High resolution spatial and timing observations of millisecond pulsar PSR J0218+4232 with Chandra

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Abstract

We report on the high-resolution spatial and timing results for binary millisecond pulsar PSR J0218+4232 obtained during two $\sim$ 75 ks observations with the Chandra HRC-I and HRC-S in imaging mode. The aim of the observations was to investigate the spatial extent of the X-ray emission from the direction of PSR J0218+4232 and to obtain for the first time an X-ray pulse profile in absolute time. An earlier $\sim$ 100 ks ROSAT HRI observation indicated that about 60% of the 0.1-2.4 keV X-ray emission from PSR J0218+4232 is unpulsed (DC) and with a spatial extent consistent with that of a nebula with a diameter of $\sim 14''$. However, the sub-arcsecond resolution image of the HRC-I (0.1-1 keV) showed that the emission from the direction of PSR J0218+4232 is consistent with that of a point source. Thus, the DC-component has a compact spatial origin ($\lesssim 0.5''$). The soft nature of the DC-emission (absent above 4 keV) as observed with the ROSAT HRI and BeppoSAX MECS instruments coupled to its compact nature makes it pausible that we are dealing with thermal emission from the surface of the neutron star.

With our second observation, the HRC-S in imaging mode, we obtained a 0.1-10 keV pulse profile with high statistics, showing the well-known double peaked morphology. The absolute timing accuracy of $100 - 200 \mu s$ makes it possible to compare for the first time in absolute phase the X-ray pulse profile with the highly structured radio profile(s) and the high-energy γ-ray profile reported recently from an analysis of CGRO EGRET data between 100 MeV and 1 GeV. It turns out that the two γ-ray pulses are aligned within absolute timing uncertainties with the two pulses seen at X-rays, thus strengthening the credibility of the **first** detection of pulsed high-energy γ-ray emission from a millisecond pulsar.

The wealth of data from radio-wavelengths up to high-energy γ-rays makes it possible to study the pulsed emission from this enigmatic object over a wide spectral window posing severe constraints on pulsar high-energy emission models.

CATEGORY: SUPERNOVAE, SUPERNOVA REMNANTS AND ISOLATED NEUTRON STARS