Abstract Submitted
for the MAR06 Meeting of
The American Physical Society

Inverted Berezinskii-Kosterlitz-Thouless Behavior on Scale-Free Hierarchical-Lattice Small-World Net MICHAEL HINCZEWSKI, F. Gürsey Res. Cent. and MIT, A. NIHAT BERKER, Koç U. and MIT — We have obtained exact results for a hierarchical lattice incorporating three key features of real-world networks: a scale-free degree distribution, a high clustering coefficient, and the small-world effect. By varying the probability p of long-distance bonds, the entire spectrum from an unclustered non-small-world network to a highly-clustered small-world system is studied. Expressions for the degree distribution $P(k)$ and clustering coefficient C are obtained for all p, as well as for the average path length ℓ for $p = 0, 1$. The Ising model on this network is studied by exact renormalization-group transformation of the quenched bond probability distribution, using up to 562,500 renormalized probability bins for the distribution. For $p < 0.494$, we find power-law critical behavior of the magnetization and susceptibility, with exponents continuously varying with p, and exponential decay of correlations away from T_c. For $p \geq 0.494$, where the network exhibits a small-world character, the critical behavior radically changes: We find an inverted Berezinskii-Kosterlitz-Thouless singularity, between a low-temperature phase with non-zero magnetization and finite correlation length and a high-temperature phase with zero magnetization and infinite correlation length, with power-law decay of correlations. Approaching T_c from below, the magnetization and the susceptibility respectively exhibit $\exp(-C/\sqrt{T_c - T})$ and $\exp(D/\sqrt{T_c - T})$ singularities.

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Date submitted: 29 Nov 2005 Electronic form version 1.4