Two Disjoint AGN Populations in Low-z Clusters of Galaxies

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AGN Identification

We identify two classes of AGN. X-ray AGN have measured X-ray luminosities in excess of those expected from their host galaxies. Objects whose SEDs are fit much better by a model that includes an AGN component than by a normal galaxy alone are called IR AGN (Figure 1). The two AGN classes have similar luminosities, but the samples are nearly disjoint. The use of two selection methods that are sensitive to different types of AGN and relatively insensitive to absorption allows us to construct a more complete sample of AGN than would be possible using either technique alone.

Abstract

We present results from a detailed study of AGN found in 8 low-redshift galaxy clusters from 0.06<z<0.31. The objects we study have both visible photometry and mid-infrared (MIR) fluxes from Spitzer. We fit model spectral energy distributions (SEDs) to the combined photometry of each cluster member and use these model SEDs to determine stellar masses and star-formation rates (SFRs). We identify populations of AGN based on either their X-ray luminosities (X-ray AGN) or the shapes of their model SEDs (IR AGN). We find that the two populations are nearly disjoint with only 8 out of 43 AGN falling in both. X-ray and IR AGN hosts have similar stellar masses and SFRs, but IR AGN hosts have higher specific SFRs (sSFRs) than X-ray AGN hosts. We argue that the apparent dichotomy between X-ray and IR AGN can be understood as a result of differing extinction due to cold gas in the host galaxies of X-ray and IR AGN.

Figure 1: Model SED of an example IR AGN constructed using the templates of Assef et al. (2010). This is an unusually luminous IR AGN. Typical AGN are fainter in the MIR and have a weaker visible component relative to the host galaxy than shown here.

Figure 2: Comparison of specific SFRs (sSFRs) in the hosts of the two types of AGN with cluster members as a whole. IR AGN hosts have larger sSFRs than X-ray AGN hosts at 98% confidence. Stellar masses and SFRs are determined by SED fitting.

Figure 3: Comparison of black hole accretion rates to star-formation in AGN hosts. Lines show ratios needed to maintain the z=0 $M_\text{BH}-M_\text{bulge}$ relation (dashed) and the median growth ratio from Silverman et al. (2009; solid). There is no significant difference between the cluster sample and a z=0.8 field sample (Silverman et al. 2009; green).

Figure 4: Visible-wavelength CMD for members of all 8 clusters. Magnitudes and colors have been corrected for the AGN component in galaxies identified as IR AGN. The two AGN samples occupy different parts of color-magnitude space at 99% confidence.

Interpretation

X-ray and IR AGN are largely distinct from one another, and they are found in quite different host galaxies (see Figures 2 and 4). We interpret the larger observed sSFRs among IR AGN hosts to indicate larger cold gas fractions in these galaxies. The dearth of X-ray detections among IR AGN could be caused by host galaxy absorption. If true, this would imply that X-ray undetected IR AGN that are eventually detected in deeper Chandra images should show unusually-hard X-ray spectra characteristic of strong absorption.