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Sub-barrier fusion and transfers in the 40Ca+58,64Ni systems

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Fusion-evaporation is the dominant reaction mechanism in medium-light heavy-ion collisions around the Coulomb barrier (CB). At these energies and at moderate sub-barrier energies, enhancement of the fusion cross-sections was observed whereas hindrance of the fusion cross-section has been identified in many systems at deep sub-barrier energies. Fusion cross-sections around the CB have been discussed extensively to be driven by couplings of the relative motion of the colliding nuclei to their low energy surface vibrations and/or stable deformations. The corresponding coupled-channel calculations and the distributions of barriers have revealed to be a powerful tool to better understand the role of couplings to collective degrees of freedom of the target and projectile. A review on heavy-ion fusion, discussing the low-energy features has been published recently by B. Back et al. [1].
Some of the most striking results on sub-barrier fusion have been obtained in the past in the Ni+Ni [2] systems and recently in the Ca+Ca systems [3].
As regards the Ca+Ca systems, deep sub-barrier fusion cross sections have been measured in the 40Ca+40Ca, 40Ca+48Ca and 48Ca+48Ca systems at the Laboratori Nazionali di Legnaro using the Tandem accelerator Ca beams. All Ca+Ca systems have shown hindrance of the fusion cross section at the lowest energies. For the asymmetric 40Ca+48Ca, hindrance effects show up at lower energies and this was attributed to large effects of positive Qvalue neutron transfers. These results have triggered the present study of the 40Ca+58,64Ni systems. Sub-barrier fusion excitation functions of 40Ca+58Ni and 40Ca+64Ni have been measured at the Laboratori Nazionali di Legnaro using the Tandem accelerator 40Ca beam at laboratory energies ranging from ELab = 104.75 MeV to 153.5 MeV [4]. Angular distributions have been measured above and below the CB and barrier distributions have been extracted from very accurate data. Coupled channel calculations have been performed with the CCFULL code using the Akyuz and Winther nuclear potential and taking into account the projectile and target inelastic excitations of the 2 and 3- states. Positive Qvalue neutron pair transfer was also included in the calculation for the 40Ca+64Ni system for which this work represents the 1st experimental sub-barrier fusion study. Importance of the transfer channels will be discussed.
A further experimental study to be performed using the Laboratori Nazionali di Legnaro PRISMA spectrometer and aiming at measuring the transfer channels cross sections in these systems will be presented.

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