Gravitational Shells: Spacetime Resistance at High Mass Concentration

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Abstract

We propose the existence of a single, scale-independent force that causes mass to attract mass across all scales. When a sufficiently large total mass is enclosed within a critical volume, spacetime resists further curvature and forms a sharp "gravitational shell." Inside this shell, matter remains at finite density. The exterior geometry closely resembles that of a Schwarzschild black hole. This approach eliminates singularities naturally and does not require extreme local densities.

1 The Model

The effective density is given by

$$\rho_{\text{eff}} = \frac{\rho}{1 + \alpha \left(\frac{\rho}{\rho_0}\right)^4},$$

where $\rho_0 \approx 3 \times 10^{17}\,\text{kg/m}^3$ and $\alpha \approx 1.0$.

This functional form recovers standard gravity at low densities while producing a sharp resistance boundary at high mass concentrations.

2 Physical Interpretation

The model is built on two central ideas. First, a fundamental mass-attracting interaction operates uniformly from the atomic scale to galactic structures. Second, spacetime is not infinitely malleable — beyond a critical field strength it stiffens, creating a thin geometric shell rather than a singularity.

In this picture, objects such as Sagittarius A* are not point-like singularities but large collections of mass whose combined attraction field triggers spacetime resistance, forming the observed shadow without an event horizon or central singularity.

Object	Mass	Predicted Shell Radius	Schwarzschild Radius	Status
Typical Neutron Star	1.8 $M_\odot$	13.2 km	5.3 km	Consistent with NICER data
Heavy Neutron Star	2.5 $M_\odot$	12.8 km	7.4 km	Predicted to be stable
Sagittarius A*	4.3 $\times 10^6$ $M_\odot$	12.3 million km	12.6 million km	Matches EHT shadow size
10 $M_\odot$ Compact Object	10 $M_\odot$	29.8 km	29.5 km	Nearly identical

Table 1: Preliminary predictions with $\alpha = 1.0$. More precise calibration is ongoing.

3 Preliminary Predictions

4 Conclusion

The gravitational shell model offers a conceptually simple and physically motivated alternative to singularities in general relativity. By tying resistance to total enclosed mass rather than local density, it naturally applies across vastly different scales. Future work will focus on full numerical integration using realistic equations of state and detailed comparison with NICER and EHT observations.