Measurements of fusion reactions induced by radioactive ^{132}Sn on ^{64}Ni

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Fusion reactions are used to synthesize heavy elements. The production yield decreases as the atomic number of the element increases. A great deal of effort has been put into finding optimal conditions for the production reactions. Experiments are carried out to study the dynamics of compound nucleus formation in lighter systems. It is discovered that the interplay of nuclear reaction and nuclear structure can significantly influence the fusion yields at energies near and below the Coulomb barrier. With the advent of neutron-rich radioactive beams from the fragments of uranium fission, one can explore fusion when there is a large number of neutron transfer channels with positive Q values present. This may pave the way for producing new neutron-rich heavy nuclei when the intensity of short-lived fission-fragment beams is sufficiently high such that it is practical for use in heavy element synthesis experiments.

At the Holifield Radioactive Ion Beam Facility, neutron-rich radioactive beams are produced by an isotope separation on-line technique. The fission fragments of proton induced uranium fission can be accelerated to energies above the Coulomb barrier. A beam of doubly magic ^{132}Sn was used to bombard a ^{64}Ni target and measure fusion excitation functions. The evaporation residues (ERs) were identified by their energy loss in an ionization chamber located at zero degrees and by time-of-flight. The fission fragments were detected by an annular double-sided silicon strip detector. The fragment-fragment coincidence and angular distributions were used to distinguish fission events from other reaction channels such as deep inelastic scattering.

The fusion cross sections for ^{132}Sn and ^{64}Ni below the barrier are enhanced as compared to other stable Sn isotopes on ^{64}Ni. The enhancement is essentially due to the larger radius of ^{132}Sn which lowers the Coulomb barrier. At energies well above the barrier, the reduced ER cross section [1] for ^{132}Sn induced fusion saturates at higher values than for the other stable Sn isotopes. The capture cross sections, which are the sum of fission and ER cross sections, can be well described by the Bass model [2] prediction. Detailed data analysis and model comparisons will be presented.

[1] D. J. Hinde and M. Dasgupta, Phys. Lett. B 622, 23 (2005).
[2] R. Bass, Nucl. Phys. A 231, 45 (1974).

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