An infrared view on star formation in high redshift AGN hosts

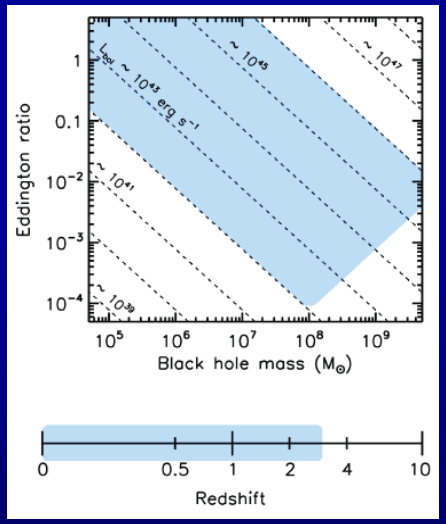
Dieter Lutz

Max-Planck-Institut für extraterrestrische Physik

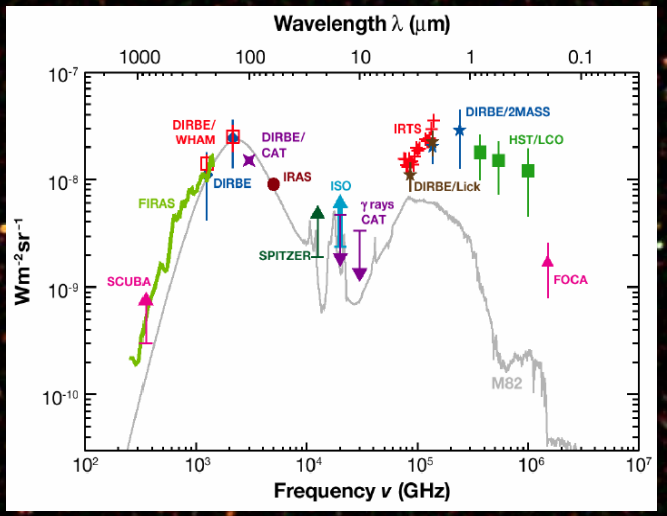
+ PEP Herschel GTO survey team

What drives the growth of black holes?

Durham, July 27, 2010

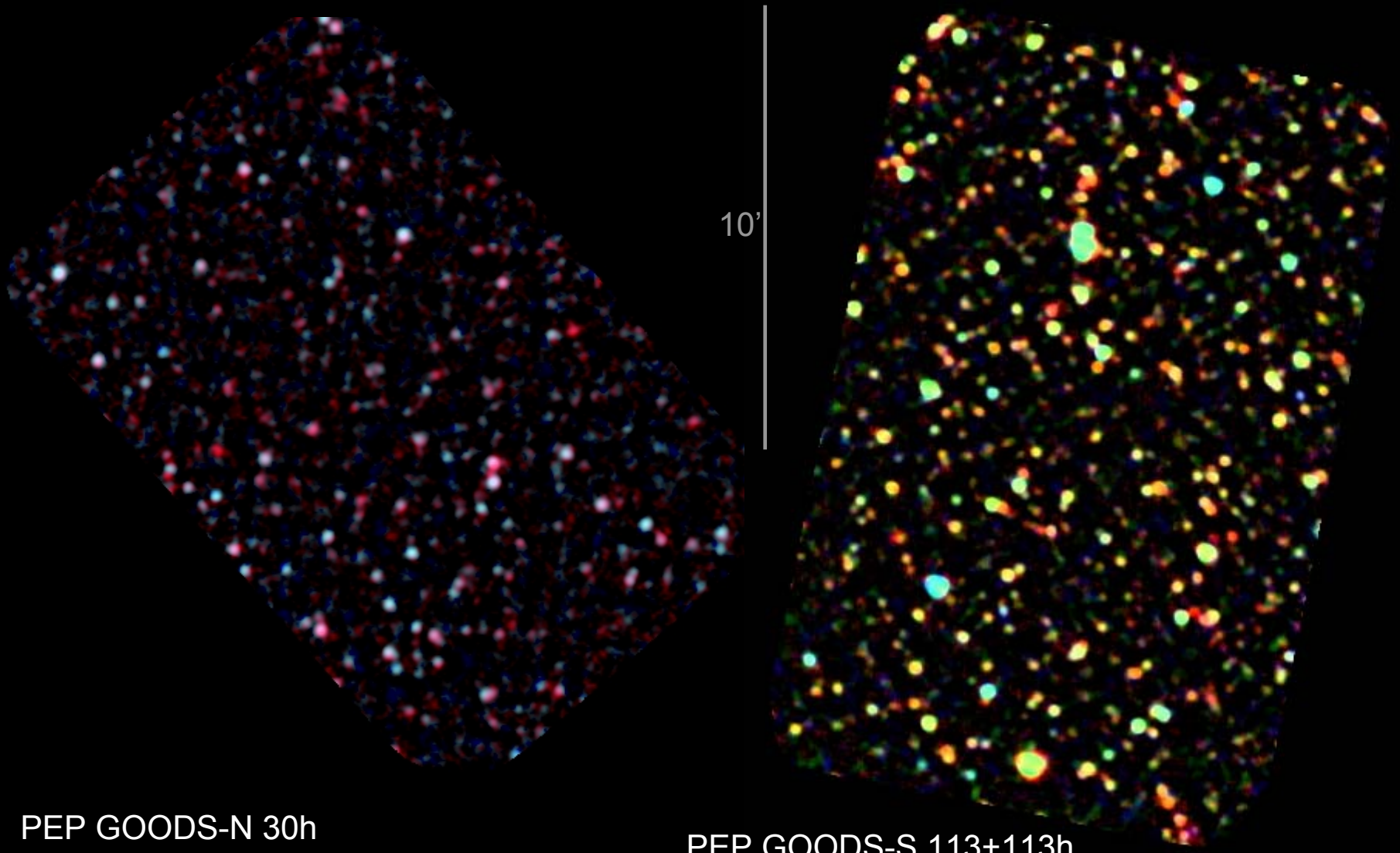


One of the main themes of Herschel: Study the formation of galaxies in the early universe and their subsequent evolution



