Spectral evolution and flaring activity during the transition hard to soft state of H1743-322

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3-200 keV spectral states and variability of the INTEGRAL black hole binary IGR J17464-3213, Capitanio et al., ApJ, in press, astro-ph/0411790

SPI/IBIS collaboration

History of IGR J17464-3213/H 1743-322/XTE J1746-319

1977/78 outburst

Discovered in August 1977 with HEAO1 observations as a new transient "with a spectrum somewhat harder than the Crab" (Kaluzienski & Holt 1977). Spectrum characterized by a soft component (1-10 keV) and a high energy tail (10-100 keV)

2003/2004 outburst

Rediscovered by INTEGRAL (Revnitsev et al. 03) and then by RXTE (Markwardt & Swank 2003)

Monitored by ASM/RXTE (Homan et al.04; Remillard et al. 04) and in IR (Baba et al. 04) and Radio (paper in preparation)

Atel 142 (Rupen et al. 03) : Strong radio flare (increase by a factor 5) between April 6 and 8 2003

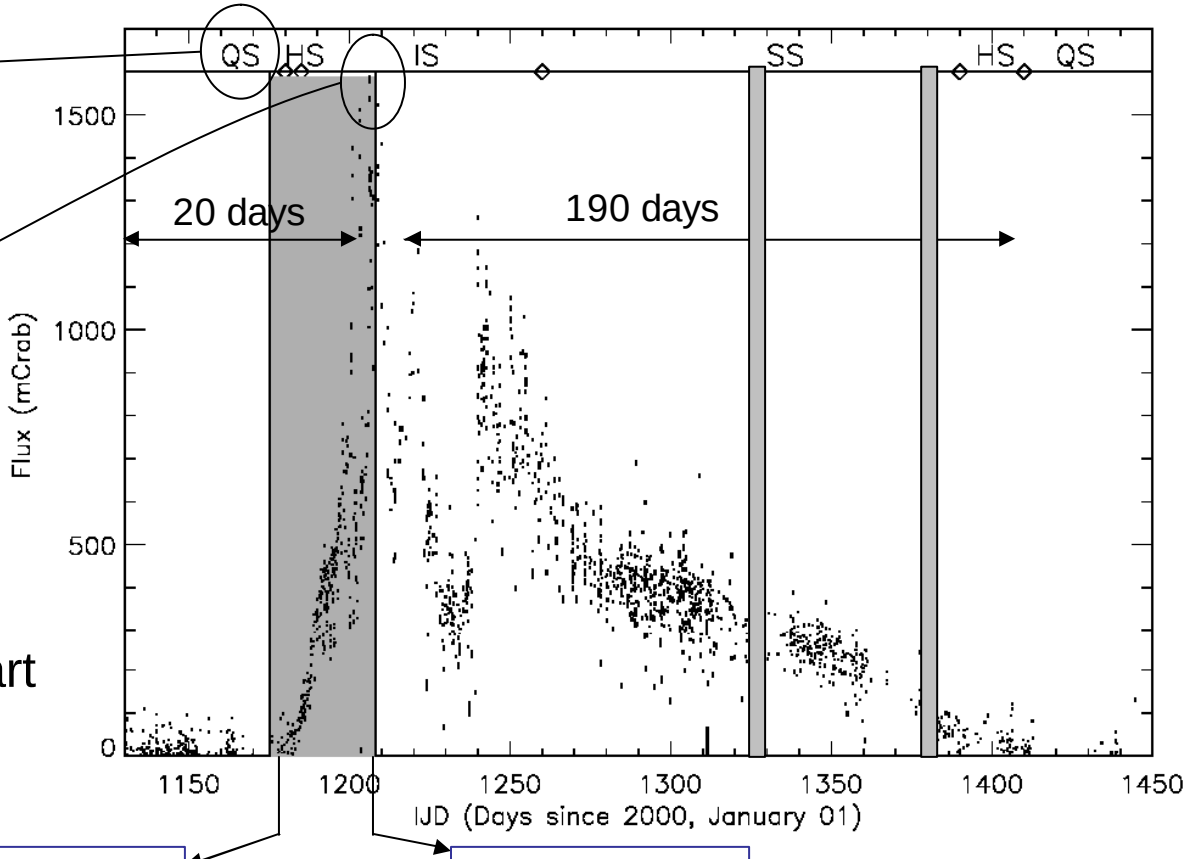
currence time >
years (RXTE)
d < 27 years
EAO1)

ighter flare:

003 April 18-24
=3.6x10^{38} erg cm^{-2}s^{-1}

INTEGRAL observations (part of the GCDE1)

30 pointings
nd 929 ks
sed: 308 ks)



2003-03-21
rev53

2003-04-20
rev63

♦ A complex profile with several dominant peaks (similar to Cygnus X-1, GRS 1915+105, other transient blackhole X-ray transient) ⇔ disc instabilities (Tanaka et al. 96)

