Three Body Symmetric Final State and the $^{24}Mg(^{12}C, 2^{12}C)^{12}C$ Reaction at 105.3 MeV

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From the Finite Range (FR)-DWIA analysis [1, 2] of our earlier $^{16}O(^{12}C, 2^{12}C)^{4}He$ reaction experiment [3, 4], performed at 118.8 MeV at Mumbai Pelletron-LINAC, it was concluded that there is a hard core of $\sim 3.35 fm$ in the ^{12}C-^{12}C interaction at the knockout vertex(see Fig.1). Before our inclusion of hard core in the C-C interaction it was believed that the C-C interaction at around 10 MeV/A is highly attractive, with depth of several hundred MeV's [5, 6]. In the $^{16}O(^{12}C, 2^{12}C)^{4}He$ reaction besides the ^{12}C-^{12}C interaction there is some uncertainty from the α-^{12}C distorting optical potentials. The uncertainty does not change much the conclusion about $3.35 fm$ hard core in the ^{12}C-^{12}C interaction but changes the extracted spectroscopic factor by a factor of 2 or 3. A sure shot way of removing this uneasiness is found in the $^{24}Mg(^{12}C, 2^{12}C)^{12}C$ reaction. Here the final state has three $^{12}C's$ and thus similar ^{12}C-^{12}C interactions operate for the distortions as well as for the ^{12}C-^{12}C knockout vertex.

The $^{24}Mg(^{12}C, 2^{12}C)^{12}C$ reaction was performed at the Mumbai LINAC using 105.3 MeV ^{12}C beam of current $\sim$ 3.5 pnA incident on 250 $\frac{\mu g}{cm^2}$ natural Mg backed by 300 $\frac{\mu g}{cm^2}$ gold target in coplanar symmetric geometry at an angle of 40.9^0. In natural Mg the abundances of ^{25}Mg and ^{26}Mg are less than 10 percent each. The Q value for removal of ^{12}C from ^{24}Mg, ^{25}Mg and ^{26}Mg are -13.92, -16.3 and -19.2 MeV respectively. Hence contributions from ^{25}Mg and ^{26}Mg to the $(^{12}C, 2^{12}C)$ reaction is expected to be very small. This is the first experiment with the new scattering chamber in the LINAC beam hall. The energy cut off in the detector telescope # 1 was kept at about 49 MeV to obtain a clean coincidence spectrum. The TAC spectra before and after banana gates on ^{12}C are shown in Fig.2 and 3 respectively. The TAC spectrum in Fig.3 is seen to be very clean, indicating no contribution of chance coincidences in the data. The summed energy (E_1+E_2) spectrum Fig.4 is seen to provide a clean separation for the ground state and 4.4 MeV excited state of

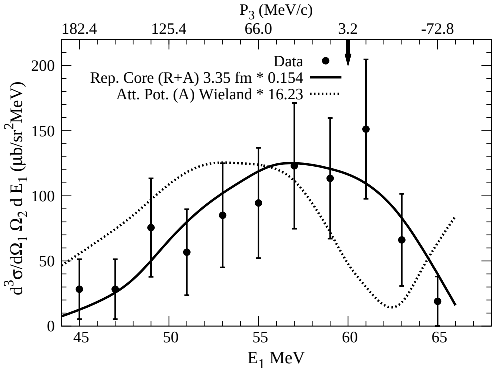

FIG. 1: Energy sharing spectrum of $^{16}O(^{12}C, 2^{12}C)^{4}He$ reaction.

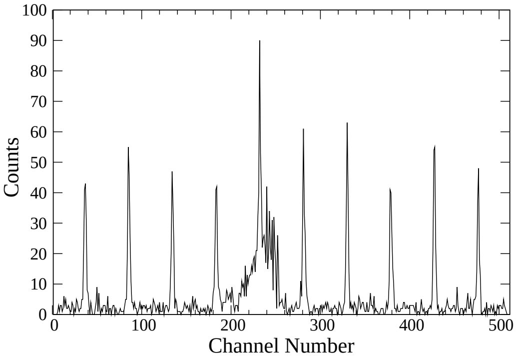

FIG. 2: Raw TAC spectrum of $Mg(^{12}C, 2^{12}C)^{12}C$ reaction.

