Spectral and timing characterization of X-6 source in M33

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Abstract

From our previous work we announced to use much more qualitative data for the second brightest X-ray binary X-6 in M33 (see Fig.1) analysis and use them to cover energy range 0.3-10.0 keV, in other words, Swift(XRT) data with not big amount of photons (their datasets' exposure were up to 3ks) have to be replaced by XMM-Newton (EPIC PN camera) for proving is it Z source or not. We plotted HID and identified 2 spectral states. Using Nustar summer 2017 data in 3.0-20.0 keV range, we analyzed spectra in 2 spectral states with diskbb+compTT model and measure disk and corona temperature, fluxes from both components and their variability.

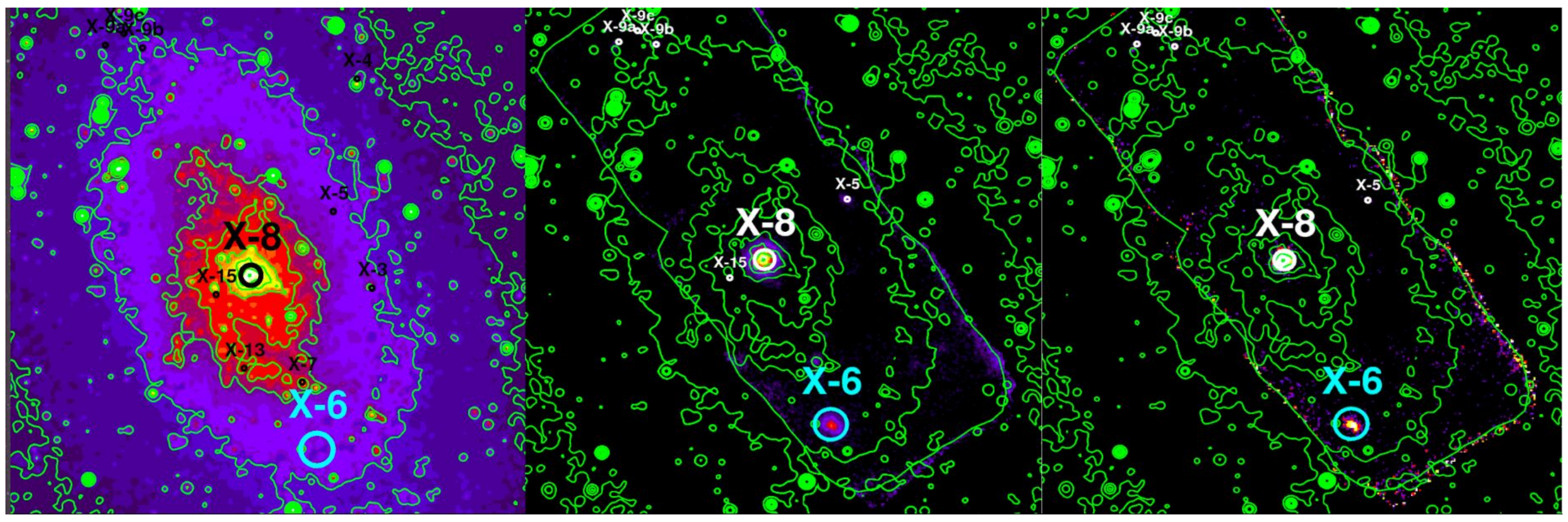

Fig.1 Left: WISE image of M33 (4.6 μm). Middle and right: NuSTAR X-ray images of M33 in 3-70 keV and 10-20 keV energy bans, respectively. Green optical contours correspond to WISE 4.6 μm image of M33.

Observations and spectral analysis

We used all archived XMM-Newton data (23 observations) with up to 3ks exposure for X-6 and processed ODF data and PPS data from 3XMM-DR8 catalog then fitted them separately with phabs*powerlaw model and calculated hardness as the ratio of fluxes in hard (3-10 keV) and soft (0.3-2.5 keV) energy bands respectively.

