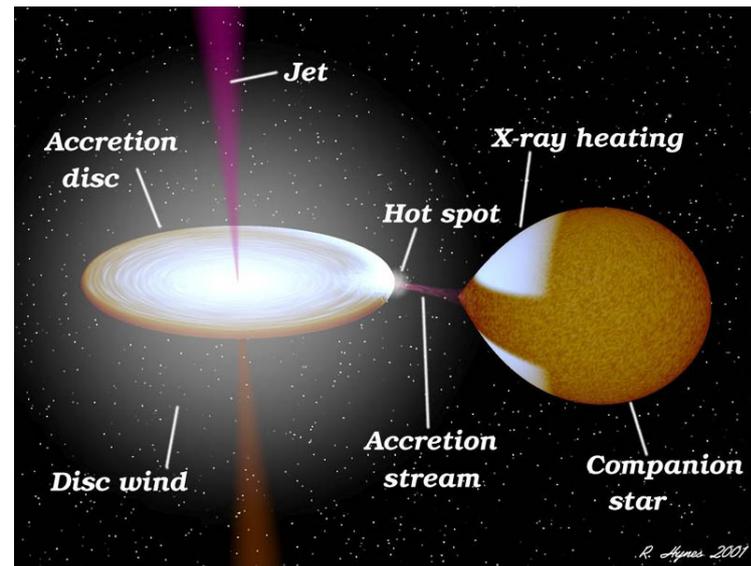
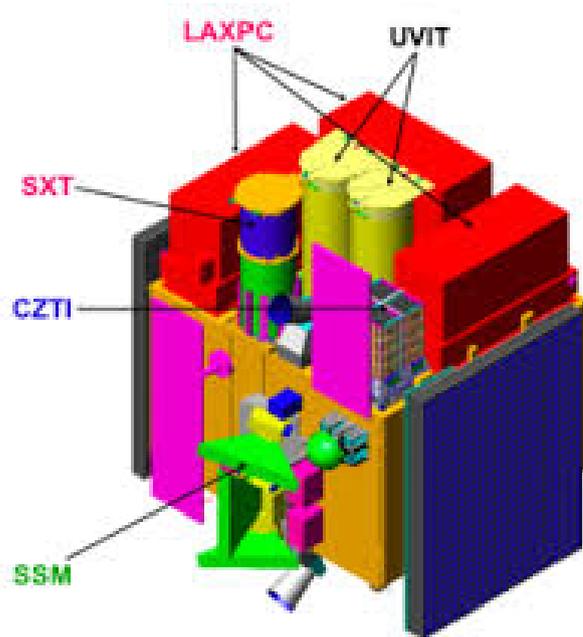


Thermonuclear X-ray Bursts in Rapid Succession in 4U 1636-536 with ASTROSAT-LAXPC

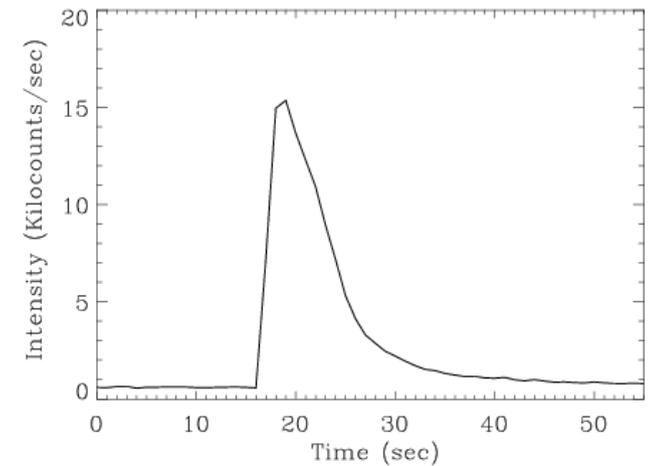
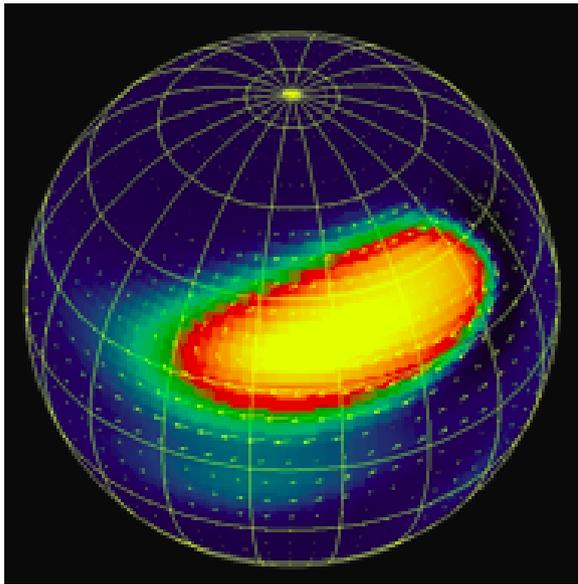


Aru Beri^{1,2} + LAXPC Team

Raman Research Institute
Royal Society-SERB Newton International Fellow, University of Southampton, U.K

Wide Band Spectral and Timing Studies of Cosmic X-ray Sources
10-13 January 2017

- **Thermonuclear X-ray bursts**



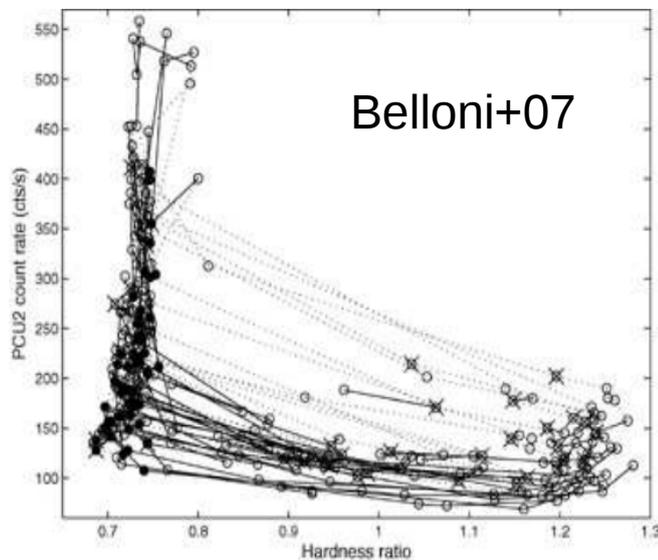
Rise Time ~ **0.5-10 seconds**
Decay Time ~ **10-100 seconds**
Recurrence Time ~ **hours to days**
Energy Release in a few seconds ~ **10^{39} ergs.**

