INTERPLANETARY SCINTILLATION - PRELIMINARY OBSERVATIONS AT 103 MHz

S. K. ALURKAR and R. V. BHONSLE
Physical Research Laboratory
Ahmedabad-380009, India

ABSTRACT

A 3-station interplanetary scintillation (IPS) observatory is being developed mainly with a view to study the solar wind plasma. The first IPS telescope operating at 103 MHz at Thaltej near Ahmedabad has been put into regular operation since April 1979. With only half the antenna aperture (~2500 m^2) presently in use, observations of 8-10 sources are being made to calculate scintillation index, temporal spectrum of intensity fluctuations and scale size of density irregularities.

INTRODUCTION

Interplanetary Scintillation (IPS) of small diameter radio sources (less than 1") has been proven to be very effective in studying the microscale (~100 km) structure and dynamics of the interplanetary medium in the plane of ecliptic as well as outside it. IPS measurements have also been used to derive structure of radio sources up to a resolution limit of 0.02" (Hewish et al., 1964; Cohen et al., 1967; Armstrong and Coles, 1972; Kakinuma and Watanabe, 1976). In this note we present preliminary observations made from the IPS station at Thaltej near Ahmedabad.

In Figure 1 is shown the locations of the three IPS stations being developed in India. The radio telescope near Ahmedabad has become operational since April 1979 and the remaining two telescopes are expected to be completed by mid-1980.

OBSERVATIONS AND ANALYSIS

The radio telescope with which the present IPS observations were made consists of a filled aperture dipole antenna array with an aperture of ~5000 m^2 at an operating frequency of 103 MHz. The obser-

M. Dryer and E. Tandberg-Hanssen (eds.), Solar and Interplanetary Dynamics, 405-408.

GEOMETRY OF THE THREE IPS STATIONS

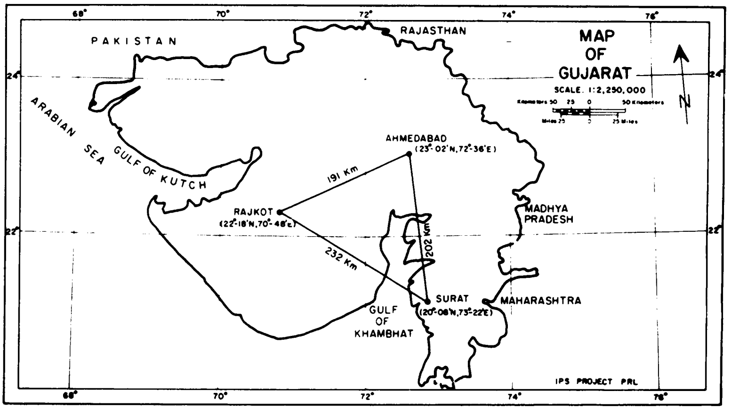

Figure 1. Geometry of IPS stations in India.

vations reported here were taken using half the antenna aperture. The RF signals after being stepped up by low noise preamps are combined in a multibeam forming matrix yielding a 32-beam pattern, with individual beams having a size of (8^{o} EW x 2^{o} NS). A selected beam is connected to a total power receiver having a predetection bandwidth of 2 MHz and the intensity fluctuations are recorded on a strip-chart with an overall time-constant of 0.1 sec. After A/D conversion at a sampling frequency of 20 Hz the data are recorded on a digital magnetic tape and processed on an IBM 360/44 computer. Normally, 20-25 min of useful data per day for each source are available. So far observations on 3C 48, 3C 144, 3C 147, 3C 161, 3C 196, 3C 237, 3C 273, 3C 298 and 3C 459 have been made.

The IPS power spectra were computed using the fast Fourier transform algorithm. Autocorrelation functions and power spectra were computed from successive 50 sec of data and after editing, the selected spectra were added to get an average spectrum with a spectral resolution of 0.04 Hz. Usually each source was recorded for about 30 min followed by an off-source recording of at least 5 min. A few examples of IPS spectra of some sources are shown in Figure 2. The straight lines on the spectra are exponential fits to the data in the frequency range 0.3 - 3 Hz for strong and 0.3-1.5 Hz for weak scintillating sources.

