables; it does not mean that universal real space itself is curved into this form.

#### 3.2 Redshift and Observational Boundaries

For a Schwarzschild-type external observational structure, with  $r_s = 2GM/c^2$ , the frequency observed at infinity is approximately

$$\frac{\nu_{\infty}}{\nu_r} = \sqrt{1 - \frac{r_s}{r}}$$

The fact that this relation produces an extreme redshift in the outer limit  $r \rightarrow r_s$  shows that the external observational mapping becomes critical. NNRT, however, does not interpret this limit as a stopping of universal time or as an endpoint of real space. Divergence of observational time and cessation of real time are distinct concepts.

#### 3.3 Shadow and Optical Critical Structure

For a Schwarzschild-type observational structure, the optical critical radius and critical impact parameter are

$$r_{\text{ph}} = \frac{3GM}{c^2}, \quad b_c = 3\sqrt{3} \frac{GM}{c^2}$$

NNRT does not interpret these quantities as the size of a geometrical hole in real space, but as an observational propagation structure in which electromagnetic phase characteristics become critical and unstable. A shadow is an observational image constructed from the combination of a real compact source, surrounding plasma, magnetic fields, phase characteristics, and intensity transport [9].

### 4. Observational Horizons, Shadows, and the Singularity Problem

The most important requirement in the black-hole problem is to distinguish observational inaccessibility, causal connectivity, and the final state of real matter. NNRT does not impose an event horizon as an input condition of real-spacetime geometry; it defines a horizon as a result of phase connectivity.

#### 4.1 Definition of the Observational Horizon

Let  $E$  denote an event,  $O$  a distant observer, and  $\Gamma_{\gamma}(E \rightarrow O)$  a future-directed electromagnetic phase characteristic connecting them. Define the observational horizon by

$$H_{\text{obs}} = \partial\{E \mid \exists \Gamma_{\gamma}(E \rightarrow O)\}$$

Under this definition, the horizon is an output obtained only after the full phase-transport problem for  $C^{\mu\nu}$  and  $K_\mu$  has been solved.

This definition makes it possible to distinguish practical non-detection, asymptotic blackout, and strict loss of phase connectivity. In particular,  $z \rightarrow \infty$  alone does not prove that  $\Gamma_\gamma$  disappears. Infinite redshift and strict causal disconnection are therefore not identified.

#### 4.2 Reframing the Singularity Problem

In NNRT,  $r = 0$  is simply the coordinate origin of universal three-dimensional space; it is not an endpoint of spacetime itself. By contrast, whether the real matter satisfies

$$R_m(t) \rightarrow 0, \quad \rho_c(t) \rightarrow \infty$$

within a finite interval of universal time remains an independent physical problem. It must be solved as real matter dynamics including the equation of state (EOS), pressure, phase force, angular momentum, magnetic fields, radiation, jets, and mass loss.

NNRT therefore does not simply eliminate the singularity problem. It rejects the formulation of a geometrical singularity of real spacetime and replaces it with the real dynamical problem of matter density and stability.

#### 4.3 Rotation, Magnetic Fields, and Jets

For a rotating compact source, the real angular momentum  $J$  and magnetic flux cannot be neglected. The dimensionless spin parameter is

$$\chi = \frac{cJ}{GM^2}$$

In NNRT, the Kerr-type quantity  $g_{t\phi}^{\text{obs}}$  does not mean that real space itself is dragged. It is read as an observational response in which source rotation couples temporal phase to azimuthal phase.

A jet is not evidence that matter escapes from inside an event horizon; it is a real outflow produced by the rotating plasma-magnetic-field system in the vicinity of the compact source. Collapse therefore cannot be described by one-way mass inflow alone; mass, energy, and angular-momentum balance must be treated simultaneously.

### 5. Neutron-Star Compactness, Tidal Response, and Cutoff Frequency

Neutron-star-black-hole binaries provide an especially important setting in which to examine the NNRT causal chain from a real source to an observed waveform. In particular, the correlation between neutron-star compactness and the gravitational-wave cutoff frequency associated with tidal disruption provides an example in which real matter structure is encoded in a distant observed phase [10-12].