Part of PEP COSMOS 2sq.deg. 24+100+160μm

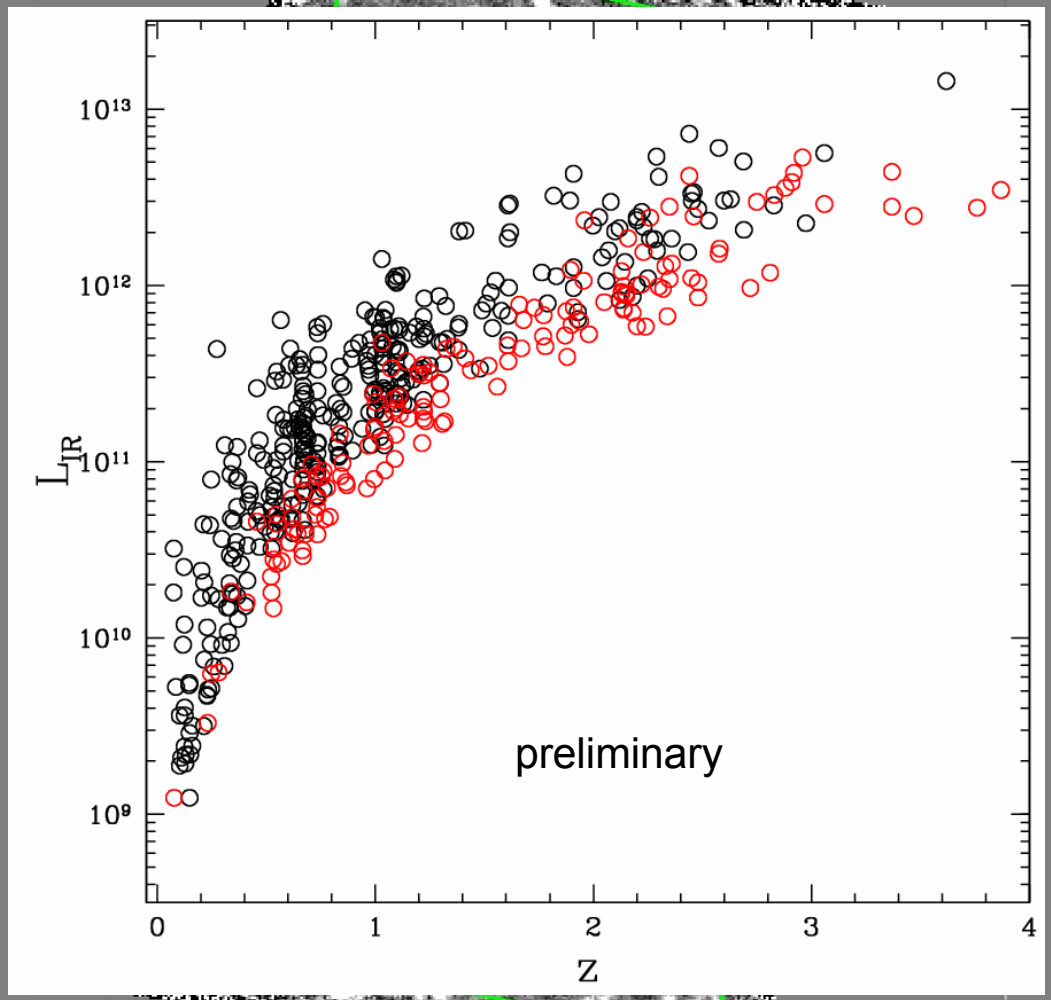
PEP GTO blank fields



PEP GOODS-N 30h
100+160μm during
Science demonstration phase
~300 sources

PEP GOODS-S 113+113h
70+100+160μm
~1000 sources

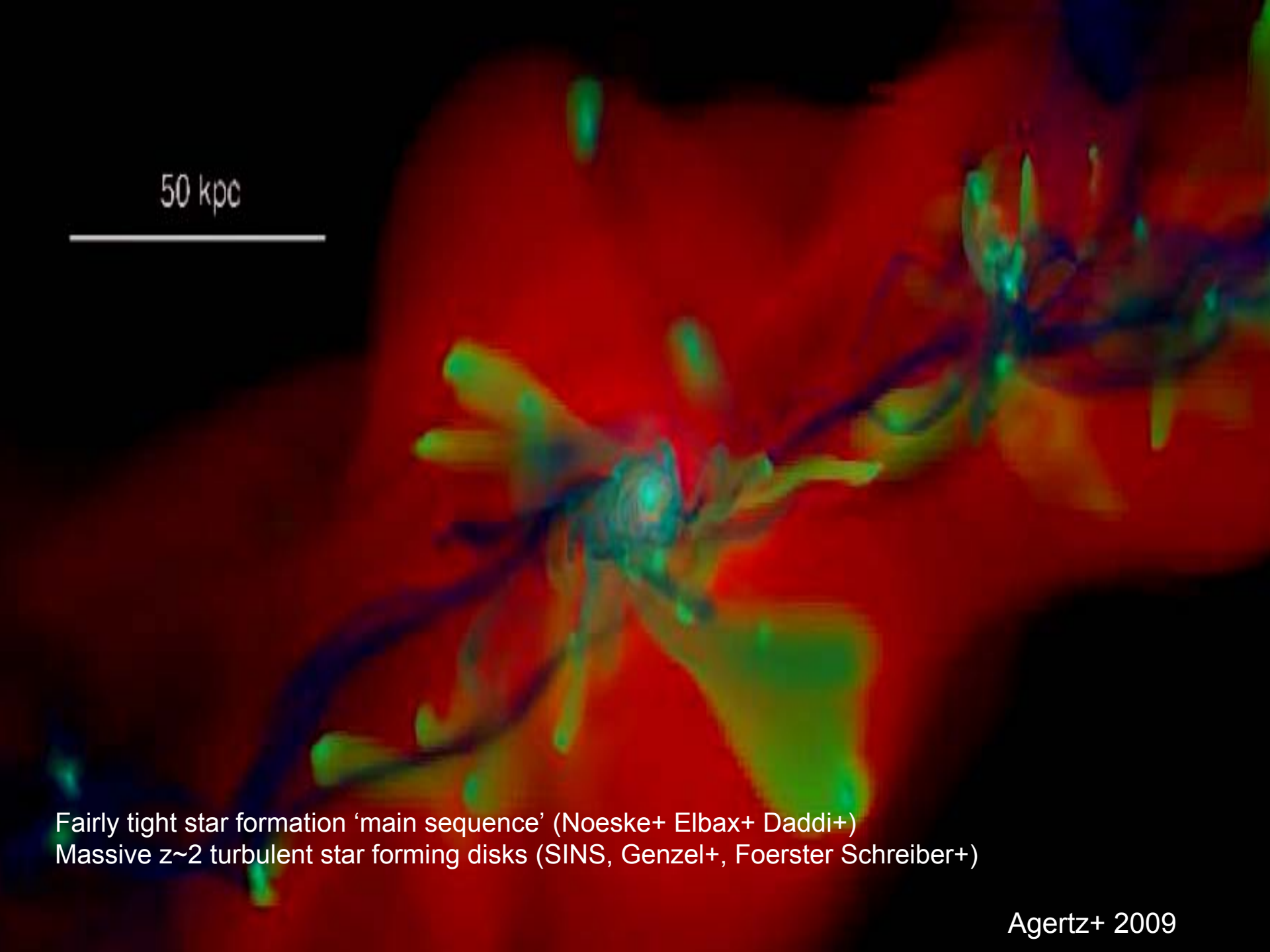
From MIPS to PACS



GOODS-S PACS 160μm
PEP team

Local ULIRGs/PG QSOs
Sanders ’88 scenario

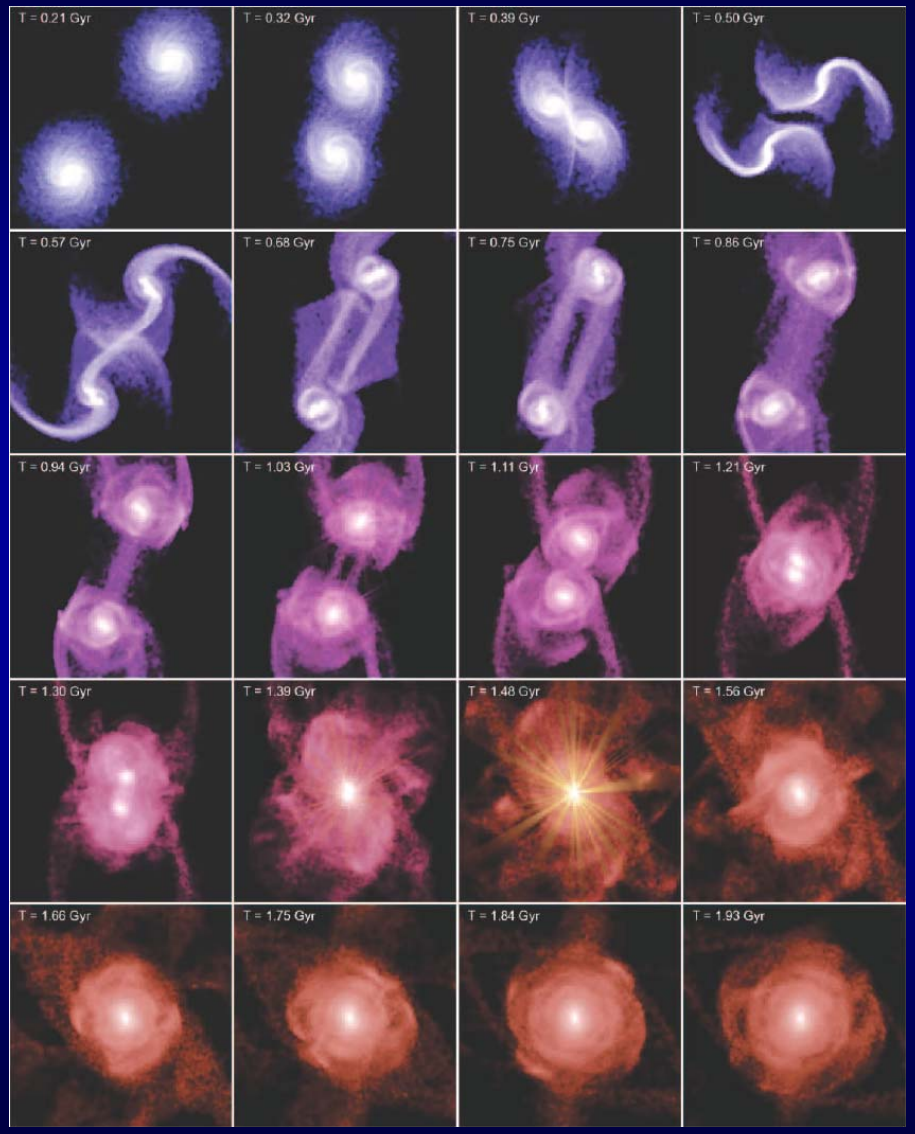
Dubinski+



