



Multi-wavelength fast correlated variability during the outburst decay of GX 339-4

Federico Maria Vincentelli

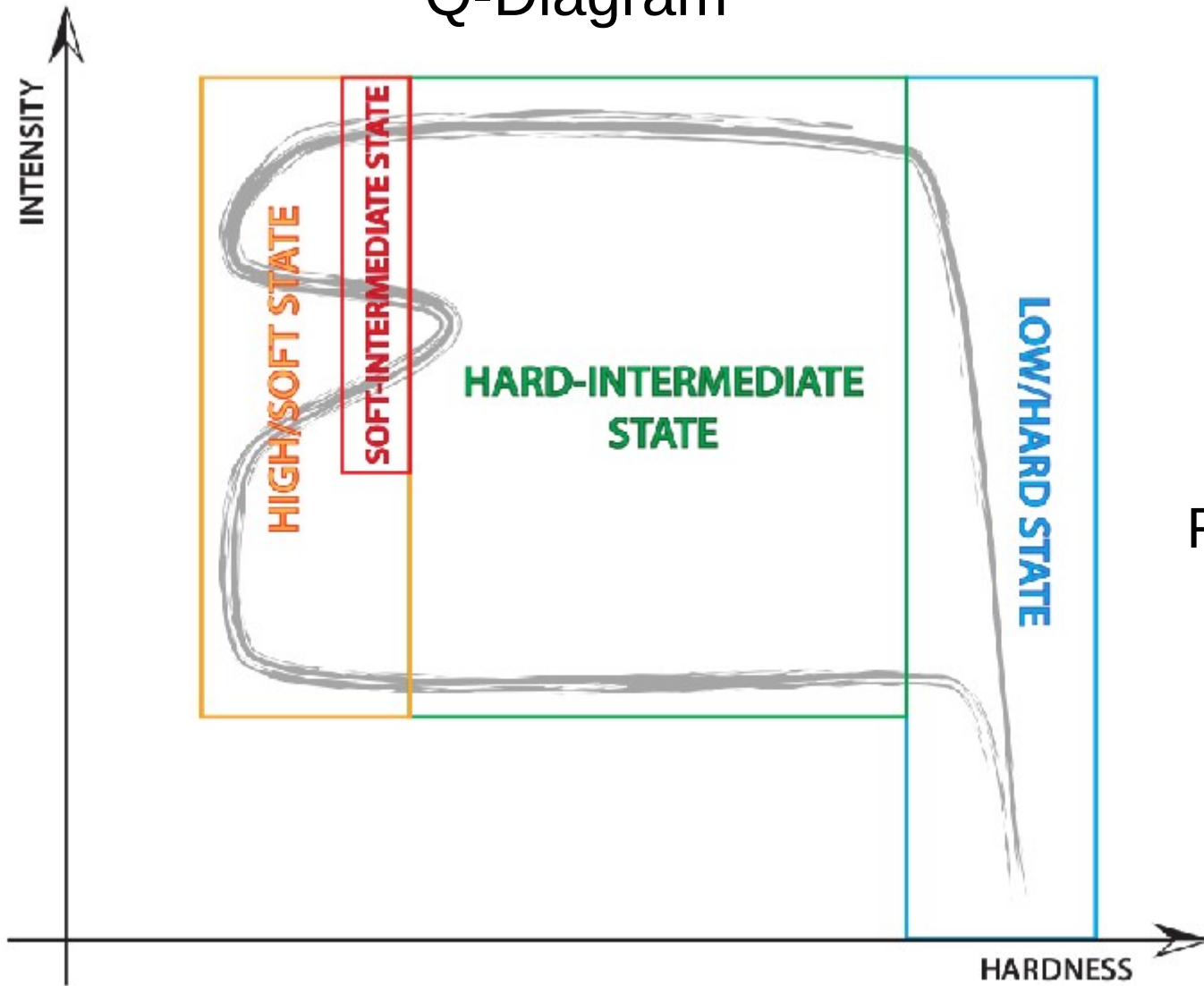
Università dell'Insubria (Como)

INAF-OAB (Merate)

INAF-OAR (Monte Porzio Catone)

Collaborators: Piergiorgio Casella, Kieran O'brien, Phil Uttley, Tomaso Belloni
Pier Oliver Petrucci, Barbara De Marco, Rob Fender,
Julien Malzac, Dave Russell, Thomas Maccarone

Q-Diagram



Hard state

Hard X-ray
component

+

Flat radio spectrum

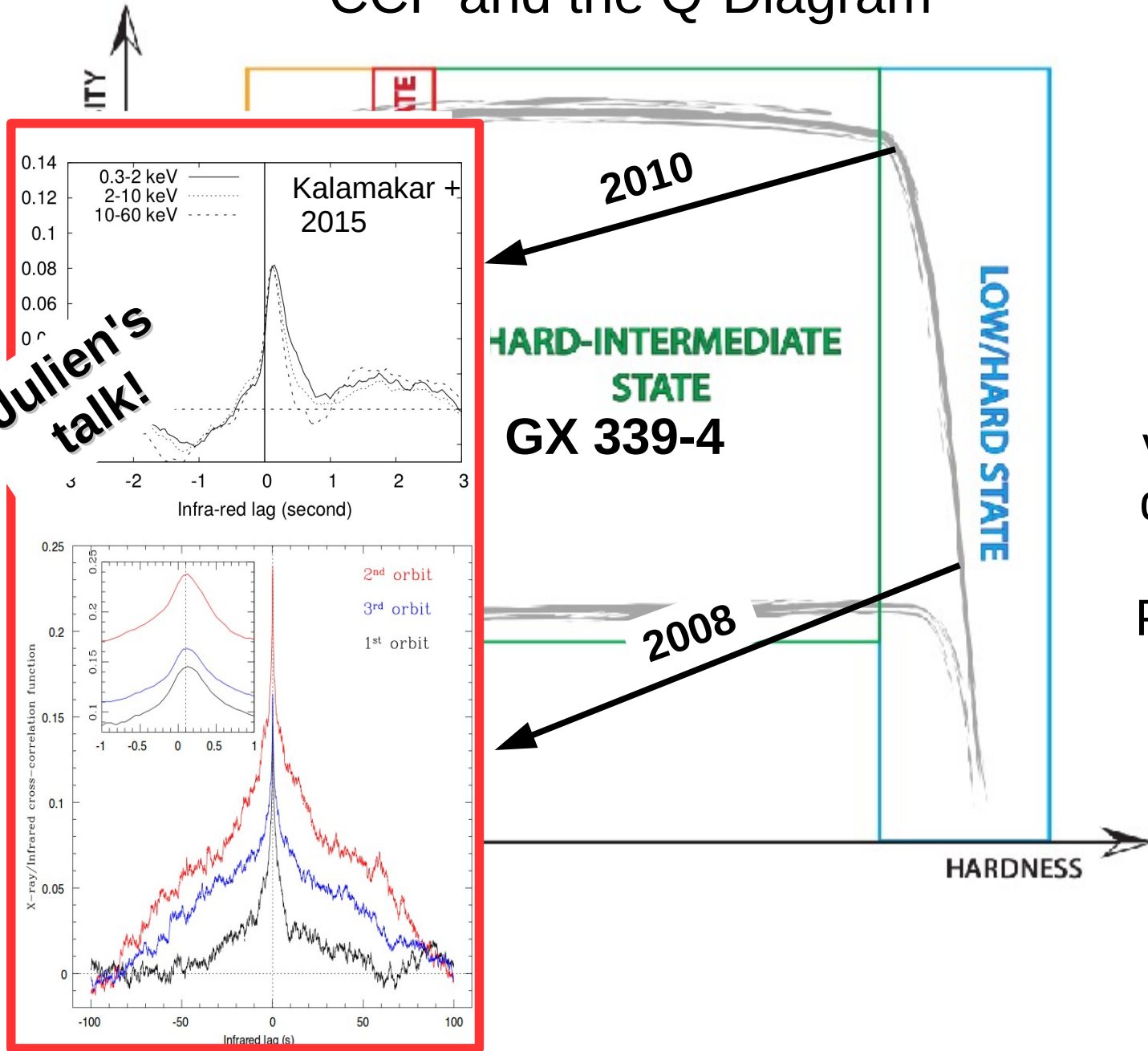
Soft state

Thermal disc
component

+

No radio

CCF and the Q-Diagram



Julien's talk!

Hard state (rise)

X-ray/IR fast variability to probe disc/jet connection

Probing most inner regions of the jet

Variability transferred into the jet

Casella + 2010

Kalamakar + 2015

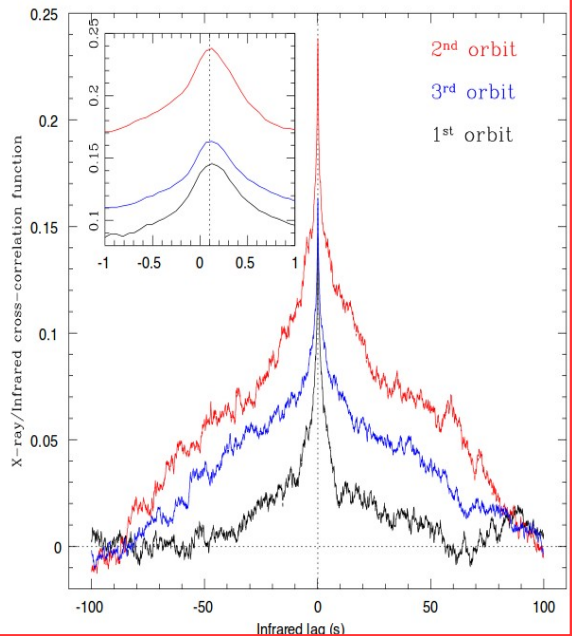
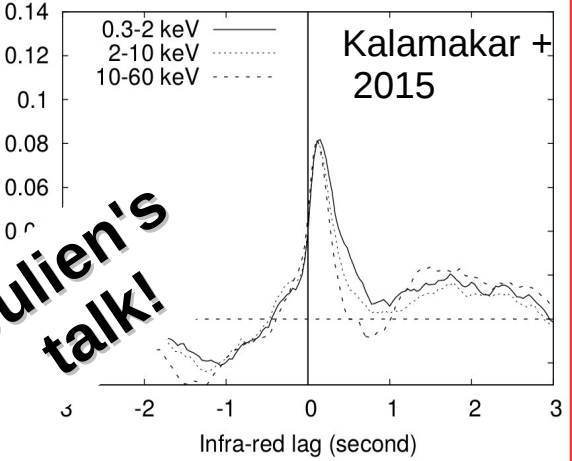
HARD-INTERMEDIATE STATE
GX 339-4

