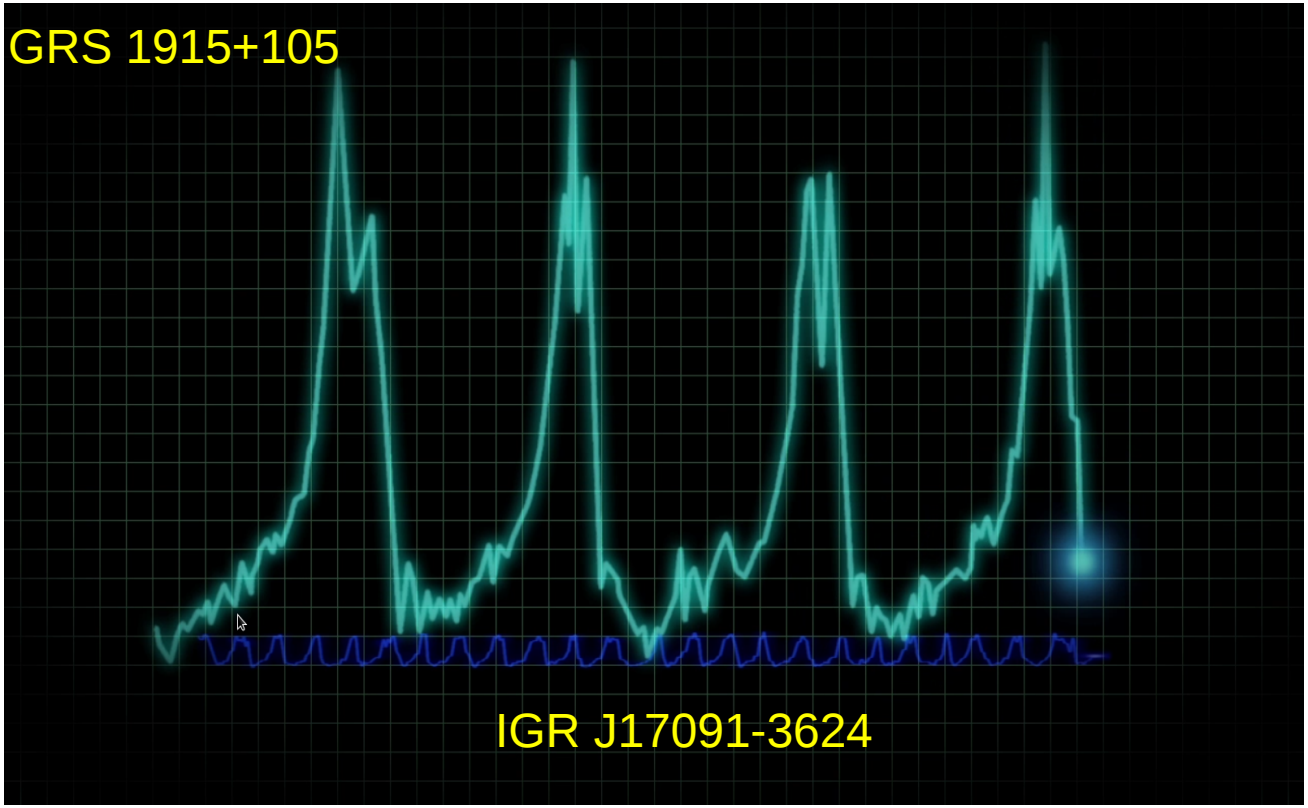


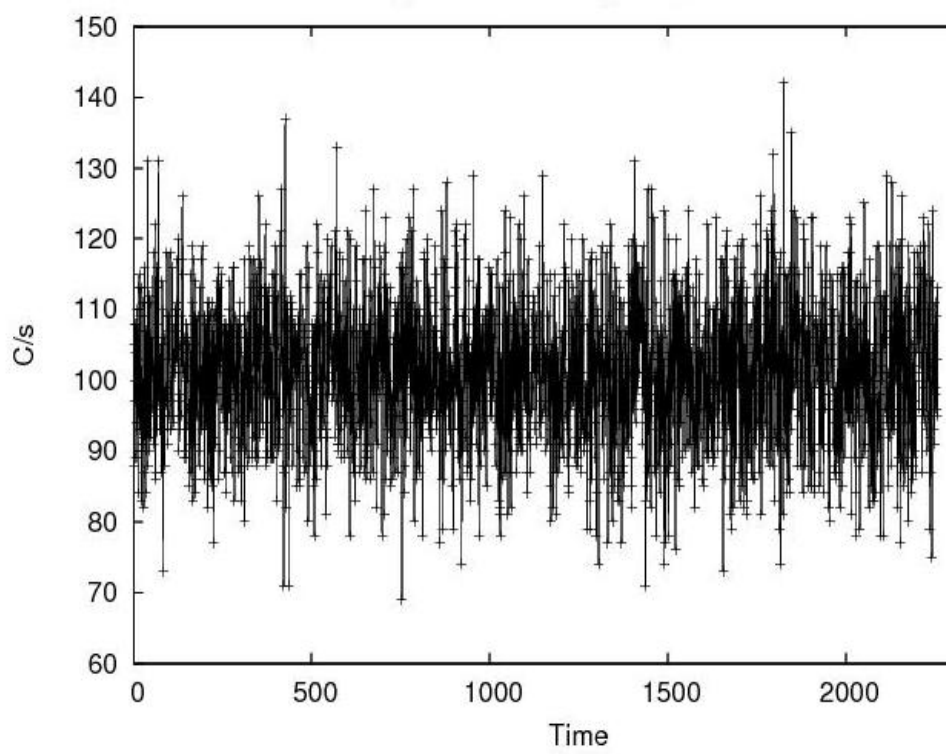
Diego Altamirano

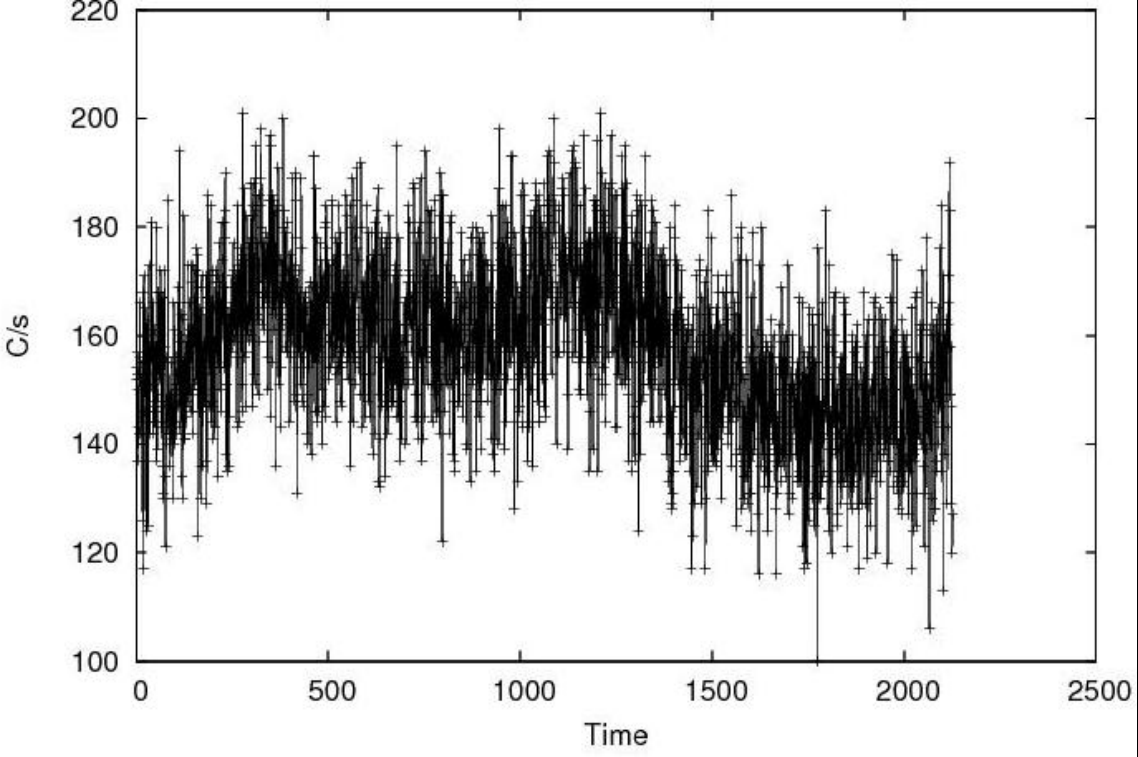
ASTRONOMICAL INSTITUTE

ANTON PANNEKOEK

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 accreting at Edd rates!


C/s
Time
150
140
130
120
110
100
90
80
70
60
0
500
1000
1500
2000


C/s
Time
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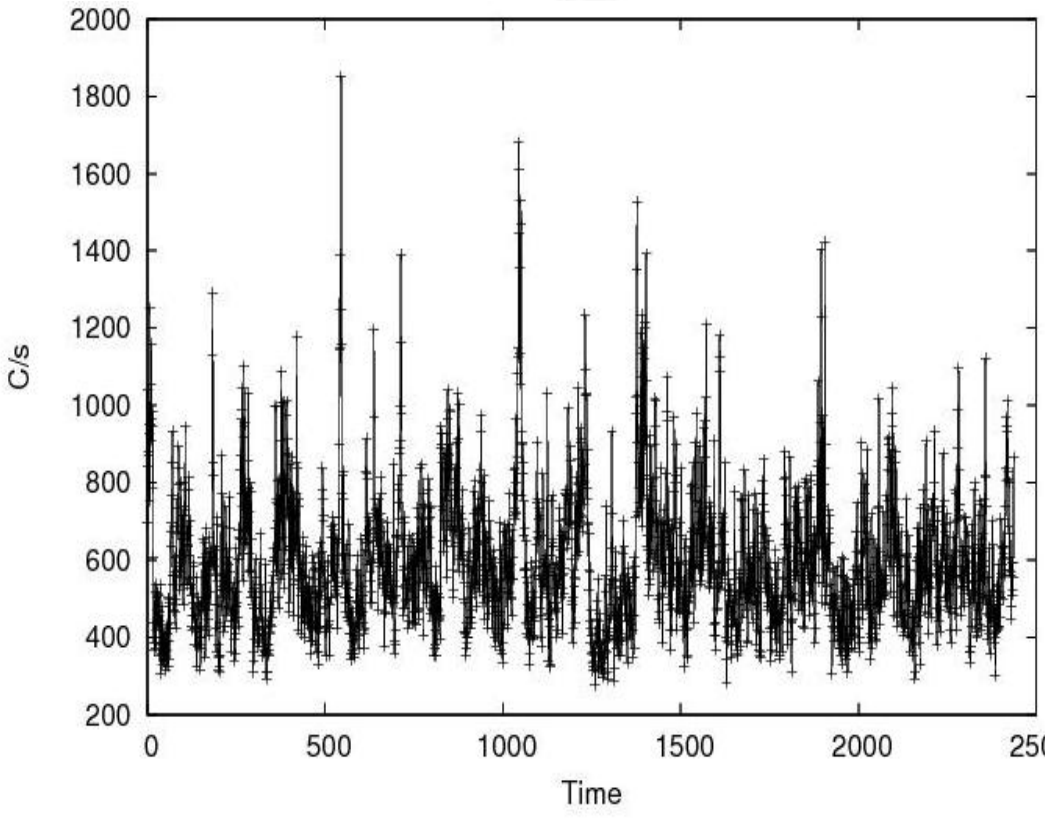
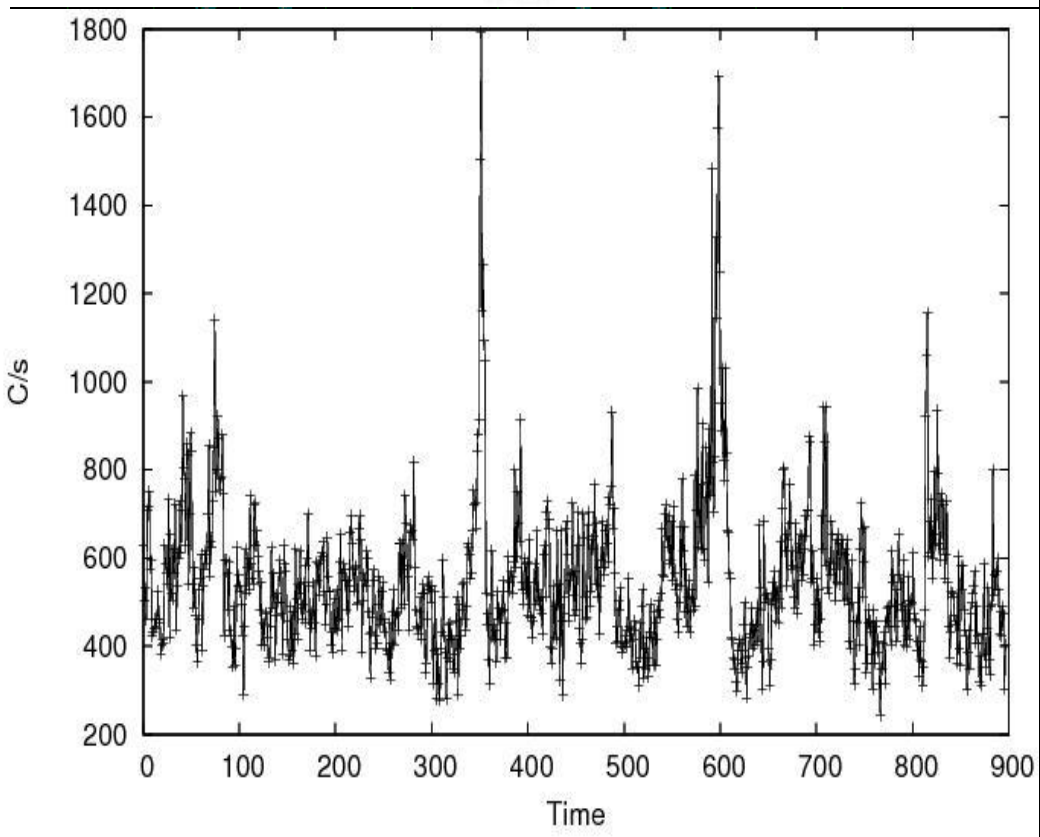
160
140
120
100
0
500
1000
1500
2000
2500


C/s
Time
2000
1800
1600
1400
1200
1000
800
600
400
200
0
500
1000
1500
2000


C/s
Time
1800
1600
1400
1200
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600
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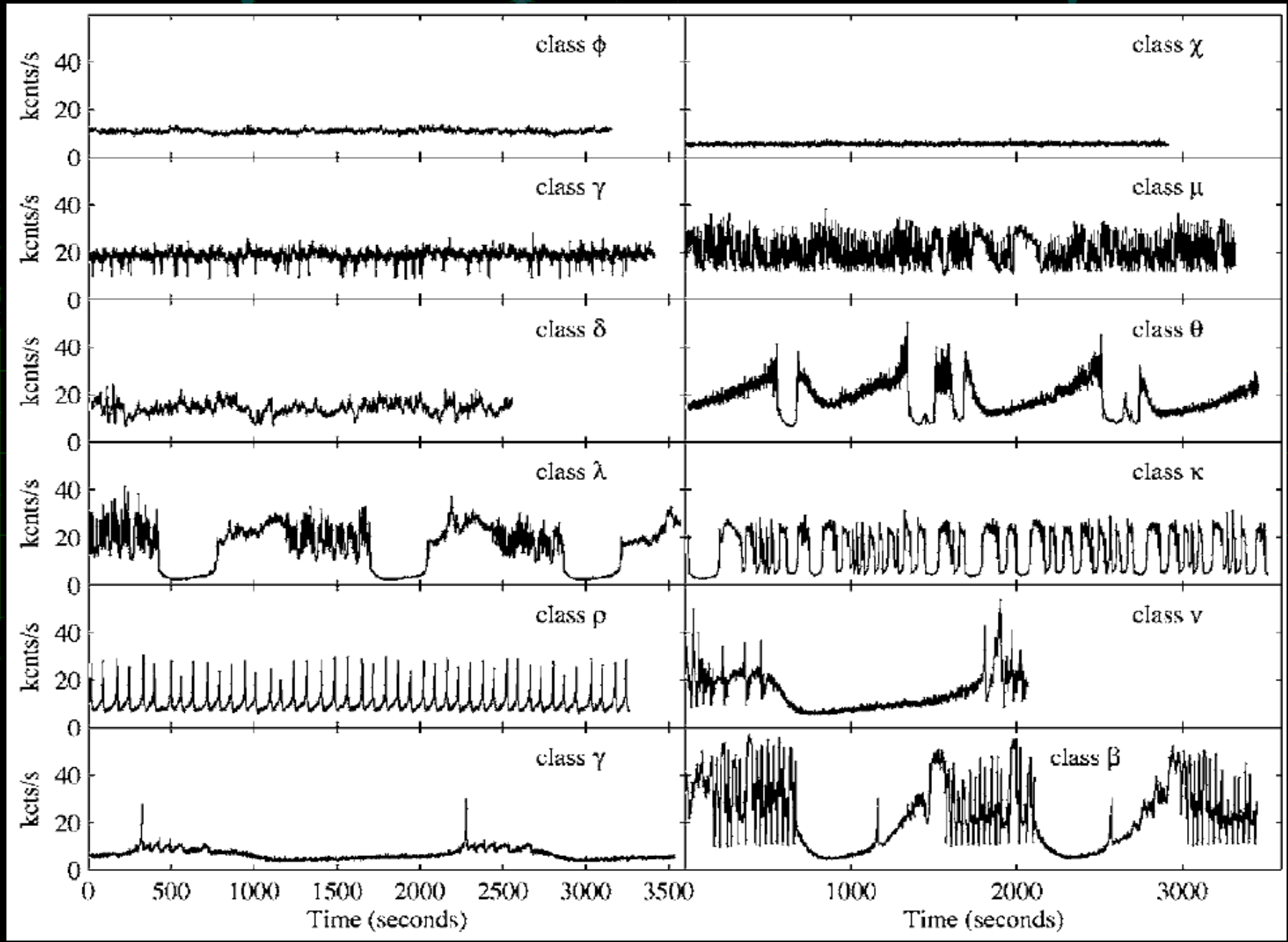
600
700
800
900

