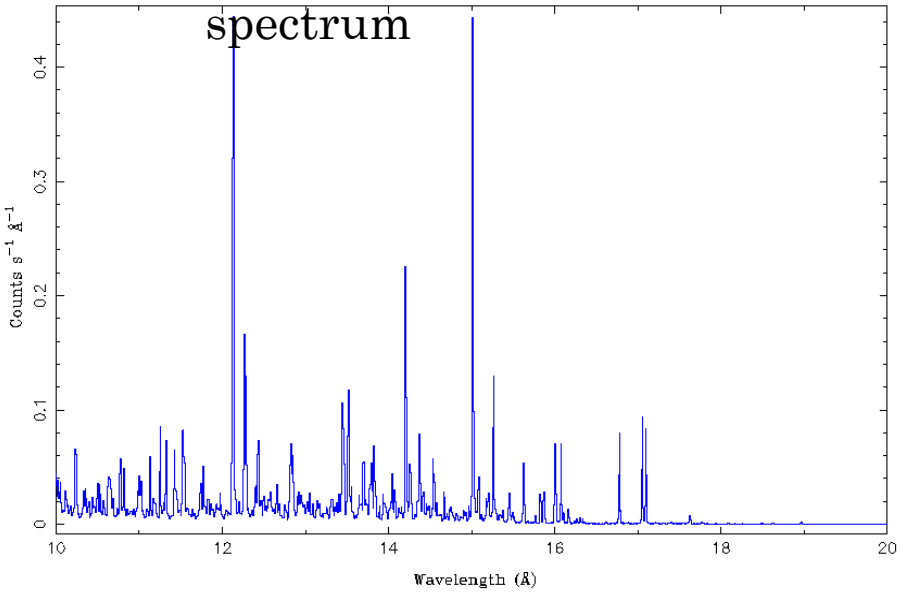
AtomDB 2.0: New Atomic Data for X-Ray Astrophysics

Adam Foster
Li Ji
Randall Smith
Nancy Brickhouse

Harvard-Smithsonian Center for Astrophysics,
60 Garden St, Cambridge, MA 02144, USA

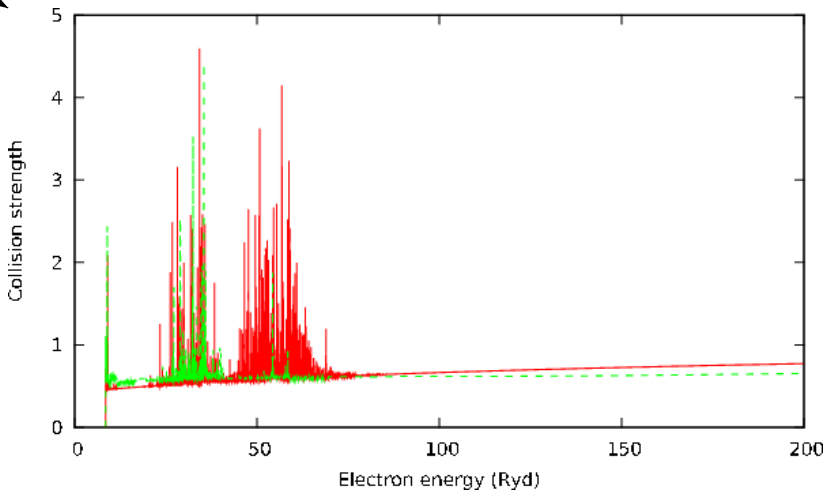
Atomic Physics in X-ray Astronomy

Capella HETG spectrum



"We do this so you don't have to"

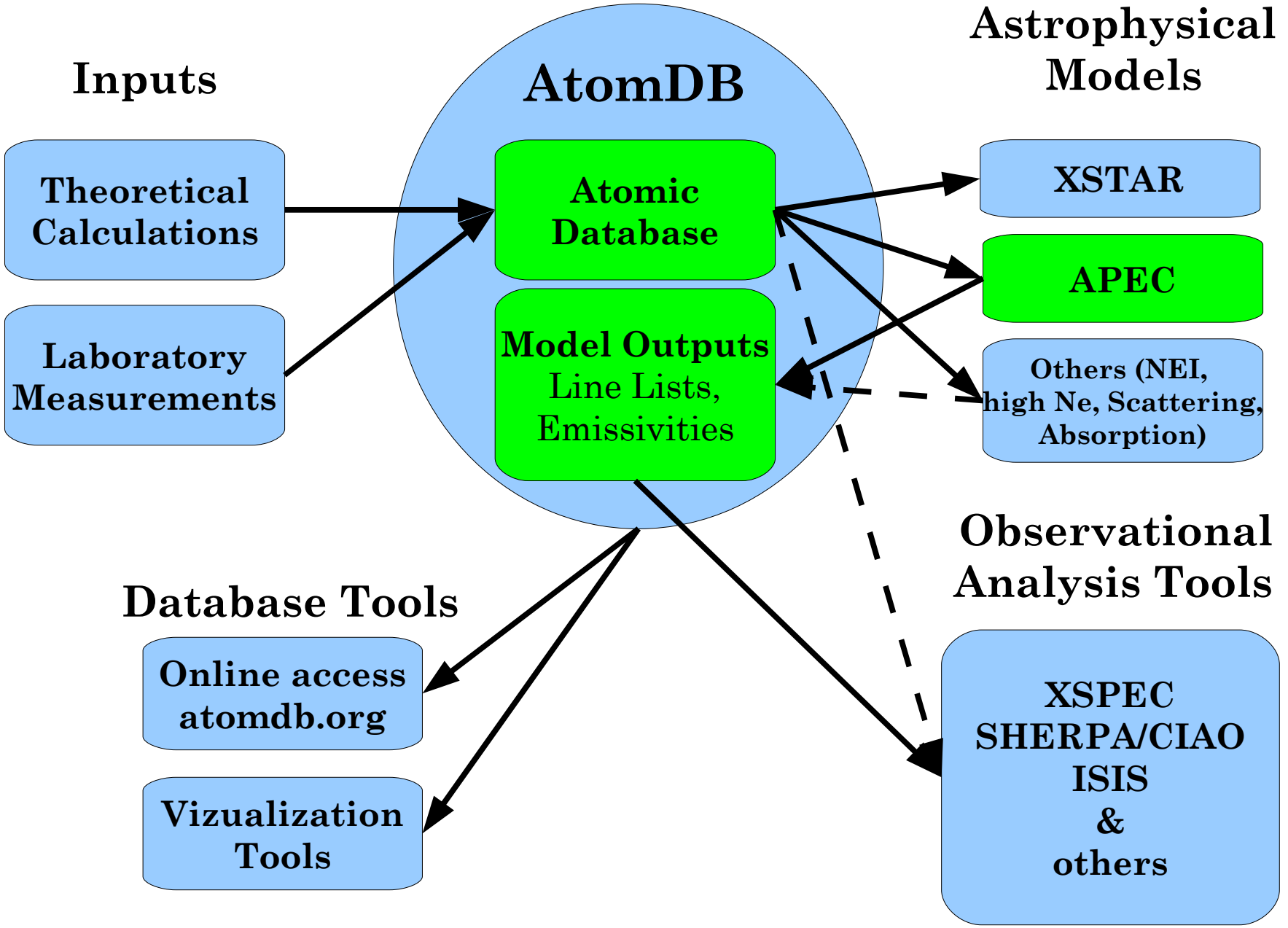
Collision strengths for the $2p^{4}{}^{3}P_{0}$-$2s2p^{5}{}^{3}P_{2}$ transition in Fe^{+18}



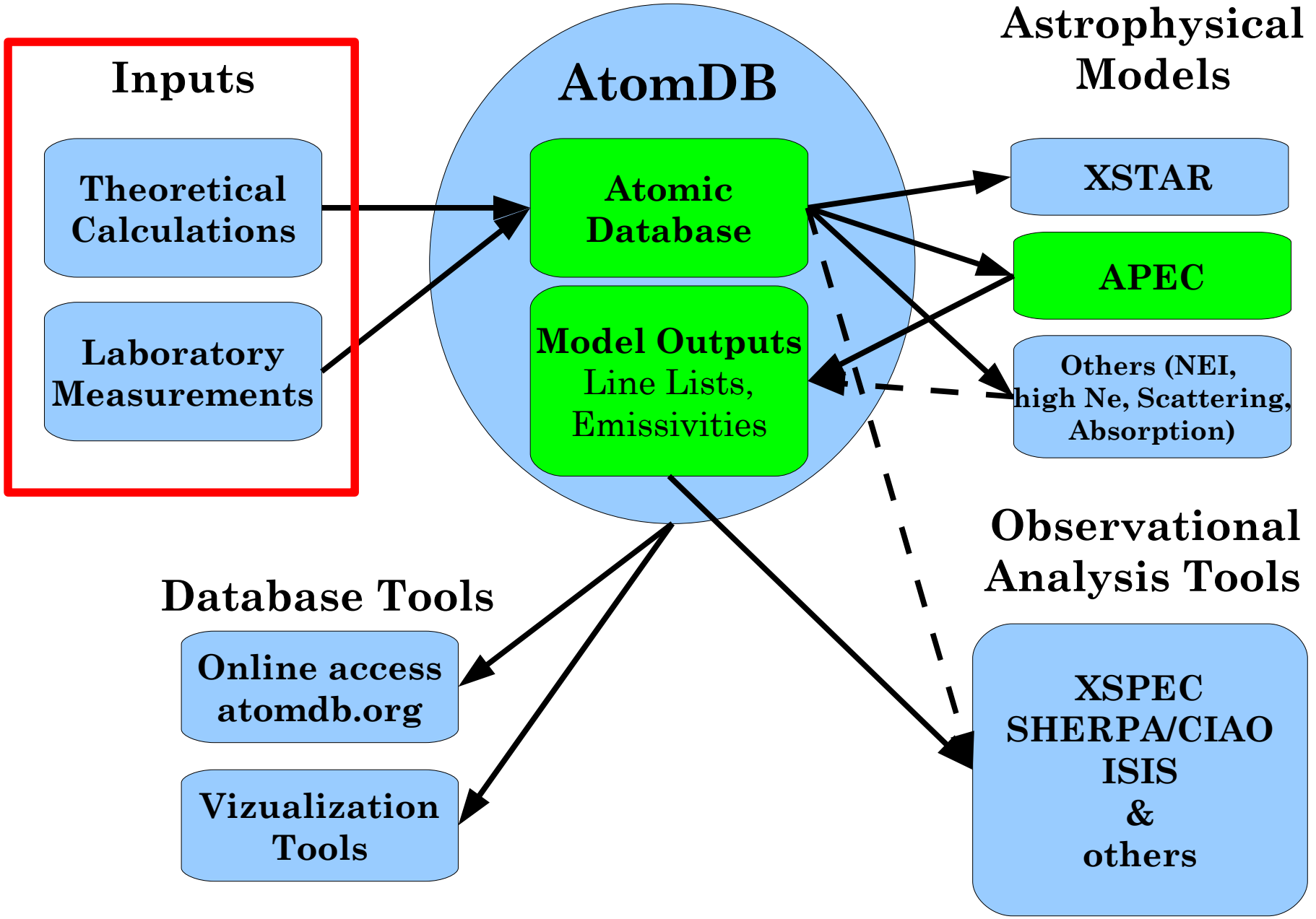
Executive Summary

- AtomDB (a.k.a APEC) has undergone the largest update in 10 years
- New atomic data for nearly every ion
- Some significant changes to important diagnostic line ratios
- Available now from www.atomdb.org

