JADES: Discovery of an Extreme Galaxy Overdensity at z = 5.4 with JWST/NIRCam in GOODS-S

JWST ADVANCED DEEP EXTRAGALACTIC SURVEY

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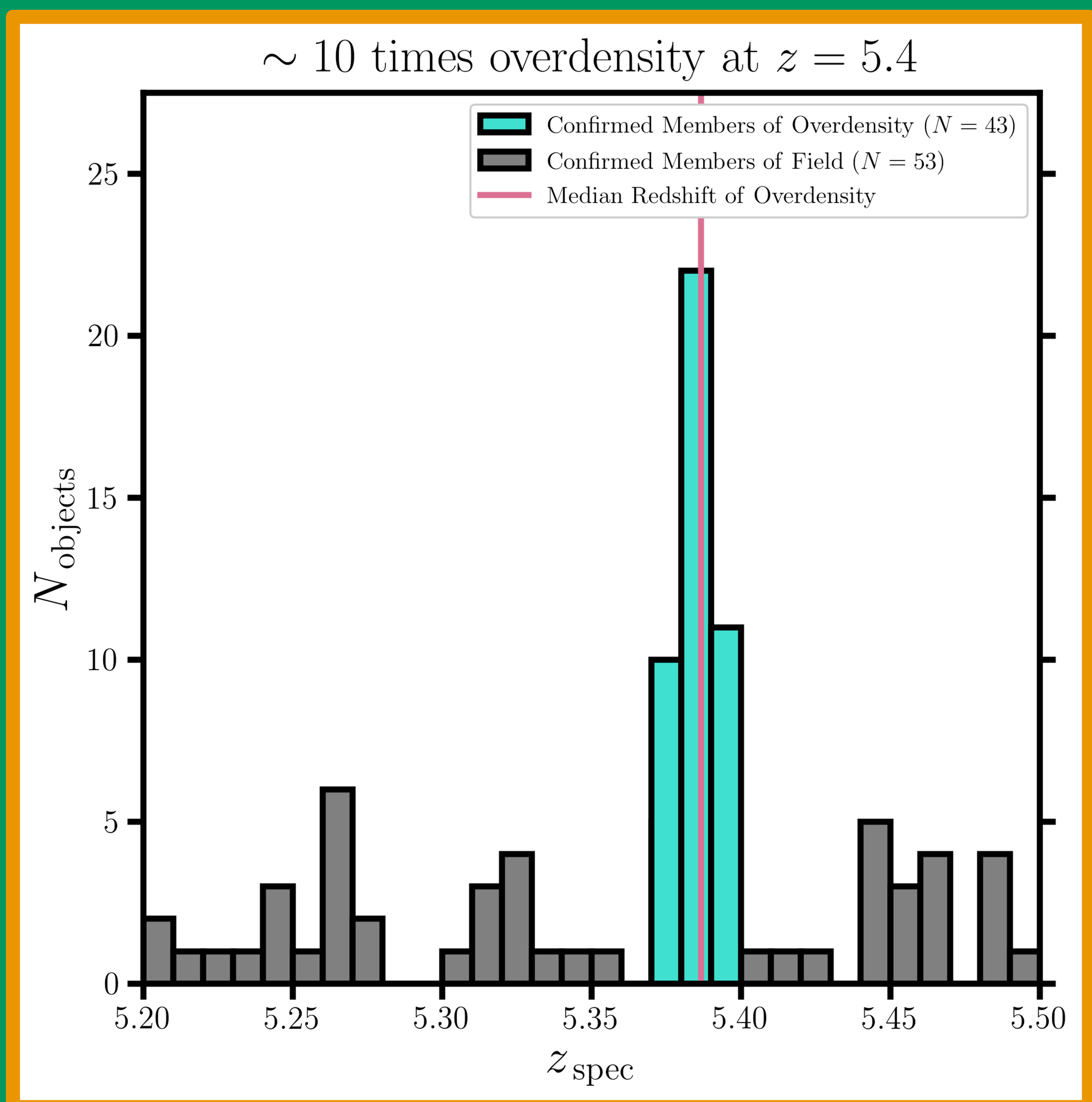
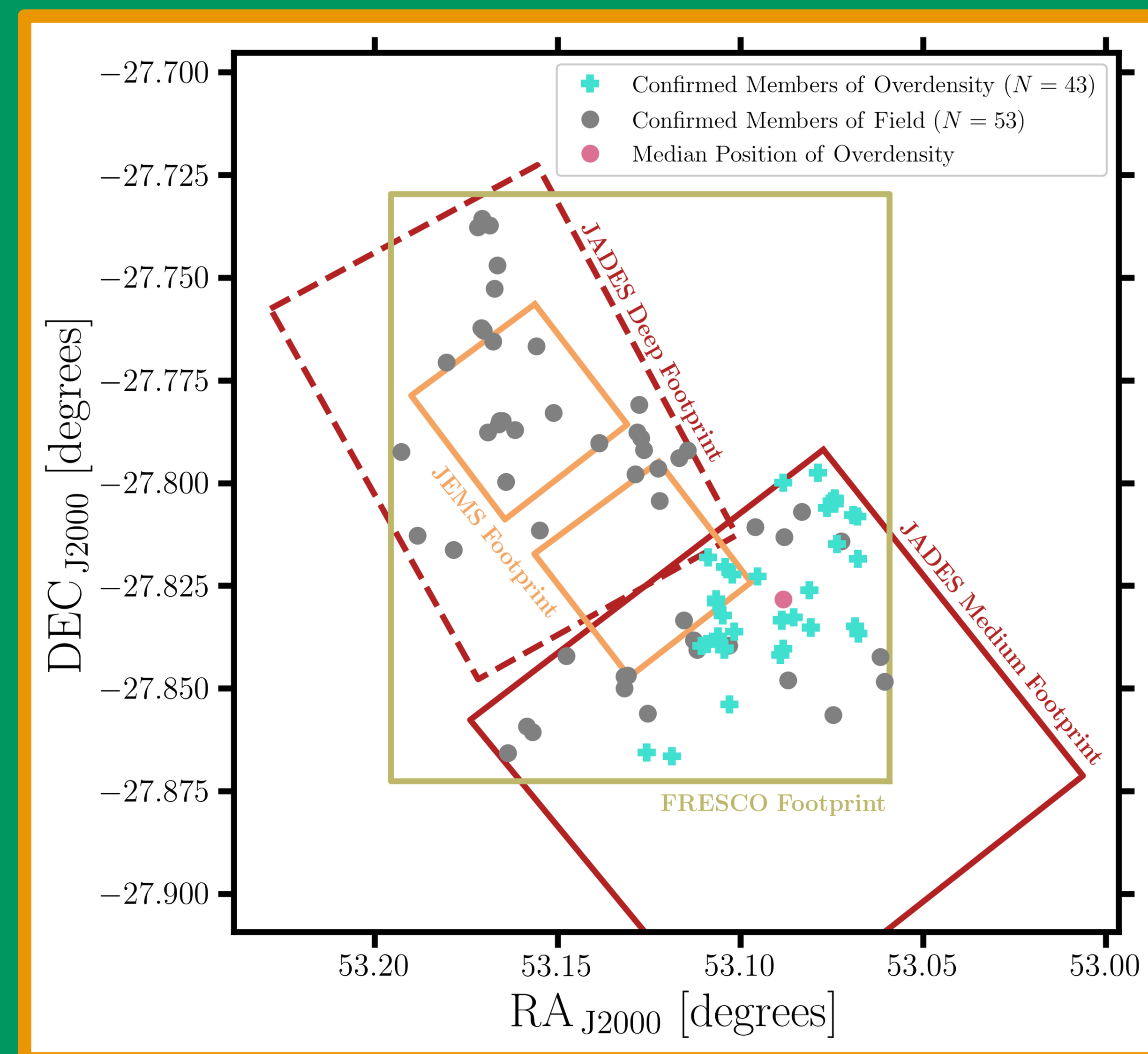
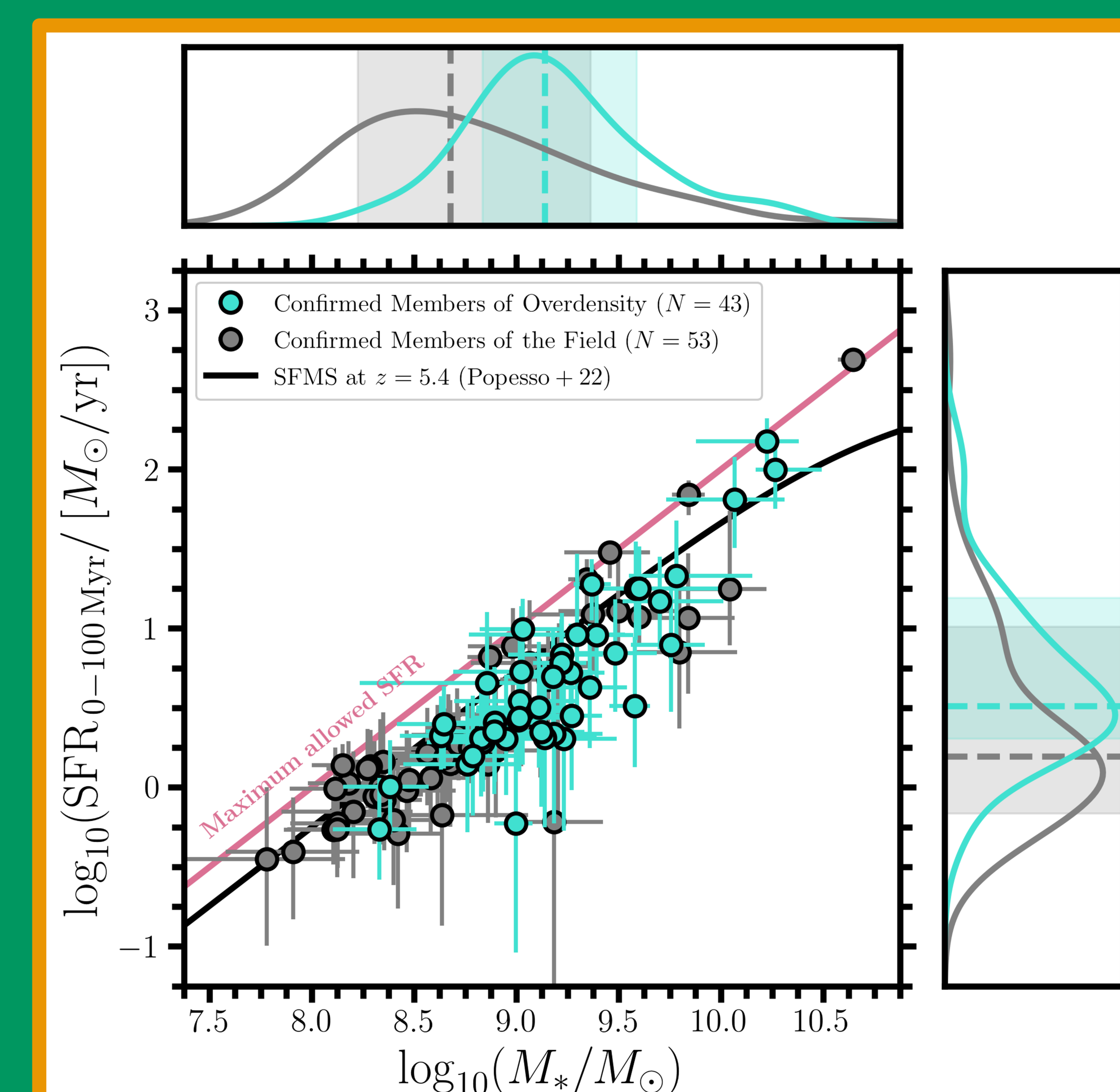
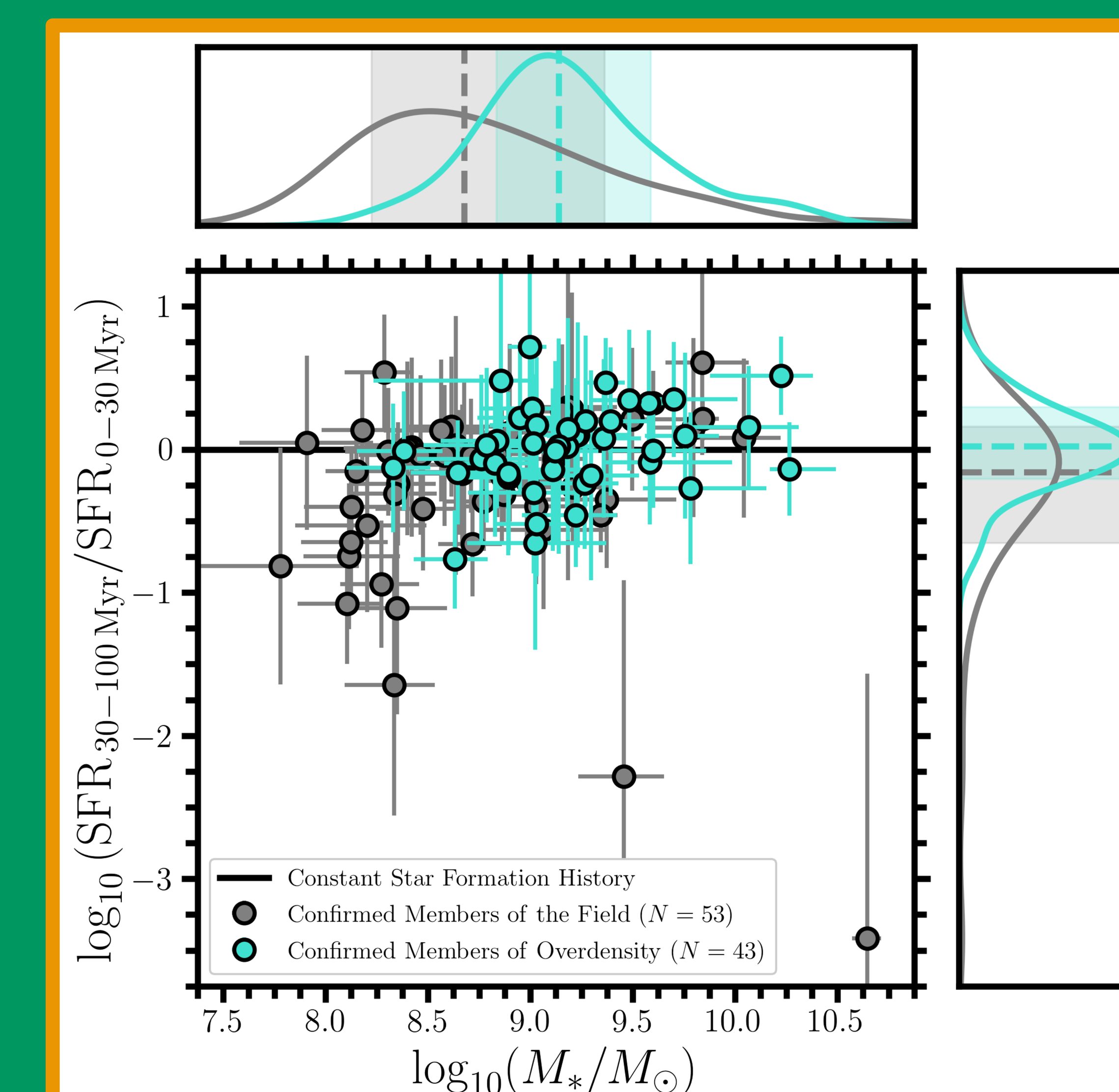




We report the discovery of an extreme galaxy overdensity at z = 5.4 in the GOODS-S field using JWST/NIRCam imaging from JADES and JEMS alongside JWST/NIRCam wide field slitless spectroscopy from FRESCO. Galaxies were initially selected using HST+JWST photometry spanning λ = 0.4 - 5.0 µm. These data provide well-constrained photometric redshifts down to m ≈ 29 - 30 mag, particularly at z = 5.2 - 5.5, where Hα excess