Limit cycles of accretion and ejection in an unstable disk



Belloni et al. 2002

GRS 1915+105 is “test case”

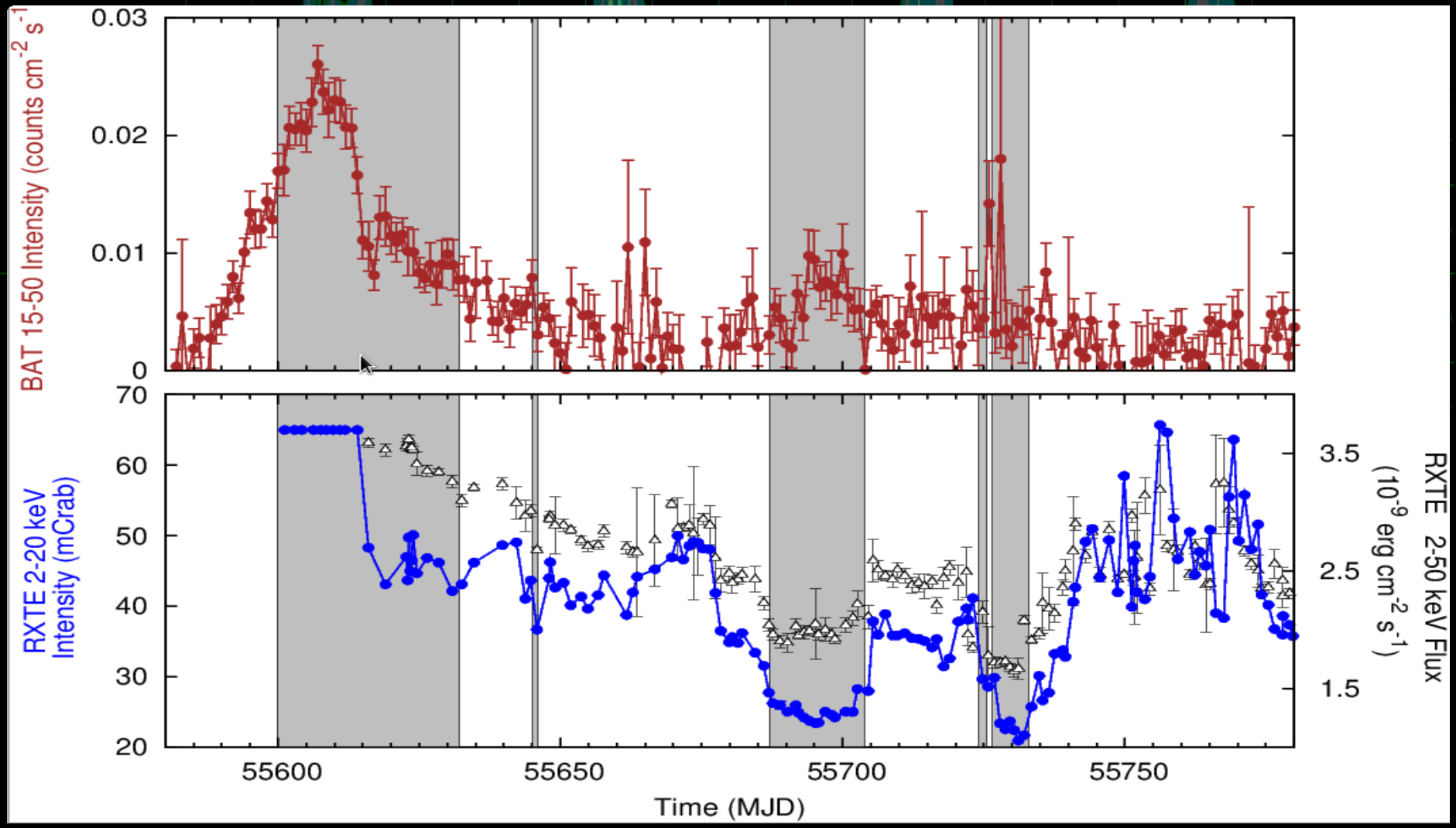
>1000 papers... even a review focused only on GRS 1915+105!!!

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

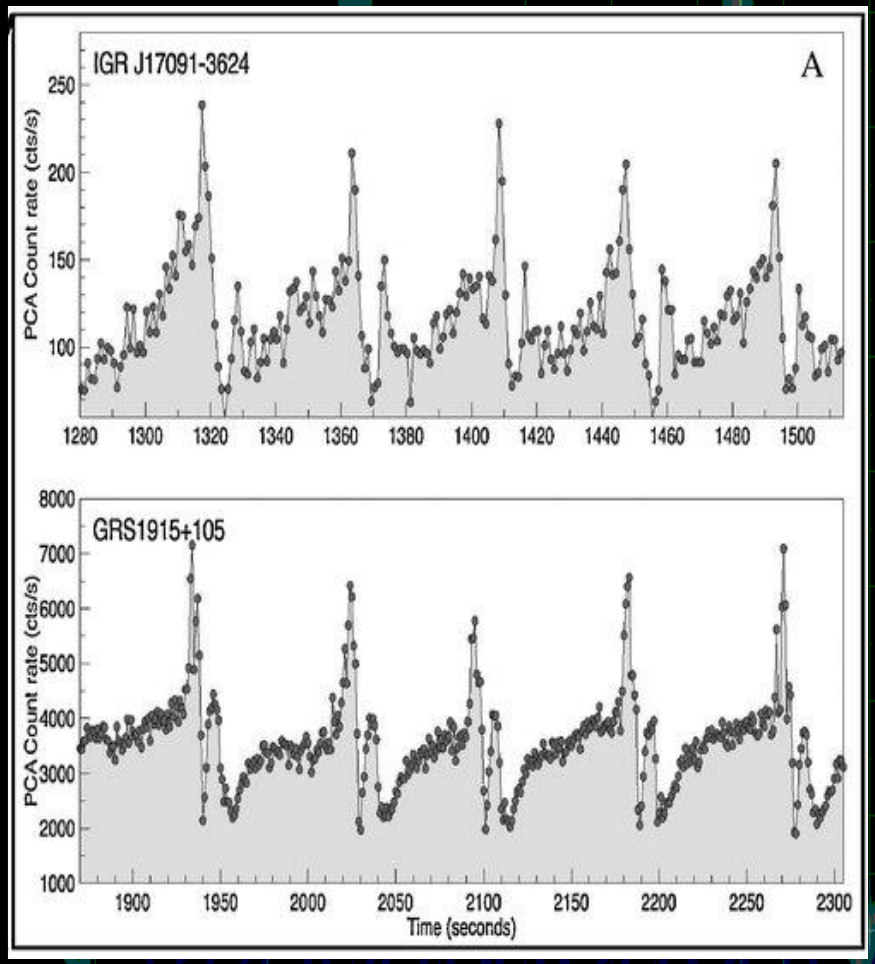
...and so far ... the tip of the iceberg...

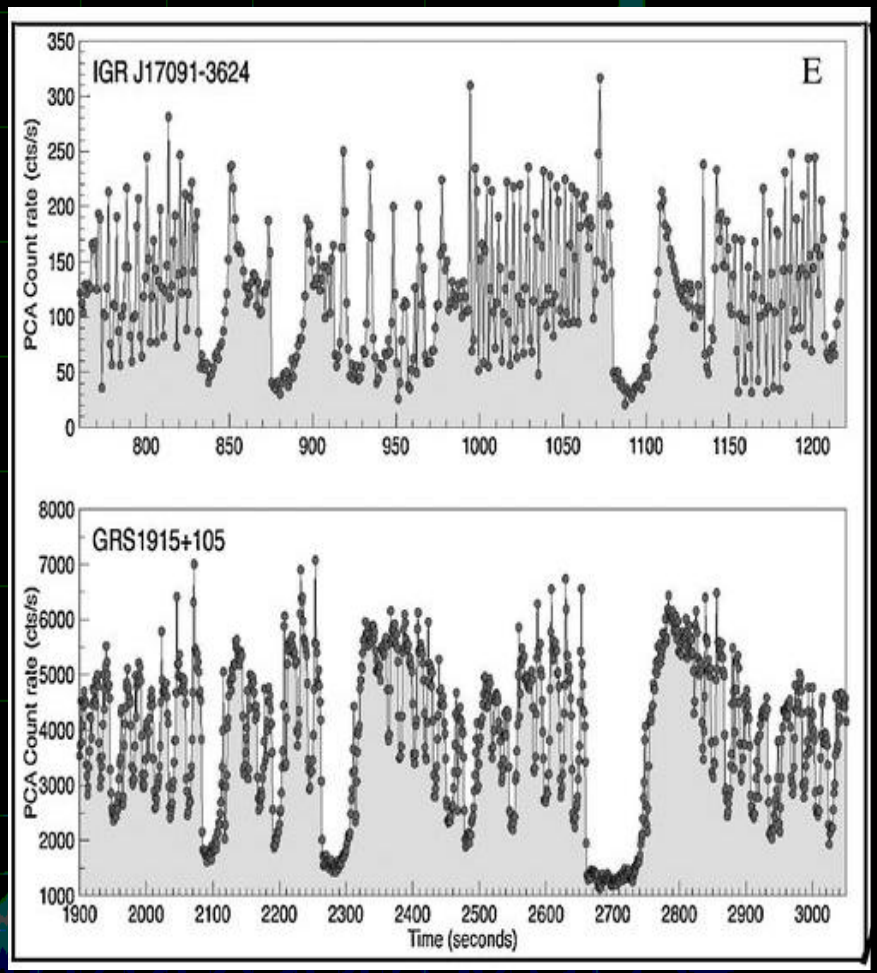
IGR J17091-3624: 2011 outburst



Altamirano et al. 2011

IGR J17091-3624



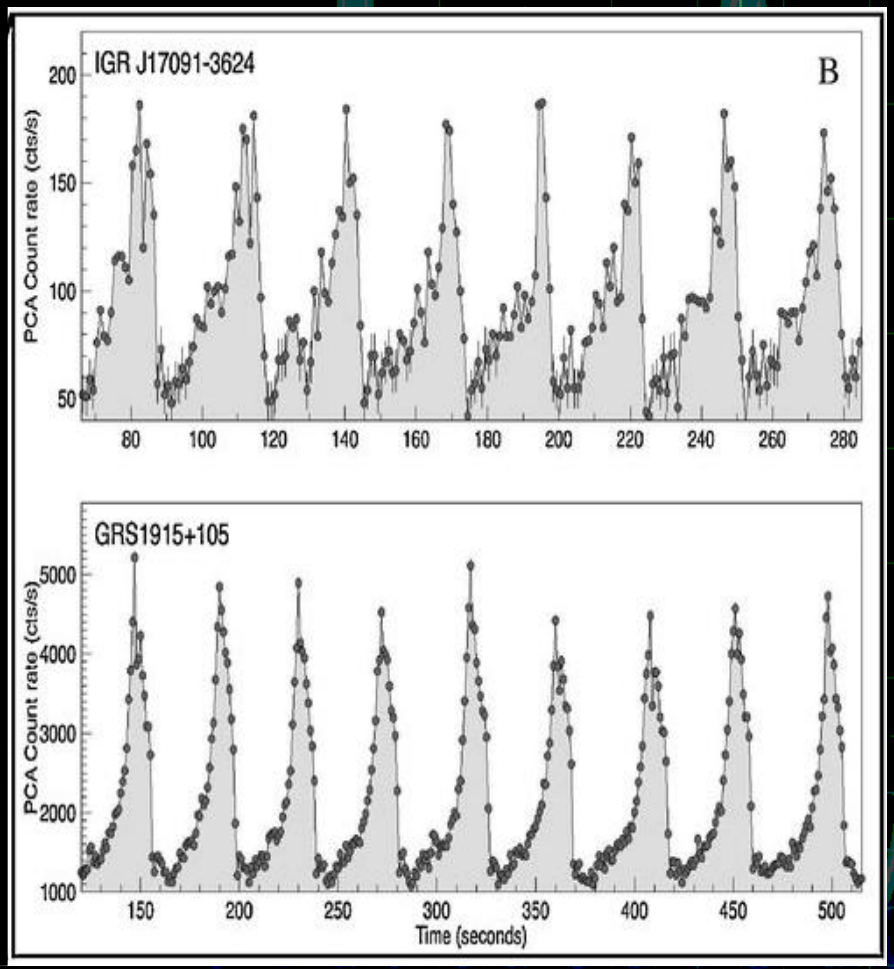


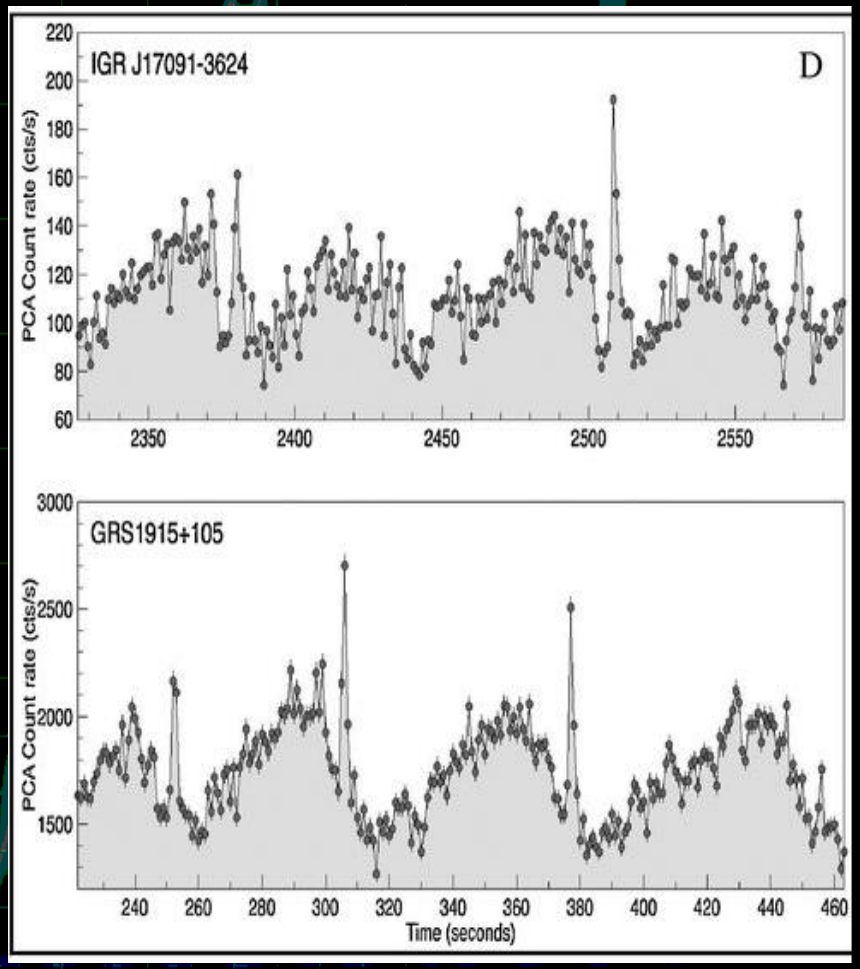
GRS 1915+105

Altamirano et al. 2011
Altamirano & Belloni 2012
Pahari et al. 2012

NASA Press Release: *http://www.nasa.gov/topics/universe/features/black-hole-heartbeat.html*

