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Examining evidence for a shorter ^{146}Sm-^{142}Nd chronology in the early solar system

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^{146}Sm, as an extinct p-process isotope, plays an irreplaceable role in the time-line construction of the early solar system (ESS) and the geochemical tracing via its α decay to ^{142}Nd. Persistent debate on both measured and theoretical half-lives of ^{146}Sm results in a large uncertainty in the initial ^{146}Sm abundance of the ESS and subsequent dating of planetary events after the birth of the Sun. In this study, a newly-proposed technique was used to analyze the α decay process within the widely-employed α-core nuclear potentials, namely, three different Woods-Saxon shapes and the double-folding potential. The half-life is obtained through large-scale random sampling of parameters for each potential, with the robust results subjected to statistical analysis. Additionally, a well-founded extrapolation for α decay energy of ^{146}Sm, based on the systematic behavior of the neighboring decay chain, is in perfect agreement with the adopted experimental value, further supporting the present evaluation on this crucial half-life. As a result, the half-life of ^{146}Sm was determined to be 71.74 ± 7.39 million years with a 95% confidence interval. The initial ^{146}Sm/^{144}Sm ratio of 0.0092 ± 0.0014 at 4568 (± 10) Ma, corresponding to the formation of the solar system, is then determined, further leading to a reduced timescale for various planetary silicate mantle differentiation events of the ESS. It is expected that this study paves the way for a theoretically calibrated ^{146}Sm-^{142}Nd chronometer in future studies of nucleosynthesis, earth and planetary astrophysics.

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