The wind structure in Supergiant Fast X-ray Transients: IGR J11215-5952

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General properties of SFXTs

By definition, a **SFXT** is a source with:

Transient *& "SHORT"* X-ray OUTBURSTS (biased def)
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OB supergiant companions

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Other properties:

Luminosity:

Lx outburst ~ 1E36 erg/s

Lx quiescence ~ 1E32 erg/s

-> high dynamic range ~ 1000-10000

Spectrum similar to typical accreting pulsars

0.1-10 keV – hard powerlaw

cut-off around 10-30 keV

IGR J11215-5952

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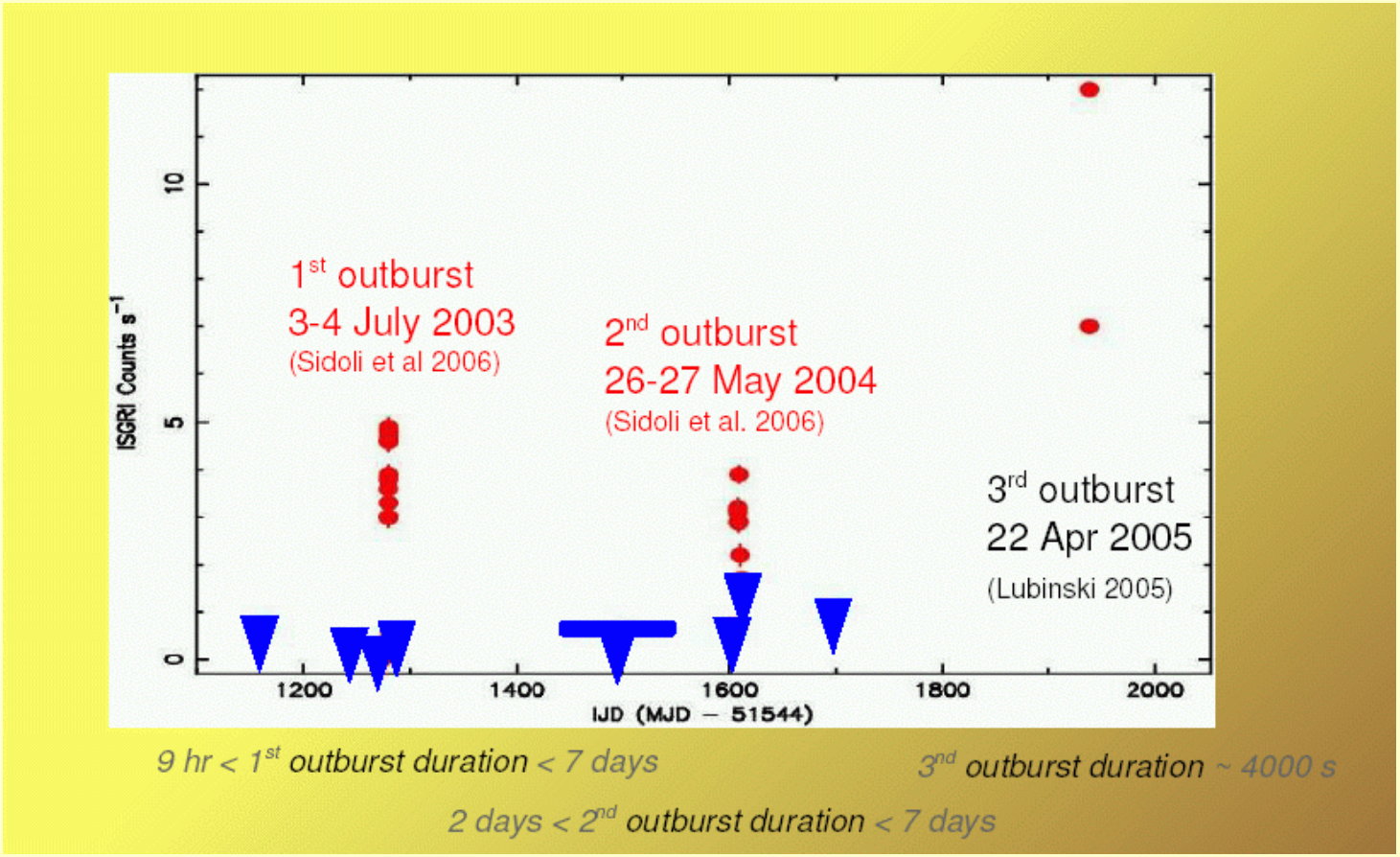
The unique SFXT with **periodic outbursts**, to date

IGR J11215-5952 lightcurve observed by **ISGRI** (17-40 keV)



outbursts every ~ 330 days

likely orbital period?
outbursts near periastron passage?

IGR J11215-5952

Outburst recurrence **period confirmed** with RXTE (**P=329 days**) in March 2006 (fourth outburst) (Smith et al. 2006, ATel 766, 773)

P pulse ~ 187 s (Smith et al. 2006, Swank et al. 2007, ATel999)

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Thanks to the **predictable** X-ray flaring activity,
we proposed a monitoring campaing with
Swift/XRT around the times of the new outburst,
expected on 2007 February 9 (Romano et al. 2007)

The monitoring campaign of IGR J11215-5952
during the fifth outburst expected on
2007 February 9
with Swift / XRT

This campaign benefits from the unique flexibility of Swift/XRT

ToO strategy:

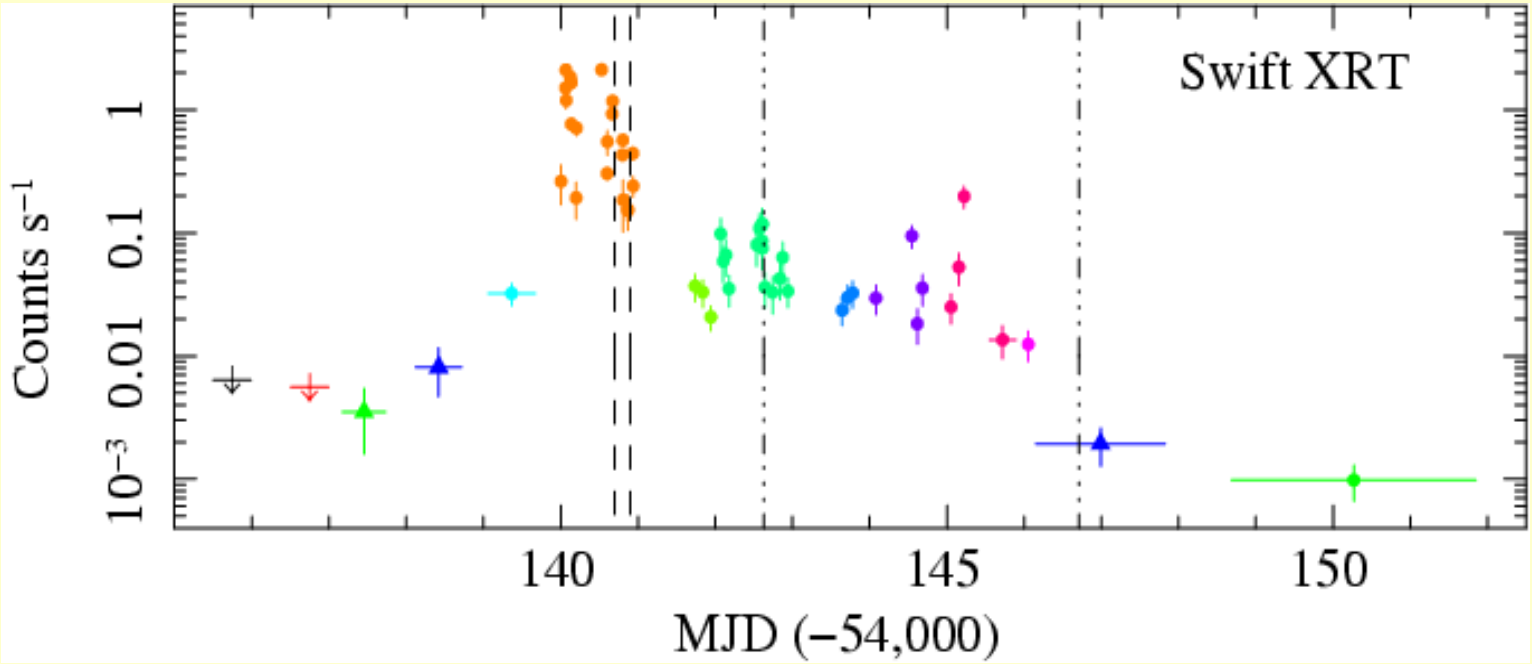
- 2 ks / day at the beginning (starting from 4th February)
- then exposure up to 10 ks / day during outburst,
if no GRB or other observations like, e.g., ToOs

