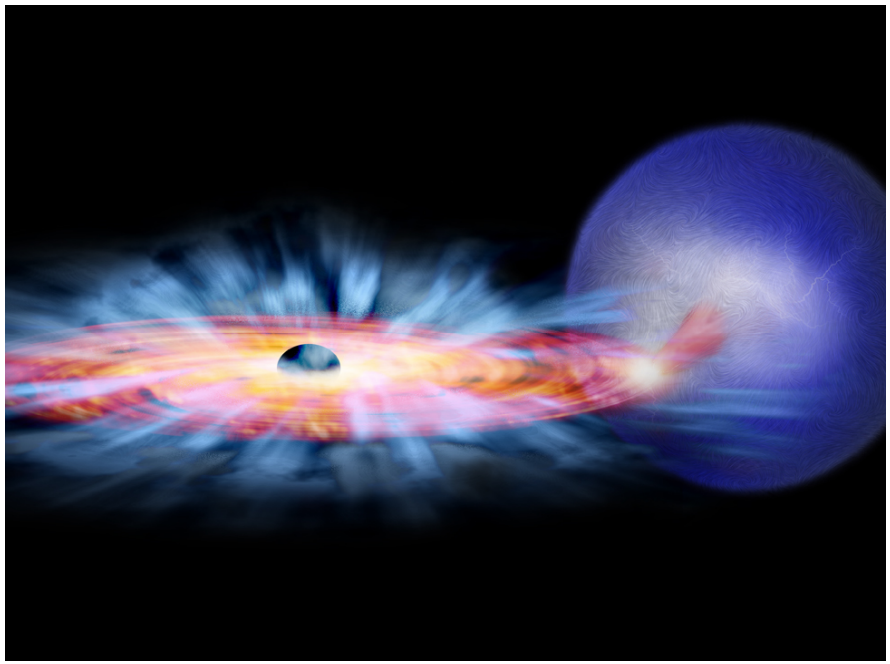
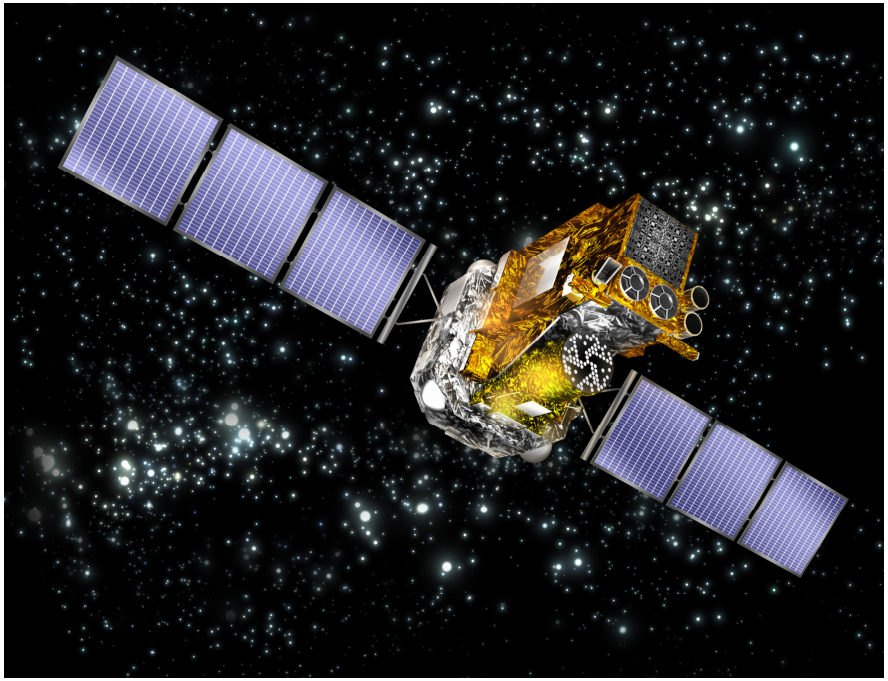
Multi-wavelength studies of the 2010 GX 339-4 outburst





M. Cadolle Bel, J. Rodriguez, P. D'Avanzo, S. Corbel, J. Tomsick, D. M. Russell, F. Lewis, E. Kuulkers, M. Buxton & F. Rahoui

1st paper on GX 339-4!

THE ASTROPHYSICAL JOURNAL, 184:L67–L70, 1973 September 1

OBSERVATIONS OF THE HIGHLY VARIABLE X-RAY SOURCE GX 339—4*

T. H. MARKERT, C. R. CANIZARES, G. W. CLARK, W. H. G. LEWIN, H. W. SCHNOPPER, AND G. F. SPROTT

Department of Physics and Center for Space Research, Massachusetts Institute of Technology

Received 1973 May 29; revised 1973 June 25

ABSTRACT

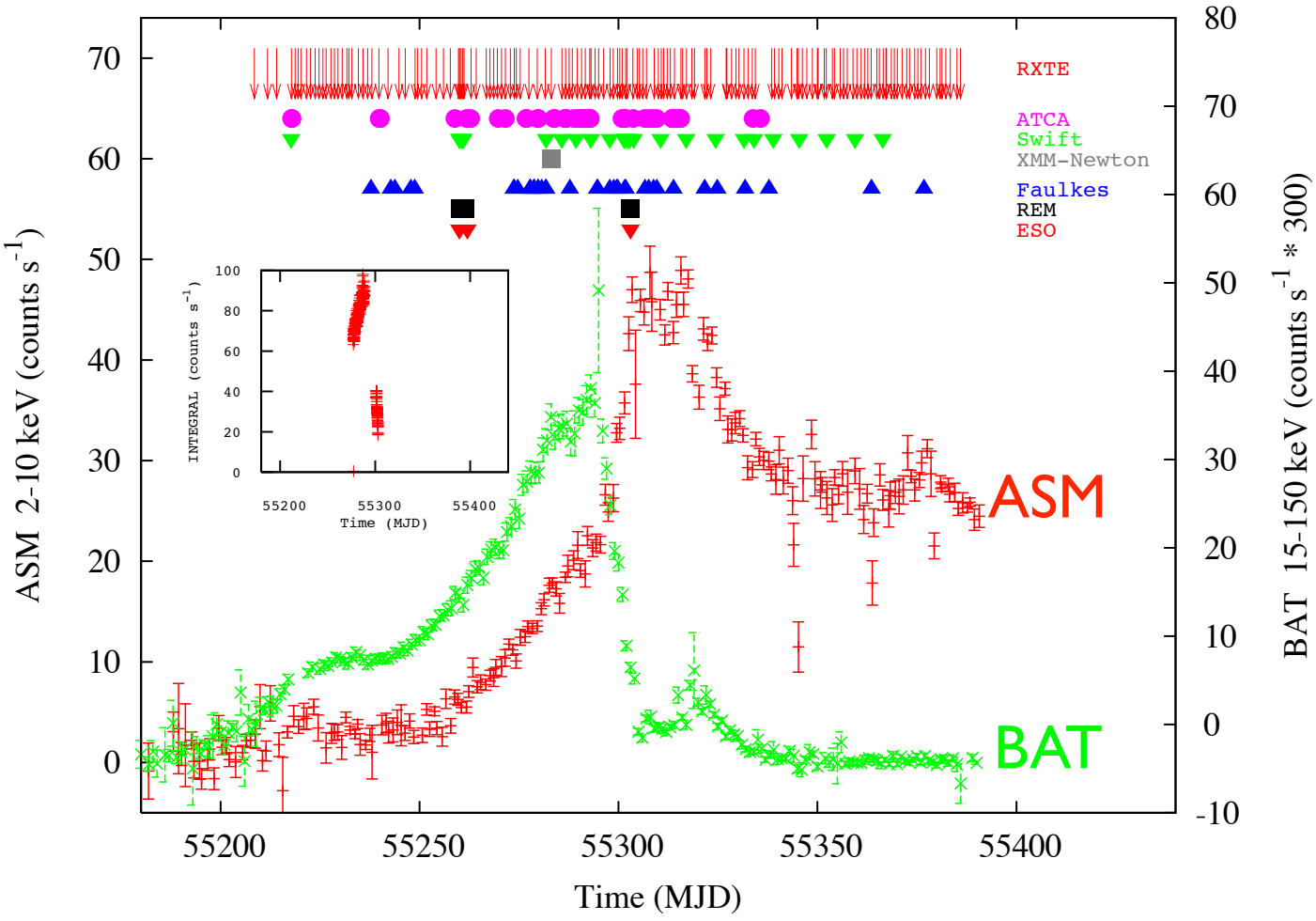
Observations with the MIT experiment on the OSO-7 have led to the discovery of an X-ray source, GX 339—4, which varies in intensity by at least a factor of 60 over hundreds of days but shows no evidence of periodic behavior or abrupt intensity changes on time scales from 3 minutes to 13 days. The observations show intense HIGH states, LOW states with spectra consistent with increased absorption, and OFF states, when no statistically significant signal is observed. The behavior is unlike that of any previously reported X-ray source.

