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**Random perfect lattices and the sphere packing problem** ALEXEI ANDREANOV, Max Planck Institute for Physics of Complex Systems, Noethnitzer Str. 38, 01187 Dresden, Germany, ANTONELLO SCARDICCHIO, The Abdus Salam ICTP, 11 Strada Costiera, 34151 Trieste, Italy — We study random sets of perfect lattices in dimensions up to $d = 19$. Perfect lattices are relevant for solution of lattice sphere packing problem. In fact the best lattice packing is a perfect lattice and perfect and eutactic lattices are local maxima of the packing fraction. We use a stochastic generating algorithm for perfect lattices and define a random ensemble with an effective temperature (reminiscent of a Monte Carlo simulation) to study typical properties of perfect lattices and show how as the temperature is decreased the best known packers are easily recovered. We find that the typical perfect lattices are denser than known families and propose two hypotheses for typical packing density between which we cannot distinguish: $\phi \sim 2^{-(0.84\pm0.06)d}$ (improvement of the Minkowksi bound), and a competitor $\phi \sim d^{-ad}$ with a very small coefficient $a = 0.06 \pm 0.04$. We also find properties of the random walk which are suggestive of a glassy system already for moderately small dimensions.

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