Ionization Pathways of Photoelectrons in Sodium: Energy and Angular Distributions

Y Boran[1], N Hart[2], J Zhou[3], A A Kolomenskii[3], and H A Schuessler[3]

[1]*Department of Fundamental Sciences of Engineering, Sakarya University of Applied Sciences, Serdivan, Sakarya, Turkey*
[2]*Texas A&M Engineering Experiment Station, Texas A&M University, College Station TX, USA*
[3]*Department of Physics and Astronomy, Texas A&M University, College Station, TX, USA*
Contact Email: alexandre-kolomenski@tamu.edu

The observed spectra of photoelectrons reflect contributions from different ionization pathways. In this work, energy spectra of sodium atoms photo-ionized with intense short laser pulses in the near-infrared region and photoelectron angular distributions (PADs) were studied. Laser pulses (duration ∼50 fs, the central wavelength of 800 nm, the output energy up to 1 mJ at 1 kHz repetition rate) with variable linear polarization from a Ti:sapphire laser system were focused onto a narrow and collimated beam of sodium atoms in a vacuum chamber. We observed above-threshold ionization (ATI) spectra of photoelectrons at laser intensities of and . The ATI peaks reflected multistep ionization through intermediate 5p, 6p,7p, and 4f levels [1]. The kinetic energies of photoelectrons were determined by converting the TOF spectra to kinetic energy spectra. Also, the PADs for zero, first, second and third-order ATI peaks were measured and fitted using a wavefunction represented as a sum of Legendre polynomials, accounting for different angular momenta for realized ionization channels. The angular distributions show anisotropic behavior with maxima at 0° and minima at 90°. There are also side lobes with maxima between 60° and 40° depending on the ATI order. The side lobes are more pronounced for the higher-order ATI peaks. The good agreement between the experimental data and fitting allowed us to evaluate the contributions of different ionization channels to the observed ATI orders. For the two selected laser intensities, the angular distribution of photoelectrons showed only slight variations. The TDSE calculations of the ATI spectra in a single active electron approximation show agreement with the experiment of most prominent features, while differences in more subtle features of angular and energy distributions still remained.

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References

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