Observations of X-ray binaries with very-faint luminosity

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Introduction

The improvement of sensitivity of the last generation of X-ray detectors makes a significant number of very faint X-ray binaries with typical luminosities of 1E34-1E36 erg/s to be detectable. Very faint X-ray binaries, whether transients or persistent, are probably a non-homogeneous class of sources. It is likely that a significant fraction are neutron stars (NS) and black holes (BH) accreting matter at very low rates (≤ 10^{-11} M_{sun}/yr) from low mass companion. It has been observed that ~1/3 of very faint X-ray transients exhibit type-I X-ray bursts, thus they can be identified as neutron star in low mass X-ray binary (see Del Santo et al. 2007b, Degenaar & Wijnands 2009 and ref. therein).

INTEGRAL and Swift Monitoring Campaign

In the framework of the INTEGRAL AO6, AO7 and AO8 Key-Programmes, we have obtained data rights of a sample of very faint X-ray binaries, being in the Galactic Centre and Galactic Plane. Thanks to the large field of view and observing programme, INTEGRAL offers the ``chance'' to catch new type-I X-ray bursts from faint X-ray binaries, as well as to detect faint hard-X ray steady emission at a level of few mCrab. Combination of the INTEGRAL observations with multi-wavelength follow-up, mainly with Swift (and/or XMM-Newton and Chandra), is crucial in unveiling the nature of very faint X-ray binaries and in better refining the global properties of this new class of sources. We present few results of our INTEGRAL and Swift monitoring campaigns.

