Nuclear Fusion in Dense Matter: A Single Equation for the Reaction Rate*

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We have been analyzing the nuclear fusion rate for five different nuclear burning regimes in dense matter (two thermonuclear regimes, two pycnonuclear ones, and the intermediate regime). The rate is determined by Coulomb barrier penetration in dense environments and by the astrophysical S-factor at low energies. We evaluate previous studies of the Coulomb barrier problem and propose a simple phenomenological formula for the reaction rate which covers all cases. The parameters of this formula can be varied, taking into account current theoretical uncertainties in the reaction rate. The S-factor at stellar energies depends on a reliable fit and extrapolation of the experimental data. We calculate the energy dependence of the S-factor using a recently developed parameter-free model for the nuclear interaction, taking into account the effects of the Pauli nonlocality.

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