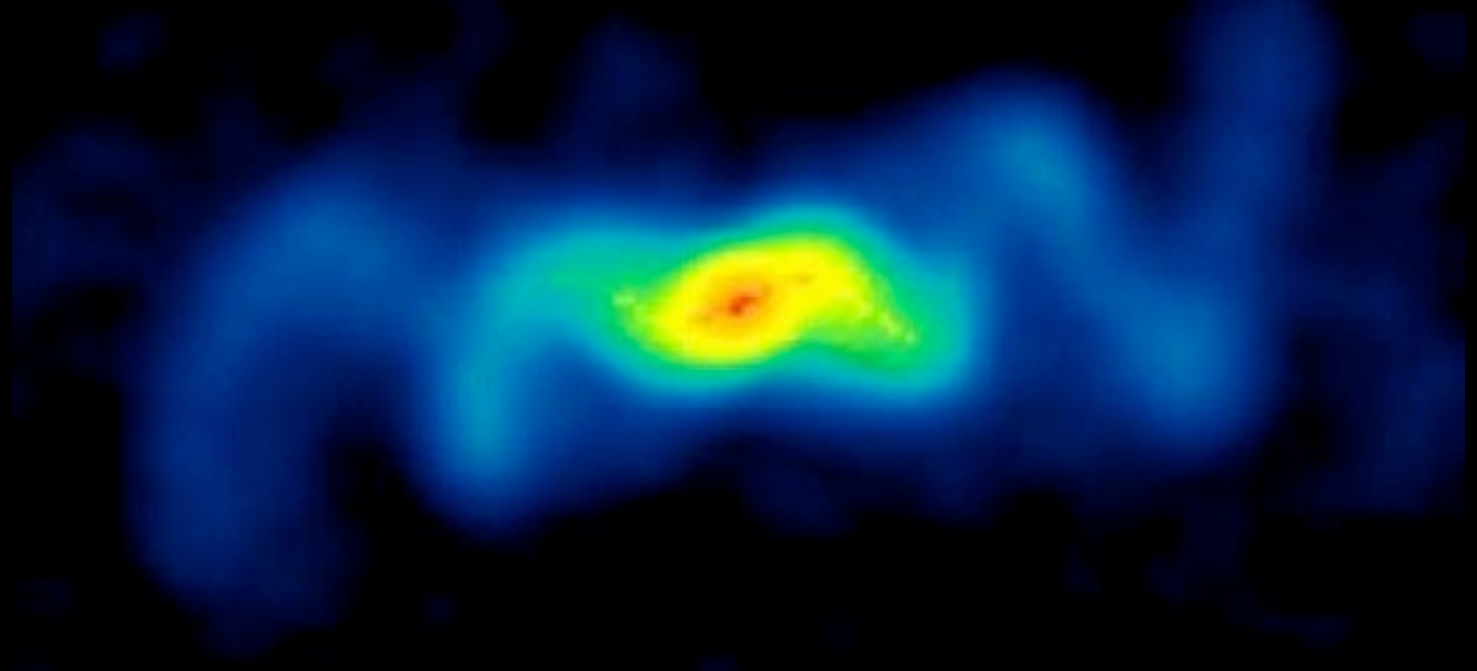
Microquasars: Multi-wavelength Phenomenology



Simone Migliari

University of Barcelona

X-ray binary

Radio

opt

IR

IR

opt

ϒ-rays

X-rays

opt

IR

Which parameters are involved in jet formation?

