Effects of focal and orientation averaging on photoelectron spectra of diatomic molecules in strong laser field

B. Kovačević[1], A. Gazibegović-Busuladžić[2], D. B. Milošević[2,3]
[1]*Faculty of Science, University of Banja Luka, Mladena Stojanovića 2, 78000 Banja Luka, Bosnia and Herzegovina*
[2]*Faculty of Science, University of Sarajevo, Zmaja od Bosne 33-35, 71000 Sarajevo, Bosnia and Herzegovina*
[3]*Academy of Sciences and Arts of Bosnia and Herzegovina, Bistrik 7, 71000 Sarajevo, Bosnia and Herzegovina*
bojan.kovacevic@pmf.unibl.org

We analyze the process of high-order above-threshold ionization (HATI) on homonuclear molecular systems N_2, O_2 and C_2 exposed to strong linearly polarized laser field. The theoretical method used to calculate the spectrum of emitted photoelectrons is based on the S-matrix approach, in which the differential probability of ionization of molecules interacting with the laser field is calculated. As calculations based on solving the time-dependent Schrödinger equation are numerically demanding even for the simplest molecular systems, the molecular strong field approximation (MSFA) was applied, which implies that the influence of the molecular ion on the liberated electron can be neglected until its eventual re-scattering. In order to obtain better agreement with experimental photoelectron spectra, it is reasonable to assume that the laser intensity distribution corresponds to a Gaussian profile. The method of obtaining corresponding intensity averaged photoelectron spectra for the case of weak and strong focusing is presented. Also, we investigate effect of averaging by the orientation of the molecule. Comparison between 2D and 3D version of orientation averaging for angle of emission $\theta_e = 0°$ is shown. Some symmetries of the (H)ATI spectrum were also analyzed, as well as the dependence of the spectrum on the laser field parameters and on the properties of the molecules themselves. Explanation for the appearance of one type of minima is based on nodal planes and explanation for the other type is given by conditions of occurrence of interference minima that are explained by theory of these processes. Interference minima appear in the spectrum of emitted photoelectrons as a consequence of the destructive interference of different partial contributions to the scattering amplitude. Special attention is paid to the influence of averaging effects on the interference minima, as well as on the general properties of the spectrum.

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