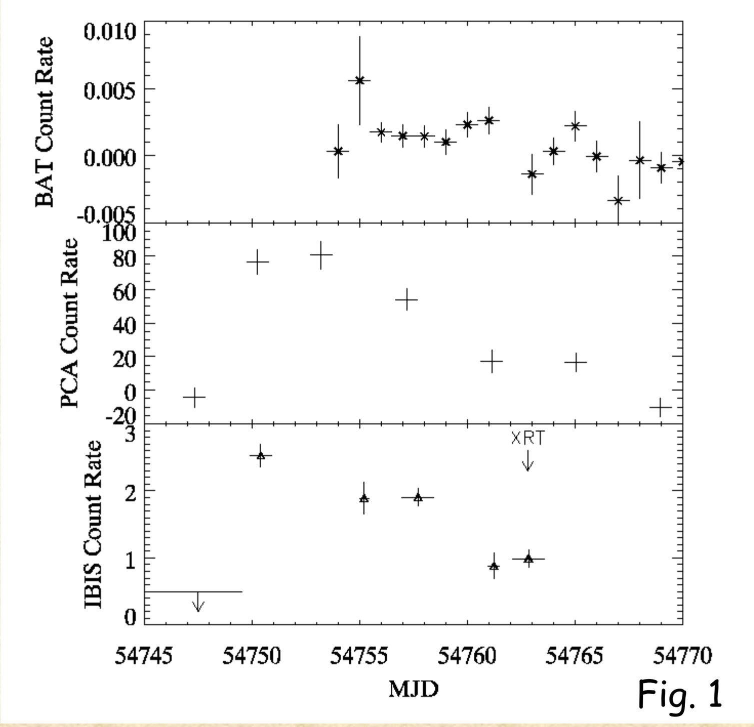

Fig. 1

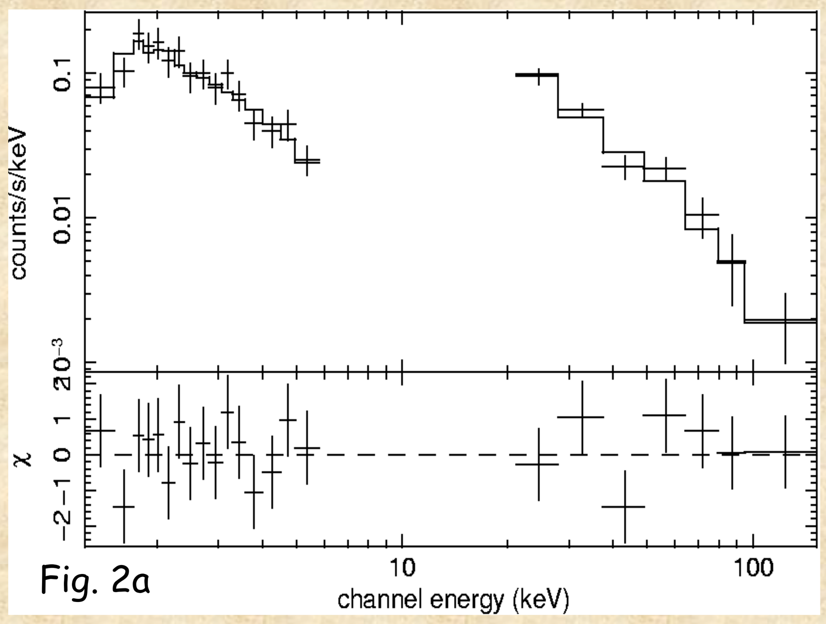

Fig. 2a

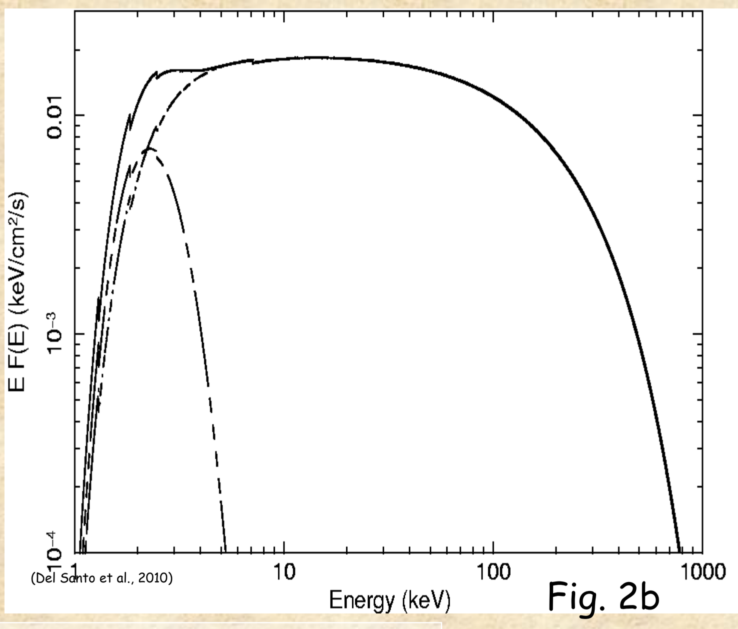

Fig. 2b

Model	N_H	kT_{BB}	Γ	E_c	kT_e	τ	χ^2_ν(dof)	F^a_{bol}
	10^{22} (cm^{-2})	(keV)		(keV)	(keV)			(erg cm^{-2} s^{-1})
POW	$2.2^{+0.5}_{-0.4}$	-	2.3 ± 0.3	-	-	-	0.91(19)	1.3×10^{-9}
BB+POW	$2.8^{+2.0}_{-1.0}$	$0.4^{+0.3}_{-0.1}$	2.1 ± 0.3	-			0.82(17)	5.6×10^{-10}
Comptt	1.9±0.4	-	-	-	> 24	$0.2^{+1.3}_{-0.1}$	1.07(18)	1.1×10^{-9}
BB+Comptt	$2.7^{+2.0}_{-1.0}$	$0.4^{+0.3}_{-0.2}$	-	-	> 17	$0.8^{+2.2}_{-0.6}$	0.86(16)	6.3×10^{-10}

$L_{2\text{-}10keV}$= 1.3×10^{36} erg/s L_{acc}= 4.3×10^{36} erg/sM_{dot} =6.7×10^{-10} M_{sun} yr^{-1}