- Monitoring end planned for 14th February (actually, IGR11215 was kindly observed up to 26th February to follow the whole outburst)

- Thanks to Neil Gehrels and to all the Swift Team, duty scientists and science planners

(Romano, Sidoli, Mangano et al. 2007)

Swift / XRT observations of ***IGR J11215-5952: Feb 2007 outburst***



9th February 2007

Romano et al. 2007

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Important results:

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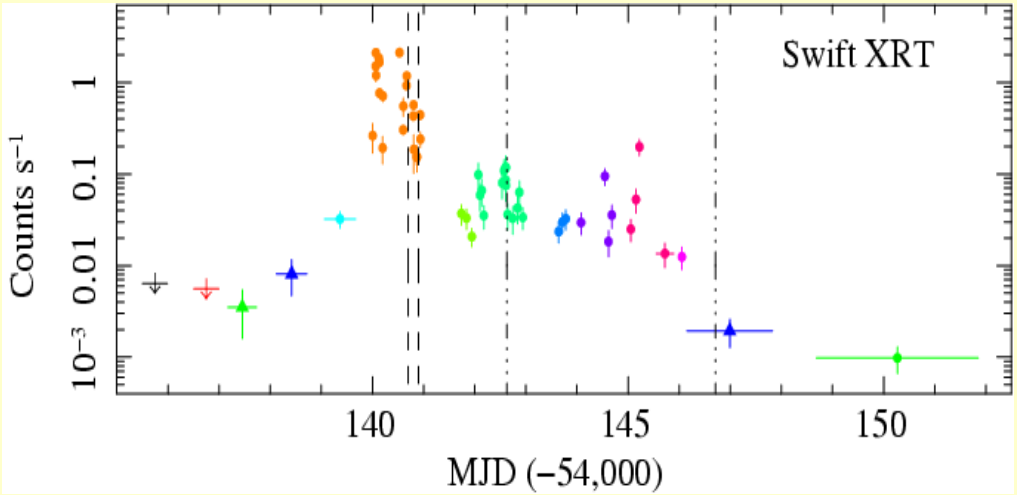

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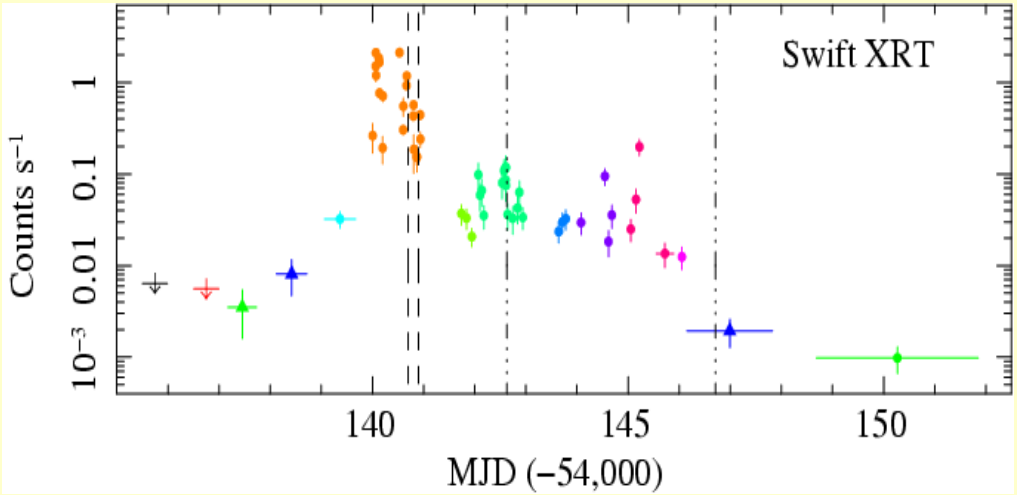

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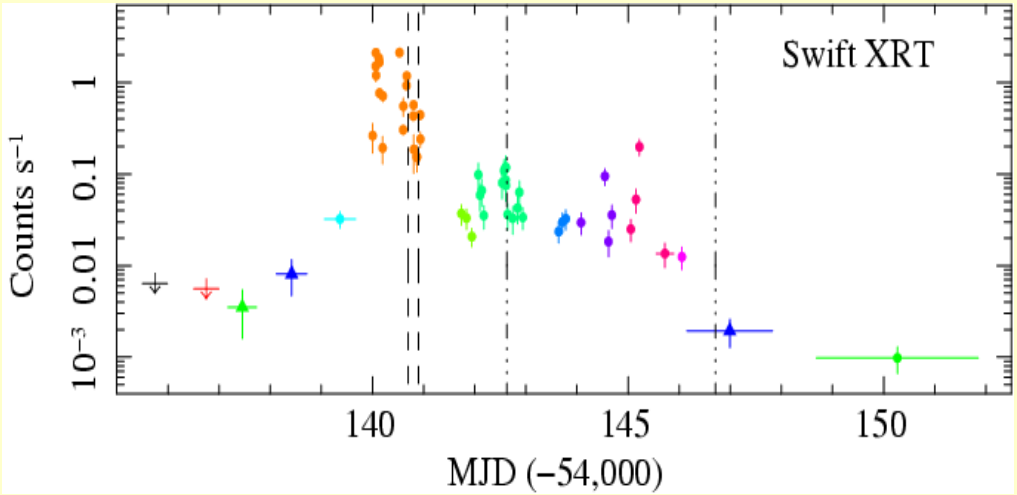

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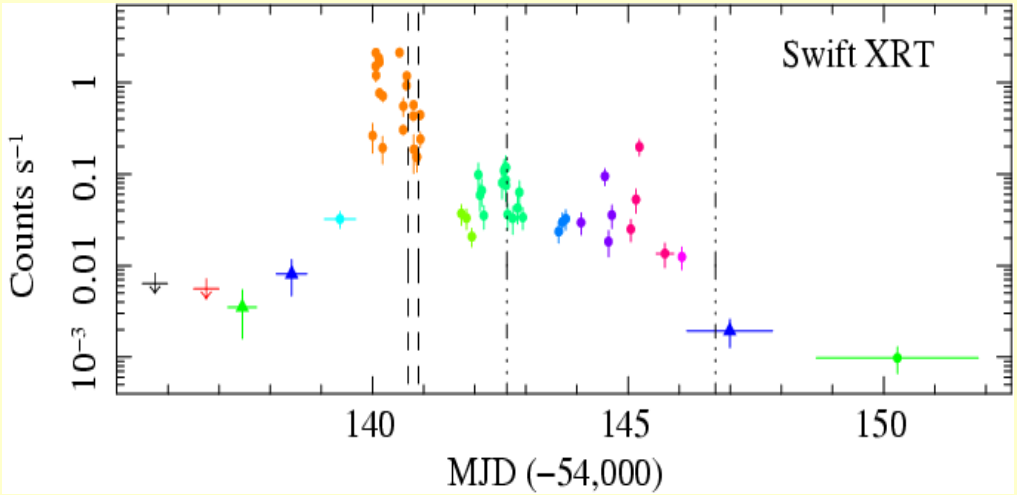

