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Active galaxies in high-z IR detected clusters

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Abstract. We present a study of the AGN and starburst galaxies content for a large sample of galaxy clusters, spanning a wide redshift range ($0.4 < z < 1.5$), drawn from the Spitzer Adaptation of the Red-Sequence Cluster Survey (SpARCS). Deep Spitzer/IRAC imaging is provided by the Spitzer Extragalactic Representative Survey (SERVS). Here we describe ongoing work to identify active galaxies, within and around those clusters, focusing on the radio-loud galaxy population. We show preliminary results and describe future work.

Key words. Galaxies: active – Galaxies: clusters

1. Introduction

At low redshift, AGN and starbursts content seem to vary from cluster to cluster, depending on the cluster overall properties (e.g. cluster baryonic mass, dynamical state). Several studies (e.g. Geach et al. 2006; Eastman et al. 2007; Temporin et al. 2009) suggest that the active galaxy population properties could also depend on redshift. Indeed, the cluster parameters vary with the epoch of the cluster formation and the surrounding large-scale structure: if star-formation and AGN are structure-induced, differences should be apparent between higher-z and lower-z clusters. How does this active galaxy cluster-related population vary with redshift? A survey spanning a large cluster redshift range (such as $0.4 < z < 1.5$) is ideal to address this issue.

2. SpARCS and SERVS surveys

SpARCS, the Spitzer Adaptation of the Red-sequence Cluster Survey (Wilson et al. 2006) consists of deep ($z' = 24$ AB) observations of the SWIRE (Lonsdale et al. 2003) Legacy Survey Fields made from both hemispheres. The cluster detection algorithm has yielded ~ 200 $z > 1$ cluster candidates detected on the basis of their $z' - [3.6]$ color. With a total effective area of 41.9 deg^2, SpARCS is currently the largest completed $z > 1$ cluster survey.

SERVS, the Spitzer Extragalactic Representative Volume Survey (Mauduit et al. 2011, in prep) will map 18 deg^2 of sky to AB magnitudes of 24.0 and 23.2 (5σ) at

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3.6μm and 4.5μm respectively. SERVS is deep enough to undertake a complete census of massive galaxies from $z \sim 6$ to $z \sim 1$ in a volume $\sim 0.8\,\mathrm{Gpc}^3$, large enough to overcome the effect of cosmic variance. SERVS will build complete NIR spectral energy distributions and derive accurate photometric redshifts, stellar masses and SFRs for a large sample of high-z galaxies.

3. Cluster associated radio-loud AGN

Radio-loud objects are straightforward to match with SERVS galaxies given the ancillary radio data at hand from the GMRT (Garn et al. 2008a,b) and VLA (Owen & Morrison 2008; Ibar et al. 2009). We also use the Rowan-Robinson et al. (2008) photometric redshifts from SWIRE to restrict the projected space, until it is superseded by SERVS phototometric redshifts (Maraston & Pforr, in prep.) and inevitably yield more objects. For completeness reasons at $z = 1.4$, the sample consists of 81 sources with $\log(L_{radio}) > 24.4$ (assuming a spectral index of $S_\nu = \nu^{-0.7}$), which roughly corresponds to sources that have AGN-like radio luminosities within the SpARCS redshift range of $0.4 < z < 1.4$. Cross-identifying the SpARCS cluster centers with the SWIRE and GMRT data, we find seven powerful radio sources within a projected distance of $\theta = 3$ Mpc and a redshift slice of $z = \pm 0.05$ for the 18 cluster centers in EN1. Five radio sources lie at the clusters peripheries. Two are identified as the central brightest cluster galaxy (BCG), and are also the most radio luminous of this sample, corresponding to FRI levels.

4. Future work

A further analysis using the full SERVS data with photometric redshifts in both EN1 and Lockman fields will greatly improve the number of radio-loud cross-identified objects. Spectroscopic follow-ups of the SpARCS clusters, with a dozen $z > 1$ confirmed clusters ($\sim$ 50 members/cluster), bring invaluable 3D and substructure information that will better constrain our analysis of the photometrically detected clusters. We plan to compare clusters of different redshifts bins, looking at their AGN numbers and radial distribution. The presence of radio-loud BCGs will also be compared to low and intermediate redshifts results (Best et al. 2007; Whiley et al. 2008). The future combination of LOFAR and SERVS/SpARCS data would allow to probe fainter levels of radio emission. Non radio-loud AGN and ULIRGs will also be identified using color-color wedge diagrams in the mid-IR (Lacy et al. 2004; Stern et al. 2005).

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