$\dot{M}$

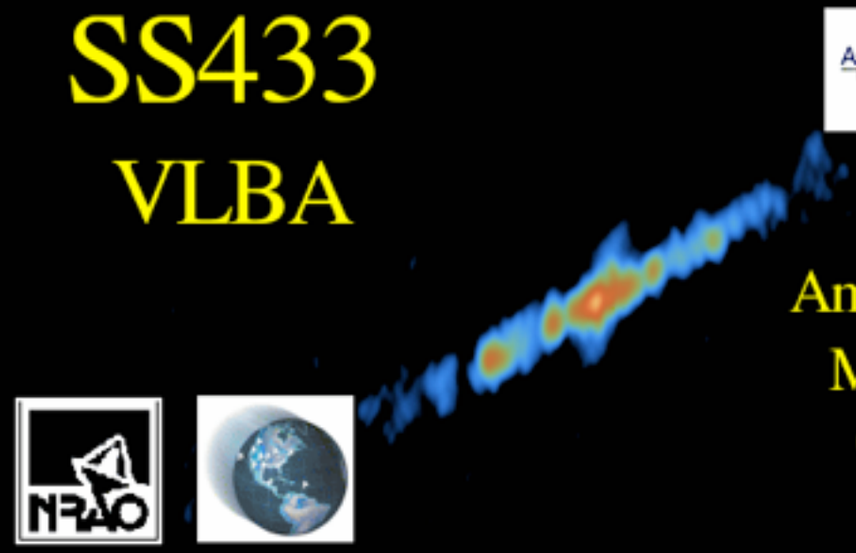
Accreting Object

Radio: types of jets

transient

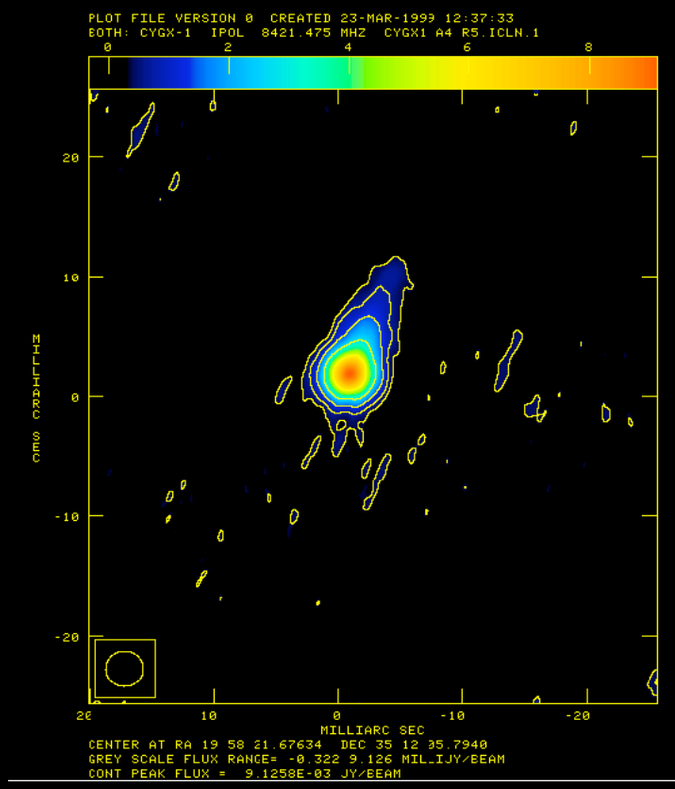
SS433

VLBA

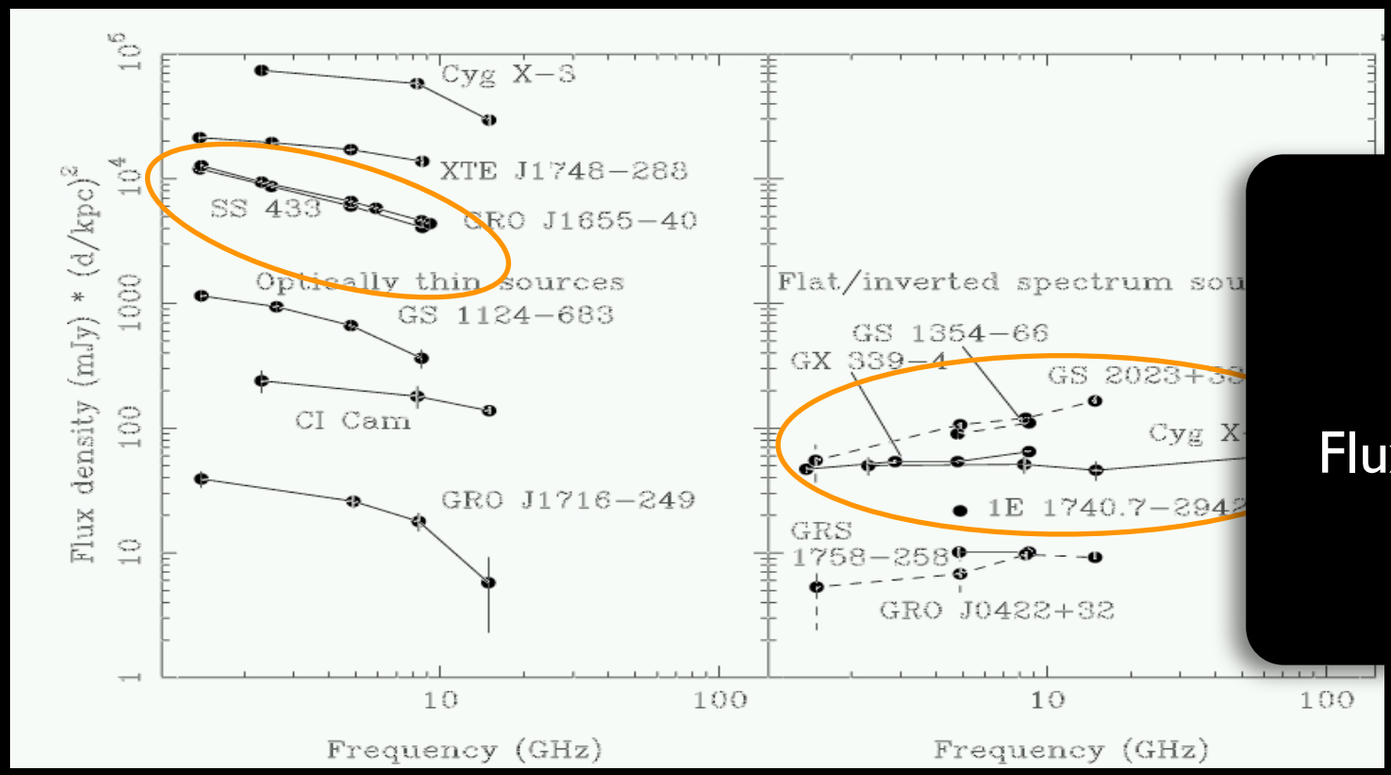


Amy Mioduszewski
Michael Rupen
Craig Walker
Greg Taylor

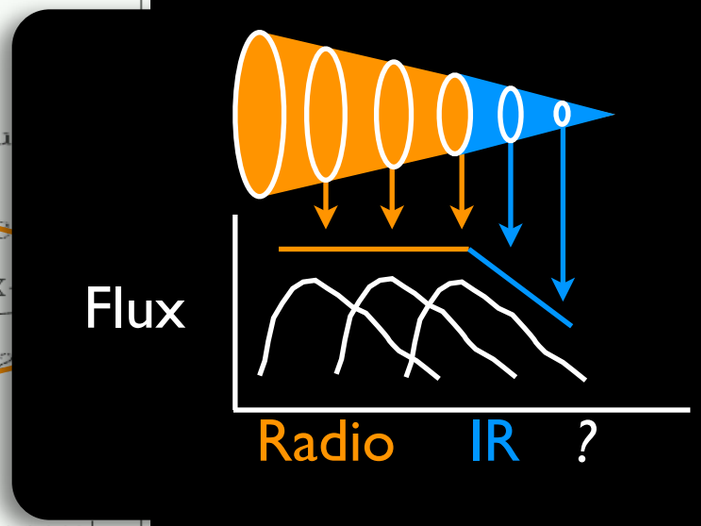
compact



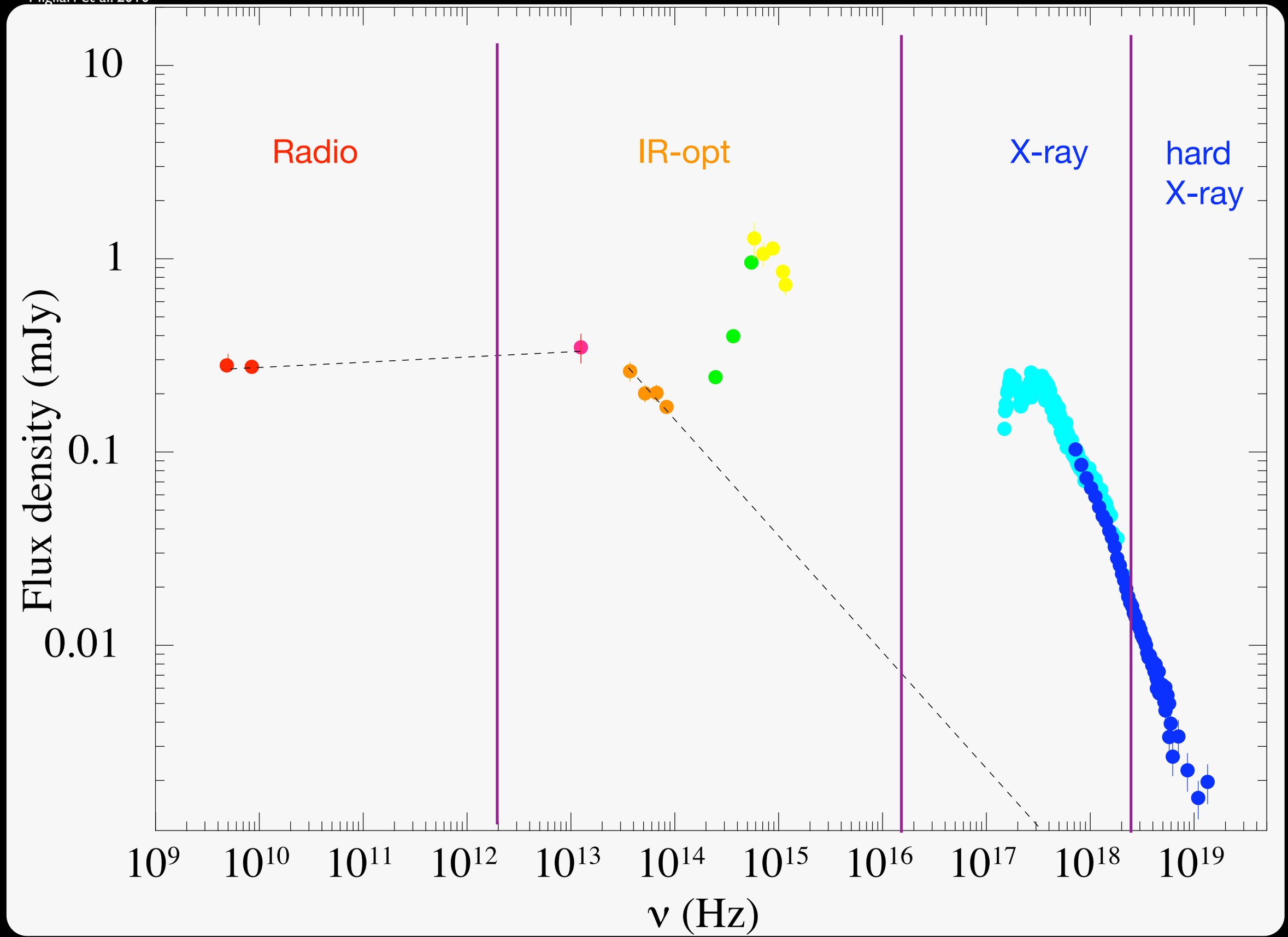
Starling et al. ‘01



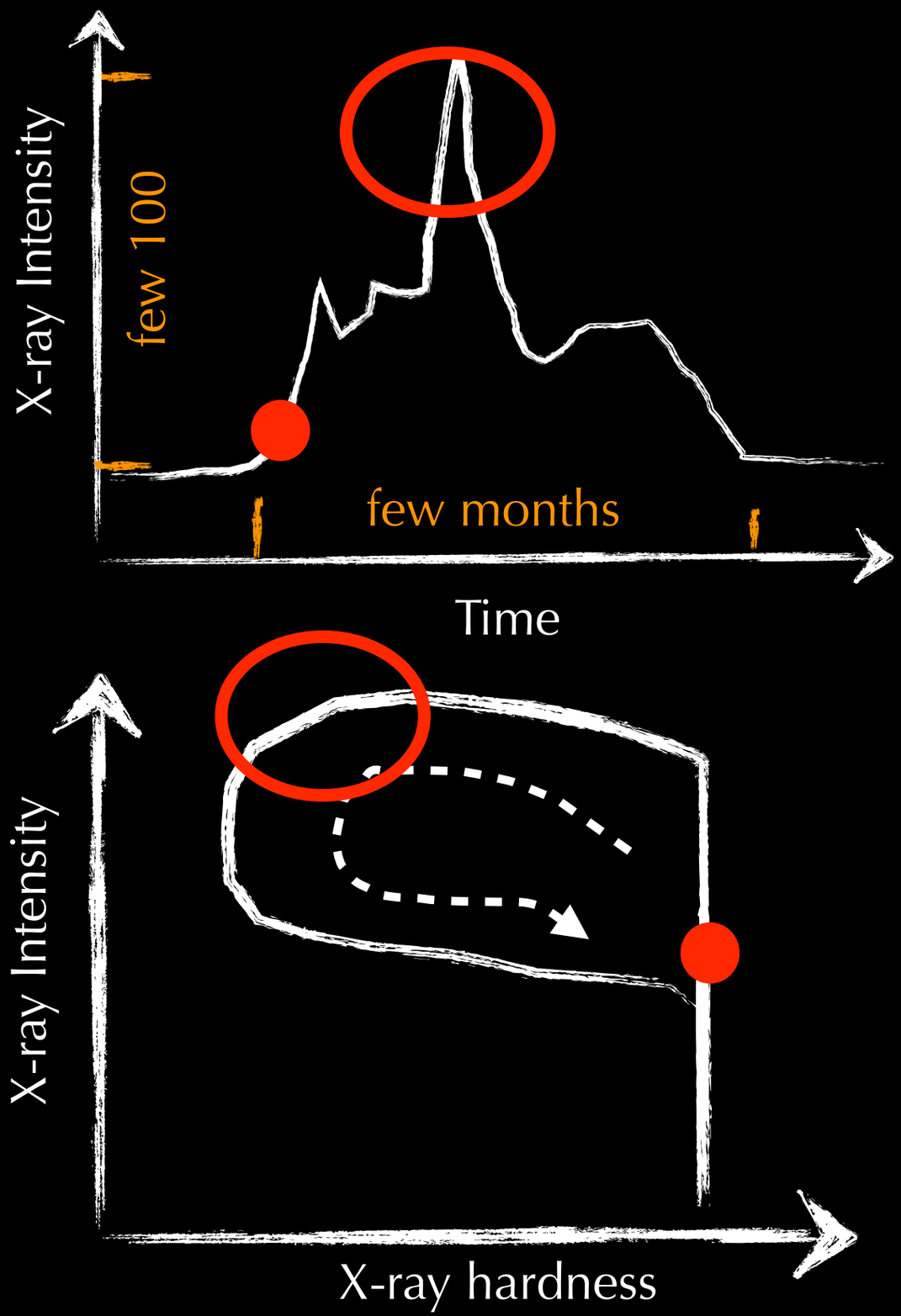
Fender 2001



Migliari et al. 2010

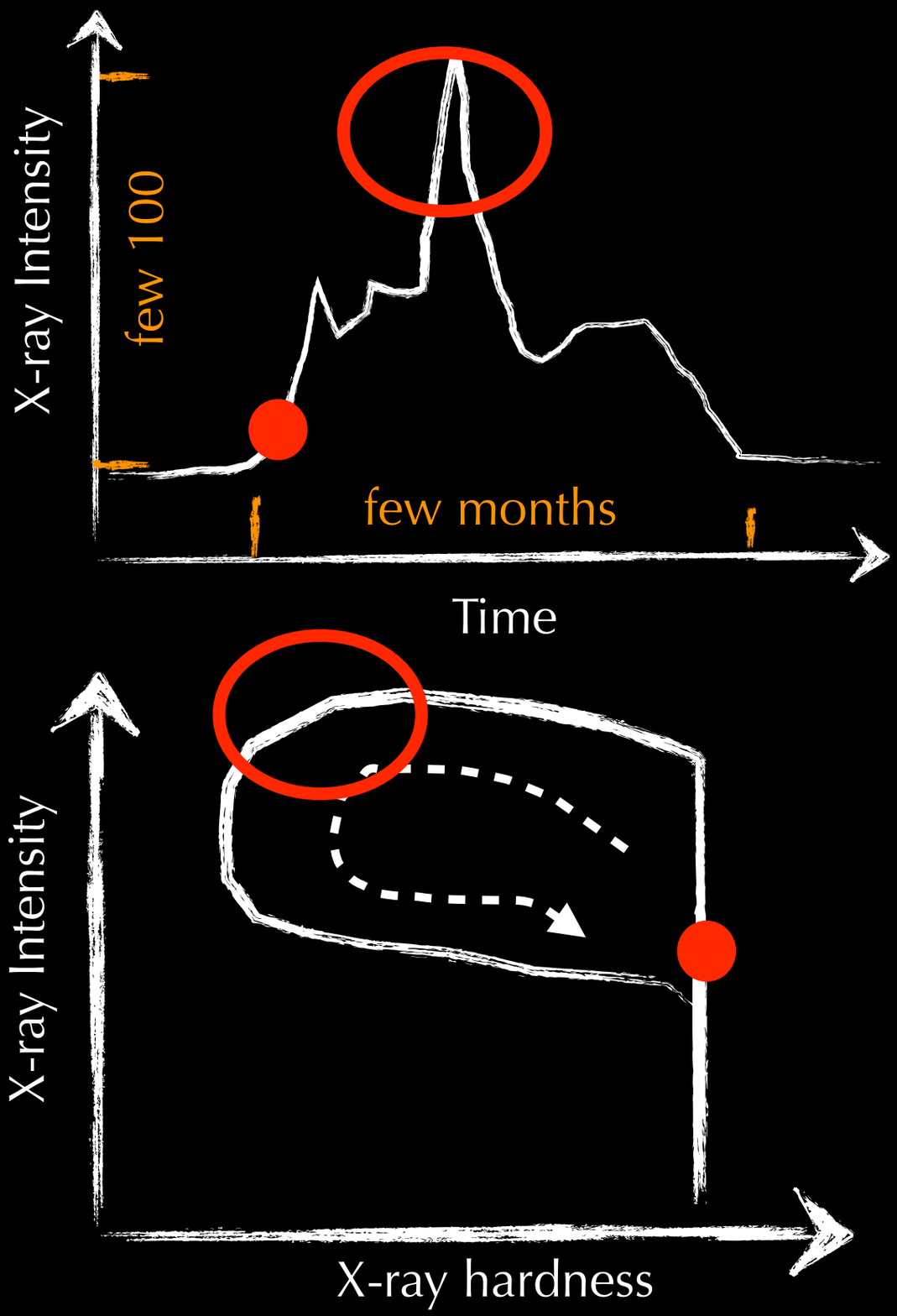


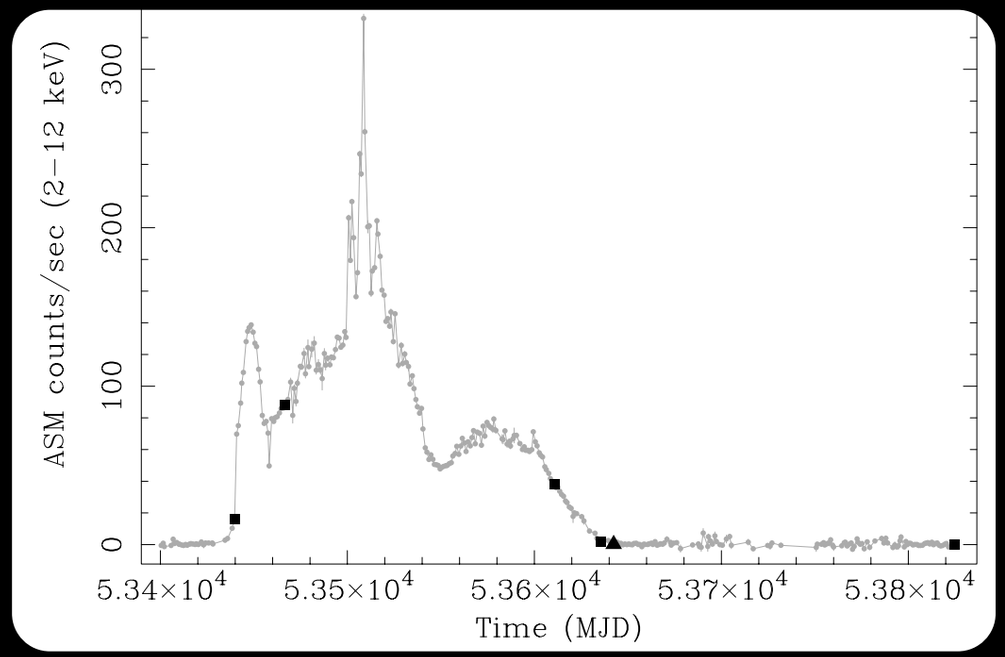
BH X-ray binaries

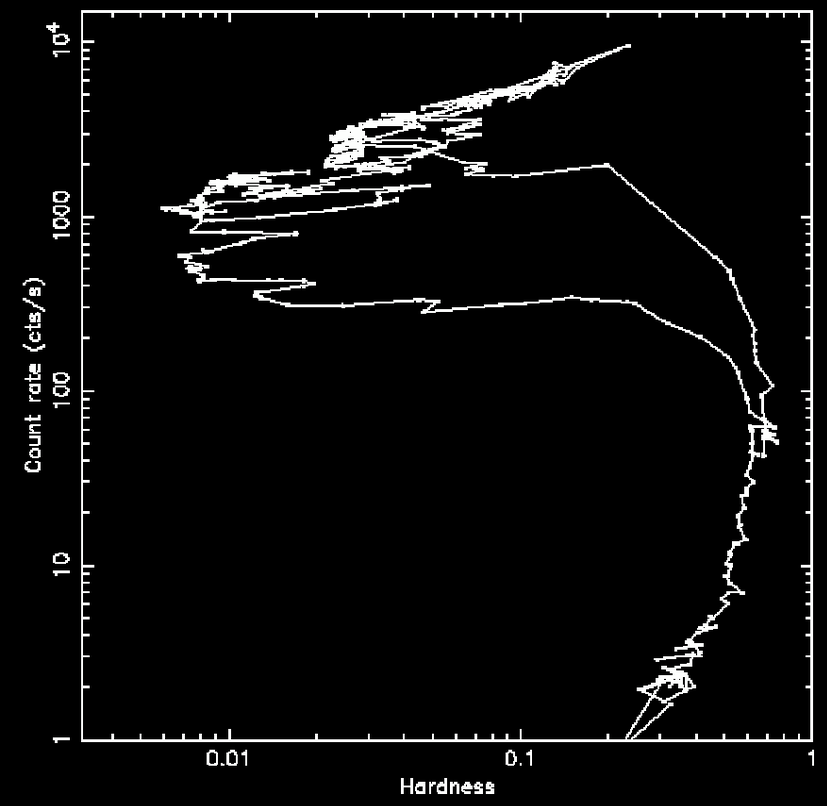


accretion disc instability

full cycle of an outburst


X-ray Intensity
few 100
few months
Time
X-ray Intensity
X-ray hardness

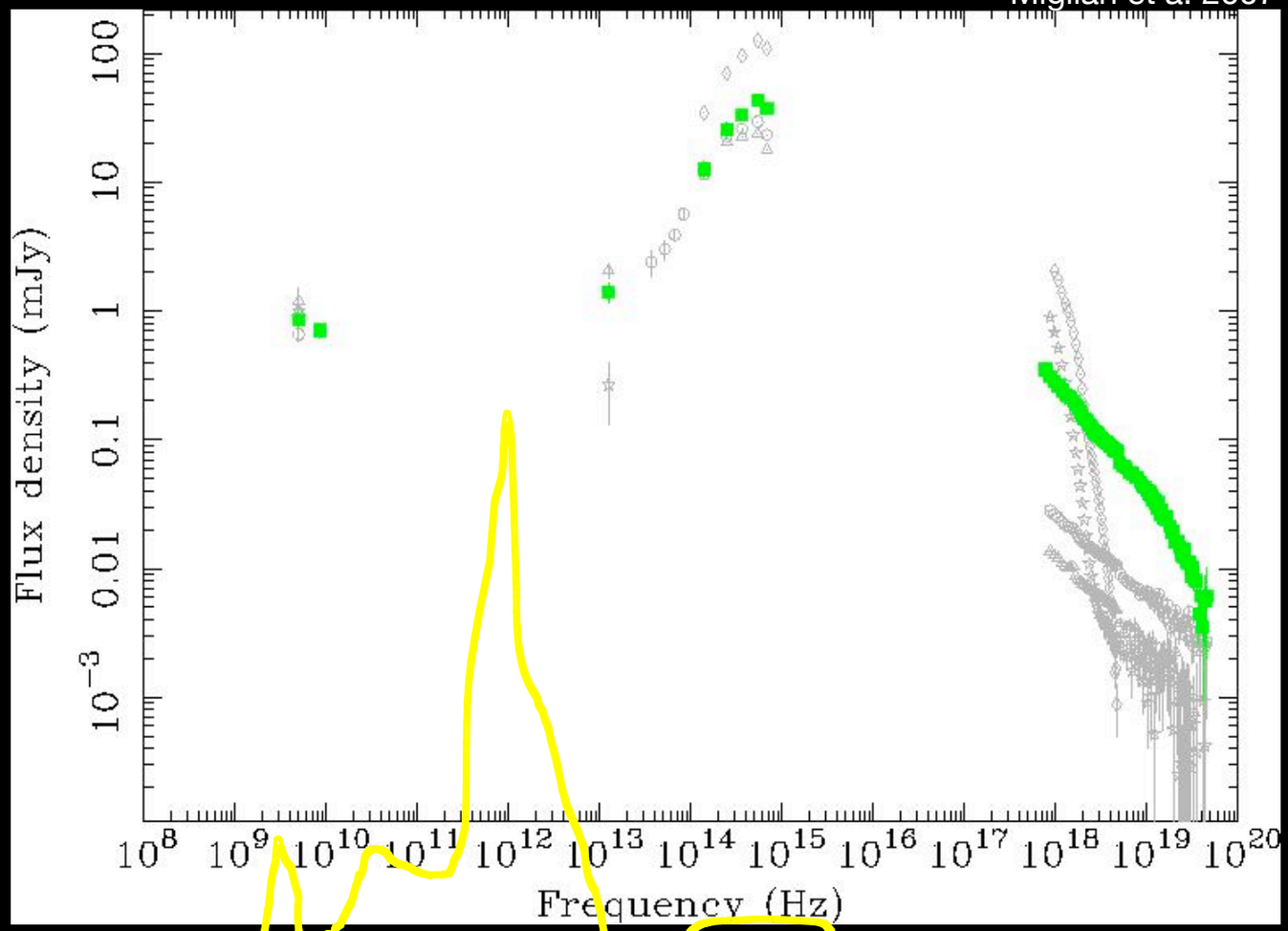

ASM counts/sec (2–12 keV)
0
100
200
300
5.34×10^4
5.35×10^4
5.36×10^4
5.37×10^4
5.38×10^4
Time (MJD)