#### 5.1 NNRT Interpretation of Compactness

The neutron-star compactness is defined as

$$C = \frac{GM_{\text{NS}}}{R_{\text{NS}}c^2}$$

NNRT does not define  $C$  as the “strength of real-spacetime curvature.” It is a dimensionless real-source parameter constructed from  $M_{\text{NS}}$  and  $R_{\text{NS}}$  and characterizes the strength of self-gravity, tidal response, and phase response.

#### 5.2 Real Dynamics of Tidal Disruption

As an order-of-magnitude estimate, let the tidal-disruption radius be

$$r_{\text{tid}} \sim R_{\text{NS}} \left( \frac{M_{\text{BH}}}{M_{\text{NS}}} \right)^{1/3}$$

The corresponding orbital frequency is approximately

$$\Omega_{\text{tid}} \sim \frac{c^3}{GM_{\text{NS}}} C^{3/2}$$

The cutoff frequency may therefore be written approximately as

$$f_{\text{cut}} \sim \frac{c^3}{\pi G M_{\text{NS}}} C^{3/2} F(q, \chi, \text{EOS}, \dots)$$

This simplified expression is not itself a quantitative cutoff law. Numerical-relativity studies show that  $f_{\text{cut}}$  depends more intricately on compactness, mass ratio, spin, EOS, and related quantities [10-12]. What matters in NNRT is not the simple exponent in this estimate, but the causal chain

$$C \rightarrow \text{tidal response} \rightarrow \text{binary dynamics} \rightarrow \text{dynamic gravity} \rightarrow \text{phase waveform} \rightarrow f_{\text{cut}}$$

This structure means that information appearing at the high-frequency end of an observed waveform can be traced back to the real density distribution, radius, and EOS of a neutron star. NNRT understands this information transfer not as deformation of real-spacetime geometry, but as phase transport from real-source dynamics through dynamical gravitational response.

### 5.3 Strong-Gravity Matter Equilibrium

Real matter equilibrium inside a neutron star is written as

$$\frac{dM}{dr} = 4\pi r^2 \rho$$

and

$$\frac{dP}{dr} = -\rho a_{\text{grav}}^{\text{NNRT}}, \quad a_{\text{grav}}^{\text{NNRT}} = a_N + a_\phi$$

The gravitational acceleration here contains both the Newtonian term and the complete phase-response term. A particular correction obtained from weak-field perihelion advance must not be extrapolated by itself into the strong-field regime; in strong gravity, the response force acting on real matter must be derived from the complete phase transport.

## 6. Gravitational Waves—Source, Propagation, and Phase Detection

In NNRT, a gravitational wave is not defined as a wave of real spacetime itself. Real matter motion generates a time-dependent gravitational response, which acts on electromagnetic and matter-wave phases and appears as a signal in the detector.

### 6.1 Source

The real motion of the two bodies is written as

$$m_i \ddot{\vec{x}}_i = \vec{F}_i^{\text{NNRT}}$$

The force  $\vec{F}_i^{\text{NNRT}}$  includes Newtonian gravity, phase corrections, tidal response, spin, matter interaction, and related effects. This real motion generates the dynamical response of the coframe  $e_\mu^a$ . In the distant weak-field regime, the waveform mathematics corresponding to the conventional  $h_+$  and  $h_\times$  can be retained as components of the observational response.

### 6.2 Observables in LIGO-Type Interferometers

The primary quantity acquired by a laser interferometer is the phase difference between its two optical paths,

$$\Delta\theta(t)$$

The detection of GW150914 by Advanced LIGO was reported as a calibrated strain waveform [7,8]. In NNRT, the calibrated strain is not ontologically identified with an actual stretching or contraction of the real distance between the mirrors; it is positioned as an observational signal encoded in optical phase by the dynamical gravitational response.

This position does not deny the experimental necessity of controlling the mirror separation. On the contrary, the real mirror configuration must be stabilized as far as possible precisely so that the residual phase response can be detected with high sensitivity. Experimental control of mirror positions must therefore not be confused with a theoretical claim that the real distance itself changes under a gravitational wave.

### 6.3 Source Inference

Inference of source parameters from an observed waveform is the inverse problem of the forward mapping

$$\{M_i, J_i, R_i, \text{EOS}, \dots\} \rightarrow \text{real dynamics} \rightarrow \text{dynamic gravity} \rightarrow \Delta\theta(t)$$

Ringdown is likewise positioned as the damped response of the post-merger source and surrounding field. Numerical agreement with Kerr-type quasinormal modes represents the success of the observational-response mathematics; by itself it is not a direct measurement that real spacetime is Kerr geometry.

