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Universal behaviors for the dynamics across a quantum phase transition in ferromagnetic spinor atomic Bose-Einstein condensates MING XUE[1], SHUAI YIN[2], LI YOU[3], Tsinghua Univ — We study the equilibrium and dynamical properties of a ferromagnetic spinor atomic Bose-Einstein condensate. In the vicinity of the critical point for a continuous quantum phase transition, universal behaviors are observed both in the equilibrium state and in the dynamics when the quadratic Zeeman shift is sweeped. Three distinct dynamical regions are identified corresponding to different sweeping time scales (τ), manifested by the excitation probability $\mathcal{P}$ and the heat density $\mathcal{Q}$. We show that the adiabatic region of $\mathcal{P} \sim \mathcal{Q} \sim \tau^{-2}$ follows from the Landau-Zener theory, while the non-adiabatic universal region of $\mathcal{P} \sim \mathcal{Q} \sim \tau^{-1}$ in the thermodynamic limit is described by the Kibble-Zurek mechanism. The dynamical Kibble-Zurek scaling is postulated for a finite-size system in the latter region and several experimentally falsifiable features are predicted. The region of the fastest time scale is found to be non-universal and far-from-equilibrium with $\mathcal{P}$ and $\mathcal{Q}$ essentially being constants independent of τ.

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