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Prize for Research at an Undergraduate Institution Talk: A Discrete Wigner Function

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For a quantum particle moving in one dimension, the Wigner function represents the particle's quantum state as a real function on the two-dimensional phase space. Though the Wigner function typically takes negative values and can therefore not be interpreted as a probability distribution, its integral along any axis in phase space—even a skew axis—is in fact the probability distribution of an observable associated with that axis. A number of authors have developed generalizations of the Wigner function that apply to discrete quantum systems, but such generalizations are often problematic when the state-space dimension is even. Here we present a discrete Wigner function that shares with the continuous Wigner function the "tomographic" property described above, and is well suited to describe a system of binary quantum objects. We discuss potential applications to quantum computation and quantum cryptography.