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Special and general relativity (SR/GR) describe nature "subjectively", that is, from the perspective of just *one observer at a time* (one group of observers, to be exact). Mathematically, SR/GR are correct. I show: (1) Physically, SR/GR have an issue. Despite the covariance of SR/GR, there is always just one active perspective. Because of this constraint, there is no holistic view of nature. The issue shows itself in unsolved mysteries. Still, the Lorentz factor and gravitational time dilation are correct. This is why the concepts of spacetime in SR/GR work well except for cosmology and quantum mechanics. (2) Euclidean relativity (ER) describes nature "objectively", that is, from the perspectives of *all objects at once.* Any (!) object's proper space d_1, d_2, d_3 and proper time τ span natural spacetime, which is 4D Euclidean space (ES) if we interpret $c\tau$ as d_4. All energy moves through ES at the speed c. An observer's reality is created by projecting ES orthogonally to his proper space and to his proper time. In SR, these concepts are considered coordinate space and coordinate time. Neither their reassembly to a non-Euclidean spacetime nor the parameterization in SR/GR provides a holistic view. The scalar τ, in particular, cannot factor in an object's 4D vector "flow of proper time" $\boldsymbol{\tau}$. However, the SO(4) symmetry of ES is incompatible with waves. This is fine because waves and particles are subjective concepts. We must learn to distinguish between an observer's reality (described by SR/GR) and the master reality ES (described by ER). ER solves 15 mysteries at once.

Keywords: time; cosmology; Hubble tension; dark energy; quantum mechanics; non-locality

This paper is not about a minor issue. It is about a reformation of physics. There are two approaches to describing nature: "subjectively" (from the perspective of just one observer or one group of observers at a time) or "objectively" (from the perspectives of all objects at once). Special and general relativity (SR/GR) take the first approach (Einstein, 1905b; Einstein, 1916). SR/GR are mathematically correct, but they lack a holistic view of nature. Euclidean relativity (ER) takes the second approach. ER is mathematically and physically correct because it provides a holistic view. My theory was rejected by several top journals in physics. I was told that manuscripts are not considered if they challenge SR/GR. While it is true that many attempts to falsify SR/GR have failed, we must not reject all attempts. Scientific theories must be falsifiable (Popper, 1935). I finally submit to a journal in philosophy. May the cradle of physics give physicists a hand. Subjectively, we live in a curved, non-Euclidean spacetime. Objectively, we live in a flat, Euclidean space.

Six pieces of advice: (1) *Do not take SR/GR as the ultimate truth.* Correct predictions do not prove SR/GR. ER predicts the same relativistic effects as SR/GR. Some reviewers made a systematic error when they evaluated ER with the concepts of SR/GR. ER is different. In ER, all energy moves at the speed of light c. (2) *Be patient and fair.* I cannot address all of physics in one paper. SR/GR have been tested for 100+ years. ER deserves the same chance. (3) *Do not reject ER on a knee-jerk reaction.* What is wrong with describing nature objectively rather than subjectively? (4) *Do not be prejudiced against a theory that solves many mysteries.* New concepts often do so. (5) *Appreciate illustrations.* Geometric derivations are as good as equations. (6) *Consider that you may be biased.* Some concepts of today's physics are obsolete in ER. If you are an expert in such a concept, you may feel offended.

To sum it all up: Predictions made by SR/GR are correct, but ER penetrates to a deeper level. I apologize for having prepared several preprint versions. It was tricky to figure out why the concepts of spacetime in SR/GR work so well despite an issue. Sect. 2 is about this issue. Sect. 3 presents the foundations of ER. In Sect. 4, the Lorentz factor and gravitational time dilation are recovered. In Sect. 5, ER solves 15 mysteries at once.

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1. Introduction

Today's concepts of space and time were coined by Albert Einstein. In SR, he merges them into a flat spacetime described by an indefinite distance function. SR is often presented in Minkowski spacetime because it illustrates the invariance of the spacetime interval very well (Minkowski, 1910). Predicting the lifetime of muons (Rossi & Hall, 1941) is an example that supports SR. In GR, curved spacetime is described by a pseudo-Riemannian metric. Predicting the deflection of starlight (Dyson et al., 1920) and the high accuracy of GPS (Ashby, 2003) are examples that support GR. Quantum field theory (Ryder, 1985) unifies classical field theory, SR, and quantum mechanics (QM) but not GR.

Two postulates of ER: (1) All energy moves through 4D Euclidean space (ES) at the speed of light c. (2) The laws of physics have the same form in each "observer's reality", which is created by projecting ES orthogonally to his proper space and to his proper time. To improve readability, I always refer to an observer as "he". To make up for it, I refer to nature as "she". My first postulate is stronger than the second SR postulate: c is absolute and universal. My second postulate refers to realities rather than to inertial frames. I also introduce a generalized concept of energy: All energy is "wavematter", which may appear as wave packets or as particles in an observer's reality (see Sect. 5.12).

Newburgh and Phipps (1969) pioneered ER. Montanus (1991) described an "absolute Euclidean spacetime" with a preferred frame of reference, where a pure time interval is a pure time interval for all observers. Montanus (2023) claims that a preferred frame would avoid the twin paradox in ER, collisions of particles at a distance, and a "character paradox" (confusion of photons, particles, and antiparticles). As we will see, a preferred frame is not required. There is no twin paradox in ER, there are no collisions at a distance in the projections from ES, and the character paradox is reasonable. Montanus (2001) used the Lagrange formalism to set up the kinematic equations in proper time τ. Montanus (2023) even tried to formulate Maxwell's equations in ER, but he wondered about a wrong sign. He overlooked that the SO(4) symmetry of ES is incompatible with waves.

Almeida (2001) investigated geodesics in ES. Gersten (2003) showed that the Lorentz transformation is an SO(4) rotation in a "mixed space" (see Sect. 3). van Linden (2023) runs a website about various ER models. However, physicists are still opposed to ER because dark energy and non-locality make cosmology and QM work, waves are excluded in ER, and paradoxes may turn up. *This paper marks a turning point:* I disclose an issue in SR/GR, I justify the exclusion of waves, and I avoid paradoxes by projecting ES.

It is instructive to contrast Newton's physics, Einstein's physics, and ER. In Newton's physics, all energy moves through 3D Euclidean space as a function of independent time. The speed of matter is $v_{3D} \ll c$. In Einstein's physics, all energy moves through 4D non-Euclidean spacetime. The speed of matter is $v_{3D} < c$. In ER, all energy moves through ES. The 4D speed of all energy is $u_{4D} = c$. Newton's physics (Newton, 1687) influenced Kant's philosophy (Kant, 1781). Will ER reform both physics and philosophy?

2. Disclosing an Issue in Special and General Relativity

In SR (Einstein, 1905b), there are two concepts of time: coordinate time t and proper time τ. The fourth coordinate in SR is t. In § 1 of SR, Einstein provides an instruction on how to synchronize two clocks at P and Q. At "P time" t_P, a light pulse is sent from P to Q. At "Q time" t_Q, it is reflected. At "P time" t_P^*, it is back at P. The clocks synchronize if

$$t_Q - t_P = t_P^* - t_Q \tag{1}$$

In § 3 of SR, Einstein derives the Lorentz transformation. The coordinates x_1, x_2, x_3, t of an event in a system K are transformed to the coordinates x_1', x_2', x_3', t' in K' by

$$x_1' = \gamma\,(x_1 - v_{3D}\,t)\;, \quad x_2' = x_2\;, \quad x_3' = x_3 \tag{2a}$$

$$t' = \gamma\,(t - v_{3D}\,x_1/c^2) \tag{2b}$$

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where K′ moves relative to K in x_1 at a constant speed v_{3D}, while $\gamma = (1 - v_{3D}^2/c^2)^{-0.5}$ is the Lorentz factor. *Mathematically,* Eqs. (1) and (2a–b) are correct for an observer R in K. There are covariant equations for an observer B in K′. *Physically,* SR and also GR have an issue. They describe nature from the perspective of just one observer at a time (one group of observers, to be exact). In SR, a group consists of observers who do not move relative to each other. In GR, a group consists of observers who share the same gravitational field. The physical issue lies in the fact that there is always just one *active* perspective. Because of this constraint, there is no holistic view of nature. In particular, observers do not always agree on what is past and what is future. Physics paid a very high price for surrendering simultaneity as a general concept: By replacing SR/GR with ER, 15 fundamental mysteries of physics are solved. *Thus, the issue is real.* I show that the scope of SR/GR is rather limited. Their concepts of spacetime work well except for cosmology and QM.

