

IGR J17091-3624:
learning from the little sister of
GRS 1915+105

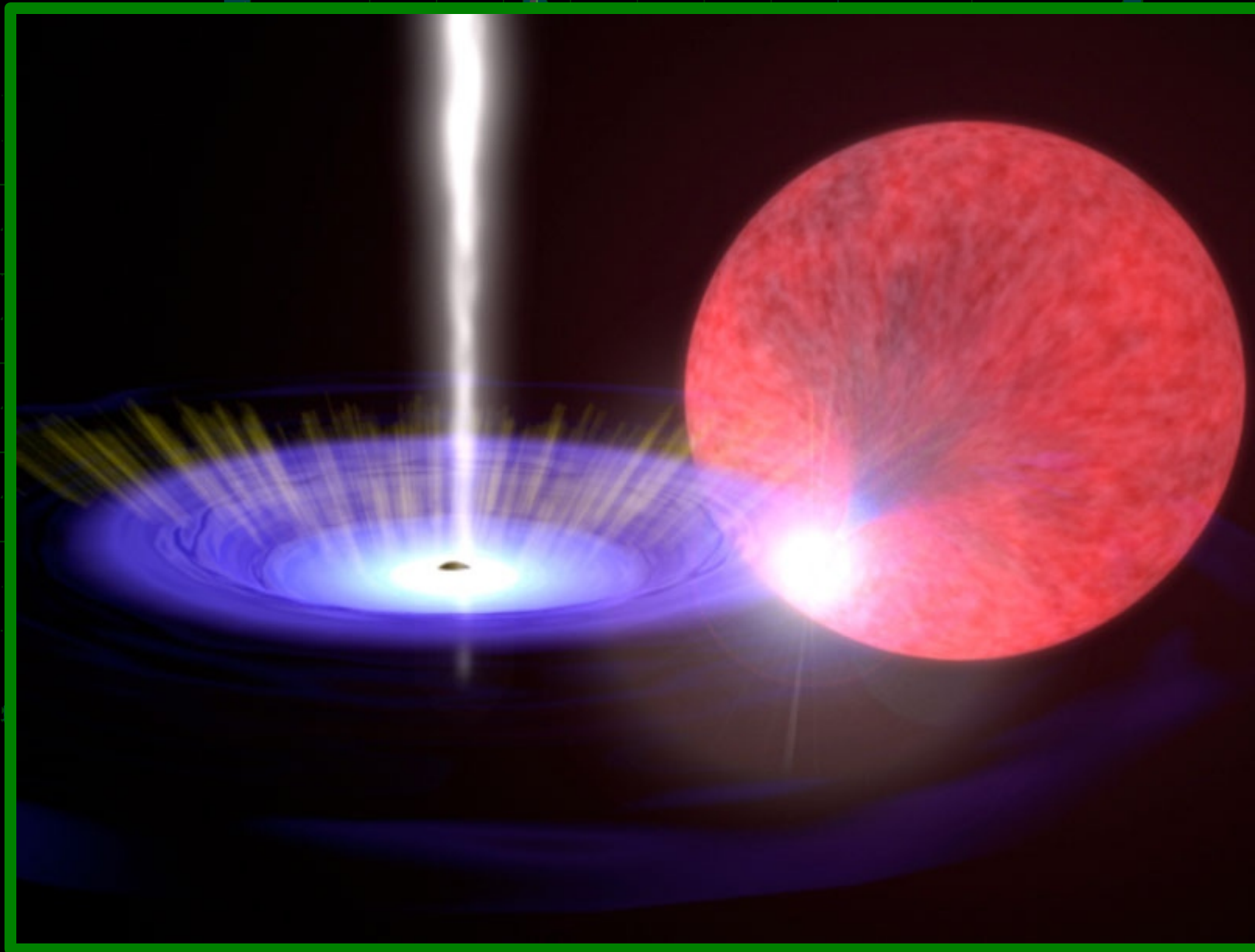


Diego Altamirano





Belloni, T.; Linares, M.; van der Klis, M.; Wijnands, R.; Curran, P. A.;
Kalamkar, M.; Stiele, H.; Motta, S.; Muñoz-Darias, T.;
Y. J. Yang, Casella, P.; Krimm, H.

GRS 1915+105



GRS 1915+105

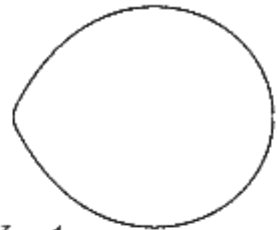
- Discovered in August 1992 (WATCH all-sky monitor)
- $\sim 14 \pm 4 M_{\odot}$ Black hole
- ~ 12 kpc
- ~ 33 days orbital period
- $\sim 1.2 M_{\odot}$ K-M III companion star
- Often at L_{Edd}

companion star 
 accretion disk and black hole 

 ←-----→x
 Sun Mercury



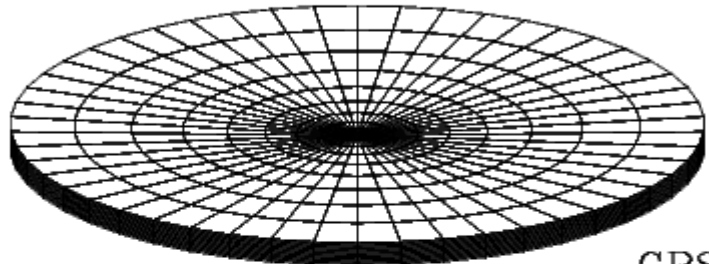
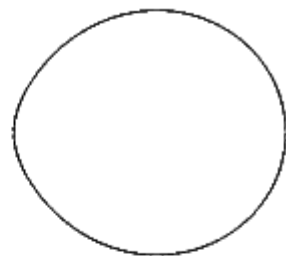
LMC X-3



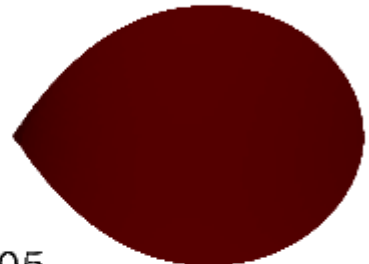
LMC X-1



Cyg X-1




GRS 1915+105





 XTE J1650-500


 XTE J1118+480



 XTE J1859+226


 GRS 1009-45


 GRS 1124-683


 SAX J1819.3-2525


 GS 2000+25

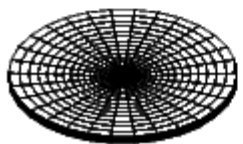

 H1705-250


 GRO J1655-40

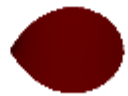

 A0620-00


 GRO J0422+32


 XTE J1550-564



GS 2023+338



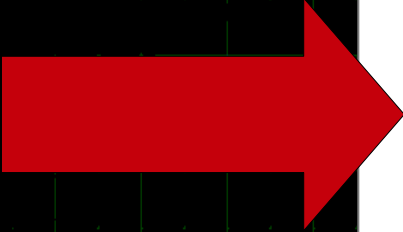
GS 1354-64



GX 339-4

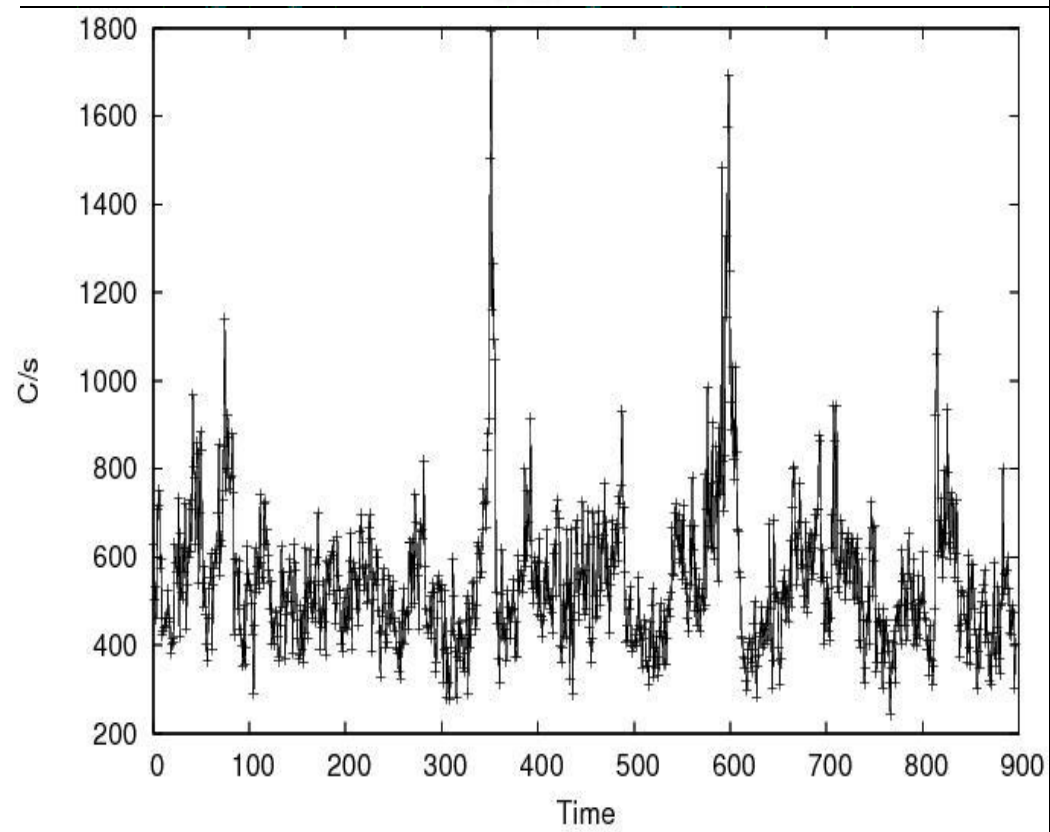
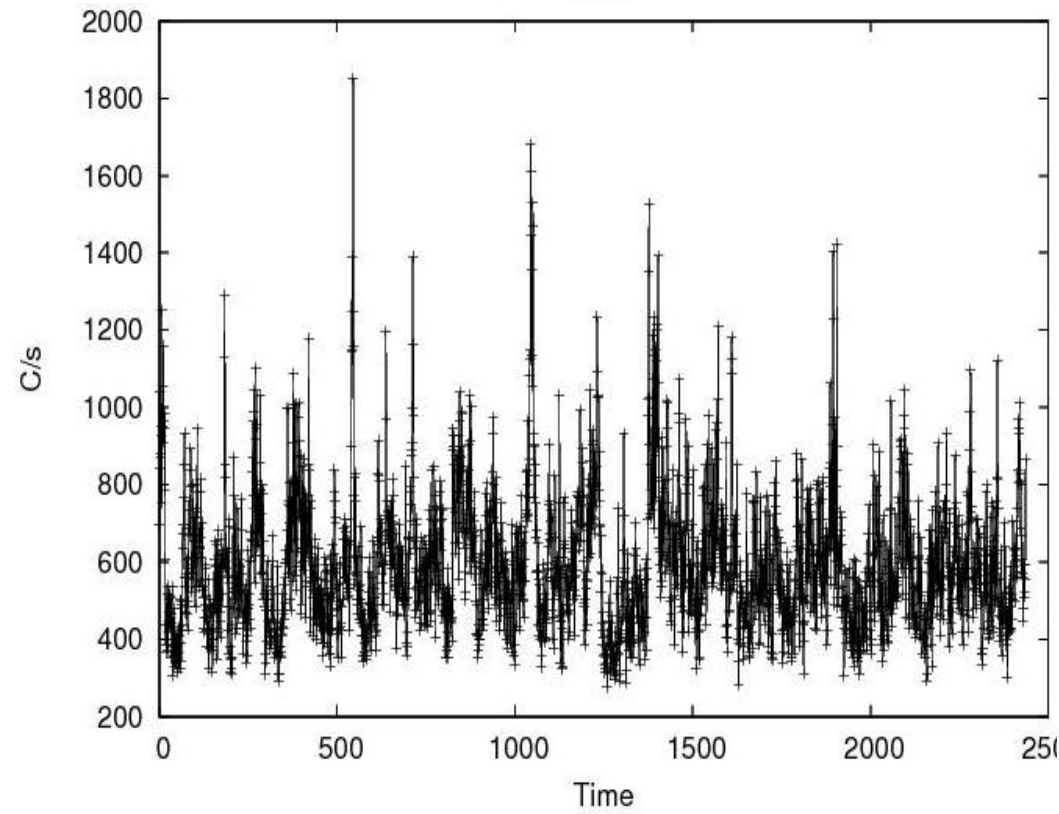
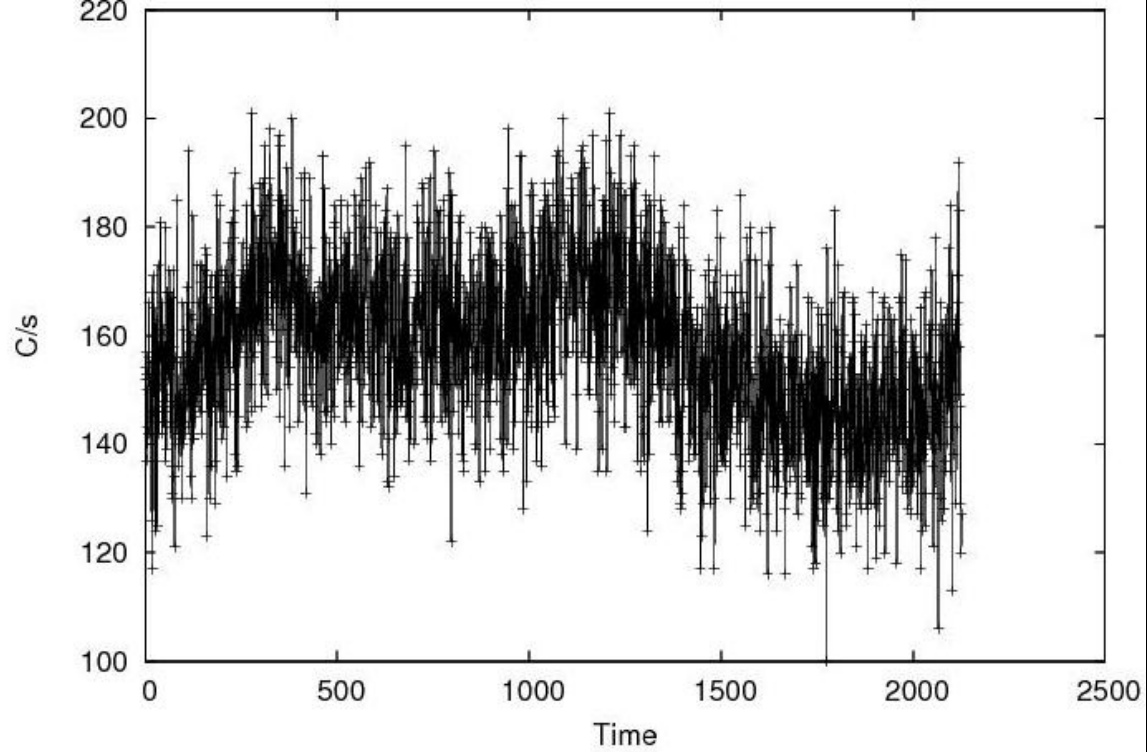
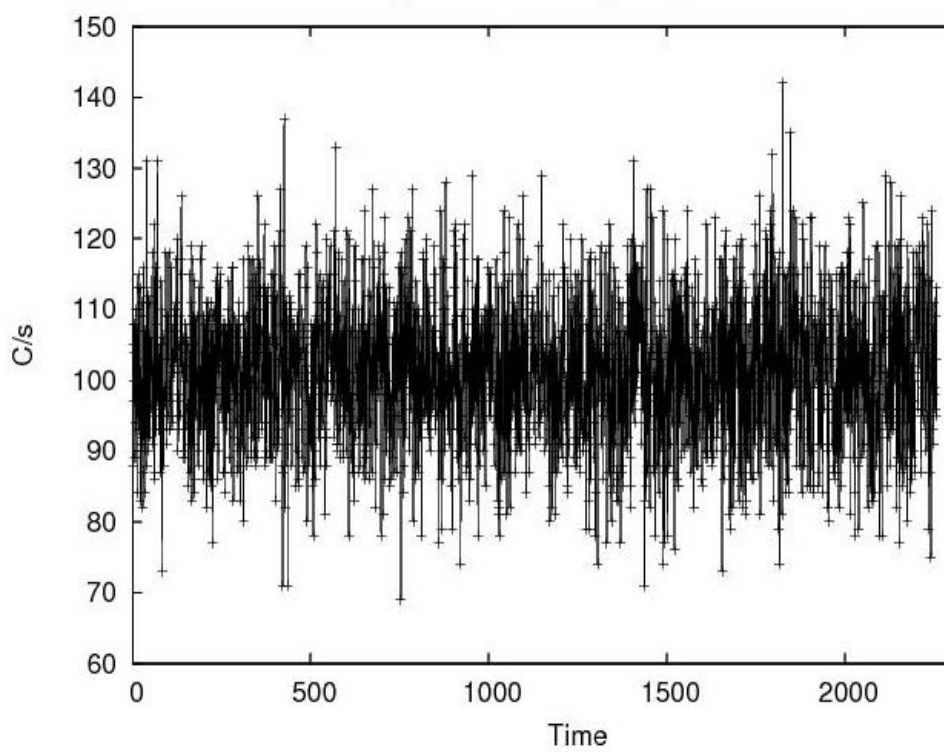


