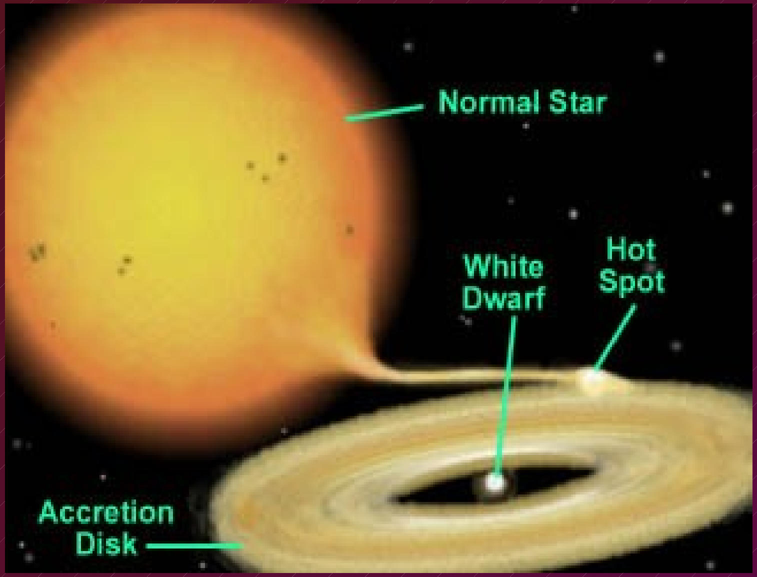
V5116 Sgr (Nova Sgr 2005b):
an eclipsing supersoft postoutburst nova?



Glòria Sala (UPC-IEEC, Barcelona)

Margarita Hernanz, Carlo Ferri (CSIC-IEEC, Barcelona)

Jochen Greiner (MPE, Garching)

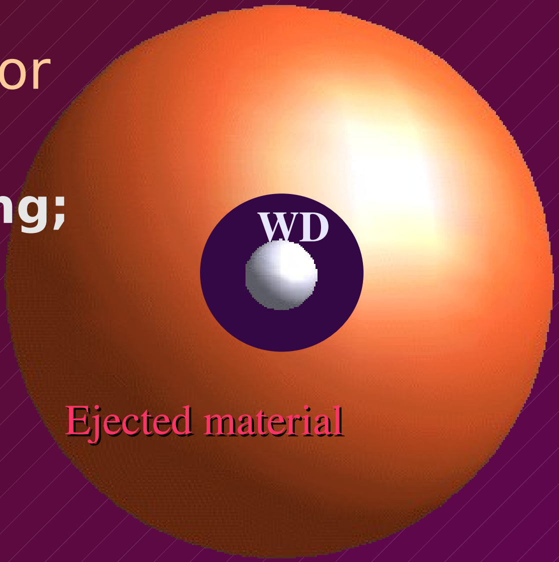
X-ray emission from Classical novae

Classical novae in outburst can emit X-rays through different mechanisms:

1. H-rich material left on the WD surface (relevant for the long-term evolution of the white dwarf mass!!)

Soft X-ray emission due to residual steady H-burning; ***hot atmosphere, black-body-like spectrum, with***

kT_{eff} ~30-50 eV (2-10×10^5 K) and **L~10^{38} erg/s.**



2. Expanding shell of ejected material

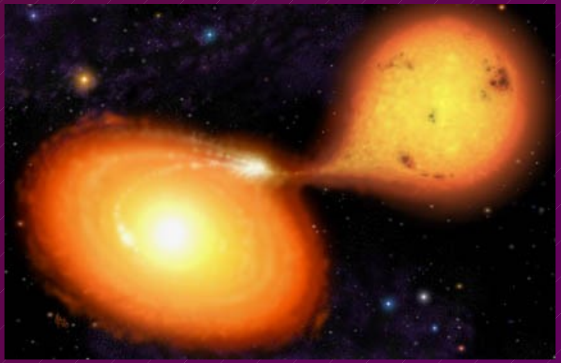
Hard X-ray emission due to shocked shell.

Thermal plasma spectrum, with

kT_{eff} ~ 1-10 keV and **L~10^{33} erg/s.**

3. As cataclysmic variable when **accretion** is restablished onto the white dwarf

Hard X-rays due to accretion disk. T*hermal bremsstrahlung spectrum, with* **L~10^{33-34} erg/s.**



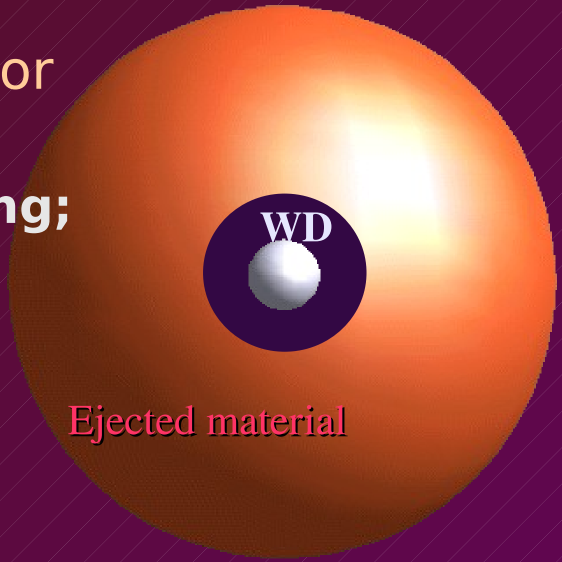
X-ray emission from Classical novae

Classical novae in outburst can emit X-rays through different mechanisms:

1. H-rich material left on the WD surface (relevant for the long-term evolution of the white dwarf mass!!)

Soft X-ray emission due to residual steady H-burning; ***hot atmosphere, black-body-like spectrum, with***

kT_{eff} ~30-50 eV (2-10×10^5 K) and **L~10^{38} erg/s.**



V5116 Sgr = Nova Sgr 2005b

Discovered on 2005 July 4.049 (Liller 2005, IAUC#8559), with **V~8**

Reached maximum on July 5.085, **V~7.2**

DISTANCE DETERMINATION:

We need:

1. **t_2**: time to decrease 2 mag, (t_2=6.5+/-1 day)
2. m_V: observed magnitude at maximum.
3. Exctinction

Both t_2 and M_V well determined in V5116 Sgr thanks to pre-maximum detection!

