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IPS survey at 327 MHz for detection of compact radio sources

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Abstract. In early 1992 a new feed was installed along the focal line of the 530 m long and 30 m wide parabolic cylinder reflector of the Ooty Radio Telescope (ORT). The new feed consisting of 1056 GaAsFET low noise amplifiers, one behind each dipole, helps reduce the system temperature to about 150 K as compared to about 350 K for the earlier feed. For a receiver bandwidth of 4 MHz and an R-C time constant of 0.5 sec the present system gives a signal to noise ratio per jansky of about 25 : 1. This implies enough signal to noise ratio to be able to produce an IPS spectrum on every 52 second stretch of data for sources with flux density as small as 1.5 Jansky. Hence it was decided to make a systematic interplanetary scintillation (IPS) survey at 327 MHz with the following aims :

1. To obtain a finding list of compact milli arc second sources for the space VLBI mission "Radio Astron" due for launch in 1996.
2. To obtain a spatially well distributed list of scintillating sources around the ecliptic plane for interplanetary weather mapping.
3. To have a complete sample of sub arc second extragalactic compact sources for cosmological investigations.
4. For studies of interstellar scattering in the inner galaxy.

This paper briefly reports the methodology of the scintillation survey and presents the results from the preliminary analysis of the data obtained so far from the ongoing survey.

Key words : interplanetary scintillation—radio observations—extragalactic compact sources

1. Methodology

An IPS survey was initiated in August 1992 to detect compact sources in the 7 steradian of the sky visible to the ORT. The ORT being equatorially mounted, can track a source in RA for 9.5 hours while steering in declination is achieved by appropriately phasing the 1056 dipoles electrically. This method provides a coverage in declination of ±35°.

To scan the sky most efficiently, the telescope is parked at a particular hour angle (HA) and all sources transiting are observed by switching the beam in declination as required. For each setting of the beam of the telescope, data is recorded for three minutes in a computer. The positions in hour angle and declination to which the beam of the telescope is to be set were selected from the Molonglo and Texas surveys for radio sources (1, 2) in the following manner : All sources with flux densities $S \geq 1.5$ jansky listed in the catalogues of radio sources from the above two surveys were selected. This implies that the source corresponding to the settings of the beam of the ORT will have $S_{408} \geq 1.5$ jansky for positions selected from the Molonglo catalogue; while it will be $S_{365} \geq 1.5$ jansky for sources selected from the Texas catalogue.

After two hours of observation the telescope is moved to a different HA and the sources missed during the previous HA slot are observed. Thus in a 10 hour stretch of observation about 180 sources are recorded. This program runs for four days a week every alternate week. The aim is to observe every source at least three times in the solar elongation (ε) range 10° to 55°. However, during August and September 1992, due to the non-availability of the ORT only two observations per source could be made on most of the sources in the RA range 10-13 hrs.

The data is analyzed in several steps, the first of which is to produce the IPS spectra and determine the scintillating flux ΔS for each observation, after editing out records contaminated by terrestrial interference. ΔS for a given source is dependent on ε and shows a systematic increase with decreasing ε until about 10°, at 327 MHz. After this it falls off sharply with further decrease in ε. ΔS therefore cannot be directly used to decide whether a source is a strong scintillator or not. The ΔS obtained for each observation in the survey is made independent of ε by dividing by the scintillation index ($\Delta S/\langle S\rangle$) for a known point source at the same ε. The point source used was PKS 1148 – 001.

