AtomDB: Atomic Data for Astrophysics

Adam Foster
Hiroya Yamaguchi
Randall Smith
Nancy Brickhouse
Smithsonian Astrophysical Observatory

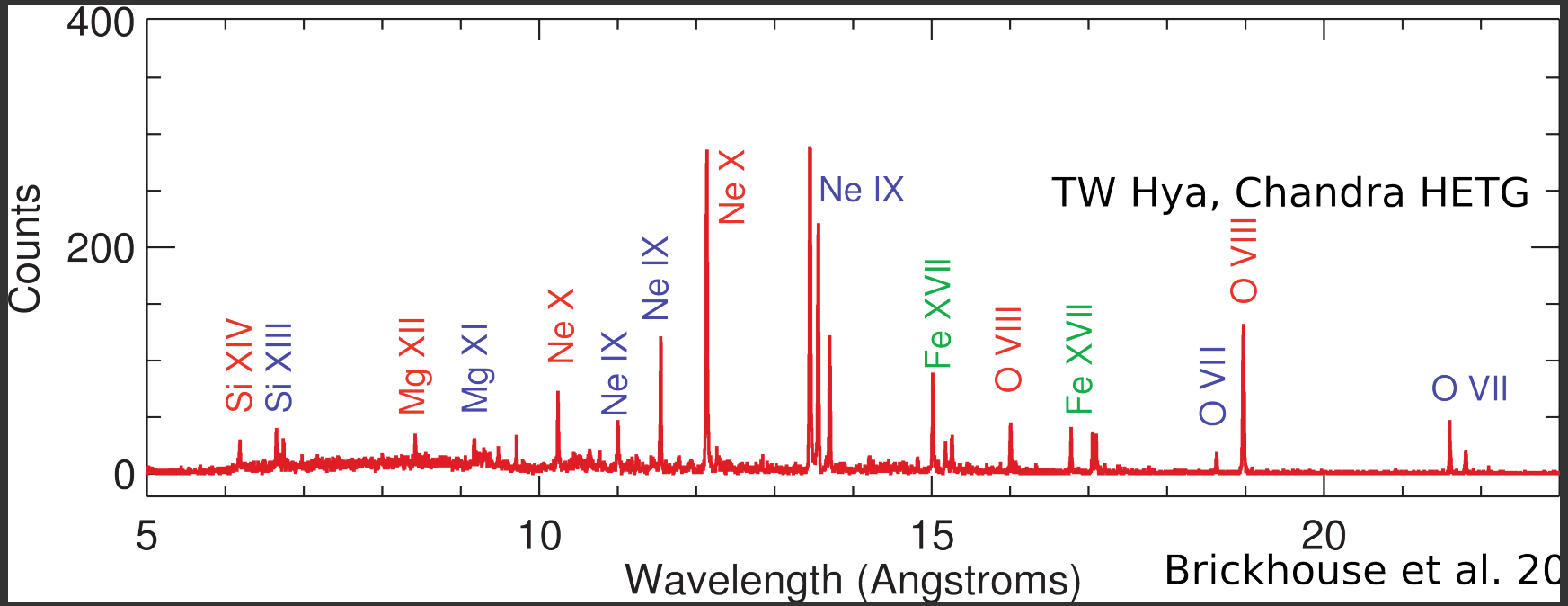
Li Ji
Purple Mountain Observatory

Tim Kallman
NASA Goddard

Joern Wilms
Universität Erlangen-Nürnberg

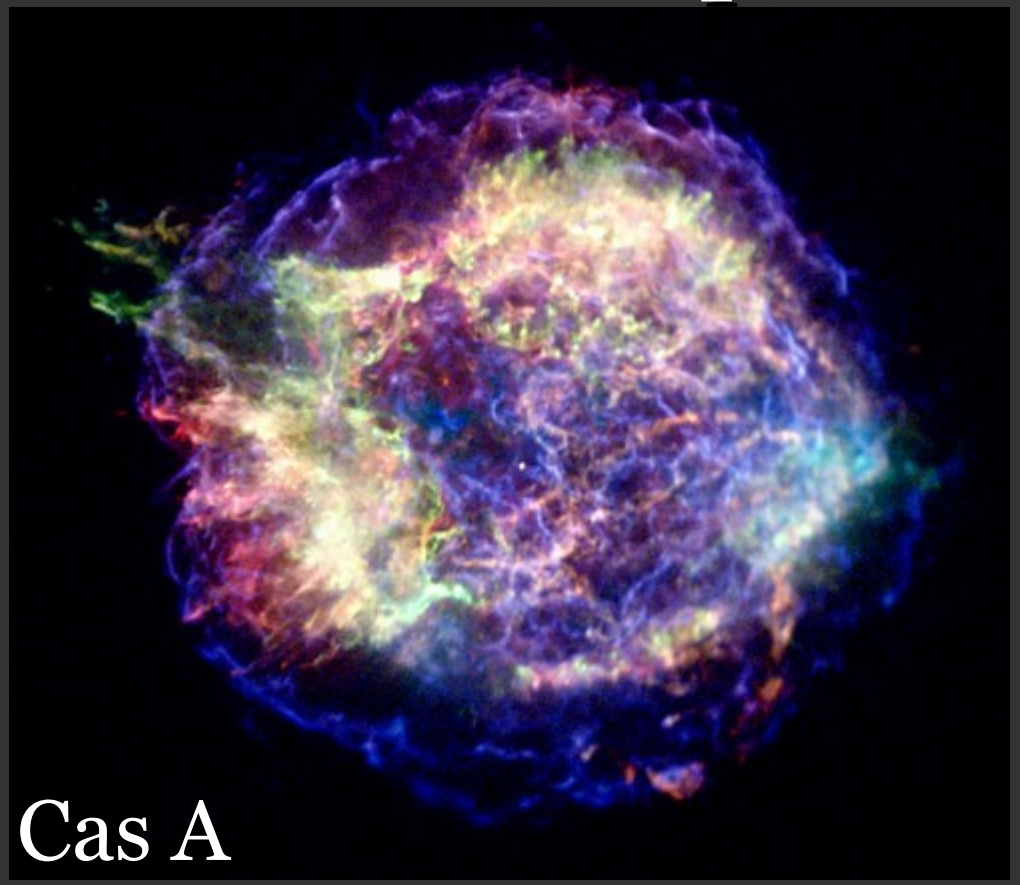
www.atomdb.org
afoster@cfa.harvard.edu

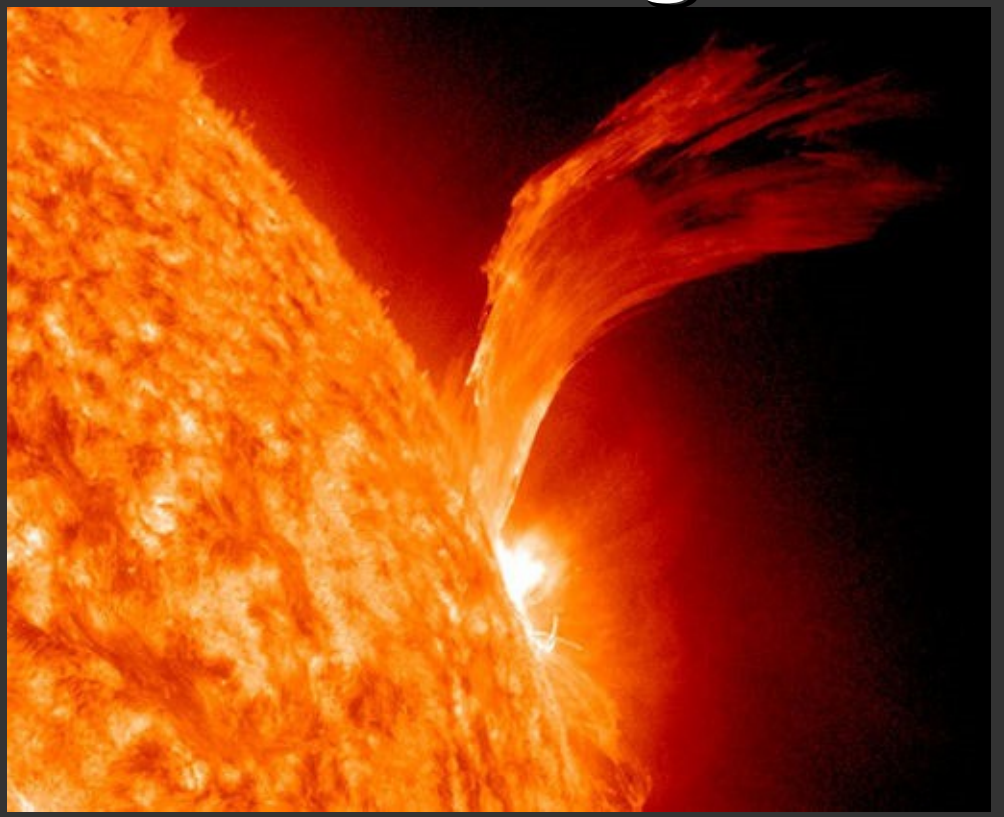
X-Ray Astronomy



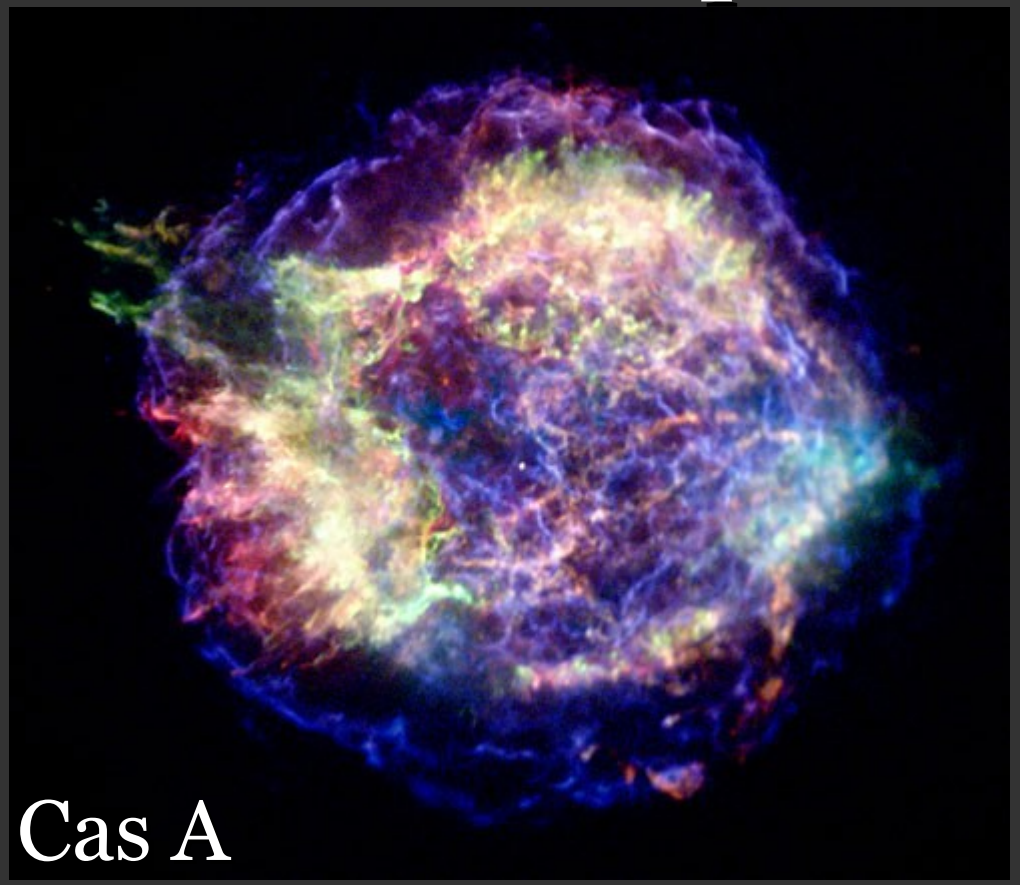
Major needs are **H-like**, **He-like**, and **Fe** (and to a lesser extent Ni) **L-shell** line data

