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Evaluation for half-lives in the α-decay chains of $^{309-312}126$ based on semi-empirical approaches

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Abstract. In this paper, we estimated half-lives using semi-empirical formulae for isotopes with $Z = 100 - 126$ in four α-decay chains, which can appear in the syntheses of the $^{309-312}126$ nuclei. The spontaneous fission half-lives were calculated using the Anghel, Karpov, and Xu models, whereas the α-decay ones were predicted using the Viola-Seaborg, Royer, Akrawy, Brown, modified formulae of Royer, Ni, and Qian approaches. We found that there are large differences among the spontaneous fission half-lives estimated using the Xu model and those calculated using the others, which are up to 50 orders of magnitude. The α-decay half-lives also have large uncertainties due to difference in either methods or uncertainties in nuclear mass and spin-parities. Subsequently, there is an argument in determination of α-emitters, especially for the $^{312}126$ isotope. On the other hand, the α-decay half-lives are in the range from a few microseconds ($^{309-312}126$) to thousands of years ($^{257-260}$Fm) in the decay chains. It was found that the half-lives are very sensitive to not only the shell closure but also the angular momentum in the α decay. For experiments, with relatively long half-lives (a few milliseconds), the $^{289-292}$Lv isotopes can be observed as evidences for syntheses of the unknown super-heavy $^{309-312}126$ nuclei. Furthermore, measurements for precise mass, fission barrier, and spin-parity are necessary to improve accuracy of half-life predictions for super-heavy nuclei.

Keywords: super-heavy nuclei, alpha decay, spontaneous fission, fission barrier, half-life

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