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Deep learning for nuclear masses in deformed relativistic Hartree-Bogoliubov theory in continuum

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Most nuclei are deformed and deformations play an important role in various nuclear phenomena. Modern microscopic nuclear mass models have been/are being developed based on the relativistic Hartree-Bogoliubov theory in continuum to explore exotic nuclear properties. Among them we adopt the mass models based on the relativistic continuum Hartree-Bogoliubov theory (RCHB) with spherical symmetry and deformed relativistic Hartree-Bogoliubov theory in continuum (DRHBc) with axial symmetry to study possible effects of deformation on the rapid neutron-capture process abundances. Since the DRHBc mass table is so far finished only for even-Z nuclei, we first study if a Deep Neutral Network (DNN) can be of use to fill out the DRHBc mass table focusing on nuclear binding energy. To include information about odd-odd and odd-even isotopes to the DNN we also use the binding energies in AME2020 as a training set in addition to those of even-Z nuclei from the DRHBc mass table. After we obtain a reasonable mass table through the DNN, we perform a sample sensitivity study of r-abundances to deformation or masses by using the RCHB⊠ and DRHBc⊠ mass tables. Here, ⊠ means the mass table is obtained by the DNN. To see if such effects persist in various astrophysical sites of the r-process, we use the magnetohydrodynamic jets, collapsars and neutron star mergers.

Primary authors: KIM, Kyungil (IRIS/IBS); CHOI, Soonchul (CENS/IBS); KAJINO, Toshitaka (Beihang University, National Astronomical Observatory of Japan, University of Tokyo); KIM, Youngman (CENS/IBS)

Presenter: CHOI, Soonchul (CENS/IBS)

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