Status of Multiple Scattering Calculations of the Nucleon-Nucleus System

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There are recently been considerable effort, and advances made, in studies of the nucleon optical potential at medium energies ($60 \leq E \leq 300$ MeV) based on multiple scattering methods. To a large extend these were stimulated by the realisation that, unlike the underlying free nucleon-nucleon (NN) potential itself and also derived effective and g-matrix NN interactions, the free NN transition amplitudes derived from state-of-the-art NN interaction models [1] are remarkably consistent and well determined and thus form a stable basis from which to develop calculational schemes.

There have subsequently been very careful investigations of the first order (single scattering) and second order (Pauli-blocking) terms of the multiple scattering expansion of the nucleon optical potential based on our most realistic descriptions of the NN system (the Paris and Bonn interactions). Studies of the first order term include considerations of the need for full folding versus factored forms of the optical interaction [2] and of the treatment of the 'effective' energy for the active interacting NN pair entering the required NN amplitudes. These include consideration of medium effects due to the struck nucleon Fermi momentum [3], the struck nucleon binding energy and the binding potenial [4], and of mean field distortions on the incident nucleon in intermediate NN states.

Studies of the second order (Pauli blocking) multiple scattering terms have been carried out [6], including their local representation [7] and consideration of the accuracy of their description in methods, such as assume nuclear matter NN effective interaction descriptions, and which then make use of local density approximations in calculating optical potentials for finite nuclei [8].

In this paper we review the theoretical status of the multiple scattering calculations of the nucleon optical potential for finite nuclei, and its use in the calculation of the optical potential, wavefunction, and observables for the nucleon-nucleus system for incident energies of order 60 MeV and above.

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