MAGNETIC INTERACTION BY EXCHANGE OF FIELD BOSONS

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The experimental indications are presented that in addition to short range Heisenberg interactions via exchange of electrons there must be another long range interaction mechanism by exchange of bosons. The bosons can be supposed to be mass less magnetic density waves, i.e. they have neither charge nor magnetic moment. Consequently, they propagate ballistic across the crystal, independent of atomistic structures. This is the reason for the observed universal temperature dependence of the order parameter. Magnons propagate atomistic, i.e. from spin to spin. According to the different propagation mechanisms magnons and field bosons have different dispersion relations. In practically all ordered magnets the dominant interaction process is by exchange of bosons. This is because the field bosons usually have lower excitation energies than magnons. Ballistic propagation means that the dispersion relation of the field bosons is a simple power function of wave vector. The big problem is that mass less particles cannot be observed using inelastic neutron scattering. Experiments on standing magnetic waves in thin ferromagnetic films allow one to directly observe the field bosons via resonance. These experiments show that the dispersion of the field quanta is $\sim q$ in three dimensions, $\sim q^2$ in two dimensions but $\sim q^{\frac{3}{2}}$ in one dimension.

9.7 cm

13.4 cm

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