# Simplified Hydrostatic Carbon Burning in White Dwarf Interiors

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## 1 Problem Definition

This project aims to develop a library to model and solve the set of nuclear reactions that occur in white dwarf interiors approaching ignition in SNeIa.

## 2 Terms

- $\lambda$ is the thermally averaged cross-section or rate of occurrence per particle per unit time - seems like fixed values.
- Type Ia supernovae (SNeIa) - thermonuclear explosion of white dwarf stars
- White dwarf stars - Stars composed of electron-degenerate matter; said to be the final stage of some stars.

## 3 Features of Proposed System

- System takes in temperature and density values; initial C/O ratio given by nuclide mass fractions $X(^{12}C) = 0.3$ and $X(^{16}O) = 0.7$ but reasonable variations allowed.
- Find values of $\lambda$
- Find rates of different reactions at equilibrium
- Equilibrium mol fractions of trace nuclei can be calculated directly using Eq (13) in paper.
- Time scales can be calculated using equilibrium values. Alternatively, reverse calculation/missing values can be found using timescale information from given Table 1.
- System of equations can be solved to determine when equilibrium occurs, produce decay graphs.
- All values can be found in terms of the $^{12}C$ mol fractions.

Stretch goals:

- Find different behaviour for different concentration - is similar for reasonable changes to proposed ratio, but we might have to read more literature to do this.

# 4 General Notes

- Phases of evolution in the pre-explosion phase
  - Cooling phase - cooling to constant density after birth
  - Accretion phase
  - Simmering phase
  - Thermonuclear flash
  - Thermonuclear runway
- N1 traces the decay of major elements to generate $^{13}C$ from $^{12}C$.
- N2 includes the effects of leak reactions that occur at different densities due to different rates of production of reacting species. This produces properties of full network at 5% level, i.e. its time evolution reflects the time evolution of the full network.