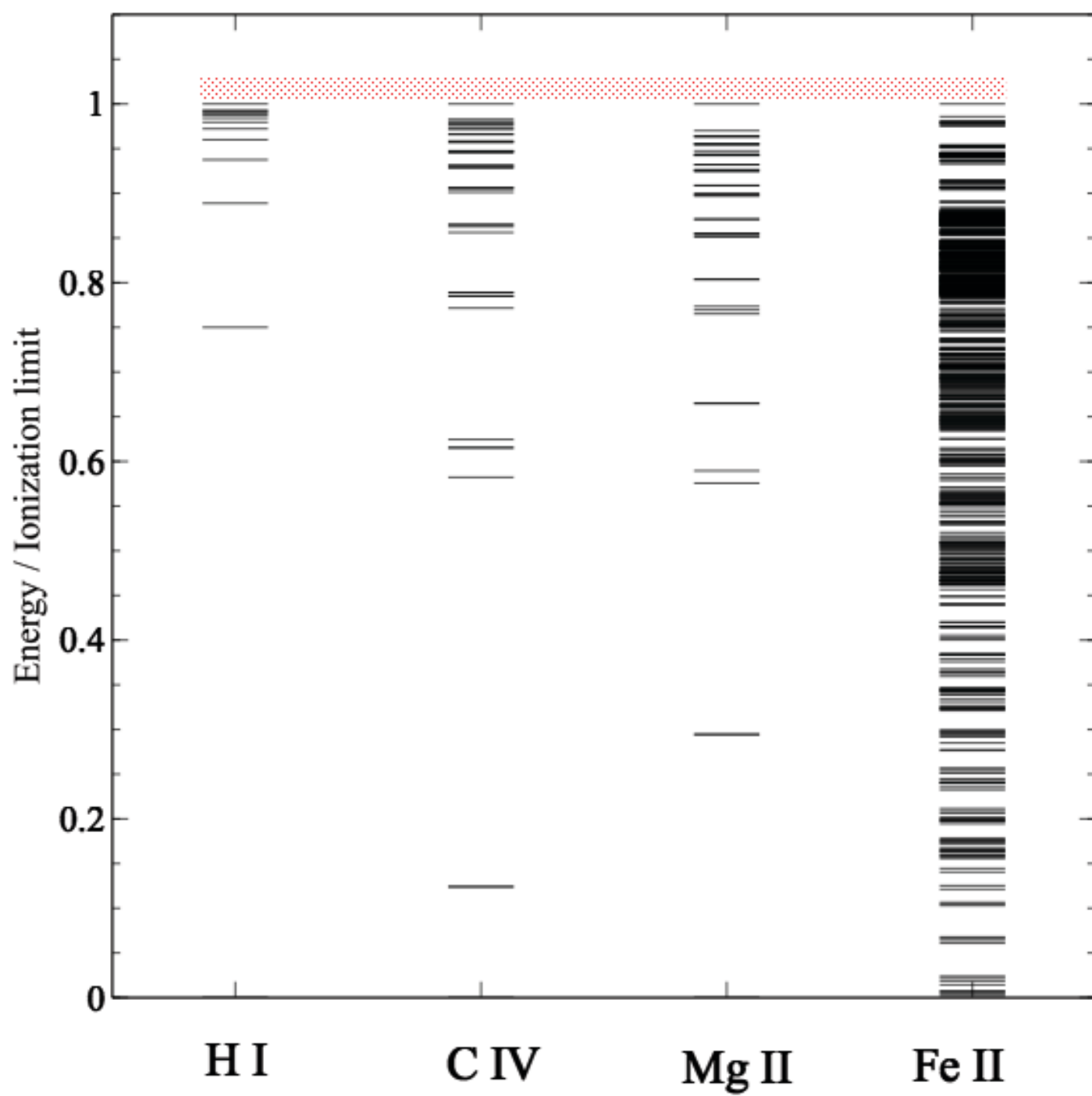
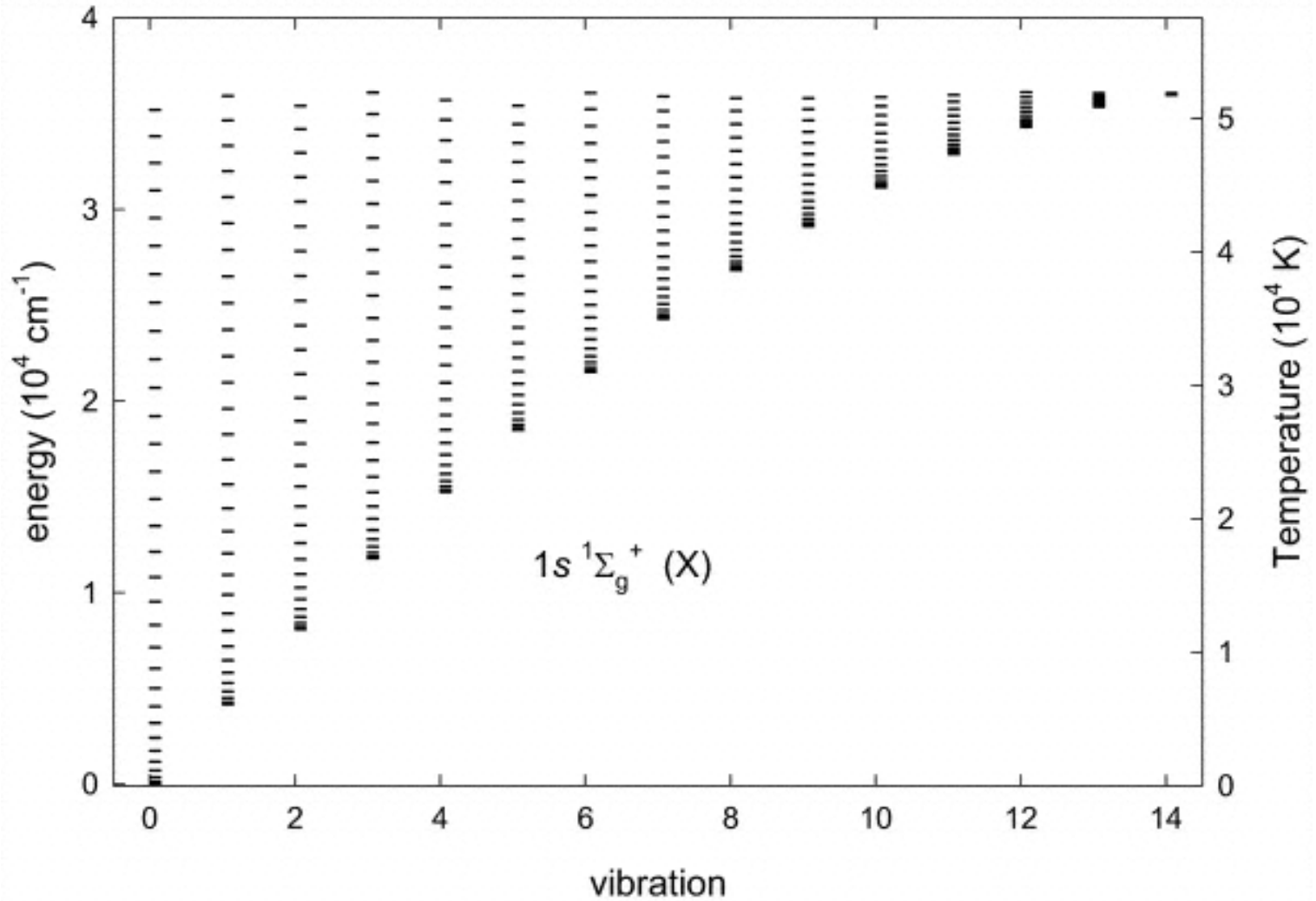


