A SHORT REVIEW ON X-RAY BINARIES

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XRB KESACKO?

Binary systems w/ star + compact object

Bulk of emission in the X-rays

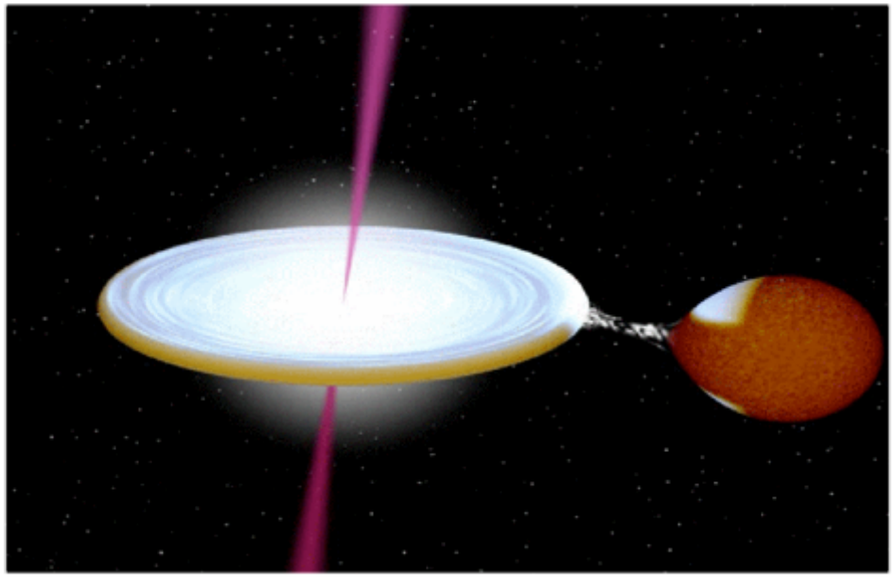
Accretion powered systems....

....+coupled ejection phenomena aka microquasars

ILLUSTRATION

ACCRETING SOURCES DIFFERENCIATED BY COMPONENTS

Low mass star with jets/no jet
LMXB/microquasars



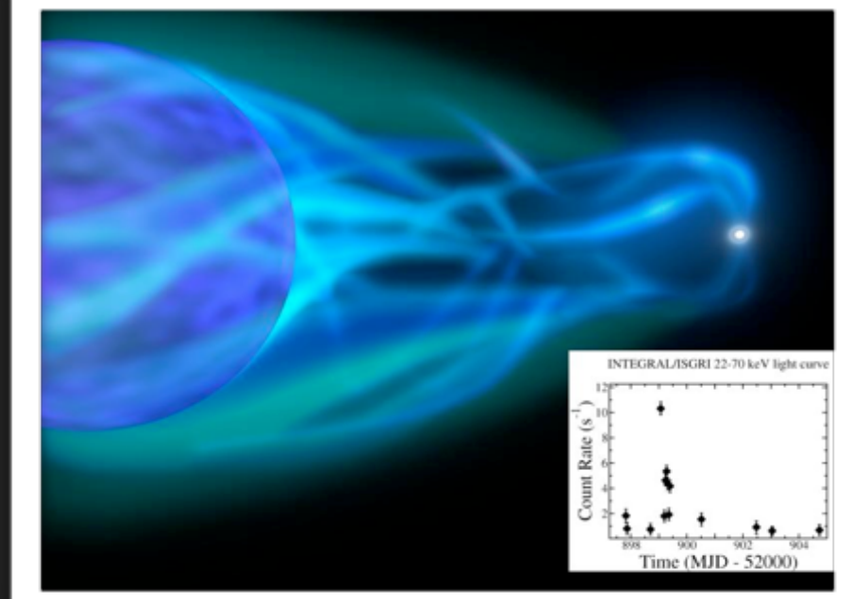
Neutron stars:

- **Transient vs persistent**
- Atoll, Z sources
- bursters
- ms X-ray pulsars
- Radio quiet/loud

Black holes:

- **Transient**
- Hard X-ray
- Q-shape (HID)
- Fundamental plane
- Spectral states

NS/BH+high mass star, jets/no jet :HMXBs, HM-microquasars



Sg stars:

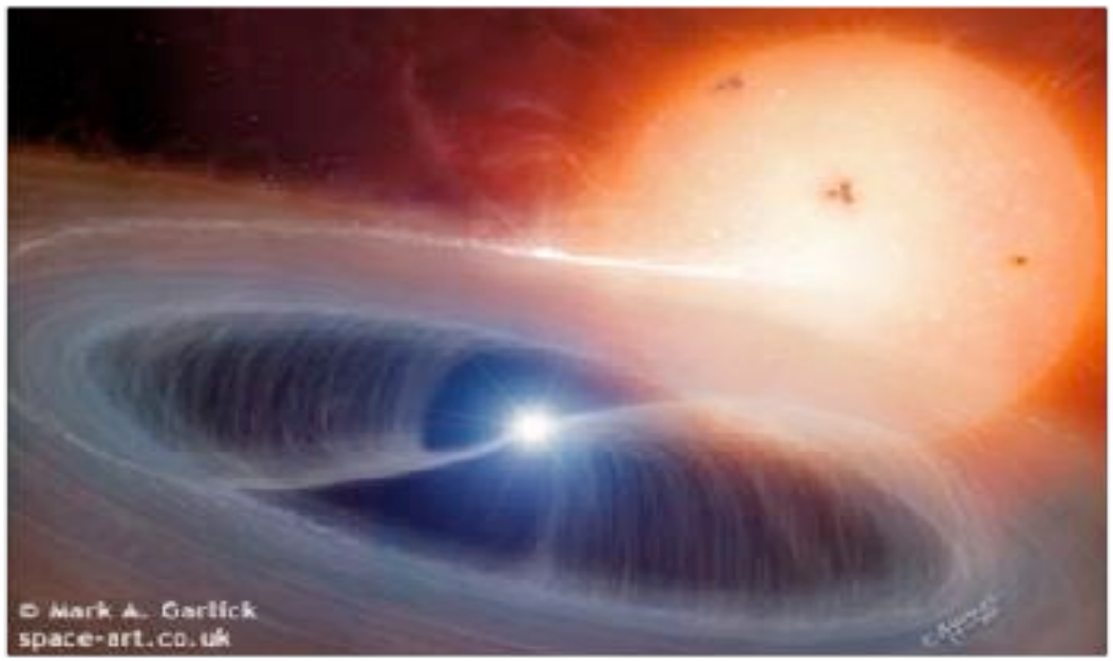
- **persistent**
- Black hole : disk/jet/states
- Neutron star (no disk): faint
- SFXTs: faint short bursts

Be stars:

- **Transient**
- No black hole !
- Pulsars (young systems)
- γ-ray binaries (G. Dubus)

ZOOLOGY SUITE

White dwarf + star
Cataclysmic Variables



- Transient
- Recurrent outbursts
- Sources for development of DIM
- Thermonuclear runaway (Nova)
- UV- Soft X-ray emitters
- Hard X-ray emitters (IP)
- B >~10^8 G (Polar)
- Symbiotic systems
- γ-ray emitters (Fermi)

ACCRETION–EJECTION: UBIQUITOUS IN THE UNIVERSE !

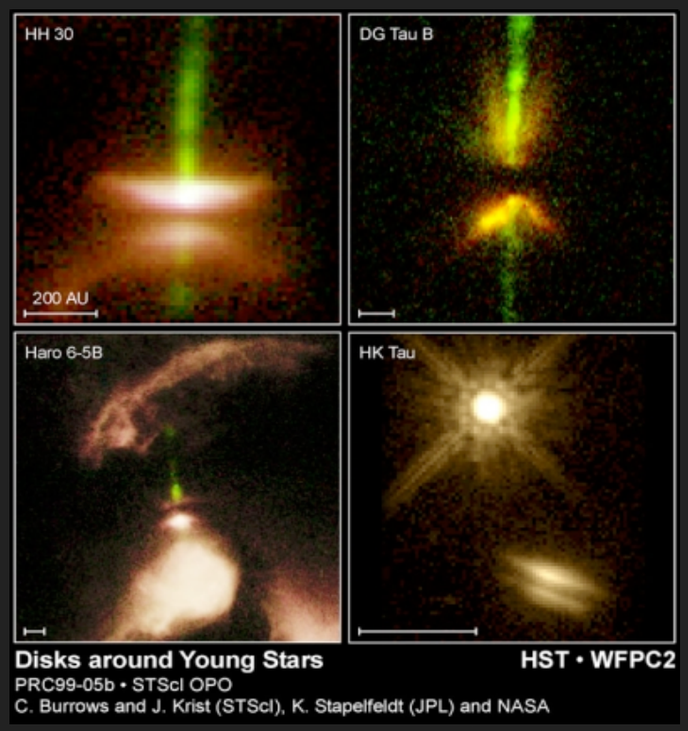
Megayears

month-years

hrs-days

min-hrs

Star formation……



Centres of galaxies

Microquasars

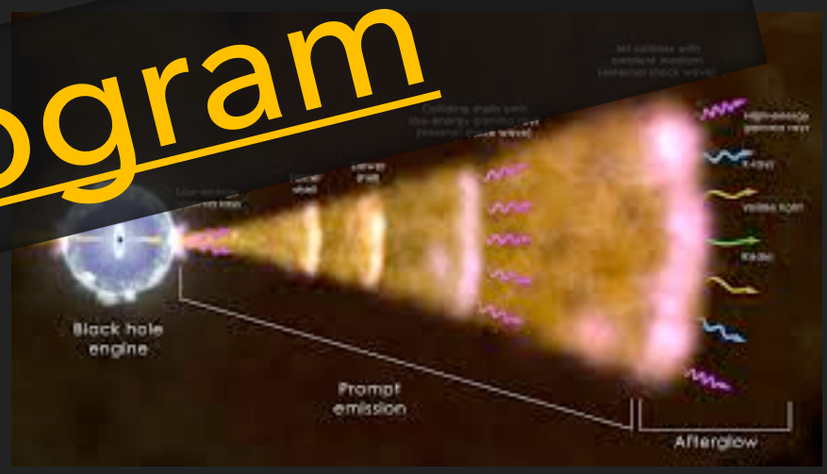
SVOM General Program

0.1-1 s

10-100 s

Mergers of compact objects (NS)

fate of most massive stars



SVOM Core Program

XRBS (AND ACCRETION-EJECTION) = LAB OF EXTREME

Fundamental Physics

- Strong gravity
- Plasma physics
- Dense matter
- Strong B field (NS)
- Black holes

