Analysis of ^{12}C(^{23}O,^{22}O+n)^{12}C stripping reaction within the first order corrected eikonal approximation

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Significant development in the nuclear techniques has made it possible to explore some peculiar features of the heavier exotic nuclei lying close to the neutron/proton drip lines. Interestingly, the oxygen isotope with mass number 23 having low binding energy (S_n = 2.74 MeV) with a well established $J^{\pi} = 1/2^{+}$ as the ground state spin parity offers its strong candidature to unravel the structure of heavier neutron-rich isotopes [1-5]. Hence it may be used to test the available theoretical models used in analysis of data observed in various nuclear reactions involving loosely bound nuclei.

Owing to very low binding energy, the breakup reactions are used as an effective tool to explore various features of neutron or proton rich isotopes. When the colliding nuclei are very close to each other and one of the constituent fragments of the projectile is absorbed by the target leaving the other unaffected, this mechanism is referred to as stripping reaction. At high energies, since momentum transferred is small, the stripping reactions are well governed by the method developed by Glauber [6], based on the eikonal approximation approach. However at large angle scattering the method needs corrections and may be extended by incorporating some correction terms. The present work is primarily concerned with investigation of longitudinal momentum distribution (LMD) data obtained in ^{12}C(^{23}O,^{22}O+n)^{12}C stripping reaction at 72*A*MeV incident energy, through zero order and zero plus first order eikonal approach as developed by S J Wallace [7]. The nucleon stripping cross section differential in k_{cz} , longitudinal momentum of the core is given by [1,8]

$$\frac{d\sigma_{n,\,str.}}{dk_{cz}} = \frac{1}{(2\pi)}\frac{1}{(2L_0+1)}\sum_{M_0}\int d^2\vec{r}_{\perp}\int d^2\vec{b}[1-\left|S_n(\vec{b}_n)\right|^2]\left[\left|S_C(\vec{b}_C)\right|^2\right]$$
$$\times\left|\int dz\exp(-ik_{cz}\,z)\,\psi_{0,M_0}(\vec{r})\right|$$

Here, $\psi_{L_0M_0}(\vec{r})$ contains the structural information of the projectile and in the single particle shell model, $\psi_{L_0M_0}(\vec{r}) = Y_{L_0M_0}(\hat{r})R_{L_0}(r)$ with $R_{L_0}(r)$ as the radial part of the relative motion wave function and $Y_{L_0M_0}(\hat{r})$ are the well known spherical harmonics. $S_n(\vec{b}_n)$ and $S_c(\vec{b}_c)$ represent the neutron and core profile functions. The choice of profile functions governing the neutron-target and core-target interaction plays very significant role in the calculations. In the present work we have used the profile functions based on eikonal approximation with and without the inclusion of corrected eikonal phases. The zeroth order profile function reads

$$S_i^0(b_i) = \exp\,(i\,\chi_{i0}(b_i)), \qquad i = n, c$$

here $\chi_{i0}(b_i) = -2K\varepsilon_i\int_{-\infty}^{\infty} dz\; U_{iT}(r_i)$

with $\varepsilon_i = V_{io}/Kv$, V_{io} and $U_{iT}(r)$ are the strength and form factors for the spherically symmetric potential. The r_i is the neutron–target and core-target relative separation for $i = n$ *or* c. Here K and v are the momentum of the projectile in the centre-of-mass frame of reference and the beam velocity respectively.
Now the first order corrected profile function is expressed as

$S_i^{(1)}(b_i) = \exp[(i\,\chi_{i0}(b_i) + \tau_{i1}(b_i))]$ with

$$\tau_{i1}(b) = -K\varepsilon_i^2\int_0^{\infty} dz\left(2 + r\frac{\partial}{\partial r}\right)U_{iT}^2(r)$$

as the first eikonal correction term.

In figure the cross section differential in longitudinal momentum (LMD), of the core from ^{12}C(^{23}O,^{22}O+n)^{12}C stripping reaction at 72*A*MeV incident energy, is compared with the corresponding data taken from Ref.[3]. Since the contribution of second order correction term is found to be negligible and hence is omitted in the present conference contribution [9].

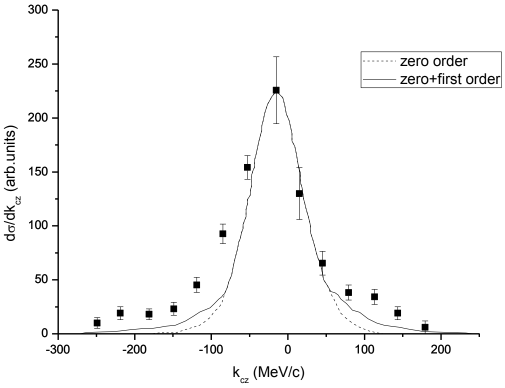

Fig. Longitudinal momentum distribution of ^{22}O coming out from the stripping of ^{23}O on carbon target at 72 MeV/A incident beam energy. Here, dotted and solid lines give the contributions, corresponding to $0^{+} \otimes 2s_{1/2}$ configuration, of zero order eikonal and zero+ first order corrected eikonal respectively.

It is clearly observed from the figure that the inclusion of first order correction term alters the tail region of the distribution and leads to a significant shift of the distribution towards the data points. It may be understood in terms of large momentum transfer in tail region. However, width of calculated LMD is slightly smaller than that of the observed one. It may be attributed to the fact that during the present calculations we have considered pure s- wave configuration for the ground state of the projectile which allows spatial extension and hence reduction in momentum width.

In conclusion we have investigated $^{12}C(^{23}O,^{22}O+n)^{12}C$ stripping reaction at 72*A*MeV incident energy with a motive to emphasize the effects of leading order correction term to eikonal approximation and have observed that the inclusion of correction term reduces the mismatching between the data and prediction.

References

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