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ON THE MISSING HEAVILY OBSCURED AGN POPULATION

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Introduction - I

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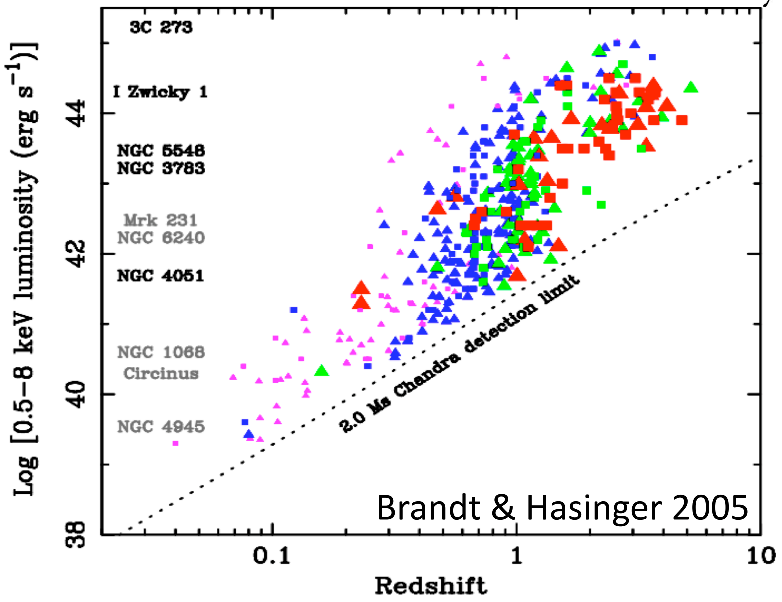
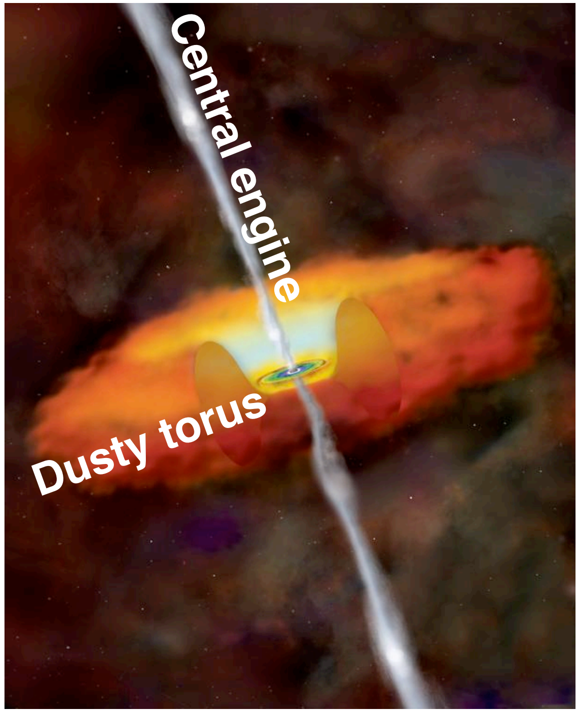
X-rays are very effective in finding AGNs as they can penetrate large column densities

- detect AGNs up to high redshifts
- large number of obscured (Compton-thin) AGNs
- ~100% of the X-ray background resolved at E<5 keV
- only very few Compton-thick AGN





Why looking for heavily obscured AGN?

- AGNs are a phase in the evolution of BH and galaxies
- The majority of the accretion is obscured by large amount of dust and gas within the galaxies
- Possibly Compton-thick AGN are a different evolutionary phase → associated to major mergers