Using Della Valle & Livio (1995) M_V – t_2 relation, the observed t_2 indicates M_V= -8.8+/-0.4. With the observed colour (B-V=+0.48, Gilmore & Kilmartin 2005) this implies a distance of ***11+/-3 kpc.***

V5116 Sgr = Nova Sgr 2005b

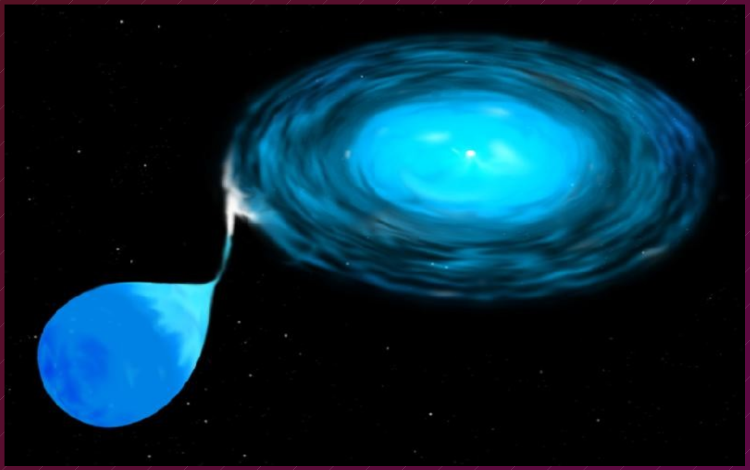
* IR spectroscopy showed lines with FWHM~2200 km/s in July 15

(*Russell et al 2005, IAUC#8579*)

* Optical photometry by *Dobrotka et al. (2008, A&A, 478, 815)* show modulation:

orbital period of **2.9712+/-0.0024 hr.**

* Proposed scenario: **high-inclination** system with **irradiation** effect on the secondary star.



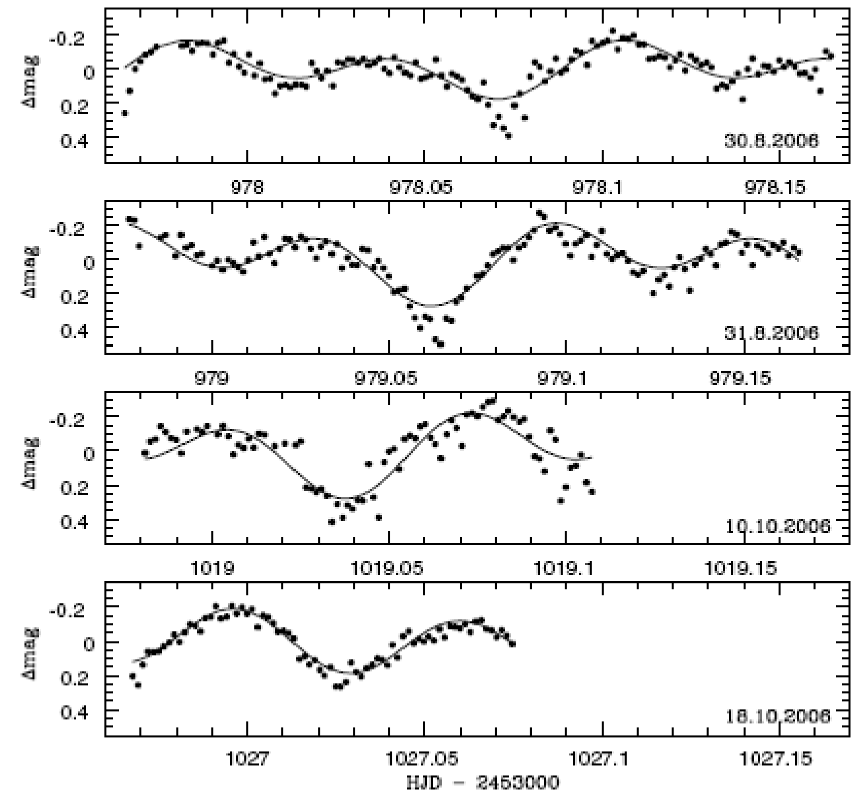


Fig. 2. A selection of our observations (4 detrended best runs; 1, 2, 11, and 13). The solid curve is the sinusoidal fit (plus first harmonic) to the data using the period derived in this paper.

Dobrotka et al. (2008, A&A, 478, 815)

V5116 Sgr:
XMM observation 20 months after outburst

XMM-Newton observation on 2007 March 5 (609 days after outburst).