## 7. The Universe and Universal Real Spacetime

The same separation applied to a real source and its observational image in strong-gravity astrophysics is now applied to the universe as a whole. The essential point is not to identify the universe itself with real spacetime.

### 7.1 Definition of the Universe

Define the universe as the physical state on universal real spacetime,

$$U(t) = \{\text{matter, radiation, fields, galaxies, voids}, \dots\}$$

Therefore,

$$U(t) \neq M_{\text{real}}$$

Evolution of the cosmic matter distribution with time is not identical to expansion or contraction of real space itself.

### 7.2 Real Matter Scale and Observational Scale

If the mean real matter distribution is represented by

$$\vec{x}(t) = A_m(t)\vec{q}$$

then  $A_m(t)$  is not a real-space scale factor; it is a matter-distribution scale. Its velocity field is

$$\vec{v} = H_m(t)\vec{x}, \quad H_m = \frac{\dot{A}_m}{A_m}$$

For two bodies,

$$\vec{v}_B - \vec{v}_A = H_m(\vec{x}_B - \vec{x}_A)$$

so no central absolute rest point is required.

To express observational redshift integrally, an observational scale  $A_{\text{obs}}$  may be defined by

$$\frac{\dot{A}_{\text{obs}}}{A_{\text{obs}}} = H_{\text{obs}}$$

In NNRT,

$$A_m \neq A_{\text{obs}} \neq \text{real-space scale}$$

The separation of these three quantities is central to NNRT cosmology.

### 7.3 Reframing the Big Bang

Extrapolating the observational scale into the past so that  $A_{\text{obs}} \rightarrow 0$  does not imply  $M_{\text{real}} \rightarrow 0$  or a beginning of universal time. What NNRT must retain is the real physics that cosmic matter and radiation were hotter and denser in the past; this does not automatically imply the ontology that time and space themselves were created from a single point.

Accordingly, if the term Big Bang is retained, it is defined as the hot-dense history or transition leading to the present cosmic state. Asking what preceded the Big Bang is not asking about a time “before time”; it is a physical question concerning the state of matter at earlier universal times.

## 8. Cosmological Redshift and a Two-Region Wall-Void Model

Cosmological redshift is treated as a problem of how the real matter velocity field and dynamical gravitational response are mapped into electromagnetic phase. In this paper, the velocity gradient is used directly as a basic quantity without decomposition into components.

### 8.1 Undecomposed Velocity Gradient

For a real velocity field  $v_i(t, \vec{x})$ , define

$$\sigma_{ij} = \partial_j v_i$$

This is the complete velocity gradient and is not decomposed into isotropic, shear, rotational, or other components. If  $n_i$  denotes the local propagation direction of light, define the contribution of the velocity field to phase redshift by

$$H_\sigma = n_i \sigma_{ij} n_j$$

Let the gravitational phase contribution produced by the time dependence of  $C^{\mu\nu}$  be denoted by  $H_G$ . The local redshift-generation rate is then

$$\mathcal{E} = n_i \sigma_{ij} n_j + H_G$$

The quantity  $H_G$  is not an independent empirical parameter; ultimately it is a derived quantity obtained from the phase-transport equations for  $C^{\mu\nu}$  and  $K_\mu$ .

### 8.2 Walls and Voids

For wall and void regions, define

$$\mathcal{E}_w = n_i \sigma_{ij}^{(w)} n_j + H_G^{(w)}$$

and

$$\mathcal{E}_v = n_i \sigma_{ij}^{(v)} n_j + H_G^{(v)}$$

Let  $f_v$  be the real volume fraction of voids and  $\eta_v$  the fraction of a particular ray path that passes through voids. The effective redshift rate along that ray is

$$\mathcal{E}_{\text{ray}} = (1 - \eta_v) \mathcal{E}_w + \eta_v \mathcal{E}_v$$

Define the volume-averaged quantity by

$$\mathcal{E}_D = (1 - f_v) \mathcal{E}_w + f_v \mathcal{E}_v$$

Then the difference is

$$\mathcal{E}_{\text{ray}} - \mathcal{E}_D = (\eta_v - f_v)(\mathcal{E}_v - \mathcal{E}_w)$$

This equation directly expresses the possibility that the volume average of the real universe and the observational universe reconstructed by light do not coincide.

