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Quadrupole Raman transitions in ultracold ^{87}Rb driven by optical vortex beams JOSEPH D. MURPHREE, MAITREYI JAYASEELAN, ZEKAI CHEN, ELISHA HABER, NICHOLAS P. BIGELOW, Department of Physics and Astronomy, University of Rochester — Two-photon Raman processes are widely used to coherently manipulate atoms using a pair of laser fields. For dipole transitions, the transfer of angular momentum to the cloud is partitioned into one exchange between the fields polarization and the electrons angular momentum and another exchange between the fields orbital angular momentum (OAM) and the center-of-mass motion of the atom. Quadrupole transitions lift these restrictions, allowing for a richer interplay between polarization, OAM, and the angular momenta of the atom. This opens up the possibility of electronic state control using both the polarization and spatial mode of the applied fields and modified mechanical effects. These transitions are amplified to experimentally relevant magnitudes in the presence of large electric field gradients. This enhancement has been observed in atoms in the evanescent fields generated by light passing through prisms and in trapped ions illuminated by singular beams propagating in free space. We consider an ultracold cloud of Rb-87 atoms undergoing two-photon Raman interactions on the 5S→4D quadrupole transition. By using combinations of Gaussian and Laguerre–Gaussian beams, we explore the effects of the fields polarizations and orbital angular momenta on the atoms.

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