MOLONGLO DEEP SURVEY AT 843 MHz

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ABSTRACT. The Molonglo Observatory Synthesis Telescope has been used for a deep survey of 25 southern fields of about 1° diameter. All these fields have been observed on several occasions in 120 x 12-hour sessions during 1983-85. Radio sources have thus been detected down to a few millijansky at 843 MHz in 20 deg^2 of sky from these observations and in a few selected fields, it has been possible to reach a detection limit of 1 mJy. The first results on the source counts and optical identifications are presented. By supplementing these data with some existing observations of stronger radio sources, we have been able to obtain source counts at 843 MHz for the entire range of flux densities above 1 mJy.

1. INTRODUCTION

The Molonglo Observatory Synthesis Telescope (MOST) is a multiple fan-beam radio telescope operating at 843 MHz capable of synthesizing a 23 x 23 cosec δ $arcmin^2$ with a beam of 43 x 43 cosec δ $arcsec^2$ (Mills 1981; Durdin, Large & Little 1984; Crawford 1984). The diameter of the synthesized field can be expanded to 46 or 70 arcmin by time-multiplexing the hardware beams within each sampling interval. The large collecting area of MOST (18000 m^2 total) makes it a very sensitive telescope with an estimated thermal noise of about 0.2 mJy rms in a 12-hour observation of a very southern field.

The deep survey with the MOST covers 25 well-separated fields of diameter 70 arcmin. Most of these fields have been observed on several occasions to reach a uniform detection limit of a few mJy while confusion-limit has been reached in the case of central portions of the best fields. In this paper, we present preliminary results from the deep survey and for completeness, supplement the resulting source counts

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with those at higher flux densities based on other surveys carried out with the MOST.

2. DEEP SURVEY

2.1. Observations

The fields chosen for the deep survey are all in the far southern declinations where the telescope sensitivity is the best and they have been chosen to be well away from catalogued sources. Unless the initial large field map showed particularly bad grating responses or confusion, each field has been observed on several occasions depending on the quality of the maps. Out of the 25 fields, 19 have been mapped over the large field of 70 x 70 cosecδ arcmin^2, 23 with the intermediate size (46 arcmin diameter), and 9 with the normal field of 23 arcmin diameter. The project involves a total of 120 x 12-hour observations carried out between 1983 June and 1985 October, mostly during winter nights. Initial reduction of data is essentially complete and the tabulation of sources and work on optical identification are in progress. For the purpose of this paper, the maps from different observations have been combined and a preliminary compilation of sources based on a computer program has been used to derive the source counts at 843 MHz. In the case of best fields, the sources have been verified manually from contour plots before estimating the counts.

2.2. Optical Identifications

The final radio positions are expected to be accurate to 1-3 arcsec in most cases. Initial search for optical identifications are being made on the film copies of the SRC-J and ESO-R sky surveys. Preliminary results on some of the fields indicate 20-30 percent identifications to the limit of SRC IIIaJ films ($\sim$ 23 mag). For one of the fields, a deep plate has been specially obtained from the service photographic facility of the Anglo Australian Telescope. Nearly half of the sources have been identified on this plate. Further identifications and a follow up of optical spectroscopy are being planned for all the fields.

2.3. Source Counts

The initial results on the source counts at 843 MHz are presented in Figure 1, where the deep survey has been divided into 3 ranges of flux-density. An area of 0.4 deg^2 of sky has been covered in the range 1-2 mJy, 2.3 deg^2 in the range 2-7 mJy and 20 deg^2 for 7-224 mJy. At higher flux densities, the counts would be biased by the rejection of strong sources in the initial selection of the fields and also the sky coverage is not adequate to obtain good statistics. The Figure shows the observed (uncorrected) source counts, normalised to a Euclidean integral count of 100 $S_{Jy}^{-1.5}$ sr^{-1}.