IGR J17091-3624





GRS 1915+105

Altamirano et al. 2011
Altamirano & Belloni 2012
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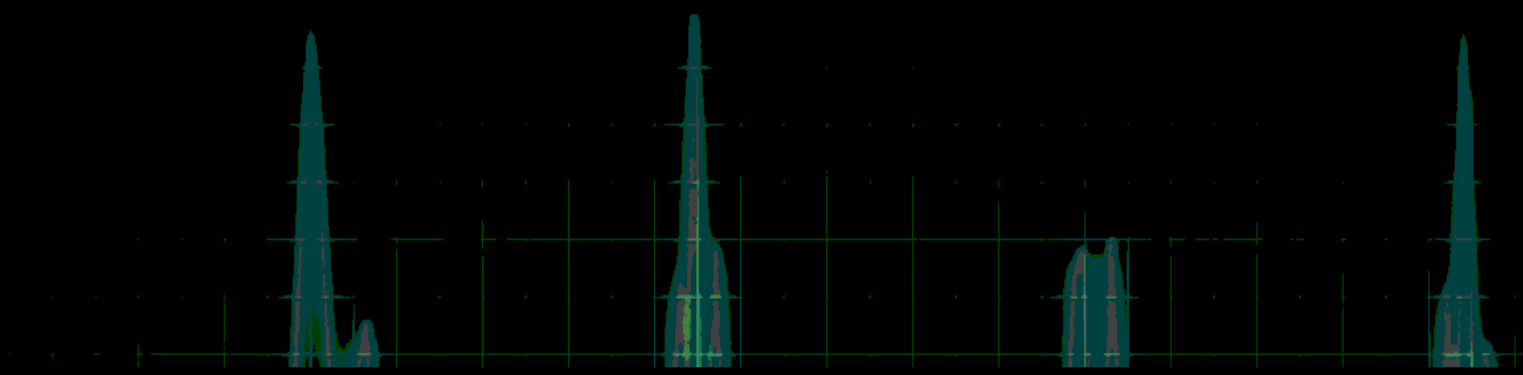
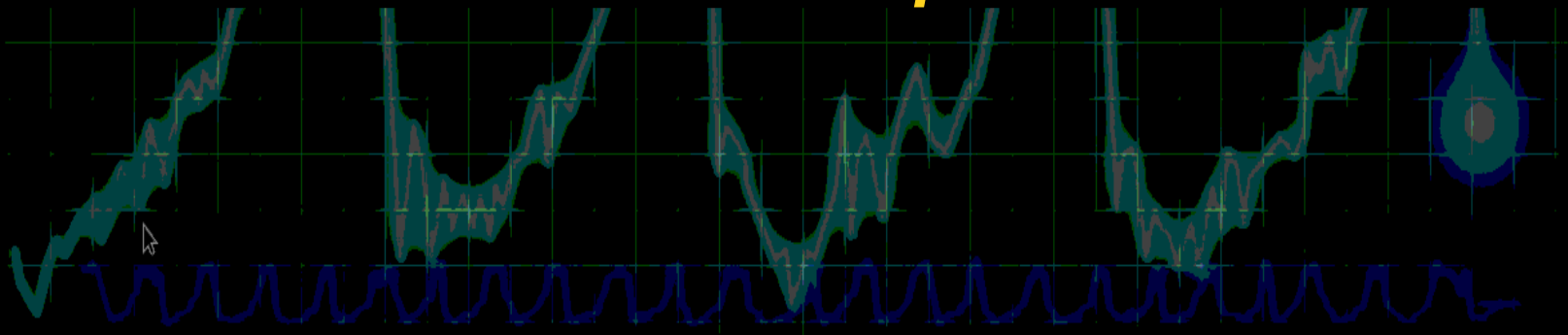
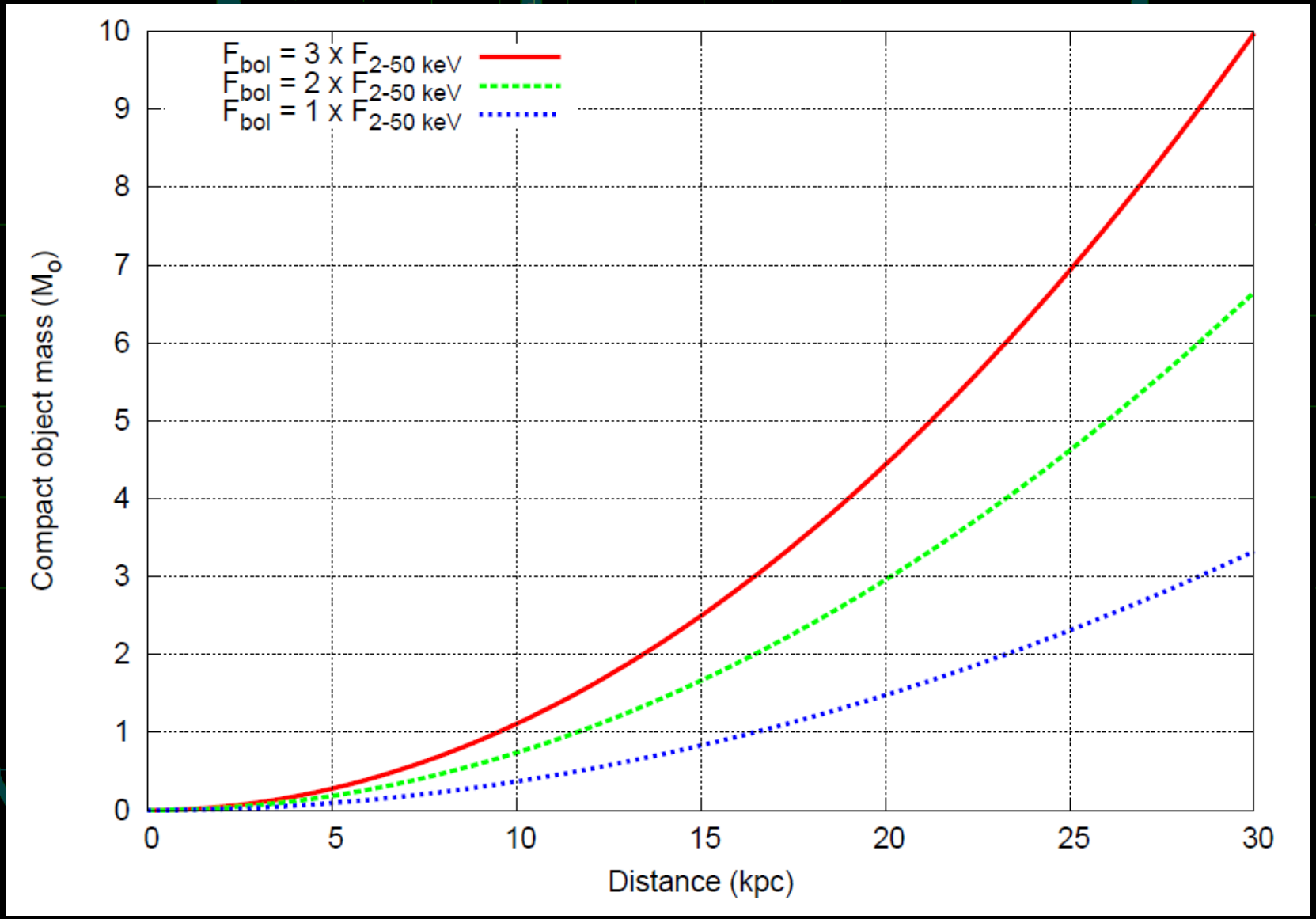
NASA Press Release: *http://www.nasa.gov/topics/universe/features/black-hole-heartbeat.html*



Main problem:
*IGR J17091 flux is a **factor >20***
lower than observed in GRS
1915+105 for comparable states



How far is it?



Altamirano et al. 2011

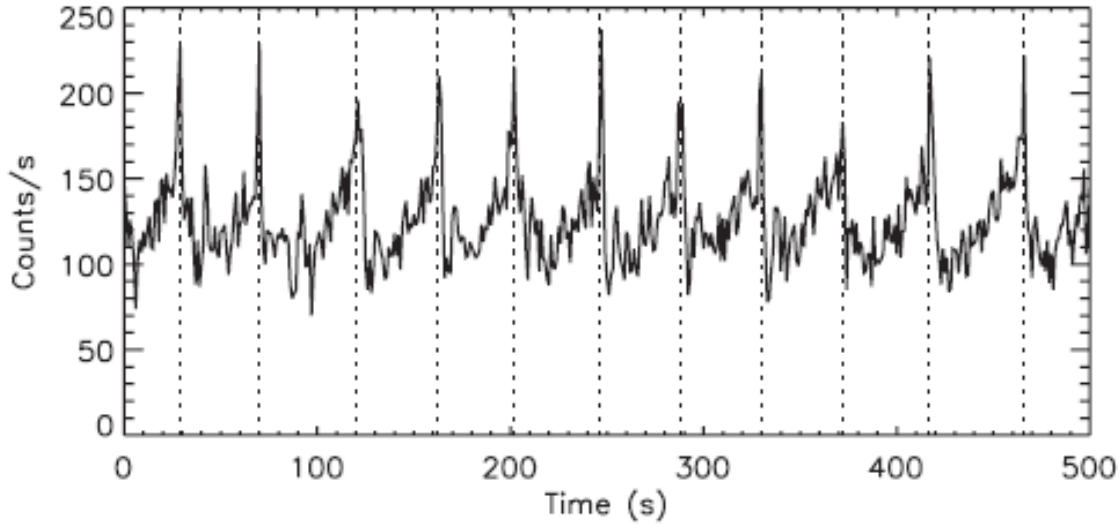


Figure 1. *RXTE*/PCA light curve of IGR J17091−3624 from observation 96420-01-05-000. The light curve was extracted with a bin size of 1 s from PCU2 covering an energy range of 2.0–60.0 keV. The vertical lines show the identified peak times of bursts.

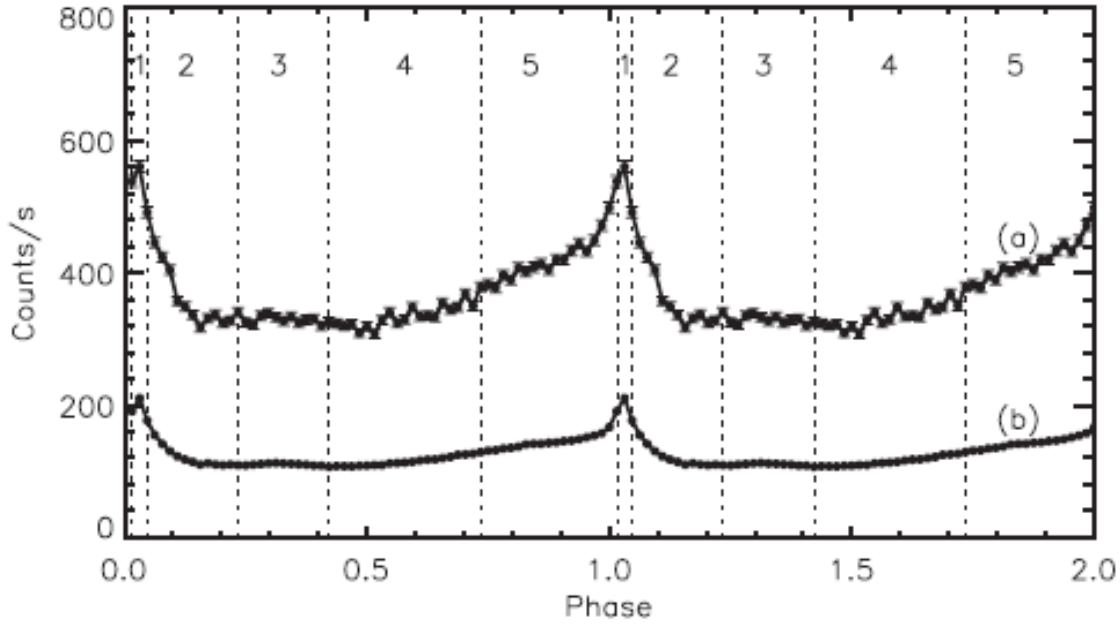
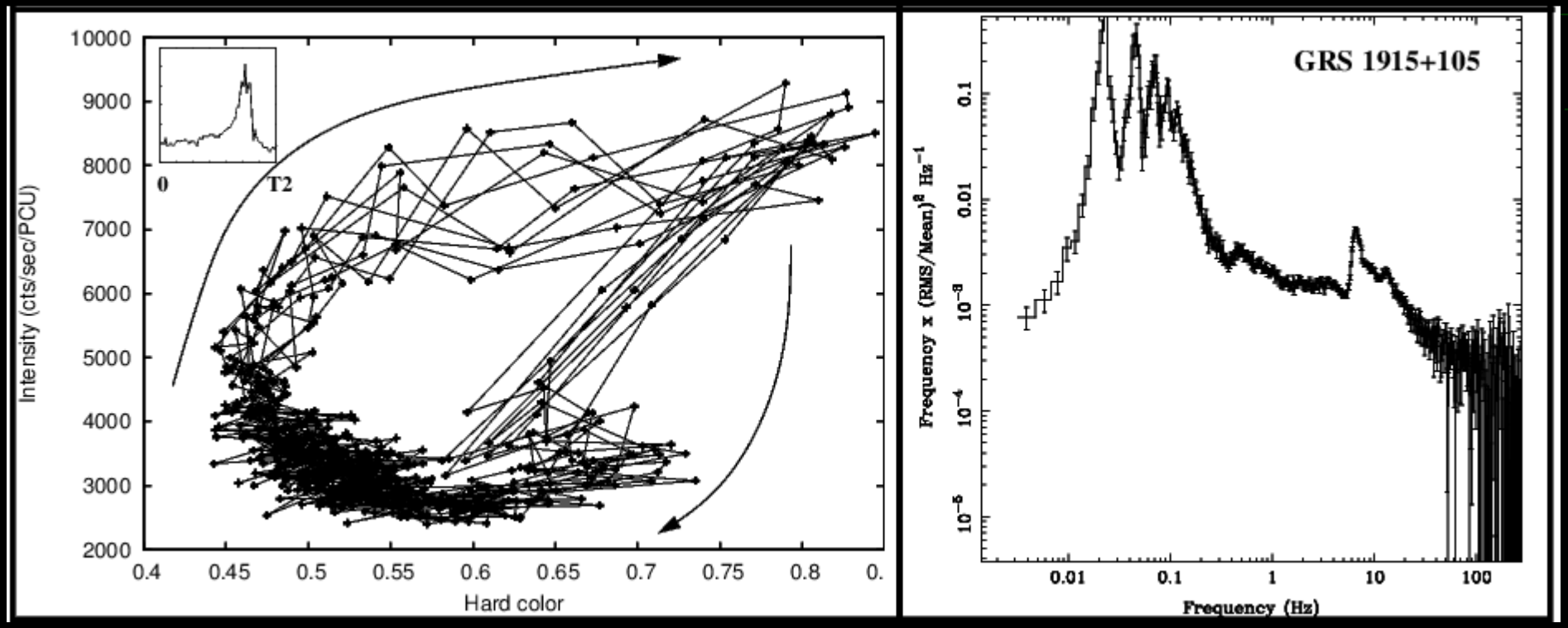
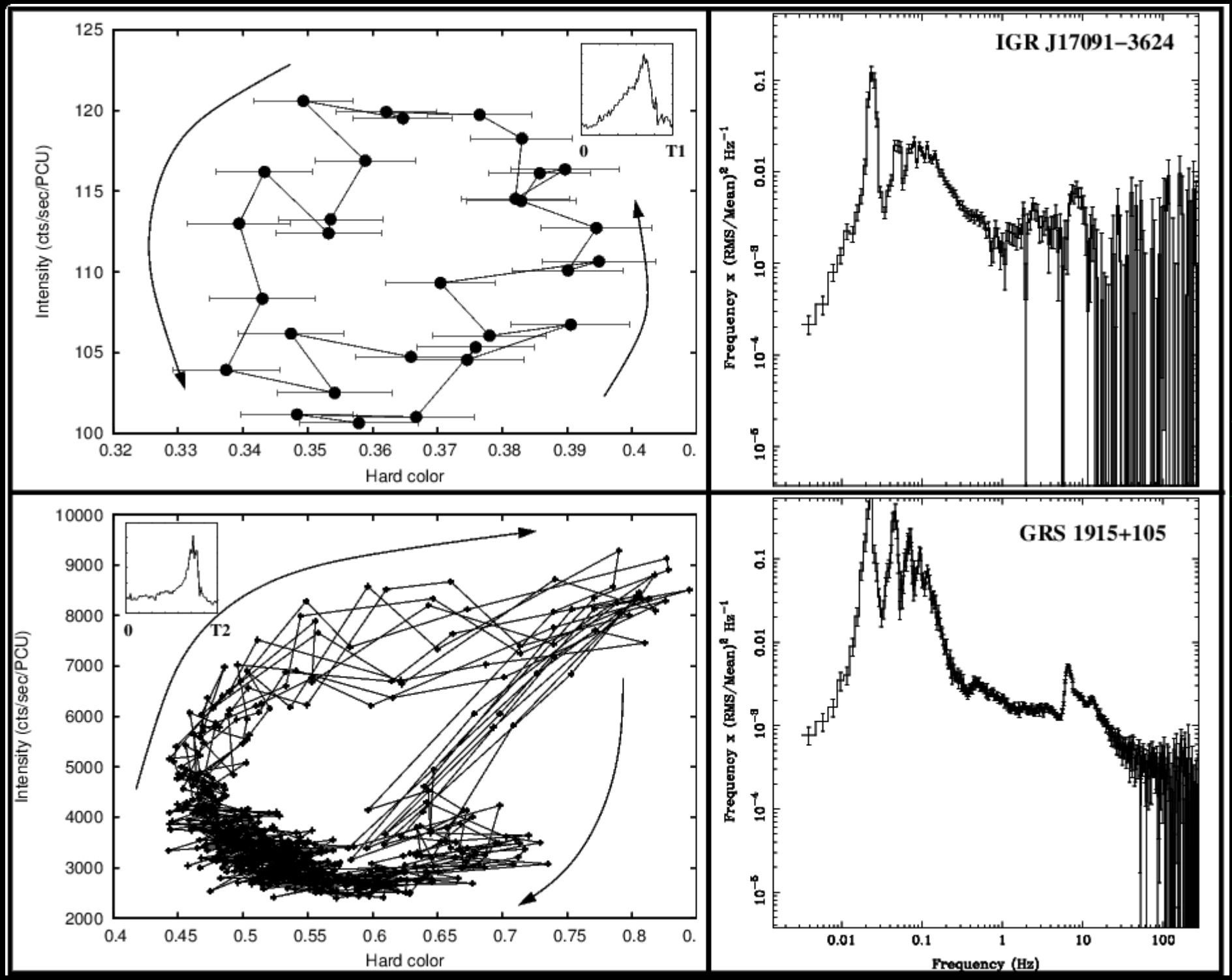


Figure 2. Phase-folded light curves from *XMM-Newton* and *RXTE*, labeled (a) and (b), respectively. Dotted vertical lines show demarcations for the five phases used for the simultaneous spectral fitting.

