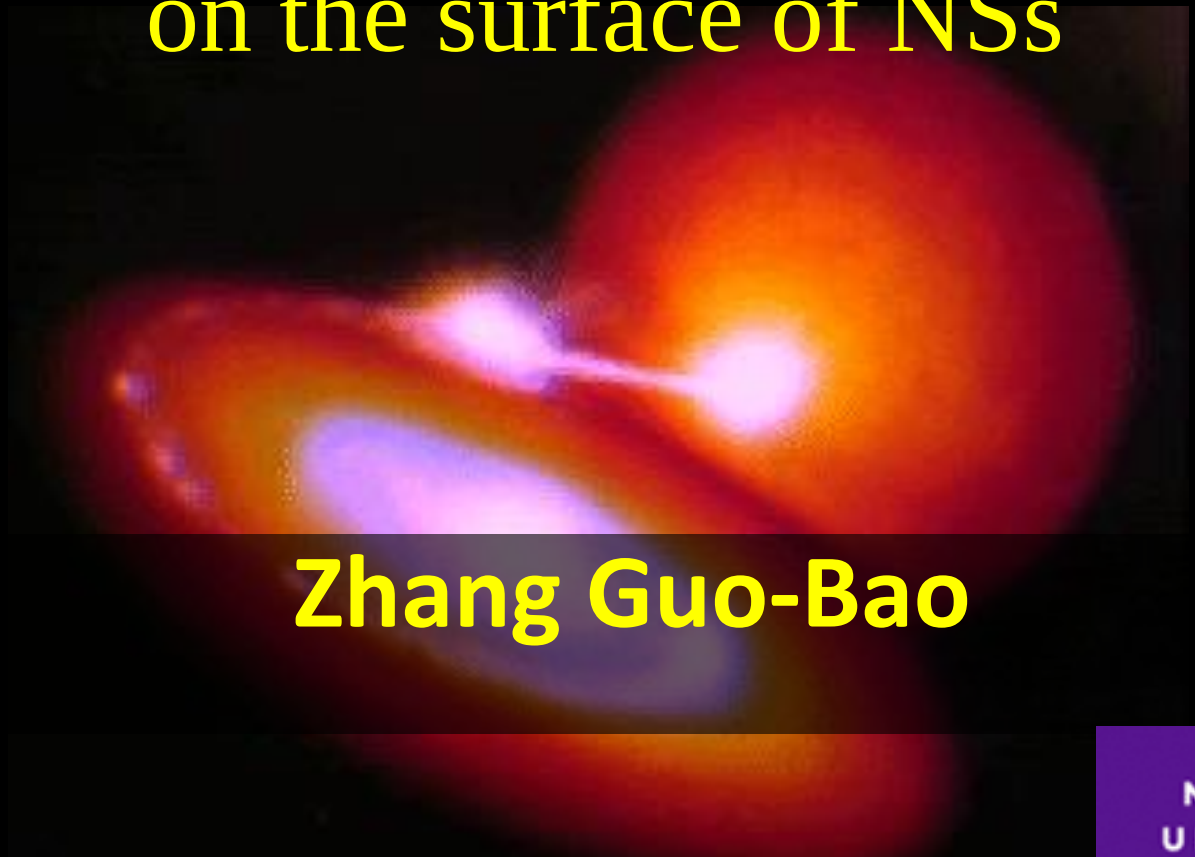
The ignition site of type-I X-ray bursts on the surface of NSs



