AN XMM-NEWTON STUDY OF HYPER-LUMINOUS INFRARED GALAXIES

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ABSTRACT

We have selected a sample of Hyper-Luminous Infrared Galaxies (HLIRGs) with public observations in the XMM-Newton archive. This is the first time that a systematic study of this type of objects is carried out in this spectral band. Their X-ray spectra are characterized by the presence of a power-law continuum, associated to the AGN, and, in a few cases, of a thermal component probably associated to the starburst (SB). We have looked up for relationship between the X-ray and far-IR luminosities. We find that most HLIRGs are "mixed" sources: their X-ray luminosity is too high to be produced by a SB, and their infrared luminosity is too high to be produced by an AGN, assuming a standard SED for QSOs as in Elvis et al. (1994). The X-ray to IR luminosity ratio is constant with redshift, indicating that their respective power sources could be physically related.

Key words: galaxies:infrared; galaxies:starburst; galaxies:evolution; galaxies:active; HLIRG.

1. INTRODUCTION

Hyper-Luminous Infrared Galaxies (HLIRGs, $L_{IR} \geq 10^{13} L_{\odot}$) are the most luminous objects in the Universe. They exhibit extremely high star formation rates, and most of them seem also to harbour an AGN. HLIRGs are strong candidates for being primeval galaxies (Rowan-Robinson, 2000), in the process of a major episode of star formation. As they represent the most vigorous stage of galaxy formation, they are unique laboratories to investigate extremely high star formation, and its connection to supermassive black hole growth. X-ray studies of HLIRGs have the potential to unravel the AGN contribution to the bolometric output from these bright objects.

The main objective of this study is to determine the relative contribution of starburst (SB) and AGN emission to the bolometric luminosity and their interplay. The dependence of the SB versus AGN contribution with cosmic time has been investigated. We have also studied the relation of HLIRGs with their lower IR luminosity version, Ultra-Luminous Infrared Galaxies (ULIRGs) (Franceschini et al., 2003).

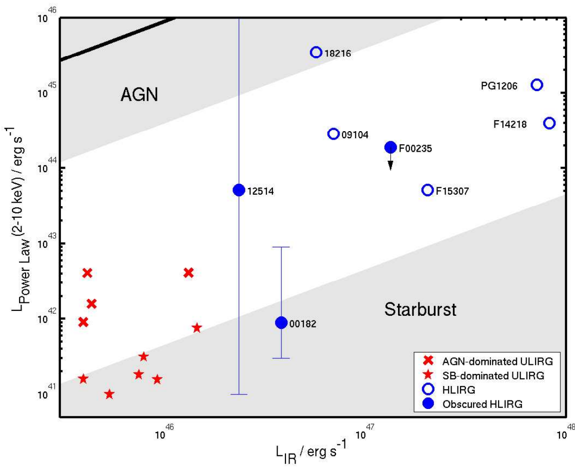

Figure 1. 2-10 keV L_X of the power-law component versus L_{IR}. The top grey area indicates the L_{IR} expected (at 90% of confidence) for an AGN with the corresponding L_X (Elvis et al., 1994). The bottom grey area indicates the L_X expected for a SB with the corresponding L_{IR} (Persic et al., 2004; Kennicutt, 1998). IRAS F00235 X-ray data are upper limits from Wilman et al. (2003).

2. SAMPLE AND RESULTS

Our sample has been selected from Rowan-Robinson (2000) sample of HLIRGs with redshift between ∼0.3 and ∼1.5, and with public data in XMM-Newton archive. The EPIC spectra extracted from this data have been modelled, revealing an heterogeneous spectral properties for this objects.