Unveiling the hard X-ray spectrum from SAX J1753.5-2349 in outburst (Del Santo et al., 2010, MNRAS, 403, L89)

In 1996 SAX J1753.5-2349 was discovered by BeppoSAX during a type-I burst event (in't Zand et al. 1998). Since it was not detected any steady emission, this source was classified as "burst-only". A number of burst-only were detected by BeppoSAX (Cornelisse et al 2004): the persistent emission luminosity of this class was of sure lower than 1E36 erg/s (Wide Field Camera sensitivity). In 2008 October, RXTE/PCA, Swift/BAT and INTEGRAL/IBIS detected an outburst from SAX J1753.5-2349 (Markwardt et al. 2008; Cadol Bel et al. 2008; Fig. 1). Combining IBIS and XRT data, we have obtained for the first time the broad-band spectrum of the steady emission (Fig. 2a and 2b; Del Santo et al. 2010). SAX J1753.5-2349 is a hybrid system, displaying very-faint (L_{peak}< 10^{36} erg/s) as well as faint (L_{peak}~ $10^{36\text{-}37}$ erg/s) outbursts, such as AX J1745.6-2901 and GRS 1741.9-2853 (Degenaar & Wijnands 2009). According with King (2000), we proposed SAX J1753.5-2349 as accreting NS in a very-compact system (P_{orb}<80 min).

