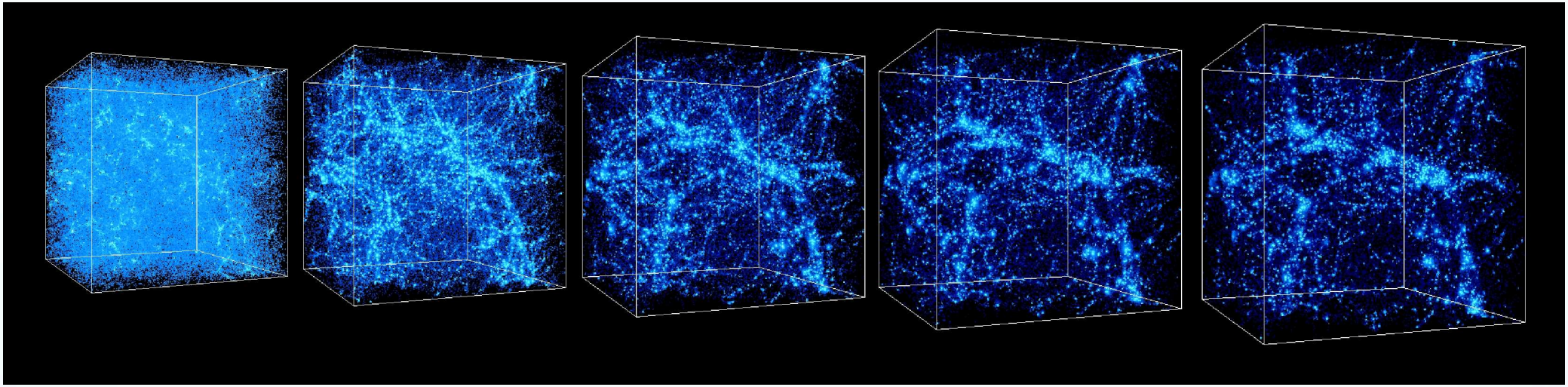
Galaxy Evolution & Cosmology with the new deep continuum surveys

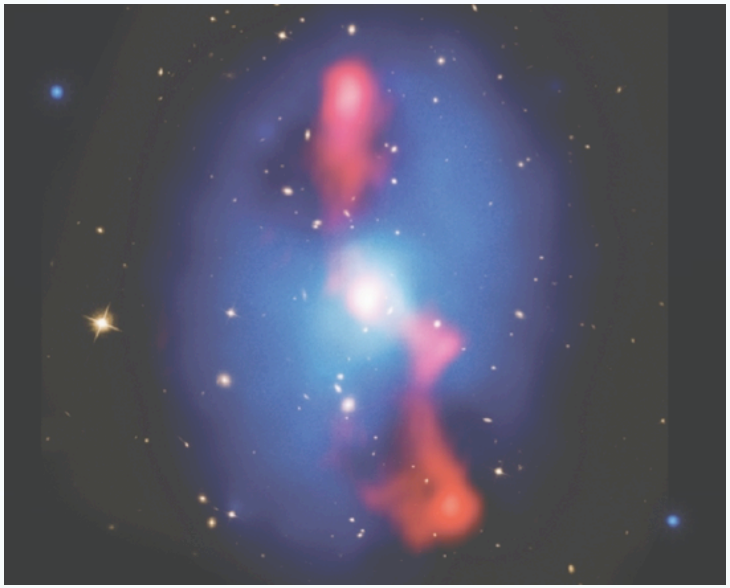


Matt Jarvis

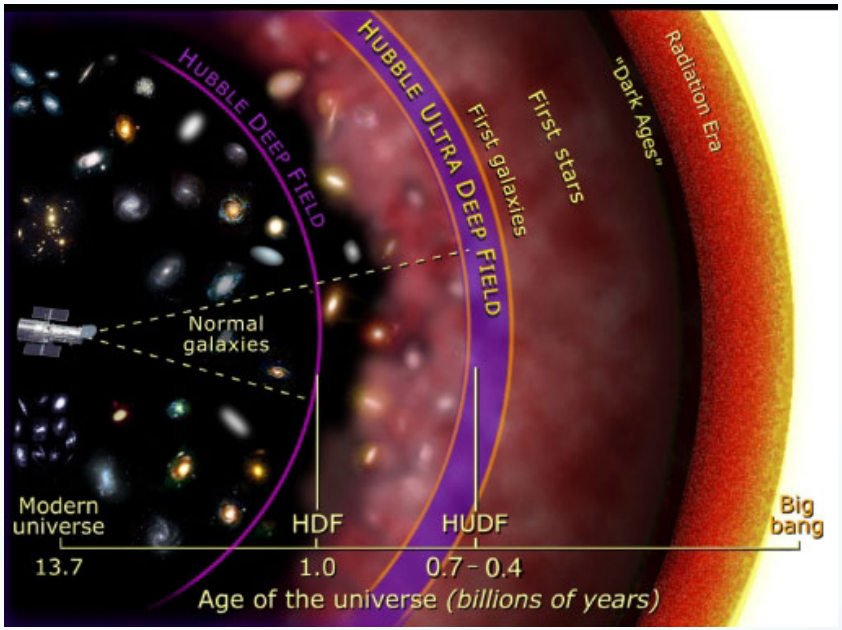
University of Oxford &
University of the Western Cape

Galaxy Formation and Evolution

How does accretion onto black holes affect the evolution of galaxies?

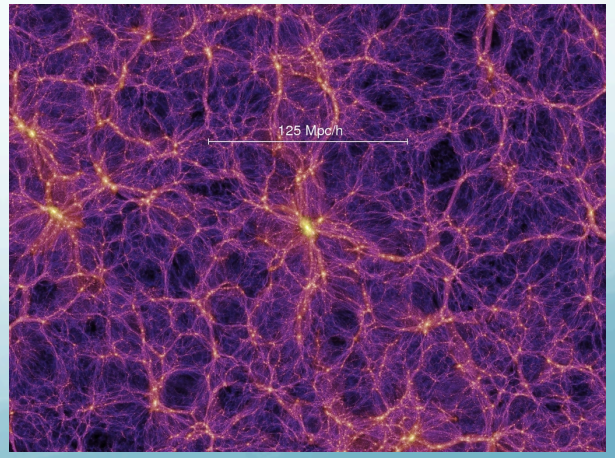


How and when were the first galaxies formed?



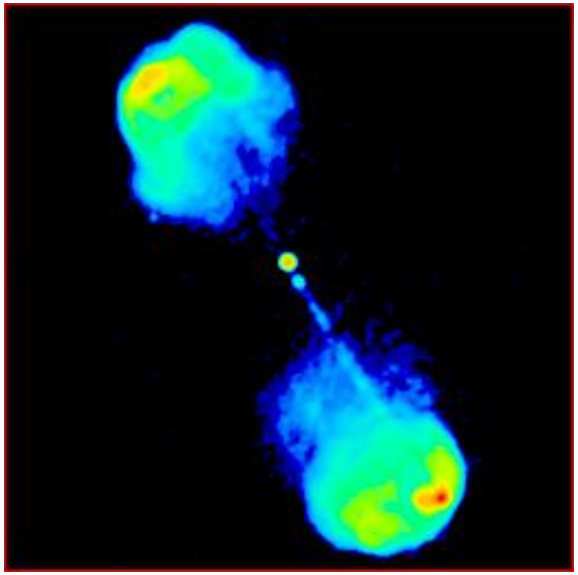
What is the environmental influence?

How do Baryons trace and affect the Dark Matter distribution?

