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Angular Momentum Exchange in Atomic E2 Transitions[1] STEFAN EVANS, HAROLD METCALF, Physics, Stony Brook University, Stony Brook NY 11794-3800 — Electric quadrupole (E2) transitions in atoms require $\Delta\ell = 2\hbar$ but ordinary light carries angular momentum of only $1\hbar$. However, Laguerre Gaussian beams can carry arbitrary integer orbital angular momentum (OAM). Atomic E2 transition matrix elements are typically smaller than those of electric dipole transitions by a factor of $\alpha^2 \approx 10^{-5}$, but may be enhanced by angular momentum mixing in atomic states. Instead of seeking these, we look for a nearly pure E2 transition and this means a low-Z atom. While a plane wave approximation is valid for a Gaussian beam, this may not be the case for light with OAM, where the electric field profile is steep near the radial singularity. We compare this gradient to that of a plane wave and incorporate the electric field distribution and gradients into the E2 transition matrix elements. Also important is how large an area of the beam profile interacts with the atom and where to place the atomic sample in the beam profile.

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