→ Tracing accretion at all z is essential to prove the evolution scenario

→ Understand the link between BH and galaxy

Introduction – II

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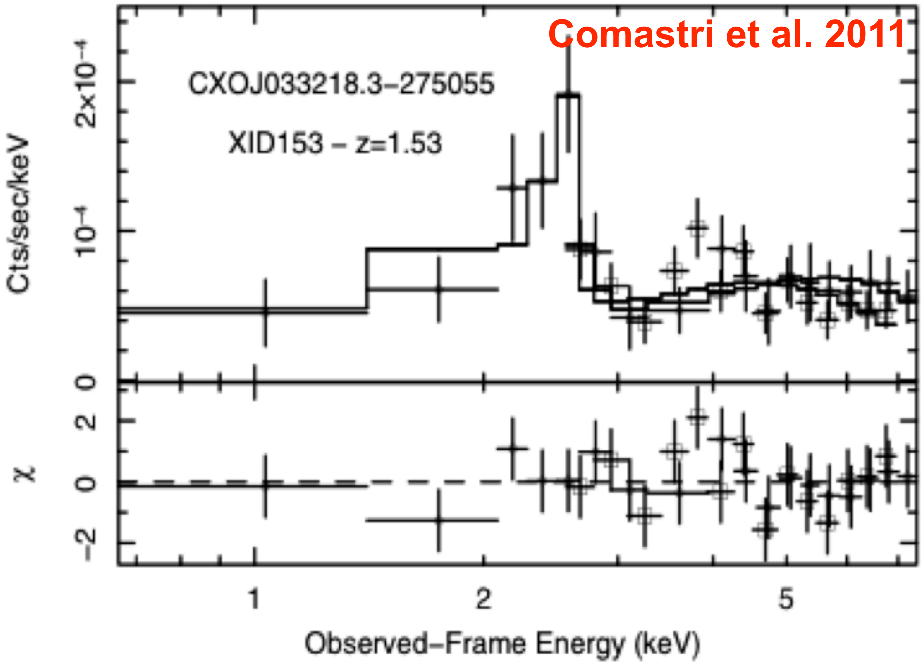
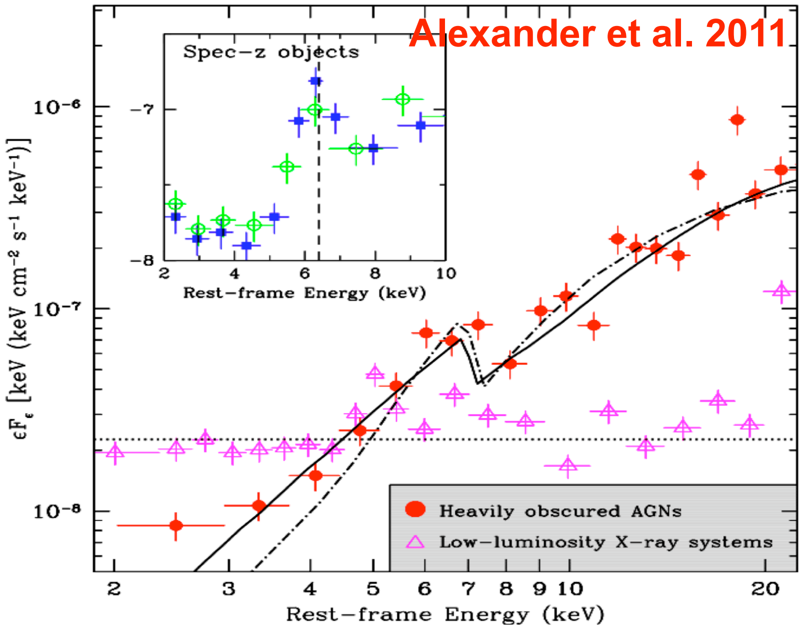
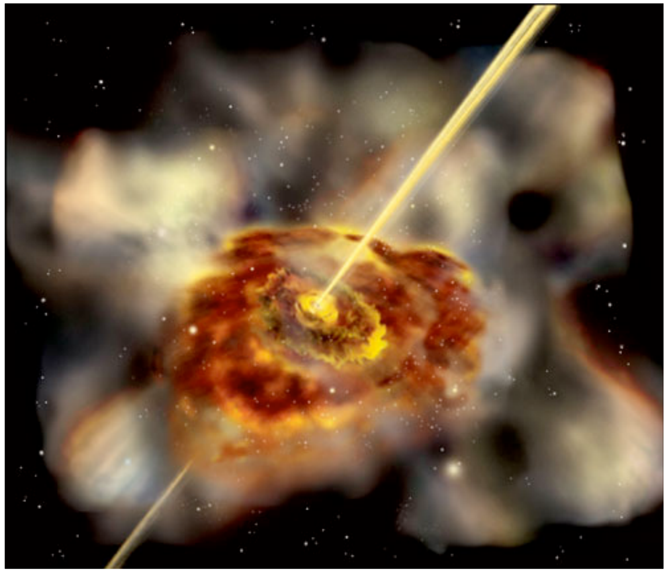
Some progresses… but still not enought



