IGR J17091-3624: the Little Sister of the Enigmatic Black Hole GRS 1915+105

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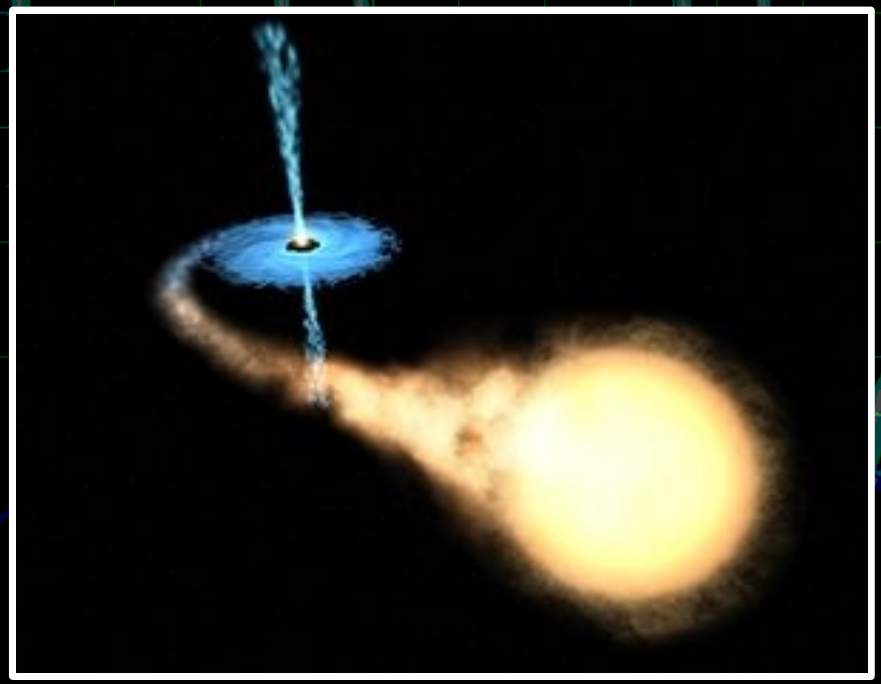
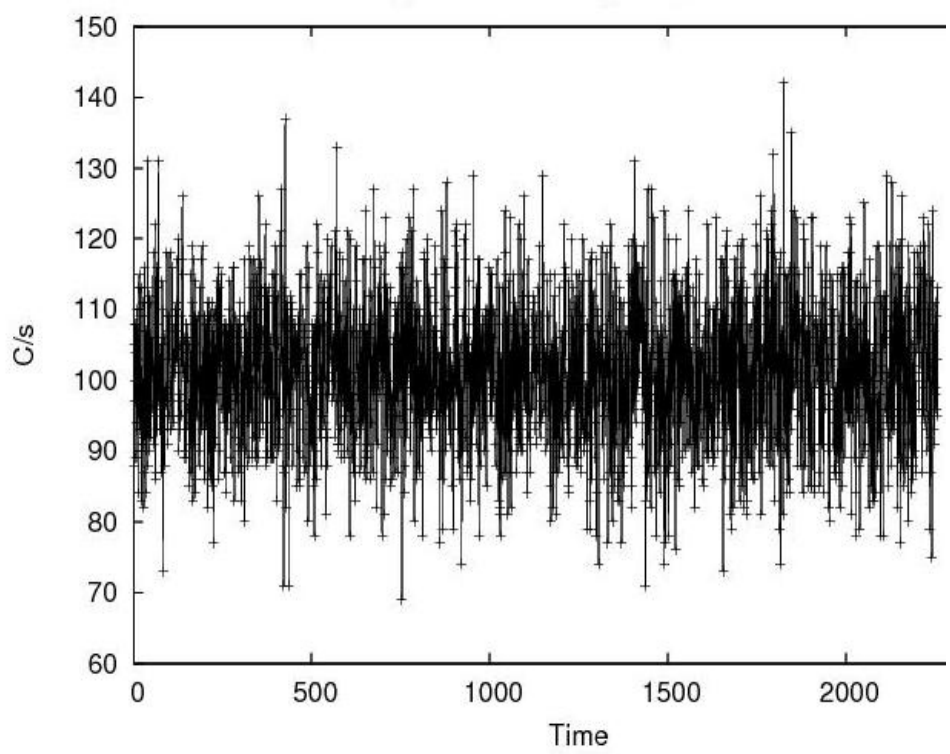
Belloni, T.; Linares, M.; van der Klis, M.; Wijnands, R.; Curran, P. A.; Kalamkar, M.; Stiele, H.; Motta, S.; Muñoz-Darias, T.; Yang,Y. J, ; Casella, P.; Krimm, H.

X-ray light curves of typical BHs

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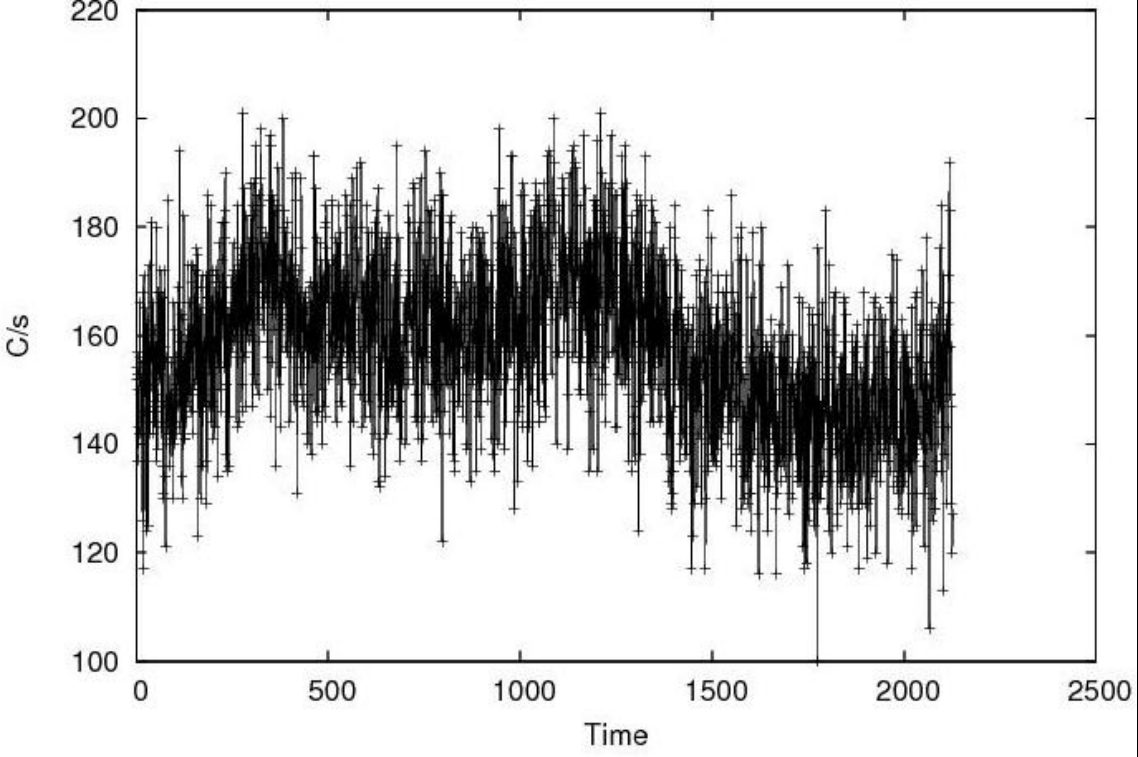
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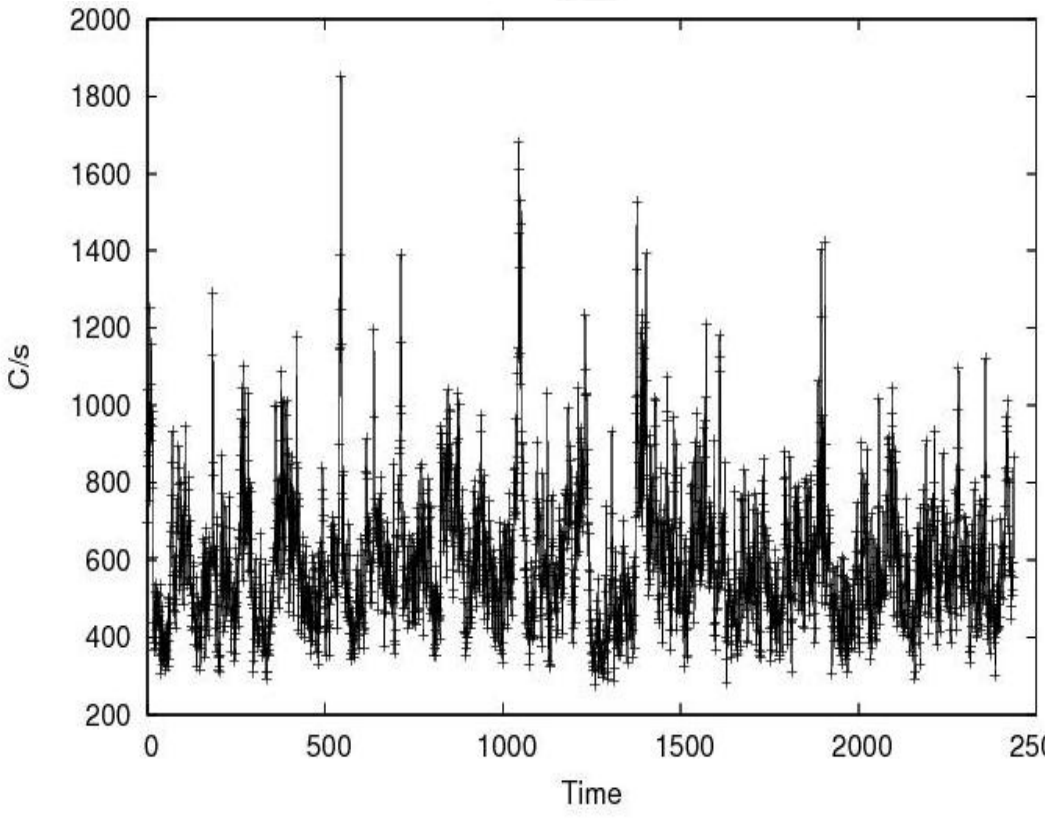
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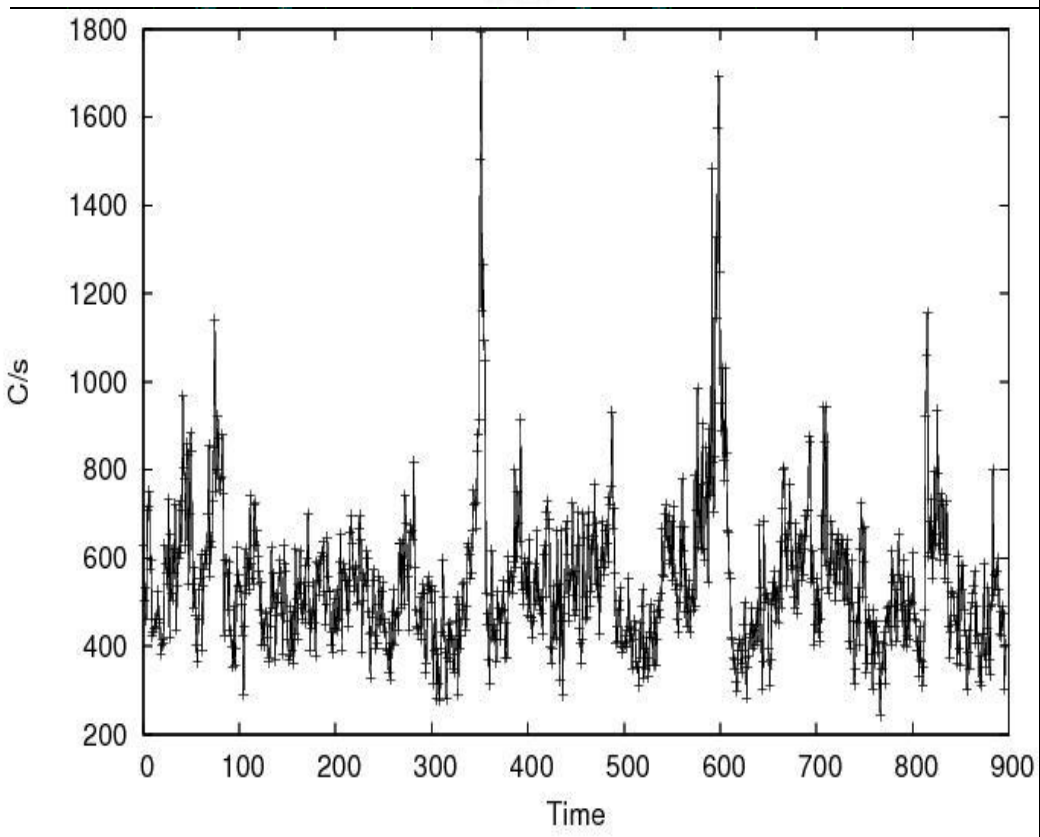
C/s
Time
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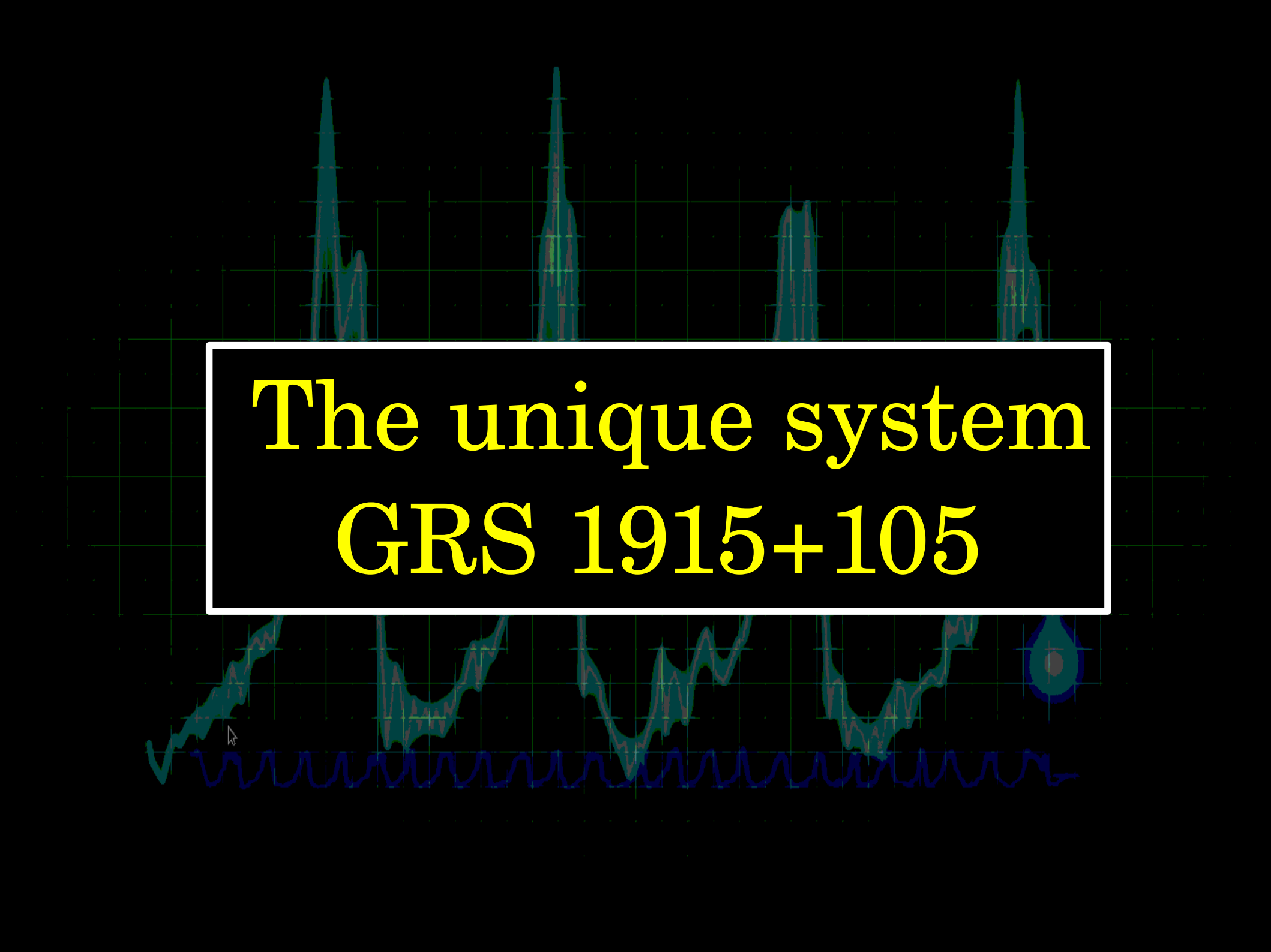
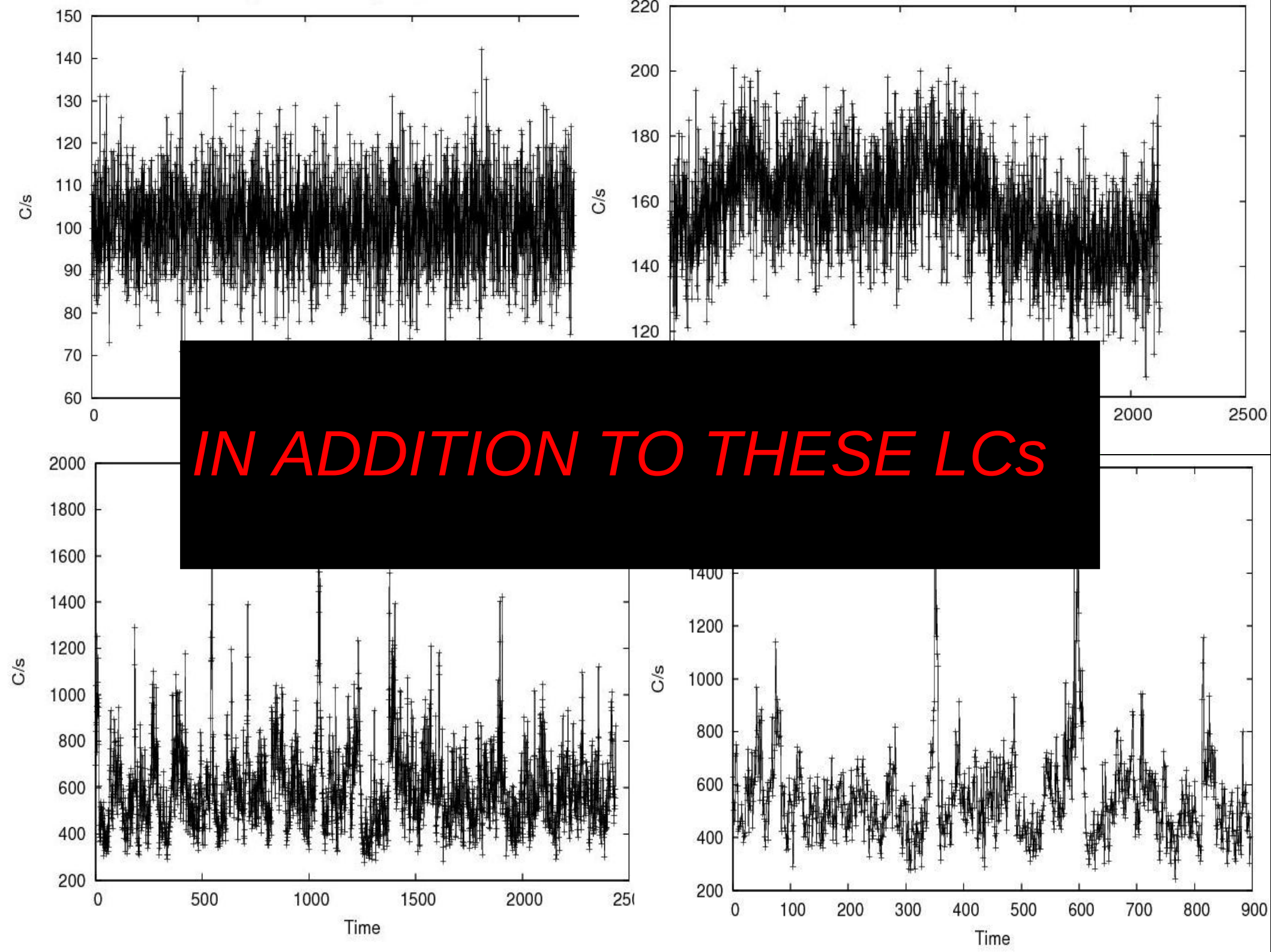