In Fig.2 you can see HID (hardness vs luminosity in 0.3-10.0 keV) and in fig.3 the distribution of observations by hardness. We identified soft (left, 6 observations) and hard (right, 17 observations) spectral states in relation to the weighted mean value (see fig. 4) and found constant factors for XMM-Newton data regarding NuSTAR (which are fixed at const = 1). Because of big errors, we didn't notice any tracks or strongly different spectral states which are peculiar to LMXBs with neutron star (Z and atoll sources)

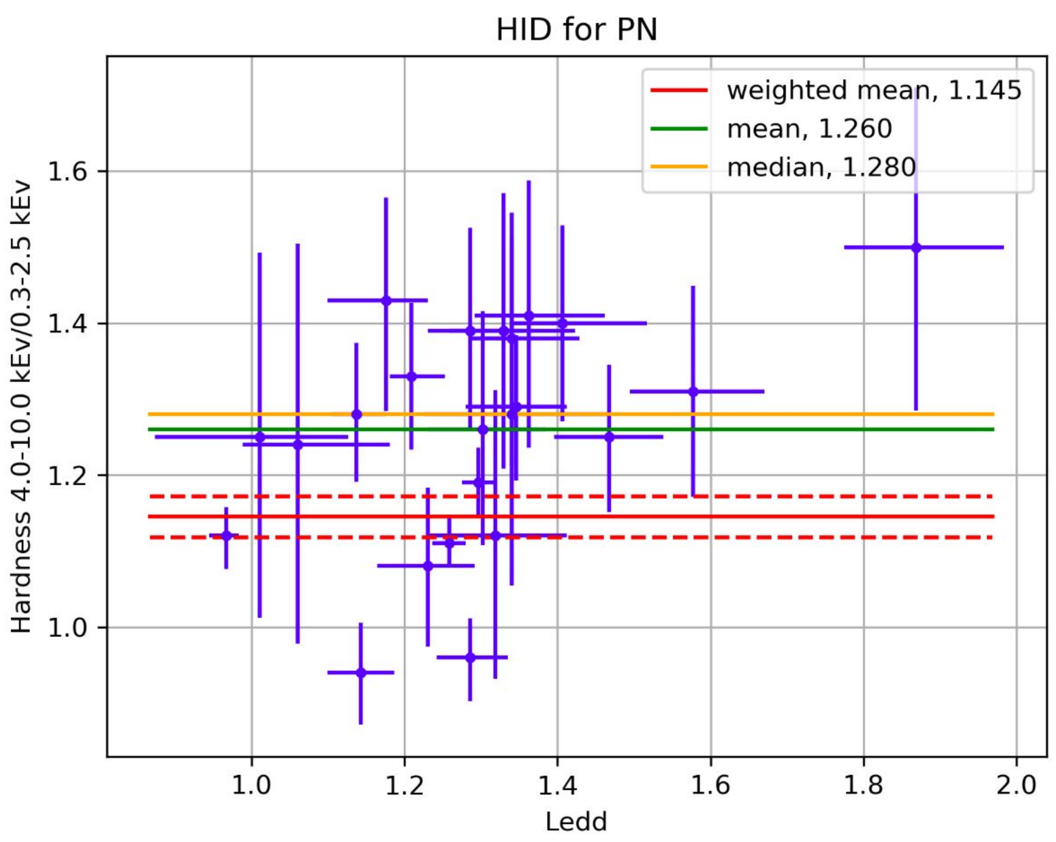

Fig. 2 HID diagram for 23 XMM-Newton observations which was made with using fit of poweplaw model with absorption.

