Classification of High-resolution X-ray spectra of Super-Soft-Sources

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Conclusions

1) Grating spectra reveal two types of SSS spectra
- Photospheric absorption line spectra
- Strong emission lines on top of weak continuum

→ SSS**a** and SSS**e**

2) SSS**e** mostly high inclination angle systems

3) SSS**e** could be SSS**a** with partially obscured continuum

Significant fraction of continuum comes from Thomson scattering

(shown by eclipses ← U Sco)

Version of February 6, 2013
Preprint typeset using LaTeX style emulateapj v. 03/07/07

EFFECT OF VIEWING ANGLE ON SUPER-SOFT-SOURCE X-RAY SPECTRA

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ABSTRACT

Systematic comparative studies of a large set of archival high-resolution X-ray grating spectra of Super-Soft-Sources (SSS) as well as Classical Novae (CNe) and Recurrent Novae (RNe) during their SSS phase reveal two distinct types of spectra which we name SSSa and SSSe. Their main

*Arvind Parmar et al. 1998, A&A **332**, 199*

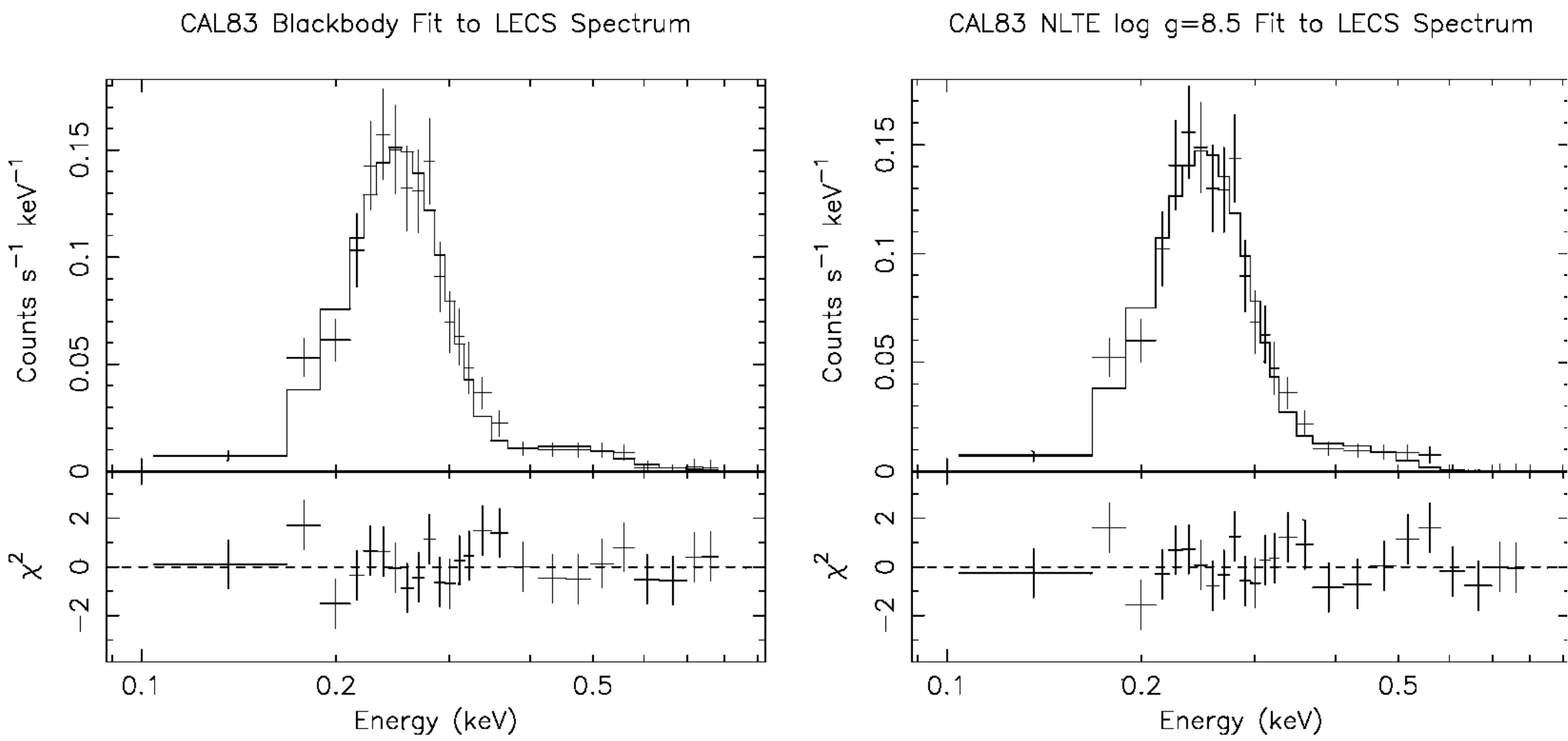


Fig. 1. Best-fit absorbed blackbody (left-panel) and NLTE (right panel) model fits to the LECS CAL 83 spectrum

T_{eff}=41eV; L_{bol}=0.2-0.7L_{Edd}; χ^2_{red}=0.75 | T_{eff}=33eV; L_{bol}=0.3L_{Edd}; χ^2_{red}= 0.8

