ID de Contribution: **3** Type: **Non spécifié**

Gravitational waves from flavoured SU(2) early-universe phase transitions

mercredi 11 mars 2026 15:10 (20 minutes)

We show that first-order phase transitions generically arise during the breaking of TeV-scale SU(2) flavour gauge symmetries and can generate gravitational-wave signals observable by next-generation detectors. These transitions occur only for order-one flavour gauge couplings: beyond $g_f \sim 1.0 - 1.5$, one-loop corrections to the quartic interaction dominate the thermal potential and weaken the transition. To obtain reliable predictions, we match each phase transition to its steady-state hydrodynamical solution, capturing out-of-equilibrium plasma effects through an effective friction parameter primarily sourced by soft flavour gauge boson interactions with the Standard Model plasma. This treatment reveals both runaway solutions for strong transitions and regions of the parameter space where gravitational-wave production is enhanced even as the transition strength decreases. Finally, we demonstrate that the Einstein Telescope provides the most relevant probe of these flavour scenarios, with the proposed Big Bang Observer offering marginal additional sensitivity.

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Classification de Session: Particle cosmology