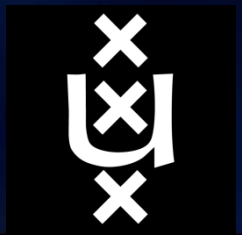
Observations of accreting millisecond X-ray pulsars (AMXPs)

and

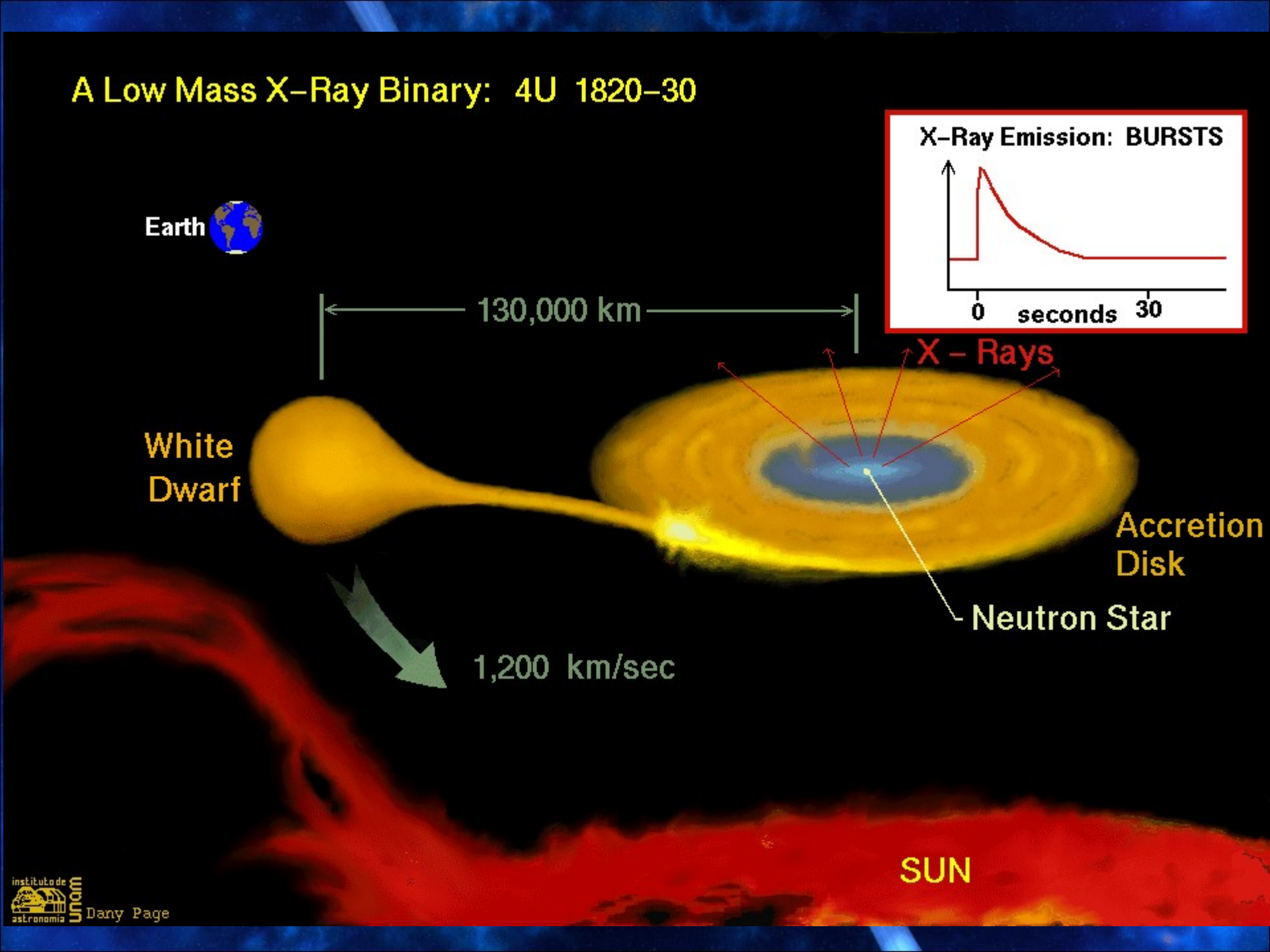
X-ray bursters

Diego Altamirano

Tokyo 2010



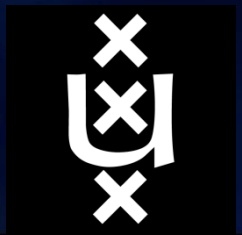
A Low Mass X-Ray Binary: 4U 1820-30



What are X-ray bursts?
(see in't Zand talk)

Diego Altamirano

Tokyo 2010



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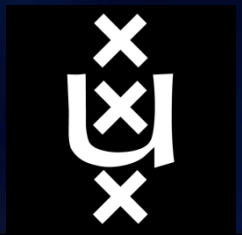

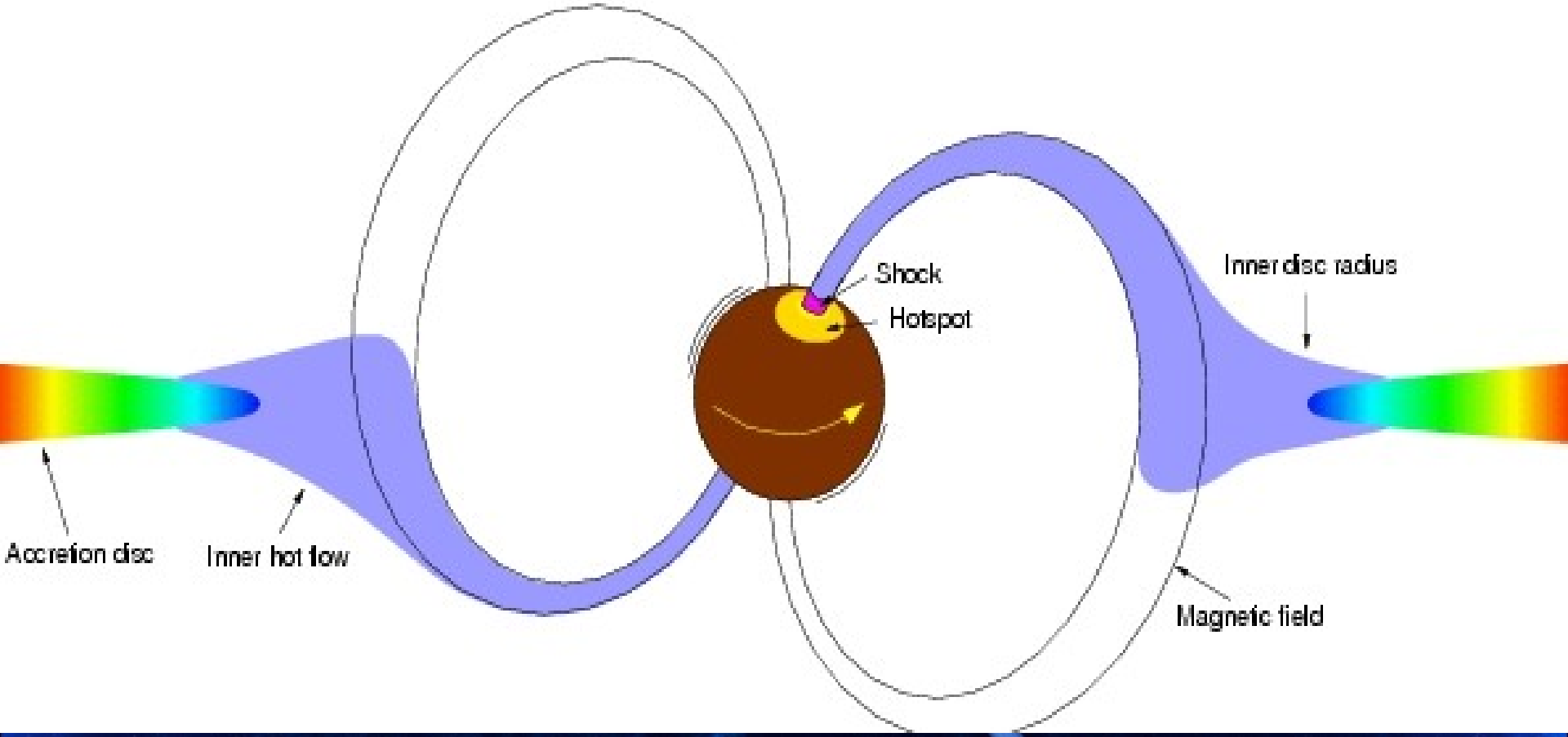

(http://www.issibern.ch/teams/observephysics/)

13 accreting millisecond X-ray pulsars

Name	Spin (Hz)	Binary period (min)	$M_{c,min}$ (solar mass)	When discovered?
SAX J1808.4-3658	401	120	0.043	April 1998
XTE J1751-305	435	42	0.014	April 2002
XTE J0929-314	185	44	0.083	April 2002
XTE J1807-294	191	40	0.0066	Feb 2003
XTE J1814-338	314	258	0.17	June 2003
IGR J00291+5934	599	150	0.039	December 2004
Swift J1756.9-2508	182	54	0.007	June 2007
HETE J1900.4-2455	377	83	0.016	December 2006
SAX J1748-2021	442	522	1.	December 2007
Aql X-1	550	1140	1.5-0.8	December 2007
NGC 6440 X-2	205	57	0.007	August 2009
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13 accreting millisecond X-ray pulsars

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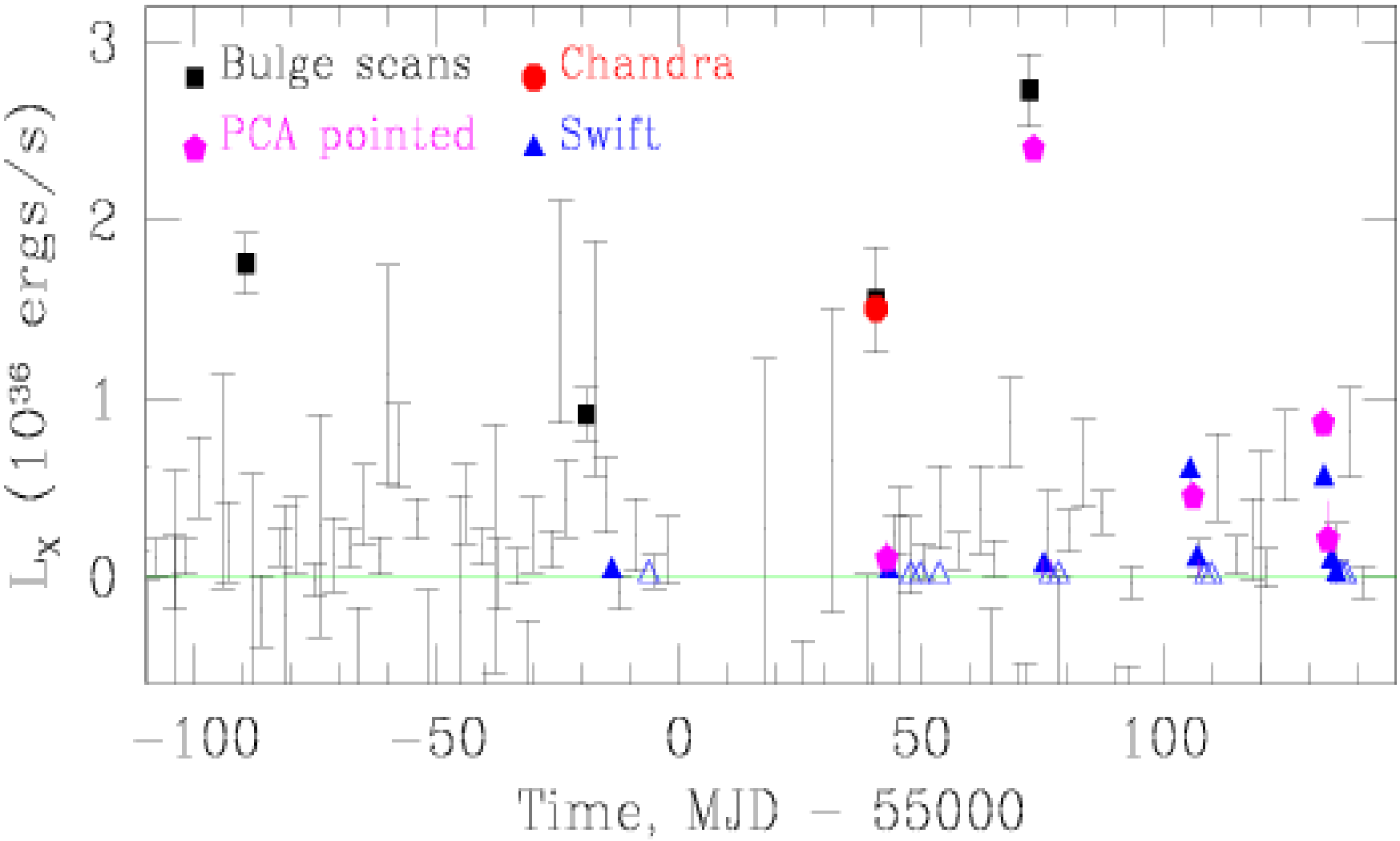
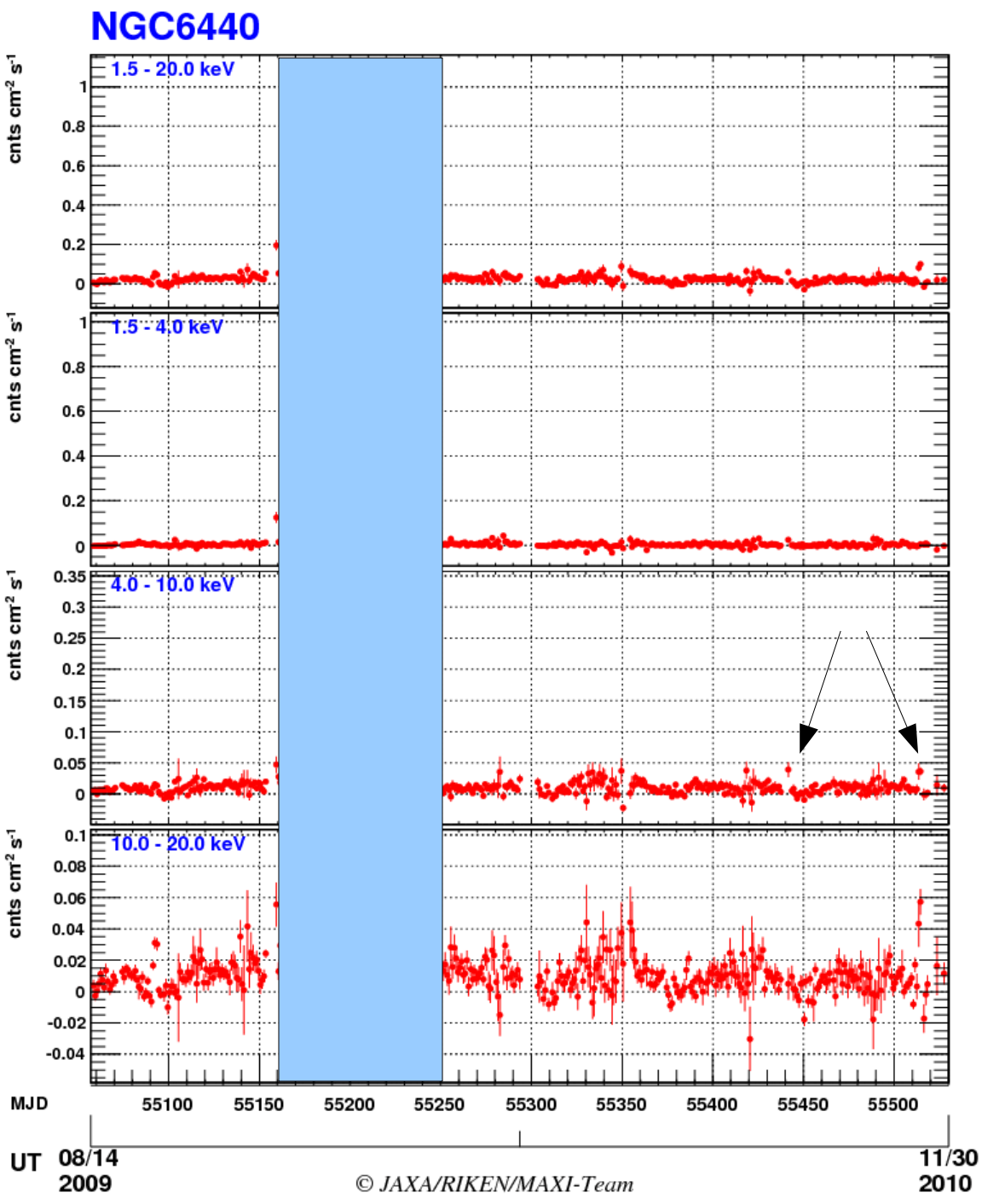


