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Isospin dependence in heavy-element synthesis in fusion-evaporation reactions with neutron-rich radioactive ion-beams

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Climbing up the “Island of Stability” and approaching the long-predicted next spherical neutron shell closure at N=184 is a persistent dream hampered, among others, by the lack of (i) sufficiently neutron-rich target and projectile combinations and (ii) insufficient knowledge about the projectile isospin (T=(N-Z)/2) dependence of the fusion neutron-evaporation residue cross section. With the advent of radioactive ion-beam facilities, which are delivering ever more intense neutron-rich ion beams, the answer to the latter question is now coming within reach.

“Hot-fusion” reactions based on relatively light (A ˜ 20 - 50) neutron-rich projectiles and heavy actinide targets have been exploited to access relatively neutron-rich isotopes of the heaviest elements. See, e.g. [1] for an overview of reactions with 48Ca leading to the most neutron-rich known isotopes, which belong to elements Z=112-118. Still, in these elements, the neutron number N=184 cannot be reached using complete fusion-evaporation reactions with stable isotope beams, and when going to yet heavier elements with Z˜122-124, cross sections are predicted to be orders of magnitude smaller than those nowadays accessible in even the most advanced and sensitive experiments. Therefore, to reach N=184, more neutron-rich radioactive beams of high intensity are required [2].

Systematic studies to investigate the role of isospin on the magnitude of fusion-evaporation reacations that include exotic neutron-rich radioactive beams are still scarce (see, e.g., [3]). We suggest pursuing the “hot-fusion” path in our investigations on the projectile isospin dependence of heavy element fusion-evaporation residue cross sections at Coulomb barrier energies by exploiting the Ar + Sm ⊠ Hg system [4] and using intense beams of exotic Ar isotopes available at the TSR [5]. Neutron-evaporation residues will be detected in an ultrasensitive nuclear chemical detection system [6], which is also applied for nuclear chemical studies of single atoms of superheavy elements [7].

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