# The radio luminosity function and redshift evolution of low- and high-excitation AGN

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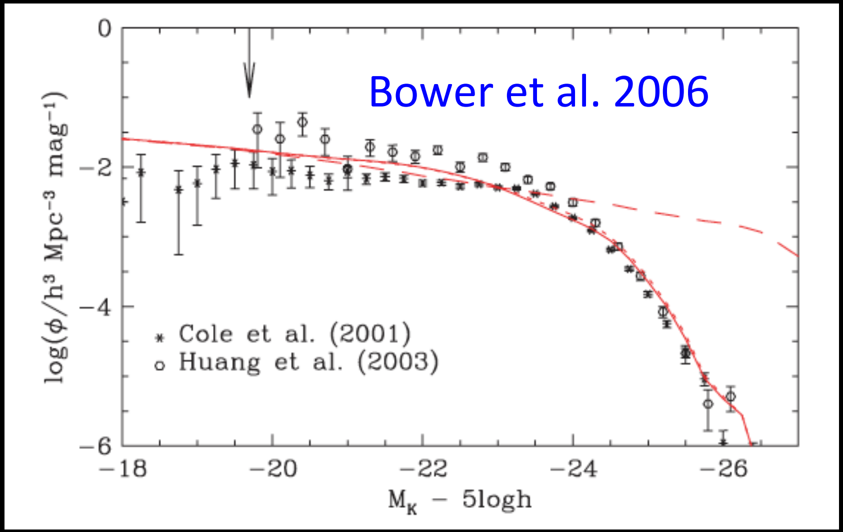
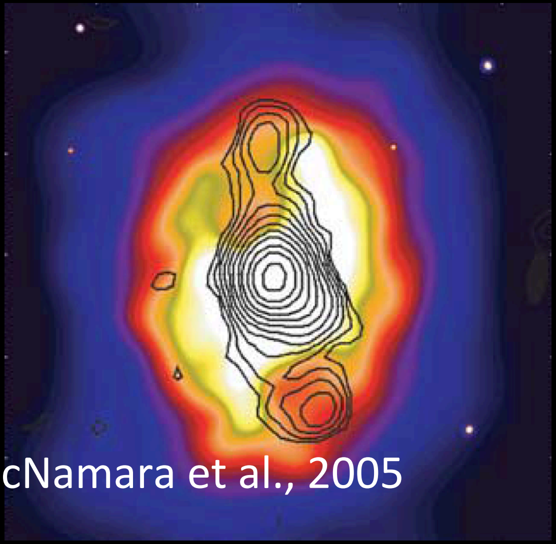
Image credit: Hubble Heritage

THE UNIVERSITY OF SYDNEY

# Motivation: Radio mode feedback

- Radio jets and AGN are thought to play a critical role in Galaxy evolution (particularly in LERGs)
- Radio jets inhibit gas cooling and suppress star formation in massive galaxies (e.g. Croton et al. 2006; Bower et al. 2006)
- Solves the cooling flow problem
- Explains the sharp downturn at the bright end of the optical galaxy luminosity funciton
- There is good observational evidence for radio mode feedback in massive galaxies with hot gas halos