Zhang Guo-Bao

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Outline

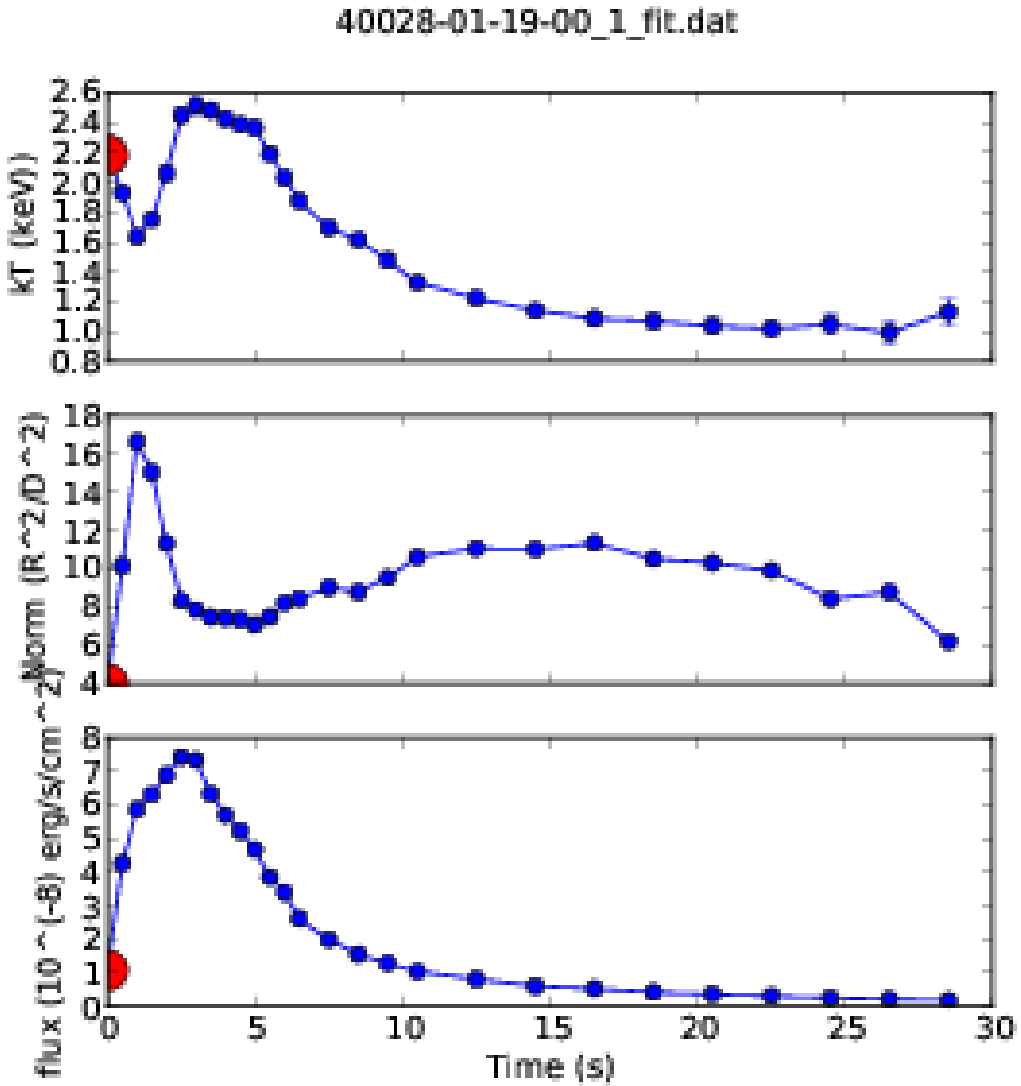
Introduction

Burst oscillations in 4U 1636-53 and 4U 1728-34

Burst rising phase in 4U 1728-34 and 4U 1636-53

Burst with mhz QPOs 4U 1636-53

Discussion

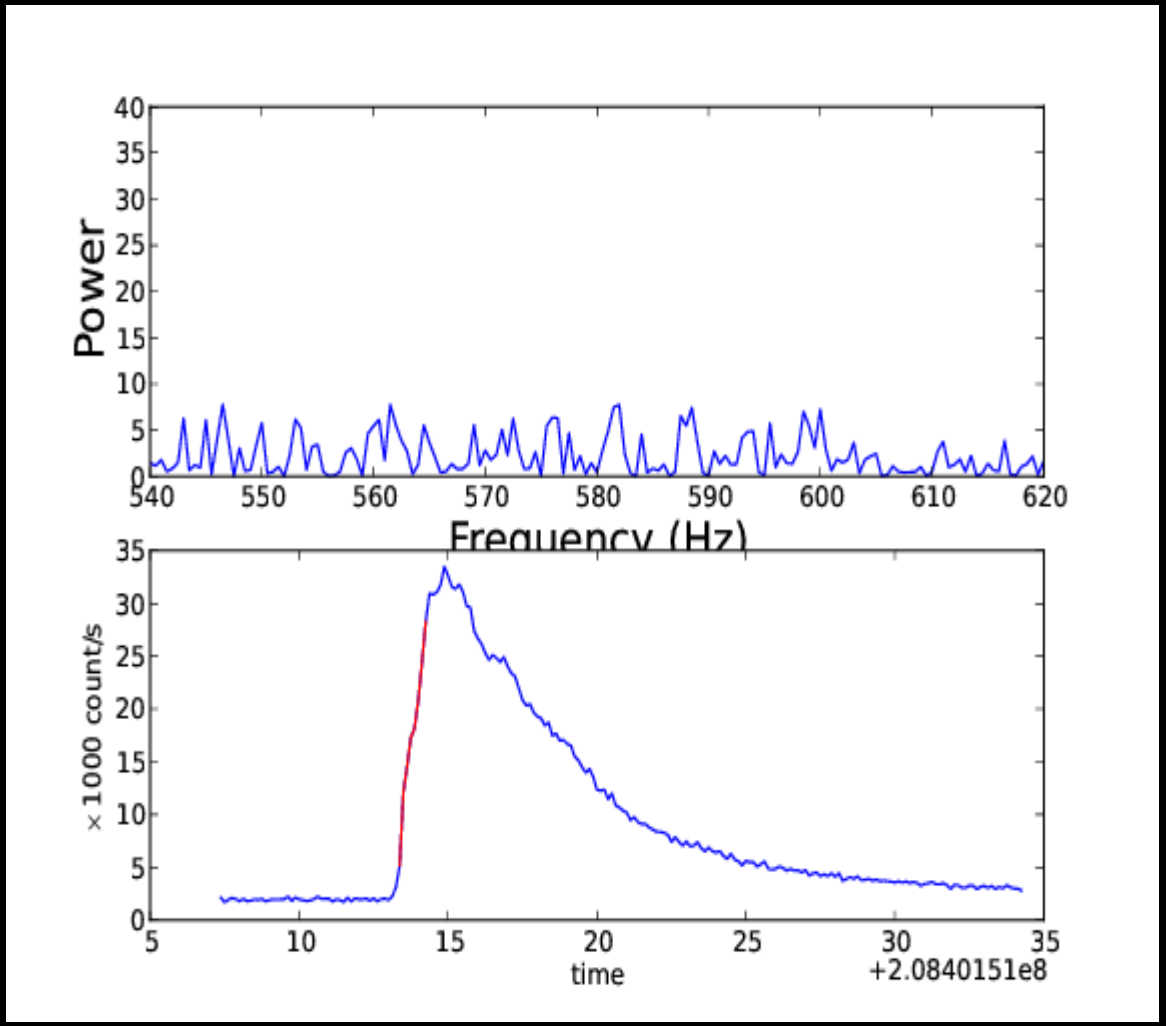


Blackbody Temperature

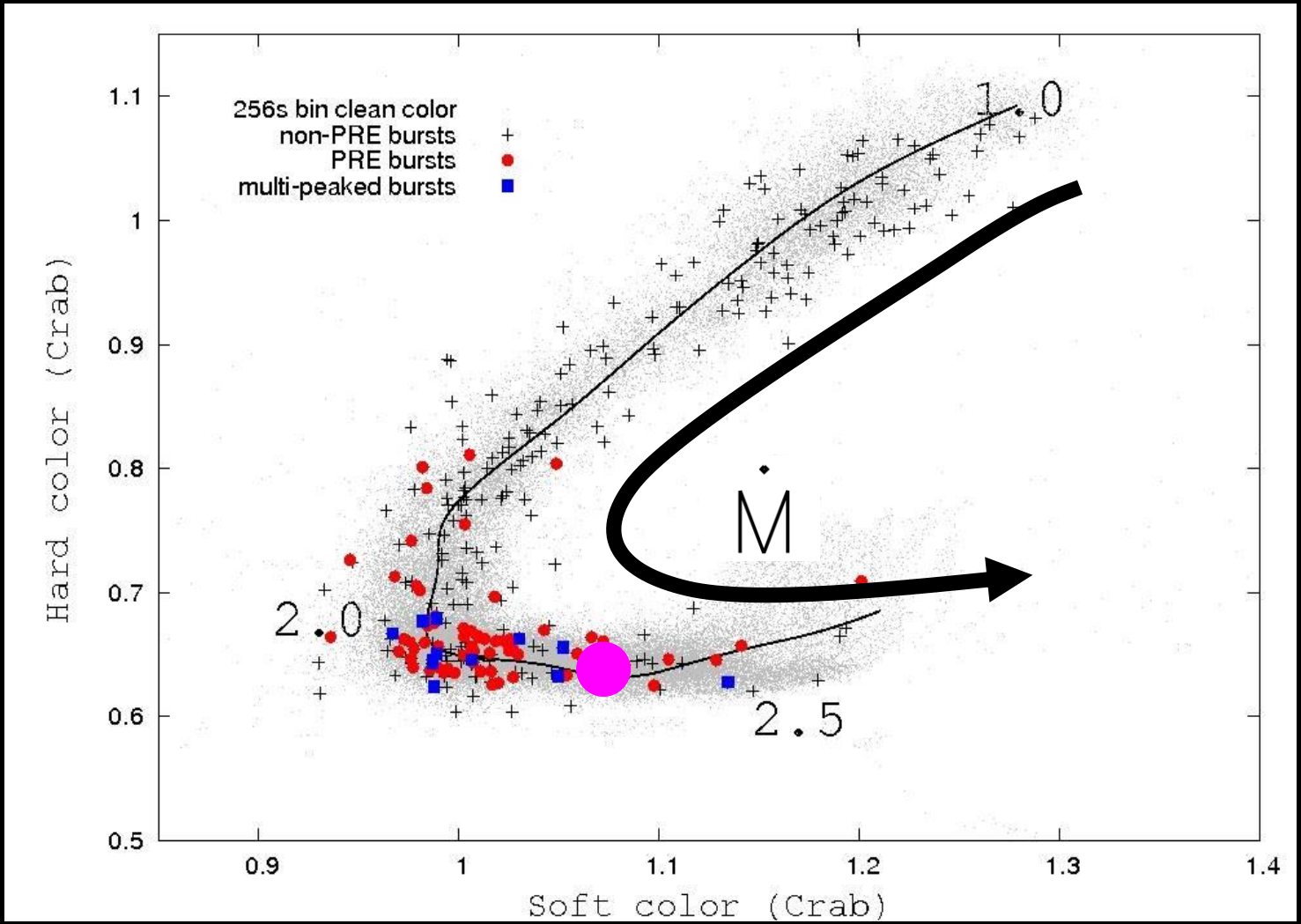
Blackbody radius

Flux

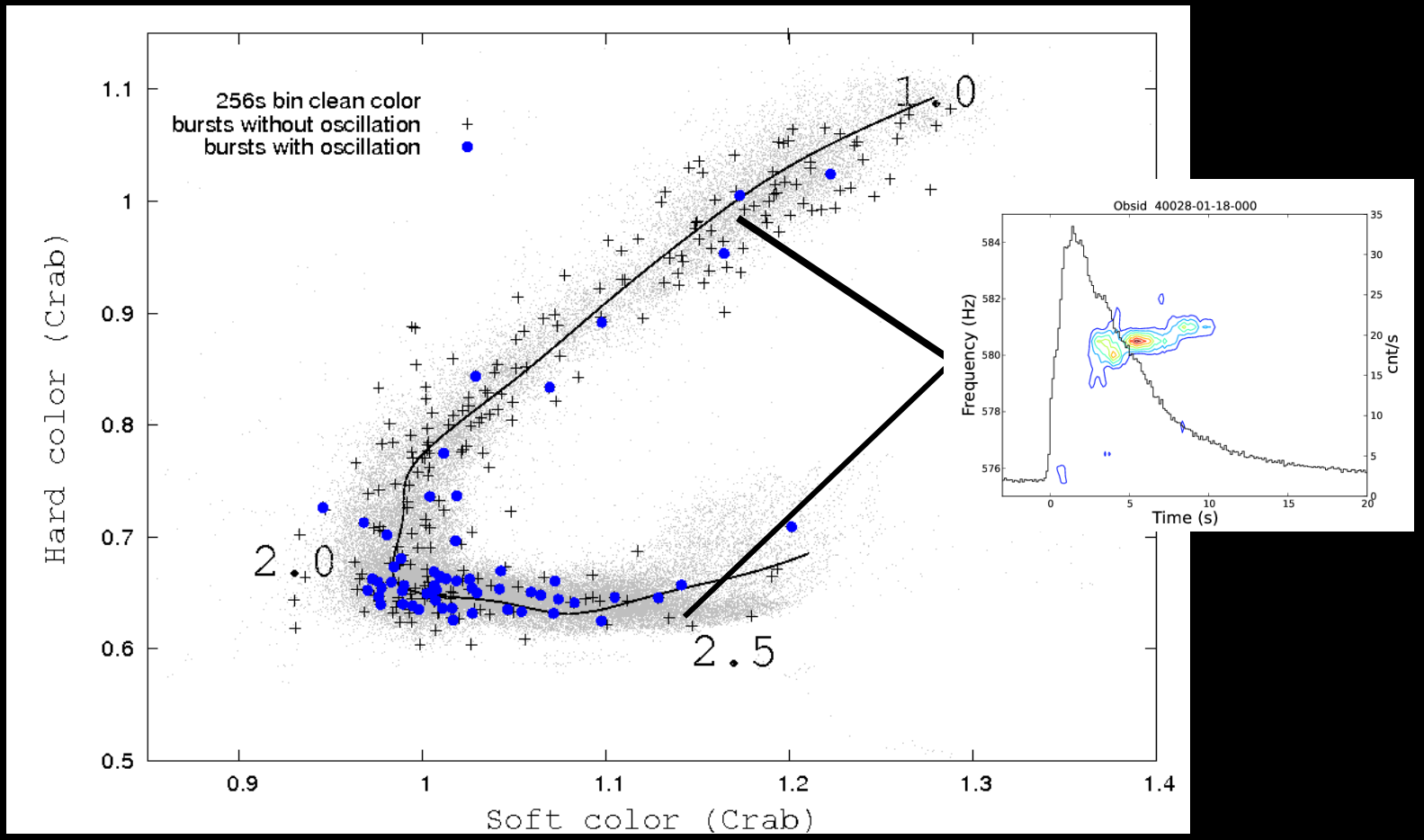
Bursts with oscillations