The issue in SR/GR is very similar to the issue in the geocentric model: In either case, there is no holistic view but just one *active* perspective. In the old days, it was natural to believe that all celestial bodies would revolve around Earth. Only the astronomers wondered about the retrograde loops of planets and claimed: Earth revolves around the sun. In modern times, engineers have improved the precision of rulers and clocks. Eventually, it was natural to believe that it would be fine to describe nature as accurately as possible but from just one *active* perspective. The human brain is very powerful, but unfortunately it often deems itself the center/measure of everything in the universe.

The analogy is strong: (1) It holds despite the covariance of SR/GR. After a transformation (or else after replacing the center Earth), there is again just one *active* perspective. (2) SR/GR miss the big picture just like the geocentric model. Retrograde loops are obsolete but only in the holistic view of the heliocentric model. Dark energy and non-locality are obsolete but only in the holistic view of ER. (3) In the old days, alternatives to the geocentric model were not taken seriously. Today, alternatives to SR/GR are not taken seriously. *Have physicists not learned from history? Does history repeat itself?*

3. Foundations of Euclidean Relativity

The indefinite distance function in SR (Einstein, 1905b) is usually written as

$$c^2\,\mathrm{d}\tau^2 \;=\; c^2\,\mathrm{d}t^2 - \mathrm{d}x_1^2 - \mathrm{d}x_2^2 - \mathrm{d}x_3^2 \tag{3}$$

where $\mathrm{d}\tau$ is an infinitesimal distance in τ, while $\mathrm{d}t$ and $\mathrm{d}x_i$ $(i = 1, 2, 3)$ are infinitesimal distances in coordinate spacetime x_1, x_2, x_3, t. This spacetime is *construed* because coordinate space x_1, x_2, x_3 and coordinate time t are subjective concepts: They are not immanent in rulers and clocks but defined by an observer! Rulers measure proper distance d_μ $(\mu = 1, 2, 3, 4)$. Clocks measure proper time τ. We may rearrange Eq. (3) and obtain

$$c^2\,\mathrm{d}t^2 \;=\; \mathrm{d}d_1^2 + \mathrm{d}d_2^2 + \mathrm{d}d_3^2 + \mathrm{d}d_4^2 \tag{4}$$

where $\mathrm{d}d_i = \mathrm{d}x_i$ $(i = 1, 2, 3)$ and $\mathrm{d}d_4 = c\,\mathrm{d}\tau$ are infinitesimal distances in ES. The roles of t and τ are switched: The fourth coordinate in ER is an object's proper time τ (measured by itself) multiplied by c. The new invariant is cosmic time t. I retain the symbol t to stress the equivalence of Eqs. (3) and (4). The indices 1 to 4 point out the full symmetry. Any (!) object's proper space d_1, d_2, d_3 and proper time τ span natural spacetime, which is ES if we interpret $c\tau$ as d_4. This spacetime is *natural* because all d_μ $(\mu = 1, 2, 3, 4)$ are objective concepts: They are immanent in rulers and clocks! We must not confuse ER with a Wick rotation (Wick, 1954), which replaces t with it and keeps τ invariant.

"ES diagrams" show ES from an object's perspective. For each object, we are free to label the four axes of ES. We always take d_4 as the axis in which the object itself moves at the speed c. During its lifetime, the object keeps moving in d_4 (always drawn vertically). An "object's reality" is created by projecting ES orthogonally to its proper space and to its proper time. For any two objects, τ and τ' may flow in different 4D directions.

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$$\tau = d_4/c \ , \quad \tau' = d'_4/c \tag{5}$$

$$\boldsymbol{\tau} = d_4\, \boldsymbol{u}/c^2 \ , \quad \boldsymbol{\tau}' = d'_4\, \boldsymbol{u}'/c^2 \tag{6}$$

where $\boldsymbol{\tau}$ is the 4D vector "flow of proper time" of an object and $\boldsymbol{u}$ is its 4D velocity. For all objects, there is $u_\mu = \mathrm{d}d_\mu/\mathrm{d}t$ (cosmic time t). Thus, Eq. (4) matches my first postulate

$$u_1^2 + u_2^2 + u_3^2 + u_4^2 = c^2 \tag{7}$$

My second postulate revises the principle of relativity, and it defines an observer's reality: It is created by projecting ES orthogonally to his proper space and to his proper time. In SR, these concepts are considered coordinate space and coordinate time. Neither their reassembly to a non-Euclidean spacetime nor the parameterization in SR/GR provides a holistic view. The scalar τ, in particular, cannot factor in an object's 4D vector $\boldsymbol{\tau}$. Since replacing coordinate time with cosmic time is a discontinuous operation, there is no continuous transition between SR/GR and ER. We take an object's $d_1(t), d_2(t), d_3(t), d_4(t)$ for granted rather than an observer's $x_1(\tau), x_2(\tau), x_3(\tau), t(\tau)$.

Since ES is "beyond" (prior to) projecting, I call it the "master reality" (master of each observer's reality). Spacetime in SR/GR is relative. ES is absolute. All ES diagrams and the projections are relative. However, the SO(4) symmetry of ES is incompatible with waves. This is fine because waves and particles are subjective concepts (see Sect. 5.12). We must learn to distinguish between an observer's reality with waves and particles (described by SR/GR) and the master reality ES with wavematters (described by ER).

It is instructive to contrast the three concepts of time. *Coordinate time* t is a subjective measure of time: It is equal to $\tau = |\boldsymbol{\tau}|$ for the observer only. *Proper time* τ is an objective measure of time: It is independent of observers. *Cosmic time* t is the total distance covered in ES (length of a geodesic) divided by c. By taking cosmic time as the parameter, all observers agree on what is past and what is future. Since cosmic time is invariant and thus absolute, there is no twin paradox in ER. Twins share the same age in cosmic time. In ER, time is a subordinate quantity: *Only by covering distance is time passing by.* I suggest that we define a standard unit for speed and that we measure time in compound units.

Let us compare SR with ER. We consider two identical clocks "r" (red clock) and "b" (blue clock). In SR, "r" shall be "at rest": It moves only in the ct axis at $x_1 = 0$. Clock "b" starts at $x_1 = 0$, but it moves in the x_1 axis at a constant speed of $v_{3\mathrm{D}} = 0.6\,c$. Fig. 1 left shows the instant when either clock moved 1.0 s in the coordinate time of "r". Clock "b" moved 0.6 Ls (light seconds) in x_1 and 0.8 Ls in ct'. Thus, "b" displays "0.8". In ER, no clock is at rest: Fig. 1 right shows the instant when either clock moved 1.0 s in cosmic time. Both clocks display "1.0". Clock "b" moved 0.6 Ls in d_1 and 0.8 Ls in d_4.

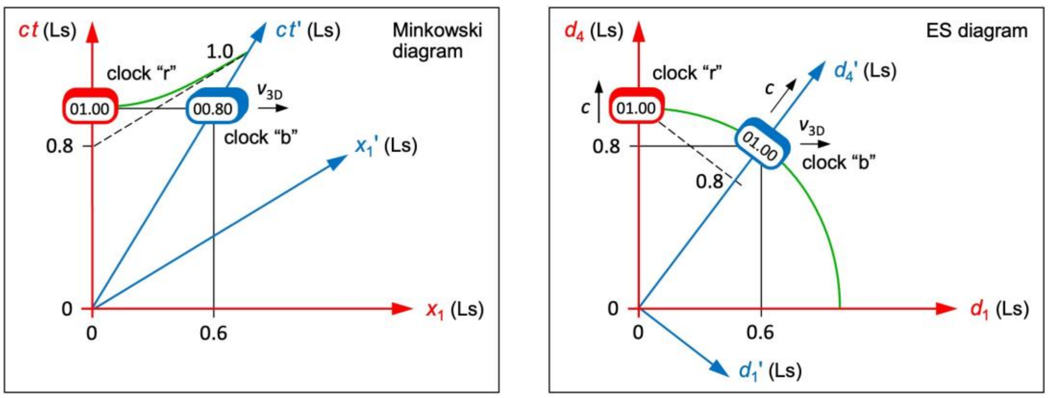

Fig. 1 Minkowski diagram and ES diagram for two clocks "r" (red) and "b" (blue). **Left:** In SR, "b" is slow with respect to "r" in t'. Coordinate time is relative ("b" is not at the same positions in ct and ct'). **Right:** In ER, "b" is slow with respect to "r" in d_4. Cosmic time is absolute ("r" is in d_4 at the same position as "b" in d'_4). Only ER provides a holistic view. Rotate either graph to see it!

