

# NIST

The *National Institute of Standards and Technology (NIST)* hosts a [data base](#) of spectroscopic transitions for a variety of elements and their ions. This data base is an excellent tool for identifying spectral lines in stellar spectra. This article is a short introduction on how to use this web page.

Most important for our purpose is the upper part of this *NIST* web page, where one has to:

The screenshot shows a search interface with a teal background. It contains four main input areas, each with a red number indicating a step:
 

- Step 1:** A text box labeled 'Spectrum' with the example text 'e.g., Fe I or Na;Mg; Al or mg i-iii'.
- Step 2:** A text box labeled 'Lower Wavelength:' followed by 'or Upper Wavenumber (in cm<sup>-1</sup>)'.
- Step 3:** A text box labeled 'Upper Wavelength:' followed by 'or Lower Wavenumber (in cm<sup>-1</sup>)'.
- Step 4:** A dropdown menu labeled 'Units:' with 'Å' selected.

1. enter the element symbol and optional the degree of ionization, otherwise the transitions from all ions will be displayed, keep it empty to search for all elements
2. enter the lower value of the wavelength range of interest
3. enter the upper value of the wavelength range of interest
4. choose a unit (usually angstrom makes the most sense)

By clicking on the Retrieve Data button, a list with all spectral lines that fit the above criteria will be displayed.

## Special remarks

**Important note on the line identification:** One has to roughly account for the abundances of the elements in the stellar atmospheres! For example rare earth elements have that name for a reason!

Furthermore, it is important to identify which of the presented transitions might be the one that is actually visible in the spectrum. For this purpose, it is helpful to also print the oscillator strength of all listed transitions. This can be achieved by activating the  $f_{ik}$  option, which can be found via Additional Criteria → Transition Strength on the input page. Moreover, one can and should restrict the oscillator strength to a reasonable range. With the exception of hydrogen and maybe helium, a line transition with an oscillator strength of less than  $10^{-3}$  is unlikely to be visible in our spectra. A corresponding value needs to be entered in the Minimum transition strength field in the Optional Search Criteria box. Note that one also has to choose  $f_{ik}$  in the above drop-down menu ("Transition strength bounds will apply to").

Output Options	Additional Criteria
Format output: <input type="text" value="HTML (formatted)"/>	Lines: <input checked="" type="radio"/> All <input type="radio"/> Only with transition probabilities <input type="radio"/> Only with energy level classifications <input type="radio"/> Only with observed wavelengths
No JavaScript <input type="checkbox"/>	
Energy Level Units: <input type="text" value="eV"/>	
Display output: <input type="text" value="in its entirety"/>	Bibliographic Information: <input checked="" type="checkbox"/> TP references, Line references
Page size: <input type="text" value="15"/>	
Output ordering: <input checked="" type="radio"/> Wavelength <input type="radio"/> Multiplet	Wavelength Data: <input checked="" type="checkbox"/> Observed <input checked="" type="checkbox"/> Ritz <input type="checkbox"/> Observed - Ritz (difference) <input type="checkbox"/> Wavenumber (in cm <sup>-1</sup> )
<b>Optional Search Criteria</b>	
Maximum lower level energy: <input type="text" value=""/> (e.g., 100000)	Wavelengths in: <input type="radio"/> Vacuum (< 2,000 Å) <input type="radio"/> Air (2,000 - 10,000 Å) <input type="radio"/> Wavenumber (> 10,000 Å) <input type="radio"/> Vacuum (< 10,000 Å) <input type="radio"/> Wavenumber (> 10,000 Å) <input checked="" type="radio"/> Vacuum (< 2,000 Å) <input type="radio"/> Air (2,000 - 20,000 Å) <input type="radio"/> Vacuum (> 20,000 Å)
Maximum upper level energy: <input type="text" value=""/> (e.g., 400000)	<input type="radio"/> Vacuum (all wavelengths) <input type="radio"/> Vacuum (< 1,850 Å) <input type="radio"/> Air (> 1,850 Å) <input type="radio"/> Wavenumber (all wavelengths)
Transition strength bounds will apply to: <input type="text" value="fak"/>	
Minimum transition strength: <input type="text" value="1.0e-03"/> (e.g., 1.2e+05)	Transition strength: <input checked="" type="radio"/> $A_{ul}$ <input type="radio"/> $g_u A_{ul}$ <input type="checkbox"/> in units of 10 <sup>8</sup> s <sup>-1</sup> <input checked="" type="checkbox"/> $f_{ul}$ <input type="checkbox"/> $S_{ul}$ <input type="checkbox"/> log(gf)
Maximum transition strength: <input type="text" value=""/> (e.g., 2.5e+12)	<input checked="" type="checkbox"/> Relative Intensity
	Transition Type: <input checked="" type="checkbox"/> Allowed (E1) <input checked="" type="checkbox"/> Forbidden (M1, E2, ...)
Accuracy minimum: <input type="text" value=""/> (e.g., C+)	
Relative intensity minimum: <input type="text" value=""/> (e.g., 1.2e-03)	Level information: <input checked="" type="checkbox"/> Configurations <input checked="" type="checkbox"/> Terms <input checked="" type="checkbox"/> Energies <input checked="" type="checkbox"/> J <input type="checkbox"/> g