LOW/HARD STATE

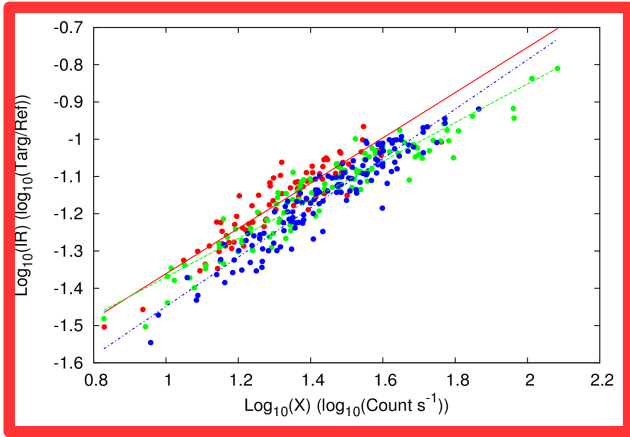
2010

2008

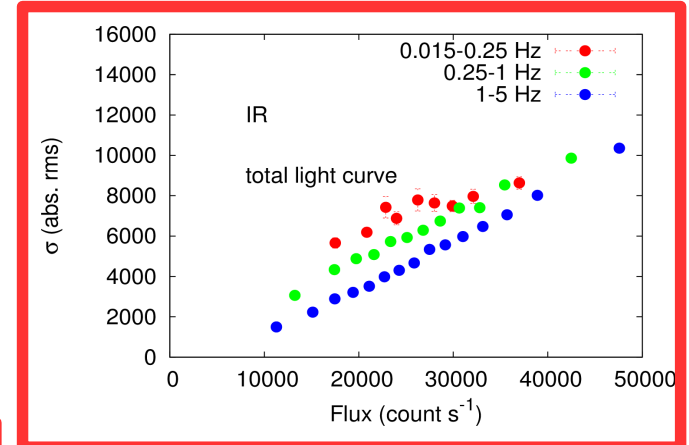
HARDNESS



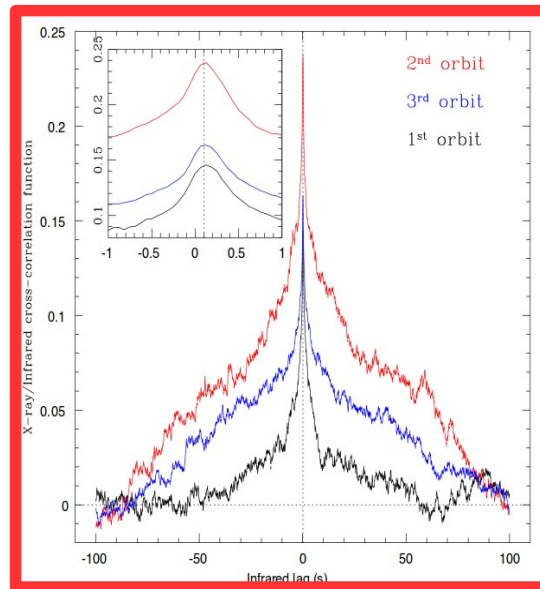
Deeper insight!



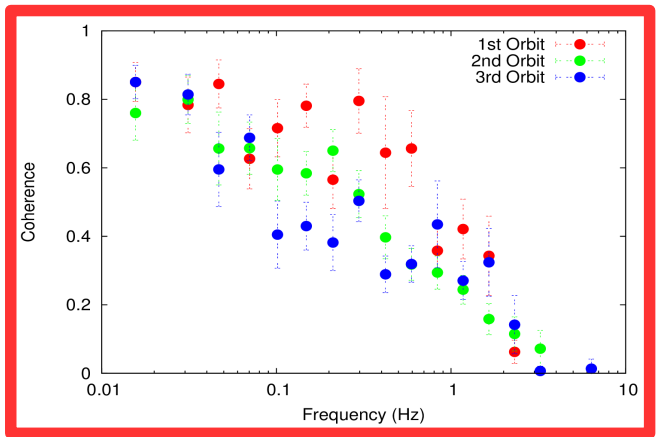
Time dependent Flux-Flux



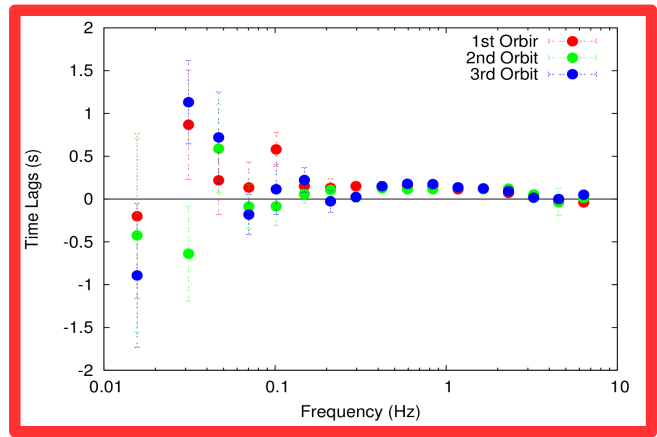
IR rms-flux relation



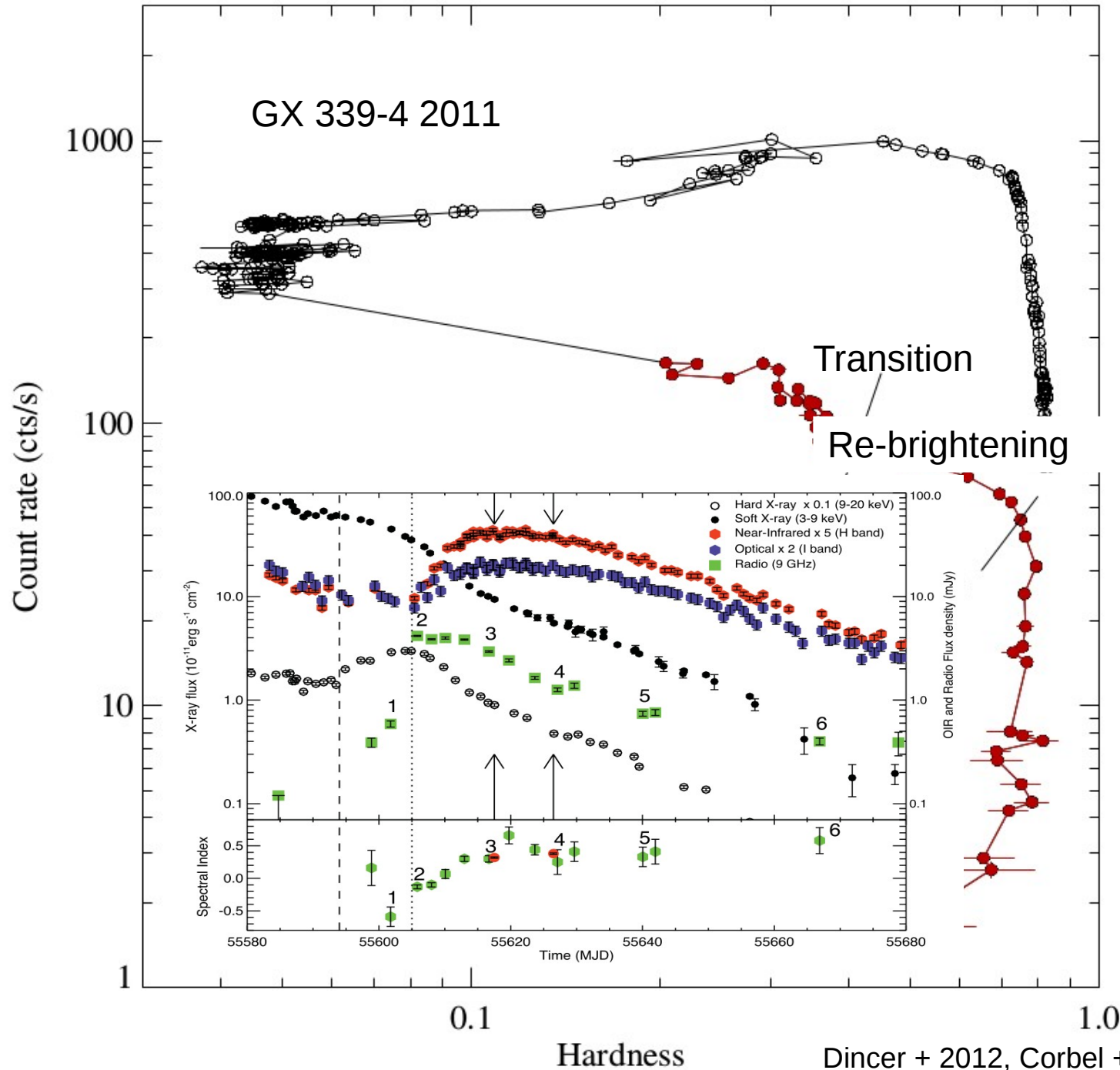
Coherence



Time Lags



CCF and the Q-Diagram



Hard state (decay)

OIR Re-brightening

Jet turns on again

Lots of unknowns..