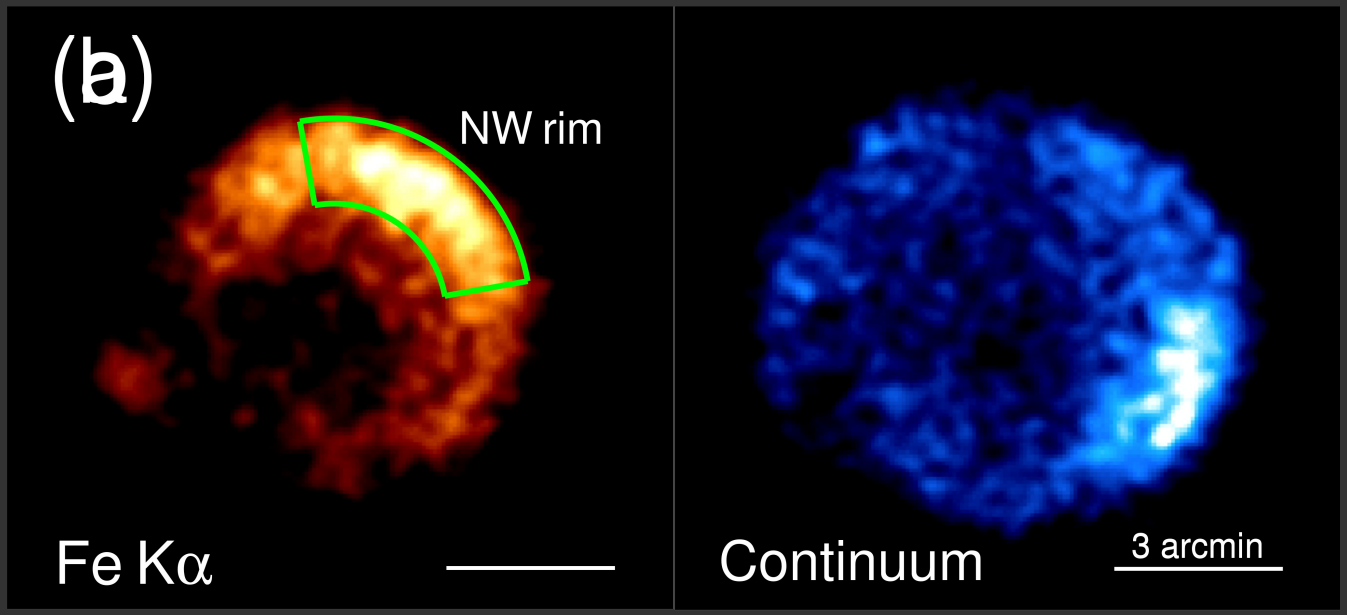
Non equilibrium modeling

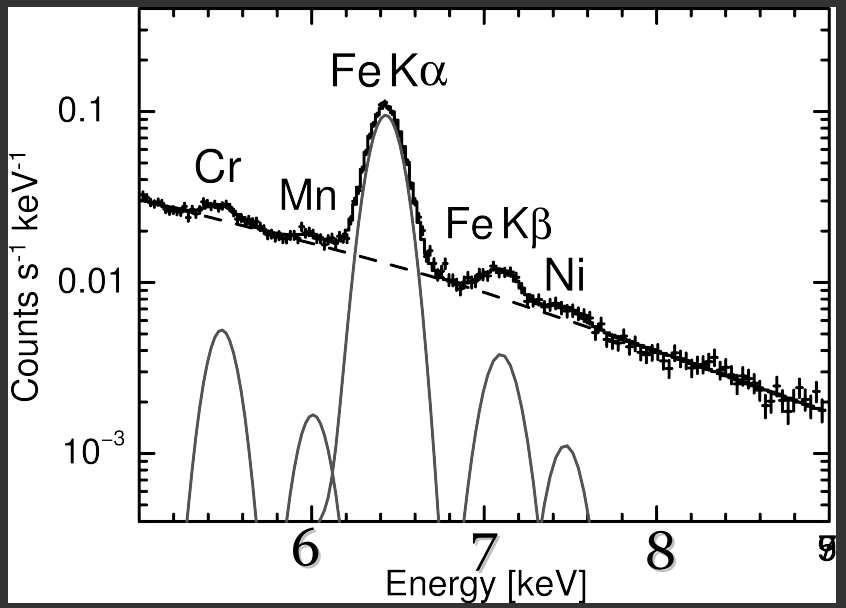




Non equilibrium modeling

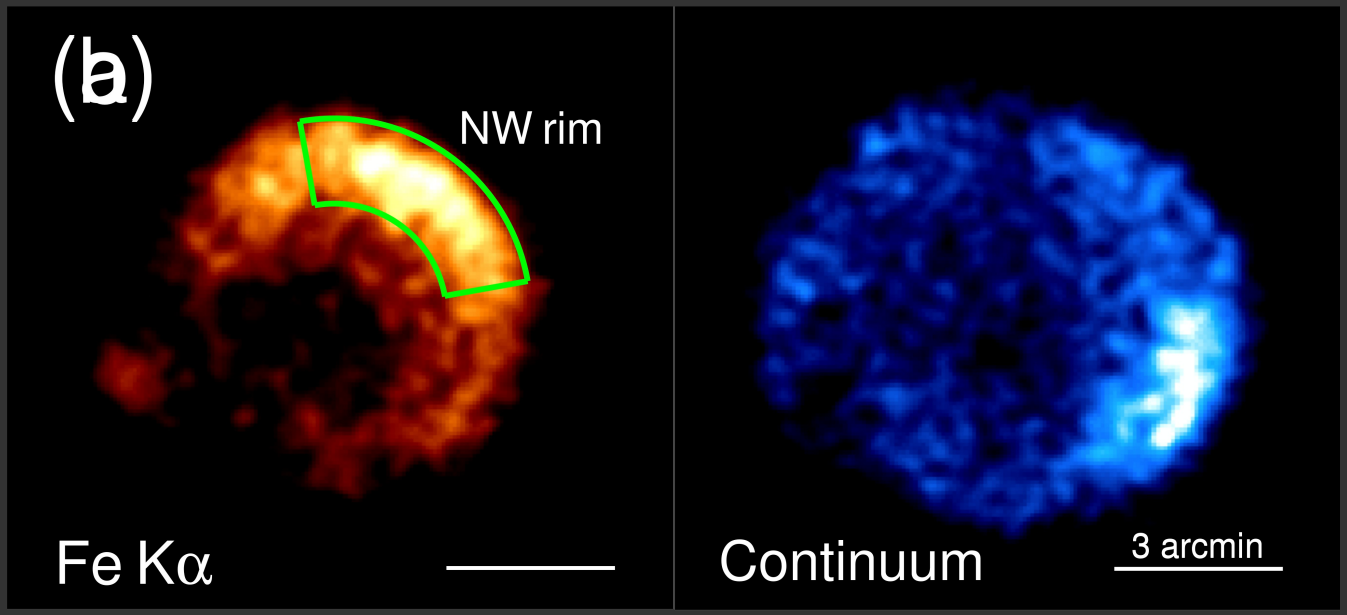


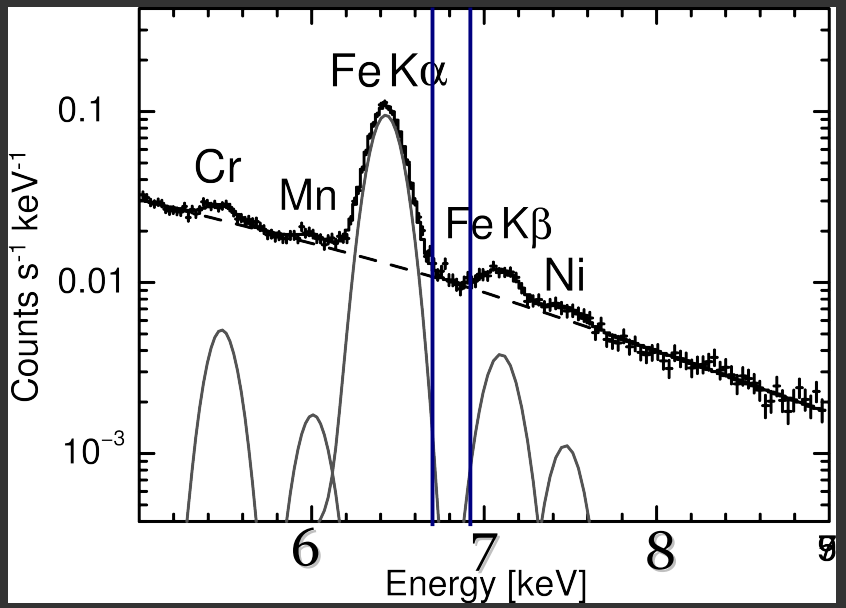




Yamaguchi+2013

Tycho SNR
Type 1a
Exploded 1572





Yamaguchi+2013

Tycho SNR
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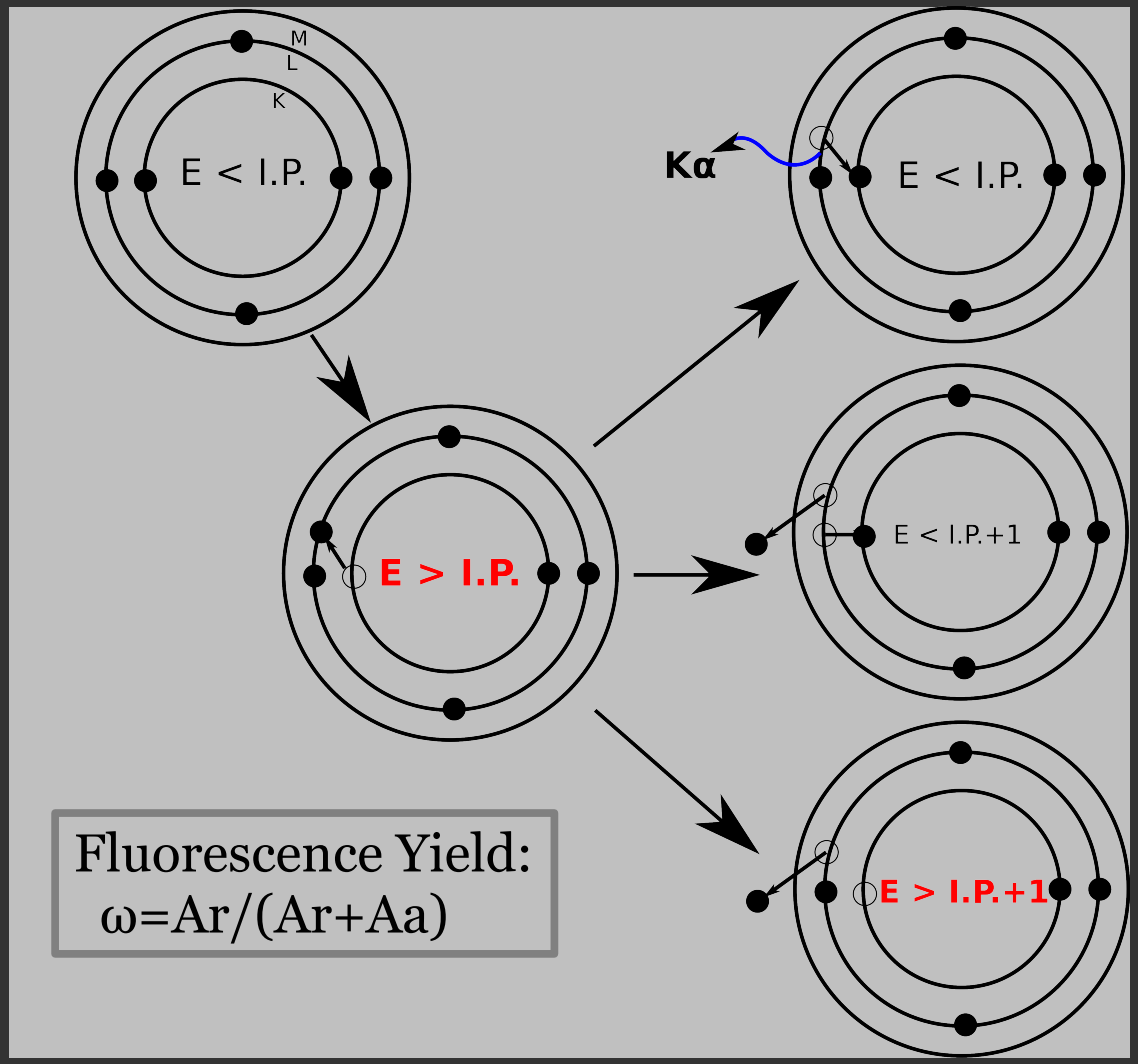
Inner Shell Processes