Let observer R (or B) now be with clock "r" (or else "b"). In the blue frame of Fig. 1 left, "b" displays $t' = 1.0$ s at the instant when "r" displays $t = 0.8$ s (dashed line). In the red frame of Fig. 1 left, "b" displays $t' = 0.8$ s at the instant when "r" displays $t = 1.0$ s (solid line). In SR, time dilation with respect to "r" thus occurs in t' of B. In the red frame of Fig. 1 right, "b" is at $d_4 = 0.8$ Ls at the instant when "r" is at $d_4 = 1.0$ Ls (same axis d_4). In ER, time dilation with respect to "r" thus occurs in d_4 of R. *In both SR and ER, "b" is slow with respect to "r".* However, $t' = 0.8$ s is calculated only (B measures time in τ'), while $d_4 = 0.8$ Ls is measurable (d_4 relates to τ). Rotate either graph in Fig. 1 to see that only ER provides a holistic view: The ES diagram lives up to R and B *at once.* A new Minkowski diagram is required for B, where x_1' and ct' are orthogonal.

Montanus (2001) used the Lagrange formalism to set up the kinematic equations in proper time τ. I will not repeat the derivation. The reader is referred to his paper. My task is to turn ER into an accepted theory by solving 15 mysteries. Gersten (2003) showed that the Lorentz transformation is an SO(4) rotation in a "mixed space" x_1, x_2, x_3, ct', where ct' is the only primed coordinate. A "mixed space" is physical nonsense. It is another hint that SR has an issue. A Lorentz transformation rotates mixed x_1, x_2, x_3, ct' to x_1', x_2', x_3', ct. In ER, unmixed d_1', d_2', d_3', d_4' rotate with respect to d_1, d_2, d_3, d_4 (see Sect. 4).

There is also a big difference in the synchronization of clocks: In SR, each observer is able to synchronize a uniformly moving clock to his clock (same value of t in Fig. 1 left). If he does, the two clocks are not synchronized from the perspective of the moving clock. In ER, clocks with the same 4D vector $\boldsymbol{\tau}$ are always synchronized, while clocks with different $\boldsymbol{\tau}$ and $\boldsymbol{\tau}'$ are never synchronized (different values of d_4 in Fig. 1 right).

4. Geometric Effects in 4D Euclidean Space

We consider two identical rockets "r" (red rocket) and "b" (blue rocket) and assume that there is an observer R (or B) in the rear end of rocket "r" (or else "b"). His ES diagram is d_1, d_2, d_3, d_4 (or else d_1', d_2', d_3', d_4'). The 3D space of R (or else B) is spanned by d_1, d_2, d_3 (or else d_1', d_2', d_3'). We use "3D space" and "proper space" as synonyms. The proper time of R (or else B) relates to d_4 (or else d_4'). The rockets started at the same point P and move relative to each other at the constant 3D speed v_{3D}. We are free to label the axis of motion in 3D space. Here, it is d_1. The ES diagrams in Fig. 2 top must fulfill my two postulates and the initial condition (starting point P). This is achieved by rotating the ES diagrams with respect to each other. Fig. 2 bottom shows the projection to the 3D space of R (or else B). The rockets are drawn in 2D although their width is in d_2 or d_3 (d_2' or d_3').

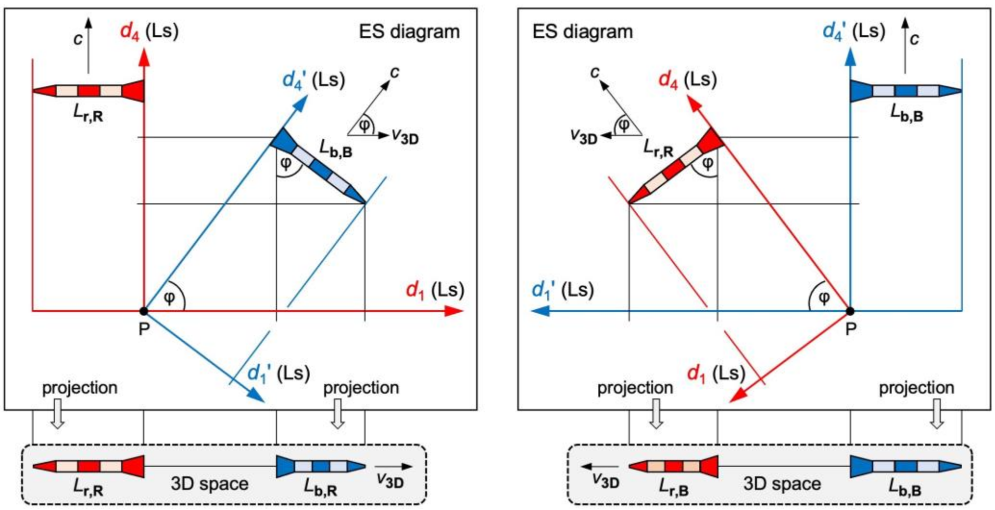

Fig. 2 ES diagrams and 3D projections for two rockets "r" (red) and "b" (blue). **Top left and top right:** Both rockets move at the speed c but in different directions. **Bottom left:** Projection to the 3D space of observer R. Rocket "b" moves at the speed v_{3D} and contracts to $L_{b,R}$. **Bottom right:** Projection to the 3D space of observer B. Rocket "r" moves at the speed v_{3D} and contracts to $L_{r,B}$

We now verify: (1) The fact that the ES diagrams of R and of B are rotated with respect to each other causes length contraction. (2) The fact that proper time flows in different 4D directions for R and for B causes time dilation. Let $L_{i,j}$ be the length of rocket i for observer j. In a first step, we project the blue rocket in Fig. 2 top left to the d_1 axis.

$$\sin^2\varphi + \cos^2\varphi = (L_{\mathrm{b,R}}/L_{\mathrm{b,B}})^2 + (v_{3\mathrm{D}}/c)^2 = 1 \quad (8)$$

$$L_{\mathrm{b,R}} = \gamma^{-1} L_{\mathrm{b,B}} \qquad \text{(length contraction)} \quad (9)$$

where $\gamma = (1 - v_{3\mathrm{D}}^2/c^2)^{-0.5}$ is the same Lorentz factor as in SR. For R, rocket "b" contracts by the factor γ^{-1}. Which distances will R observe in his d_4 axis? We mentally continue the rotation of "b" in Fig. 2 top left until it points vertically down and serves as R's ruler in the d_4 axis. In the projection to the 3D space of R, this ruler contracts to zero: The d_4 axis disappears for R because of length contraction at the speed c.

In a second step, we project the blue rocket in Fig. 2 top left to the d_4 axis.

$$\sin^2\varphi + \cos^2\varphi = (d_{4,\mathrm{B}}/d'_{4,\mathrm{B}})^2 + (v_{3\mathrm{D}}/c)^2 = 1 \quad (10)$$

$$d_{4,\mathrm{B}} = \gamma^{-1} d'_{4,\mathrm{B}} \quad (11)$$

where $d_{4,\mathrm{B}}$ (or $d'_{4,\mathrm{B}}$) is the distance that B moved in d_4 (or else d'_4). With $d'_{4,\mathrm{B}} = d_{4,\mathrm{R}}$ (R and B cover the same distance in ES but in different directions), we calculate

$$d_{4,\mathrm{R}} = \gamma\, d_{4,\mathrm{B}} \qquad \text{(time dilation)} \quad (12)$$

where $d_{4,\mathrm{R}}$ is the distance that R moved in d_4. Eqs. (9) and (12) tell us: SR works so well because γ is recovered when projecting ES to d_1 and to d_4. This is not a surprise. Weyl (1928) showed that the Lorentz group is generated by 4D rotations.

To understand how an acceleration manifests itself in ES, we return to our two clocks "r" and "b". We assume that "r" and Earth move in the d_4 axis of "r" at the speed c and that "b" accelerates in the d_1 axis of "r" toward Earth (Fig. 3). Because of Eq. (7), the speed $u_{1,\mathrm{b}}$ of "b" in d_1 increases at the expense of its speed $u_{4,\mathrm{b}}$ in d_4.

