Analysis of Elastic Scattering Cross Section for $^{18}O+^{206}Pb$ in the CRC Formalism and Dependence on the Choice of Double Folding Potential

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Measurement and detailed analysis of elastic scattering and inelastic excitations in $^{206}Pb(^{18}O, ^{18}O)$ have been reported here. The experiment was carried out with ^{18}O beam, @79, 139 and 140 MeV obtained from the BARC-TIFR Pelletron-LINAC facility at Mumbai. The target was an enriched ^{206}Pb target (t~250μg/cm^2) on carbon backing with a backing thickness of ~30μg/cm^2. Reaction products were detected and identified by four SSB detector telescopes in ΔE-E configuration. Angular distributions for the elastic, inelastic and in addition 2n-transfer cross sections were measured. A typical projected spectrum @79 MeV is shown in Fig.1.

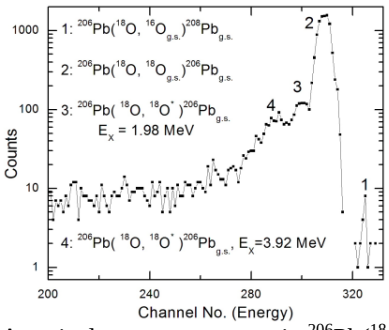

Fig1: A typical energy spectrum in $^{206}Pb(^{18}O,x)$.

The data were analyzed in the coupled reaction channel(CRC) model with a double folding(DF) potential to reproduce, simultaneously, cross section for all the measured quasi-elastic processes. In the coupling scheme, the elastic scattering, projectile & target excitations, and 1n- and 2n- stripping reactions were included. The details of the transfer couplings are described in an another communication to this conference[1]. First, the elastic scattering cross section was calculated with a bare double folded real potential. The DF potential consists of folding of a harmonic oscillator density distribution to simulate ^{18}O with the sum of two Fermi density distributions for the proton and neutron in ^{206}Pb with correct normalizations. Our measured higher energy data for the same system was first analyzed with this DF potential (Fig.2). No additional normalization to the real potential was needed. The real part of the potential was thus fixed. It is to mention that at this high energy the coupling effects from various quasi-elastic processes are expected to be less important.

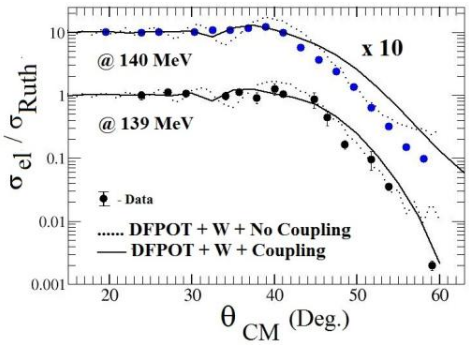

Fig.2: Measured data and FRESCO calculations for $^{18}O+^{206}Pb$ at higher energy.

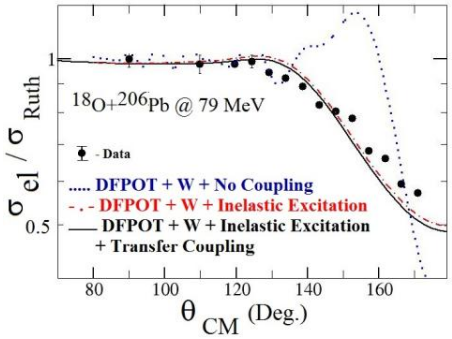

Fig.3. The CRC calculations and data. Coupling effects from different processes are shown.

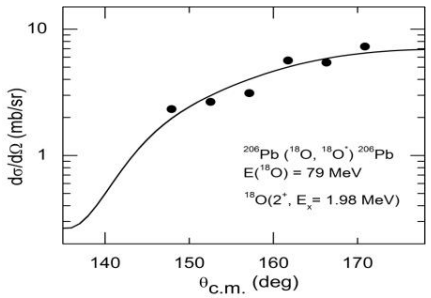

Fig.4. Experimental data and FRESCO results.

