Contribution ID: **132** Type: **Oral**

Confinement and False Vacuum Decay in Quantum Spin Chains

Thursday 22 August 2024 15:00 (30 minutes)

The confinement of elementary particles and the decay of the false vacuum are two paradigmatic predictions of quantum field theory. In their simplest formulation, the two phenomena can be understood as two facets of an underlying symmetry-breaking mechanism: the degeneracy of a double-degenerate vacuum is lifted by adding an explicit symmetry-breaking external field. Confined states are false vacuum bubbles within a true vacuum (the true ground state of the model); likewise, false vacuum decay refers to the dissolution of the metastable vacuum through true vacuum bubbles nucleation via quantum tunneling.
The interest in this area of research has been recently revamped by the advances in experimental techniques (e.g. trapped ions, ultracold atoms, Rydberg atoms): confinement has already proved to be accessible in condensed matter laboratory experiments while the direct laboratory study of the false vacuum decay is promisingly within reach. Moreover, in the past few decades the out-of-equilibrium dynamics of quantum many-body systems was promoted to the forefront of research in condensed matter physics. I will present relevant investigations of such phenomena in the context of quantum spin chain models through the observation of their real-time dynamics following a quantum quench (the paradigmatic theoretical and experimental protocol for non-equilibrium dynamics).

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Session Classification: QCD and New Physics

Track Classification: E: QCD and New Physics