



The X-ray spectra of the black hole candidate 4U 1630–47 during its 2012 Outburst

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Introduction

4U 1630–47 is a black-hole candidate that shows regular outbursts every ~600-690 days. The source shows strong absorption by interstellar material (ISM) along the line of sight, with a column density $N_{\text{H}} = 5 - 12 \times 10^{22} \text{ cm}^{-2}$.

Díaz Trigo et al. (2013) reported the detection of three relativistically Doppler-shifted emission lines arising from baryonic matter in the jet of 4U 1630–47 during its 2012 outburst. The three lines had energies of 4.04 keV, 7.28 keV and 8.14 keV.

In this paper, we used the same data as Díaz Trigo et al. (2013) but we propose an alternative model to fit the spectra.

Results - I

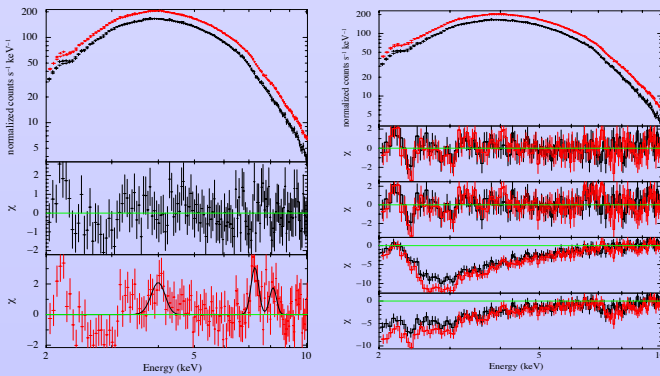


Figure 1. X-ray spectra of ObsIDs 0670673101 and 0670673201 fitted with two different models.

Right panel: Model of Díaz-Trigo et al. (2013) with three relativistically Doppler-shifted emission lines

Left panel: Our model consisting of the same continuum as in Díaz-Trigo et al. (2013), without the emission lines but with variable Fe and S abundance in the ISM. Our best-fitting abundances are $A_{\text{Fe}} = 0.82 \pm 0.04$ and $A_{\text{S}} = 1.48 \pm 0.02$. The resulting Fe abundance is consistent with other measurements in the ISM (Pinto et al. 2013)

Conclusion

- We can fit the same data as Díaz-Trigo et al. (2013), but with a simpler model.
- This model is also suitable for the other four observations during the same outburst.

Observations

Table 1. XMM-Newton observations of 4U 1630–47 used in this work.

ObsID	Observation Times (UTC) (day.month.year hr:min)	Observation mode	RAWX source	RAWX back
0670671501	04.03.2012 11:24 - 04.03.2012 12:27	Timing	[27,46]	[4,10]
0670671501-2	04.03.2012 13:43 - 05.03.2012 09:23	Timing	[28,45]	[4,10]
0670671301	20.03.2012 19:54 - 21.03.2012 02:30	Timing	[28,45]	[4,10]
0670672901	25.03.2012 04:14 - 25.03.2012 21:56	Timing	[28,45]	[4,10]
0670673001	09.09.2012 21:14 - 10.09.2012 07:49	Timing	[28,45]	[4,10]
0670673101	11.09.2012 20:56 - 12.09.2012 05:38	Burst	[20,51]	[4,10]
0670673201	28.09.2012 07:16 - 28.09.2012 21:48	Burst	[20,51]	[4,10]

ObsID 0670671501 contains two separate observations. We listed one as 0670671501 and another one as 0670671501-2.

Results - II

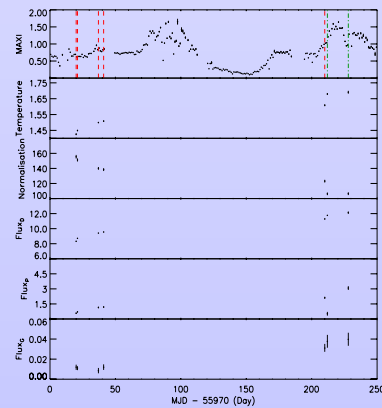
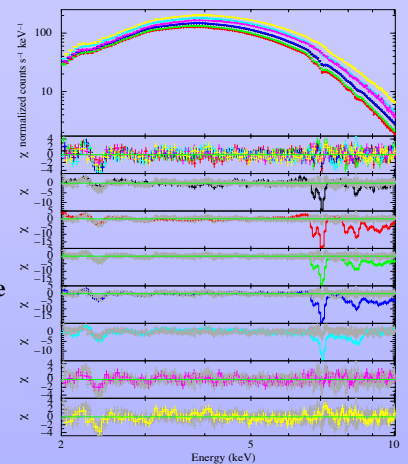


Figure 2: Light curve (upper panel) and some model parameters of 4U 1630–47 during the 2012 outburst.

We subsequently applied the same model to all six observations during this outburst.

Figure 3. X-ray spectra and best-fitting model of all six observations fitted simultaneously with our model.

The first panel shows the data and model; the second panel indicates the residual of the best-fitting model; the other panels are the residuals of each observation when the emission and absorption lines are set to zero.



References

- Díaz-Trigo M. et al., 2013, Nature, 504, 260
 Pinto C. et al., 2013, A&A, 551, A25