AtomDB Structure

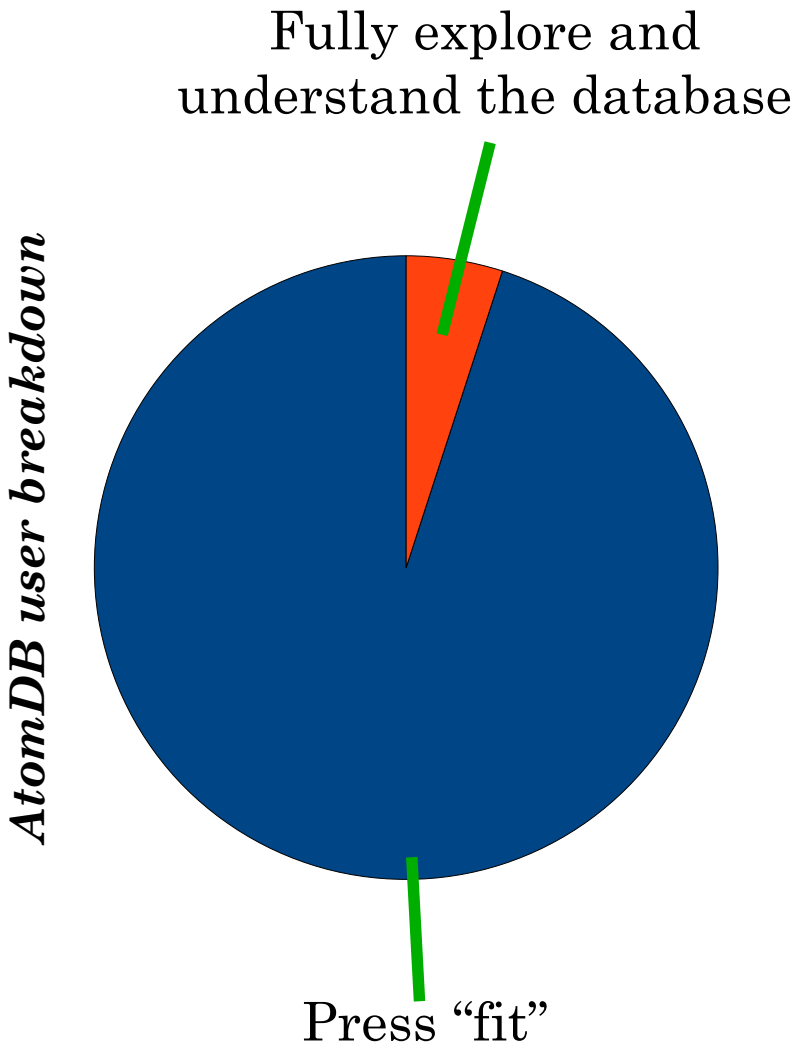


AtomDB Structure

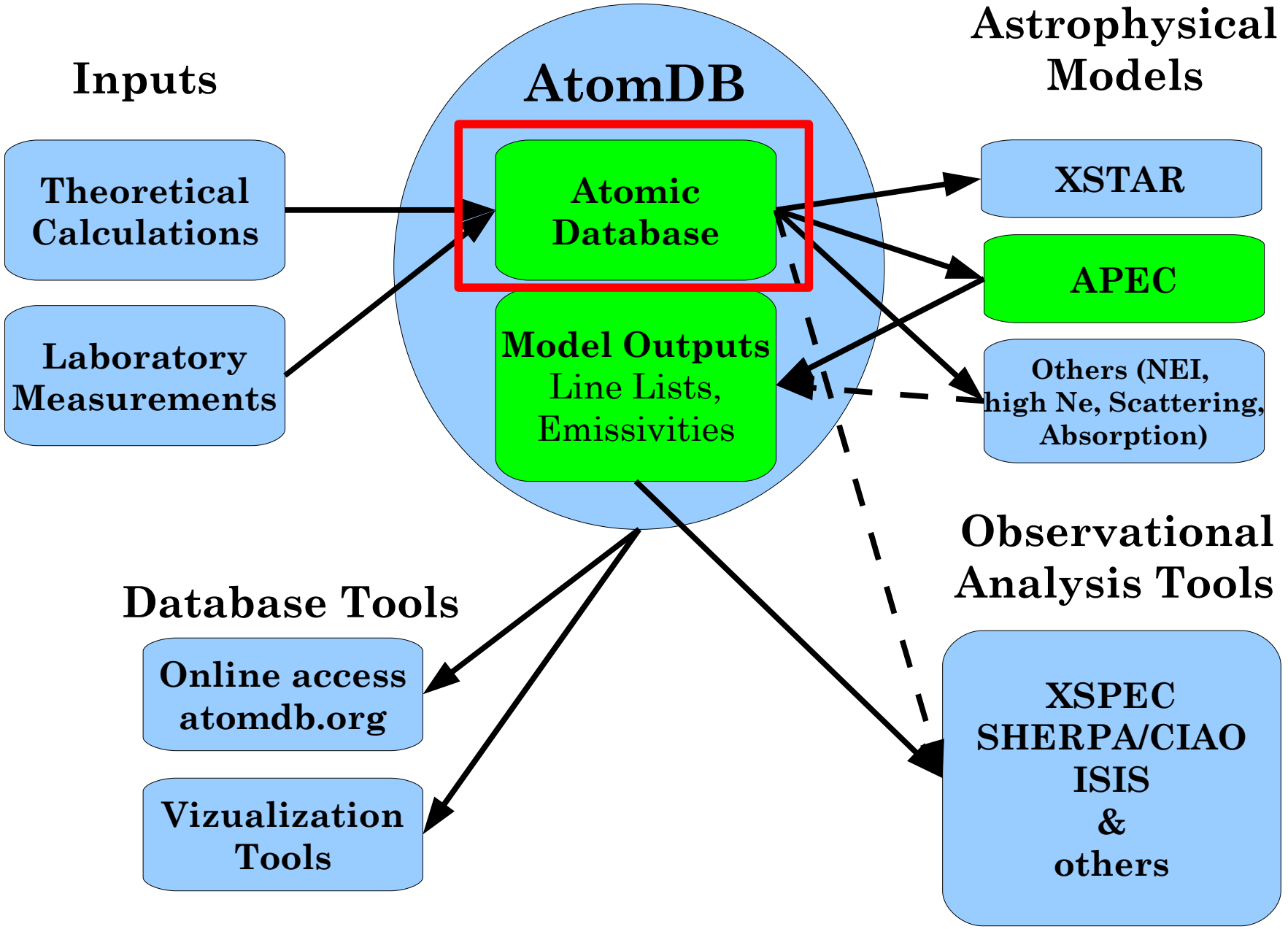


Choosing Data Sets

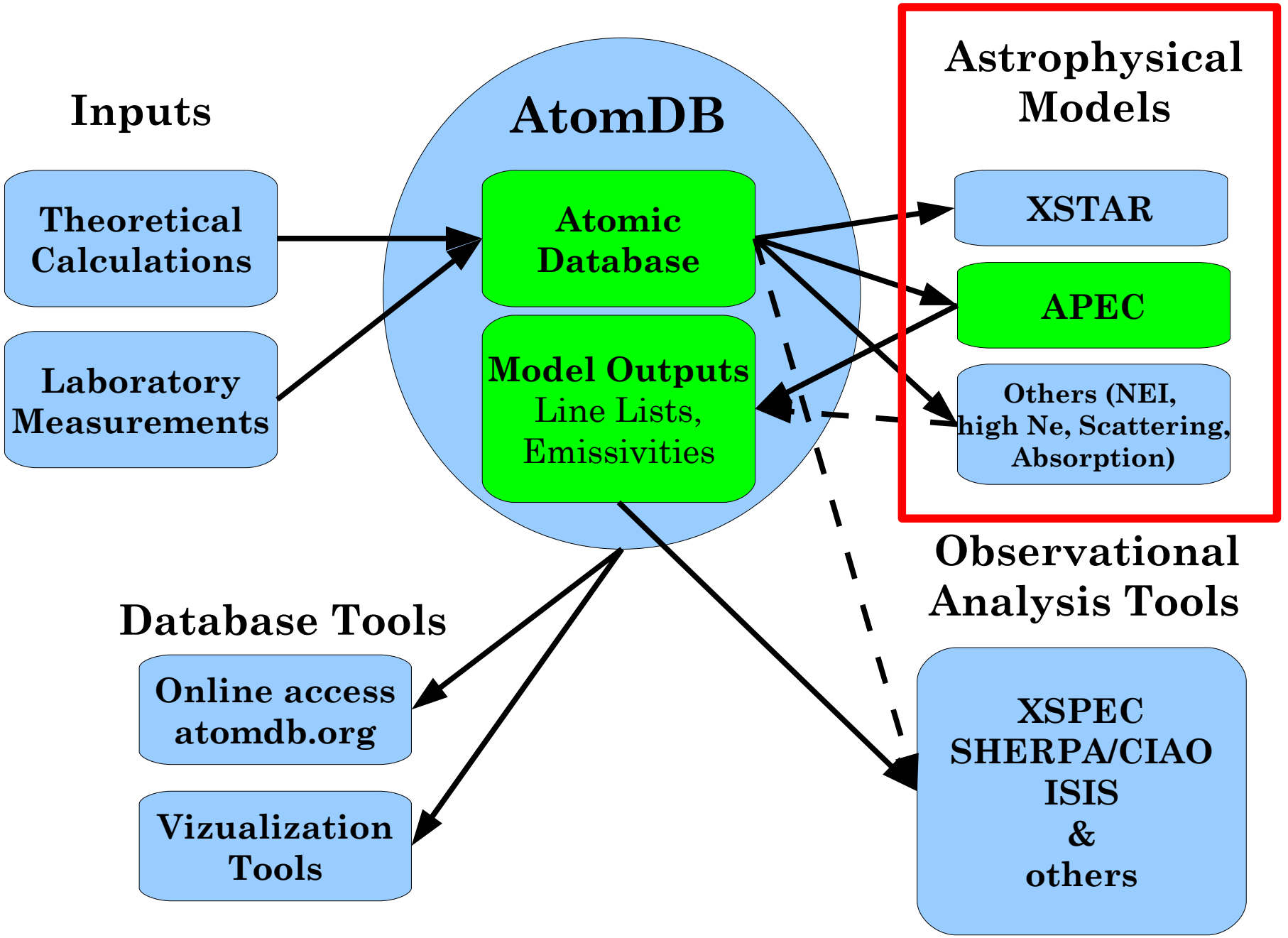
- Most ions have only 1 “good” data set
- Compare with experimental results
- Differences usually not that large



