Probing New Physics at the Pulsar Timing Array Frontier

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Pulsar Timing Array (PTA) collaborations around the globe recently announced compelling evidence for low-frequency gravitational waves permeating our entire Universe, that is, a gravitational-wave background (GWB) reaching us from all directions and at all times. This breakthrough achievement has important implications for astrophysics, as the GWB signal, if genuine, is likely to originate from a cosmic population of supermassive black holes orbiting each other at the centers of galaxies. As I will illustrate in this talk, the new PTA data is, however, also of great interest to the high-energy physics community, as it allows to probe a broad range of particle physics models of the early Universe that predict the generation of a cosmological GWB in the Big Bang. In this sense, the PTA data opens a new window onto the very early Universe and enables particle physicists to constrain scenarios of new physics beyond the Standard Model at extremely high energies. In my talk, I will give an overview of these searches for new physics at the PTA frontier and highlight several cosmological scenarios that underline the relevance of PTA observations for fundamental problems such as dark matter, neutrino masses, and the matter-antimatter asymmetry of the Universe. Finally, I will conclude with a brief outlook on future measurements that may help in discriminating between a GWB signal of astrophysical origin and a GWB signal from the Big Bang.