# Radio Quiet AGN: Black Hole & Host Galaxy Properties

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(ESO)

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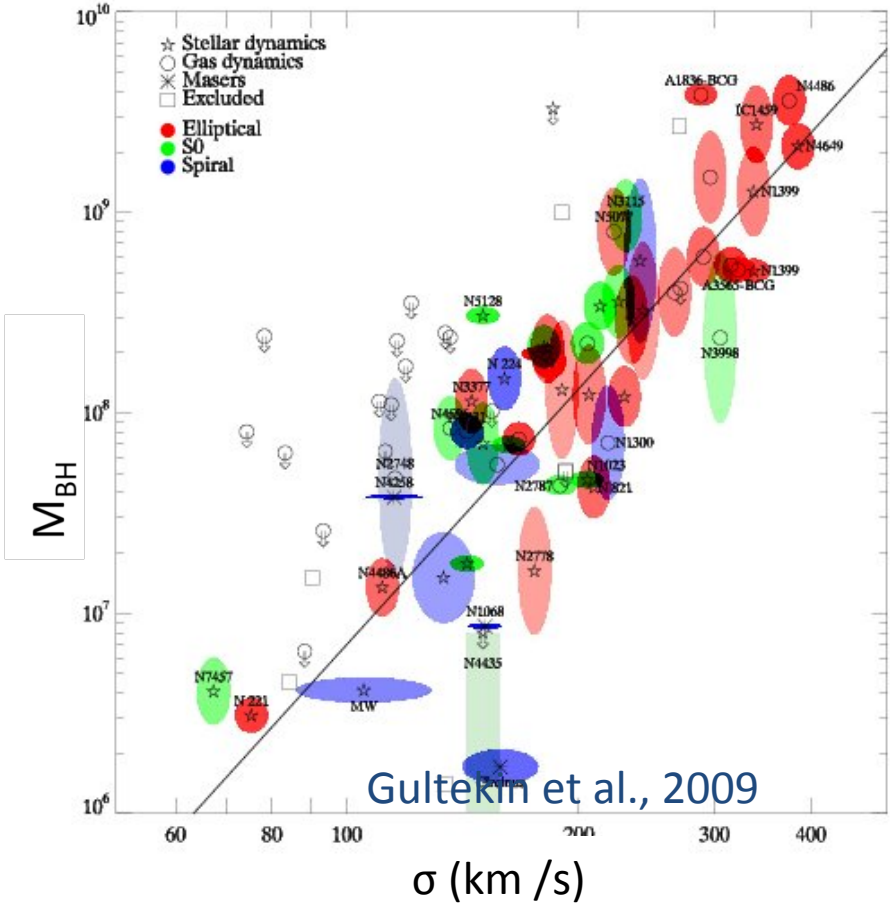
+ PEP Collaboration

Credit: ESO

In the RADIO!

Credit: ESO

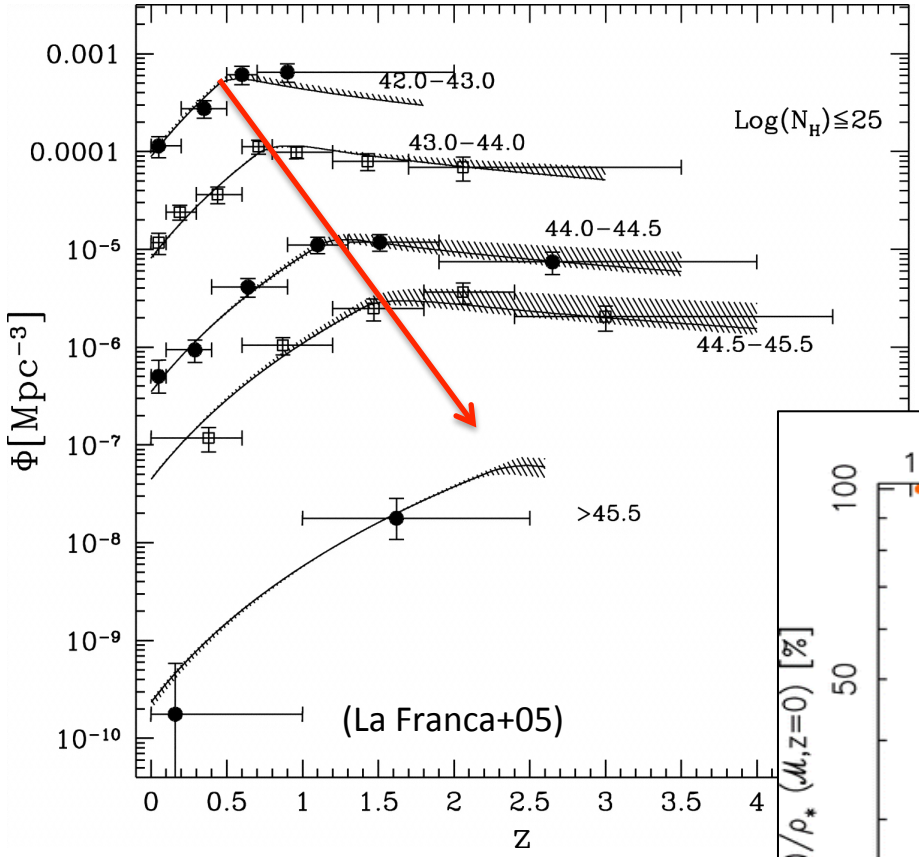
# AGN-host galaxy coevolution




## $M_{BH}$–σ relation

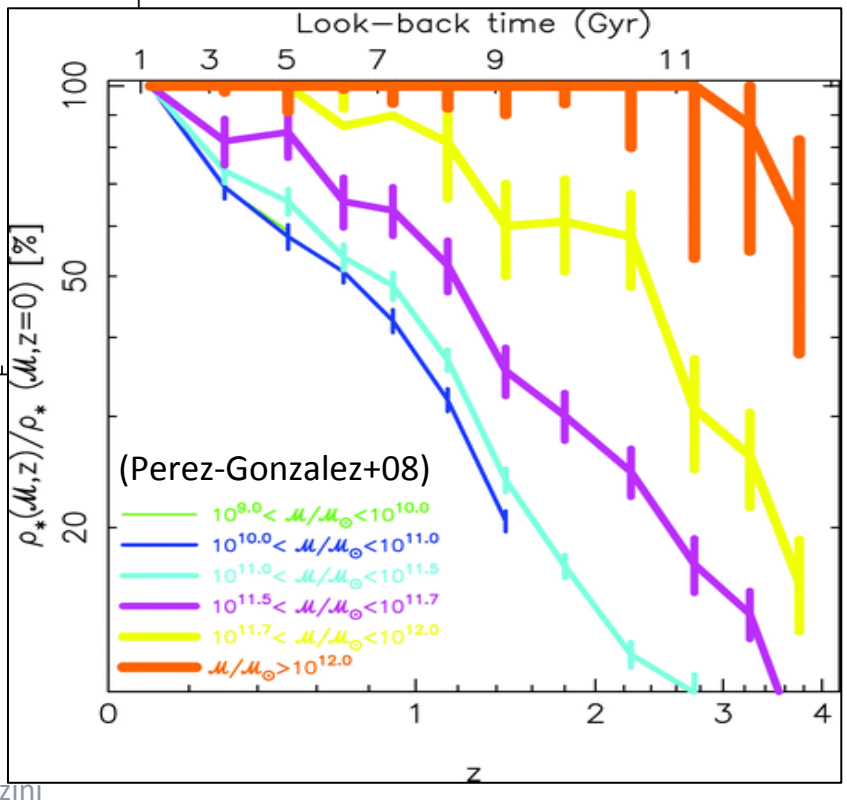
(Ferrarese & Merritt 2000; Gebhardt+00; Haering&Rix 2004; Greene+07, Gultekin et al., 2009)

# AGN-host galaxy coevolution



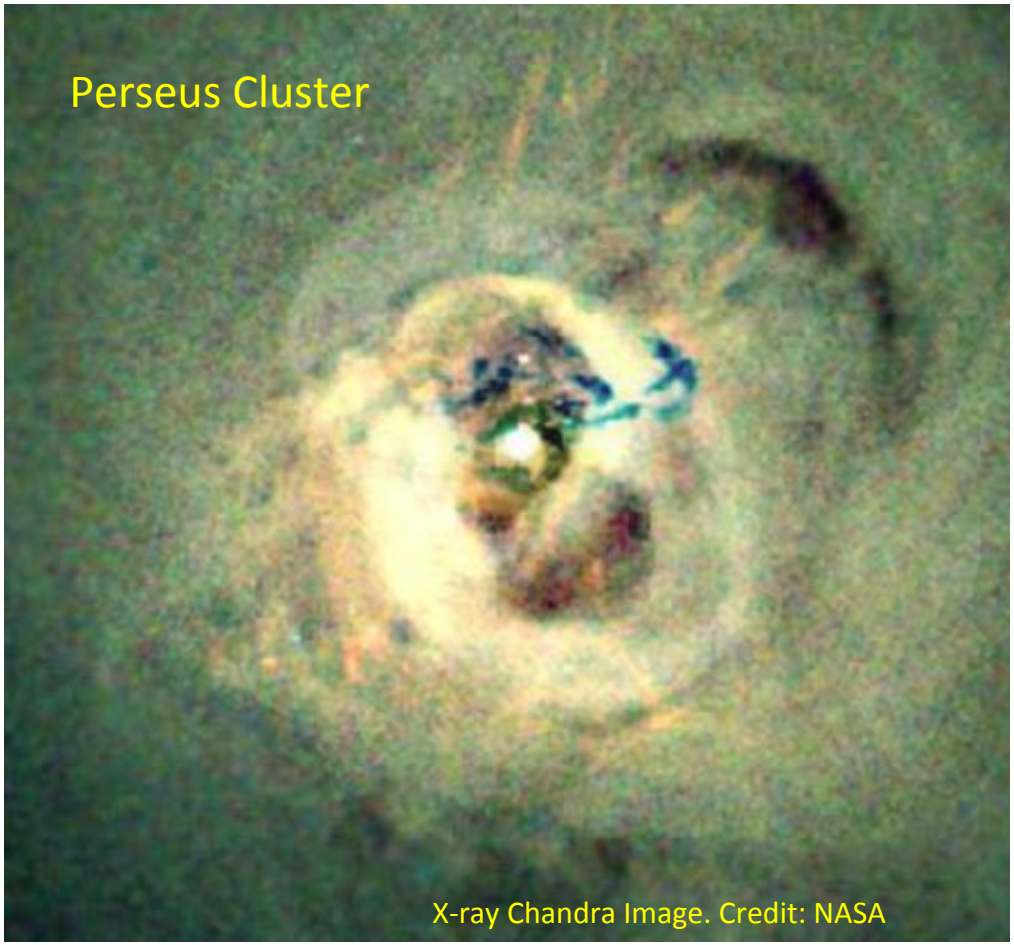

## Downsizing:

- More luminous AGN had the peak of activity at earlier redshifts
- More massive galaxies form at higher redshift




## Feedback

# Why in the radio?




- X-ray cavities inflated by radio jets.