Thermonuclear X-rays Bursts often exhibit **thermal blackbody spectra.**

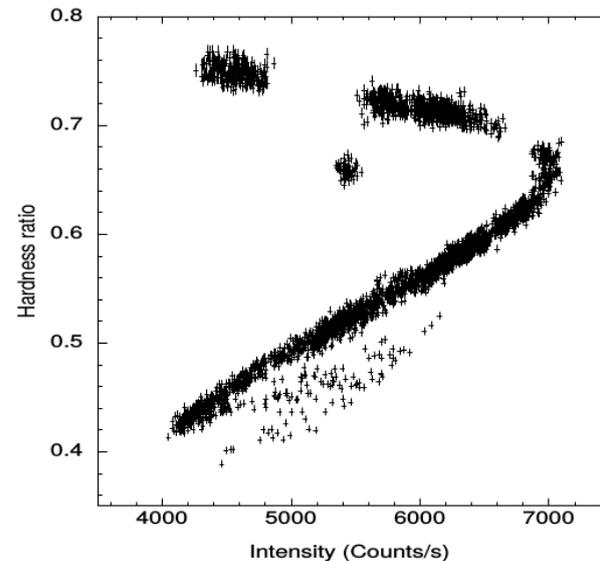
These X-ray bursts are one of the very ways to **estimate neutron star parameters, hence to understand deep interior of a neutron star.**

