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The Life Cycle of Massive Red Galaxies

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Abstract. Samples of Extremely Red Galaxies (ERGs) have generally been seen to comprise a mix of actively star-forming galaxies with significant dust reddening and evolved, passive galaxies, at redshifts about $z \approx 1-2$. Initial results from deep Keck spectroscopy of ERGs (Doherty *et al.* 2005) revealed dominant old stellar populations in 75% of our spectroscopic sample, but only 28% have spectra with no evidence of recent star formation activity, such as would be expected for a strictly passively-evolving population. This study suggests that the bulk of the ERGs are luminous, spheroidal, evolved galaxies, but undergoing intermittent activity consistent with continued growth.

Through a detailed investigation of individual galaxies in our sample we aim to address various outstanding questions. What fraction of their mass is produced in ongoing star formation? Is there a characteristic mass at which star formation is abruptly truncated? What mechanism provokes a secondary burst of star formation in evolved galaxies?

We fit Bruzual & Charlot (2003; BC03) simple stellar population models to the broad band SEDs over a wide baseline, using a reduced χ^2 minimisation, to investigate ages, stellar masses and star formation histories. The fits for the early types agree well with information in the spectra and return ages of 2–3 Gyr and masses in the range 10^{11}–$10^{12} M_{\odot}$. The objects with recent star formation episodes are more complex. Some are fit well by continuous star formation models, accounting for the effects of dust. We are now in the process of exploring multi-population fits to investigate the effects of episodic bursts.

Previous morphological studies of ERGs have revealed a diverse mix of galaxies - a combination of pure bulges, disks and a small fraction of irregular or interacting systems. We are curious to determine whether a morphological analysis produces results consistent with the spectroscopic properties of our sample. We are investigating a sub-sample of our galaxies which have HST imaging publically available. Initial results from a quantitative analysis using bulge/disk decomposition with GALFIT and GIM2D indicate that most galaxies with Early type spectra are bulge dominated. In contrast, a significant fraction of the galaxies showing spectroscopic signatures of on-going star formation on top of underlying old stellar populations appear to have a well-established classical spiral morphology, wih knots of star formation located in spiral arms around a central bulge. There is tenuous evidence (under further investigation) that at least half of the post-starbursts in our sample are barred spirals, lending support to theories relating post-starbursts to recent mergers.

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