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# Numerical modeling of core-collapse supernovae and neutron star formation

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The gravitational collapse of massive stars that reach the end of their lives leads to the onset of powerful core-collapse supernova (CCSN) explosions that can be observed at cosmological distances.
Moreover, these events are the main formation sites of neutron stars and black holes of stellar size, which are not only unique laboratories to study the properties of matter in extreme physical conditions, but are also crucial players in explaining astrophysical high-energy sources of electromagnetic, neutrino and gravitational wave radiation.
The complexity of the physical processes that regulate CCSN (e.g. magnetohydrodynamics, neutrino-matter interactions, nuclear matter equations of state…) makes it an absolute necessity to rely on numerical simulations, which have now the capability of producing quantitative predictions for the explosion dynamics, the evolution of the young compact object forming at its center, and the multi-messenger emission associated with the explosive event.
In this talk I will present the current state-of-the-art of numerical simulations of CCSN and their potential in investigating some open issues in fundamental particle physics through the modeling of the neutrino and gravitational wave signals produced during the explosion.
I will then focus on recent results from simulation of magnetized and rotating supernovae, which are associated to the most energetic and violent stellar explosions and the formation of the most magnetized objects in the Universe, i.e. magnetars.

## Affiliation de l'auteur principal

UniTo - CEA Saclay

**Auteur principal:** BUGLI, Matteo (UniTo - CEA Saclay)

**Orateur:** BUGLI, Matteo (UniTo - CEA Saclay)

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