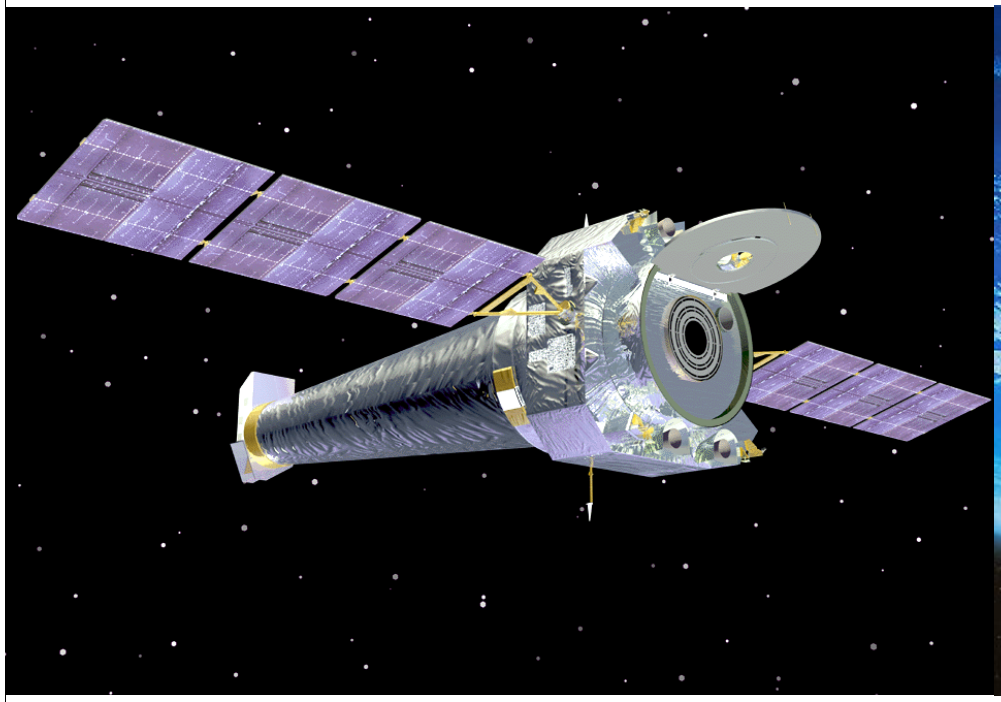
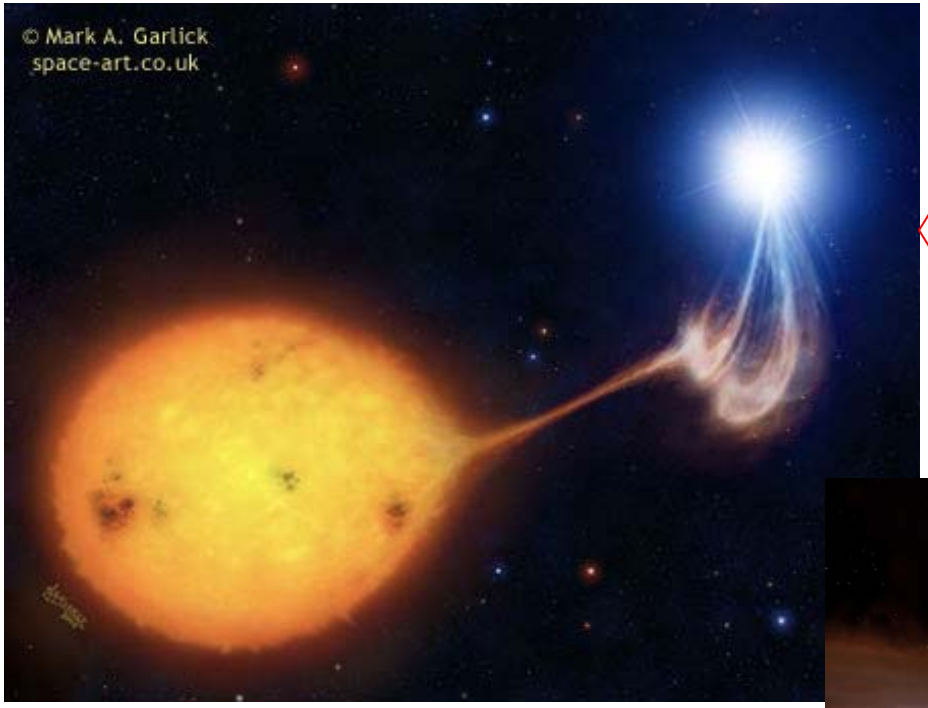
High-Resolution X-ray Spectra of magnetic CVs



Vadim Burwitz (MPE)

MSSL, March 28, 2006

Magnetic cataclysmic variables (mCVs)

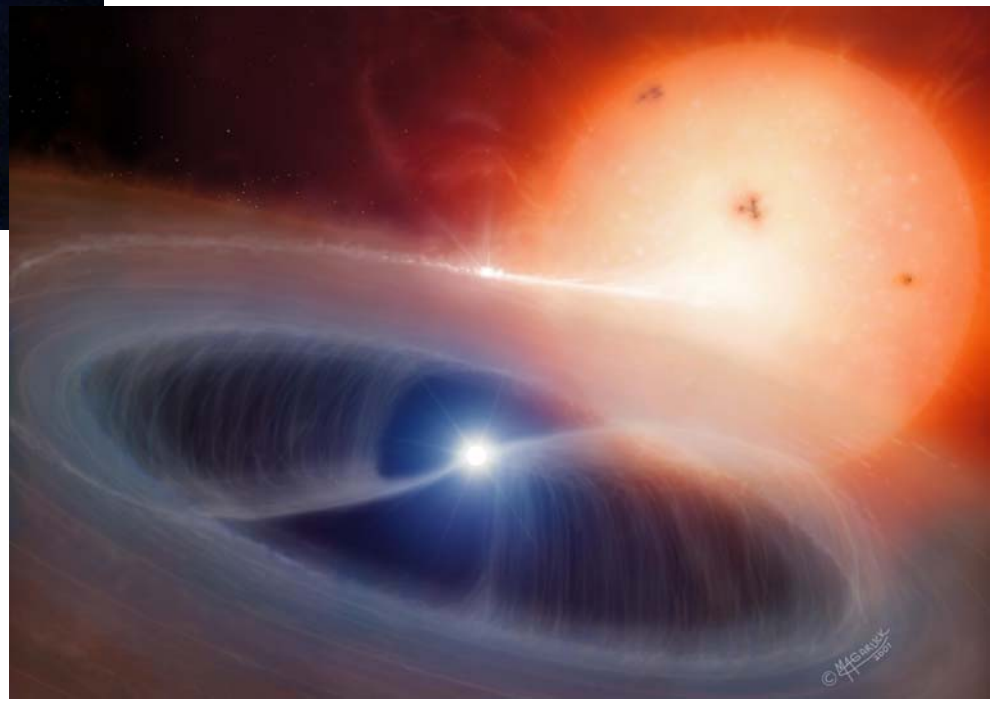


Polars

$P_{orb} = P_{spin}$ (synchronous)

