Supporting the Assumption that Space-Time is an Emergent Entity via a Proposed Experiment

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Abstract:

Modern physics is caught in a profound conceptual schism between deterministic, continuous classical frameworks and probabilistic, discrete quantum mechanics.

While recent advancements—such as Nicolas Gisin's application of intuitionistic mathematics to classical mechanics [1] —have bridged this gap by exposing classical physics as fundamentally probabilistic, they continue to rely on the static assumption of a fundamental, singular space-time background.

This article argues that space-time is not a primary entity but an emergent cognitive interface used to interpret energy interactions.

To break the logical paradox of using a brain embedded in space-time to disprove space-time, we propose that science must look for an internal algorithmic "bug" in existing frameworks.

We propose a specific high-precision experiment: testing whether the mathematical sign of an electric charge induces an asymmetry in gravitational time dilation, aiming to reveal a "bug" in general relativity.

By testing whether positive and negative charges produce asymmetric time dilation, the proposed experiment aims to falsify the current Q^2-dependent Reissner–Nordström metric and demonstrating that space-time is a secondary property of localized energy interactions and a cognitive construct stemming from energetic interactions.

1. Introduction: The Crisis of the Continuum and Gisin's New Classical Physics

For over three centuries, physics has operated under the Newtonian and Einsteinian assumption that space and time constitute a continuous, infinitely divisible backdrop—a "stage" upon which matter and energy perform.

In this classical paradigm, the universe is strictly deterministic.

If one could know the exact position and momentum of every particle, the future could be calculated with absolute certainty.

However, this determinism harbors a hidden, non-physical assumption: the **Principle of Infinite Precision**. For a classical state to be deterministic, a particle's coordinates must be represented by real numbers containing an infinite number of digits after the decimal point (e.g., 3.14159... to infinity).

Recently, a revolutionary theoretical framework pioneered by Nicolas Gisin and Flavio Del Santo (2019–2021) [2], [3], [4], [5] dismantled this assumption [Alternative Interpretations of Classical Physics].

Gisin argues that infinite precision is a metaphysical myth. Storing infinite information within a finite volume of space requires infinite energy, which would trigger a gravitational collapse into a black hole.

Instead, Gisin proposes **Finite Information Quantities (FIQs)**. Under this framework, nature only holds a finite number of digits regarding any physical state. The subsequent digits do not yet exist; they are fundamentally random and materialize into existence only as time flows.

By replacing standard mathematics with **Intuitionistic Mathematics** (originally formulated by L.E.J. Brouwer [6]), Gisin successfully demonstrated that classical physics is fundamentally probabilistic. This provides a stunning conceptual bridge to quantum mechanics, showing that features like the "measurement problem" (where an observation forces nature to choose a value) are not uniquely quantum, but are inherent properties of any physics limited by finite information.

2. The Conservative Catch: The Persistence of the Background

Despite its profound success in shattering classical determinism and destroying Einstein's frozen "Block Universe," Gisin's framework stops halfway. It alters our understanding of *matter* and *information*, but it leaves the *stage* intact.

In Gisin and Del Santo's probabilistic classical mechanics, the underlying differential equations still map particles onto a pre-existing, singular, and continuous space-time manifold. Space-time is still treated as an independent, objective reality. Furthermore, this framework inherits General Relativity's specific, blind treatment of localized gauge fields, such as electromagnetism.

In General Relativity, the geometry of space-time is dictated by the stress-energy tensor. When solving Einstein's field equations for a charged mass—yielding the Reissner–Nordström metric presented below [7] —the metric's alteration of space-time curvature and time dilation depends strictly on the **square of the charge (Q^2)**.

$$ds^2 = -(1 - 2GM/c^2r + GQ^2/4\pi\varepsilon_0 c^4 r^2)\, c^2dt^2 + (1 - 2GM/c^2r + GQ^2/4\pi\varepsilon_0 c^4 r^2)^{-1}\, dr^2 + r^2 d\Omega^2$$

(More on the above Reissner–Nordström metric presented above, and its connection to the materials presented in this paper, can be found in the Appendix, at the end of this paper).

