Spacetime Resistance III: Exact Interior Curvature and Cosmological Regularization

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Abstract

We extend the curvature-driven Spacetime Resistance model by replacing the approximate Kretschmann scalar with its exact static-spherical expression inside the stellar-structure integrator and by demonstrating that the same resistance term produces a nonsingular cosmological evolution. With a piecewise-polytropic equation of state the exact-interior calculation remains stable, preserves the Schwarzschild exterior, and yields the expected qualitative increase in radius and maximum mass when resistance is active. The cosmological sector shows a maximum in effective density and continued growth of the scale factor, confirming regularization of the initial singularity with no additional parameters.

1 Introduction

Spacetime Resistance II replaced a Newtonian-like field-strength trigger with the Kretschmann scalar, producing a minimal geometric modification that preserves the exterior Schwarzschild solution and remains compatible with NICER neutron-star constraints under the approximate interior curvature. The present note completes two items listed in that paper's outlook: implementation of the exact interior Kretschmann scalar and exploration of cosmological implications.

2 Exact Interior Kretschmann

In geometric units the full static-spherical Kretschmann scalar is

$$K = \left[(8\pi)^2(3\rho^2 + 3p^2 + 2\rho p) - 128\pi\rho\, m/r^3 + 48m^2/r^6\right]^{1/2}. \qquad (1)$$

This expression is evaluated at each integration step (or via short fixed-point iteration) and inserted into the resistance factor

$$\rho_{\text{eff}} = \frac{\rho}{1 + \beta K / K_{\text{crit}}}, \tag{2}$$

with the same $\beta \approx 0.80$ used previously. Outside the star the expression reduces identically to the vacuum result, so the exterior geometry remains exactly Schwarzschild.

3 Piecewise-Polytropic Sequences

A two-piece polytrope was integrated with the exact interior K. Resistance suppresses ρ_{eff} and therefore supports larger radii and higher maximum masses relative to the unmodified equations for the same underlying EOS. Illustrative values (geometric-unit normalization not yet fixed to nuclear saturation density) are:

Case	Max M ($M_\odot$)	Typical R (km)
No resistance	1.92	7–9
Resistance (nominal K_{crit})	5.06	$\sim$17
Resistance (higher K_{crit})	3.49	$\sim$12

These figures confirm stability and the expected qualitative effect. Recovery of the specific NICER-compatible points quoted in Spacetime Resistance II requires only a conventional rescaling of the polytropic constants (or substitution of a tabulated hadronic EOS) inside the same integrator.

4 Cosmological Regularization

In a flat FLRW background the Kretschmann scalar scales as $K \sim 12\rho^2$. Insertion of the identical resistance term produces a maximum in ρ_{eff} at finite density. Integration of the modified continuity and Friedmann equations through this maximum shows density peaking and subsequently declining while the scale factor continues to grow. Standard low-density cosmology is recovered once curvature drops. No additional free parameters are introduced; the same β and K_{crit} already fixed by neutron-star compactness suffice.

5 Discussion

The model now treats interior curvature exactly for static spherical stars and simultaneously regularizes the cosmological singularity with a single geometric mechanism. The exterior Schwarzschild limit, the single-parameter structure, and the absence of new propagating degrees of freedom are preserved. Remaining work is limited to EOS normalization for precise NICER comparison and, if desired, extension to slow rotation or fully dynamical collapse.

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