The peculiar, intermittent millisecond X-ray pulsar SAX J1748.8-2021

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In collaboration with:
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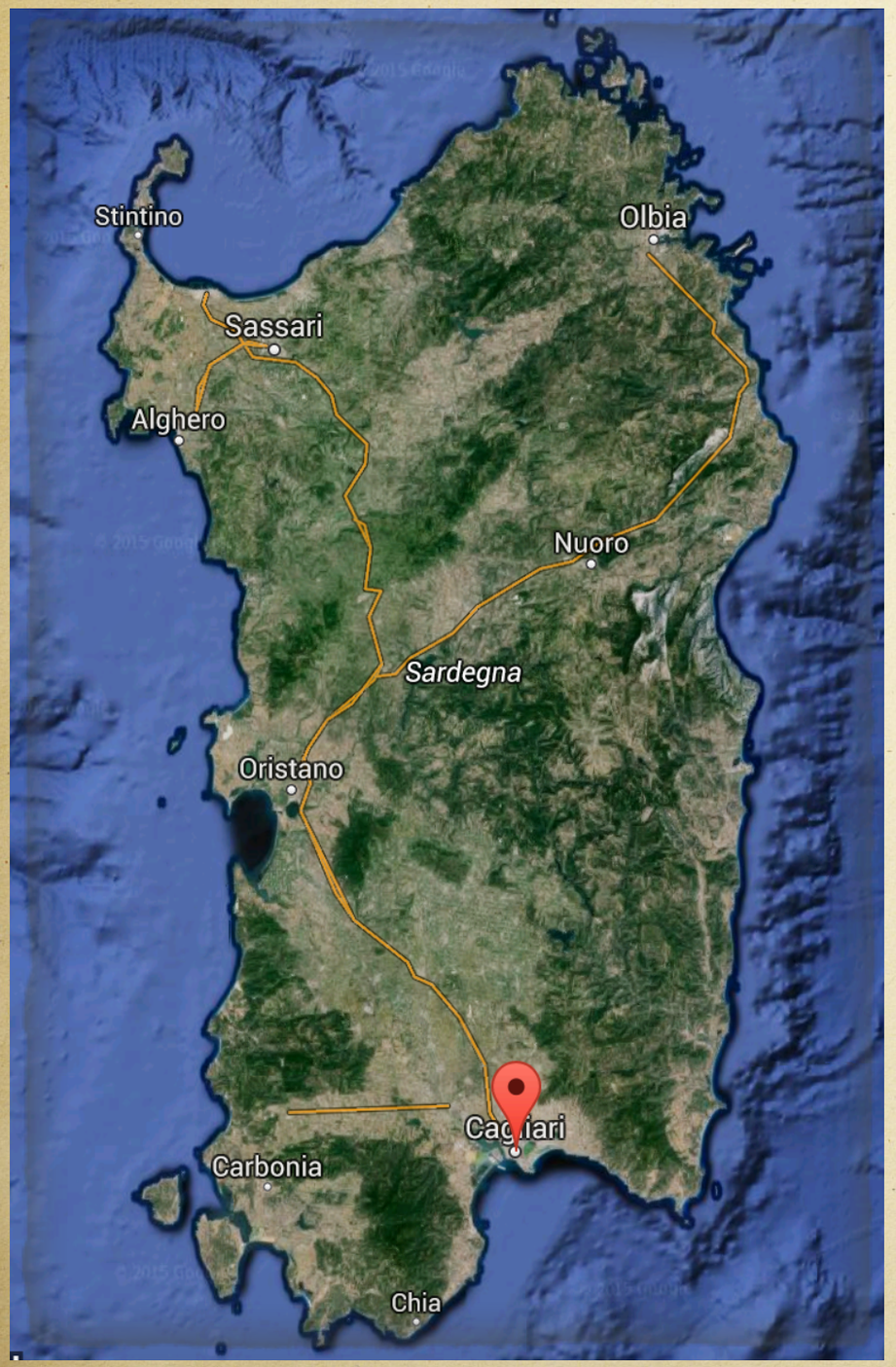
A bit about me...



- 2009: Master degree in Physics at the University of Cagliari with a thesis about the millisecond pulsar SAX J1808.4-3658

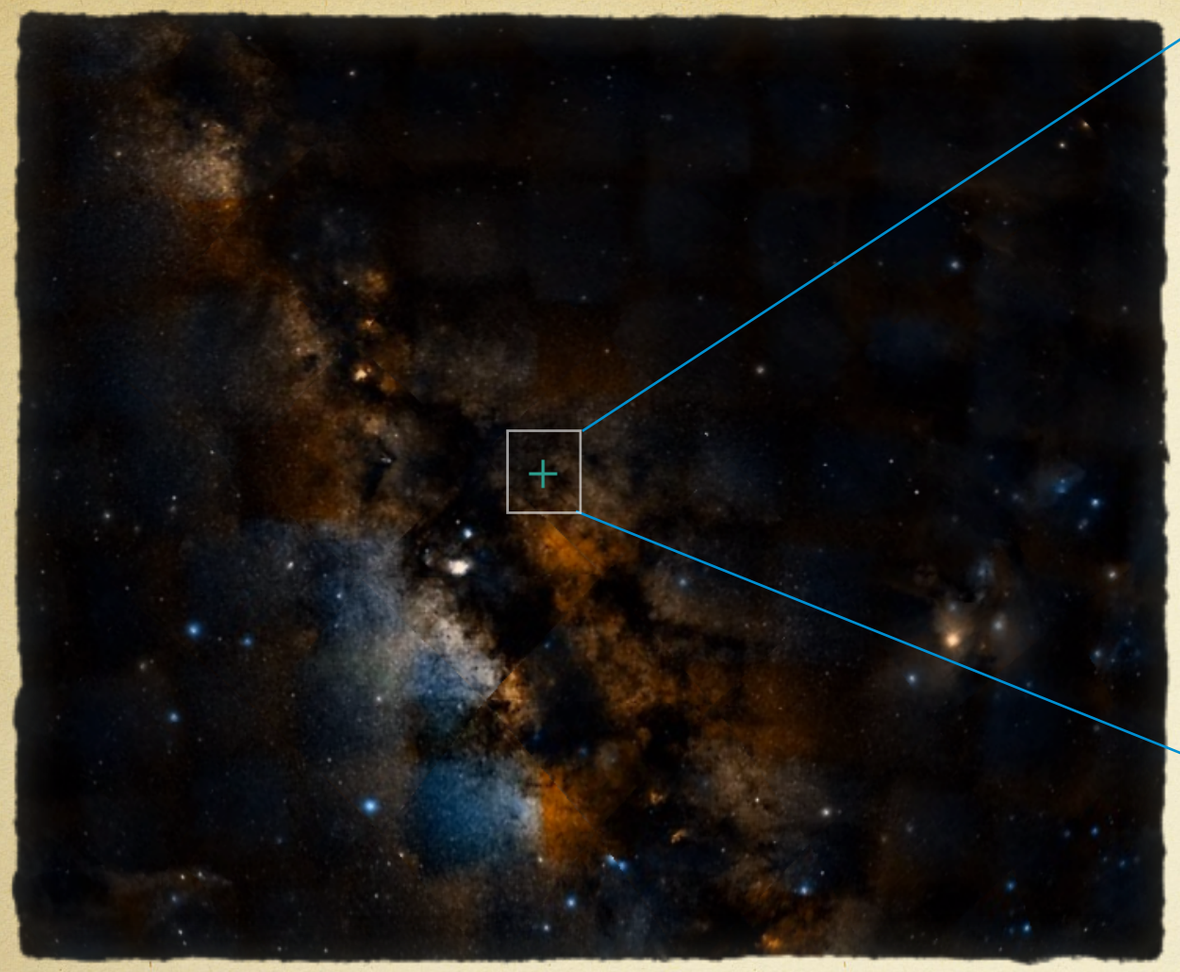
A bit about me...