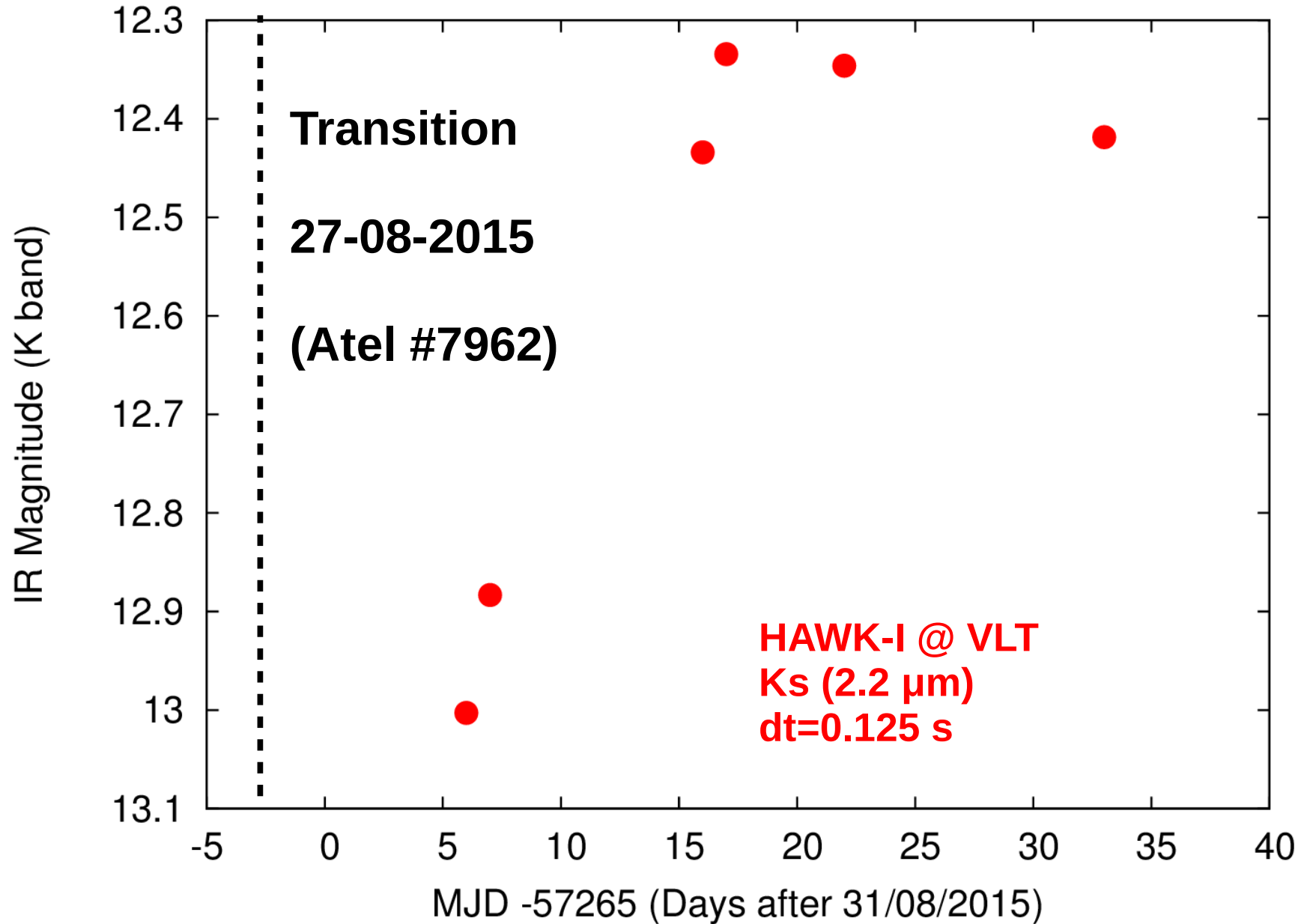
What is the origin of the hysteresis?

How does the jet form after the transition?

IR fast Phot can have the answer!

