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Evaluation of the astrophysical rates of the ^{42}Ti$(p,\gamma)^{43}$V and ^{43}V$(p,\gamma)^{44}$Cr reactions

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In this study we estimated the astrophysical rates of the ^{42}Ti$(p,\gamma)^{43}$V and ^{43}V$(p,\gamma)^{44}$Cr reactions and their variations due to mass uncertainties of the ^{43}V and ^{44}Cr exotic nuclei in the rp-process. The associated photodisintegration related to the $(p,\gamma)-(\gamma,p)$ equilibrium is also considered. The results show that the photodisintegration-rate variation of the ^{42}Ti$(p,\gamma)^{43}$V and ^{43}V$(p,\gamma)^{44}$Cr reactions are decreased at higher temperatures. The proton-capture rate variation between those reactions at T_9 = 0.5 is about 35% while it is approximately 60% at T_9 = 2.0. We found that the rate variation less than 20% if the precise mass of 10 keV can be achieved. To reduce the variation of the astrophysical rates, the precise mass measurements using MR-TOF technique at future facility RAON is suggested. Therefore, we also analyzed the resolving power, mass precision, counting rate, timing spread, and the half-life of the exotic isotopes for the MR-TOF technique. It is found that to achieve a mass accuracy of 0.1 ppm at the resolving power 10^5, a counting number of 10^4 is required for the isotopes. In addition, the half-life of the exotic nuclei must be longer than 10 ms for the reflections in the measurements using MR-TOF systems.

Keywords: mass uncertainty, reaction rates, rp-process, MR-TOF technique, exotic isotopes, timing spread, resolving power.

Field of your work

Astrophysics

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