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Report on the recent advances performed in the determination of radiative parameters for spectral lines of astrophysical interest in heavy elements

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Abstract. We present an overview of the advances made during the past 15 years by the Atomic Physics and Astrophysics Group of Mons University regarding the analysis of the spectra, the transition probabilities, and the radiative lifetimes in heavy elements. More precisely, this review is focused on neutral and lowly ionized atoms belonging to the lanthanide group, the fifth row, and the sixth row of the periodic table (Z = 37–86), for which a very large amount of new data has been obtained.

Keywords. atomic data, atomic processes

The study of complex atomic structures has known a considerable development over the past years, the new improvements arising both from theory and from experiment. During the period 1998–2015, part of our research activities has been focused on the combination of computational and experimental techniques for providing new accurate atomic data for neutral and lowly ionized atoms of astrophysical interest. In the present contribution, we report on the recent advances we have made concerning the determination of new radiative parameters (transition probabilities, oscillator strengths, radiative lifetimes) in heavy elements belonging to the fifth row, the sixth row and the lanthanide group of the periodic table. In astrophysics, these elements present a great interest for the investigation of the atmospheres of chemically peculiar stars, for deriving chemical abundances and for computing the opacity of the stellar matter, and consequently for building stellar models. In stellar nucleosynthesis, a detailed analysis of the *r*- and *s*-processes is not possible without a great deal of reliable atomic data corresponding to heavy elements not only for the strongest lines but also for a huge number of weak absorption features which are now observable on the high resolution astrophysical spectra.

All the data obtained so far in our work correspond to transition decay rates for more than 200000 spectral lines in about 100 heavy atoms and ions. These were generally deduced from a combination of experimental radiative lifetimes measured with the time-resolved laser-induced fluorescence (LIF) (over 700 lifetimes were measured) and of theoretical branching fractions calculated with a relativistic Hartree-Fock (HFR) approach taking core-polarization effects into account. This extensive work and the numerous subsequent comparisons have provided us with a broad experience concerning the evaluation of radiative parameters. On that basis, we have been able to deduce some criteria regarding the accuracy estimate of these atomic data both on the theoretical and on the experimental sides. Our research team has published about 100 papers in relation with this work. A comprehensive list of those references has been given at the IAU General Assembly.