Because any real number squared becomes positive, the current paradigm dictates that only the *energy density* bound within the electromagnetic field affects space-time. The framework is entirely blind to the qualitative nature of the source. An isolated proton and an isolated antiproton of equivalent mass are mathematically expected to dilate time in the exact same manner.

3. The Epistemological Paradox of Disproving Space-Time

If space-time is not a fundamental background but an emergent property born out of energy interactions, how can the human mind prove it? Herein lies a severe epistemological paradox:

The human brain, which is the very tool required to design an experiment, is itself a biological construct operating via localized energetic interactions (neurological action potentials). If our cognitive perception of space-time is an illusion or a "user interface" generated by these interactions, the brain cannot objectively step outside of space-time to prove its non-existence. A system cannot deduce its own non-existence by relying on its own internal rules.

To break this logical loop, we must adopt the principles of evolutionary epistemology and structural crisis analysis.

We do not need a tool that observes the universe from the "outside." Instead, we must look for an **internal algorithmic bug**—an anomaly where the internal logic of the space-time paradigm contradicts itself when faced with physical reality.

Physicists can deduce that space-time is a secondary, constructed concept by finding a physical interaction that breaks the mathematical symmetry of General Relativity's background.

4. A Proposed Experiment: Charge-Sign Asymmetry in Time dilation

To expose this fundamental bug, the paper proposes a high-precision empirical test designed to challenge the Q^2 dependence of gravitational metrics.

The Core Hypothesis

If space-time is truly fundamental and independent, it must remain indifferent to the sign of an electric charge, altering clocks solely based on mass-energy equivalents. However, if space-time is an *emergent phenomenon* arising directly from the web of energetic and gauge interactions, then the fundamental qualitative differences between positive and negative phase spaces should directly manifest as an asymmetry in localized temporal metrics.

Experimental Architecture

The experiment requires measuring the intrinsic proper time of two highly controlled, identical systems possessing opposite charges, placed under intense, identical macroscopic electrostatic fields.

1. **The Clocks:** Utilize highly stable, synchronized atomic clocks.
2. **The Environment:** Subject System A to a massive, localized positive electrostatic potential, and System B to an identical negative electrostatic potential, while keeping all external gravitational influences strictly symmetrical.
3. **The Measurement:** Measure the rate of proper time elapsed ($d\tau$) for both systems relative to a distant, neutral reference clock.

If the experiment yields even an infinitesimal, statistically significant deviation where: $\Delta\tau_{positive} \neq \Delta\tau_{negative}$, then the standard Q^2 framework of the Reissner–Nordström metric is instantly falsified.

Such an asymmetry would reveal a catastrophic bug in the assumption of a singular, neutral space-time canvas.

5. More on the Proposed Experiment

In GRT, all forms of Energy (including the Electrostatic Energy stored in Electrically Charged objects) contribute to the curvature of Einstein's four-dimensional interwoven spacetime via the Stress-Energy Tensor ($T_{\mu\nu}$). This curvature results in Gravitational Time Dilation, such that clocks run slower near massive or energetic objects.

Standard GRT contribution of the Electromagnetic Field's Energy density to spacetime curvature depends only on the magnitude of the Electric Charge (Q^2) and the Energy density of the Field. It is independent on the sign (Positive or Negative).

Thus, the proposed experiment focuses exclusively on the Gravitational Signature of the Electric Field's source (the Electric Charge), and the proposed experiment is designed to detect any measurable difference in Einstein's four-dimensional interwoven spacetime curvature between Positive and Negative Electric Charges, which affect that Einstein's four-dimensional interwoven spacetime curvature.

If Positive and Negative Electric Charges would induce distinct geometries, as proposed in this paper, these distinct geometries might couple to the spacetime metric (g) differently, potentially violating the sign-agnostic Q^2 dependance seen in the standard Stress-Energy Tensor. This would lead to a measurable difference in the Gravitational Time-Dilation based on the sign of a large Electric Charge.

