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Dynamics of simultaneously measured non-commuting observables[1]

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In quantum mechanics, measurement restores a classical notion of reality via collapse of the wavefunction, which yields a precisely defined outcome. On the other hand, the Heisenberg uncertainty principle dictates that incompatible observables, such as position and momentum, cannot both take on arbitrarily precise values. But how does a wavefunction evolve when two such quantities are probed simultaneously, and how does the uncertainty principle dynamically inhibit precise measurement outcomes? We present a novel detection scheme that allows control over the measurement operators of multiple readout channels of a superconducting qubit. We will show how the uncertainty principle governs the dynamics of the state by enforcing a lower bound on the measurement-induced disturbance, inhibiting wavefunction collapse and consequently leading to persistent diffusion. We will also present the ramifications of this scheme in the context of quantum control and metrology applications.

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