



XMM-Newton Observation of PSR B1957+20



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ABSTRACT: The "Black Widow pulsar", PSR B1957+20, is a millisecond pulsar which is in a 9.16-hour binary system. Ha bow-shock nebula created by the interaction between the relativistic wind of the pulsar and the surrounding ISM and ablation of the low-mass companion star by the pulsar wind were observed. We report on a 30 ksec observation of PSR B1957+20, using the EPIC-MOS and PN detector on-board the XMM-Newton Observatory. The X-ray diffused emission detected from this source is consistent with the result derived from Chandra observations. The spectrum of the nebular emission can be modeled with a single power law spectrum of photon index 2.3 ± 0.2 . The extended emission generated by accelerated particles in the post shock flow is considered to explain this result. For the first time, we detected significant x-ray flux modulation near the pulsar's radio eclipse.

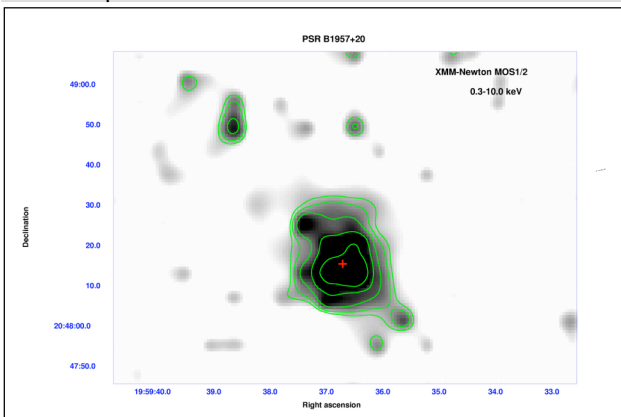


Figure 1. XMM-Newton MOS1/2 image of PSR B1957+20 with the overlaid contours. Adaptive smoothing with a Gaussian kernel of $\sigma < 4$ pixels has been applied to the image which has the binning factor of 6 arcsec. The contour lines are at the levels of (5, 6.3, 9.3, 16.1, 31.9, 68) $\times 10^{-6}$ cts s^{-1} arcsec $^{-2}$. The red cross indicates the position of the pulsar.

A 30-ksec observation obtained from XMM-Newton MOS1/2 was conducted. An elongated morphology associated with PSR B1957+20 in the energy range of 0.3 - 10.0 keV was obtained (Figure 1). This is in line with the previous results derived from the Chandra data (Stappers et al. 2003).

After subtracting the background photons, in total 369 source counts were available in our analysis. The X-ray spectrum in the 0.3-12.0 keV energy band can be modeled with a single power law spectrum of photon index 2.3 ± 0.2 (Figure 4). The unabsorbed fluxes are 8.62×10^{-14} and 9.44×10^{-14} erg sec $^{-1}$ cm $^{-2}$ in the energy range of 0.1-2.4 and 0.3-12.0 keV, respectively.

The pulsed radio signal of PSR B1957+20 is eclipsed at orbital phase 0.25. Using the XMM-Newton, we detected for the first time significant X-ray flux modulation near the orbital phase of the pulsar's radio eclipse.

Reference:

- Arzoumanian, Z., Fruchter, A. S., Taylor, J. H., 1994, ApJ, 426L, 85
- Becker, W., Truemper, J., 1999, ApJ, 341, 803
- Stappers, B. W., Gaensler, B. M., Kaspi, V. M., van der Klis, M., Lewin, W. H. G., 2003, Science, 299, 1372

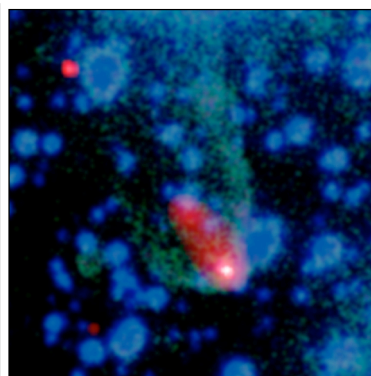


Figure 2. This composite X-ray (red/white) and optical (green/blue) image reveals an elongated cloud of high-energy particles flowing behind PSR B1957+20 (white point-like source). Credit: X-ray: NASA/CXC/ASTRON/B. Stappers et al., Optical: AAO/J.Bland-Hawthorn & H.Jones

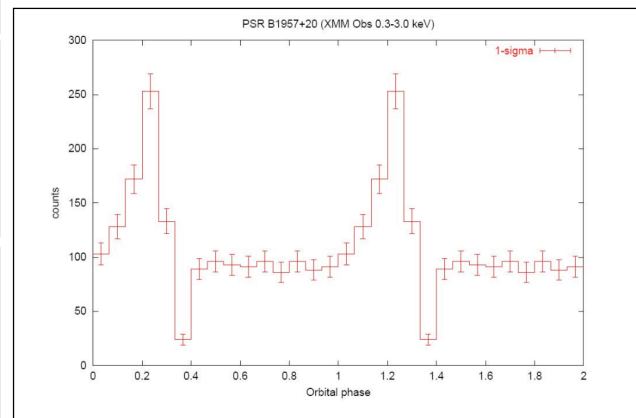


Figure 3. The light curve of the x-ray emission of PSR B1957+20 derived from the XMM PN Timing Mode data with the energy range of 0.3-3.0 keV. It was folded with the known orbital ephemeris.

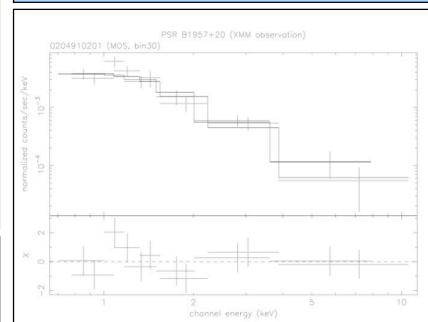


Figure 4. Energy spectrum of PSR B1957+20 obtained from the XMM MOS1/2 data. The X-ray spectrum can be fitted with an absorbed power law model.

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