The first and (square root) second moments f_1 and f_2 of the intensity spectra were computed from the relations

$$f_1 = \int_0^{f_c} f\, P(f) df / \int_0^{f_c} P(f)\, df, \text{ and}$$

https://doi.org/10.1017/S0074180900067917 Published online by Cambridge University Press

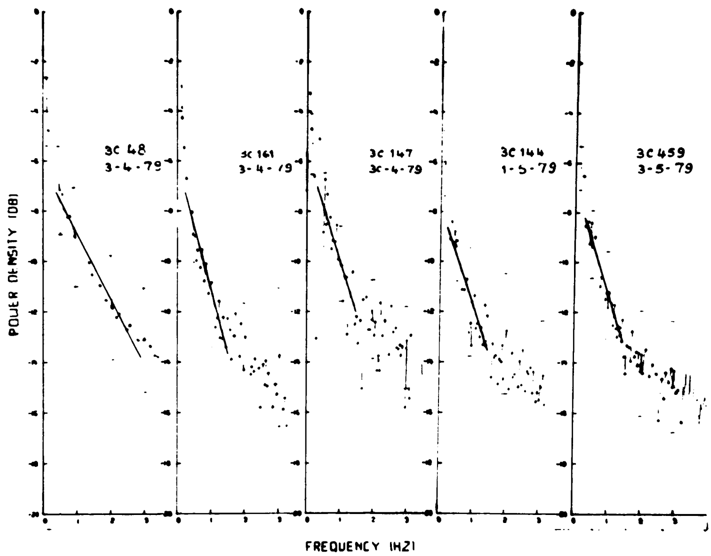

Figure 2. IPS temporal spectra.

$$f_2 = \int_0^{f_c} f^2 \, P(f) \, df / \int_0^{f_c} P(f) \, df$$

where P(f) is the spectrum and f_c is the cut-off frequency, giving the upper limit of frequency up to which the spectrum can be accurately determined. f_1 and f_2 are a measure of the width of the spectrum, the former being less affected than the latter by the noise in the tail of the spectrum. Also the first moment gives more weight to large scale components in which case the accuracy is higher due to increased signal/noise ratio (Readhead et al., 1978).

Table I gives the summary of the observed parameters. Only a few specimen days were selected for preliminary analysis. The values of scintillation index (S.I.), which is the rms fluctuation of intensity about its mean, were derived using the relation $(S.I.)^2 = (\langle I^2 \rangle - \langle I \rangle^2)/\langle I \rangle^2$.

DISCUSSION

The temporal power spectrum of intensity is best described by a power law $P \propto f^{-n}$ with index n of about 2.6 for a strongly scintillating source, like 3C 48 at a solar elongation of 31^o in the frequency range

https://doi.org/10.1017/S0074180900067917 Published online by Cambridge University Press

TABLE I. Summary of Observed IPS Parameters

Date	Source	Elongation	S.I.	f_1 (H_z)	f_2 (H_z)	f_2/f_1	Power law index, n
3-4-79	3C 48	31^o	0.31	1.38	1.59	1.2	2.6
3-4-79	3C 161	86^o	0.03	0.66	0.76	1.1	4.8
30-4-79	3C 147	53^o	0.01	0.84	0.67	0.8	4.1
1-5-79	3C 144	44^o	0.34	0.55	0.62	1.1	3.9
3-5-79	3C 459	50^o	0.03	0.76	0.77	1.0	4.2

0.3-3 Hz. This is in good agreement with the mean value of the index of 2.4 ± 0.2 for solar elongation larger than 10^o obtained by Milne (1976). For weakly scintillating sources the power law index is about 4 in the frequency interval 0.3 - 1.5 Hz, since their solar elongations are also greater. The ratio f_2/f_1 is nearly unity; while for a noise-free exponential spectrum it is equal to $\sqrt{2}$.

ACKNOWLEDGMENT

We express our sincere thanks to Professors D. Lal and S. P. Pandya for showing keen interest in this work. We are grateful to all our colleagues in the IPS group for their dedicated efforts in developing the IPS station. Financial support for this project came from the Departments of Space and Science & Technology, Government of India.

REFERENCES

Armstrong, J. W., and Coles, W. A.: 1972, *J. Geophys. Res., 77,* pp. 4602-4610.

Cohen, M. H., Gundermann, E. J., Hardebeck, H. E., and Sharp, L. E.: 1967, *Astrophys. J., 147,* pp. 449-466.

Hewish, A., Scott, P. F., and Wills, D.: 1964, *Nature, 203,* pp. 1214-1217.

Kakinuma, T., and Watanabe, T.: 1976, *Space Sci. Rev., 19,* p. 611.

Milne, R. G.: 1976, *Aust. J. Phys., 29,* pp. 201-209.

Readhead, A. C. S., Kemp, M. C. and Hewish, A.: 1978, *Mon. Not. R. Astr. Soc., 185,* pp. 207-225.