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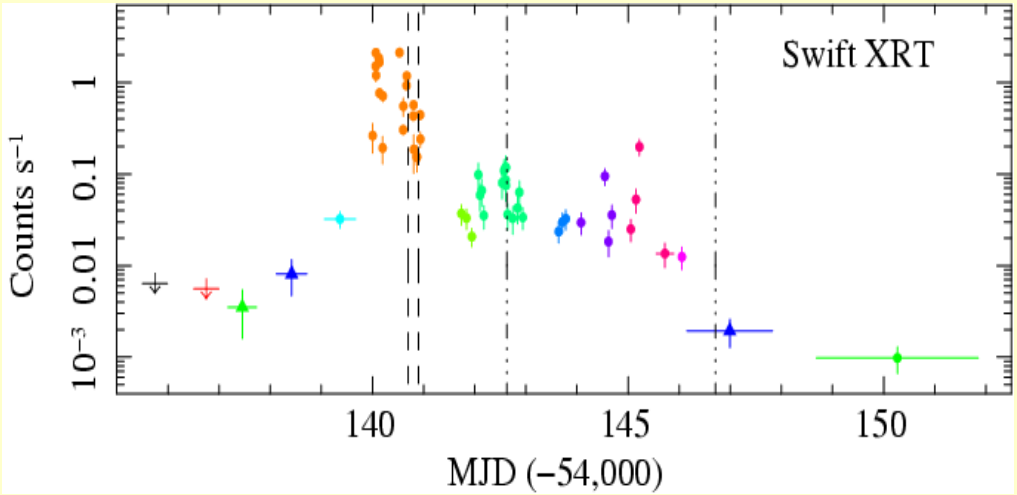
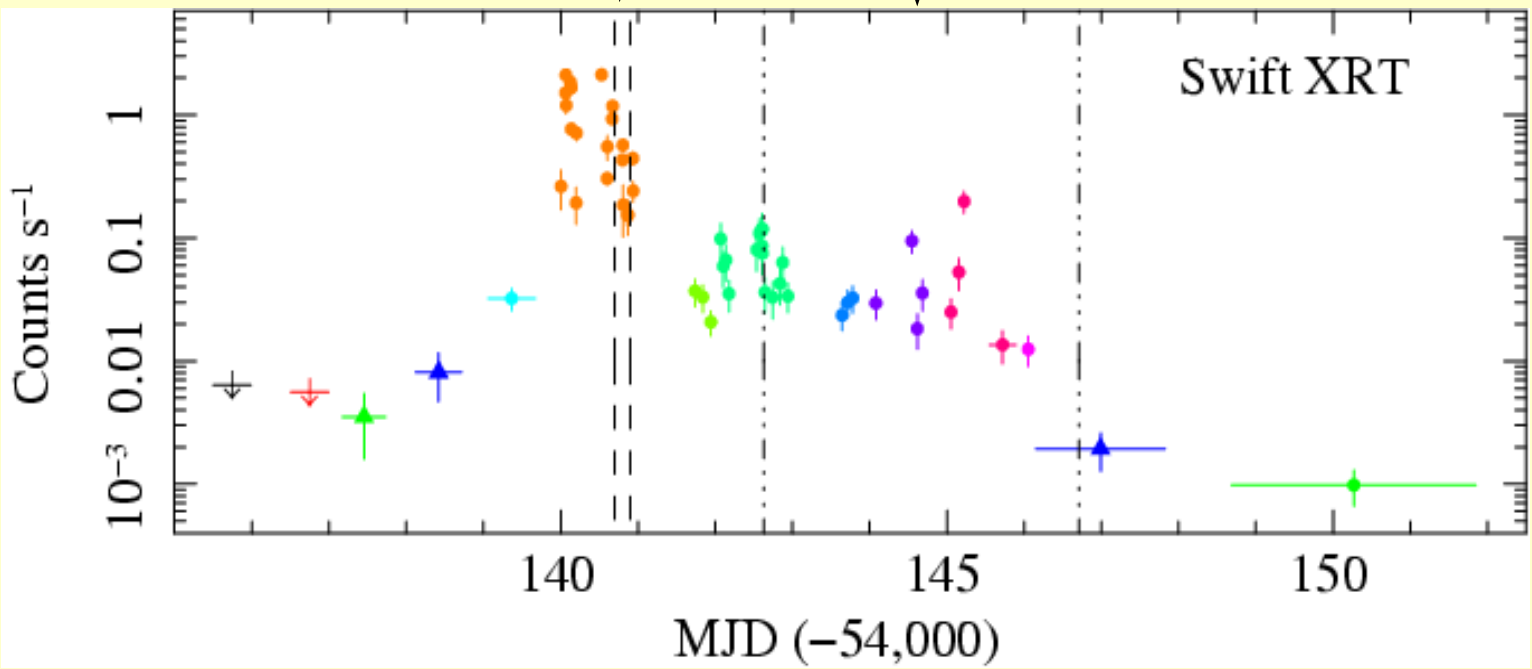
5)- more important.....the SHAPE of the lightcurve is telling us something ...



Swift / XRT observations of IGR J11215-5952 allowed us to trigger XMM-Newton and INTEGRAL

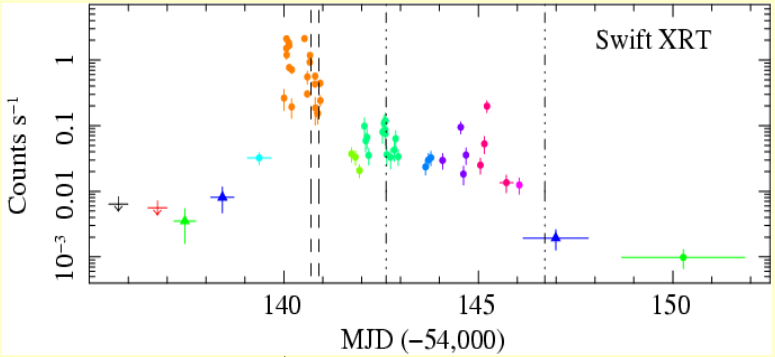
XMM-Newton ToO **INTEGRAL ToO:** the source was not detected

