Dynamics of gapped spin systems in high magnetic field

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The subject of the talk is the dynamics of gapped spin systems in presence of an external magnetic field sufficiently high to close the energy gap. The focus will be on anisotropic $S = 1$ Haldane chain, although applications to weakly coupled dimer system of the $\mathrm{TlCuCl_3}$ type and spin ladders with four-spin (ring) interaction will be briefly considered.

Existing effective field-theoretical descriptions [1, 2, 3] of anisotropic $S = 1$ Haldane chain in applied field are reviewed and their predictions are compared with the results of recent inelastic neutron scattering experiments on the Haldane chain material NDMAP [4]. It is shown that none of the known theories can provide a consistent description of the experimental data. A new effective theory, based on the dimer field description for alternated $S = \frac{1}{2}$ chain, is proposed. In the isotropic case it coincides with the theory of Affleck [1] but differs from it considerably when a finite anisotropy is present. It is shown that the theory is capable of a quantitative description of the data on NDMAP with a satisfactory accuracy, in the whole range of the applied fields both below and above the critical field [4, 5, 6].

Special physics arising in the axially symmetric case in one-dimensional systems is briefly discussed. It is well known that in this case the low-energy physics is peculiar and can be described in terms of the Luttinger liquid model. The low-energy response is thus determined by a continuum of particle-hole-type excitations (in contrast to axially asymmetric models where the response is of the quasiparticle type). We show that in case of axial symmetry the high-energy response is also peculiar and is dominated by edge singularities [7].

References

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