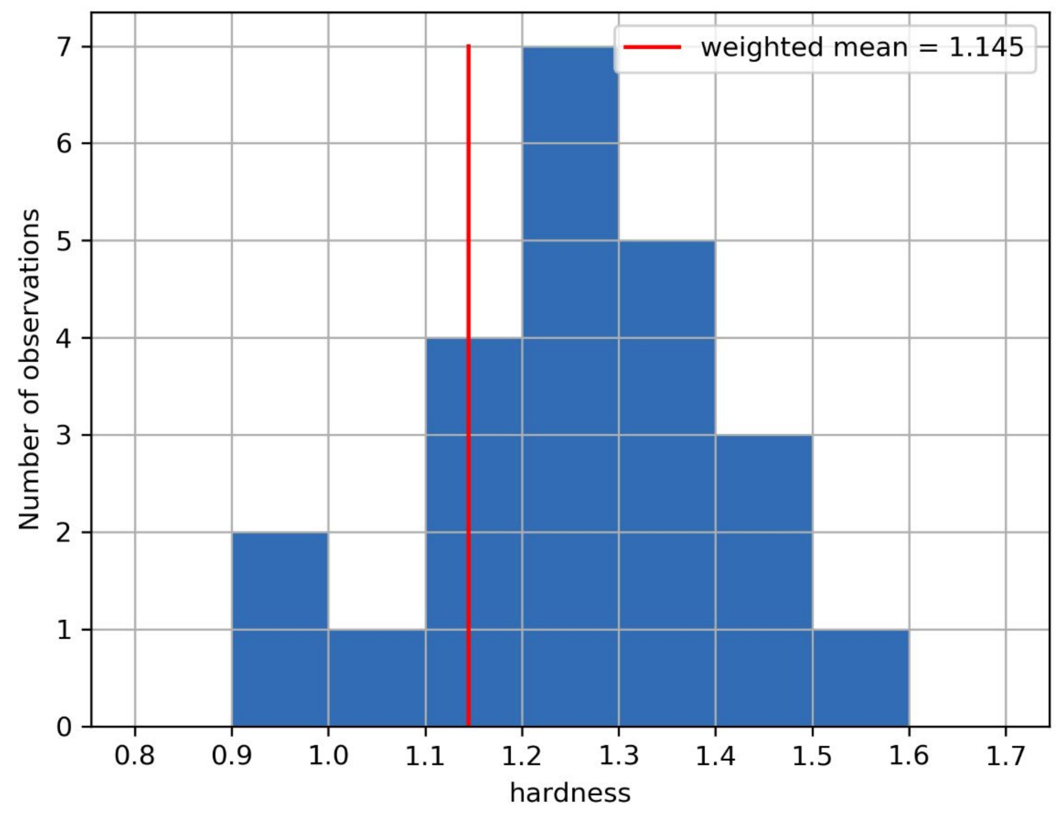

Fig.3 The histogram shows the distribution of the number of observations by hardness. Redline shows the weighted mean value.

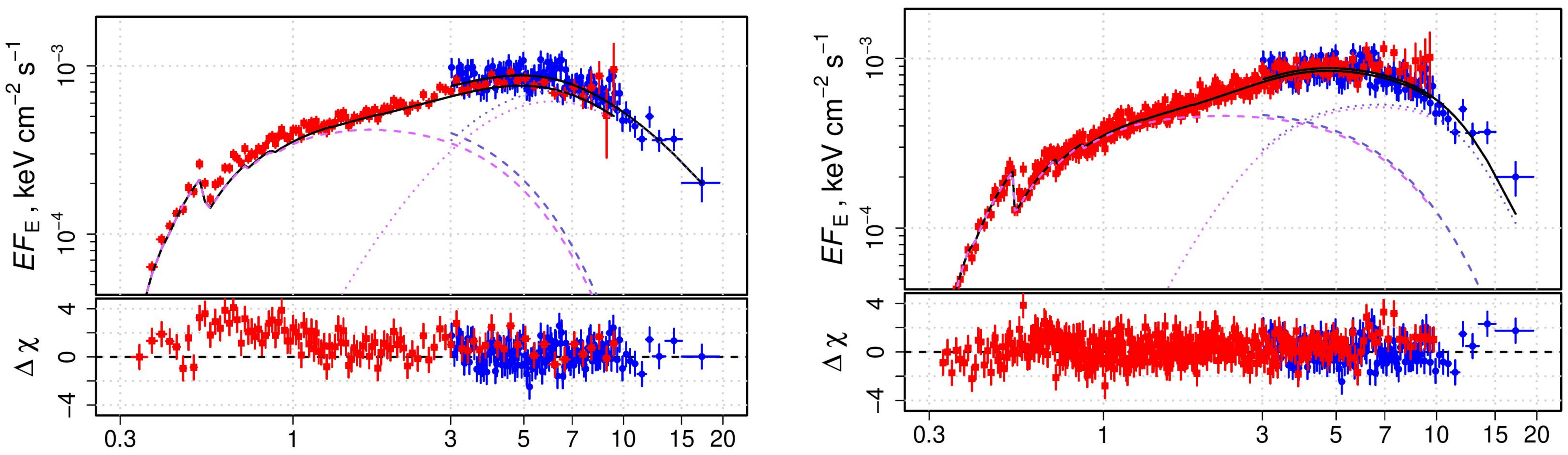

Fig. 4 Broadband X-ray spectrum of M33 X-6 based on XMM (red) and NuSTAR (blue) observations. Best-fitting model phabs*const*(diskpbb+compTT) is shown by a black solid line for 2 groups of observations. Accretion disk emission and comptonization are shown by dashed and dotted lines respectively for XMM and NuSTAR data, *left:* spectrum in soft state, *right:* spectrum in hard state.

