ROLE OF PROJECTILE DEFORMATION IN FUSION: STUDY THROUGH QUASI-ELASTIC BARRIER DISTRIBUTION

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The relative importance of coupling to inelastic excitation of the ^{28}Si projectile in the presence of permanently deformed target has been explored. To this end, the “barrier distribution” (BD) derived from quasi-elastic (QE) back scattering has been studied for the 28Si+154Sm system. In order to quantitatively understand the measured BD, quantum coupled channel (QCC) calculations have been performed. An attractive fact appears while the comparison of derived experimental BD for 28Si+154Sm with that existing for 16O +154Sm system [1]. A hump-like structure on the high-energy side of the BD appear as the experimental signature of collective-state excitations in 28Si. Furthermore, the QCC approach showed that such a structure can be well reproduced using coupled-channels calculations that approximate 28Si as a pure vibrator, despite its well established rotational nature. The resolution of this anomaly lies in the hexadecapole deformation of ^{28}Si; the contributions to the re-orientation coupling ($2^+ \rightarrow 2^+$) from the quadrupole deformation is largely canceled out by that from the hexadecapole deformation. In order to achieve this cancellation, one requires a large positive value of β_4 and we have used here the Möller-Nix value [2] of β_4= 0.25, a value also obtained from proton scattering experiments. Apart from this, we have observed the effect of negative value of hexadecapole deformation ($\beta_4 = -0.25$) of the ^{28}Si. It causes the shift in the high energy peak of the BD by ≈ 3 MeV towards higher energy side with respect to that for its positive value and makes the fitting to experimental BD worse. Hence, it confirms the value of β_4 for ^{28}Si to be positive. Although our results cannot be regarded as a measurement of this quantity, we believe that they do at least confirm that this nucleus does indeed possess a large positive hexadecapole moment. Thus QCC approach reveals that in addition to the inelastic excitation of permanently deformed target ^{154}Sm, large positive hexadecapole deformation of projectile ^{28}Si is responsible for the measured QE BD. Furthermore for the ^{28}Si+^{154}Sm system, the probability of the processes where incident flux may go apart from transmission and reflection (such as quasi-fission or non-compound fission, etc.) is negligible. Hence the QE BD will indeed be similar to that for fusion, although the former may be somewhat smeared. Thus, our results show that a large positive hexadecapole deformation of projectile ^{28}Si play a significant role in the fusion process of the ^{28}Si+^{154}Sm system.

REFERENCES

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