Galaxy/AGN evolution: ongoing activities towards SKA

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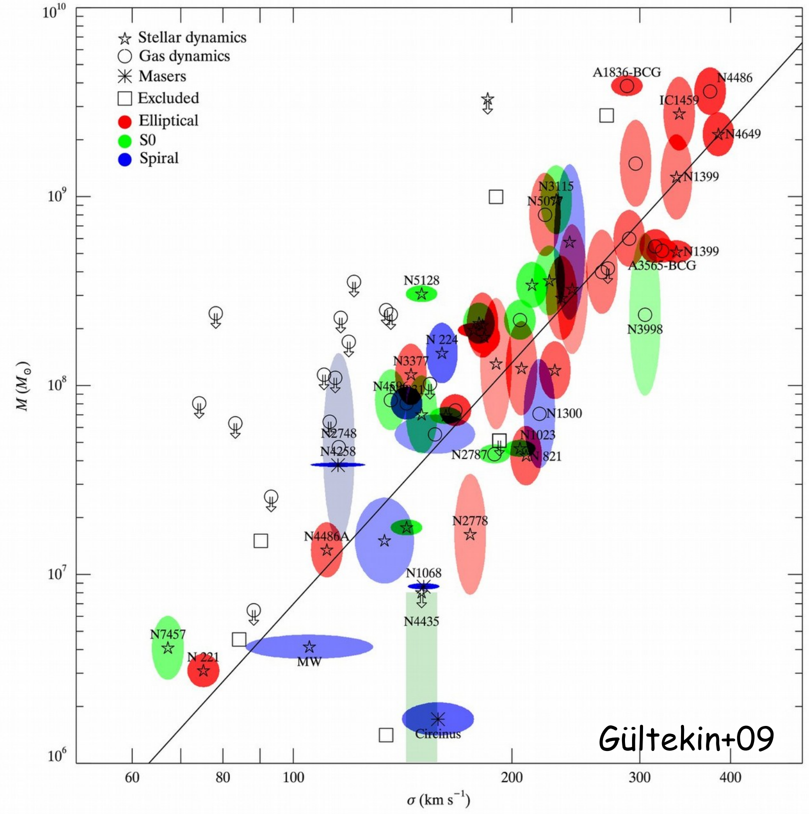
Outline

- Galaxy/AGN co-evolution.
- Why radio observations are useful.
- Some selected results from the 3 GHz VLA-COSMOS Large Program.
- Forecasts for the SKA.

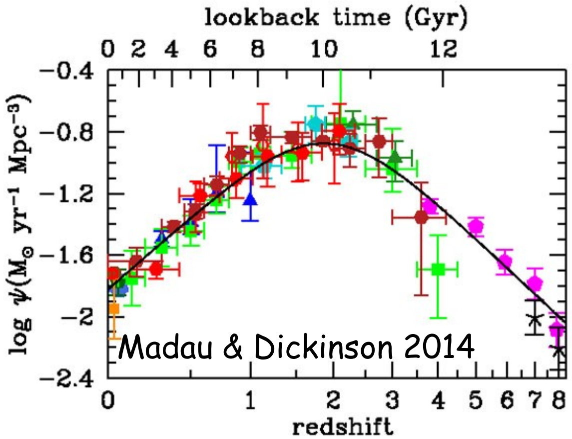
AGN/Galaxy co-evolution: evidences

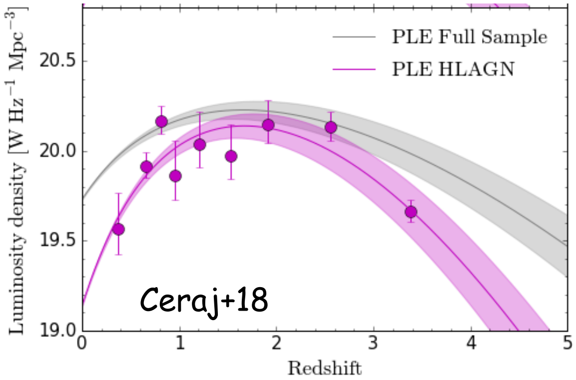
- increasing evidence that evolution of galaxies and SMBH/AGN are related:
  - Correlation between SMBH and galaxy bulge masses (e.g. Magorrian+98, Ferrarese & Merritt 2000, Gebhardt+00).