Subject headings: variable stars — X-ray sources

I. INTRODUCTION

The bright variable X-ray source GX 339—4, first reported by Markert *et al.* (1973), has been observed extensively by the MIT 1–60 keV X-ray detector aboard the OSO-7 satellite. Our observations show variations in intensity by large factors on time scales of weeks and months with associated systematic spectral changes. No evidence of eclipses or other periodic variations is seen during continual observations for periods of up to 13 days.

GX 339-4 log



7 solar Mass
Companion: evolved low mass star
P_{orb} 42.14 h N_h 6.10^{21} cm^{-2}
6 kpc < d <15 kpc
20 deg < i < 70 deg
collimated relativistic jet 0.9 c

XMM-Newton: see Uttley's talk

- Temporal and spectral state changes: hints on accretion/ejection processes
- Predictions of Wu+ 2010: time of hard X-ray peak after previous outburst ok, but @ lower flux than predicted

Multi-wavelength light curves

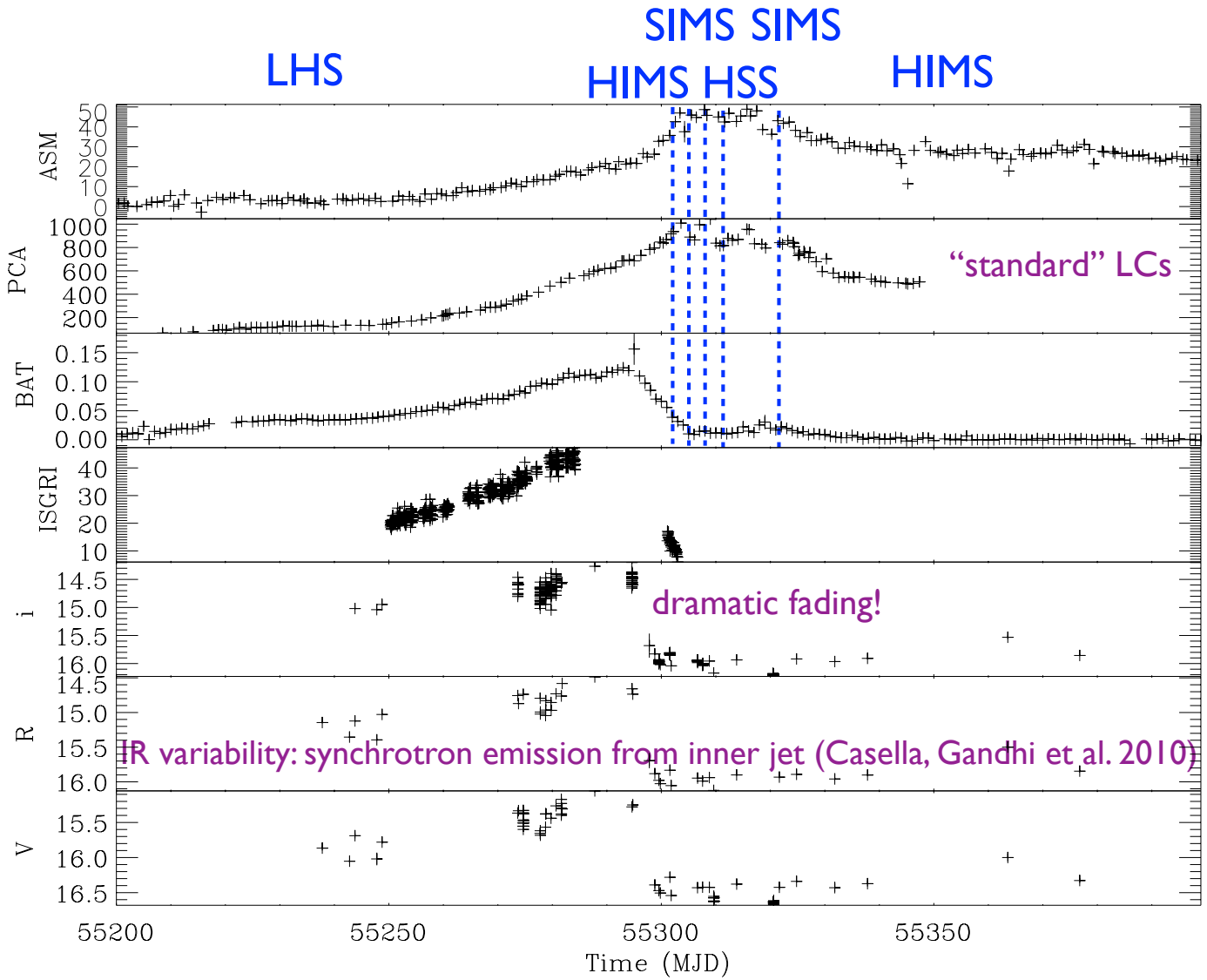
ASM (Cts/s) 2-10 keV

PCA (Cts/s/PCU) 3-30 keV

BAT (Cts/cm^2/s) 15-40 keV

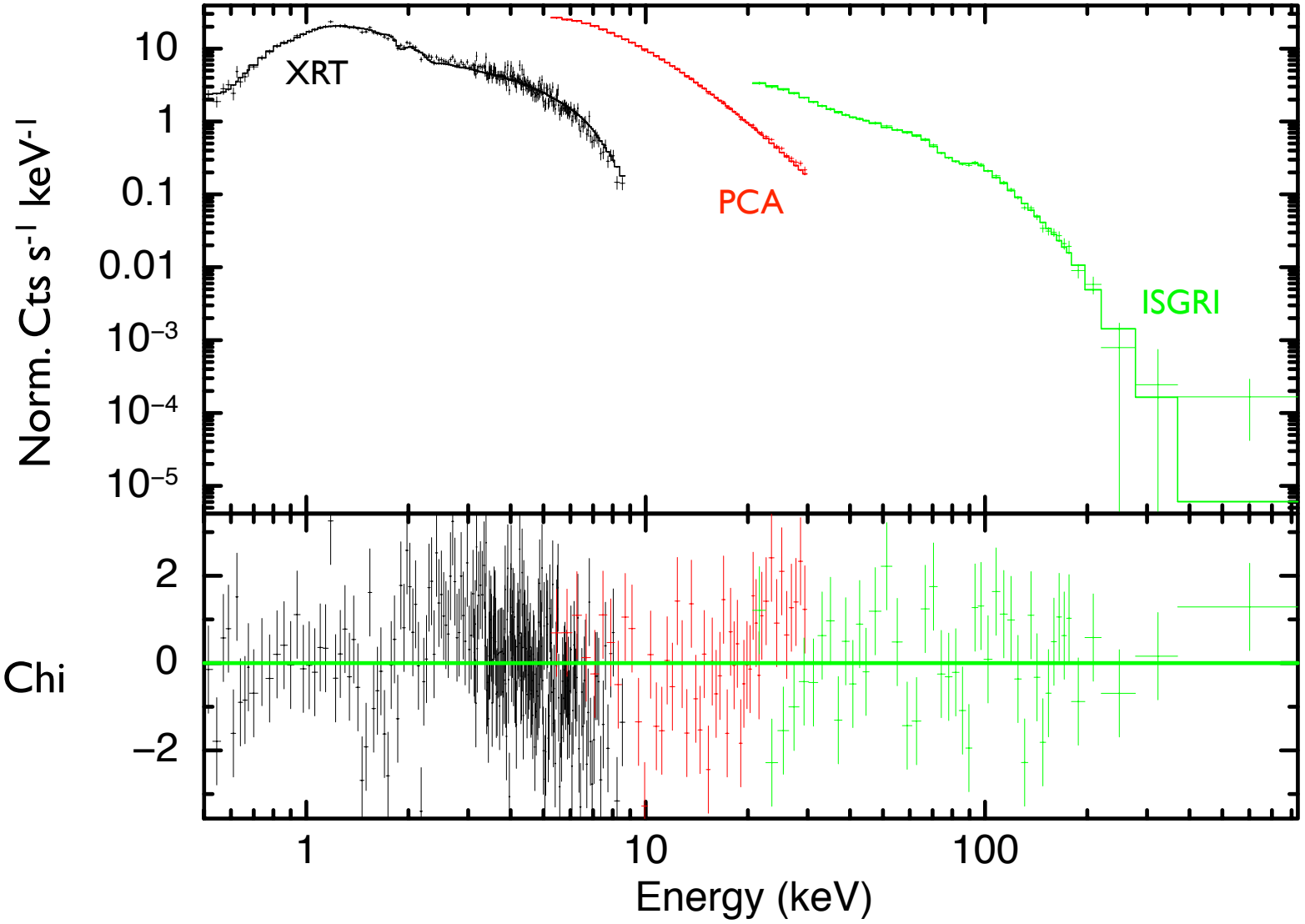
ISGRI Cts/s 40-80 keV

FT South magnitudes I R V



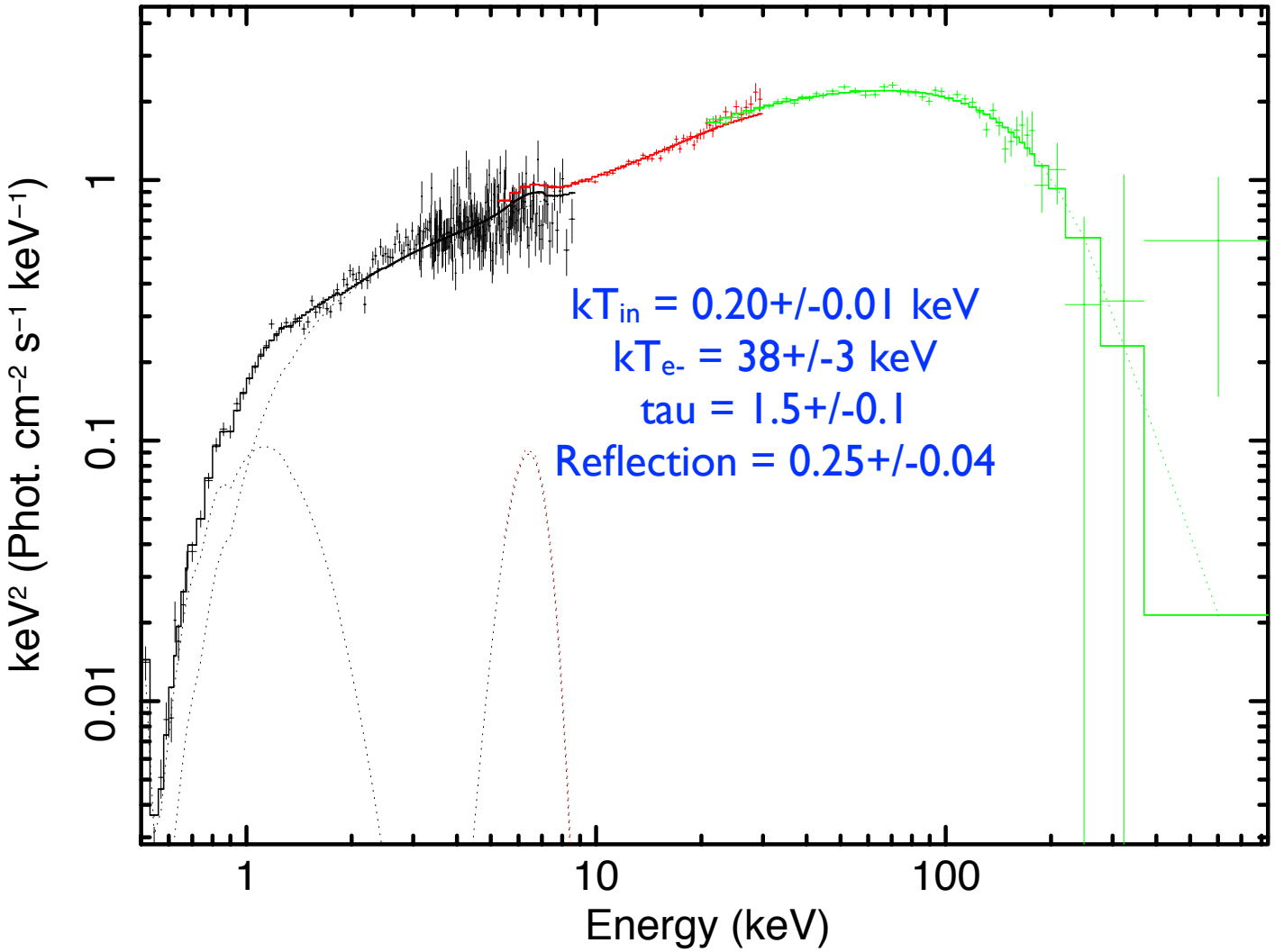
Lower flux than in 2002/3 & 2007 outbursts, higher flux than in 2004-2005 (Lewis+, Prat+ & Cadolle Bel+ 2010a). 2^{ndary} peak: non-thermal emission associated with jet formation?

Count spectra



Excess as in Del Santo+ 2008

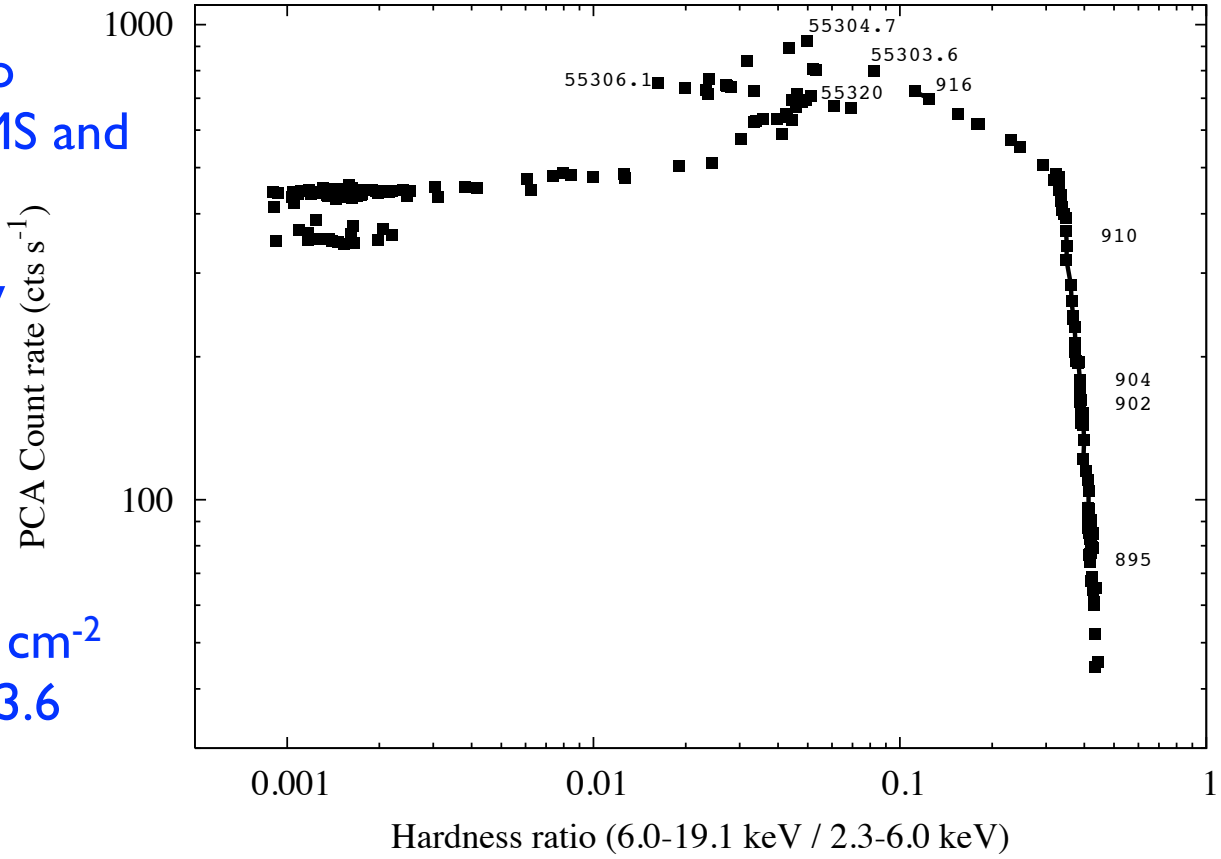
Photon spectra



See poster B29 of Ueda+, distinct modeling: Cadolle Bel+ in prep.

