Long-term variability of HMXBs with MAXI

J. J. Rodes, T. Mihara, J. M. Torrejón, M. Sugizaki, G. Sanjurjo-Ferrín, G. Bernabéu, S. Nakahira

Universitat d'Alacant
Universidad de Alicante

IU FACyT I.U. de Física Aplicada a las Ciencias y las Tecnologías

RIKEN

XMM-NEWTON 2018 SCIENCE WORKSHOP Poster C9

Abstract

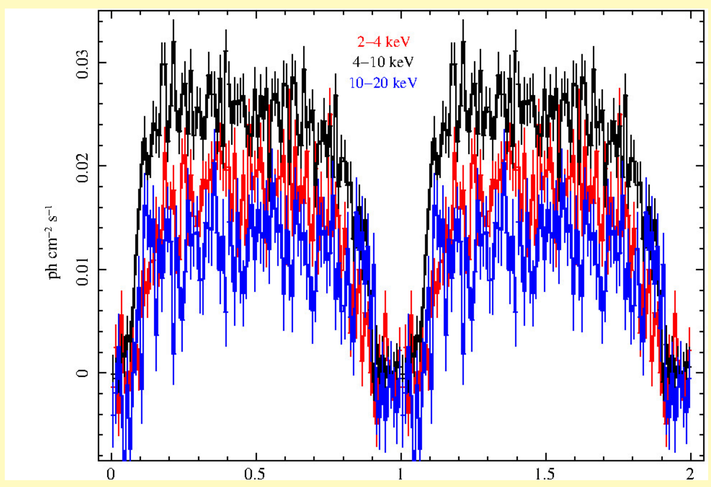
In this work we present our **long-term analysis** of some **X-ray binary sources observed by MAXI**. We start to obtain its light-curves, then we estimate its orbital periods and finally derive the good time interval to extract **orbital phase-resolved spectroscopy**. Our data show an **excellent coverage for many orbits of the systems** and extend over more than five years. Thus, the study of the X-ray spectrum from the neutron star at different orbital phases provides us the **variability of the model parameters** we can use to compare with the **different stellar wind accretion scenarios**. This analysis strategy allow us to study the **stellar wind structure and physical conditions of the circumstellar medium**.

Introduction

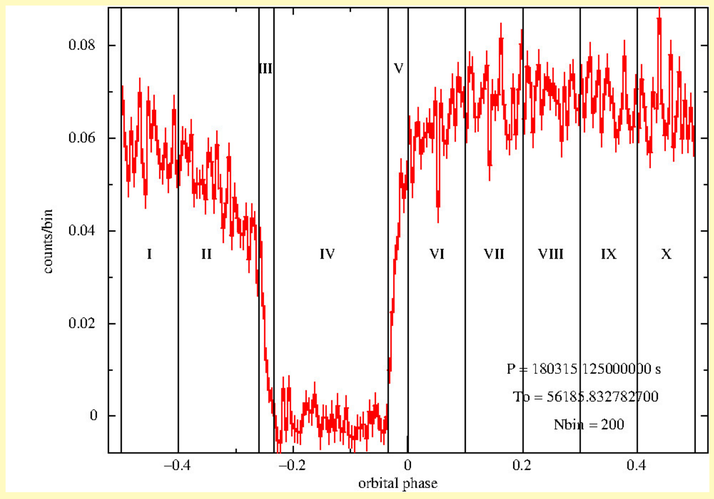
The **Monitor of All Sky X-ray Image** (*MAXI*) is a Japanese X-ray astronomical mission that has been carried out on the **International Space Station** (*ISS*) since 2009 August [4]. The operation of MAXI has officially been extended by *JAXA* until the end of March 2021. The main on-board instrument, **Gast Slit Camera** (GSC), which consists of Xe-gas proportional counters and slits to cover 1-dimensional fields of view, **scans the almost entire sky every 92 minutes** of the ISS orbit [5], [8]. Thanks to the large-area counter arrays, about a hundred of bright X-ray sources with intensities $\geq$20 mCrab are positively observed every day. *MAXI* presents both **all-sky coverage and moderate energy resolution**, which gives us the possibility to investigate the orbital light curves and the orbital phased-resolved spectra of **high-mass X-ray binaries** (HMXBs). *MAXI* observing strategy suppress effectively the short term variability associated with accretion and enhances the long term, **permanent structures present in the stellar wind and circumsource environment** [1], [3], [2], [6], [7].

Timing analysis

First, we have obtained the *MAXI/GSC* on-demand light-curve of each source covering almost the whole *MAXI* operation time in the 2–20 keV energy band. Then, we have searched for an **orbital period** assuming a sinusoidal signal and derived a $P_{\rm orb}$ in **days** for the binary system. Then we **folded the light curves** with the best orbital period to extract the orbital phase-resolved spectra. We also used the orbital ephemeris published for every system with the **phase zero** took at the **mid-eclipse time**. Below we show two examples of background subtracted orbital phase light curves.