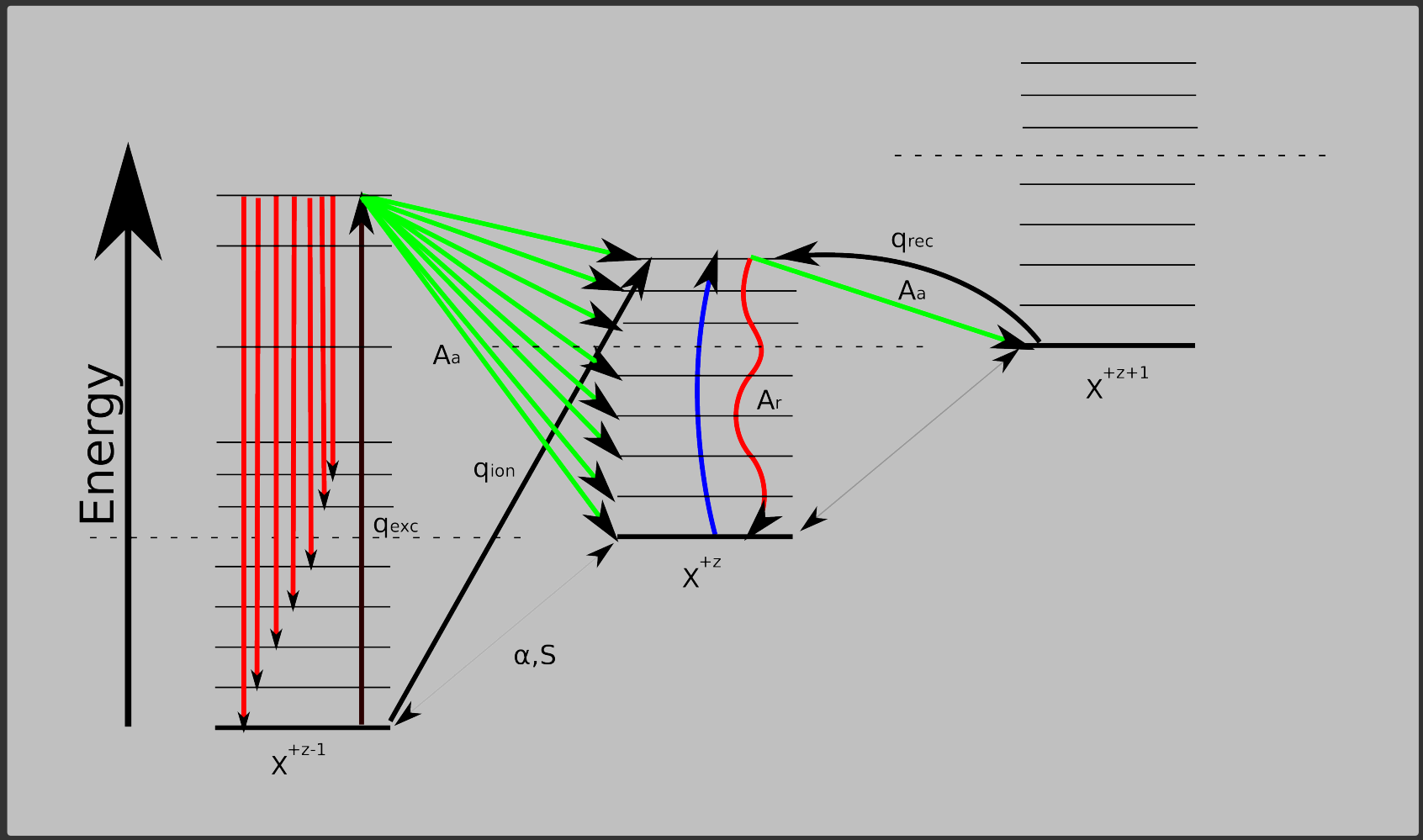


Fluorescence

Autoionization

Autoionization+

Modeling NEI emission



New Model

Build in proper handling of autoionizing levels to AtomDB.

- Inner shell excitation
- Inner shell ionization

} ??? et al.

- Fluorescence
- Auger breakup

} Palmeri, Mendoza, Gorczyca, Hasoglu, etc

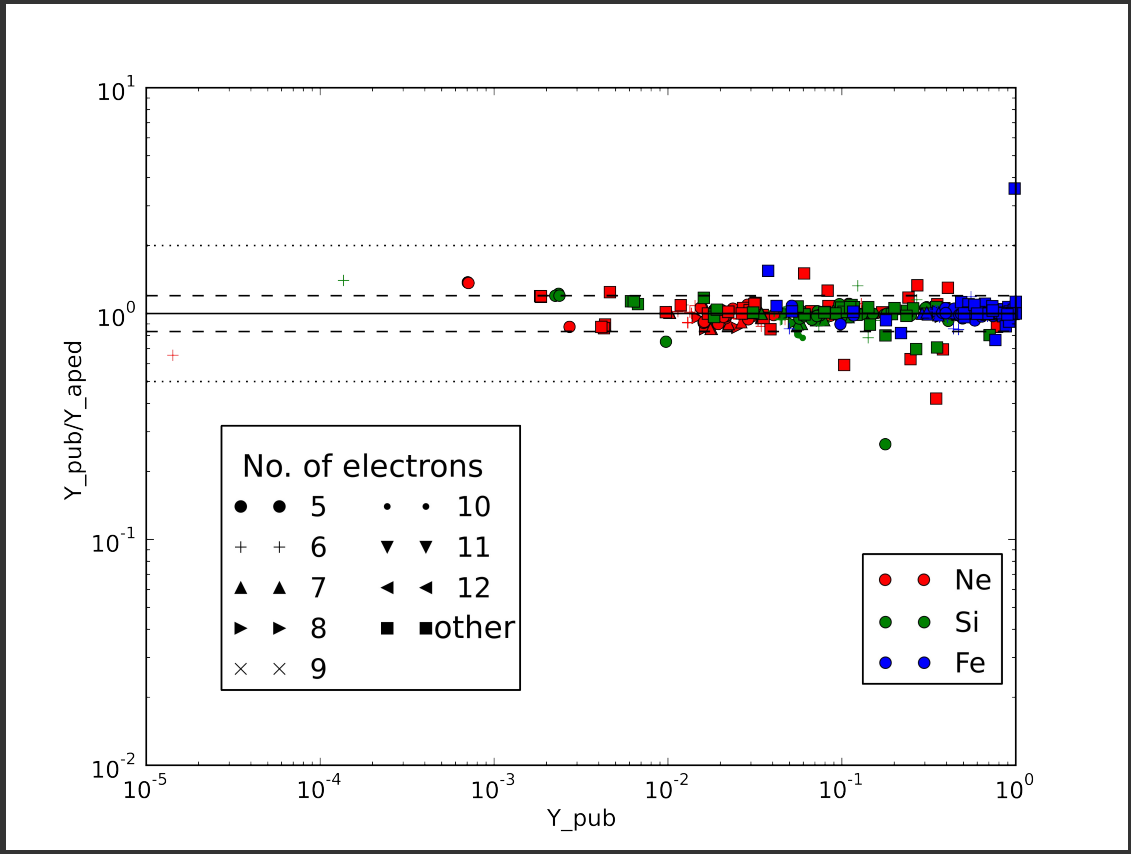
- Include levels for Kβ, Kγ.

