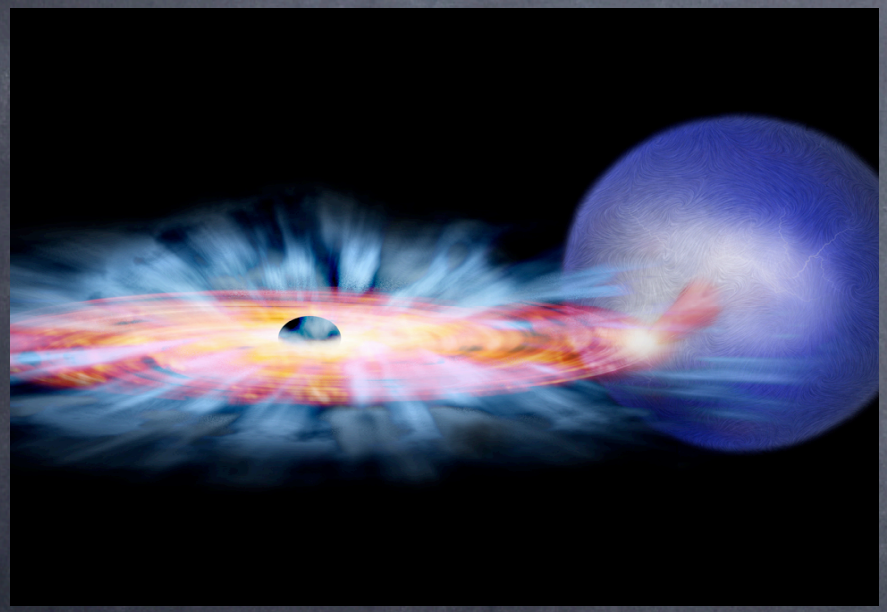
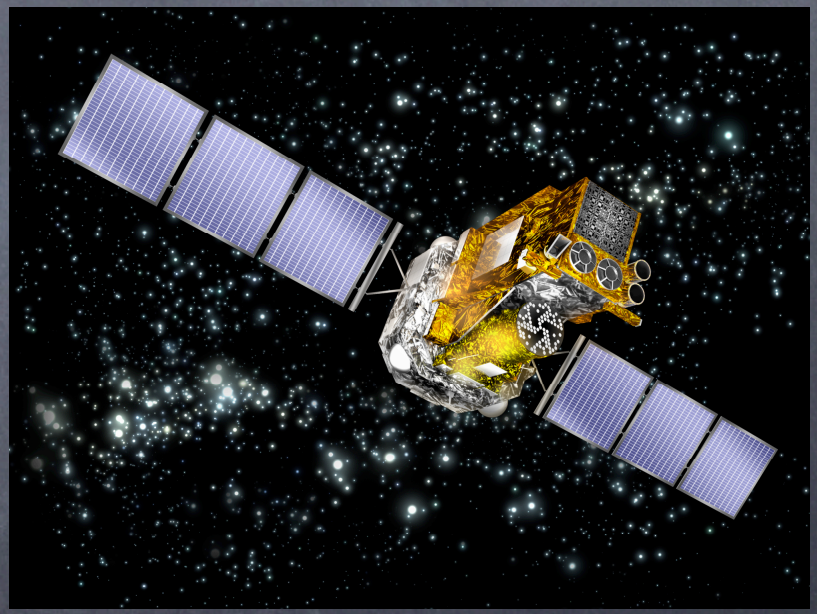
Broadband properties of Cygnus X-1 and comparisons with other microquasars

XTE J1818-245, H 1743-322, XTE J1817-330

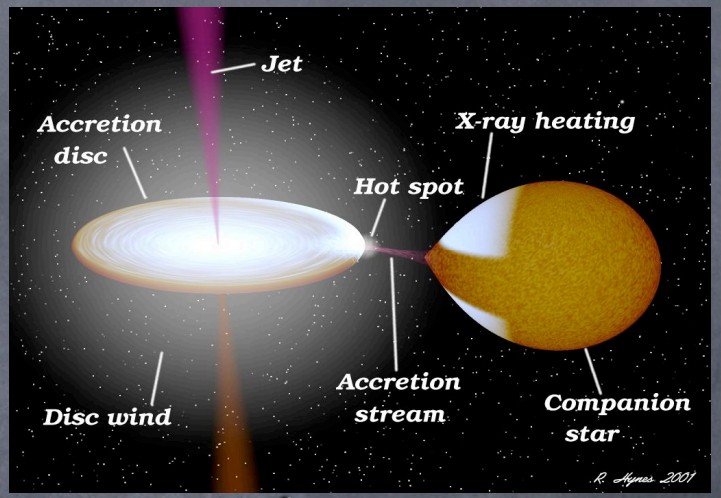


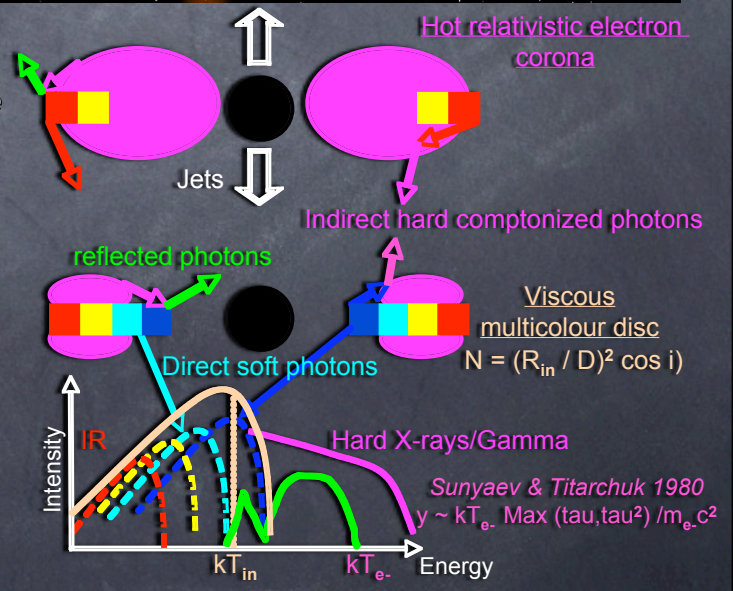


M. Cadolle Bel, D.M. Marcu, V. Grinberg, K. Pottschmidt, J. Wilms, A.M. Lohfink, F. Fuerst, M. Hanke, M.A. Nowak, S. Markoff, S. Corbel, J.A. Tomsick, J. Rodriguez, L. Prat, G.G. Pooley, M. Ribo, D. Hannikainen, P. D'Avanzo, J. Malzac, on behalf of a larger collaboration

Introduction

- Transients (bright month-long outbursts) vs Persistent: interesting!
- Spectral states show component evolutions=hints on accretion/ejection processes & strong gravity role
- Wide-band campaigns essential: INTEGRAL, Swift, RXTE, NTT, REM, VLA, VLBA, ATCA,...

