AGN and Starburst signatures in the mid- and far-IR

In collaboration with Antonio Hernán-Caballero[1], Anna Feltre[2]
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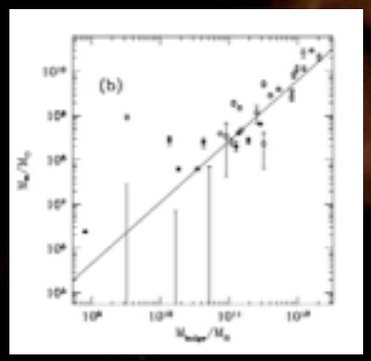
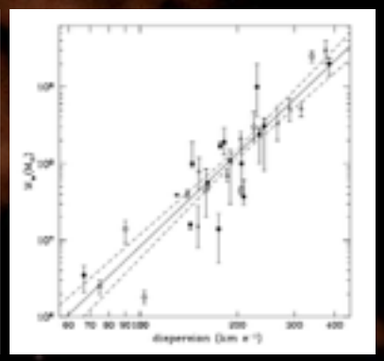
ESO - Garching

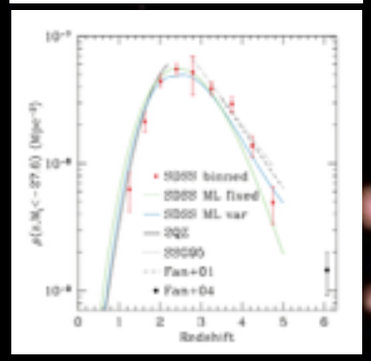
AGN vs Star formation, Durham, 28 July - 1 August, 2014

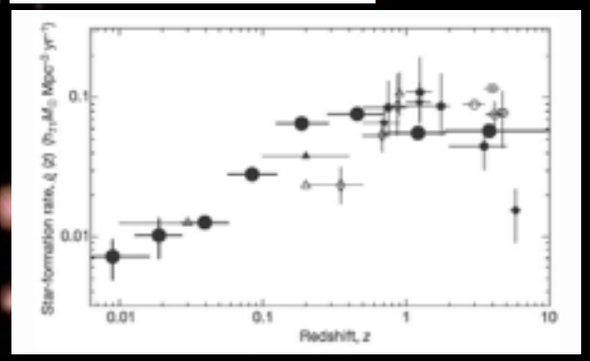
Facts and other stubborn things

- M - σ relation *(Magorrian et al. 1998; Ferarrese & Merritt 2000; Tremaine et al. 2002; Häring & Rix 2004; Gültekin et al. 2009 + another 10^8 references)*
- Quasar number density vs SFR history *(Boyle & Terlevich 1998; Heavens et al. 2004; Richards et al. 2006 etc)*
- Molecular outflows *(e.g. Sturm et al. 2011; Brusa et al. 2014)*
- Feedback necessary to suppress SF in massive galaxies in cosmological simulations (*Blandford & Rees 1974; Zanni et al. 2005; Wagner & Bicknell 2011; Di Matteo et al. 2005; Bower et al. 2006; ; Croton et al. 2006; Booth & Schaye 2009 + many more)*









1) What is an AGN- or SB-dominated system when both phenomena are present? (6)
2) Are star-forming galaxies aware of the presence of an active nucleus in their centre? (3)

The HerMES/IRS sample[1]

Band	Detections
IRAC 3.6 & 4.5μm, MIPS 24μm	100%
IRAC 5.8 & 8.0μm	90%
MIPS 70μm / MIPS 160μm	77% / 43%
SPIRE 350μm (3σ)	98% (72%)
SPIRE 500μm (3σ)	84% (35%)
SDSS *ugriz*	73%

- 375 sources detected at > 3σ at 250 μm
- in the northern HerMES[2] fields (Bootes, FLS, Lockman, EN1)
- with low-res IRS spectra[3]
- with reliable spectroscopic redshift measurements (optical or IRS)

[1] *Feltre et al., MNRAS, 434, 2426 (2013)*
[2] HerMES; http://hermes.sussex.ac.uk
[3] CASSIS; http://cassis.astro.cornell.edu/atlas

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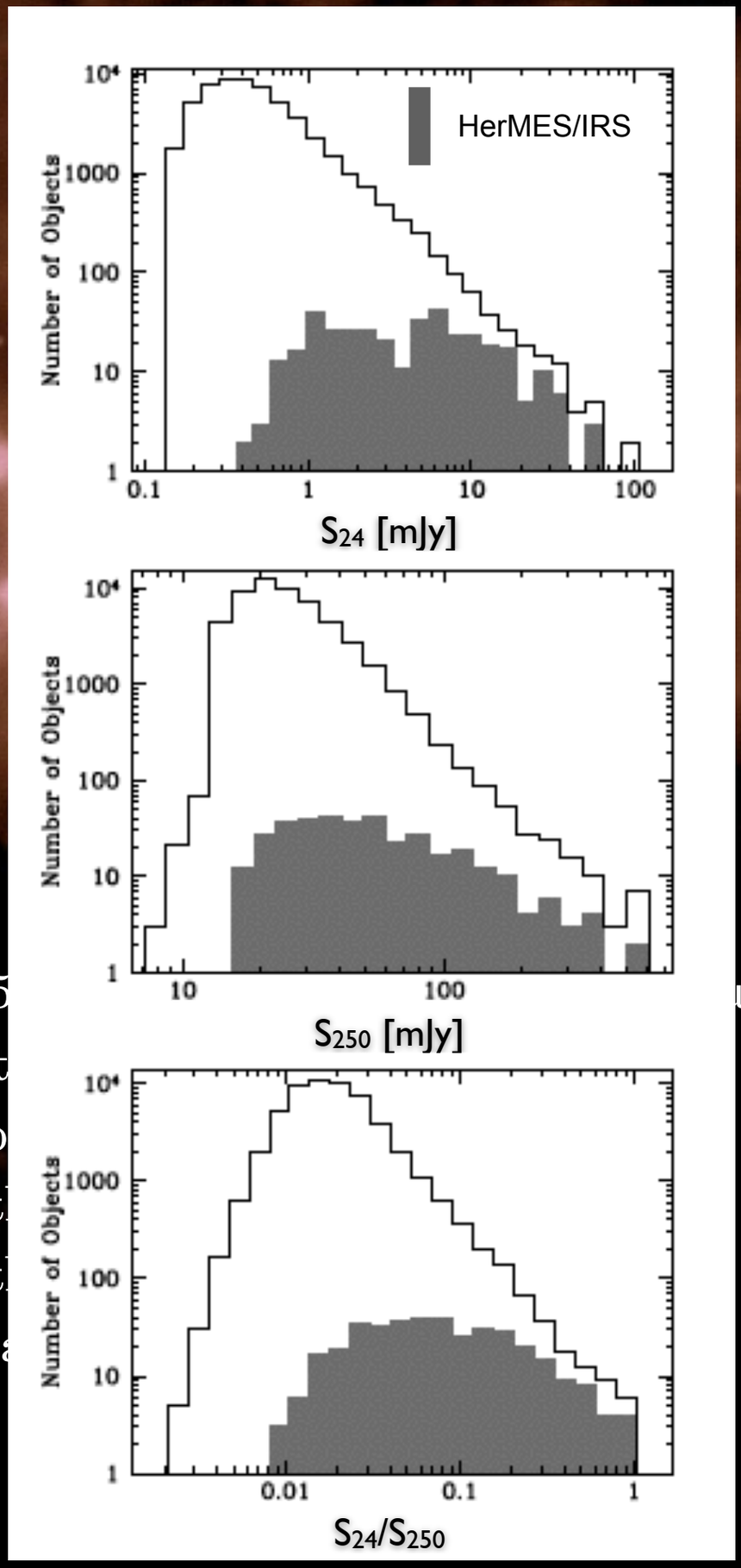

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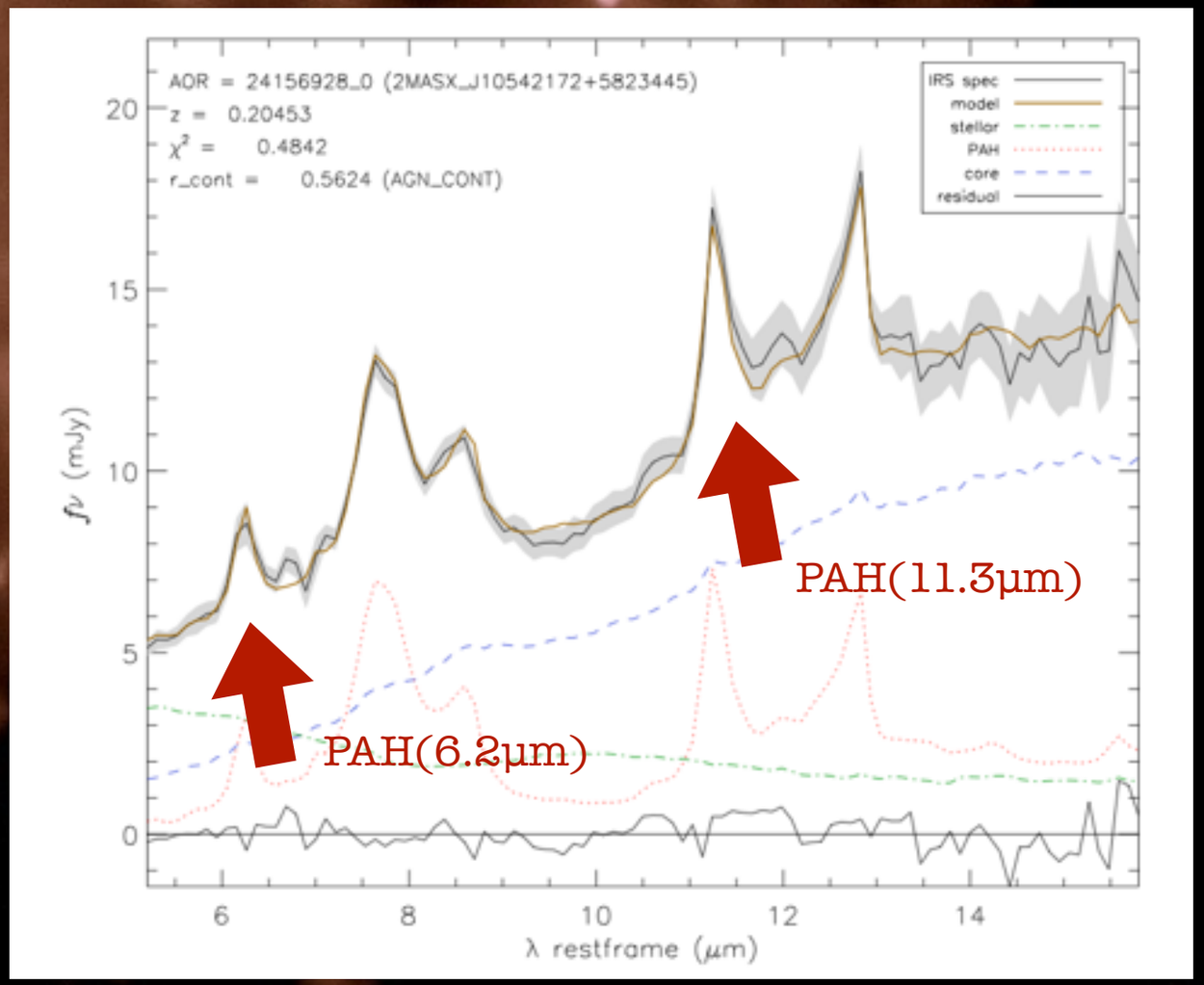
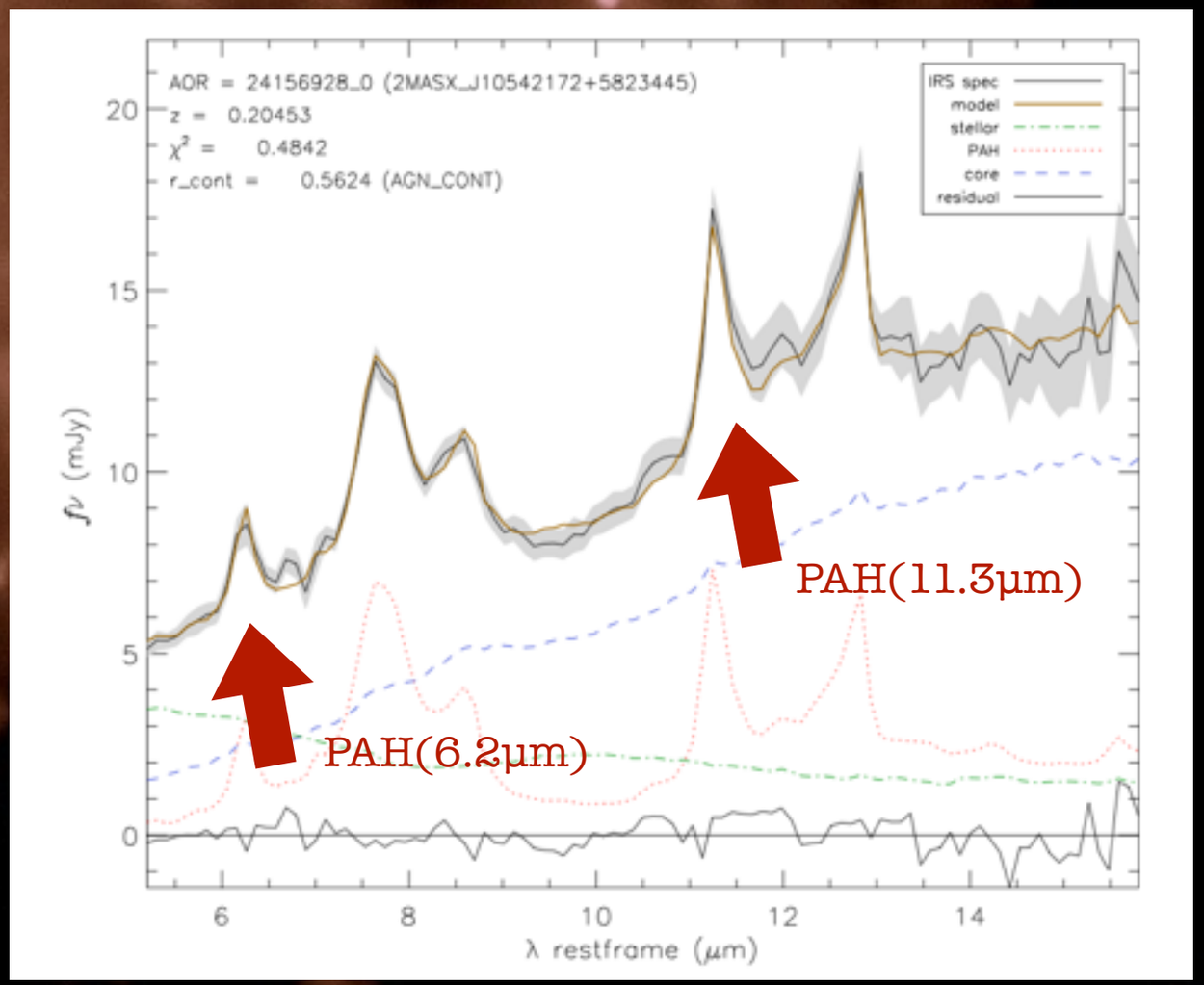
Representative of the IR-bright HerMES population, includes strong MIR AGN or SB emitters; excludes early-type, passively evolving, dust-free galaxies

