Neutron Halo of ^{22}C from coulomb dissociation reaction crosssection

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Abstract- Coulomb dissociation reaction crosssection of ^{22}Chas been obtained when it is incident on ^{181}T a target at various incident energies. The large value of the crosssection is mainly responsible of the neutron halo of the nucleus. The present theoretical findings have been compared with the most recent experimental data on this nucleus.

Index Terms- Diffraction dissociation, Coulomb effect, Halo structure.
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I. Introduction

The recent experimental data on ^{22}C by 40A Mev energy on proton rich carbon nucleus to look for neutron halo of ^{22}C by Tanaka etal [1] shows a large value of the reaction crosssection in comparison to the values obtained for the same in other adjacent carbon nuclei. The result is likely because of the very small two neutron separation energy S_{2n} = 420 KeV as this is the bench mark indication of the halo signatures in neutron and proton rich drip line nuclei.

In recent years with the availability of the radioactive ion beam , the importance of the study of the weakly bound nuclear system has received attention[2-3]. The two neutron removal cross section in the exotic nuclear species is quite large as it has been observed through the works of Tanihata group at Berkley. A wealth of information from BEVELAC and RIKEN shows the existence of gaussian type of momentum distribution for the out-going ejectile when the projectile breaks up during reaction process.

In the present research scheme, dissociation of the ^{22}C under coulomb and nuclear effects have been reviewed to look for the characteristic features in the reaction cross section after dissociation.

The target nucleus is ^{181}Ta and the projectile is ^{22}C.

The direct fragmentation model scheme has also been applied recently in a few halo nuclei[4]. Here we will apply the same model to look for the characteristic features of ^{22}C break-up just through coulomb dissociation mechanism.

The details of the model have been explained in our works on drip line nuclei [4-6].

II. Results and Discussion

The projectile ^{22}C encounters coulomb and nuclear fields of the target nucleus ^{181}T a.It splits instantaneously into fragments. In the final channel, the fragmented core and the detached two neutrons interact individually with the target and at the same timethe interaction between the core and neutrons is weak and the effect has been dropped out. Naturally, the fragmented core interacts with the coulomb field of the target nucleus. Also for heavy target nucleus, coulomb dissociation reaction crosssection becomes very large. This is main reason for the application of the direct fragmentation model for the break-up of the neutron rich drip line nucleus.

The input values of the radius parameter r0 and the diffuse ness parameter Δ have been taken as 1.2 fm and 0.5 fm respectively. They have been kept fixed also throughout our calculation. The incident projectile energy has been kept at 40A Mev. The dissociation cross section has been calculated at various angles starting from 00. The results are tabulated in table 1. The large values of the reaction crosssection in mb definitely proves the halo structure of ^{22}C. The nuclear effect is appreciably small as its value comes out to be only 180.031 mb. From the table 1, it is observed that only at 0^0 angle, a large value of the reaction crosssection is observed and the value gradually diminishes as we proceed towards higher angles. The comparatively large value of the cross section in comparison to experimental limit is definitely due to integration limits over a wide range of angles for getting the total differential reaction crosssections. The same one has also been seen in our ^{19}C [5] observation. For ^{22}C, the two neutron separation energy is 420 keV and the present calculation shows the crosssection value as 773390 mb. This physical picture is quite obvious because of the comparatively low two neutron separation energy in case of ^{22}C. The more accurate picture of the neutron halo of ^{22}C can be ascertained if the neutron distribution is known starting nuclear centre to surface.

The nuclear break-up crosssection is very much low in comparison to Coulomb break-up. This is because of interaction of the 22C with the coulomb field of target ^{181}Ta. The interaction of the projectile with light target nucleus strictly depends on nuclear effect. Also the large value of the coulomb dissociation crosssection is due to spatial extension of the loosely bound neutron converging along the nuclear surface and there by providing with the confirmed halo signature of the ^{22}C. Further, the integration limits in θ and ϕ for the solid angle ω cover a wide region and thereby opening up the possibility of having the break-up fragment ^{20}C from ^{22}C over a wide angular range. Also the limit of the integration for the Coulomb energy distribution of the fragment covers a broad range and that is symmetrically distributed around the maximum point around which the energy distribution takes a maximum limit.

III. Conclusion

The following points emerge from the study of the neutron halo of ^{22}C.

1) The large value of the coulomb dissociation crosssection within the frame work of the direct fragmentation model proves the existence of the neutron halo.

2) The experimental neutron density distribution needs to prove the further halo aspect of the nucleus and these results may be compared with the Skyrme Hartree Fock scheme where the relevant parameters can be optimized with the experimental available binding energies of the magic nuclei.

3) The depleted neutron hole strengths in the valence orbitals beyond $1f_{7/2}$ shell-model state of ^{21}C within the Core-Polarisation effect[7] may prove further existence of the neutron halo of ^{22}C and for this we need high resolution pick-up reaction on ^{22}C.

Table1: The coulomb dissociation reaction crosssection of ^{22}C

Angle θ in degree	Cross section (σ) in mb	Exp. Cross section in mb
0	773390	1338
1	44880	—
2	7805	—
3	2619	—
4	1196	—

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