*Arvind Parmar et al. 1998, A&A **332**, 199*

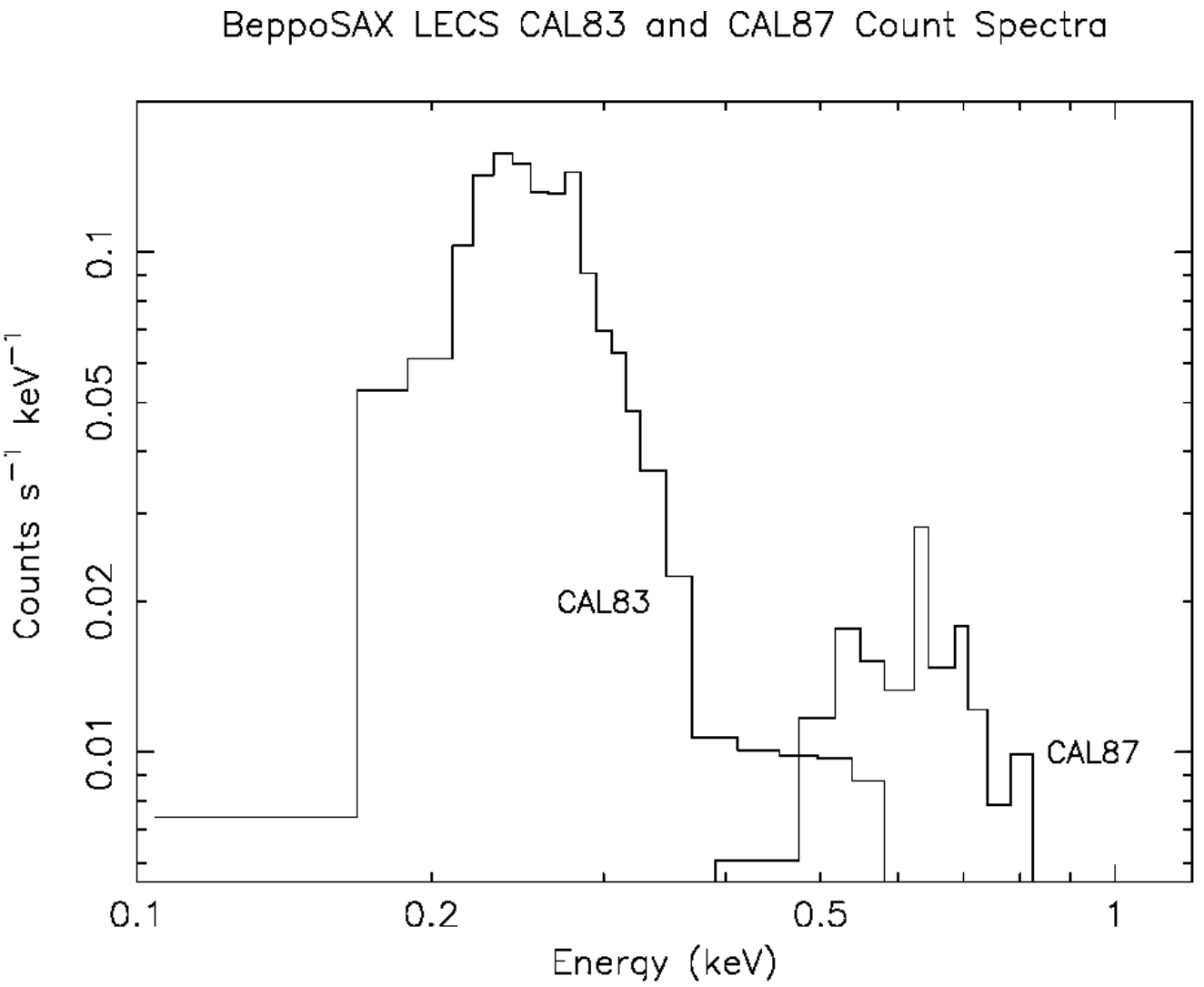
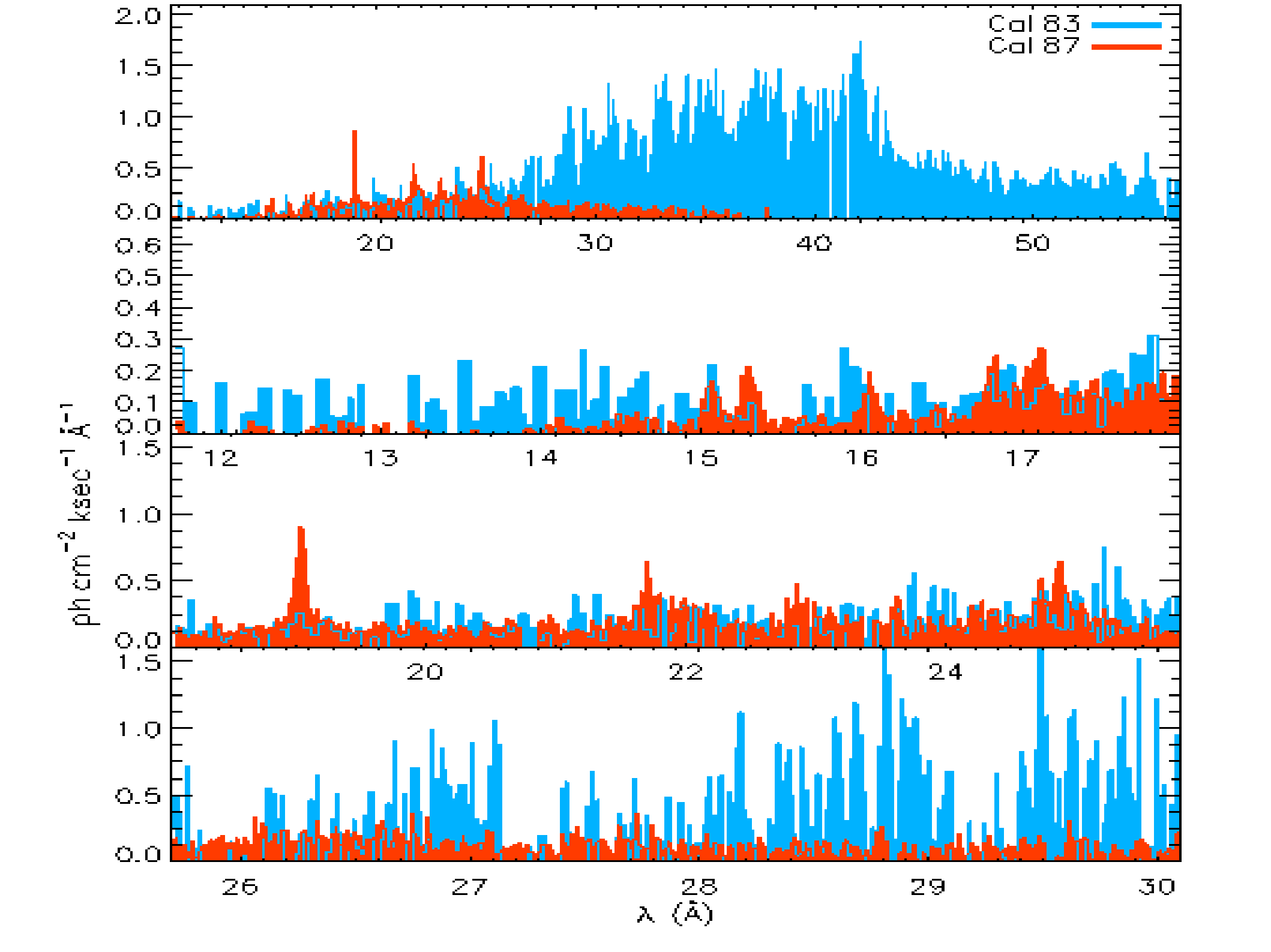
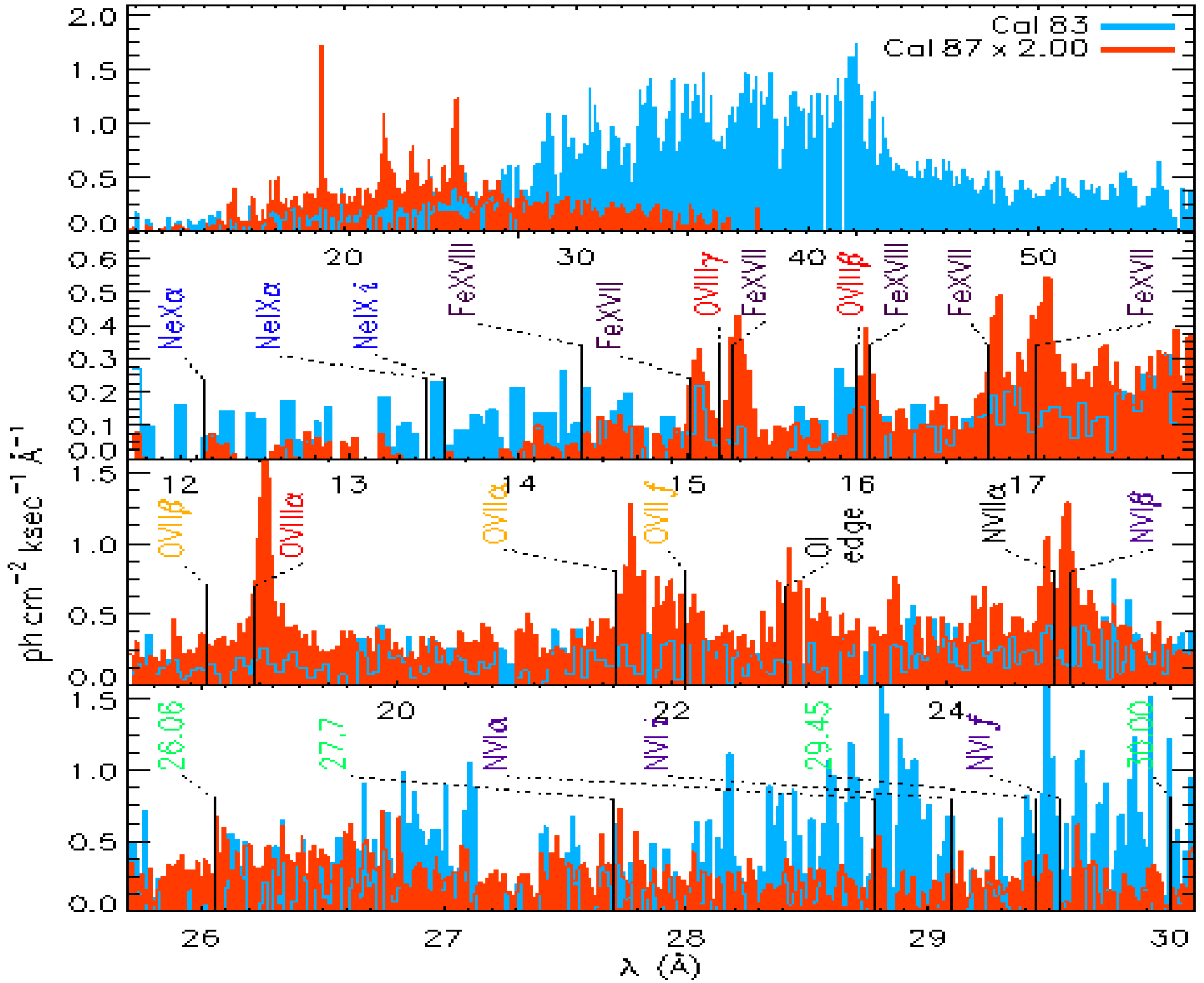
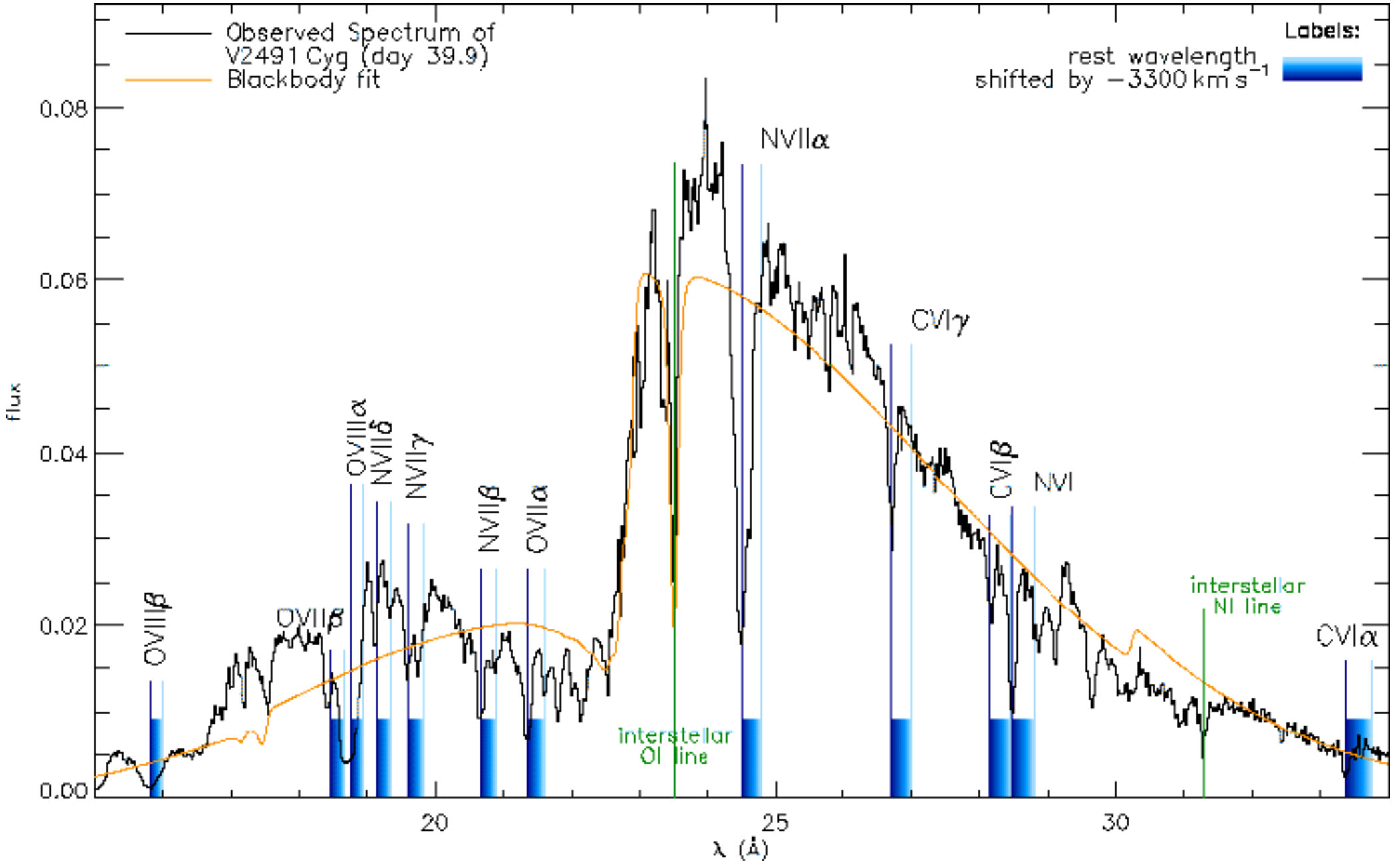


Fig. 3. Observed LECS count spectra for CAL 87 (taken from Parmar et al. (1997a) and CAL 83


Cal 83
Cal 87
ph cm^{-2} ksec^{-1} Å^{-1}
λ (Å)


Cal 83
Cal 87 x 2.00
NeXα
NeIXα
NeIXi
FeXVIII
FeXVII
OVIIIγ
OVIIIβ
FeXVII
FeXVIII
FeXVII
FeXVII
OVIIβ
OVIIIα
OVIIα
OVIIγ
OI edge
NVIIα
NVIIβ
26.06
27.7
NVIα
NVIIδ
29.45
NVIε
30.00
ph cm^{-2} ksec^{-1} Å^{-1}
λ (Å)