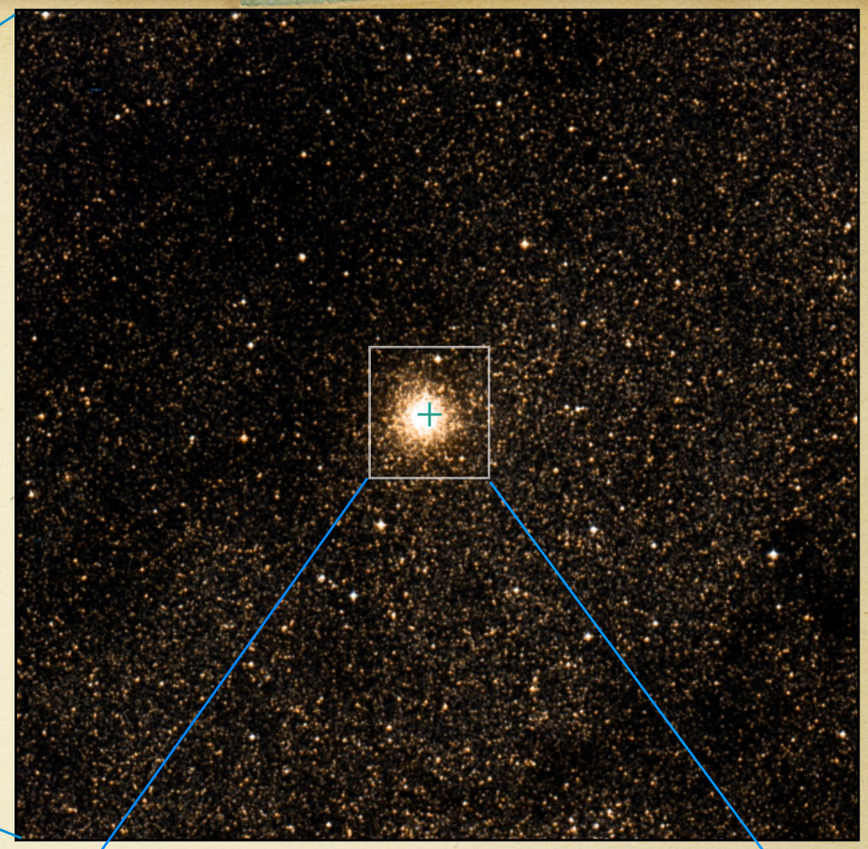
- 2010-2013: PhD in Astronomy at the University/Osservatorio astronomico of Padova, with a thesis on the Ultraluminous X-ray sources;

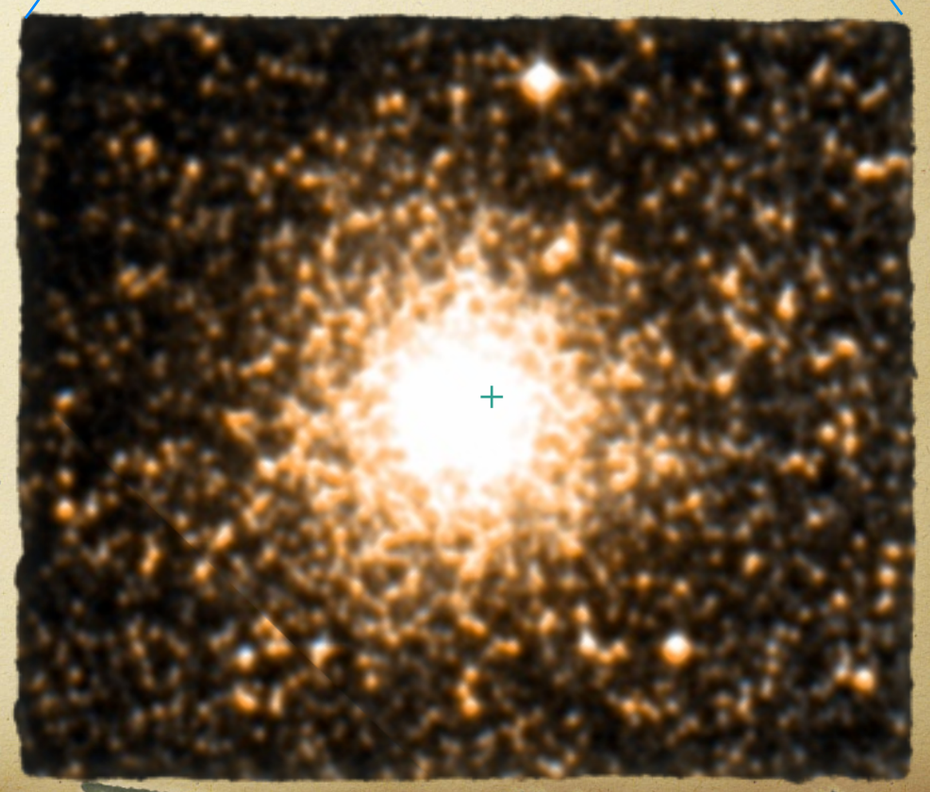
A bit about me...

- 2014-2015: Post-doc at the University of Cagliari;
- 2015-2017: Post-doc at IASF-Milano with Sandro Mereghetti

Project: Getting to GUNS (Grand Unification of Neutron Stars) through X-ray variability studies of non-accreting neutron stars





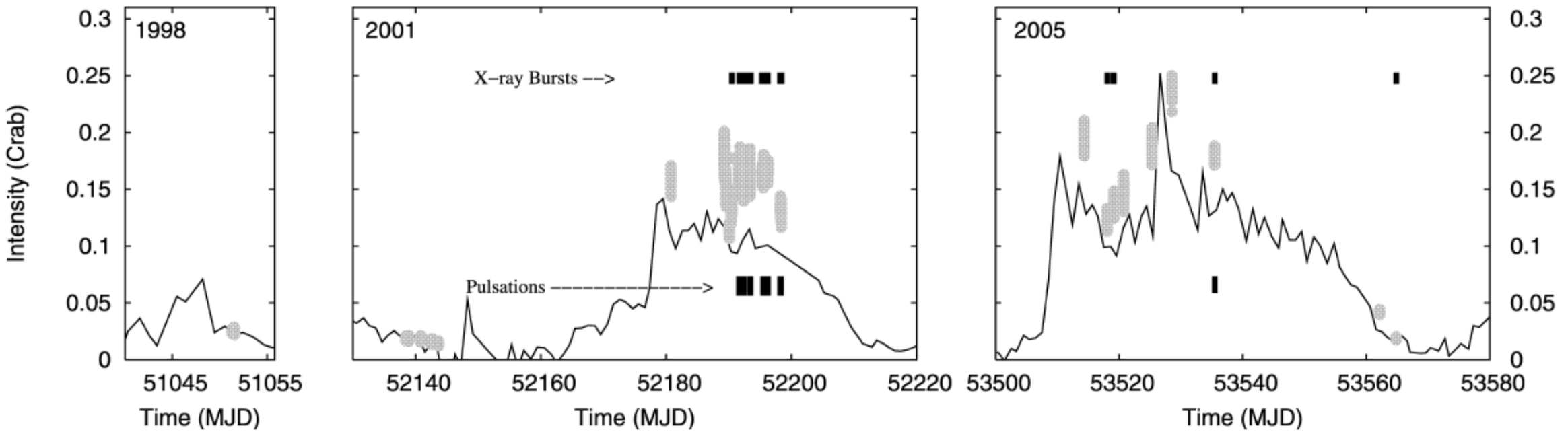


SAX J1748.9-2021

distance of 8.5 kpc and at 0.6 kpc above the Galactic plane

Four outbursts were observed in 1998, 2001, 2005 and 2010

Altamirano et al. (2008)



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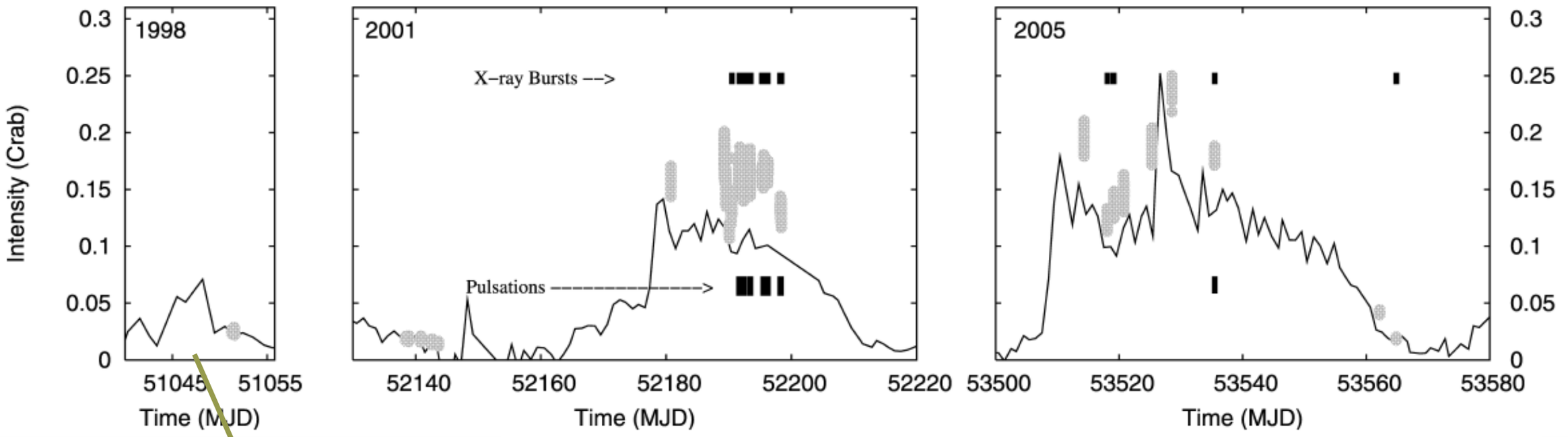
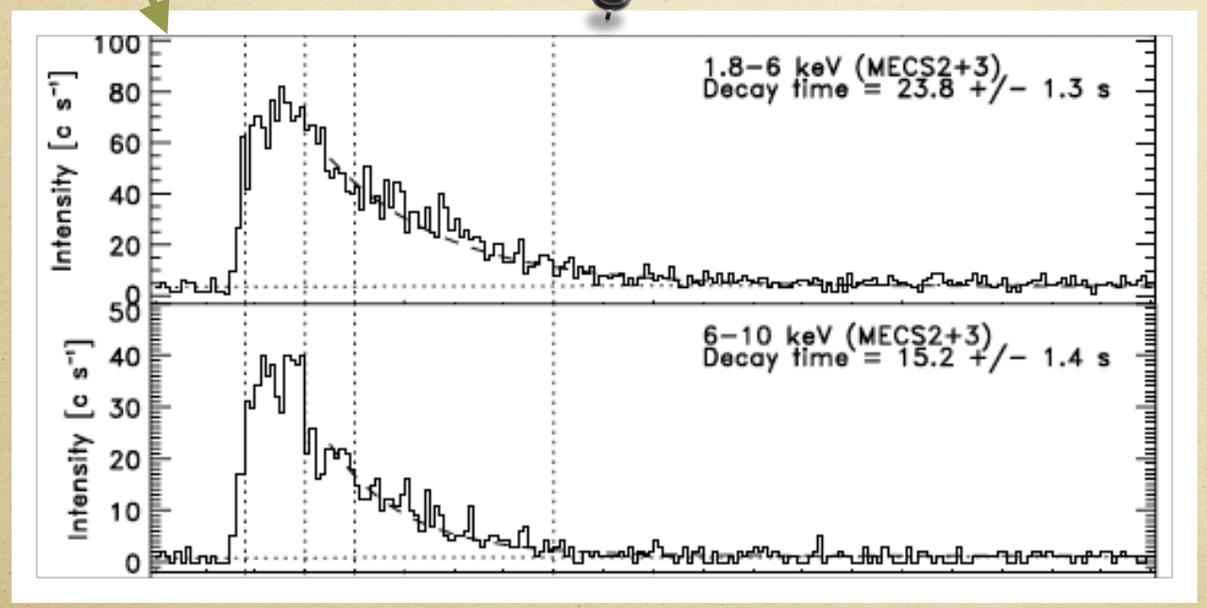