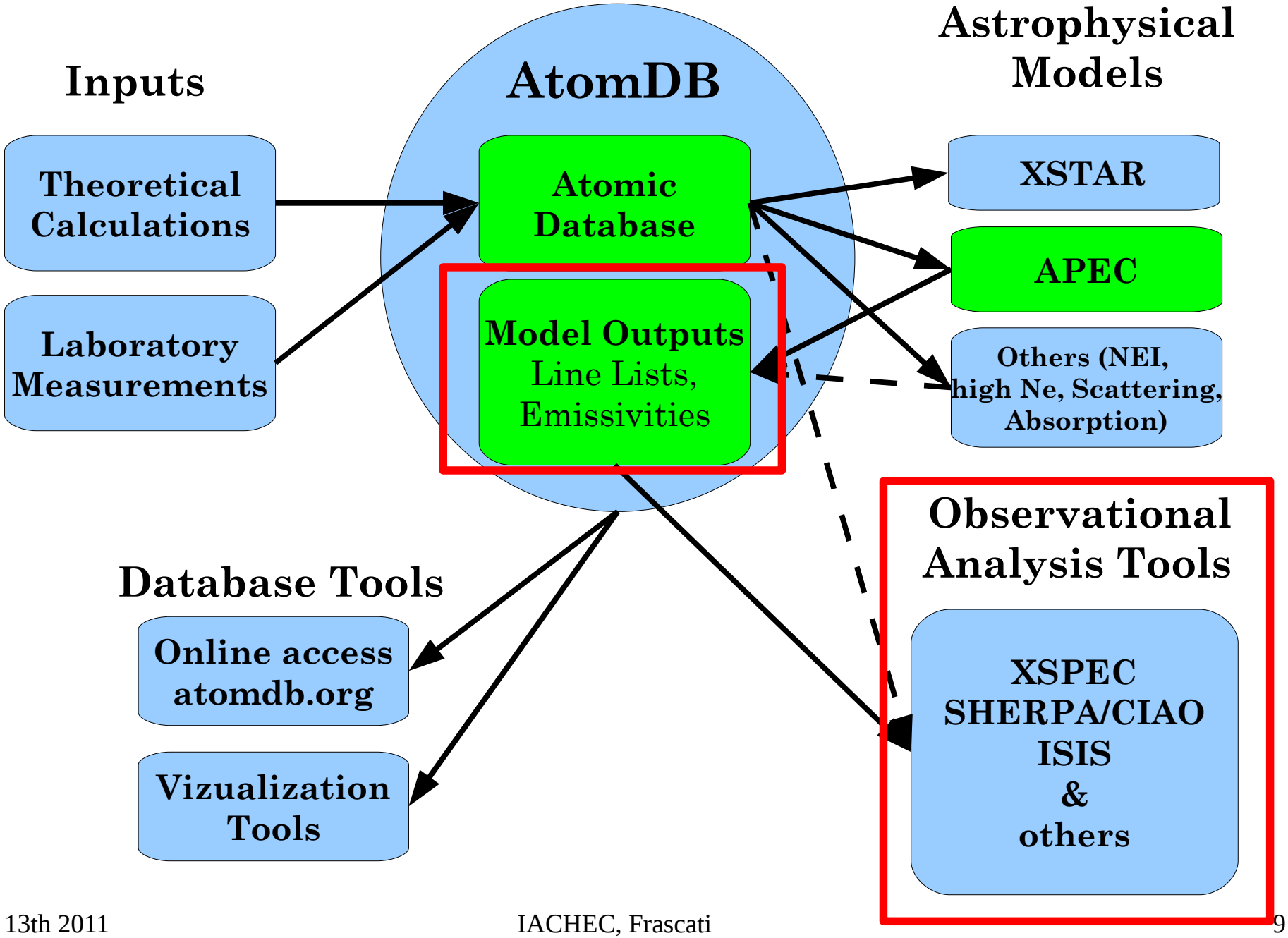
AtomDB Structure



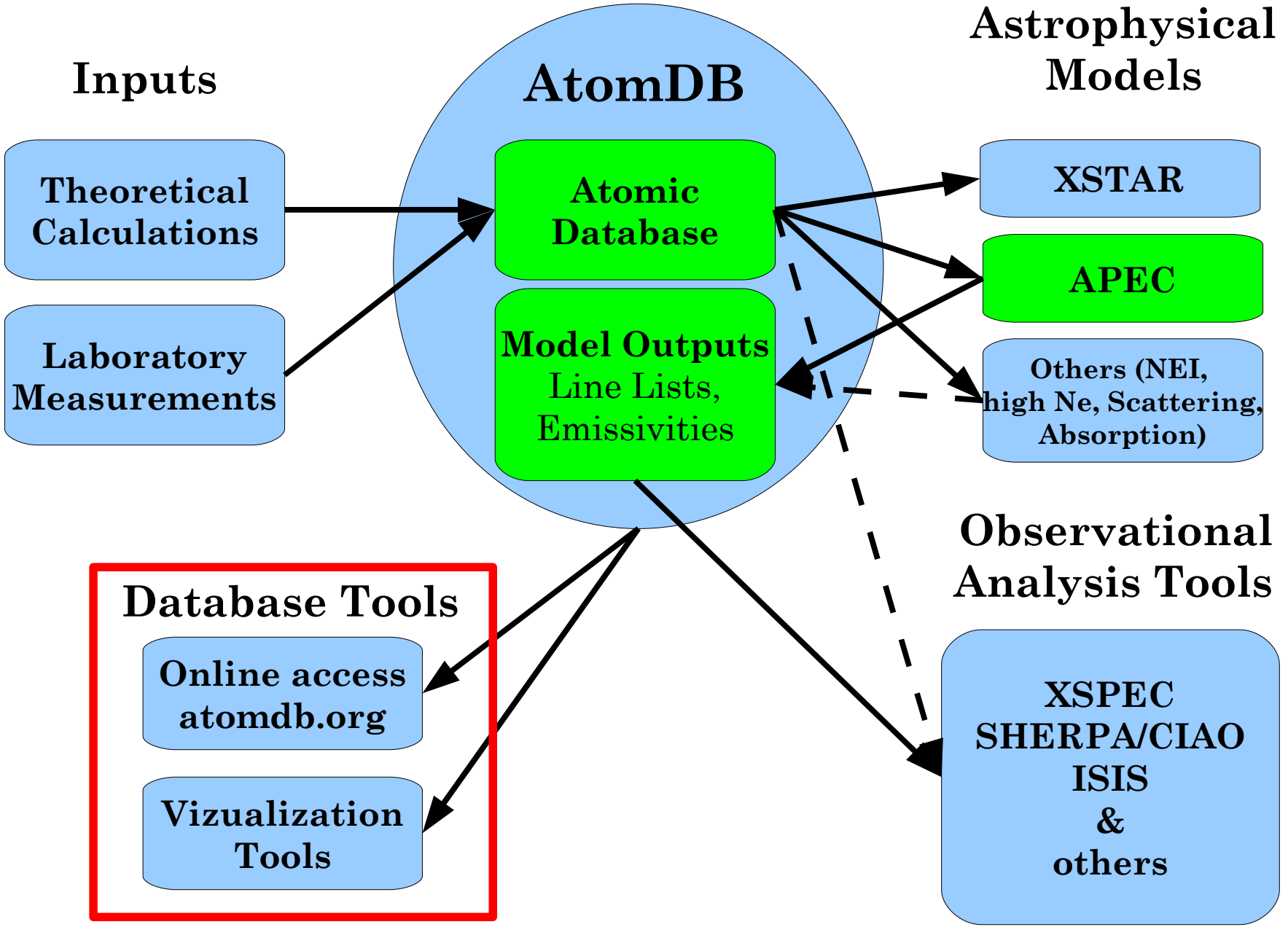
AtomDB Structure



AtomDB Structure

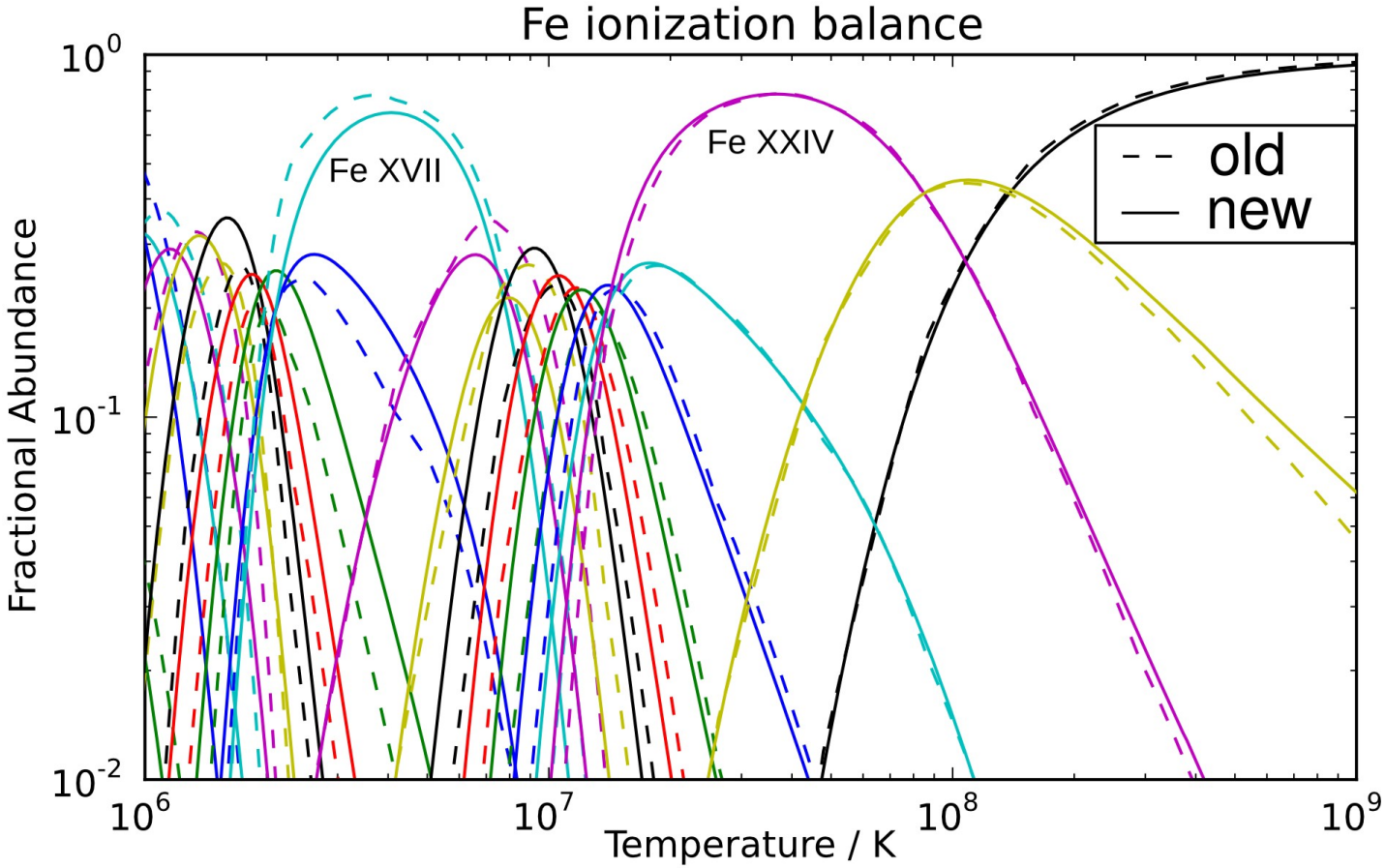


AtomDB Structure



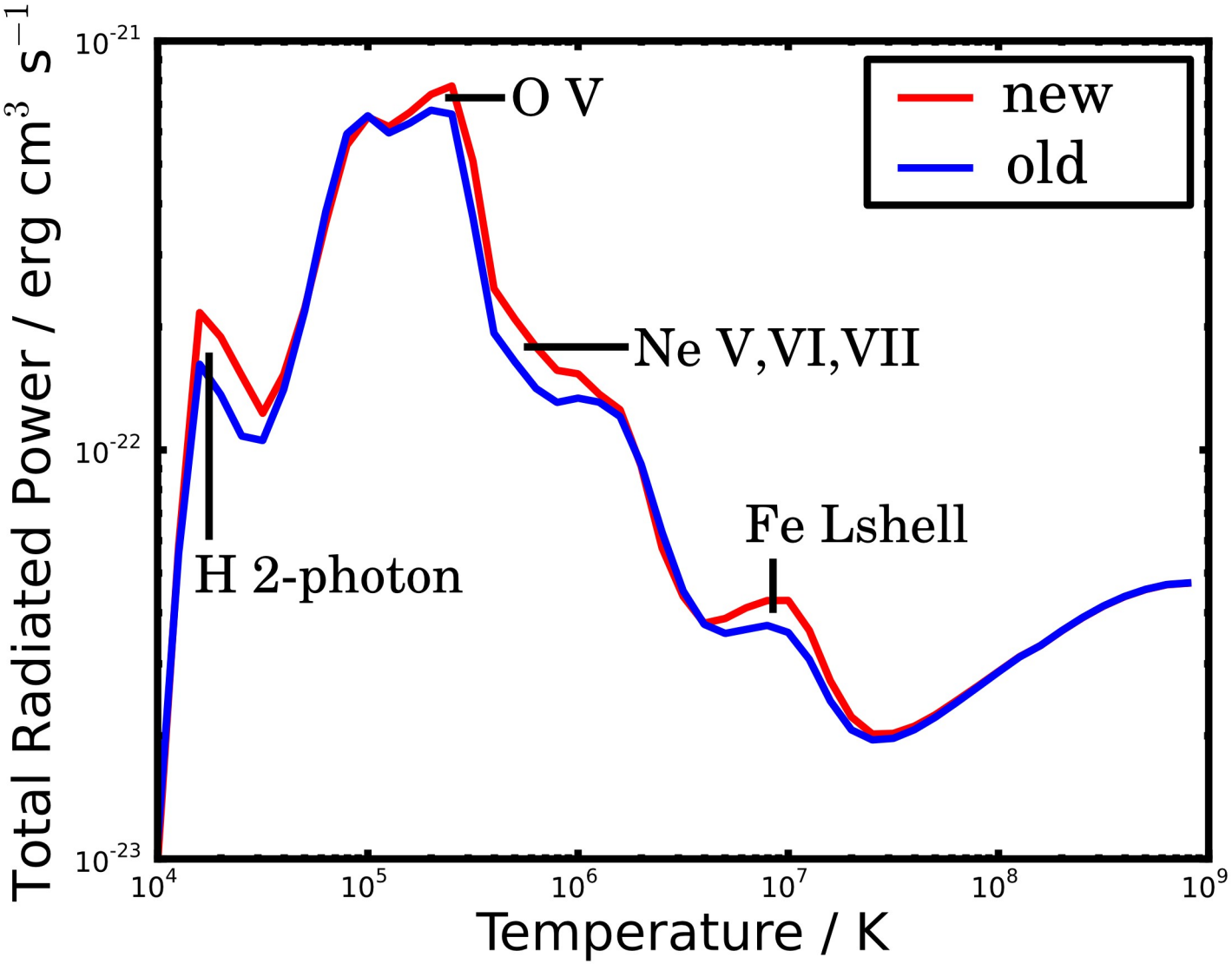
Some of the changes in AtomDB 2.0

Ionization Balance

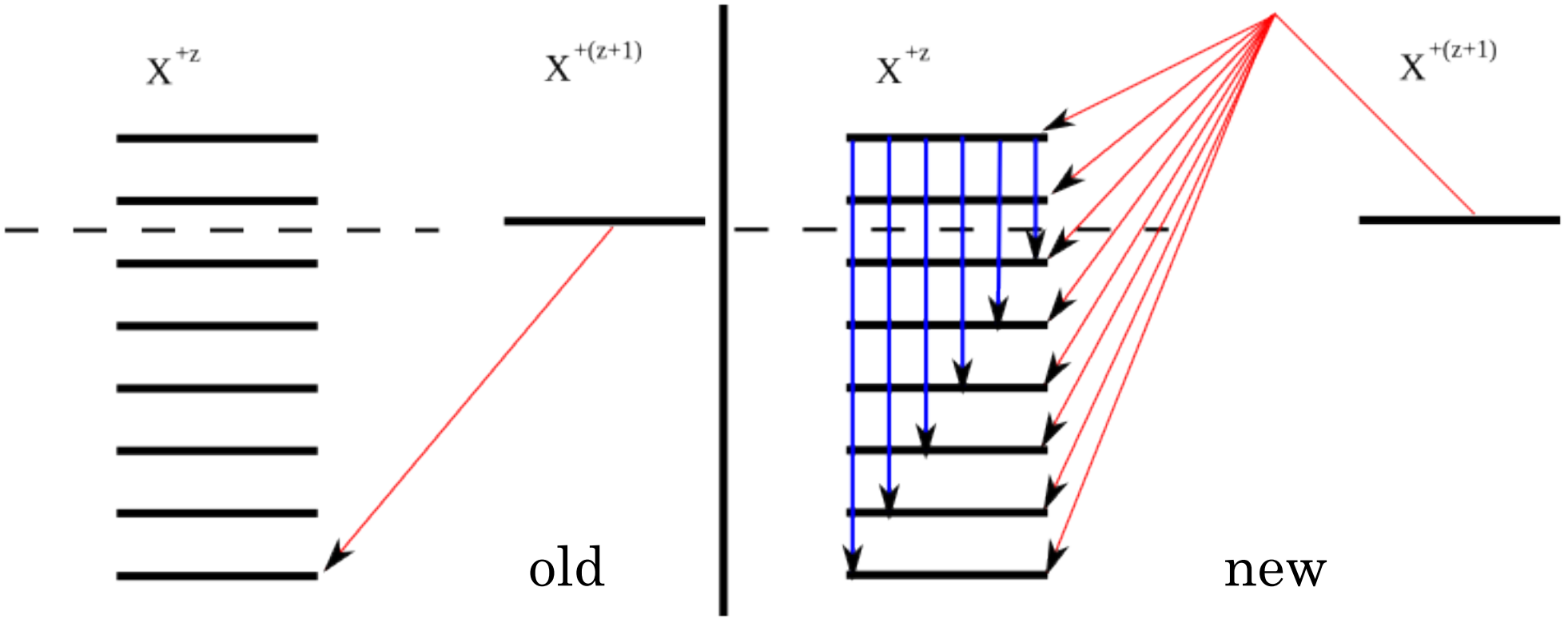


- Ionization balance data from Bryans+ 2009
- Replaces Mazzotta+ 1998

