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High precision calculations of nuclear charge radii using Bayesian neural networks

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Charge radius is one of the most fundamental properties of a nucleus. However, a precise description of the evolution of charge radii along an isotopic chain is highly nontrivial, as reinforced by recent experimental measurements. In this presentation, a Bayesian neural network (BNN) based approach with six inputs including the proton number, mass number, and engineered features associated with the pairing effect, shell effect, isospin effect, and "abnormal" shape staggering effect of ^{181,183,185}Hg, is proposed to accurately describe nuclear charge radii. The new approach is able to well describe the charge radii of atomic nuclei with $A \geq 40$ and $Z \geq 20$. The standard root-mean-square (rms) deviation is 0.014 fm for both the training and validation data. In particular, the predicted charge radii of proton-rich and neutron-rich calcium isotopes are found in wonderful agreement with experimental data. We further demonstrate the reliability of the BNN approach by investigating the variations of the rms deviation with extrapolation distances and mass numbers.

Presentation type

Primary authors: Mr DONG, XiaoXu (BeiHang University & University of Tokyo); Prof. GENG, Lisheng (BeiHang University)

Presenter: Mr DONG, XiaoXu (BeiHang University & University of Tokyo)

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