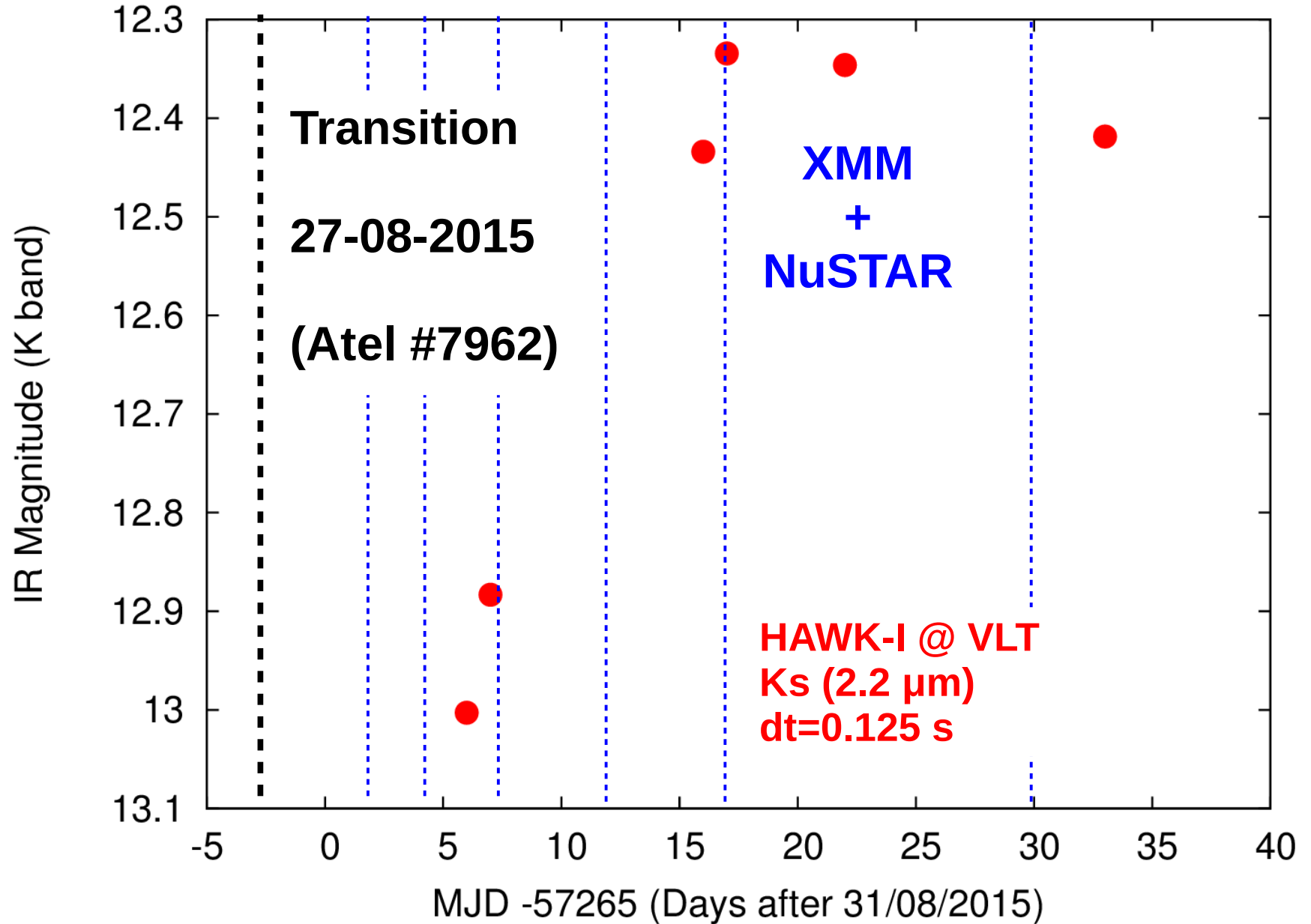
GX 339-4 2015 outburst DECAY

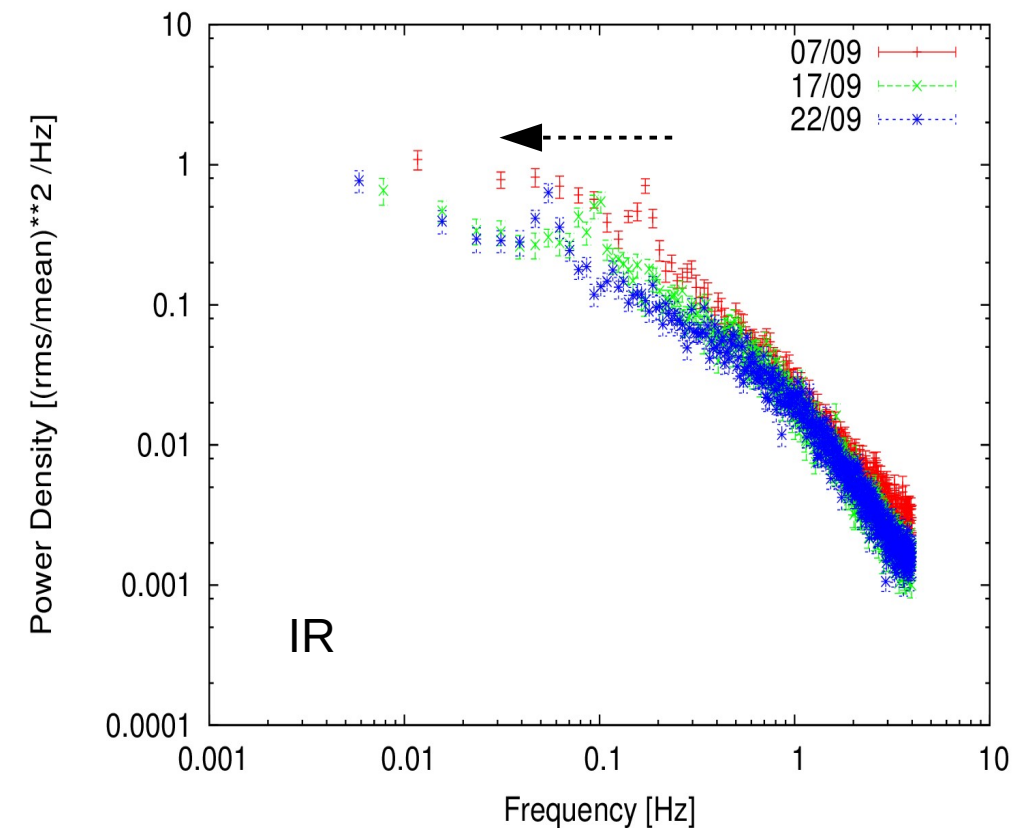
X/IR Observation during re-brightening



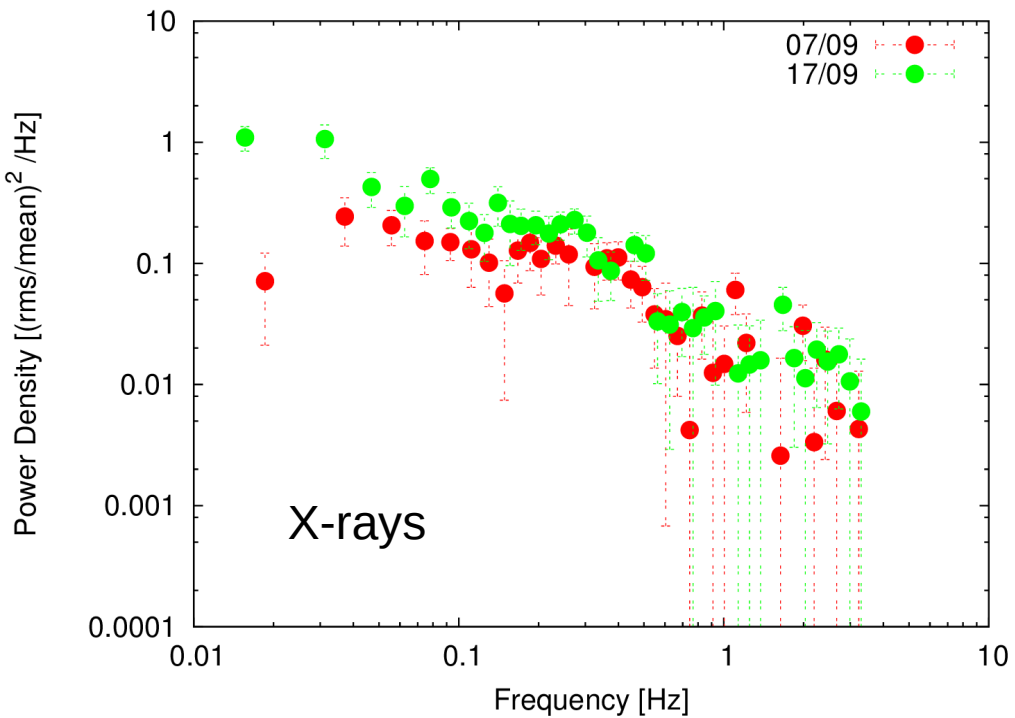
GX 339-4 2015 outburst DECAY

X/IR Observation during re-brightening

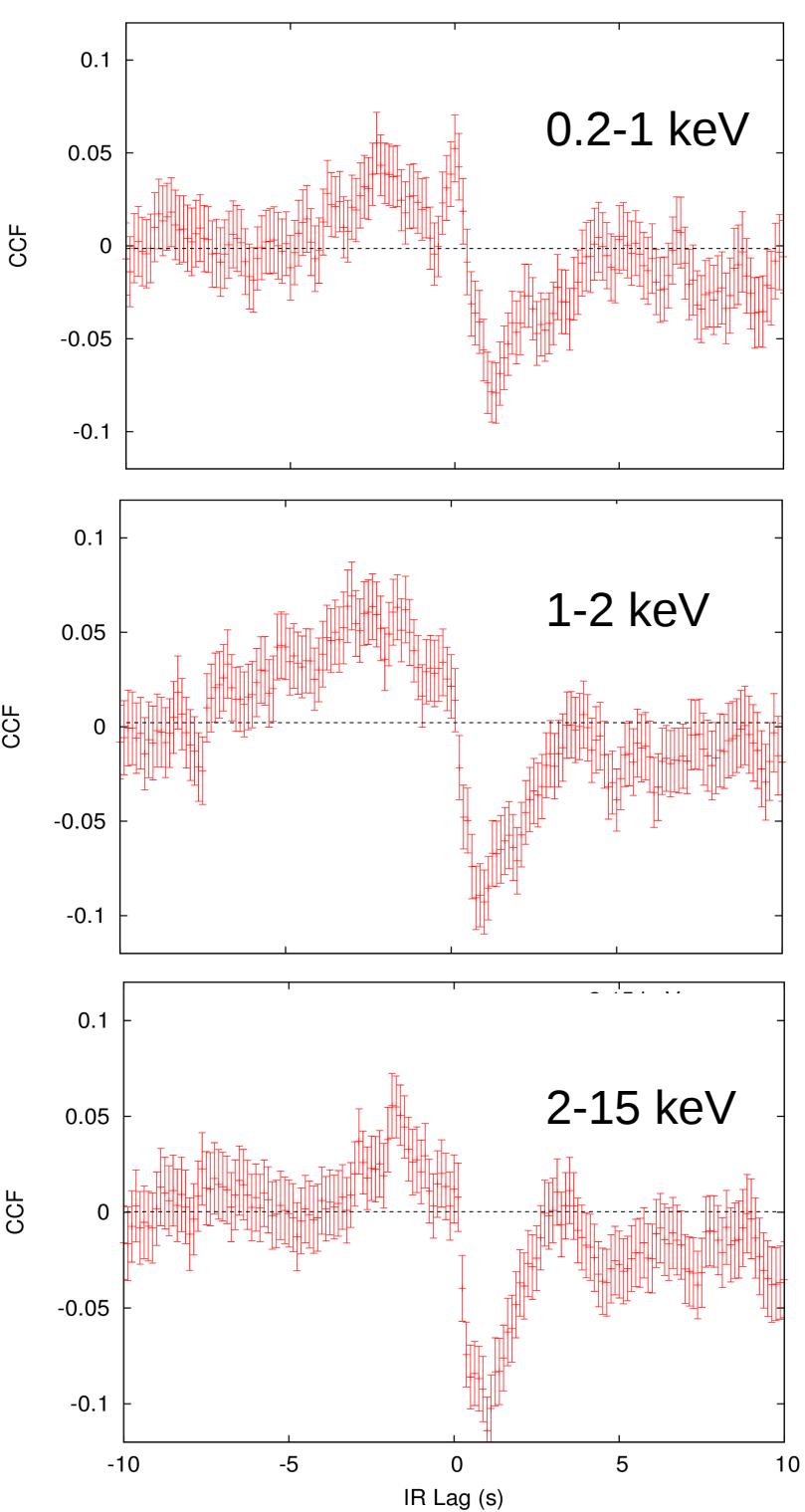




**Fourier Analysis:
Power spectrum**