4U 1543-47



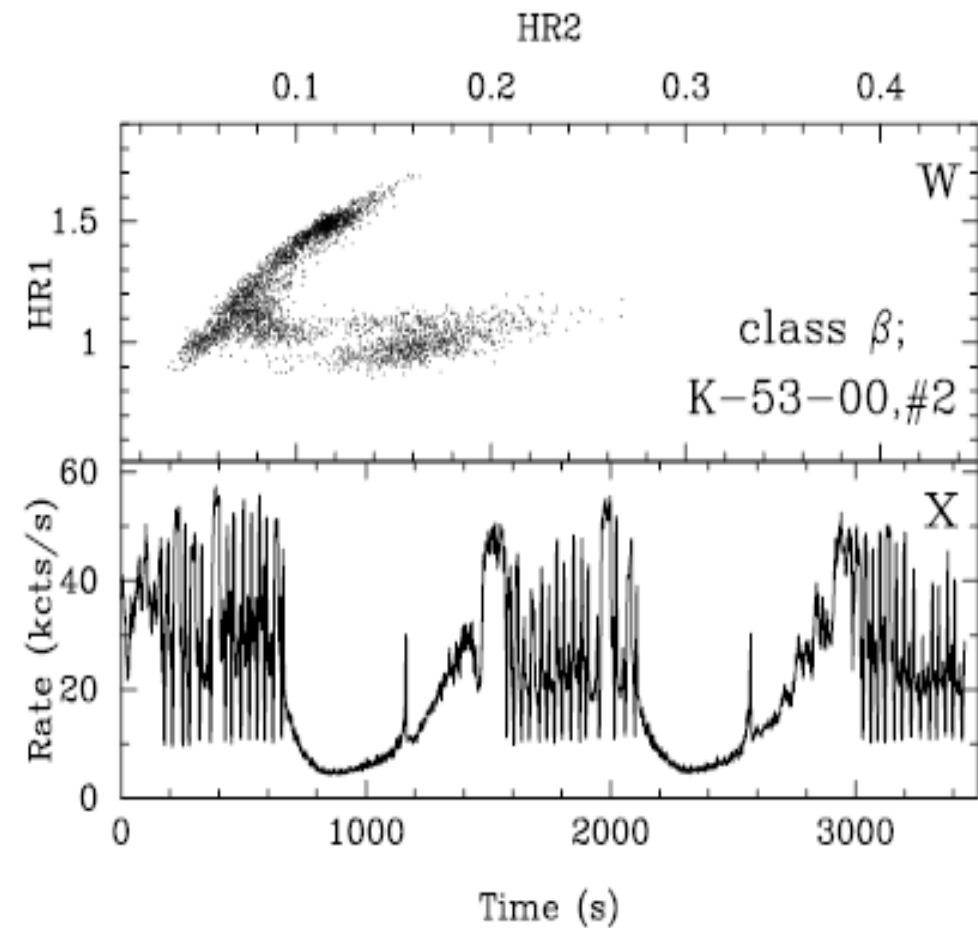
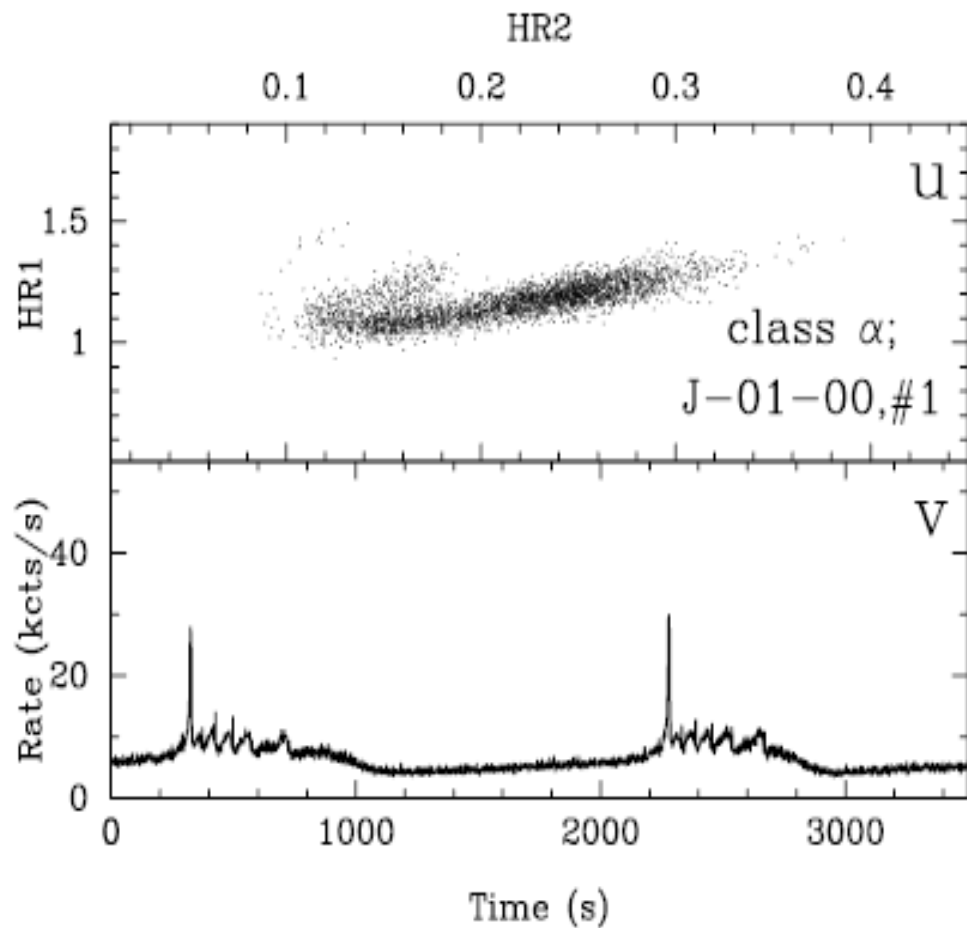
The background features a dark blue grid. A prominent blue waveform, resembling a light curve, is overlaid on the grid. The waveform has several sharp peaks and a more complex, oscillating section. A small white mouse cursor is visible near the bottom left of the waveform. In the bottom right corner, there is a small circular icon with a blue and white gradient.

X-ray light curves of typical BHs

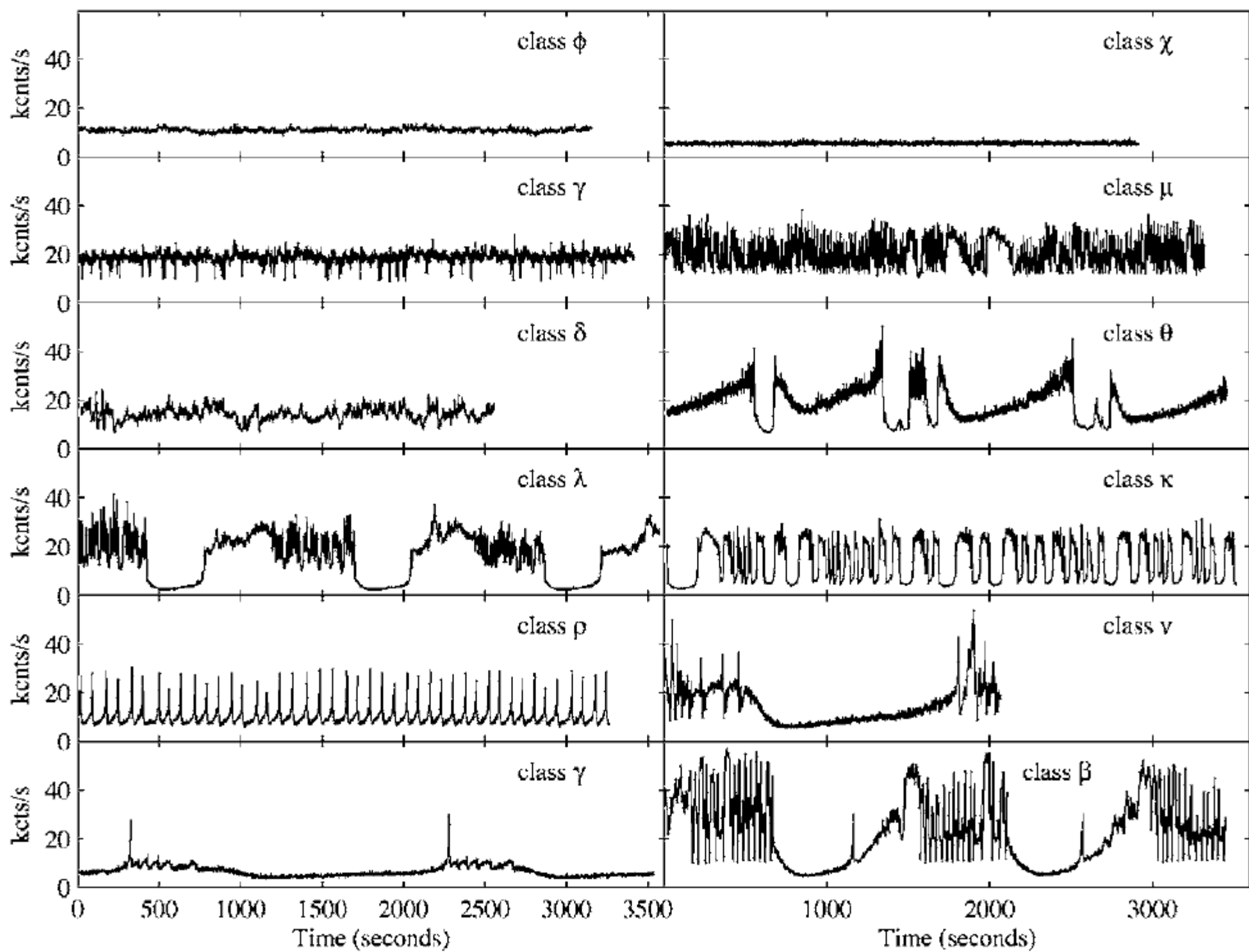


GRS 1915+105

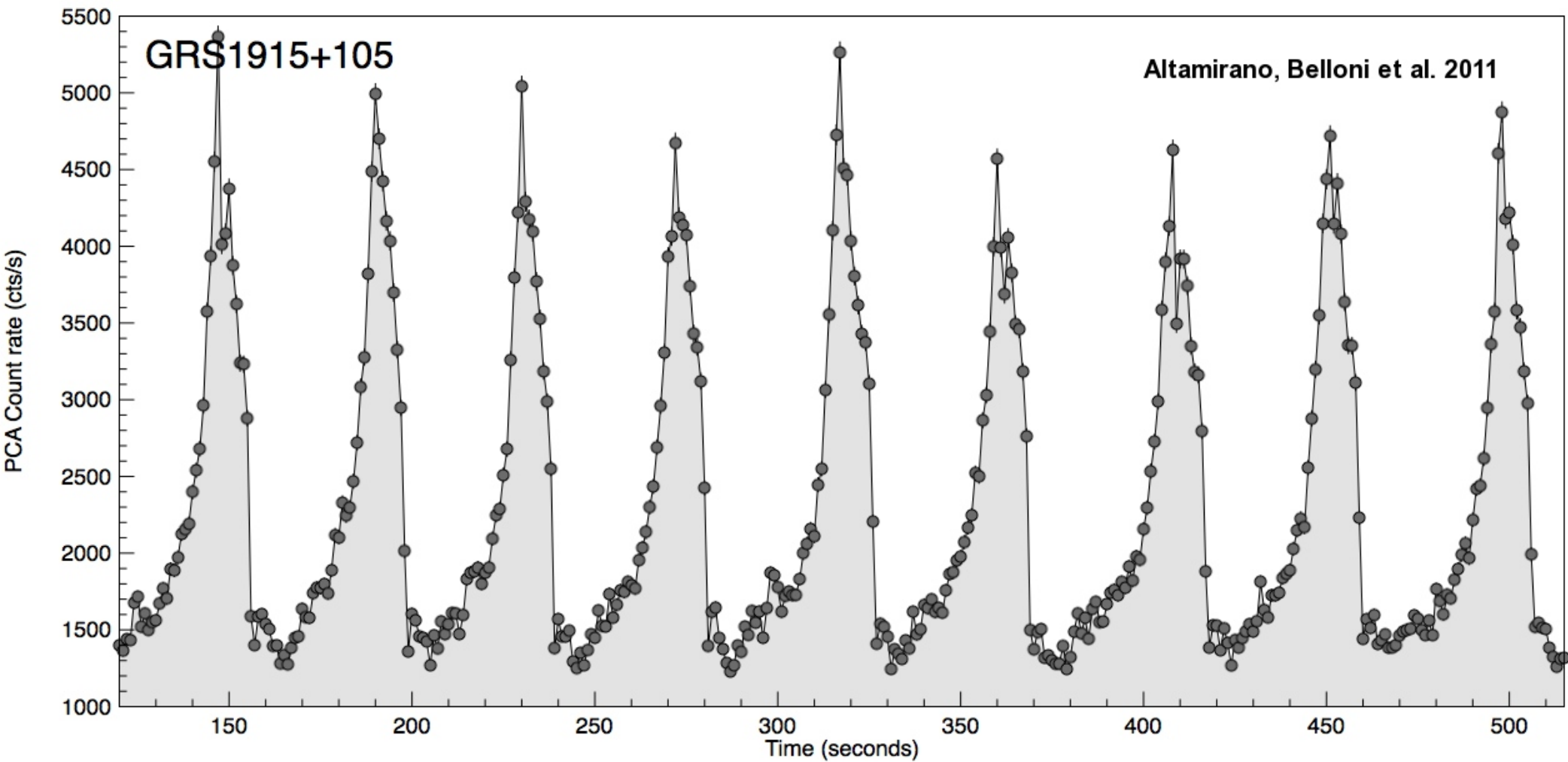
Limit cycles of accretion and ejection in an unstable disk



Belloni et al. 2000



GRS 1915+105 Heartbeats



See recent Neilsen et al. papers for interpretation based on Chandra/RXTE data....

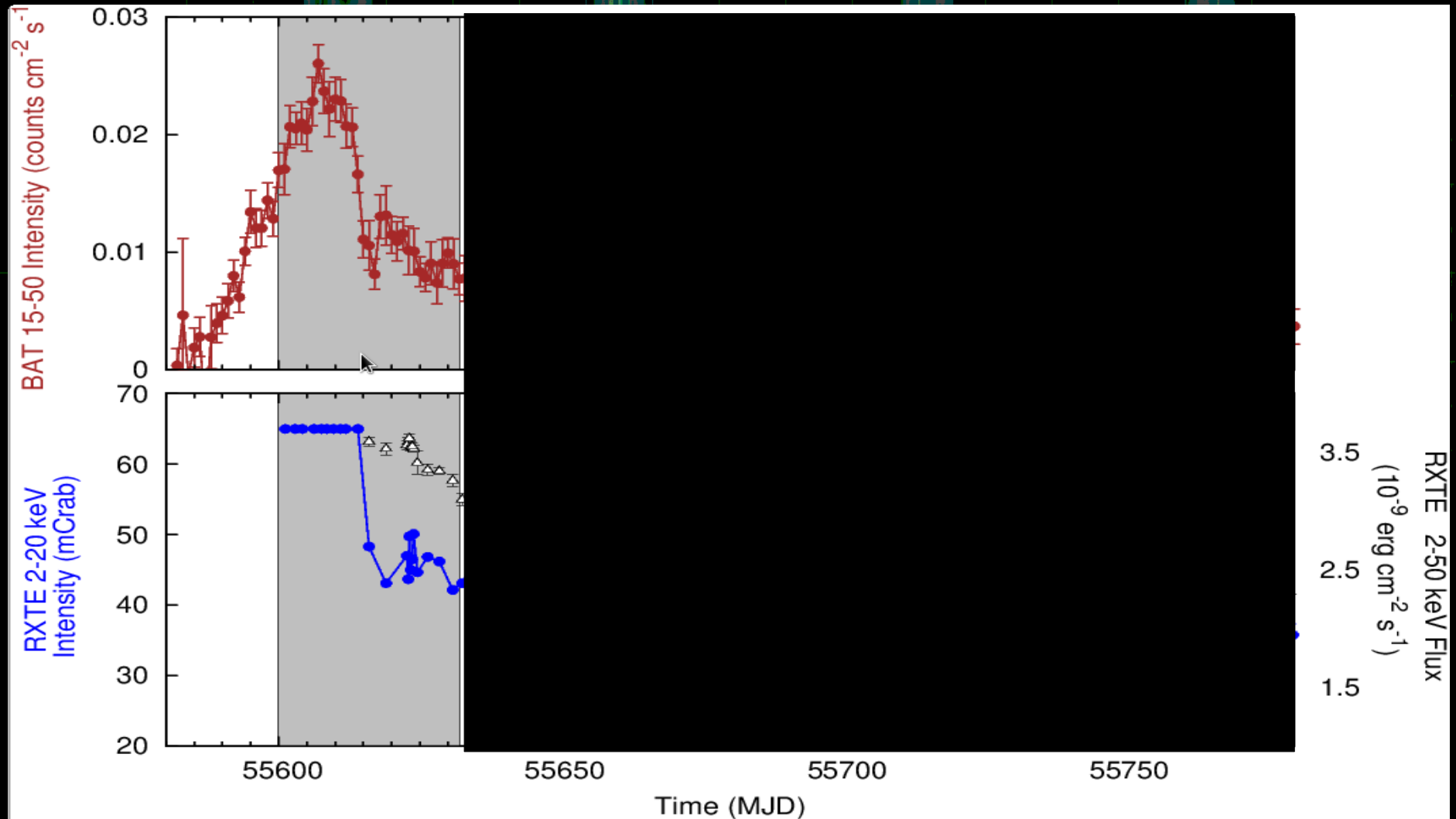
How can we know if we understand GRS 1915+105
If we don't have a second source to compare?



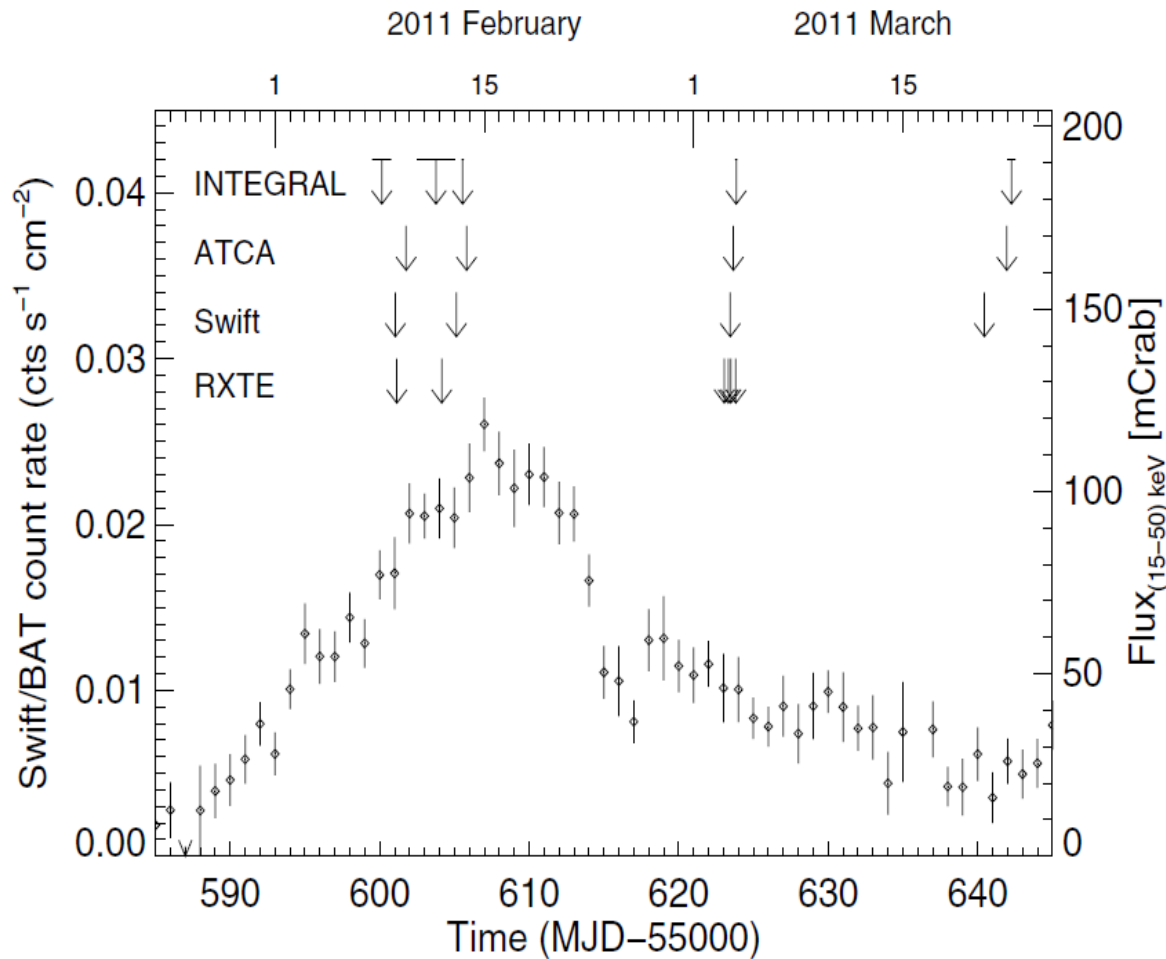
IGR J17091-3624
the last treasure discovered with RXTE

...and so far ... the tip of the iceberg...