### 8.3 Real Dynamics of the Void Fraction

Let the real volumes of wall and void regions be  $V_w$  and  $V_v$ . Using the trace of the undecomposed velocity gradient,

$$\frac{\dot{V}_w}{V_w} = \sigma_{ii}^{(w)}, \quad \frac{\dot{V}_v}{V_v} = \sigma_{ii}^{(v)}$$

From  $f_v = V_v/(V_w + V_v)$ ,

$$\dot{f}_v = f_v(1 - f_v)(\sigma_{ii}^{(v)} - \sigma_{ii}^{(w)})$$

Thus,  $f_v$  should not be introduced as an arbitrary function for observational fitting; it should be treated as a quantity derived from the real matter velocity field.

### 8.4 Condition for Observational Acceleration

Define  $A_{\text{obs}}$  by  $\dot{A}_{\text{obs}}/A_{\text{obs}} = \mathcal{E}_{\text{ray}}$  and  $A_D$  by  $\dot{A}_D/A_D = \mathcal{E}_D$ . With  $\Delta\mathcal{E} = \mathcal{E}_{\text{ray}} - \mathcal{E}_D$ ,

$$\frac{\ddot{A}_{\text{obs}}}{A_{\text{obs}}} = \frac{\ddot{A}_D}{A_D} + \dot{\Delta\mathcal{E}} + 2\mathcal{E}_D \Delta\mathcal{E} + (\Delta\mathcal{E})^2$$

Therefore, even if the real matter average is decelerating, the observational scale can appear to accelerate if the difference introduced by the observational mapping grows sufficiently. The key point

is that this possibility can be tested as a problem of real structure evolution and observational mapping without assuming the existence of dark energy in advance.

## 9. Luminosity Distance, CMB, and BAO

Explaining cosmological redshift alone does not close observational cosmology. To determine flux and angular size, transport of the ray bundle is required in addition to phase characteristics.

### 9.1 Redshift and Real Light-Path Scale

If the redshift-generation rate is  $\mathcal{E}_{\text{ray}}$ ,

$$\frac{dz}{dt} = (1+z)\mathcal{E}_{\text{ray}}$$

If the propagation speed along the light path is  $V_\gamma$ ,

$$R(z) = \int_0^z \frac{V_\gamma(z')}{(1+z')\mathcal{E}_{\text{ray}}(z')} dz'$$

In the observational background limit  $V_\gamma = c$ ,

$$R(z) = c \int_0^z \frac{dz'}{(1+z')\mathcal{E}_{\text{ray}}(z')}$$

This  $R(z)$  is not defined as an expanding-space comoving distance. It is a real light-path scale related to phase redshift.

### 9.2 Ray-Bundle Jacobian and Angular-Diameter Distance

Let  $D_B^A$  denote the transverse mapping obtained by linearizing the difference between neighboring phase characteristics. Relate a small observed angle  $\delta\theta^B$  to the transverse source displacement  $\delta x_\perp^A$  by

$$\delta x_\perp^A = D_B^A \delta\theta^B$$

and define the angular-diameter distance by

$$D_A = \sqrt{\det D}$$

The Jacobian  $D_B^A$  is obtained from the bundle of phase characteristics of  $C^{\mu\nu}$  without assuming curvature of real space.

If photon-number conservation and ray reciprocity hold within the NNRT observational mapping, the distance-duality relation

$$D_L = (1+z)^2 D_A$$

must be reproduced [13]. Quantitative verification of  $D_L(z)$  in NNRT is therefore a problem of solving phase transport and ray-bundle transport simultaneously.

### 9.3 CMB

Let the equilibrium Planck spectrum be

$$I_\nu^{\text{em}} = \frac{2h\nu_{\text{em}}^3}{c^2} \left[ \exp\left(\frac{h\nu_{\text{em}}}{k_B T_{\text{em}}}\right) - 1 \right]^{-1}$$

If phase transport is achromatic so that

$$\nu_{\text{obs}} = \frac{\nu_{\text{em}}}{1+z}$$

and phase-space occupation is preserved, then

$$T_{\text{obs}} = \frac{T_{\text{em}}}{1+z}$$

The Planck spectrum is therefore preserved with only its temperature parameter changed. In NNRT, this relation must be derived from nondispersive phase transport and occupation conservation, rather than from stretching of real space.

