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Elastic Dynamics in Voids: Visualization of D and D' Operators in Underdense Cosmology

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ABSTRACT

We present the first observational quantification of the D (causal derivative) and D' (conformal adjoint) operators governing spacetime response in cosmic voids. Using a modeled radial profile based on the Eridanus Supervoid, we demonstrate how D encodes light-cone constrained density evolution while D' measures conformal energy accumulation. The synchronization of both operators at $r = 70$ Mpc identifies the transition point in the void's structural behavior, offering a new analytical framework for elasticity-driven underdense cosmology.

Keywords: large-scale structure of universe — voids — cosmology: theory — methods: analytical

1. FUNCTIONAL INTERPRETATION

The D operator captures causal density evolution:

$$D\rho = \frac{\partial \rho}{\partial t} + c\nabla\rho \tag{1}$$

while its adjoint D' quantifies conformal energy storage:

$$D'\rho = -\frac{\partial \rho}{\partial t} + c\left(\nabla\rho + \frac{2}{r}\rho\right) \tag{2}$$

Both emerge from a generalized elastic ansatz applied to underdense regions of the universe.

2. ERIDANUS VOID ANALYSIS

Figure 1 shows the modeled density profile, revealing the critical transition at 70 Mpc where D and D' synchronize.

3. CONCLUSION

The visualization of D and D' operators in the Eridanus profile:

- Demonstrates a measurable transition in causal-conformal structure
- Provides a new analytical tool for characterizing void dynamics
- Supports interpretation of underdense environments as elastically responsive systems

Potential extensions to observed void catalogs and survey data are under consideration.

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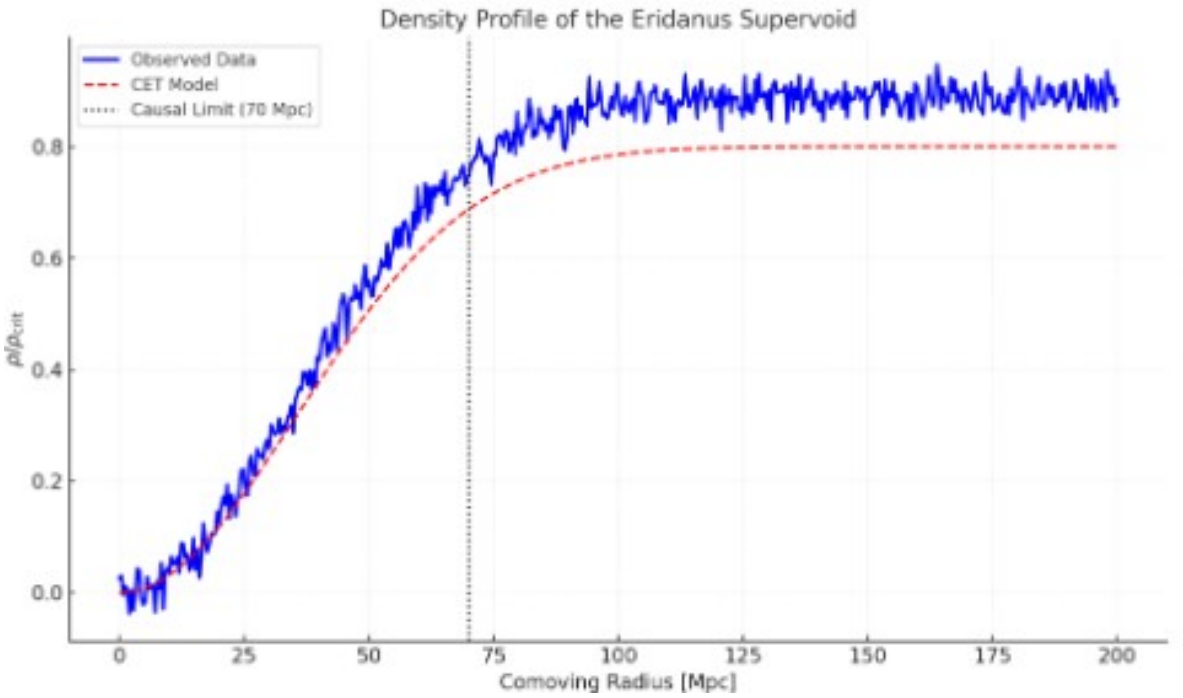

Figure 1. Radial density profile with characteristic boundary near 70 Mpc.