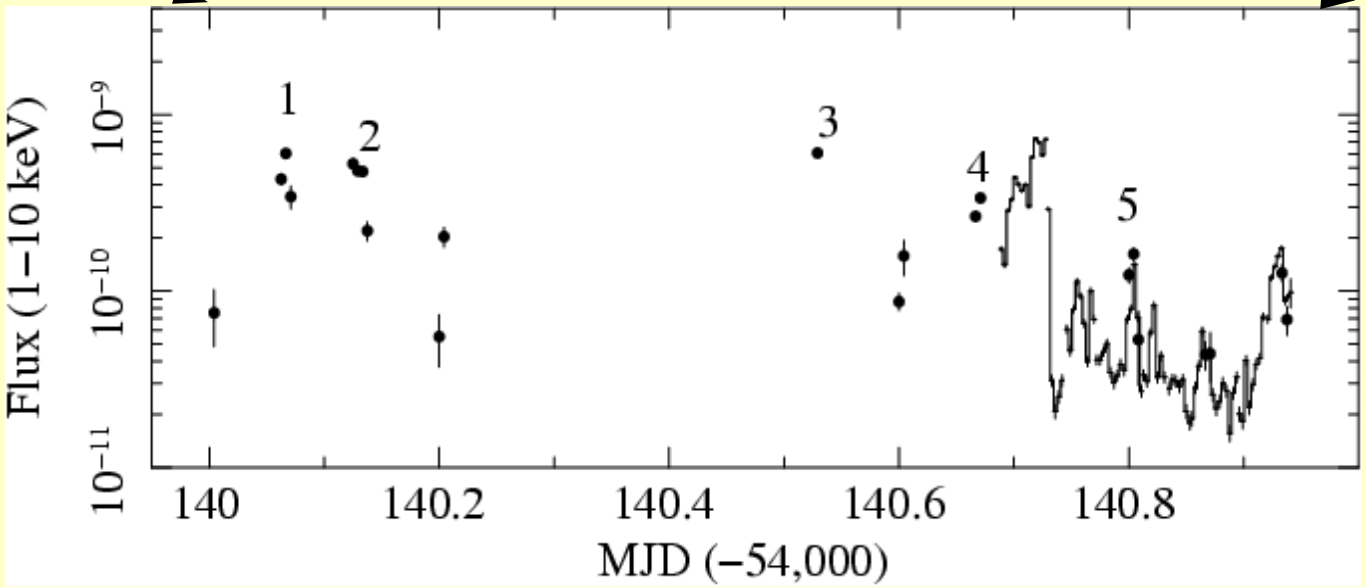


9th February 2007

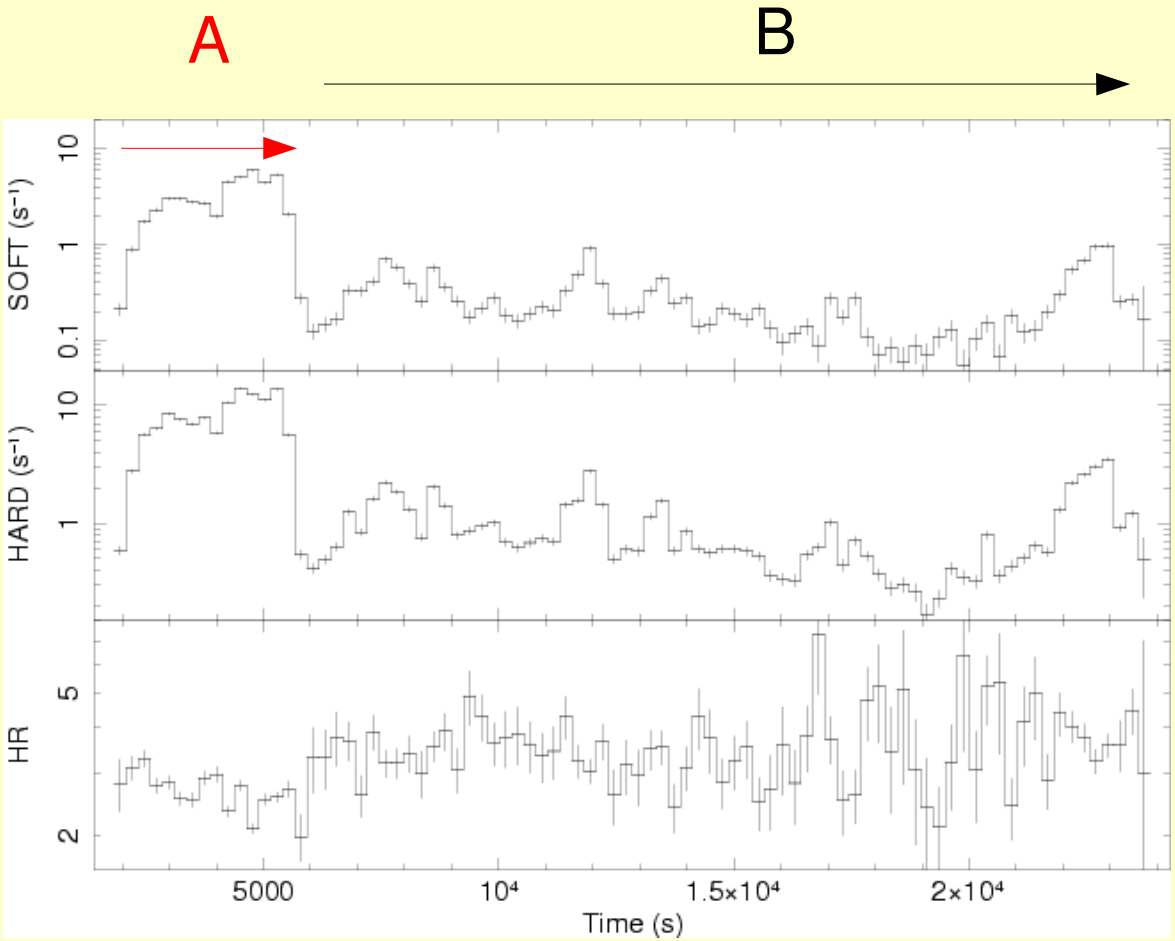
Romano et al. 2007

XMM-Newton ToO





XMM-Newton ToO on IGRJ11215-5952

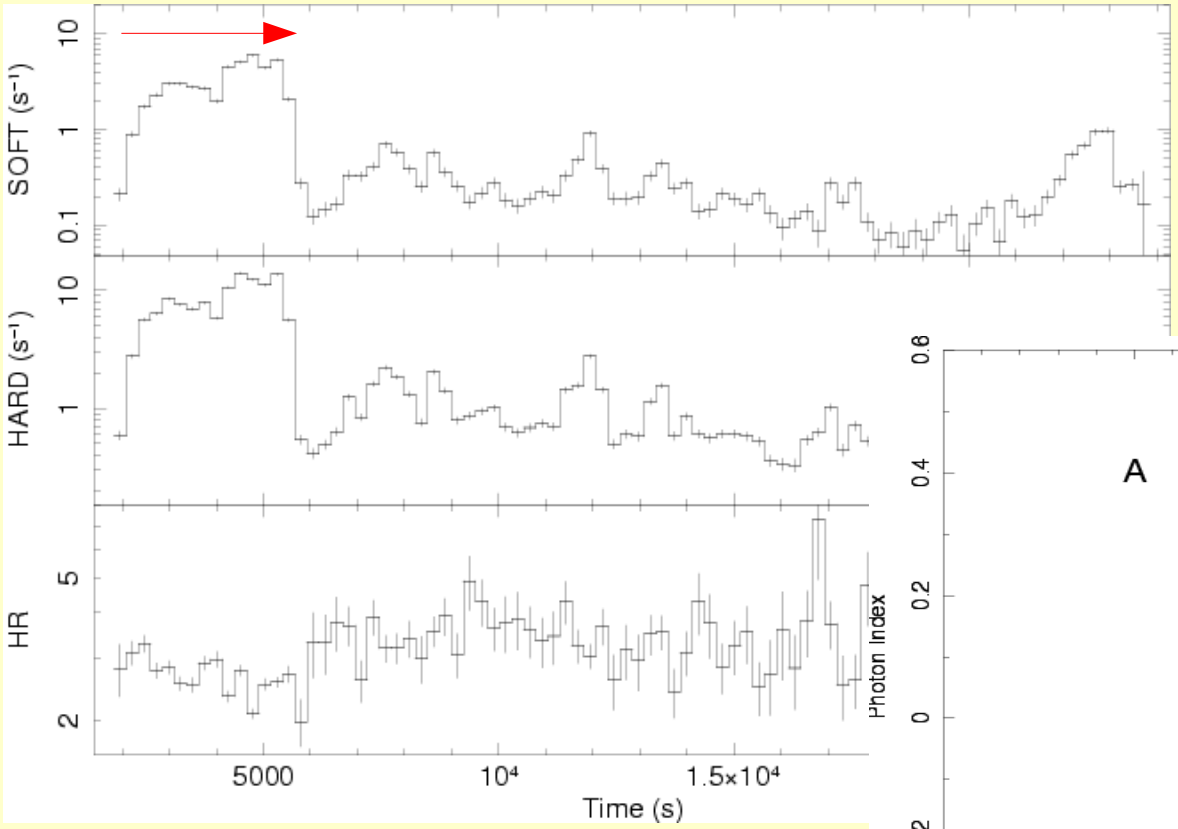


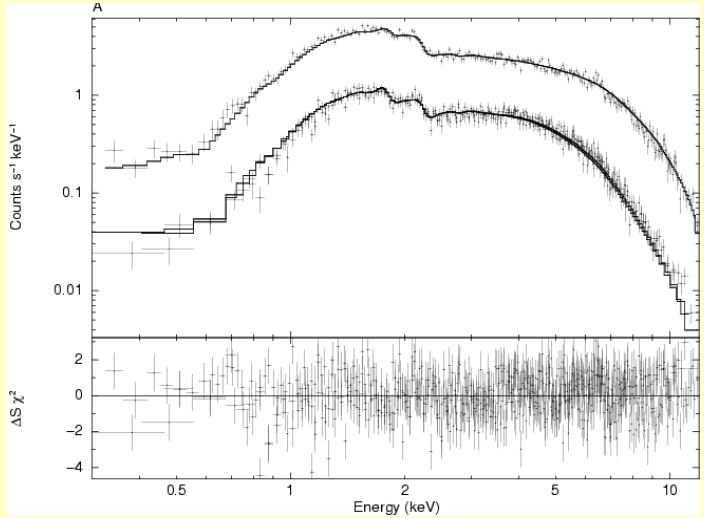
XMM-Newton ToO on IGRJ11215-5952

