Discovery of an X-ray nebula associated with PSR J2124-3358

C. Y. Hui & W. Becker

Max Planck Institute for Extraterrestrial Physics, Giessenbachstrasse 85748 Garching, Germany

ABSTRACT: We report the discovery of an X-ray nebula associated with the nearby millisecond pulsar PSRJ2124-3358. This is the first time that extended emission from a solitary millisecond pulsar is detected. The emission extends from the pulsar to the northwest by ~ 0.5 arcmin. The spectrum of the nebular emission can be modeled by a power law spectrum with photon index of 2.2±0.4. This is inline with the emission is originated from accelerated particles in the post shock flow.

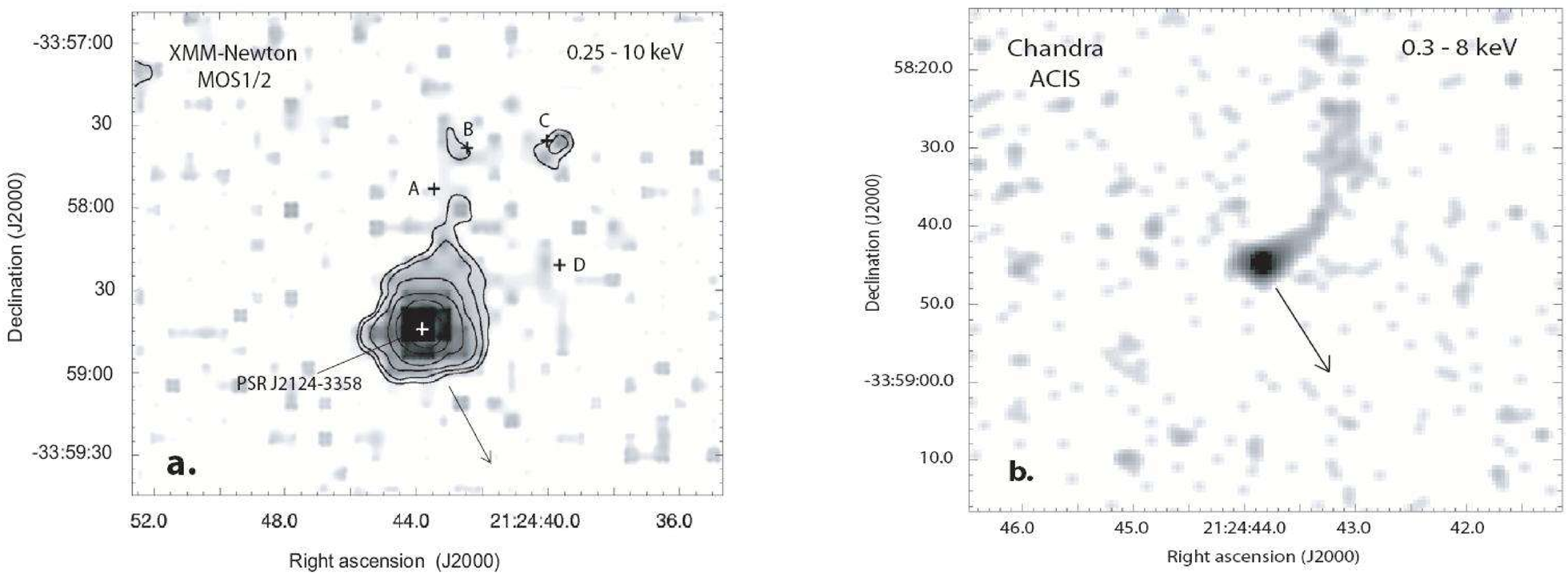

Figure 1. a) XMM-Newton MOS1/2 image of PSR J2124-3358 with the overlaid contours. The pulsar proper motion is indicated by an arrow. The position of bright stars located in the 1.5 arcmin neighborhood of PSR J2124-3358 are indicated. **b)** PSR J2124-3358 as seen by the ACIS-S3 detector aboard Chandra.