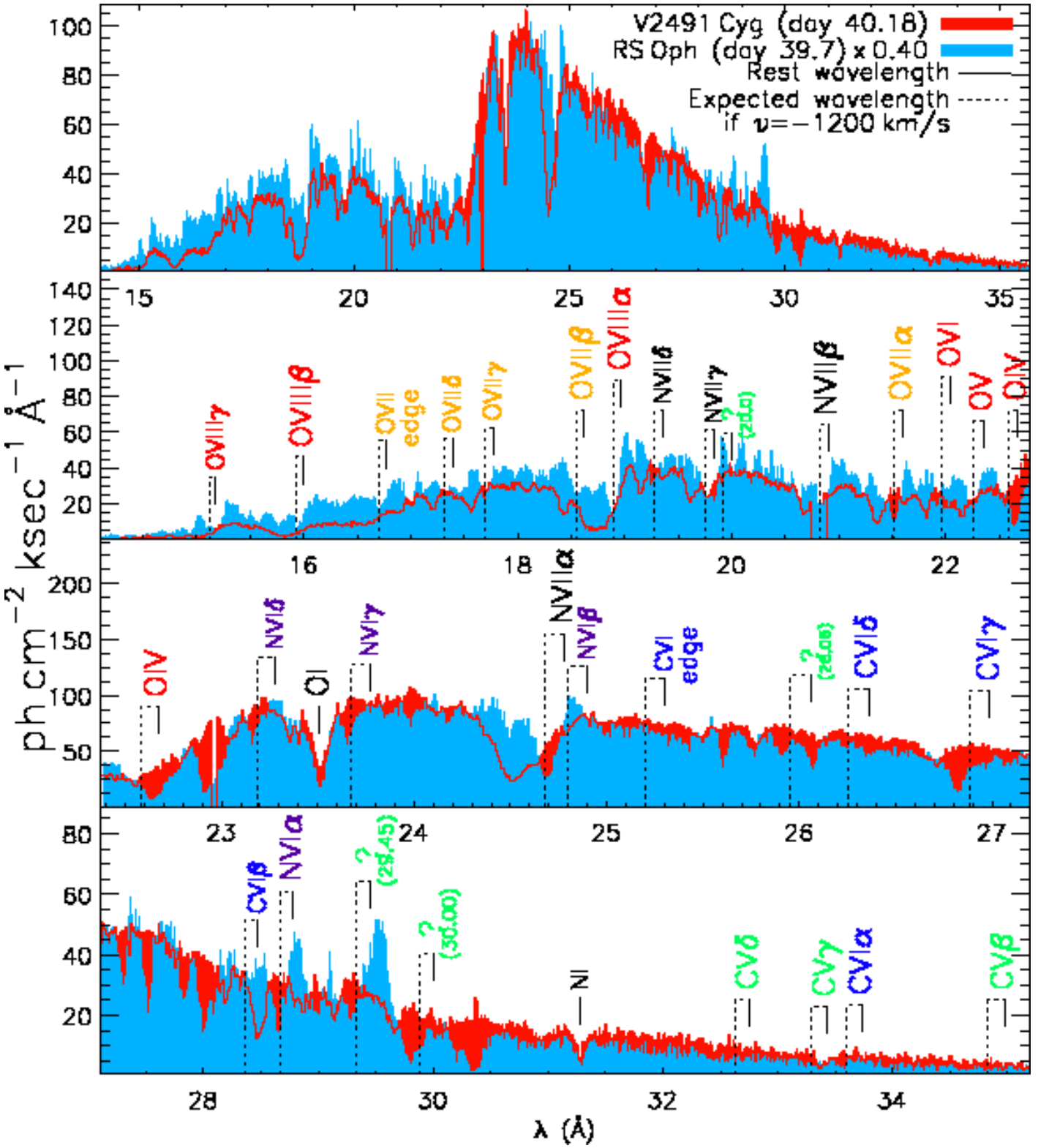
V2491 Cyg


Observed Spectrum of
V2491 Cyg (day 39.9)
Blackbody fit
Labels:
rest wavelength
shifted by −3300 km s^{-1}
OVIIIβ
OVIIδ
OVIIIα
NVIIδ
NVIIγ
NVIIβ
OVIIα
NVIIα
CVIγ
CVIβ
NVI
CVIα
interstellar
OI line
interstellar
NI line
flux
0.00
0.02
0.04
0.06
0.08
20
25
30
λ (Å)