No accretion disk

B ~ 10-200 MG



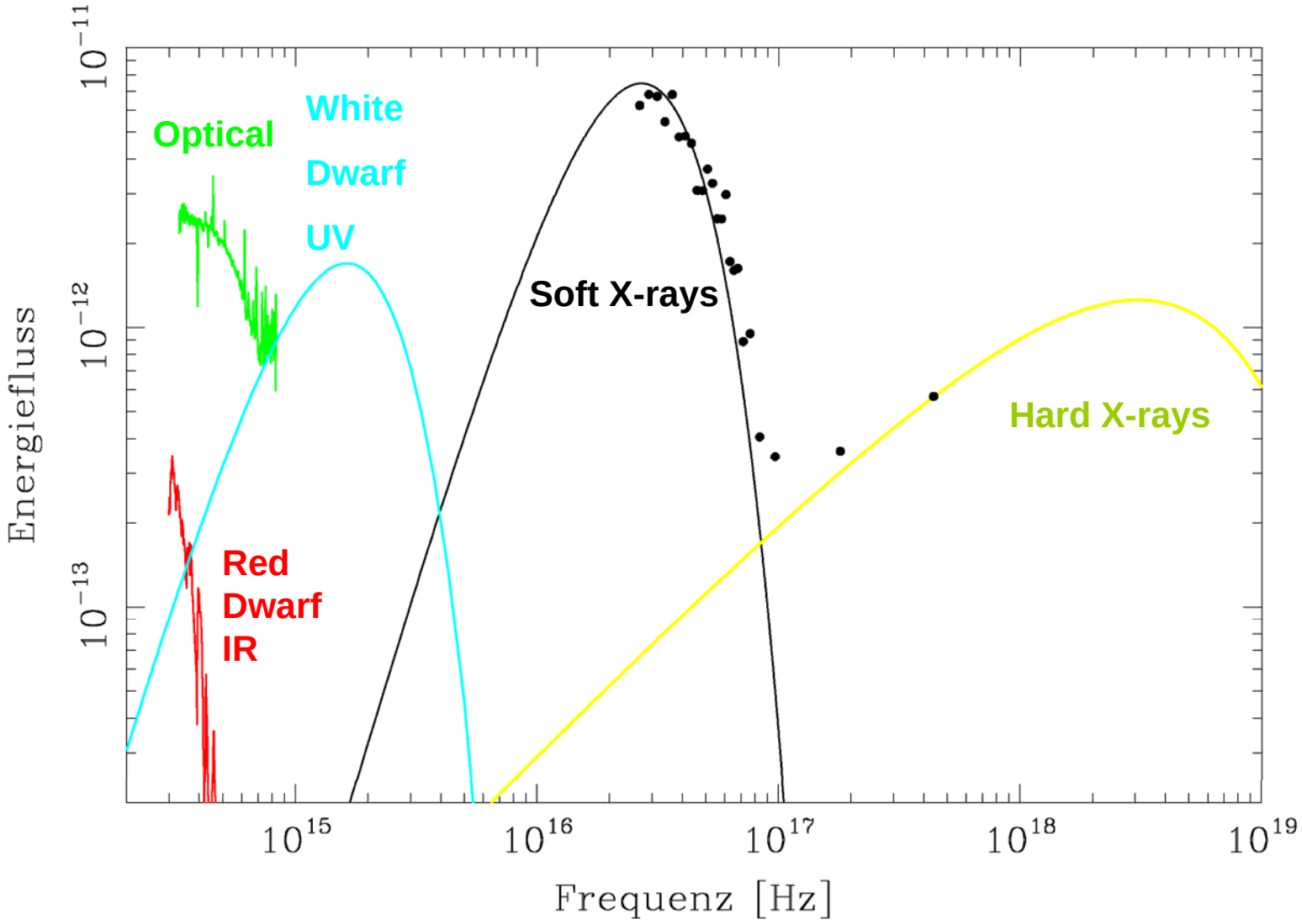
Intermediate Polars

$P_{orb} > P_{spin}$

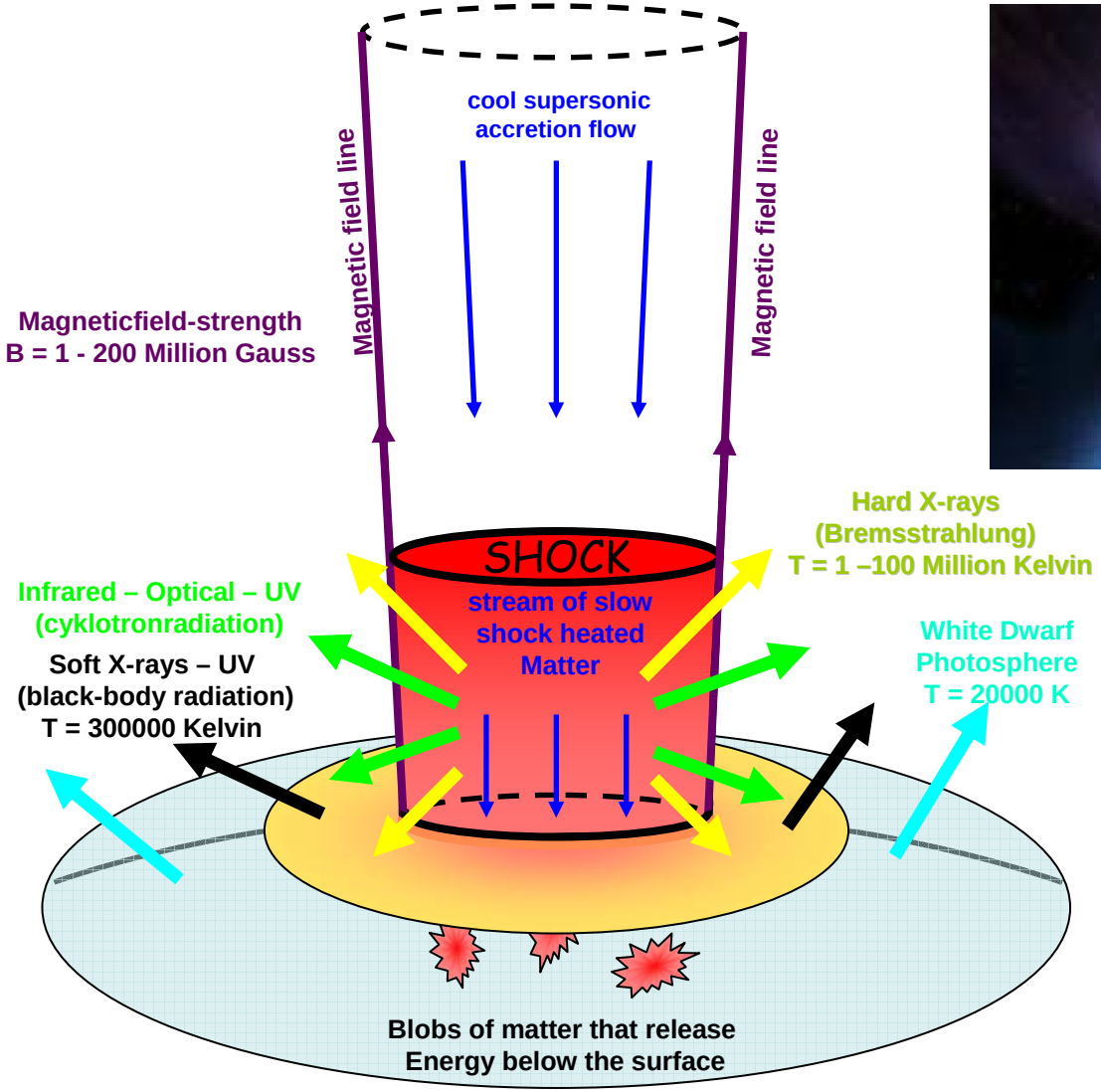
possible accretion disk

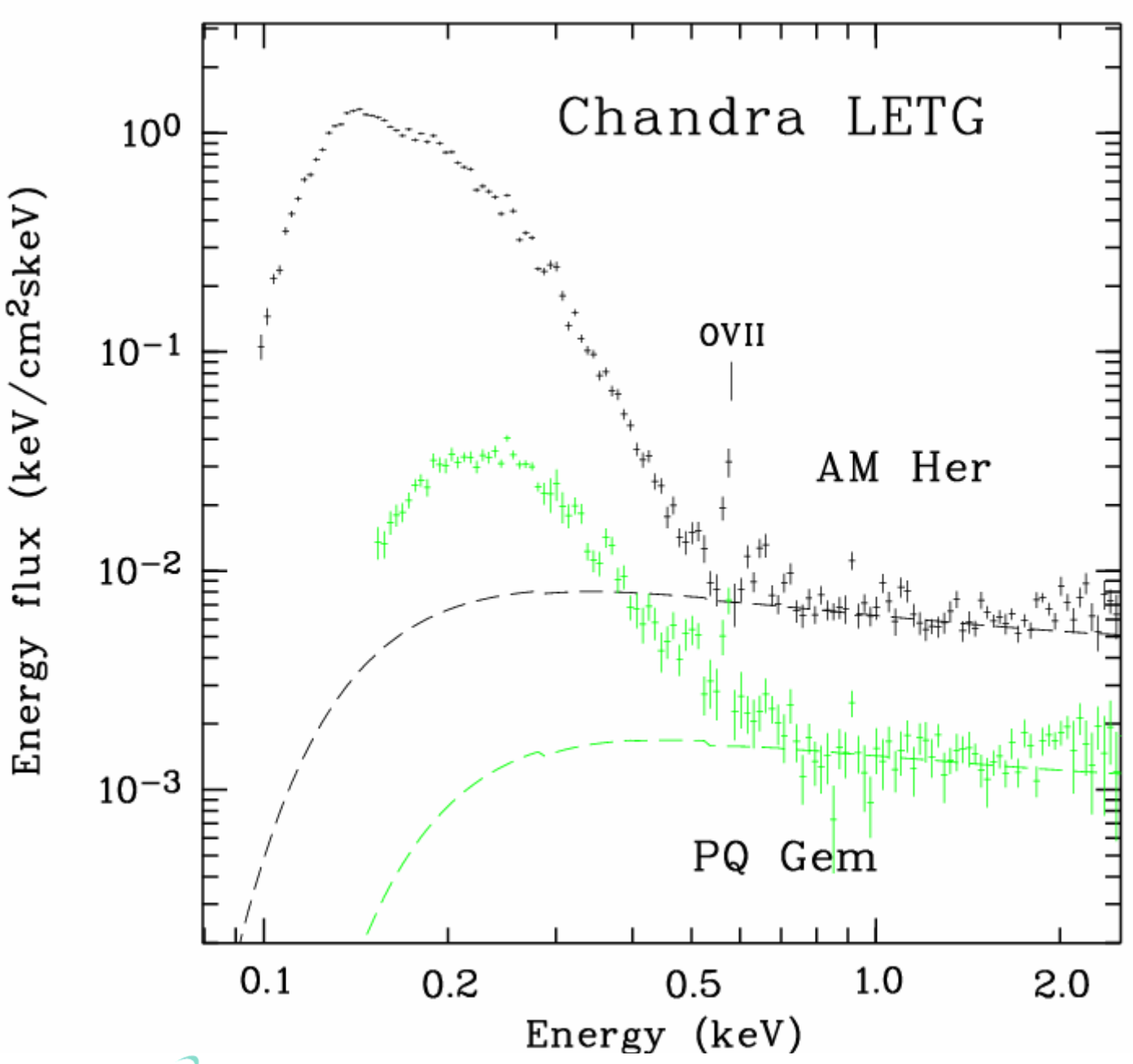
B upto 20 MG

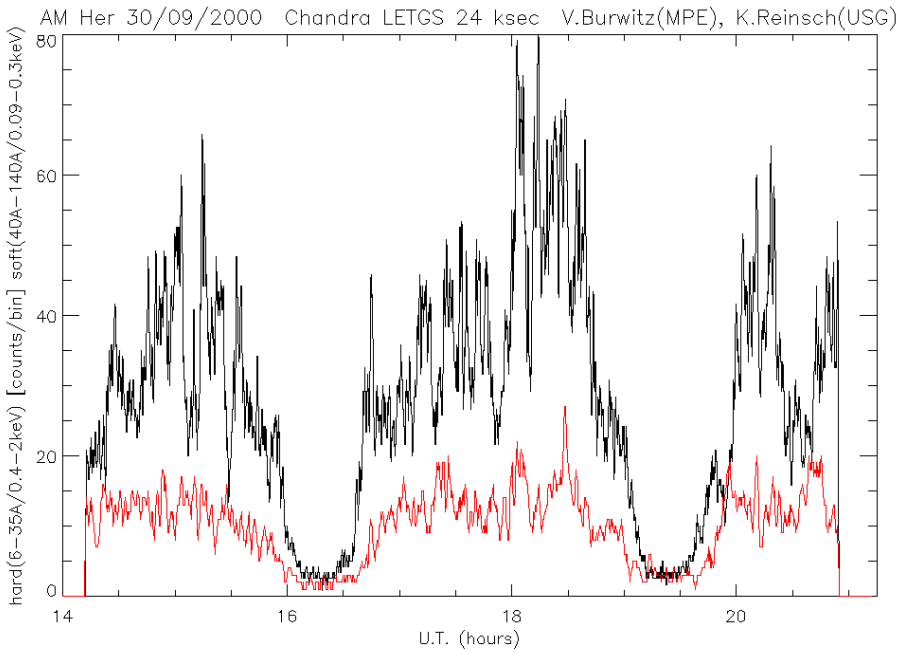
Overall spectrum of mCVs

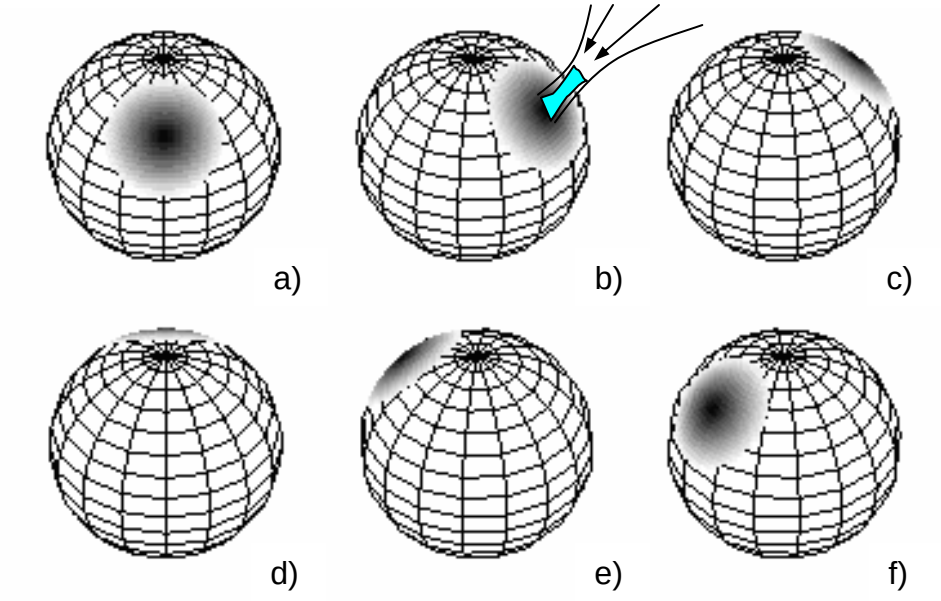


Standard accretion scenario in mCVs