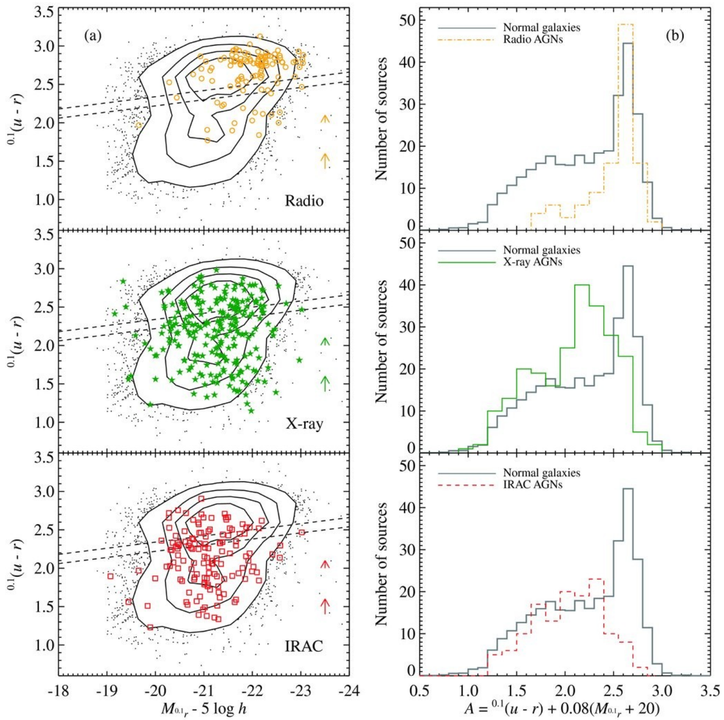
Agn/Galaxy co-evolution: evidences

- increasing evidence that evolution of galaxies and SMBH/AGN are related:
    - Correlation between SMBH and galaxy bulge masses (e.g. Magorrian+98, Ferrarese & Merritt 2000, Gebhardt+00).
    - Redshift evolution of SF and AGN activity (e.g. Madau+94, Ueda+03).





AGN/Galaxy co-evolution: the role of AGN

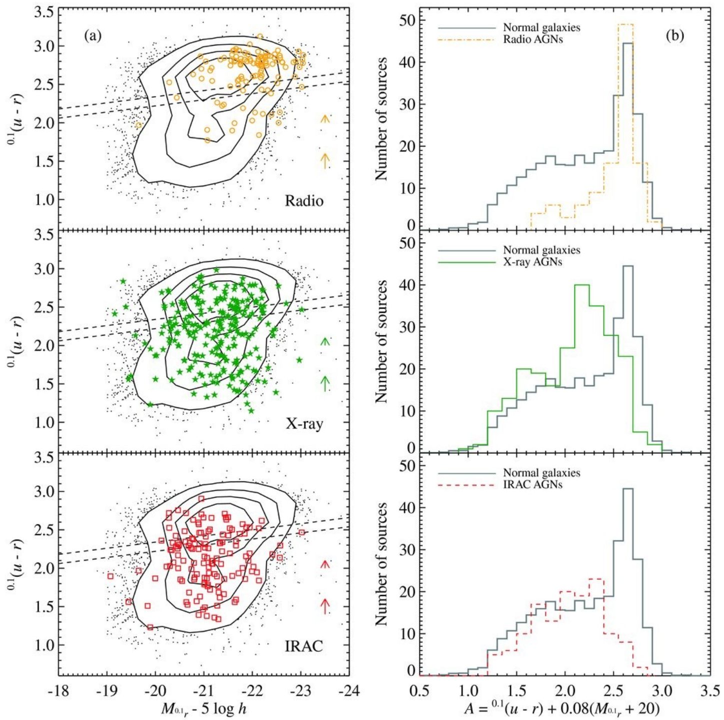


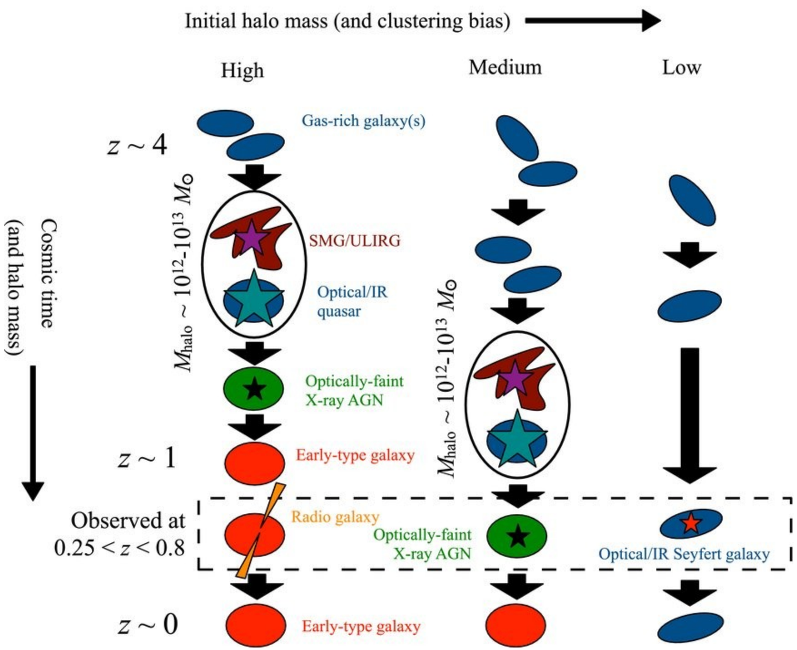
Hickox+09

Galaxy color bimodality (e.g. Faber+07).