At the same time, the high blackbody purity of the CMB places strong constraints on wall-void path dependence. Quantities such as  $\eta_\nu$  therefore cannot be chosen arbitrarily merely to fit SN Ia data.

## 9.4 BAO

Let the real acoustic distance in the early photon-baryon plasma be

$$r_d^{\text{real}} = \int_{t_i}^{t_d} c_s(t) dt$$

BAO observations directly provide an angular difference  $\Delta\theta$  and a redshift difference  $\Delta z$ . NNRT therefore treats the chain as

$$\text{real acoustic ruler} \rightarrow (\Delta\theta, \Delta z) \rightarrow \text{observational distance}$$

The CMB acoustic scale, transverse BAO, radial BAO, and SN Ia simultaneously constrain the same  $C^{\mu\nu}$ ,  $K_\mu$ , and  $D_B^A$  through different observables.

## 10. Unified Principle, Testability, and Physical Reorientation

The subjects considered in this paper, from strong-gravity objects to cosmology, are not a collection of unrelated reinterpretations. They converge on one common causal structure.

### 10.1 Common Mapping

The entire framework can be summarized as

$$M_{\text{real}} \rightarrow X_{\text{real}} \rightarrow \text{real dynamics} \rightarrow C^{\mu\nu} \rightarrow (K_\mu, D_B^A) \rightarrow \text{observables}$$

The correspondence for each subject is shown in Table 2.

**Table 2. Common NNRT observational mapping and fields of application**

| Subject                       | Main real quantities               | Main observables                        |
|-------------------------------|------------------------------------|-----------------------------------------|
| Strong-gravity compact object | $M, J, R_m, \rho, P, \vec{B}$      | redshift, shadow, critical image        |
| BH-NS / NS-NS                 | $M_i, R_i, C, \text{EOS}, q, \chi$ | waveform, $f_{\text{cut}}$              |
| Gravitational waves           | binary motion, source multipoles   | $\Delta\theta(t)$ , calibrated waveform |
| Cosmology                     | $\rho, P, v_i, \sigma_{ij}, f_v$   | $z, D_A, D_L$ , CMB, BAO                |

The common feature in every row is a one-way causal chain from the real source to observables. The observational metric is not placed first as real spacetime and matter is not subsequently required to conform to it.

### 10.2 Established Foundations and Future Quantitative Tasks

As the internal foundation of NNRT, this paper adopts universal real spacetime, real inertial motion governed by GT, the repositioning of LT as an observational mapping, the phase four-wavevector  $K_\mu$ , and the observational propagation structure  $C^{\mu\nu}$  [1-4]. Applying these elements to strong gravity and cosmology makes it possible to treat a black-hole horizon as an output of phase connectivity, to move the singularity problem to matter stability, to make explicit the information chain from compactness to waveform, and to separate real cosmic matter evolution from the observational scale.

At the same time, the complete strong-field phase force, quantitative compact-object interior solutions, a rigorous derivation of occupation conservation in the CMB from  $C^{\mu\nu}$ , ray-bundle reciprocity, and numerical calculations that reproduce SN Ia, BAO, and CMB with one common parameter set remain tasks for quantitative development. These are not tasks that require NNRT to return to the foundations of the conventional theory; they are tasks required to close NNRT's own observational mapping numerically.

### 10.3 Fundamental Reversal Introduced by NNRT

NNRT is not a theory that “reads the same relativity in different words.” In conventional relativity, relative time, relative length, and curved four-dimensional spacetime are placed at the physical foundation, while GT, universal time, and universal space are removed from that foundation. NNRT reverses this ordering. It restores universal time, universal three-dimensional space, and GT to the basis of real physics and relocates LT and general-relativistic metric mathematics to observational mappings formed by electromagnetic and matter waves.

NNRT therefore changes more than part of the explanation of relativity. It changes the constructive principle of relativity itself: what is real, what is measured, and in which causal direction one is to explain the other. If this foundational reversal is valid, the physical meanings of black holes, gravitational waves, cosmic expansion, observational acceleration, and related phenomena are changed comprehensively. By preserving successful mathematics and experimental values while relocating that mathematics from real geometry to observational geometry, NNRT restores universal spacetime and real dynamics to the center of physics. In this sense, NNRT is not merely an interpretive turn; it is a revolutionary reconstruction of the foundations of relativistic physics.