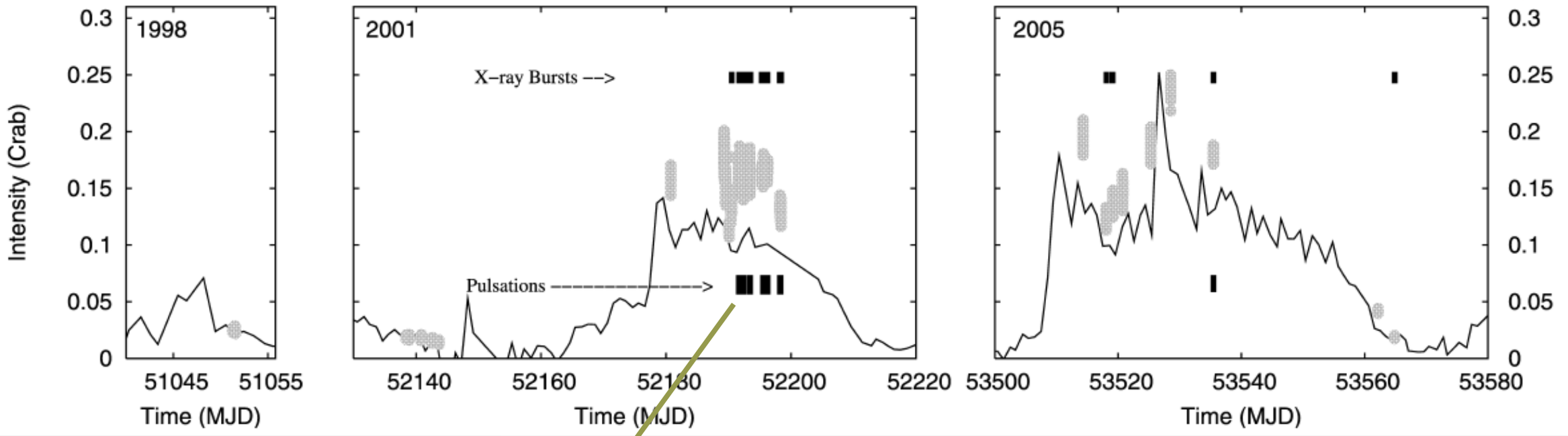


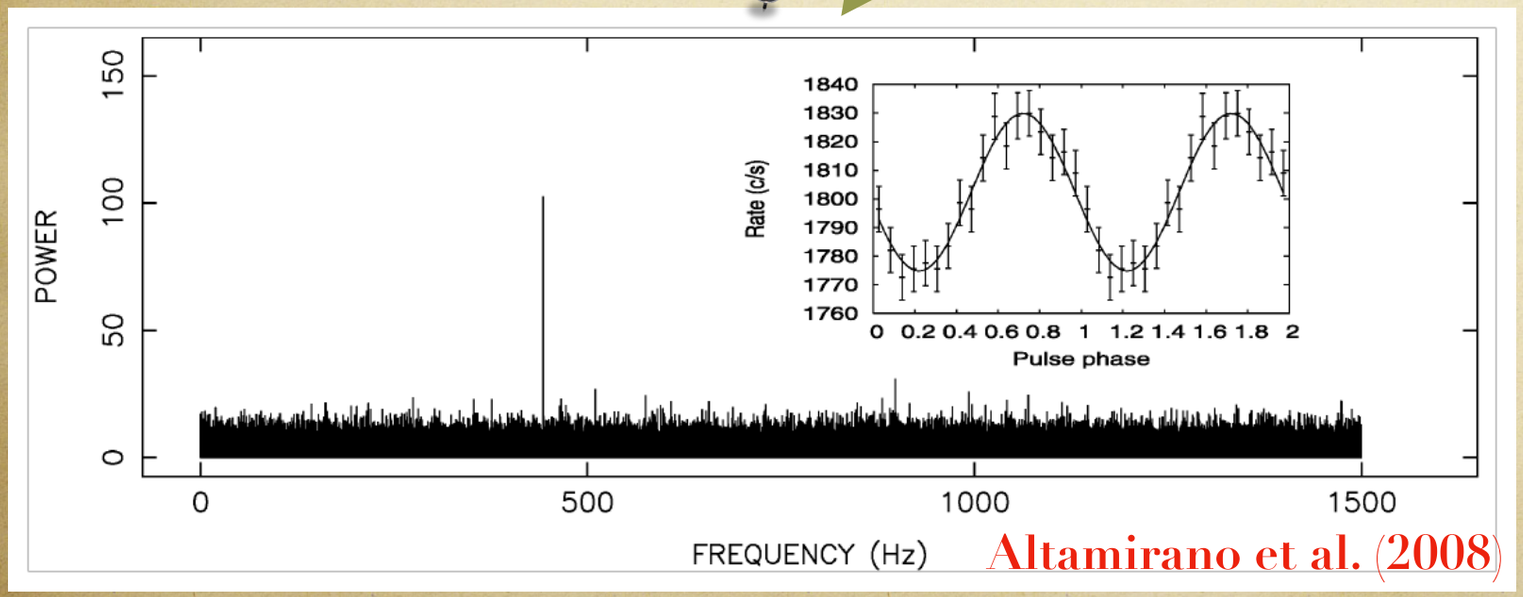
in 't Zand et al. (1999)

Type-I X-ray bursts: evidence for a neutron star (NS)

Four outbursts were observed in 1998, 2001, 2005 and 2010

Altamirano et al. (2008)



