Two Modes of Activity in AGN Host Galaxy Populations at z ~ 1

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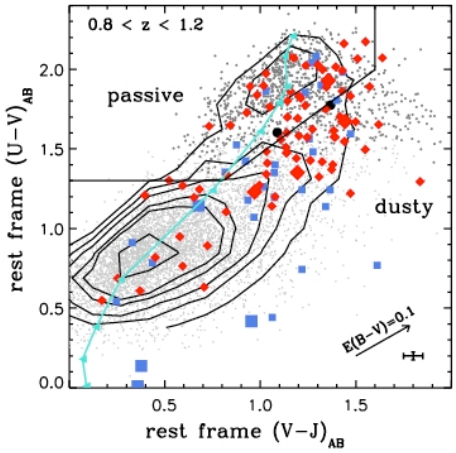
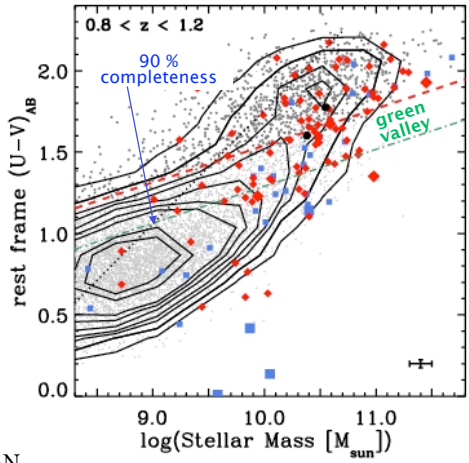
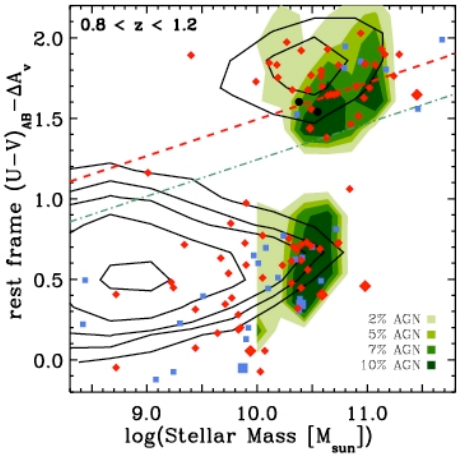
Abstract: We fit synthetic stellar population models to 32-band photometry to compare AGN host galaxies to inactive galaxies at 0.8 < z < 1.2. AGN host galaxies appear to be predominantly massive galaxies on the red sequence and in the green valley of the color-mass diagram. However, after using rest-frame near-infrared colors to separate passively evolving stellar populations from galaxies reddened by dust, we find that, as with the overall galaxy population, ~25% of the "red" AGN host galaxies and ~75% of the "green" AGN host galaxies have unreddened colors consistent with young stellar populations in star-forming galaxies. This means most "green valley" AGN hosts are in fact not aging passively to the red sequence. **At z~1, AGN activity is roughly evenly split between two modes of black hole growth: (1) in massive, old, passively evolving host galaxies, where a low level of AGN emission may be heating the galaxy's gas and preventing future episodes of star formation, and (2) in dust-reddened young star-forming galaxies, where the AGN may be ionizing the galaxy's interstellar medium and shutting down star formation.**



The rest frame optical colors of many AGN host galaxies are reddened by dust, as shown by this color-color diagram. Half the AGN population has colors consistent with older passive stellar populations (*upper left*), while the other half is either dusty or blue, indicative of younger star forming galaxies. The green track shows how colors evolve to the red with stellar aging.



The distribution of observed rest-frame AGN host galaxy colors on the color-mass diagram peaks in the green valley. We use stellar population fitting to determine dust content (A_V) and correct the observed $(U\text{-}V)_{AB}$ color for dust reddening.

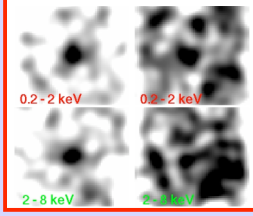


The dust-corrected color-mass distribution of AGN is bimodal, with roughly half the AGN host galaxies on the red sequence and the other half in the blue cloud. The AGN duty cycle in massive galaxies is ~10%. AGN hosts on the red sequence are preferentially bluer than inactive red-sequence galaxies, implying that AGN are predominately new arrivals on the red sequence.

Sample: The MUSYC Survey in the ECDF-S samples Galaxy Spectral Energy Distributions (SEDs) are densely sampled by optical (U38UBVRIz, 18 medium bands), near- and mid-infrared (JHK & 3.6-8.0μm) data, allowing for extremely accurate photometric redshift determinations (Δz/(1+z)~0.007; Cardamone et al. 2010).Deep *Chandra* X-ray images are used to identify 114 AGN host galaxies at 0.8 < z < 1.2.

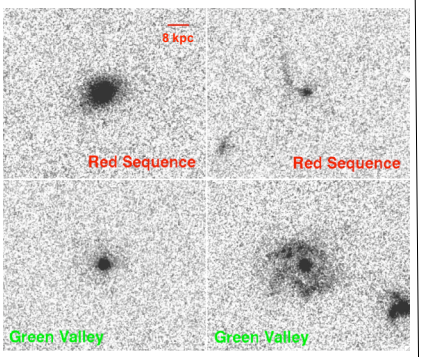
Stacked *Chandra* Data for Massive Galaxies, M>10^{10} M$_{sun}$

Observed Colors	0.5-2 keV Flux	2-8 keV Flux	Number of Sources
	ergs cm^{-2} (S/N)	ergs cm^{-2} (S/N)	
Red Sequence	7.8×10^{-18} (5)	2.6×10^{-17} (3)	387
Green Valley	1.1×10^{-17} (4)	2.1×10^{-17} (2)	128
Dusty	8.5×10^{-18} (4)	2.2×10^{-17} (2)	181
Passive	7.6×10^{-18} (5)	2.3×10^{-17} (2)	334



There are significant (5σ) detections in the soft band X-ray stack of galaxies on the red sequence (top) and galaxies in the green valley (bottom). Average X-ray luminosities are ~ $10^{40\text{-}41}$ ergs/s, consistent with star formation rates of ~10 M_{sun} yr^{-1}.

Galaxy Morphologies



HST images show that AGN hosts, like other galaxies, rarely show signs of morphological disturbance. Independent of AGN content, passive galaxies (*left*) are more regular and less disturbed than dusty or star forming galaxies (*right*).

Conclusions:

At z~1, AGN are found preferentially in massive galaxies (M>10^{10} M_{sun}), with a duty cycle ~10%. The observed distribution of AGN host galaxies peaks in the Green Valley but 75% of green valley AGN hosts and inactive galaxies are highly reddened. After correcting for dust-obscuration, we find that half of all AGN host galaxies have young, star-forming stellar populations in which AGN feedback could be heating up the gas to eventually shut down star formation. The remaining 50% of AGN host galaxies lie on the blue side of the red sequence, meaning they are potentially recent arrivals to the population of passively aging older galaxies.