Role of AGN: quenching of star formation in blue gals and their transition to the red sequence (e.g. Hopkins+06, Croton+06)

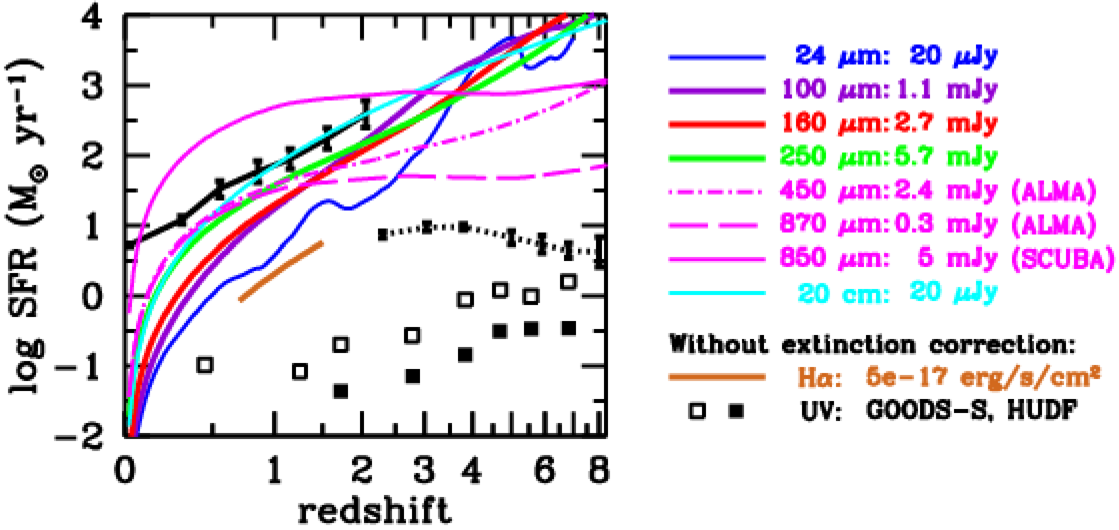
AGN/Galaxy co-evolution: the role of AGN





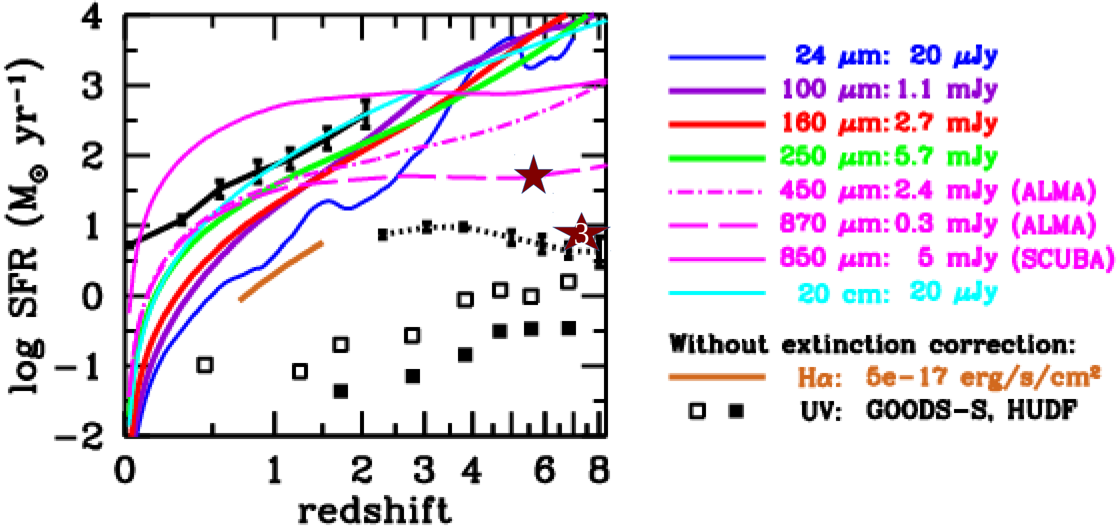
Hickox+09

The contribution of radio observations



Madau & Dickinson 2014

The contribution of radio observations



Madau & Dickinson 2014

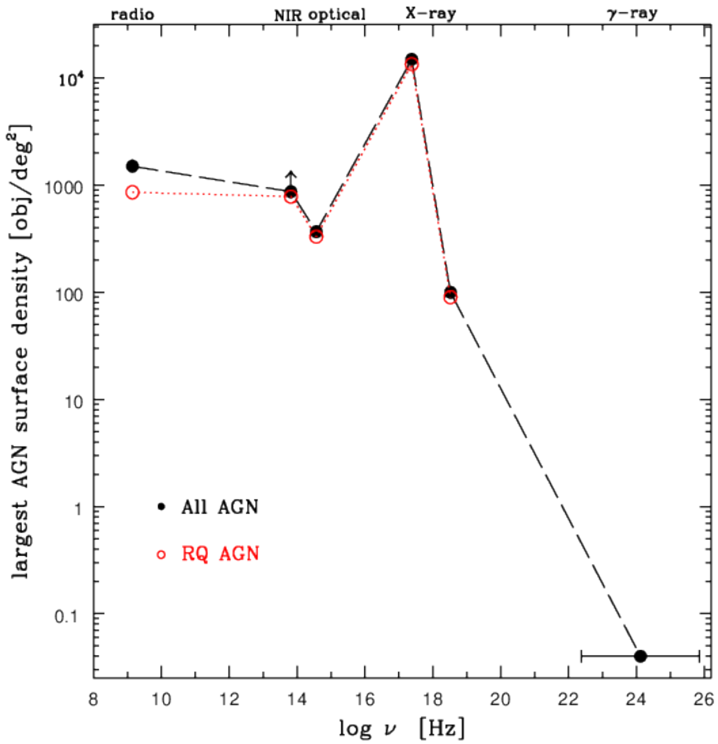
~1 μJy limit implies sensitivity to 50-100 Msun/yr at z~6.

~0.1 μJy limit implies sensitivity to 20 Msun/yr at z~7

The contribution of radio observations

1) Jet-mode RL AGN can be identified only in the radio band.

