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Application of multiple scattering theory to develop nuclear optical potentials

The optical potential is a well-known and successful tool that is widely used to describe nucleon-nucleus scattering processes. Within this approach it is possible to compute the scattering observables for elastic processes across wide regions of the nuclear landscape and extend its usage to inelastic scattering and other types of reactions. A phenomenological approach is usually preferred to achieve a good description of the data. However, it lacks predictive power due to the presence of free parameters contained in the model that need to be fixed. With the upcoming facilities for exotic nuclei, we strongly believe that a microscopic approach, completely free from phenomenology, will be the preferred tool to make reliable predictions, assess the unavoidable approximations, and provide a clear physical interpretation of the process under consideration. The Watson multiple scattering theory provides a successful framework to derive such optical potential for energies above 100 MeV. In its simplest formulation, derived at the first order, the optical potential is obtained as the folding integral of the nucleon-nucleon scattering t matrix and the target density, representing the two fundamental ingredients of the model. After many years of advances in theoretical nuclear physics, it is now possible to calculate these two quantities using the same nucleon-nucleon interaction that is the only input of our calculations. Results obtained within this framework will be presented for light- and medium-mass nuclei, adopting different ab initio approaches to calculate the densities, such as No-Core Shell Model and Self-Consistent Greens Function. Preliminary results for future extensions of the model, such as the inclusion of medium effects and the calculation of the inelastic scattering, will be also presented. Finally, we will also present the extension of the multiple scattering formalism to derive a nucleus-nucleus optical potential for elastic scattering calculations.

Thursday 10th July 2025,14h00
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