Heinke et al 2010.


NGC6440
1.5 - 20.0 keV
1.5 - 4.0 keV
4.0 - 10.0 keV
10.0 - 20.0 keV
cnts cm^{-2} s^{-1}
MJD
55100
55150
55200
55250
55300
55350
55400
55450
55500
UT
08/14
2009
11/30
2010
© JAXA/RIKEN/MAXI-Team

With MAXI running at its best we should detect more of these type of weak sources... and probably many more AMXPs!!!

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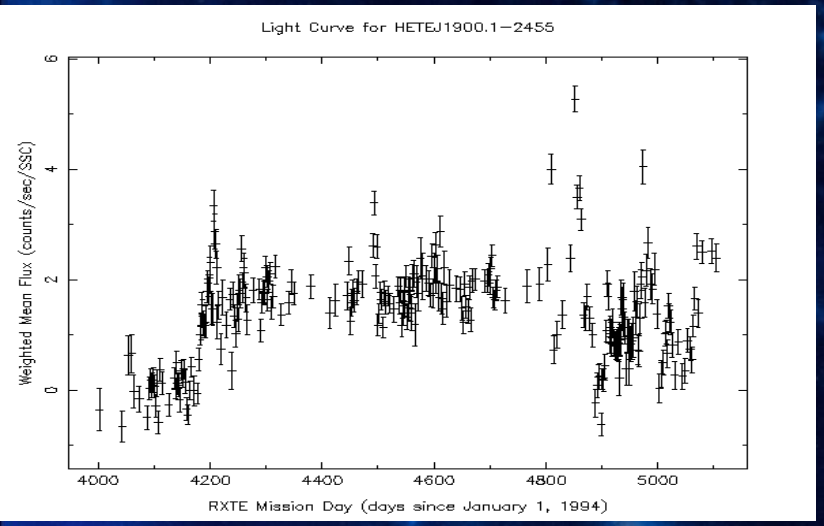
Intermittent AMXPs!



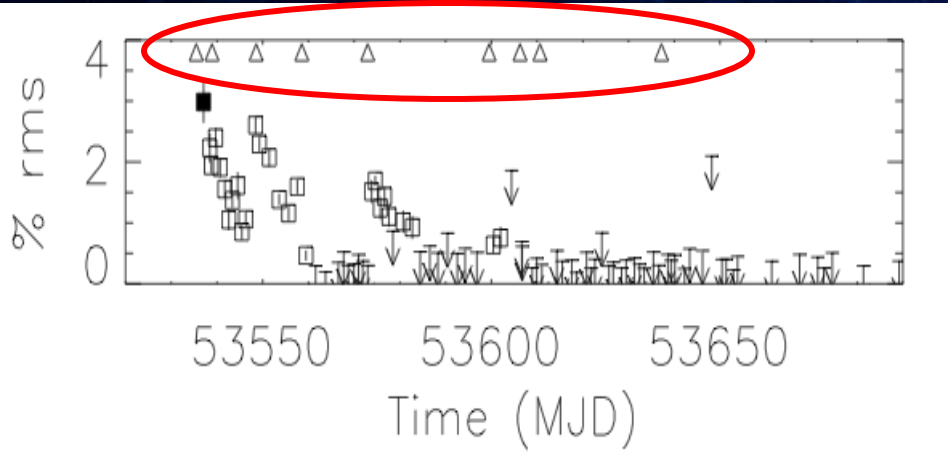
HETE J1900.1-2455

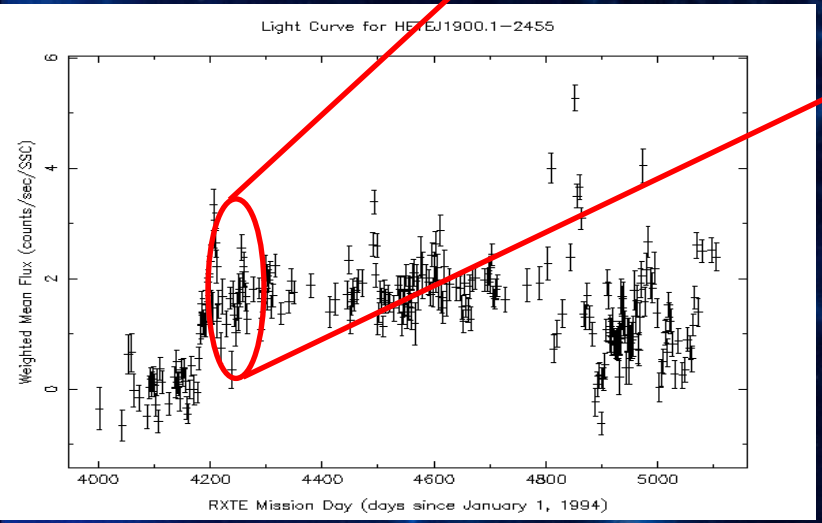
Kaaret et al. 2006 ; Galloway et al. 2007

1. Pulsations detected during only the first 2 months

2. Rms amplitude variations in timescales of days

Thermonuclear X-ray burst





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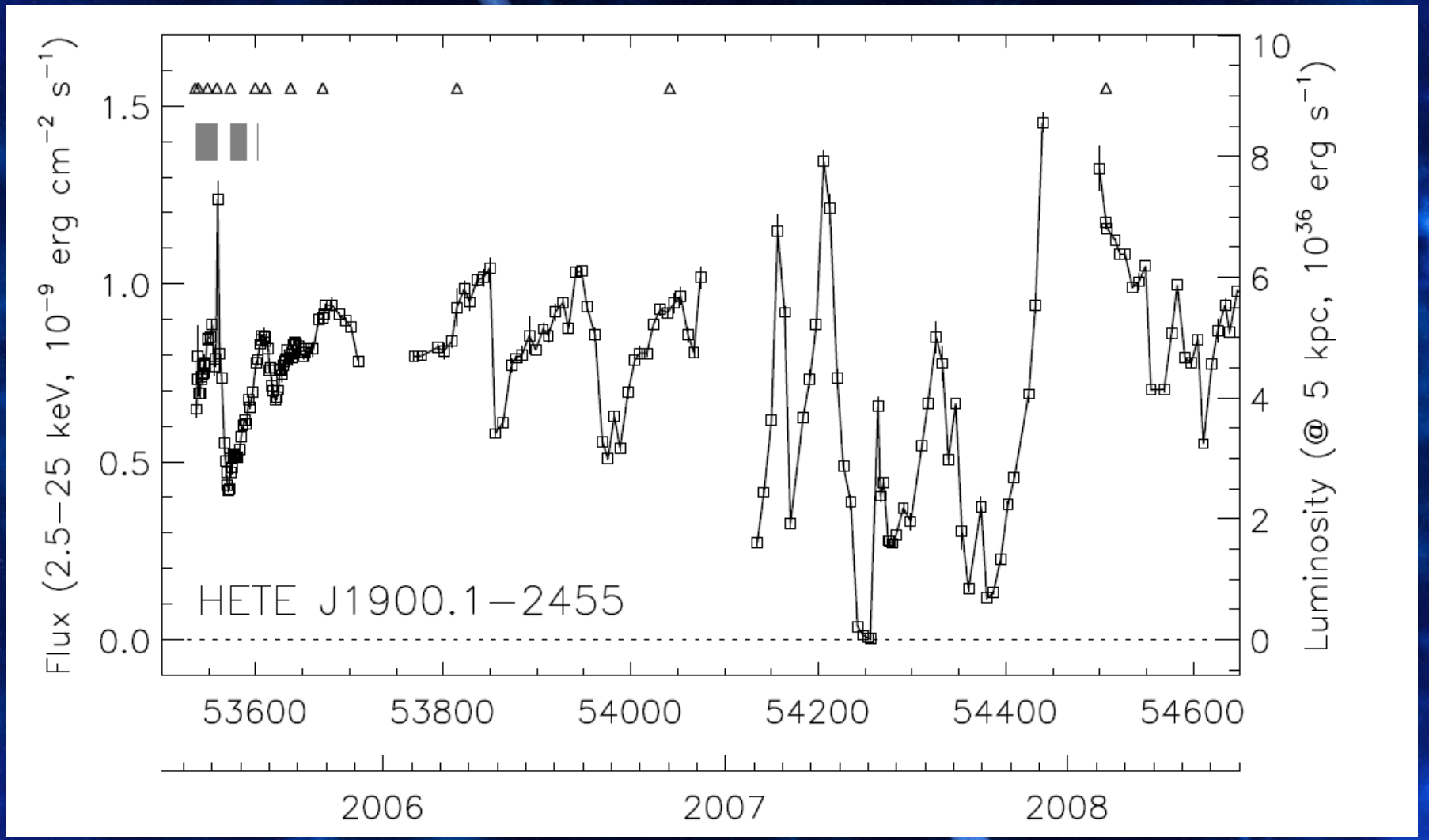
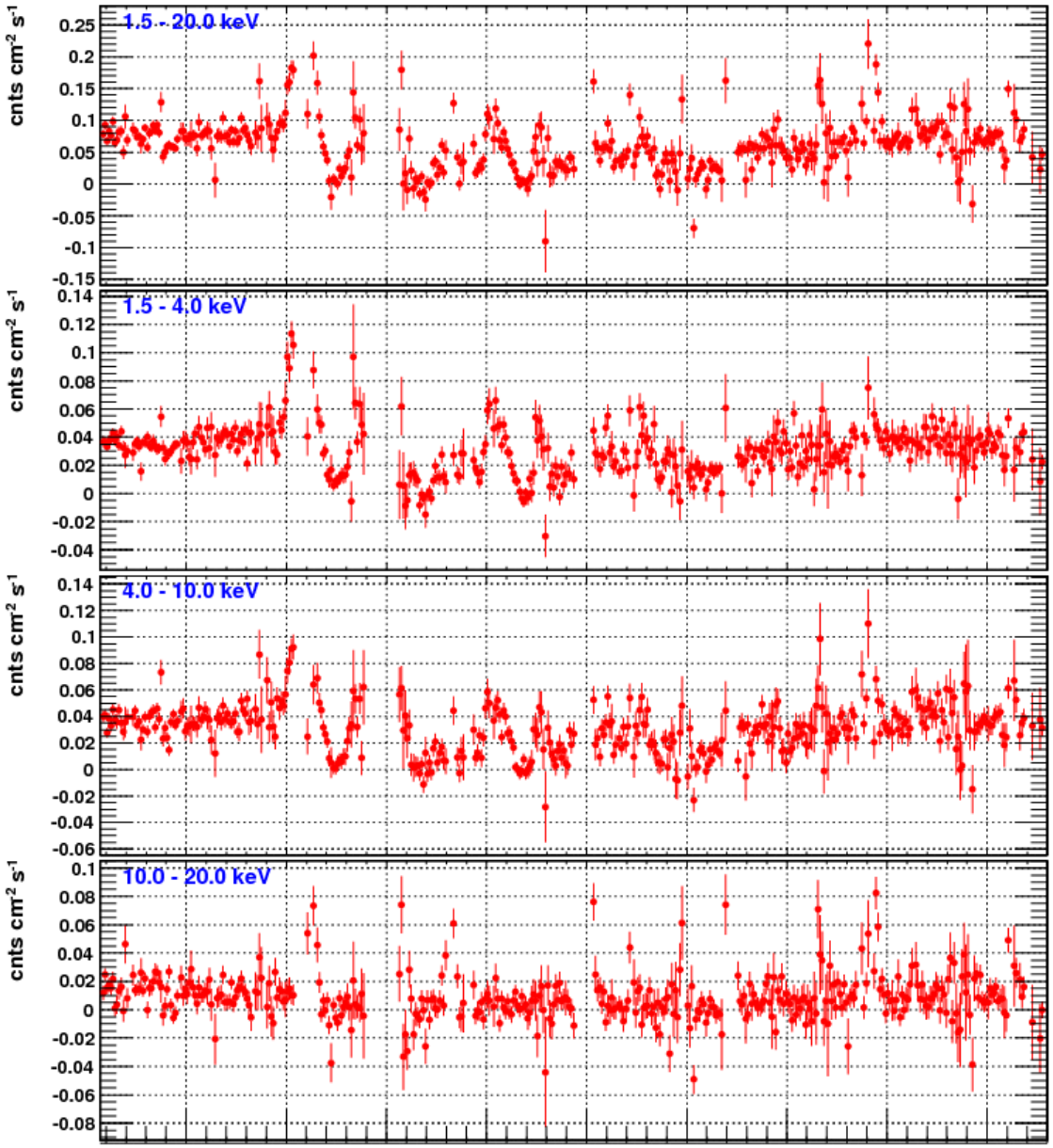
HETE J1900.1-2455



