Dimensionality in field theory and spin wave theory

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It is illustrated on account of experimental examples that the terms universality and dimensionality have a different meaning in field theory and in spin wave theory. Universality means that the dynamics is independent of material specific atomistic details such as the exchange interactions between spins. Atomistic theories therefore are inappropriate. This reveals clearly from the fact that the observed critical power functions of type $(T_c - T)^{\beta}$ hold over a finite temperature range instead of asymptotically at T_c only. Within the finite critical range thermal energy is in a boson guiding field. The dynamics of the spins is that of the boson field. Field theories therefore need to consider the field degrees of freedom exclusively. Since the observed critical exponents and the actual value of the ordering temperature are due to the field, they should not be compared with atomistic model predictions. The dimensionalities of field and exchange interactions can be different. In the tetragonal antiferromagnet MnF_2 magnon dispersions are isotropic but the boson field is one-dimensional and aligns all moments rigidly along tetragonal axis. One therefore has to classify MnF_2 as a one-dimensional antiferromagnet in spite of isotropic magnon dispersions.

References:

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