DEUTERON AND α-PARTICLE SEMI-MICROSCOPIC OPTICAL POTENTIALS

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The high-priority nuclear data for the accelerator driven systems (ADS) and fusion-reactor projects (e.g., IFMIF) concern also the deuteron and α-particles interactions which are of actual interest for the related neutron production, activation, heating, shielding, and material damage estimation. By using advanced nuclear models that account for details of nuclear structure and the quantum nature of the nuclear scattering, significant gains in the prediction accuracy can be achieved. This has motivated the interest on the semi-microscopic optical model potential (OMP) analysis for deuterons[1] and *α*-particles[2].

Description of the elastic deuteron-nucleus scattering represents an important test for the quality of semi-microscopic optical models. However, the difficulties to interpret these data in terms of the usual optical-model potential hampered such a comprehensive analysis. The weak binding of the deuteron results in significant contributions of the breakup channel and enhances a variety of reactions at low bombarding energy. Moreover, the description of the interactions between deuterons and light nuclei becomes much complex because of the pronounced cluster structure of some light nuclei, e.g. ^{6}Li. Thus the presence of the deuteron as a sub-cluster structure of the ^{6}Li target has to be considered explicitly in the semi-microscopic analysis of the deuteron interaction by adding the elastic α-transfer contribution to the elastic differential cross sections by means of coupled reaction channels (CRC) calculations[3]. Also the dynamical coupling of the elastic to nonelastic channels, important in the deuteron interactions mainly due to the corresponding great probability of breakup, has been taken into account by an empirical nonlocality correction to the microscopic real potential together with dispersion correction. Finally, a good agreement between the semi-microscopic d-^{6}Li elastic-scattering differential cross sections for scattering and the experimental data has been obtained.

On the other hand, the OMP analyses for α-particles at low energies pointed out two main questions which are still open, namely (i) the OMP parameter sets obtained from α-particle elastic scattering at high energies (>80 MeV) do not describe either the low-energy (<40 MeV) elastic scattering or the complete fusion data, and (ii) the statistical α-particle emission is underestimated by the OMPs that account for elastic scattering on the (cold) ground-state nuclei. In the latter case, the need for new physics in potentials to describe nuclear deexcitation within the statistical model calculations was pointed out[4]. It was thus suggested that particle evaporation occurs from a transient nuclear stratosphere of the emitter nucleus, with a density that differs from cold nuclei[5] and which has not yet relaxed to the density profile expected for complete equilibration[6]. Therefore, effects due to changes of the nuclear density at a finite temperature have been considered within the double folding (DF) formalism[7] of the alpha-nucleus real part of the optical potential. Thus, it is shown that a temperature-dependent nuclear density distribution can be an important aspect to be included in statistical-model calculations even for temperatures <2 MeV. At the same time, the high precision of recent measurements[8,9] of α-particle elastic-scattering data makes possible the pointing out of additional features of the α-particle scattering at low energy and, consequently, of further limits and possible improvement of global OMP parameters obtained previously through semi-microscopic analysis[2] of the low-energy α-particle elastic scattering.

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