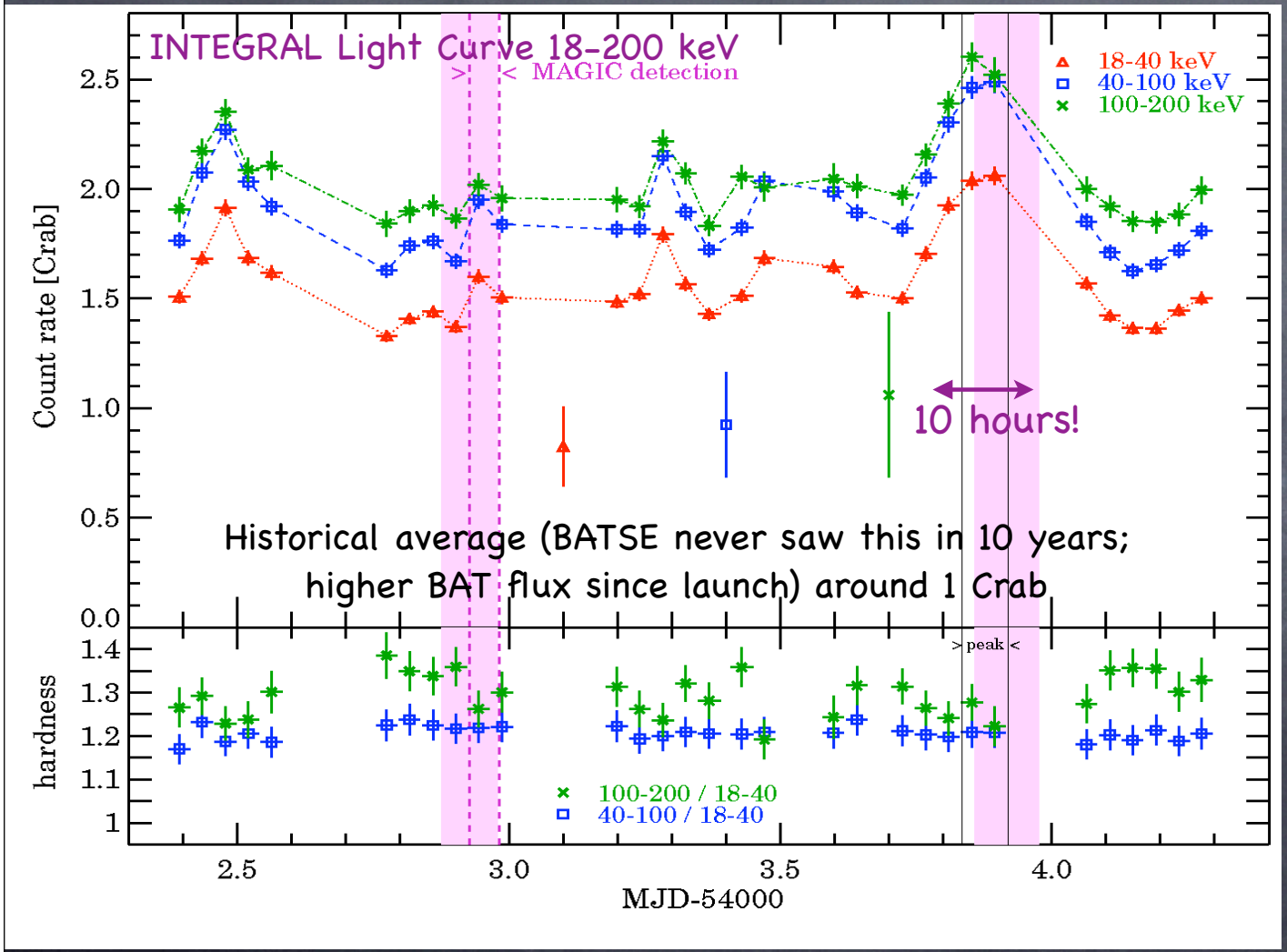




Data log

Cygnus X-1: INTEGRAL+MAGIC long "flare" in hard state. Malzac et al. 08; Neronov, Cadolle Bel et al. 08. INTEGRAL KP data (Cadolle Bel et al. 10a in prep). XTE J1818-245, XTE J1817-330: INTEGRAL ToOs and Galactic Bulge monitoring program simultaneously to Swift, RXTE, NTT, REM and VLA/VLBA/ATCA. Cadolle Bel et al. 08; 09; 10b (in prep). H 1743-322: 2008 outburst seen by INTEGRAL, RXTE, XMM and ATCA. Prat, Rodriguez, Cadolle Bel et al. 09.

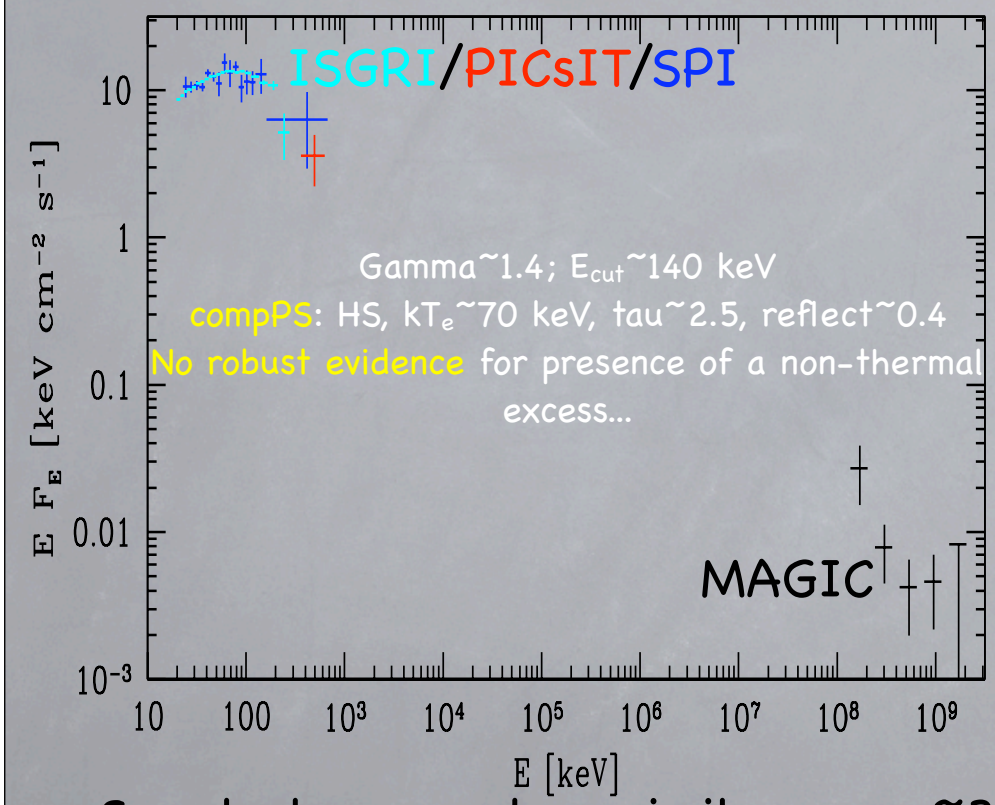
The Cyg X-1 2006 Sept. flare



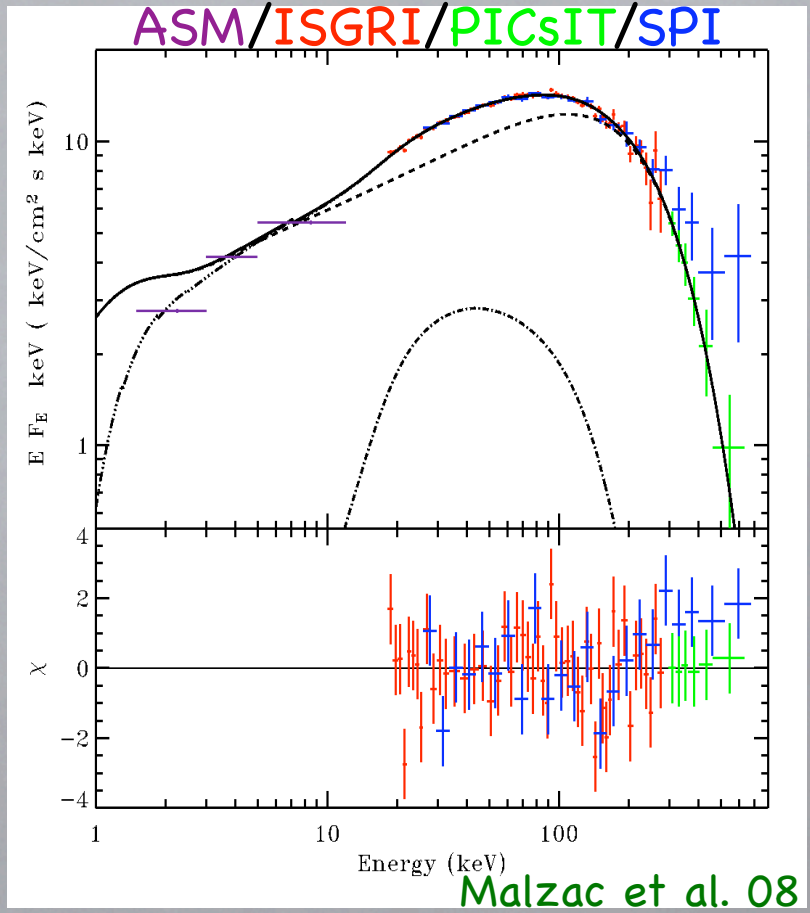
Fast-rise X-ray flux 5 min just before MAGIC detection, but no HR changes; decreases after.