Make spectra of stable phases

- ◆ **Cold, warm, hot stable phases**
- ◆ **Ccurve.in**
 - Remove grid, vary option
 - Leave ISM abundances
 - Save continuum (units microns), cooling
- ◆ **Compute stable points**
 - $T=5e2K$ $2e4K$, $8e4K$, $1.5e6K$, $2e7K$



H₂ (Shaw+05)



Peter's atomic line list

- ◆ <http://www.pa.uky.edu/~peter/atomic/>
- ◆ **Search wavelength range to find what lines are present**

◆ <http://www.nist.gov/pml/data/asd.cfm>

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NIST Home > PML > Physical Reference Data > Atomic Spectra Database

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NIST ATOMIC SPECTRA DATABASE

Version 4

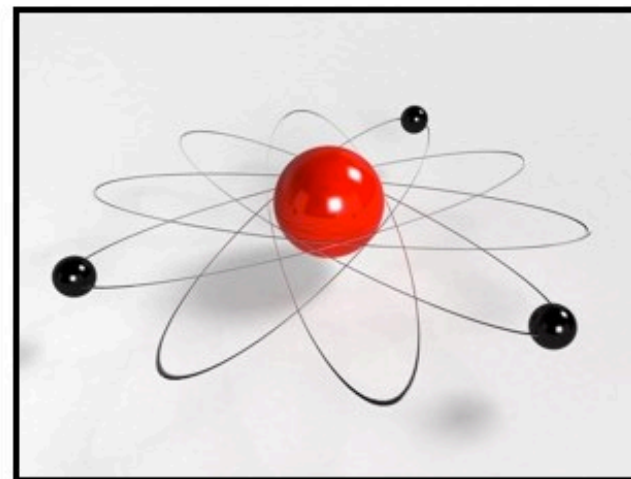
Welcome to the NIST Atomic Spectra Database, NIST Standard Reference Database #78. The spectroscopic data may be selected and displayed according to wavelengths or energy levels by choosing one of the following options:

LINES

Spectral lines and associated energy levels displayed in wavelength order with all selected spectra intermixed or in multiplet order. Transition probabilities for the lines are also displayed where available.

LEVELS

Energy levels of a particular atom or ion displayed in order of energy above the ground state.



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NIST ASD Team

Principal Developers (Currently Active):

Yu. Ralchenko, A. Kramida, and J. Reader

NIST Atomic Spectra Database Levels Form

Best viewed with the latest versions of Web browsers and Java

This form provides access to NIST critically evaluated data on atomic energy levels.

Spectrum: e.g., Fe I

Default Values

Retrieve Data

Level Units:

Format output:

Display output:

Page size:

Term ordered term energy

Energy ordered

Level information:
 Principal configuration
 Principal term
 Level J
 Lande-g

Extended Search: for all levels search

Two types of lines

- ◆ **Recombination AGN3 sec 4.2**

- $q \sim 1e-13 \text{ cm}^3 \text{ s}^{-1}$

- Mainly H, He

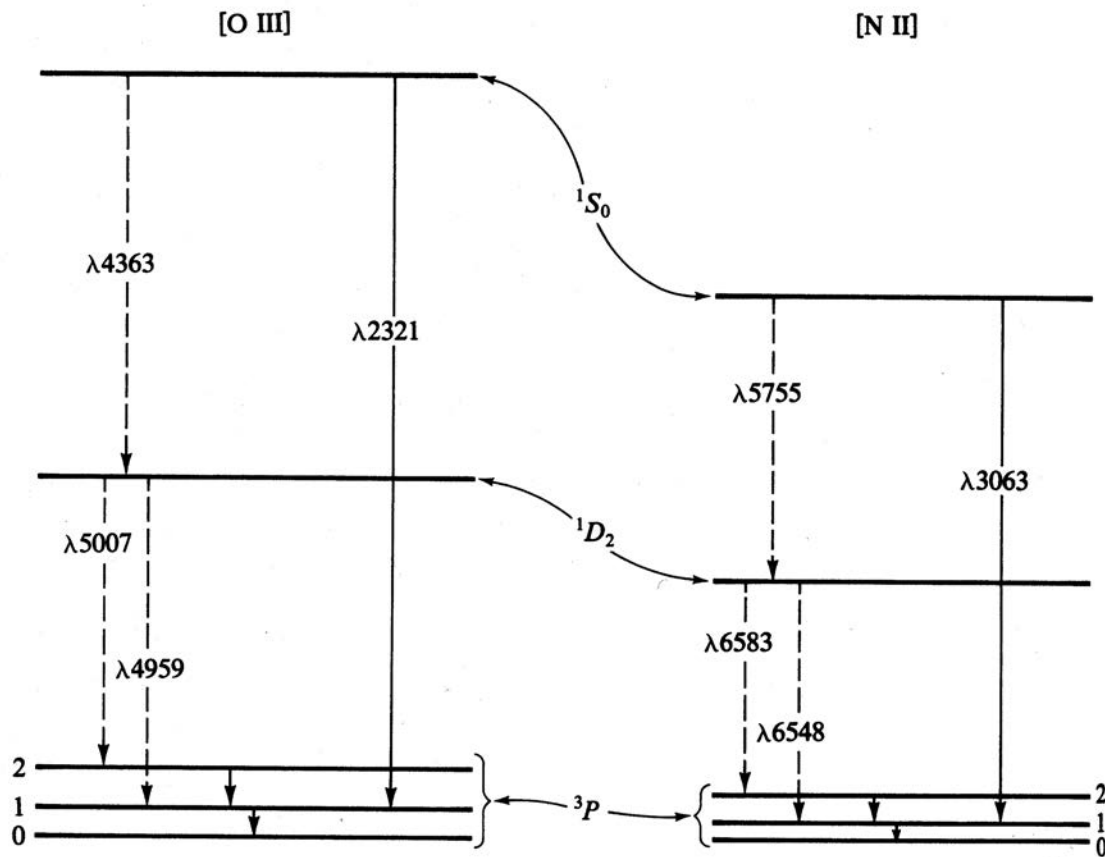
- ◆ **Collisionally excited AGN3 3.5**

- $q \sim 1e-9 \text{ cm}^3 \text{ s}^{-1}$

- Heavy element

[O III]

