Master Internship project – Erasmus Mundus

Place : Grand Accélérateur National d'Ions Lourds (GANIL) / Laboratoire de Physique Corpusculaire de Caen (LPC Caen)

Title : CORE-COLLAPSE SUPERNOVA AND IMPACT OF NUCLEAR PHYSICS INPUTS

Project type : nuclear astrophysics : theoretical

Scientific context and project details:
This project sets itself in the theory of core-collapse supernova. In particular, it aims to study the impact of some key input data on the core-collapse dynamics of massive stars.

At the end of their life, stars with a mass greater than 8-10 times the mass of the Sun collapse under the action of the gravitational force, before exploding in a catastrophic event known as supernova. The physical conditions in density and temperature encountered during the collapse are so extreme that it is not currently possible to reproduce them exactly in terrestrial laboratories. Numerical simulations are therefore needed. The collapse dynamics and the consequent explosion depend in a crucial way on both nuclear physics and astrophysical inputs. Among the different microscopic ingredients, the equation of state of hot dense stellar matter and the electron-capture process play a key role.

During the Master internship, a theoretical study of nuclear physics input data crucial in the supernova dynamics will be performed. In particular, the study will be focused on the treatment of electro-weak processes (electron captures), that are of utmost importance in the collapse dynamics and evolution. Moreover, numerical simulations of the core collapse will be carried out and an improved prescription for the electron capture shall be implemented. This will allow one to perform systematic analyses of the impact of these input data on the collapse dynamics and on the supernova observables.

Prerequisites:
- Physics courses at bachelor level;
- Understanding of program languages (e.g. Fortran) and linux-based system at bachelor level.

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