HID

- Source evolves quickly from LHS to HIMS, SIMS->HSS, then back to SIMS and HIMS, and finally quiescence!
- Disc temperature: 0.18 to 1.03 keV
- Gamma: 1.5 to 2.5
- Comptonization y: 0.22 to 0.01
- Bolometric flux: 0.8 to 2.9 10^{-8} erg cm^{-2} s^{-1} . Luminosity (6 kpc) below L_{Edd}: 3.6 (5%) to 12.9 (18%) 10^{37} erg s^{-1}



(see poster B27 of Stiele+ & talk of Cassatella on lags)

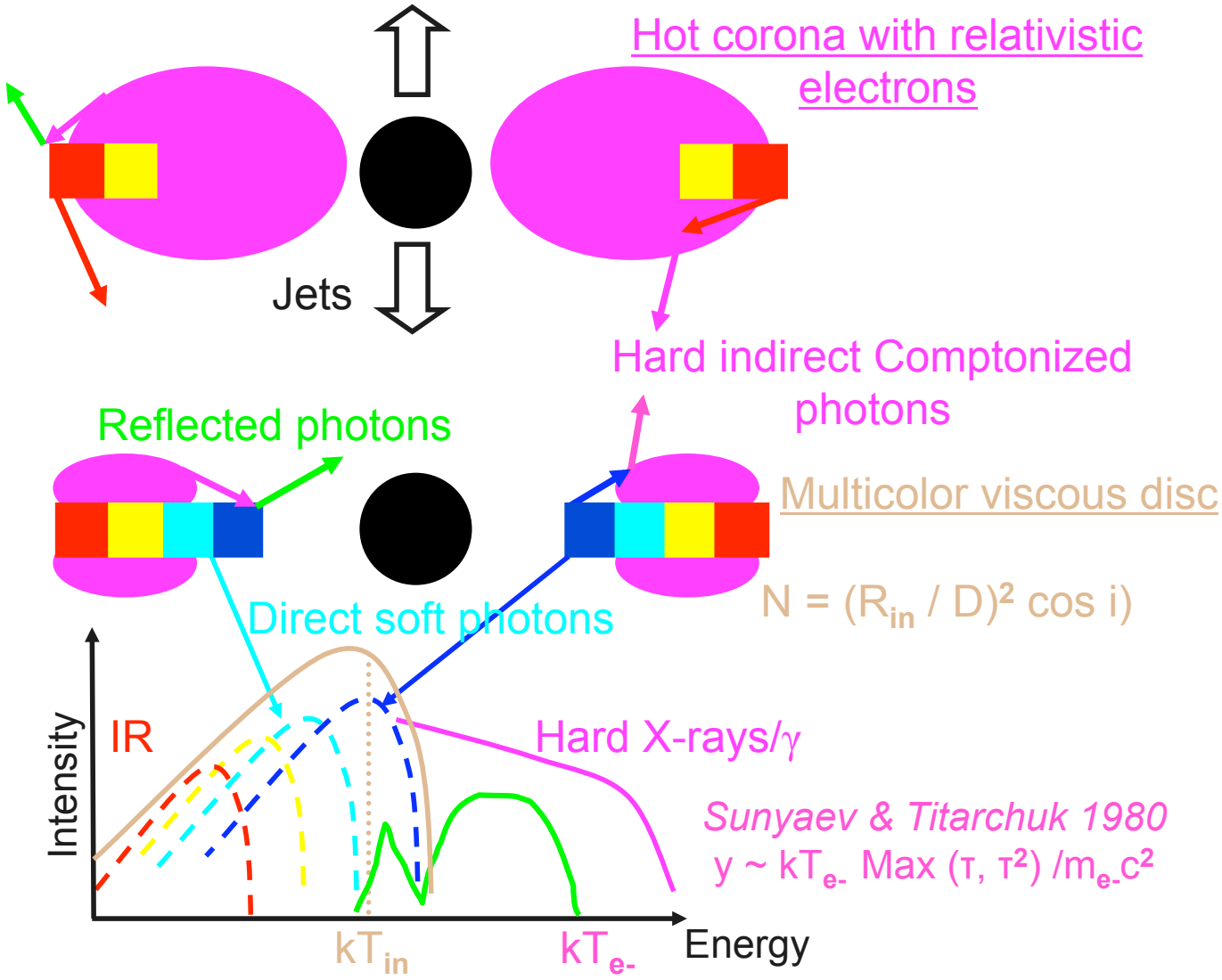
Standard picture ok?

...Almost (why: next slide)!

