Study of the Reaction $^{12}C(^{18}O, X)$ at an Incident Energy of E_{CM} (^{18}O) ~ 5 $V_{Coulomb}$

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In a recent study by Rudchik et al., [1], the elastic scattering angular distribution data for the systems $^{12}C+^{18}O$ and $^{12}C+^{16}O$ were compared at a wide range of energies. It was observed that the large angle data for these two systems differ by as much as a factor of 100 (for E_{cm} ~ 42 MeV). A detailed coupled reaction channel calculations indicate that this large-angle enhancement for the $^{12}C+^{18}O$ elastic scattering to arise from the transfer of nucleons. This enhanced elastic scattering cross sections that appear at large angles for systems made up of "α" particle nuclei such as $^{16}O+^{12}C$ and for the systems of "xα + yn" such as $^{18}O+^{12}C$ is continued to be an interesting feature as that allows us to understand the role of particle transfer on elastic cross section and the mechanism of correlated particle transfer. The isotopic effects for these two systems have been studied in Ref.[2] and in [1] and the greatest difference observed is in their imaginary potentials. While the difference in the real part of the potentials is small, the absorption part for $^{16}O+^{12}C$ has a potential pocket in the surface region for laboratory energies up to 100 MeV and disappear at E_{Lab} > 200 MeV. Such a pocket is absent in $^{18}O+^{12}C$ potential. With a motivation to have a further understanding on this, we plan to measure elastic scattering angular distributions for these two systems at energies around 140 MeV. Only one measurement exists at this energy but in the limited angular region.

The reaction (^{18}O, ^{16}O) is also well suited for understanding of reaction mechanism aspects of correlated n-pair transfer & pairing force and possible population of Giant Pairing Vibration (GPV). As detailed in Ref.[4], this 2n- transfer reaction on medium mass target (10 ≤ A ≤ 20) and at energies ~ 4 – 5 times the Coulomb barrier ($V_{Coulomb}$) seems to be an interesting probe for observation of GPV. Their data, taken on the magnetic spectrograph MAGNEX, indicate the observation of GPV resonance at excitation energy of 16.9 MeV in ^{14}C.

Usually these experiments are done with a high resolution spectrometer. Using simple ΔE-E detector telescopes though Z separation is relatively easy to achieve, the main concern is to get mass separation for higher Z. In a recent study by us[3], using a suitable choice of ΔE-E combination, good mass separation for all PLFs up to ^{18}O has been achieved (Fig.1 and 2).

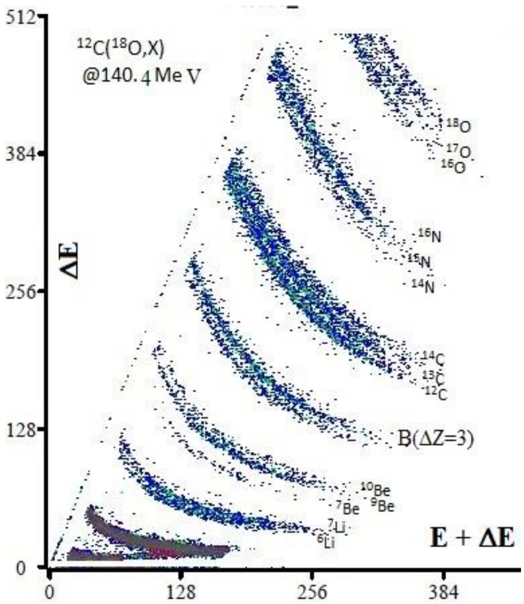

Fig.1: *Two dimensional plot for the reaction $^{12}C(^{18}O, x)$ at an indicated energy of $E(^{18}O)$ = 140.4 MeV. As seen in the figure not only Z but also a good isotope separation is obtained. Identification of reaction products up to ^{18}O has been achieved.*

The experiment was carried out with ^{18}O beams from the BARC-TIFR Pelletron-LINAC facility at Mumbai. The target was self- supporting ^{nat}C target of thickness ~ 50μg/cm^2. The use of inverse kinematics will allow the measurement of both forward and backward angle elastic scattering data simultaneously.