HR2 stable but small var. (15%) anti-correlated with flux

Cyg X-1 spectra up to TeV



Spectral parameters similar over ~3 days despite strong flux oscillations, even when MAGIC detection occurs...



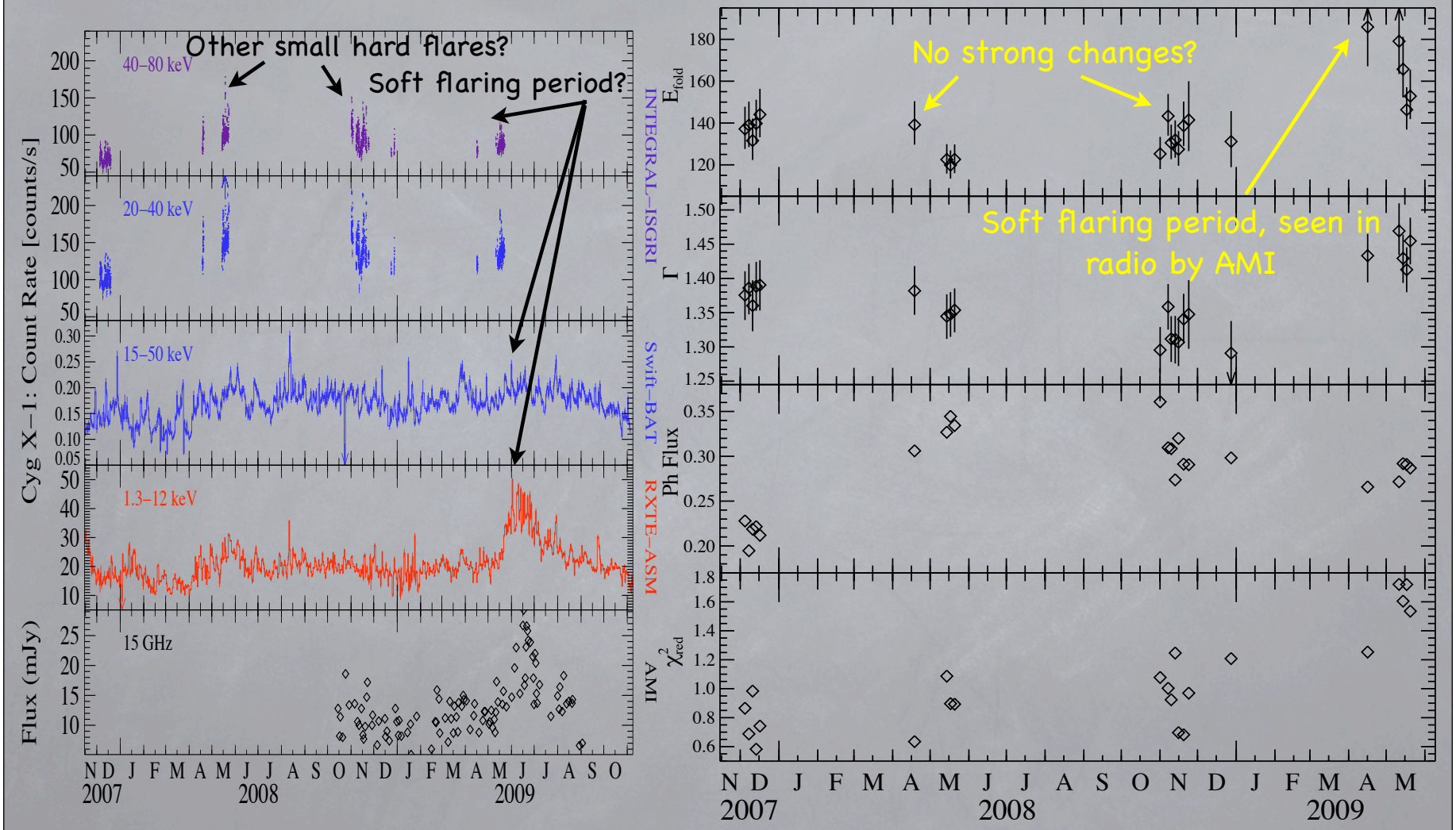
Malzac et al. 08

Luminosity~3% L_{Edd}

No correlation TeV/keV for Cyg X-1

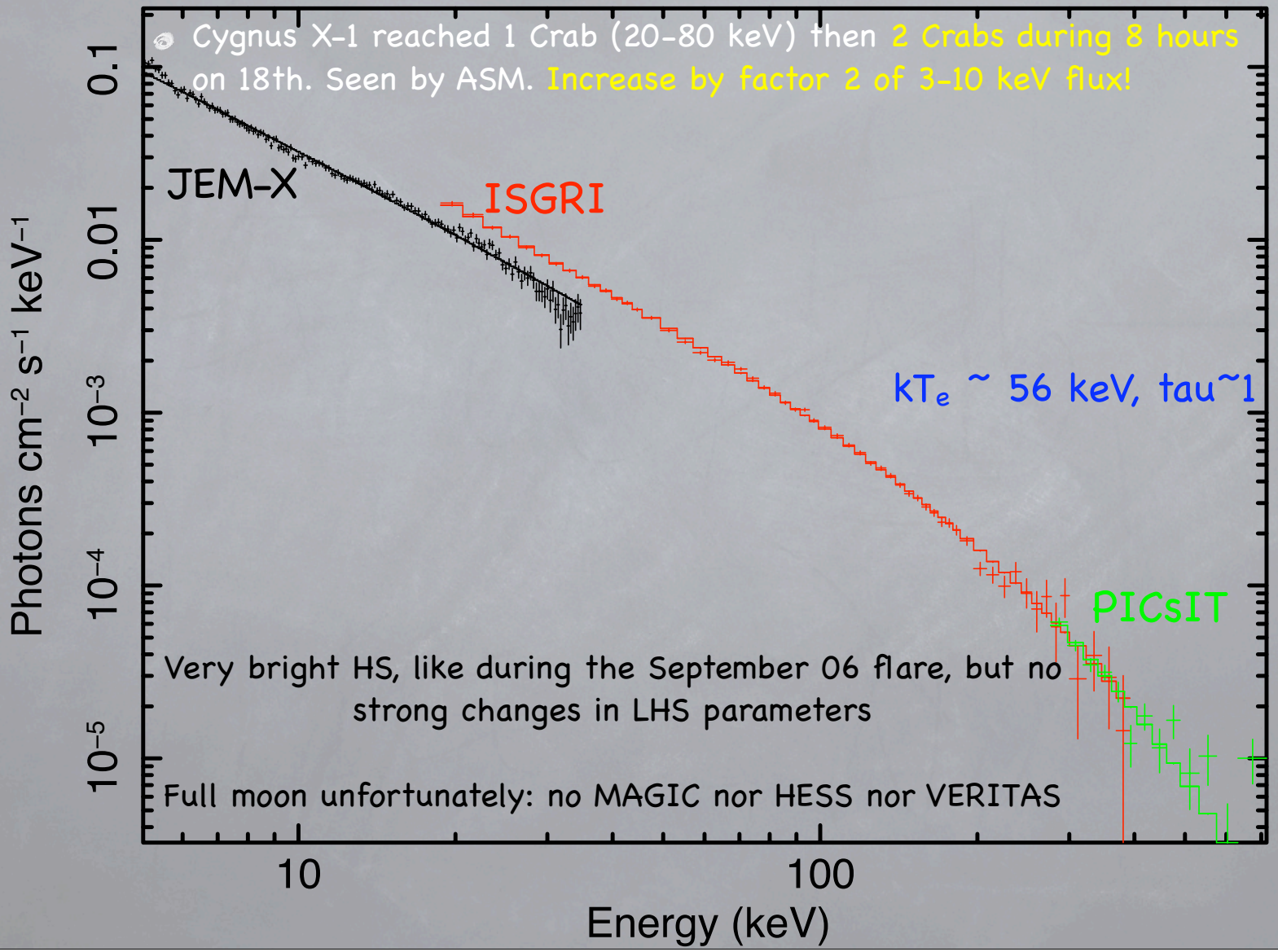
- Events not extreme in luminosity but in duration. No special light curve/spectral feature when MAGIC detection occurs (puzzling):
  - TeV emission (Albert et al. 07) "could" explain high-E excess (IF REAL): matches extrapolation from SPI data if simple power law from < 1 MeV up to TeV (unlikely to happen!). Pair absorption/production? Shocks with ISM/wind (compact radio jet, e.g., Markoff/Corbel/Gallo or Zdziarski et al. 09)? ISSUE!
  - Radio/X-ray flares explained by ejection of e- bubbles emitting synchrotron radiation (Wilms et al. 07): is it the case in our recent observations? Other issues to study (Hanke et al. 09, Nowak et al. 08, Wilms et al. 06).