Accretion disk ... vs ... Disk winds ... vs ... relativistic jets ....
(see Neilsen et. al. papers)

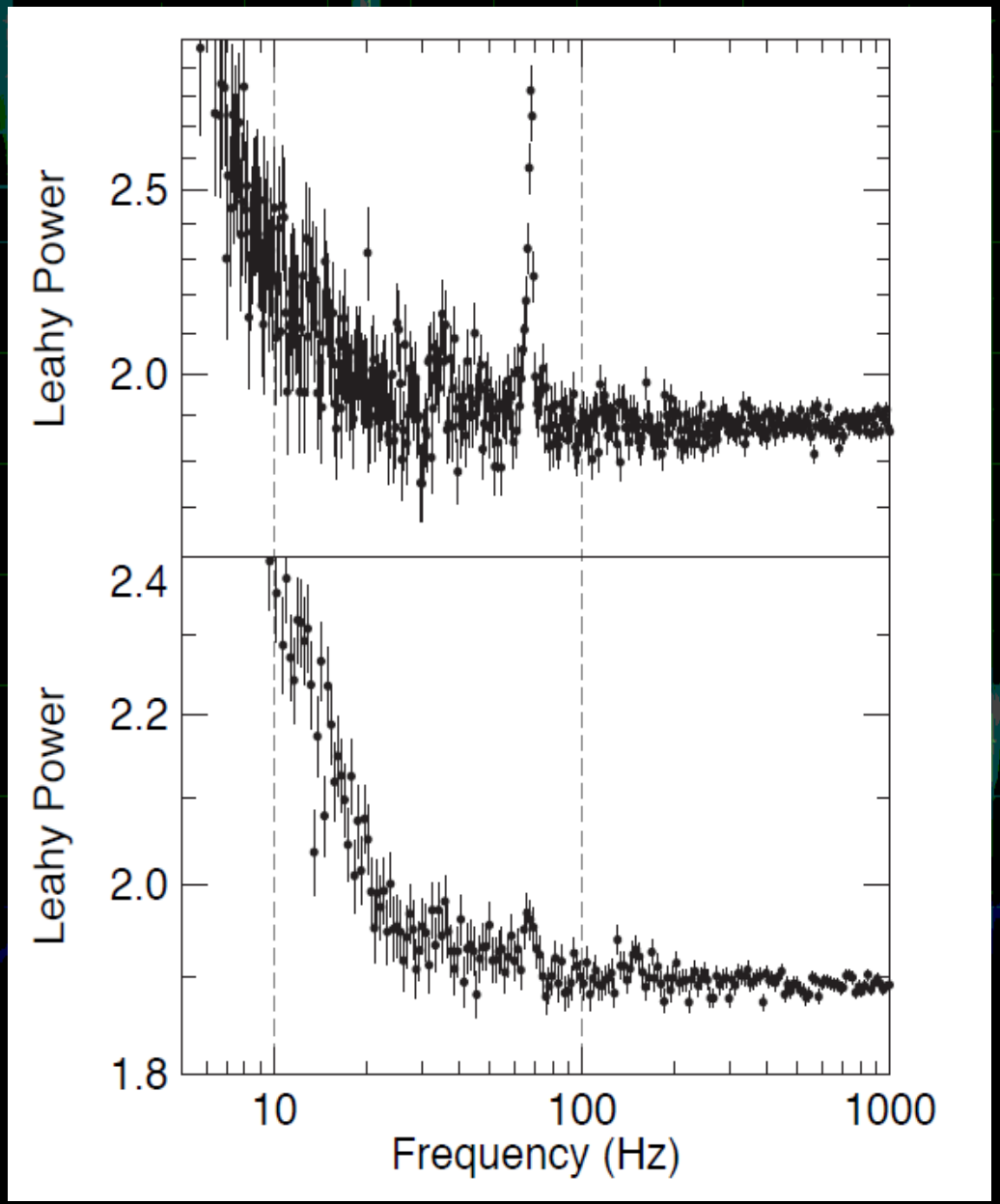


Altamirano et al. 2011



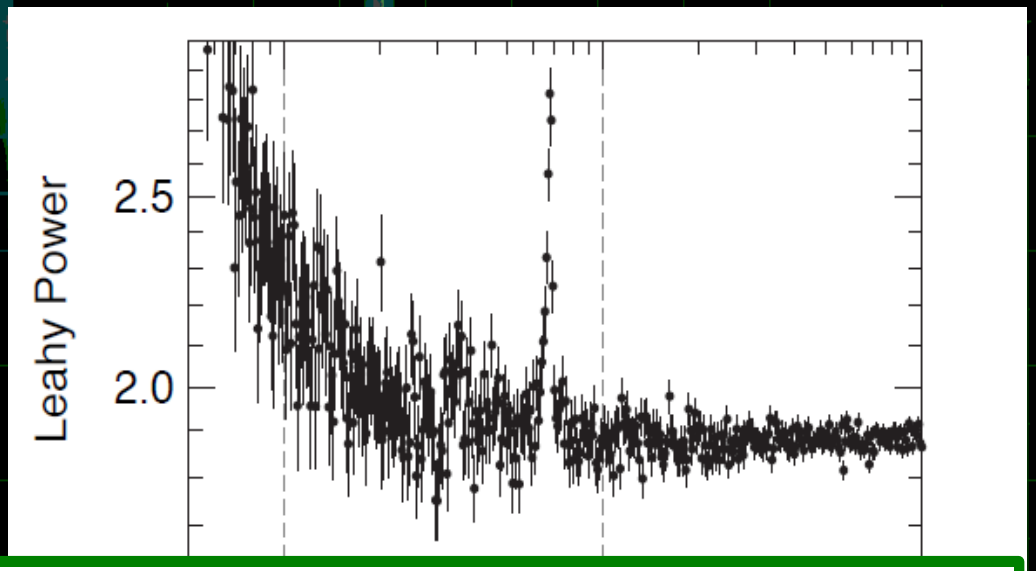
Altamirano et al. 2011

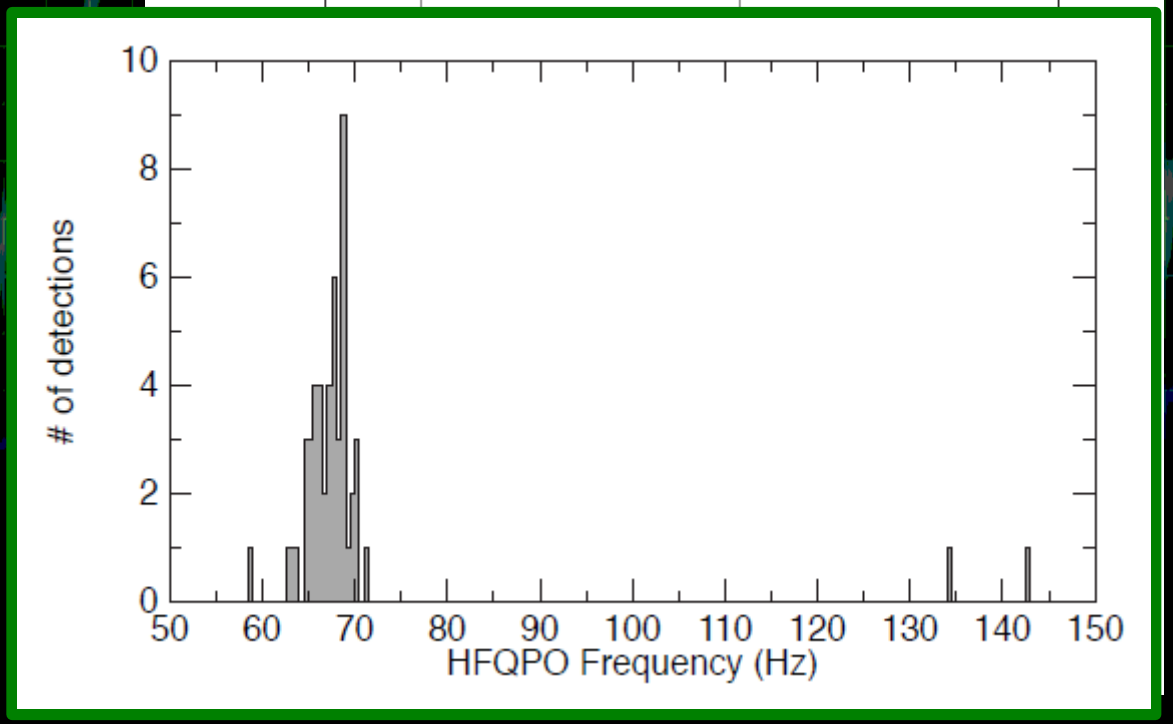
...High-Frequency QPOs as tracers of black hole mass and spin ....



Belloni & Altamirano 2013

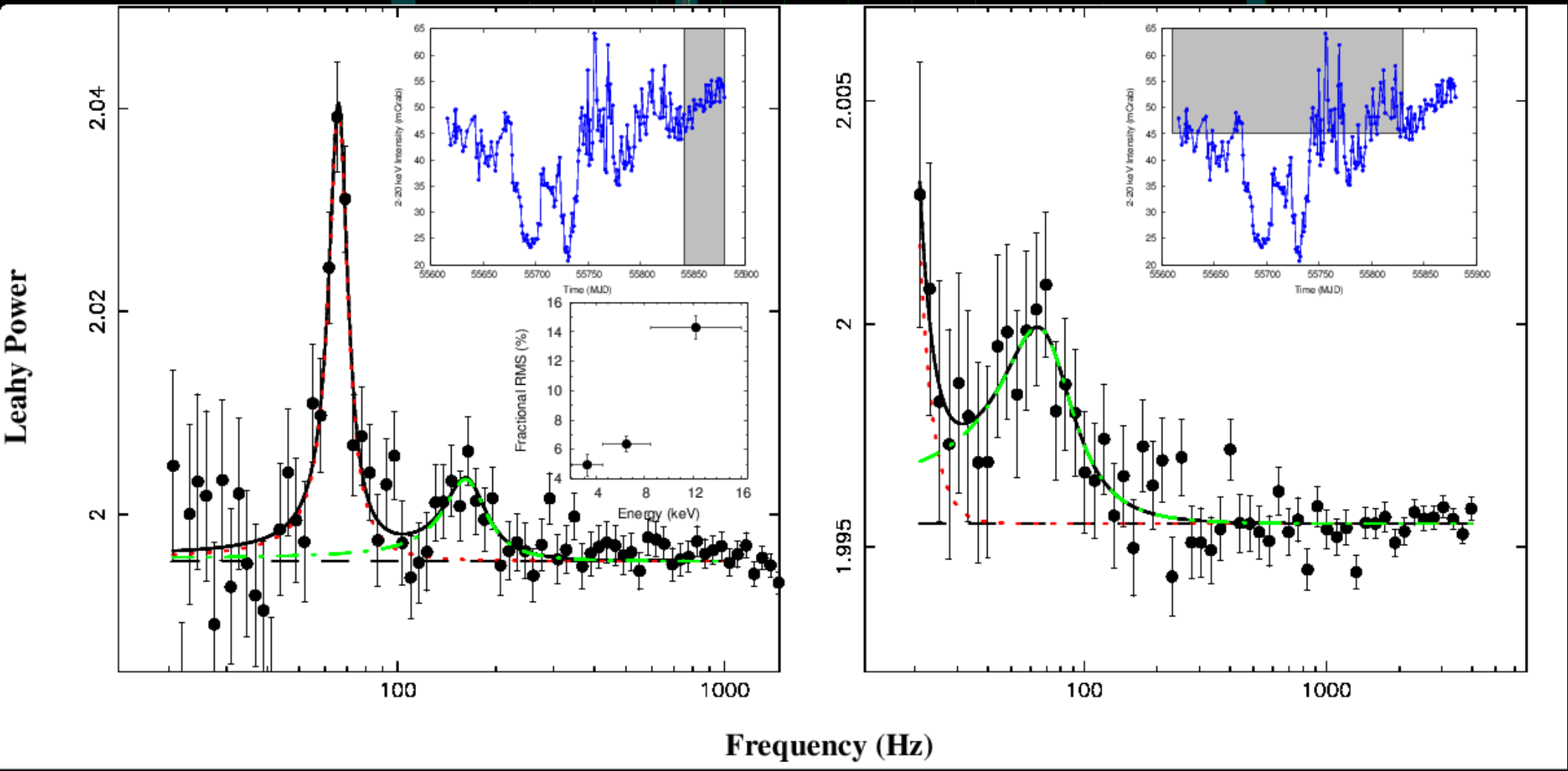
...High-Frequency QPOs as tracers of black hole mass and spin ....