Method

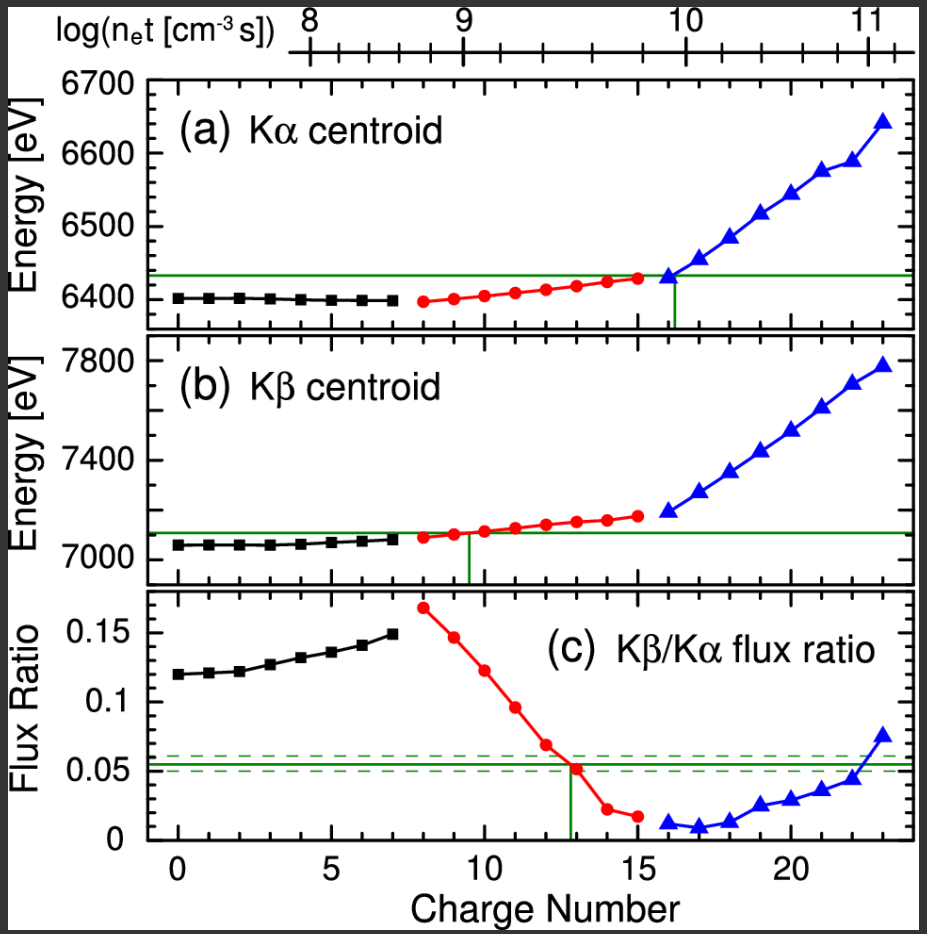
- Large scale Flexible Atomic Code runs

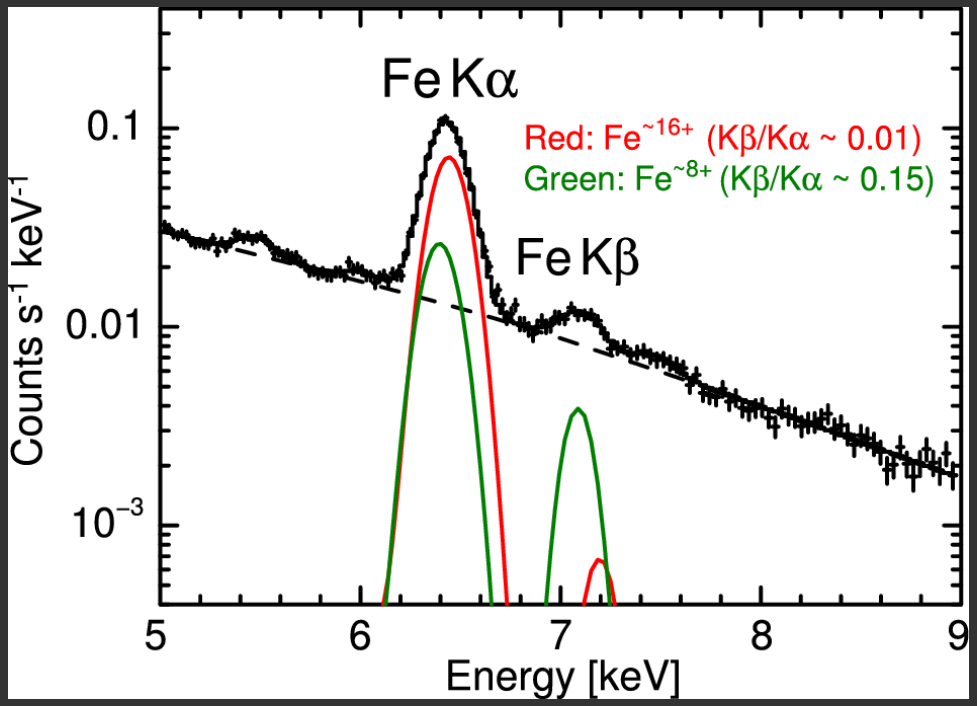
  All ions, all 14 most common elements

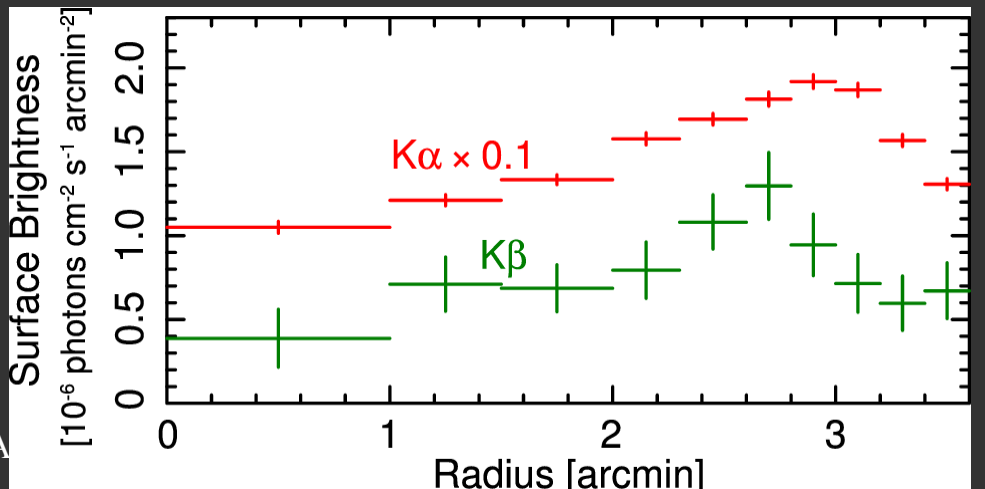
- Fe data for L & K shell ions from Eriksen+ 2013