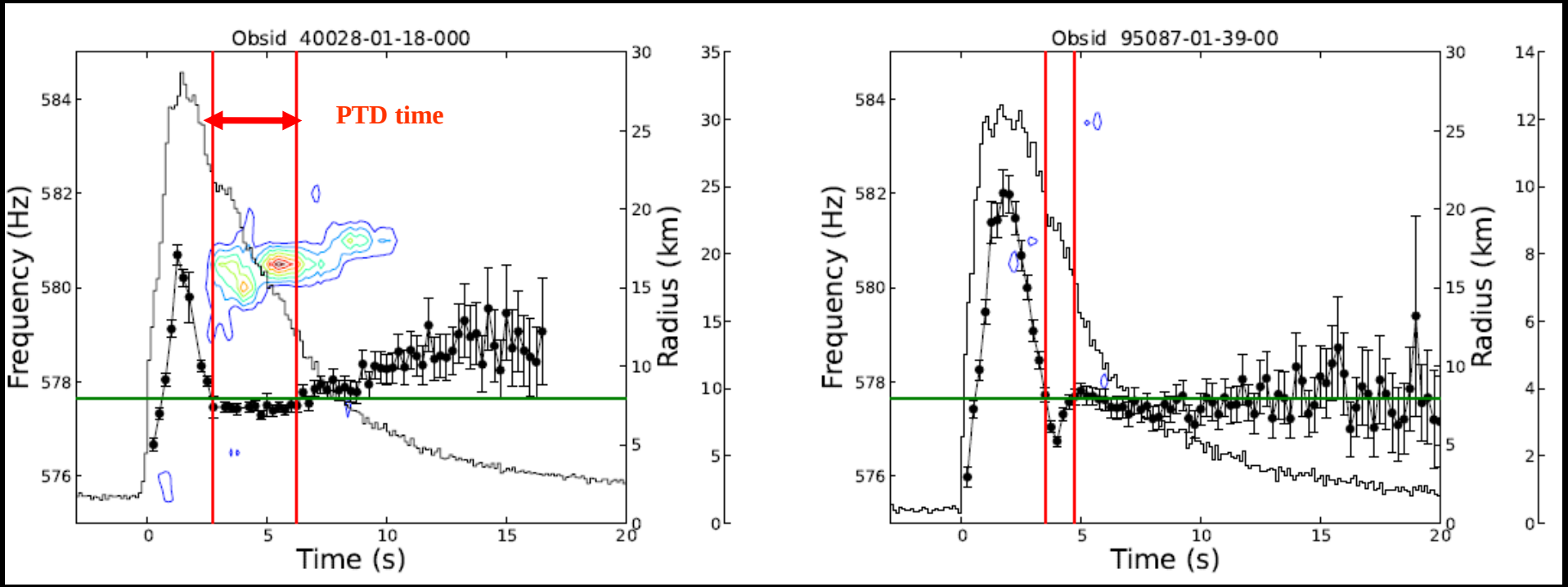
Bursts along color-color diagram (CD) in 4U 1636-53



Bursts with/without oscillations along CD in 4U 1636-53

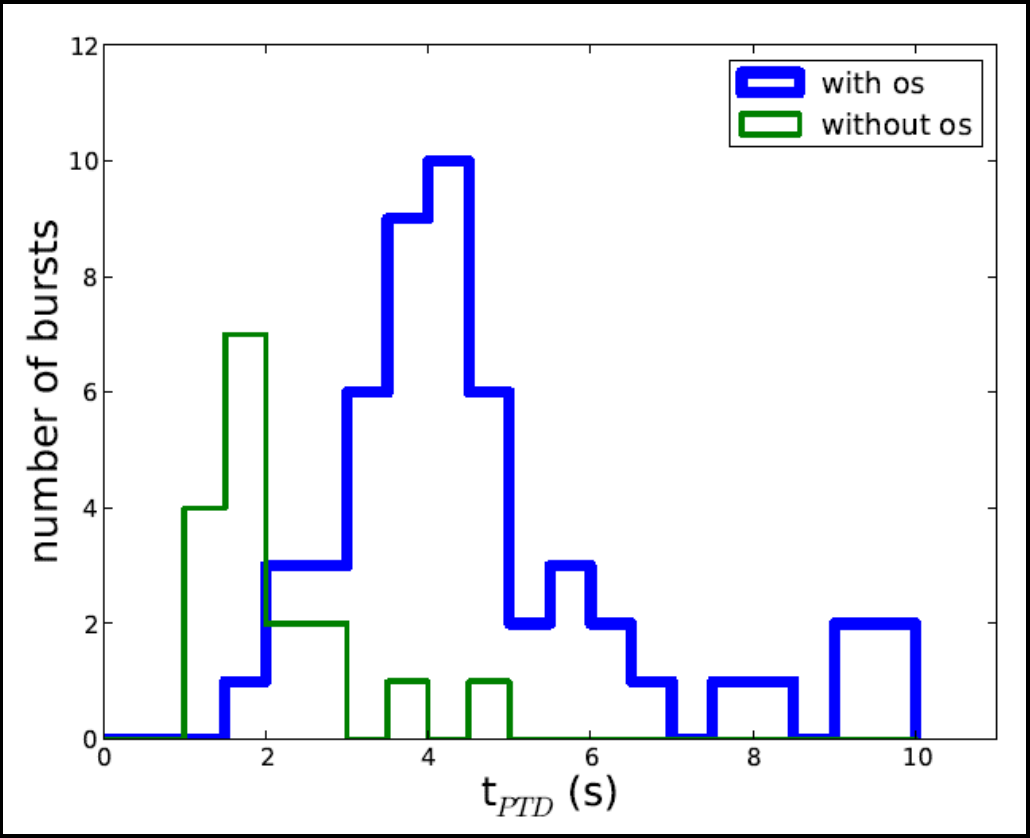


PRE bursts in 4U 1636-53



Blackbody radius and burst tail-oscillations evolve as a function of time. The red vertical lines define the post Touchdown, PTD, phase.

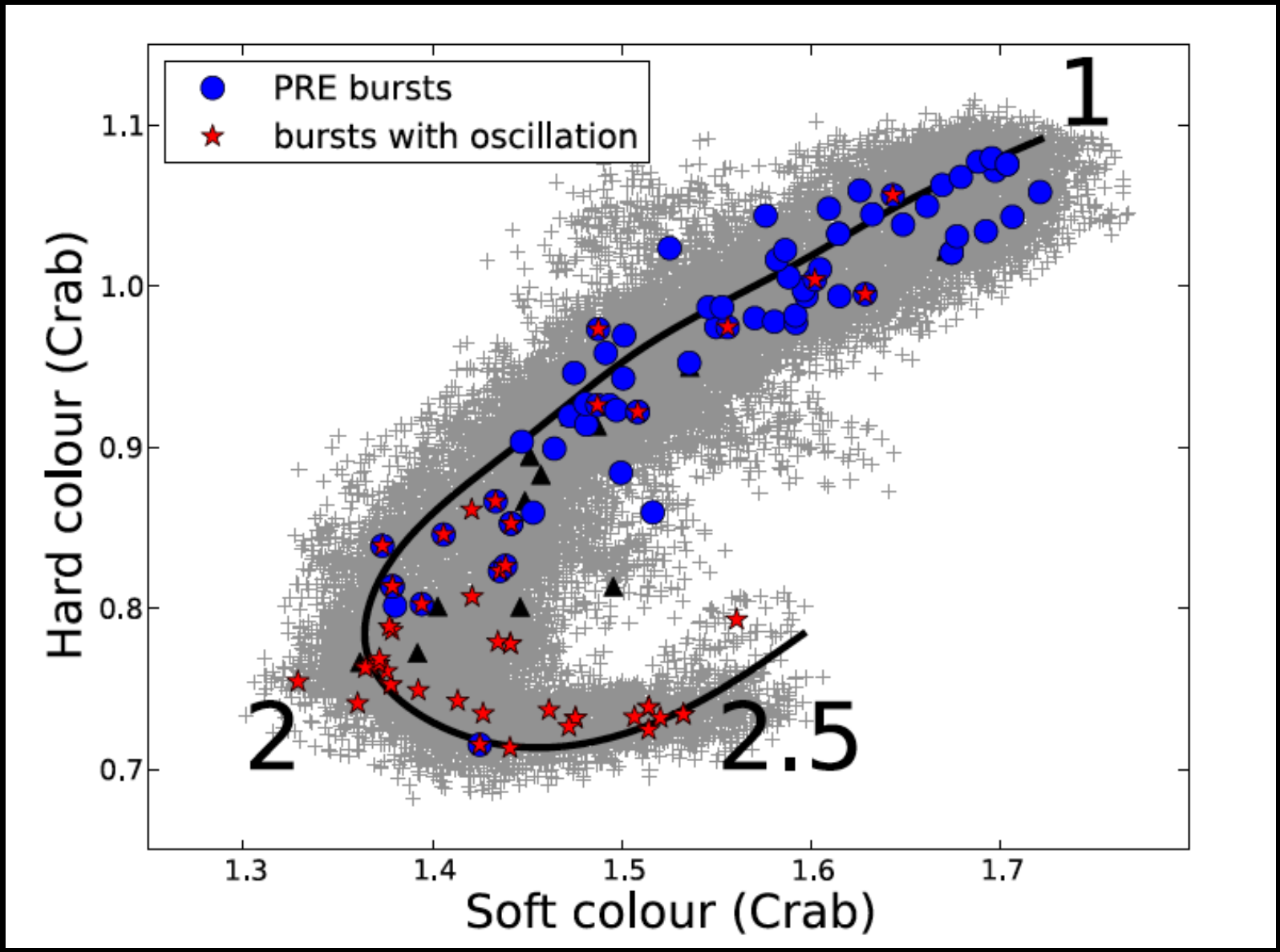
Distributions of PTD time



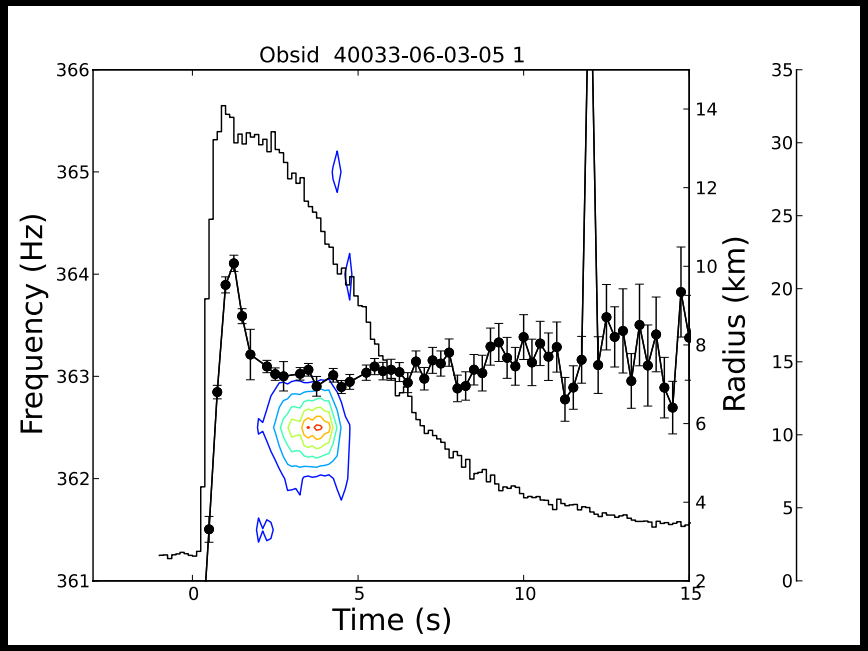
Zhang et al. (2013)

