

Discovery of BH instabilities in an accreting NS

Tullio Bagnoli & Jean in 't Zand

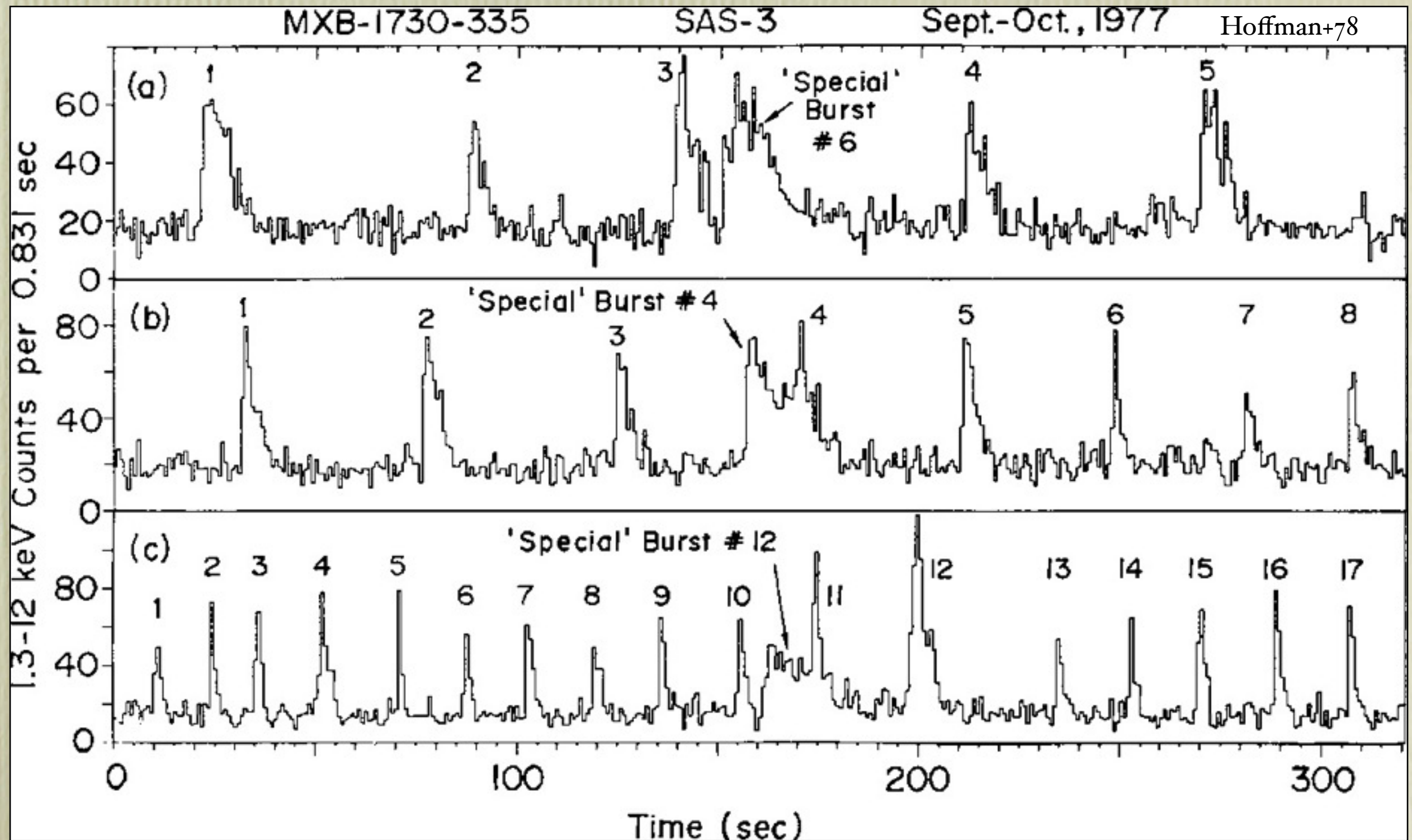
The GC Liller 1

Gemini, J+K IR bands
85" x 85"

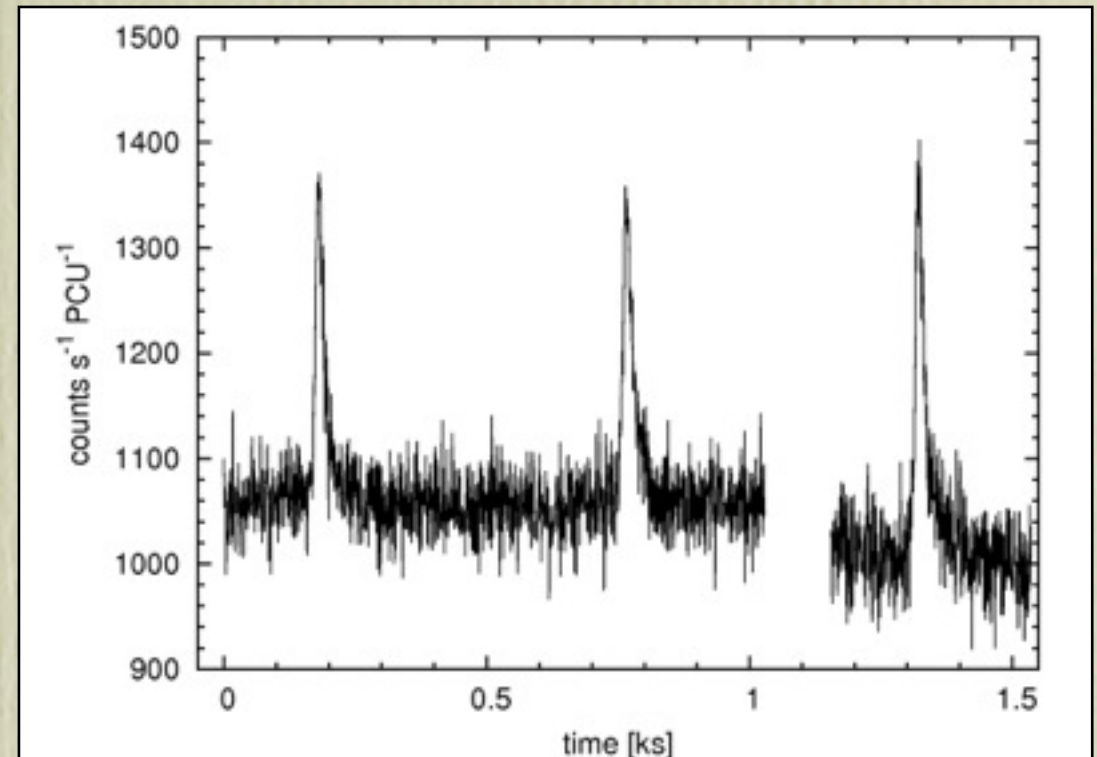
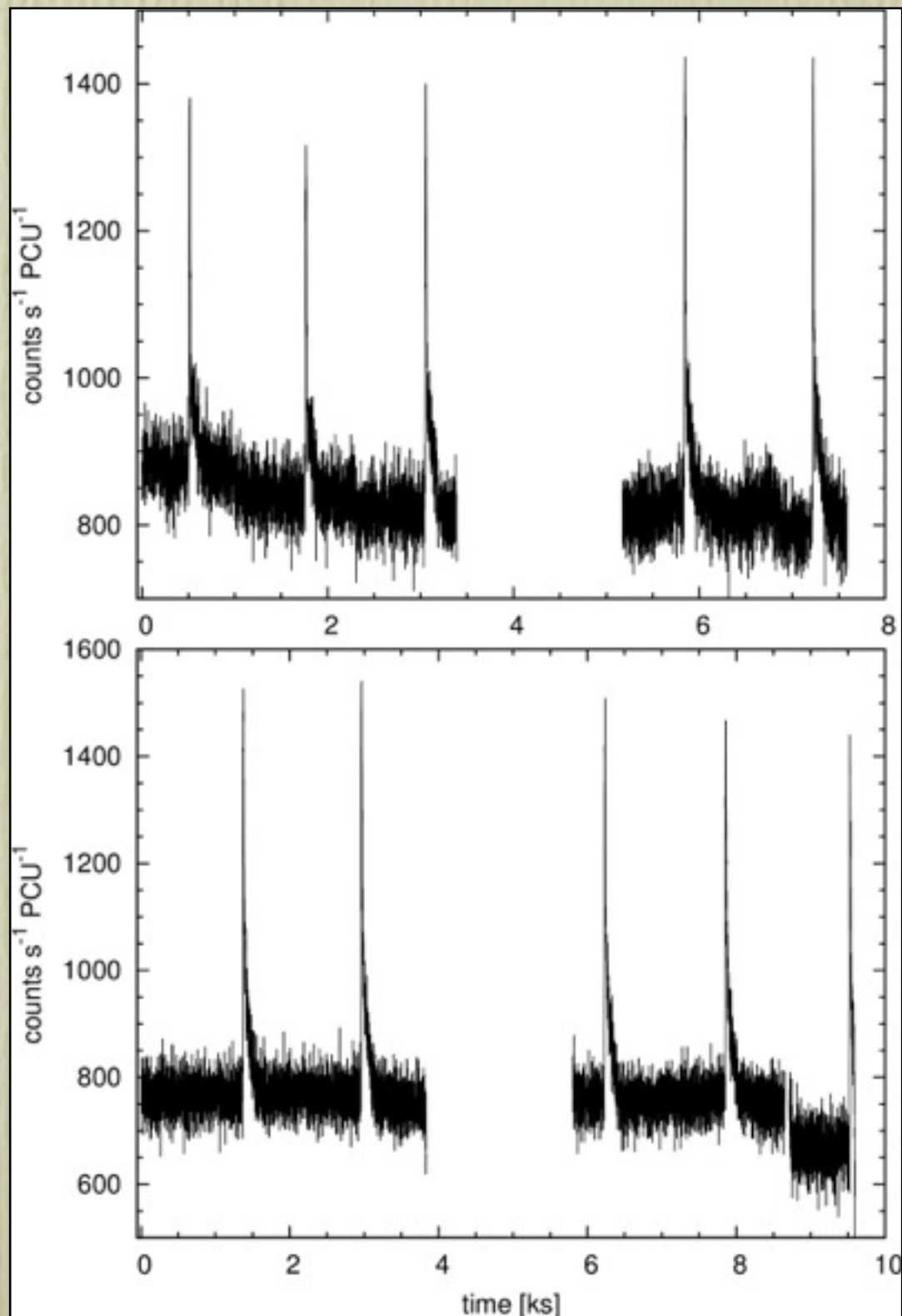


