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Terrestrial effects of PSR 0950 + 08 (Paper II)

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Abstract. This article presents indirect evidence that on July 29, 1992 PSR 0950 + 08 emitted a burst of X-ray emissions along with the enhanced radio pulses. This indirect evidence is seen in the form of excess absorption of HF waves in the ionospheric sounding experiment. We present calculations of possible emission mechanism which indicates that during this event PSR 0950 + 08 accreted a comet like object.

Key words : pulsar—ionosphere—X-rays

1. Introduction

Deshpande *et al.* (1993a and b) recently reported that PSR 0950 + 08 produced very large enhancement in the pulsation activity at 103 MHz. The careful analysis of the data also indicate that the enhancement seen at 103 MHz is not due to the propagation of the radio pulses in any of the intervening medium e.g. interstellar medium, interplanetary medium and ionosphere. Thus the effect is intrinsic to the source. This pulsar PSR 0950 + 08 is 1.6×10^7 years old and is not a known X-ray source. However, during this event on July 29, 1992 it produced X-ray bursts. The observations are presented in the next section.

2. Observations

The effect of celestial X-ray sources in the 'D' region of the ionosphere is quite well known (Ananthakrishnan & Ramanathan 1969; Ananthakrishnan *et al.* 1970). In these investigations sources were Scorpio X-1 and Taurus X-1 and the effect was monitored by the field strength measurements at 164 KHz. The signal was transmitted from Tashkant and received at Ahmedabad. The minimum in the field strength was found to coincide with the time of meridian transit of these sources. The results were explained by the fact that X-rays from these sources during their transit increased the ion production in D region. The increased electron density in the D region reduced the field strength by non deviative absorption.

The non deviative absorption can also be inferred by $f_{\min}$ the minimum frequency received and recorded by the ionospheric sounding experiment. In this experiment, there is a variable frequency (0.5-20 MHz) pulsed transmitter. The pulses are transmitted vertical upward and received back on reflection from the ionosphere. The absorption in the D region of the ionosphere decides the minimum frequency at which enough signal strength is received back to be recorded on the ionogram. The normal day time variation of f_{min} is shown in figure 1 by filled circles. Here, the value of f_{min} increases from 1.2 MHz in the morning to about 1.8 MHz in the midday and reduces again to lower value in the evening. The open circles show the variation of f_{min} indicate increase in the non deviative absorption by the ionization in the D region.

Such a large increase seen in f_{min} is known to have occurred only by an intense solar X-ray flare. However, Sun on this day is reported to be unusually quiet. The X-ray observation of GOES satellite (Solar Geophysical Data) indicate very low level (below normal) of X-ray emission from Sun. Thus the required X-ray flux to produce excess D region ionization must have emanated from celestial source. This we believe is from PSR 0950 + 08 which was directly observed to be exceedingly active at 103 MHz (Deshpande *et al.* 1993a and b). There are three peaks in f_{min} (figure 1). The third peak coincides with the local transit of PSR 0950 + 08. Since the IPS radio telescopes used by Deshpande *et al.* (1993a and b) are transit instruments with beam width of 1.8° and 7.2° at Thaltej and Rajkot respectively, thus recording of pulsar

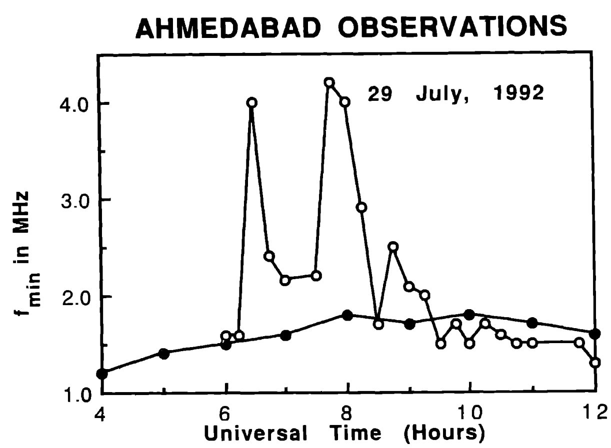

Figure 1. Temporal variation of f_{min} at Ahmedabad on July 29, 1992 (o — o) and on a normal day (• — •).

will be possible only for about 7.5 and 30 minutes respectively at these sites. However, beamwidth of the antenna used in ionospheric sounding experiment is large (~1 radian) and hence this experiment can record the effect for about four hours (if the effect is substantially large). Since the first two peaks in f_{min} are much larger than the third one, it appears that if the telescope would have been pointing toward PSR 0950 + 08, one would have seen even larger enhancement than that seen by Deshpande *et al.* (1993a and b).

3. Discussions

The average radio luminosity from the observations at 103 MHz calculates to ~ 3×10^{29} ergs/sec. If we assume that the total luminosity is about five order of magnitude larger than the radio luminosity, we can estimate the required accretion rate using a simplified approach (Borner 1973) for a neutron star with spherical symmetry. Using the argument of Eddington limit, the required accretion rate comes out to be 3.2×10^{11} kg/sec. Since enhanced activity lasted for about 3-4 hours, the total accretion would be 3.5×10^{14} to 4.6×10^{14} kg. This is almost the mass of a comet. Thus it appears that PSR 0950 + 08 accreted a comet like object during this event and this resulted into the sudden outbursts of X-rays from the pulsar. These X-rays produced observed $f_{\rm min}$ behaviour.

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