One neutron removal reaction using relativistic mean field densities in Glauber model

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Introduction

The developement of accelerator technique for Radioactive ion beams(RIBs) help to study numerous experimental as well as theoritical measurements for nuclei far from β - stability line. Experimental methods and theoretical analysis have been widely used to collect information about the nuclear size, valence nucleon distribution and halo structure. The measurement of various cross sections like reaction cross section, neutron removal cross section and momentum distribution are some of the established tools for such studies.

Unlike shell model, relativistic mean field theory in conjunction with Glauber model provide a consistent strucure model for neutrons at the boundary with the p shell and in the lower part of the sd shell[1]. It is well known that narrow fragment momentum distribution reflects large space distribution of the valence neucleon and there is a correleation of the magnitude of the removal cross sections with the width of the longitudinal momentum distributions in approaching either the neutron and proton dripline. But one neutron removal cross sections provide important nuclear structure information complementary to that obtained from momentum distributions.

Relativistic mean field (RMF) and effective field theory motivated RMF formalism (E-RMF) using Glauber model shows a good agreement with experimental data for both NL3 and G2 parameter set during measurements of the total nuclear reaction cross sections σ_R and elastic differential scattering cross sections [2]. Considering this success in the present contribution, we will report the one neutron removal reaction cross section σ_{1N} within the Glauber model with RMF and E-RMF densities as input.

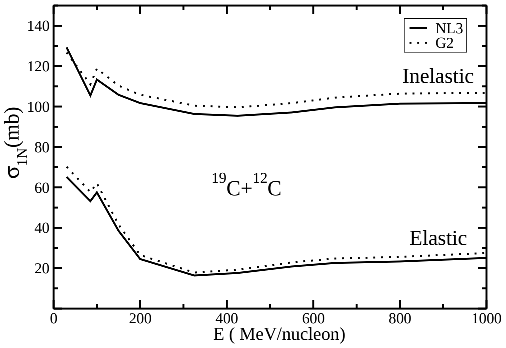

FIG. 1: The energy depedence of the neutron-removal cross section for ^{19}C+^{12}C system using NL3 and G2 parameter sets for both elastic and inelastic processes.

Thus the objective of the present study is to undertake a systematic analysisy of σ_{1N} over a range of neutron rich nuclei in the frame work of the Glauber model.

Theoretical Framework

The use of RMF and E-RMF formalisms for finite nuclei as well as the infinite nuclear matter are well documented and details can be found in [3] for the RMF theory and the E-RMF in Refs. [4, 5]. Here in the following, we present only some essential steps, needed for this paper. We need the RMF and E-RMF density profiles for our calculations of σ_R as well as σ_{1N}. The theoretical formalism to calculate the total nuclear reaction cross section and one neutron removal cross section using the Glauber approach, has been given by R. J. Glauber [6] and data for σ_R can be obtained

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TABLE I: Calculated results for the one-neutron removal cross sections of $^{9,12,13,19}C$ and ^{8}B isotopes on ^{12}C target with available experimental data.

Prjectile	Energy	$\sigma_{1N}(I)$			$\sigma_N(II)$	
		Exp.	RMF	E-RMF	RMF	E-RMF
^{9}C	285	48(8)	81	96	34	31
^{12}C	1050	45(3)	71	37	55	39
^{13}C	800		29	28	47	37
^{19}C	910	233(51)	134	127	44	34
^{8}B	285	89(2)	135.8	107	41	33

from [2]. The expression for one neutron removal reaction is given by [7]

$$\sigma_{1N}(I) = \sum_c \int d\overrightarrow{k}\,\sigma_{a=(k,g=0),c}, \qquad (1)$$

where the projectile nucleus breaks up into the core with an internal wave function ϕ_g and one-neucleon in the continuum state with asymptotic momentum, $\hbar k$ relative to the core.

Result and Discussion

First of all we compare the predicted and measured one neutron removal cross sections across some of the isotopes for which data are available. It is also shown in [7, 8], the Glauber model predicts that if a nucleus(^{A}Z) consists of a core (^{A-1}Z) and a loosely bound nucleon as the case of a halo (1n), then the following equation could be satisfied.

$$\sigma_{1N}(II) = \sigma_R(^{A}Z) - \sigma_R(^{A-1}Z) \qquad (2)$$

The results of our calculations are presented in TABLE I. In this table, the one-nucleon removal reaction cross-section obtained from eqs.(1) and (2) are compared with the experimental data. The associated single-neutron removal cross sections are consistent with Ref. [7] and for a representative case it is shown in Fig.1.While the results compare with experiment [9, 10], it is obtained that our calculated results some how overestimate for lighter and underestimate for heavier nuclei. On the otherhand the results obtained using eq^{n}(2) gives a systematic lower value of σ_{1N}. The origin of this discrepancy may be due to the spherical densities considered in the calculations. To see more detail works in this direction are needed.

Summary and Conclusion

In summary, one neutron removal cross-sections from the neutron rich isotopes have been calculated using the RMF theory for both G2 and NL3 parameter sets. The one neutron removal cross sections are in good agreement with Ref. [7] for both the parameter sets but is inconsistent with the experimental results. The theoretical calculations do not follow the experimental trend as the input density is spherically symmetry. Thus considering deformed density a further study is in progress.

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