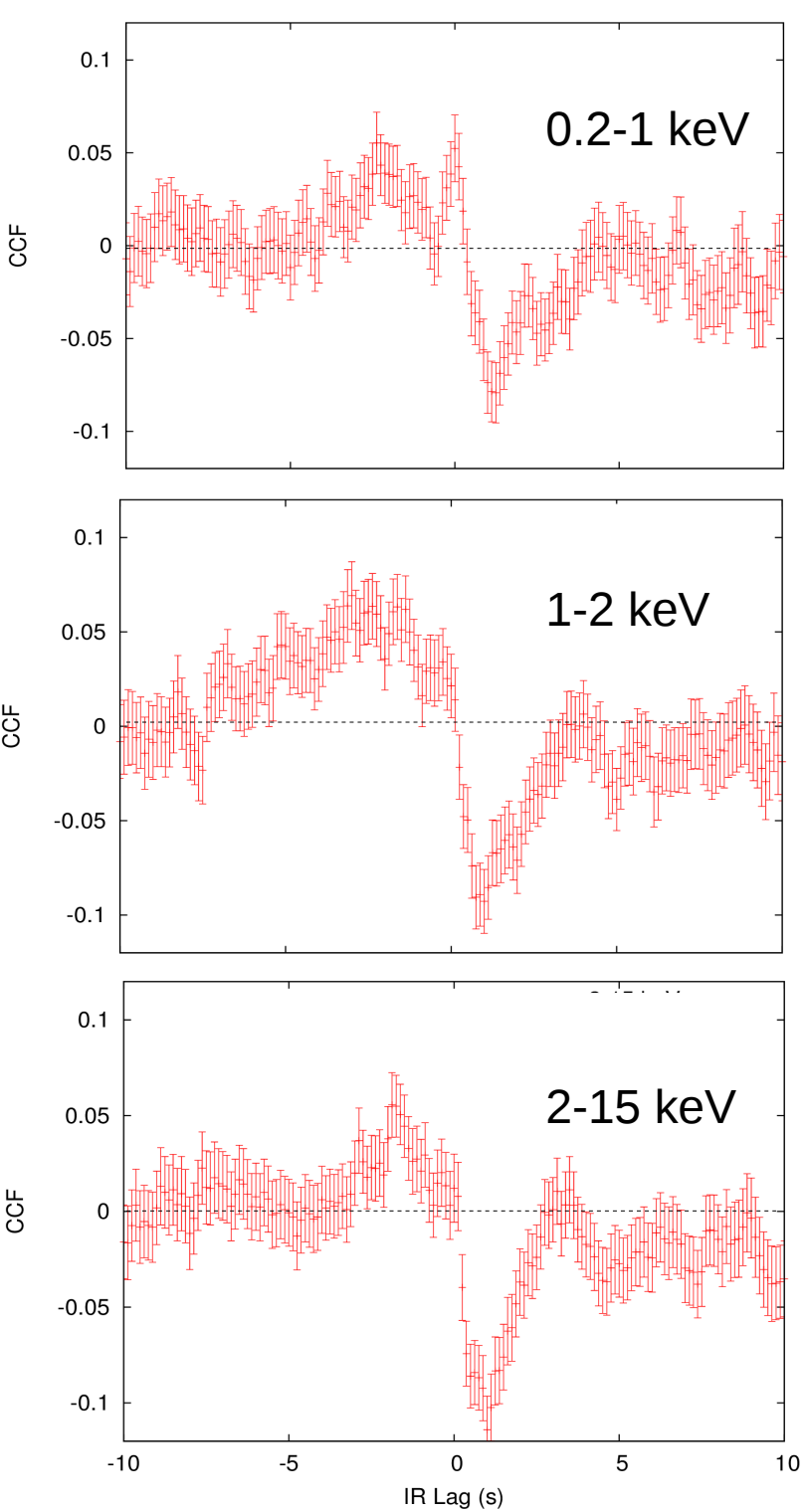
**Shifting IR QPO
too faint in X-ray?**



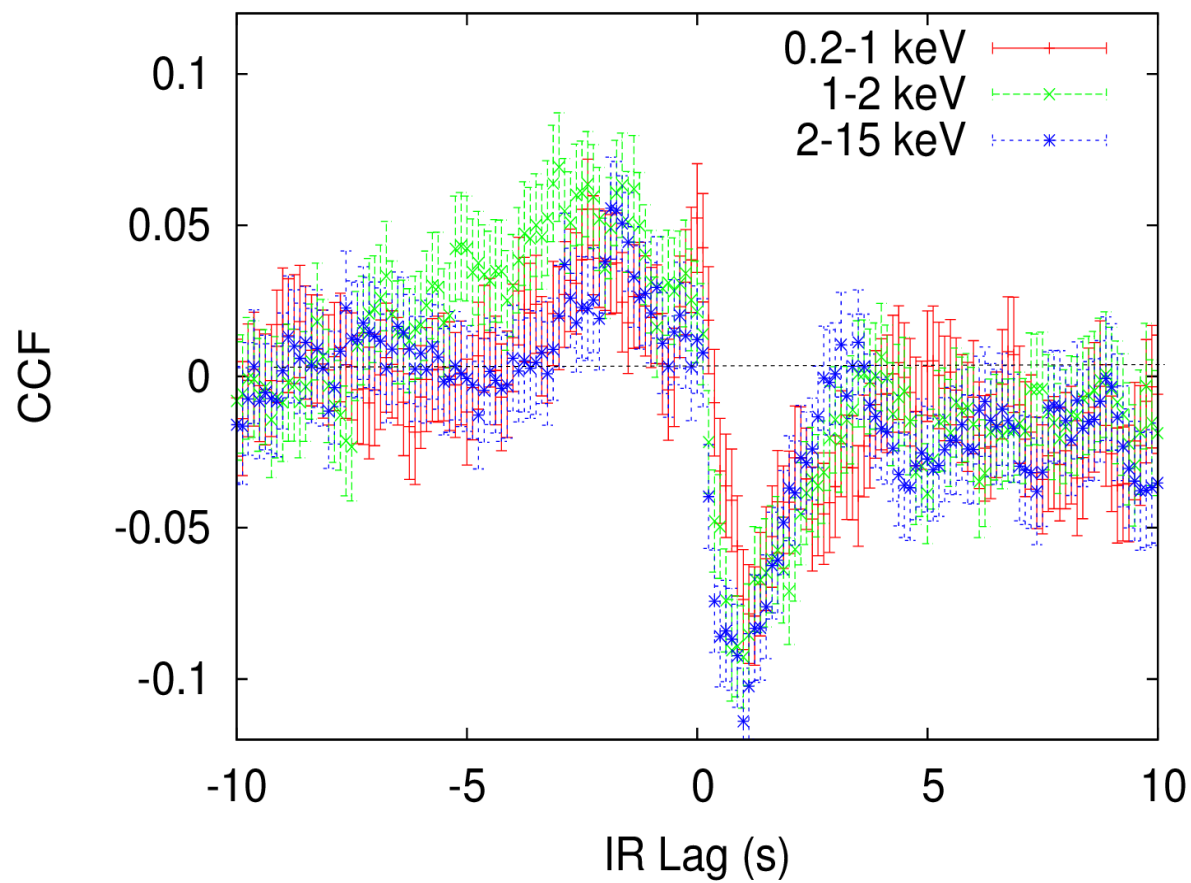
CROSS CORRELATION FUNCTION

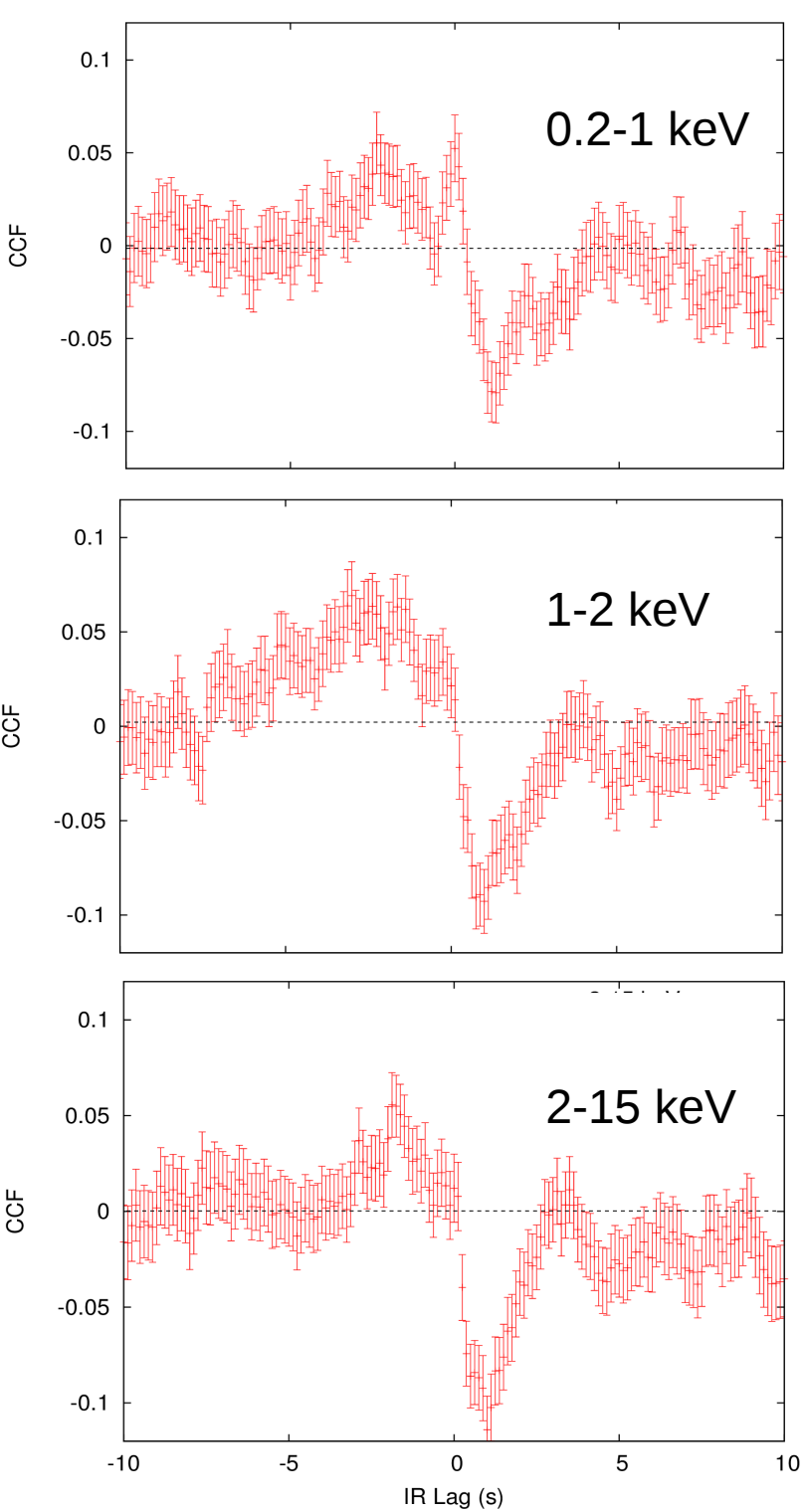
SIGNIFICANTLY DIFFERENT FROM RISE STATE

- 1) LONG INVERTED LAG
- 2) STRONG ANTISYMMETRIC DIP
- 3) EVIDENCE OF ENERGY DEPENDENCE

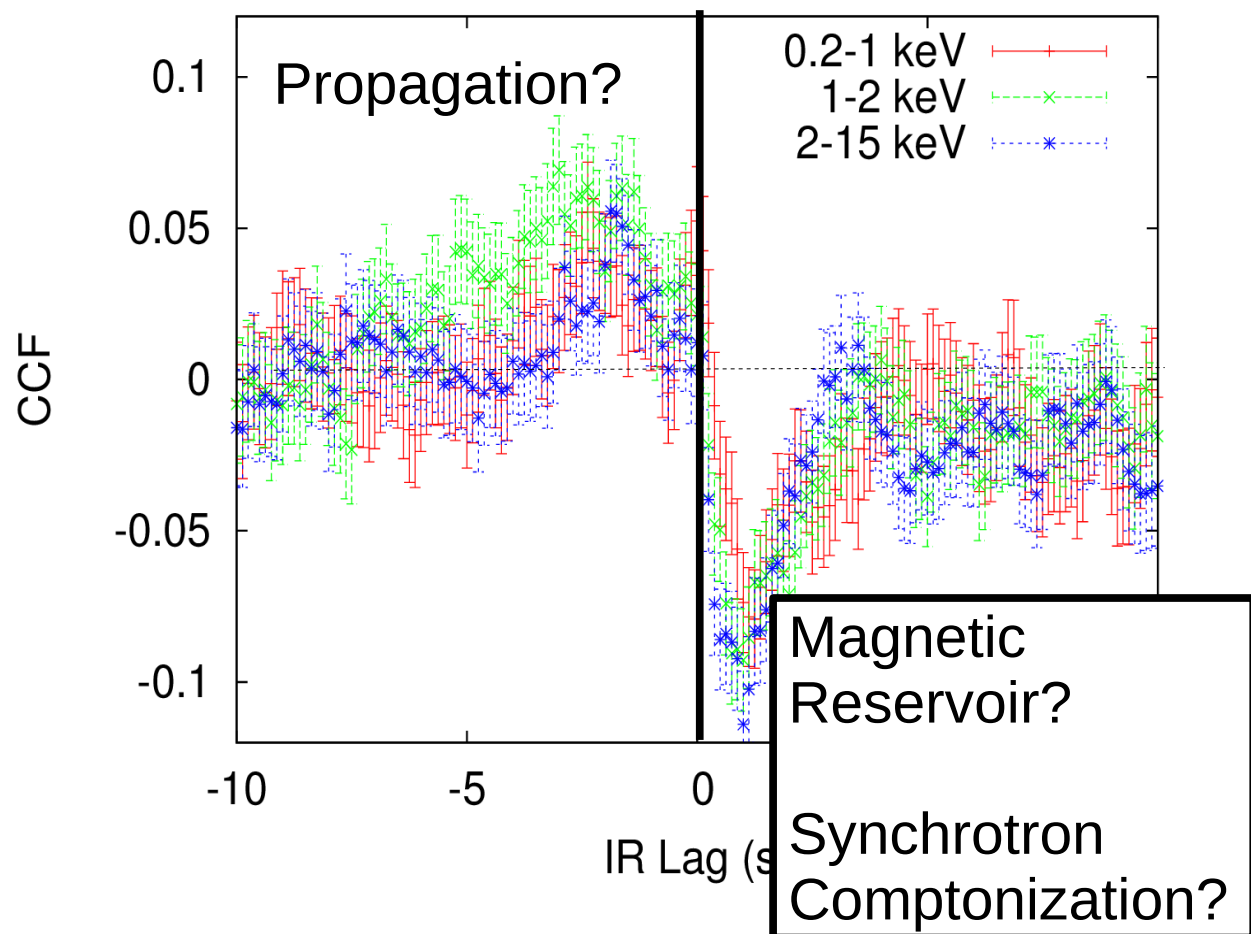