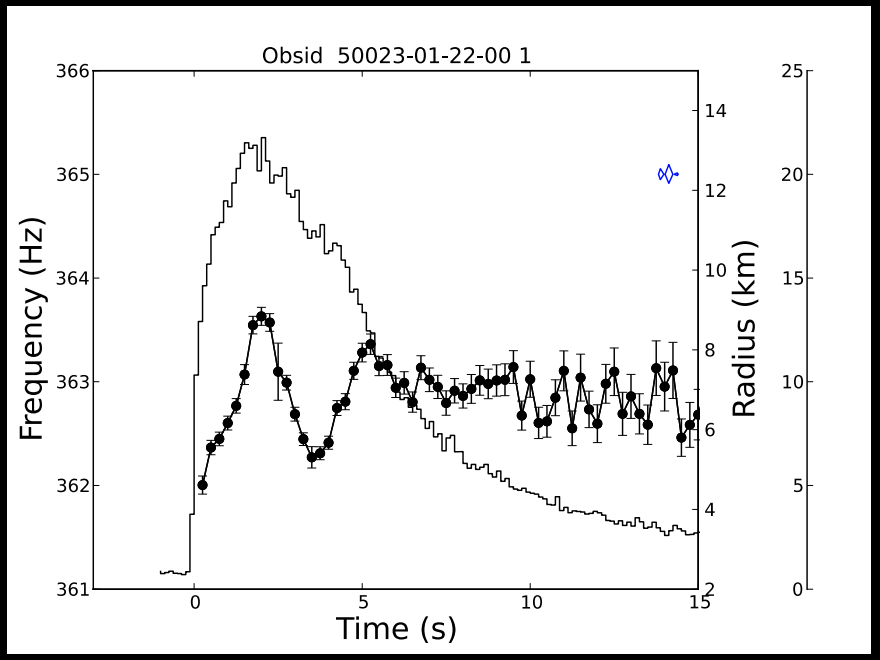
17 without tail oscillation, 52 with tail oscillation
probability=3.5*10^{-7} (kolmogorov-smirnov, KS, test)

Bursts in 4U 1728 - 34



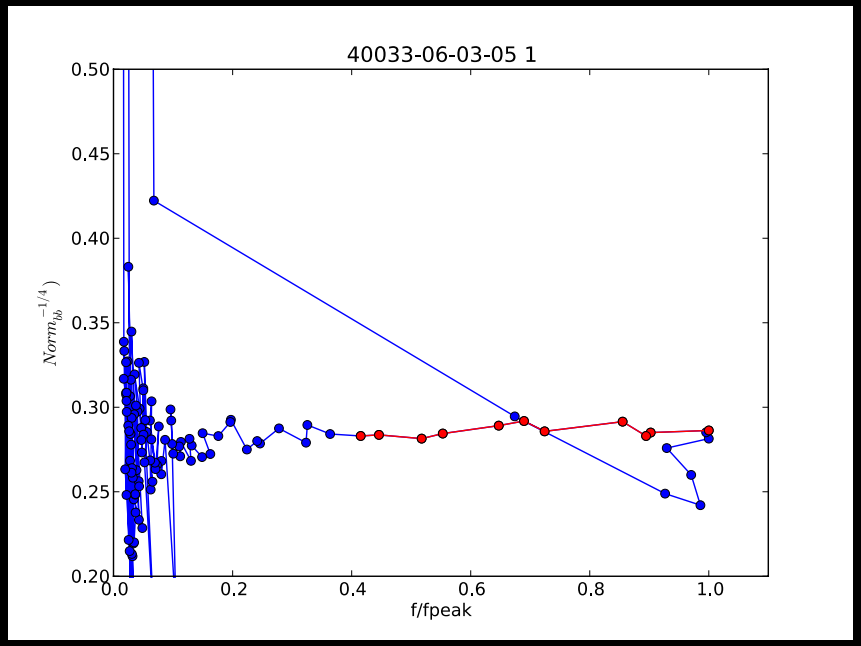
Bursts in 4U 1728-34

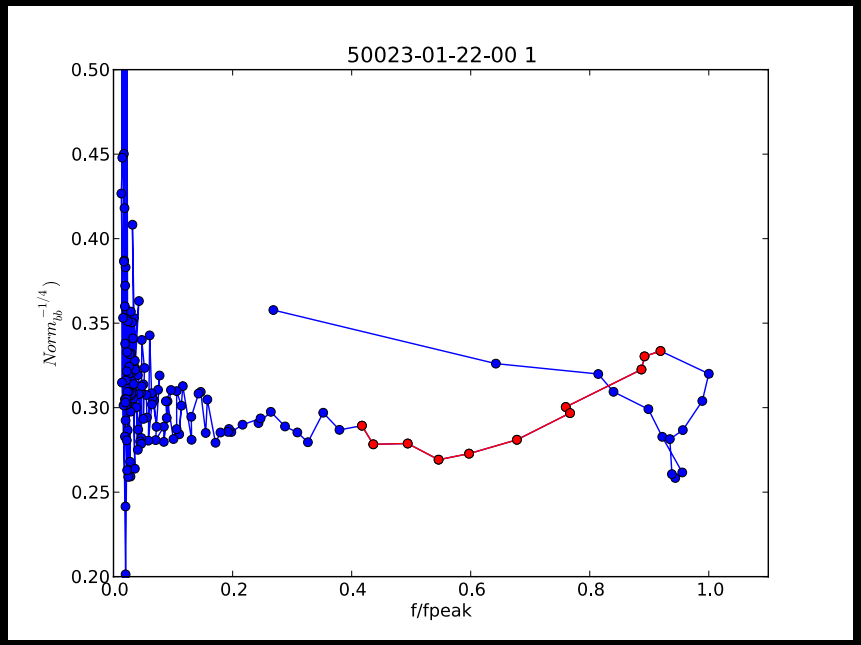




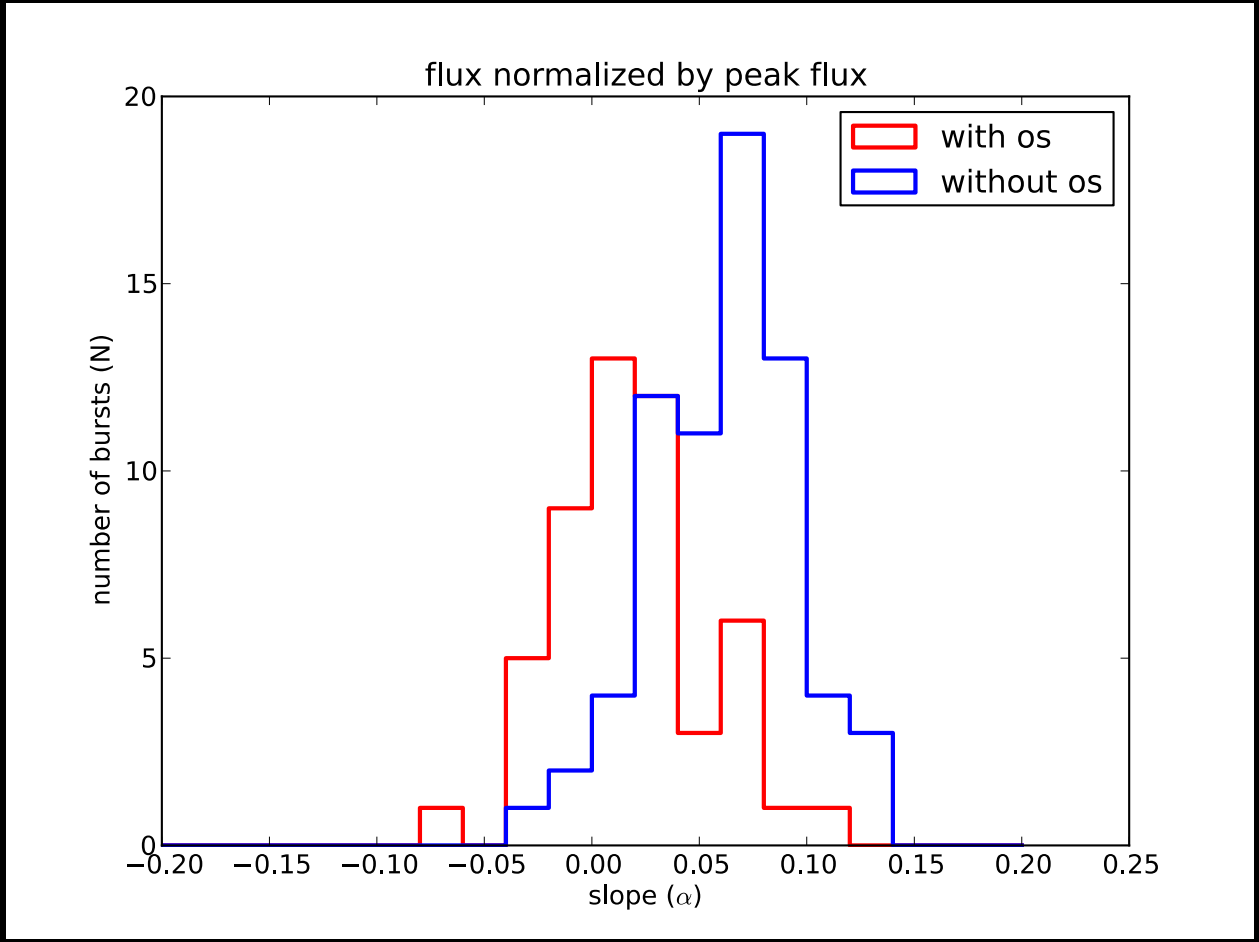
Bursts are different in both rising and decay

