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Microscopic optical potentials: recent achievements and applications.

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Nucleon elastic scattering is a very important process to understand
nuclear interactions in finite nuclei.
Even if this process has been extensively studied in the last years,
a consistent microscopic description is still under development.
In this perspective, our long term project was to study
the domain of applicability of microscopic two- and three-body
chiral forces in the construction of an optical potential (OP) with the ultimate goal
to obtain a consistent description of both the target and the projectile-nucleus dynamics.
In general, the OP is obtained as the first-order term within the spectator expansion
of the multiple scattering theory and adopting the impulse
approximation.
As a first step, we derived a nonrelativistic theoretical optical potential
from nucleon-nucleon chiral potentials at fourth (N3LO) and fifth order (N4LO).
We checked convergence patterns and establish theoretical error bands for
Wolfenstein amplitudes and the cross sections, analyzing powers,
and spin rotations of elastic proton scattering off some light nuclei at an incident
proton energy of 200 MeV [1,2]. Then, we extended our analysis to
the cross sections and analyzing powers of calcium, nickel, tin, and lead
isotopes exploring the range $156 \leq E \leq 333$ MeV,
where experimental data are available. In addition,
we provided theoretical predictions for Ni56 at 400 MeV,
which is of interest for the experiments at EXL [3].
In the last years we explored the impact of three-body forces [4] and how the developed
formalism could be applied to non-zero spin targets [5].
In conclusion, we also performed some predictions for antiproton elastic scattering
off nuclei at energies close to 200 MeV [6], in remarkable agreement with
experimental data. Recent works in connection with the Ab-Initio
Self-Consistent Green Functions method will also be presented [7].

Our results clearly indicate that microscopic optical potentials derived from
nucleon-nucleon chiral potentials can provide reliable
predictions for the cross section and the analyzing power
of stable and exotic nuclei.

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Topic

Theory

Author: Prof. FINELLI, Paolo (University of Bologna and INFN)

Presenter: Prof. FINELLI, Paolo (University of Bologna and INFN)

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