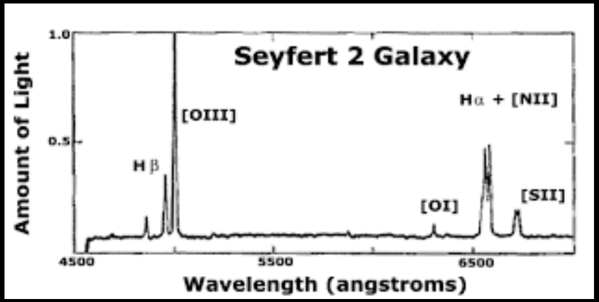


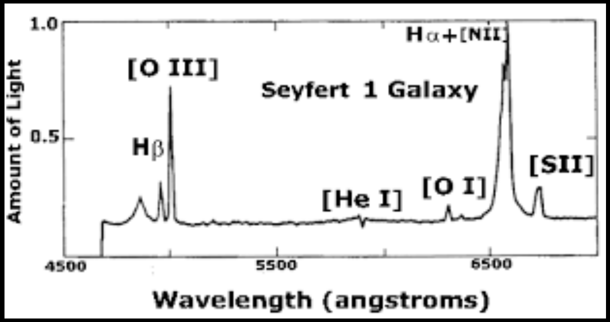



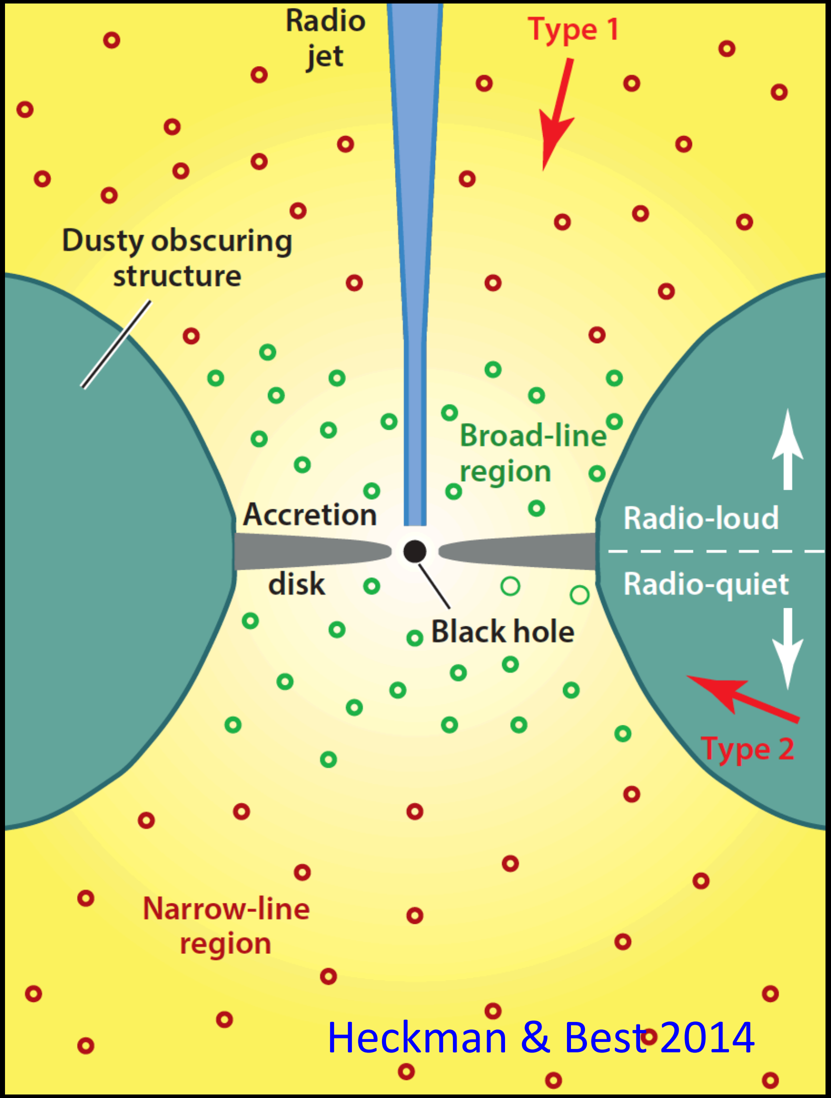
McNamara et al., 2005

# Motivation: two different accretion modes in AGN

## High Excitation Radio Galaxies (HERGs)

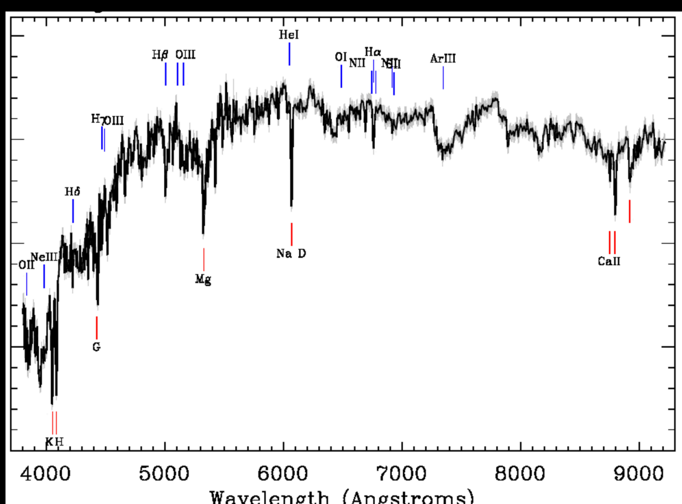