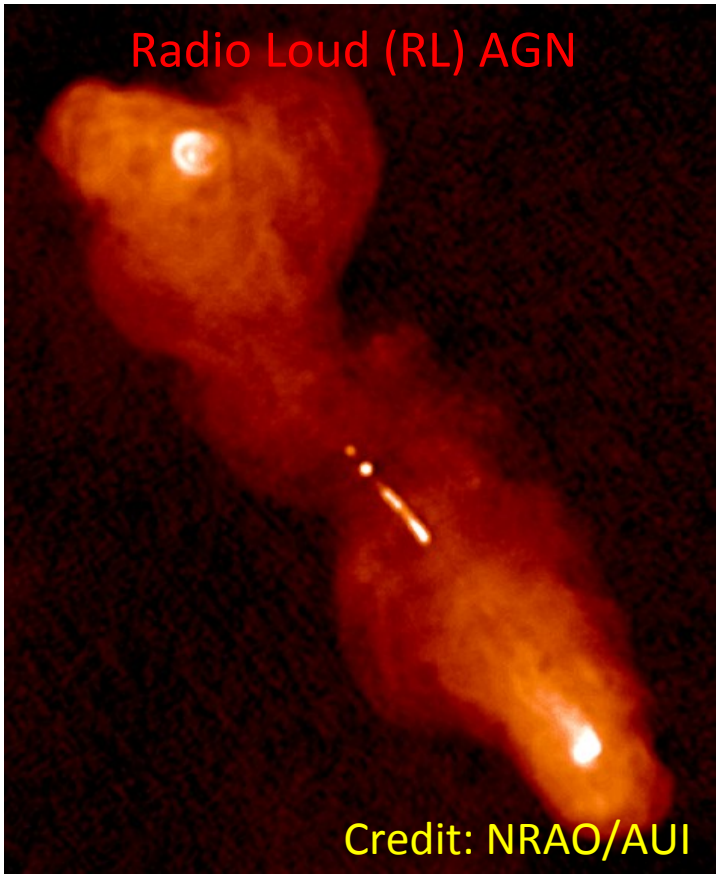
(e.g Fabian & Sanders 2006)

- Not affected by DUST

  - Obscured sources
  - High z

# Why **deep** in the radio?

1) Below 0.1 mJy: **Star Forming Galaxies (SFG)**



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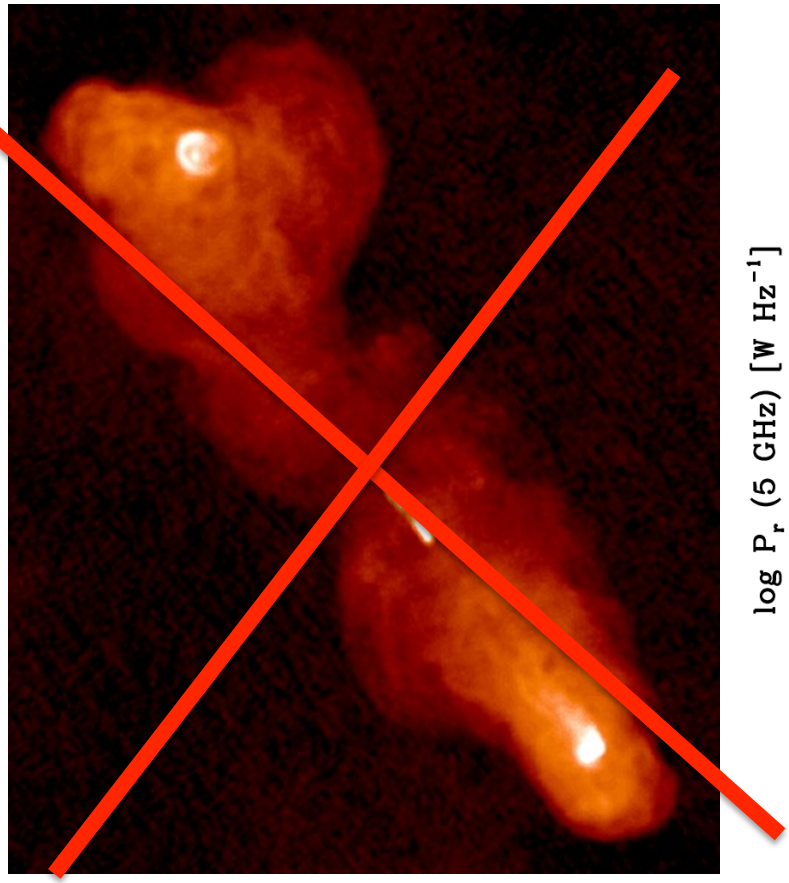
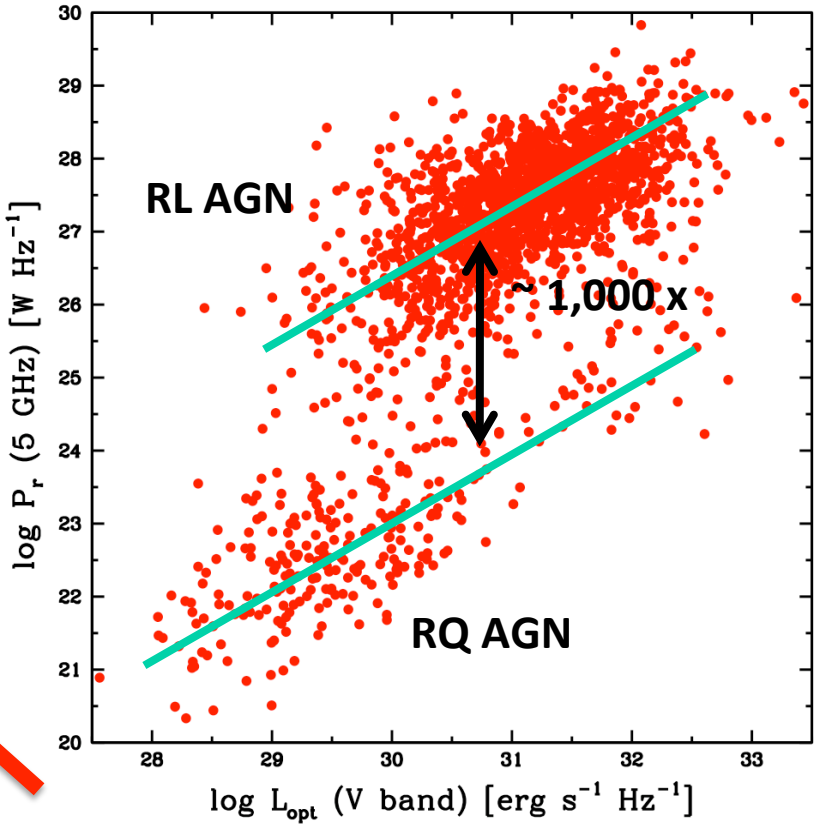
1) Below 0.1 mJy: **Star Forming Galaxies (SFG)**

2) Most of the AGN are **Radio Quiet (RQ) AGN**





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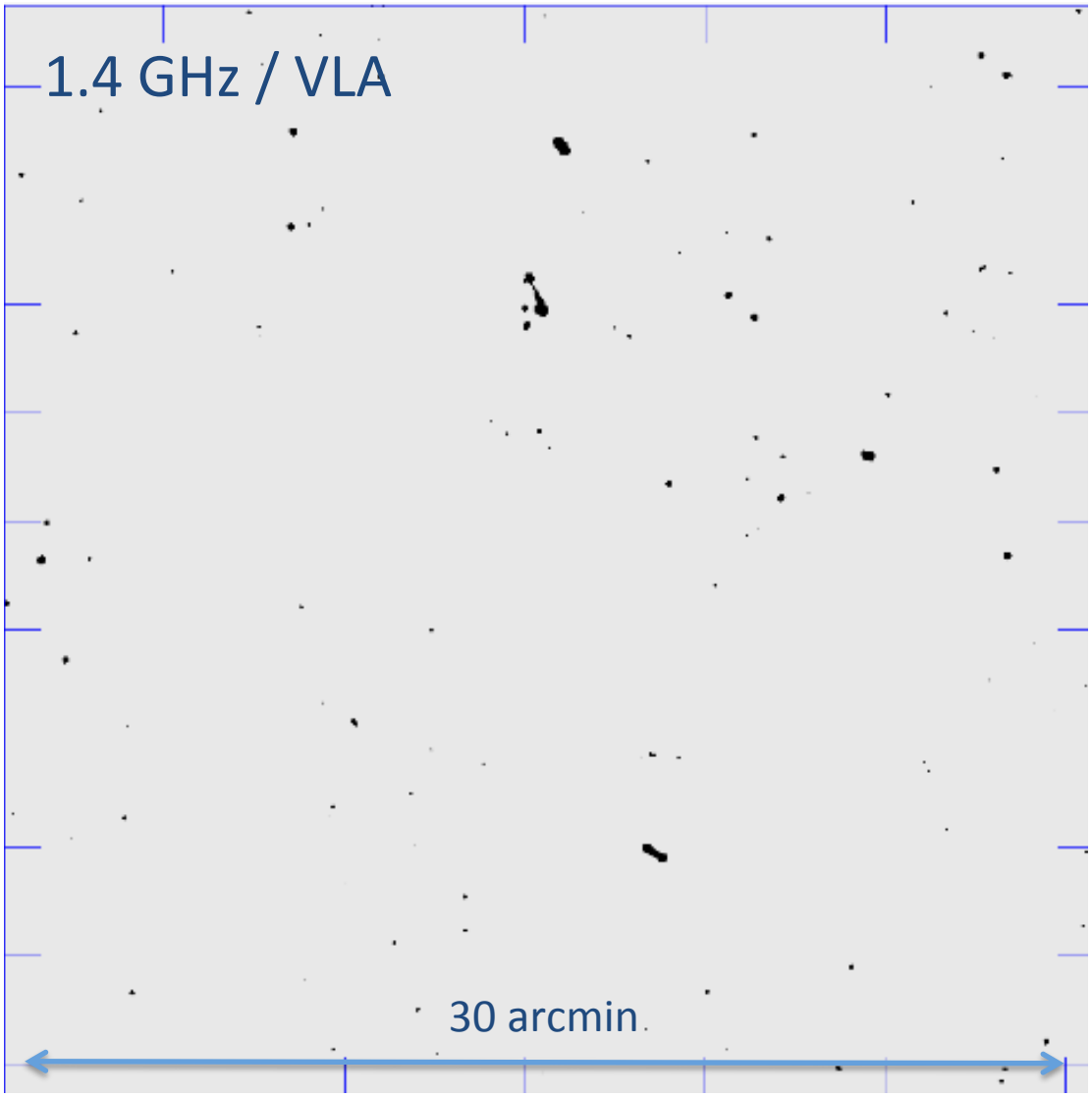
3) Square Kilometer Array (SKA) & pathfinder

ASKAP

MeerKAT

SKA

# Extended Chandra Deep Field South




- ~ 900 sources
  5σ flux density limit: ~30 μJy
  (Miller+,in preparation)