## Example

In the following an example of neutral sodium is shown. In the wavelength range between 5000 Å and 6000 Å the well known sodium D-line doublet as well as further transitions with significantly lower oscillator strengths can be found. In the column  $Rel. Int.$ , the relative intensities of the transitions are specified. Whether a line can be observed for a specific value of the relative intensity or not strongly depends on the investigated ion. Nevertheless, by comparing the intensities of different lines of the same ion the observability of a line can be evaluate.



## NIST Atomic Spectra Database Lines Data

Na I: 7 Lines of Data Found

Z = 11, Na isoelectronic sequence

Wavelength range: 5000 - 6000 Å

Wavelength in: vacuum below 2000 Å, air between 2000 and 20000 Å, vacuum above 20000 Å

Highest relative intensity: 80000

Some data for neutral and singly-charged ions are available in the [Handbook of Basic Atomic Spectroscopic Data](#)

Primary data sources			Query NIST Bibliograph
Energy Levels:	<a href="#">Sansonetti 2008</a>	Identifications and values of core-excited energy levels of the $2p^33nl$ configurations are from <a href="#">Kramida 2010</a>	Na I (new w
Lines:	<a href="#">Sansonetti 2008</a>		Na I Energy I
Transition Probabilities:	<a href="#">Kelleher and Podobedova 2008</a> ; <a href="#">Sansonetti 2008</a>		Na I Line Wavelengths a
			Na I Transition Pr

Observed Wavelength Air (Å)	Ritz Wavelength Air (Å)	Rel. Int. (%)	$A_{ki}$ ( $s^{-1}$ )	$f_{lk}$	Acc.	$E_i$ (eV)	$E_k$ (eV)	Lower Level Conf., Term, J	Upper Level Conf., Term, J	Type	TP Ref.	Line Ref.
5 148.8381	5 148.8383	1	1.14e+06	4.52e-03	B+	2.102297085	- 4.5096297	$2p^63p \ 2P^* \ 1/2$	$2p^66s \ 2S \ 1/2$		c30	L15039
5 153.4024	5 153.4024	2	2.27e+06	4.52e-03	B+	2.104429110	- 4.5096297	$2p^63p \ 2P^* \ 3/2$	$2p^66s \ 2S \ 1/2$		c30	L15039
5 682.6333	5 682.6333	5	1.01e+07	9.83e-02	A	2.102297085	- 4.2835006	$2p^63p \ 2P^* \ 1/2$	$2p^64d \ 2D \ 3/2$		c30	L15039
5 688.1934	5 688.1933	1	2.02e+06	9.82e-03	A	2.104429110	- 4.2835006	$2p^63p \ 2P^* \ 3/2$	$2p^64d \ 2D \ 3/2$		c30	L15039
5 688.2046	5 688.2047	9	1.21e+07	8.83e-02	A	2.104429110	- 4.2834963	$2p^63p \ 2P^* \ 3/2$	$2p^64d \ 2D \ 5/2$		c30	L15039
5 889.950954	5 889.950943	80000	6.16e+07	6.41e-01	AA	0.00000000	- 2.104429110	$2p^63s \ 2S \ 1/2$	$2p^63p \ 2P^* \ 3/2$		T6617,T6568,T6567	L5918
5 895.924237	5 895.924237	40000	6.14e+07	3.20e-01	AA	0.00000000	- 2.102297085	$2p^63s \ 2S \ 1/2$	$2p^63p \ 2P^* \ 1/2$		T6617,T6567	L5918

Query time: 0.1 sec

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