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Color-Color diagrams of Z and Atoll sources observed with INTEGRAL/JEM-X

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Disc-accreting neutron stars come in two distinct varieties, Atoll and the Z sources, so named after their differently shaped tracks in their color-color diagrams. Using JEM-X (both units 1 and 2) public data from the INTEGRAL archive we produced long-time color-color diagrams (CCDs) for a sample of 4 Z and 4 Atoll sources.Our data cover a three years monitoring period from 2002 December to August 2005. We also compare also our results with the previous ones found with PCA/RXTE.

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1. Introduction

Low-mass X-ray binaries (LMXBs) hosting a neutron star can be divided in two classes, Z and Atoll sources based on the patterns that they trace in the color-color and color-intensity diagrams (CCD and HID respectively) (Hasinger & Van der Klis 1989). In a plot of soft color against hard color of a Z source the shape is, as inferred from its name, Z-like and the whole pattern is traced on timescale of hours to few days. The typical atoll shape in a CCD or HID is a region similar at an atoll that is divided in two different region: island and banana, the pattern begin traced on timescale of weeks/months. In this work we examine, using public data from the INTEGRAL archive, the changes in CCD and HID diagrams in 8 sources belonging to both classes and we compare our results with those reported by Muno et al. 2002 (hereafter, M02) related to the same sources, seen in the epoch 1996 - 2001 with PCA/RXTE. From ISDC data archive we analyzed all public JEM-X data in the period from 2002 December to 2005 August. We define Soft Color (SC) and Hard Color (HC) respectively as the ratios C(5-10 keV)/C(3-5 keV) and C(10-20 keV)/ C(5-10 keV), where C is the count rate in the mentioned energy bands.

In the PCA/RXTE observations the CCDs were derived in similar bands for the HC C(8.6-18keV)/ C(5-8.6keV)and in different bands for the SC, C(3.6-5keV)/ C(2.2-3.6keV). As observed by M02, the distinction between Z and Atoll was not so clear and they presuppose that a unification of the two classes was possible. They find that atoll sources, where the variation of intensity (in the band 2.2-18) was higher ($\gtrsim 10$), trace three branched in the CCDs in a similar way of classical Z sources. However, these sources traces their Z-shape on timescale of a few weeks typical of classical atoll sources.

2. Results on Z-sources

Z track of Cyg X-2, GX 340+0, GX 5-1 and GX 17+2 (see Fig.1 and Fig.2) is well known to be Z shaped (see also PCA results). The JEM-X CCDs we do not reveal the full Z-shape, but apparently only the normal branch. The reason for that cannot be the integration time of our data points (1800 sec vs. 64 sec in the case of PCA results), given that the sources track its diagram in time scale of 1 day. On the contrary we attribute the different diagrams observed with JEM-X to the different energy bands of the SC: in our case we are not sensitive to the low energy part (< 3keV) of the source spectrum. In this energy band the blackbody component is more relevant. If the BB temperature can be reasonably considered almost constant, it appears that the major contribution to the SC_{pca} variation is due to the intrinsic absorption of the material.

With this assumption we can suppose some kind of correlation between the variation of intrinsic absorption and orbital period. We cannot exclude however that the lower sensitivity of JEM-X and/or the times of the source sampling can have contributed to our results.

3. Results on Atoll-sources

4U 1705-440: the source shows (Fig.3) two distinct regions, in agreement with PCA results.