Saracino+15

The Rapid Burster and its X-ray bursts



thermonuclear bursts



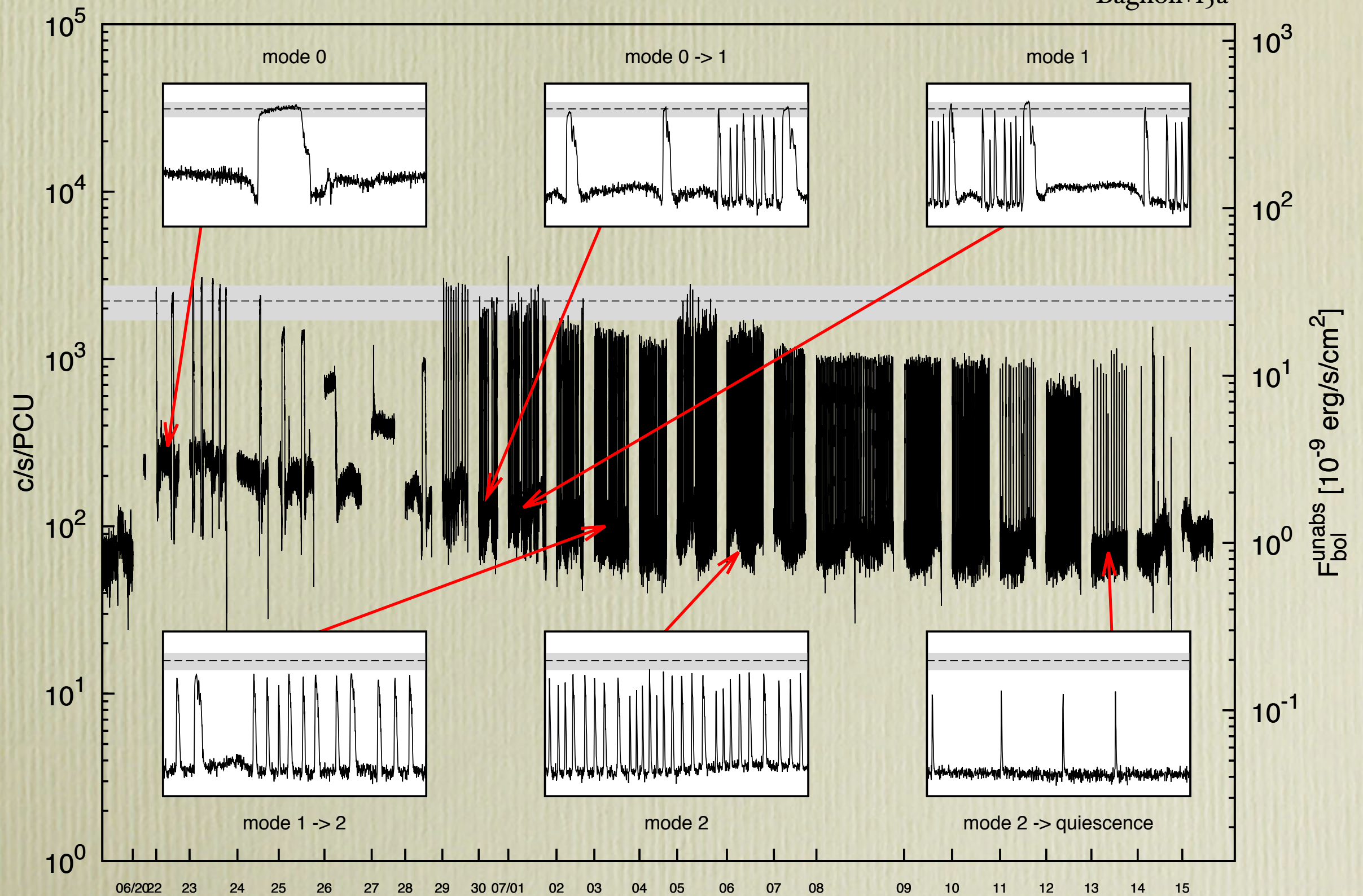
Bagnoli+13

- unstable burning of accreted material
- 105 Galactic NS LMXBs
- $t_{\text{rec}} \sim$ hours
- surface phenomenon