The unique system
GRS 1915+105

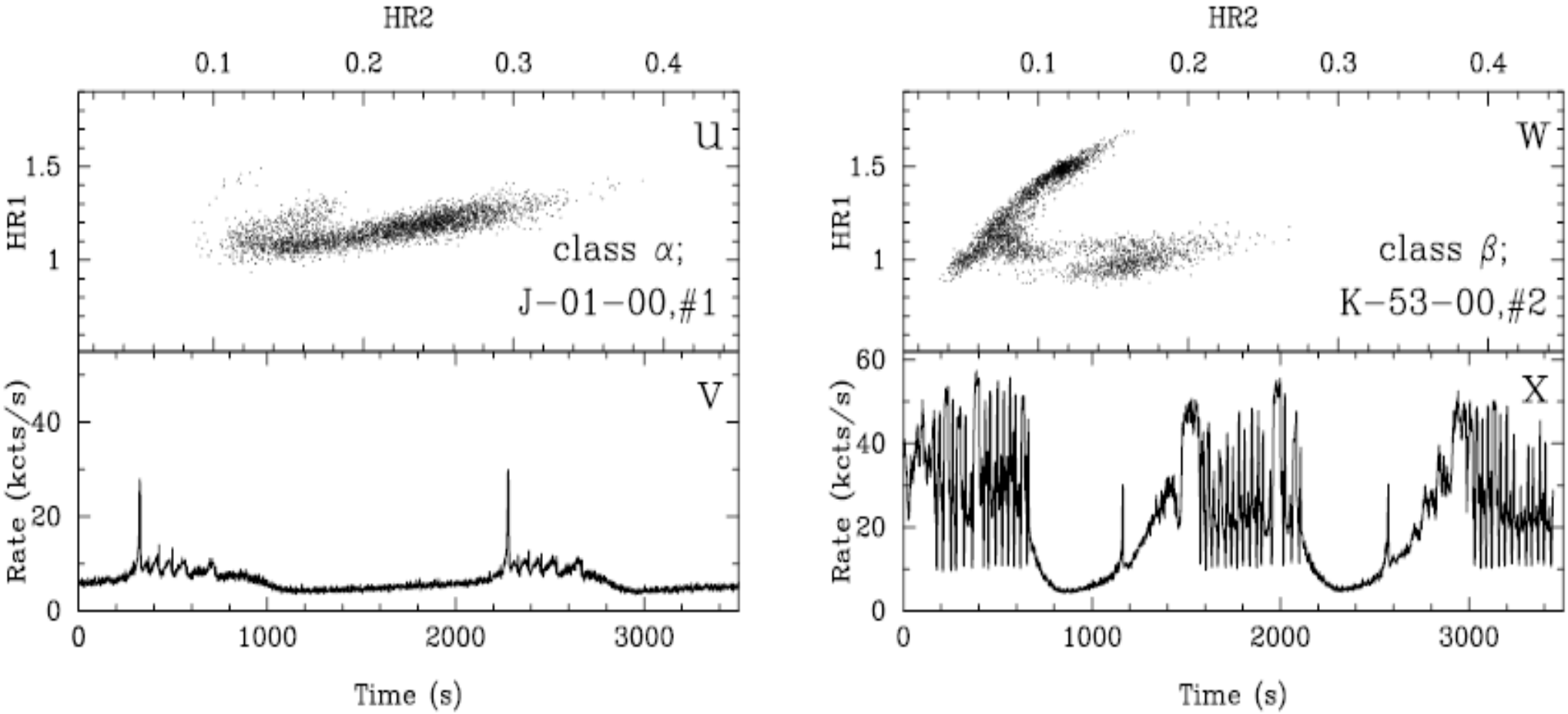
GRS 1915+105

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


C/s
Time
IN ADDITION TO THESE LCs

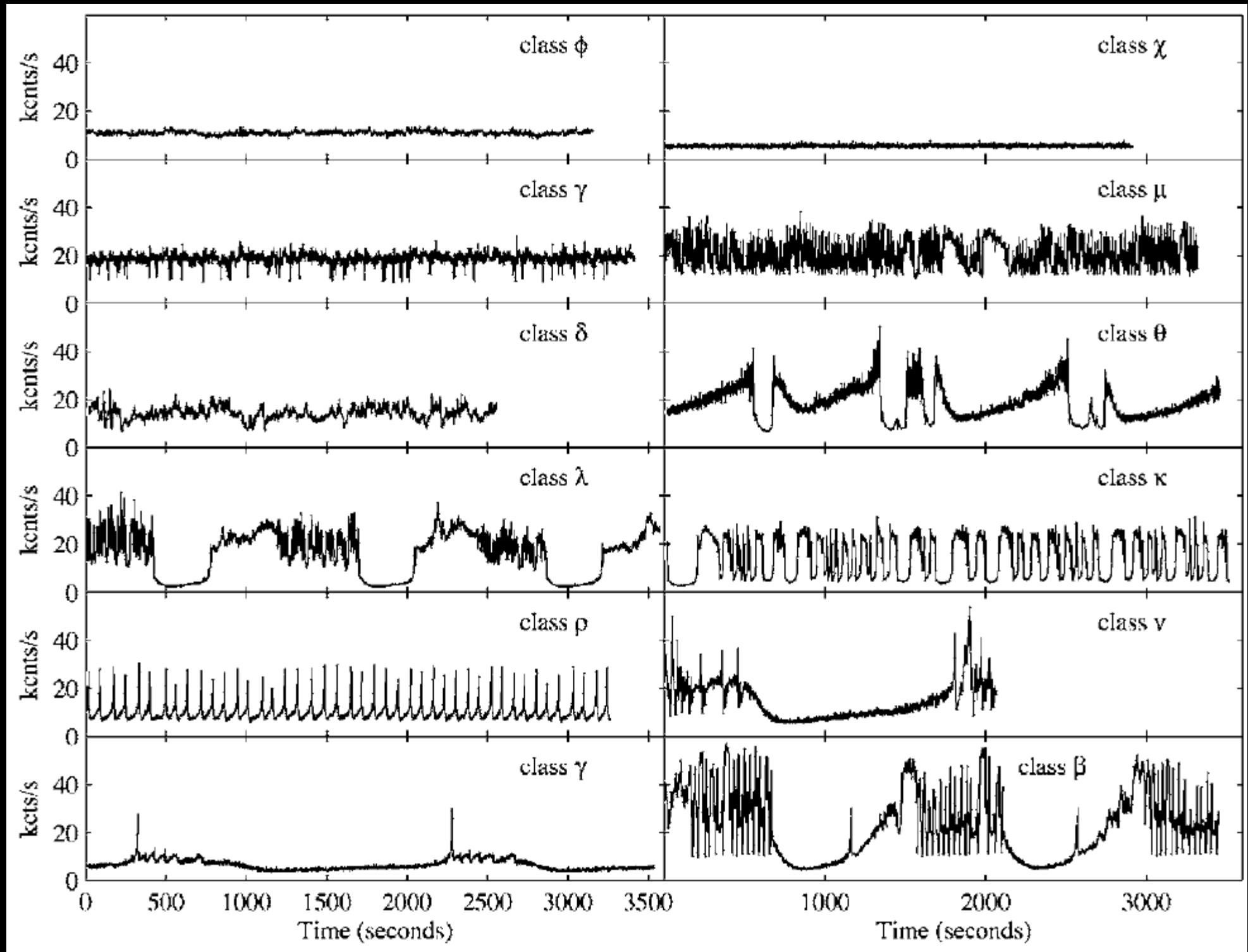
GRS 1915+105

Limit cycles of accretion and ejection in an unstable disk



Belloni et al. 2000

(See also Poster 25)


class ϕ
class χ
class γ
class μ
class δ
class θ
class λ
class κ
class ρ
class ν
class γ
class β
kcnts/s
kcts/s
0
20
40
0
500
1000
1500
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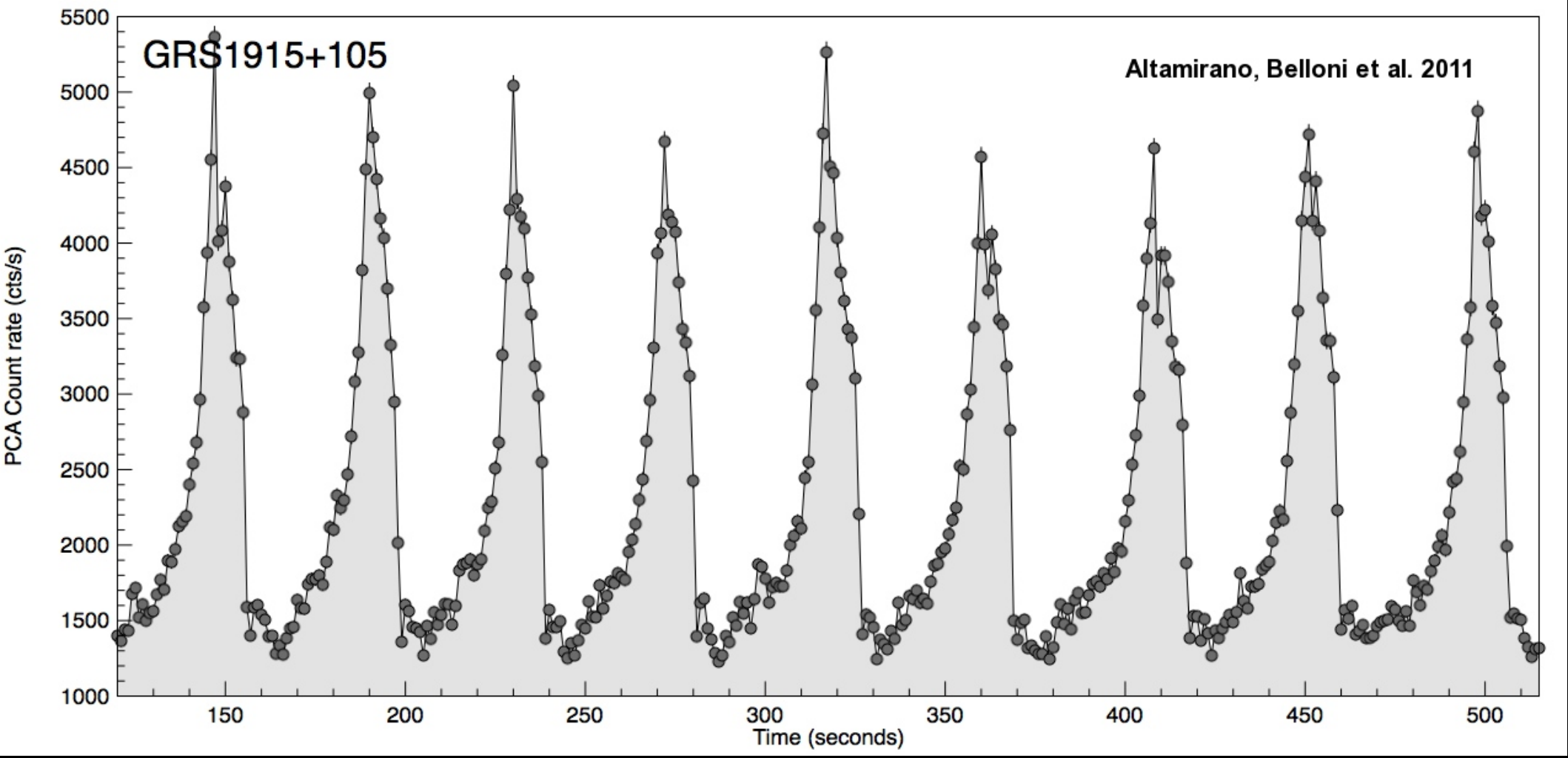
3000
3500
Time (seconds)
1000
2000
3000
Time (seconds)

GRS 1915+105 Heartbeats



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

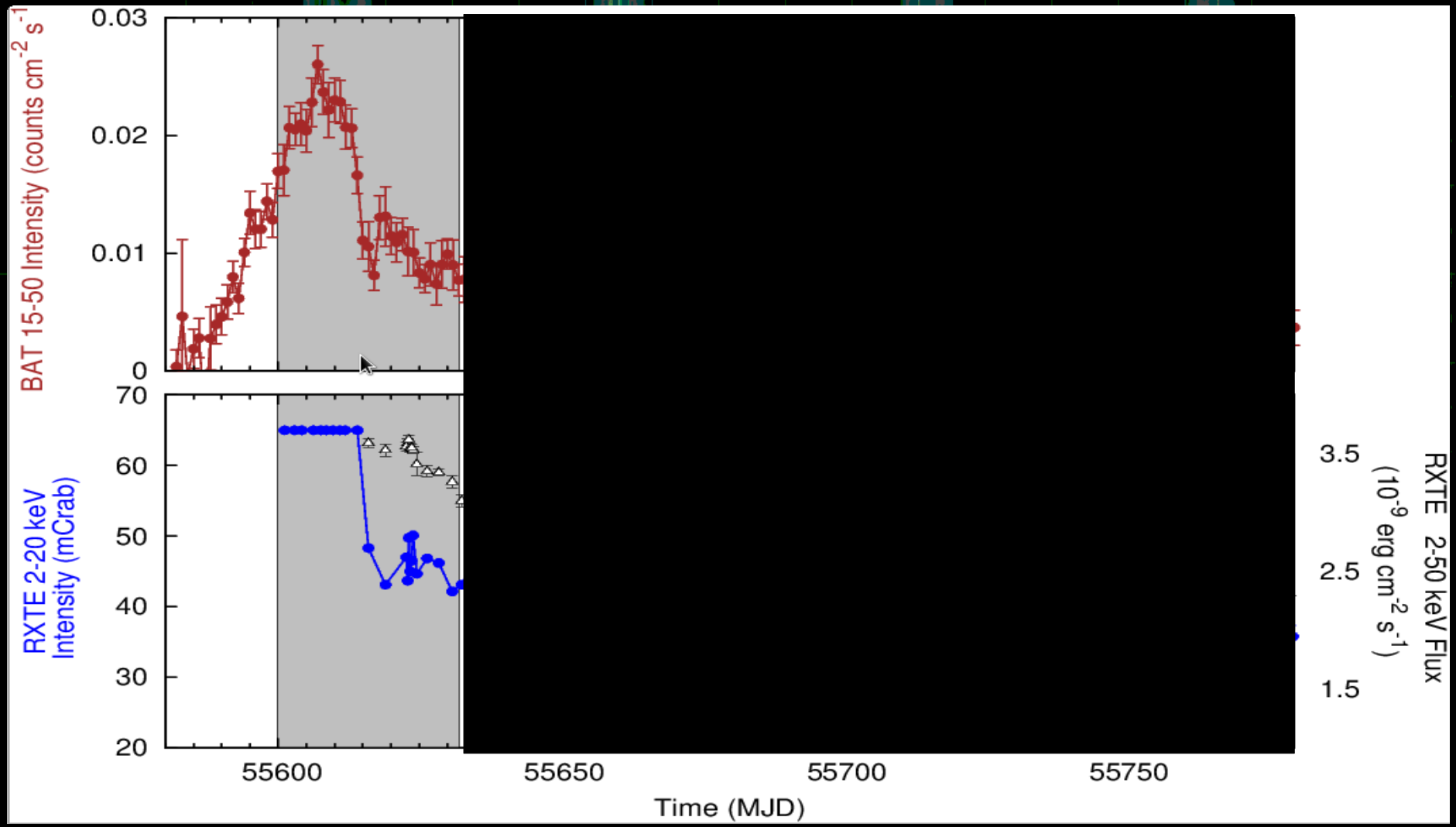
How can we know if we understand GRS 1915+105
If we don't have a second source to compare?

