

Physics 402
Spring 2019
Prof. Belloni

Discussion Worksheet for April 17, 2019

1. Electric quadrupole matrix element selection rules. Suppose we relax the constraint that the electric field is uniform over the size of an atom (i.e., we do not just consider the case solved in class: $\vec{E}(t) = E_0 \hat{z} \cos(\omega t)$). By expanding the traveling wave electric field $\vec{E}(y, t) = E_0 \hat{z} \cos(ky - \omega t)$, find the potential experienced by the electron in the atom to next order of approximation ($ky \ll 1$). This is the electric quadrupole potential. Estimate how big the correction is relative to the original term for optical radiation.

2. What is the form of the quadrupole matrix element? For the hydrogen atom, what selection rules on changes in the quantum number m arise from this type of matrix element?