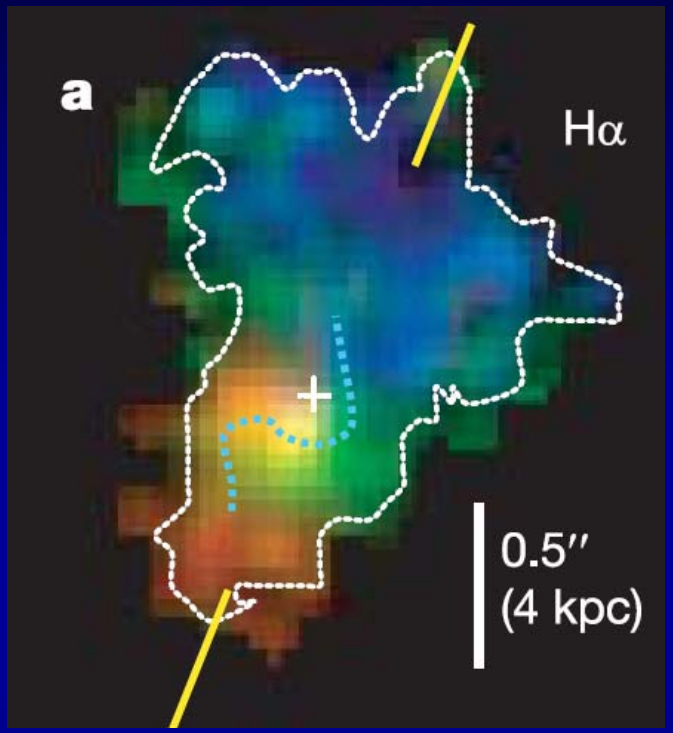
Fairly tight star formation ‘main sequence’ (Noeske+ Elbax+ Daddi+)
Massive z~2 turbulent star forming disks (SINS, Genzel+, Foerster Schreiber+)

Agertz+ 2009

Co-evolution of AGN and star formation

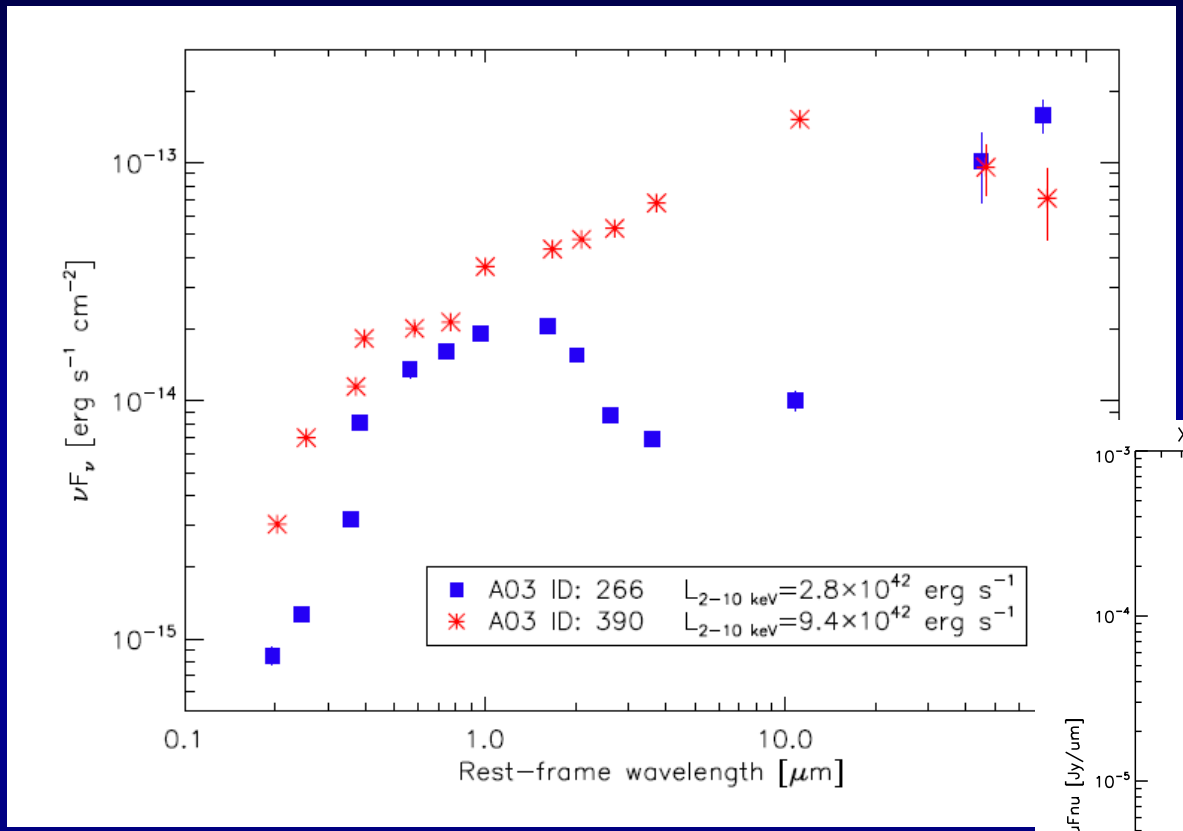


Models of merging galaxies (Hopkins+06)

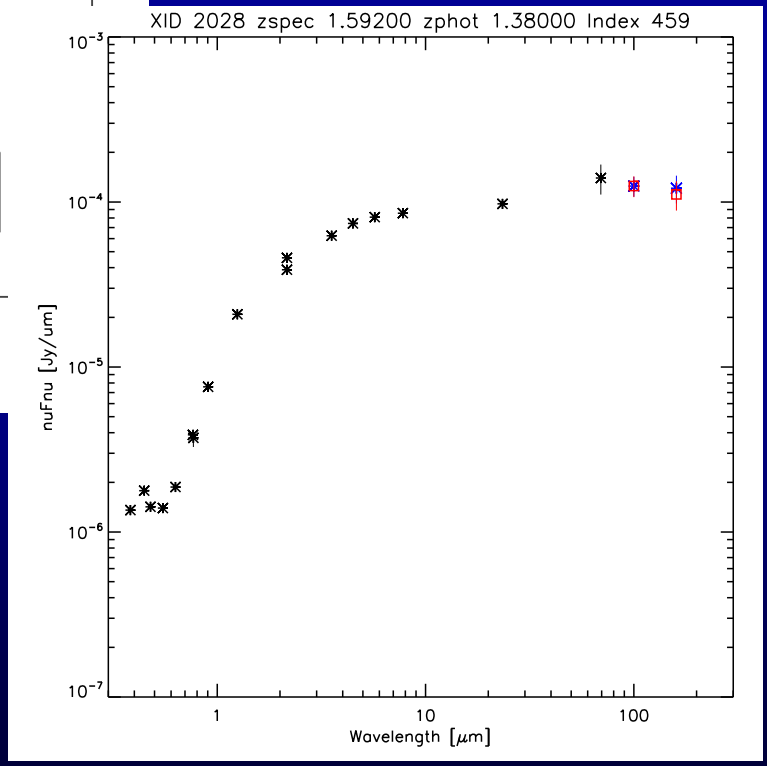


BzK-15504 z~2.38 rotating disk with central AGN (Genzel+06,08)

