Article

Euclidean Relativity Outperforms General Relativity

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Abstract: Today's concept of time traces back to Einstein's theory of special relativity (SR). In SR, he shows how inertial systems relate to each other. In general relativity (GR), he considers gravitation a property of curved spacetime. Here we prove: Einstein makes two mistakes in his concept of time. (1) He claims that clocks in a system K′ could synchronize at any instant with clocks in K, where K′ moves relative to K. If they did, they would have no clockwork. (2) He assigns variables of time to K′ (or else K) instead of assigning them to the measuring observer. Mislead by SR, Einstein makes a third mistake: In GR, he selects again an indefinite metric. Our "Euclidean relativity" (ER) is based on a Euclidean metric. We postulate: (1) In Euclidean spacetime (ES), all energy is moving radially away from an origin at the speed of light. (2) The laws of physics have the same form in each reality (projection of ES to an observer's 3D space). (3) All energy is "wavematter" (electromagnetic wave packet and matter in one). Previous ER models run into paradoxes as they conceive of ES as reality. We show: The Lorentz transformation in SR is recovered in ER; gravitation relates to a rotation; ER is compatible with quantum mechanics. Einstein's mistakes in SR have no measurable consequence, but GR is only an approximation for individual observers. We solve 12 fundamental mysteries, like today's Hubble constant, dark energy, wave–particle duality, and quantum entanglement.

Keywords: relativity; quantum mechanics; cosmology; spacetime; gravitation; Theory of Everything

1. Introduction

Albert Einstein coined today's concepts of space and time. His theory of special relativity (SR) [1] is usually interpreted in Minkowski spacetime (MS) because Hermann Minkowski's geometric interpretation [2] was very successful in explaining relativistic effects. SR comes with an indefinite Minkowski metric and is limited to inertial reference frames. General relativity (GR) [3] includes gravitation and turns flat MS into a curved spacetime with a pseudo-Riemannian metric. SR and GR are good for describing the world that we perceive on and from Earth: Explaining the lifetime of muons [4], predicting the deflection of starlight [5], and the high accuracy of GPS are just a few examples. Quantum field theory [6] unifies classical field theory, SR, and quantum mechanics, but not GR.

Our theory confirms relativity and quantum mechanics as the two pillars of physics, but we do question the ground on which they stand: today's concepts of time and energy. We introduce three new concepts to physics. Superior concepts of *time* and *distance* give us a superior theory of relativity. A superior concept of *energy* enables us to make relativity compatible with quantum mechanics. Our theory [7] was already peer-reviewed once, but the outcome was disturbing: We wouldn't know anything about physics. The review reports disclosed that there was a systematic error in most of them: *Reviewers took today's concepts of physics for granted while evaluating our new concepts.* Mankind would still believe in the geocentric model if science had never let go obsolete concepts. Interestingly enough, no contradictions were found in our theory.

We ask all readers including editors and reviewers: *Do not take SR and GR for granted while reading this report. If you do, you won't understand.* We have revised our reasoning and start off with a striking proof: Einstein makes two mistakes in his concept of time! Mislead

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by the indefinite Minkowski metric in SR, he makes a third mistake: He selects a generalized indefinite metric in GR. This is why physicists have been on the wrong track for more than 100 years. Most likely, Einstein's mistakes were overlooked because of two reasons: (1) In SR, they have no measurable consequence. (2) His mistake in GR is hidden by dark energy. Yet dark energy won't make GR compatible with quantum mechanics.

Five journals rejected our manuscript at the editor's desk because of "no scholarly research". The editor of a top journal argued we wouldn't provide extraordinary proof for our extraordinary claims. Isn't solving 12 mysteries extraordinary proof? Another editor told us that science wouldn't care about a non-observable, mathematical world, but only about the observable, physical world. Really? Can we observe time? We consider it irony that one journal—where Einstein once published—replied they wouldn't even look at our manuscript because we wouldn't be experts. What makes a physicist an expert? Working for decades with a concept of time that we prove to be flawed? SR and GR turned into a dogma as they must not be questioned. Be aware that scientific theories can't be proven, but only be disproven. We do just that! *We knock out Einstein's concept of time.*

We call our theory "Euclidean relativity" (ER) and formulate three postulates: (1) In Euclidean spacetime (ES), all energy is moving radially away from an origin at the speed of light. (2) The laws of physics have the same form in each "reality" (projection of ES to an observer's 3D space). (3) All energy is "wavematter" (electromagnetic wave packet and matter in one). Our first postulate is stronger than Einstein's second postulate. The speed of light is absolute and universal: Everything is moving through ES at the speed of light. Our second postulate is the same as Einstein's first postulate, except that ER isn't limited to inertial frames and that we distinguish ES from an observer's reality. Our third postulate paves the way for unifying relativity and quantum mechanics.

Immanuel Kant [8] provided the philosophical framework of classical physics. Find out for yourself whether our theory could be the philosophical framework of cosmology and quantum mechanics! Physics can be improved, but not by just flipping a switch. Some authors claim that everything would move *through MS* at the speed of light [9]. They just multiply the dimension of time t by the speed of light c to match the unit of space. What they don't see: Moving through MS at the speed of light is a pointless concept. An object at rest in an observer's reference frame would move in the axis ct at the speed c. That is, it would move in time at the trivial speed "one second per one second".

We aren't the first physicists to investigate ER: [10] makes a first attempt to describe ES. [11] investigates relativistic dynamics in ES. [12] tries to implement electrodynamics and gravitation in ES. [13] proves that the Lorentz transformation in SR becomes an SO(4) rotation in ER. [14] studies energy and momentum in ES. *Yet in none of these models is reality formed by projecting ES to 3D space.* By conceiving of ES as an observer's reality, they all run into geometric paradoxes that we discuss in Sect. 4. Only [15] adds a "boundedness postulate" to avoid paradoxes, but that postulate sounds contrived.

Our theory must not be confused with the Hypergeometrical Universe Theory (HU theory) [16], which never passed the peer-review process. There are two huge differences: (1) HU theory claims that the universe has four spatial dimensions. So, it also fails to solve those paradoxes in Sect. 4. In our initial model [17], we struggled with the same issue until we surrendered the idea of four spatial dimensions. (2) In HU theory, matter is made from deformed space. In our theory, ES is non-deformable. Matter is "a matter" of an observer's perspective. We will show in Sect. 5.9: What I deem wave, deems itself matter.

It is helpful to compare our theory with Newton's physics and Einstein's physics. In Newton's physics, all objects are moving through a non-deformable 3D space as a function of independent time. The speed of matter is $v_{3D} \ll c$. In Einstein's physics, all objects are moving through a deformable spacetime given by 3D space and time, where time is linked to, but different from space (time is measured in seconds). The speed of matter is $v_{3D} < c$. In our theory, all objects are moving through a non-deformable ES given by 4D "distance" (all distances are measured in light seconds), where time is a subordinate quantity derived from the distance covered in ES. The 4D speed of everything in ES is $u_{4D} = c$.

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Because breaking a dogma is likely a once-in-a-century event, we provide a roadmap of how we will proceed. Section 2: We prove that Einstein makes two expensive mistakes. Section 3: (a) We introduce ES. (b) We formulate a Theory of Everything in hyperspherical coordinates. (c) We convert these to Cartesian coordinates. Section 4: (a) We show that the Lorentz transformation in SR is recovered in ER. (b) We solve three geometric paradoxes in ER. Section 5: We solve 12 mysteries of physics. Section 6: We draw conclusions.

2. Two Expensive Mistakes in Einstein's Concept of Time

The concept of time in today's physics traces back to Albert Einstein. For this reason, we call it "Einstein time". Einstein starts his theory of SR [1] with a § 1 which is a detailed instruction of how to synchronize two clocks at the positions A and B in space. He sends a ray of light at "A time" t_{A} from A towards B. At "B time" t_{B}, this light is reflected at B towards A. Finally, at "A time" t_{A}^* this light is back at A. The clocks synchronize if

$$t_{\mathrm{B}} - t_{\mathrm{A}} = t_{\mathrm{A}}^* - t_{\mathrm{B}} \ . \tag{1}$$

In § 2, he is considering a rod that is moving at a constant speed (we call it $v_{3\mathrm{D}}$) with respect to some stationary system. We are now following the English translation of [1] by Jeffery and Perrett [18]. Einstein writes: "We imagine further that at the two ends A and B of the rod, clocks are placed which synchronize with the clocks of the stationary system, that is to say that their indications correspond *at any instant* to the time of the stationary system at the places where they happen to be. These clocks are therefore synchronous in the stationary system. We imagine further that with each clock there is a moving observer, and that these observers apply to both clocks the criterion established in § 1 for the synchronization of two clocks. Let a ray of light depart from A at the time t_{A}, let it be reflected at B at the time t_{B}, and reach A again at the time t_{A}^*. Taking into consideration the principle of the constancy of the velocity of light we find that

$$t_{\mathrm{B}} - t_{\mathrm{A}} = r_{\mathrm{AB}} \,/\, (c - v_{3\mathrm{D}}) \ , \tag{2a}$$

$$t_{\mathrm{A}}^* - t_{\mathrm{B}} = r_{\mathrm{AB}} \,/\, (c + v_{3\mathrm{D}}) \ , \tag{2b}$$

where r_{AB} is the length of the moving rod—measured in the stationary system. Observers moving with the moving rod would thus find that the two clocks were not synchronous, while observers in the stationary system would declare the clocks to be synchronous."

