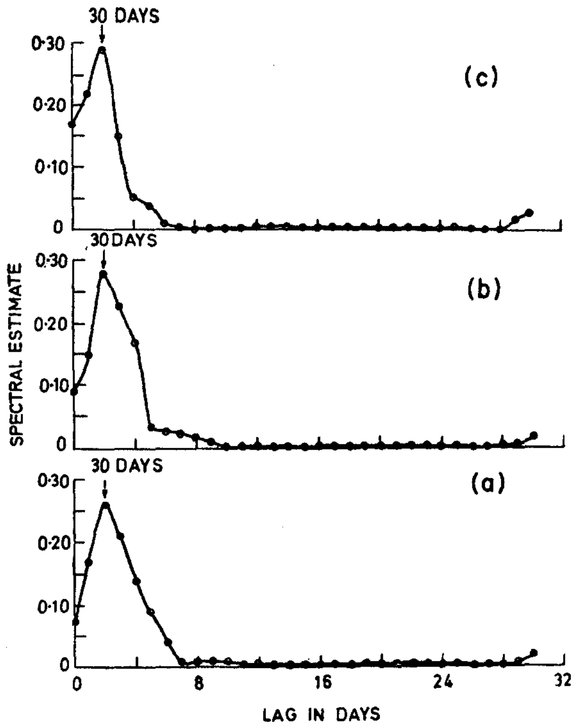

Fig. 1 — Power spectra of: (a) normalized rainfall of Tamil Nadu for the period 1 July-30 Sep. for 1961-70 (maximum lag $m = 30$ days); (b) normalized sunspot numbers of Kodaikanal for the period 1 July-30 Sep. for 1961-70 (maximum lag $m = 30$ days); and (c) sunspot means given by Gillettee for the period 1 July-30 Sep. for 1889-1938 (maximum lag $m = 33$ days)

possible but not exceeding one-third of the total number of days of the record involved in the analysis. The period corresponding to any spectral estimate is given by the relation $P = 2m/L$, where m is the maximum lag (30) and L denotes the lag in days of the spectral estimate in question.

The values obtained by spectral estimate are shown in Fig. 1 (a, b, c). The spectra in all cases are a mixture of red and white noise continuum. The associated 99, 95 and 90 percent confidence limits have been calculated. The spectral peaks at lag in days = 2 in Fig. 1 (a, b, c) correspond to a period of 30 days. These peaks are tested with that of red noise by the method followed by Jagannathan and Parthasarathy.[15] The peaks are found significant at 99% level. Thus the rainfall series and the sunspot numbers point out marked spectral peaks of 30-day periodicity which are significant.

We conclude from the present study that the sunspot activity and the rainfall contain a 30-day periodicity which is highly significant during the southwest monsoon period when the sun remains at all times in the northern hemisphere. The possible association between these periodicities requires investigation.

References

1. Walker G, *Mem. Indian Met. Dept.*, **21** (Part X) (1915), 17.
2. Sen Gupta P K, *Vayu Mandal*, **2** (1972), 4.
3. Jagannathan P & Bhalme H N, *Mon. Weath. Rev. USA*, **101** (1973), 691.
4. Xantakis J, *Solar activity and related inter-planetary and terrestrial phenomena*, edited by J Xantakis (Springer-Verlag, Berlin) 1973, 20.
5. King J W, *Aeronautics Astronautics*, **13** (1975), 10.
6. Wilcox J M, *J. atmos. terr. Phys.*, **37** (1975), 237.
7. Gillettee H P, *Bull. Am. met. Soc.*, **35** (1954), 374.
8. Chapman S & Bartels J, *Geomagnetism*, Vol. 1 (Clarendon Press, Oxford), 1940, 168.
9. Srirama Rao M & Gopalakrishna Murty A, *Indian J. Radio Space Phys.*, **3** (1974), 356.
10. Rosenberg R L & Coleman P J, *Nature, Lond.*, **250** (1974), 481.
11. Reddy R S & Ramana Murty Bh V, *Indian J. Radio Space Phys.*, **5** (1976), 298.
12. Reddy R S & Ramana Murty Bh V, *Indian J. Radio Space Phys.*, **5** (1976), 277.
13. Srirama Rao M & Lokanadham B, *J. atmos. terr. Phys.*, **26** (1964), 301.
14. *WMO tech. note No.* 79 (WMO, Geneva, Switzerland), 1966, 33.
15. Jagannathan P & Parthasarathy B, *Mon. Weath. Rev. USA*, **101** (1973), 371.

