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Gravitational wave symphony from (light) scalar fields in the early universe

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The stochastic gravitational wave background (SGWB) has recently emerged as a promising new probe of new particle physics and the dark side of the Universe. In this talk, we present well-motivated examples of SGWB sourced by the early Universe dynamics of light scalar fields with masses well below the electroweak scale. These include mechanisms such as post-inflation parametric resonance of oscillating scalar fields and early Universe phase transitions. Through systematic analysis of benchmark models using lattice simulations and scanning a broad range of parameters, we show that these scenarios can generate detectable signals across a wide frequency range, potentially connecting to recent results from Pulsar Timing Array experiments. We further demonstrate that these models may simultaneously address longstanding puzzles such as dark matter and baryogenesis. Finally, we highlight how these examples reveal new complementarity between SGWB signals and laboratory searches for low-scale new physics across the frontiers of particle physics.

Author: Prof. CUI, Yanou (University of California, Riverside)

Co-authors: BANIK, Amitayus (Chungbuk National University); GHOSHAL, Anish (University of Warsaw, Poland); SFAKIANAKIS, Evangelos (University of Illinois at Urbana-Champaign); SAHA, Pankaj; TSAI, Yu-Dai (University of California, Irvine); TSAI, Yuhsin (University of Notre Dame)

Presenter: Prof. CUI, Yanou (University of California, Riverside)

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