CROSS CORRELATION FUNCTION

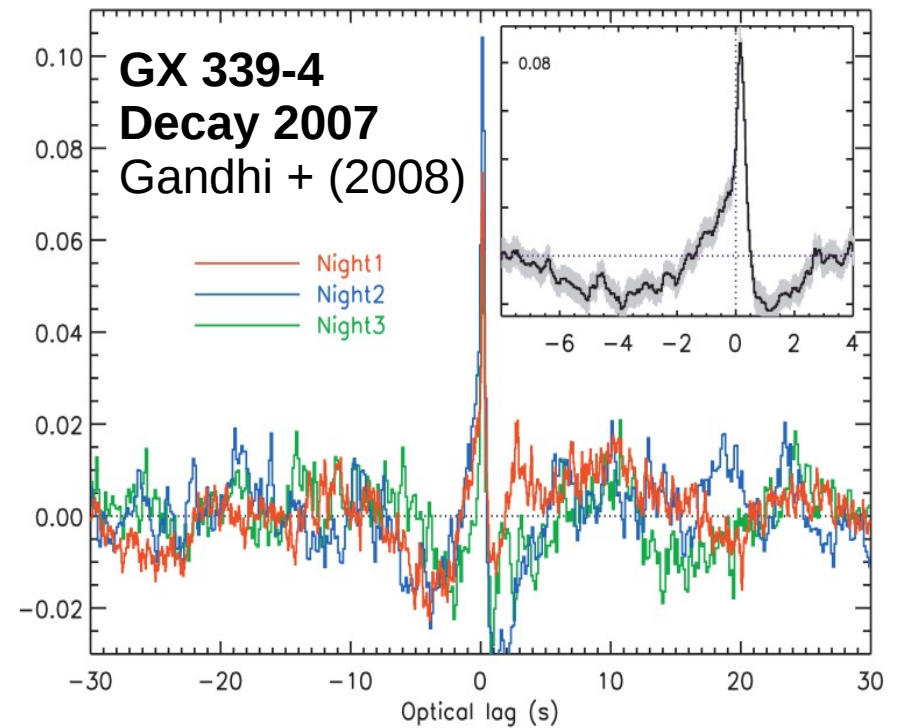
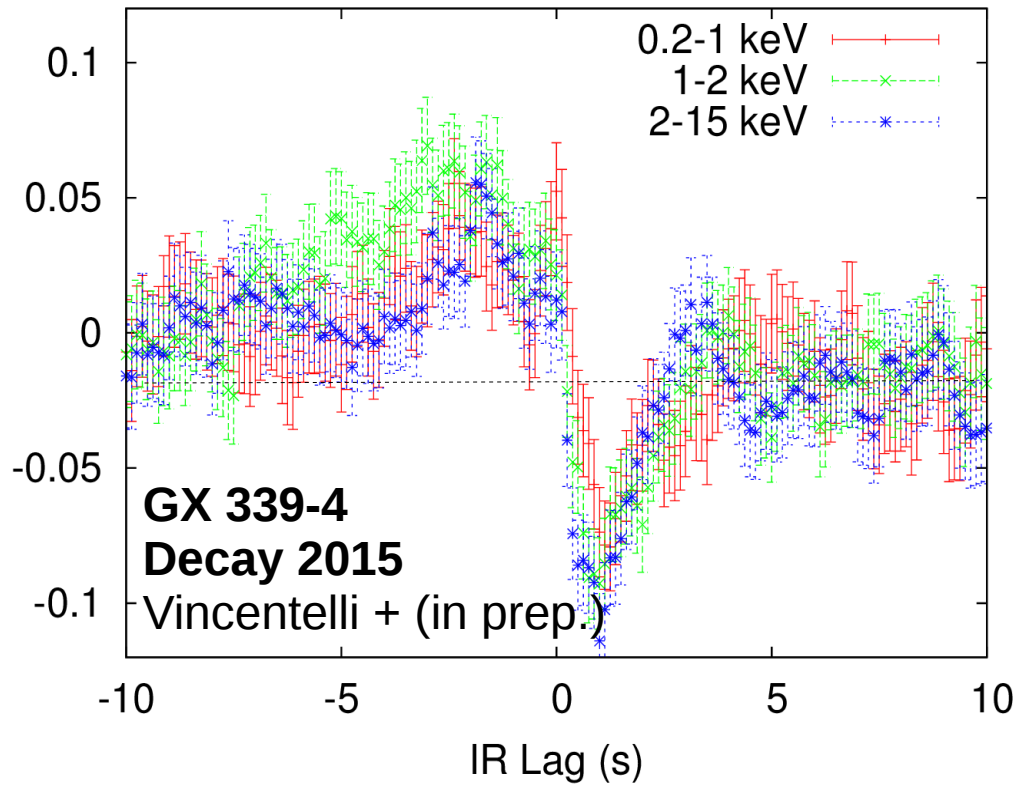




CROSS CORRELATION FUNCTION

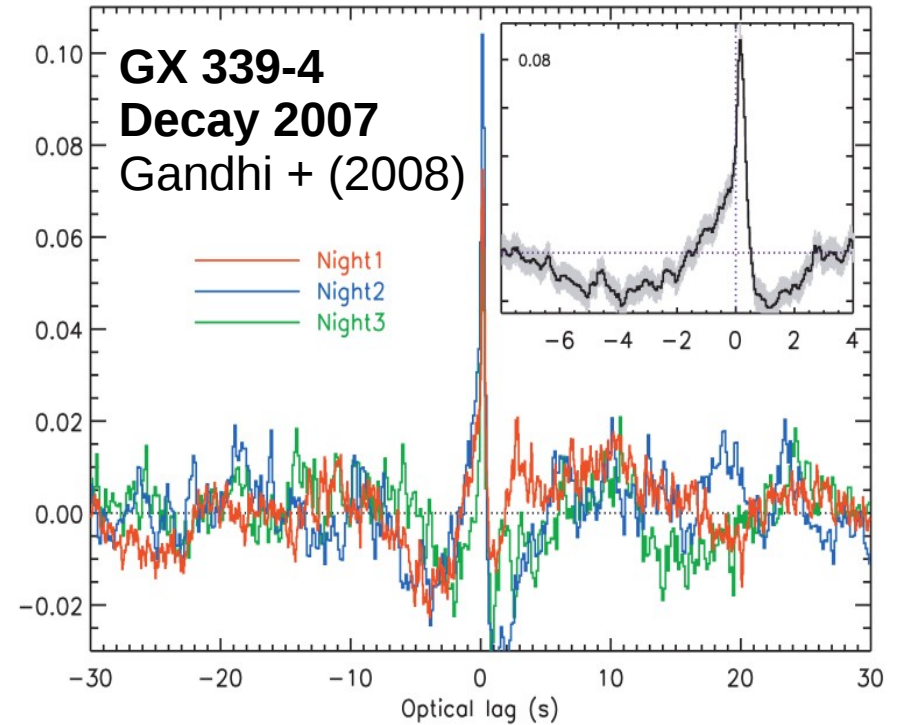
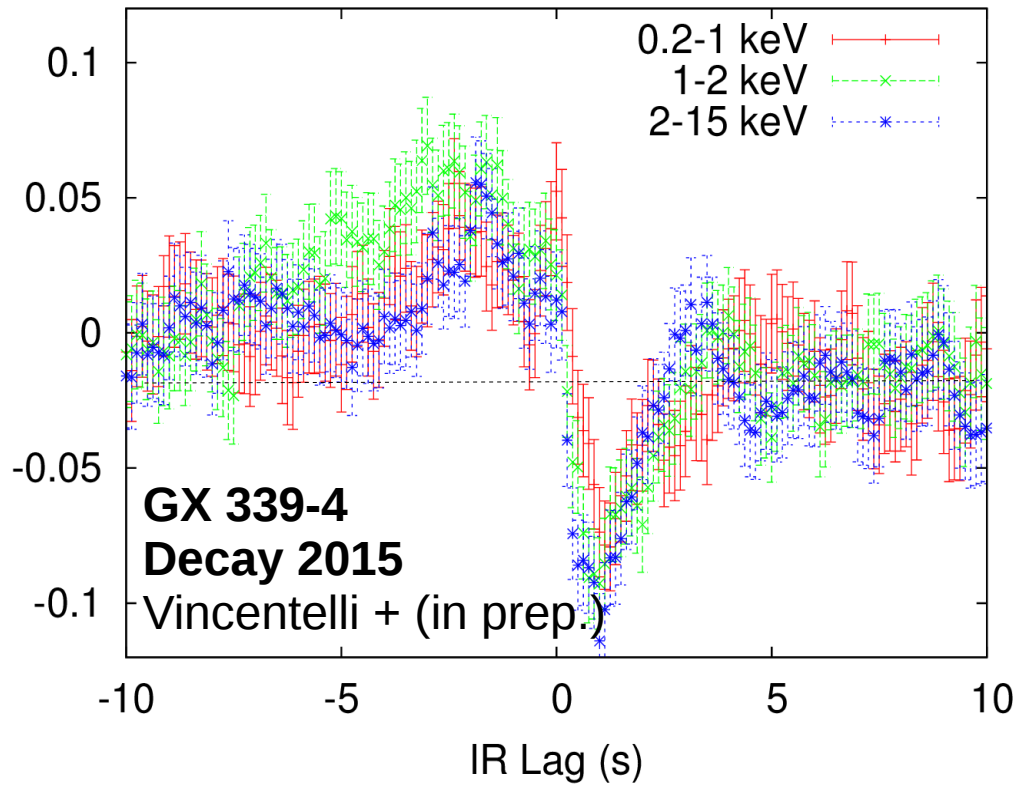


A “familiar” dip



Outburst:	2015	2007
Band:	KS (2.2 μm)	r' (0.63 μm)
X-ray flux :	1.8	1.6
(10^{-10} erg s^{-1} cm^{-2})		
Γ :	1.6	1.7