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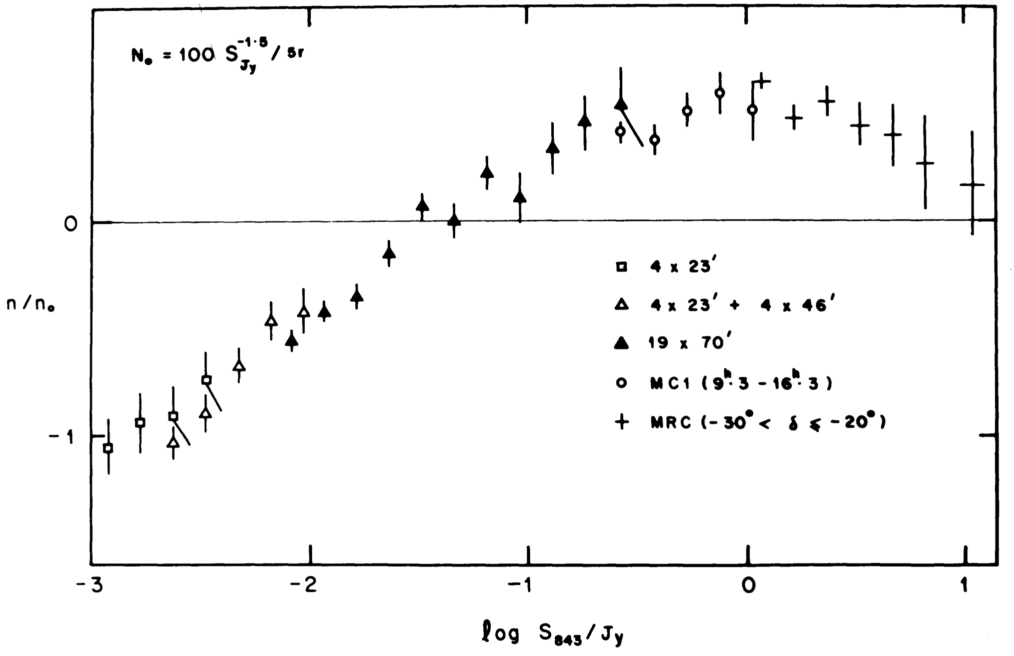

Figure 1. Normalised differential source counts at 843 MHz. All the counts are derived from observations with the MOST. In the case of deep survey, the number of independent fields and the individual field diameters are indicated in the explanation of symbols.

The observed counts for S_{843} > 1 mJy correspond to a source density of 150 deg^{-2} or about half million sources per steradian. This density corresponds to about 50 beam areas per source, suggesting that we are close to confusion limit. In the case of multiple observations of the same field, the noise fluctuations of the sum and difference between various maps confirm that the confusion is about 0.2 mJy rms.

3. COUNTS FOR STRONGER SOURCES

A large number of catalogued radio sources have been observed with the MOST in the form of short scans at several hour angles. Sufficient observations of complete samples now exist to enable us to derive the counts reliably for the stronger sources not adequately represented in our deep survey. Details of these observations will be published elsewhere(Subrahmanya 1987, in preparation). For the sake of completeness, we consider here the counts derived from two samples.

In the region $9^h < \alpha < 16^h$, $-20° > \delta > -22°$, flux-densities at 843 MHz are available for all sources with listed (peak or integrated) $S_{408} \gtrsim 0.2$Jy in the MC1 catalogue (Davies, Little & Mills 1973). Based on these, we have derived the source counts between 0.2 and 1 Jy at 843 MHz, although the derived counts may have been underestimated near 0.2 Jy due to some sources of inverted spectra below the flux density limit at 408 MHz sample. At the brighter end, about 700 sources in the Molonglo Reference Catalogue (MRC; Large et al 1981) with $S_{408} > 0.9$ Jy, $-20° > \delta > -30°$, $|b| > -20°$ have been observed with the MOST. In addition, the observations have also included inverted spectrum sources selected from Parkes catalogue which were likely to be stronger than 0.8 Jy at 843 MHz on the basis of the catalogued flux densities at 2.7 and 5 GHz. Using these observations, a complete sample has been defined with $S_{843} \geq 1$ Jy over 0.7 sr of sky, whose details will be published elsewhere (Subrahmanya 1987, in preparation). For the present purpose, we have included in Figure 1, the counts based on the integrated flux-densities of the above samples.

4. DISCUSSION

The radio source counts presented in Fig. 1 cover the widest range of flux-densities for which the counts have ever been derived from a single instrument. By including progressively larger areas of sky for stronger sources, we have been able to achieve reasonable statistics for the entire range of flux densities above 1 mJy. Our results at 843 MHz are in good statistical agreement with the source counts at 1.4 GHz reviewed by Windhorst et al 1985. However, this does not rule out field-to-field variations due to small scale statistical inhomogeneities in the radio source distribution. Since our deep survey covers a large number of independent fields, we are in a position to investigate such inhomogeneities in the counts and identification content of weak radio sources. The results of such studies will be published in due course.

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