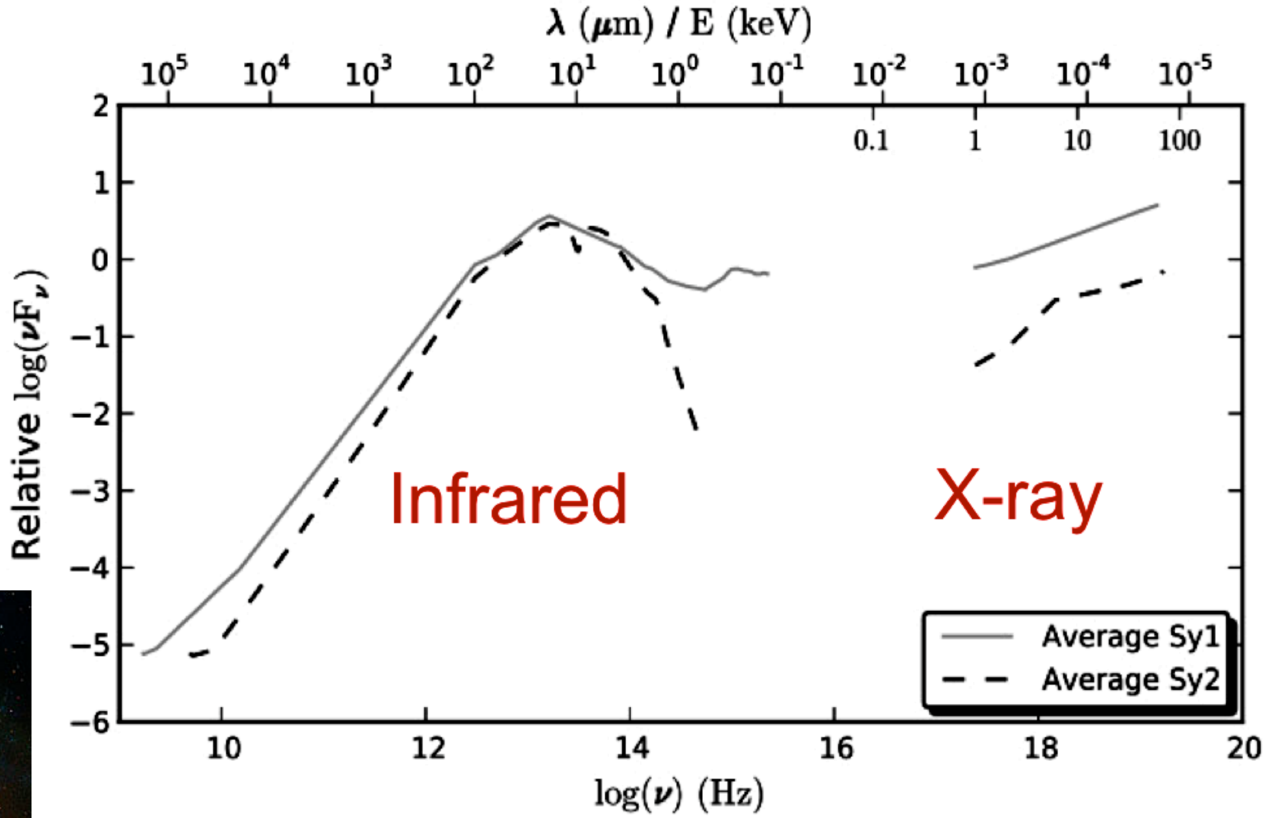


Also optical spectroscopy or MIR spectroscopy (e.g. Polletta et al 2006; Alexander et al 2008; Gilli et al 2010, <u>and **next talk**</u>; Vignali et al 2010)

Introduction – III



New techniques to find the most heavily obscured AGNs are needed



Infrared band → peak of the dust emission

GOODS-*Herschel*

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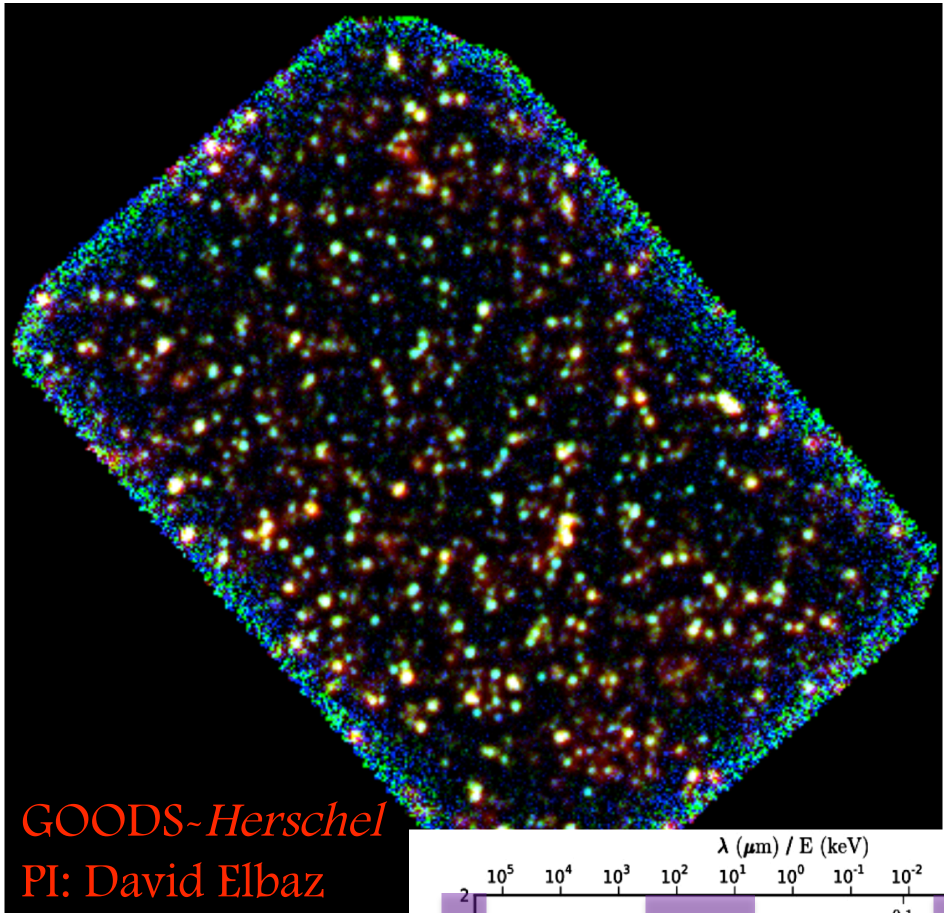


<u>X-ray</u>: *Chandra* GOODS-North

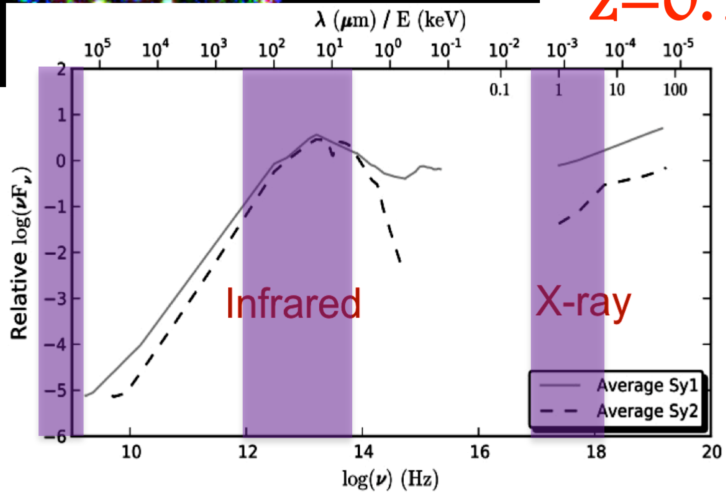
2Ms, 0.5-8 keV (Alexander et al. 2003)

<u>Infrared</u>: *Spitzer* 8, 16, 24 um + *Heschel* PACS-100, 160 um + SPIRE-250, 350, 500 um

(Elbaz et al. 2011)

<u>Radio</u>: deep VLA data (Morrison et al. 2010), S_R>20 uJy (1.4 GHz)