accretion bursts

outburst June-July 2006

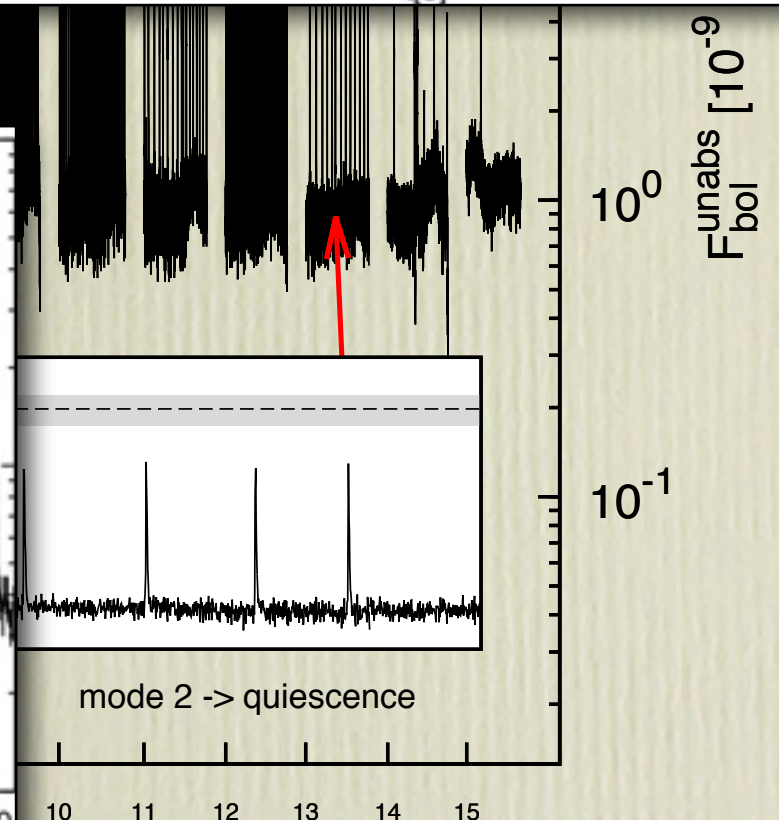
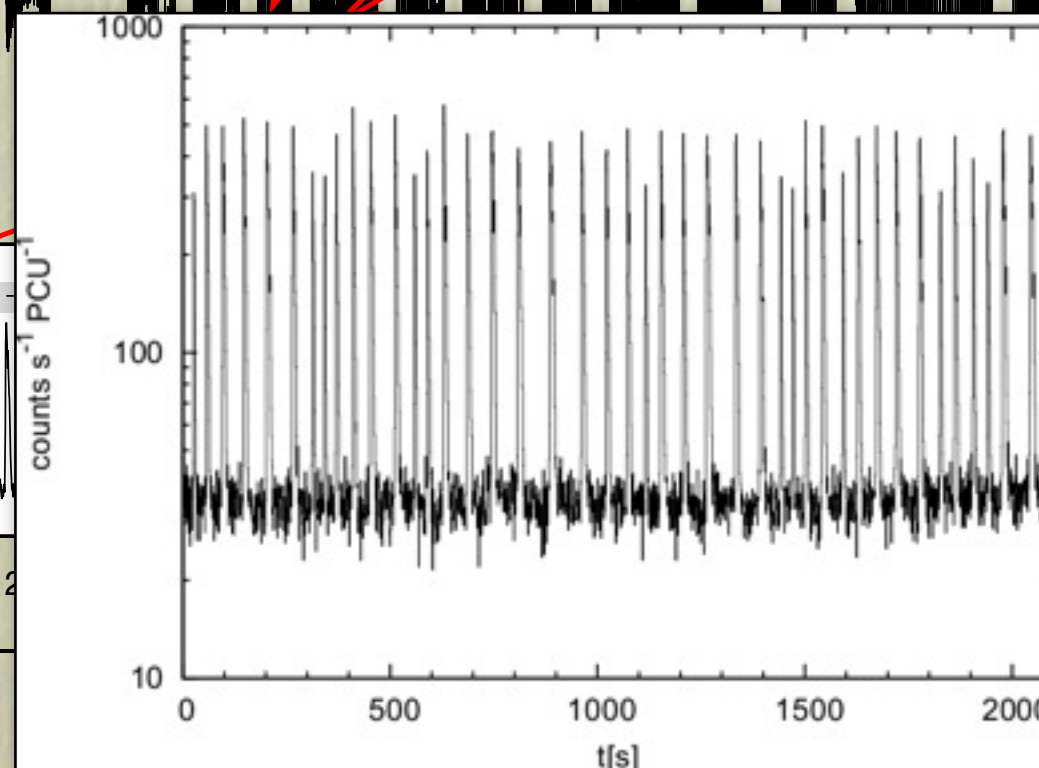
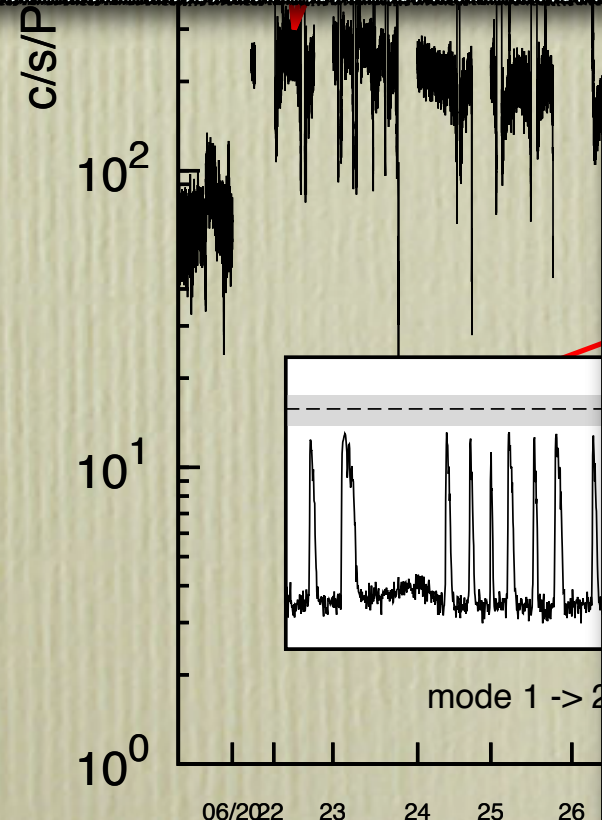