Belloni
&
Altamirano
2013

Sharp at 67 Hz == GRS 1915+105



High-frequency QPOs in IGR J17091-3624, Altamirano & Belloni 2012

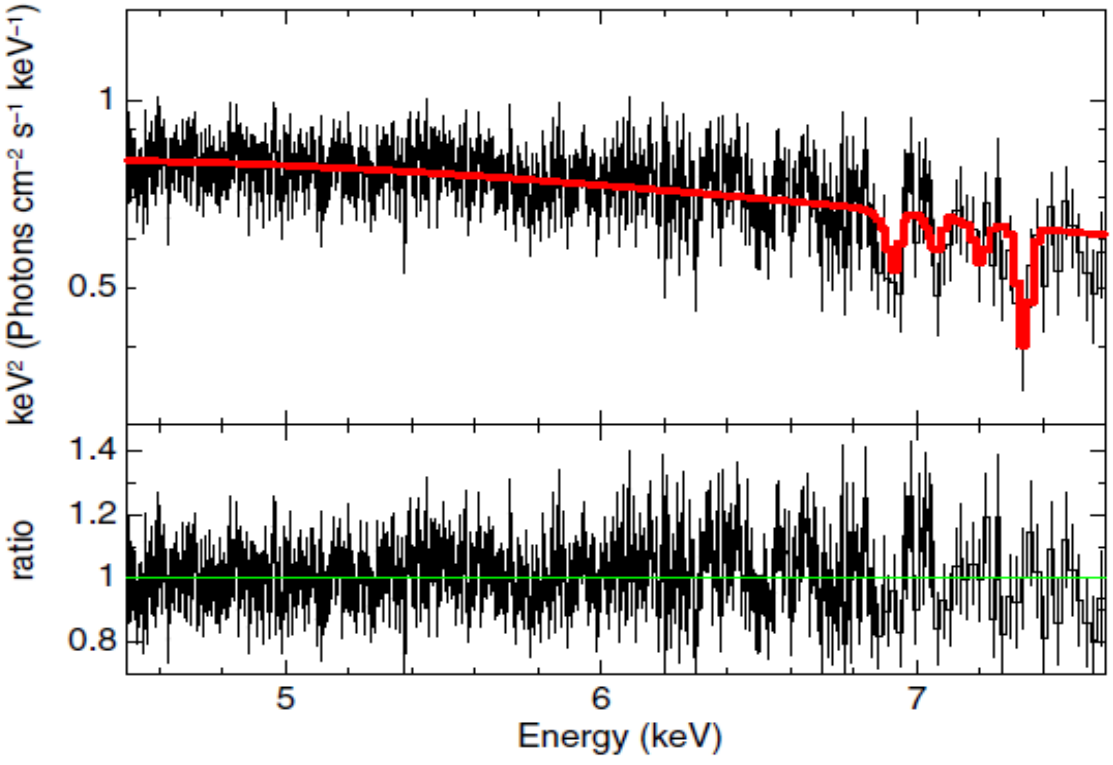
AN EXTREME X-RAY DISK WIND IN THE BLACK HOLE CANDIDATE IGR J17091−3624

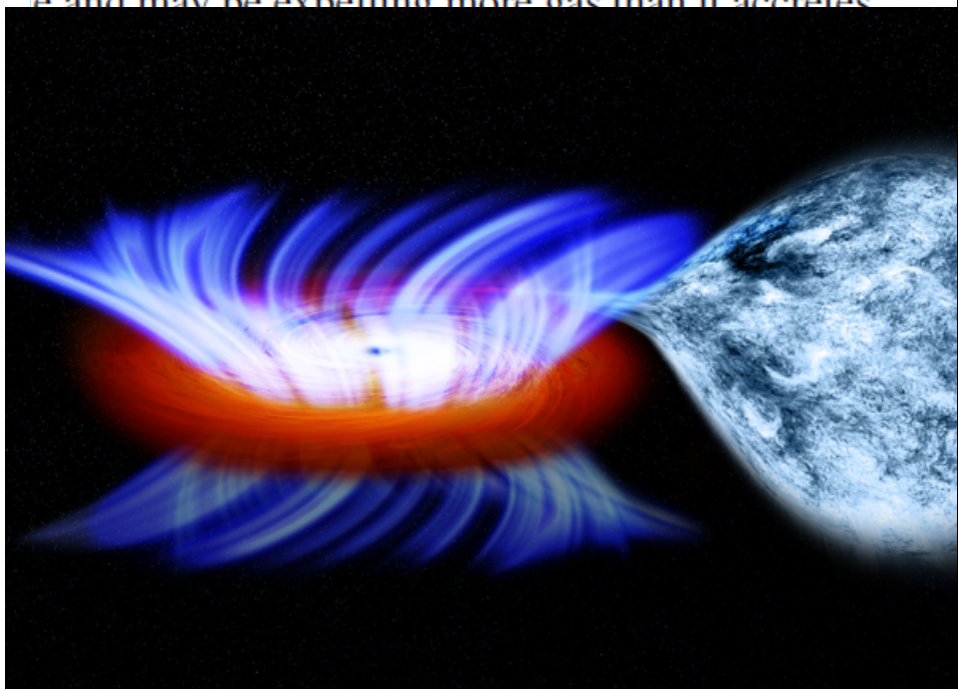
A. L. King[1], J. M. Miller[1], J. Raymond[2], A. C. Fabian[3], C. S. Reynolds[4], T. R. Kallman[5], D. Maitra[1], E. M. Cackett[3,6], and M. P. Rupen[7]

ABSTRACT

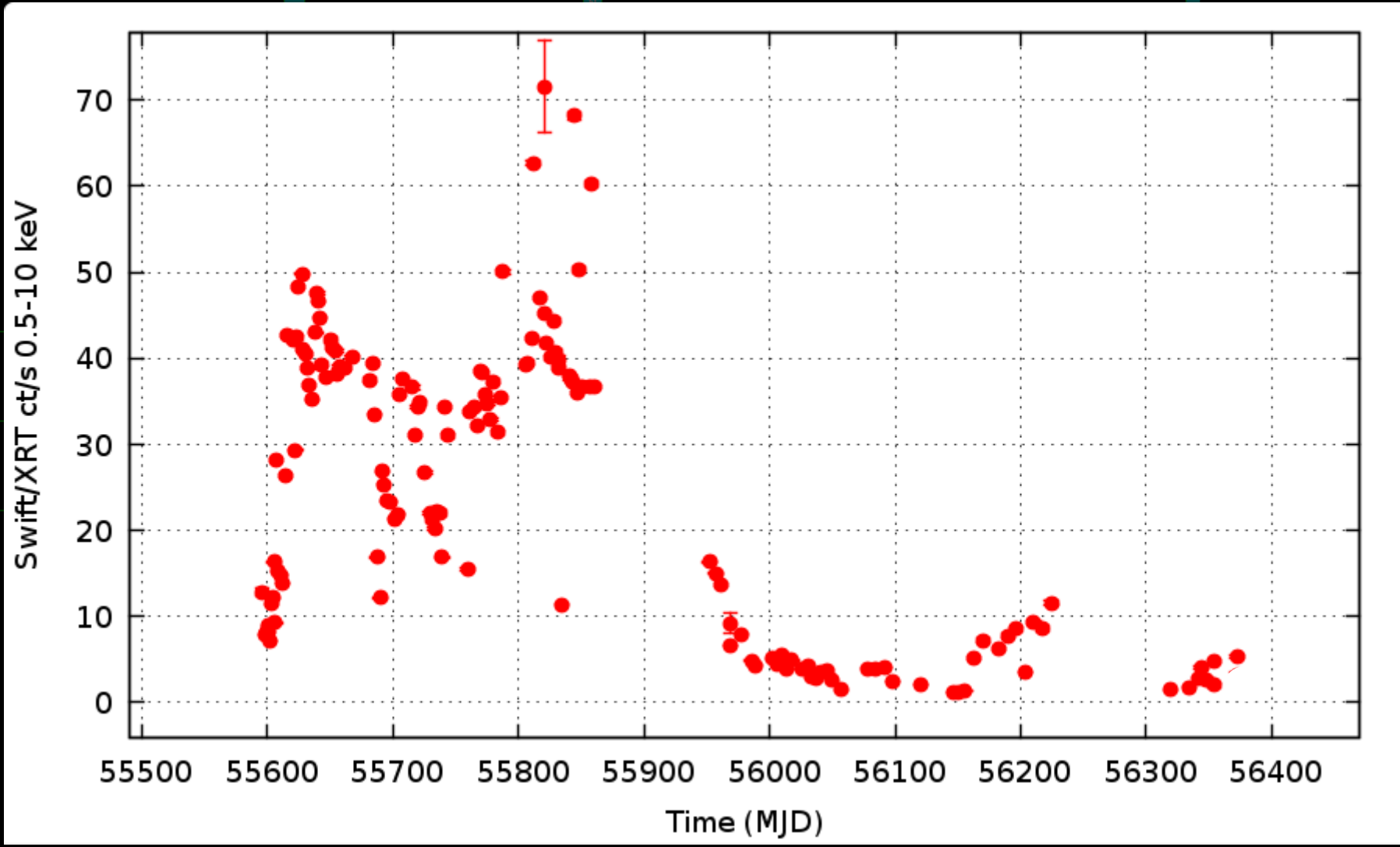
Chandra spectroscopy of transient stellar-mass black holes in outburst has clearly revealed accretion disk winds in soft, disk-dominated states, in apparent anti-correlation with relativistic jets in low/hard states. These disk winds are observed to be highly ionized, dense, and to have typical velocities 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



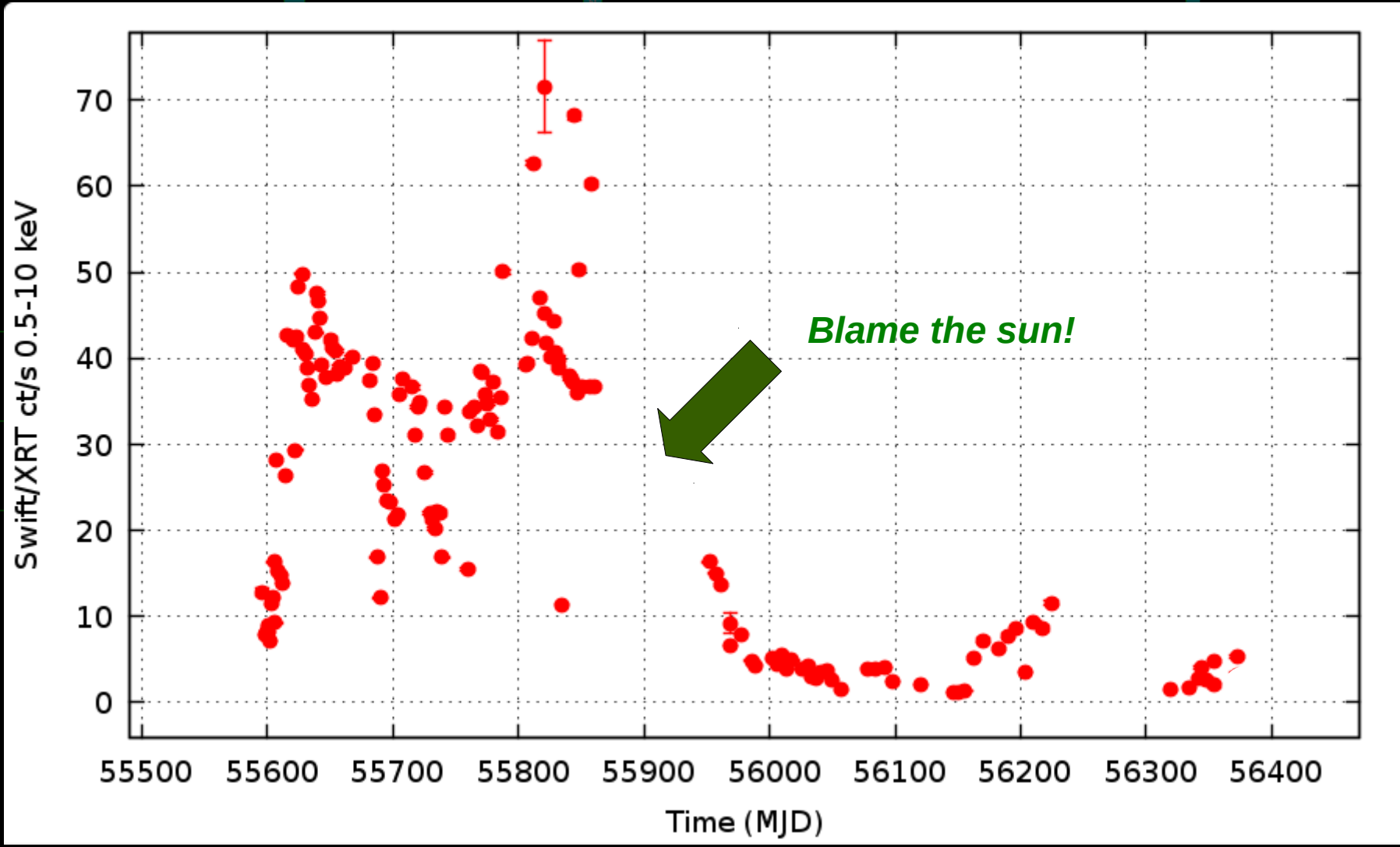


IGR J17091-3624 is still active!!



Altamirano et al. 2013a in prep

IGR J17091-3624 is still active!!



Altamirano et al. 2013a in prep

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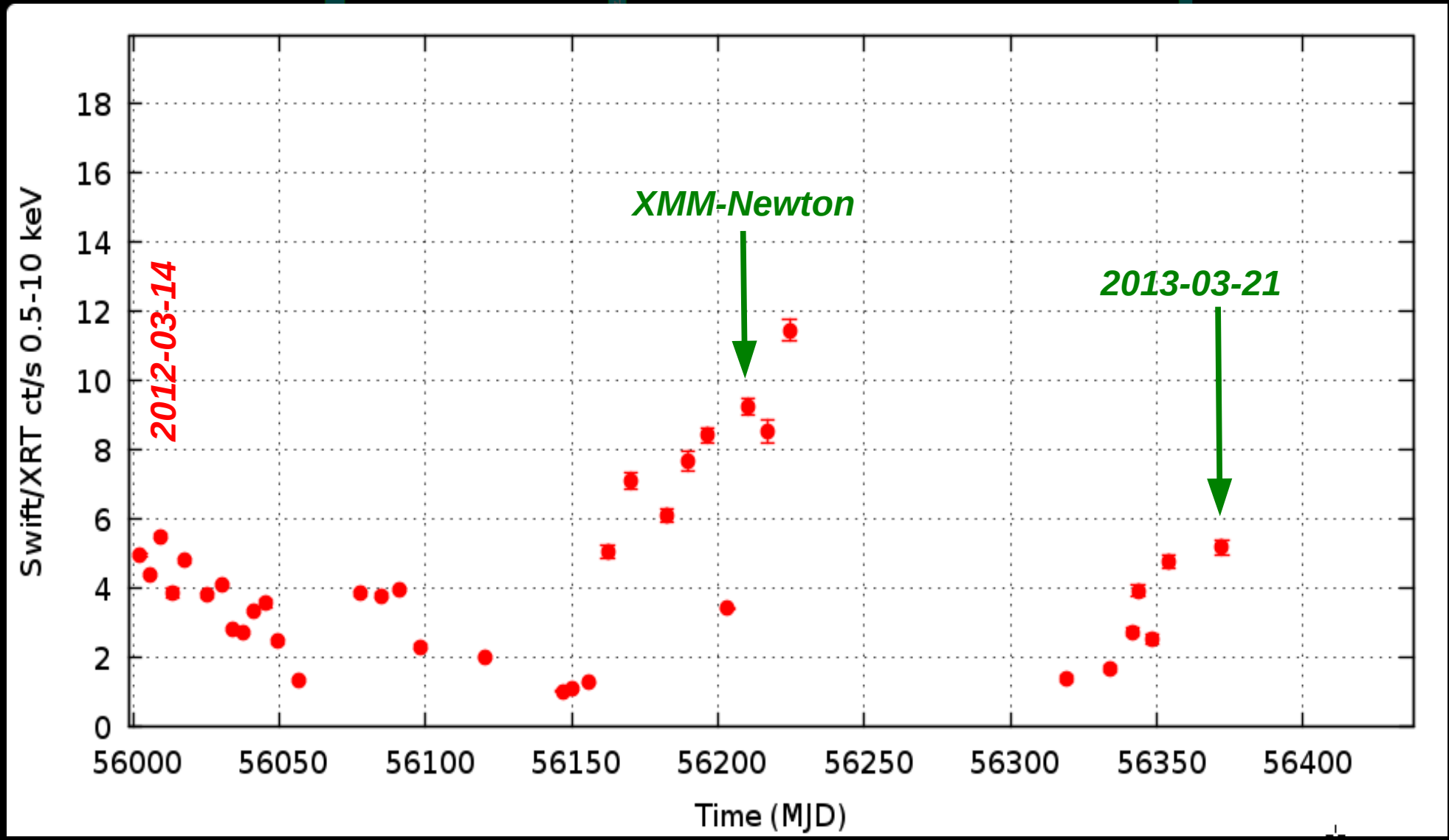