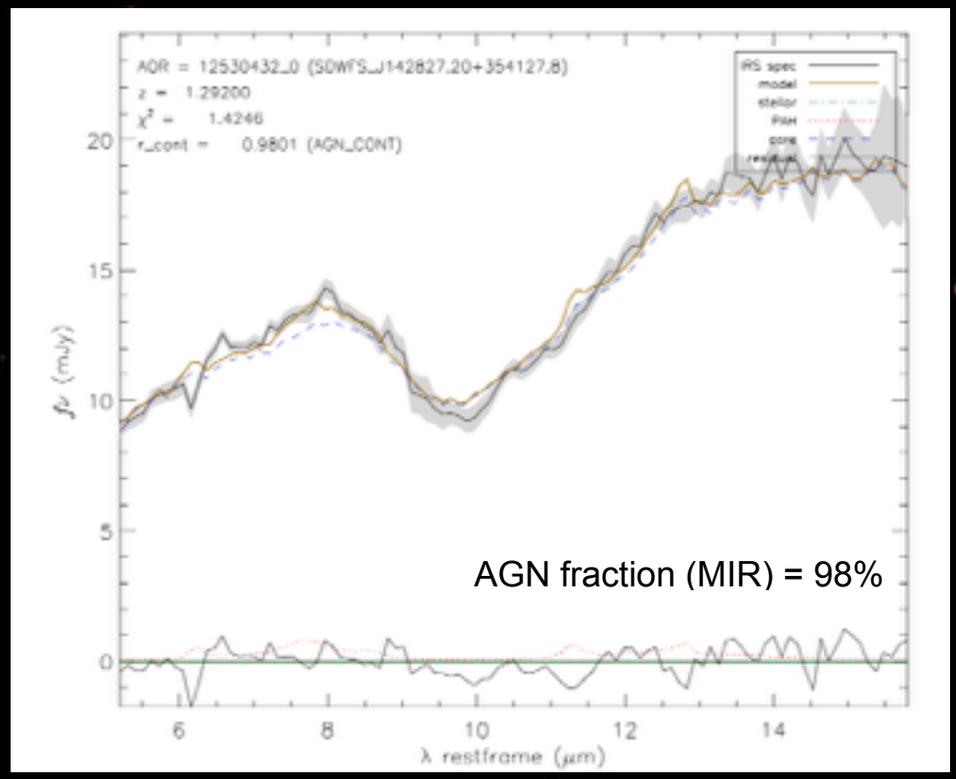
IRS measurements & spectral decomposition



- EW_{PAH} (6.2μm, 11.3μm)
- $L_{PAH} \Rightarrow SFR_{PAH}$

IRS measurements & spectral decomposition





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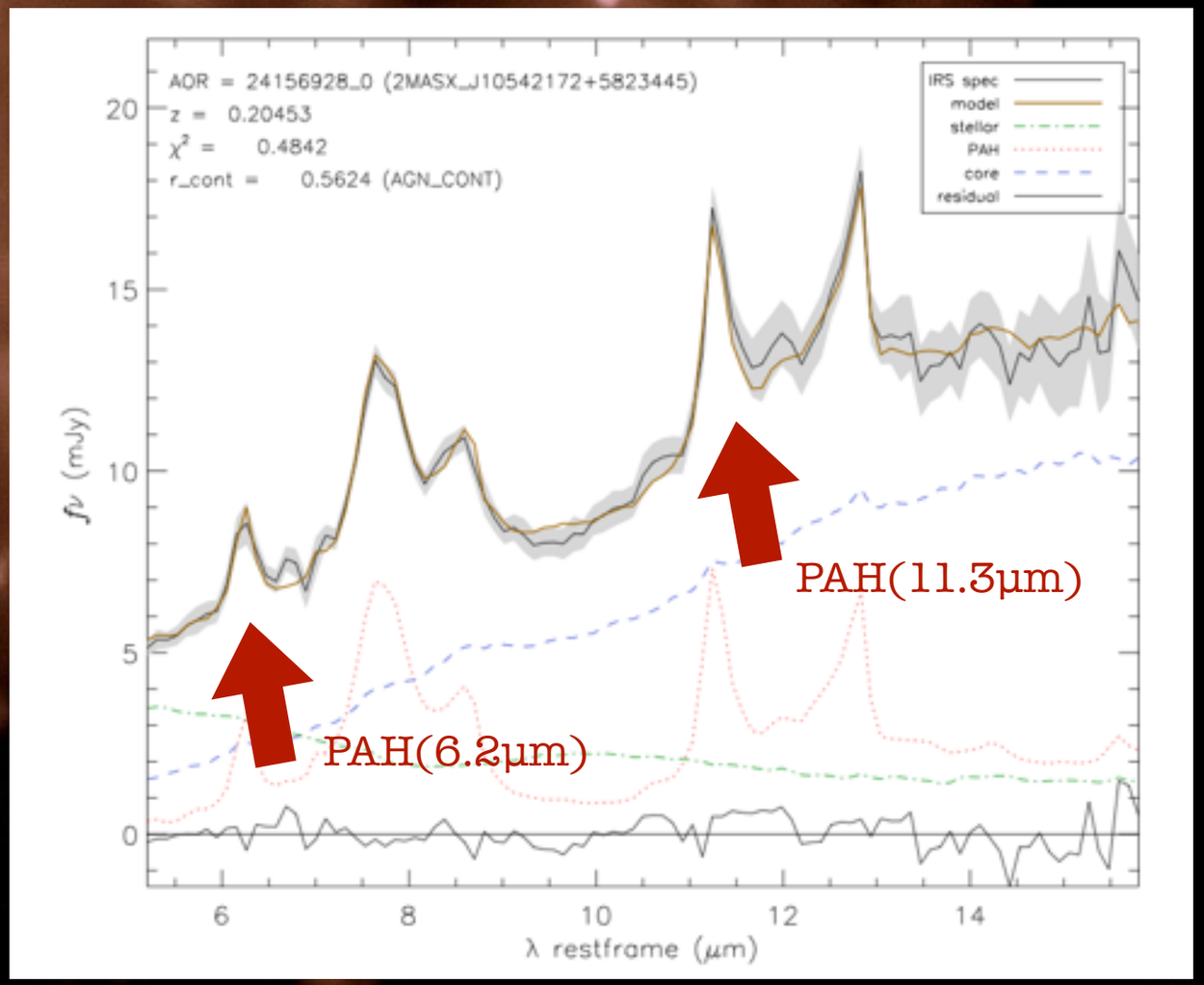

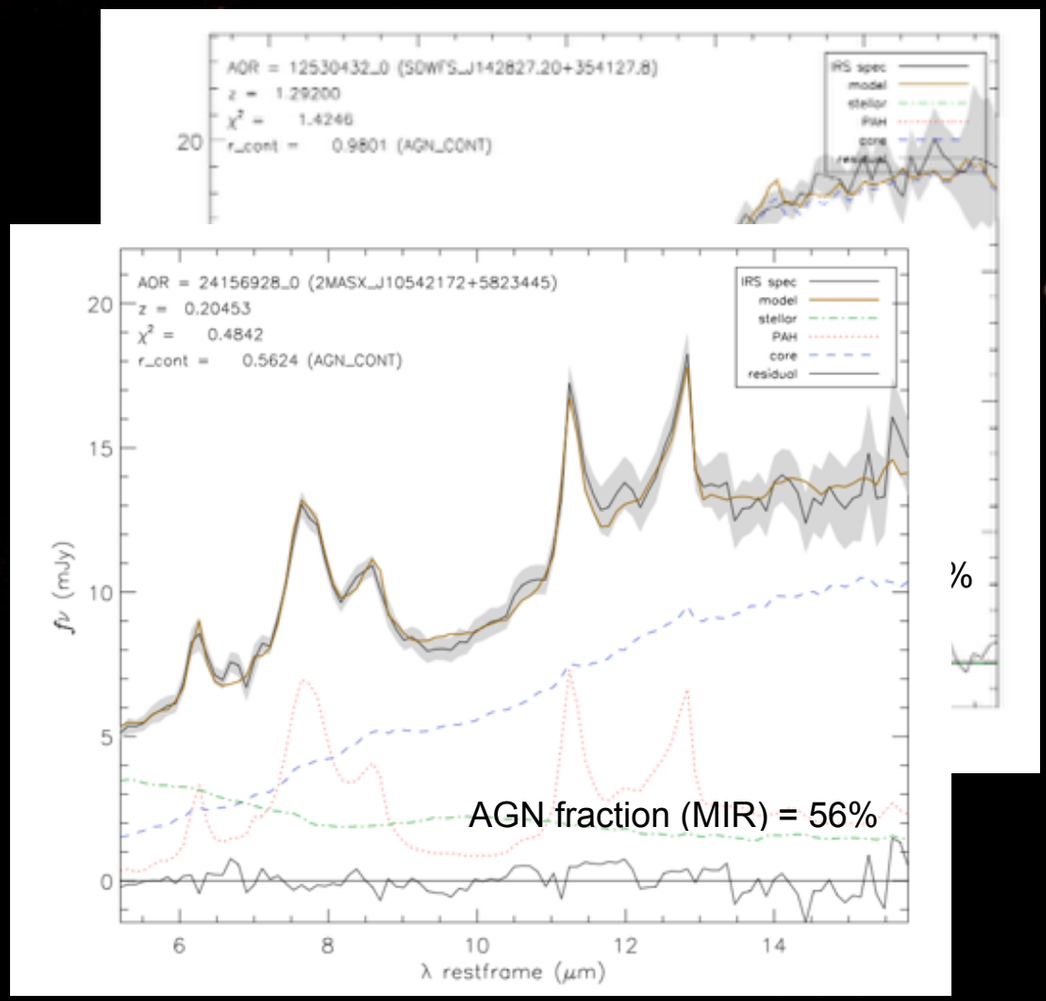

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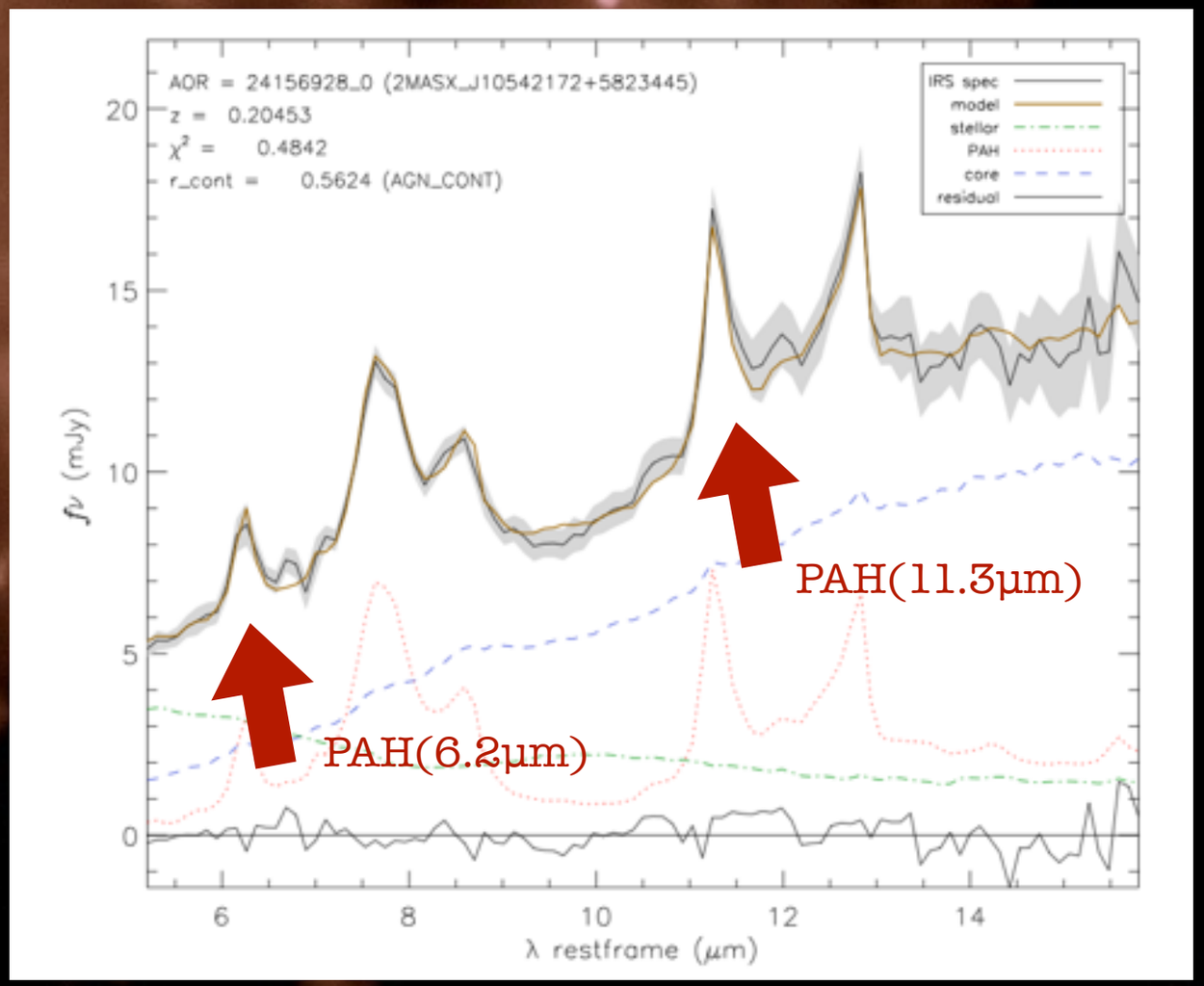

