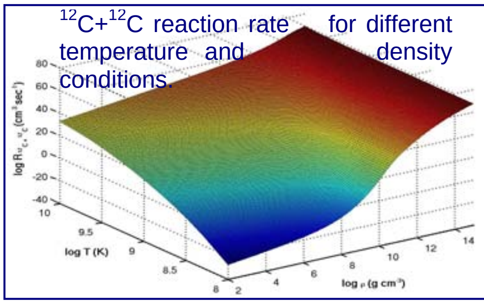
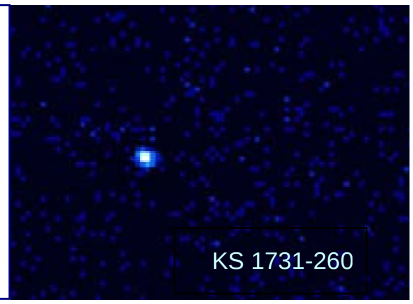
From thermonuclear to pycnonuclear carbon burning





Nuclear processes in stellar matter are either driven by high temperature conditions (thermonuclear burning) or by extreme pressure conditions (pycnonuclear burning). We have developed a new formalism to consistently model nuclear fusion processes at all phase conditions of stellar matter.

A classical case is the fusion of $^{12}C+^{12}C$ which controls carbon burning during late stellar evolution, triggers Type-I supernova explosions of white dwarf matter, and ignites X-ray super bursts in the crust of accreting neutron stars. All these events take place at completely different temperature density conditions. It is important to define the ignition conditions of the fusion process for all of these scenarios.

Based on the new formalism we have re-evaluated the ignition conditions for carbon burning for different temperature and density stellar environments. Also calculated have been the limiting time scale conditions for carbon burning ranging from t = 1 s, for type Ia Supernova explosions, to t = 10 Gy corresponding to the age of the Universe. The results indicate that for low densities ignition

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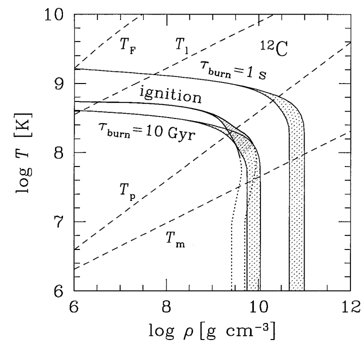

The Doppler shift and the shape of the γ-decay transition from the 4.03 MeV resonance state corresponds directly to the lifetime of the state

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