Cooling Power



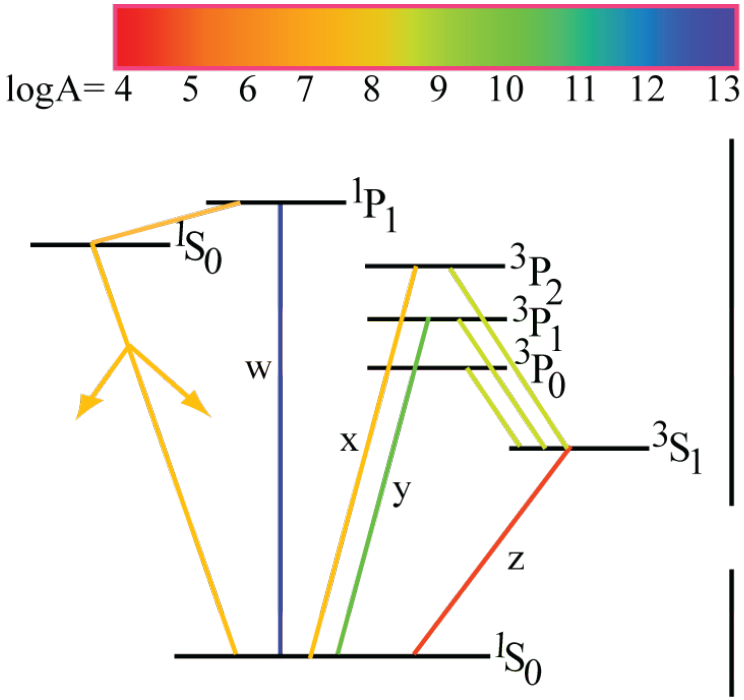
State-Selective Recombination



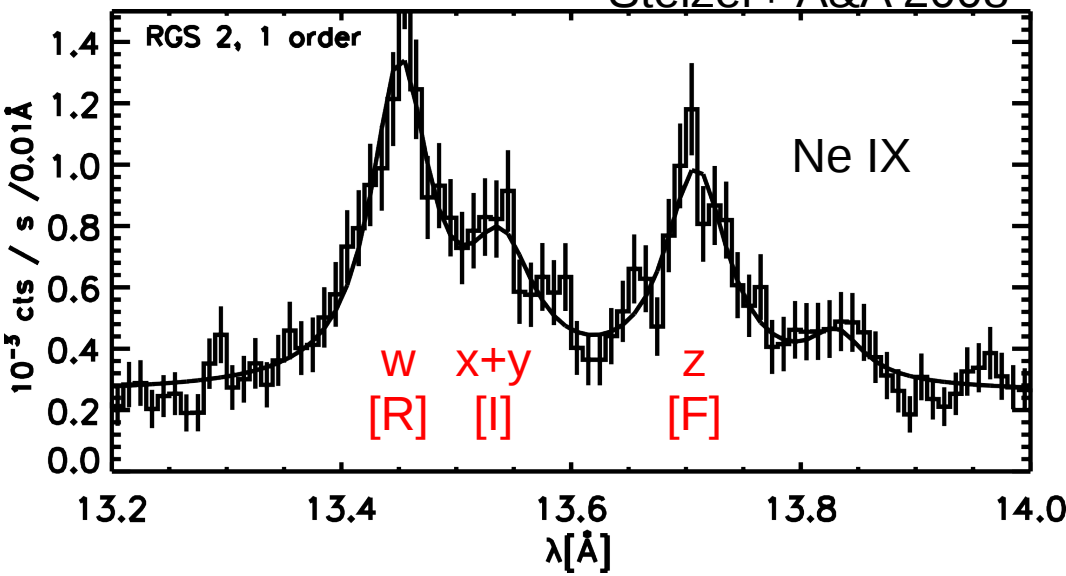
H & He-like data

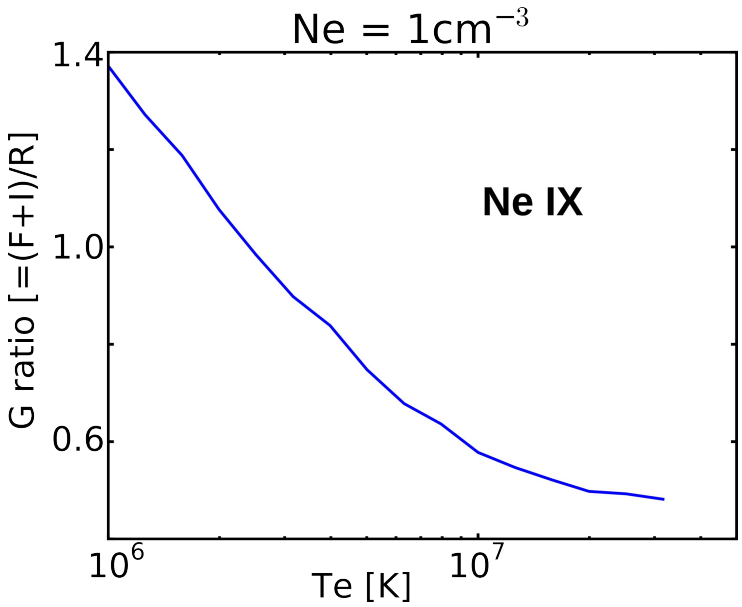
- Collisional excitation data updated to R-Matrix calculations.
- Covers $n \leq 5$, for all elements C to Kr.
- Data extended to higher n-shells ($n \leq 10$)
- Created data for “missing” ions.

