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Astrophysical Impact of Recent Measurements of the 23Na(α,p)26Mg Reaction

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The
23 Na(α,p) 26 Mg reaction has been identified as having a significant impact on the nucleosynthesis of elements, such as
23 Na [1] and 26 Al [2], in massive stars, and of light isotopes in
type-Ia supernovae [3]. We will present new experimental results, as well as a combined reaction rate based on all available data, and an assessment of its astrophysical impact on massive stars and type-Ia supernovae.
Until 2014 this reaction was only measured in experiments which suffered from normalisation issues. Accordingly, reaction rate compilations such as REACLIB preferred Hauser-Feshbach statistical reaction rates, whose uncertainty may be greater than a factor of 3 for alpha-induced reactions. These uncertainties may be further compounded by the relatively light nuclei involved, where the level density is low. An improved experimental measurement was therefore suggested in reference [2]. Since 2014 there have been several measurements of the reaction utilising various new techniques to avoid the earlier experimental issues [4 –8]. All of the experiments have found results consistent with one another, as well as with Hauser-Feshbach predictions in the energy range E cm = 1.7 − 3.0 MeV.
We have directly measured new angular distributions using the setup in reference [5] and have corrected the data in references [4, 6] based on these angular distributions, in order to reduce their systematic uncertainty. From these corrected data we calculate a new, combined, experimental reaction rate. We have then implemented this reaction rate into astrophysical models of massive stars and type-Ia supernovae to identify its impact on the nucleosynthesis of key isotopes, and from these provide improved constraints on abundances. These constraints may help to identify the primary astrophysical site of
26 Al production.
The impact of this new experimental rate on hydrostatic shell burning in massive stars, explosive burning in massive stars, and type-Ia supernovae was determined using the nuclear post-processing codes ppn [9] and a delayed detonation model reference [10]. The change in abundance of isotopes in the region of A = 20 − 30 was calculated and compared to REACLIB reaction rates, along with the uncertainty in isotopic abundances. The impact of these results on galactic
23 Na and 26 Al production will be discussed.

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