Burst decay phase



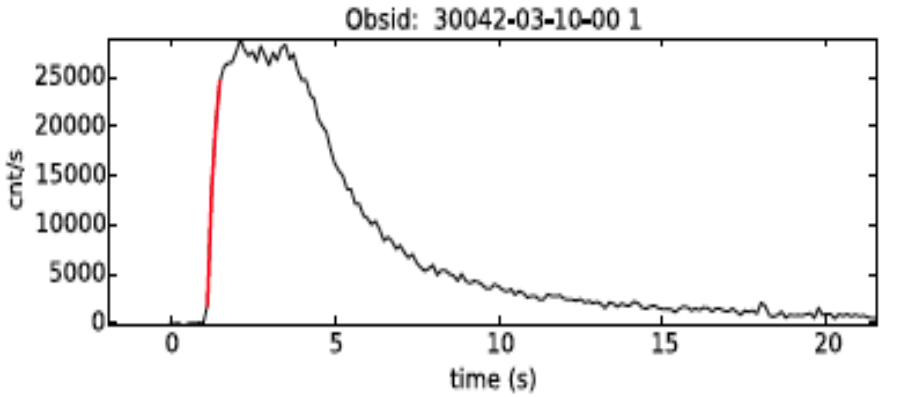


The $(Norm_{BB})^{-1/4}$ as a function of flux during the type-I X-ray burst in 4U 1728-34. The red points are selected from **F**_peak/**F**_TD to the 40% of **F**_peak/**F**_TD during the cooling track of the burst

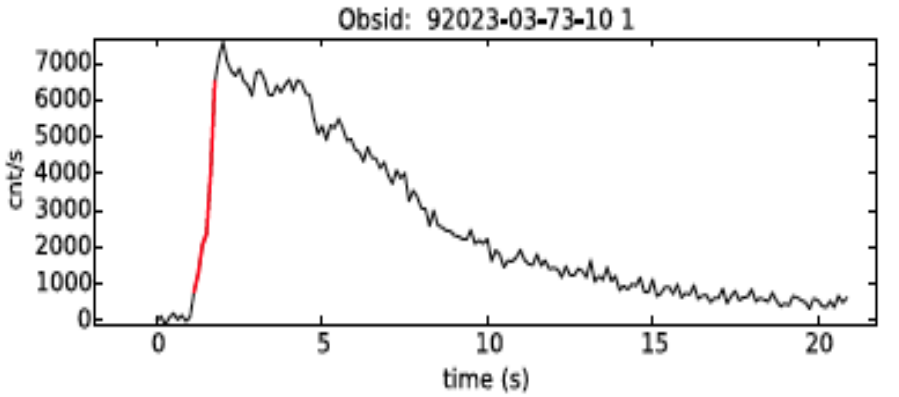


The distribution of slope value for bursts with (red) and without (blue) oscillations in 4U 1728–34.

Rising phase (convexity)