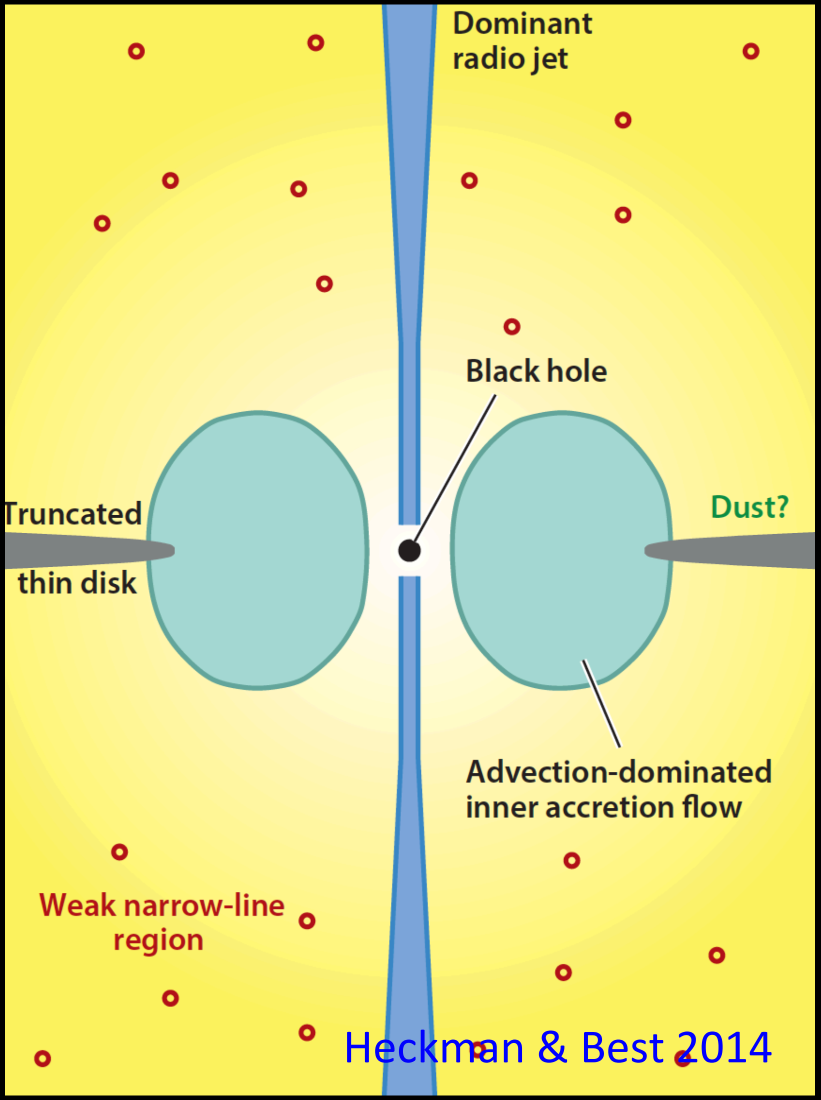



# Motivation: two different accretion modes in AGN

**Low Excitation Radio Galaxies (LERGs)**

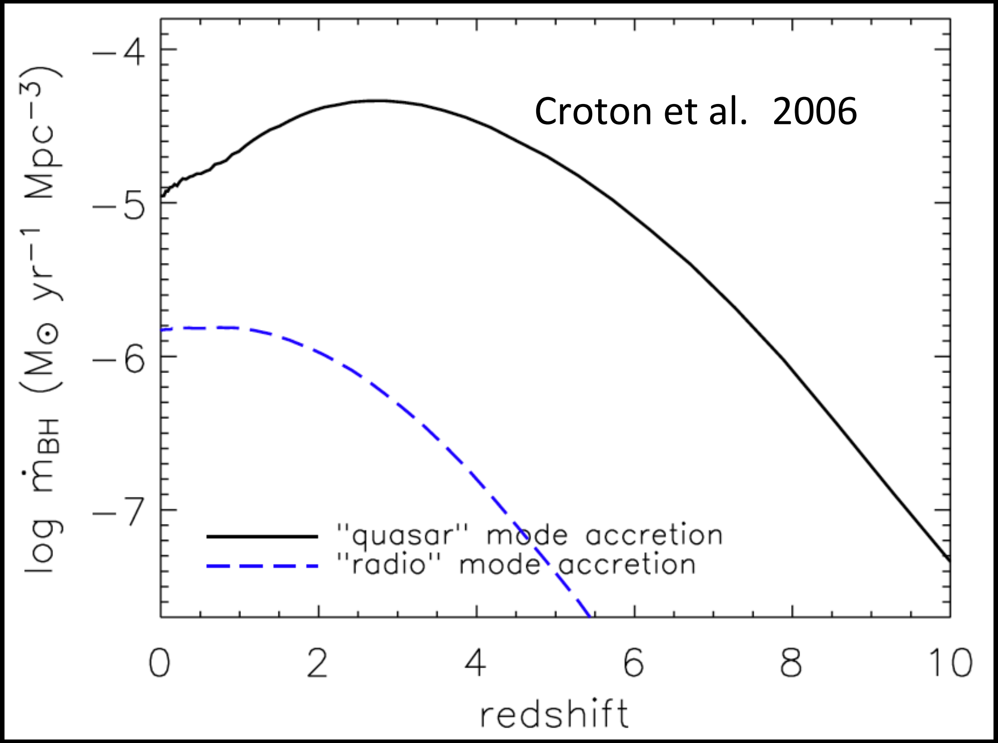


# Motivation: Evolution

Is the high- low-excitation split are true dichotomy?

