Density distribution in ^{14}Be: A candidate for two neutron Halo

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Introduction

The availability of radioactive nuclear beam provides an opportunity to study exotic nuclei using inverse kinematics [1]. Recently Moriguchi *et al*. [2] at RIKEN, measured the reaction cross sections of ^{14}Be with proton target at 41 and 76 MeV/Nucleon and deduced the matter density distribution using Glauber model, indicating a Borroomean halo structure of ^{14}Be. Based on a similar experiment at 700MeV/Nucleon at GSI, S.Ilieva *et al.*[3], using Glauber model, deduced the nuclear matter radii and radial density distribution of ^{12,14}Be and confirmed the halo structure of ^{14}Be having a ^{12}Be core plus two valance neutrons. The observed [4], small (~130 KeV) two nucleon separation energy (S_{2n}) of ^{14}Be supports the claim for halo structure of ^{14}Be.

Here we present an analysis of p- ^{14}Be reaction cross section (σ) data at 41, 76 and 700MeV/Nucleon using Brueckner-Hartee-Fock (BHF) approach. Earlier the BHF approach has been successfully employed to study exotic nuclei ^{22}C,^{9}C,^{6,8}He and ^{6,7,9,11}Li. isotopes [5].The BHF approach requires only two inputs: the realistic inter-nucleon potential to calculate reaction matrices (effective interaction) and the nucleon density distributions of the target required in the folding to obtain the optical potential (OP). We have used Argonne v-18 [6] inter-nucleon potential with relativistic correction along with the neutron density distribution to calculate the effective interaction. The required nuclear density distributions are obtained using the semi-phenomenological model for nuclear density distributions [7]. The resulting OP with these two inputs is then used to calculate the physical observables. Thus there are no free parameters in this microscopic approach for obtaining the nuclear optical potential.

Results and Discussion

The calculated neutron density distributions of ^{12,14}Be are shown in Fig. 1. The hatched region shows the contribution from the two valance neutrons indicating halo structure in ^{14}Be.

The imaginary part of the central OP is multiplied by a factor 0.8 to incorporate phenomenologically the effects of the three body forces (TBF). The calculated reaction cross section of p-^{14}Be presented in Table 1 are compared with the experimental values obtained by Moriguchi *et al*, [2]. We observe an excellent agreement between the experimental value of **σ** and the BHF predictions at all the three energies.

Fig. 2 shows the predicted differential cross sections of p-^{14}Be at 41, 76 and 700 MeV/Nucleon using Av-18 inter-nucleon interaction. It would be interesting to see future experimental data on differential cross section and its agreement with our BHF results.

Energy (MeV/Nucleon.)	**σ (Av-18)**	**σ (Ref.[2])**
41	735	712±14
76	484	473±16
700	277	328±82

Table 1: BHF predictions and the corresponding experimental values of the p-^{14}Be reaction cross section in mb.

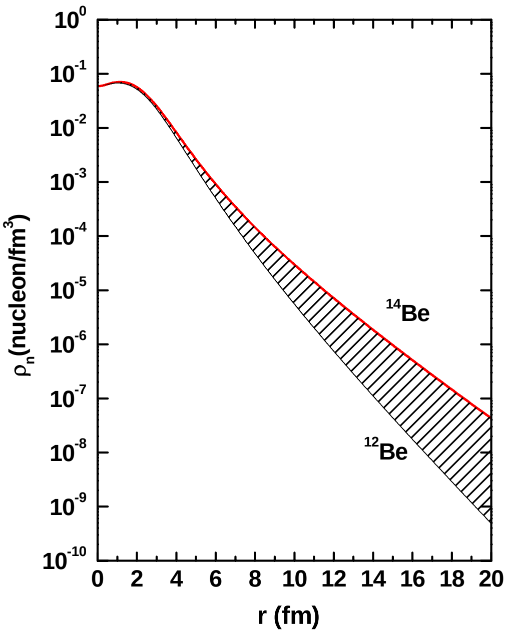

Fig. 1 Semi-phenomenological neutron density distributions of ^{12,14}Be .

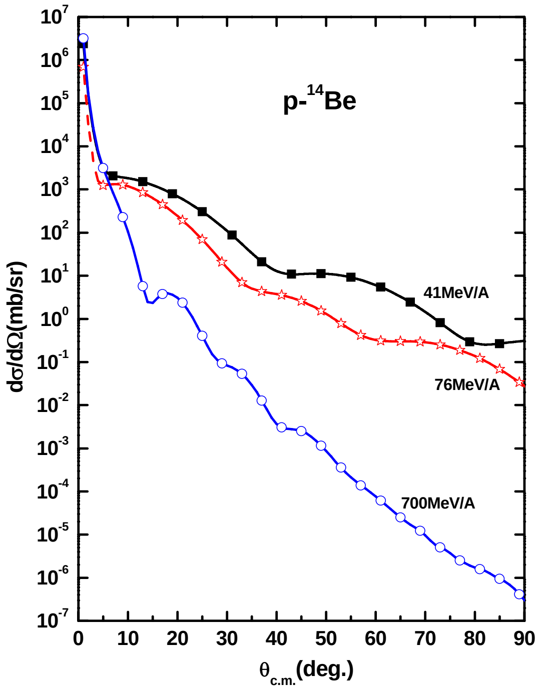

Fig. 2 BHF Predictions for the differential cross sections for p-^{14}Be at 41,76 and 700 MeV/Nucleon.

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