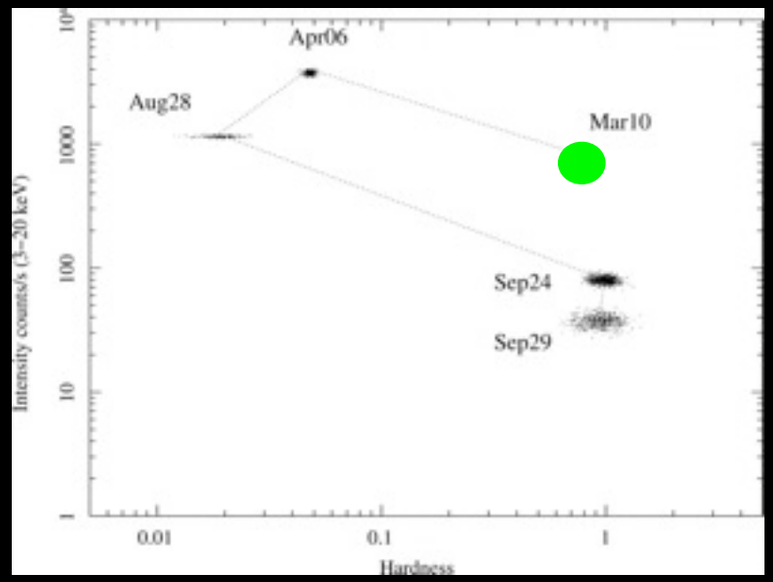

Count rate (cts/s)
1
10
100
1000
10^4
0.01
0.1
1
Hardness

spectra

GRO J1655-40

Migliari et a. 2007

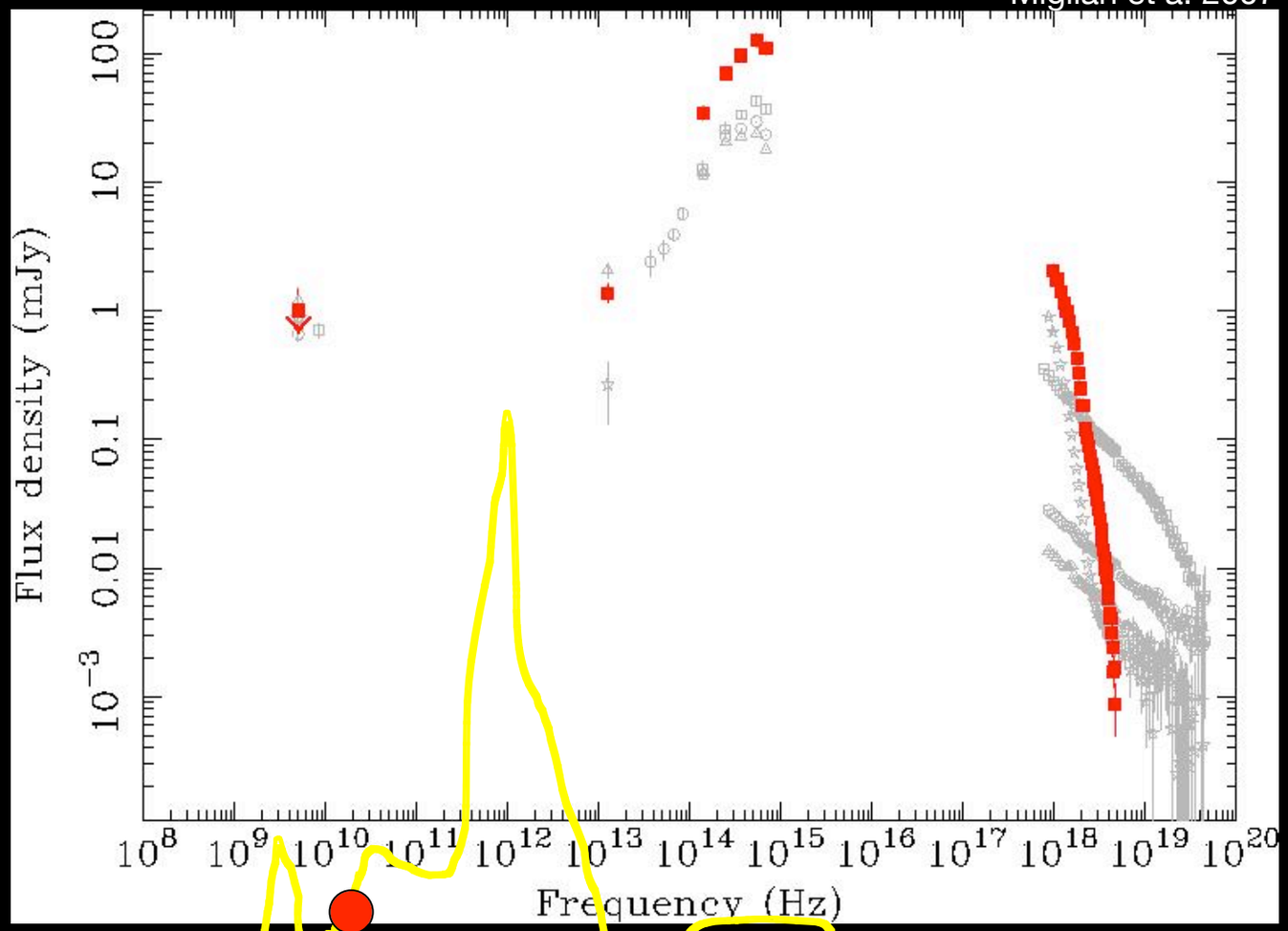


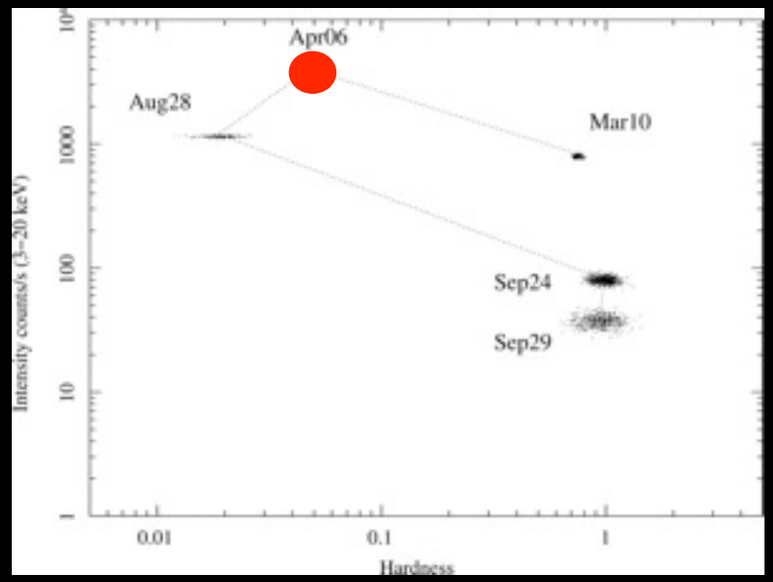


spectra

GRO J1655-40

Migliari et a. 2007

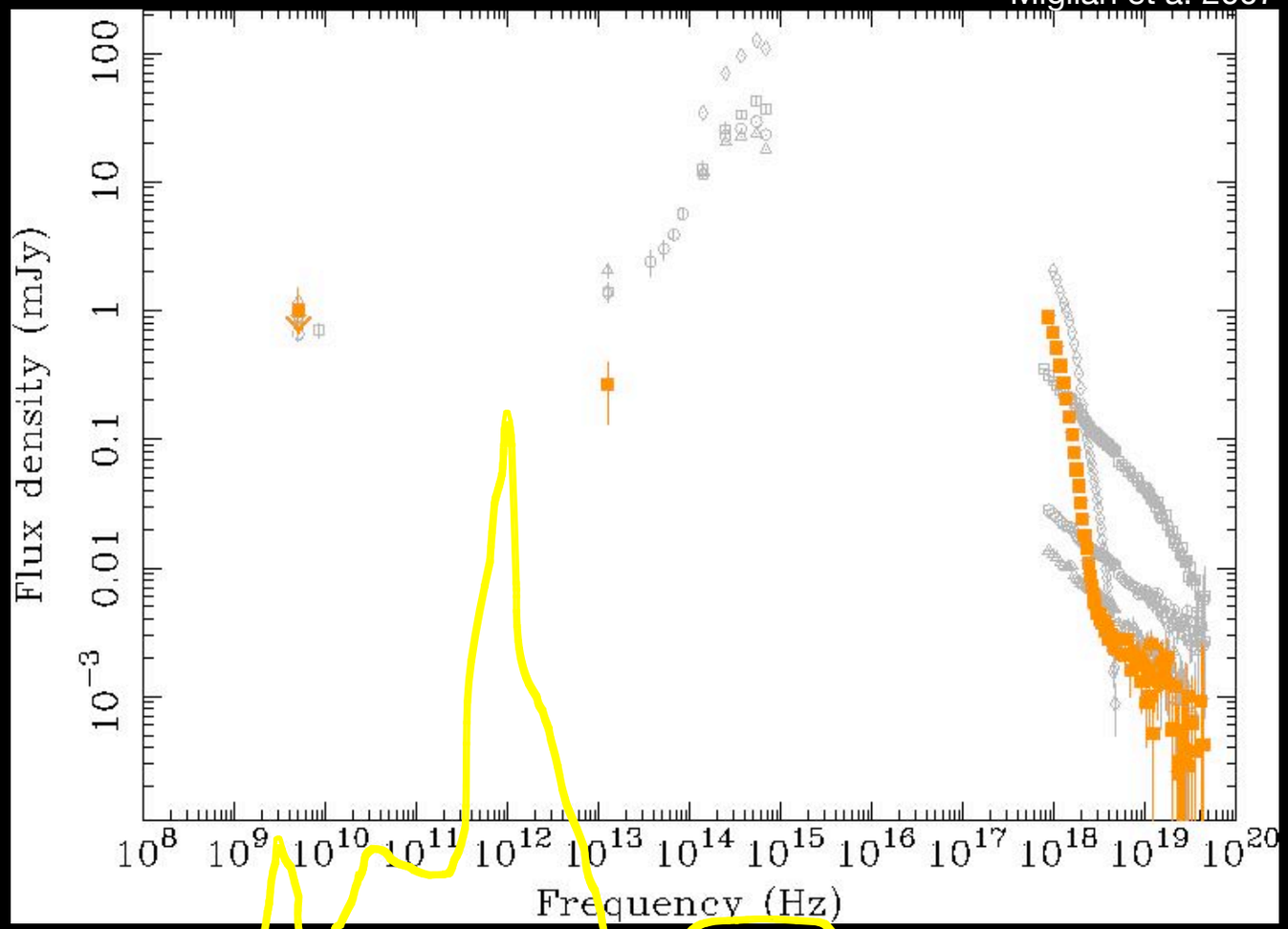


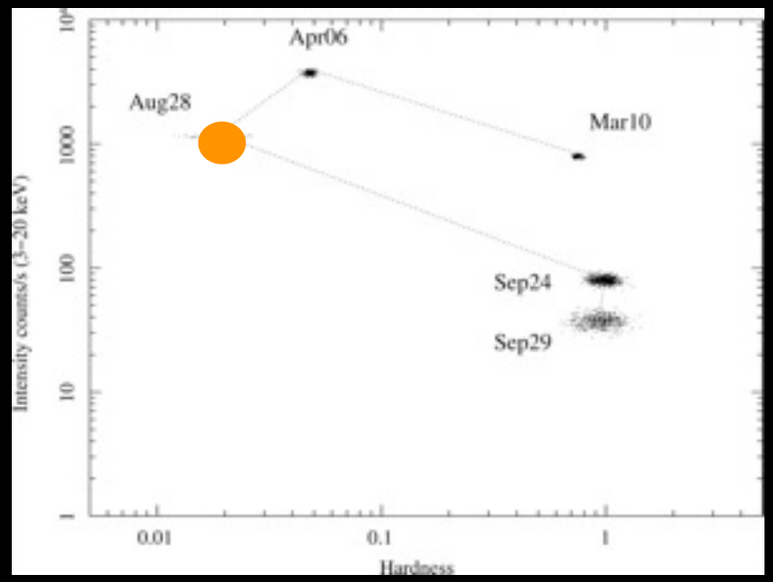


spectra

GRO J1655-40

Migliari et a. 2007

