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Order of Explosive Percolations

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Percolation, a simple model for metal-insulator transition in disordered systems, is the formation of a spanning cluster connecting between two opposite ends in a system. In the mean-field limit, the case beyond the upper critical dimensions, the notion of percolation is transformed into the formation of a giant cluster in non-equilibrium dynamic systems, in which edges are added between two nodes randomly selected. This dynamic process is called the Erdős and Rényi (ER) model. Recently, this ER model is modified by imposing suppressive external bias. At each time step, m candidate pairs of unconnected nodes are randomly selected, among which one of them is actually connected that yields the least growth rate of clusters in the system. This additional rule suppresses the growth of large clusters, and a giant cluster is eventually formed in a sudden manner at a delayed time. The issue whether such an explosive percolation transition is indeed discontinuous or continuous has been controversial. Here, using analytic method, we clarify the order of the explosive percolation transition in a unified framework covering low-dimensional systems and the mean-field limit.

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