

# Cluster galaxies 10 billion years ago

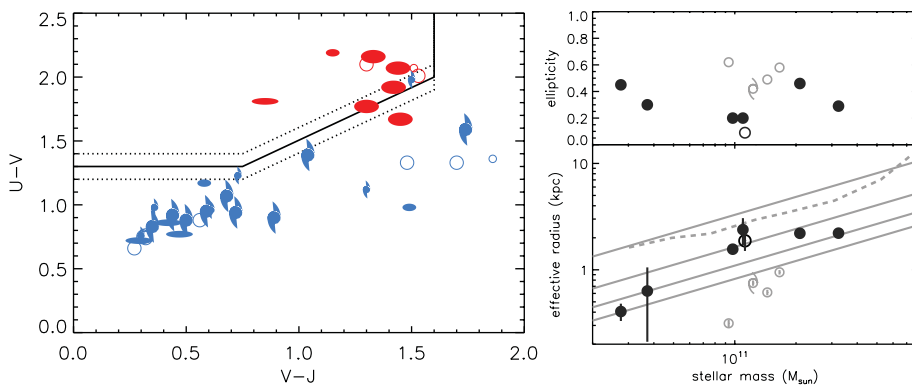
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**Abstract.** Cl J1449+0856 is a spectroscopically confirmed galaxy cluster at  $z \sim 2$ . The detection of a faint, extended X-ray emission, suggestive of an already evolved, partially relaxed structure, puts this system among the most distant “established” clusters rather than in the realm of  $z \gtrsim 2$  proto-clusters. This gives us a chance of studying galaxies in an evolved overdense environment very close to their formation epoch, and in particular to trace the evolution of early-type galaxies in clusters back to ten billion years ago.

**Keywords.** Galaxies: clusters, Galaxies: evolution, Galaxies: high-redshift

Cl J1449+0856 at  $z = 2$  is the most distant X-ray detected and spectroscopically confirmed galaxy cluster discovered so far. We studied its galaxy populations with a sample of  $\sim 100$  candidate cluster members ( $\gtrsim 10^{10} M_{\odot}$ ) within 500kpc of the cluster center. Already at this redshift, the central cluster region ( $r < 200\text{kpc}$ ) hosts a population of massive galaxies with quiescent stellar populations and early-type morphologies. At the same time, the cluster core also seems to host massive galaxies still in their active formation phase, with significant star formation and ongoing merging activity. A clear correlation is observed between morphological structure and stellar populations, with quiescent galaxies typically showing a high Sersic index profile, as also observed in the field up to this redshift. In general agreement with many high-redshift studies, quiescent early-type candidate cluster members are smaller than similarly massive early-types in the nearby Universe, although the most compact  $z \sim 2$  galaxies in our field are spectroscopically confirmed interlopers, leaving the mass-size relation of cluster early-types a factor 2–3 lower in size than the commonly used Shen *et al.* (2003) local determination.



**Figure 1.** Left: UVJ restframe color plot (Wuyts *et al.* 2007) of candidate cluster members ( $m_{F140W} < 24.5$ , symbol shape according to Sersic index). Right: effective radius and ellipticity vs stellar mass for candidate quiescent early-type cluster members (dark symbols), and for 4 quiescent spectroscopic interlopers at similar redshift (light symbols). Solid lines show the Shen *et al.* (2003) local relation scaled down in size by a factor 1,2,3,4.