Influence of tensor forces in the analysis of ^{58}Ni (^{3}He, t)^{58}Cu charge exchange reaction

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Introduction

The (^{3}He, t) charge-exchange reactions at intermediate incident beam energies are extensively used to analyze the spin-isospin response of nuclei. [1,2] Particularly the charge exchange reactions involving Gamow-Teller (ΔL=0, ΔS=1, ΔJ=1) transitions strength is the main concern of investigation especially in regions of excitation energy which is unapproachable by beta decay process. Further the Gamow-Teller (GT) transition strength (B(GT)), play a key role in various processes such as late stellar evolution, neutrino nucleosynthesis as well as in ascertaining nuclear structure and hence consequently the charge exchange reactions mediated by these transitions have been studied around the globe. [3]

In order to interpret the data obtained through charge exchange reactions the computer codes DW81 and FOLD have been developed and used frequently in the literature. However, in DW81 the composite particle scattering is not entertained while the FOLD code supports the composite particle charge exchange reaction but the knock-on exchange effects are treated approximately. [4]

As here we are analyzing the charge exchange reaction data involving composite particle therefore, we have used newly developed computer code DCP-2 (based on the distorted wave impulse approximation) wherein the knock-on exchange effects are treated exactly for composite particle scattering. [5] In this conference contribution we present the results for differential cross-section calculations for (^{3}He, t) charge exchange reaction on ^{58}Ni for GT transitions along with the results obtained through code FOLD and data. Further, here, the contribution of tensor force is also included in the DCP-2 calculations and the preliminary results obtained are show in next section.

Results and discussion

The input parameters used in DCP2 calculations, such as OBTDs, optical model potential (OMP) parameters, single particle binding energy, effective nucleon-nucleon (N-N) interaction were all taken from previous work. [6,7] The calculation of OBTDs were done using shell model code OXBASH.

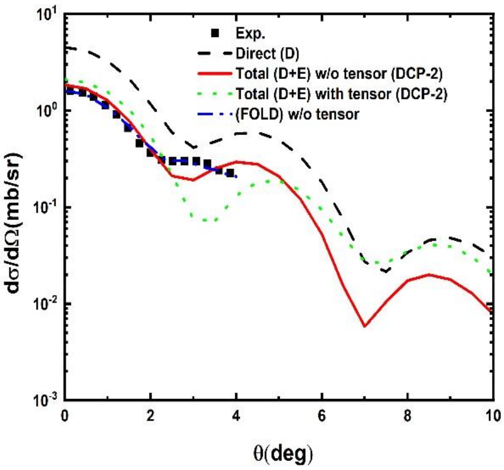

Figure: The differential cross-section for (^{3}He, t) on ^{58}Ni at 140 MeV/nucleon for GT transitions calculation. The dashed (black) line represents the direct component contribution. The solid (red) line and dotted (green) line represents the total contribution of direct with exchange term without or with tensor force contribution using DCP-2 code respectively. Compared with the dash-dotted (blue) line represents the FOLD code calculation and the solid (black) dots represent the experimental data.

The impulse approximation is appropriate approach for understanding nucleon – nucleus scattering at intermediate energies. Wherein the interaction between target and projectile nucleus is taken to be free nucleon – nucleon t matrix. For the purpose Franey and Love interaction at 140 MeV were used for nucleon-nucleon t-matrix interaction strength. These interactions have been constructed from determined N-N amplitude at different energies and the detailed techniques used with validity are discussed by M.A Franey and W. G. Love [8,9]. The OMP parameters used in the calculations are taken from reference [10].

Now, we have calculated cross-sections using DCP-2 for (^{3}He, t) reaction on ^{58}Ni target at 140 MeV/nucleon energy within distorted wave impulse approximation (DWIA) corresponding to Gamow-Teller transition and results obtained are depicted in figure. In the figure, the calculations for knock-on exchange effects with or without inclusion of tensor force components along with the experimental data are given. [11] It is evident from figure that the experimental data at forward angles is reproduced well when we considered exchange terms (Total (D+E) w/o tensor) contribution without inclusion of tensor term. Further for the sake of comparison the calculation from code FOLD also given in the figure and it is observed that these are also in well agreement with the data, however the exchange term contribution is not entertained in it. [11] The detail comparison and validity of code FOLD and DCP-2 is discussed in ref [12] Further we have also estimated the tensor force contribution to cross sections and it results into overestimation of experimental data by 23% at forward angles. The probability of constructive or destructive interference between ΔL=0 or 2 driven by tensor component of the effective n-n interactions may be the main cause behind this overestimation.

In conclusion it becomes clear from this contribution that the proper consideration of exchange term improves the matching between theoretical results and data. While the tensor contribution leads to an overestimated data. Hence, the genuine estimation of both exchange and tensor component is crucial while analyzing the charge exchange reaction,

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