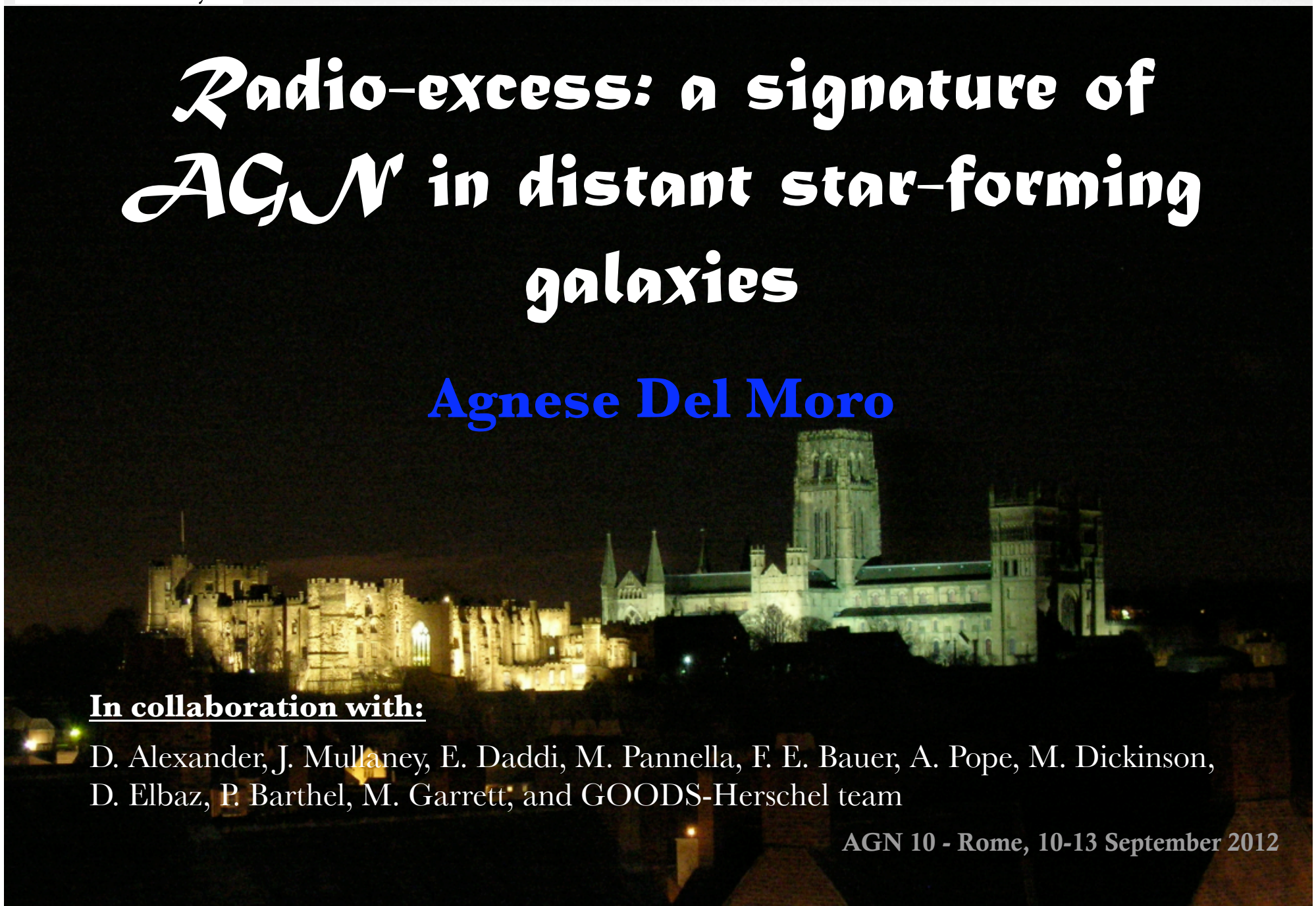
Durham University

Radio-excess: a signature of AGN in distant star-forming galaxies

Agnese Del Moro



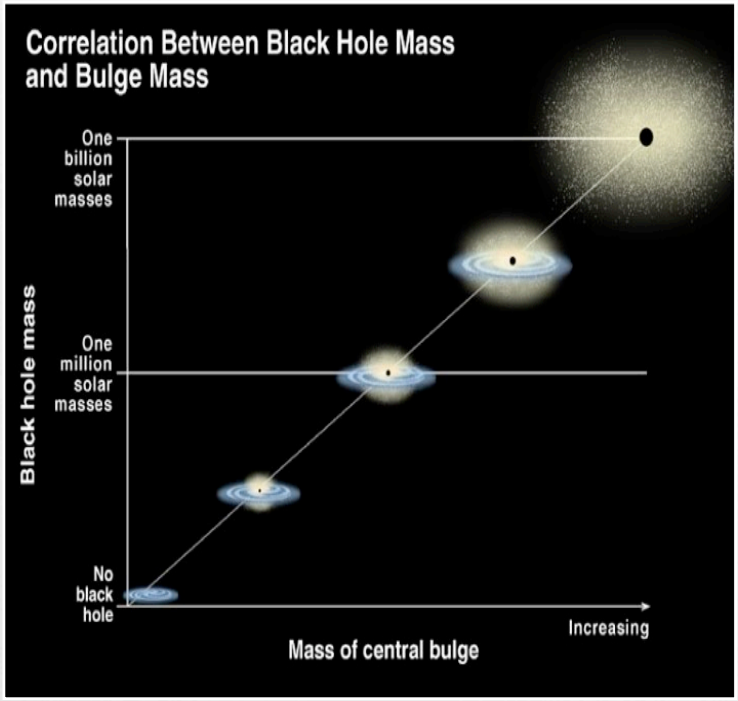
In collaboration with:

D. Alexander, J. Mullaney, E. Daddi, M. Pannella, F. E. Bauer, A. Pope, M. Dickinson, D. Elbaz, P. Barthel, M. Garrett, and GOODS-Herschel team

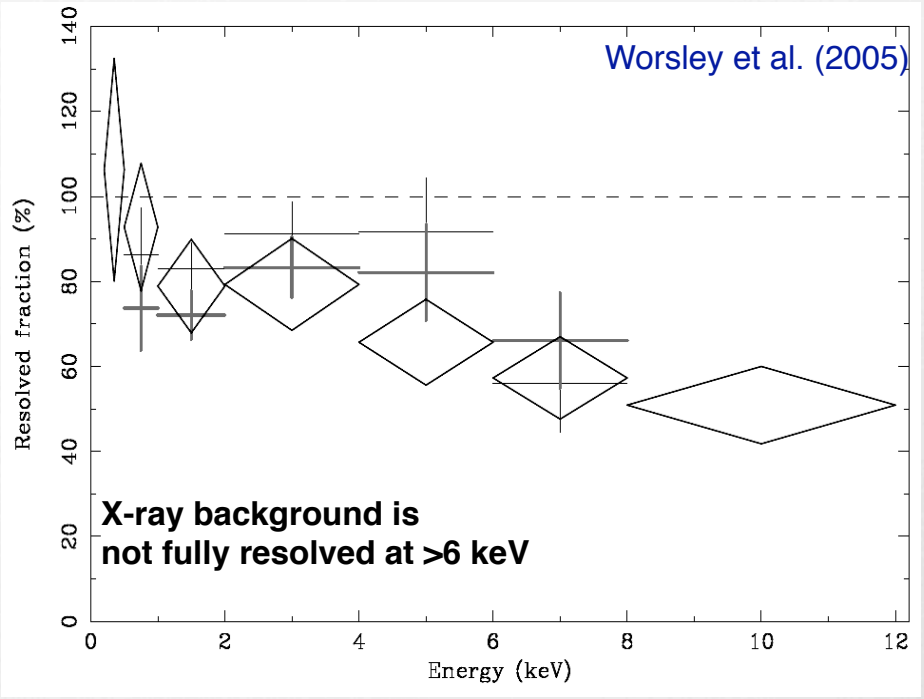
AGN 10 - Rome, 10-13 September 2012

Why looking for missing AGN?