♦ PCA/RXTE observations (Miller et al. 04, Homan et al. 04) : behavior similarities with a BH (QPOs observations and power density spectrum), flaring period before the source settle into a relatively steady and soft X-ray state

SPI (20-36 keV) and ASM (1.5-12keV) light-curve

rom SPIROS image

ky model with 14 sources (S/N>7σ)

known position

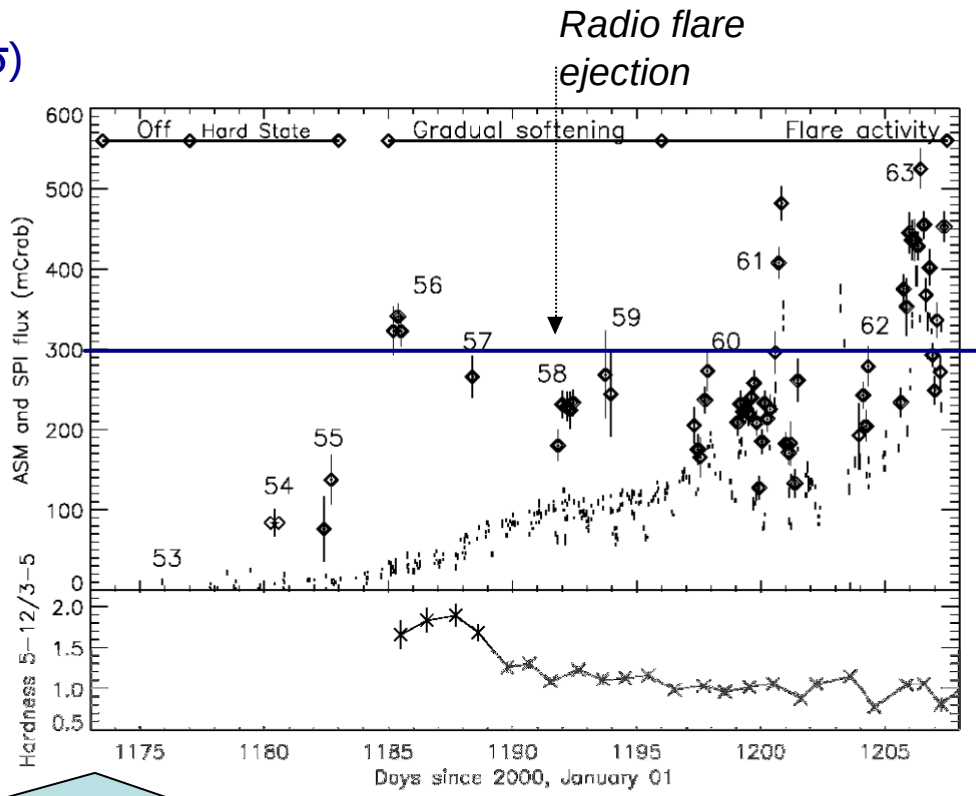
A priori knowledges on imescale variability

sources *H1743-322 (7200s), U1700-377(10800s), E1740.7-2942 (1day)*

background (6 hours)

Least square minimisation:

counts/light curve from CESR* software (L.Bouchet)



High temporal variability in both X and g ray energy band

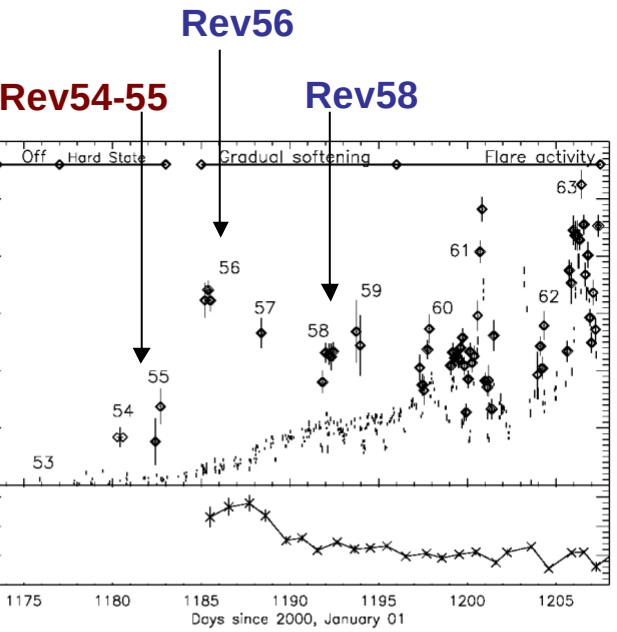
- ASM and SPI lightcurves correlated during flare events of rev61 & rev63