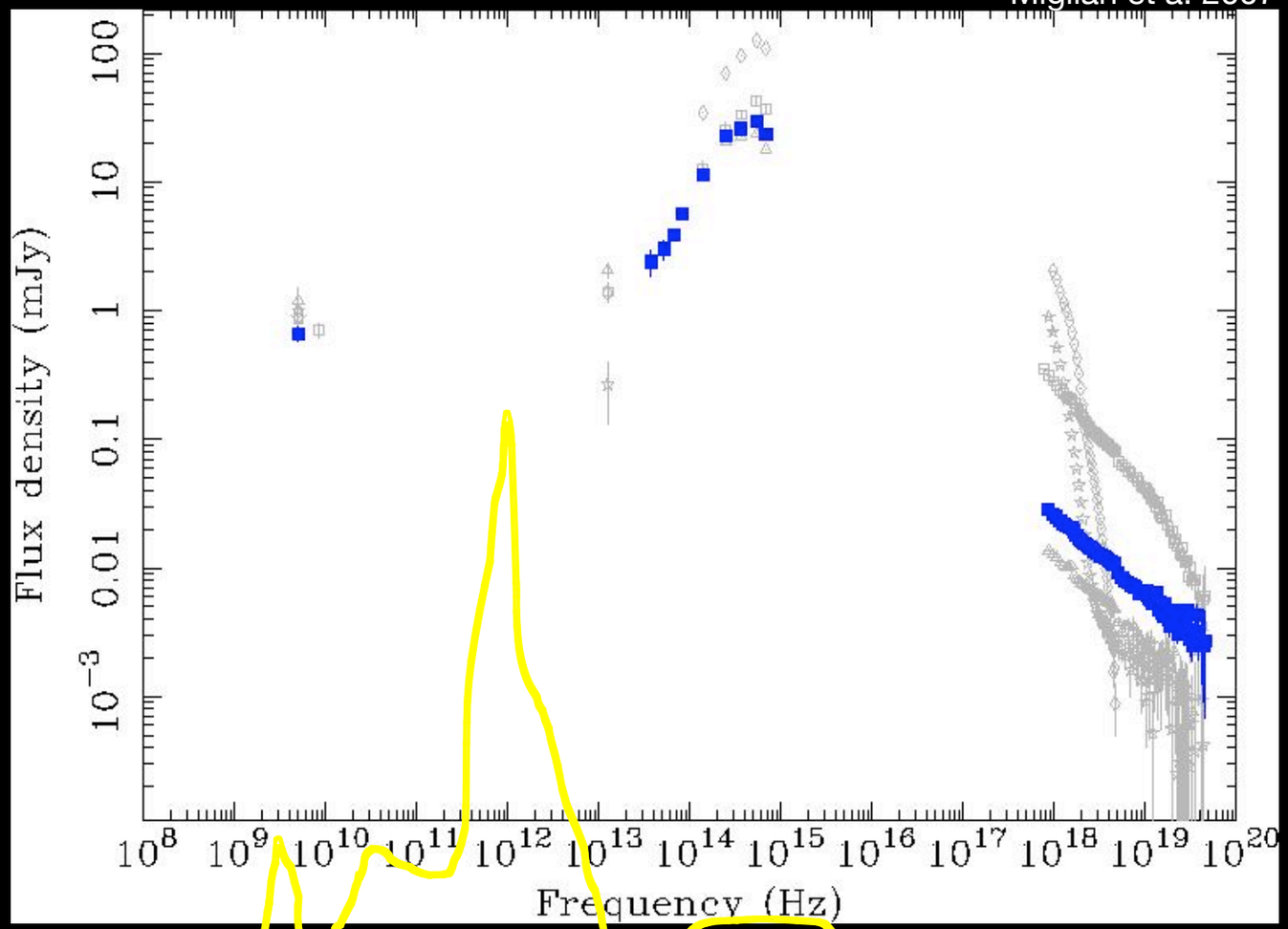


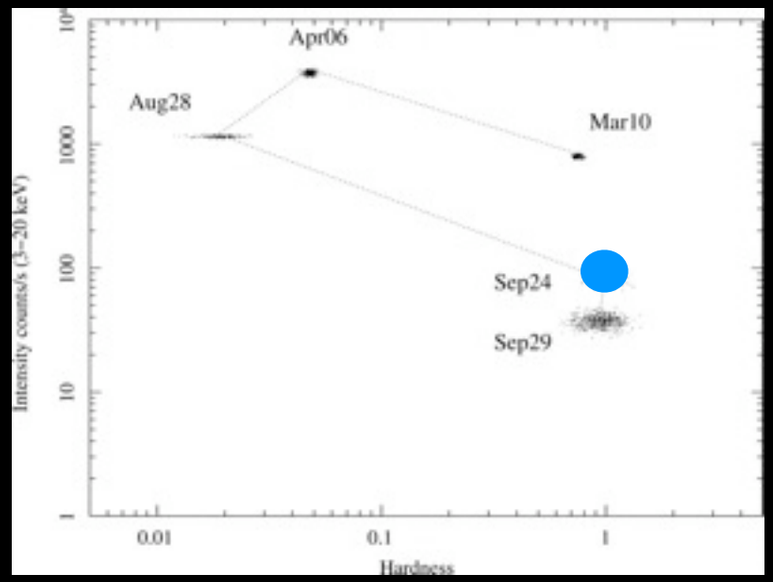


spectra

GRO J1655-40

Migliari et a. 2007

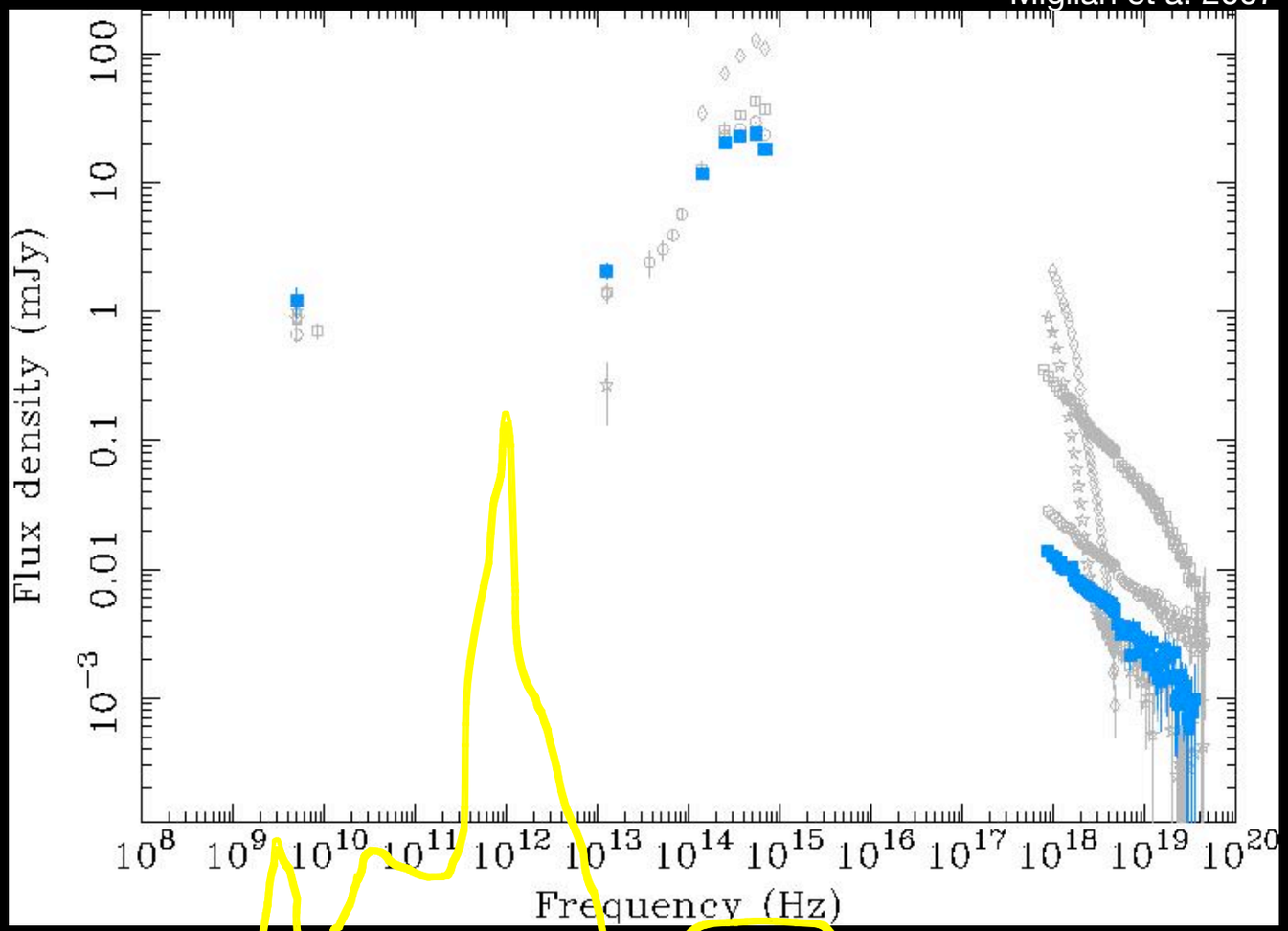


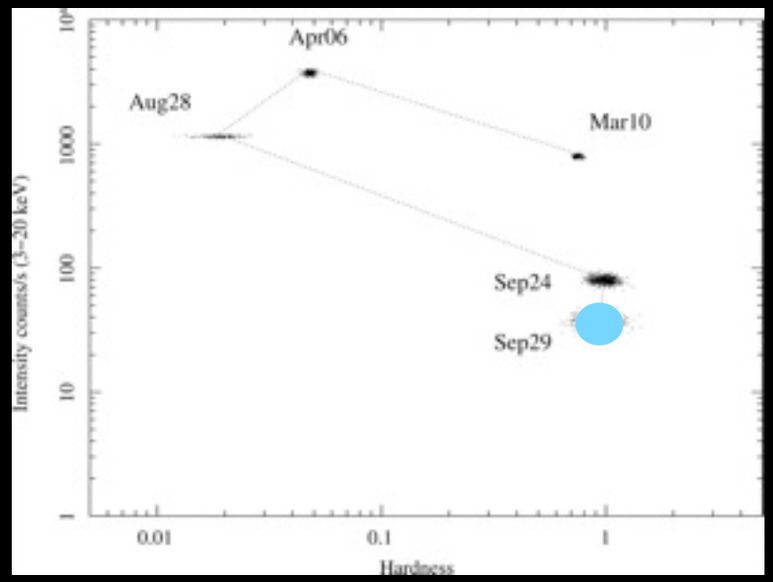


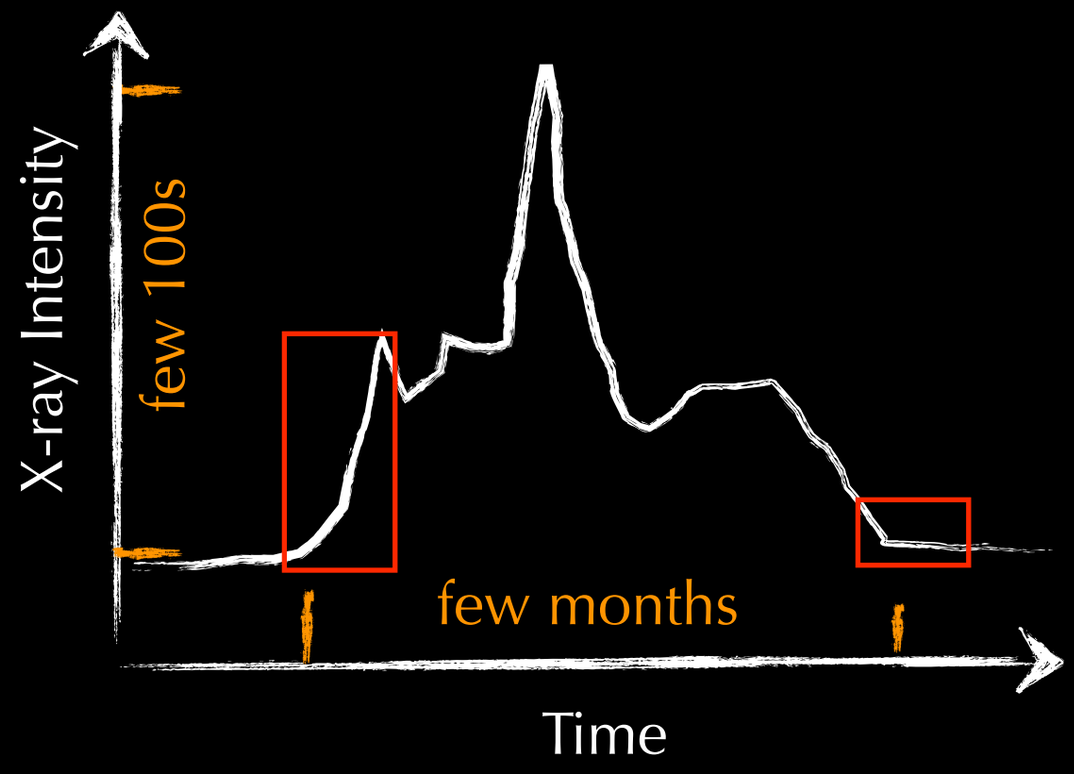
spectra

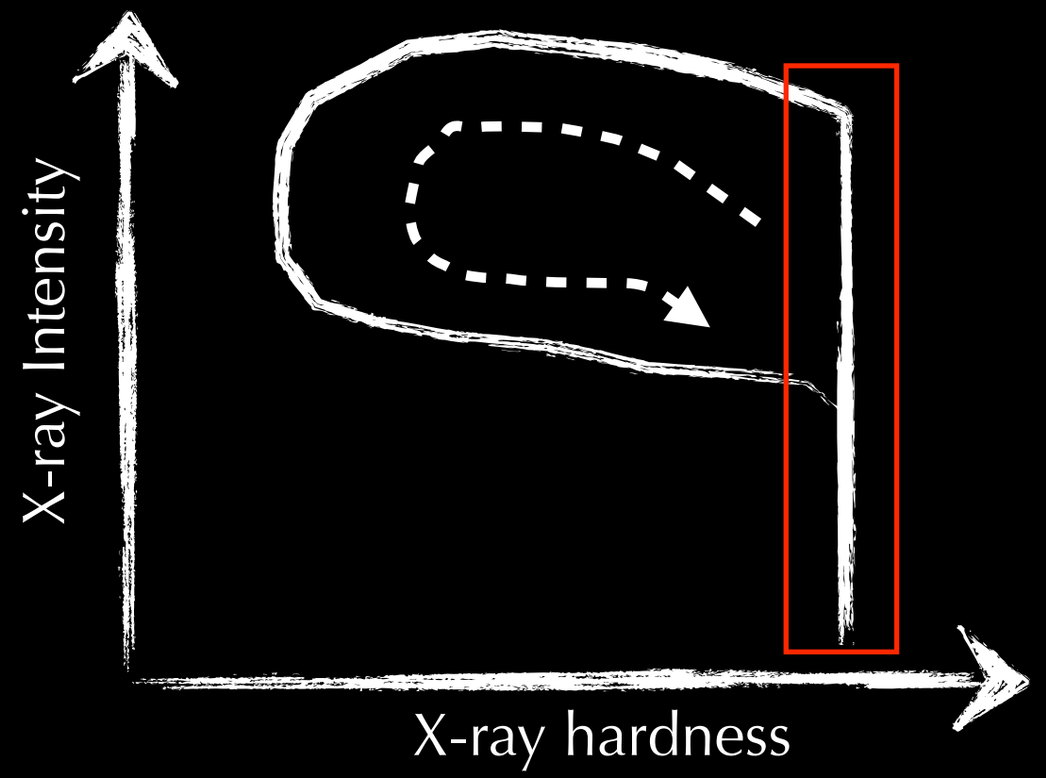
GRO J1655-40

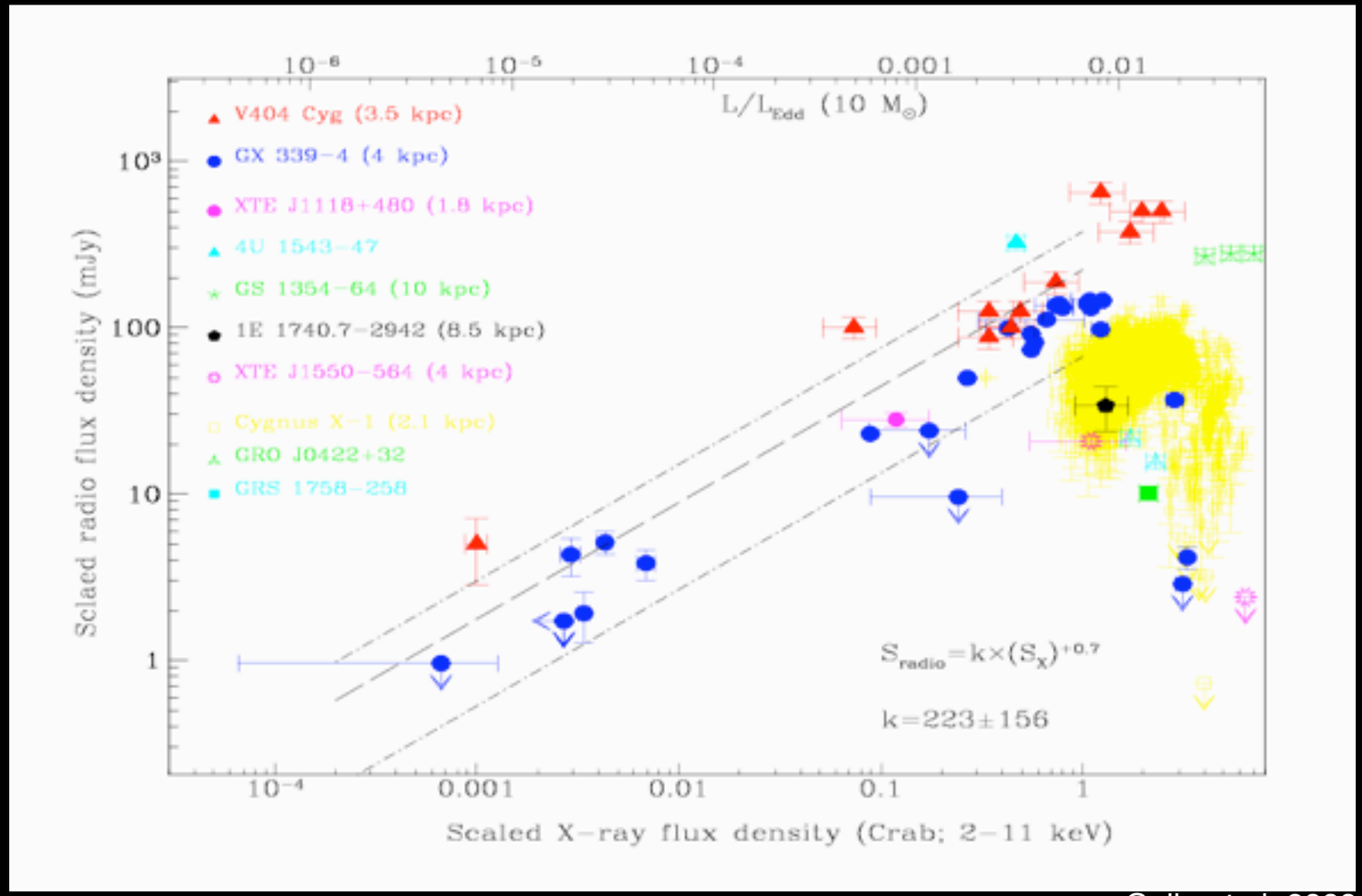
Migliari et a. 2007



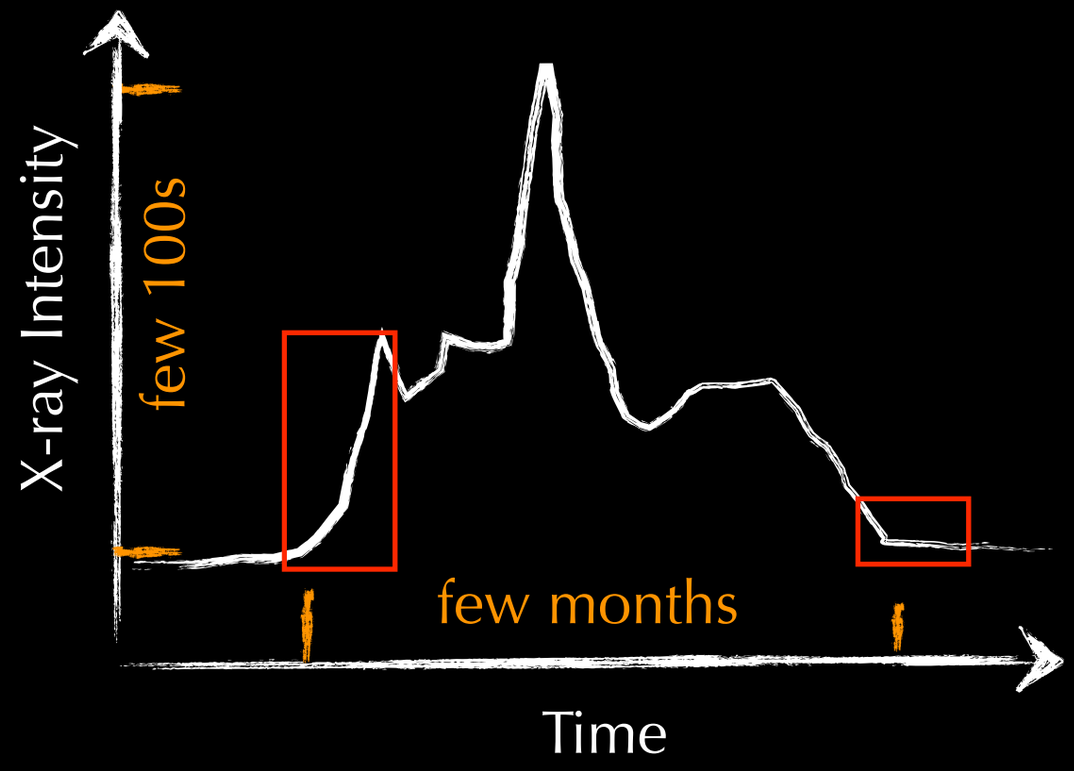