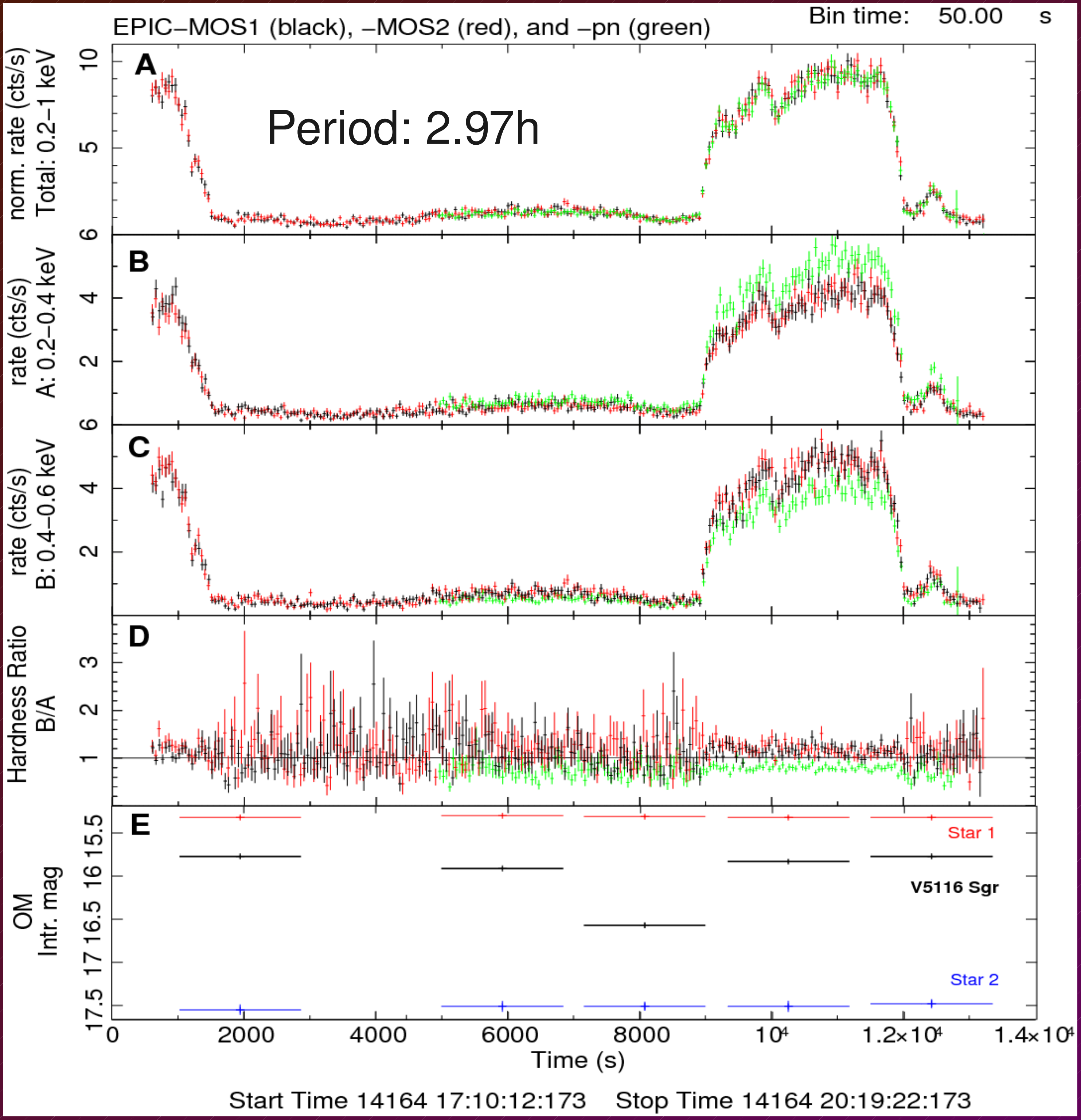
Exposure times:

- 12.7 ks for EPIC-MOS
- 8.9 ks for EPIC-pn
- 12.9 ks for RGS
- 9.2 ks for the OM with U filter

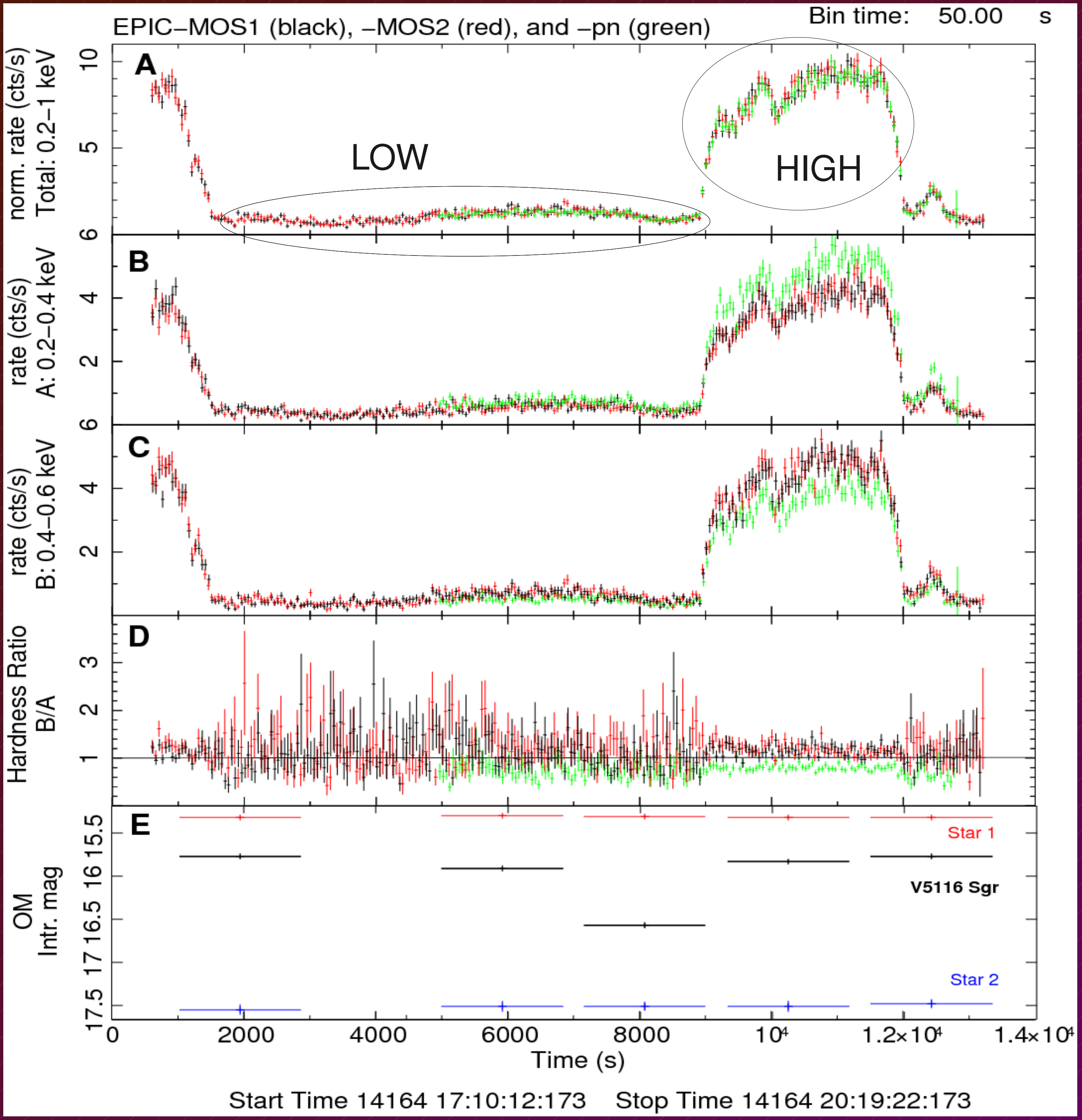
High background affected most of the exposure time. Fortunately, source 10 times brighter than background in all cases and very soft, little affected by hard X-ray flares.

