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### Hot fusion or cold fusion, best route to the SHEs?<sup>1</sup>

WALTER LOVELAND, Oregon State University

Elements 102-113 have been synthesized using cold fusion reactions (Pb or Bi target nuclei, massive projectiles,  $E^*=13$  MeV, high survival probabilities, significant fusion hindrance). The production cross sections decrease with increasing  $Z_{CN}$  with a cross section of 27 fb being measured for element 113. Synthesis of elements 102-108 by hot fusion reactions (actinide target nuclei, intermediate mass projectiles,  $E^*=30-50$  MeV, low survival probability, small fusion hindrance) shows decreasing production cross sections for  $Z=102$  to  $Z=108$  and then the cross sections level out at a few pb out to  $Z=118$ . Upper limit cross sections for the production of  $Z=120$  nuclei in hot fusion reactions are  $\sim 0.1$  pb. How should one go forward to make nuclei with  $Z > 120$  or with large neutron numbers,  $N \sim 184$ ? The cross section for the production of an evaporation residue,  $\sigma_{EVR}$ , is  $\sigma_{EVR} = \sigma_{CN}W_{sur}$  where  $\sigma_{CN}$  is the complete fusion cross section and  $W_{sur}$  is the survival probability of the completely fused system. The complete fusion cross section can be written as  $\sigma_{CN} = \sum_{J=0}^{J_{max}} \sigma_{capture}(E_{c.m.}, J)P_{CN}(E_{c.m.}, J)$

where  $\sigma_{capture}(E_{c.m.}, J)$  is the capture cross section and  $P_{CN}$  is the probability that the projectile-target system will evolve inside the fission saddle point to form a completely fused system rather than reseparating (quasifission). I have used this formalism to make estimates of the best reactions to make new heavy nuclei using stable and radioactive beams. I conclude that stable beams offer the best opportunities to make new chemical elements and that radioactive beams offer new opportunities to make nuclei to study the atomic physics and chemistry of the heaviest elements. The radioactive beam reactions involve the light neutron-rich projectiles interacting in hot fusion reactions. If time permits I will also discuss recent experiments to make heavy nuclei using multi-nucleon transfer reactions.

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