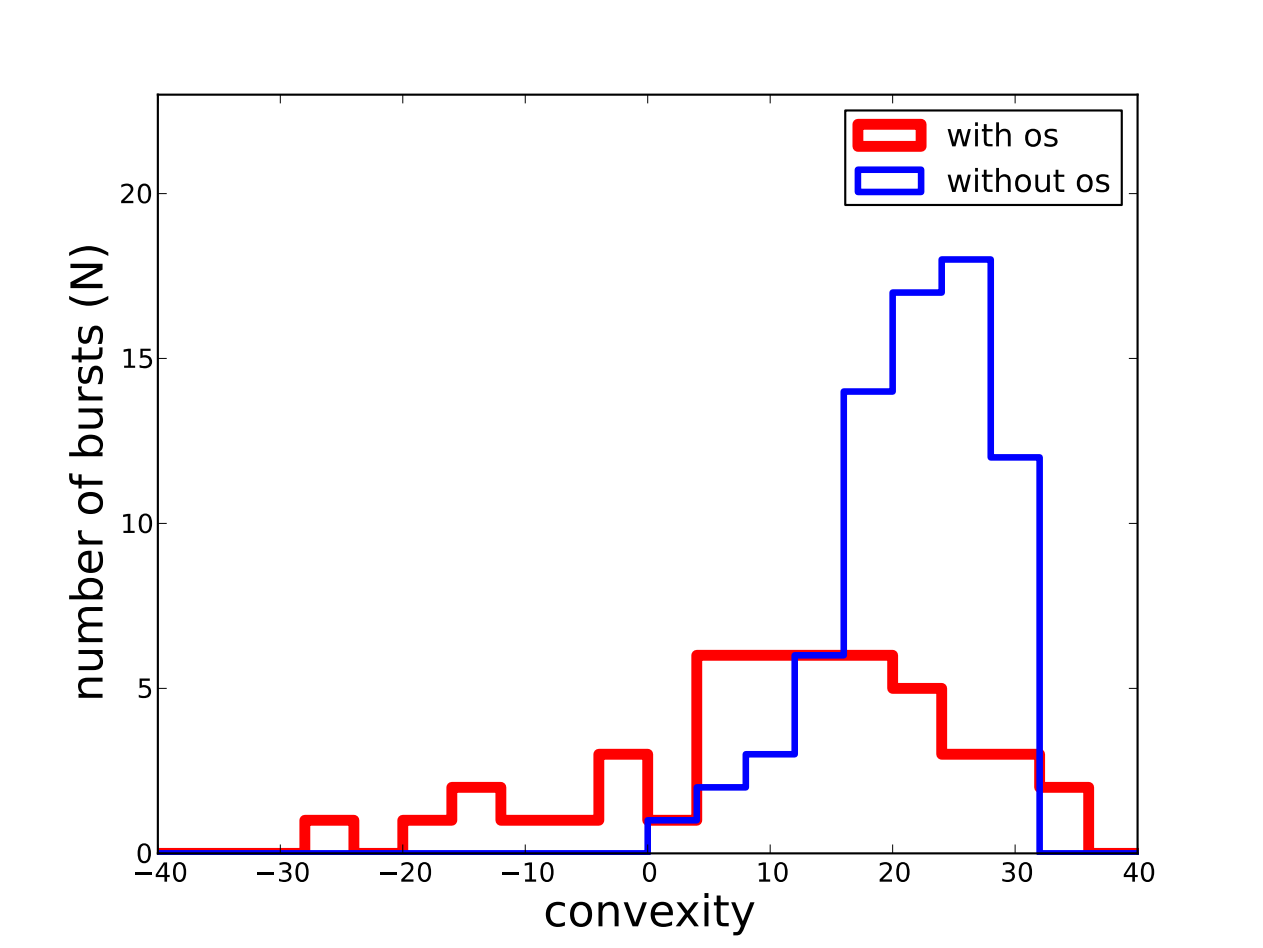
(a) convex burst



(b) concave burst

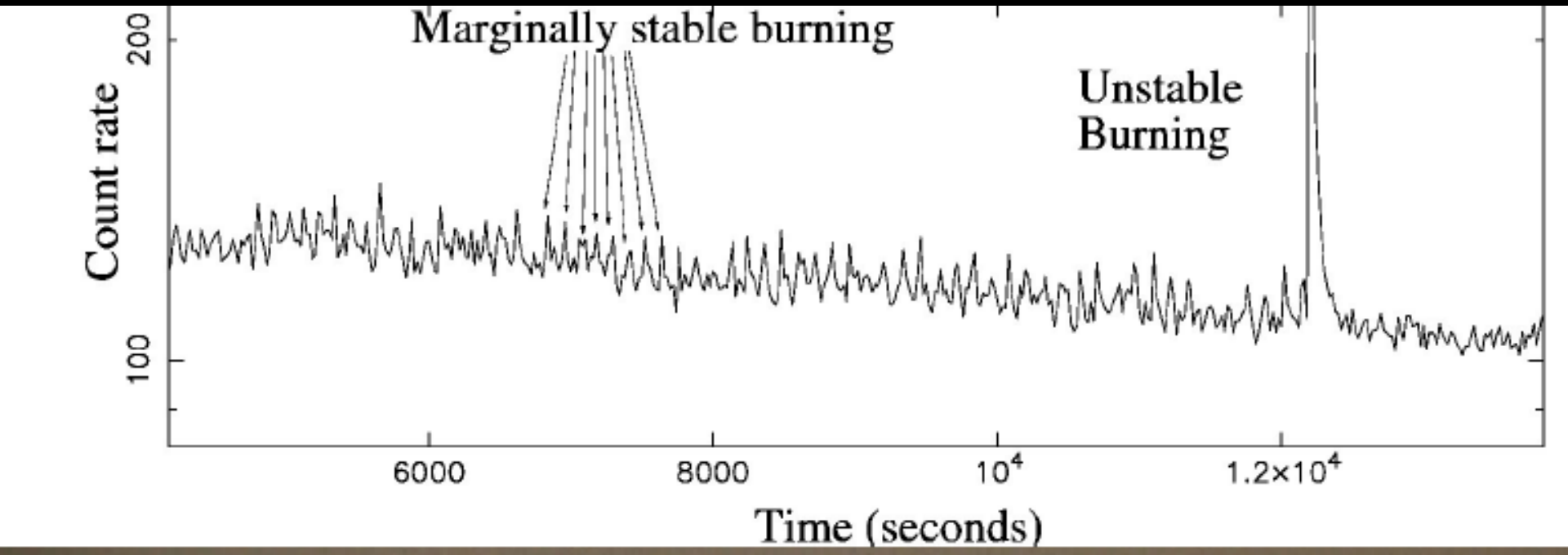
Positive

Negative

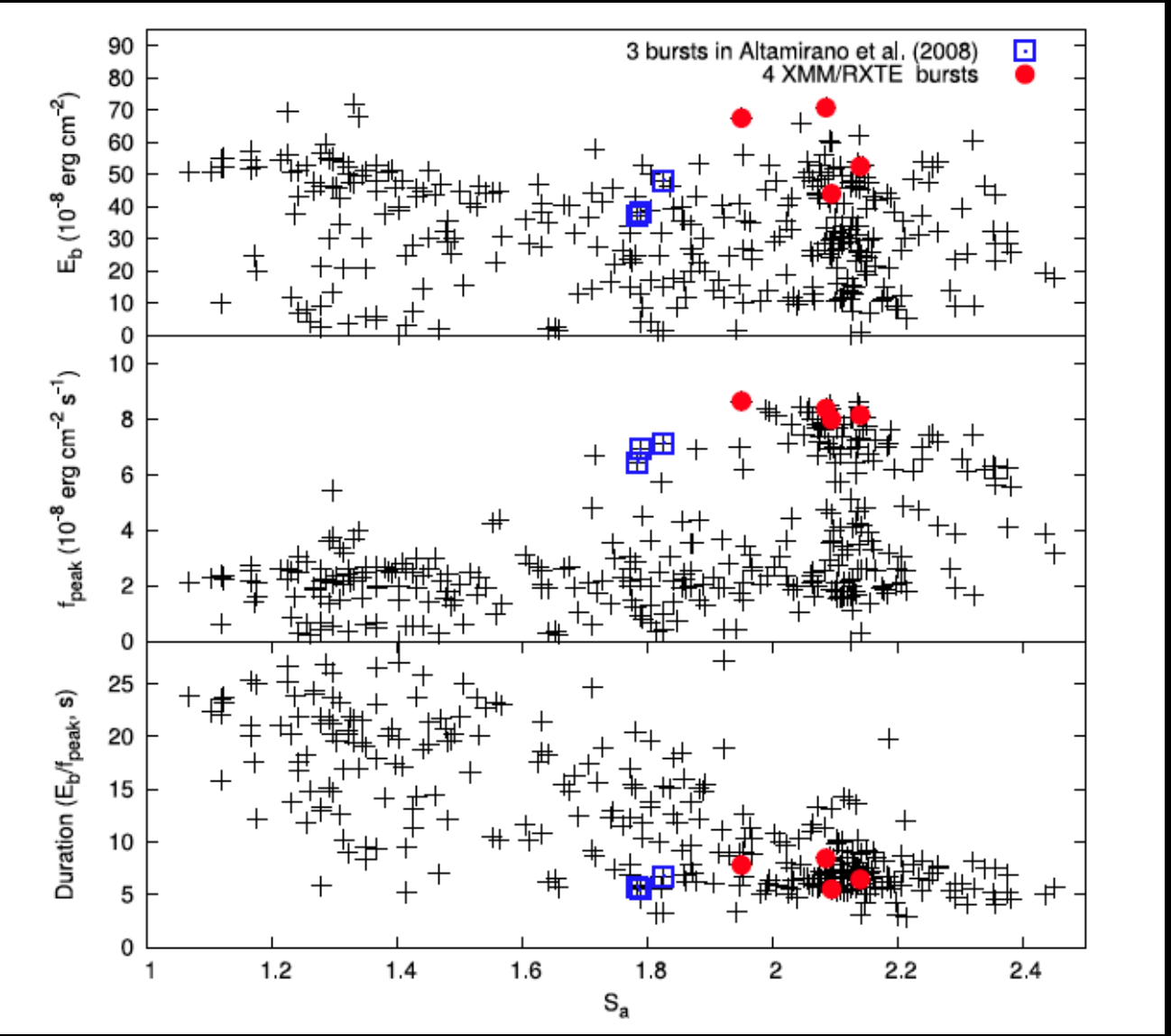


The distribution of the burst convexity

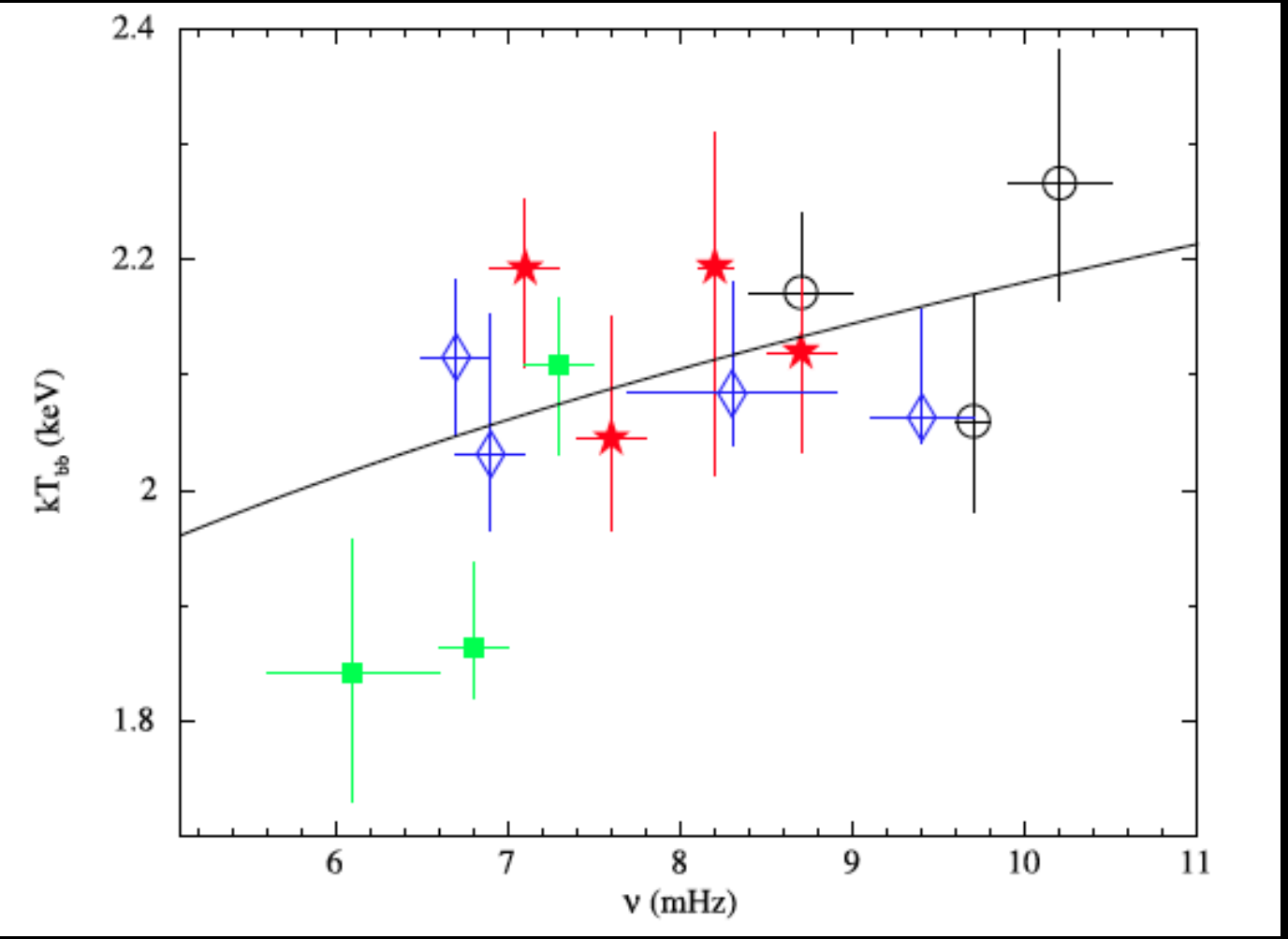
Mhz QPOs disappear just before an X-ray burst