333 sources with z-spec or z-phot: z=0.1-3.0



AGN-Starburst SED fitting tool

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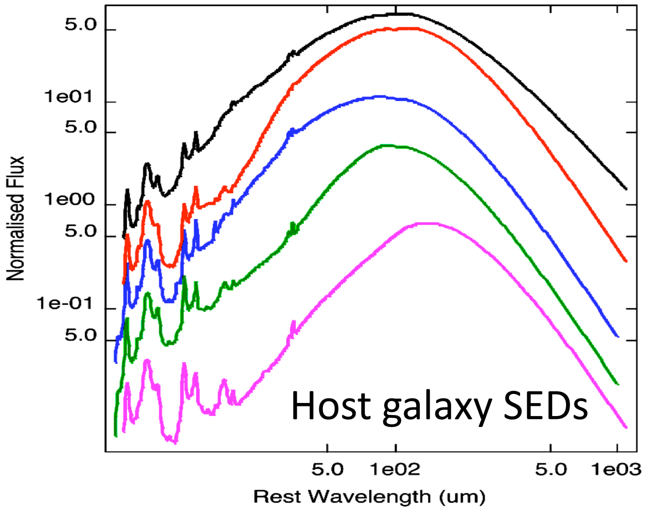
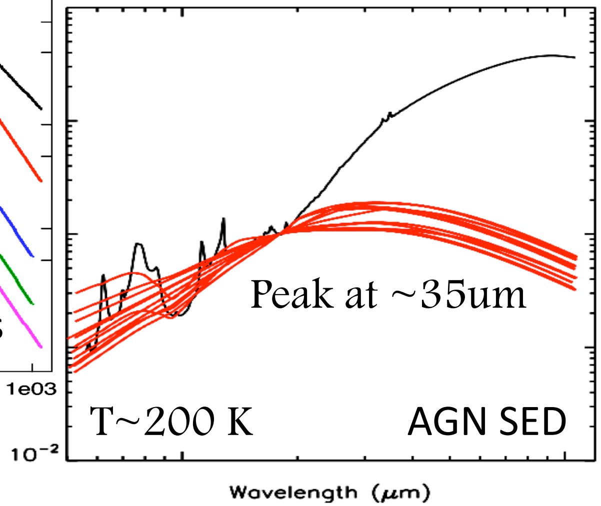
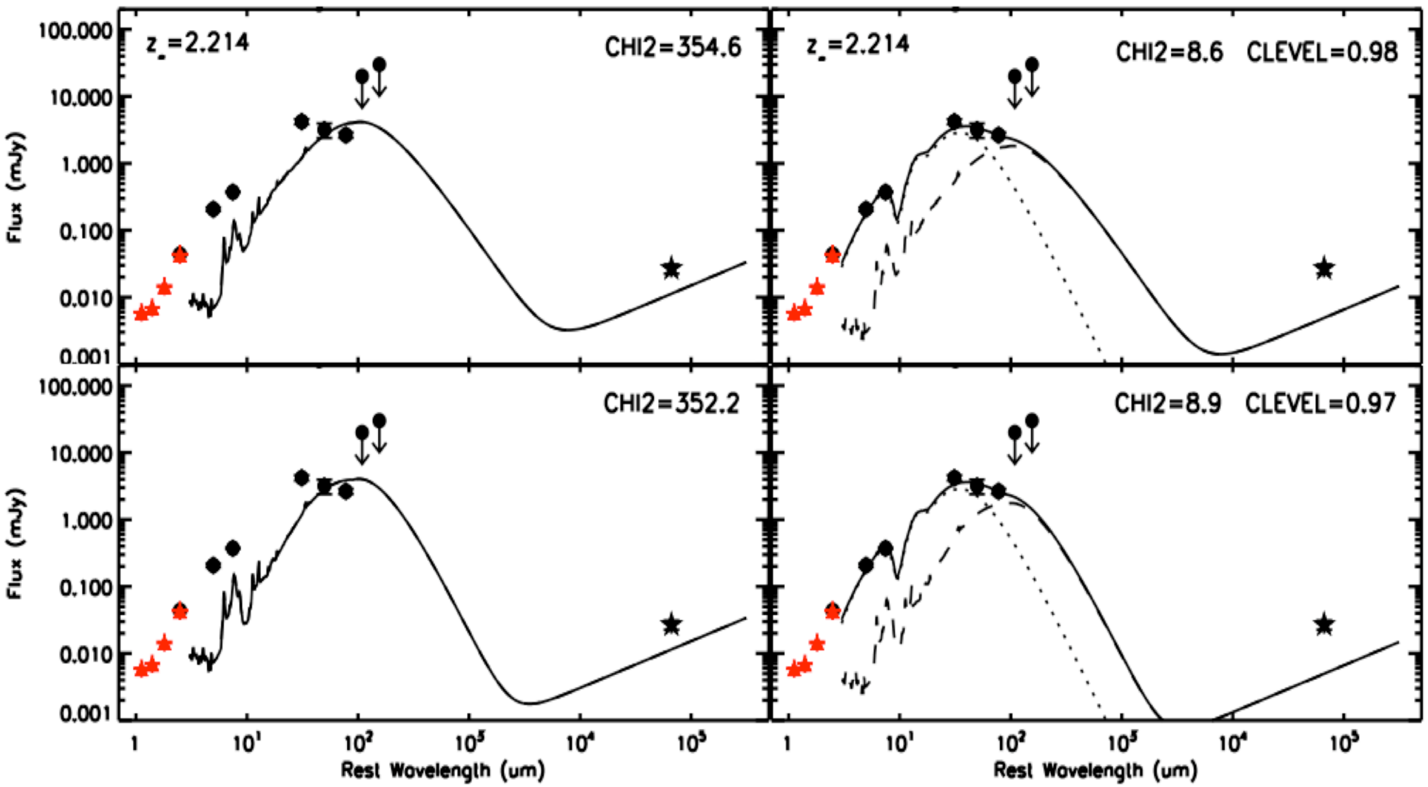