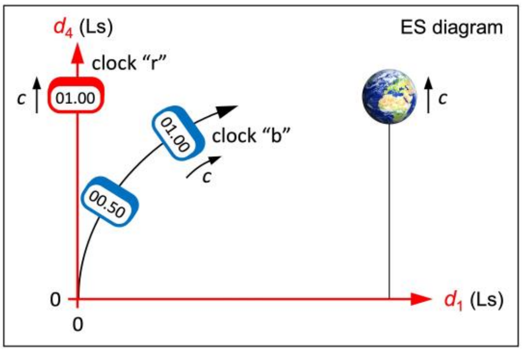

Fig. 3 ES diagram for two clocks "r" (red) and "b" (blue). Clock "r" and Earth move in the d_4 axis of "r" at the speed c. Clock "b" accelerates in the d_1 axis of "r" toward Earth

Gravitational waves support the idea of GR that gravitation is a feature of spacetime (Abbott et al., 2016). However, classical physics considers gravitation a force that has not yet been unified with the other three forces of physics. I claim that curved geodesics in ES replace curved spacetime in GR. To support my claim, we now calculate gravitational time dilation in ES. Let "r" and "b" be two identical clocks far away from Earth. Initially, they move next to each other in the d_4 axis of "r". At some point, "b" is sent in free fall toward Earth in the d_1 axis of "r" (Fig. 3). The kinetic energy of "b" with the mass m is

$$\frac{1}{2} m u_{1,\mathrm{b}}^2 \; = \; GMm/r \tag{13}$$

where G is the gravitational constant, M is the mass of Earth, and r is the distance of clock "b" to Earth's center. By applying Eq. (7), we obtain

$$u_{4,\mathrm{b}}^2 \; = \; c^2 \; - \; u_{1,\mathrm{b}}^2 \; = \; c^2 \; - \; 2GM/r \tag{14}$$

With $u_{4,\mathrm{b}} = \mathrm{d}d_{4,\mathrm{b}}/\mathrm{d}t$ ("b" moves in the d_4 axis at the speed $u_{4,\mathrm{b}}$) and $c = \mathrm{d}d_{4,\mathrm{r}}/\mathrm{d}t$ ("r" moves in the d_4 axis at the speed c), we calculate

$$\mathrm{d}d_{4,\mathrm{b}}^2 \; = \; (c^2 \; - \; 2GM/r)\,(\mathrm{d}d_{4,\mathrm{r}}/c)^2 \tag{15}$$

$$\mathrm{d}d_{4,\mathrm{r}} \; = \; \gamma_{\mathrm{gr}}\, \mathrm{d}d_{4,\mathrm{b}} \qquad \text{(gravitational time dilation)} \tag{16}$$

where $\gamma_{\mathrm{gr}} = (1 - 2GM/(rc^2))^{-0.5}$ is the same dilation factor as in GR. It does not depend on $u_{1,\mathrm{b}}$. Eq. (16) tells us: GR works so well because γ_{gr} is recovered when projecting ES to d_4. Thus, GPS satellites do their job in ER as well as in GR! When "b" returns to "r", clock "b" is behind clock "r". This dilation stems from projecting curved geodesics. In GR, it stems from a curved spacetime. *We sum up time dilation:* In SR/ER, a moving clock is slow with respect to an observer. In GR/ER, a clock in a stronger gravitational field is slow with respect to an observer. In SR/GR, an observed clock is slow in its flow of proper time. In ER, an observed clock is slow in the observer's flow of proper time. Since both γ and γ_{gr} are recovered, the experiment by Hafele and Keating (1972) also supports ER.

Three instructive examples (Fig. 4) demonstrate how to project from ES to 3D space. Problem 1: A rocket moves along a guide wire. In ES, rocket and wire move at the speed c. We assume that the wire moves in its d_4 axis. As the rocket moves along the wire, its speed in d_4 must be slower than c. Wouldn't the wire eventually be outside the rocket? Problem 2: A mirror passes a rocket. An observer in the rocket tip sends a light pulse to the mirror and tries to detect the reflection. In ES, all objects move at the speed c but in different directions. We assume that the observer moves in his d_4 axis. How can he ever detect the reflection? Problem 3: Earth revolves around the sun. We assume that the sun moves in its d_4 axis. As Earth covers a distance in d_1 and d_2, its speed in d_4 must be slower than c. Wouldn't the sun escape from the orbital plane of Earth?

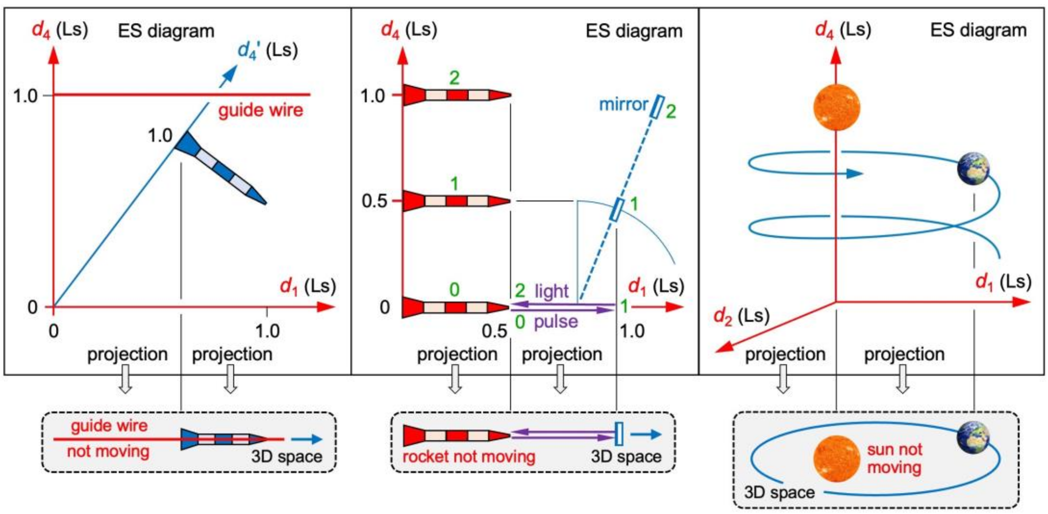

Fig. 4 Graphical solutions to three geometric paradoxes. **Left:** A rocket moves along a guide wire. In 3D space, the guide wire remains within the rocket. **Center:** An observer in a rocket tip tries to detect the reflection of a light pulse. Between two snapshots (0–1 or 1–2), rocket, mirror, and light pulse move 0.5 Ls in ES. In 3D space, the light pulse is reflected back to the observer. **Right:** Earth revolves around the sun. In 3D space, the sun remains in the orbital plane of Earth

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The questions in the last paragraph seem to imply that there are geometric paradoxes in ER, but there aren't any. The fallacy in all problems lies in the assumption that all four spatial dimensions would be observable. Just three of them are observable! All problems are solved by projecting ES to 3D space (Fig. 4 bottom). These projections tell us what an observer's reality is like because "suppressing the d_4 axis" is equivalent to "length contraction makes d_4 disappear". The suppressed axis d_4 is experienced as time. We easily verify in an observer's 3D space: The guide wire remains within the rocket; the light pulse is reflected back to the observer; the sun remains in the orbital plane of Earth.

5. Solving 15 Fundamental Mysteries of Physics

We recall: (1) An observer's reality is created by projecting ES orthogonally to his proper space and to his proper time. (2) There is a unique 4D vector $\boldsymbol{\tau}$ for each object. (3) Cosmic time t is the correct parameter for a holistic view. In Sects. 5.1 through 5.15, ER solves 15 mysteries, and it declares five concepts of today's physics obsolete.

5.1. Solving the Mystery of Time

Proper time τ is what clocks measure (d_4 divided by c). Cosmic time t is the total distance covered in ES divided by c. For each clock, its own proper time is always equal to cosmic time. An observed clock is slow in the observer's flow of proper time $\boldsymbol{\tau}$.

5.2. Solving the Mystery of Time's Arrow

The arrow of time is a synonym for "time moving only forward". The arrow emerges from the fact that the distance covered in ES is steadily increasing.

5.3. Solving the Mystery of the Factor c^2 in mc^2

In SR, if forces are absent, the total energy E of an object is given by

$$E \;=\; \gamma mc^2 \;=\; E_{\text{kin,3D}} + mc^2 \tag{17}$$

where $E_{\text{kin,3D}}$ is its kinetic energy in an observer's 3D space and mc^2 is its energy at rest. SR does not tell us why there is a factor c^2 in the energy of objects that in SR never move at the speed c. ER provides this missing clue: The object is not at rest, but it moves in its d'_4 axis. From its own perspective, its $E_{\text{kin,3D}}$ is zero, and mc^2 is its kinetic (!) energy in d'_4. The factor c^2 is a hint that it moves through ES at the speed c. In SR, there is also

$$E^2 \;=\; p^2c^2 \;=\; p_{\text{3D}}^2c^2 + m^2c^4 \tag{18}$$

where p is the total momentum of an object and p_{3D} is its momentum in an observer's 3D space. Again, ER is eye-opening: From the object's perspective, its p_{3D} is zero, and mc is its momentum in d'_4. The factor c is a hint that it moves through ES at the speed c. Eqs. (17) and (18) are not valid in ER. In ER, there is $E = mc^2$ and $p = mc$ for each object.

5.4. Solving the Mystery of Length Contraction and Time Dilation

ER discloses that length contraction and time dilation stem from projecting ES to an observer's reality. In SR, length contraction and time dilation can be derived from the Lorentz transformation, but their physical cause remains in the dark.

