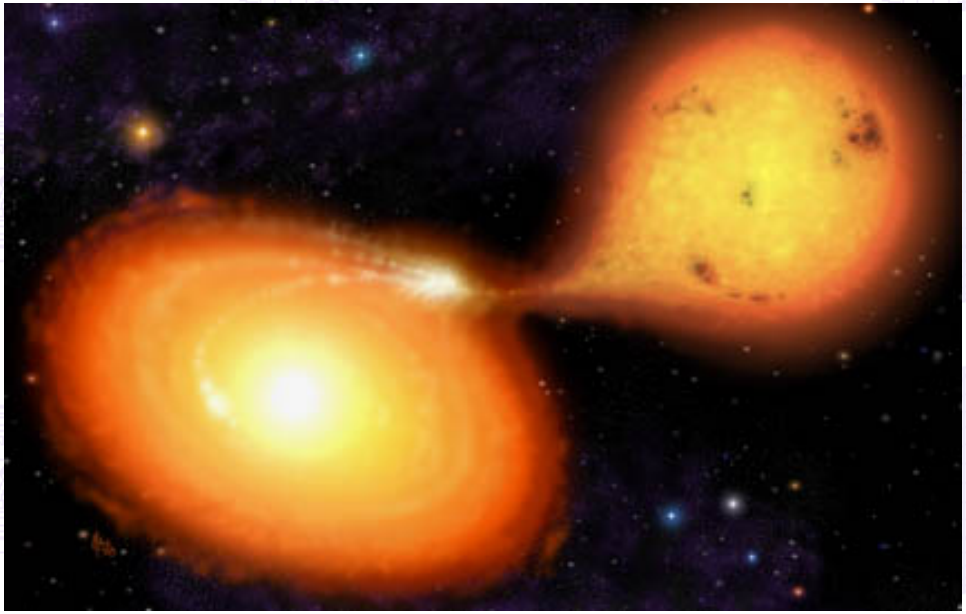
Reflections On, and In, Suzaku Observations of Cataclysmic Variables



Koji Mukai

CVs and Friends in BAT survey

Intermediate Polars (20):

V709 Cas, 1RXS J005528.0+461143, XY Ari, GK Per, TV Col, TX Col, V405 Aur, BG CMi, Swift J0732.5-1331, PQ Gem, EI UMa, YY Dra, EX Hya, NY Lup, V2400 Oph, IGR J17303-0601, V1223 Sgr, RX J2133.7+5107, FO Aqr, AO Psc

Polars (4):

BY Cam, V1432 Aql, 1RXS J145341.1-552146, 1RXS J231920.9+261525

Dwarf Nova (1):

SS Cyg

CV/IP Candidates (3):

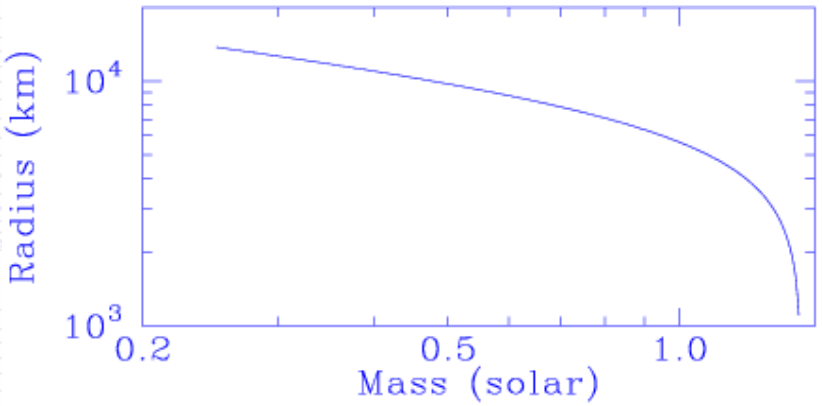
Swift J052522.48+241331.8, 1RXS J122758.8-485343, 1RXS J171935.6-410054

Symbiotic Stars (4):

CD-57 3057, RT Cru, T CrB, CH Cyg

These are accreting white dwarf binaries in the BAT 22 month catalog observed with Suzaku or approved for a Suzaku observation

Accretion onto White Dwarfs



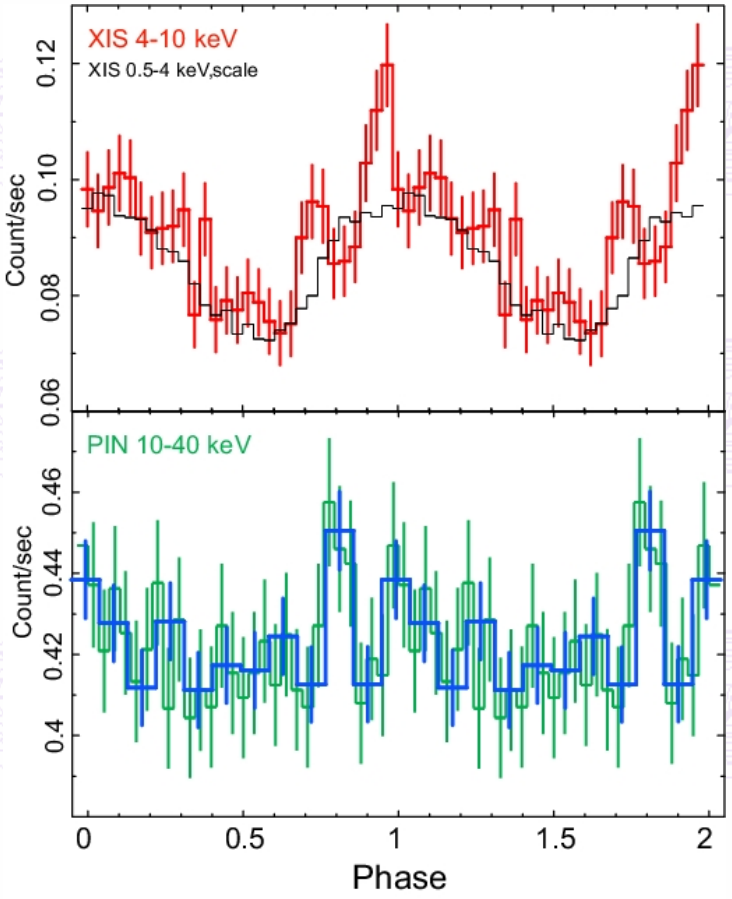
Two cases:
Magnetic systems - free fall, strong shock, higher kTmax;
Non-magnetic systems - Keplerian, weaker shock, hence lower kTmax.

