Anomalous Transport and Thermodynamics of Quantum Spin Systems

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Low-dimensional quantum spin systems, such as spin chains or spin ladders offer an ideal playground to study the generic behavior in the vicinity of quantum phase transitions. For comparatively weak magnetic interactions, typical laboratory magnets can be used as an easily tunable control parameter to change the groundstate by continuously opening or closing magnetic excitation gaps. In this talk, measurements of the highly anomalous low-temperature thermal expansion and magnetostriction will be discussed [1-3]. The thermal expansion has various sign changes and shows $1/\sqrt{T}$ divergencies on approaching the quantum critical points. It will be shown that the thermal expansion and magnetostriction measurements give a direct access to the magnetic-field- and temperature-dependent spin-spin correlation functions. Another topic is the dynamics of the magnetic excitations which is of particular interest, because on the hand the magnetic heat transport In integrable 1D spin systems is expected be ballistic while on the other hand impurities in 1D systems may cause localization effects. Our thermal conductivity measurements on various spin-chain and spin-ladder compounds indeed suggest that the occurrence of a large magnetic heat transport sensitively depends on the presence or absence of a small but finite 3D coupling between neighboring spin chains or ladders [4,5].

References:

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