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An analysis of critical phenomena

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The Ising model is one of the most widely studied systems in statistical mechanics; the general theory has been reviewed by Domb [4]. The present author has investigated two generalisations of the Ising model with the aim of describing a wider range of phenomena.

The first generalisation considered is to allow for anisotropic interactions so that interactions between neighbouring Ising spins depend on the direction of the displacement vector between them. The main technique used is the analysis of the high temperature susceptibility by obtaining series expansions to 11th order in $1/T$ and extrapolating the behaviour to estimate the position and character of the singularity, [6]. The standard techniques of series analysis, [5], seem to give a value of the critical temperature T_c that is too low, and a critical exponent that, apparently incorrectly, varies continuously with the degree of anisotropy. Other more specialised techniques of analysis seem to indicate that the behaviour in the critical region agrees with predictions of scaling theory and the universality hypothesis, [3]. It is shown that the scaling law prediction for the exponent describing the variation of T_c with anisotropy is a rigorous upper bound for the true value of this exponent.

The second generalisation of the Ising model that is considered is the possibility of interactions between magnetic spins and lattice vibrations. The basic formalism was developed by Bolton and Lee [2]. The particular problems investigated are the ground state in an applied magnetic field and the possibility of a disorder point. The concept of a disorder point, a temperature at which the two spin correlation function becomes an

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oscillatory function of distance, has been described by Stephenson [7]. Approximate expressions for the disorder temperature in a spin-phonon system are obtained.

High temperature series expansions for the susceptibility are obtained for some classes of spin-phonon interaction. The structure of these series seems to indicate that disorder point phenomena do occur and that the system has a first order transition as found for a more specialised model by Baker and Essam [1].

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