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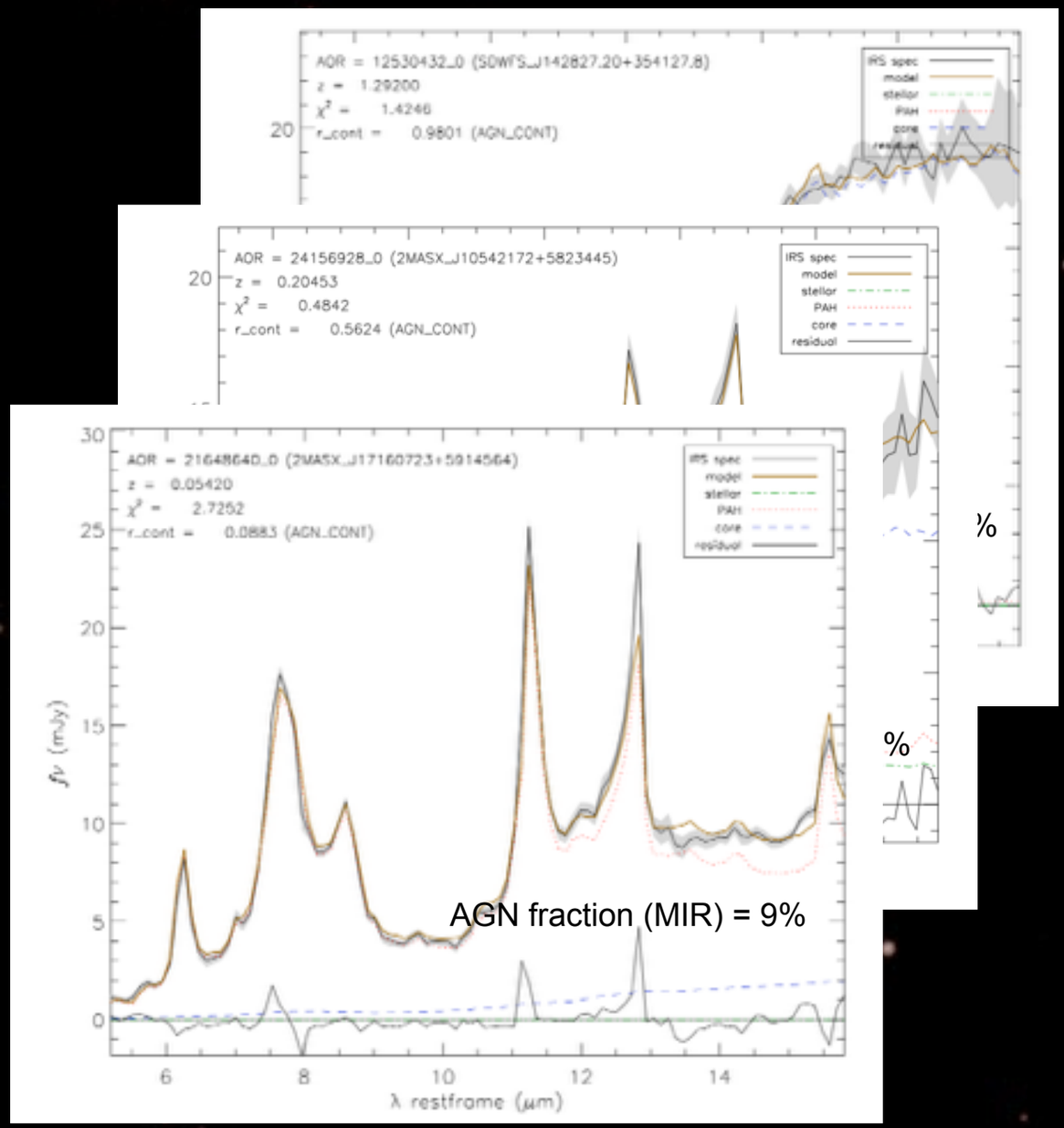
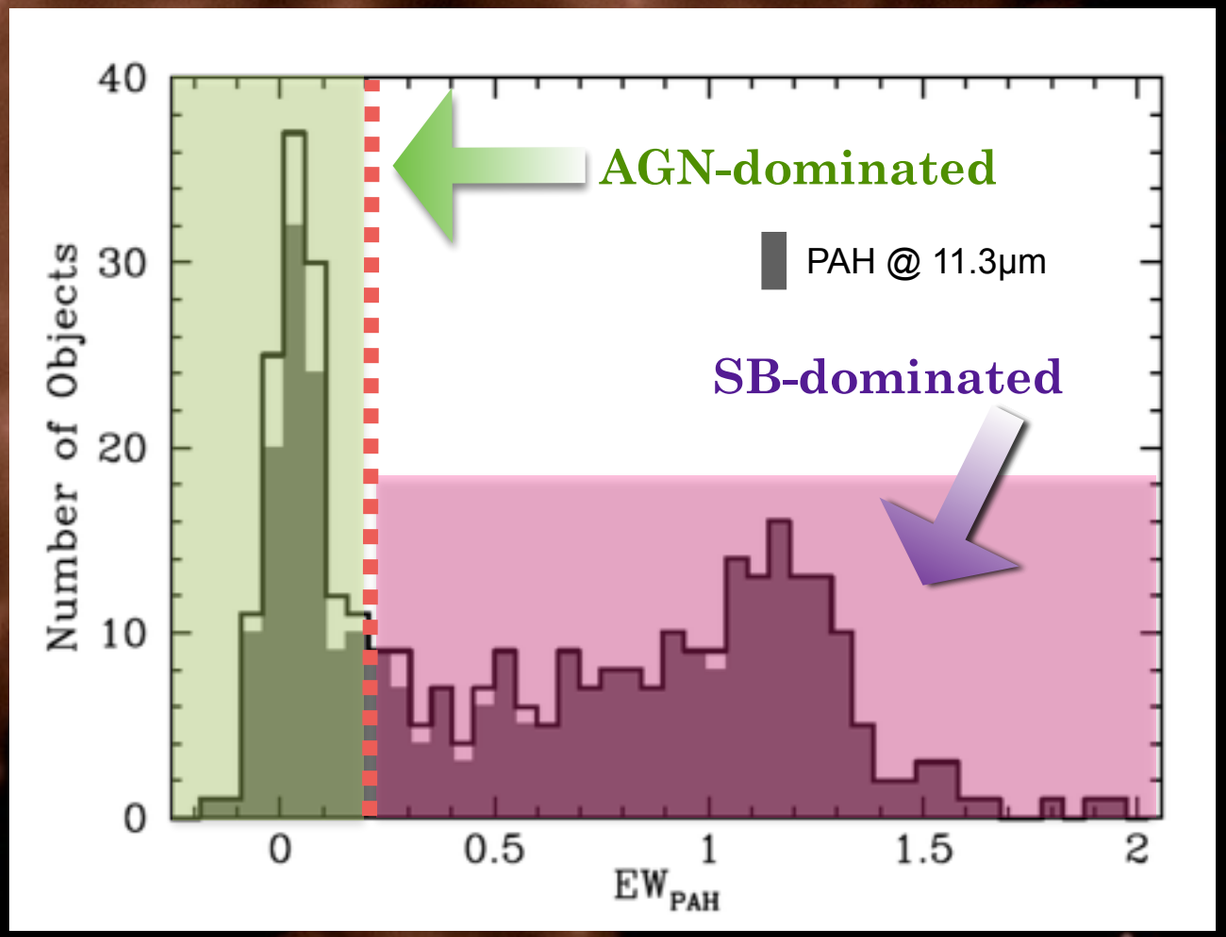


Hernán-Caballero, in prep

- f_{AGN} [L(5-15μm)]

IRS measurements & spectral decomposition



e.g. Spoon et al. 2007; Smith et al. 2007; Hernán-Caballero et al. 2009, Wu et al. 2010

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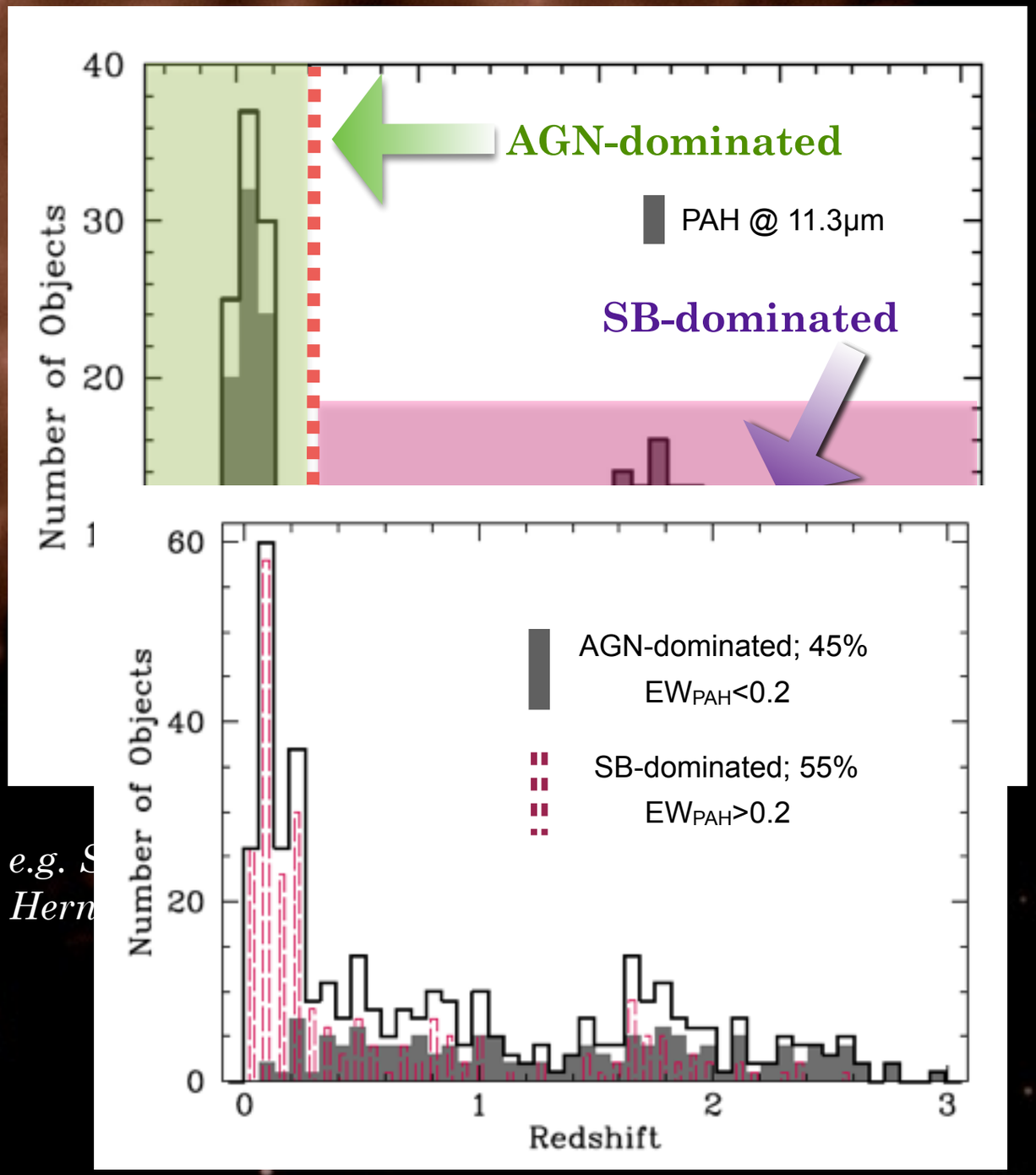
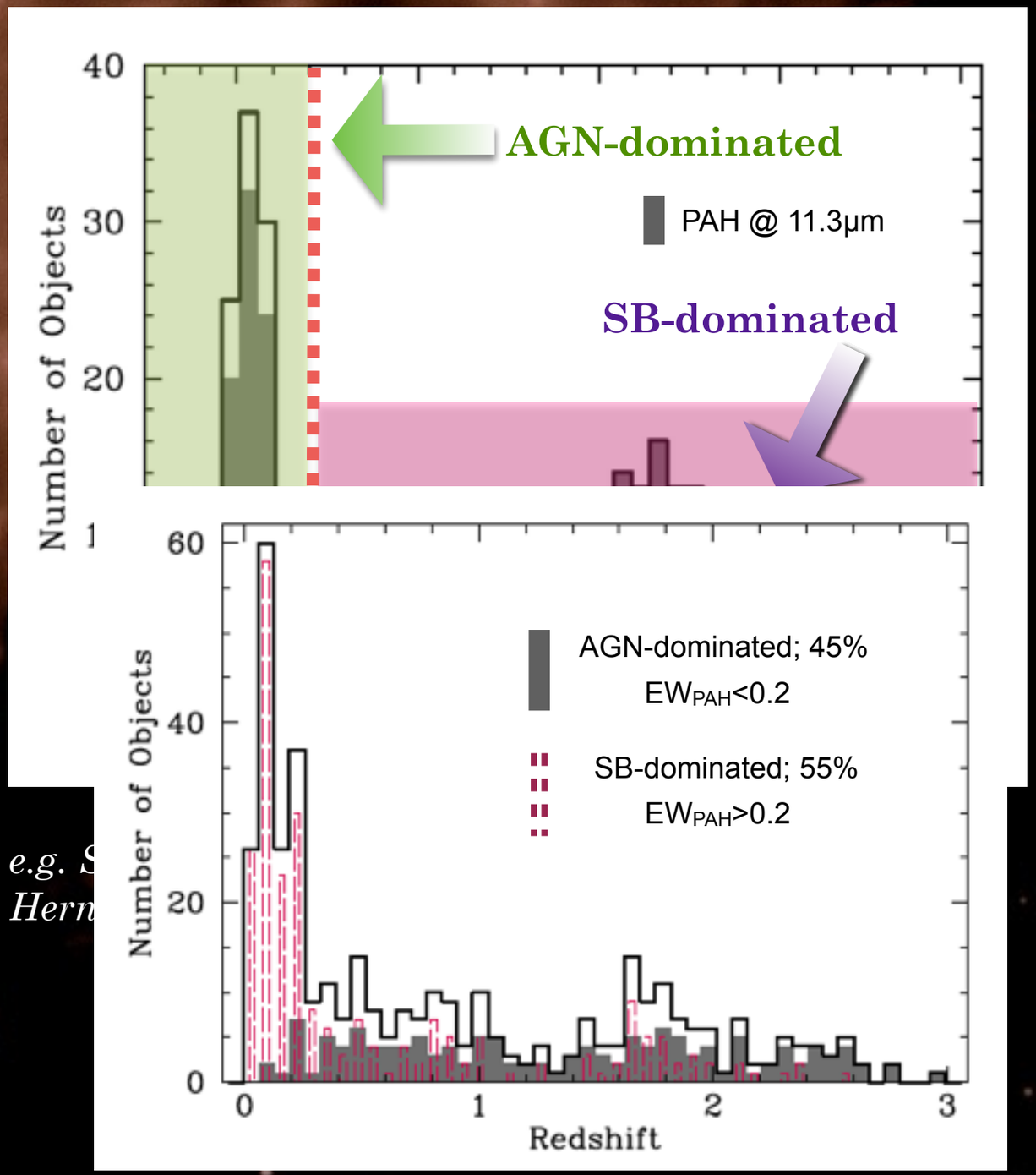


