Properties of the Accretion Disk Corona in Her X-1

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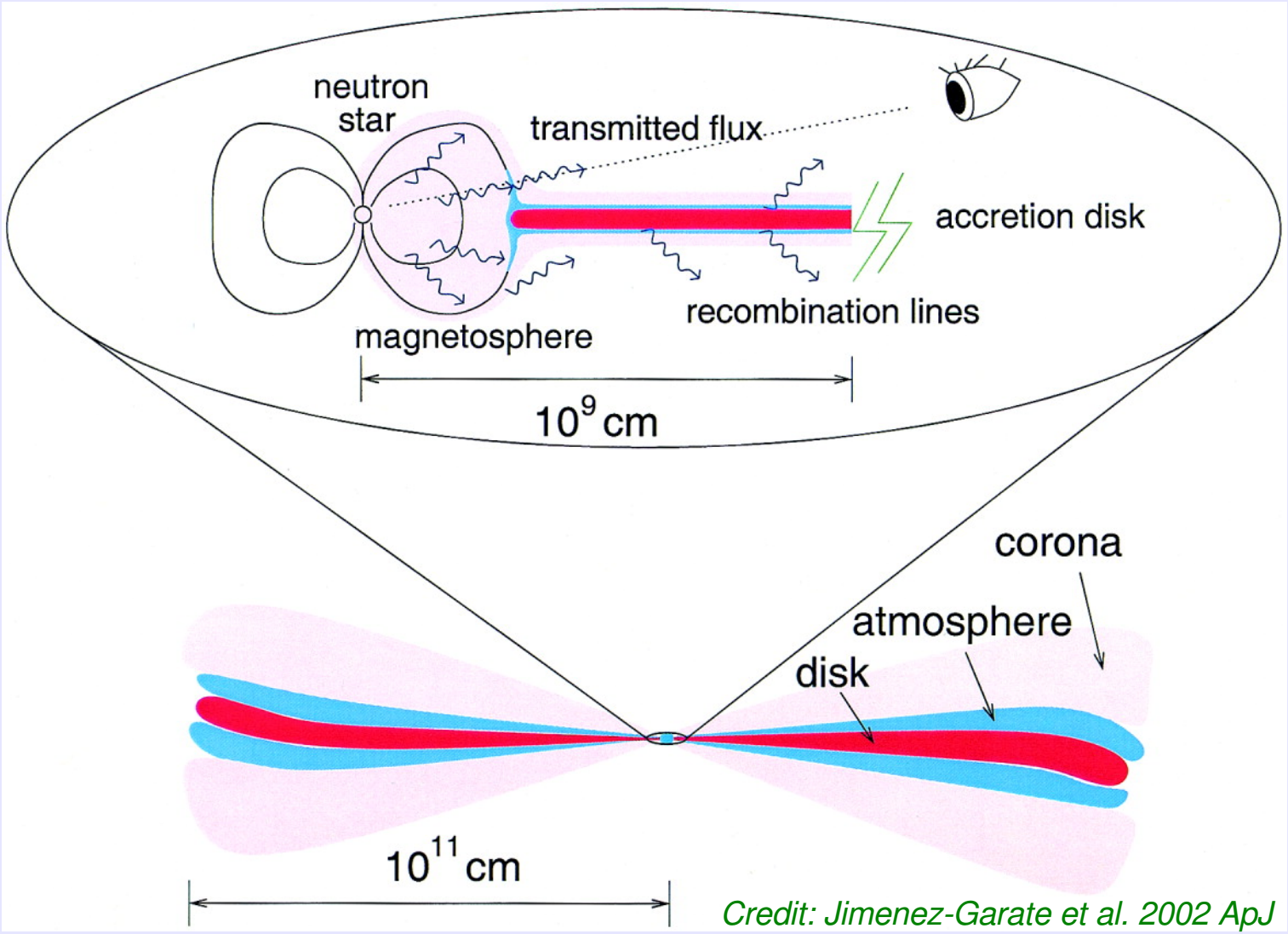
- Neutron star: 1.5±0.3 $M_\odot$
- Companion: 2.3±0.3 $M_\odot$
- Distance: 6.6±0.4 Kpc
- Disk size: ~$1.4\times10^{11}\,cm$

