Investigation of alpha particle emission from the ^{14}N+^{197}Au reaction at an incident energy of 250MeV

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Introduction

In recent years, heavy ion reactions study with projectile nuclei near the drip-line such as (^{6}He, ^{9,11}Li, ^{10,11,14}Be etc.) is being given a great deal of attention to probe the internal structure of the nuclei by studying the break-up coupling effects on various reaction channels. However, due to the limited beam intensity and availability of unstable wekaly bound nuclei, stable wekaly bound nuclei such as ^{6,7}Li and ^{9}Be is being considered on experimental front. The similarity in structural properties of stable and unstable weakly bound nu- clei further enhanced the importance of various reaction studies with stable weakly bound nuclei which can be used as testing ground for unstable weakly bound nuclei.

In the direct reaction the projectile ^{14}N may break into α+^{10}B or it may break into ^{12}C+d and then ^{12}C break into ^{8}Be+α thus producing three alpha particles. Secondly, α-particles may get emitted after complete and incomplete fusion of the projectile with the target. Also, the contribution from evaporation channels should be considered. Thus, the energy and angular distributions of the emitted α-particles from the above mentioned channels would have different values. In the Ref.[4], the results of measured inclusive double differential cross sections of α-particles emitted in the interaction of ^{14}N with ^{59}Co and ^{93}Nb at incident energy of 250 MeV are presented. It has been inferred that at such a high incident energy, significant contribution to the alpha particle emission comes from direct reactions and re-emission of alpha after incomplete fusion and these mechanisms are dominant in forward angles. Towards larger emission angles the contributions from non-equilibrium and evaporation processes increase and start competing with direct reactions. This indicates that the measured alpha cross sections originating from various reaction mechanisms are important at this high energy.

It is of great interest to see any changes in the measured alpha particles cross sections and thus cluster structure effects involving heavy target mass nucleus ^{197}Au. It is also important to compare the present result of ^{14}N projectile with that of involving ^{12}C[5] as ^{14}N projectile also emits ^{12}C fragments during direct interaction with the target nucleus ^{197}Au.

Experimental procedure

The experiment was performed at K200 cyclotron facility of iThemba LABS, South Africa. ^{14}N beam was delivered at 250MeV. The target was mounted in aluminium frame with 25 mm diameter apertures. For particle identification, conventional charged-particle telescopes were used. Each consisted of a stack of two Si surface-barrier detectors and a NaI stopping detector. Characteristic alpha par-

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ticles from ^{228}Th-sources were used for energy calibrations of the Si surface-barrier detectors. Standard fast coincidence electronics and an online computer were used to acquire and store the event data stream. Experimental data were acquired at scattering angles ranging from 8°-120°. More details on this facility and its associated experimental equipment etc may be found in the Refs.[5, 6].

Results and Discussion

The obtained α-particle spectra at various angles is shown in the Fig. 1 for the reaction of ^{14}N with ^{197}Au at incident energy of 250 MeV. One can see that the obtained cross sections do not change much at very forward angles in the range from 8°-15° but shows a very broad maximum around 100 MeV. It decreases gradually as angle increases. These broad maxima and high energy tails are interpreted as the signature of non-equilibrium emission of α-particles. It can be observed that at larger angles the broad maxima disappear and the cross section decreases rapidly with increase in α-particle energy. Which indicates that the contribution from break-up followed by incomplete fusion (ICF) and other non-equilibrium phenomena become dominant at larger angles, which are responsible for the high-energy tails. Preliminary calculation on estimating α-particles from direct breakup of ^{14}N via ^{12}C+d, shows small contribution.

Conclusions

α-particle double differential cross sections have been measured at 250 MeV in the angular range from 8°-120°. From the experimental data analysis it has been observed that α-particles cross sections are varying in energy and angles due to the difference in their origins. At forward angles upto 20° direct processes dominate in contributing the α-particle cross sections. At larger angles more contributions from incomplete fusion and evaporation channels were understood. Further, theoretical analysis in terms of various methodology using Fresco code [7] is being carried out to explore the emission of α-particles from various reactions. Detailed calculation and its result

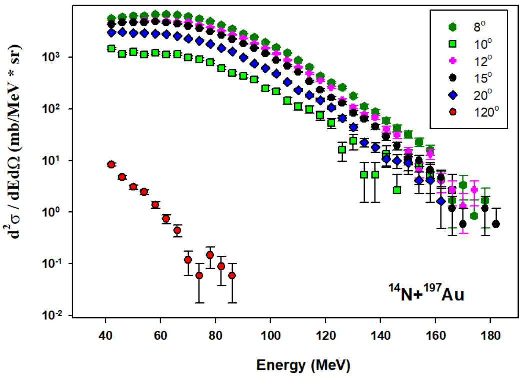

FIG. 1: Experimental double differential α-particle cross sections in the reaction of ^{14}N with ^{197}Au at incident energy of 250 MeV

will be presented during the symposium.

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