All the sources present a power-law continuum, probably associated to the AGN. We have included a thermal (two sources), reflection (one source) and/or absorption (one source) component where it was needed. In two spectra we have also found Kα iron lines. A detailed description

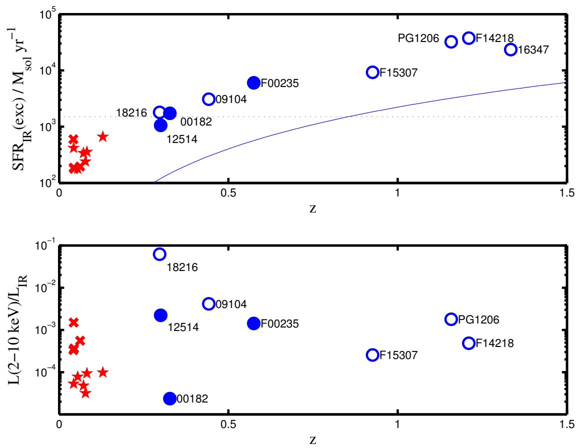

*Figure 2. **Top:** SFR derived from L_{IR} (Kennicutt, 1998), versus z. The dotted line represents the SFR limit corresponding to the HLIRGs definition. The solid line is the SFR for a source with IRAS fluxes equals to the IRAS FSC sensitivity limits (Moshir et al., 1990). **Bottom:** 2-10 keV X-ray to IR luminosities ratio versus z.*

of the sample and data analysis will be presented in Ruiz et al.(in prep.).

We have calculated the X-ray luminosities (L_X), using XMM-Newton data, and far-IR (8-1000 μm) luminosities (L_{IR}), using IRAS fluxes (Pérault, 1987). We have also estimated the star formation rate (SFR) for each source using its far-IR luminosity (Kennicutt, 1998).

2.1. X-ray PL vs Far-Infrared: Starburst or AGN?

In Fig. 1 HLIRGs seem to follow the same tendency as AGN-dominated ULIRGs, although no significant correlation is observed. Most of HLIRGs and all AGN-dominated ULIRGs seem to be "mixed" sources: their X-ray luminosity is too high to be produced only by a SB, and their infrared luminosity is too high to be produced by only an AGN. Note that IRAS 18216+6418 is the only source that clearly shows AGN-dominated properties.

Compton thick obscuration could in principle move up some HLIRGs from the "mixed zone" to the "AGN zone" (see Wilman et al. 2003, Iwasawa et al. 2006, this volume).

2.2. Redshift evolution?

Higher SFR at higher redshift is observed in upper plot of Fig. 2. However this could be due to a selection effect. We can see in bottom plot that the ratio of hard X-ray to IR luminosity remains constant with z, suggesting that AGN and SB are physically connected at least below z$\sim$1.5. A sample at higher z is needed to check this issue.

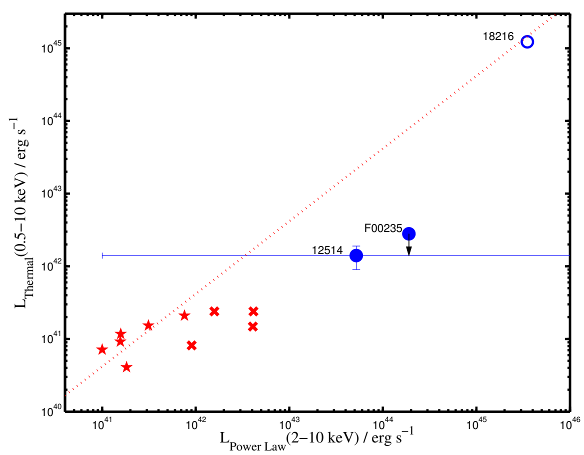

Figure 3. L_X (0.5-10 keV) of the thermal component versus L_X (2-10 keV) of the power-law component. The dotted line is a correlation obtained by Franceschini et al. (2003) for SB-dominated ULIRGs. IRAS F00235 X-ray data are upper limits from Wilman et al. (2003).

2.3. X-ray thermal vs PL: Where is thermal emission?

As shown in Fig. 3, only two HLIRGs present intrinsic thermal emission, while in all ULIRGs a thermal component has been observed. Also, IRAS 18216+6418, whose emission is clearly AGN-dominated, follows the same correlation as starburst-dominated ULIRGs (Franceschini et al., 2003), but the limited statistics of the samples prevent from further discussion.

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