RS Oph

vs

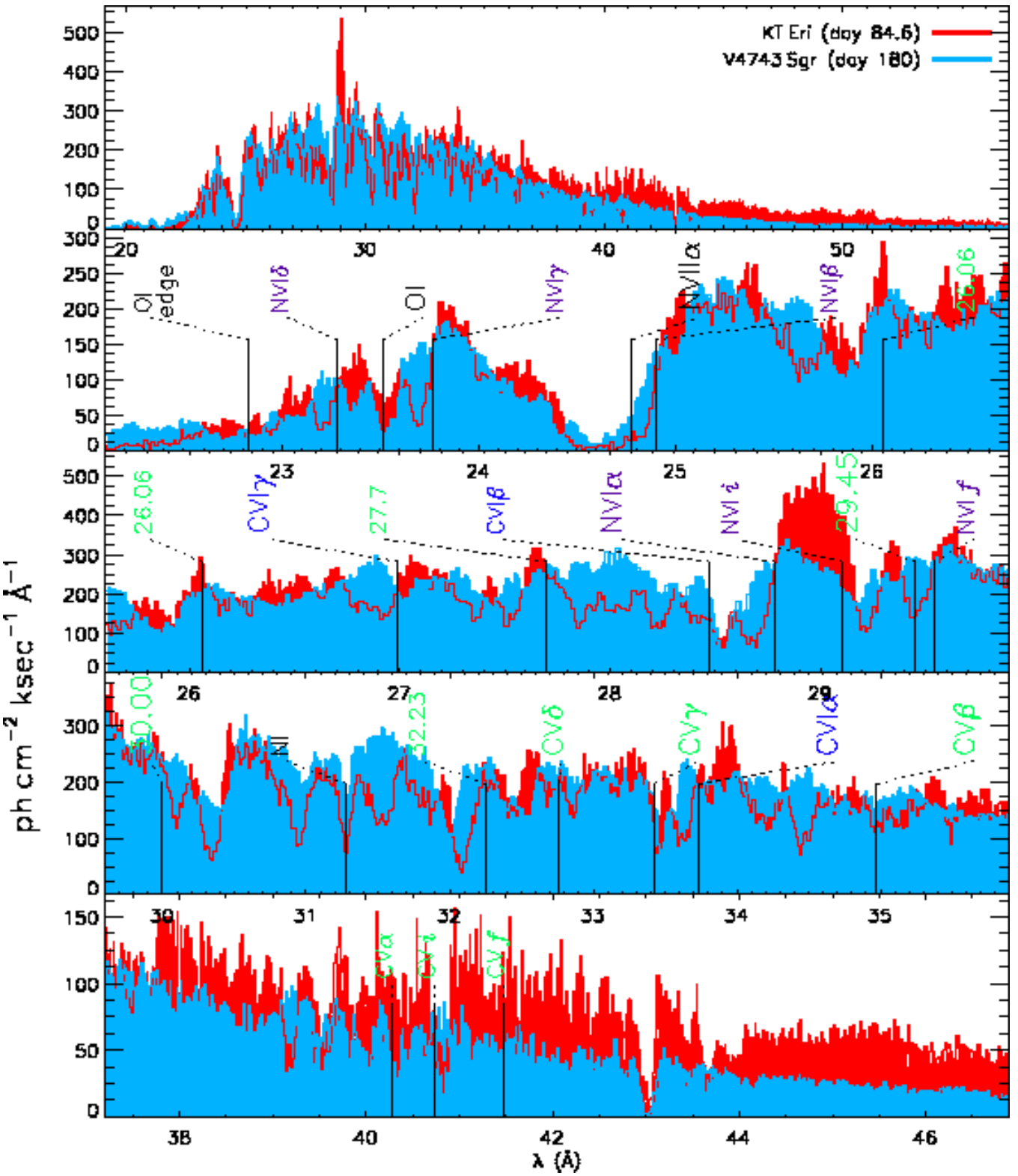
V2491 Cyg



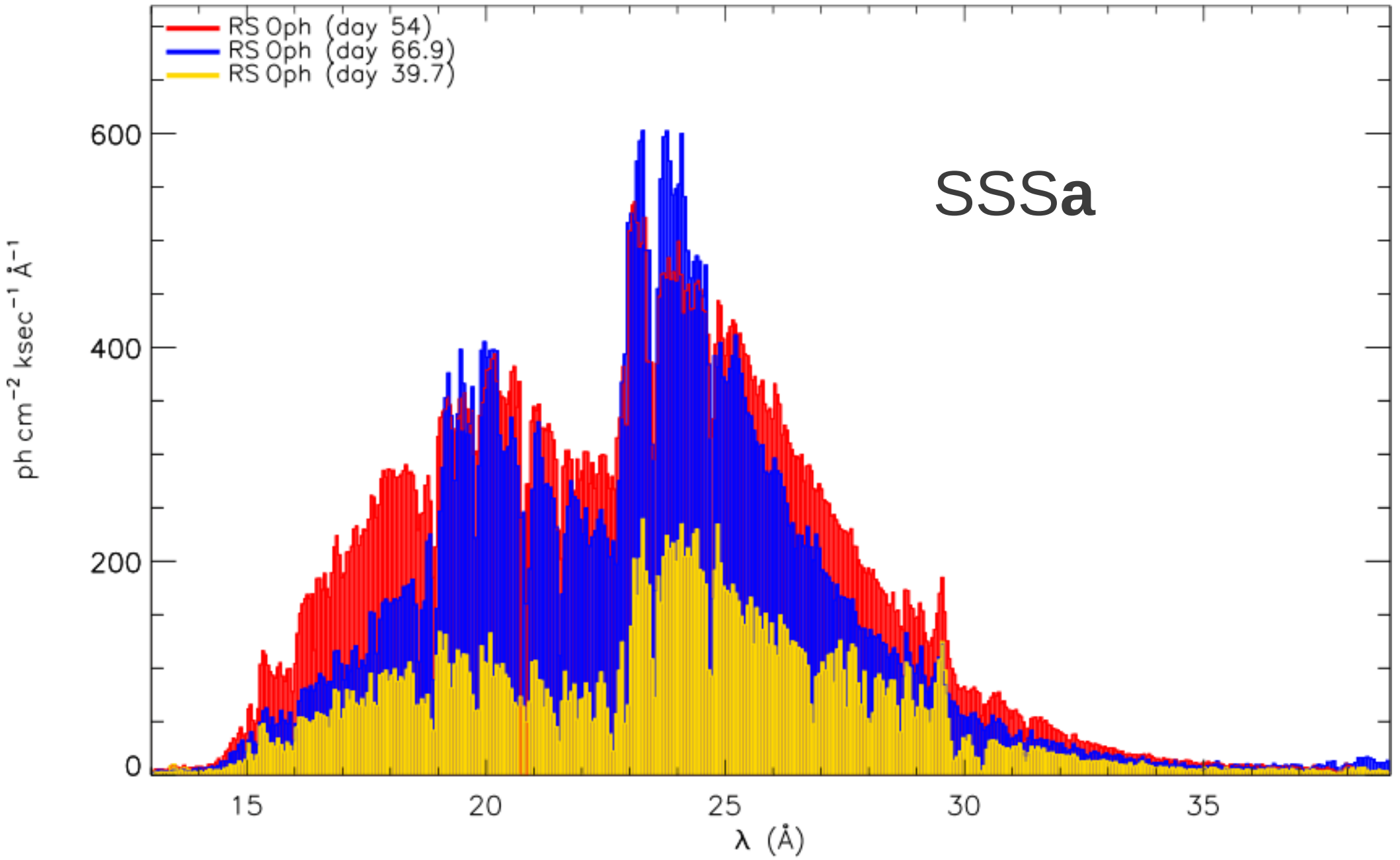
V4743 Sgr

vs

KT Eri

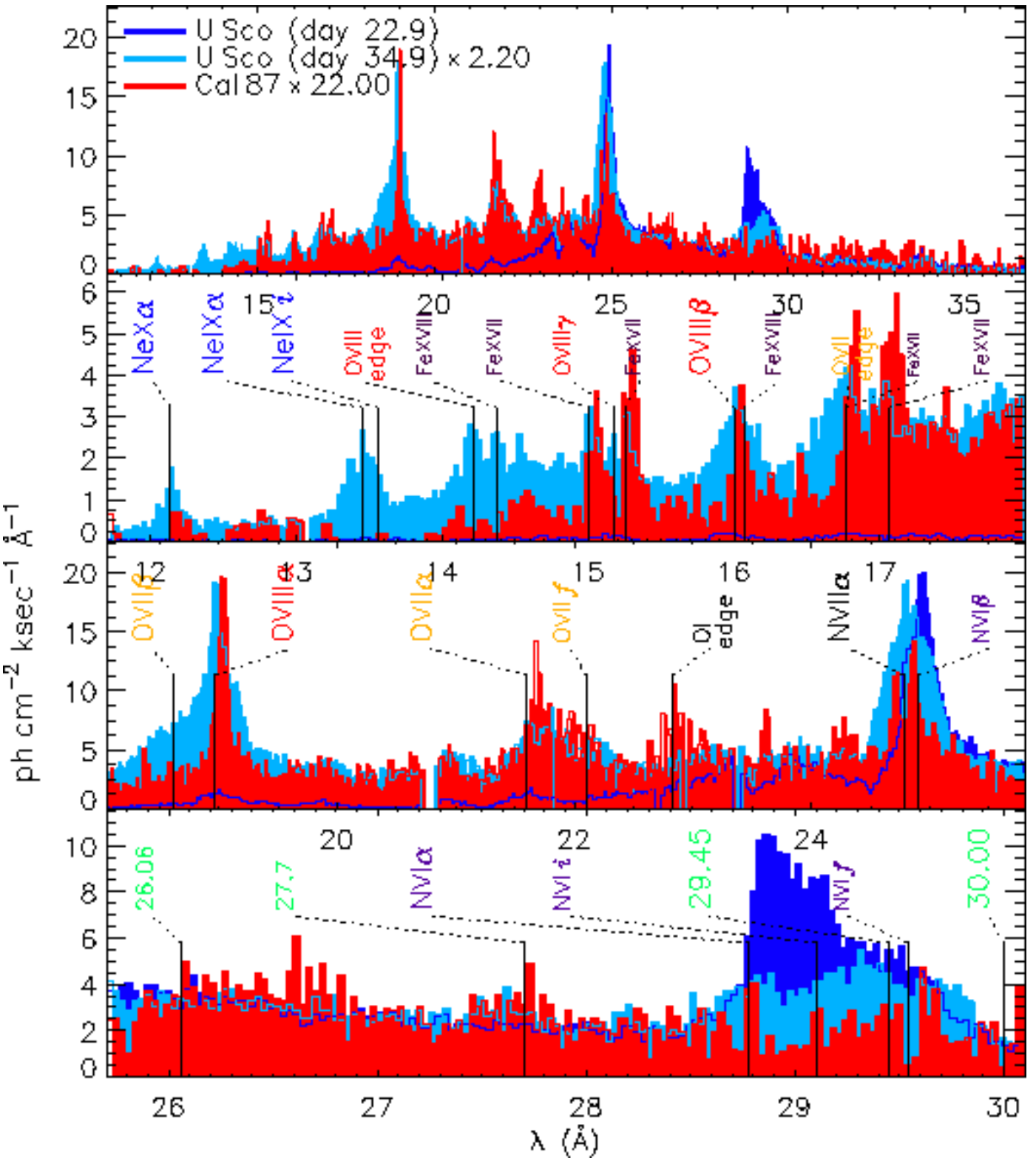


RS Oph in time



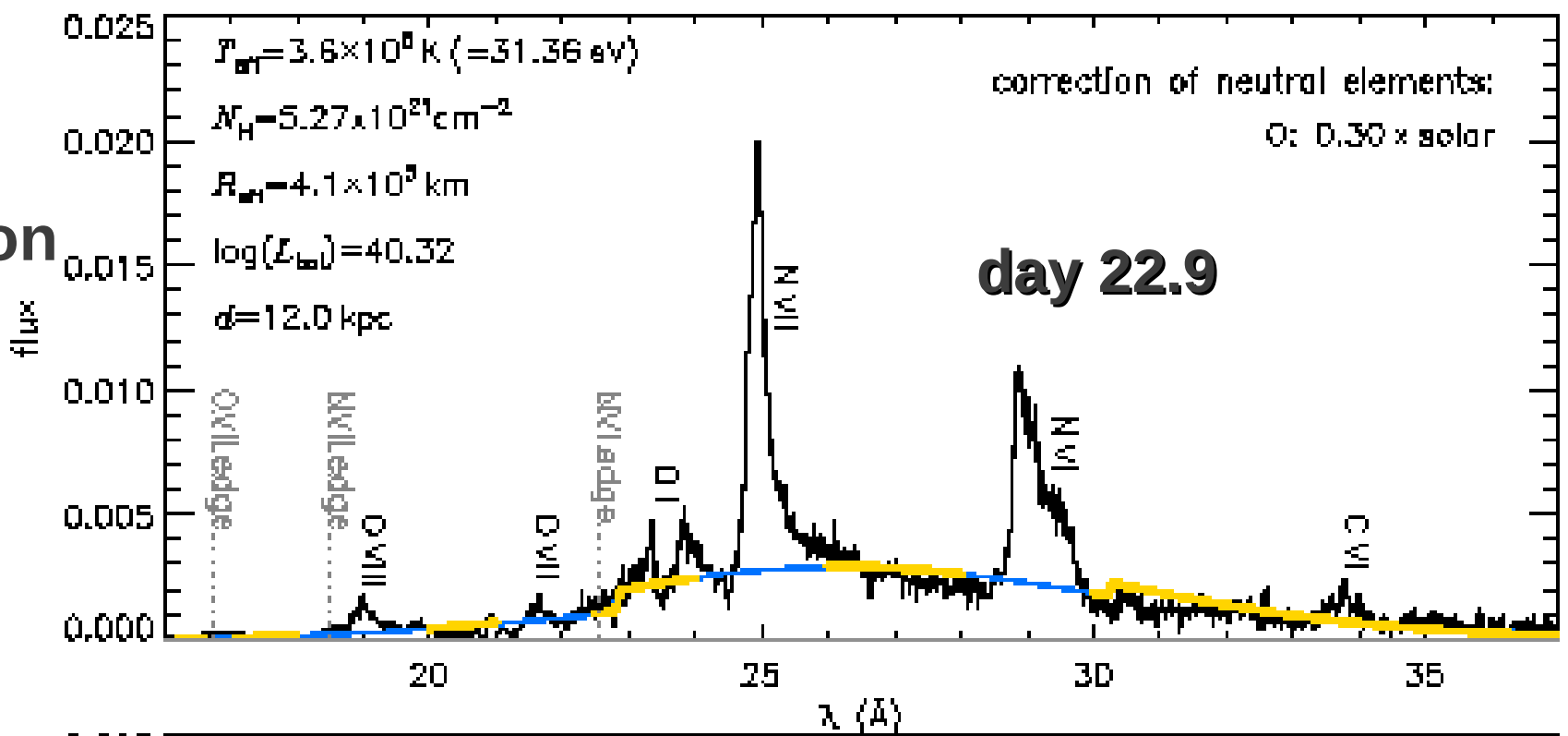
U Sco vs Cal 87

