The grating spectra of the SSS classical novae V5116 Sgr and V5115 Sgr

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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. time to decrease 2 mag, (t_2=6.5+/-1 day) and
2. observed magnitude at maximum.

Both quite 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.***

(consistent with Ederoclite & Mason 2006, RS Oph meeting)

V5116 Sgr = Nova Sgr 2005b

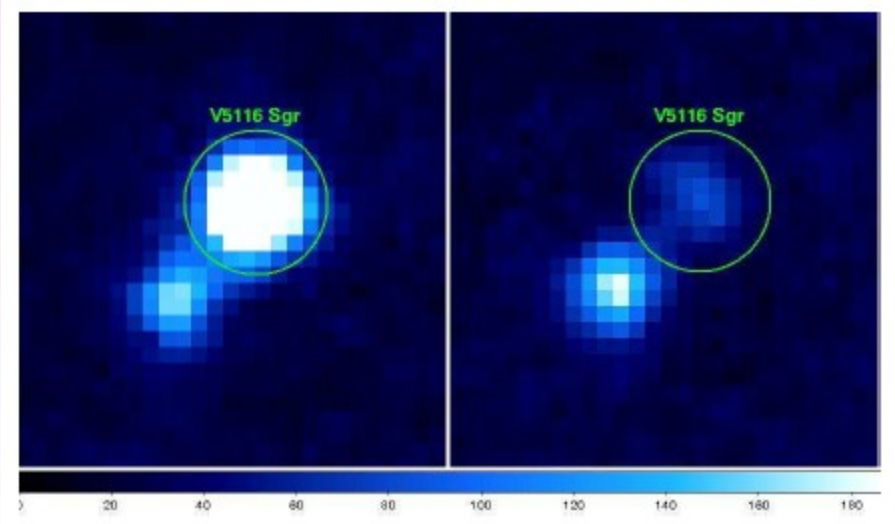
* Optical => orbital period of

2.9712+/-0.0024 hr.

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

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

* OM data of our two XMM observations, in 2007 and in 2009 support this hypothesis: bright optical source when SSS on (2007), faint when SSS off (2009).



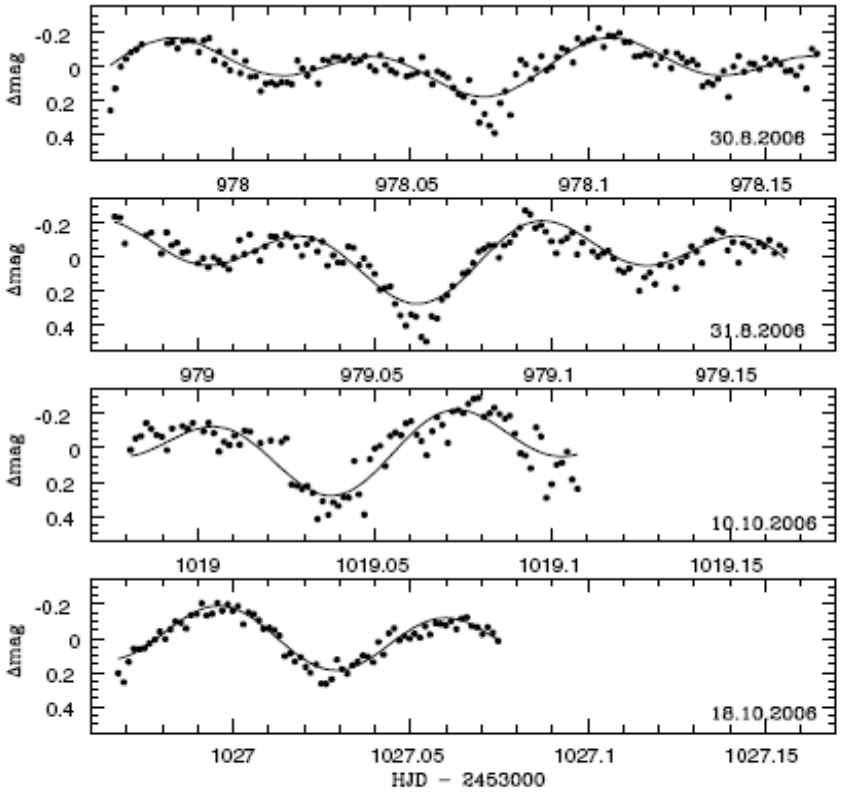
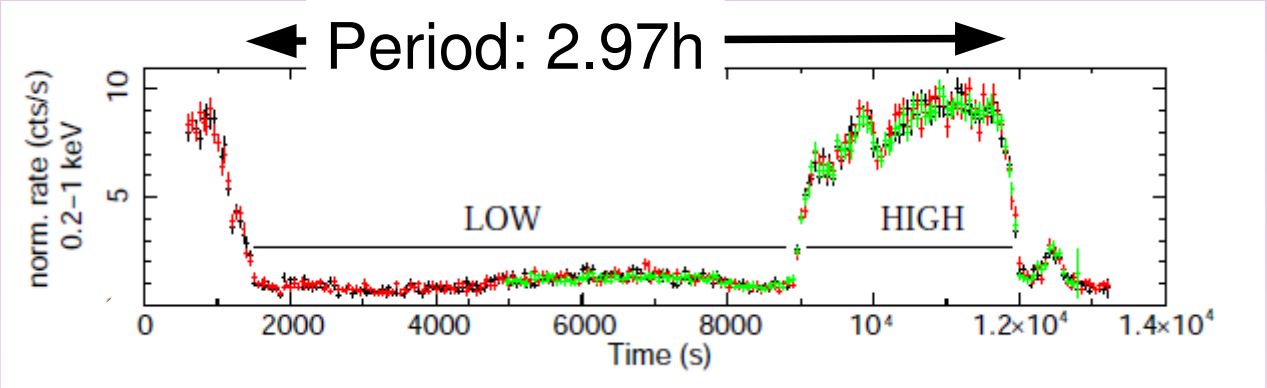


Fig. 2. A selection of our observations (4 detrended best runs; 1, 2, 11, and 13). The solid curve is the sinusoidal fit (plus first harmonic) to the data using the period derived in this paper.

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

V5116 Sgr: amazing X-ray light-curve



EPIC spectrum with same temperature in "low" and "high"

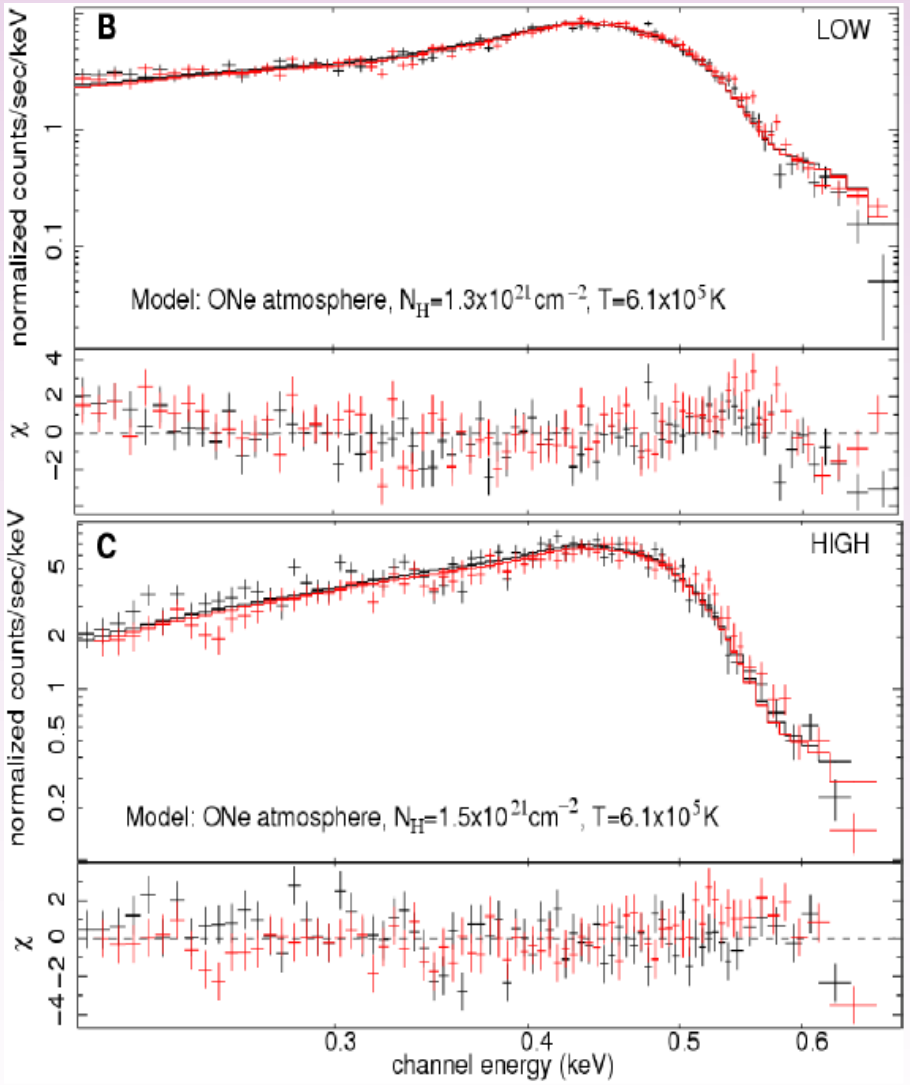
Only luminosity is changing by a factor 8!

During **high flux**,

L=3.9(+/-0.8)x10^{37} erg/s (for d=10kpc)

imply **R=6x10^{8} cm,**

compatible with whole



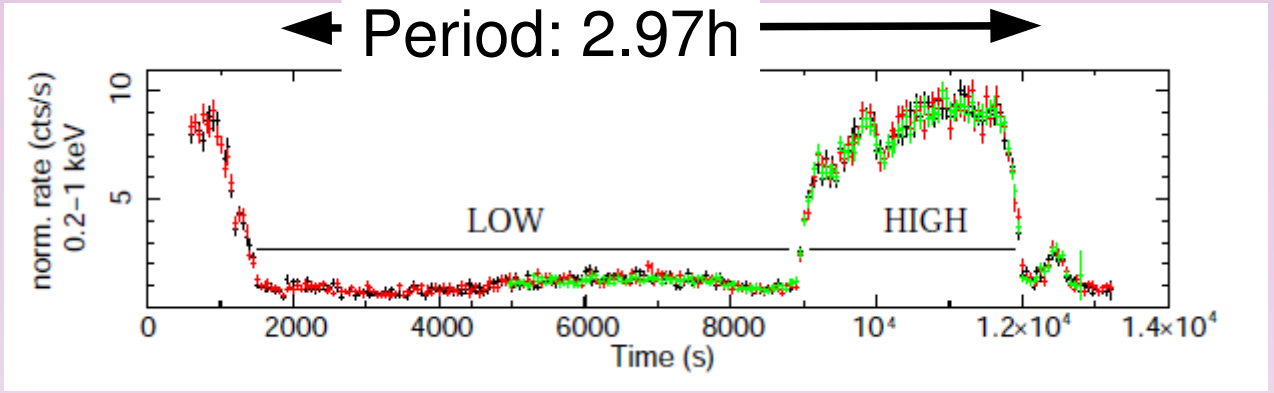
OBSCURATION OF THE CENTRAL WD DURING 2/3 OF ORBIT

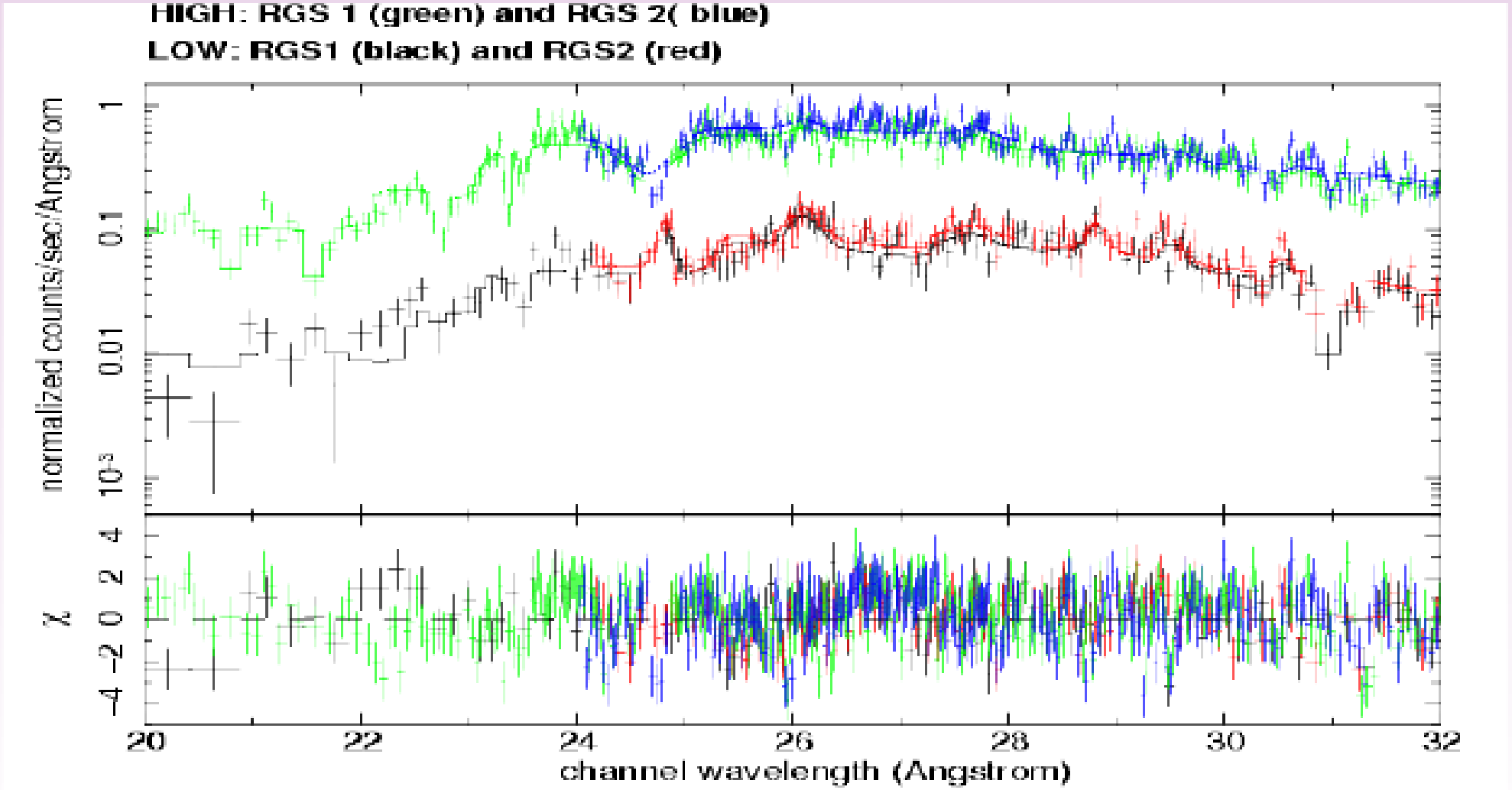
BY IRREGULAR, ASYMMETRIC ACCRETION DISC?