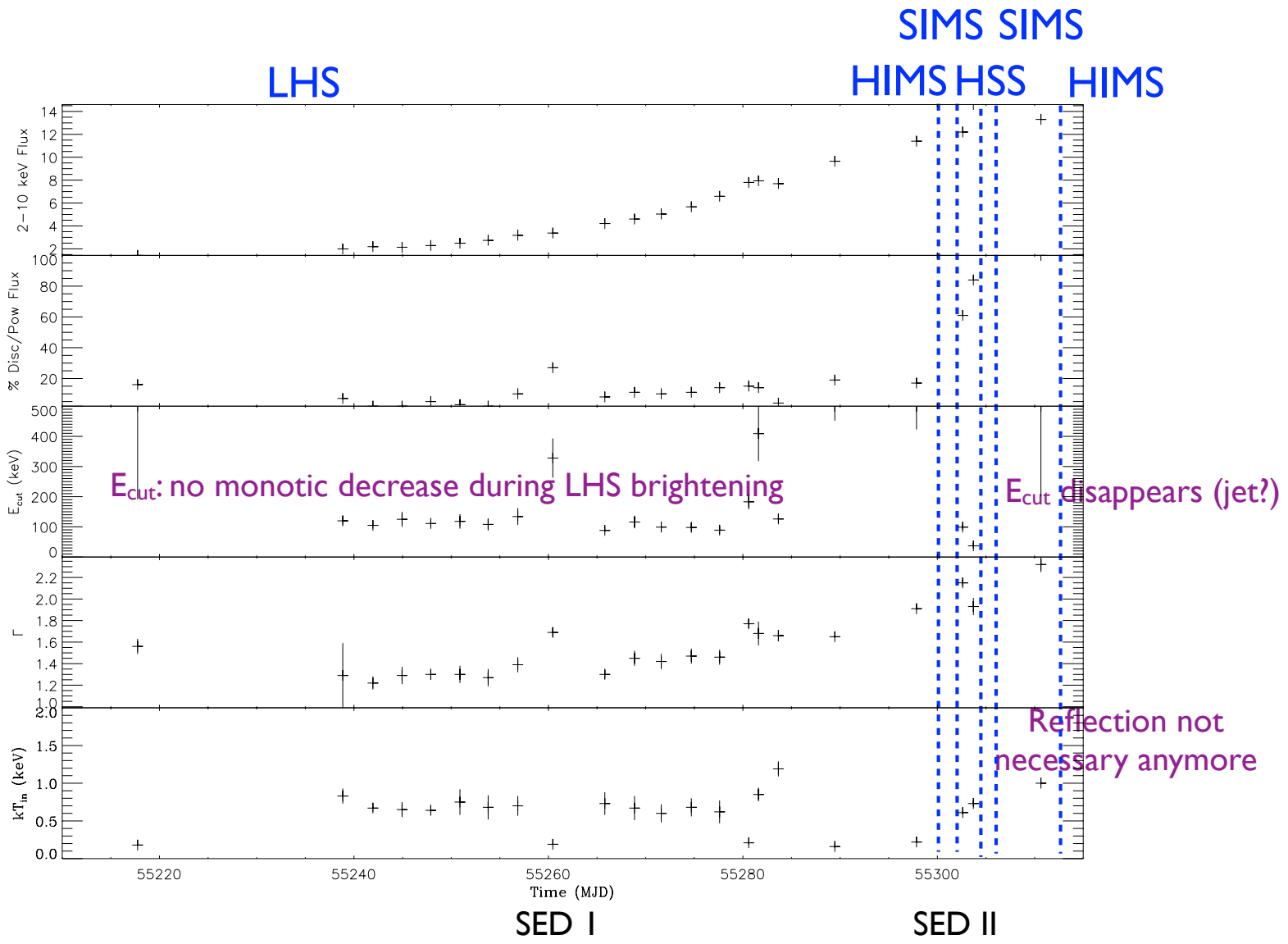
A possible schema

LHS

HSS



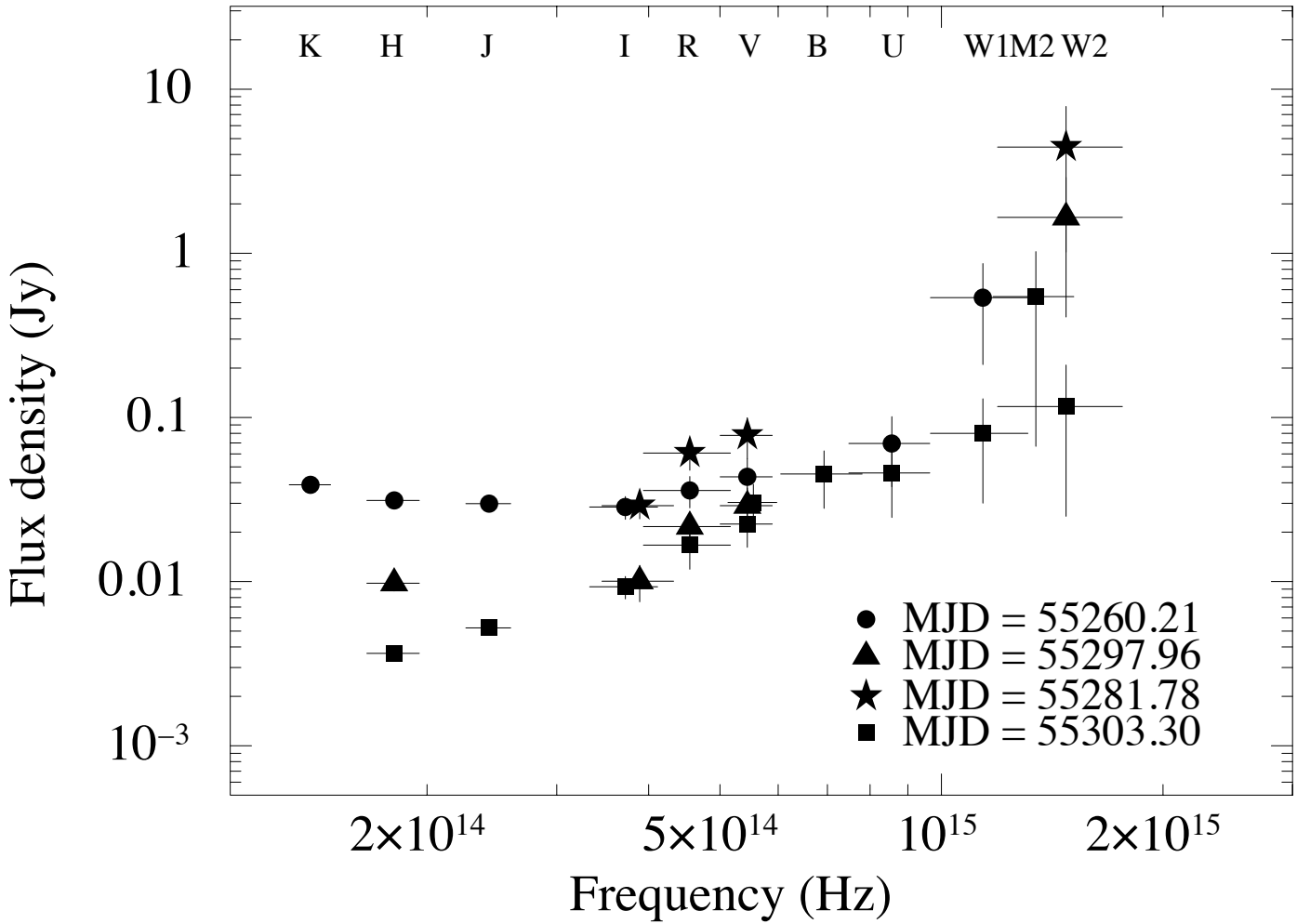
Parameters' evolution



Evolution of the spectral parameters distinct from, e.g., Motta+ 2009

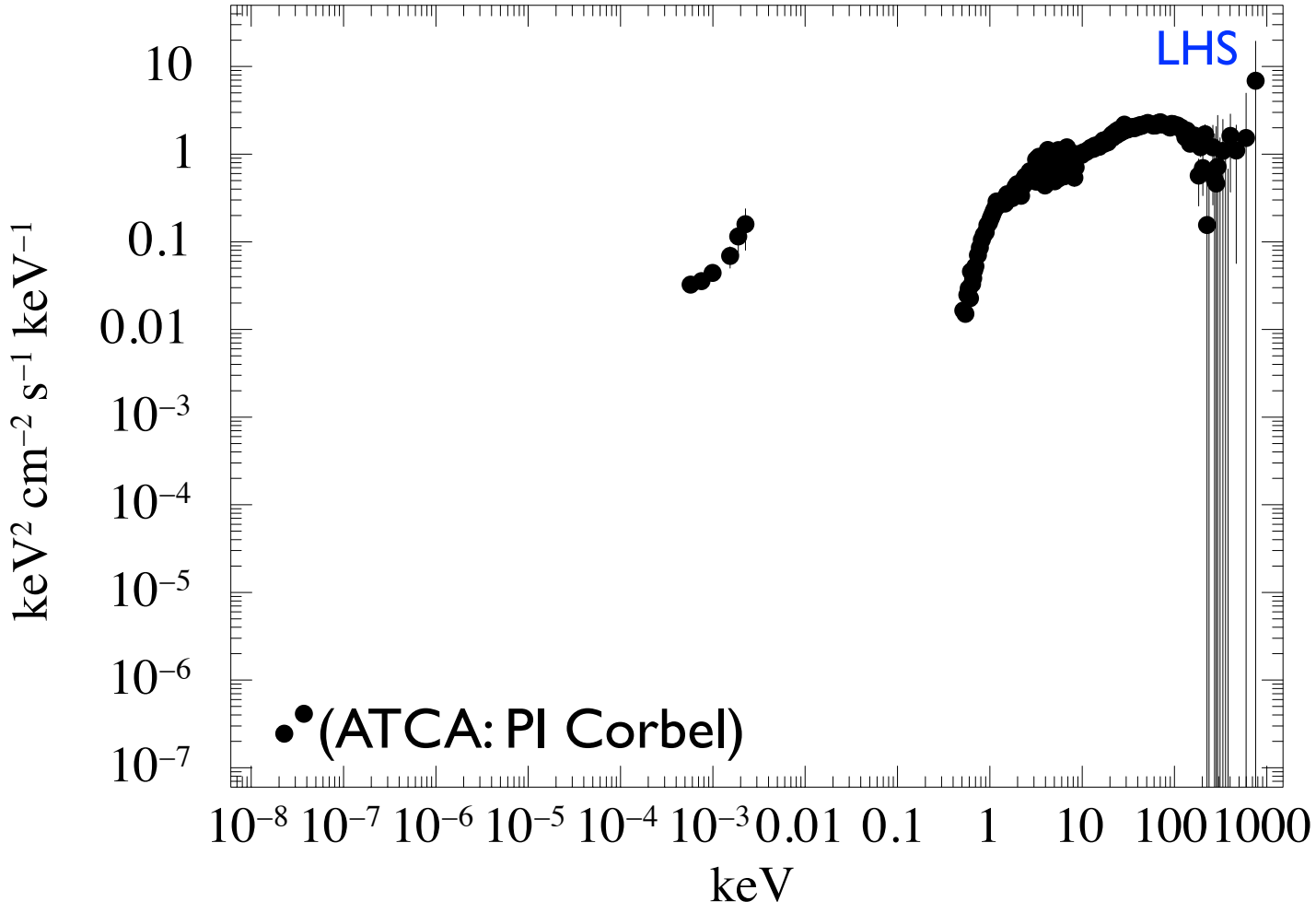
Opt./NIR SEDs

with UVOT, REM, SMARTS and FT South data at distinct MJDs