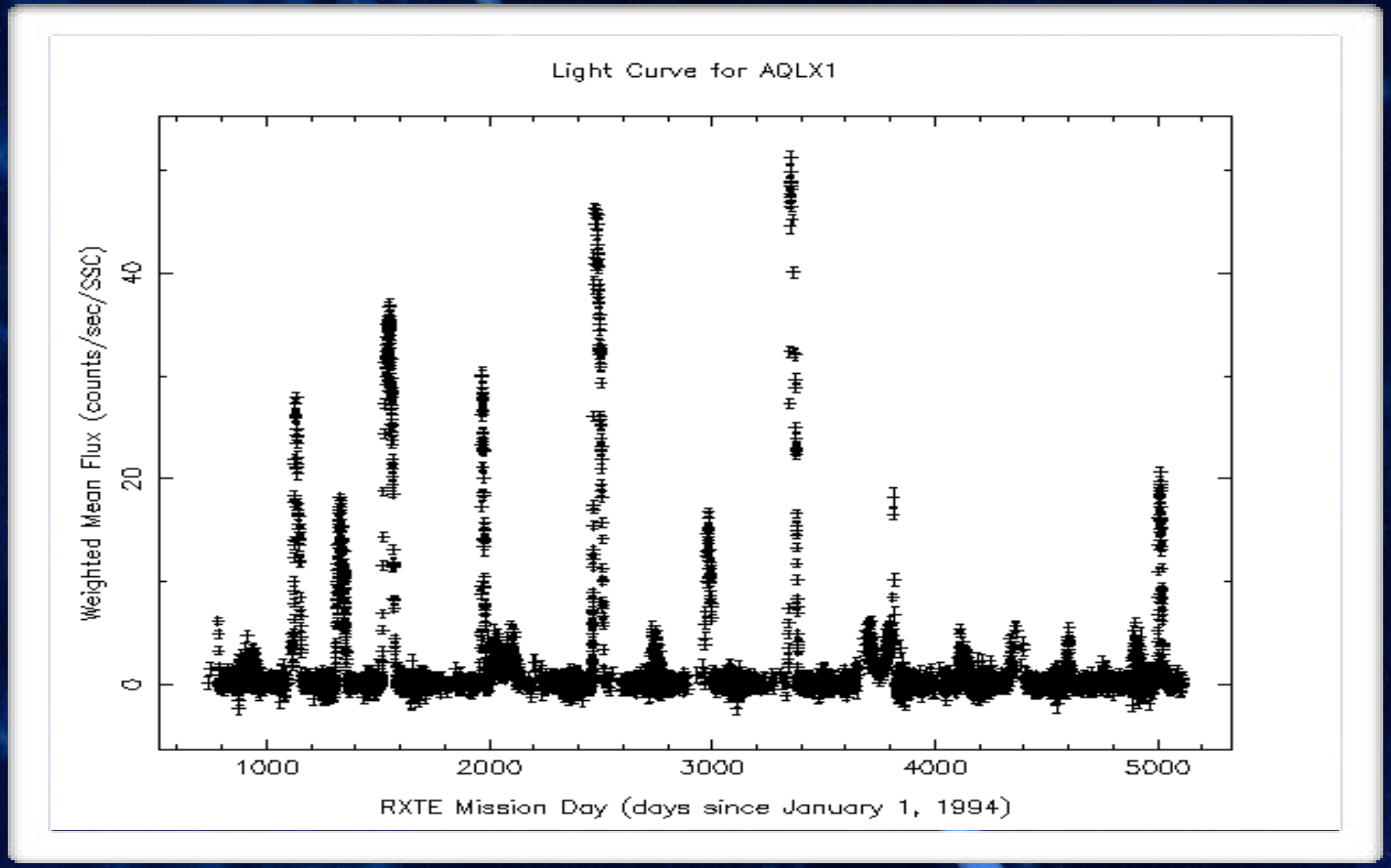
Galloway et al. 2008

HETEJ1900.1-2455



UT 08/14 2009 — 11/30 2010

Aql X-1

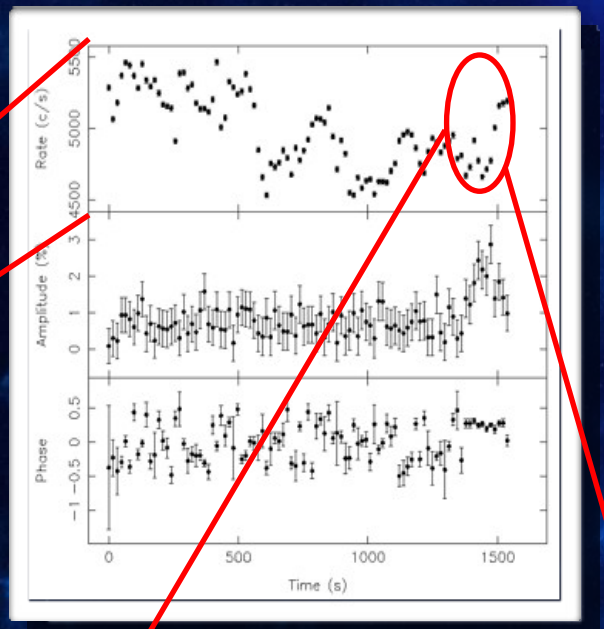


12 years

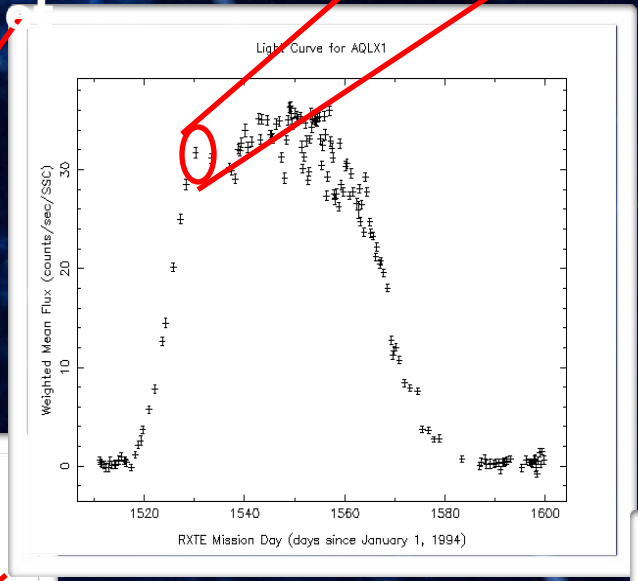
Pulsations in Aql X-1

(Casella, Altamirano et al. 2008)