- P_orb: 1.7d
- Pψ: ~ 35d



Credit: Jimenez-Garate et al. 2002 ApJ

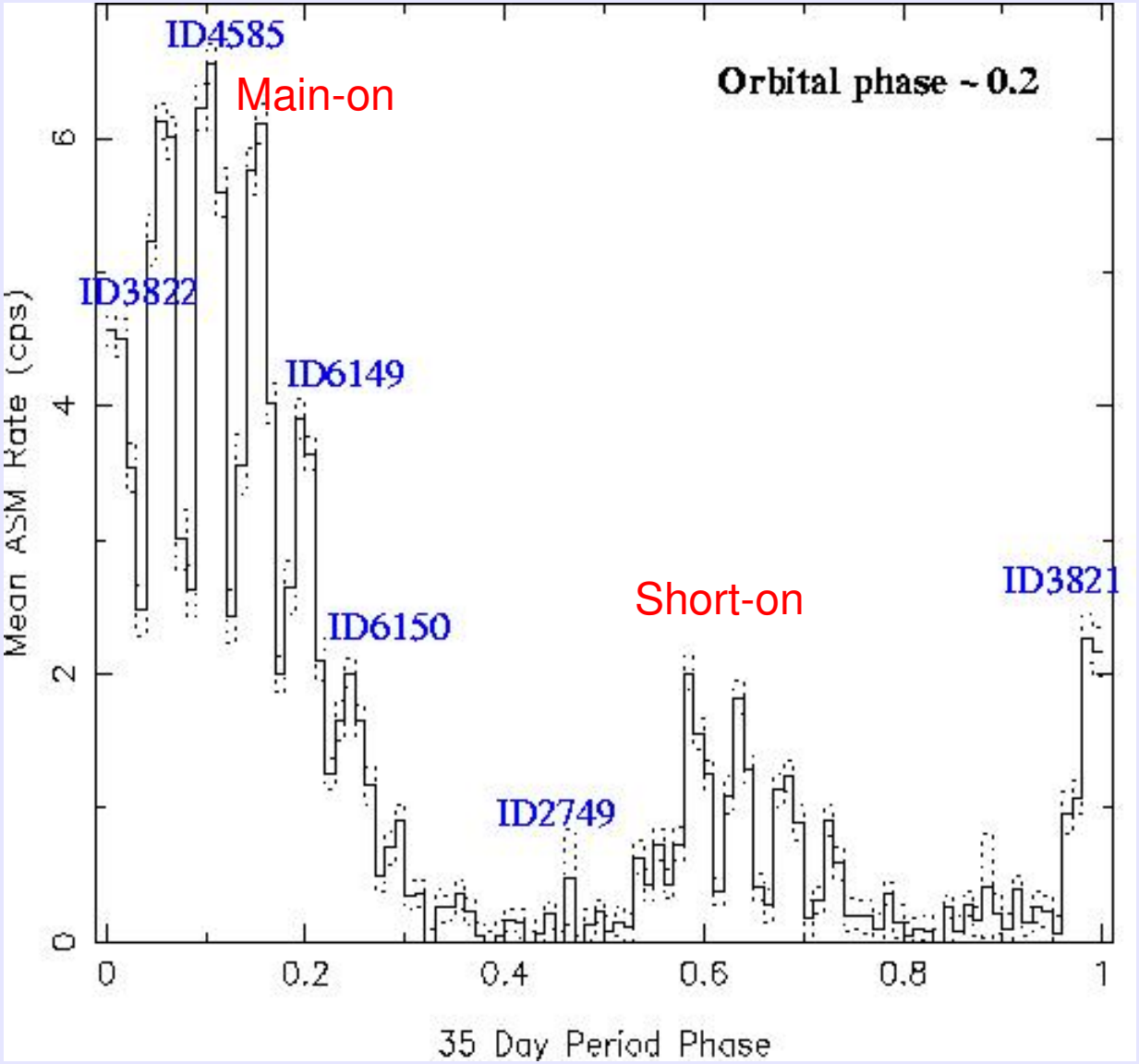
Existing Chandra HETGs Observations

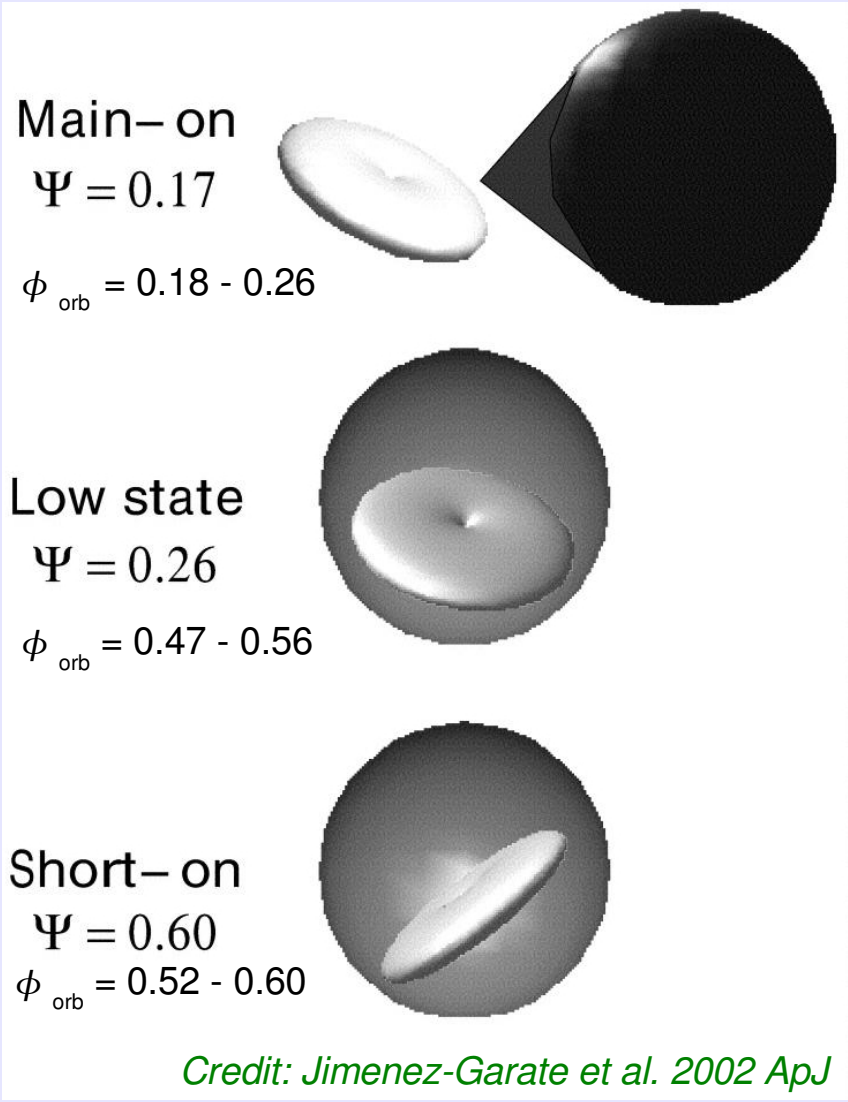
obsID	MJD interval	Observation Start	Exposure(ks)	Orbital phase[a]	35 day Phase[a]
2749	52399.427 - 52400.032	2002-05-05 10:14:49 UT	50.17	0.33 - 0.68	0.42
3821	52875.886 - 52876.261	2003-08-24 21:15:16 UT	30.10	0.57 - 0.79	-0.03
3822	52982.987 - 52983.379	2003-12-09 23:41:44 UT	30.14	0.57 - 0.80	0.04
4585	53335.256 - 53335.512	2004-11-26 06:08:16 UT	20.16	0.76 - 0.91	0.10
6149	53338.630 - 53338.913	2004-11-29 15:06:38 UT	22.14	0.75 - 0.91	0.19
6150	53340.370 - 53340.647	2004-12-01 08:52:39 UT	22.05	0.77 - 0.93	0.24

[a]Using $P_{orb} = 1.700167387$ s at $T_{\pi/2} = 50290.659202$ (MJD) (Private contact from R. Staubert)

