

Determining Energy Dispersion of Spin Excitations with Scanning Tunneling Spectroscopy

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Conventional methods to measure the dispersion relations of collective spin excitations involve probing bulk samples with particles such as neutrons, photons, or electrons, which carry a well-defined momentum. Open-ended finite-size spin chains, on the contrary, do not have a well-defined momentum due to the lack of translation symmetry, and their spin excitations are measured with an eminently local probe, using inelastic electron tunneling spectroscopy (IETS) with a scanning tunneling microscope (STM). Here[1], we discuss under what conditions STM-IETS spectra can be Fourier-transformed to yield dispersion relations in these systems. We relate the success of this approach to the degree to which spin excitations form standing waves. We show that STM-IETS can reveal the energy dispersion of magnons in ferromagnets and triplons in valence bond crystals, but not that of spinons, the spin excitations in Heisenberg spin-1/2 chains. We compare our theoretical predictions with state-of-the-art measurements on nanographene chains that realize the relevant spin Hamiltonians.

[1] JCG Henriques et al., *Physical Review Letters* 135, 096703 (2025).