IGR J17091-3624: 2011 outburst

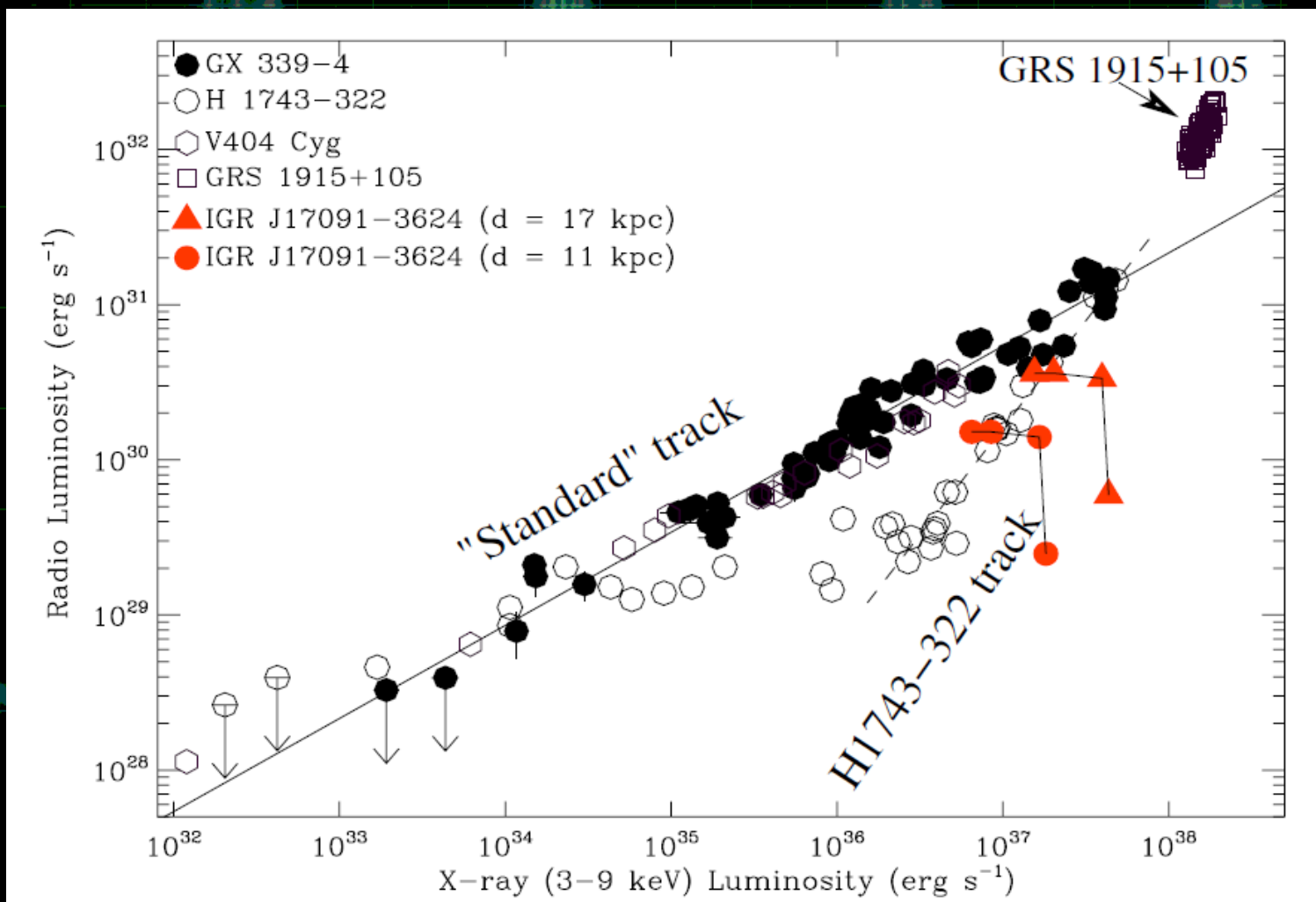


IGR J17091-3624: 2011 outburst

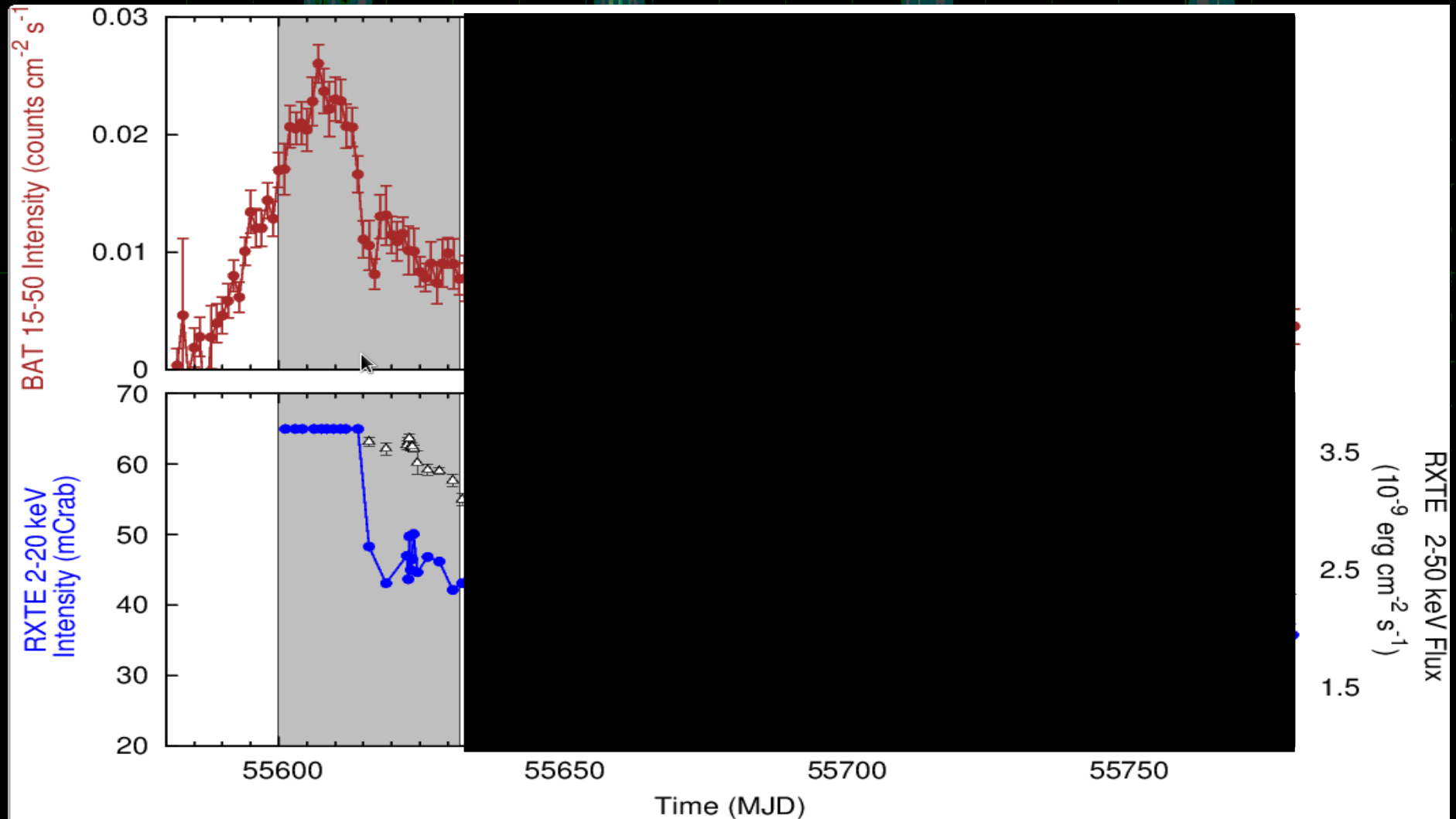


Obs.	$F_{5.5 \text{ GHz}}$ (mJy)	$F_{9 \text{ GHz}}$ (mJy)	α
A1	1.40 ± 0.05	1.24 ± 0.06	-0.25 ± 0.12
A2	1.53 ± 0.10	1.57 ± 0.10	$+0.05 \pm 0.19$
A3	2.41 ± 0.10	1.13 ± 0.10	-1.54 ± 0.20
A4	0.17 ± 0.05	<0.08	