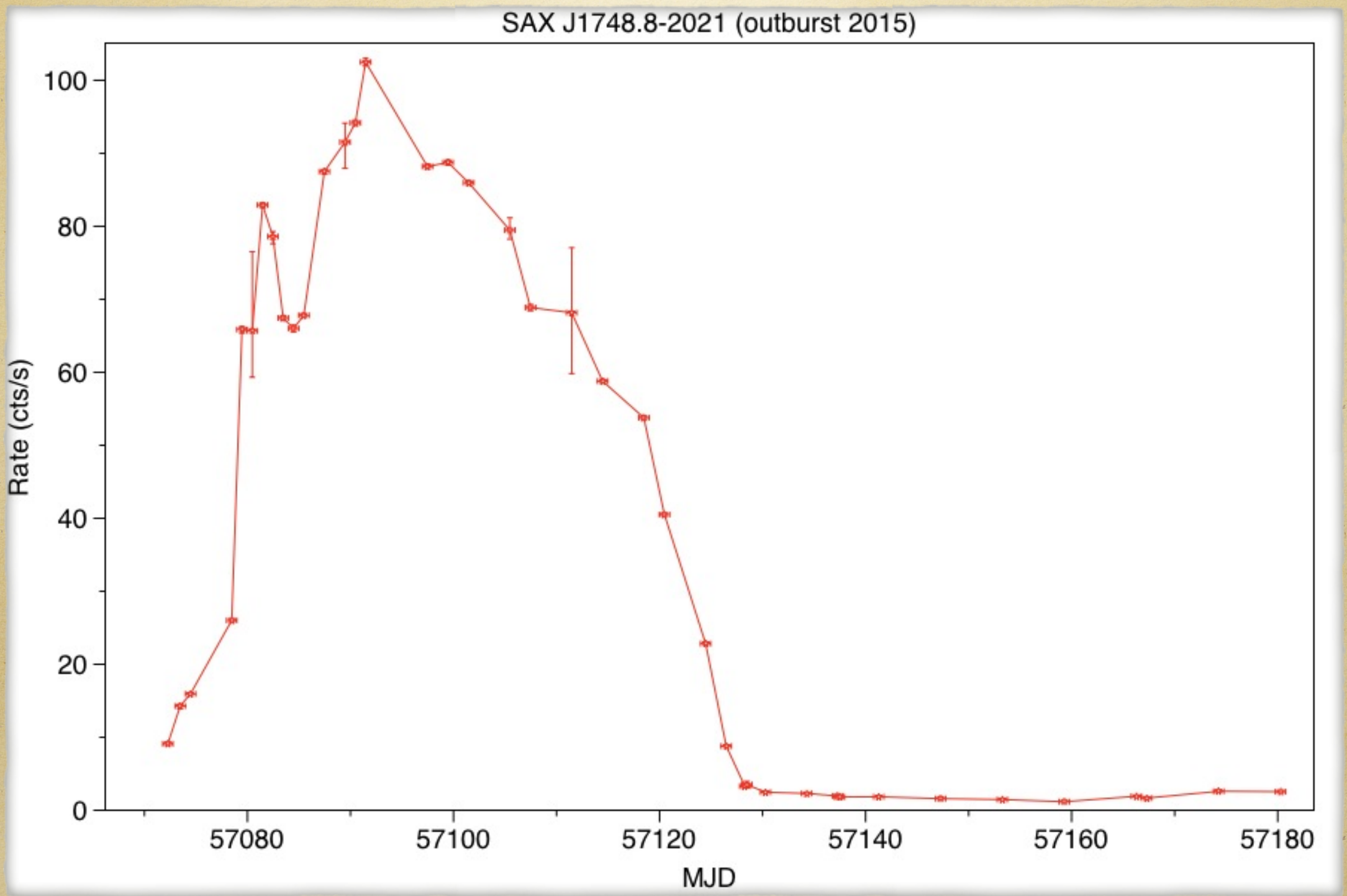


Altamirano et al. (2008)

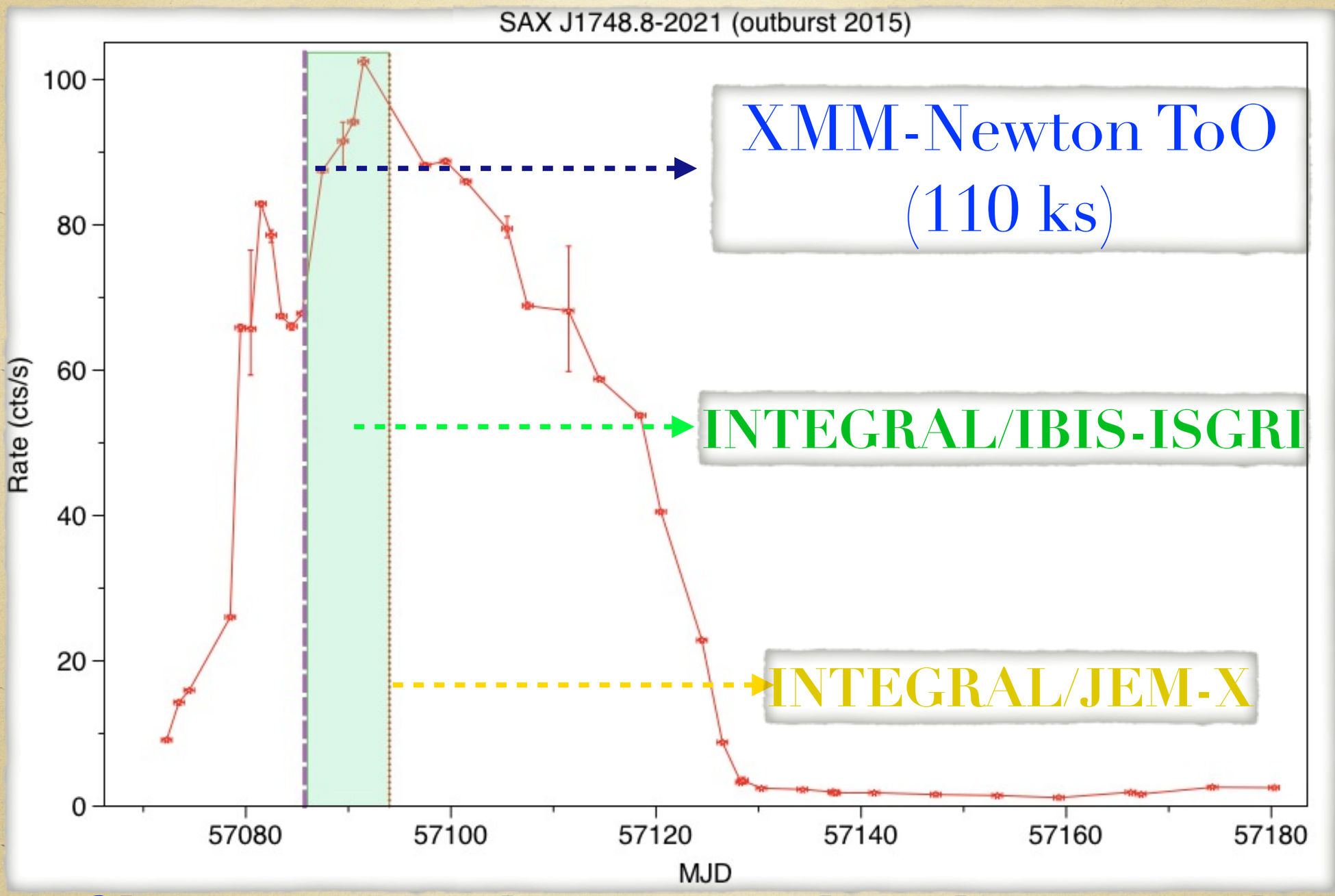
Intermittent, coherent pulsation at 442.36 Hz:

