Synthesis of superheavy elements using the dynamical cluster-decay model

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Superheavy elements (SHEs) have not been found in nature they can be produced in the laboratories by accelerating beams of nuclei and shooting them at the heaviest possible target nuclei. Fusion of two nuclei a very rare event occasionally produces a superheavy element. They generally exist for a short time. Theoretically and experimentally a number of studies has been done and many are being done. There are different types of phenomenological models to describe the reaction dynamics of heavy-ions, e.g., the dinuclear system (DNS) model, Langevin-type dynamical equations of motion. These are statistical models, based on CN fusion probability P_{CN} and the CN survival probability P_{surv}. However, the Dynamical Cluster decay Model (DCM) [1] is equally capable in determining the individual contributions of all decay cross sections in a nuclear reaction. The DCM, defines the compound nucleus decay/formation cross section of fragments for partial waves, within the DCM for each pair of exit/decay channels as;

$$\sigma = \frac{\pi}{k^2}\sum_{\ell=0}^{\ell_{max}}(2\ell+1)P_0P; \qquad k=\sqrt{\frac{2\mu E_{c.m.}}{\hbar^2}} \tag{1}$$

According to theoretical predictions, the island of stability is believed to be near the neutron shell at N=184 and proton shells at Z=120-126. Using the DCM with the different configurations, coplanar ($\Phi_c = 0^0$) and non-coplanar degree of freedom ($\Phi_c=0^0$) a number of cases have been studied, i.e., Z=116, 118, 120 and 122 [2]. Now, we are interested in the predicted cross sections for Z=126 using the DCM. We are doing the calculations to predict the cross sections for possible decay channels using these combinations: ^{160}Gd+^{150}Sm, ^{164}Dy+^{146}Nd and ^{182}W+^{128}Te. Although, we cannot claim our predicted results without any experimental verification but our theoretical predictions may be helpful for experiments to move in a proper direction.

References:

[1] R. K. Gupta, S. K. Arun, R. Kumar, and Niyti, Int. Rev. Phys. (IREPHY) 2, 369 (2008).

[2] Sahila Chopra, Neetu Goel, Manoj K. Sharma, Peter O. Hess and Hemdeep, Phys. Rev. C.106 L031601 (2022).