Dynamical Spin Structure Factor for the Anisotropic Spin-1/2 Heisenberg Chain

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One important quantity for transport properties of spin chains is the longitudinal dynamical structure factor $S^{zz}(q,\omega)$, defined as the Fourier transform of the $\langle S^z S^z \rangle$ correlation function. The low-energy picture says that $S^{zz}(q,\omega)$ for small wave vector q is simply given by a delta peak at the energy $\omega = v|q|$ carried by the free bosons of the Luttinger model (v is the spin-wave velocity). However, for any finite q this sharp peak should be broadened due to irrelevant interactions that allow the bosons to decay. In this work we combine field theory, Bethe ansatz and density matrix renormalization group (DMRG) to calculate $S^{zz}(q,\omega)$ for the anisotropic spin-1/2 Heisenberg chain for general values of anisotropy and magnetic field. We argue in favor of a q^2 scaling of the peak width at finite field. We also discuss the lineshape suggested by numerical Bethe ansatz calculations. Finally, we calculate the high-frequency tail ($\omega \gg v|q|$) using a low-energy effective Hamiltonian and present evidence that the lineshape depends on the integrability of the lattice model.

[1] R.G. Pereira *et al.*, cond-mat/0603681.