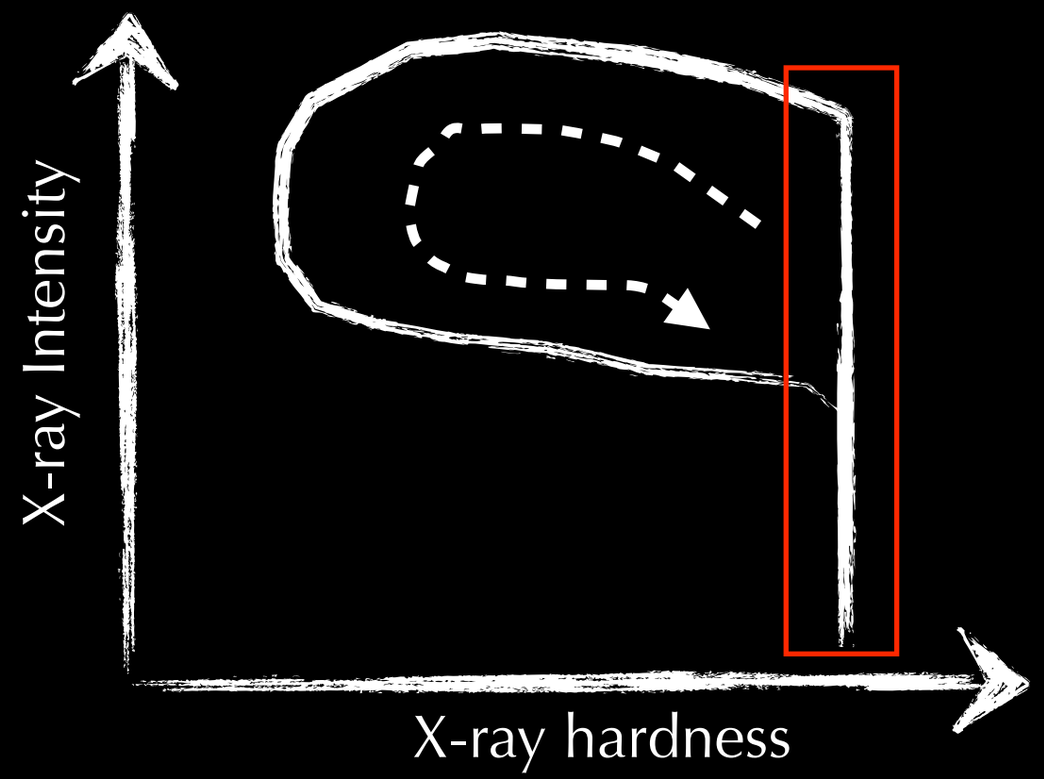


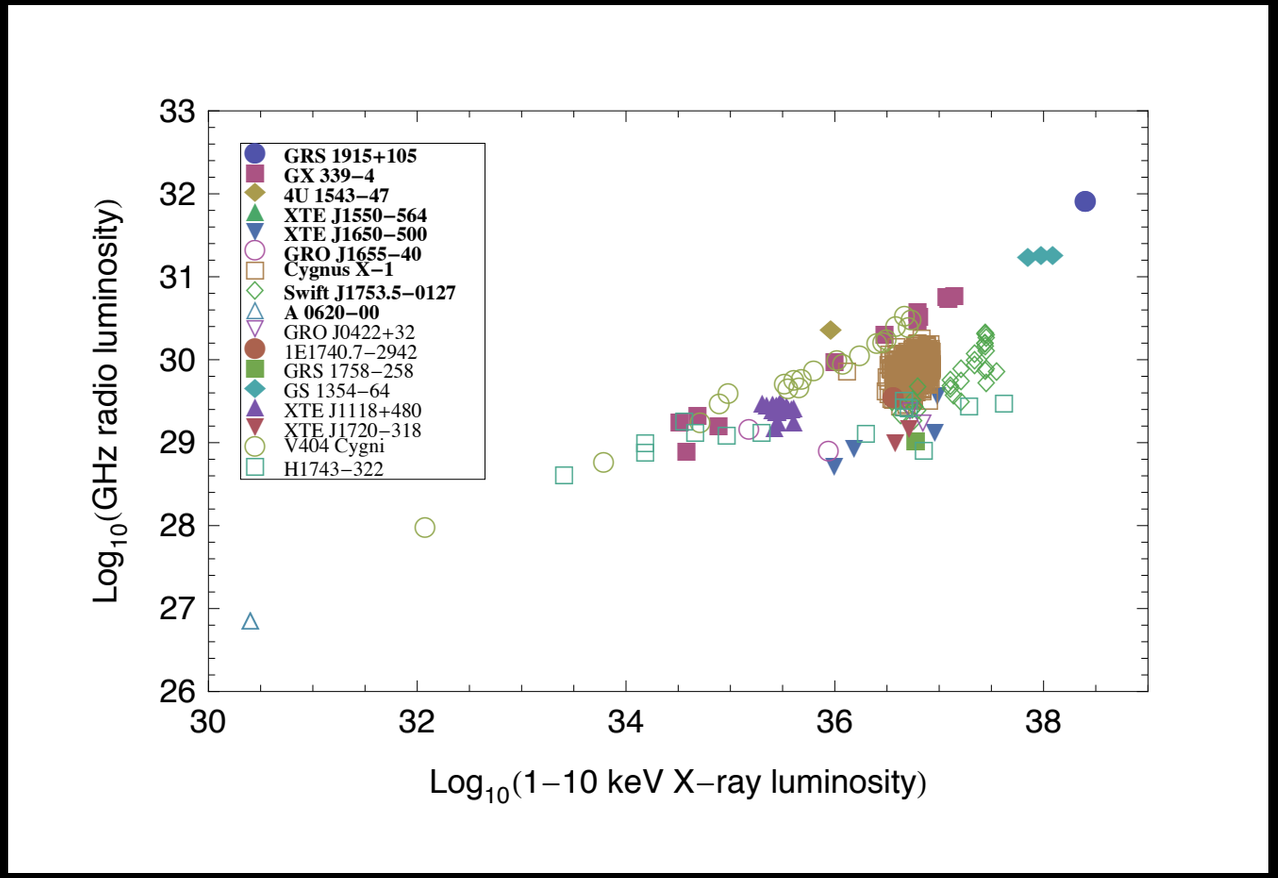




Gallo et al. 2003

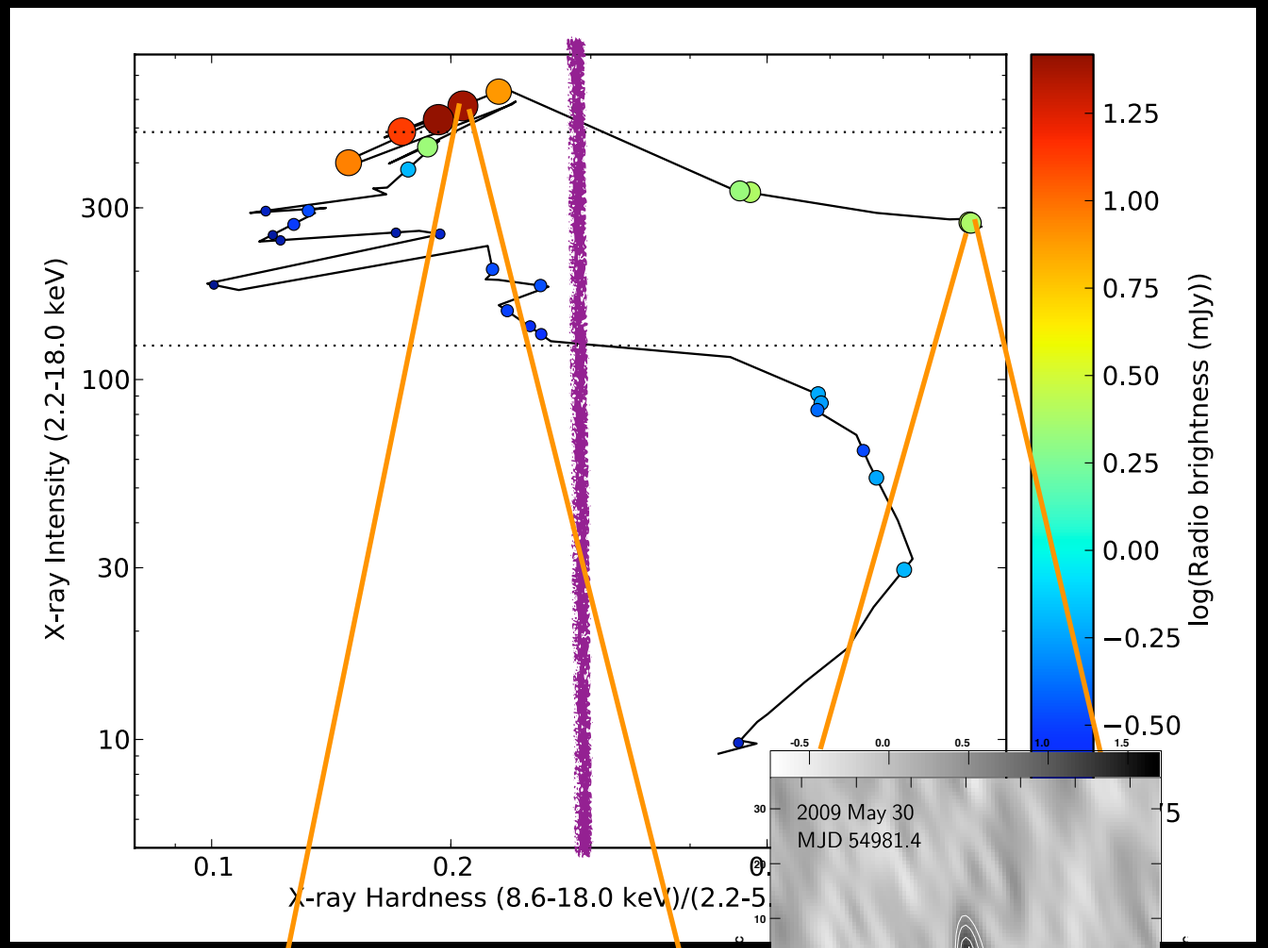




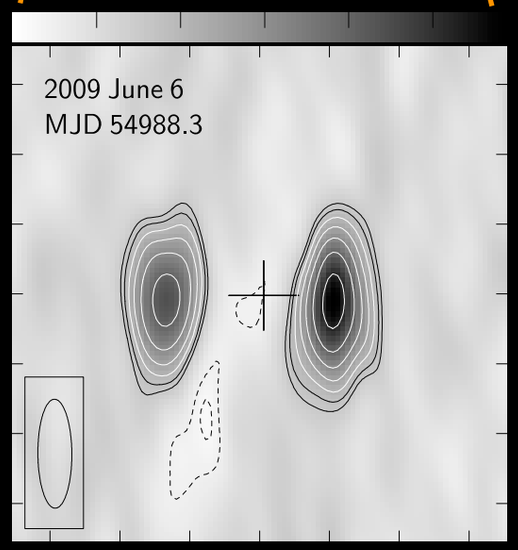


Soleri & Fender 2010

jet line May 2009 H 1743-322



transient

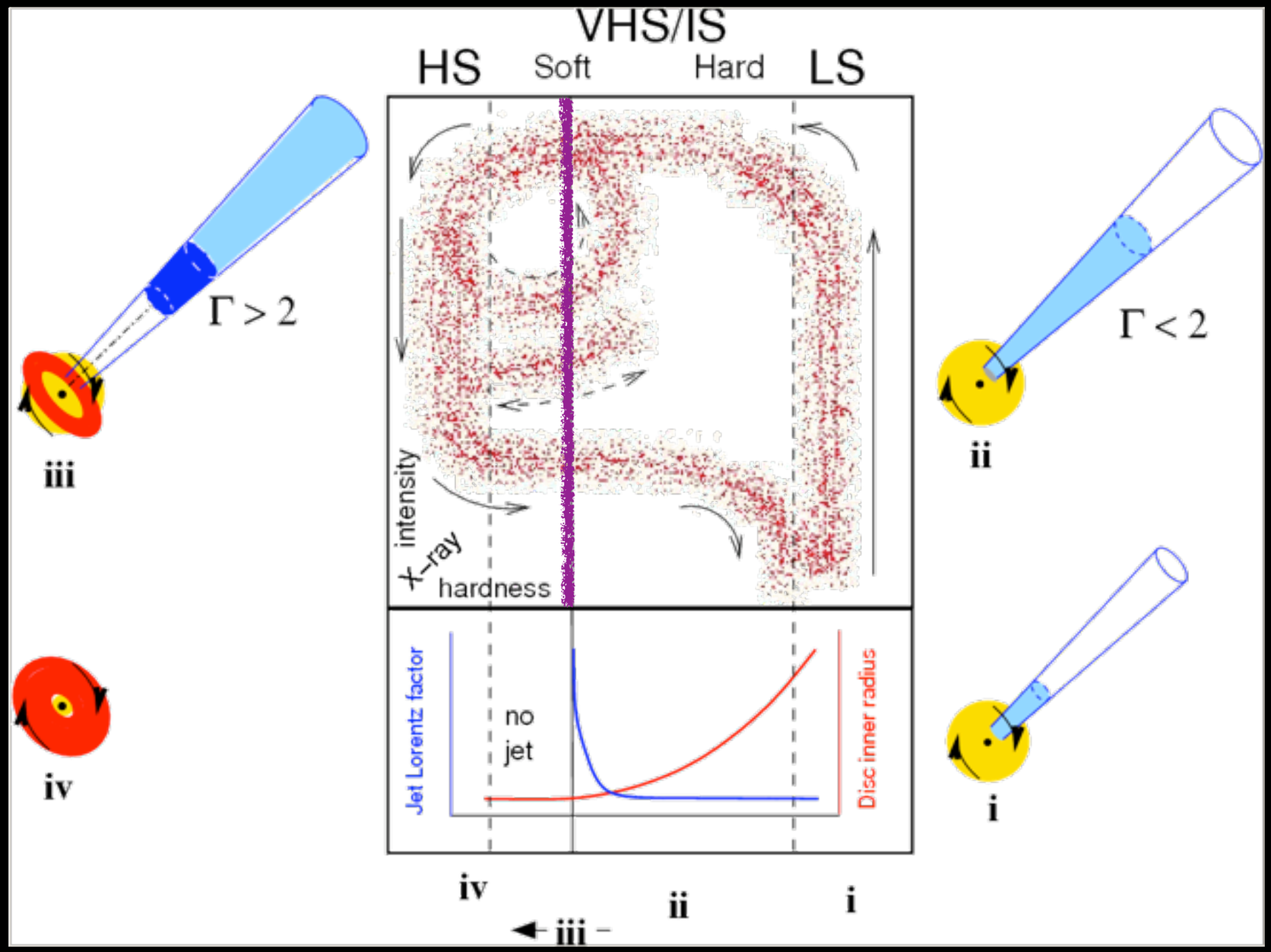


compact

Miller-Jones et al.: JACPOT collaboration
http://www.astro.virginia.edu/xrb_jets/