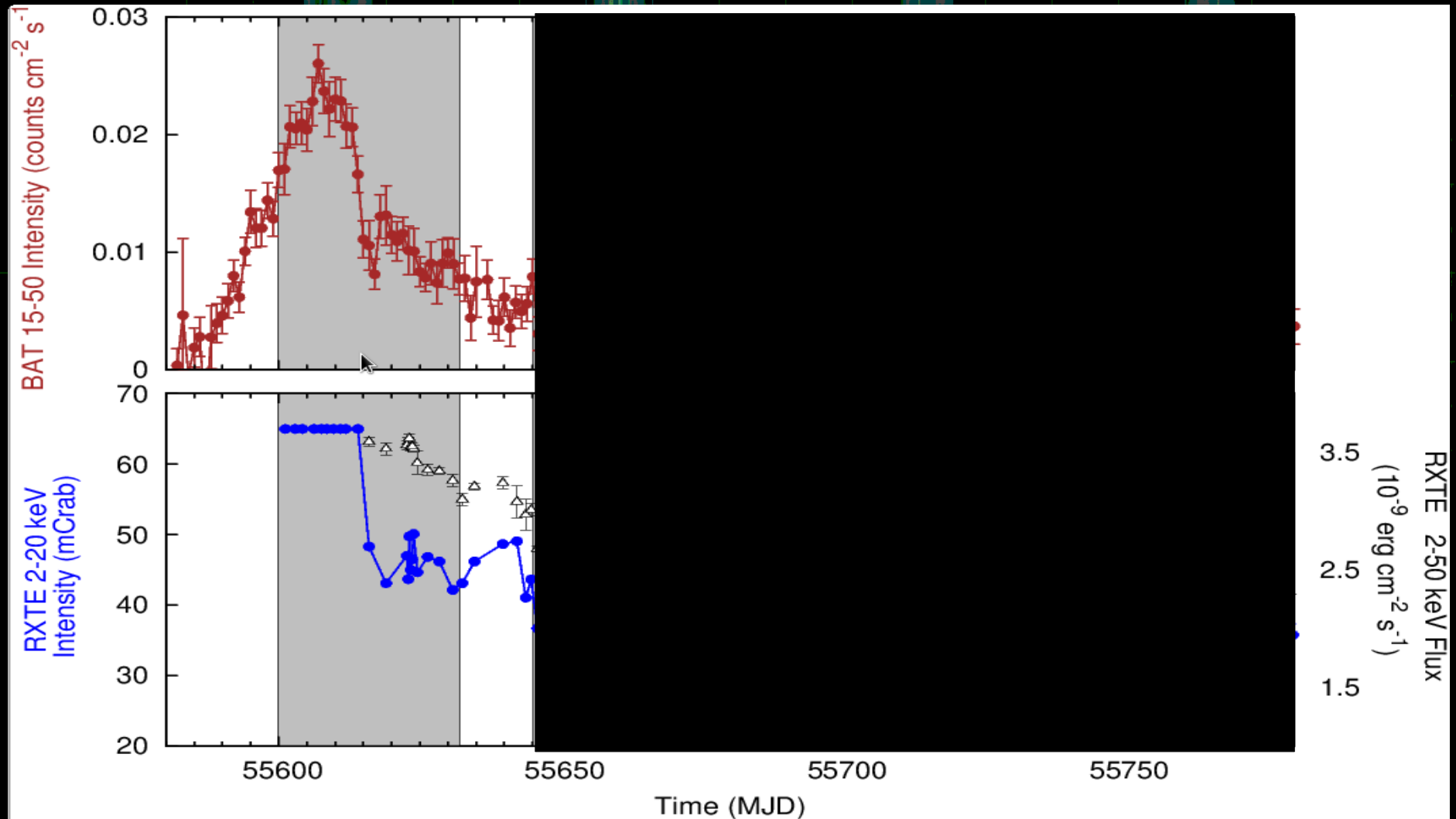
IGR J17091-3624: 2011 outburst



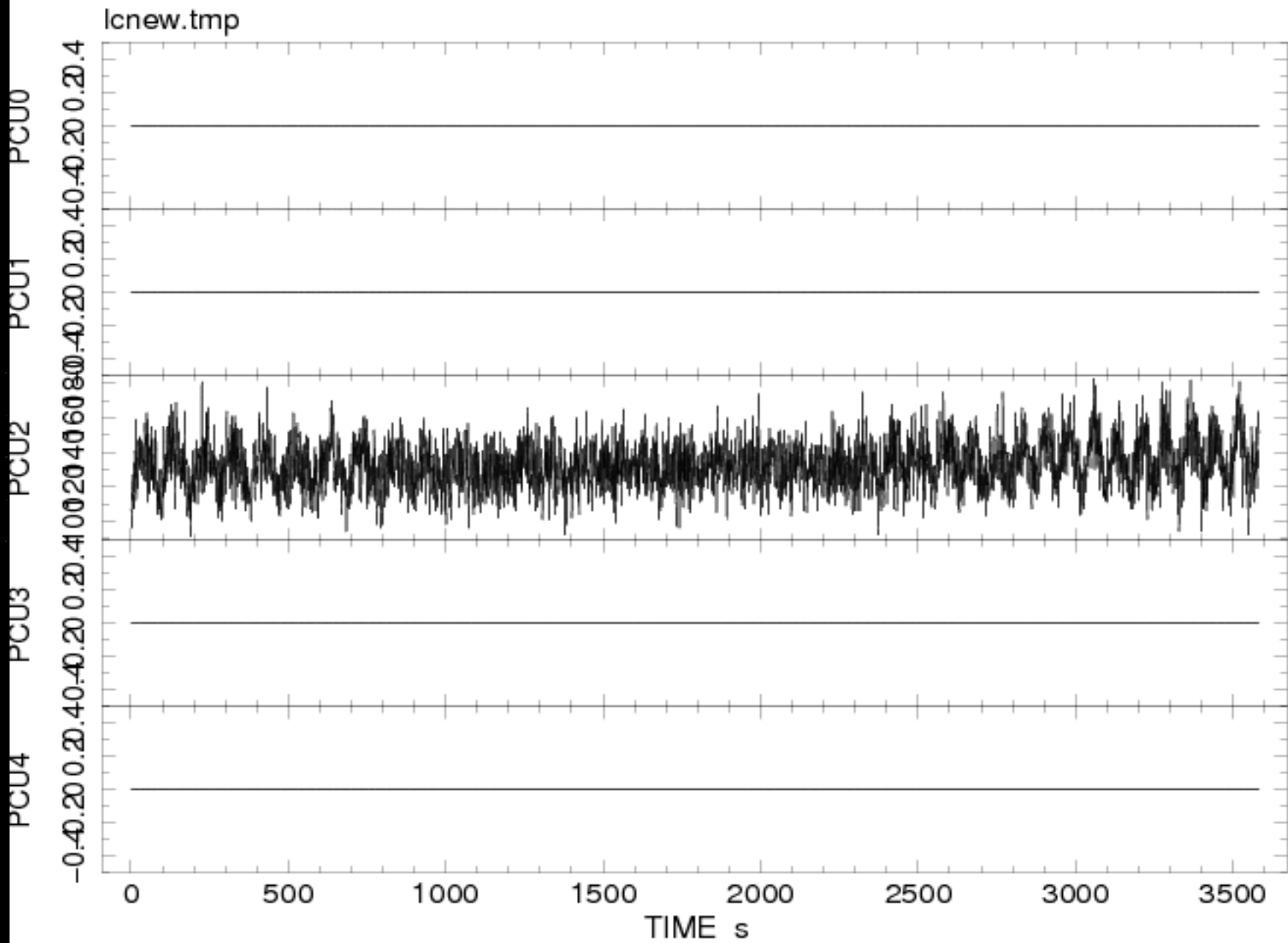
IGR J17091-3624: 2011 outburst



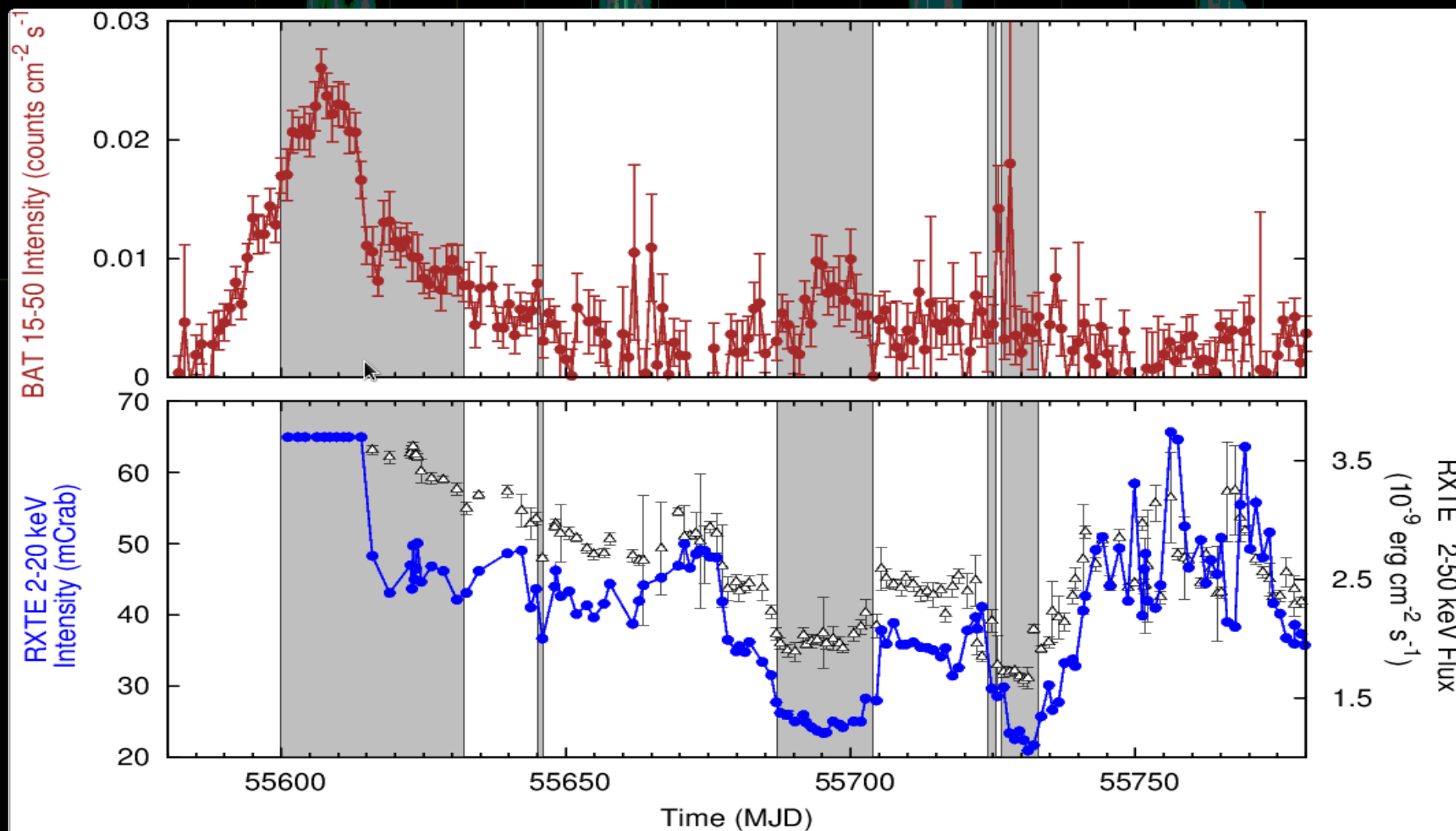
IGR J17091-3624: 2011 outburst



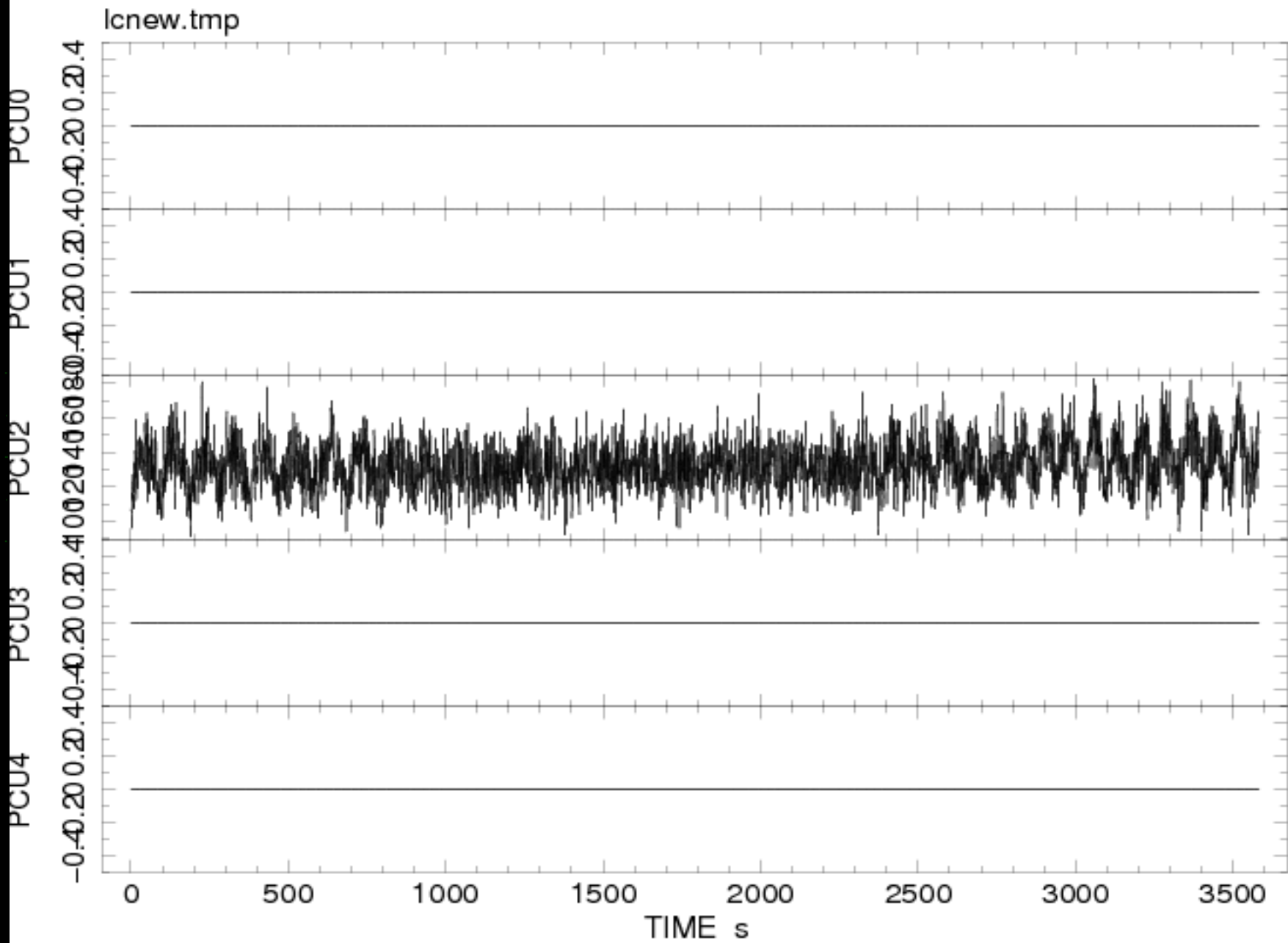
Offset by 542735315.378428 sec.
1.0 sec resolution Std1 Ic of ObsID 96420-01-03-01



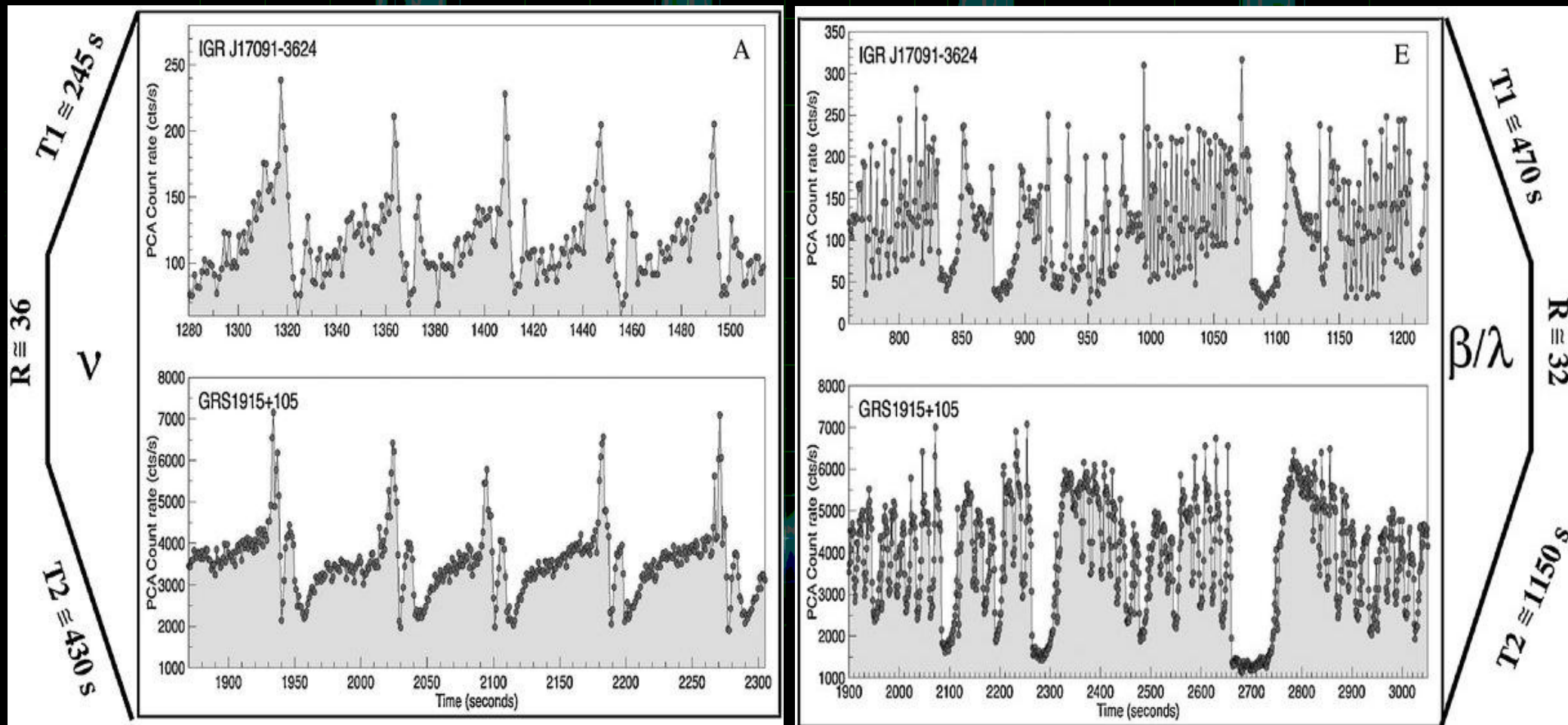
IGR J17091-3624: 2011 outburst



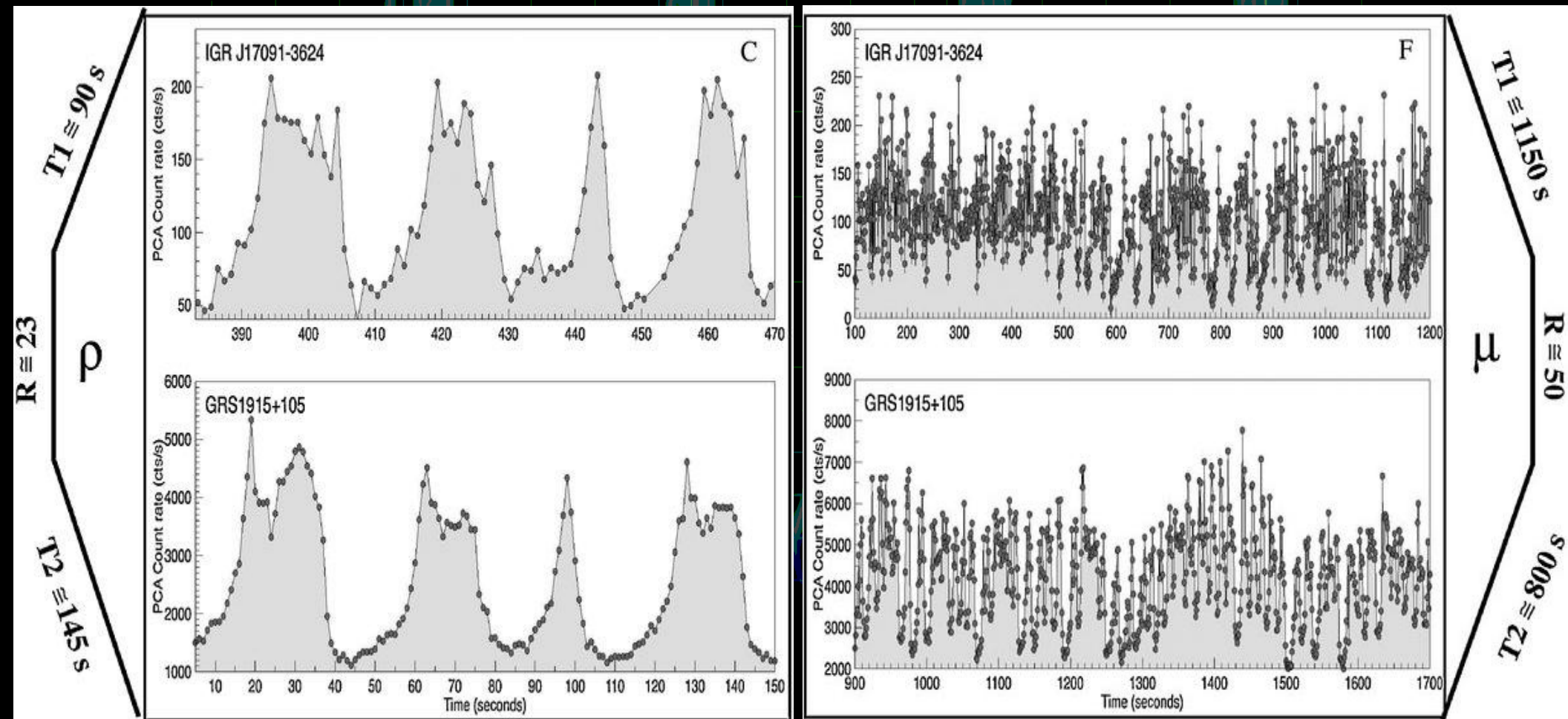
Offset by 542735315.378428 sec.
1.0 sec resolution Std1 lc of ObsID 96420-01-03-01



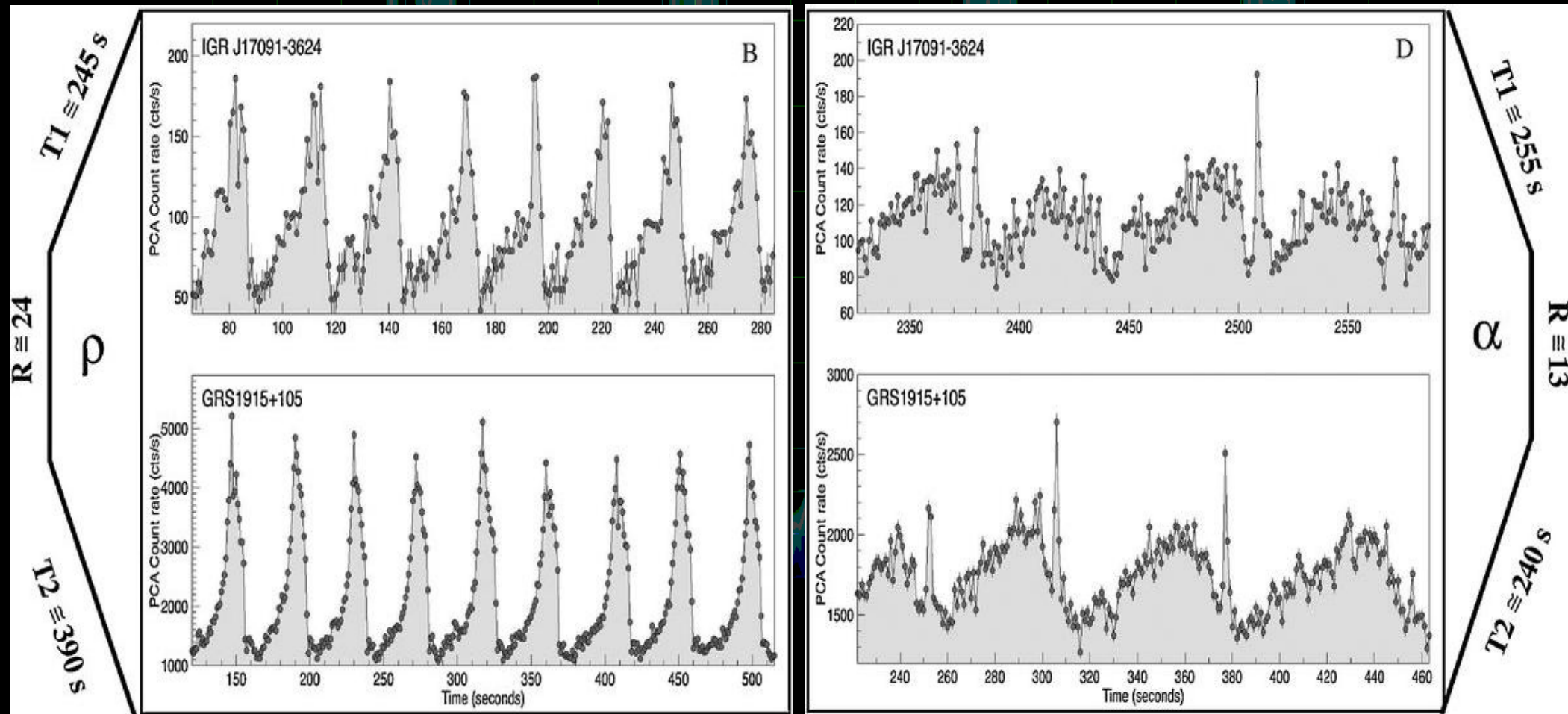
IGR J17091-3624: 2011 outburst

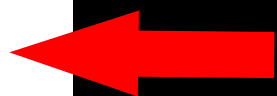
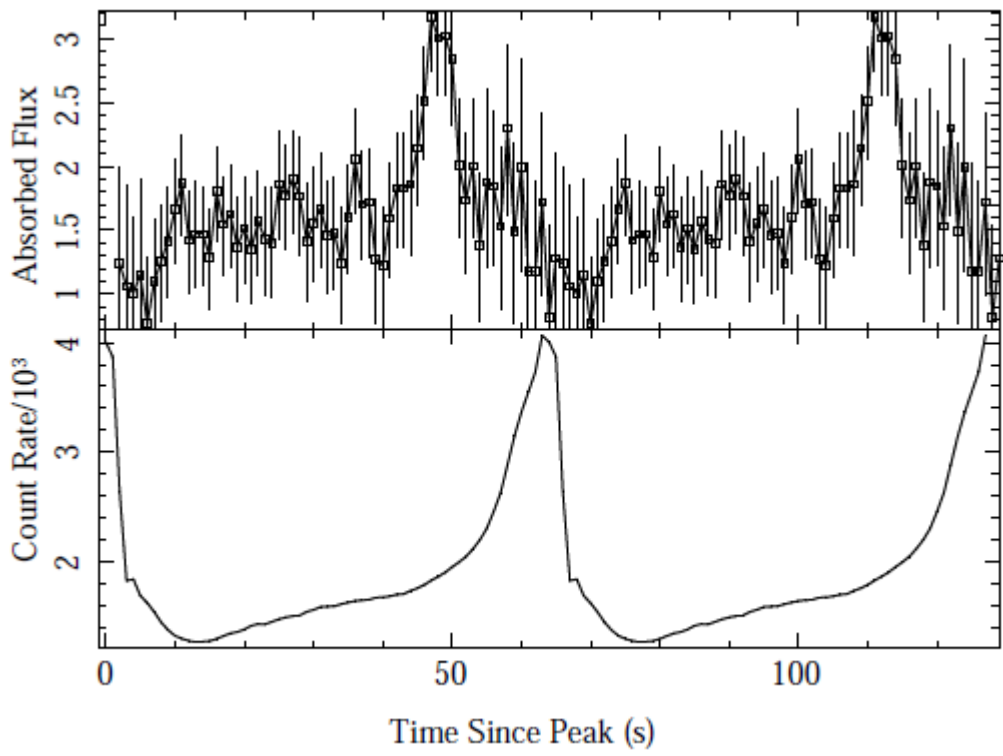