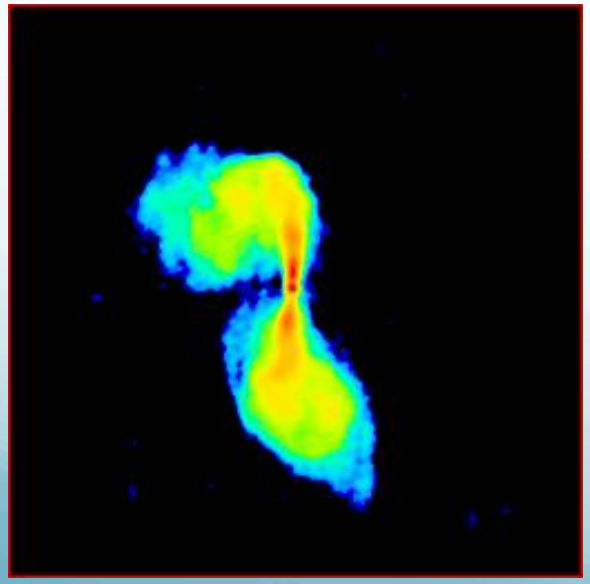


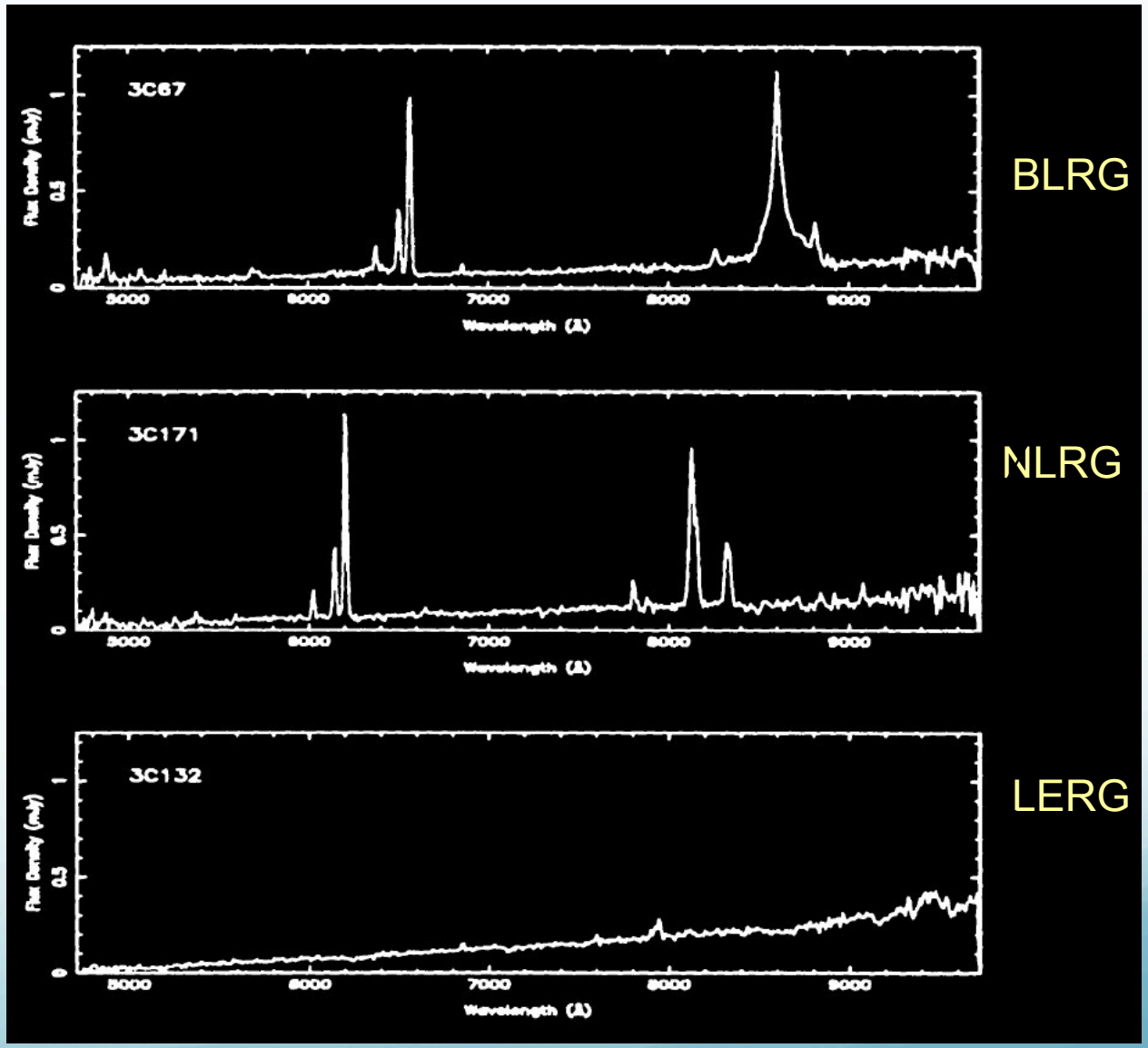
AGN: Two populations?