Astronomy

- Populations
- Star evolution
- Links w/ Galactic history
- Geometry of media and systems

Astrophysics

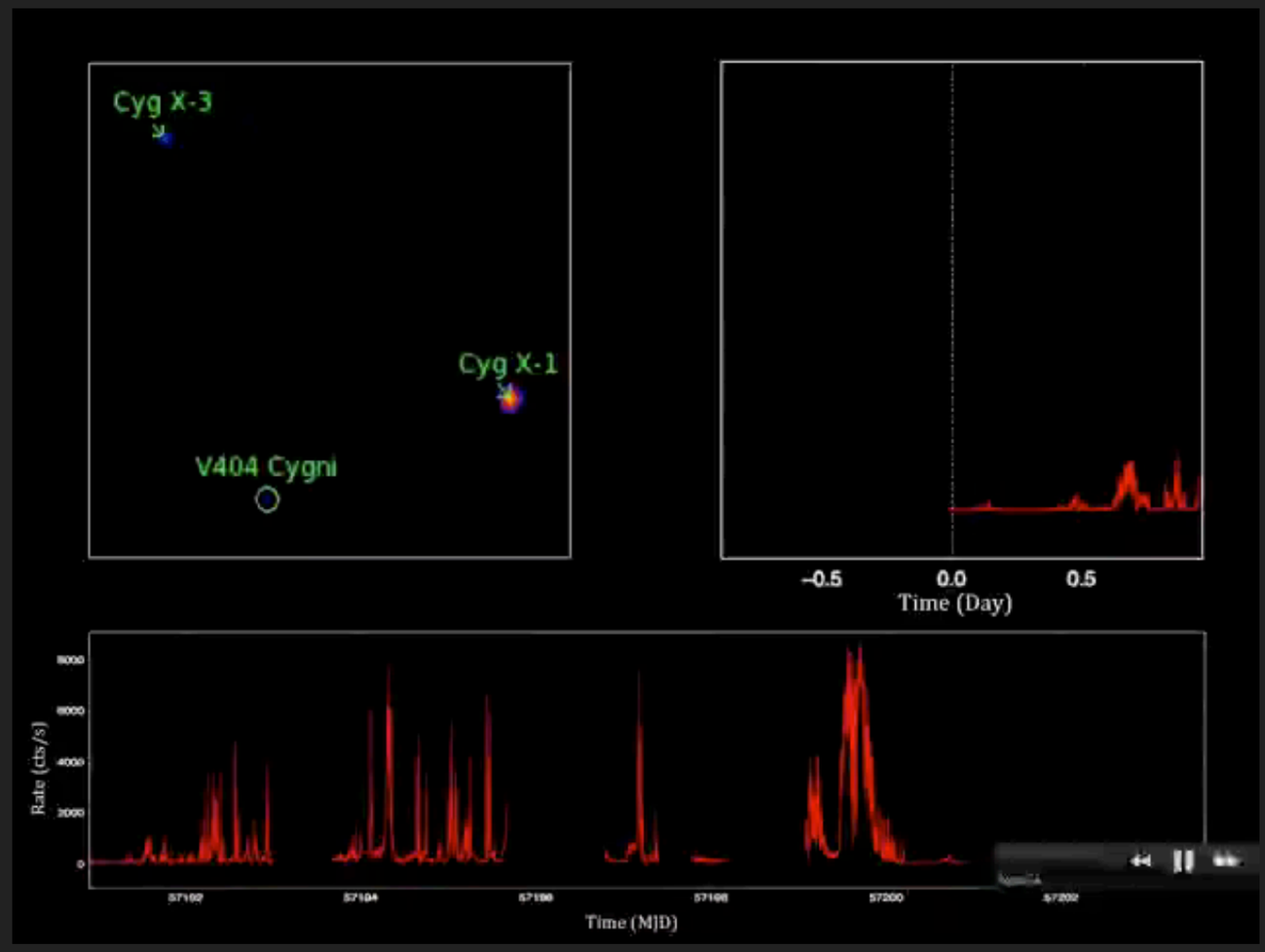
- Accretion
- Acceleration
- Feedback on the ISM
- Radiation
- Matter-radiation

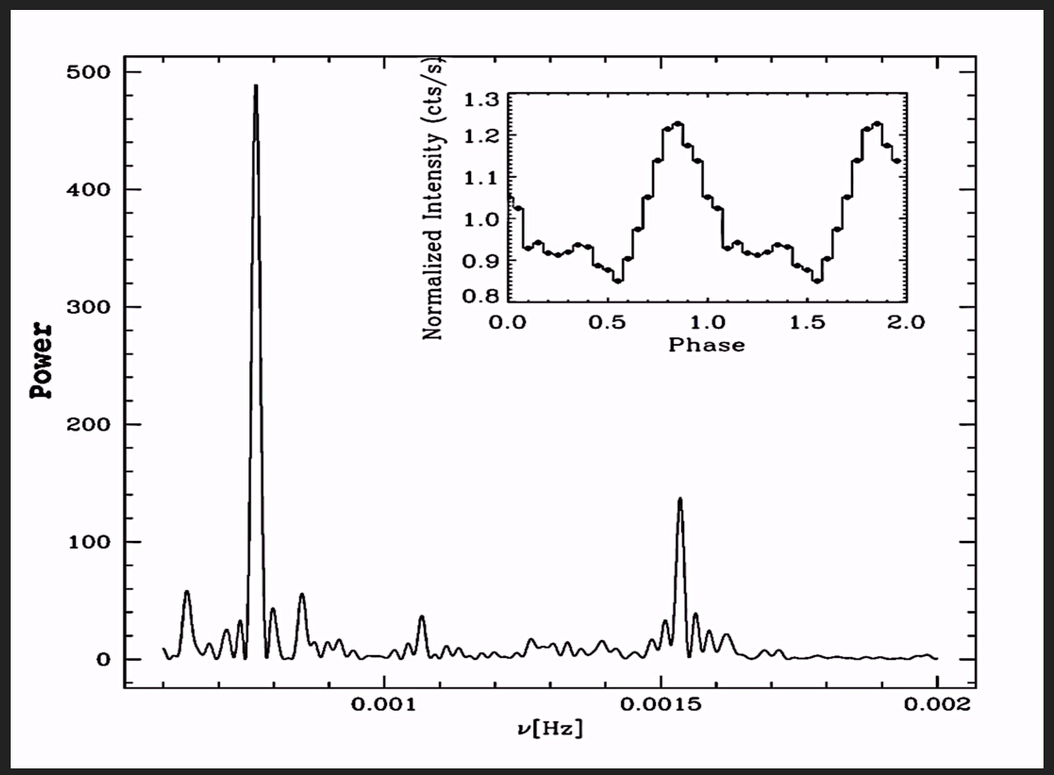
X-RAY DIAGNOSTICS: VARIABILITY

- Detection/discovery
- Outburst evolution and state changes (W. Yu's talk)

Evolution of media

Physics of ejections (need multi-λ follow-ups)

