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THE OBSCURATION IN LINERS

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RESUMEN

Los LINERs constituyen un tipo de AGN de baja luminosidad difícilmente explicable en los modelos unificados. Se ha encontrado (González-Martín et al. 2009b) que un porcentaje alto de ellos son fuentes oscurecidas. Los datos de resolución espacial alta en el infrarrojo medio nos ofrecen la oportunidad de estudiar el oscurecimiento de estas fuentes peculiares. Estas observaciones constituyen un reto debido a la debilidad de las fuentes y a la inclusión de emisión circunnuclear. En este trabajo investigamos el gran potencial del instrumento CanariCam del GTC. Con una muestra preliminar de LINERs observada con VISIR en el VLT y T-ReCs en GEMINI hemos obtenido que los LINERs siguen la relación sugerida por Asmus et al. (2011) para los AGNs.

ABSTRACT

LINERs have been a class of low-luminosity AGN difficult to explain under the unified model. It has been claimed (González-Martín et al. 2009b) that a high percentage of them are obscured sources. Mid-infrared high spatial resolution data will bring us the oportunity to study the obscuration of these intringuing sources. However, these observations have been challenging due to the faintness of the sources and the inclusion of circumnuclear emission. Here, we investigate the great potential of the new instrument CanariCam at GTC. With a preliminary sample of LINERs observed with VISIR at VLT and T-ReCs at GEMINI we have obtained that LINERs fit into the relation claimed by Asmus et al. (2011) for AGNs.

Key Words: galaxies: active

1. SETTING THE STAGE

The detection of compact X-ray nuclei would be one of the most convincing evidences of the AGN nature of LINERs. Chandra's excellent resolution allowed us to perform a careful study of the X-ray nuclear properties of these galaxies (González-Martín et al. 2006, 2009a,b). Our analysis demonstrates that 60% of a sample of 82 LINERs shows compact unresolved nuclear sources at high energies (4.5–8 keV) and median values X-ray luminosity of 3.2×10^{40} erg s^{-1}, being excellent candidates to host AGN. Furthermore, around 90% of our sample shows evidence of AGN when considering other indicators as radio flatness, UV variability and presence of a broad Hα line (González-Martín et al. 2006, 2009a,b).

Moreover, the hydrogen column densities (NH) range from the expected galactic value up to NH $\sim 10^{24}$ cm^{-2}. For NH $< 10^{24}$ cm^{-2}, photons above a few keVs can penetrate the expected blocking torus providing an unobstructed view of the nuclear source (Compton-thin; Pier & Krolik 1993; Nenkova et al. 2002). Only the high energy X-ray emission (>10 keV) can pass through the obscuring material above NH $> 1.5 \times 10^{24}$ cm^{-2} (Compton-thick or CT hereafter; Turner et al. 1998). Without X-ray observations at energies larger than 10 keV, only indirect estimates of Compton-thickness can be obtained. The most suitable estimate is based on the $L([\mathrm{OIII}])/L_X(2\text{–}10$ keV) ratio (Maiolino et al. 1998; Panessa et al. 2006; González-Martín et al. 2009b). We have found that LINERs show $L([\mathrm{OIII}])/L_X(2\text{–}10$ keV) ratios indicating that up to 53% of the LINERs have a CT nature, a percentage two times higher than that reported for Seyferts 2 (Panessa et al. 2006).

The presence of obscuring material has been suggested to be most directly inferred from large X-ray absorbing columns as well as thermal re-emission at the mid infrared (MIR) of the intercepted optical-UV nuclear radiation (Pier & Krolik 1993; Nenkova et al. 2002; Honig et al. 2006). Observations at MIR will be hence crucial to reassess the obscured nature of many AGN. Indeed, we would expect that a huge amount of energy will be re-emitted in the MIR and the way it does will give important clues on the nature of the obscuring matter.

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2. MIR EMISSION

Using 24″ angular resolution SPITZER data, a correlation between $L(6\mu\text{m})$ and the absorption-corrected L_X(2–10 keV) has been reported by Lutz et al. (2004) for a sample of 71 Seyferts. In this work they found a different behaviour for Seyfert 1s and Seyfert 2s, which was not confirmed by Ramos-Almeida et al. (2007).

However, the observed MIR emission is a function, not only of the putative torus obscuration, but also of the dust at larger scales. For Seyfert nuclei, a tight correlation between the 10.5 μm continuum and the absorption-corrected L_X(2–10 keV) has been reported for 8 nearby Seyferts (Krabbe et al. 2001) with 1″.2 resolution data.

Then, a crucial issue is to isolate the AGN MIR continuum from that of the host galaxy. The highest resolution studies (Asmus et al. 2011, and references therein) have found, by means of VLT/VISIR 0.35″ resolution data, a strong correlation between rest frame $L(12.3\mu\text{m})$ and L_X(2–10 keV), Seyfert 1 and Seyfert 2 following the same correlation. They found that this correlation extends four orders in luminosity extending to low luminosity AGNs, independently of their accretion rates. These results clearly disfavour star formation as the dominant nuclear source in LLAGNs.

Similar data for a sample of LINERs have been reported by Mason et al. (2011, in preparation). They found that indeed a similar trend between $L(12.3\ \mu\text{m})$ and L_X(2–10 keV) seems to be also present for the 13 LINERs included in their sample. Moreover they claim that MIR morphologies appear to be different for low and high Eddington sources.

As part of our systematic multiwavelenght study of LINERs, we have detected 4 out of the 12 LINERs observed with VISIR at MIR. Adding up the data for 7 LINERs from the T-ReCs GEMINI archive, we have analyzed a sample of 11 LINERs, 5 if them are also included in the work by Mason et al. (2011, in prep.), but at variance with their claim, we do not find any correlation between MIR morphologies and Eddington ratios. Except for NGC 3628 where the very extended morphology seems to be asociated to star forming regions,we found a nuclear unresolved source with no or insignificant extended emission.

Finally, the correlation between $L(12.3\ \mu\text{m})$ and L_X(2–10 keV) has been investigated and the results are presented in Figure 1. LINERs appear to follow the general trend reported for high luminous AGN. It is worthwhile to notice that once X-ray luminositoes are corrected of Compton thickness, the points move into the AGN line. Unfortunately this conclusion is based only in a few data points. We expect to significantly contribute at this respect with the new observations planned to be performed with CanariCam at the GTC. Twelve hours of observing time have been granted to this project in the coming semester. The proposed analysis will then allow us, for the first time, to study the obscuring material by means of high spatial resolution data at MIR wavelengths.

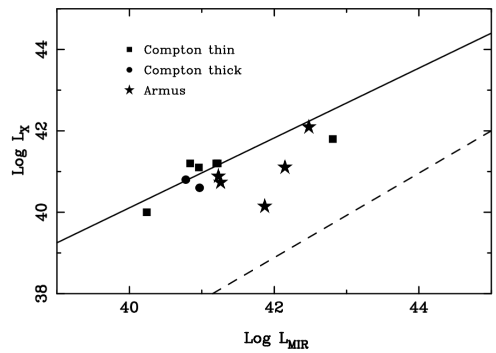

Fig. 1. Relation between X-ray and MIR luminosities. Dashed line indicates the locus of Starburst Galaxies and continous line is for the locus of the AGN population. Our sample of LINERs are shown as filled squares (Compton thin) and bullet symbols(Compton thick). Stars are the LINERs from Asmus et al. (2011) work.

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