IGR J17091-3624
the last treasure discovered with RXTE

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

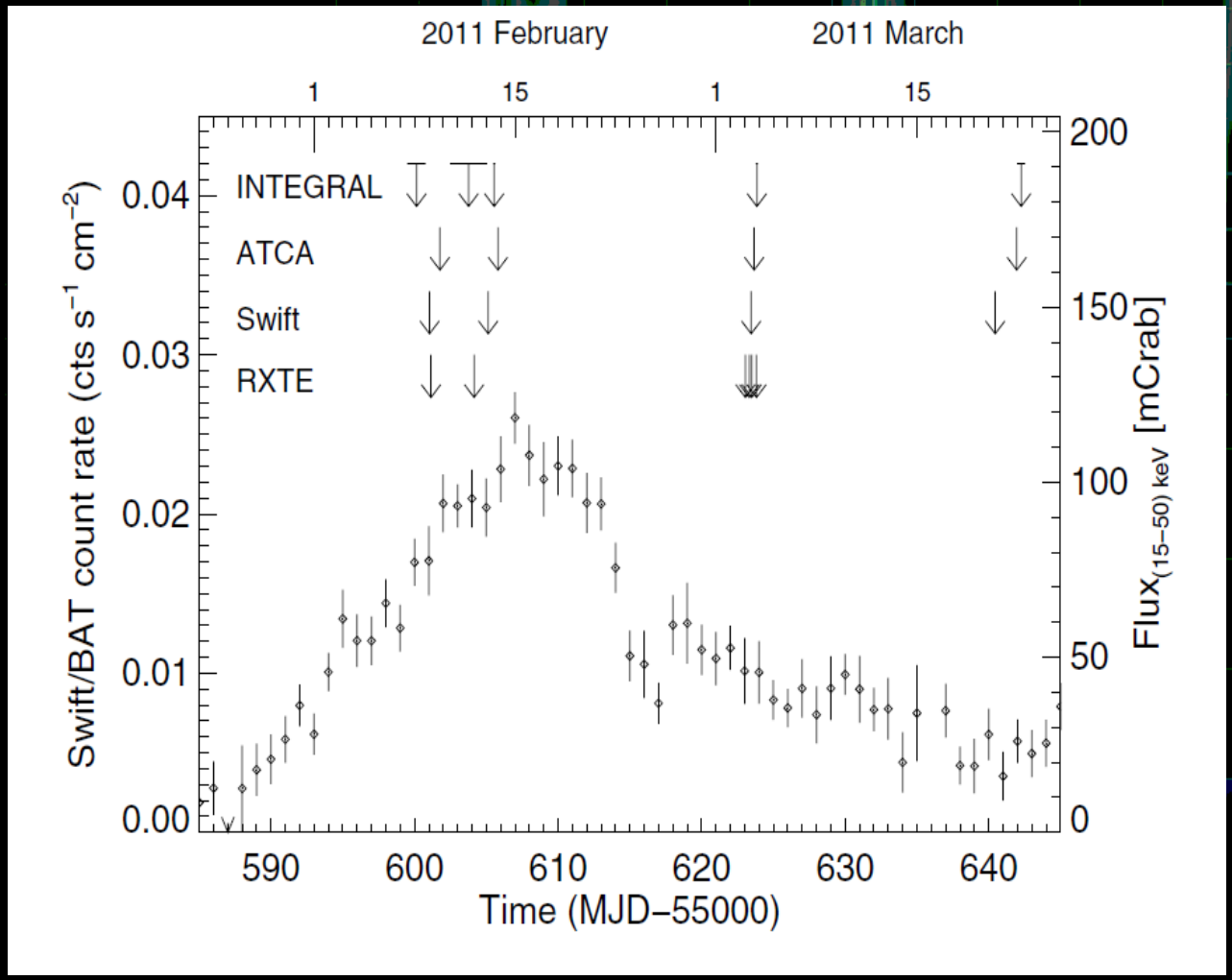
IGR J17091-3624: 2011 outburst

(The part of the outburst we did not see for GRS1915+109)



Altamirano et al. 2011

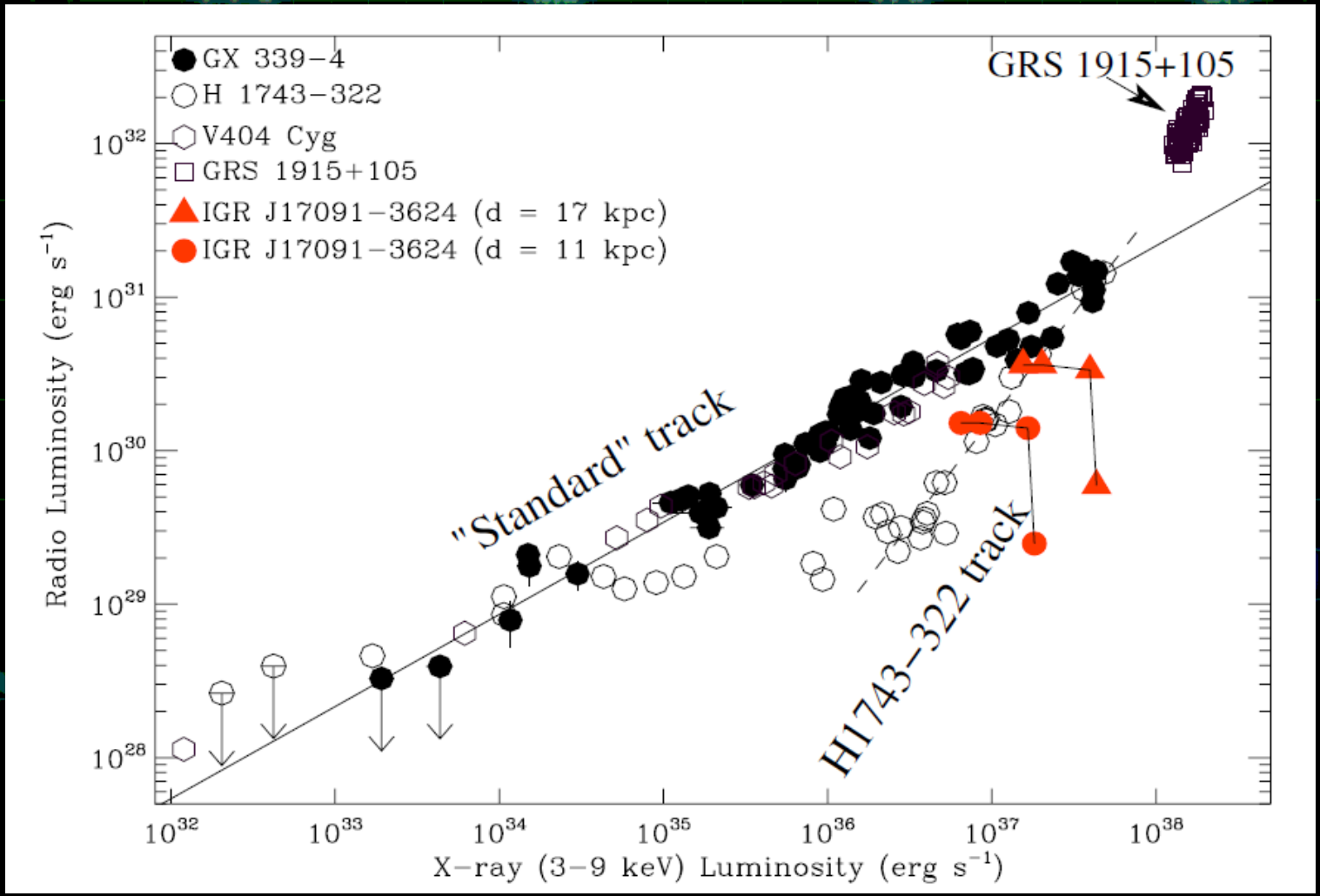
IGR J17091-3624: 2011 outburst



Obs.	$F_{5.5\ GHz}$ (mJy)	$F_{9\ GHz}$ (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 ± 0.19
A3	2.41 ± 0.10	1.13 ± 0.10	−1.54 ± 0.20
A4	0.17 ± 0.05	<0.08	

Rodriguez et al. 2011

IGR J17091-3624: 2011 outburst



Rodriguez et al. 2011

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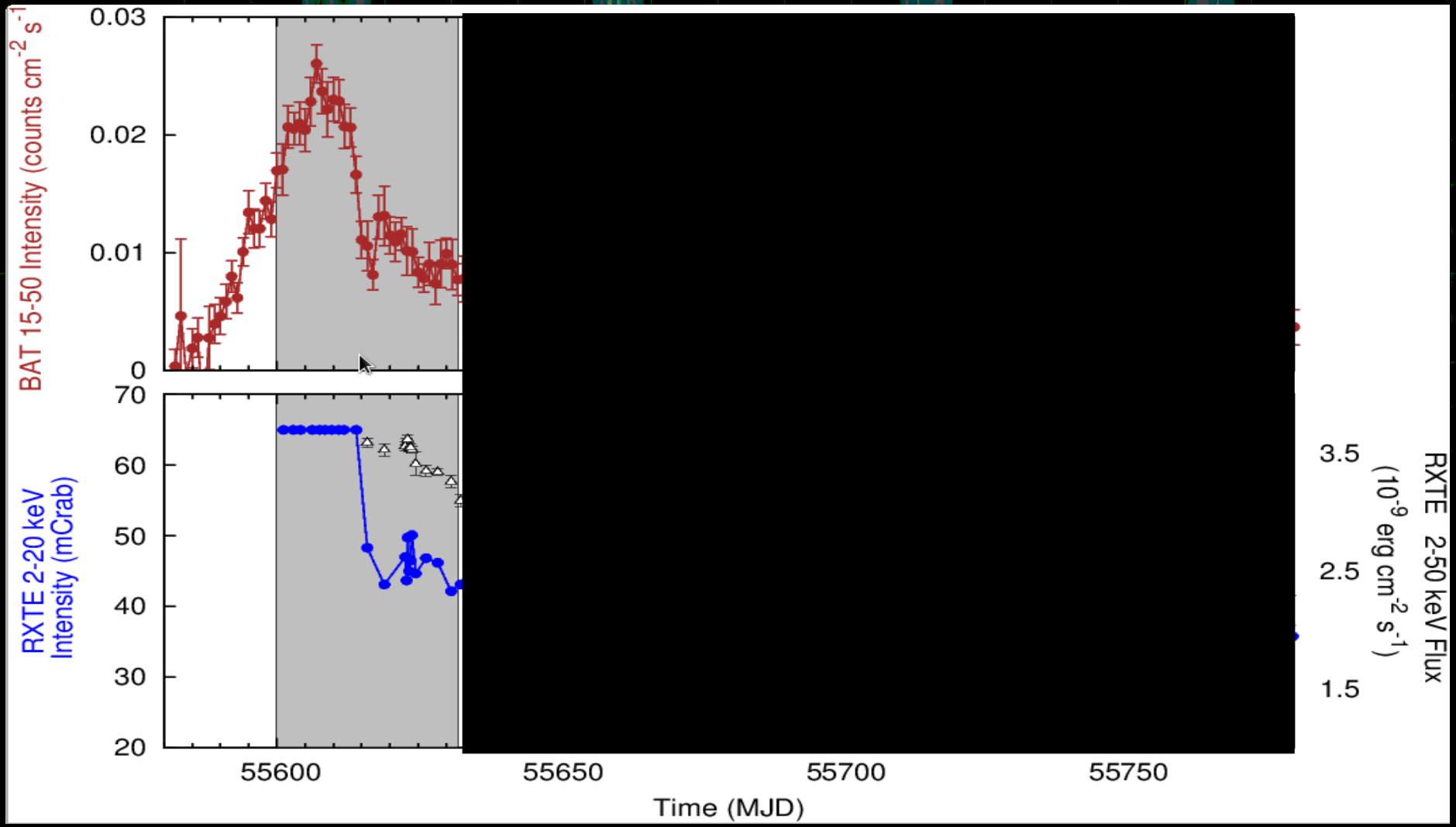
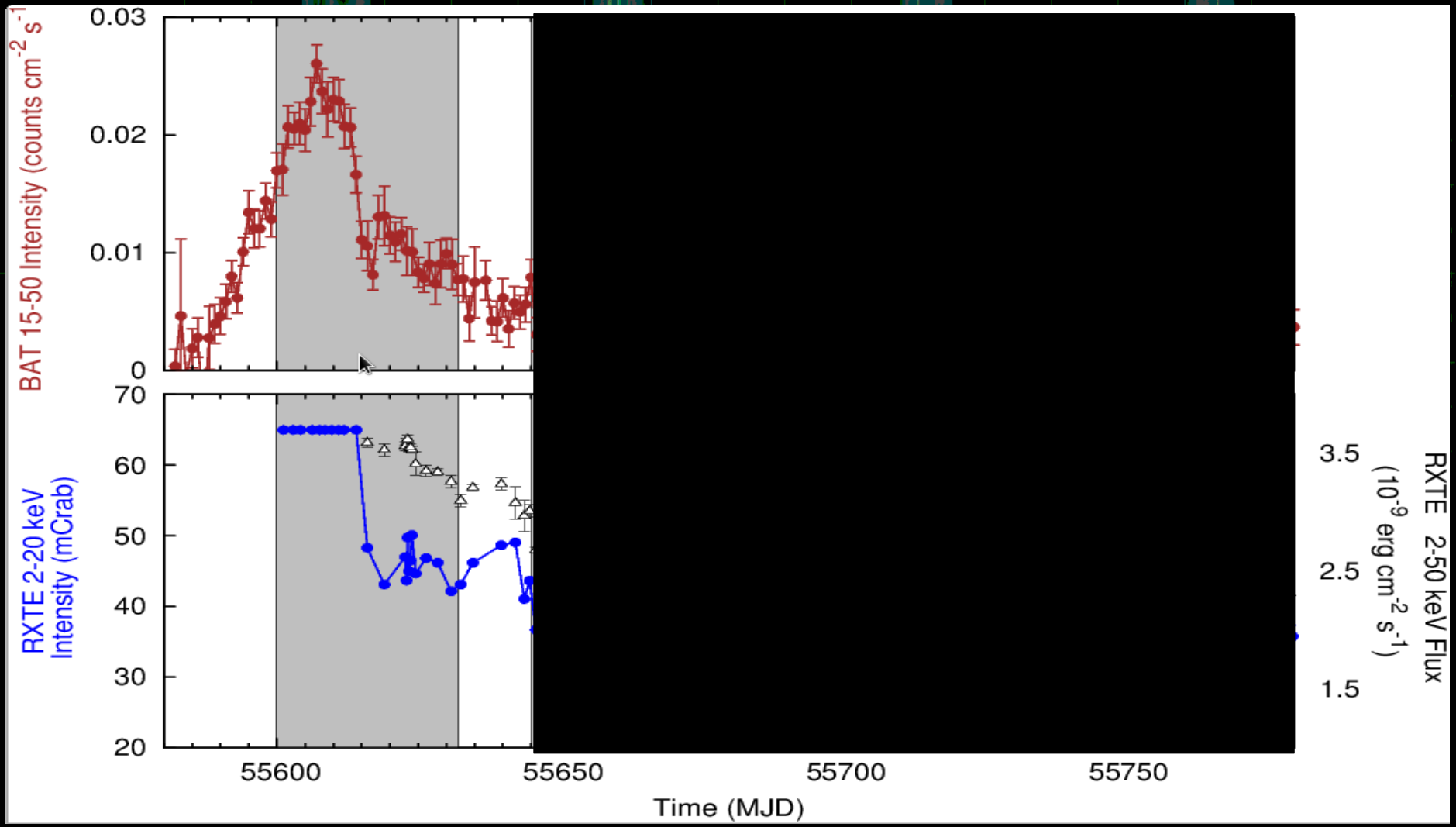
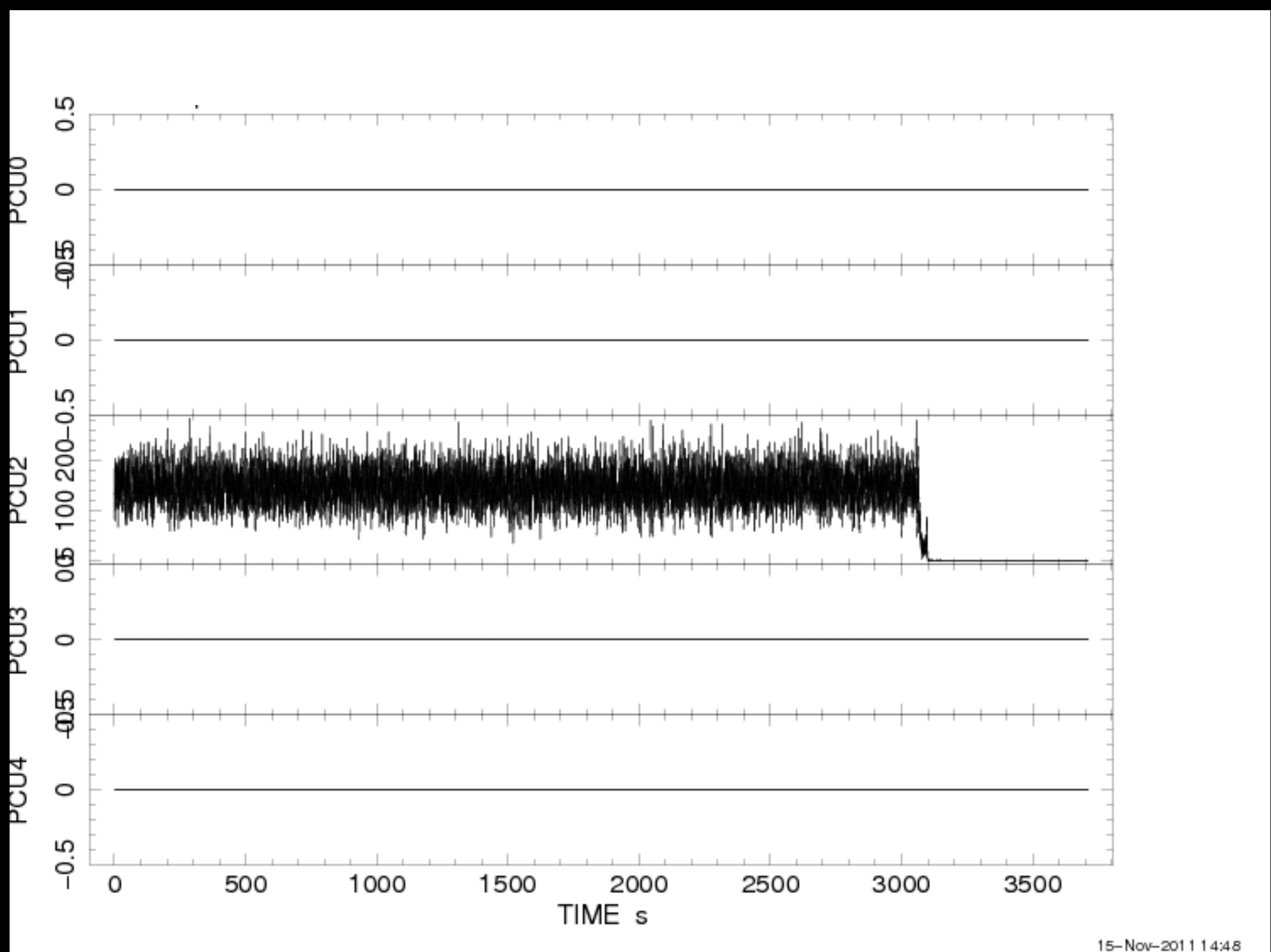