X-RAY MILLISECOND PULSAR

2015 OUTBURST



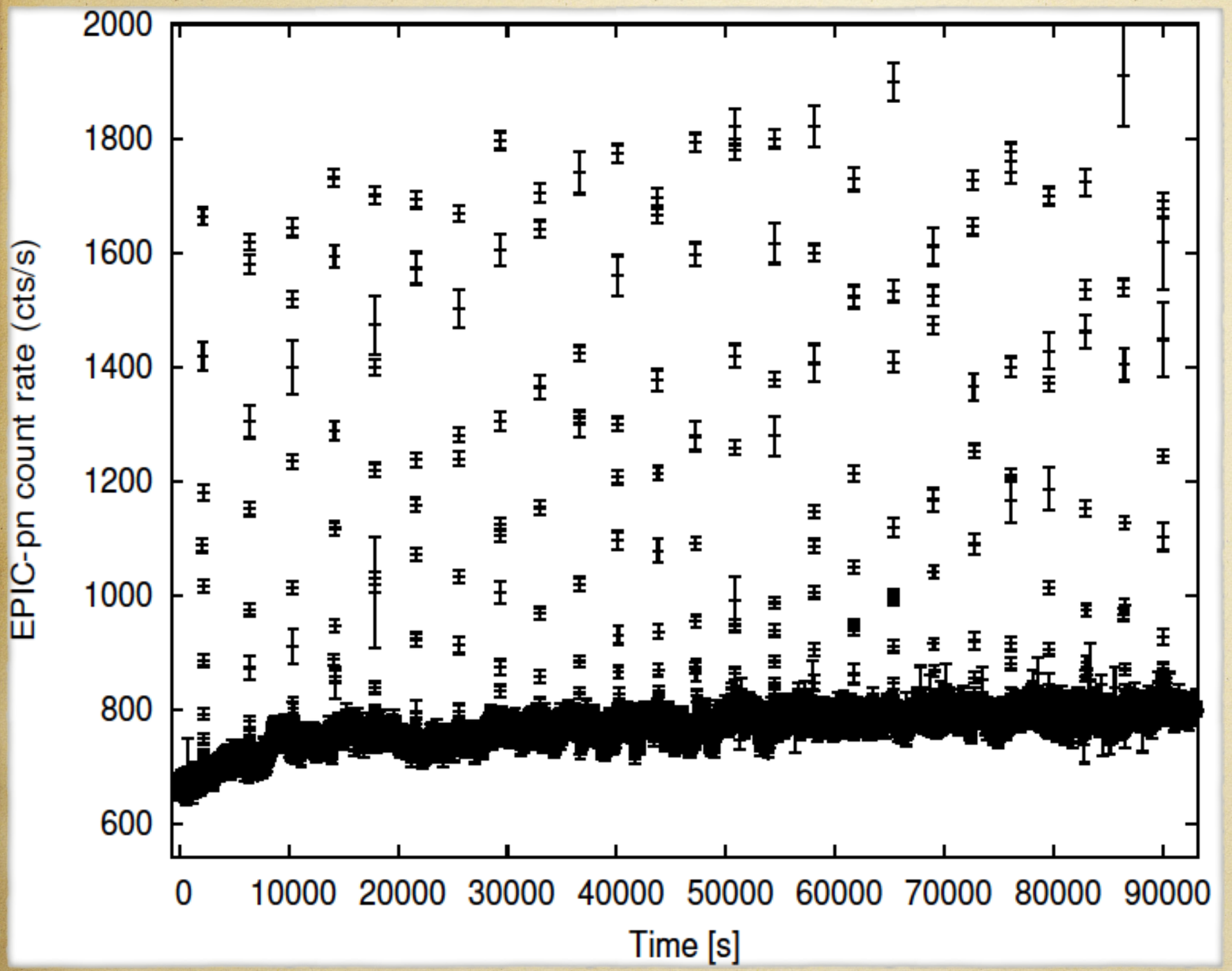
2015 OUTBURST



Characterize the spectral and temporal properties of the source

Pintore et al. accepted Today, arXiv:1601.05215

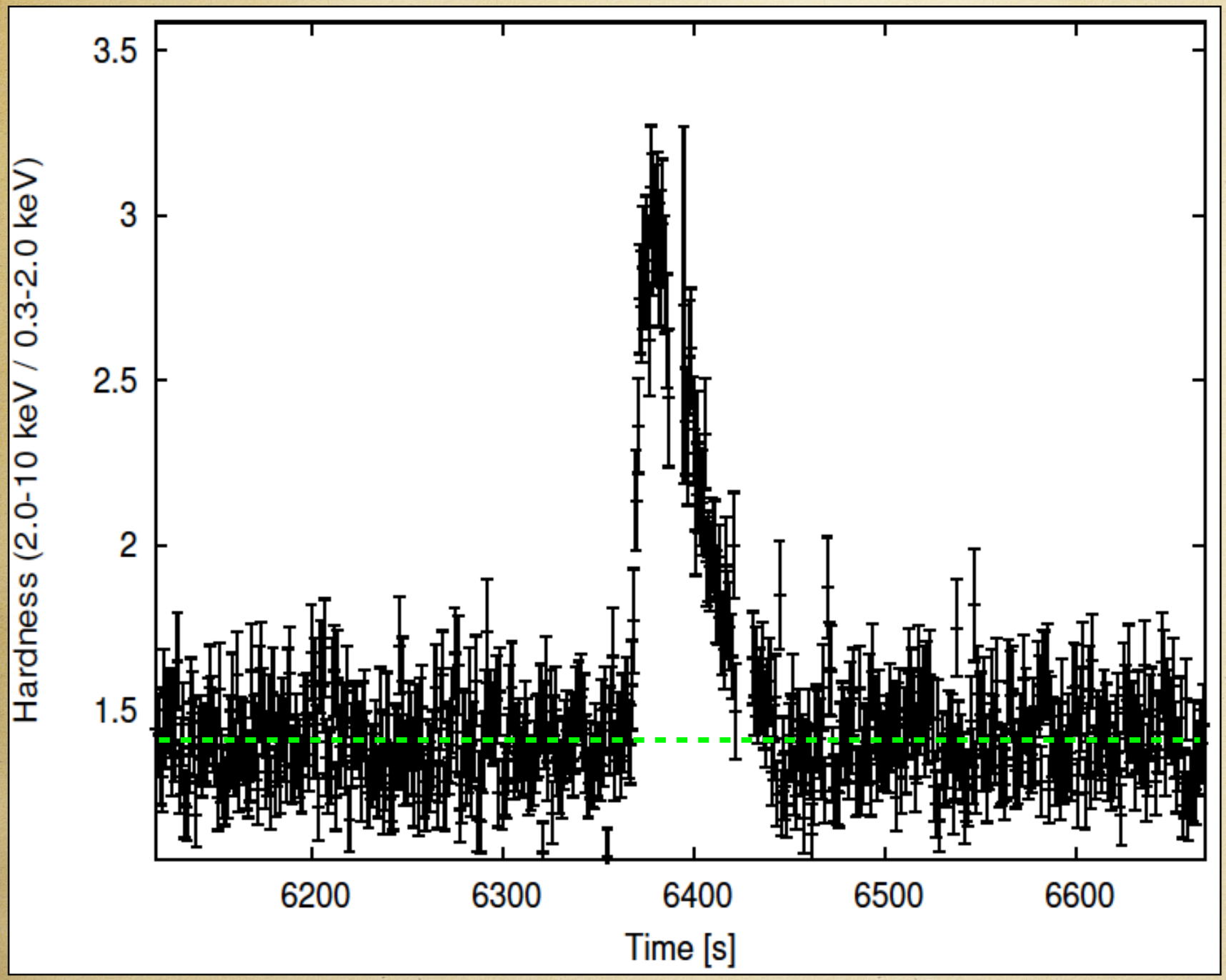
2015 OUTBURST



~ 1 burst/hour and quite constant count rate during the observation

Pintore et al. accepted

2015 OUTBURST

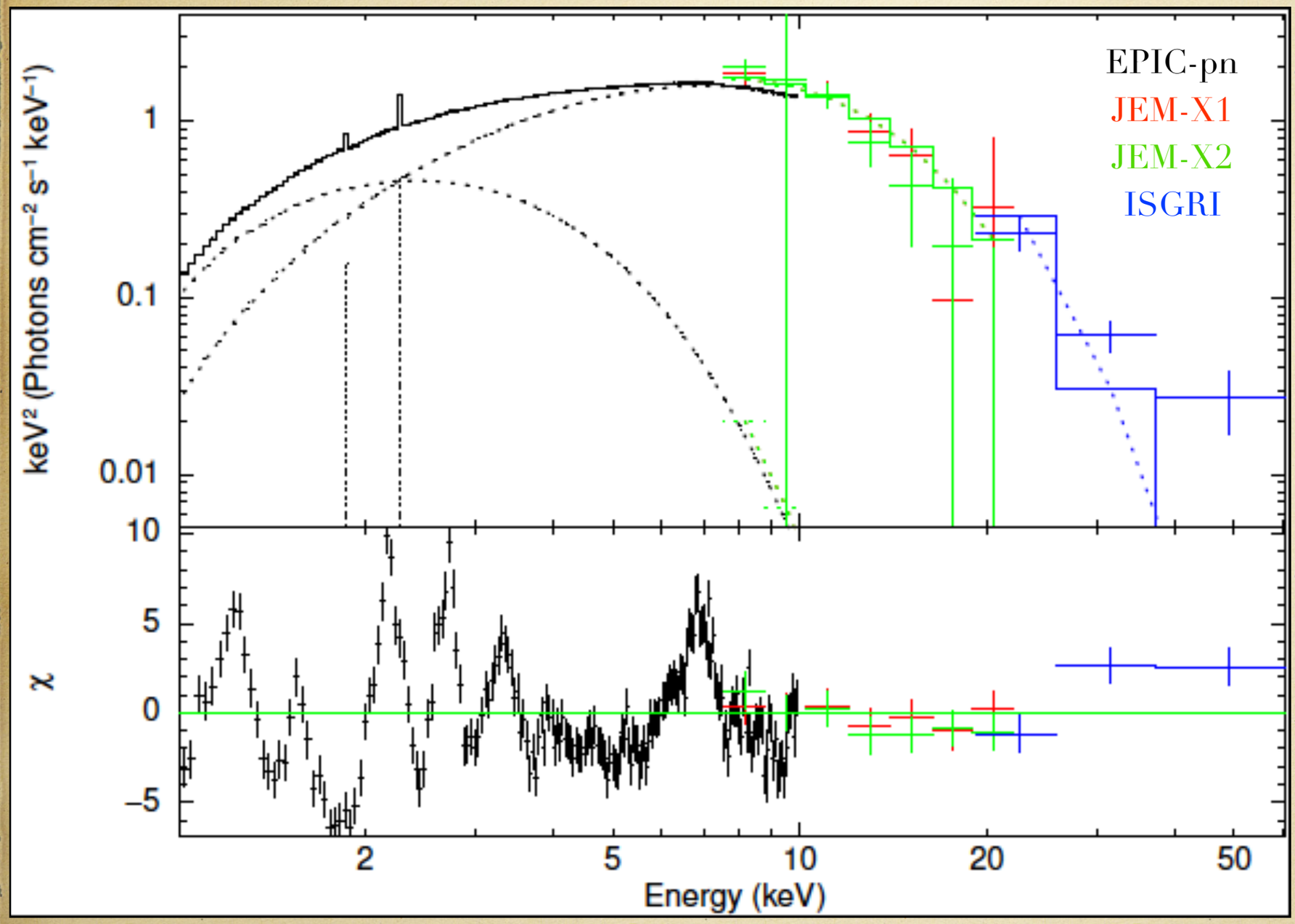


Hardness ratio of a burst: type-I burst

We perform a spectral analysis of persistent and burst epochs separately