A Measurement of Ionospheric Irregularity from Radio Star Scintillations

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The hourly variations of scintillation index and scintillation rate are studied during the nights of a summer month, June 1970, from the radio star scintillation data recorded at Ahmedabad. The variation of scintillation index showed a peak occurrence around 0200-0400 hrs local time and the variation of scintillation rate correlated well with that of the vertical component (V) of earth's magnetic field. The power spectral analysis carried out for different samples of data gave velocity of ionospheric of irregularity ranging from 95 to 133 m/sec at F-region heights.

The study of radio star scintillations had been developed as an important method for investigating the ionospheric irregularities.[1,2] Recently, the use of power spectral analysis technique to the radio star scintillations data has received much attention for studying such irregularities.[3-5]

This communication reports the results of the analysis of the scintillation records of the radio stars Cygnus A and Cassiopia A obtained over Ahmedabad during the nights of June 1970, using a

Ryle type two-element phase switched interferometer operating at 60 MHz (Ref. 6). The noise figure of the receiver system is 2·7 dB and most of the scintillation records selected, showed amplitude variations much above the noise level. Fig. 1 shows the hourly variations of the mean amplitude index and the scintillation rates presented as curves (a) and (b), respectively. These curves are compared with the mean variations of the sum of magnetic *K* indices, horizontal component *H*, vertical component *V* and the declination *D* presented as curves (c), (d), (e) and (f), respectively, in Fig 1. From a study of these curves it is seen that the mean amplitude index varies from hour to hour having a maximum value of 0·14 between 0200 and 0400 hrs. The individual values of amplitude index varied considerably from night to night from a maximum value of 0·5 to a minimum of about 0·05. Similar variations were also noticed in Gulmarg scintillation data recorded at 74 MHz (Ref. 7). The mean scintillation rate curve (b) does not show any such trend. Such scintillation studies carried out at higher latitudes[8] showed the occurrence of maximum scintillation index near the pre-midnight hours, while the present observation at a low latitude station shows a post-midnight maximum. The scintillation rate curve (b) is found to be closely following the variations of the magnetic horizontal component (*H*) of curve (c) and even more closely with that of the vertical component (*V*) of curve (d) as was noticed earlier by Daag.[1]

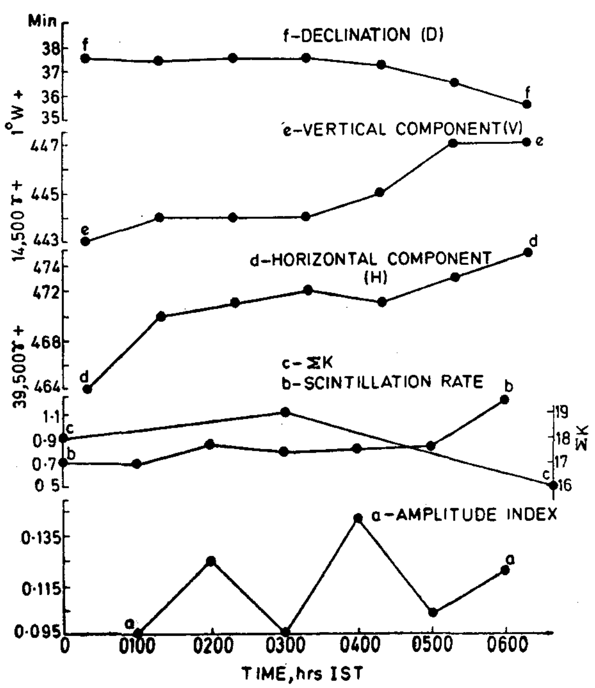

Fig. 1 — Time variations of the scintillation index and the scintillation rate and their comparison with that of geomagnetic components