A Brief View of 4U 1636-536

- An extraordinary X-ray source → Most Luminous **Atoll Source**



AtollSource

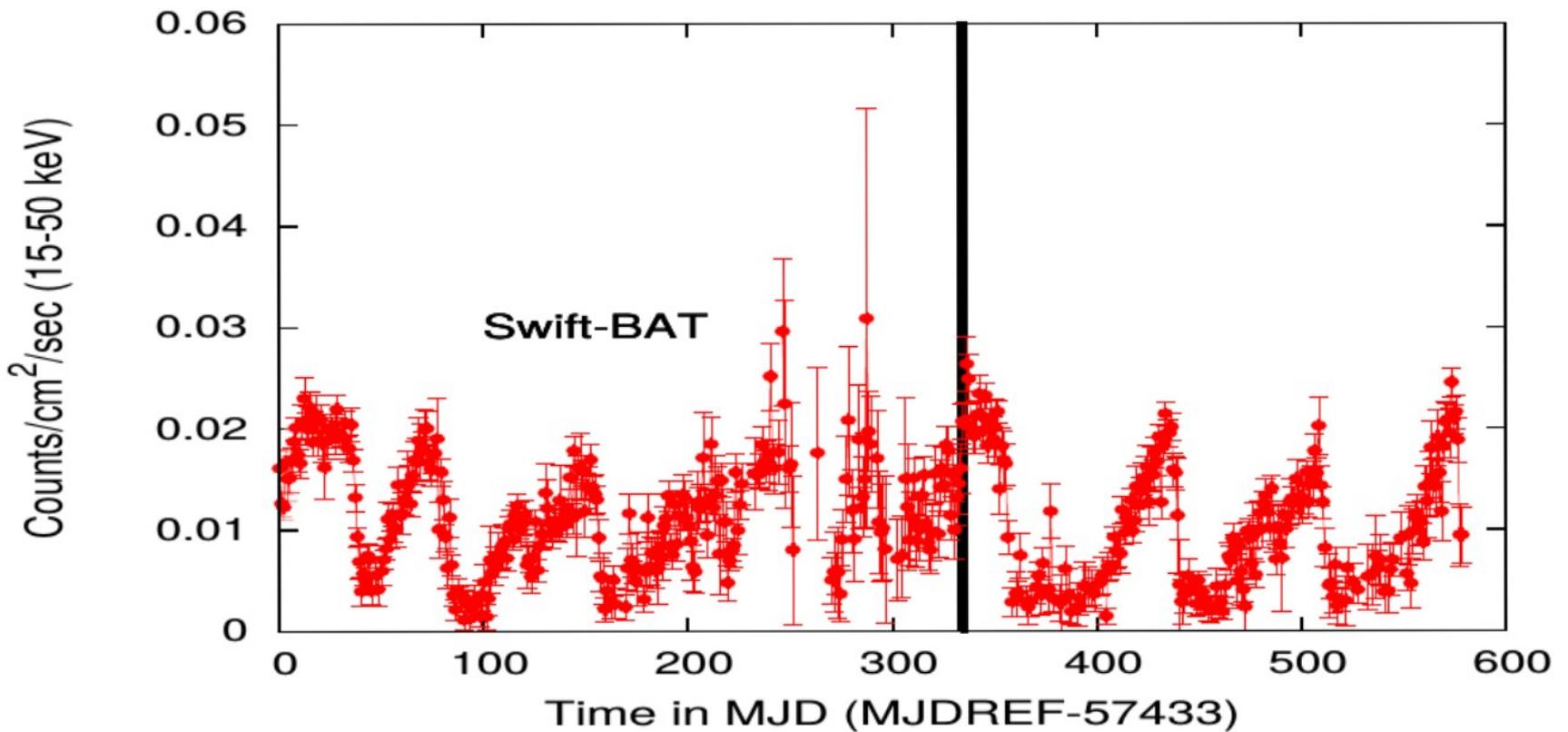


Z Source

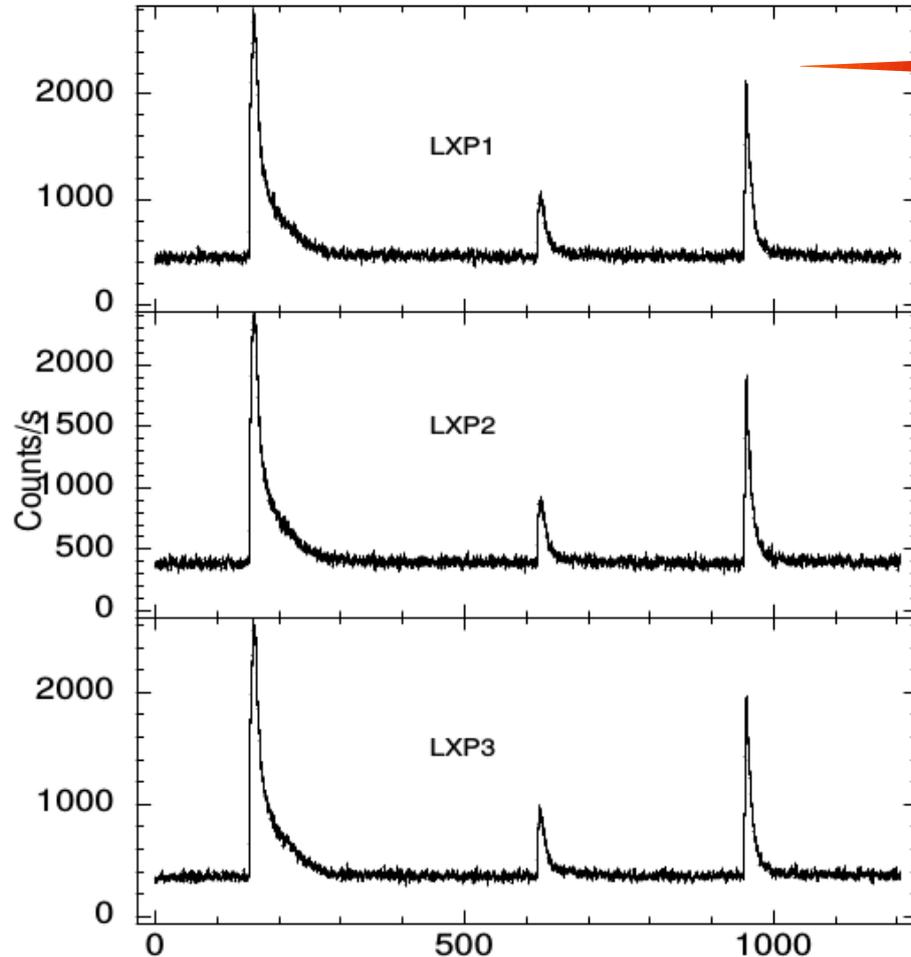
- Exhibits several thermonuclear X-ray Bursts
- Power Density Spectrum shows wide variety of quasi-periodic oscillations such as kilohertz QPOs, milli-hertz QPOs, low-frequency QPOs, hecto-hertz QPOs.

LAXPC Observations of 4U 1636-536 (PV Phase)

Orbit Number	Date	Start Time	Effective exposure (s)
02082	15-02-2016	16:24:14.69	2750
02085	15-02-2016	21:13:48.08	3900
02093	16-02-2016	07:22:16.53	1900
02097	16-02-2016	16:39:55.04	2500



Thermonuclear X-ray Bursts Observed with the LAXPC data



Triplet of X-ray Bursts observed.
Very Rare!

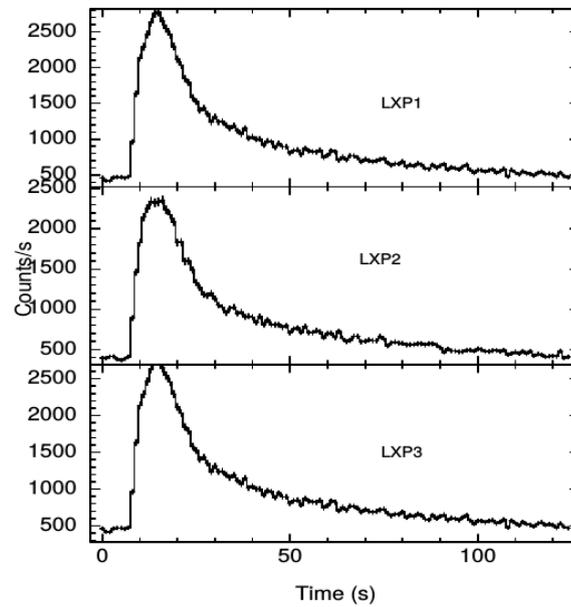
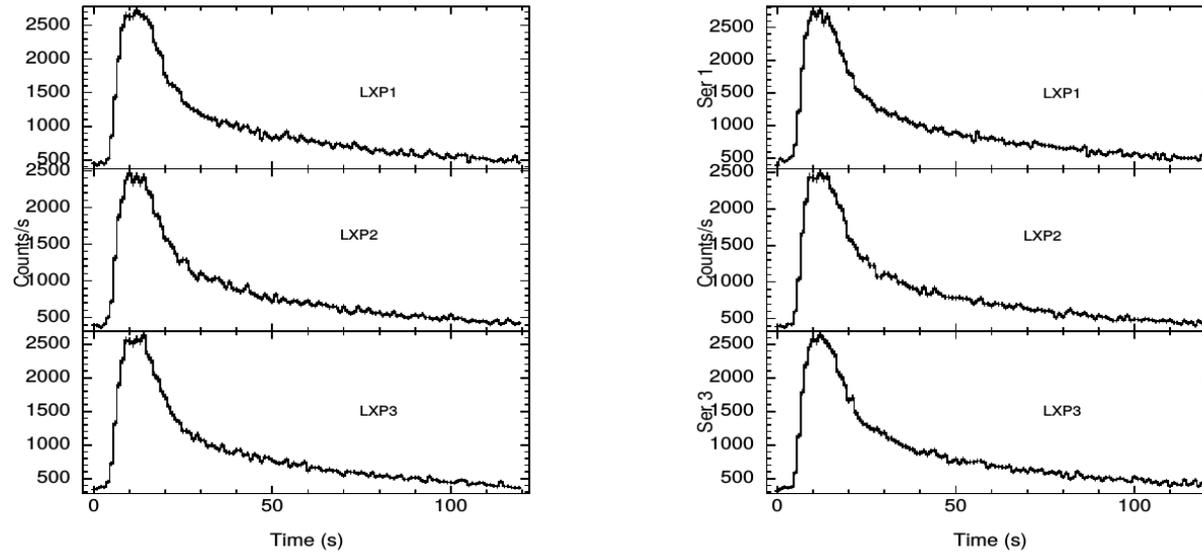
**Observed for the first time in
4U 1636-536.**