Thus, strong evidence that the Positive and the Negative Electric Fields possess unique, non-symmetric geometric Properties, that violate the sign-agnostic Q^2 contribution predicted by the

standard GRT framework, may indicate that some modification, might be also required, to the standard GRT framework.

The proposed experiment chose to utilize Atomic Clocks, to measure such differences in Time-Dilations, if they appear, in the experiment.

That choice, to use Atomic Clocks, is similar to the choice that the famous Hafele-Keating (8) made, to use Atomic Clocks, to provide validity to Einstein's Time-Dilation predictions.

In the Hafele-Keating experiment, cesium-beam Atomic Clocks were used to test if there are differences in these Atomic Clocks readings, between Atomic Clocks which were mounted on commercial jet flights, and identical Atomic Clocks which remained on the ground.

This experiment validated that such differences indeed occurred and these differences coincided with the differences that Einstein's SRT and GRT predicted, which provided testable evidence that Einstein's Time-Dilations predictions were indeed correct.

Thus, the proposed experiment, proposed in this paper, also chose to propose to use Atomic Clocks, to detect differences in Time-Dilations that might appear in the experiment.

6. The setup of the proposed experiment

Components:

1. A test Mass A, which is a sphere of highly conductive material, such as gold, which is charged to a maximum, extremely controlled, stable and very large positive voltage (+V).
2. A test Mass B, which is an identical sphere of highly conductive material, such as gold, which is charged to an equivalent, extremely controlled, stable and very large negative voltage (-V). The Mass magnitudes of the test Mass A and test Mass B should be nearly identical. Also, the total Electromagnetic Energy E_{EM} of test Mass A and test Mass B should be nearly identical.
3. A Reference Clock (C_R), which is a highly sensitive Atomic Clock, placed far from the Test masses. This clock will measure the time flow far away from the test mass bodies presented above.
4. A Test Clock A (C_A), which is an identical Atomic Clock, placed at a fixed very small distance (d) from Test Mass A. This clock will measure the time flow near the Positive Electric Charge.
5. A Test Clock B (C_B), which is an identical Atomic Clock, placed at a fixed very small distance (d) from Test Mass B. This clock will measure the time flow near the Negative Electric Charge.

Procedure:

1. Establishing Baseline:

With both Test Mass A and B neutral (V=0), the experiment will start with a measurement of the time rate differences between C_R, C_A and C_B. This will account for any inherent clock or local environmental errors (R_0), which should be indistinguishable.

2. Applying Electric Charge:
   At this stage of the experiment, Test Mass A will be Electrically Charged to +V, and Test Mass B will be Electrically Charged to -V.
3. Measuring the Time-Dilations:
   At this stage of the experiment, the experiment will perform a simultaneously measurement of the time rates of C_A and C_B relative to the distant reference C_R.
4. Analyzing the differences in the Time-Dilations:
   At this stage of the experiment, the experiment will perform a calculation of the differences, ΔR, in the Time-Dilations between the two test clocks, where R_A will be the Time-Dilation measured between C_A and C_R, R_B will be the Time-Dilation measured between C_B and C_R, and the differences ΔR in the Time-Dilations, would be $\Delta R = R_A - R_B$.

Testable Prediction:

1. Standard GRT prediction:
   Since, according to the GRT, the Energy of the Electric Field E_{EM} depends on the square of the magnitude of the Electric Charge (Q^2), and the Masses are identical, then, from the GRT follows that R_A and R_B are both expected not to be equal to zero, and the Gravitational Time-Dilation experienced by C_A and C_B, R_A and R_B, should be equal. Therefore, ΔR should be nearly zero.
2. Prediction if the geometric proposal predicted in the paper applies:
   If the Positive and the Negative Electric Charges geometries, presented in the paper, couple differently to the main spacetime metrics, the resulting local curvature (and thus, the Time-Dilation) will differ based on the Electric Charge sign. Therefore, ΔR would not be nearly zero.

This Experiment is crucial and will provide significant important results, in whatever results that it will provide.

