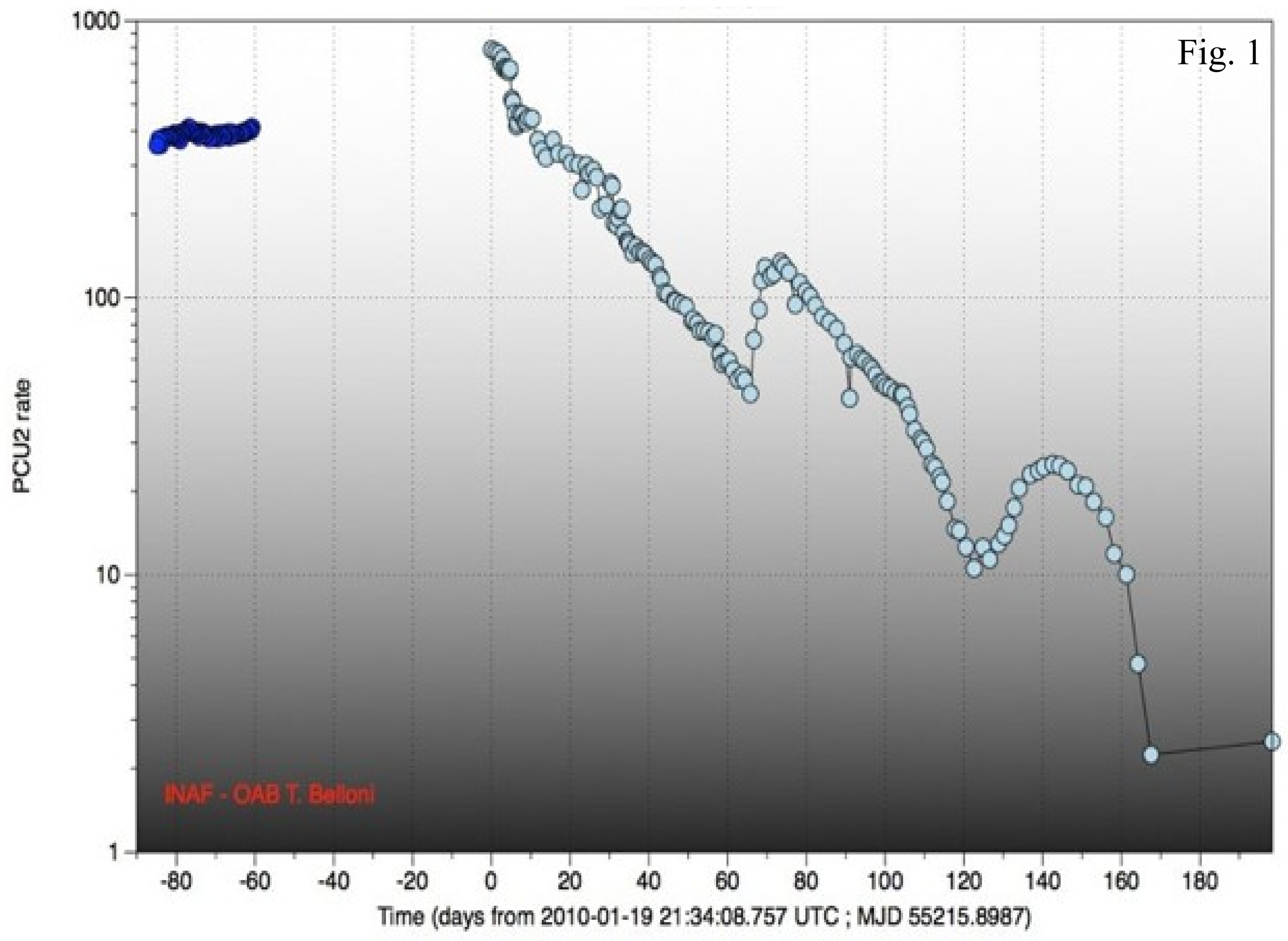
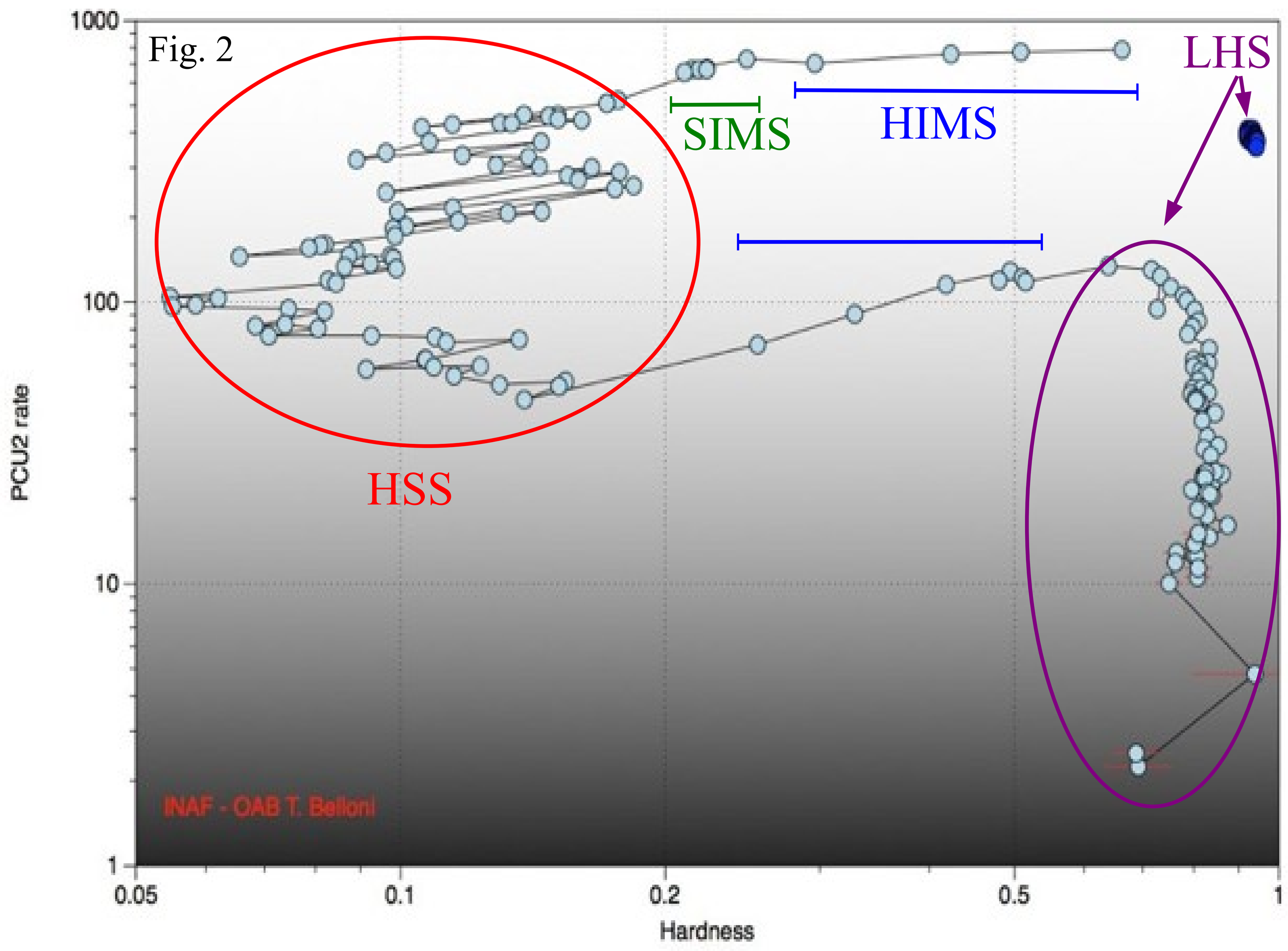
XTE J1752-223: A new transient black hole candidate