The gravitational potential of a white dwarf is deep enough to shock-heat the plasma that strikes its surface to kT~10-50 keV, depending on the white dwarf mass. They cool by emitting Mekal/APEC type optically thin thermal plasma emission

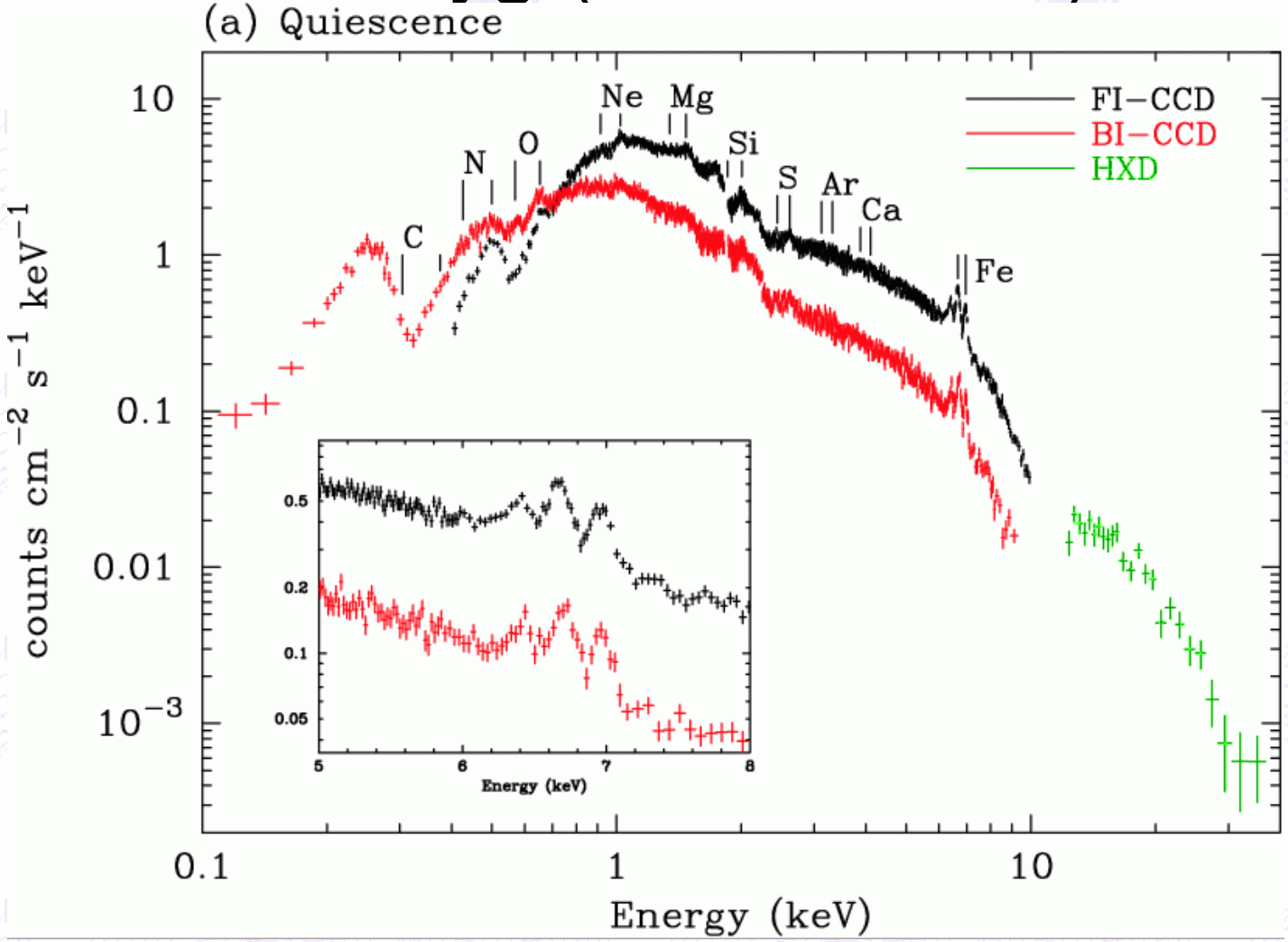
The BAT sample is dominated by magnetic CVs and high Mwd systems

