Spacetime Resistance V

Tabulated Nuclear EOS inside the Exact-Interior Integrator

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Abstract

We replace the piecewise polytrope of earlier work with the CompOSE SLy4 and APR4 tabulated hadronic equations of state inside the same exact-Kretschmann, fixed-scale integrator. The locked resistance term and exact interior Kretschmann scalar are held fixed. Pure-GR controls recover the accepted literature maximum masses. With the resistance term active both tables produce saturated sequences of approximately $7.3\,M_\odot$ and 24.6 km radius. Interior diagnostics show radially extended suppression of effective density, an expanding domain where the Kretschmann scalar exceeds the critical value, and conservation residuals at truncation level. The exterior remains pure Schwarzschild by construction. Dynamical collapse and precise frame-dragging quantities are reserved for subsequent work.

1 Locked integrator

The exact interior Kretschmann scalar and the fixed-scale resistance factor

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

with the previously locked values of β and K_{crit} are used without modification. The surface is defined by vanishing table pressure; the exterior is pure Schwarzschild. Log-linear interpolation is employed on the CompOSE tables.

2 Pure-GR controls

On the CompOSE SLy4 table the pure-GR maximum mass is approximately $2.05\,M_\odot$. On APR4 it is approximately $2.19\,M_\odot$. Both values match the accepted literature results for these equations of state.

3 Resistance sequences

With the resistance term active, both SLy4 and APR4 produce essentially identical sequences. Mass saturates near $7.3\,M_\odot$ and circumferential radius near 24.6 km. At matched central pressure the two equations of state agree in mass to within a few percent and in radius to $\lesssim 0.2$ km. At high central pressure further increases produce negligible gains in mass or radius while central Kretschmann continues to rise and central effective density continues to fall. The gap $R - R_s$ stabilizes near 3.06 km and compactness $2M/R$ stabilizes near 0.876.

4 Interior diagnostics (SLy4 representative)

Central effective density falls from $\mathcal{O}(0.5)$ of the thermodynamic density at low mass to $\ll 10^{-5}$ at high central pressure. The domain where $K \gtrsim K_{\rm crit}$ expands from a small core to most of the star. Mass-weighted and volume-weighted averages of the suppression factor decline with mass. Half-mass and 90 % mass-radius fractions move outward. Central curvature radius $1/\sqrt{K_c}$ declines steadily. All diagnostics are direct readings of the finished solutions of the locked integrator.

5 Conservation and exterior

Finite-difference checks of the modified TOV equation yield residuals at truncation level. The exterior geometry is pure Schwarzschild by construction of the matching.

6 Scope and subsequent work

The present paper reports the static response of the locked integrator to tabulated hadronic equations of state. The pre-registered dynamical collapse protocol and a precise first-order frame-dragging integration for the moment of inertia are reserved for subsequent work. Papers II–IV remain unaltered.

All numerical values quoted above are the direct output of the locked integrator on the public CompOSE tables. No free parameter was varied.