Nauji absorbcijos linijų spektroskopiniai duomenys tarpžvaigždinės ir tarpgalaktinės medžiagos stebėjimams

Revised spectroscopic data for absorption lines relevant to observations of interstellar and intergalactic matter

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Measurements of element abundances in galaxies from astrophysical spectroscopy depend sensitively on the atomic data used. With the goal of making the latest atomic data accessible to the community, we present a compilation of selected atomic data for resonant absorption lines at wavelengths longer than 911.753 Å (the H I Lyman limit), for key heavy elements (heavier than atomic number 5) of astrophysical interest [1]. In particular, we focus on the transitions of those ions that have been observed in the Milky Way interstellar medium (ISM) , the circumgalactic medium (CGM) of the Milky Way or other galaxies, and the intergalactic medium (IGM).

We provide wavelengths, oscillator strengths, associated accuracy grades, and references to the sources of the oscillator strength data. We also make attempt to compare, to evaluate, and to assess the recent oscillator strength data, originating both from the theoretical and experimental determinations. For about 22% of the lines that have updated oscillator strength *f*-values, the differences between the former values and the updated ones are larger than or close to 0.1 dex.

Our compilation can be a useful resource for absorption line studies of the ISM, as well as studies of the CGM and IGM traced by sight lines to quasars and gamma-ray bursts. Further, the studies (including those enabled by future generations of extremely large telescopes) of absorption by galaxies against the light of background galaxies will also benefit from our compilation.

In the CGM/IGM community, the most commonly used reference for atomic data, by far, is [2]. Our goal is to make the latest improvements accessible to the community, thus here we present a compilation of oscillator strengths for key transitions, including updates made since 2003. We focus, in particular, on the ions that have been measured in ISM/CGM/IGM studies for the selected elements ranging from C (Z = 6) to Ge (Z = 32), and for Kr (Z = 36) and Pb (Z = 82). Various ionization stages are considered.

In data sources selection we wish to be as consistent as possible. Hence we have devised selection rules and procedure for the listed lines; (a) we give priority to the observed wavelength, which we denote λ_{vac} over the Ritz wavelength λ_{Ritz} ; (b) as a rule, the line wavelength source is the NIST database [3]; (c) we tabulate absorption lines originating from the ground level only. We do not investigate lines originating from the excited levels of the ground configuration or the ground term; (d) we consider only those lines that have $f \geq 0.001$; (e) usually, we tabulate *f*-values from the newest sources giving priority to the experimental data over the theoretical values. In the cases where new data are not significantly different from the older data, we choose to rely on the older data preferring the most advanced theoretical methods for data production.

We investigated 576 spectral lines, for 400 of these transitions, we have listed updated data. Of these, 60 transitions, though listed either in [2] or [3], previously had no oscillator strength value reported. A breakdown of the accuracy grades for these lines is given in Fig. 1.

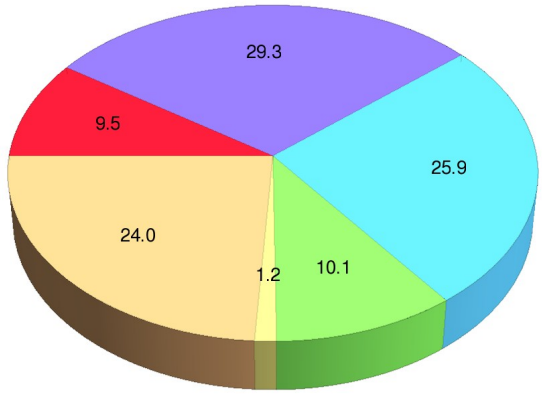

Fig.1. Statistical distribution by data accuracy grades for the 576 absorption lines: grade ≥ A: accuracy ≤ 3%; A > grade ≥ B: 3% < accuracy ≤ 10%; B > grade ≥ C: 10% < accuracy≤ 5%; C > grade ≥ D: 25% < accuracy ≤ 50%; D > grade ≥ E: accuracy > 50%.

Key words: atomic data, absorption lines, oscillator strenghts, interstellar medium, quasars

References

[1] F.H. Cashman, V.P. Kulkarni, R. Kisielius, G.J. Ferland, P. Bogdanovich, ApJS, **230**, 8 (2017)
[2] C.D. Morton,D. C. 2003, ApJS, **149**, 205, (2003)
[3] A. Kramida, Yu. Ralchenko, J. Reader, NIST ASD Team, *NIST Atomic Spectra Database, ver. 5.4* (Gaithersburg, MD: National Institute of Standards and Technology, 2016)