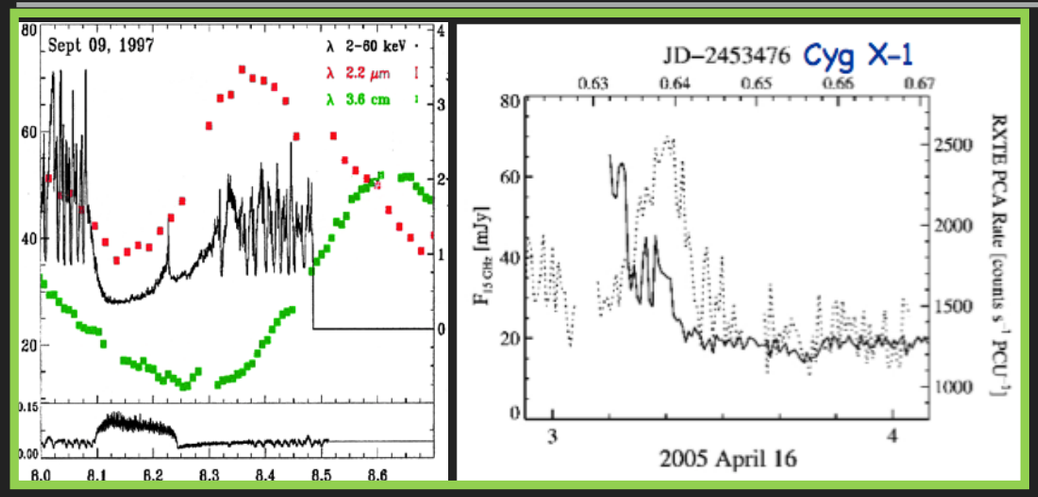




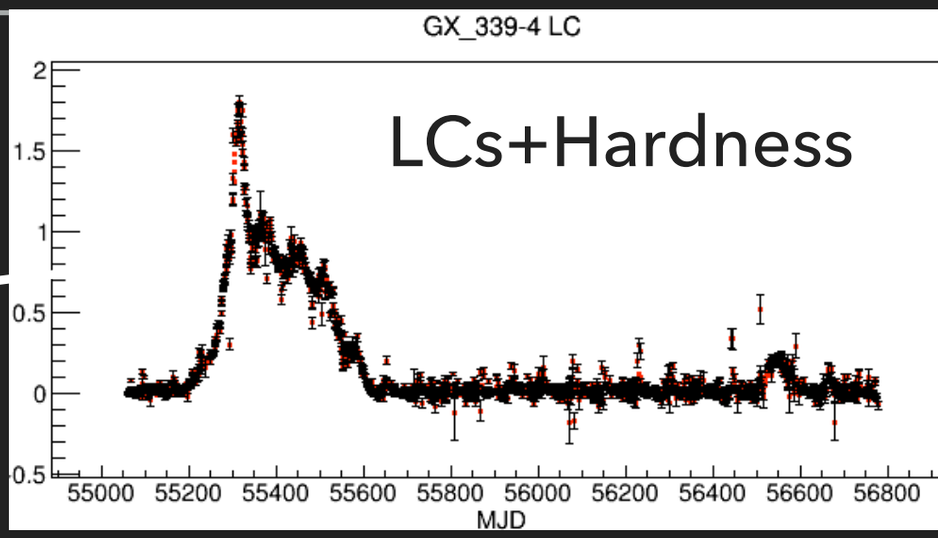
- Periodicities
- Pulsations
- QPOs

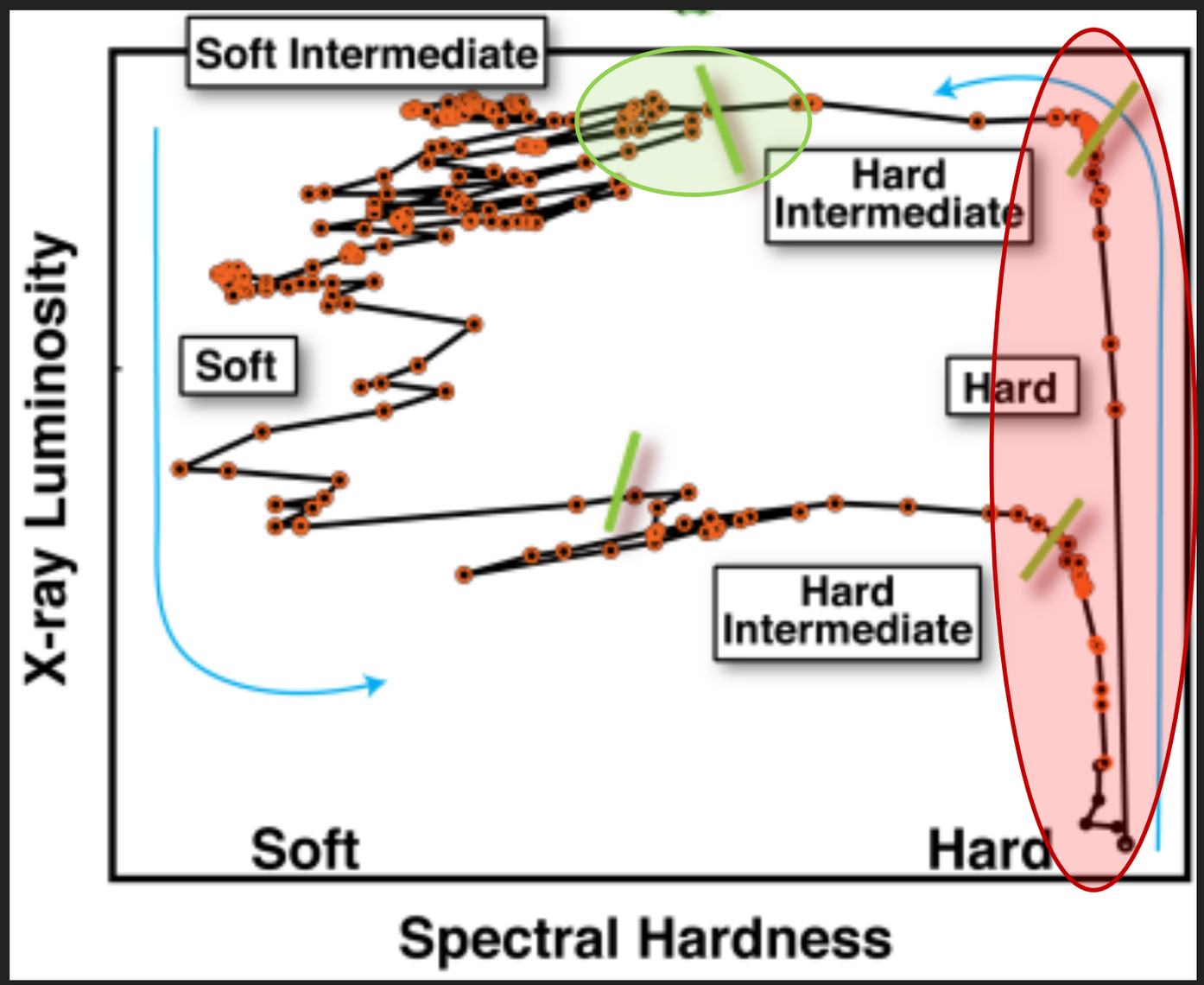
Geometry of systems (orbits)
Physics of compact objects (spins)

DYNAMIC PICTURE

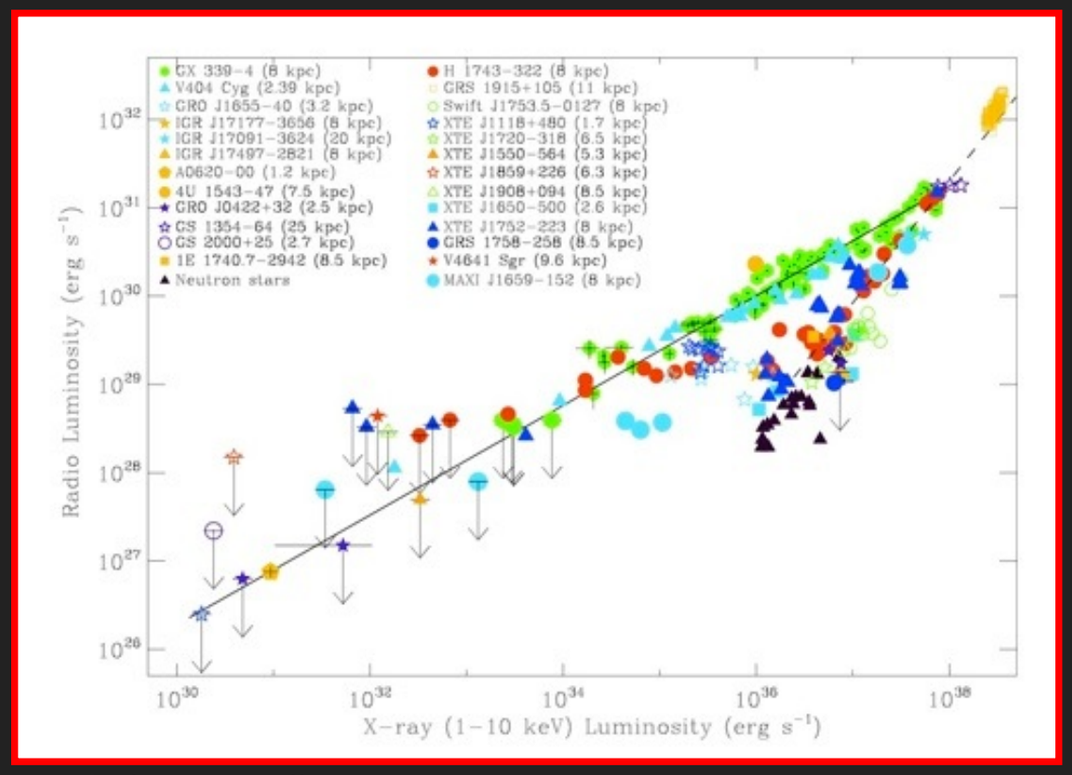


Mirabel+'98; Wilms+ '06, R+ '08, ...



