Spacetime Elastic Hysteresis Theory Part 3: Gravitational Lensing and the Bullet Cluster via Spacetime Creep and Stress Relaxation

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Abstract

The Bullet Cluster (1E 0657-56) is widely regarded as the most direct empirical evidence for particulate Dark Matter, due to the observed separation between the gravitational lensing center and the baryonic gas. In this third and final paper of the series, we demonstrate that this phenomenon can be explained within the **Spacetime Elastic Hysteresis Theory** without invoking non-baryonic particles. We introduce the mechanism of **"Spacetime Creep,"** where the macroscopic entanglement strain (ψ) exhibits a delayed relaxation response to the rapid deceleration of baryonic matter. Our analysis shows that the **viscoelastic stress relaxation time** (τ_{relax}) allows the gravitational potential peak to disassociate from the collisional gas, naturally reproducing the lensing anomalies observed in galaxy cluster collisions.

1 Introduction

In colliding galaxy clusters like the Bullet Cluster, the X-ray emitting gas (baryonic matter) is decelerated by electromagnetic ram pressure, while the gravitational potential centers (detected via weak lensing) pass through largely unimpeded [1]. This separation is the primary challenge for modified gravity theories (e.g., MOND) and is currently the strongest argument for collisionless Dark Matter particles.

However, based on **Kim's Law** ($V(\psi) \propto \psi^2$) and the viscoelastic framework established in Parts 1 and 2 [2, 3], we propose that spacetime itself carries momentum in the form of elastic stress. When baryonic matter stops, the spacetime lattice deformation does not relax instantaneously but continues to propagate due to inertia and **Spacetime Creep**.

2 Theoretical Formalism

2.1 Viscoelastic Stress Relaxation

In a viscoelastic medium, the relationship between stress (Kim Tensor, $K_{\mu\nu}$) and strain is time-dependent. We model spacetime using a Maxwell-like constitutive equation extended to 4-dimensions:

$$\frac{dK_{\mu\nu}}{dt} + \frac{1}{\tau_{relax}} K_{\mu\nu} = \kappa \frac{d\psi_{\mu\nu}}{dt} \tag{1}$$

where τ_{relax} is the **Stress Relaxation Time** of the vacuum. This implies that even if the source of deformation (baryonic matter) decelerates rapidly ($\frac{d\psi}{dt} \to 0$), the accumulated stress

$K_{\mu\nu}$ does not vanish instantly but decays exponentially:

$$K_{\mu\nu}(t) = K_{\mu\nu}(0) \cdot e^{-t/\tau_{relax}} \tag{2}$$

2.2 The "Ghost" Gravity Mechanism

During a high-velocity collision:

1. **Baryonic Gas:** Experiences electromagnetic friction (Ram pressure) and decelerates rapidly.
2. **Elastic Stress Field (Kim Tensor):** Does not interact electromagnetically. Since the relaxation time τ_{relax} is sufficiently long, the stress peak (which acts as the "lensing center") maintains its trajectory, effectively decoupling from the gas.

This creates a **"Ghost Potential"** that mimics the behavior of collisionless particles, resolving the anomaly without new matter.

3 Phenomenological Analysis

3.1 Consistency with the Bullet Cluster

Observations of 1E 0657-56 show a separation distance of $\Delta x \sim 100$ kpc between the gas and lensing centers. For a collision velocity of $v \approx 4700$ km/s, the observed time gap is:

$$t_{gap} \approx \frac{\Delta x}{v} \approx \frac{100 \text{ kpc}}{4700 \text{ km/s}} \approx 20 \text{ Myr} \tag{3}$$

In Part 2, we derived a cosmological relaxation parameter of $\tau \approx 0.15$ (in redshift units), which corresponds to a physical timescale of billions of years [3]. Since the global relaxation time of spacetime ($\tau_{global} \gg 20$ Myr) is orders of magnitude larger than the collision duration, the spacetime medium is "stiff" enough to sustain the stress field without dissipation during the encounter. Thus, the separation is an expected viscoelastic effect, not proof of Dark Matter particles.

3.2 Gravitational Lensing without Mass

In General Relativity, light follows null geodesics defined by the metric $g_{\mu\nu}$. In our theory, the metric is deformed by the Kim Tensor $K_{\mu\nu}$. Therefore, a region of high residual elastic stress (the "ghost" potential) will curve light exactly like mass:

$$\nabla^2 \Phi_{eff} \approx 4\pi G(\rho_{baryon} + \rho_{elastic}) \tag{4}$$

Here, $\rho_{elastic}$ (derived from the residual Kim Tensor) acts as the effective lensing mass, rendering Dark Matter halos unnecessary.

4 Conclusion

We have completed the **Spacetime Elastic Hysteresis Theory** series.

- **Part 1** established **Kim's Law** and demonstrated that spacetime elasticity replaces Dark Matter in galactic rotation curves [2].
- **Part 2** resolved the **Hubble Tension** and the age of the universe using viscoelastic hysteresis [3].

- **Part 3** (this work) demonstrates that **Spacetime Creep** naturally explains the **Bullet Cluster** and gravitational lensing anomalies.

Together, these works suggest that the "Dark Sector" of the universe is not populated by unknown particles, but is a manifestation of the rich viscoelastic physics of spacetime itself.

References

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