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X-ray observations of PSR J0218+4232 and of PSR B1937+21

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1. Introduction

Navarro et al. (1995) have discovered a 2.3 ms radio pulsar in a 2.0 day orbit around a low-mass companion. An interesting feature of this pulsar, PSR J0218+4232, is that radio emission is discovered throughout the pulse period; this is taken by Navarro et al. as an indication that the pulsar magnetic field is almost aligned with the rotation axis, and may also be related to the rather high radio luminosity of this pulsar, $L_{400\mathrm{MHz}} > 2700\,\mathrm{mJy\ kpc^2}$. The dispersion measure $DM = 61.25\mathrm{pc\ cm^{-3}}$ indicates a minimum distance of 5.7 kpc, according to the model for the free electron distribution in the Galaxy by Taylor and Cordes (1993).

2. X-ray observations

We observed PSR J0218+4232 with the High Resolution Imager of ROSAT for 22000 s, and the archetypal millisecond pulsar PSR B1937+21 for 7000 s. PSR J0218+4232 was detected at a countrate of $(2.1\pm0.4)\times10^{-3}$ cts/s. For an assumed spectrum similar to that of PSR J0437-4715 (Becker and Trümper 1993), and a column $N_{\mathrm{H}} = 2.2\times10^{21}\mathrm{cm^{-2}}$ (roughly estimated from the dispersion measure), this countrate corresponds to an X-ray luminosity in the $0.1-2.4$ keV bandpass of $L_{\mathrm{x}} \geq 1.8\times10^{33}\mathrm{erg\ s^{-1}}$, where the lower limit corresponds to the minimum distance. With the same spectrum and column for PSR B1937+21, a 3-σ upper limit to the countrate of 0.66×10^{-3} cts/s corresponds to an X-ray luminosity at 3.6 kpc of $2.3\times10^{32}\mathrm{erg\ s^{-1}}$.

3. Discussion

In Figure 1 we compare the new X-ray measurements with those of other radio pulsars, taken from Becker (1995). In a plot where the X-ray luminosity is

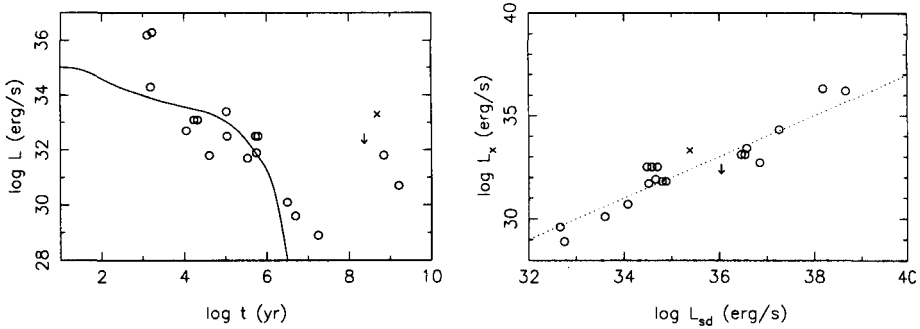

Figure 1. The X-ray luminosity of PSR J0218+4232 (×) and upper limit of PSR B1937+21 (↓) compared to the X-ray luminosities of other radio pulsars (○, data from Becker 1995), as a function of characteristic age (left, with a standard cooling curve after Umeda et al. 1993), and as a function of spin-down energy loss (right, the dashed line indicates $L_x = 10^{-3} L_{sd}$).

plotted as a function of age (after Trümper 1995), PSR J0218+4232 is shown to be the brightest millisecond pulsar in X-rays detected so far. It is clear that the luminosity of the millisecond pulsars cannot be due to the cooling of the neutron star. The correlation between X-ray luminosity and total spindown luminosity found by Seward and Wang (1988) is also present in the Rosat data, and describes both young and recycled radio pulsars.[1]

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[1] After the conference, we have noted that the EGRET source 2EG J0220+4228 has a position which is compatible with that of PSR J0218+4232; and we have discovered marginal evidence for variability on the pulse period in both X-ray and γ-ray data. These results are described in Verbunt et al. (1996).

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