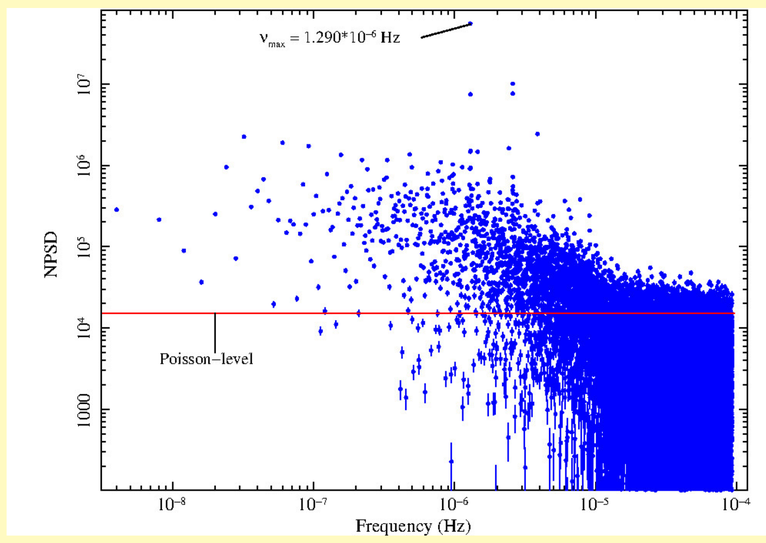


a) 4U 1538−52/QV Nor



b) Cen X−3/V779 Cen

Power spectrum with *MAXI/GSC*

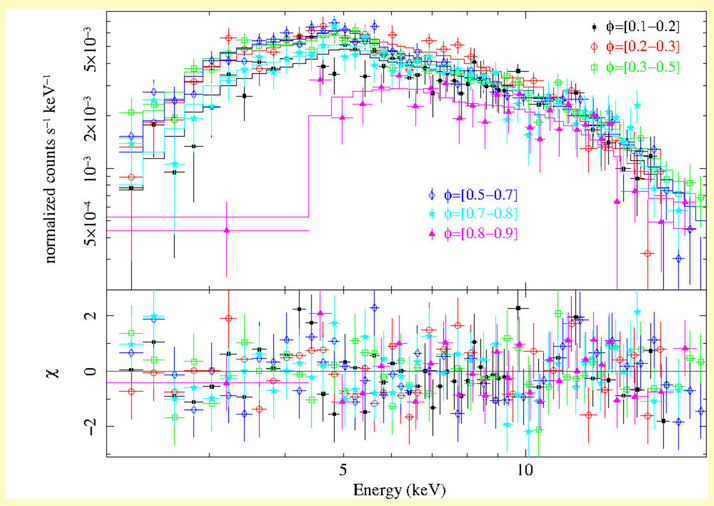


Conclusions

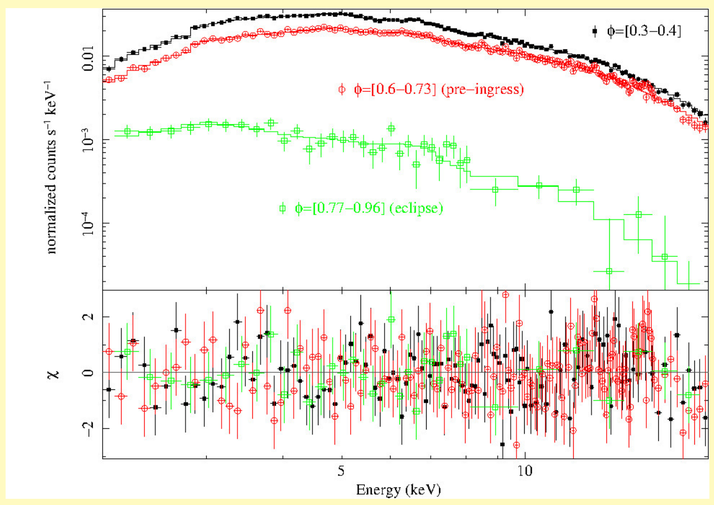
We have presented the **results** of a very long *MAXI* observation of 4U 1538−52 and Cen X−3 which allow us to perform both **time- averaged and time-resolved spectroscopy** in the 2–20 keV energy band and **light curve analysis**. In summary, *MAXI* not only brings us interesting discoveries from orbital phase-resolved spectroscopy of X-ray binary pulsars, but also **long trend variations** of these systems. Besides, *MAXI* offers us the possibility to study the **stellar wind in massive X-ray binaries** comparing it with the theoretical models [1], [3], [2], [6], [7].

Spectral analysis

The **orbital phase-averaged spectral analysis** was performed using the *MAXI* on-demand processing, carefully excluding any contamination by nearby brighter sources. Both **phenomenological and physical models** commonly **applied to accreting X-ray pulsars** were tested. Then, we filtered the *MAXI/GSC* data with GTIs corresponding to the different orbital phase bins to obtain the **orbital phase-resolved spectra**. We rebined all extracted spectra to obtain **spectral bins Gaussian distributed**. The time-resolved spectra was fitted with the same best fit model as used in the orbital phase-averaged spectrum.



a) 4U 1538−52



b) Cen X−3

Figures show two examples of orbital phase-resolved spectra fitted with a **Comptonisation of of cool photons on hot electrons modified by an absorbing column** along our line of sight. In Cen X−3, we also added the fluorescence iron emission line at ∼6.4 keV assuming a Gaussian profile.

References

[1] Doroshenko, V. et al. 2013, *A&A, 554, A37*
[2] Islam, N. & Paul B. 2014, *MNRAS, 441, 2539*
[3] Malacaria, C., Mihara, T. et al. 2013, *A&A, 554, A37*
[4] Matsuoka, M., Kawasaki, K. et al. 2009 *PASJ, 61, 999*
[5] Mihara, T., Nakajima, M. et al. 2011 *PASJ, 63, 623*
[6] Rodes-Roca, J. J., Mihara, t. et al. 2015 *A&A, 580, A140*
[7] Rodes, J. J., Mihara, T. et al. 2016, *Proc. 5th MAXI Workshop*
[8] Sugizaki, M., Mihara, T. et al. 2011, *PASJ, 63, 635*

Funding

This work was supported partially by the project **ESP2017-85691-P**. MS acknowledges the support from the **EU H2020 programme under the AHEAD** project (grant agreement n. 654215). JJRR acknowledges the support by the **Matsumae International Foundation Research Fellowship No14G04**.