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Powerful AGN in dusty galaxies

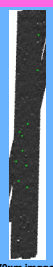
We study a sample of intermediate redshift dusty galaxies selected by Spitzer's photometer MIPS at 70μm.
By using a combination of X-ray, infrared and optical data we show that:

1) If an AGN is powerful enough to dominate or contribute substantially to the bolometric energy output in luminous and ultraluminous infrared galaxies (LIRGs and ULIRGs) then it *cannot* be hidden even if X-ray absorbed. Its presence will be obvious in the near/mid IR.

2) For a given flux density limit, the MIPS 70μm band can *cleanly* select LIRGs and ULIRGs primarily powered by star-formation.

Symeonidis et al. (2010)

Sample selection



70μm image with X-ray counterparts

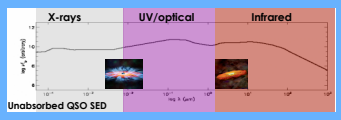
61 objects from the Extended Groth Strip
(multi-wavelength data and spectroscopy from AEGIS)

- 70μm-selected using MIPS on Spitzer - (~10mJy 5σ)
- 0.1<z<1.2, mean z~0.5 (DEEP2 spectroscopy)
- B, R, I magnitudes from DEEP2 survey
- 3.6, 4.5, 5.8, 8, 24, 70, 160 μm Spitzer IRAC & MIPS fluxes for the IR SED

Chandra/X-ray ~200ks - data products made available in Laird et al. 2009

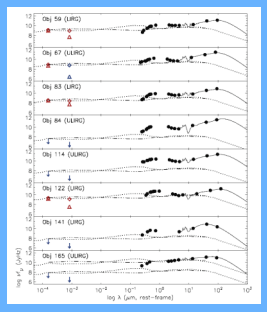
X-ray fraction is 16%: 10 out of 61 sources have a detection in at least one X-ray band

Looking for AGN in dusty host galaxies



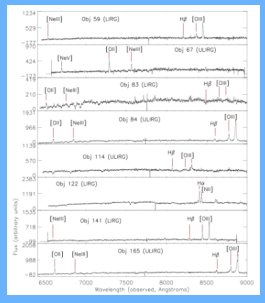
Optical/UV
strongly attenuated by dust in host galaxy (although spectral lines & line ratios are good diagnostics)
Infrared
Emission from torus detected in the near/mid-IR
X-rays
Soft (0.5-2 keV)X-rays could be absorbed by torus gas, but need column densities >10^{24} cm^{-2} to absorb hard (2-10keV) X-rays

The AGN fraction



13% of sources in the sample show AGN signatures, i.e. at least one of: high ionisation lines in the optical spectra, hard X-ray emission, very red near-IR colours.

This figure shows their broadband SEDs from X-ray to IR wavelengths. Dust models are fitted on the IR data and unabsorbed QSO and AGN SED templates are normalised to the absorption corrected hard X-rays (or upper limits), apart from the last object where they are also normalised to the near-IR.



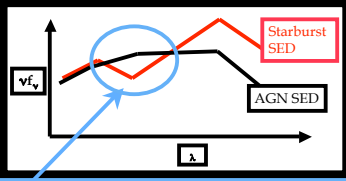
Optical spectra for the sources which host an AGN
- the power and presence of an AGN cannot always be recognised in the optical spectra of dusty galaxies.

The AGN contribution

We calculate the total AGN power by integrating under the unabsorbed QSO template normalised 1) in the X-rays and 2) in the near-IR.
The ratio of total IR power to AGN power is shown in columns 7 and 8 in the table below.
Although hard X-rays can be absorbed and hence lead to an underestimation of the AGN contribution, normalising the QSO template to our near-IR photometry gives an upper limit to the AGN power.

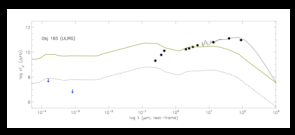
ID	L_{IR} class	SED type	log $L_{2-10keV}$(erg s^{-1})	[O III]/Hβ	[Ne V]	L_{IR}/L_{AGN} (X)	L_{IR}/L_{AGN} (8)	Powered by
59	LIRG	SB	42.9	7	out of range	23	10	SB
67	ULIRG	SB	43.3	out of range	yes	59	40	SB
83	LIRG	SB	42.6	too weak	out of range	42	13	SB
84	ULIRG	SB	not detected	9	out of range	2448	90	SB
114	ULIRG	SB	not detected	3	out of range	640	27	SB
122	LIRG	SB	43.4	out of range	out of range	14	13	SB
141	LIRG	SB	not detected	6	out of range	192	26	SB
165	ULIRG	power-law	not detected	8	out of range	550	6	SB /AGN

The AGN contribution to the bolometric luminosity of the galaxies that host an AGN is less than 10%, consistent with the SED shapes and the prominence of the far-IR bump.
This implies that the 70μm sample cleanly consists of sources dominated by star-formation.



The important point to note is that an AGN of bolometric luminosity >10^{44} erg/s which will contribute substantially to or dominate the energetics of a LIRG or ULIRG will begin to show up in the galaxy's SED.

- Hot dust emission from the torus fills the inflection that is otherwise visible in a starburst-type SED.



For example, object 165 in our sample is not detected in the hard X-rays but the AGN power emerges through a clear power-law continuum in the near-IR.
Even so, the total IR luminosity is at least 6 times higher than the integrated AGN power, implying that this object is still primarily powered by star formation.