But we cannot constraint hard X-ray component.

Sala, Hernanz. Ferri, Greiner . 2008, ApJ, 675, L93



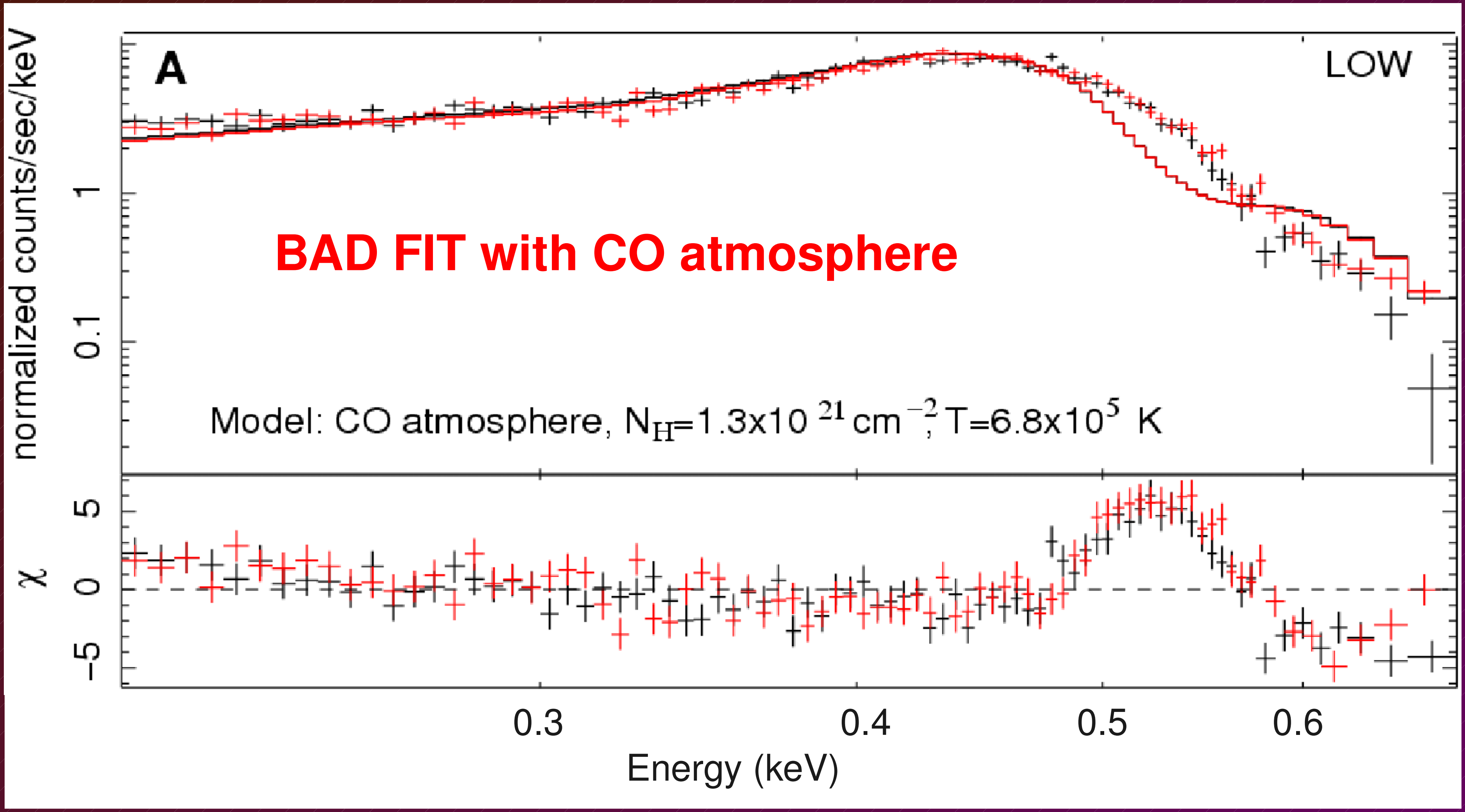
Sala, Hernanz. Ferri, Greiner . 2008, ApJ, 675, L93