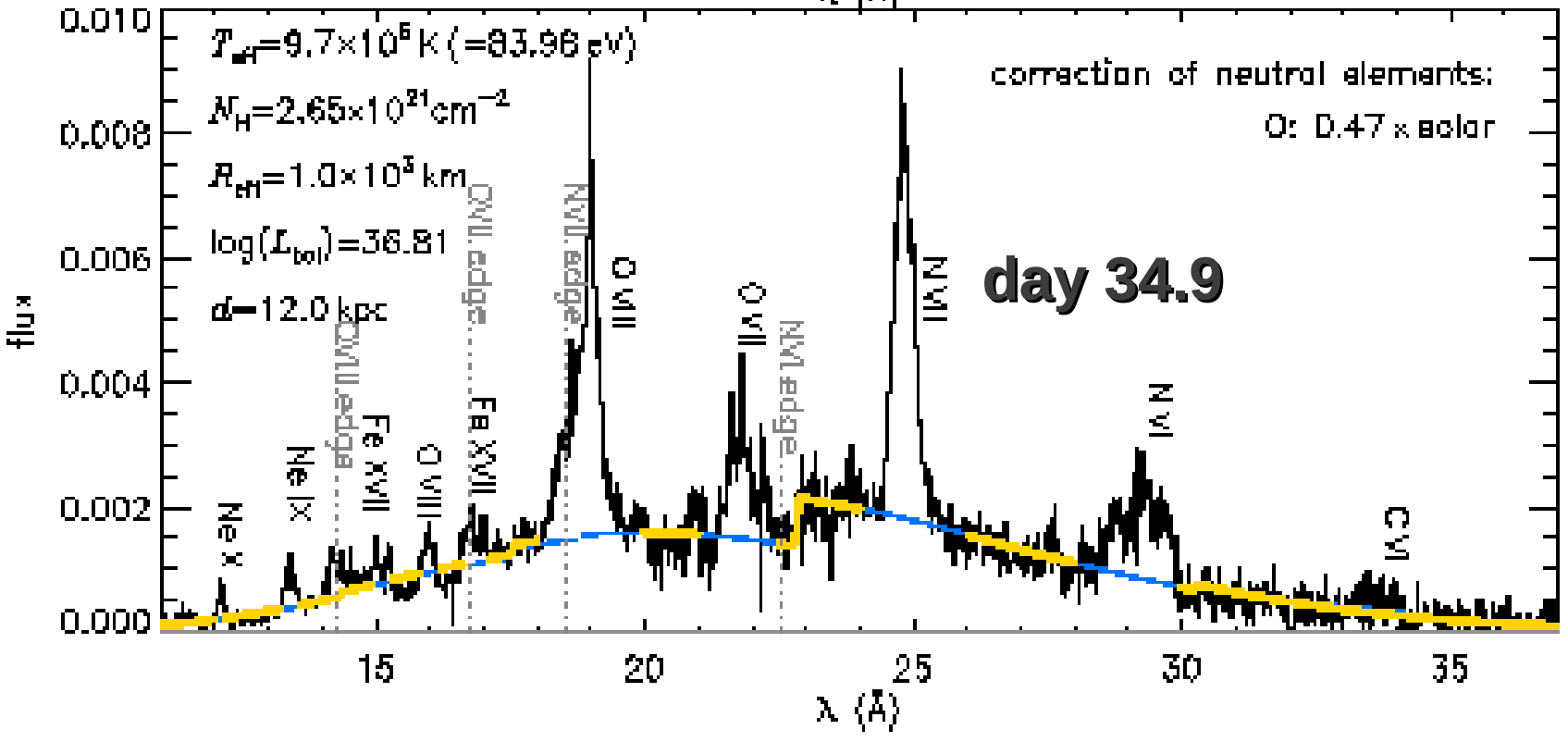
SSSe



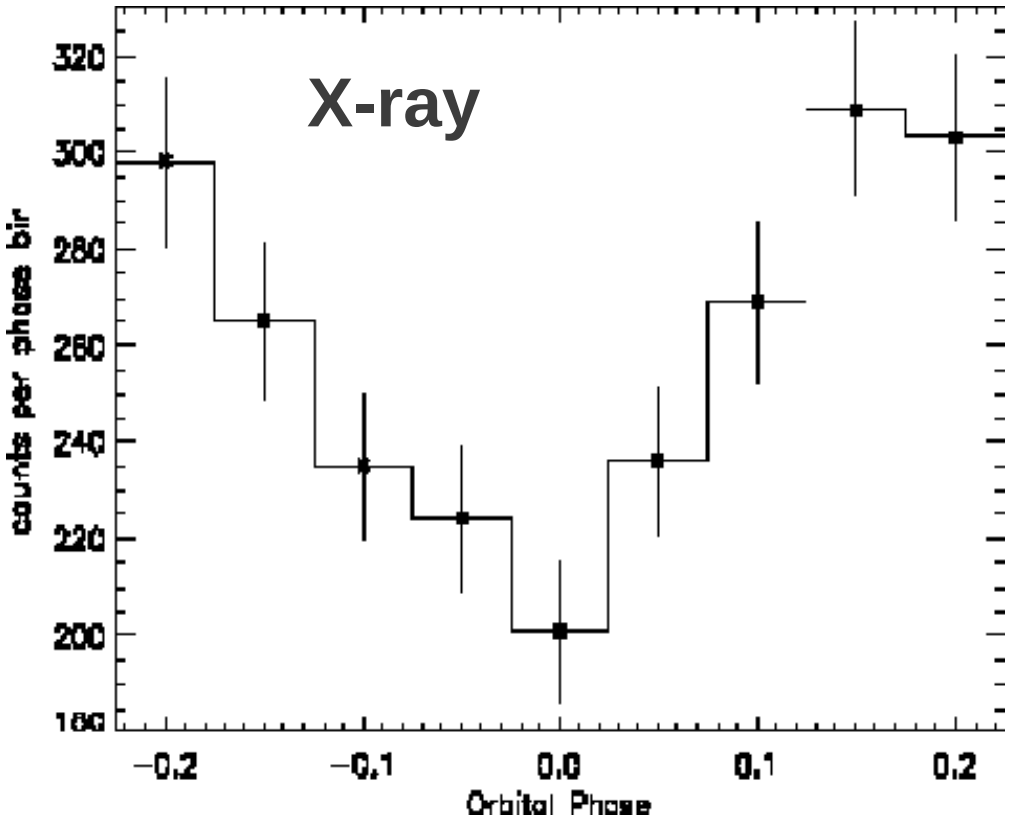
U Sco

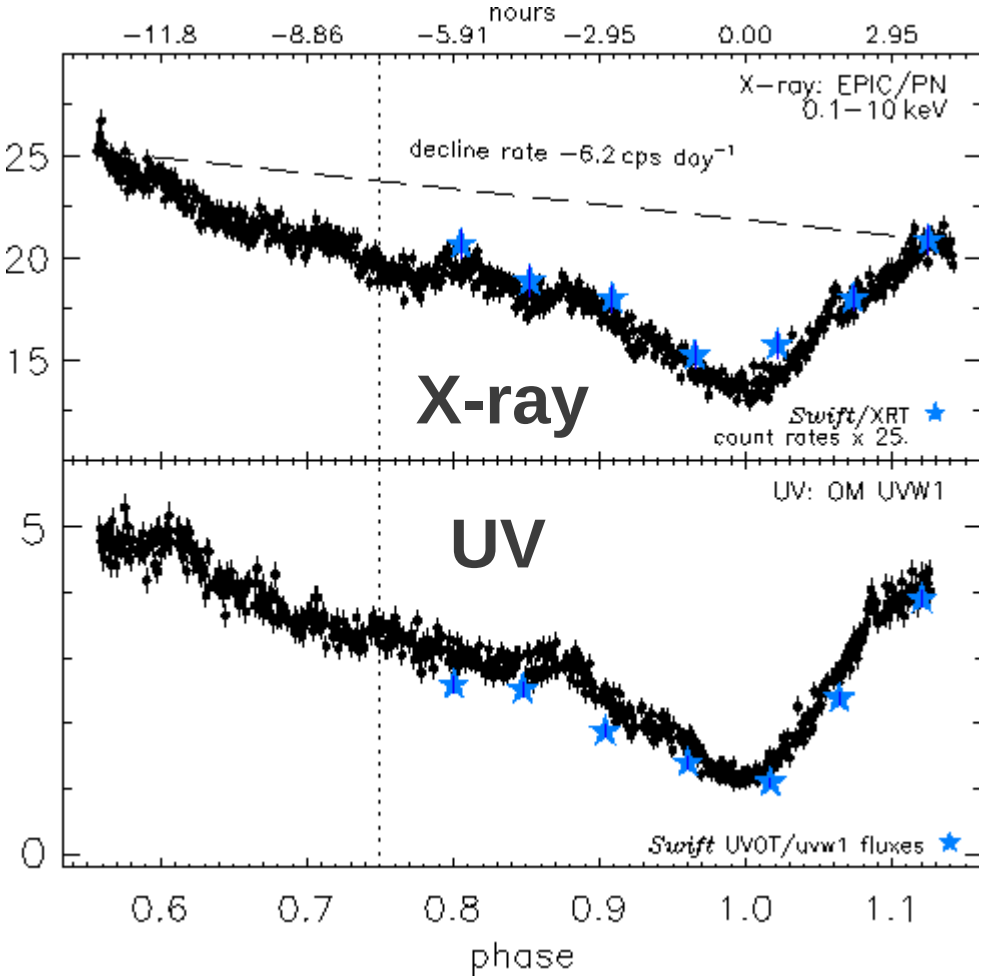
XMM-Newton spectra





Cal 87 & U Sco are eclipsing systems

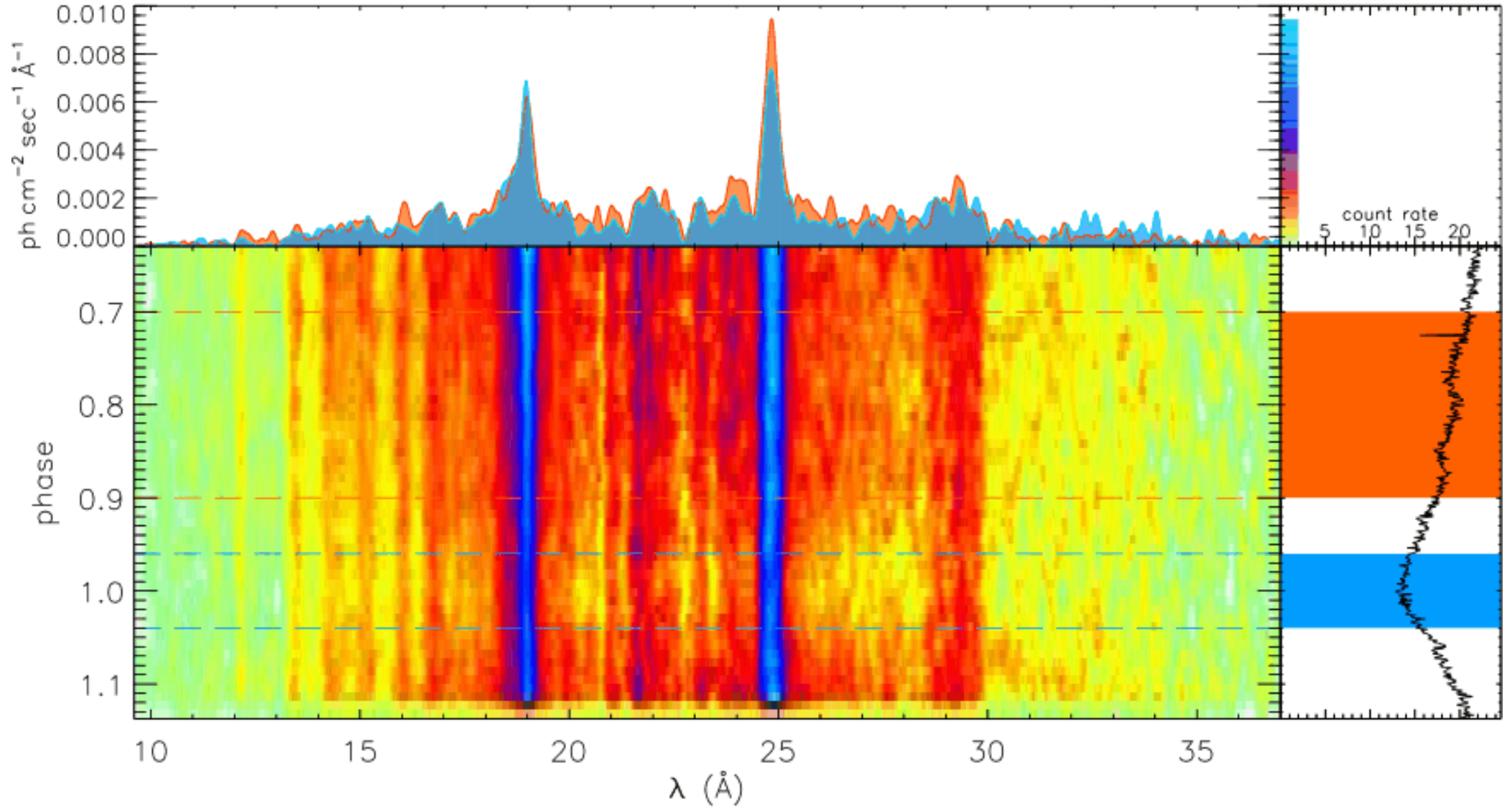




