Analysis of Measured Fusion Cross Sections Near the Coulomb Barrier for the Reactions ^{32}S + ^{98,100}Mo, ^{32}S + ^{102,104}Ru ◇

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We present the results of the analysis for the measurements of the energy dependent total fusion cross sections $\sigma_{fus}(E_{cm})$ performed near and below the Coulomb barrier with the gas-filled spectrograph $Q3D$ for the reactions ^{32}S + ^{102,104}Ru and ^{32}S + ^{98,100}Mo [1].

A description of the experimental set up and the procedure of measurement can be found in [1]. The number of the Rutherford scattered projectiles and the evaporation residues are extracted from the energy spectra of two monitor counters and the anode part of the ionisation chamber, which measures the differential energy loss dE. For all three signals proper background corrections have been performed.

A background peak in the energy spectra of both monitor counters at an energy above the elastic peak can be attributed to scattering of beam particles on the slits at the entrance to the scattering chamber. In the analysis particular attention was paid to time-dependent fluctuations during measurement of the intensity and the inclination of the incoming beam relative to the target plane. Since the beam was focused only through a single aperture at the target position, the angle of the incoming beam could vary within about $\pm 0.55^0$ every time the beam was refocused after changing the energy. The cross section integrated over the angular acceptance ($\pm 3.2^0$) measured at a nominal angle of 0^0 [2] is very little influenced by this, because of its symmetric gaussian shape, whereas the 6.4^0 measurement is strongly affected.

Therefore only the $\sigma_0(E_{cm})$ are used for the determination of $\sigma_{fus}(E_{cm})$. Beam position correction is applied using the monitor spectra and the energy loss of the incoming projectiles at the capton foil and the N_2 gas between capton foil and target is taken into account. Normalisation of the relative σ_0 is achieved by calculating σ_{fus} for each reaction at a certain energy well above the Coulomb barrier assuming the efficiency of the $Q3D$ at the 0^0 position to be constant within the energy range of the measurement. The statistical model code CASCADE [3] and appropriate formulae [4], which estimate the FWHM of the angular distribution of evaporation residues behind the target by mainly taking into account the evaporation of particles from the compound nuclei and multiple scattering of the evaporation residues with the target nuclei, determine the linear development of the efficiency as a function of energy. With this information the $\sigma_{fus}(E_{cm})$ are corrected.

Finally for each reaction the barrier distribution $D_{fus}(E_{cm})$ [5] is calculated from the extracted $\sigma_{fus}(E_{cm})$ and compared to coupled channel calculations including measured form factors and slope parameters of the important transfer channels [6]. For the reactions ^{32}S+^{102,104}Ru the observed $D_{fus}(E_{cm})$ can be reasonably well reproduced by coupling all relevant inelastic and transfer channels. Here the $+2n$ transfer channel with positive Q_{eff} -value plays the most decisive role [7]. Coupling the $+2n$ -channel produces two barriers [8]. Since the Q_{eff} -value of the $+2n$ channel is larger for the reaction ^{32}S + ^{104}Ru than for ^{32}S + ^{102}Ru, for ^{32}S + ^{104}Ru the barrier at the higher energy has most of the weight, whereas for ^{32}S + ^{102}Ru both barriers share about an equal amount of weight. The analysis of $D_{fus}(E_{cm})$ for ^{32}S + ^{98,100}Mo is in progress.

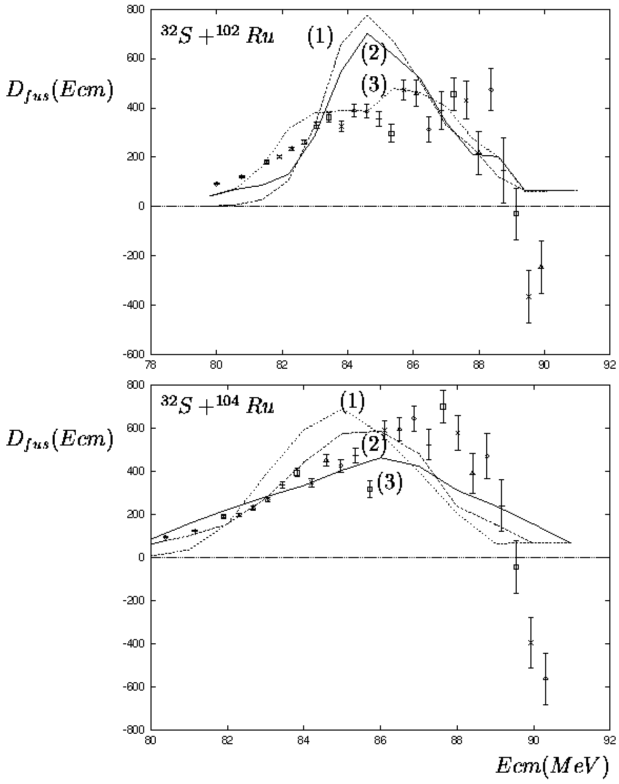

Fig. 1: The barrier distributions $D_{fus}(E_{cm})$ for the reactions ^{32}S + ^{102,104}Ru compared to CCFUS calculations: (1) including all inelastic and one-nucleon transfer channels; (2) including all relevant channels without the $+2n$ transfer channel; (3) including all relevant channels.

References

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