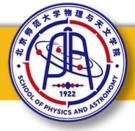# 物理与天文学院学术报告

## Finite-size scaling of the high-dimensional Ising model

**Abstract |** We perform large-scale simulation of the critical Ising model on a $d$-dimensional hypercube with periodic boundary conditions ($d$=4,5,6,7), respectively in the original spin, the Fourtuin-Kasteleyn random-cluster and the loop representation. We find that a complete description of the finite-size scaling behavior at criticality requests simultaneously two sets of critical exponents, respectively from the Gaussian fixed point in the renormalization group and from the Ising model on the complete graph. In addition, we obtain strong numerical evidence that the FK random-cluster representation of the Ising model has simultaneously two upper critical dimensions at ($d_c$=4, $d_u$=6). For $4 \leq d \leq 6$, it is suggested that the largest cluster $C_1$ has a finite-size fractal dimension $d_{C_1} = 3d/4$ and the remaining clusters have the fractal dimension $d_{C_2} = 1 + d/2$. For $d \geq 6$, all the clusters, except the largest one, have the same fractal structures as the critical uncorrelated percolation clusters in high dimensions--e.g., the finite-size fractal dimension is $d_{C_2} = 2d/3$. These observations are supported by (semi-) analytical results for the so-called random-length random walk as well as the Ising and self-avoid random walk on the complete graph.

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