Non-BAT CVs

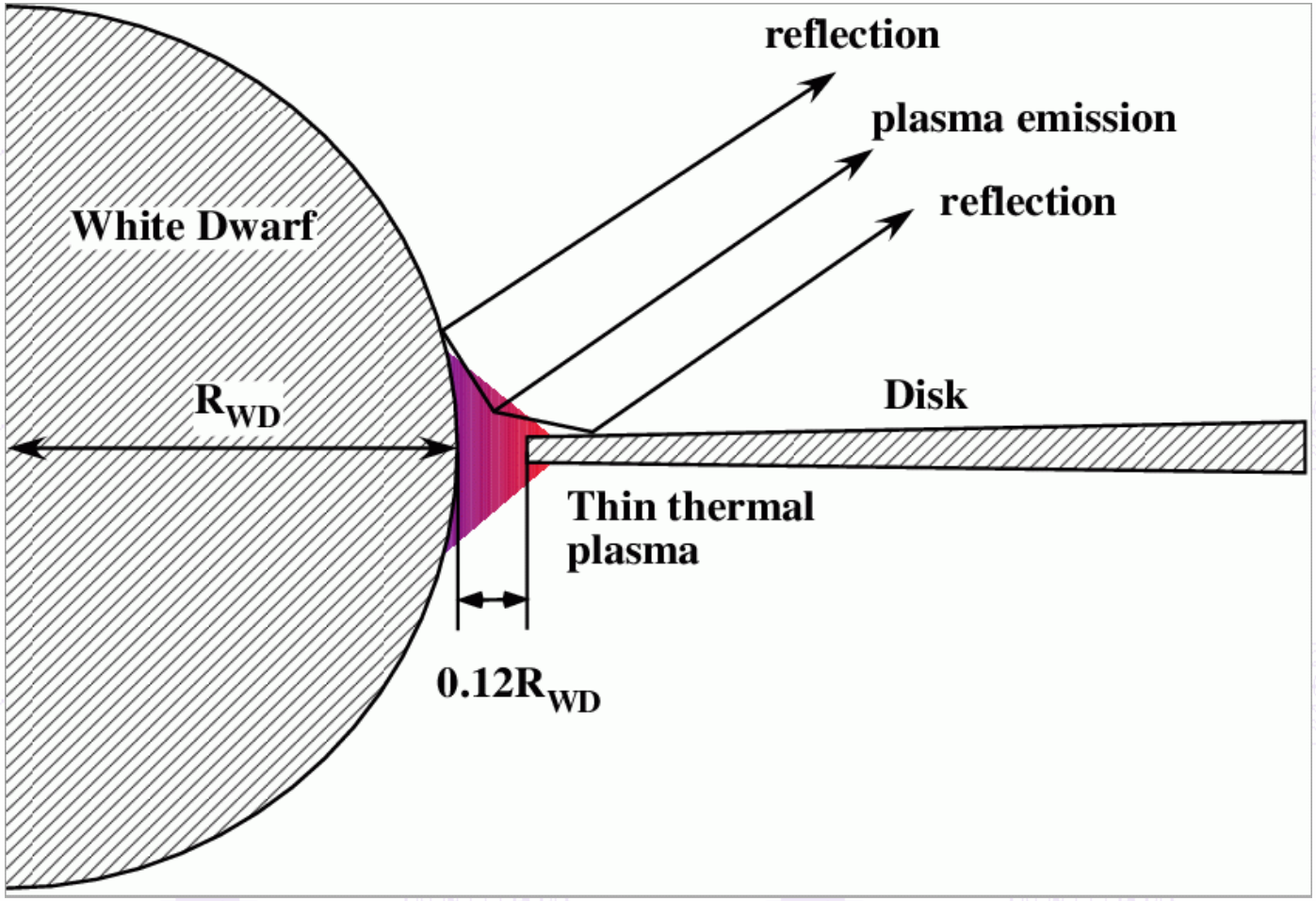
- Probable detection of non-thermal hard X-rays in the propellar system, AE Aqr
- First detection of a partial X-ray eclipse in a dwarf nova system, V893 Sco
- Study of dwarf nova X-ray luminosity function using the Thorstensen sample of systems with parallactic distance determinations (Bycklying et al. in preparation)