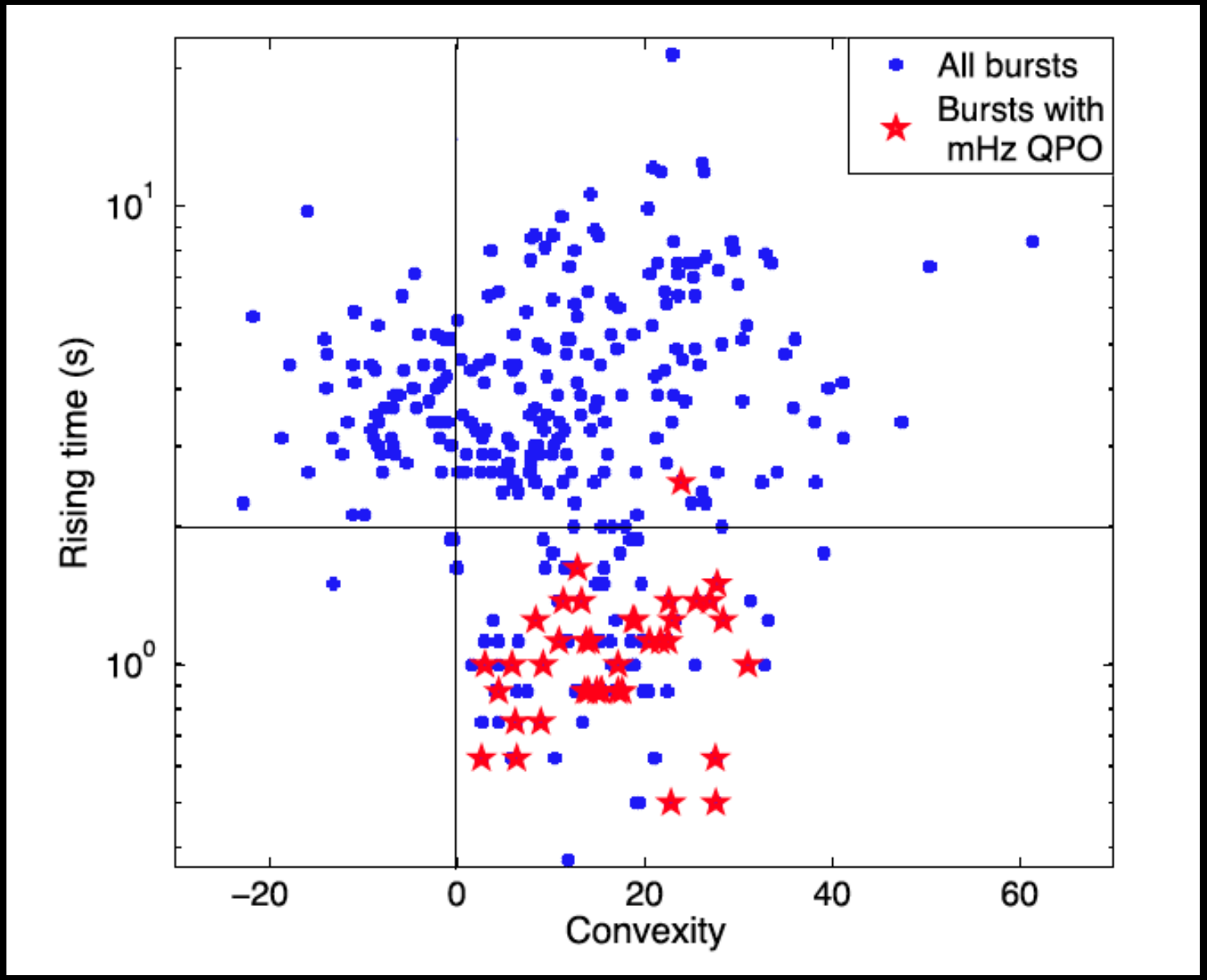
Bursts with mHz QPO observed by XMM-Newton/RXTE in 4U 1636–53



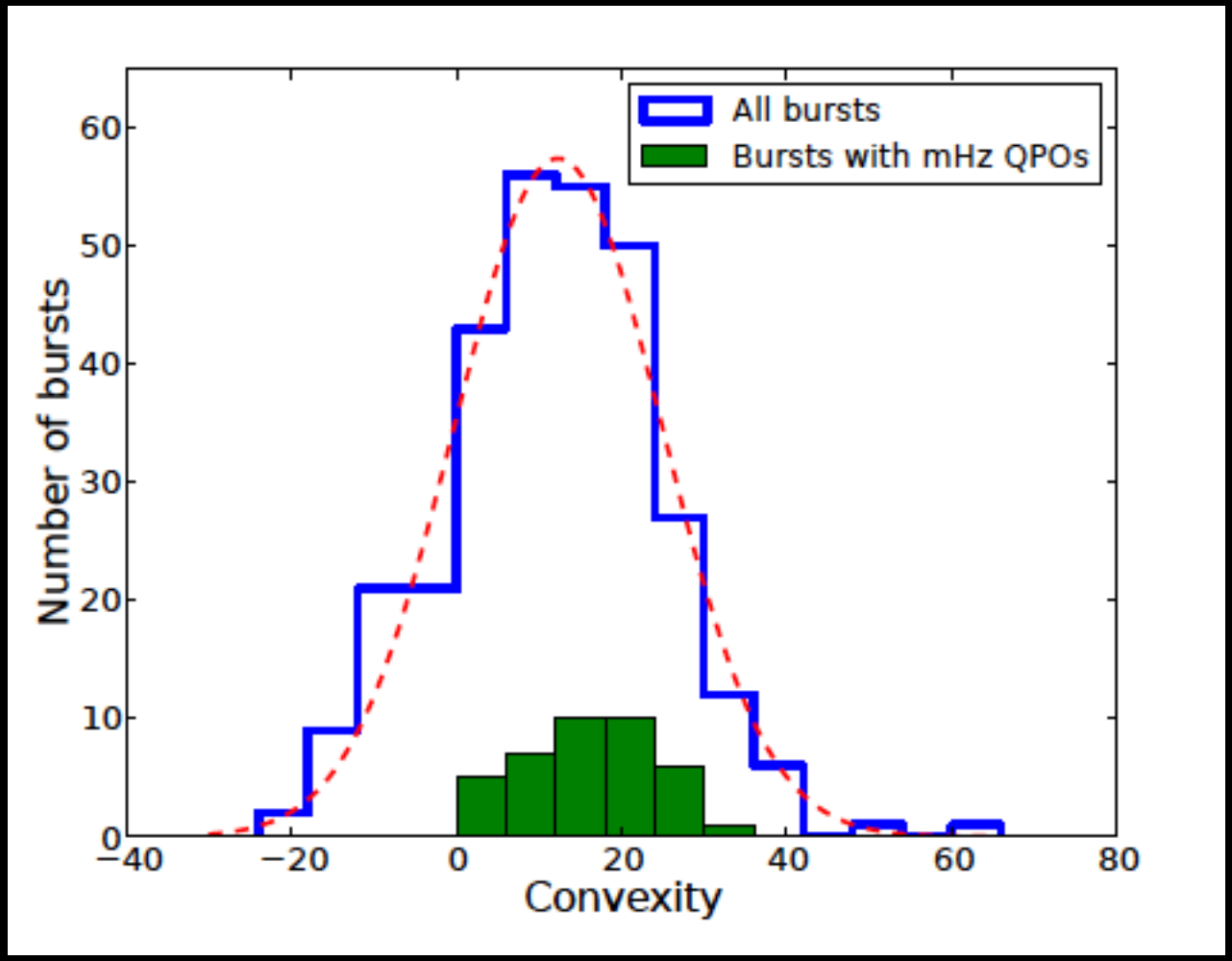
Average frequency of the mHz QPO versus the temperature of the blackbody in 4U 1636–53



Lyu et al. 2015

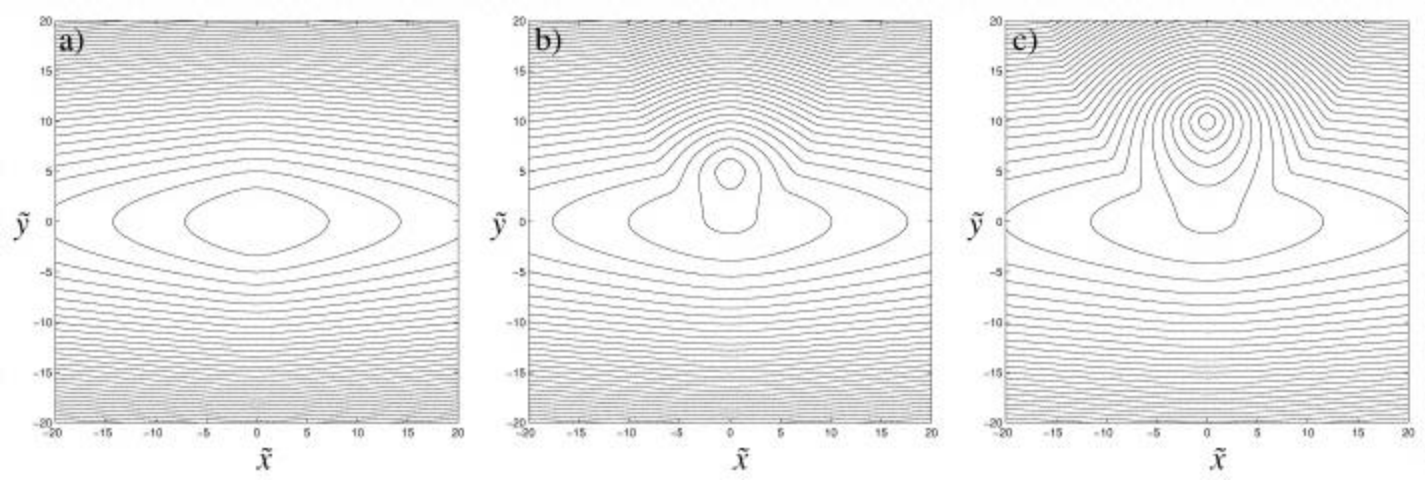

All bursts
Bursts with mHz QPO
Rising time (s)
10^1
10^0
−20
0
20
40
60
Convexity

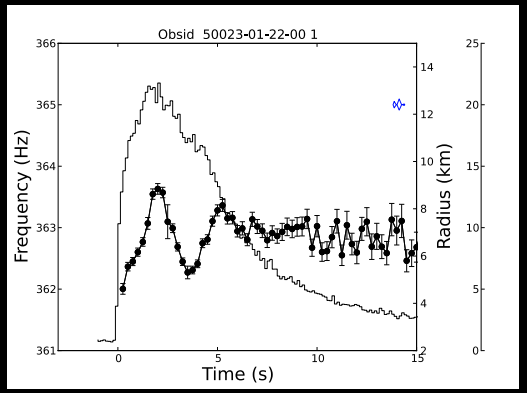
Millihertz QPOs in 4U 1636-53 associated with bursts with positive convexity only