Chandra LETG
OVII
AM Her
PQ Gem
Energy flux (keV/cm²skeV)
Energy (keV)
10⁰
10⁻¹
10⁻²
10⁻³
0.1
0.2
0.5
1.0
2.0





The Polar AM Herculis

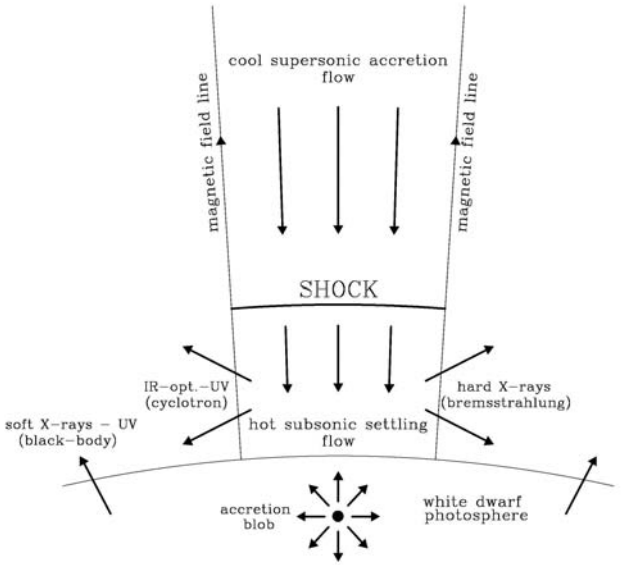
companion of type dM4

P_{orb} = 186 min = 3.1 hours

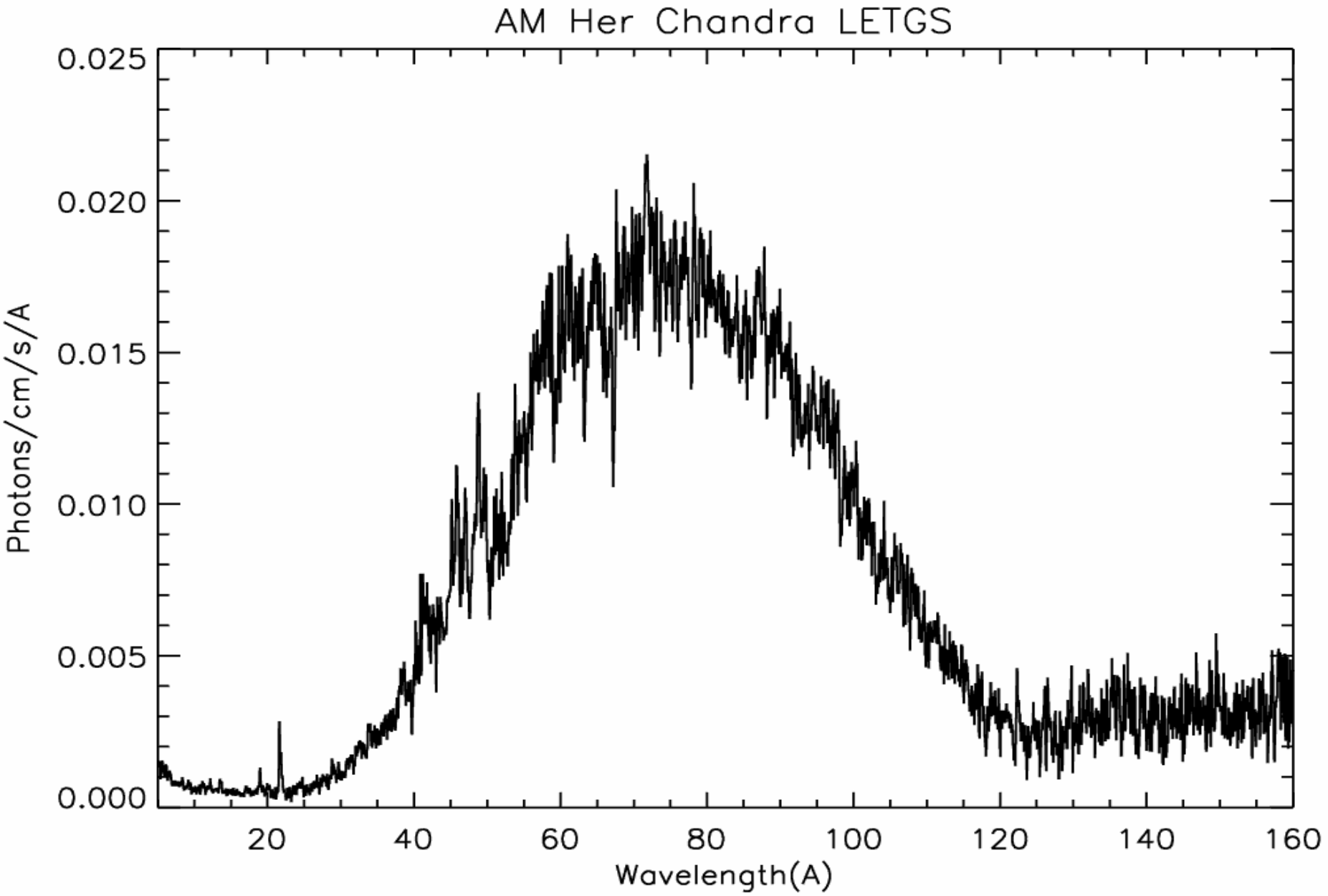
d = 85 ± 5 pc

B = 14.5 MG

T_{wd} = 24.000 K



AM Herculis: Spectrum (24 ksec)