Example SEDs: Wide range

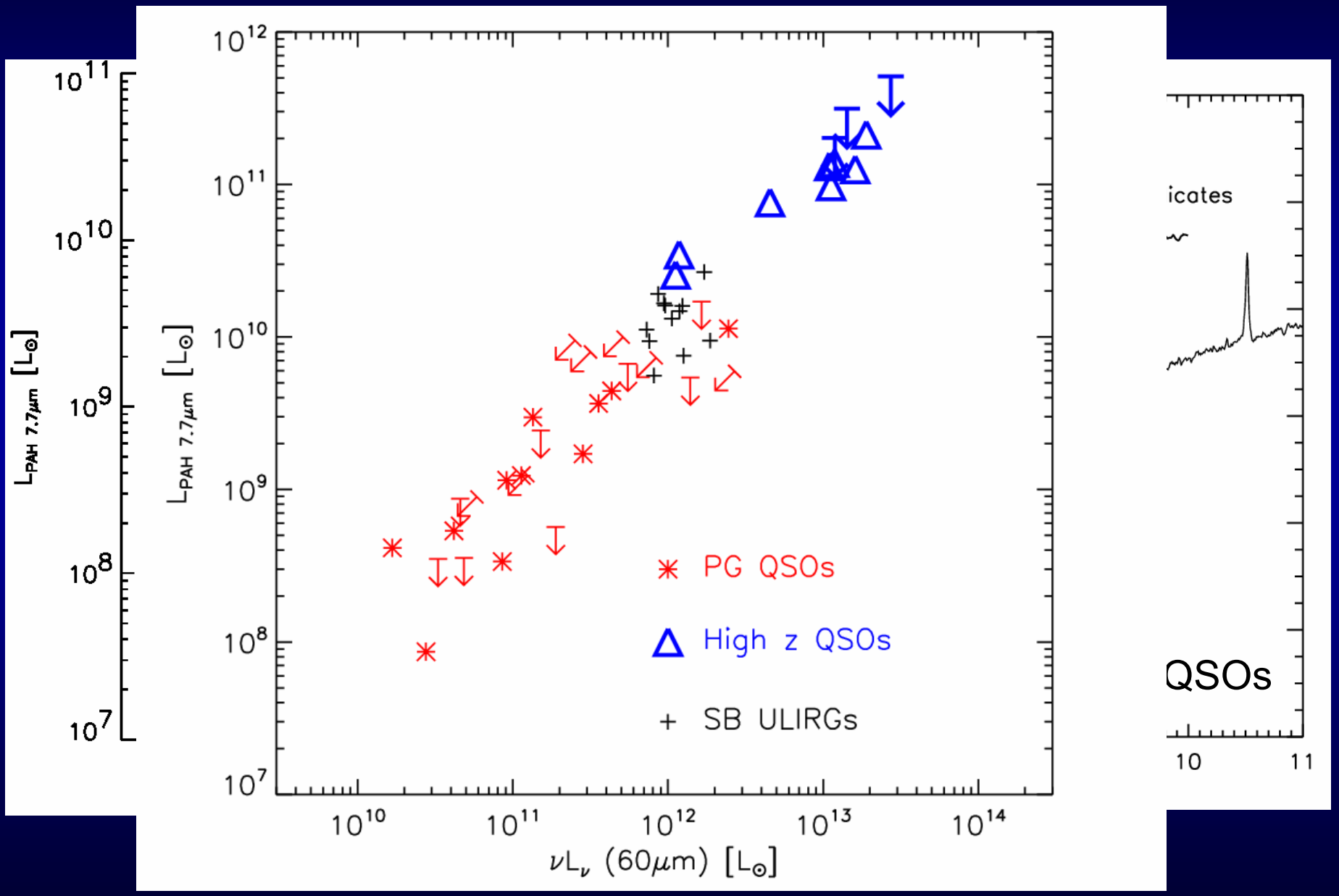


GOODS-N Chandra AGN (Shao et al. 2010)

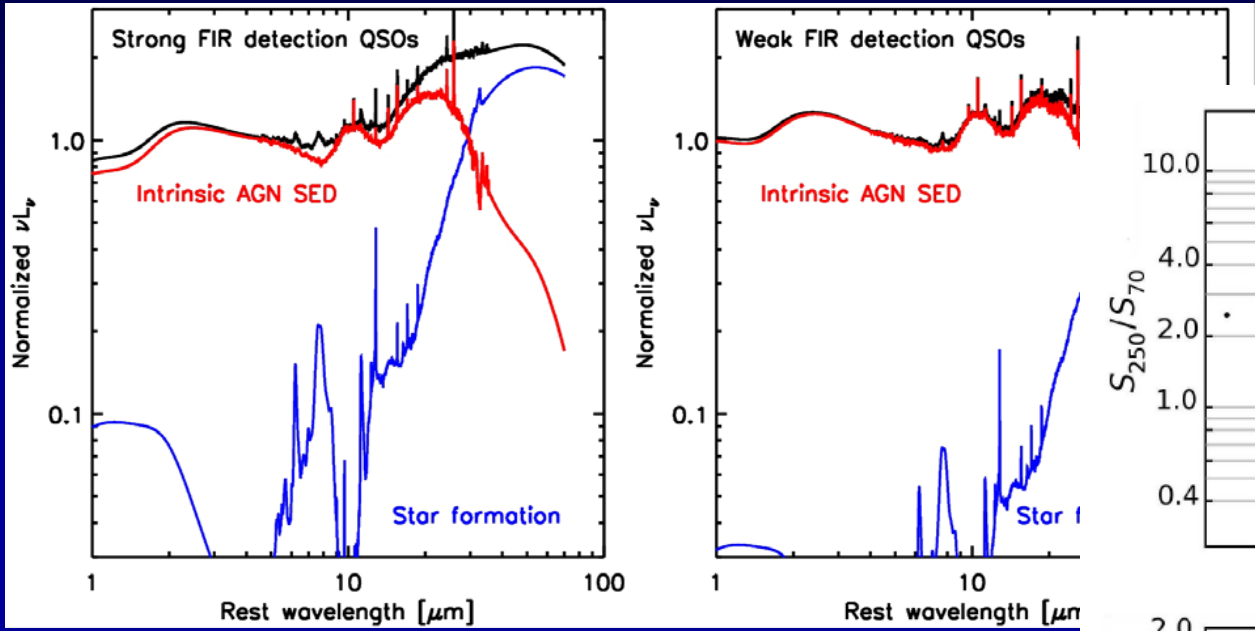


COSMOS AGN
(with Brusa, Salvato, Mainieri,…)