The power spectra were computed for different samples of scintillation records programmed on the IBM-36044 computer of the Physical Research Laboratory, Ahmedabad, following Tukey method.[5,9] The spectrum of each sample consisting of about 500 data points was computed, with sampling intervals of 0·5 sec and by incorporating a Tukey lag window.[9] Fig. 2 shows an example of such spectra plotted on a logarithmic scale. The Fresnel frequencies were then determined from those plots as the spectral break frequencies following Rufenach's[5] method. The ionospheric irregularity velocities were calculated using the relation $\nu_f = \frac{V}{\sqrt{\pi \lambda z}}$ where ν_f is Fresnel frequency, *V* the irregularity velocity, λ the radio wavelength and *z*

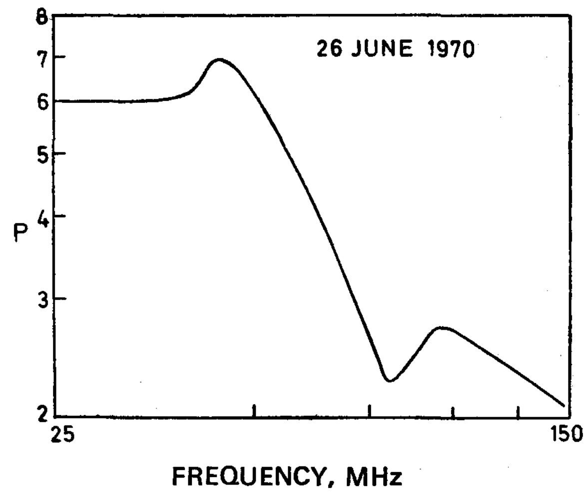

Fig. 2 — A typical power spectrum (ν_f=46 MHz) (The ordinate *P* represents power spectral density)

Table 1 — Calculated Values of *V* for Different Values of ν_f for Several Days in June 1970

Date	Fresnel frequency (ν_f) MHz	Irregularity velocity (*V*) m/sec
16	52	126
20	42	101
21	40	95
22	43	99
25	51	113
26	55	133
27	45	114
28	42	101

the height of scattering medium. The results are tabulated in Table 1. From Table 1 it is seen that the Fresnel frequencies are in the range 40-55 MHz with a mean value of 46 MHz. The corresponding irregularity velocities are in the range 95 to 133 metres per second with a mean value of 110 metres per second. It is also noticed that the Fresnel frequency increases at the time of high scintillation rate thereby resulting in an increased irregularity velocity. These results are in good agreement with that of earlier investigators.[3]

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References

1. Daag M, *J. atmos. terr. Phys.*, **10** (1957), 194.
2. Briggs B H & Parkin I A, *J. atmos. terr. Phys.*, **25** (1963), 339.
3. Elkins T J & Papagiannis M D, *J. geophys. Res.*, **74** (1969), 4105.
4. Chivers H J A, *J. geophys. Res.*, **76** (1971), 2526.
5. Rufenach C L, *J atmos. terr. Phys.*, **33** (1971), 1941.
6. Bhonsle R V, Alurkar S K, Narayan K and Matto S K, *J. Instn Telecommun. Engrs*, New Delhi, **17** (1971), 21.
7. Matto S K & Bhonsle R V, *Indian J. pure appl. Phys.*, 9 (1971), 601.
8. Chivers H J A, *J. atmos. terr. Phys.*, **25** (1960), 54.
9. Jenkins G M & Watts D G, *Spectral analysis and its applications* (Holden Day, San Francisco), 1969