EUVE data Paerels ApJ 1996

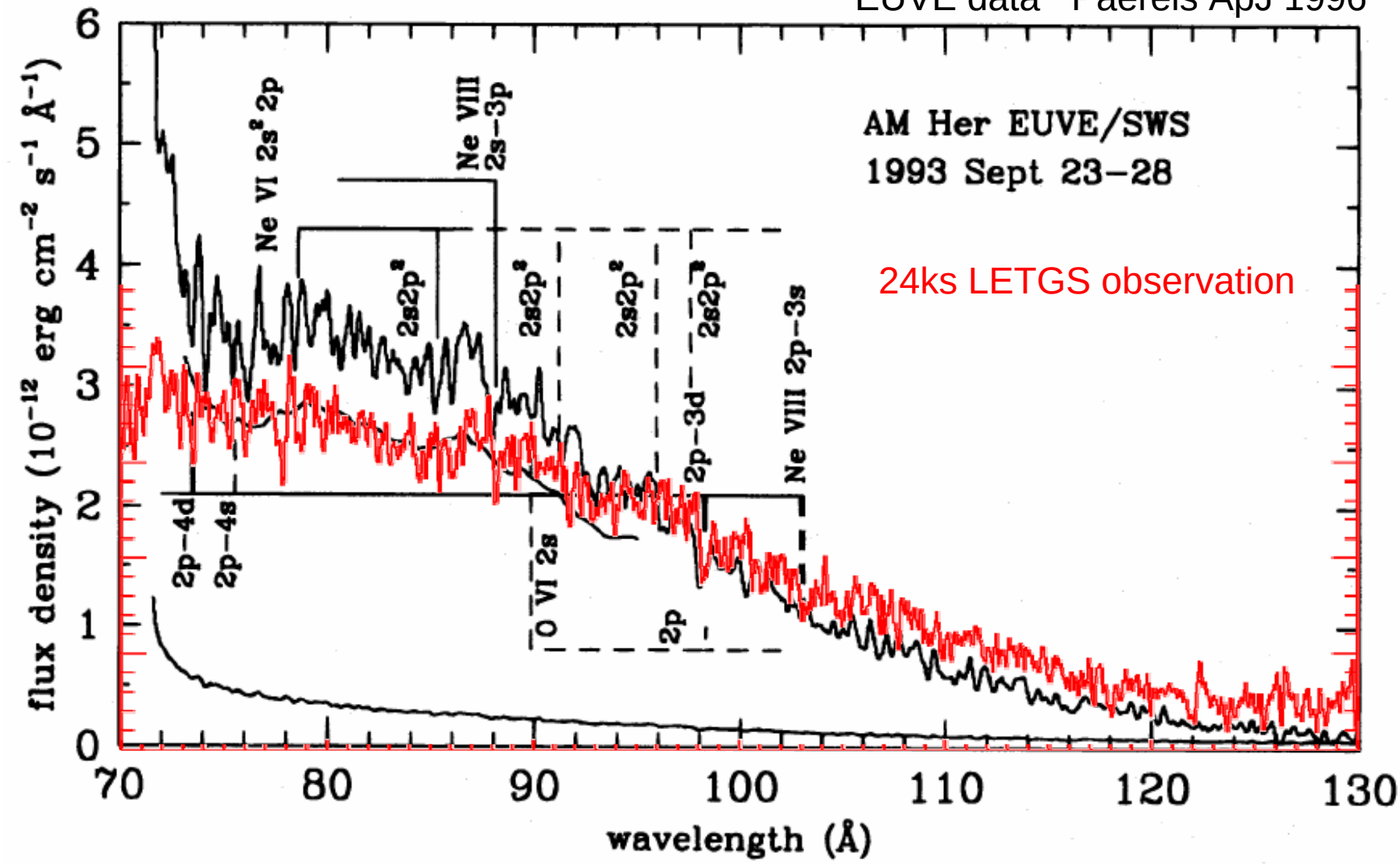
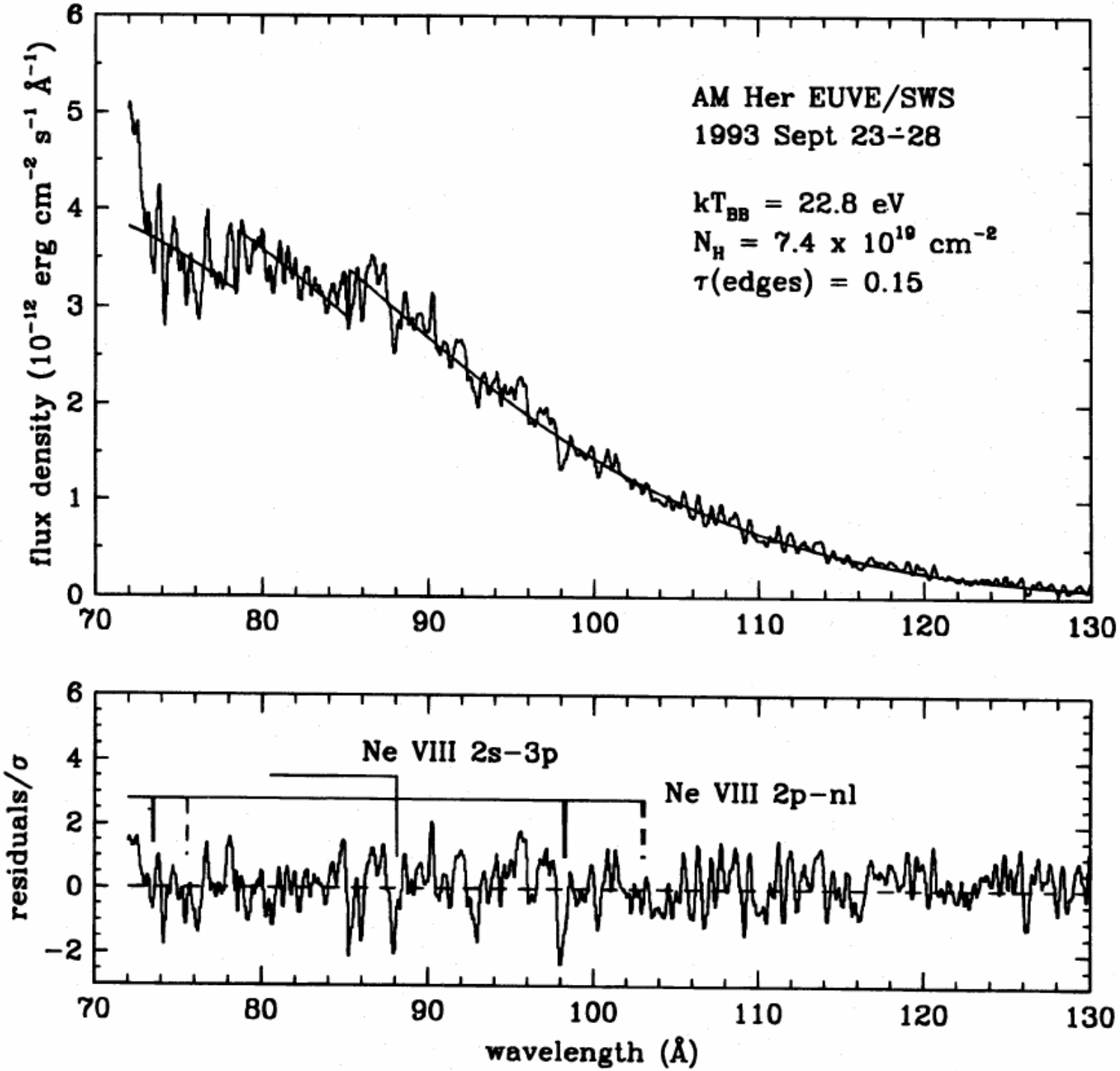


FIG. 1.—EUV spectrum of AM Her summed over all binary phases. Detector background has been subtracted; fluxes shortward of 73 Å are too close to the detector edge to be reliable. The lower curve is an estimate of the uncertainty in the flux, based on counting statistics only. Spectral resolution is about ~0.5 Å. The positions of the Ne VI $2s^22p$ and $2s2p^2$ edges are indicated by solid lines; positions of edges from higher excited states (not seen) are marked by dashed lines, as are the positions of the O VI 2*s*, 2*p* edges. Positively detected Ne VIII lines are indicated by solid lines. Also plotted is part of the spectrum smoothed over a 2.2 Å range to emphasize the Ne VI edges (scaled by a factor 0.8 for clarity).


AM Her EUVE/SWS
1993 Sept 23-28
kT_BB = 22.8 eV
N_H = 7.4 x 10^19 cm^-2
τ(edges) = 0.15
flux density (10^-12 erg cm^-2 s^-1 Å^-1)
residuals/σ
Ne VIII 2s-3p
Ne VIII 2p-nl
wavelength (Å)

