SFB/TRR 21 - Seminar

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The quantum XY chain, a toy model for almost everything

The quantum XY chain is often used as a paradigmatic many-body system that exemplifies important issues, such as quantum-criticality, entanglement or non-equilibrium dynamics. After a brief sketch of some of these aspects, two questions will be addressed in more detail. First the anisotropic XY chain will be used for discussing a class of variational many-body ground states (the Gutzwiller ansatz in the case of the Hubbard model). The corresponding variational results for the XY chain are perfectly smooth as functions of the anisotropy parameter, in contrast to the exact result which exhibits a singularity for infinitesimal anisotropy. Quite generally, these variational states are ädiabatically"linked to a reference state and therefore not appropriate for describing quantum phase transitions [1]. Ways out of this dilemma include long-range Jastrow factors or pairs of wave functions describing different phases. The XY model can also shed light onto a second question, namely the effects of an interface on spin correlations in its vicinity (Friedel oscillations in the fermionic language). We have considered an XY chain with a discontinuity at some site, either in the exchange or in the field [2]. Interface effects are particularly pronounced close to the "metal-insulator transition", which occurs if the field strength reaches the value of the exchange constant. For odd-numbered chains with a field +h in the left half and -h in the right half of the chain a midgap state is found in the insulating regime, together with a two-fold degeneracy of the ground state.
[1] D. B., Ann. Phys. (Berlin) 19, 724 (2011). [2] G. Ferraz and D. B., work in progress.

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