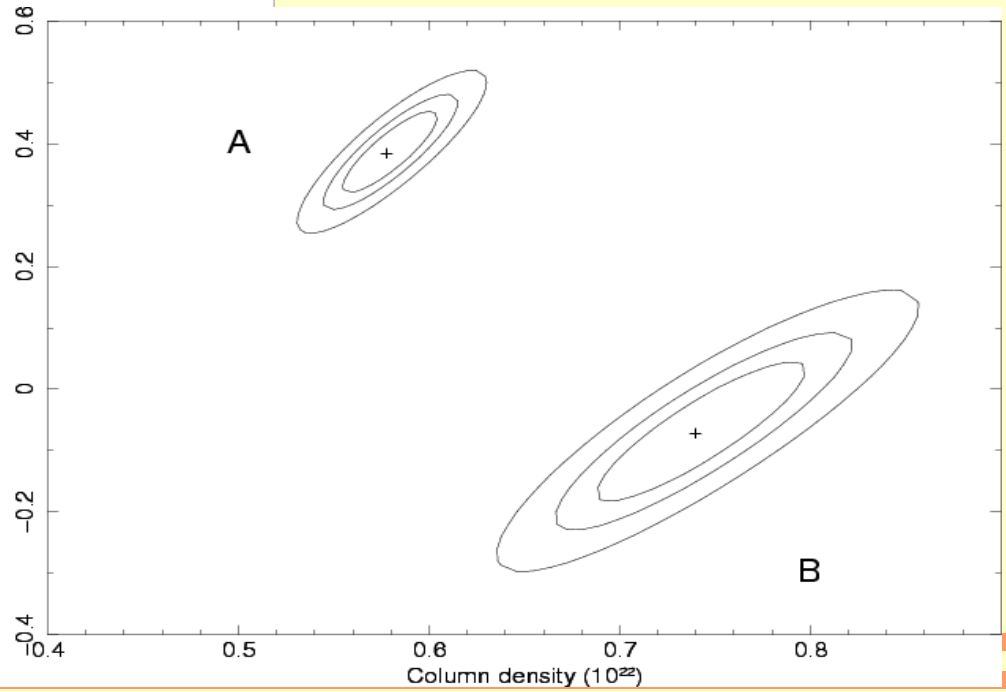
A

1 hour flare

B







Fit with an absorbed cut-off powerlaw

A new Swift/XRT campaign

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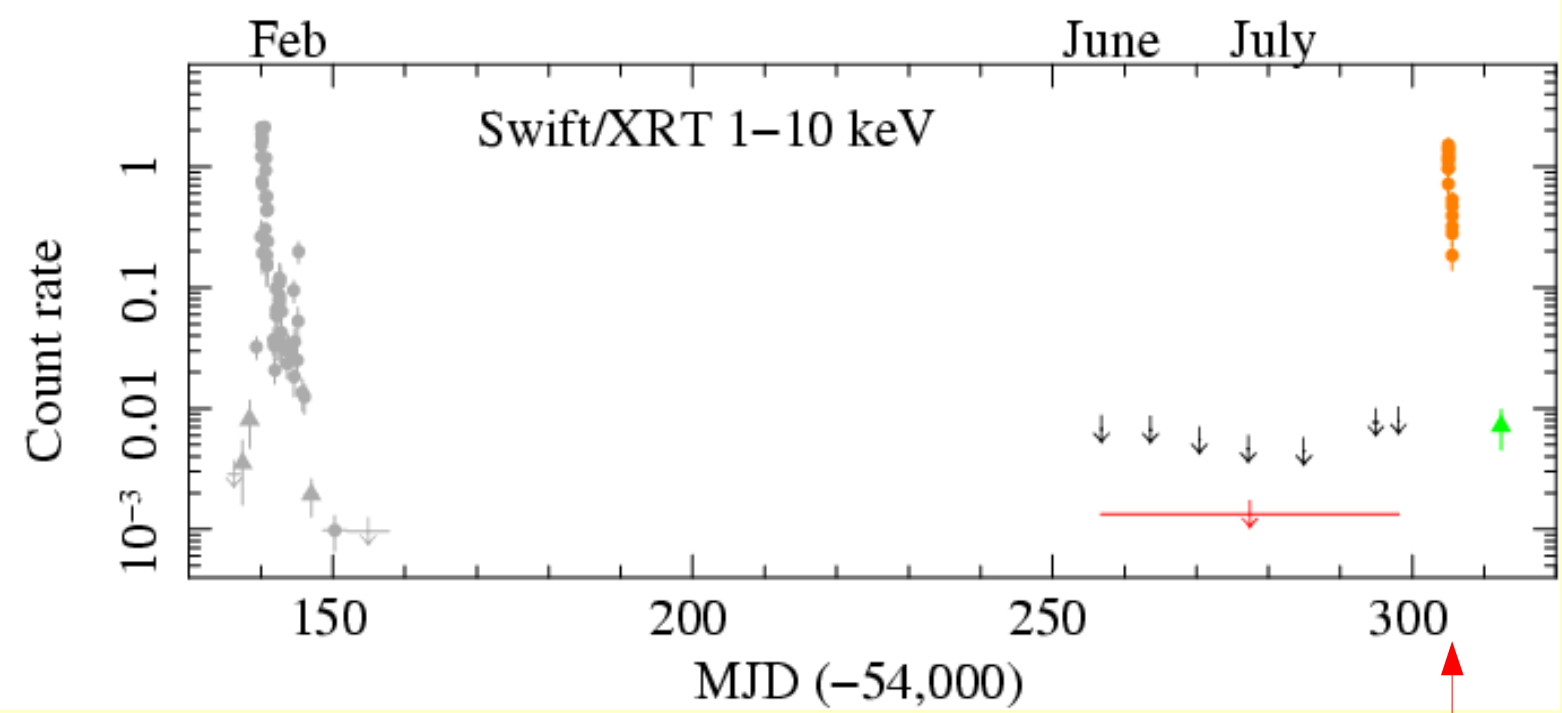
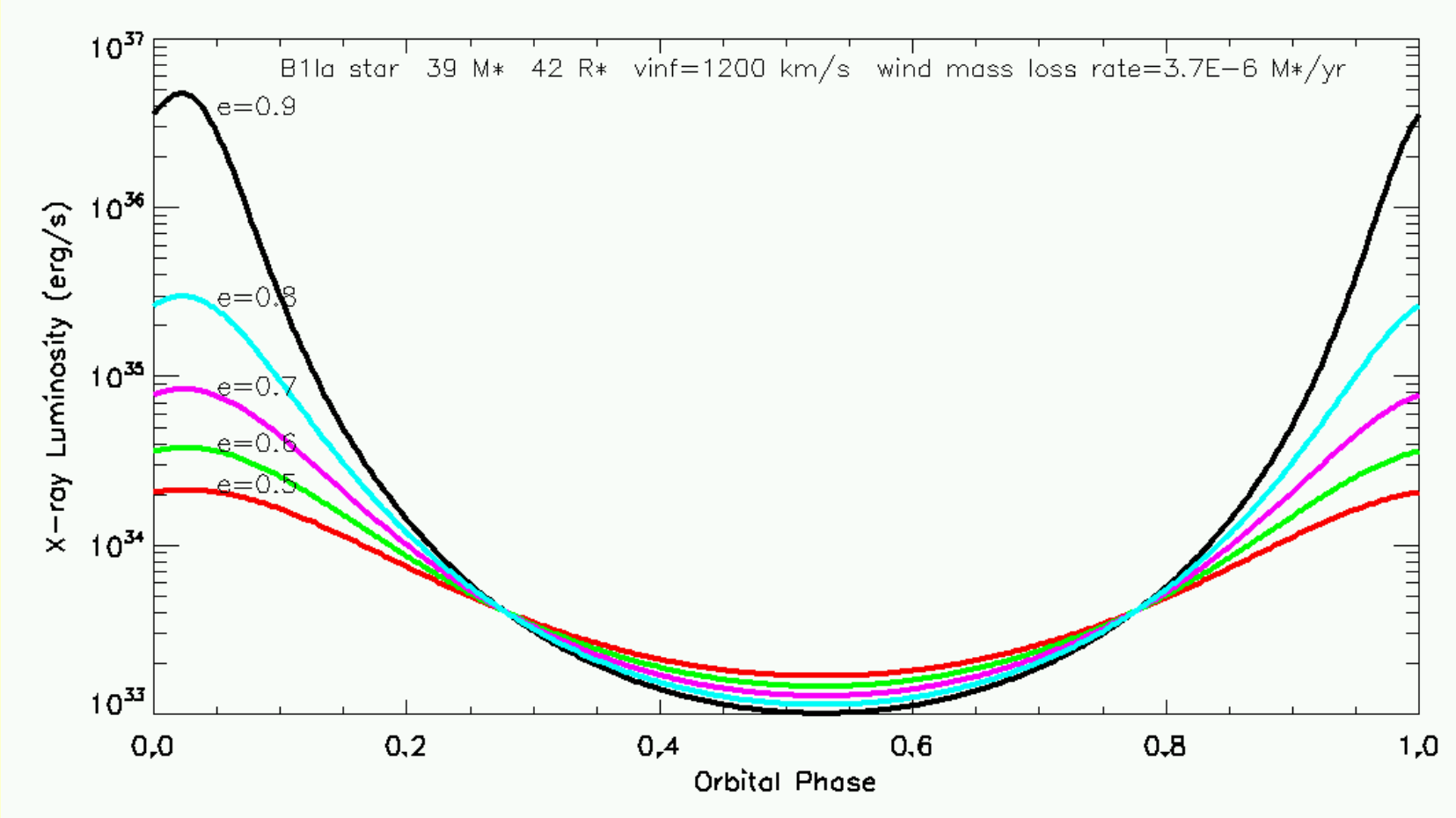