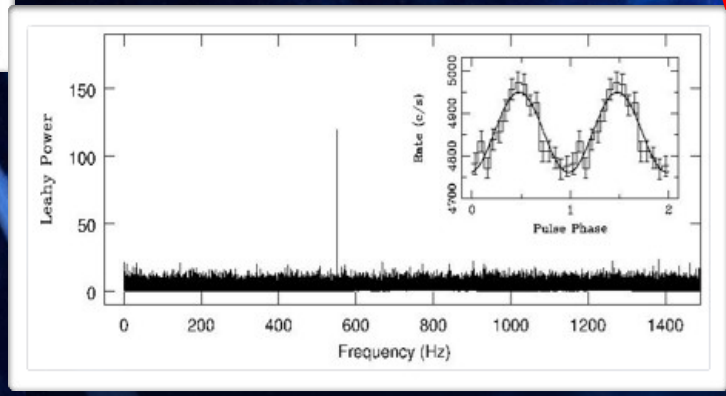
25 minutes

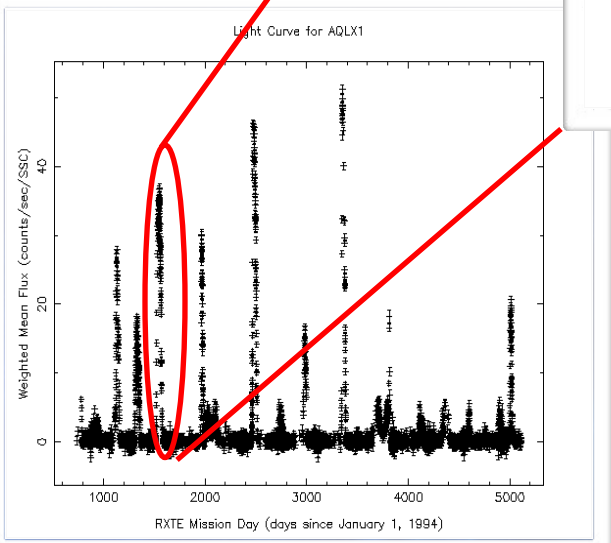


150 seconds



3 months

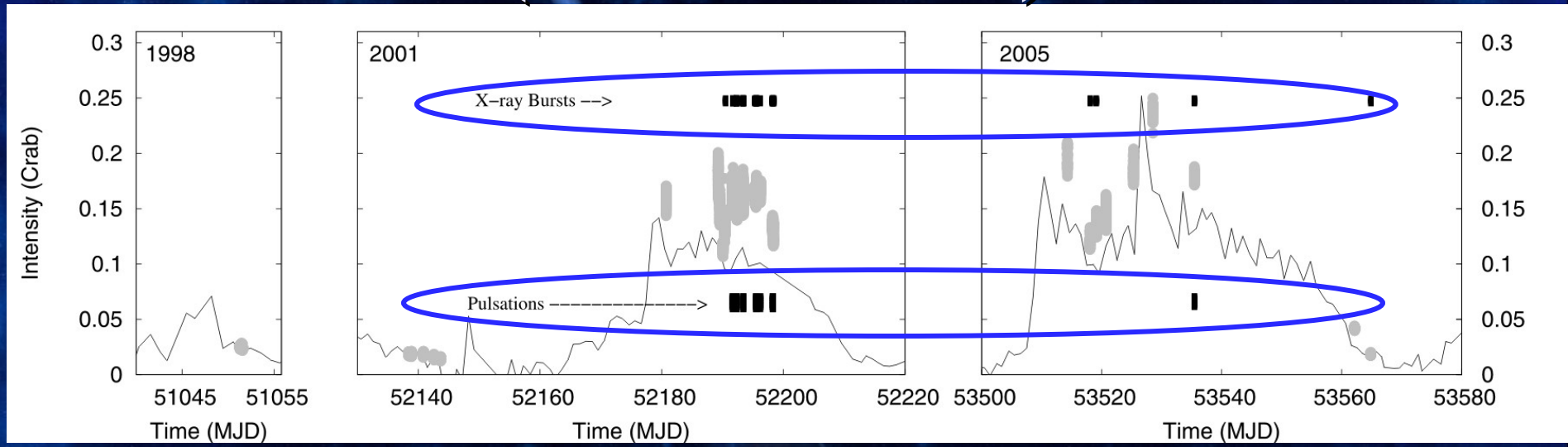


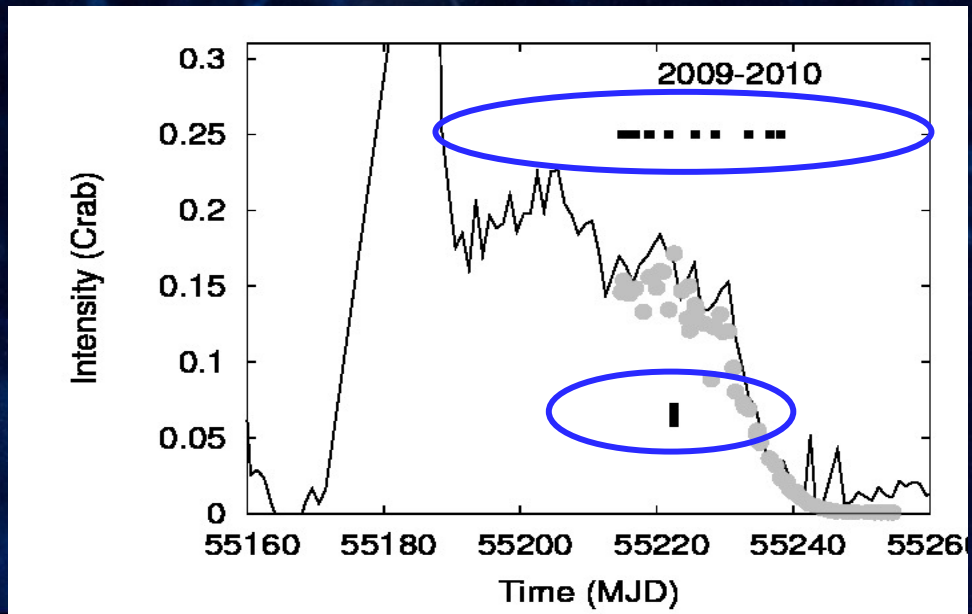


12 years

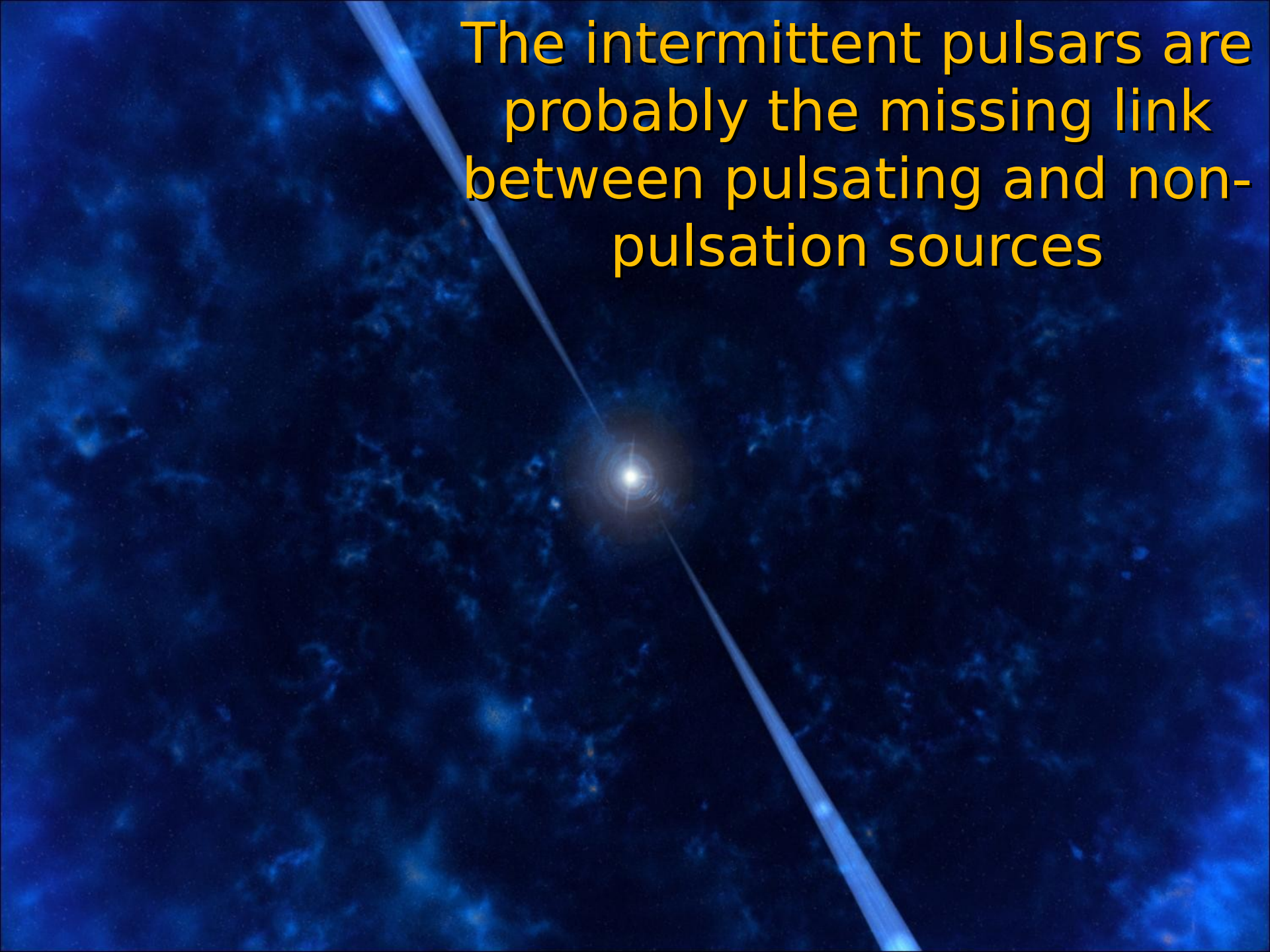
SAX J1748.9-2021 (4 outbursts!)

Altamirano et al. 2008





Altamirano et al. 2011


The intermittent pulsars are probably the missing link between pulsating and non-pulsation sources

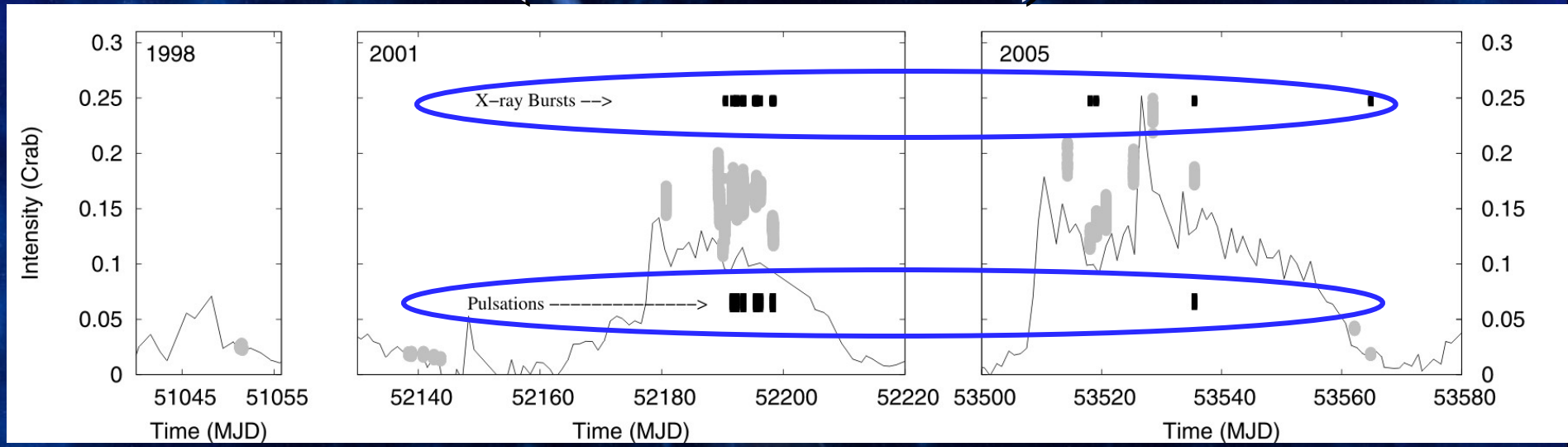
A strict division between pulsating and non-pulsating sources cannot be made anymore.

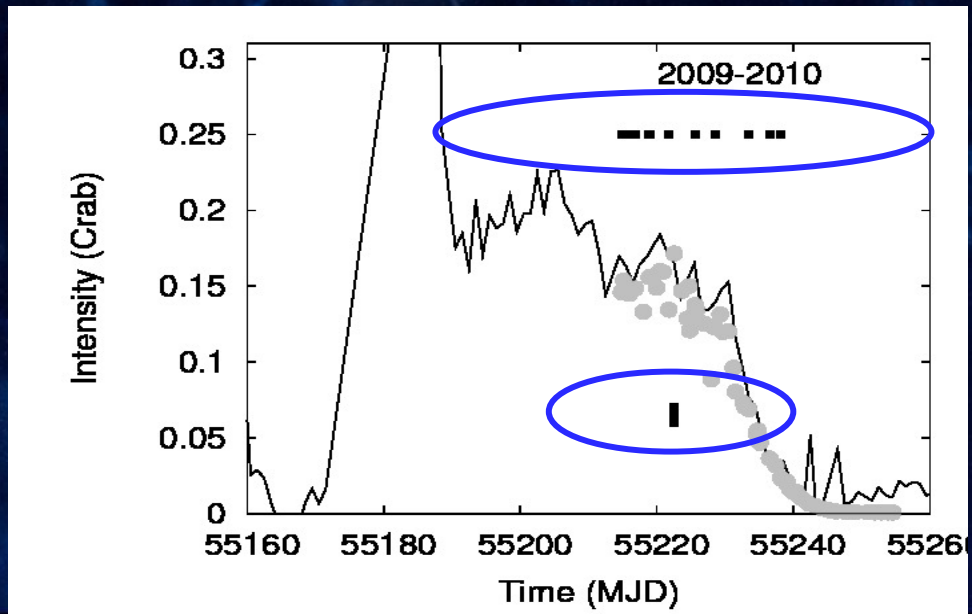
All sources could be pulsating occasionally although the recurrence times are probably very long.

To understand better these sources
we do not ONLY need to detect their
Intermittent pulsations
BUT
we need to know the context!

SAX J1748.9-2021 (4 outbursts!)