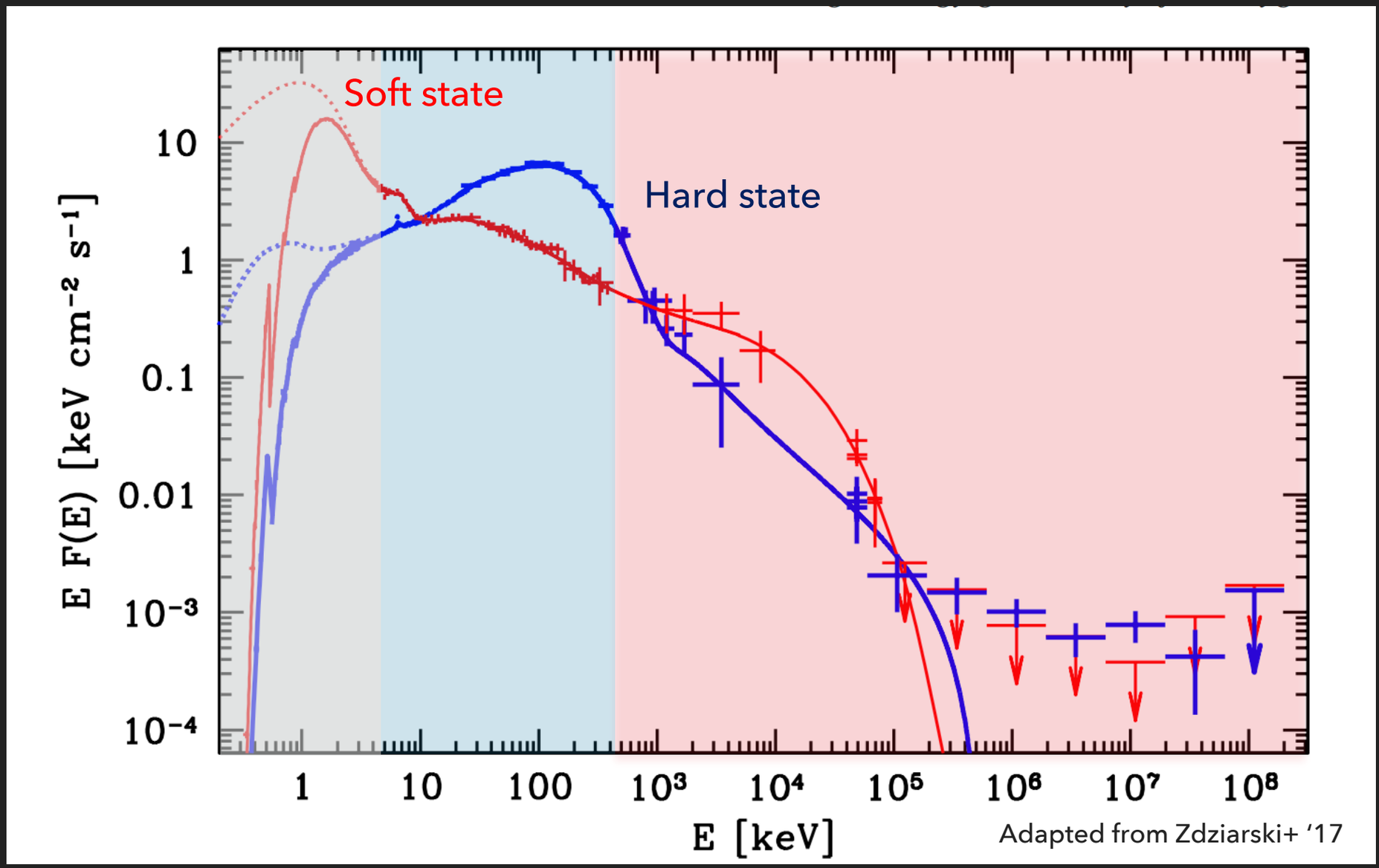


X-ray+Radio(+IR)



Corbel +'13; Gallo+ '13, ...

(X-RAY) DIAGNOSTICS: SPECTROSCOPY



kT_{disc}
cooling of NS/CV
local absorption
Wind properties

Properties of corona (t, kT_{e-})
reflection component
cyclotron lines (=>B NS)

Jet vs hybrid plasma,
Properties of media
e-/e+ annihilation
Gate to the (V)HE?

=> Broad band sensitivity + (fine/fair) spectral resolution

«STATIC» PICTURE

Neutrino telescopes

Jet emission: radio to IR/ Optical

Ground Tel/GWAC/VT
+ SYNERGY w/ SKA

ECLAIRs

Hard X-ray (10-200 keV): Corona

(External) disc/companion: IR - Visible

MXT+ECLAIRs

Thermal emission black body: soft X-rays ~1keV
+
crustal emission and thermonuclear flashes (NS & CVs)

GRM

Soft γ-ray emission 0.2-10 MeV: Origin?

+ SYNERGY w/ CTA

ILLUSTRATION

SO WHAT REMAINS TO BE DONE?

- How do accretion proceed?
- What triggers outbursts?
- How are outflows launched and accelerated ?
- What is the composition of jets (baryons, leptons) and outflows?
- What are their impact on the interstellar/galactic media?
- What is the interplay between the disk, the outflows(s)?
- How does accretion-ejection vary into different «flavours » of accretion states/outflow/jet states?
- What is the origin of the sub-sec variability ?

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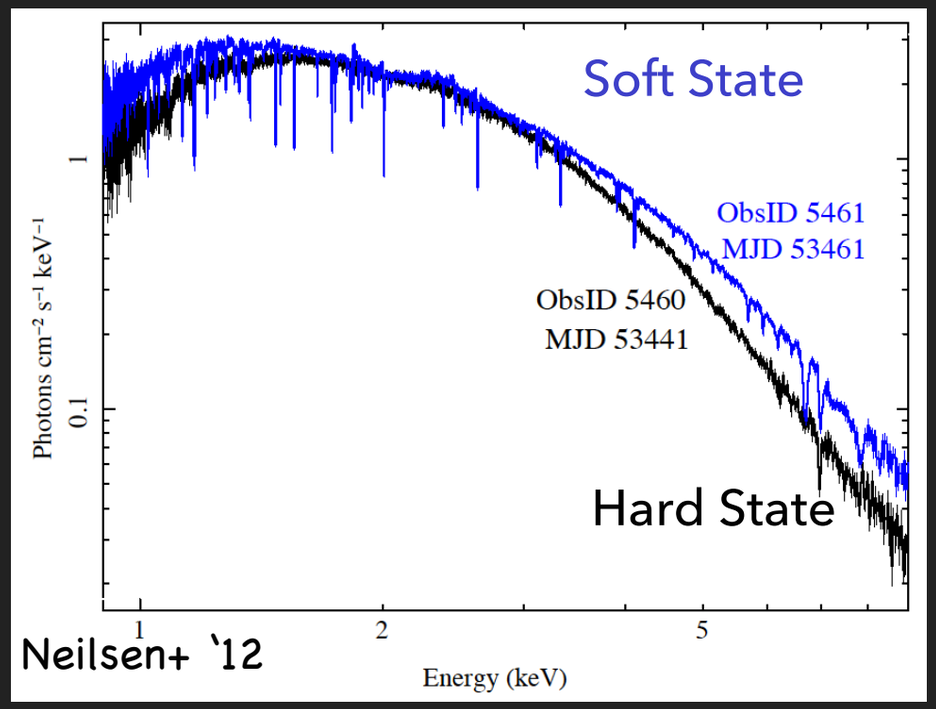
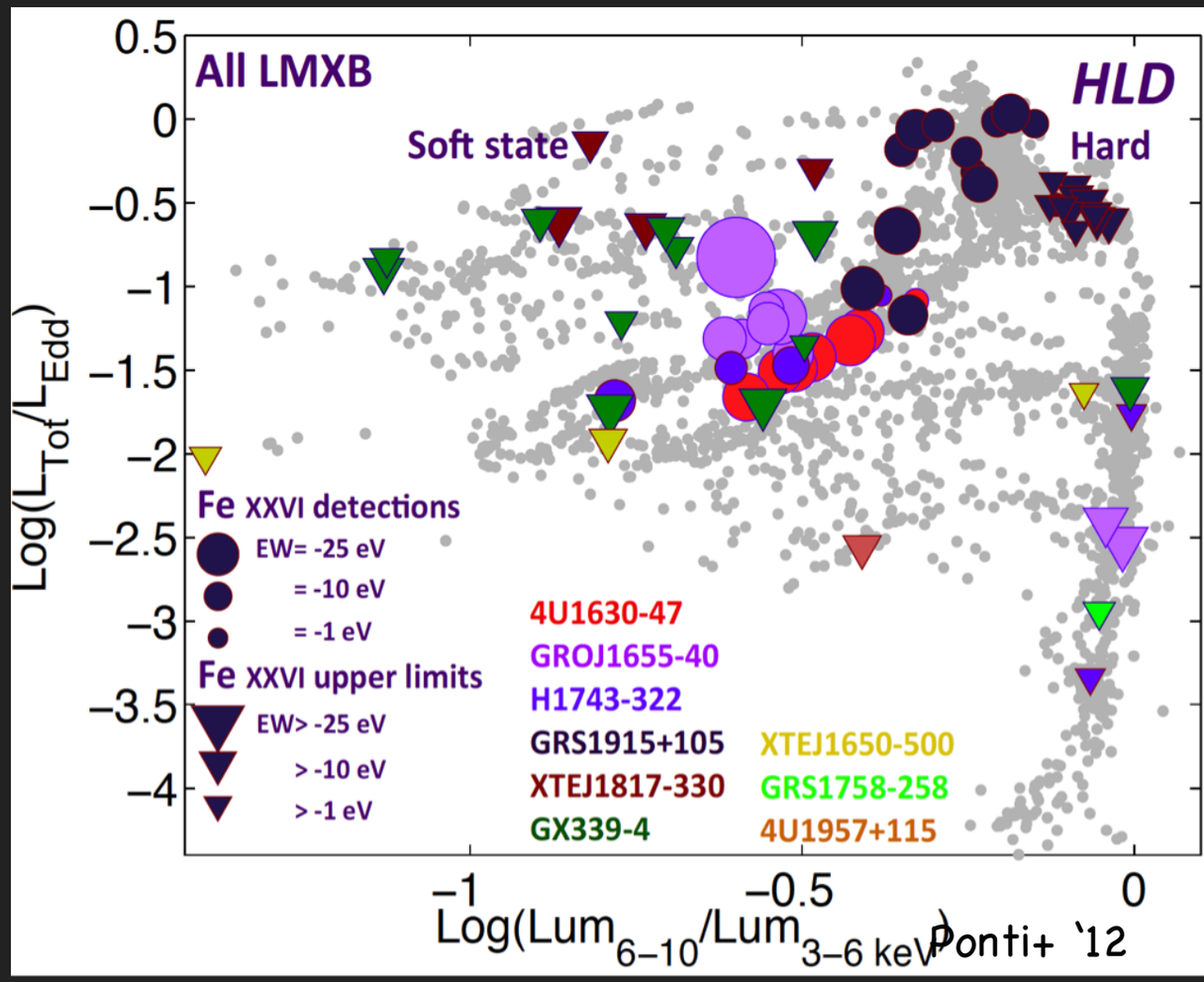
THE ADVENT OF DISK WINDS