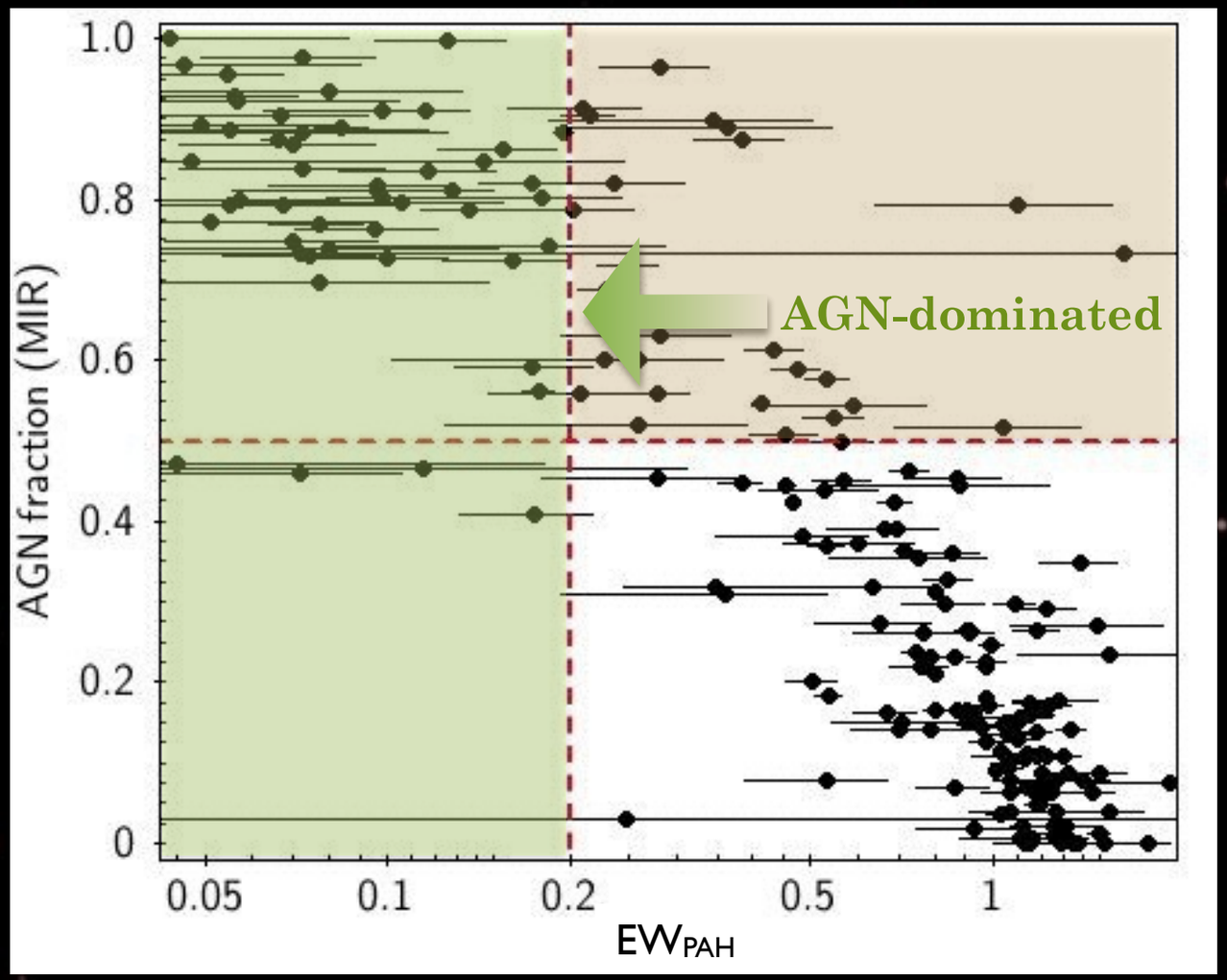
e.g. S
Hern

IRS measurements & spectral decomposition

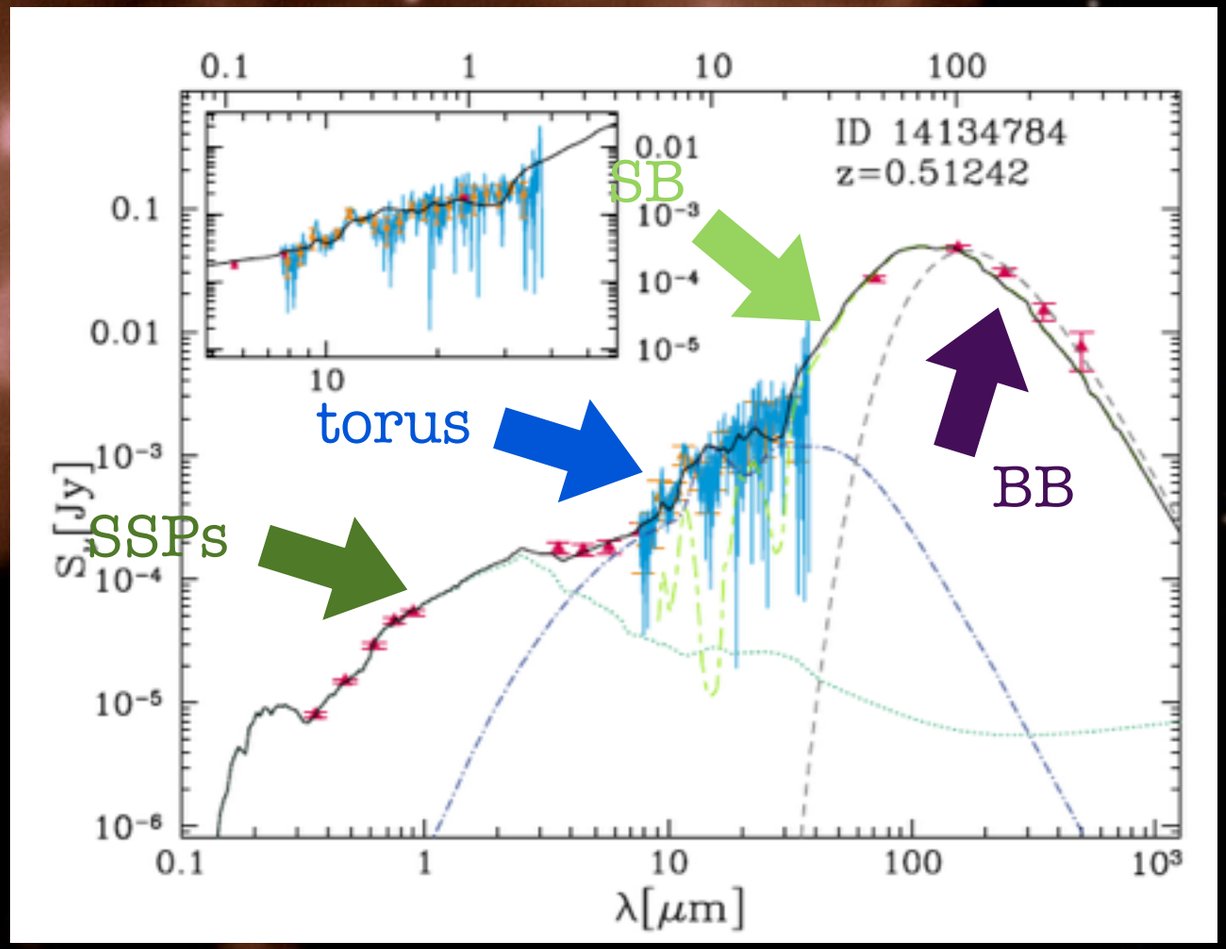


e.g. S
Hern

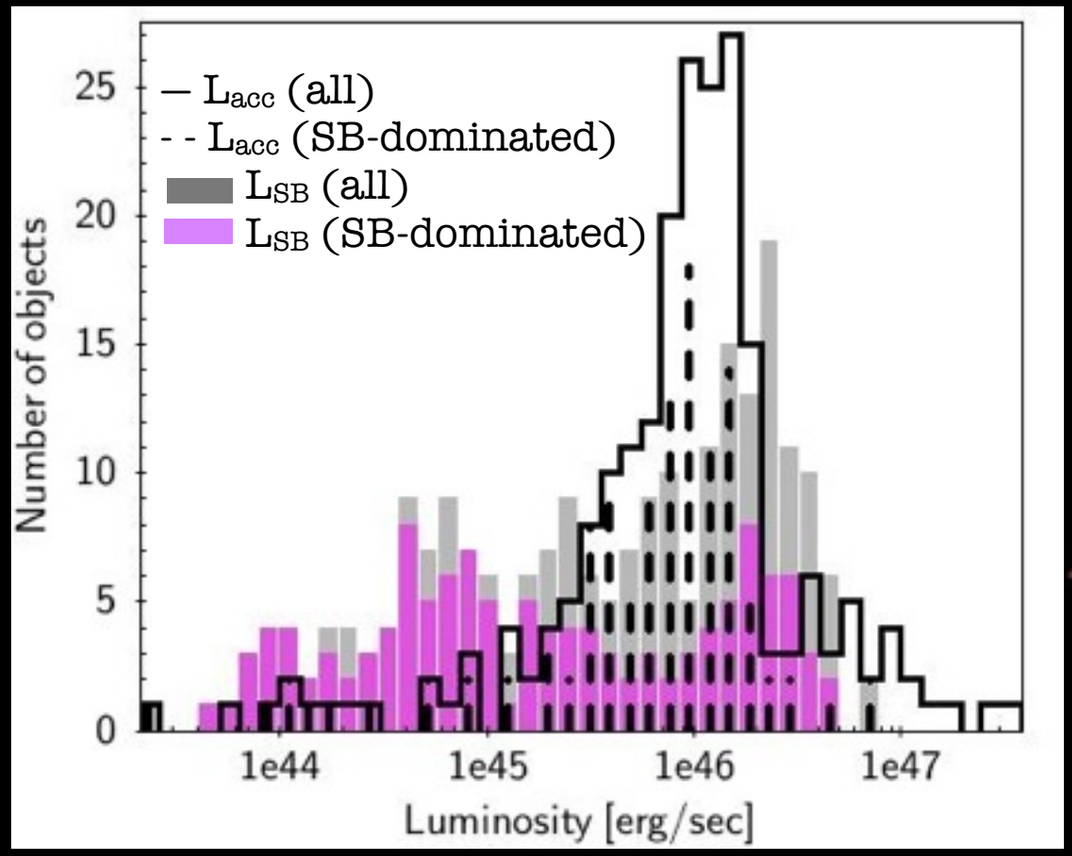
10% $f_{AGN} > 50\%$ but not 'AGN-dominated'



SED fitting (or *everybody's favourite*)

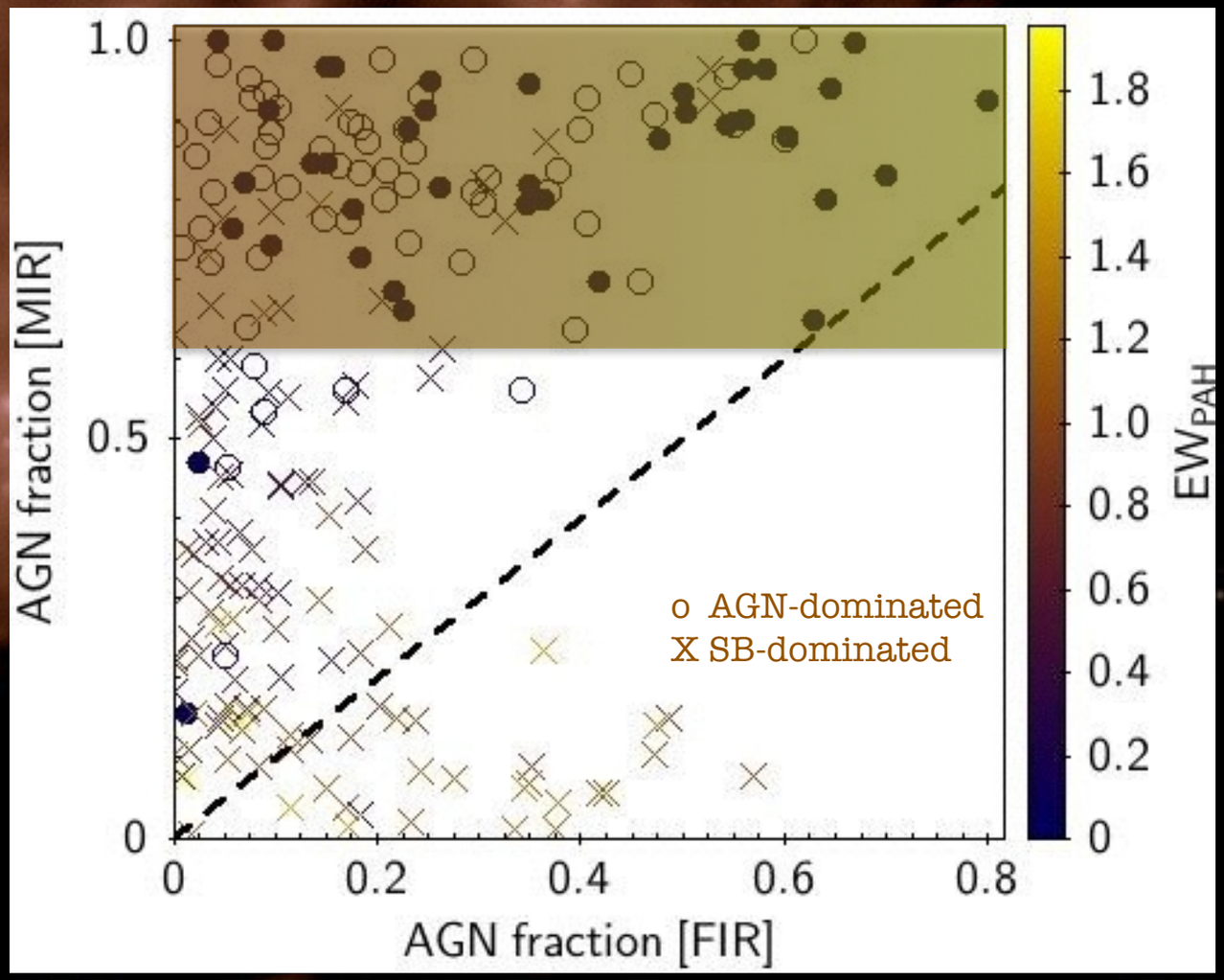


- stars, AGN/torus, SB | | BB
- L_{acc}, L_{IR}, $L_{SB} \Rightarrow SFR_{FIR}$
- f_{AGN}, f_{SB} [L_{IR}(8-1000μm)]
- M_{hot}, M_{cold}, T_{cold}



