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Magically, the negativity of the discrete Wigner function is useful VICTOR VEITCH, CHRISTOPHER FERRIE, JOSEPH EMERSON, Institute for Quantum Computing and Department of Applied Mathematics, University of Waterloo — It is possible to represent d-dimensional quantum states as probability distributions over a phase space of d^2 points. However, to encompass the full quantum formalism we must allow negative representations. The well known magic state model of quantum computation gives a recipe for universal quantum computation using perfect Clifford operations and repeat preparations of a noisy ancilla state. It is an open problem to determine which ancilla states enable universal quantum computation in this model. In this talk we will show that for systems of odd dimension a necessary condition for a state to enable universal quantum computation is that it have negative representation in a particular quasi-probability representation. This representation is a natural discrete analogue to the Wigner function. This condition implies the existence of a large class of bound states for magic state distillation: states which cannot be prepared using Clifford operations but which are not useful for quantum computation. This settles in the negative the conjecture that all states not representable as a convex combination of stabilizer states enable universal quantum computation.

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