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Enhancement of the Triple-Alpha Reaction Rate in Hot, Dense Environments[1] SAM M. AUSTIN, RICHARD H. CYBURT, NSCL/Michigan State Univ — In typical helium-burning stars, the rate of the triple-alpha (3α) reaction depends primarily on the radiative width of the 0^+ state at 7.65 MeV in ^{12}C (the Hoyle state) as observed in the laboratory. At sufficiently high temperatures (T) and densities (ρ), however, interaction with particles in the astrophysical environment can induce de-excitation of the Hoyle state. This effectively increases the relevant width of the Hoyle state and thereby the 3α rate. The strength of these processes is given by the inverse of inelastic scattering rate leading to the Hoyle state. The strength of some of these processes can be obtained from experiment. Earlier measurements of excitation of the Hoyle state by inelastic proton and alpha scattering showed that these enhancements can be significant. This is not possible for induced de-excitation from the Hoyle state to the 2^+ state at 4.44 MeV; inelastic scattering from the excited 2^+ state to the Hoyle state is not measurable. Given possible ranges of T and ρ one anticipates that only de-excitation by protons, neutrons and alpha particles might be important. There is no information at relevant energies for neutrons. In the present work we have used experimental cross sections where available, supplemented by TALYS calculations to provide cross sections for unobservable (2^+ to 0^+) cross sections or unobserved energy ranges. We find that enhancements can be significant in reactions preceding the r-process in supernovae.

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