It is right here in the underlined sentences from above, where Einstein makes his first mistake. Here is why: Einstein is building on a made-up trick that doesn't work in reality. The clocks at the two ends A and B are certainly moving with that rod, but Einstein *forces* them to synchronize with the stationary system by requesting that each moving clock shall always display the local time of the stationary system. Next to the moving clocks, Einstein places moving observers who are reading the clocks. From Eqs. (2a-b), he then concludes that the clocks wouldn't be synchronized for the moving observers. *Einstein is mistaken in assuming that moving clocks could synchronize with stationary clocks.* He has a wrong idea of what synchronizing clocks is about. "Synchronizing" two clocks means that we set a given offset (a difference in displayed time) to zero. Performing a synchronization makes sense only if the two *clockworks* are running approximately the same. This isn't the case in SR if one clockwork is moving fast relative to the other clockwork: Einstein himself concludes in § 4 of SR [18] that the time displayed by a moving clock is slow by $1 - (1 - v^2/c^2)^{0.5}$ seconds per second if it is observed in the stationary system.

A desperate attempt to make Einstein's trick work is his extra request that the moving clocks synchronize "at any instant" (permanently) with the stationary clocks. Only a permanent synchronization could accomplish that moving *and* stationary observers measure time in the same variables $t_{\mathrm{A}}, t_{\mathrm{B}}, t_{\mathrm{A}}^*$. Only then would Eqs. (2a-b), where r_{AB} is measured by stationary observers, make sense. Even this attempt fails: By forcing the moving clocks

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to be permanently synchronized with the stationary clocks, Einstein disables the moving clocks to run on their own. He turns them into slaves which only pass through (reproduce) and display time signals that they receive from the stationary clocks. *That is, these moving clocks would have no clockwork.* They would be some special radio-controlled clocks that are always synchronized with an atomic clock. A look inside them would reveal that they are just receivers. Clocks without a clockwork knock out Einstein time!

Einstein makes his second mistake in storing measured time in the wrong variables. Let K be the stationary system, K′ be the moving system, R be an observer in K, R′ be an observer in K′. Now **WATCH OUT** as this paragraph is very important for understanding why Einstein time is flawed! As a consequence of his first mistake, Einstein uses the same variables $t_{\mathrm{A}}, t_{\mathrm{B}}, t_{\mathrm{A}}^{*}$ in Eqs. (2a-b) for storing the time in K′, as measured *by both R′ and R.* Here he makes his second mistake: He assigns variables of time to a system K′ (or else K) instead of assigning them to the measuring observer R′ (or else R). *Any variable in physics belongs to the measuring observer.* An observer R in K (or else R′ in K′) uses t (or else t') to measure time *in both K and K′.* We store time (in K and K′), if measured by R, in unprimed variables (or in primed variables if measured by R′). Einstein assigns r_{AB} to R. He should have defined new variables (other than $t_{\mathrm{A}}, t_{\mathrm{B}}, t_{\mathrm{A}}^{*}$) for “R measuring time”.

Why is it important to assign the variables of time to an observer instead of assigning them to a system? In SR, clocks of R′ run slower (than clocks of R) in the variables ***of R′.*** *After discussing Fig. 1, you will know: In ER, clocks of R′ run slower in the variables* ***of R.*** *Einstein's claim (clocks of R′ run slower in the variables of R′) contradicts his first postulate because clocks of R′ observed by R′ must run the same as clocks of R observed by R.*

Up next, we explain why we never accepted SR and how we discovered that Einstein time is flawed. In § 3 of SR [18], Einstein derives the Lorentz transformations

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

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

where x_1, x_2, x_3, t are the coordinates of K, x_1', x_2', x_3', t' are the coordinates of K′, $v_{3\mathrm{D}}$ is the speed at which K′ is moving relative to K in the axis x_1, and $\gamma = (1 - v_{3\mathrm{D}}^2/c^2)^{-0.5}$ is the Lorentz factor. There is a vital condition attached to Eqs. (3a-b): *They are valid only for an observer R in the system K.* Einstein's first postulate requires that the laws of physics for R in K and for R′ in K′ are the same. So, R′ calculates the coordinates of K with the same Eqs. (3a-b), except that x_1, x_2, x_3, t are the coordinates of K′ and x_1', x_2', x_3', t' are the coordinates of K. *Yet now Eqs. (3a-b) are valid only for an observer R′ in the system K′.*

We never accepted SR because Eqs. (3a-b) are valid for only one observer at once. To get the same form of equations for the other observer, we can't transform the coordinates. We must interchange the coordinates! There is no superordinate reference frame in which two observers R and R′ are treated alike at once if they move relative to each other. Physics has been aware of this flaw as it is the trademark of SR: Each observer has *individual* concepts of space and time. R and R′ can't synchronize their clocks at once in the same reference frame. *They are treated as if they lived in different worlds.* In Sect. 4, we will show: ES is a superordinate reference frame in which R and R′ are treated alike at once.

We now explain how we discovered that Einstein time is flawed. Fig. 1 top shows a Minkowski diagram of two identical rockets—except for their color—with a proper length of 0.5 Ls (light seconds). They started at a common origin and are now moving relative to each other at a speed of $0.6\,c$. Observer R is in the rear end of the red rocket (system K). His view is the red frame with the coordinates x_1 and t. Observer R′ is in the rear end of the blue rocket (system K′). His view is the blue frame with the coordinates x_1' and t'. For R, the blue rocket contracts to 0.4 Ls *because of length contraction.* For R, the rear end of the blue rocket has moved 1.0 s in the time t. For R′, it has moved only 0.8 s in the time t' *because of time dilation.* Only for clarity do we draw 2D rockets although the width of either rocket is in the dimensions x_2, x_3 or else x_2', x_3' (not displayed in Fig. 1 top).

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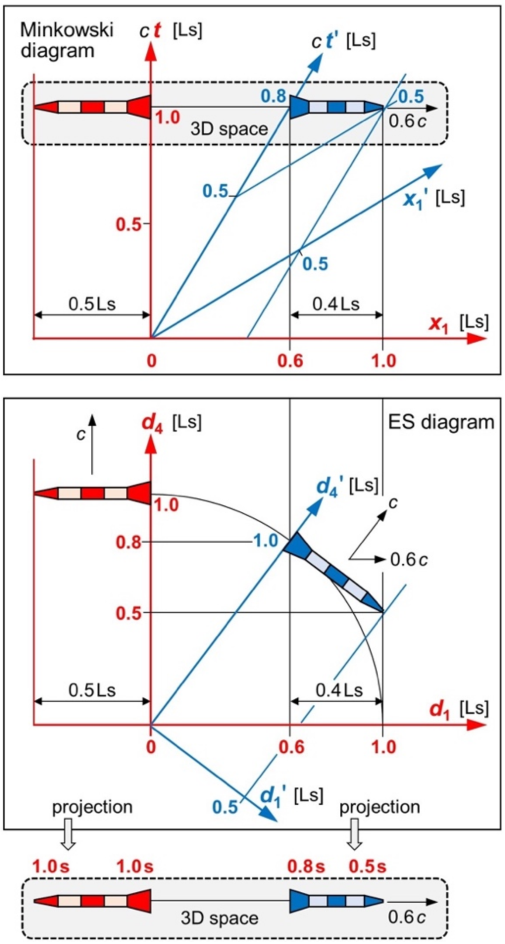

Figure 1. Minkowski diagram, ES diagram, and 3D projection for two identical rockets. **Top:** The Minkowski diagram isn't symmetric. For observer R, clocks inside the red rocket display the same time (1.0 printed in the red frame). For observer R′, clocks inside the blue rocket display a different time (0.8 and 0.5 printed in the blue frame). **Center:** The ES diagram is rotationally symmetric. The values 0.8 and 0.5 are measured by R in the red frame. **Bottom:** Projection to the 3D space of R.

We now draw your attention to the two values 0.8 and 0.5 printed in the blue frame (Fig. 1 top): In SR, Einstein's trick forces clocks inside the blue rocket to synchronize with clocks inside the red rocket. For R, they thus display the same time: $t = 1.0$ s. Yet for B, they display a different time: $t' = 0.8$ s and $t' = 0.5$ s. This isn't in line with experimental physics because a team of observers inside the blue rocket would, of course, also synchronize all of their own clocks! Reality is the other way around: Clocks inside the blue rocket display the same time t' for an observer R′ inside the blue rocket; they display a different time (like 0.8 s or 0.5 s) for an observer R inside the red rocket. We attribute the mistaken assignment to a missing 4D vector "flow of time" in SR: In Fig. 1 top, the blue rocket isn't aligned orthogonally to the axis ct'. Instead, it is drawn horizontally as if the time t' of R′ were flowing in the same direction as the time t of R. Yet t' belongs only to R′, and t belongs only to R. Minkowski diagrams visualize flawed Einstein time.

Since we claimed both rockets to be identical, we must restore the symmetry. We can do so *by rotating* the blue rocket (Fig. 1 center). In order to do so, we must first replace the two asymmetric dimensions "space" (x_1) and "time" (t) with two symmetric dimensions (distances d_1 and d_4). Only then is a 4D rotation of the blue rocket enabled. We call this procedure "physical repair". The new concept of distance is explained in Sect. 3. We end up with an ES diagram where 0.8 and 0.5 are printed in the red frame as they are measured only by R. In SR (Fig. 1 top), clocks of R′ run slower (than clocks of R) in the variables of R′ (blue frame). In ER (Fig. 1 center), they do so in the variables of R (red frame). We also confirm in ER: "Stationary clocks" (clocks inside the red rocket *and observed in the red frame,* or else clocks inside the blue rocket *and observed in the blue frame*) are synchronized, while "moving clocks" (clocks inside the red rocket *and observed in the blue frame*, or else clocks inside the blue rocket *and observed in the red frame*) aren't synchronized.