ASCA => Highly ionised plasma in GRO J1655-40 and GRS 1915+105 (Ueda+'98; Kotani+'00)





=> Confirmed in many systems (e.g. Miller+ '06, '08; Ueda+ '09; Neilsen +'09, '12; King +'12; Diaz-Trigo+'14)

=> Typical outflow velocities ~1000 km/s, as high as ~1e4 km/s (0.3c) in IGR J17091-3624 (King+'12)

=> Associated with HSS (e.g, Neilsen+ '12; Ponti+'12)

=> Mutually exclusive with compact jet (Neilsen & Lee '09; Ponti+ '12), but see V404 Cyg

=>Amount of mass in outflow >~ mass accreted (Ponti+ '12)

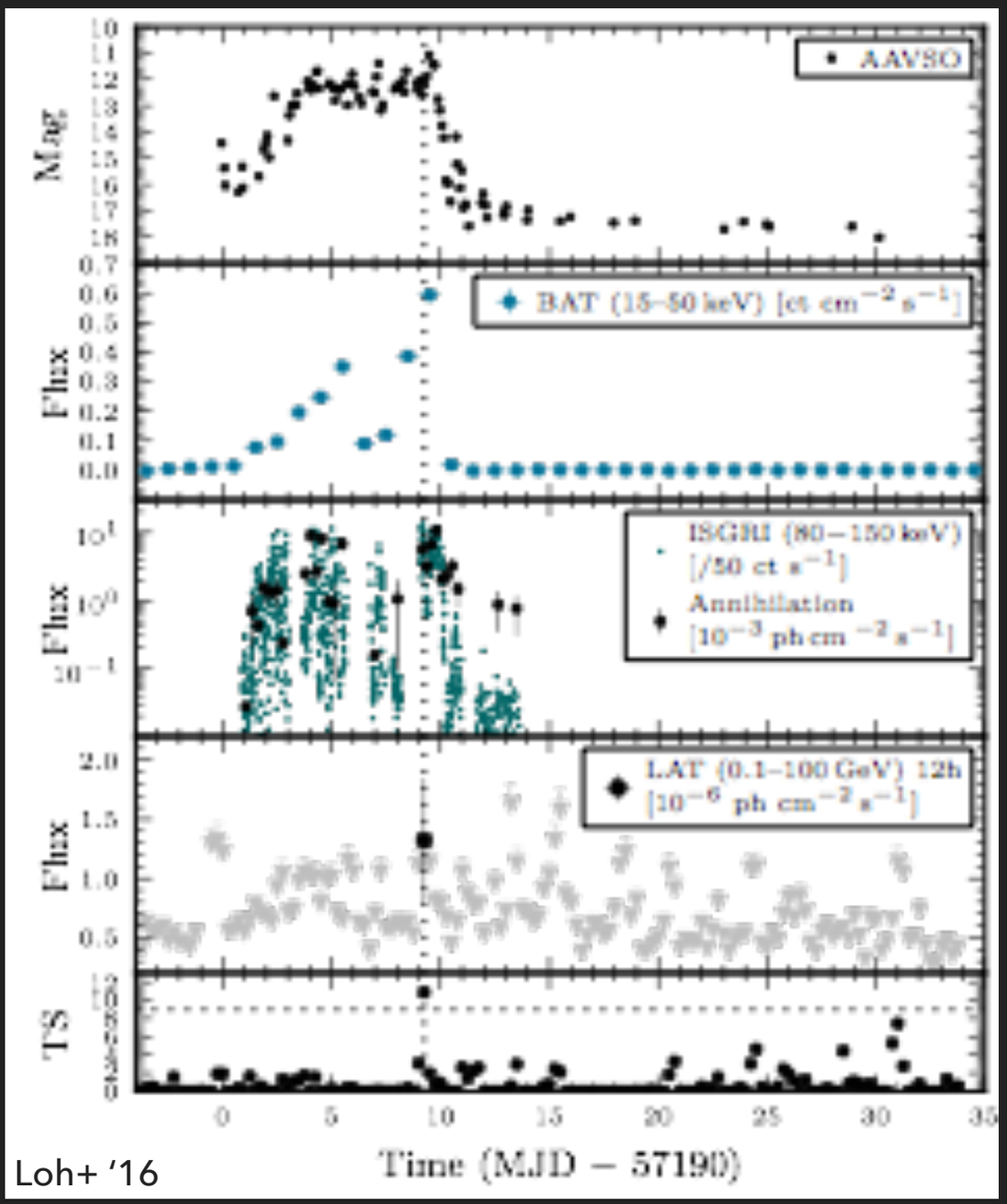
Production?

Instabilities, state transitions ?

Regulation of accretion ?

V404 CYGNI: A WEALTH OF (STILL TO BE EXPLOITED) DATA

Worldwide largest multi-wavelength effort from radio to γ-rays



Loh+ '16

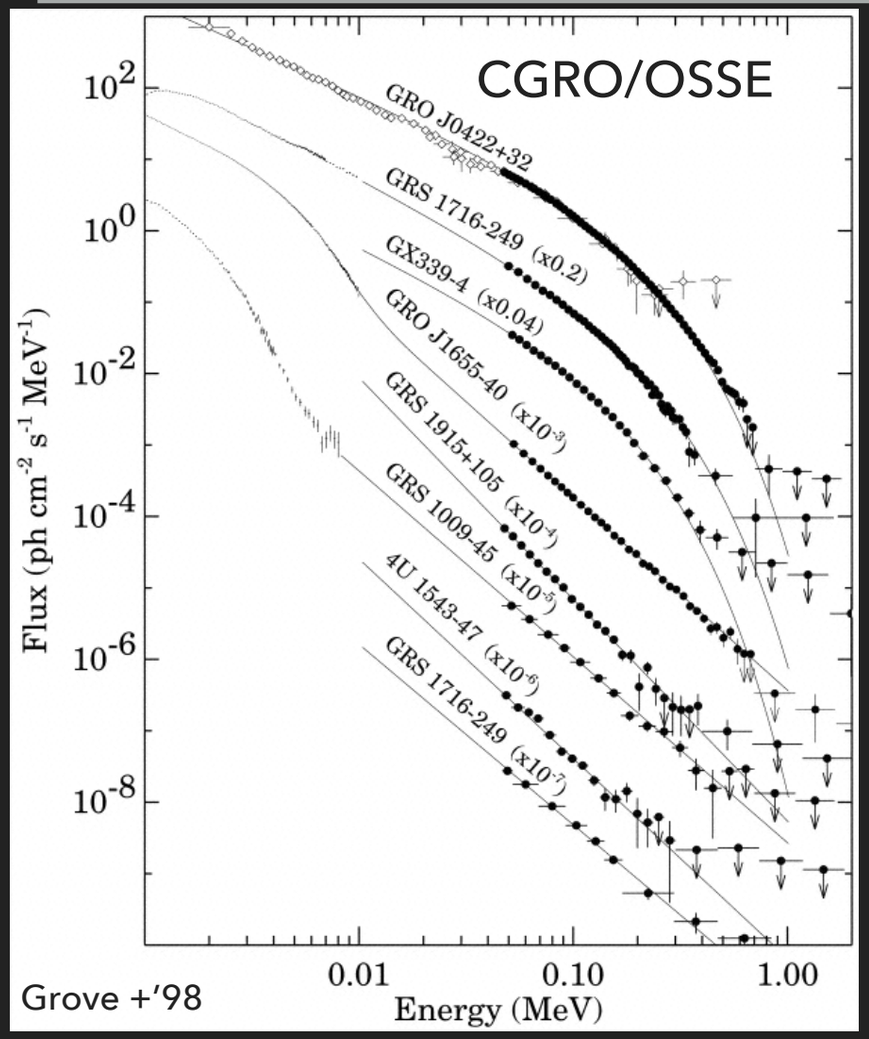
- 50 Crab flares at 20 keV. No spectral state transitions (R.+ '15)
- Flares due to variations of local absorption (Motta+ '17), but intrinsic variability real ⇔ variable dust scattering rings (Beardmore+ '16)
- Optical :Sustained disc wind (Muñoz-Darias+ '16)
- Companion mass loss rate >> accretion rate ⇔ large fraction of mass in outflows (Ziolkowski & Zdziarski '18)

