

Boson fields in ordered magnets

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Universality in the critical dynamics near phase transitions means that the dynamics is independent of the interactions between spins and therefore is identical for ferromagnets and antiferromagnets. As a consequence, the magnetic ordering transition is not executed by exchange interactions. From Renormalization Group (RG) theory [1] we know that the critical dynamics is as for a continuous medium. Quite generally, the excitations of a continuous medium are bosons. Since spin dynamics is that of the boson field, field theories treat on the dynamics of the field exclusively. Typical for boson dynamics is that the critical power functions hold over a finite distance from critical temperature. Within the finite temperature range thermal energy is in the boson field. The field quanta were, however, not specified by RG theory. Realistic field theories therefore are not yet possible. We will show that the field quanta are essentially magnetic dipole radiation emitted upon precession of the magnetic moments. The field therefore has radiation character. Since Ising spins do not precess they are unable to generate magnetic dipole radiation. The boson field remains, so to say, empty. Only in Ising magnets the dynamics is defined by exchange interactions.

References:

[1] K.G. Wilson, Rev. Mod. Phys. 47, 773 (1975)