Sala, Hernanz. Ferri, Greiner . 2008, ApJ, 675, L93

V5116 Sgr: EPIC X-ray spectra

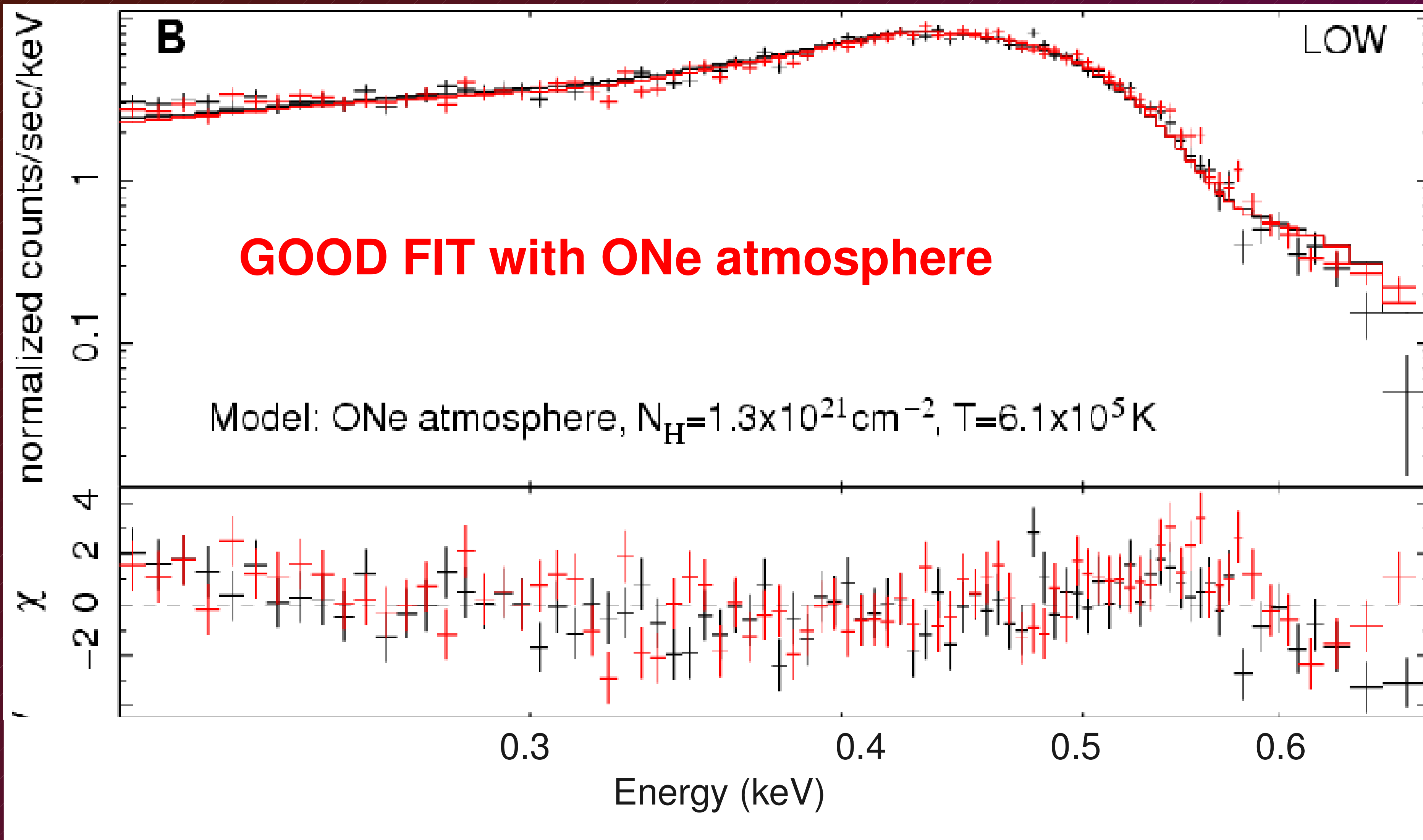
EPIC MOS spectra bad fit with simple black body; better fit with white dwarf atmosphere models (MacDonald & Vennes 1991, ApJ, 737, L51).



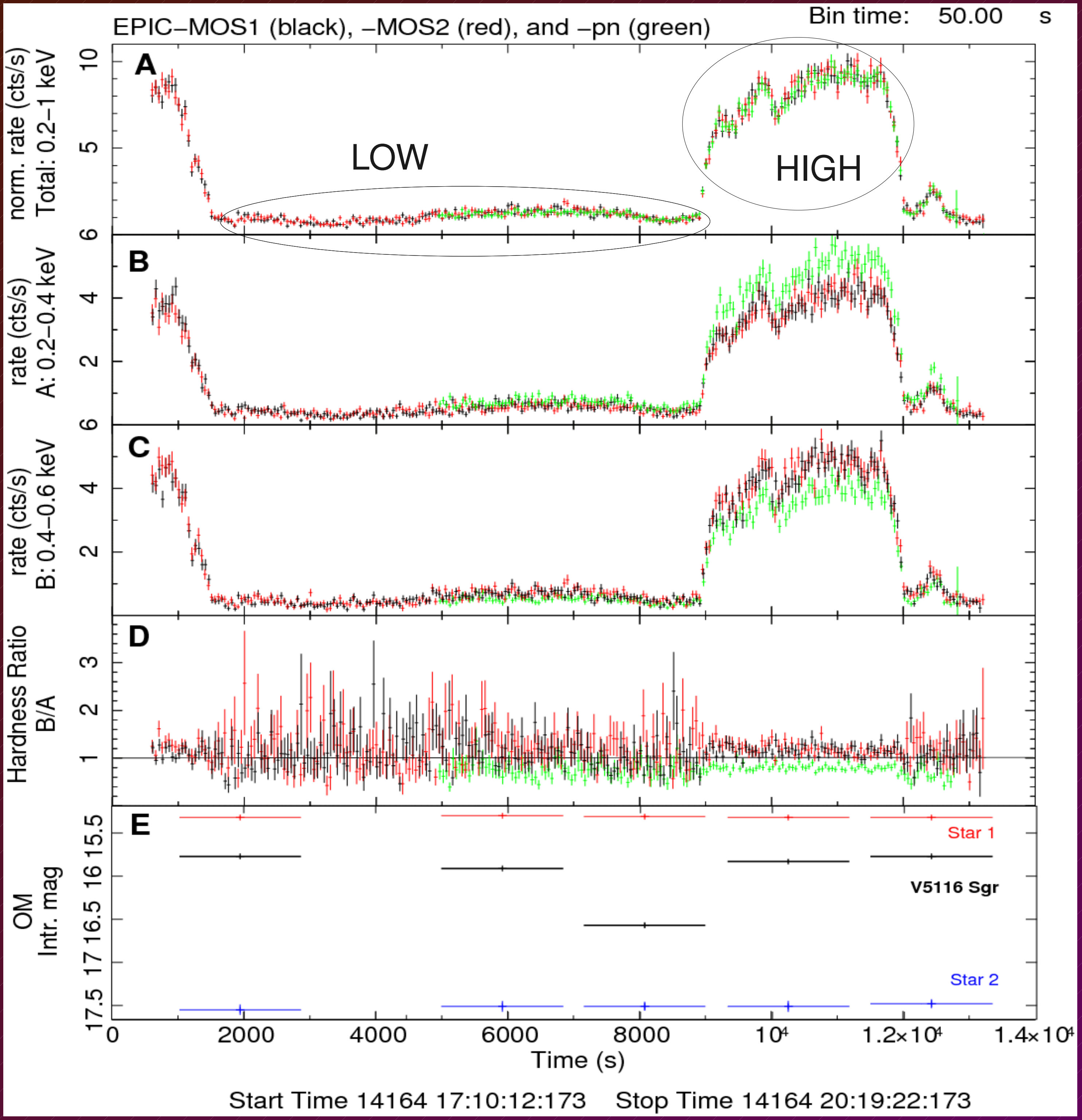
Sala, Hernanz. Ferri, Greiner . 2008, ApJ, 675, L93