Effect of NEI Modelling







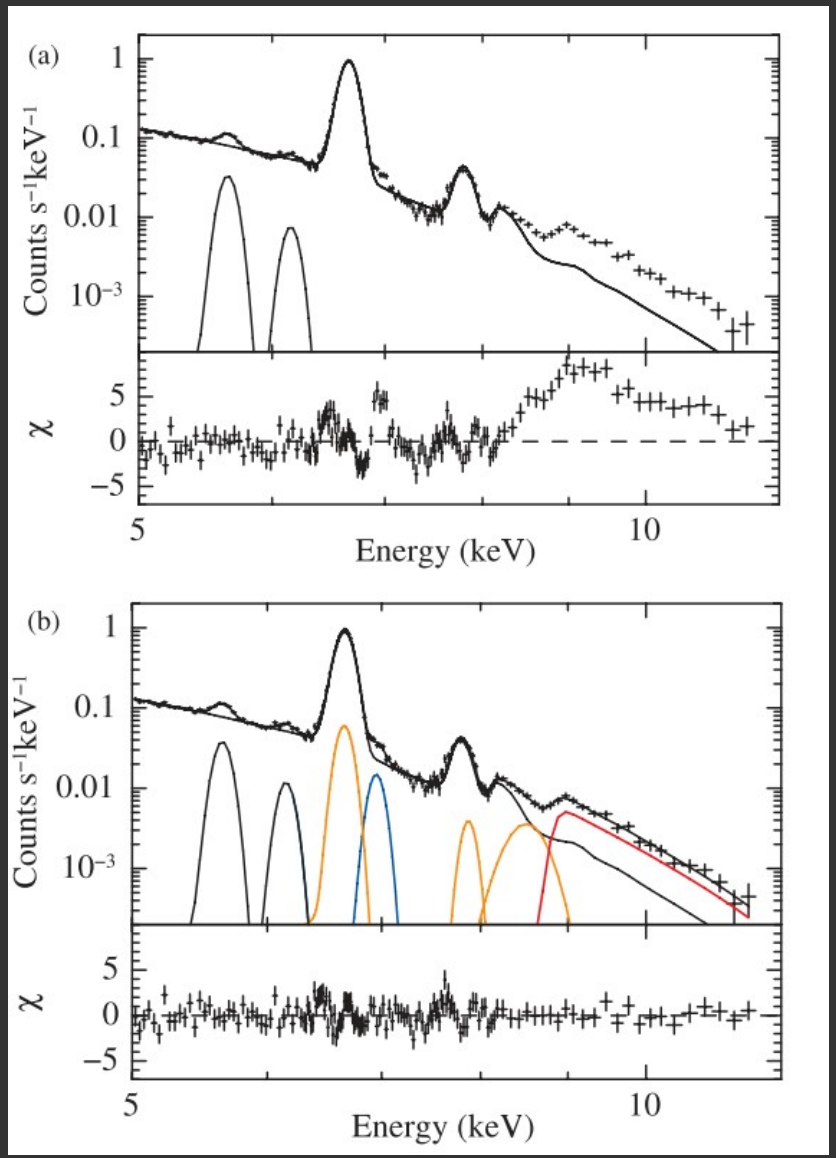
Recombining plasma

Observed in many SNR

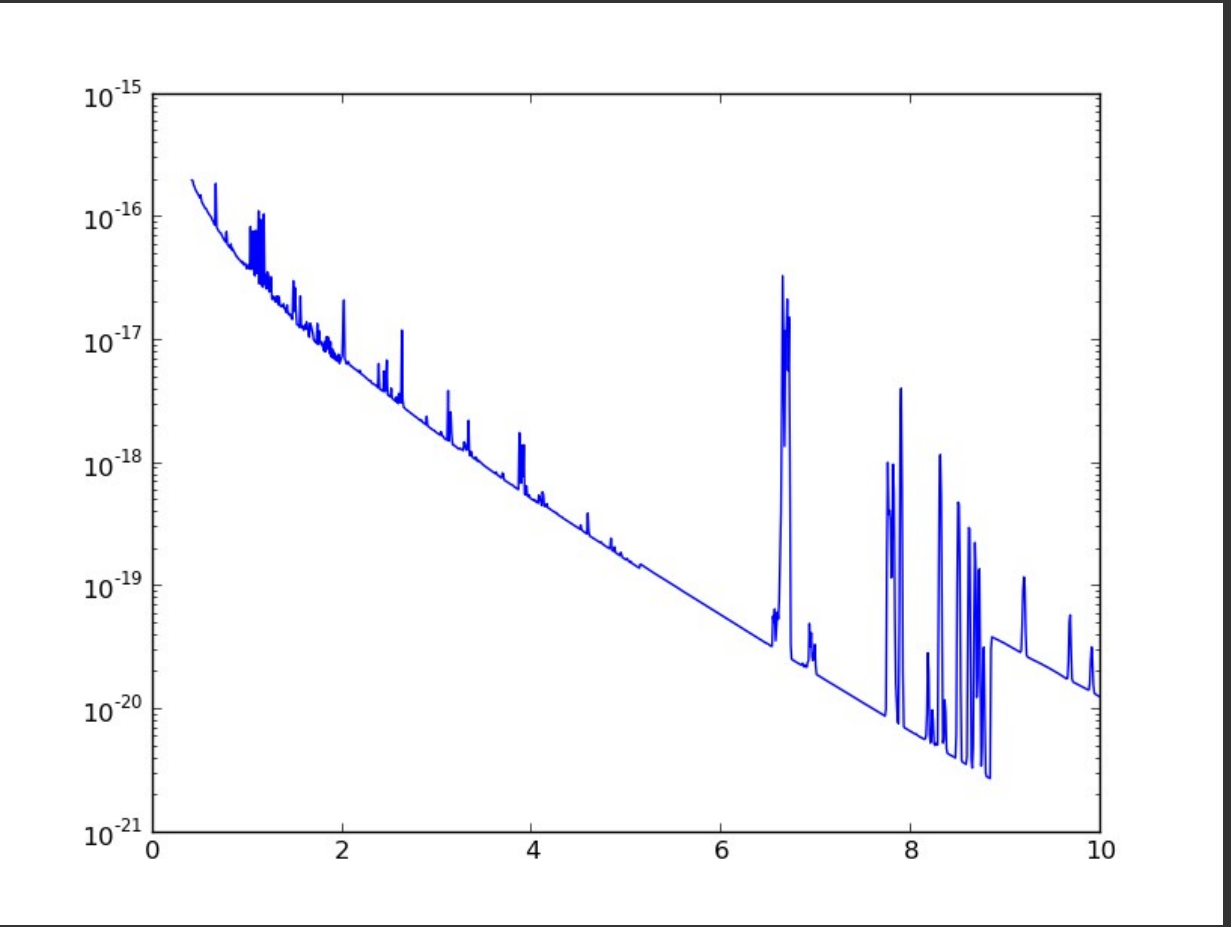
Ozawa+ 2009, W49B

kT_e = 1.5keV

kT_i = 2.7keV



Recombining NEI run

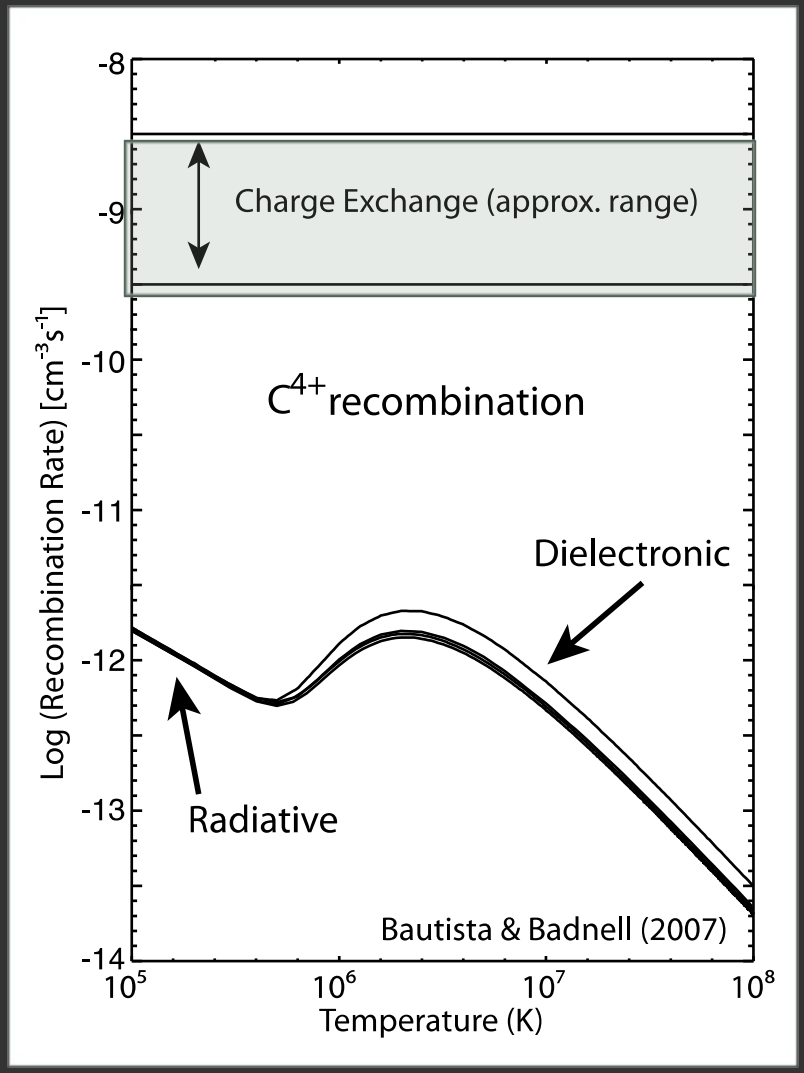


AtomDB CX Model

If there is neutral H and/or He to mix with hot ions, charge exchange dominates!

No comprehensive model of CX emission available

Low energy:
400-700km/s = 1-3 keV/amu



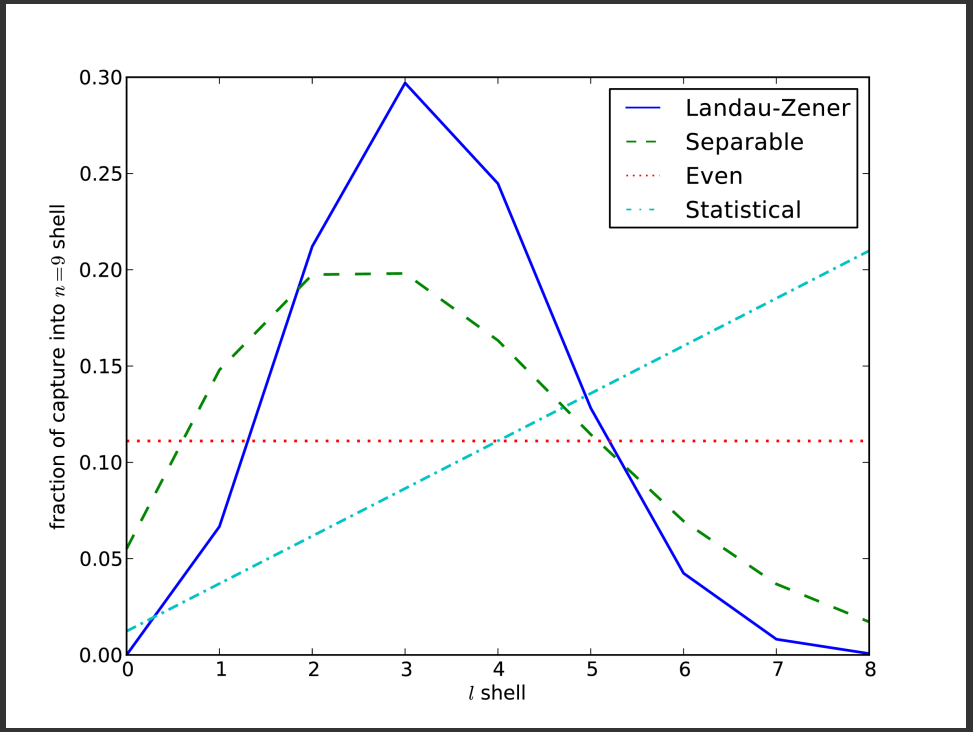
CX Model

$$\varepsilon = \int N_H N_{ion} \sigma_{cx}(E)\, dl$$

Assume σ_{tot} constant = 3×10^{-13} cm^2

Peak n shell:

$$n' = q\sqrt{\frac{1}{2}\frac{I_H}{I_p}}\left(1+\frac{q-1}{\sqrt{2}q}\right)^{\frac{-1}{2}}$$



CX Model

$$\varepsilon \overset{?}{=} \int N_H N_{ion} \sigma_{cx}(E) dl$$

CX Model

$$\varepsilon = \int \overset{?}{N_H} \overset{?}{N_{ion}} \sigma_{cx}(E)\, dl$$

CX Model

$$\varepsilon = \int \overset{?}{N_H}\,\overset{?}{N_{ion}}\,\sigma_{cx}(E)\,\overset{?}{dl}$$

CX Model

$$\varepsilon = \int \overset{?}{N_H}\, \overset{?}{N_{ion}}\, \overset{?}{\sigma_{cx}}(E)\, \overset{?}{dl}$$

