Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Inducing mean-field criticality in spin glasses on quasi-planar topologies: Improved quantum annealer designs HELMUT G. KATZGRABER, Texas AM University, MARK A. NOVOTNY, Mississippi State University — Using large-scale Monte Carlo simulations, we demonstrate how mean-field behavior can be induced in spin glasses on (quasi) planar topologies. By adding spin-spin interactions whose length is distributed according to a small-world distribution, we show that the zero-temperature two-dimensional spin-glass universality class becomes a mean-field-like universality class. In particular, this means the system orders at a finite transition temperature. This has important consequences for the design of quantum annealing chips: Combined with the fact that the addition of small-world bonds also changes the percolation universality class to mean field [Phys. Rev. E 93, 042128 (2016)], this means that the embedding of complex problems and the generation of harder benchmark instances should be easier in these topologies. Although the implementation of unrestricted small-world couplers (spin-spin interactions) would be prohibitively difficult in quantum annealers, we show that the mean-field behavior only requires four additional fabrication layers with a fixed general direction and small number of small-world couplers – something that can, in principle, be implemented.

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Date submitted: 09 Nov 2016 Electronic form version 1.4