How could SR and GR have been so successful despite being grounded on a flawed concept of time? In Sect. 4, we will show that the Lorentz transformation in SR is recovered in ER. *So, Einstein's mistakes in SR have no measurable consequence.* Regarding GR, things are different. Mislead by the indefinite Minkowski metric in SR, Einstein makes a third mistake: He selects a generalized indefinite metric in GR [3] that enforces individual concepts of space and time in GR, too. Just as Newton's physics is an approximation for low speeds, *so is GR an approximation for individual observers* (for mankind describing the world on and from Earth). We claim: In cosmology and quantum mechanics, concepts must not be limited to individual observers, but absolute. We will prove our claim *indirectly* by solving 12 mysteries that GR can't solve. Albert Einstein was one of the most brilliant physicists ever, but he wasn't aware of ER. It was a very wise decision to award him with the Nobel Prize in Physics for his theory of the photoelectric effect [19], and not for SR and GR.

3. Introducing Euclidean Spacetime

We introduce ES by starting with a simple geometry. Let us imagine that all energy is in a 1D reality which is the line of a circle around an origin O. The circle is expanding at the speed of light. As observers are energy, too, they can't observe the radial dimension. All that they see is the projection of that circle *to a straight 1D line.* We add one dimension and imagine that all energy is in a 2D reality which is the surface of a sphere around an origin O. The surface is expanding at the speed of light. As observers are energy, too, they can't observe the radial dimension. All that they see is the projection of that sphere *to a flat 2D surface.* We add one last dimension and imagine that all energy is in a 3D reality which is the 3D hypersurface of a 4D hypersphere around an origin O. The 3D hypersurface is expanding at the speed of light. As observers are energy, too, they can't observe the radial dimension. All that they see is the projection of that 4D hypersphere *to a flat 3D space.* We stop and claim: This third scenario describes the world that we live in. For each observer, that 4D hypersphere is projected to a unique 3D space. That is to say: *The 3D hypersurface itself is absolute, but each observer's 3D space is relative.*

In all three scenarios, the radius is expanding at the speed of light. So, the radius r of the 2D circle, the 3D sphere, or the 4D hypersphere divided by time is always equal to the speed c. Here the underlying concept of time isn't Einstein time, but a universal concept of time. We call it "Euclidean time". So, Euclidean time is related to the radius r of that 4D hypersphere. The radial dimension itself disappears in the projection to 3D space. Time is felt as aging! We now define a 4D vector "flow of time" $\boldsymbol{r}/c$, where $\boldsymbol{r}$ is pointing from the origin O to an observer. The absolute value r/c is the same for all observers as they are all the same distance away from the origin O. Yet the orientation of $\boldsymbol{r}/c$ is unique. That is to say: *Euclidean time itself is absolute, but each observer's flow of time is relative.*

$$\tau = r/c \qquad \textit{(Euclidean time).} \tag{4}$$

Eq. (4) tells us that Euclidean time isn't a primary quantity, but a subordinate quantity derived from the distance covered in ES. Distance and speed are more significant than time. This is why we suggest new units for speed and time. In ER, the universal constant c shouldn't be specified in meters per second, but in its own new unit (to be given by the community). Euclidean time should be specified in light seconds per that new unit.

Mathematically, ES is an open 4D manifold with a Euclidean metric. We can describe ES either in four *absolute* hyperspherical coordinates $(\phi_1, \phi_2, \phi_3, r)$, where each ϕ_i is a hyperspherical angle and r is *radial distance* from an origin—or in four *relative,* symmetric Cartesian coordinates (d_1, d_2, d_3, d_4), where each d_i is *axial distance* from an origin. In our new concept "distance", we conceive of each distance (either the one radial distance r or the four axial distances d_i) as spatial and temporal distance in one. Distance isn't covered

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as a function of independent time. Only by covering distance in ES is Euclidean time passing by for an object! Unlike MS, where space and time are measured in different units, all distances in ES are measured in the same unit "light seconds" (Ls).

Hyperspherical coordinates are good for grasping the "big picture" that physics tries to describe in cosmology. We claim that a huge amount of energy was injected into ES at some point that we take as the origin O. Right here our first postulate comes into play: In ES, all energy is moving radially away from an origin at the speed of light. *That is, we live in the 3D hypersurface of an expanding 4D hypersphere.* Hyperspherical coordinates have the great benefit of reducing all that is ever happening to one formula. So, this formula is the Theory of Everything (TOE) in hyperspherical coordinates: *All energy is covering radial distance r which, divided by Euclidean time τ, is equal to the speed of light c.*

$$r/\tau \;=\; c \qquad \textit{(Theory of Everything)}. \tag{5}$$

One reviewer argued that Eq. (5) couldn't be a TOE since it doesn't address dynamics in 3D space. We disagree. In hyperspherical coordinates, everything is moving radially at the same speed. So, the 3D hypersurface is expanding as a whole. *There is no motion within that hypersurface in these coordinates.* So far, so good. As we will show in Sect. 5.4, motion in an observer's view of the hypersurface (which is his 3D space, his reality, and what he calls "universe") is enabled by means of a rotation and a projection. As these are geometric operations, all the dynamics in 3D space is pure math. So, Eq. (5) does describe *all physics*, but in hyperspherical coordinates! Symmetry-matching simplifies physics.

Cartesian coordinates are good for projecting 4D ES to an observer's 3D space. They are calculated from hyperspherical coordinates by

$$d_1 \;=\; r\,\cos\phi_1\;, \tag{6a}$$

$$d_2 \;=\; r\,\sin\phi_1\,\cos\phi_2\;, \tag{6b}$$

$$d_3 \;=\; r\,\sin\phi_1\,\sin\phi_2\,\cos\phi_3\;, \tag{6c}$$

$$d_4 \;=\; r\,\sin\phi_1\,\sin\phi_2\,\sin\phi_3\;. \tag{6d}$$

In Cartesian coordinates, too, all objects are moving at the speed of light c. Yet their 4D velocity $\boldsymbol{u}$ splits up into four components $u_i = \mathrm{d}d_i/\mathrm{d}\tau$ with

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

In our ES diagrams, we often choose Cartesian coordinates in which an object, like a rocket, starts moving from some origin P other than O. Because of the ES symmetry, we are free to label all four axes. In this report, we always assume that the axis d_4 coincides with an object's flow of time $\boldsymbol{r}/c$. Below our ES diagrams, we project ES to an observer's 3D space. Here we are free to label the axis that we are projecting onto. In this report, we always assume that—if two objects are moving against each other in ES—they will do so only in the axes d_1 and d_4. Our ES diagrams thus display d_1 and d_4, and our 3D projections display d_1. Just keep in mind that the axis d_1 always stands for d_1, d_2, d_3.

We point out: (1) In ER, clocks measuring seconds are replaced with odometers measuring light seconds. There is no need to calibrate these odometers as light seconds in ER are absolute. (2) In ES diagrams, a moving object appears rotated. In Minkowski diagrams, a moving object must not be drawn rotated as its length can't be a mix of space and time. (3) The indefinite Minkowski metric in SR is replaced with a positive definite Euclidean metric in ER. (4) In SR, the proper time of an object is invariant. In ER, Euclidean time is invariant. *In cosmology and quantum physics, where the "big picture" matters more than single objects, the proper time of an object has been a very unfortunate invariant.*

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4. Geometric Effects in Euclidean Spacetime

Up next, we prove two effects in Cartesian ES coordinates: (1) If I observe a moving object, its 3D space is rotated with respect to my 3D space causing *length contraction.* (2) If I observe a moving object, its time flows in a 4D direction other than my time causing *time dilation.* So, these relativistic effects aren't unique to MS. We consider the same two rockets as in Fig. 1. They differ only in color (r = red rocket, b = blue rocket). Observer R in the rear end of the red rocket has the coordinates d_1, d_2, d_3, d_4 (red frame). Observer R′ in the rear end of the blue rocket has the coordinates d_1', d_2', d_3', d_4' (blue frame). Initially, both rockets are back-to-back at the same point P. They move only in the axis $d_4 = d_4'$.

We now assume that these rockets are also moving against each other. As explained above, that relative motion occurs in the axis d_1 or else d_1' (Fig. 2). Our ES diagrams must fulfill three requirements: (1) According to our first postulate, the red rocket must keep on moving in the axis d_4 at the speed c, and the blue rocket must keep on moving in the axis d_4' at the speed c. (2) Our second postulate must be satisfied. (3) Both rockets started at the same point P. There is only one way to draw ES diagrams that fulfill all requirements (Fig. 2 top left and top right): *We must rotate the two reference frames with respect to each other.* Only a rotation guarantees that the situation is symmetric, so that the laws of physics have the same form in the 3D space of R and in the 3D space of R′.

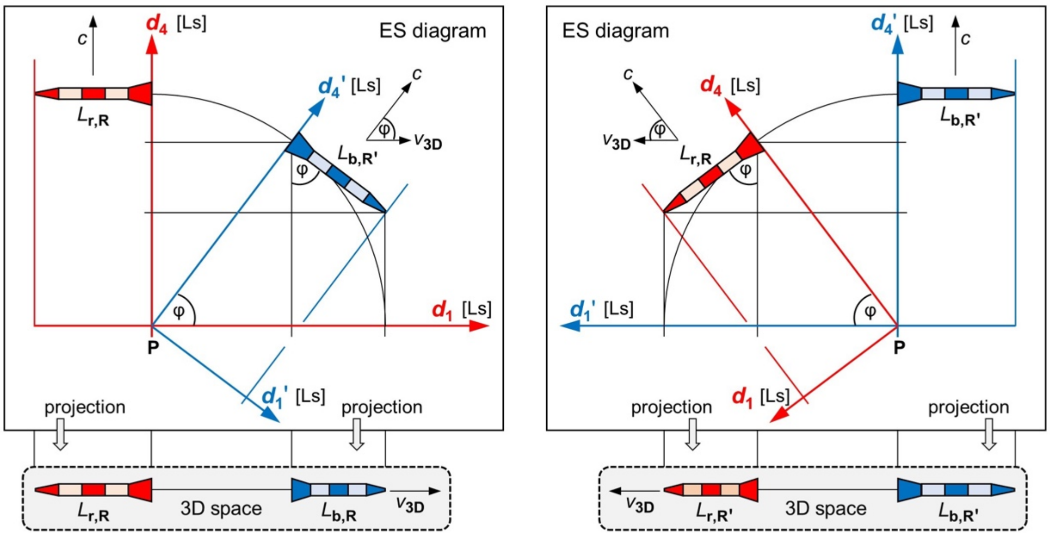

Figure 2. ES diagrams and 3D projections for two identical rockets. All axes are in Ls (light seconds). **Top left and top right:** In the ES diagrams, both rockets are moving at the speed c, but in different directions. The diagrams are rotationally symmetric with respect to the red and the blue reference frame. **Bottom left:** Projection to the 3D space of R. The relative speed is v_{3D}. The blue rocket contracts to $L_{b,R}$. **Bottom right:** Projection to the 3D space of R′. The red rocket contracts to $L_{r,R'}$.