=>Sustained wind regulating the outburst

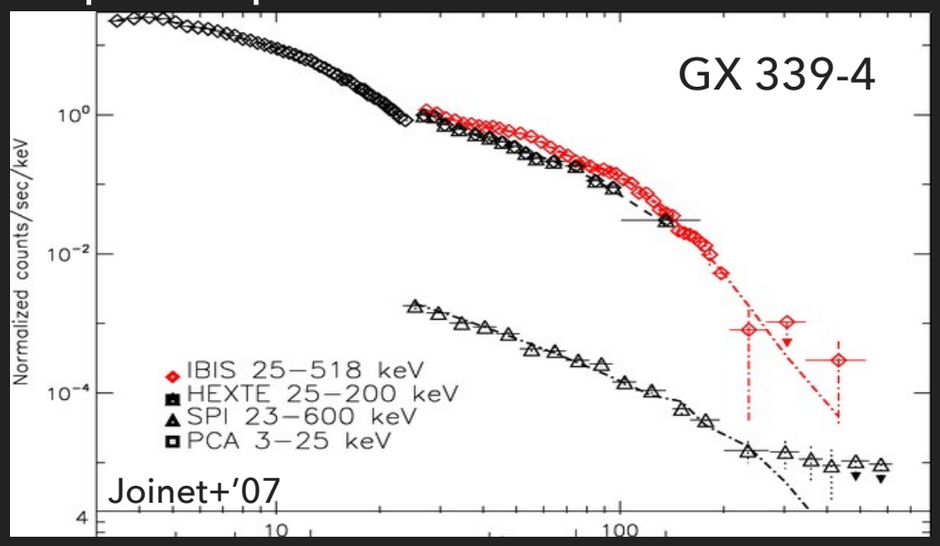
- Detection of a variable 511 keV line (Siegert+ '16): e-/e+ jet, pair plasma production
- Detection with Fermi @ GeV (Loh+ '16)

=> Gamma emission related to jet ?

