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The Scalar Era: Listening for New Scalar Fields with Gravitational Waves

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The stochastic background of primordial gravitational waves (GWs) carries information on the expansion history of the Universe throughout its entire evolution. This offers the exciting possibility to probe scenarios of new physics beyond the Standard Model (BSM) as well as the thermal history of our Universe prior to Big Bang nucleosynthesis in future GW experiments. In this talk, I will specifically consider the case of a generic BSM scalar field whose coherent oscillations dominate the energy budget of the Universe at very early times. Such a "scalar era" preceding the standard radiation-dominated era is expected to occur in a variety of BSM scenarios, with the scalar field being identified, e.g., with an axion-like field, a flavon, or a modulus in string theory. In my talk, I will discuss the impact of the scalar era on the spectrum of relic GWs across the entire viable parameter space, which will lead me to two fascinating conclusions: (i) A number of elusive BSM scenarios that are hard to test otherwise will eventually be probed in GW experiments. (ii) Finding conclusive evidence for a scalar era in the Universe is a realistic possibility thanks to the complementarity of different GW experiments across a vast range of frequencies. This talk is based on work in collaboration with Francesco d'Eramo at the University of Padua.

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