Altamirano et al. 2013a in prep

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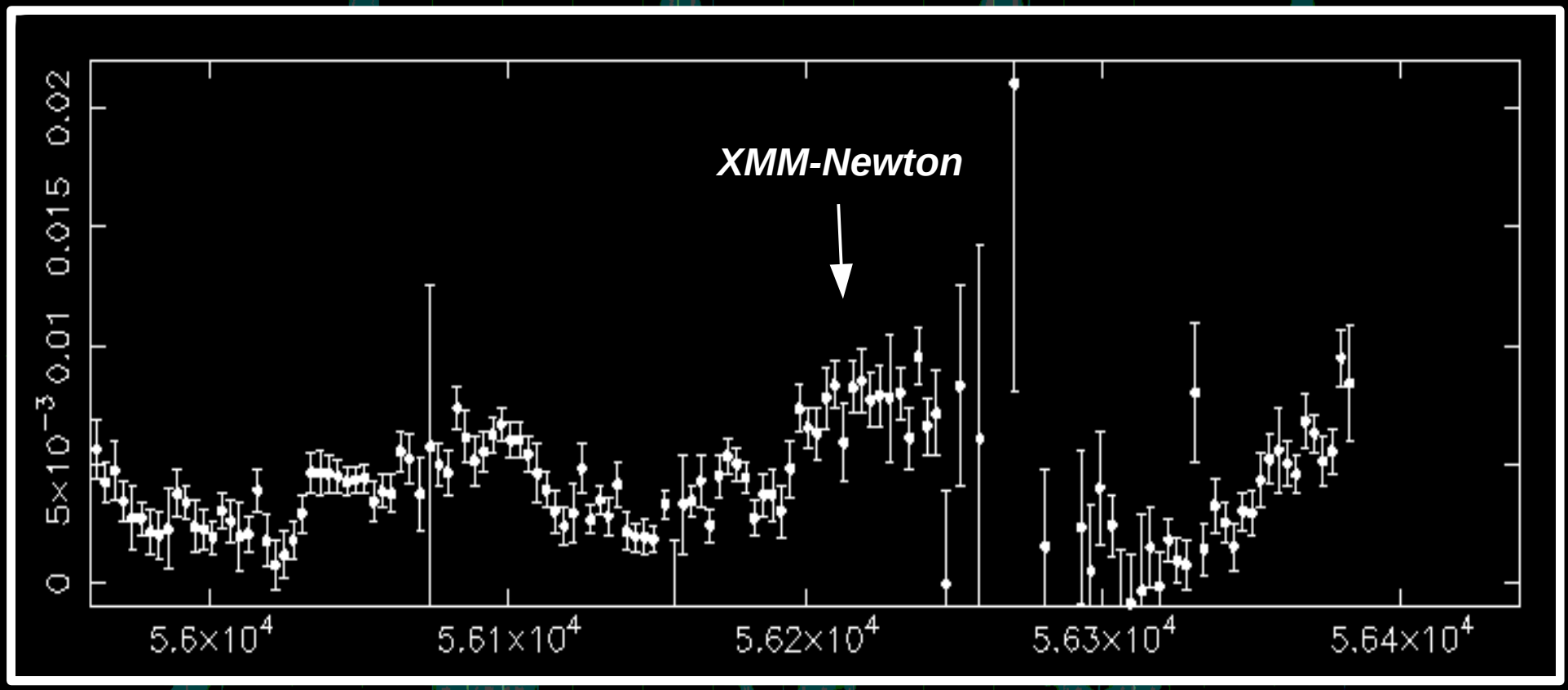
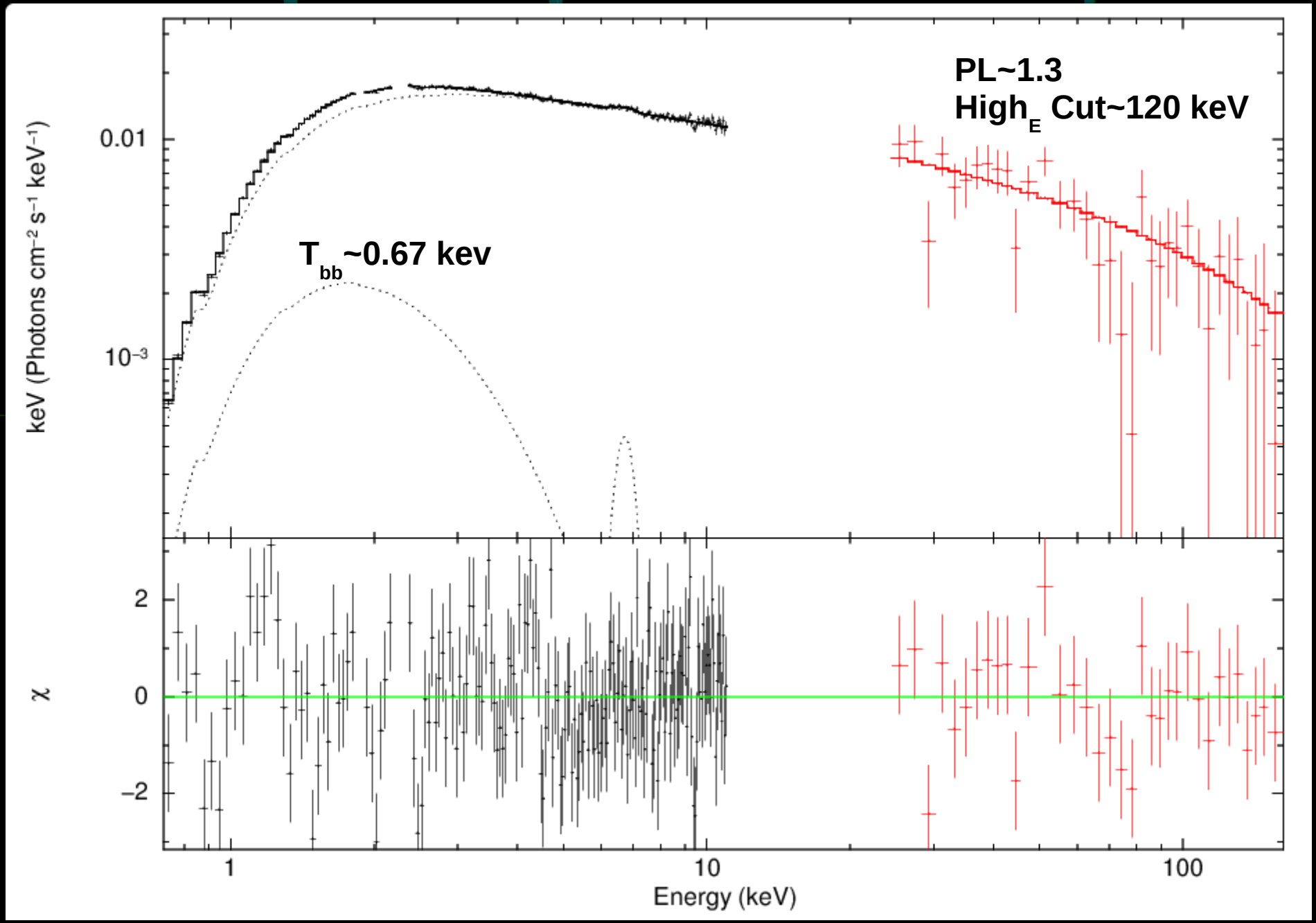