FRII

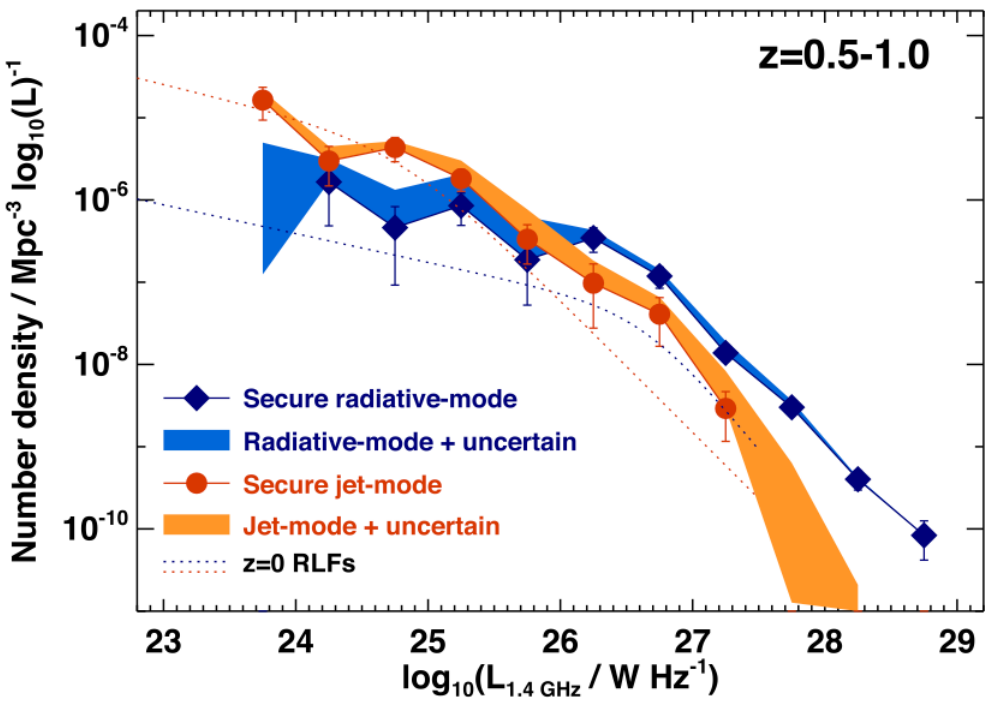


FRI



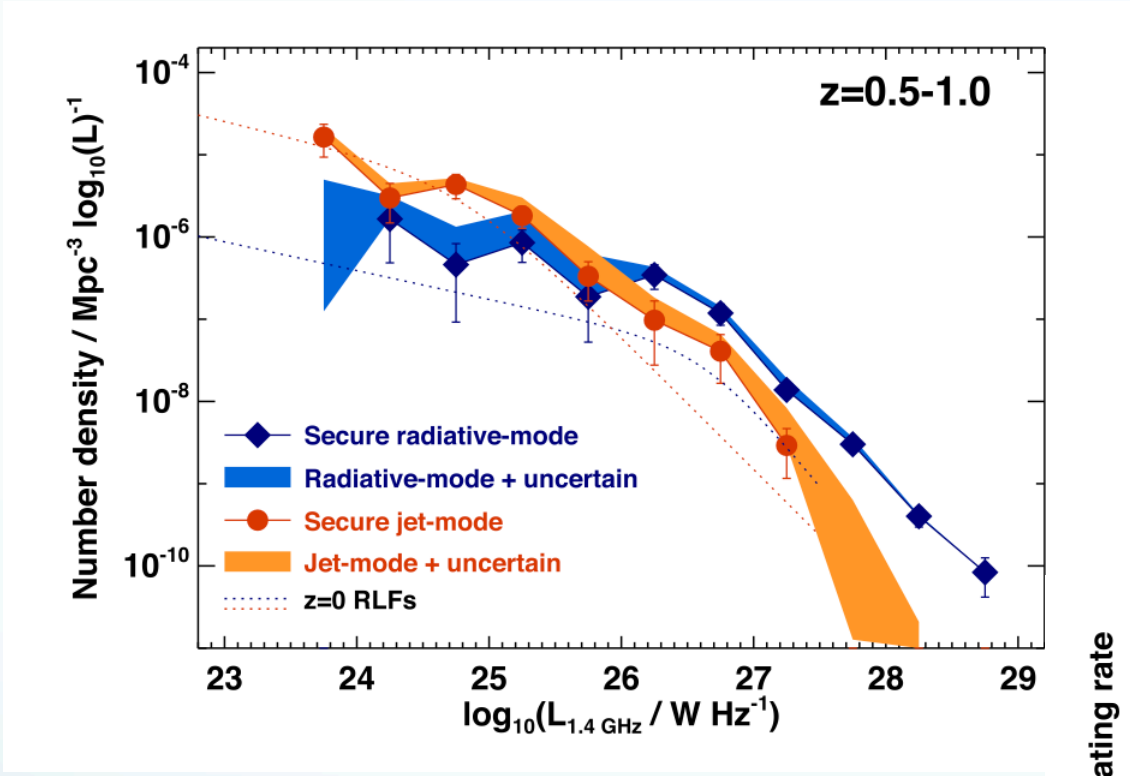


AGN: Feedback



Best et al. 2014
See also Smolcic et al. 2009, 2015

AGN: Feedback



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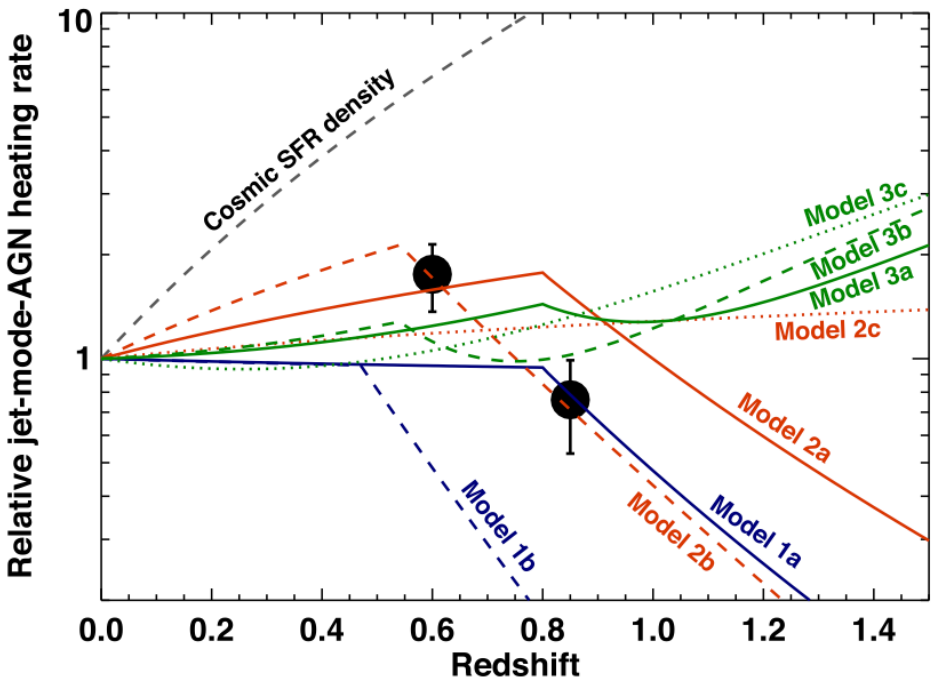
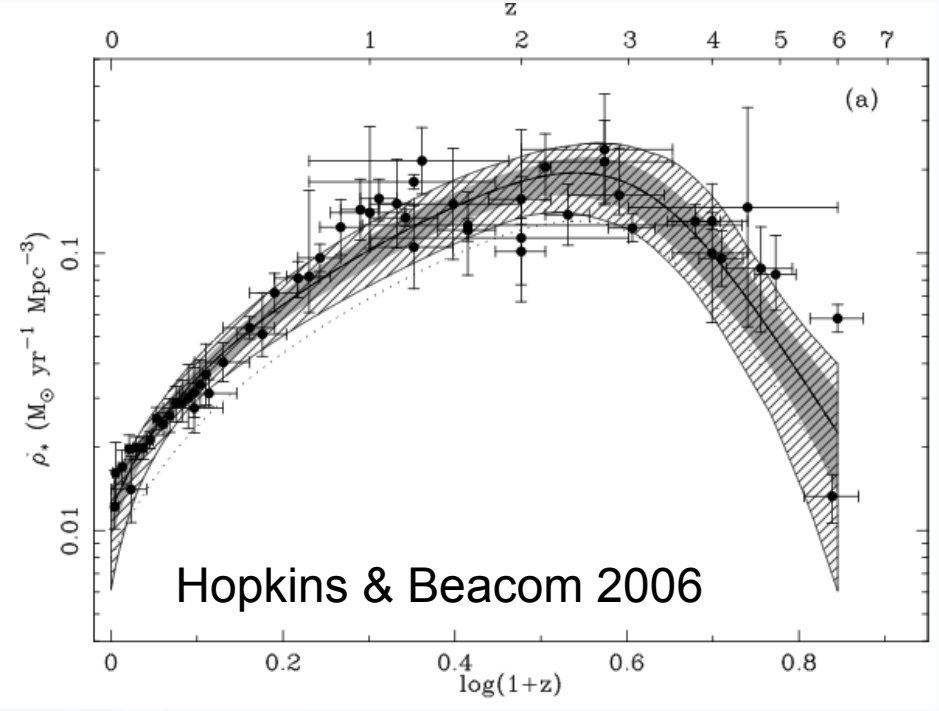


Evolution of the star-formation rate density

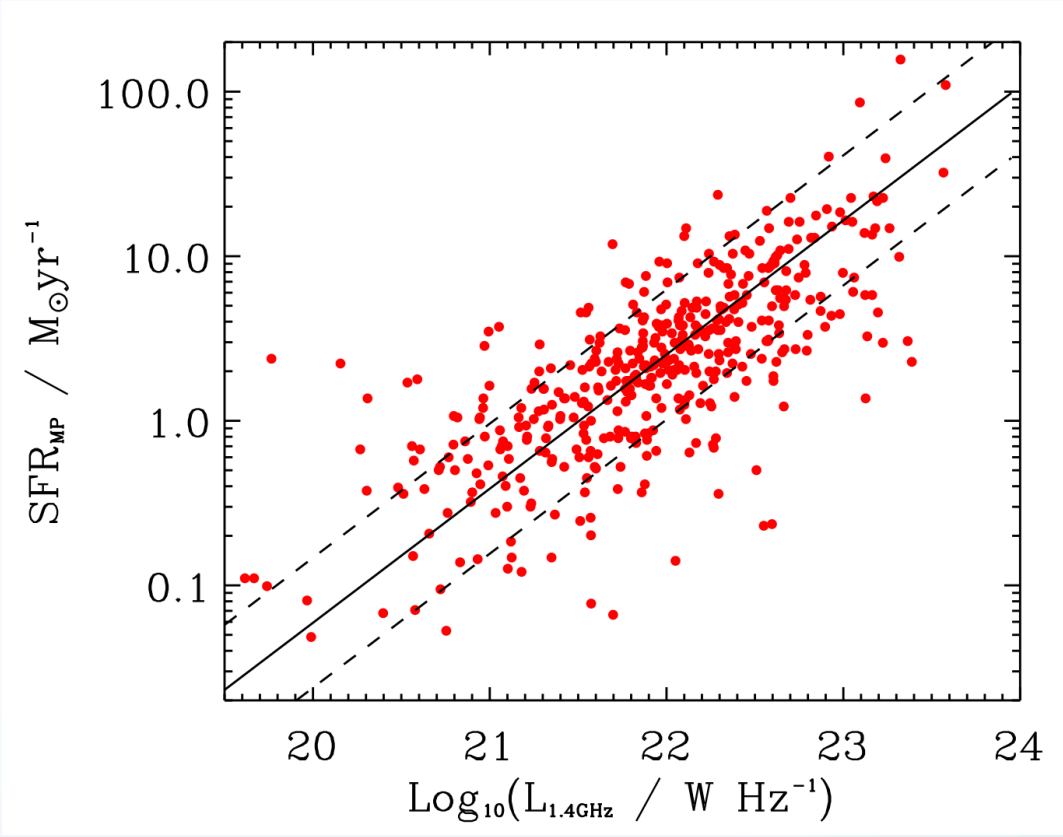


UV/Optical – dust extinction

Far-IR – poor resolution means confusion

Radio – unaffected by dust, high-resolution

*AGN contamination in all at varying degrees



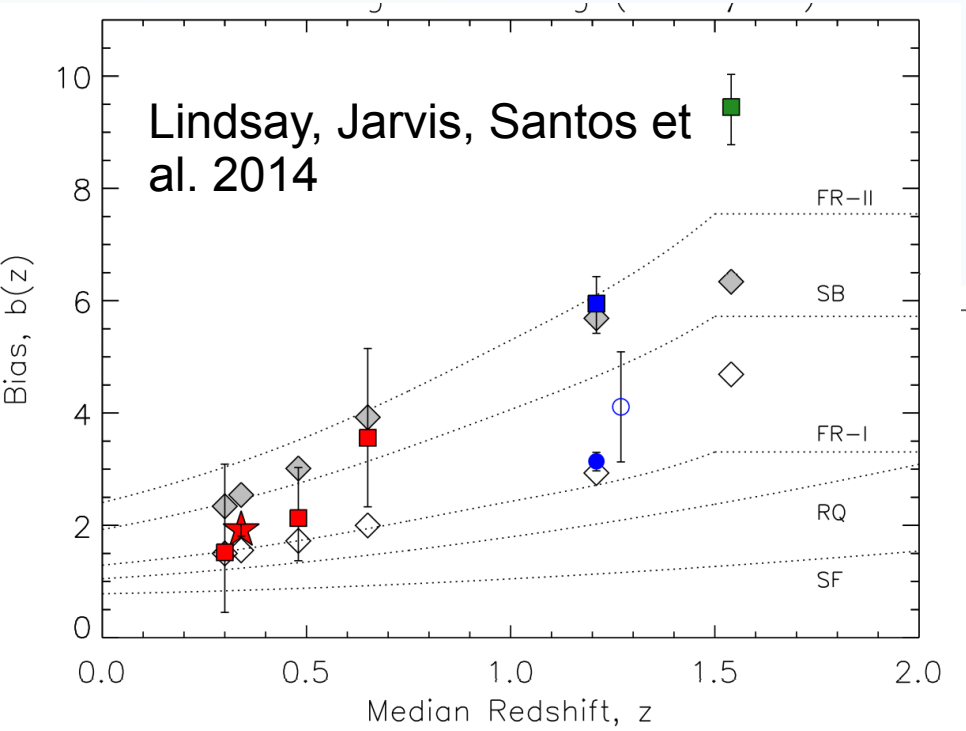
SFR – radio correlation from H-ATLAS (Jarvis et al. in prep.)

