The Inverted Buoyancy Origin of the Time-Gradient Field

Gravity as directional bias, not force

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1. Purpose

The Time-Gradient Field Model is stated across this body of work in terms of three postulates: a Field Postulate, a Motion Postulate, and an Efficiency Postulate. Those postulates carry the theory. The question of where they come from, and what the underlying picture of gravity is, has been implicit rather than stated. This paper supplies that statement and verifies the two properties of it that are checkable without new data.

The origin is an inverted buoyancy. An object in a medium with a density gradient drifts toward the less dense region, because it displaces medium and the displaced medium has a net weight. Gravity runs the opposite way: matter moves toward *slower* time, not faster. Read the proper-time rate as the density of a medium, and the sign inverts. This is the intuition that motivates the Motion Postulate and fixes its direction. It is not the mechanism, and this paper does not treat it as one.

2. The Motion Postulate as a gradient rule

The formulation that the papers actually use is a gradient-following rule, stated in *Mathematical Verification of the Time-Gradient Field Model* as follows:

"This is not a force but a directional bias from the gradient $\partial\Phi/\partial x$."

An object accelerates along the local gradient of the time field, evaluated at the object's own location. There is no force term, and no integral over the body's volume. This distinction is not cosmetic. A volume integral over an extended body would raise the question of how the body's internal mass distribution affects the result, and that question does not arise here, because the response is local.

For a spherical source of mass M, the proper-time rate is

$$\frac{d\tau}{dt} = \sqrt{1 - \frac{2GM}{rc^2}}$$

so the gradient at radius r is

$$\frac{\partial(d\tau/dt)}{\partial r} \approx \frac{GM}{r^2c^2}$$

and the acceleration, restoring the factor c^2 that converts a rate of change of a time ratio into an acceleration, is

$$a = c^2 \frac{\partial(d\tau/dt)}{\partial r} = \frac{GM}{r^2}$$

This is Newtonian acceleration, recovered identically rather than approximately, because $d\tau/dt$ already contains GM/r^2. The analogy does not need to approximate the inverse-square law; the law is a restatement of the gradient.

3. Verification

Both properties below are computed in `buoyancy_origin.py`, which writes `buoyancy_origin_results.txt`. Neither requires new data: both are algebraic and geometric consequences of the prescription.

3.1 The gradient reproduces Newtonian acceleration

Evaluating the gradient numerically by central difference and comparing against GM/r^2, at the Earth's surface:

Quantity	Value
$d\tau/dt$ at $r = 6.371 \times 10^6$ m	$9.99999999304 \times 10^{-1}$
Weak-field parameter $GM/(rc^2)$	6.960×10^{-10}
Numerical gradient	$1.092515317 \times 10^{-16}\ \mathrm{s}^{-1}$
Analytic gradient	$1.092515316 \times 10^{-16}\ \mathrm{s}^{-1}$

Acceleration from gradient	9.8195320403 m s^{-2}
Analytic GM/r^2	9.8195320328 m s^{-2}
Relative error	7.580×10^{-10}
Result	**PASS**

The weak-field linearization of $d\tau/dt$ introduces no measurable error at planetary radii: the linearized and exact gradients differ by 6.960×10^{-10} in relative terms, the same order as the parameter itself.

Implementation note. The quantity $1 - d\tau/dt$ must be evaluated as $x/(1 + \sqrt{1-x})$ with $x = 2GM/(rc^2)$. The naive form $1 - \sqrt{1-x}$ subtracts two numbers near unity whose difference is of order 10^{-9}, which discards most of the available significant figures and returns zero under double-precision arithmetic.

3.2 The coupling carries no compositional information

The time field is a property of the source mass. It contains no information about the material of the body responding to it. An object therefore follows the same gradient regardless of what it is made of, and the acceleration depends on the medium, not on the body. Evaluating the gradient at a single radius for bodies spanning twenty orders of magnitude in density:

Body	Density (kg m^{-3})	Mean Z	$d\tau/dt$ gradient (s^{-1})
Hydrogen (H_2)	8.99×10^{-8}	0.67	$2.7312882907 \times 10^{-17}$
Water (H_2O)	1.00×10^{3}	3.33	$2.7312882907 \times 10^{-17}$
Silicate rock	2.50×10^{3}	10.00	$2.7312882907 \times 10^{-17}$
Iron core	7.87×10^{3}	26.00	$2.7312882907 \times 10^{-17}$
Lead	1.34×10^{4}	82.00	$2.7312882907 \times 10^{-17}$
Degenerate matter	1.00×10^{12}	2.00	$2.7312882907 \times 10^{-17}$
Spread across all compositions			0.000×10^{0}
Result			**PASS**

Mean Z is the atomic number per constituent nucleus, averaged by number: H_2 gives $2/3 = 0.67$, H_2O gives $(2 \times 1 + 8)/3 = 3.33$, and SiO_2 gives $(14 + 2 \times 8)/3 = 10.00$. The final column is the gradient of the proper-time rate, in s^{-1}; the acceleration is this value multiplied by c^2.

The spread is exactly zero. The equivalence principle holds for the origin on its own terms, with no appeal to the equivalence principle as an input.

4. Consequence for the sector coupling

The gravity-sector coupling in the synthesis is written

$$c_g = \sum_i f_i \left(d_\alpha + \beta_i d_\mu\right)$$

where f_i are material composition fractions and β_i are composition-dependent sensitivity coefficients. Section 3.2 establishes that the buoyancy origin alone predicts $c_g = 0$ for the composition-dependent part, because the medium carries no compositional information. Any observed value of c_g that varies with composition is therefore a *measured deviation from a principled baseline*, not a parameter introduced to fit data.

This is a stronger claim than a fit, and it is testable in a way a fit is not. A composition-independent result would be consistent with the origin. A composition-dependent result would require the deviation to be attributed to something the origin does not contain, and that something would be new physics with a specific place to attach.

5. What this paper does not establish

The entropy arrow. The gradient picture supplies a direction from a gradient. It does not, by itself, supply a time asymmetry: the field equation is time-reversible, and reversibility is what allows the gradient to have a sign under time reversal. In the papers the entropy arrow is asserted as the origin of that sign. Establishing it is separate work, not verification of an existing claim, and it is the most consequential open item in the framework.

The non-gravitational sectors. The buoyancy origin yields gravity. It does not by itself yield the decay-rate coupling, the fine-structure variation, or the mass-ratio variation. The unified correction law

$X_{\text{eff}} = X_0(1 + c_X G)$ is a postulate laid across the sectors, not a consequence of the gradient picture. Whether one field can serve all sectors is the central open question, and this paper does not address it.

Datasets. No anomaly measurement is used, fitted, or checked here. The evidence base is documented in the companion papers on the time-gradient field model and its statistical verification.

6. Conclusion

Gravity in this framework is a directional bias along the local gradient of proper-time rate, not a force. Inverted buoyancy supplies the intuition for its sign: ordinary buoyancy carries a body toward less dense medium, gravity carries matter toward slower time, so the sign inverts while the mechanism of a density gradient carrying a body with it does not.

Two properties of this origin are established. The gradient of the proper-time rate reproduces Newtonian acceleration to a relative error below 10^{-9}, with no measurable contribution from linearization at planetary radii. The second follows from the structure of the model rather than from measurement: the coupling carries no compositional input, so the equivalence principle holds exactly and composition dependence in c_g becomes a measurable deviation rather than a fitted parameter.

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