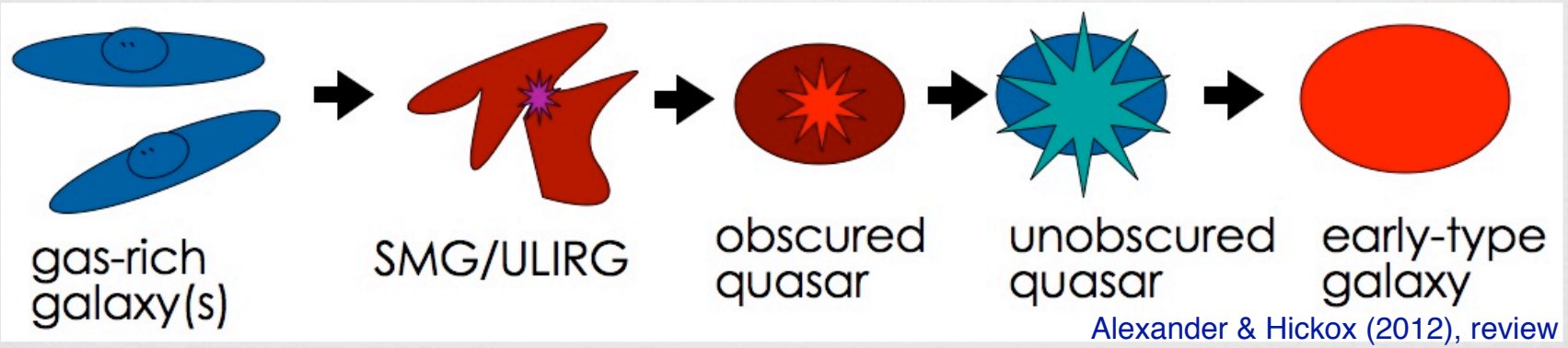
BH-spheroid growth connection



Missing AGN population

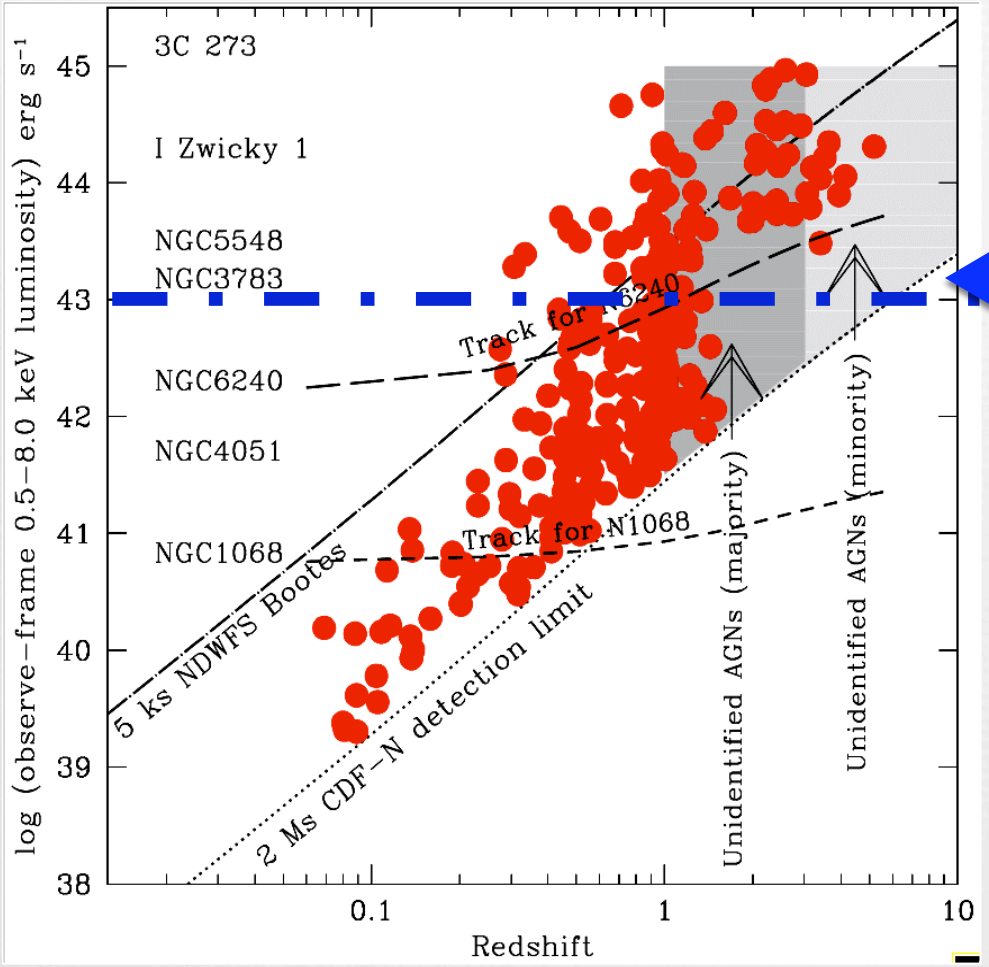


Major-merger evolution scenarios



Alexander & Hickox (2012), review

Deep X-ray surveys are great to detect distant AGN…
… but still not complete



Brandt & Hasinger (2005) for a review

