Nuclear Mass Systematics with Neural Nets and Astrophysical Nucleosynthesis

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One of the main subjects of Nuclear Astrophysics is the study of the various nucleosynthesis processes and the justification of the present abundances [1]. The input for such studies from Nuclear Physics involves among others masses, separation energies and Q-values for nuclei far from stability line. The experimental activity with the existing and under construction radioactive ion-beam and heavy-ion facilities will provide partially this input. Reliable models of these quantities will supplement the rest.

In this work [2] we present new global statistical models of the atomic mass-excess and related quantities (separation energies, Q-values) using neural networks that model the differences between the experimental mass-excess values ΔM^{exp} [3] and the theoretical values ΔM^{th} given by the finite range droplet model (FRDM) of Möller et al [4]. The model of the differences seems to catch subtle regularities of nuclear structure not yet embodied in the best microscopic/phenomenological models of atomic-mass systematics. It is for this reason that the predictive performance of the above constructed models outperforms in the majority of the case those of FRDM and of models developed by training neural networks solely on the masses [5]. We will present mainly results of the mass excess, one and two neutron and proton separation energies and Q-values for β-decay that are used as input for the astrophysical nucleosynthesis processes r and rp.

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