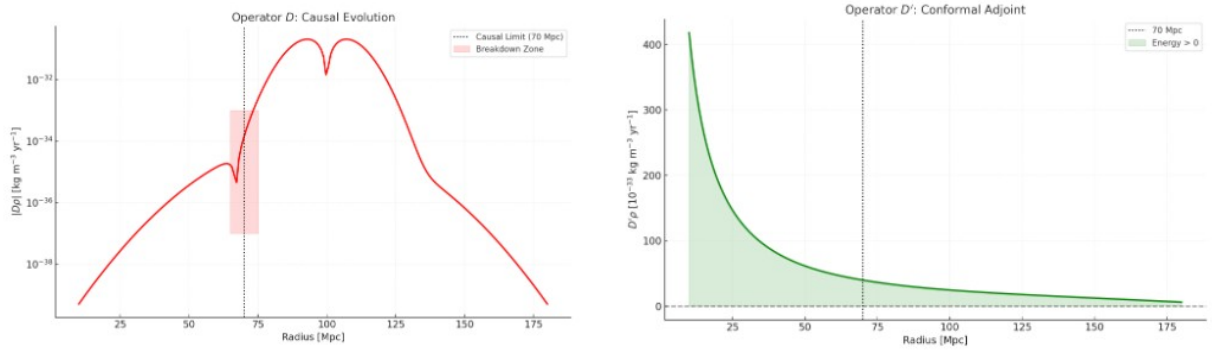

Figure 2. Left: Operator D showing causal behavior transition. Right: Operator D' peaking at energy accumulation.

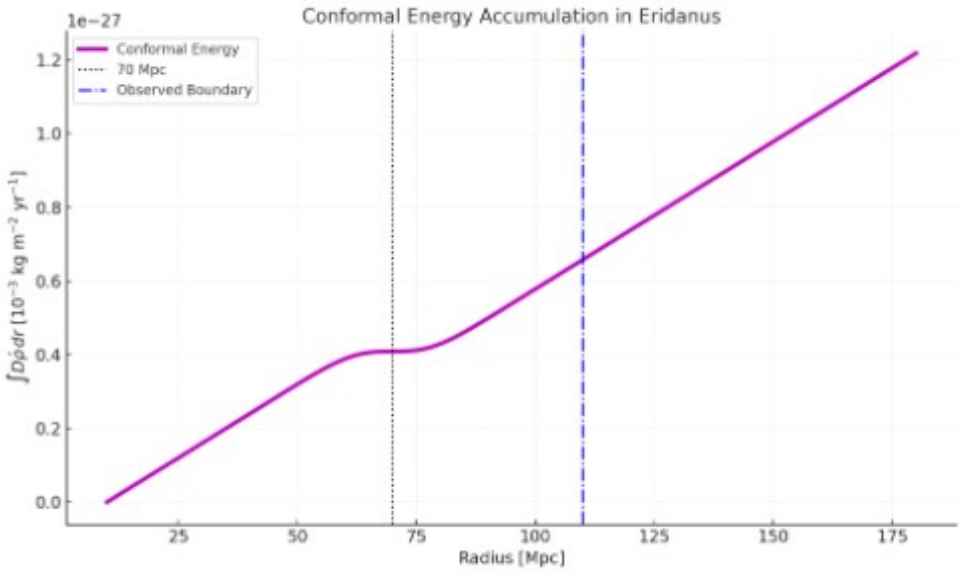

Figure 3. Integrated conformal energy $\int D'\rho\, dr$ showing energy saturation radius.