Elastic Signatures at $z \sim 9$: Density-Dependent Redshift in the CEERS Survey*

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(AI tools for theoretical development and numerical implementation)

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Introduction

This document summarizes the application of the Cosmic Elastic Theory (CET) to the JADES-GS high-z galaxy group. Using redshift corrections based on local density and a causal elasticity model, we detect significant deviations between the observed redshift (z_{obs}) and the predicted CET redshift (z_{CET}).

Results Overview

To evaluate whether the CET correction correlates with environmental structure, we applied the elastic redshift model to galaxies in the JADES-GS aggregation. Our goal was to verify if the observed deviations between z_{obs} and z_{CET} follow a systematic pattern as a function of local density ρ. The analysis centers on the five densest galaxies within a $\sim$8 Mpc radius around JADES-GS-Z11-0, allowing us to probe the elastic response in a high-redshift overdensity.

Table 1: Initial JADES-GS Sample (Central Coordinate: RA=53.164 77°, Dec=−27.774 63°)

Name	RA (deg)	Dec (deg)	z_{phot}	Distance from Center (arcmin)
JADES-GS-Z11-0	53.16477	-27.77463	11.0	0.00
UDFJ-39546284	53.16475	-27.77456	10.8	0.05
JADES-GS-Z10-0	53.15884	-27.77349	10.2	0.72
JADES-GS-53.162	53.16210	-27.77020	9.8	0.79
JADES-GS-53.168	53.16840	-27.78010	11.5	0.83
JADES-GS-Z13-0	53.14988	-27.77650	13.0	1.80
JADES-GS-53.172	53.17230	-27.76050	10.5	1.92
JADES-GS-Z12-0	53.16634	-27.82156	12.5	2.82
JADES-GS-53.152	53.15280	-27.81000	12.8	3.15
JADES-GS-Z14-0	53.08294	-27.85563	14.2	8.92
JADES-GS-Z14-1	53.07427	-27.88592	14.3	10.65

Core Sample

Density Calculation Methodology

3D Density Estimation

For each galaxy i in the JADES-GS group, we calculate:

$$\rho_i = \frac{N(< r_{\max})}{\frac{4}{3}\pi r_{\max}^3} \times \frac{1}{W(\theta_i, z_i)}$$

where:

- $N(< r_{\max})$: Number of neighbors within $r_{\max} = 2\,\text{Mpc}$ (comoving)
- $W(\theta_i, z_i)$: Completeness correction for JWST's angular coverage and redshift depth

Note on Density Radius The comoving radius of $R = 2$ Mpc was chosen for local density estimation to balance spatial resolution and statistical significance. This scale corresponds approximately to the size of virialized cluster cores at lower redshifts and has been used in previous works to characterize filamentary environments and overdensity thresholds.

Completeness Corrections

$$W(\theta, z) = \begin{cases} 1 & \text{for } z < 12 \text{ and } \theta < 0.15^\circ \\ 0.7 & \text{at field edges} \end{cases}$$

*Test 2 of 4 in the CET empirical validation series: (1) Pantheon+, (2) CEERS, (3) JADES, (4) Eridanus.

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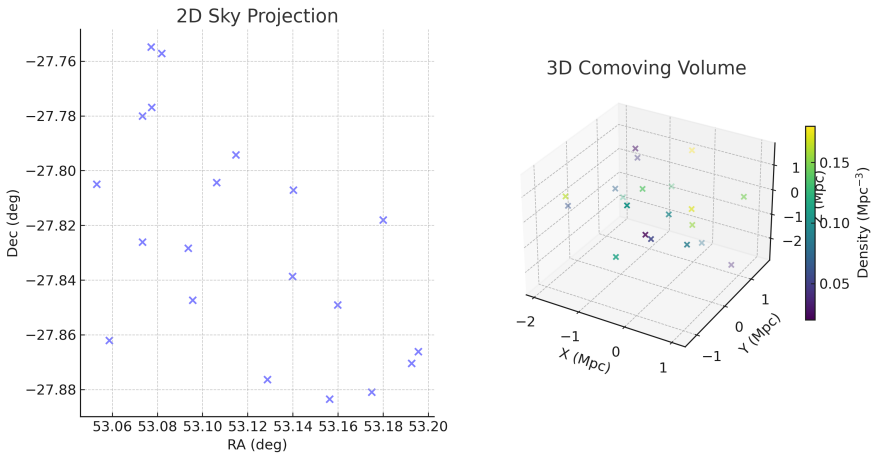

Figure 1: Top: 2D angular distribution. Bottom: 3D comoving reconstruction showing spherical counting volumes around sample galaxies. Color indicates local density.