Greiner et al. 2004, Rev.MxAC, 20, 18

Ness et al. 2012, ApJ 745, 43

Spectral Time Map of U Sco



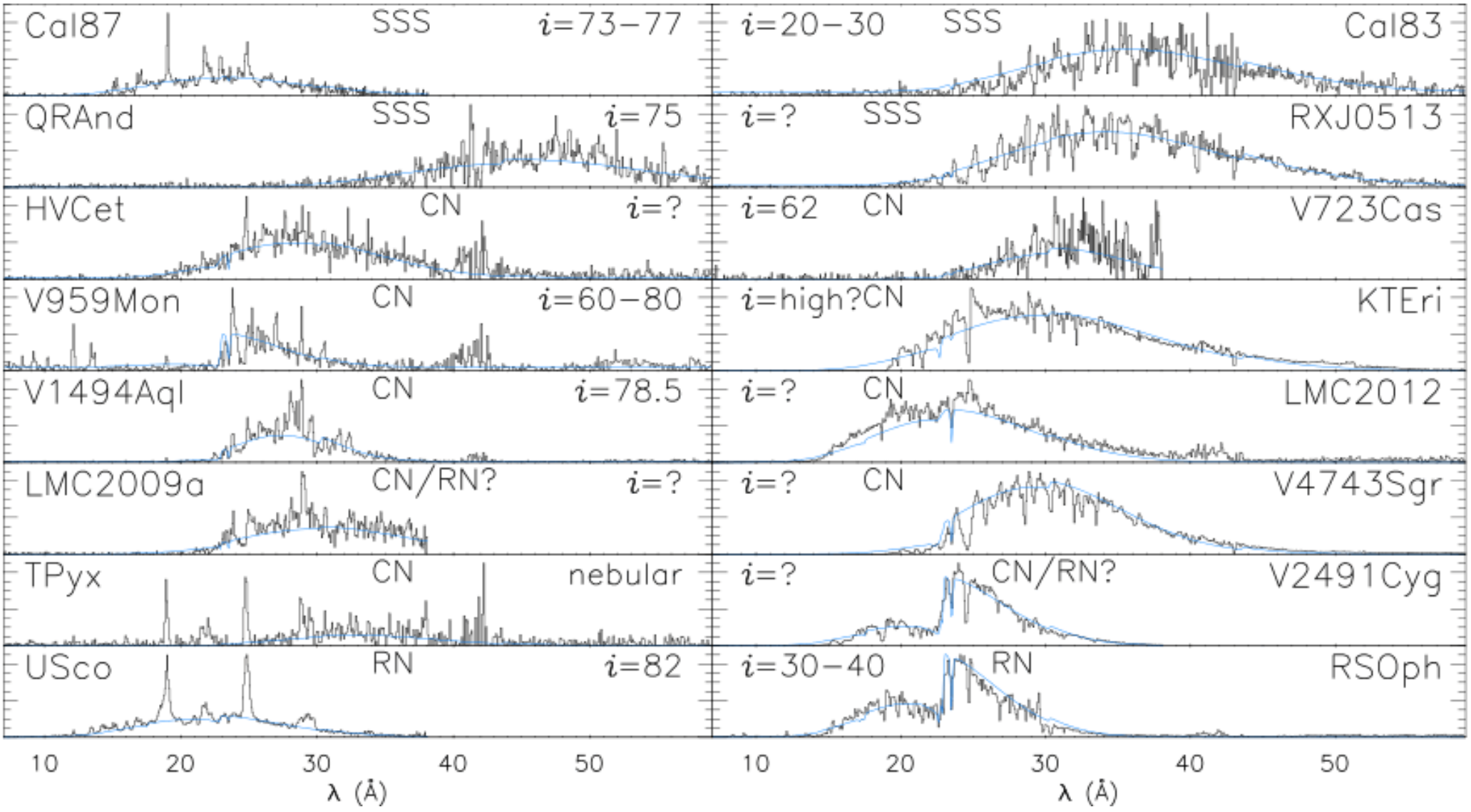
X-ray grating spectra of
- Super Soft Sources (SSS)
- Classical Novae (CN)
- Recurrent Novae (RN)

