Cluster halos and other diffuse sources in SUMSS

R.W. Hunstead and the SUMSS team

School of Physics, University of Sydney, NSW 2006, Australia
rwh@physics.usyd.edu.au

The Sydney University Molonglo Sky Survey (SUMSS; Bock et al. 1999) is a sensitive radio imaging survey of the sky south of declination $-30°$ being carried out with the Molonglo Observatory Synthesis Telescope (MOST). Operating at a frequency of 843 MHz, MOST produces images with a resolution of $43'' \times 43''\,\mathrm{csc}\,|\delta|$ and an rms noise level of ~ 1 mJy beam^{-1} over a 5 deg^2 field-of-view. SUMSS is therefore similar in sensitivity and resolution to the NRAO VLA Sky Survey (NVSS; Condon et al. 1998) and provides complementary coverage of the southern sky, together with overlap in the $-30°$ to $-40°$ region.

An important feature of MOST, in contrast to minimum-redundancy arrays such as the VLA, is its inherently continuous u-v coverage, making deconvolution a refinement rather than a necessity. This feature, together with the wide field-of-view, is a particular advantage for detecting and imaging the diffuse emission from clusters of galaxies. Fig. 1 shows an early SUMSS image centred on the luminous X-ray cluster A3667 and corrected for primary beam attenuation. After calibration and image quality checks, individual SUMSS images are combined into $4° \times 4°$ mosaics. The pointing centres and weights have been chosen to give essentially uniform signal-to-noise over each mosaic.

A deeper, co-added MOST image of A3667 is shown in Fig. 2 overlaid as contours on a smoothed pixel image from a pointed ROSAT PSPC observation. The radio image is the weighted sum of six separate MOST images, and has a background rms noise level of 0.57 mJy beam^{-1}. Despite the improved sensitivity there is no detectable radio emission from the X-ray core regions. Note that the ROSAT image has not been corrected for shadowing by the support structure for the PSPC entrance window. A greyscale image of the south-eastern relic, shown in Fig. 3, reveals an edge-brightened morphology similar to the north-western relic.

The ability of MOST to image regions of low surface brightness with excellent fidelity is illustrated in Fig. 4, in which MOST and NVSS images of the enigmatic diffuse source PKS B1400$-$33 (Goss et al. 1987) are compared.

The survey has been underway for a little over two years, and is progressing at a rate of $>$ 1000 deg^2 per year. Some preliminary images are available at `http://www.astrop.physics.usyd.edu.au/SUMSS`. The reduced survey data will be made publicly available as the survey proceeds so to maximise its exploitation. To this end we are keen to expand the circle of SUMSS end-users and our observing schedule is sufficiently flexible that we are able to accommodate specific requests for priority fields on survey centres.

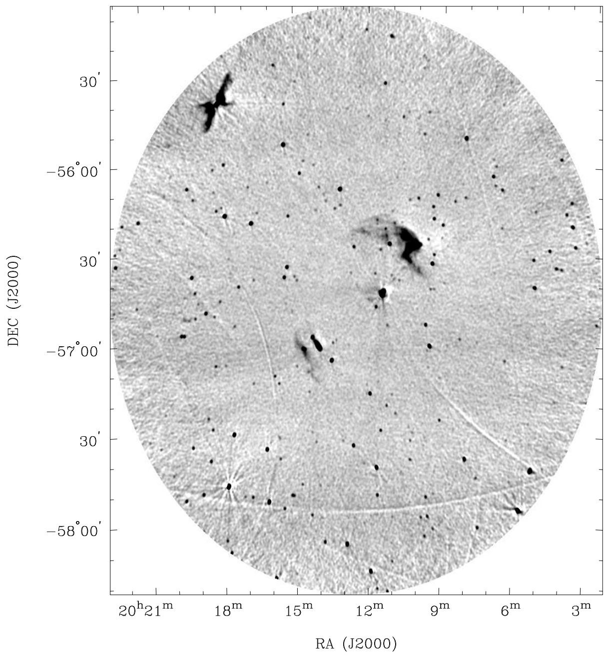

Fig. 1. Preliminary SUMSS image of the field of the cluster A3667 showing the full field-of-view; the greyscale range is from -5 to $+20$ mJy beam^{-1}. The two spectacular radio 'relics' (Röttgering et al. 1997) are clearly seen, as is the FR I radio galaxy B2014$-$558 to the north-east. The arc-like artifacts in the image are grating responses from out-of-field sources, a consequence of the periodic structure of MOST. Subsequent processing, including self-calibration, is expected to improve significantly the cosmetic quality of SUMSS images.

Acknowledgements. The MOST is operated with the support of the Australian Research Council and the Science Foundation for Physics within the University of Sydney.