KP Long term LCs and spectral parameters

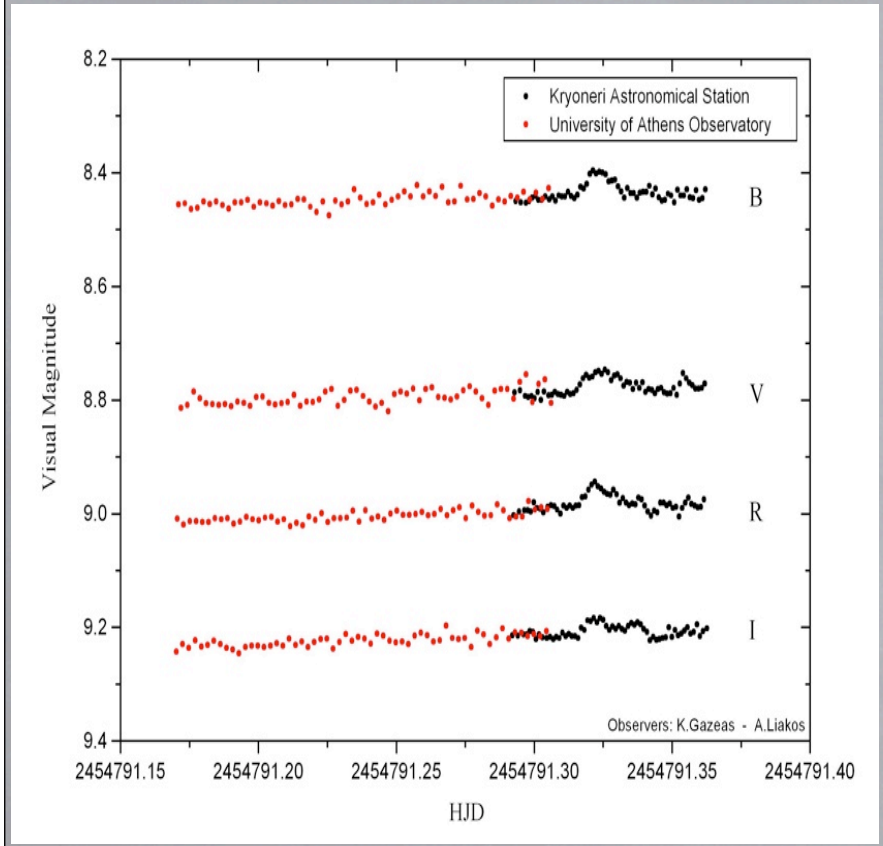


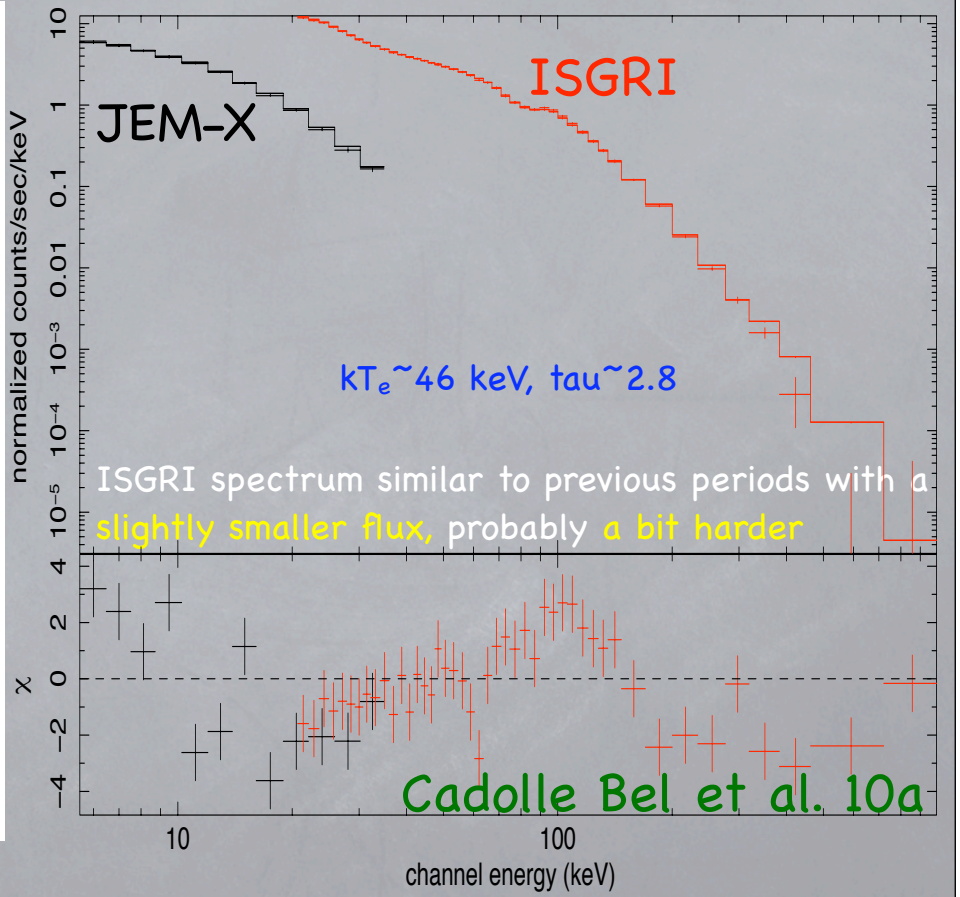
22 INTEGRAL revolutions (~3 days) on Cyg X-1: Hard State, except May 2009, simultaneous radio flare -> FST?