Feltre et al. 2013

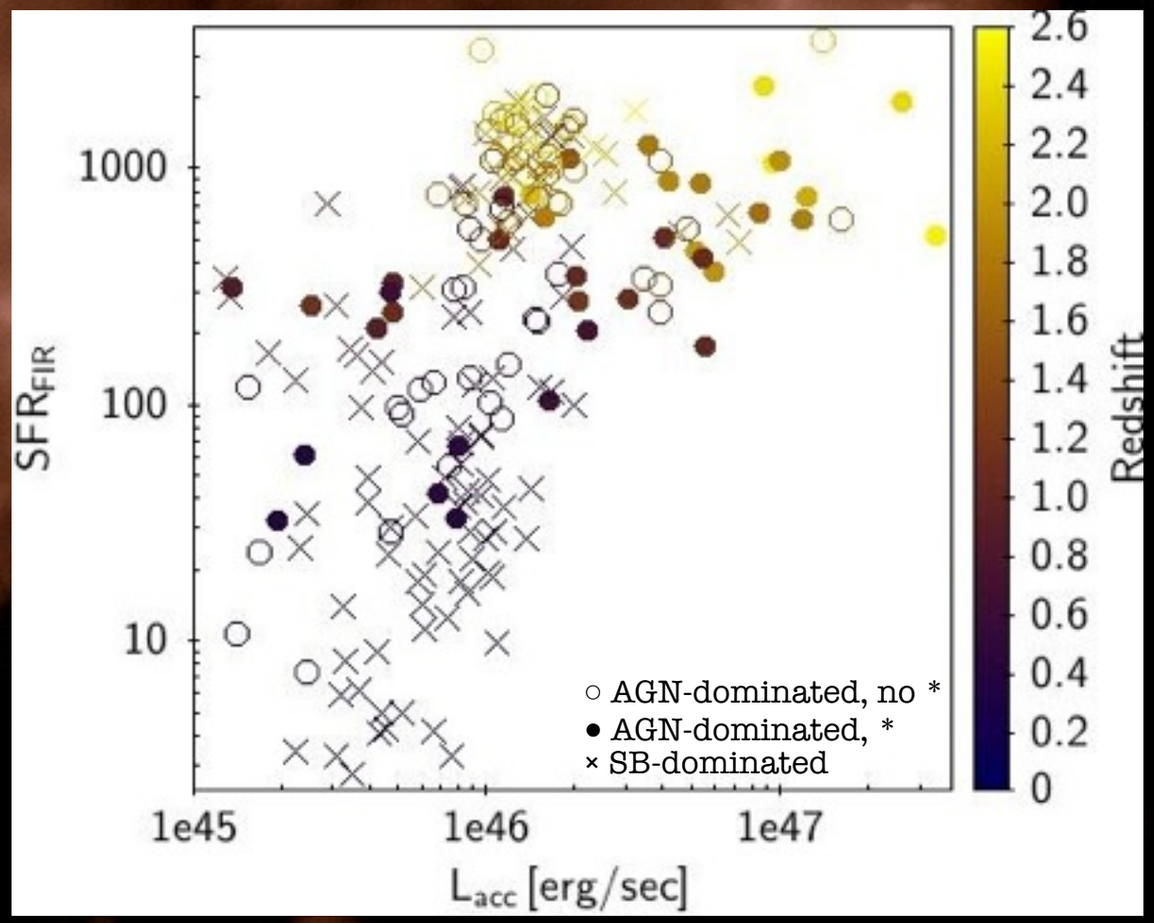
AGN indicators in MIR and FIR



	EW <0.2	IRS/ AGN	SED/ AGN
EW <0.2	129	112/ 105	128/24
IRS/ AGN		286/ 145	230/27
SED/ AGN			308/39

An “AGN-dominated” system is wavelength- and method-dependent

AGN and star formation



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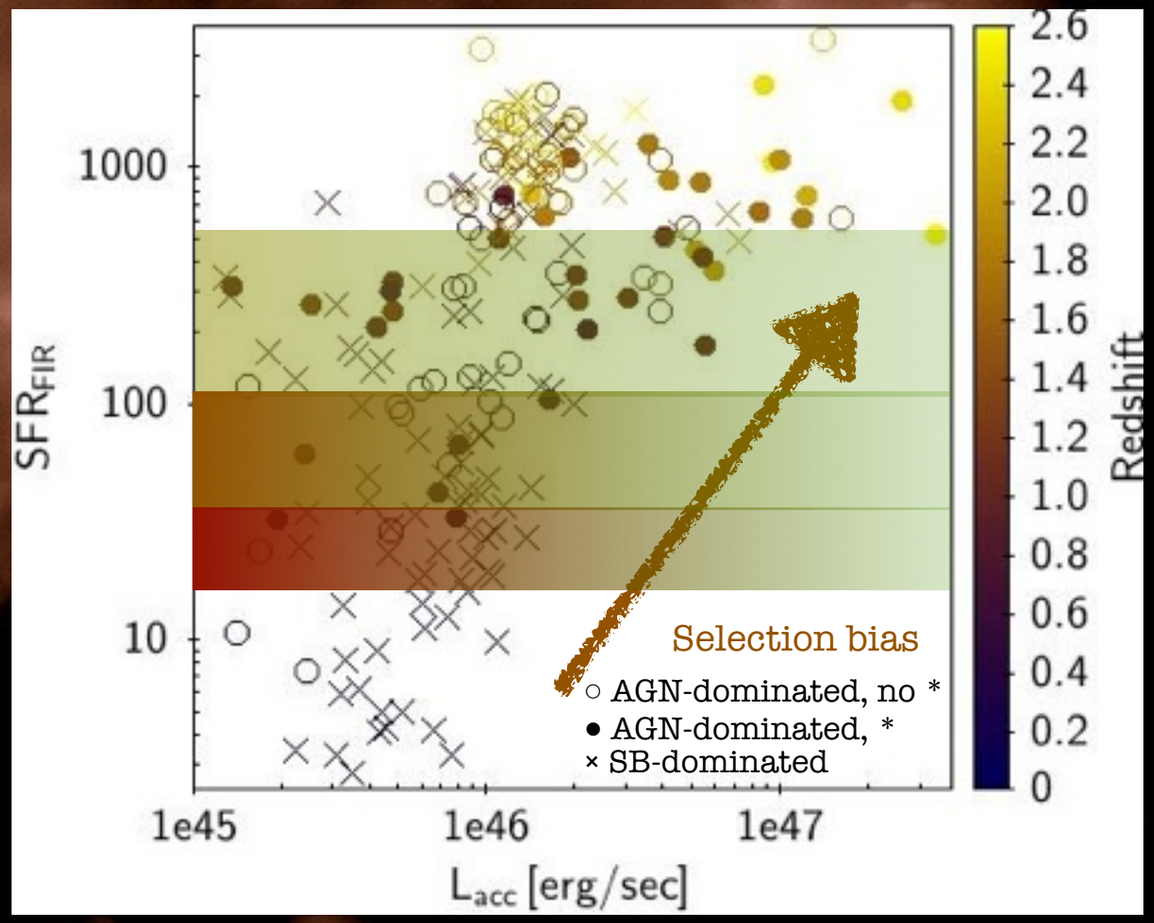

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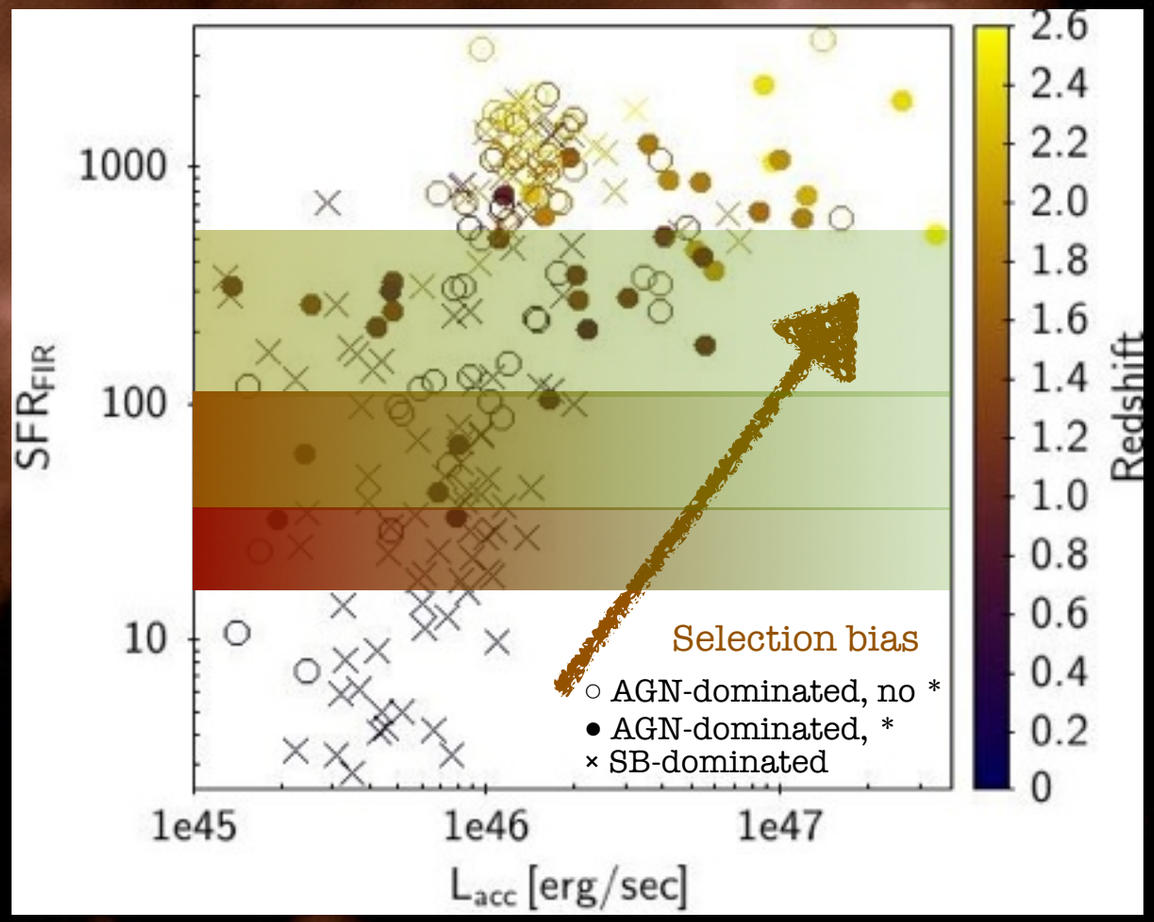

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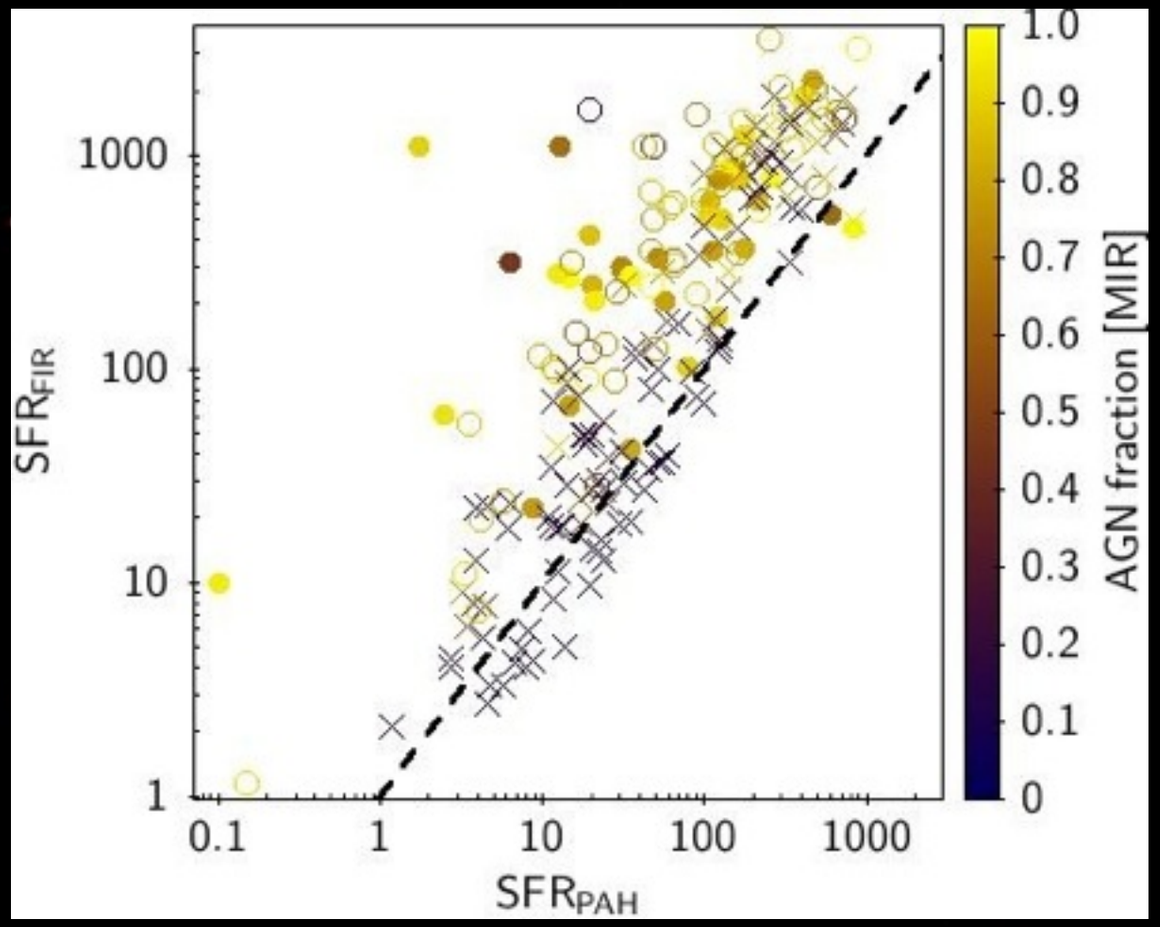