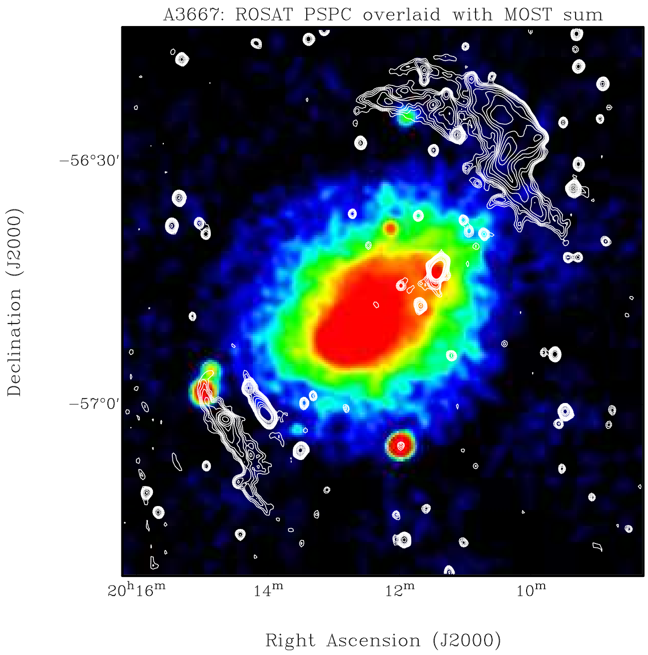

Fig. 2. MOST 843 MHz contour image of the cluster A3667 overlaid on a smoothed ROSAT PSPC image. Contours are at 2, 3, 4, 5, 7, 10, 15, 20, 30, 50, 70, 90 mJy beam^{-1}. The PSPC broad-band image is from the public archive, and has been smoothed with a 70″ FWHM gaussian. The strong X-ray point source south of the main cluster emission is identified with the Seyfert I galaxy Fairall 339, which is a cluster member and a weak radio source.

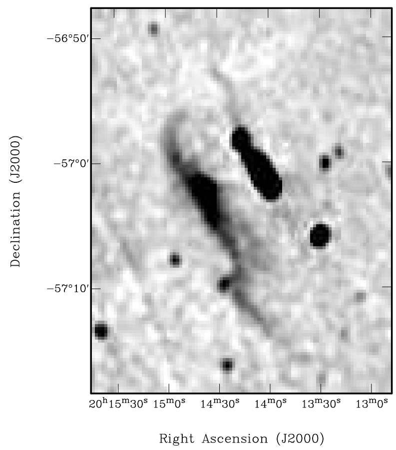

Fig. 3. MOST 843 MHz pixel image of the south-eastern relic in A3667. Recent AT compact array images at 20 and 13 cm (M. Johnston-Hollitt, priv comm) show that the elongated central source has a narrow-angle tail morphology, and is identified with a cluster member; the MOST image shows a possible faint extension of the tail to the north-east.

References

Bock, D.C.-J, Large, M.I. & Sadler, E.M., 1999, AJ 117, 1578

Condon, J.J., Cotton, W.D., Greisen, E.W., Yin, Q.F., Perley, R.A., Taylor, G.B., & Broderick, J.J., 1998, AJ 115, 1693

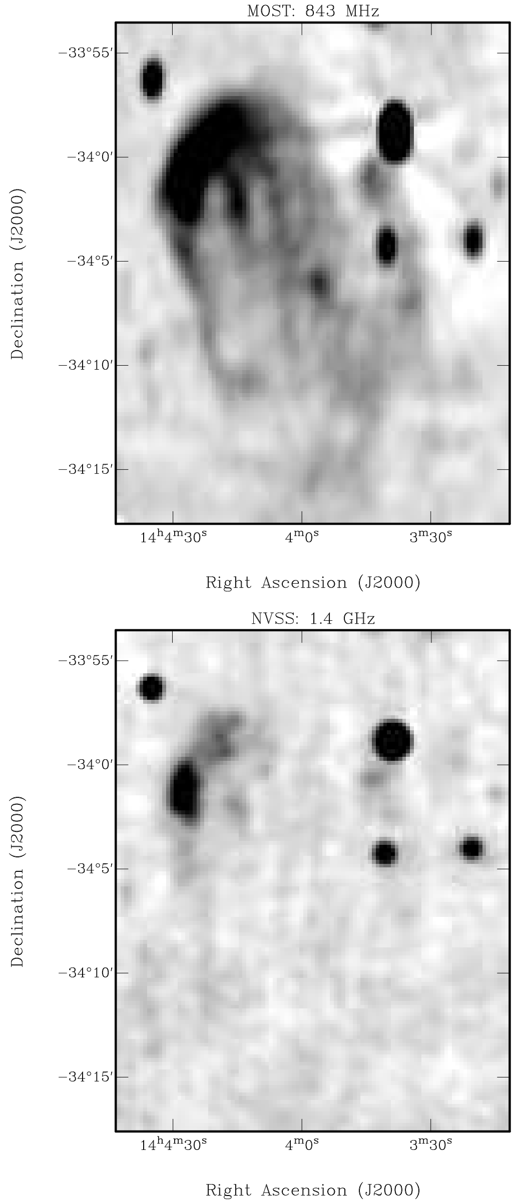

Fig. 4. The diffuse radio source PKS B1400−33 observed with MOST (upper panel) and with the NVSS (lower panel), showing the benefit of MOST's continuous u-v coverage in recording the low-level emission.

Goss, W.M., McAdam, W.B., Wellington, K.J. & Ekers, R.D., 1987, MNRAS 226, 979

Röttgering, H.J.A., Wieringa, M.H., Hunstead, R.W. & Ekers, R.D., 1997, MNRAS 290, 577