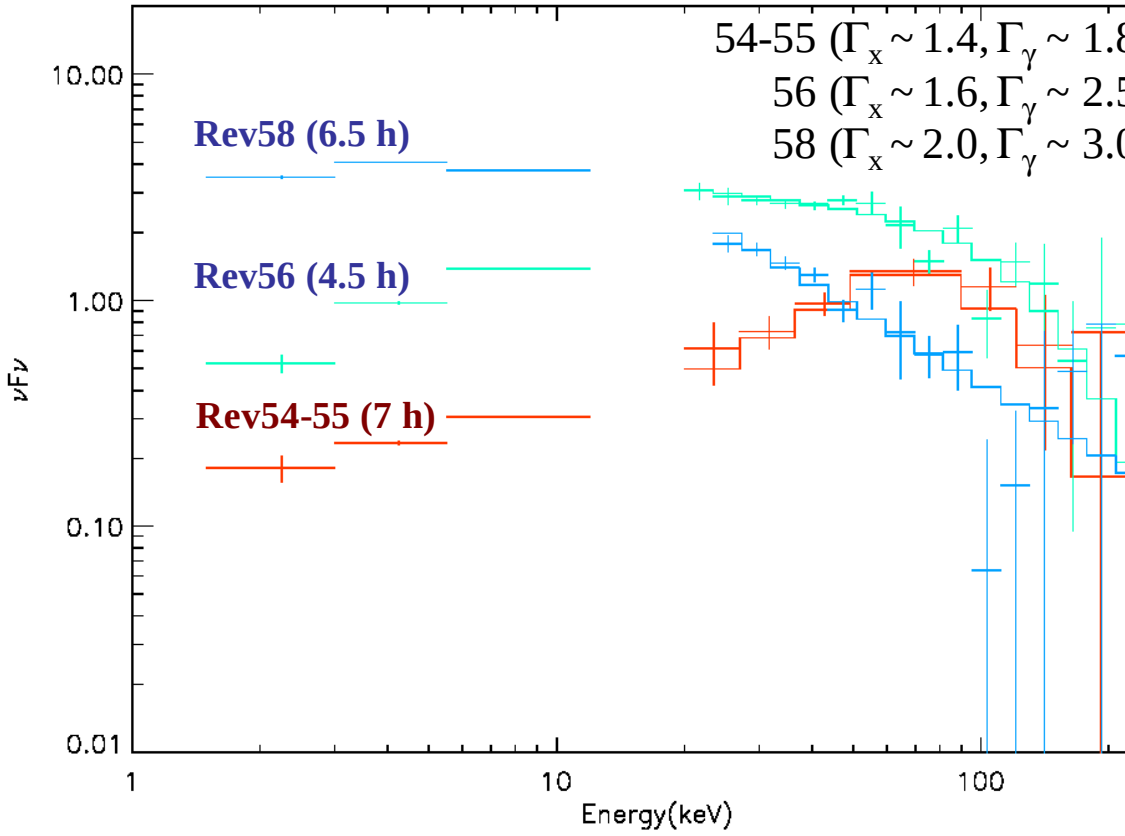
-The initially hard spectrum rapidly evolves to a softer one

-L[2-200]/Ledd increases from 0.03 (rev54-55) up to 0. 3(61-63 flare)