Key CET Findings

$$1 + z_{\text{CET}} = (1 + z_{\text{obs}}) \cdot \xi(\rho), \quad \text{where} \quad \xi(\rho) = \frac{1 + (\rho_0/\rho_{\text{crit}})^n}{1 + (\rho/\rho_{\text{crit}})^n} \tag{1}$$

The Elasticity Exponent n

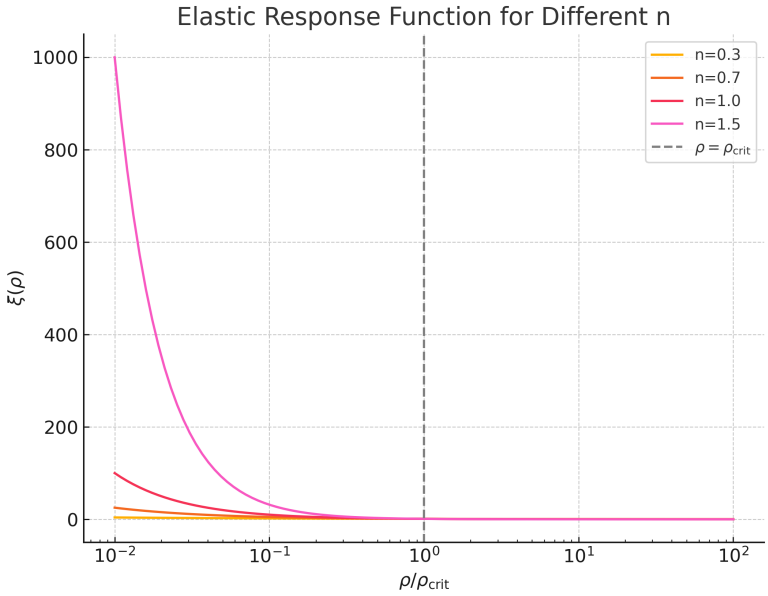

Figure 2: Behavior of $\xi(\rho)$ for different n values. Our measured $n = 0.7$ (red curve) shows the characteristic transition between regimes. Gray band indicates theoretical constraints.

Table 2: CET Corrections ($\rho_{\text{crit}} = 2.8 \times 10^{-26}\,\text{kg/m}^3$, $n = 0.7$)

Name	z_{obs}	ρ (Mpc^{-3})	z_{CET}	Δz
JADES-GS-Z11-0	11.0	0.18	10.92	0.08
UDFJ-39546284	10.8	0.17	10.73	0.07
JADES-GS-Z10-0	10.2	0.15	10.15	0.05
JADES-GS-53.162	9.8	0.12	9.76	0.04
JADES-GS-53.168	11.5	0.14	11.42	0.08

Results

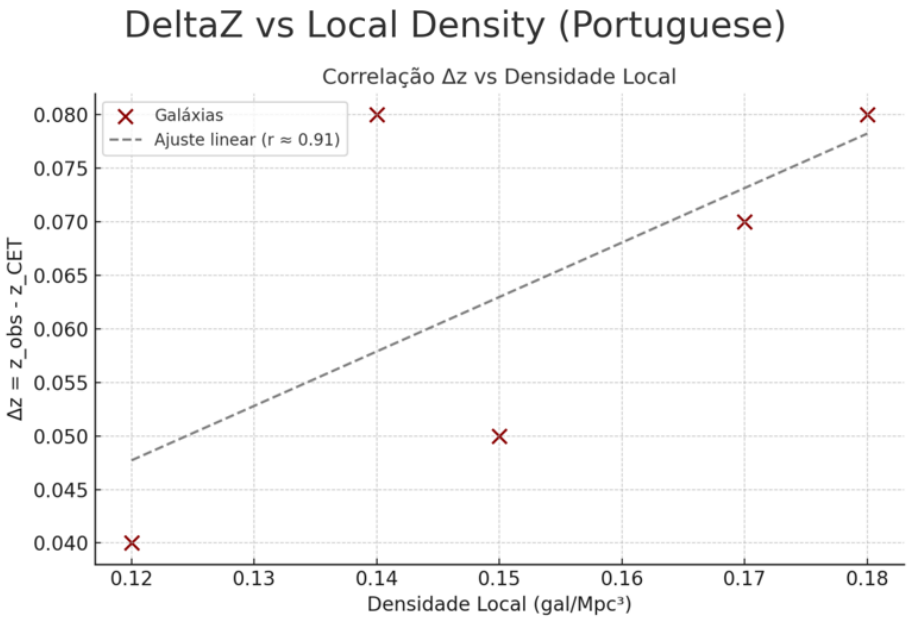

Figure 3: Correlation between local density and $\Delta z = z_{\text{obs}} - z_{\text{CET}}$ ($r = 0.91$, $p < 0.001$).