2) With the actual sensitivities of radio deep fields, detecting quasar-mode RQ AGN in the radio is as effective as in the optical/NIR bands !



Largest AGN surface density over the whole EM spectrum (Padovani 2016).

SKA Pathfinders

- Frequency > 1 GHz
- High sensitivity: rms ~ 1 μJy
- Resolution: few arcsec-milliarcsec

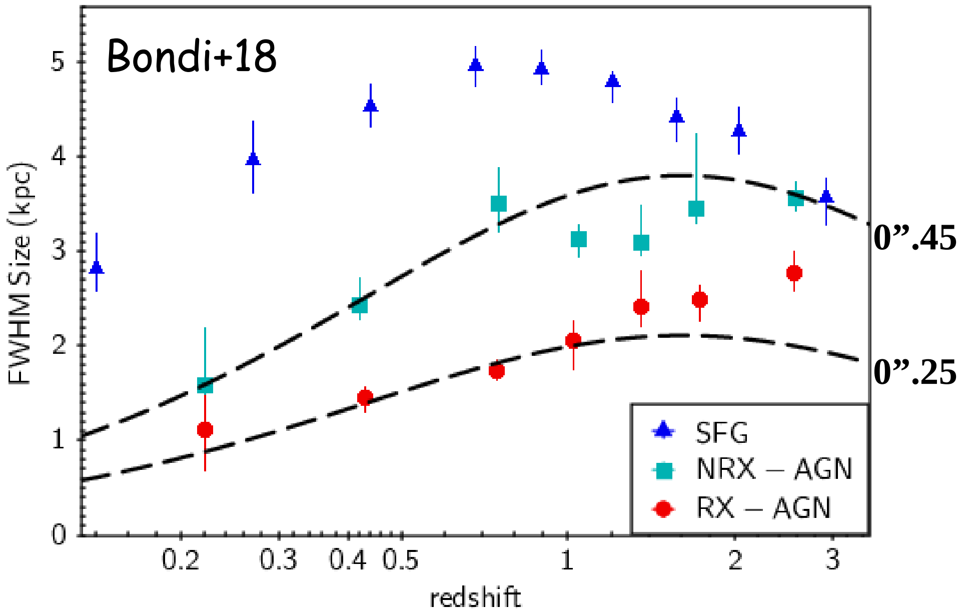
VLA-COSMOS 3 GHz Large Project (P.I. V. Smolčić)

- 3 GHz VLA: 384 hr, imaging 2.6 sq. deg.
- Resolution: 0.75 arcsec
- Median Sensitivity: 2.3 μJy/beam in the 2 sq.deg. field
- 10830 radio sources
- 93% optical/NIR/IRAC id.
- INAF participates through IRA and OAS

Linear radio sizes of SFGs and AGN

- RX-AGN (Jet-mode AGN)

median ~0.25" (1-2 kpc). Larger sizes at z>1.5 (z or Lradio effect ?).



Linear radio sizes of AGN and SFGs

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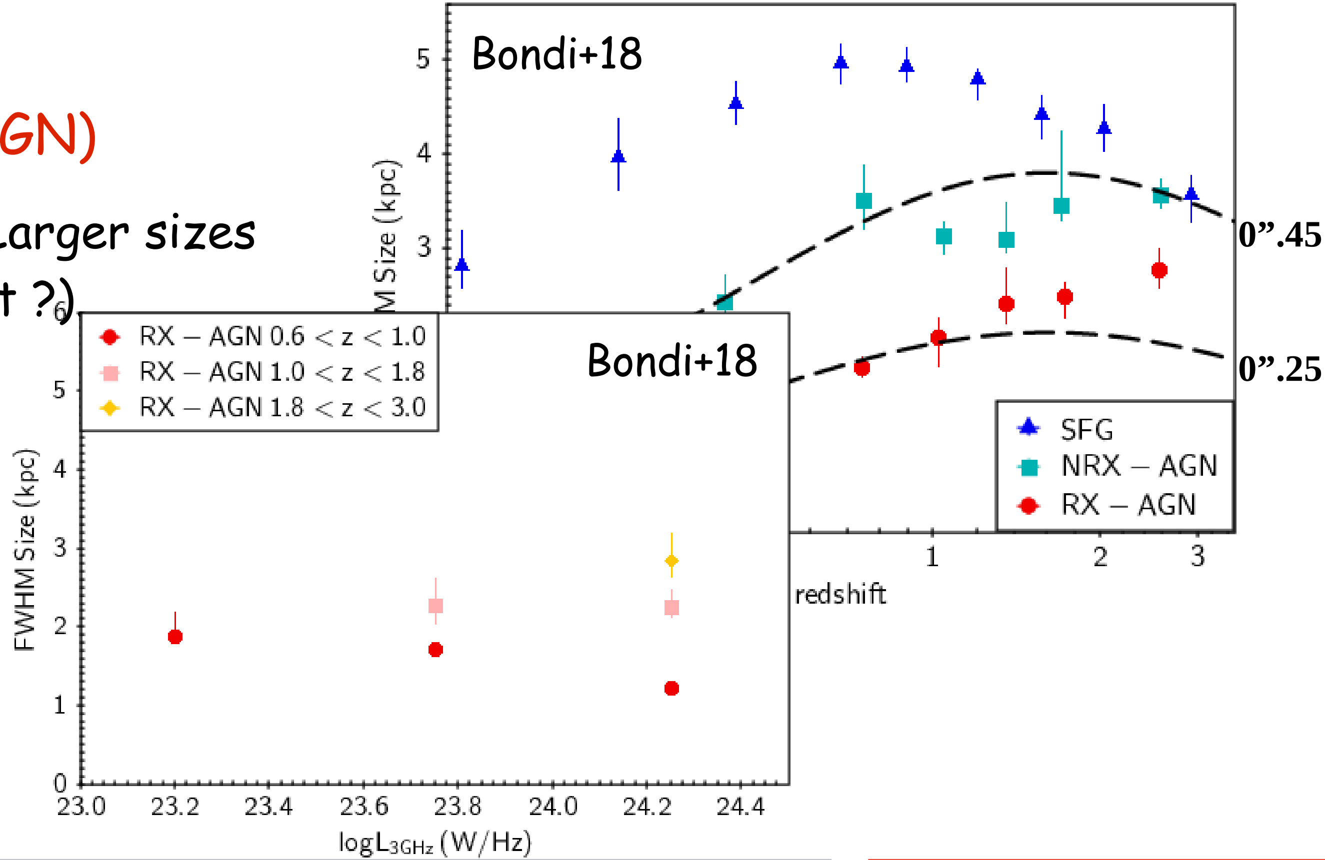
High z RX sources have lower stellar masses and larger radio sizes, comparable to size of quiescent galaxies at z~2 (e.g. Szomoru+12).

