
# A protocluster in formation traced by LAEs at z ~ 4.5 in the COSMOS field

Mariana Rubet

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|---|---|
| First Name: | Mariana |
| Last Name: | Rubet |
| Institution/Affiliation: | Universidade Federal do Rio de Janeiro |
| Country of Residence: | Brasil |
| Preferred type of presentation | Poster |
| Will you attend in person or online? | — |
| Email | rubetmariana@gmail.com |

## Abstract

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 Lyα emitters (LAEs) within a 21cMpc radius from the submm source J1000+0234, at z = 4.54 ± 0.03, to identify typical star- forming 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 × 1014 M⊙) at z ~ 0. This structure likely forms an extension at z ~ 4.5, a few comoving Mpc away from the recently identi- fied 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.