Emergent Soliton Chirality and Spin Currents in a Quantum Antiferromagnet

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We demonstrate the emergence of chirality as a novel degree of freedom of a soliton in antiferromagnetic Heisenberg- Ising spin-1/2 chains. While static Ising-solitons do not have an internal degree of freedom, quantum fluctuations due to transverse exchange are giving rise to a band whose degenerate lowest energy states are chiral.
This chirality is hidden, as right-handed and left-handed solitons occur with equal probability in the absence of an external field. In an external magnetic field this degeneracy is lifted and a polarization dependent contribution to the inelastic neutron scattering cross section appears.
We report on the experimental observation of this effect in the quasi 1D Ising compound CsCoBr3, where the scattering of thermally activated soliton excitations gives rise to the quasielastic “Villain-mode”. In quantitative agreement with theory, we have detected an asymmetry in the polarization dependence of the neutron cross section for both soliton scattering and soliton pair creation. Our observations provide the first explicit example of the emergence of spin currents and hidden chiral order that accompany the disappearance of antiferromagnetic order.