Quantum backaction of measurements revealing the value of a spin-1/2 along x, y and z simultaneously

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Measuring a spin-1/2 along one direction projectively randomizes maximally the outcome of a following measurement along a perpendicular direction. Here, going beyond projective measurements alone, we measure simultaneously the three components $x = \langle\sigma_x\rangle$, $y = \langle\sigma_y\rangle$ and $z = \langle\sigma_z\rangle$ of the Bloch vector of a superconducting qubit.
The σ_x and σ_y components are obtained by measuring the two quadratures of the fluorescence field emitted by the qubit whose amplitude is proportional to $\sigma_- = (\sigma_x - i\sigma_y)/2$. Conversely the σ_z component is accessed by probing an off-resonant cavity dispersively coupled to the qubit. The frequency of the cavity depends on the energy of the qubit and the strength of this last measurement can be tuned from weak to strong *in situ* by varying the power of the probe. In this experiment, the tracked system state diffuses inside the Bloch sphere and performs a random walk whose steps obey specific rules revealing the backaction of incompatible quantum measurements. The associated quantum trajectories follow a variety of dynamics ranging from diffusive to Zeno. Their peculiar dynamics highlight the non trivial interplay between the backaction of the two aforementioned incompatible measurements.