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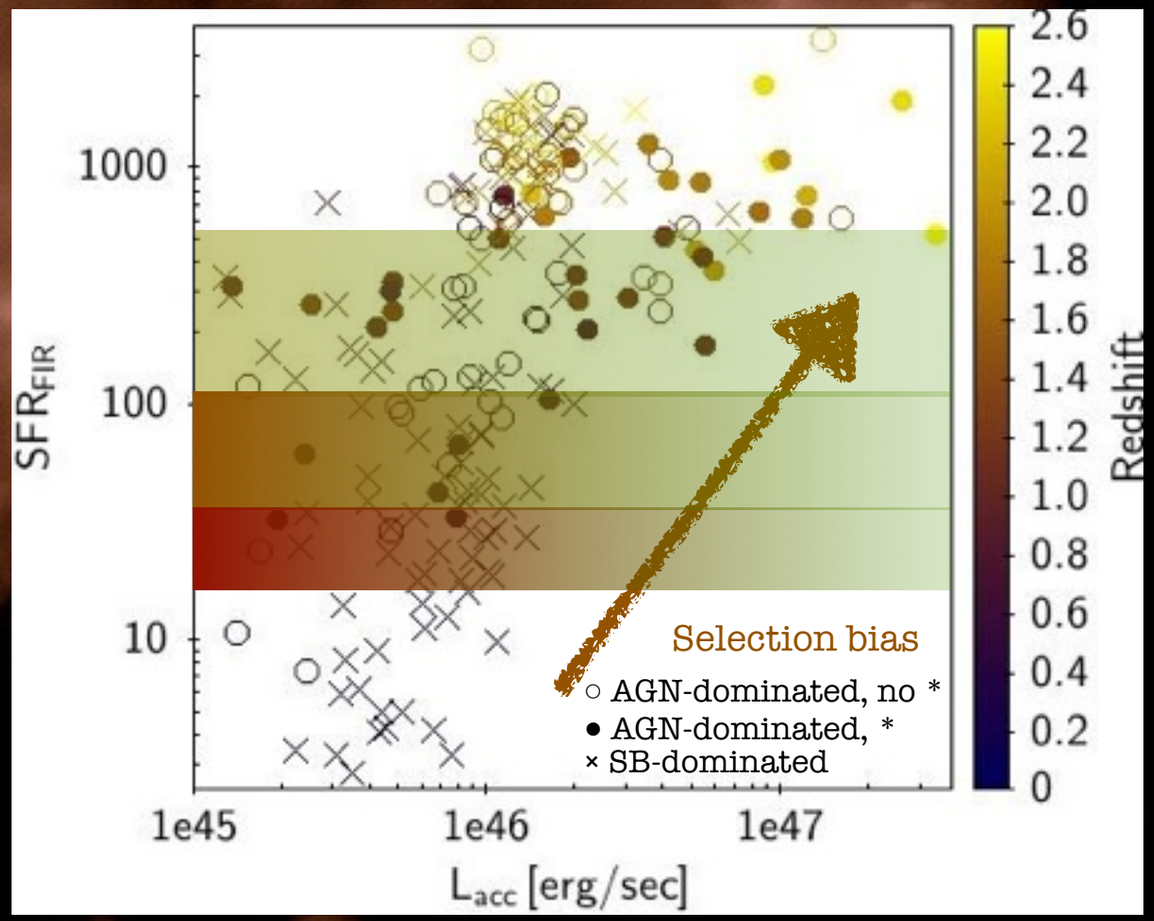

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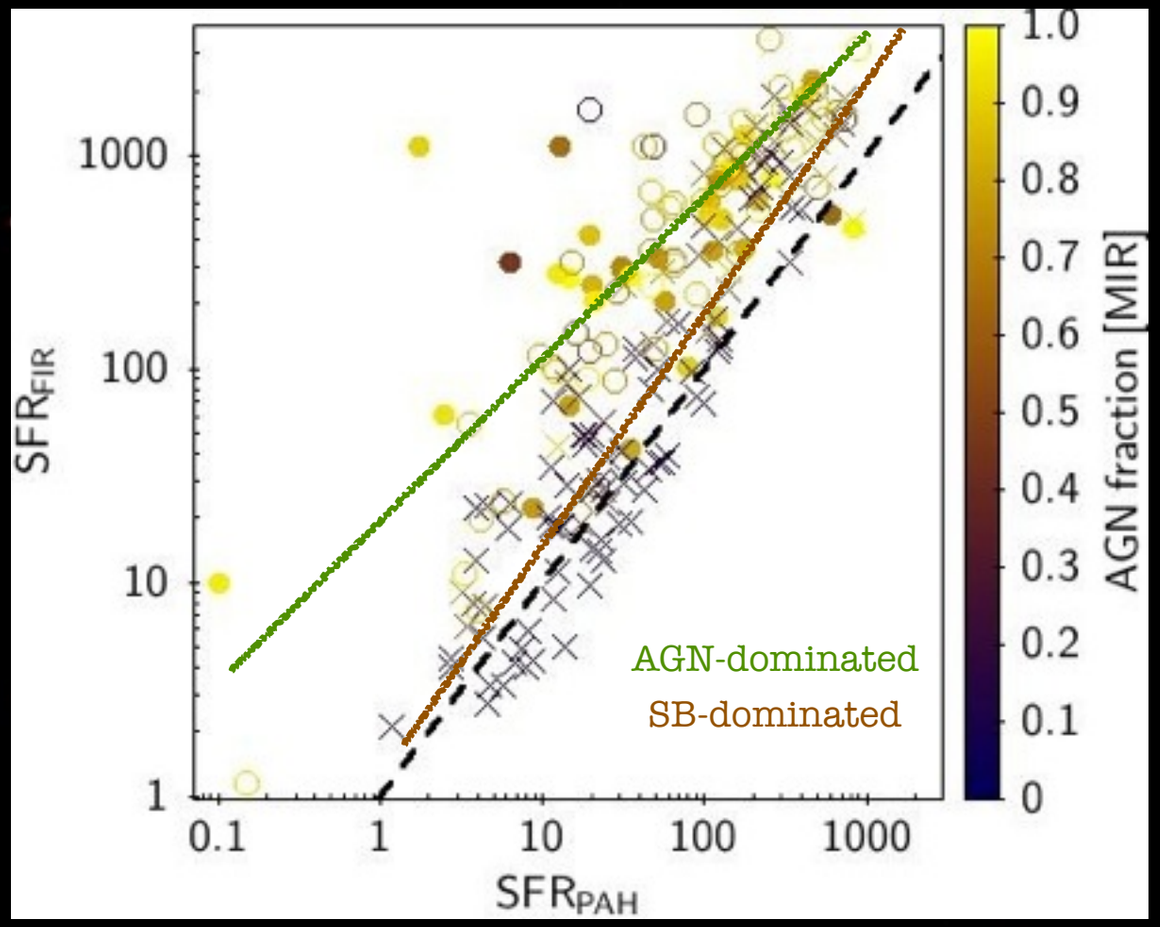

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Schweitzer et al. 2006; Netzer et al. 2007; Lutz et al. 2008; Armus et al. 2007; Brandl et al. 2006; Smith et al. 2007; Pope et al. 2008; Fadda et al. 2010

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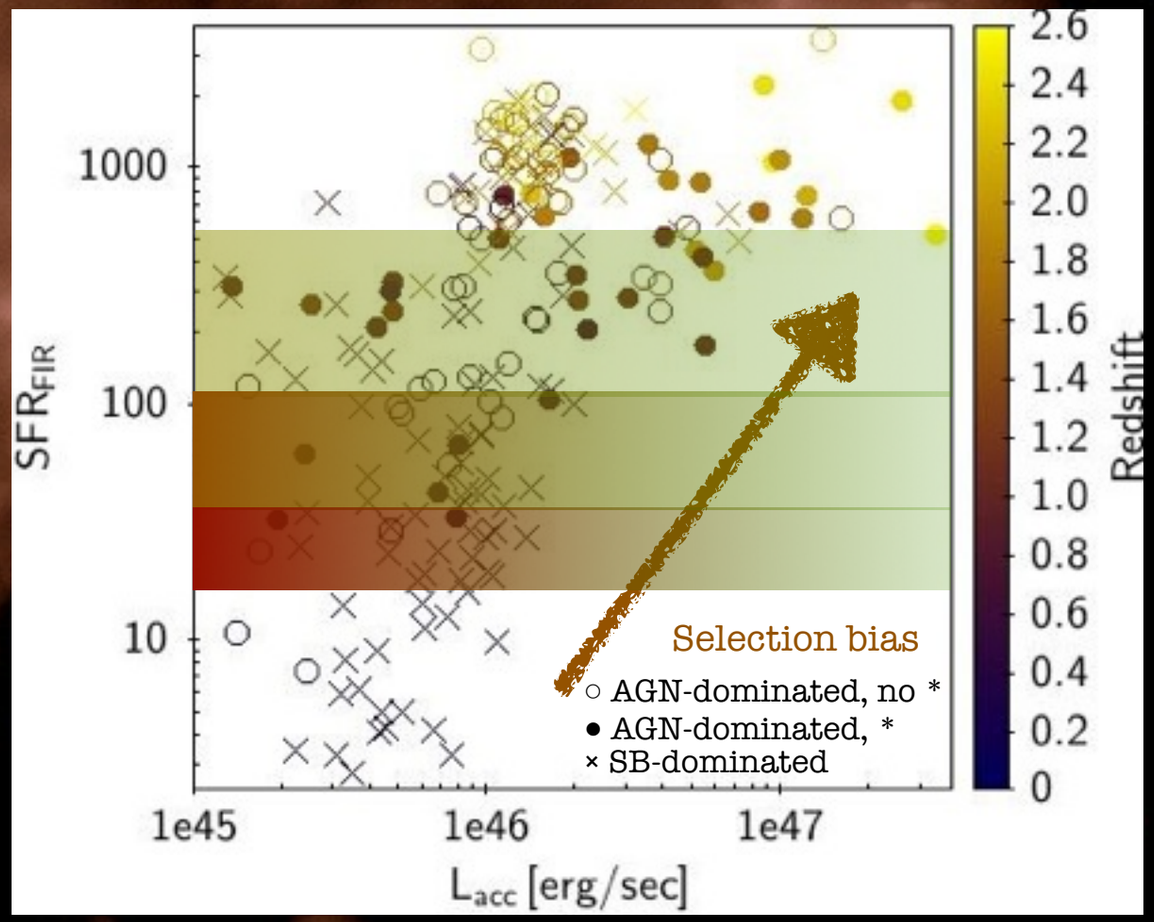

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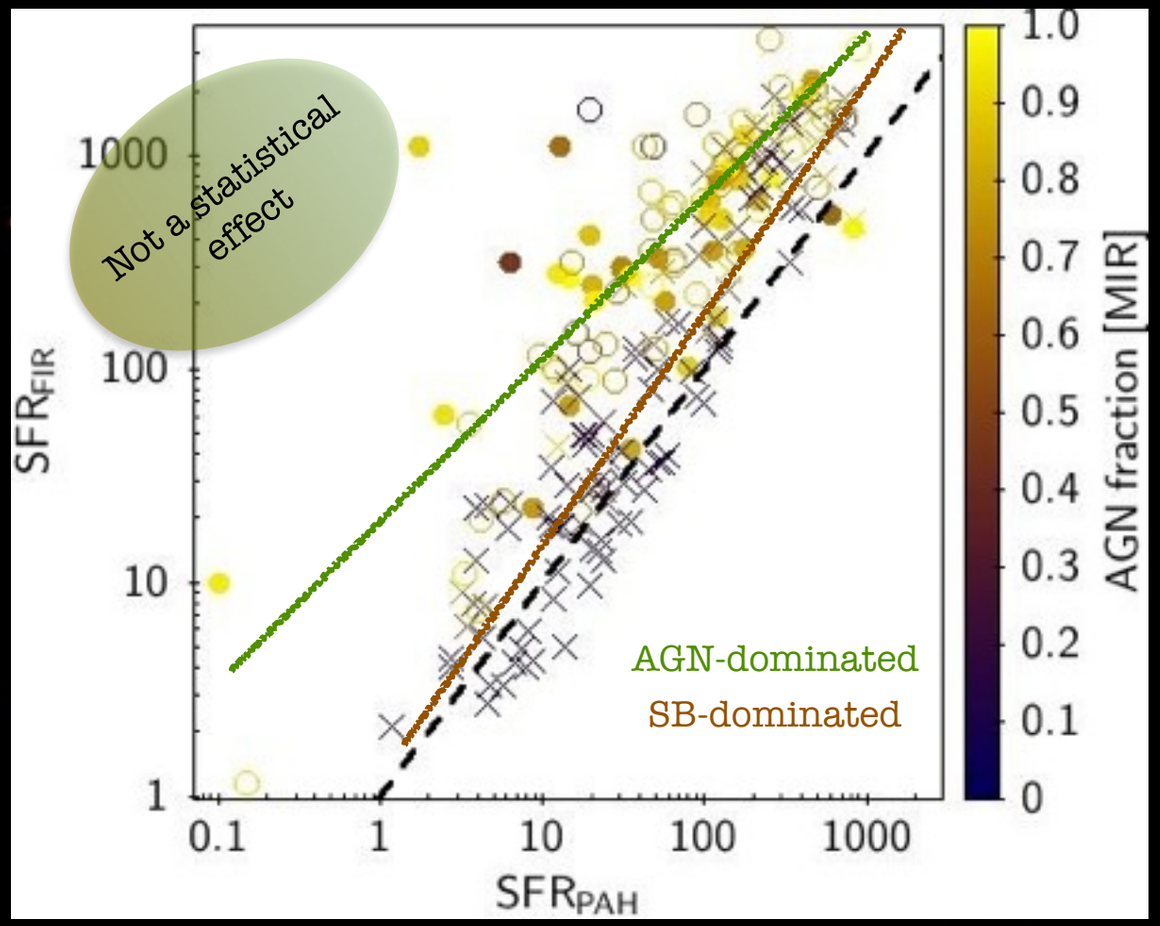