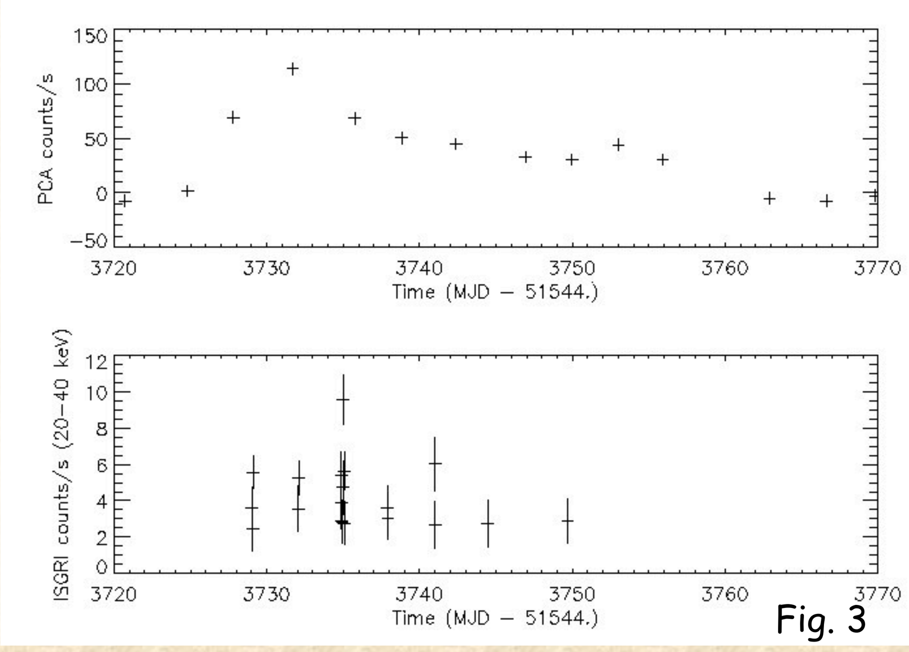

Fig. 3

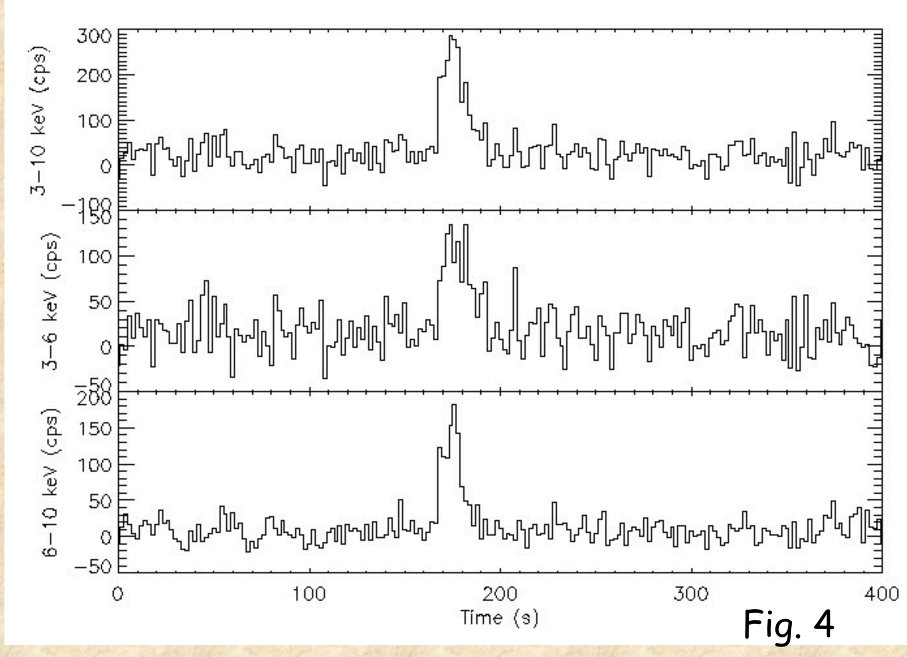

Fig. 4

The 2010 SAX J1753.5-2349 outburst (De Cesare et al. in prep)

In March 2010 SAX J1753.5-2349 was again in outburst and detected in hard X-rays (PCA/RXTE and IBIS/INTEGRAL light-curve in fig. 3). JEM-X/INTEGRAL telescope detected a type-I X-ray burst / (Atel #2505). This event lasted about 20 s. The Light curve is plotted with a bin size of 2 seconds (fig. 4).

First hard X-ray detection of the SAX J1806.5-2215 (Del Santo et al. in prep)

On 2011 March 6th, in the framework of the INTEGRAL observations of the Galactic Inner Disc, we obtained the first hard X-ray detection up to 70 keV of the "burst-only" SAX J1806.5-2215 (in 't Zand et al. 1998, NuPhS 69, 228) at a level of about 20 mCrab (Atel #3210). The estimated fluxes were 3.8E-10 erg/cm^2/s in 2-10 keV and 3.2E-10 erg/cm^2/s in 20-80 keV. For a distance of 8 kpc (the upper limit reported in Cornelisse et al. 2002, A&A 392, 931), this translates into a 2-10 keV luminosity of ~3E36 erg s-1. We have triggered a Swift/XRT monitoring campaign which is on-going since the source ist still in outburst (XRT light-curve in fig. 5).

