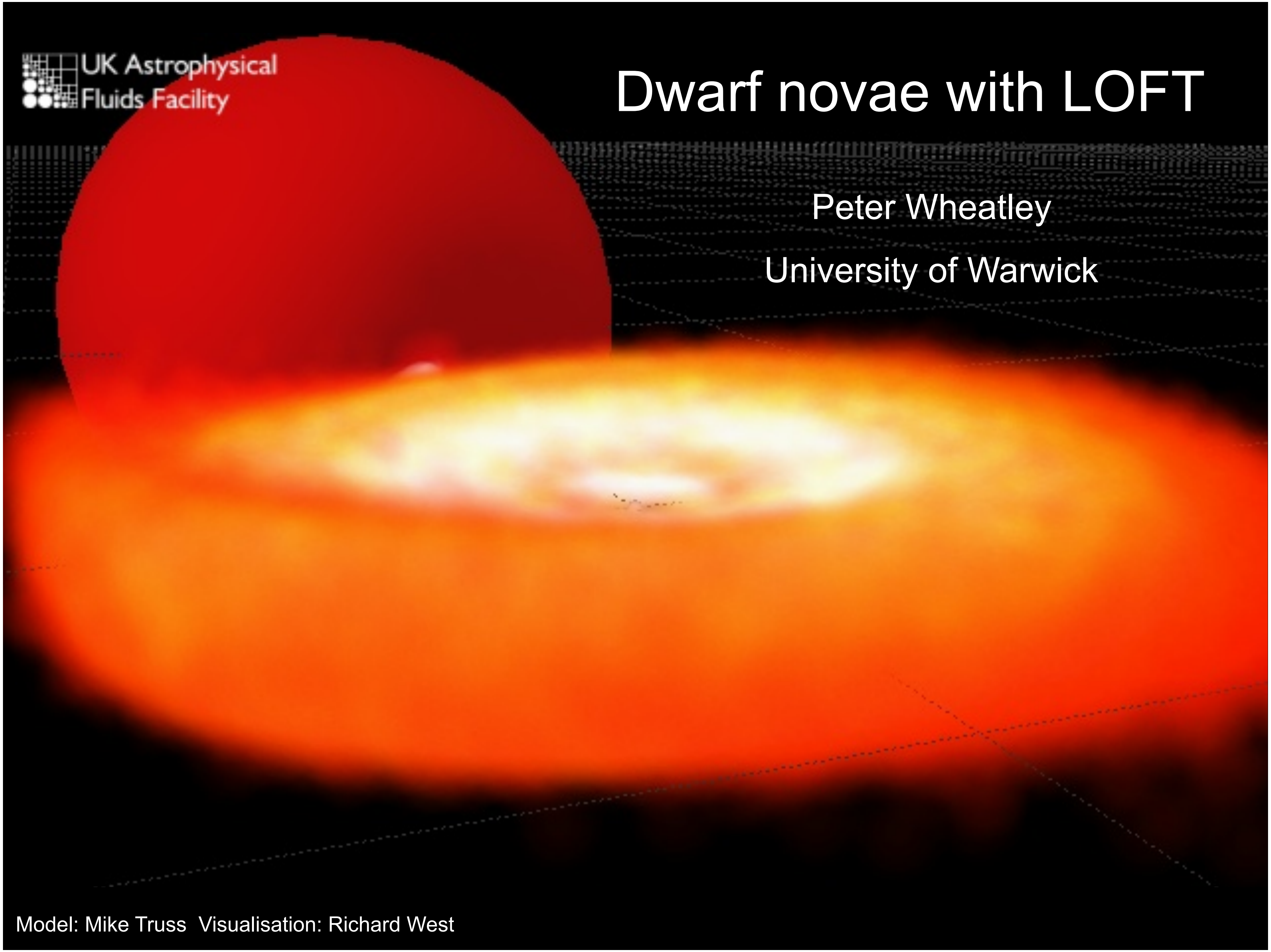
Dwarf novae with LOFT

Peter Wheatley

University of Warwick

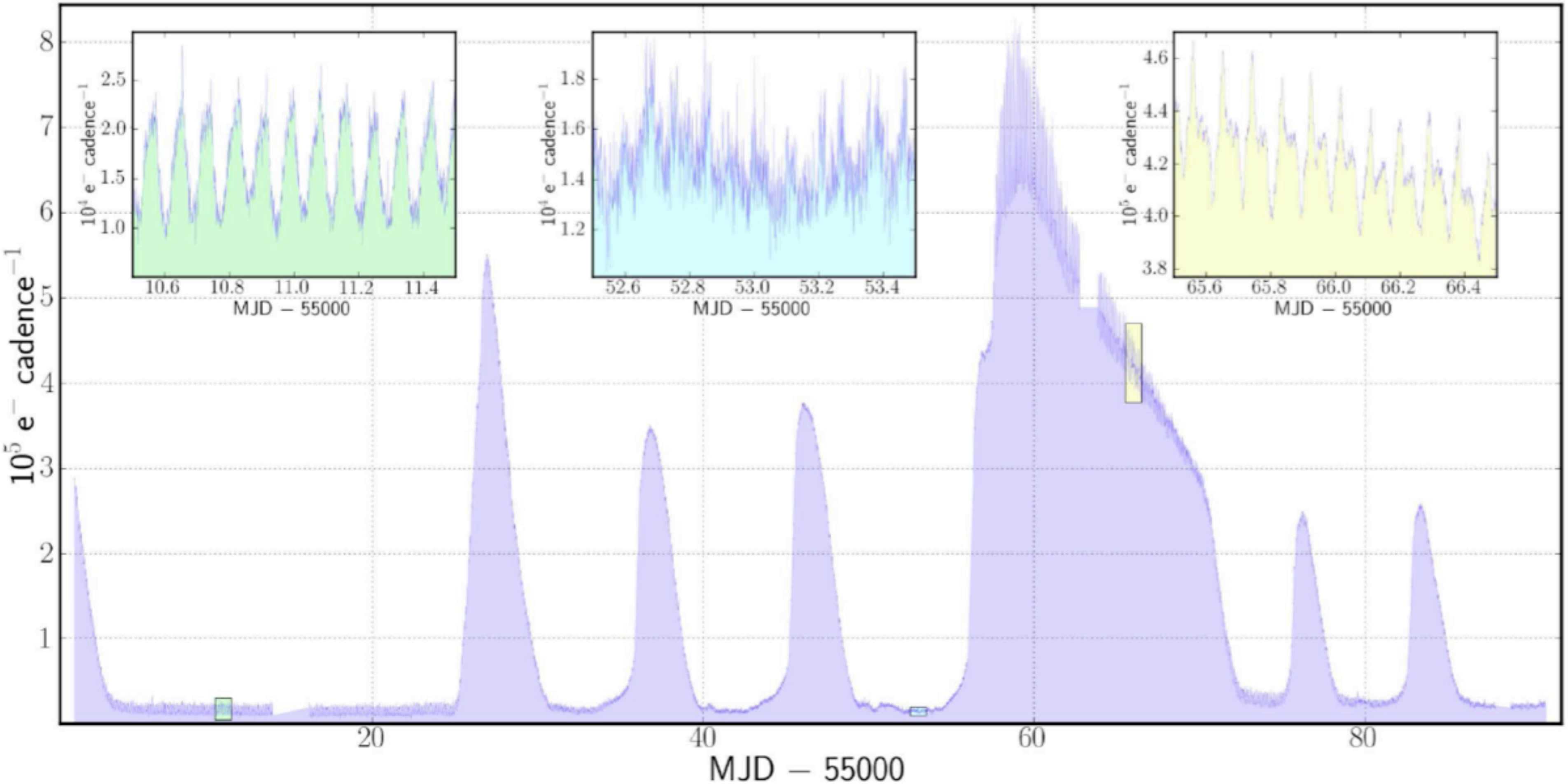


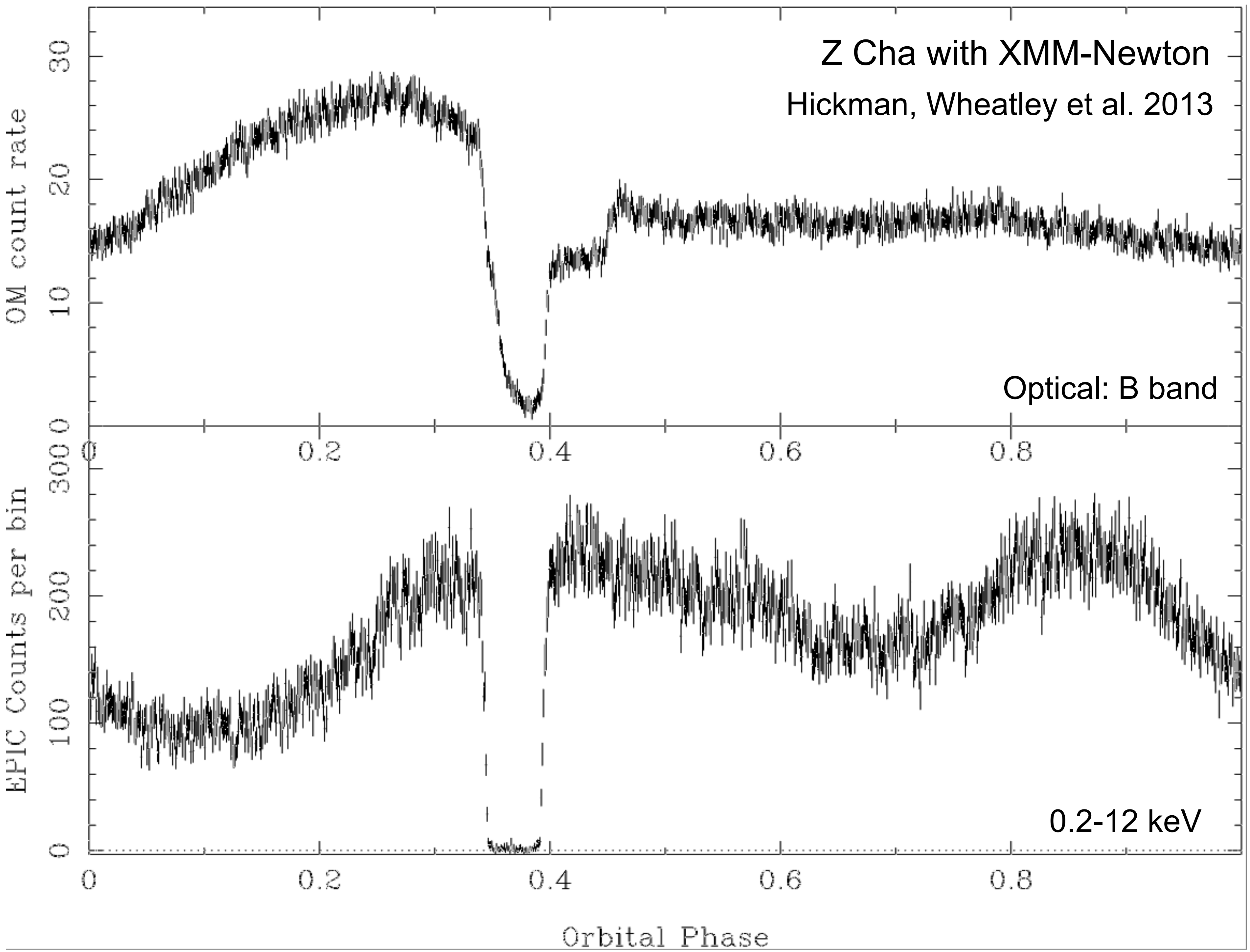
Model: Mike Truss Visualisation: Richard West