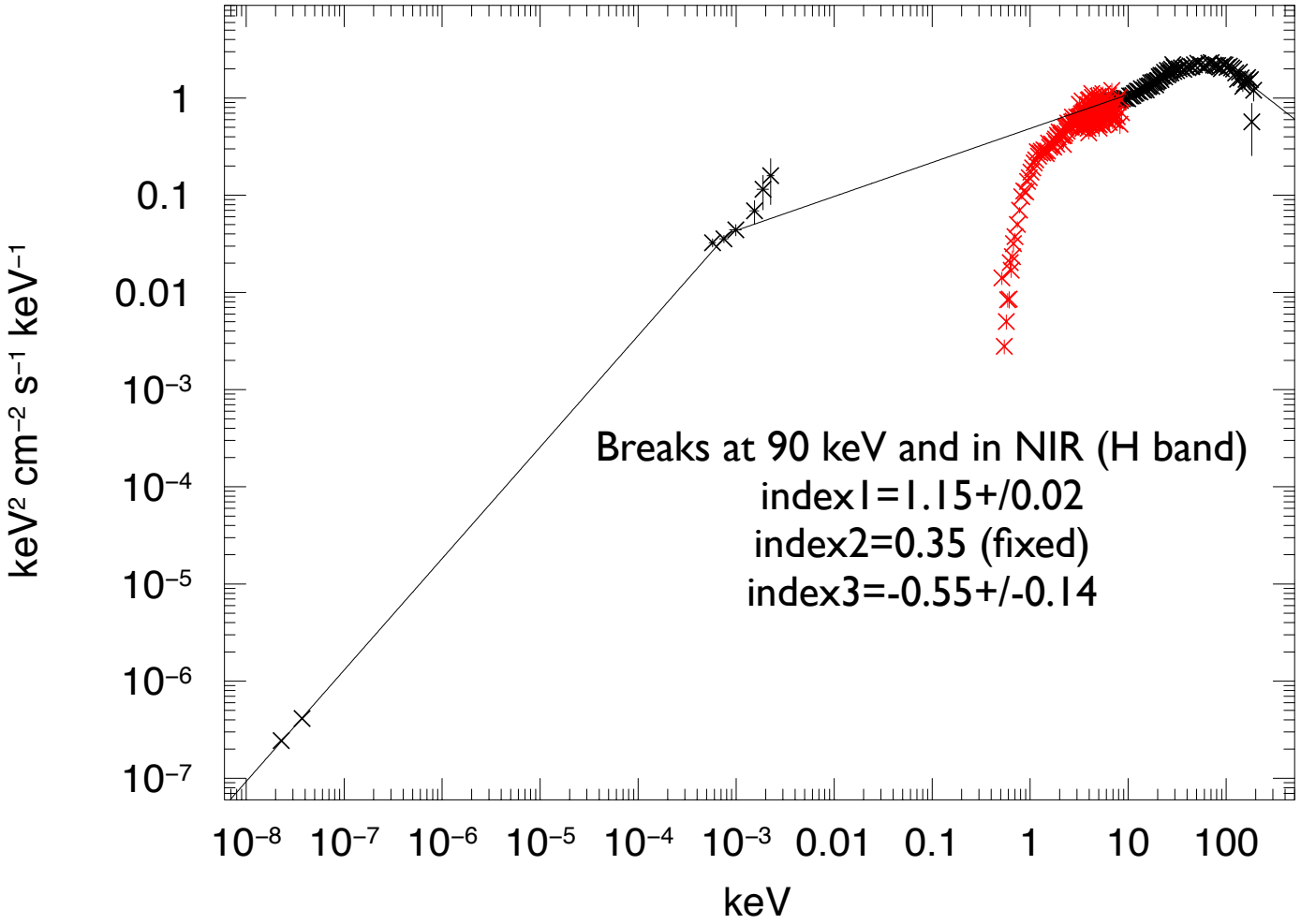
Flux&spectra changes: interpreted as *dramatic* quenching of synchrotron emission from the jet (that no longer contributes to optical)

SED 1



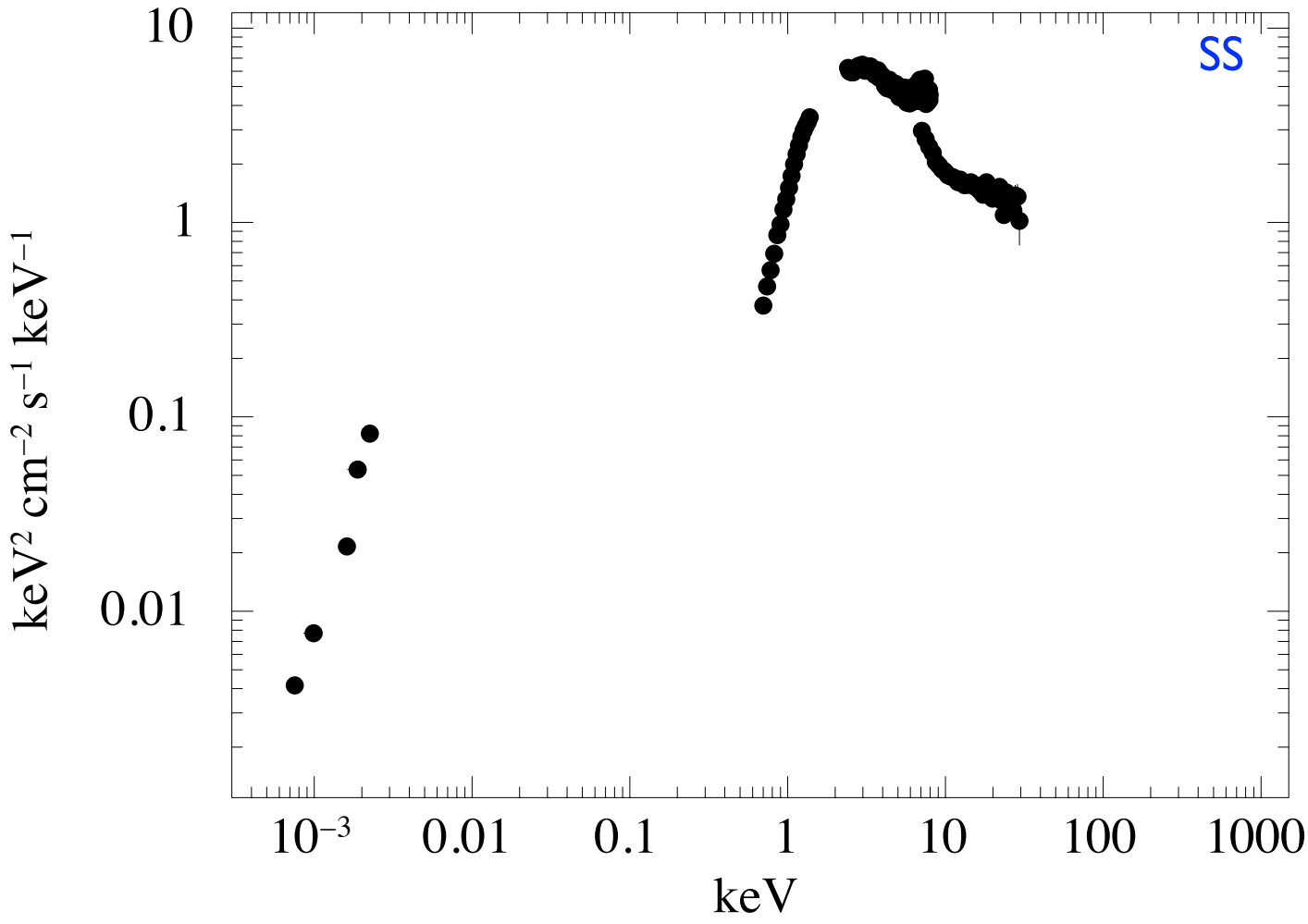
Major ejection close to transition from LHS+re-acceleration of particles up to *very high-energies* (months later, no more radio emission)

