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Arbitrary Control Techniques and Applications for Spin-1 Atoms
MATTHEW BOGUSLAWSKI, H M BHARATH, MARYROSE BARRIOS, LIN XIN, MICHAEL CHAPMAN, Georgia Institute of Technology — We have developed a scheme to apply arbitrary U(3) transformations to a spin-1 state. Using a multi-tone microwave pulse and an external light shift, we eliminate the need for more complicated, multiple-step pulse sequences to initialize or measure a particular quantum state. This technique holds promise for the arbitrary control and measurement of our system of spin-1 rubidium-87 atoms. Firstly, we develop a control protocol in which we can create arbitrary spin operators, via coherent construction of any U(3) operator, and apply synthetic Hamiltonians of our choosing to the atoms. Secondly, we can architect convenient projection-valued measurements to directly measure arbitrary expectation values, giving way to the ability to perform single shot tomography and fully reconstruct a spin-1 state. Beyond arbitrary control and measurement of our spin-1 system, the multi-tone technique can be applied to a novel scheme for quantum-enhanced magnetometery involving squeezed spin-1 atoms. This experiment transforms a spin-nematic squeezed quantum state to a magnetically sensitive state, thereby increasing our phase sensitivity by a factor equivalent to the squeezing parameter.

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