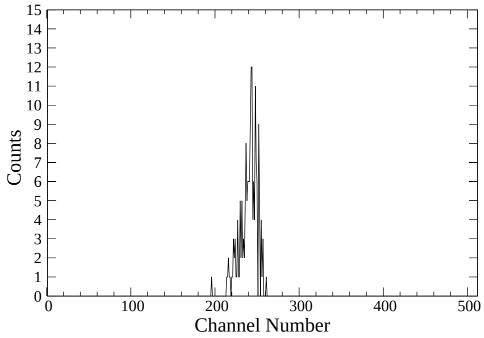

FIG. 3: ^{12}C Gated TAC spectrum for $Mg(^{12}C, 2^{12}C)^{12}C$ reaction.

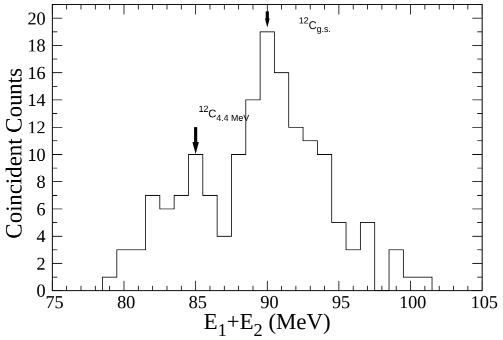

FIG. 4: Summed energy spectrum of $Mg(^{12}C, 2^{12}C)^{12}C$ reaction.

^{12}C. The $\frac{d^3\sigma}{d\Omega_1 d\Omega_2 dE_1}$ vs E_1 spectrum known as the energy sharing spectrum is shown in Fig.5. (Due to symmetric geometry, the lower energy E_1 data is obtained from the lower energy E_2 data). The middle part of the spectrum could not be measured due to large cut off in one of the telescopes. However there is a substantial information still available in the data.

The plane wave calculations normalized to the E_1=50 MeV data point give a reasonable spectroscopic factor, $S_{^{24}Mg \to ^{12}C_{g.s}+^{12}C_{g.s}}$ of 0.48 while the zero range (ZR)-DWIA calculations underestimate the cross section very much and provide an unrealistic value; of $S_{^{24}Mg \to ^{12}C_{g.s}+^{12}C_{g.s}}$ = 124 indicating large distortion and finite range effects in the data. It is also seen that similar to the

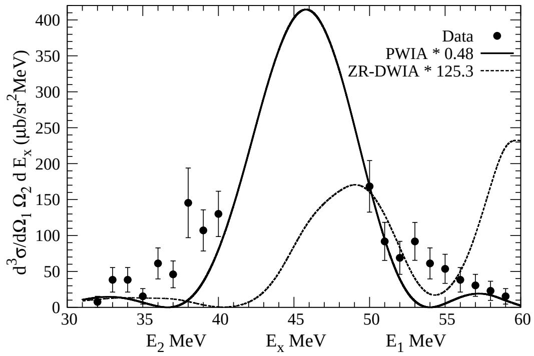

FIG. 5: Energy sharing spectrum of $Mg(^{12}C, 2^{12}C)^{12}C$.

$^{16}O(C, 2C)^4He$ reaction at 118 MeV, reported last year[3, 4] the $^{24}Mg(C, 2C)C$ reaction cross section is enhanced by a factor of 2.5 more than the $(C, 2C)$ reaction on ^{16}O using the same conventional $\frac{B}{A}$ -prescription for the initial state optical potentials.

This preliminary result tends to confirm our earlier finding that the ^{12}C-^{12}C interaction could contain a 3.35 fm hard core at least for the description of $(C, 2C)$ reactions.

Acknowledgments

We would like to thank the Pelletron and LINAC personnel for the excellent beam quality and the TIFR target lab for making the Magnesium target. We thank the Department of Science and Technology, Govt. of India also for funding the project.

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