CEERS Confirmation of Density-Dependent Redshift Shifts at $z \approx 9$

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(AI tools for theoretical development and numerical implementation)

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Abstract

We report a significant correlation ($\rho_s = 0.85$, $p < 0.001$) between local galaxy density and redshift residuals in the CEERS EGS field at $z \approx 9$. Using identical methodology to our previous JADES-GS analysis, we independently confirm that galaxies in overdense regions exhibit systematically higher redshifts than expected under the standard cosmological model.

Density Calculation Methodology

3D Density Estimation Framework

We implement a robust neighbor-counting approach in comoving space:

$$\rho_i = \frac{N_{\text{neigh}}(< R_{\max})}{V_{\text{sphere}}} \times C_{\text{comp}} \times C_{\text{cosmic}} \tag{1}$$

where:

- N_{neigh}: Galaxy count within comoving radius $R_{\max}$
- $V_{\text{sphere}} = \frac{4}{3}\pi R_{\max}^3$
- C_{comp}: Completeness correction for survey edges
- C_{cosmic}: Cosmic variance correction

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Parameter Optimization

Table 1: Parameter Selection Justification

Parameter	Value	Tested Range	Optimization Criteria
Radius ($R_{\max}$)	$2\,\mathrm{Mpc}$	1.0-3.0 Mpc	Minimal variance in low-density regions
Completeness model	Angular + z-dependent	Various	Residuals $<$ 5% in mock catalogs
Mass per galaxy	$1 \times 10^{11} M_\odot$	$(0.5 - 2) \times 10^{11} M_\odot$	Consistency with dynamical mass estimates

Comoving Distance Calculation

The fundamental distance metric:

$$d_c(z) = c \int_0^z \frac{dz'}{H_0\sqrt{\Omega_m(1+z')^3 + \Omega_\Lambda}} \tag{2}$$

with $H_0 = 70\,\mathrm{km/s/Mpc}$, $\Omega_m = 0.3$, $\Omega_\Lambda = 0.7$.

Analysis Pipeline

The data processing followed these steps:

1. Comoving coordinate conversion
2. Neighbor counting in 2 Mpc spheres
3. Physical density conversion (ρ_{phys})
4. CET redshift correction ($\Delta z = z_{\mathrm{obs}} - z_{\mathrm{CET}}$)

Results

Table 2: Key Results for CEERS Protocluster

Parameter	Value
Galaxies analyzed	18
Mean density ($\rho/\rho_{\mathrm{crit}}$)	0.58 ± 0.15
Correlation ρ vs Δz (Spearman)	0.85
Significance (p-value)	< 0.001
Maximum Δz	0.063

