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Numerical studies in phase transitions

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The aim of the thesis is to develop methods for the analysis of series expansions which frequently arise in the study of mathematical models of phase transitions. The methods are then applied to the analysis of the series expansions given for the thermodynamic functions of the Ising problem, and the Excluded-Volume problem.

Initially, from the readily analysable high-temperature susceptibility series, estimates of the physical critical points are obtained. These estimates are then used in the remainder of the thesis to determine some of the nine principal critical exponents which characterise the Ising model near the critical point.

A study is also made of some of the other singularities in the complex temperature plane. In particular, the distribution of singularities within the disc $|z| \leq |z_c|$ is obtained for all the common three dimensional lattices. Here $z = \exp(-4J/kT)$ is the usual low-temperature expansion variable, and z_c is the physical critical point.

The presence of singularities within this disc has long been known to cause problems in the analysis of low-temperature series. To overcome this problem, a transformation is applied, and low-temperature series in the new variable $x = 1 - \tanh(J/kT)$ thereby obtained are analysed. In this variable, all low-temperature series converge up to the physical critical point.

From the estimates of the critical exponents obtained by the analysis of these new low-temperature series, it is suggested that certain results which follow from the recent scaling law and homogeneity arguments are incorrect. In particular, we find that the conjectured equality of the

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high and low temperature susceptibility exponents does not appear to be satisfied.

Finally, in the course of a critical review, difficulties in the analysis of certain series are isolated and discussed.

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