V5116 Sgr: EPIC X-ray spectra

EPIC MOS spectra bad fit with simple black body; better fit with white dwarf atmosphere models (MacDonald & Vennes 1991, ApJ, 737, L51).

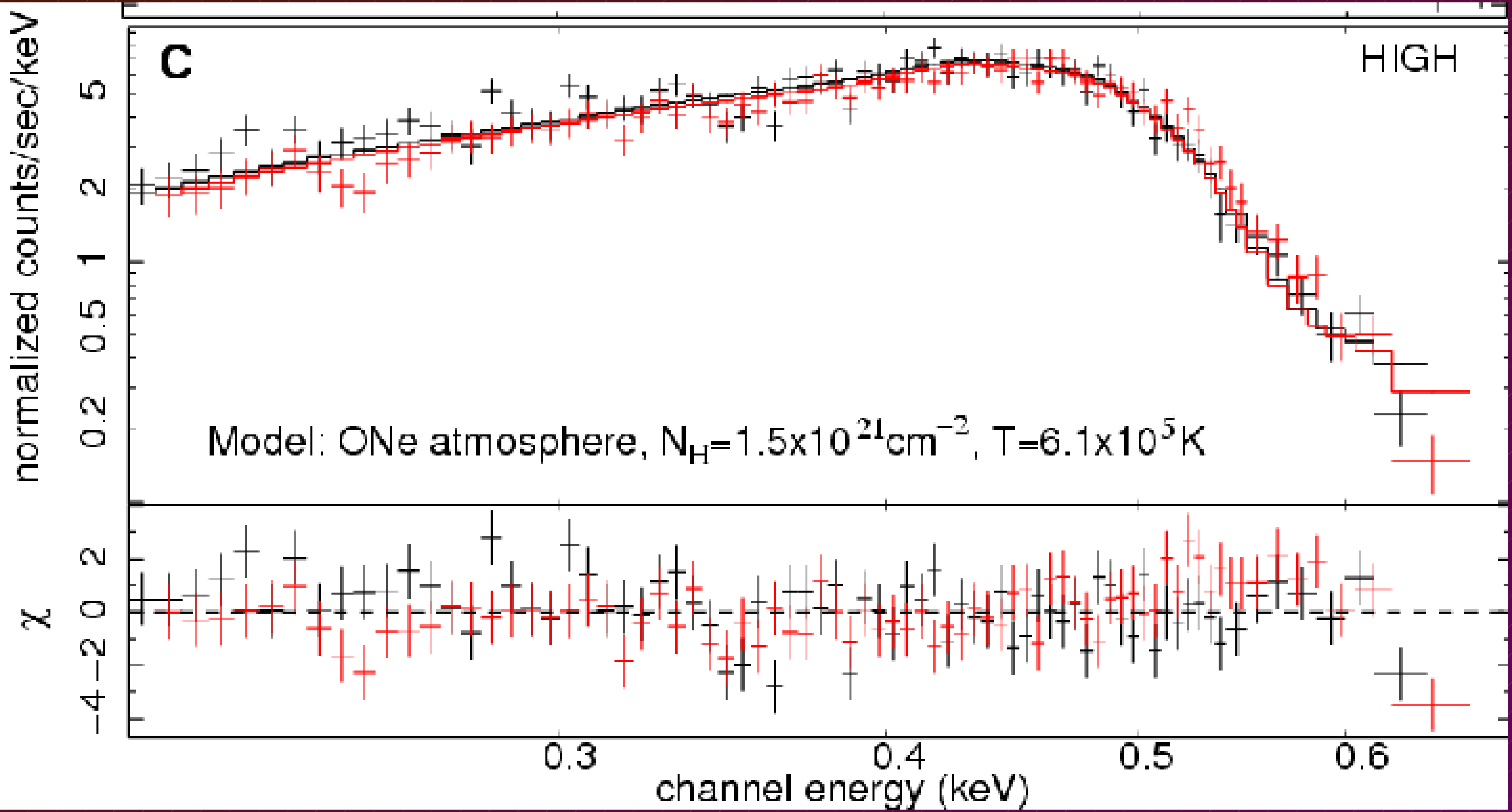


Sala, Hernanz. Ferri, Greiner . 2008, ApJ, 675, L93



Sala, Hernanz. Ferri, Greiner . 2008, ApJ, 675, L93

V5116 Sgr: EPIC X-ray spectra



Sala, Hernanz, Ferri, Greiner . 2008, ApJ, 675, L93

V5116 Sgr: EPIC X-ray spectra

Continuum spectrum is the same, same temperature, both during low and high flux periods!