Deep X-ray surveys are great to detect distant AGN…
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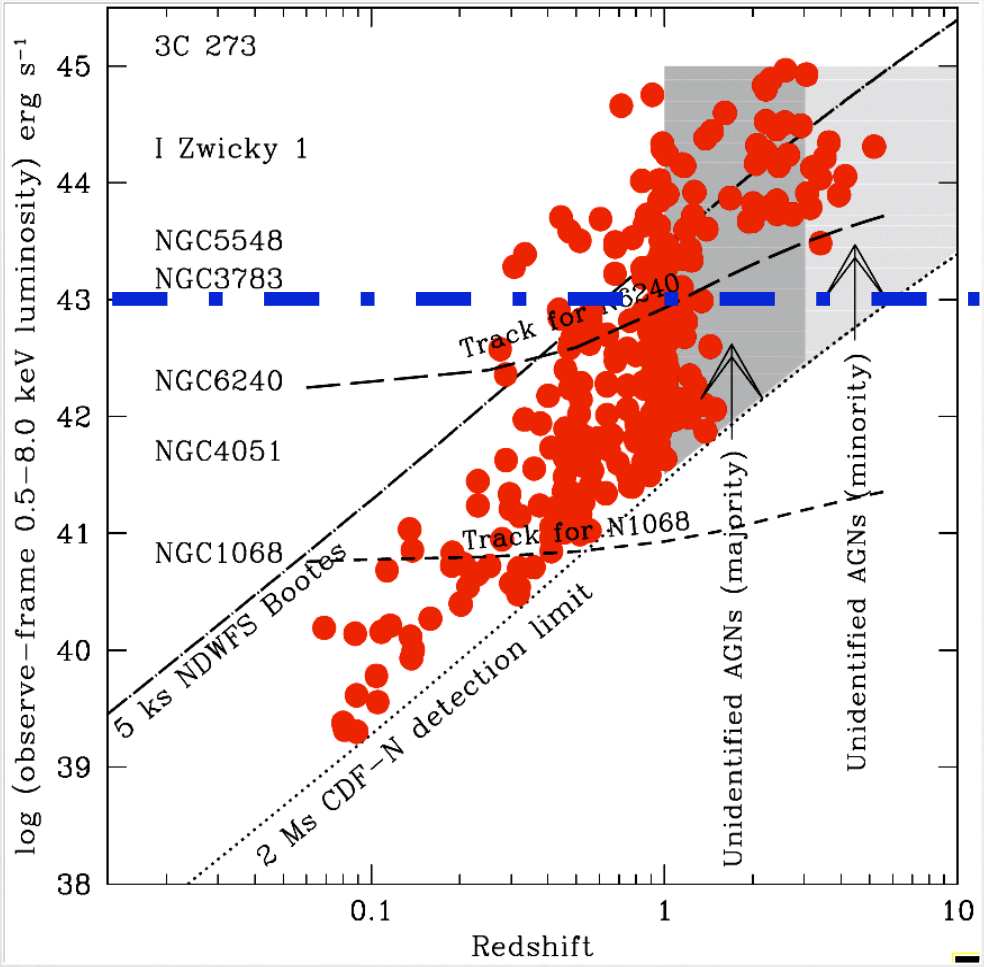
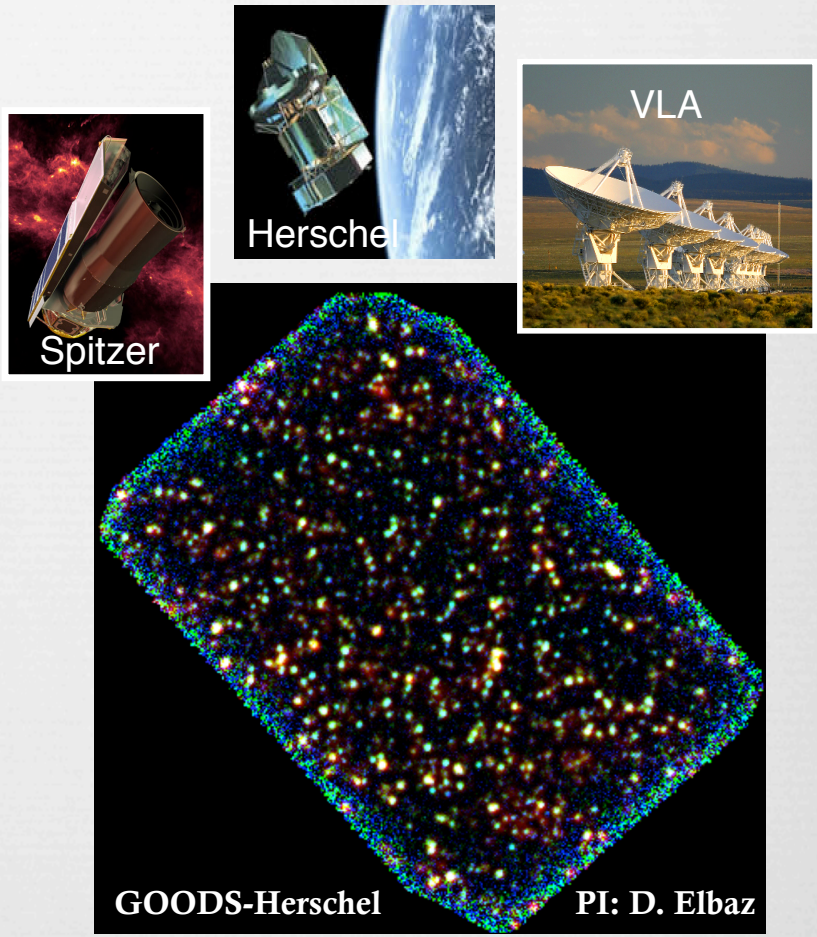
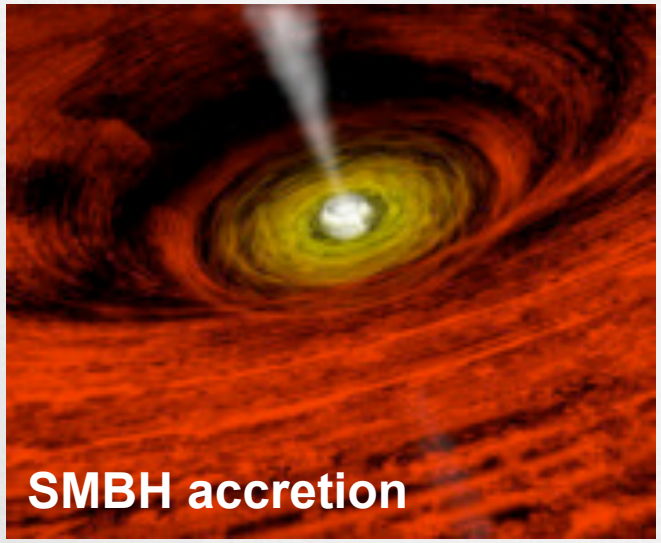


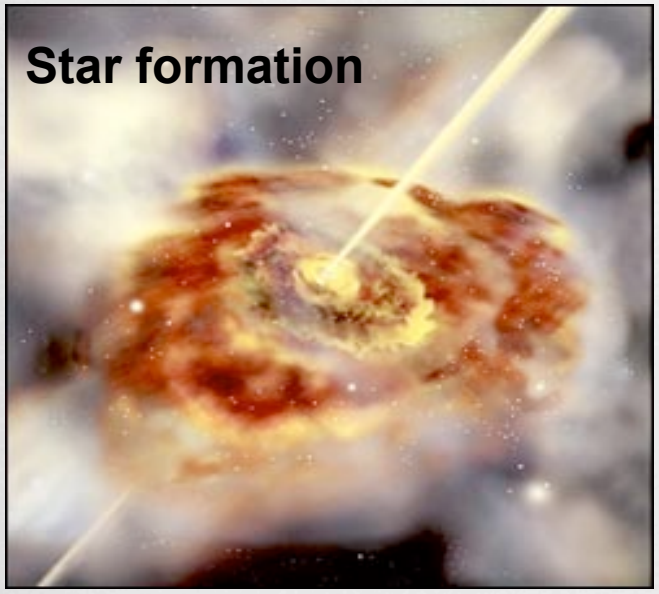
Brandt & Hasinger (2005) for a review

Go multiwavelengths!



