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Is the photon recoil equal to the photon momentum? KURT GIBBLE, Penn State University — It is well known that an isolated atom recoils with the momentum of the photon when it absorbs a photon from an infinite plane wave. When the transverse electromagnetic field has a finite extent, the photon wave vector in the longitudinal direction is smaller. When an isolated atom absorbs a photon from a finite laser beam, is the atomic recoil smaller than that for an infinite plane wave? We show that it is smaller and it has a peculiar dependence on the transverse variation of the field. For atom interferometers that measure the photon-recoil, the difference in the size of the photon recoil is safely below the current measurement accuracy for the laser beams that are used. A related problem is the photon-recoil frequency-shift for microwave atomic clocks. For a cesium clock, the usual photon-recoil frequency shift of $h^2k^2/2m$ gives a fractional frequency shift of 1.5×10^{-16}, which is not far below the accuracy of current clocks. We show that the frequency shift does not have the usual form and has a similar behavior as for the transverse field variations above. It depends in unusual ways on the interrogation time, and the size of the atomic wavefunction at the first interaction.

Kurt Gibble
Penn State University

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