RXTE-PCA detected Quadruple
bursts in 4U 1636-536
(Keek + 2010)

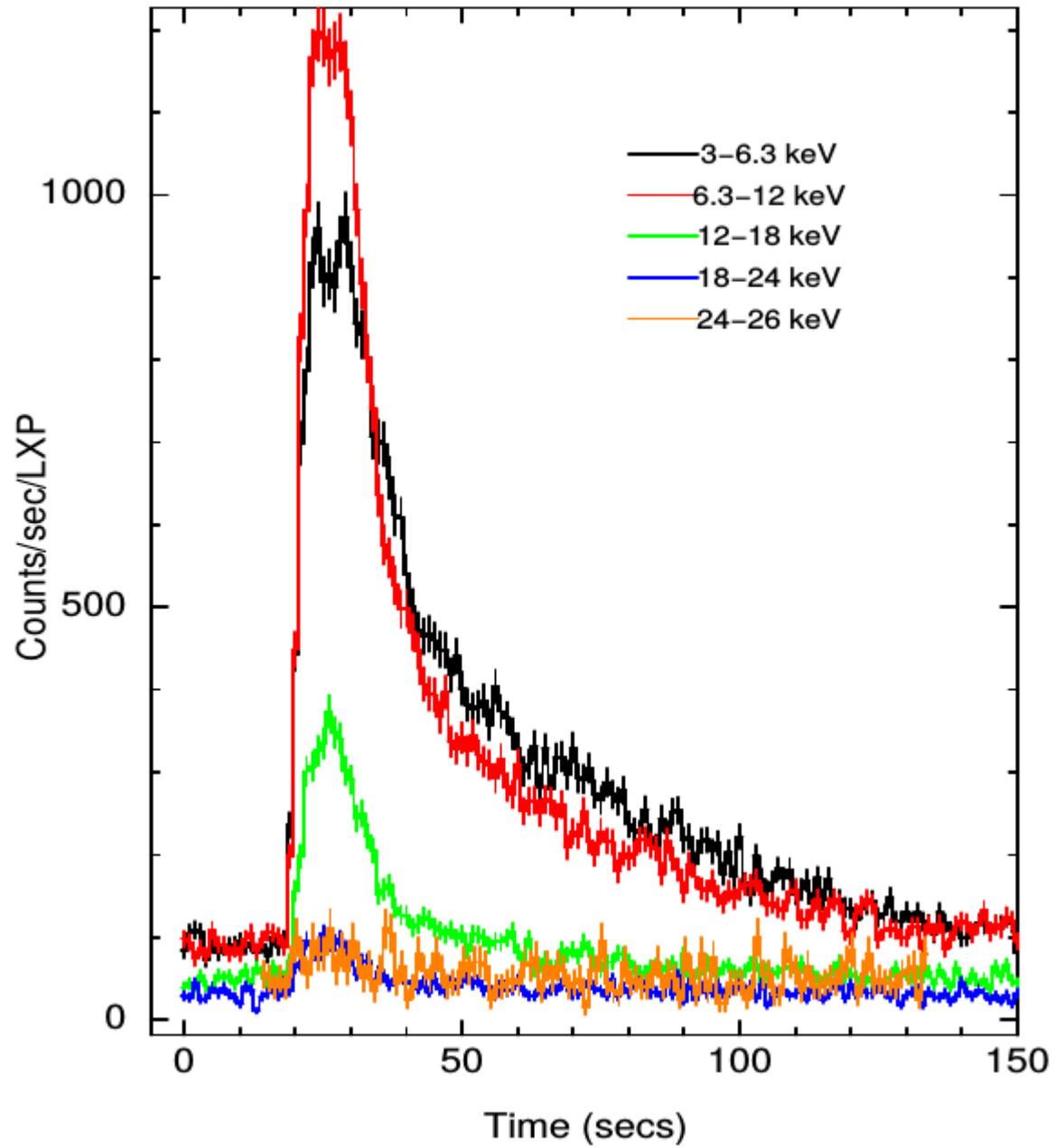
The time difference between the
two bursts is **~ 4 minutes.**