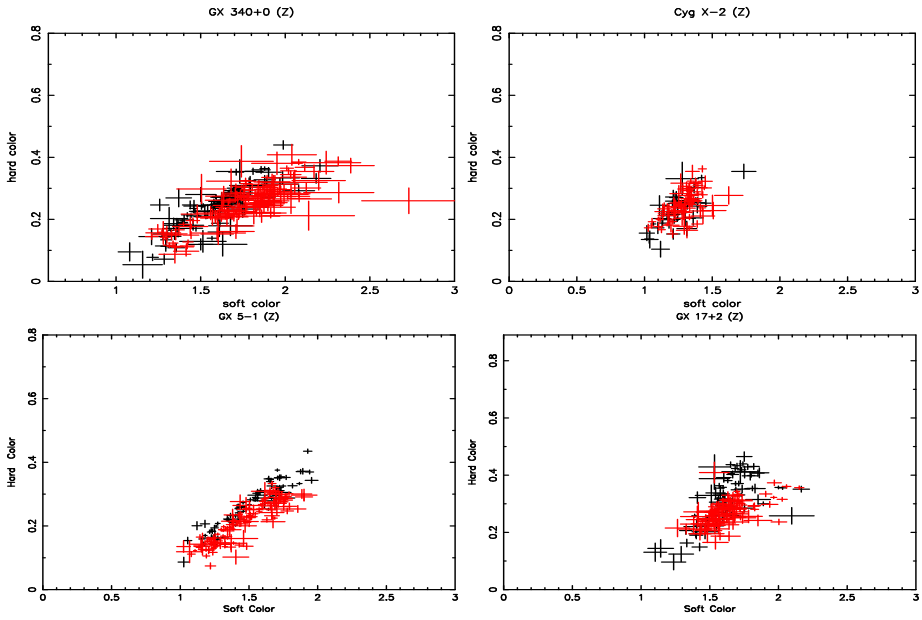

Figure 1: JEM-X/CCD of the four Z sources analyzed in this work. Each point corresponds to a bin time of $\sim$ 1800 sec.

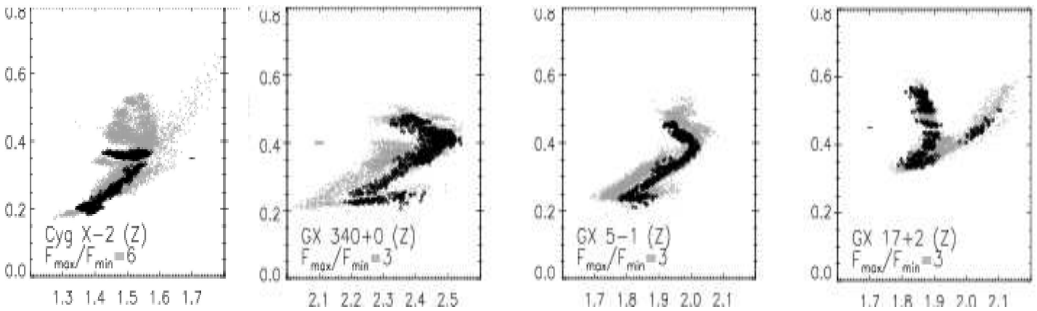

Figure 2: RXTE/PCA CCDs of the Z sources reported in Fig.1

These regions could be interpreted as top and bottom portions of an hypothetic Z-shape, as proposed by M02.

4U 1728-34 (GX 354-0): only an elongated track is visible, unlike the shape observed with the PCA observations which was interpreted in M02 as a Z track without the horizontal branch. We cannot confirm the same results.

Ser X-1 and GS 1826-24: they show similar results to those found with PCA, but we cannot suggest the interpretation in terms of a Z-like scenario in which are only observed the flaring or the horizontal branch, respectively. Indeed it should be very strange that in a data run that spans 10 years, never the source is observed in the normal branch which is the most probable state.