Altamirano et al. 2011

IGR J17091-3624: 2011 outburst



Altamirano et al. 2011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PCU1
PCU2
PCU3
PCU4
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−0.5
100
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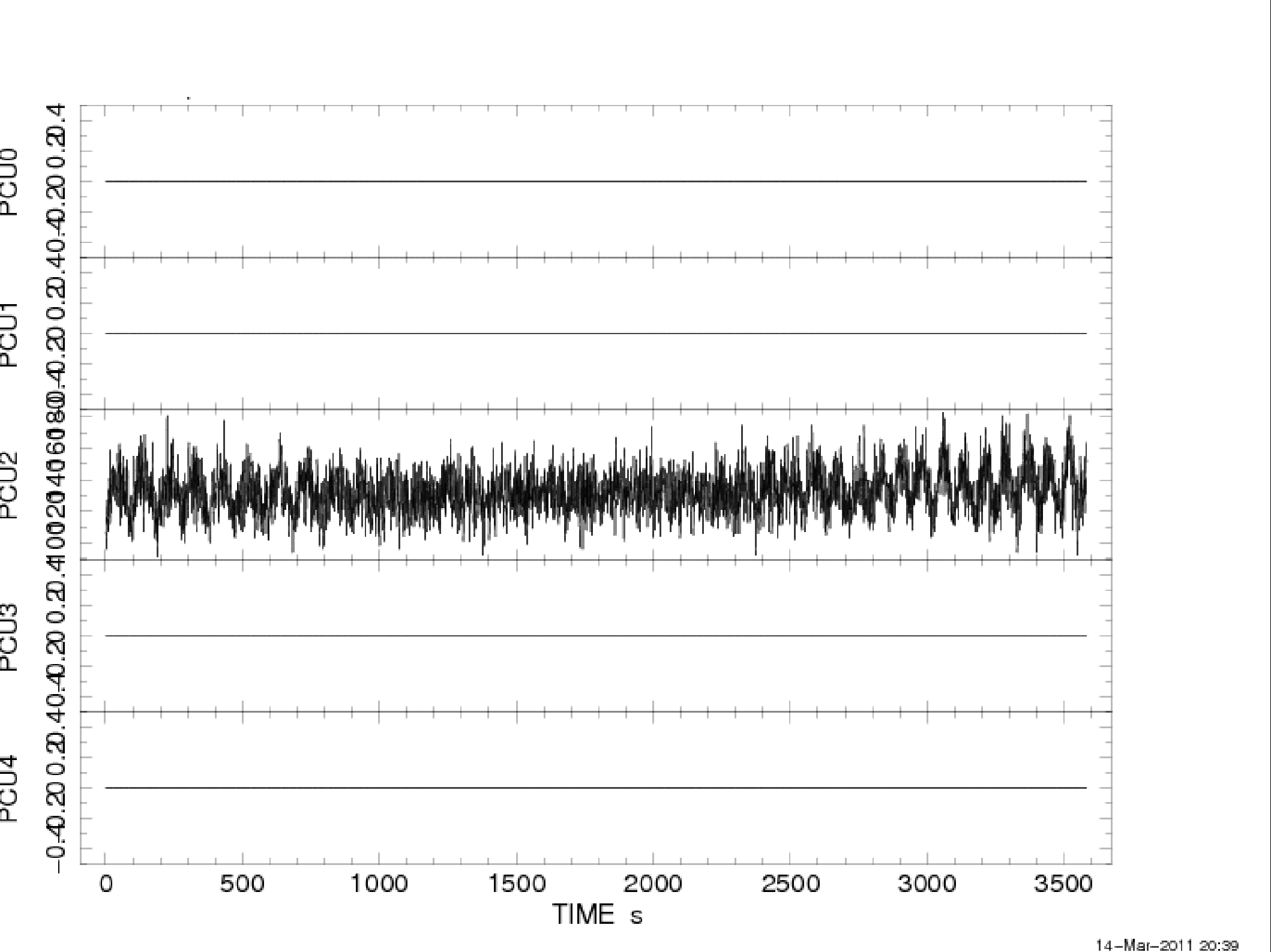
0
500
1000
1500
2000
2500
3000
3500
TIME s
15−Nov−2011 14:48


PCU0
PCU1
PCU2
PCU3
PCU4
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0.2
0.0
−0.2
−0.4
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1000
1500
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2500
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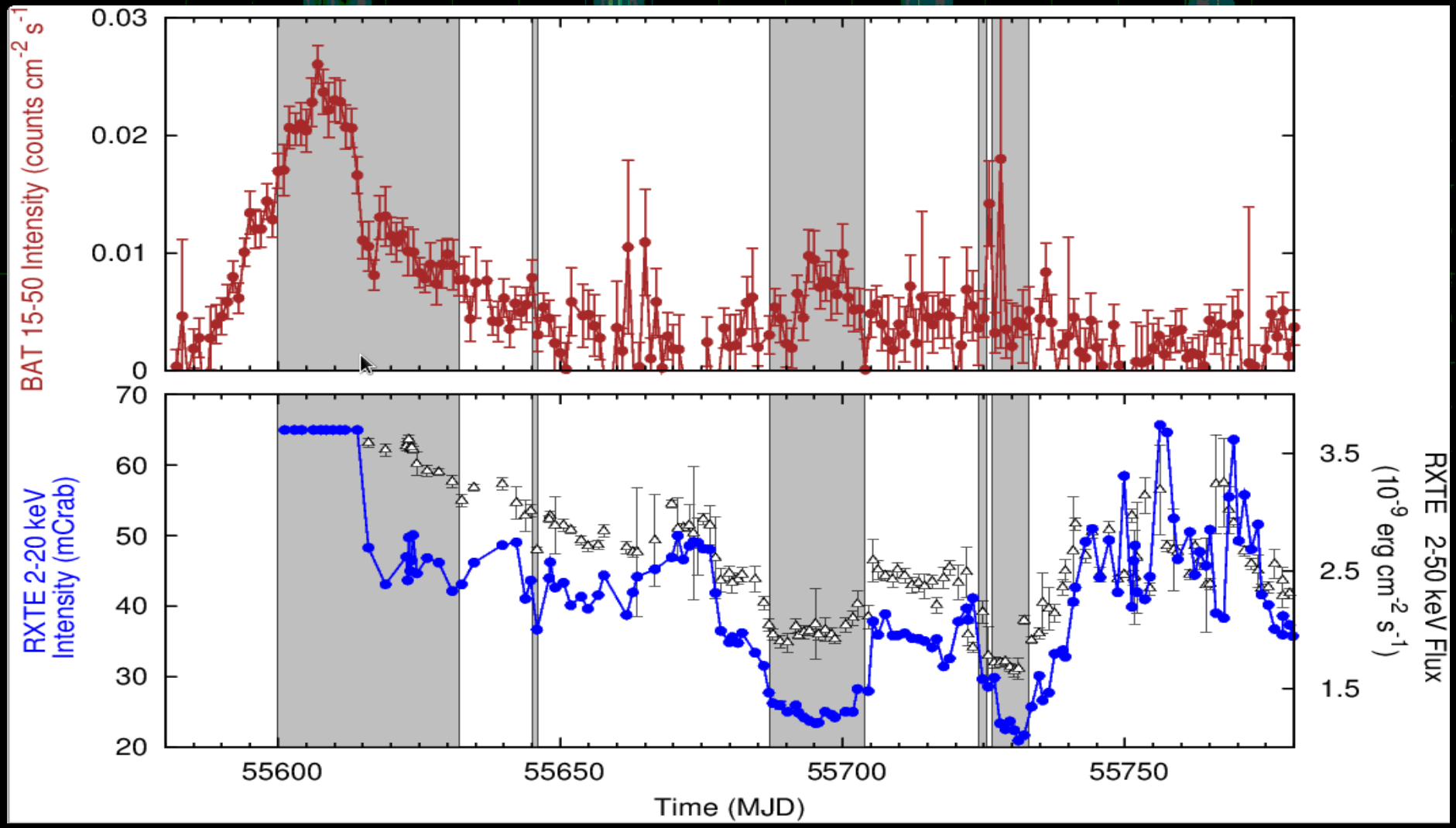
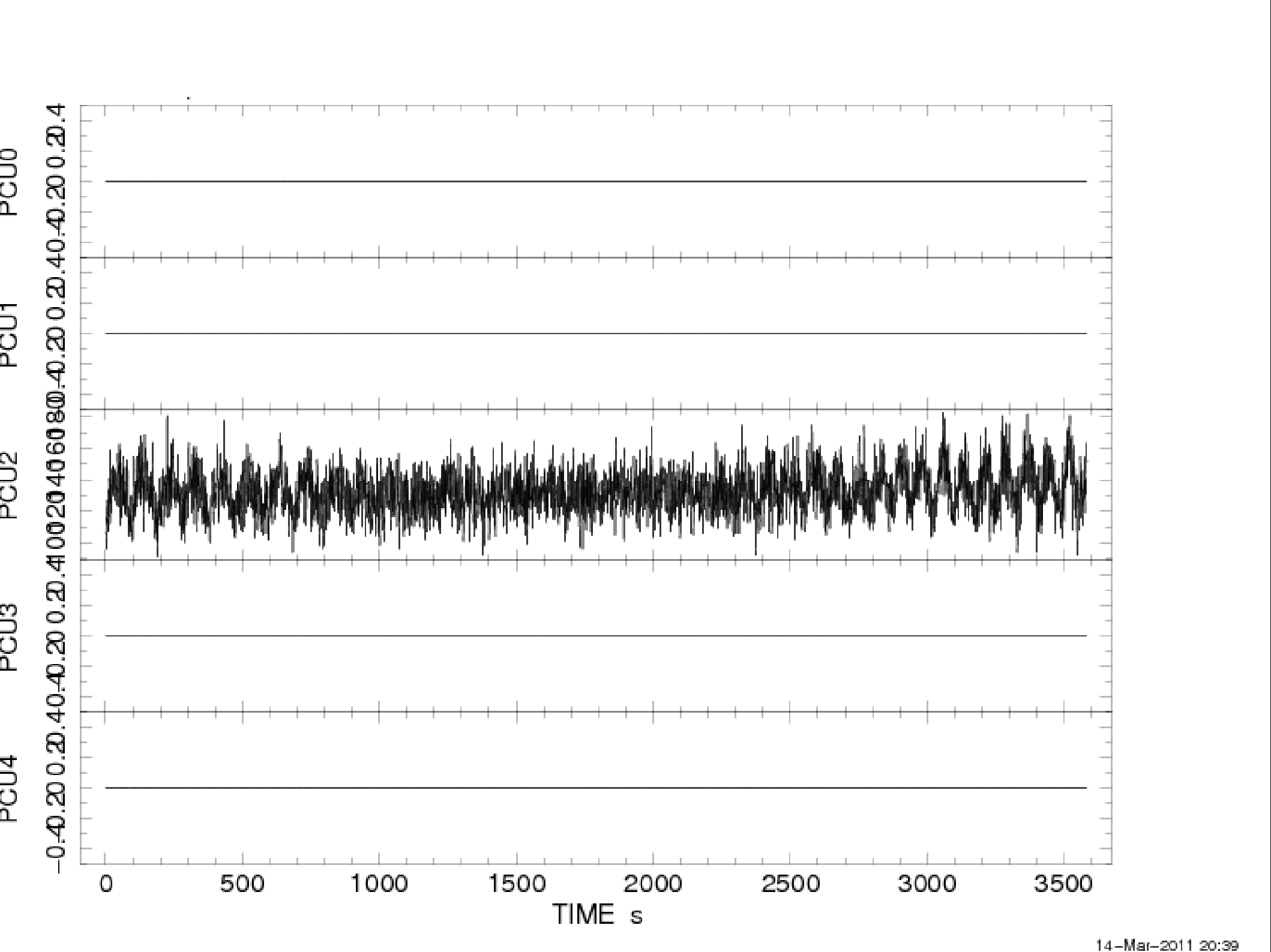
TIME s
14−Mar−2011 20:39

IGR J17091-3624: 2011 outburst



Altamirano et al. 2011


PCU0
PCU1
PCU2
PCU3
PCU4
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TIME s
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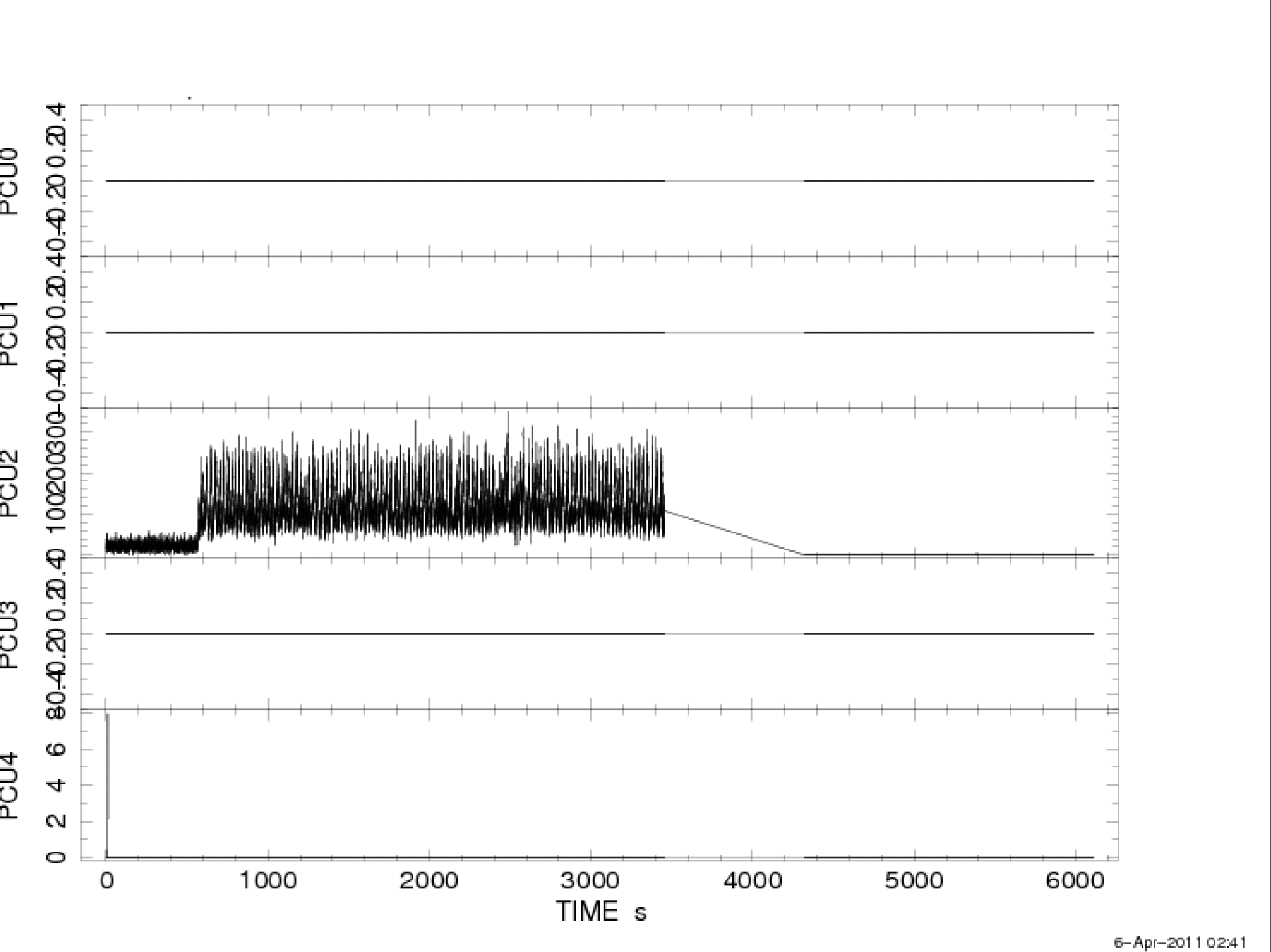
PCU0
PCU1
PCU2
PCU3
PCU4
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-0.4
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6
4
2
0
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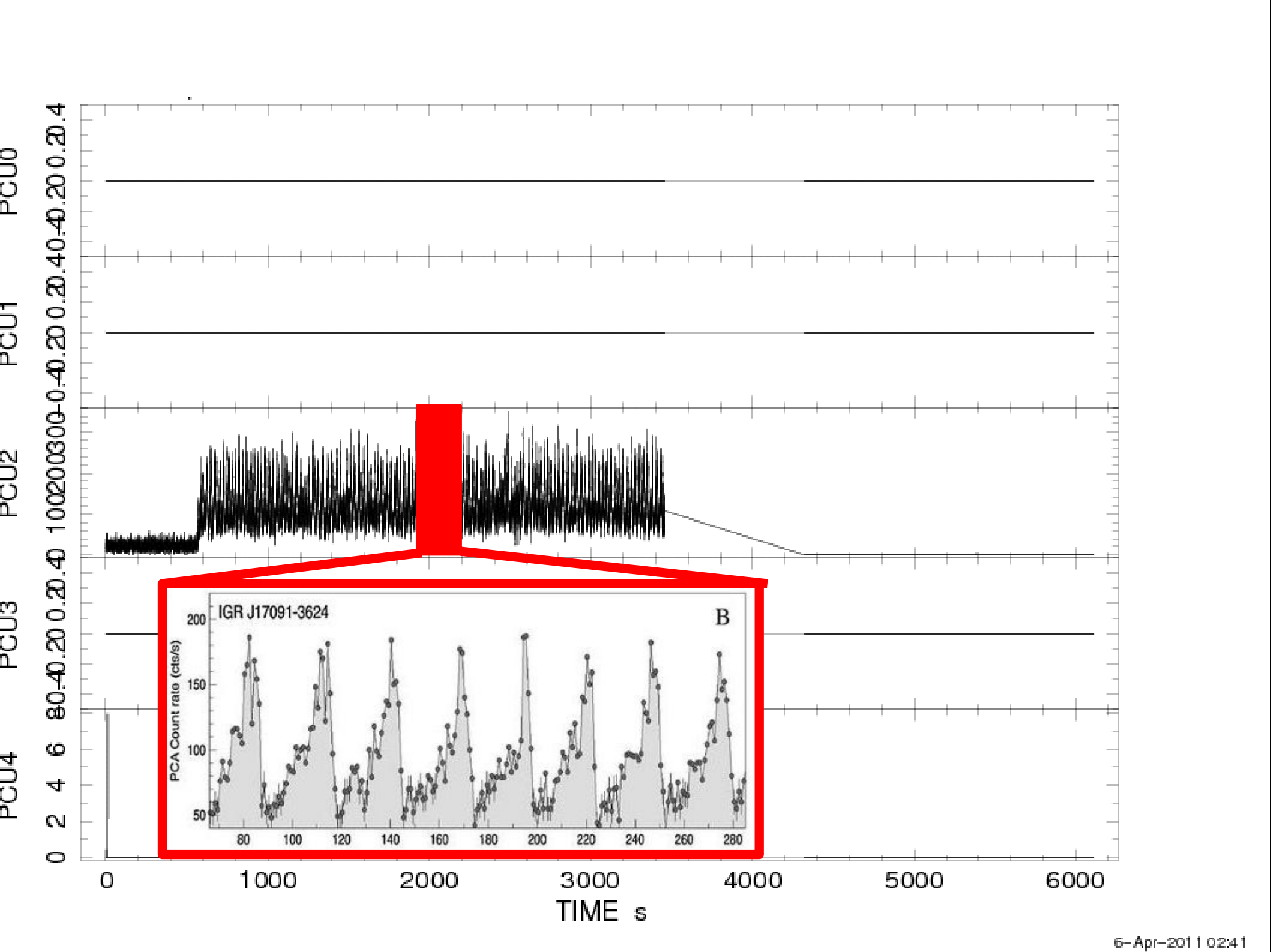
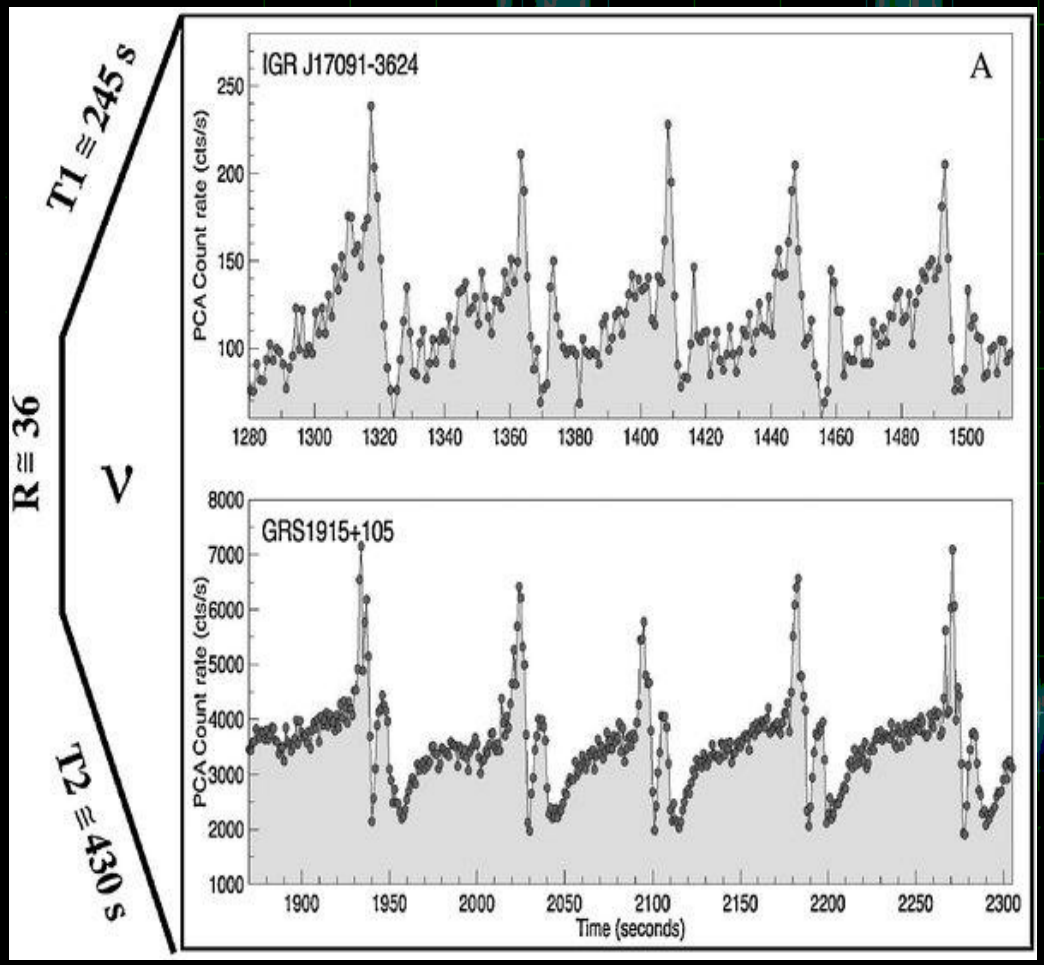
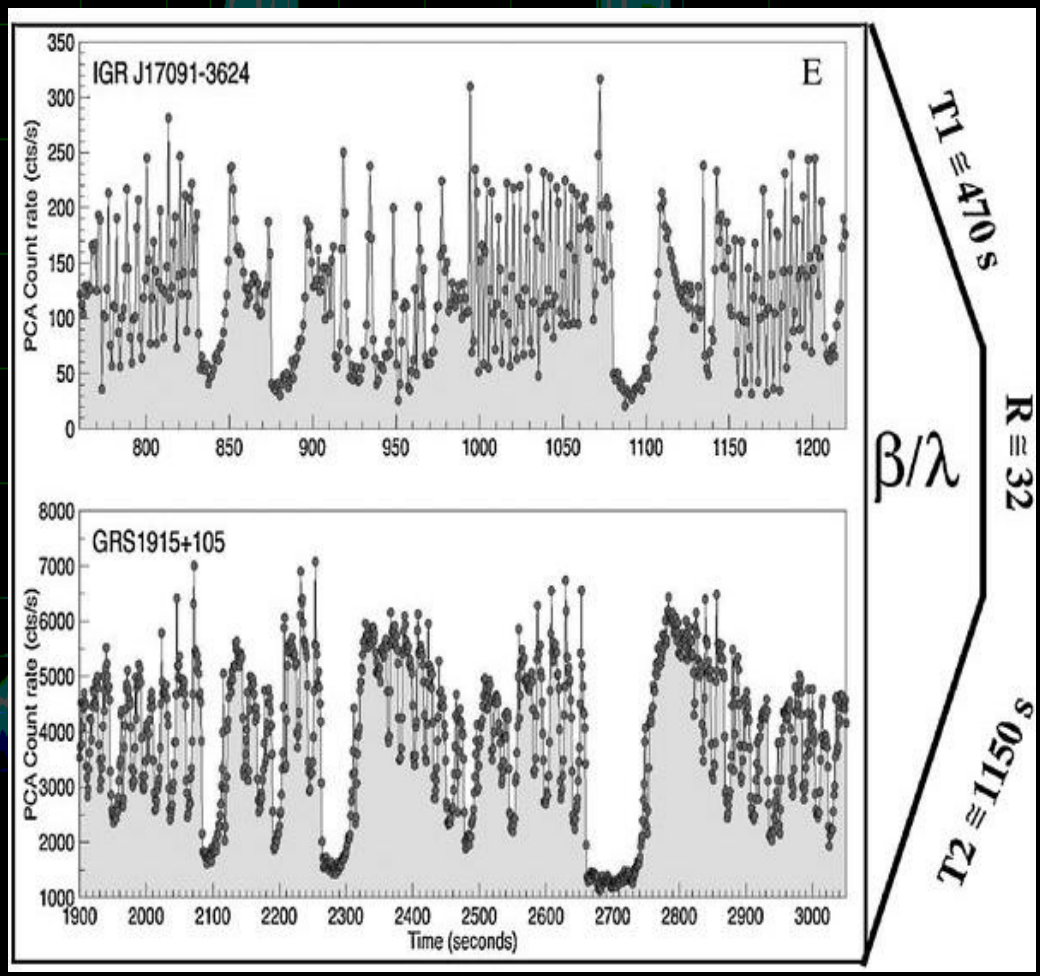
3000
4000
5000
6000
TIME s
6-Apr-2011 02:41