Timing analysis

We tried to identify QPOs or just source variability on a smaller time scale of this source by performing the power spectrum of the time series of 1s. Due to low time resolution in imaging mode (XMM (EPIC PN) observed X-6 only in this mode) of EPIC PN camera and noisy data, we didn't find any peaks and didn't find periods there.

Preliminary results

We obtained the first detailed analysis of spectral states of M33 X-6. Broadband spectrum is well described by model of radiation of corona COMPTT (including boundary layer emission for neutron star) and multitemperature black body disk DISKBB. Alhrough we didn't find peaks in power spectrum and strong variabilities in lightcurves, we can see some variabilities on HID: 2 spectral states - soft and hard are well described by thick accretion disk model with comptonization and disk temperature ~ 2 keV and 1 keV and corona - ~1 keV and 4 keV for hard and soft states respectively. And flux of disk component is decreasing and flux of corona component is increasing when the source is switching from soft to hard state.
This work is in progress.

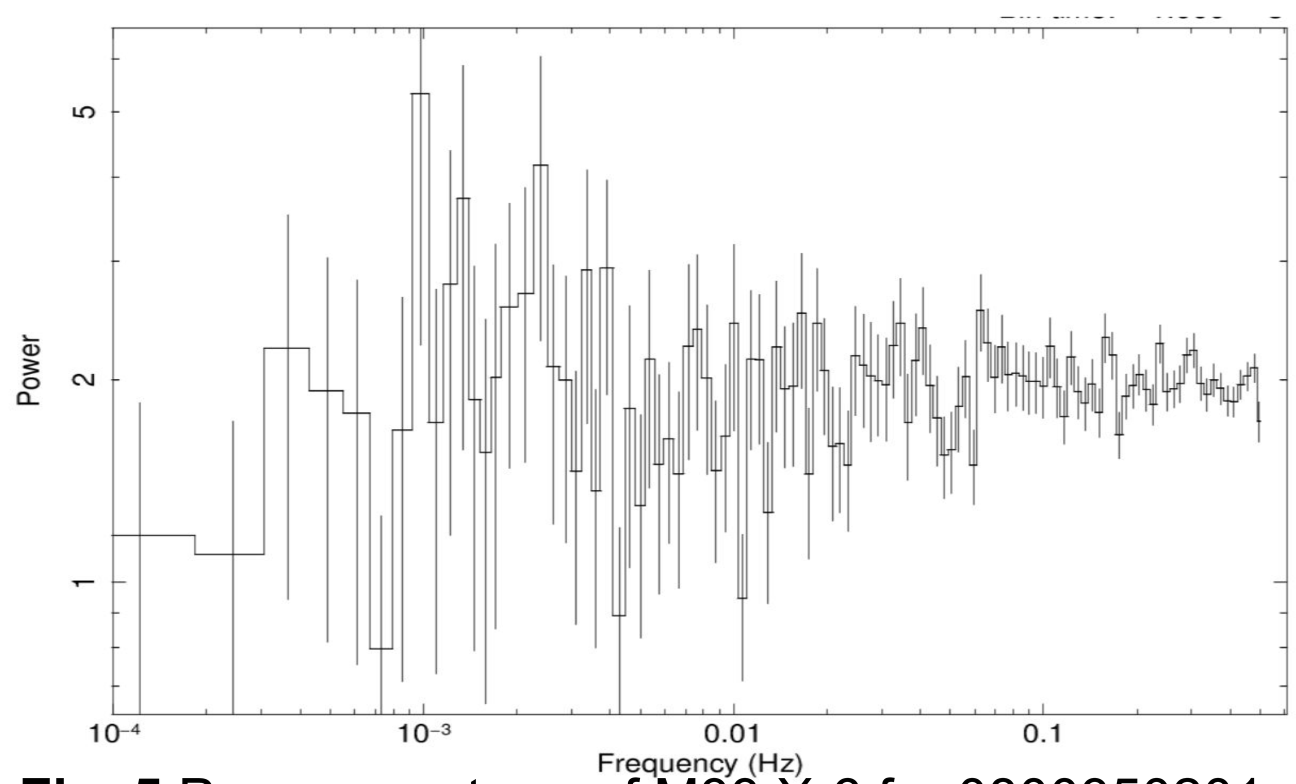

Fig. 5 Power spectrum of M33 X-6 for 0800350201 observation. It was rebinned as a geometrical series with factor of -1.05