Kepler GO highlight

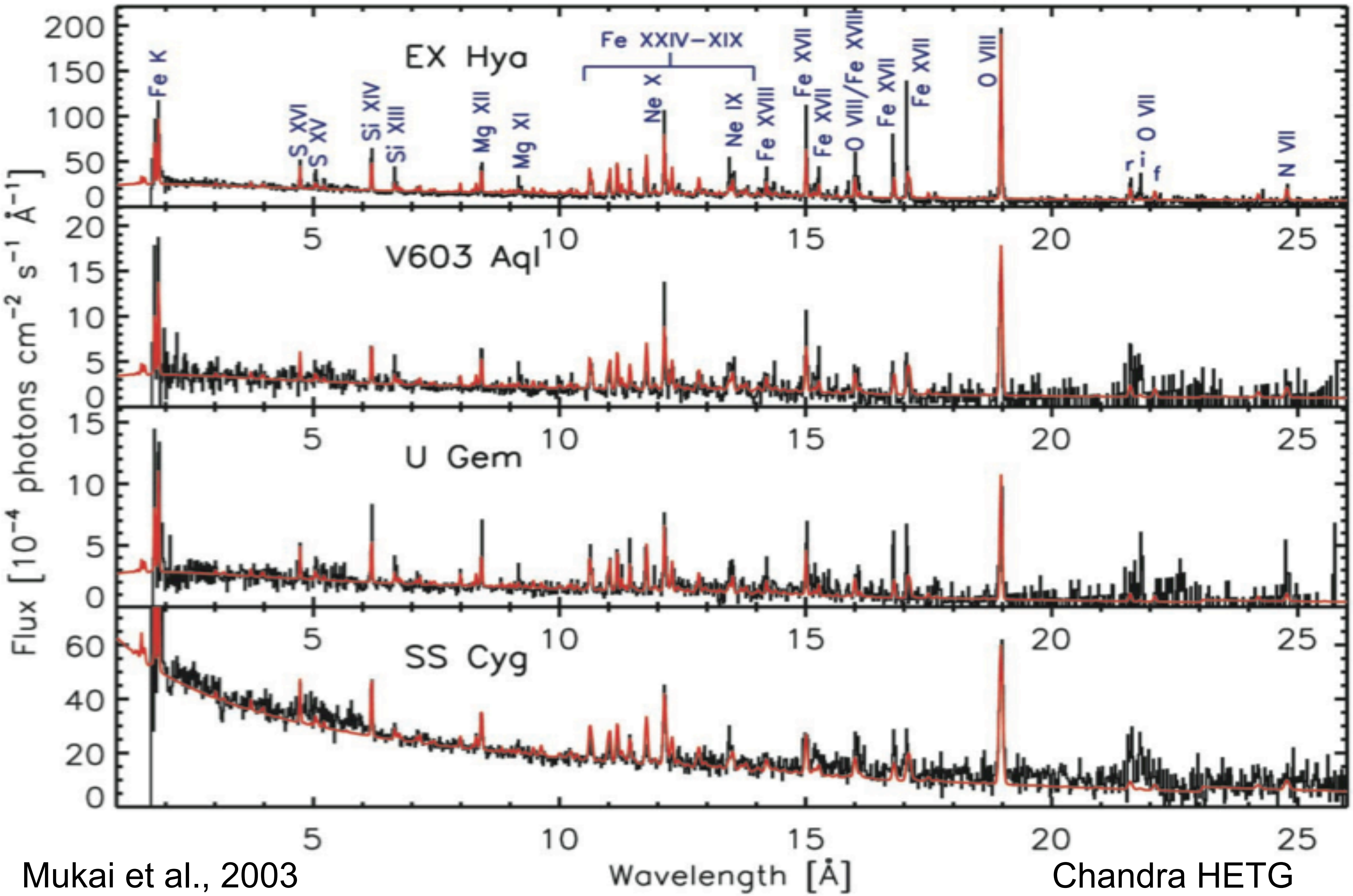
V344 Lyr

Still et al 2010



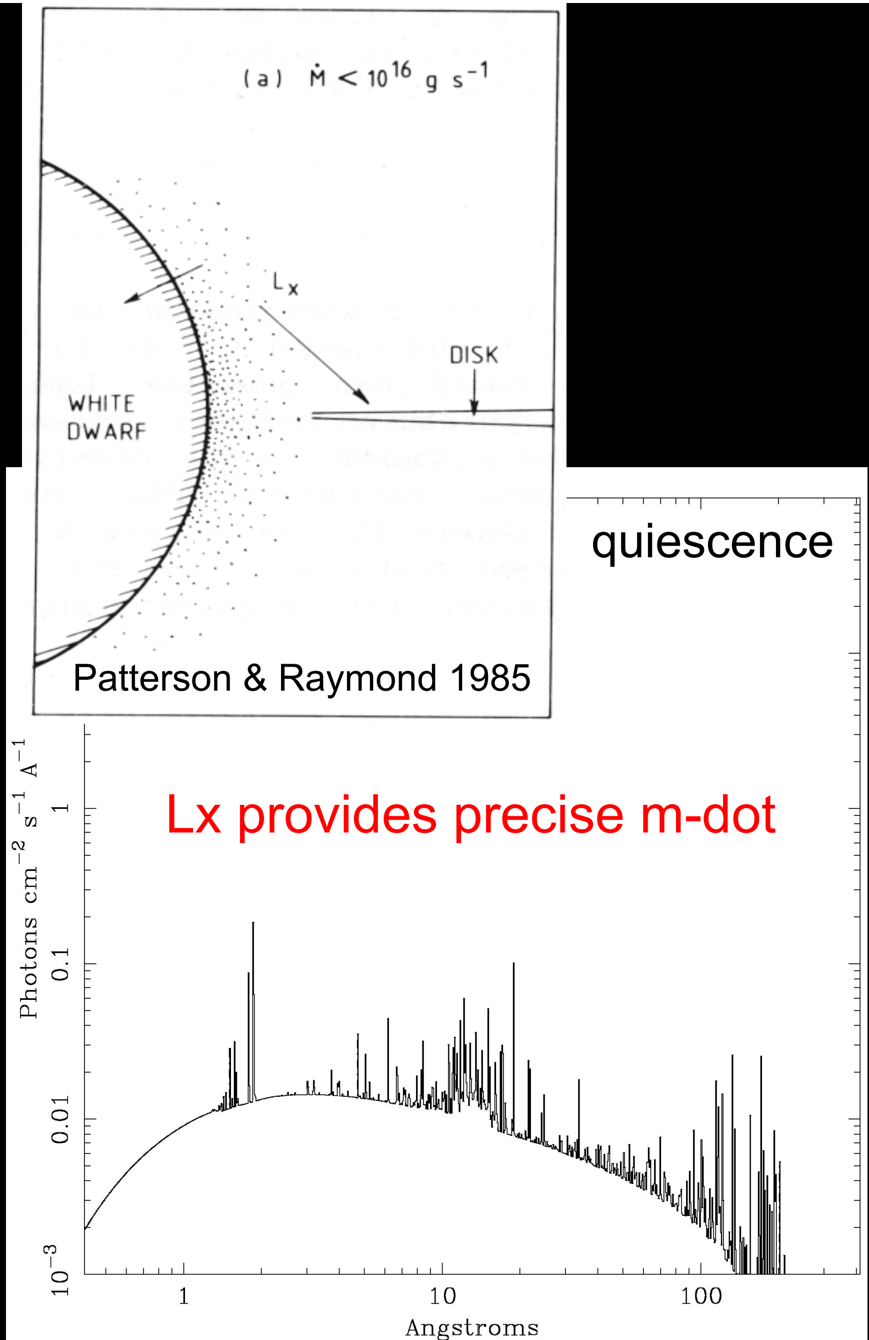

Z Cha with XMM-Newton
Hickman, Wheatley et al. 2013
Optical: B band
OM count rate
0
10
20
30
0
0.2
0.4
0.6
0.8
EPIC Counts per bin
0
100
200
300
0.2-12 keV
0
0.2
0.4
0.6
0.8
Orbital Phase