5.5. Solving the Mystery of Gravitational Time Dilation

ER discloses that gravitational time dilation stems from projecting curved geodesics in flat ES to the d_4 axis of an observer. If an object accelerates in his proper space, it automatically decelerates in his proper time. I am aware that more studies will be necessary to explain other gravitational effects. In GR, gravitational time dilation stems from a curved spacetime. In the next six sections, I show that ER outperforms GR in cosmology.

5.6. Solving the Mystery of the Cosmic Microwave Background

In this section, I outline an ER-based model of cosmology. There is no need to create ES. Space exists just like numbers. For some reason, there was a Big Bang. In the GR-based Lambda-CDM model, the Big Bang occurred "everywhere" because space inflated from a singularity. In the ER-based model, we can locate the Big Bang: It injected a huge amount of energy into a *non-inflating* and *non-expanding* ES all at once at what I call "origin O", the only natural reference point. The Big Bang occurred at the cosmic time $t = 0$ and was a singularity in terms of providing energy and radial momentum. Initially, all this energy receded radially from O at the speed c. Because of physical interactions (scattering, transversal acceleration, spontaneous emission), some energy departed from its radial motion while maintaining the speed c. Today, all energy is confined to a 4D hypersphere, while a significant amount of energy is confined to its 3D hypersurface.

Shortly after the Big Bang, energy was highly concentrated in ES. In the projection to any 3D space, a very hot and dense plasma was created. While the plasma was expanding, it cooled down. Cosmic recombination radiation (CRR) was emitted that we still observe as cosmic microwave background (CMB) today (Penzias & Wilson, 1965). At temperatures of 3,000 K, hydrogen atoms formed. The universe became increasingly transparent for the CRR. In the Lambda-CDM model, this stage was reached about 380,000 years "after" the Big Bang. In the ER-based model, these are 380,000 light years "away from" the Big Bang. The number needs to be recalculated if there was no cosmic inflation.

In Fig. 5, nature is described from the perspective of Earth (Earth moves vertically). From this perspective, the CRR cannot move in d_4 because it moves in d_1, d_2, d_3 at the speed c. The ER-based model must be able to answer these questions: (1) Why do we still observe the CMB today? (2) Why is the CMB nearly isotropic? (3) Why is the temperature of the CMB so low? Here are some possible answers: (1) The CRR has been scattered multiple times in d_1, d_2, d_3 (Fig. 5 left shows d_1). Some of the scattered CRR reaches Earth as CMB (in the projection to its 3D space) after having covered the same distance in d_1, d_2, d_3 as Earth in d_4. The cross section for scattering is low, but the fluence of the CRR is high. (2) The CRR was created and scattered equally in d_1, d_2, d_3. (3) The very low temperature is due to a very high recession speed (see Sect. 5.10) of all plasma particles.

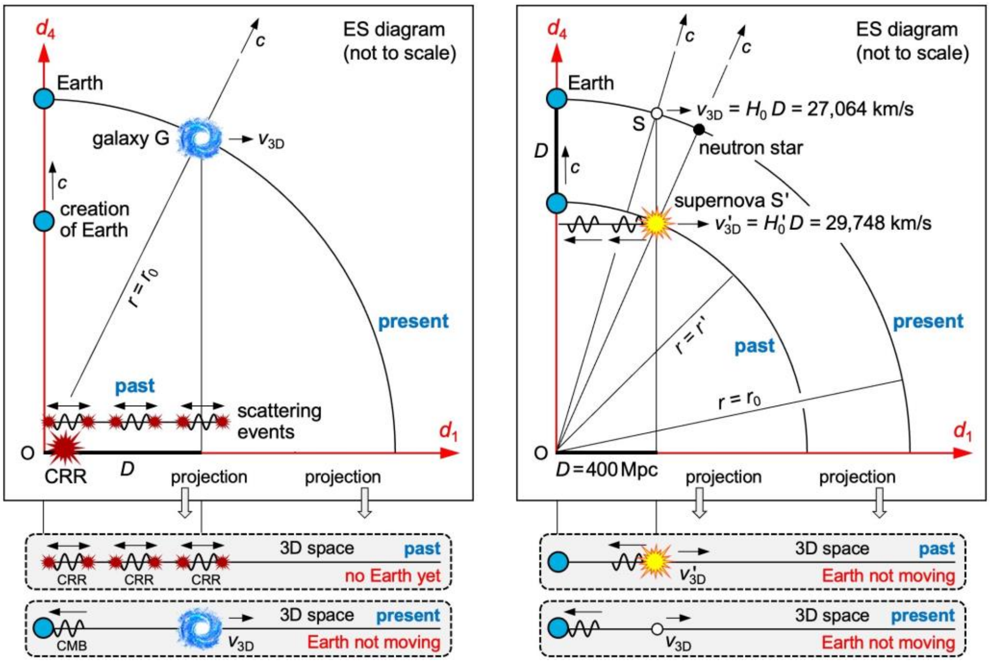

Fig. 5 ES diagrams and 3D projections for solving the mysteries 5.6, 5.7, 5.10, and 5.11. The circular arcs are part of an expanding 3D hypersurface. **Left:** The CMB is CRR that has been scattered in the past. Galaxy G recedes from Earth at the speed v_{3D}. **Right:** Supernova S′ occurred in the past at the distance D. If a supernova S occurs today at the same distance, it recedes more slowly than S′

5.7. Solving the Mystery of the Hubble–Lemaître law

The speed v_{3D} at which a galaxy G recedes from Earth in 3D space (Fig. 5 left) relates to its 3D distance D as c relates to the radius r of the 4D hypersphere.

$$v_{3D} = Dc/r = H_t D \quad (19)$$

where $H_t = c/r = 1/t$ is the Hubble parameter and t is the cosmic time elapsed since the Big Bang. Eq. (19) is the Hubble–Lemaître law (Hubble, 1929; Lemaître, 1927): The farther a galaxy is, the faster it recedes from Earth. Cosmologists are aware that H_t is a parameter rather than a constant. They are not yet aware of the 4D Euclidean geometry.

5.8. Solving the Mystery of the Flat Universe

For each observer, ES is projected orthogonally to his proper space and to his proper time. Thus, he experiences two seemingly discrete structures: a flat 3D space and time.

5.9. Solving the Mystery of Cosmic Inflation

Many physicists assume that an inflation of space in the early universe (Linde, 1990; Guth, 1997) would explain the isotropic CMB, the flatness of the universe, and large-scale structures (inflated from quantum fluctuations). I just showed that ER explains the first two effects. ER also explains the third effect if the impacts of quantum fluctuations have been expanding at the speed c. ***In ER, cosmic inflation is an obsolete concept.***

5.10. Solving the Mystery of the Hubble Tension

There are different methods for calculating the Hubble constant $H_0 = c/r_0$, where r_0 is today's radius of the 4D hypersphere. Up next, I explain why the calculated values do not match (also known as the "Hubble tension"). I compare CMB measurements using the *Planck space telescope* with distance ladder measurements using the *Hubble space telescope*. Team A (Aghanim et al., 2020) calculates $H_0 = 67.66 \pm 0.42$ km/s/Mpc, but team B (Riess et al., 2018) calculates $H_0 = 73.52 \pm 1.62$ km/s/Mpc. Team B made efforts to minimize the error margins in the distance measurements. I will show that misinterpreting the redshift data causes a systematic error in team B's calculation of H_0. We assume that the value of team A is correct. We simulate a supernova S′ at a distance of $D = 400$ Mpc. If this supernova occurred today (S in Fig. 5 right), we would calculate from Eq. (19)

$$v_{3D} = H_0 D = 27{,}064 \text{ km/s} \quad (20)$$

$$z = \Delta\lambda/\lambda_{\text{emit}} \approx v_{3D}/c = 0.0903 \quad (21)$$

where the redshift parameter z tells us how each emitted wavelength λ_{emit} of the supernova's light is either *passively stretched* by an expanding space (team B), or how each λ_{emit} is redshifted by the Doppler effect of *actively receding* objects (ER-based model). In Fig. 5 right, there is an arc called "past" when the supernova S′ occurred and an arc called "present" when its light arrives on Earth. While the supernova's light moved the distance D in the d_1 axis, Earth moved the same D in the d_4 axis (first postulate). Thus, team B receives data from a time $t' = 1/H_{t'}$ when there was $r' < r_0$ and $H_{t'} > H_0$.

$$1/H_{t'} = r'/c = (r_0 - D)/c = 1/H_0 - D/c \quad (22)$$

$$H_{t'} = 74.37 \text{ km/s/Mpc} \quad (23)$$

Since team B is not aware of Eq. (22), it concludes that 74.37 km/s/Mpc would be the value of H_0. In truth, team B ends up with a value $H_{t'}$ of the past. For a short distance of $D = 400$ kpc, Eq. (22) tells us that $H_{t'}$ deviates from H_0 by only 0.009 percent. However,