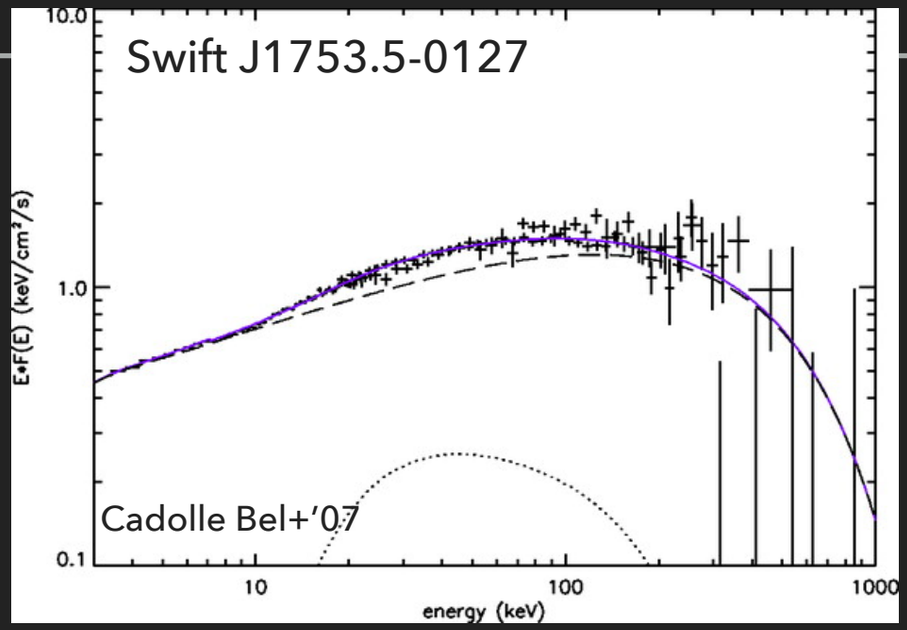
HARD TAILS



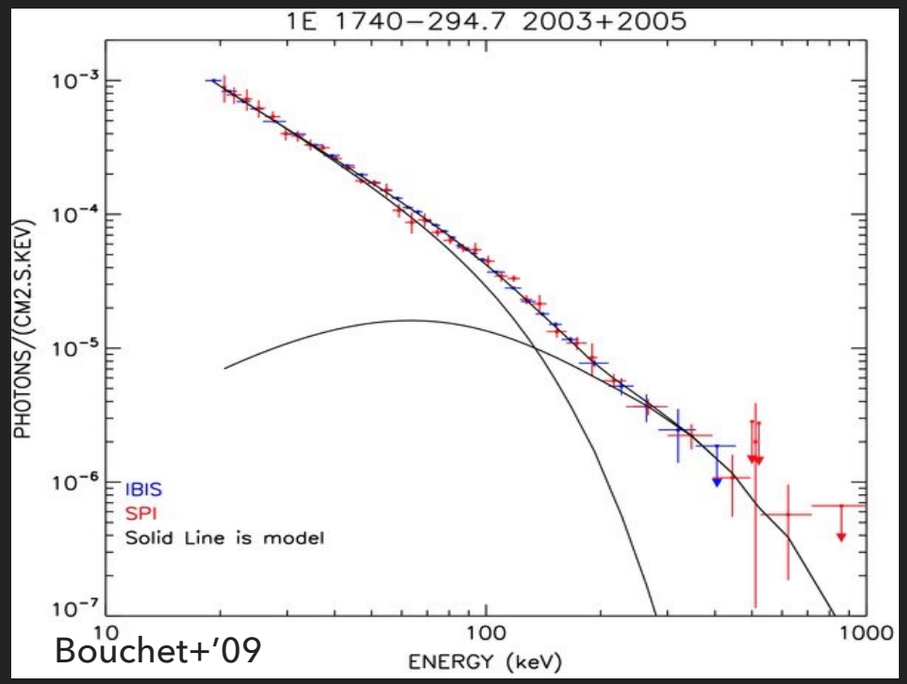
Compton + power law



INTEGRAL



Compton + reflection



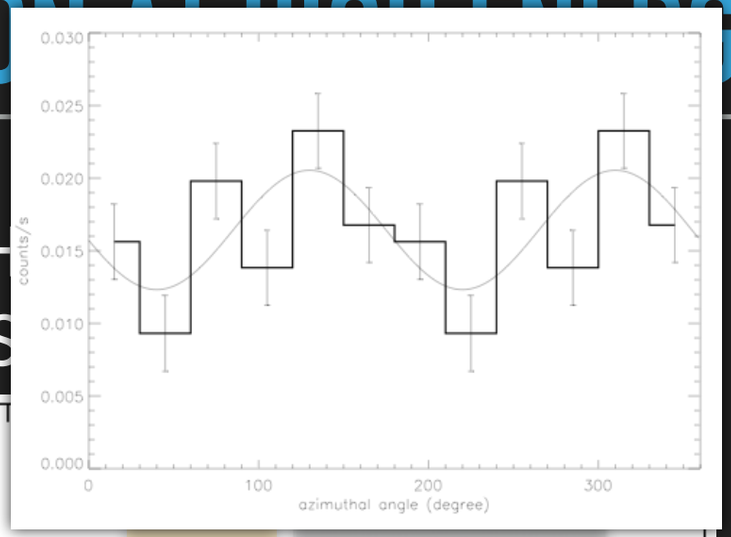
Compton + Compton

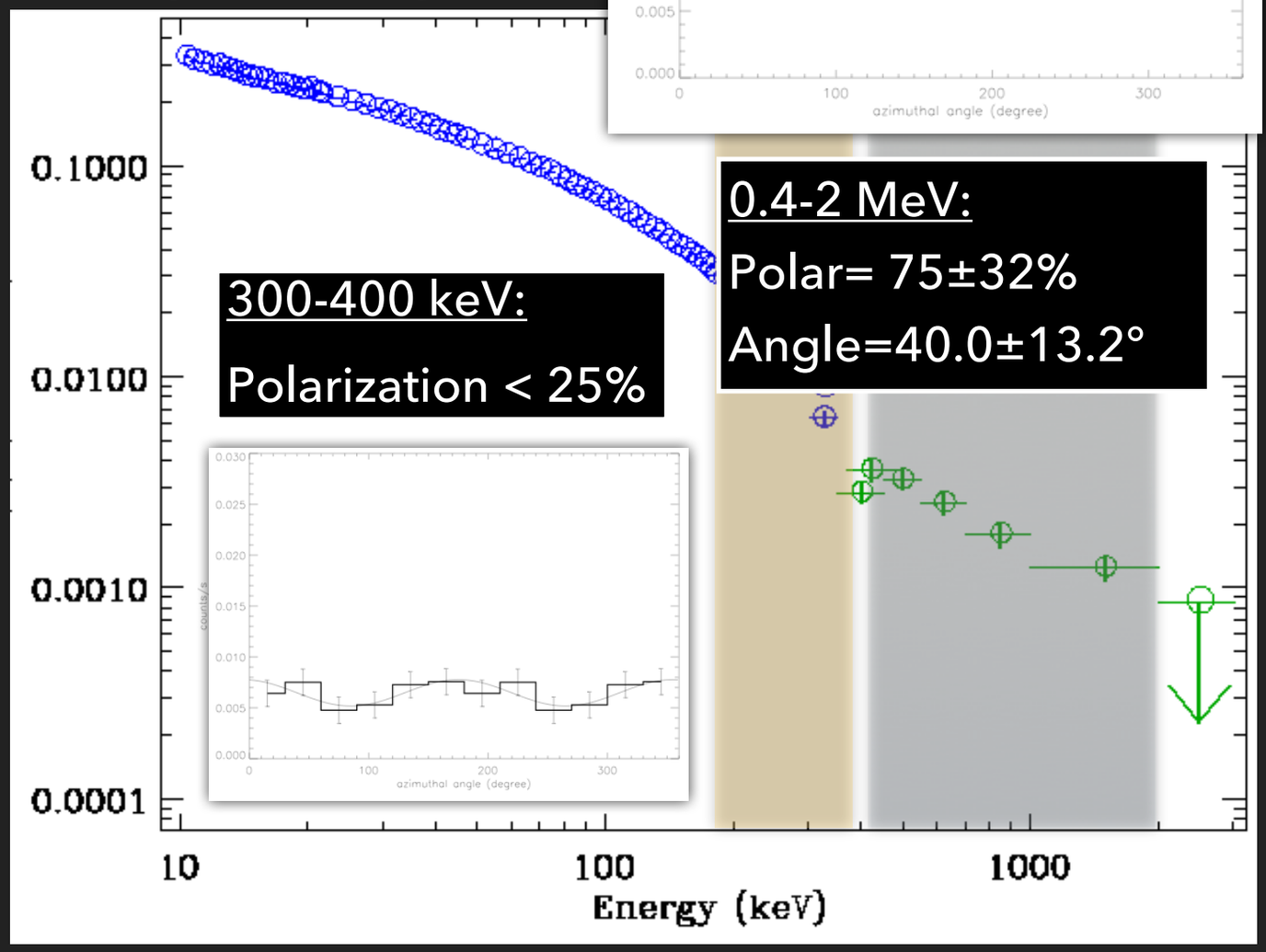
Hard tails ubiquitous in BHs (and NS although at lower fluxes, Paizis+ '06)

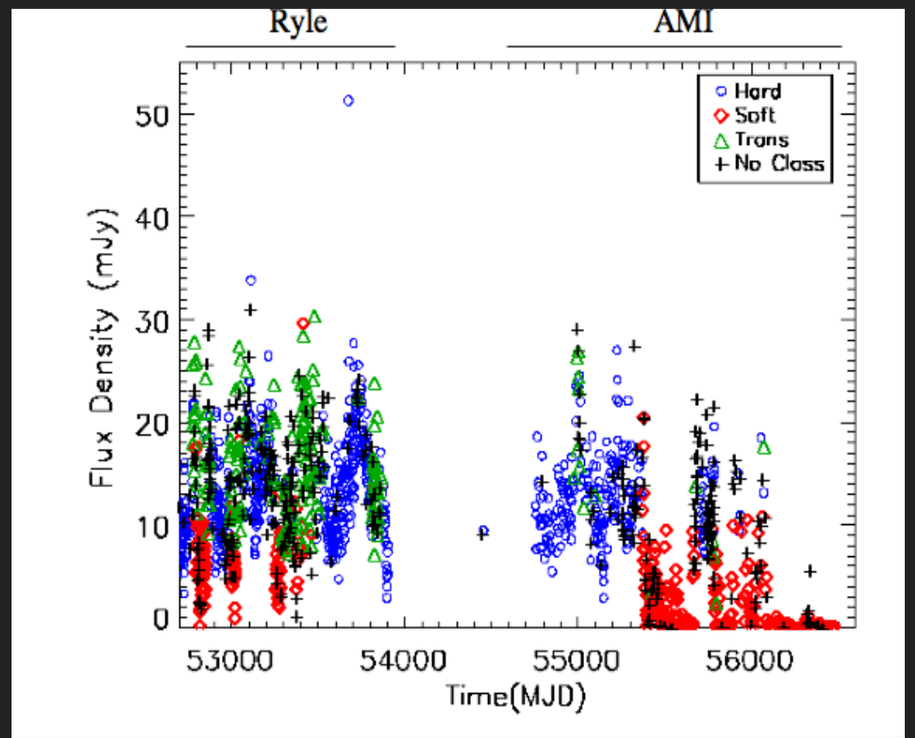
Origin debated: Comptonisation ? Hybrid models? Jet? Other?

A JET EMISSION AT HIGH ENERGY IN CYG X-1 (?)

Compton + PL in LH
Compton only in HS







Grinberg+ '13; R+ '15

-Radio (jet) associated with hard state

-Hard tail associated with hard state

-Strongly polarized >400 keV tail (LHS)

> 400 keV hard tail likely jet emission

LEPTO-HADRONIC JET IN CYG X-1

Prototypical microquasar

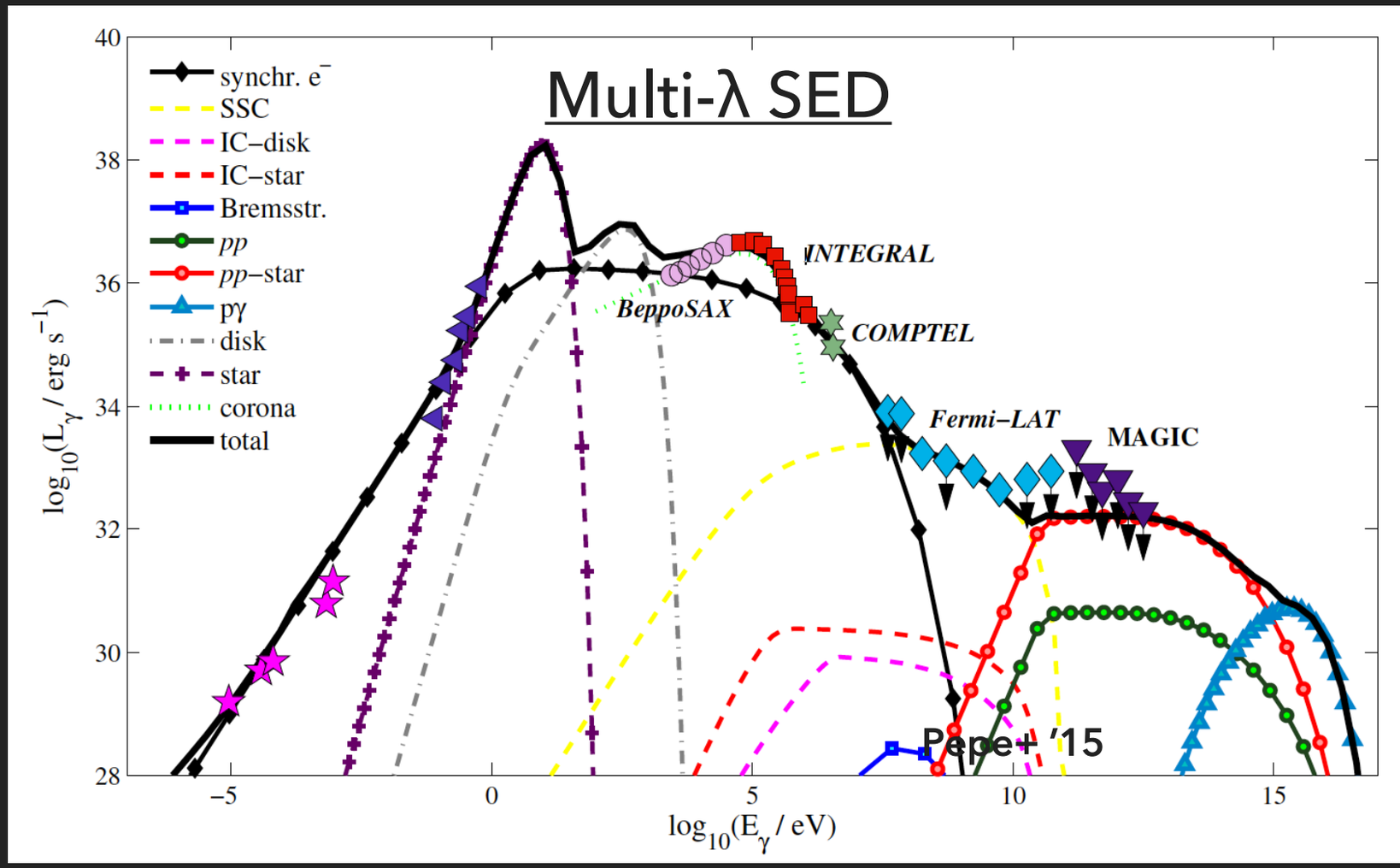
-Canonical disc/jet states

-Polarised emission @ MeV

-Detection @ GeV due to jet
(Bodaghee+'13, Zanin+'16)

-Flares @ TeV (Magic)

-Inflated bubbles => jet carry significant Ekin (Gallo+ '05)