AGN + host galaxy templates (Mullaney et al. 2011)

→ λ=6~1000 um (MIR~FIR)

Starburst templates extended to 3 um (Dale et al. 2001) and to radio band ($f_\nu = \nu^{-0.7}$)



Application: Radio-excess AGN

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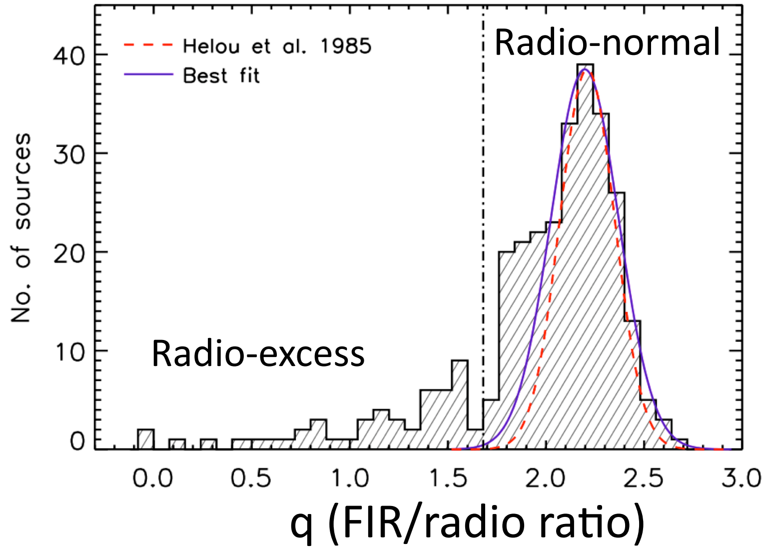
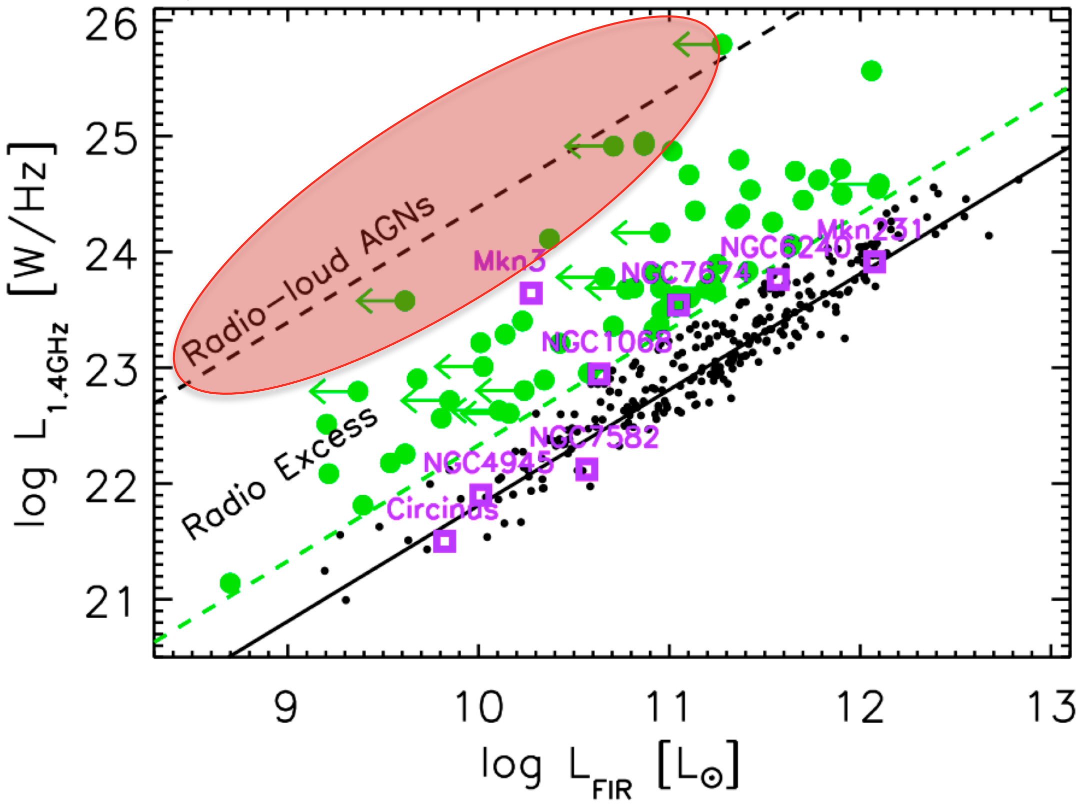


✦ FIR/radio relation for SB galaxies q≈2.2

✦ 64 radio-excess sources (q<1.68; 19%)