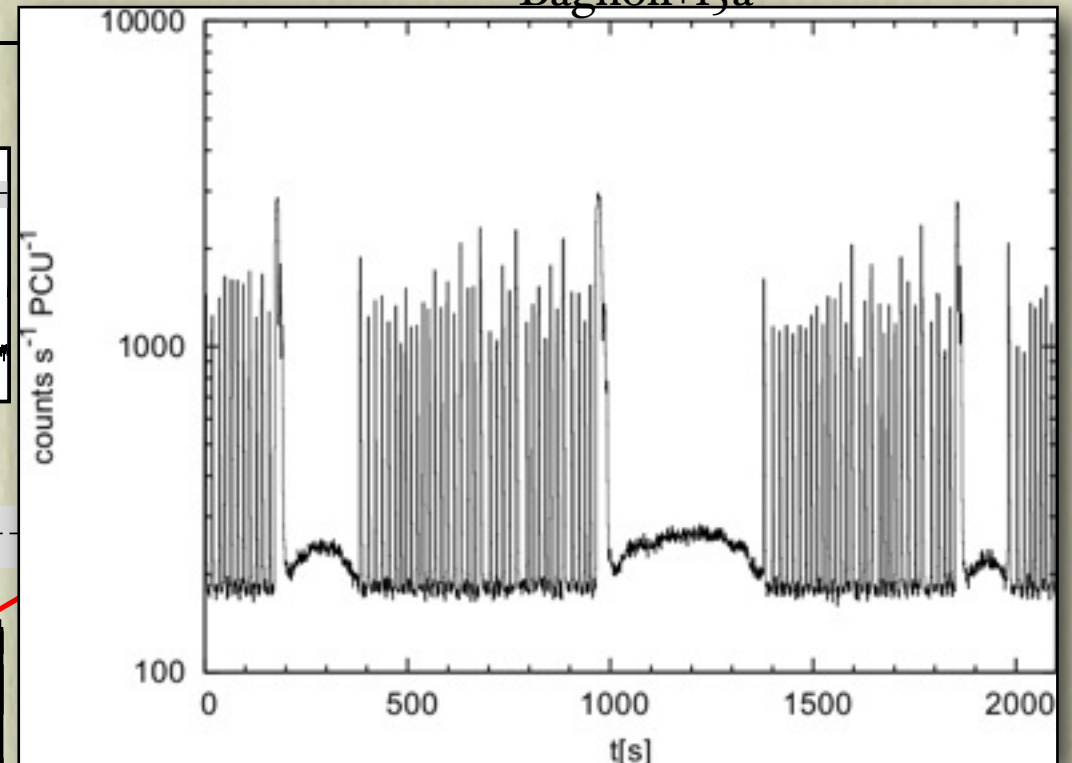
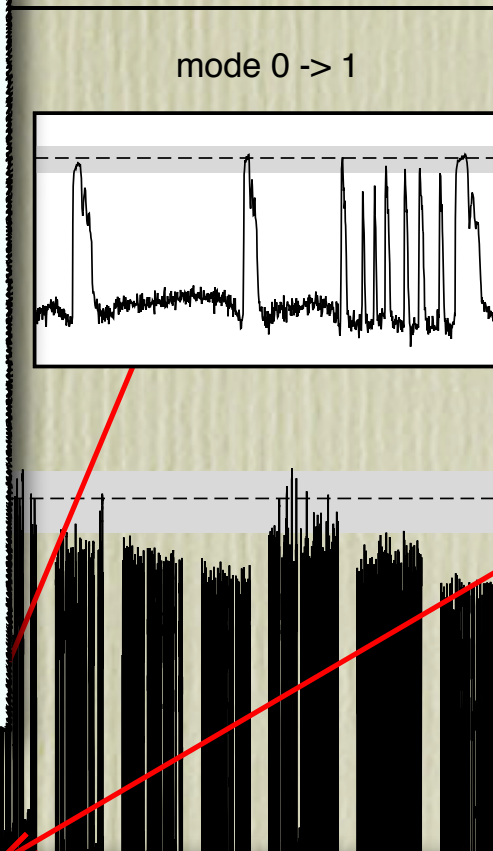
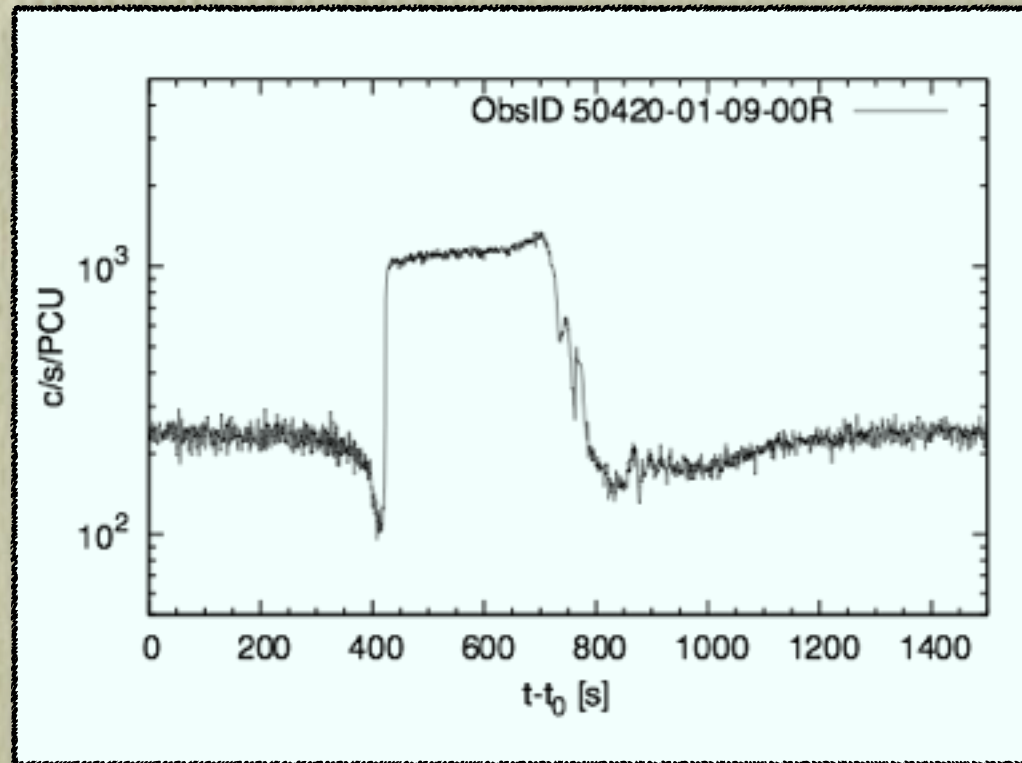
Bagnoli+15a



