Active Galactic Nuclei: from Central Engine to Host Galaxy
ASP Conference Series, Vol. xxx, 2003
S. Collin, F. Combes, and I. Shlosman

Search for diffuse extended mid-IR emission in Luminous IR Galaxies

Vassilis Charmandaris
Cornell University, Astronomy Department, Ithaca, NY 14853, USA

Emeric Le Floc'h, Felix I. Mirabel
CEA/Saclay, Service d'Astrophysique, F-91191 Gif-sur-Yvette, France

Abstract. The discovery by IRAS of luminous ($L_{IR} > 10^{11}$ $L_{\odot}$) and ultraluminous ($L_{IR} > 10^{12}$ $L_{\odot}$) IR galaxies (LIRGs / ULIRGs) opened a new window in extragalactic astronomy, since it revealed that they are for those luminosities the dominant population of extragalactic objects in the local Universe ($z<0.3$). It is now widely accepted that i) nearly all ULIRGs are advanced mergers harboring powerful nuclear starbursts and/or enshrouded AGN, and ii) the mid-IR is a powerful tracer of the star formation activity and bolometric luminosity of galaxies. The poor spatial resolution of IRAS though, due to the large ($\sim$1 arcmin) pixels used, made it impossible to resolve the physical extent of the region which produces the bulk of their mid-IR emission. Recently, ground based 10 and 18 μm imaging for a number of the nearest and brightest objects, has revealed compact nuclear emission from regions of just few arcsecs in diameter, (i.e. Soifer et al. 2001), even though the ground measurements are hampered in sensitivity by the low mid-IR atmospheric transmission. Using ISOCAM, the most sensitive mid-IR camera to date, and the good spatial resolution images it provides we searched for extended emission from a sample of nearby luminous IR galaxies (Arp 220, Arp 299, NGC 6240, VV 114, IRAS 14248-1447, IRAS 19254-7245, IRAS 23128-5919) for which the 5–16 μm spectral energy distribution was available.

We find that with the exception of VV 114 more than 90% of the integrated IRAS 12 μm flux originates from their nuclear regions ($\sim 5'' < 2$ kpc). This result suggests that the 10–15 μm properties of distant unresolved ULIRGs would likely to also be dominated not by their disks, but by their nuclear region instead.

1. Discussion

Using deep ISOCAM mid-IR imaging we searched for the presence of extended emission in the 8–16 μm range in a number of nearby luminous and ultraluminous infrared galaxies which were detected by IRAS at 12 μm. Our goal was to examine whether cases of extended extranuclear activity which can account for a considerable fraction of the mid-IR thermal emission similar to those observed by ISO in interacting systems such as NGC 4038/39 (Mirabel et al. 1998) or Stephan's Quintet (Xu et al. 1999) are also present in LIRGs or ULIRGs. All systems examined are rather close-by and consist of two well defined galaxies which are either currently violently interacting, or are mergers containing double nuclei. For most galaxies high resolution near-IR data were available. Ground based mid-IR imaging for the brightest galaxies (Arp 220, Arp 299,

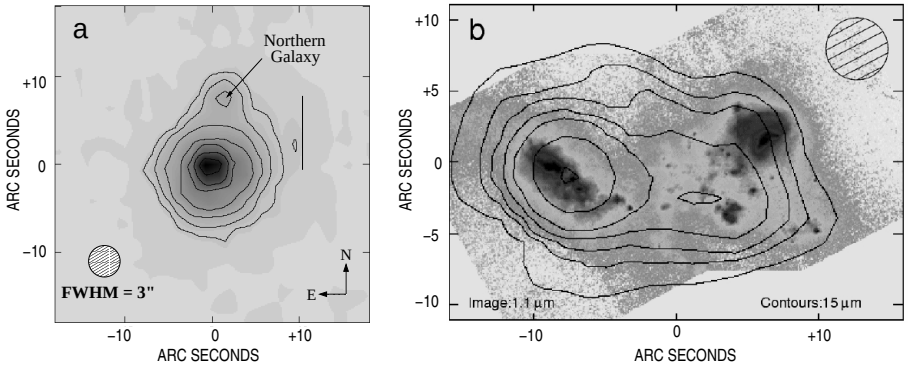

Figure 1. a) A 7 μm image of IRAS 19254-724 (The "Superantennae"). More than 90% of the mid-IR flux originates from the unresolved southern galaxy (Charmandaris et. al 2002). b) The 15 μm emission of VV 114 overlayed on its 1.1 μm HST image. Note the presence of the extended mid-IR emission between the two galaxies (Le Floc'h et al. 2002).

VV 114) only identified emission compact regions associated with the nuclei of the galaxies. Our results indicate that: i) Despite the superior sensitivity and improved spatial resolution ($\sim 4''$ at 15 μm) of ISOCAM compared to IRAS no significant extended emission was observed and we can account for nearly all of the IRAS 12 μm flux from areas confined in the nuclei of the galaxies. This would suggest that the excess of thermal emission at 15 μm which is observed in distant unresolved IR luminous galaxies does not originate from an ensemble of discrete sources in their interacting members but more likely is due to the enshrouded energy source of their nuclei. ii) VV 114 is the only exception to the abovementioned result (Le Floc'h et al. 2002) . This could be due to the fact the VV 114 (a LIRG) is in the process of becoming a ULIRG. The strong radiation from the elusive AGN and circumnuclear starbursts in VV 114E can heat the gas/dust which was stripped during an earlier phase of the interaction out to distances of $\sim$3 kpc. iii) Since all galaxies presented here are targets of the SIRTF GTO programs, and several of them are hosts to numerous young star clusters, it would be interesting to take advantage of the $\sim$100x increase of sensitivity provided by SIRTF to re-examine this issue at the 3–8 μm region by tracing the PAH emission from weak extra-nuclear enshrouded star forming regions.

References

Charmandaris, V., Laurent, O., Le Floc'h, E., et al. 2002, A&A, 391, 429

Le Floc'h, E., Charmandaris, V., Laurent, O., et al. 2002, A&A, 391, 417

Mirabel, I.F., Vigroux, L., Charmandaris, V., et al. 1998, A&A, 333, L1

Soifer, B.T. Neugebauer, G., Matthews, K., et al. 2001, AJ, 122, 1213

Xu, C., Sulentic, J.W., & Tuffs, R. 1999, ApJ, 512, 178