Competing processes heating the dust

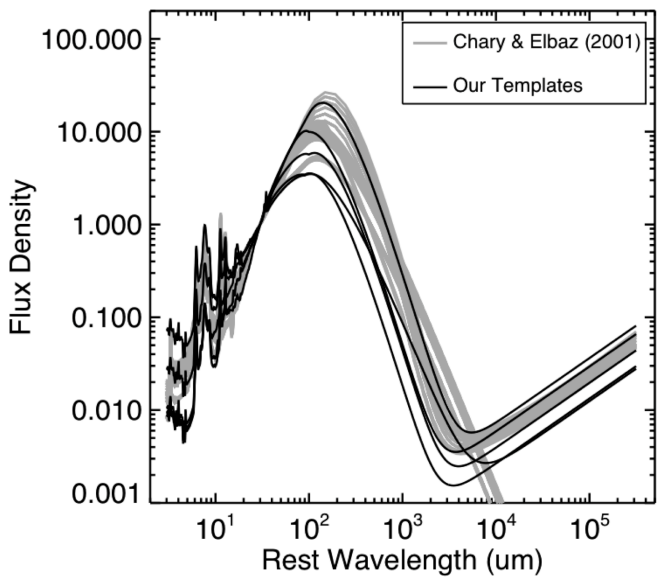


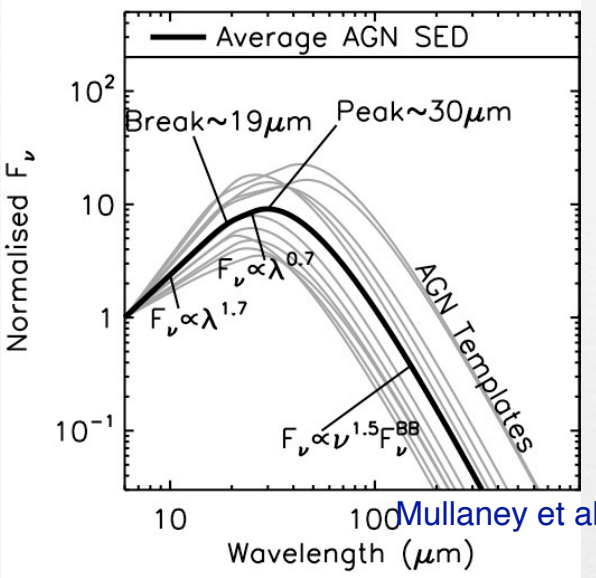


Dust

Reprocessed emission in the infrared/ sub-mm bands

AGN-galaxy SED decomposition





Mullaney et al. (2011)

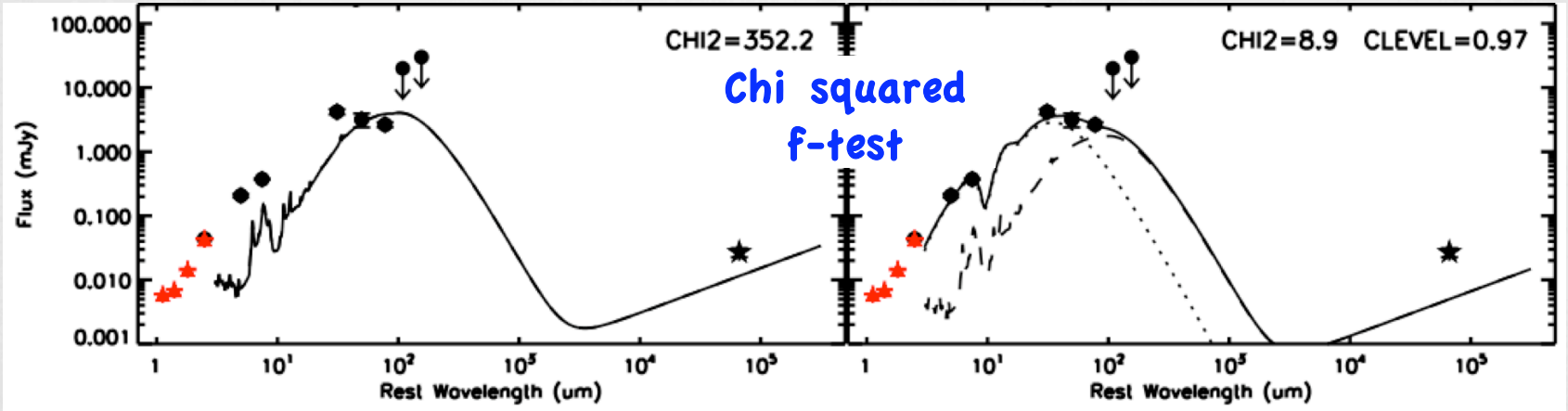
5 host galaxy templates (Mullaney+2011)

Extended to:

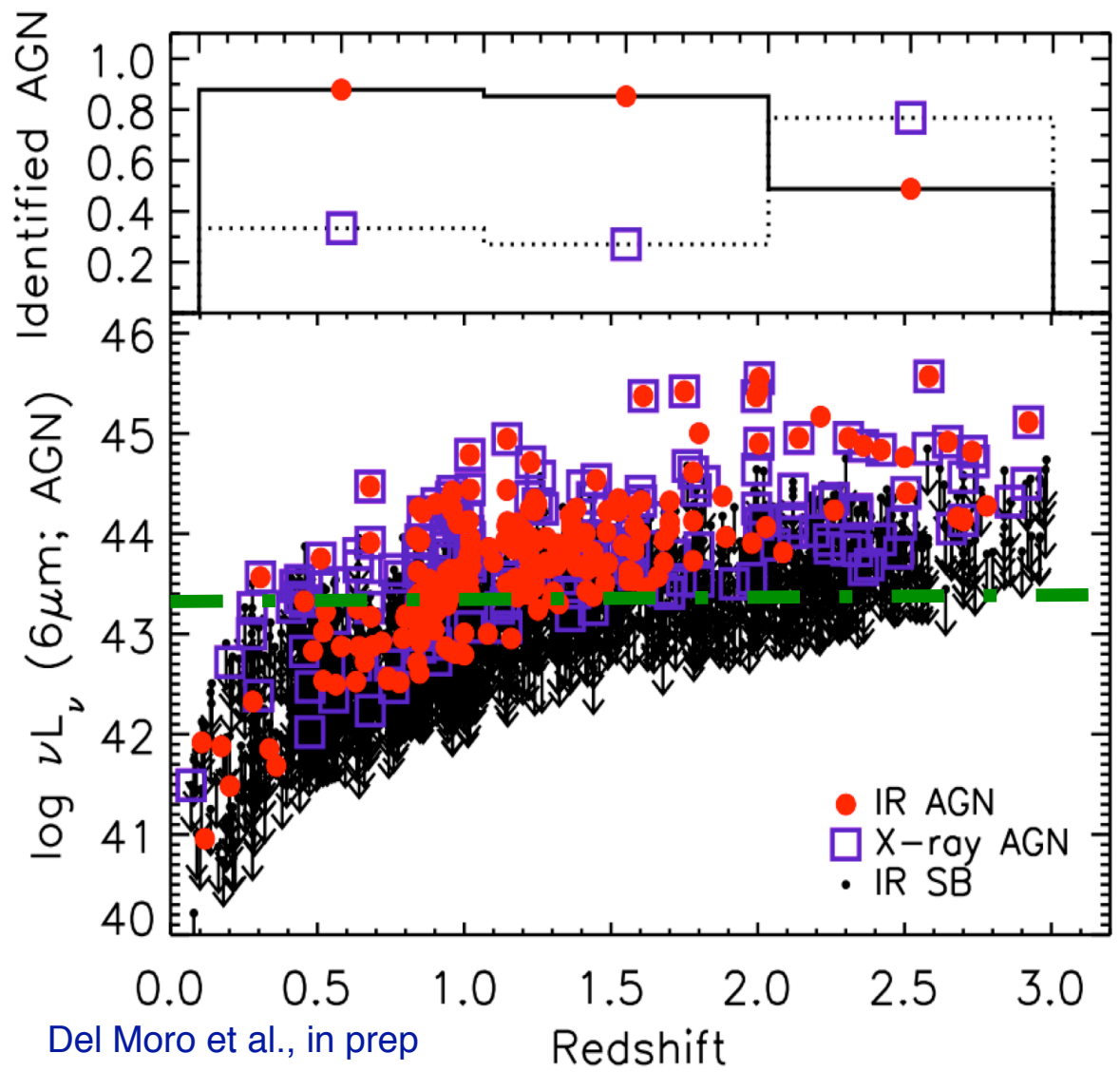
- 3 um using average SB SED (Dale+2001)
- radio band ($f_\nu = \nu^{-0.7}$), FIR/radio ratio ~2.2 (Helou+1985)