- Total ~ 170 ks
- Three combinations of orbital and super-orbital phases

Averaged Light Curve

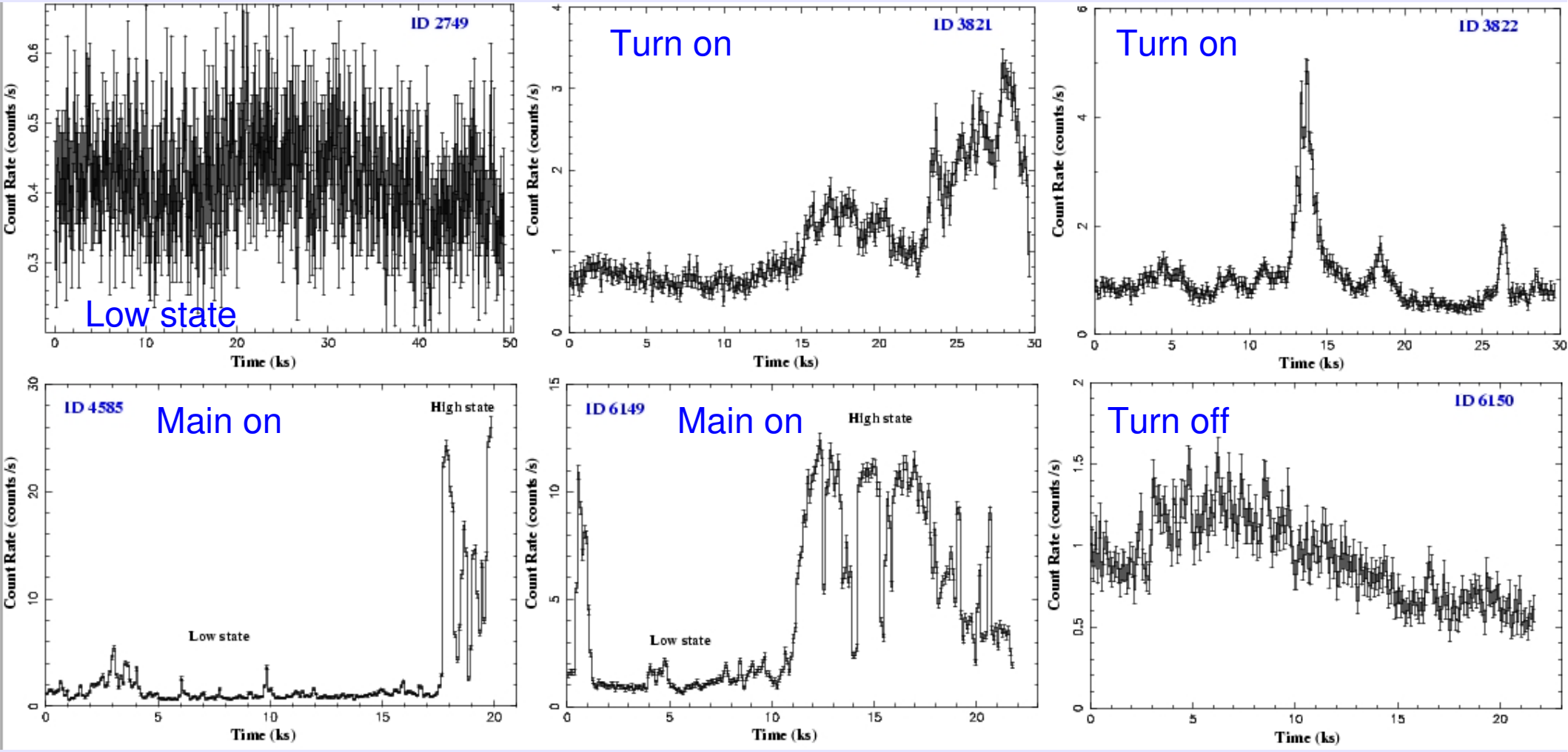




Credit: Jimenez-Garate et al. 2002 ApJ

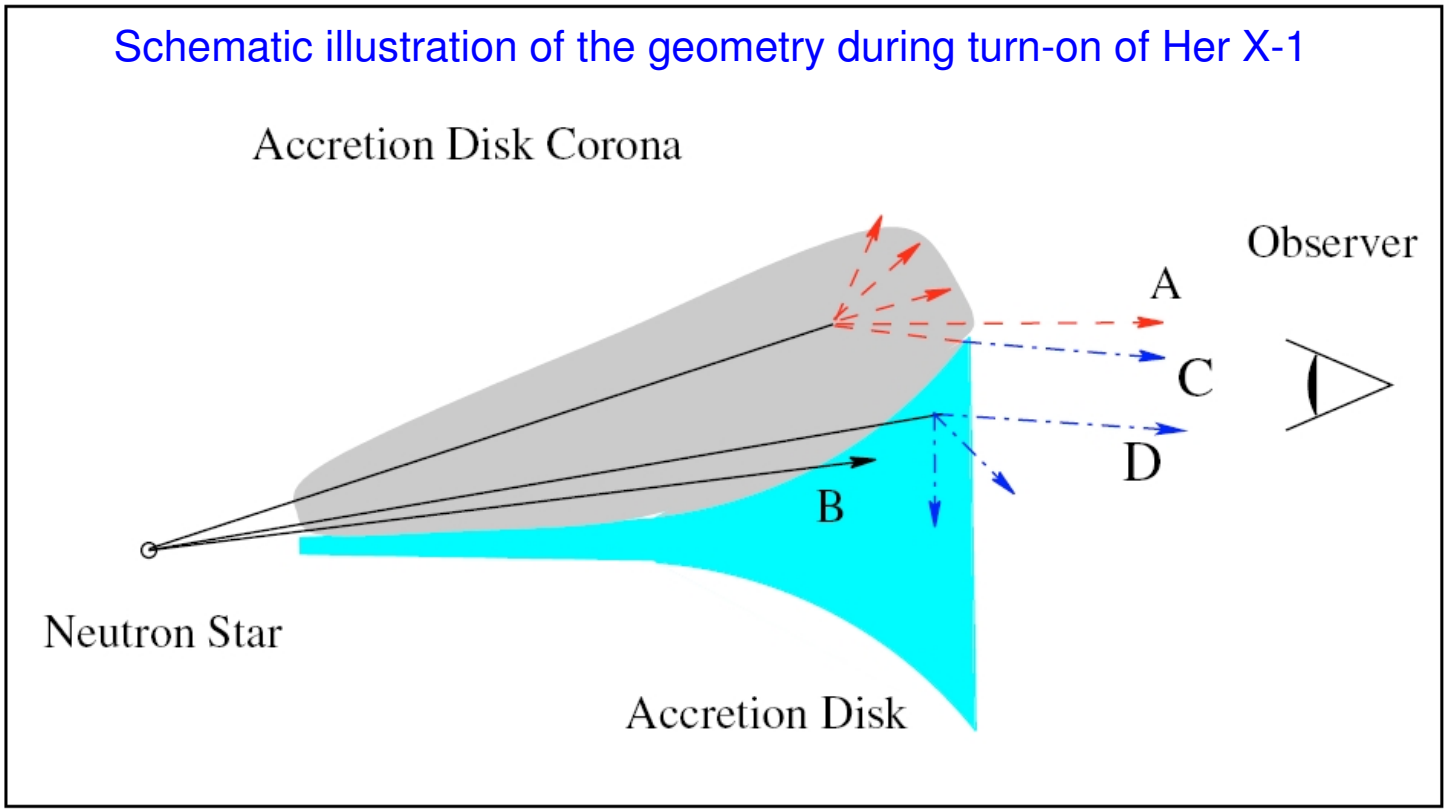
- Observations from *ASM* on board of *RXTE*

