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A protocluster in formation traced by Lyα emitters at z ~ 4.5 in the COSMOS field

The densest structures of the Universe formed at the knots of the cosmic web at high redshifts and constitute the present-day clusters of galaxies. The early stages of these structures are called protoclusters. In this work, we use the submm source J1000+0234, representative of a population of dusty and distant starburst galaxies expected to inhabit peaks of matter density, as a target for a potential protocluster region. We use combined wide-band and narrow-band optical photometry to identify Lya emitters (LAEs) within a 21cMpc radius from the submm source J1000+0234, at $z = 4.54 \pm 0.03$, to identify typical starforming galaxies that may trace the underlying structure containing our target source. Our approach selects line emitters as narrow-band excess objects and we use the COSMOS2020 photometric redshift catalog to eliminate potential low-redshift interlopers whose line emission (e.g. [OIII] at z ~ 0.3) might be responsible for the observed excess in the narrow band. In comparison with the LAE density in the field, our results point to a mean LAE number overdensity of δ = 3, spanning a region of 27 x 20 x 36 cMpc³, probably evolving into a moderate-mass cluster (3 – 10×10^{14} MØ) at z ~ 0. This structure likely forms an extension at z ~ 4.5, a few comoving Mpc away from the recently identified Taralay protocluster. This work supports the idea that submm sources, although offset from the major overdensity peaks, serve as traces of moderately massive, potentially infalling structures.

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