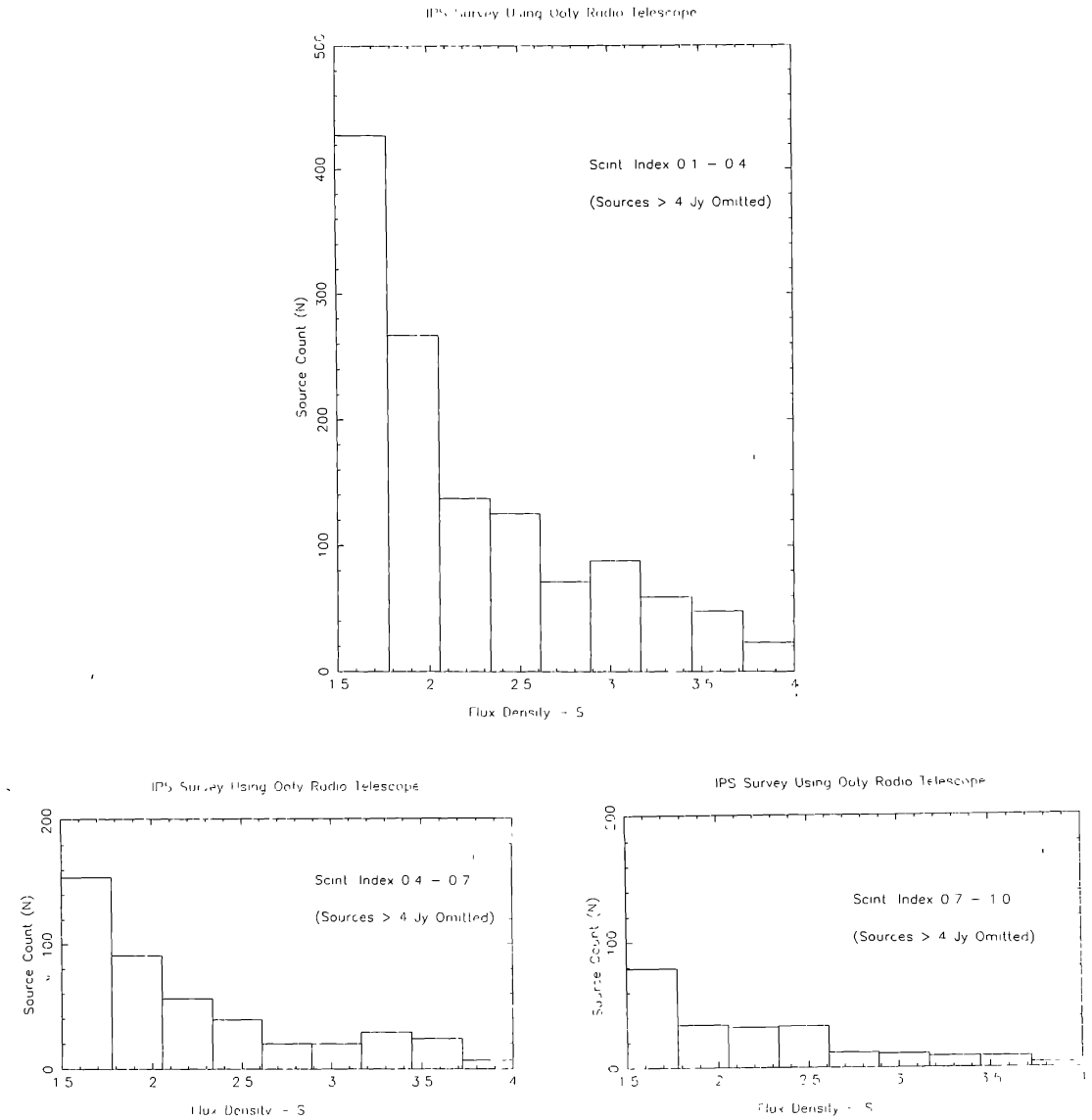
2. Result

The normalized scintillation index of a source is an indicator of the angular size of the scintillating component. For example $0.7 < \Delta S/\langle S\rangle < 1.0$ would imply angular sizes $\theta < 80$ milli arcseconds (approximately). The scintillating sources were grouped into three ranges of scintillation index. The results from the preliminary analysis of data on about 2500 sources observed during the past 6 months are as follows :

$\Delta S/\langle S\rangle$	0.1 to 0.4	0.4 to 0.7	0.7 to 1.0
θ mas (approx)	< 240	< 160	< 80
No. of sources	1261	457	213

Figures 1, 2, and 3 present the histograms of sources in different ranges of flux density (up to 4 Jy). It may be noted that the flux values in the histograms correspond to the flux densities reported in the sources listed in the Molonglo and Texas catalogues. However, it is to be expected that these values will closely approximate the flux densities at 327 MHz also (which is the operating frequency of the ORT) as the compact sources exhibiting IPS have flat spectra, in general.

The above is an approximate but rapid method of choosing compact sources. A more rigorous and detailed method of analysis of data is underway. It is based on details of the



Figures 1-3. Show histograms of source count versus flux density for sources with normalised scintillation index in each of the three ranges 0.1 to 0.4, 0.4 to 0.7 and 0.7 to 1.0 respectively. Sources with flux densities > 4 Jy have been omitted.

power spectra of the observed data (such as second, third moments), correction for effects of receiver bandwidth and time constant, methods of identifying cases where the spectra are contaminated by ionospheric scintillation etc. From such analysis reliable estimates of angular sizes and fluxes of compact components of the observed sources can be made.

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