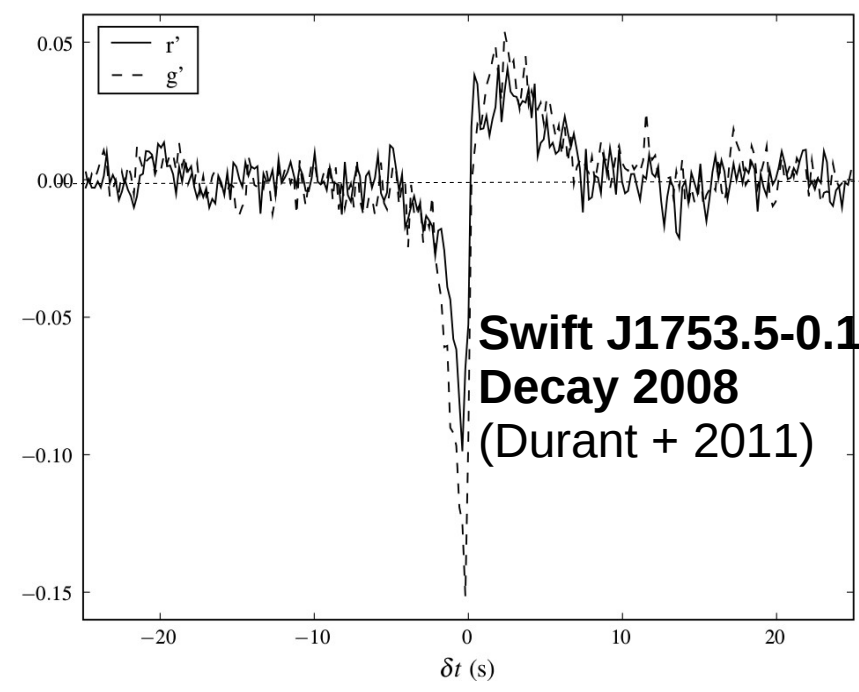
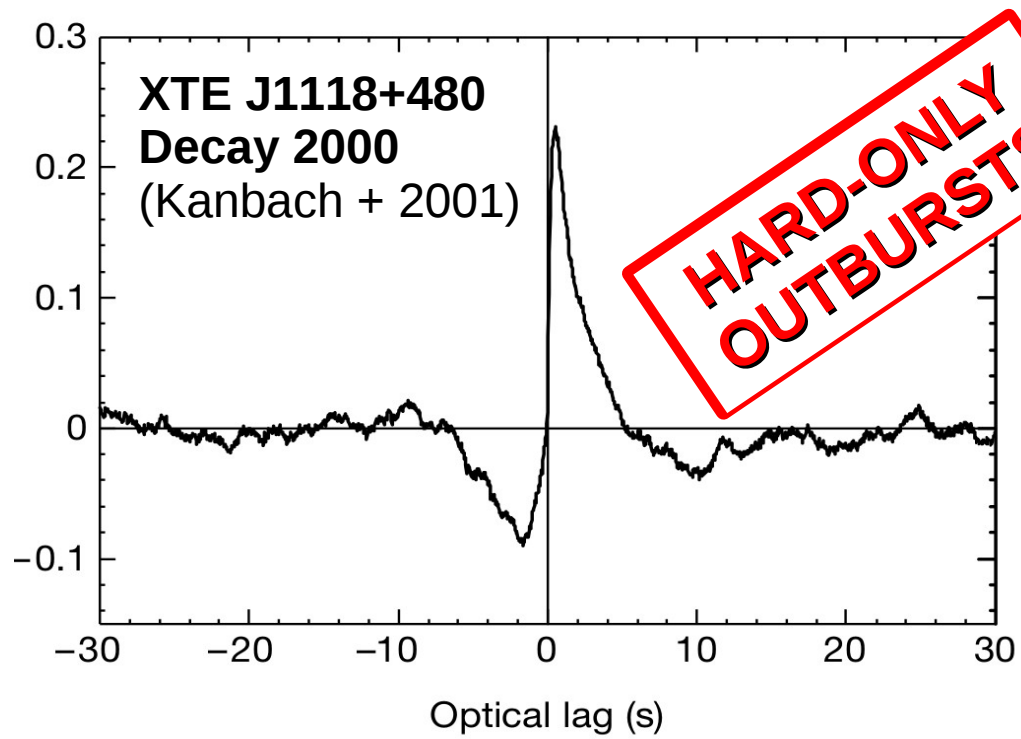
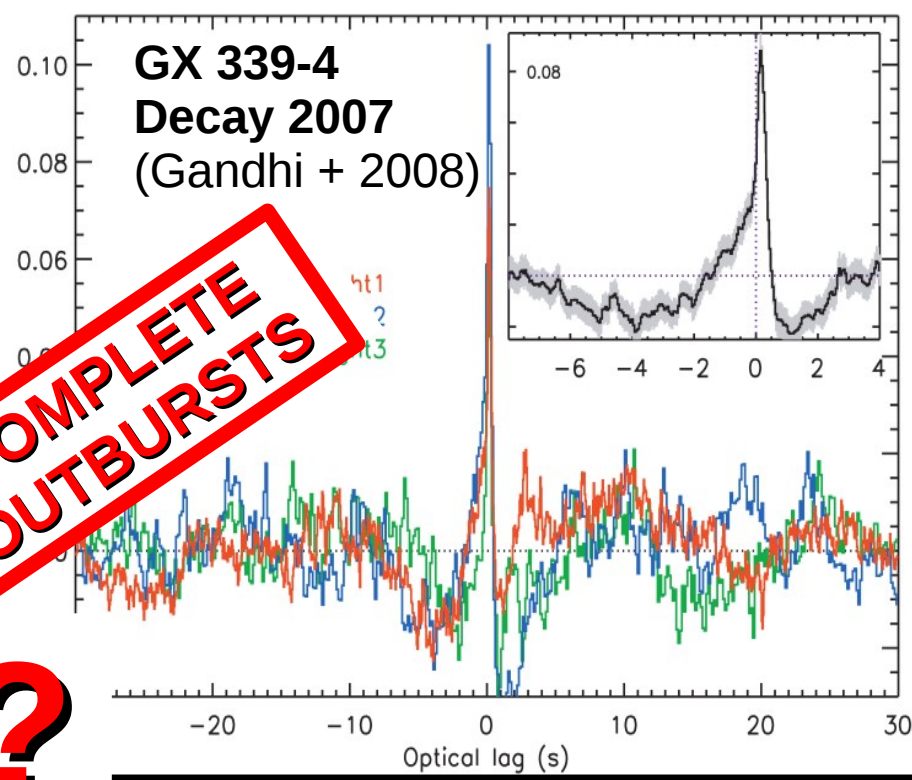
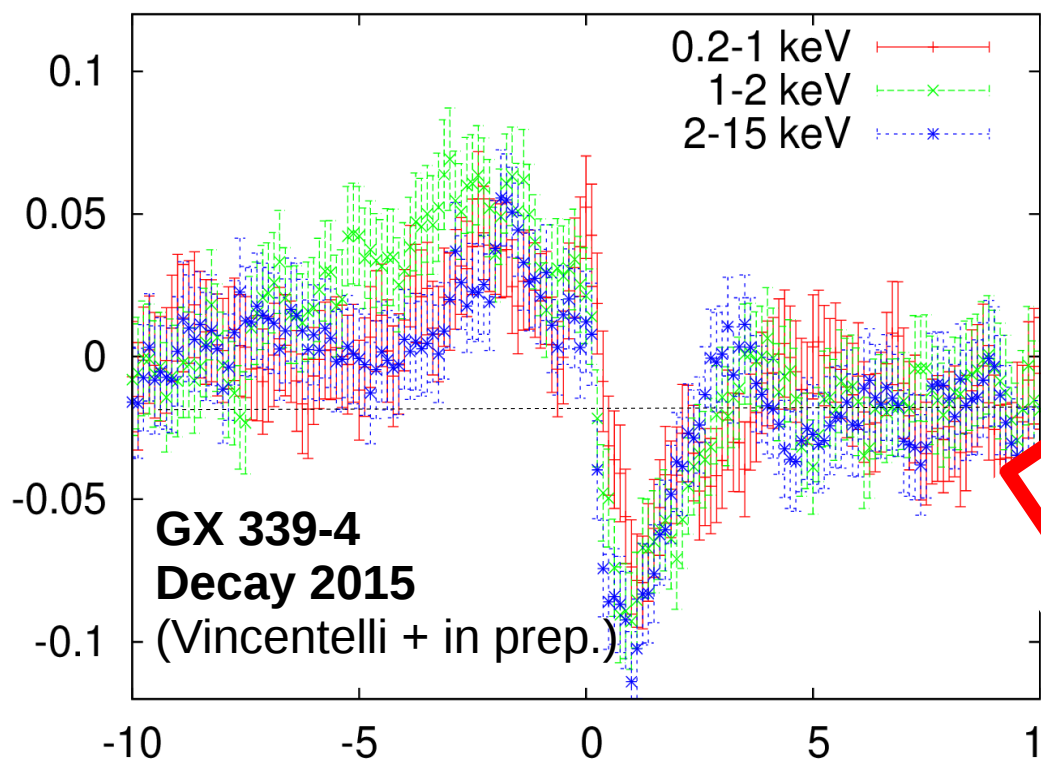
A “familiar” dip

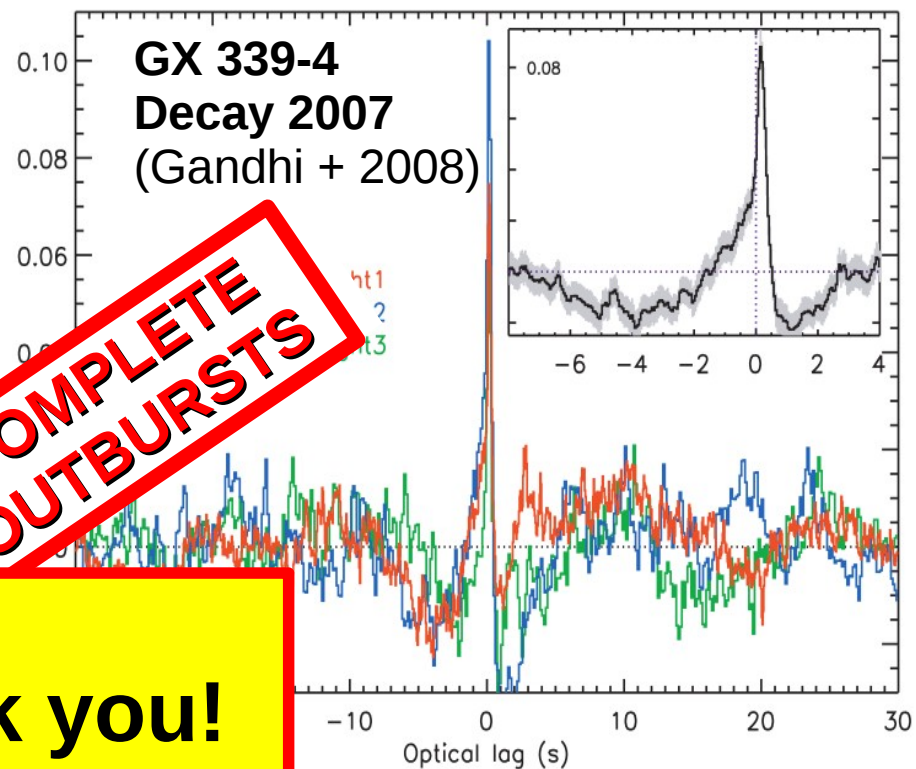
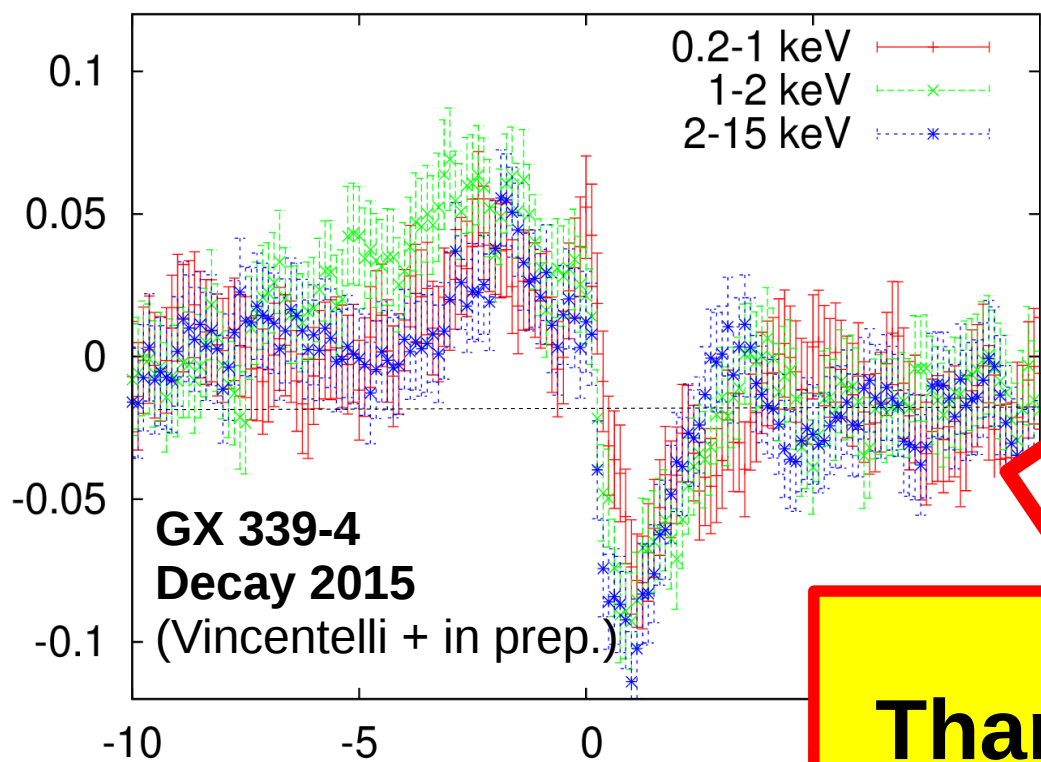