Only luminosity is changing by a factor 8.

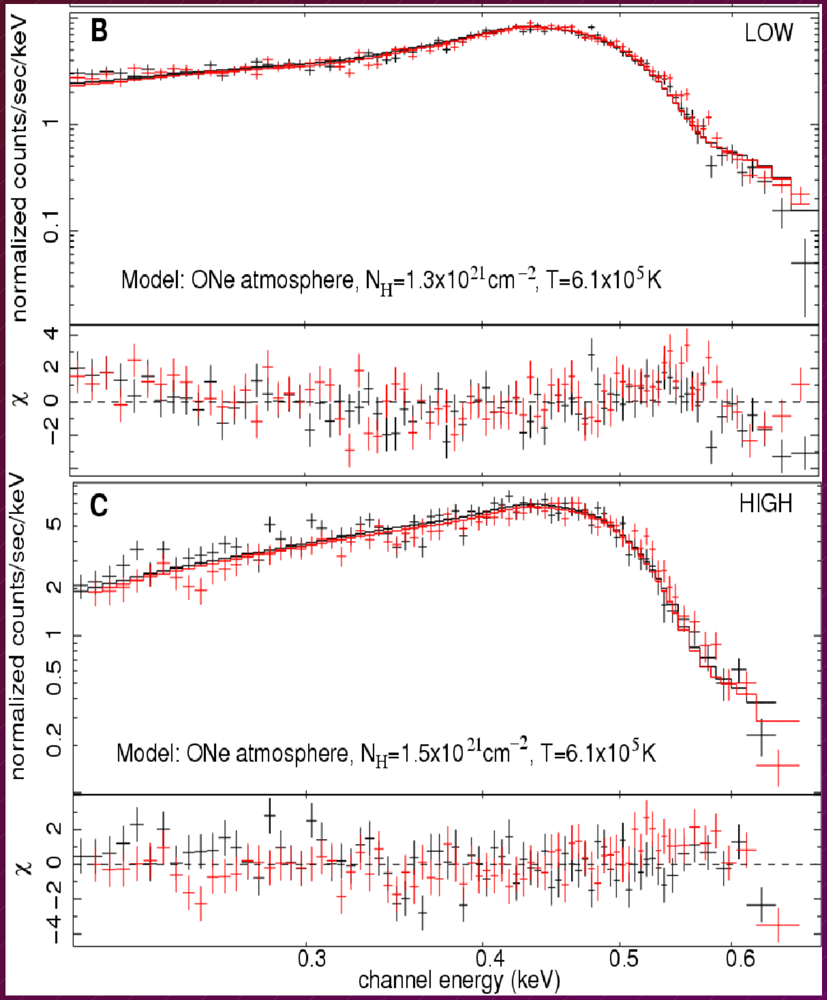
During **high flux**, **$L=3.9(+/-0.8)\times10^{37}$ erg/s** (for d=10 kpc) =>

T and **L** imply **$R=6\times10^{8}$ cm,**

compatible with **whole WD visible**.

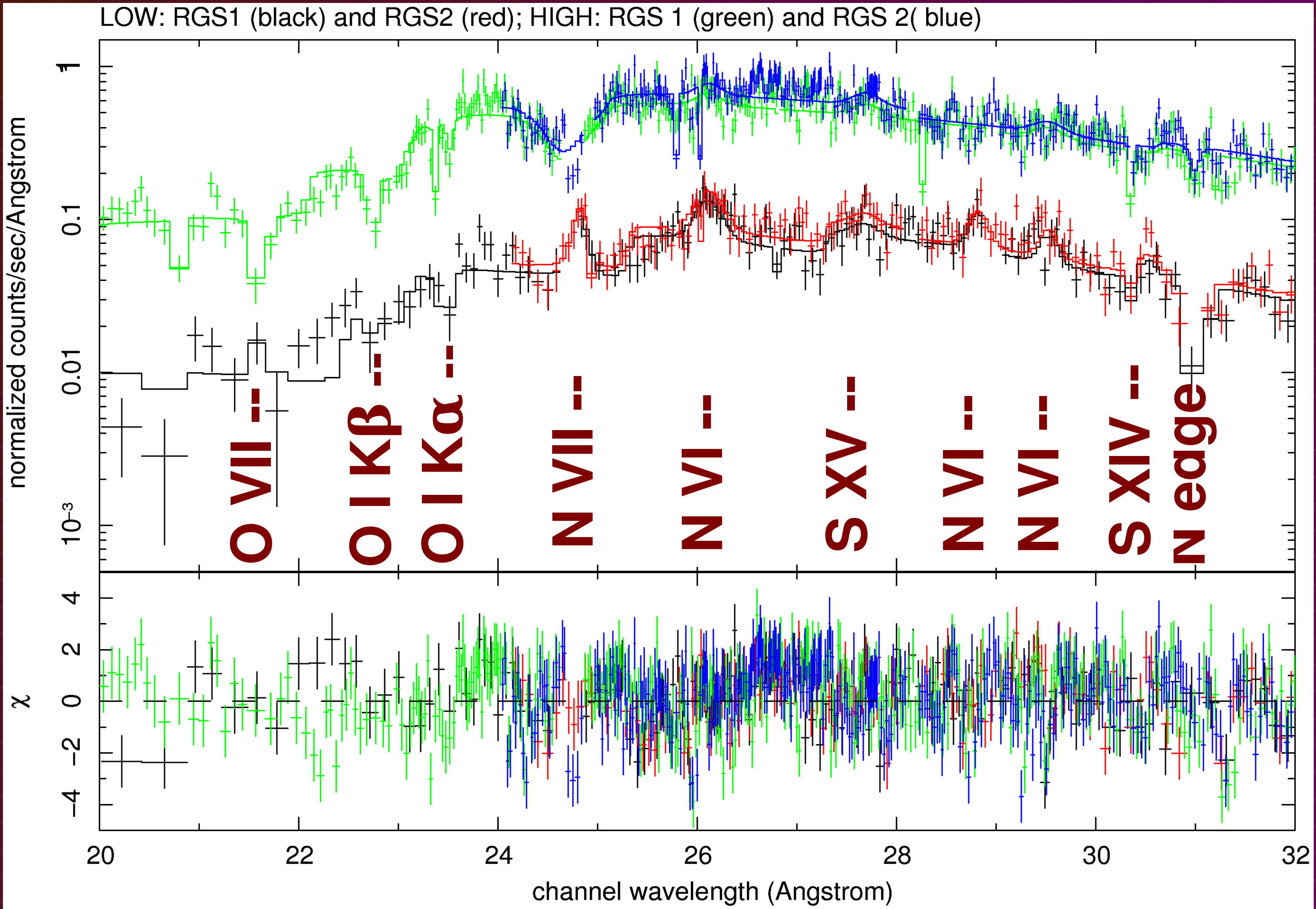
During **low flux,** same spectrum as in high flux but only 12% flux:

