Global Models of Masses and β^- Decay Half-Lives With Neural Networks and R-Process Nucleosynthesis

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The understanding of r-process nucleosynthesis is an important issue for both nuclear physics and astrophysics [1]. Various nuclear data for nuclei including masses and β^-decay halflives far from the β-stability line up to the neutron-drip line are needed and have to be provided by reliable global models. A constellation of *theory thick* macroscopic or semi-microscopic models has been developed during the last decades for generating these quantities. Statistical modeling of nuclear data, using Artificial Neural Networks [2] and more recently Support Vector Machines [3], is providing a complementary *theory-thin* approach to prediction of nuclear systematics. In this work we present our latest global statistical models for the nuclear mass excess and related quantities as well as for the halflives of β^-decaying nuclei. Concerning masses, results are presented from a Hybrid Model which is constructed by combining the Finite Range Droplet Model (FRDM) [4] with a neural network model that predicts the difference between the experimental mass-excess values and the theoretical values of FRDM [5]. Concerning halflives of nuclei that decay 100% by the β^-mode from their ground states, results are presented for a fully-connected multilayer feedforward network [6]. The results are discussed and compared with the available experimental data [7] and theoretical predictions. We focus on nuclei near the r-process paths and give predictions for their masses and related quantities and halflives. It is found that the hybrid models of masses and related quantities that combine macroscopic/microscopic and statistical approaches outperform either whereas the new statistical -i.e., data driven- global model of β^- decay halflives can at least match the predictive performance of the best conventional theory-driven global models. Work is in progress to develop global statistical models of other quantities of nuclear systematics that are involved in the r-process using techniques of machine learning.

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