NEW unexpected outburst
after ~ 165 days from the Feb 2007 outburst:
new orbital period??

How to explain the outburst?

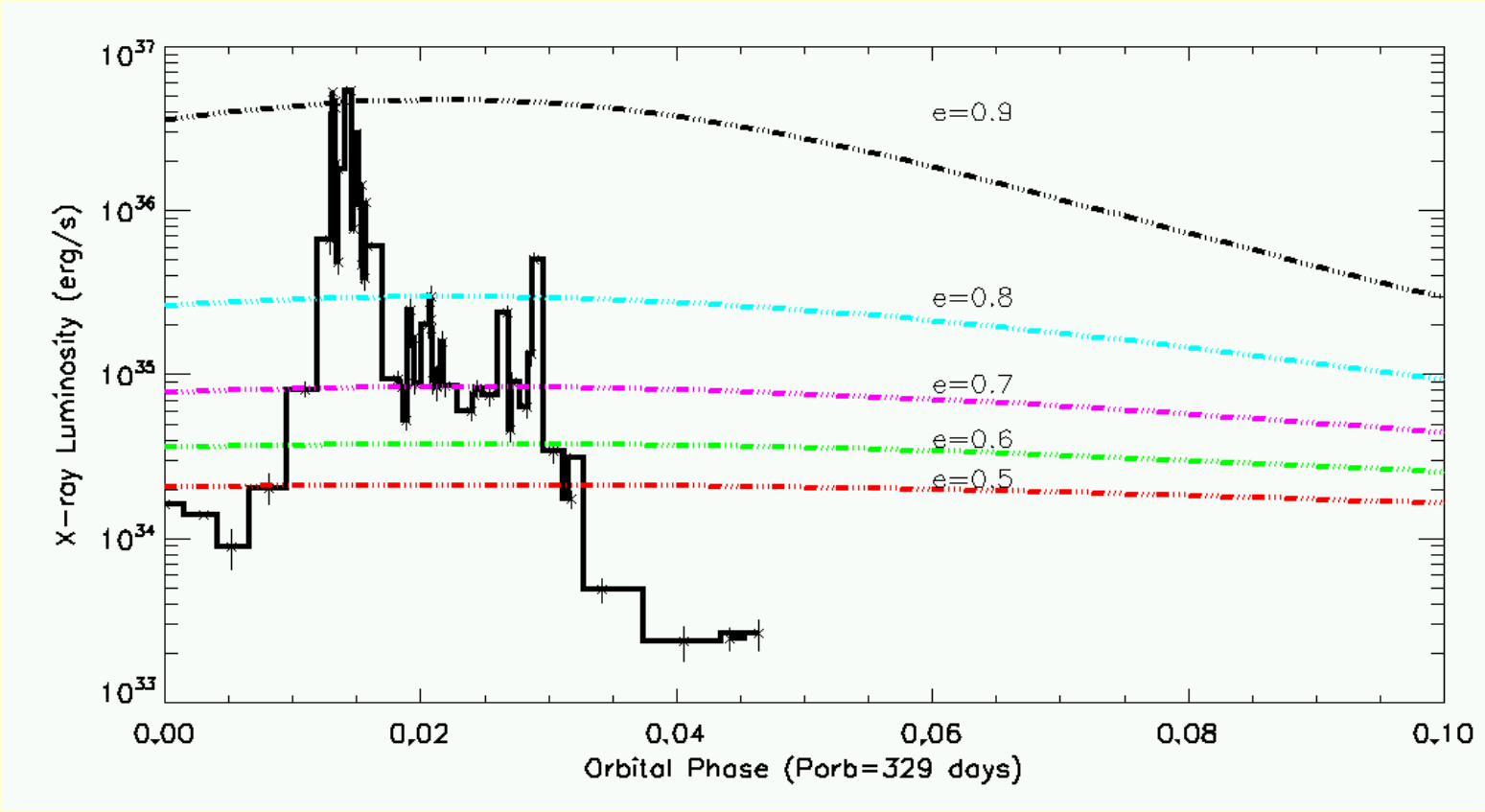
The recurrence time in IGRJ11215-5952 is the underlying clock of the phoenomenon, which can be interpreted in a natural way as the **orbital period** of the binary system



Model of accretion from a spherical homogeneous wind in an eccentric orbit around the HD star

An important result of the Swift/XRT monitoring

The lightcurve is **too narrow and steep** to be explained within a model of Bondi accretion from a spherical and homogeneous wind in an eccentric binary (even with extreme eccentricities!)



