Study of ^{11}Li+p elastic scattering using BHF Formalism with Three Body Force

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In the present work we have analyzed the elastic scattering of ^{11}Li + p at 62,68.4 and 75 MeV/nucleon, using the microscopic optical potential calculated within the framework of Brueckner-Hartree-Fock formalism (BHF). The calculation use Argonne v18 [1] internucleon interaction and the Urbana IX (UVIX) model [1] of three body force. The required nuclear density distributions of ^{11}Li(shown in Fig.1) is obtained using the semi phenomenological model [2] for nuclear density distributions. The optical potential has been obtained by folding the calculated reaction matrices (with and without three-body forces) over the nucleon density distributions. It should be noted that we have used the exact method [3] for calculating both the direct and the exchange parts of the spin-orbit potential. Since ^{11}Li is a borromean nuclei (A three body bound system in which no two-body sub-system is bound).Thus, inclusion of three body force are expected to provide some interesting and useful results. Our calculation also reveals the significant contribution of spin-orbit potential for ^{11}Li+p elastic scattering at all three incident energies. The analysis reveals that the calculated microscopic optical potentials, with and without three body force using, BHF approach with phenomenological form of density distribution, provides satisfactory agreement for the considered nuclear reaction for ^{11}Li. The numerical details of the calculations and self-consistency requirements are described in Refs.[3]. Both the real and the imaginary parts of the calculated central and spin-orbit potentials for ^{11}Li+p at 62, 68.4 and 75 MeV using AV18 and AV18+UVIX are shown in Fig.2. It is observed that the strength of the central real and imaginary potentials are reduced for distances r < 3 fm for UV IX model of the TBF. We notice that there is a negligible TBF effect on the calculated spin-orbit potential. The calculated differential cross section using, two g-matrices (AV18, AV18+UVIX) shown in Fig.3, are in satisfactory agreement with experimental data. The visual fits with two and three body forces are nearly identical at all incident energies. At 75 MeV the three body force gives better agreement at backward angles as compared to two body forces. It is important to note that we do not require any normalization for the calculated spin orbit potentials. In our calculation we kept λ^I (scaling factor for imaginary part of microscopic OP =0.6(62 MeV), 0.7(68.4 MeV), 0.6 (75 MeV), λ^R (scaling factor for real part of microscopic OP) = 0.9 and 0.8 at 68.4 and 75 MeV respectively from AV18, but we kept λ^R =1.0, at 62 MeV(AV18) and for AV18+UVII at all energies considered here, unlike the earlier findings [4], where the real folded potential required large reduction(λ^R=0.54)for a successful description of ^{11}Li+p elastic scattering at all three incident energies. It has been discussed in many earlier papers that coupling of the elastic channel with the low-lying breakup channels of loosely bound nuclei is responsible for appreciable reduction of λ^R. However, our unit value of scaling factor for real part provides a new insight in understanding the reaction mechanism of ^{11}Li+p and does not allow us to accept the concept that the coupling of elastic channel is primarily responsible for large reduction of the potentials as discussed earlier. The effect of the spin-orbit interaction on the cross sections of ^{11}Li +*p* elastic scattering at 75 MeV with AV18+UVII interaction using Phenomenological form of density is shown in fig.3. From Fig.4 it is clear that we have been able to get agreement with experimental data, when spin-orbit term has been added in our calculated potential. The results for other energies are same as shown for 75 MeV. Hence, we do not show them. It gives an important conclusion that spin-orbit potential plays an important role in study of structure and reaction dynamics of ^{11}Li. However, our results shows disagreement with the earlier findings [5], where, the elastic scatting of ^{11}Li+p at same incident energies have been studied and they [5] made a conclusive remark that the role of spin orbit term is quite weak (see Fig.4 in Ref.[5]) and the results, with and without spin orbit term differ slightly at large angles (>60∘)(see Fig.9 in Ref. [5]).

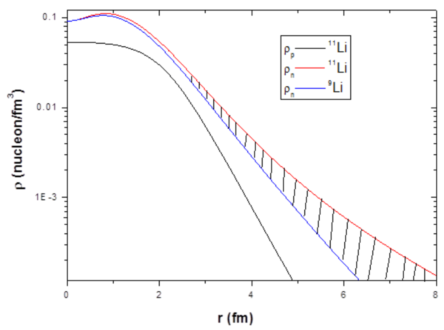

Fig.1.The calculated neutron and proton densities for ^{11}Li. The 2n halo for ^{11}Li is shown by hatched.

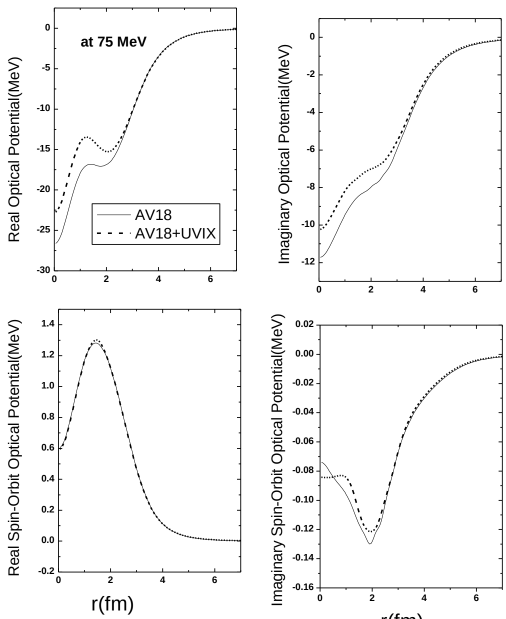

Fig.2

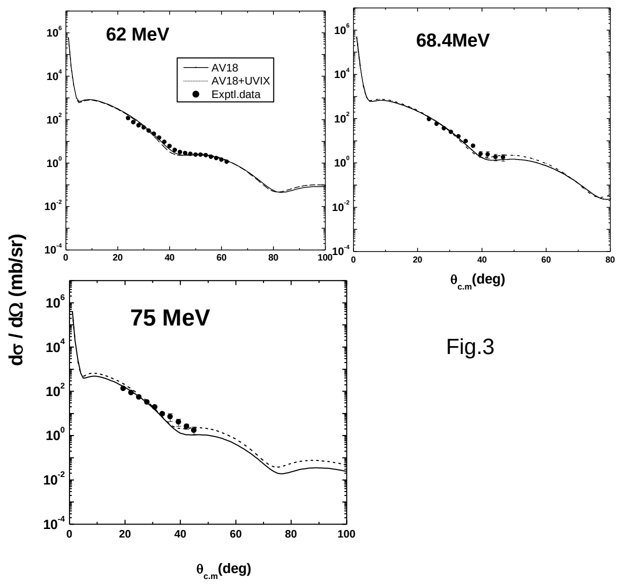

Fig.3

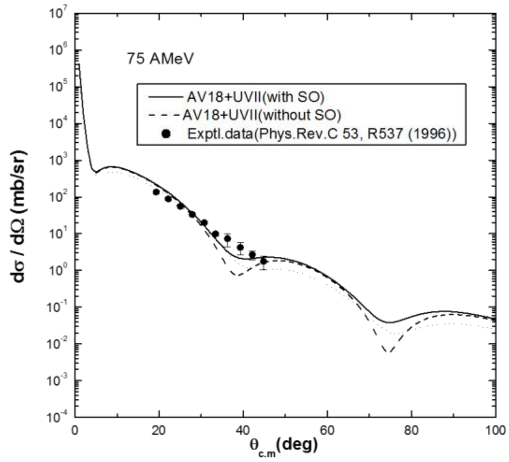

Fig.4

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