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Exploring late stages of massive stars evolution in the context of new precise nuclear reaction rates

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In recent years, new experimental determinations of nuclear reaction rates relevant to astrophysics have been obtained using experimental (direct and indirect) and theoretical methods, highlighting specific trends such as the unexpected fusion hindrance phenomenon for ions or multiple resonances. Especially, a precise determination of the nuclear reaction rates is a crucial ingredient in understanding stellar evolution using stellar evolution models. We now need to take into account these new results, which can provide one of the keys to a better understanding of stellar and chemical evolutions.

New direct measurements of the $^{12}C+^{12}C$ nuclear reaction at very low energies have been obtained by the STELLA collaboration in France, paving the way for improvements in stellar evolution modelling. Using the evolution code GENEC, we computed a grid of models (8-30 $M_{\odot}$) including rotation. We show the change of nuclear rates impacts the core properties, burning lifetime and nucleosynthesis. We highlight an enhanced effect due to rotation and a strong dependence on the stellar mass related to the observed resonance (Dumont 2024, revised). Finally, we will discuss the potential hindrance effects for the $^{12}C+^{16}O$ and $^{16}O+^{16}O$ nuclear reactions involved in later evolutionary stages, which will be measured as part of the CarbOx project.

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