Nonlocality and deformation in alpha and cluster decay of superheavy nuclei

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Alpha decay was the first radioactive decay process to be systematically studied. It was first observed by Rutherford in 1899 and occurs in heavy nuclei (HN). Later, another type of radioactive decay, known as cluster decay, was proposed by Sandulescu, Poenaru, and Greiner in 1980 [1] and experimentally discovered by Rose and Jones in 1984 [2]. Both decay modes have also been observed in superheavy nuclei (SHN) [3], defined as nuclei with atomic number $Z > 103$. Since SHN lie at the limits of nuclear stability, studying their decay properties is essential for improving our understanding of nuclear structure and stability. Therefore, the present work incorporates two important ingredients into the theoretical framework: nonlocality and nuclear deformation within a preformed cluster model of decay. Specifically, it aims to investigate the role of nonlocal nuclear potentials between the α particle or light cluster and the daughter nucleus which are preformed inside the decaying parent. Majority of cluster decays such as those including the emission of a ^{14}C, ^{20}O, ^{28}Mg or ^{23}F (which can be deformed) leave behind a spherical daughter nucleus. On the other hand, alpha decays can involve deformed daughters. To account for these effects, we evaluate the interaction potential including nonlocality and deformation within the double-folding model (DFM). Effects of nonlocality and deformation were found to be significant in the case of heavy nuclei [4] and necessitates a similar investigation in the case of SHN. Sensitivity of SHN decay rates to deformation and nonlocality will be presented along with a comparison to available data. However, the decay data for SHN is scarce and we expect the results to motivate experiments in future.

References

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