K^-- nucleus elastic scattering at 800 MeV/c

Deeksha Chauhan[1*], Z. A. Khan[1] and Minita Singh[2]
[1]*Department of Physics, Aligarh Muslim University, Aligarh - 202002, INDIA*
[2]*Mangalayatan University, Aligarh, INDIA*
* *email: dee.physics@gmail.com*

Introduction

In a recent article [1], we have analyzed the elastic angular distribution of K^+-nucleus scattering at intermediate energies, within the framework of Coulomb modified Glauber model. The basic (input) K^+N amplitude is taken from the phase shift analysis, and for nuclear form factors we use the nucleon density distributions as obtained from the analyses of intermediate energy proton scattering experiments [2,3] and the relativistic mean field (RMF) calculations [4]. It is shown that the elastic angular distribution is sensitive to the choice of the nucleon density distributions. The effect of two-body correlations is found to be only marginal. This gives an indication of the fact that K^+ mesons are weakly absorbed in nuclear matter.

In this work, we propose to analyze the elastic angular distribution of K^- - nucleus scattering at 800 MeV/c within the framework of Glauber model. The basic (input) K^-N amplitude is parametrized in the same form as the K^+N amplitude [1], but its parameters are obtained from the analysis of K^-N elastic scattering measurements. Our aim is to see how far the elastic K^- - nucleus angular distributions are sensitive to the similar nucleon density distributions as used in Ref. [1]. Moreover, we would also investigate the relative importance of nuclear two-body correlations.

Formulation

Following Ahmad and Auger [5], the correlation expansion for the Glauber amplitude describing the scattering of kaons from a target nucleus takes the form

$$F_{00}(q) = F_0(q) + \sum_{l=2}^{A} F_l(q), \qquad (1)$$

where F_0 is the uncorrelated part involving all orders of scattering and F_l is the correlation term of order l. Here it may be mentioned that, in this work, we restrict ourselves up to F_2 with the aim of studying the effects of two-body correlations on K^-- nucleus scattering. Moreover, it is to be noted that Eq. (1) has been modified to account for the (i) Coulomb effects, and (ii) deviation in the straight line trajectory of the Glauber model because of the Coulomb field.

Results and discussion

We analyze the elastic angular distribution of K^- on ^{12}C and ^{40}Ca at 800 MeV/c. The inputs needed in the theory are the elementary K^- N amplitude and the nuclear form factors. For nuclear form factors, we use the nucleon density distributions as obtained from the analyses of intermediate proton scattering experiments [2,3] and the relativistic mean field (RMF) calculations [4].

As already mentioned, we parametrize the K^- N amplitude in the same form as the K^+N amplitude [1]

$$f_{K^-N}(q)= \frac{ik\sigma}{4\pi}\sum_{n=0}^{\infty} A_{n+1}\left[\frac{\sigma}{4\pi\beta^2}\right]^n \frac{(1-i\rho)^{n+1}}{(n+1)}\exp\left(\frac{-\beta^2q^2}{2(n+1)}\right)+ i\left(\frac{q^2}{4m^2}\right)^{\frac{1}{2}}\left(\frac{\sigma}{4\pi\beta^2}\right)^n\frac{[D_s(1-i\rho_s)]^{n+1}}{(n+1)}\exp\left(\frac{-\beta_s^2q^2}{2(n+1)}\right)\vec{\sigma}.\hat{n} \quad (2)$$

$$A_{n+1}= \frac{A_1}{n(n+1)}+\frac{A_2}{(n-1)n}+\ldots+\frac{A_n}{1\times 2}, \quad (3)$$

with A_1=1, and $\vec{\sigma}$ is the spin operator of the target nucleon. The amplitude (2) has six adjustable parameters σ, ρ, β^2 , D_s, ρ_s, and β_s^2. The values of these parameters which reproduce simultaneously the total cross section [6] and the angular distribution of K^- N elastic scattering [7,8] are listed in table 1.