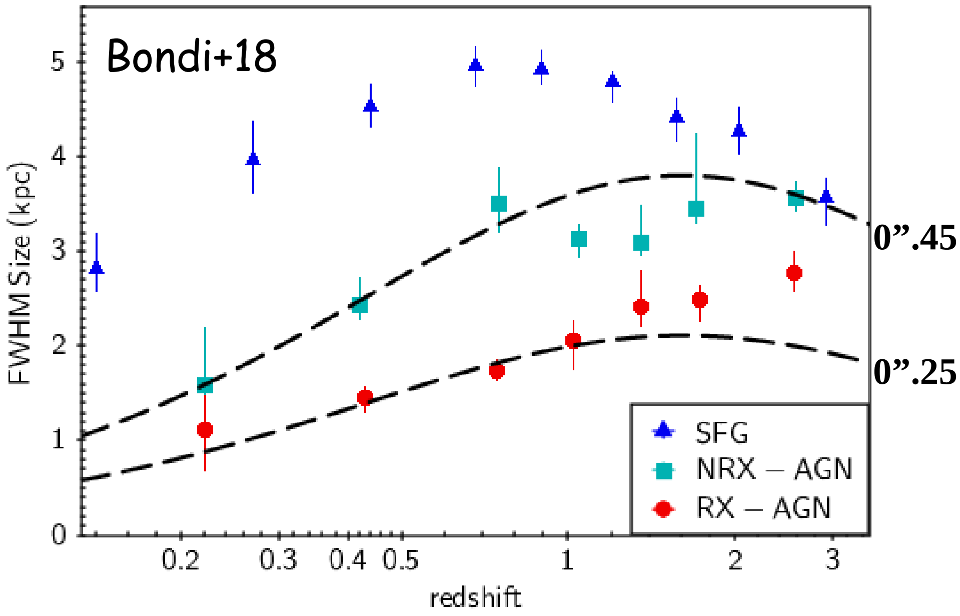


Linear radio sizes of AGN (and SFGs)

- NRX-AGN (Quasar-mode AGN)

median ~0.45" (2-4 kpc) intermediate between SFGs and RX-AGN.

Origin of radio emission in NRX-AGN ?



