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Thermal X-Ray Pulses Resulting From Pulsar Glitches

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Abstract. The non-spherical symmetric and exact thermal evolution model is used to calculate the transient thermal response to pulsar glitches. The three ways of energy release originated from glitches, namely the 'shell', 'ring' and 'spot' cases are compared. The 'ring' case is always the middle one in terms of the response time, the response duration and the intensity of the response. Taking the relativistic light bending effect and the rotational effect into consideration, the X-ray light curves resulting from the thermal response to the glitches are calculated. Only the 'spot' case produces modulative X-rays. Different sets of parameters result in different evolution patterns of light curves. This is thus a good method to determine the equations of state for pulsars.

1. Introduction

Pulsar glitches are believed to be mainly starquake-driven (Ruderman 1969) which gives the 'spot' case (Van Riper et al. 1991) or superfluid-driven (Anderson 1975) which gives the 'ring' case (eg. Bildsten & Epstein 1989; Epstein and Baym 1992; Link and Epstein 1996; Jones 1998). The 'shell' case is not realistic and is used as a comparison.

2. Comparison of 'shell', 'ring' and 'spot' cases

The non-spherical symmetric general relativistic energy balance and thermal transport equations according to Cheng, Li, & Suen (1998) are used to study the thermal evolution of the pulsar after a glitch. Besides the amount of energy deposition in form of heat, other Physics inputs include equations of state (EOS), composition of the star and initial core temperature which are important in determining the luminosity profiles. Result of a particular case is shown in Figure 1.

3. Thermal X-Ray Modulation

Gravitational lensing effect for a softer EOS will cause a larger diffraction. With consideration of the rotational effect, the total energy flux of the pulsar is calculated in order to compare with the actual data obtained. An example of predicted light curves evolution due to a glitch is given in Figure 2.

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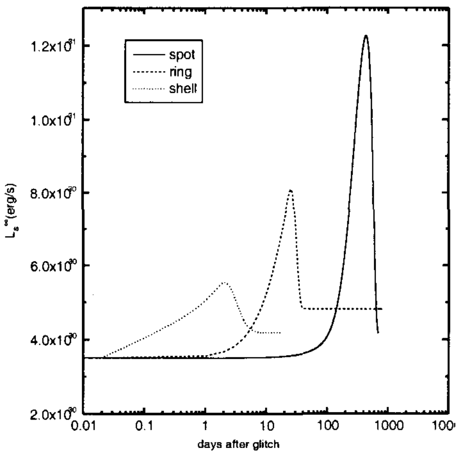

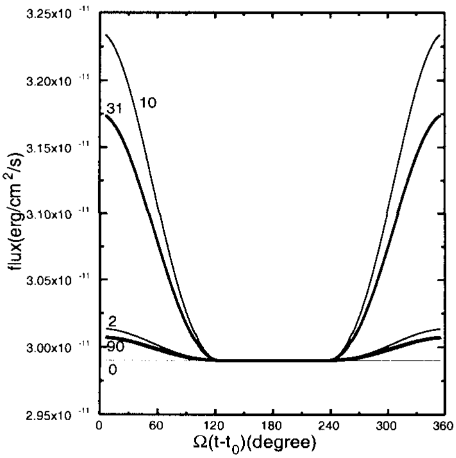

Figure 1. The left figure. The luminosity profiles of a UT-star with $T_{core} = 10^7\ K$, $\triangle E = 10^{42}\ erg$, $\rho_{glitch} = 10^{13}\ g/cm^3$.

Figure 2. The right figure. The evolution of total energy flux of a UT-star with $T_{core} = 10^8\ K$, $\triangle E = 10^{39}\ erg$, $\rho_{glitch} \sim 10^{10}\ g/cm^3$. $(f_F = 0.0814)$

4. Conclusion and Outlook

In this paper, the magnetic field effect is neglected. It will be considered in Tang & Cheng (1999). Since different sets of parameters will give rise to different light curves, in comparing with the observed light curves, our calculation is a good method to determine the equations of state for pulsars.

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