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On the nature of compact components of radio sources at 327 MHz

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Abstract. The interplanetary scintillation (IPS) survey of about 5000 radio sources carried out during 1992-93 with the Ooty Radio Telescope (ORT) at 327 MHz has resulted in the detection of compact components in about 2700 sources. Angular sizes of the scintillating components have been determined by using IPS technique in the case of 1050 sources which are the strongest scintillators amongst these sources. Infomation such as spectral index at centimeter wavelengths, optical identification and red shift are available in the literature for a sizeable number of these sources. VLBI maps at centimeter wavelengths are also available for a small number of cases.

In this paper we present preliminary results from our investigations on correlations between low frequency compact structures and properties observed at centimeter wavelengths for the strongly scintillating sources.

1. The Survey

The Ooty Telescope (ORT) operating at 327 MHz was used for carrying out a survey to detect compact components in radio sources by using the technique of interplanetary scintillations (IPS) of radio sources. For this purpose a master list of about 5100 sources was prepared by selecting all sources from the following two catalogues, whose flux densities were greater than or equal to 1.5 Jy and which lie in the declination range $-35° \leq \delta \leq 35°$.

(i) The Molonglo Catalogue of radio sources surveyed at 408 MHz (Large *et al.* 1981)

(ii) The Texas Catalogue of radio sources surveyed at 365 MHz (Ghigo and Owen, 1978)

On any particular day of observation, only those sources were selected from the master list such that the solar elongation ϵ for the sources were in the range $10° < \epsilon \leq 55°$. (Solar elongation ϵ is the angle between the line of sight to the source and the line joining the sun and the earth). For observations at 327 MHz, the above range elongations consitutes the weak scattering regime. For $\in > 55°$ there would be negligible fluctuations in intensity of the source due to IPS at 327 MHz and for $\in < 10°$ the fluctuations start decreasing rapidly with decrease in $\in$ owing to strong scattering.

During any observing session on a day, data was acquired from about 20 sources for a duration of 3 minute per source. The observaitonal schedule was such that any source from the master list of 5100 sources would have been observed at three epochs (while its elongation $\in$ was in the range $10° - 55°$) during the course of an year of observation. The first phase of the survey observations were carried out from August 1992 to September 1993.

Data from an off-source region was also recorded at intervals of about half an hour. The sensitivity of the telescope was determined by monitoring standard calibration sources at the beginning and / or at the end of the day. Gain variations of the telescope, if any, were monitored simultaneously by recording data from an adjacent beam which was pointing away from the source. This off-source beam also helped in identifying terrestrial interference.

2. Data analysis

The time scale of intensity fluctuations due to IPS at 327 MHz is around 0.1 second. The data was therefore integrated for 50 milliseconds, sampled at 20 millisecond intervals and stored in the computer in blocks of 2600 consecutive measurements of intensity points corresponding to 52 seconds of data stretch. Power spectra were obtained for each 52 s data block using a standard algorithm, and then averaged by adding the spectra of all the data blocks. This averaged power spectrum was corrected for the effects of the time constant response of the receiver system and stored in the computer. The scintillation index m was also computerd for each source, where m is defined as the ratio of the rms of the scintillation to the difference between the on-source and of-source mean values of intensity. Model spectra were fitted to those observed spectra with high signal to noise ratio (S/N > 13 db). From the best-fit models one could determine the solar wind velocity across the line of sight to the source and the angular size of the compact scintillating component of the source.

3. Results

The IPS survey has resulted in a large data bank which has not been fully analysed at present. Out of a total of 5100 sources observed during the survey about 2700 exhibited detectable IPS in one of the data stretch at least. Of these, 1056 sources were strong scintillators whose power spectra had signal to noise ratio (S/N) of more than 13 db. Reliable estimates of angular sizes of compact components could be readily made in these cases. In what follows we report the highlights of the results for a subsample of 531 sources which have S/N ≥ 20 db in their power spectra. Other additional information such as optical identification, redshift, spectra index at cm wavelength etc. could be gathered for 79 sources from published literature (Wall & Peacock 1985; Laing *et al.* 1983; Steickel *et al.* 1995).

This information is summarised in Table 1.

Table 1.

Total number of strong scintillators	531
Number of scintillators with optical identification	79
Number of Galaxies	23
Number of steep spectrum galaxies	17
Number of flat spectrum galaxies	6
Range of the redshifts of the galaxies	$0.02 \leq z \leq 0.99$
Number of quasars	56
Number of steep spectrum quasars	17
Number of flat spectrum quasars	31
Range of redshifts of the quasars	$007 \leq z \leq 2.66$

From the above result it is seen that although the main population of scintillators is of flat spectrum type, compact steep spectrum (CSS) sources form a sizeable fraction of the scintillating sources. This is especially so in the case of galaxies. It is noticed further that the redshifts of the 6 flat spectrum galaxies are low, being less than 0.13. No such distinction could be readily made out in the case of the SS and FS quasars.

At any given level of flux density, the IPS technique is favourably biased towards detection of emission from more compact components than emission from extended regions. This is seen from the histogram for the number of sources in various ranges of angular sizes, shown separately for galaxies and quasars in Fig. (1a) and Fig. (1b) respectively.