Spitzer PAH correlates with FIR luminosity of local and high-z QSOs

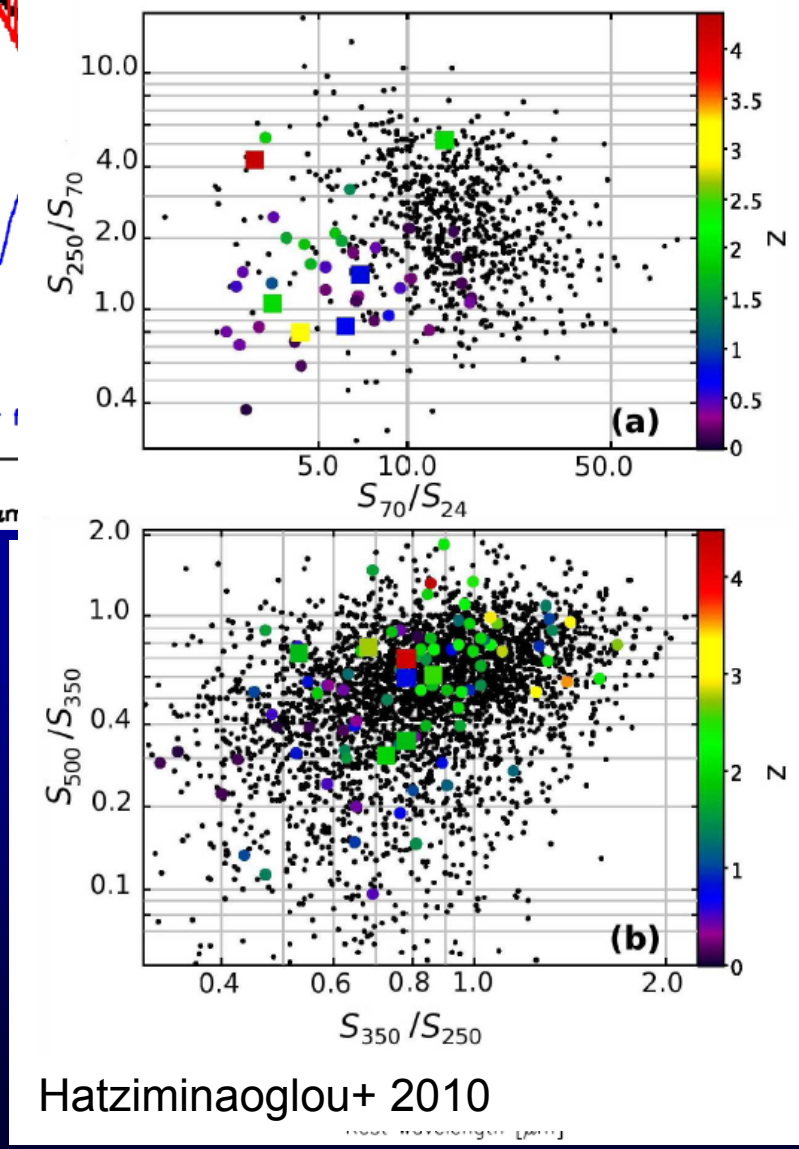


Using FIR to measure star formation



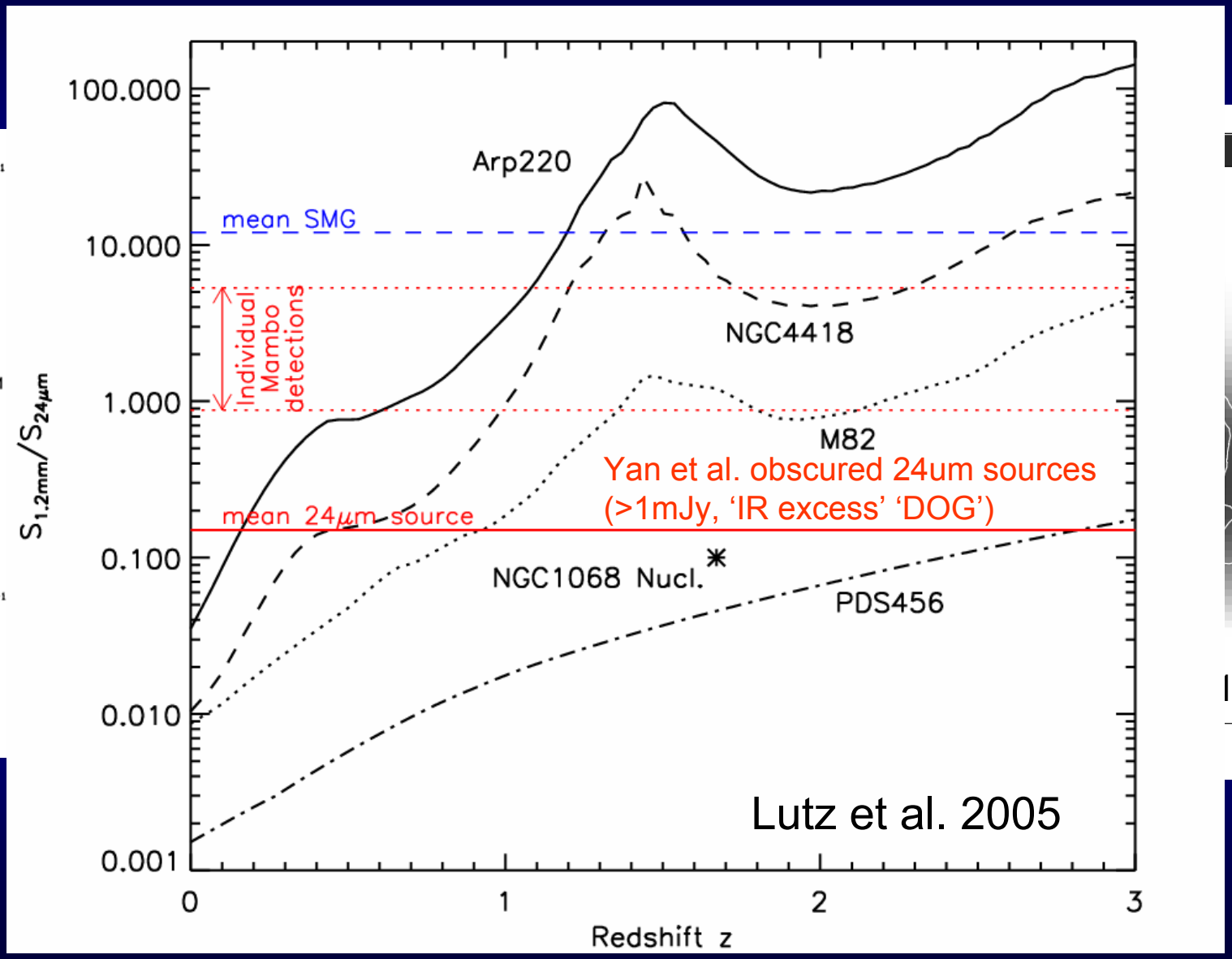
QSO SEDs from Netzer+07

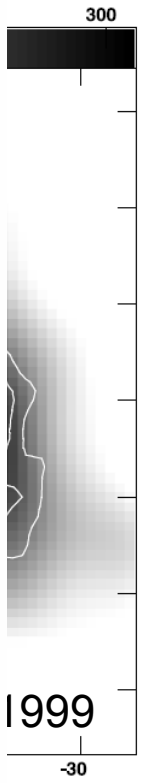
L(FIR)~0.1 L(BOL,AGN)



Hatziminaoglou+ 2010

NGC 1068: Log L(IR)~11.3 Log L(2-10keV)~43.5 (intrinsic)



