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Spectroscopy of Particle Couplings with Gravitational Waves

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We discuss the possibility to measure particle couplings with stochastic gravitational wave backgrounds (SGWBs). Under certain circumstances a sequence of peaks of different amplitude and frequency - a stairway - emerges in a SGWB spectrum, with each peak probing a different coupling. The detection of such signature opens the possibility to reconstruct couplings (spectroscopy) of particle species involved in high energy phenomena generating SGWBs. Stairway-like signatures may arise in causally produced backgrounds in the early Universe, e.g. from preheating or first order phase transitions. As a proof of principle we study a preheating scenario with an inflaton ϕ coupled to multiple daughter fields $\{\chi j\}$ with different coupling strengths. As a clear stairway signature is imprinted in the SGWB spectrum, we reconstruct the relevant couplings with various detectors.

Authors: FLORIO, Adrien; FIGUEROA, Daniel G. (Univ. of Valencia and CSIC (ES)); PIERONI, Mauro (Imperial College London); LOAYZA ROMERO, Nicolás (IFIC - Uniersitat de Valéncia)

Presenter: LOAYZA ROMERO, Nicolás (IFIC - Uniersitat de Valéncia)

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