Solitonic excitations in non-periodic interacting 1D systems

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The emergence of protected excitations is a paradigmatic signature of non-trivial topology in insulators, usually rationalized in the single-particle formalism for a periodic system. Here we explore two purely interacting systems [1,2], both lacking translational symmetry, yet showing robust localized excitations. We solve exactly those two genuinely interacting models using the kernel polynomial tensor network formalism. First, we show that interfaces between a superconductor and a quantum antiferromagnet can host robust in-gap excitations without breaking time-reversal symmetry [1]. We illustrate this phenomenon in a one-dimensional model system with an interface between a conventional s-wave superconductor and a one-dimensional Mott insulator described by a standard Hubbard model [1]. Second, we show that superlattice modulations in a many-body spin Hamiltonian give rise to robust topological boundary modes in the excitation spectrum of the spin chain [2]. We show that the persistence of edge modes for arbitrary quasiperiodicities and local spin of the sites [2]. In the situations stated above [1,2], we show that the emergence of such modes can be rationalized by an adiabatic connection to a Jackiw-Rebbi soliton [1] and an Aubry-Andre problem [2], and we will highlight potential experimental realizations. Our results put forward two purely interacting systems hosting robust excitations, whose existence relies on broken translational symmetry, and that are not protected by a conventional bulk topological invariant.

[1] J. L. Lado, M. Sigrist, arXiv:2002.05495 (2020)
[2] J. L. Lado, O. Zilberberg, Phys. Rev. Research 1, 033009 (2019)