Quantum critical points and crossover lines of alternating spin- (s, S) ferrimagnetic chain: 
Spin-wave theory from a fully polarized vacuum

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Quantum critical (QC) phenomena [1] can be accessed by studying quantum magnets under an applied magnetic field (B). The QC points are located at the end points of magnetization plateaus and separate gapped and gapless phases. In one dimension [2], the low-energy excitations of the gapless phase form a Luttinger liquid (LL), and crossover lines bound insulating (plateau) and LL regimes, as well as the QC regime. Alternating ferrimagnetic chains have a spontaneous magnetization at T = 0 and gapped excitations at zero field. Besides the plateau at the fully polarized (FP) magnetization, due to the gap there is another magnetization plateau at the ferrimagnetic (FRI) magnetization. We develop spin-wave theory from the FP and the FRI states [3] to study the thermal properties of these chains under an applied magnetic field. We compare the results with Quantum Monte Carlo data, and discuss in more detail the FP case. In particular, from local extreme points in the susceptibility and magnetization curves, we identify the crossover between an LL regime formed by excitations from the FRI state to another built from excitations of the FP state. These two LL regimes are bounded by an asymmetric domelike crossover line, as observed in the phase diagram of other quantum magnets under an applied magnetic field.

References