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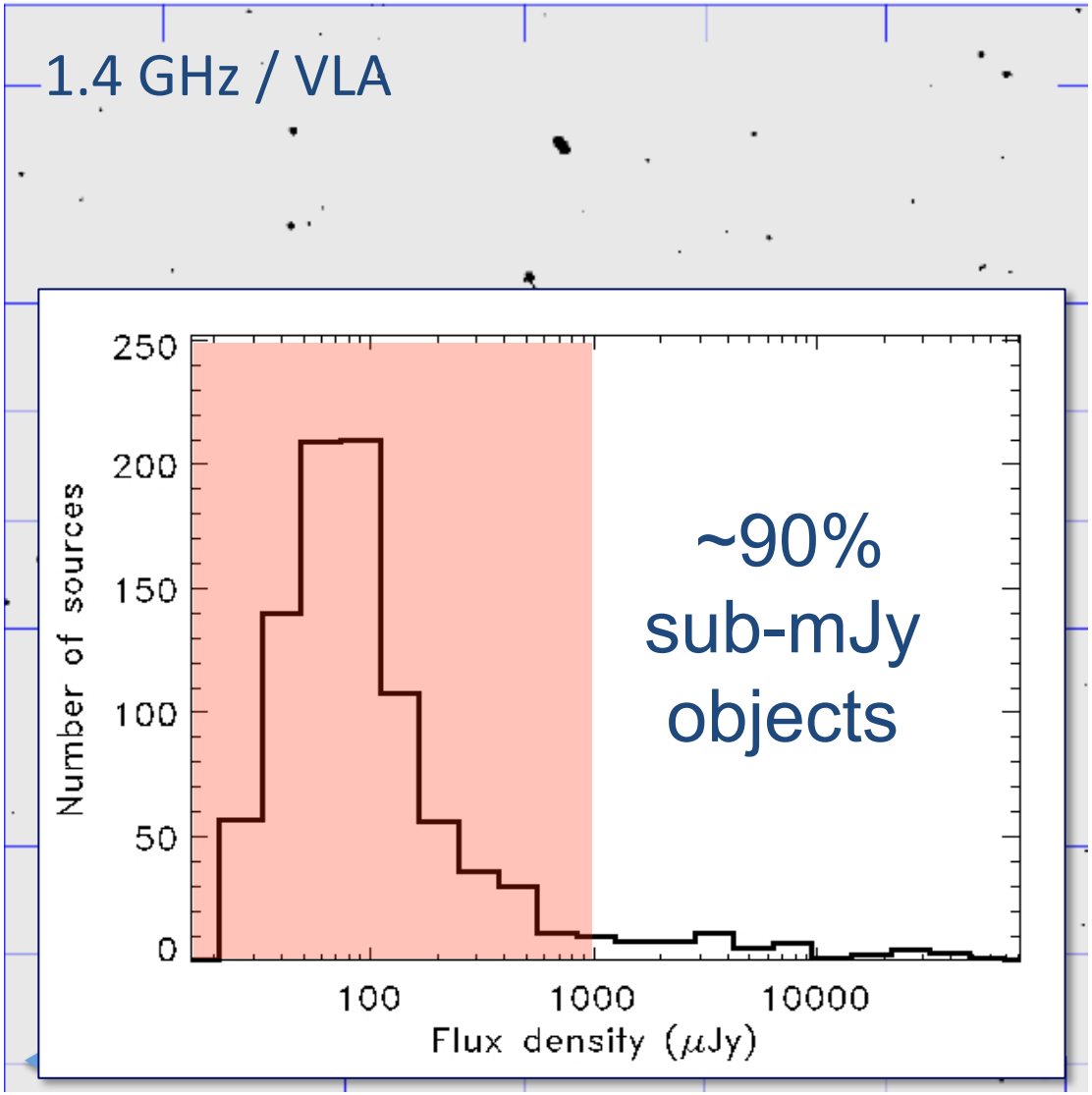


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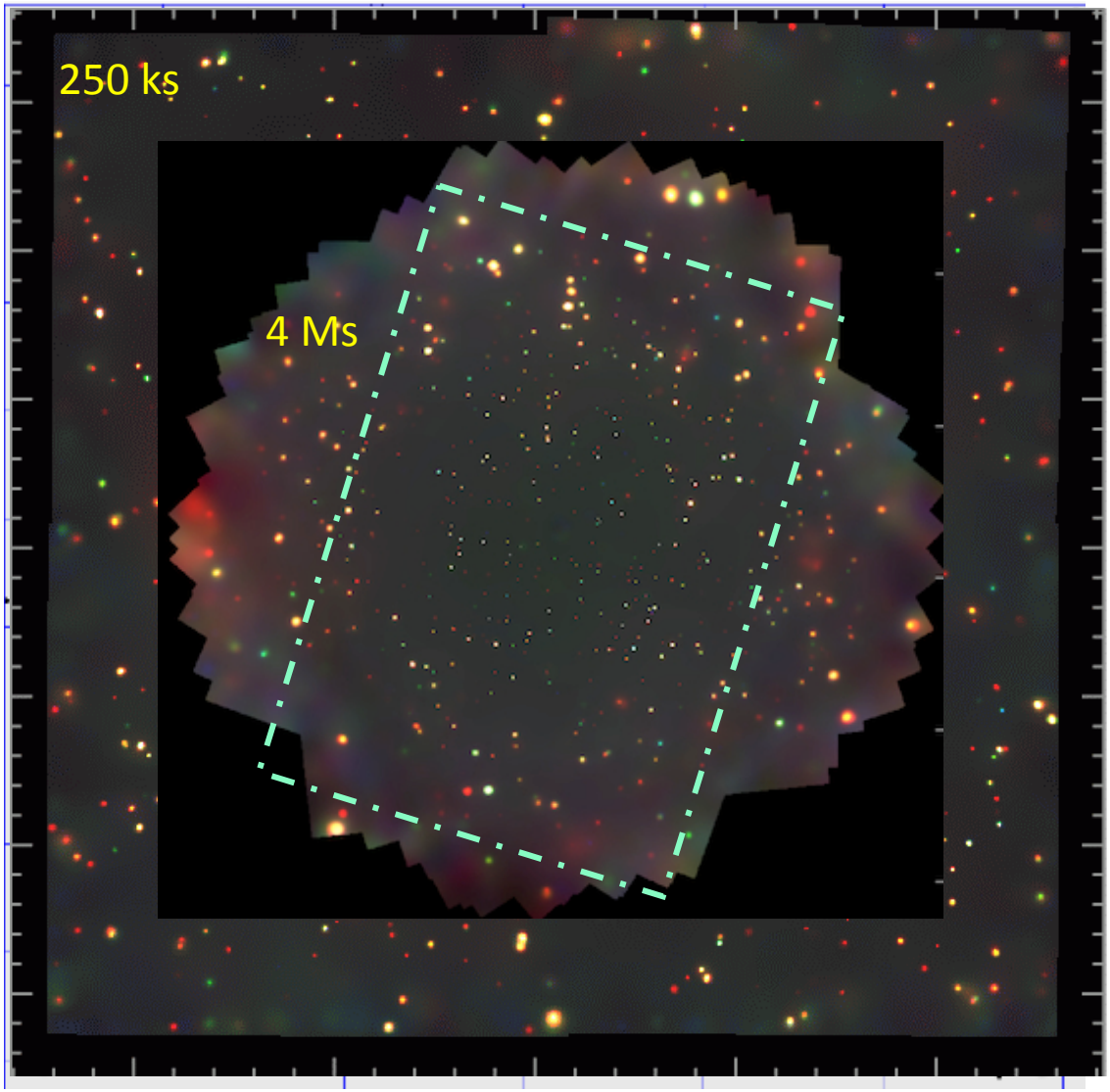
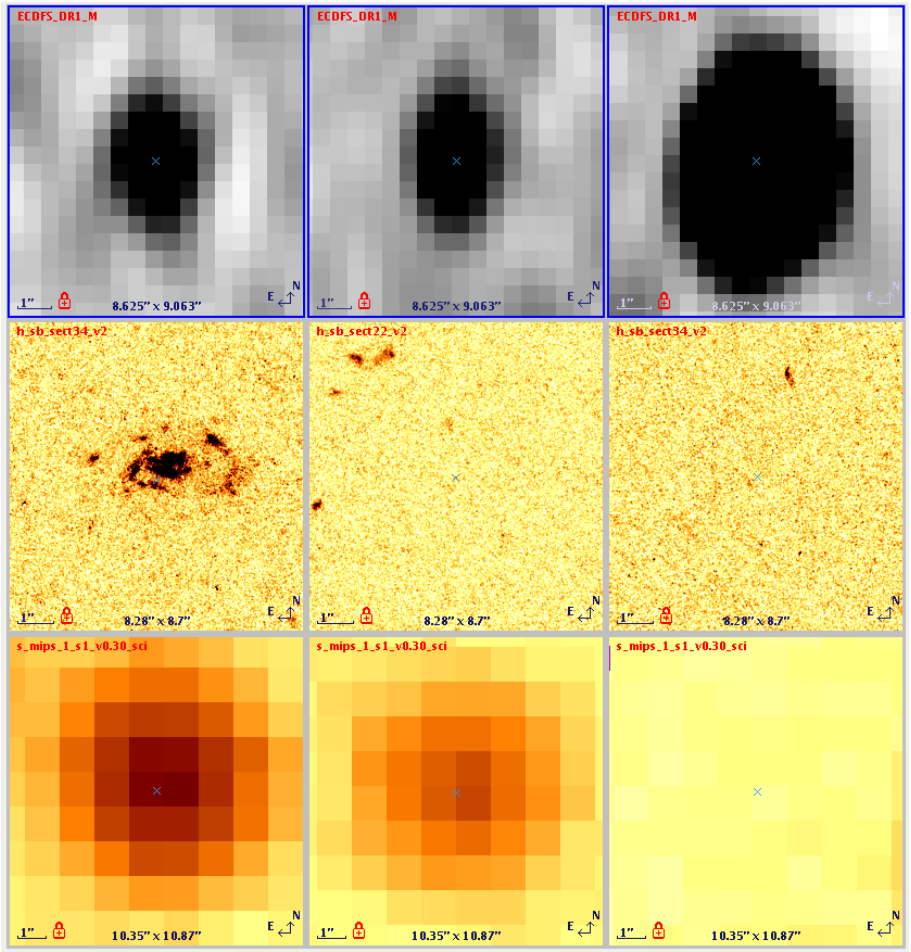



- ~ 900 sources
  5σ flux density limit: ~30 μJy
  (Miller+,in preparation)
- Chandra: 250 ks + 4 Ms
- GEMS/ACS, VLT/FORS + ISAAC, Subaru, NTT/SOFI, ESO2.2m/WFI
- GOODS/ACS
- Spitzer/IRAC +MIPS