OR THICK RIM OF ACCRETION DISC? IN HIGH INCLINATION SYSTEM

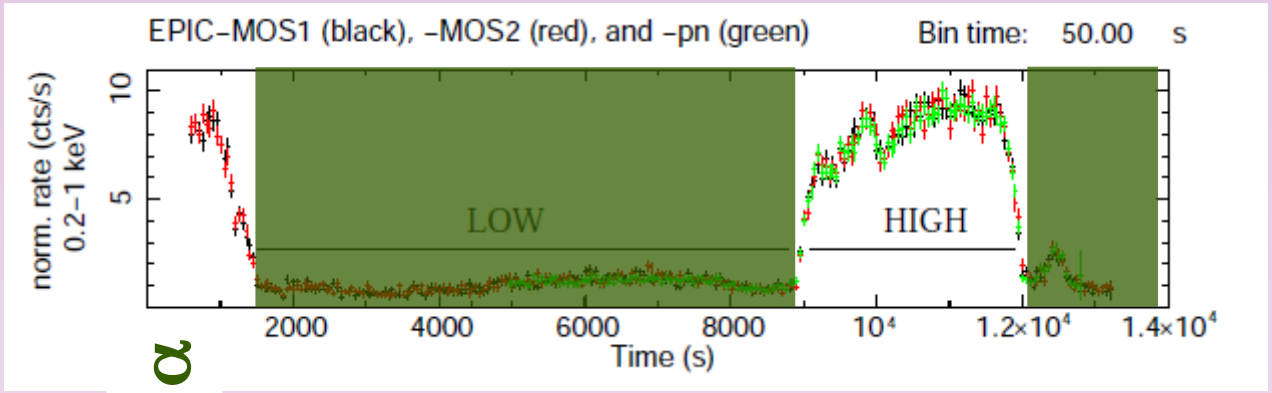
Sala, Hernanz. Ferri, Greiner . 2008, ApJ, 675, L93

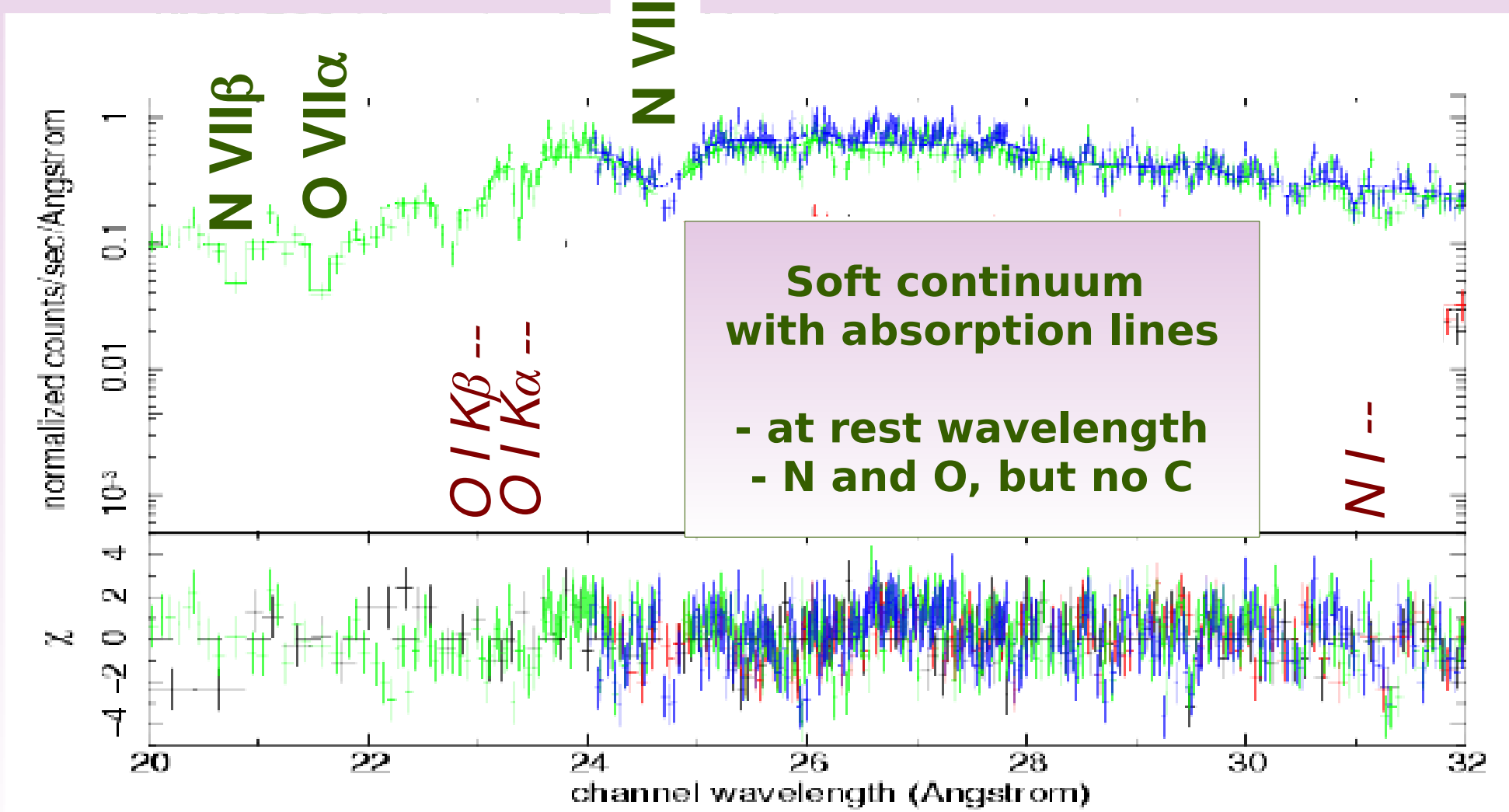
V5116 Sgr: RGS spectra





V5116 Sgr: RGS spectra HIGH





V5116 Sgr

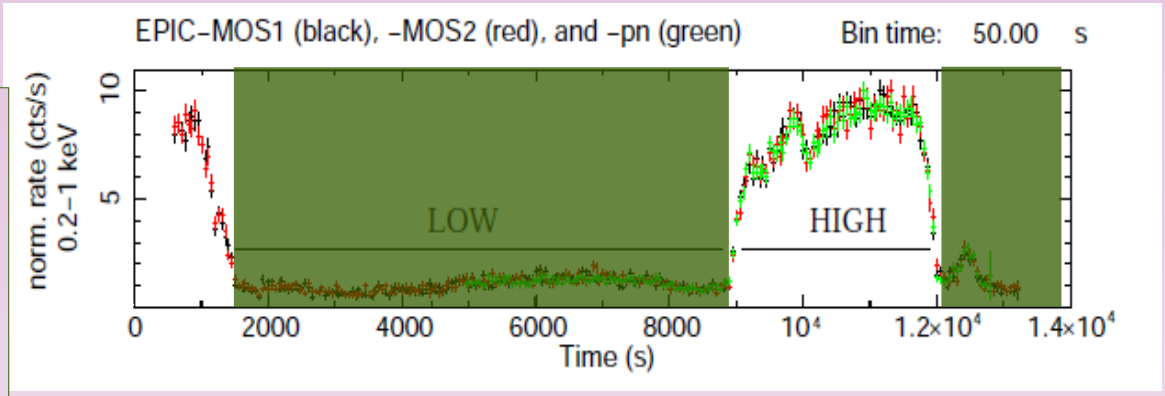
Soft continuum
with absorption lines
AT REST WAVELENGTH
20 months after outburst
no expansion

=> NLTE WD atmosphere

FIT with
white dwarf atmosphere
models by Thomas Rauch

log g= 9

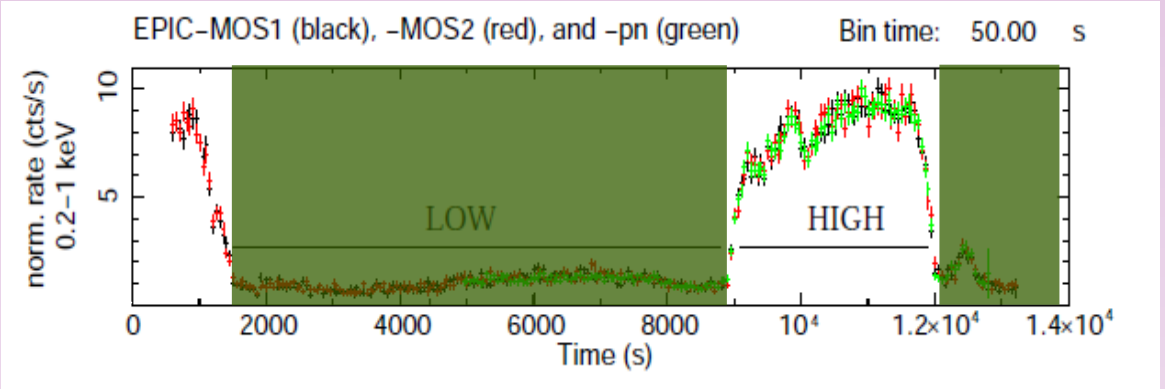
12 different abundance sets
with
C, N, O, Ne, Mg, Si, S, Ca-Ni
enhancements



model series	003	004	005	006	007	008	009	010	011	201
	003	004	005	006	007	008	009	010	011	201
[H]	-0.688	-0.683	-0.677	-0.673	-0.672	-0.671	-0.670	-0.670	-0.669	-0.885
[He]	0.382	0.387	0.393	0.397	0.398	0.399	0.400	0.401	0.401	0.489
[C]	-1.513	-1.073	-0.772	-0.675	-0.596	-0.529	-0.471	-0.420	-0.374	-0.057
[N]	1.803	1.678	1.460	1.159	1.062	0.937	0.761	0.460	0.159	1.668
[O]	1.528	1.533	1.538	1.543	1.544	1.544	1.545	1.546	1.547	1.206
[Ne]	-0.474	-0.469	-0.464	-0.459	-0.459	-0.458	-0.457	-0.456	-0.456	-0.517
[Mg]	-0.454	-0.450	-0.444	-0.439	-0.439	-0.438	-0.437	-0.436	-0.436	-0.497
[Si]	0.167	0.172	0.178	0.182	0.183	0.184	0.185	0.186	0.186	0.125
[S]	-1.583	-1.578	-1.573	-1.568	-1.567	-1.567	-1.566	-1.565	-1.565	-1.625
[IG]	0.828	0.833	0.838	0.843	0.843	0.844	0.845	0.846	0.846	0.786

Model publicly available at
http://astro.uni-tuebingen.de/~rauch/TMAF/flux_HHeCNONeMgSiS_gen.html

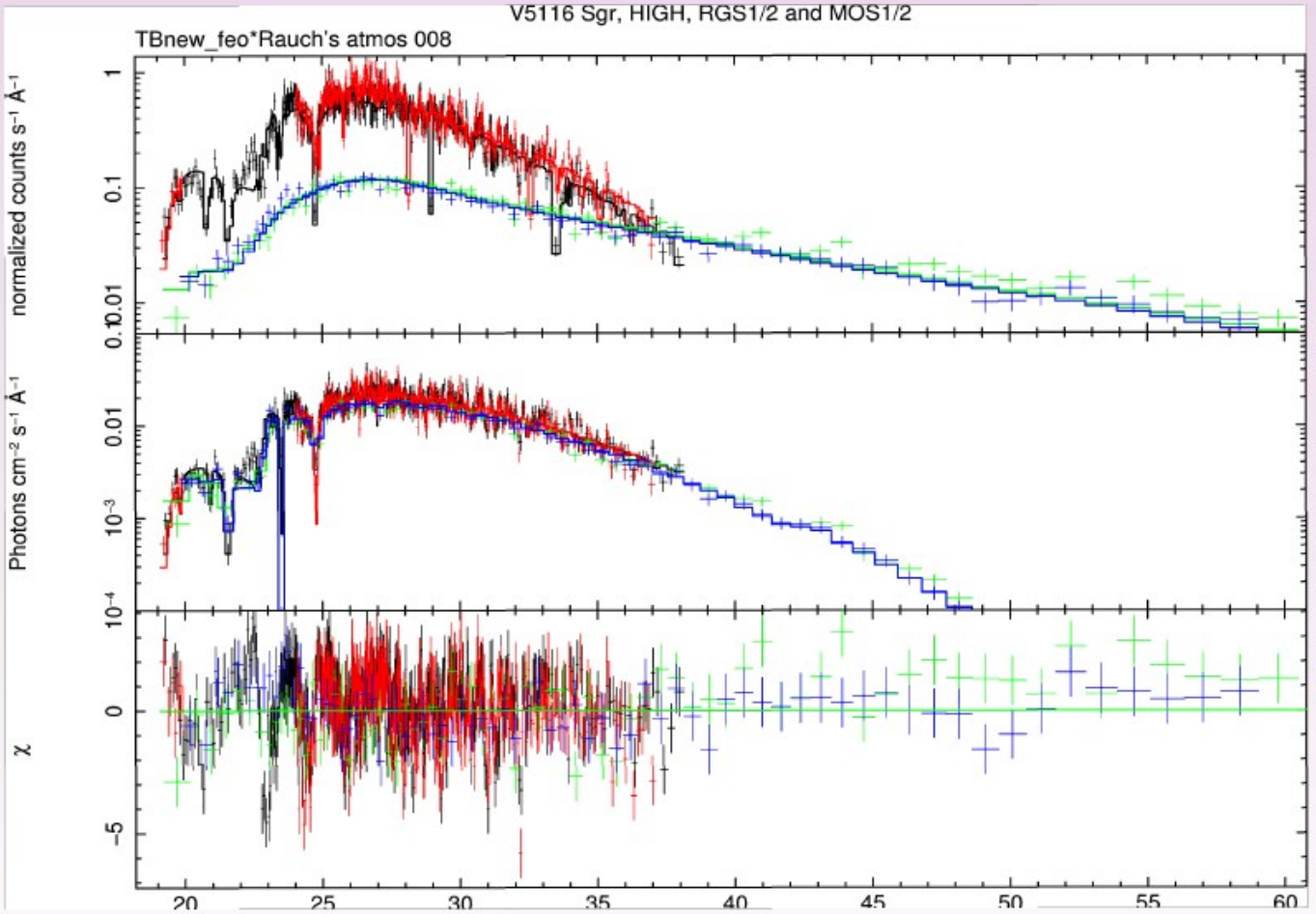
V5116 Sgr RGS spectra HIGH FIT with Rauch's atmosphere models