We define $L_{i,J}$ as length of the rocket with color i (r = red, b = blue) as seen from the perspective of observer J (R = observer R, R′ = observer R′). From Fig. 2, we derive

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

$$L_{b,R} = \gamma^{-1} L_{b,R'} \quad \textit{(Length contraction)}, \tag{9}$$

$$\gamma = (1 - v_{3D}^2/c^2)^{-0.5} , \tag{10}$$

where γ is the same Lorentz factor as in SR. So, we calculate the same length contraction in ER as in SR: The blue rocket appears contracted to observer R by the factor γ^{-1}. Yet which distances will R observe in his axis d_4? For the answer, we mentally continue the rotation of the blue rocket (Fig. 2 top left) until it is pointing vertically down ($\varphi = 0°$) and

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serves as a ruler of R in the axis d_4. The projection to 3D space now tells us that the ruler contracts to zero. The dimension d_4 "is suppressed" (disappears) for R. He observes a 3D space, but only feels d_4 as "aging" (time passing by). From Fig. 2, we also derive

$$\sin^2\varphi + \cos^2\varphi = (d_{4,\mathrm{R}'}/d'_{4,\mathrm{R}'})^2 + (v_{3\mathrm{D}}/c)^2 = 1 \,, \tag{11}$$

$$d_{4,\mathrm{R}'} = \gamma^{-1}\, d'_{4,\mathrm{R}'} \,, \tag{12}$$

where $d_{4,\mathrm{R}'}$ and $d'_{4,\mathrm{R}'}$ are the distances that R′ has moved in d_4 or d'_4. With $d'_{4,\mathrm{R}'} = d_{4,\mathrm{R}}$ (full symmetry in ES), Eq. (12) turns into

$$d_{4,\mathrm{R}'} = \gamma^{-1}\, d_{4,\mathrm{R}} \,. \tag{13}$$

We now substitute $d_{4,\mathrm{R}'} = ct_{\mathrm{R}'}$ and $d_{4,\mathrm{R}} = ct_{\mathrm{R}}$

$$t_{\mathrm{R}} = \gamma\, t_{\mathrm{R}'} \qquad \textit{(Einstein time dilation)}, \tag{14}$$

where t_{R} and $t_{\mathrm{R}'}$ are the distances that R and R′ have moved in the Einstein time t of R. In order to see how Eq. (14) looks like in ER, we recall that Euclidean time is absolute (the same for R and R′). So, there is no dilation in Euclidean time.

$$\tau_{\mathrm{R}} = \tau_{\mathrm{R}'} \,. \tag{15}$$

Be aware that the Lorentz factor γ in Eq. (10) is the same as in SR. So, we just proved a statement that is very important for the scope of ER: *Although the metric in ER is Euclidean, the Lorentz signature is recovered in the projection of ES to an observer's 3D space.* That is to say: The Lorentz transformation in SR and thus electrodynamics are recovered in our theory of ER. This discovery isn't surprising. Hermann Weyl already showed in Chap. III (§ 8c) of [20] that the generators of the Lorentz group are rotations. They are rotations in ES. We also recall from our Introduction that [13] already proved that the Lorentz transformation in SR becomes an SO(4) rotation in ER.

Now we discuss three instructive, geometric paradoxes that demonstrate the benefit of our concept "distance". Problem 1: A rocket moves along a guide wire at a high speed. The wire enters the rocket at its top and exits at its rear end. In ES, rocket and wire move at the speed of light. We may assume that the wire moves in some axis d_4. As the rocket moves along the wire, it can also move in the axis d_4, but slower than the speed of light. Wouldn't the wire eventually be outside the rocket? Problem 2: In billiard, the white cue ball is hit to collide with the red ball. In ES, cue ball and red ball move at the speed of light. We may assume that the red ball moves in some axis d_4. As the cue ball covers spatial distance to the red ball, it can also move in the axis d_4, but slower than the speed of light. How can the balls ever collide if their d_4 values never match? Problem 3: An observer in the tip of a rocket sees how a mirror is passing the rocket. He sends a short light pulse to the mirror and tries to detect the reflection. In ES, rocket, mirror, and light pulse all move at the speed of light, but in different directions. We may assume that the rocket moves in some axis d_4. How can the light pulse ever be reflected back to the observer?

The questions that we are asking in the last paragraph seem to be paradoxes in ER, but they aren't. In all problems, the fallacy lies in the assumption that there would be four spatial dimensions. ES is four dimensions of distance. We solve all problems by projecting four distances to 3D space (Fig. 3). The suppressed distance is felt as time! *Projections tell us what reality is like because "suppressing the axis d_4" is equivalent to "length contraction makes d_4 disappear"*. We easily verify in 3D space: The guide wire remains within the rocket, and the cue ball collides with the red ball, and the light pulse is reflected back to the observer. Previous ER models can't solve any of these geometric paradoxes as they don't project ES to an observer's 3D space. They conceive of ES as an observer's reality.

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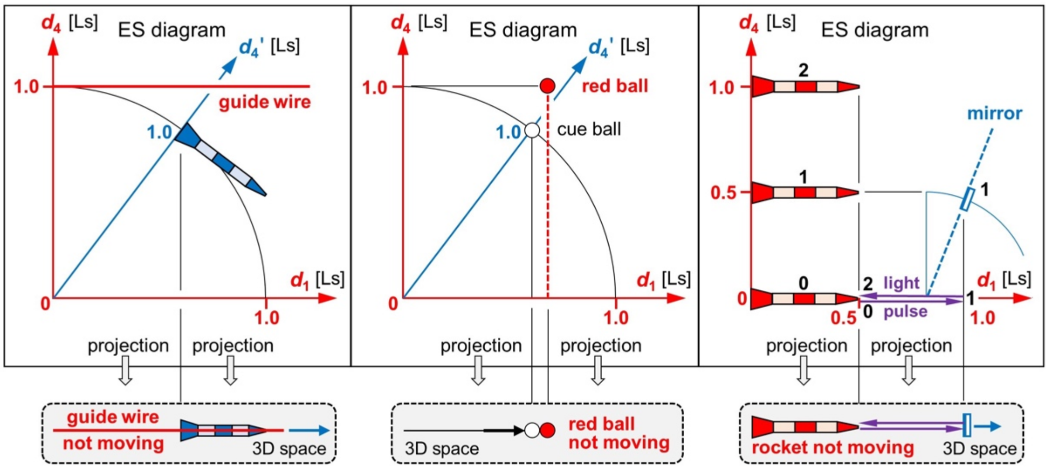

Figure 3. Graphical solutions to three geometric paradoxes. **Left:** A rocket moves along a guide wire. In 3D space, the guide wire is always within the rocket. **Center:** A cue ball is hit to collide with the red ball. In 3D space, the cue ball collides with the red ball. **Right:** An observer inside a rocket tries to detect the reflection of a short 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.

5. Solving 12 Fundamental Mysteries of Physics

In Sects. 2 and 4, we learned: As the Lorentz transformation in SR is recovered in ER, Einstein's mistakes in SR have no measurable consequence. *Only in GR, particularly in cosmology and in its incompatibility with quantum mechanics, does Einstein time prove to be flawed.* Up next, we support our theory by solving 12 mysteries that GR can't solve.

5.1. Solving the Mystery of Time

There is absolute Euclidean time τ. According to Eq. (4), τ is radial distance r from O in ES divided by the speed of light c. In the projection to my 3D space, this dimension disappears because of length contraction at the speed c. So, I only feel τ as aging.

5.2. Solving the Mystery of Time's Arrow

"Time's arrow" in today's physics is a synonym for time moving only forward. It has its origin in ER: We can't reverse the 4D vector "flow of time" because radial momentum provided by the Big Bang drives all energy away from the origin O.

5.3. Solving the Mystery of mc^2

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

$$E \;=\; \gamma\, m\, c^2 \;=\; E_{\text{kin,3D}} \;+\; m\, c^2 \;, \tag{16}$$

where $E_{\text{kin,3D}}$ is an object's kinetic energy in 3D space and mc^2 is its "energy at rest". SR doesn't give us any clue of *why* there is a c^2 in both the total energy and the energy at rest for material objects that in SR never move at the speed c. ER gives us this missing clue: mc^2 is the kinetic energy in the fourth dimension! That is to say: *mc^2 is the kinetic energy of moving through Euclidean time τ*. The multiplicator c^2 in Eq. (16) is very strong evidence that everything is steadily moving at the speed c even if it is at rest in its 3D space. c^2 is passed through from ES to 3D space. We can also give a geometric explanation for

$$E^2 \;=\; p^2\, c^2 \;=\; p_{3D}^2\, c^2 \;+\; m^2\, c^4 \;, \tag{17}$$

where p and p_{3D} are the momenta in ES and in 3D space. In ES, an object's energy moves in the direction of its flow of time. Dividing Eq. (17) by c^2 tells us: *It is the vector addition of an object's momentum in 3D space and its momentum mc of moving through time.*

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5.4. Solving the Mystery of the Cosmic Microwave Background

Now we are ready for our new model of cosmology based on ER. There is no need to create ES. It exists just like numbers and can't be deformed. Because of some reason that we don't know, there was a Big Bang in ES. In today's model of cosmology, it makes no sense to ask *where* the Big Bang occurred: Since space and time started as a singularity and space inflated thereafter, the Big Bang occurred "everywhere". In ES, it is indeed possible to localize the Big Bang at what we take as origin. We claim that the Big Bang was a sudden incident that injected a huge amount of energy into ES all at once. The adjective "sudden" allows for metaphysical speculations that aren't subject of this report.