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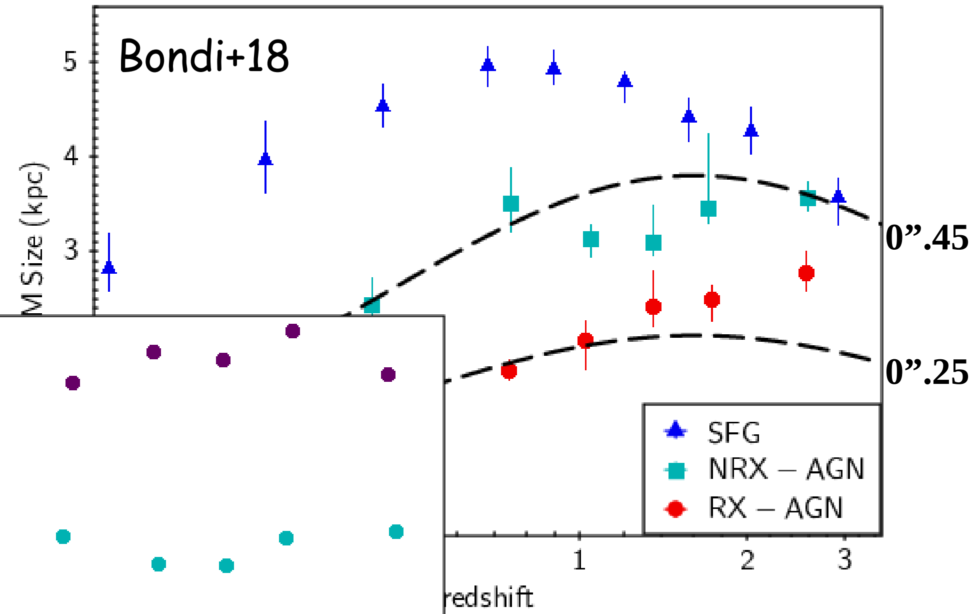
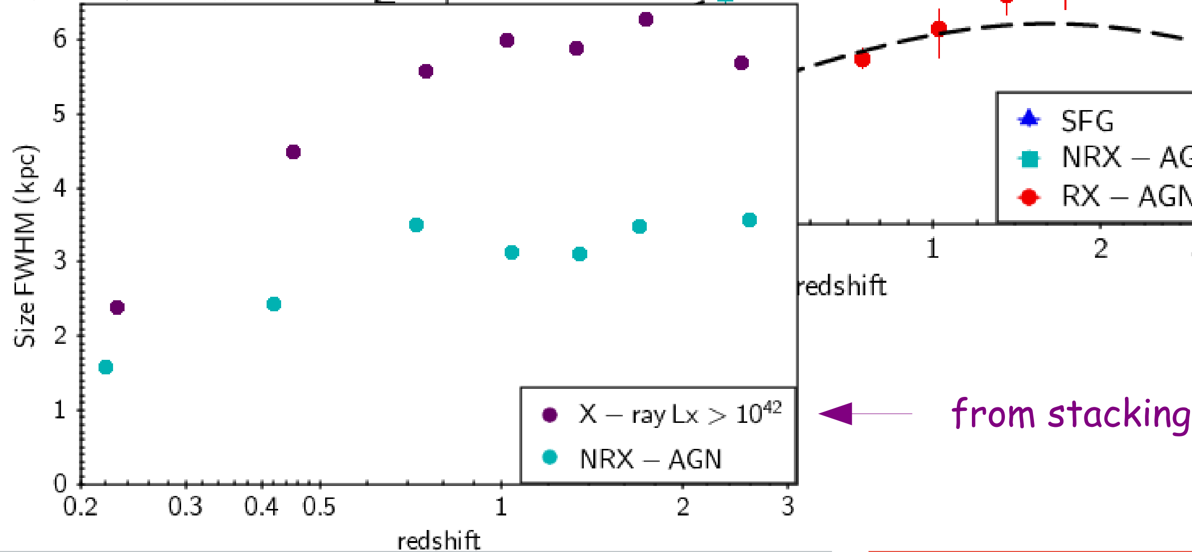
Star fomation in X-ray selected AGN.

Star formation + weak radio core in radio selected AGN.

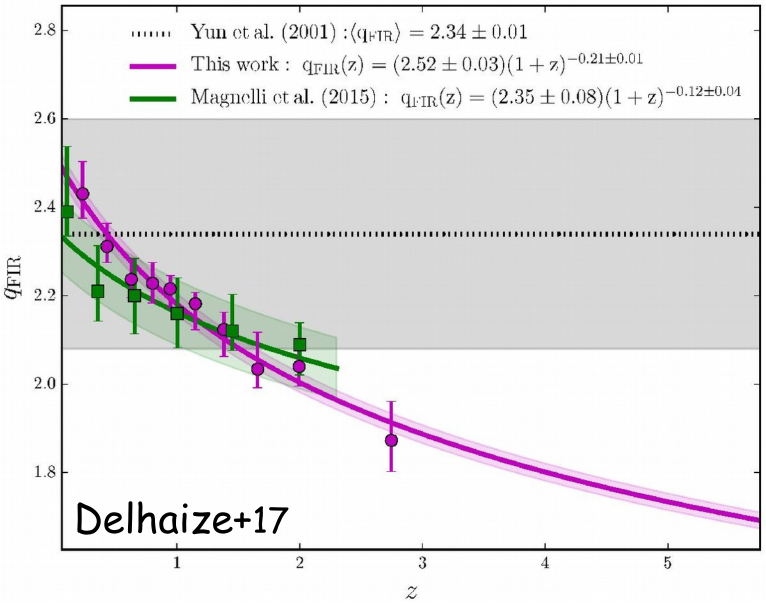




Infrared-radio correlation

Provides the basis for radio luminosity as a star-formation tracer (e.g. Helou+85, Condon 1992, Kennicut 1998).

q=S(TIR)/S(radio) decreasing with z (e.g. Ivison+10, Magnelli+15, Delhaize+17, Calistro-Rivera+17)



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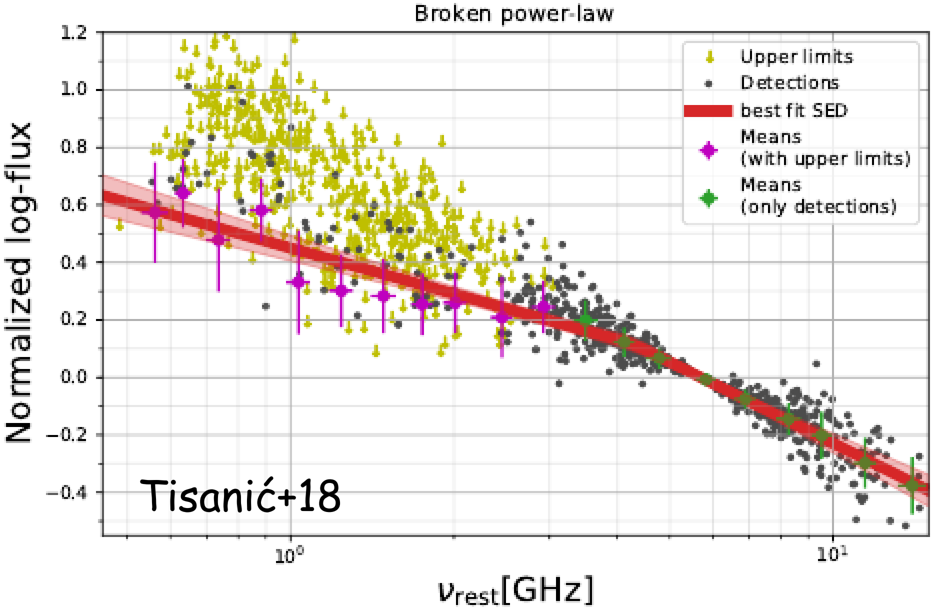
Average radio SED of HSFGs (SFR>100 Msun/yr). Steep radio spectrum (Tisanić+18).