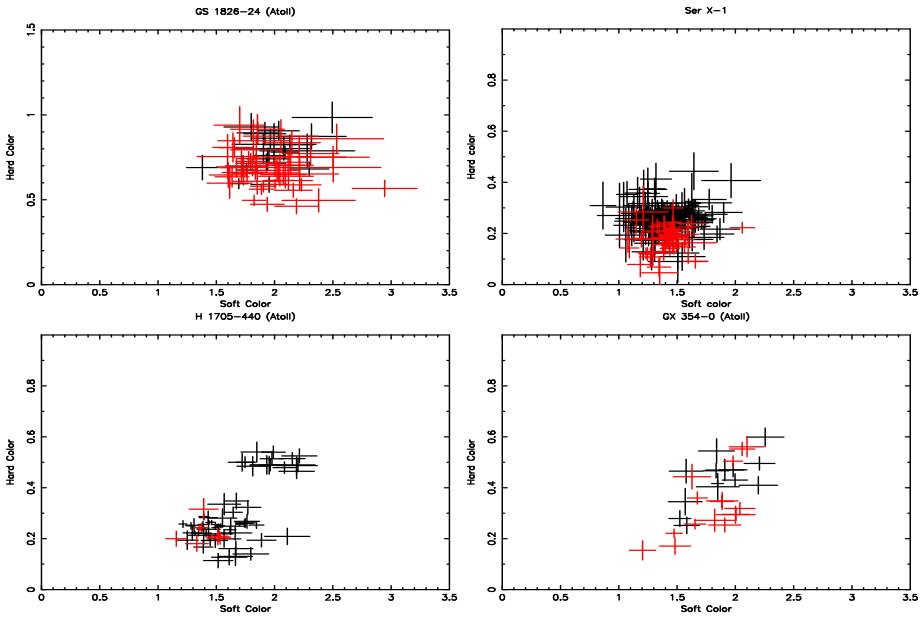

Figure 3: JEM-X/CCDs of the four Atoll sources analyzed in this work. Each point corresponds to a bin time of $\sim$ 1800 sec.

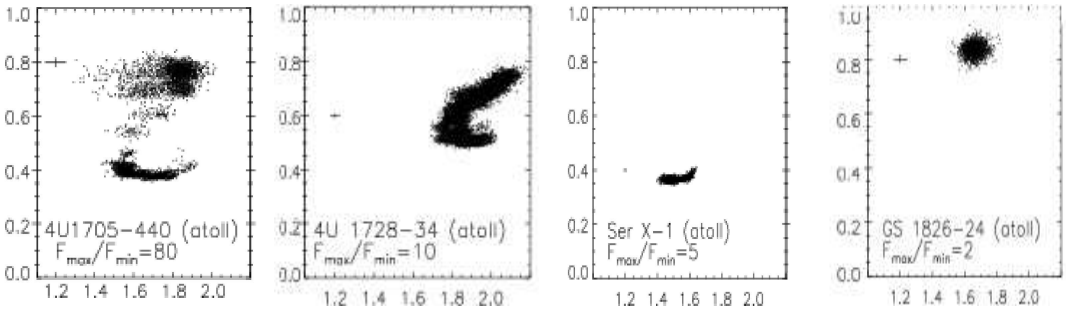

Figure 4: RXTE/PCA CCDs of the atoll sources reported in Fig.3.

4. Conclusions

We examined the changes in the CCD and HID from 4 Z sources and 4 atoll sources with public data from INTEGRAL archive. We cannot fully confirm the results obtained by M02 with the PCA on the same sample of sources. One reason for that could be the lower JEM-X sensitivity. The error bars on data points indeed may be large enough to partially cover the source features in the CCDs (compare Fig.1 and Fig.3 with Fig.2 and Fig.4). A second possibility (even additional), as discussed in Section 1.1, can be due to the different definition of the SC, which could not map, in the JEM-X case, the low-energy source changes (intrinsic or due to absorption) responsable for the observed results with PCA.

References

[Muno et al. 2002] Muno, M. P., Remillard, R. A., Chakrabarty, D., 2002, ApJ, 568, L35-L39.

[Gierlinski et al. 2002] Gierlinski, M., Done, C., 2002, MNRAS, 331, L47-L50 .

[Hasinger & Van der Klis, 1989] Hasinger & Van der Klis, 1989 A&A, 225, 79-96.