Shortest wait time known for
this source is **5.4 minutes!**

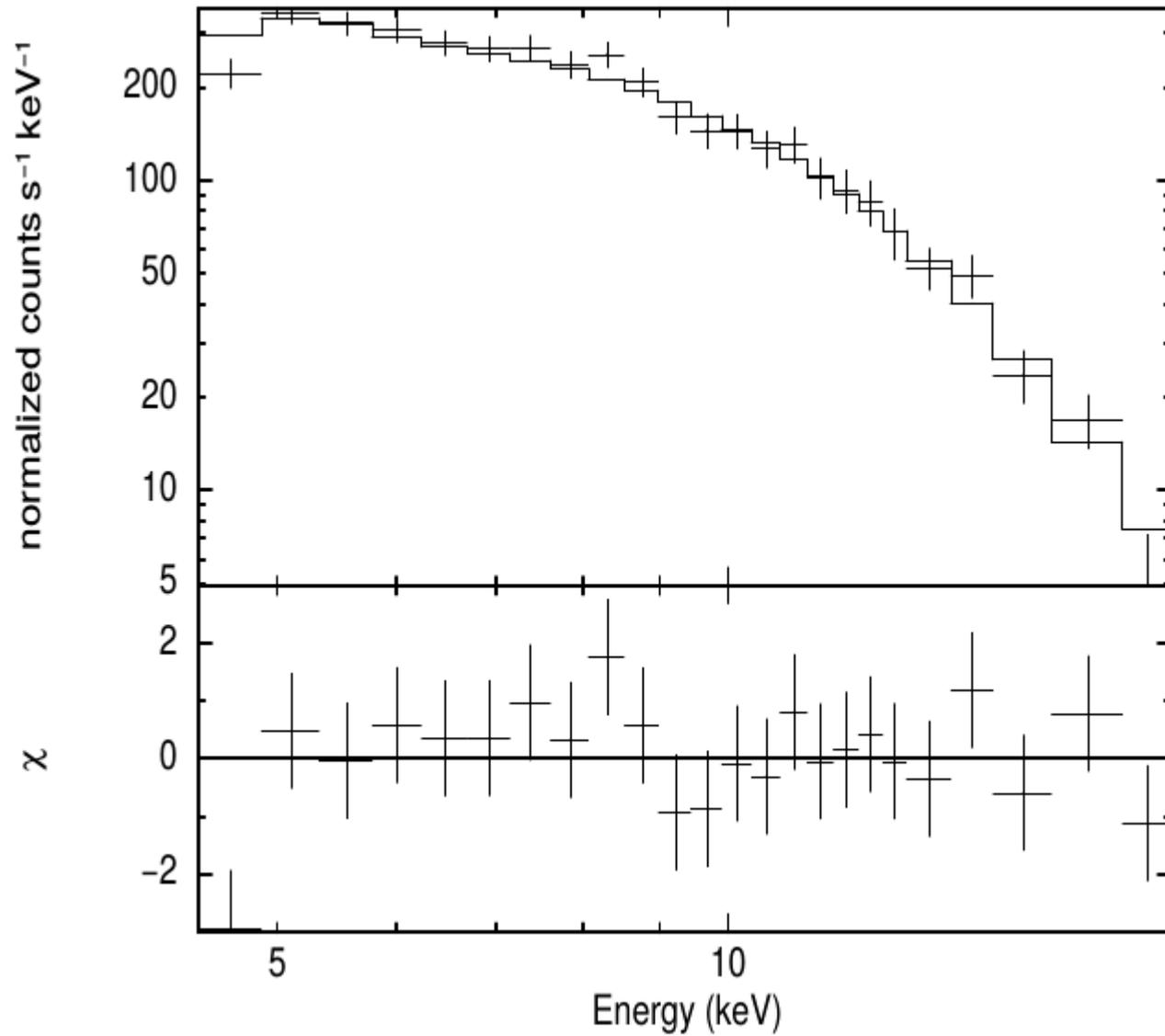
Thermonuclear X-ray Bursts Observed with the LAXPC data