Pintore et al. accepted

PERSISTENT EMISSION



Multicolour disc

+

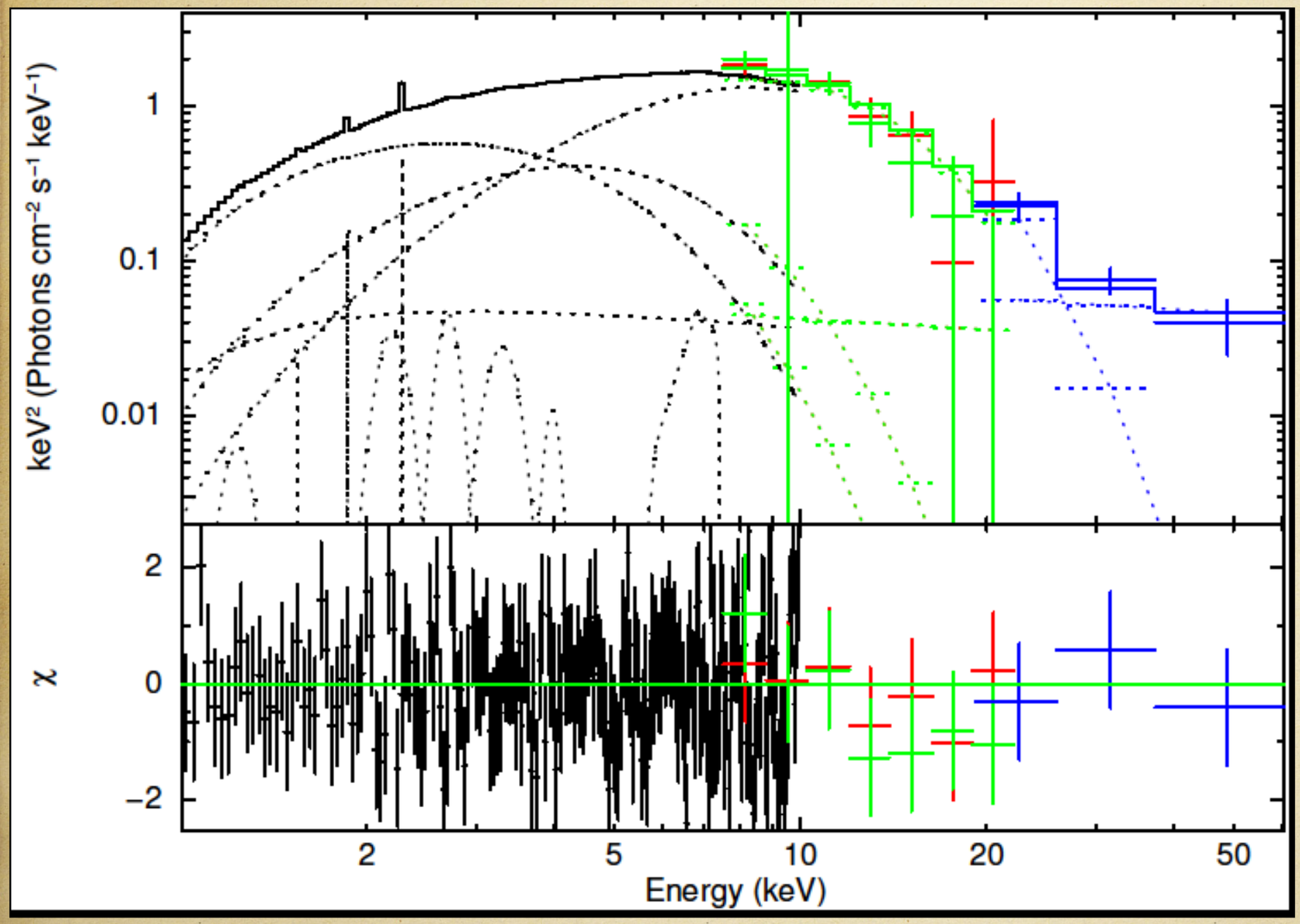
cold

Comptonization

Iron line and some other low energy features,

and an excess at > 20 keV

PERSISTENT EMISSION



χ^2/dof = 204.63/184

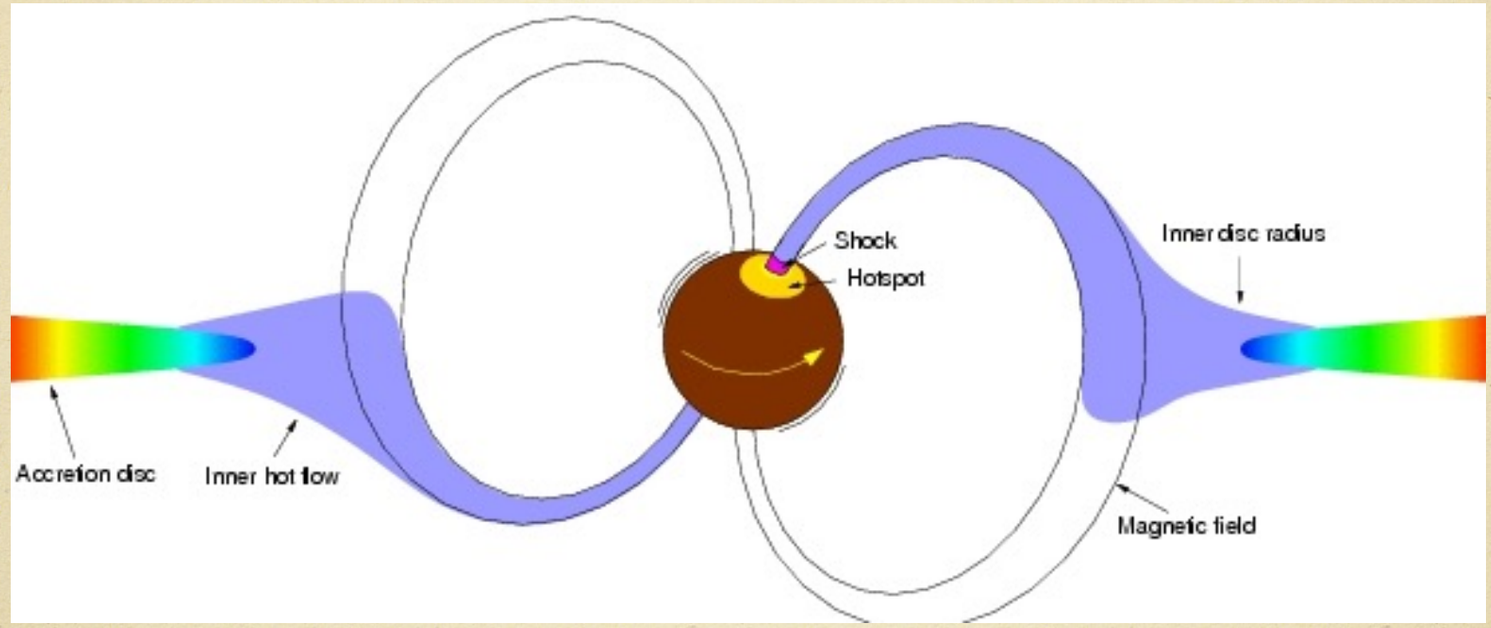
Multicolour disc
+
blackbody
+
cold
Comptonization
+
Powerlaw
+
6 broad
emission
line
(Iron line fitted
with a Diskline
model)

Reflection?

PERSISTENT EMISSION

Three ingredients:

1. (<u>persistent</u>) pulsation: the accretion disc has to be truncated;



