Optical/Near-Infrared Imaging of Infrared-Excess PG QSOs

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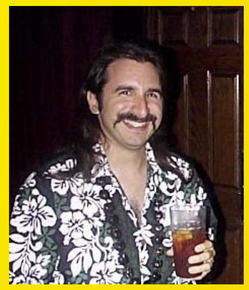

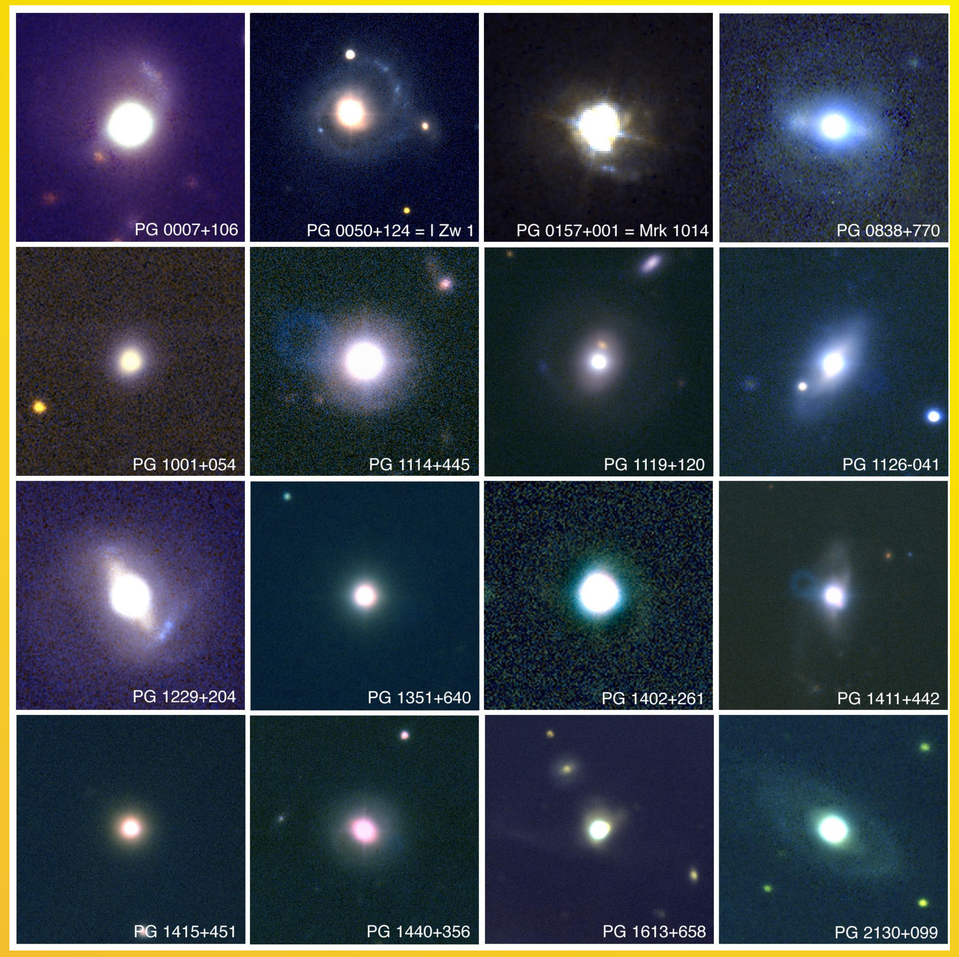

Shown above are truecolor images of the IR-excess QSOs made from B & I band data. Host galaxies are visible in nearly every system. In the majority of cases, these appear to be spiral-like or disturbed galaxies, half of which have strong bar features.

Background

Sanders et al. (1988) proposed an evolutionary connection between Ultraluminous Infrared Galaxies (ULIGs) and optically-selected QSOs. In this scenario, mergers of dust and gas-rich galaxies provide the fuel to create and/or fuel an AGN and circumnuclear starburst. This same dust completely enshrouds the AGN, and subsequent reradiation of the AGN emission produces the high far-IR luminositiy that defines ULIGs as a class. Dust clearing by superwinds eventually begins to unveil the central AGN, resulting in ULIGs with so-called "warm" characteristics, e.g. SEDs and line widths more similar to classical, optically-selected AGN. Eventually enough dust is cleared away that the object appears the same same as (and indeed is) an optically selected QSO. Surace et al. (1998,1999,2000) carried out detailed multi-wavelength high spatial resolution studies of ULIGs which showed in particular that "warm" ULIGs (defined by their mid-IR color) are mergers of two L* galaxies, with compact central sources whose luminosity and colors are similar to reddened AGN. They also possess "knots" of star formation distributed both in the circumnuclear region and along the merger-generated tidal structures.

See the poster, then read the paper, coming soon to a journal near you! You might also be interested in a CO study of these same objects - see Evans et al. 2001 elsewhere at this conference.

This Project

In the evolutionary scenario, if the "warm" ULIGs are a transition phase between the greater population of ULIGs and optical QSOs, then it must be the case that between the classical optical QSO state and the ULIG state there must be a phase when the systems appear to be optical QSOs yet still have the large far-IR excesses characteristic of ULIGs. A sample of 18 QSOs was selected from the Palomar-Green Bright Quasar Survey. They lie within the same space volume as the previous samples of ULIGs examined by Surace et al., thereby alleviating resolution dependencies in interpreting the data. By virtue of the definition of ULIGs, the QSOs and ULIGs also have the same minimum bolometric luminosities. The far-IR data from IRAS presented by Sanders et al. (1989) was used to evaluate the contribution to the bolometric luminosity of the "big blue bump" (100-1000 angstroms) relative to that emitted in the far-IR between 10 and 1000 microns. We selected all the QSOs with far-IR excesses as great as the least far-IR active ULIG (3C 273). We have carried out a campaign of high resolution observations at B, I, H, and K' using a fast tip/tilt guider on the UH 2.2m telescope. Typical spatial resolutions at H and K' are 0.3" while those at B and I are 1". All of the data is photometric.

What We Found

Our observations are sufficiently deep to reveal the host galaxies around the QSOs as well as small-scale structure.

1) All of the IR-excess QSOs have readily detectable host galaxies. The morphologies of these host galaxies are varied, but at least 50% are spiral-type systems, and just over half of these are barred. This is similar to known results for Seyfert galaxies. This is probably a result of our IR selection, which strongly selects spirals, and the relatively low luminosity of these QSOs selected for by our redshift range.

2) The mean H-band luminosity is approximately 2.2 L*. The distribution of host galaxy luminosities for AGN-like ULIGs and QSOs are very similar.

3) 22% are in obvious merger systems. As many as 50% are compatible with late-merger morphology that has produced bar structures.

4) A handful have small scale (<1 kpc) structure similar to the star-forming clusters seen in ULIGs. The QSOs also have considerable near-IR excesses which may be the result of recent star-forming activity.

Shown at right is the cumulative distribution function of host galaxy luminosities for the IR-excess PG QSOs, "warm" AGN-like ULIGs, and the larger body of ULIGs with non-AGN SEDs. The tight correspondence between the former strongly suggests a common population.