Comparative study of elastic scattering in ^{16,18}O+^{209}Bi reactions

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Introduction

In heavy ion induced reactions such as fusion or multi nucleon and cluster transfer, around the coulomb barrier, the projectile structure plays a significant role. The evidence of di-neutron configuration in ^{18}O projectile outside ^{16}O core has been reported earlier in ^{18}O+^{174}Yb,^{164}Dy reactions[1, 2]. Significant difference in the transfer behavior was observed between ^{16}O and ^{18}O. On the other hand, elastic scattering of heavy ions from heavy targets at incident energies around the Coulomb barrier was shown in early measurements to have a characteristic shape that is remarkably independent of the internal structure of both the target and the projectile[3]. But high precision measurements showed slight differences between isotopes, such as that between ^{6}Li and ^{7}Li+^{208}Pb elastic scattering[4]. The observation of an anomalously large interaction cross section for ^{11}Li[5] led to the concept of halo “nuclei”, and it was widely speculated that elastic scattering of this nucleus and other possible halo nuclei might show anomalous scattering patterns because of the neutron tail in their matter distributions. Therefore, it is very interesting to see the effect of di-neutron configuration in ^{18}O over ^{16}O in their elastic scattering. With this aim we have carried out elastic scattering angular distribution measurement for ^{18}O+^{209}Bi and ^{16}O+^{209}Bi at the energies 86.0 and 90.0 MeV.

Experimental Details

The experiment was performed with ^{16}O and ^{18}O beam from the 14 UD BARC-TIFR Pelletron accelerator facilities, Mumbai, India. A self-supporting ^{209}Bi target of 1.4 mg/cm^2 thickness was bombarded with the ^{18}O and ^{16}O projectile in the energy E_{lab}= 86.0 and 90.0 MeV. Three ΔE -E silicon surface barrier detector telescope was mounted inside the scattering chamber to measure the elastic scattering angular distribution from 50° to 130°. Another silicon surface barrier detector at an angle of 20° with respect to the beam direction was used to measure Rutherford scattering events for normalization. The

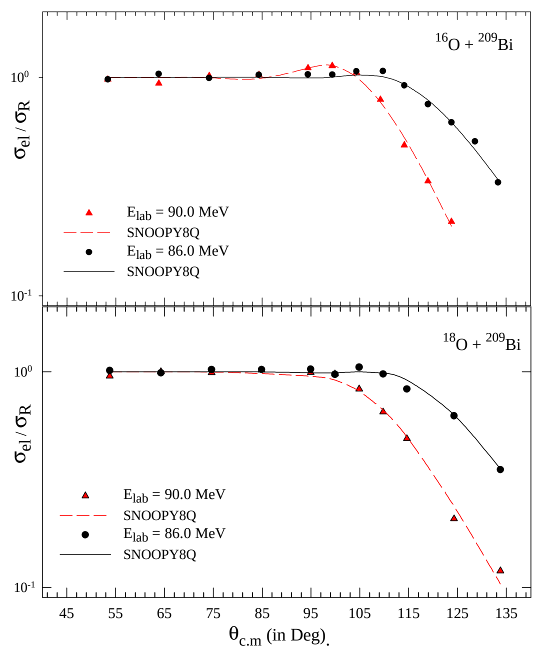

FIG. 1: Energy dependence of the ratio of the elastic to the Rutherford scattering cross section for ^{16,18}O+^{209}Bi reactions.

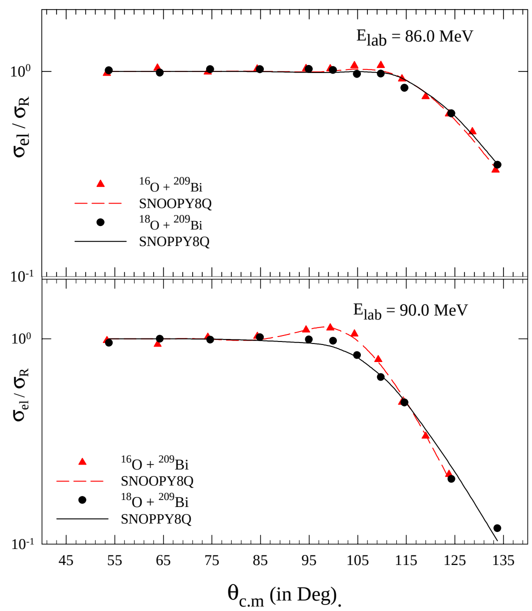

FIG. 2: Ratio of elastic to the Rutherford scattering cross section as a function of scattering angle ^{16}O,^{18}O+^{209}Bi reactions. The continuous and dashed lines are the predictions of SNOOPY8Q calculations.

elastically scattered particles were identified for ^{16}O,^{18}O+^{209}Bi reactions at 86 and 90 MeV from the ΔE versus E correlation plot.

Results and Discussion

The ratio of elastic cross section to the Rutherford as a function of scattering angle in the C.M. frame, has been plotted in Fig.1. For comparison between the elastic scattering behavior of ^{16}O and^{18}O, angular distribution for ^{18}O+^{209}Bi and ^{16}O+^{209}Bi at a given incident energy is shown in Fig.2. The solid and dashed lines in the figures represent optical model fit to the data using the SNOOPY8Q code. It is observed that in general, the optical parameters are similar for both the systems. In Fig.1 angular distribution for both reactions show typical energy dependence which is a characteristics of heavy ion elastic scattering. Though the overall elastic scattering angular distribution pattern is similar for the two reaction, it is observed that there is a suppression of “Coulomb rainbow” for ^{18}O which can be clearly seen at E_{lab}=90.0 MeV. As it is reported recently[6], albeit for loosely bound nuclei, that the coulomb rainbow can be strongly suppressed because of the presence of strong coulomb and/or nuclear couplings. In present case for ^{18}O (E_{2+}=1.98 MeV) presence of relatively lower lying excited states in comparison to ^{16}O (E_{2+}=6.92 MeV) can provide significant couplings. Moreover there can be additional neutron transfer channel that can give significant nuclear coupling, which in turn can suppress the coulomb rainbow peak as observed in the work for ^{18}O+^{209}Bi reaction. More detail coupled channel calculation is require to ascertain the influence of various channel couplings in the elastic scattering angular distribution.

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