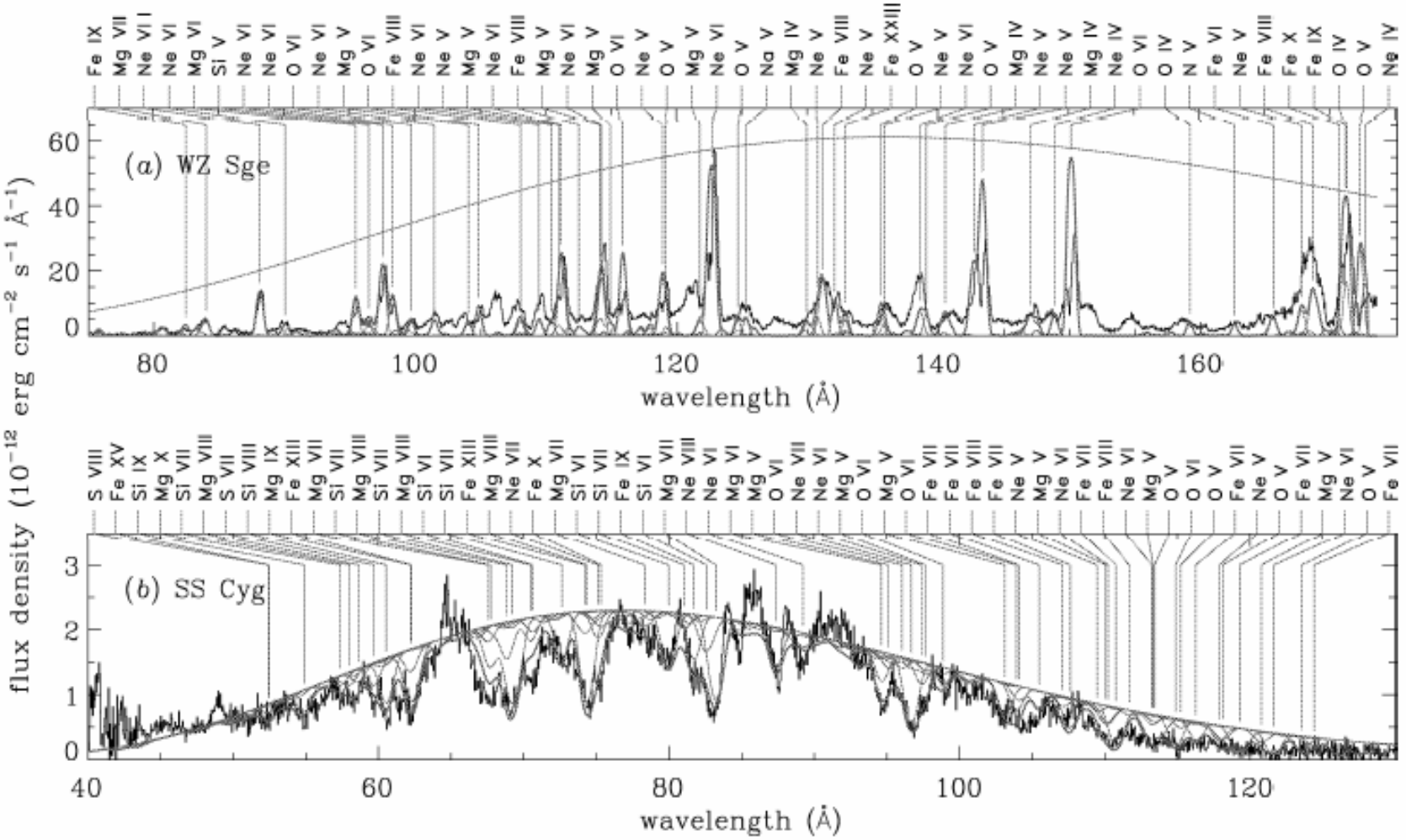
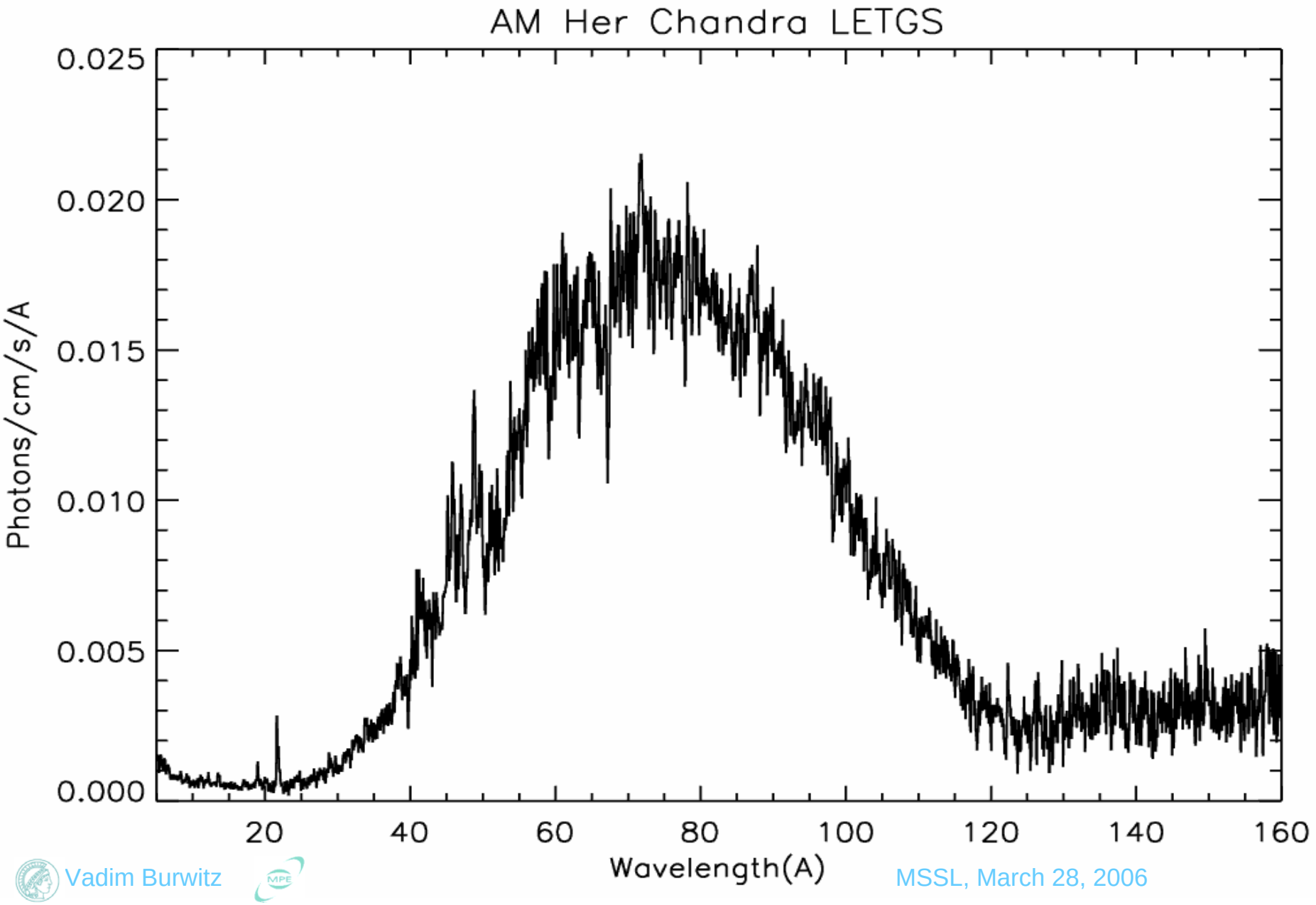
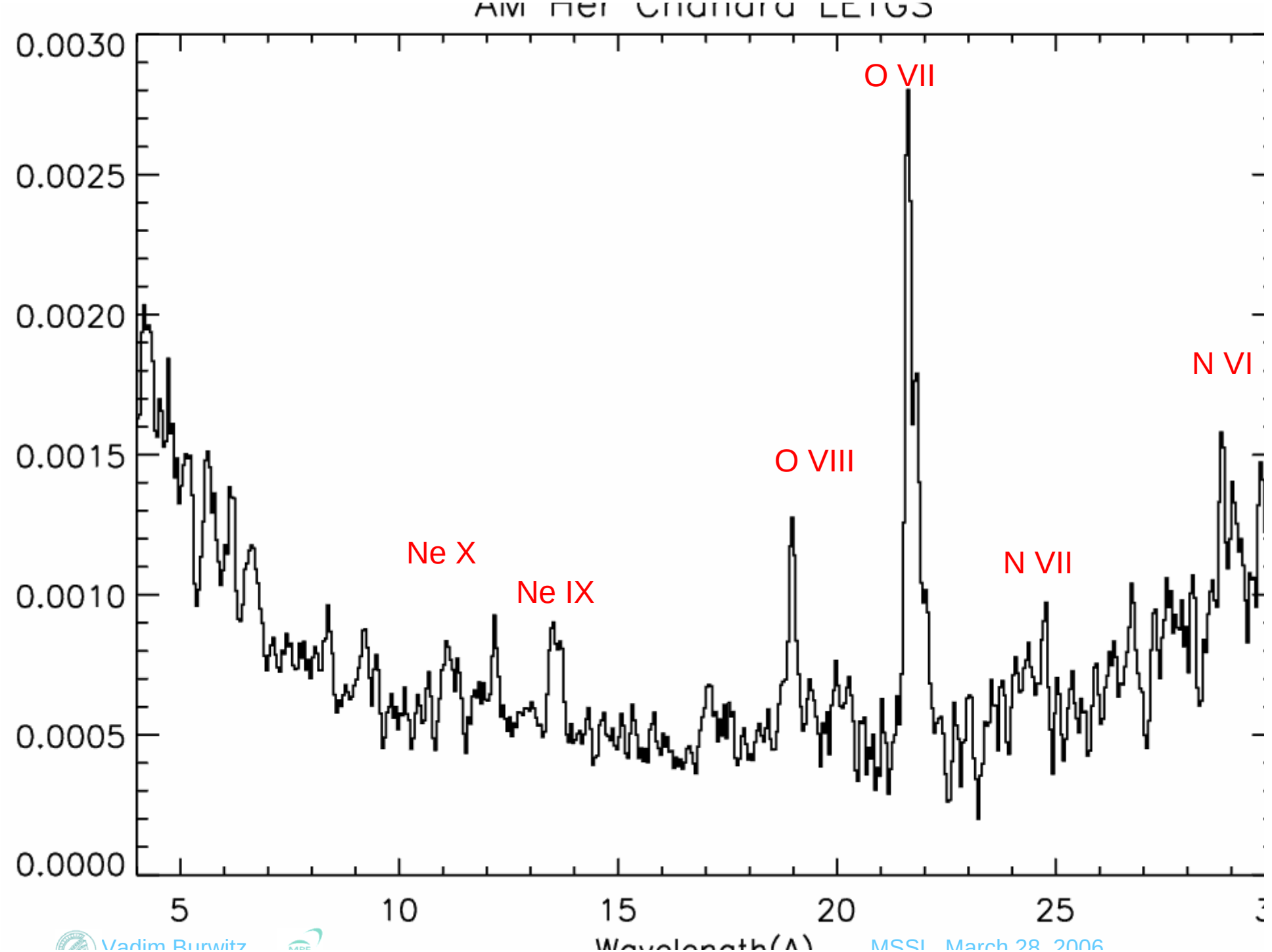


Fig. 3. *Chandra* LETG spectra of WZ Sge in superoutburst (*top panel*) and SS Cyg in outburst (*bottom panel*). The data are shown black and the model spectrum grey with the strongest lines indicated (from [54]).

AM Herculis: Spectrum (24 ksec)