# Optical and IR counterparts

Sources with counterpart: **94%**

with redshift: **78% (40% spectroscopic)**, <z>≈1




VLA
1.4 GHz
images

ACS
z-band
images

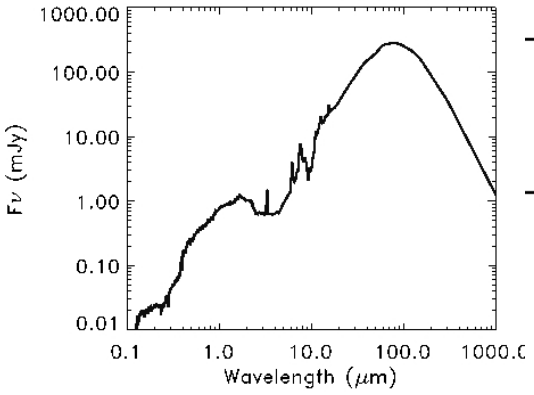
MIPS
24 μm
images

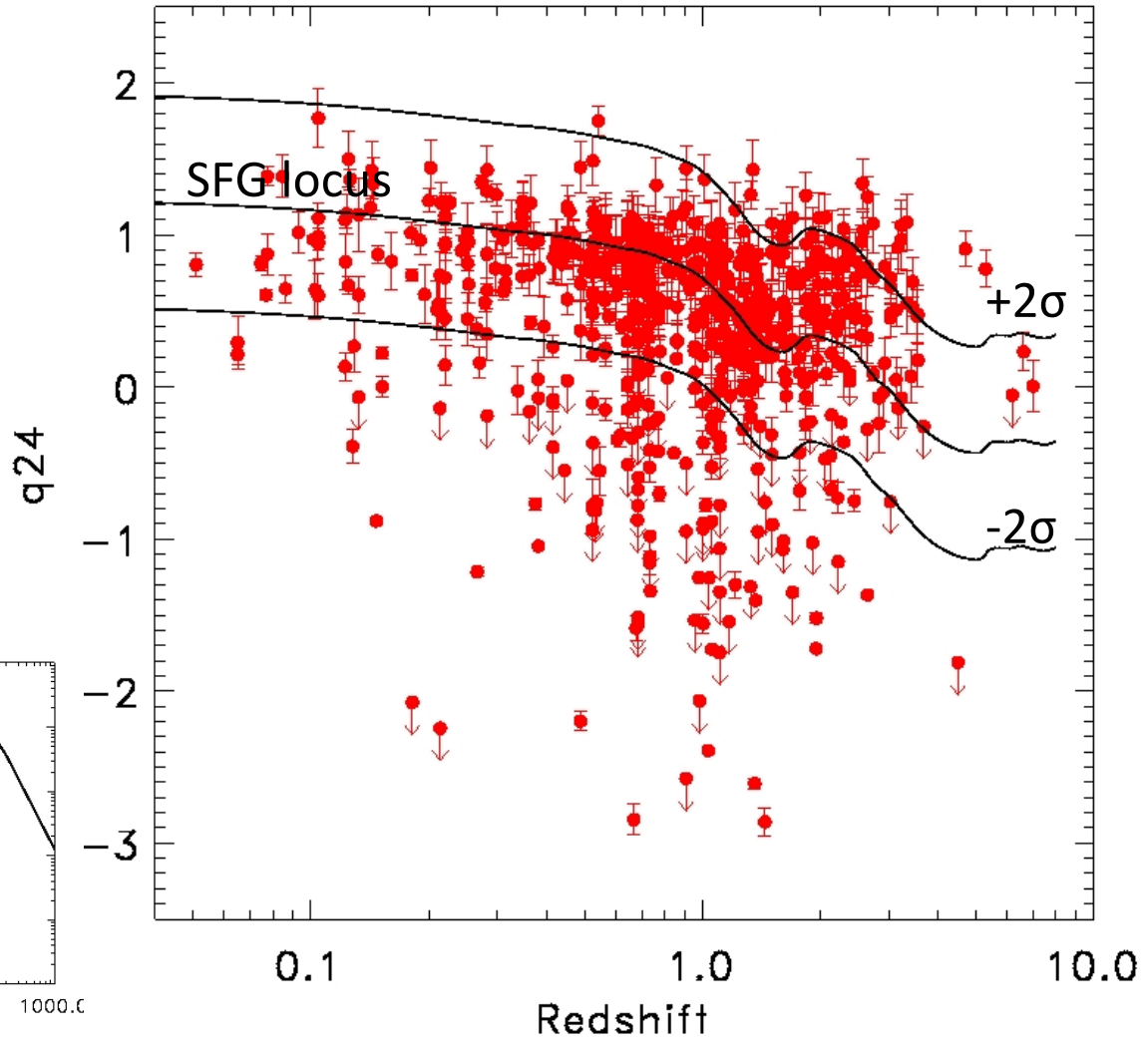


(Bonzini+. 2012, in press on ApJS)

# AGN or SFG?

$$q24 = \frac{S_{24\mu m}}{S_{1.4GHz}}$$




(Sargent+10)

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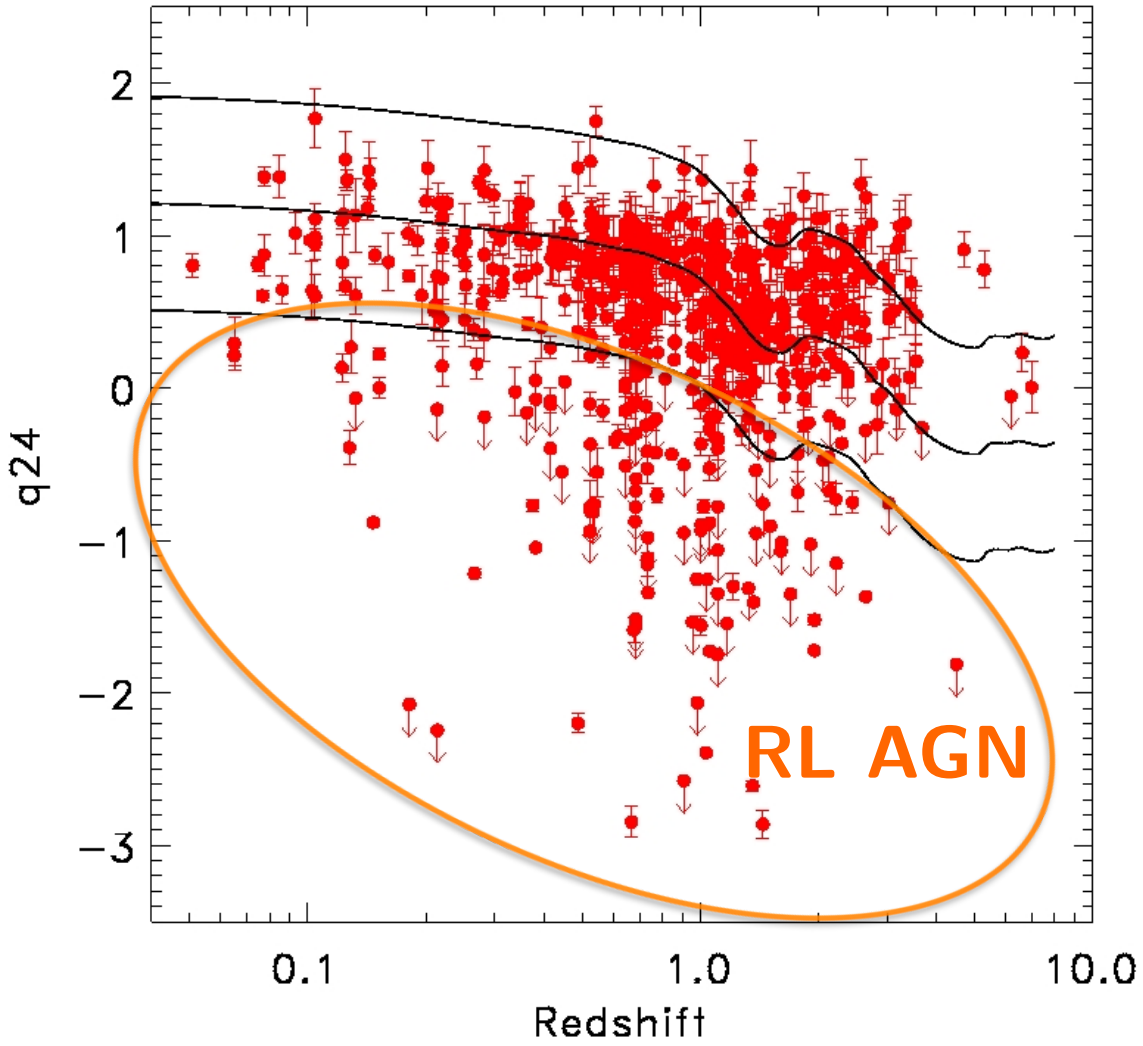
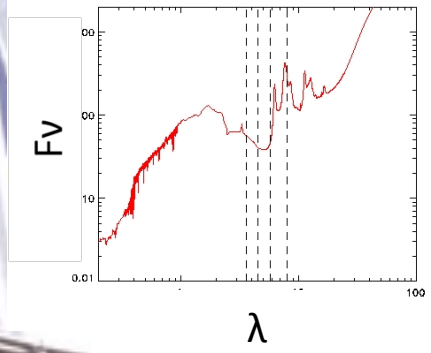


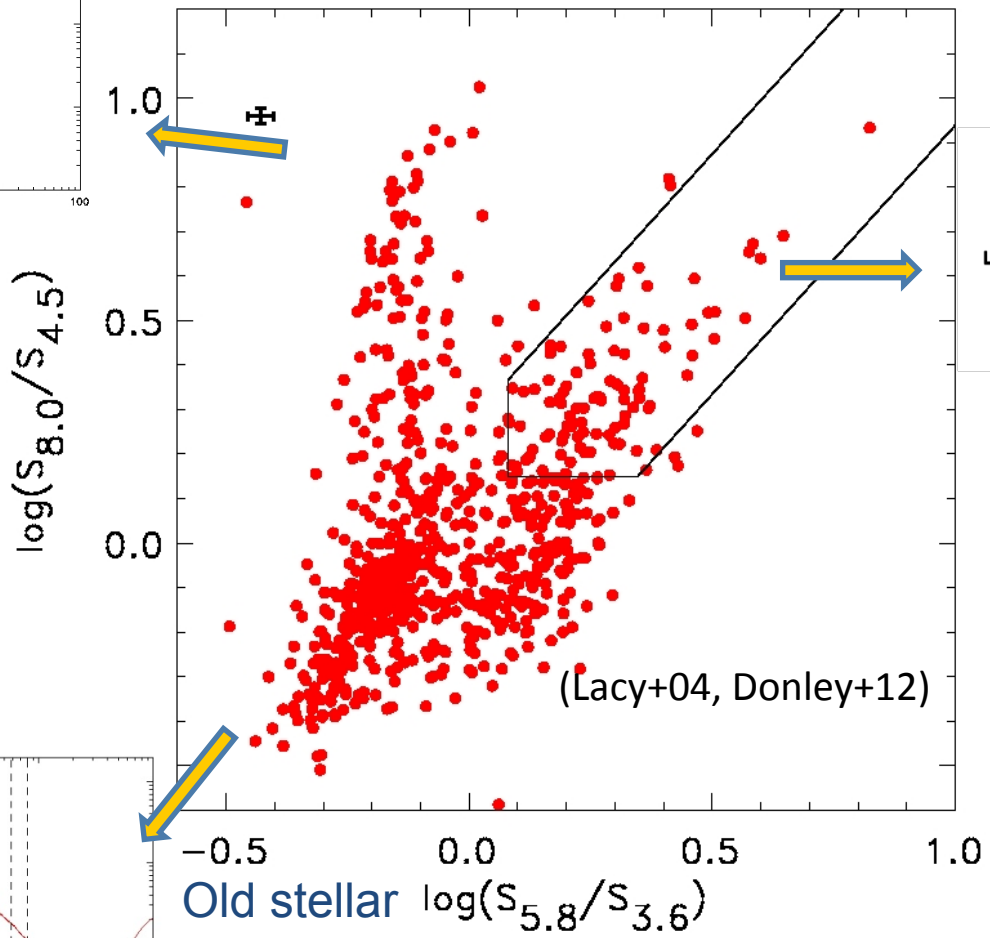
# AGN or SFG?

SFG

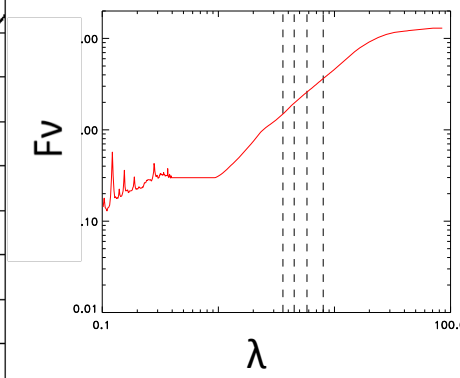



PAH dominated sources

IRAC color-color diagram:

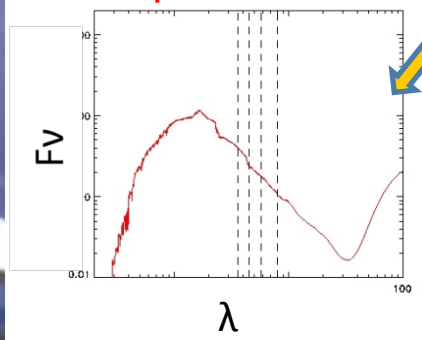



QSO




Power law sources: AGN dominated

Elliptical



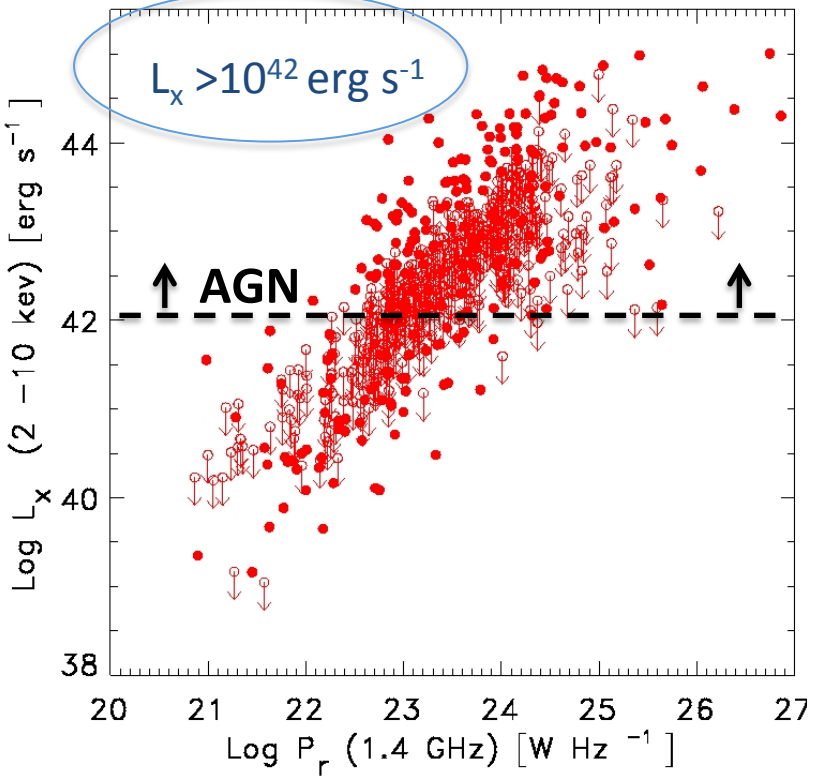

Old stellar population galaxies

(Templates from Polletta+07)

