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Impact of theoretical uncertainties on model parameter reconstruction from gravitational wave signals sourced by cosmological phase transitions

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Different thermal resummation techniques impact the gravitational wave (GW) spectra from cosmological first-order phase transitions predicted in a given particle physics model. To investigate this effect, we perform large-scale parameter scans of the electroweak phase transition (EWPT) in the dynamical real-singlet extension of the Standard Model (SM) using three different perturbative approximations of the effective potential. While predictions of the GW amplitudes from the common, four-dimensional (4D) Daisy-resummed potentials are unreliable compared to state-of-the-art dimensionally reduced (3D) potentials, I will demonstrate that the overall detectable parameter spaces are robust up to a few percent in uncertainty. Regarding the reconstruction of the model parameters given a GW signal, I will illustrate that theoretical uncertainties however remain dominant over the experimental ones when using 4D standard techniques. Three-dimensional thermal effective theory, on the other hand, is accurate already at one-loop order, therefore providing the most promising route towards robust predictions for upcoming GW observatories.

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