accretion bursts

outburst June-July 2006

Bagnoli+15a

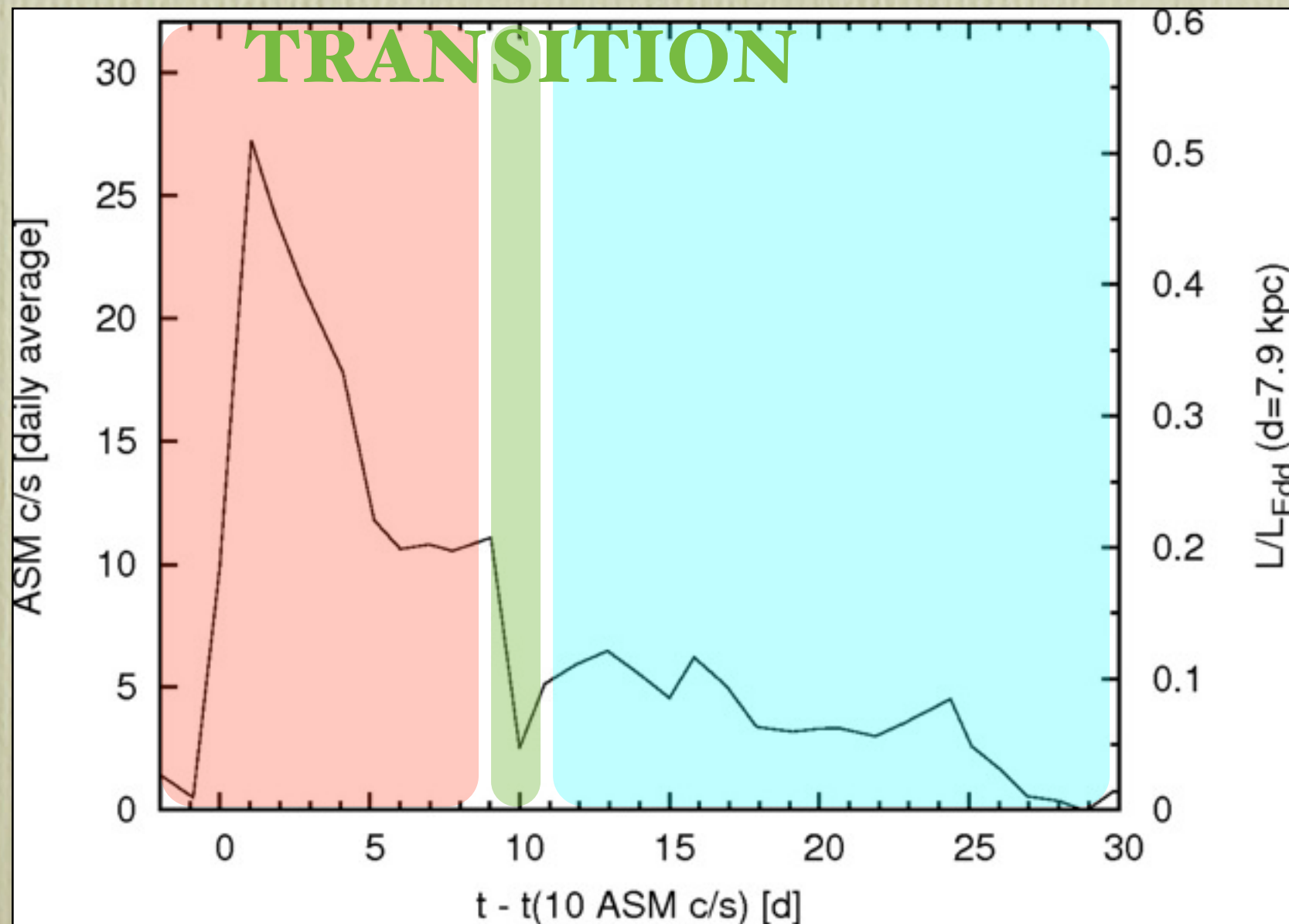


Rapid Burster outbursts

**SOFT
STATE**

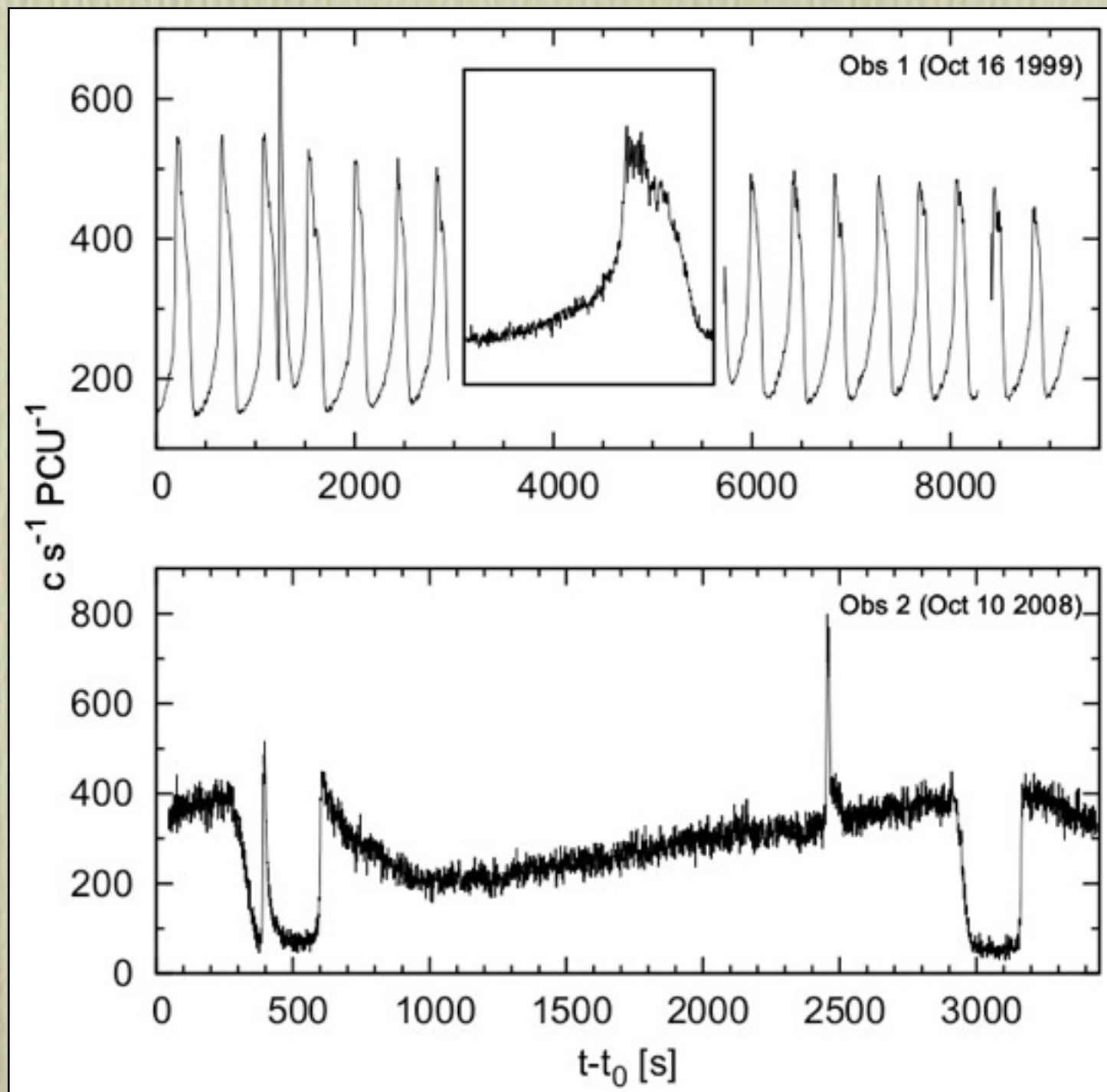
**HARD
STATE**

TRANSITION



- **SOFT:**
only thermonuclear
- **TRANSITION:**
funky stuff..
- **HARD:**
both
thermonuclear and
accretion bursts

variabilities during transition

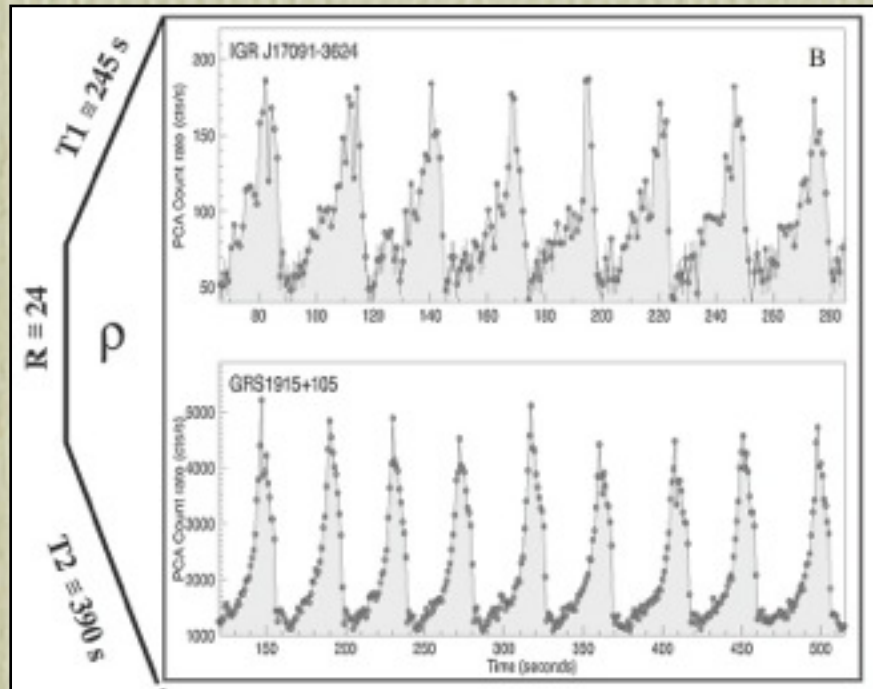


- $P \sim 350\text{--}450$ s (obs 1)
- $L \sim 7\text{--}18\%$ L_{edd} (obs 1)
 $\sim 3.5\text{--}21\%$ L_{edd} (obs 2)
- no interaction between thermonuclear burst and the variabilities
- no increased absorption (obs 2)