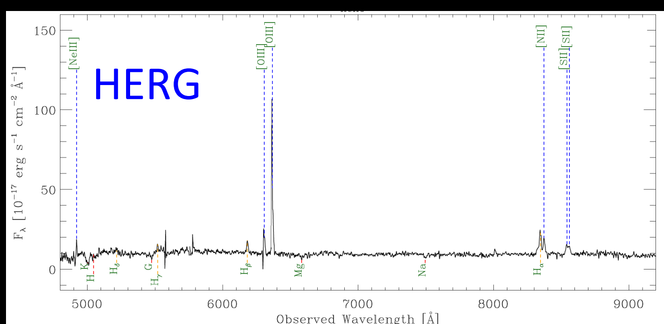
We expect the two modes to evolve differently, Do they?

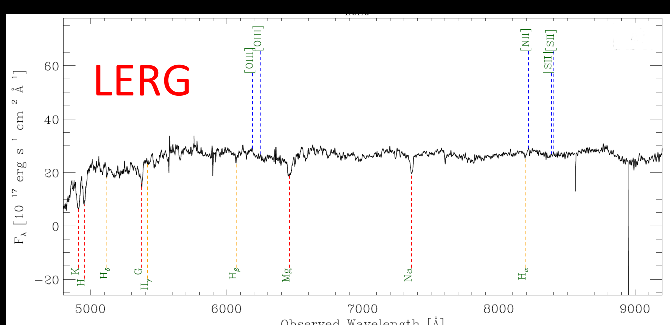


# A new spectroscopic survey (John Ching's PhD thesis)

**Optical spectroscopy the key!**

- Spectroscopy classification used to separate high- and low excitation AGN
- Star forming galaxies rejected using BPT and Hα-radio star-formation correlation




The Large Area Radio Galaxy Evolution Spectroscopic Survey (LARGESS)

- Matched FIRST 1.4GHz with SDSS photometry to faint optical limit i<20.5
- Spectroscopy from archival sources such as SDSS (bright galaxies) and from a dedicated `spare-fibre' campaign on the AAT piggy-backing on the WiggleZ and GAMA AAT large surveys
- No colour selection
- Point sources included
- Over 10,000 good quality spectra in catalogue ~20x larger sample than the only other measurements of high and low-excitation RLFs outside the local Universe

# Constructing the bivariate LF

$$\Phi(M_{\rm i}, L_{\rm 1.4GHz})\Delta M_{\rm i}\Delta \log L_{\rm 1.4GHz} = \sum_{\rm gal} \frac{w_{\rm gal}}{V_{\rm max}({\rm gal})}$$

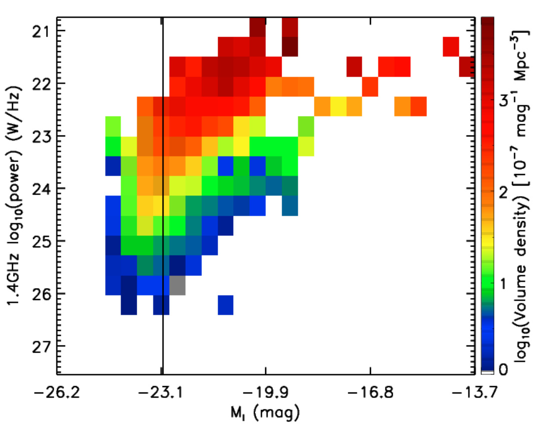
Weight = reciprocal of completeness. We calculate in colour-magnitude plane

Volume over which galaxy could have been detected (K-corrections in optical and radio)

We construct our luminosity functions in three redshift bins:

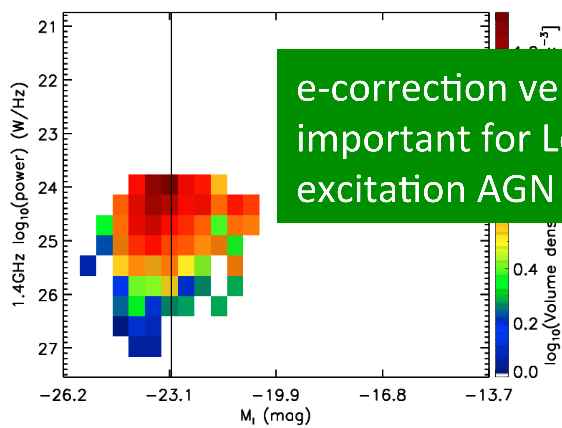
Radio power

Z<0.3



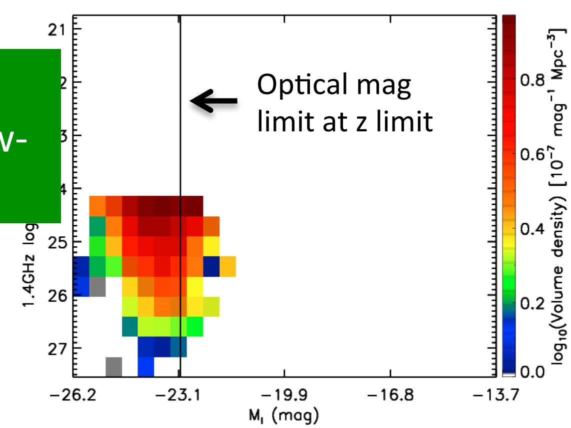

Absolute i magnitude

0.3<z<0.5




Absolute i magnitude