Empirically defined AGN template (Mullaney+2011)

+ Extinction



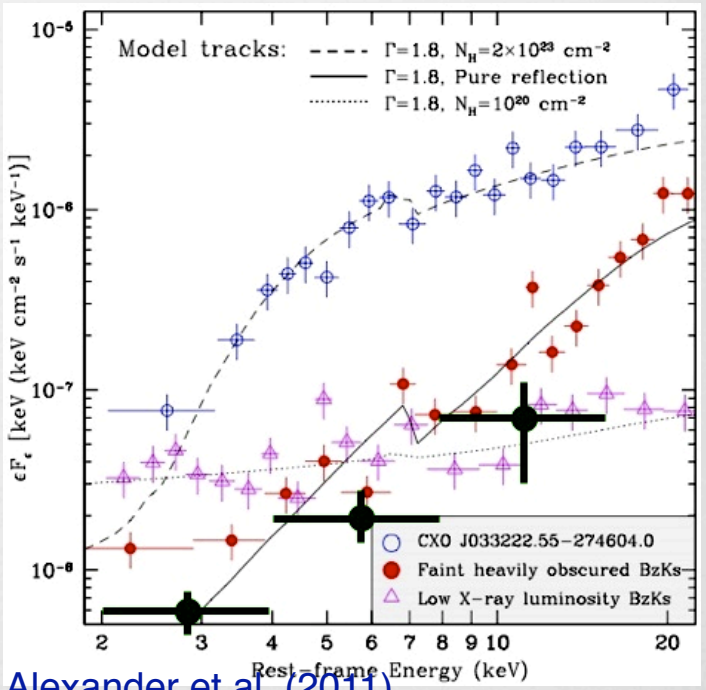
Identifying the AGN dominating the cosmic BH growth



Del Moro et al., in prep

-Large population of X-ray undetected AGN are identified in IR at z<2

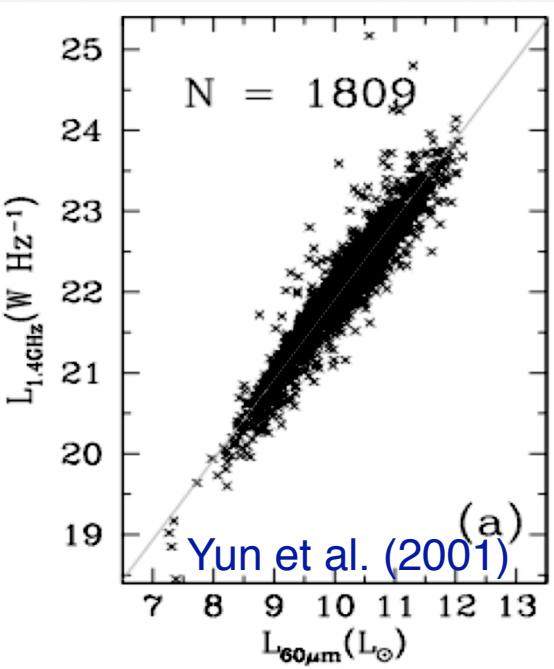
- Stacking of X-ray undetected IR AGN at z<1 consistent with reflection dominated spectrum



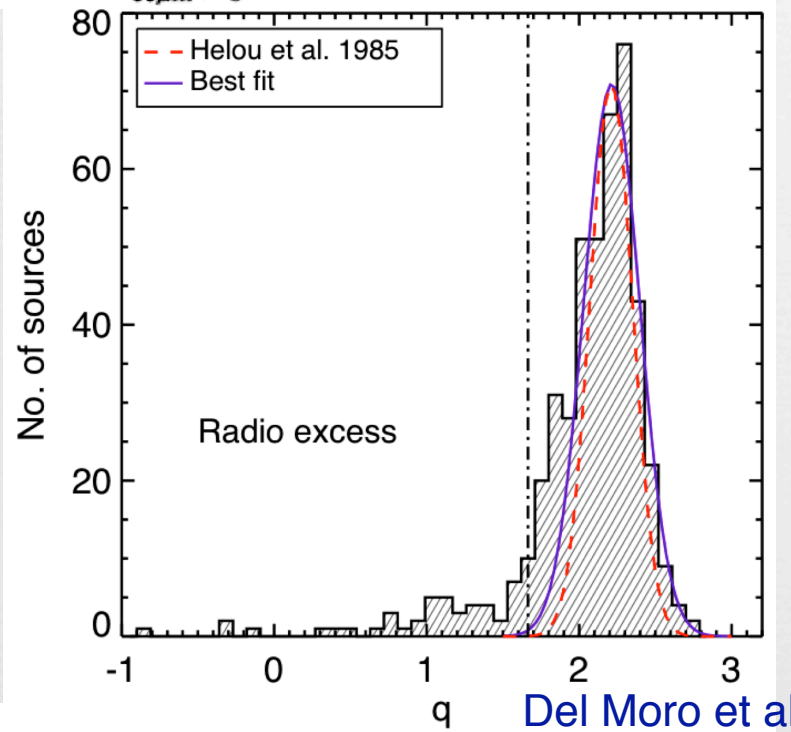
Alexander et al. (2011)