Thermal X-ray emission from white dwarf surface

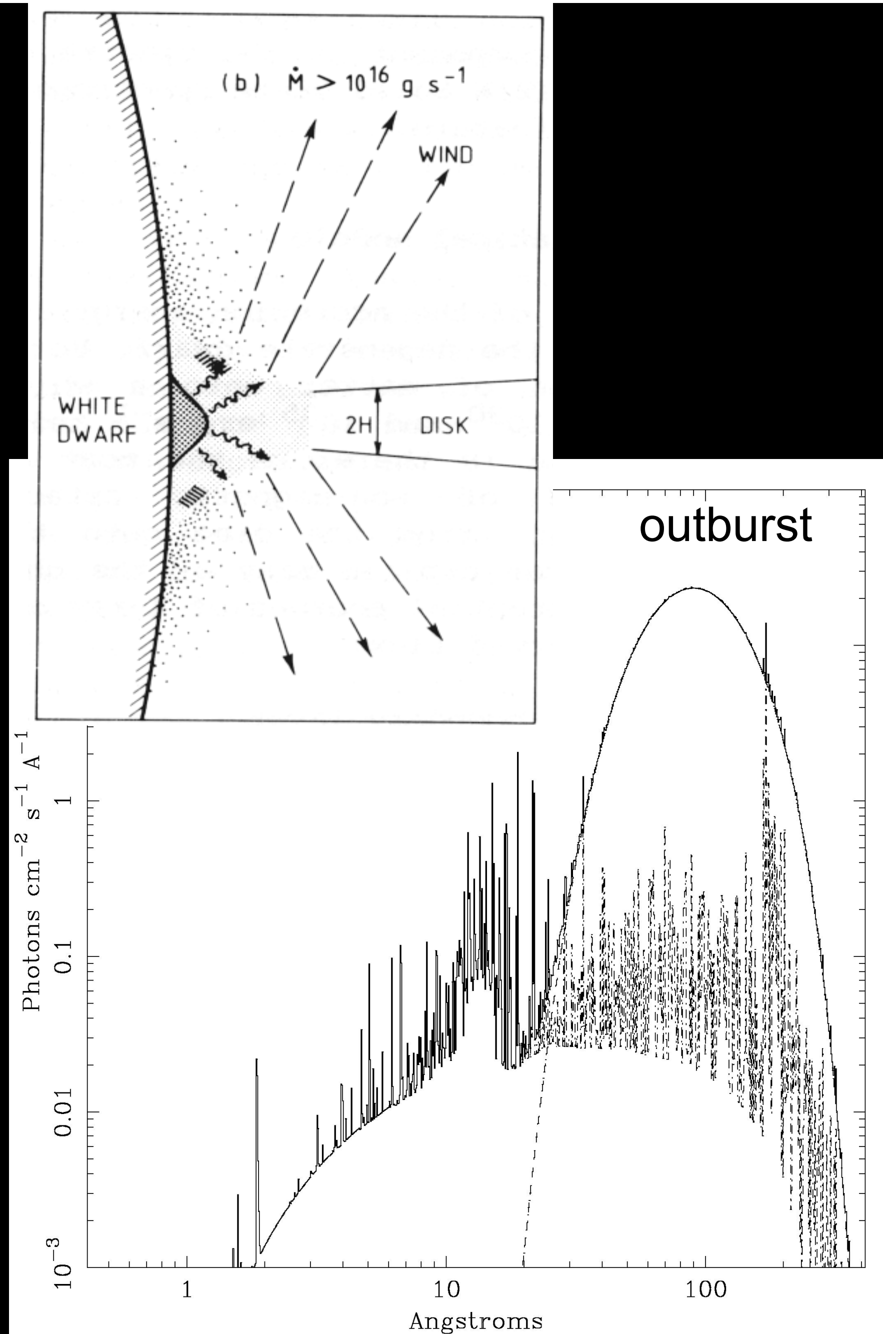


Mukai et al., 2003

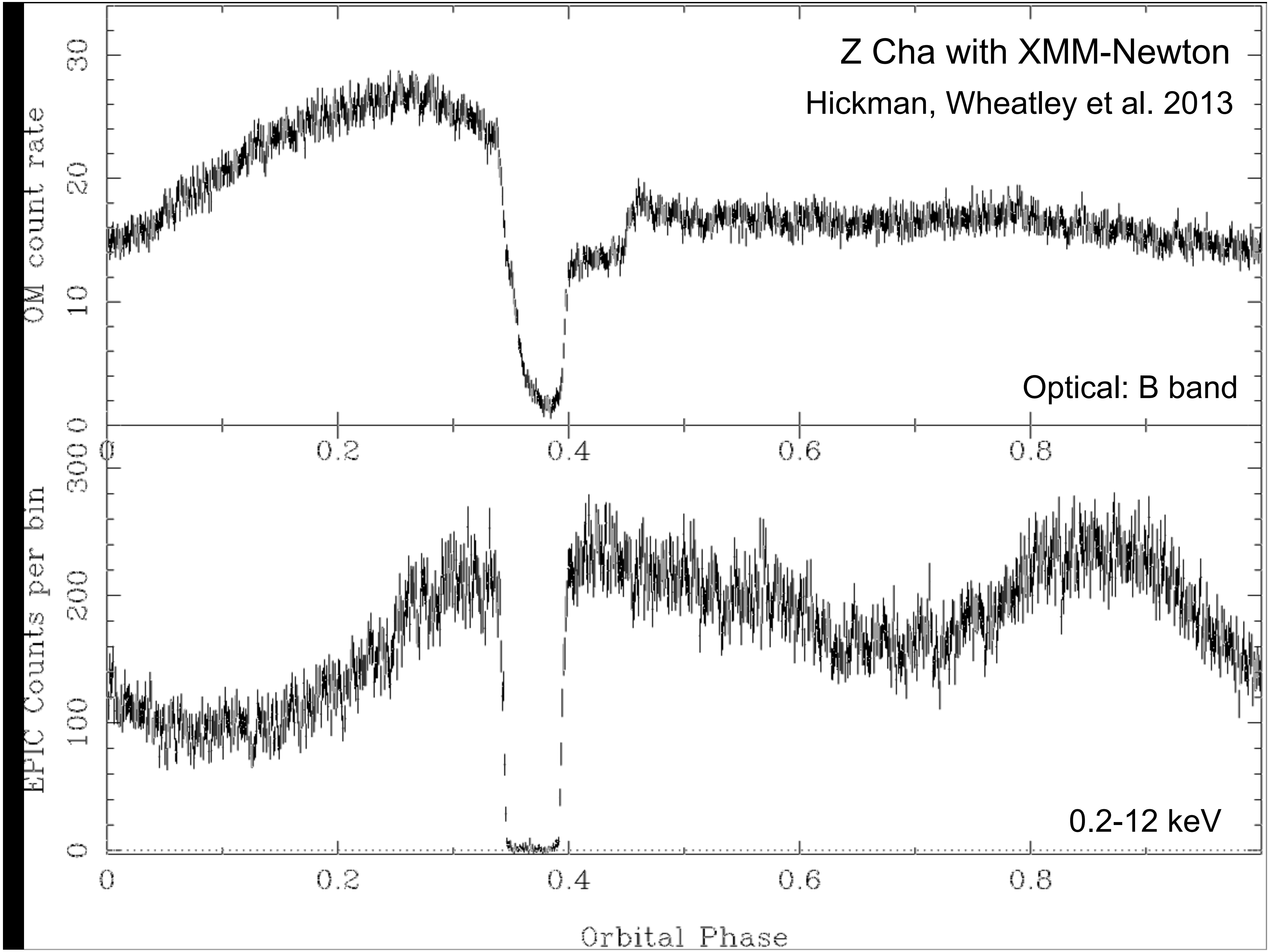
Chandra HETG

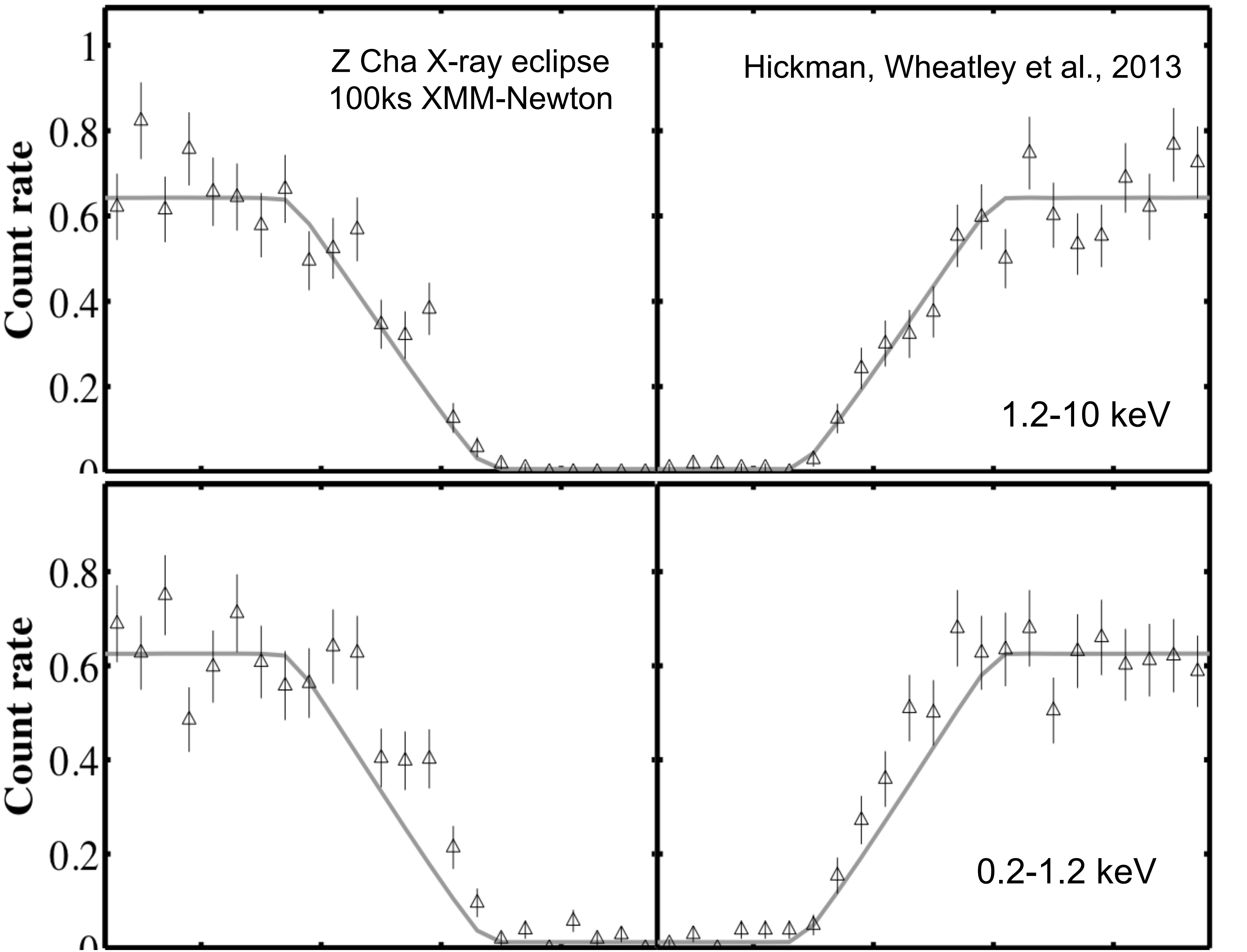


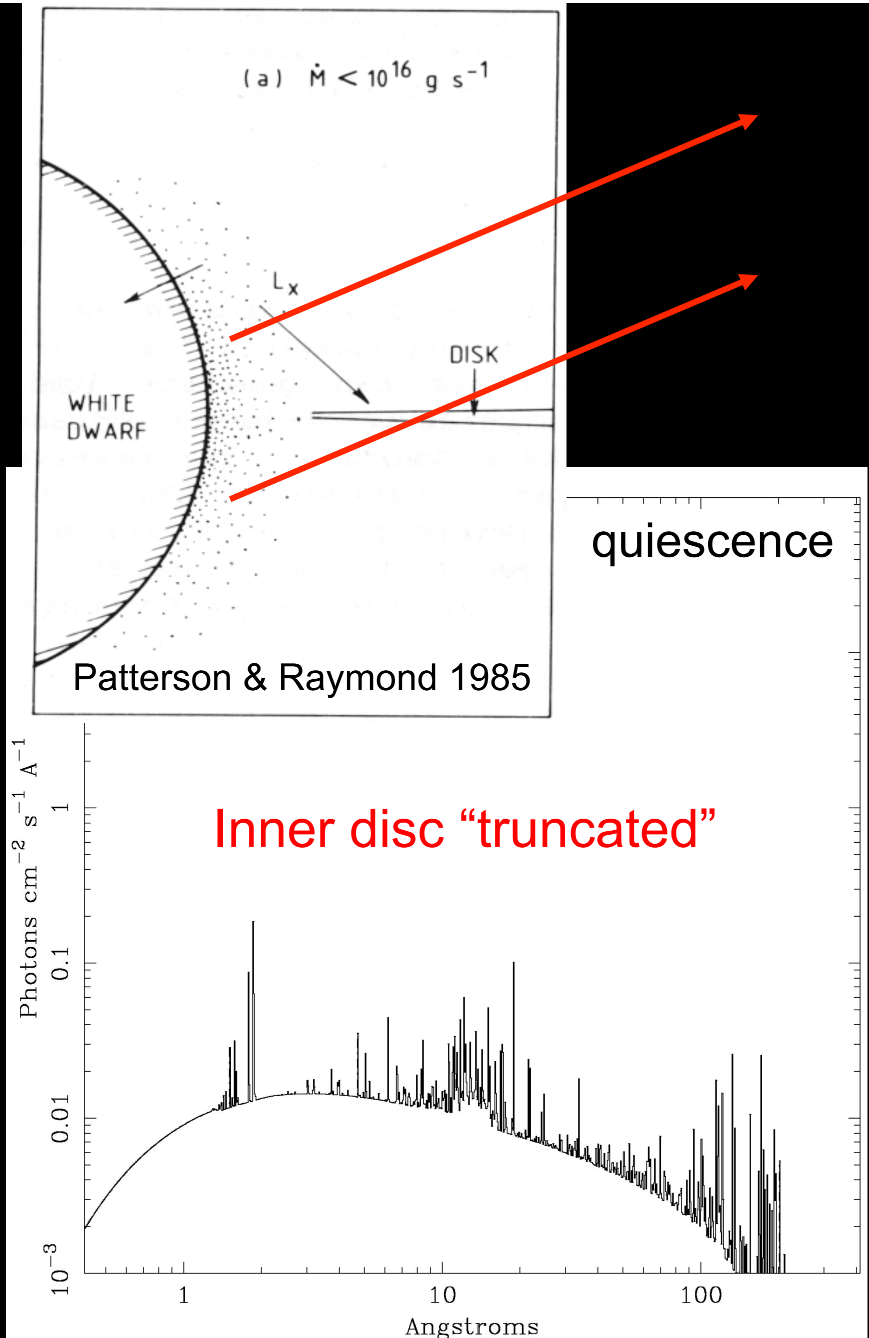
(a) $\dot{M} < 10^{16}$ g s^{-1}
L_x
DISK
WHITE DWARF
Patterson & Raymond 1985
quiescence
Lx provides precise m-dot
Photons cm^{-2} s^{-1} A^{-1}
10^{-3}
0.01
0.1
1
1
10
100
Angstroms

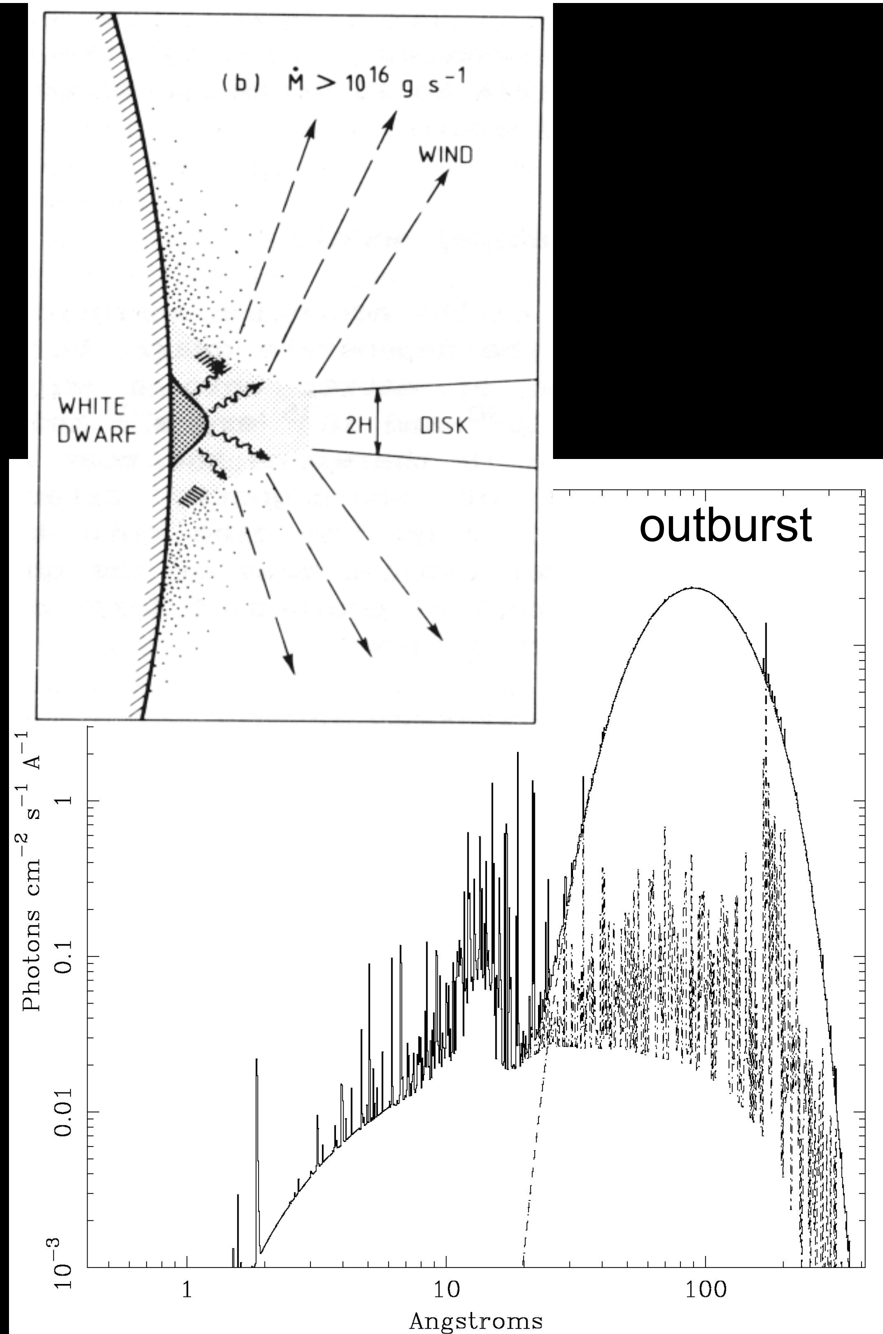


(b) $\dot{M} > 10^{16}$ g s^{-1}
WIND
WHITE DWARF
2H
DISK
outburst
Photons cm^{-2} s^{-1} A^{-1}
10^{-3}
0.01
0.1
1
1
10
100
Angstroms


Z Cha with XMM-Newton
Hickman, Wheatley et al. 2013
Optical: B band
0.2-12 keV
OM count rate
EPIC Counts per bin
Orbital Phase
0
10
20
30
100
200
300
0.2
0.4
0.6
0.8


Z Cha X-ray eclipse
100ks XMM-Newton
Hickman, Wheatley et al., 2013
1.2-10 keV
0.2-1.2 keV
Count rate
Count rate
1
0.8
0.6
0.4
0.2
0

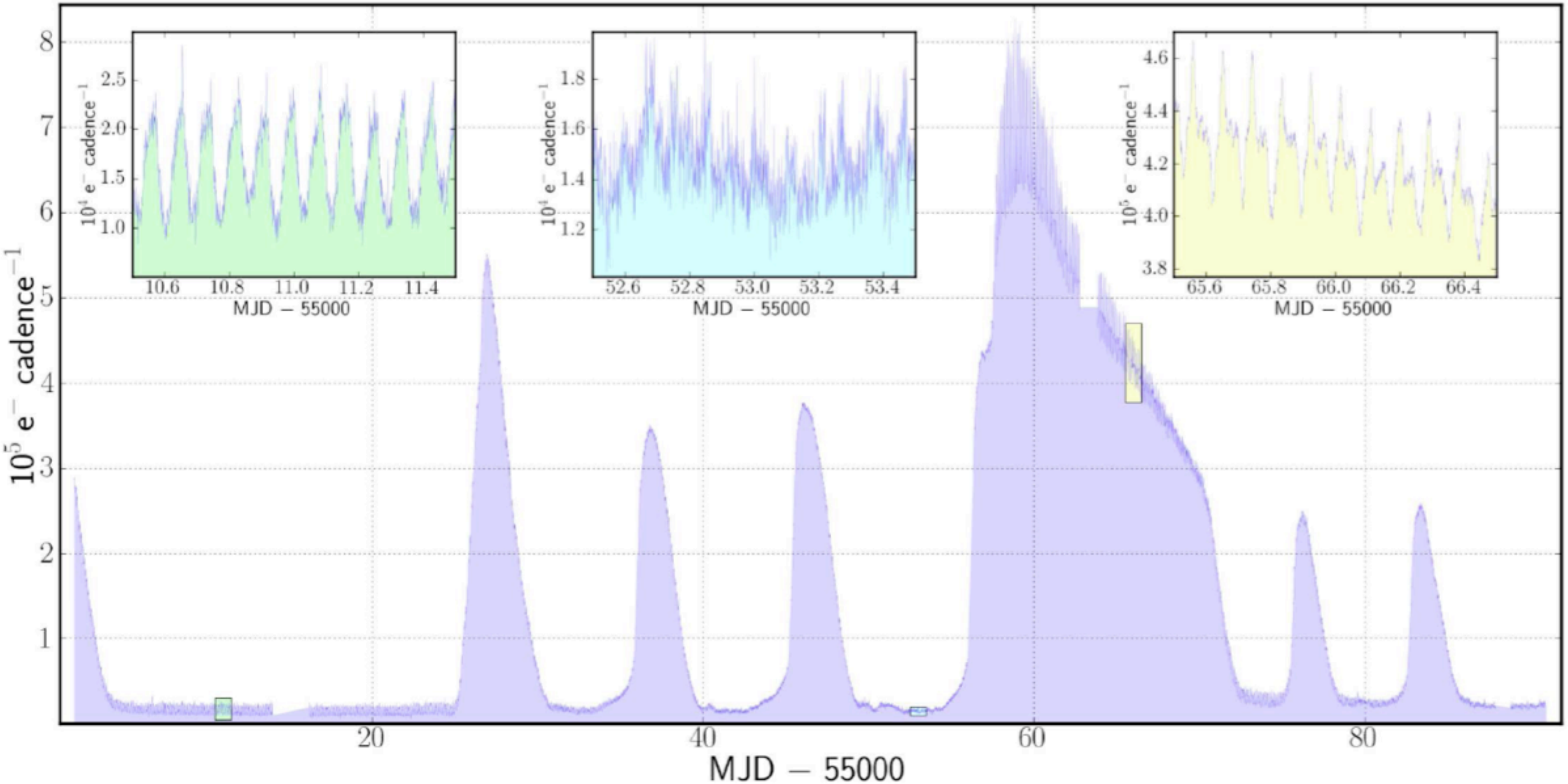

(a) $\dot{M} < 10^{16}$ g s^{-1}
L_x
DISK
WHITE DWARF
Patterson & Raymond 1985
quiescence
Inner disc "truncated"
Photons cm^{-2} s^{-1} A^{-1}
10^{-3}
0.01
0.1
1
1
10
100
Angstroms


(b) $\dot{M} > 10^{16}$ g s^{-1}
WIND
WHITE DWARF
2H
DISK
outburst
Photons cm^{-2} s^{-1} A^{-1}
10^{-3}
0.01
0.1
1
1
10
100
Angstroms

