Potential energy landscape of superheavy ^{298}119

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Introduction

A potential energy surface (PES) is a mathematical model that defines the energy of a system, particularly a group of atoms, in terms of certain characteristics, typically the atoms' locations. If there is only one coordinate, the surface is called a potential energy curve or energy surface. The nuclear potential-energy surface (NPES) was computed by Larsson [1] using the modified oscillator model(MOM), which included the degrees of freedom of axial asymmetry.

The regions studied were the actinide and superheavy element (SHE) region. A mapping from the microscopic shell model space to a geometrical model is used [2] to predict the PES of some superheavy nuclei(SHN). The shell model space's content was determined by absolute deformation and a single-particle spectrum as a function of deformation. The three-cluster model PESs are used [3] to investigate ternary fission of SHN. The stability of SHN has been anticipated to be connected with Z = 114, 120, and 126 and N = 184 due to shell effects.The impact of the relative orientations of deformed nuclei on the PESs, as well as the evaporation residue cross sections of particular cold fusion events leading to SHE, are explored [4] using a dinuclear system model(DSM).

In the SHN mass region, PESs corresponding to alpha accompanied ternary fragmentation have been [5]explored. The arrangement with the alpha particle in between the other two components has the lowest potential energy value. The deepest dips on the PES reflect the most likely tri-partition of a specific nucleus. Bender et al.,[6] explore the structure of the PESs of the SHN Z= 100,108,112,114 and 120 using self-consistent nuclear models, such as relativistic mean-field(RMF) model and the Skyrme-Hartree-Fock (SHF) approach. The ground state potential energy (PE) and spontaneous-fission (SF) half-lives are investigated [7] in a broad range of even even nuclei with in the atomic number range Z = 100 to 130 and neutron number range N = 140 to 210. The macroscopic-microscopic approach was used to compute PESs and fission barriers of SHN. The Lublin-Strasbourg Drop (LSD) model was employed [8] to calculate the macroscopic part of the energy, while the shell and pairing energy corrections are made using the Yukawa-folded potential, the barrier heights are determined using a normal flooding technique. Calculations of PESs [9] in even-even SHN demonstrate the possibility of multi quasiparticle states with deformed axially symmetric geometries and huge angular momenta at low excitation energies.

There is a need to study the potential energy surface for fission studies. In the present work, the FRLDM model is used to study the influence of the Potential-Energy Surface (PES) on the dynamical evolution of a fissioning superheavy nuclei nucleus ^{298}119.

Theoretical Framework

To study the potential energy surface, Langevin equations have been solved in a three dimensional deformation space for the collective coordinates {q1, q2, q3}.The co-ordinate q1 is connected to elongation, where as, q2 and q3 are connected to neck constriction and left-right mass-asymmetry of the nucleus, respectively. The calculations are executed by the FRM-epot code given by the Nadtochy et al.,[10]

Results and Discussions

The potential energy surface of symmetric fissioning nuclei is computed by assuming

q_3 = 0. Figure 1 shows the potential energy landscape at $L = 0\hbar$ in the (q_1, q_2) plane.

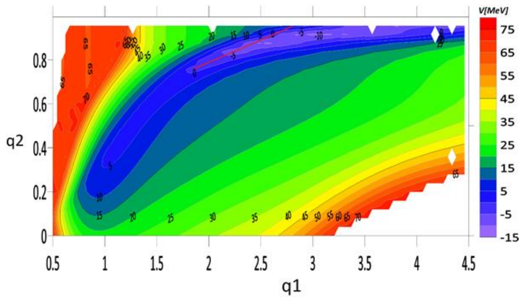

Fig. 1 Two-dimensional {q_2, q_1} potential energy surfaces with q_3 = 0 for ^{298}119 calculated with the FRLDM for $L = 0\hbar$. Red line guide the eye along mean fission paths.

The elongation of the nuclei is assumed to zero by substituting q_1 = 0. The potential energy landscape in the (q_3, q_2) at $L = 0\hbar$ plane is shown in the figure 2.

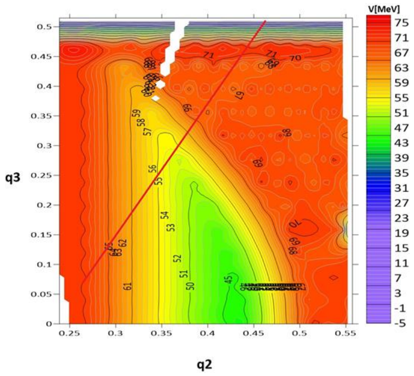

Fig. 2 Two-dimensional {q_3, q_2} potential energy surfaces with q_1 = 0 for ^{298}119 calculated with the FRLDM for $L = 0\hbar$. Red line guide the eye along mean fission paths.

The same potential energy landscapes in the planes ($q1$, $q2$) and ($q3$, $q2$) at $L = 0\hbar$ and $L = 20\hbar$ are shown in the figures 3 &4. The mean fission paths are also highlighted in the figures. These figures gives the topography of the potential energy landscape of the superheavy nuclei ^{298}119. Laboratories such as GSI, JINR and RIKEN are attempting to synthesis superheavy nuclei ^{298}119 through various fusion reaction, at this moment present study finds importance in studying its fission properties

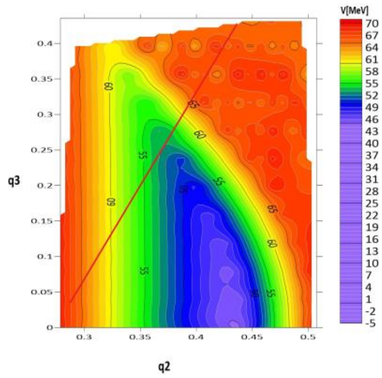

Fig. 3 Two-dimensional {q_3, q_2} potential energy surfaces with q_1 = 0 for ^{298}119 calculated with the FRLDM for $L = 20\hbar$. Red line guide the eye along mean fission paths.

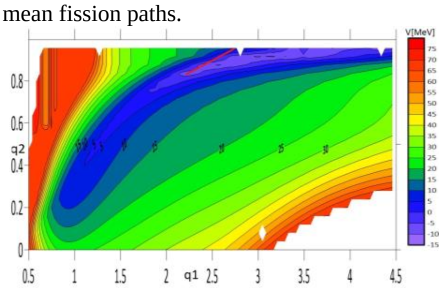

Fig. 4 Two-dimensional {q_2, q_1} potential energy surfaces with q_3 = 0 for ^{298}119 calculated with the FRLDM for $L = 20\hbar$. Red line guide the eye along mean fission paths.

Summary

Potential energy landscape for superheavy nuclei ^{298}119 is presented with in FRLDM model by solving Langevin equations in a three dimensional deformation space for the collective coordinates {q1, q2, q3}. Mean fission paths are also highlighted.

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