During the initial stage after the Big Bang, there was a huge amount of concentrated energy inside ES. In the projection to any 3D space, this energy created a very dense and hot plasma. While the plasma was expanding, it cooled down. During the recombination of plasma particles, electromagnetic radiation was emitted that we observe as cosmos microwave background (CMB) [21]. At a temperature of roughly 3,000 K, hydrogen atoms formed [22]. According to GR, this stage was reached 380,000 years "after" the Big Bang. In ER, these are 380,000 light years "away from" the Big Bang. The value of 380,000 needs to be recalculated if the universe is expanding at a constant speed.

Yet why is the CMB so isotropic? According to our first postulate, all energy is moving radially away from an origin at the speed of light (Fig. 4 left). We claim: *The CMB is so isotropic because it is swinging equally from ES into all three dimensions of my 3D space.* To grasp the process of swinging, we mentally continue the rotation of the blue rocket (Fig. 2 top left) until it is pointing vertically down. We then mentally replace that blue rocket with a photon and finally look at its projection to 3D space. We learn from this thought experiment (Fig. 4 right): In each photon, I do observe energy from ES whose 4D motion "swings completely" (by an angle of 90°) into my 3D space.

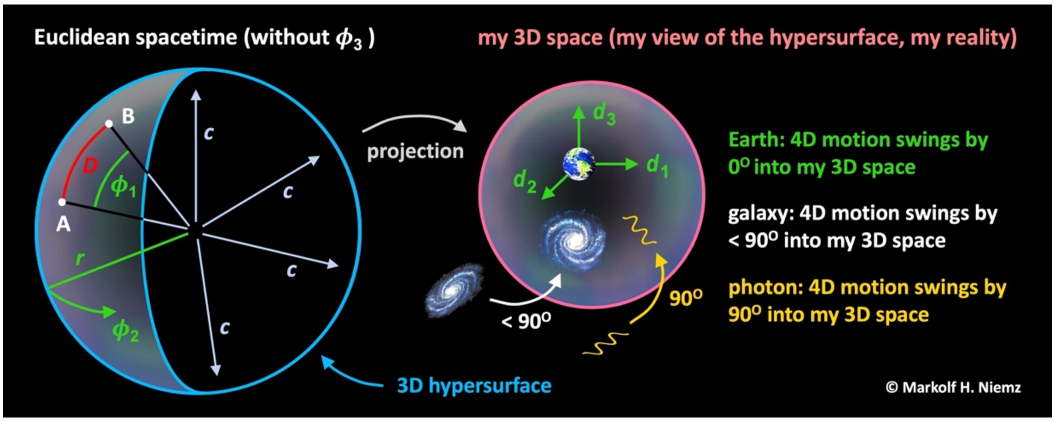

Figure 4. Model of cosmology based on ER (not to scale). Artwork illustrating how a 3D hypersurface is expanding in ES. **Left:** Non-observable ES in hyperspherical coordinates $(\phi_1, \phi_2, \phi_3, r)$. The angle ϕ_3 can't be displayed here. Hubble's law is derived from the geometry of the hypersurface. **Right:** Projection of ES to my 3D space in Cartesian coordinates (d_1, d_2, d_3), which is my view of the hypersurface and my reality. The axis d_4 (related to time) disappears because of length contraction.

Our eyes aren't made for *perceiving* all four dimensions of ES. Yet we can *conceive* of them with our brain by employing our trick: Rotating that blue rocket in Fig. 2 top left and looking at its projection to 3D space. This trick tells us that the process of swinging covers both geometric operations: *"Swinging" is a single word for the combined action of rotating and projecting.* In my 3D space, I observe the final result of this combined action.

We just learned that a photon is energy from ES whose 4D motion swings completely into my 3D space ($v_{3D} = c$). In the case of matter, the 4D motion swings partly (by an angle $< 90°$) into my 3D space, like the blue rocket in Fig. 2 top left ($v_{3D} < c$). In the case of Earth, the angle is 0° because Earth isn't moving relative to myself ($v_{3D} = 0$). This explains how swinging enables the motion of objects in my view of the hypersurface.

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Swinging also explains why this motion in 3D space can be on a curved line, as in the cyclic motion of planets. Motion on a curved line is due to an acceleration. To understand where acceleration stems from, we assume that the blue rocket in Fig. 2 bottom left would be accelerating in 3D space. According to Eq. (7), its speed u_1 in ES must then increase at the expense of its speed u_4. That is, the blue rocket is rotating in Cartesian ES coordinates. Generally spoken: *Acceleration and thus gravitation in 3D space are related to a rotation in ES.* In his 3D space, an observer can't see any 4D rotations, but he feels them as acceleration and gravitation. He also feels time (related to d_4). Any change of motion in the axis d_4 is felt as acceleration and gravitation! Just for comparison: In GR, gravitation is considered a geometric property of curved spacetime [3].

Photons are *moving* in my view of the hypersurface at the speed c, whereas the entire hypersurface is *expanding* at the speed c. One may ask: "Doesn't a photon then exceed the speed c?" No, it doesn't. Speeds in my view of the hypersurface must not be added to the speed of the hypersurface itself. What I deem photon, is energy from ES whose 4D motion swings completely into my 3D space. So, in the speed c of each photon I actually see the speed c of the hypersurface!

5.5. Solving the Mystery of Hubble's Law

The speed v_{3D} at which a galaxy A (Fig. 4 left) is moving away from another galaxy B or Earth relates to their distance D as c relates to the radius r of the hypersurface

$$v_{3D} = D\,c/r = H_0\,D \qquad \text{(Hubble's law)}, \tag{18}$$

where $H_0 = c/r$ is the Hubble constant, c is in km/s, and r is in Mpc. There it is! Eq. (18) is Hubble's law [23]: *The farther a galaxy, the faster it is moving away from Earth.* We derived it from the geometry of an expanding hypersurface. Because of Eq. (4), there is $H_0 = 1/\tau$. So, it does make sense to speak of a "Hubble function" $H(\tau)$. We must be careful with the metaphor of an inflating balloon. The hypersurface isn't the shell of a 3D sphere.

5.6. Solving the Mystery of the Flat Universe

As the entire hypersurface is expanding at the speed of light (Fig. 4 left), the radial dimension disappears for any observer inside the hypersurface. Together with this dimension, the 4D curvature of the 3D hypersurface disappears, as well. He observes a *flat* 3D universe. Our situation compares to that of an ant: Since it observes only two dimensions of space, the 3D curvature of Earth's 2D surface disappears for the ant.

5.7. Solving the Mystery of Today's Hubble Constant

There are several methods of calculating the Hubble constant H_0, but unfortunately the results vary from one method to another. Here we consider measurements of the CMB made with the *Planck space telescope* [24]. We compare them with calculations of calibrated distance ladder techniques (measurement of distance and redshift of celestial objects) using the *Hubble space telescope* [25]. By taking the ES geometry into account, we now explain why the obtained values of H_0 don't even match within the specified error margins

$$H_0 = 67.66 \pm 0.42 \text{ km/s/Mpc according to team A [24]},$$

$$H_0 = 73.52 \pm 1.62 \text{ km/s/Mpc according to team B [25]}.$$

Team B made efforts to minimize the error margin by optimizing the distance measurement. Yet as we will prove up next, team B's value of H_0 is wrong *because of a systematic error in the redshift measurement.* Let us assume that 67.66 km/s/Mpc would be today's correct value of H_0. We now simulate a supernova at a distance of $D = 400$ Mpc from Earth that moves at the 3D speed v_{3D} away from Earth. From Eq. (18), we calculate

$$v_{3D} \;=\; H_0\, D \;=\; 27{,}064\ \text{km/s}\ , \tag{19}$$

$$z \;=\; \Delta\lambda/\lambda_0 \;\cong\; v_{3D}/c \;=\; 0.0903\ , \tag{20}$$

where the parameter z measures how the initial wavelength λ_0 of the supernova's light *is either passively stretched by expanding space in GR (team B) or how it is redshifted by the Doppler effect of actively receding galaxies in ER (our model).*