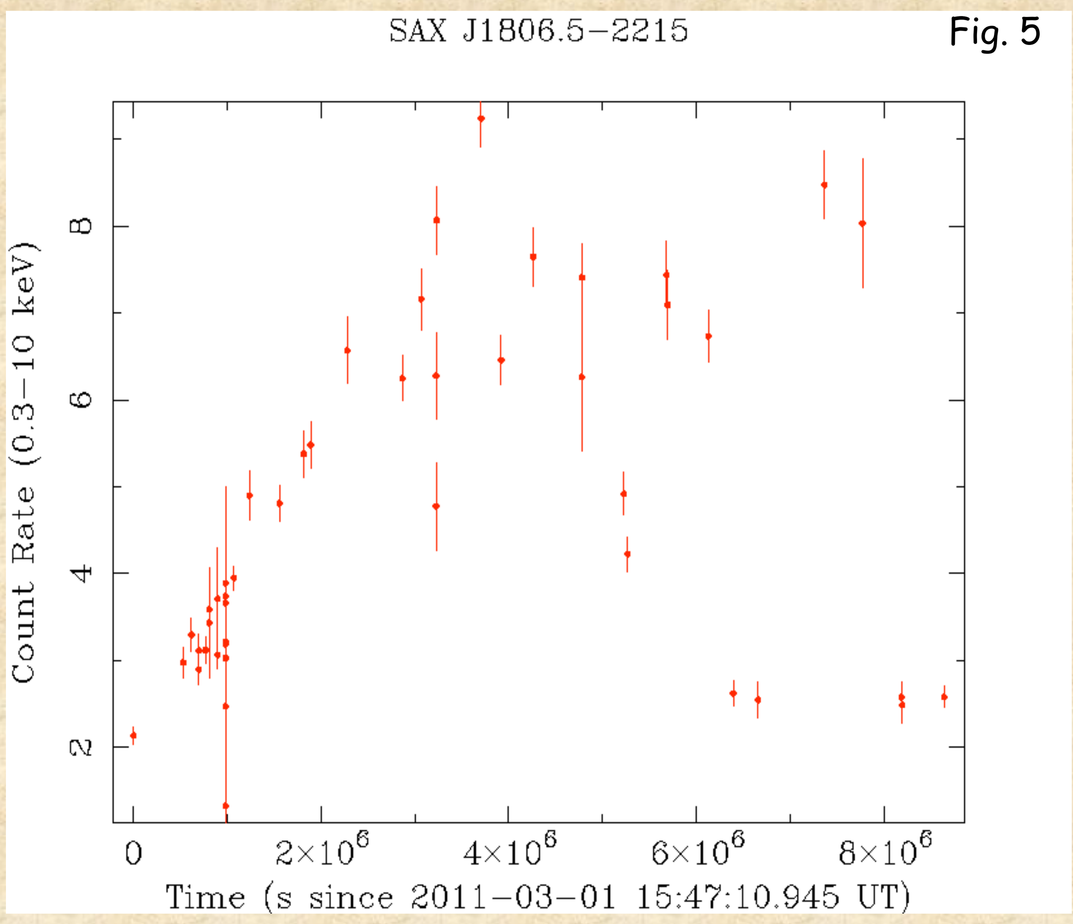

Fig. 5

Unveiling the nature of XMMU J174716.1-281048 (Del Santo et al. 2007, A&A, 468, L17)

- ✓ Type-I X-ray burst caught by JEM-X monitor on board INTEGRAL satellite. The double-peaked profile is signature of an Eddington limited burst (Fig. 6). The bolometric peak flux is 5 x 10^{-8} cgs. Assuming the Eddington luminosity as 3.8×10^{38} erg/s (Kulkeers et al. 2003) we estimate a **distance of ~8 kpc** (Del Santo et al. 2007a).
- ✓ XMM-Newton revealed the transient nature of the source (Fig. 7).
- ✓From α=(L_{pers}xt_{rec})/(L_{burst}xt_{decay}) ~ 40÷100 (Strohmayer & Bildsten 2006) and L_{pers}~10^{34} erg/s it results in a long recurrence time, **t_{rec} ~ 3-8 yrs** (Del Santo et al. 2007b).

We proposed the source as the first quasi-persistent VFXT

- ✓the Swift long monitoring campaign has been confirmed that the system is undergoing a prolonged accretion episode of many years (Fig. 8).

