Stellar Populations as Building Blocks of Galaxies
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Stellar Population in Extremely Red Galaxies

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Abstract. We describe our results on multi-colour observations of extremely red galaxies found in two gravitational lensing clusters (Abell 1835 and AC114). Applying a colour criteria of R-K $\geqslant$ 5.6 we have selected 12(10) EROs, of which 10(4) have no R-band detection. 5 of these objects have exceptional red colours (R-K>7.5). We compare their colours with other galaxy populations, like distant red galaxies and infrared detected extremely red galaxies, in order to differentiate between them.

Keywords. galaxies, fundamental parameters

1. Introduction

Almost 30 years after Elston *et al.* (1988) first announced the detection of extremely red objects (EROs), the discussion about their nature is still ongoing. Originally, the two competing scenarios classify EROs either as old passively evolved galaxies or as extremely dust reddened star bursts (Daddi *et al.* (2002), Geogakakis *et al.* (2006)). However, the picture is complicated by the results of numerous morphological studies on EROs, which assigns a large fraction of EROs to disk galaxies. In addition, a small fraction of EROs could also be active galactic nuclei (AGNs), as shown by deep XMM and Chandra data. One of the important open questions is the relative abundance of each ERO population. We discuss this problem using the method of Pozetti & Mannucci (2000)), which separates both populations by their R-K and J-K colour and use SED fitting to restrict their redshift.

2. Sample selection

For the EROs selection we adopted a criteria of R-K>5.6, which selects both galaxies with an old stellar population as well as dusty starburst, in a redshift interval between 1 and 2 and ensures that these objects are not included in a sample of high-redshift galaxies (see Fig. 2 and 8 in Richard *et al.* (2006). Although colours alone cannot provide the same strong constrains on their nature and on their redshift as SEDs or spectra, we used the colour based classification scheme introduced by Pozetti & Mannucci (2000), for a first separation between the two populations.

3. Results

Using the method of Pozetti & Mannucci (2000) to classify an ERO either as evolved elliptical or dusty starburst, we find that 75% of all objects have colours assigned to evolved

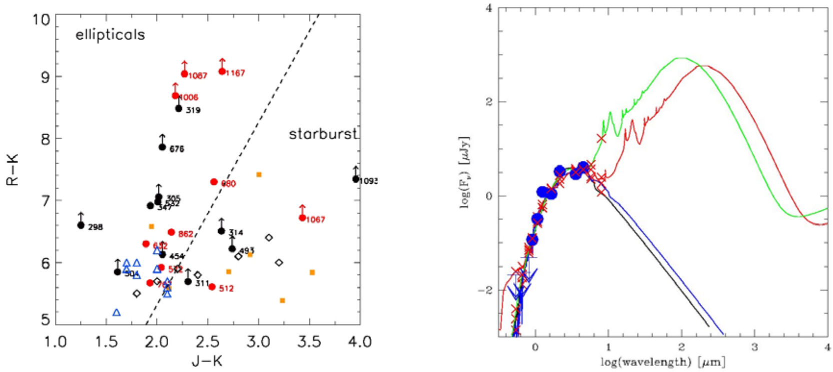

Figure 1. (left): R-K vs. J-K colour-colour diagram of EROs found in A1835 (black) and AC114 (red). Black diamonds: (Takata *et al.* (2003), orange symbol:Yan *et al.* (2004) and blue triangles: Longhetti *et al.* (2005), small dots: Grazian *et al.*. (2007).The dashed line shows the separation between old passive galaxies and dusty starburst, according to Pozetti & Mannucci (2000) **(right:)**Fits to the SED, including models of Bruzual and Charlot at z=0.5 (black) and 1.35 (blue), and fits with dusty starburst models from GRASIL templates at z=1.75 (M82, red) and 0.4 (M82, green, plus additional extinction of $A_v = 3.8$).

ellipticals. One of the remaining 5 sources is the known sub-mm source SMMJ14009+0252. The spectral energy distributions of sources with no optical detection show strong similarities to the SED of the high-z object of Mobasher *et al.* (2005), i.e. a degeneracy between a low- and high-z solution. For most objects we accept the low-z solution as the better fit. A large fraction of EROs in AC114 (5 out of 10) were detected with MIPS (24μm) and their SED is best fitted GRASIL templates plus an additional extinction. That suggests that these objects are low-z starbursts, contradicting the classification based on their J-K colour. However, the gap between both populations is approximately 0.3 mag and many of these objects have J-K colours close to it. Additionally we have to consider that many of our EROs have very extreme colours for which this classification scheme might not be valid. Using IRAC colours we find that EROs with R-band detection have colours similar to DRGs and BzKs (Grazian *et al.* 2007), while an optical non-detection puts these at the edge of distribution. A detailed analyses of the colour properties and spectral energy distribution will be published in two forthcoming papers (Schaerer et al., Hempel *et al.*)

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