Fig.2 shows excitation energy spectrum in ^{14}C obtained through the 2n-transfer reaction. Though the data were collected for a very short time, one may identify [4] the states populated in ^{14}C as g.s.: 0^+(#1), no. of unresolved stated E_x ~ 7 MeV(#2), E_x=10.7 MeV(#3) and states around Ex = 12.3 MeV(#4). A broad peak at ~ 17 MeV excitation in ^{14}C is also observed. More measurements with improved statistics are being planned.

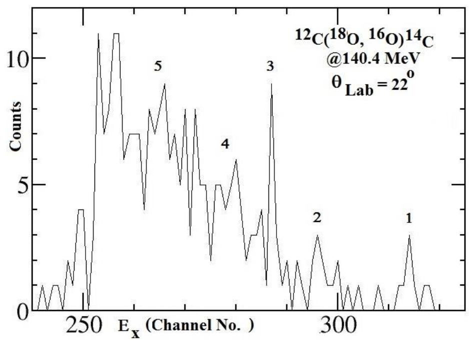

Fig.2. *Excitation energy spectrum in ^{14}C populated via the 2n transfer reaction $^{12}C(^{18}O,^{16}O)$.*

Multi-nucleon transfer up to 12 nucleons transfer from the projectile to the target nucleus is observed (Fig.1). Reaction cross section for these transfer channels (Q-integrated data) have been extracted from the Fig.1 and are shown in Table 1. Measured transfer probabilities ($P_{tr}(\theta)$) for x-nucleon transfer, as defined in [3],

$$(d\sigma/d\Omega)_{tr} = (d\sigma/d\Omega)_{el} \ . \ P_{tr}(\theta),$$

can then be compared in order to shed a light on the reaction mechanism aspects and to distinguish between multistep sequential and one step cluster transfer. A detailed Coupled Reaction Channel (CRC) calculation is being performed with the code FRESCO.

Table 1. *Reaction cross section for different transfer processes measured at θ_{Lab} = 22 deg.*

Reaction	Q_{gs} MeV	ΔZ	ΔN	$(d\sigma/d\Omega)_{Lab}$ mb/sr
$^{12}C(^{18}O,^{17}O)$	-3.1	0	-1n	2.49
$^{12}C(^{18}O,^{16}O)$	+0.934	0	-2n	3.60
$^{12}C(^{18}O,^{16}N)$	-9.33	1	-1p-1n	1.53
$^{12}C(^{18}O,^{15}N)$	-0.99	1	-1p-2n	11.60
$^{12}C(^{18}O,^{14}N)$	-9.33	1	-1p-3n	4.69
$^{12}C(^{18}O,^{14}C)$	-0.93	2	-2p-2n	7.81
$^{12}C(^{18}O,^{13}C)$	-3.1	2	-2p-3n	19.19
$^{12}C(^{18}O,^{12}C)$	0.0	2	-2p-4n	25.53
$^{12}C(^{18}O, B)$	-	3	-	20.36
$^{12}C(^{18}O,^{10}Be)$	-6.35	4	-4p-4n	2.75
$^{12}C(^{18}O,^{9}Be)$	-6.40	4	-4p-5n	7.56
$^{12}C(^{18}O,^{7}Be)$	-11.40	4	-4p-7n	1.14
$^{12}C(^{18}O,^{7}Li)$		5	-5p-6n	10.36
$^{12}C(^{18}O,^{6}Li)$		5	-5p-7n	6.96

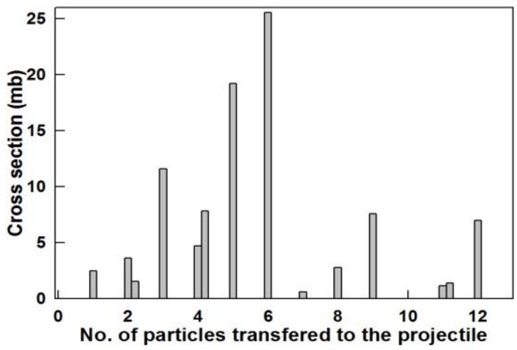

Fig.3. *Reaction cross section versus number of particles transferred for $^{12}C(^{18}O,x)$ at 140.4MeV.*

Acknowledgements

The authors would like to acknowledge the co-operation and support received from the Linac-Pelletron staff during the experiment and the target laboratory, TIFR for preparation of the target. The authors would like to thank U.K.Pal and R.Talukdar for her interest and help during the initial stages of the experiment.

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