Very hard spectra-May 2008



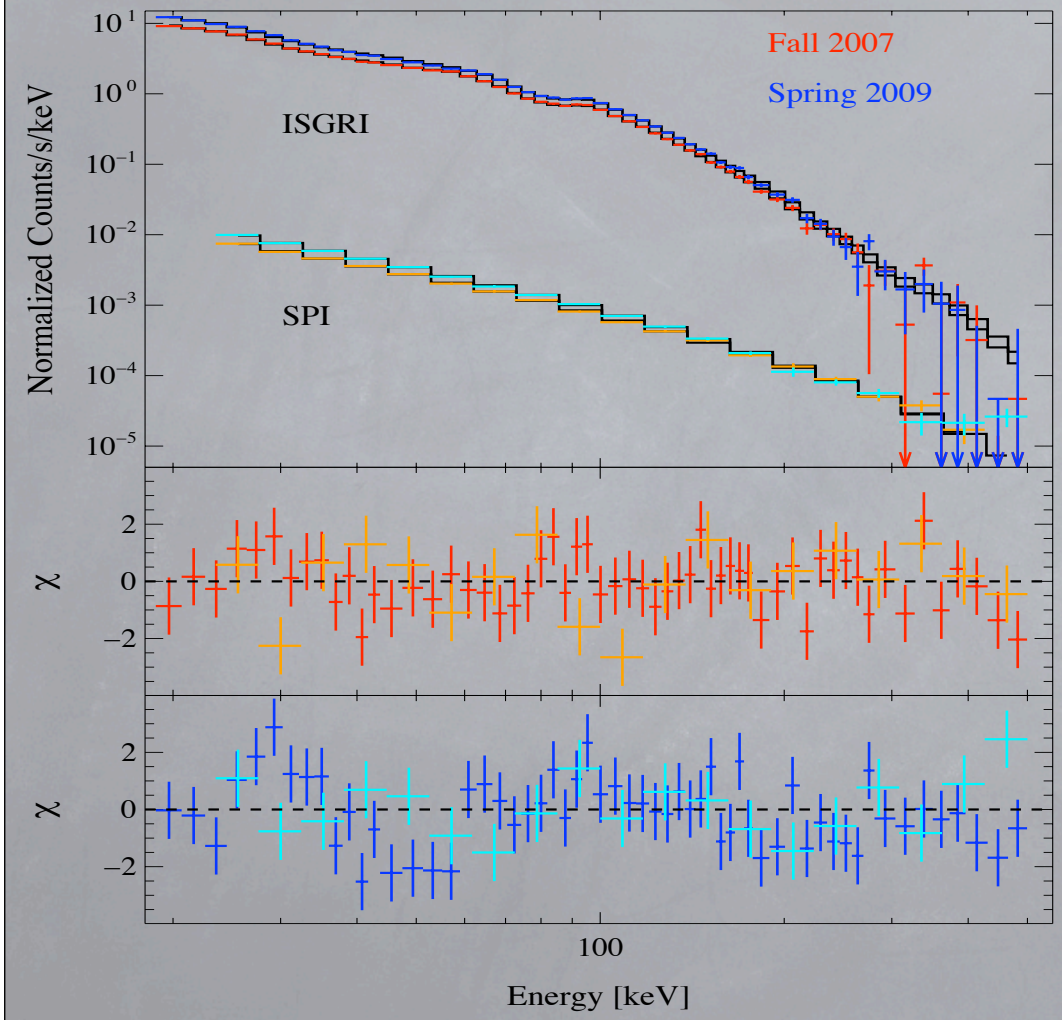
Cyg X-1 variabilities-Nov. 2008?





- More variability in LC than previously (May) with short flares on a several SCW scale
- Optical flare: sudden increase of matter falling in the disc; more obvious in B band (shorter wavelength) NOT due to companion...

Cyg X-1 spectra: comparisons



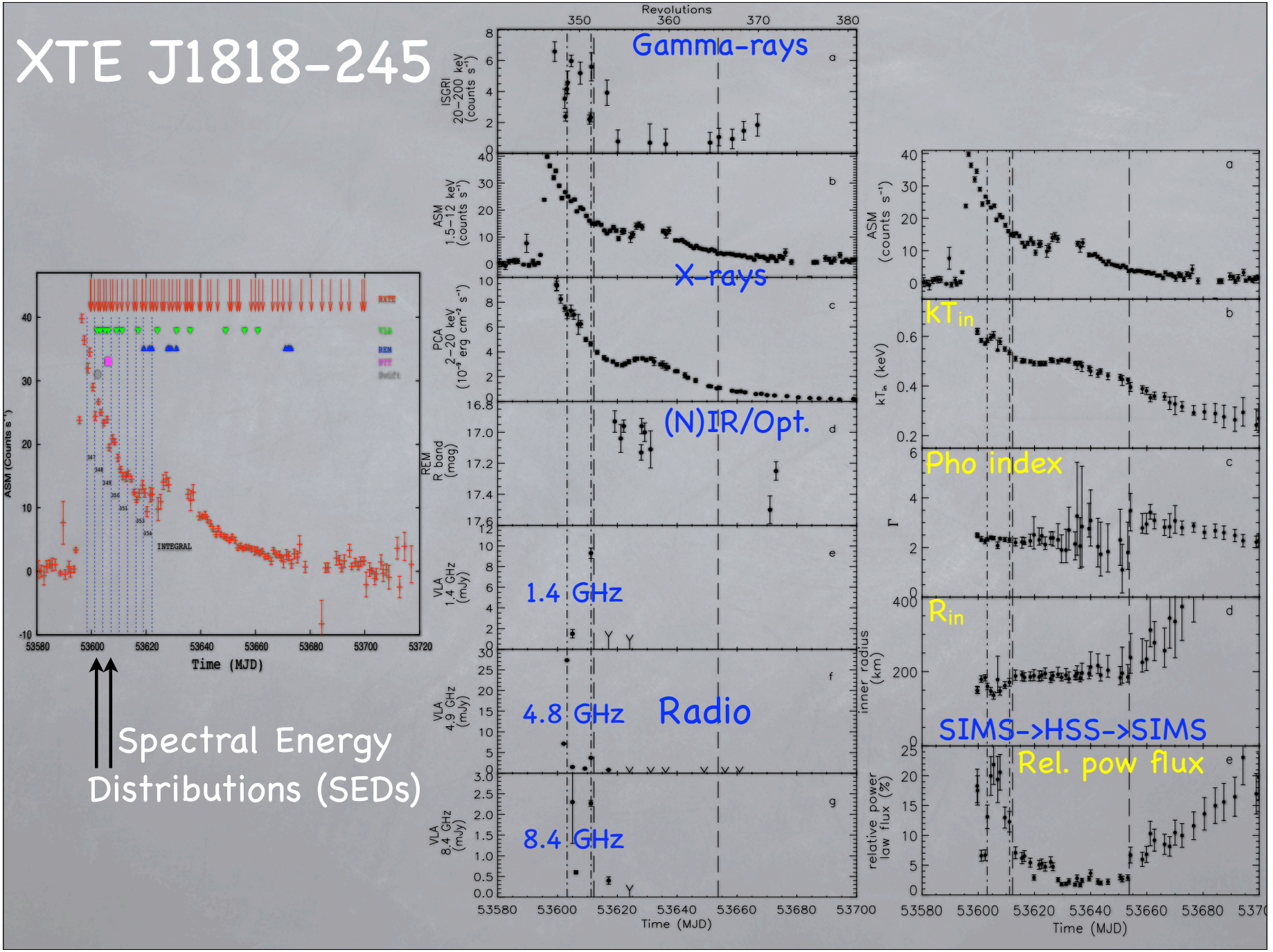
Hard state 2007 December vs recent "flaring" May 2009:

Gamma: 1.37->1.45 (as in GX 339-4)
E_{cut}: 140->160 keV
but no 20-450 keV clear flux variations... FST

compTT kT_e 46->48 keV, tau 1.3->1.2 (Wilms et al. 06, Cadolle Bel et al. 06: pure thermal Compt. less good descriptions?)

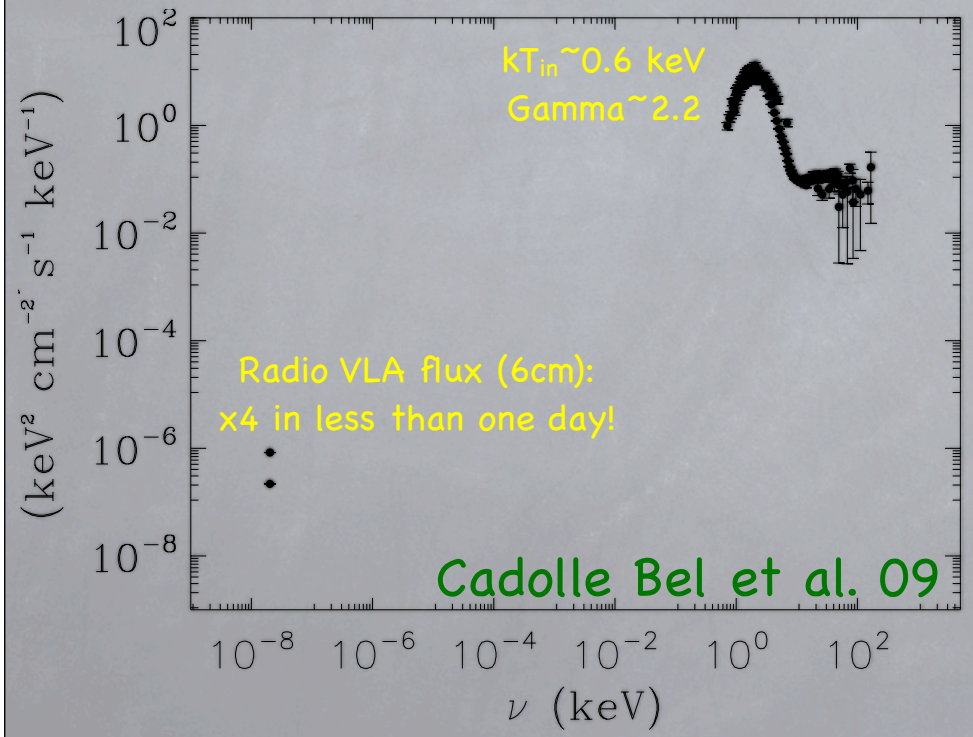
With the 3 following LMXBs: "luckier" in our multiwavelength campaigns, better constraints on BH physics and ejection events