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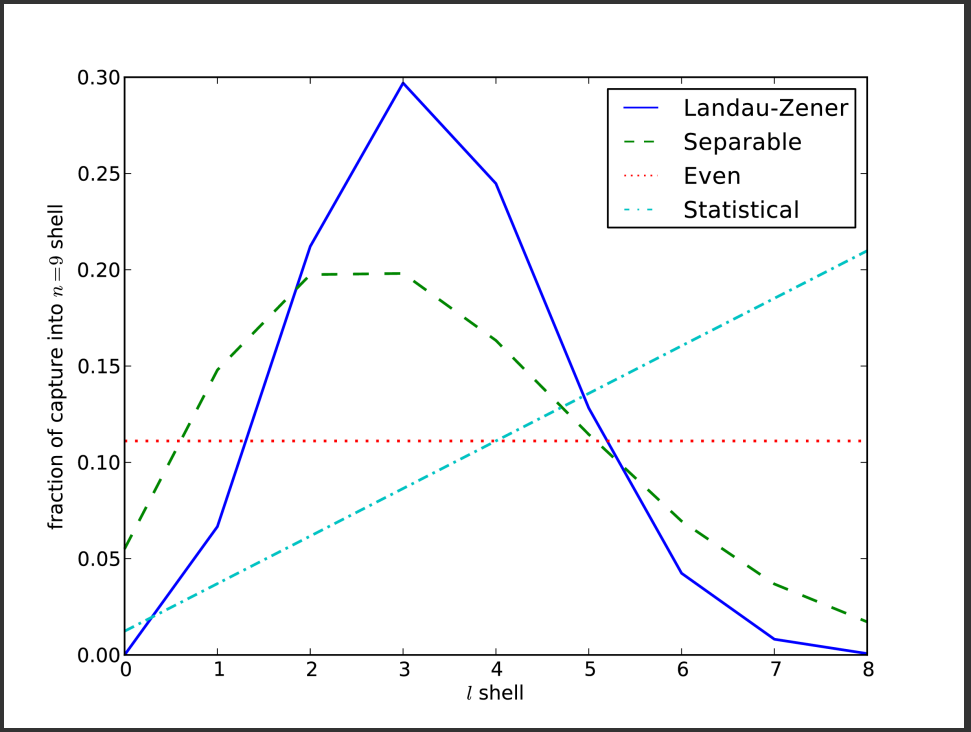
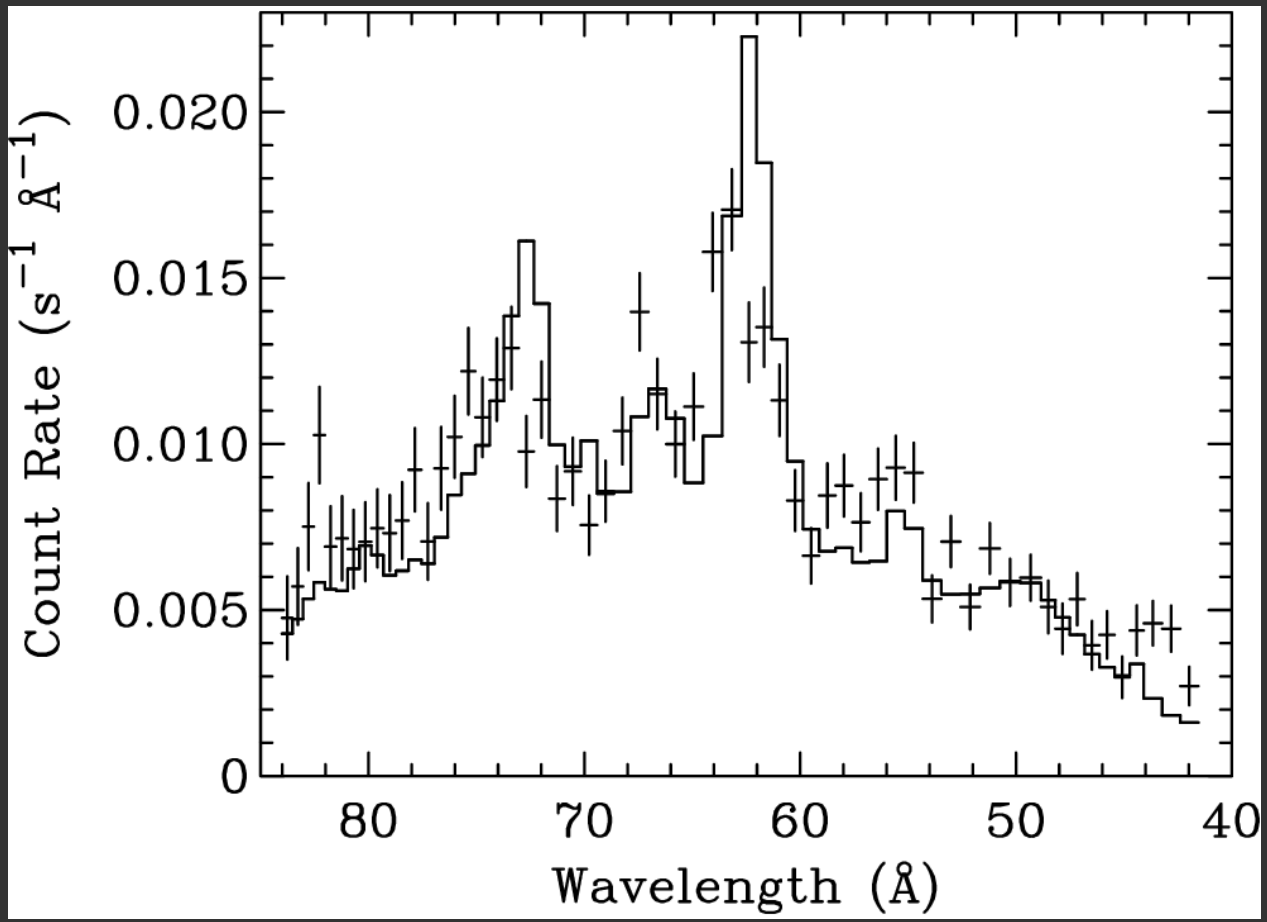
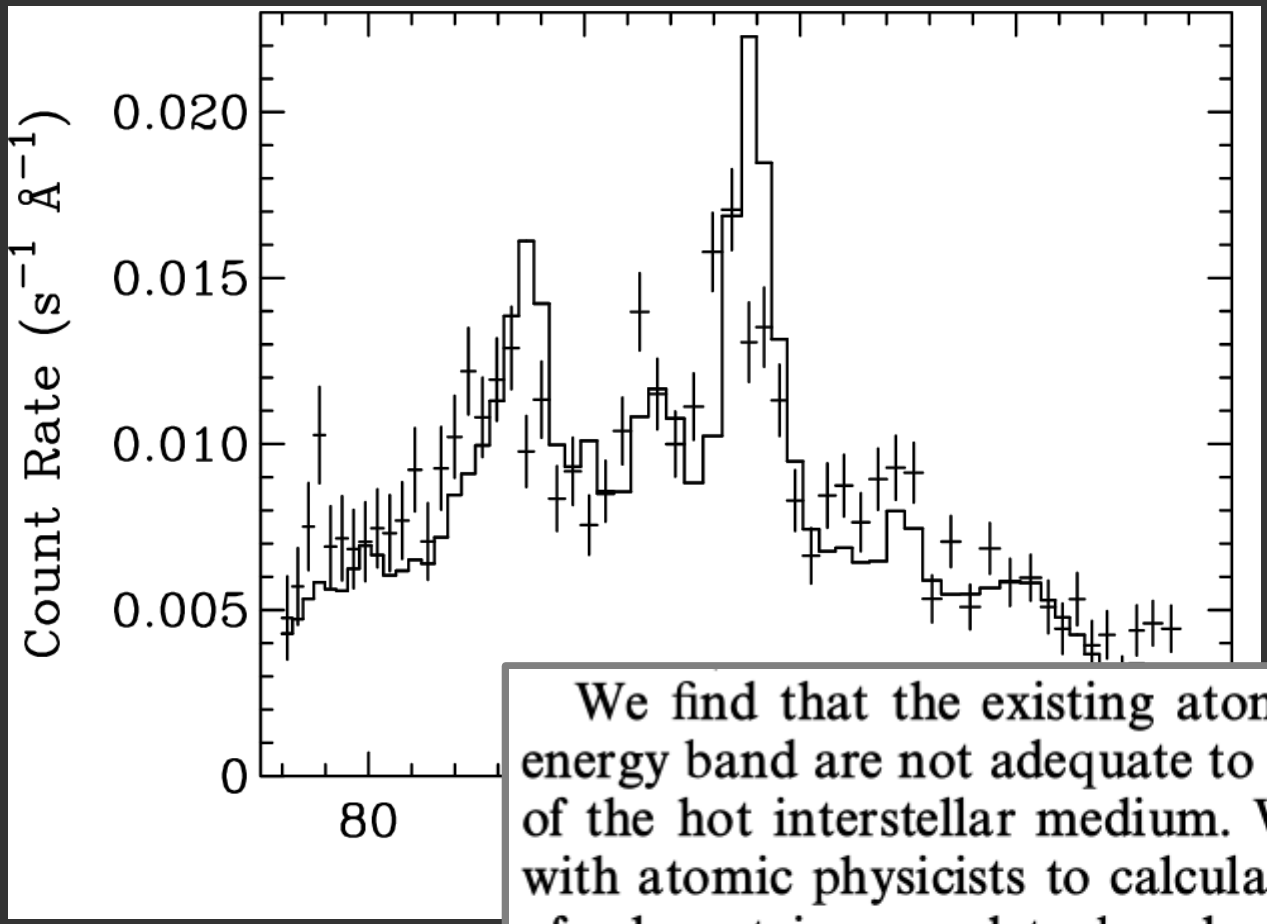