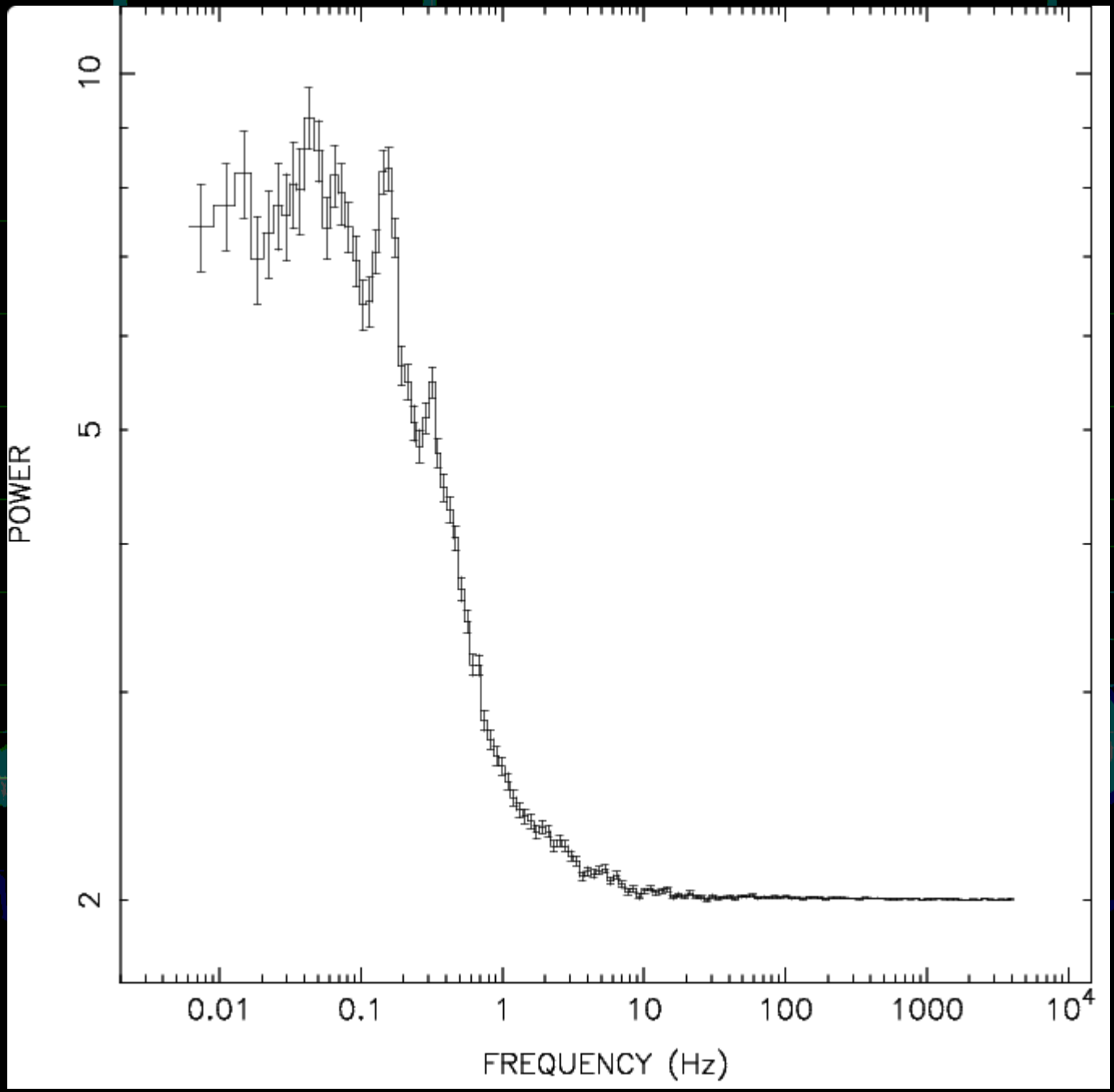
Altamirano et al. 2013a in prep

IGR J17091-3624 in the hard state



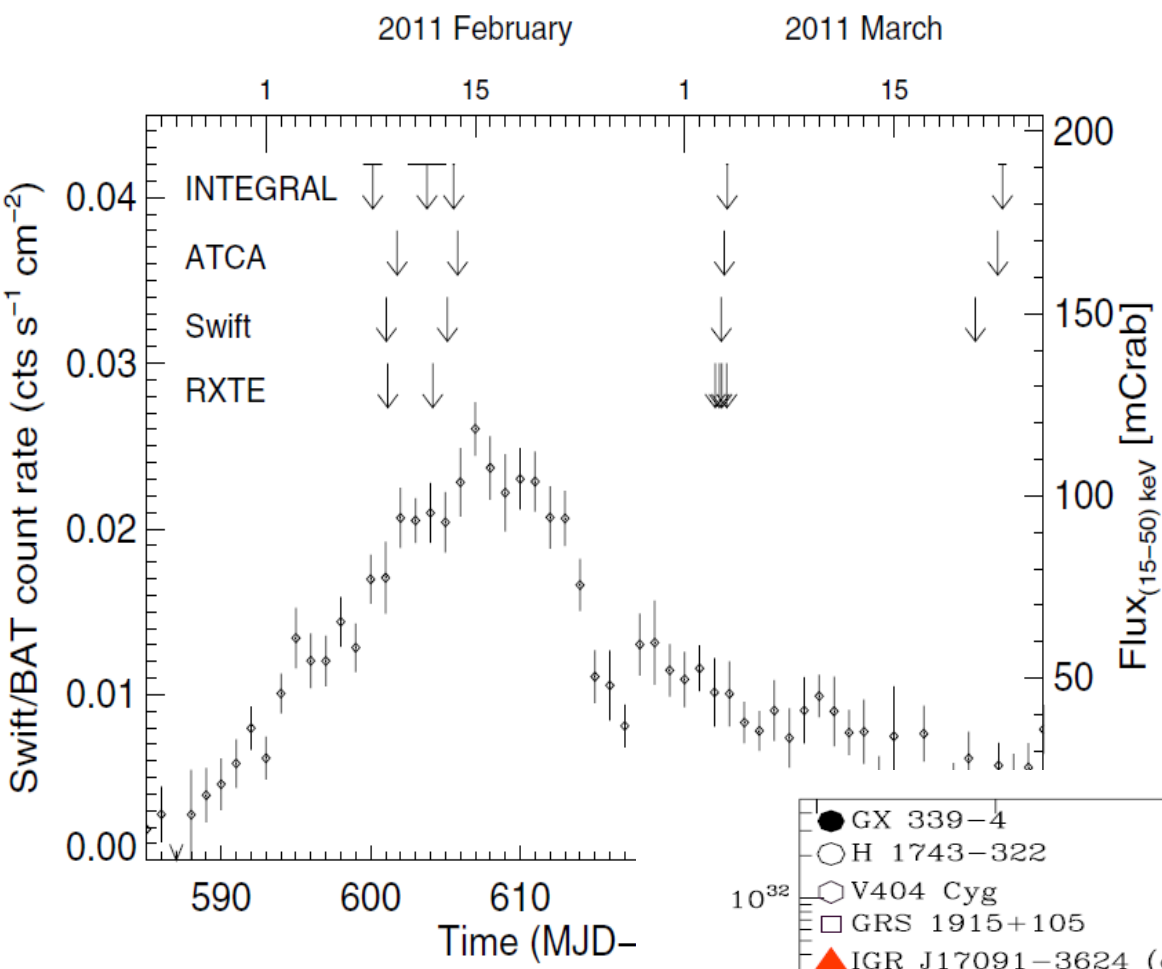
Altamirano et al. 2013a in prep

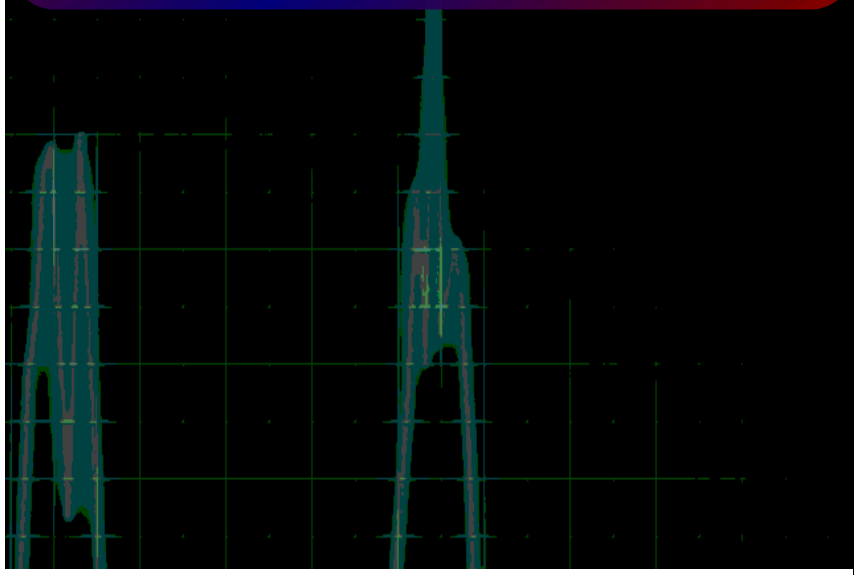
IGR J17091-3624 in the hard state

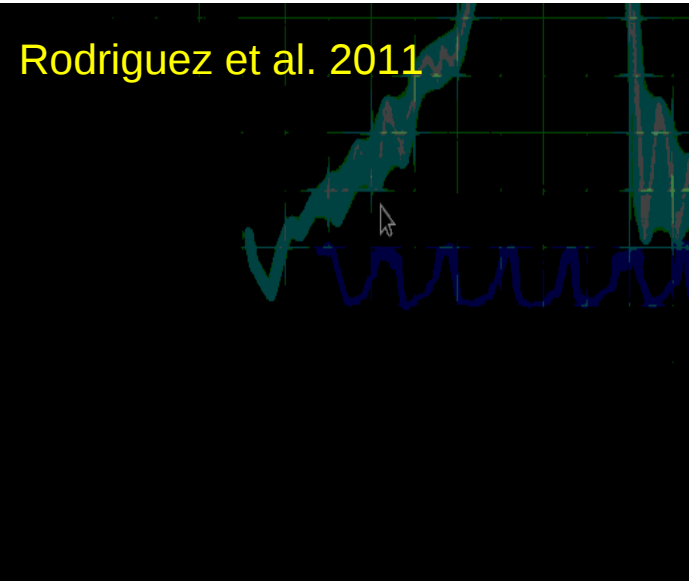


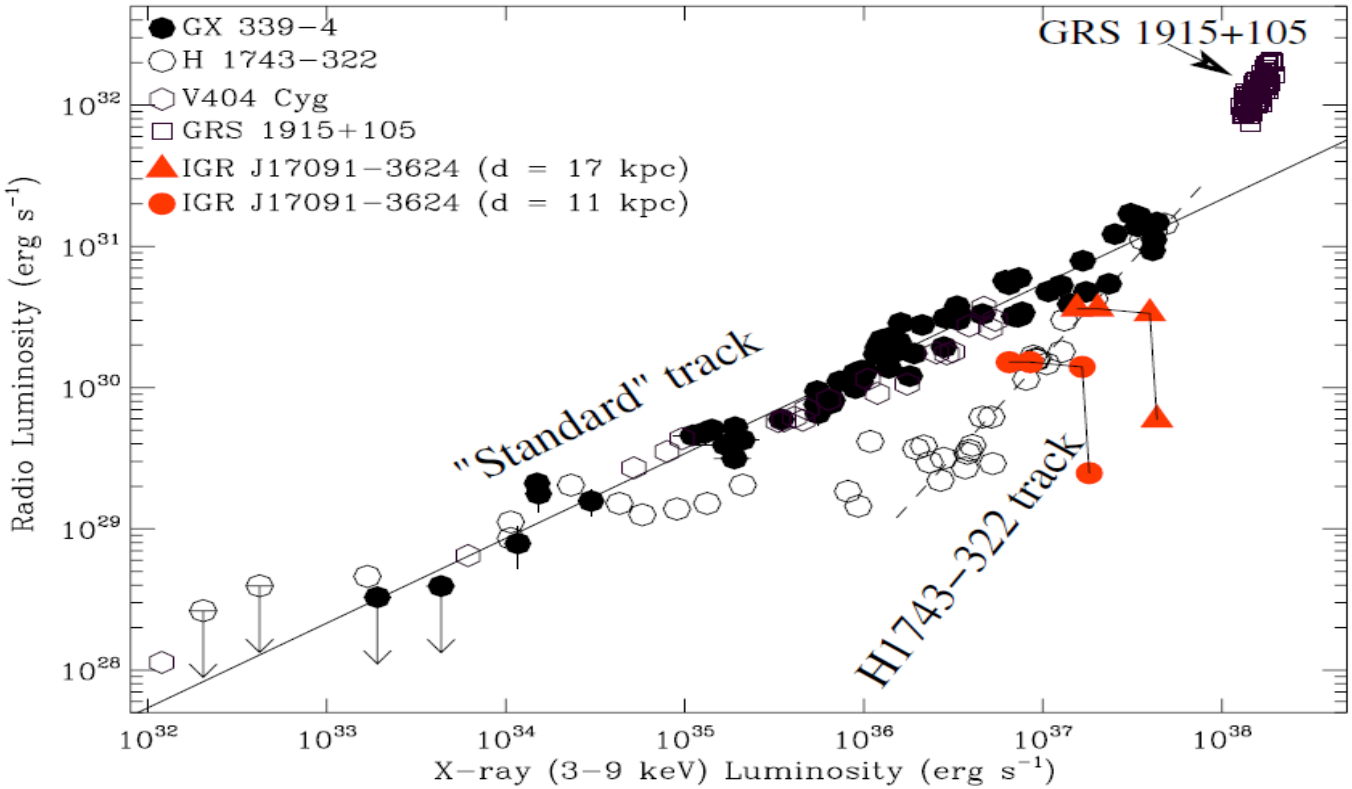
Altamirano et al. 2013a in prep

IGR J17091-3624: 2011 outburst

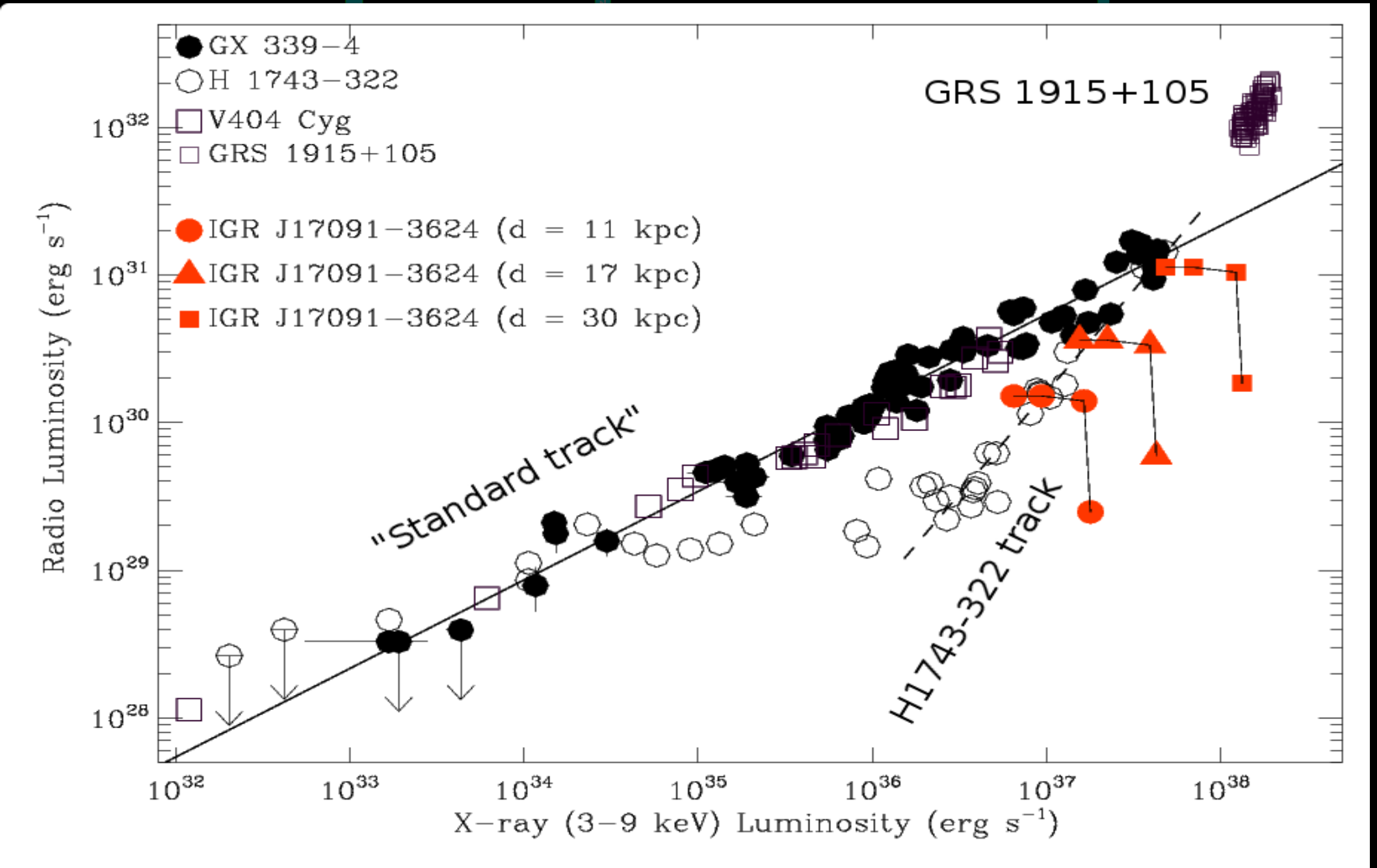




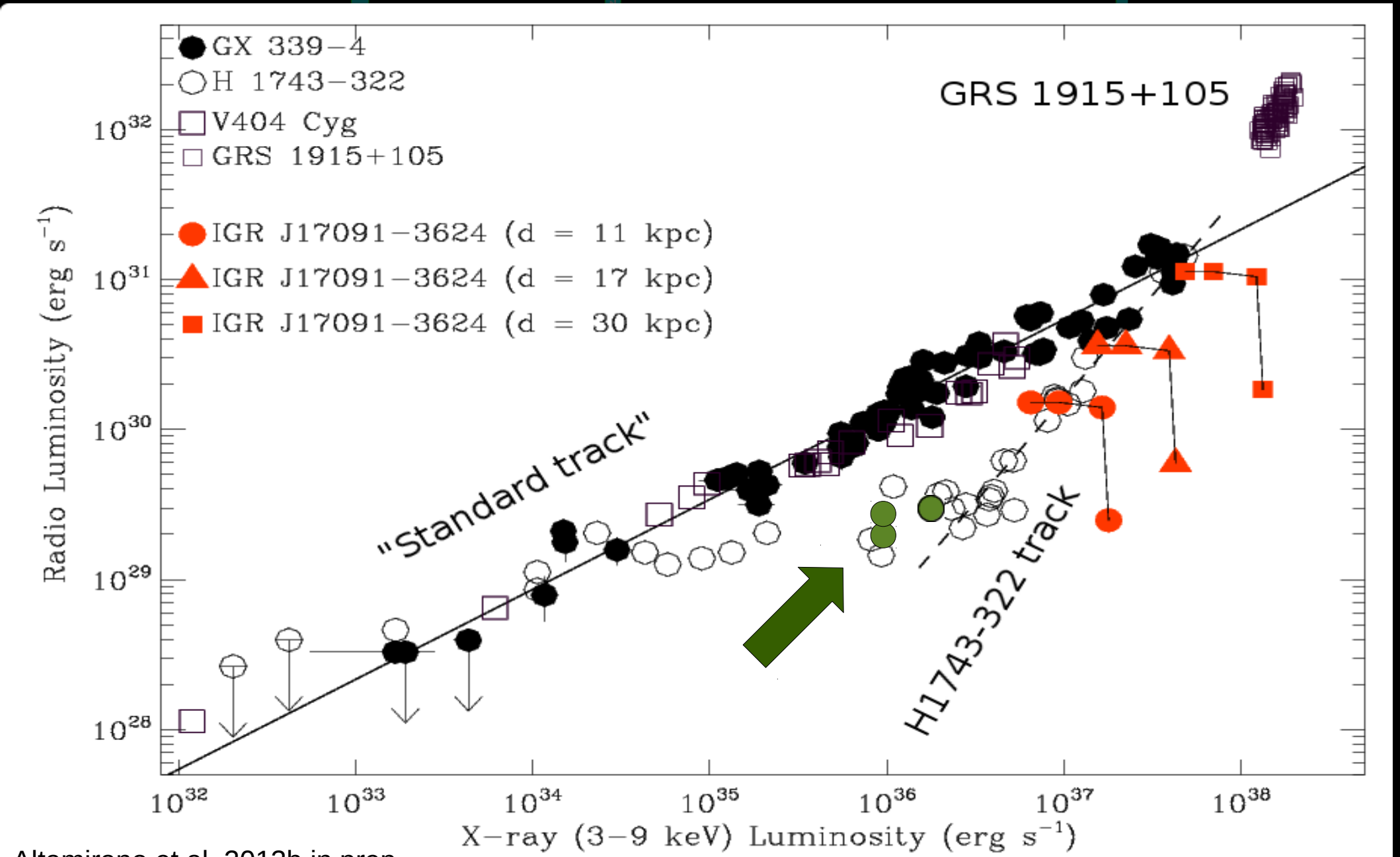




IGR J17091-3624: 2011 outburst

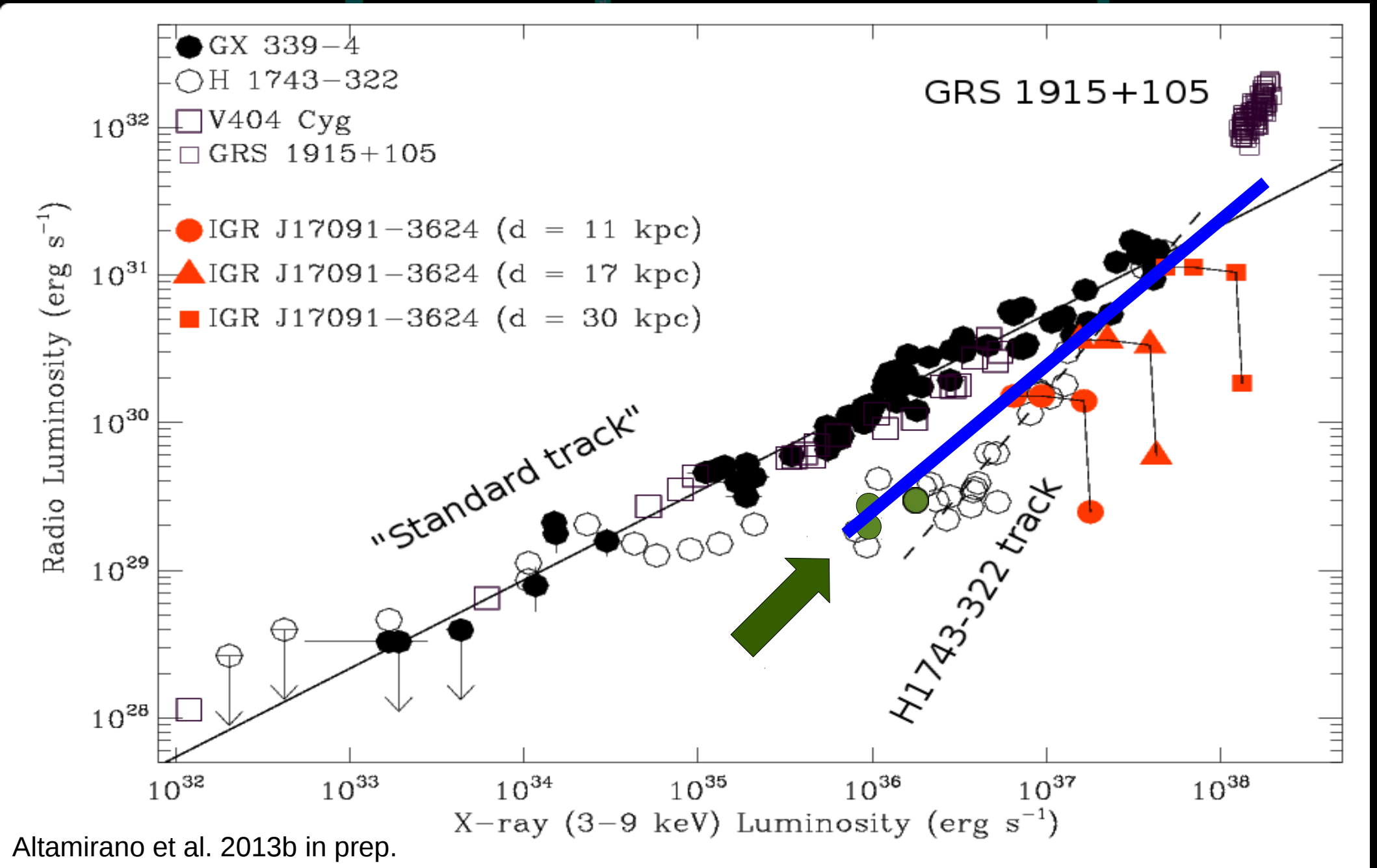


IGR J17091-3624: 2011 outburst



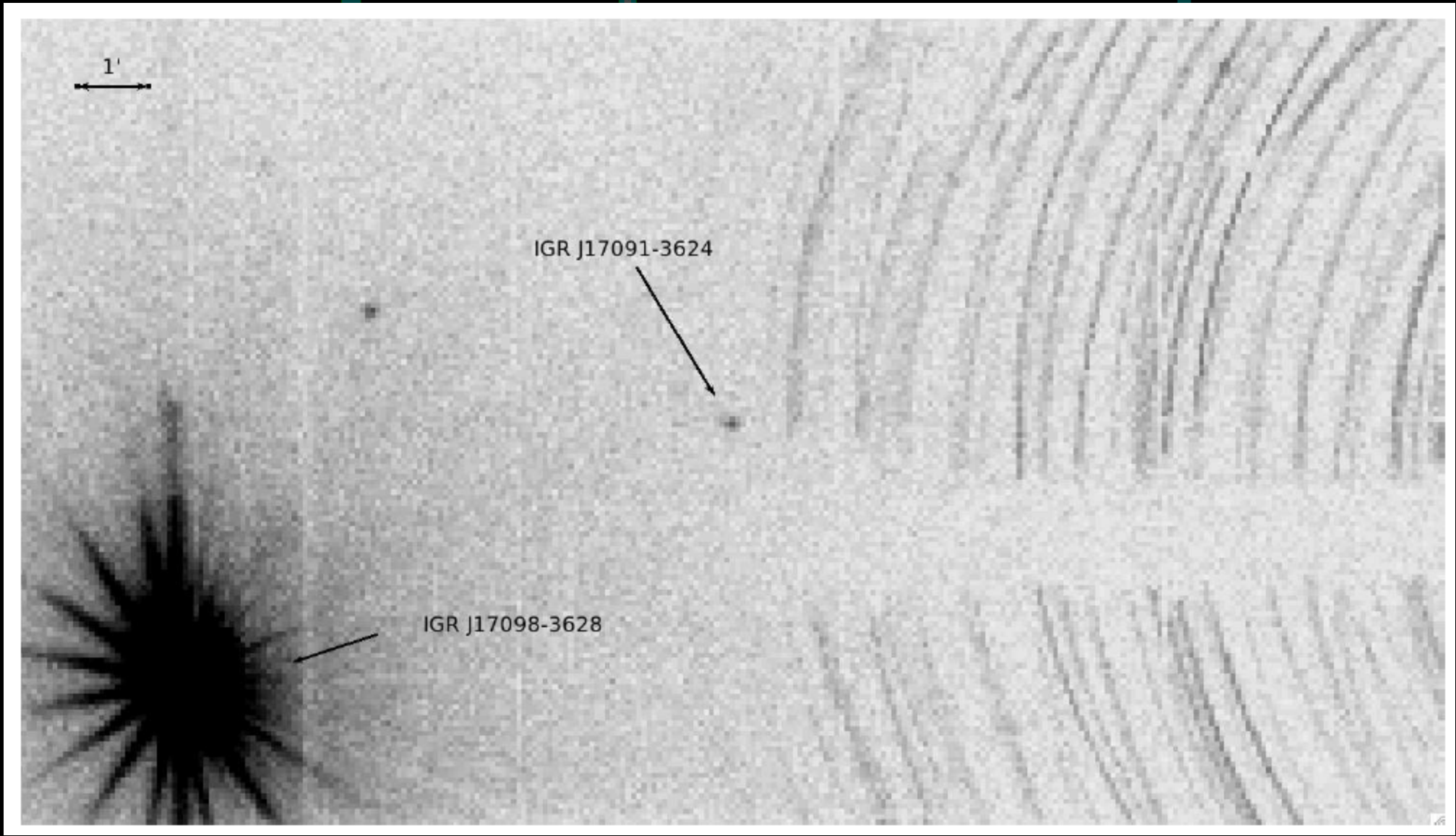
Altamirano et al. 2013b in prep.