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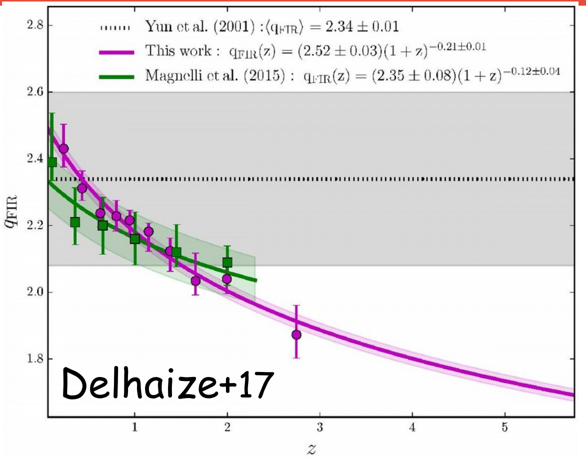
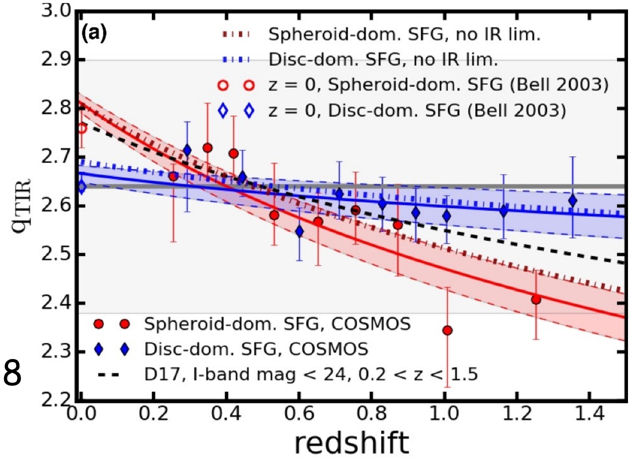
Steep redshift evolution of q is produced by spheroid-dominated SFGs (Molnar+18).

