

# The Structure and Signals of Neutron Stars, from Birth to Death



Contribution ID: 24

Type: **not specified**

## Phase diagram of nuclear matter in the stellar medium

*Monday 24 March 2014 14:50 (20 minutes)*

Dense matter as it can be found in core-collapse supernovae and neutron stars is expected to exhibit different phase transitions which impact the matter composition and equation of state, with important consequences on the dynamics of core-collapse supernova explosion and on the structure of neutron stars. In this talk we will address the specific phenomenology of two of such transitions, namely the crust-core solid-liquid transition at sub-saturation density, and the possible strange transition at super-saturation density in the presence of hyperons' degrees of freedom.

The opening of hyperons degrees of freedom at the super-saturation densities corresponding to the neutron stars core modifies the equation of state, with important consequences on the total mass and radius of the star, as well as possible effects on the neutrino dynamics. The conditions of existence of such a phase transition and its observable consequences will be discussed in the framework of the self-consistent relativistic as well as non-relativistic mean-field approach. The need of constraints from laboratory data will be highlighted.

Concerning the neutron star crust-core phase transition at zero and finite temperature, a Nuclear Statistical Equilibrium model will be presented including in-medium modifications of the clusters self-energies consistently calculated from realistic nuclear effective interactions. Some quantitative results relevant for the structure of neutron star crusts and the supernova dynamics will be shown.

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**Session Classification:** Afternoon session - Parallel B