Light Curves for λ>1.5Å



Continuum Analysis

Schematic illustration of the geometry during turn-on of Her X-1

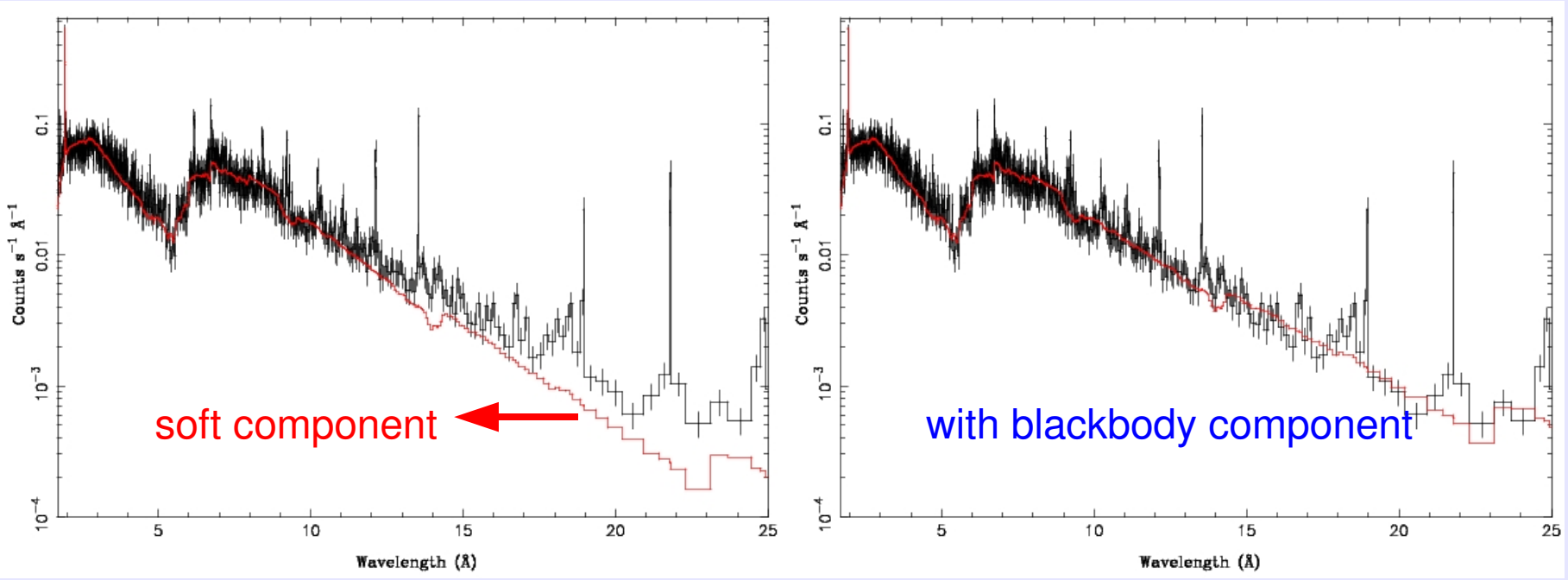


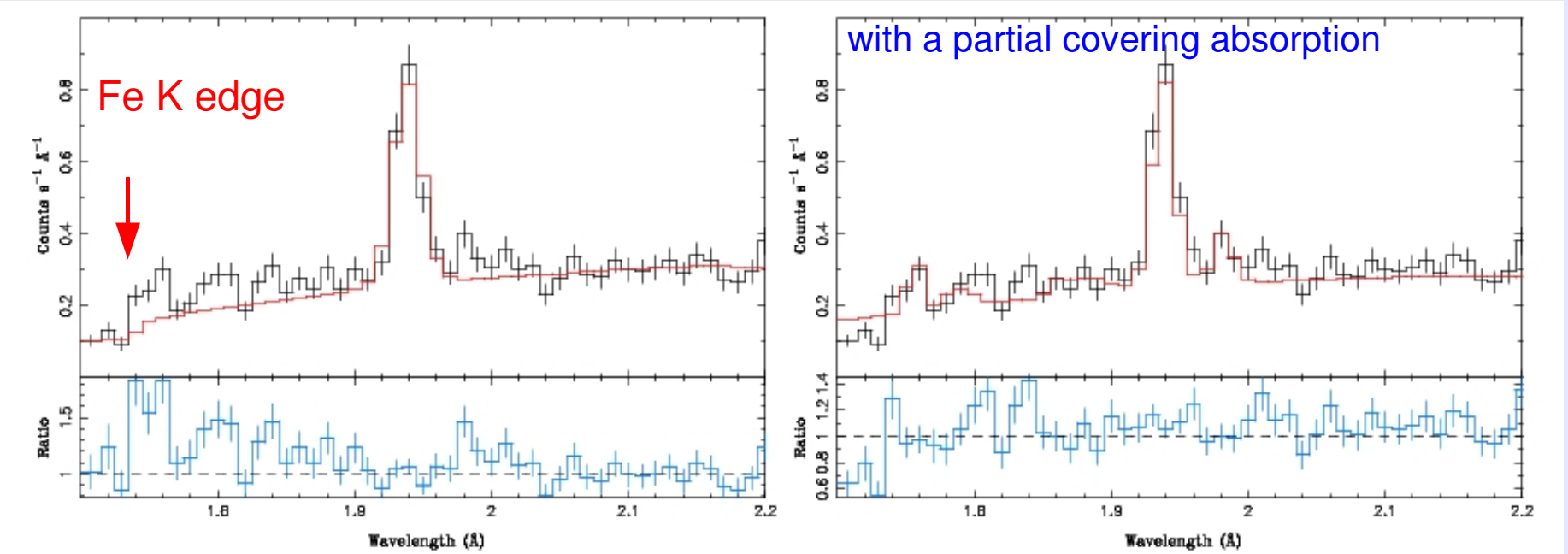
Parameter	Value
α	1.068
E_{cutoff}	21.5 keV
E_{fold}	14.1 keV
E_{cyc}	39.4 keV
σ_{cyc}	5.1 keV
E_{Fe}	6.45 keV
σ_{Fe}	0.45 keV

Analysis of RXTE observations shows that the spectra in [3,17] keV can be well described by a partial covering model.

Credit: Kuster et al. A&A 2005

Continuum Analysis





Continuum Analysis Results

obsID	nH $10^{22} cm^{-2}$	C	kT (keV)	K1[a] 10^{39} ergs $s^{-1}/(10\ kpc)^2$	K2[b] photons keV^{-1} cm^{-2} s^{-1}	Cash/dof	Flux[d]
2749	$19.573^{+1.590}_{-1.538}$ [c]	$0.753^{+0.020}_{-0.018}$	$0.129^{+0.012}_{-0.012}$	$1.341^{+0.353}_{-0.275} \times 10^{-4}$	$7.349^{+0.664}_{-0.599} \times 10^{-3}$	1026/598	0.95
3821	$19.307^{+1.408}_{-1.336}$	$0.833^{+0.008}_{-0.009}$	$0.100^{+0.014}_{-0.013}$	$4.810^{+2.657}_{-1.574} \times 10^{-4}$	$3.049^{+0.167}_{-0.157} \times 10^{-2}$	1068/781	3.74
