The wide band spectral observation of High Mass X-ray Binary 4U1700-37 with Suzaku

Yuu Koseki[1,2], Motohide kokubun[1,2]

[1] The Graduate University of Advanced Studies
[2] Institutes of Space Aeronautics and Science / JAXA
E-mail : koseki@astro.isas.jaxa.jp

Abstract

We report on the spectral analysis of the High Mass X-ray Binary 4U1700-37 with Suzaku.
Key words: stars:individual(4U1700-37=HD153919) — X-rays:binaries — X-ray:spectra

1. Introduction

4U1700-37 is a High Mass X-ray Binary (HMXB) discovered by Uhuru satellite [1], whose companion star HD153919 is the brightest one in the visible light. Physical parameters of 4U1700-37 are summerized in Table.1.

There have been several observations of this source with X-ray satellites. BeppoSAX observed 4U1700-37 in 1997, and a spectrum obtained in 10 ksec was fitted with a cutoff power-law model [2] in the energy band 0.5-200 keV [3]. The Chandra spectrum in 1-10 Å was explained with two power-law components with different absorptions [4]. Three low flux period spectra in the range of 0.5-10 keV were investigated with XMM-Newton [5]. With Suzaku, we aim to analyze a wider spectrum with high time resolution to investigate the temporal change of the electron energy distribution in HMXBs.

Table 1. Physical parameters of 4U1700-37

RA (J2000)	17h 03m 56.772s [6]
DE (J2000)	-37d 50m 38.92s [6]
Orbital Period	3.41days [7]
Stellar Mass	58±11M$_\odot$ [8]
Compact Object Mass	2.44±0.27M$_\odot$ [8]
Distance	1.9kpc [9]

2. Observation

4U1700-37 was observed with Suzaku from September 13th to 14th, 2006. The observational period corresponded to an orbital phase of 0.30-0.72, and the XIS mode was set to be 1/4 window mode with 1 sec Burst mode. As shown Figure 1, the light curve of 4U1700-37 fluctuated a factor of 10 and divided four energy bands sometimes changed differently.

3. Data Analysis

We firstly tried to explain hard spectra below 100 keV by a single power-law with an absorption model, but

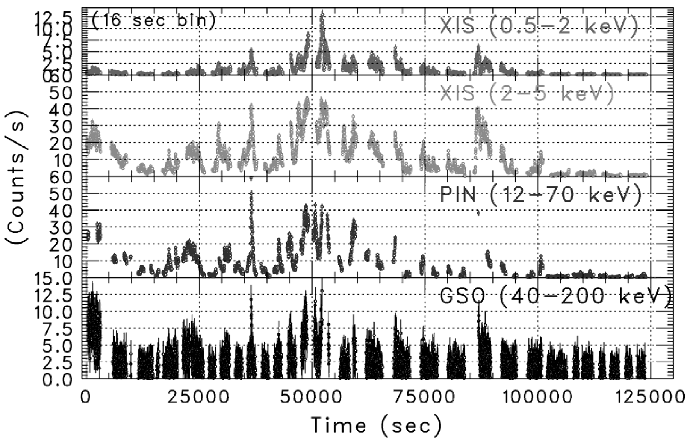

Fig. 1. The Light Curve of Each Energy Band

realized that these spectra in all range were more properly shown by a cutoff power-law with absorption model. Therefore all observation data were divided into 1000 sec periods and the extracted spectrum from each period was fitted by the cutoff power-law model. A light curve of best-fit parameters is plotted in Figure 2.

4. Light Curve of Best-Fit Parameters

Several results were revealed from Fig.2. The normalization of power-law and line flux was fluctuating by a factor of 10, and the absorption was also making a variation such order.

However, the power-law index approximately stayed in a range of 0.7-1.2, except a short period in which the value dropped smaller than 0. We defined this period as a "transition duration" and analyzed in detail. We made a light curve normalized by a 7-12 keV band flux to examine the transition duration. It was discovered that the duration was approximately only 100 sec. Then we tried to study the spectral change in the transition duration. We defined the Red Spectrum as a spectrum