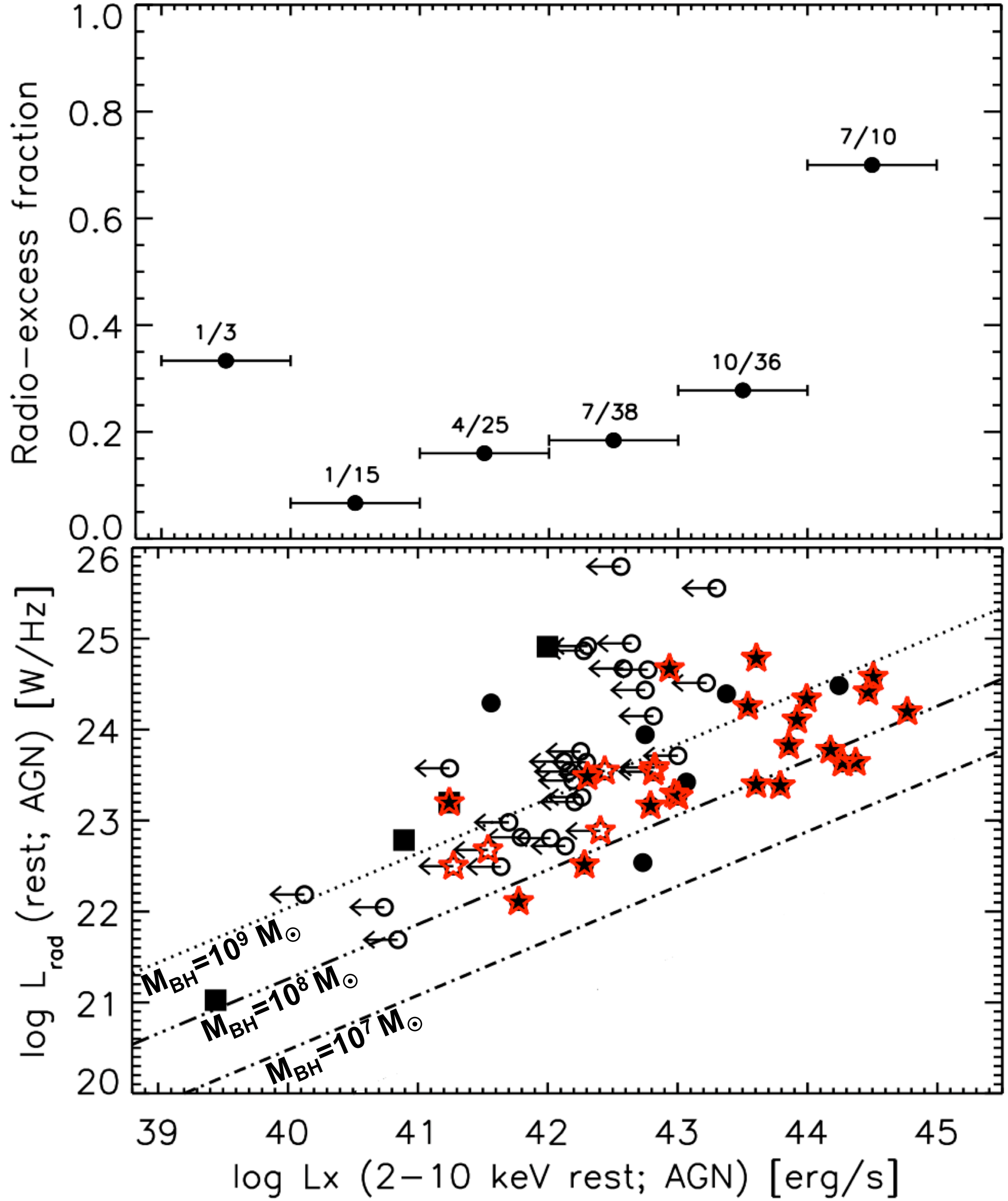
previous study on the GOODS-N field (Donley et al. 2005), but used f_{24um} as proxy for FIR → significant limitations

✦ IR AGN significantly detected in 42% of the radio-excess sample (only 20% in the "radio normal" sources)



Radio- X-ray relation

- 47% of the radio-excess sources are detected in X-rays
- Their fraction increases with X-ray luminosity
- Correlation between X-ray and radio luminosity (Merloni et al. 2003; Falcke et al. 2004)
- Probably heterogeneous mix of sources