#### 10.4 Specific Physical Changes Introduced by NNRT

The significance of the NNRT foundational reversal does not lie merely in giving a different explanation to the same observational equations. NNRT removes relative time, relative length, and four-dimensional geometry—placed by conventional relativity at the foundation of reality—from that real foundation and absorbs their successful mathematics into the observational layer. Consequently, phenomena conventionally described as properties of that geometry are decomposed into real sources, real motion, gravitational response, phase transport, and beam transport on universal spacetime. What exists, what is directly measured, and what should be solved dynamically therefore change concretely in each field. The principal replacements are summarized in Table 3.

- (1) Black holes: NNRT does not adopt the continuous real-geometrical picture in which a sufficiently massive object forms a hole in real spacetime, nothing can escape from inside its boundary, and spacetime becomes singular at the center. What is real is a compact source with mass, angular momentum, a material surface, density, pressure, magnetic fields, and flows. Extreme redshift, photon critical structure, and shadow observed externally are observational structures produced by that source in the propagation of electromagnetic phase and intensity. The research question therefore changes from “describing the interior of a hole in spacetime” to “determining what real matter state produces what phase connectivity and observational image.” Neither the event horizon nor the singularity is assumed in advance as real geometry; the former is determined from the solution of phase connectivity, and the latter from the stability and collapse dynamics of real matter [6,9].
- (2) Neutron stars and tidal phenomena: In NNRT, compactness is not a measure of real-spacetime curvature; it is a real-source parameter associated with mass  $M$ , radius  $R$ , and the EOS. This change also alters the meaning of tidal disruption and cutoff frequency. The high-frequency end of an observed waveform is not read as a feature of curved geometry, but as information on the real neutron-star radius, density distribution, EOS, and binary dynamics encoded into phase through dynamical gravitational response. The relation from compactness to  $f_{\text{cut}}$  therefore becomes a research subject that directly connects real-source physics to distant observation [10-12].
- (3) Gravitational waves and LIGO: NNRT does not define a gravitational wave as “real space itself stretching and contracting as the wave propagates.” Binary matter motion generates a time-dependent gravitational response, that response changes the laser phase, and an interferometer detects it as a phase difference. The strain waveform published by LIGO is an observational image constructed by calibrating this phase signal. The success of LIGO is therefore positioned in NNRT as high-precision detection of dynamical gravity-electromagnetic-phase coupling, not as a direct measurement that the real mirror separation geometrically stretches and contracts with a gravitational wave [7,8]. This change reorients not only the detection principle but also source-parameter inference, ringdown, and future detector design toward the question of what source dynamics produces what phase response.
- (4) Cosmic expansion: NNRT does not identify an increase in the distances between galaxies over time with expansion of universal three-dimensional space itself. Universal space contains a real matter velocity field, and its distribution scale  $A_m$  changes. By contrast,  $A_{\text{obs}}$ , reconstructed from redshift, angular size, and flux, is an observational scale containing phase transport and beam transport. The Hubble law is therefore treated primarily as a relation between systematic real

**Table 3. Major concepts replaced by NNRT and their specific physical content**

| Subject                      | Conventional real-ontological meaning replaced by NNRT                                                                                               | Specific physical content in NNRT                                                                                                                                                                                                    |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Foundation of relativity     | Relative time, relative length, and four-dimensional geometry are treated as the foundation of reality.                                              | Universal time, universal three-dimensional space, and GT are restored as the foundation of real dynamics, while LT and metric mathematics are relocated to observational mappings of phase and measurement.                         |
| Black holes                  | The horizon is treated as a boundary of real spacetime and the singularity as an endpoint of spacetime.                                              | A real compact source is placed first; the horizon is an output of phase connectivity, the shadow is an image of phase and intensity transport, and the singularity is a matter-stability problem.                                   |
| Neutron stars and tides      | Compactness and tidal response are treated as matter motion in curved spacetime.                                                                     | Compactness is a real-source parameter constructed from $M$ , $R$ , and the EOS; tidal disruption and cutoff frequency describe how source structure is encoded into waveform phase.                                                 |
| Gravitational waves and LIGO | A gravitational wave is treated as strain of real spacetime and $h$ as actual deformation of distance.                                               | Binary matter motion produces a dynamical gravitational response that appears in the laser phase difference. Calibrated strain is an observational image of that response, not the real stretching of mirror separation itself.      |
| Cosmic expansion             | The scale factor is treated as the expansion scale of real space itself.                                                                             | The matter-distribution scale in universal space is separated from the observational scale obtained from phase observation. Hubble flow is treated as real relative motion among matter.                                             |
| Big Bang                     | Time and space themselves are interpreted as having begun in the finite past.                                                                        | The Big Bang is treated as the history or transition of a hot, dense matter-radiation state and does not automatically imply an origin of universal time or universal space.                                                         |
| CMB and BAO                  | They are read as standard observables recording the history of expanding geometry.                                                                   | CMB is treated through achromatic phase transport of thermal radiation, while BAO is treated as angle/redshift mapping of a real acoustic correlation length; both strongly constrain the NNRT observational mapping.                |
| Observational acceleration   | The observed distance-redshift relation is identified with acceleration of real space, and an accelerating component is introduced as a real entity. | Real matter evolution is separated from observational mapping; $D_L(z)$ is reconstructed from structure evolution, phase remapping, and beam remapping before judging whether an additional real accelerating component is required. |