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when plotting v'_{3D} versus D for long distances (50 Mpc, 100 Mpc, ..., 450 Mpc), the slope $H_{t'}$ is 8 to 9 percent greater than H_0. *This solves the Hubble tension.* I kindly ask team B to recalculate H_0 after converting all v'_{3D} of the past to v_{3D}. Eq. (22) tells us how to do so:

$$H_{t'} = H_0\, c \,/\, (c - H_0\, D) = H_0 \,/\, (1 - v_{3D}/c) \tag{24}$$

$$v_{3D} = v'_{3D} \,/\, (1 + v'_{3D}/c) \tag{25}$$

Of course, team B is well aware of the fact that the supernova's light was emitted in the past, but all that counts in the Lambda-CDM model is the timespan during which the light is moving to Earth. Along the way, each wavelength λ_{emit} is continuously stretched by an expanding space. The redshift parameter z increases during the journey to Earth. That moment when the supernova occurred is irrelevant. In the ER-based model, that very moment is relevant, but the timespan is irrelevant. Each λ_{emit} is initially redshifted at the cosmic time t' by the Doppler effect. During the journey to Earth, the redshift parameter z' remains constant. This parameter is tied up in a "package" when the supernova occurs and sent to Earth, where it is measured. A 3D hypersurface (made of energy) expands in 4D space. ***In ER, expansion of space is an obsolete concept.***

5.11. Solving the Mystery of Dark Energy

Team B can fix the systematic error in its calculation of H_0 within the Lambda-CDM model by converting all v'_{3D} to v_{3D} according to Eq. (25). I now reveal another systematic error, but it is inherent in the Lambda-CDM model itself. It has to do with assuming an accelerating expansion of space, and it can be fixed only by replacing that model with the ER-based model of cosmology unless we postulate a dark energy. Cosmologists (Perlmutter et al., 1998; Riess et al., 1998) favor an accelerating expansion of space because the calculated recession speeds deviate from Eq. (19). The deviations increase with distance, and an accelerating expansion of space would stretch each λ_{emit} even further.

The ER-based model provides a simpler explanation for the deviations from Eq. (19): $H_{t'} = 1/t'$ from any past is greater than H_0. The older the redshift data are, the more $H_{t'}$ deviates from H_0, and the more v'_{3D} deviates from v_{3D}. If a supernova S (small circle in Fig. 5 right) occurred today at the same distance of 400 Mpc as S', the supernova S would recede more slowly (27,064 km/s) than S' (29,748 km/s) according to Eq. (25). It would do so because of $H_{t'} > H_0$. As long as we are not aware of the 4D Euclidean geometry, higher redshifts are attributed to an accelerating expansion of space. Now that we are aware of the geometry, we can attribute higher redshifts to the Doppler effect of receding galaxies. Since the Lorentz factor is recovered in the projections from ES, the equations of SR remain valid in an observer's reality. Thus, there is

$$\frac{v_{3D}}{c} = \frac{(1+z)^2 - 1}{(1+z)^2 + 1} \tag{26}$$

where z is the observed redshift. While the supernova's light moved the distance D in the d_1 axis, Earth moved the same D in the d_4 axis (first postulate). The light was created at the radius r'. From Eq. (19) and $r' = r_0 - D$, we calculate v'_{3D} at the time t'.

$$v'_{3D} = v_{3D}\, r_0/r' = v_{3D} \,/\, (1 - D/r_0) \tag{27}$$

Fig. 6 shows the distance modulus μ of 16 low-redshift and 24 high-redshift supernovae. The low redshifts were published by Hamuy et al. (1996). The high-redshifts were published by Perlmutter et al. (1998). I considered those supernovae that had been studied by both Perlmutter et al. (1998) and Riess et al. (2004). For all 40 supernovae, I calculated v_{3D} from Eq. (26). Subsequently, I used Eq. (27), the relation $D = 10^{0.2\mu+1}$, and a radius of $r_0 = 14.25$ Gpc (Bars & Terning, 2010) to calculate v'_{3D}.

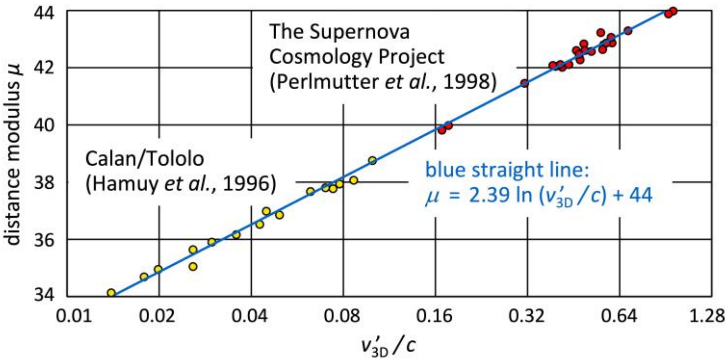

Fig. 6 Hubble diagram for 40 Type Ia supernovae. The horizontal axis displays adjusted speeds. All the data, including their uncertainties, are listed in the Appendix A

Linear regression yields the blue straight line in Fig. 6. Its equation is given by

$$v'_{3D} \;=\; H_0^* \, D \tag{28}$$

where H_0^* is a true constant. The offset "44" in Fig. 6 relates to $H_0^* \approx 48$ km/s/Mpc (see Appendix B). H_0^* is lower than H_0 in the Lambda-CDM model, but it is not the task of ER to recover a value that stems from a different spacetime. Only in ER do all 40 supernovae, including the high redshifts, fit very well to a straight line. Eq. (28) is the correct Hubble–Lemaître law. The term "dark energy" was coined by Turner (1998) to explain an accelerating expansion of space. Space does not expand, but energy recedes. ***In ER, dark energy is an obsolete concept.*** It has never been observed anyway.

Any expansion of space (uniform as well as accelerating) is only virtual. There is no accelerating expansion of the Universe even if the Nobel Prize in Physics 2011 was given "for the discovery of the accelerating expansion of the Universe through observations of distant supernovae" (The Nobel Foundation, 2011). There are two misconceptions in this praise: (1) In the Lambda-CDM model, the term "Universe" implies space, but space is *not expanding* at all. (2) There is receding energy, but it recedes *uniformly* at the speed c. There only seems to be an accelerating expansion of space in an observer's reality.

Radial momentum provided by the Big Bang drives all galaxies away from the origin O. They are driven by themselves rather than by dark energy. If the 3D hypersurface has always been expanding at the speed c, the time elapsed since the Big Bang is $1/H_0^*$, which is 20.4 billion years rather than 13.8 billion years (Choi et al., 2020). The older age fits better to stars that are 14.5 billion years old (Bond et al., 2013). Table 1 compares two models of cosmology. Be aware that the "Universe" (uppercase) in the Lambda-CDM model is not the same as the "universe" (lowercase) in the ER-based model. In the next two sections, I show that ER is compatible with QM. Since "quantum gravity" is meant to make GR compatible with QM, I conclude: ***In ER, quantum gravity is an obsolete concept.***

Lambda-CDM model based on GR	**Model of cosmology based on ER**
Big Bang was the beginning of the Universe.	Big Bang was the injection of energy into ES.
Big Bang occurred "everywhere".	Big Bang can be localized at an origin O of ES.
Big Bang occurred about 13.8 billion years ago.	Big Bang occurred about 20.4 billion years ago.
There are two competing values of H_0.	H_0^* is approximately 48 km/s/Mpc.
The Universe: all space, all time, and all energy.	The universe: proper space of an observer.
Space is inflating and expanding.	Galaxies are receding radially in ES.
Space is driven by dark energy.	Galaxies are driven by radial momentum.
Spacetime is curved.	Trajectories of objects are curved in ES.
Time is what I read on my clock.	Time is distance covered in ES divided by c.
GR is not compatible with quantum mechanics.	ER is compatible with quantum mechanics.

Table 1 Comparing the Lambda-CDM model with the ER-based model of cosmology

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5.12. Solving the Mystery of the Wave–Particle Duality

The wave–particle duality was first discussed by Bohr and Heisenberg (Heisenberg, 1969) and has bothered physicists ever since. Electromagnetic waves are oscillations of an electromagnetic field, which propagate through an observer's 3D space at the speed c. In some experiments, objects behave like waves. In other experiments, these objects behave like particles. Up next, I explain how the very same object appears as a wave packet or as a particle depending on the perspective. From an observer's perspective, it may appear as a wave packet or as a particle. From its own perspective, it is a particle at rest.