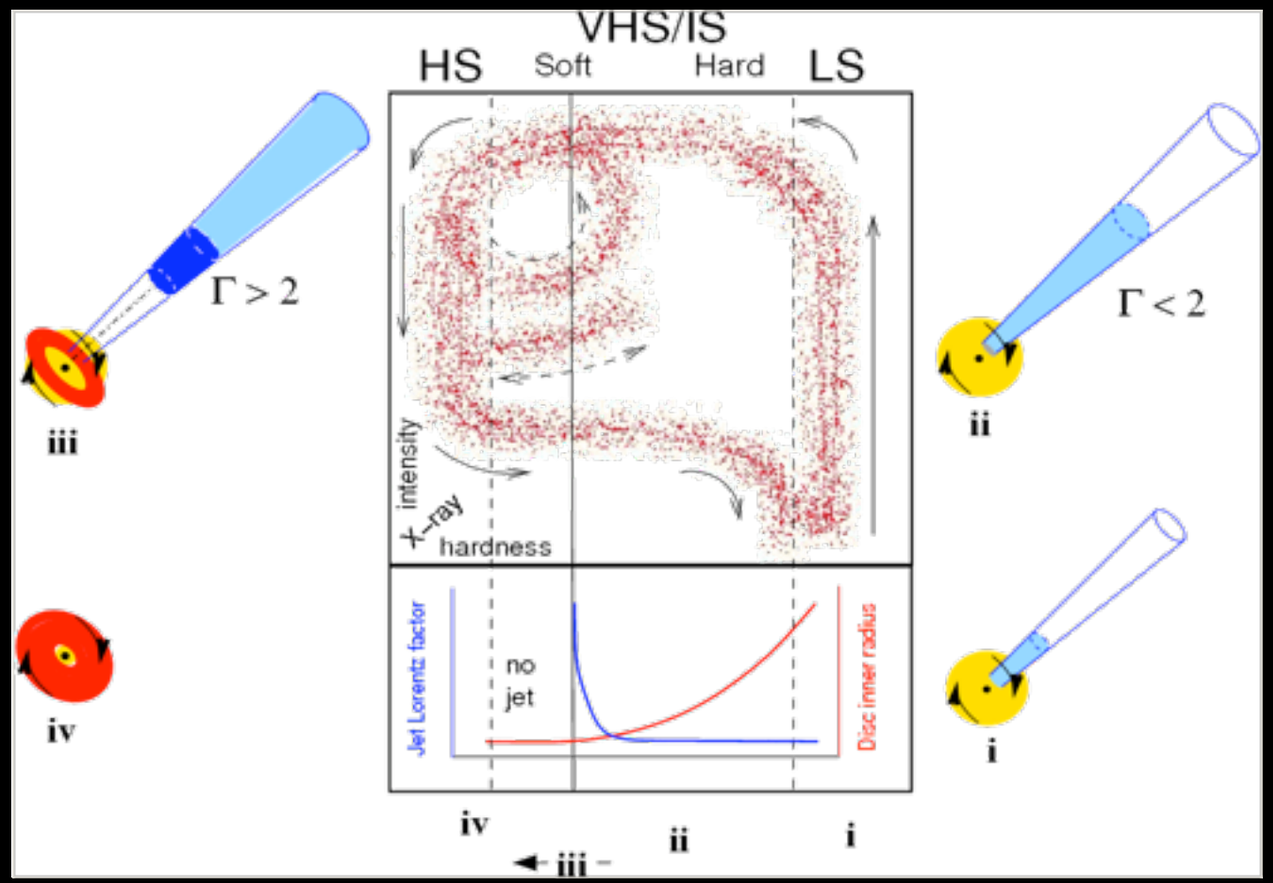
proposed Unified Scenario

Fender et al. 2004



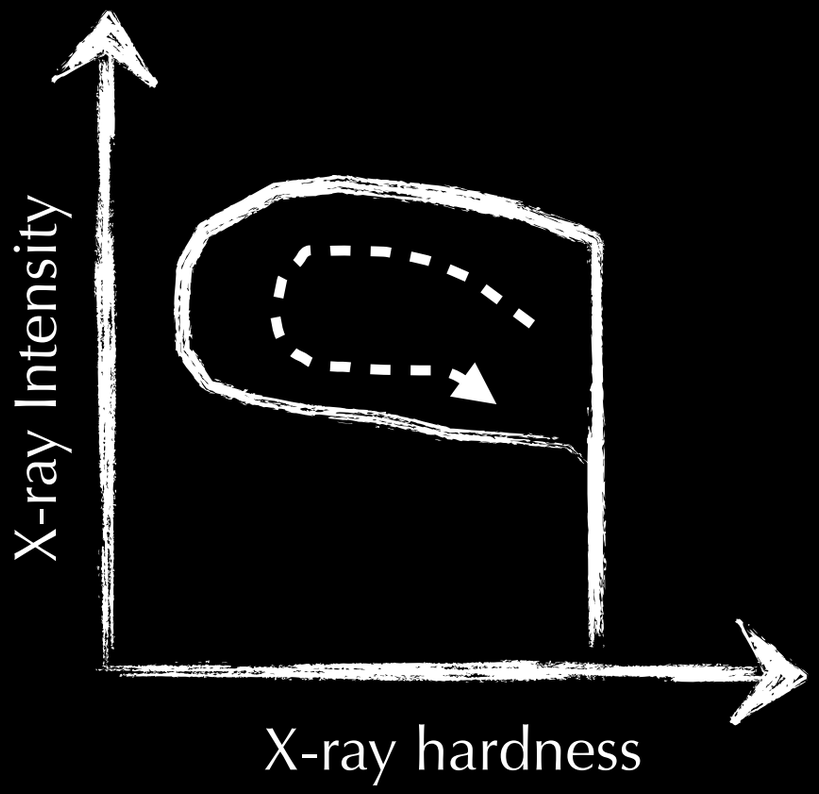
- does the disk radius vary?
- correlation slope?
- Lorentz factor?
- does the jet speed increases as increases potential well.
- is there a jet line? is it vertical?

- is the ejection, an ejection of the corona?
- does the core jet quench? when exactly during the outburst?
- at what hardness/the core jet reforms back?
- do subsequent ejecta vary speed?
- and what about QPOs and jets?
- ...

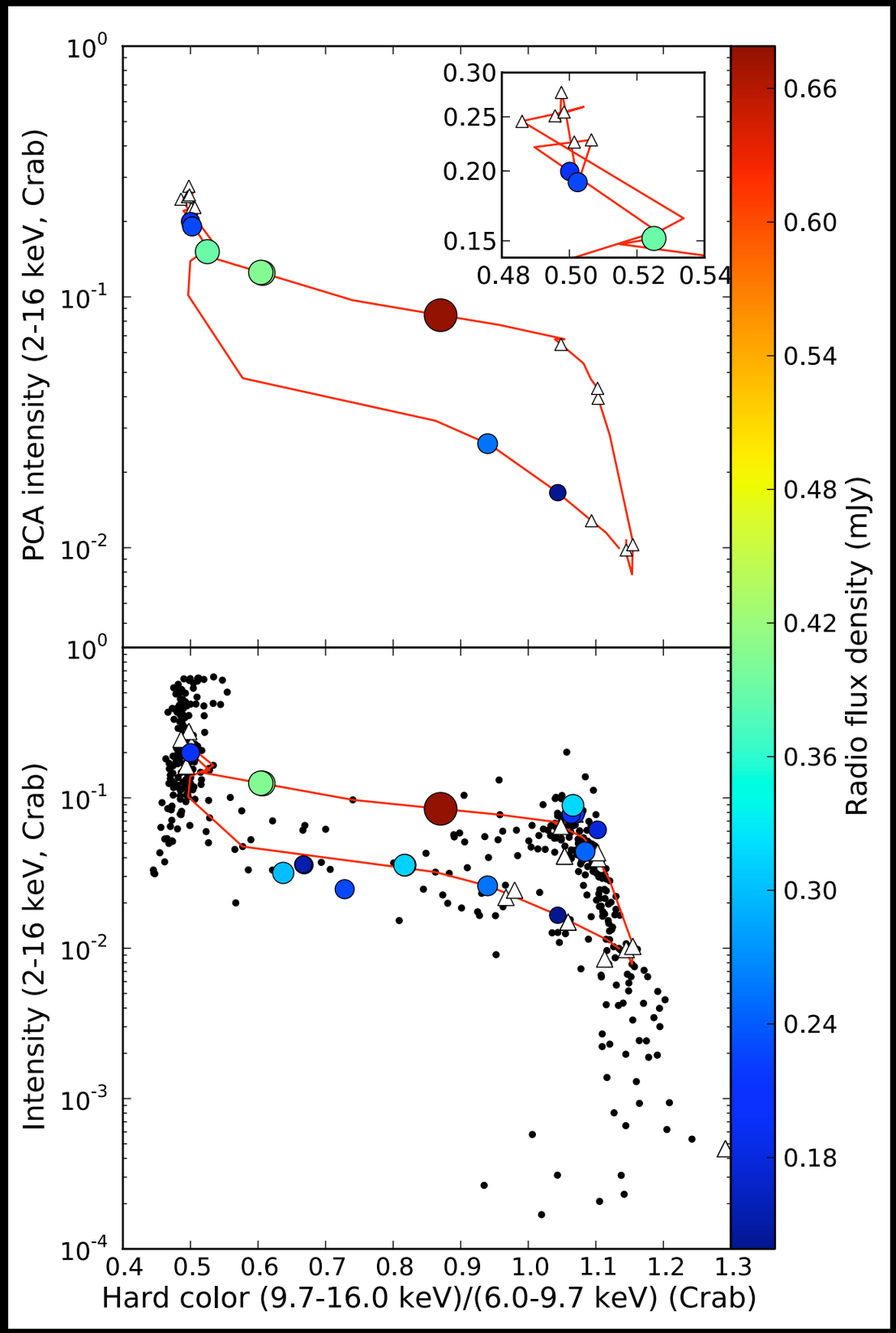


Radio flare H->S	Major ejection	Confirmed
Reactivation of radio emission S->H	Reactivation compact jet	Unclear
No radio emission in S	jet off	Consistent, not proven
H jet slow, Transient Jet fast	internal shocks	Unclear: no compact jet speed measuerements
Ejection - X variability power	Ejection of corona	Unclear

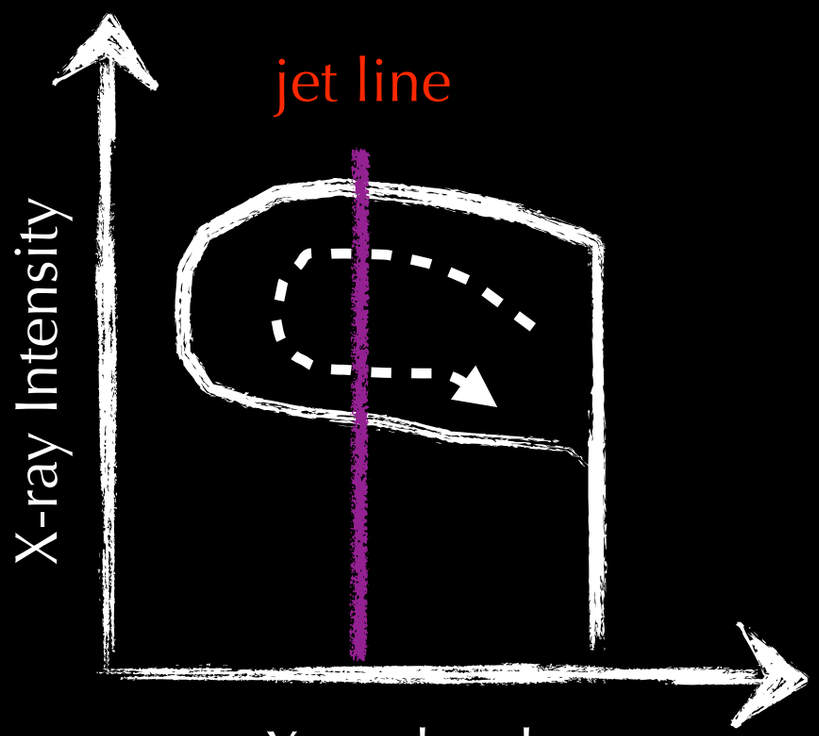
NSs?