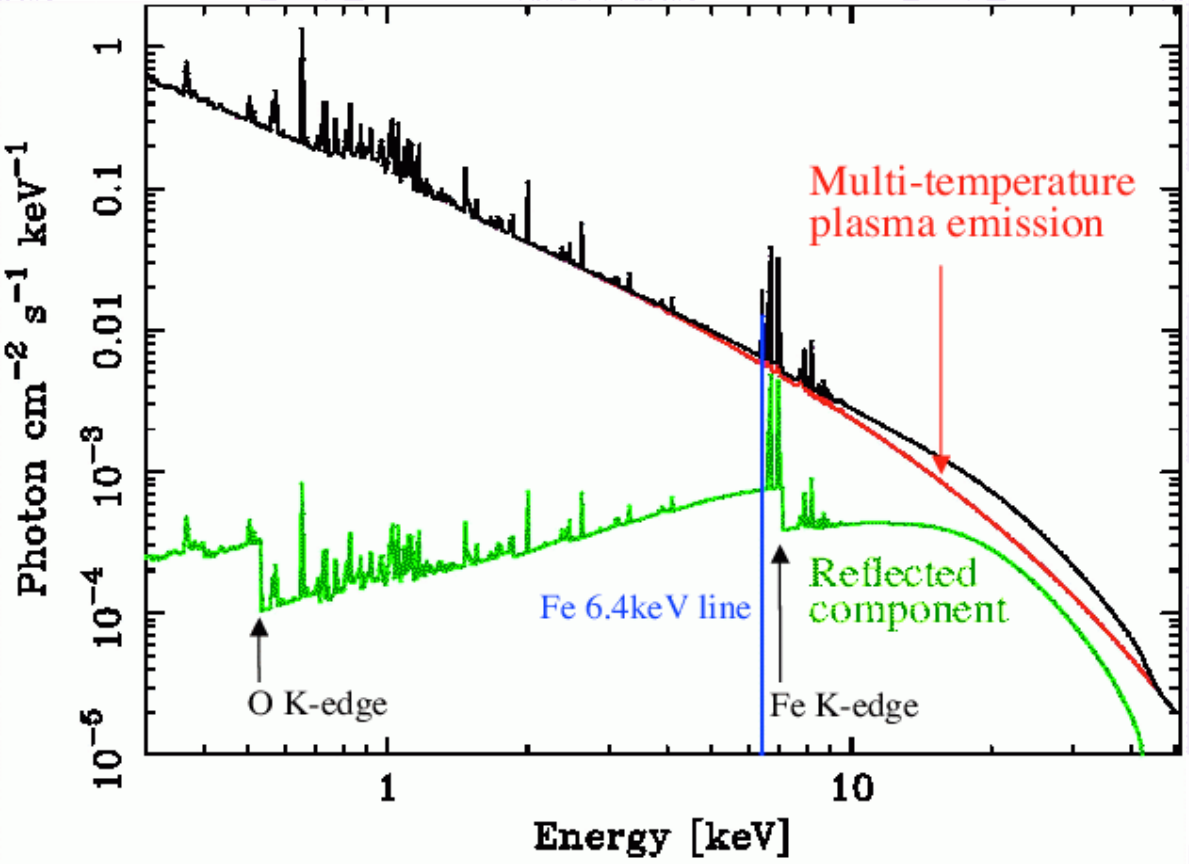
SS Cyg (Mwd~1.1Mo)



Probable Geometry



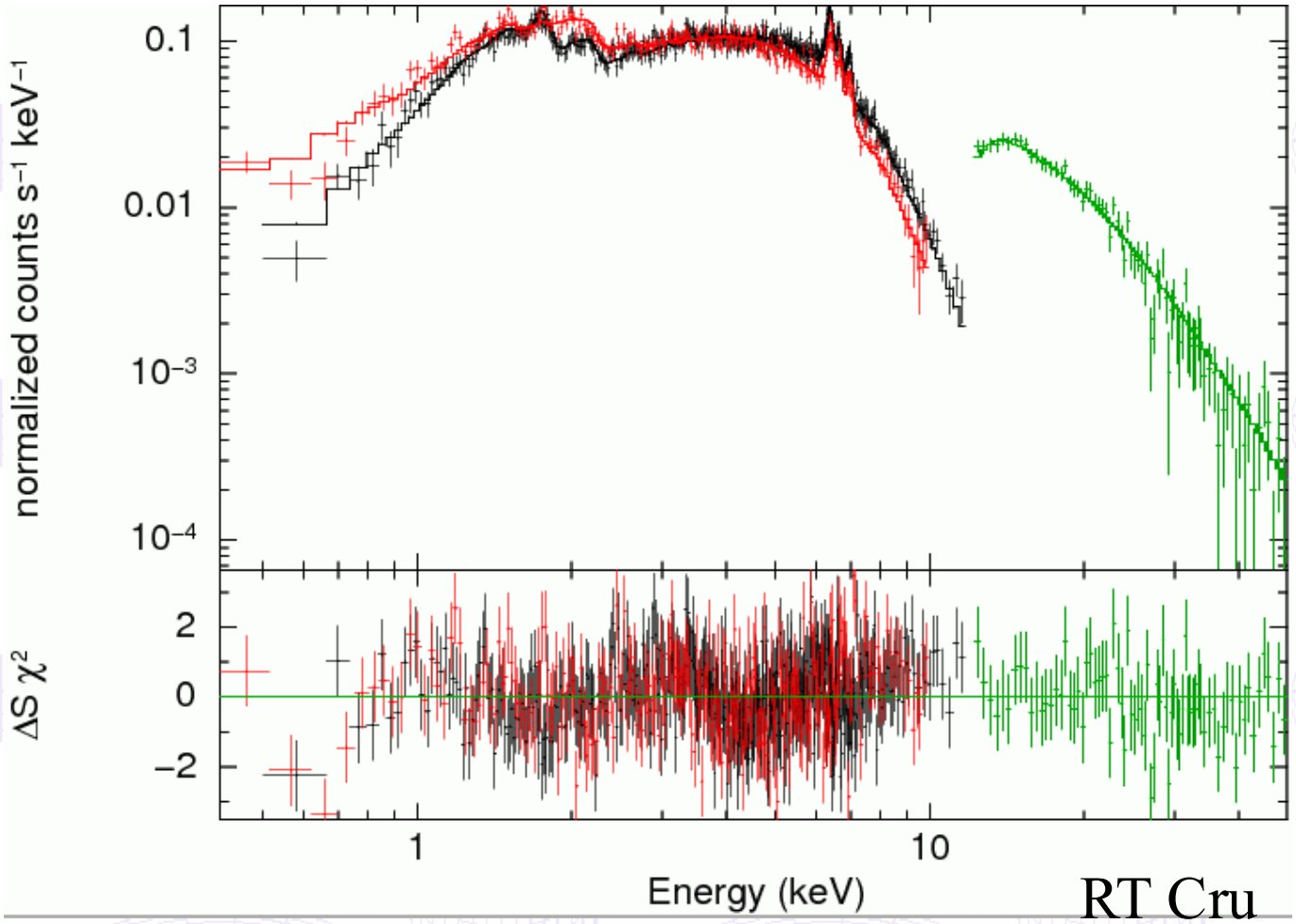
Unfolded Spectra of SS Cyg



(Schematic)