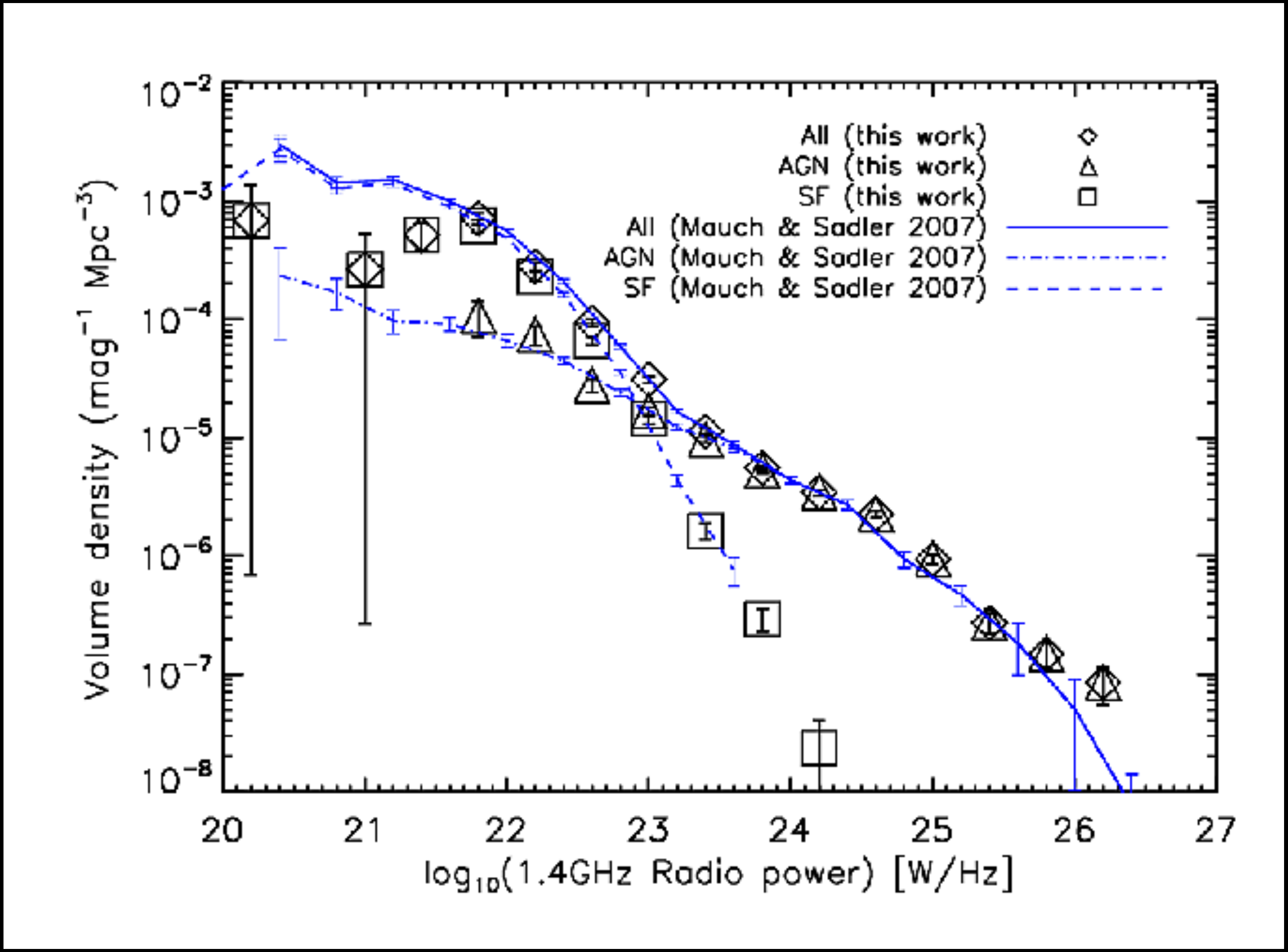
0.5<z<0.75



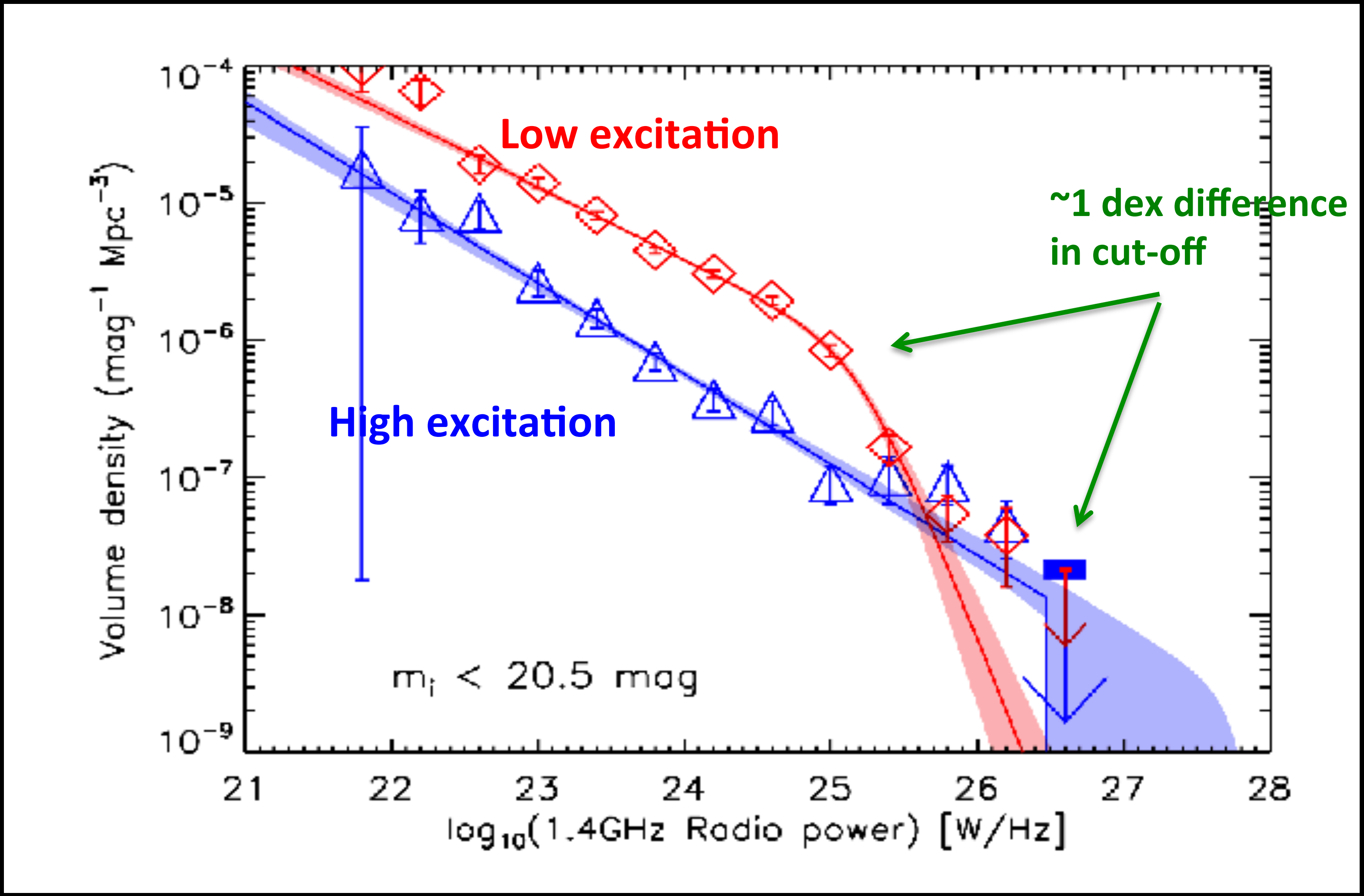

Absolute i magnitude

Can then make Radio LFs by marginalizing over optical magnitude…….

