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Global microscopic description of nucleon-nucleus scattering with quantified uncertainties

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The nuclear optical potential provides an essential tool for studying nucleon-nucleus elastic scattering and reaction cross sections by incorporating the complexity of many-body correlations into an effective one-body mean field between projectile and target. We develop for the first time a microscopic global nucleon-nucleus optical potential with quantified uncertainties suitable for analyzing nuclear reaction experiments at next-generation rare-isotope beam facilities. We start from the nuclear matter approach, in which the nucleon self-energy in infinite homogeneous matter at varying density and isospin asymmetry is used to construct nucleon-nucleus optical potentials for 1800 nuclei by matching to the isoscalar and isovector densities of the target isotopes by way of the improved local density approximation. This is repeated for five different chiral interactions from which a covariance analysis of the parameters entering in the global optical potential can be used to create a continuous distribution of optical potentials and derived uncertainties.

Primary authors: HOLT, Jeremy (Texas A&M University); Dr WHITEHEAD, Taylor (Michigan State University); LIM, Yeunhwan (Ewha Womans University)

Presenter: HOLT, Jeremy (Texas A&M University)