Kirkwood-Dirac Nonpositivity is a Necessary Resource for Quantum Computing

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(Dated: September 4, 2025)

Classical computers can efficiently simulate quantum-computational models with restricted input states. The identification of such states can sharpen the boundary between quantum and classical computations. Previous works describe the efficiently classically simulable states of odd-dimensional systems. Here, we further our understanding of systems of qubits. We do so by casting a real-quantum-bit model of computation in terms of a Kirkwood-Dirac (KD) quasiprobability distribution. In this talk, we show that algorithms, throughout which this KD distribution is positive, can be simulated efficiently on a classical computer. Furthermore, we show that KD nonpositivity is a resource monotone under a model of quantum computation. Thus, we establish KD nonpositivity as a necessary resource for computational quantum advantage.