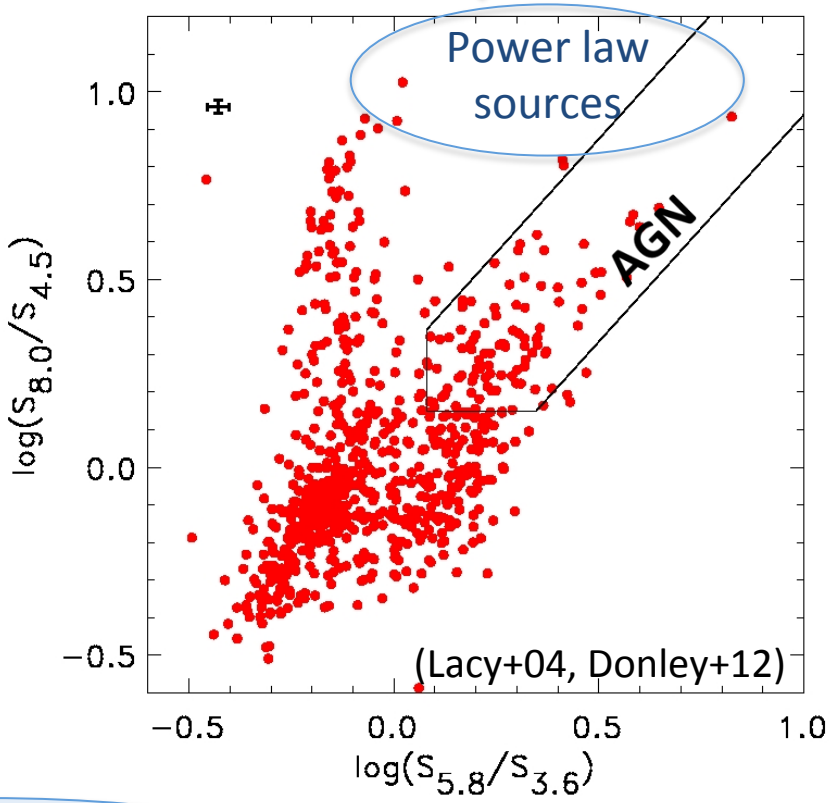
# AGN or SFG?

If NOT RL AGN

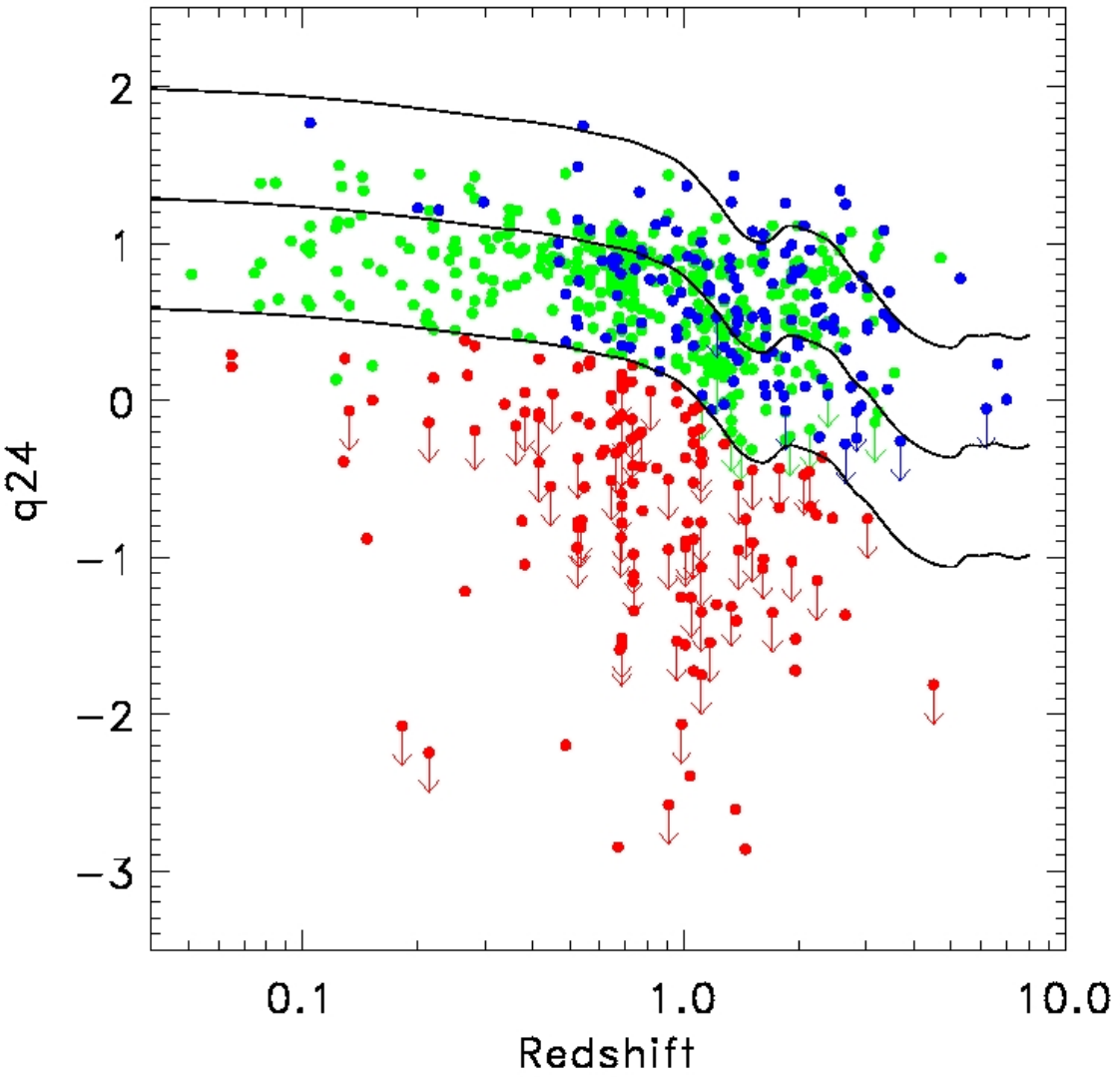
$L_x > 10^{42}$ erg s$^{-1}$




Power law sources




YES = RQ AGN; NO = SFG

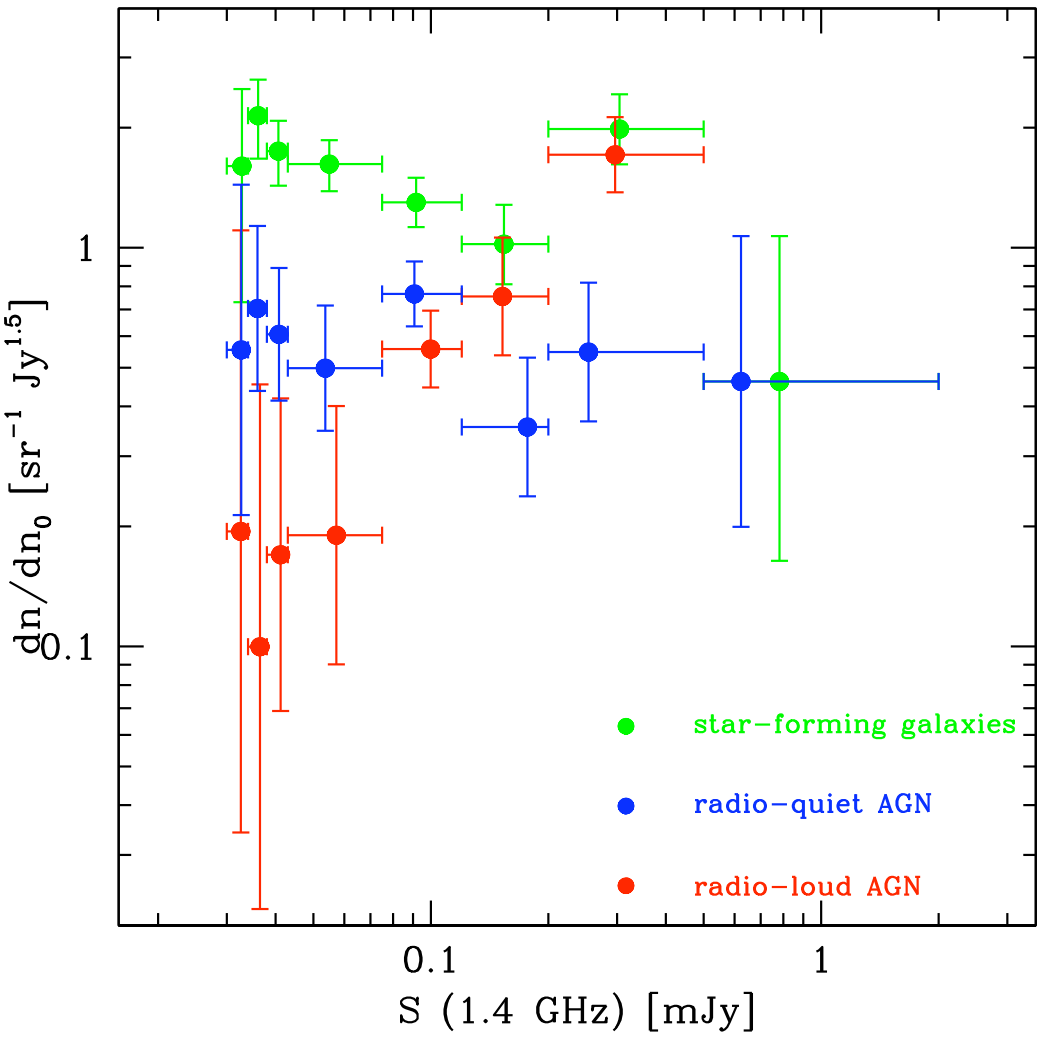



63% SFG - 20% RQ AGN - 17% RL AGN



(Bonzini+. 2012, in preparation)