The results of the calculation for K^- - ^{12}C and K^- - ^{40}Ca elastic angular distributions at 800 MeV/c are presented in figs. 1 and 2. The solid and dotted lines correspond, respectively, to the proton and neutron density distributions obtained from Refs. [2,3] and [4]. We find that the (calculated) angular distributions though they follow similar trends as it was observed for K^+ scattering [1], the predictions in the present case, with both the density distributions, [2,4] for ^{12}C and [3,4] for ^{40}Ca, lie within experimental errors, giving rise satisfactory explanation of the experimental data up to the available range of scattering angles. Still we feel that one requires some more investigations of the nucleon density distributions in ^{12}C and also in ^{40}Ca in order to have a better picture of K^- - nucleus scattering.

Figure 2 presents the elastic angular distributions of K^- on ^{12}C and ^{40}Ca in which the solid and dotted lines are, respectively, the predictions with and without the two-body correlations. It is found that that the effects of two-body correlations are relatively more important in the case of K^- - nucleus elastic scattering than the K^+ -nucleus one [1]. This result gives an indication of stronger K^- N interaction as compared to K^+N.

Table 1: Parameter values for K^-N amplitude.

k_{lab} (MeV/c) /system	σ (fm$^{2)}$	β^2 (fm^2)	ρ
800/ K^-p	4.17745	0.32099	-0.24662
800 / K^-n	3.19355	0.23944	-0.10289

k_{lab} (MeV/c) /system	D_s	βs^2 (fm^2)	ρ_s
800/ K^-p	1.79615	0.72905	0.84450
800 / K^-n	2.51697	1.00545	1.20548

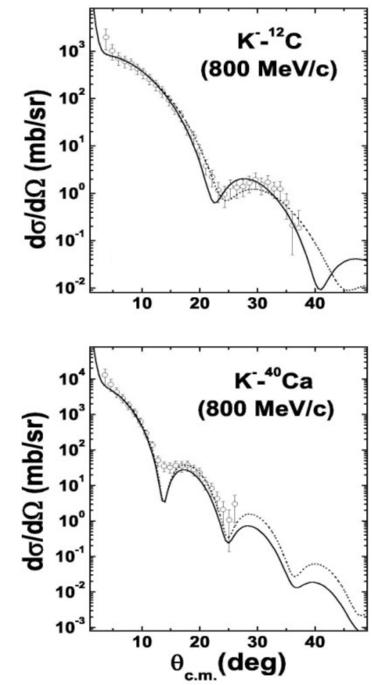

Fig. 1: Elastic angular distribution of K^- - ^{12}C and K^- - ^{40}Ca at 800 MeV/c. The data are taken from ref. [6].

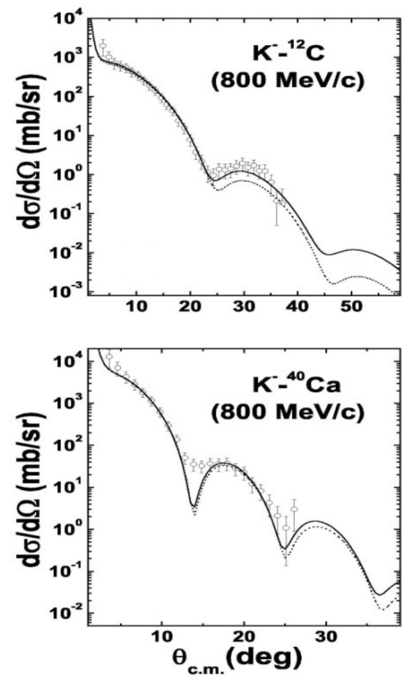

Fig. 2: Elastic angular distribution of K^- - ^{12}C and K^- - ^{40}Ca at 800 MeV/c, with and without the two- body correlations. The data are taken from ref. [6].

References

[1] Deeksha Chauhan and Z. A. Khan, Phys. Rev. **C85**, 067602 (2012)

[2] G. S. Blanpied et al., Phys. Rev. Lett. **39**, 1447 (1977)

[3] L. Ray et al., Phys. Rev. **C23**, 828(1981)

[4] Y. K. Gambhir, P. Ring and A. Thimet, Ann. Phys. (N.Y.) **198**, 132 (1990) and references therein.

[5] I. Ahmad and J. P. Auger, Nucl. Phys. **A352**, 425 (1981)

[6] D. Marlow et al., Phys. Rev. C25, 2619 (1982)

[7] B. Conforto et al., Nucl. Phys. **B34**, 41 (1971)

[8] C. J. S. Damerell et al., Nucl. Phys**. B129**, 397 (1977)