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Extending the Hoyle-state paradigm to ^{12}C + ^{12}C fusion

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Carbon burning is a key step in the evolution of massive stars, Type 1a supernovae and superbursts in x-ray binary systems. Determining the ^{12}C+^{12}C fusion cross section at relevant energies by extrapolation of direct measurements is challenging due to resonances at and below the Coulomb barrier. A study of the ^{24}Mg(α,α')^{24}Mg reaction has identified several 0^+ states in ^{24}Mg, close to the ^{12}C+^{12}C threshold, which predominantly decay by ^{20}Ne(g.s)+α. These states were not observed in ^{20}Ne(α,α_0)^{20}Ne resonance scattering suggesting that they may have a dominant ^{12}C+^{12}C cluster structure. Given the very low angular momentum associated with sub-barrier fusion, these states may play a decisive role in ^{12}C+^{12}C fusion in analogy to the Hoyle state in helium burning [1]. We present estimates of updated ^{12}C+^{12}C fusion reaction rates based on these newly observed potential resonances.

[1] P. Adsley. M. Heine, D.G. Jenkins et al., Phys. Rev. Lett. (in press)

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