Based on the wave–particle duality, I suggest that we introduce a generalized concept of energy: All energy is "wavematter", which may appear as wave packets or as particles in an observer's reality (Fig. 7). In my reality (external view, coordinate spacetime!), such a wavematter may appear as a wave packet or as a particle. As a wave, it propagates in my x_1 axis at the speed c, and it oscillates in my axes x_2 (electric field) and x_3 (magnetic field). Both propagating and oscillating occur as a function of coordinate time t. In its own reality (internal view, "in-flight view"), the axis of the wavematter's 4D motion disappears because of length contraction at the speed c. Thus, it deems itself particle at rest (energy at rest). "Wavematter" is more than just another word for the duality. The internal view requires at least four spatial dimensions and is thus not available in SR/GR.

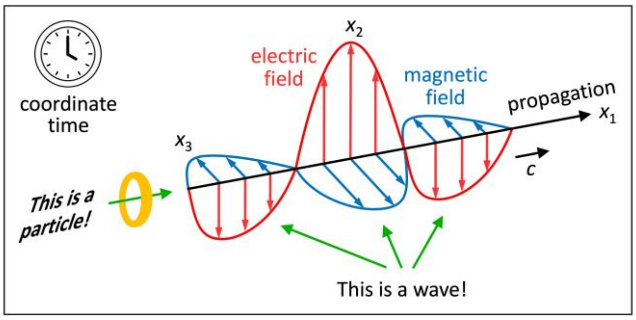

Fig. 7 Artwork illustrating the concept "wavematter". If I observe a wavematter (external view), it may appear as a wave packet or as a particle. As a wave, it propagates and oscillates as a function of coordinate time. In its own reality (internal view), the axis of the wavematter's 4D motion disappears because of length contraction at the speed c. It deems itself particle at rest

Like coordinate space and coordinate time, waves and particles are subjective concepts (defined by an observer): *What I deem wave, deems itself particle at rest.* Einstein (1905c) taught that energy is equivalent to mass. The equivalence shows itself in the wave–particle duality: Since each wavematter moves through ES at the speed c, the axis of its 4D motion disappears for itself. From its own perspective (that is, in its own reality), all of its energy "condenses" to what we call "mass" in a particle at rest.

In a double-slit experiment, wavematters pass through a double-slit and produce an interference pattern on a screen. An observer deems them wave packets as long as he does not track through which slit each wavematter is passing. Thus, he is an external observer. The photoelectric effect is quite different. Of course, one can externally witness how one photon releases one electron from a metal surface. However, the physical effect—do I have enough energy to release an electron?—is all up to the photon's view. Only if the photon energy exceeds the binding energy of an electron is this very electron released. Thus, we must interpret the photoelectric effect from the internal view of the photon. Here, its view is crucial! The photon behaves like a particle.

The duality is also observed in matter, such as electrons (Jönsson, 1961). Electrons are wavematters too. From the internal view (if the electron is tracked), this electron is a particle: Which slit will it pass through? From the external view (if the electron is not tracked), this electron behaves like a wave. Since I automatically track all slow objects (slow for me), I deem macroscopic objects matter/particles rather than waves. This argument justifies the drawing of solid rockets and celestial bodies in the ES diagrams.

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5.13. Solving the Mystery of Non-Locality

The term "entanglement" was coined by Schrödinger (1935) in his comment on the Einstein–Podolsky–Rosen paradox (Einstein et al., 1935). These three authors argued that QM would not provide a complete description of reality. Schrödinger's word creation did not solve the paradox but demonstrates our difficulties in comprehending QM. Bell (1964) showed that no local hidden variable theory is compatible with QM. In many experiments (Freedman & Clauser, 1972; Aspect et al., 1982; Bouwmeester et al., 1997), entanglement violates locality. Ever since, entanglement has been considered a non-local effect.

Up next, we untangle entanglement *without* the concept of non-locality. All we have to do is discuss it in ES. Four spatial dimensions make non-locality obsolete. Fig. 8 displays two wavematters that were created at once at a point P. They are now moving away from each other in opposite directions $\pm d_4'$ at the speed c. It turns out that these wavematters are automatically entangled. For an observer moving in any direction other than $\pm d_4'$ (external view), they are two distinct objects. The observer cannot understand how these two wavematters are able to communicate with each other in no time.

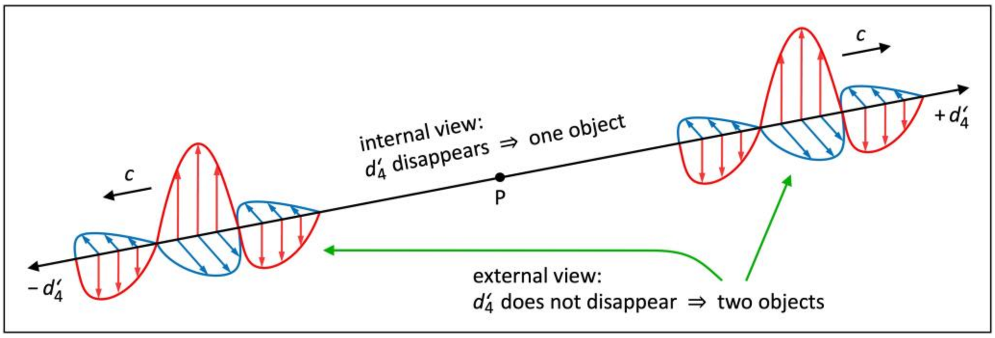

Fig. 8 Solving non-locality in ER. For an observer moving in any direction other than $\pm d_4'$ (external view), the displayed wavematters moving in $\pm d_4'$ are two distinct objects. For each wavematter (internal view), the $\pm d_4'$ axis disappears. They are one object that has never been separated

For each wavematter in Fig. 8 (internal view), the $\pm d_4'$ axis disappears because of length contraction at the speed c. In their common (!) proper space spanned by d_1', d_2', d_3', either of them deems itself at the very same position as its twin. From either perspective, they are *one object* that has never been separated. This is how they communicate with each other in no time. There is no "spooky action at a distance". The twins stay together in their proper space even if their proper time flows in opposite directions. Entanglement occurs because an observer's proper space *may be different* from an observed object's proper space. This is possible only if there are at least four spatial dimensions. ER explains the entanglement of electrons or atoms too. In my proper space, they move at a speed $v_{3D} < c$. In their $\pm d_4'$ axis, they move at the speed c. Any measurement tilts the axis of 4D motion of one twin and destroys the entanglement. ***In ER, non-locality is an obsolete concept.***

5.14. Solving the Mystery of Spontaneous Effects

In *spontaneous emission,* a photon is emitted by an excited atom. Prior to the emission, the photon energy moves with the atom. After the emission, this energy moves by itself. Today's physics cannot explain how this energy is boosted to the speed c in no time. In ES, both atom and photon move at the speed c. Thus, there is no need to boost any energy to the speed c. All it takes is energy from ES whose 4D motion "swings completely" (rotates by an angle of $90°$) into an observer's 3D space. This energy speeds off at the speed c. In *absorption,* a photon is spontaneously absorbed by an atom. Today's physics cannot explain how this energy is slowed down to the atom's speed in no time. In ES, both photon and atom move at the speed c. Thus, there is no need to slow down any energy. Similar arguments apply to pair production and to annihilation. Spontaneous effects are another clue that all energy moves through ES at the speed c.

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5.15. *Solving the Mystery of the Baryon Asymmetry*

According to the Lambda-CDM model, almost all matter in the Universe was created shortly after the Big Bang. Only then was the temperature high enough to enable the pair production of baryons and antibaryons. However, the energy density was also very high so that the baryons and antibaryons should have annihilated each other again. Since we observe more baryons than antibaryons today (also known as the "baryon asymmetry"), it is assumed that an excess of baryons was produced in the early Universe (Canetti et al., 2012). However, an asymmetry in pair production has never been observed.

ER solves the baryon asymmetry: Since each wavematter deems itself particle, there were particles in ES immediately after the Big Bang. There are much less antiparticles than particles today *because antiparticles are created in pair production only.* One may ask: Why do wavematters not deem themselves antiparticles? Antiparticles are not the opposite of particles but particles with the opposite electric charge. They seem to flow backward in time because proper time flows in opposite directions for any two wavematters created in pair production. These two wavematters are automatically entangled.

6. Conclusions

ER solves mysteries that have not been solved in 100+ years or that have been solved but with concepts that are obsolete in ER: cosmic inflation, expansion of space, dark energy, quantum gravity, non-locality. Today's physics needs these concepts to make cosmology and QM work, but Occam's razor shaves them off. However, the SO(4) symmetry of ES is incompatible with waves. This is fine because waves and particles are subjective concepts emerging from a construed spacetime in SR/GR. Beyond an observer's reality with waves and particles, there is the master reality ES with wavematters.