XTE J1818-245

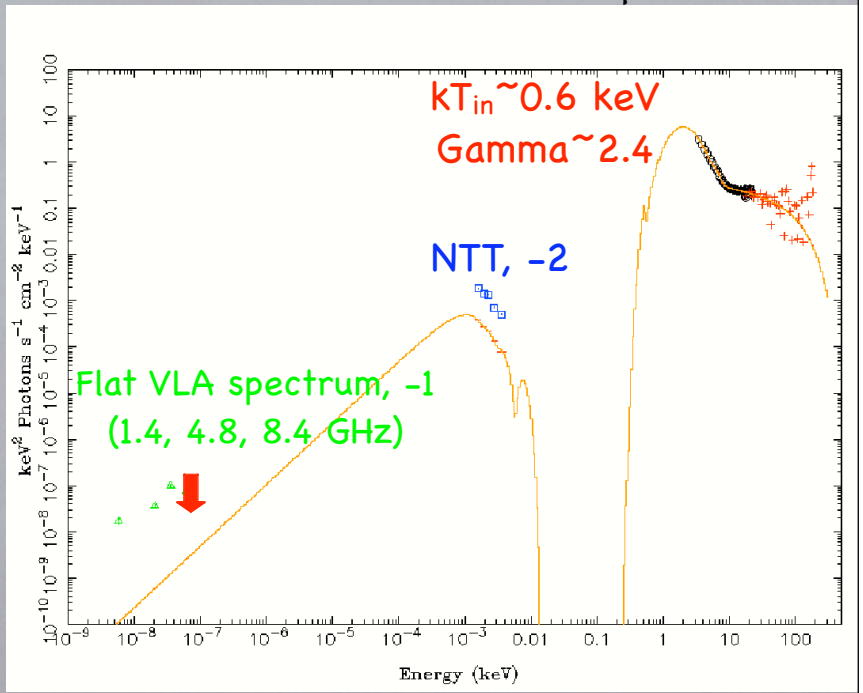


Spectral energy distributions of XTE J1818-245

20-21 Aug.
Average Swift/XRT, RXTE/PCA+HEXTE and INTEGRAL/JEM-X+ISGRI spectra



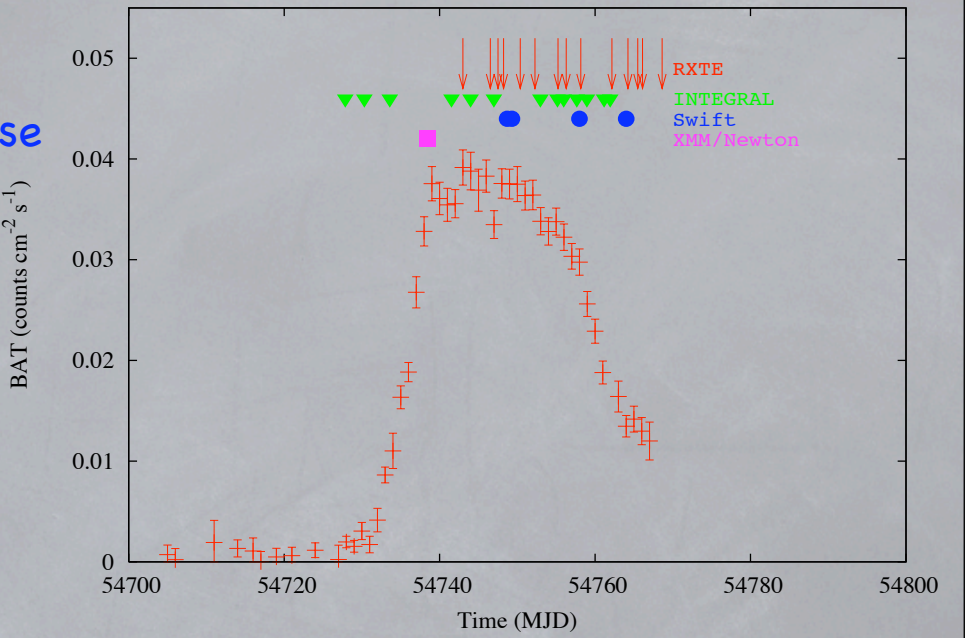
22-23 Aug.
Average RXTE/PCA+HEXTE and INTEGRAL/JEM-X+ISGRI spectra

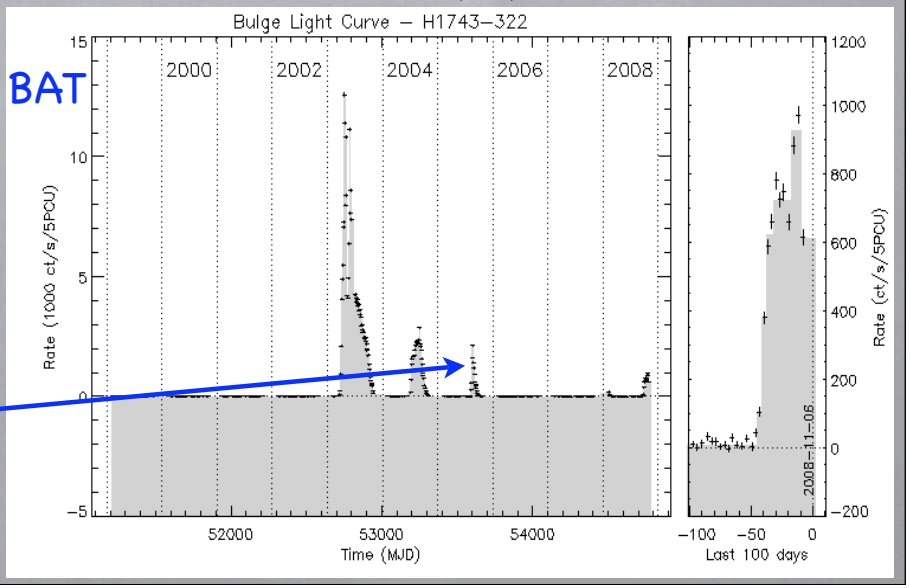


Classical spectral parameter evolutions (disc, hot media)
BUT radio behaviour puzzling...