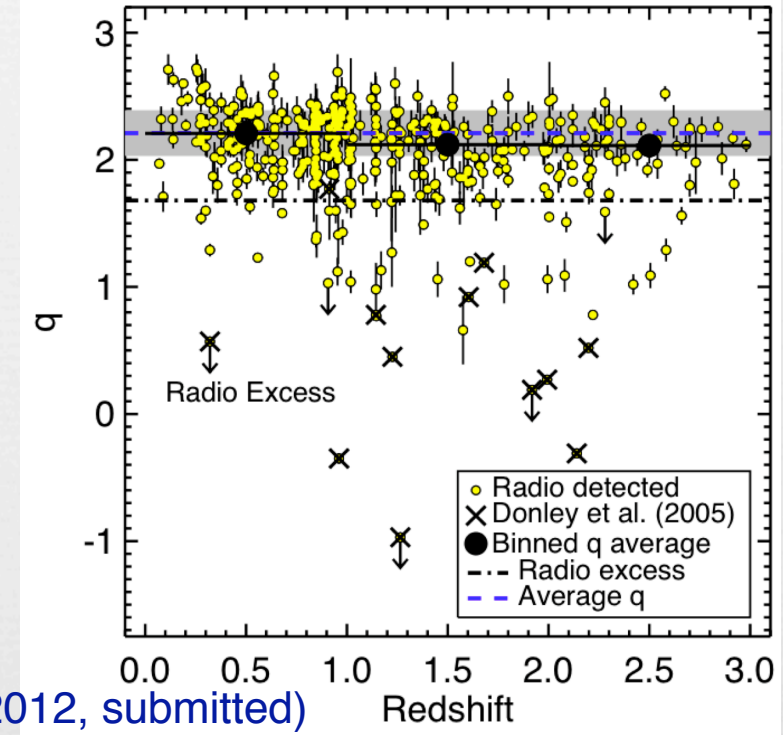
Radio-excess sources

- Tight FIR/radio correlation for star-forming galaxies **q≈2.2** (Helou et al. 1985)
- Population of 51 radio-excess sources **q<1.68** out to z=3
- 47% are undetected in X-rays



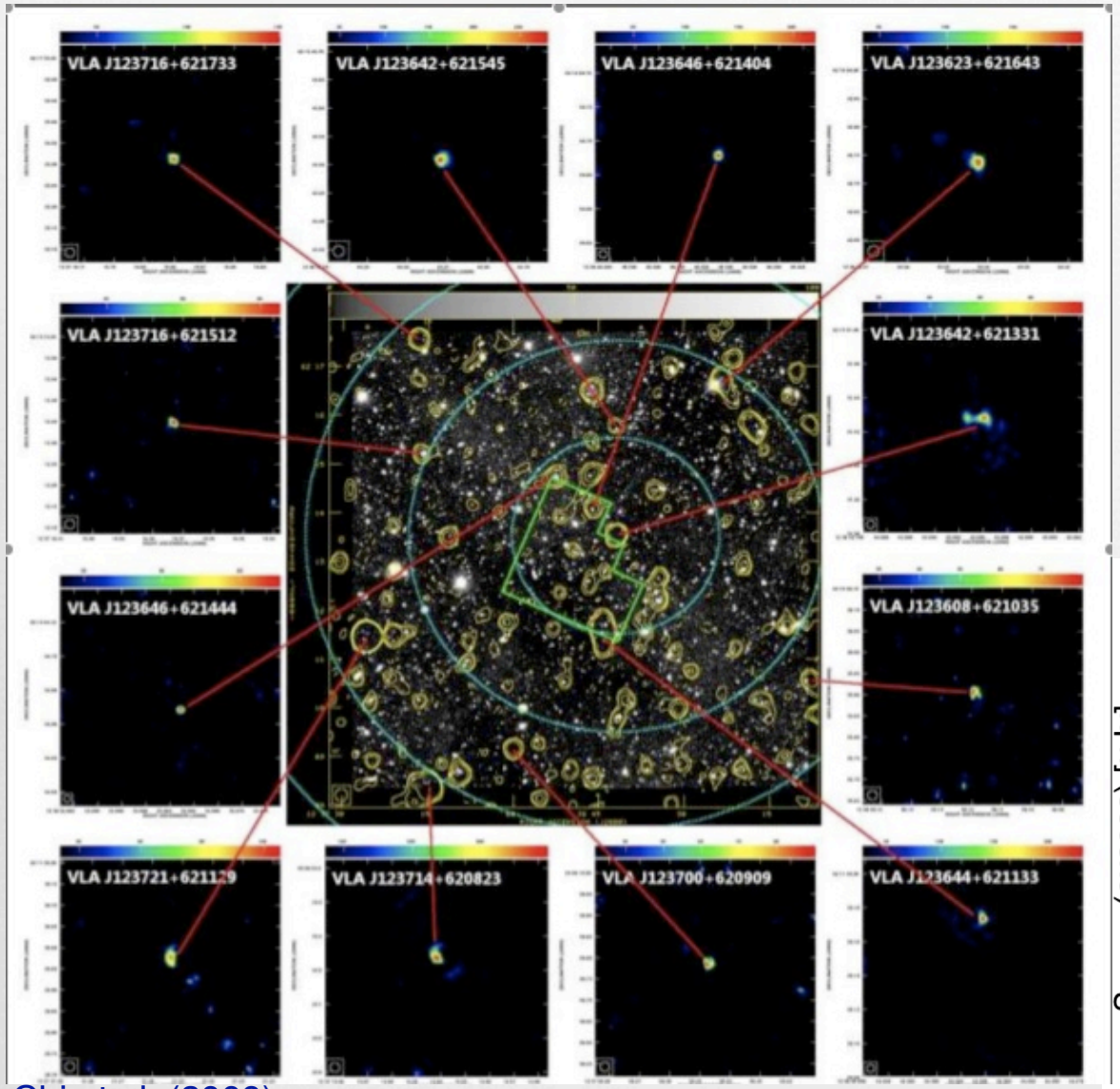
Yun et al. (2001)





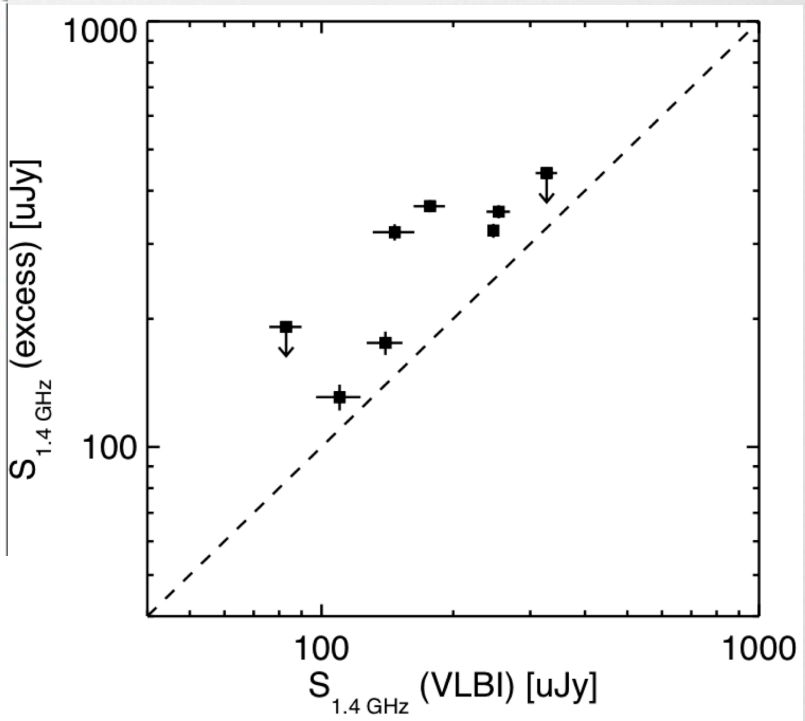
Del Moro et al. (2012, submitted)