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a second wind component in an

“equatorial disk”

with lower wind velocity and a higher wind mass loss rate

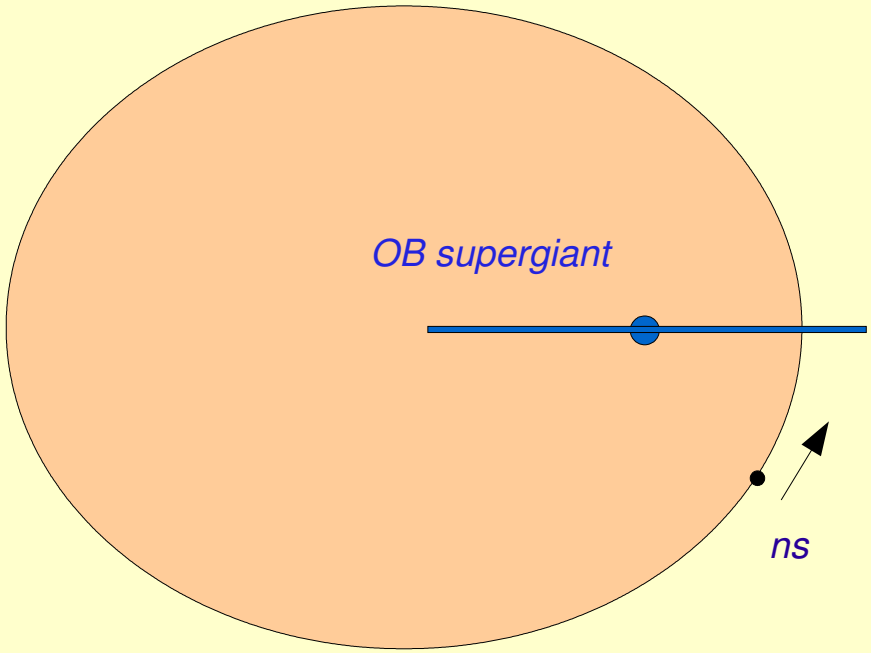
compared to the “polar wind component”

and

inclined with respect to the orbital plane

(e.g. an inclined disk has been proposed by Apparao 1985 to explain the outbursts from the Be-transient A0538-66)

The proposed geometry to explain the short SFXT outbursts:

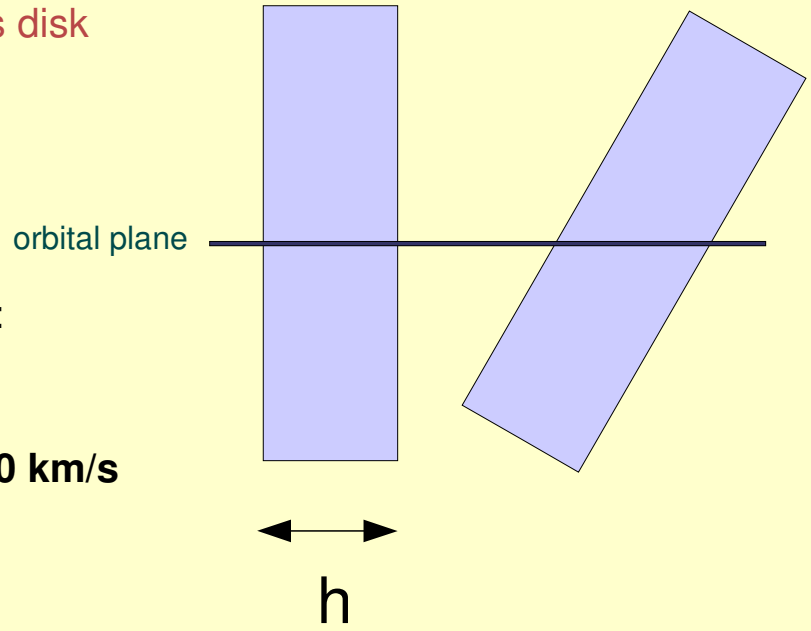


The thin equatorial disk of the B-supergiant
is **inclined** with respect to the orbital plane

The star has also a polar wind with higher velocity and lower mass loss rate
To explain the low X-ray emission level out of the outbursts, we probably need a not circular orbit

Sidoli et al., 2007, A&A in press

The thickness “**h**” of the densest region of this disk

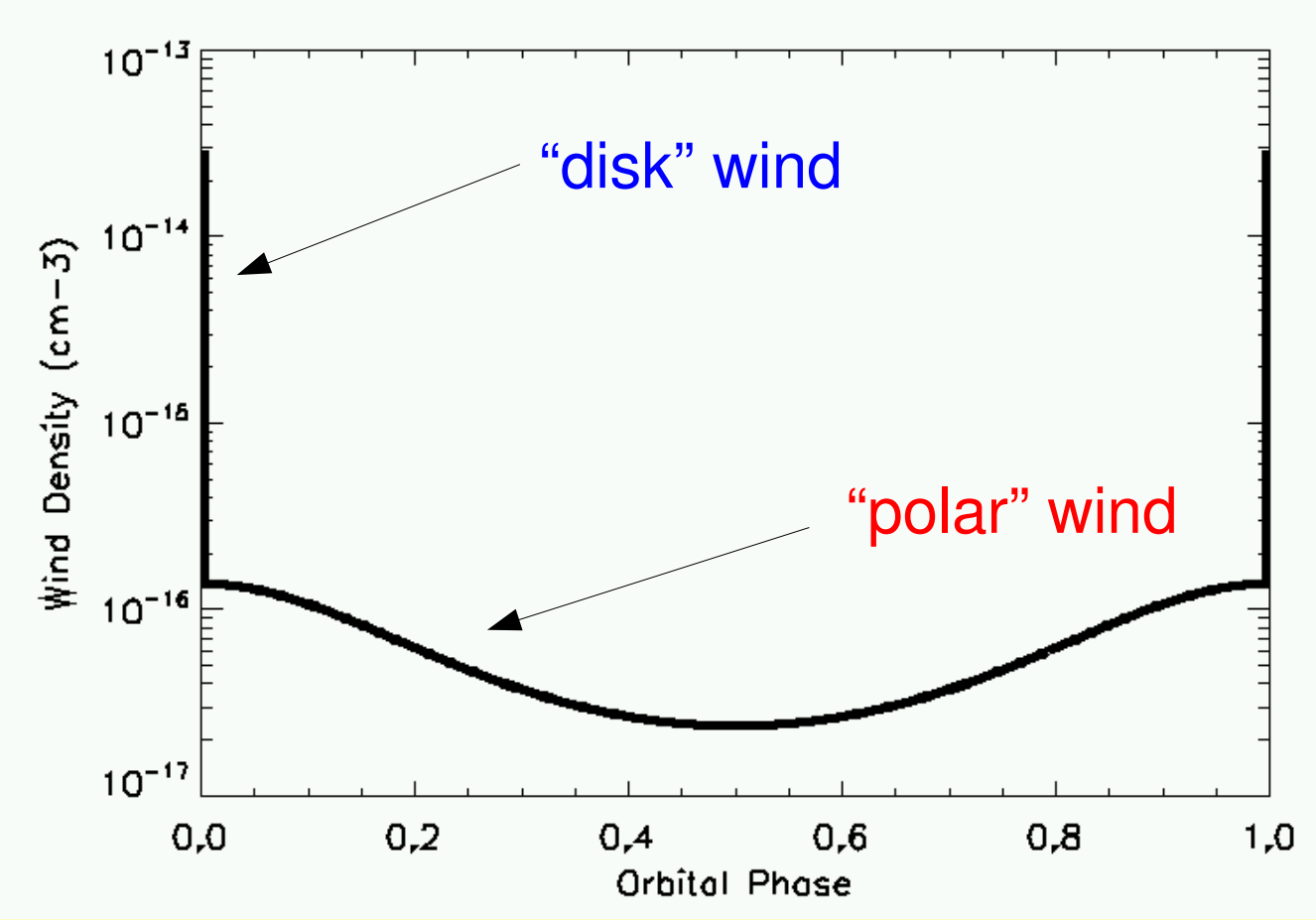


“h” can be estimated from the duration of the outburst:
the duration **t** of the brightest part of the outburst
is **t ~ 1 day,**
the ns velocity near periatron is roughly **vns ~ 100-200 km/s**