IGR J17091-3624: 2011 outburst

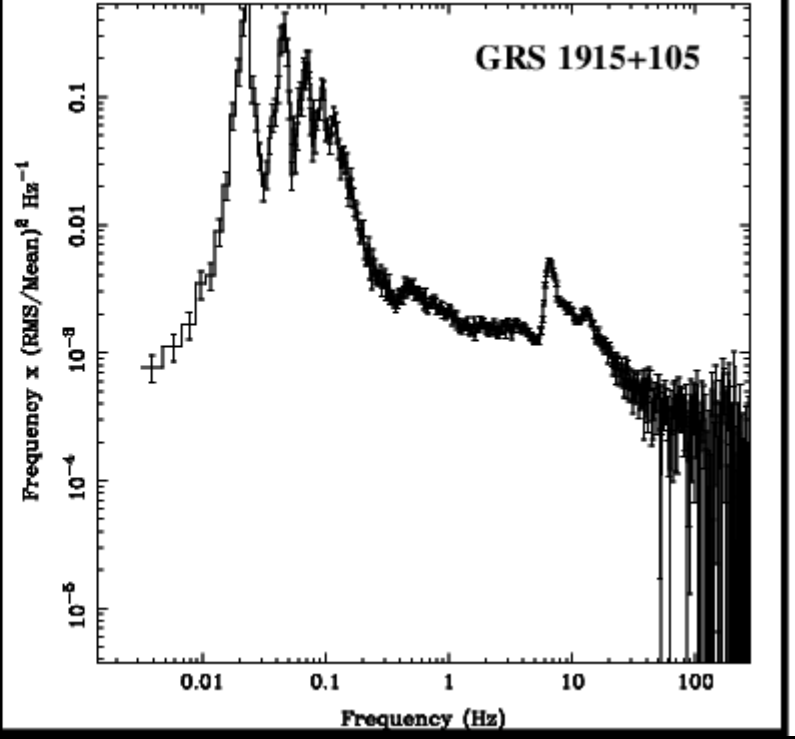
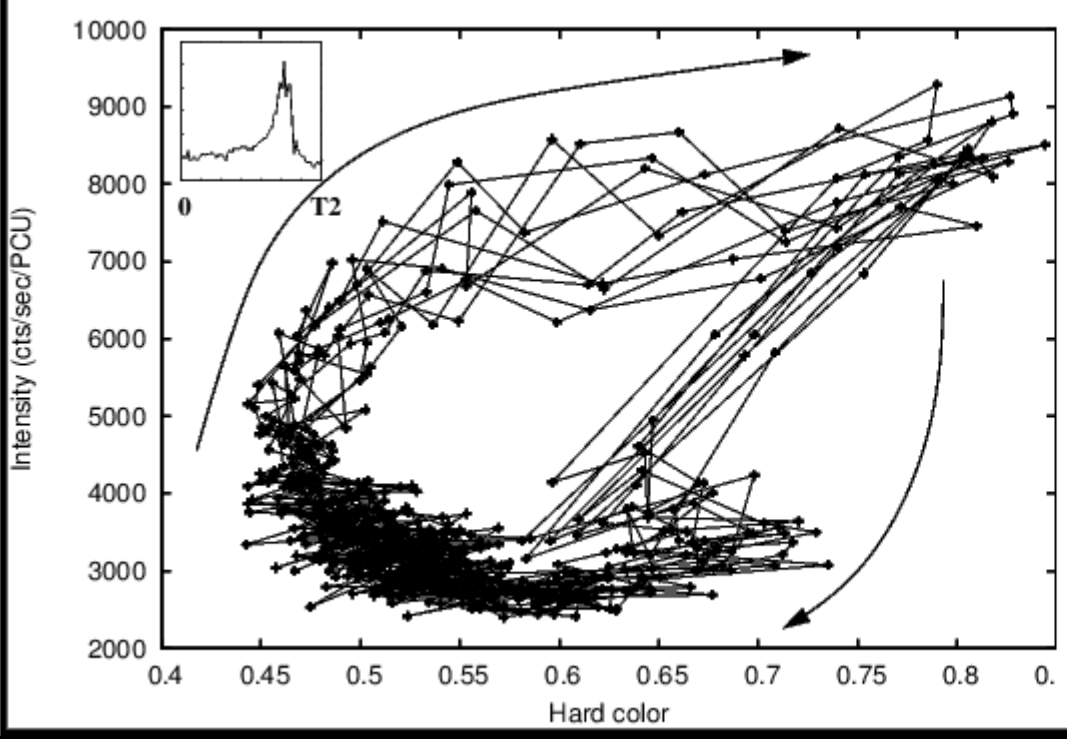


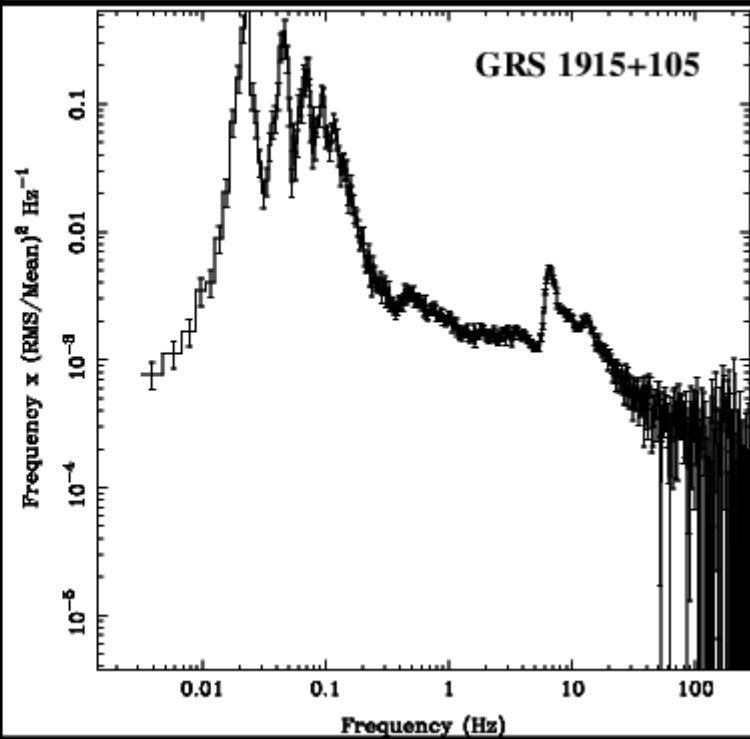
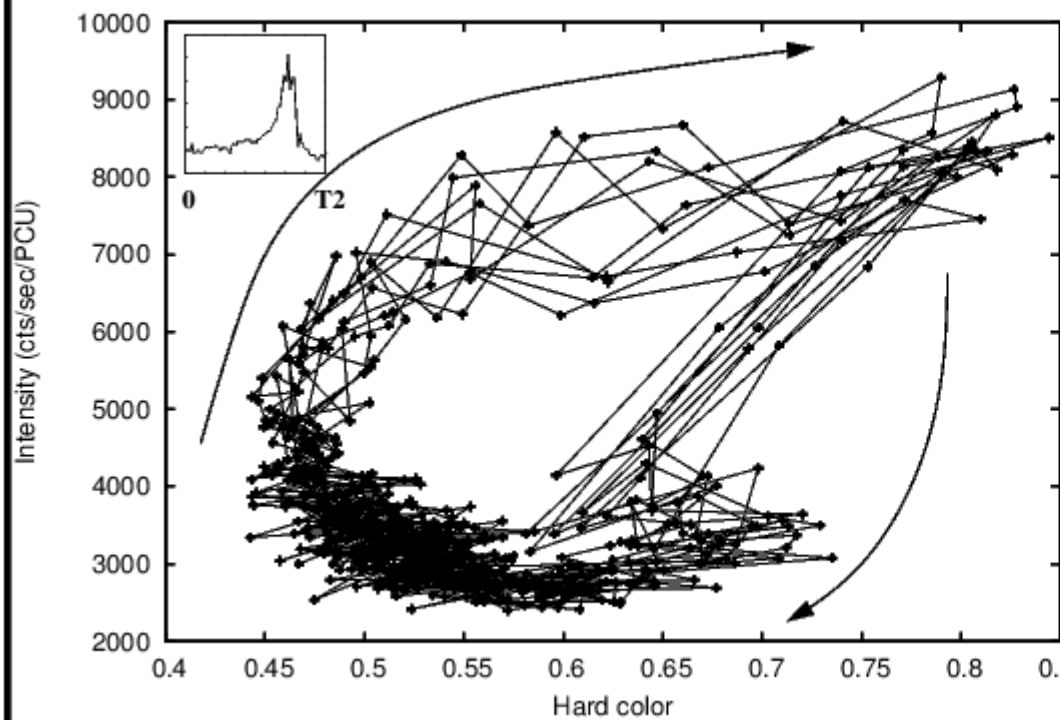
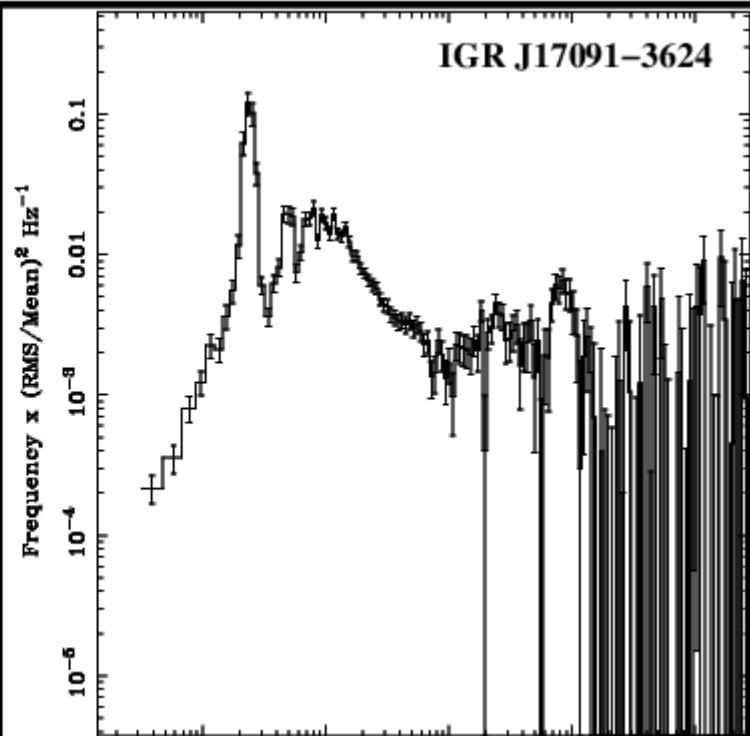
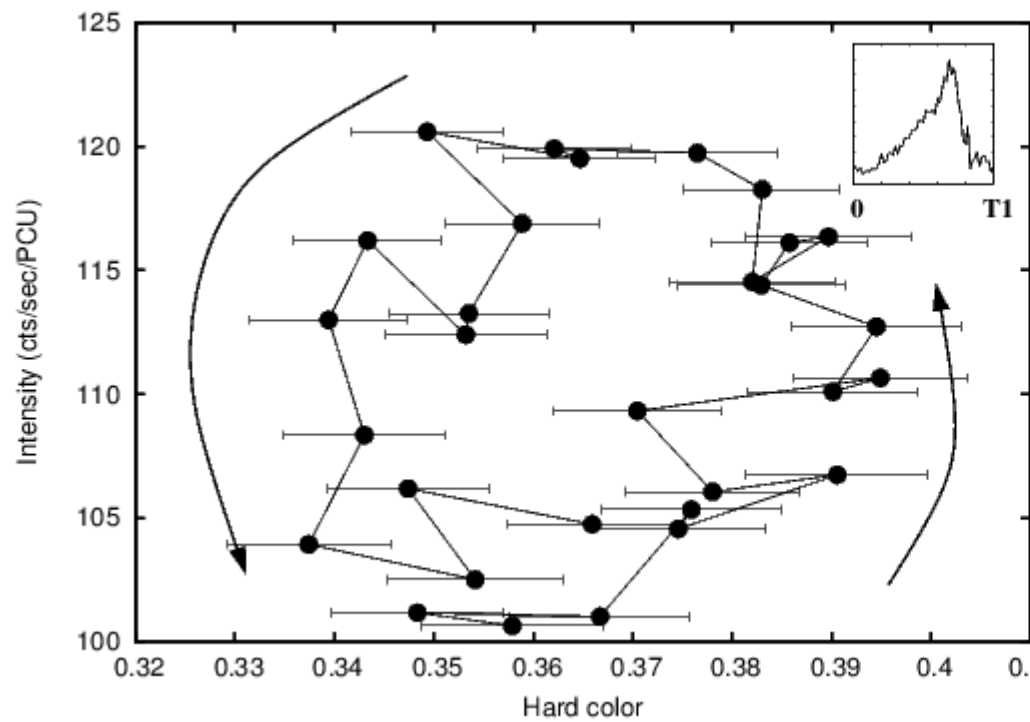
IGR J17091-3624: 2011 outburst