In Ishida et al., we used this basic combination to derive the elemental abundances and reflection fraction to infer the boundary layer geometry

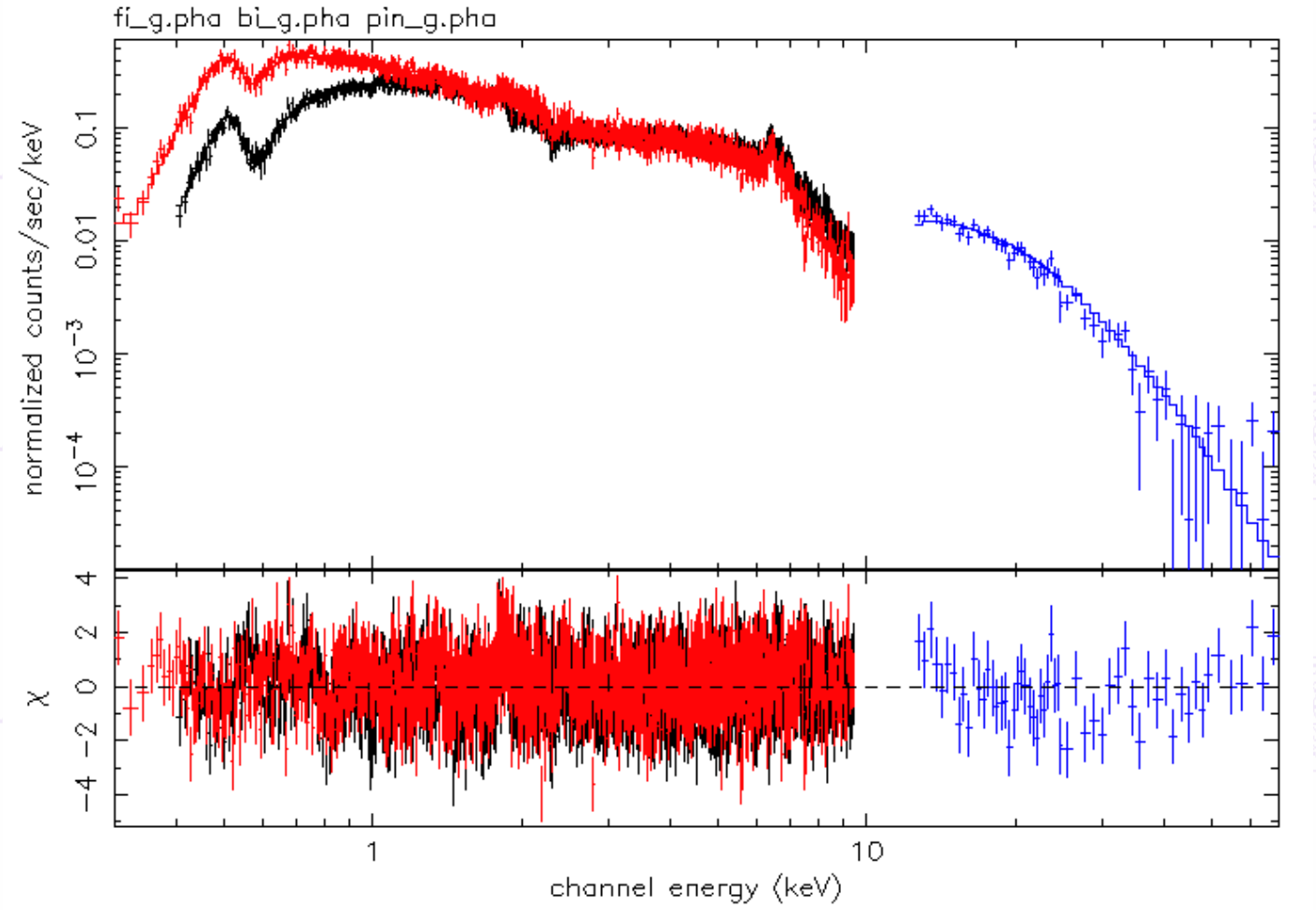
More massive WDs



Symbiotic Stars

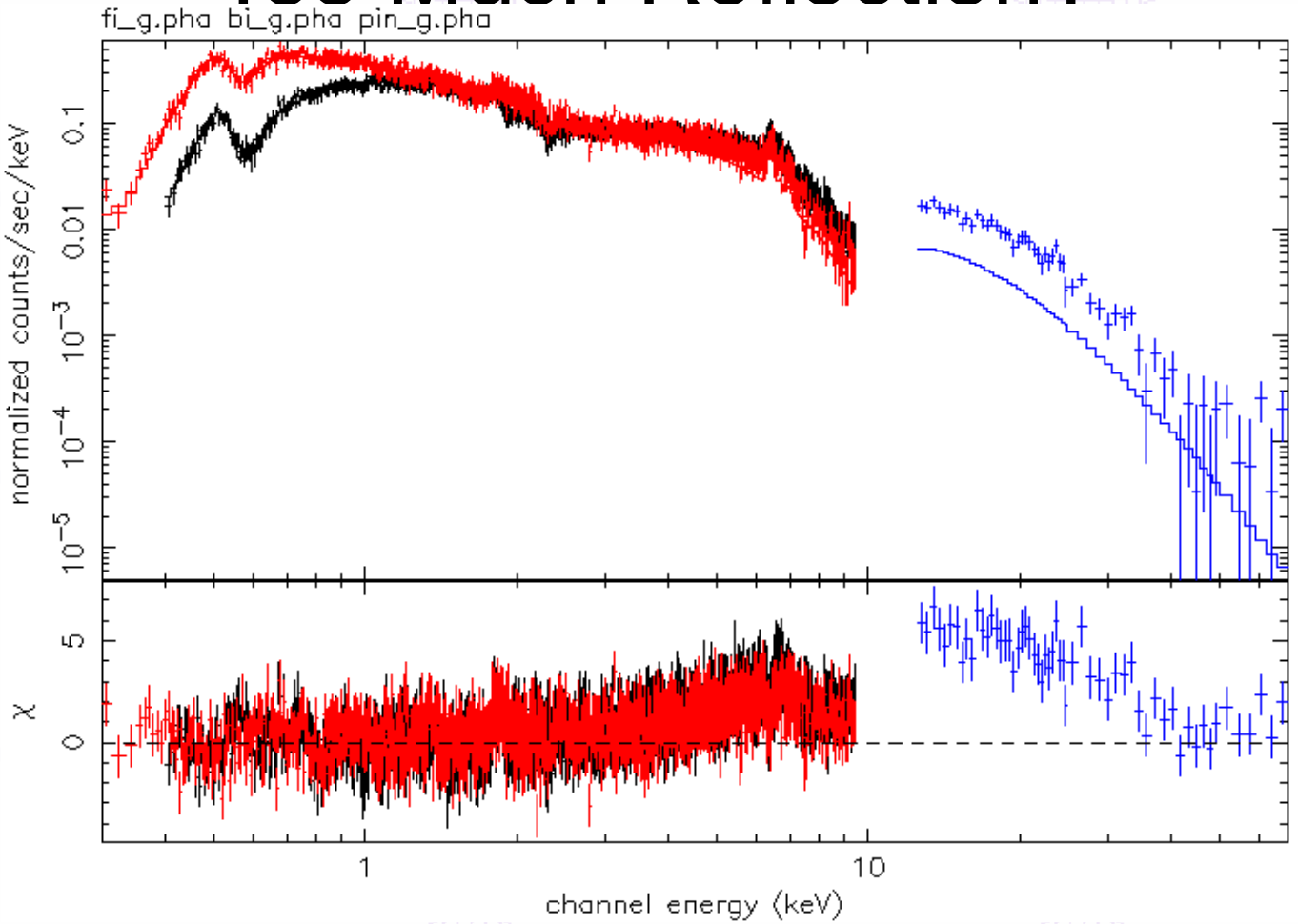
- Symbiotic stars are binaries in which a white dwarf is accreting from an M giant, rather than an M dwarf (which would make it a CV)
- 4 (and now, possibly 5) symbiotic stars have been detected in the BAT survey
- No indications in X-ray or optical data that these white dwarfs are magnetic
- Likely reason for them showing up in the BAT survey: really massive white dwarfs, 1.35 Mo and above!