thus:

h ~ 8E11 – 1.7 E12 cm

variable wind density along the orbit

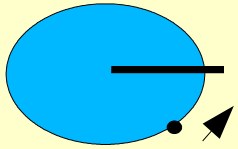


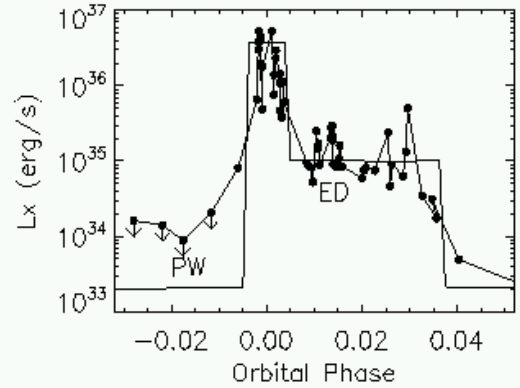
A model for IGRJ11215-5952

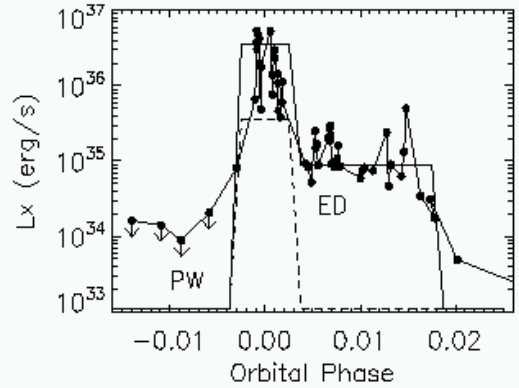
Porb=164.5 days

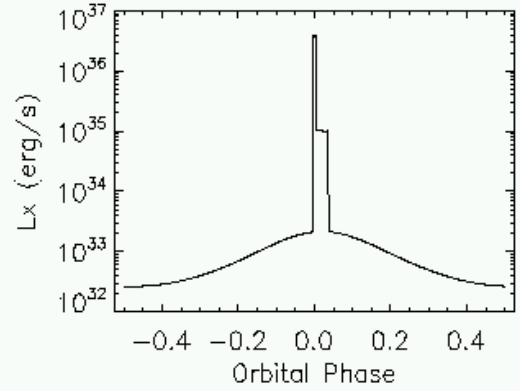
ecc = 0.4

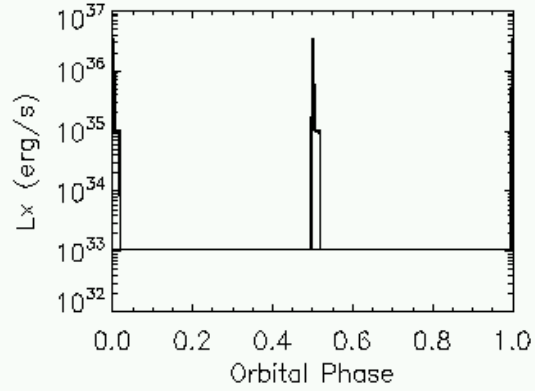
(to reach low “quiescent” luminosities Lx~1e32 erg/s
with reasonable wind parameters)

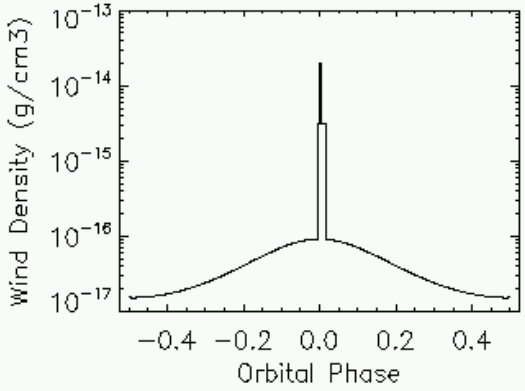


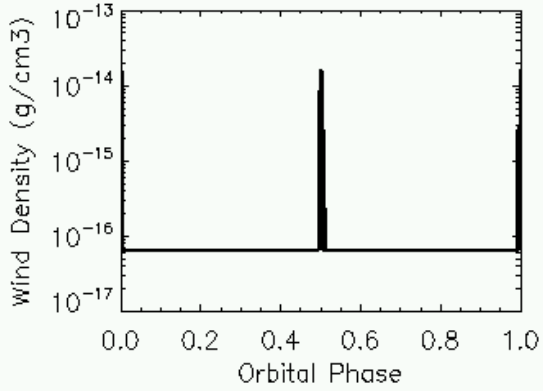








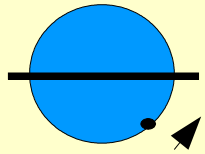




Porb=329 days

ecc = 0

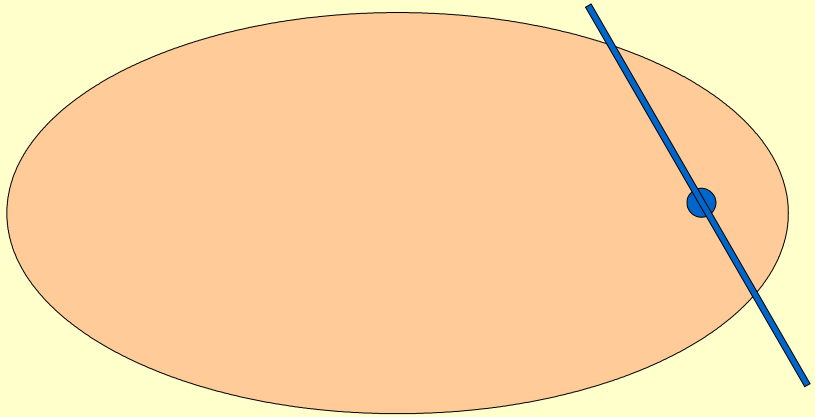
(this because the 2 outbursts observed with Swift have roughly the same peak luminosity)



ED = equatorial disk
PW = polar wind

how to explain other SFXTs where a clear periodicity in the outbursts has not been found yet?

probably a different eccentricity & a different geometry of the thin disk with respect to the orbital plane



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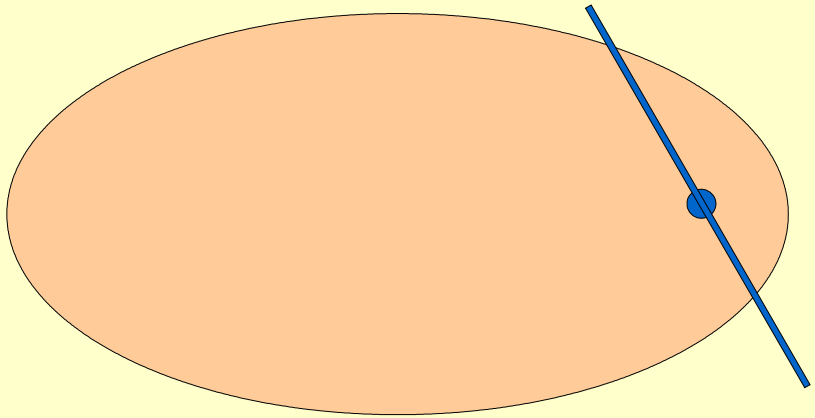

how to explain the persistent Vela X-1-like HMXBs with supergiant donors?

probably the “equatorial disk” of the supergiant in the persistent systems lies on the orbital plane and the ns always moves inside the disk

Conclusions

- **INTEGRAL** observations opened a **new view on High Mass X-ray Binaries**
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