can be traced by comparing photometry in the F410M and F444W filters. Galaxies were subsequently selected using slitless spectroscopy over λ = 3.9 - 5.0 µm via a targeted emission line search for Hα around the best-fit photometric redshift. The final spectroscopic sample of galaxies includes N = 96 objects. A Friends-of-Friends algorithm was used to identify this extreme galaxy overdensity by iteratively looking for three-dimensional structural groupings within the final spectroscopic sample. One large-scale structure consisting of N = 43 objects galaxies was discovered, which is ~10 times more dense in one-dimension and ~12 times more dense in three-dimensions than the N = 53 analogous field galaxies at z = 5.2 - 5.5.

The stellar populations for these N = 96 objects at z = 5.2 - 5.5 were inferred using the SED fitting code Prospector (Johnson et al. 2021). We constructed the star-forming main sequence at and found that nearly all the galaxies in our sample agree with the empirically derived star-forming main sequence at z = 5.4 derived by (Popesso et al. 2022). Combined with our relatively low star-formation rate detection limit, this suggests that we are sampling the bulk of the star-forming population at these redshifts despite our Hα selection criteria. By comparing members of the overdensity with a mass-matched sample of members of the field, we find evidence suggesting that environment has induced earlier star formation and earlier stellar mass assembly within the overdensity relative to the field, although there are large uncertainties associated with these parameters. We estimated the total dark matter halo mass associated with this extreme galaxy overdensity to be $13.0 < \log_{10}(M_{\rm halo}/M_\odot) < 13.5$. As a result of our selection criteria, we are potentially missing objects that fall outside either the JADES or the FRESCO footprints, as well as some subset of objects with relatively unconstrained photometric redshifts and/or low levels of star formation. This means the total dark matter halo mass range quoted above is likely an underestimate of the true halo mass. This massive large-scale structure is expected to evolve into a Coma-like cluster with $\log_{10}(M_{\rm halo}/M_\odot) > 15$ by z = 0.





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