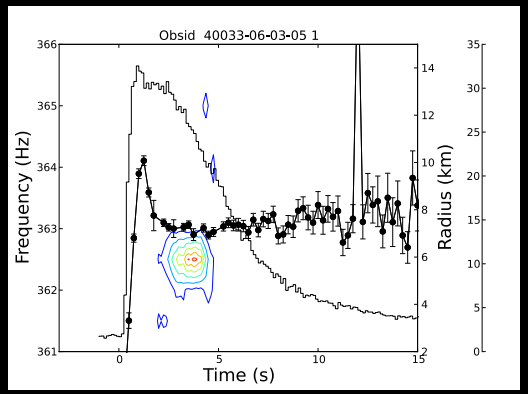


Lyu et al. 2016

Discussion: oscillation

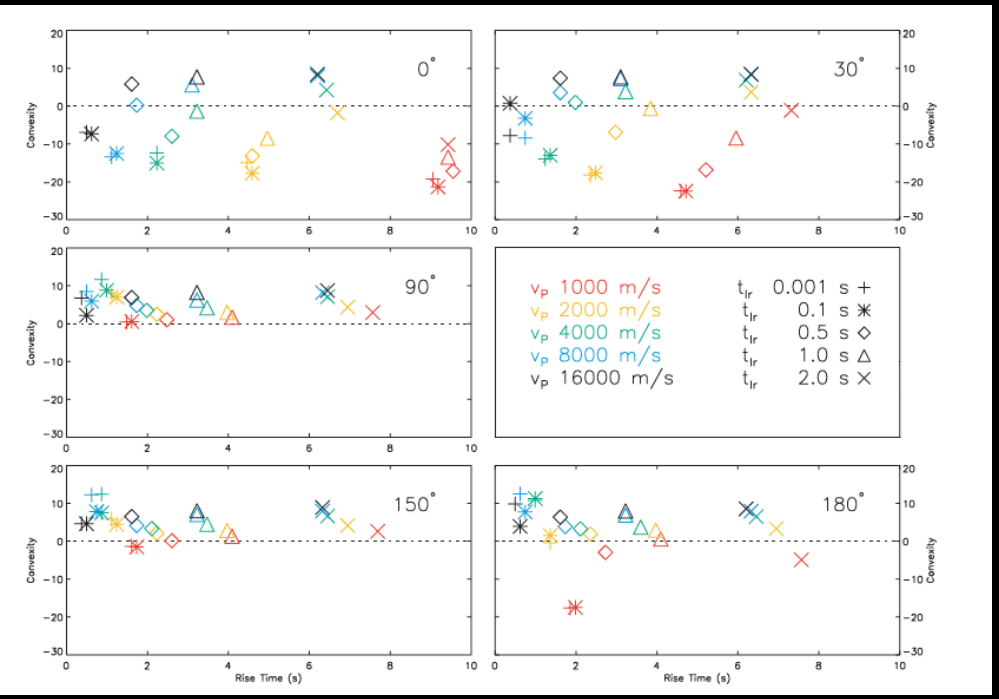




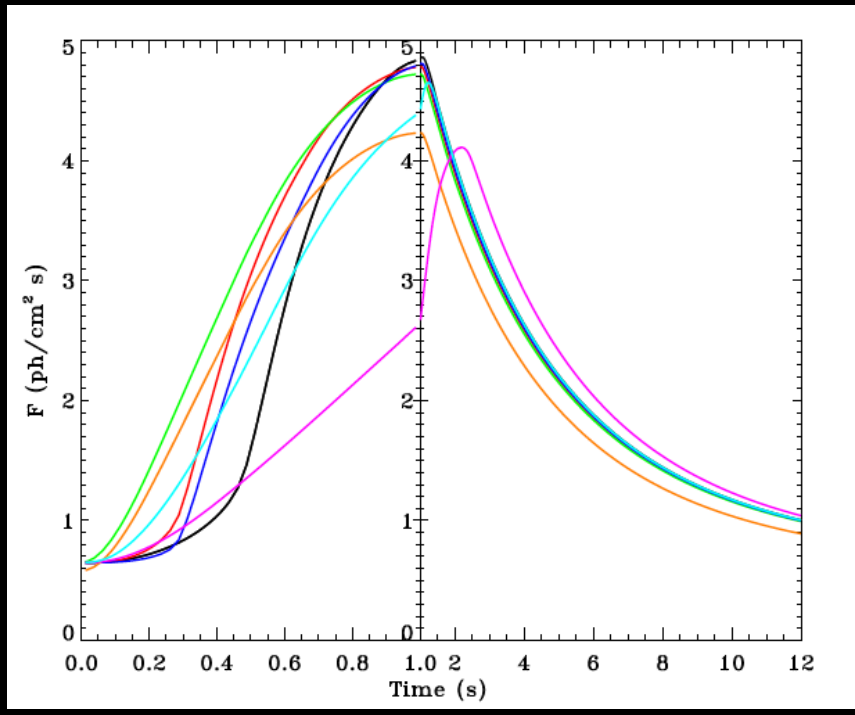


Propagation of burning front for different ignition location (Spitkovsky, Levin & Ushomirsky 2002).

Discussion: lightcurve



Maurer and Watts 2008



Mahmoodifar & Strohmayer 2016

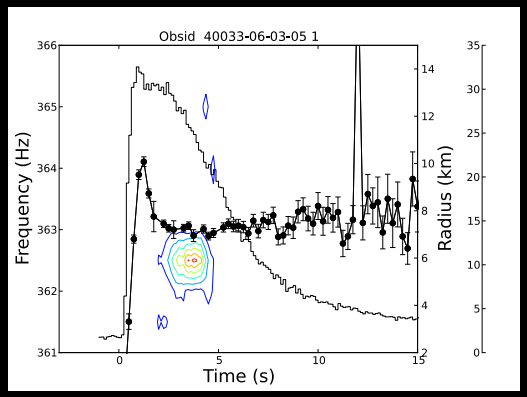
Discussion: mHz QPO

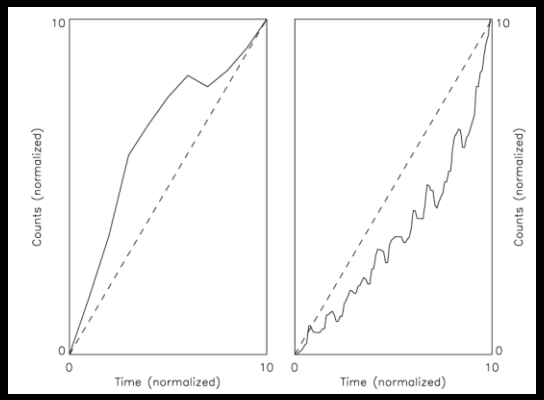
(1) Results from simulations:			
(a) Low-latitude ignition	$\Rightarrow$	$\mathcal{C} > 0$	(1,2)
High-latitude ignition	$\Rightarrow$	$\mathcal{C} > 0$ or $\mathcal{C} < 0$	
	...		
(b) Low-latitude ignition	$\Rightarrow$	Short rising time	(1,2)
High-latitude ignition	$\Rightarrow$	Long/Short rising time	
(2) Results from observations:			
(a) mHz QPOs	$\Rightarrow$	$\mathcal{C} > 0$	(3)
No mHz QPOs	$\Rightarrow$	$\mathcal{C} > 0$ or $\mathcal{C} < 0$	
	...		
(b) mHz QPOs	$\Rightarrow$	Short rising time	(3)
No mHz QPOs	$\Rightarrow$	Long/Short rising time	
(3) The statements *a* or *b* are logically equivalent to:			
mHz QPOs	$\Rightarrow$	Low-latitude ignition	
No mHz QPOs	$\Rightarrow$	Low-/High-latitude ignition	

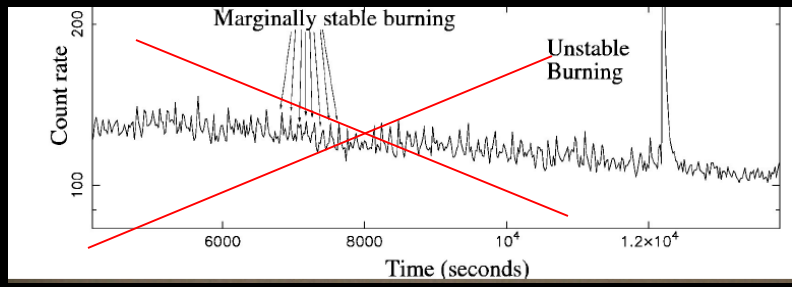
Notes. References: (1) Maurer & Watts (2008); (2) Mahmoodifar & Strohmayer (2016); (3) This paper.

Summary

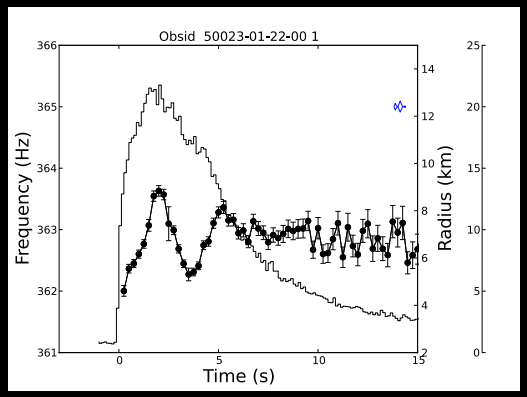
Ignite from high latitude

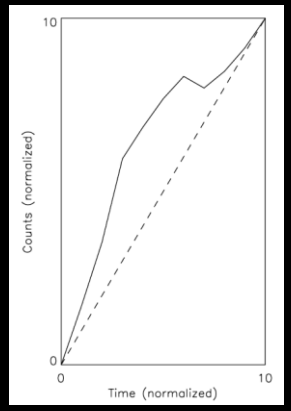


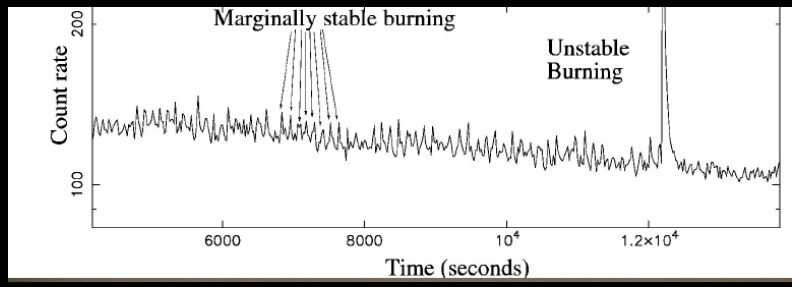




Ignite from low latitude







Grazie