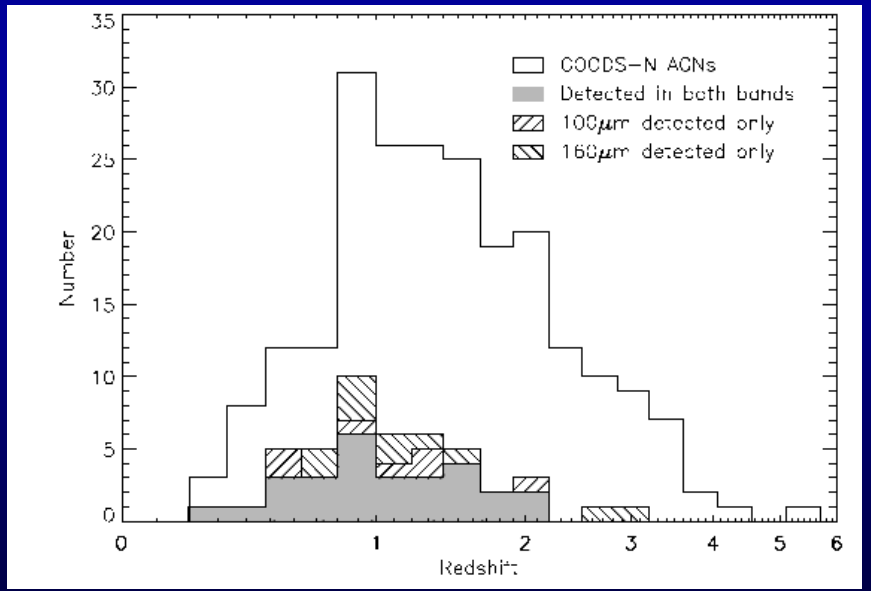


GOODS-N detection rates

FIR detection rate 21% for X-ray AGN from 2Msec Chandra

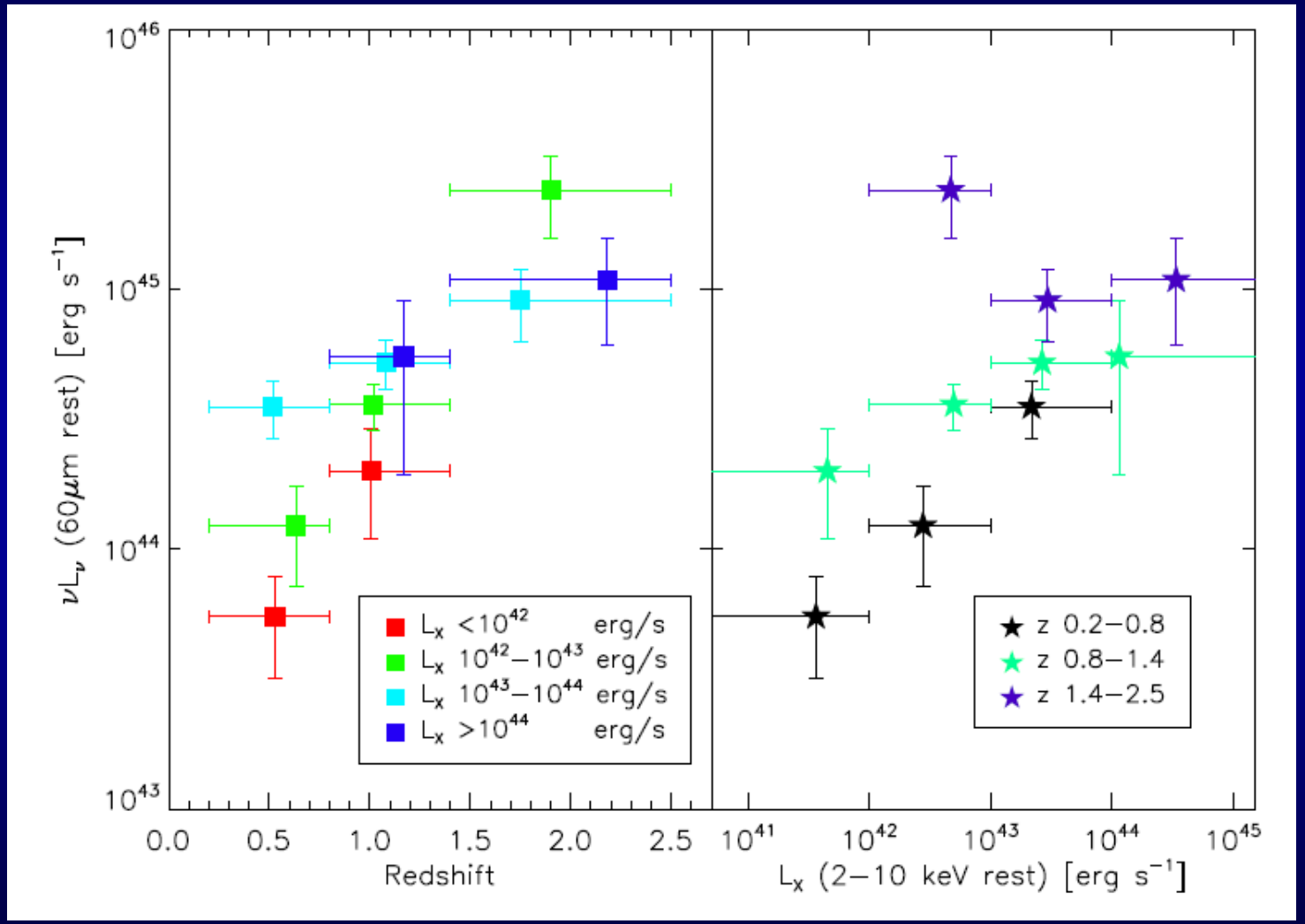
+Stacking of far-infrared nondetections

… 60% detection rate for non-AGN X-ray detected galaxies
… a different story

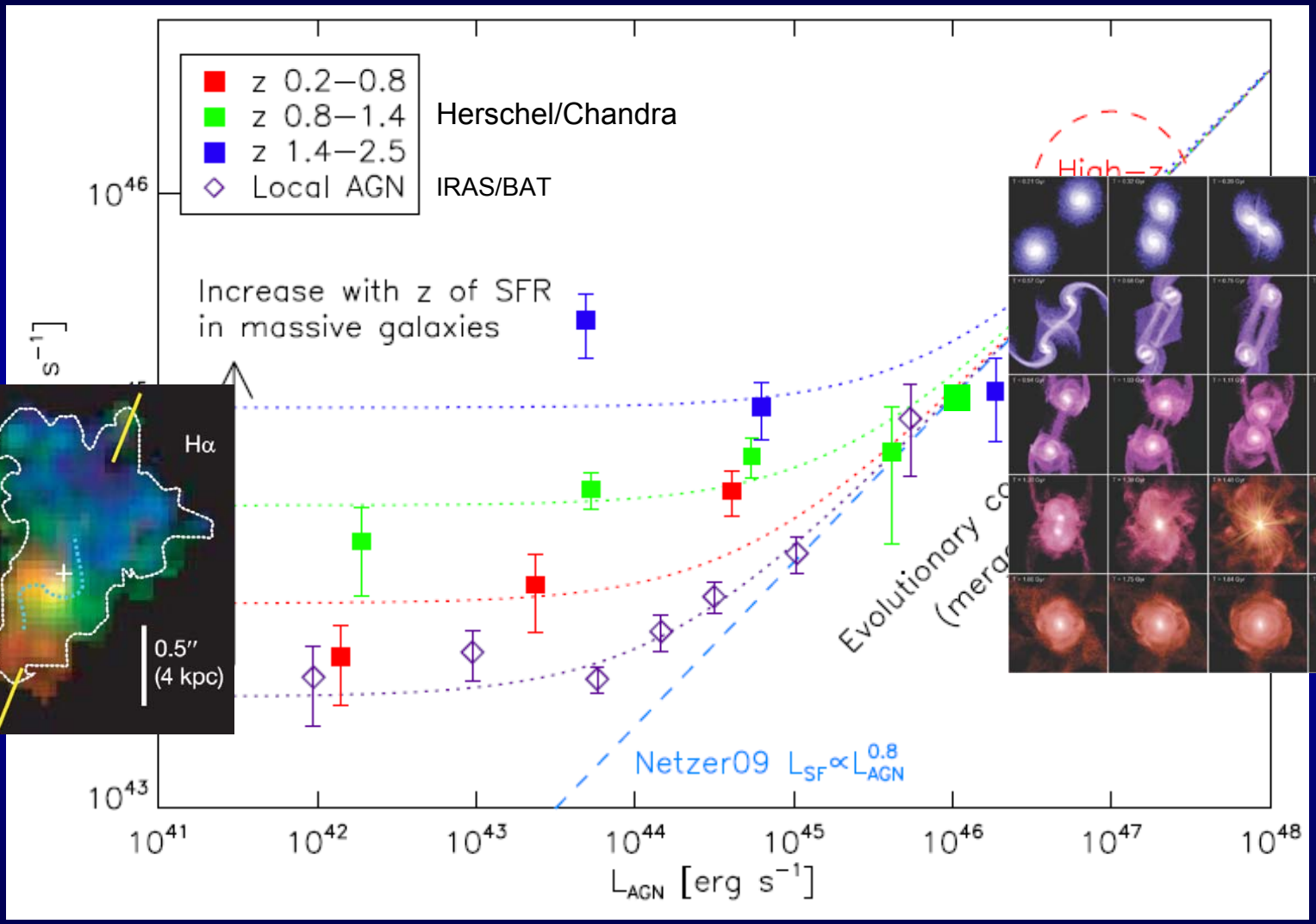


Shao et al. 2010 (arXiv)

