MICROSCOPIC CALCULATIONS OF BETA DECAY RATES FOR R-PROCESS

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Heavy element nucleosynthesis is a very complex process that requires the knowledge of the characteristics, mainly neutron capture and beta-decay rates, of thousands of nuclei. However, due to the limitations of current experimental facilities, only a relatively small number of nuclei have so far been studied experimentally. Consequently, most of the relevant information must be obtained from nuclear structure models.

Given the amount of nuclei, and the regions of the nuclear chart involved in the heavy element nucleosynthesis, it is of vital importance to use models which can be reliably applied to even the most exotic nuclei. Therefore, because the underlying microscopic theory of nuclear interaction is expected to be valid across the whole nuclear chart, self-consistent, microscopic nuclear structure models present themselves as the optimal choice for the study of very neutron-rich nuclei.

The r-process, i.e. the rapid neutron capture process depends on the delicate balance between the neutron capture and the beta decay of nuclei along the path towards heavy elements. Therefore, the beta decay properties are key to a successful description of the dynamics of the heavy element nucleosynthesis and of the resulting elemental abundances. The large-scale calculations based on the Finite Range Droplet Model (FRDM) [1] have become the standard in the field and are regularly used in simulations. However, there have been several recent studies where important advances have been made based on self-consistent theoretical frameworks using both Skyrme [2], Gogny [3] and relativistic interactions [4].

The results of these studies will be presented and compared, with special focus on the impact of new calculations on the heavy element nucleosynthesis and the distribution of elemental abundances. Additionally, new results for the beta-delayed neutron emission probabilities calculated in the framework of the relativistic nuclear energy density functional will be presented and compared with the available data.

REFERENCES

[1] P. Möller, B. Pfeiffer, and K.-L. Kratz, Physical Review C 67, 055802 (2003)
[2] M. T. Mustonen and J. Engel, Physical Review C 93, 014304 (2016)
[3] M. Martini, S. Péru, and S. Goriely, Physical Review C 89, 044306 (2014)
[4] T. Marketin, L. Huther, and G. Martínez-Pinedo, Physical Review C 93, 025805 (2016)