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Current and future constraints on cosmology and modified gravitational-wave friction from binary black holes

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Gravitational wave (GW) standard sirens are well-established probes with which one can measure cosmological parameters, and are complementary to other probes like the cosmic microwave background or supernovae standard candles. In my talk I will focus on dark GW sirens, specifically binary black holes (BBHs) for which there is only GW data. The approach relies on the assumption of a source frame mass model for the BBH distribution, and we consider four models that are representative of the BBH population observed so far. In addition to inferring cosmological and mass model parameters, we use dark sirens to test modified gravity theories. These theories often predict different GW propagation equations on cosmological scales, leading to a different GW luminosity distance which in some cases can be parametrized by variables Ξ_0 and n. General relativity (GR) corresponds to $\Xi_0 = 1$. We perform a joint estimate of the population parameters governing mass, redshift, the cosmology, and the modified GW luminosity distance. We use data from the third LIGO-Virgo-Kagra observation run (O3) and find - for the four mass models and for three SNR cuts of 10, 11, 12 - that GR is consistently the preferred model to describe all observed BBH GW signals to date. Furthermore, all modified gravity parameters have posteriors that are compatible with the values predicted by GR at the 90% confidence interval (CI). We then focus on future observation runs O4 and O5: We show that there are strong correlations between cosmological, astrophysical and modified gravity parameters. If GR is the correct theory of gravity, and assuming narrow priors on the cosmological parameters, we recover the modified gravity parameter Ξ_0 with a precision of 51% with O4, and 20% with O4 and O5. If, however, Nature follows a specific modified gravity model we exclude GR at the $1.7\,\sigma$ level with O4 and at the $2.3\,\sigma$ level with O4 and O5 combined.

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