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A hidden variable model for universal quantum computation with magic states on qubits

A central question in quantum information theory is to determine physical resources required for quantum computational speedup. In the model of quantum computation with magic states classical simulation algorithms based on quasi-probability distributions, such as discrete Wigner functions, are used to study this question. For quantum systems of odd local dimension it has been known that negativity in the Wigner function can be seen as a computational resource. The case of qubits, however, resisted a similar approach for some time since the nice properties of Wigner functions for odd dimensional systems no longer hold for qubits. In our recent work we construct a hidden variable model, which replaces the Wigner function representation, for qubit systems where any quantum state can be represented by a probability distribution over a finite state space and quantum operations correspond to Bayesian update of the probability distribution. When applied to the model of quantum computation with magic states the size of the state space only depends on the number of magic states. This is joint work with Michael Zurek and Robert Raussendorf; Phys. Rev. Lett. 125, 260404 (2020).