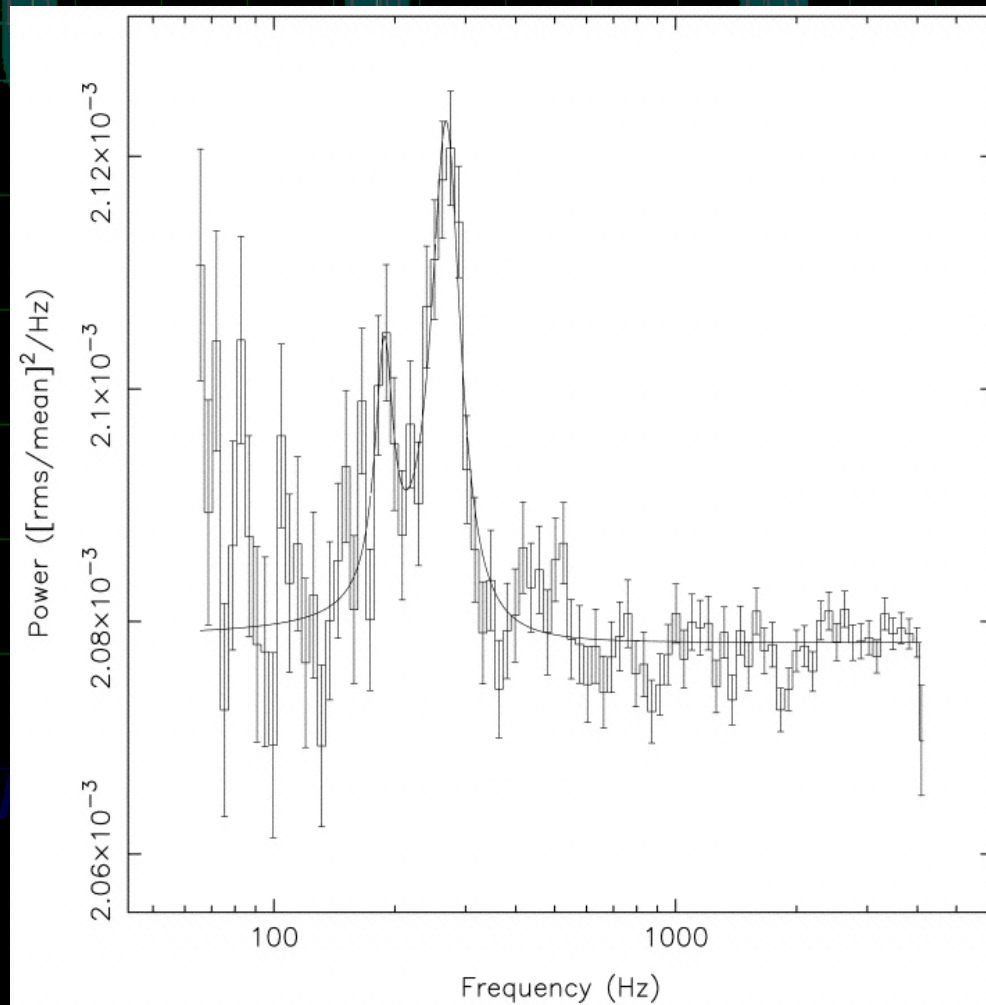


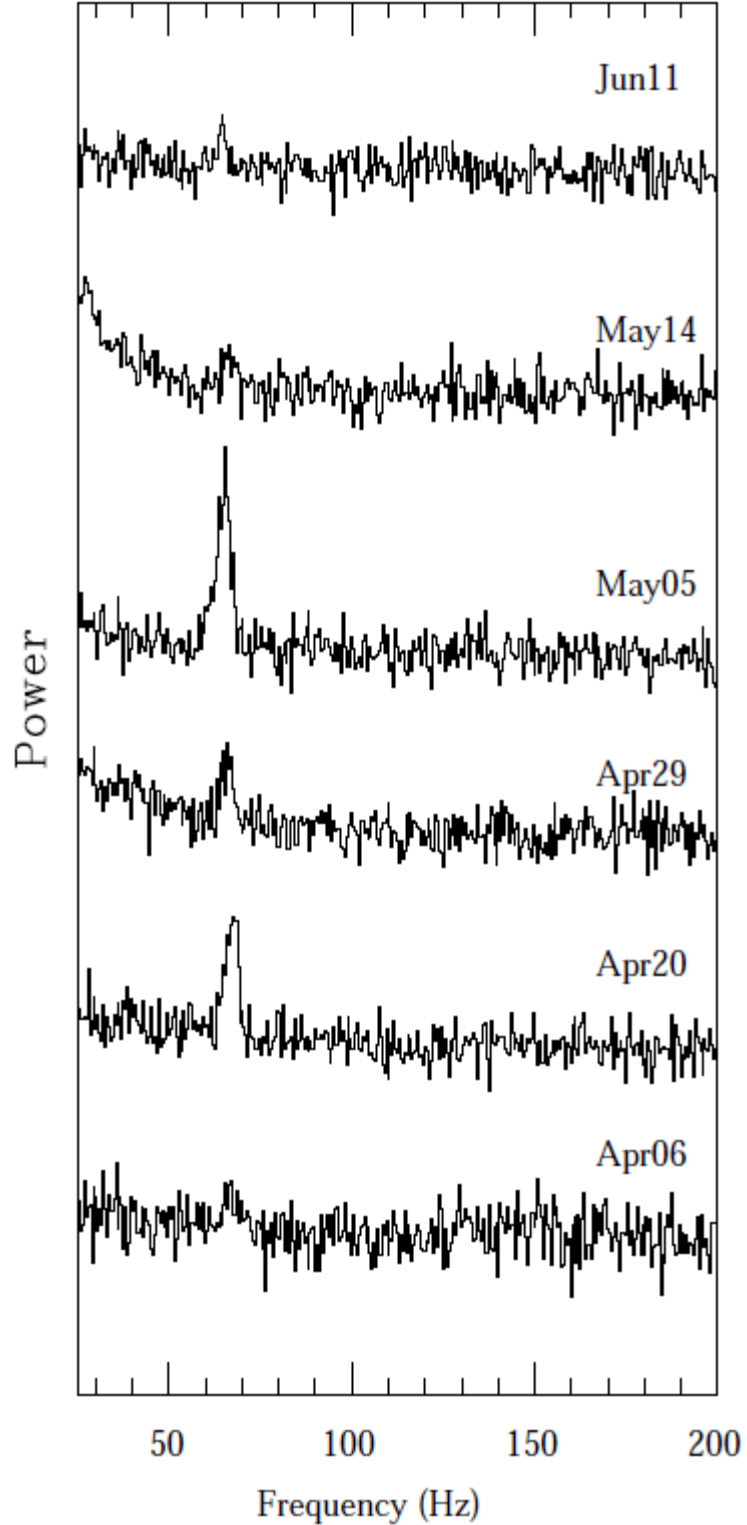
Neilsen's talk



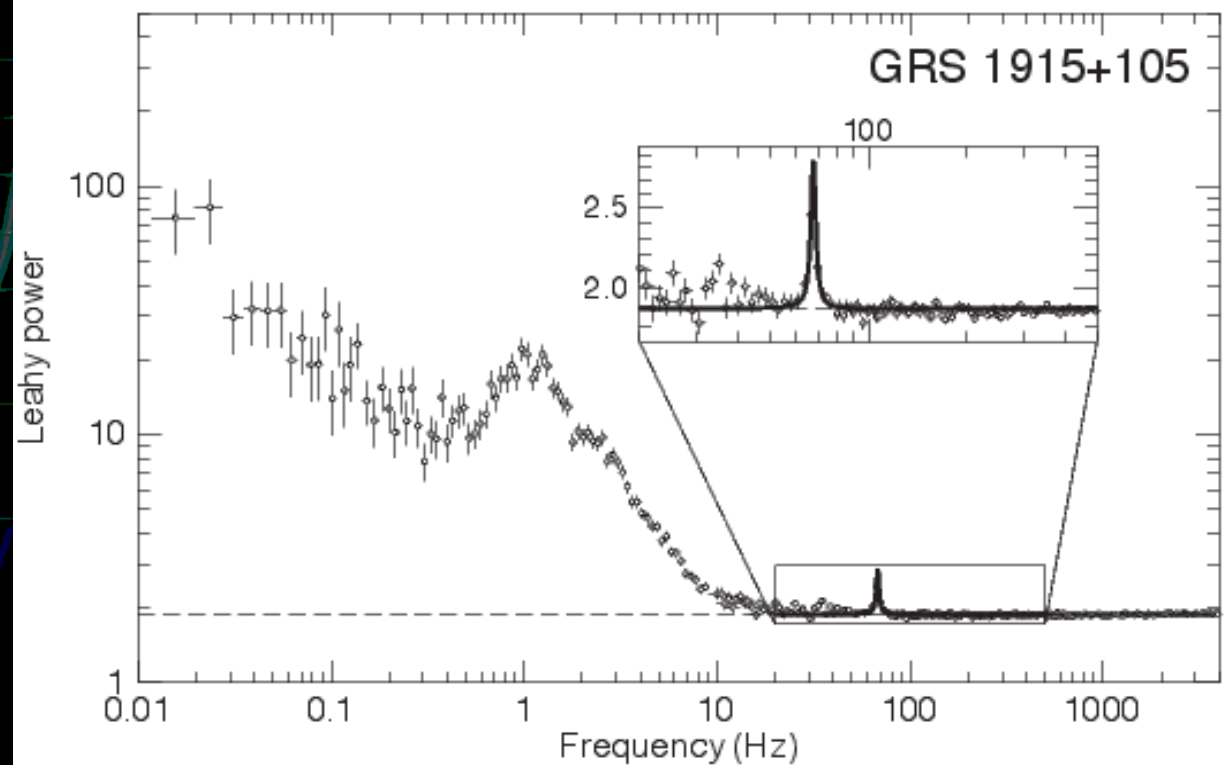
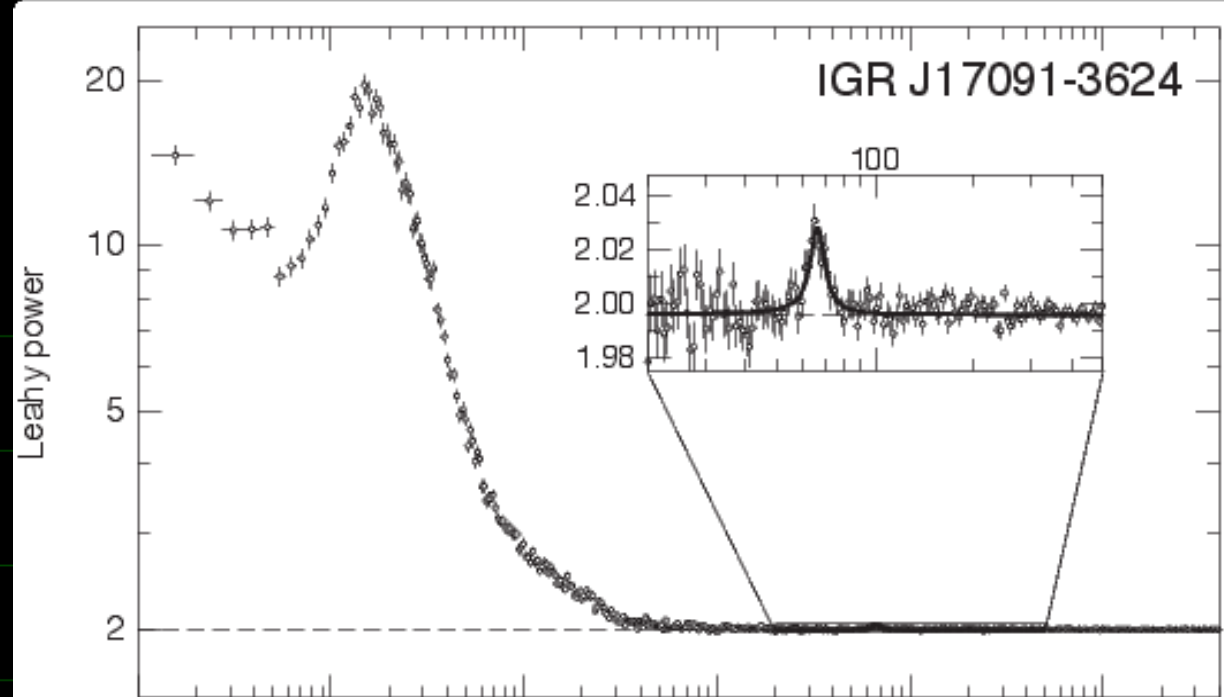


...High-Frequency QPOs as tracers of black hole mass and spin ...



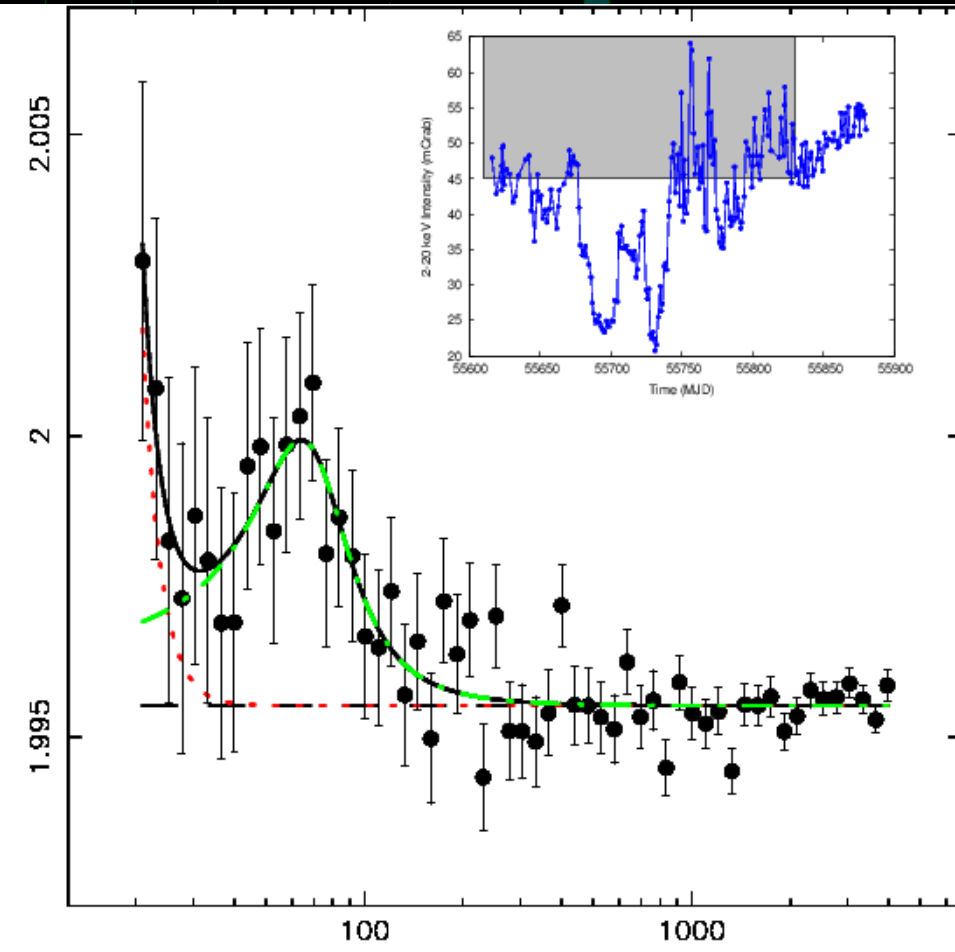
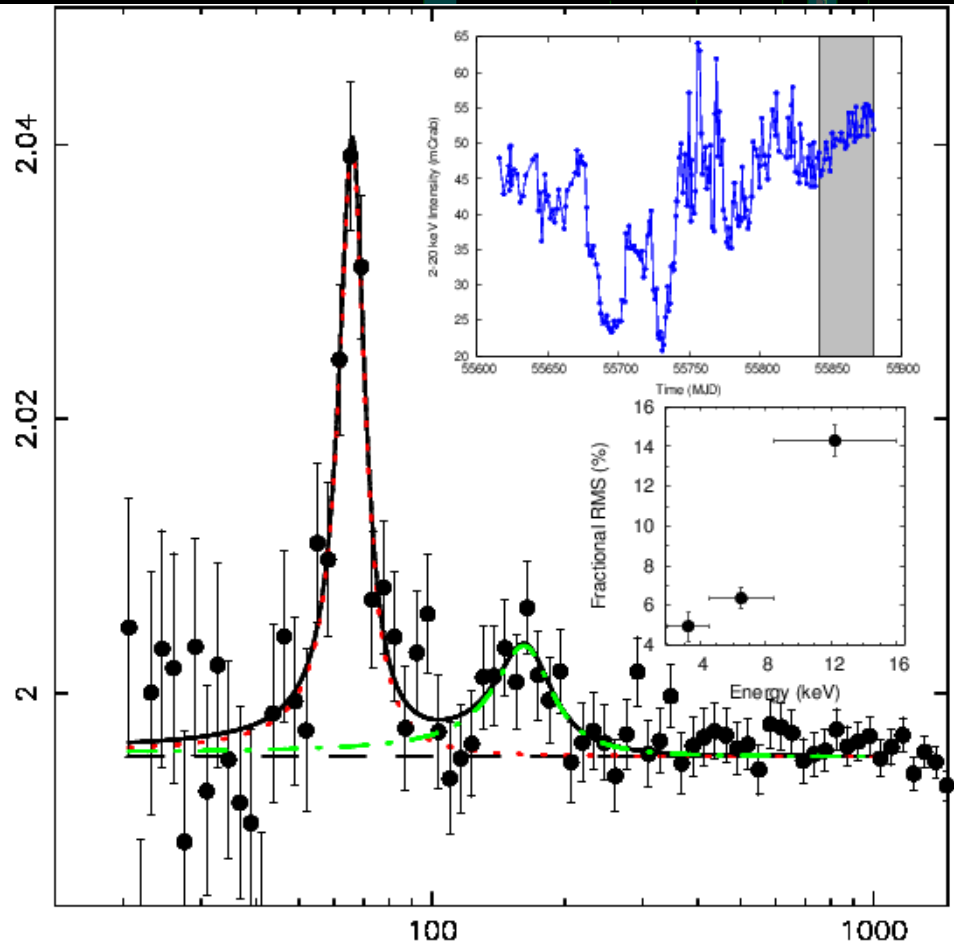


Morgan et al. 1997



Altamirano & Belloni 2012

Leahy Power



Frequency (Hz)

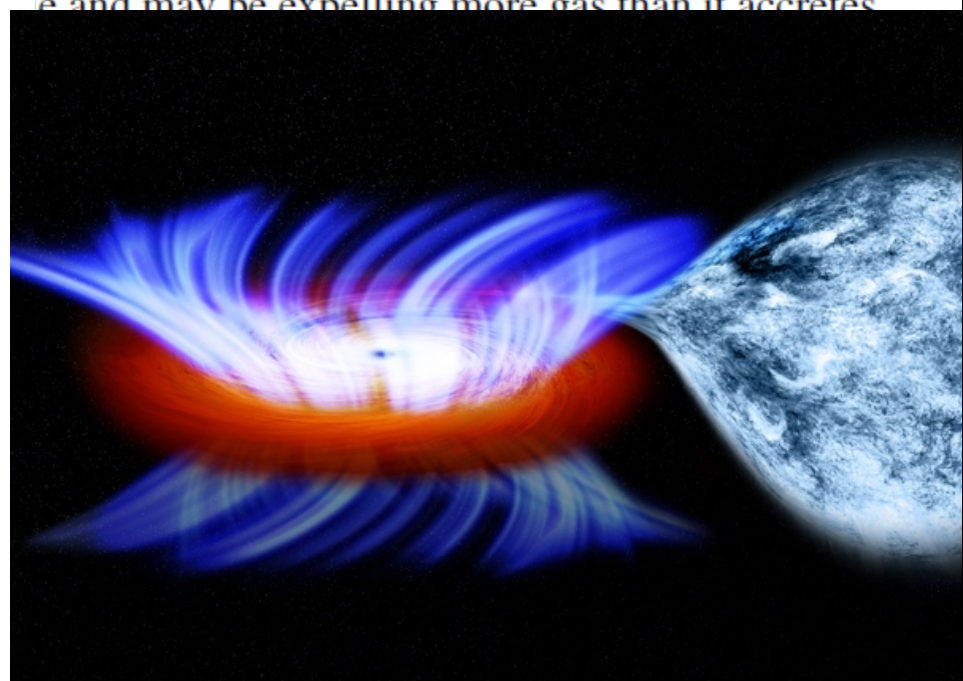
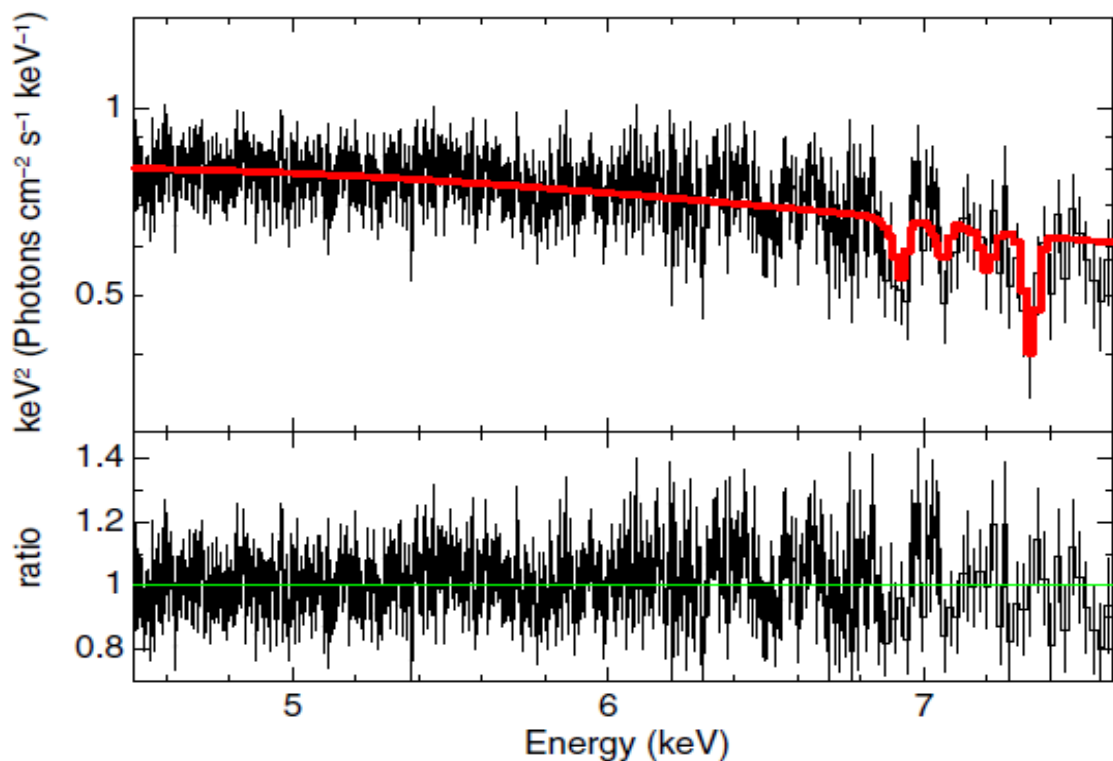
AN EXTREME X-RAY DISK WIND IN THE BLACK HOLE CANDIDATE IGR J17091–3624

