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Simultaneous Observations of Large Enhancement In the Flux of PSR 0950+08 Over a 200 km Baseline at 103 MHz.

A.D. Bobra, Harish Chandra, Hari Om Vats, P. Janardhan, G.D. Vyas and M.R. Deshpande

Physical Research Laboratory, Ahmedabad 380 009, India.

1. Introduction

Interplanetary Scintillation (IPS) is a diffraction phenomenon in which coherent electro-magnetic radiation, from a distant radio source, passes through the solar wind, which is a turbulent refracting medium, and suffers scattering. This results in random temporal variations of the signal intensity (scintillation) at the Earth. IPS observations to monitor the interplanetary medium (IPM), to measure solar wind velocities in the directions of a number of compact extra-galactic radio sources and to estimate the angular diameters of their compact components have been carried out for many years at 103 MHz using the IPS facility (Alurkar et al. 1989) of the Physical Research Laboratory (PRL), Ahmedabad, India. Over a period of approximately 10 years of such observations, it has been seen that PSR 0950+08 has always remained well within the noise level. We observed a sudden enhancement in its flux (Deshpande et al. 1994) on 29 July, 1992. The ionospheric observations which are being carried out on a regular basis at PRL using an ionosonde also recorded a steep increase in the absorption index F_{min}, which is an indicator of the excess ionization produced due to X-rays. During this period, the Sun was exceptionally quiet, thereby raising the question about the origin of the X-ray flux responsible for the observed steep rise in F_{min} during the transit of PSR 0950+08.

2. Data Analysis

The two telescopes, at Thaltej (Ahmedabad) and Rajkot (separated by $\sim$ 200Km), operate as transit instruments, and therefore the signal strength is modulated by the beam shape in East-West, as the beam sweeps past the source. The system AGC also compresses the signal strength. After due corrections for these, the on-source Hanning-smoothed spectrum was derived from 6-minutes data around the transit for Thaltej and from 14-minutes for Rajkot. The normalized power spectrum with frequency resolution of 0.041 Hz (before Hanning), showed two distinct peaks at 3.95 Hz and 7.9 Hz corresponding to the fundamental and the second harmonic of the pulsar period (253 ms). The results of folding the Thaltej data in blocks of 12.124 s (corresponding to 253 samples, sampling interval being 48 ms) clearly showed 48 peaks, as expected, indicating the presence of PSR 0950+08. The result of the cross-correlation of Thaltej and Rajkot data as a function of time lag (Δ t = 48 ms), showed a sinusoidal observed cross-correlation corresponding to the pulsar period, a third order polynomial fit gave the travel

time (0.35 Sec) of the diffraction pattern caused by the solar plasma irregularities in the IPM. It is important to note that (i) in the absence of the pulsar, the periodic oscillations would not have been present in the cross-correlation, and (ii) in the absence of solar plasma motion in the IPM, the cross-correlation would have been maximum at zero lag. The analysis of the Thaltej digital data showed that the averages of the ten largest pulses on 28,29 and 30 July, 1992 are in the ratio 1:250:23 respectively. The peak flux of several individual pulses on 29 July, exceeded 850 Jy.

The ionosonde operating at PRL, between 0.5 and 20 MHz, showed a large increase in F_{min} from an average value of $\sim$ 1.7 MHz to $\sim$ 2.6 MHz during the event. Such ionospheric absorption generally originates due to X-ray emission from the Sun, with the minimum levels of X-ray flux, required to cause the observed increase in F_{min}, being 10^{-5} Wm^{-2}. However, the GOES-7 X-ray flux (*Solar-Geophysical Data Prompt Reports, August 1992, 576-part 1*) was as low as 10^{-8} watt m^{-2} indicating exceptionally quiet conditions on the sun.

3. Discussion and Conclusions

PSR 0950+08 has been well studied over a wide range of frequencies for its flux variability (Slee et. al. 1986; Gupta et. al. 1993). Pilkington et. al. (1968) have reported the variation in the peak pulse energy of $\sim$ 50. The observed large enhancement in the flux was confined to PSR 0950+08, while the compact extra galactic source 1005+08 (3C237), transiting just 15 minutes after, was unaffected, and showed normal levels of scintillation. This clearly ruled out any focusing effects by large scale irregularities in the IPM. The simultaneous observations over a 200 km baseline also ruled out any large scale ionospheric focusing effects and variations due to ionospheric Faraday rotation as proposed by Gupta et. al. (1993) to explain the long term variability. Refractive interstellar scintillation which typically has a time scale of a few days to weeks can also be ruled out as we did not observe any periodic fluctuations over a whole year of observations. The IPS data at 81.5 MHz from Cambridge showed that 3C237 was observed at the normal levels of intensity. The other IPS radio telescope operating at 327 MHz in Japan also showed the normal intensity of 3C237.

PSR 0950+08 is known to be an X-ray emitter with its X-ray luminosity (as inferred from *Einstein* data) of the order of $10^{29.4}$ ergs s^{-1}. So far, no X-ray enhancement or variation in the X-ray flux have been reported. In the light of our observations it will be very interesting to make more and long term monitoring of PSR 0950+08 using either ROSAT or other space based platforms.

References

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