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Probing flavor violation and baryogenesis via primordial gravitational waves

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We show that observations of primordial gravitational waves of inflationary origin can shed light into the scale of flavor violation in a flavon model which also explains the mass hierarchy of fermions. The energy density stored in oscillations of the flavon field around the minimum of its potential redshifts as matter and is expected to dominate over radiation in the early universe. At the same time, the evolution of primordial gravitational waves acts as bookkeeping to understand the expansion history of the universe. Importantly, the gravitational wave spectrum is different if there is an early flavon dominated era compared to radiation domination expected from a standard cosmological model and this spectrum gets damped by the entropy released in flavon decays, determined by the mass of the flavon field m_S and new scale of flavor violation $\Lambda_{\rm FV}$. We derive analytical expressions of the frequency above which the spectrum is damped, as-well-as the amount of damping, in terms of m_S and $\Lambda_{\rm FV} = 10^{5-10}$. We show that the damping of the gravitational wave spectrum would be detectable at BBO, DECIGO, U-DECIGO, $\mu-$ARES, LISA, CE and ET detectors for $\Lambda_{\rm FV} = 10^{5-10}$ GeV and $m_S = \mathcal{O}(\rm TeV)$. Furthermore, the flavon decays can source the baryon asymmetry of the universe. We identify the $m_S - \Lambda_{\rm FV} = 10^{5-10}$ parameter space where the observed baryon asymmetry $\eta \sim 10^{-10}$ is produced and can be tested by gravitational wave detectors like LISA and ET. We also discuss our results in the context of the recently measured stochastic gravitational background signals by NANOGrav.

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