A spectro-temporal study on the timescale of about 1 day needed

Spectral behavior : hard to soft state transition

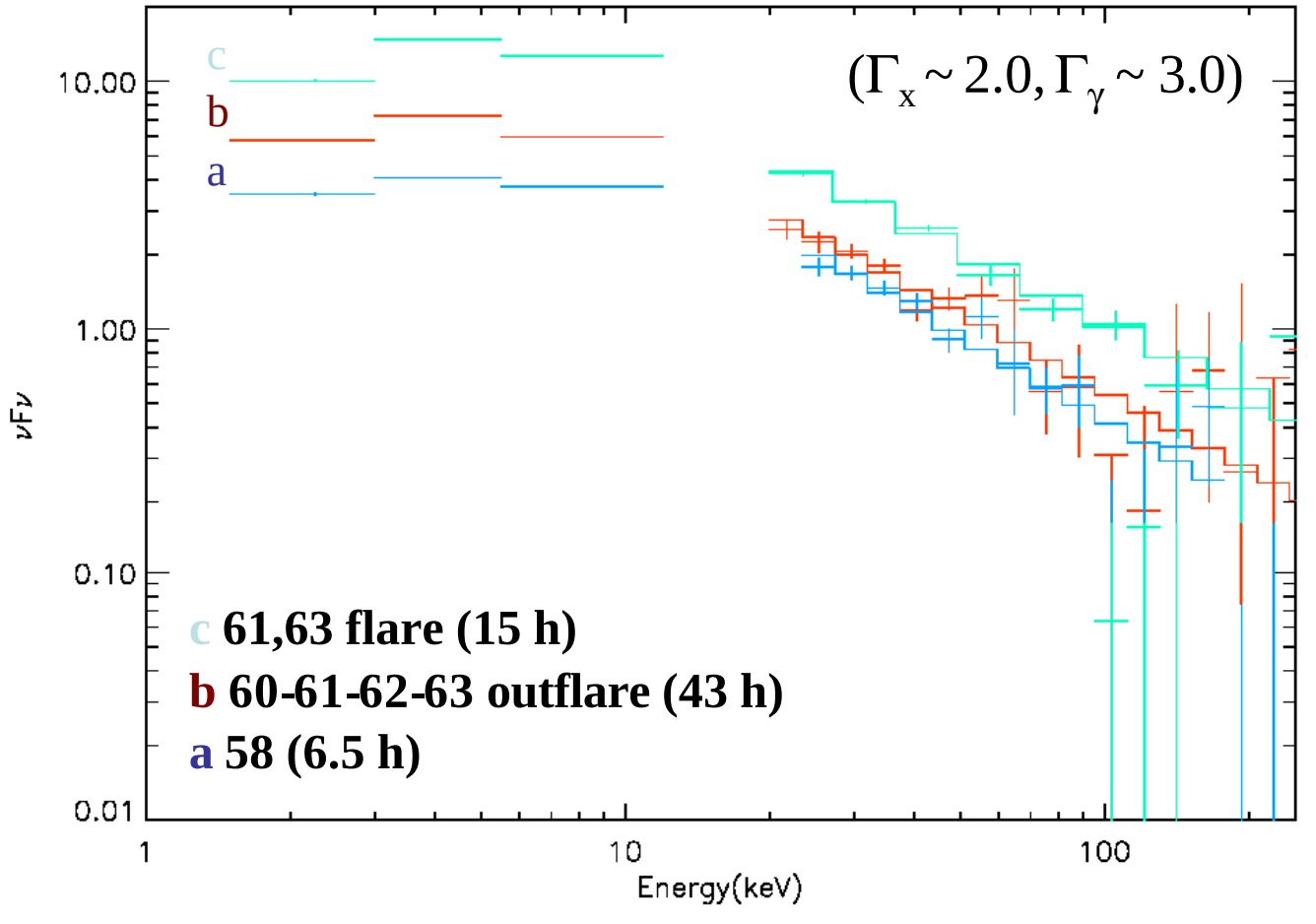




♦ rev54-55 → rev58: maximum of the luminosity decreases towards low energy (from 80 keV down to few keV)

♦ increases of the soft component

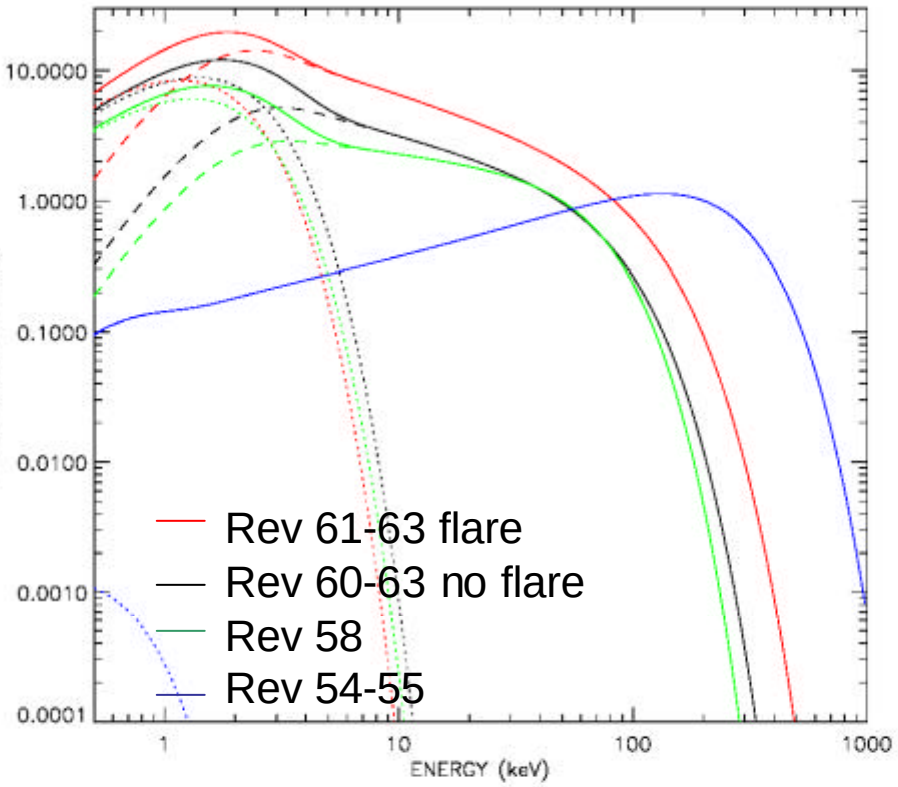
Spectral behavior during flaring activity



