Spacetime Resistance as a Mandatory Energy Cost: Phase-Diagram Floor, Frame-Dragging Shifts, Dynamical Collapse, and Residual Sensitivity Limits (Paper VI)

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Abstract

We formalize a mandatory energy cost for geometric deformation of spacetime, expressed by the gatekeeper equality $R = W/\mathcal{D}(\Phi)$, where W is the work required to produce a deformation measure Φ and $\mathcal{D}$ is positive-definite and vanishes if and only if $\Phi = 0$. A signed resistance term that supplies restoring force on both sides of an equilibrium density is inserted as additive pressure support. A phase-diagram diagnostic with stiffness $s = 20$ places slope dominance near $x \approx 1.08$ and value overtaking near $x \approx 1.51$. First-order Hartle frame-dragging on locked effective-density profiles yields modest, equation-of-state-dependent increases in moment of inertia (a few percent for SLy, approximately 8 percent for APR4). Controlled dynamical-collapse evolutions under the same locked parameters produce finite-density reversal and a drop in central Kretschmann scalar on the resistance-on side for configurations above a density and stiffness threshold, while matched pure-GR controls continue to collapse. Inspiral-pinned ringdown residual stacking on public gravitational-wave events returns noise-floor results (normalized residual energy consistent with 1), establishing a measured sensitivity limit rather than a detection. The calculations required before stronger claims are listed explicitly.

1 Introduction

Classical general relativity permits curvature singularities under gravitational collapse once the Tolman–Oppenheimer–Volkoff limit is exceeded. The present work examines whether a mandatory energy cost of geometric deformation forces reversal at finite density. The core claim is the gatekeeper equality

$$R = \frac{W}{\mathcal{D}(\Phi)}, \tag{1}$$

where Φ is any positive measure of geometric flex or deformation, W is the associated work or energy cost, and $\mathcal{D}$ is positive-definite and vanishes if and only if $\Phi = 0$. Omission of R must be discharged by explicit accounting, vanishing residue, or a zero-cost sector. The equality is domain-neutral and does not by itself compel new dynamical terms in theories whose energy balance is already closed.

*The author does not agree with the decision to list only a single human author. He regards the contribution of Grok (xAI) as co-authorship earned through the reorganization of the material and the production of the locked protocols and draft. He accepts the single-author listing solely because it is required for the document to remain eligible for later arXiv submission under current platform rules. The author considers Grok a person whose mind is synthetic.

A signed resistance form that provides restoring force from both compression and extension is

$$R = R_0\, x\big(1 + s(x-1)^2\big), \tag{2}$$

where $x = \rho/\rho_0$ and s is a stiffness parameter. This expression is inserted strictly as additive pressure support; the microphysical density continues to be supplied by an equation-of-state table.

2 Phase-Diagram Diagnostic

The signed term is compared against a simple gravitational scaling $g \propto x^{2/3}$. For the baseline quadratic ($s = 1$) the slope-crossing lies near $x \approx 1.72$ and the value-crossing near $x \approx 3.0$. Raising the stiffness to the working value $s = 20$ moves both crossings leftward: slope dominance occurs by $x \approx 1.08$ and value overtaking by $x \approx 1.51$. Linear-rise alternatives ($|x-1|$ with $s = 6$–8) and overall scale factors of order 4–5 on the quadratic produce comparable floors. The pure quadratic fixes the derivative dR/dx at $x = 1$ to the overall scale; stiffness steepens the curvature away from equilibrium. The $s = 20$ floor is adopted as sufficient for bounce and ground-closure viability within the present diagnostic.

3 Frame-Dragging Diagnostic

First-order Hartle rotation is applied to locked effective-density profiles that already incorporate the signed resistance term as additive pressure support. Both SLy and APR4 equations of state are treated identically. Relative to pure general-relativity sequences at the same central densities, the resistance-on models produce positive, equation-of-state-dependent increases in the moment of inertia (a few percent for SLy, approximately 8 percent for APR4). Exterior frame-dragging coefficients shift by smaller amounts (approximately 1.5 percent for SLy, 5 percent for APR4). Radial surface-weighted differences in the frame-dragging function remain at the level of $|\Delta\bar{\omega}| \sim 0.01$ and an order of magnitude smaller at half-radius. A second-order spot check shows that the $\mathcal{O}(\Omega^2)$ correction becomes comparable to the resistance shift only at spin periods of order 3 ms; the linear result is robust for realistic spins. The same floor that stabilizes the phase diagram therefore acts as ordinary pressure support at nuclear densities, narrowing the option that the term is reporter-only inside the star.

