The Physics of Reaction Rates in Stellar Environments

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Abstract

The nuclear energy generation and the origin of the elements in stars is controlled by the reaction rates of nuclear processes. Thermonuclear reaction rates drive stellar evolution and stellar explosions, pycnonuclear reaction rates control the energy production in high density environments as found in White Dwarfs or the crust of Neutron stars. The nuclear reaction rates depend sensitively on the nuclear reaction cross sections and are typically defined by low energy threshold phenomena. These phenomena are extremely difficult to measure and therefore depend largely on theoretical interpretations; this introduces large model dependent uncertainties into the reaction rate. I will demonstrate these phenomena on the example of a number of carbon driven nuclear fusion processes, 12C(,)16O, 12C+12C, which define the ignition conditions of type Ia supernovae and fusion between very neutron rich carbon isotopes which have been predicted as internal heat source in the deeper layers of the neutron star crust.