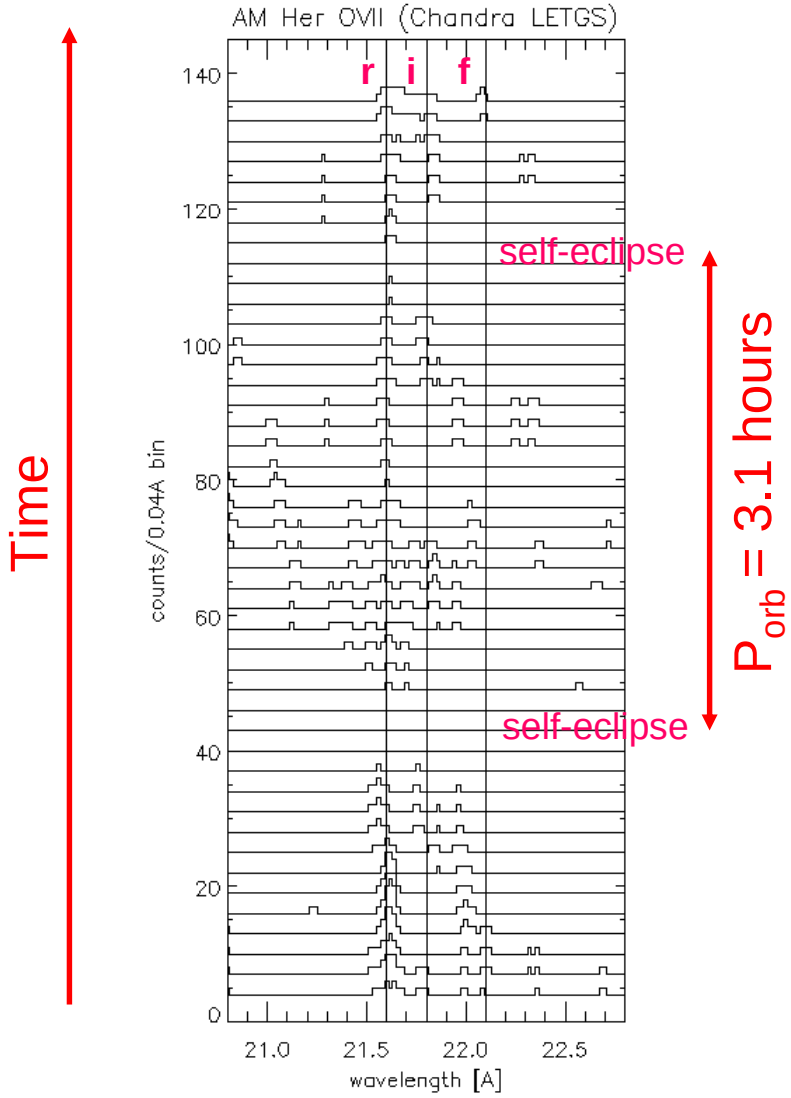


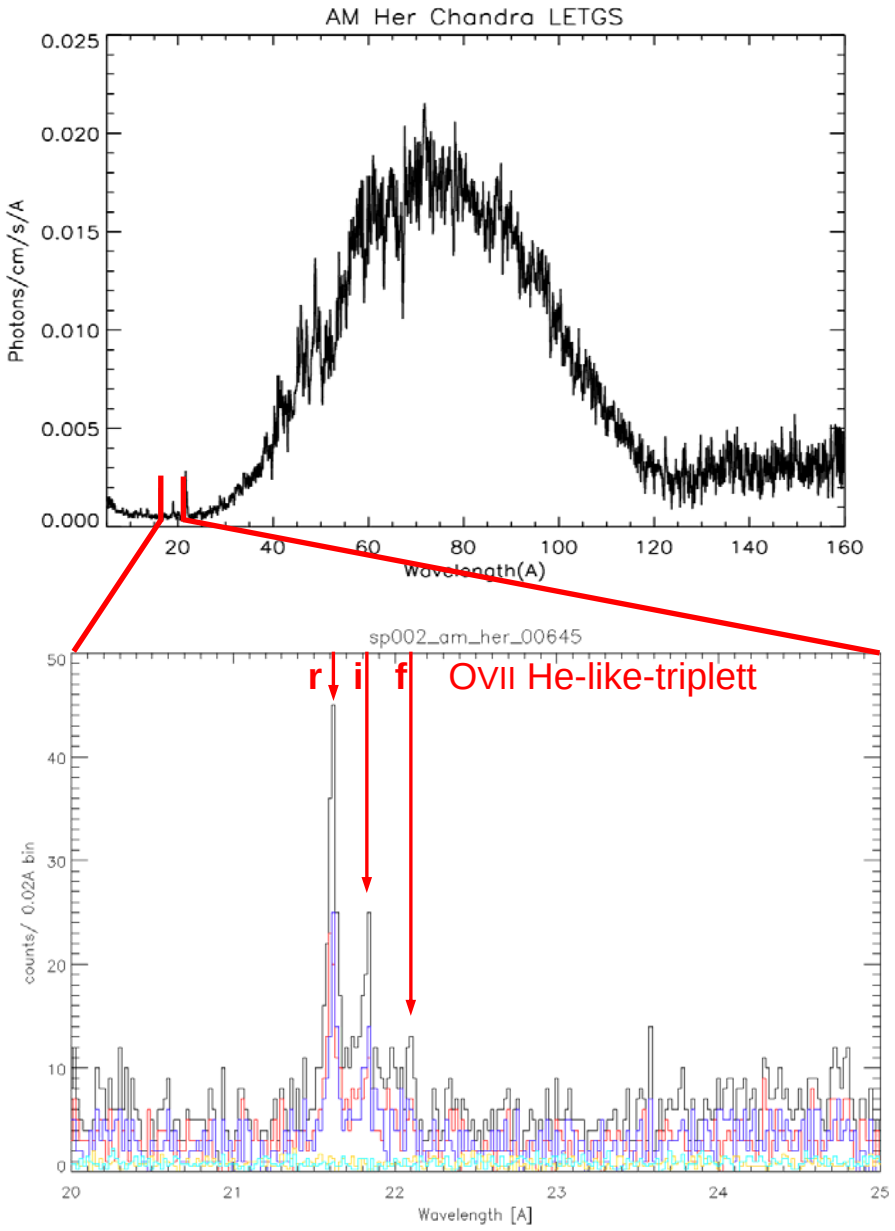

AM Her Chandra LETGS
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
O VII
N VI
O VIII
Ne X
Ne IX
N VII
5
10
15
20
25
Wavelength(A)

AM Herculis: Spectra

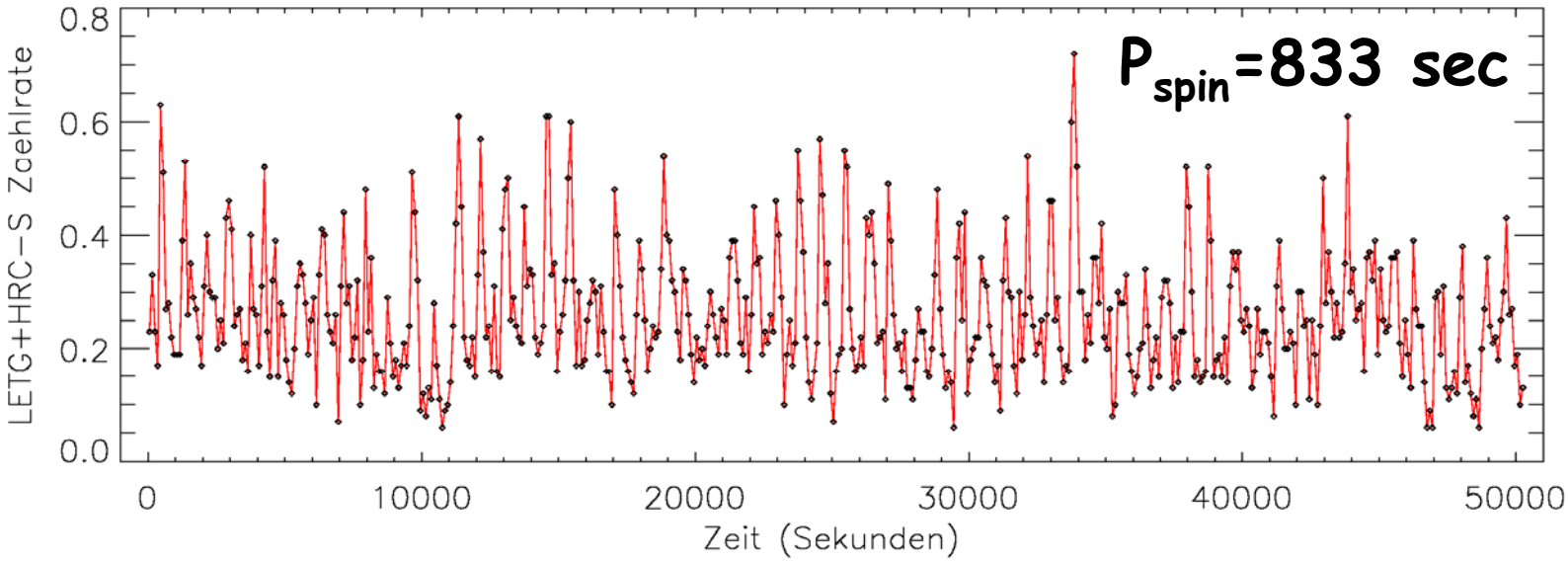
Chandra LETGS spectra (24 ksec)

