Tracing High Redshift Star Formation in the Current and Next Generation of Radio Surveys

Nick Seymour (MSSL/UCL)

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Deep 1.4GHz Source Counts

Seymour et al. 2004

1.4GHz flux density (mJy)
Methods to discriminate between AGN and star forming activity

• Radio morphology
• Radio spectral index/radio SED
• Radio variability
• Radio polarisation
• Flux density ratios/full SED modeling
Fraction of SFG at Faint Radio Flux Densities

Seymour et al. 2008
Fraction of SFG at Faint Radio Flux Densities

- $^{13}$H XDF - Seymour et al. 2008
- HDFN - Muxlow et al. 2005
- SXDF - Simpson et al. 2006
- COSMOS - Smolčić et al. 2008
- Lockman - Ibar et al. 2009
- ECDFS - Padovani et al. 2008

Fraction of SFGs

Flux density (mJy)
The Current and Next Generation of Surveys

By Isabella Prandoni

Major Deep Surveys @ 1.4 GHz (updated 2009)
The Current and Next Generation of Surveys

By Isabella Prandoni (plus my own estimates)
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What science can we do with radio-selected star forming galaxies?
At high redshift we discover extreme starbursts in massive galaxies which we don’t see locally!
Radio: Seymour et al. (2008)
Other wavelengths: Hopkins (2004)

Radio results also show the rapid rise to $z=1-2$
Seymour et al. 2008b

IR/Luminosity Density = Star Formation Rate Density

Shaded region from Le Floc’h et al. (2005)
Does the radio luminosity/star formation rate density relation hold at high redshifts/luminosities?

This primarily depends on the IR-radio correlation.
Far-IR/Radio Correlation

Observed Flux Density Ratio

Local galaxy templates

Seymour et al. 2009
Far-IR/Radio Correlation

Observed Flux Density Ratio

\[ q_{70} = \log\left(\frac{S_{70 \mu m}}{S_{1.4 \text{GHz}}}\right) \]

\[ \text{redshift} \]

Seymour et al. 2009
Why might the 70um/radio correlation change at high redshift?

- Locally the IR SED is luminosity dependant?
- If high-z star forming regions in ULIRGs are more extended and hence be:
  - More optically thin and have less free-free absorption and therefore have a higher radio flux
  - Characterised by cooler IR dust SEDs and therefore have a lower 70um flux
The Link Between SCUBA, Spitzer and Herschel: Cold Galaxies at $z \leq 1$

Track from Rieke et al. (2008) templates

IRAS Bright Galaxy Sample

70µm selected sources

(Symeonidis et al., 2009, in press, astrophys/0905.0854)
What will *Herschel* see?
What does *BLAST* see?

![Graph showing flux ratios of local templates vs. redshift]
Conclusions

• Radio observations of the distant Universe used to study AGN, but we will now begin to get a full census of star formation from deep, wide radio surveys

• There are three crucial issues in exploiting such data:
  • distinguishing between AGN and SFG
  • calibrating the radio/SFR relation across all redshifts, radio luminosities and type of galaxy
  • obtaining redshifts from ancillary data

• The radio/IR relation appears to depend on IR SED and hence waveband. We must understand this locally before applying to high redshift.
Fin
Far-IR/Radio Correlation

Observed Flux Density Ratio

Seymour et al. 2009
Far-IR/Radio Correlation

Seymour et al. 2009
The link between IR SED and radio spectral index??
Structure of Talk

- Motivation to Observe in the Radio
- *Spitzer* Observations of High Redshift Radio Galaxies
- Extreme Starbursts at High Redshift
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