SSS**e**

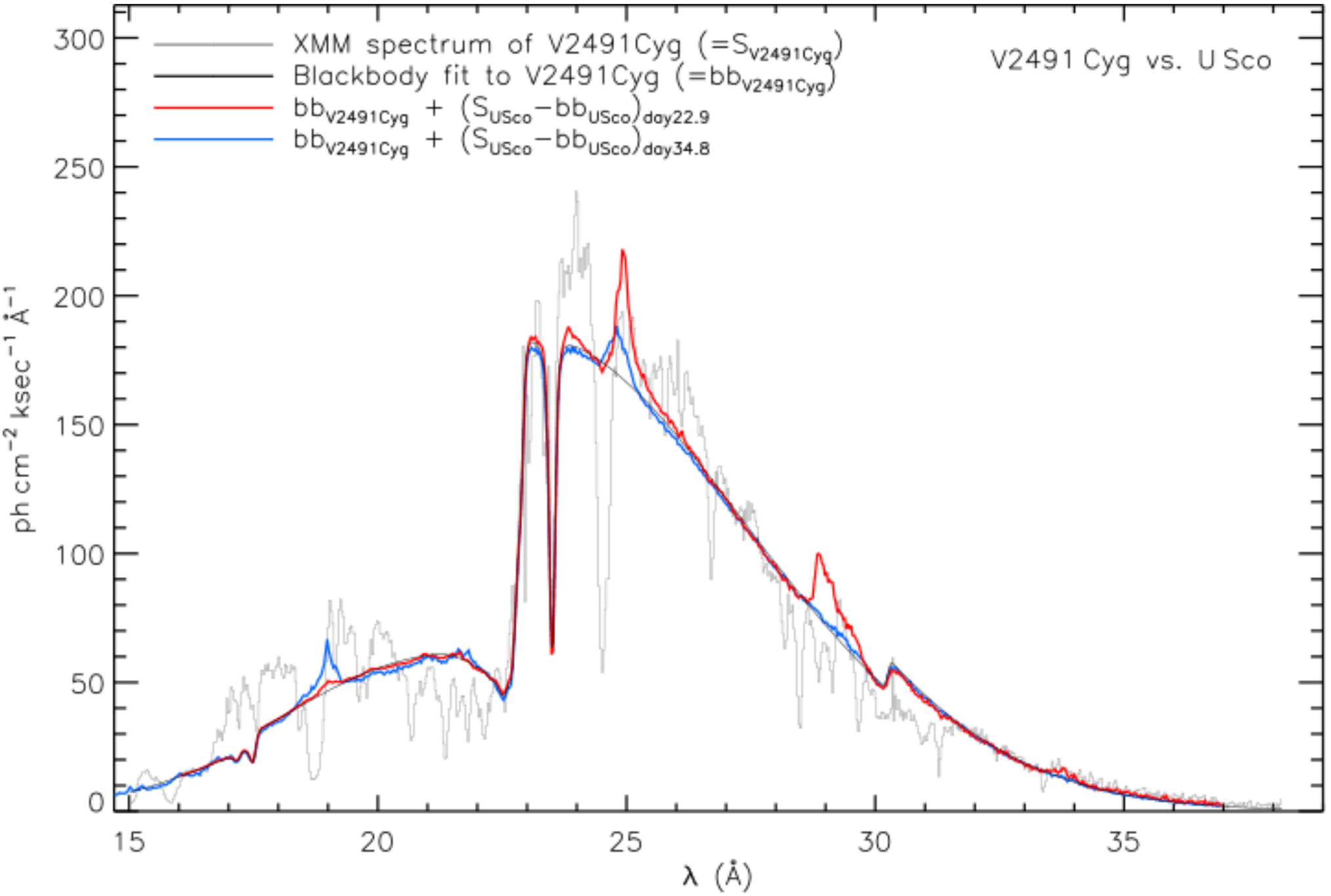
~ high i systems

SSS**a**

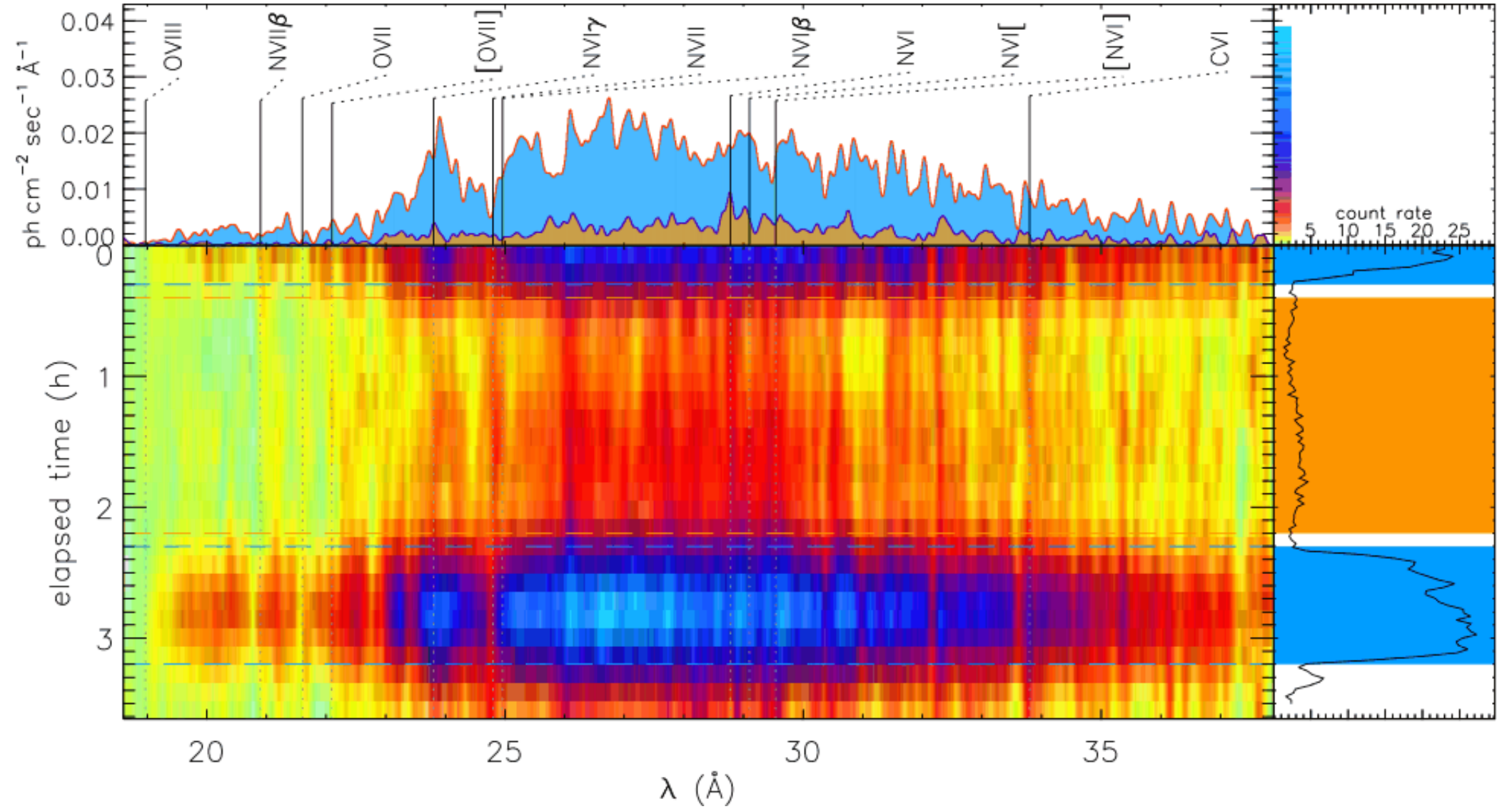
~ low i systems

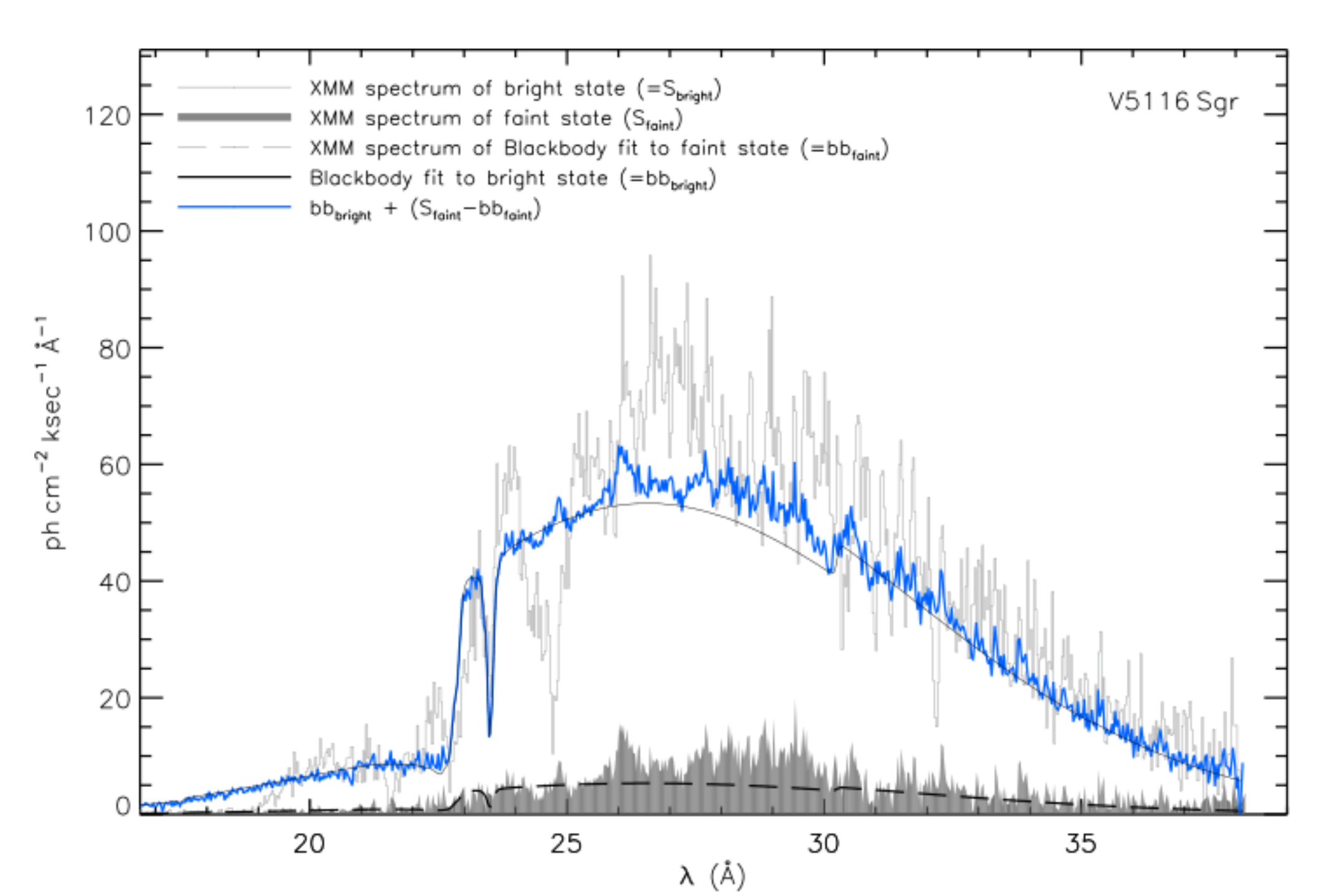


V2491 Cyg ⊕ U Sco

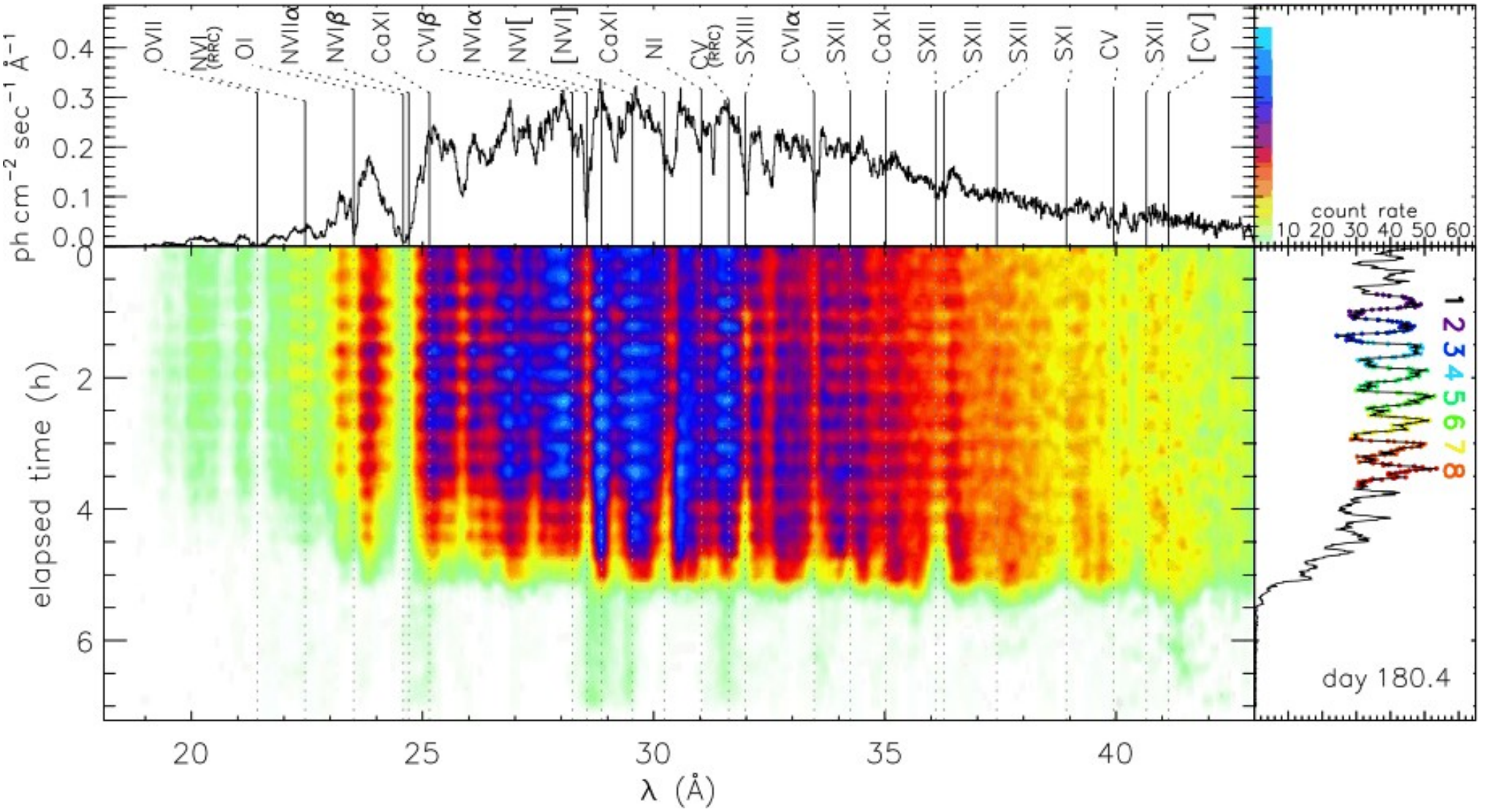


V5116 Sgr

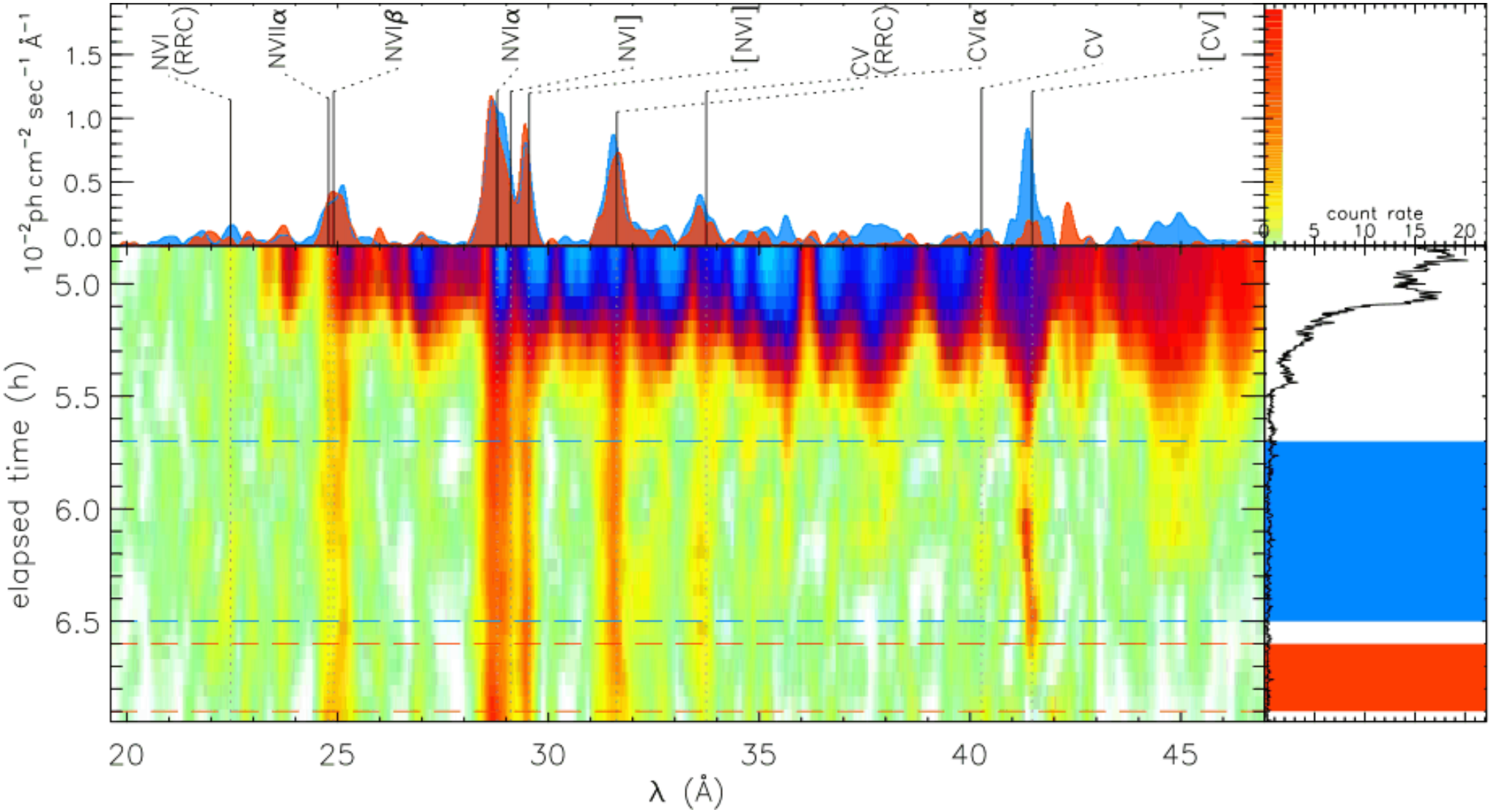

OVIII
NVII β
OVII
[OVII]
NVI γ
NVII
NVI β
NVI
NV[
[NVI]
CVI
ph cm^{-2} sec^{-1} Å^{-1}
0.04
0.03
0.02
0.01
0.00
count rate
5 10 15 20 25
elapsed time (h)
0
1
2
3
20
25
30
35
λ (Å)

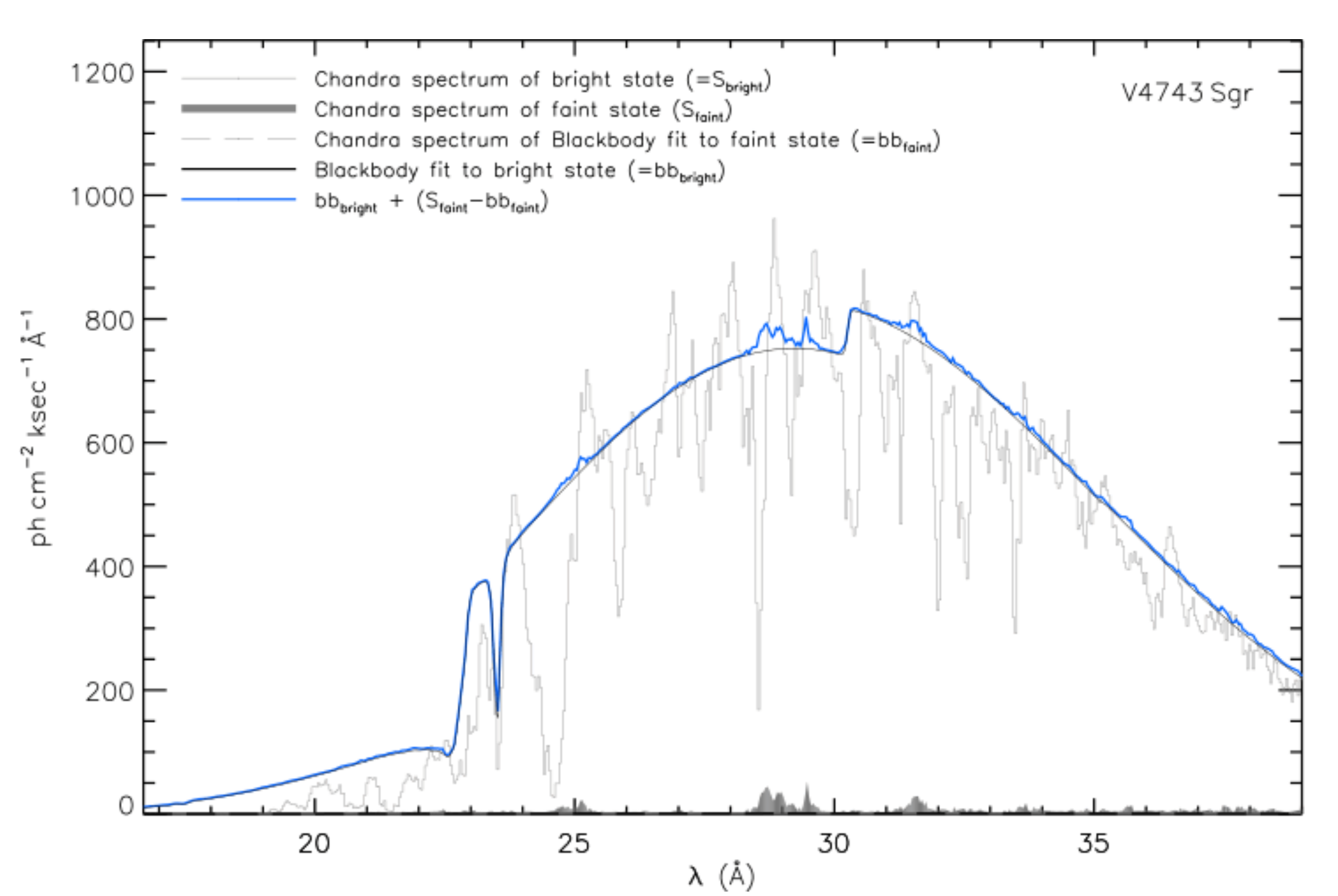

XMM spectrum of bright state (=S$_{bright}$)
XMM spectrum of faint state (S$_{faint}$)
XMM spectrum of Blackbody fit to faint state (=bb$_{faint}$)
Blackbody fit to bright state (=bb$_{bright}$)
bb$_{bright}$ + (S$_{faint}$−bb$_{faint}$)
V5116 Sgr
ph cm^{-2} ksec^{-1} Å^{-1}
λ (Å)
0
20
40
60
80
100
120
20
25
30
35

V4743 Sgr


OVII
NVI (RRC)
OI
NVIIα
NVIβ
CaXI
CVIβ
NVIα
NVI[
[NVI]
CaXI
NI
CV (RRC)
SXIII
CVIα
SXII
CaXI
SXII
SXII
SXII
SXI
CV
SXII
[CV]