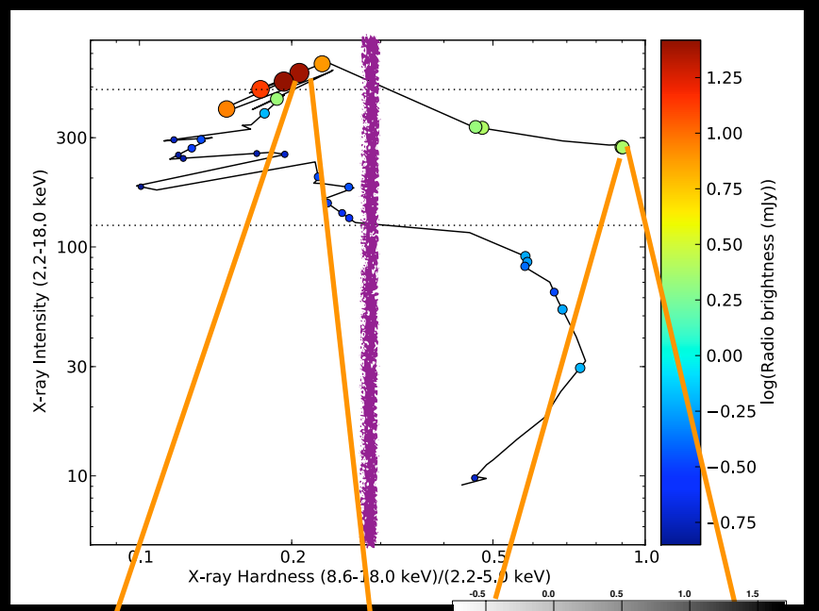
Aql X-1

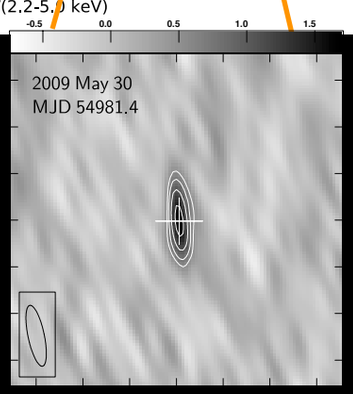


Miller-Jones et al. 2010

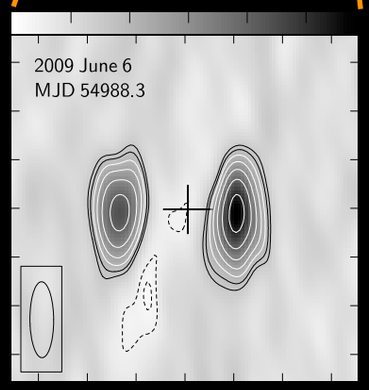


BH



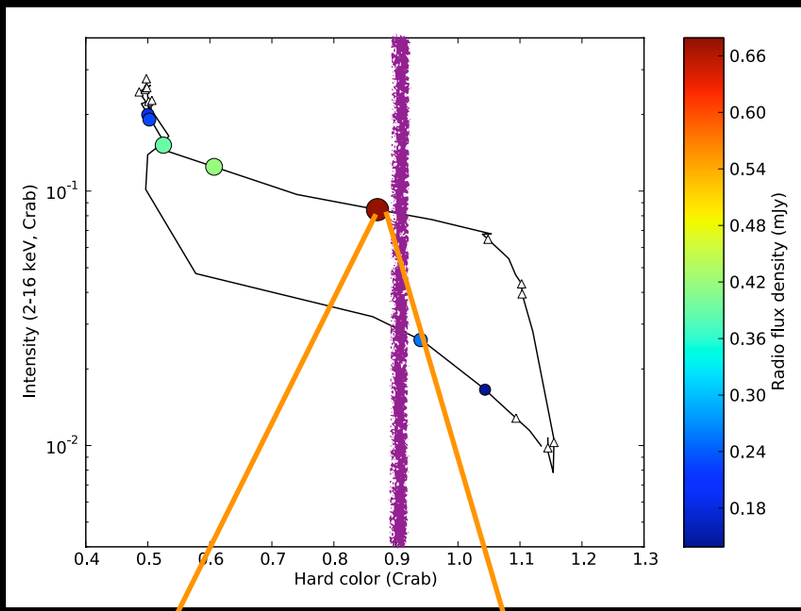


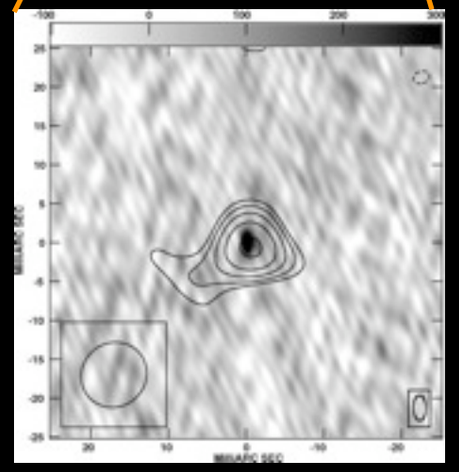
compact



transient

NS

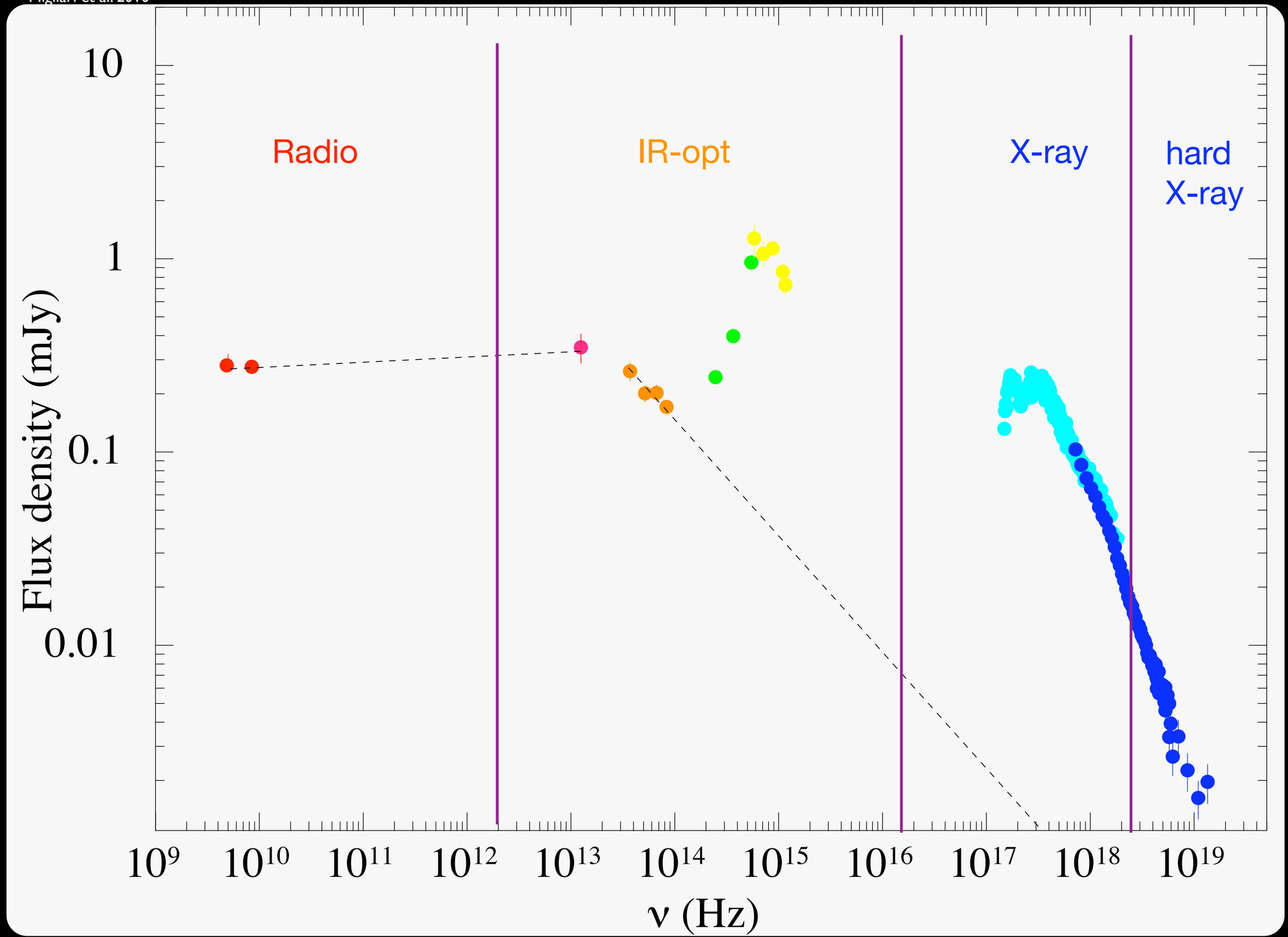




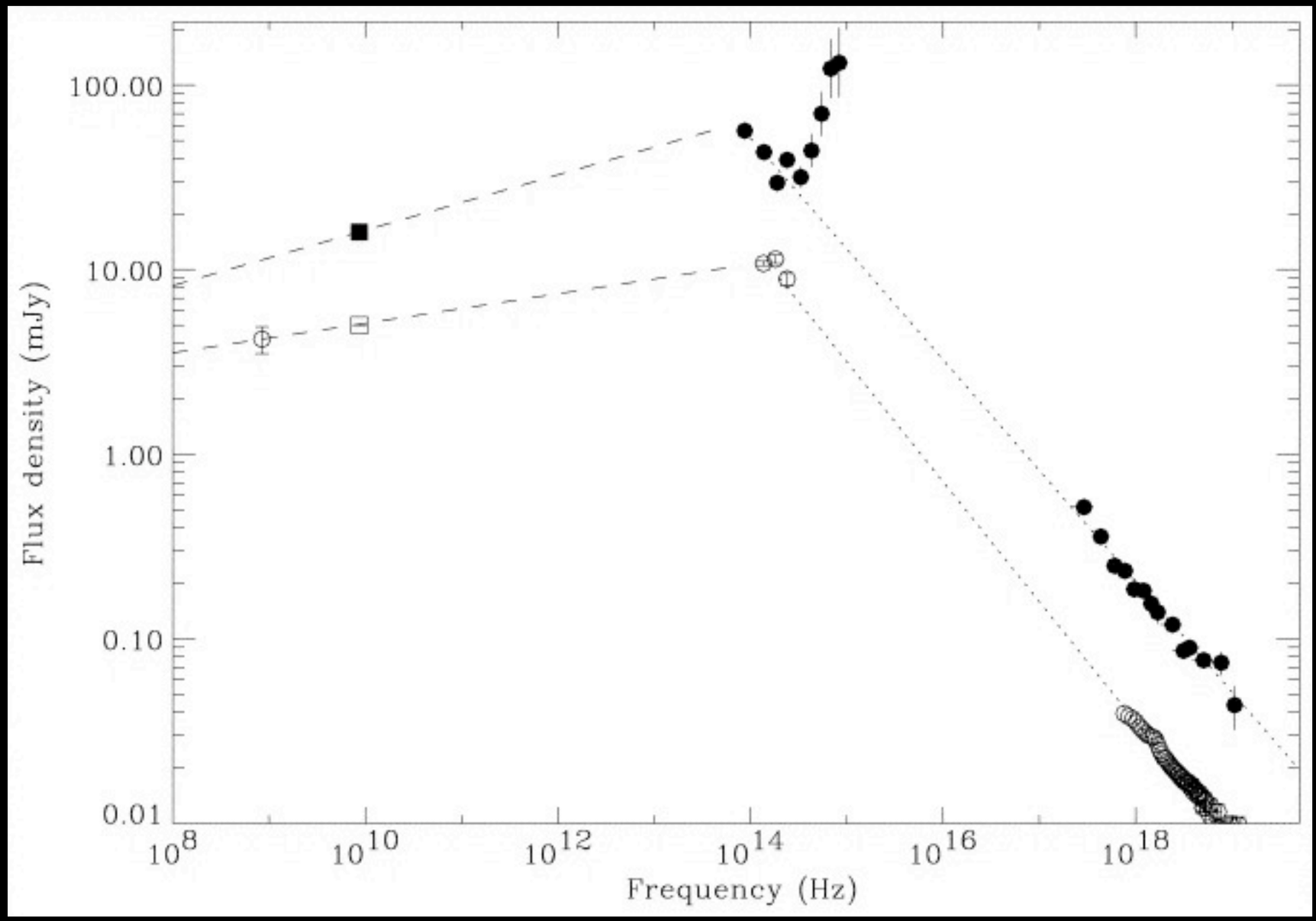
always compact

IR - hard X-ray tail

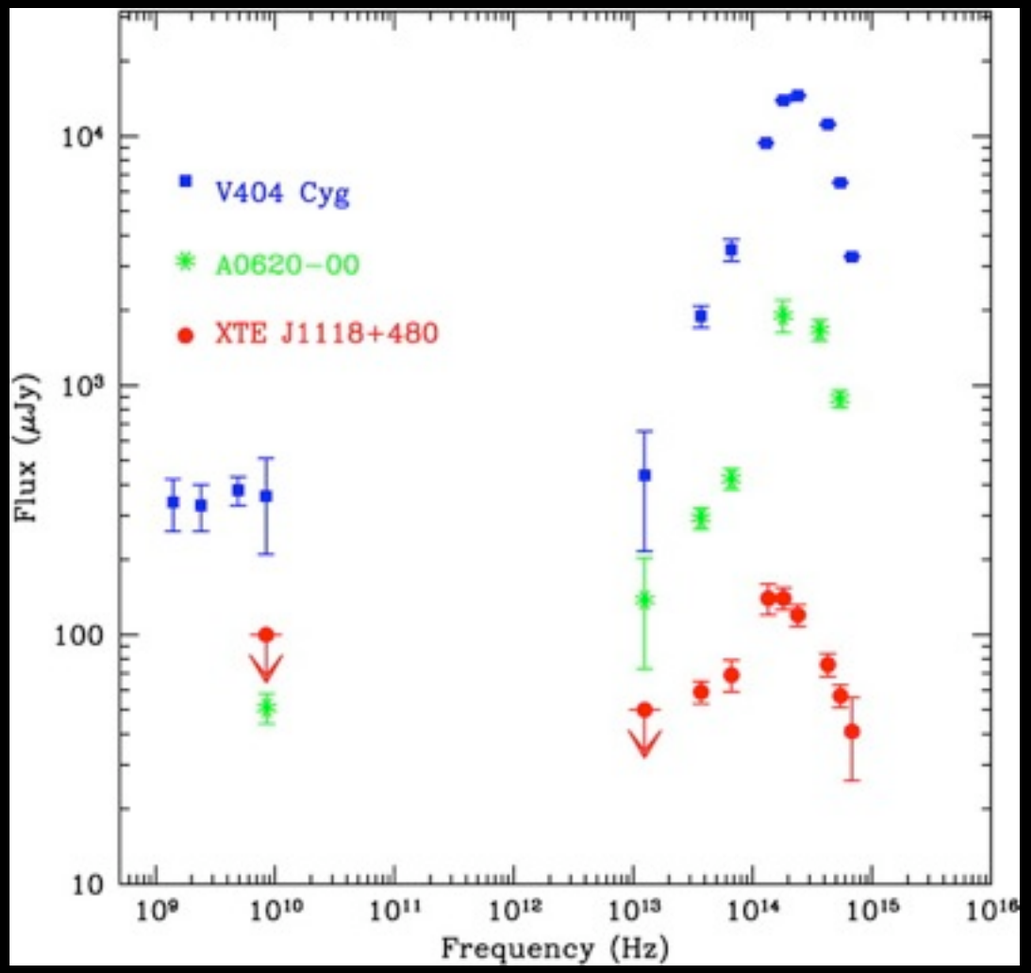
Migliari et al. 2010

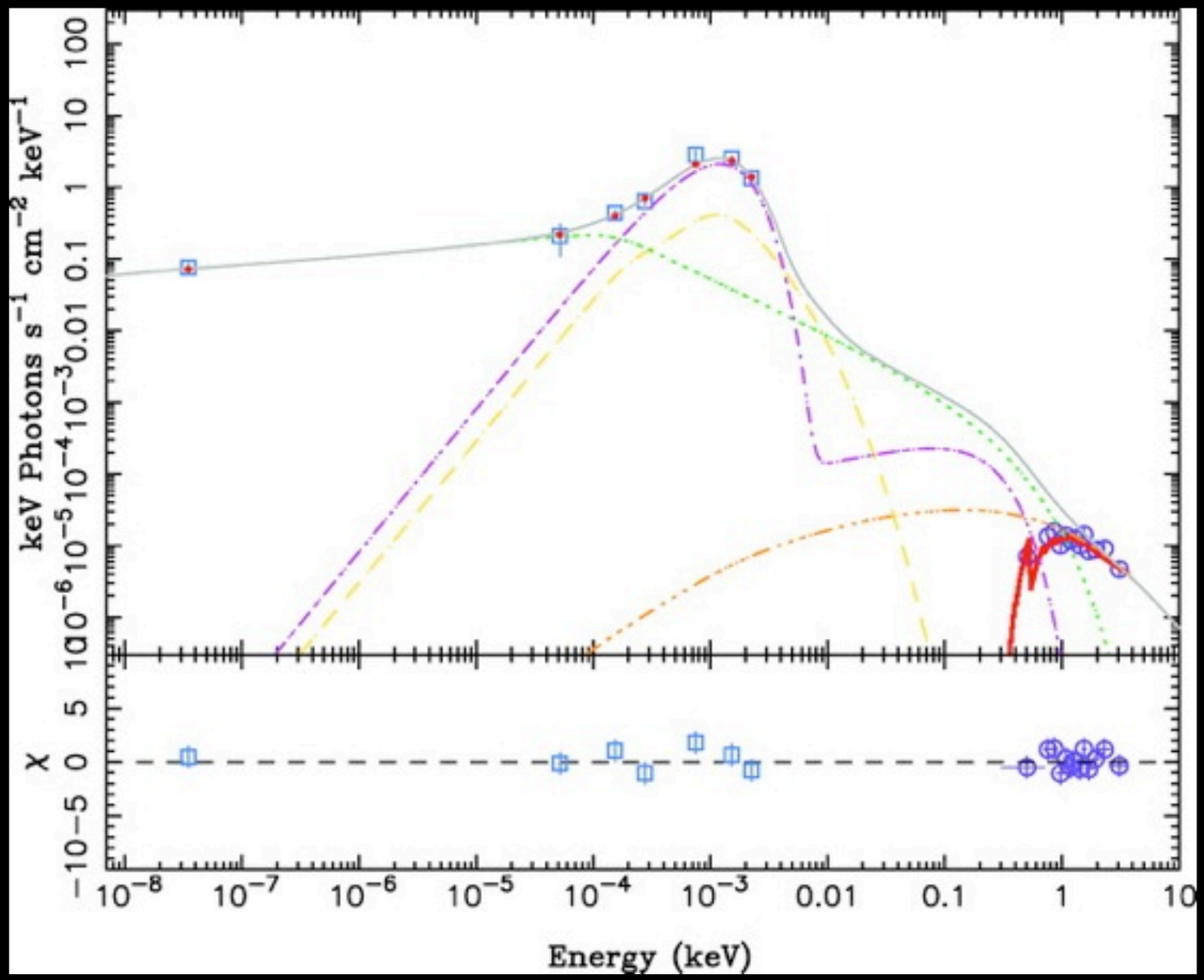


GX 339-4



Corbel & Fender 2002

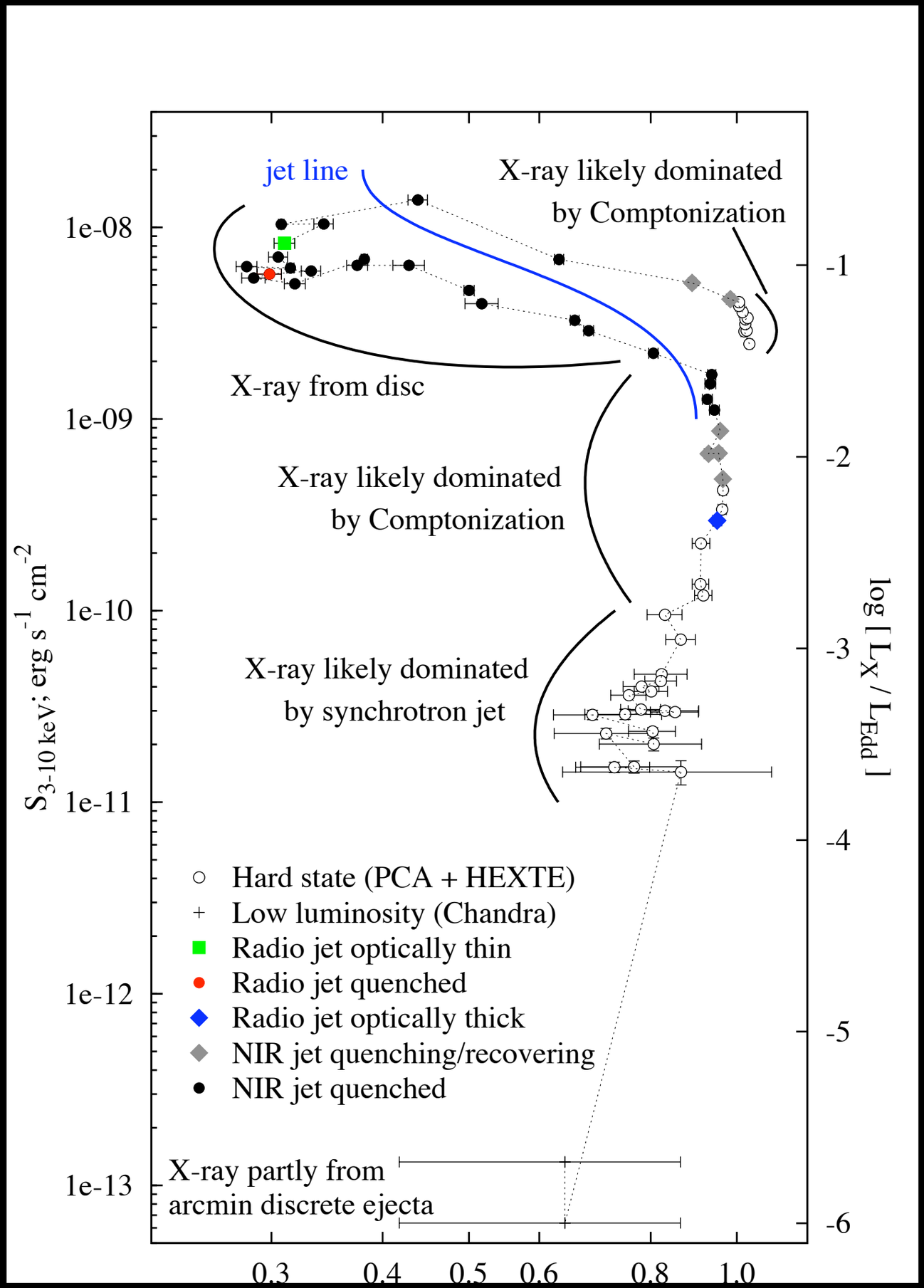




Gallo et al. 2007

Gallo, Migliari et al. 2007

XTE J1550



Russell et al. 2010

Where do we expect VHE emission in a ‘normal’ jet X-ray binary?

