

# Decay Mechanisms in Superheavy Nuclei: A Detailed Study of Rf and Hs Isotopes

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**Abstract.** The decay properties of the isotopes of rutherfordium ( $134 \leq N \leq 190$ ) and hassium ( $142 \leq N \leq 189$ ) are examined through a detailed analysis of their half-lives for various decay modes, including  $\alpha$ -decay, cluster-decay,  $\beta^-$ ,  $\beta^+$ -decay, and spontaneous fission.  $\alpha$  and cluster-decay half-lives are calculated using the Unified Fission Model with a Woods–Saxon potential [1–3], while analytical formulas are employed for  $\beta$ -decay [4, 5] and spontaneous fission [6]. A preliminary comparison of four mass models (LDM, DZ28, WS4, FRDM), enhanced via machine learning techniques [7], identifies the improved WS4 model as the most reliable for predicting  $\alpha$ -decay  $Q$ -values. Using this model, the competition between decay modes is systematically investigated. The analysis reveals that  $\alpha$ -decay and spontaneous fission overwhelmingly dominate over cluster emission and  $\beta$  processes. Based on these results, we identified three decay chains for rutherfordium and sixteen for hassium. The high degree of alignment between our predictions and the available experimental observations provides a robust framework for evaluating hassium decay chains which remain unconfirmed by laboratory experiments.

## References

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