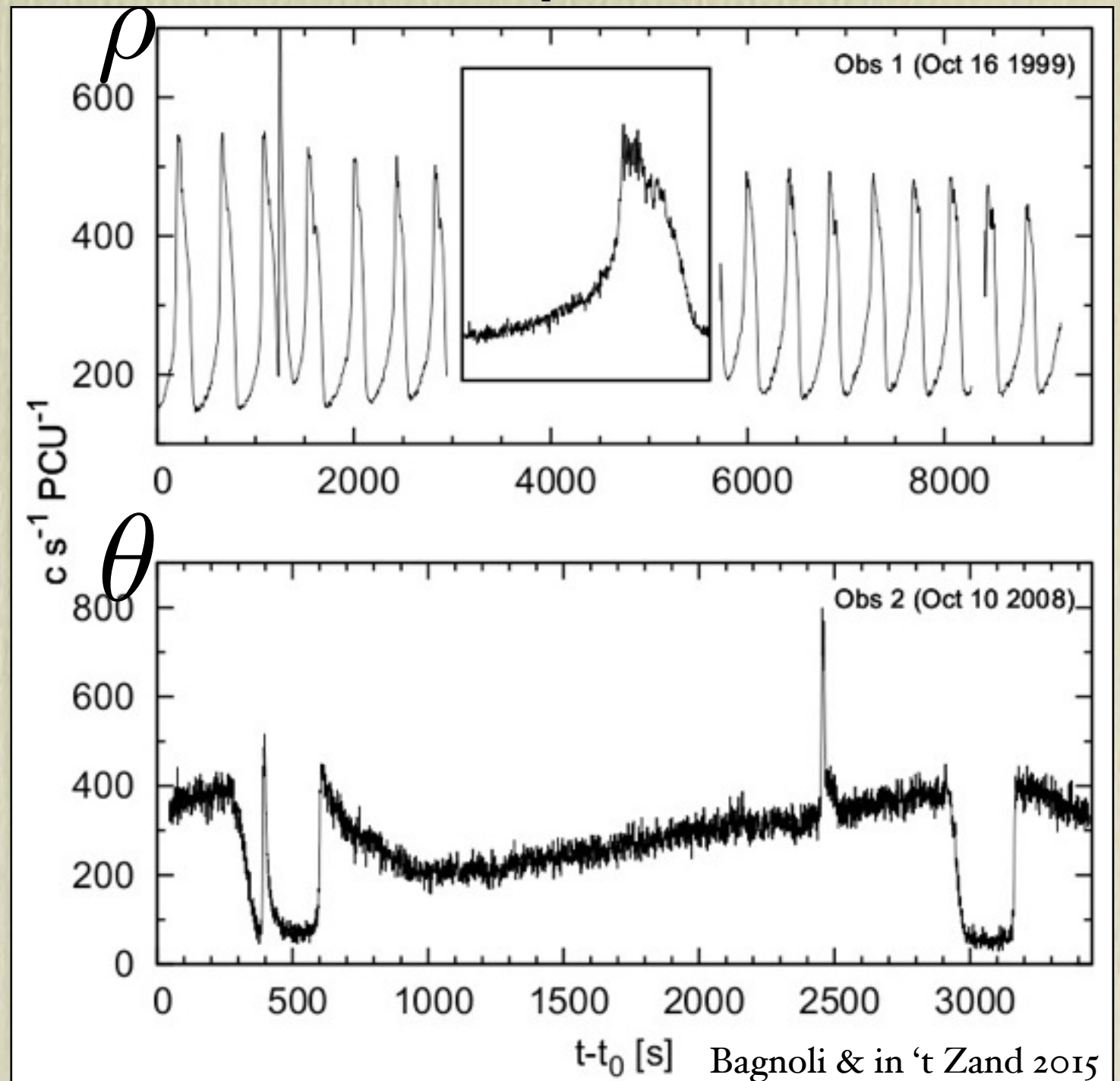
black-hole-like variability

Altamirano+11

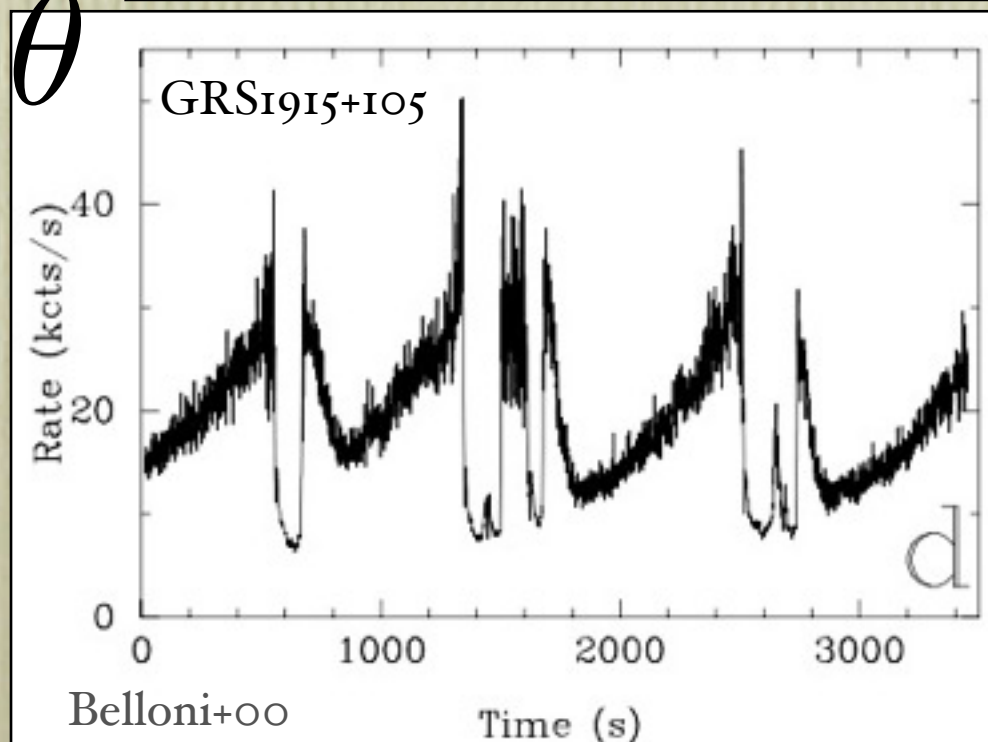
ρ



Rapid Burster



θ

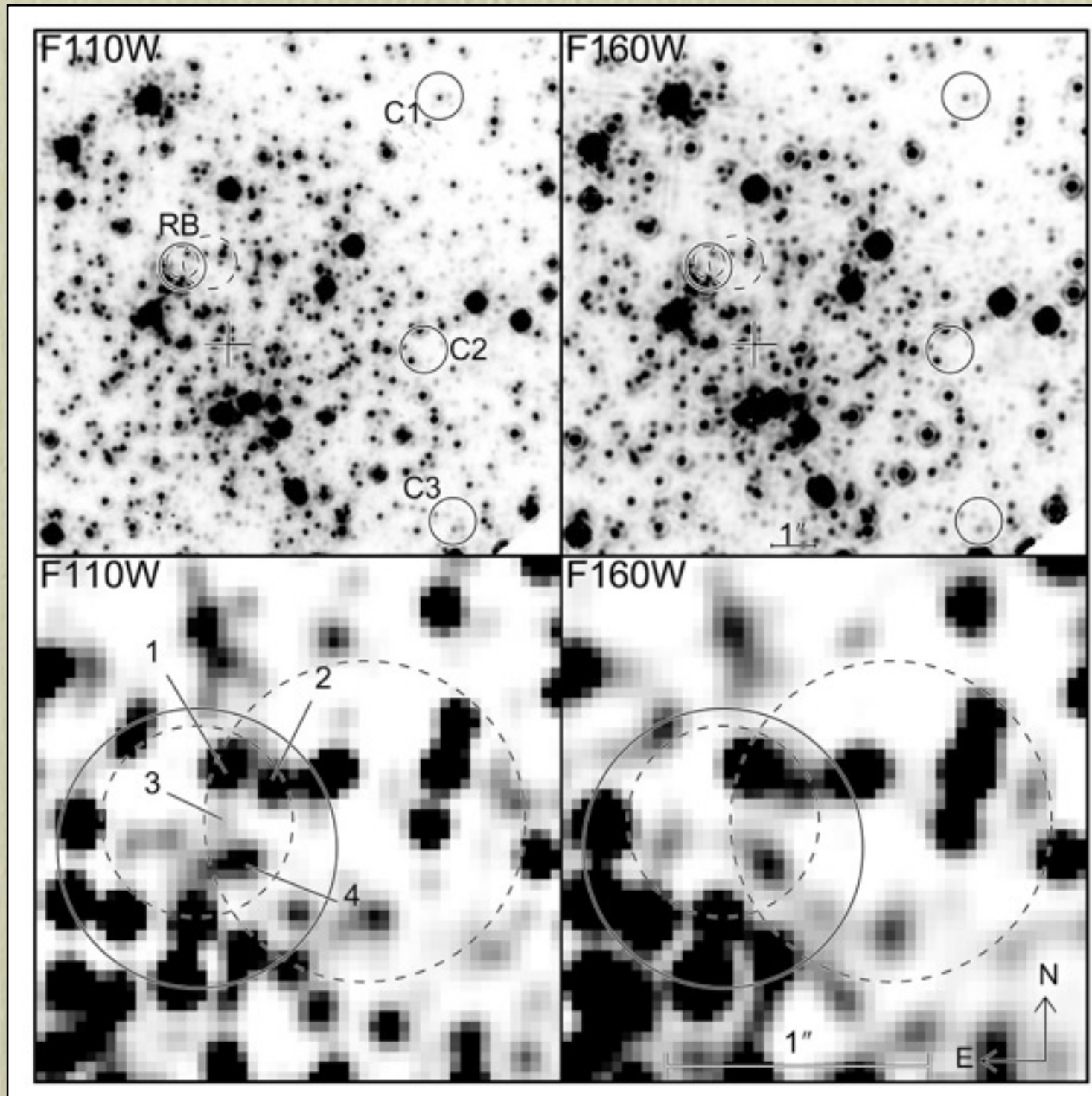


Conclusions

- **rare:** $\sim 1\%$ all active-RB RXTE data
- Only at **transition** from soft to hard state
- not because of BH or Eddington:
IGR J17091 sub-Eddington too
- **what about the** accretion bursts?

The Rapid Burster in Liller 1

Hubble image, 25" x 25"