IR properties of the sources

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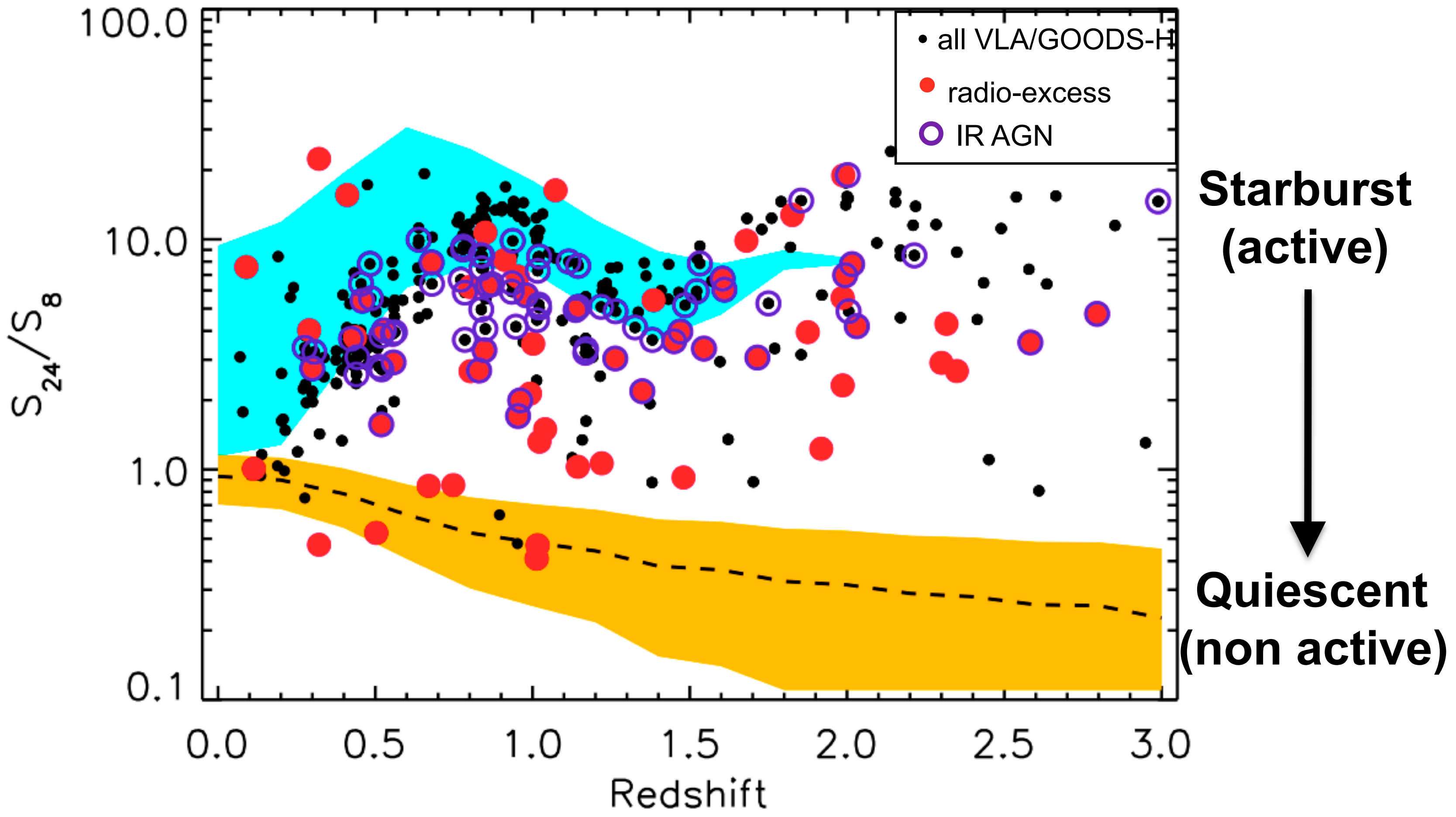

- Some sources are dominated by stellar emission → "dead" galaxies
- These could be low accretion rate type systems (e.g. RIAFs, ADAFs)

Heterogeneous population

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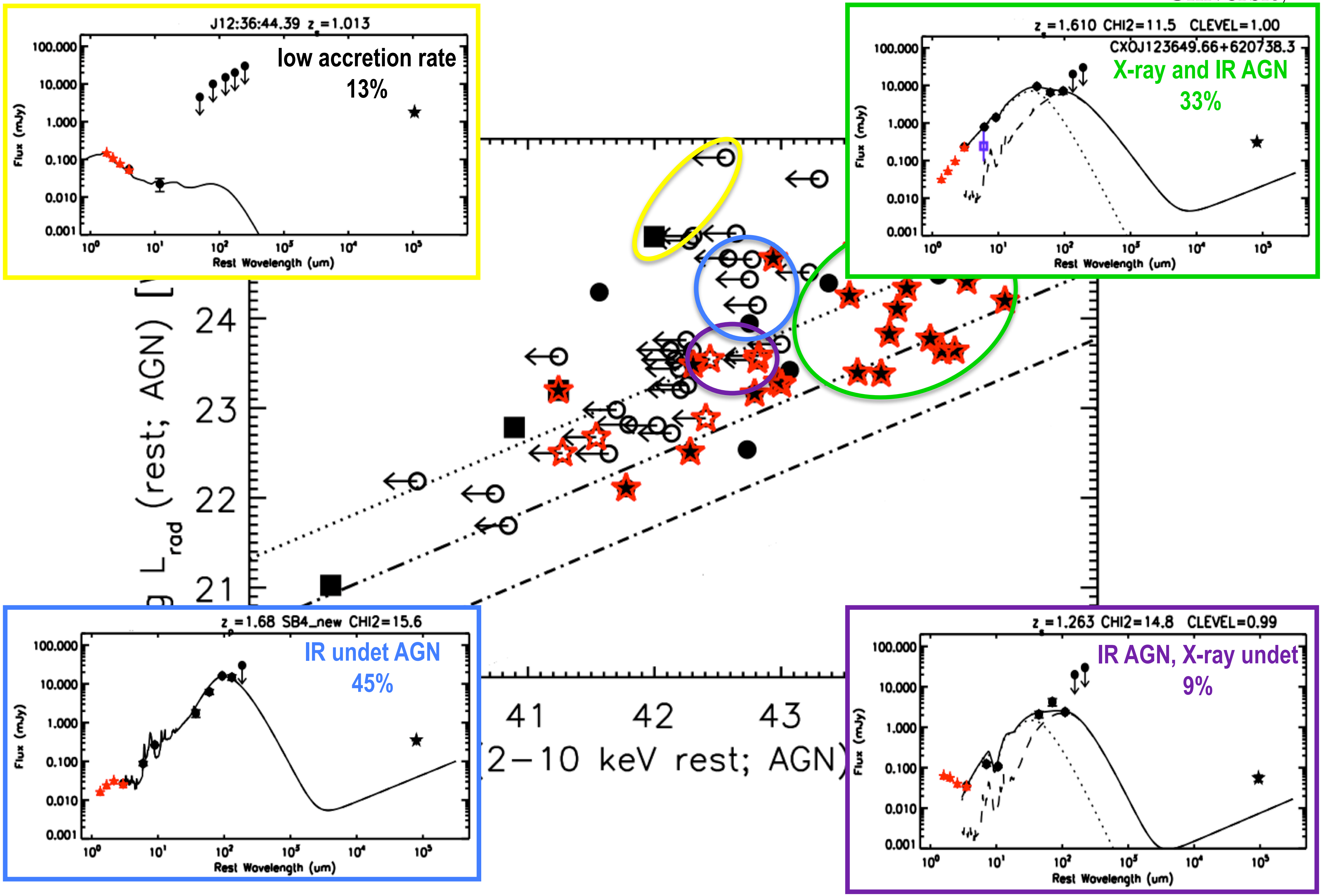

X-ray and IR AGNs: how many may be C-thick?