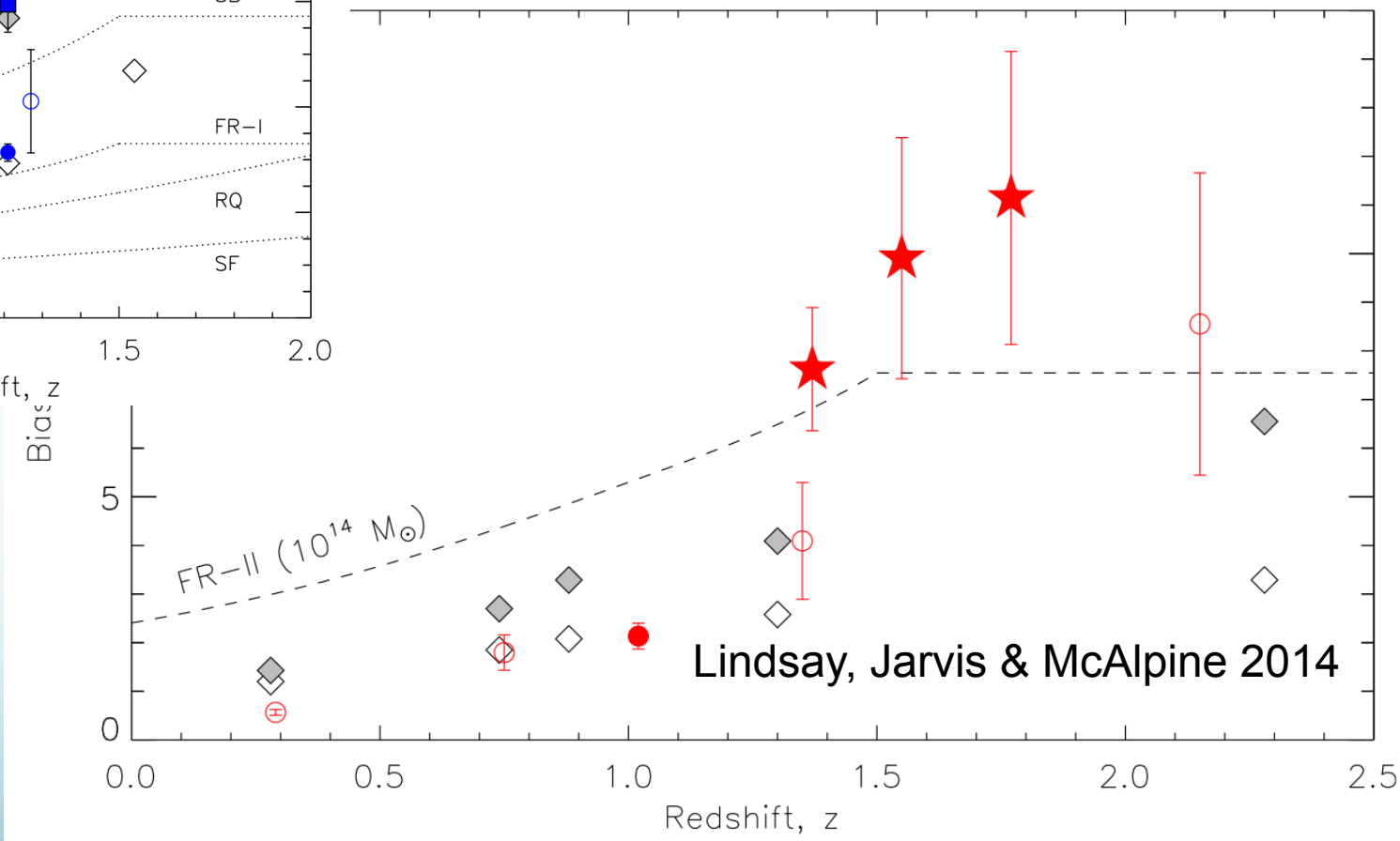
Cosmology with radio continuum surveys?

Now getting to the point that the depth of radio continuum surveys is similar to optical surveys in terms of number density, and with SKA may overtake them

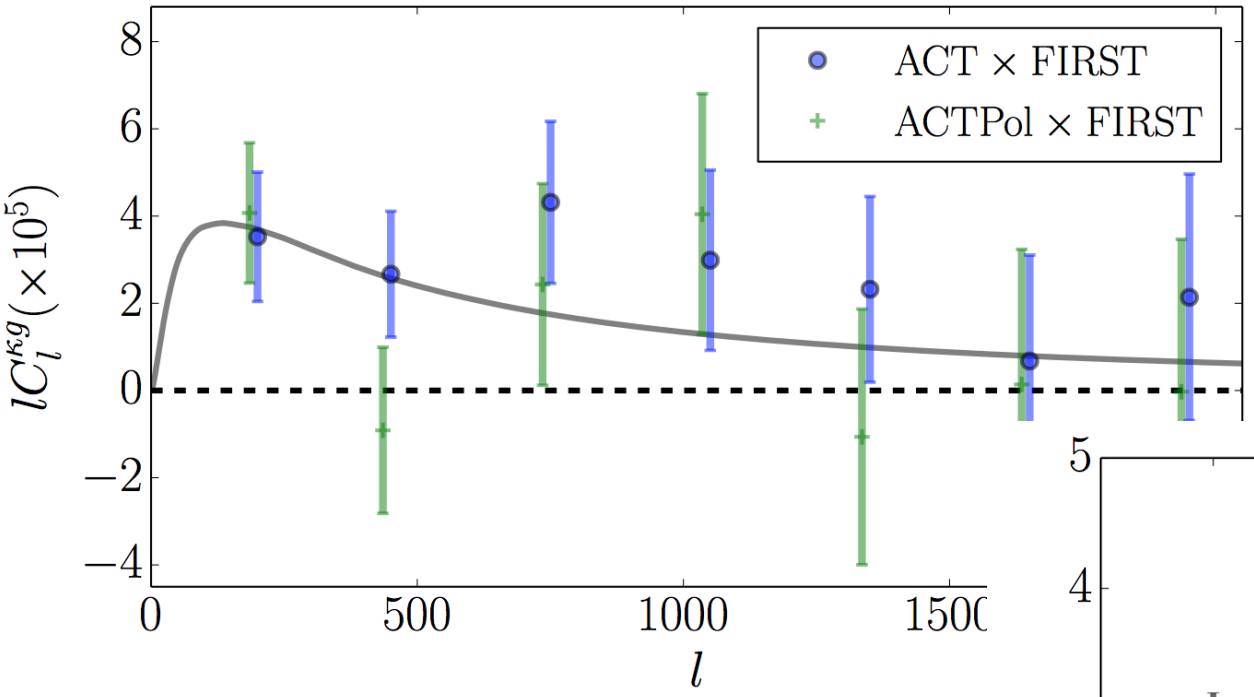
Allows some unique studies…

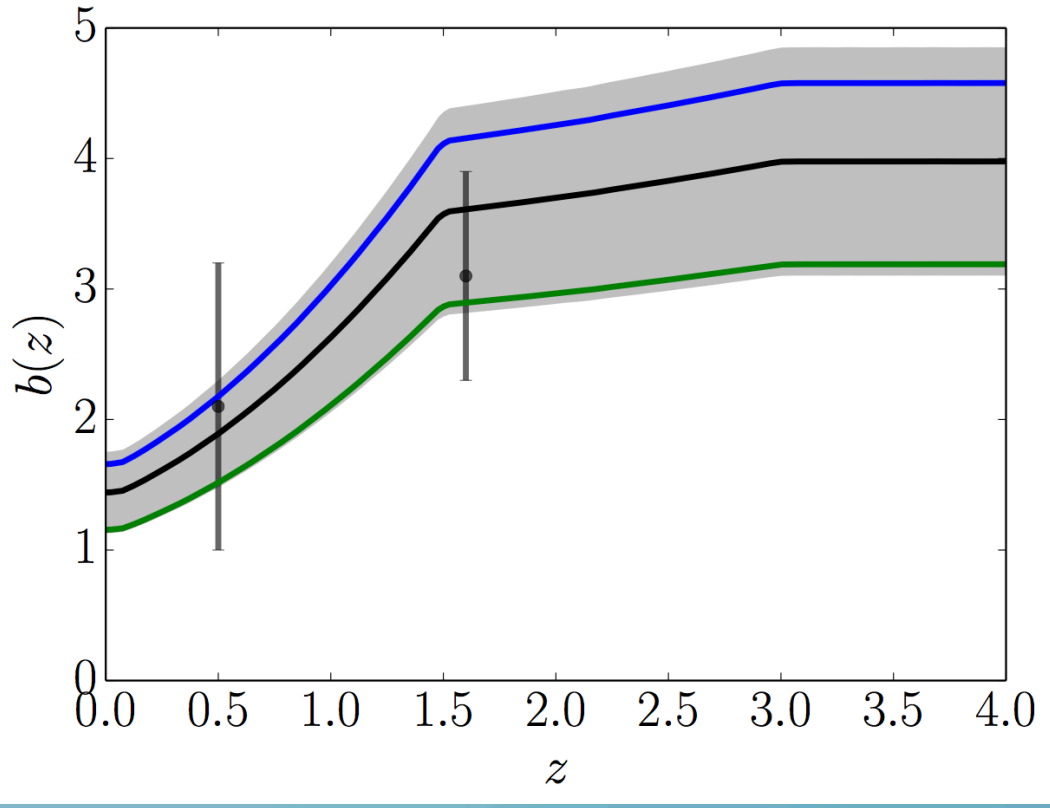
Halo Occupation and link to DM distribution