PCU0
PCU1
PCU2
PCU3
PCU4
IGR J17091-3624
B
PCA Count rate (cts/s)
TIME s
6-Apr-2011 02:41

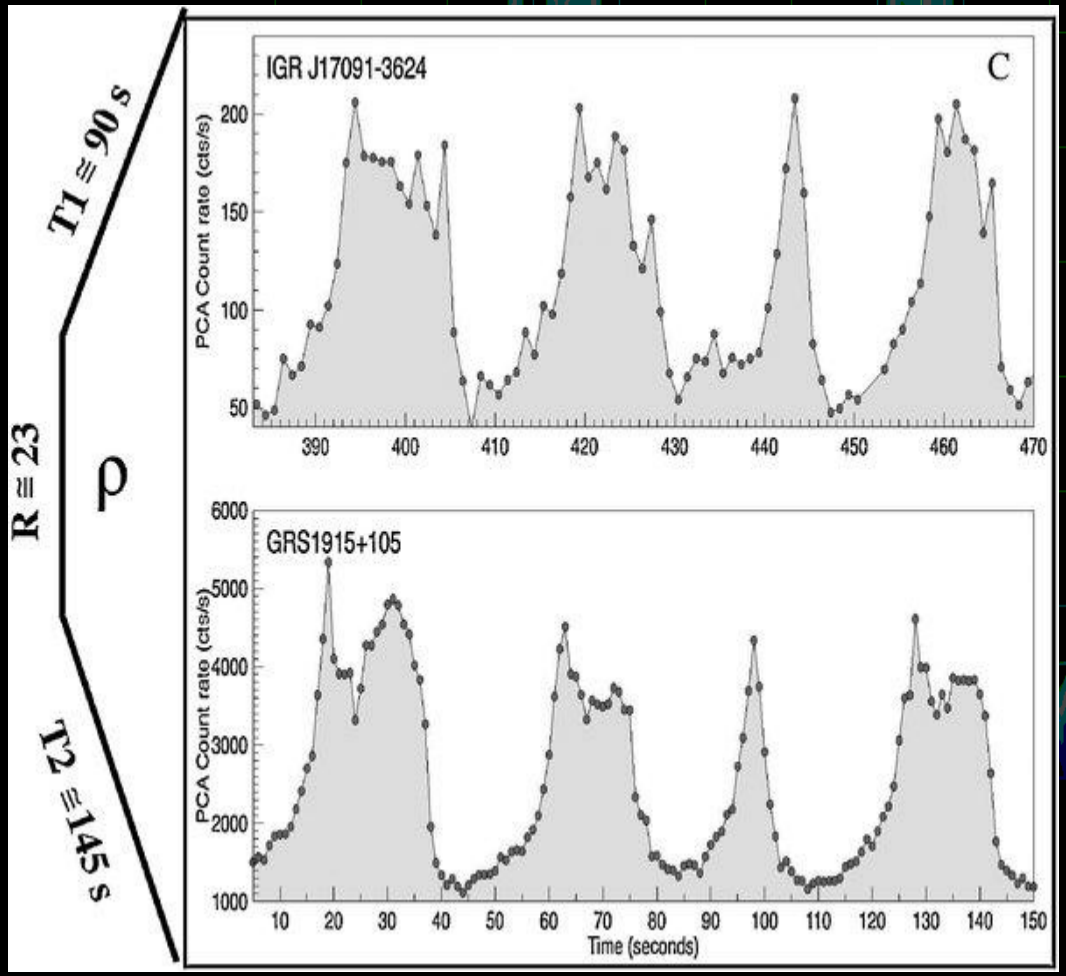
IGR J17091-3624: 2011 outburst

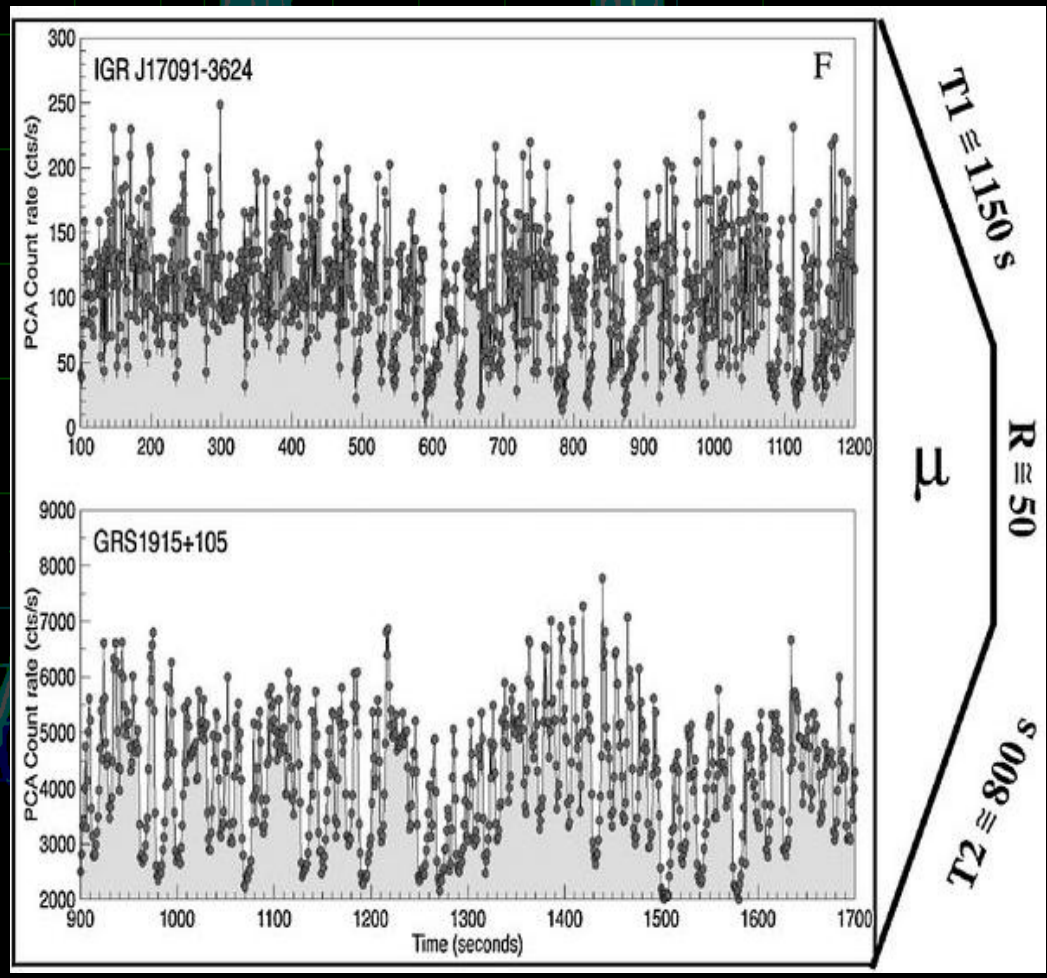




Altamirano et al. 2011

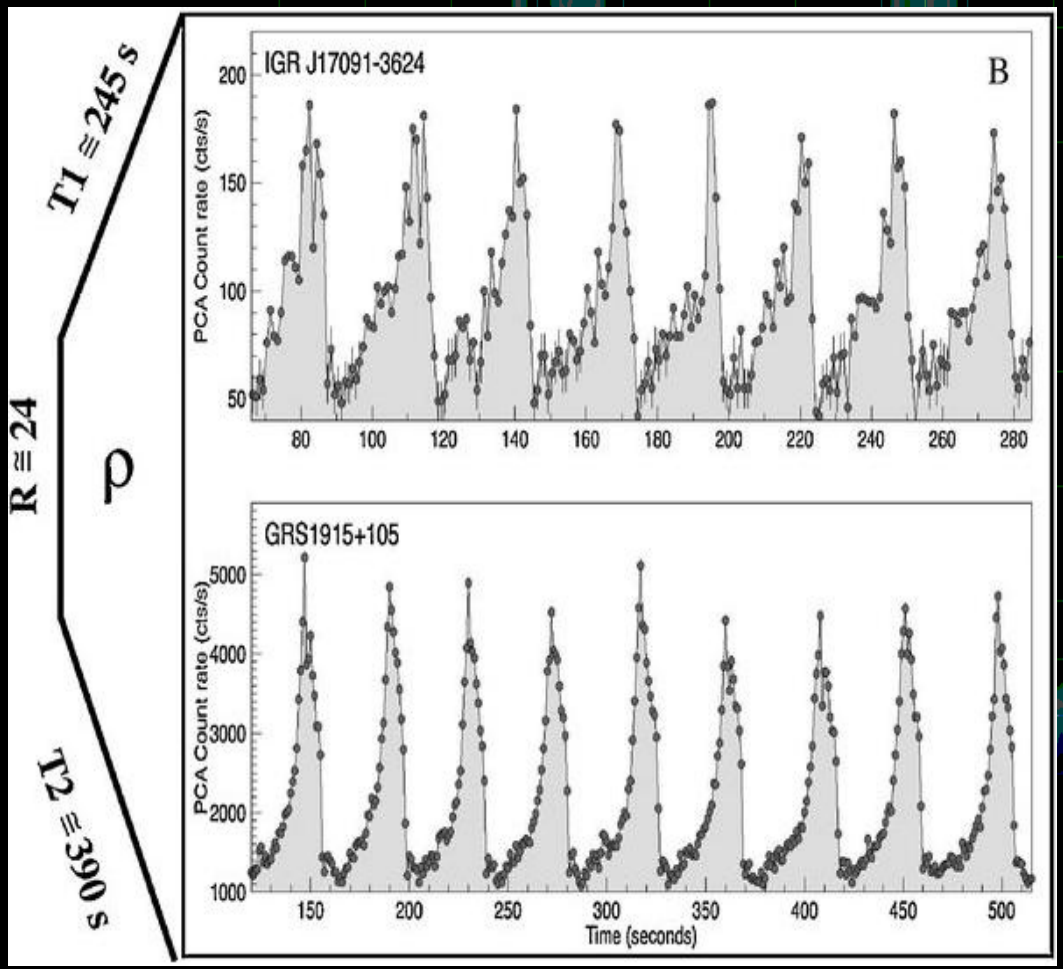
IGR J17091-3624: 2011 outburst

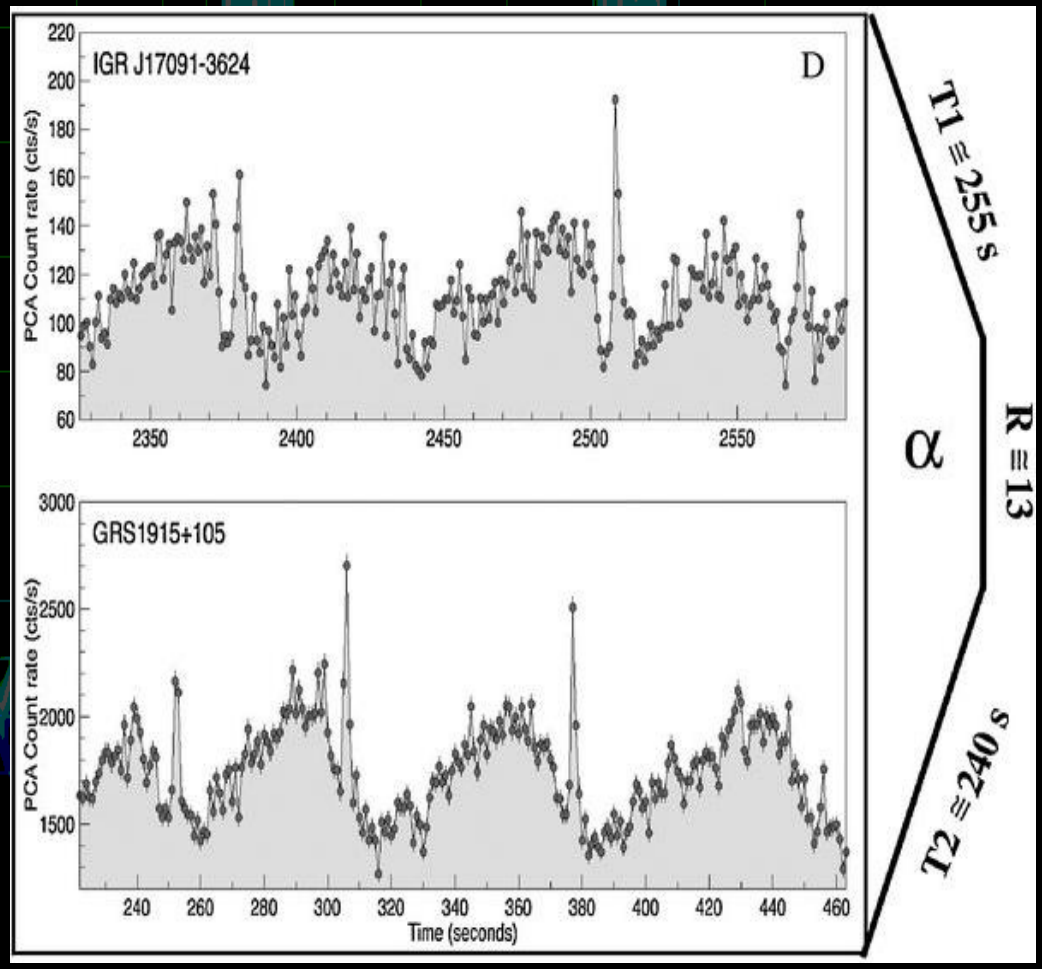




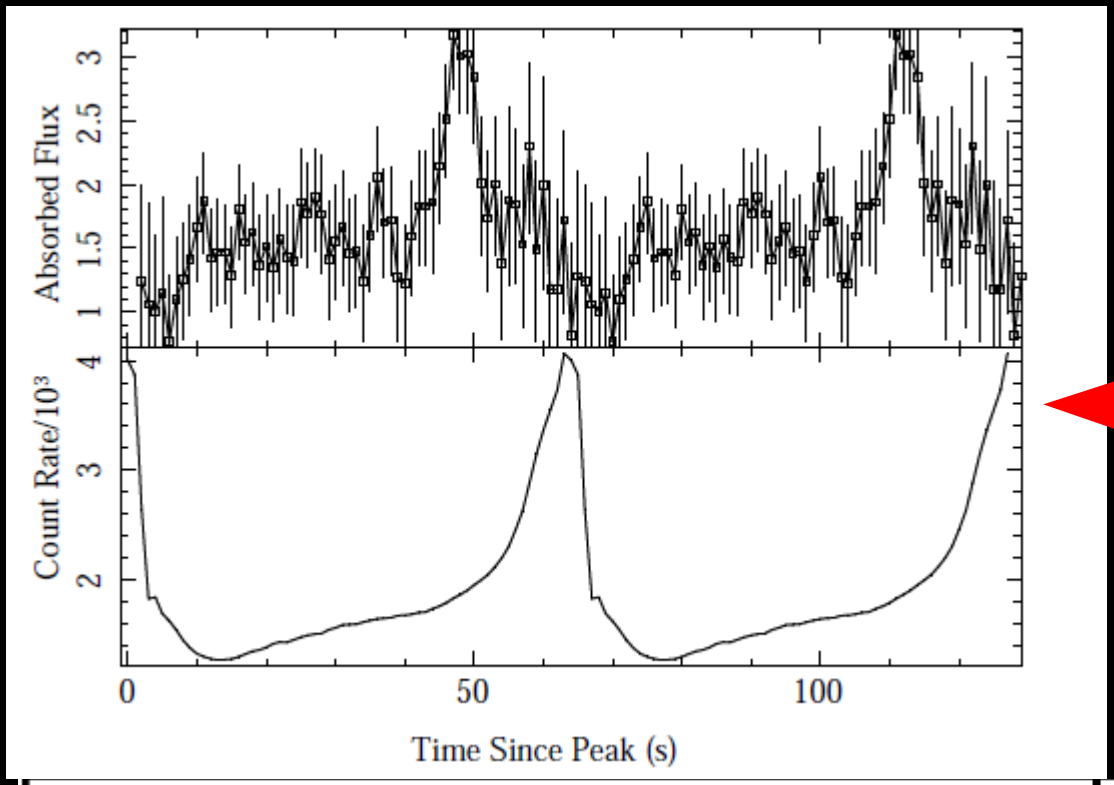
Altamirano et al. 2011

IGR J17091-3624: 2011 outburst

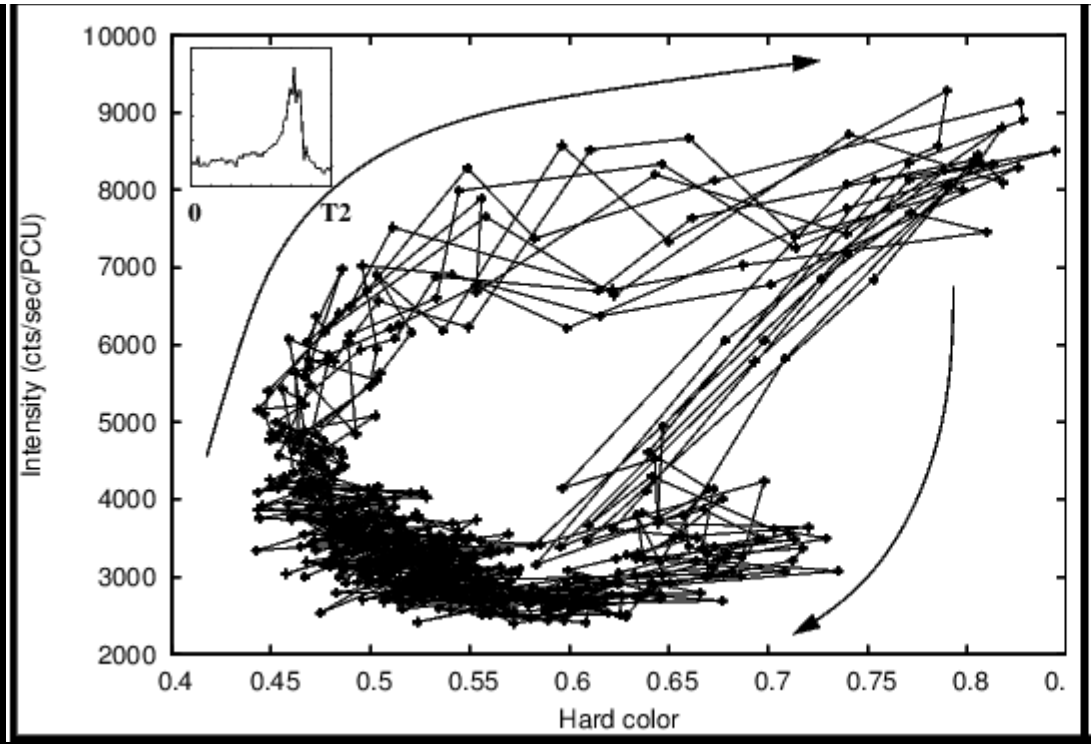


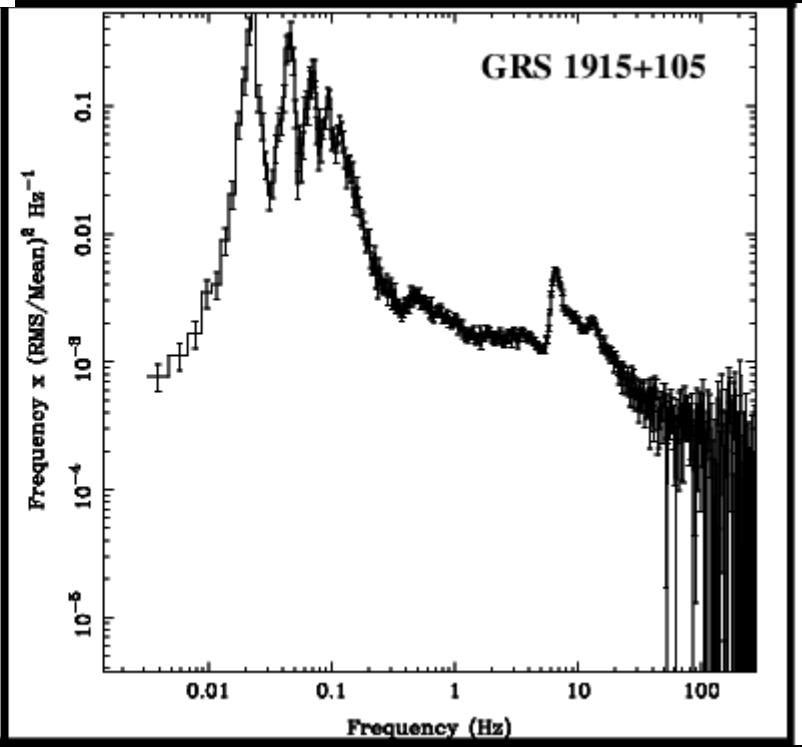


Altamirano et al. 2011

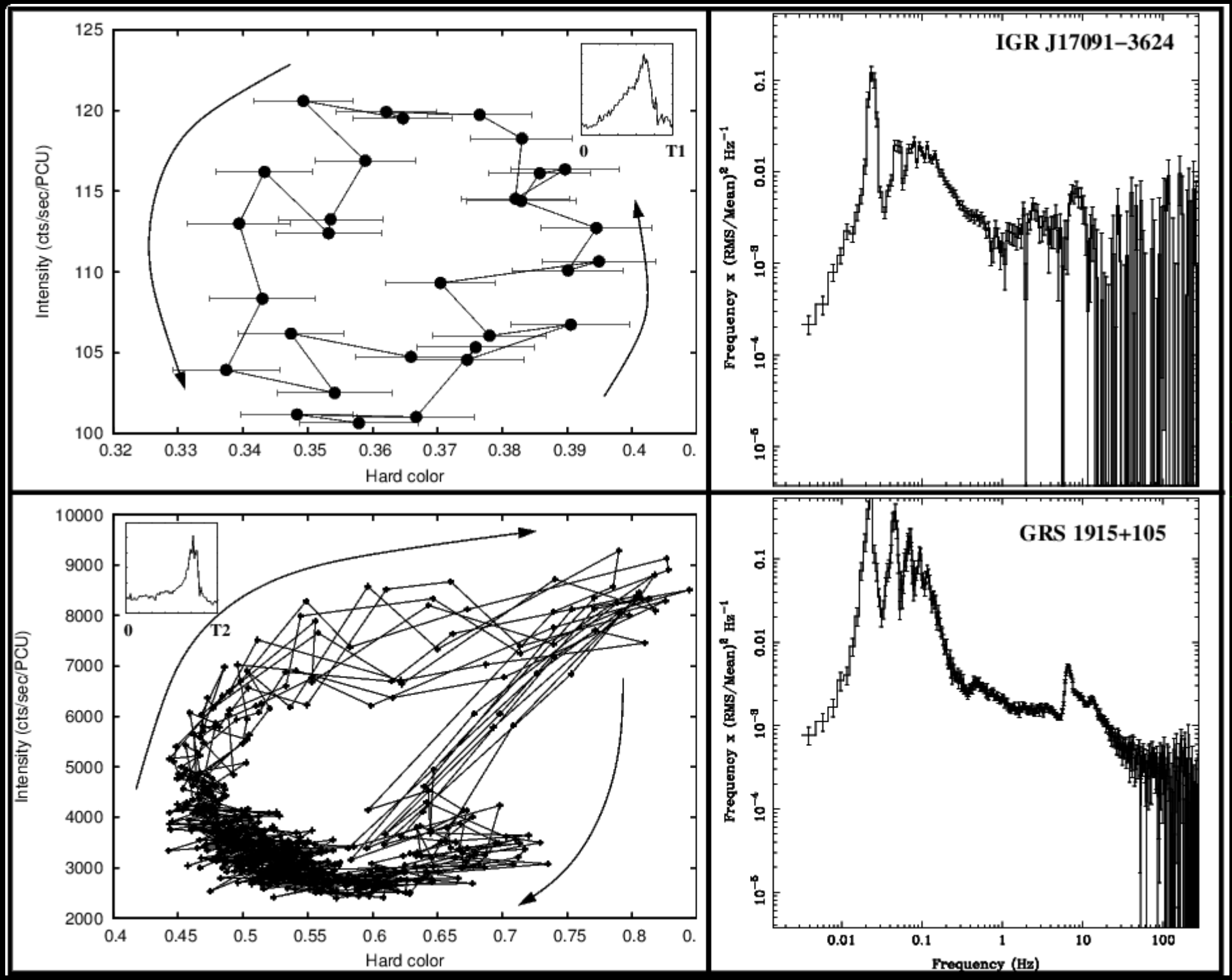


Neilsen's talk



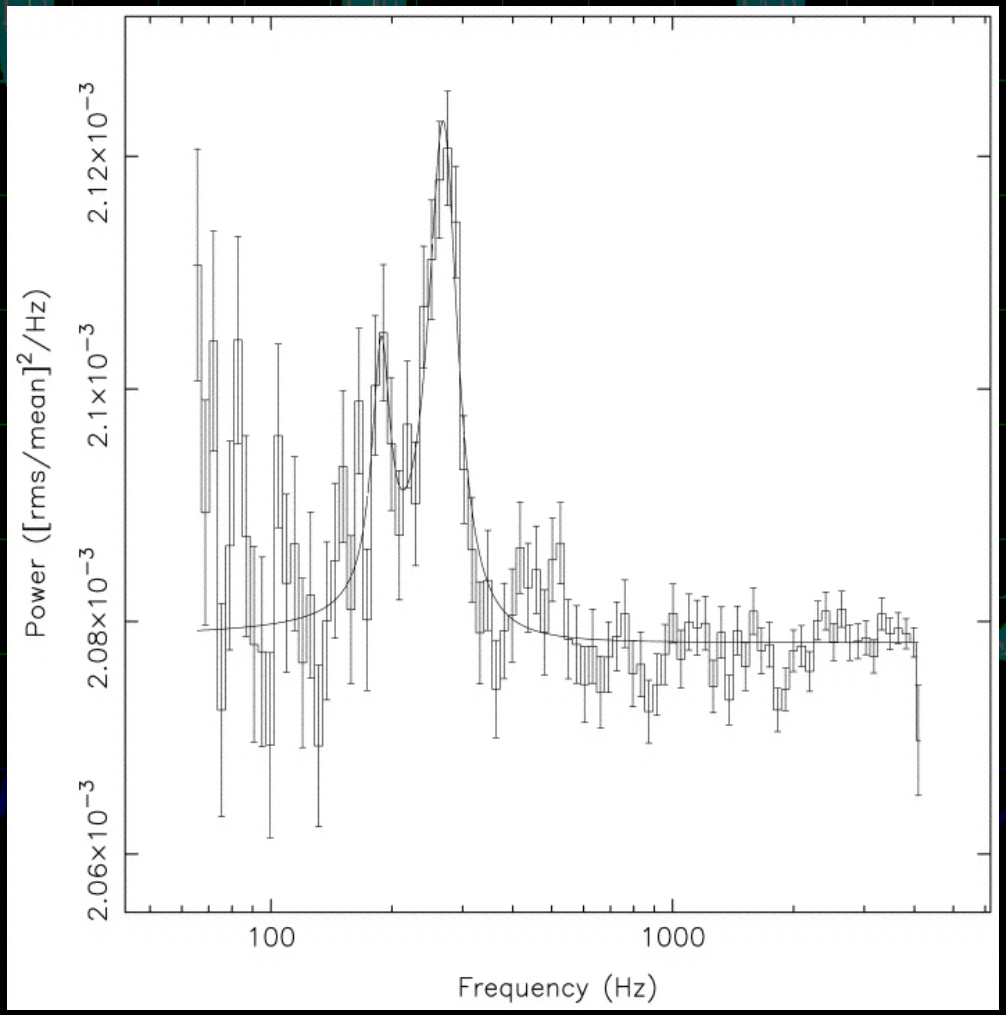


Altamirano et al. 2011

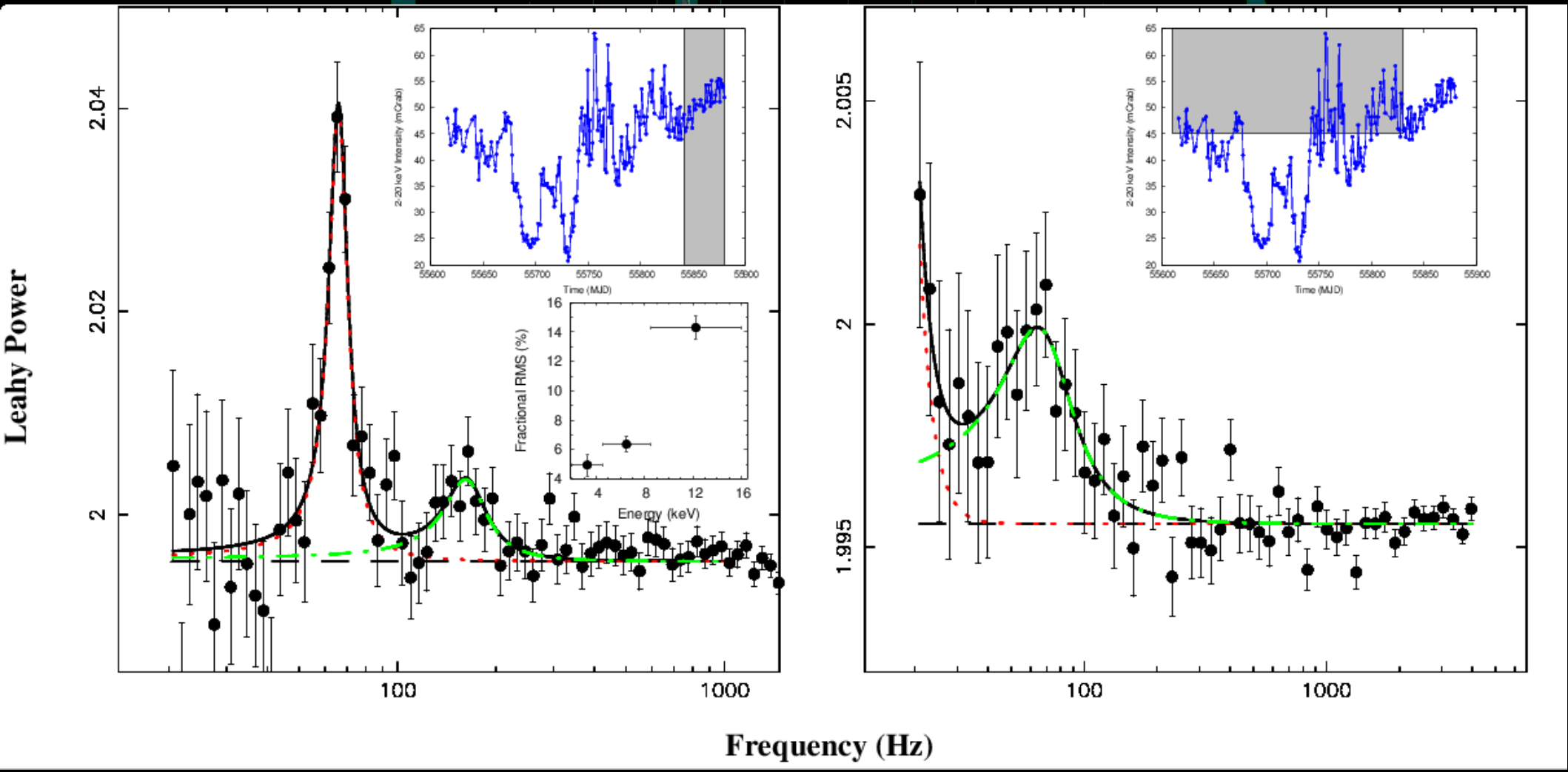


Altamirano et al. 2011

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



Sharp at 67 Hz == GRS 1915+105



Altamirano & Belloni 2012

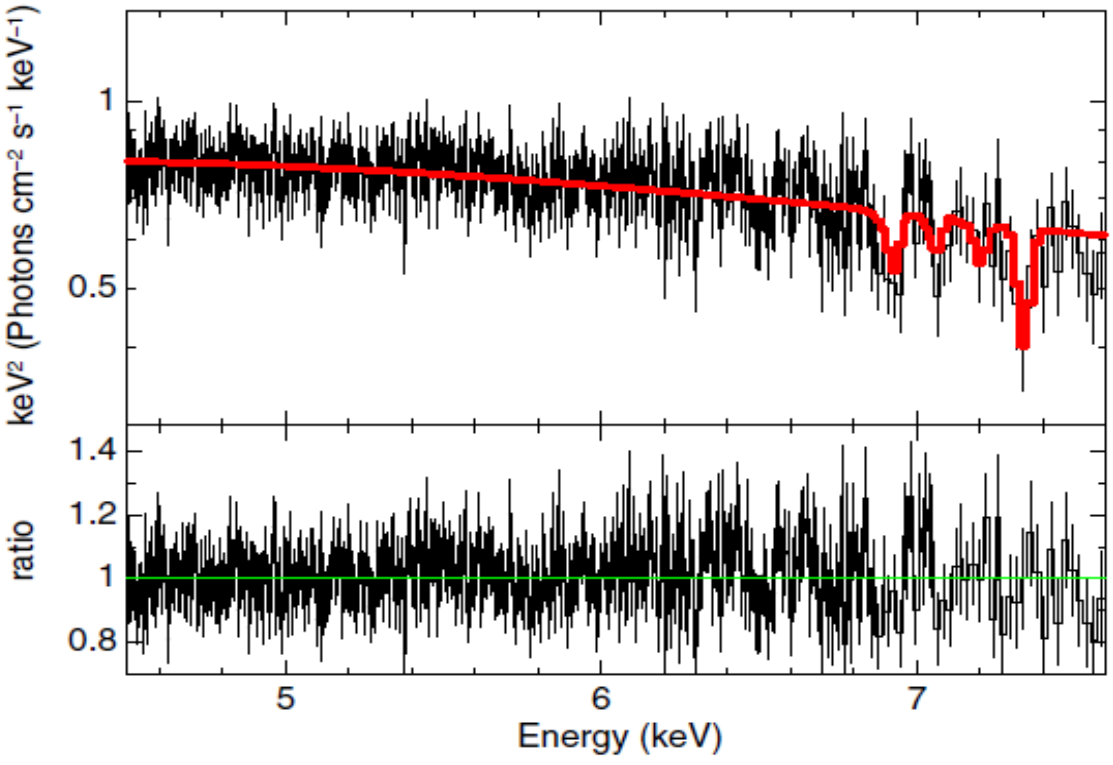
AN EXTREME X-RAY DISK WIND IN THE BLACK HOLE CANDIDATE IGR J17091−3624

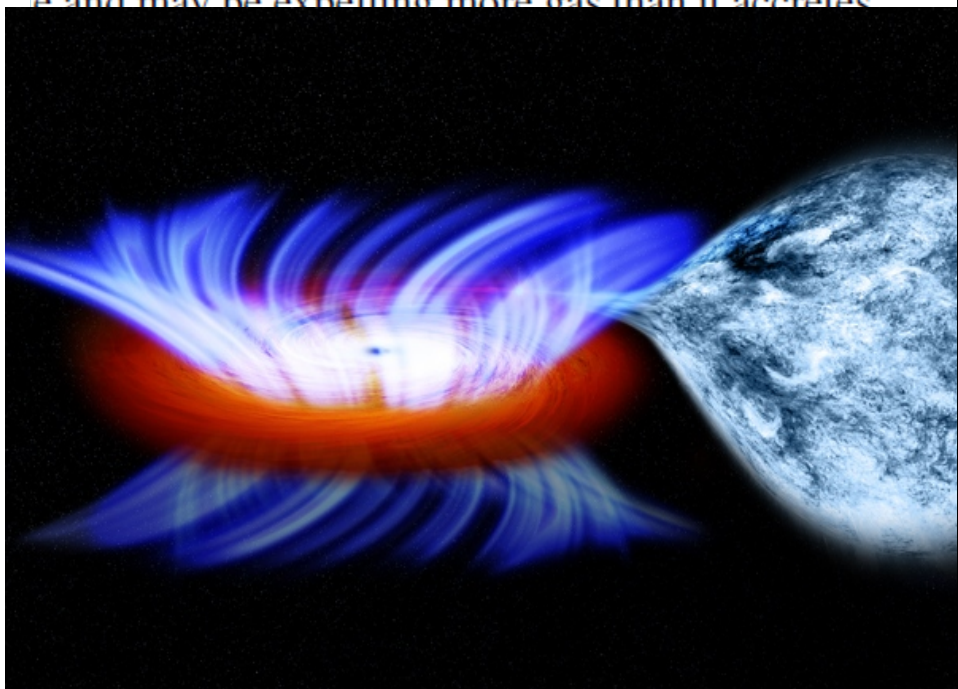
