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High-Resolution Mid-Infrared Observations of AGN

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Abstract. This paper represents only a summary of mid-IR observations of four AGN presented at the Spitzer Space Telescope: New Views of the Cosmos conference. For more detail please refer to the corresponding publications.

1. Circinus (Packham et al., 2005, ApJL, 618, L17)

We observed sub-arcsecond resolution mid-infrared images of the Seyfert 2 galaxy Circinus (D$\sim$4.2 Mpc) at 8.74 and 18.33μm with the University of Florida designed facility mid-IR imager/spectrometer T-ReCS on Gemini South. We resolve extended emission at both wavelengths, extending $\sim 2''$ from each side of the nucleus in an approximate east-west direction. These extensions are spatially coincident with previously detected compact ($\sim$30pc) v-shaped [OIII] emission extending NW of the nucleus. This extended mid-IR emission is also coincident with countercone [SiVI] emission which has been interpreted as delineating the interface between inflowing material and the ionization cone. We detect no extended mid-IR emission associated with the structure responsible for collimating the ionizing photons (i.e. obscuring torus or disk of material) limiting the surface brightness of such a structure to = 0.27mJy or a diameter of = $0.20''$ (= 4pc).

2. NGC 4151 (Radomski et al., 2003, ApJ, 587, 117)

The Seyfert 1 - 1.5 galaxy NGC 4151 (D$\sim$13.2 Mpc) is one of the most extensively studied AGN. The extended narrow emission line region (NLR) has a cone like geometry and is interpreted as an ionization cone caused by anisotropic illumination of the NLR. We present subarcsecond-resolution mid-infrared images of NGC 4151 at 10.8μm and 18.2μm. These images were taken with the University of Florida mid-IR imager/spectrometer OSCIR at the Gemini North 8-m telescope. We resolve emission at both 10.8μm and 18.2μm, extending 3.5$''$ across at a P.A. of 60°. This coincides with the narrow-line region of NGC 4151, as observed in [OIII] by the HST. The most likely explanation for this extended mid-IR emission is dust in the narrow-line region heated by a central engine. We find no extended emission associated with the proposed torus and place an upper limit on its mid-IR size of $\simeq$35 pc.

3. Cygnus A (Radomski et al., 2002, ApJ, 566, 675)

Cygnus A is the prototypical FR II radio galaxy (D$\sim$224 Mpc). We present subarcsecond resolution mid-infrared images at 10.8μm and 18.2μm of Cygnus A. These images were obtained with the University of Florida mid-IR imager /spectrometer OSCIR at the Keck II 10-m telescope. Our data show extended mid-IR emission primarily to the east of the nucleus with a possible western extension detected after image deconvolution. This extended emission is closely aligned with the ionization cone observed at optical and near-IR wavelengths by the HST. We show this emission is consistent with dust heated from the active galactic nucleus at the heart of Cygnus A. We also marginally detect large-scale low level emission extending >1.5 kpc from the nucleus which may be caused by in-situ star formation, line emission, and/or PAH contamination within the bandpass of our wide N-band filter.

4. M87 (Perlman et al., 2001, ApJL, 561, L51)

M87 is a nearby giant elliptical galaxy (D$\sim$16 Mpc). We analyze a 10.8μm image of M87, obtained with the Gemini North 8-m telescope using the University of Florida mid-IR imager/spectrometer OSCIR. The combined image has a fwhm $<$0.5$''$ and represents 7 hr of observing time, making it (at the time) the deepest high-resolution mid-IR image. Low level galactic emission around the core is marginally resolved, and we detect five counterparts to optically bright knots in the jet. The spectral energy distributions of the knots are entirely consistent with synchrotron radiation. However, we find little evidence of thermal emission from a dusty torus. Four faint jet regions are below the noise level of these observations. We also find evidence for diffuse galactic emission on a larger scale than the core.