3822	$28.304^{+1.655}_{-1.434}$	$0.907^{+0.005}_{-0.005}$	> 0.052	$> 3.283 \times 10^{-4}$	$4.438^{+0.268}_{-0.232} \times 10^{-2}$	970/673	5.38
4585-H	$29.949^{+0.832}_{-0.796}$	0.95	$0.110^{+0.015}_{-0.016}$	$1.709^{+1.075}_{-0.571} \times 10^{-3}$	$7.929^{+0.180}_{-0.176} \times 10^{-2}$	664/454	10.00
6149-H	$24.642^{+1.459}_{-1.433}$ [c]	$0.884^{+0.010}_{-0.010}$	$0.127^{+0.014}_{-0.013}$	$1.237^{+0.403}_{-0.302} \times 10^{-3}$	$5.805^{+0.535}_{-0.489} \times 10^{-2}$	520/426	7.40
4585-L	$11.254^{+1.221}_{-1.127}$	$0.734^{+0.012}_{-0.012}$	$0.141^{+0.008}_{-0.008}$	$3.521^{+0.470}_{-0.416} \times 10^{-3}$	$1.440^{+0.073}_{-0.068} \times 10^{-1}$	977/795	18.61
6149-L	$10.295^{+0.998}_{-0.635}$	$0.699^{+0.004}_{-0.007}$	$0.136^{+0.003}_{-0.004}$	$3.126^{+0.246}_{-0.195} \times 10^{-3}$	$9.428^{+0.338}_{-0.235} \times 10^{-2}$	1665/1208	12.80
6150	$27.711^{+2.322}_{-1.863}$	$0.897^{+0.008}_{-0.007}$	$0.110^{+0.014}_{-0.013}$	$6.430^{+3.026}_{-2.038} \times 10^{-4}$	$3.581^{+0.305}_{-0.235} \times 10^{-2}$	782/530	4.44

