

Probing SUSY at Gravitational Wave Observatories

Under the assumption that the recent pulsar timing array evidence for a stochastic gravitational wave (GW) background at nanohertz frequencies is generated by metastable cosmic strings, we analyze the potential of present and future GW observatories for probing the change of particle degrees of freedom caused, e.g., by a supersymmetric (SUSY) extension of the Standard Model (SM). We find that signs of the characteristic doubling of degrees of freedom predicted by SUSY could be detected at Einstein Telescope and Cosmic Explorer even if the masses of the SUSY partner particles are as high as about 10^4 TeV, far above the reach of any currently envisioned particle collider. We also discuss the detection prospects for the case that some entropy production, e.g. from a late decaying modulus field inducing a temporary matter domination phase in the evolution of the universe, somewhat dilutes the GW spectrum, delaying discovery of the stochastic GW background at LIGO-Virgo-KAGRA. In our analysis we focus on SUSY, but any theory beyond the SM predicting a significant increase of particle degrees of freedom could be probed this way.

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