He-like Diagnostic Ratios



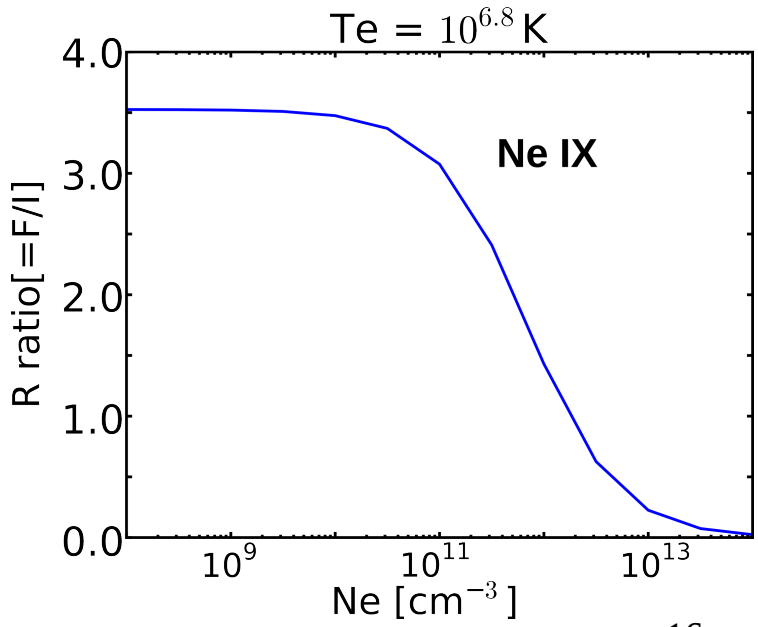
Stelzer+ A&A 2008



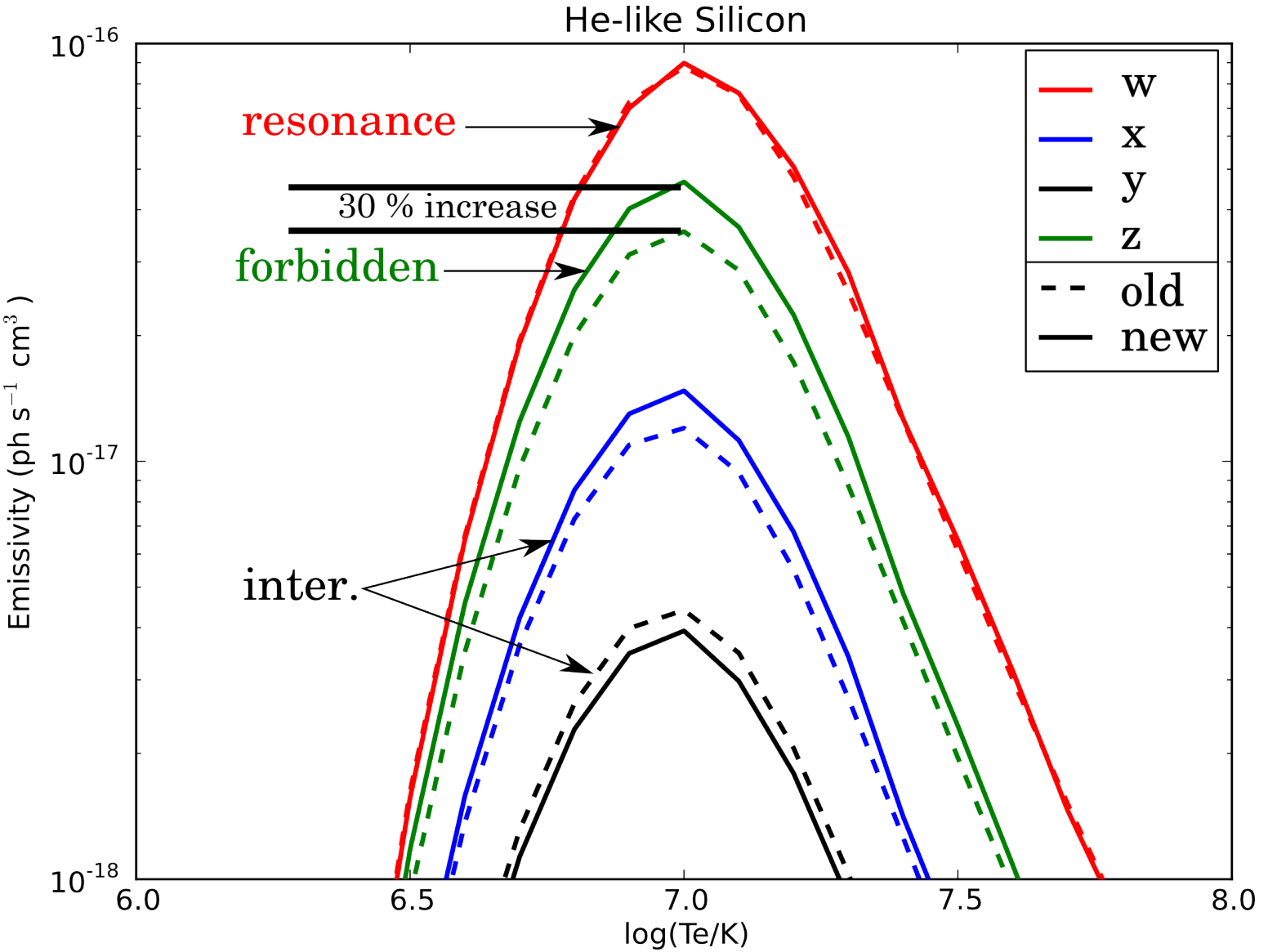


G = (F+I)/R

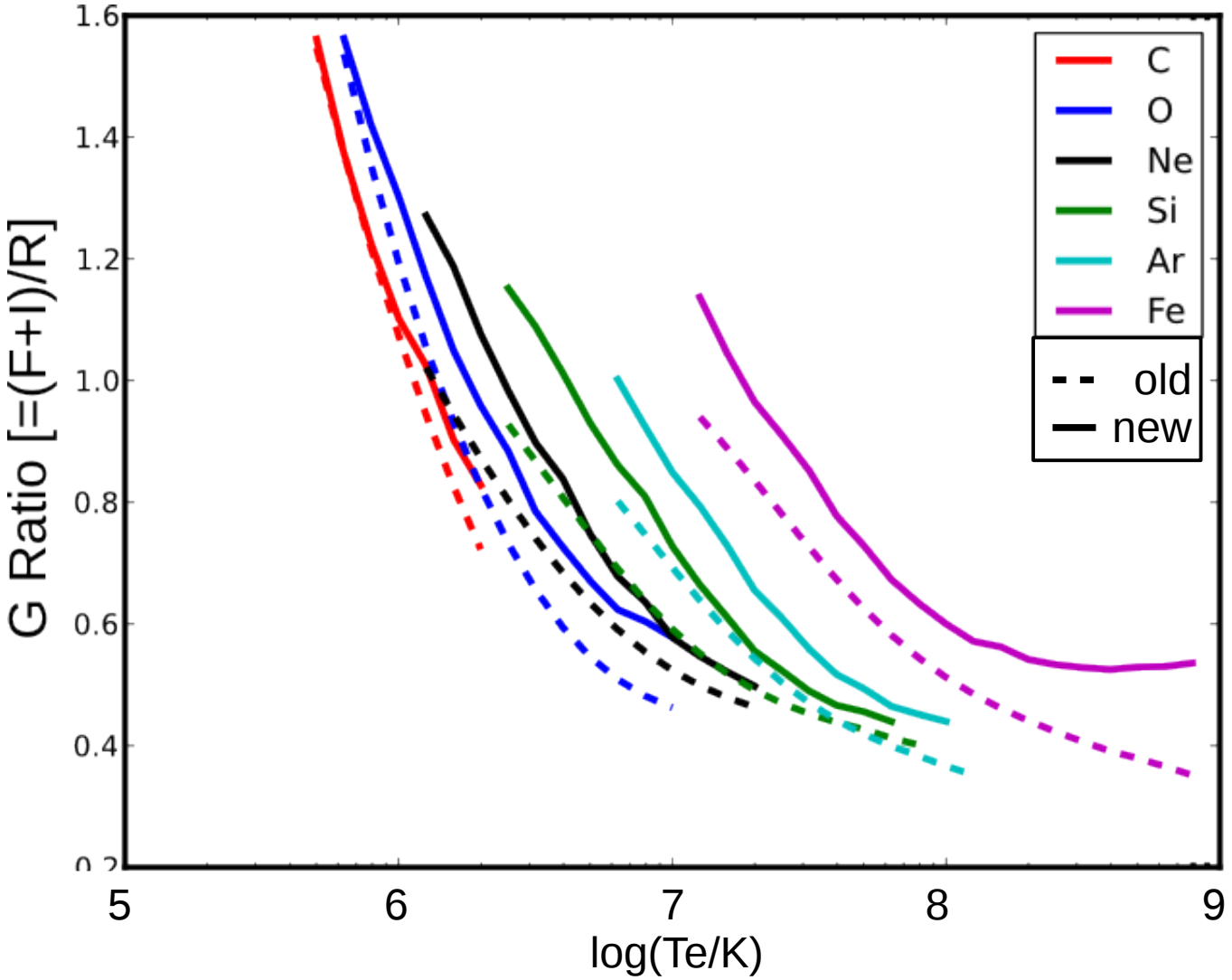
R = (F/I)



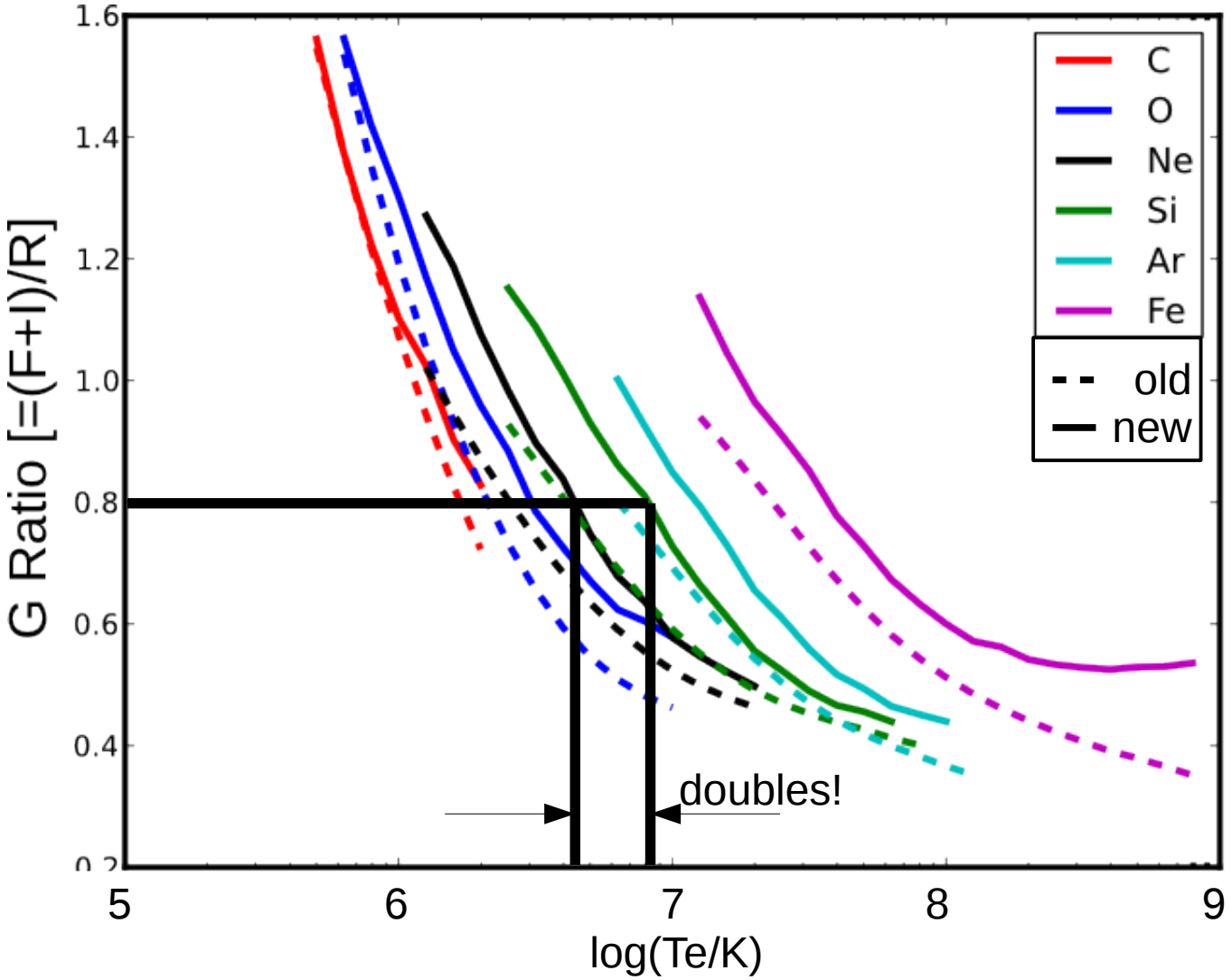
He-like Ions


He-like Silicon
resonance
30 % increase
forbidden
inter.
w
x
y
z
old
new
Emissivity (ph s^{-1} cm^3)
10^{-16}
10^{-17}
10^{-18}
6.0
6.5
7.0
7.5
8.0
log(Te/K)