A. L. KING¹, J. M. MILLER¹, J. RAYMOND², A. C. FABIAN³, C. S. REYNOLDS⁴, T. R. KALLMAN⁵,
D. MAITRA¹, E. M. CACKETT^{3,6}, AND M. P. RUPEN⁷

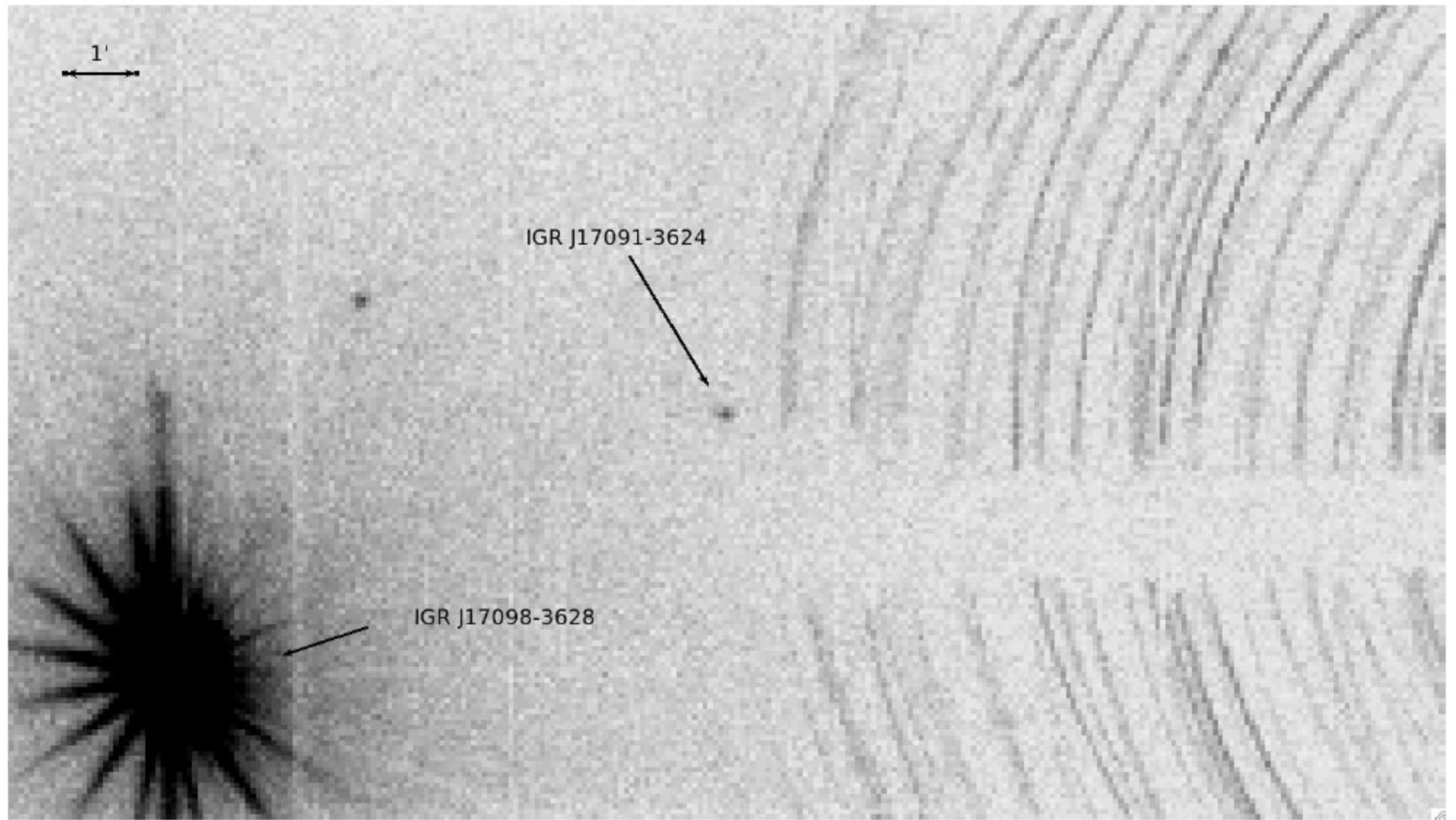
ABSTRACT

Chandra spectroscopy of transient stellar-mass black holes in outburst has clearly revealed accretion disk winds in soft, disk-dominated states, in apparent anti-correlation with relativistic jets in low/hard states. These disk winds are observed to be highly ionized, dense, and to have typical velocities of $\sim 1000 \text{ km s}^{-1}$ or less projected along our line of sight. Here, we present an analysis of two *Chandra* High Energy Transmission Grating spectra of the Galactic black hole candidate IGR J17091–3624 and contemporaneous Expanded Very Large Array (EVLA) radio observations, obtained in 2011. The second *Chandra* observation reveals an absorption line at $6.91 \pm 0.01 \text{ keV}$; associating this line with He-like Fe xxv requires a blueshift of $9300^{+500}_{-400} \text{ km s}^{-1}$ ($0.03c$, or the escape velocity at $1000 R_{\text{Schw}}$). This projected outflow velocity is an order of magnitude higher than has previously been observed in stellar-mass black holes, and is broadly consistent with some of the fastest winds detected in active galactic nuclei.

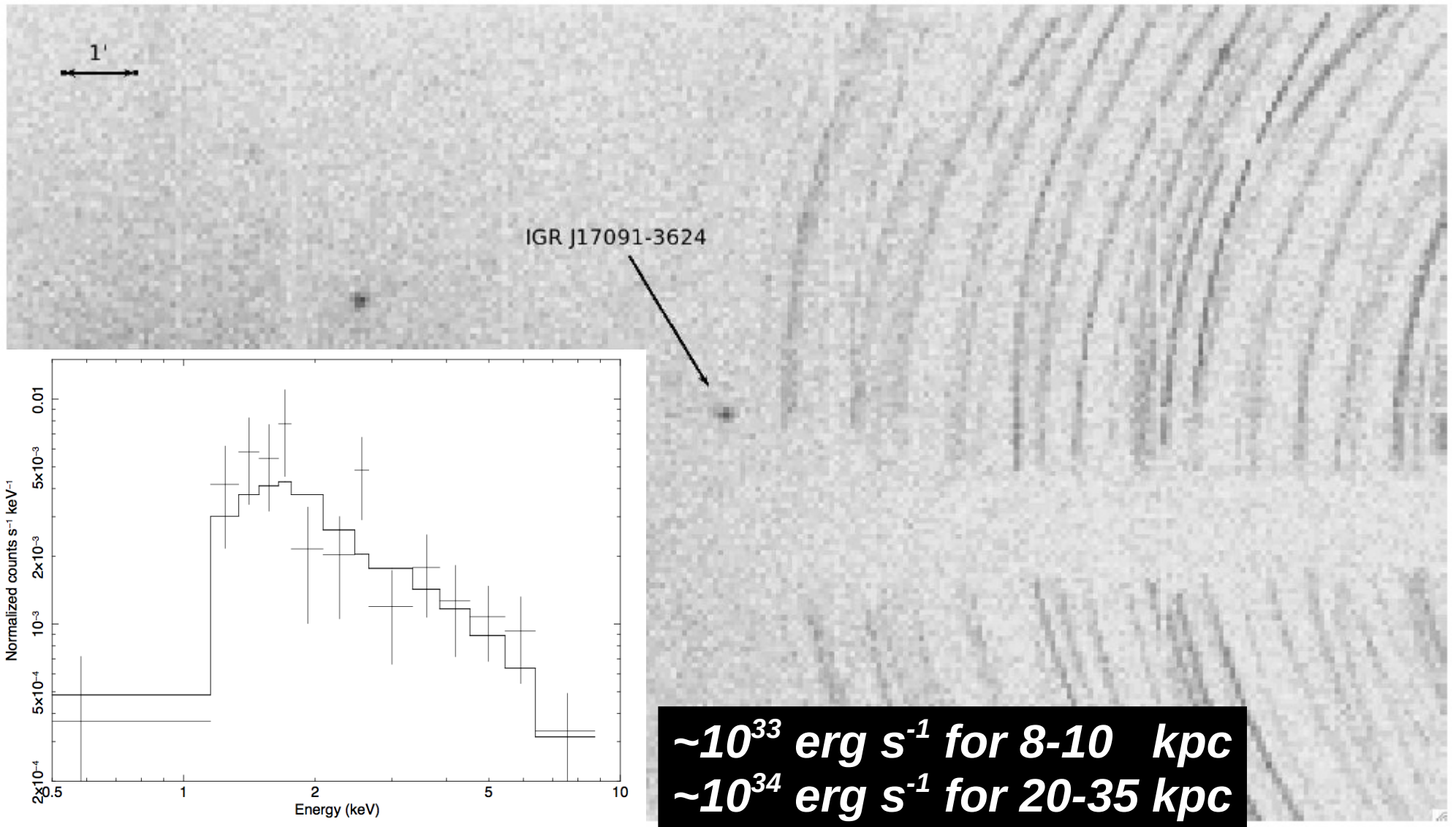
at a velocity of $\sim 14,600 \text{ km s}^{-1}$ ($0.05c$), but this is much faster than the accretion disk wind in IGR J17091–3624 and may be expelling more gas than it accretes.



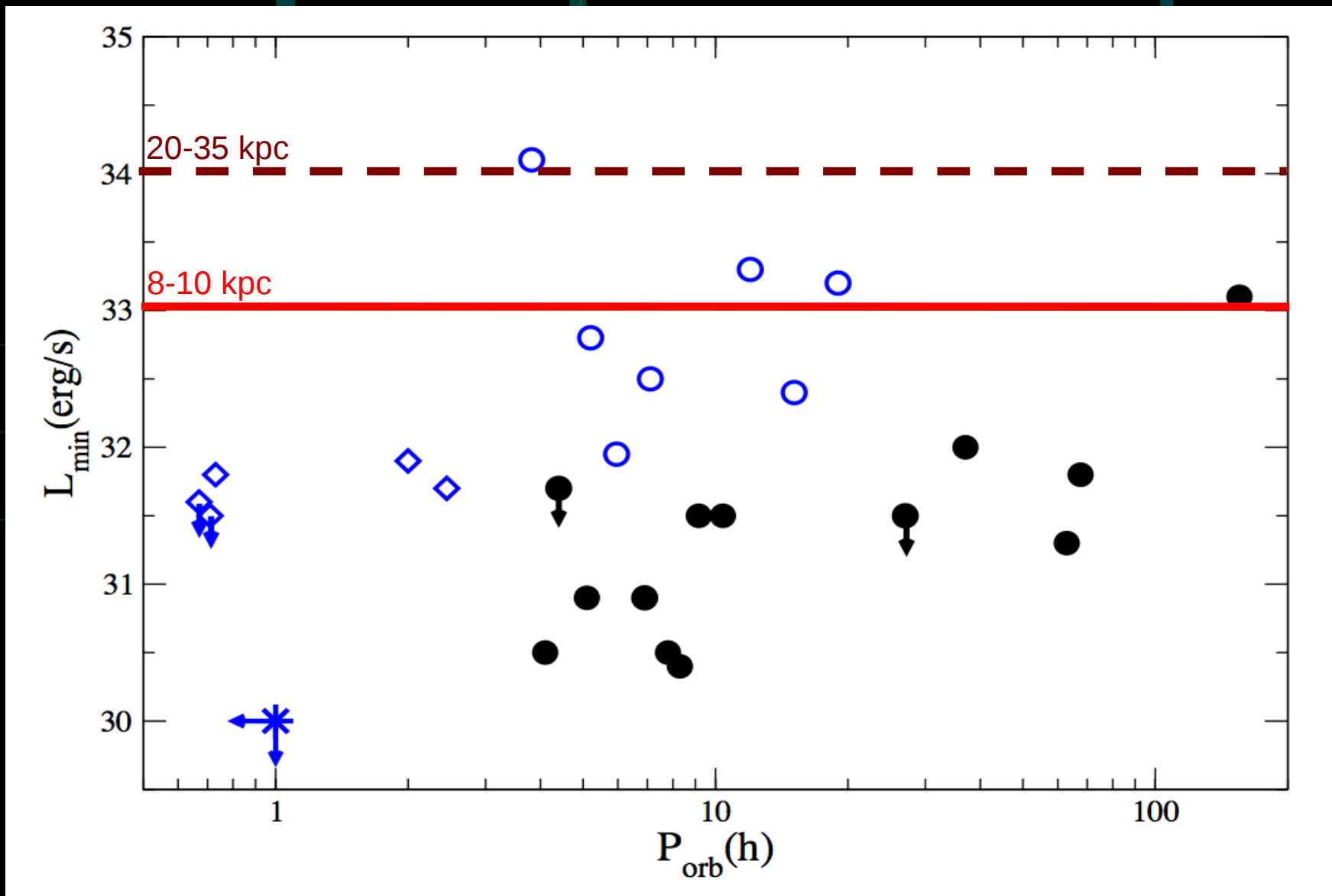
...IGR J17091-3624 in quiescence ...



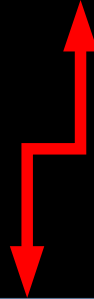
...IGR J17091-3624 in quiescence ...



...IGR J17091-3624 in quiescence ...



Same type of low-frequency
X-ray variability !!!



Same type of low-frequency
X-ray variability !!!

PDS very similar
Between sources

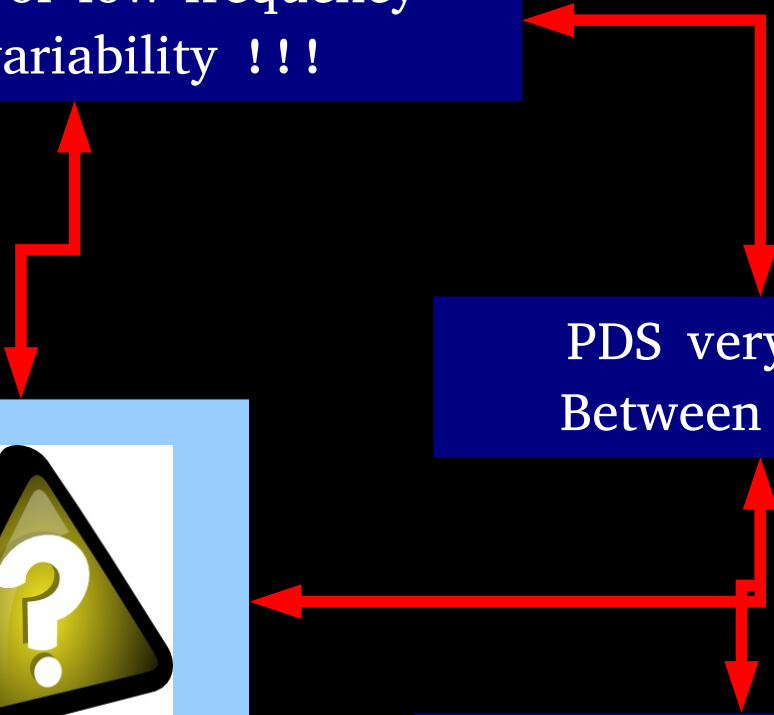


Same type of low-frequency
X-ray variability !!!



PDS very similar
Between sources

Heartbeats and others
Faster than in GRS1915



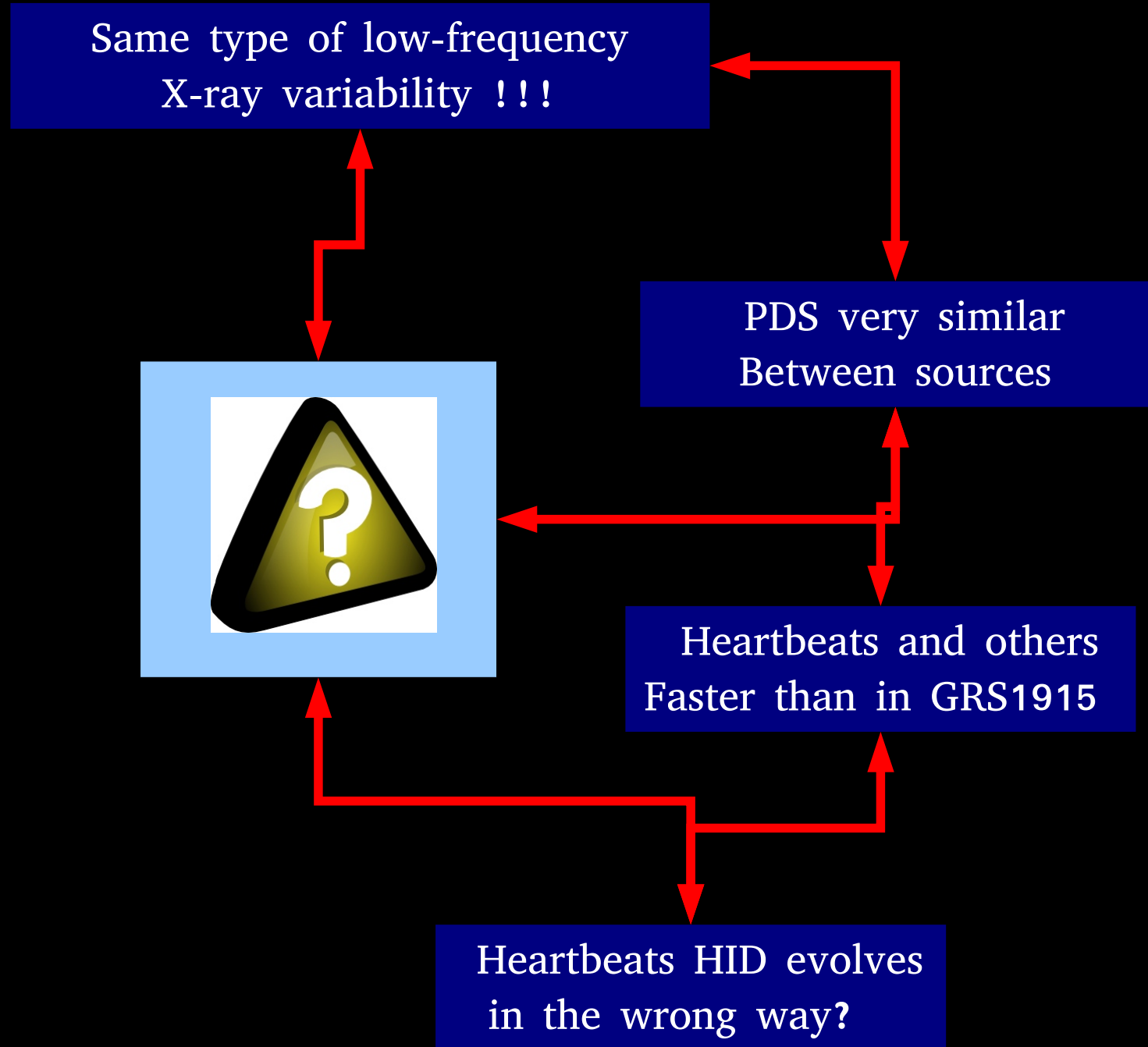
Same type of low-frequency
X-ray variability !!!