# The local radio galaxy luminosity function



# The local radio galaxy luminosity function



# Fitting the LF and quantifying the evolution

**Double power law**

$$\Phi(L) = \frac{\Phi^*}{(L^*/L)^\alpha + (L^*/L)^\beta}$$

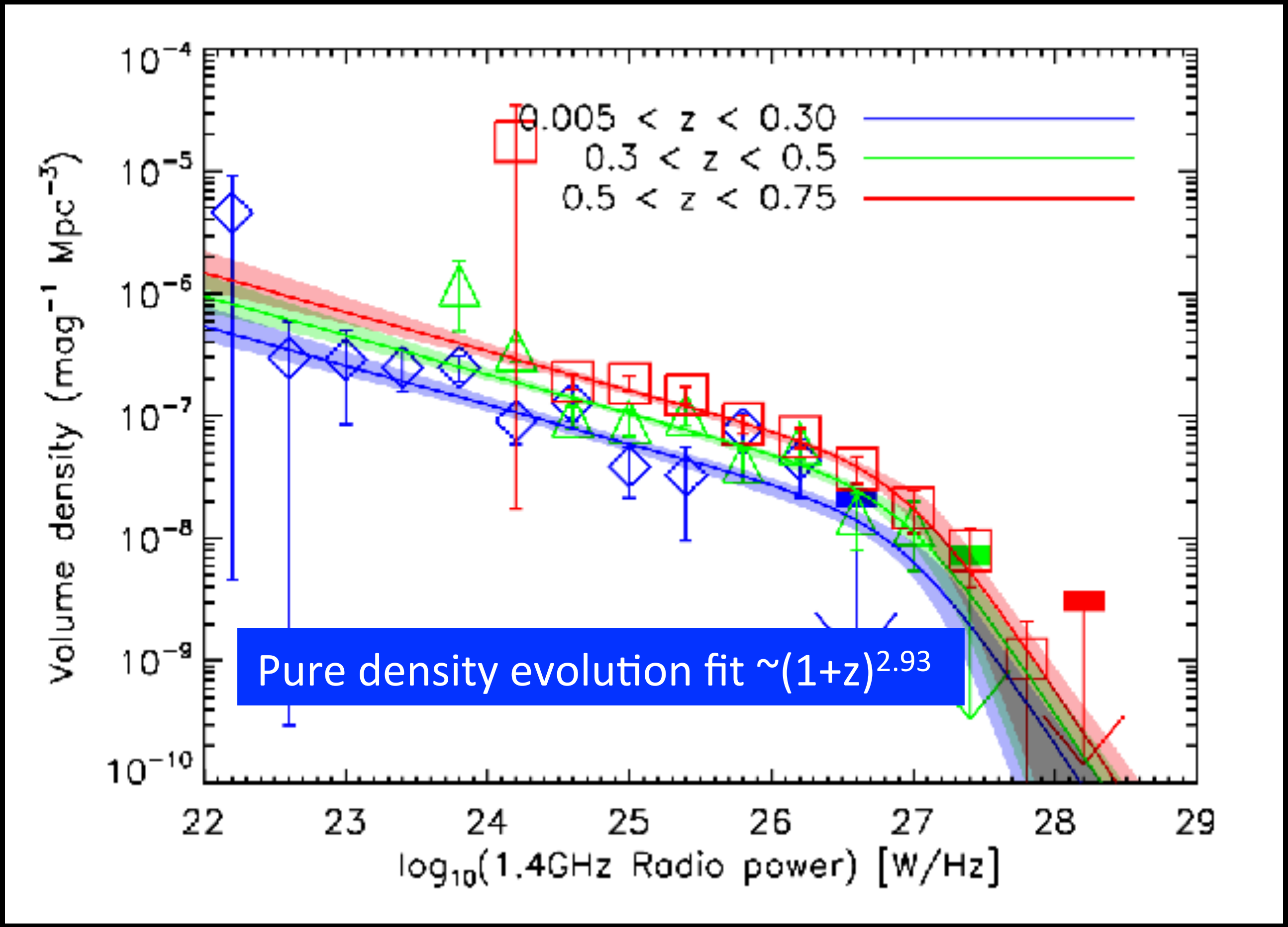
**Pure Density**

$$\Phi(z) = (1+z)^{K_D}\,\Phi(0)$$

**Pure Luminosity**

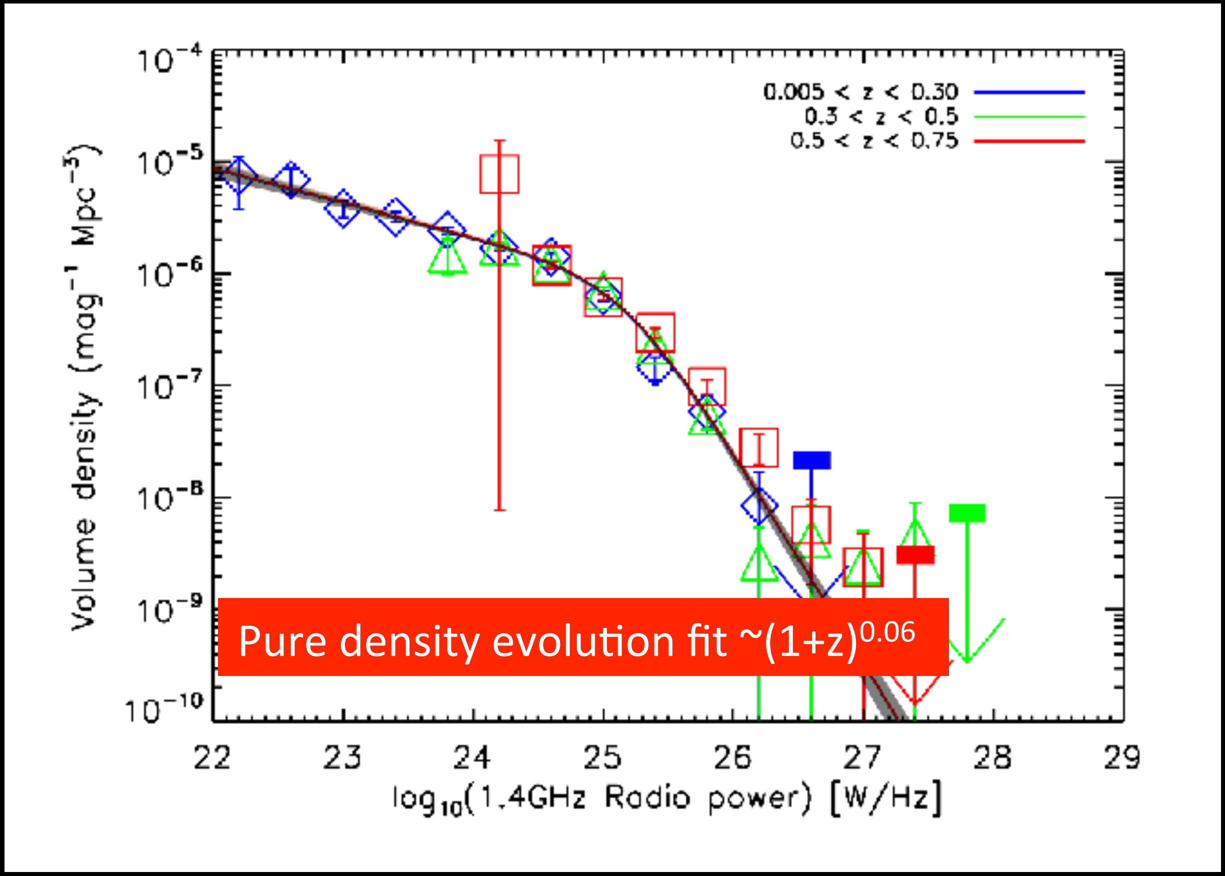
$$L^*(z) = L^*(0)(1+z)^{K_L}$$

# Redshift Evolution of the High Excitation RGs




Similar to that found by Best et al. 2014 comparing a sample of 123 HERGs at 0.5<z<1.0 with the SDSS at z<0.3

# Redshift Evolution of the Low Excitation RGs




Some tension with that found by Best et al. 2014 comparing a sample of 45 LERGs at 0.5<z<1.0 who found positive evolution in LERGs at the bright end and a decrease at the faintest radio powers at z~1

# Summary

- Bright end cut-off in the HERGs LF about 1dex higher than the LERGs…..this is consistent with different accretion modes/rates

- ~Zero evolution in the Low excitation radio galaxies  to z = 0.75

- Rapid evolution in the HERGs out to z=0.75
- Evolving in space density $\sim(1+z)^3$