Altamirano et al. 2008





Altamirano et al. 2011

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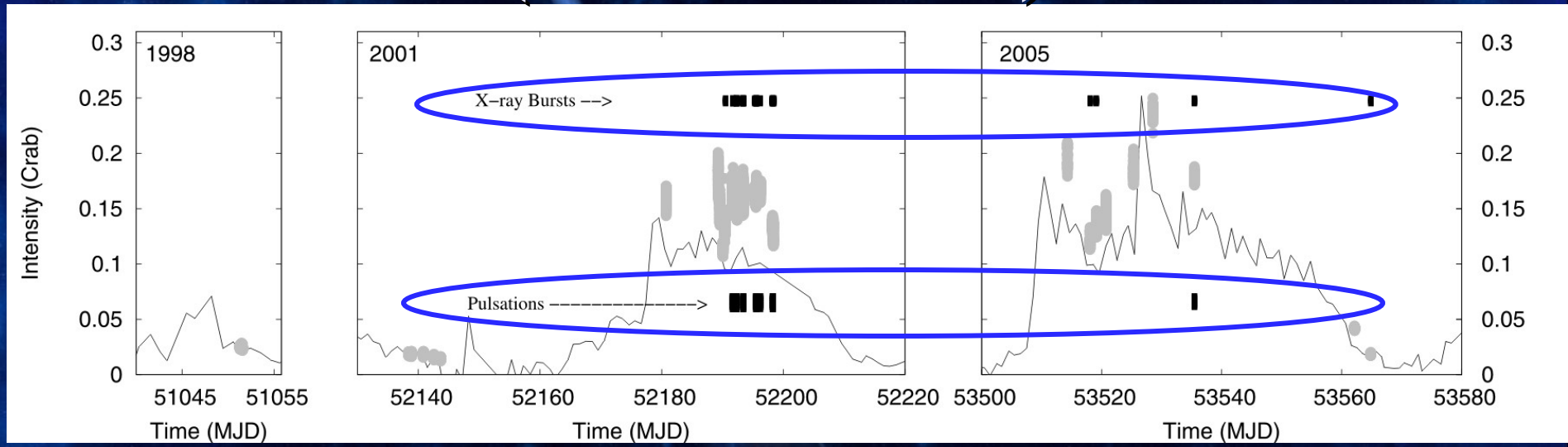
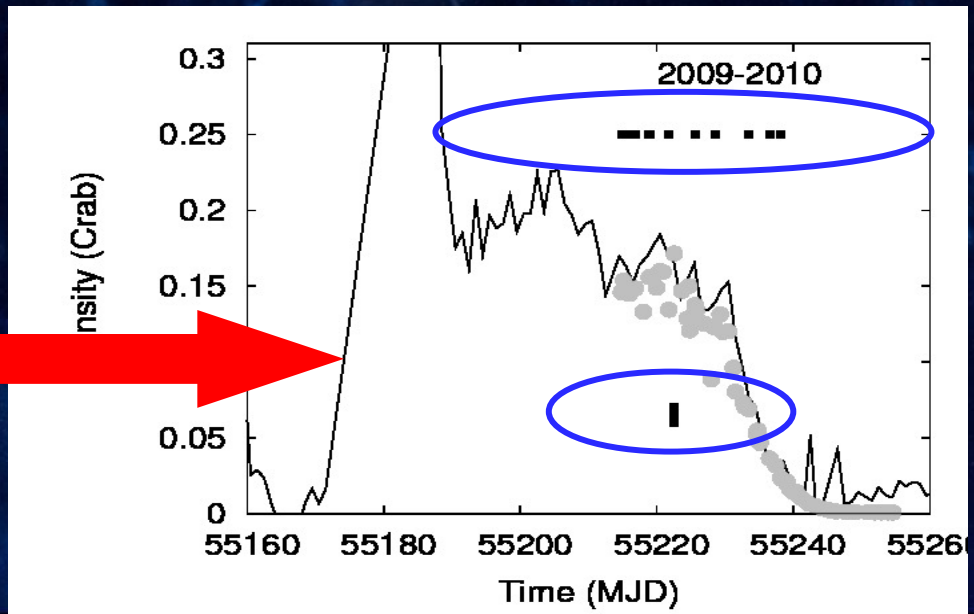


MAXI



Altamirano et al. 2011

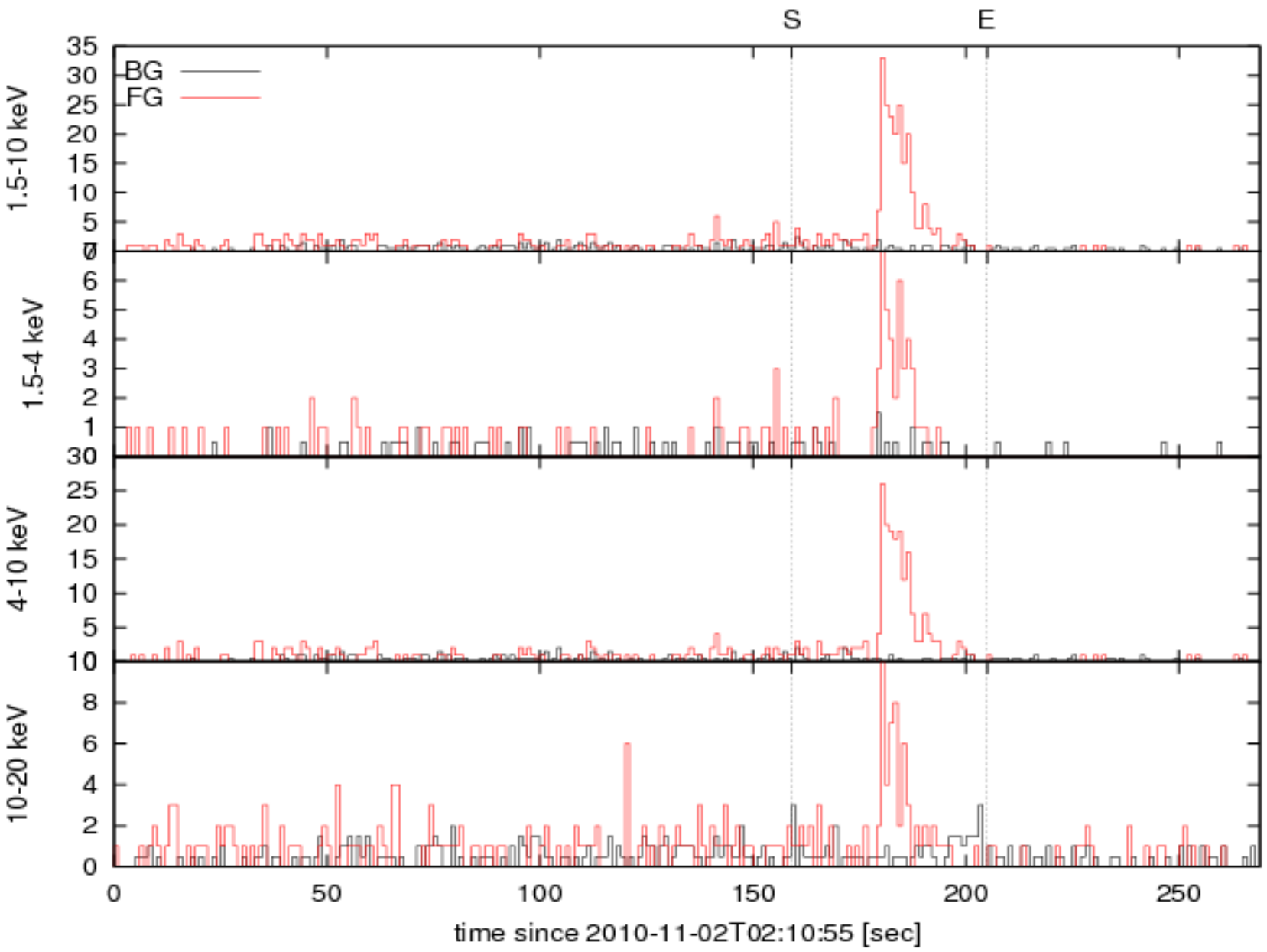
So the main problem we often have in many of these "*Single Event*" phenomena we catch is...

THE CONTEXT!

And very similarly for Intermediate, long, super bursts
(see previous talk)

and many other phenomenology we observe and need to understand!

MAXI detection of a thermonuclear X-ray burst in 4U 1850-087



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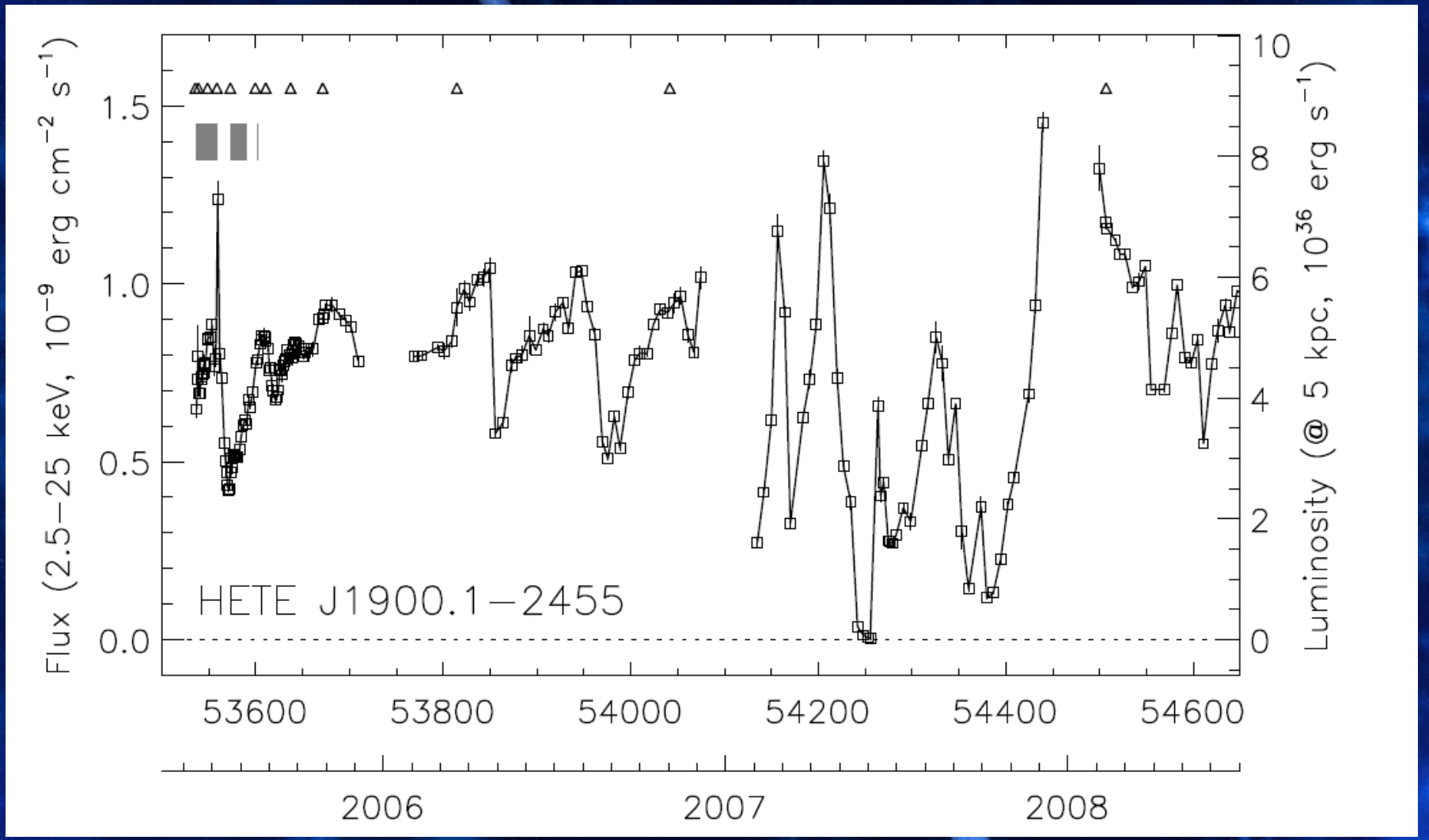
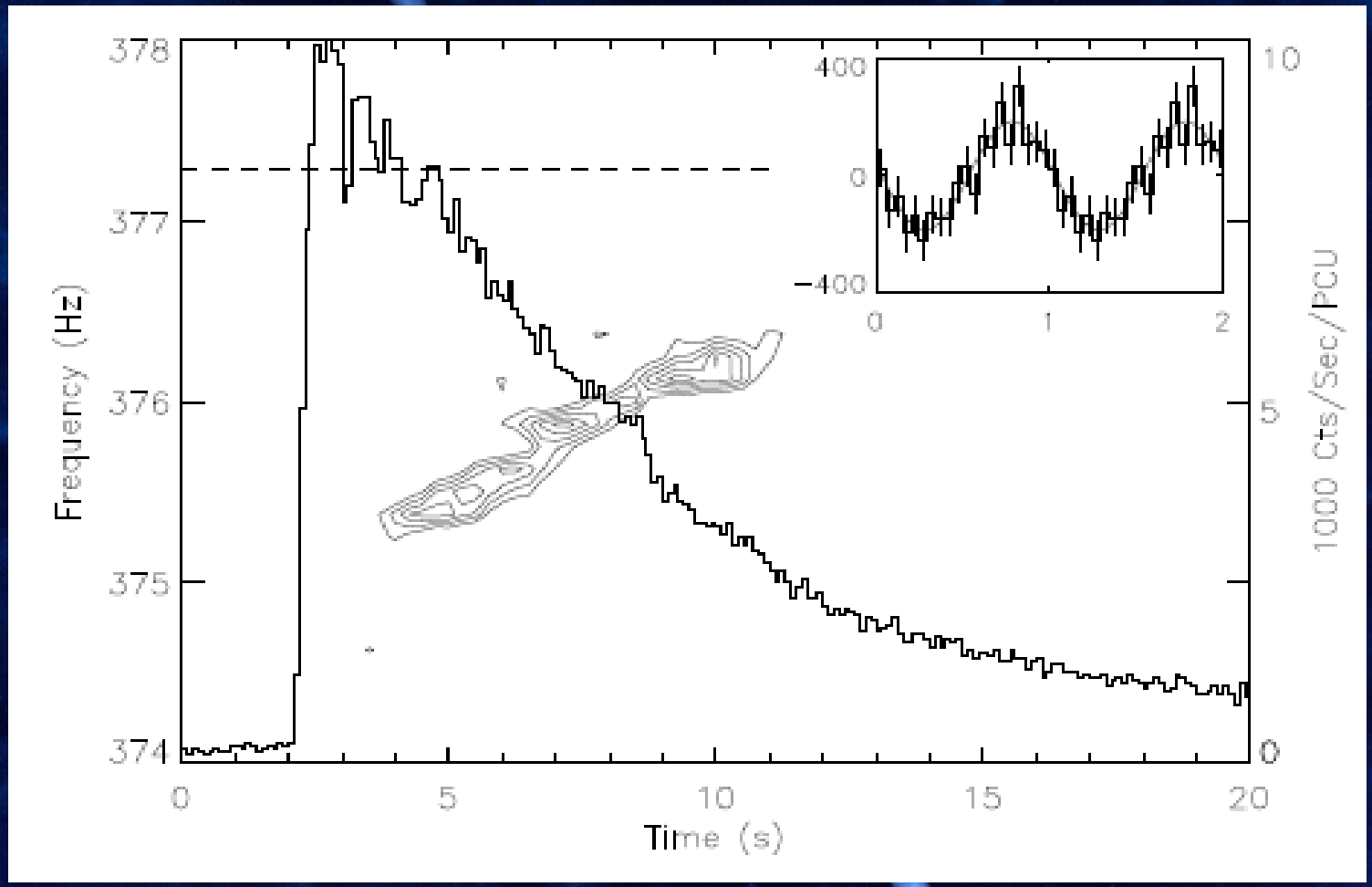
HETE J1900.1-2455