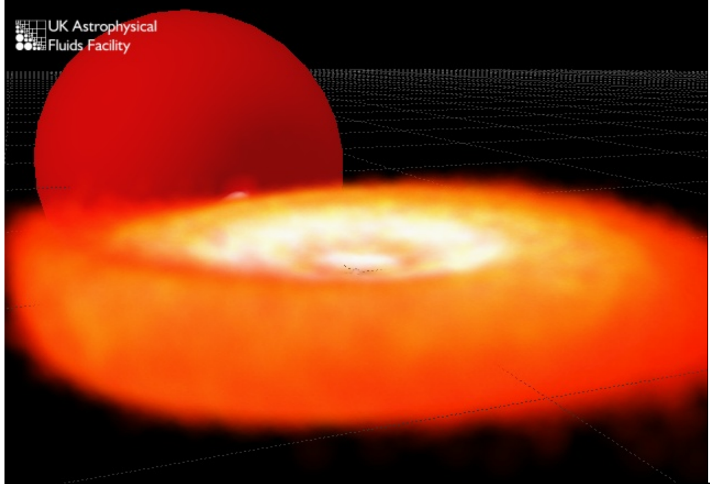
Kepler GO highlight

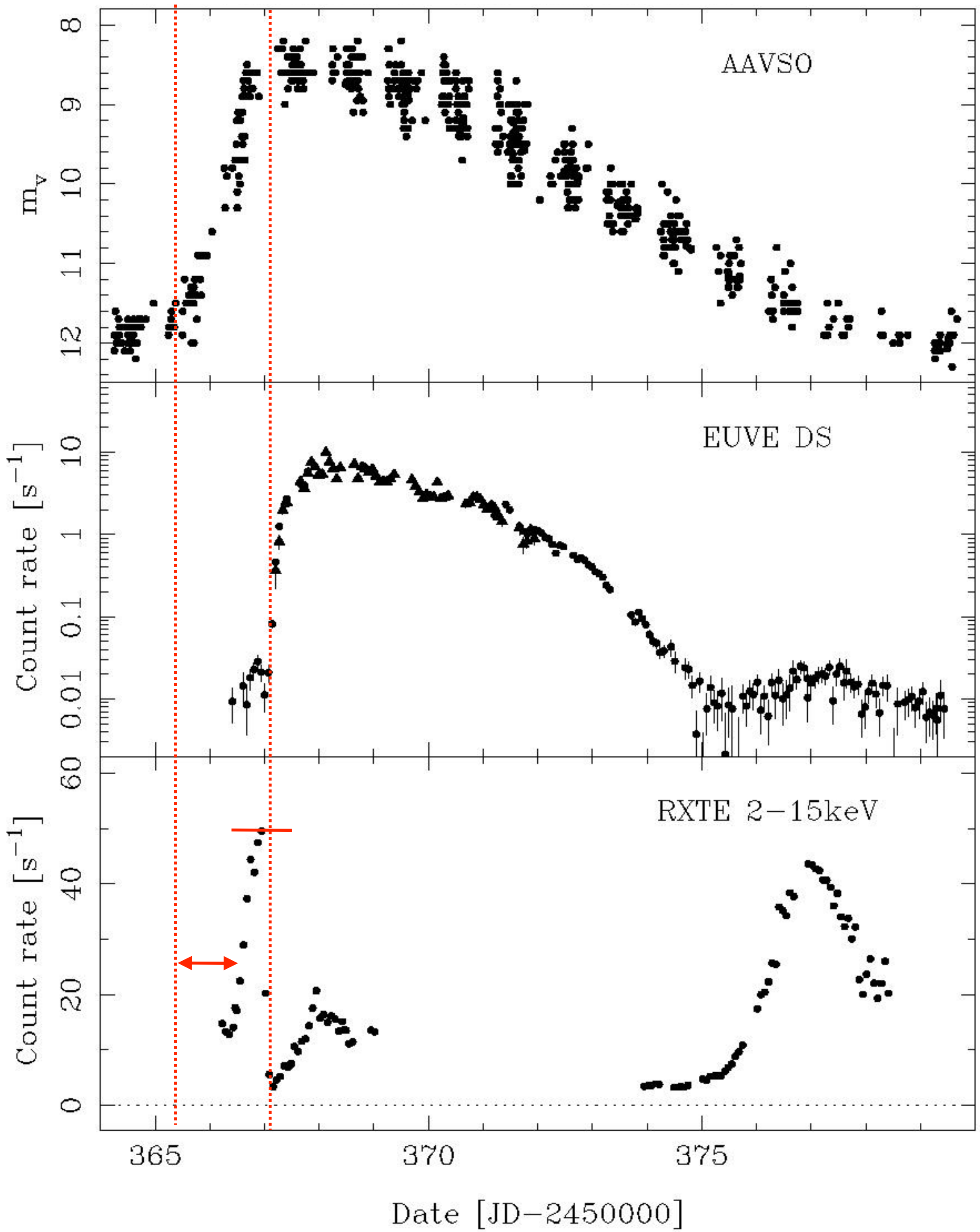
V344 Lyr

Still et al 2010

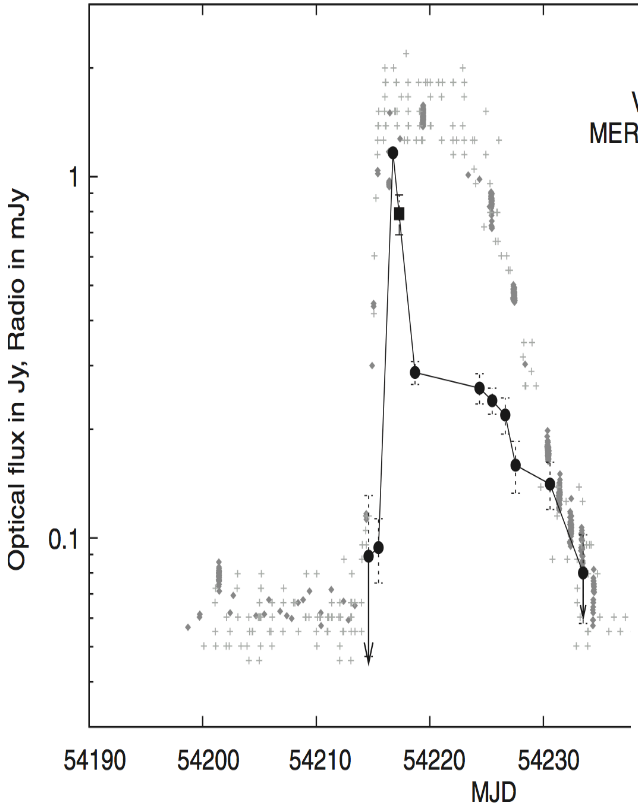


Wheatley, Mauche & Mattei
2003

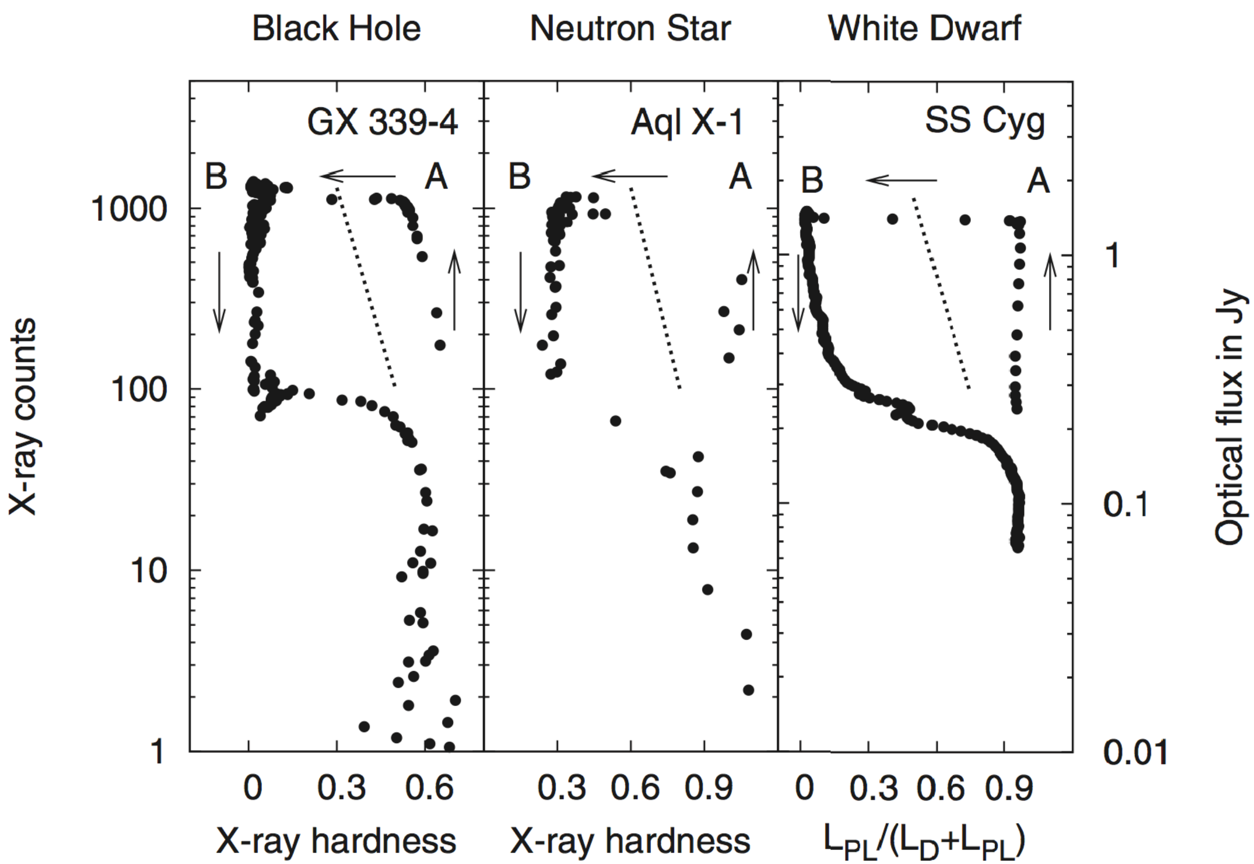




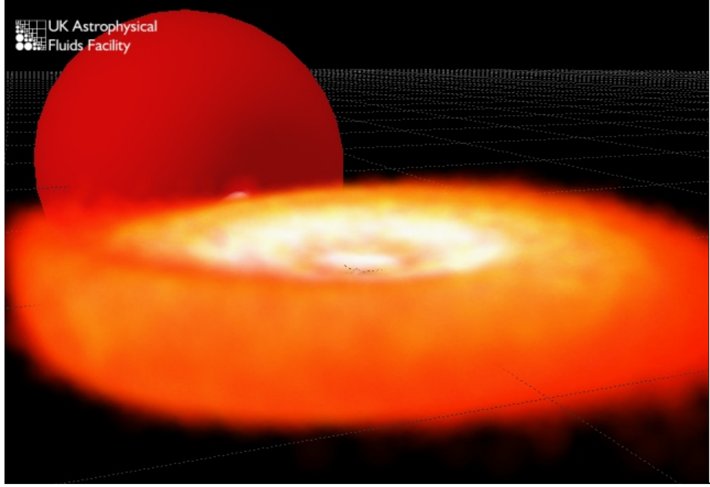
Jets in dwarf novae

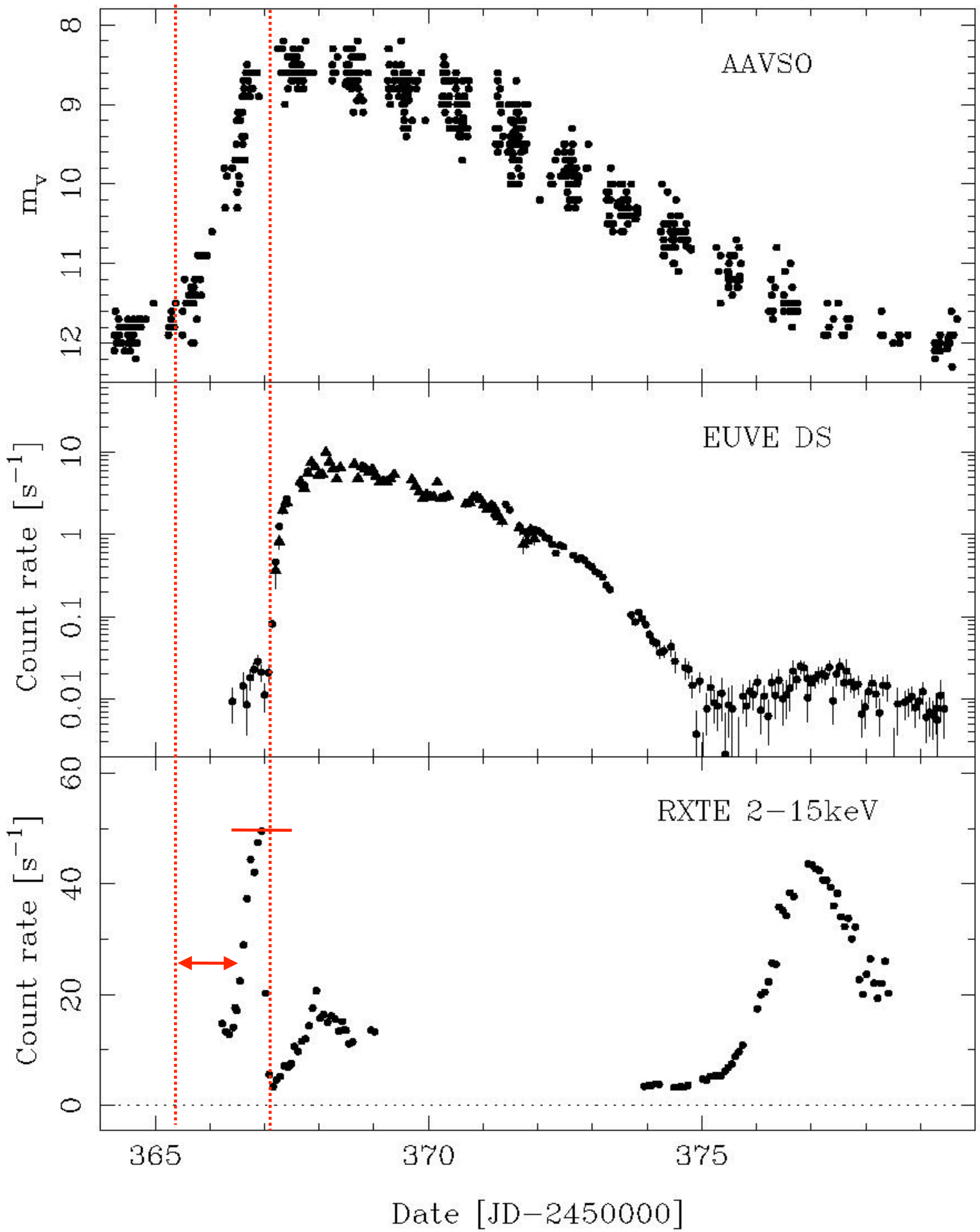