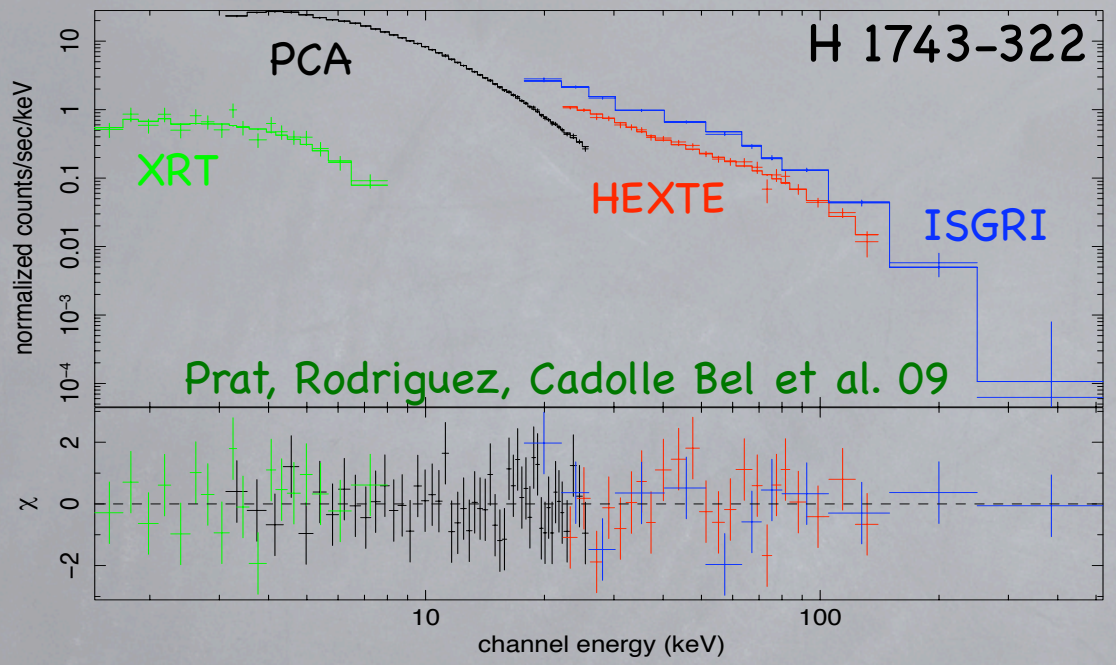
H 1743-322

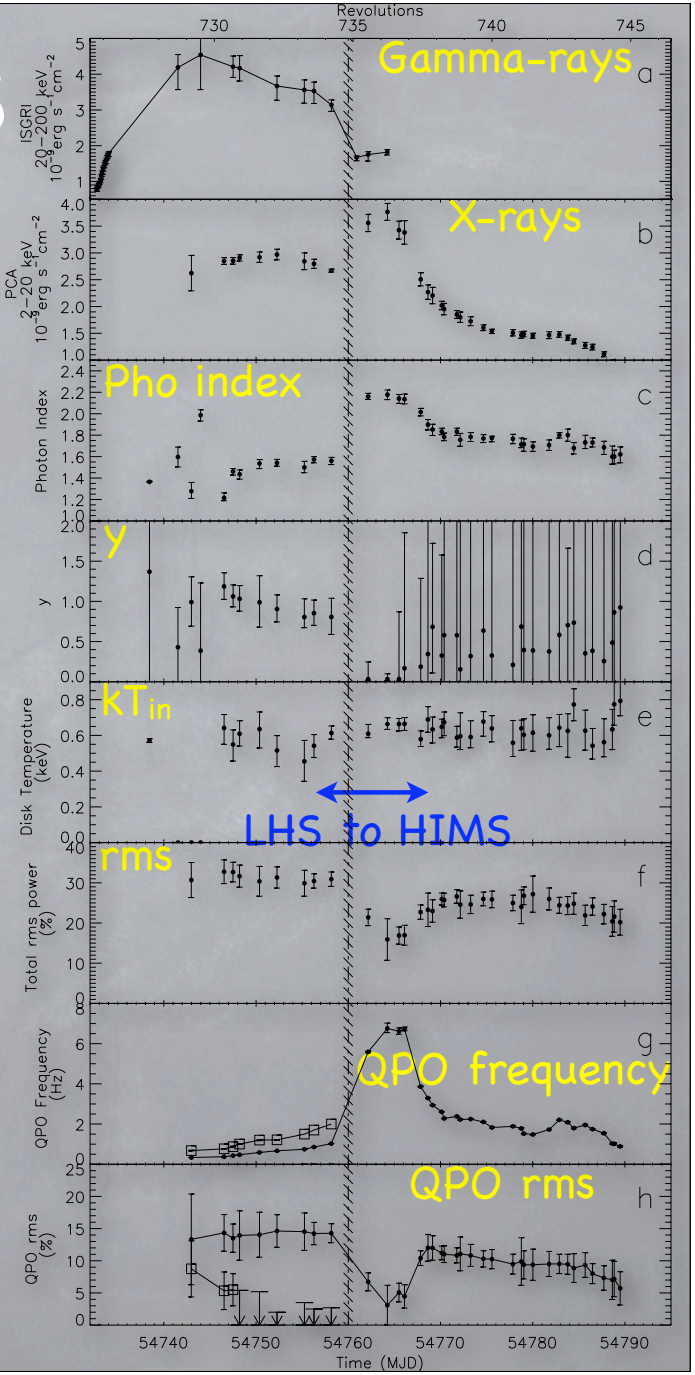
- 2008 outburst seen in very early phase
  - 10 mCrab (3-10 keV), 17 mCrab (18-40 keV), and 31 mCrab (40-100 keV). No emission 3 days before!
  - 1/2 day(s) later fluxes increased+power law~1.3 with cut-off 151 keV;1 day later, no cut-off. Pho index~1.6
  - Radio: compact jet. XMM: no clear relativistic broad Fe K-alpha line. RXTE: flux increasing, LFQPO, state change LHS to HIMS. Seen by INTEGRAL: 20-200 keV flux decreased by ~45% within 2 days simultaneously to spectral softening (Pho index ~2.2).
- (Will the disc be empty soon...?)





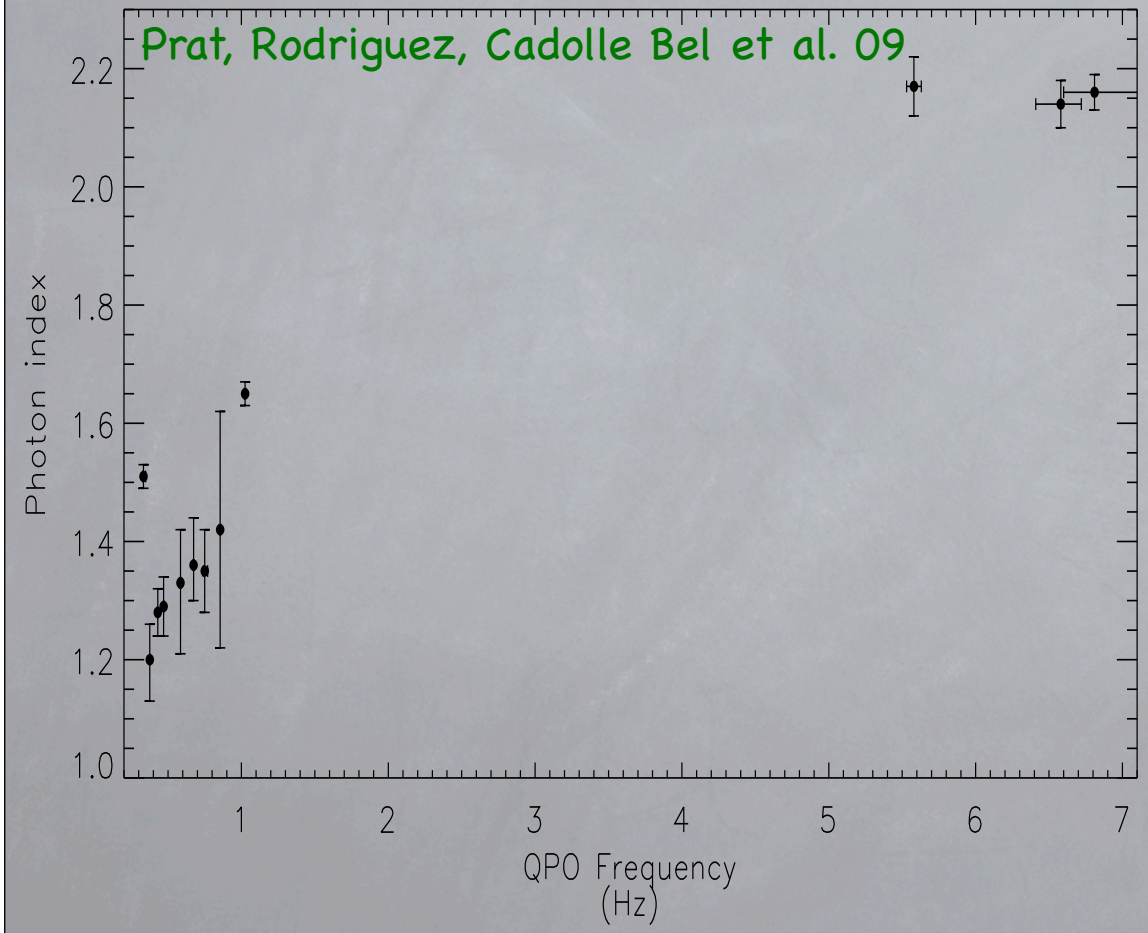
Spectral parameters





- LHS during 28 days, then HIMS. Slow spectral and timing characteristics evolutions. Previous 2003 outburst: 12 days only in LHS. Spectral indexes and flux comparable.
- Total rms power~25-30%. QPOs detected at 0.5 and 1 Hz (ratio~2); rms amplitude of 5 and 10% respectively, while in 2003 only 0.1 Hz QPO detected at 3-14% rms.