H. Stiele, T. Muñoz-Darias, S. Motta and T. Belloni

INAF Osservatorio Astronomico di Brera, Via E. Bianchi 46, I-23807 Merate (LC), Italy (holger.stiele@brera.inaf.it)

We report on X-ray monitoring observations of the new transient black hole candidate (BHC) XTE J1752-223 with the Rossi X-ray Timing Explorer (RXTE). The source was discovered on 2009 October 23 and during its low/hard state all timing and spectral properties were similar to those of Cyg X-1 during its canonical hard state (Munoz-Darias et al. 2010, MNRAS 404, L94). The evolution through the hardness intensity diagram and the timing properties observed in the power density spectrum suggest that the source crossed all the canonical BHCs states. We discuss the different states and present the results of our spectral and timing investigations.





The PCA **lightcurve** is shown in Fig. 1, while Fig. 2 shows the **hardness intensity diagram**. For the first 29 days (dark blue dots; about 50 observations) the count rate was rather constant. During this time the source was in the **hard/low state (LHS)**, showing rms variability of ~40% (see Fig. 3). After that XTE J1752-223 was not observable with RXTE for a further 60 days due to solar constrains. When the source was observed again its count rate has increased and the source was in the **hard intermediate state (HIMS)**. During this observation and the following two observations the source showed type C QPOs (quasi periodic oscillations) at 2.2 Hz, 4.1 Hz and 5.5 Hz, respectively, while the rms variability decreased from 25% to 18% (see Fig. 3). XTE J1752-223 evolved further through the **soft intermediate state (SIMS)**, showing type A/B QPOs, into the **high/soft state (HSS)**. In the following the source shows several transitions between these two states. A detailed discussion of these transitions will be given in Stiele et al. (in prep.). After a further 59 days XTE J1752-223 passed through another HIMS at lower luminosity into the LHS. In total XTE J1752-223 was for more than about 300 days in outburst and evolved through all canonical BHCs states, before it fated into quiescence again.