Simultaneous fit RGS and MOS data constrains N_H

$(1\text{-}1.6)\times10^{21}$ cm^{-2}

Compatible with ISM N_H



V5116 Sgr
RGS spectra HIGH
FIT with Rauch's atmosphere models

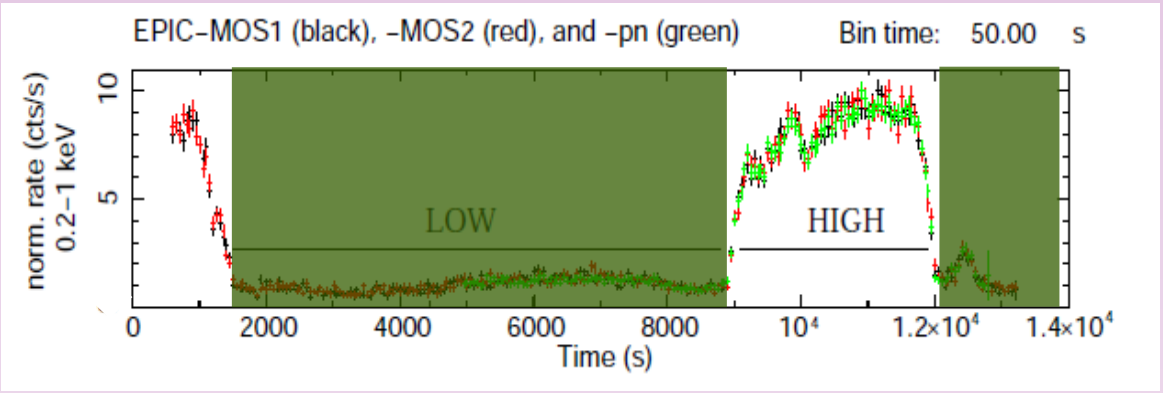
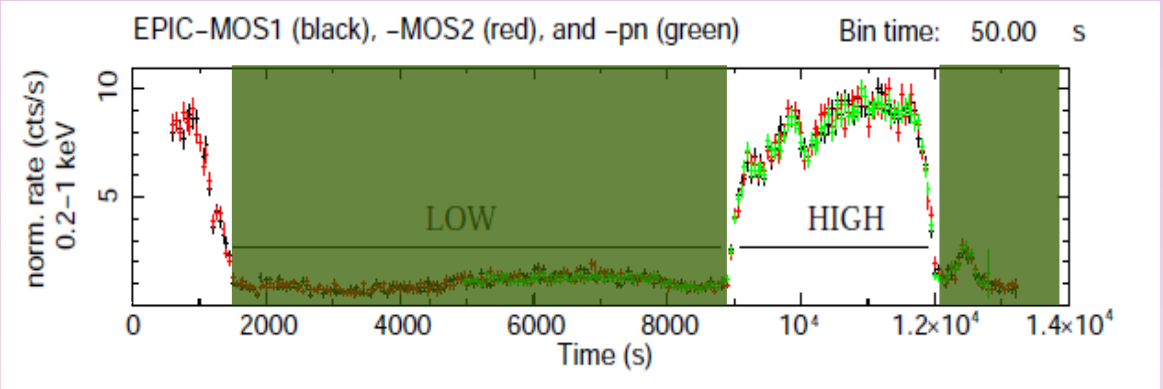


Table 3. Simultaneous fits to RGS1/2 and MOS1/2 high spectrum with Rauch's atmosphere models (with the new TBabs, free Oxygen abundance, and free N_H; radius from MOS normalization K_{MOS}, assuming D= 11 kpc, $R = 10^{-11} \times \sqrt{K_{MOS}} \times D$.)

Model	T_{eff} 10^5K	K_{RGS} 10^{-6}	K_{MOS} 10^{-6}	R $10^8 cm$	ISM [O]	N_H $10^{21} cm^{-2}$	chi^2_{nu}	MOS Flux 0.2-0.7 keV $10^{-10} erg/cm^2/s$
003	7.7	2.5	2.2	5.0	3.8	1.25	2.2	1.25 (±0.05)
004	7.6	2.9	2.5	5.4	3.5	1.32	2.1	1.25 (-0.08/+0.05)
005	7.5	3.7	3.2	6.1	3.0	1.44	2.0	1.22 (-0.11/+0.07)
006	7.3	4.5	3.9	6.7	3.2	1.53	1.9	1.2 (±0.1)
007	7.3	4.6	4.0	6.8	3.3	1.54	1.9	1.22 (-0.09/+0.06)
008	7.3	4.6	3.9	6.7	3.6	1.52	1.8	1.22 (-0.1/+0.05)
009	7.3	4.7	4.0	6.8	3.8	1.52	1.8	1.22 (±0.06)
010	7.3	4.8	4.1	6.9	4.0	1.53	1.9	1.21 (-0.08/+0.04)
011	7.3	4.9	4.2	7.0	4.2	1.53	1.9	1.21 (-0.06/+0.05)
201	7.9	1.8	1.6	4.3	5.0	1.11	2.1	1.24 (±1.24??)

No model gives a statistically perfect fit
No significant best model

V5116 Sgr
RGS spectra HIGH
FIT with Rauch's atmosphere models



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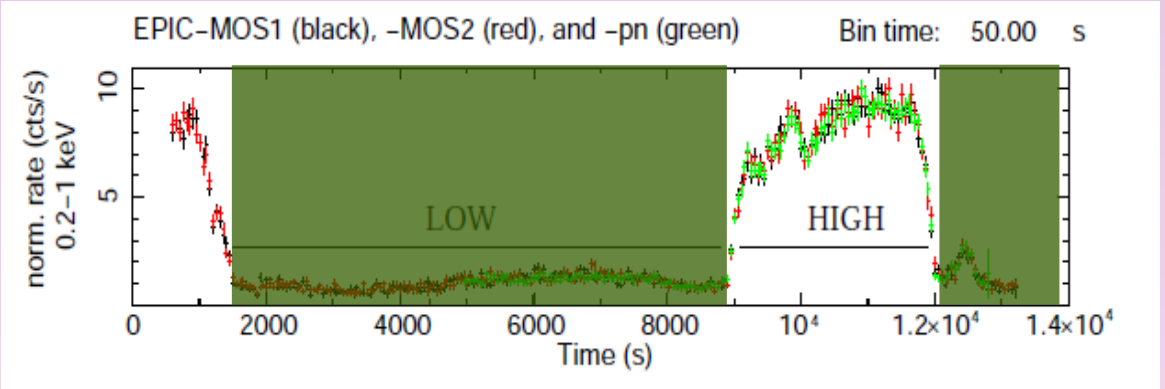
006	7.3	4.5	3.9	6.7	3.2	1.53	1.9	1.2 (±0.1)
007	7.3	4.6	4.0	6.8	3.3	1.54	1.9	1.22 (-0.09/+0.06)
008	7.3	4.6	3.9	6.7	3.6	1.52	1.8	1.22 (-0.1/+0.05)
009	7.3	4.7	4.0	6.8	3.8	1.52	1.8	1.22 (±0.06)
010	7.3	4.8	4.1	6.9	4.0	1.53	1.9	1.21 (-0.08/+0.04)
011	7.3	4.9	4.2	7.0	4.2	1.53	1.9	1.21 (-0.06/+0.05)
201	7.9	1.8	1.6	4.3	5.0	1.11	2.1	1.24 (±1.24??)

From confidence ranges of ALL models:

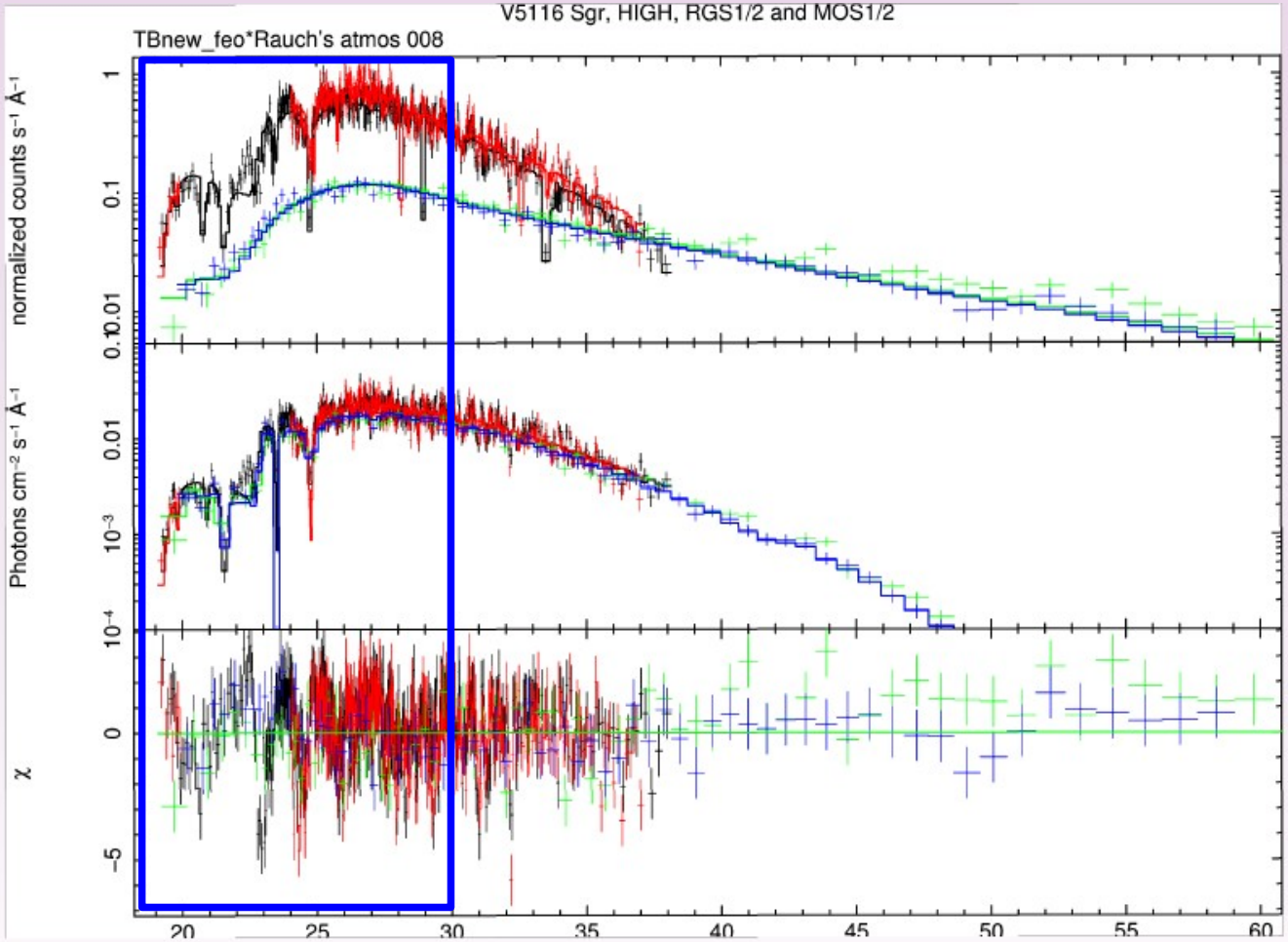
T=(7-8)x10^5 K

R=(3-9)x10^8 cm (@ 11 kpc)

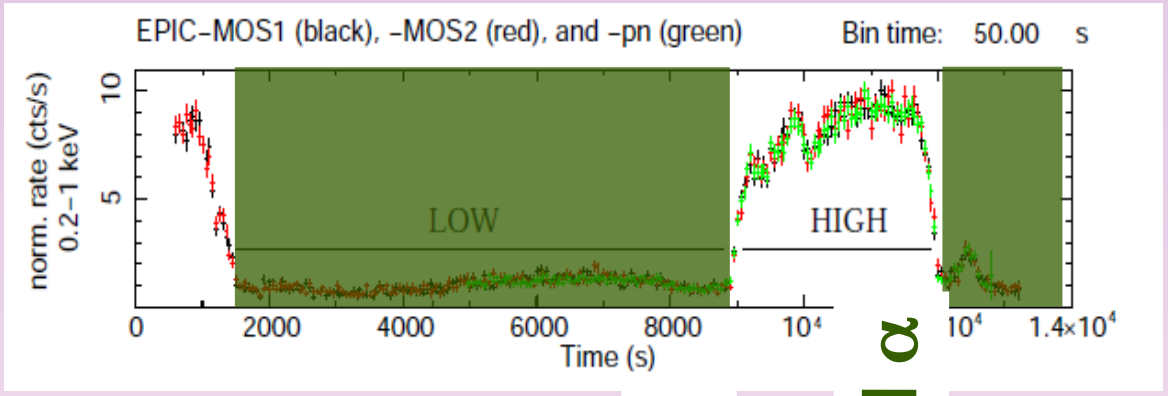
V5116 Sgr RGS spectra HIGH FIT with Rauch's atmosphere models