Homer+OI

Chandra position
+2 radio positions:
at least 4 IR counterparts

spectral comparison

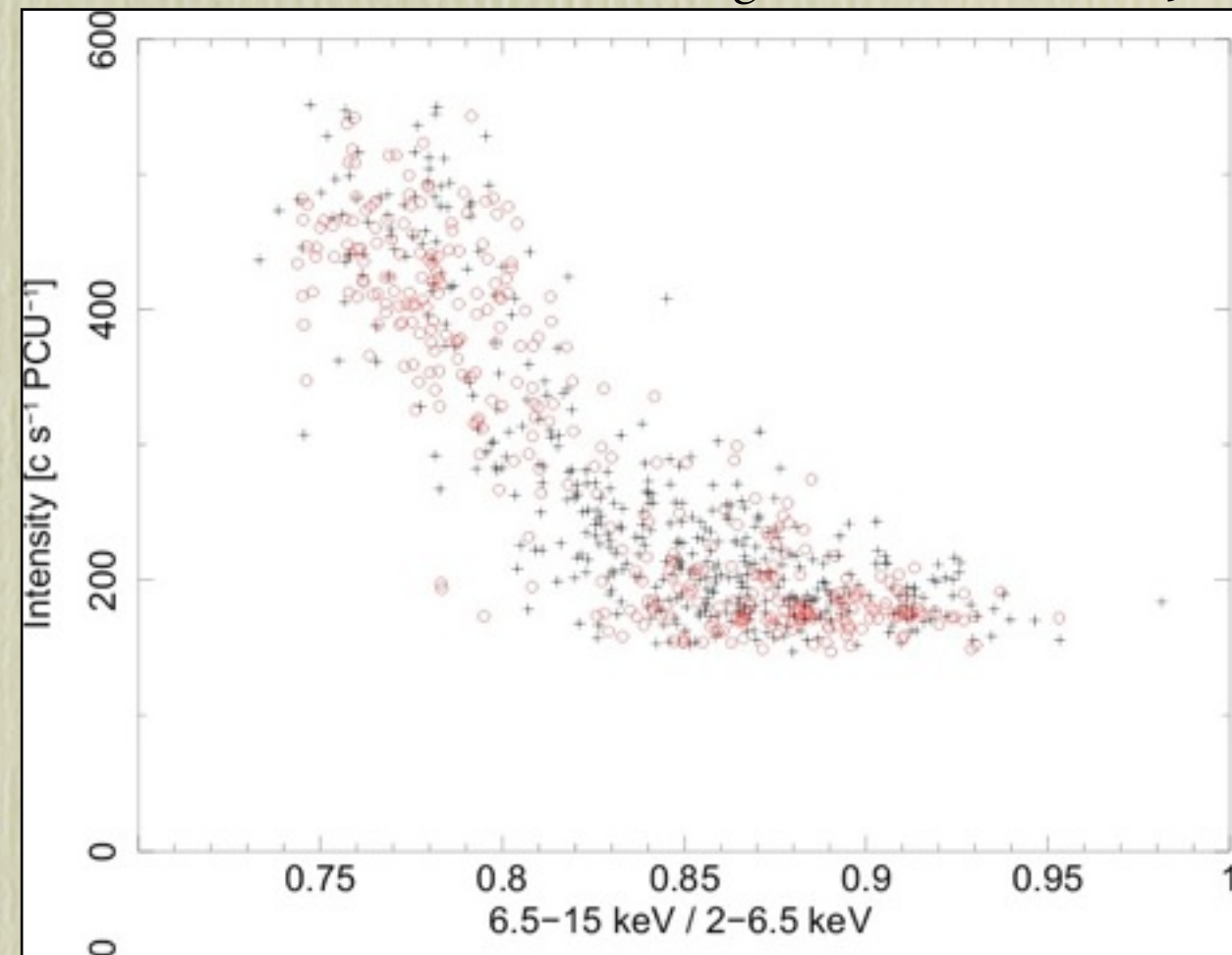
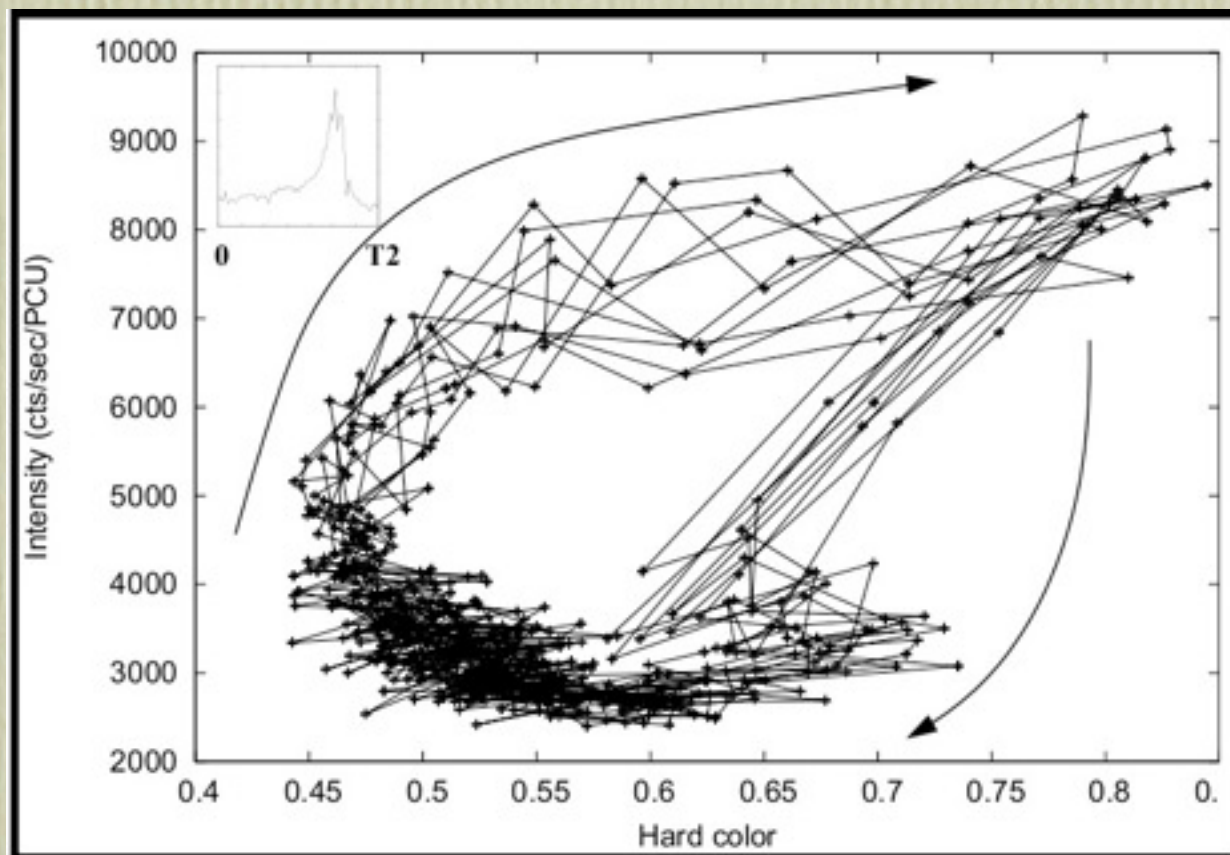
GRS 1915+105