ph cm^{-2} sec^{-1} Å^{-1}
0.0
0.1
0.2
0.3
0.4
count rate
10 20 30 40 50 60
elapsed time (h)
0
2
4
6
1 2 3 4 5 6 7 8
day 180.4
20
25
30
35
40
λ (Å)

V4743 Sgr


NVI (RRC)
NVIIα
NVIβ
NVIα
NVI]
[NVI]
CV (RRC)
CVIα
CV
[CV]
10⁻²ph cm⁻² sec⁻¹ Å⁻¹
1.5
1.0
0.5
0.0
count rate
0
5
10
15
20
elapsed time (h)
5.0
5.5
6.0
6.5
20
25
30
35
40
45
λ (Å)


Chandra spectrum of bright state (=S$_{bright}$)
Chandra spectrum of faint state (S$_{faint}$)
Chandra spectrum of Blackbody fit to faint state (=bb$_{faint}$)
Blackbody fit to bright state (=bb$_{bright}$)
bb$_{bright}$ + (S$_{faint}$−bb$_{faint}$)
V4743 Sgr
ph cm^{-2} ksec^{-1} Å^{-1}
λ (Å)
0
200
400
600
800
1000
1200
20
25
30
35

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- Photospheric absorption line spectra
- Strong emission lines on top of weak continuum

$\rightarrow$ SSS**a** and SSS**e**

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3) SSS**e** could be SSS**a** with partially obscured continuum