In the next paragraphs, we demonstrate that team B will measure a higher value of z, and thus calculate a higher value of v_{3D}, and thus calculate a higher value of H_0. Fig. 5 left shows the geometry of the supernova and Earth in hyperspherical coordinates. We define one circle called "past" where the supernova occurred, and a second circle called "present" where its light is observed on Earth. Today, that supernova has turned into a neutron star. Fig. 5 right shows the same geometry, but in Cartesian coordinates. Because both light and matter are moving at the speed of light, Earth has moved the distance D in the axis d_4 when the supernova's light arrives. So, team B is receiving data from a time $\tau = 1/H_0'$ when there was a different radius r' and a different Hubble constant H_0'

$$1/H_0' \;=\; r'/c \;=\; (r-D)/c \;=\; 1/H_0 \;-\; D/c\ , \tag{21}$$

$$H_0' \;=\; 74.37\ \text{km/s/Mpc}\ . \tag{22}$$

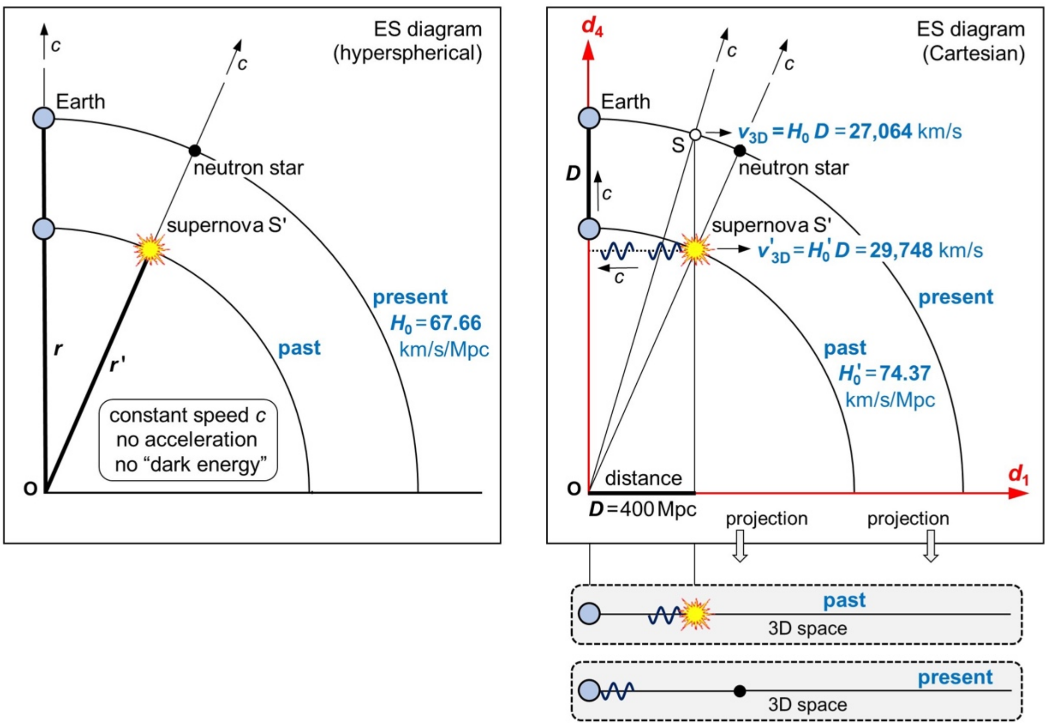

Figure 5. ES diagrams for team B's calculation of the Hubble constant. The location of the Big Bang serves as the origin O. **Left:** We suppose that 67.66 km/s/Mpc is the correct value of today's Hubble constant H_0 (present). A supernova S′ occurred in the past when the radius r' of the hypersurface was smaller than today's radius r. **Right:** Team B observes that supernova at a distance of 400 Mpc. Since the occurrence of that supernova, Earth has moved 400 Mpc in the axis d_4. Team B calculates a Hubble constant H_0' of the past (74.37 km/s/Mpc). A supernova S occurring today (same distance, small white circle), recedes slower (27,064 km/s) than a supernova S′ in the past (29,748 km/s).

Because of this higher H_0' value and Eq. (18), *all data* measured by team B are related to a higher 3D speed of the past $v_{3D}' = 29{,}748\ \text{km/s}$ for the same D. So, team B will measure a redshift of $z' = 0.0992$ according to Eq. (20), which is indeed higher than 0.0903. Team B isn't aware of Eqs. (21) and (22) and the geometry shown in Fig. 5. Yet because of

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that too high value of z', team B will calculate $v'_{3D} = 29{,}748\ \mathrm{km/s}$ from Eq. (20), and then $H'_0 = 74.37\ \mathrm{km/s/Mpc}$ from Eq. (18). So, team B will conclude that 74.37 km/s/Mpc would be the correct value of *today's* Hubble constant. But in truth, team B ends up with a Hubble constant *of the past* as it has been relying on redshift data from the past!

A short calculation confirms: For $D = 400$ kpc, team B's Hubble constant H'_0 would deviate from team A's Hubble constant H_0 by only 0.007 percent. Yet for distances up to 500 Mpc, team B's Hubble constant is *on average* (all $0 < D < 500$ Mpc taken into account) 8 to 9 percent higher than team A's Hubble constant. So, we advise team B to improve its value of H_0 by eliminating the systematic error in the redshift measurement. Team B can easily do so by adjusting the measured speed of the past v'_{3D} to today's actual speed v_{3D}. The equation for the correct adjustment is derived by converting Eq. (21) to

$$H'_0 = H_0\, c\, /\, (c - H_0\, D) = H_0\, /\, (1 - v_{3D}/c)\ , \tag{23}$$

$$v_{3D} = v'_{3D}\, /\, (1 + v'_{3D}/c)\ . \tag{24}$$

We conclude: *The redshift is caused by the Doppler effect of receding galaxies in ER.* It isn't due to an expanding space in GR. Since team B is calculating a Hubble constant H'_0 of the past, we do prefer the method of team A: $H_0 \approx 67 - 68$ km/s/Mpc. If we assume that the hypersurface has been expanding uniformly at the speed c, the age τ of today's universe is equal to $1/H_0$. In this case, its age isn't 13.8 billion years [26] as claimed by the Lambda-CDM model, but 14.5 billion years. The adjusted age is in agreement with the observation that there are stars out there as old as 14.5 billion years [27].

In hyperspherical coordinates, there is no motion within the hypersurface. For this reason, the path of the supernova's light can't be drawn into Fig. 5 left. Just recall that ES isn't an observer's reality. Only upon projecting Cartesian ES coordinates to an observer's 3D space do we see his reality (Fig. 5 bottom right). We can draw the light's path horizontally into Fig. 5 top right, like the path of the light pulse in Fig. 3 top right.

Of course, team B is well aware of the fact that the supernova's light was emitted in the past. Yet in the Lambda-CDM model, all that counts is the timespan Δt during which light is traveling from the supernova to Earth. Along the way, its wavelength is stretched by expanding space. So, stretching occurs passively. The total redshift is only developing during the journey to Earth. We can put it this way: The redshift parameter z' starts from zero and increases continuously during the journey to Earth. The fact that the supernova occurred long ago in the past at a time t_s is irrelevant for team B's calculation.

In our model, the moment τ_s (when a supernova occurs) is very significant, but the timespan $\Delta\tau$ (during which light is traveling to Earth) is irrelevant. The farther τ_s is in the past, the higher are the Hubble constant H'_0, the recession speed v'_{3D}, and the redshift parameter z'. The wavelength of the supernova's light is initially redshifted by the Doppler effect. During its journey to Earth, the parameter z' remains constant. In ER, there is no expansion of space! As discussed in Sect. 5.4, ES can't be deformed. *In GR, space itself is expanding. In ER, a hypersurface is expanding in ES. The expanding hypersurface isn't expanding space, but energy receding from the origin O.* We can put it this way: The redshift parameter z' is tied up at the moment τ_s in a package and sent to Earth, where it is measured.

5.8. Solving the Mystery of Dark Energy

In the CDM model of cosmology, space is expanding in order to explain the distance-dependent recession of galaxies. The CDM model has been extended to the Lambda-CDM model, where "Lambda" is the cosmological constant. Cosmologists are now favoring an accelerated expansion [28] over a uniform expansion of space. This is because measured recession speeds v_{3D} deviate from values predicted by Eq. (18) if H_0 is considered an averaged constant. The deviations increase with distance D and are compensated by assuming an accelerated expansion of space. An acceleration would stretch the wavelength even more and thus increase v_{3D} according to Eq. (20).

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Our model gives a much simpler explanation for the deviations from Hubble's law: Because of Eq. (4), there is $H_0 = 1/\tau$. So, the parameter H_0' from every past is higher than today's value H_0. The "older" the considered redshift data are, the more will H_0' deviate from today's value H_0, and the more will v_{3D}' deviate from v_{3D}. The small white circle in Fig. 5 right helps us to understand these deviations: If a new supernova S occurred today at the same distance $D = 400$ Mpc as the mapped supernova S′ in the past, then S would recede slower (27,064 km/s) than S′ (29,748 km/s) just because of the different values of H_0 and H_0'. If the ES geometry is unknown, as in the Lambda-CDM model, the too-high redshifts can only be explained by an accelerated expansion of space. Now that we know about the ES geometry, we can attribute the higher redshifts to measuring data from the past. We conclude: *Any expansion of space is only virtual.*

The term "dark energy" [29] was coined to come up with a cause for an accelerated expansion of space. We gave strong evidence that cosmology can do without any expansion of space. The hypersurface isn't driven by dark energy, but by intrinsic energy: Radial momentum provided by the Big Bang drives all energy away from the origin. All that we ask for is to apply Occam's razor even if a Nobel Prize was given "for the discovery of the accelerating expansion of the Universe through observations of distant supernovae" [30]. *Dark energy, which has never been observed anyway, is a redundant concept.* Einstein's mistake of selecting an indefinite metric in GR is only hidden by that concept of dark energy. We claim that cosmology has been misled by GR.

In Tab. 1, we compare the Lambda-CDM model of cosmology with our model based on ER. There are huge differences regarding the meaning of the Big Bang, universe, space, and time. In the Lambda-CDM model, the Big Bang was the beginning of the universe. In our model, the Big Bang was the beginning of Euclidean time. In the Lambda-CDM model, the universe is all space, all time, and all energy. In our model, the universe is my view of a 3D hypersurface. In the Lambda-CDM model, spacetime is finite and deformable. In our model, spacetime is infinite and non-deformable.

Lambda-CDM model of cosmology	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 about 13.8 billion years ago.	Big Bang occurred about 14.5 billion years ago.
There are two competing calculations of H_0.	H_0 is approximately 67–68 km/s/Mpc.
Universe is all space, all time, and all energy.	Universe is my view of a 3D hypersurface.
Spacetime is finite and deformable.	Spacetime is infinite and non-deformable.
Neither space nor time are absolute.	3D hypersurface and time are absolute.
Space and time are relative.	3D space and flow of time are relative.
Space is driven by dark energy.	3D hypersurface is driven by radial momentum.
Space itself is expanding.	3D hypersurface is expanding in spacetime.
"Time is what I read on my watch." (Einstein)	Time is radial distance from origin O divided by *c*.

