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Transport in Heisenberg spin chains

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Measurements of spin diffusion in ultracold Fermi gases recently reported astonishingly small values for the diffusivity and a strong dependence on the dimensionality of the system. Furthermore, in Heisenberg quantum magnets even the nature of spin transport – ballistic or diffusive – is an open issue. Here we report on transport measurements in Heisenberg spin systems realized with ultracold Bosons in an optical lattice. We study spin transport close to and very far away from equilibrium. For weak perturbations, that is, close to equilibrium, we observe ballistic transport of single as well as bound magnons along 1d chains. In contrast, in a far-from-equilibrium situation we find effectively diffusive transport which is microscopically explained by the spectral distribution of the initial far-from equilibrium states. Repeating the latter measurement in 2d, we observe anomalous superdiffusion.