Reflections in IPs



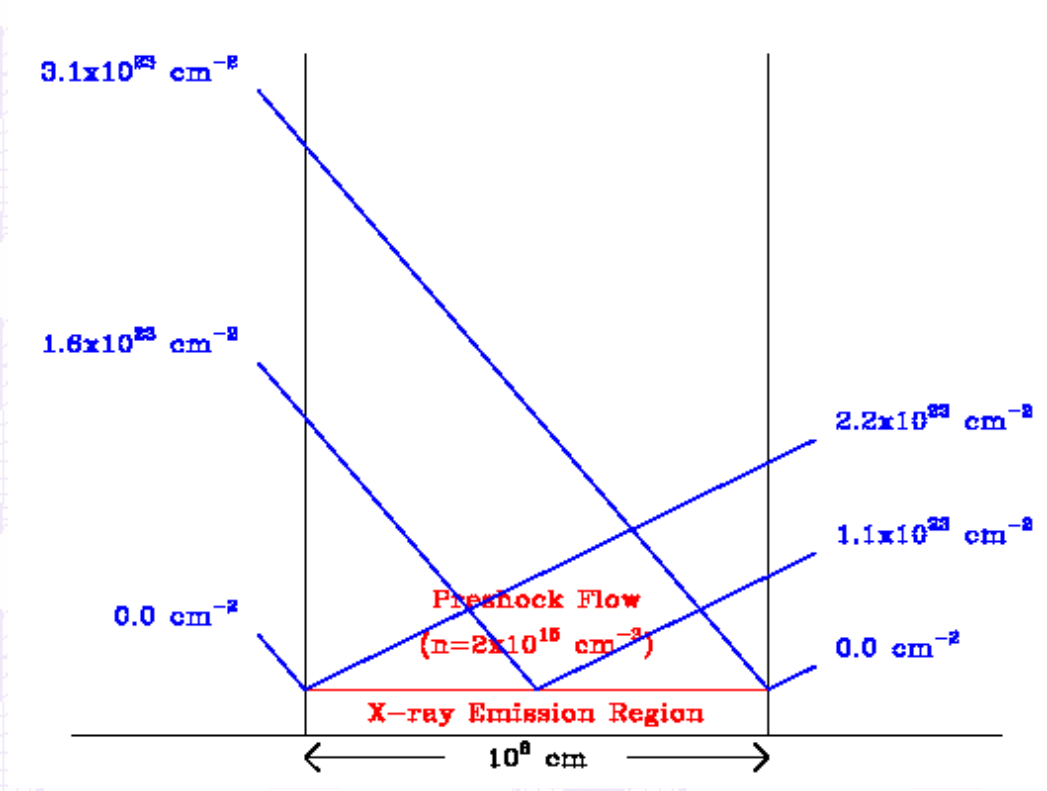
RX J2133

Too Much Reflection?



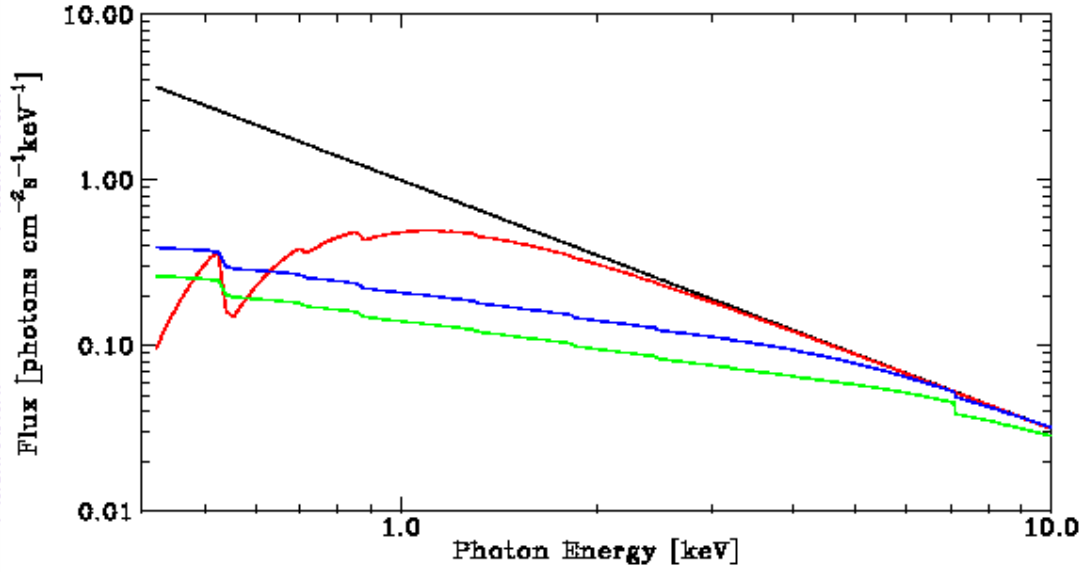
The fit had rel_refl=4.62! This often happens with MKCFLOW intrinsic model with partial covering absorber model

Complex Absorber



Even a double or triple partial covering absorber model is not realistic - a continuous distribution of Nh is expected from this geometry

