A comprehensive line list for atomic transitions on the WWW

Peter A.M. van Hoof

University of Kentucky, Department of Physics & Astronomy, 177 CP Building, Lexington, KY 40506–0055, USA (E-mail: peter@pa.uky.edu)

Abstract. We discuss two comprehensive line lists of atomic transitions with wavelengths ranging from 910 Å to 10 000 Å and from 1 μm to 1000 μm respectively. These lists are primarily intended for identifying spectral features. In the near future both lists will be combined and the wavelength range will be extended to encompass the full range from 1 Å to 1000 μm. Also other improvements to the list are planned.

1. Introduction

We have made a compilation of allowed and forbidden atomic transitions, currently consisting of two parts, one containing approximately 296 000 lines with wavelengths ranging from 910 Å to 10 000 Å and one with approximately 136 000 lines ranging from 1 μm to 1000 μm. The primary purpose of these lists is to allow the identification of observed absorption or emission features. The wavelengths in these lists are all calculated from the difference between the energy of the upper and lower level of the transition. No attempt has been made to include observed wavelengths. Most of the atomic energy level data has been taken from the Atomic Spectroscopic Database provided by the National Institute of Standards and Technology (NIST).

2. Using the line list

When attempting to identify an observed line usually many possible candidates can be found in the list. In order to facilitate narrowing down the number of possible identifications a selection tool has been constructed which allows imposing, apart from the wavelength, several additional criteria. Possible criteria are:

- Select one or more specific elements and/or ions.
- Select only elements above a threshold abundance.
- Select an energy range for the upper and/or lower level.
- Ignore quantum levels with high n and/or l.
- Select a specific multiplet.
- Select only certain types of transitions (allowed, intercombination, forbidden)

3. Contents of the line list

Allowed lines are compiled for all ionization stages of the following elements: H, He, C, N, O, Na thru S, K thru Ni, Cu (except Cu VIII-IX) and Zn (except Zn IX-X, XXVI) and additionally also for the following ions: Li III, Be I, Be IV, B V, F IX, Ne X, Cl XVII and Ar XVIII.

Intercombination lines are compiled for the same ions, provided that the ground state of that ion has at least one electron in the $3p$ shell.

Forbidden magnetic dipole and electric quadrupole transitions are compiled for all ionization stages of the following elements: C thru Zn (except Cu VIII-IX and Zn IX-X, XXVI).

4. Where is the line list ?

The UV & optical line list can be found on:
www.pa.uky.edu/~peter/opt_list/linelist.html
The infrared line list can be found on:
www.pa.uky.edu/~peter/line_list/linelist.html

5. Future work

In a parallel effort a second line list has been constructed by D.A. Verner at our institute. Using an up-to-date compilation of experimental energy levels, he has calculated accurate wavelengths for a complete list of infrared forbidden transitions between the ground term levels of all elements up to zinc (atomic number $Z = 30$) and all isoelectronic sequences up to argon-like ions (number of electrons $N = 18$). In total, this list includes 1200 lines. For these lines, he has compiled and critically evaluated a full set of atomic transition probabilities both from the literature and available atomic databases. We plan to extend this list to other isoelectronic sequences ($N > 18$) and also compile the best available collision strengths for these infrared forbidden transition.

It is our intention to combine both line lists and include the transition probabilities in the atomic line list presented on the WWW. But first we will make an effort to complete the line list on the web for all observed ions of all elements up to zinc and to update the atomic level data where necessary. It is also our intention to combine the UV & optical line list with the infrared list and extend the wavelength range from 1 Å to 1000 μm. We currently are busy to improve the selection tool presented on the web in order to make it more versatile. In the meanwhile we will also critically re-assess the selection rules employed to construct the line list. For instance the rule that at least one $3p$ electron should be present in the ground state in order to include intercombination transitions, should be relaxed.

6. Acknowledgments

The author thanks the NFRA for support through grant 782–372–033 and ESO for their hospitality and financial support during his stay in Santiago, Chile, where part of this work was done. Research in Nebular Astrophysics at the University of Kentucky is supported in part by the National Science Foundation through grant Ast 96–60756.