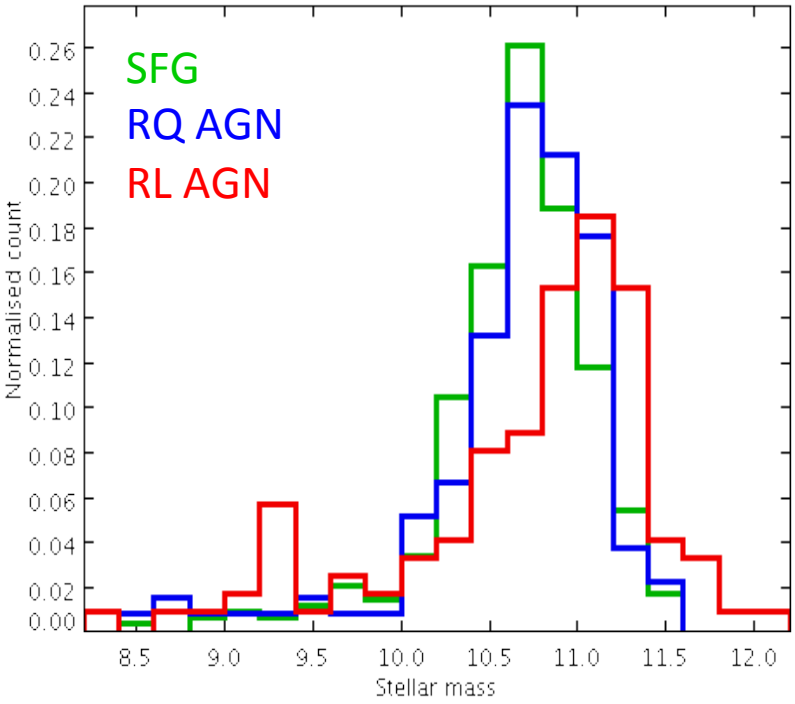
# Euclidean normalized number counts

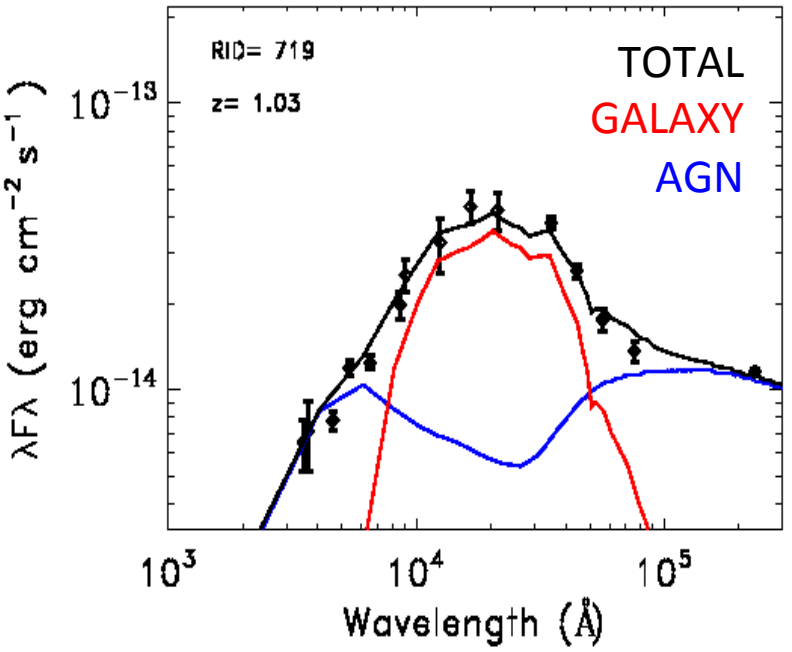


# $M_{star}$ & Morphology

Stellar mass from SED fitting:

(Bongiorno+12;
Bruzual&Charlot03, Richards+06)



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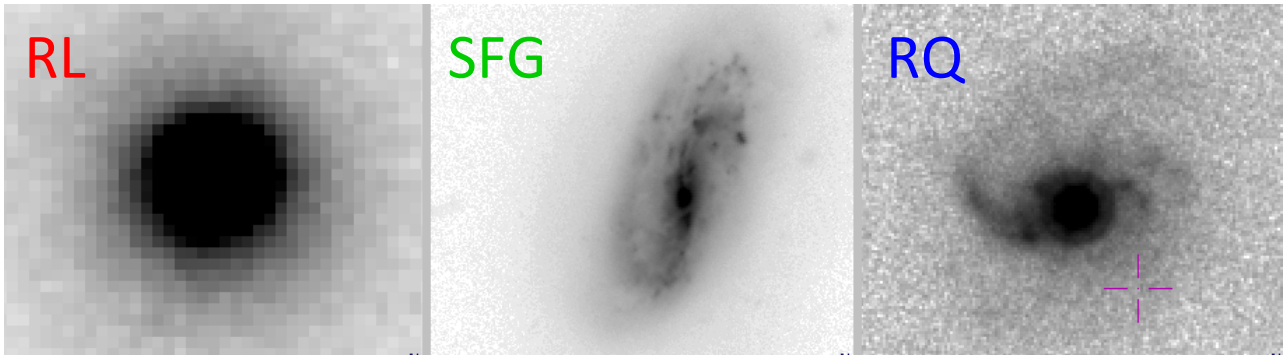
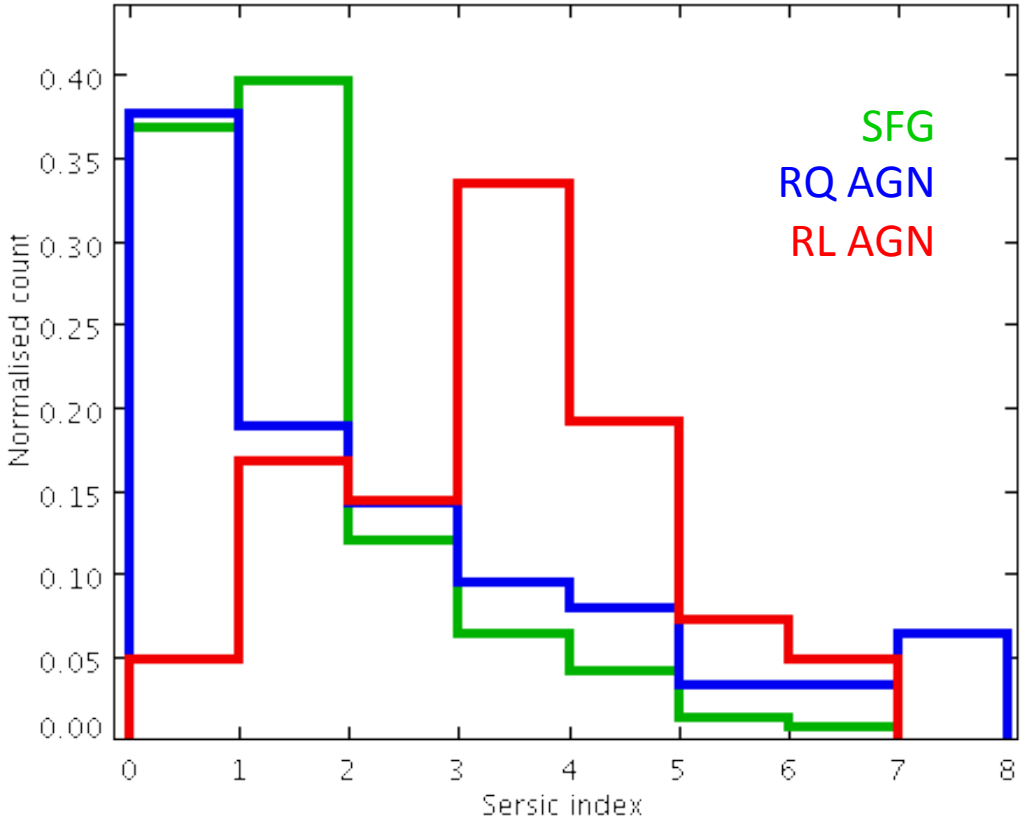
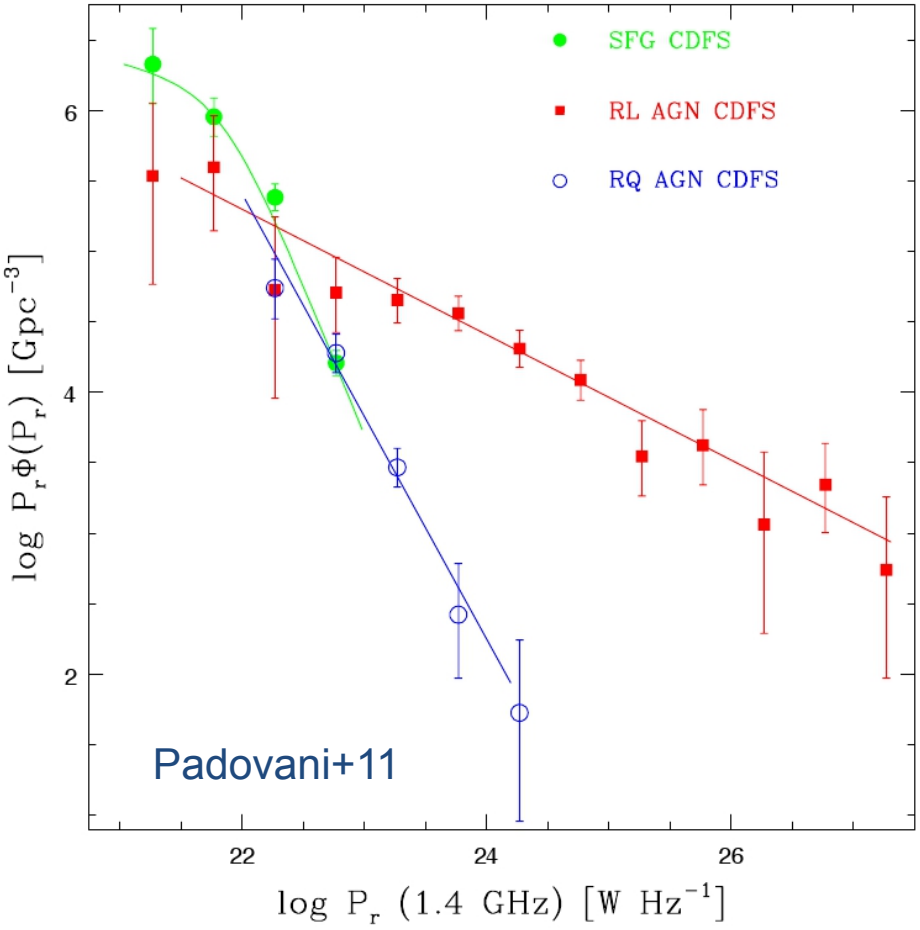



Blue band rest-frame morphology:
higher fraction of late type host galaxies for RQ AGN.




(Sérsic index from GEMS catalog, Häußler et al. 2007)

# Radio emission in RQ AGN




The Luminosity Function (LF) of RQ AGN appears as an extension of the SFG LF

+

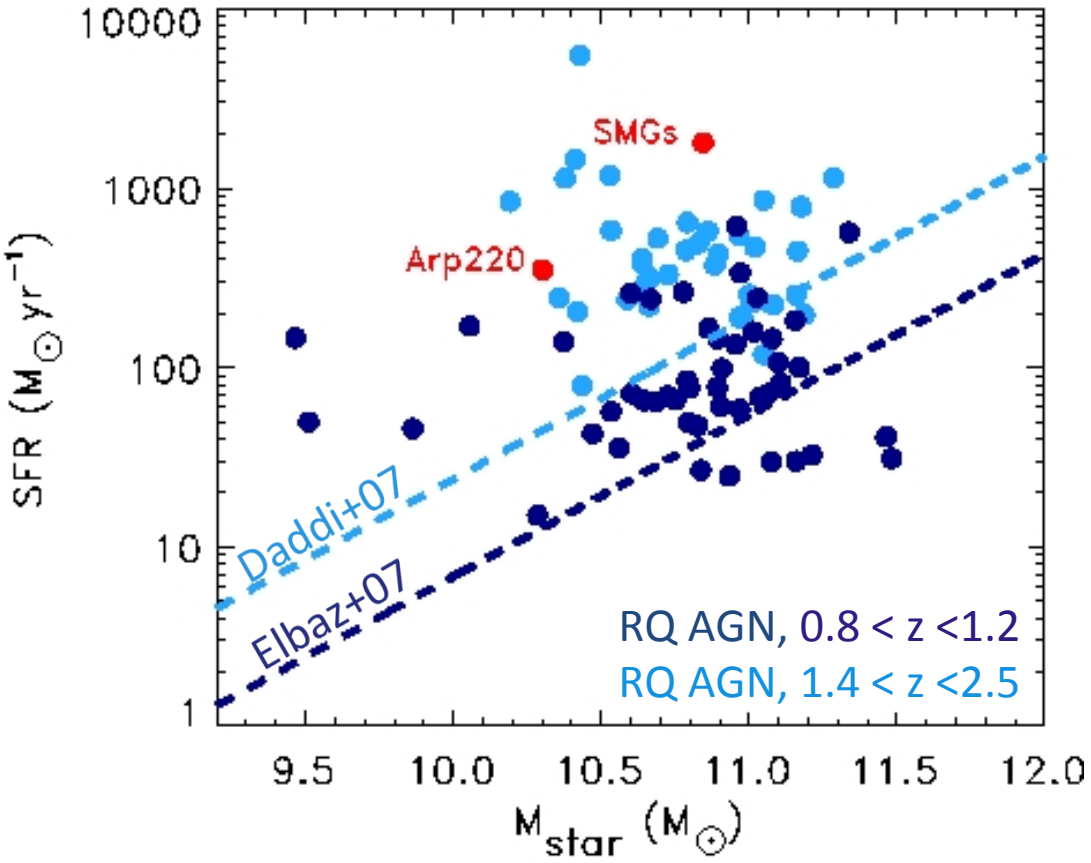
SFG and RQ AGN have the same evolution

Hypothesis: radio emission from **star formation** rather then from accretion

# SFR from **radio** luminosity

$$SFR = 5.9 \pm 1.9 \times 10^{-22} L_{1.4GHz} [M_{sun} yr^{-1}]$$

(Bell+03)