Xcorrelation with CMB lensing

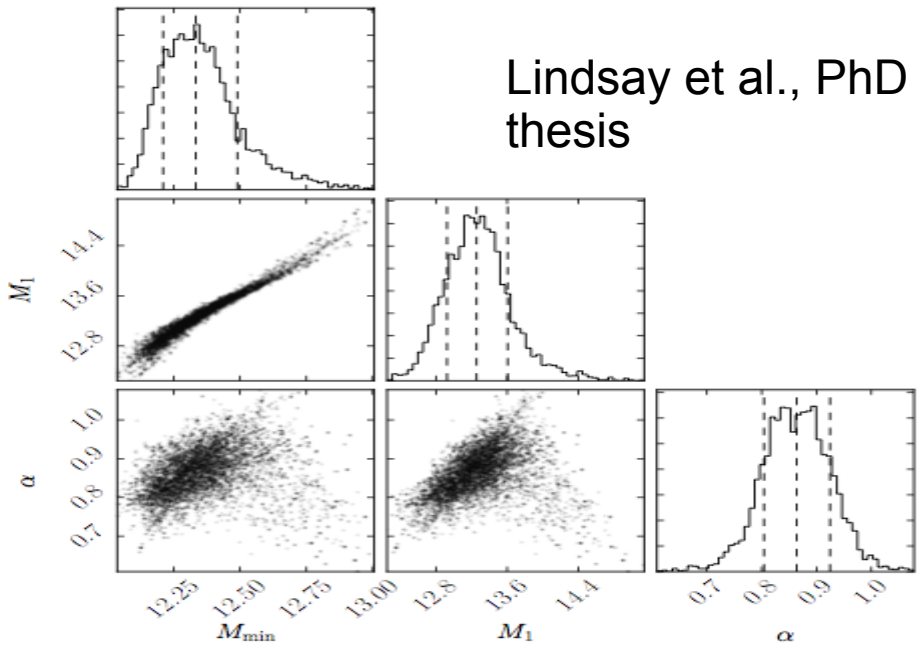


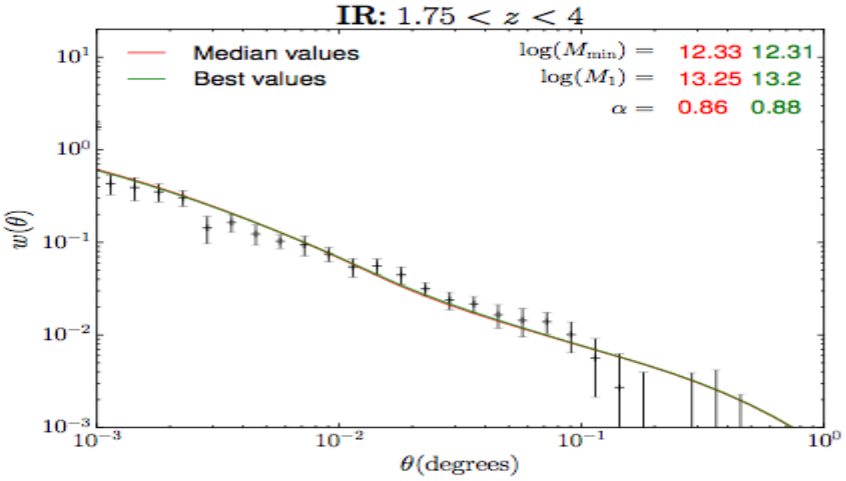


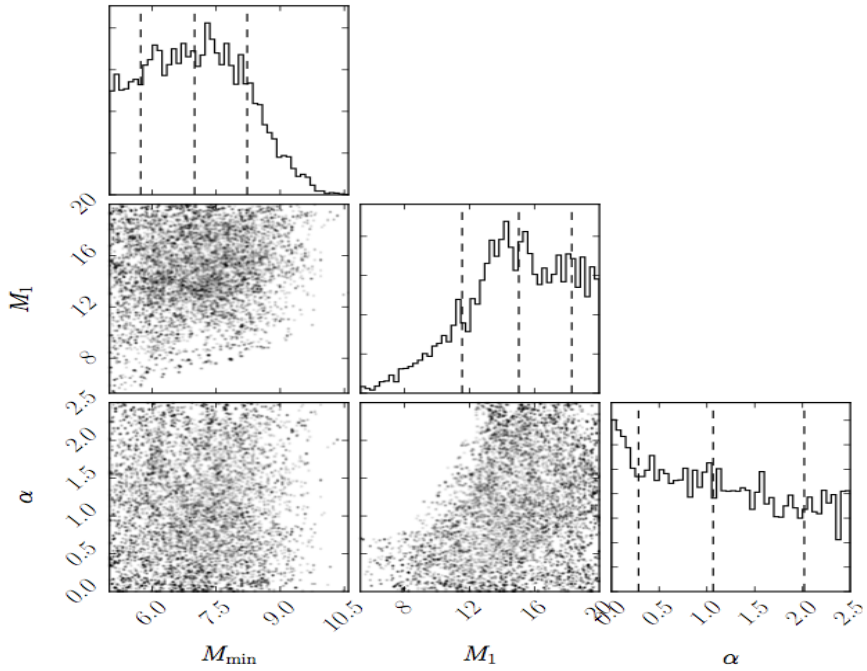
Allison et al. 2015

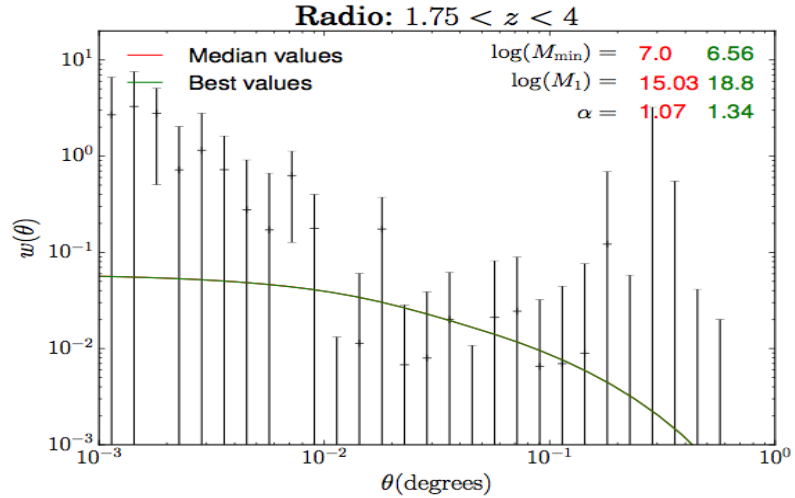
But source density is poor (currently)