Unfortunately, most physicists consider SR/GR two of the greatest achievements of physics just because they have been confirmed many times over. I showed that SR/GR do not provide a holistic view, and I suspect that the stagnation in today's physics is due to this limitation. Physics got stuck in its own concepts. 15 solved mysteries tell us that there is a lot more physics beyond SR/GR. It is very unlikely that 15 solutions in various (!) fields of physics are just 15 coincidences. *Only in natural spacetime does Mother Nature disclose her secrets.* If we think of each observer's reality as an oversized stage, the keys to cosmology and QM are beyond the stage curtain. The true pillars of physics are ER and QM. Together, they describe the very large and the very small.

It was a wise decision to award Albert Einstein the Nobel Prize for his theory of the photoelectric effect (Einstein, 1905a) and not for SR/GR. ER penetrates to a deeper level. Einstein—one of the most brilliant physicists ever—failed to realize that the fundamental metric chosen by Mother Nature is Euclidean. Nature chose a simple but beautiful setting for life: fully symmetric, 4D Euclidean space. Einstein sacrificed absolute space and time. I sacrifice the absoluteness of waves and particles, but I restore absolute time. For the first time, mankind understands the nature of time: Cosmic time is the total distance covered in ES divided by c. The human brain is able to imagine that we all move through 4D space at the speed of light. *With that said, conflicts of mankind become all so small.*

Final remarks: (1) I addressed gravitation only briefly, but I ask you once more to be patient and fair. We should not reject ER just because gravitational effects are not yet fully understood. It is promising that ER predicts the same gravitational lensing and the same perihelion precession of Mercury's orbit as GR (Montanus, 2023). (2) To cherish the beauty of ER, we must give ourselves a push and accept that an observer's reality is a projection. We must not ask in physics: Why is it a projection? Nor must we ask: Why is it a probability function? In my opinion, an inflating or expanding space is at least as speculative as a projection. (3) It looks like Plato was right with his *Allegory of the Cave* (see Politeia, 514a): Mankind experiences a projection that is blurred—because of QM. It is not by chance that the author of this paper is an experimental physicist. The construed concepts of spacetime in SR/GR are not suspicious to theorists. This paper lays the groundwork for ER. Everyone is welcome to join in! May ER now get the broad acceptance that it deserves.

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Declarations

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Comments: It takes open-minded, courageous editors and reviewers to evaluate a theory that comes with a paradigm shift. Whoever adheres to established concepts is paralyzing the scientific progress. I did not surrender when my paper was rejected by several journals. Interestingly, I was never given conclusive arguments. Rather, I was asked to try a different journal. Were the editors dazzled by the success of SR/GR? Did they underestimate the benefits of ER? Even friends refused to support me. However, each setback inspired me to work out the benefits of ER even better. Finally, I succeeded in disclosing an issue in SR/GR and in formulating a new theory that is even more general than GR. I publish these comments to encourage young scientists to stand up for promising ideas, but opposing the mainstream can be exhausting. Here are some statements that I received from top journals: "Unscholarly research." "This is fake science." "Too simple to be true." Simplicity and truth are not mutually exclusive! The editor-in-chief of a top journal replied that publishing is "for experts only". A well-known preprint archive suspended my submission privileges.

Conflict of Interest: The author has no competing interests to declare.

Ethical Approval: not applicable.

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Availability of Data and Materials: All the data displayed in Fig. 6 are listed in the Appendix A.

Appendix A

All the data displayed in Fig. 6, including their uncertainties.

Col. 1: IAU name assigned to the supernova.
Col. 2: Redshift z according to Perlmutter et al. (1998).
Col. 3: Uncertainty in z according to Perlmutter et al. (1998).
Col. 4: Distance modulus μ according to Riess et al. (2004).
Col. 5: Uncertainty in μ according to Riess et al. (2004).
Col. 6: Distance D in parsec calculated from $D = 10^{0.2\mu+1}$.
Col. 7: v_{3D}/c calculated from Eq. (26).
Col. 8: v'_{3D}/c calculated from Eq. (27).

SN	z	σ_z	μ	σ_μ	D (pc)	v_{3D}/c	v'_{3D}/c
1990O	0.030	0.002	35.90	0.20	1.514E8	0.0296	0.0299
1990af	0.050	0.002	36.84	0.21	2.333E8	0.0488	0.0496
1992P	0.026	0.002	35.64	0.20	1.343E8	0.0257	0.0259
1992ae	0.075	0.002	37.77	0.19	3.581E8	0.0722	0.0741
1992ag	0.026	0.002	35.06	0.24	1.028E8	0.0257	0.0259
1992al	0.014	0.002	34.12	0.25	6.668E7	0.0139	0.0140
1992aq	0.101	0.002	38.73	0.20	5.572E8	0.0959	0.0998
1992bc	0.020	0.002	34.96	0.22	9.817E7	0.0198	0.0199
1992bg	0.036	0.002	36.17	0.19	1.714E8	0.0354	0.0358
1992bh	0.045	0.002	36.97	0.18	2.477E8	0.0440	0.0448
1992bl	0.043	0.002	36.53	0.19	2.023E8	0.0421	0.0427

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1992bo	0.018	0.002	34.70	0.23	8.710E7	0.0178	0.0179
1992bp	0.079	0.002	37.94	0.18	3.873E8	0.0759	0.0780
1992br	0.088	0.002	38.07	0.28	4.111E8	0.0841	0.0866
1992bs	0.063	0.002	37.67	0.19	3.420E8	0.0610	0.0625
1993B	0.071	0.002	37.78	0.19	3.597E8	0.0685	0.0703
—	—	—	—	—	—	—	—
1995ar	0.465	0.005	42.81	0.22	3.648E9	0.3643	0.4896
1995as	0.498	0.001	43.21	0.24	4.385E9	0.3835	0.5540
1995aw	0.400	0.030	42.04	0.19	2.559E9	0.3243	0.3953
1995ax	0.615	0.001	42.85	0.23	3.715E9	0.4457	0.6029
1995ay	0.480	0.001	42.37	0.20	2.979E9	0.3731	0.4717
1995ba	0.388	0.001	42.07	0.19	2.594E9	0.3166	0.3871
1996cf	0.570	0.010	42.77	0.19	3.581E9	0.4228	0.5647
1996cg	0.490	0.010	42.58	0.19	3.281E9	0.3789	0.4922
1996ci	0.495	0.001	42.25	0.19	2.818E9	0.3818	0.4759
1996cl	0.828	0.001	43.96	0.46	6.194E9	0.5393	0.9540
1996cm	0.450	0.010	42.58	0.19	3.281E9	0.3554	0.4617
1997F	0.580	0.001	43.04	0.21	4.055E9	0.4280	0.5982
1997H	0.526	0.001	42.56	0.18	3.251E9	0.3992	0.5172
1997I	0.172	0.001	39.79	0.18	9.078E8	0.1574	0.1681
1997N	0.180	0.001	39.98	0.18	9.908E8	0.1640	0.1763
1997P	0.472	0.001	42.46	0.19	3.105E9	0.3684	0.4710
1997Q	0.430	0.010	41.99	0.18	2.500E9	0.3432	0.4162
1997R	0.657	0.001	43.27	0.20	4.508E9	0.4660	0.6816
1997ac	0.320	0.010	41.45	0.18	1.950E9	0.2707	0.3136
1997af	0.579	0.001	42.86	0.19	3.733E9	0.4275	0.5792
1997ai	0.450	0.010	42.10	0.23	2.630E9	0.3554	0.4358
1997aj	0.581	0.001	42.63	0.19	3.357E9	0.4285	0.5606
1997am	0.416	0.001	42.10	0.19	2.630E9	0.3345	0.4102
1997ap	0.830	0.010	43.85	0.19	5.888E9	0.5401	0.9205

Appendix B

Estimation of H_0^*.

$$\mu \;=\; 2.39\ln(v'_{3\mathrm{D}}/c) + 44$$

$$5\log D - 5 \;=\; 2.39\ln(v'_{3\mathrm{D}}/c) + 44$$

$$\ln D/\ln 10 \;=\; 0.478\ln(v'_{3\mathrm{D}}/c) + 9.8$$

$$\ln D \;=\; 1.1\;\ln(v'_{3\mathrm{D}}/c) + 22.6$$

$$D \;\approx\; (v'_{3\mathrm{D}}/c) \times 6.31\mathrm{E}9$$

$$v'_{3\mathrm{D}} \;\approx\; D \times 0.048\ \mathrm{m/s/pc}$$

$$H_0^* \;\approx\; 48\ \mathrm{km/s/Mpc}$$

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