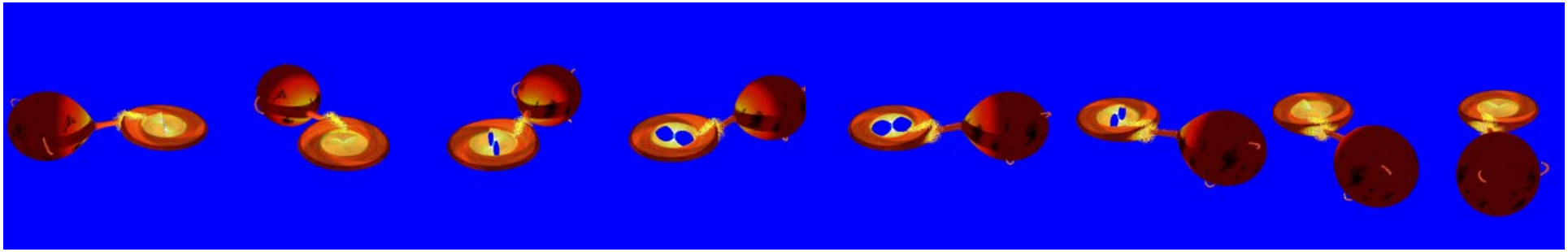
Doppler Shift ~0.05Å @ 22Å => ~750km/s



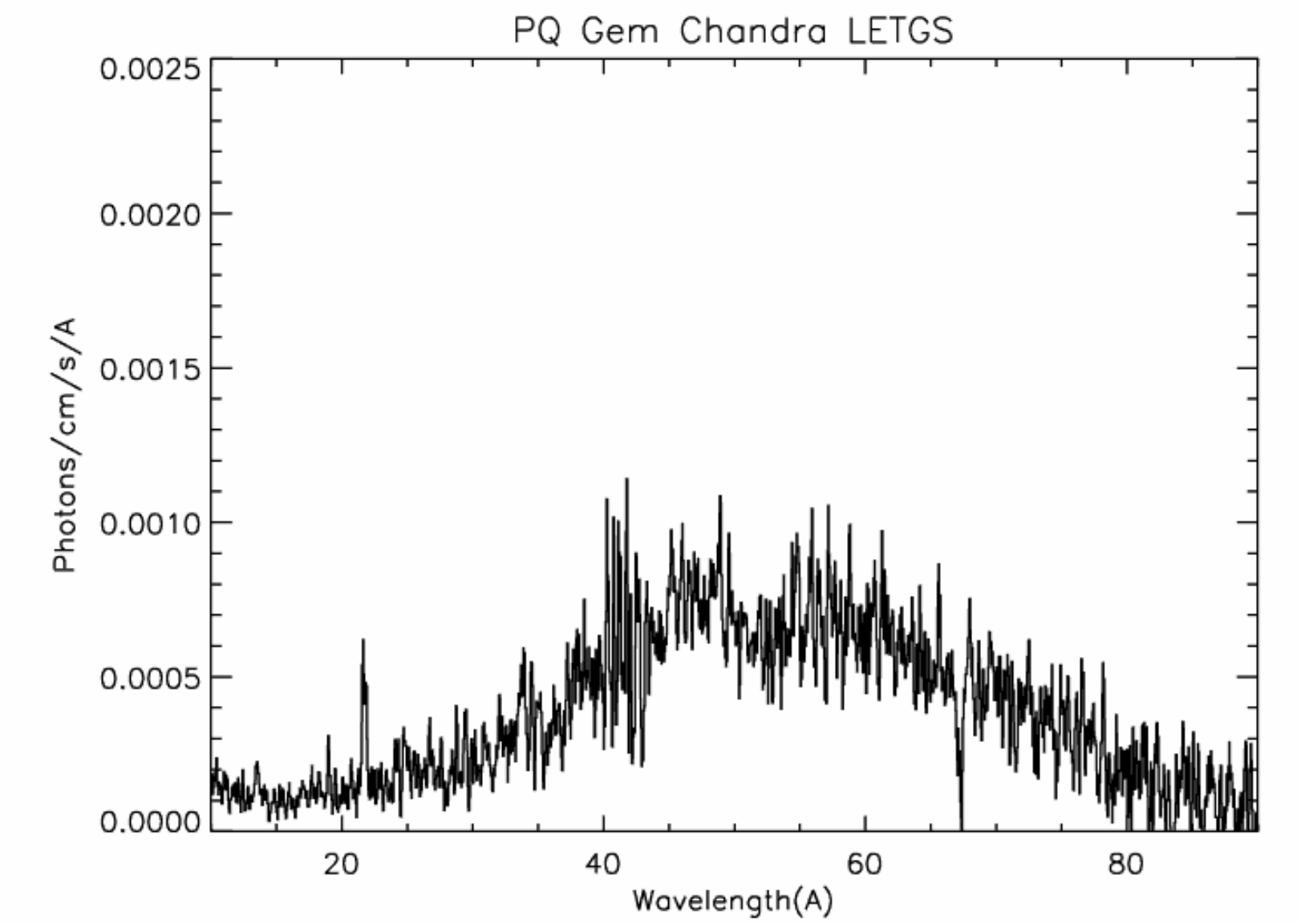


Chandra X-ray lightcurve of the intermediate polar PQ Gem

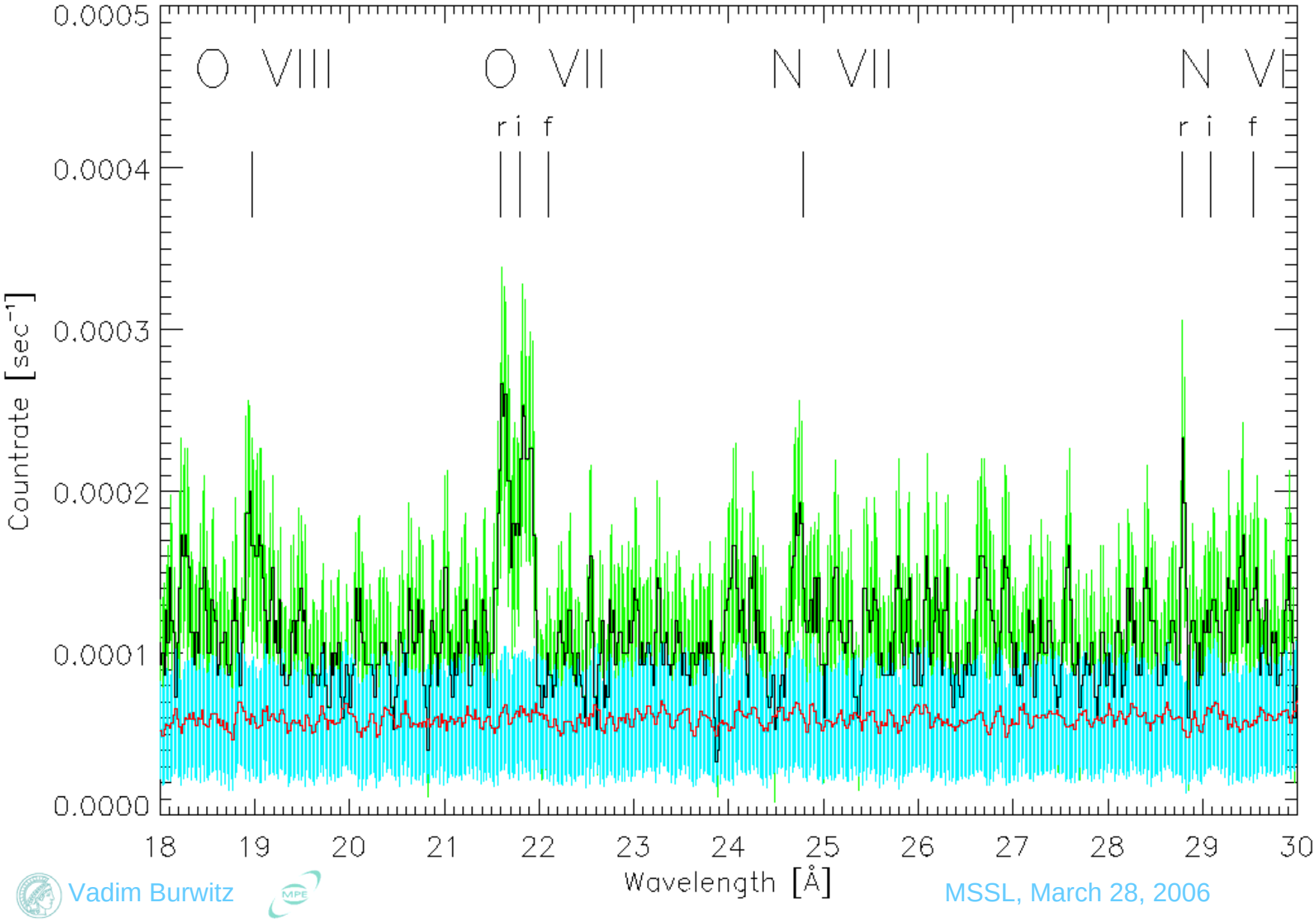




PQ Geminorum: Spectrum (50 ksec)



PQ Gem: OVII and NVI He-Like tripletts



EUVE data Paerels ApJ 1996

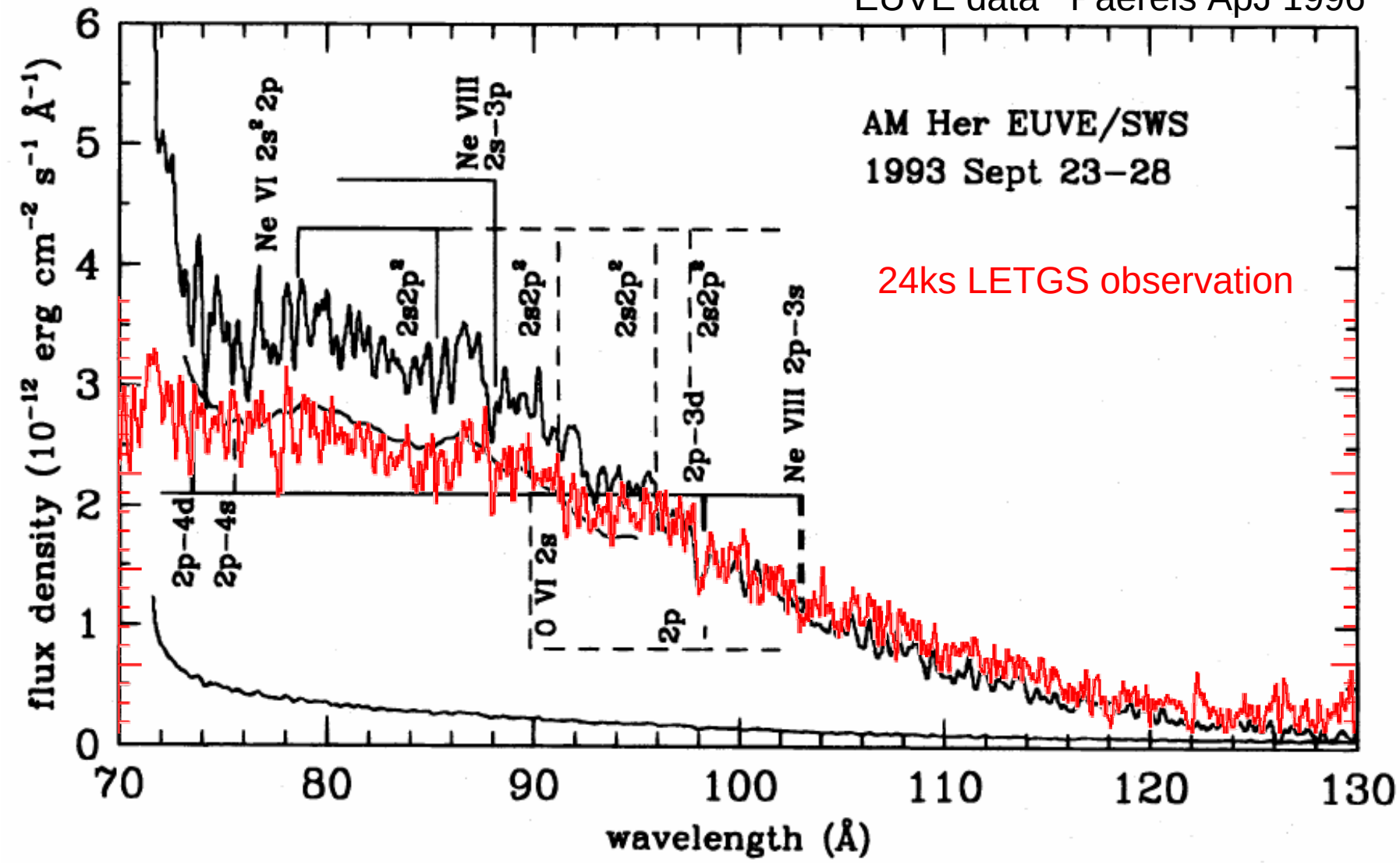


FIG. 1.—EUV spectrum of AM Her summed over all binary phases. Detector background has been subtracted; fluxes shortward of 73 Å are too close to the detector edge to be reliable. The lower curve is an estimate of the uncertainty in the flux, based on counting statistics only. Spectral resolution is about ~0.5 Å. The positions of the Ne VI $2s^2 2p$ and $2s2p^2$ edges are indicated by solid lines; positions of edges from higher excited states (not seen) are marked by dashed lines, as are the positions of the O VI 2*s*, 2*p* edges. Positively detected Ne VIII lines are indicated by solid lines. Also plotted is part of the spectrum smoothed over a 2.2 Å range to emphasize the Ne VI edges (scaled by a factor 0.8 for clarity).