G ratios for He-like Ions

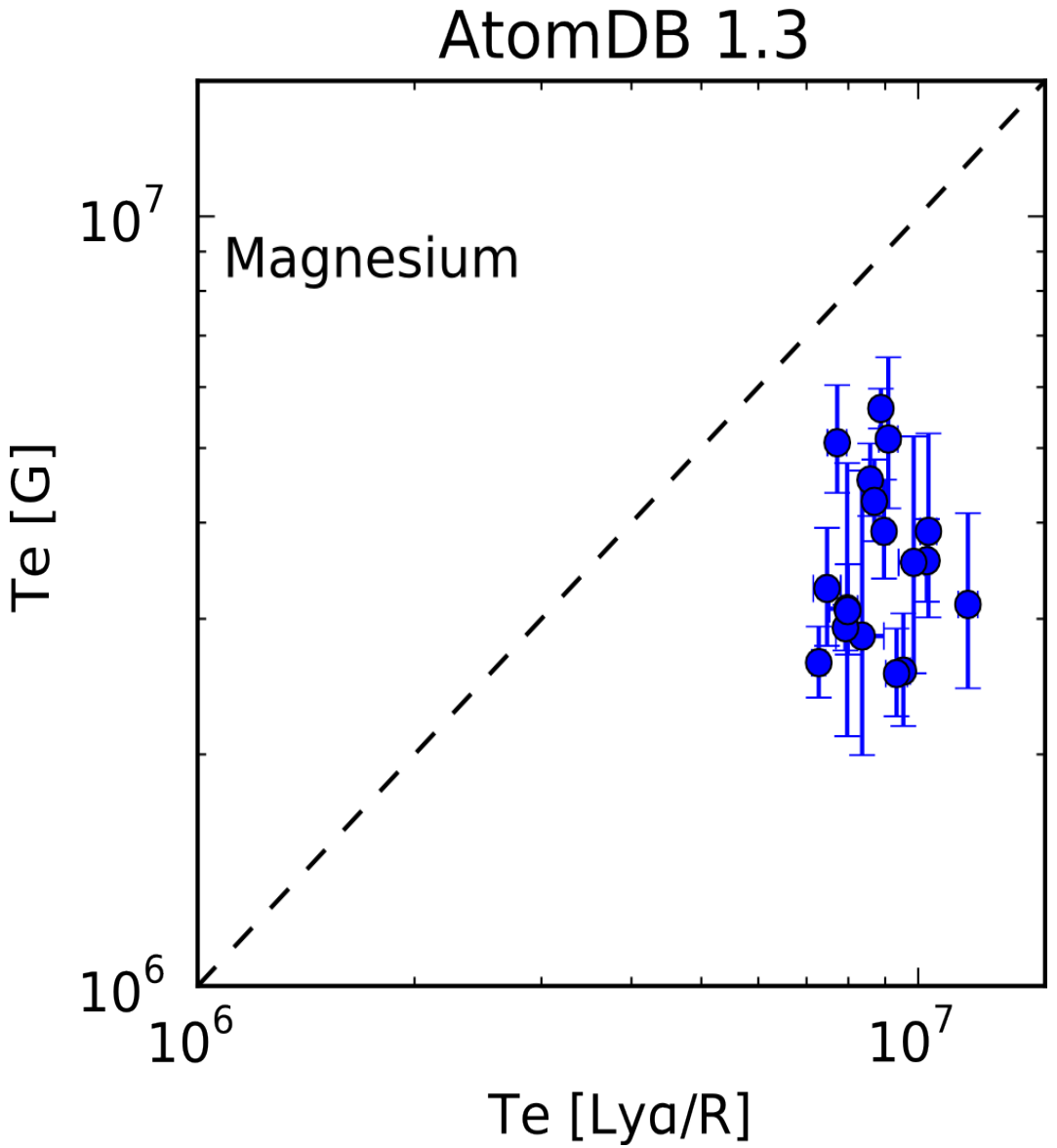


G ratios for He-like Ions



Current Problem

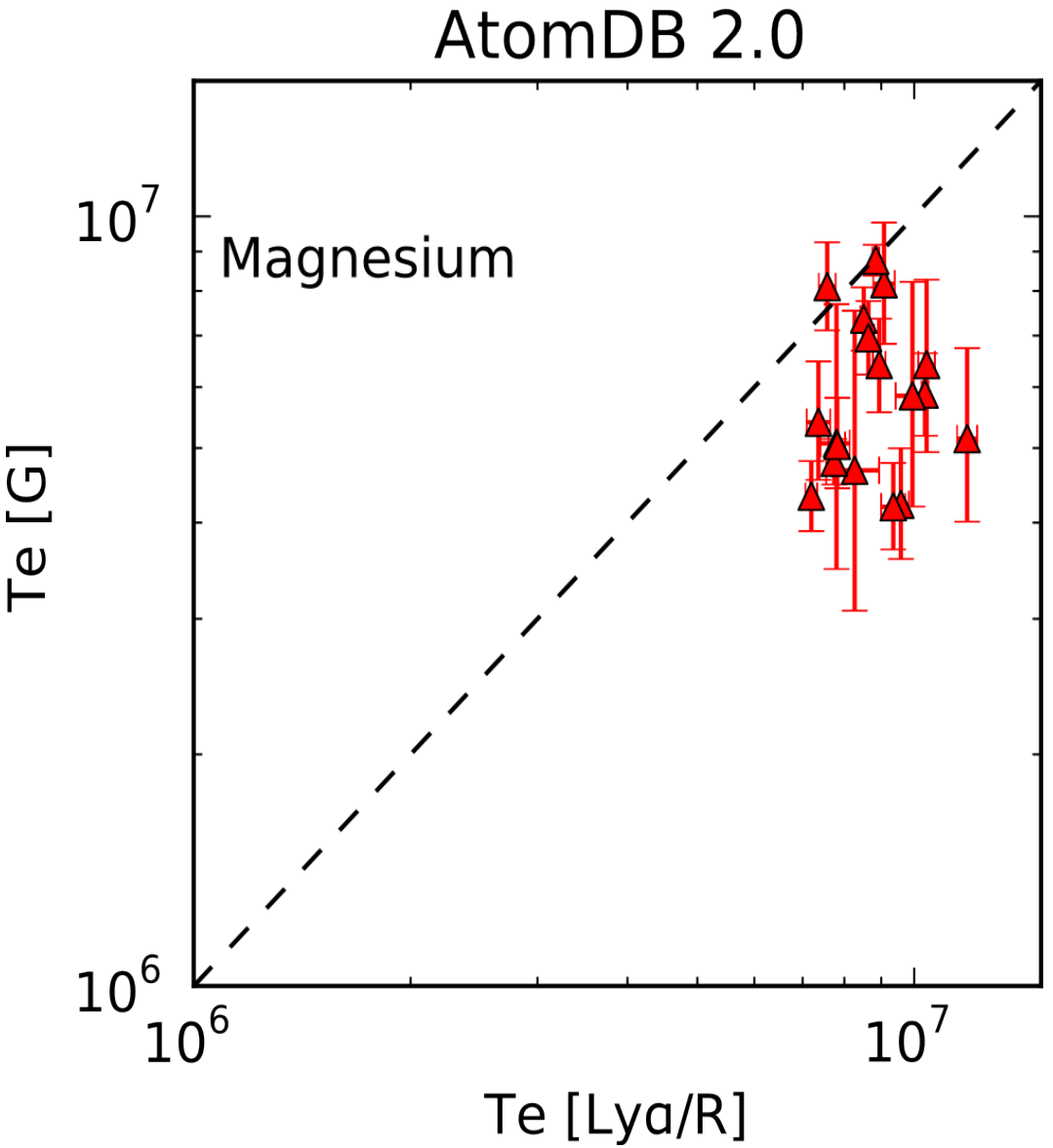
Testa+ 2004:
Temperatures obtained from G ratios are consistently smaller than those from the Ly-α to He-like resonance line ratio



