

Thermal equilibrium

- ◆ Heating by radiation field in photo case
- ◆ In coronal case external process sets temperature
- ◆ Cooling is anything that converts kinetic energy into light that escapes

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Photoelectric heating

- ◆ **AGN3 eq 3.1**
- ◆ **Dependence on depth**
 - Spectrum, heating, across H⁺ region
- ◆ **SED**
 - Heating for different SEDs
- ◆ **Save heating**

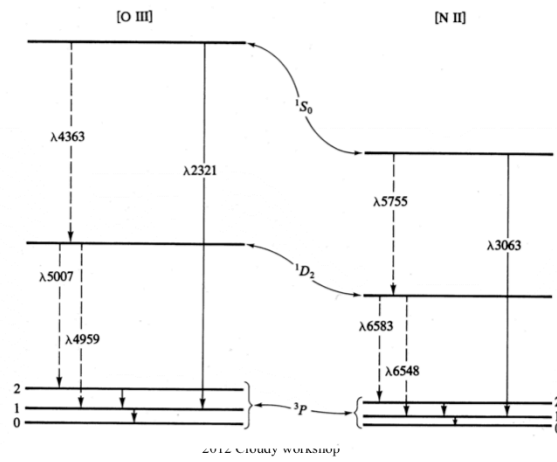
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Two types of lines

- ◆ **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



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

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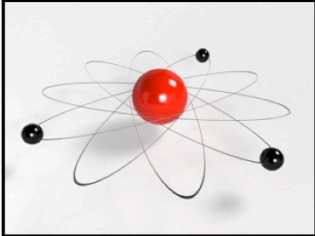
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NIST Atomic Spectra Database

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

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NIST Atomic Spectra Database Levels Form

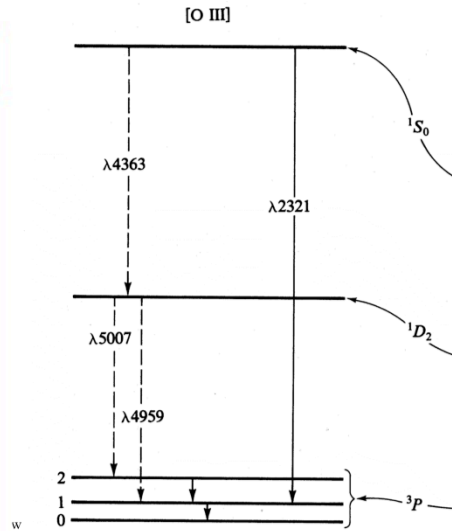
Best viewed with the latest versions of Web browsers and Java

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

Spectrum: <input type="text" value="o iii"/> c.g., Fe I	
<input type="button" value="Default Values"/>	<input type="button" value="Retrieve Data"/>
Level Units: <input type="text" value="cm-1"/>	Extended Search: <input type="button" value="Set Additional Criteria"/> for all levels search
Format output: <input type="text" value="HTML (formatted)"/>	
Display output: <input type="text" value="in its entirety"/>	
Page size: <input type="text" value="15"/>	
Term ordered: <input checked="" type="radio"/> term energy <input type="checkbox"/>	
Energy ordered: <input type="radio"/>	
Level information: <input checked="" type="checkbox"/> Principal configuration <input checked="" type="checkbox"/> Principal term <input checked="" type="checkbox"/> Level <input checked="" type="checkbox"/> J <input checked="" type="checkbox"/> Lande-g	

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°	2	60 324.79
2s2p ³	3D°	3	120 025.2
		2	120 053.4
		1	120 058.2



Energy levels for few, many electron systems

- ◆ H I, He I, He II
- ◆ O III

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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

Other cooling processes

- ◆ **Save cooling command**
- ◆ **Look at various output**

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