A. L. King[1], J. M. Miller[1], J. Raymond[2], A. C. Fabian[3], C. S. Reynolds[4], T. R. Kallman[5], D. Maitra[1], E. M. Cackett[3,6], and M. P. Rupen[7]

ABSTRACT

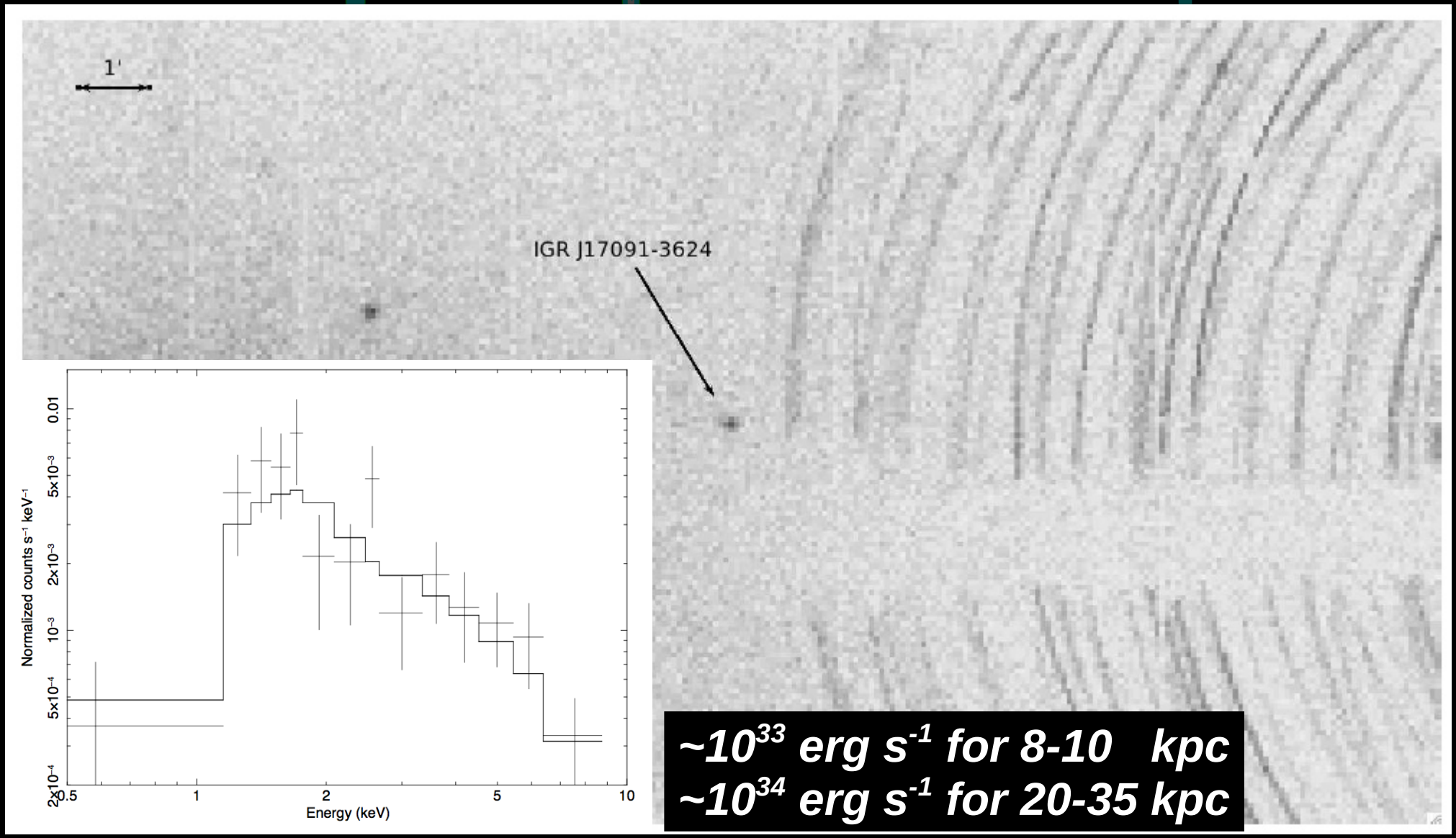
Chandra spectroscopy of transient stellar-mass black holes in outburst has clearly revealed accretion disk winds in soft, disk-dominated states, in apparent anti-correlation with relativistic jets in low/hard states. These disk winds are observed to be highly ionized, dense, and to have typical velocities of ∼1000 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 ± 0.01 keV; associating this line with He-like Fe XXV requires a blueshift of 9300^{+500}_{-400} km s^{-1} (0.03*c*, or the escape velocity at 1000 $R_{\rm Schw}$). 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.

/ a velocity of ∼14,600 km s^{-1} (0.05*c*), but this
hat the accretion disk wind in IGR J17091−3624
e and may be expelling more gas than it accretes





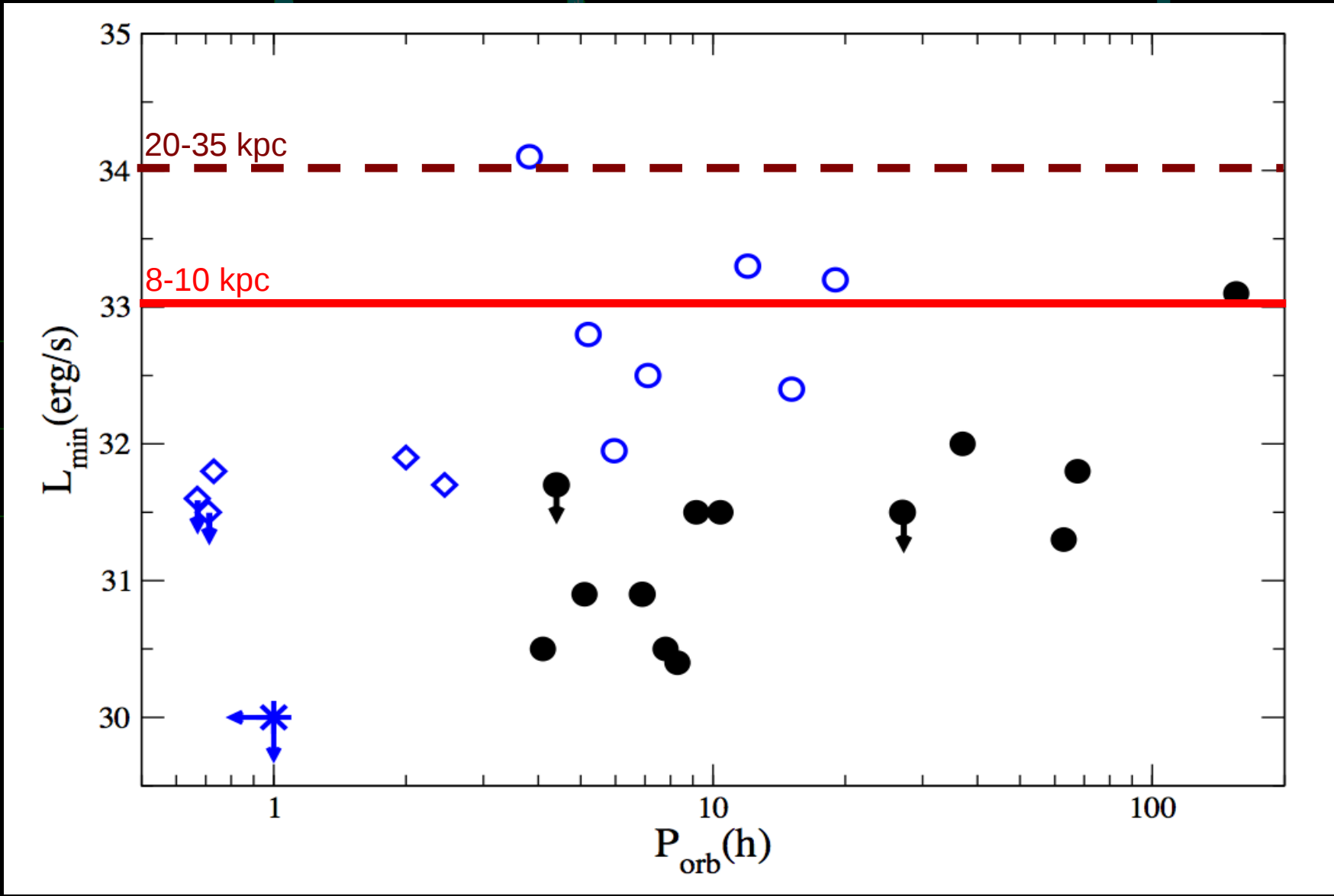
...IGR J17091-3624 in quiescence ....



~10^33 erg s^-1 for 8-10 kpc
~10^34 erg s^-1 for 20-35 kpc

Wijnands, Yang & Altamirano 2012

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



Lasota 2008 + Courtesy of R. Wijnands

... Summary ...

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

PDS very similar
Between sources

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X-ray variability !!!

PDS very similar
Between sources

Heartbeats and others
Faster than in GRS1915

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Heartbeats HID evolves
in the wrong way?

Same type of low-frequency
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Between sources

Heartbeats and others
Faster than in GRS1915

Super fast
X-ray winds?

Heartbeats HID evolves
in the wrong way?

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

PDS very similar
Between sources

>10 times weaker
than GRS1915
for similar states

Heartbeats and others
Faster than in GRS1915

Super fast
X-ray winds?

Heartbeats HID evolves
in the wrong way?

