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Fusion Hindrance and Pauli Blocking in 58Ni +64Ni

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We report here on the measurement of deep sub-barrier fusion cross sections for ^{58}Ni +^{64}Ni. In this system the influence of positive Q-value transfer channels on sub-barrier fusion was evidenced in a famous experiment by Beckerman et al. [1]. Subsequent experiments for the two symmetric systems ^{58}Ni +^{58}Ni and ^{64}Ni +^{64}Ni showed that fusion hindrance is clearly present in both cases. The lowest measured cross section for ^{58}Ni +^{64}Ni, however, was relatively large ($\sim$0.1 mb), so that no hindrance was observed. The present measurements have been recently performed at the XTU Tandem accelerator of LNL and the excitation function has been extended by two orders of magnitude downward.

The case of ^{58}Ni +^{64}Ni is very similar to ^{40}Ca+^{96}Zr [2] because of the flat shape of the two sub-barrier fusion excitation functions, originating from the couplings to several Q>0 neutron pick-up channels. ^{40}Ca+^{96}Zr was studied to very small cross sections (2μb) and fusion hindrance does not show up, suggesting [3] that this unusual behavior is due to the Q>0 transfer couplings, since the valence nucleons can flow freely from one nucleus to the other without being hindered by Pauli blocking [4].

Our experiment indicates that the flat trend of the sub-barrier cross sections for ^{58}Ni +^{64}Ni continues down to the level of $\sim 1\mu$b and fusion hindrance is not observed. This trend at far sub-barrier energies reinforces the suggestion that the availability of several states following transfer with Q>0, effectively counterbalances the effect of Pauli repulsion that, in general, is predicted to reduce tunneling probability inside the Coulomb barrier.

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[3] H. Esbensen et al., Phys. Rev. C 89, 044616 (2014)
[4] C. Simenel et al., Phys. Rev. C 95, 031601(R) (2017)

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