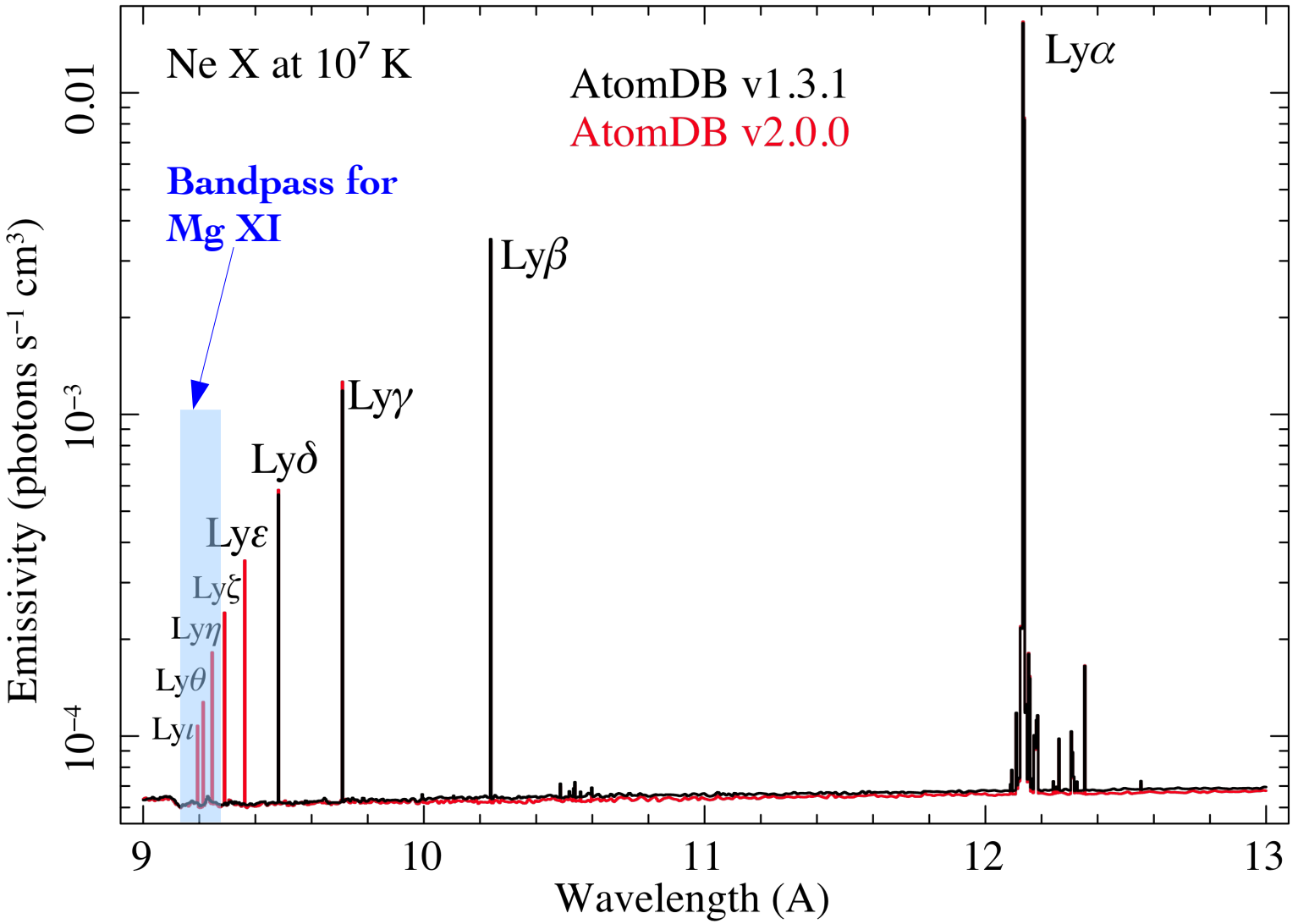
Current Problem

Testa+ 2004:
Temperatures obtained from G ratios are consistently smaller than those from the Ly-α to He-like resonance line ratio

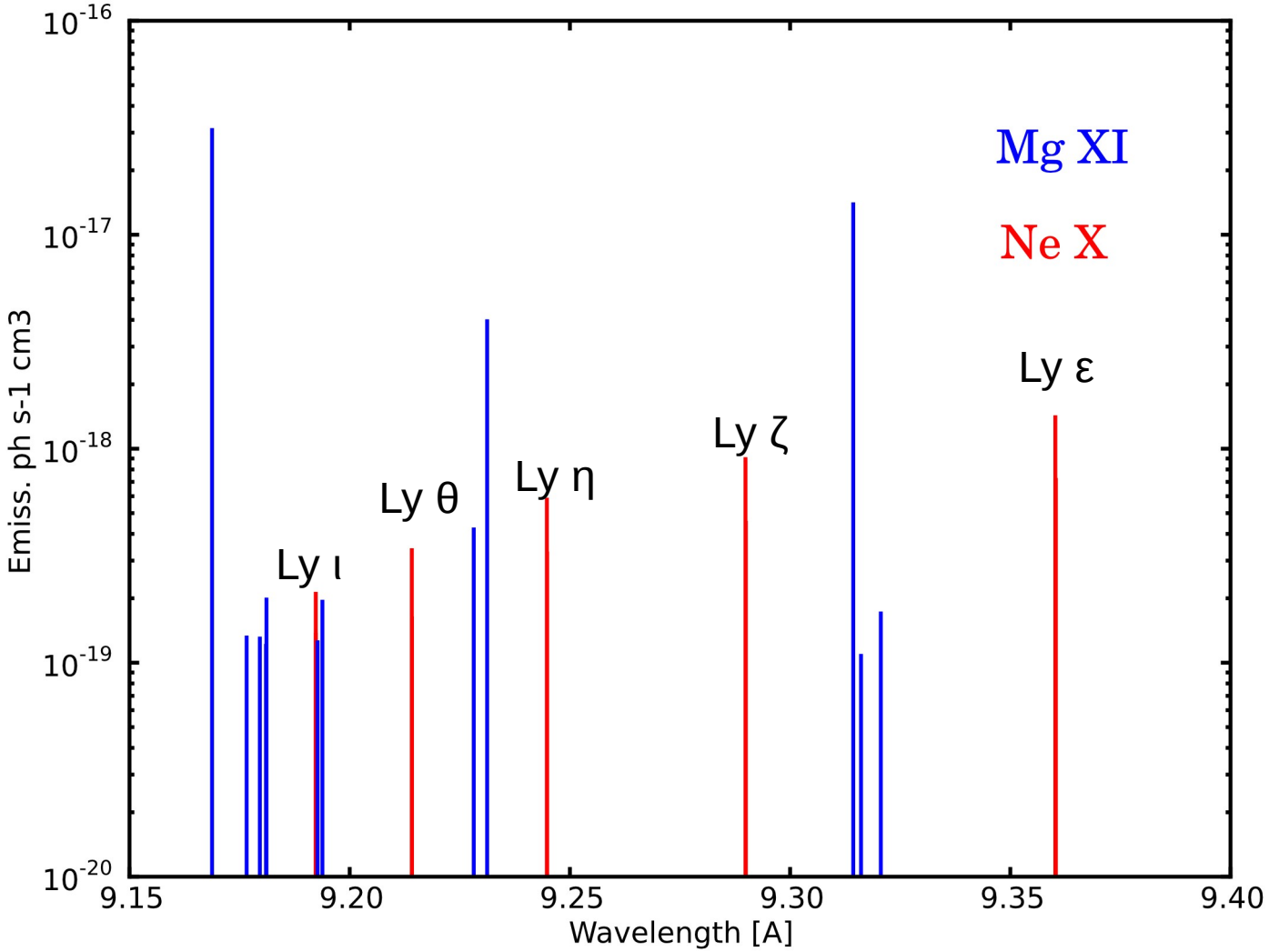
New data significantly reduces this discrepancy