It would be premature to draw any firm conclusions from the above results, owing to the following reasons :

i) The fraction of flux emitted by the compact components in the scintillating sources is yet to be computed.

ii) Although it would be difficult to make precise estimates of sizes of compact components in the case of sources with S/N < 20 db for the power spectra, estimates on upper limits of angular sizes can be made.

Such data will influence the statistical correlations amongst properties.

iii) It is important to ascertain that the sources branded as non-scintillators from this survey are definitely so.

For this purpose, more number of observations of these sources at low solar elongations are necessary. The optical identification status of as many as possible of these non-scintillators is also to be investigated.

HISTOGRAM OF ANGULAR SIZES OF COMPACT COMPONENTS IN QUASARS

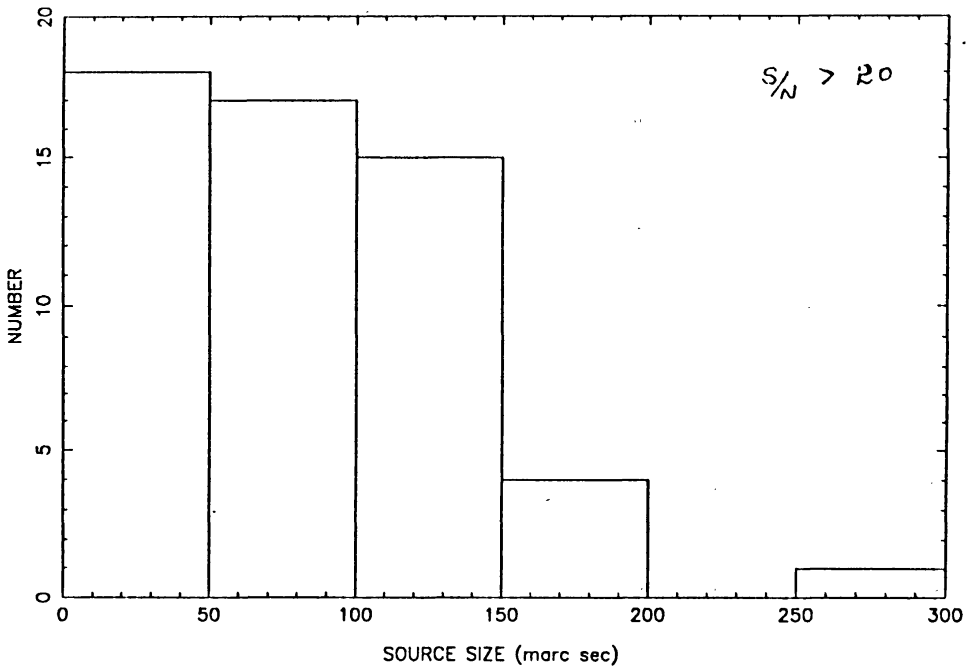
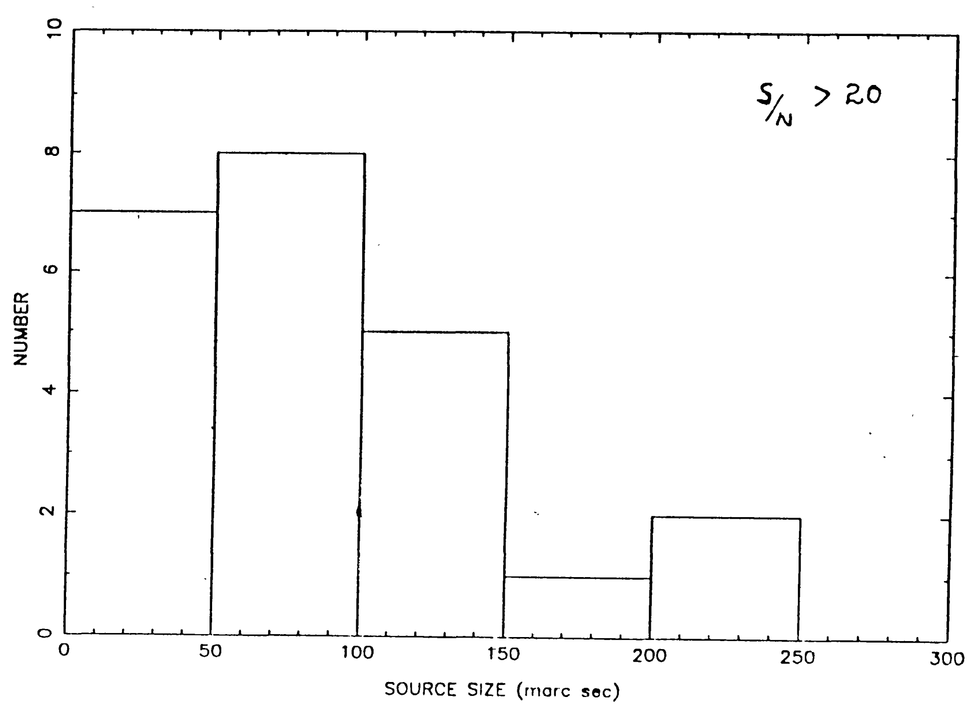


FIGURE 1 B

HISTOGRAM OF ANGULAR SIZES OF COMPACT COMPONENTS IN GALAXIES



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