Mem. S.A.It. Vol. 76, 166

Memorie della

The nature of the Mid-IR faint radio sources from the Spitzer First Look Survey

M. Orienti[1,2], M.A. Garrett[3], C. Reynolds[3] and R. Morganti[4]

[1] Istituto di Radioastronomia - CNR, via Gobetti 101, I-40129 Bologna, Italy e-mail: `orienti@ira.cnr.it`
[2] Dipartimento di Astronomia, Università di Bologna, via Ranzani 1, I-40127 Bologna, Italy
[3] Joint Institute for VLBI in Europe, Postbus 2, 7990 AA, Dwingeloo, The Netherlands
[4] Netherlands Foundation for Research in Astronomy, Postbus 2, 7990 AA, Dwingeloo, The Netherlands

Abstract. Data from the Spitzer Space Telescope (the First Look Survey - FLS) have recently been made public. We have compared the 24 μm images with very deep WSRT 1.4 GHz observations, centred on the FLS verification strip (FLSv). Approximately 75% of the radio sources have corresponding 24 μm identifications. Such a close correspondence is expected, especially at the fainter radio flux density levels, where star forming galaxies are thought to dominate both the radio and mid-IR source counts. However, a significant fracion of radio sources detected by WSRT ($\sim$ 25%) have no mid-IR identification in the FLSv (implying a 24 μm flux density $\leq$ 100 μJy). We present initial results on the nature of the radio sources without Spitzer identification, using data from various multi-waveband instruments, including the publicly available R-band data from the Kitt Peak 4-m telescope.

Key words. starburst galaxies – infrared galaxies – low-luminosity AGN

1. Introduction

Deep radio surveys (S $\leq$ 1 mJy) have clearly indicated the emergence of a new population of radio sources at mJy and sub-mJy levels. Several class of objects have been invoked to explain the steep rise in the integral radio source counts at faint sub-mJy levels: star forming galaxies, similar to M 82 and Arp 220 (Rowan-Robinson et al. 1993), and low-luminosity AGN like M 84.

The fact that the locally derived far-IR/radio correlation (e.g. Helou & Bicay 1993) also applies to the vast majority of the faint (and cosmologically distant) radio source population (Garrett 2002), strongly supports the idea that star forming galaxies begin to dominate the microJy radio source population.

The Spitzer's First Look Survey verification strip, with its 3σ sensitivity level of $\sim$ 80 μJy at 24 μm (Marleau et al. 2004), provides an important opportunity to constrain the nature of the sub-mJy radio source population.

Send offprint requests to: M. Orienti
Correspondence to: IRA - CNR, via Gobetti 101, I-40129 Bologna, Italy

2. The samples

We have extracted a catalogue of sources observed by Spitzer's Multiband Imaging Photometer at 24 μm (MIPS-24), and using the 1.4 GHz WSRT catalogue (1σ noise level ~ 8.5 μJy; Morganti et al. 2004), we identify two distinct samples:

- Sample I: 292 radio sources with clear MIPS-24 identification, comprising 75% of the complete FLSv radio sample;
- Sample II: 97 radio sources *without* MIPS-24 identification, comprising 25% of the complete FLSv radio sample.

Both samples were cross-correlated with the optical R-band FLS catalogue from the Kitt Peak 4-m telescope (Fadda et al. 2004).

3. Results

Making a comparison between the two radio samples, we find different flux density and magnitude distributions: Sample I is dominated by the faintest radio sources ($S \leq 300$ μJy) with an optical counterpart brighter than R = 22.5, while Sample II appears to comprise the brighter radio sources (S > 1 mJy) with optical counterpart fainter than R = 22.5.

These results suggest that the two samples are dominated by different radio source population. This is in agreement with the hypothesis that the mJy regime is dominated by the faint tail of the AGN population, while star forming galaxies dominate at sub-mJy levels (Richards 2000). Our results suggest that the radio sources **without** MIPS-24 identification (Sample II) are likely to be dominated by distant low-luminosity AGN. A study of the SED of variuos class of objects projected to different redshift supports this hypothesis: an Ultra-Luminous IR Galaxy like Arp 220 is detectable to z ~ 0.7 with both WSRT and MIPS-24, while a low-luminosity AGN like M 84 can be detected up to z ~ 0.7 by WSRT, but only to z ~ 0.15 by MIPS-24.

Another possible explanation is related to the mass and temperature of the dust in the host galaxy: a galaxy like Arp 220 with a lower temperature (e.g. < 30 K) is only detectable up to z ~ 0.2 by MIPS-24.

Deep spectroscopy, VLBI, sub-mm and X-ray observations will be crucial in order to further constrain the nature of this class of radio sources not detected by Spitzer at 24 μm.

Acknowledgements. This work is based in part on observations made with the *Spitzer Space Telescope*, which is operated by the JPL, California Institute of Technology, under NASA contract 1407. The National Optical Astronomy Observatory (NOAO) is operated by the Association of Universities for Research in Astronomy (AURA), Inc. under cooperative agreement with National Science Foundation.

References

Fadda, D. et al., 2004, AJ, 128, 1
Garrett, M.A. 2002, A&A, 384, 19
Helou, G., Bicay, M.D. 1993, ApJ, 415, 93
Marleau, F.R. et al. 2004, ApJS, 154, 66
Morganti, R. et al. 2004, A&A, 424, 371
Richards, E.A. 2000, ApJ, 533, 611
Rowan-Robinson, M. et al. 1993, MNRAS, 263, 123