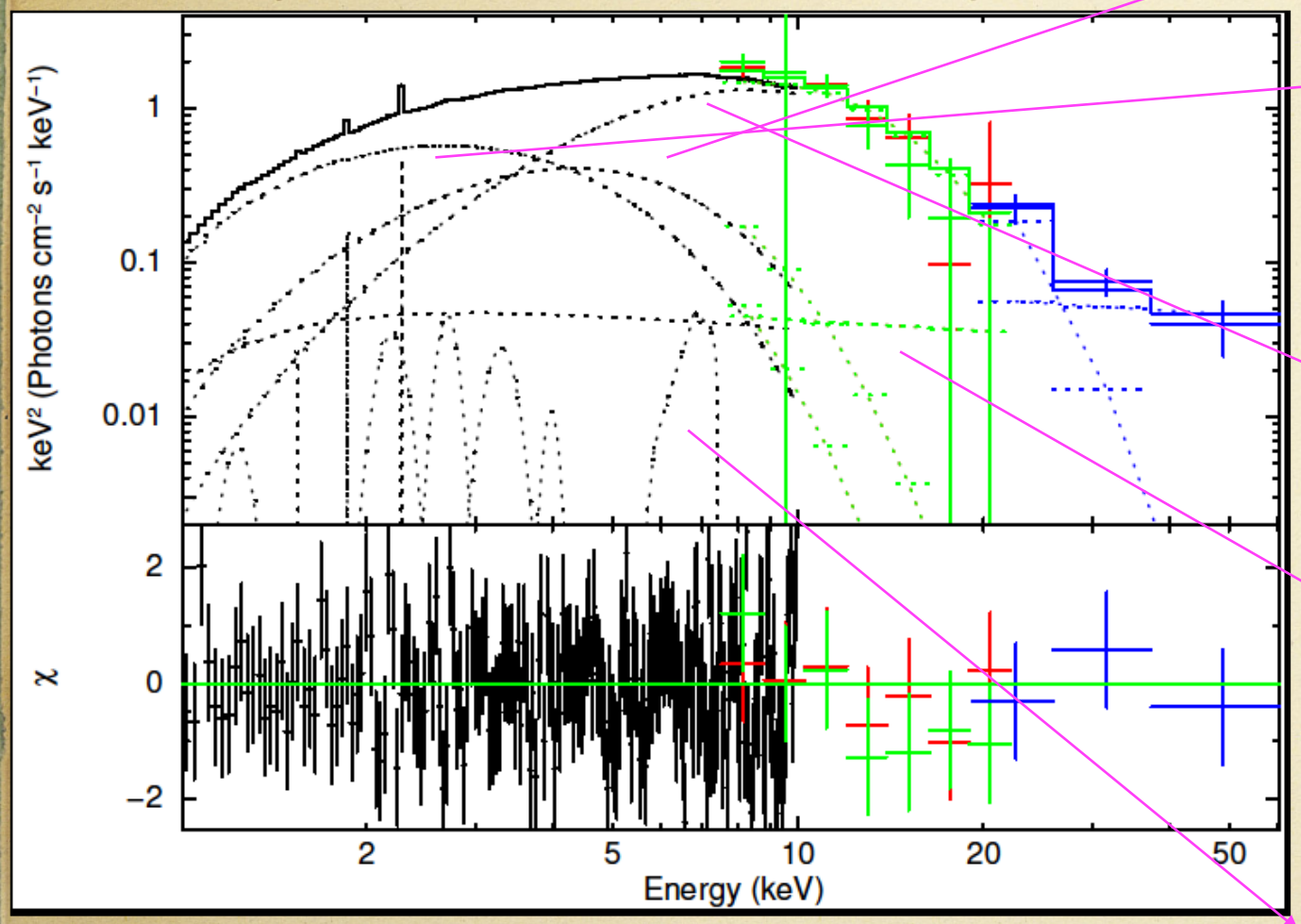
2. iron line: from the spectral profile we can infer the inner disc radius;
3. accretion disc component: comparison with the Iron line estimation

PERSISTENT EMISSION

Diskline	VS	Multicolour accretion disc
From the Iron emission line (6.79 ± 0.04 keV):		For an inclination angle of 45°:
- R_{in} : 40–80 km (~20-40 R_g)		- R_{in} : ~20 km (~10 R_g)
- Inclination i: 45°		- kT_{disc} = 0.9 ± 0.5 keV

The two estimates are quite similar

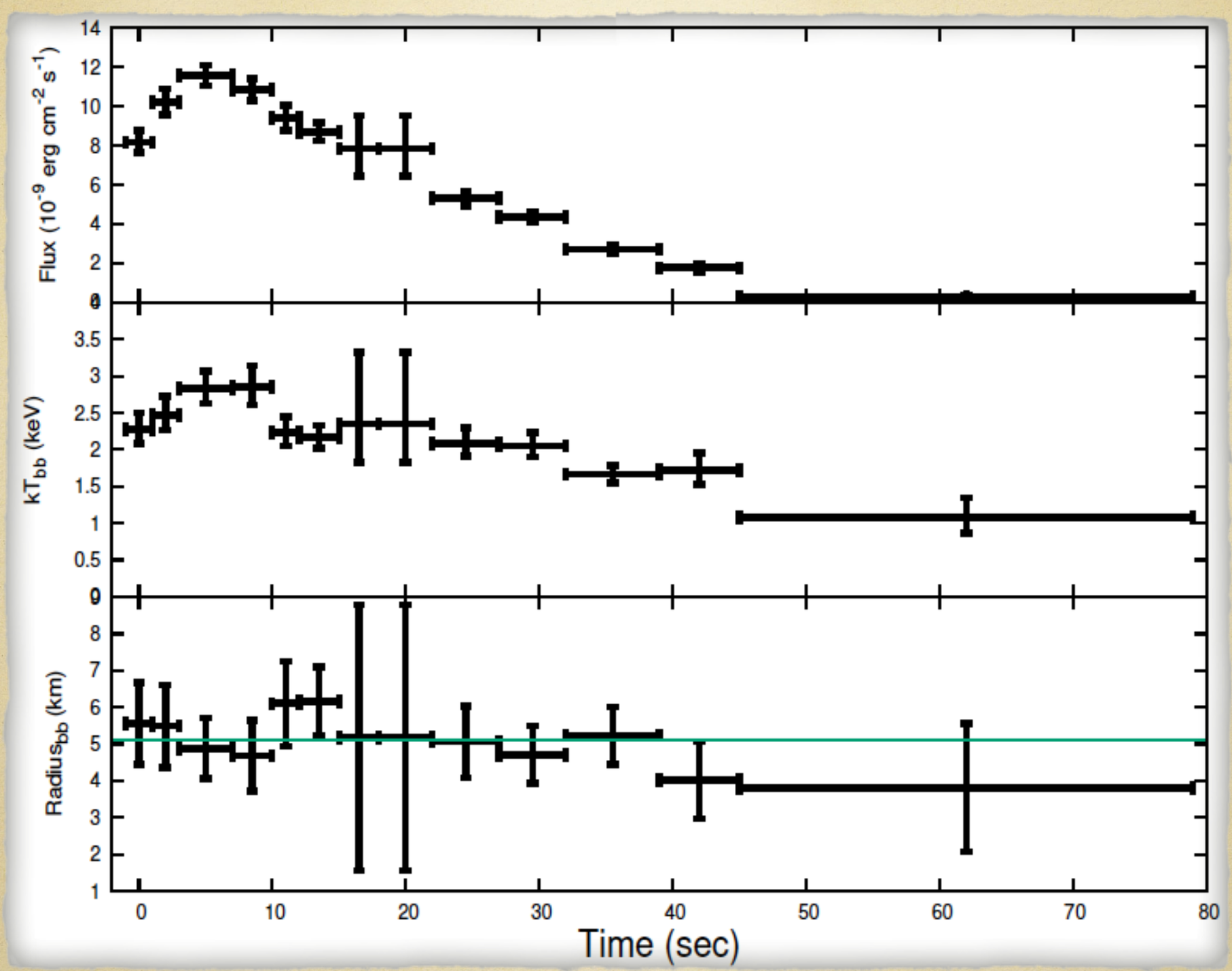
PERSISTENT EMISSION



- Blackbody: 1.1 KeV, NS surface (~25%)
- Multicolour disc: 0.9 keV, truncated accretion disc (~20%)
- Comptonization: 2-3 keV, accretion column (~50%)
- Powerlaw: $\Gamma \sim 2.3$; synchrotron emission; comptonization in a non-thermal medium; bulk motion of accreting material; (~5%)
- Emission lines: reflection off of hard photons from the disc surface

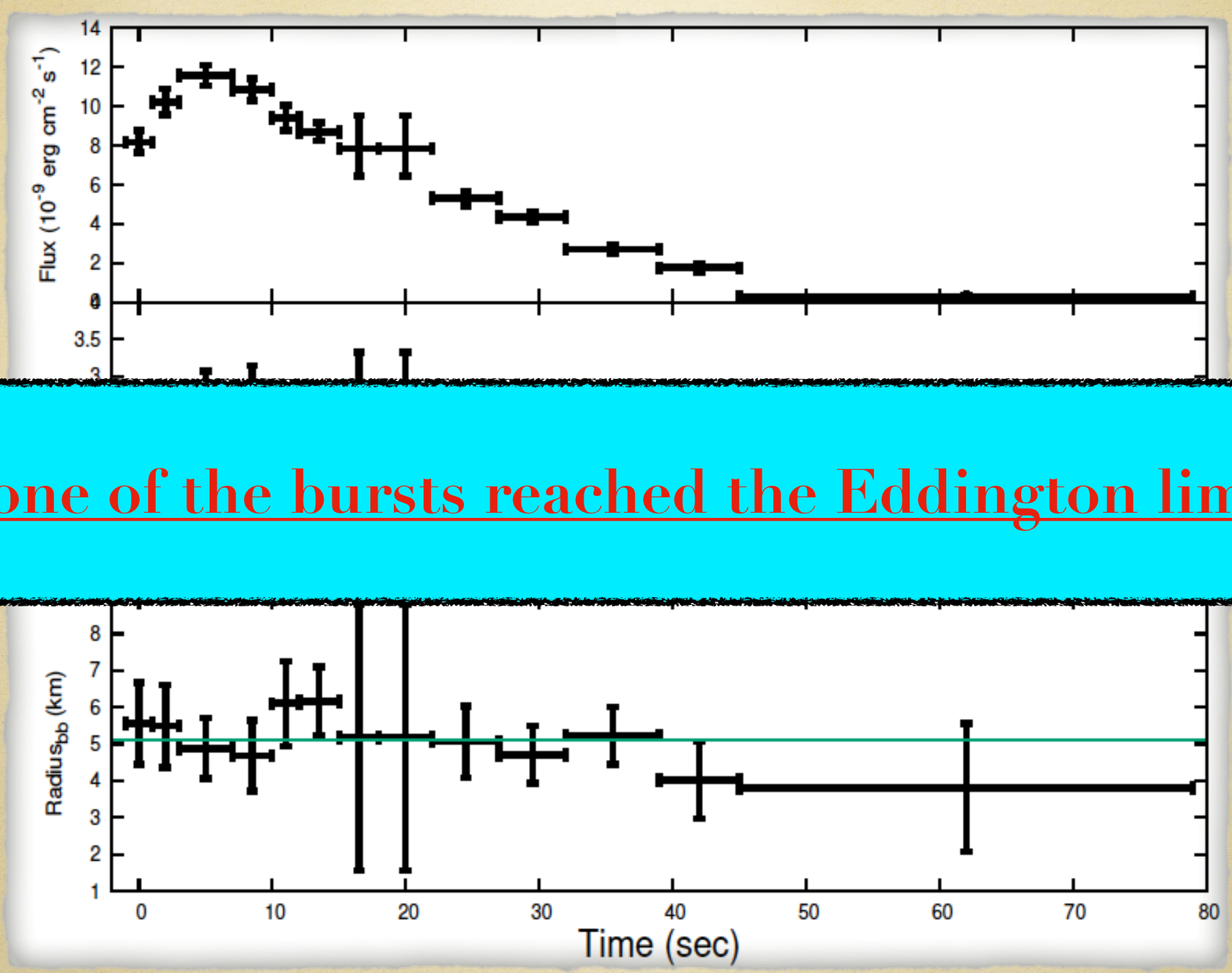
$L_X \sim 5 \times 10^{37}$ erg/s (1.0-50 keV, 8.5 kpc)