IGR J17091-3624: 2011 outburst



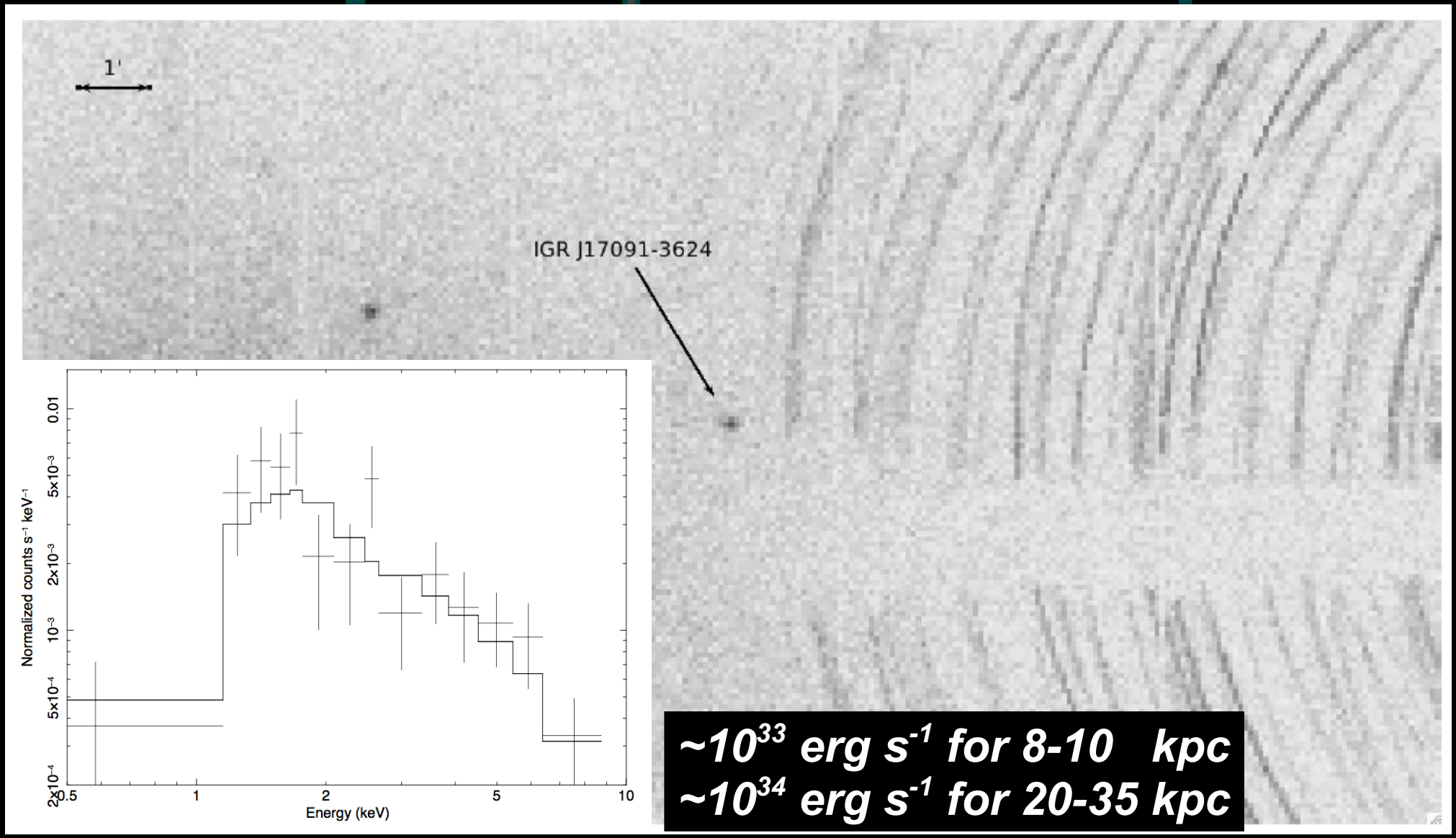
Altamirano et al. 2013b in prep.

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



Wijnands, Yang & Altamirano 2012

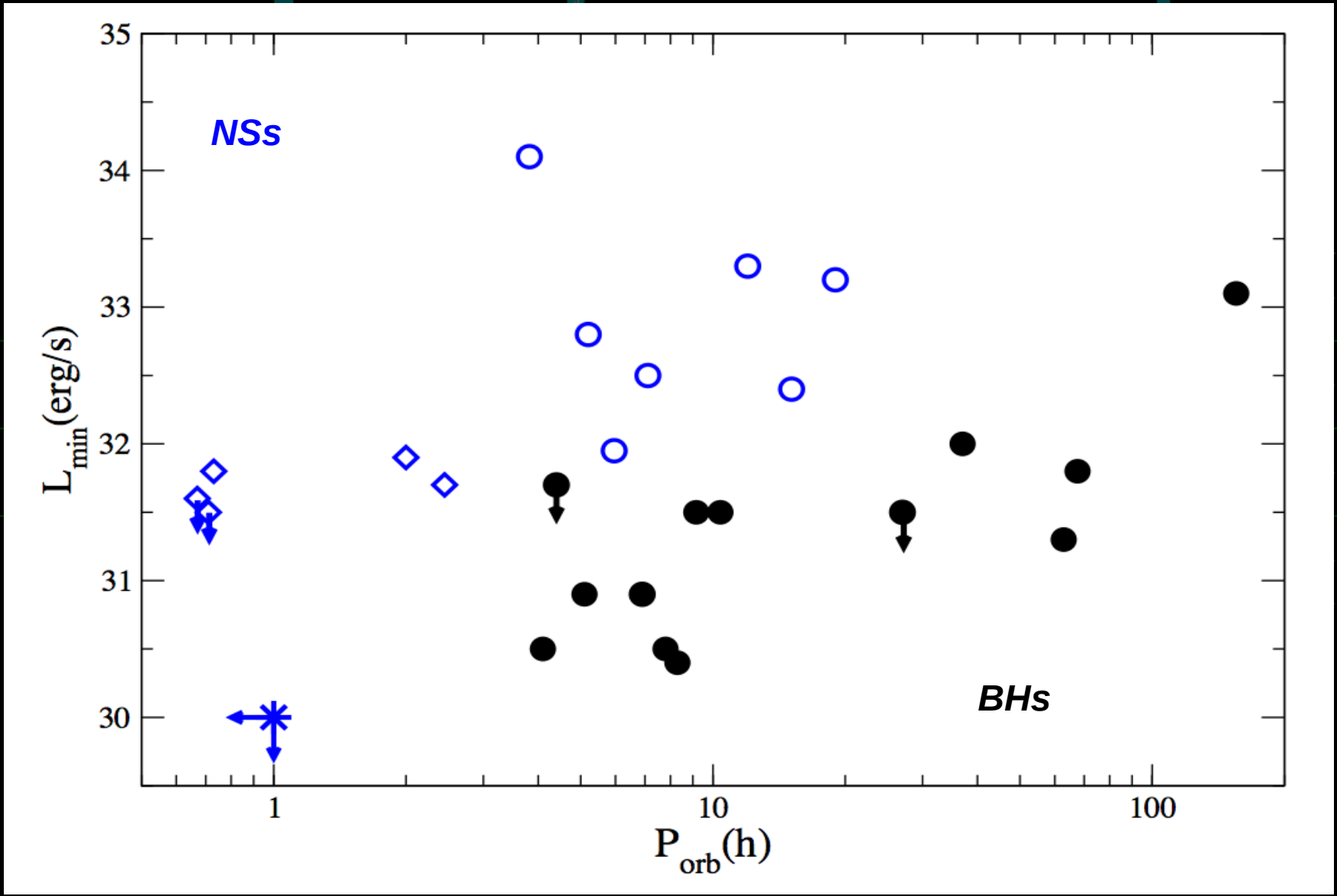
...IGR J17091-3624 in quiescence ....



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

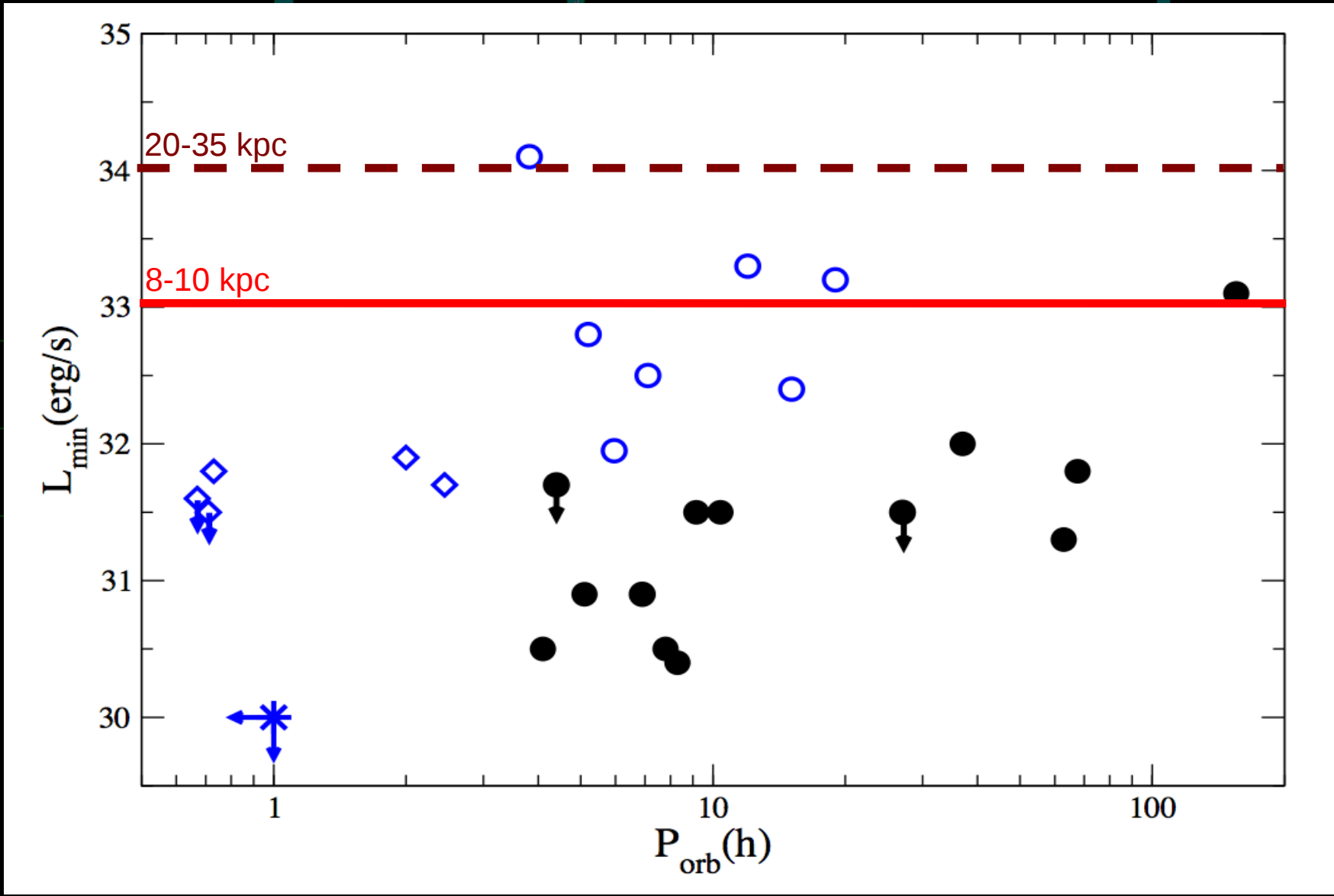
Wijnands, Yang & Altamirano 2012

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



Lasota 2008 + Courtesy of R. Wijnands

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

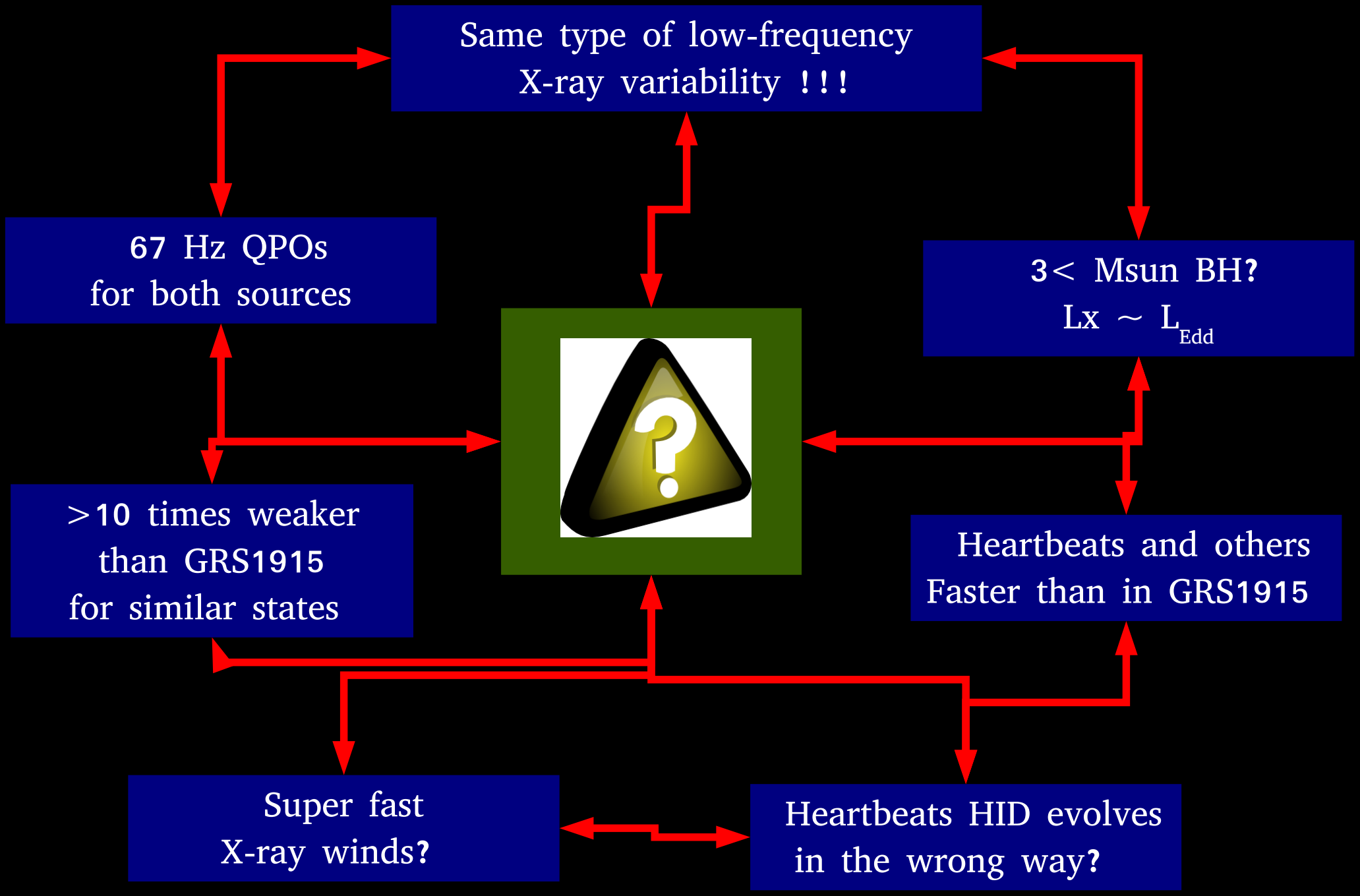


Lasota 2008 + Courtesy of R. Wijnands

... Summary ...

... Summary ...

- Distance unknown ....
- Spin unknown ....
- Mass unknown ....
- Inclination unknown ...


Same type of low-frequency
X-ray variability !!!
67 Hz QPOs
for both sources
3< Msun BH?
Lx ~ L Edd
>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?