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Investigating Branching Points and Isomeric Influences in the s-Process \newline near A -180

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near A ~ 180

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Abstract

The slow neutron capture process (s-process) near A ~ 180 plays a critical role in stellar nucleosynthesis, with isomeric states significantly influencing nuclear reaction pathways[1]. These states, characterized by their unique decay properties and long half-lives, act as branching points that redirect the nucleosynthetic flow under stellar conditions. In particular, isomeric states allow for neutron capture over extended timescales, thereby modifying isotopic abundances and affecting the relative ratios of heavy elements. Moreover, the presence of isomers in nuclei such as 176Lu, 186Re, and 192Ir introduces additional pathways[2], which are sensitive to the temperature and neutron density of the stellar environment. Understanding these mechanisms is crucial for accurate modeling of nucleosynthesis in asymptotic giant branch (AGB) stars and other astrophysical sites[3].
Our study focuses on calculating the effective thermalization temperature formalism to analyze the astrophysical importance of long-lived isomeric states[4, 5], such as 176Lu (7−, 122.845 keV, T1/2 = 3.67 h), 186Re (8+, 148.3 keV, T1/2 = 2.0 × 105 yr), and 192Ir (11−, 168.1 keV, T1/2 = 241 yr)[6]. These nuclei serve as branching points within the s-process due to their long half-lives and distinct spin states, which impact neutron capture and decay chains. By integrating these isomeric states into computational nuclear networks, we aim to resolve discrepancies in abundance predictions for elements in this mass region. This study underscores the necessity of precise nuclear data for isomers in the A ~ 180 region to refine stellar models and improve our understanding of heavy-element synthesis in the universe.

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