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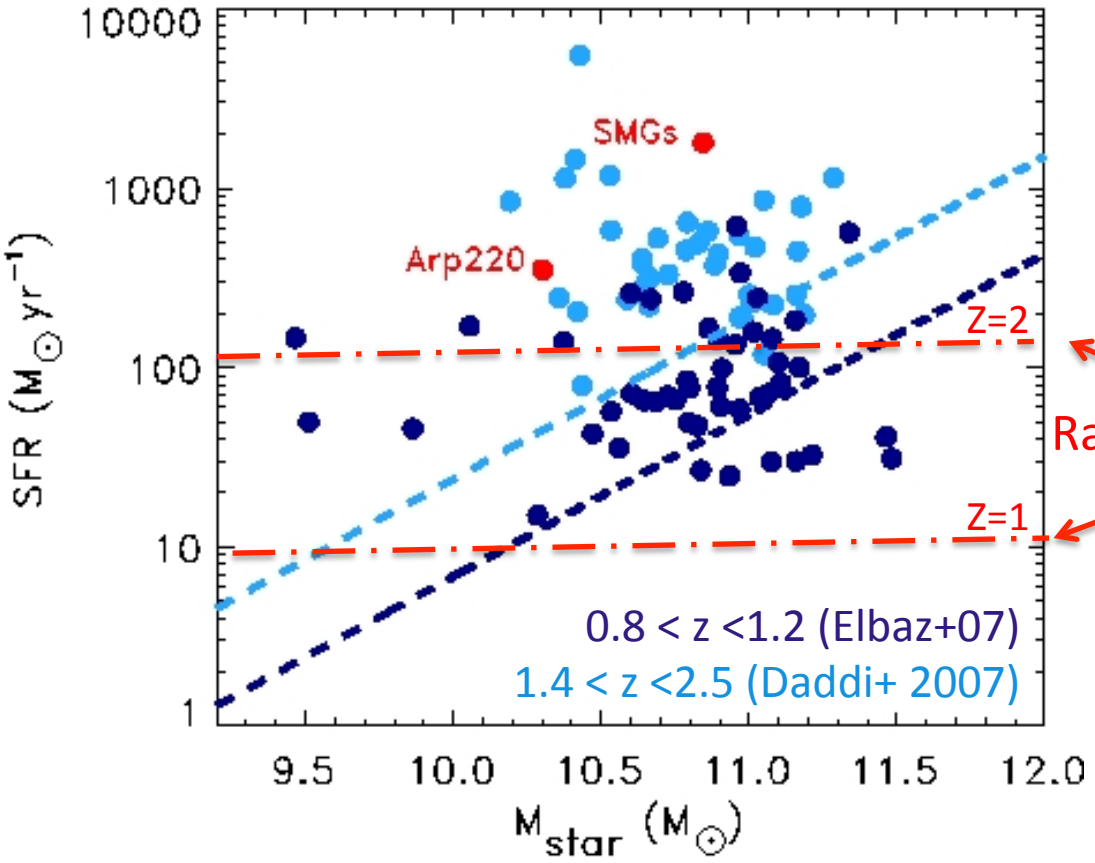
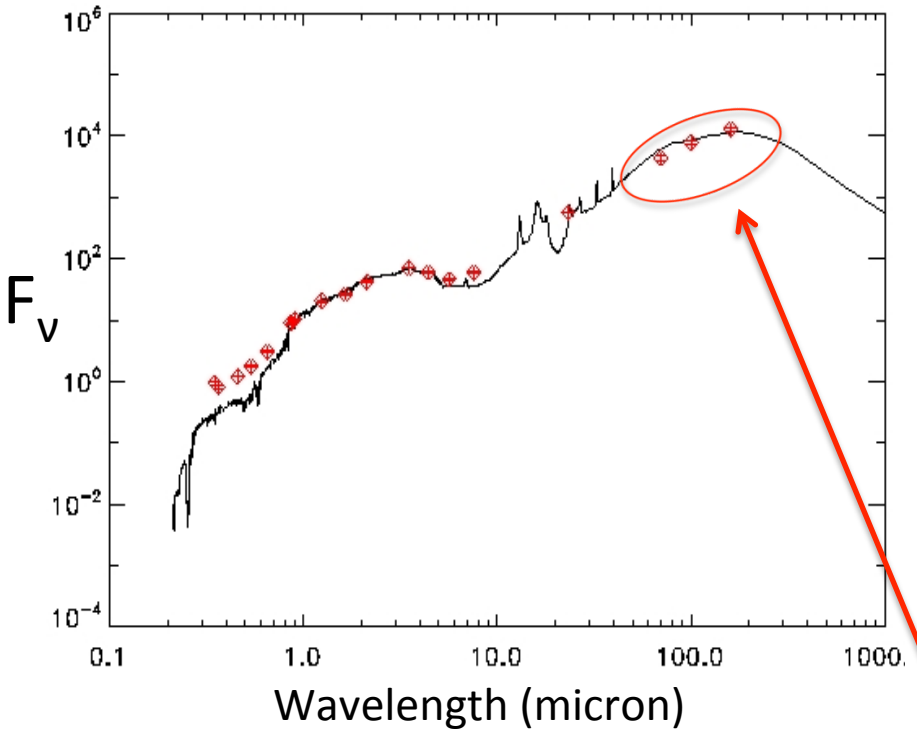



Radio flux density limits

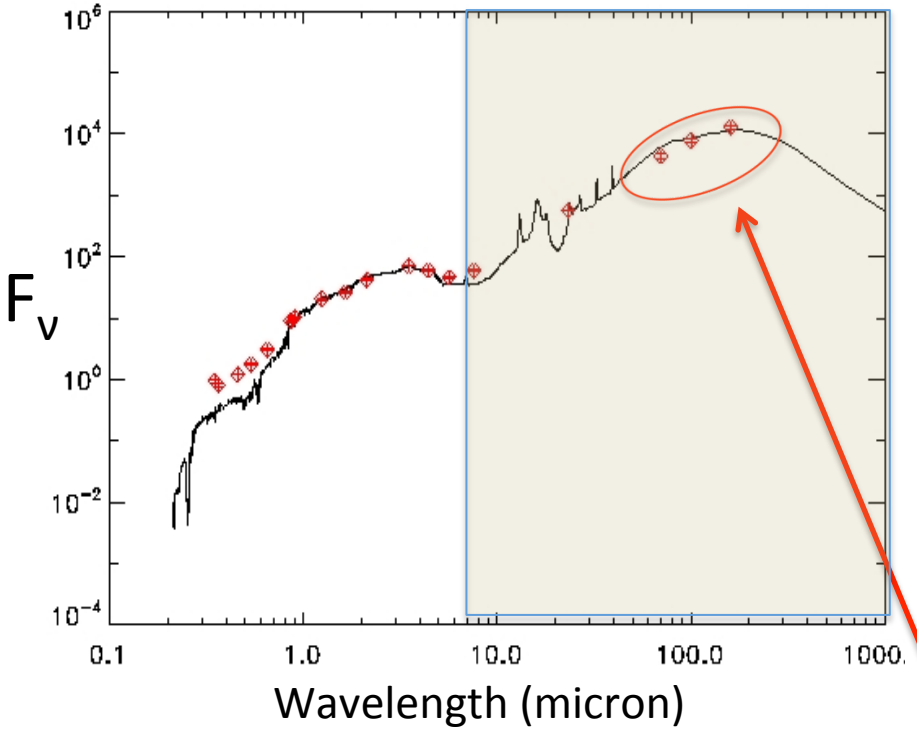
# SFR from **Far-IR** luminosity



Herschel/PACS:

PEP project, PI: D. Lutz

# SFR from **Far-IR** luminosity



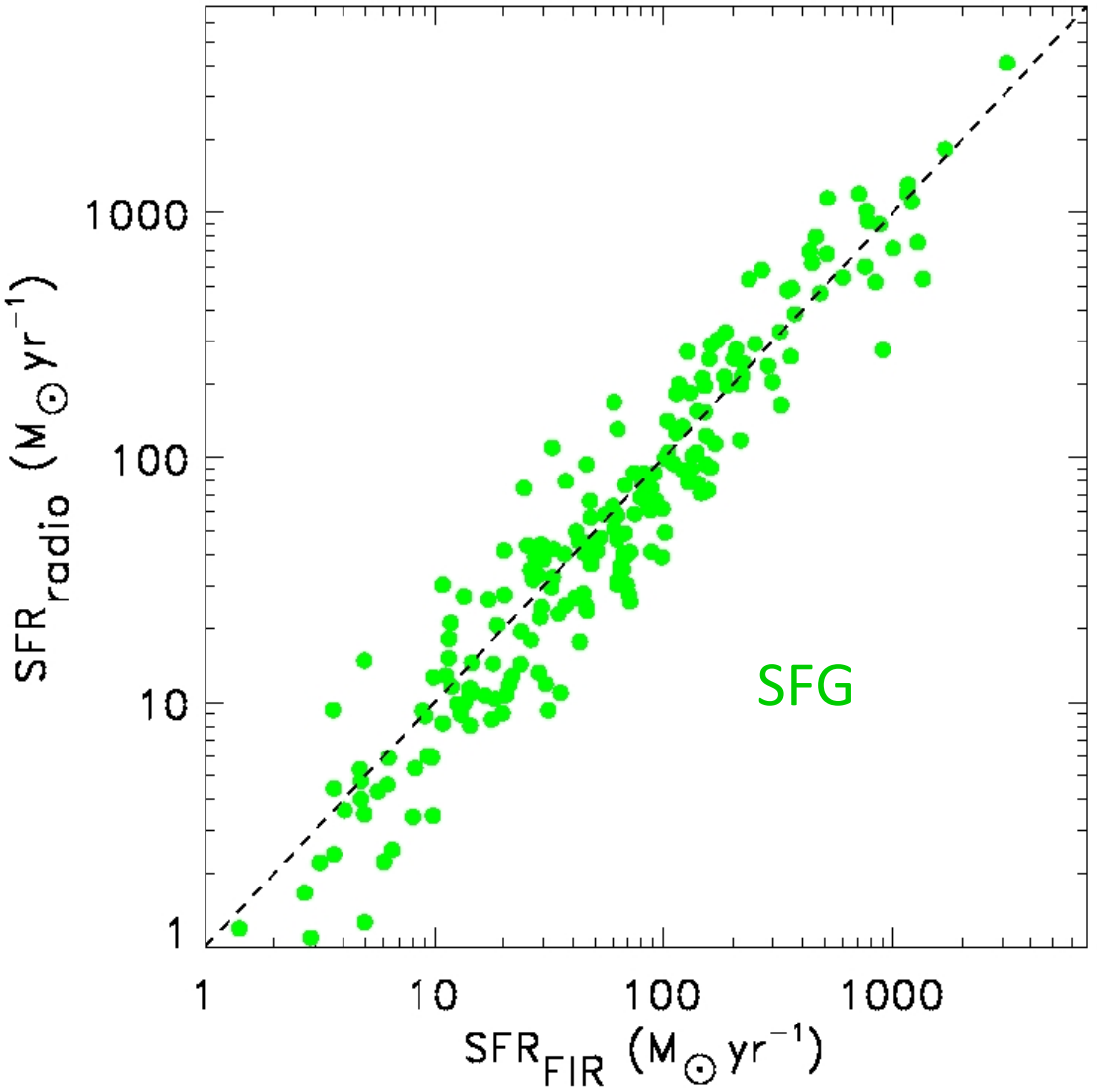
$$SFR = 1.8 \times 10^{10} L_{bol} / L_{sun} [M_{sun} yr^{-1}]$$