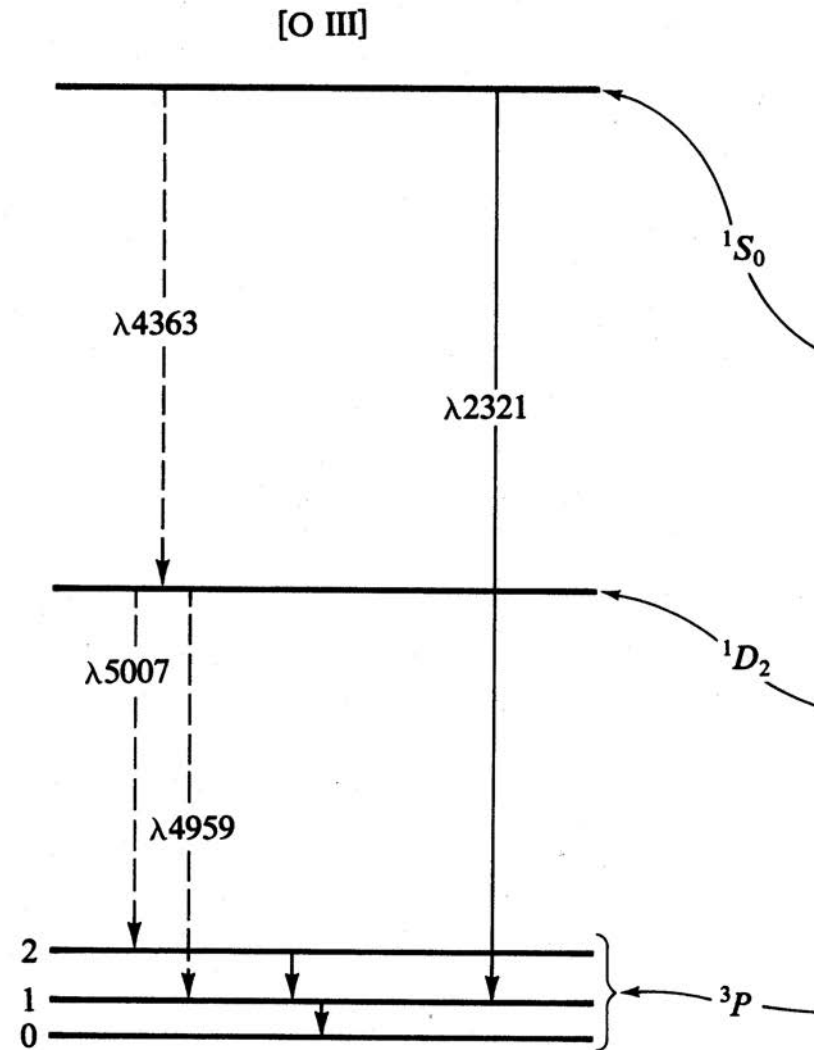
◆ AGN3 Fig 3.1



O III

Configuration	Term	J	Level (cm ⁻¹)
2s ² 2p ²	3P	0	0
		1	113.178
		2	306.174
2s ² 2p ²	1D	2	20 273.27
2s ² 2p ²	1S	0	43 185.74
2s2p ³	5S ^o	2	60 324.79
2s2p ³	3D ^o	3	120 025.2
		2	120 053.4
		1	120 058.2

w



Emissivity vs density, temperature

- ◆ **Recombination line, O III forbidden lines**

Two level atom AGN3 Sec 3.5

- ◆ **Excitation, deexcitation rates**
- ◆ **Transition probabilities**
- ◆ **Critical density**
- ◆ **Two limits**
 - Low densities, every excitation leads to emission of a photon
 - high densities, levels are in LTE, photon emission proportional to $n_u A_{ul}$

Recombination lines

- ◆ $\text{H}^+ + \text{e} \rightarrow \text{H}^{0*} \rightarrow \text{H}^0 + \text{photons}$
- ◆ Critical densities of H I, He I, and He II optical lines are very high, $n > 1\text{e}15 \text{ cm}^{-3}$, so they are usually in LDL
- ◆ Emissivity goes as n^2

Forbidden lines

- ◆ [O III]
- ◆ $O^{++} + e \rightarrow O^{++*} \rightarrow O^{++} + \text{photons}$
- ◆ Critical densities of many forbidden lines $n \sim 1e3 \text{ cm}^{-3}$, so they can be in LDL or HDH
- ◆ Emissivity goes as n^2 or n