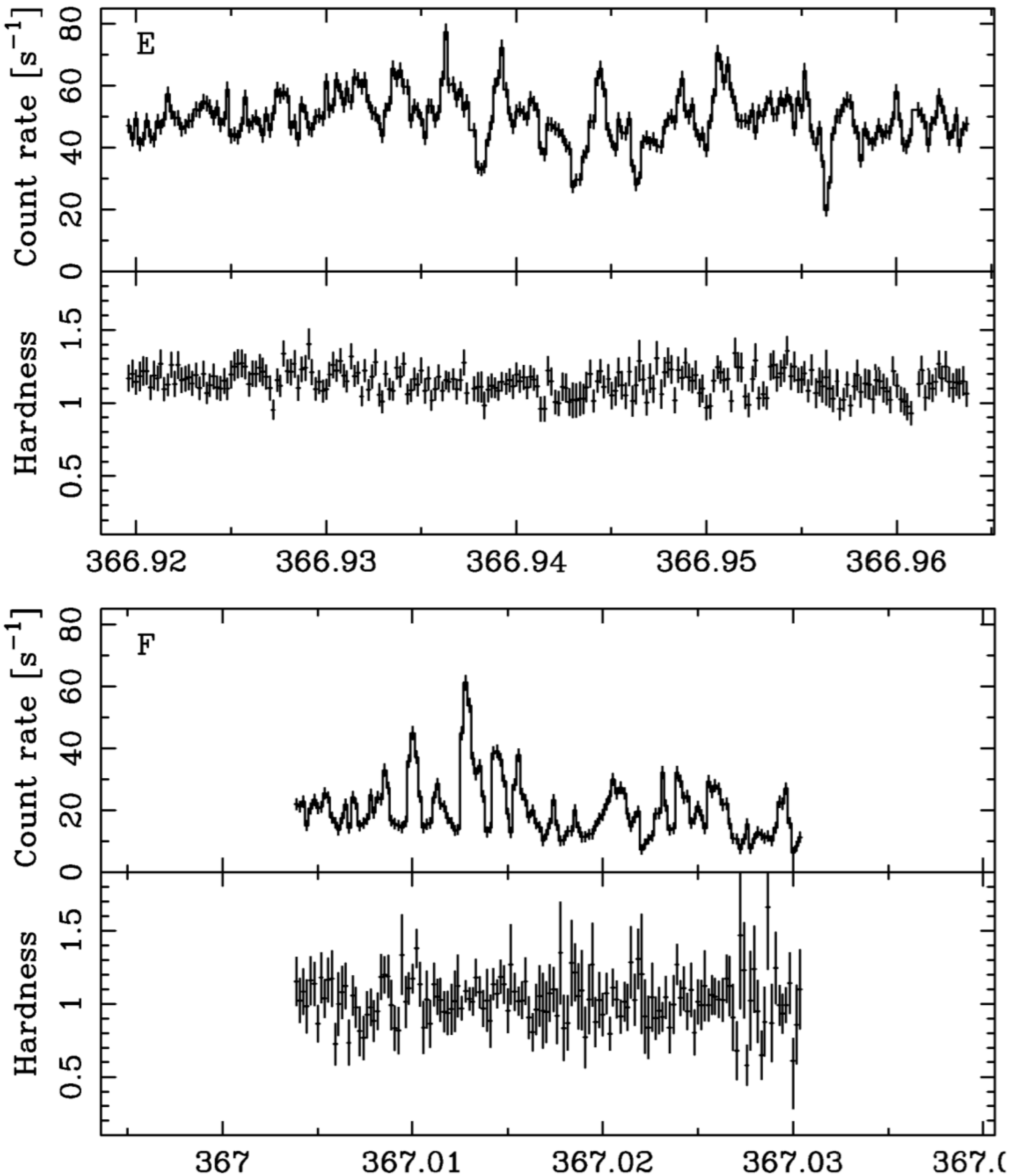
Koerding et al, 2008, Science



Wheatley, Mauche & Mattei
2003



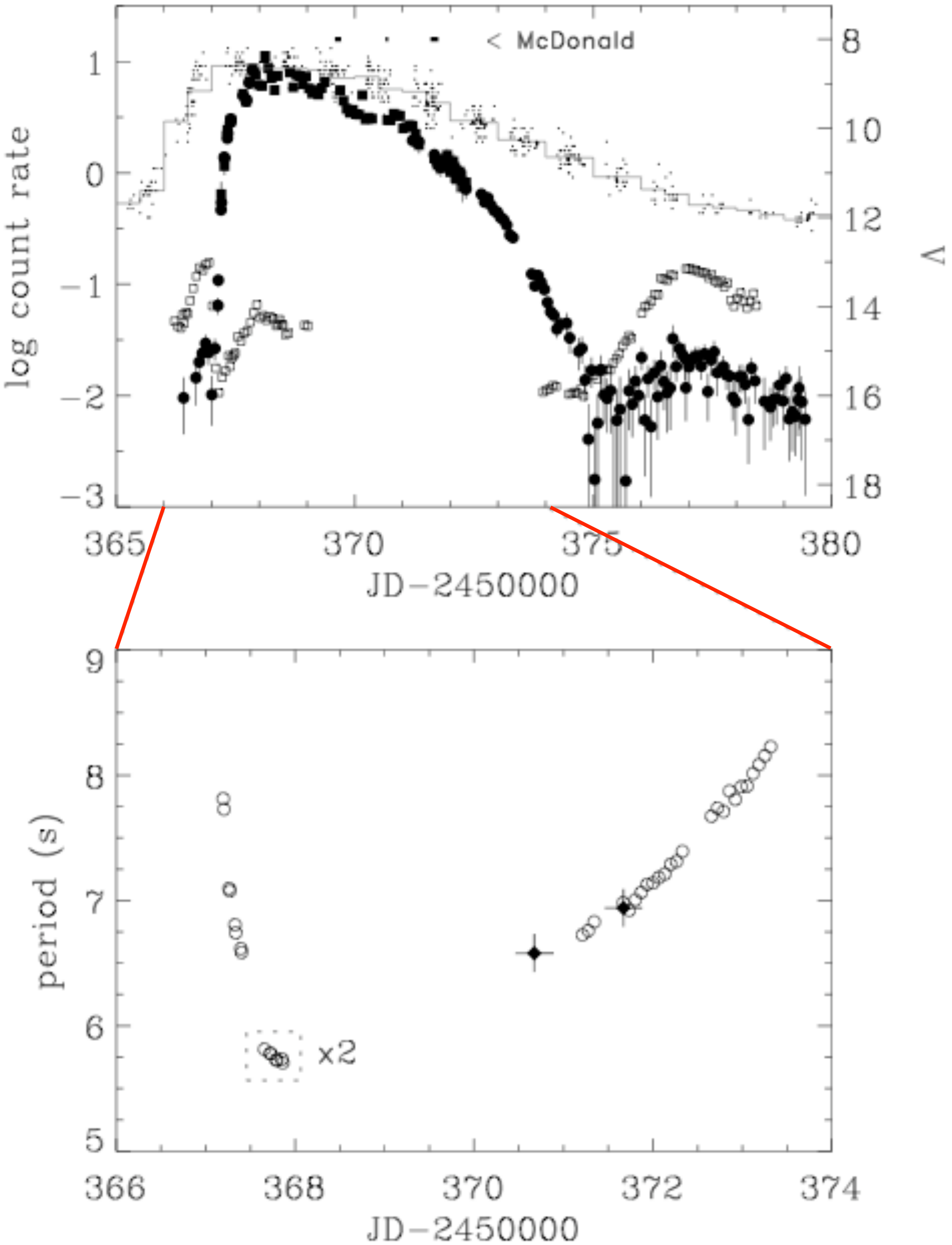




Disc-jet connection in hard X-rays?

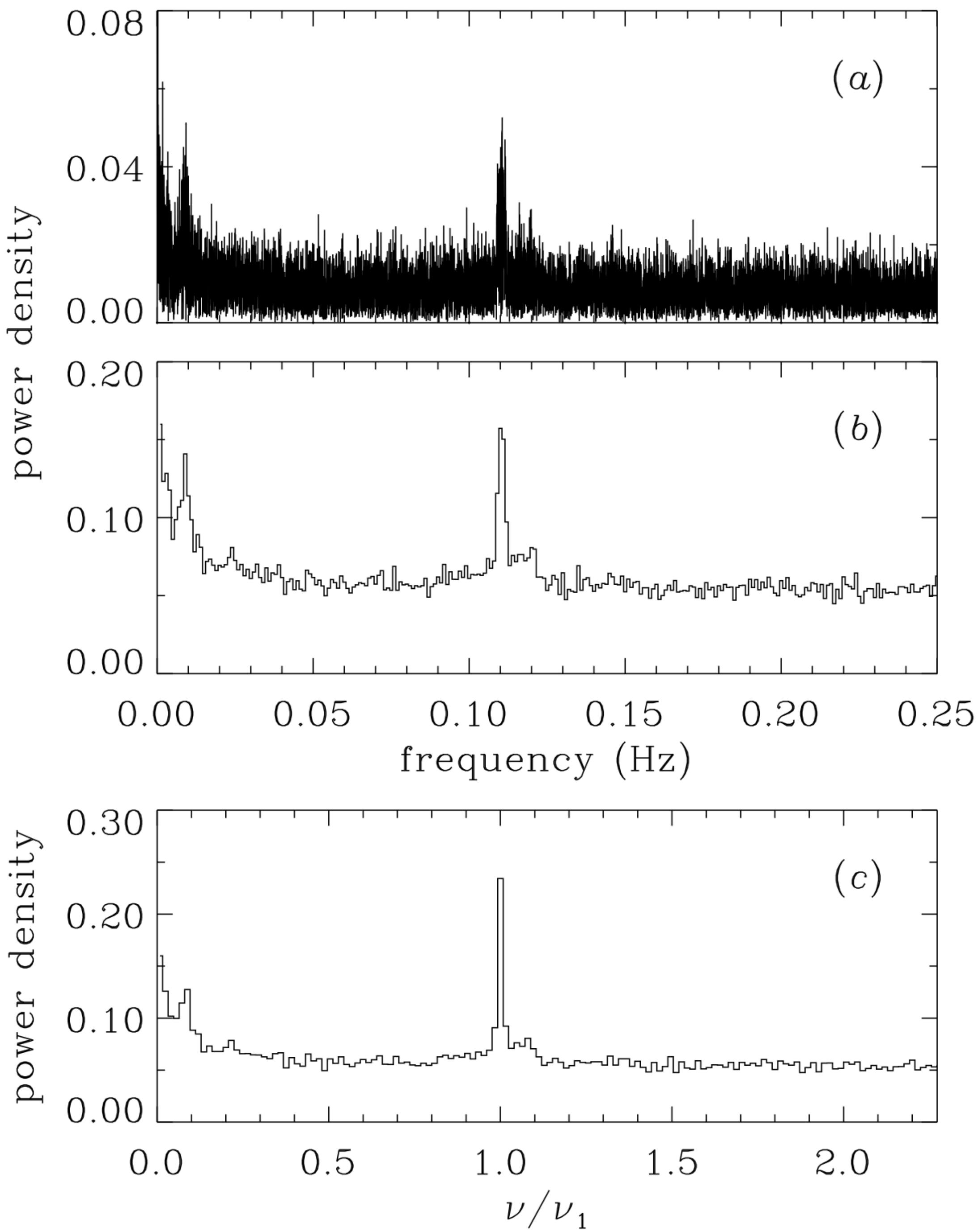
Loft area will provide precise X-ray spectral evolution simultaneously with radio jet production