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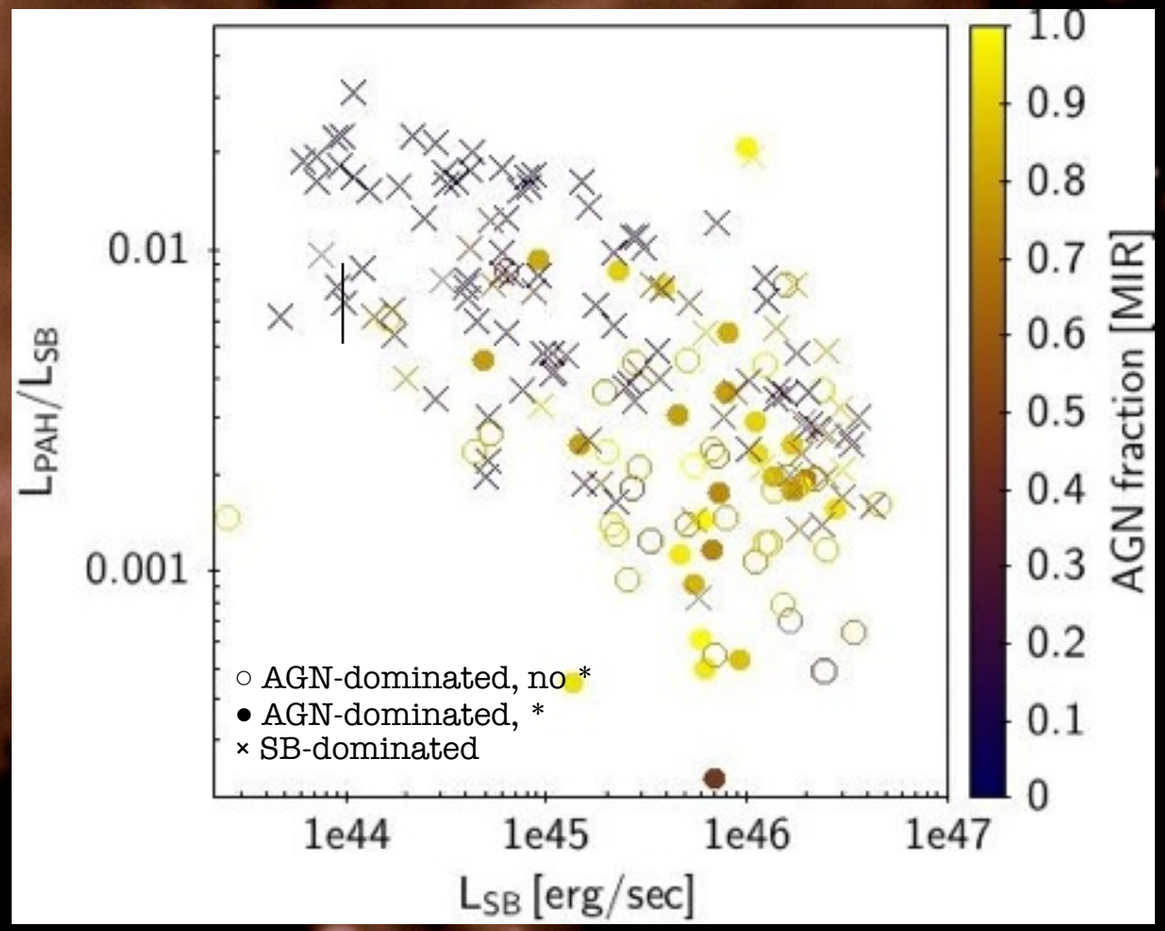

Lutz et al. 2008 report a constant L_{PAH}/L_{SB} ratio over > 4 orders of magnitude in L_{SB} on a sample of local ULIRGs. *Wu et al. 2010* observe a slight decrease.

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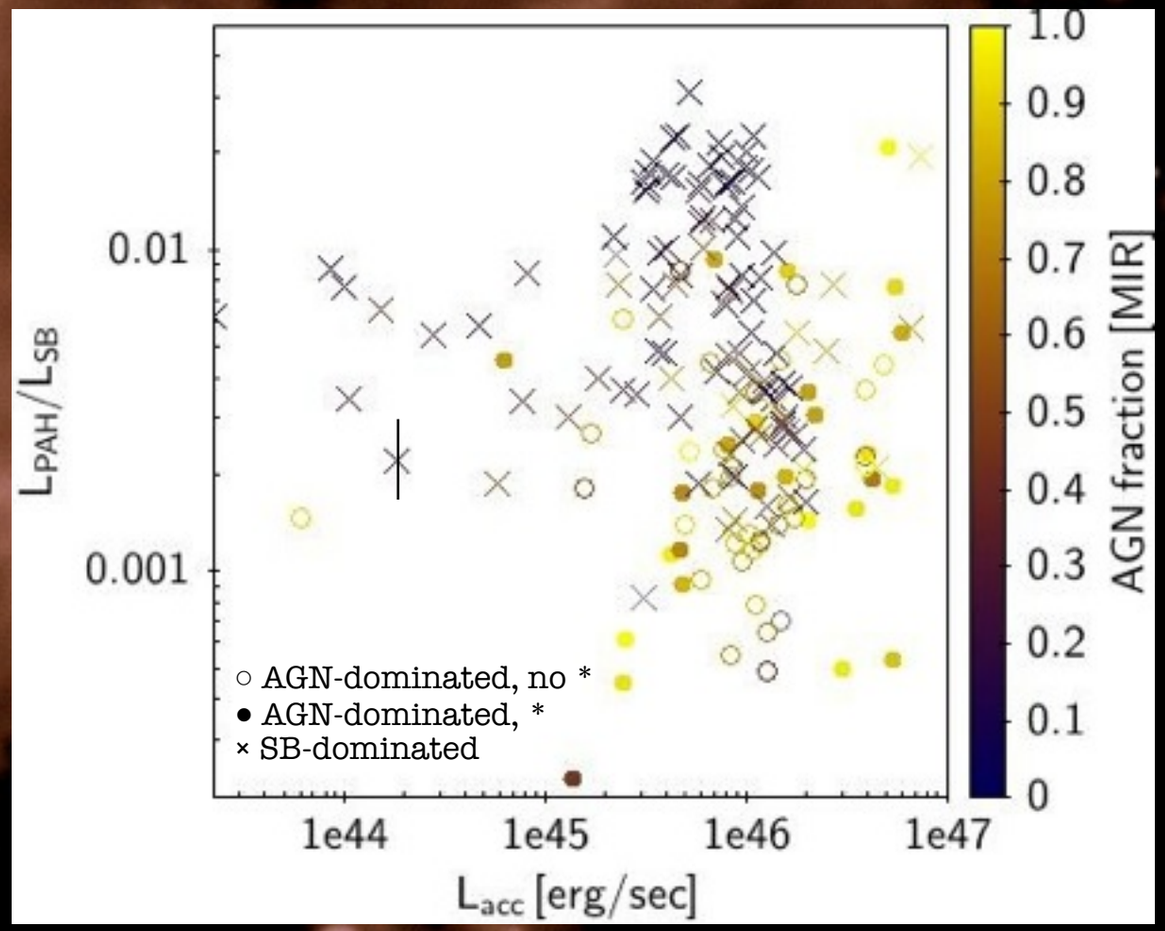

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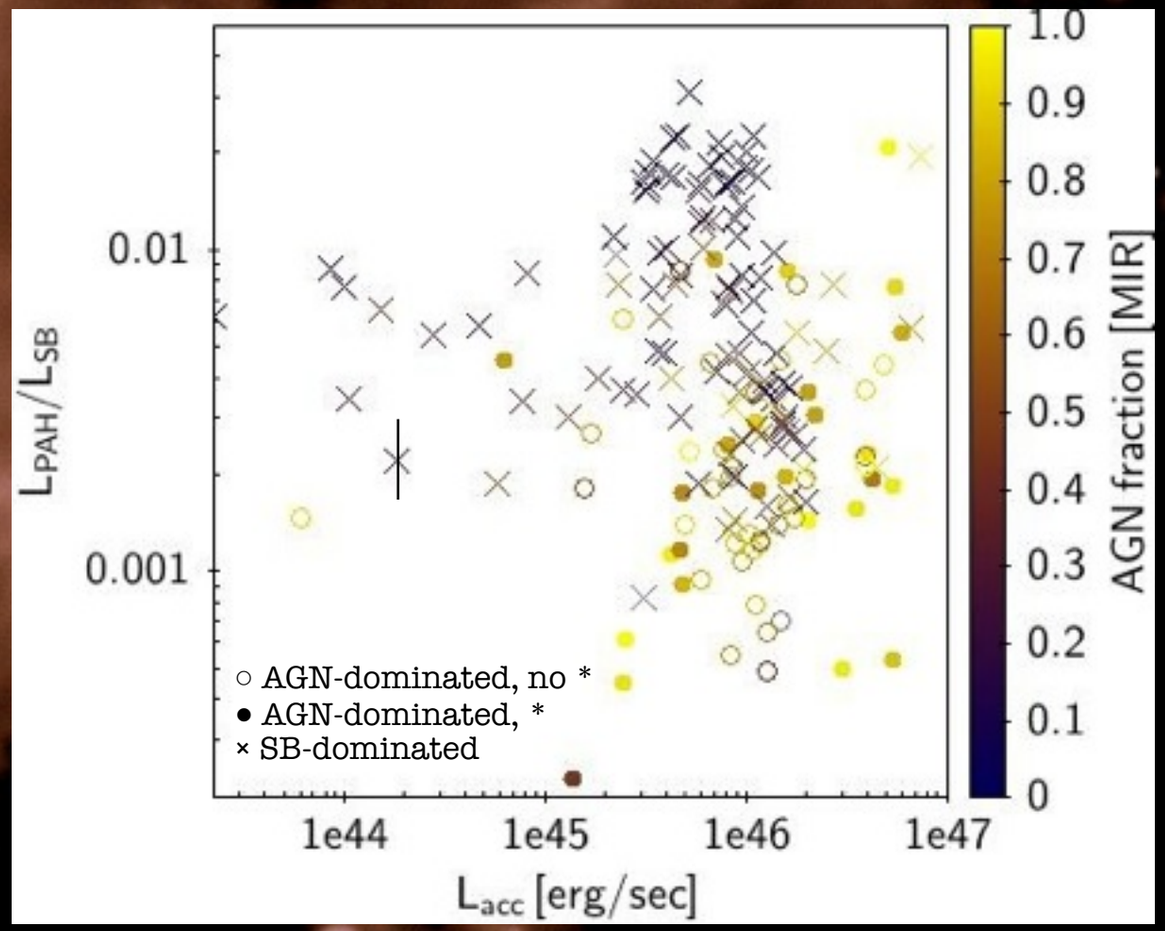
PAH features not affected by L_{acc} ⇒ most likely hiding behind high column densities ⇒ AGN cannot heat the dust at large distances.

Variations in the environment of SF regions

AGN and star formation



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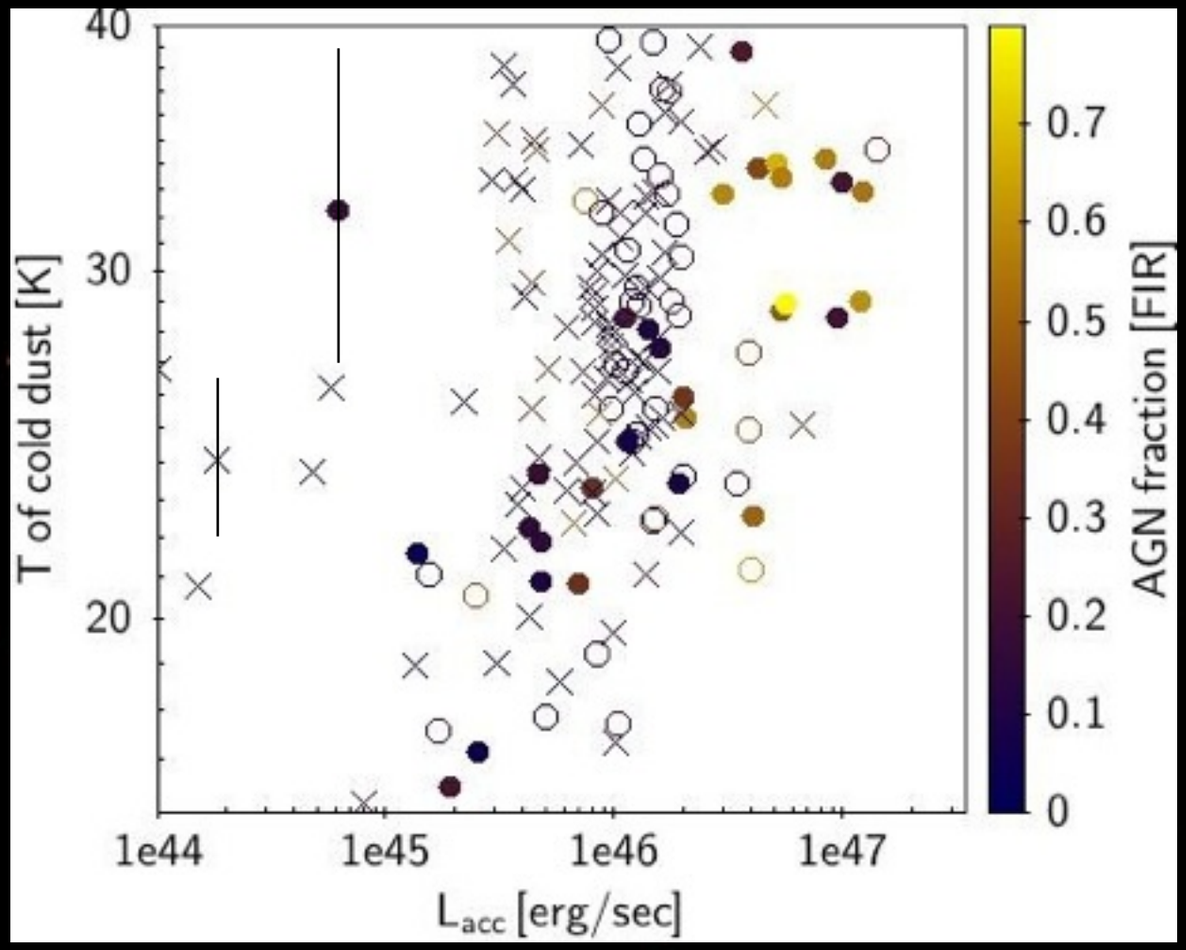
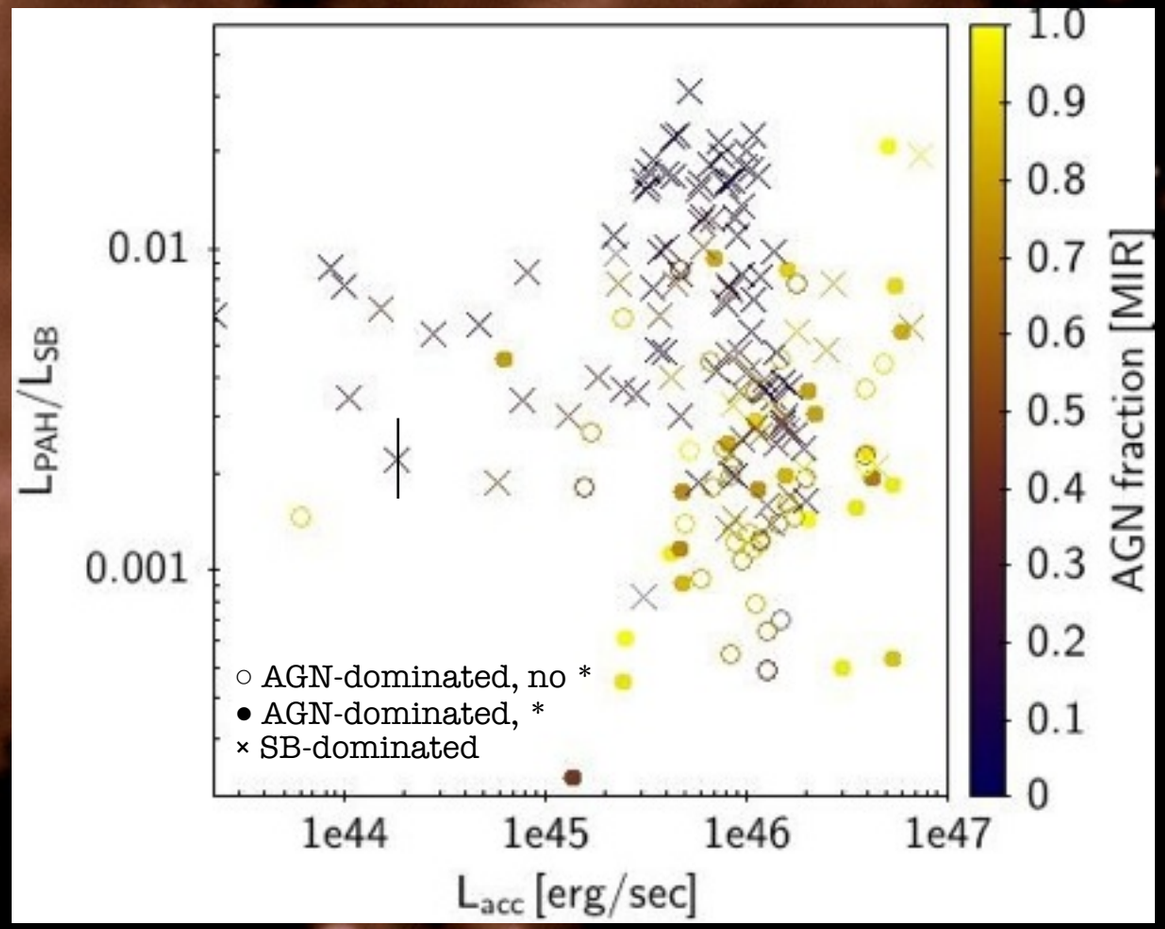