Excess radio emission from AGN

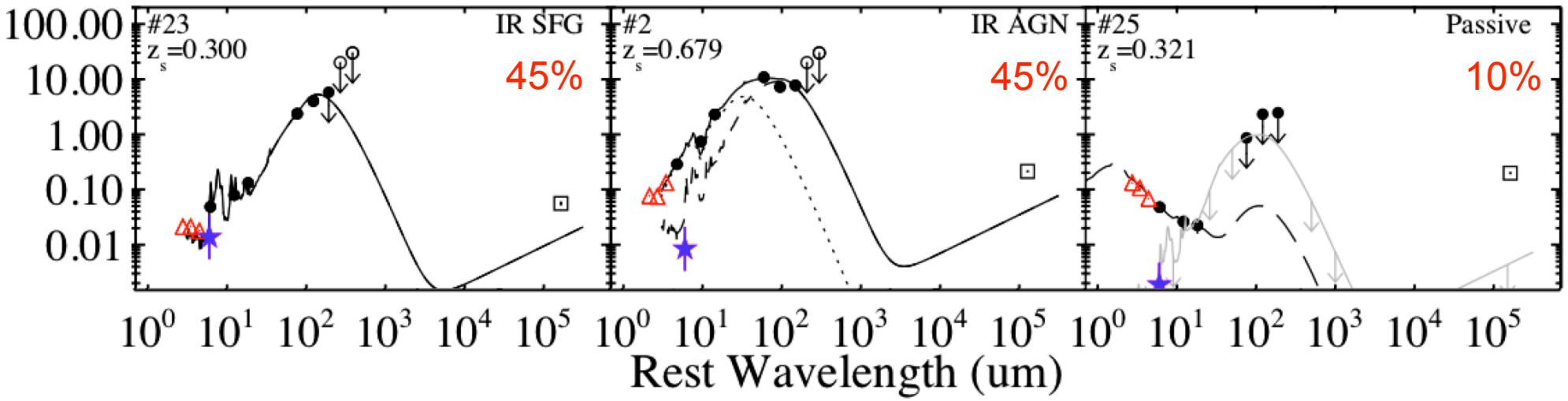


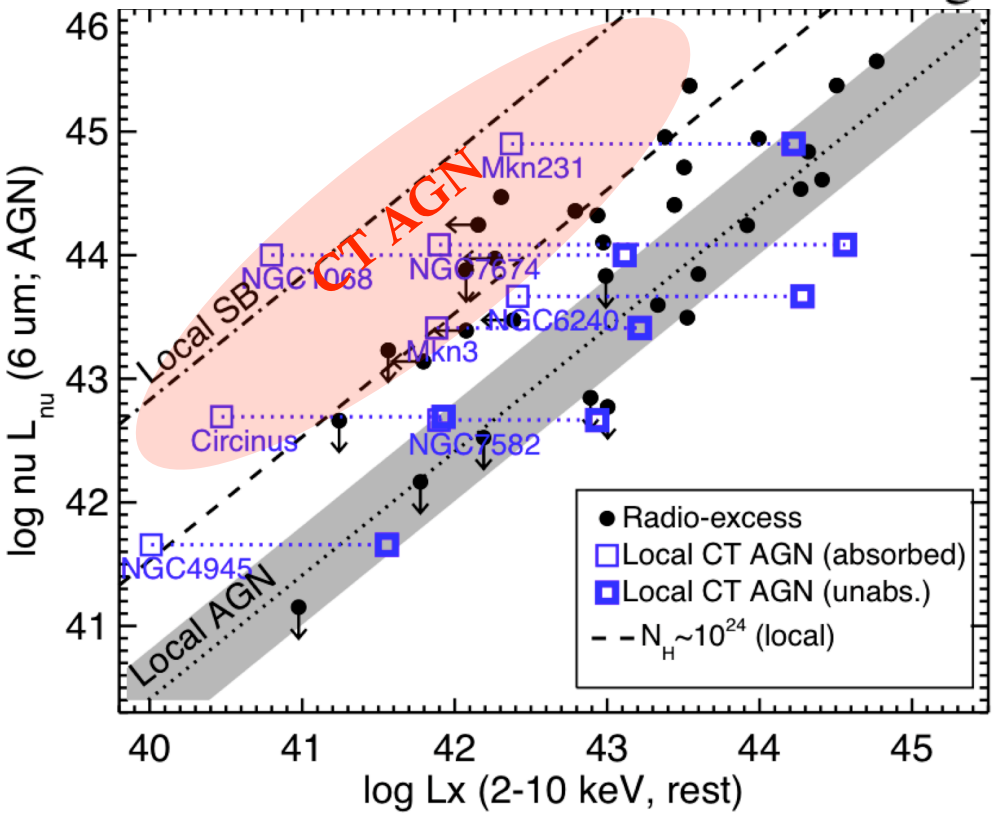
Chi et al. (2009)

- Compact radio core detected by VLBI for 8 sources
- Radio core flux predicted within a factor ~2 by SED analysis