(Rodighiero+10b)

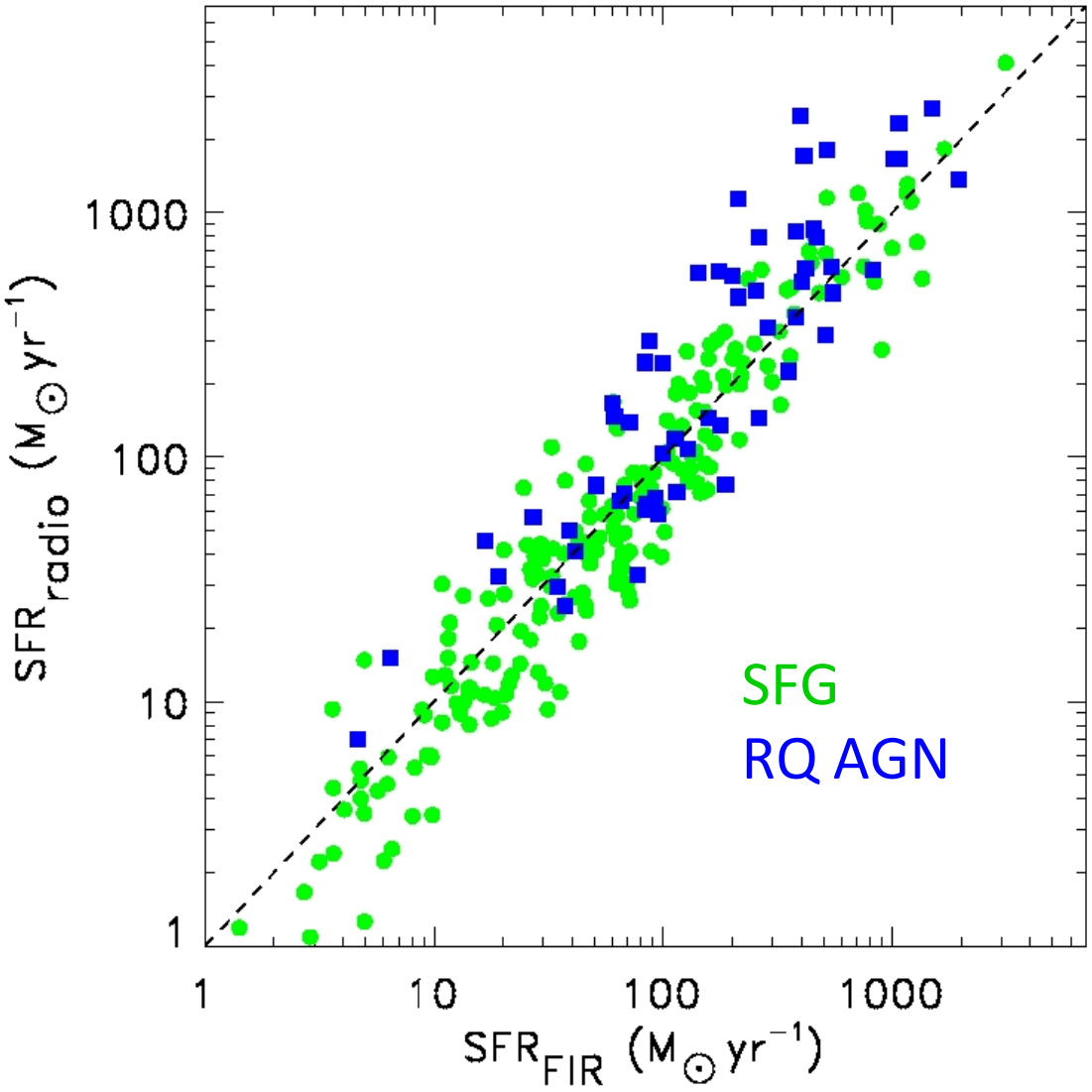
Herschel/PACS

PEP project, PI: D. Lutz

# SFR comparison for SFG



# SFR comparison for RQ AGN



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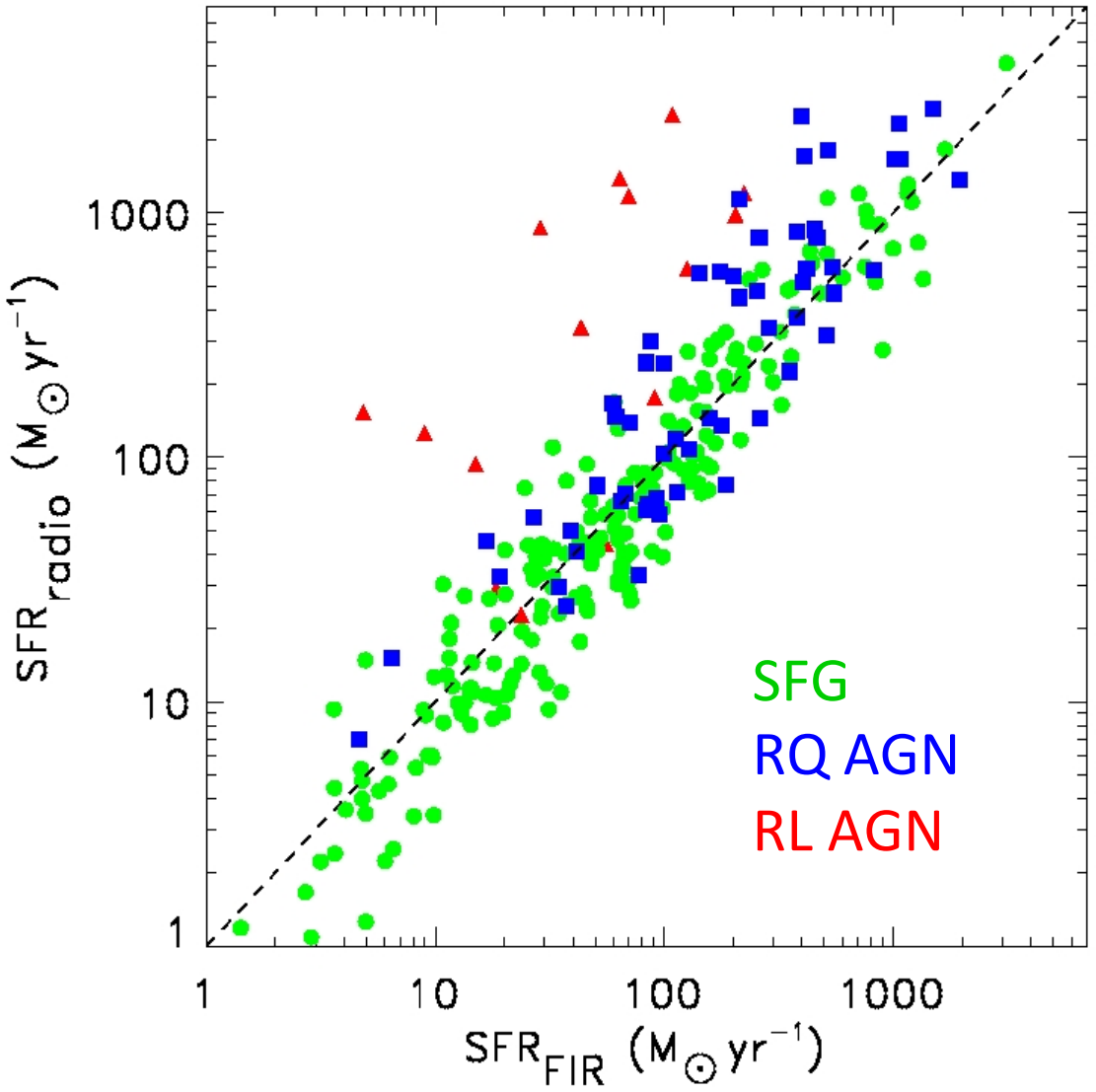


# Summary & Outlook

- Deepest radio sources counterpart catalog

  Bonzini et al. 2012, in press

- Host galaxy properties vs radio loudness: from RQ AGN (late type, $M_{star}$~$10^{10.5}M_{\odot}$) to RL AGN (early type, $M_{star}$~$10^{11}M_{\odot}$)

  → 2 evolutionary phases?

- Black hole properties: $M_{BH}$ & Eddington Ratio

  → Optical and NIR spectroscopy (FMOS → KMOS)

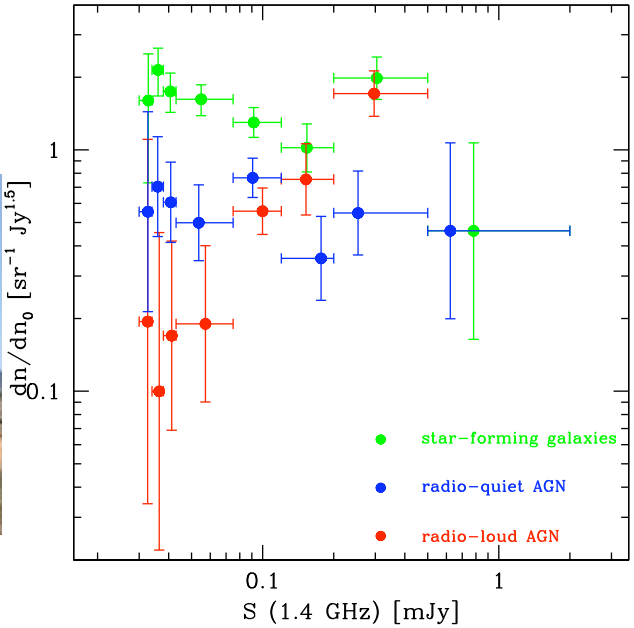
- Radio emission in RQ AGN due to SF

  → ALMA proposal submitted

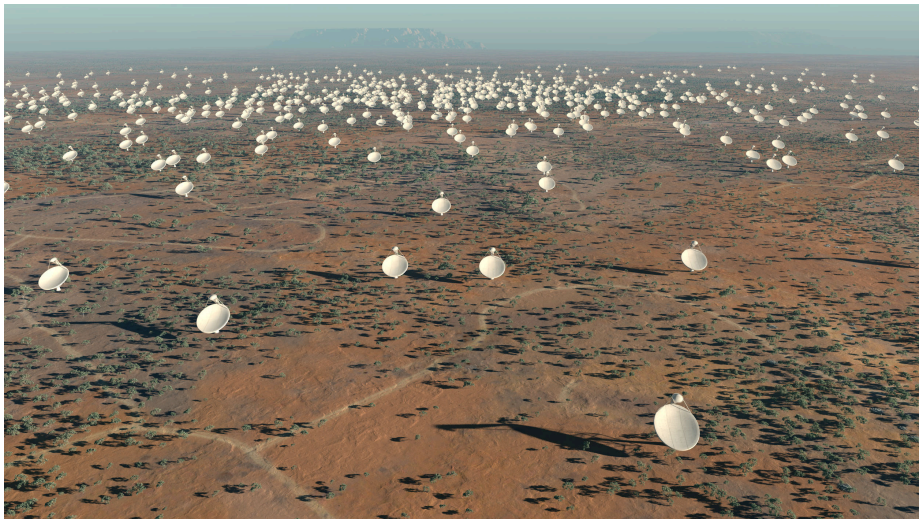
  Luminosity function

# Summary & Outlook

ASKAP




SKA



MeerKAT