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Beyond the Standard Models with Cosmic Strings

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A stochastic gravitational-wave (GW) background from cosmic strings spans a broad range of frequencies. By measuring the slope of its spectrum with future GW observatories, we can infer the equation of state of the universe much earlier than the onset of Big-Bang Nucleosynthesis (BBN). In this work, we consider a variety of cosmological scenarios beyond the standard hot-Big-Bang cosmology and examine what are the energy and time scales in the early universe that each GW experiment could be sensitive to. For example, a secondary intermediate inflation era at an energy scale up to 10^{14} GeV could have detectable features even if it lasts only a few e-folds, while generic heavy-unstable particles generating an intermediate matter era could be probed down to a life-time of 10^{-16} seconds, extending the BBN constraint which stops around 0.1 seconds. In precise particle-physics models, this new method can be used to probe oscillating moduli up to a mass of 10^{10} GeV and heavy dark photons with a kinetic mixing as low as 10^{-18}.
Interestingly, the recent stochastic GW background observed by NANOGrav collaboration can be explained by cosmic strings.

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