Wheatley, Mauche & Mattei 2003



Fast QPOs in dwarf nova outbursts

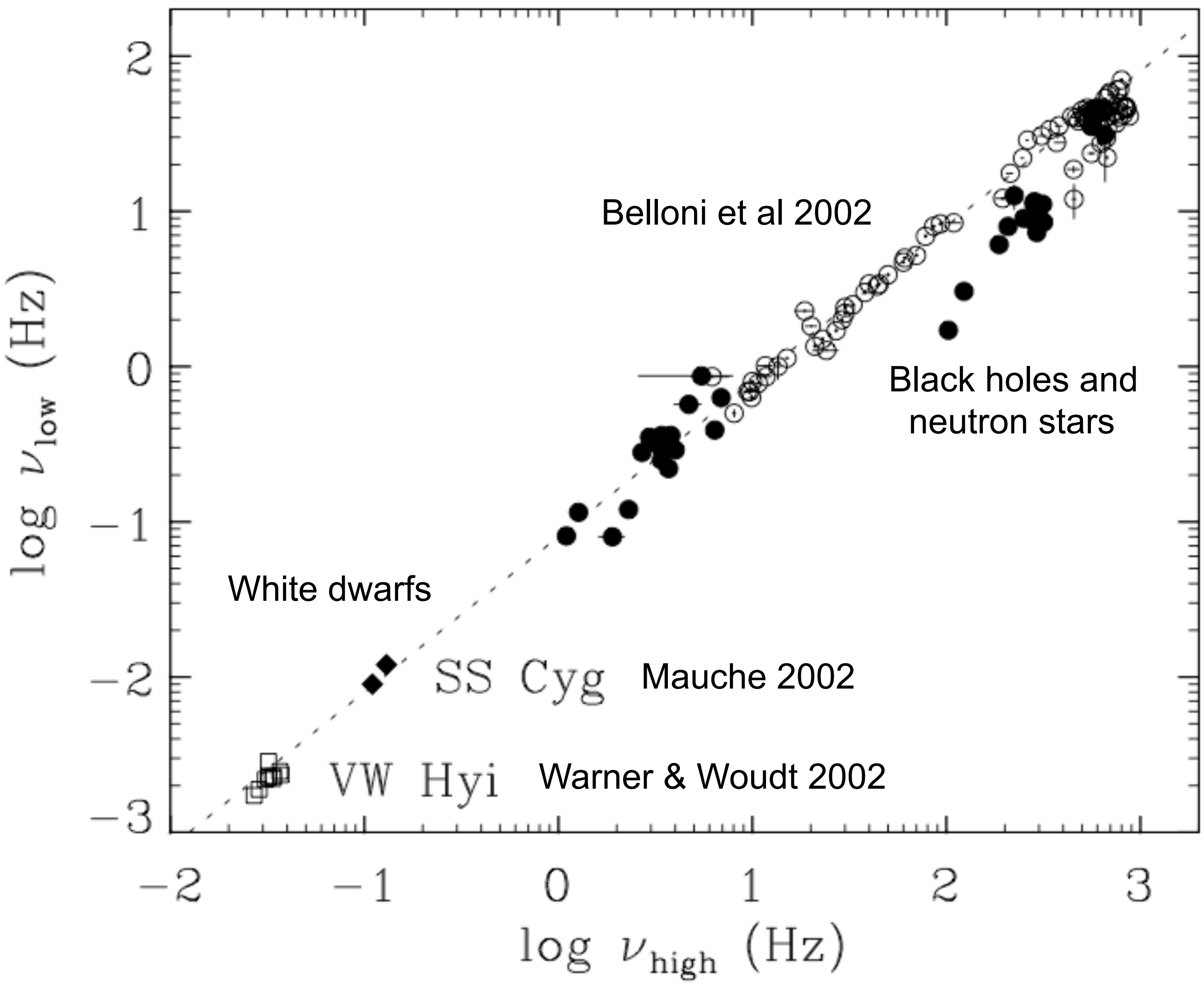
Mauche 2004



Fast and slow QPOs in dwarf nova outburst in EUV

Chandra LETG
Mauche 2002

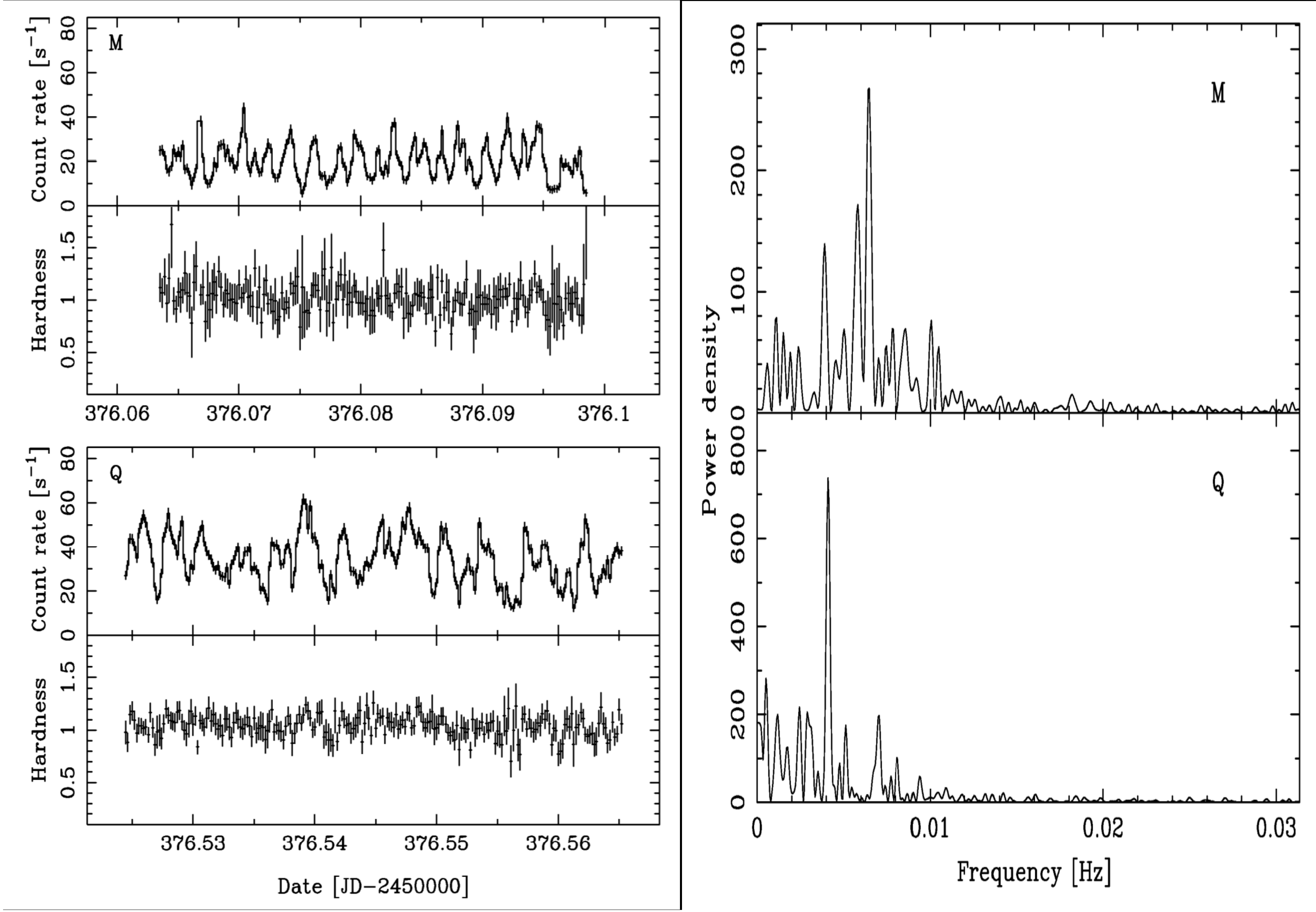
The dwarf nova and LMXB QPO connection



Mauche 2002

Slow QPO detected in hard X-rays outburst

Wheatley, Mauche & Mattei 2003

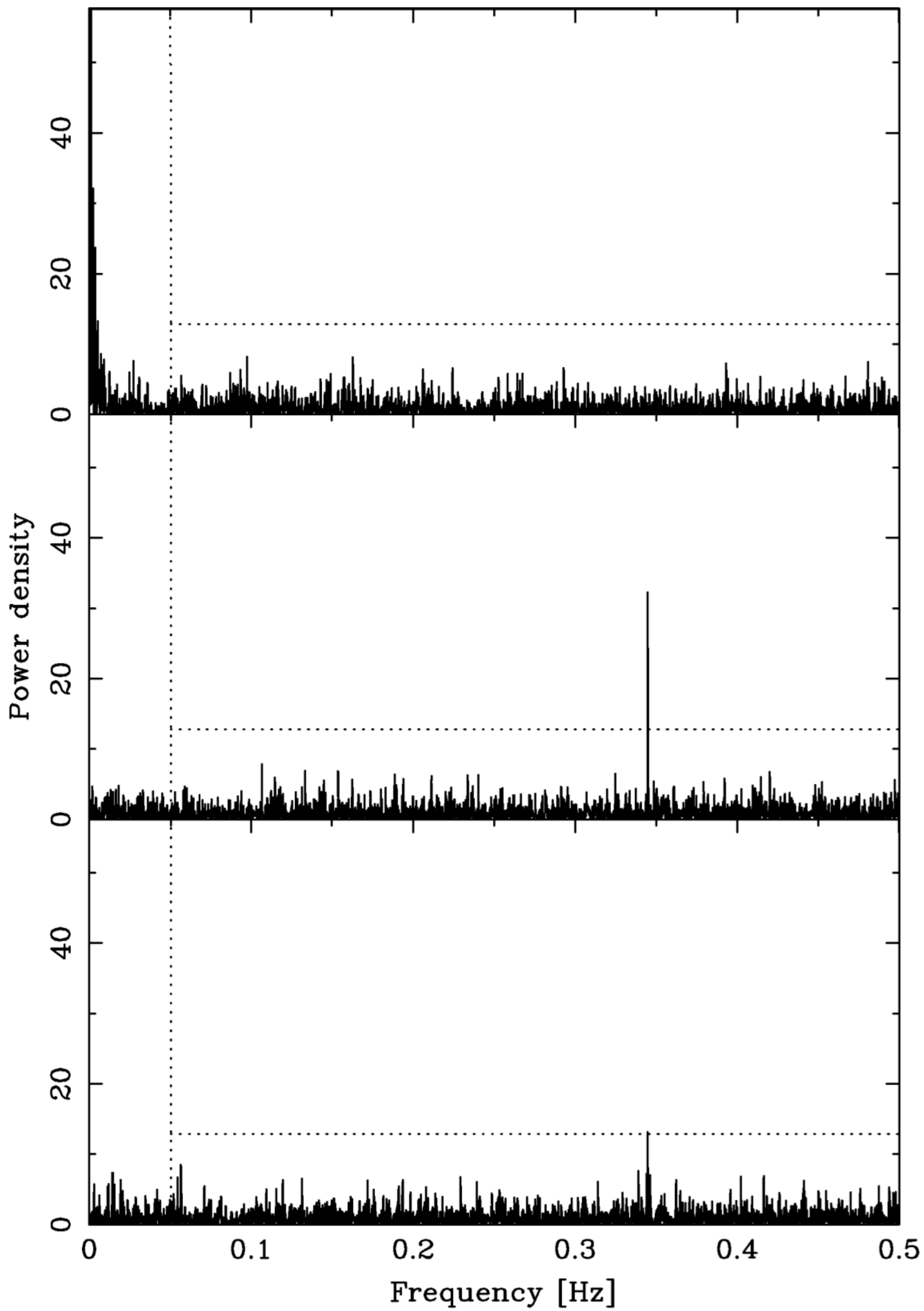


Fast QPO in X-rays?

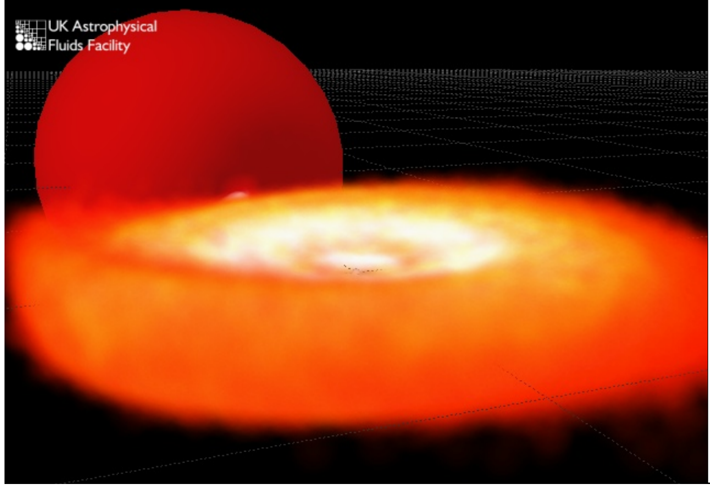
7% upper limit with RXTE

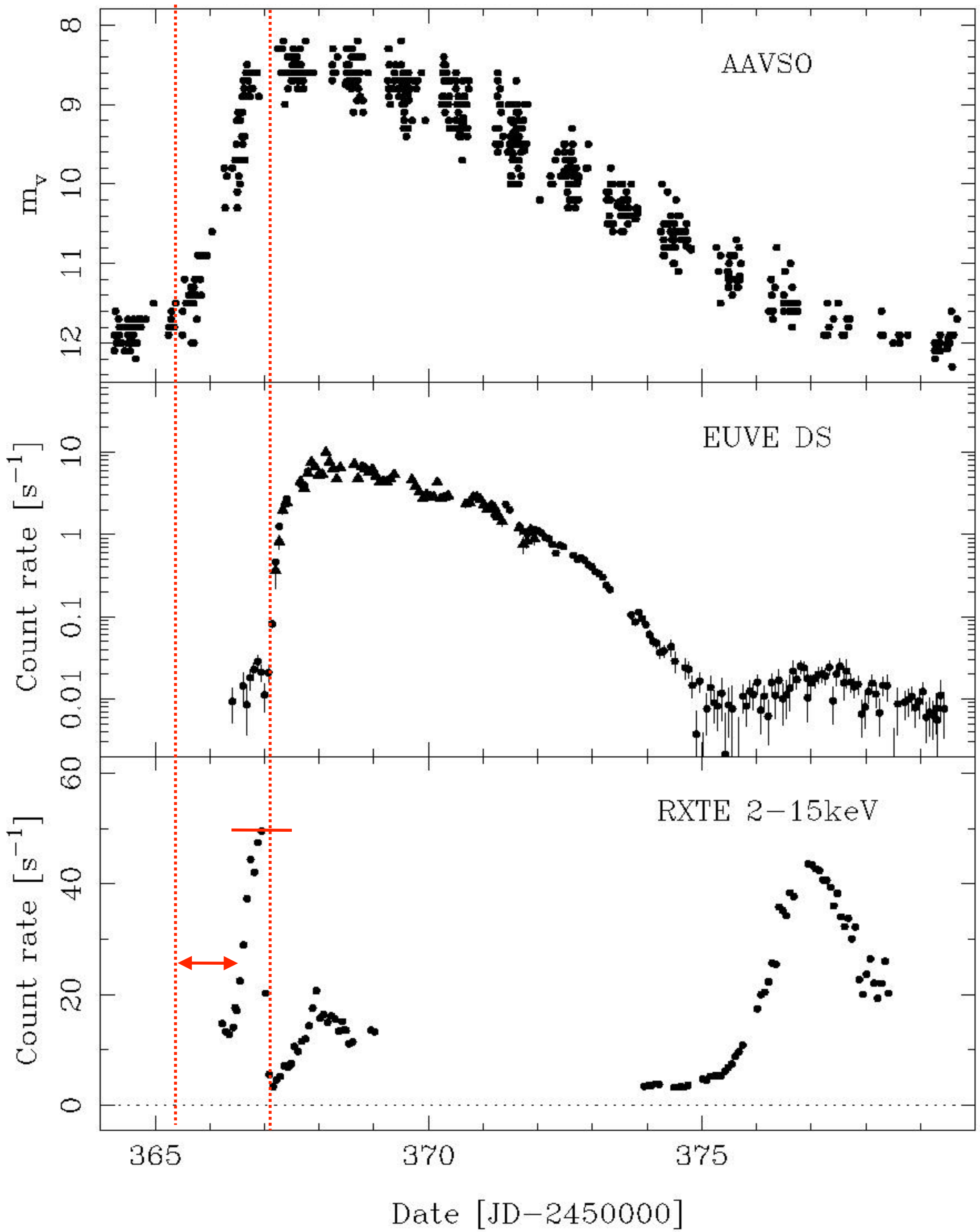
Amplitudes of <2% detectable with Loft (White book)