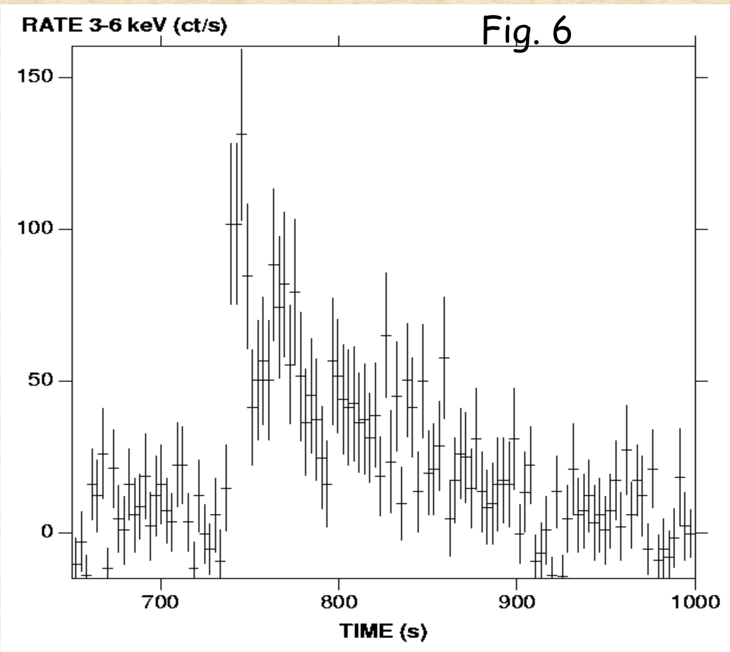

Fig. 6

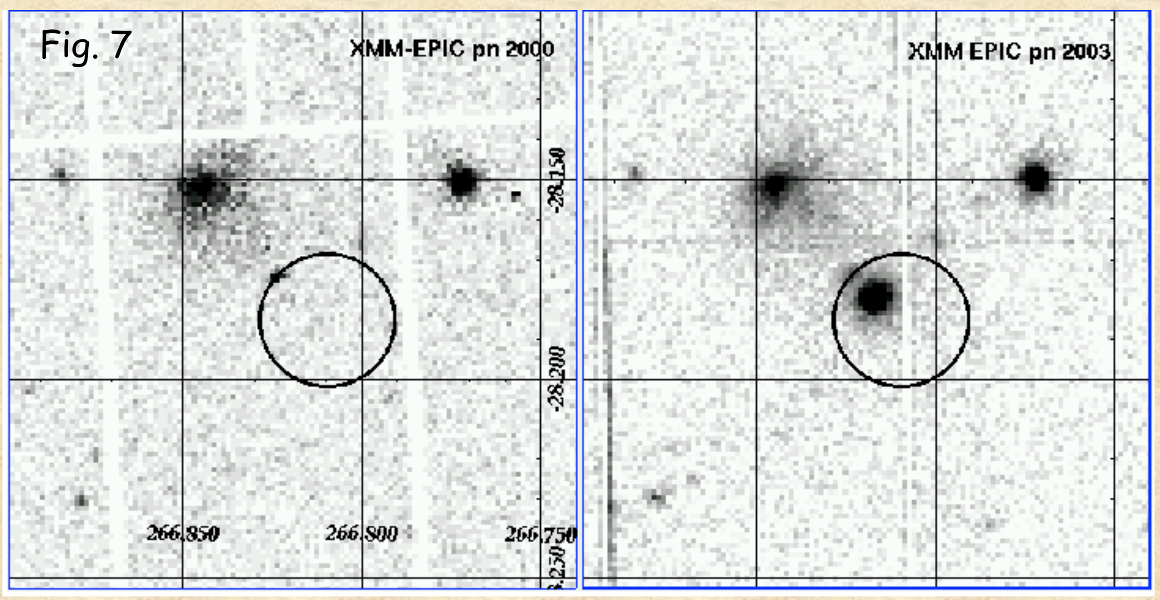

Fig. 7

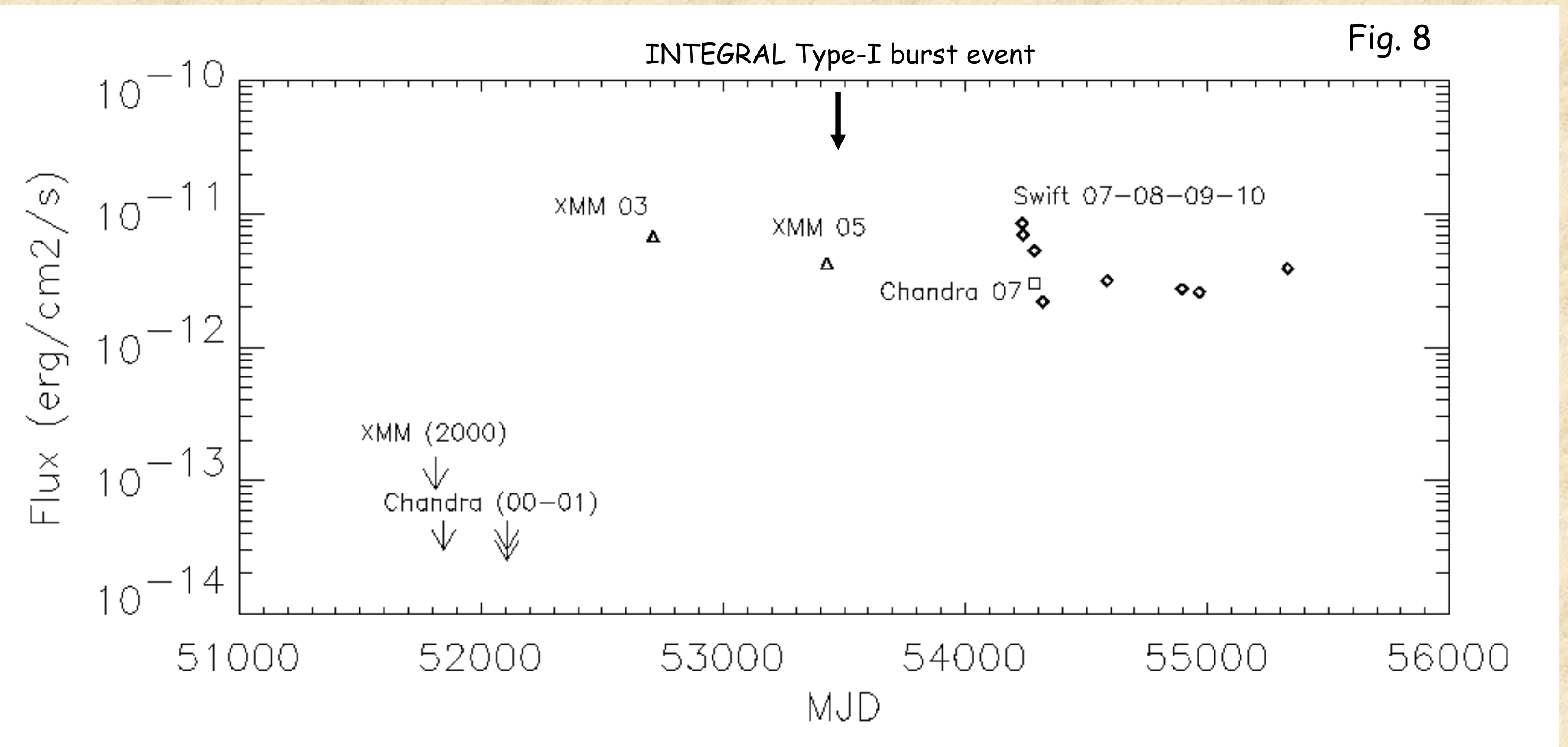

Fig. 8

References

Cornelisse et al. 2004, Nucl. Phys. B, 132, 518; Cadol Bel et al. 2008, Atel 1810; Cornelisse et al. 2004, Nucl. Phys., 132, 518; Del Santo et al., 2007a, ATel #1207; Del Santo et al. 2007b, A&A, 468, L17 ; Del Santo et al., 2010, MNRAS, 403, L89; in't Zand et al. 1998, Nucl. Phys. , 69, 228; Markwardt et al. 2008, ATel 1799; Kuulkers et al. 2003, A&A, 399, 663; Strohmayer, T. & Bildsten, L. 2006, Compact Stellar X-Ray Sources, eds. W.H.G. Lewin and M. van der Klis, Cambridge University Press; Wijnands et al. 2006, A&A, 449, 1117; Degenaar et al. 2009, A&A, 495, 547