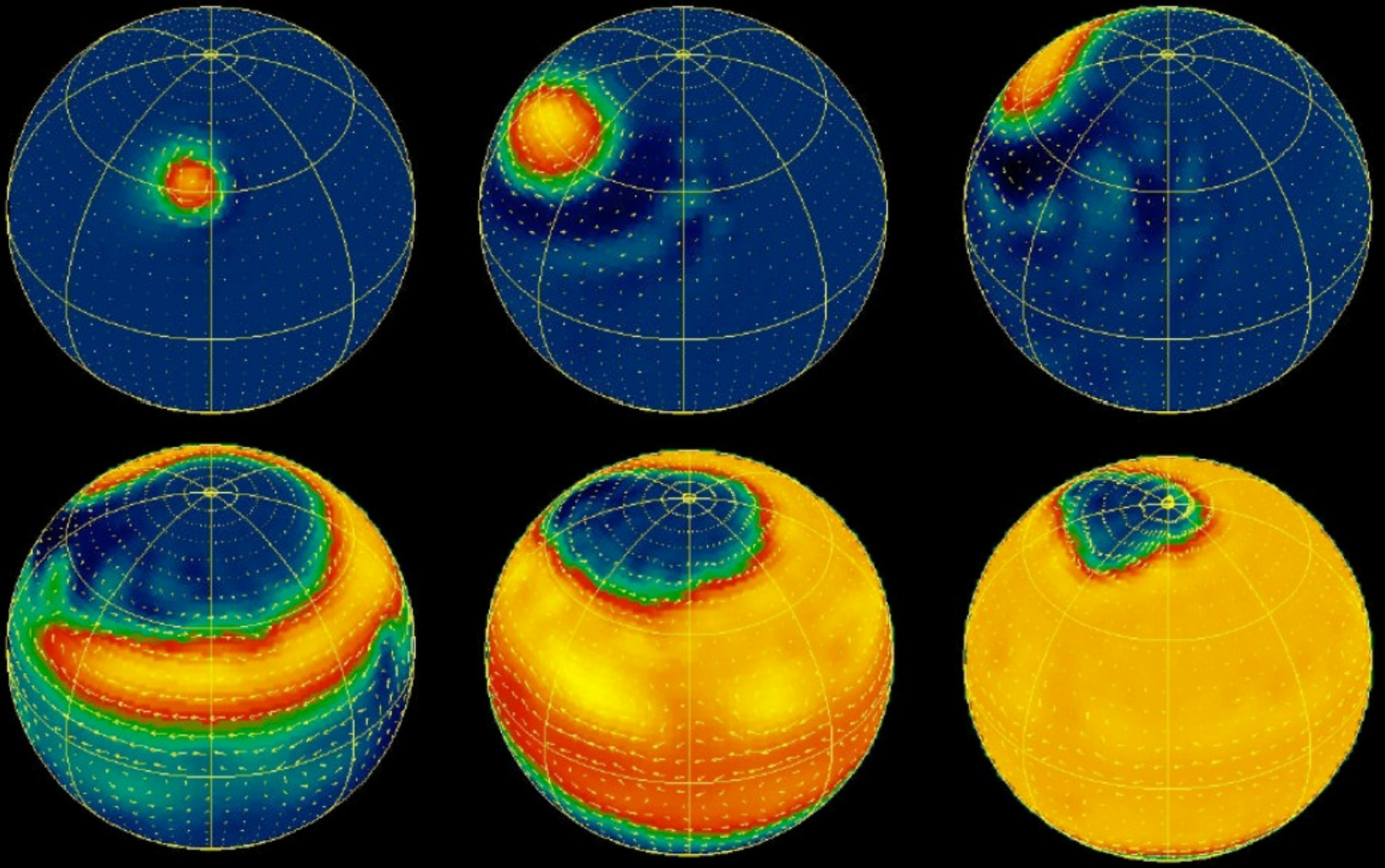
Galloway et al. 2008



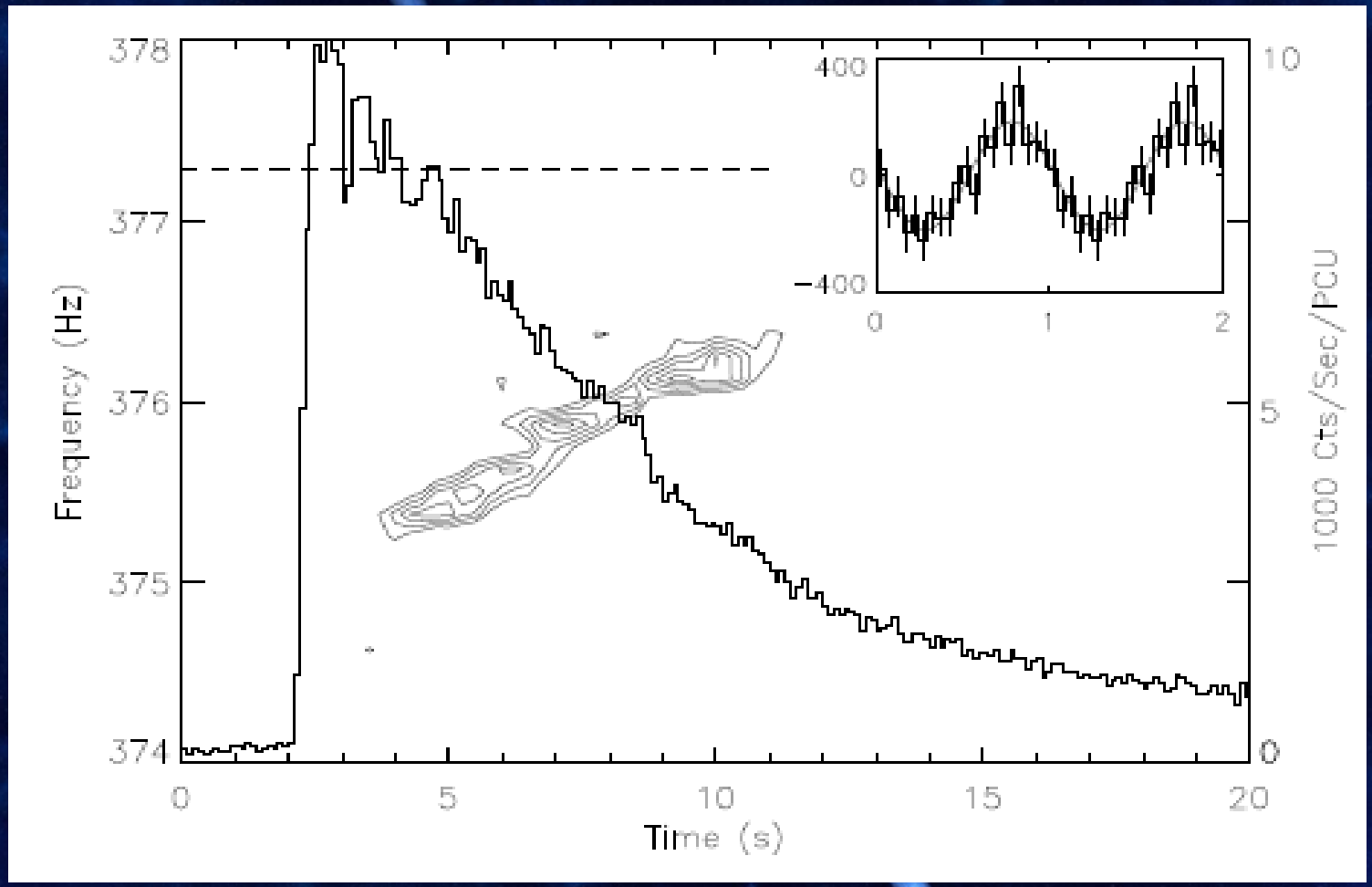
Watts, Altamirano et al. 2009

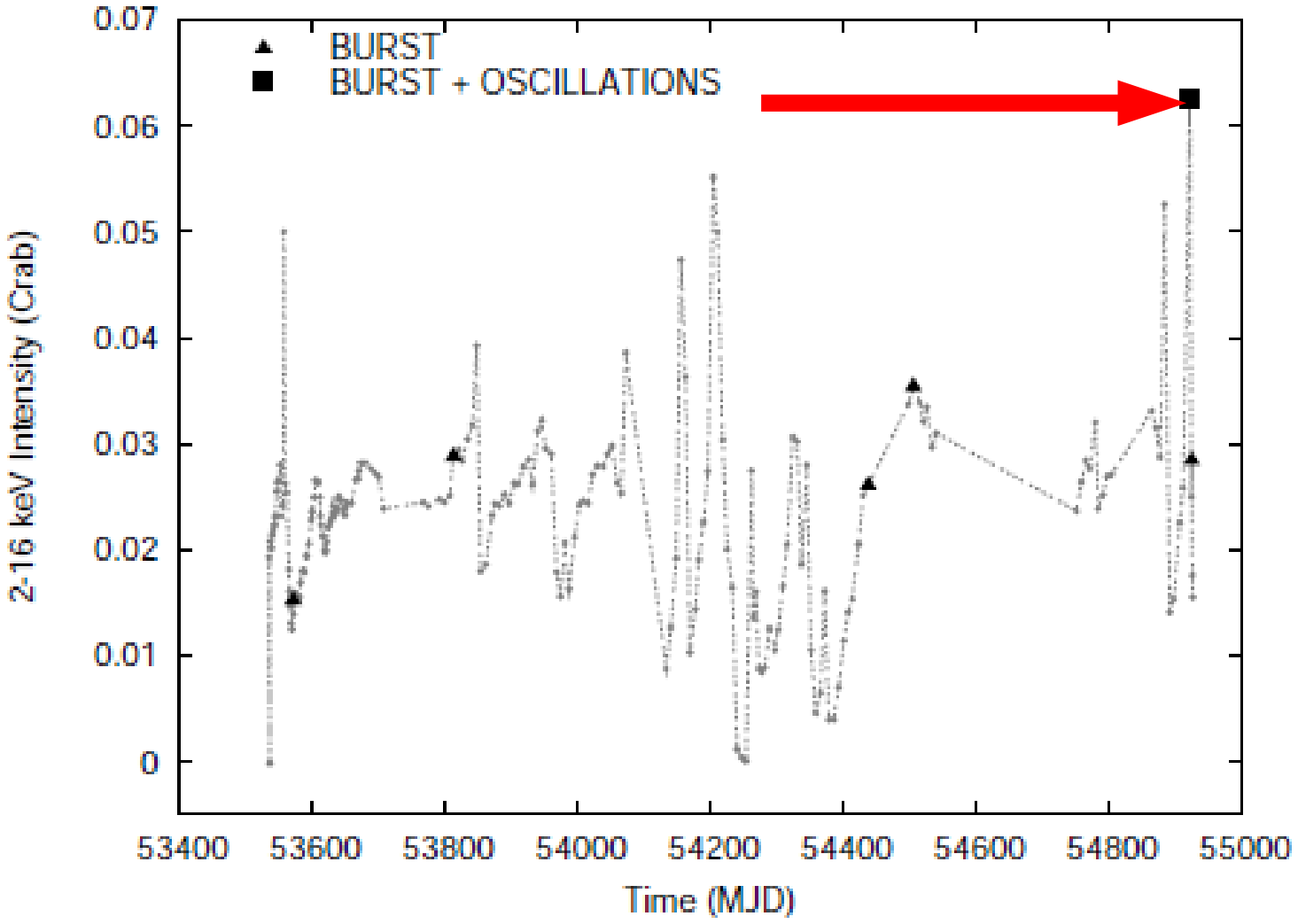
Ignition and spreading

2D shallow water model on a sphere
ν=300 Hz; 200 revolutions

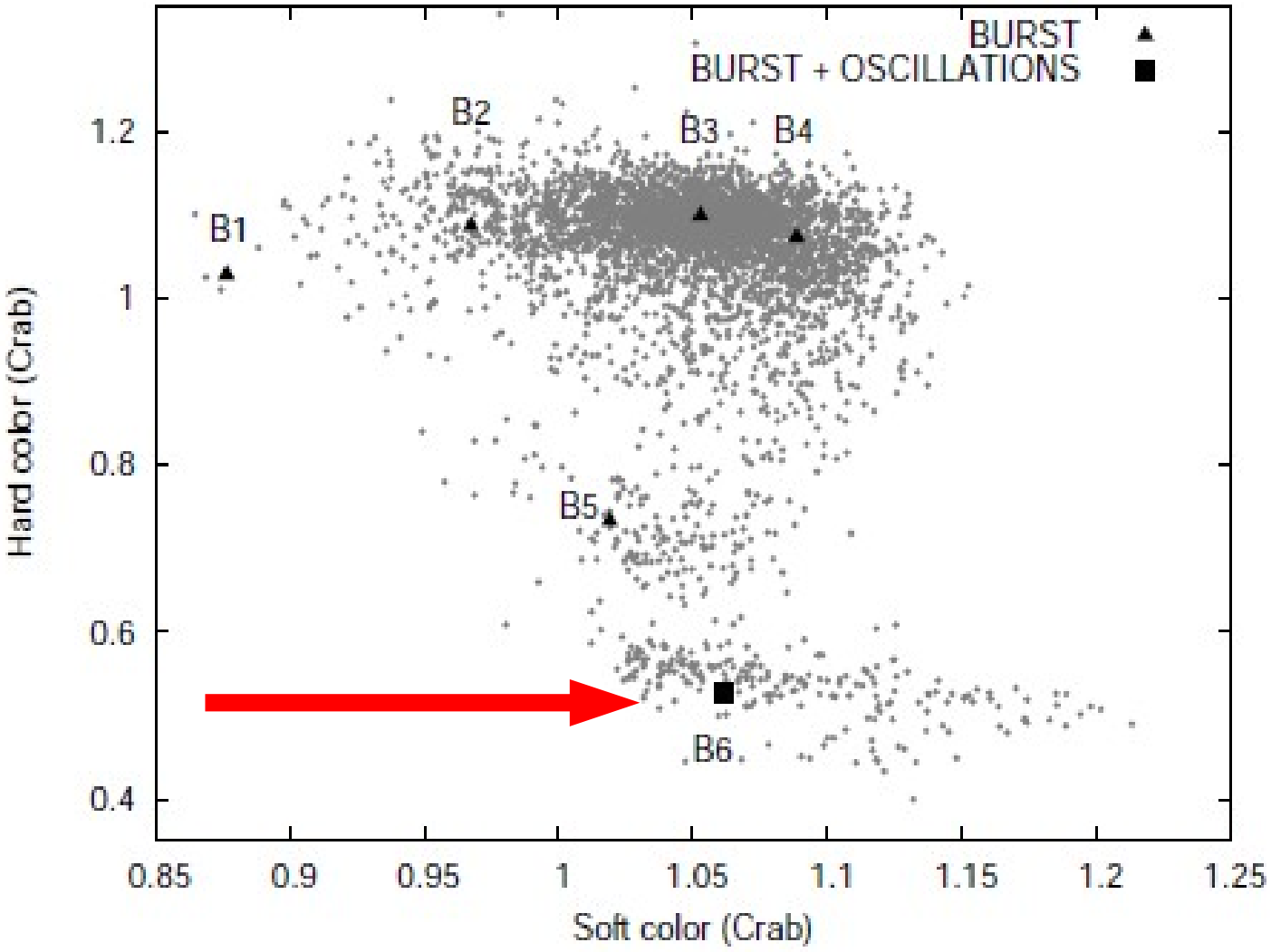


Spitkovsky, Levin, & Ushomirsky (2002)


378
377
376
375
374
Frequency (Hz)
0
5
10
15
