Analysis of fusion reaction data for $^{28}Si +^{96} Zr$ and $^{28}Si +^{154} Sm$ systems at energies around Coulomb barrier

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Introduction

Intense research work has been going on in the recent years around the globe to explain the observed enhancement in sub-barrier fusion over the standard 1-Dimensional Barrier Penetration model(BPM)predictions[1].Existing studies have suggested that the consideration of coupling of excited states of target and projectile in conjunction with nucleon transfer channels account for this enhancement[2].It has been found that presence of positive Q-value neutron transfer channel leads to enhancement of sub-barrier fusion[3, 4].However in some systems in spite of having positive Q-value neutron transfer channels no effect on sub-barrier fusion was observed[5, 6].Therefore in order to obtain unambiguous results in context to neutron transfer,in this conference contribution we present the results for $^{28}Si +^{96} Zr$and$^{28}Si +^{154} Sm$ systems.

Coupled Channel Calculations

In order to examine behaviour of sub-barrier fusion for $^{28}Si+^{96}Zr$ and $^{28}Si+^{154}Sm$ systems, coupled channel(CC)calculations are performed using the code CCFULL[7]. Major ingredients required for the calculation are the parameters of nuclear part of total interaction potential.Here we have used Wood-Saxon form with depthV_0=67.82MeV, radius r_0=1.176fm and the diffuseness a_0=0.662fm for$^{28}Si +^{96} Zr$ system while for $^{28}Si +^{154} Sm$, depth V_0 = 185MeV, radius r_0=1.11fm and diffuseness a_0=0.65fm are used.In addition to this the values of energy and deformation parameter of excited states of projectile and target used in the calculations are listed in table.

TABLE I: Excited states(λ^π) along with excitation energies(E_λ)and the corresponding deformation parameters(β_λ)used in coupled channel calculations[8].

Systems	λ^π	E_λ(MeV)	β_λ
^{28}Si	2^+	1.78	-0.407
	4^+	4.62	0.250
^{96}Zr	2^+	1.75	0.080
	3^-	1.90	0.283
^{154}Sm	2^+	0.081	0.341
	4^+	0.267	0.08

Results and Discussion

The calculated fusion reaction cross section for the systems$^{28}Si +^{96} Zr$ and $^{28}Si +^{154} Sm$ are shown in Fig 1(a)and 1(b) respectively. It becomes clear from figure that 1D-BPM model calculations are very far from experimental results for both the systems.However significant enhancement in fusion reaction cross section has been noticed on inclusion of coupling of excited states of projectile and target. Due to positive Q-value(4.77 MeV) for two neutron transfer channel for $^{28}Si +^{96} Zr$ system here we have also included the coupling to neutron transfer which eventually enhanced the fusion cross section which in turn further improves the matching between data and predictions specially in below barrier region.Inspite of having positive Q value (5.247 MeV) for the 2n transfer channel,neutron transfer effect remains insignificant for $^{28}Si +^{154} Sm$ system.It is pertinent to mention here that for ^{96}Zr there is increment in the deformation ($^{96}Zr(\beta_2 = 0.080) \rightarrow^{94} Zr(\beta_2 = 0.090)$) of the interacting nuclei after 2n trans-

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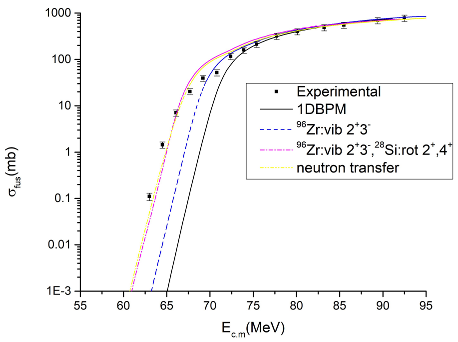
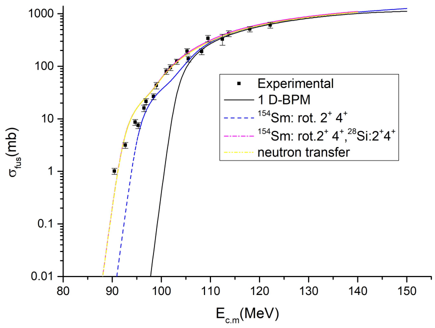


(a)$^{28}Si +^{96} Zr$



(b)$^{28}Si +^{154} Sm$

FIG. 1: Calculated fusion excitation function for the systems(a)$^{28}Si +^{96} Zr$and(b) $^{28}Si +^{154} Sm$.1-DBPM calculations are shown by solid line(black).Dash line(blue)give the result corresponding to coupling of excited states of target.While the coupling of excited states of both target and projectile is depicted with dash dot line(pink)The calculations for neutron transfer is shown by dash dot dot line(yellow). Data are taken from ref[9, 10]

fer.For ^{154}Sm deformation in target decreases after 2n transfer($^{154}Sm(\beta_2 = 0.341) \rightarrow^{152} Sm(\beta_2 = 0.3064)$).Now it clearly indicates that the enhancement in sub barrier fusion cross section may be caused by increase in deformation parameter after two neutron transfer.

Conclusion

In conclusion here we have examined the contribution of inclusion of coupling of excited states of target and projectile in conjunction with neutron transfer channel and found that an enhancement has been observed due to coupling of excited states of projectile and target particularly in below barrier region while above barrier region remain unaffected.Further it has been also observed that status of deformation in target after neutron transfer play a crucial role in the contribution due to neutron transfer coupling towards the fusion excitation function.

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