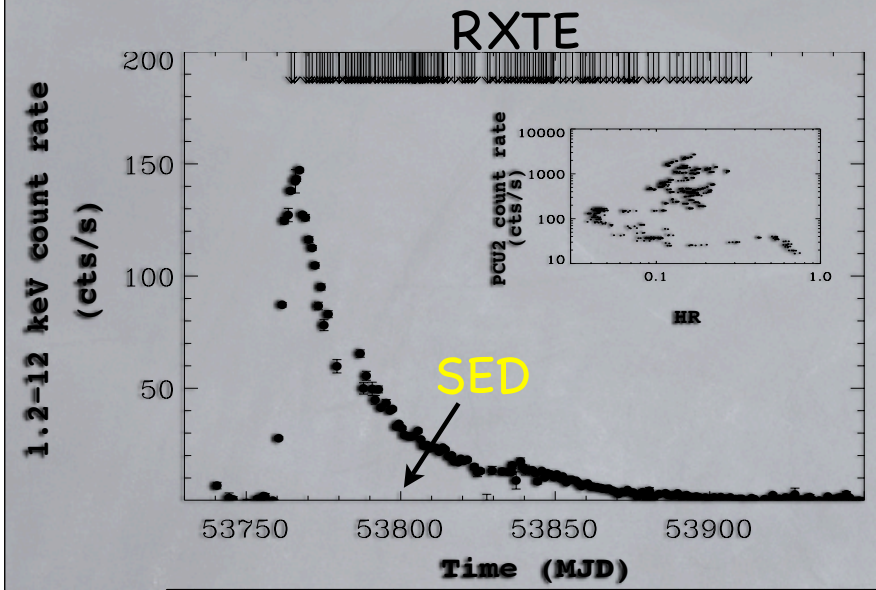
H 1743-422: correlation pho index/QPO

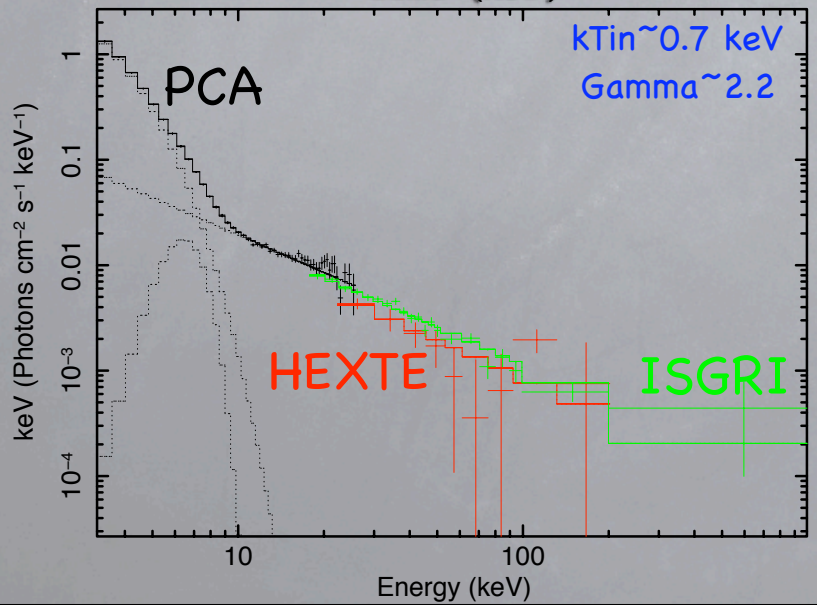


LFQPO frequency increases with pho index: although disc properties probably set the frequency, the "corona"/hot medium plays a crucial role in the generation and/or amplification of the QPO power

See also Prat & Rodriguez (ArXiv: 0902.1226)

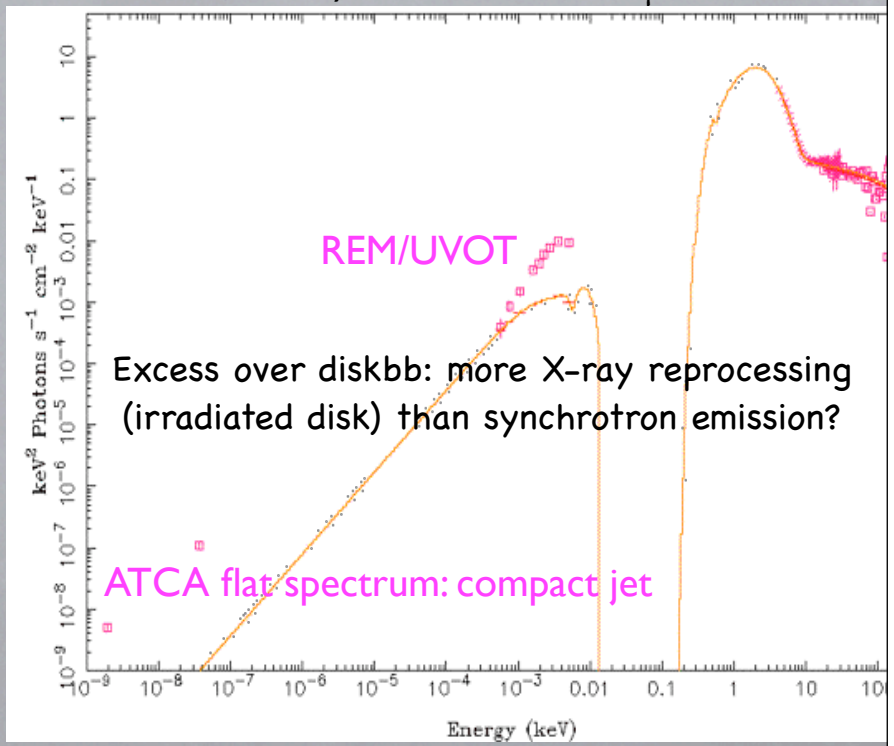
XTE J1817-330





4-7 March

Average RXTE/PCA+HEXTE and INTEGRAL/JEM-X+ISGRI spectra



see Gierlinksi et al. 08 vs Rykoff et al. 07 & Sala et al. 07

Cadolle Bel et al. 08, 10b

Conclusions

- Cyg X-1: hard state with weak variability+FST. Spectra well described by thermal CompTT/exp. cutoff. Next steps: search for non-thermal component (Cadolle Bel et al. 06)+include radio data in modelling (Markoff et al. 05).
- LMXBs: Classical evolutions of disc temperatures, Fe lines and power law hard component of BHs, 3 components in SED BUT slight deviations from "standard picture" (see, e.g., Cadolle Bel et al. 07, Gallo et al. 08).
  - XTE 1817-330: Clear optical/IR excess over viscous disc model: reprocessing of X-rays (irradiated disc) instead of synchrotron emission?
  - Radio flares in XTE J1818-245: compact jet/discrete ejections (bubbles)? But sometimes flare seen 5 days after transition to soft state!
  - H 1743-322: 2 distinct trends=2 physical media. Viscous timescale vs faster jet/corona: Prat & Rodriguez (ArXiv: 0902.1226).
- See also poster A03 on broad Fe lines in bright NS LMXBs

Still a lot to learn on media in strong gravity to have coherent picture!

->ASTRO-H, IXO, VLBI, LOHFAR,...