20
Time (s)
10
5
0
1000 Cts/Sec/PCU
400
0
−400
0
1
2

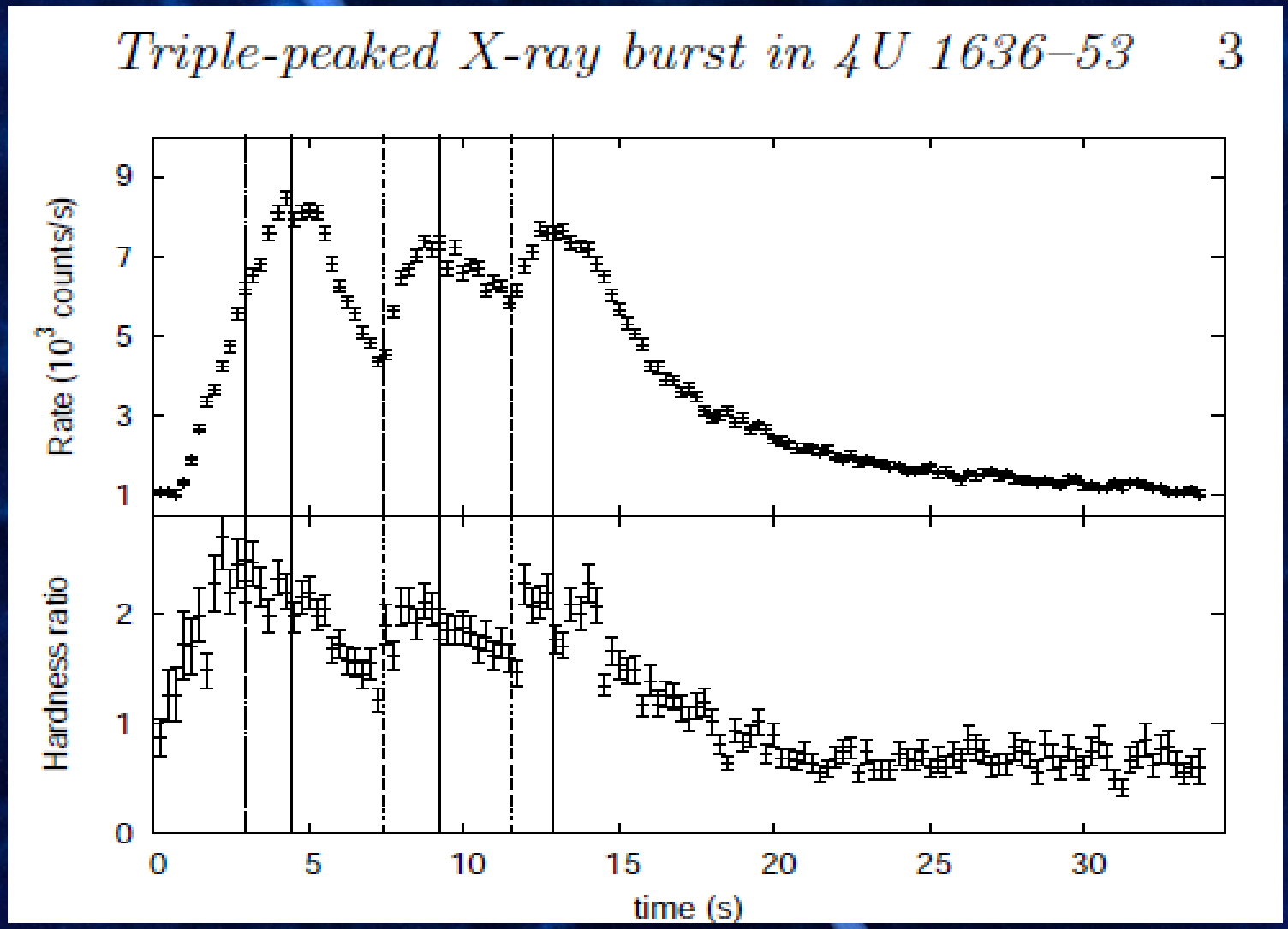


Watts, Altamirano et al. 2009

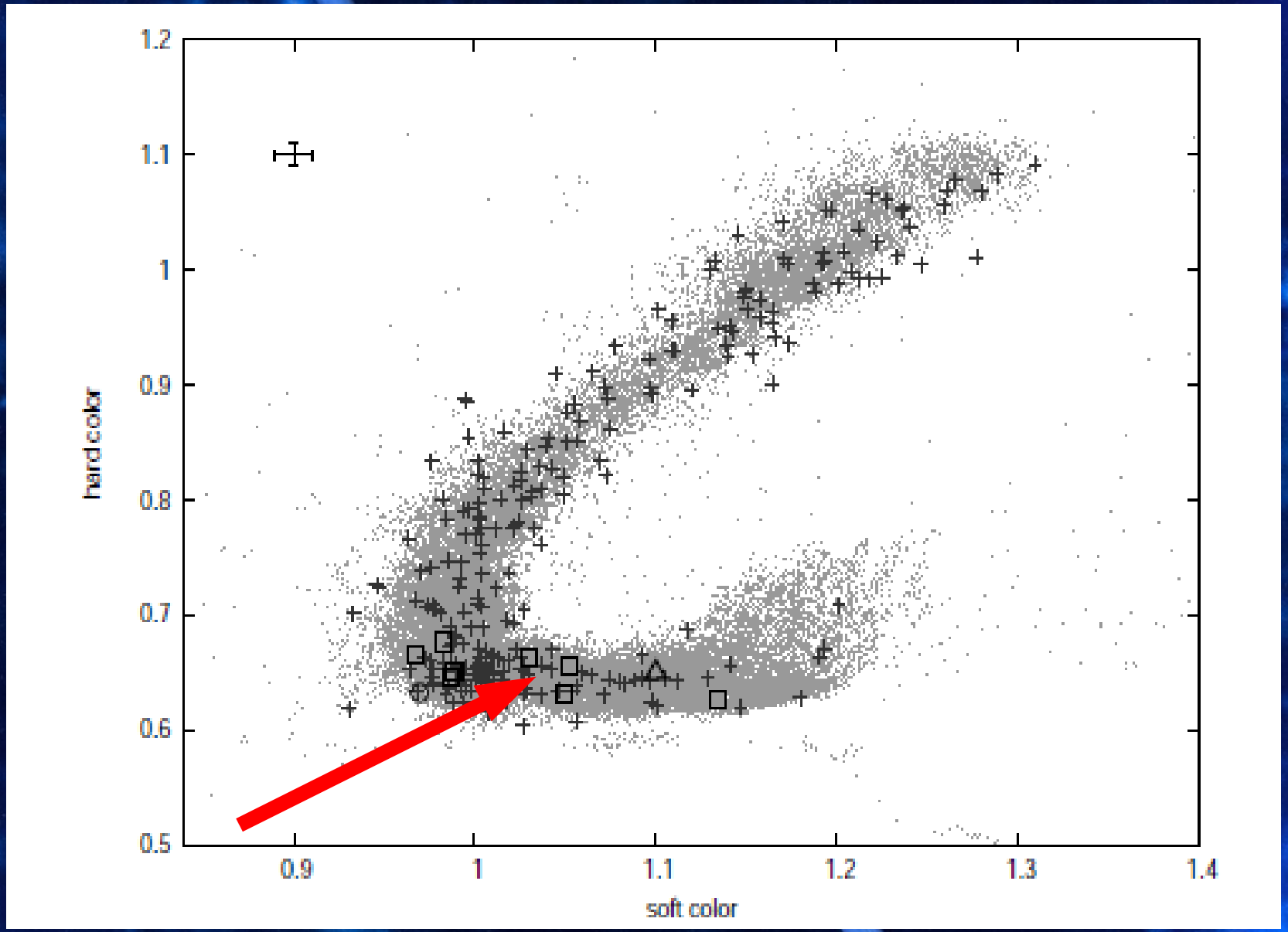


Watts, Altamirano et al. 2009

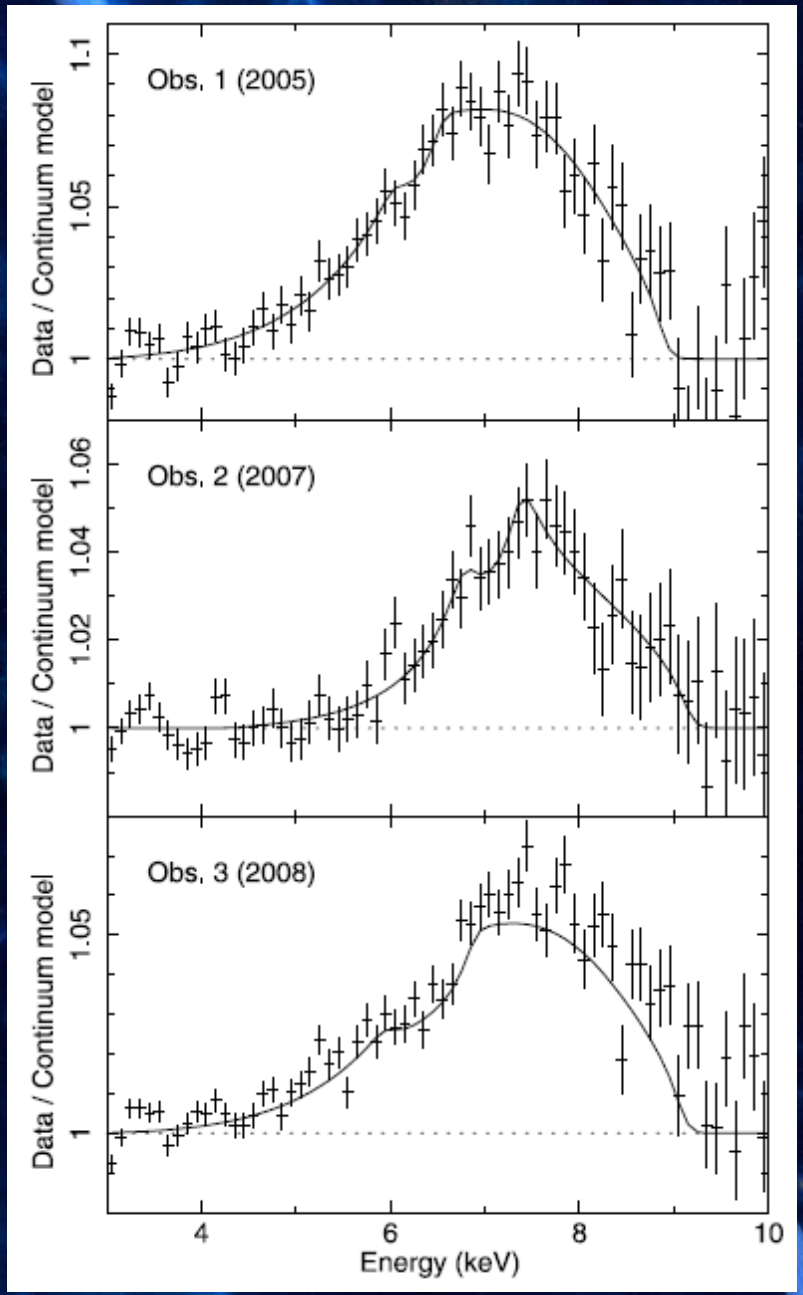

CONTEXT



Zhang, Mendez, Altamirano et al. 2009


1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
hard color
0.9
1
1.1
1.2
1.3
1.4
soft color