(Too) simple fit of SED 1



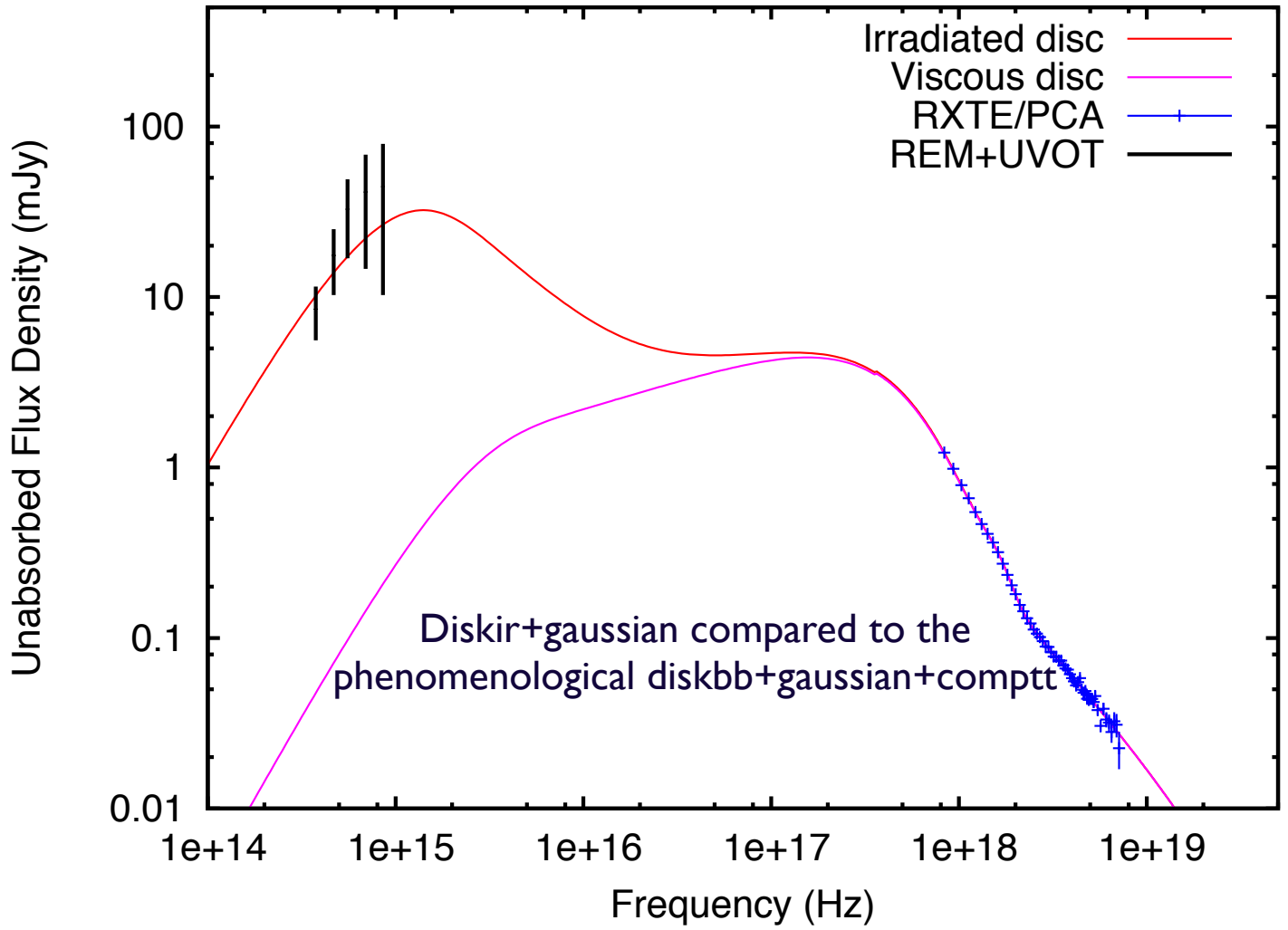
Broken PLs (Nowak+ 2004); values consistent with Homan+2005, Fender +2001&Corbel+2002: SSC origin of X-rays in which break frequency varies between optically thick & thin regime of the jet spectrum

SED II



Steepening of X-ray spectra + disappearance of *turn-over* in Opt./NIR
More optically thin emission as source brightens (Homan+ 2005)

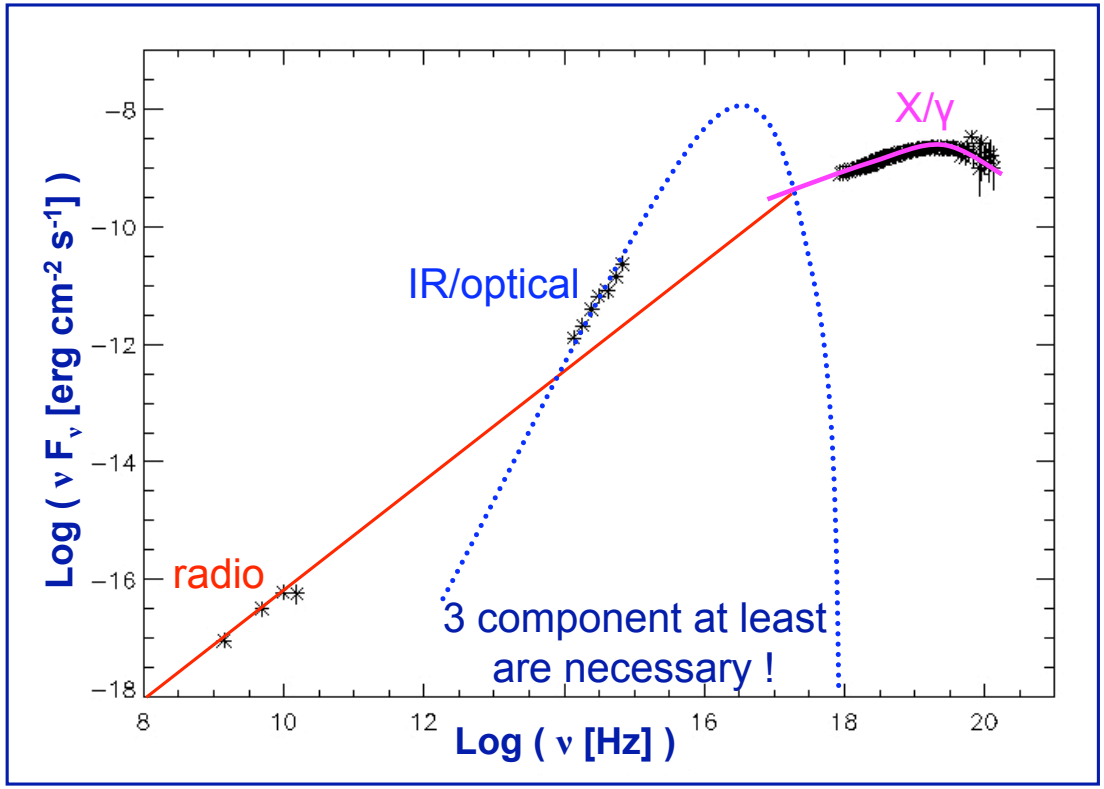
Fitting SED II



Opt. slope of ~2.V, R and I high fluxes: important thermal disc irradiation/reprocessing in soft state, dominates UV+Opt (though badly constrained with only photometry) but see Gandhi's talk!

