The Interplay among Black Holes, Stars and ISM in Galactic Nuclei
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The Starburst-AGN connection in ultraluminous infrared galaxies

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Abstract. We present the results of L-band spectroscopic observations of local bright ULIRGs, performed with ISAAC at VLT. The excellent sensitivity of the telescope and instrument provided spectra of unprecedented quality for this class of objects, which allowed a detailed study of the relative AGN/starburst contribution to the energy output, and of the composition of the circumnuclear absorber. A new mid-infrared diagnostic diagram is proposed, in which starbursts and AGNs are clearly separated.

1. Introduction

Ultraluminous Infrared Galaxies (ULIRGs, $L_{IR} > 10^{12} L_{\odot}$) are the most luminous sources in the local universe, and represent the local counterpart of the class of high-redshift objects dominating the far-infrared and sub-mm background. The huge infrared emission is due to reprocessing by dust of higher frequency radiation, emitted by starburst (SB) activity or by an active nucleus. Several attempts have been made in the last years to understand which of these two sources of energy is dominant in ULIRGs. Known diagnostics involve optical and near-IR spectroscopy (Veilleux et al. 1999a,b), mid-IR imaging and spectroscopy (Genzel et al. 1998), hard X-ray observations (Braito et al. 2003, Ptak et al. 2003), L-band spectroscopy (Imanishi & Dudley 2000). However, none of the above methods can conclusively assess the relative importance of AGN and SB in a representative sample of objects. This is mainly due to the fact that all the different diagnostic techniques are effective in "extreme" cases, with a clear dominance of one of the two energy sources.

Here we present new L-band spectroscopic results on a sample of bright ULIRGs. We will show that L-band spectra obtained with ISAAC at VLT can provide a quite effective way to disentangle the AGN and star formation contributions in ULIRGs. This diagnostics is successful for bright sources, for which independent classification is already present, and can be extended to fainter sources, for which the known diagnostics at other frequencies cannot be used yet, because of insufficient signal-to-noise.

2. Observations and results

The sample chosen for this study is the one of Genzel et al. (1998) consisting of the 15 ULIRGs with IRAS 60 μm flux density $F_{60} > 5.4$ Jy. Several sources have been already observed in the L-band (3-4 μm) with 4-meter class telescopes in the northern emisphere (Imanishi & Dudley 2000). 9 out of 15 objects are visible from the southern emisphere. Our project is to observe these 9 sources with the Infrared Spectrometer and Array Camera (ISAAC) at the VLT. 6 spectra have been already obtained. Observations

† Based on observations collected at the European Southern Observatory, Chile (proposal ESO 69.A-0643)

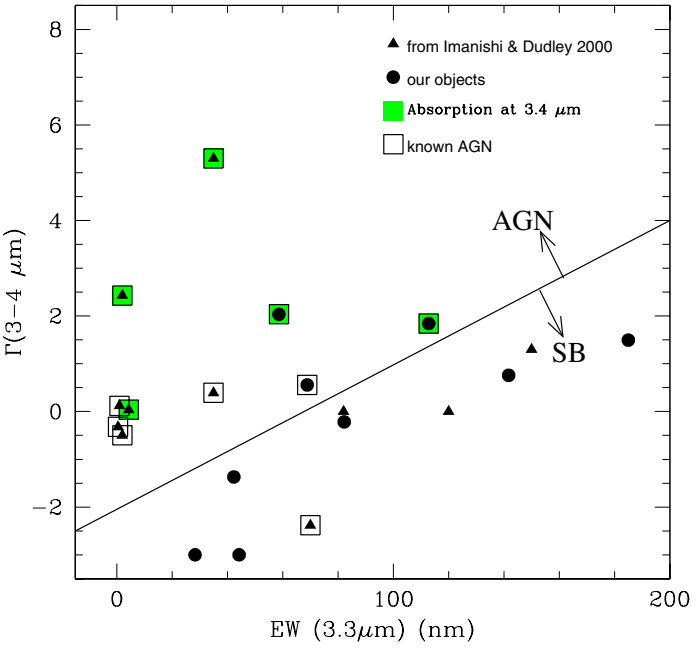

Figure 1. Continuum slope (in a $\lambda - f_\lambda$ plot) versus 3.3 μm emission feature EW for all the bright ULIRGs with an independent (mostly X-ray) starburst/AGN classification. While the single indicators are not able to distinguish between AGN and starburst in most cases, the combination of the two provides a correct classification in all but one (NGC 6240) cases: all AGNs are above the continuous line, and all SB are below the line.

of the remaining 3 are scheduled for July 2004. The main results of our work (Risaliti et al. 2003, Risaliti et al. 2004 in prep.) are summarized in Fig. 1, where we plot two of the main indicators of the SB/AGN origin of the IR emission (the equivalent width of the emission feature at 3.3 μm, due to PAH molecules, and the 3-4 μm continuum slope in a $\lambda - f_\lambda$ plot) for all the ULIRGS with an independent AGN/SB classification (our sources make $\sim$ half of the sample).

If only one parameter is considered, only if its value is extreme the AGN/SB classification is possible. However, AGNs and SBs are clearly separated in the plane obtained using the two indicators together.

This shows that L-band low resolution spectroscopy provides a powerful tool to understand the origin of the IR emission in ULIRGs. We plan to extend this method to fainter sources, for which no other AGN/SB indicator is available with the currently available instrumentation.

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