Simultaneous fit
RGS and MOS data



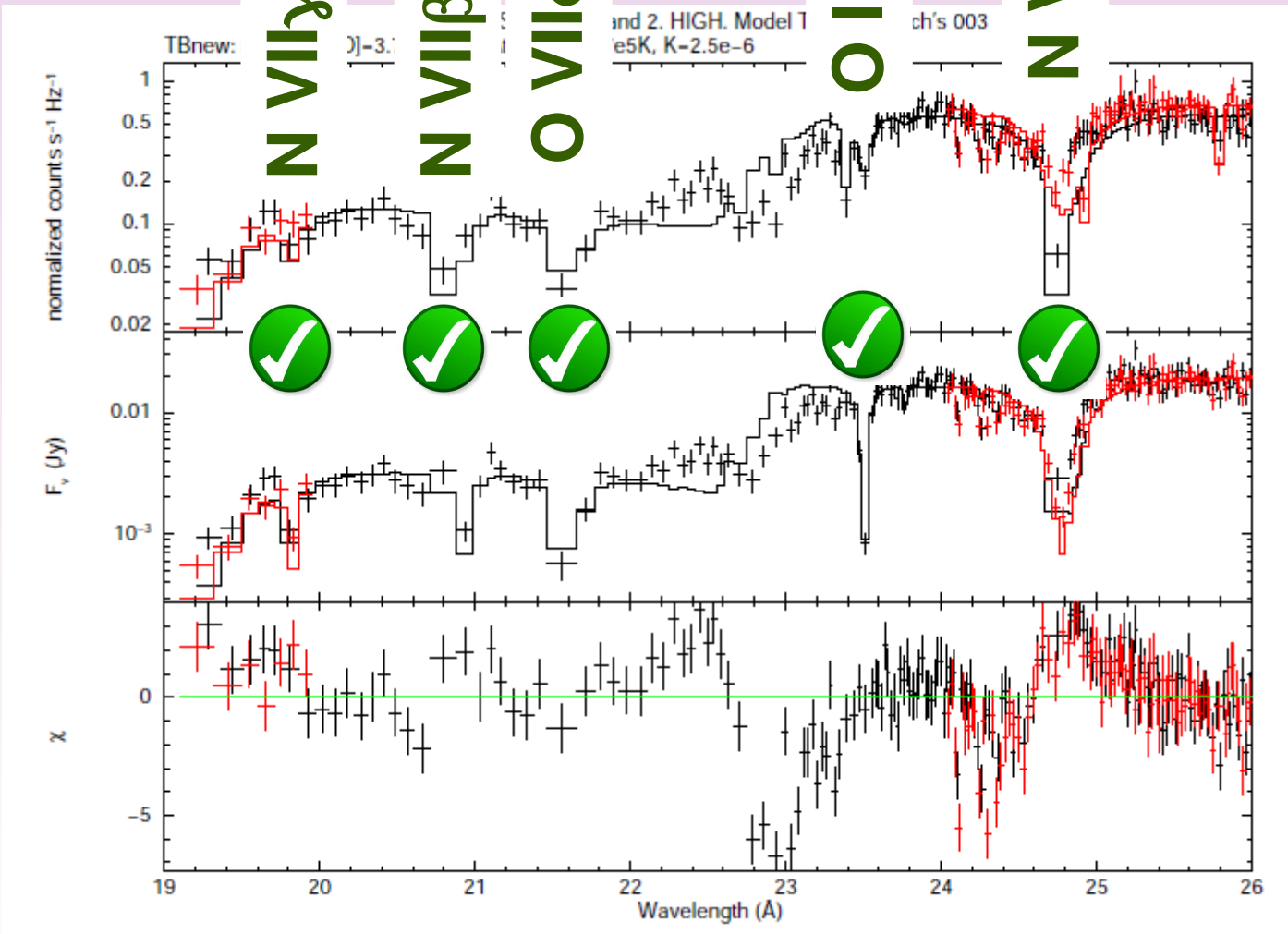
V5116 Sgr RGS spectra HIGH FIT with Rauch's atmosphere models



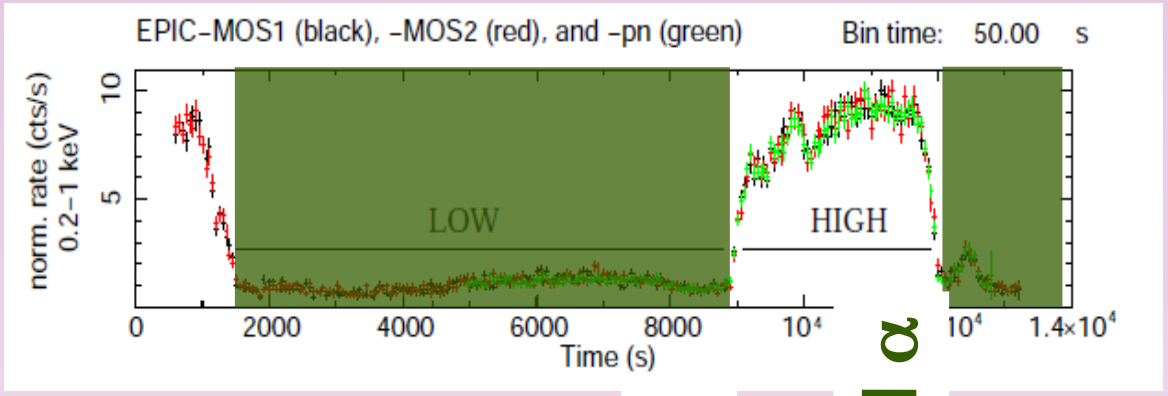
Atmosphere fits well
N VII α
N VII β
O VII α

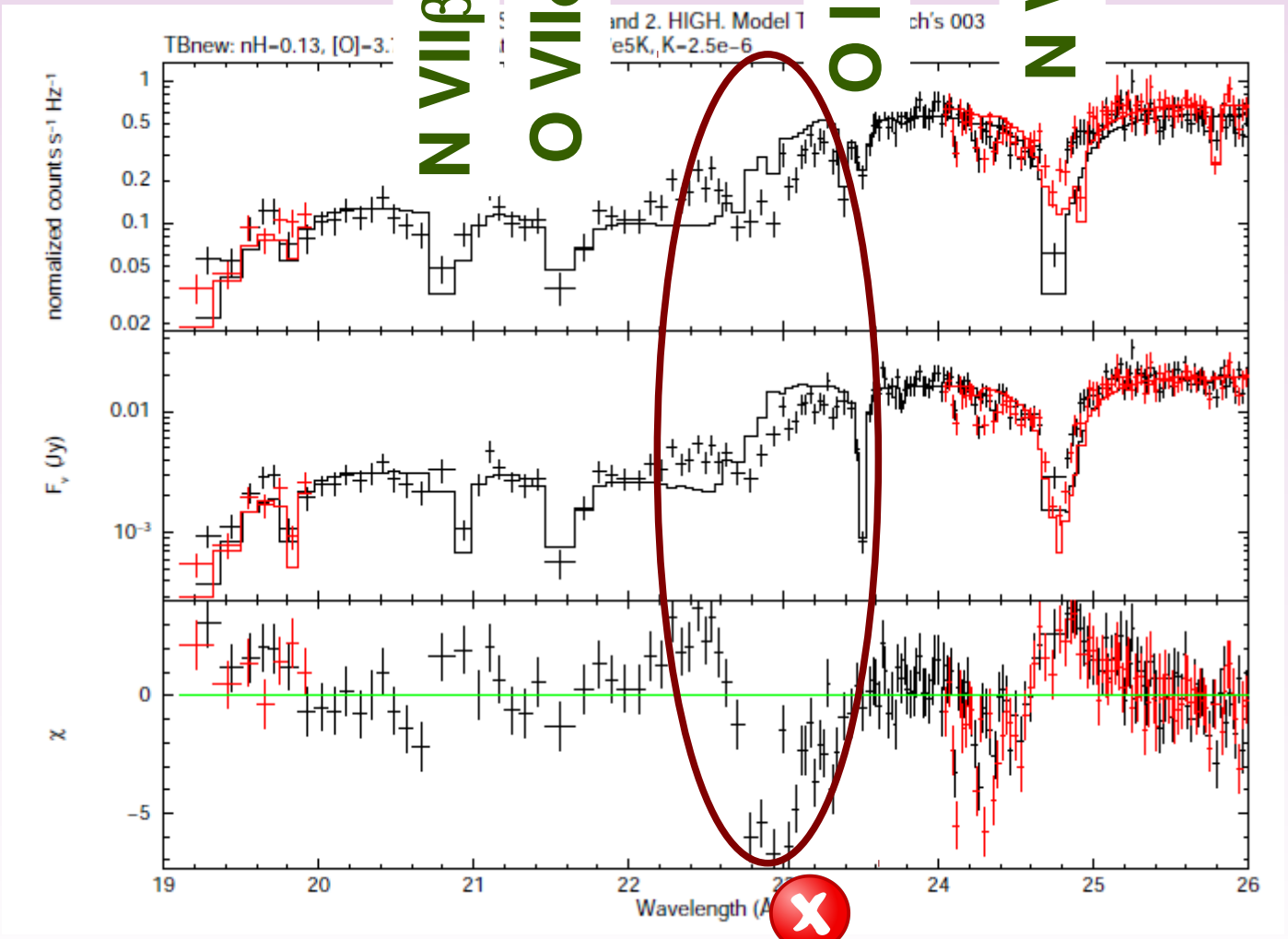
New TBabs absorption model *(Wilms et al 2011)* **fits well**

O I 1s-2p



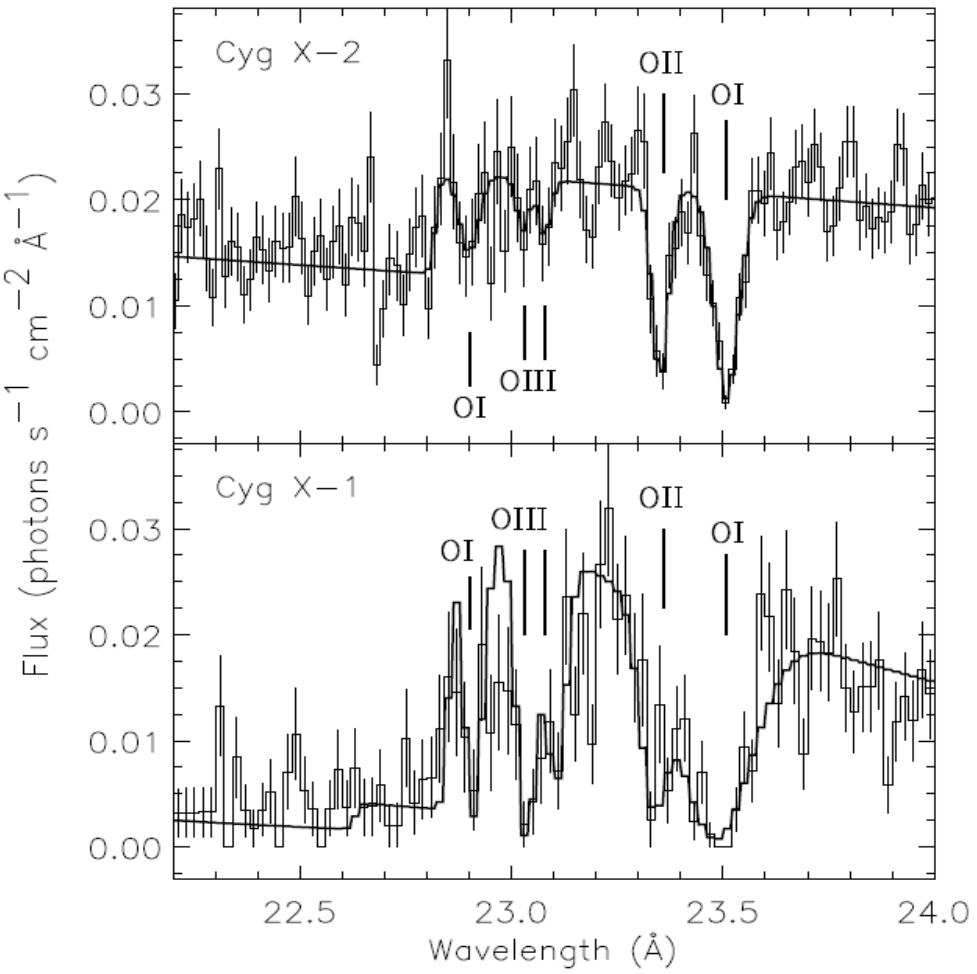
V5116 Sgr RGS spectra HIGH FIT with Rauch's atmosphere models