Separating L and z



Two modes of AGN / host coevolution: Merger vs. secular



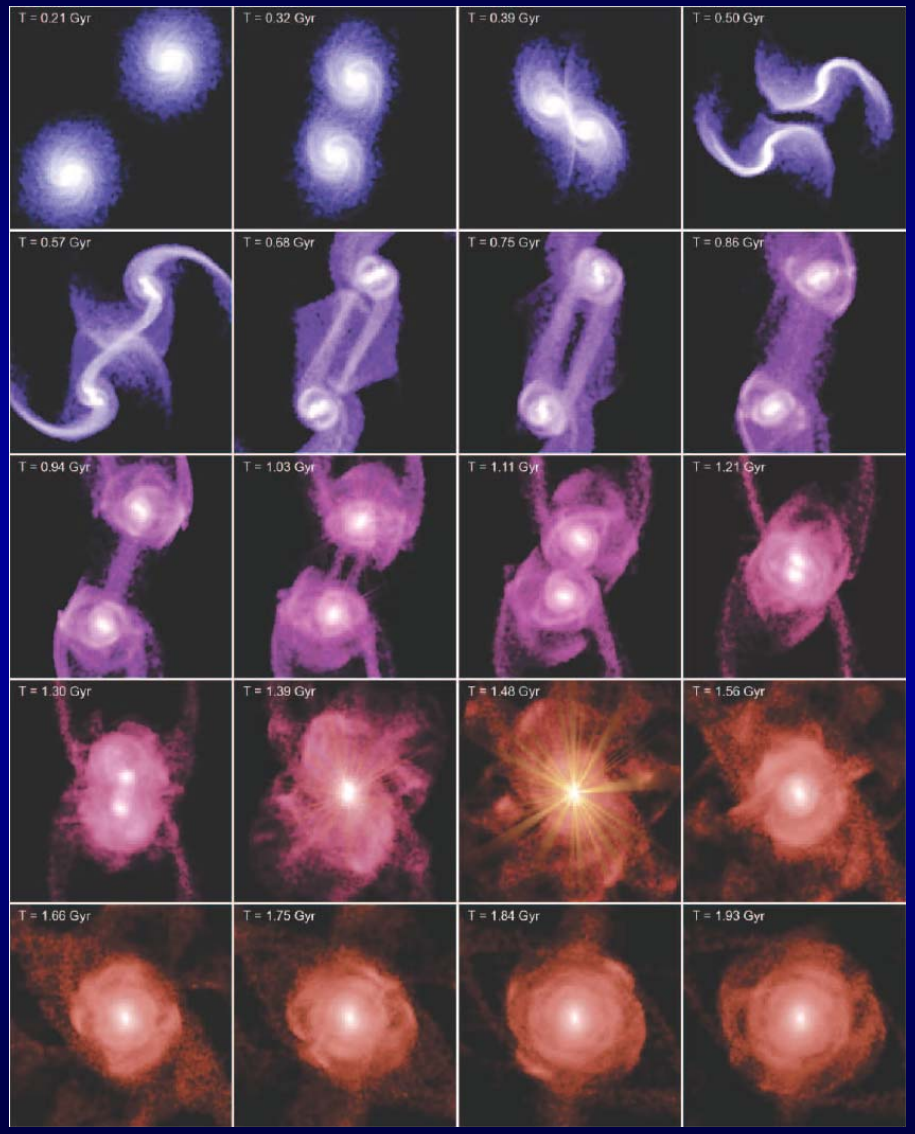
Shao et al. 2010 (arXiv)

(see also Lutz et al. 2010 submm results, Mullaney et al. 2010 Spitzer)

Further support for non-merger nature of a major fraction of X-ray AGN

- HST morphologies typically show bulgy morphologies with few mergers (Grogin+05 Pierce+07)
- Host colors similar to mass-matched non active galaxies (Xue +10)
- [OII] SFRs similar to inactive galaxies (Silverman+09)
- Rate of cosmic halo mergers ok to match quasars, but not all X-ray AGN (Hasinger+08, Hopkins+09)

Do we observe trends of star formation with AGN obscuration?

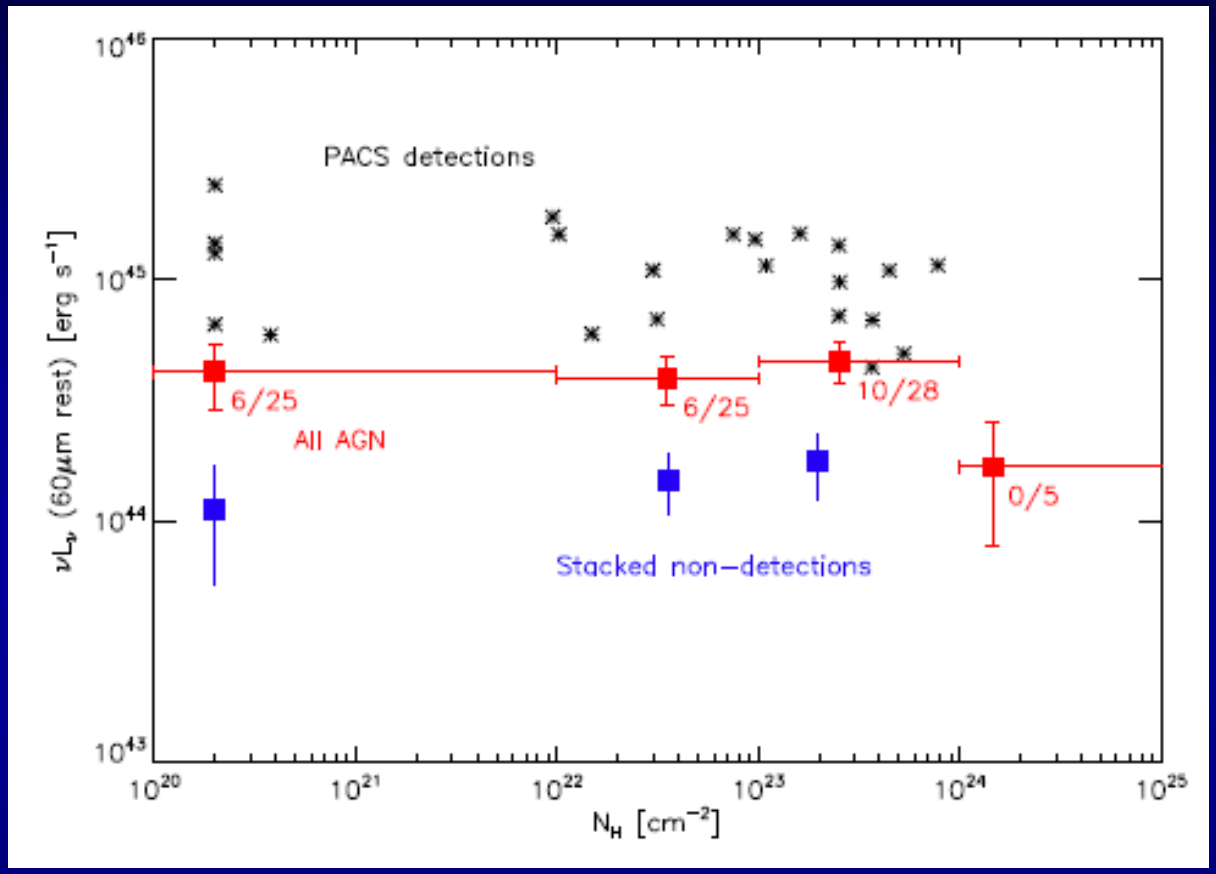


1. High SFR
2. High SFR + obscured AGN
3. Decreasing SFR + unobscured AGN

→ Expect a correlation host star formation – AGN obscuration!

