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Confinement and false vacuum decay on the Potts quantum spin chain

Confinement is a central concept in the theory of strong interactions, which leads to the absence of quarks (and gluons) from the spectrum of experimentally observed particles. The underlying mechanism is based on a linear potential, which can also be realised in condensed matter systems. A one-dimensional example with a great analogy to quantum chromodynamics is the mixed-field three-state Potts quantum spin chain in the ferromagnetic regime. Compared to the analogous setting for the Ising spin chain, the Potts model has a much richer phenomenology and non-equilibrium dynamics, which originates partly from baryonic excitations in the spectrum and partly from the various possible relative alignments of the initial magnetisation and the longitudinal field in a global quantum quench. In my presentation, I will discuss how we obtain the low-lying excitation spectrum by combining semi-classical approximation and exact diagonalisation, and how the results can be applied to explain the various dynamical behaviours we observe in numerical simulations. Besides recovering dynamical confinement, as well as Wannier-Stark localisation due to Bloch oscillations similar to the Ising chain, a novel feature is the presence of baryonic excitations in the quench spectroscopy. In addition, when the initial magnetisation and the longitudinal field are misaligned, both confinement and Bloch oscillations only result in partial localisation, with some correlations retaining an unsuppressed light-cone behaviour together with a corresponding growth of entanglement entropy.

Reference:

[1] O. Pomponio, A. Krasznai and G. Takács, "Confinement and false vacuum decay on the Potts quantum spin chain,"Scipost Phys. 18 (2025) 082

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