H-like Neon


Ne X at 10^7 K
AtomDB v1.3.1
AtomDB v2.0.0
Bandpass for
Mg XI
Lyα
Lyβ
Lyγ
Lyδ
Lyε
Lyζ
Lyη
Lyθ
Lyι
Emissivity (photons s^{-1} cm^3)
0.01
10^{-3}
10^{-4}
9
10
11
12
13
Wavelength (A)

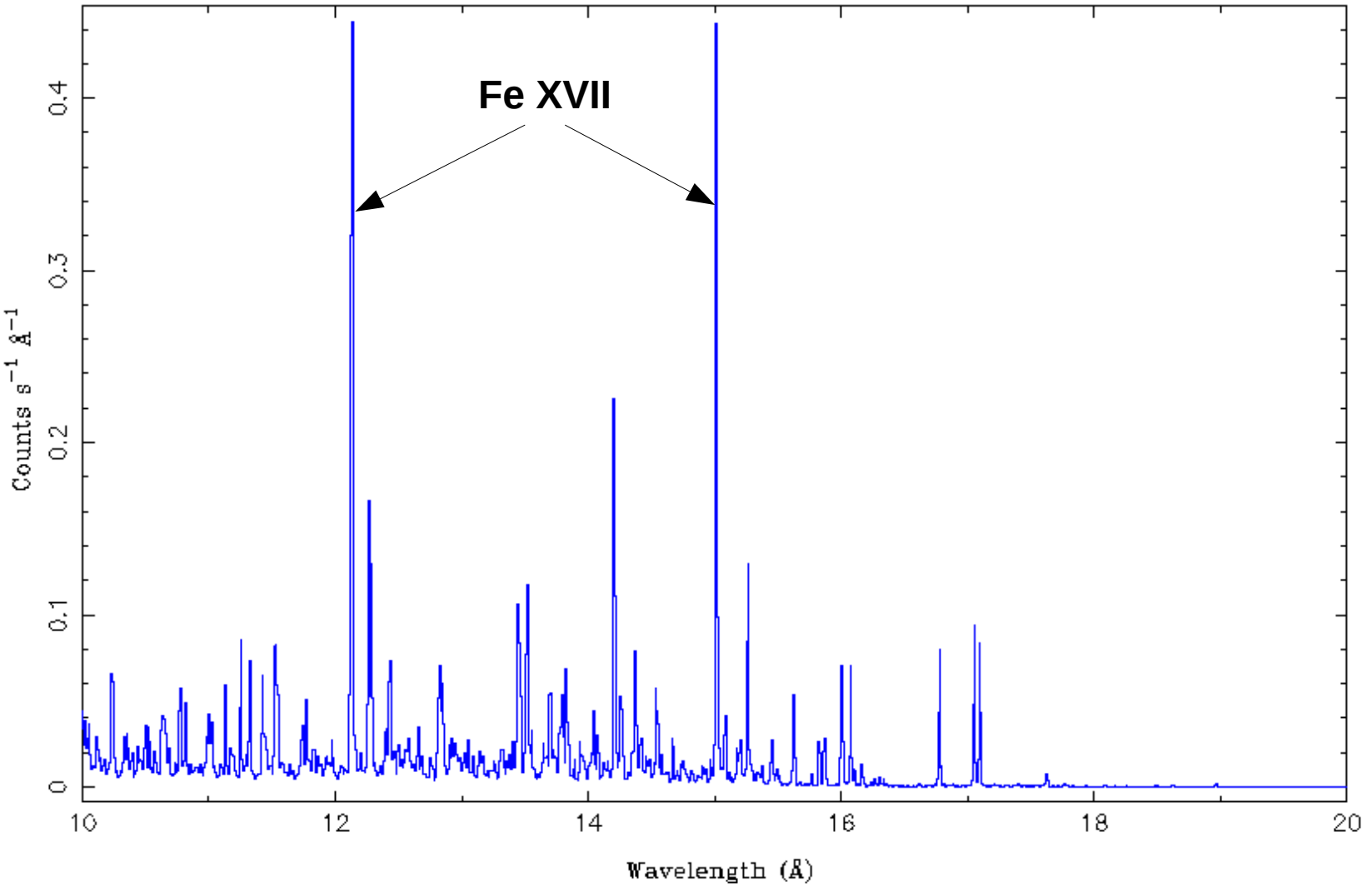
H-like Neon


Mg XI
Ne X
Ly ε
Ly ζ
Ly η
Ly θ
Ly ι
Emiss. ph s-1 cm3
Wavelength [A]
10^-16
10^-17
10^-18
10^-19
10^-20
9.15
9.20
9.25
9.30
9.35
9.40

Iron L-shell data

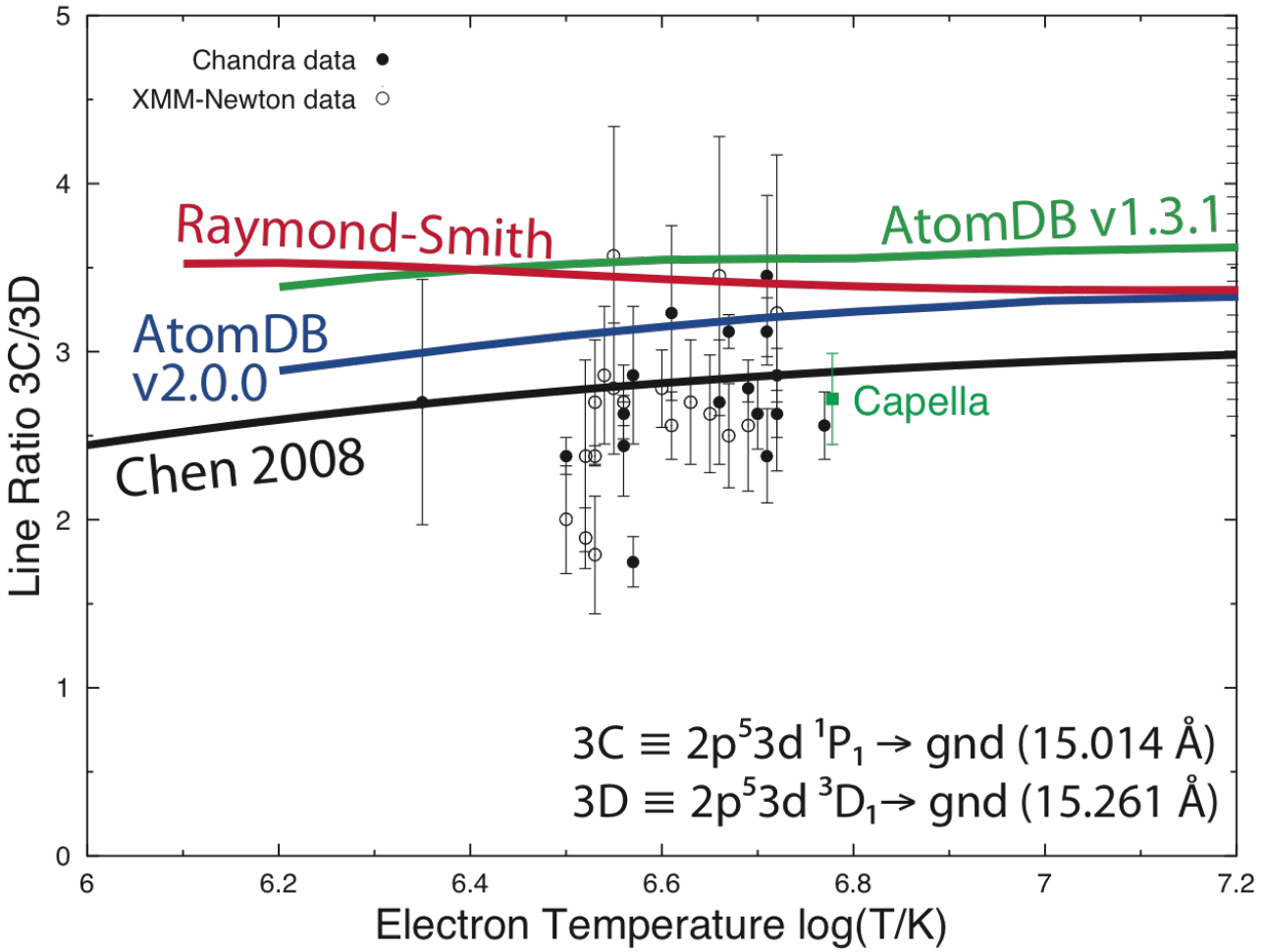
- A variety of different R-Matrix data exists as part of the Iron Project (Hummer+, A&A 1993)
- Due to complex nature of ions, “simple” top up to higher-n not done
- New data generally covers a smaller range of n-shells than previous data (Liedahl, 1997)
- Merge datasets to use best of both worlds

Fe XVII Line Ratios



Capella HETG spectrum

Fe XVII 3C/3D



Fe XVII data taken from Loch+2004

So What Else Is New?

- Updated non X-ray ions to Chianti v6.0.1

- Included ionization/recombination rates in release to allow non-equilibrium modeling

- General tidy-up (fixed quantum numbers, made configuration strings uniform, etc.)

- Nearly all data has been replaced, excluding Nickel L-shell.

Summary

- The atomic data in AtomDB has undergone a complete overhaul
- Nearly every piece of data has been replaced, representing 10 years of progress in lab astro
- Database is ready for use
- Next step is to work with analysis suites (CIAO/Sherpa, ISIS, XSPEC)
- Get people using the data!

Summary

Now available for download from

http://www.atomdb.org