Gravitational-wave cosmology with dark sirens: state of the art and perspectives for 3G detectors

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Gravitational-wave (GW) cosmology provides a new way to measure the expansion history of the Universe, based on the fact that GWs are direct distance tracers. This property allows at the same time to test gravity at cosmological scales, since in presence of modifications of General Relativity the distance inferred from GWs is modified - a phenomenon known as "modified GW propagation". On the other hand, obtaining the redshift (whose knowledge is essential to test cosmology) is the challenge of GW cosmology. In absence of a direct electromagnetic counterpart to the GW event, the source goes under the name of "dark siren" and statistical techniques are used. In this talk, I will present measurements of the Hubble parameter and bounds on modified GW propagation, obtained from the latest Gravitational Wave Transient Catalog 3 with new, independent, open-source codes implementing the statistical correlation between GW events and galaxy catalogues and information from the mass distribution of binary black holes. I will discuss methodological aspects, relevant sources of systematics, the interplay with population studies, current challenges and possible ways forward. I will finally present perspectives for the use of statistical dark siren techniques with third generation (3G) ground-based GW detectors, in particular the Einstein Telescope.