

Study of two pulsars with the Indian X-ray Astronomy Experiment

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Abstract. The X-ray pulsars Cep X-4 and 4U 1907+09 were observed with the Indian X-ray Astronomy Experiment (IXAE). Observations of Cep-X4 were made during the declining phase of its latest 30 days outburst in 1997, July-August. The X-ray pulse profiles obtained during IXAE observations show inter-pulse dominated double-peak pulse. The second X-ray pulsar 4U 1907+09 with a period of 440s was observed in August 1996 and again in June 1998. The X-ray profile shows a double-peak pulse shape. The \dot{P} obtained from these two observations indicate that the pulsar is in monotonically spin-down phase, at the rate of 0.23 s yr⁻¹.

Key words : X-ray pulsar, IXAE, profile

1. Introduction

The study of X-ray pulsars provide understanding of various astrophysical problems, such as accretion processes in the presence of strong gravitational field, various emission mechanism, the geometry of X-ray emission regions, and the nature of the magnetic field of the neutron star etc., To study some of these aspects, two high mass X-ray binary pulsars Cep X-4 and 4U 1907+09 were observed with the Indian X-ray Astronomy Experiment (IXAE) on board IRS-P3 satellite. Cep X-4, a 66 s transient Be/X-ray binary pulsar, underwent its latest outburst in July 1997. The source was observed by IXAE during the decay of the outburst before its entry into the quiescent phase. The pulsar 4U 1907+09 with a spin period of 440s of the neutron star, undergoes regular flaring activity due to periastron passage of the neutron star during its 8.38 day binary period. In this paper, we present results of our observations of pulse characteristics of these two pulsars.

2. Observations

The source were observed by Pointed Mode Proportional Counters of IXAE in nominal mode. In this mode, data are acquired with sampling time of 1.02 seconds for five consecutive orbits in a day. The observation of the 4U 1907+09 was carried out in 1996 from August 4-7 and from

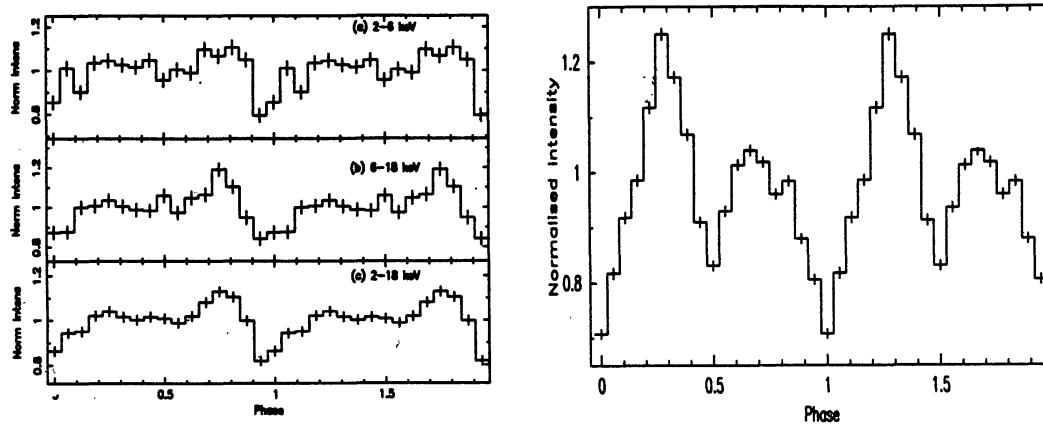


Figure 1. Cep X-4 pulse profiles between 2-18 keV energy band are shown on the left and pulse profile of 4U 1907+09 in 2-18 keV energy band obtained from 1996 data is shown on the right.

May 29-June 2 in 1998. Cep X-4 was observed in 1997, July 28-30. The IXAE instrument and operational details were described by Agarwal et al. 1997.

3. Results

The X-ray pulse of Cep X-4 in 2-18 keV, has inter-pulse dominated two-peak pulse profiles as shown in Figure 1 (left). The pulse shape of 4U 1907+09 is also shown in Figure 1 (right), has a double-peak. The pulsar period was found to be 440.53 ± 0.02 s in 1996 and 440.95 ± 0.01 s in 1998. The \dot{P} was found to be $+0.23 \pm 0.02$ s yr⁻¹.

4. Conclusion

The luminosity dependence of pulse profile provides new avenue for understanding the basic properties of the emission region in X-ray pulsars. In the case of Cep X-4, we find that the pulse profile observed by BATSE and RXTE (Colleen et al. 1999) has main-pulse dominated profile during the initial phase of the outburst, While the source luminosity decreased to about 6×10^{35} ergs s⁻¹ during IXAE observations, profile changed to inter-pulse dominated one. A simple dipole modeling of the pulse light curve suggests that at lower luminosity, a switch occurred in the preferred direction of beaming from a fan to a pencil-beam. This is also consistent with a change in the emission region from a cylindrical geometry to a slab configuration. The pulse characteristics of 4U 1907+09 indicate that the double-peak pulse resemble with earlier observations of the pulsar. The spin-down rate of the pulsar is found to be consistent with the earlier derived values 0.22 ± 0.03 from EXOSAT (Cook & Page 1987) and 0.212 ± 0.004 from RXTE (Colleen et al. 1999). These observations indicate that the pulsar is undergoing monotonically spin-down phase.

References

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