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The photon momentum sharing in photoionization

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We investigate the photon-momentum sharing between an electron and an ion in photo ionization. Our work is motivated by the recent experiment [1] in which the average photo-electron component along the laser propagation (which we call later the parallel component) was measured in the process involving absorption of many (30-50) photons. It was observed that the parallel component of the electron momentum grows linearly as function of the laser intensity, more specifically it was shown that this component is equal to the average electron energy divided by the speed of light. Assuming that the number of photons absorbed is the number needed to overcome I_p + the number required to supply to the Above Threshold ionization, ATI, the above finding means that the momentum associated with the ionization potential I_p is absent from the electron momentum In most theoretical work the center of mass motion is not considered at all and the the theory is formulated in terms relative electron-ion coordinate and relative electron-ion momentum. Thus the total transfer of photon momentum to the atom is not taken into account even if when in the calculations the dipole approximation is not used. We derive simple formulas showing how the photon momentum is shared between the electron and the ion in the case of the photo-effect (one photon-absorption) and in the case of the multiphoton absorption process. In the latter case we use the Strong Field Approximation (SFA). Recently [2,3], radiation pressure (which results from non-zero photon momentum) has been invoked as an explanation for the terahertz radiation emitted by laser generated filaments.

References

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