9.7 cm

CRITICAL AND MASSIVE PHASES IN SPIN CHAINS AND SPIN LADDERS

J. Sólyom

Research Institurte for Solid State Physics, H-1525 Budapest, P. O. Box 49, Hungary

In the last one and a half decade the properties of low dimensional systems of localized spins has been intensively studied. This is to a large extent due to the surprising conjecture by Haldane that one-dimensional Heisenberg antiferromagnets should have a finite gap in the excitation spectrum for integer spin, and no gap for half-odd-integer spins. The situation became even more interesting when several new types of material have been synthetized in which the ions carrying localized spin are arranged in weakly coupled chains or pairs of chains forming so called spin ladders.

It was known for some time already, that for appropriately chosen couplings a spin ladder built up from $s = 1/2$ spins would behave as an effective $S = 1$ spin chain. Thus a two-leg spin ladder might have a gapped Haldane phase, even though the legs alone would be in a critical phase. It has been shown that in isotropic models the Haldane gap opens as an arbitrarily weak interchain coupling is switched on. In the talk I will present result obtained for anisotropic models by numerical calculations using the density matrix renormalization group algorithm, and by analytic methods on the bosonized version of the spin ladder.

We are interested especially in the situation when two or four chains are coupled, since the gapped phase of the two-leg ladder is expected to appear in a larger region of the parameter space than in four-leg ladders. In fact we are able to show, that the generation of gapped modes happens somewhat differently in two-leg and four-leg ladders, and therefore in contrast to the former case in four-leg ladders the Haldane phase appears only in a narrow neighbourhood of the isotropic point.

I will also discuss how other massive phases, like the dimerized phase of the bilinear-biquadratic spin-1 chain may appear in spin ladders.

13.4 cm

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Corresponding author :
J. Sólyom

Address for correspondence :
Research Institurte for Solid State Physics, H-1525 Budapest, P. O. Box 49, Hungary

Email address :
solyom@power.szfki.kfki.hu