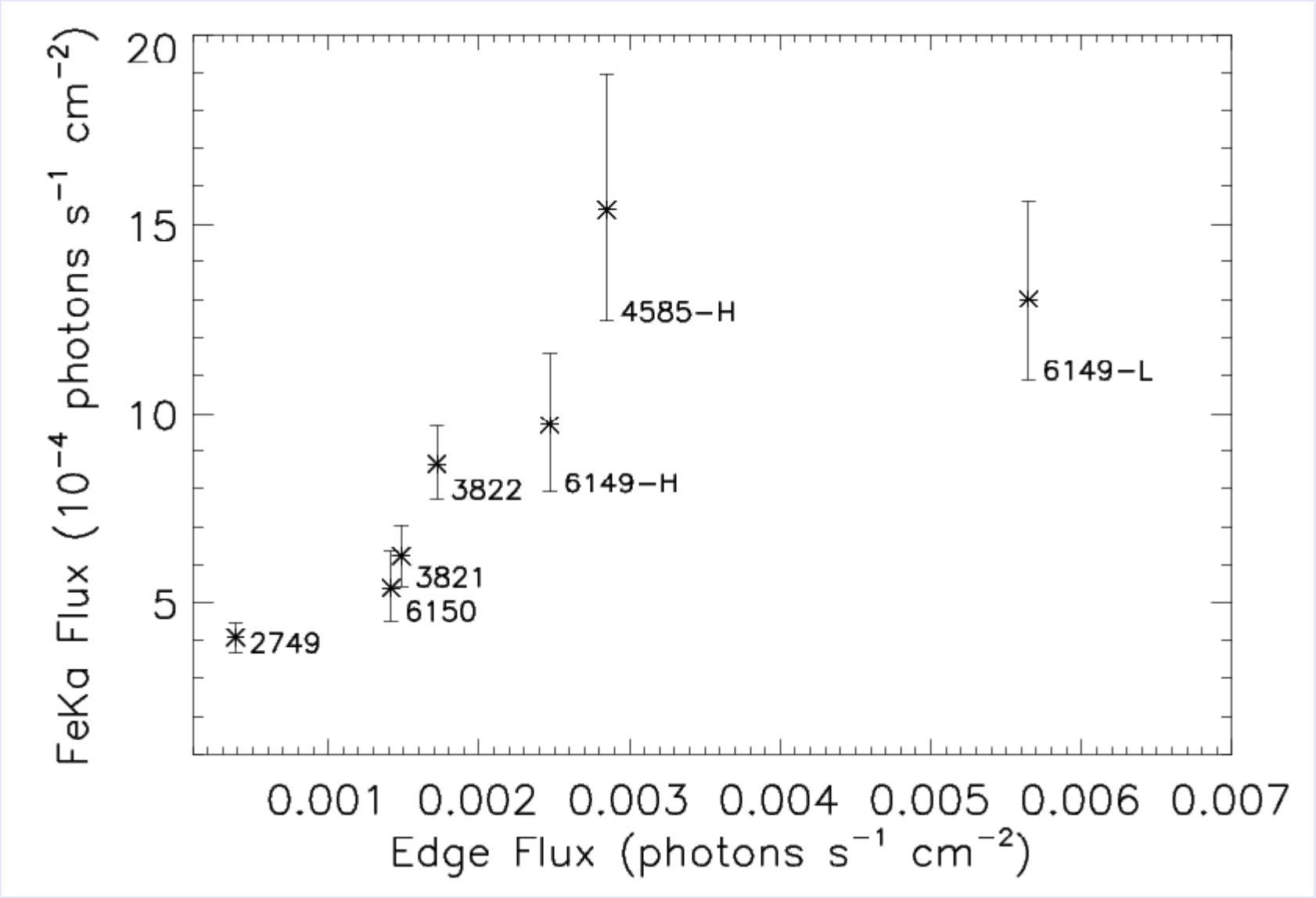
[a]Normalization for blackbody component

[b]Normalization for cutoff-powerlaw component, where photon index is fixed at 1.068 and high energy cut at 21.5 keV

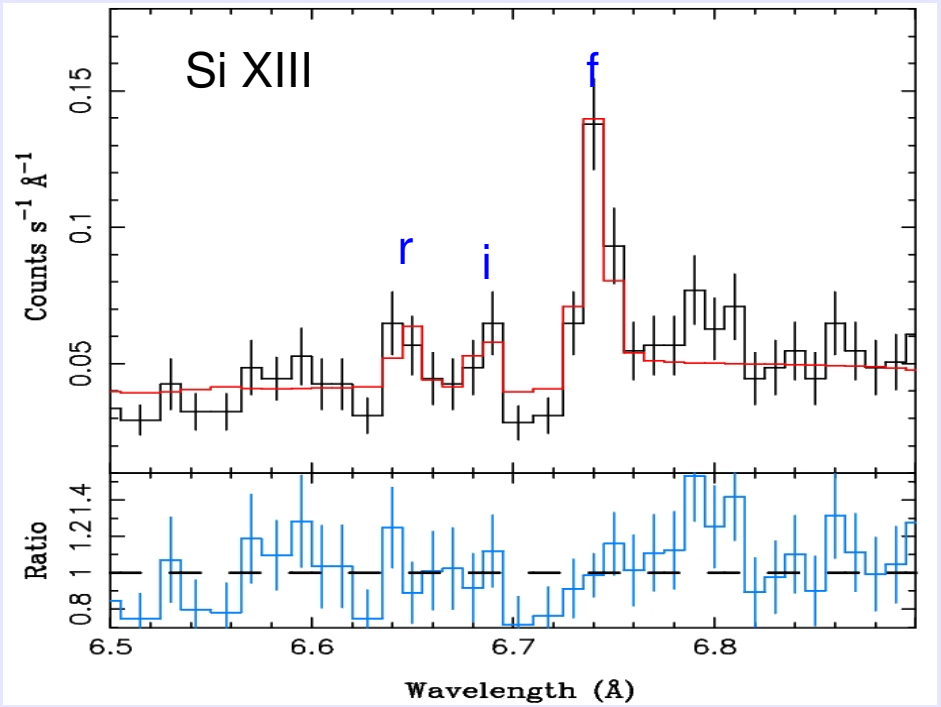
[c]at 67% confidence level

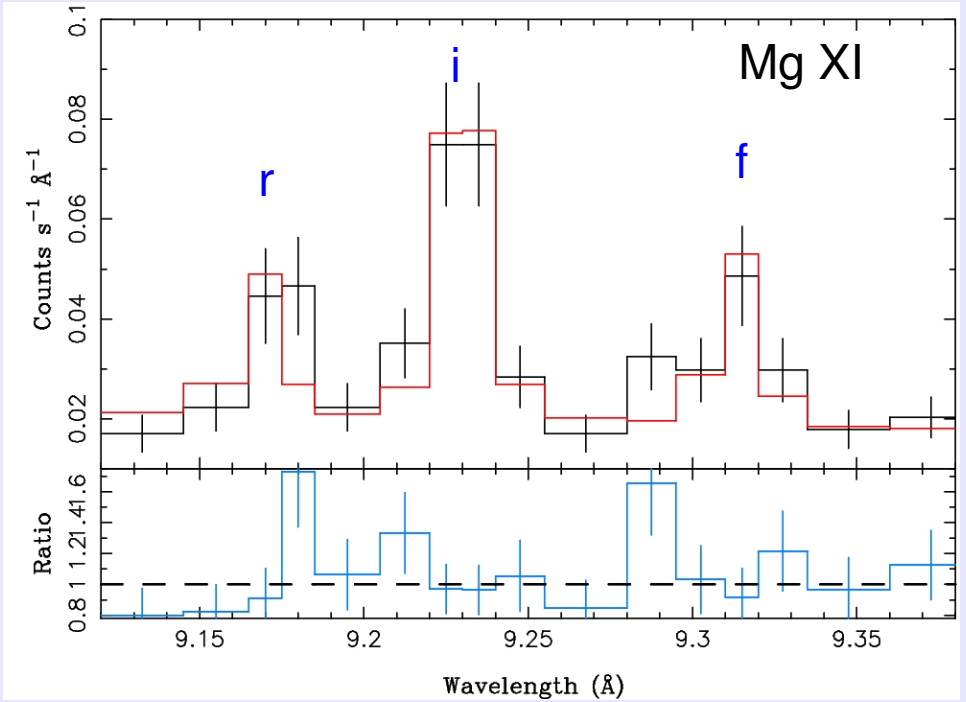
[d]Flux is in unit of 10^{-10} ergs s^{-1} cm^{-2} and in[0.3,10]keV band