_is the non-thermal hard X-ray tail coming from the jet and extending to VHE?

Need the IR break contemporaneous to hard X-rays

Complete radiative jet model fitting the spectra w/ statistical test

_internal shock?

Transition H-->S: high time/spatial resolution multi-wavelength coverage

Problem: Infer the velocity of the compact jet.

_is the corona ejected in the jet?

X-ray, IR, radio rapid variability studies

_jet-ISM shock?

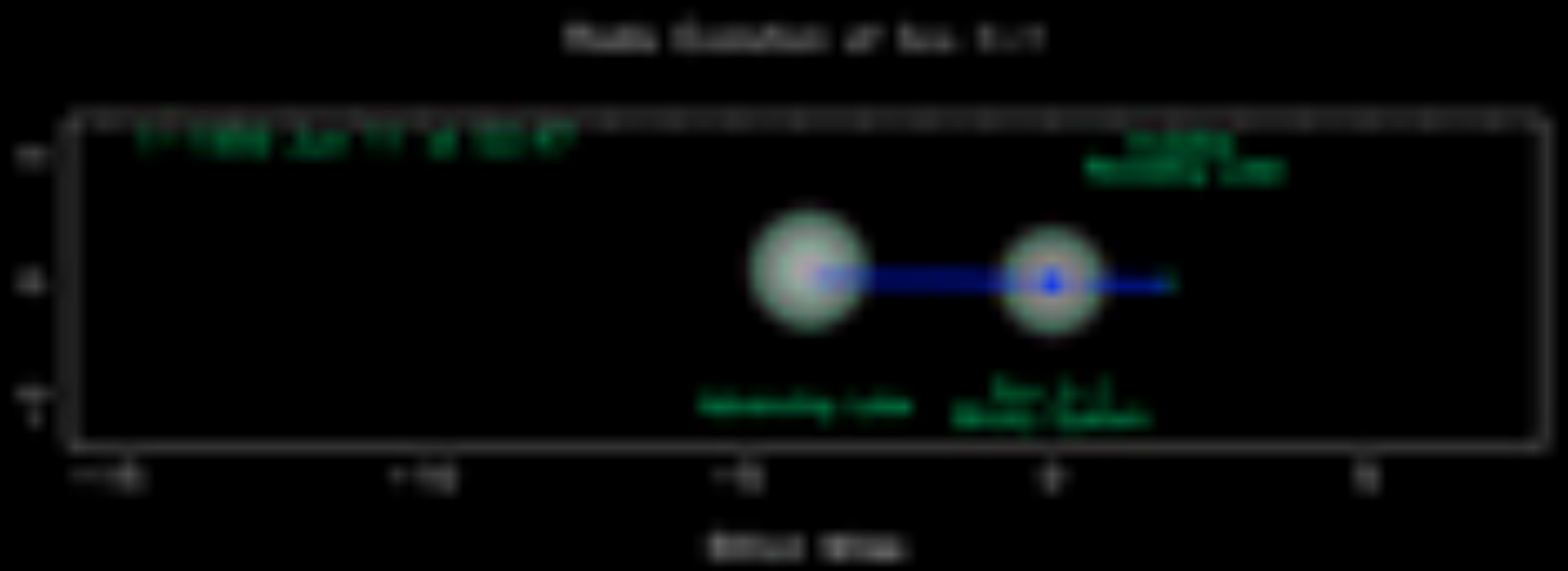
More candidates?

But based on known correlations between jet and X-ray power in ‘normal’ X-ray binaries, then you would expect these γ-ray sources to be also clearly identified with ‘normal’ X-ray sources…

Sco X-1

At least three components associated with the jet

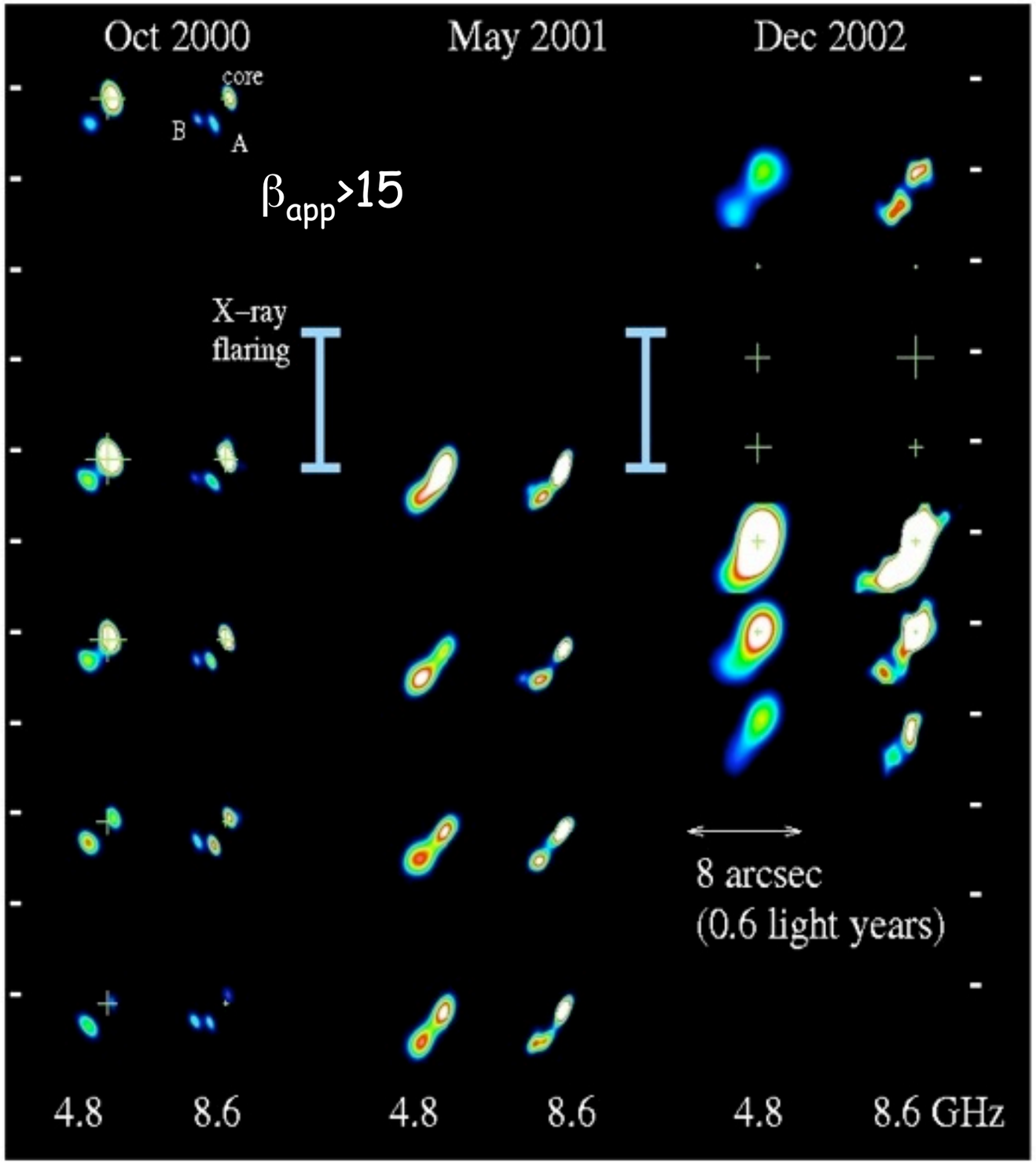
1. Core flares
2. Invisible, highly relativistic (Γ>2)
3. `Lobes' energised by beams at ~0.4c



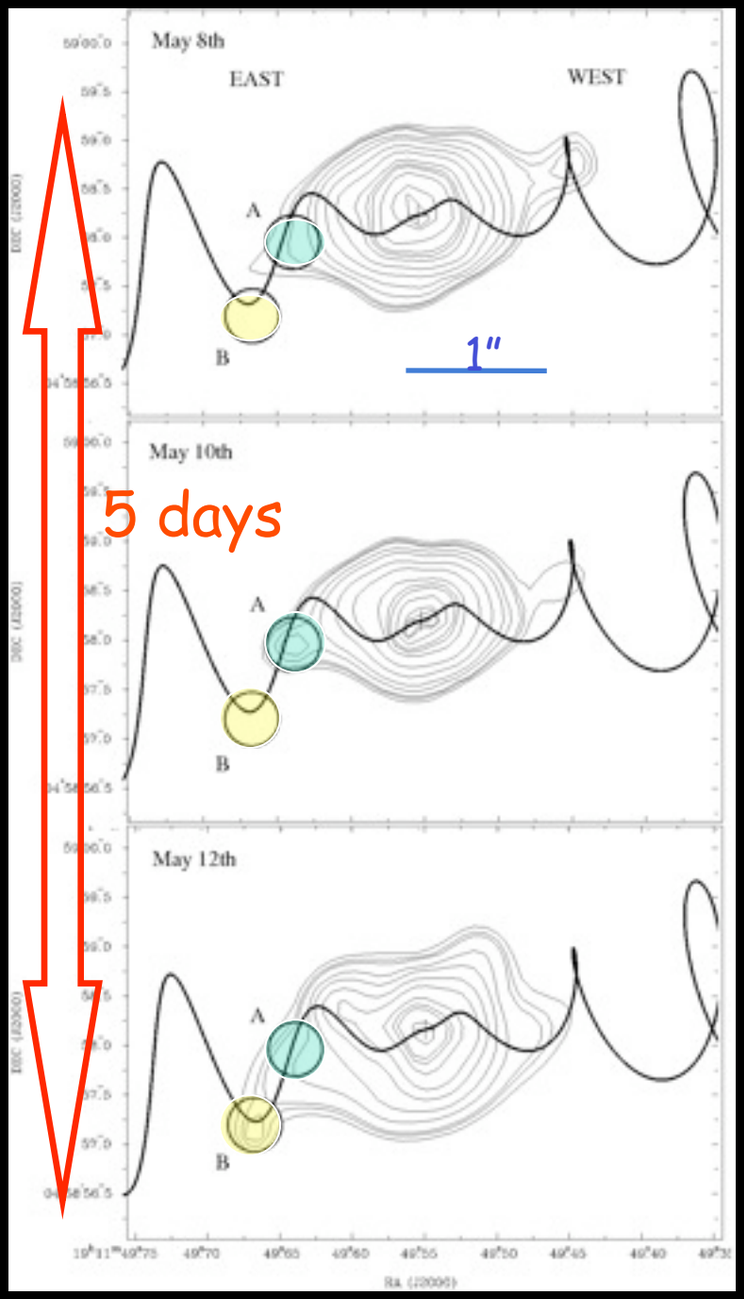
Fomalont et al. (2001)

Cir X-1

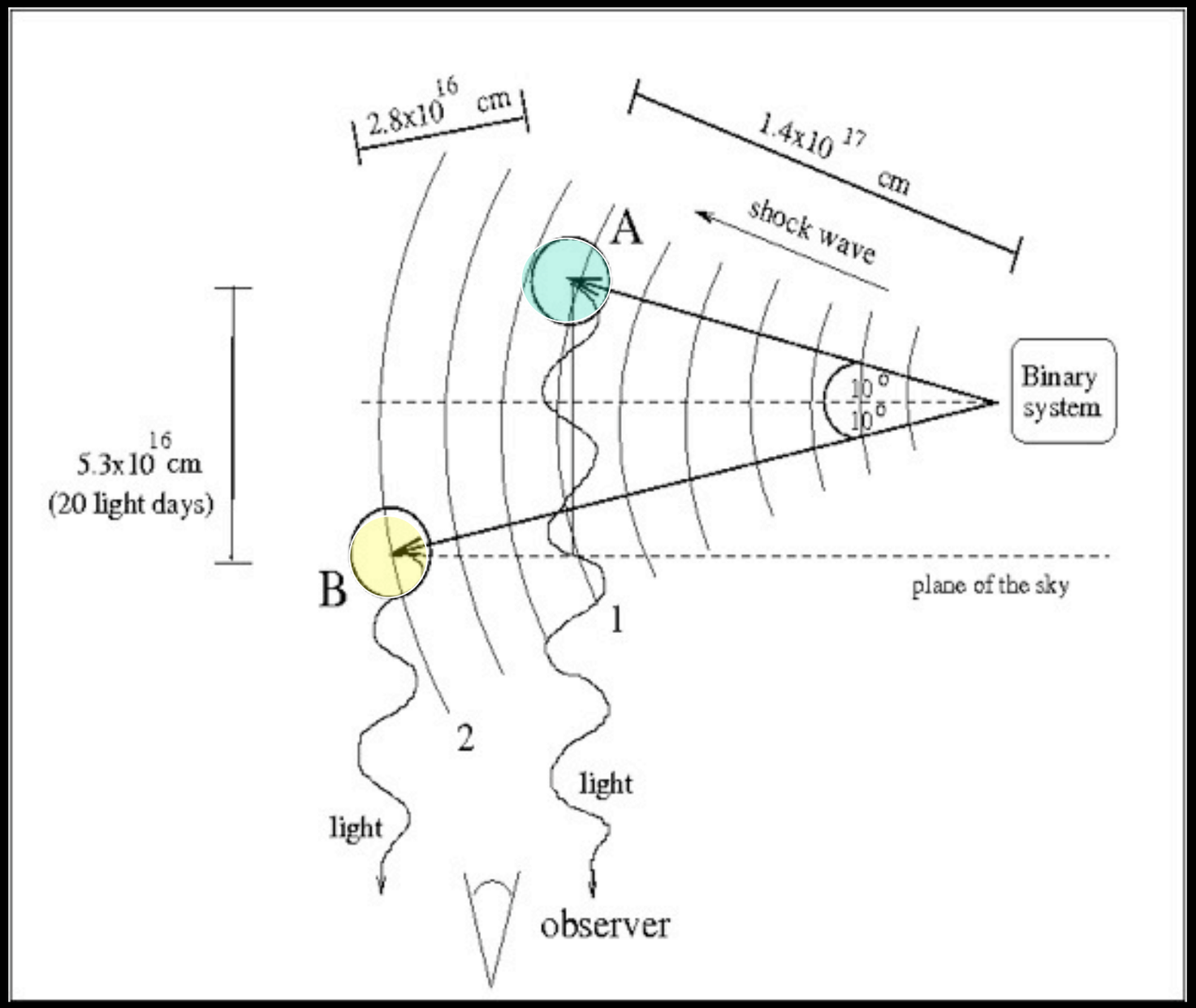
Mildly relativistic knots energised by an ultrarelativistic (Γ>15) <u>invisible</u> outflow following each outburst



Fender et al. (2004)



Migliari et al. (2005)



$\beta > 0.6$

Where do we expect VHE emission in a ‘normal’ jet X-ray binary?

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Need the IR break contemporaneous to hard X-rays

Complete radiative jet model fitting the spectra w/ statistical test

_internal shock?

Transition H-->S: high time/spatial resolution multi-wavelength coverage

Infer the velocity of the compact jet. (but How?)

_is the corona ejected in the jet?

X-ray, IR, radio rapid variability studies

_jet-ISM shock?

More candidates?

But based on known correlations between jet and X-ray power in ‘normal’ X-ray binaries, then you would expect these γ-ray sources to be also clearly identified with ‘normal’ X-ray sources…