Elastic scattering of 0.8 GeV protons on ^{12}C

Minita Singh[1]* and Z.A. Khan[2]
[1]*Department of Physics, Mangalayatan University, Beswan, Aligarh, U.P., INDIA*
[2]*Deptartment of Physics, A.M.U., Aligarh, U.P., INDIA*
* email: minita.singh@mangalayatan.edu.in

Introduction

Working within the framework of Coulomb modified correlation expansion for the Glauber amplitude [1], we, in this work, analyse the elastic scattering of 0.8 GeV protons on ^{12}C. Emphasis has been put on the use of different parametrizations of the basic (input) NN amplitude, which provide equivalently good description of the elastic NN scattering observables up to the available momentum transfer region. These parametrizations assume the same form as used in Ref. [2].

Using realistic form factor for ^{12}C and considering terms up to two-body correlations in the correlated Glauber amplitude [1], it is found that the proton-nucleus collisions could provide a test to have a better understanding of the NN amplitude at intermediate energies.

Formulation

The correlation expansion for the Glauber amplitude [1] for describing the elastic scattering of protons with momentum $\vec{K}$ from a target nucleus in the ground state ($|\psi_0\rangle$) takes the form

$$F_{00}(\vec{q}) = F_0(\vec{q}) + \sum_{l=1}^{A} F_l(\vec{q}), \qquad (1)$$

where

$$F_0(\vec{q}) = \frac{iK}{2\pi}\int d^2b\, e^{i\vec{q}.\vec{b}}[1-(1-\Gamma_0)^A], \qquad (2)$$

and

$$F_l(\vec{q}) = -\frac{iK}{2\pi}\int d^2b\, e^{i\vec{q}.\vec{b}}\langle\psi_0|(1-\Gamma_0)^{A-l}.$$
$$.\sum_{i\langle j...\langle k}\gamma_i\gamma_j...\gamma_k|\psi_0\rangle, \qquad (3)$$

with

$$\gamma_j = \Gamma_0(\vec{b}) - \Gamma_{NN}(\vec{b}-\vec{s}_j), \qquad (4)$$

and

$$\Gamma_0(\vec{b}) = \langle\psi_0|\Gamma_{NN}(\vec{b}-\vec{s_j})|\psi_0\rangle, \qquad (5)$$

where $\vec{s_j}$ is the projection of jth target nucleon coordinate $\vec{r_j}$ on to a plane perpendicular to $\vec{k}$, and the NN profile function Γ_{NN} is related to the NN amplitude f_{NN} as:

$$\Gamma_{NN}(\vec{q}) = \frac{1}{2\pi ik}\int d^2q\, e^{-i\vec{q}.\vec{b}} f_{NN}(\vec{q}) \qquad (6)$$

In the present work, we restrict ourselves up to F_2[3] in the expression for F_{00} as it provides a leading correction to the uncorrelated part (F_0) of the Glauber amplitude $(F_{00}(\vec{q}))$

Results and discussion

Following the above mentioned approach, we analyze the elastic angular distribution and polarization of 0.8 GeV protons on ^{12}C. The inputs needed in the theory are the elementary NN amplitude, the nuclear form factor and the oscillator constant [6].

For the NN amplitude we use the same parametrization as used in Ref. [2]. This parametrization has eight adjustable parameters σ, ρ, β^2, γ_c, Ds, ρ_s, β_s^2 and γ_s, but we invoke them in such a way that they lead to three different q-dependences in the NN amplitude. In the first case (B1), we treat β^2 and β_s^2as real, and assume constant phase $\gamma_c = \gamma_s = 0$. The second case(B2) also considers β^2 and β_s^2 as real but assumes different phase variations $\gamma_c \neq \gamma_s$ in central and spin dependent parts of the NN amplitude. The third possibility (B3) assums β^2

and βs^2 as complex, and the constant phase in the central and spin-dependent parts of the NN amplitude.

In all the three cases, the values of the corresponding parameters are chosen under the conditions that at 0.8 GeV incident energy (i) the optical theorem be valid, (ii) the ratio Re $f_{NN}(0)$ / Im $f_{NN}(0)$ be equal to the experimental value, and (iii) the experimental elastic angular distribution and polarization data for NN scattering be correctly reproduced. The results of the calculations are presented in Fig. 1. It is found that all the three parametrizations of the NN amplitude provide an equivalently good description of both the angular distribution and polarization data up to the available momentum transfer. The corresponding values of the parameters involved in these parametrizations are taken from Ref.[7]

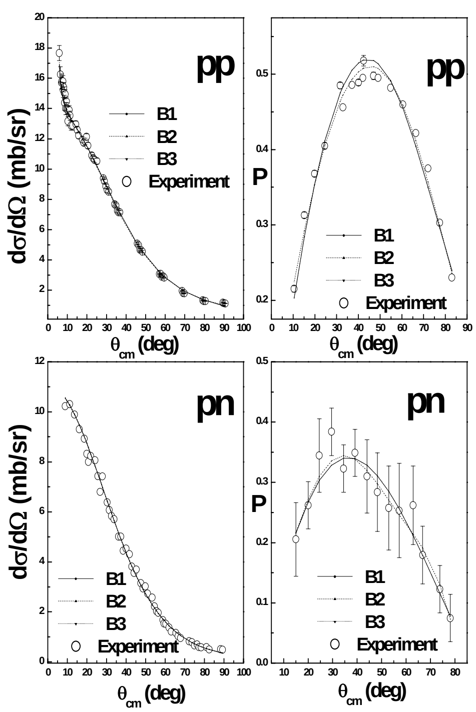

Fig. 1

For computational simplicity we parametrize the required nuclear form factor as a sum of Gaussians:

$$F(\vec{q}) = \sum_i a_i e^{-b_i q^2} \qquad (7)$$

The values of a_i and b_i for ^{12}C are taken from Ref. [3]. The value of the oscillator constant is taken from Ref. [6].

The results of the calculations for the elastic angular distribution and polarization of 0.8 GeV protons from ^{12}C are presented in Fig. 2. The solid, dashed and dotted curves correspond, respectively, to parametrizations B1, B2 and B3. These results make a clear distinction among the parametrizations B1, B2 and B3 and suggest that the parametrization B2 seems to be the better choice of the NN amplitude out of the suggested parametrizations.

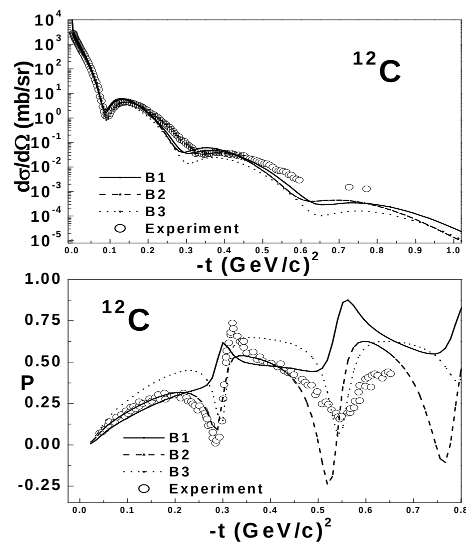

Fig. 2

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