A systematic search for proto-cluster cores at a transition epoch of star formation activity

Nr.3

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Abstract

- We search for protocluster (PC) cores at $z \sim 1.5$ based on wide field ($\sim 22\,\mathrm{deg}^2$) optical survey.
- Regarding massive galaxies with $\log(M_*/M_\odot) > 11.3$ as the central galaxies of PC cores, we detect ~ 2000 core candidates. Their estimated halo masses, $\log(M_*/M_\odot) \sim 13.5$, are massive enough to be progenitors of present-day clusters comparable to or more massive than Fornax-type clusters.
- Interestingly, only cores with red central galaxies show red fraction excess compared to the field, while those with blue centrals show no excess, suggesting a galactic conformity.
- Red fraction excess is an increasing function of stellar mass, suggesting stellar mass dependent environmental quenching.

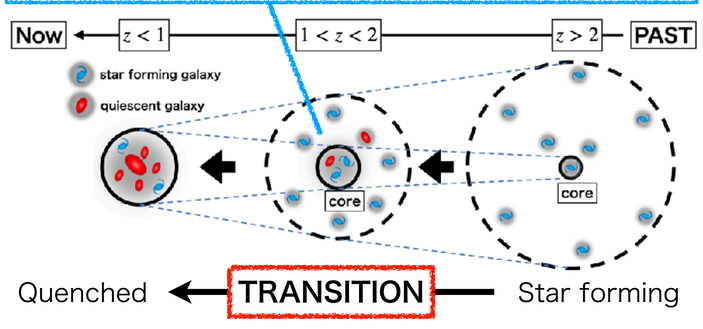
1. Protocluster Core...?

"Core" is the most massive halo in a protocluster

➡ typical mass: $\log(M_\mathrm{h}/M_\odot) \gtrsim 13.5$ at $z \sim 1.5$

✓strong environmental effects (Muldrew+18)

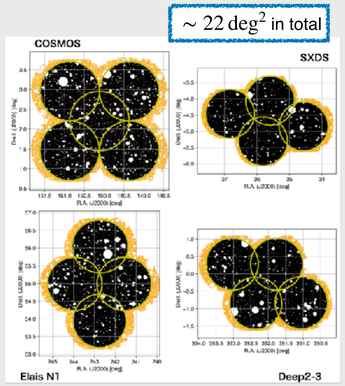
✓good laboratory to investigate the dominant cause of environmental quenching



- investigate how quenching occurs in PC cores
  - ✓ Deep/wide optical survey data from Hyper-Suprime Cam Subaru Strategic Program (HSC-SSP)
  - ✓ Halo mass estimate by clustering analysis
  - ➡ conduct a systematic search for PC cores at $z \sim 1.5$ and investigate member galaxies associated to them

2. Data

- HSC-SSP D/UD field (Aihara+19)
  - [grizy] photo-z catalog (Nishizawa+20)
- stellar mass: $\log(M_*/M_\odot) > 9$
- redshift: $1 < z < 1.5$, $\sigma_z/(1+z) \sim 0.06$
- galaxy color (indicator of star formation):
  - red galaxy if $(\mathrm{g}-\mathrm{i}) > 2.1$
  - blue galaxy if $(\mathrm{g}-\mathrm{i}) < 2.1$
    - threshold: trade-off b/w purity and completeness
    - 80% purity and 80% completeness for quiescent galaxies (comp. rest-UVJ)

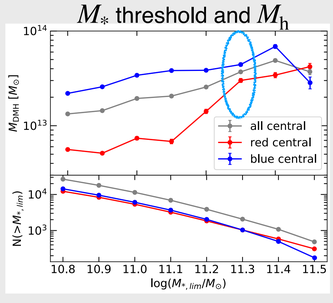


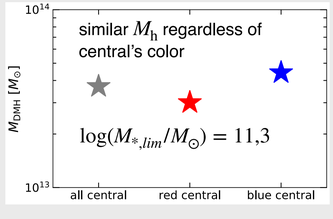
footprint of HSC-D/UD fields

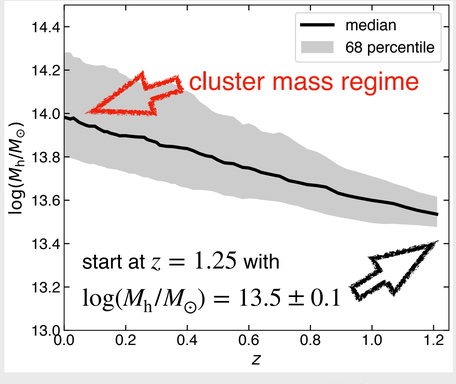
3. Search for Protocluster Cores

- Method:
  1) select massive galaxies with stellar mass thresholds as central galaxy
  2) estimate their average host halo mass by clustering analysis
  3) check whether their host halos can evolve into cluster mass regime
- host halos of galaxies with $\log(M_*/M_\odot) > 11.3$ are massive enough as PC cores (IllustrisTNG300, Nelson+18). Thus we regard they are PC cores.

M_* threshold and M_h



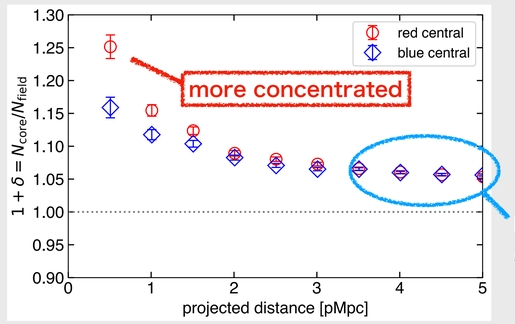




halo mass growth in the IllustrisTNG300

4. Overdensity

- count galaxies ($10 < \log(M_*/M_\odot) < 11$) around cores with red/blue centrals



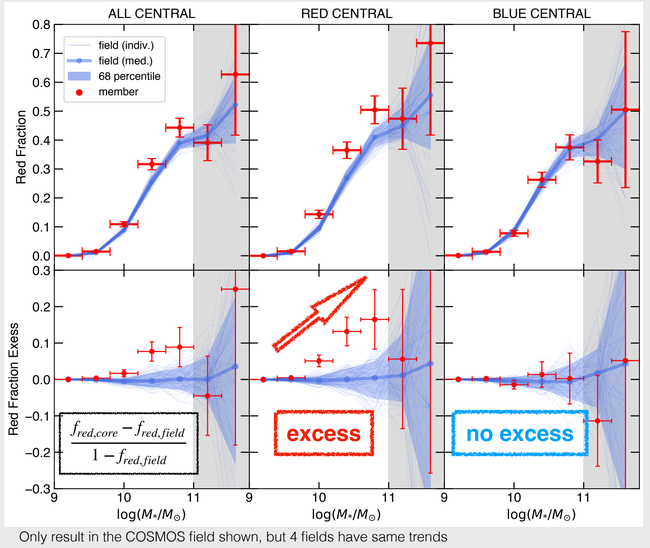
located in large scale structure?

Cumulative overdensity profile around cores

Only result in the COSMOS field shown

5. Red Fraction

- galaxies within $dr < 0.5$ pMpc and $dz < 0.15$ & field subtraction
- red fraction excess is only seen in cores with red central galaxies
  - galactic conformity (red central have red satellites, blue centrals have blue satellites)
  - conformity is not caused by the difference of halo mass, but possibly related to the difference of concentration of satellite galaxies? (see overdensity plot)
- larger excess for larger stellar mass => mass dependent environmental quenching



Only result in the COSMOS field shown, but 4 fields have same trends