Recently, we have conveyed searches for diffuse X-ray emission around a group of millisecond pulsars. The pulsars are PSR J2124-3358, J0437-4715, J0030+0451 and J1024-0719 which have comparable spin parameters. The period the period derivative of this group have ranges of 4.87-5.76 ms and (1.0-1.87)×10^{-20} s/s respectively. From the XMM-Newton's MOS1/2 image, an elongated structure associated with PSR J2124-3358 was discovered (Fig 1a). The S/N ratio of this feature is ~4 in the energy range of 0.25-5 keV. It is found to be deviated from the direction of the pulsar proper motion and extended to the northwest by ~0.5 arcmin. The detection was subsequently confirmed by Chandra ACIS archival data in which the diffuse emission has a S/N ratio ~5 in the energy range of 0.3-8 keV (Fig 1b). With the superior spatial resolution of Chandra, the arc-like diffuse emission is clearly detected. Since the width of the PSF of XMM-Newton is about 10 times that of Chandra, most of the detailed structure seen in the Chandra data was blurred. The direction of the feature in the Chandra image is consistent with the orientation of the trail detected by XMM-Newton. For further details, please see Hui & Becker (2006).

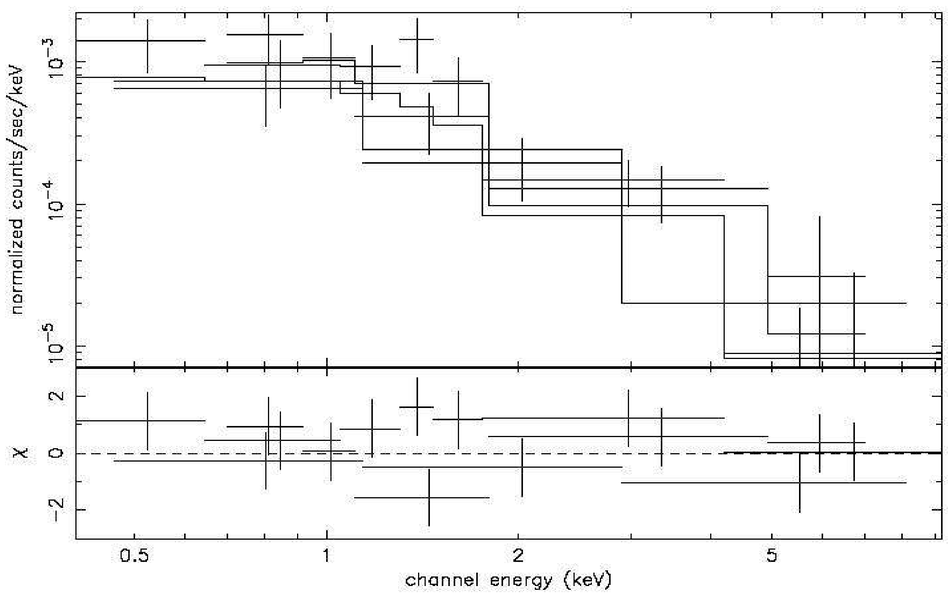

Figure 2. Energy spectrum of the X-ray trail of PSR J2124-3358 as observed with MOS1/2 and ACIS-S3 detectors and simultaneously fitted to an absorbed power law model.

Examining the emission nature of the diffuse emission associated with PSR J2124-3358, we have found that a single power law model describes the observed spectrum. The photon index is 2.2±0.4 (1-σ error). The unabsorbed fluxes deduced for the best-fitted parameters are fx=1.8×10^{-14} erg s^{-1} cm^{-2}, Lx=1.3×10^{29} erg s^{-1} and fx=1.2×10^{-14} erg s^{-1} cm^{-2}, Lx=1.3×10^{29} erg s^{-1} in the energy ranges 0.1-2.4 keV and 0.5-10 keV respectively. These values are found to be consistent with the theoretical estimates (Cheng, Taam & Wang 2006).

References:

C. Y. Hui & W. Becker, 2006, A&A, 448, L13
K. S. Cheng, Ronald. E. Taam, & W. Wang, 2006, ApJ, 641, 427

For further information, please contact: dhui@mpe.mpg.de