

# Abstract

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. In this dissertation, we summarize our efforts to better understand the impact of the early stages of bubble growth on its final fate. To this end, we developed a dedicated numerical code to study the real-time evolution of expanding bubbles and investigate how their walls approach stationary configurations.

We first focus on the approximation of local thermal equilibrium, within which we confirm that pure hydrodynamic backreaction can lead to steady-state expansion. In such cases, the resulting bubble-wall velocity agrees very well with analytic estimates known in the literature. However, this outcome is not generic. In many realistic scenarios, the early-stage dynamics following bubble nucleation allow walls to accelerate to supersonic speeds before a sufficient thermal shell can form in front of the wall. This often results in a runaway behaviour.

To account for this effect, we extend the analytical framework beyond the LTE regime. We identify a qualitative criterion that distinguishes between different modes of bubble wall propagation and determines which is physically realized in a given situation. This distinction is crucial for reliably assessing the cosmological consequences of first-order phase transitions.