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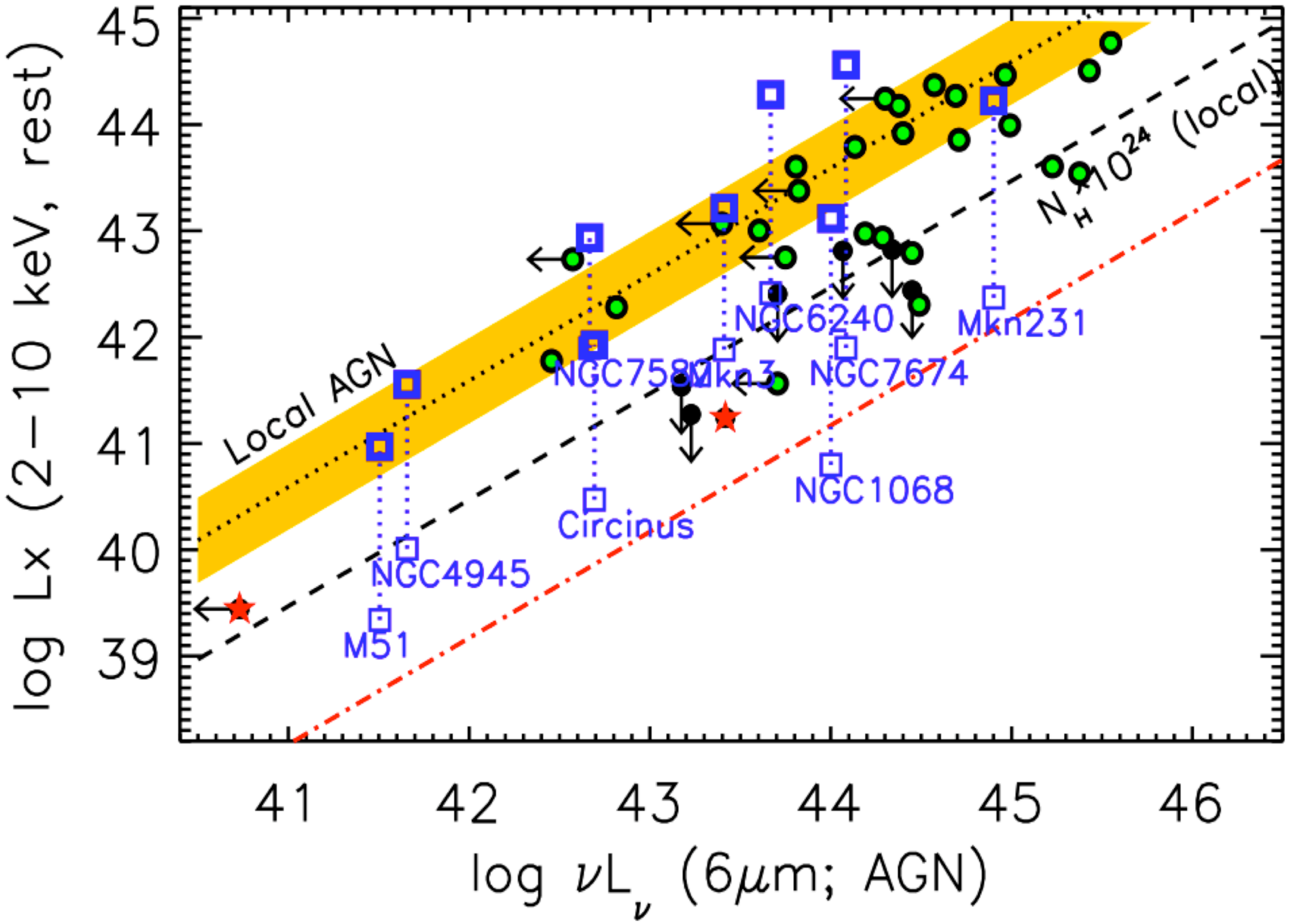

- The majority of the X-ray AGNs follow the local L_{6um}-L_X relation (Lutz et al. 2004)
- At $L_{6um}>10^{43}$ erg/s, ~50% are Compton-thin and ~50% are Compton-thick AGN candidates
- Of the C-thick candidates, 50% are X-ray detected and 50% are undetected

CONCLUSIONS

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- Detailed mid-far-IR SED analysis of 333 VLA/GOODS-*Herschel* sources
- 19% have excess of radio emission, indicating the presence of a hidden AGN
- Only 47% of the radio excess-sources are detected in X-rays
- The fraction of radio-excess AGN increases with X-ray luminosity → relation between radio and X-ray power
- Heterogeneous population →X-ray AGN, Compton-thick AGN, but also low accretion rate sources (e.g. RIAF, ADAF)
- The fraction of Compton-thick AGN candidates is ~25-50% at $L_{6um}>10^{43}$ erg/s (intrinsic $L_X> 4x10^{42}$ erg/s)