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Reactions Induced by Neutron-Rich Nuclei[1]

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Nuclear reactions involving the fusion of neutron-rich nuclei allow us to study the properties of halo or other loosely bound projectile nuclei, such as ^{6}He and ^{11}Li and to form and study the properties of the heaviest nuclei. In the latter case, the n-rich projectile allows us to reach nuclei with large neutron numbers, with resulting longer half-lives (qualitatively changing the study of the atomic physics and chemistry of these elements) along with allowing increased production cross sections due to lowered fusion barriers and higher survival probabilities. In four typical reactions ^{32,38}S + ^{181}Ta, ^{27,29,31}Al + ^{197}Au, ^{124,132}Sn + ^{64}Ni and ^{32,38}S + ^{208}Pb, one observes enhanced fusion cross sections and most interestingly, large and unanticipated shifts of the fusion barrier heights for the most n-rich projectiles. The systematics of these shifts are presented and compared to ideas of neutron flow in these reactions. In a related measurement for the ^{124,132}Sn + ^{96}Zr reaction, no evidence for increasing fusion hindrance with increasing isospin of the system was found. The implications of these results for the synthesis of heavy nuclei using radioactive beams are discussed. The interaction of ^{6}He with ^{209}Bi and ^{238}U has been extensively studied. The fusion cross section is enhanced at sub-barrier energies and reduced above the barrier. Detailed calculations of the fusion excitation functions that consider breakup processes do reproduce the observed cross sections. The recent attempt to measure the fusion excitation functions for the ^{9,11}Li + ^{70}Zn reaction will be discussed.

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