Observation of false vacuum decay in a ferromagnetic superfluid

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In quantum field theory, the decay of an extended metastable state into the real ground state is known as "false vacuum decay" and it takes place via the nucleation of spatially localized bubbles. Despite the large theoretical effort to estimate the nucleation rate [1] and intriguing speculations over the fate of our universe, experimental observations were still missing. In our experiment, we observe bubble nucleation in isolated and highly controllable superfluid atomic systems [2], and we find good agreement between our results, numerical simulations and instanton theory opening the way to the emulation of out-of-equilibrium field phenomena in atomic systems.

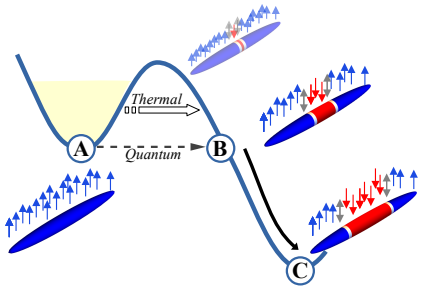

Fig. 1: False vacuum state decays via bubble formation in an extended superfluid. Tunnelling can take place from the false vacuum state (A) to the resonant state (B), leading to bubble formation. This state eventually relaxes into the real vacuum state (C).

References

[1] S. Coleman, Phys. Rev. D 15, 2929 (1977) [2] A. Zenesini, et al, arXiv:2305.05225 (2023)

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