Towards asteroseismology of core-collapse supernovae with gravitational wave observations

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Core-collapse supernova (CCSN) explosions are a promising source of gravitational waves (GW). Improvements in ground-based advanced GW detectors may soon allow us to observe the signal of a nearby CCSN. For most progenitors, likely with slowly rotating cores, the dominant GW emission mechanisms are the post-bounce oscillations of the proto-neutron star (PNS) before the explosion. We present a new procedure to compute the eigenmodes of the system formed by the PNS and the stalled accretion shock in general relativity including space-time perturbations. We apply our analysis to two core-collapse simulations and show that our improved method is able to obtain eigenfrequencies that accurately match the features observed in the GW signal and to predict the qualitative behaviour of quasi-radial oscillations. Our analysis is possible thanks to a newly developed algorithm to classify the eigenmodes in different classes (f, p, and g modes). This work provides further support for asteroseismology of core-collapse supernovae and the inference of PNS properties based on GW observations.