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New $^{12}\text{C}(\alpha, \gamma)^{16}\text{O}$ reaction rate and its astrophysical implications

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The $^{12}\text{C}(\alpha, \gamma)^{16}\text{O}$ reaction is one of the most crucial reactions in nuclear astrophysics, and thus in the past several decades attracts great efforts that further our understanding of this fundamental reaction [1]. The properties of several states in ^{16}O strongly affect the $^{12}\text{C}(\alpha, \gamma)^{16}\text{O}$ reaction rate. In recent years we developed an independent technique based on the $(^{11}\text{B}, ^7\text{Li})$ transfer reaction [2,3], and with this technique constrained the contributions from the external capture [4] and two subthreshold resonances [5,6] by measurement of properties of the ground state and the excited states at $E_x = 6.917$ MeV and 7.117 MeV in ^{16}O . An increase of up to 21% in the total reaction rate is found within the temperature range of astrophysical relevance compared with the previous recommendation of a recent review. The updated $^{12}\text{C}(\alpha, \gamma)^{16}\text{O}$ reaction rate decreases the lower and upper edges of the mass gap of black holes about 12% and 5%, respectively [7]. Furthermore, we found that in a sufficiently hot and dense astrophysical environment the $^{12}\text{C}(\alpha, \gamma)^{16}\text{O}$ rate is enhanced by a factor of 8.1 at typical temperature of 0.1 GK in inner AGB stars due to change of the effective width of the excited state at $E_x = 9.558$ MeV of ^{16}O . Such enhanced rate well matches the observations of single CEMP stars with the stellar modelling, and thus presents an explanation of the formation of single CEMP stars [8].

References:

- [1] R. J. deBoer, J. Görres, M. Wiescher et al., *Rev. Mod. Phys.* 89, 035007 (2017).
- [2] Y. P. Shen, B. Guo, T. L. Ma et al., *Phys. Lett. B* 797, 134820 (2019).
- [3] Y. P. Shen, B. Guo, W. P. Liu, *Prog. Part. Nucl. Phys.* 119, 103857 (2021).
- [4] Y. P. Shen, B. Guo, R. J. deBoer et al., *Phys. Rev. Lett.* 124, 162701 (2020).
- [5] Y. P. Shen, B. Guo, Z. H. Li et al., *Phys. Rev. C* 99, 025805 (2019).
- [6] W. Nan, Y. P. Shen, B. Guo et al., *Phys. Rev. C* 109, 045808 (2024).
- [7] Y. P. Shen, B. Guo, R. C. DeBoer et al., *Astrophys. J.* 945, 41 (2023).
- [8] G. Fu, Z. An, S. Jin, B. Guo, submitted.

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