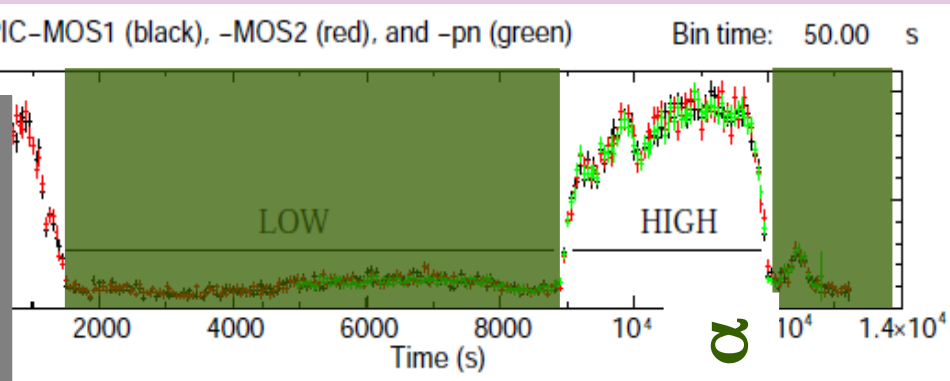


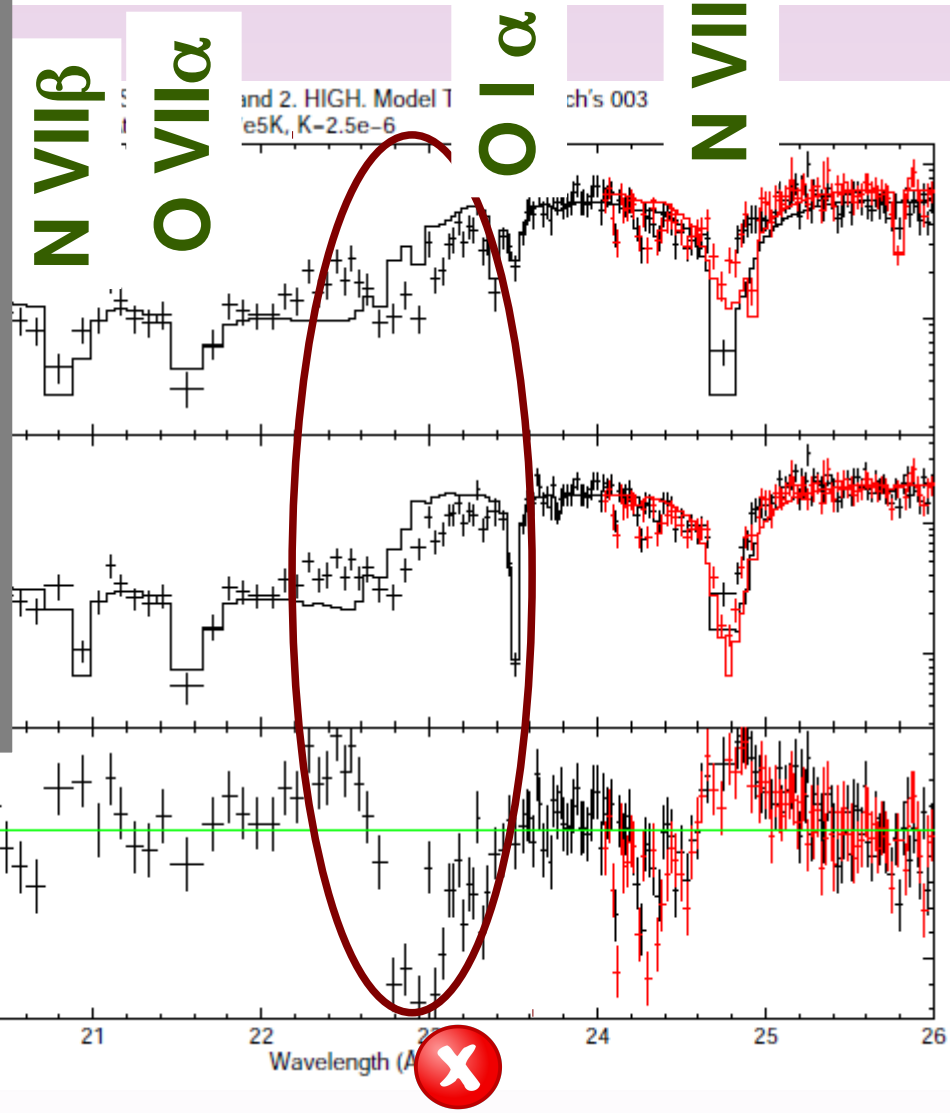


BUT even new TBabs still fails to fit well the O K-*edge complex*

Oxygen edge structure
(Juett et al. 2004, ApJ 612, 308)

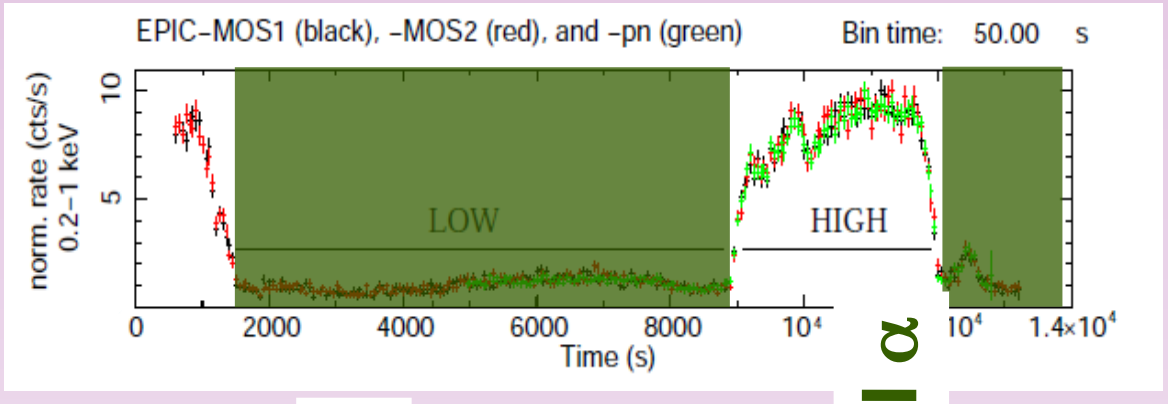






complicated contributions of ISM

V5116 Sgr
RGS spectra HIGH
FIT with Rauch's atmosphere models

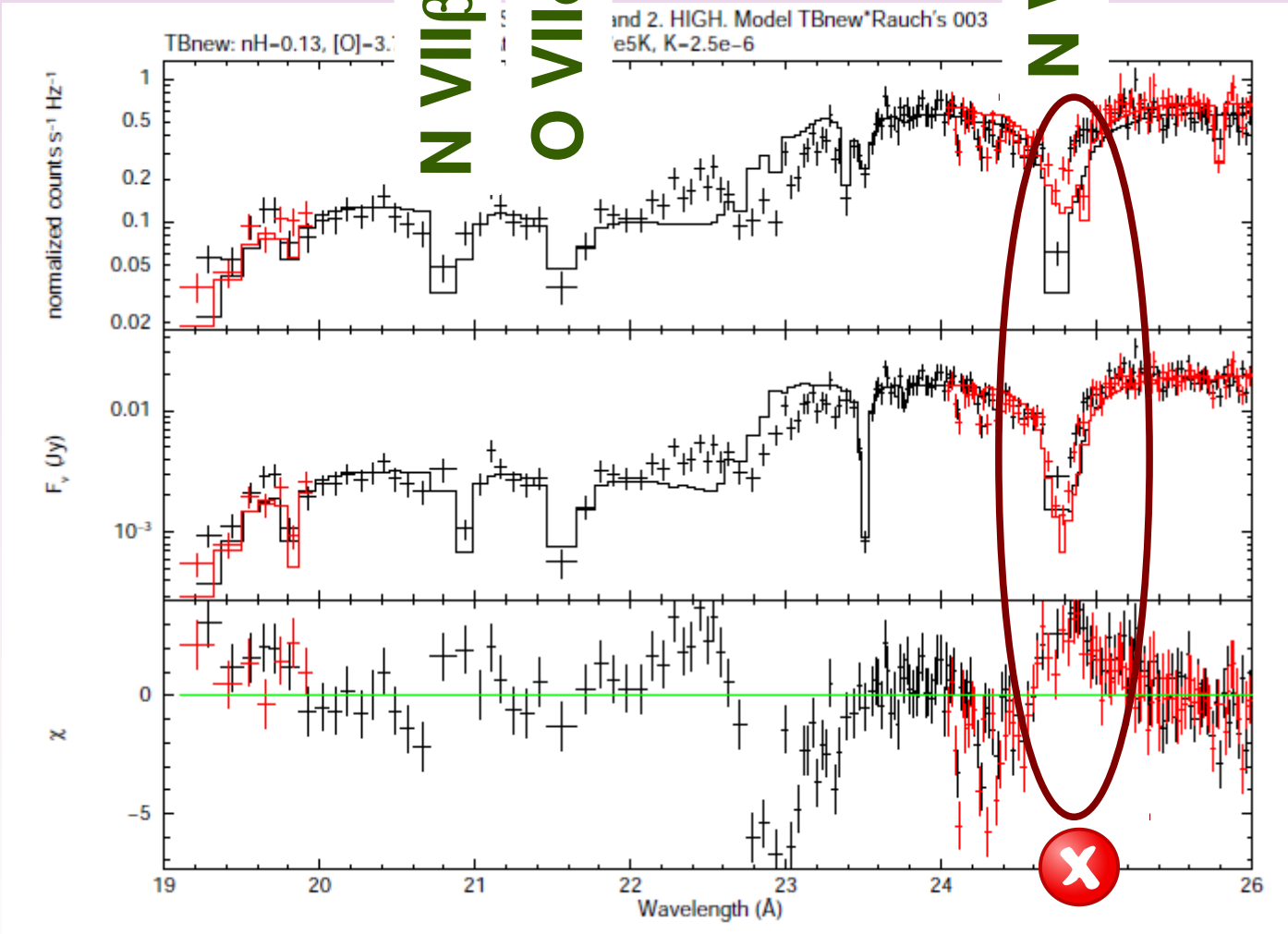


ATMOSPHERE model fails to fit N VII α PROFILE;

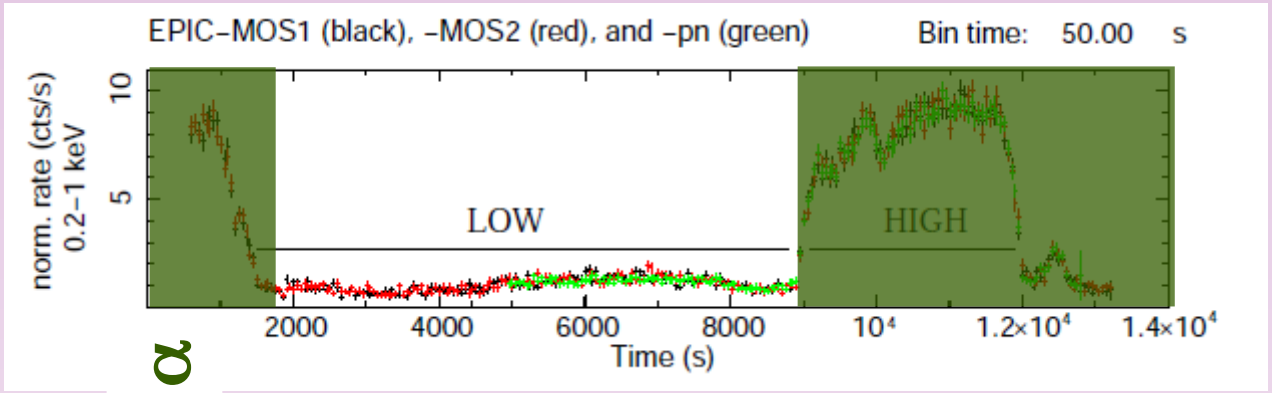
red wing excess

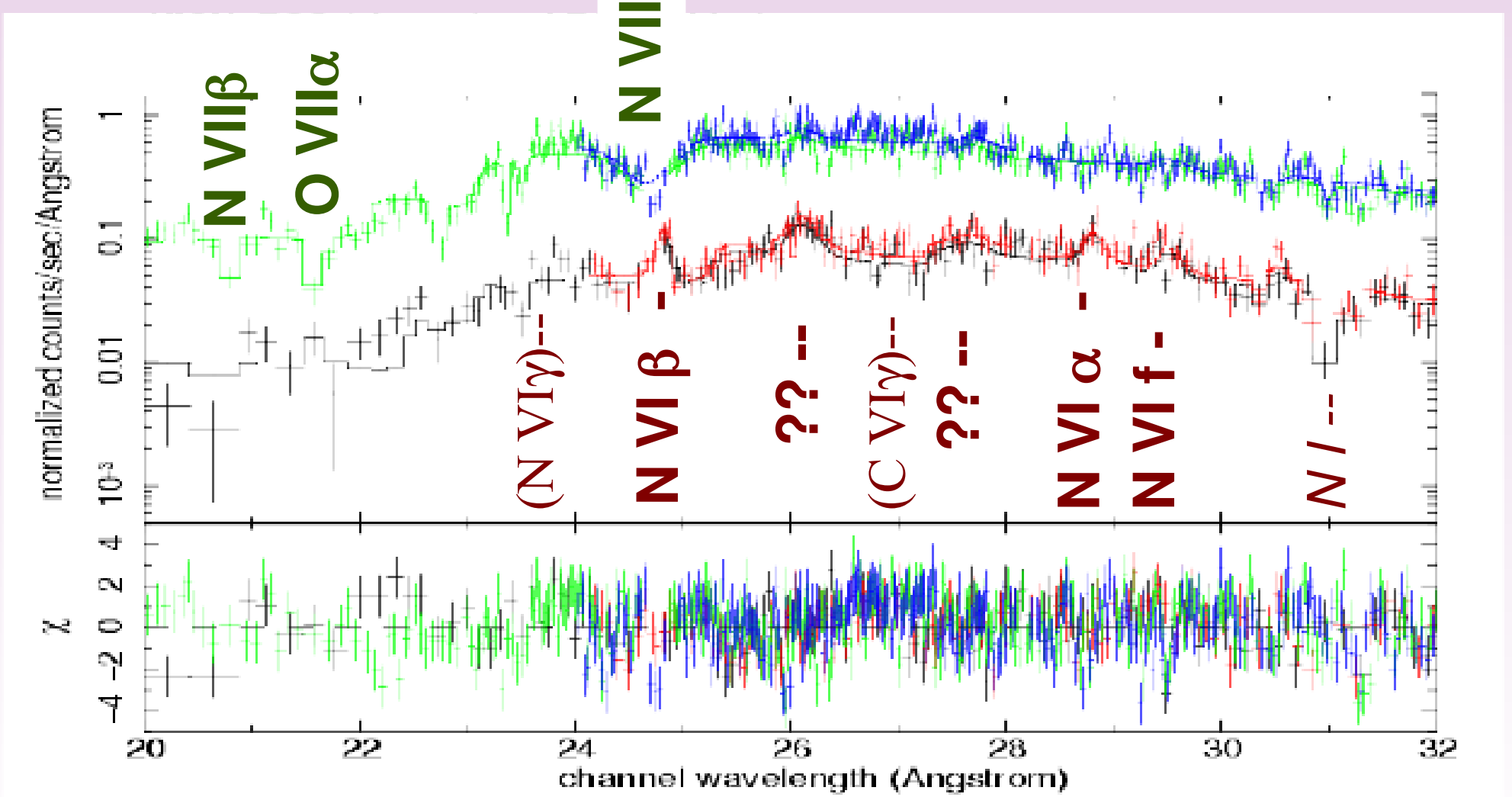
Contribution from N VI β In emission ??