Single-T modified BB *(Fritz et al. 2012)* but range of temperatures consistent with multi-T approach (*e.g. Kirkpatrick et al. 2012).*

AGN and star formation



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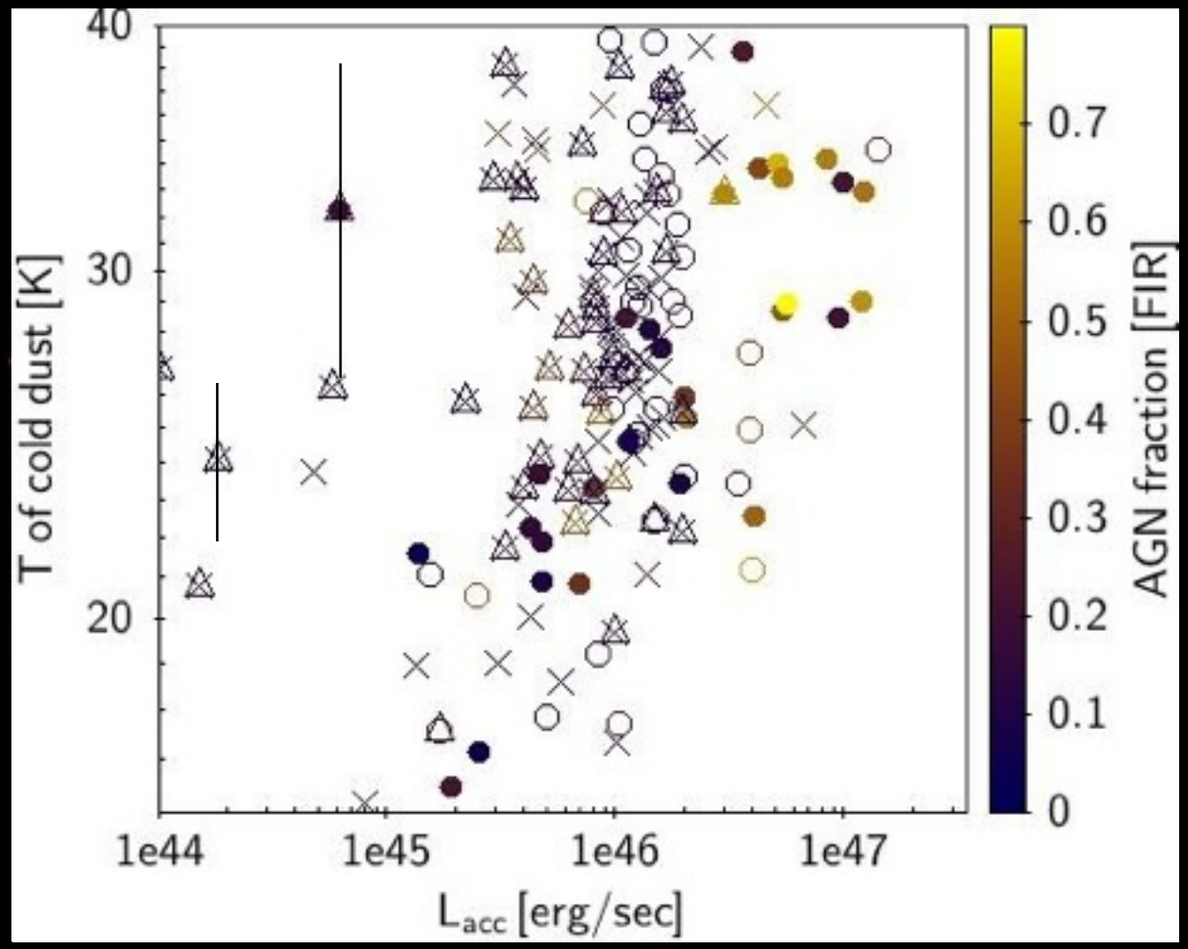
Variations in the environment of SF regions

L_{acc}	⟨T⟩ [K]
Total	28.3 ± 5.0
≤ 10	27.1 ± 3.8
10	27.7 ± 4.6
> 10	30.9 ± 5.6



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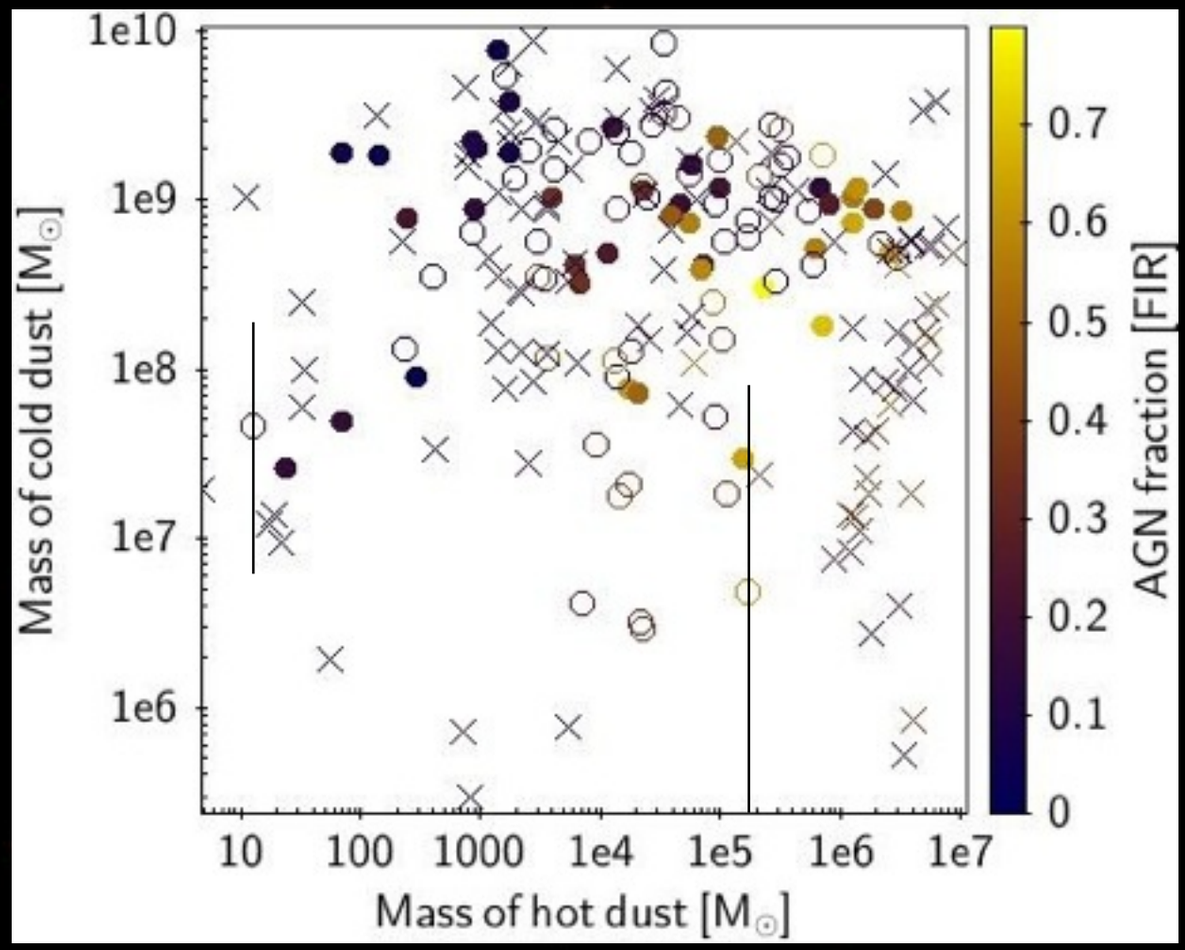
Hot and cold dust components



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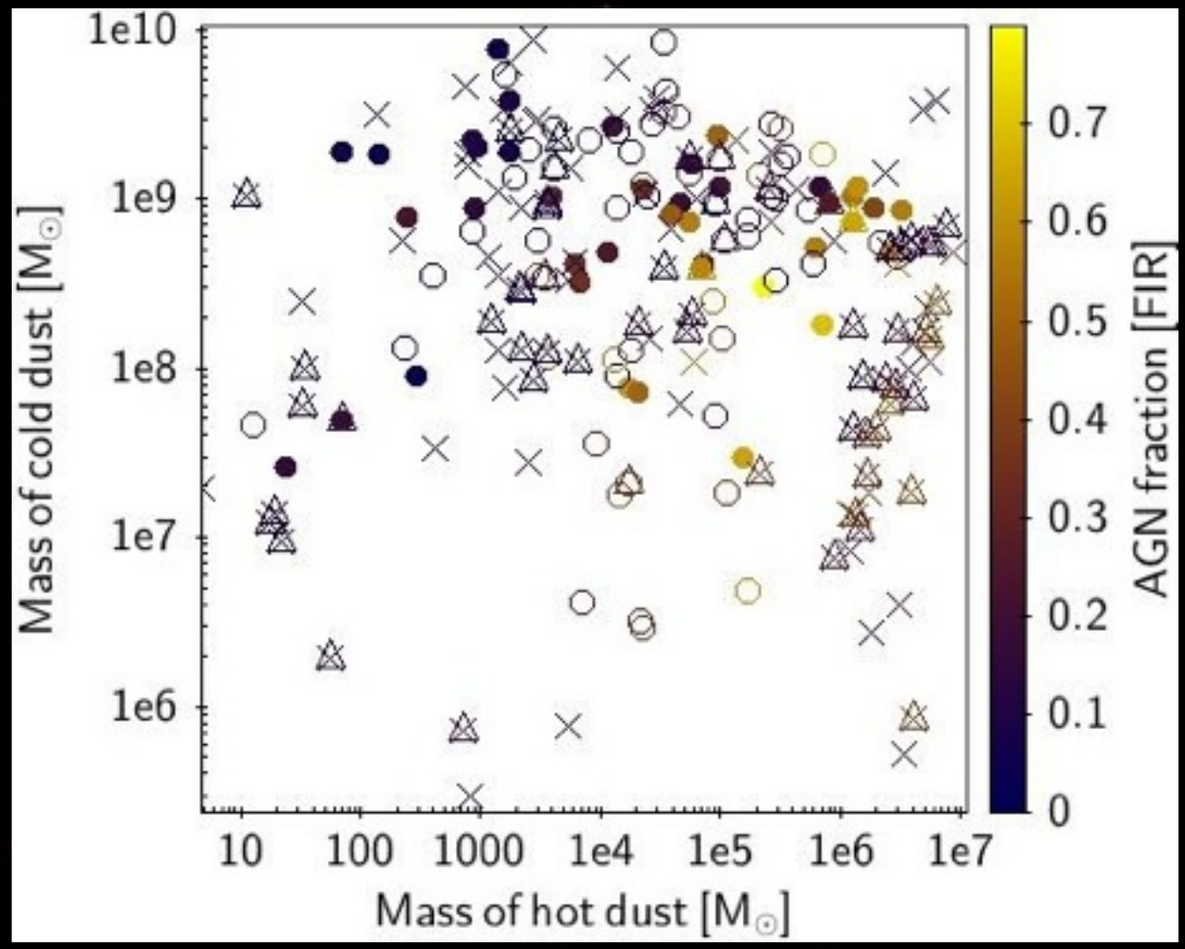

Fraction of gas funnelled to the AGN is not constant; consistent with a short feedback phase

The take aways

- AGN and SF co-exist in a variety of sources, spanning several orders of magnitude in both L_{acc} and L_{SB}
- The definition of an AGN- (SB-) dominated system is method- and wavelength-dependent but AGN rarely contribute >50% to L_{IR}
- The L_{acc} does not affect the SFR estimates
- SFR_{FIR} and SFR_{PAH} can be used interchangeably for SB-dominated objects
- No robust evidence that the temperature of the cold dust is affected by the AGN
- The gravitational effects that drive SF do not divert a fixed fraction of gas to the centre
- No real evidence of impact of the AGN on the SF of the host: consistent with very brief feedback phase, averaged observed effect on IR samples