

7. Phase Transitions in Chemisorbed Systems

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Renormalization-group and other methods are used to treat microscopic Hamiltonians for surface systems and for other systems exhibiting novel phase transition phenomena.¹⁻⁹

7.1 Selenium Chemisorbed on the Nickel (100) Surface

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Very recently, a comprehensive experimental study was done with selenium chemisorbed on the nickel (100) surface, using reflection high-energy electron diffraction. A new phase diagram, including $c(2 \times 2)$ and $p(2 \times 2)$ ordered phases, was found. We are currently developing a renormalization-group theory² which yields this phase diagram in terms of phase separation regions. We identify, in this theory and in a new Landau functional expansion, important symmetry-breaking terms which grow under renormalization. A close analogy is drawn to the effect of dangerous irrelevant variables on structural transitions in three dimensions. It thus appears that the original interpretation, by another group, of the experimental results is incorrect.

7.2 The Effect of Criticality on Wetting Layers

Joint Services Electronics Program (Contract DAAG29-83-K-0003)

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The surface tension argument of Cahn for a wetting transition near a critical point is examined for systems with long-range forces.⁸ An interaction, comparable in range to the van der Waals interaction, is predicted by finite-size scaling theory whenever the wetting layer is near bulk criticality. Its relative strength is estimated by exact calculations, position-space renormalization, and mean-field theory. Finite-size interactions are predicted to modify wetting near critical endpoints, e.g., in ternary fluid mixtures.

7.3 Critical Behavior with Axially Correlated Random Bonds

Joint Services Electronics Program (Contract DAAG29-83-K-0003)

David Andelman, A. Nihat Berker

Critical properties are studied in systems with quenched bond disorder that is correlated along d_1 of d dimensions.⁹ A renormalization-group scheme which follows the full distribution of the random bonds and which gives correctly the modified Harris criterion $\varphi = \alpha + d_1\nu$ is used. For $d_1 < d - 1$, we find fixed distributions at finite temperatures, yielding new "random" exponents for various q -state Potts models. For $d_1 = d - 1$, there is no long-range order if there is a finite weight of zero coupling. Otherwise, we find a novel zero-temperature fixed distribution, for which all the moments diverge to infinity with finite ratios among them. This fixed distribution has a magnetic exponent equal to d , indicating a magnetization jump and possible related essential singularities. The results for $d_1 = 1$ are relevant to quantum systems with quenched-in disorder.

7.4 Duality and Pseudodimensional Variation in Potts Phase Transitions

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Miron Kaufman

By using the duality transformation on a class of hierarchical lattices, we show that the Potts critical amplitude above and below the critical temperature are equal.⁵ Logarithmic modifications of the power-law singularity occur when the exponent $2 - \alpha$ is an even integer, but do not occur when it is an odd integer. Also, Potts models with equivalent- and nearest-neighbor interactions are solved exactly on Cayley trees.⁶ A parameter Δ is identified as playing a role similar to the spatial dimension of Bravais lattices. Breaking translational symmetry by the Cayley-tree hierarchy reduces Δ , leading to a changeover in the order of the phase transition via a novel tricritical point.

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