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Inference of cosmological parameters from the stochastic gravitational wave background

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Gravitational waves (GWs) can be used to measure H_0 and help solve the Hubble tension since they provide us with an independent estimates of a source's luminosity distance and redshift. Future-generation detectors, such as LISA or ET, will contribute to this field both by improving the measurement of resolved events, and by providing measurement of the stochastic gravitational waves background (SGWB).

The SGWB is given by the superposition of unresolved GW events coming from all directions, and it is studied by cross-correlating the channels of an interferometer. The cross correlation is proportional to the energy density $\Omega_{\rm GW}$, whose dependence on astrophysical and cosmological parameters is well known, making it a starting point to infer the sources' population characteristics, and H_0.

The objective of the project I have been developing at the L2IT laboratory is using the estimate for the SGWB in LVK, given a catalogue of mock BBH sources, to infer via hierarchical inference both astrophysical and cosmological parameters. Even if my analysis is aimed at LVK, the method can be reapplied to LISA and ET, whose sensitivities will allow for the detection of the SGWB, making this topic of relevance for the future.

This work is relevant for two reasons. The first, is that studies have up to now relied on an analytic approach to compute Ω_{GW} from analytical models. I have instead developed my own Python pipeline for the generation of a catalogue of BBH sources, based on the standard LVK population models. The SGWB is therefore obtained through realistic waveform models that are directly projected onto the detector, leading to a more accurate simulation.

The second reason is that for third generation detectors, the inference process will have to take into consideration both resolved sources and the background. Up to now, all studies have relied on the independence of the two sources to model their two likelihood separately. A likelihood model that takes into account their interaction is yet to be derived. This work also aims at setting the theoretical framework for the future developmente of this computation, approaching the subject from a theoretical point of view.

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