Lindsay et al., PhD thesis

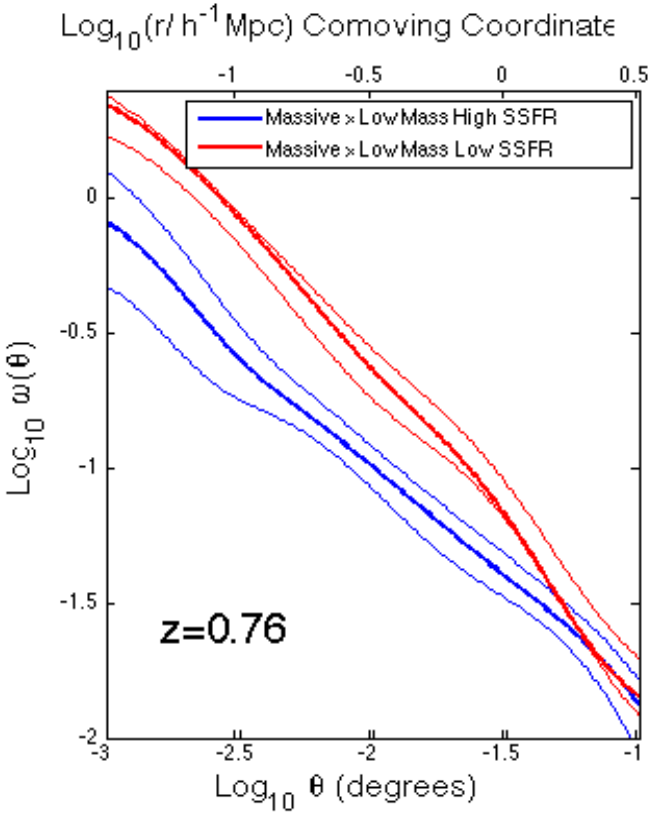


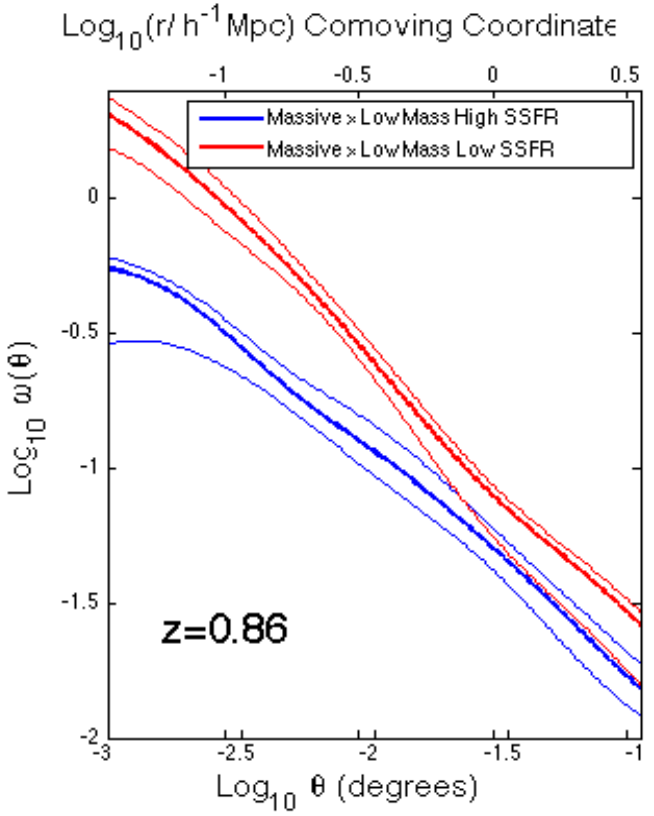


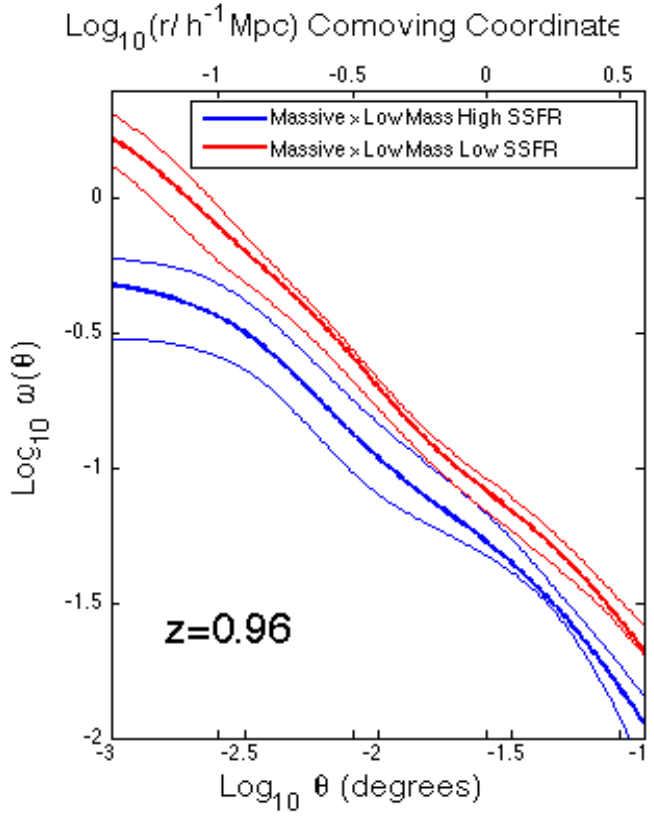




Radio deep fields for understanding quenching of SF and Galactic Conformity







Hatfield et al. in prep.

Weak Lensing

Radio surveys offer exciting and unique opportunities for weak lensing analyses

⋆ Measuring galaxy shapes in overlapping optical & radio surveys…

- In general, the observed ellipticity is composed of the lensing-induced ellipticity, the galaxy's intrinsic shape and instrumental systematics:

$$\tilde{\gamma} = \gamma + \gamma^s$$

- Cross-correlating shear estimates:

$$\langle \tilde{\gamma}\tilde{\gamma} \rangle = \langle \gamma\gamma \rangle + \langle \gamma\gamma^s \rangle + \langle \gamma^s\gamma^s \rangle$$

Courtesy of Michael Brown

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Cosmic shear signal

Instrumental systematics

Courtesy of Michael Brown

Weak Lensing

Radio surveys offer exciting and unique opportunities for weak lensing analyses

⋆ rejects spurious instrumental systematic effects:

- In general, the observed ellipticity is composed of the lensing-induced ellipticity, the galaxy's intrinsic shape and instrumental systematics:

$$\tilde{\gamma} = \gamma + \gamma^{s}$$

- Cross-correlating optical and radio-based shear estimates:

$$\langle \tilde{\gamma}_o \tilde{\gamma}_r \rangle = \langle \gamma\gamma \rangle + \langle \gamma\gamma_o^s \rangle + \langle \gamma\gamma_r^s \rangle + \langle \gamma_o^s \gamma_r^s \rangle$$

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Cosmic shear signal

Systematics will be uncorrelated for optical and radio telescopes

Courtesy of Michael Brown

Jarvis & Jain (2008); Patel et al. (2010)

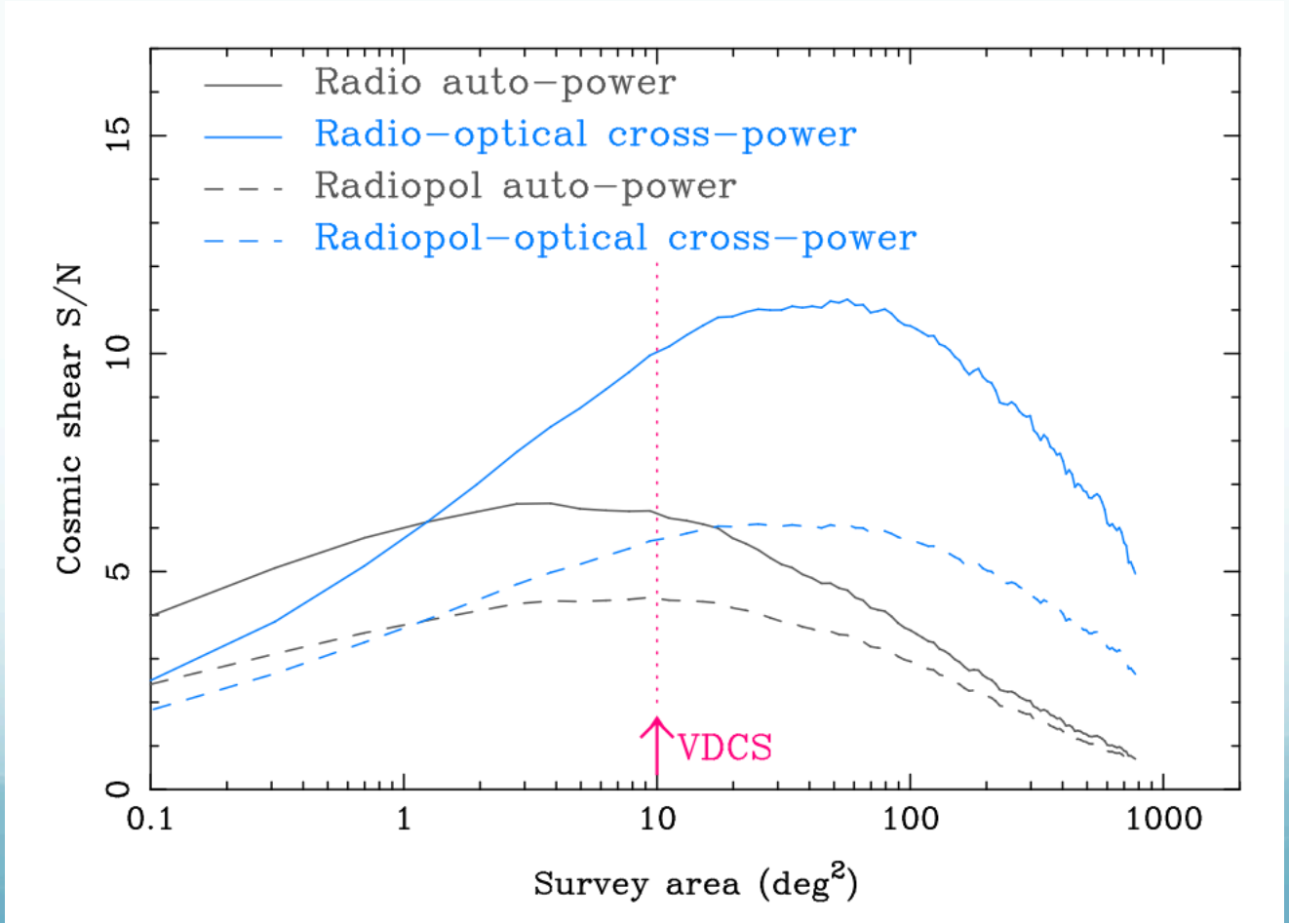
VLASS to V-DECS

PI: Eric Murphy

- VLASS will focus on a wide-area transients & polarisation survey of the northern sky
- Deep part of VLASS encouraged to be submitted in open time for multi-cycle large project
- A,B,C-array survey covering 10sq.deg (COSMOS, XMMLSS or EN1)
    - A-Array: 1.5uJy rms (2-4 GHz; 0.7arcsec resolution)
    - B-array: 4x shallower than A-array
    - C-array: 4x shallower than B-array
- Main drivers: Weak lensing, evolution of AGN and SF galaxies, clustering of radio sources

Radio Weak Lensing

- Very different systematics to optical surveys.
- Possible precise redshift information from HI measurements.
- Extend reach of weak lensing to higher redshifts.
- Unique to JVLA until SKA1 (>2022). V-DECS would be the key survey