BURST EMISSION



Single burst; No radius expansion

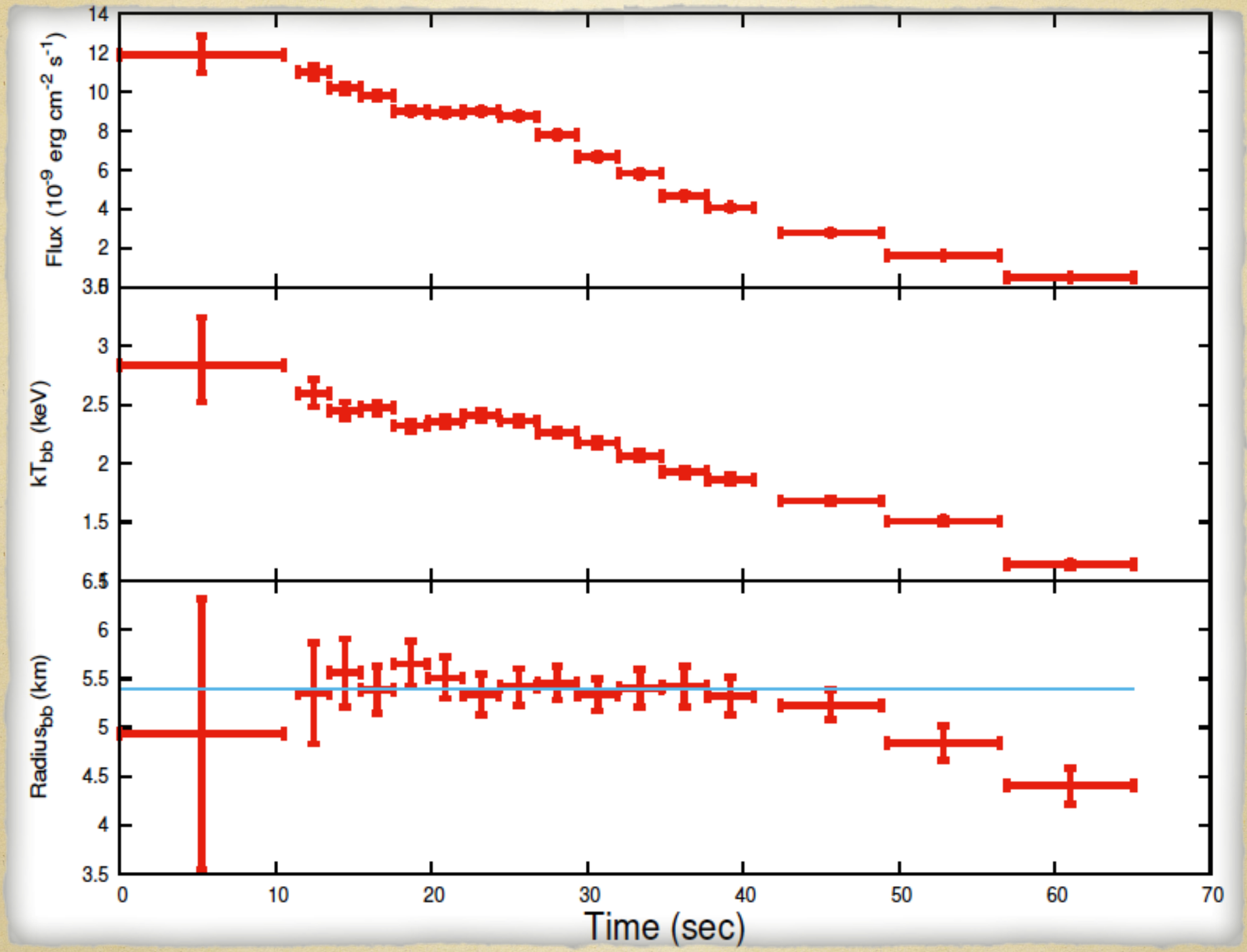
BURST EMISSION



None of the bursts reached the Eddington limit

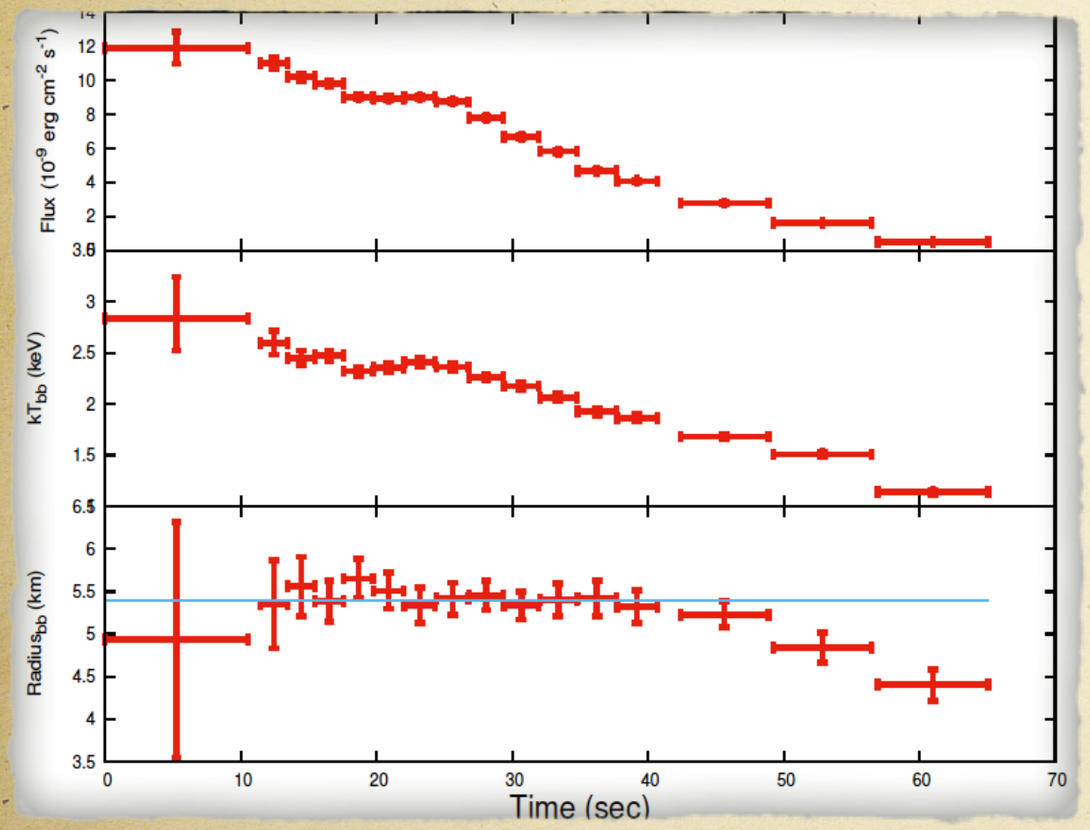
Single burst; No radius expansion

BURST EMISSION



Stacked burst

BURST EMISSION



Stacked burst

- NS radius: 5.5 km;

- Corrected for the NS atmosphere: 7-7.6 km:

Previous estimates:
8.18 ± 1.6 km;
Guver and Ozel (2013)

Summary

- After 10 years, SAX J1748.9-2021 renewed its X-ray activity;

- The source has been caught in a soft state at a luminosity of 5×10^{37} erg/s (1.0-50 keV); truncated disc;

- First time that a persistent millisecond X-ray pulsation has been observed in a soft state;

- About 1 Type-I burst/hour;

- None of the bursts reached the Eddington limit;

- Possibility to estimate the NS radius (7-8 km);

Thanks for the attention

and may the torque be with you...