Let's see spectrum during "LOW"!!



V5116 Sgr: RGS spectra LOW

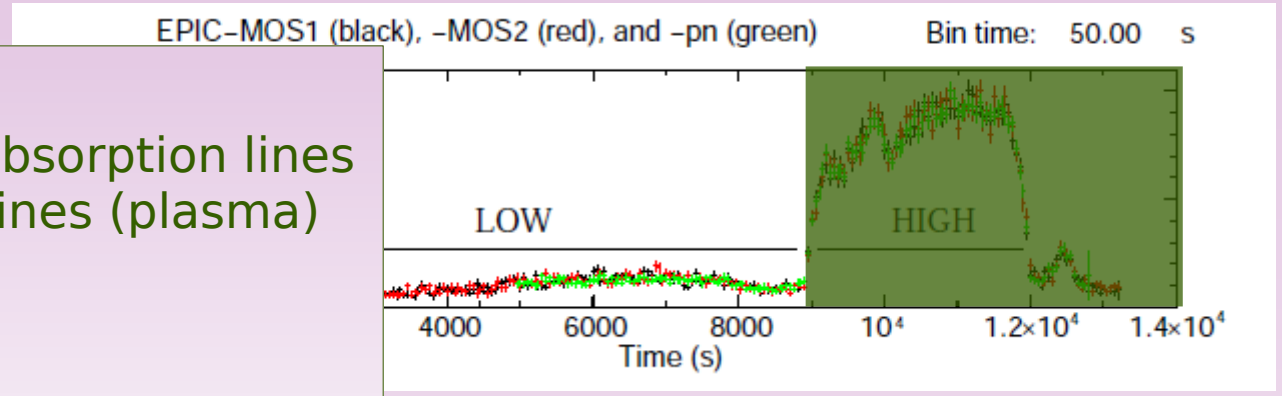


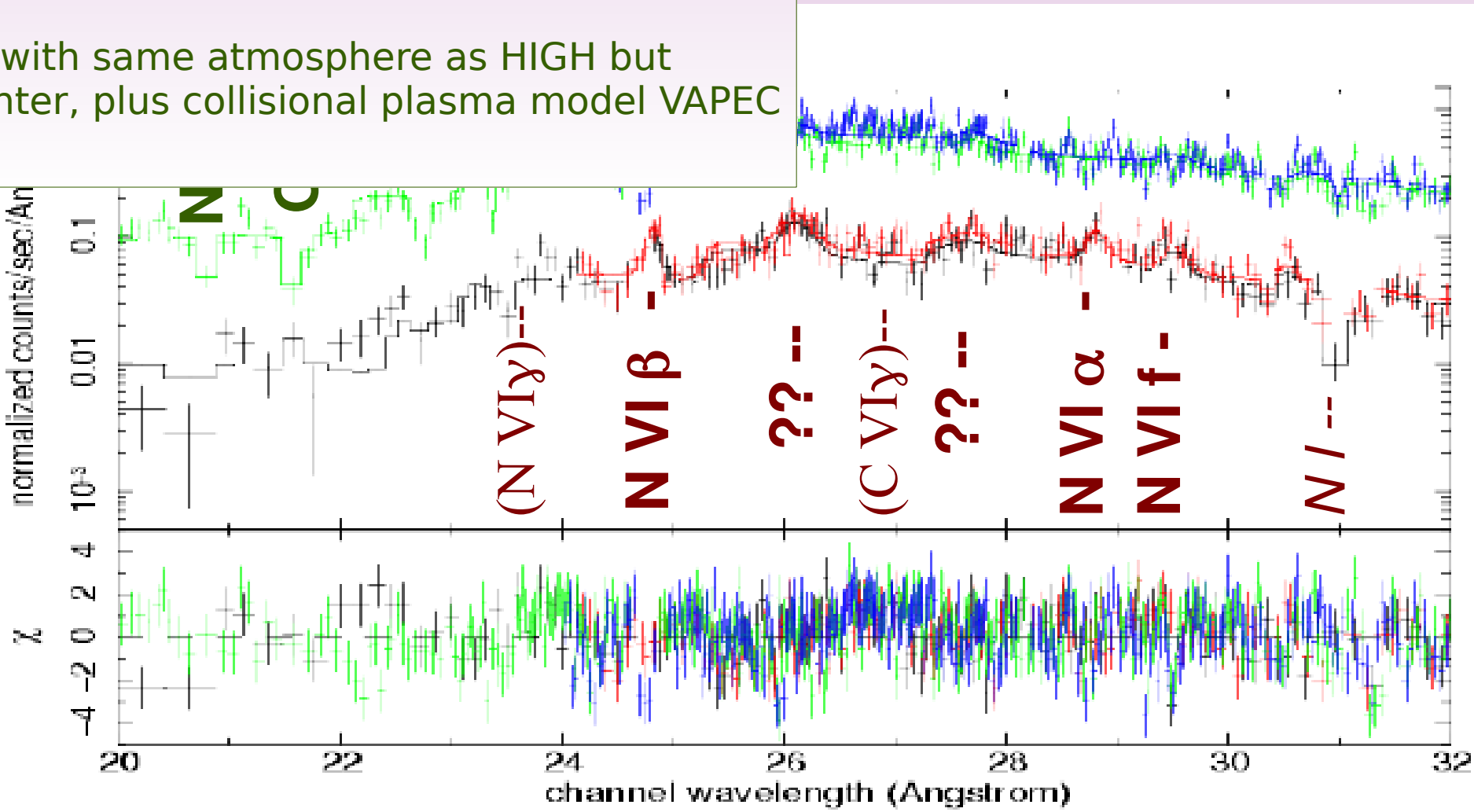


Fainter soft continuum with absorption lines (atmosphere) plus emission lines (plasma)

- at rest wavelength
- N enhancement, but not C

Fit with same atmosphere as HIGH but fainter, plus collisional plasma model VAPEC





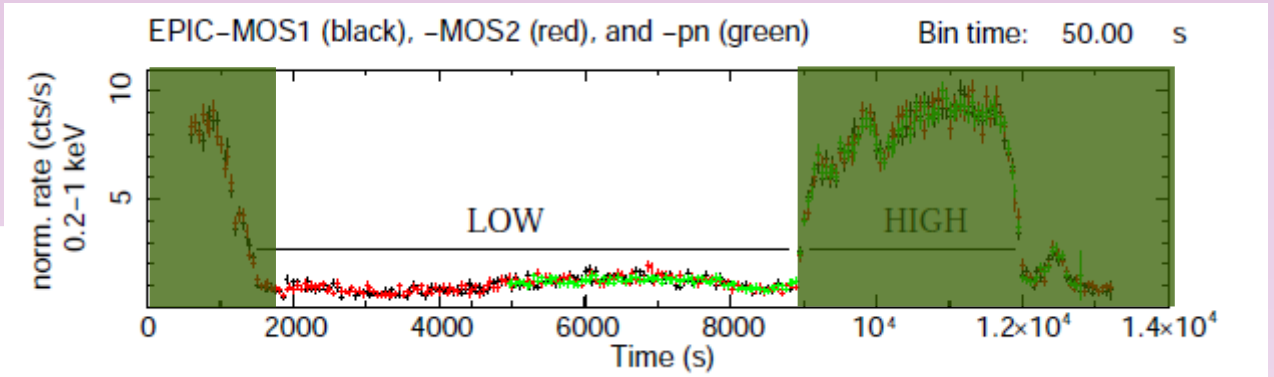
V5116 Sgr: RGS in LOW flux

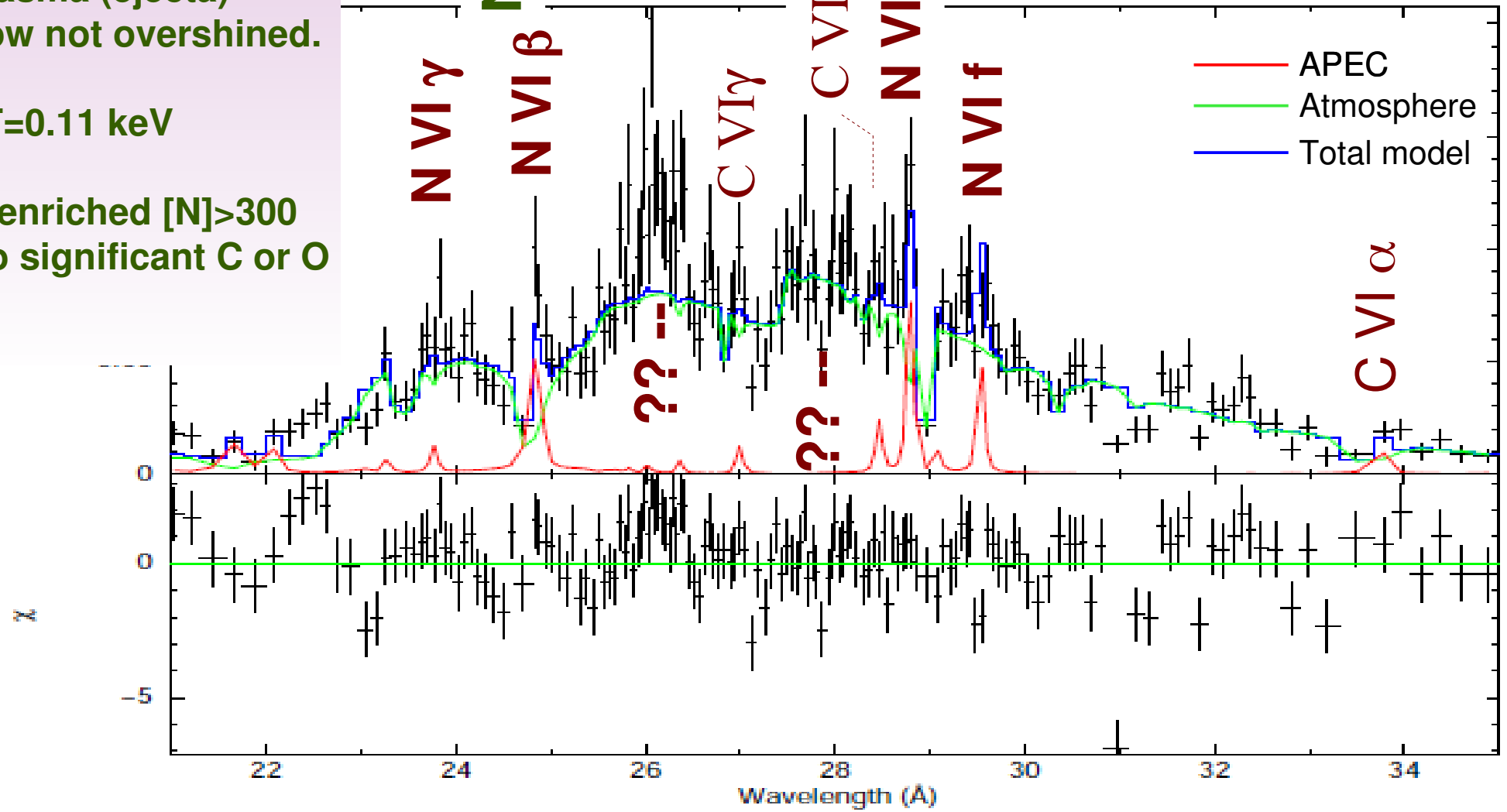
Atmosphere a factor 8 fainter than in HIGH

Plasma (ejecta) now not overshined.

kT=0.11 keV

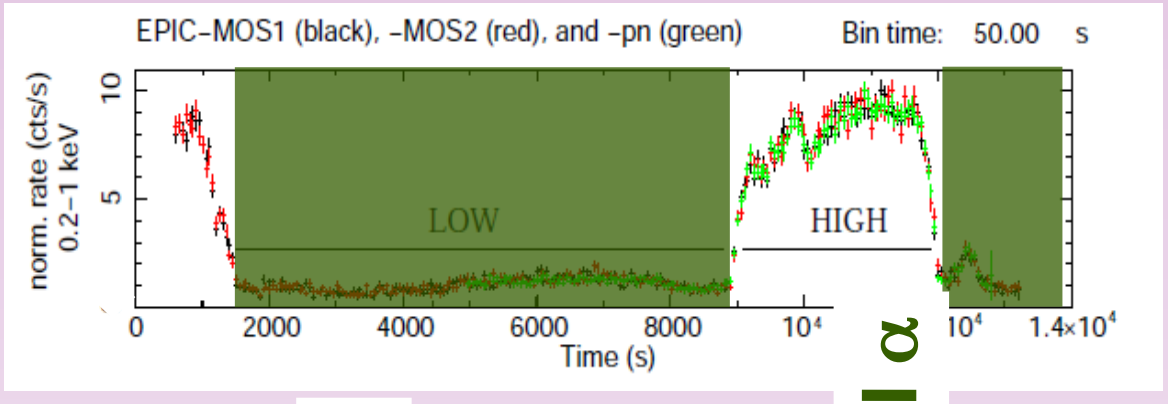
N enriched [N]>300
No significant C or O