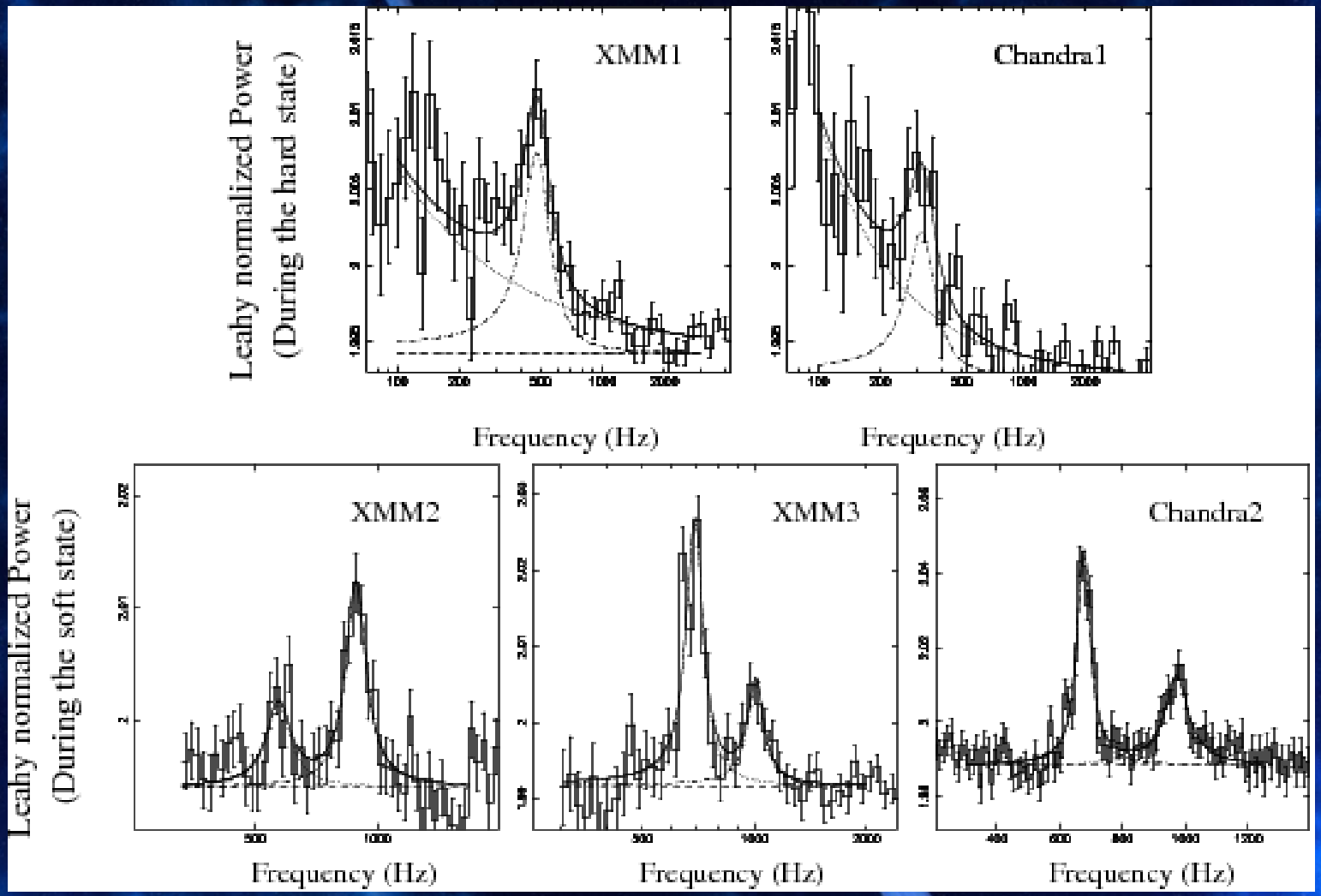

CONTEXT



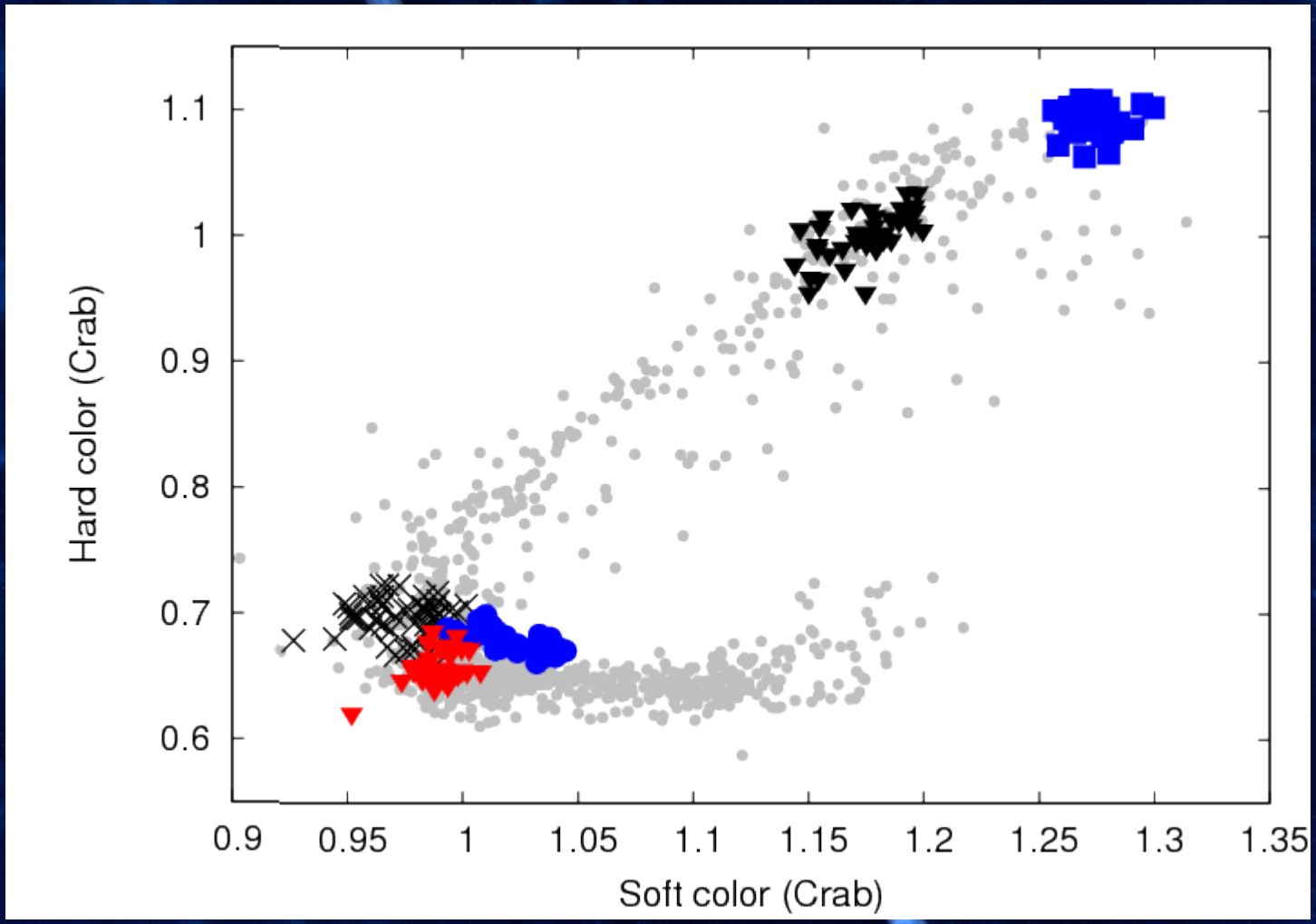
Iron Lines!

Pandel et al. 2008

Khz QPOS!



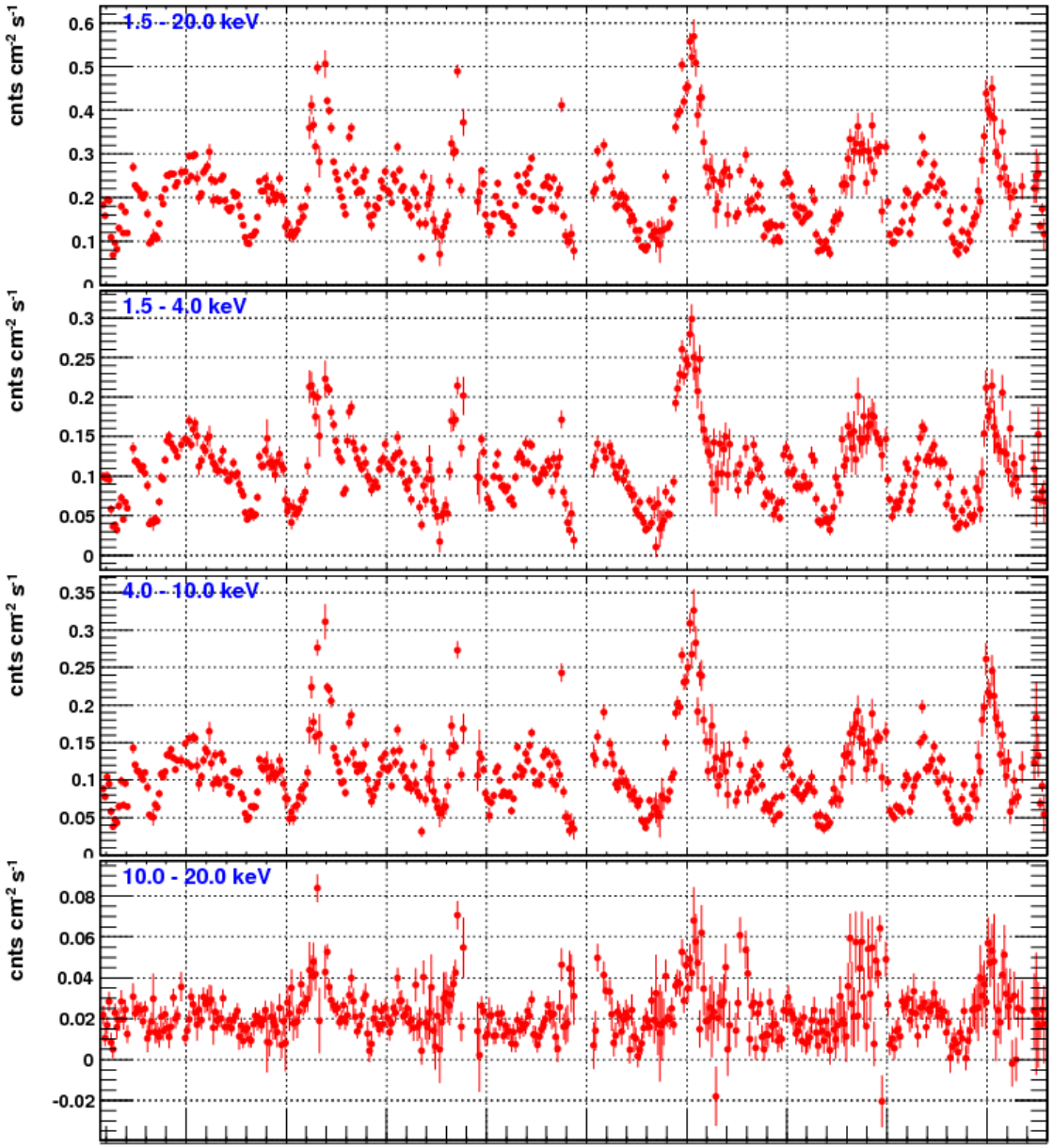
Sanna et al. 2011



Sanna et al. 2011


CONTEXT

H1636-536



UT 08/14 2009 — 11/30 2010

CONTEXT

MAXI monitoring observations are a very important complement to other X-ray, as well as Radio, Optical and other wavelength observations!