	2015	2007
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<small>(10^{-10} erg s$^{-1}$ cm$^{-2}$)</small>		
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What is the difference then?

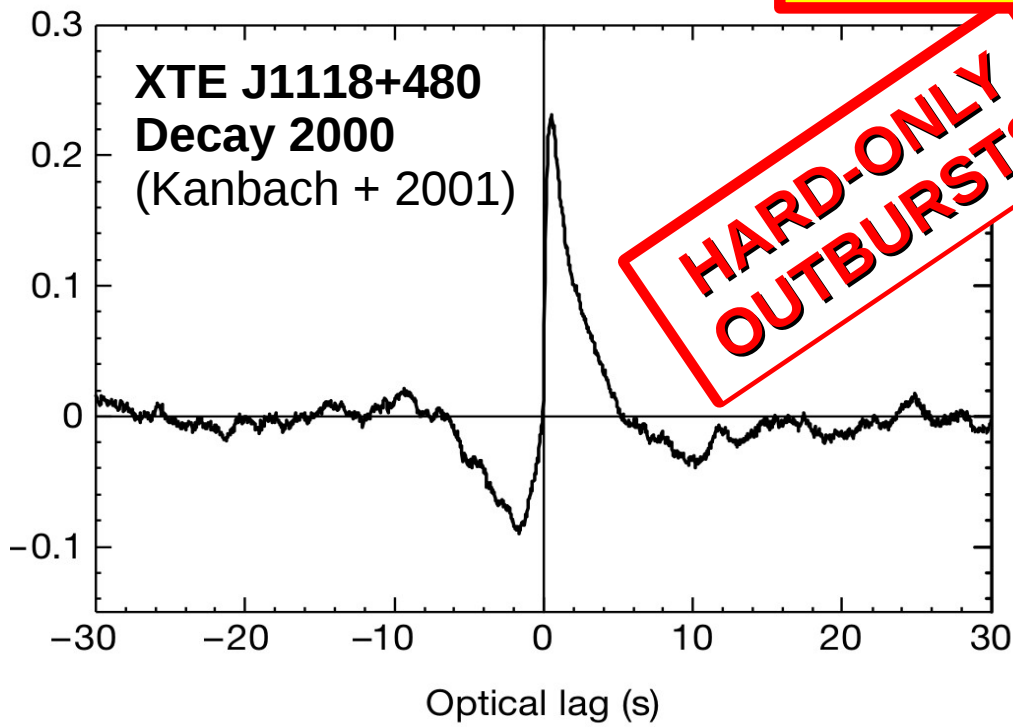
Time or Wavelength?



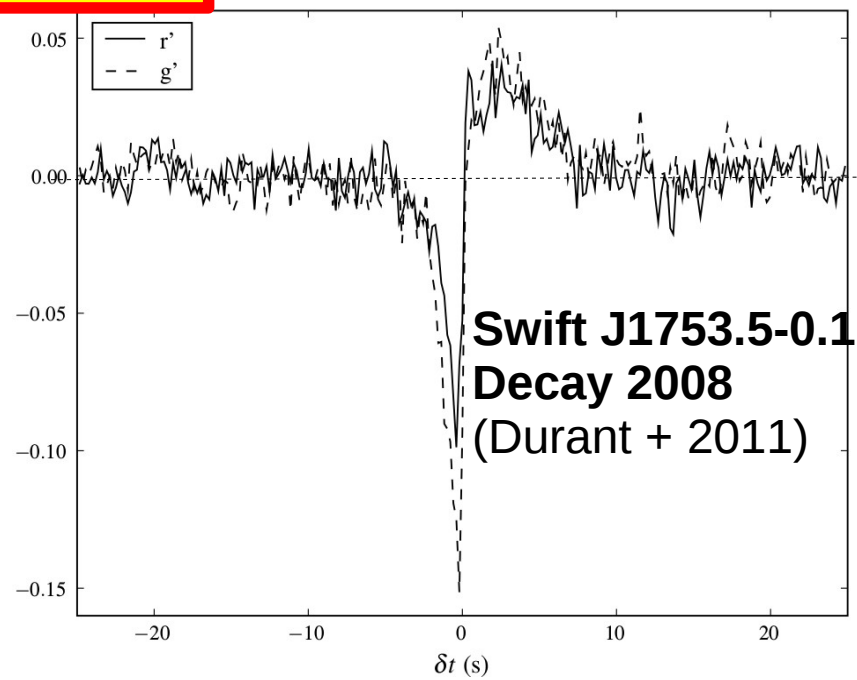


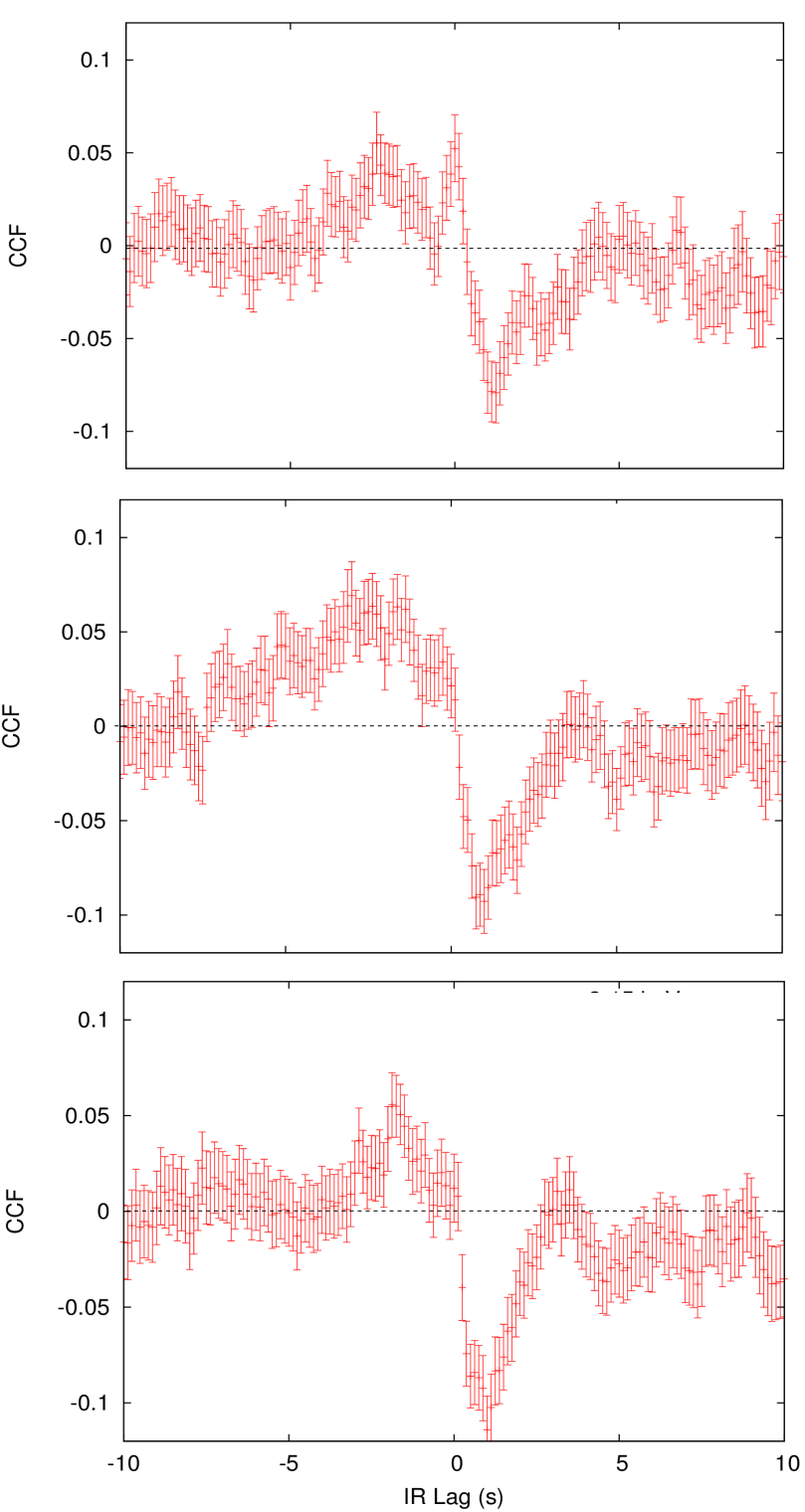
**COMPLETE
OUTBURSTS**

Thank you!



**HARD-ONLY
OUTBURSTS**





0.2-1 keV

1-2 keV

2-15 keV