CX Testing

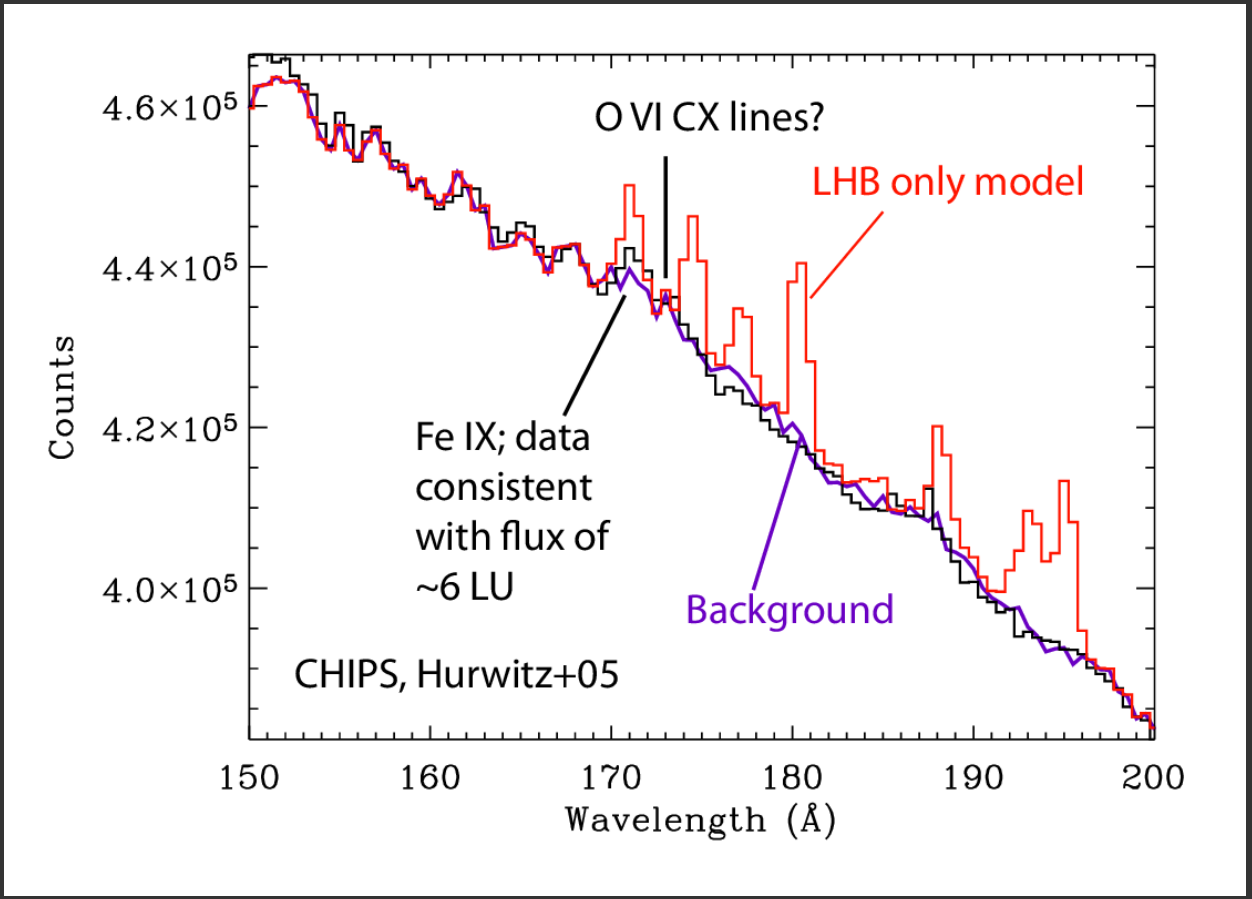

Count Rate (s^{-1} Å^{-1})
0.020
0.015
0.010
0.005
0
80
70
60
50
40
Wavelength (Å)

CX Testing

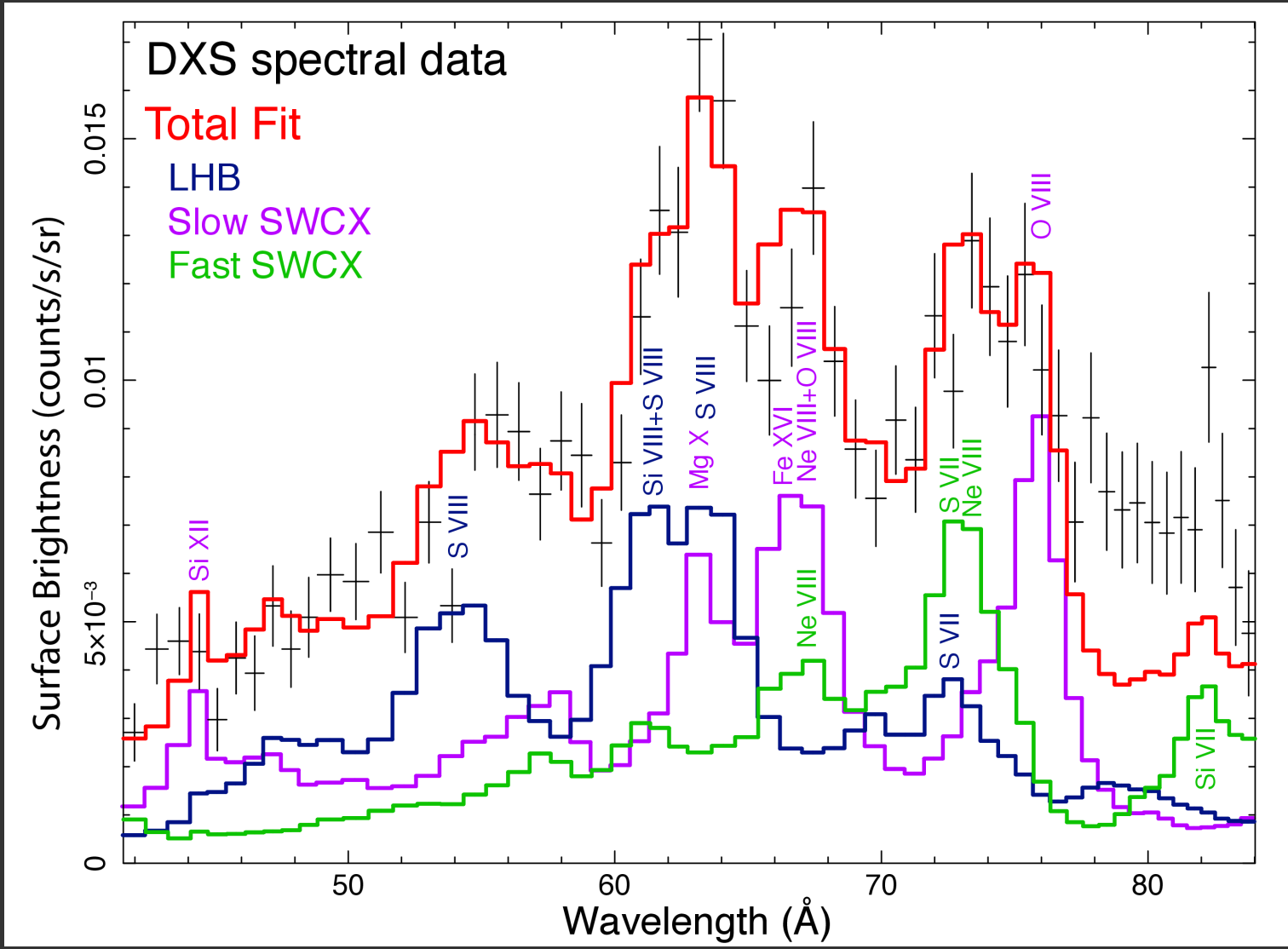


We find that the existing atomic emission data for this energy band are not adequate to fit the measured spectrum of the hot interstellar medium. We will continue to work with atomic physicists to calculate new theoretical spectra of relevant ions, and to benchmark these spectra against astrophysical spectra of bright, relatively well-understood stars that have been obtained with the *Chandra X-ray Observatory*. When we have adequate atomic data for the

CX Testing


4.6×10⁵
4.4×10⁵
4.2×10⁵
4.0×10⁵
Counts
O VI CX lines?
LHB only model
Fe IX; data consistent with flux of ~6 LU
Background
CHIPS, Hurwitz+05
150
160
170
180
190
200
Wavelength (Å)

New Model


DXS spectral data
Total Fit
LHB
Slow SWCX
Fast SWCX
Surface Brightness (counts/s/sr)
0
5×10⁻³
0.01
0.015
50
60
70
80
Wavelength (Å)
Si XII
S VIII
Si VIII+S VIII
Mg X
S VIII
Fe XVI
Ne VIII+O VIII
Ne VIII
S VII
S VII
Ne VIII
O VIII
Si VII

Queries and Questions...

- Inner shell data – better sources?
- CX data – low energy model improvements?

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