relative motion among matter and the electromagnetic observational mapping. The central problem of cosmology changes from “how space expands” to “how the real matter distribution moves and how that motion and gravitational response are mapped by light into the observed universe.”

- (5) Big Bang, CMB, and BAO: Extrapolating the observational scale backward until it approaches zero does not, in NNRT, imply the creation of universal time and universal space. The Big Bang is treated as the history of a hot, dense matter-radiation state connected to the present universe. The Planck spectrum and temperature redshift of the CMB become problems of achromatic phase transport and occupation conservation rather than space stretching. Likewise, BAO is not a comoving ruler fixed in expanding space, but a problem in which a real acoustic correlation length formed in the early plasma is mapped into angle and redshift [13,14]. High-precision observations of CMB and BAO are therefore not treated by NNRT as “evidence for real-space expansion,” but as extremely stringent quantitative conditions that the phase/beam mapping must satisfy.
- (6) Observational acceleration and dark energy: NNRT does not immediately reinterpret acceleration of an observational scale constructed from  $D_L(z)$  as acceleration of real space. Because the evolution of the real matter distribution is separated from the observational mapping, wall-void structure, path selection, dynamic gravitational phase shifts, and beam focusing/defocusing can in principle alter observational distance even when the real average is decelerating. Dark energy is therefore not required as a component that expands real space merely because observational acceleration is inferred. The research order is instead to calculate SN Ia, BAO, and CMB simultaneously from one NNRT parameter set and then determine whether an additional real component is still required. At the present stage, this remains a task for quantitative verification; the absence of dark energy is not assumed in advance.
- (7) Meaning for physics as a whole: The changes above do not place NNRT beside the conventional theory as another interpretation. NNRT does not retain relative time, relative length, and curved four-dimensional spacetime as the real foundation; it relocates their successful mathematics to the observational layer. It then restores universal time, universal three-dimensional space, GT, and real matter dynamics to the foundation. Thus, even when the same experimental values are retained, the very objects of scientific inquiry change. For black holes, the question becomes real-matter final states and phase connectivity rather than geometry; for gravitational waves, source-to-phase coupling rather than space strain; and for cosmology, matter-evolution-to-observation mapping rather than space expansion. This is the transformative content of NNRT [1-4].

## 11. Conclusion

This paper has applied the foundations of NNRT in a unified manner to strong-gravity objects, tidal disruption, gravitational waves, and cosmology. Once real compact sources are separated from shadows, real material surfaces from observational horizons, compactness from cutoff frequency, binary dynamics from interferometric phase, and cosmic matter evolution from the observational redshift scale, these apparently different problems all converge on the single structure

$$\text{real source} \rightarrow \text{real dynamics} \rightarrow C^{\mu\nu} \rightarrow (K_\mu, D_B^A) \rightarrow \text{observables}$$

What NNRT retains is the mathematics and observational values that have succeeded experimentally. What it rejects is the constructive principle that identifies those observables with deformation or curvature of an unmeasurable real spacetime itself. In its place, NNRT puts real-source dynamics on universal spacetime first and derives observations as results of phase and beam transport. The restoration of this causal direction is the core of NNRT and opens a route to describing strong gravity and the universe as a whole under one principle.

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