Page, Stevens+ 2001 etc: Evidence from submm observations of X-ray obscured optically unobscured QSOs

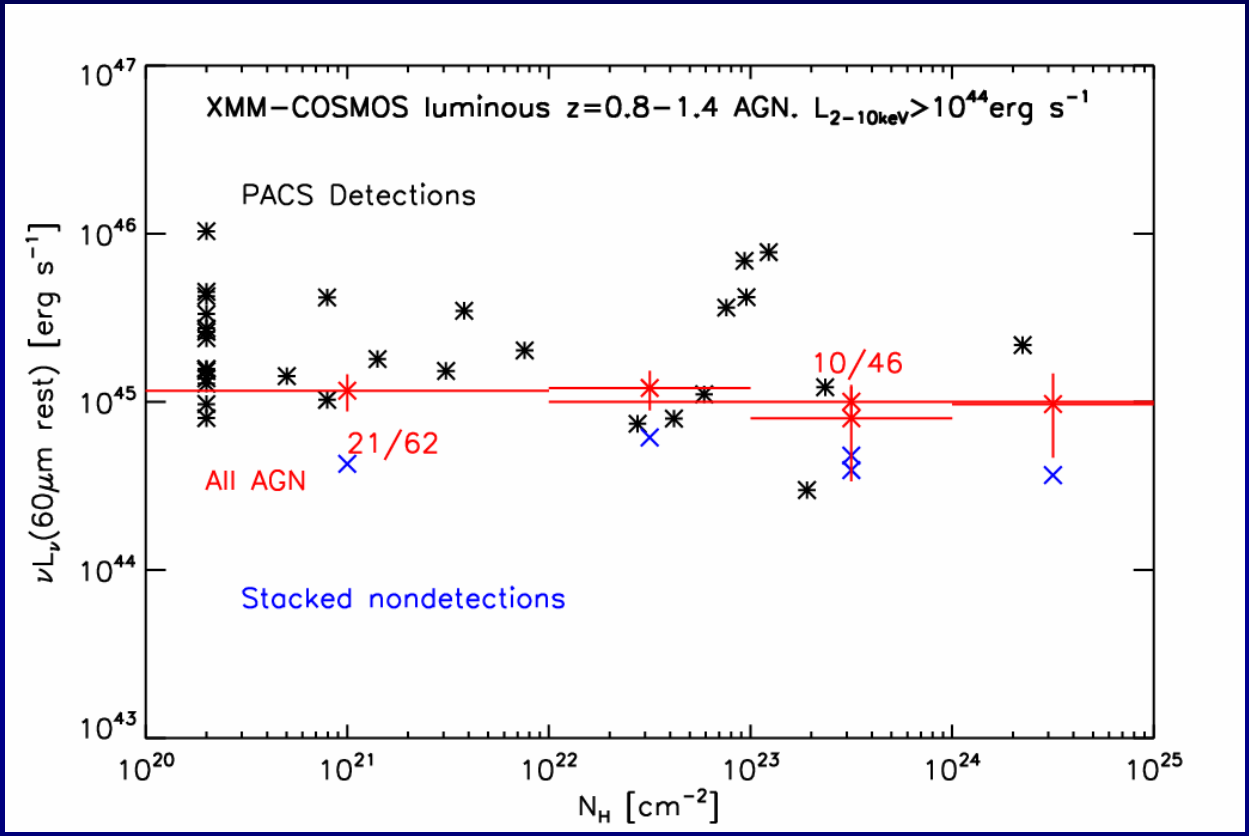
Z~1 GOODS-N X-ray AGN: No Trend



Shao et al 2010 Herschel/PACS

… but mostly modest X-ray luminosity sources

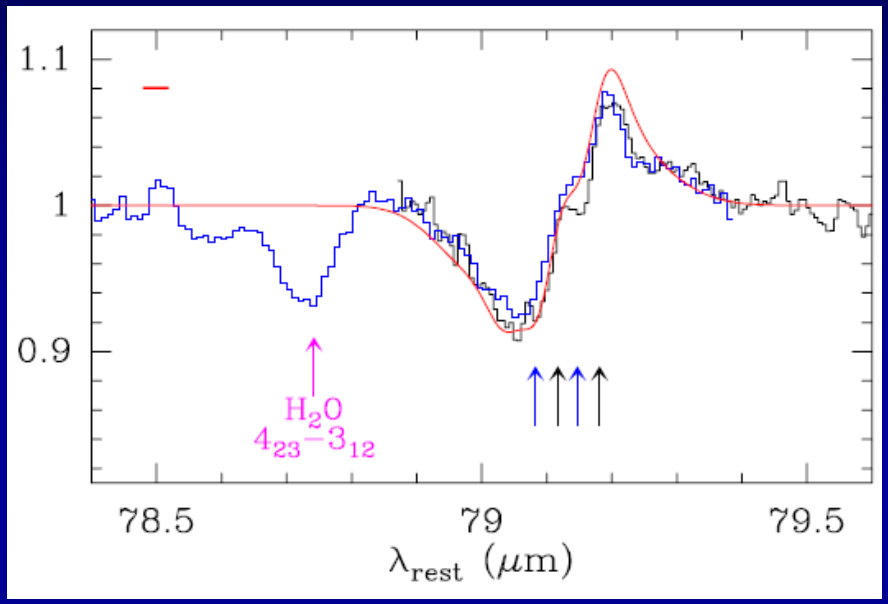
Z~1 L(2-10keV)>10^{44} COSMOS AGN: No trend

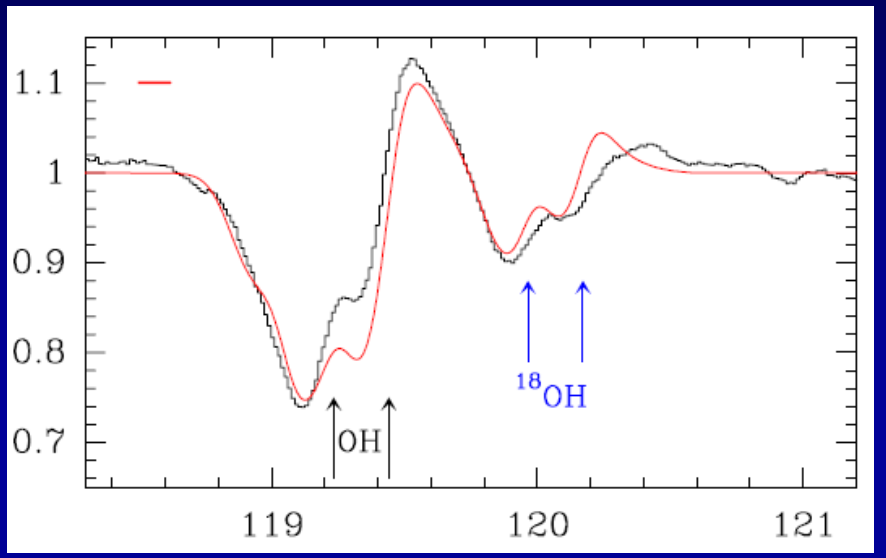


… not what is suggested by the most simple version of a merger evolutionary pattern

AGN(?) feedback at work…

OH absorptions in the AGN ULIRG Mrk 231



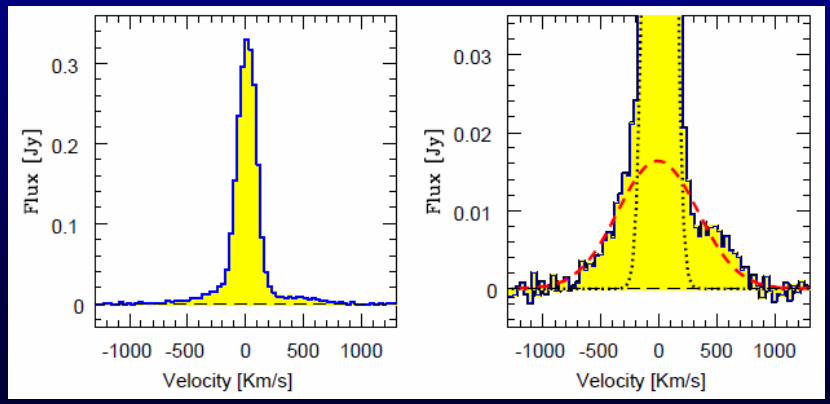


Fischer et al. 2010 (arXiv). First estimates:

- outflow mass of 7×10^7 Msun
- outflow velocities of -1400 km/s
- Mechanical energy ≥ 10^{56} erg/s

See also Feruglio et al. 2010 arXiv (Mrk 231 CO IRAM PdB)

- Outflow rate ~700Msun/yr



Thanks

- More than half of the cosmic infrared background resolved into individual sources
- AGN host star formation rates suggest 2 evolutionary modes: merger vs. secular
- Star formation and AGN obscuration not clearly correlated

Lockman Hole