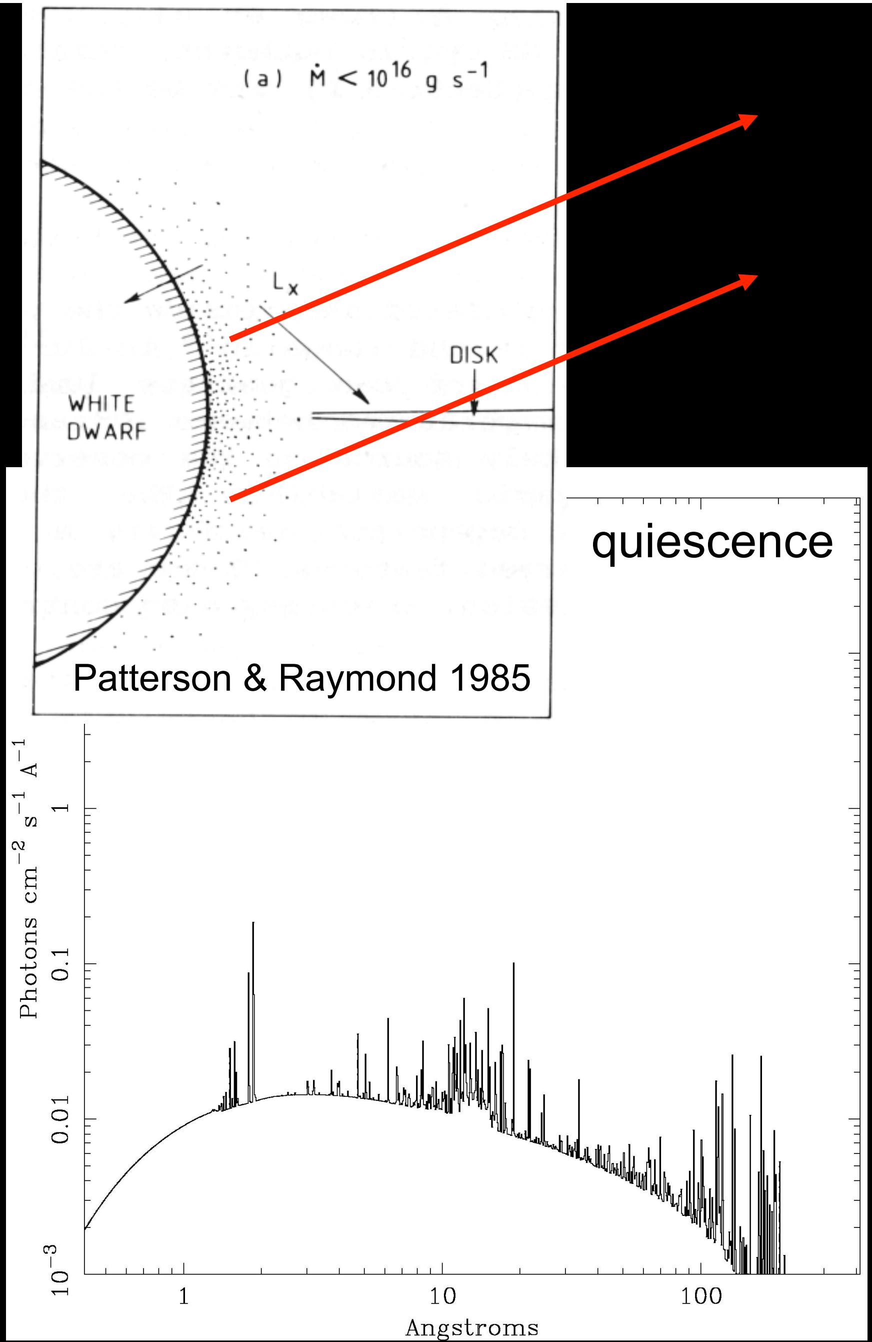
Wheatley, Mauche & Mattei 2003



Wheatley, Mauche & Mattei
2003



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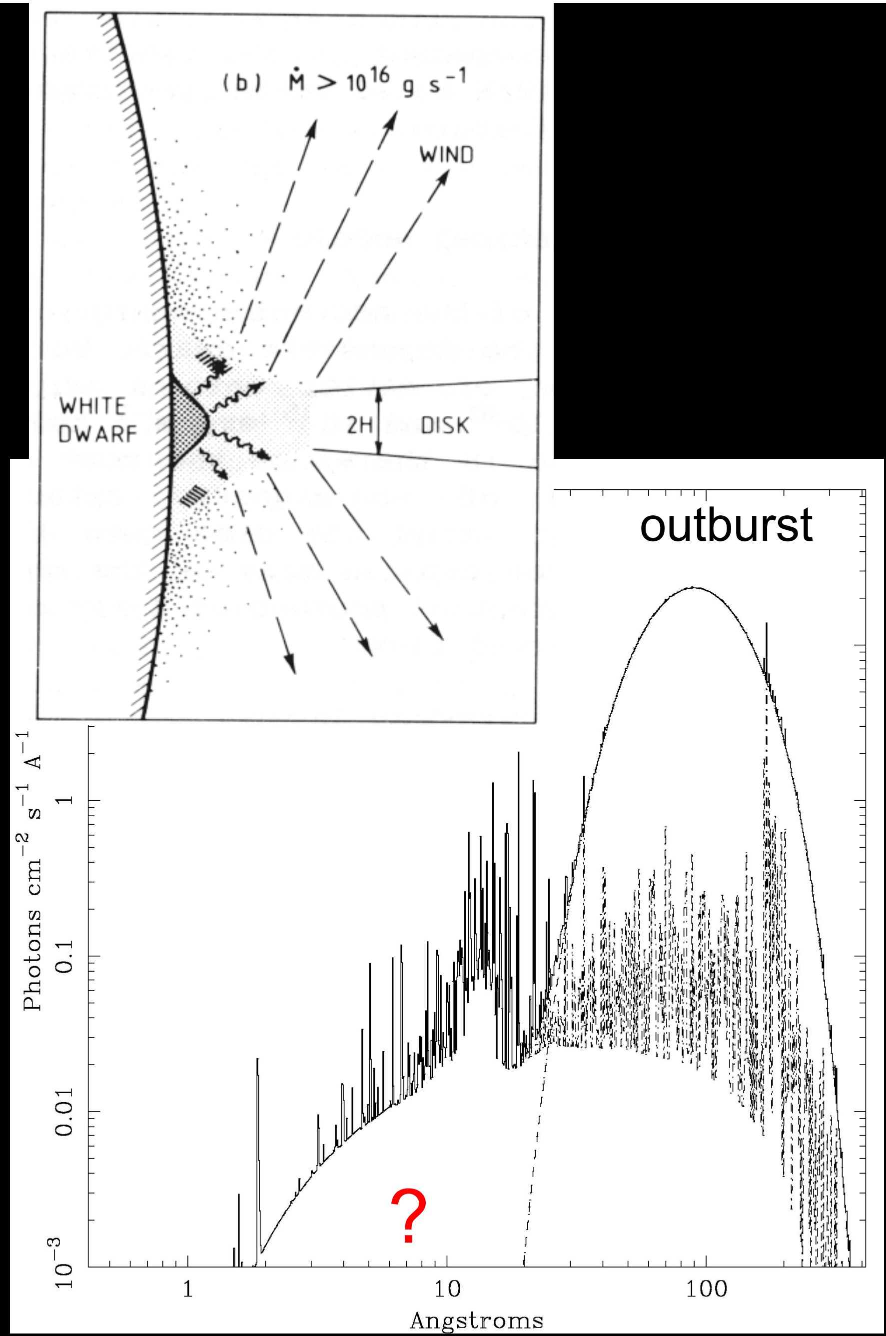
quiescence
Patterson & Raymond 1985
Photons cm^{-2} s^{-1} A^{-1}
10^{-3}
0.01
0.1
1
1
10
100
Angstroms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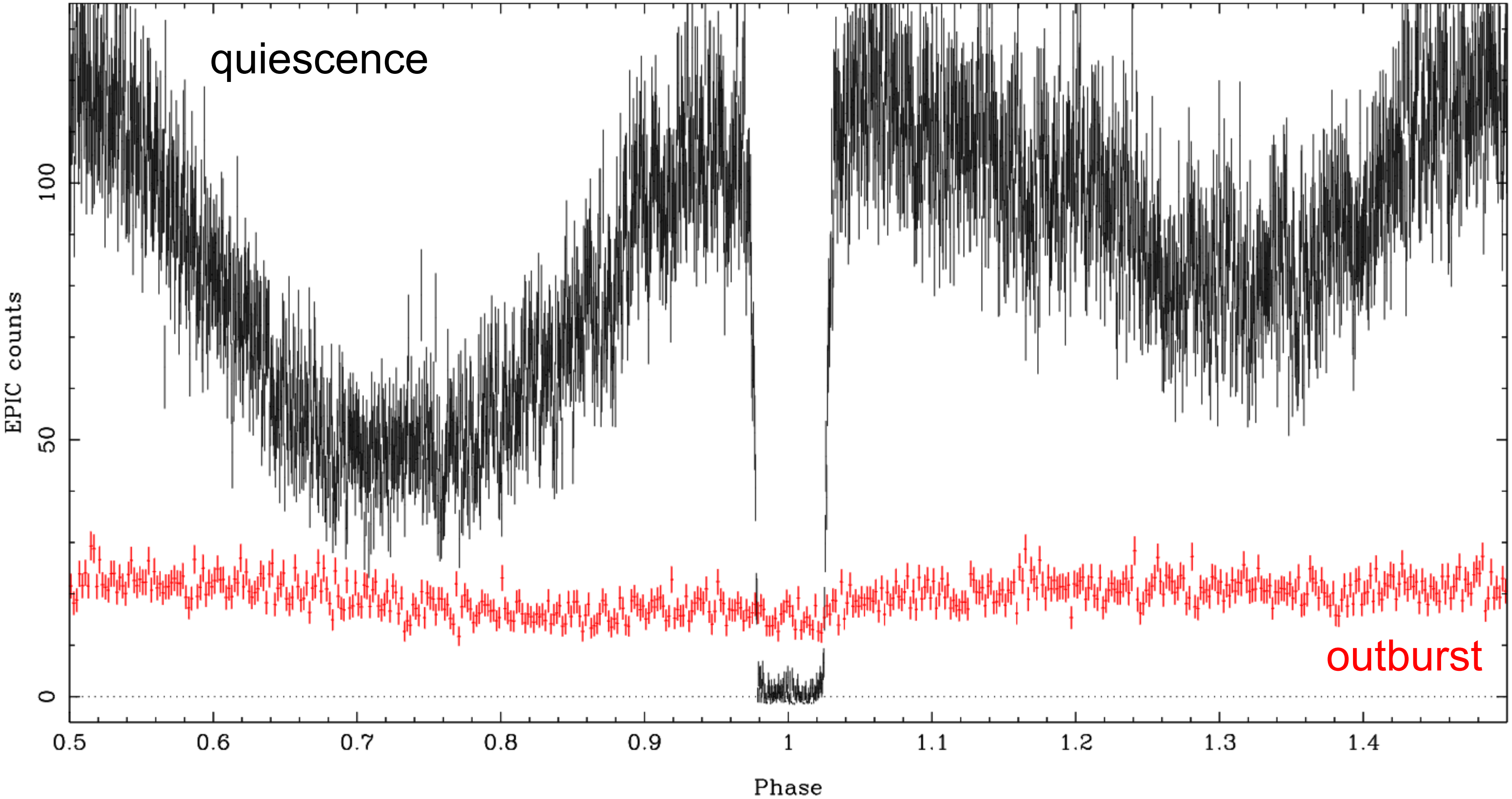
WIND
WHITE DWARF
2H
DISK
outburst
Photons cm^{-2} s^{-1} A^{-1}
10^{-3}
0.01
0.1
1
1
10
100
Angstroms
?

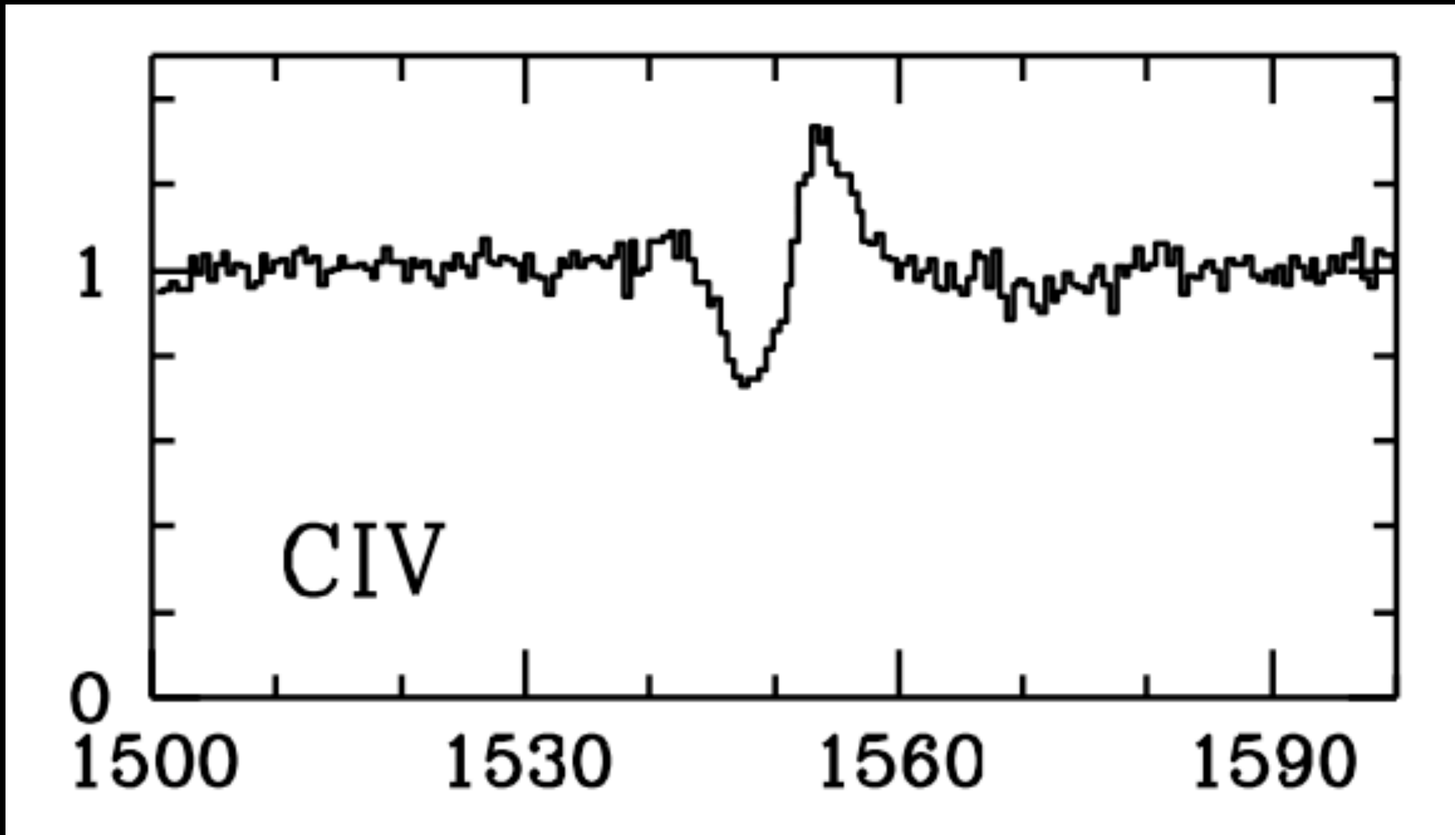
Z Cha in outburst with XMM-Newton



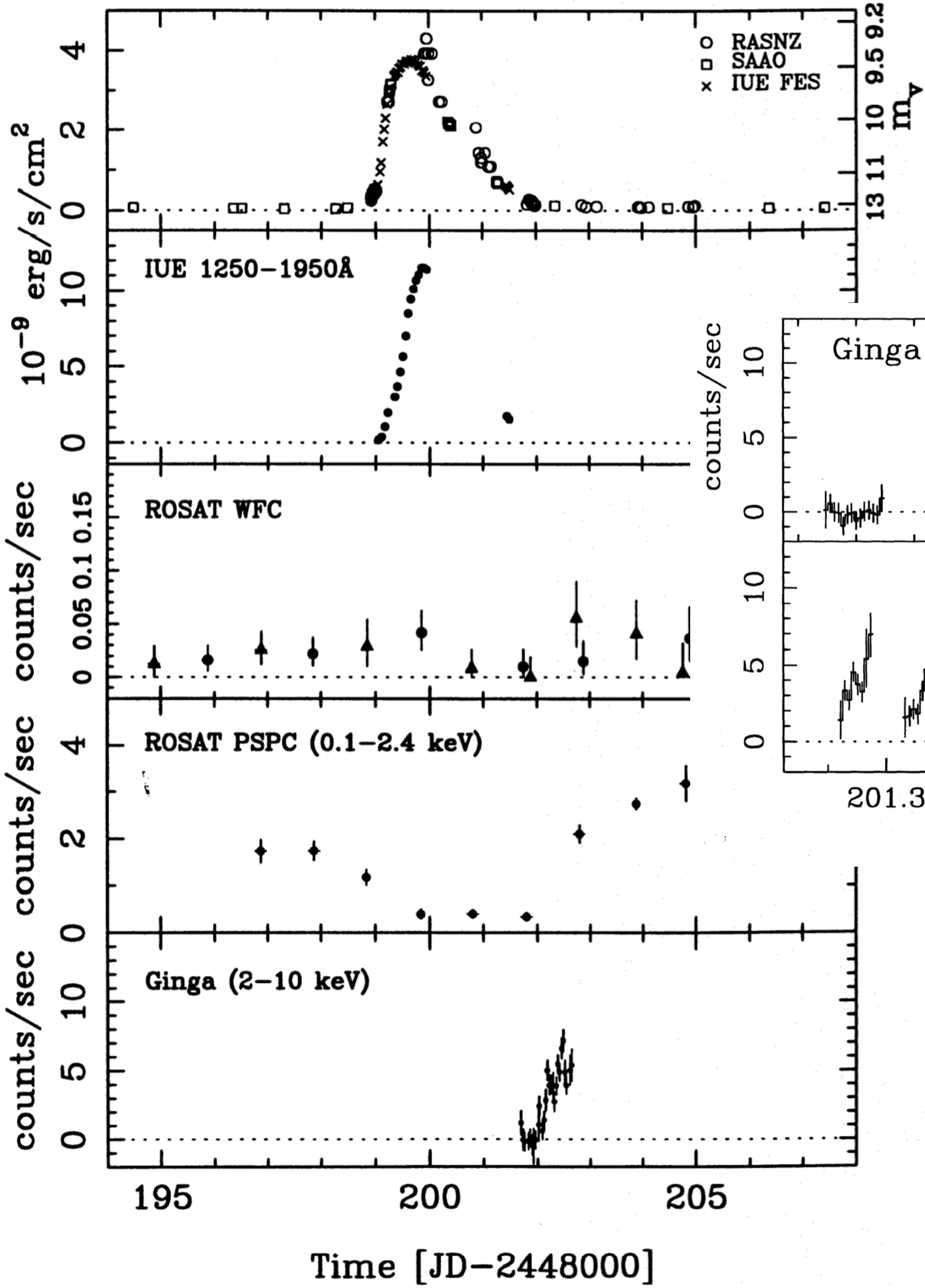
Outburst X-rays from shocks in disc outflows?