MIGHTEE

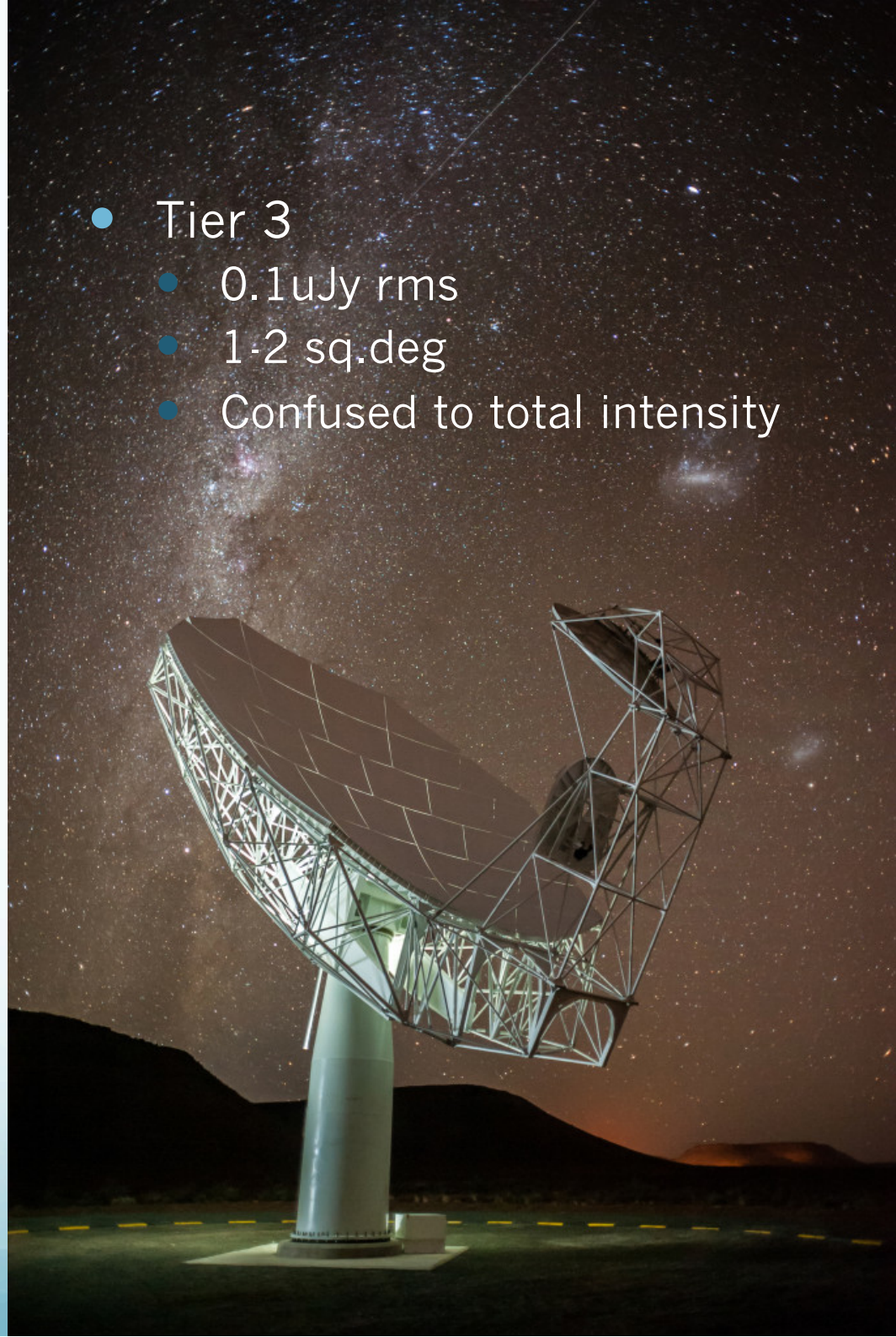
PIs: Matt Jarvis & Kurt van der Heyden

- Tier 2
  - 1uJy rms (L-band)
  - 35 sq.deg
  - 7arcsec resolution
  - HI absorption & emission
  - Polarisation

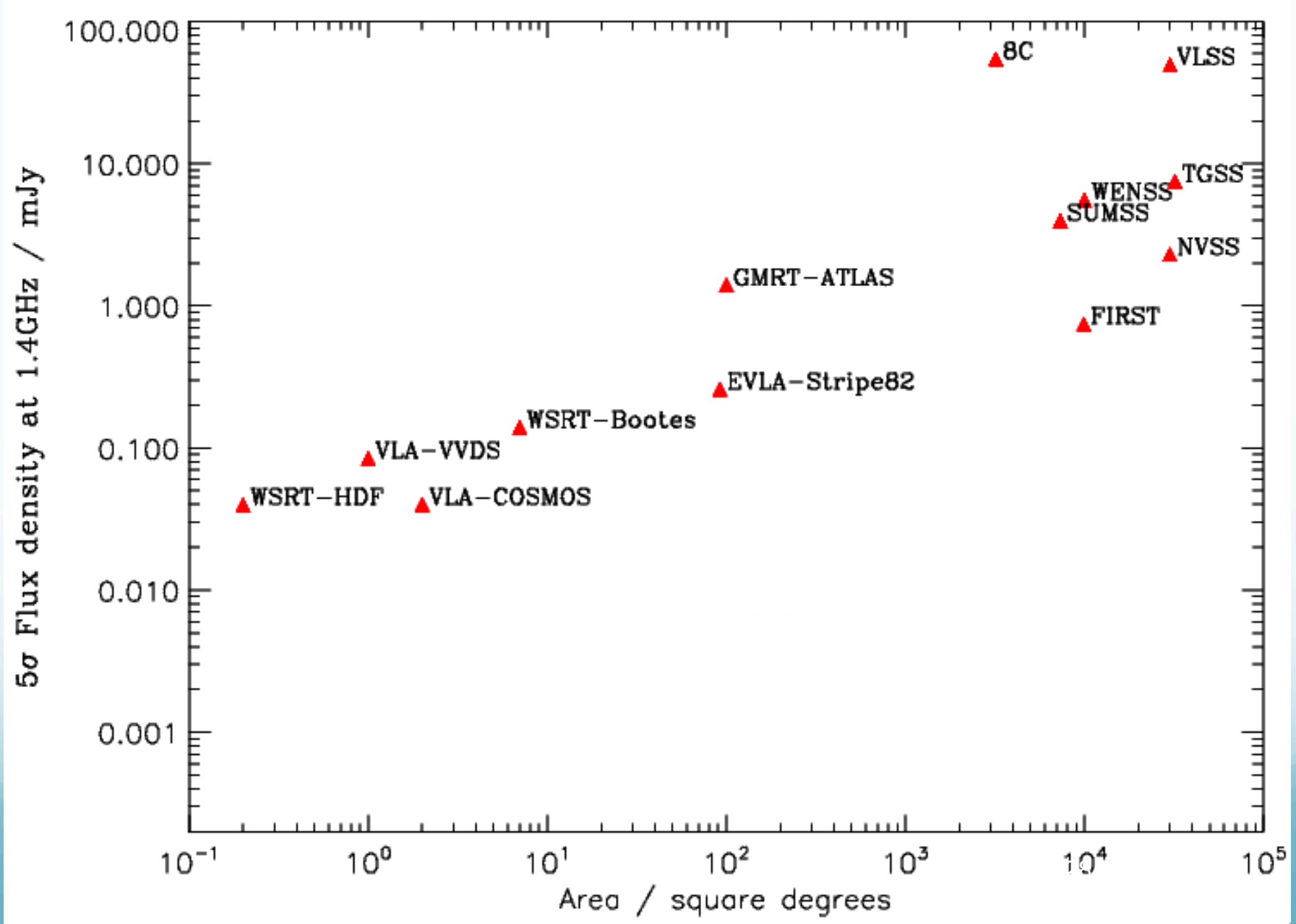
Early science 16-element array in 2016

64 dishes read for observations mid-late 2017

Science case and survey being updated in light of ***MORE*** sensitivity than expected



The new radio surveys



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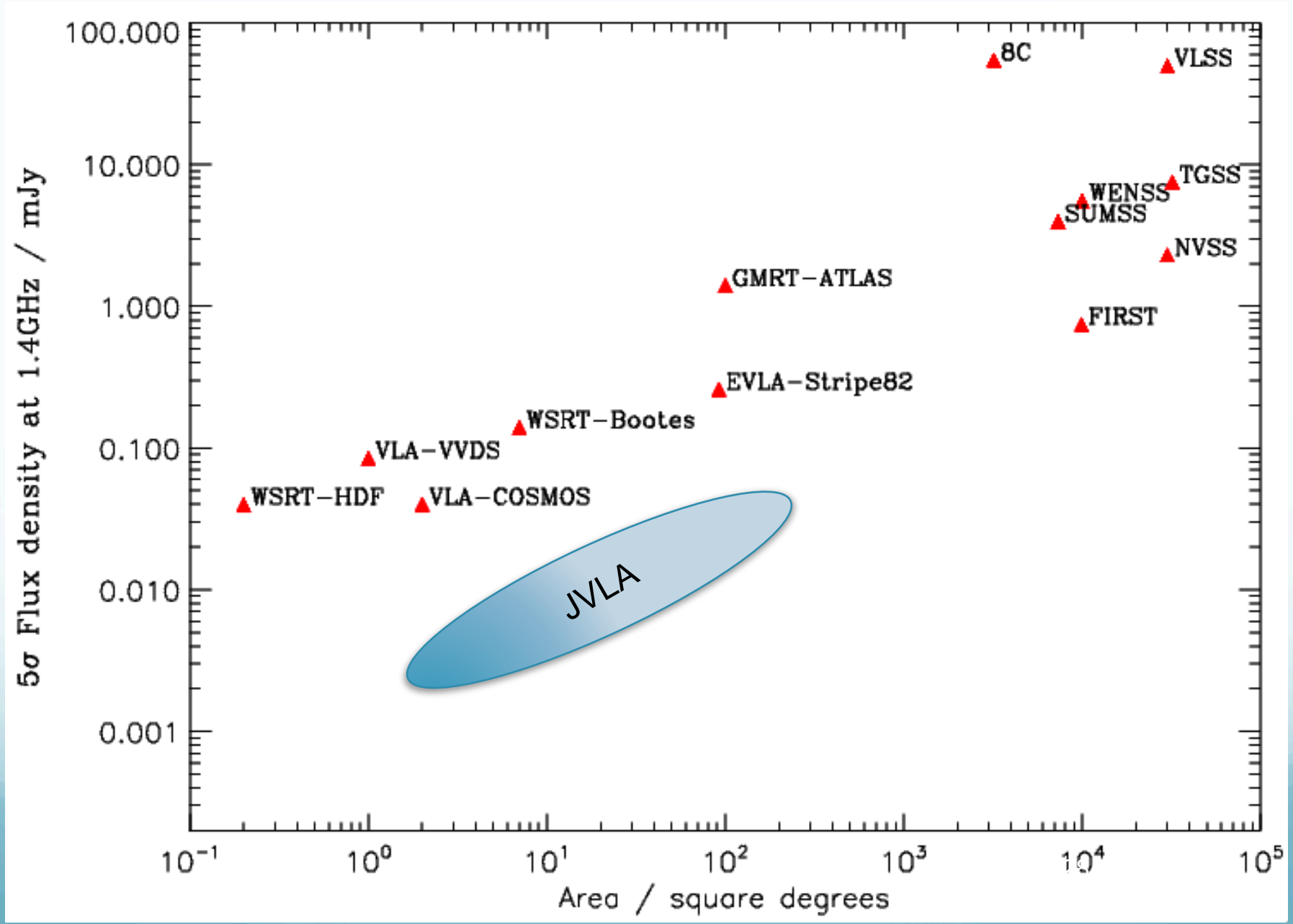

