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Bubble wall velocity from hydrodynamics

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Terminal velocity reached by bubble walls in cosmological first-order phase transitions is an important parameter determining both primordial gravitational wave spectrum and the production of baryon asymmetry in models of electroweak baryogenesis. We developed a numerical code to study the real-time evolution of expanding bubbles and investigate how their walls reach stationary states. We discuss the recent results for local thermal equilibrium approximation for which we confirmed that pure hydrodynamic backreaction can lead to steady-state expansion and that bubble-wall velocity in such case agrees very well with the analytical estimates. However, this is not the generic outcome. Instead, it is much more common to observe runaways, as the early-stage dynamics right after the nucleation allow the bubble walls to achieve supersonic velocities before the heated fluid shell in front of the bubble is formed. In order to capture this effect, we generalized the analytical methods beyond the local thermal equilibrium and find a qualitative way to predict whether the runaway is physical, which has a crucial impact on cosmological observables.

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