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Study of radiative properties of helium isoelectronic sequence

The heavy elements with high Z are of potential interest in controlled thermonuclear fusion and astrophysics. Indeed, they could be used in plasma-facing materials such as the divertors in tokamaks or/and could be generated by neutron-induced transmutations of divertor's materials. So, extensive spectroscopic studies both experimental and theoretical have been performed in the last years in order to estimate the power loss from the impurities in the forthcoming fusion reactors [1].
In this work, two independent theoretical atomic structure computational approaches have been considered, i.e. the ab initio multiconfiguration Dirac-Hartree-Fock with subsequent relativistic configuration interaction method (MCDHF-RCI) implemented in the code GRASP2018 [2] and the Dirac-Fock-Slater (DFS) implemented in the code FAC (Flexible Atomic Code) [3]. The relativistic configuration interaction method was applied to estimate the electron correlation effects.
The radiative properties of ions (Z=2-53) belonging to the helium isoelectronic sequence are reported. Energy levels for the ground state and the lowest 1s2l singly excited states are considered. The effects of correlation effects are studied for the selected ions by increasing the active set (AS). Relativistic effects such as the Breit interaction and the QED corrections are also computed. The transition probabilities and the oscillator strengths have been calculated for E1, E2, M1 and M2 transitions spanning the spectral range from Uv to IR regions. Our results are compared with available experimental and other theoretical values. Good agreement was found for the majority of cases. Lifetimes are also considered in this work, first to check the accuracy of calculated results of transitions rates and second, to complete the databases by a complete and accurate values of lifetimes. This can help future works by experimentalists to compare their results with those results calculated theoretically.
Finally, this study underlines the importance of relativistic corrections especially for the heavy atomic ions. This computational approach enables us to present a consistent and improved data set of all-important atomic data of the helium isoelectronic sequence, which are useful for identifying transition lines in further investigations.

References

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