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

5.9. Solving the Mystery of the Wave–Particle Duality

We can't tell which solved mystery is the most important one. Yet the wave–particle duality has certainly kept physicists busy since it was first discussed by Niels Bohr and Werner Heisenberg [31]. The Maxwell equations tell us that electromagnetic waves are oscillations of an electromagnetic field that move through 3D space at the speed of light. In some experiments, objects behave like "waves" (electromagnetic wave packets). But in other experiments, the same objects behave like particles. In MS, an object can't be both at once because waves distribute energy in space over time, while the energy of particles is localized in space at a given time. This is why we added our third postulate: All energy is "wavematter" (electromagnetic wave packet and matter in one). By combining our new concepts of distance and wavematter, we now demonstrate: *Waves and particles are actually the same thing (energy), but seen from two perspectives.*

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"Wavematter" isn't just a new word for the wave–particle duality, but a generalized concept of energy, which discloses why there is wave–particle duality in an observer's 3D space. One reviewer argued our concept of wavematter would only take electromagnetic interaction into account. We agree that this interaction is special as it is related to the speed of light c. Yet we claim that all forces (electromagnetic force, weak force, strong force, and gravitation) are geometric effects that act only in an observer's 3D space. We proved this claim for electrodynamics in Sect. 4 and for gravitation in Sect. 5.4. We encourage all our colleagues to show that weak force and strong force are geometric effects, too.

Fig. 6 illustrates in Cartesian ES coordinates what our new concept of wavematter is all about. If I observe a wavematter (we call it the "external view"), that wavematter comes in four orthogonal dimensions: It propagates in my axis d_1 at some speed $v_{3D} \leq c$, and it oscillates in my axes d_2 (electric field) and d_3 (magnetic field); propagating and oscillating are functions of Euclidean time τ (related to my fourth axis d_4). So, I can observe how that wavematter is propagating and oscillating: *I deem it wave.*

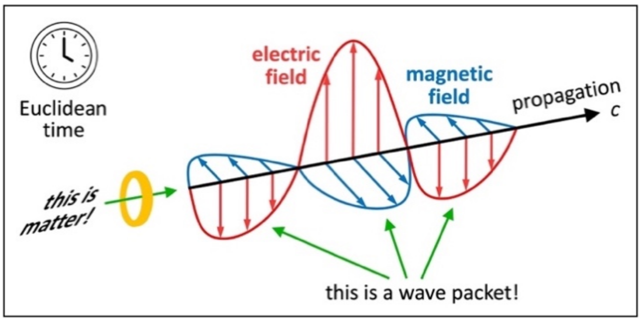

Figure 6. Concept of wavematter in Cartesian ES coordinates. Artwork illustrating how the same object can be deemed wave or matter. Wavematter comes in four dimensions: propagation, electric field, magnetic field, and Euclidean time. Each wavematter deems itself matter (internal view). If it is observed by some other wavematter (external view), it is deemed electromagnetic wave packet.

From its own perspective (we call it the "internal view"), that wavematter propagates in its axis d'_4 at the speed c. Yet because of length contraction at the speed c, the axis d'_4 (its flow of time) disappears for that wavematter. So, its own propagating and oscillating disappears for itself: *It deems itself matter at rest.* It still observes other objects propagating and oscillating in its 3D space since it keeps on feeling Euclidean time while it is invisibly propagating in the axis d'_4. We thus conclude that there is an external view and an internal (in-flight) view of each wavematter. In SR and GR, there is no internal view of a photon because there is no reference frame moving at the speed c.

As an example, we now investigate the symmetry in three wavematters WM_1, WM_2, and WM_3. We assume that they are all moving away from the same point P in ES, but in different directions (Fig. 7 top left). d_1, d_2, d_3, d_4 are Cartesian coordinates in which WM_1 moves only in d_4. Hence, d_4 is that axis which WM_1 deems time multiplied by c, and d_1, d_2, d_3 span WM_1's 3D space (Fig. 7 bottom left). As the axis d_4 disappears because of length contraction, WM_1 deems itself matter at rest (M_1). WM_3 moves orthogonally to WM_1. d'_1, d'_2, d'_3, d'_4 are Cartesian coordinates in which WM_3 moves only in d'_4 (Fig. 7 top right). In this case, d'_4 is that axis which WM_3 deems time multiplied by c, and d'_1, d'_2, d'_3 span WM_3's 3D space (Fig. 7 bottom right). As the axis d'_4 disappears because of length contraction, WM_3 also deems itself matter at rest (M_3).

Yet how do WM_1 and WM_3 move in each other's view? We must fulfill our first two postulates and the requirement that they both started at the same point P. There is only one way to draw ES diagrams (Fig. 7 top left and top right) that fulfill all requirements: *We must rotate the two reference frames with respect to each other.* Only a rotation guarantees that the situation is symmetric, so that the laws of physics have the same form in either 3D space. As the rotation angle is 90°, WM_3's 4D motion swings completely into WM_1's 3D space: WM_1 deems WM_3 wave (W_3). WM_3 likewise deems WM_1 wave (W_1).

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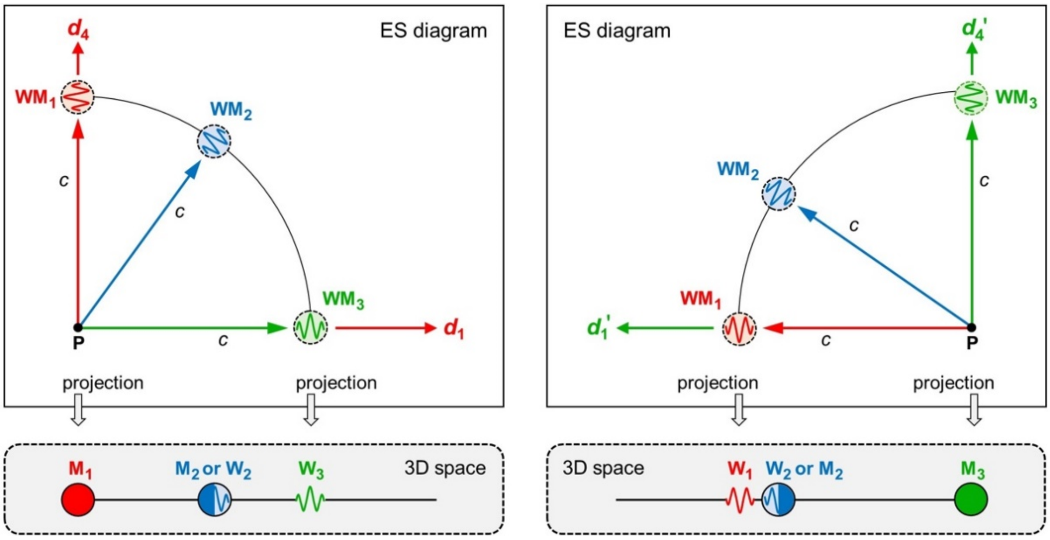

Figure 7. ES diagrams and 3D projections for three wavematters moving away from the same point P. **Top left:** ES in the coordinates d_1, d_2, d_3, d_4 in which WM_1 moves in d_4. d_1 stands for d_1, d_2, d_3. **Top right:** ES in the coordinates d_1', d_2', d_3', d_4' in which WM_3 moves in d_4'. d_1' stands for d_1', d_2', d_3'. **Bottom left:** Projection to WM_1's 3D space. WM_1 deems itself matter (M_1) and WM_3 wave (W_3). **Bottom right:** Projection to WM_3's 3D space. WM_3 deems itself matter (M_3) and WM_1 wave (W_1).

And what is WM_2 deemed by WM_1 and WM_3? For the answer, we split WM_2's 4D motion into a motion parallel to WM_1's motion (here WM_1 is viewing WM_2 internally) and a motion orthogonal to WM_1's motion (here WM_1 is viewing WM_2 externally). That is to say: WM_1 can deem WM_2 either matter (M_2) or wave (W_2). WM_3 can likewise deem WM_2 either matter (M_2) or wave (W_2).

The secret to understanding our new concepts "distance" and "wavematter" is all in Fig. 7. Here we see how they go hand in hand: We claim the symmetry of all four Cartesian coordinates in ES and—on top of that—the symmetry of all objects in ES. *What I deem wave, deems itself matter.* Just as distance is spatial and temporal distance in one, so is wavematter wave and matter in one. Here is a compelling reason for this unique claim of our theory: Einstein taught us that energy is equivalent to mass. *Full symmetry of matter and waves is a consequence of the mass–energy equivalence.* As the axis d_4 disappears because of length contraction, energy in a propagating wave "condenses" to mass in matter. In today's physics, there is no such symmetry. So, we have the same issue here as discussed in Sect. 2, except that now we replace "observers" with "objects": In Einstein's relativity, there is no superordinate reference frame in which all objects (at rest and propagating) are treated alike at once. In ER, all wavematters are treated alike at once. Only in an observer's 3D space is a wavematter deemed wave or matter.

With all this insight, we are now prepared to bring light into the concept "photon". It actually stems from a misinterpretation of the wave–particle duality. The term "photon" was coined to explain this duality from the perspective of an observer, that is, from just one perspective: An observer can—depending on the experiment—confirm that electromagnetic radiation is either wave or photon. Yet the wave–particle duality is a matter of two perspectives. In ER, each wavematter (each photon, too) has a perspective of its own. We repeat a statement from above, but replace "matter" with "particle": *What I deem wave, deems itself particle.* We now break the spell on the wave–particle duality in its two flagship experiments: the double-slit experiment and the outer photoelectric effect.