Lepto-hadronic model

1-150 keV : Compton of disk photons

Radio/γ-rays (10 MeV): Synchrotron from jet

VHE: SSC, pp and pγ interactions =>

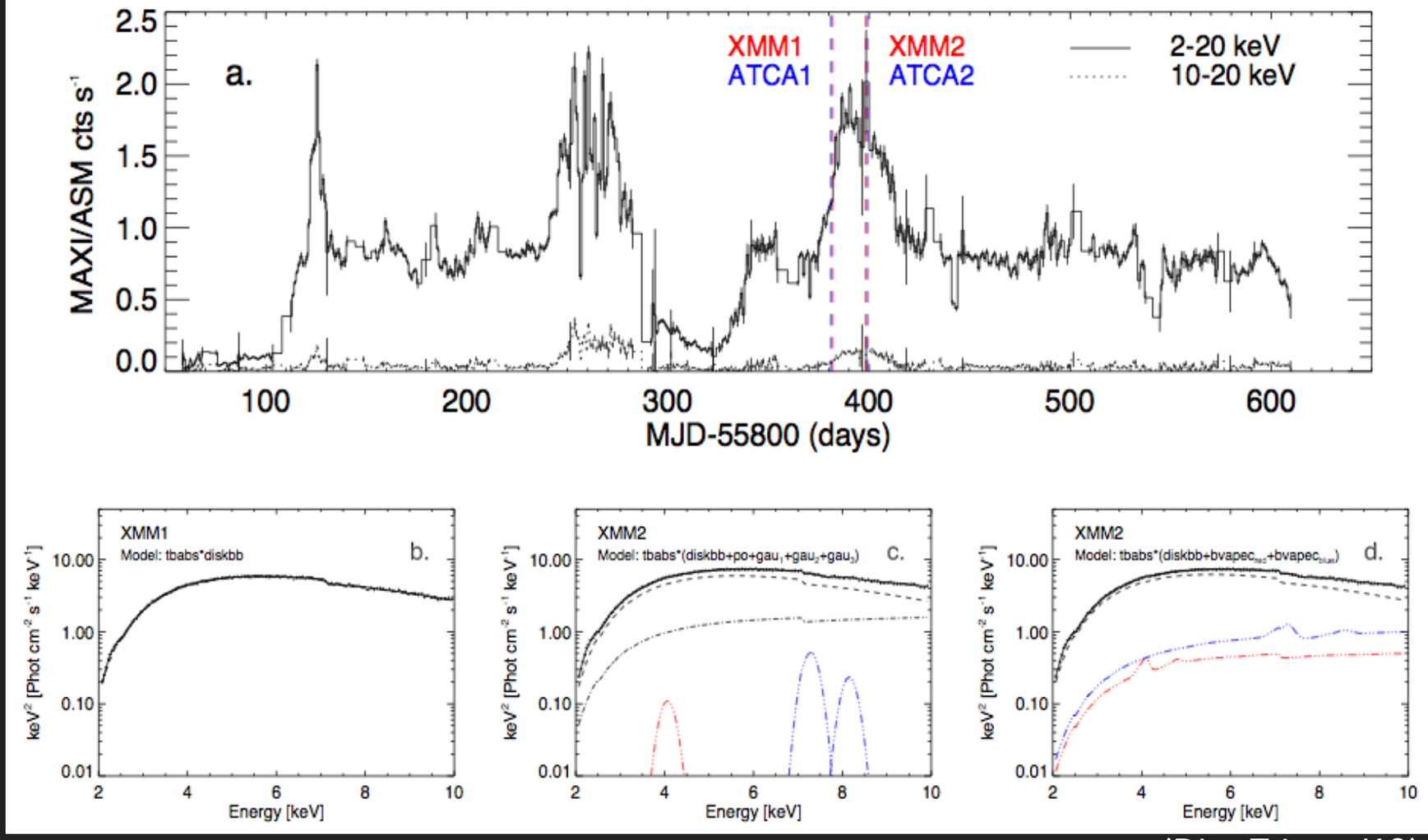
Compatible with TeV flaring (Romero+ '10)

BARYONS IN JETS ?

-Baryonic jet only in SS 433

(Margon+ ’79; Kotani+’94)

-Baryons in jets=> (V)HE emission and neutrinos (A. Coleiro)



(Diaz-Trigo+ ’13)

<u>4U 1630-47: XMM / ATCA</u>

-No radio in XMM 1

-Radio/jet in XMM 2

-Fe Doppler-shiffted lines in XMM2

=>Consistent with a v~0.66c jet

=>Flux ratio consistent with Doppler boosting

=>

Presence of heavy element/nuclei

Strong impact on E/material feedback

(Favour Accretion disk powered jet)

but

HE emission expected (not seen yet)

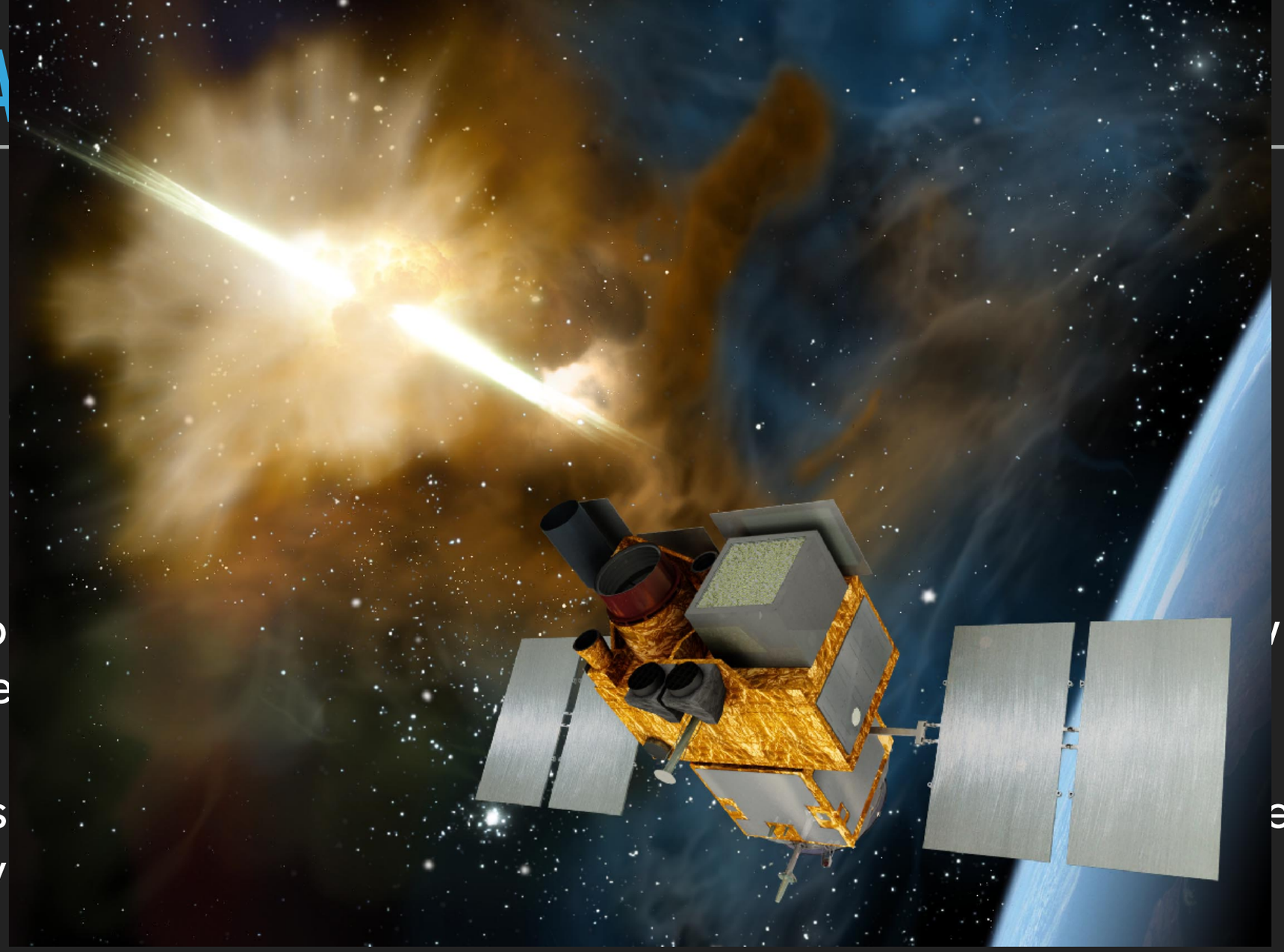
Line detection controversial

SUMMARY

- HE emission allow caracterisation of emitting media
  - Jet vs disc properties
  - Energetics and composition
- Jet can explain γ-rays emission in the hard state
- Disc wind in the soft state
- Outflows during HSS in anti-correlation with jets (but V404)

✓ Outflows and jet carry away most of the accretion energy/material
✓ They do regulate (somehow) the outburst
✓ They have a huge impact on the ISM (Cyg X-1 inflated bubble)

TAKE A



- Fine p … field and/or pointe…
- Neces… …edictable behav…

=> Need for all sky monitor/« sky survey »/wide field missions

- 2020 is the era of time domain astronomy with full sky surveys / alerts in radio/optical with a very high expected discovery space

=> Need for the possibility to quickly react to alerts at X/γ-rays