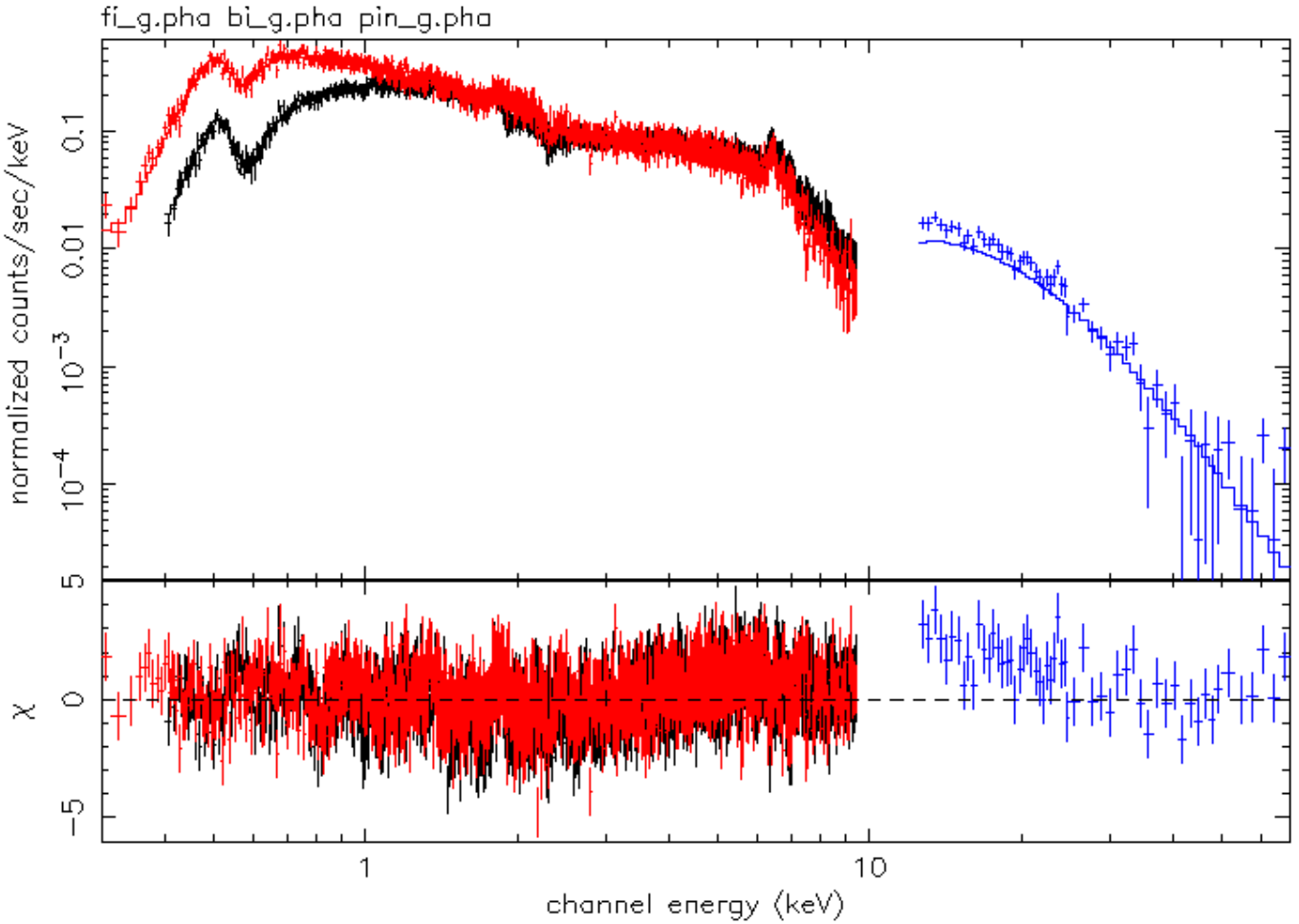
PWAB model to the rescue



Done & Magdziarz have coded an approximation of this into the XSPEC pwab model --- with parameters typical of IPs, this makes the 0.5-10 keV continuum much harder than the intrinsic emission.

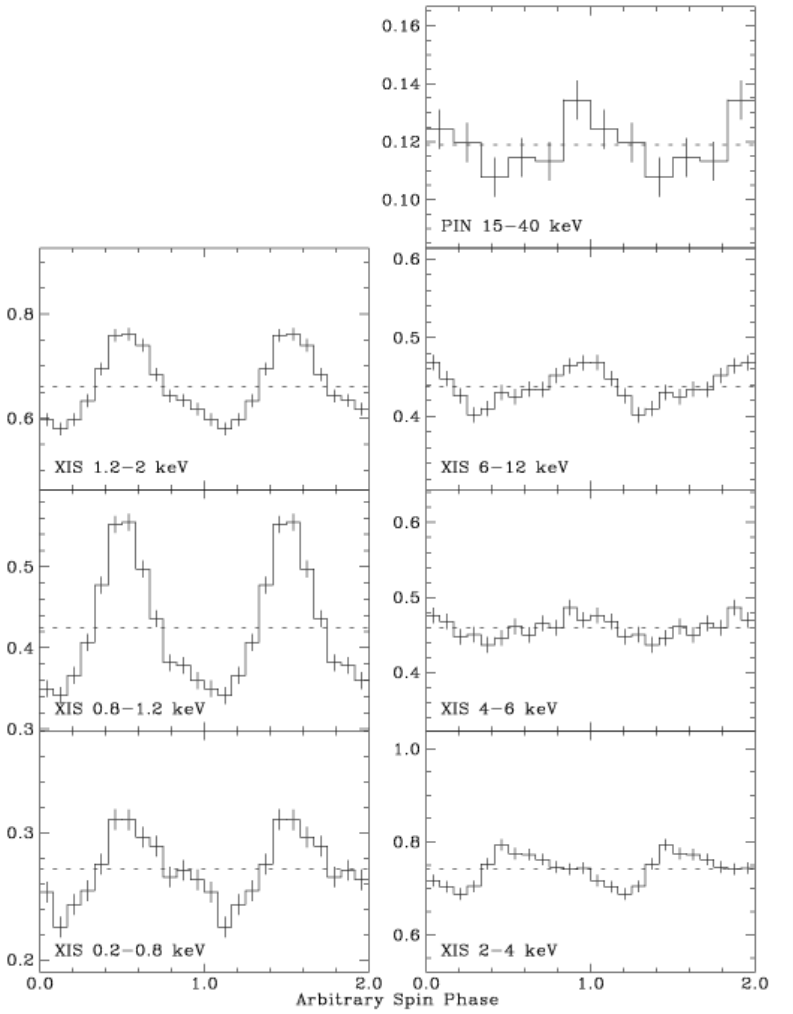
Pcfabs model is a poor approximation which potentially leads to wrong rel_refl (as well as wrong kTmax)

The Correct (?) model



Recent experimentation using pwab with reflect suggests a good fit is possible with rel_refl~1.0, consistent with the 6.4 keV spectrum

Breaking the Degeneracy



In addition to the 6.4 keV line, the spin modulation can be used to break the degeneracy.

E<4 keV: spin modulation due to variable absorption

E>6 keV: spin modulation due to variable cosi of the reflection

Of the current generation of X-ray satellites, only Suzaku can do such a study (but Astro-H would be even better)