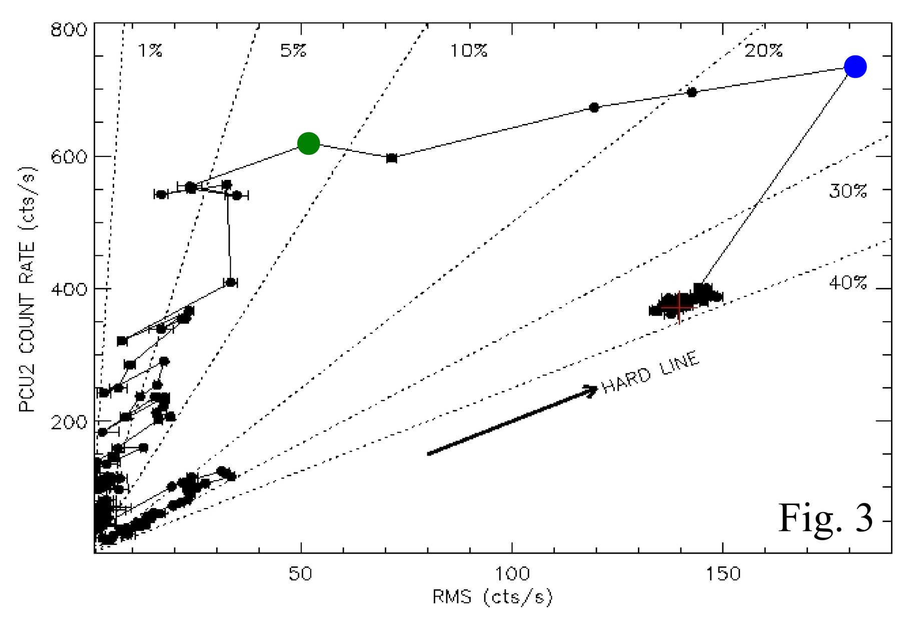


Figure 3 shows the **rms-intensity diagram**, which gives the PCU2 count rate depending on the total rms. This digram allows to constrain different states without needing any spectral information. It was introduced, based on GX 339-4 data, in a recent paper by Muñoz Darias et al. 2010b (arXiv1008.0558).

All observations of the LHS are close to the line indicating a fractional rms of 40%. The onset of the HIMS is given by a blue dot, of the SIMS by a green dot.

