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Protocluster Candidates at z~9-10 in the JWST COSMOS-Web field

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High-redshift protoclusters are crucial for understanding the formation of galaxy clusters and the evolution of galaxies in dense environments. With its unprecedented near-infrared sensitivity, the James Webb Space Telescope (JWST) enables the first exploration of protoclusters beyond z>10. Among JWST surveys, COSMOS-Web offers the largest area (~0.5 deg^2), making it an optimal field for protocluster searches.
In this study, we identify protoclusters at z ~ 9-10. We select F115W dropout galaxies (8 ≤ z ≤12) but exclude the highest-redshift end (z>11) due to the limited number (<10) of dropouts, yielding a sample of 763 galaxies. Overdensities (δ) are computed by weighting galaxy positions with their photometric redshift probability density functions (PDF), using a 0.9 cMpc aperture and a redshift slice of (±0.5). We implant 1,000 randomly scattered apertures to determine the significance (σ) of each overdensity and identify protocluster cores, as those with (σ≥3.0) and the overdensity greater than three times the standard deviation(δ≥21.8). Member galaxies are then linked using a 2D Friends-of-Friends (FoF) algorithm, with the difference between the 50th percentile of the PDF and the median redshift not exceeding 0.5. At least three member galaxies are required for a protocluster candidate.
We found four protocluster candidates at z ~ 9-10 with halo masses of ~ 10^11 solar mass. The detection of such overdensities at these redshifts provides a critical test for current cosmological simulations. However, confirming these candidates and distinguishing them from low-redshift dusty star-forming galaxies or Balmer break galaxies will require follow-up near-infrared spectroscopic observations. This work is submitted to PASA.

Section

Galaxy/Extragalactic

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