Energy Dependence of X-ray bursts

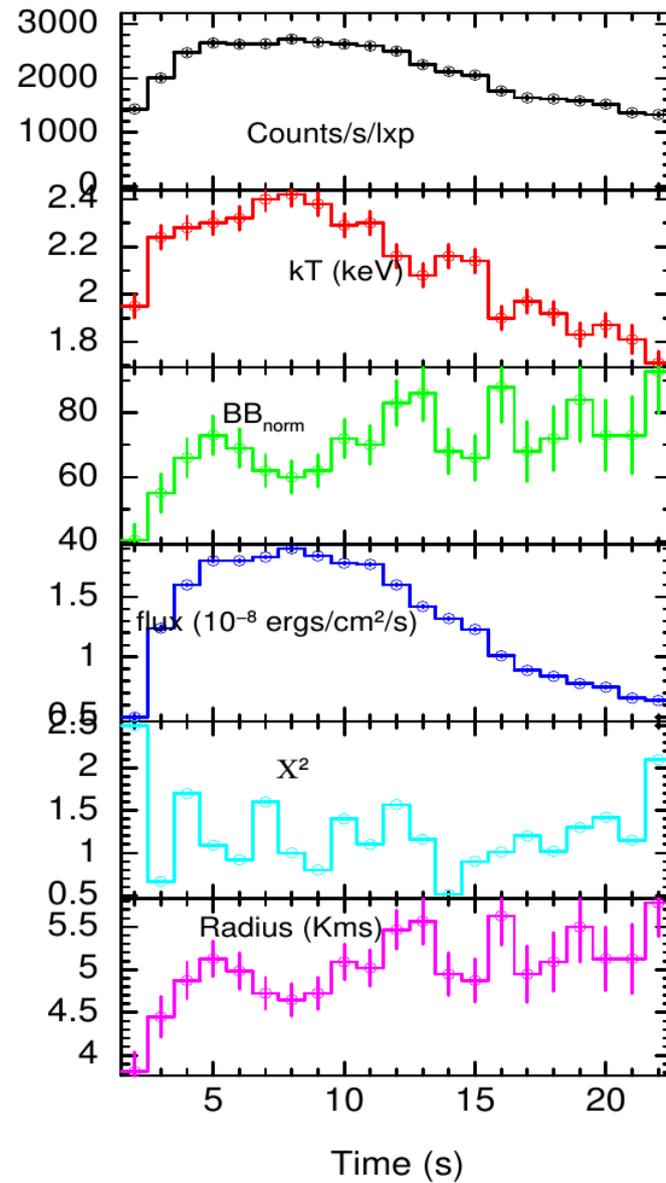


Time Resolved Burst Spectroscopy with LAXPC

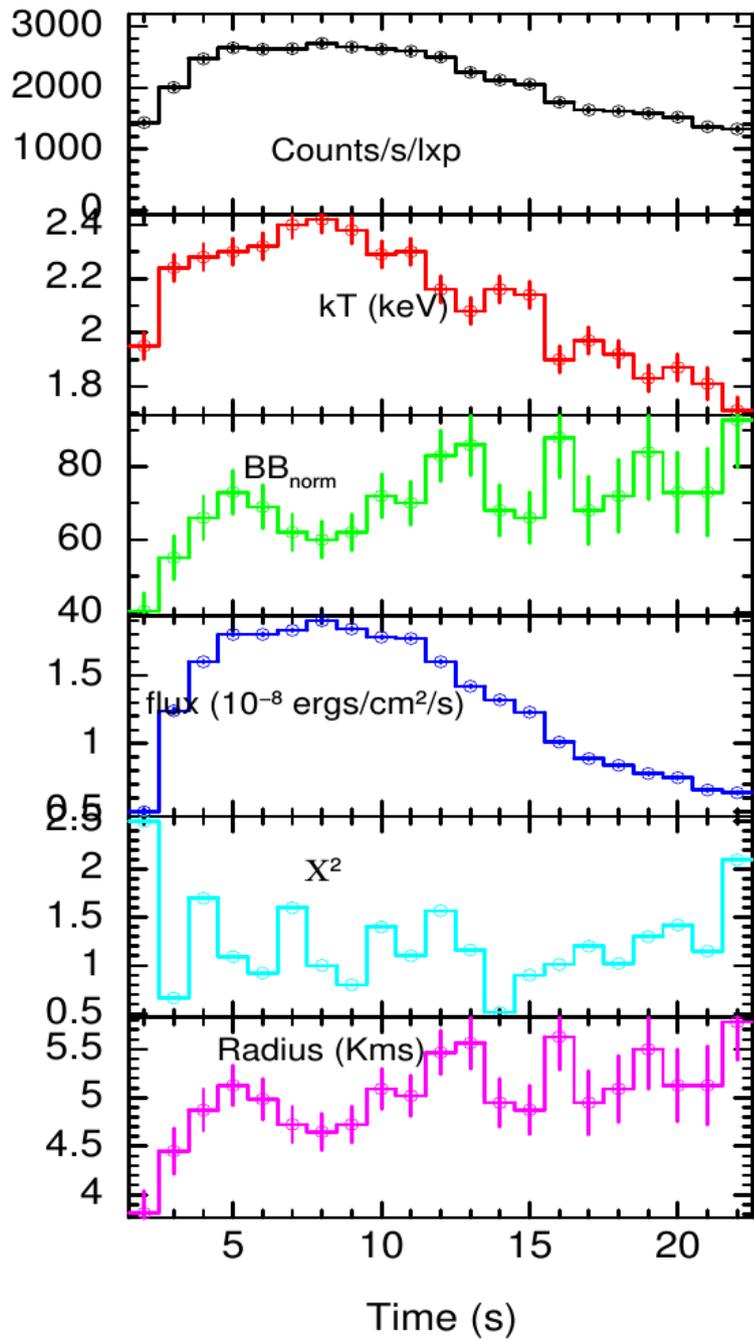


An example 1 second burst spectrum

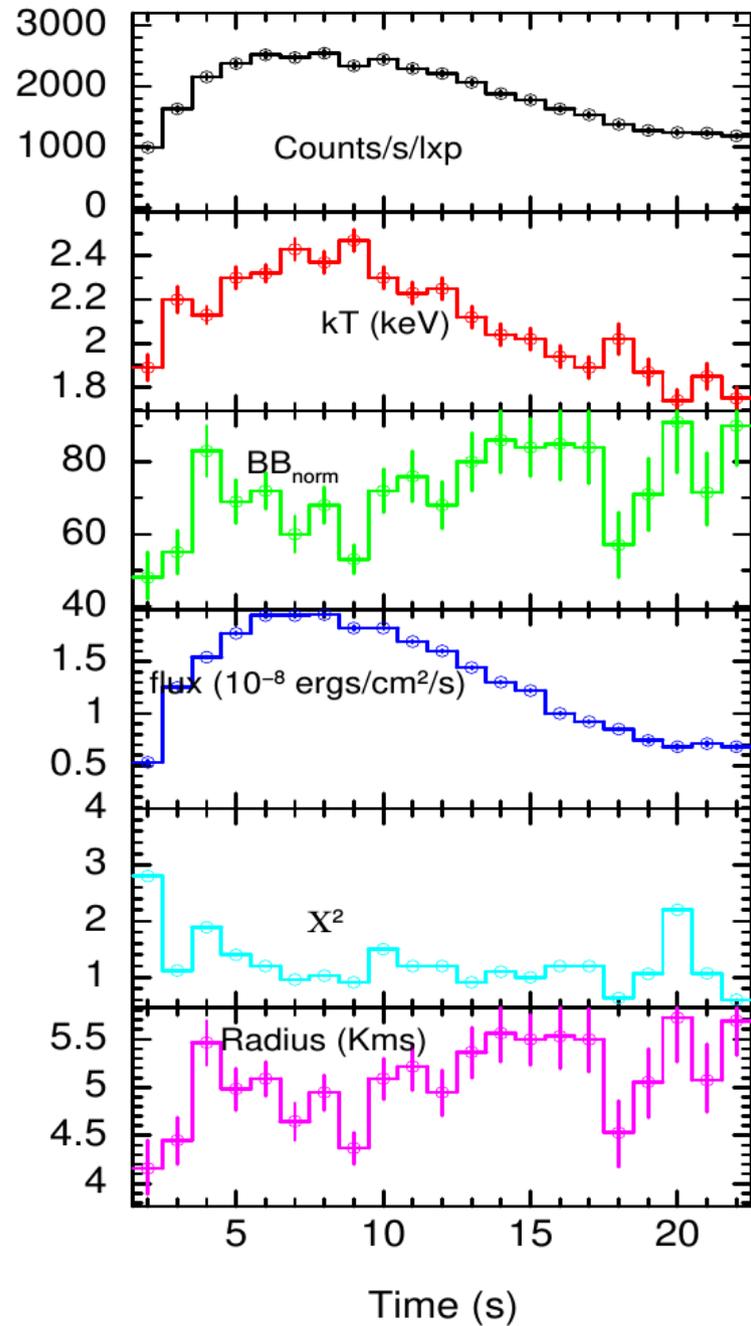
Time Resolved Burst Spectroscopy with LAXPC