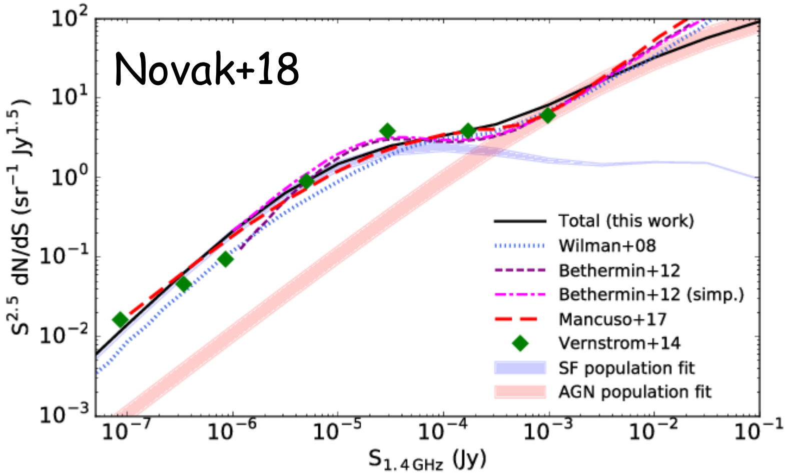


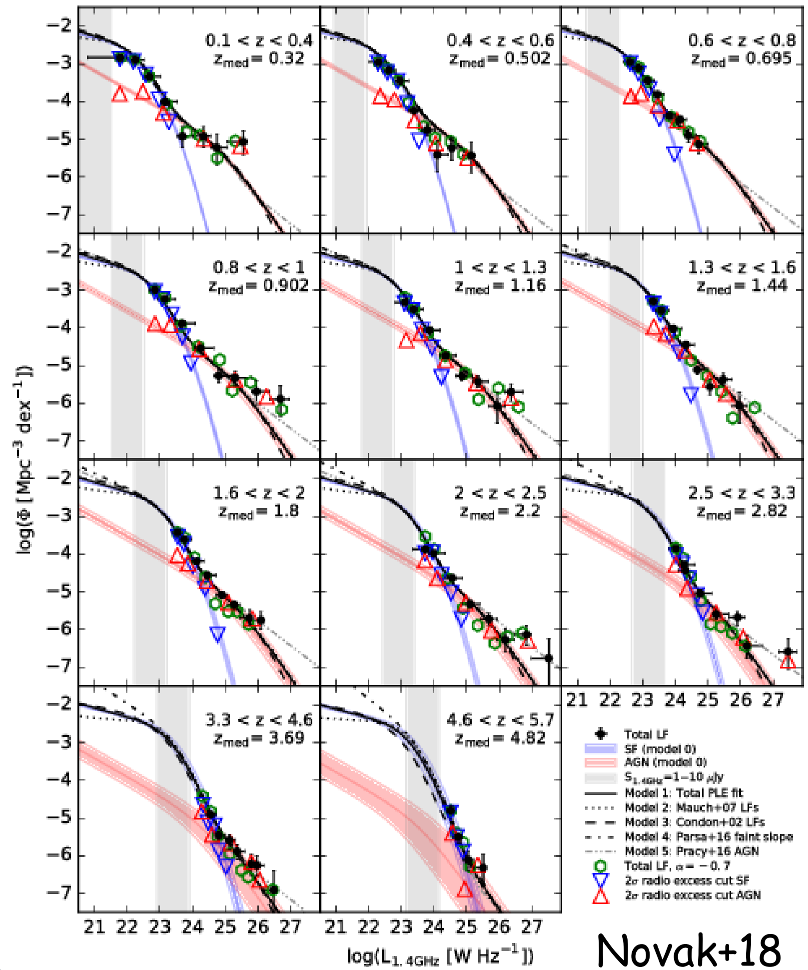
Molnar+18



Towards SKA...

Constraints on the sub-μJy radio number counts from evolving luminosity functions (Novak+18, Mancuso+17)



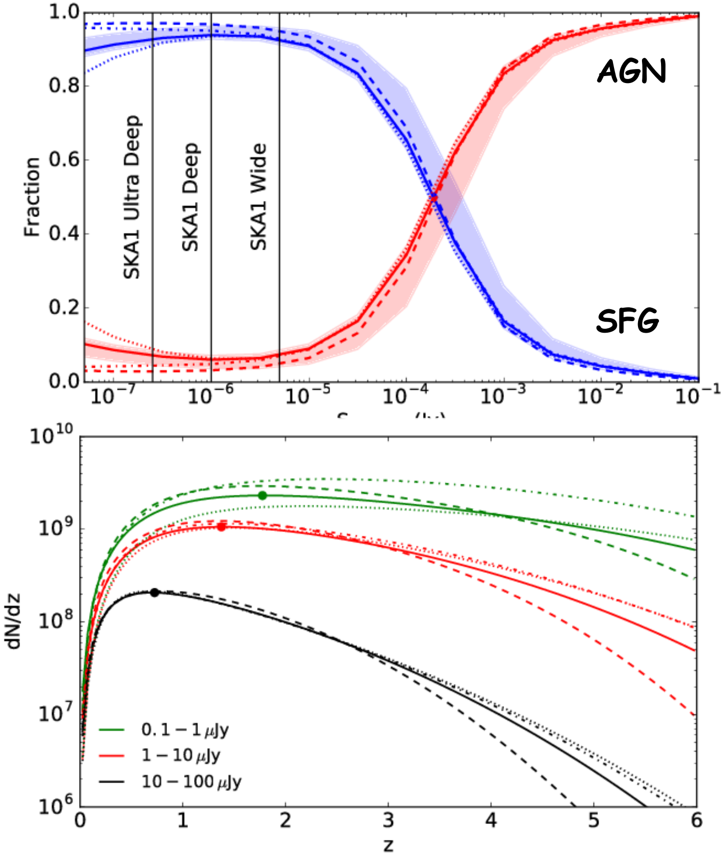


Novak+18

Towards SKA...

Between 0.1 and 10 μJy, where the 5σ sensitivity limits for future SKA surveys at 1.4 GHz are located (e.g. Prandoni & Seymour 2015), the relative fraction of SFGs is rather constant at about 90-95 %.

Novak+18

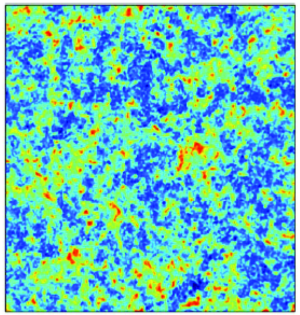


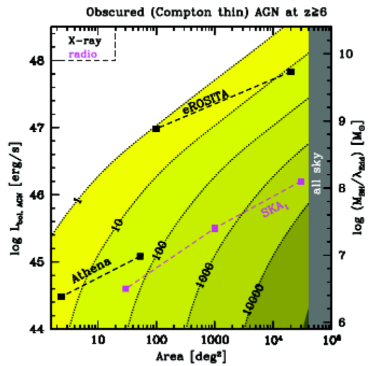
SKA-PRIN (P.I. I. Prandoni)

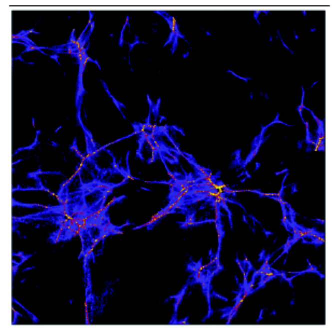
PROJECT TITLE

FORmation and Evolution of Cosmic STructures (FORECaST) with Future Radio Surveys

Mapping the Universe on the pathway to SKA: from black holes to the largest cosmic structures, a multi-scale approach to next-generation extra-galactic/cosmological radio surveys







CATEGORY: SKA

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