New effects in Above-Threshold Ionization (ATI): From THz-Pulse-Assisted ATI to Photon Emission during ATI

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Strong-field physics and attoscience explore highly nonlinear laser-field induced or assisted processes. Examples of induced processes are above-threshold ionization (ATI) and high-order harmonic generation (HHG). Extreme terahertz science has developed during last decade so that THz fields exceeding 1 MV/cm are available. We first present results for THz-pulse-assisted ATI and show that the photoelectron yield can be increased by one order of magnitude for some photoelectron energies and that the maximum electron energy can be a few times higher than that realized with the laser field alone. Hopefully, these results will be soon confirmed by experiments at the ELI-ALPS facility in Hungary.

Next, we formulate a quantum theory of photon emission during ATI and show that such photons can be emitted in a single-step process. The probability of this process is many orders of magnitude higher than that of HHG, which is a three-step process. We will analyze this photon emission for various wavelengths and intensities of the laser field (see Fig. 1).

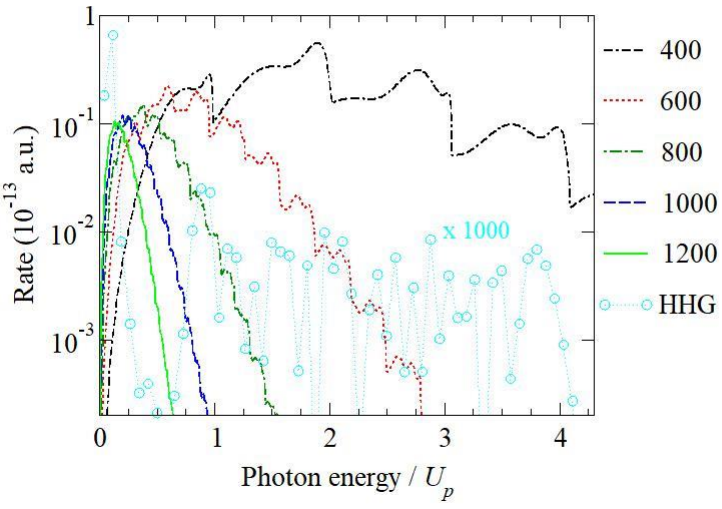

Figure 1: Photon emission rate as a function of the photon energy in units of the ponderomotive energy for photon emission during ATI of argon atoms by a linearly polarized monochromatic field with intensity 2 x 10^{14} W/cm^2 and wavelength in nanometers, as denoted in the legend. The HHG rate for wavelength 1200 nm is multiplied by 1000.