Heterogeneous SEDs



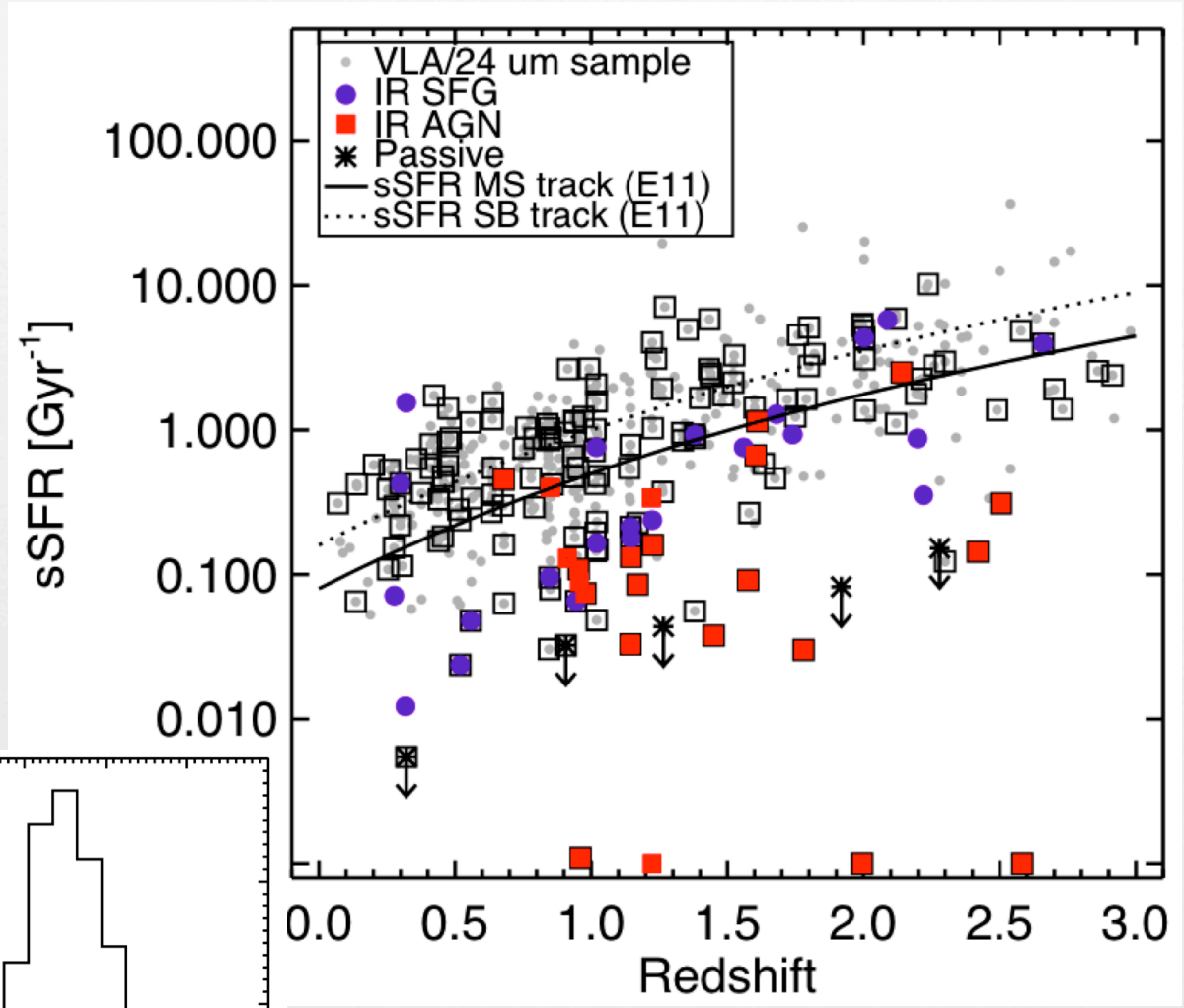


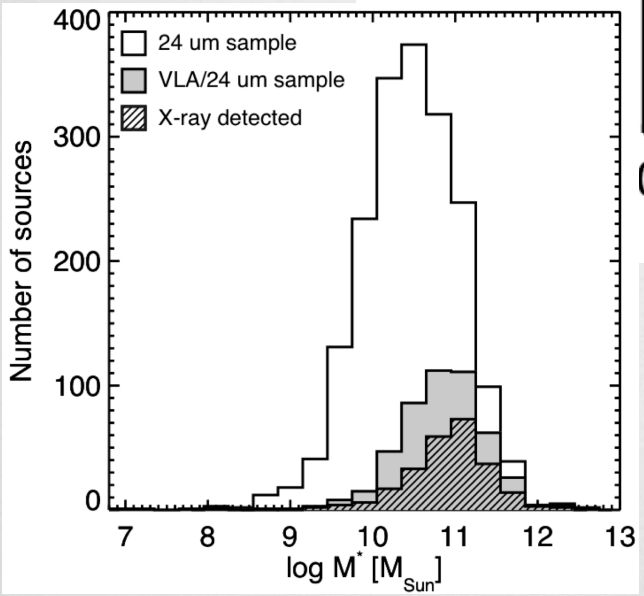
- Identified 3 types of SEDs:
  - IR SFG
  - IR AGN
  - Passive systems

- Limited in identifying AGN component when not dominating the SED

- Discrepancy between X-ray and 6 um luminosities
  ➔ heavily obscured AGN

Star-formation in radio-excess AGN



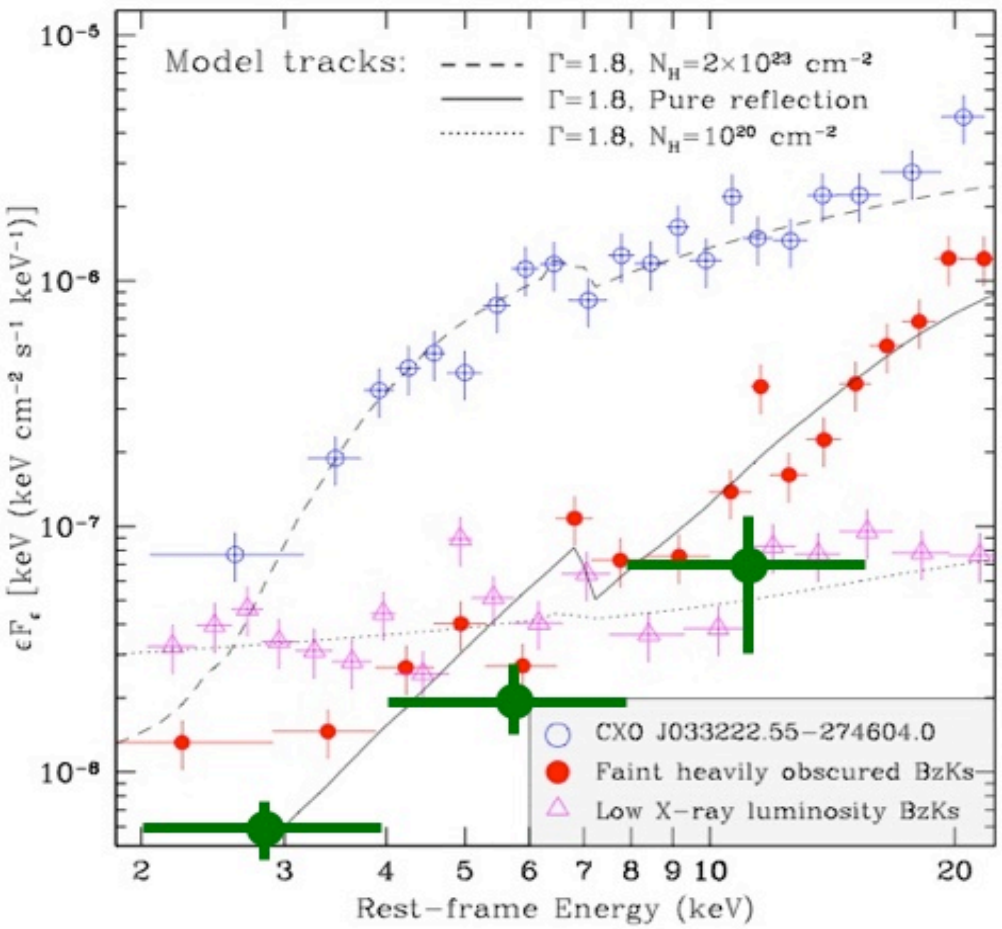


- Star-formation rate per unit mass lower than typical X-ray selected AGN
- Different stages of evolution?

Summary

- IR SED analysis very effective in identifying AGN out to z≈2
- Stacked X-ray data of X-ray undetected IR AGN at z<1 consistent with reflection dominated spectrum ➔ heavily obscured/CT AGN
- Radio-excess emission can reveal the presence of AGN activity when other methods cannot
- Heterogeneous SEDs of radio-excess sources: IR SFG, IR AGN, passive systems ➔ snapshots of different stages of evolution?
- Specific SFR lower than typical X-ray selected sources ➔ radio-excess or dimmed star-formation?

z~1 IR AGNs: the unresolved X-ray background?



Stacked X-ray data of the X-ray undetected IR AGNs: consistent with reflection dominated: heavily obscured/ Compton thick

Properties consistent with producing the unresolved X-ray background at 30 keV:

z~1, intrinsic L_X~10^{43} erg/s
And heavily obscured