First-Forbidden Transitions in N=126 Isotones and R-Process Nucleosynthesis

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The evaluation of β-decay rates, particularly at waiting point nuclei, is one of the important issues for the r-process nucleosynthesis. Here, we study β-decays of N =126 isotones by shell model calculations to see the effects of the calculated rates on the r-process nucleosynthesis at the third peak region of the element abundances. The experimental information on nuclei at this region is lacking, and theoretical half-lives of the isotones differ more among various calculations compared to the case of N =82 [1]. Evauation of the first-forbidden (FF) contributions to the rates by shell model calculations is also lacking.

Both the Gamow-Teller and FF contributions are taken into account to obtain the half-lives of the waiting point nuclei. The FF transitions are found to be important to reduce the half-lives of the isotones. The calculated half-lives are shorter than the standard half-lives of Ref. [2] by about 2$\sim$8 (1.4$\sim$2) times for even (odd) Z. These short half-lives are applied to r-process element synthesis network. The third peak of the element abundances is found to be slightly shifted to higher mass region [3]. The shift is a robust effect independent of astrophysical conditions for the supernova explosions.

Analysis of FF transitions in nuclei with Z =78$\sim$80 and N =126, where experimental data are available [4] , will be also reported.

References

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