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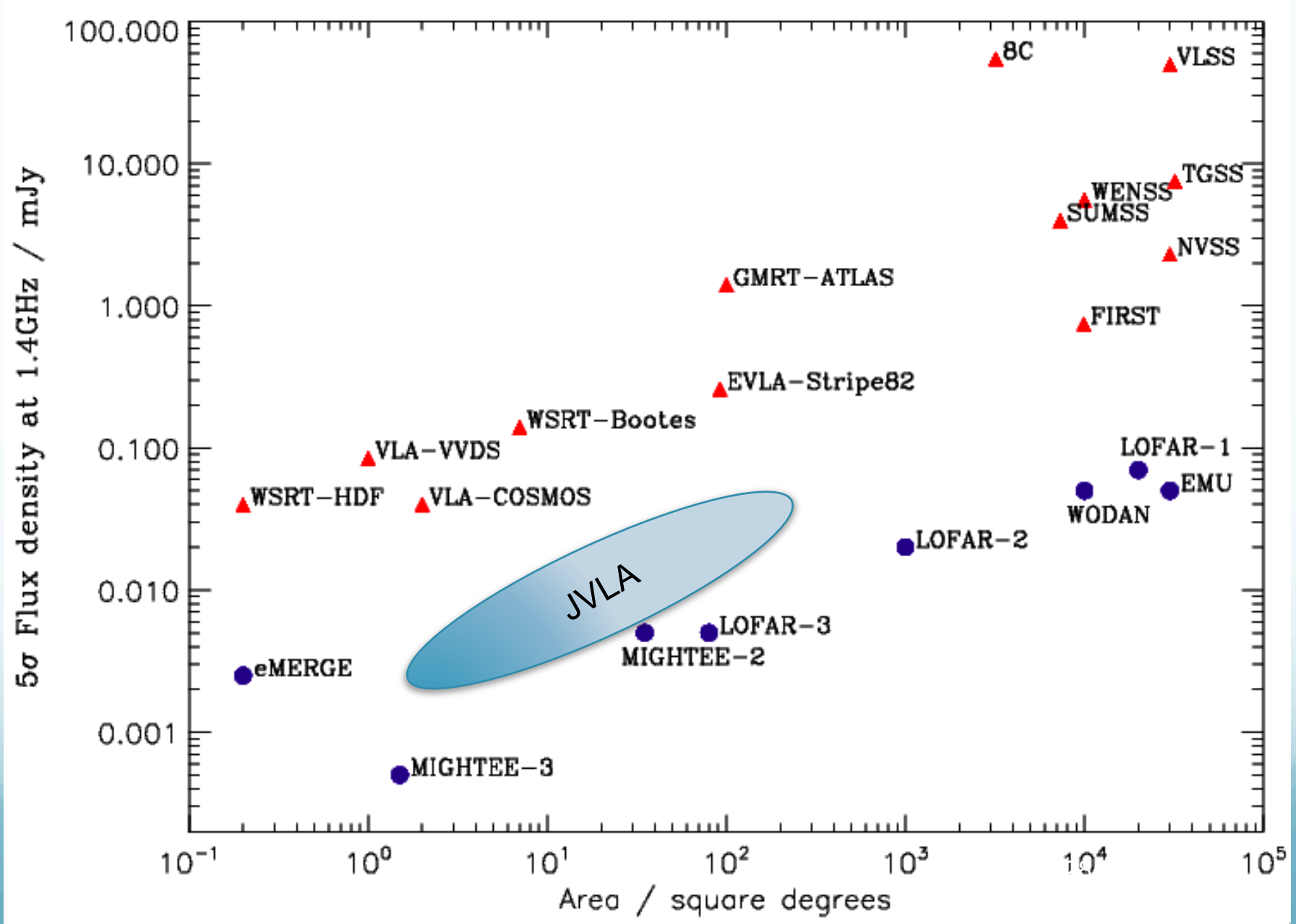

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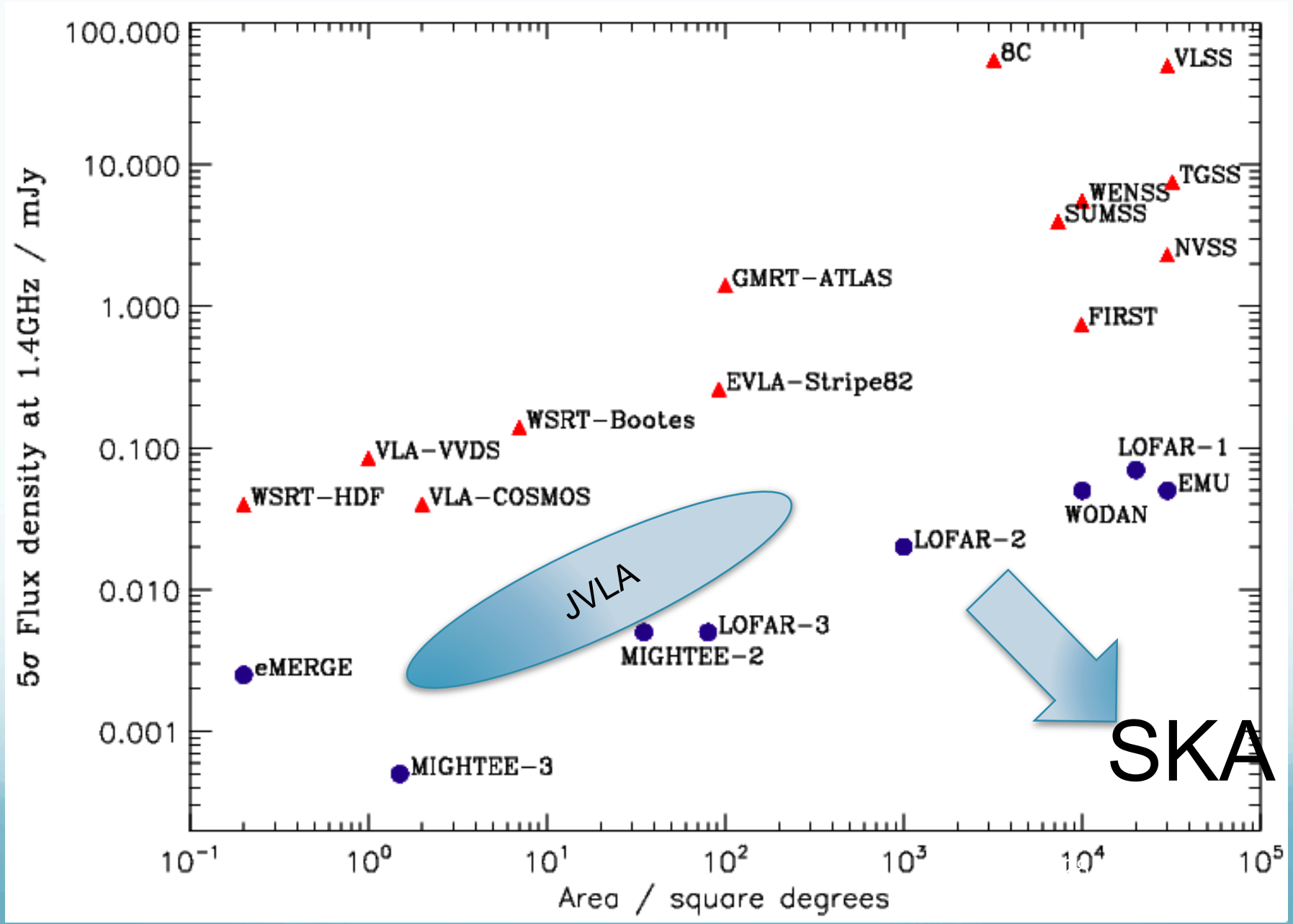

Summary

- Radio Survey and Galaxy Evolution
  - The new radio continuum surveys not only provide a massive increase in depth, but they also sample many more spatial scales than e.g. VLA
  - Allow unique studies in traditional radio astronomy science, e.g. evolution of AGN and star-forming galaxies
  - However, depth + area allows measurement of how radio sources trace the underlying DM distribution
- Radio continuum surveys have potential to do cosmology
  - Combination of depth, resolution and many more baselines means ideal surveys for distinguishing radio structures, over large sky area
  - With V-DECS can combine resolution (0.7”) and sensitivity) - radio weak lensing surveys are within reach.
  - Unique power on using intensity and size magnification, as not susceptible to dust