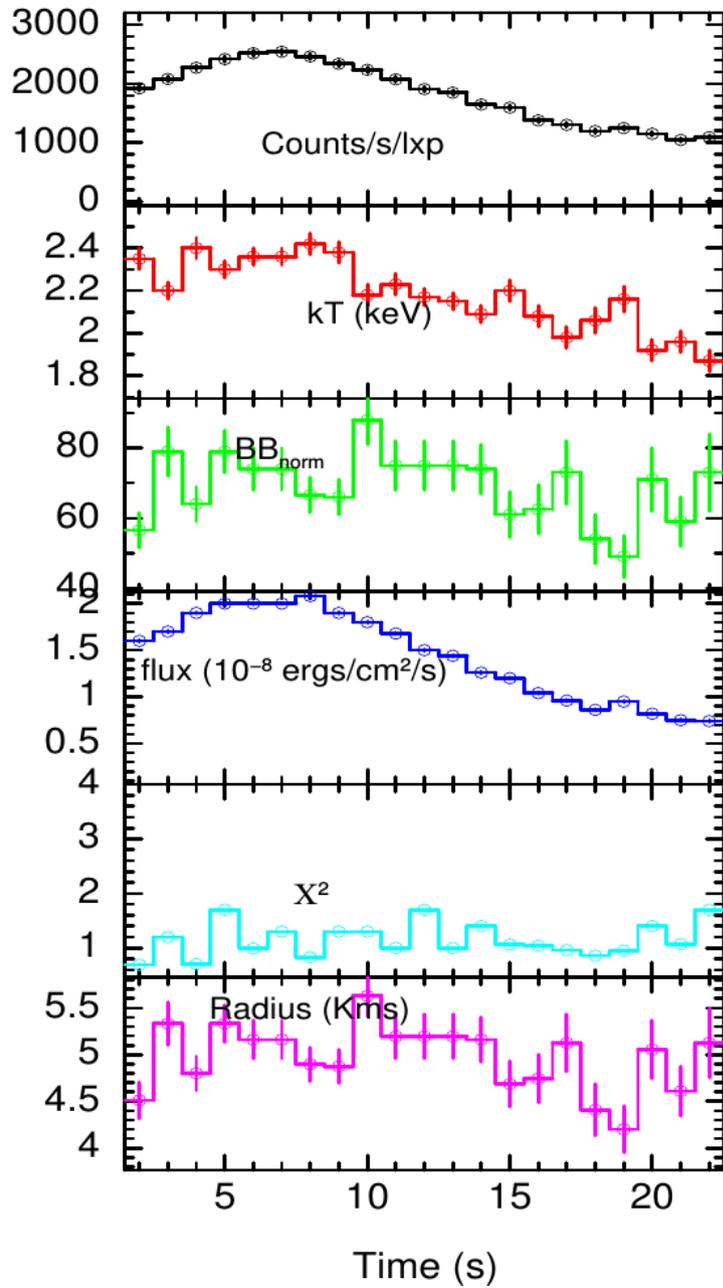
Orbit No-02082



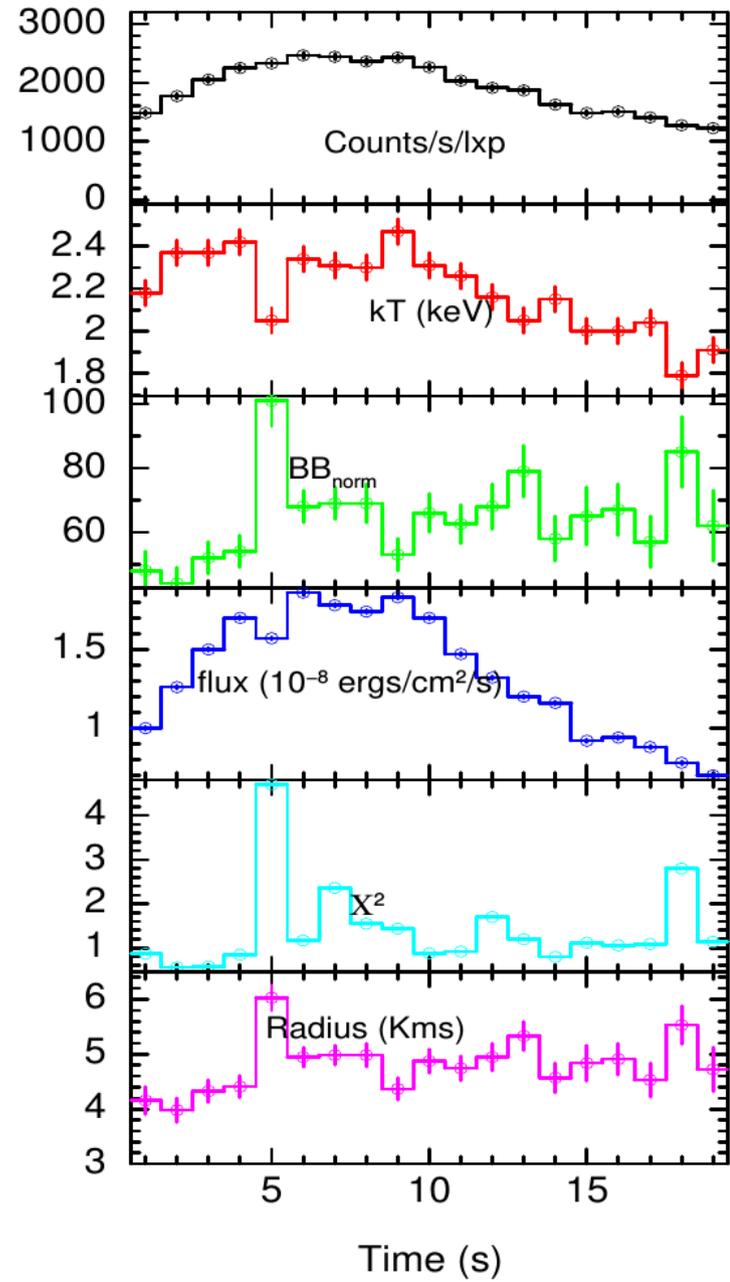
Orbit No-02082



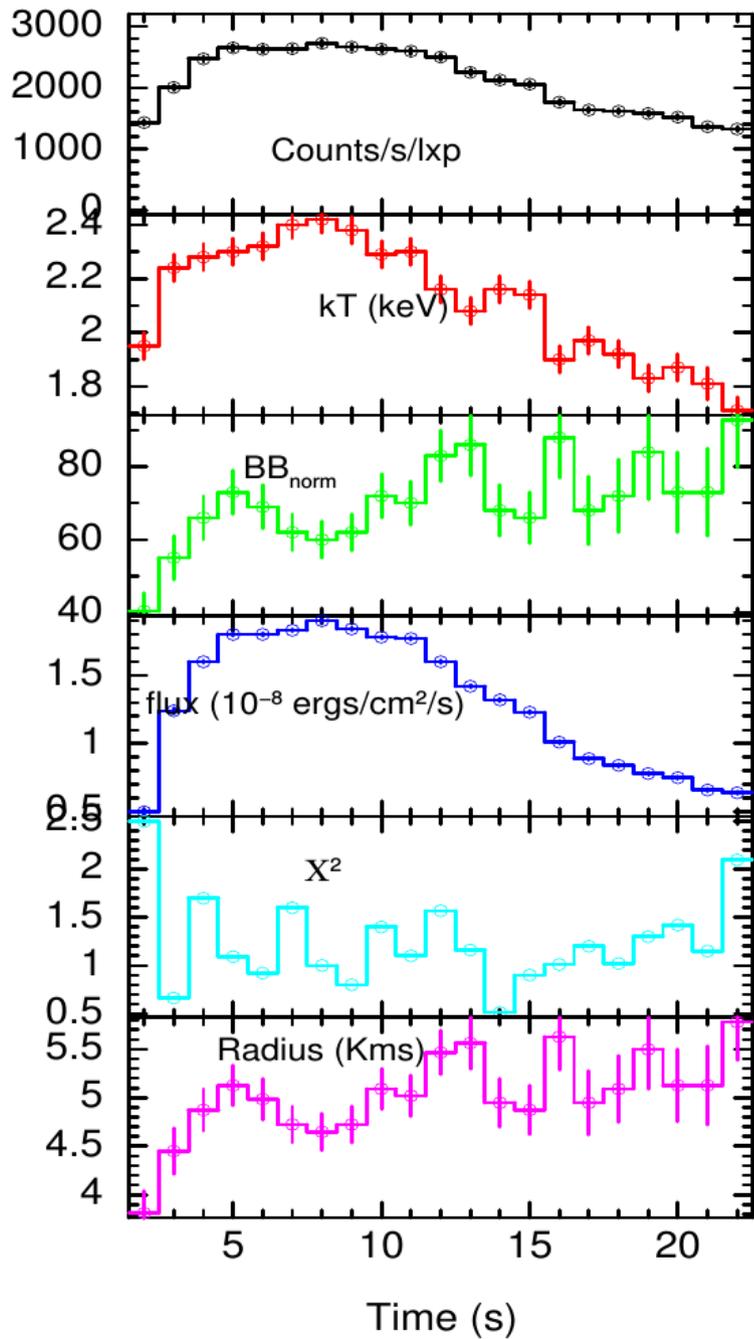
Orbit No-02085



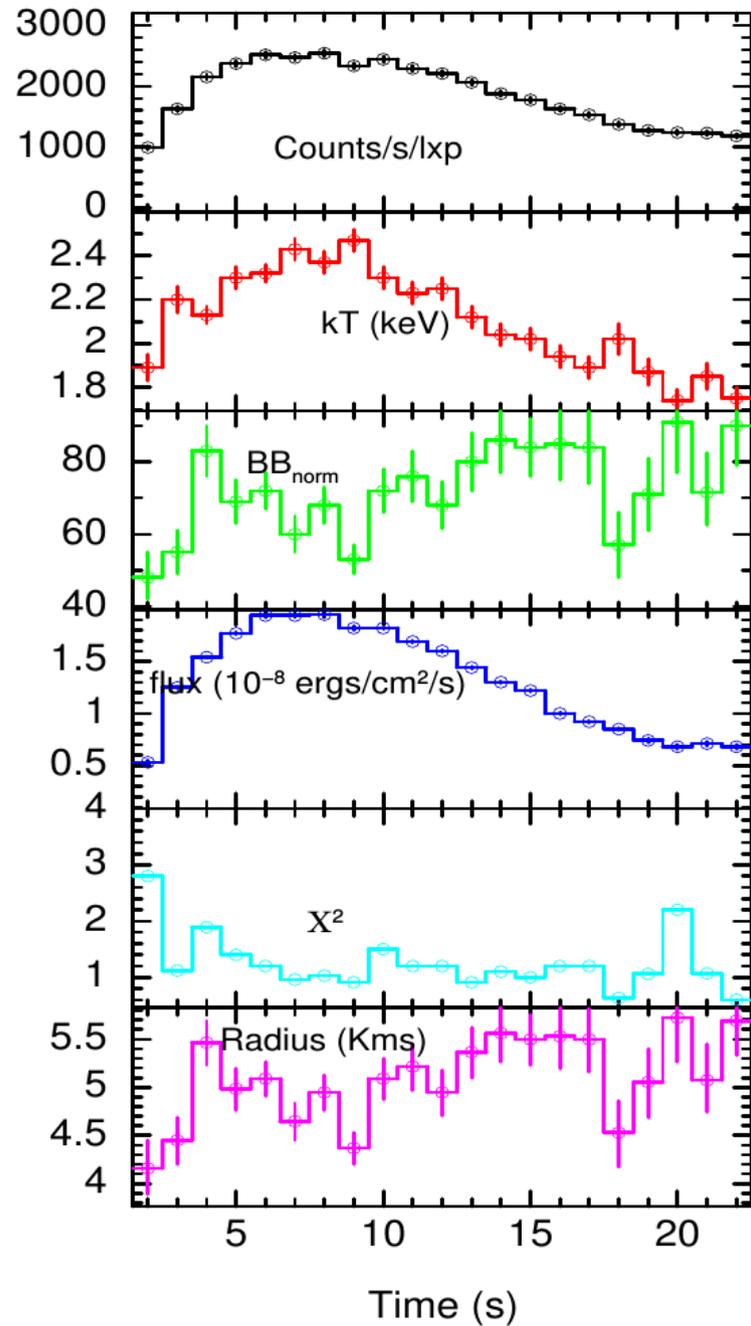
Orbit No-02093



Orbit No-02097



Orbit No-02082



Orbit No-02085

Summary

- **Rare Triplet of X-ray Bursts** have been observed!
- Wait Time is \sim **4 minutes**, between two bursts.
- Bursts are detected upto \sim 25 keV.
- Time Resolved Spectroscopy performed using data from one of the LAXPC detectors (LAXPC 1) suggests that there is some **evidence of photospheric radius expansion in some of the bursts.**
- Radius measurements are consistent for all the bursts.
- **Occurrence rate of quadruple versus triple events (also triple versus double events will provide an important constraint on theoretical models.**

Thanks!