58 → 60-63 out of flare : the soft X-ray component increases

60-63 out of flare → 61,63 flare : same spectral shape during flare events

Spectral modelling : evolution of the macroscopic parameters



Xspec model:
N_H*const*(*diskbb*+*compps*)

Comptonisation component : ***compps*** ***(Poutanen & Svensson 96)***, kTe,τ
Blackbody emission from the accretio
disk : ***diskbb*** *(Mitsuda et al.1984)* **, Tin**

const = 1.04 (normalisation facteur ASM/SPI)
N_H = 2.4 * 10^{22} cm^{-2} (PCA, Markwardt & Swank 2003) except for rev 56

rev	$T_{in}(keV)$ keV	Φ_{bb} $\times 10^{-8}$	kTe keV	τ	$\Phi_{[2-10]}$ $\times 10^{-8}$	$\Phi_{[20-100]}$ $\times 10^{-8}$	χ^2
54-55	0.37± 0.77	0.05	60± 30	3.5± 1.9	0.1	2.3	1.1(10)
$56^{(a)}$	0.51± 0.31	*1372*	32± 6	2.9± 0.6	0.4	5.5	1.6(16)
58	0.48± 0.12	1.9	22± 4	3.0± 0.2	0.9	3.1	1.5 (17)
6063	0.64± 0.06	24.8	38± 8	2.2± 0.9	1.6	3.1	2.3 (10)
6163	0.53± 0.11	26.8	30± 1	1.9± 0.3	3.1	6.3	1.1 (9)

N_H=114 *

X 1-2

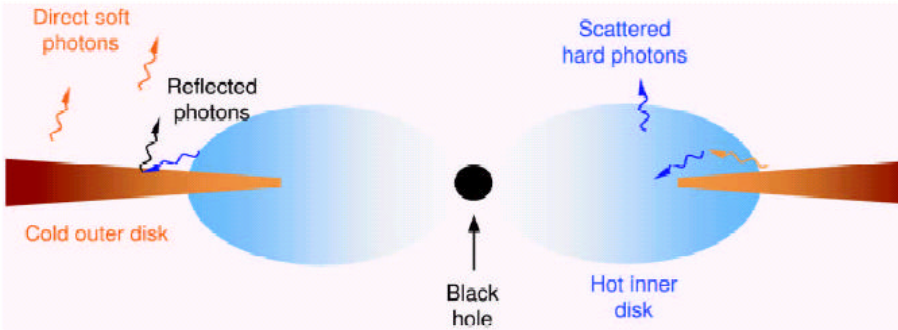
E Expressed in erg $cm^{-2}s^{-1}$

A. Joinet et al 04

Spectral modelling : Explanation of the Hard to Soft transition in terms of geometry evolution

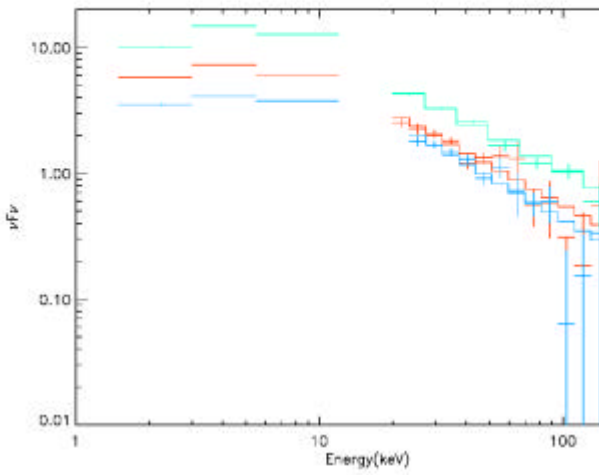
Hard, non thermal component:
Low /hard state (rev 54-55, rev 56)

