Lyα Blobs are powered by heating, not cooling

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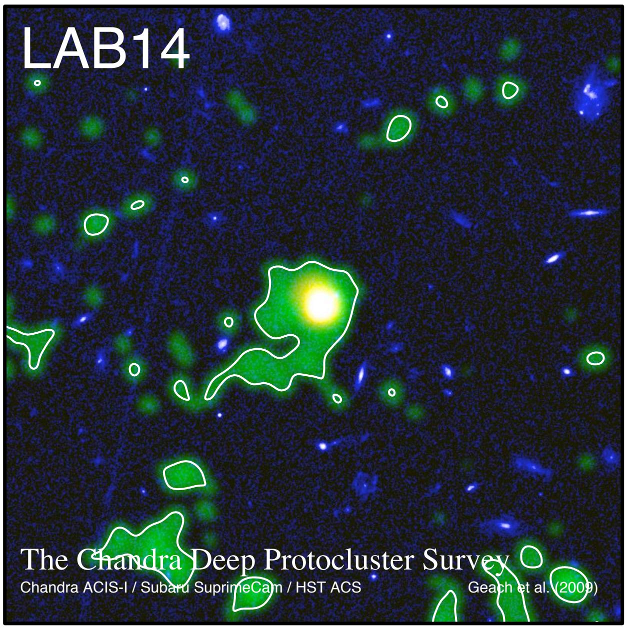
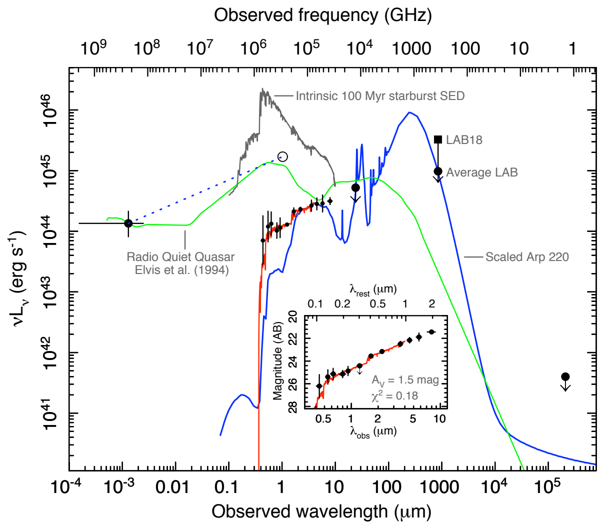
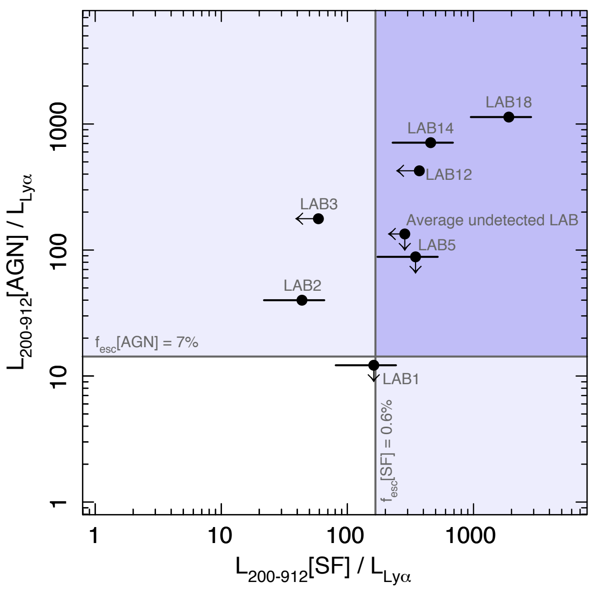


Overview We summarize the results of a 400 ks *Chandra* survey of 29 extended Lyα emitting nebulae (Lyα Blobs, LABs) in the $z = 3.09$ proto-cluster in the SSA22 field. We detect X-ray counterparts with $L_{2-32\mathrm{keV}} \sim 10^{44}\,\mathrm{erg\,s^{-1}}$ in five LABs, implying a large fraction of active galactic nuclei (AGN) in LABs, $f_{\mathrm{AGN}} = 17 \pm 8\%$. All of the AGN appear to be heavily obscured, with spectral indices implying obscuring column densities of $N_{\mathrm{H}} > 10^{23}\,\mathrm{cm^{-2}}$. We show that the UV luminosities of the AGN are easily capable of powering the extended Lyα emission via photo-ionization alone. When combined with mechanical feedback, and the UV flux from a starburst component, we demonstrate that heating by a central source, rather than gravitational cooling is the most likely power source of LABs. We argue that all LABs could be powered in this manner, but that the luminous host galaxies could often be just below the sensitivity limits of current instrumentation, or heavily obscured. Finally, we report the non-detection of an extended X-ray component in any of the LABs studied. The resulting diffuse X-ray/Lyα luminosity limit implies there is no hot gas ($T \gtrsim 10^7$ K) component in these gaseous halos, and also rules out inverse Compton scattering of cosmic microwave background photons, or local infrared photons, as a viable power source for LABs.

The pan-chromatic view The composite spectral energy distribution of the X-ray detected LABs in SSA 22. As a guide, we show the SED of Arp 220 (Silva et al. 1998) redshifted to $z = 3.09$ and normalized to our observed 4.5μm luminosity. For comparison, we also show the radio quiet quasar (RQQ) template of Elvis et al. (1994) redshifted and scaled to our average X-ray flux. The UV luminosity predicted by the RQQ template is in good agreement with the X-ray/UV power-law extrapolation of Steffen et al. (2006) which we indicate as a dotted line and point at $\lambda = 2500$Å. In the inset we show a fit to the optical–near-infrared photometry using HYPERZ. The fit is a moderately reddened ($A_V \sim 1.5$ mag) continuous star formation history of age ~100 Myr. This this is to be compared with the *intrinsic* UV luminosity from the AGN and starburst component (in the main panel we show the intrinsic SED of a 100 Myr old starburst, normalised to the SFR estimated from the far-infrared emission).





The case for feedback A comparison of the intrinsic UV (200–912Å) luminosities of LABs originating from AGN and star-formation. This has been estimated for the AGN and starburst components separately to examine the energetics of each component, relative to the total Lyα emission. Although in all cases the intrinsic UV luminosities from both components is easily sufficient to power the Lyα emission, these have to be modified to account for a dust covering fraction, which will attenuate the number of ionizing photons. Using the composite SED shown above as a guide, we estimate that the escape fractions are ~7% and ~0.6% for the AGN and starburst photons respectively, and we indicate these fractions on the figure. Note that even with this heavy obscuration, photo-ionization is sufficient to power the LABs alone. Finally we note that the short cooling timescale for gas radiating at 10^4K (the peak of the cooling function for Lyα) implies that LABs would have to accrete over $10^{12} M_\odot$ of fresh gas over their lifetimes, in addition to the $\sim 10^{11} M_\odot$ of stellar mass already in place in these objects. This is exactly the scenario that contemporary models of galaxy formation attempt to prevent – run-away star formation resulting in too many very massive galaxies by $z = 0$.