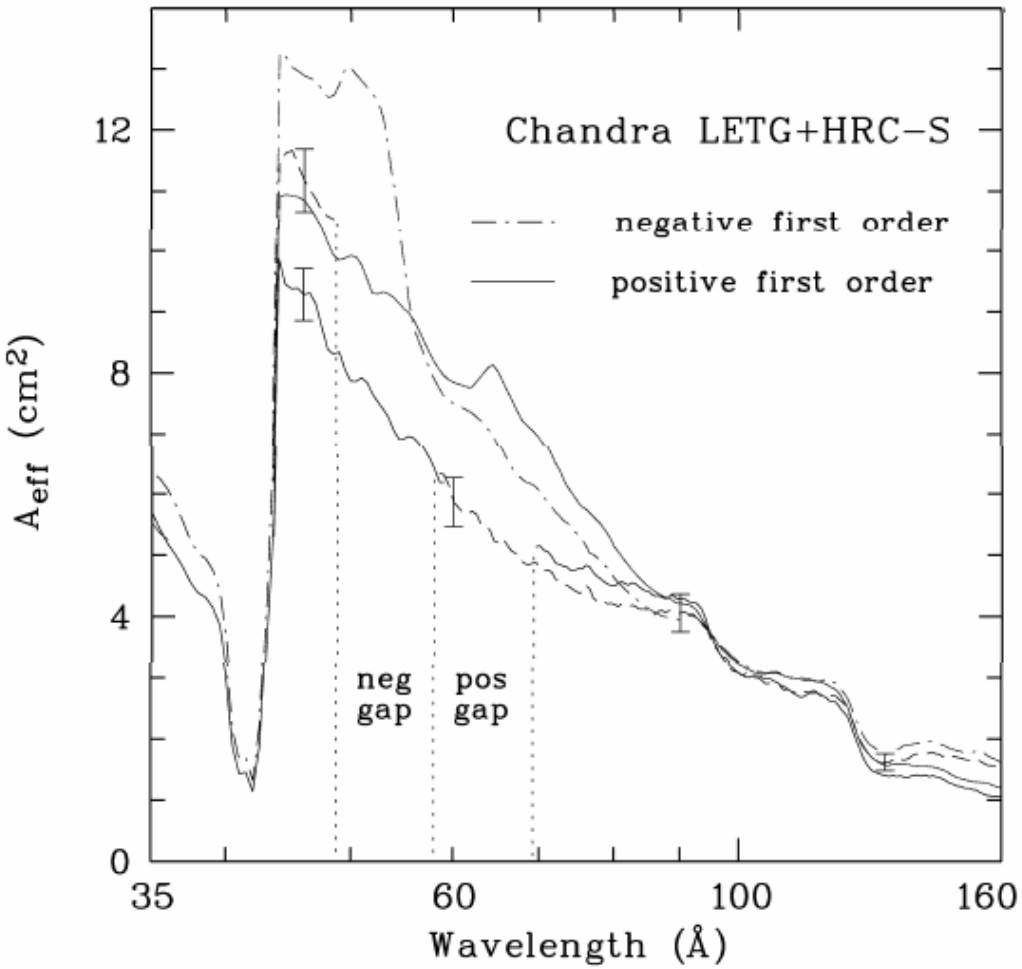
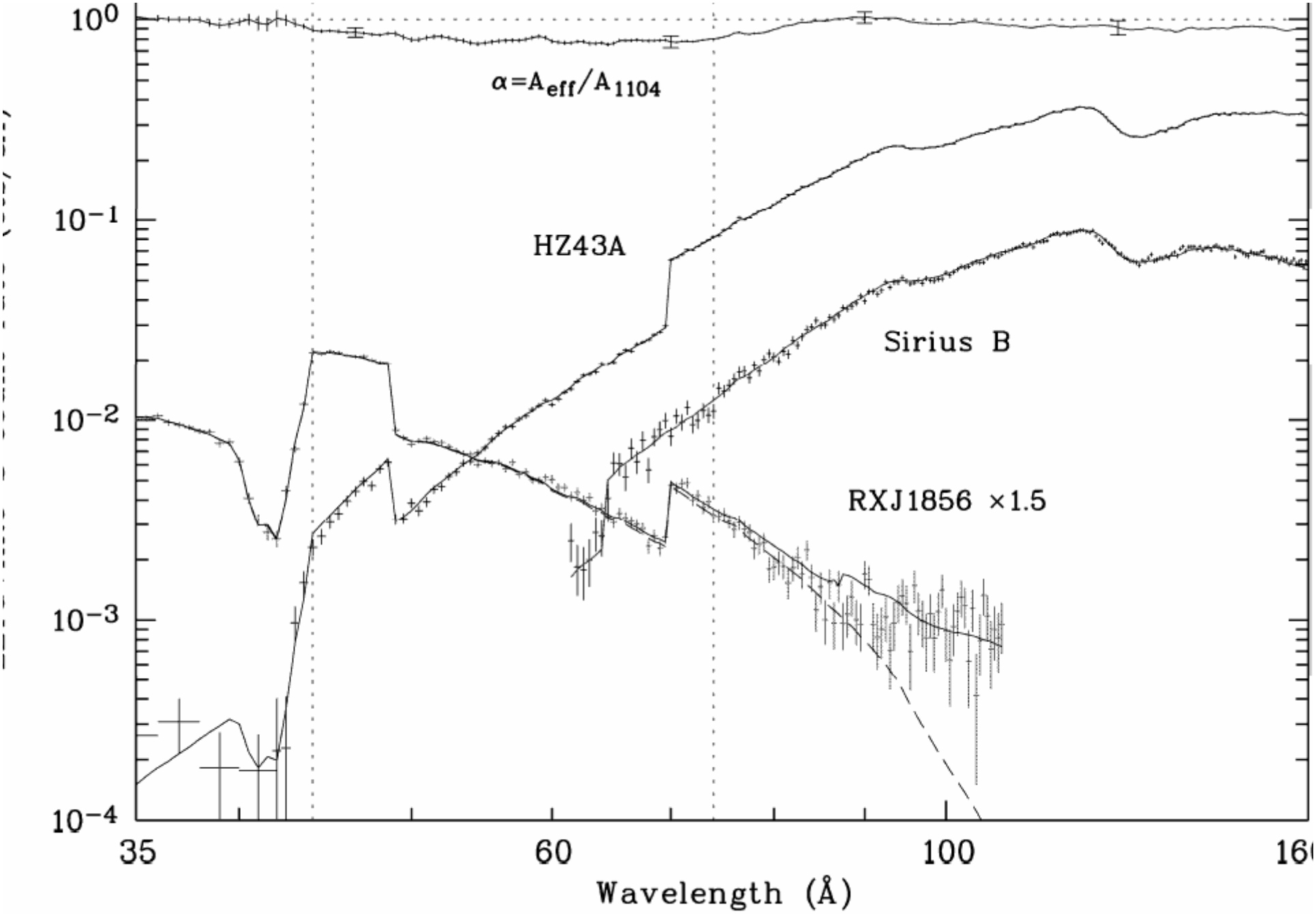


Fig. 5. Nominal effective areas of the *Chandra* LETG+HRC-S in the positive (solid curves) and negative (dot-dashed curves) dispersion directions of the November 2004 calibration data release (blue/grey curves) and the corresponding empirically adjusted effective areas (black curves) created with $\log g = 7.90$ for HZ43 A. They correspond to the correction function $\alpha(\lambda)$ displayed in Fig. 4. The systematic errors of this adjustment are indicated at four wavelengths.



taneous fit of RX J1856, HZ43 A, and Sirius B in the wavelength ranges marked by vertical dotted lines. The LETG spe
hown as data points, the corresponding best-fit models as solid curves, and the first-order contributions as dashed curve

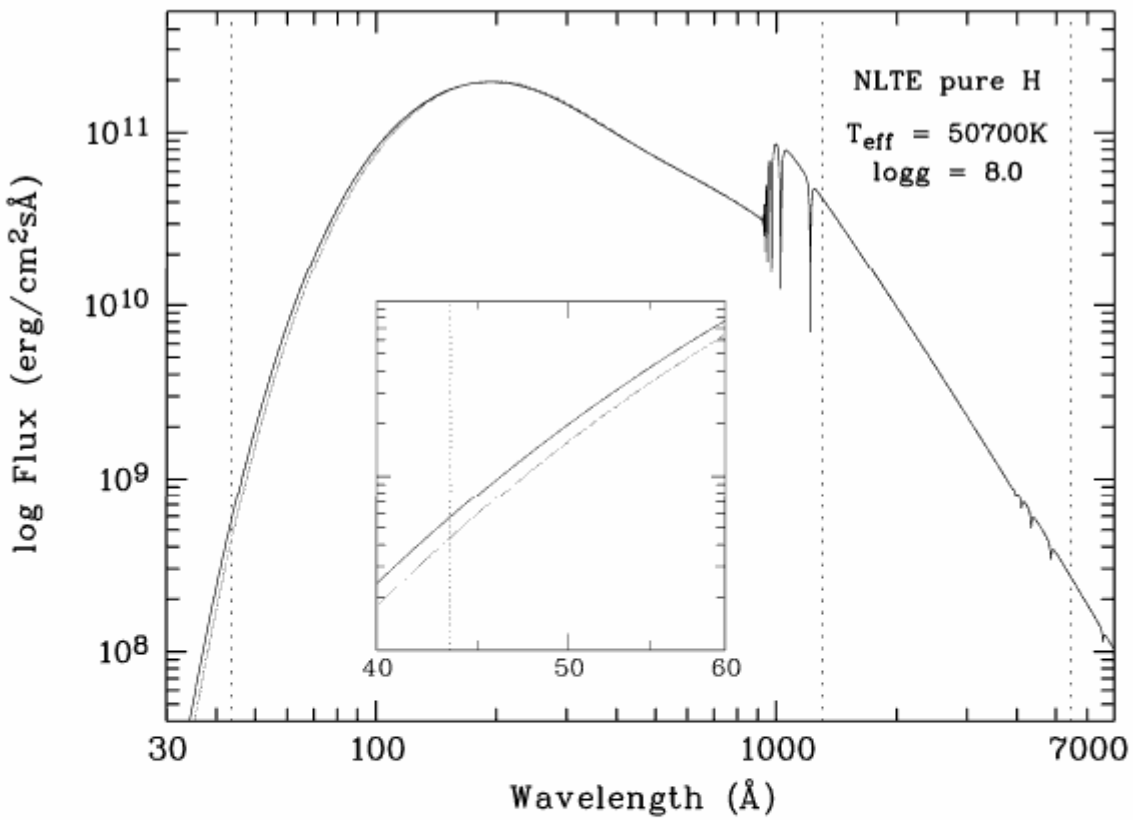


Fig. 1. NLTE pure hydrogen spectra for $T_{\rm eff}$=50700 K and log g=8.0, calculated with TMAP using two versions of the bound-free and free-free absorption coefficients, Seaton's approximation (green/grey curve) and the full Karszas & Latter (1961) description (black curve). Both models yield practically identical results at opical/ultraviolet wavelengths, but differ by a factor of 1.33 at 44Å (vertical dotted line). The insert shows an expanded view. Two further dotted lines mark λ = 1300Å and λ = 5450Å (see text).