Zdziarski et al. 02 : Cygnus X-1 geometry

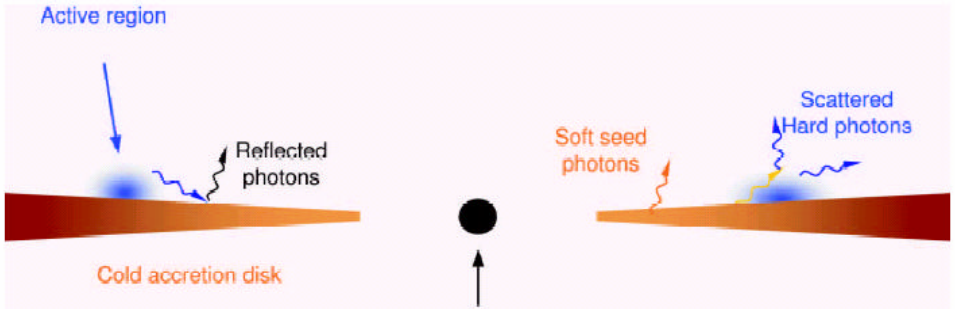


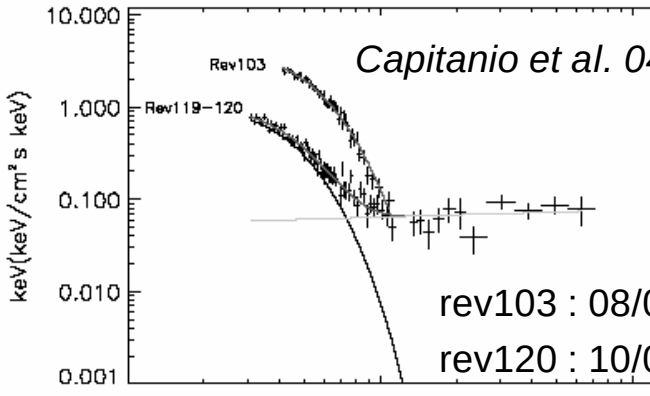
Intermediate state : rev 58-- 63
hybrid geometry

Disc with active regions on the top of it
During flare : L x 2 within 1 day
⇒ small active regions
which increase the luminosity (cascade of flares ?)
by a factor 2 in the comptonized region
but geometry unchanged



