Universal relations of core-collapse supernova with gravitational waves

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Core-collapse supernova (CCSN) explosions are a promising source of gravitational waves (GW) and might be one of the next discoveries of current or future ground-based GW observatories. Numerical simulations have shown that the GW signal, albeit highly stochastic, displays some clear trends in the time-frequency plane (spectrograms). This is the result of the excitation of PNS g-modes and, in some cases, of SASI modes. Recent work has established that the features observed in the GW spectrograms can be very accurately matched to the $l = 2$ PNS eigenmodes, l being the order of the spherical-harmonic decomposition.

In this talk, we will present the derivation, based in numerical simulations, of the universal relations that relate the frequencies of the most common oscillation modes of the proto-neutron star observed i.e. g-modes, p-modes and the f-mode, with the properties of the system, such as the surface gravity of the proto-neutron star or the mean density in the region enclosed by the shock. We show that the relations do not depend on the equation of state or progenitor star and hence are universal, and, therefore, these relations can be used to build methods to infer proto-neutron star properties from gravitational-wave observations alone.