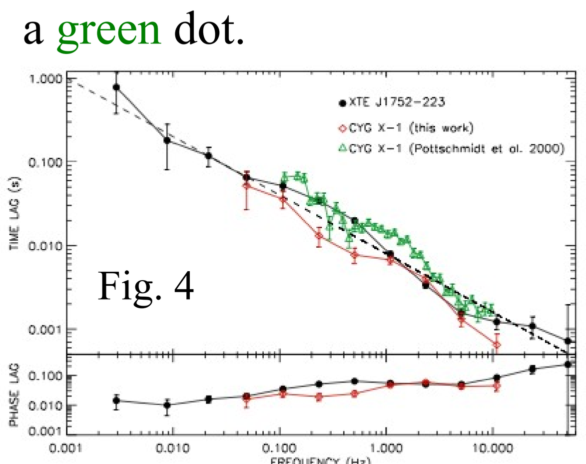
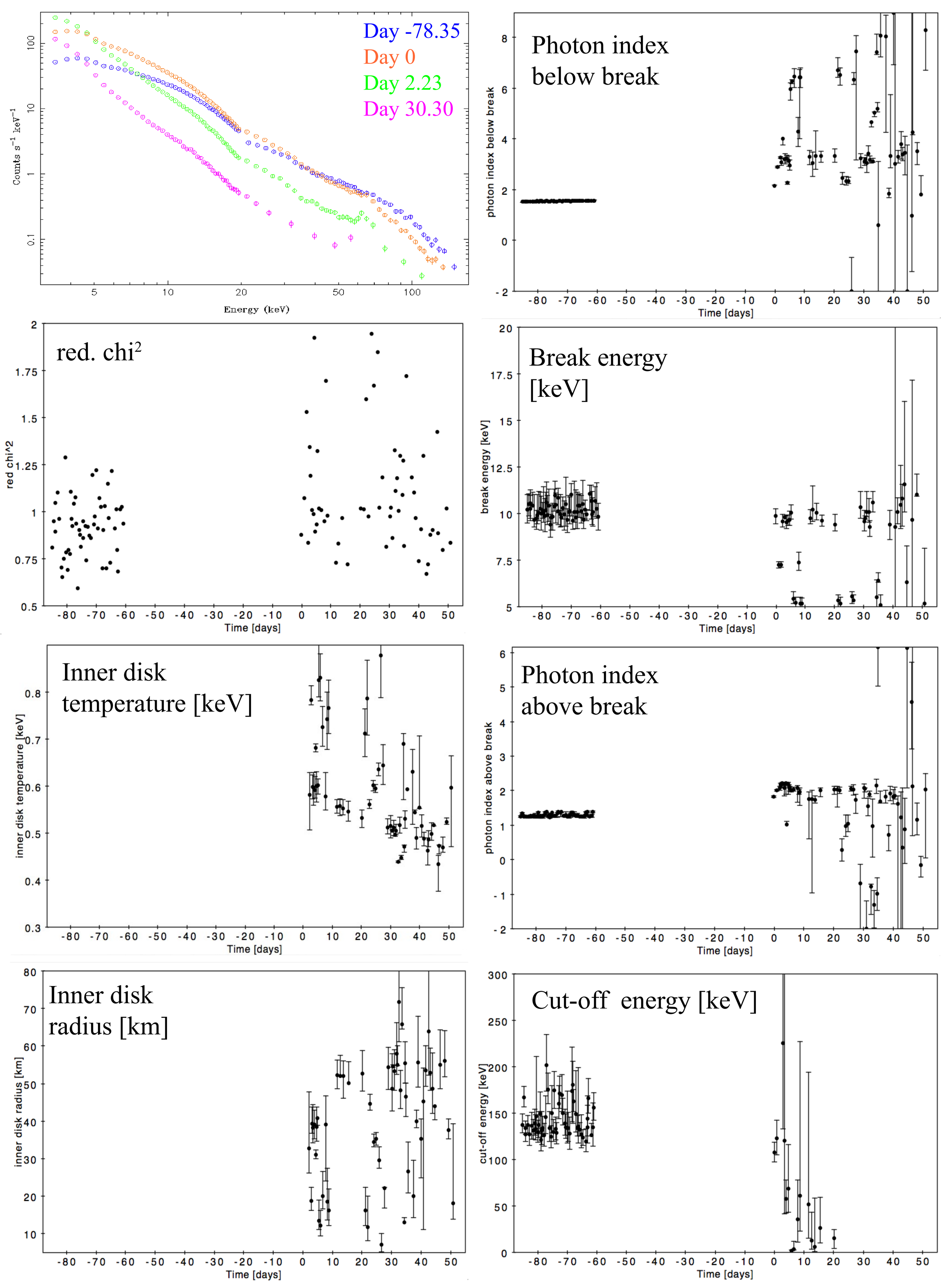


Figure 4 shows **time lag versus frequency** for XTE J1752-223 during the beginning of the LHS and for Cyg X-1. The dashed line gives the relation $\Delta t \sim \nu^{-0.7}$ previously observed in Cyg X-1. Bottom panel: corresponding phase legs. From Muñoz Darias et al. 2010a.

Spectral investigations of combined PCA and HEXTE data:

The **PCA/HEXTE spectra** were fit using an absorbed broken power law with a high energy cut-off. To account for the iron line at 6.4 keV a gaussian was added. From day 2 onwards an additional disk blackbody model was needed, representing the emission of the soft X-ray disk surrounding the black hole. The foreground absorption was fixed at N_H= 0.72 x 10^{22} cm^{-2} (Muñoz Darias et al. 2010a, MNRAS, 404, L94). The spectral fitting was done with ISIS. In the uppermost left image four different spectra representing the LHS, onset of the HIMS, onset off the SIMS, and HSS are shown. The remaining plots show the temporal evolution of individual spectral parameters (inner disc temperature and radius, photon index below and above the break energy, the break energy itself as well as the cut-off energy). To derive the inner disc radius a distance of 3.5 kpc and an inclination of 70º were assumed. It is evident, that the high energy cutoff is not well constraint in the HSS. The spectral components during the LHS are very similar to those of Cyg-X1.

The larger scatter in reduced chi^2 after day 0, originates from the fact that HEXTE detectors have stopped rocking, which leads to some uncertainties in the background determination. We already tried to take background offsets and additional residuals into account during fitting. Nevertheless, observations that show still red chi^2 >2, due to background issues, were excluded from further investigations. We want to mention once more that we also investigate the high energy range above ~45 keV compared to Shaposhnikov et al. 2010 (arXiv1008.0597) which focus only on PCA data.



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