The thermal emission from the accretion disc dominates:
High/soft state

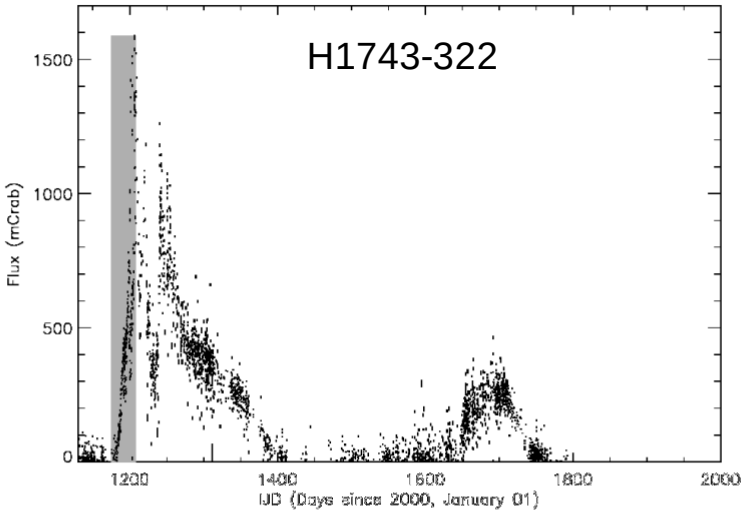


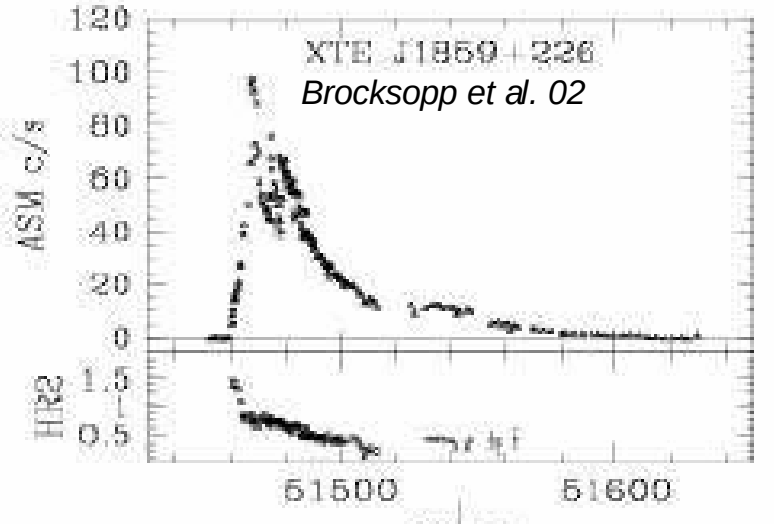


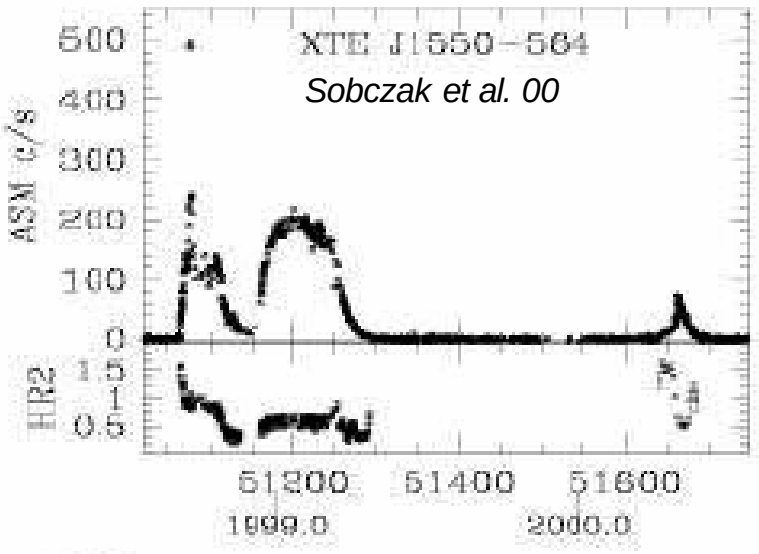
Conclusion

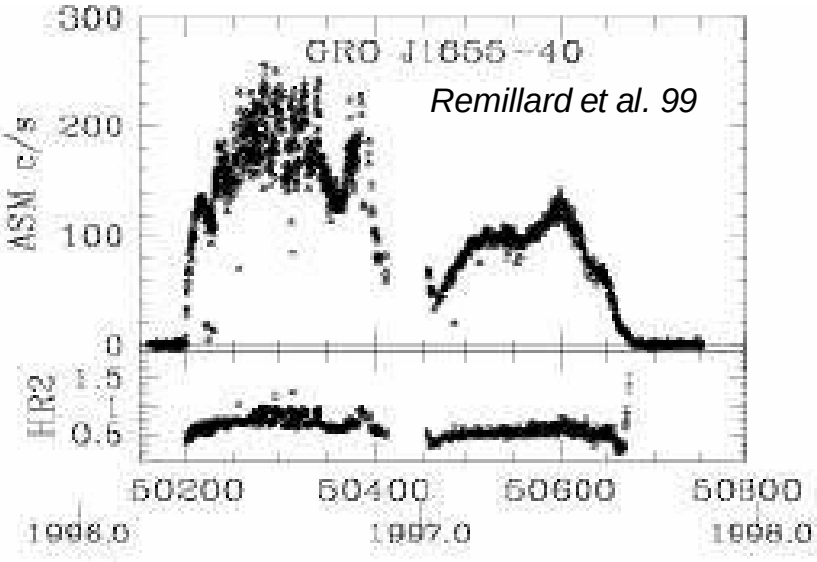
- The unique opportunity to observe a **X-ray transient** from the onset of its outburst
- Study of the **spectral variability** on the timescale of ~ 1 day for a source of 270 mCrab
  - The interest : characterization of the state of a X-ray binary on short timescale
  - Do the same study with other sources
- Radio ejection precedes the X-ray maximum flux

