ID de Contribution: **29** Type: **Oral presentation**

Multimessenger signals from core-collapse supernovae

vendredi 28 février 2020 17:30 (15 minutes)

The final step of the life of a massive star is its collapse and explosion creating a supernova. During the collapse phase, several phenomena happen in the core of the star before the observed explosion. One of these phenomena is the development of instabilities. The collapse creates a shock wave that becomes stationary ∼150 km away from the surface of the proto-neutron star (PNS). All the instabilities developing between the shock and the core of the PNS modulate the signal emitted in gravitational waves (GW) and neutrinos.
The aim of my PhD thesis is to study all the instabilities evolving within the sphere delimited by the shock. I started my PhD studying the outermost instability. The matter immediately under the shock interacts with the neutrinos emitted by the neutrinosphere. The neutrinos heat up the matter and trigger convection due to the Rayleigh-Taylor instability. This instability plays a crucial role in pushing the shock outward closer to the explosion threshold, producing GW and modulating the emission of neutrinos. I analyse the ratio between buoyancy and advection time scales in this region. Indeed, the Rayleigh-Taylor instability competes with the advection that tends to stabilise the process. I take a new look at the current stability criterion established in 2006. A new criterion is established by distinguishing several length scales: the size of the unstable domain limited by the shock position, the size of the most buoyant region and the density scale-height.

Field

Compact objects (supernovae, black holes, neutron stars)

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Classification de Session: Talk

Classification de thématique: Astrophysics