

Ultra-Low Nucleation Phase Transitions: Super-Hubble Bubbles and Non-Standard Dynamics

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Supercooled phase transitions have attracted significant interest as potential sources of strong, low-frequency gravitational wave signals detectable by Pulsar Timing Arrays (PTAs). A nucleation temperature T_n is often used to characterize the onset of the transition, defined by a threshold on the nucleation rate. However, in the regime of ultra-low nucleation rates, T_n may not exist, but this does not necessarily imply that the transition cannot complete. We show that even when nucleation remains suppressed and bubble separations exceed the Hubble scale, early-time bubbles can grow and eventually collide at late times, leading to completion. This presentation focuses on the completion condition and the associated dynamics in the regime of ultra-low nucleation rates.

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