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Percolation, polymers and square ice: exact formulas and finite size scaling

Percolation models are widely recognized in statistical physics for providing the simplest example of a phase transition and critical phenomenon. Bonds of an infinite lattice chosen to be open at random with probability p and closed otherwise form an infinite cluster when p exceeds a critical value. The statistics of open clusters show typical critical behavior at the critical point, like fat-tailed fluctuations of cluster sizes, universal long-range correlations between them, and conformal invariance of observables. When, on the other hand, there is an intrinsic finite scale in the system, like it is on a cylinder of finite circumference, the universality is still revealed in the finite-size scaling of cluster statistics. The latter brings information about the universal critical behavior of the model, as well as about the violation of scaling and conformal invariance. In the talk, I will give an overview of the recent exact results on the densities of critical percolation clusters on the cylinder. The technique based on the toolbox of the theory of integrable systems exploits the tight connection of the critical bond percolation on the square lattice with the dense loop model and with the exactly solvable six-vertex model of square ice.

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