International Conference on Dynamical Systems
in honour of Michał Misiurewicz on his 60th birthday

Będlewo, Poland, June 30 – July 5, 2008

Percolation on lattices with large holes

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In d-dimensional discrete space we consider site percolation on a sublattice which is obtained by removing larger and larger squares of lattice points in a "self-similar" manner; the remaining sites have density zero in d-dimensional space, but are in some sense "regular". We then show that for site percolation on the lattices we consider there is a critical probability which is strictly between zero and one, and if the underlying probability for independent site percolation is such that percolation occurs (in particular, if this probability is larger than the critical probability), then there is a unique infinite cluster with probability one. One of our essential tools is a new ergodic theorem for dynamical systems which are products of a strictly ergodic system with a measure preserving system, which may be of independent interest.