  → More investigation with radio observers to be done

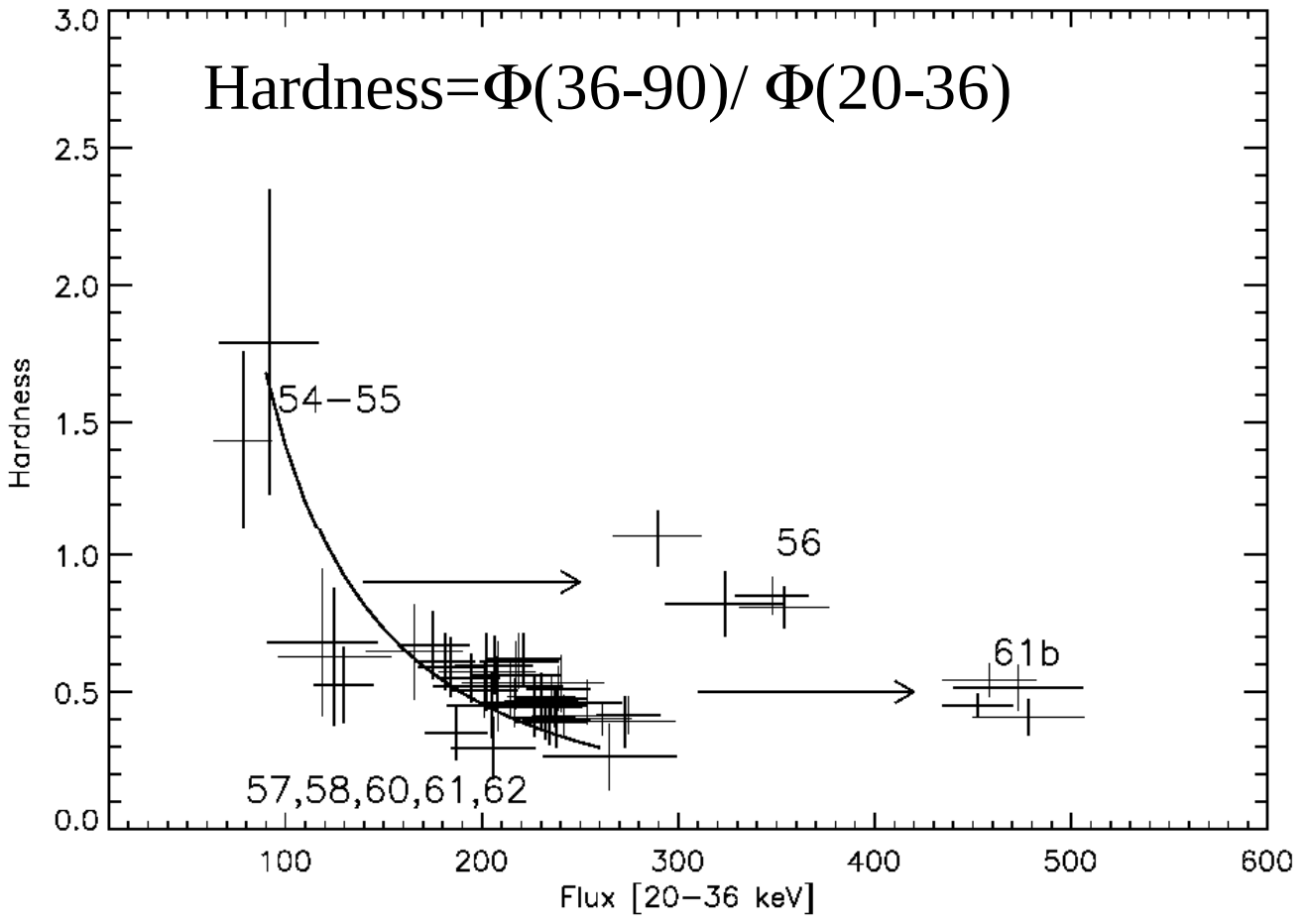

H1743-322
Flux (mCrab)
MJD (Days since 2000, January 01)


XTE J1859+226
Brocksopp et al. 02
ASM c/s
HR2

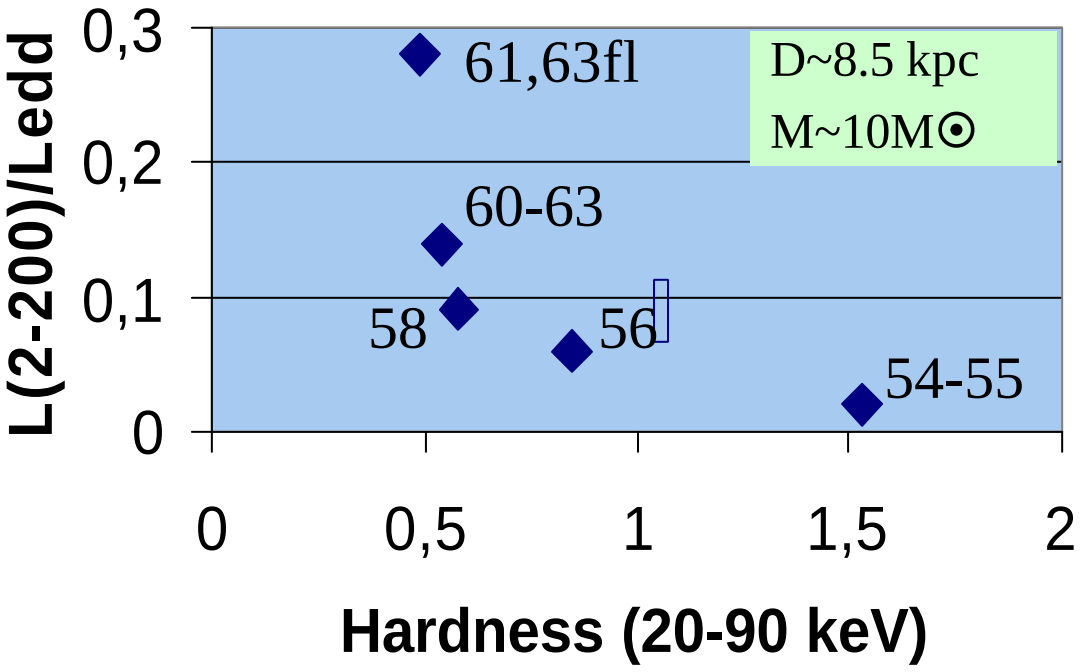

XTE J1550-564
Sobczak et al. 00
ASM c/s
HR2


GRO J1655-40
Remillard et al. 99
ASM c/s
HR2

Hardness-flux evolution in 20-90 keV energy range



- **Negative hardness-flux correlation related to the Hard State to the Soft/Intermediate state (timescale of ten days)**
- **Constant hardness during flare events**


L(2-200)/Ledd
0,3
0,2
0,1
0
61,63fl
D~8.5 kpc
M~10M⊙
60-63
58
56
54-55
0
0,5
1
1,5
2
Hardness (20-90 keV)