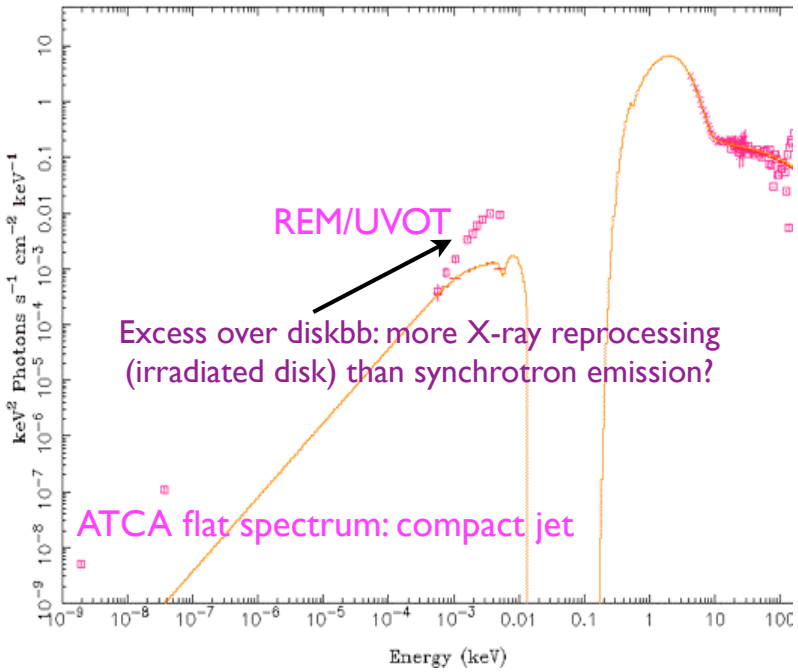
SED examples

SWIFT J1753.5-0127



Cadolle Bel+ 2007

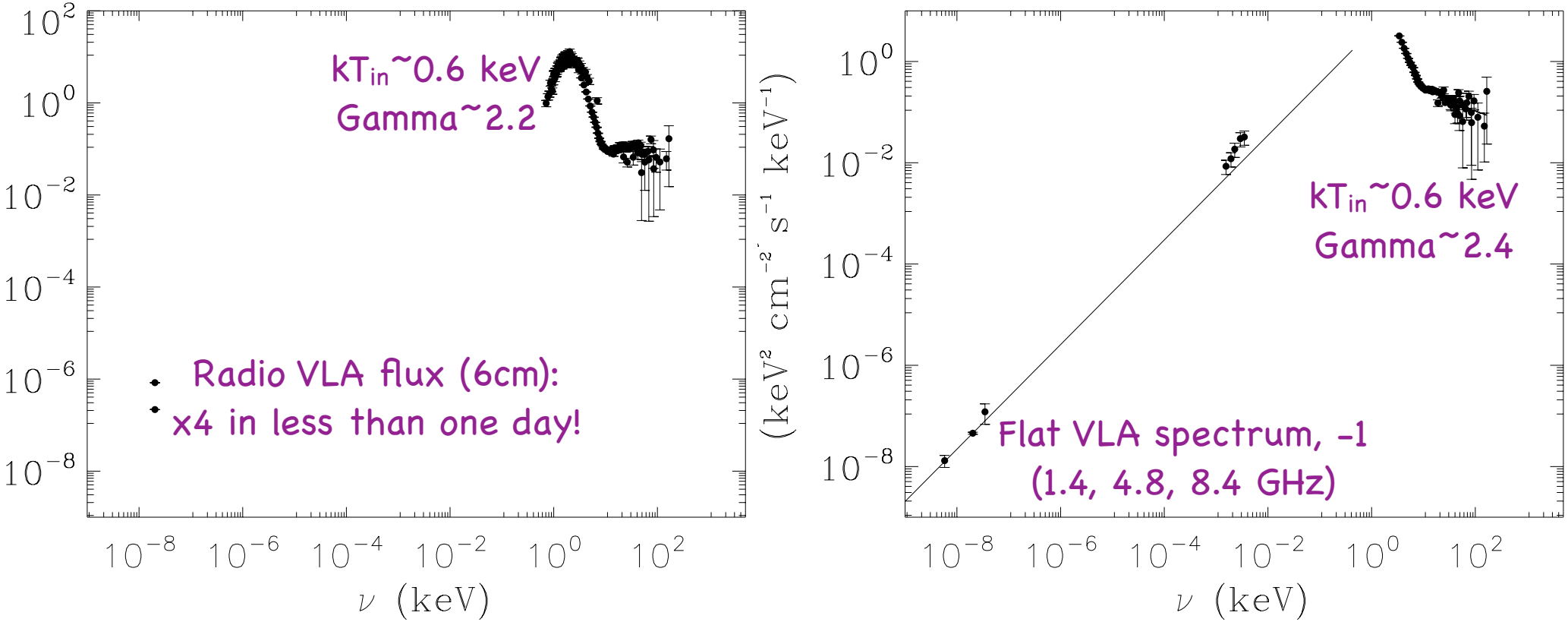
XTE J1817-330



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

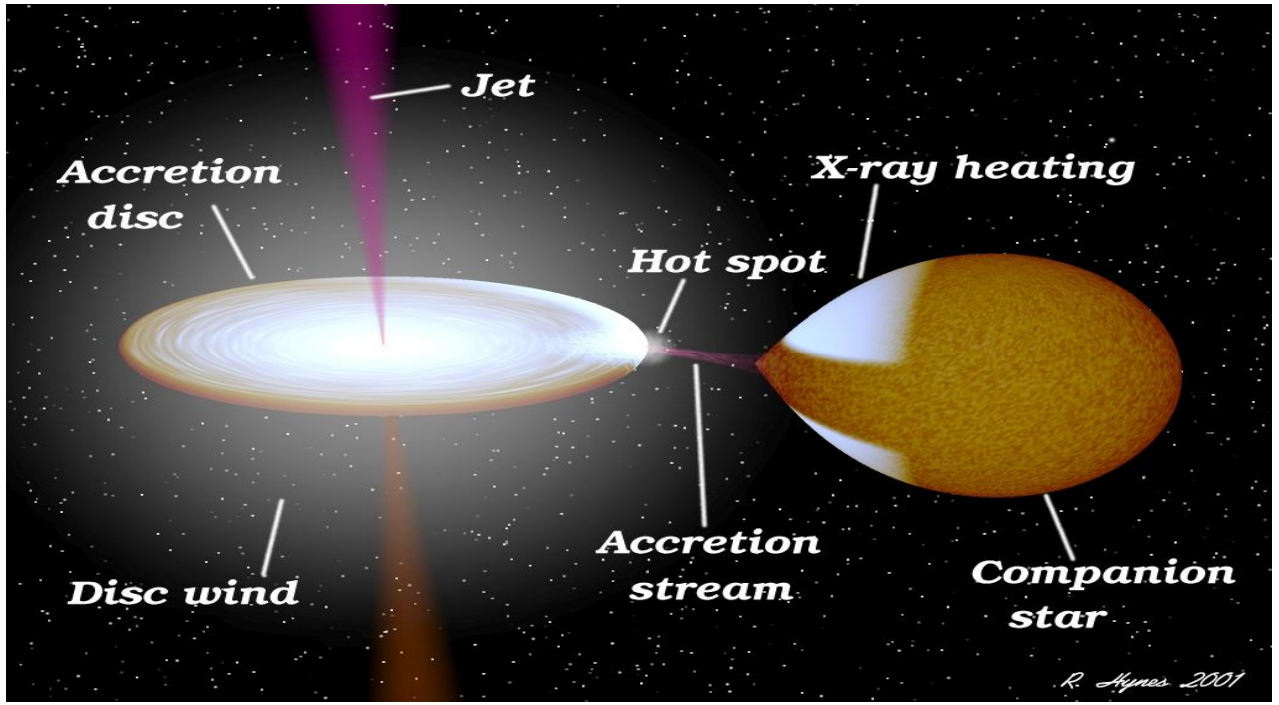
Cadolle Bel+ 2008, 2010b

SEDs of XTE J1818-245



Cadolle Bel+ 2009

Conclusions



- *Almost* standard behavior while in outburst, but some details are puzzling. Note: source transited to LHS a year later, then to quiescence: Russell+ 2011a, b
- Radio + ESO data: on-going studies with N(O)IR correlations + SEDs' fitting
- "Cyg X-1 like" polarization studies above 400 keV (jet origin of gamma-rays, Laurent+ 2011 Science; see poster B09 of Grinberg+) & (mid)-IR studies (Rahoui+ 2010, 2011) might give clues on some remaining issues...