Reversible computation via classical and quantum many-body numerical methods

S. Kourtis

Boston University, USA.

Boolean satisfiability is a class of complex computational problems with many important applications in cryptography and artificial intelligence, as well as deep connections to statistical physics. Recently, a subclass of circuit satisfiability problems was cast into a class of planar vertex models, which were subsequently studied via Monte-Carlo thermal annealing [1]. The vertex models are constructed so that they have no thermodynamic phase transitions and represent circuits of universal reversible classical computations. Imposing mixed boundary conditions with (subsets of) boundary degrees of freedom pinned and finding the ground state is thus equivalent to performing a computation. In this talk, I shall review the performance of classical annealing as a solver for these planar vertex models in terms of correlation length and relaxation rate. I will then discuss the alternative protocol of quantum annealing for relaxing into the ground state. Finally, I will describe a tensor network-based coarse-graining approach for the efficient solution of the planar vertex models. As a concrete example, I will demonstrate the application of the above approaches to semiprime factorization.

[l] C. Chamon, E.R. Mucciolo, A.E. Ruckenstein and Z.-C. Yang, Nat. Commun. **8**, 15303 (2017).