In a double-slit experiment, an observer detects coherent waves passing through a double-slit and producing some pattern of interference on a screen. We already know that he observes wavematters from ES whose 4D motion swings by an angle of 90° into his 3D space. He deems all these wavematters waves because he isn't tracking through which slit each wavematter is passing. If he did, the interference pattern would disappear immediately. *So, he is a typical external observer.* Experiments with low-noise video cameras have

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also been performed [32]. The results confirm our theory: There is interference of waves if photons aren't tracked. Yet once we focus *on the internal view* of each wavematter ("Which CCD pixel will detect me?"), it behaves like a particle.

The outer photoelectric effect is quite different. Of course, we can externally witness how one photon is releasing one electron from a metal surface. But the physical effect itself ("Do I have enough energy to release one electron?") is all up to the photon's view. Only if its energy exceeds the binding energy of an electron is that electron released. Hence, we *must* interpret this experiment from the internal view of each wavematter. Here its view is crucial! It behaves like a particle which we nowadays call "photon".

The wave–particle duality has also been observed in matter, like electrons [33]. How can they behave like waves in a double-slit experiment? According to our third postulate, *all energy* is wavematter. So, electrons are wavematter, too. From the internal view (which is our view if $v_{3D} \ll c$), electrons are particles: "Which slit will I go through?" From the external view, electrons are waves. In ES, all wavematters are moving at the speed of light, regardless of whether we deem them waves or matter. It all depends on the swing angle whether I deem a wavematter either wave ($> 0°$) or matter ($< 90°$) in my 3D space. Fig. 7 even tells us why I deem macroscopic wavematters matter: Their speed in 3D space is low compared with the speed of light thus favoring the internal view. This argument justifies drawing solid rockets and celestial bodies in our ES diagrams.

5.10. Solving the Mystery of Quantum Entanglement

The term "entanglement" [34] was coined by Erwin Schrödinger when he published his comment on the Einstein–Podolsky–Rosen paradox [35]. The three authors argued in a thought experiment that quantum mechanics wouldn't provide a complete description of reality. John Bell proved that quantum mechanics is incompatible with local hidden-variable theories [36]. Schrödinger's word creation didn't solve the paradox, but demonstrates up to the present day the difficulties that we have in grasping quantum mechanics. Many experiments have confirmed that entangled particles violate the classical concept of locality [37–39]. Ever since has entanglement been considered a non-local effect.

We will now "untangle" quantum entanglement *without* the issue of non-locality. All we need to do is discuss quantum entanglement in ES. Fig. 8 illustrates two wavematters that were created at once in the same point P and move away from each other in opposite directions at the speed c. We assume that they are entangled (for example, they were created in a non-linear crystal in P). One wavematter is moving in the axis d_4, the other one in the opposite direction ($-d_4$). If they are observed by a third wavematter in its 3D space spanned by d'_1, d'_2, d'_3, they are deemed two objects, especially if they are already far away from each other. That third wavematter can't understand how the entangled wavematters can communicate with each other in no time. This is again the external view.

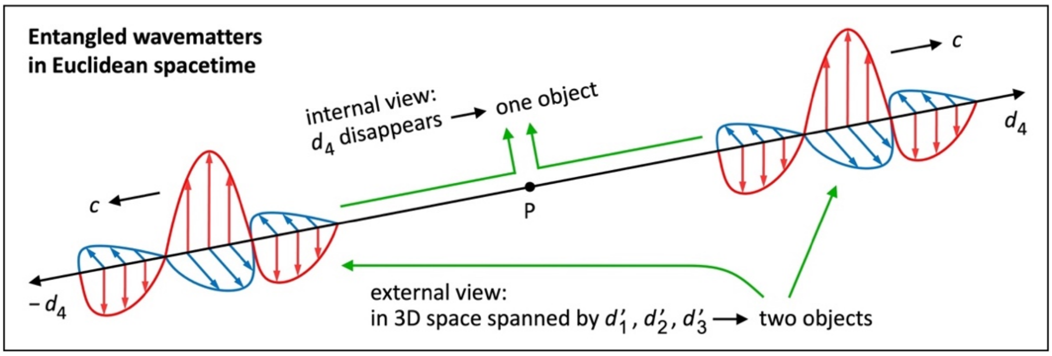

Figure 8. Quantum entanglement in ES. Artwork illustrating internal view and external view. For each wavematter (internal view), the axis d_4 disappears because of length contraction. It deems its twin and itself one object. For a third wavematter (external view) that is not moving in the axis d_4, the axis d_4 doesn't disappear. It deems them two objects.

And here comes the internal (in-flight) view in ES: For each entangled wavematter in Fig. 8, the axis d_4 disappears because of length contraction at the speed c. That is to say: In the projection to its own 3D space spanned by d_1, d_2, d_3, either wavematter deems itself at the very same position as its twin. *From either perspective, they have never been separated.* This is why they communicate with each other in no time! Our solution to entanglement isn't limited to photons. According to our first postulate, everything is moving through ES at the speed c. Hence, electrons or atoms can be entangled, too. They move at a speed $v_{3D} < c$ in my 3D space, but in their axis d_4 they also move at the speed c.

5.11. Solving the Mystery of Spontaneity

In spontaneous emission, a photon is emitted by an excited atom. Prior to the emission, the photon's energy was moving with the atom. After the emission, that energy is moving by itself. Today's physics can't explain how that energy is boosted to the speed c in no time. In ER, both atom and photon are moving at the speed c. So, there is no need to boost any energy to the speed c. All it takes is energy whose 4D motion swings by an angle of $90°$ into an observer's 3D space, and that energy is able to speed off at once. *In absorption,* a photon is spontaneously absorbed by an atom. In ER, both photon and atom are moving at the speed c. So, there is no need to slow down any energy.

In pair production, two gamma photons convert into a subatomic particle and its antiparticle, like an electron and a positron. Today's physics can't explain how the energy of the gamma photons is slowed down in no time to become matter and antimatter. In ER, all four objects are moving at the speed c. So, there is no need to slow down any energy. *In annihilation,* a subatomic particle and its antiparticle convert into two gamma photons. In ER, all four objects are moving at the speed c. So, there is no need to boost any energy to the speed c. All these effects are another clue that everything is moving through ES at the speed of light. ER even explains why the two gamma photons created in annihilation are entangled [40]: From either perspective, they have never been separated.

5.12. Solving the Mystery of How to Unify Relativity and Quantum Mechanics

In the last decades, physicists have been trying to unify GR and quantum mechanics. ER has the power to solve mysteries that today's physics either didn't solve (for example, the competing values of today's Hubble constant and the wave–particle duality) or that it has solved in its own way, but with concepts that we proved to be redundant (for example, dark energy and non-locality). We demonstrated that ER outperforms GR in cosmology and in its compatibility with quantum mechanics. We conclude: *We must not unify GR and quantum mechanics, but ER and quantum mechanics.*

6. Conclusions

We proved that Albert Einstein made two expensive mistakes in his concept of time. Mislead by SR, he ultimately made a third mistake by selecting an indefinite metric in GR. Retrospectively, it was his first mistake—assuming that moving clocks could synchronize with stationary clocks—which caused all this trouble. Einstein's mistakes were expensive: Since physicists have had a flawed concept of time for more than 100 years, they couldn't grasp the "big picture" in cosmology, nor were they able to unify relativity and quantum mechanics. For the very first time on Earth, living things now understand what time is all about: We live in the 3D hypersurface of an expanding 4D hypersphere—and its radius, divided by the speed of light, is time! We felt instantly that our discovery will revolutionize both physics and philosophy. Just imagine: *The human brain is able to grasp the idea that we are all moving at the speed of light.* Conflicts of mankind become all so small ...

We solved 12 fundamental mysteries which can be taken as 12 proofs for our theory: (1) time, (2) time's arrow, (3) mc^2, (4) cosmic microwave background, (5) Hubble's law, (6) flat universe, (7) today's Hubble constant, (8) dark energy, (9) wave–particle duality, (10) quantum entanglement, (11) spontaneity, (12) how to unify relativity and quantum mechanics. As non-cosmologists, we did have some advantage in formulating our theory because we aren't caught up in Einstein's relativity. We showed that the Lorentz transformation in SR is recovered in ER and that GR is outperformed by ER. So, SR and GR aren't really needed in physics. We didn't add that last sentence to our Abstract because it would have upset many readers. Now, at the end of our report, it is reasonable. *For quantum leaps in understanding, we must overcome traditional concepts.* Einstein sacrificed the absoluteness of space and time. We sacrifice the absoluteness of wave and matter, but we restore absolute time and pair it with an absolute 3D hypersurface. Quantum leaps can't be planned. They just happen like the spontaneous emission of a photon. ☺

Textbooks of physics must be revised to account for our three new concepts of time, distance, and energy: (1) There is absolute time. (2) Spatial and temporal distance are not two, but one. (3) Wave and matter are not two, but one. We owe Einstein a great debt of gratitude for all his theoretical work, but even he could not overcome the thinking in both space and time. We explained our three concepts and confirmed how powerful they are. We can even tell the source of their power: *beauty and symmetry*. Once you have cherished this beauty, you will never let it go again. Yet to cherish this beauty, you first need to give yourself a little push—by accepting that reality is a projection of a mathematical manifold that we can't observe. It isn't by chance that we solved 12 mysteries at once. Only a Theory of Everything has the power to do so. Because we can't address all of physics in one report, we encourage all our colleagues to take part in this paradigm shift. Hopefully, our theory will contribute to an improved understanding of physics.

Author Contributions: Markolf has a Ph.D. in physics and is a full professor at Heidelberg University, Germany. He studied in Frankfurt, Heidelberg, at UC San Diego, and Harvard. He contributed where Einstein was mistaken, the two new concepts "distance" and "wavematter", and the Theory of Everything. He also drafted the report. Siegfried taught physics and math at the Waldorf School in Darmstadt, Germany. He contributed that Minkowski diagrams aren't in line with experimental physics and today's correct Hubble constant. Everything else was solved together.

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