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Electroweak bubble wall expansion: gravitational waves and baryogenesis in Standard Model-like thermal plasma

Computing the properties of the bubble wall of a cosmological first order phase transition at electroweak scale is of paramount importance for the correct prediction of the baryon asymmetry of the universe and the spectrum of gravitational waves. By means of the semi-classical formalism we calculate the velocity and thickness of the wall using as theoretical framework the scalar singlet extension of the SM with a parity symmetry and the SM effective field theory supplemented by a dimension six operator. We use these solutions to carefully predict the baryon asymmetry and the gravitational wave signals. The singlet scenario can easily accommodate the observed asymmetry but these solutions do not lead to observable effects at future gravity wave experiments. In contrast the effective field theory fails at explaining the baryon abundance due to the strict constraints from electric dipole moment experiments, however, the strongest solutions we found fall within the sensitivity of the LISA experiment. We provide a simple analytical approximation for the wall velocity which only requires calculation of the strength and temperature of the transition and works reasonably well in all models tested. We find that generically the weak transitions where the fluid approximation can be used to calculate the wall velocity and verify baryogenesis produce signals too weak to be observed in future gravitational wave experiments. Thus, we infer that GW signals produced by simple SM extensions visible in future experiments are likely to only be produced in strong transitions described by detonations with highly relativistic wall velocities.

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