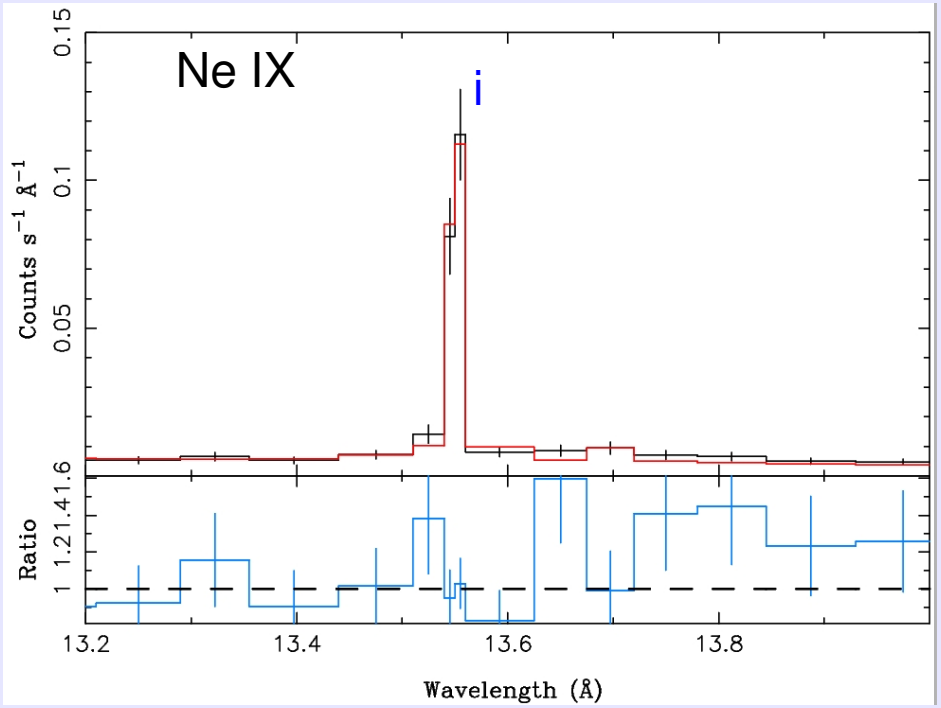
Fluorescence lines Fe K

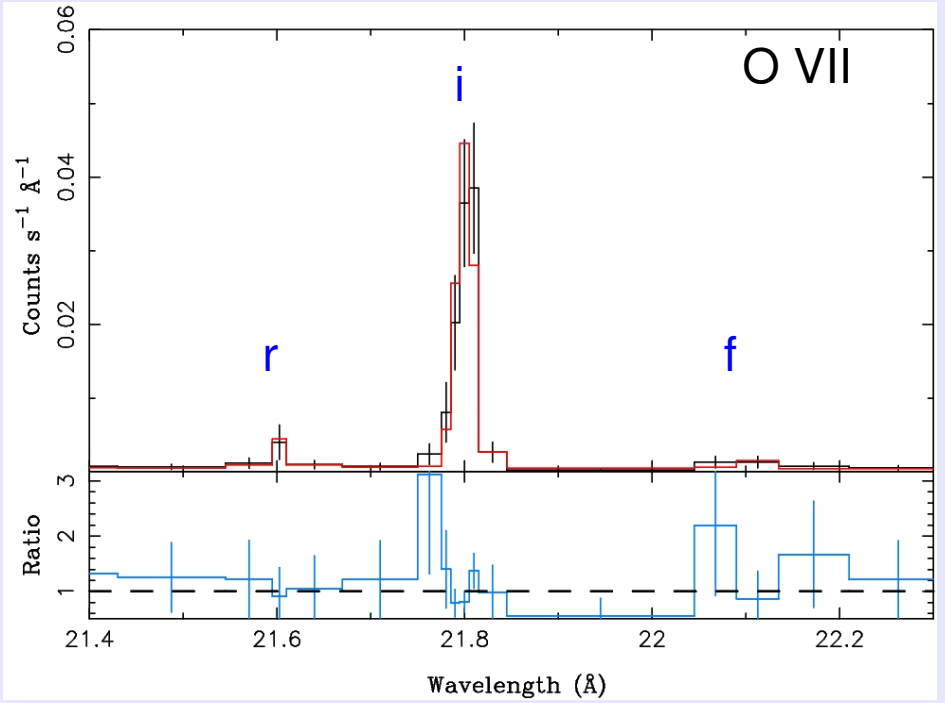


Helium-like triplet lines







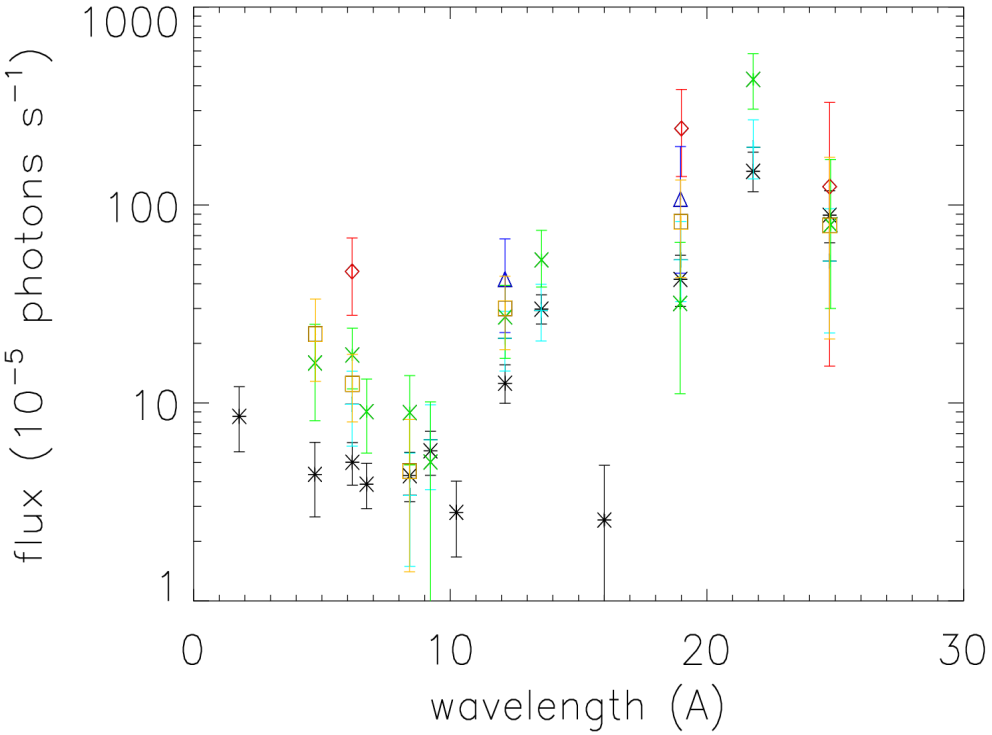


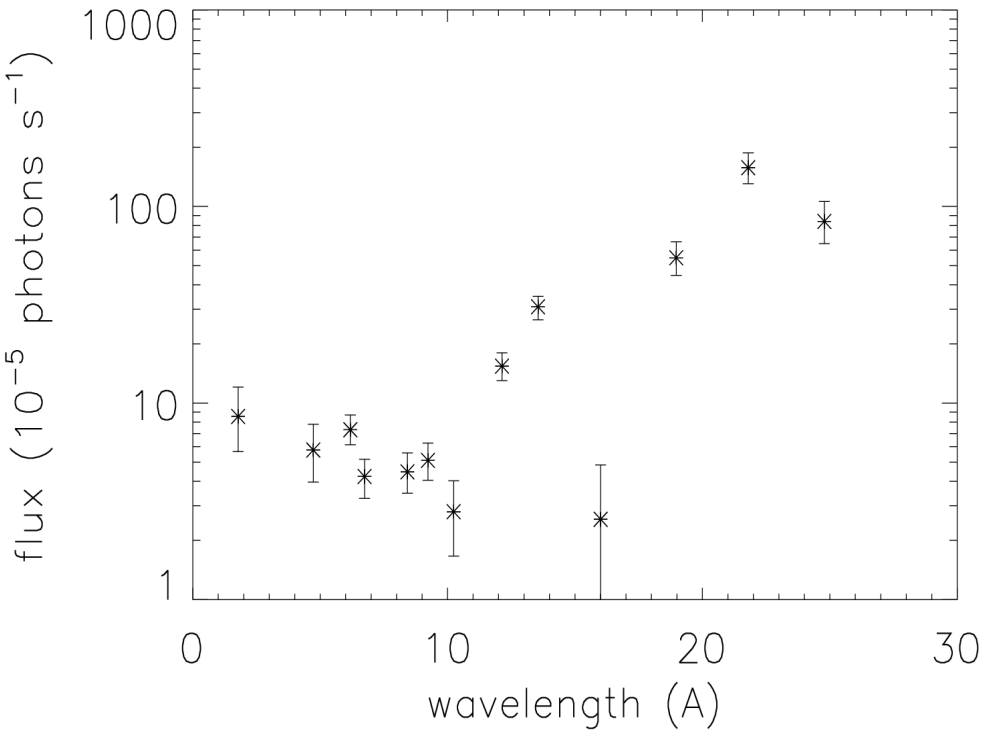
Helium-like triplet lines

Ion	Si XIII	Mg XI	Ne IX	O VII
		ID 2749		
$G = \frac{(f+i)}{r}$	$4.277^{+6.619}_{-1.912}$	$4.046^{+3.860}_{-1.609}$	> 7.063	$13.360^{+37.027}_{-7.428}$
$R = \frac{f}{i}$	$3.907^{+7.690}_{-1.823}$	$0.475^{+0.289}_{-0.205}$	$0.093^{+0.086}_{-0.065}$	$0.560^{+0.102}_{-0.054}$
Cash dof	36.1/37	17.4/16	11.2/15	10.4/17
		ID 3821		
$G = \frac{(f+i)}{r}$		$4.169^{+119.8}_{-2.474}$	> 3.861	> 2.542
$R = \frac{f}{i}$		$0.719^{+0.921}_{-0.460}$	< 0.375	< 0.480
Cash dof		18.3/23	48.0/17	51.1/18
		ID 3822		
$G = \frac{(f+i)}{r}$	> 3.085	> 0.517	> 2.712	> 2.430
$R = \frac{f}{i}$	> 1.832	< 1.408	< 0.289	< 0.262
Cash dof	30.8/40	5.2/13	11.9/12	39.3/16

[a]The line center is fixed at the theorectical value and the line width is fixed as 0.001Å.

Line flux distributions





Resonance Lines (Lyα, Lyβ) & Strong i, f lines

Summary

By analysis of six HETGs observations of HerX-1, we found:

- The continua can be described by a partial covering model which is consistent with the high energy spectra observed with *RXTE*.

- An additional thermal blackbody component is required to fit the soft band below 12 Å

- Most spectra show that the strong line emissions from a photoionized accretion disk corona.

- The strong and variable neutral Fe fluorescence lines are likely associated with the cooler, outer portions of the disk.

- With the constrains from the triplet lines and line flux distribution, photoionization modelling with *XSTAR* is in progress, which allow us to determine the ionization balance with orbital and superorbital phases.