8.0 Phase Transitions in Chemisorbed Systems

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8.1 Phase Transitions under Random Fields

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Substrate imperfections locally differentiate between chemisorption sublattices, thereby creating a random-field situation for epitaxial ordering. We have solved the three-dimensional random-field Ising model by pursuing the global renormalization-group trajectories of the full, coupled probability distribution of local fields and bonds.[2] The underlying local transformations are effected by the Migdal-Kadanoff approximation applied to bonds and fields with distinct values. The phase diagram and critical properties, as well as magnetization and specific heat curves, are calculated. A novel "hybrid-order" phase transition is discovered: the boundary between the ferromagnetic and paramegnetic phases has a discontinuous magnetization, as in a first-order transtion, and a power-law specific-heat singularity, as in a second-order transition. This boundary is controlled by an unstable strong-coupling fixed distribution, justifying our previously derived[1] modified hyperscaling relation. Analogous calculations are performed[2] for several other values of dimensionality, showing a lower-critical dimension $d_l = 2$, below which the random-field ferromagnetic phase has disappeared, and suggesting a novel medium-critical dimension $d_m > 3$, above which the fixed distribution moves away from strong coupling, which implies a singularity in the critical properties as a function of dimension. This new result could conciliate previous conflicting works.

8.2 Phase Transitions in Systems with Competing Interactions

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An extended mean-field method is developed to study a partially frustrated stacked triangular system, in which planes of Ising spins with antiferromagnetic nearest-neighbor and ferromagnetic next-nearest-neighbor interactions are connected in the vertical direction by ferromagnetic bonds. For weak next-nearest-neighbor couplings, the system undergoes three successive second-order phase transitions as the temperature is lowered. This is consistent with the experimental results on $CsCoCl_3$ and $CsCoBr_3$. In another study, an "anti-metamagnet" is constructed by reversing the signs of all interactions in a metamagnet. This anti-metamagnet is studied by our extended mean-field method. We find that the system displays a reentrant phase transition behavior for a narrow window in magnetic-field strengths.[3]

References

[1] A.N. Berker and S.R. McKay, Phys. Rev. B *33*, 4712 (1986).

[2] S.R. McKay and A.N. Berker, preprint (1987).

[3] K. Hui, preprint (1987).