A NEW APPROACH TO TRANSFER AT THE COULOMB-BARRIER

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It is well known that for many systems the measured fusion cross sections in the sub-barrier region exceed simple tunneling calculations by several orders of magnitude. For the explanation of this effect coupling of inelastic channels is necessary but not sufficient. To explain both the large enhancement of fusion cross sections in some reaction systems and the variations of the sub-barrier fusion of neighbouring isotopes it is necessary to include transfer channels.

For this reason we measured the differential transfer cross sections for the systems $^{32}S \longrightarrow {}^{102,104}Ru$ in a wide angular range of $\theta_{lab} = 35° - 120°$ down to transfer probabilities of $1 \cdot 10^{-4}$. We were able to determine not only the atomic number but also the mass number of the ejectils. The measurements were performed at two energies below the barrier, one energy at and one energy above the barrier.

To determine transfer formfactors from these data, which are required for CCFUS calculations of fusion cross sections, a coupled channel model was developed which incorporates all the relevant transfer and inelastic channels simultaneously. It can be seen that for small closest distances of approach in transfer reactions coupling effects play an important role for the explanation of the transfer cross sections and also for the transfer formfactors.

With these formfactors we calculated the fusion cross sections for the fusion of $^{32}S + {}^{102,104}Ru$. We found, that transfer channels are responsible for half of the observed asymptotic barrier shift for the two systems. We also calculated the barrier distribution for these systems and compared them to measured data. Although the measured data of the barrier distributions are not very precise, we found a good agreement, especially for low barriers which arise from transfer channels.

In our measurements we observed 'slope anomalies' at energies at and above the Coulomb-barrier, which were also found in several measurements by other groups. We give a simple and straightforward explanation for this effect which solves the problem of the slope anomalies. With this explanation it is possible to determine transfer formfactors at energies above the Coulomb-barrier, which was not possible in the semiclassical approach up to now.

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