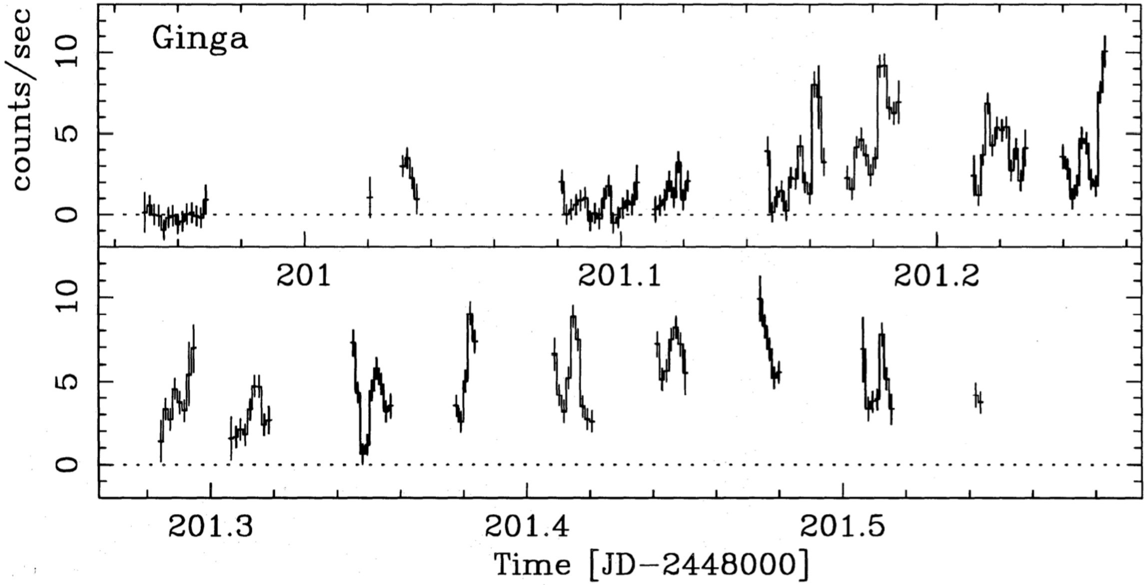
Z Cam with HUT

Knigge et al 1997



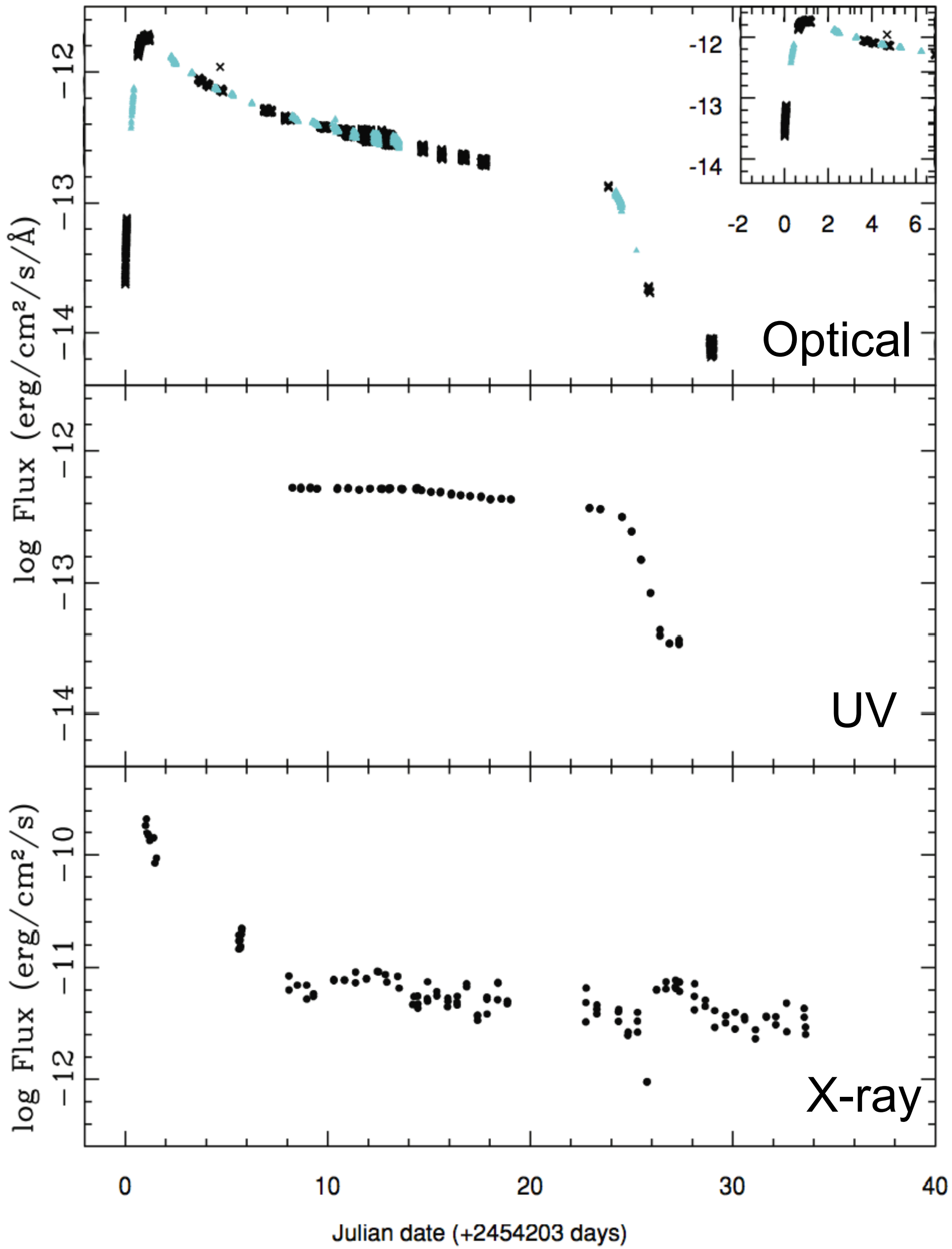
Slow QPO also in
VW Hyi with Ginga



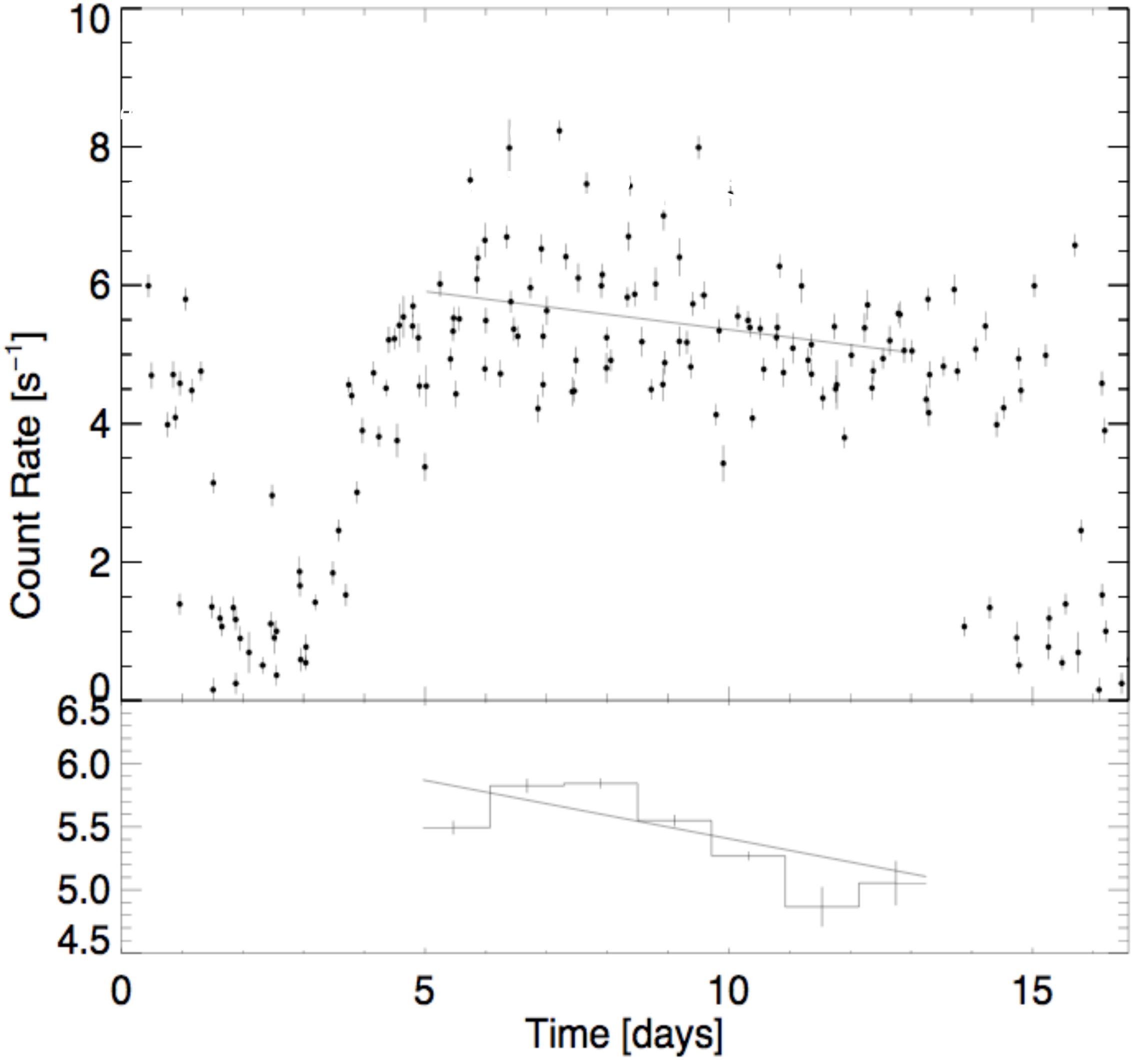


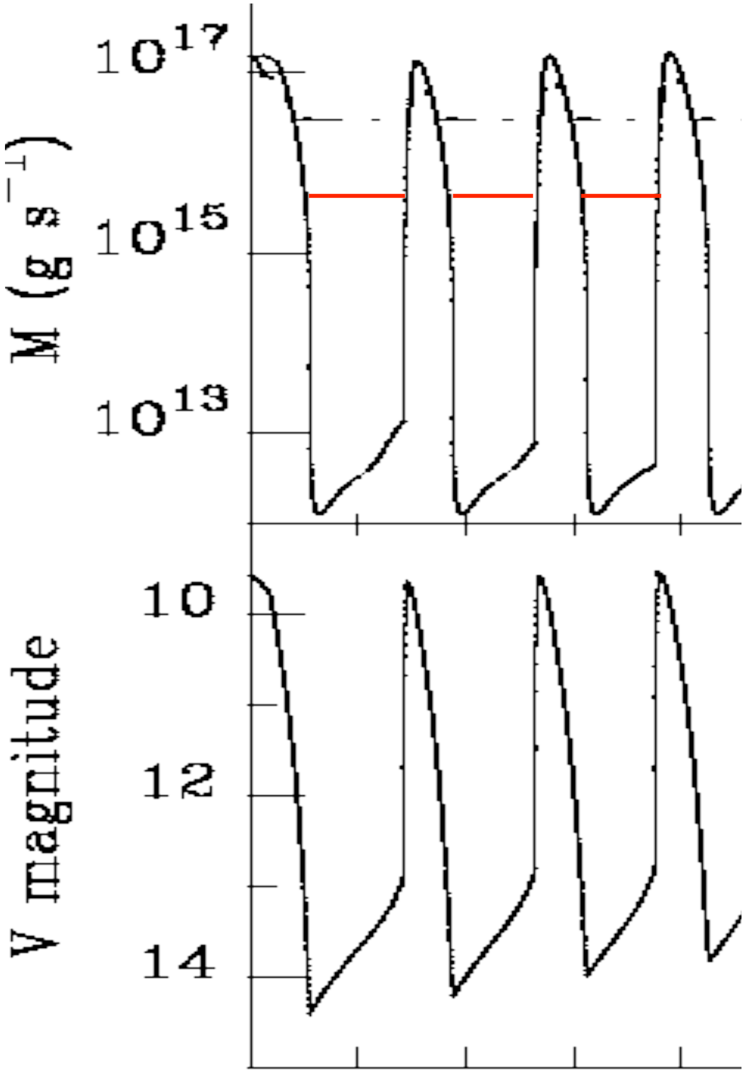
Wheatley et al. 1996

GW Lib with Swift



Byckling, Osborne, Wheatley et al. 2009



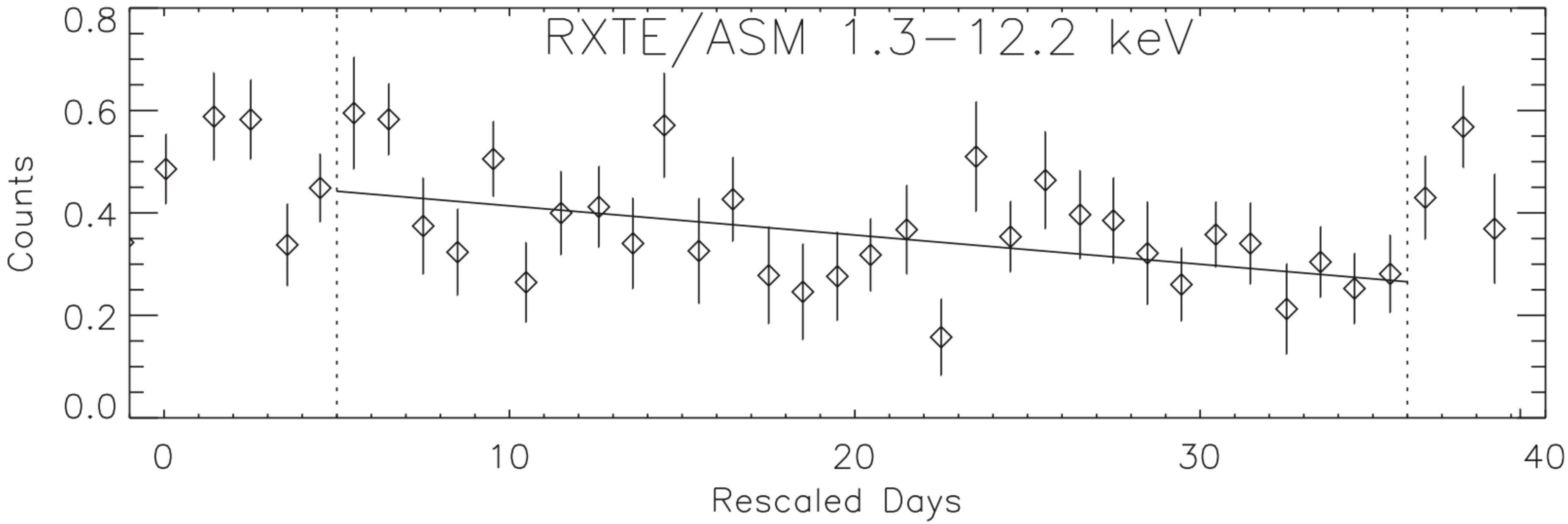


Collins & Wheatley 2010

“The Achilles' heel of the disc instability model” J.-P. Lasota

WFM Monitoring

SS Cyg with RXTE ASM



McGowan et al. 2004

Summary

- Dwarf novae provide:
  - control for separating strong gravity from accretion physics
  - our clearest view of accretion physics and accretion disc instability
- Jets, outflows and fast/slow QPOs all detected in dwarf novae
  - models cannot rely on strong gravity, stellar surface or mag field
- Disc instability model fails to explain quiescent behaviour
  - under predicts quiescent accretion rate by >100x
- Loft effective area can provide new tests of key accretion physics
  - Inner accretion disc geometry (precise eclipse observations)
  - Origin of jets (outburst observations with radio coverage)
  - Outflows (evolution of partially ionised absorption during outburst)
  - Origin of fast/slow QPOs (high speed timing during outburst transitions)