Next, various non-elastic modes which occur at the nuclear surface were coupled. The absorptive potential was generated through this coupling. Finally, a short range imaginary potential(W) of Wood Saxon shape with W=40 MeV, r_i=1.0 fm and a_i=0.4 fm was also added. The CRC calculations and effects of coupling from the inelastic and transfer modes are shown in Fig.3. The measured $(d\sigma/d\Omega)_{el}$ is well reproduced in the present CRC formalism. The calculations also reproduce, both shape and magnitude, of the experimental angular distribution for the inelastic scattering ^{18}O, 2^{+}(E_x = 1.98 MeV) state.

We have made a detailed investigation on the choice of DF potential and radial dependence of cross section on the potential. It has been observed that it is the potential at large inter-nuclear distance r~$R_{min,}$ (the distance of closest approach R_{min} is defined in [1]) that eventually determines the shape of the angular distribution, hence, one can even use a much simpler form of the potential effective to this region of r only. We have tried a simple exponential form for the real part of the potential

$V(r) = N.e^{-r}$, $R_{min}-\Delta r \leq r \leq R_{min}+\Delta r$ and
$V(r) = 0$, otherwise, ……. (1)

with Δr = 5fm and r in fm and N in MeV. Rest of the CRC calculations followed as was described above. As is seen in fig.5, where we have analyzed our measured data for different systems with this simple form of the potential, surprisingly a very good agreement has been obtained in all the cases with the data as well as with calculations using standard DF potential.

The values of the normalization factor N for different systems are listed in Table I. The same value of N for ^{18}O+^{206}Pb at different energies is consistent with the results from the double folding potential. For oxygen on zirconium, in going from ^{16}O+^{90}Zr to ^{18}O+^{90}Zr about 40% increase in the value of N has been observed. Such increase in the real part of the potential has also been observed in our earlier optical model analysis of the data in these two systems[2].

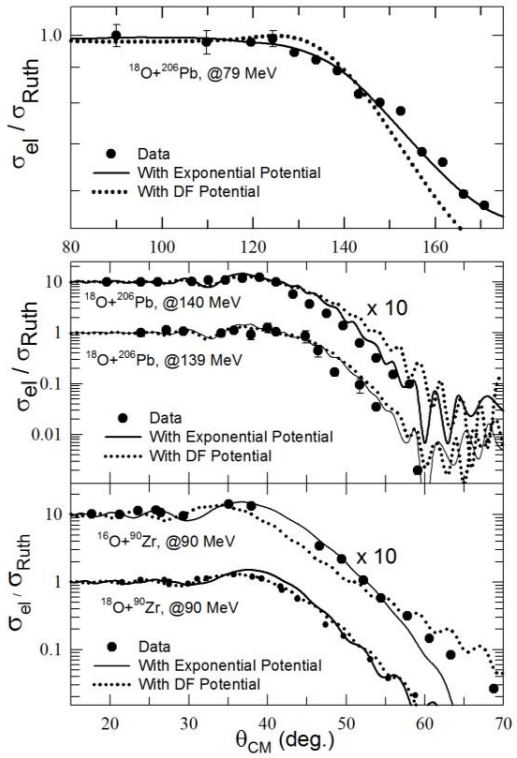

Fig.5. Experimental data and the present CRC calculations with the simple exponential form of the potential (Eq.(1)) compared with the DF potential. The data for ^{18,16}O+^{90}Zr at 90MeV are taken from our earlier measurement [2].

Table I: The normalization factor from Eq.(1)

System	E_{Lab} (MeV)	N (in MeV)
^{18}O+^{206}Pb	79	5.75 x 10^5
^{18}O+^{206}Pb	139	5.75 x 10^5
^{18}O+^{206}Pb	140	5.75 x 10^5
^{16}O+^{90}Zr	90	3.75 x 10^4
^{18}O+^{90}Zr	90	5.25 x 10^4

References

[1] B.J.Roy et al, contribution to this conference.
[2] V.Jha, B.J.Roy et al, EPJA **19**, 347 (2004).