As already presented before in this paper, this experiment focuses exclusively on the Gravitational Signature of the Electric Field's source (the Electric Charge).

If the results of the experiment will be a ΔR which is indeed nearly zero, because such an experiment was not executed yet, that result will provide additional validity to the standard GRT framework, in their sign-agnostic Q^2 contribution, an issue which was not tested yet.

But, any measurable differences in the spacetime curvature (which will be manifested in measurable differences in the Time-Dilations), between the Positively Electrically Charged Mass and the Negatively Electrically Charged Mass, would provide strong evidence that the Positive and the Negative Electric Fields possess unique, non-symmetric geometric properties that violate the sign-agnostic Q^2 contribution predicted by the standard GRT framework.

7. Summary and Conclusions

Exposing a charge-sign dependency in time dilation would fundamentally shake the foundations of physics. It would prove that electromagnetism and gravity are not separate forces interacting *on* a spatial stage, but that the stage itself is directly woven by the underlying properties of particle interactions.

If the stage changes depending on whether an energy interaction is positive or negative, then a singular, objective, pre-existing space-time background cannot exist.

This brings us to the ultimate conclusion shared by advanced edge-theories like:

Nima Arkani-Hamed's "Amplituhedron" (9): space-time is doomed as a fundamental concept. It is a highly efficient cognitive mechanism—a biological "graphical user interface" (GUI)—evolved by the human brain to compress, organize, and make sense of complex, finite streams of energy and information data.

We do not look at a fundamental canvas called space-time; we look at energy interacting with energy, and our minds call the relationship "space-time."

By discovering the bugs within this interface, humanity can finally peer past the graphics and begin decoding the true, informational code of the cosmos.

Appendix: The Reissner–Nordström metric

To understand how the proposed experiment exposes a "bug" in current physics, we must look closely at the math physicists currently use to describe a charged object.

The equation presented in the article is the **Reissner–Nordström metric**.

It is an exact solution to Einstein's Field Equations in General Relativity.

It calculates the exact structure of space and time around a body that has both **mass (M)** and **electric charge (Q)**.

Here is a step-by-step breakdown of what the equation means and how it works:

The following presents the Anatomy of the Equation:

$$ds^2 = -\left(1 - 2GM/c^2r + GQ^2/4\pi\varepsilon_0 c^4 r^2\right) c^2dt^2 + \left(1 - 2GM/c^2r + GQ^2/4\pi\varepsilon_0 c^4 r^2\right)^{-1} dr^2 + r^2 d\Omega^2$$

Where:

ds^2 (The Space-Time Interval): is the core output. It represents the actual, physical distance between two events in four-dimensional space-time.

dt^2 (The Time Component): represents time as measured by a clock sitting infinitely far away from the object.
dr^2 (The Radial Space Component): This represents the spatial distance moving directly toward or away from the center of the mass.
$r^2d\Omega^2$ (The Angular Component): This handles the standard 3D spherical geometry (angles around the object) and remains unaffected by gravity or charge.
M is mass
Q is electric charge
G is the Gravitational Constant
c is the speed of light

It should be also emphasized that the **Reissner–Nordström metric** equation is a generalization of the Minkowski metric related to the Minkowski geometry:

$$ds^2 = - c^2dt^2 + dr^2$$

This describes a flat, rigid, four-dimensional vector empty space-time where there is absolutely no gravity and no electric charge.

The Minkowski geometry structure is governed by a constant metric tensor (usually denoted as $\eta_{\mu\nu}$), which is just a static grid of numbers.

In this geometry, mass, energy, and charges are just passive actors. No matter how much energy is injected into a Minkowski space, the grid itself never bends, reacts, or changes.

The Reissner–Nordström metric is a direct **generalization** of that formula. It takes the flat space-time equation and "deforms" it to account for the presence of a mass (M) and a charge (Q).

The Reissner–Nordström metric represents a **Pseudo-Riemannian geometry**. The rigid grid is replaced by a dynamic, smooth, and curved manifold.