V5116 Sgr

BACK TO HIGH

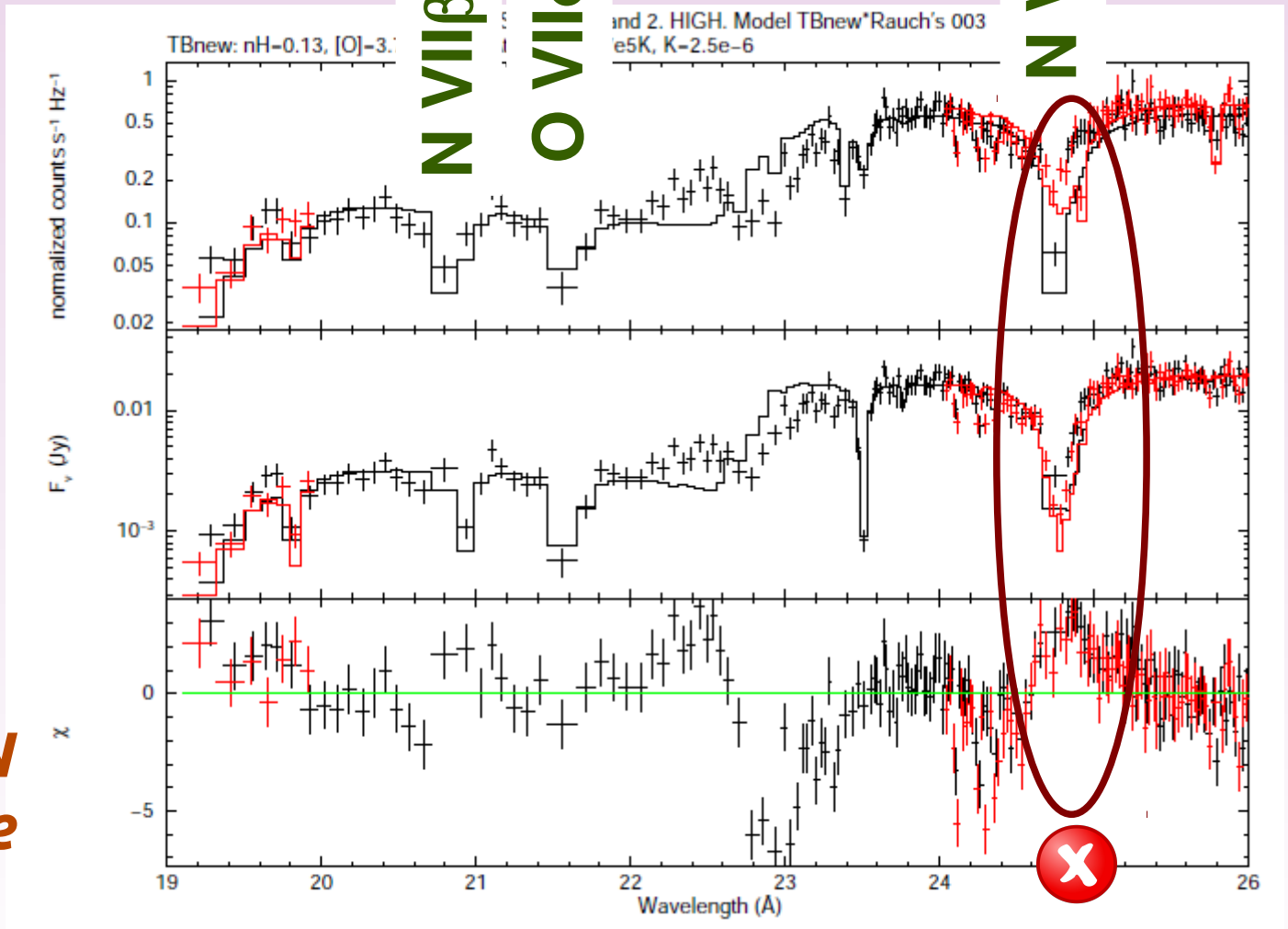


ATMOSPHERE model fails to fit N VII α PROFILE;

red wing excess

Contribution from N VI β In emission ??

TRY IF APEC AS IN LOW FITS N VI line



V5116 Sgr

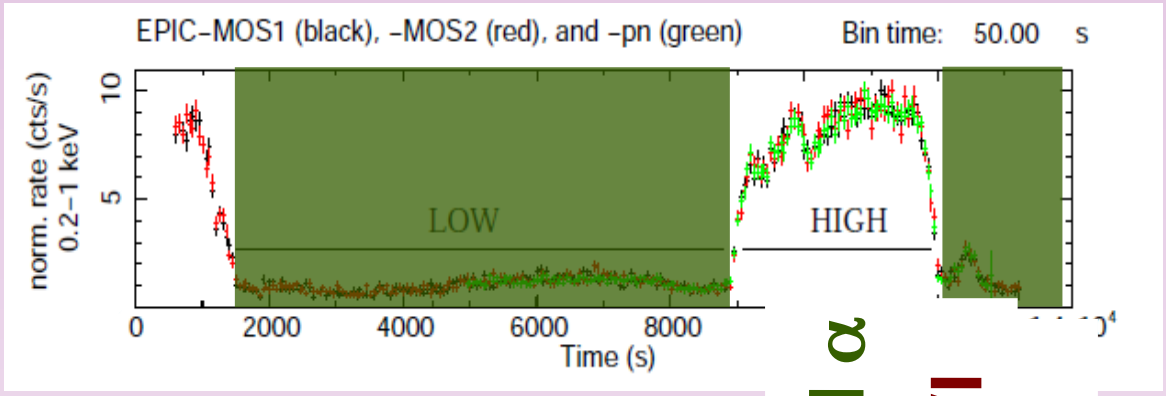
BACK TO HIGH

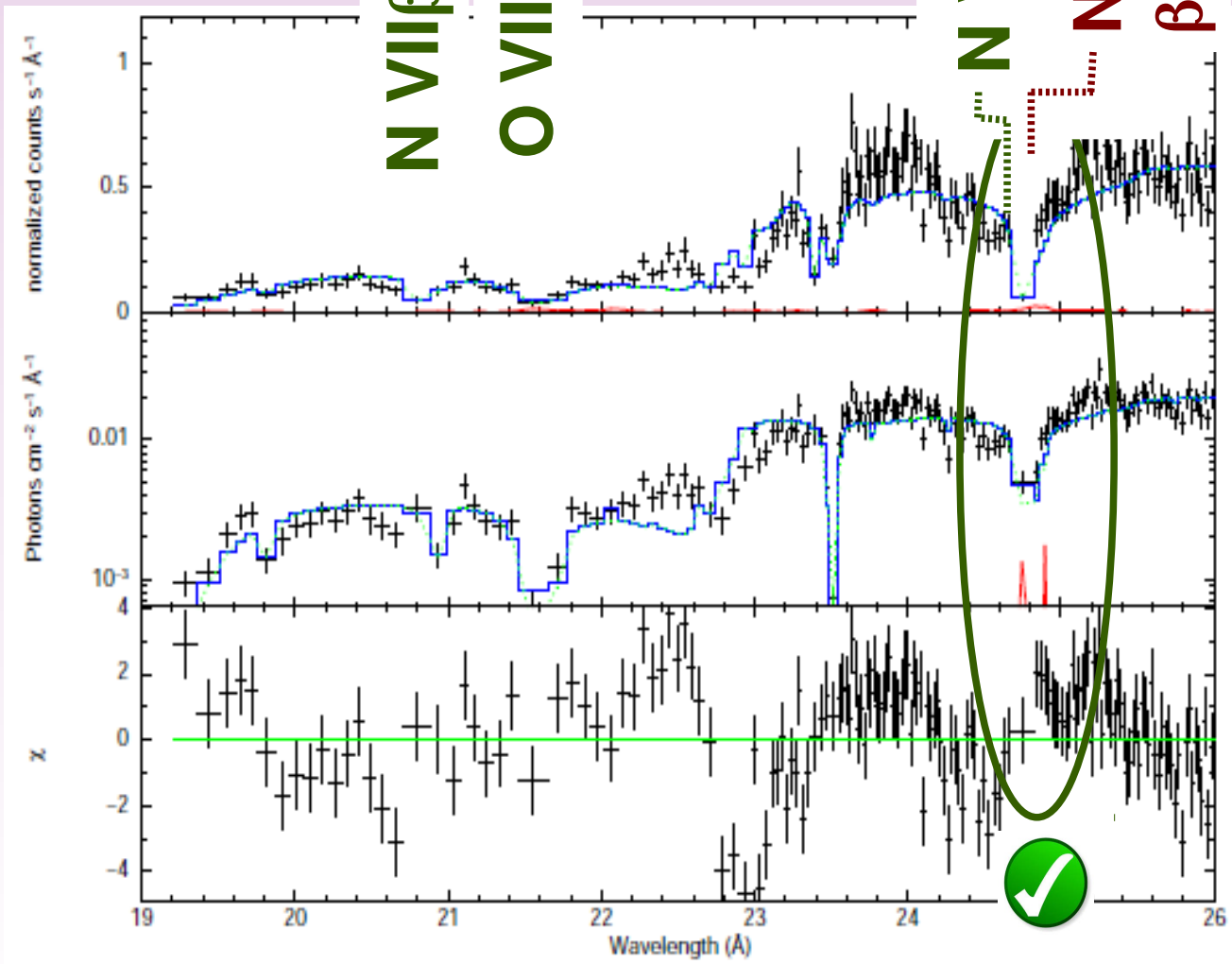
ATMOSPHERE model fails to fit N VII α PROFILE;

red wing excess

Contribution from N VI β In emission => YES!

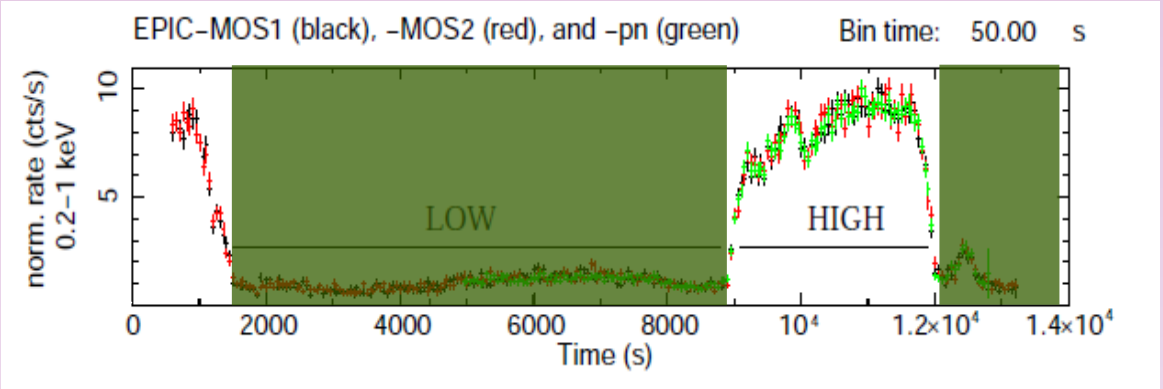
APEC AS IN LOW FITS N VI line, explains N VII red wing excess



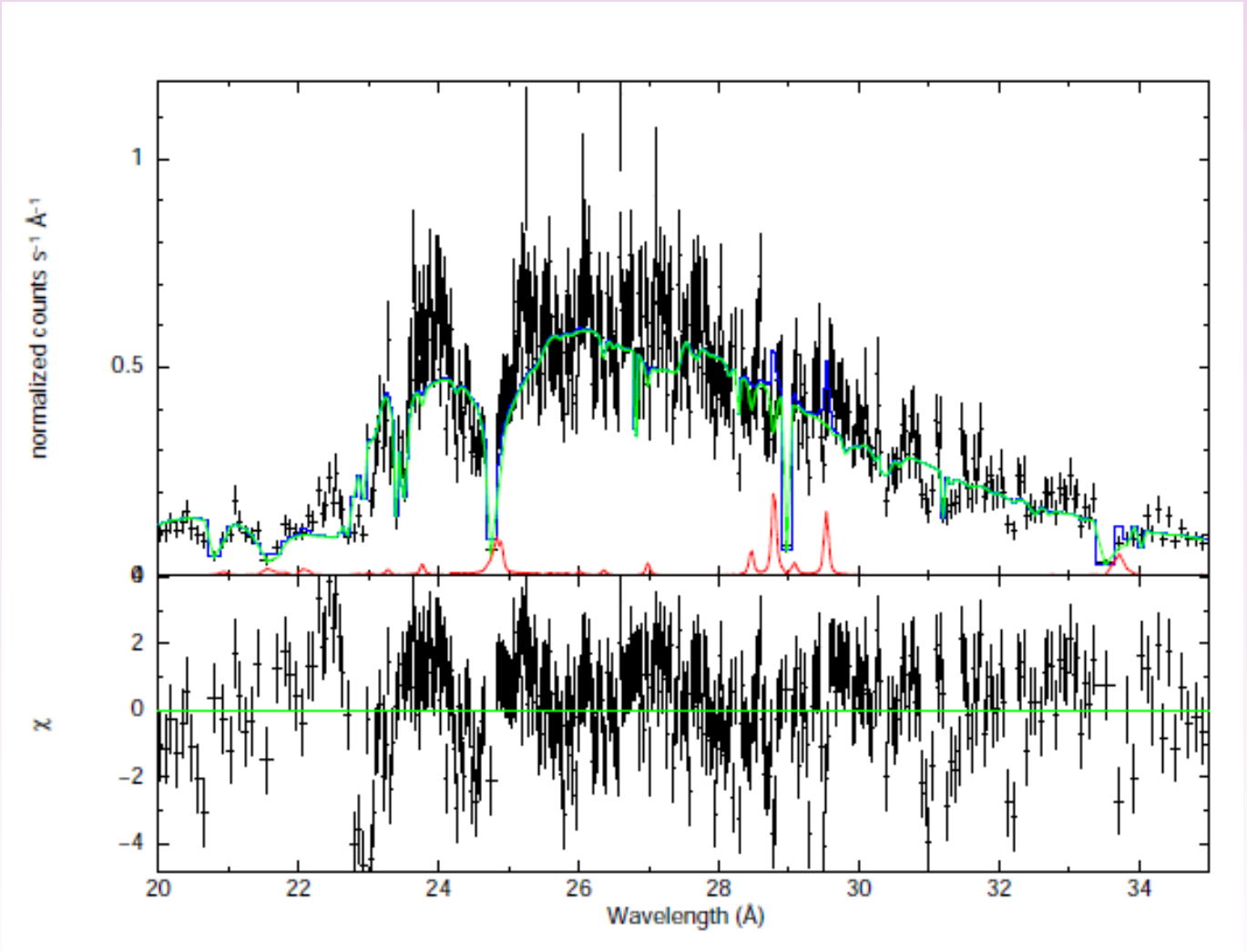


V5116 Sgr

BACK TO HIGH



APEC
AS IN LOW
FITS N VI line
WHILE BEING
COMPATIBLE WITH
DATA AT OTHER
WAVELENGTHS



V5115 Sgr = Nova Sgr 2005a

Discovered on 2005 March 28.8, with **V~8.7**

Reached maximum on March 30.12, **V~7.7**

E(B-V): 0.5-0.6

DISTANCE DETERMINATION:

We need:

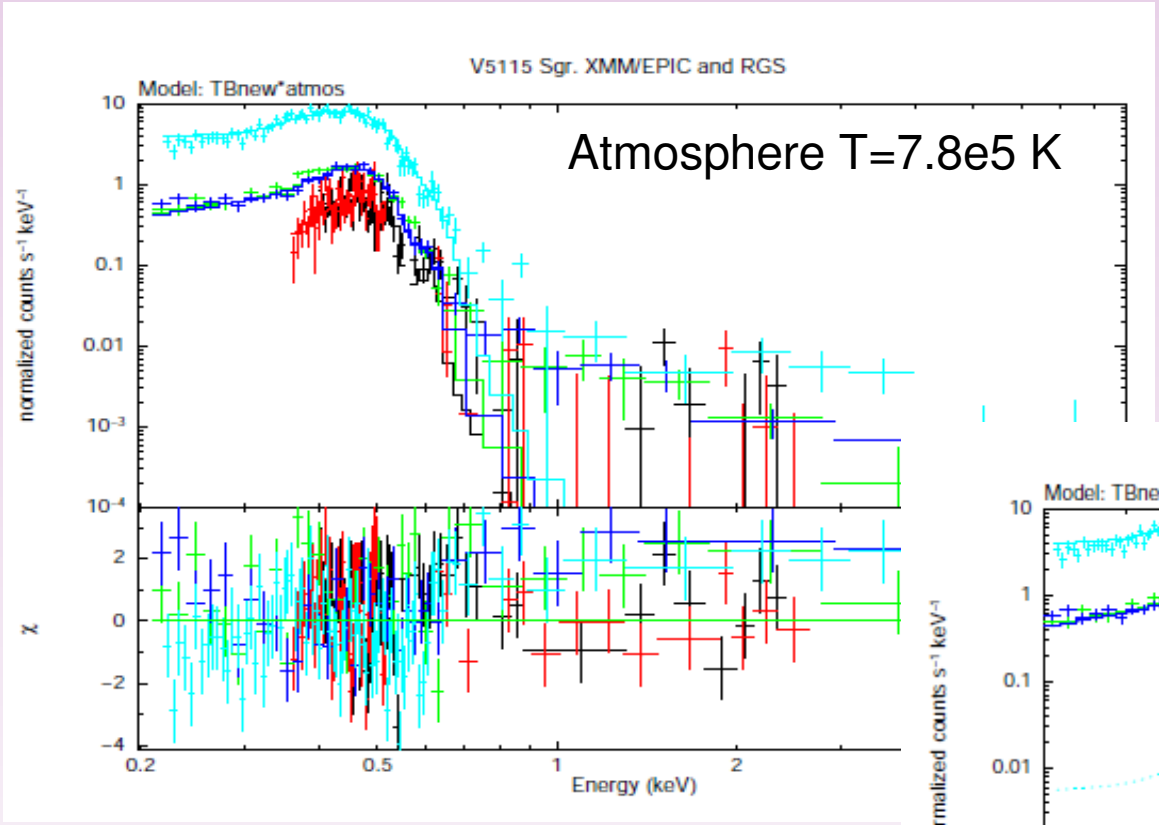
1. time to decrease 2 mag, (t_2=8+/-1days) and
2. observed magnitude at maximum.

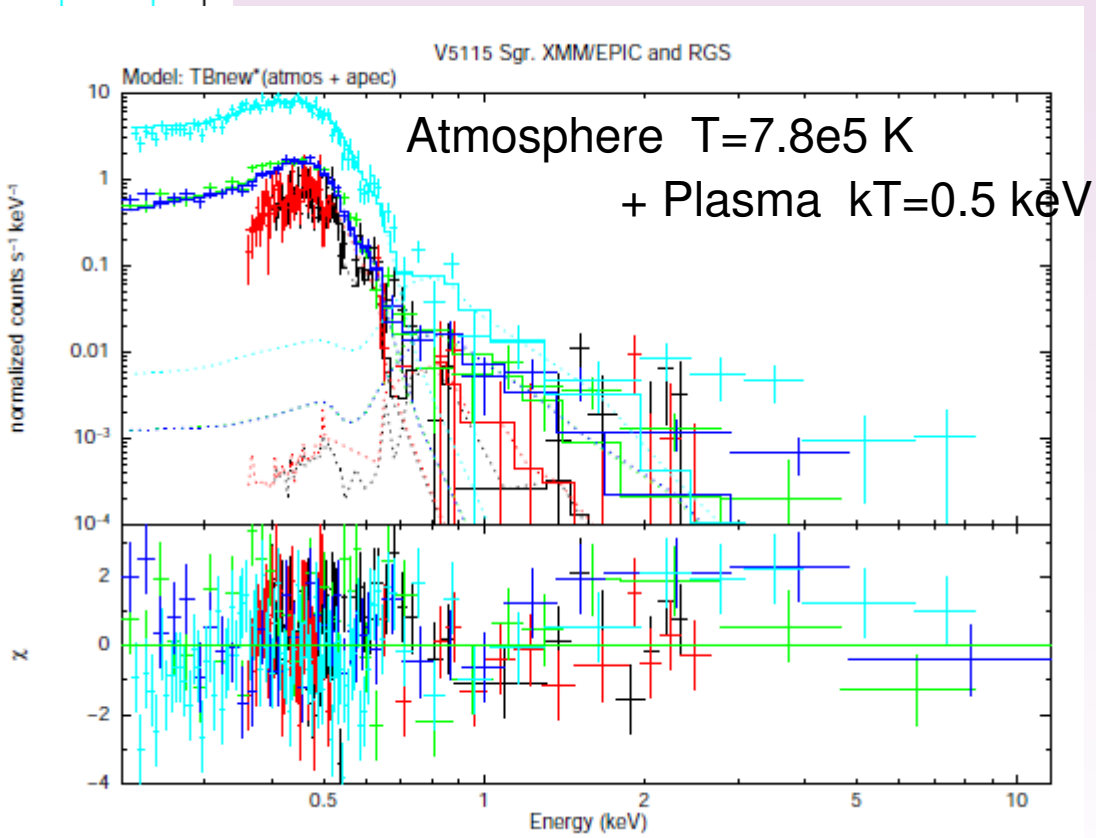
Using Della Valle & Livio (1995) M_V – t_2 relation, **d~10 kpc**

Using Buscombe -de Vaucouleurs (1955) relation, **d~15 kpc**

(Ederoclite & Mason 2006, RS Oph meeting)

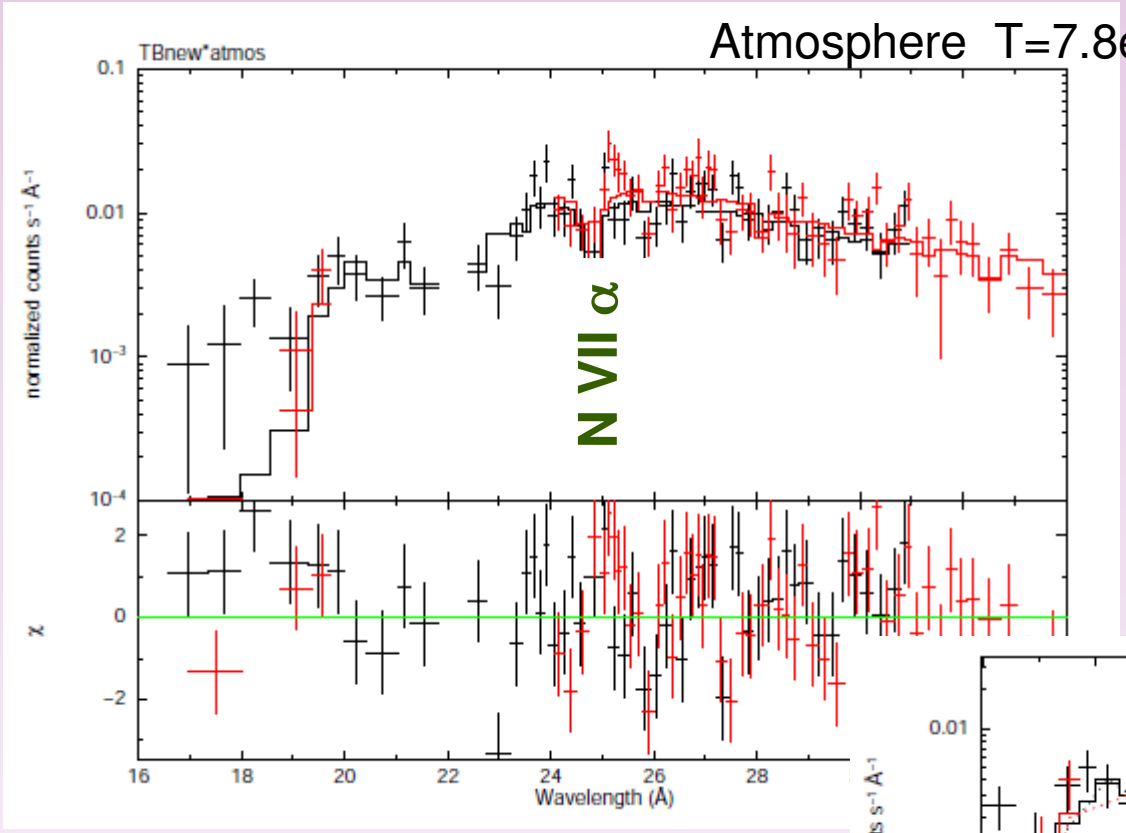
V5115 Sgr. SSS with hard excess.
Does a plasma model (APEC) fit the excess?



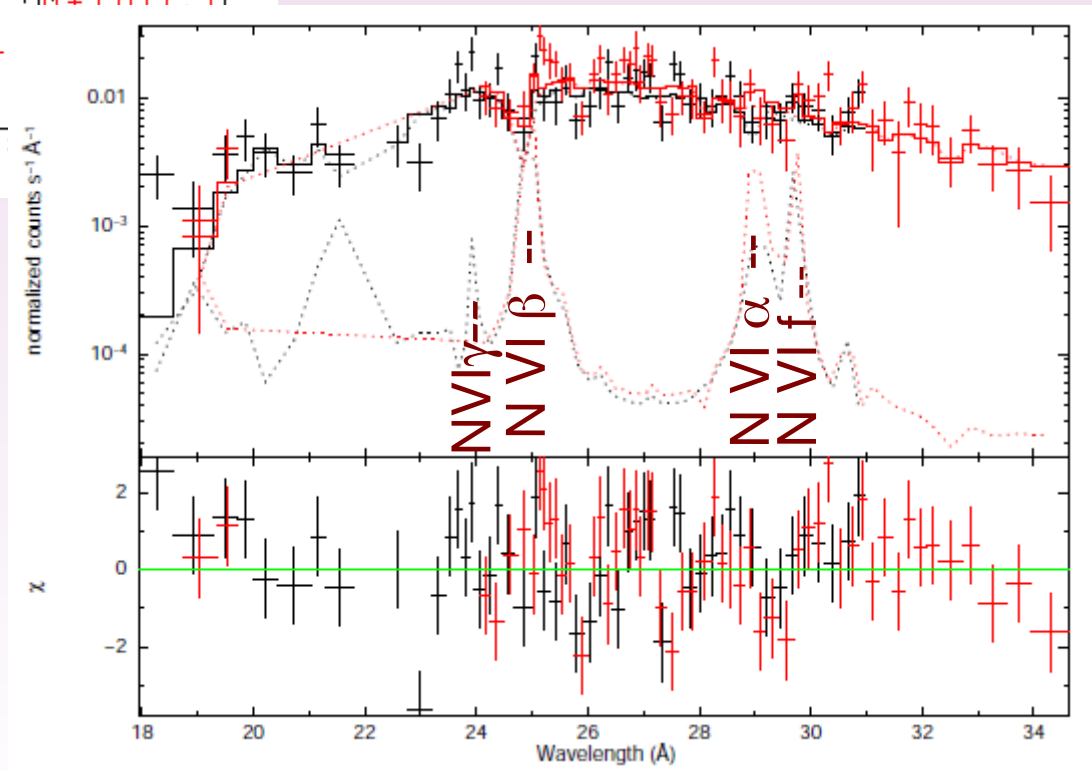


V5115 Sgr. The grating spectrum

Atmosphere T=7.8e5 K



Atmosphere T=7.8e5
+ Plasma kT=0.5 keV



Summary

- Both **V5115 Sgr** and **V5116 Sgr** show two components in their X-ray spectra: WD atmosphere and collisional plasma.

- “Old” novae, not expanding anymore, features at rest wavelength.

- NLTE WD atmosphere models and plasma models provide reasonably good fits (but some features unexplained).

- Also ISM absorption models (TBnew) fail to fit all observed ISM features

V5116 Sgr

- X-ray lc period = optical (orbital) period. But dip during 2/3 of the orbit incompatible with eclispe by the secondary => accretion disk obscuring the WD for 2/3 of the orbit: let us see WD and ejecta components with changing contributions.

- Same atmosphere temperature in low and high flux (indicating obscuration effect rather than intrinsic change in the WD emission).

- RGS spectra:

Lines at rest wavelength. N enhancement.

High flux period: Atmosphere plus some residuals explained by plasma component as seen in “low”

Low flux period, dip: Fainter (1/8) atmosphere plus collisional plasma emission from ejecta

=> from ejecta, enhanced N, not so much C