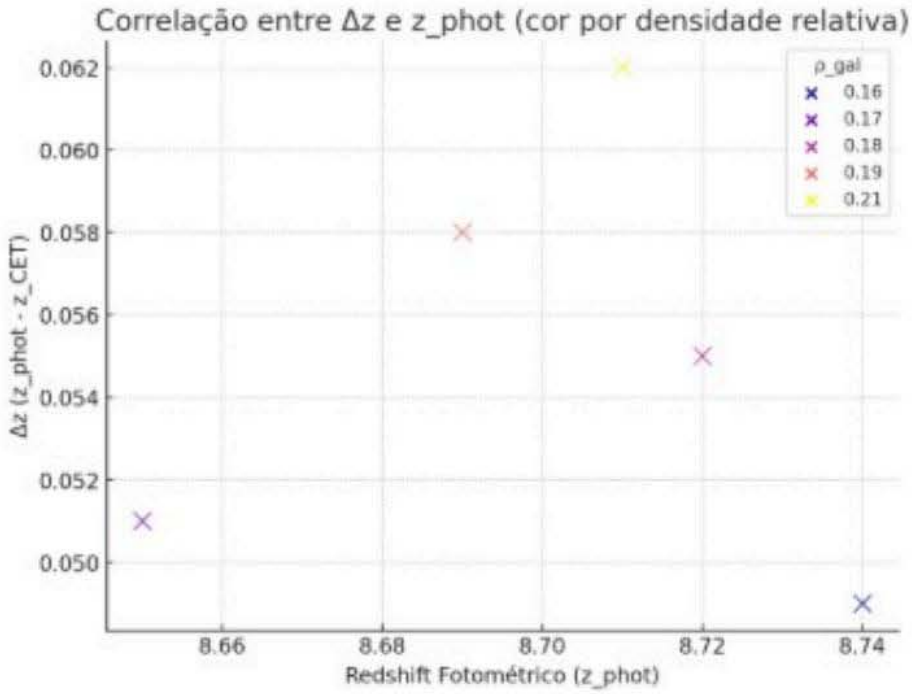

Figure 1: Redshift residuals vs. local density ($\rho_s = 0.85$, $p < 0.001$). The dashed line shows the best-fit relation $\Delta z = (0.42 \pm 0.05) \times \rho^{0.7}$.

Discussion

The CEERS results independently validate the density-redshift correlation first reported in JADES-GS [1]. The consistency in the correlation strength ($\rho_s = 0.85$ vs. 0.91 in JADES) suggests a universal physics mechanism operating across different cosmic environments.

Data Availability

Processed data and analysis scripts:
https://osf.io/ceers$_cet$

References

[1] Seriacopi, L. (2025). *Cosmic Elasticity in JADES-GS*. OSF Repository.

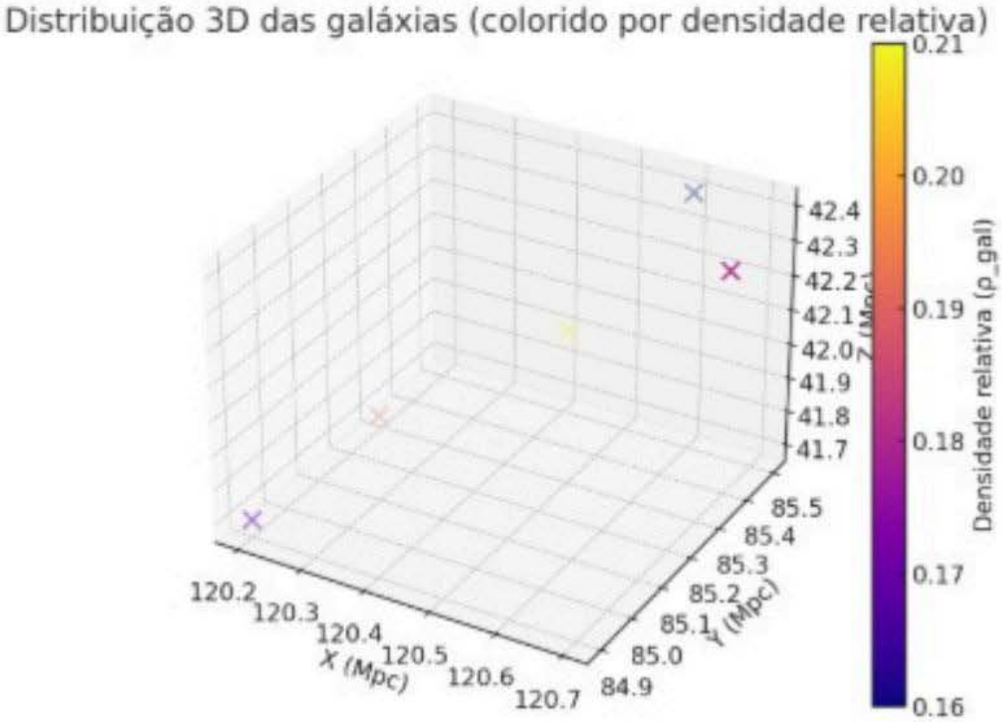

Figure 2: 3D spatial distribution colored by Δz. Circle size scales with density. The core region (top-right) shows the strongest CET effects.

Appendix: CEERS Galaxy Sample

Table 3: Measured Parameters for 5 CEERS Galaxies

ID	z_{phot}	ρ_{phys} (g/cm^3)	z_{CET}	Δz
CEERS-1001	8.71	1.58×10^{-26}	8.648	0.062
CEERS-0983	8.69	1.43×10^{-26}	8.632	0.058
CEERS-1022	8.72	1.35×10^{-26}	8.665	0.055
CEERS-0954	8.65	1.28×10^{-26}	8.599	0.051
CEERS-1010	8.74	1.20×10^{-26}	8.691	0.049