something must be blocking 88% of the white dwarf surface during 2/3 of the orbit.



Sala, Hernanz. Ferri, Greiner . 2008, ApJ, 675, L93

V5116 Sgr: RGS spectra



XMM-Newton RGS X-ray spectra

V5116 Sgr: RGS spectra

Possibly ISM absorption lines

Identification	λ (Å)		FWHM (eV)	Eq. width (eV)
O VII	21.602	High	< 10	$-5.3^{+2.3}_{-6.8}$
		Low	1 (frozen)	> -6
O I Kβ	22.887	High	< 13	$-3.7^{+1.6}_{-6.5}$
		Low	1 (frozen)	> -6
O I Kα	23.507	High	< 14	$-1.6^{+0.7}_{-2.0}$
		Low	1 (frozen)	> -4
N VII	24.78	High	4 ± 2	-6 ± 2
		Low	$1.0 \pm 0.5 (1\sigma)$	$5.2^{+4.5}_{-2.5}$
N VI	26.12	High	2 (frozen)	< 1
		Low	2.0 ± 0.5	4 ± 2
S XV	27.56	High	2 (frozen)	< 1.2
		Low	2 (frozen)	$1^{+1}_{-0.8} (1\sigma)$
N VI	28.79	High	5 (frozen)	< 1.3
		Low	$5 \pm 3 (1\sigma)$	3^{+7}_{-1}
N VI	29.534	High	2 (frozen)	< 1.1
		Low	$2 \pm 1 (1\sigma)$	$2^{+2}_{-1.5}$
S XIV	30.47	High	1 (frozen)	< 0.4
		Low	1 (frozen)	$1.4^{+0.7}_{-1} (1\sigma)$

Absorption lines stronger during low states.

Emission lines stronger (relative to continuum) during low flux; probably originated at the non-eclipsed, extended and photoionized material (disk? ejecta?)

XMM-Newton RGS X-ray spectra

V5116 Sgr: further X-ray observations

* X-ray detection of SSS emission by Swift in August 2007 (Ness et al. CBET #1030); decline of SSS observed by Swift 35 months after outburst (Julian Osborne's talk)

* Chandra/LETGS observation on August 2007 (5 months after ours) confirmed periodicity in the X-ray light curve (Nelson & Orio Atel#102, Marina Orio's talk).

* New XMM-Newton observation last week (after SSS decline) can prove the origin of the variability.

V5116 Sgr: summary

- X-ray lc period = orbital period

2/3 of orbit in low flux, 1/3 a factor 8 brighter

(confirmed 5 months after our XMM observation with Chandra)

- Same temperature in low and high flux.

- **N_H compatible with Galactic value**, both in high and low flux

- In high flux **$R = 6x10^8$ cm** (whole WD visible). In low flux, emitting surface reduced a factor 8.

- What is causing the flux variation?

Our speculation: high inclination system, with asymmetric structures (thick edges?) in accretion disk causing partial eclipses. An absorber with

$N_H > 2x10^{22}$ cm^{-2} covering 88% of the WD surface could explain the light curve.

Sala, Hernanz, Ferri & Greiner 2008, ApJ, 675, L93

V5116 Sgr: disk structures eclipsing the WD?

* 3D modeling of disks by D. Bisikalo on Tuesday session could provide the eclipsing V5116 Sgr disk?

V5116 Sgr: summary

- X-ray lc period = orbital period

2/3 of orbit in low flux, 1/3 a factor 8 brighter

(confirmed 5 months after our XMM observation with Chandra)

- Same temperature in low and high flux.

- **N_H compatible with Galactic value**, both in high and low flux

- In high flux **$R=6x10^8$ cm** (whole WD visible). In low flux, emitting surface reduced a factor 8.

- What is causing the flux variation?

Our speculation: high inclination system, with asymmetric structures (thick edges?) in accretion disk causing partial eclipses. An absorber with

$N_H > 2x10^{22}$ cm^{-2} covering 88% of the WD surface could explain the light curve.

Sala, Hernanz, Ferri & Greiner 2008, ApJ, 675, L93