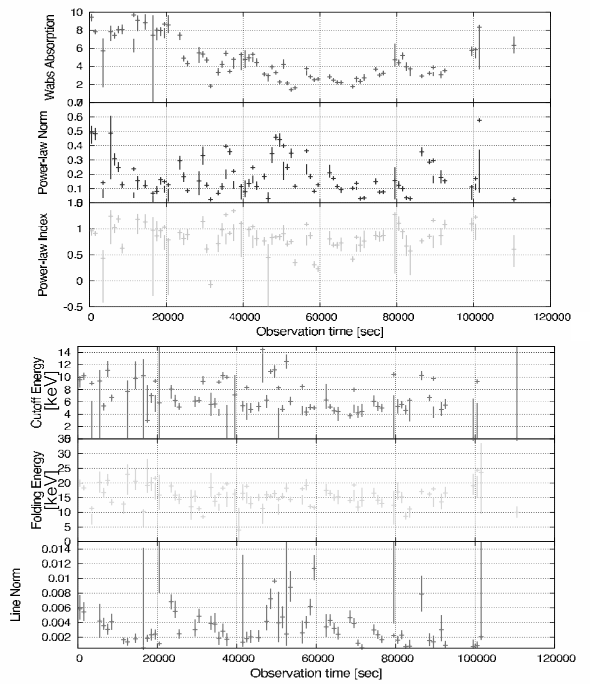

Fig. 2. The Light Curve of Model Parameters

accumulated in 1500 seconds before the transition point at 30500 sec in Fig.1 and the Blue Spectrum as that obtained in 1500 seconds after. As shown in Figure 3, the power-law index declined from 1.3 to 0.2, the fold energy halved, and the line width rapidly increased by a factor of 10^5, although the reduced χ^2 was not so good at the Blue Spectrum probably due to the descrepancy above 30 keV. The cutoff and folding energy stayed comparatively flat, changing between 4 and 14 keV, 5 and 25 keV, respectivley. The line center energy almost remained constant.

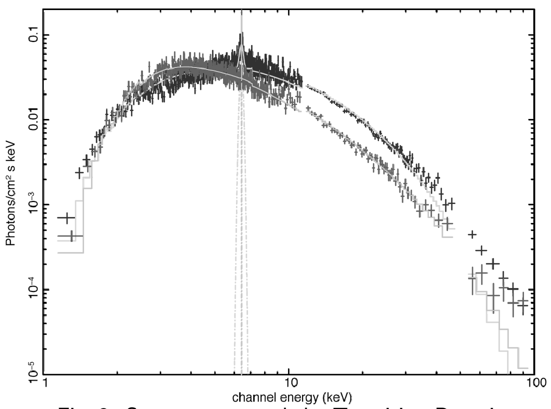

Fig. 3. Spectrum around the Transition Duration

5. Correlation of Best Fit Parameters

As shown Figure 4, we made correlation diagrams to investigate whether there was correlation between parameters or not. As a result, the index became soften when the power-law flux increased. This implied that the distribution of electron energy became depressed when the accretion matter increased. We also confirmed that the power-law index fluctuation was not responsible for the absorption, because the spectra became soft when the absorption was large. The fact that there was no correlation between the absorption and the power-law flux claimed that the accretion and absorption matter may have been different. The power-law flux was positively correlated with the line flux and it indicated the accretion matter and the Fe line emission matter may have had a same origin.

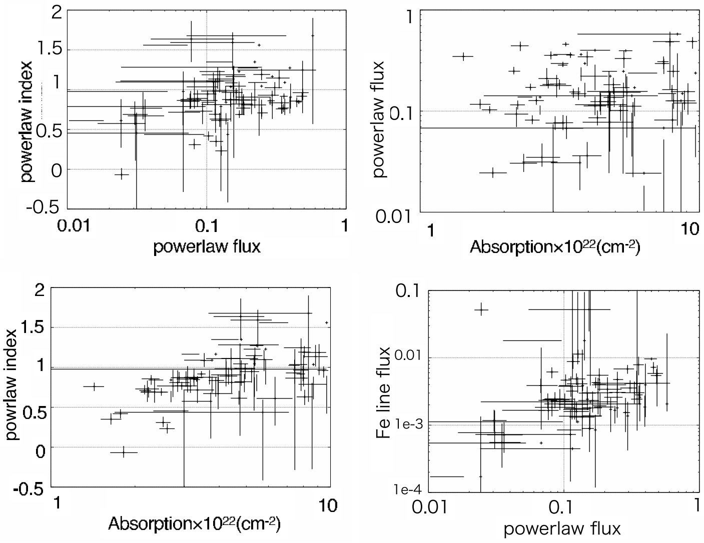

Fig. 4. Correlation Diagrams

6. Conclusion

We for the first time resolved wide-band spectra of 4U1700-37 with high time resolution and obtained temporal behaviors of individual parameters. The fitting revealed that the flux of the absorption, continuum and 6.4 keV line were fluctuating by a factor of 10 in 1000 sec timescale, but the power-law, cutoff energy and fold energy were not. The correlation diagrams of these parameters implied that the accretion and absorption matter were different, despite the accretion and line emission one were same.

We also discovered the transition period that the power-law index became hard. In that period, the power-law index decreased from 1.3 to 0.2, the fold energy also decreased and line broad extremely expanded. These transition happened in only 100 sec.

7. References

[1] C.Jones et al., ApJ, Vol.181, L43-48, 1973
[2] N.E.White et al., ApJ, Vol.270, 711-734, 1983
[3] A.P.Reynolds et al., A&A, Vol.349, 873-876, 1999
[4] B.Boroson et al., ApJ, Vol.592, 516-531, 2003
[5] A. van der Meer et al., A&A, Vol.432, 999-1012, 2005
[6] M.A.C.Perryman et al., A&A, Vol 323, L49-52, 1997
[7] B.C.Rubin et al., ApJ, Vol.459, 259-270, 1996
[8] J.S.Clark et al., A&A, Vol.392, 909-920, 2002
[9] A.Ankay et al., A&A, Vol.370, 170-175, 2001