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Gravitational waves at aLIGO and vacuum stability with a scalar singlet extension of the Standard Model

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A new gauge singlet scalar field can undergo a strongly first-order phase transition leading to gravitational waves observable at aLIGO and stabilizes the electroweak vacuum at the same time. This is because the sensitivity of aLIGO to cosmological phase transitions at 10^7-10^8 GeV coincides with the requirement that the singlet scale is close to the Standard Model instability scale. Extending the SM with a singlet, we calculate the nucleation temperature and order parameter of the PT during which the singlet acquires a vacuum expectation value in terms of Lagrangian parameters. Relating the thermodynamic quantities to the peak frequency and amplitude of the gravitational waves created during the phase transition, we present three benchmark points for which not only are gravitational waves observable at aLIGO but the electroweak vacuum is stable and the zero temperature phenomenology is acceptable. This scenario offers an intriguing possibility for aLIGO to detect traces of fundamental physics motivated by vacuum stability at an energy scale that is well above the reach of any other experiments.

Summary

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