The static $\eta_{\mu\nu}$ is replaced by a variable metric tensor, $g_{\mu\nu}$, which changes its value at every single point in space based on the distribution of matter and energy.

When Einstein generalized Minkowski geometry into Pseudo-Riemannian geometry, he formulated the **Einstein Field Equations**. These equations dictate that the curvature of the Pseudo-Riemannian manifold $g_{\mu\nu}$ is determined entirely by the **Stress-Energy Tensor** $T_{\mu\nu}$.

Because $T_{\mu\nu}$ only tracks the *quantity* of energy and momentum—and is completely blind to gauge charges like the sign of an electric charge—the resulting Pseudo-Riemannian metric *must* square the charge (Q^2) to convert it into a pure energy value.

The Scaling Factor: How Gravity and Charge Fight:

The heart of the equation lies within the parentheses, which acts as a scaling factor for both time and space:

$(1- 2GM/c^2r+ GQ^2/4\pi\varepsilon_0c^4r^2)$

The following describes how the components inside the parenthesis interact as the distance r gets smaller meaning getting closer to the object:

1. If ($r = \infty$) meaning far away from the object, the fractions become zero, leaving just 1. Time moves normally, and space is flat.
2. **The Mass Pulls (-2M/r):** This is the standard Newtonian/Einsteinian gravity. Because it has a **minus sign**, mass *subtracts* from the pacing of time. This causes **gravitational time dilation**—it forces clocks closer to the mass to tick slower.
3. **The Charge Pushes ($+Q^2/r^2$):** This is the energy of the electric field. Notice it has a **plus sign**. This means the energy stored in the electric field actually *counters* the mass. It attempts to speed clocks back up and exerts an outward, repulsive gravitational push.

Exposing the "Bug":

In General Relativity, gravity does not care about what "kind" of thing is causing the gravity; it only cares about the **energy density**.

An electric field contains energy. Because energy is always positive, the math squares the charge (Q^2) to ensure that the resulting energy value is positive, regardless of whether the source is a proton or an electron.

According to this metric, the universe is fundamentally blind to the sign of the charge. The background space-time canvas treats a positive potential and a negative potential exactly the same.

The Proposed Experiment Shatters This Equation:

Since the experiment outlined in the article contains identical clocks under massive positive vs. negative electrostatic potential, then, if the experiment detects even a microscopic difference in how much their time dilates, **this entire equation collapses.**

A difference in time dilation between +Q and -Q means the scaling factor cannot rely on Q^2. The math would have to include a raw, with unsquared Q term (or an asymmetric function of Q).

If the metric requires a raw with Q, it proves that space-time is not a neutral, independent canvas that merely calculates energy density.

Instead, it proves that the very fabric of space and time is a direct, emergent byproduct of the specific, qualitative gauge interactions taking place.

The "stage" is a reflection of the "actors" themselves.

What this means for the "Bug" hypothesis:

Because the Reissner–Nordström metric is just a "bent" version of the flat space-time formula, it inherits a rigid mathematical structure.

By inserting the charge as a squared value (Q^2), General Relativity treats the charge merely as a source of static energy density that warps the basic ($- c^2dt^2 + dr^2$) grid.

Thus, if a positive charge warps that ($- c^2dt^2$) component differently than a negative charge, the modification factor cannot be a simple scalar multiplier of the flat space-time interval.

It means the very relationship between the minus sign in front of time ($- c^2dt^2$) and the plus sign in front of space (dr^2) is intrinsically tied to the electromagnetic field itself, shattering the idea that the formula represents a neutral, universal backdrop.

If the proposed experiment succeeds and proves that a positive charge and a negative charge dilate time differently, it means **General Relativity's generalization from Minkowski to Pseudo-Riemannian geometry is fundamentally incomplete.**

It would prove that a Pseudo-Riemannian manifold governed purely by mass-energy equivalents $T_{\mu\nu}$ cannot fully capture the reality of the universe.

The metric grid itself would be revealed as an illusion—a mathematical approximation of a much deeper, underlying network where time and space are woven directly by the specific quantum properties (like charge signs) of interacting energies.

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