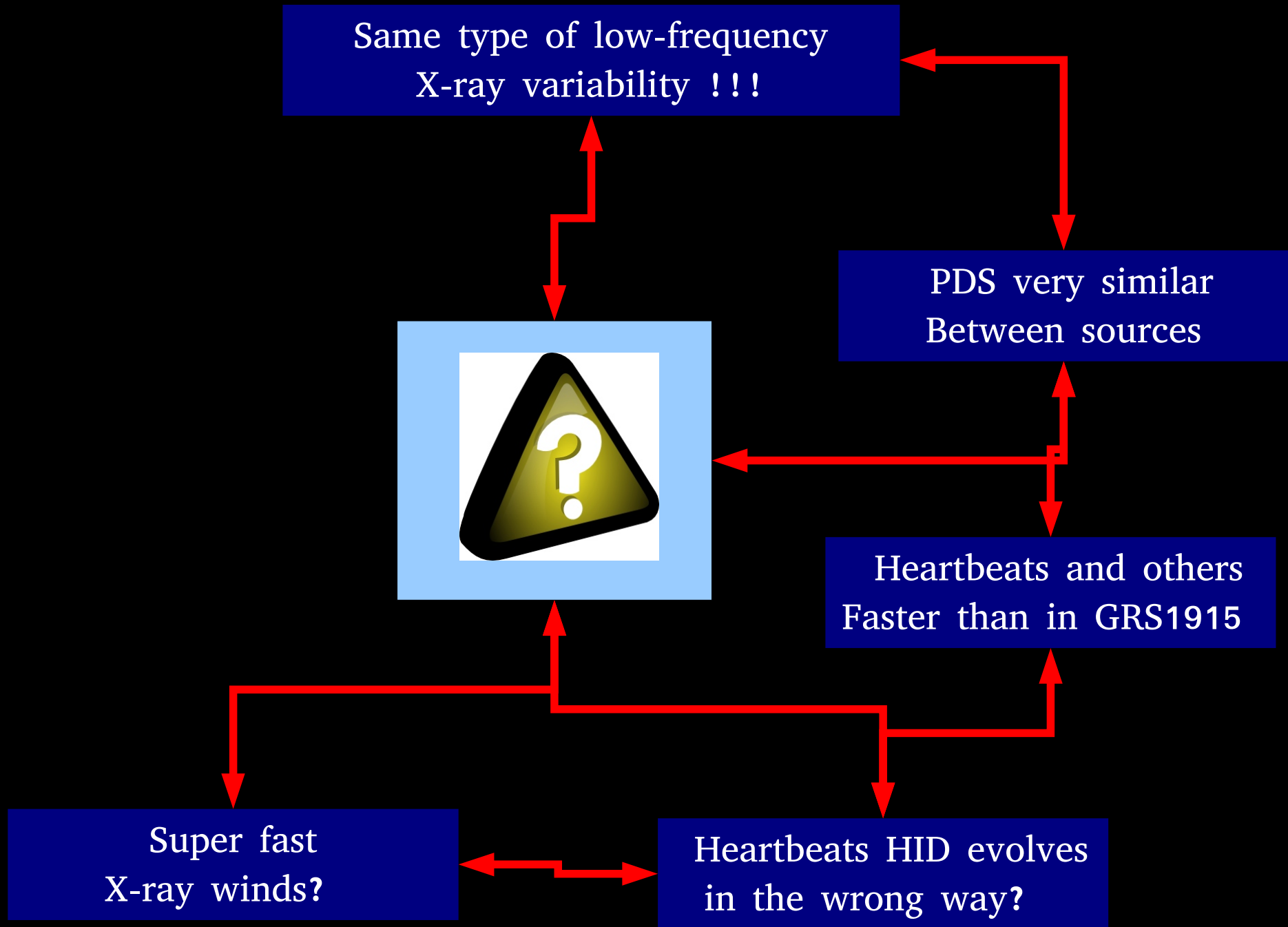
PDS very similar
Between sources

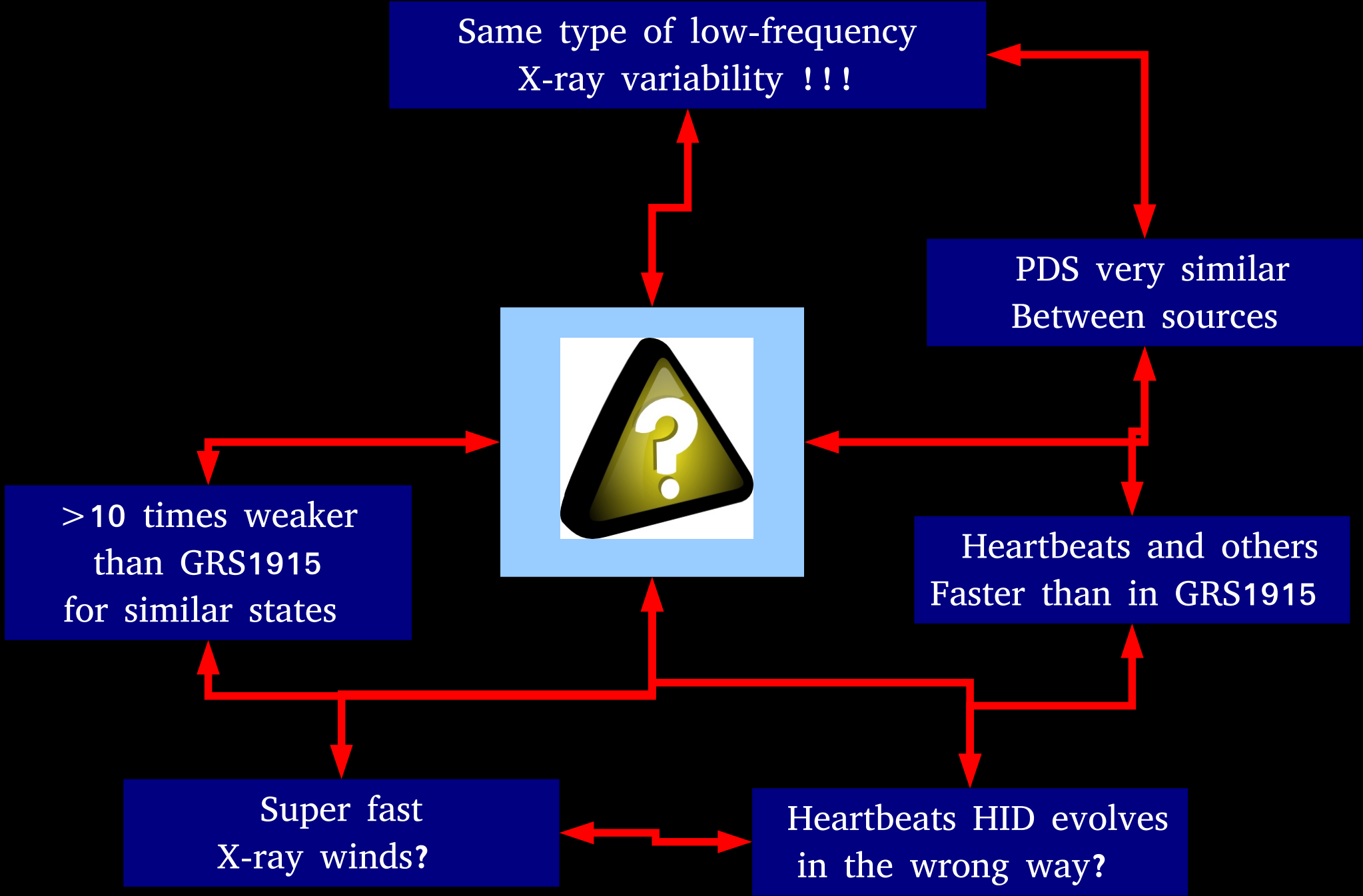


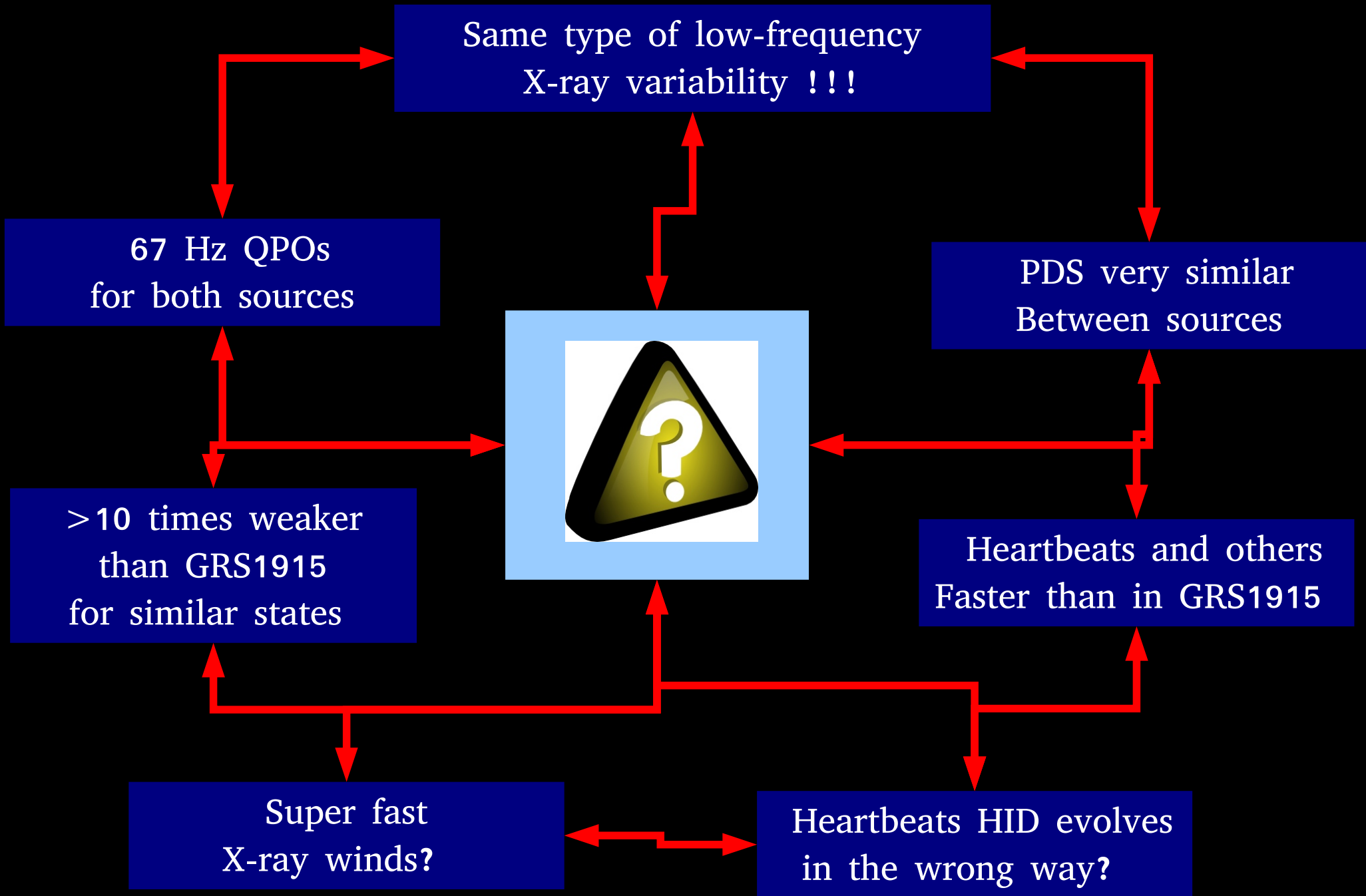
Heartbeats and others
Faster than in GRS1915

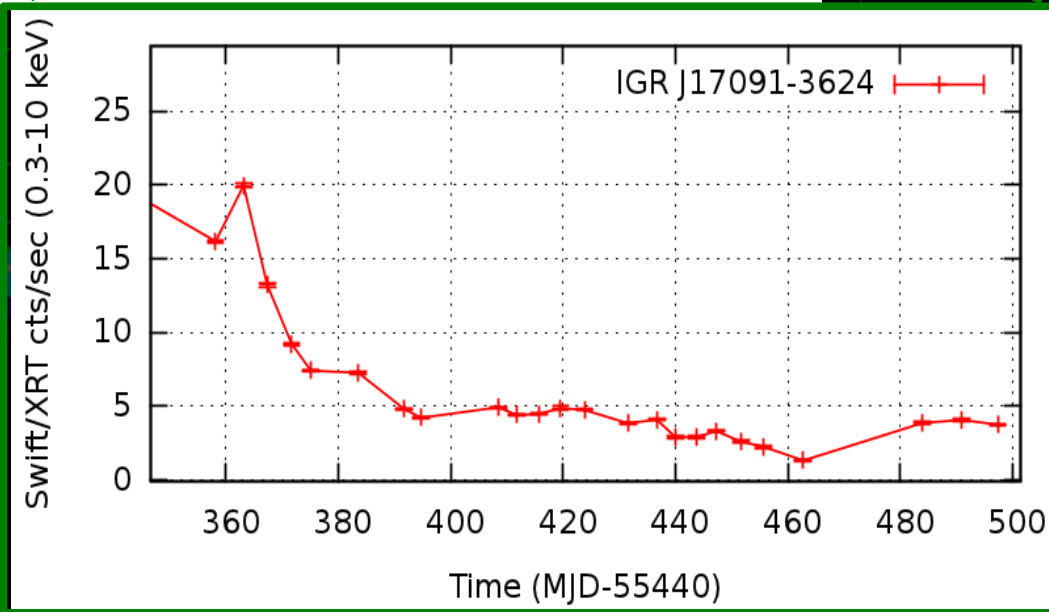
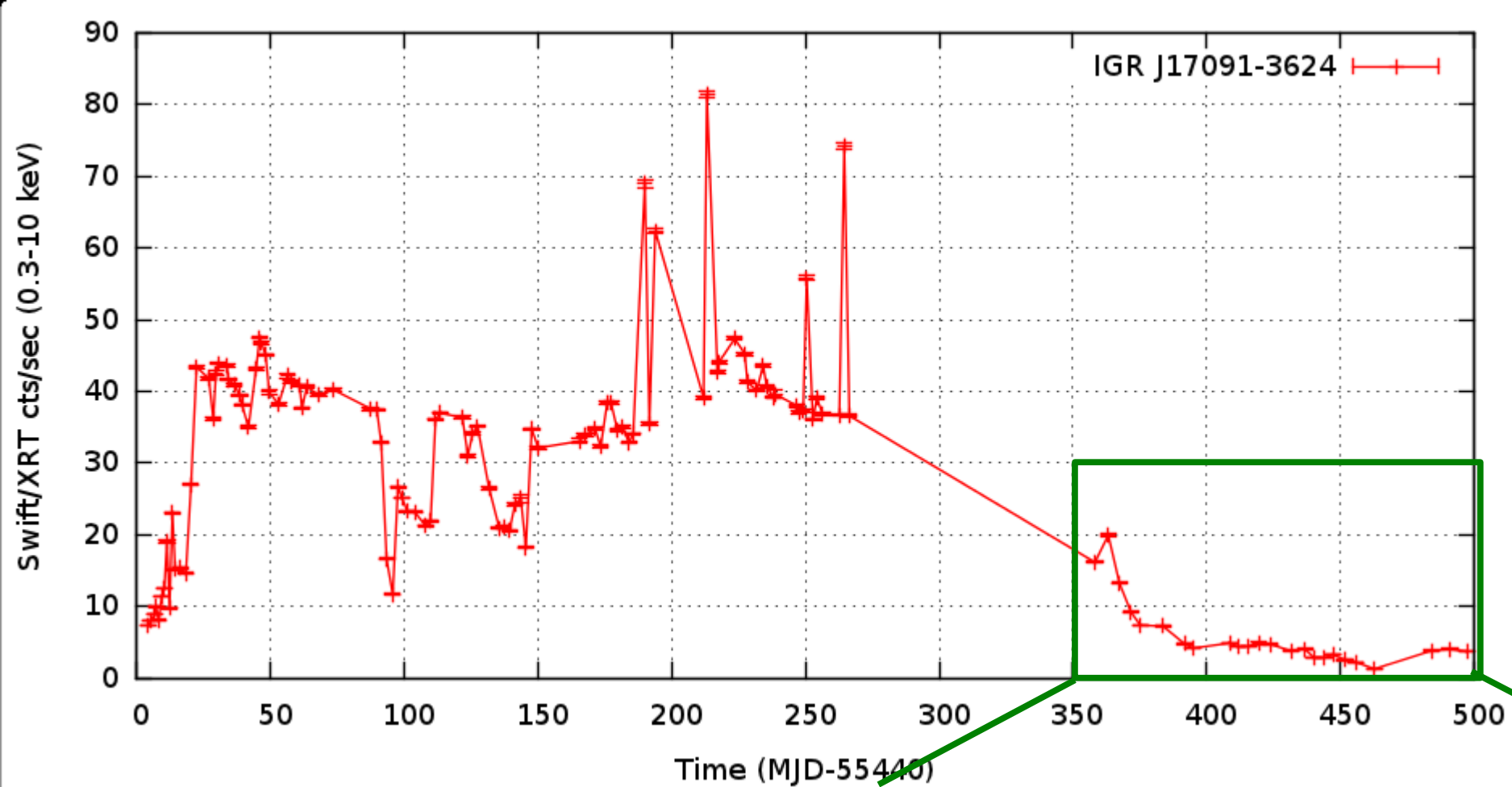
Heartbeats HID evolves
in the wrong way?











Still alive!!!
but at low flux....