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

67 Hz QPOs
for both sources

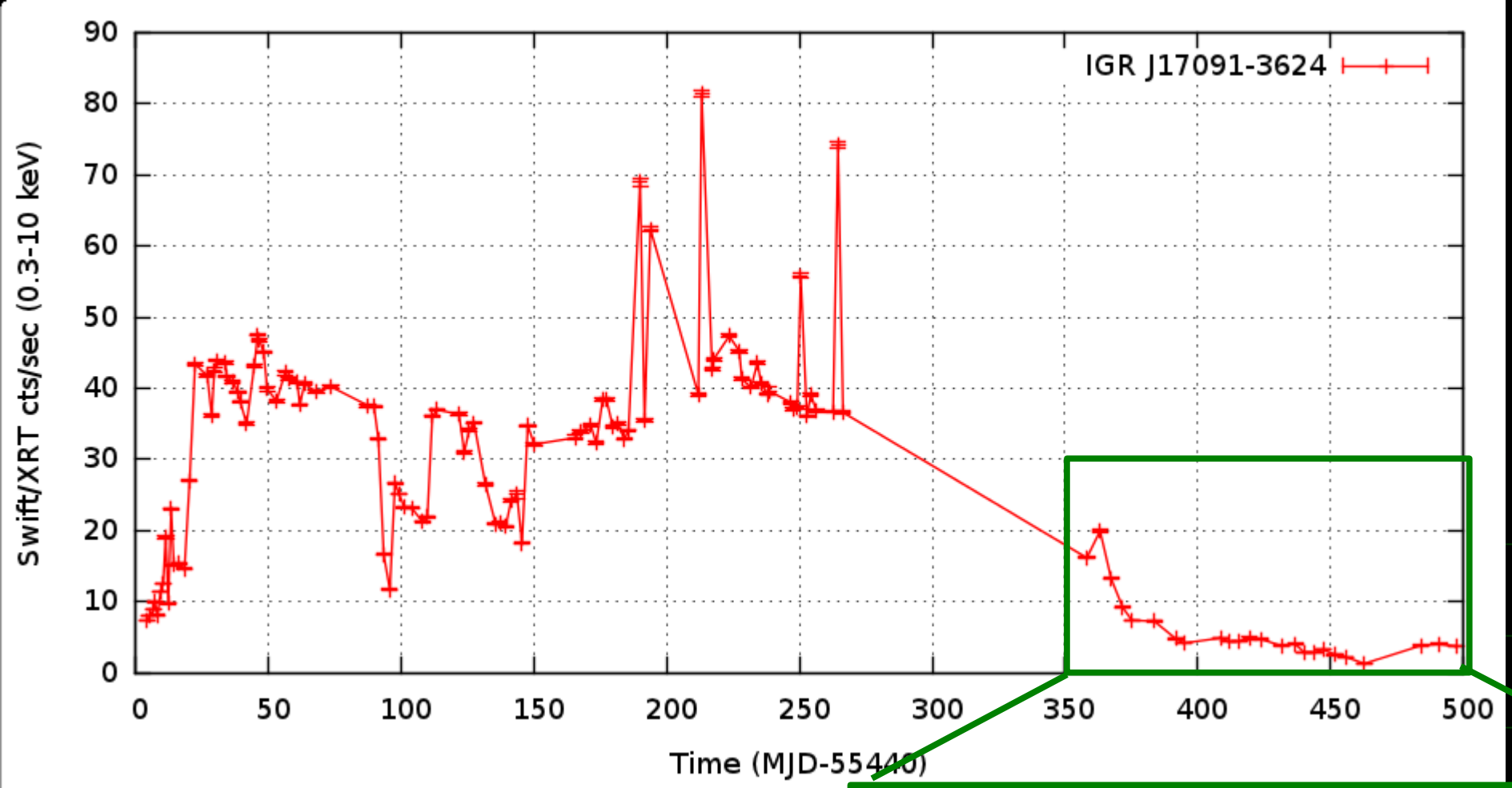
PDS very similar
Between sources

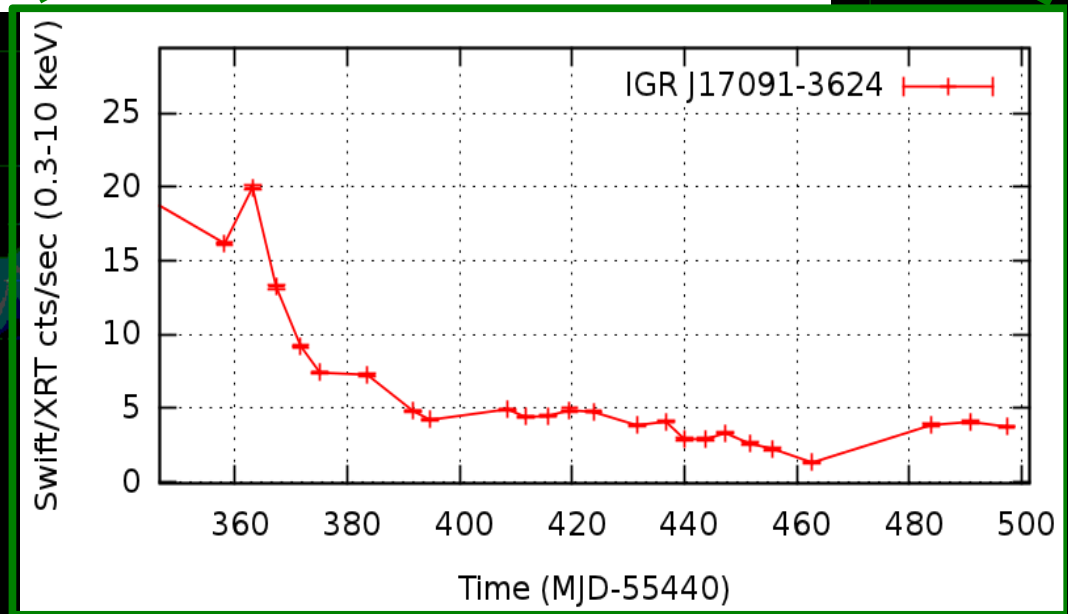
>10 times weaker
than GRS1915
for similar states

Heartbeats and others
Faster than in GRS1915

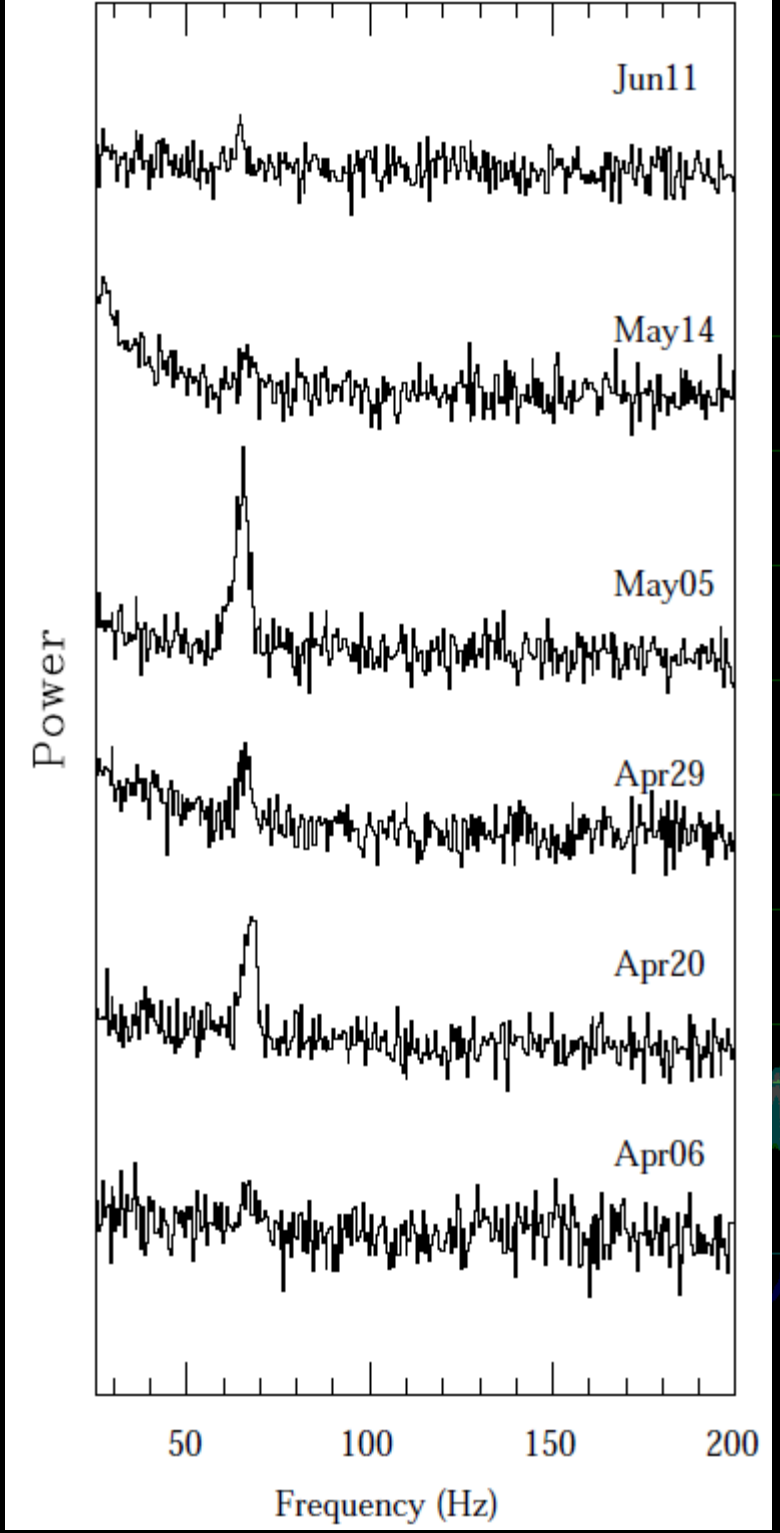
Super fast
X-ray winds?

Heartbeats HID evolves
in the wrong way?

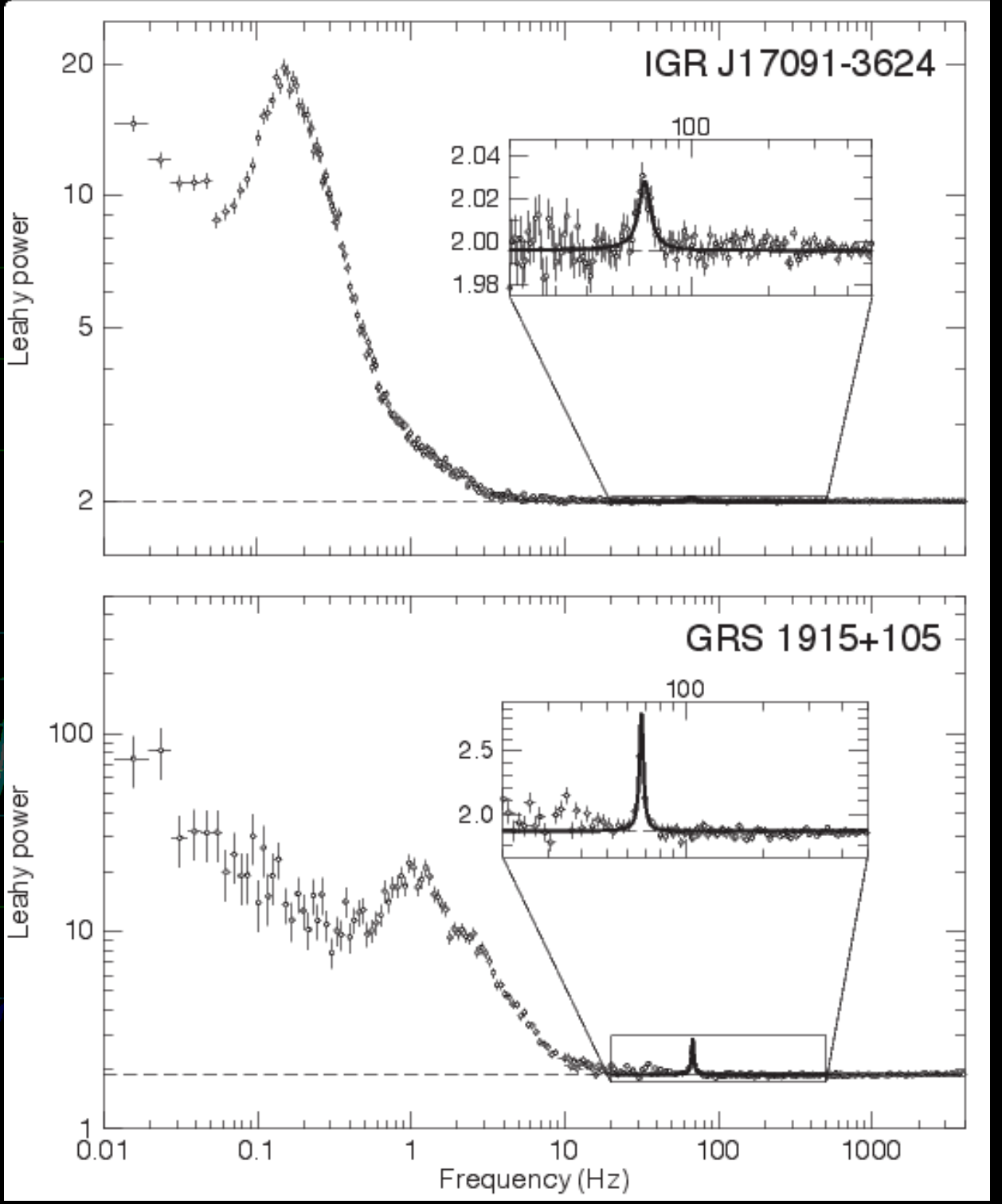




Still alive!!!
but at low flux....

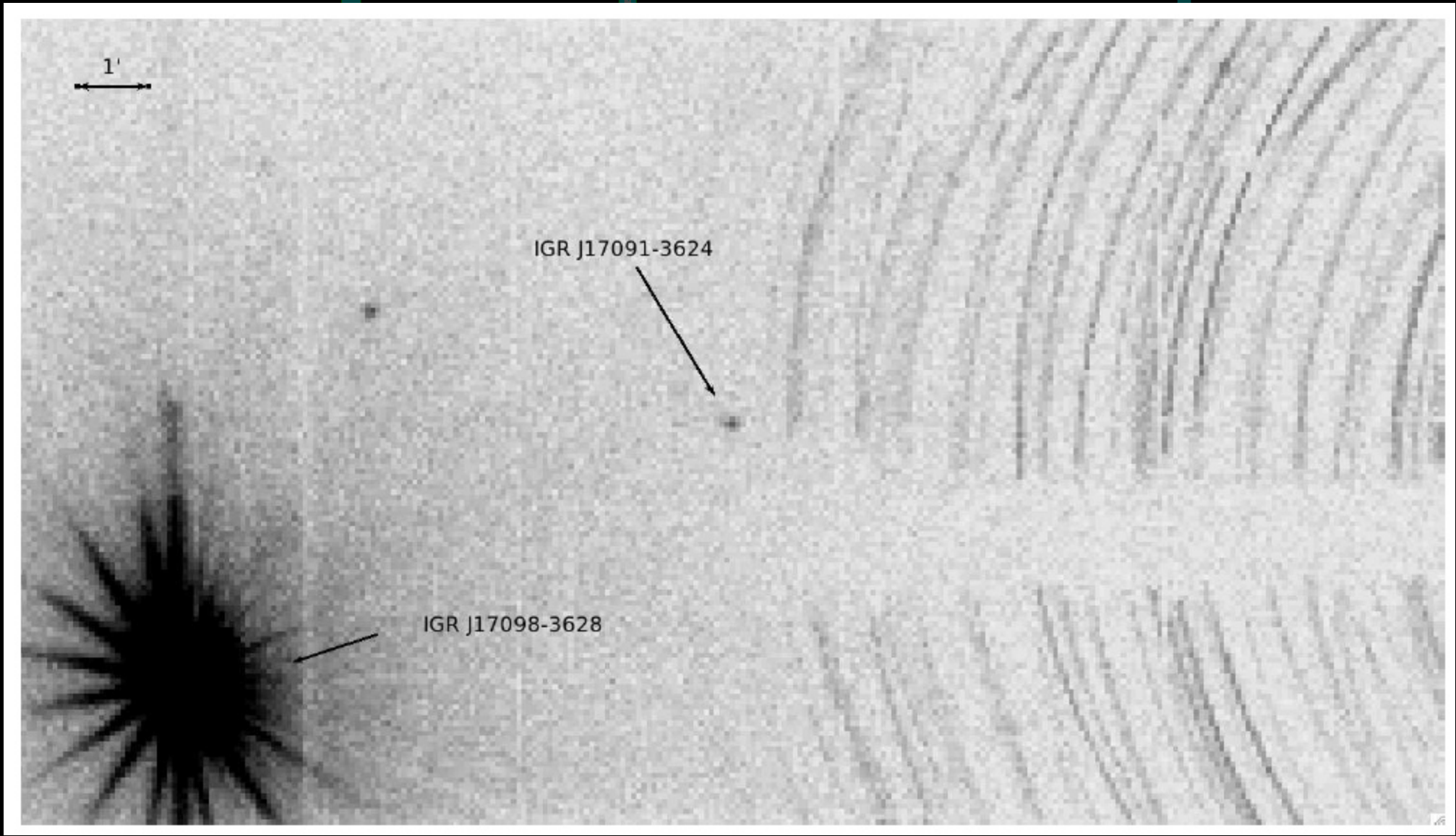


Morgan et al. 1997

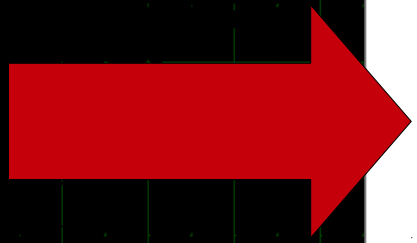


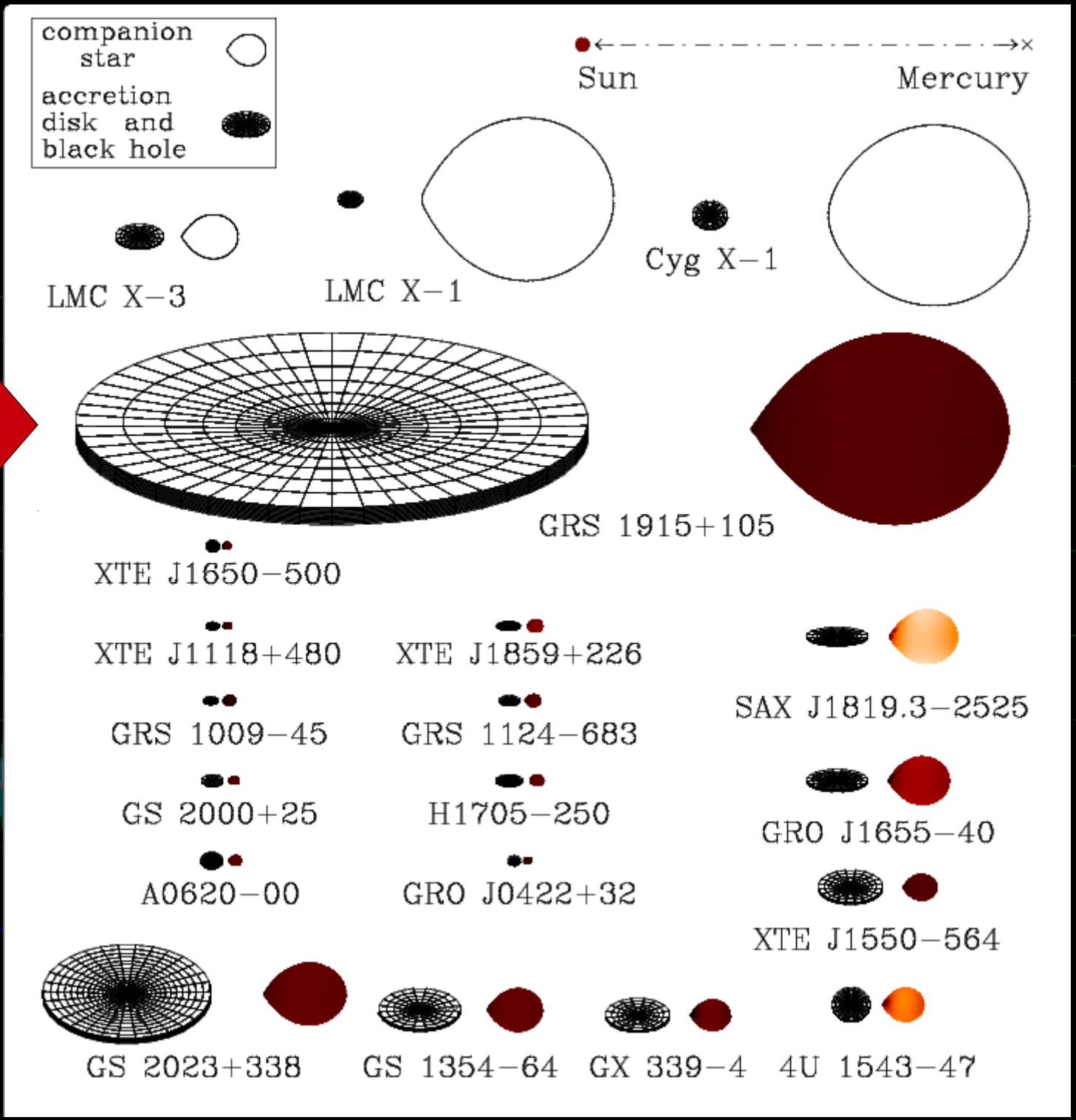
Altamirano & Belloni 2012

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



Wijnands, Yang & Altamirano 2012





Courtesy Orusz