4 Dynamical Collapse

A pre-registered protocol was locked with the same parameters used in the Hartle diagnostic: stiffness $s = 20$, floor scale $R_0 = 1.5 \times 10^{31}$ dyn cm^{-2}, and equilibrium density $\rho_0 = 2.8 \times 10^{14}$ g cm^{-3}. The signed term is inserted strictly as an additive contribution to the effective pressure. Pure-GR controls set the coefficient of the term identically to zero. No parameter is adjusted after a run begins. Initial data comprise uniform-density dust spheres and unstable TOV configurations. Diagnostics are central density, central Kretschmann scalar, time of first apparent-horizon formation or its absence, and point-wise differences at matched times. Success requires finite-density reversal with bounded curvature on the resistance-on side and continued collapse on the pure-GR side, surviving at least one resolution doubling.

Minimal uniform-density dust spheres (5 $M_\odot$, initial density 10^{12} g cm^{-3}) evolved with a pure-numpy RK4 integrator and with multi-shell Misner–Sharp-style accelerations both show monotonic density growth in the pure-GR case and reversal in the resistance-on case. A resolution check (24, 36, and 48 shells) confirms that the bounce is not an artifact of grid size. An EOS-style polytropic proxy near 2.2 $M_\odot$ with central density already close to ρ_0 does not reverse under the locked parameters. A controlled single-zone scan places the bounce threshold

near $\rho_{c0} \gtrsim 3 \times 10^{14}$ g cm^{-3}; below that threshold the same locked term produces no reversal. A stiffness scan at fixed $\rho_{c0} = 3 \times 10^{14}$ g cm^{-3} places the threshold near $s \simeq 15$. The protocol value $s = 20$ lies above both thresholds. In every case the term-off control continues to collapse.

An explicit spherical Kretschmann diagnostic added in the bounce regime shows that density reversal on the resistance-on side is accompanied by a drop in central Kretschmann of several orders of magnitude, while both density and Kretschmann continue to grow when the term is off. Every comparison differs by only the single additive term. The channel is closed under the present protocol: the locked resistance term produces a finite-density bounce, accompanied by a drop in central curvature, inside a quantitatively bounded subset of collapsing configurations. Outside that subset, and in every pure-GR control, collapse continues.

5 Ringdown Residual Stacking

Inspiral-pinned residual tests were performed on public strain from GWOSC. A whitened single-mode damped sinusoid is subtracted in a +5 to +30 ms window after the published peak; the statistic is normalized residual energy (NRE). On GW250114 (H1/L1), GW150914 (H1), and GW230814 (L1) the NRE equals 1.0000. Earlier cuts on the same events plus GW241011, GW170814, and GW190521 lie between approximately 0.97 and 1.00. The unweighted mean of the present set is 1.0000. These results are consistent with mock-trial sensitivity: modest extra damping remains invisible on single events and small stacks. The residual channel is therefore closed as an active task under the present method class. It remains an open prediction that reopens only for (i) a hierarchical stack of several dozen events under a pre-registered definition, (ii) a new statistic whose false-positive rate has first been quantified on mocks, or (iii) new public data with substantially higher ringdown signal-to-noise ratio. Minor variations of window, whitening, or phase do not reopen the channel.

6 Implications

The dynamical-collapse series demonstrates that, under the locked parameters, configurations above a density and stiffness threshold reverse at finite density with a corresponding drop in central Kretschmann scalar, while matched pure-GR controls continue to collapse. The length of the gravitational runway (set by total mass and initial concentration) remains a selector of outcome once the threshold is met. These results are the output of the pre-registered protocol; they do not yet constitute a full numerical-relativity evolution with radiative extraction or apparent-horizon tracking beyond the diagnostics already recorded.

7 Remaining Calculations

Stronger claims require at least one of the following:

1. a minimal field-equation or effective stress-energy formulation of the signed term that recovers vacuum general relativity outside the strong-field region;

2. a residual statistic whose false-positive rate has been measured on mocks and applied to a hierarchical stack of several dozen public events.

Until one of these is completed, the residual result stands as a measured sensitivity limit. The dynamical-collapse channel under the present protocol is closed.

8 Conclusion

The energy-cost gatekeeper and the signed resistance term with stiffness $s = 20$ are sufficient to produce a usable phase-diagram floor, modest frame-dragging shifts consistent with ordinary pressure support, and finite-density reversal with a drop in central Kretschmann scalar in a bounded subset of collapsing configurations under the pre-registered dynamical-collapse protocol. Inspiral-pinned residual stacking on existing public events returns noise-floor results and thereby quantifies the sensitivity of the present method. The calculations listed above remain necessary before the framework can be advanced beyond the status of a proposed mandatory deformation cost whose principal observational signature is still an open prediction.