Analysis of LMD data of core coming from Ta(^{15}C, ^{14}C+n)Ta Coulomb breakup reaction

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It is well established fact that the neutron-halo nucleus is a loosely bound exotic nuclear state wherein the valence neutron is found mostly at a much larger distance from the remaining core. The development of radioactive ion beams (RI) has provided a great opportunity to explore various peculiar properties of such nuclear systems. Consequently lots of efforts have been made on theoretical and experimental fronts to understand the exotic features of halo nuclei [1-14]. One of the clear manifestations of exotic properties of isotopes lying near neutron drip line is the loss of magicity and the tendency to posses prolate deformation. In this conference contribution, we study Ta(^{15}C, ^{14}C+n)Ta Coulomb breakup reaction with a special emphasis on the study of effects of deformation and to investigate the possibility of occupying d-orbital by valence neutron in ^{15}C.

Theoretically, the eikonal approximation is the most convenient approach to analyze the Coulomb breakup reaction data at high energies. The longitudinal momentum distribution (LMD) being independent of reaction mechanism acts as cleaner probe to investigate the projectile structure. The expression for calculating the LMD in eikonal approach corresponding to different multipolarity is given as [14]

$$\left(\frac{d\sigma}{dq_z}\right)_{L=0} = \int_0^{\infty} \frac{4Z_t^2 (Z_1^{eff})^2 \alpha^2}{3\gamma^2\beta^2} \xi^2 I_{011}^2 \times\left[(K_1^2 - K_0^2)\left\{(1+2P_2) - (1-P_2)\gamma^2\right\} + \frac{2}{\xi} K_0 K_1 (1-P_2)\gamma^2 \right] \times q\, dq$$

$$\left(\frac{d\sigma_{E1}}{dq_z}\right)_{L=2} = \int_0^{\pi} \frac{4Z_t^2 (Z_1^{eff})^2 \alpha^2}{75\gamma^2\beta^2} \xi^2 \times\left[5\left\{\left(\frac{2}{\xi}K_0K_1 - (K_1^2 - K_0^2)\right)\gamma^2 + \left(K_1^2 - K_0^2\right)\right\} \times\left(2I_{211}^2 + 3I_{213}^2\right) + 2P_2 \times\left\{-2\left(K_1^2 - K_0^2\right) + \left(\frac{2}{\xi}K_0K_1 - \left(K_1^2 - K_0^2\right)\right)\gamma^2\right\} \times\left(-\frac{1}{2}I_{211}^2 + 9I_{211}I_{213} - 6I_{213}^2\right)\right] q\, dq.$$

The symbols used here are same as in Ref. [14]. The valence neutron – core relative motion wave function depends on the orbital occupancy of valence neutron and is an essential ingredient required in the calculation. Here we have considered two possible $0^+\otimes 2s_{1/2}$ and $2^+\otimes 1d_{5/2}$ configurations, for the ground state structure of ^{15}C, wherein valence neutron may occupy s-orbital and d-orbital respectively. The wave functions corresponding to these configurations have been developed by solving radial part of Schrodinger equation for Woods- Saxon potential with and without deformation for $0^+\otimes 2s_{1/2}$ configuration and without deformation for $2^+\otimes 1d_{5/2}$. The deformed Woods-Saxon potential for neutron – core interaction may be expressed as [13]

$$V(R_0, \Delta; r, \hat{r}) = \frac{V_{ws}}{1 + \exp\left(\frac{r - R(R_0, \hat{r})}{\Delta}\right)}$$

with $R(R_0, \hat{r}) = \frac{R_0(1 + \beta Y_{20}(\hat{r}))}{\nu}$

Here V_{ws}, Δ, R_0 and β are the strength of potential, core diffuseness, range and the deformation parameter for the core and ν is given by the integral

$$v=\left(\int \frac{d\hat{r}}{4\pi}(1+\beta Y_{20}(\hat{r}))^3\right)^{1/3}.$$

Here we have calculated the LMD of ^{14}C coming from the Coulomb breakup of ^{15}C on Ta target at 85MeV/u beam energy and investigate the effects of deformation and to check the possibility of occupying d-orbital by valence neutron in ^{15}C nucleus. It is found that the consideration of deformation in W-S potential for valence neutron and core alters negligibly the shape of LMD [see fig. 1]. In fig. 2 we have considered a usual Woods-Saxon potential without deformation for neutron –core interaction.

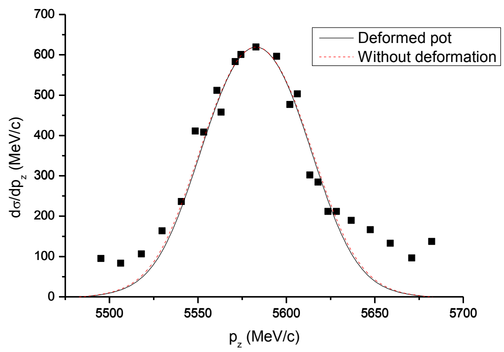

Fig.1(color online). Longitudinal momentum distribution of core fragments coming from the Coulomb breakup of ^{15}C on Ta target at 85*A*MeV. Solid and dotted lines represent the results obtained with and without deformed Wood-Saxon potential corresponding to $0^+\otimes 2s_{1/2}$ ground state configuration respectively. Data points are taken from Ref. [6].

It is observed from fig.2 that the results corresponding to $2^+\otimes 1d_{5/2}$ configuration are very far from the experimental results except in the tail region while $0^+\otimes 2s_{1/2}$ configuration provides a very good matching with the data except in the tail region. Therefore the results for the admixture of $0^+\otimes 2s_{1/2}$ and $2^+\otimes 1d_{5/2}$ are also presented in fig. 2 but still the experimental spectrum could not be reproduced well, especially in the region of large momentum transfer.

In summary, we have investigated the Ta(^{15}C, ^{14}C+n)Ta Coulomb breakup reaction data at 85MeV/u energy with $0^+\otimes 2s_{1/2}$ and $2^+\otimes 1d_{5/2}$ as the ground state configurations.

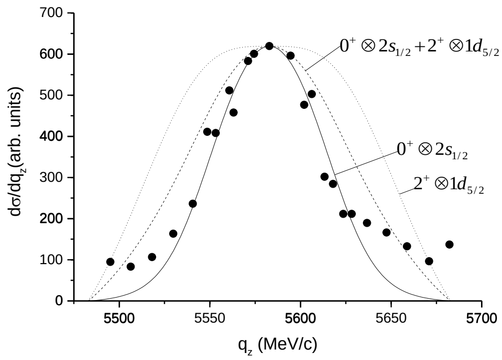

Fig. 2. Analogous to fig. 1 but for $0^+\otimes 2s_{1/2}$ and $2^+\otimes 1d_{5/2}$ configurations. Solid line represents the results corresponding to former configuration while dotted lines is for later. The admixture of $0^+\otimes 2s_{1/2}$ and $2^+\otimes 1d_{5/2}$ is shown by dashed line. Data points are taken from Ref. [6].

It is found that the results obtained through an admixed configuration reduce the mismatching between the data and prediction in tail region through a small extent.

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