ρ

Rapid Burster

Bagnoli & in 't Zand 2015

Altamirano+11



hysteresis
Eddington limited

no hysteresis
 $L_{\text{peak}} \sim 0.18 L_{\text{edd}}$

spectral comparison

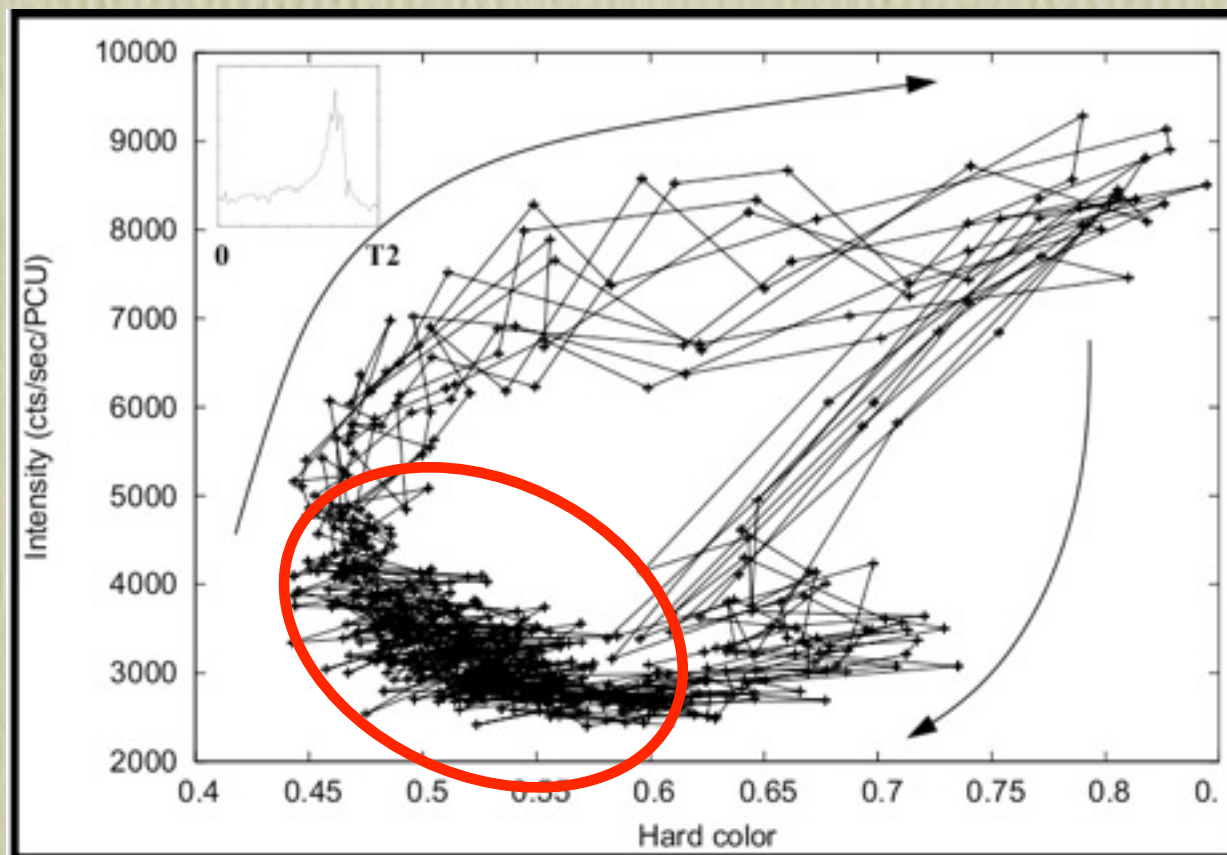
GRS 1915+105

ρ

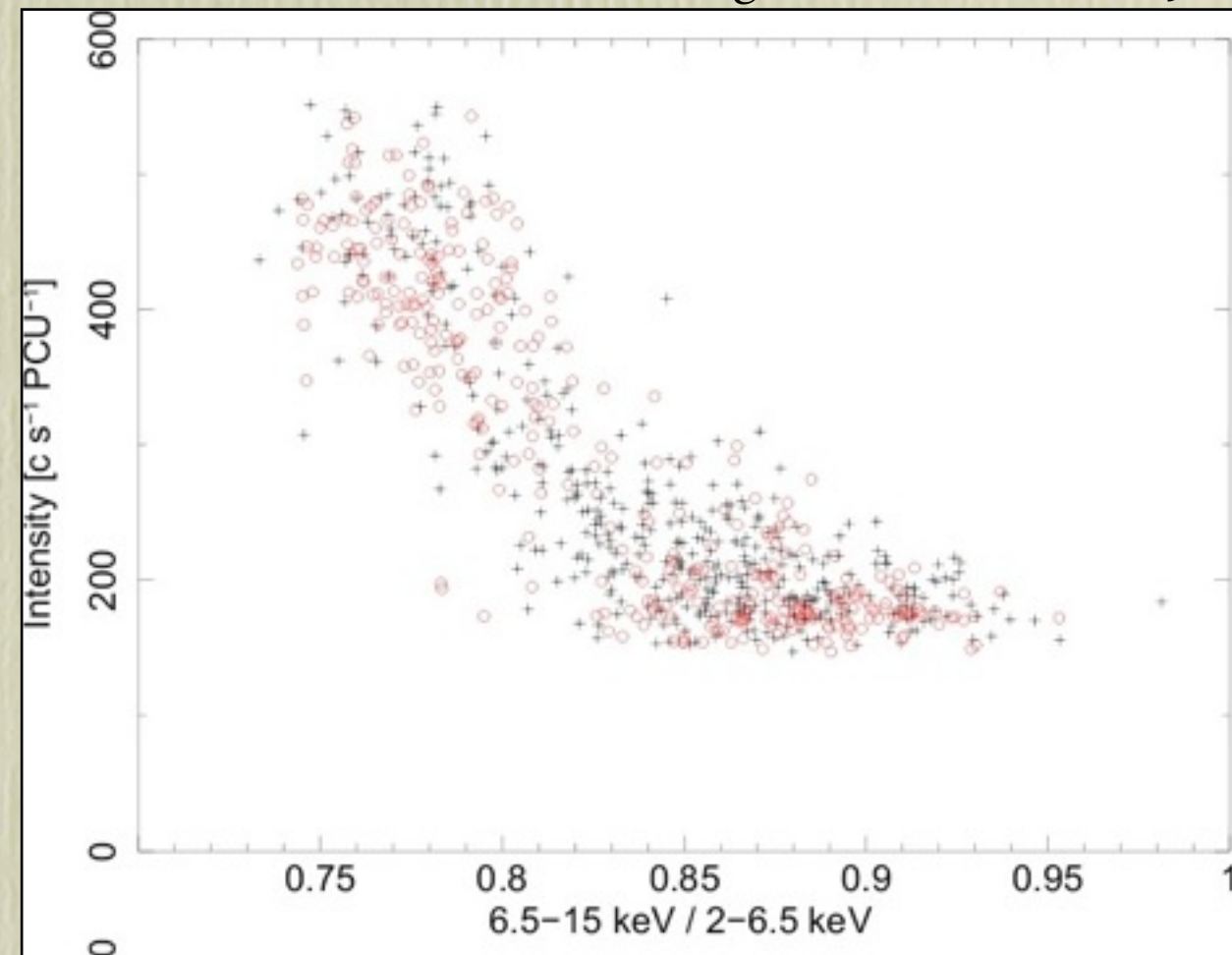
Rapid Burster

Bagnoli & in 't Zand 2015

Altamirano+11



hysteresis
Eddington limited

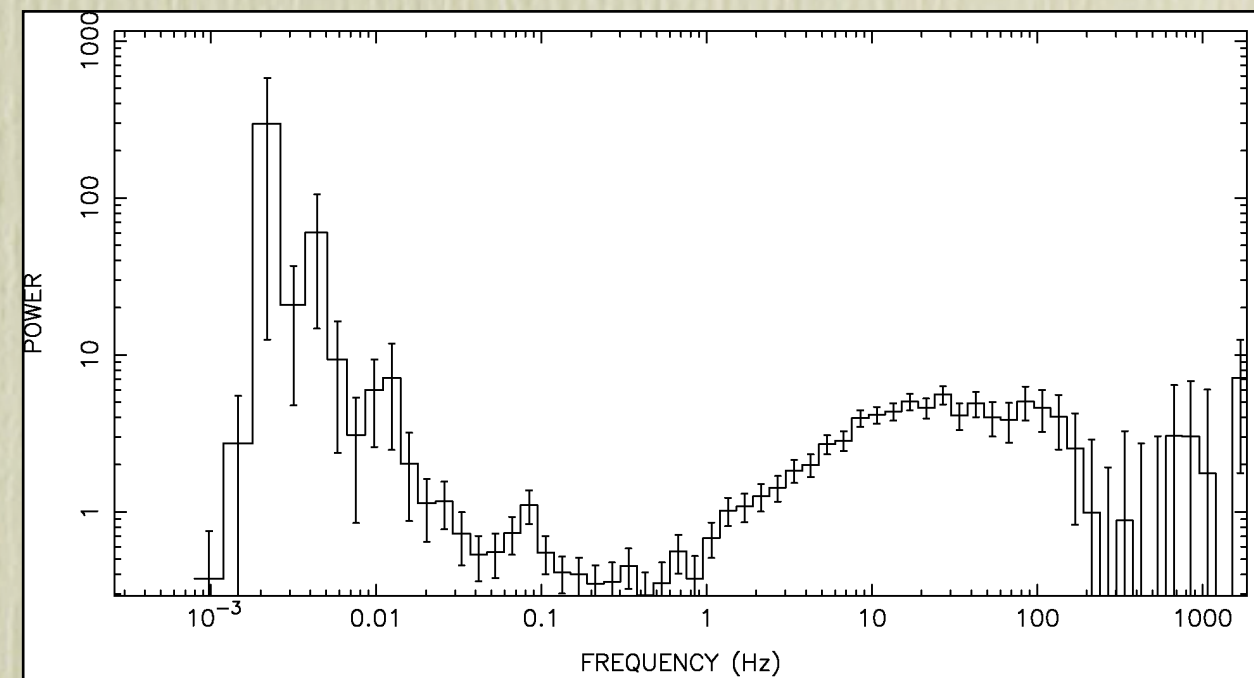
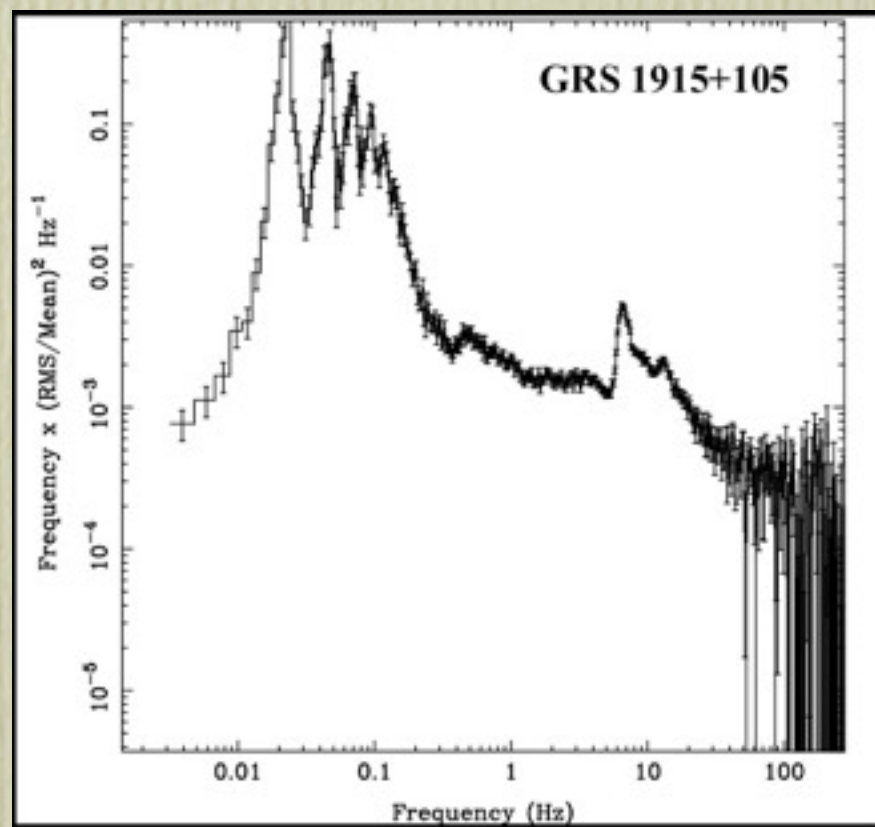


no hysteresis
 $L_{\text{peak}} \sim 0.18 L_{\text{edd}}$

timing comparison

GRS 1915+105

Rapid Burster



Altamirano+II