The surprising relationship between Lyman break galaxy UV spectral features and their environment, morphology, and kinematics

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Broadband segregation

Lyman break galaxies (LBGs) naturally separate into two distinct distributions on a color-magnitude diagram (Figure 1) when spectral information such as Lyα EW is included (Cooke 2009).

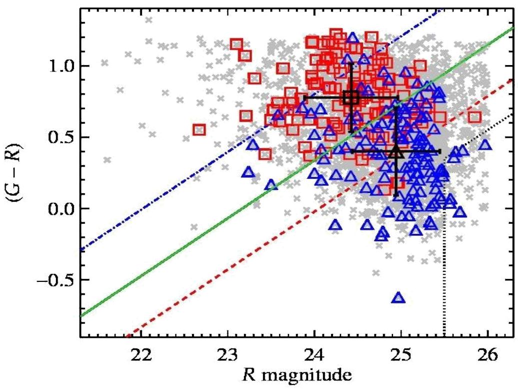

Figure 1 - Color magnitude diagram of z~3 LBGs (Cooke 2009). Gray crosses indicate the z~3 color-selected LBG sample of Steidel et al. (2003). Overlaid are LBGs with dominant Lyα in absorption and associated properties (red squares) and similarly LBGs with dominant Lyα in emission (blue triangles). The diagonal lines indicate statistical cuts made to the distributions. The solid green line splits the two distributions and the regions above the blue dot-dash and below the red dashed lines efficiently select >90% pure samples of aLBGs and eLBGs, respectively.

Application of broadband LBG spectral type cuts on 4-year stacked images of the Canada-France-Hawaii Telescope Legacy Survey (CFHTLS) Deep fields (m_r ~ 27) yields pure samples of ~20,000 LBGs with dominant Lyα in absorption **(aLBGs)** and ~40,000 LBGs with dominant Lyα in emission **(eLBGs)**. These large numbers enable detailed correlation functions to be analyzed from large to small scales for each spectral type.

Large-scale structure: Environment

The angular auto-correlation functions of aLBGs and eLBGs are remarkably different (Figure 2). aLBGs appear to found largely in a group environment whereas eLBGs appear to exist in the field or in close pairs (see Cooke et al. 2010).

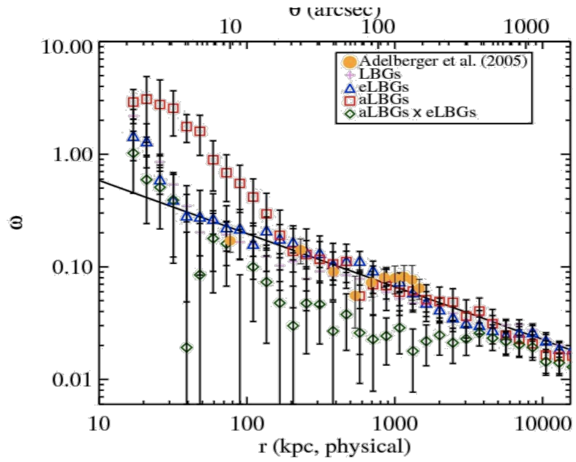

Figure 2 - LBG angular auto-correlation functions (ACFs). Orange circles represent the LBG ACF of Adelberger et al. (2005). The violet crosses indicate the ACF of LBGs in the CFHTLS Deep fields. Red squares and blue triangles indicate the CFHTLS aLBG and eLBG ACFs, respectively. A power law fit to the data $\omega = A\,\theta^{-0.6}$ is shown as the solid line. Both aLBGs and eLBGs have similar average masses as seen in the ACF at large separations (the two-halo term), but diverge at small separations that measure the number of luminous galaxies in individual halos (the one-halo term). The eLBG ACF suggests only one luminous galaxy per halo (except for close pairs at <30 kpc) but the aLBG ACF suggests multiple luminous halos per parent dark matter halo, or a group environment. The aLBG/eLBG cross-correlation (green diamonds) reveals an anti-correlation component between ~0.1 - 1 Mpc, physical, denoting that the two populations do not strongly co-exist at these scales and reinforces their distinct nature.

References - Cooke 2009, ApJ, 704, 62, Steidel et al. 2003, ApJ, 592, 728, Cooke et al. 2010, MNRAS, 403, 1020, Forster-Schrieber et al. 2009, ApJ, 706, 1364, Wisnoski et al. 2011, MNRAS, *accepted*, Law et al. 2009, ApJ, 697, 2057, Law et al. 2007, ApJ, 656, 1

UV morphology

The color and UV spectra of LBGs, help to disentangle their morphology. As suggested in Law et al. (2007), LBGs meeting eLBG criteria are compact, blue, have high Gini coefficients, and typically appear as single components. LBGs meeting aLBG criteria are extended and more diffuse (low Gini coefficient), redder, and exhibit multiple star forming clumps (Figure 3)

Rest-frame optical kinematics

Interestingly, LBGs with IFU observations (i.e., SINS survey, Wisnoski et al. 2011, Law et al. 2009) that best fit disk models are aLBGs and dispersion-dominated fits are eLBGs (Figure 3).

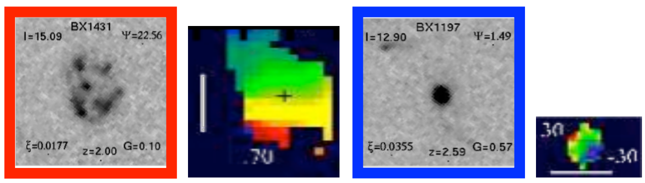

Figure 3 - aLBG and eLBG morphology and kinematics. ***Right two panels:*** An example space-based image of an aLBG (Law et al. 2007) and an example IFU kinematic observation of another aLBG (Forster Schreiber et al. 2009). aLBGs are typically extended and exhibit diffuse emission, have multiple star forming regions, and are redder than average LBGs. In addition, IFU observations of LBGs that have more ordered rotation and are disk-like meet aLBG criteria. ***Left two panels:*** Similar to the right panels except for two eLBGs. Conversely to aLBGs, eLBGs appear more compact, typically have a single star forming component, bluer continua and have dispersion-dominated or merger kinematics.