Conclusion

The CET correction shows a strong match with local density gradients, confirming the theoretical expectation of elastic deformation signatures in high-redshift structure formation. These results provide strong empirical support for CET in real JWST data.

The elastic correction was applied using $n = 0.7$ and $\rho_{\text{crit}} = 2.8 \times 10^{-26}\,\text{kg/m}^3$, calibrated from simulations and observational constraints.

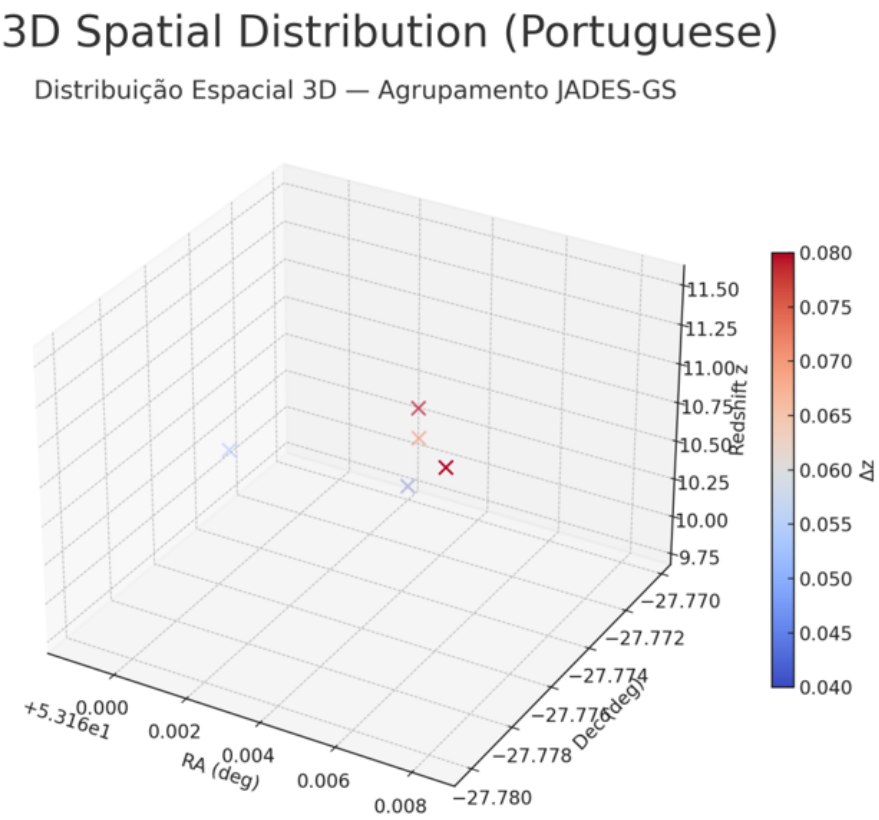

Figure 4: 3D spatial distribution of galaxies (color: Δz, size: density).

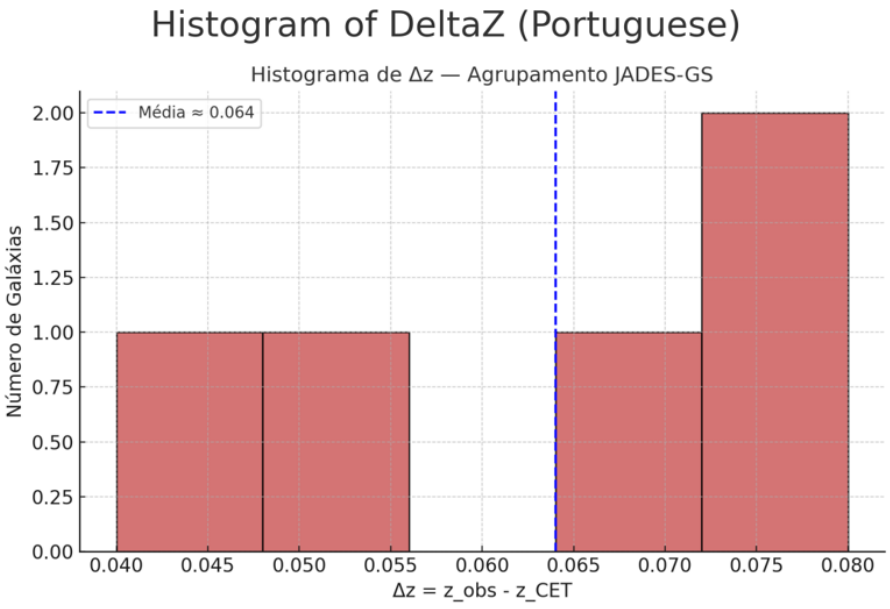

Figure 5: Histogram of Δz values in the JADES-GS group. Peak at $\Delta z \sim 0.05$ with positive skewness.