1 Sakai (Hirofumi) Group

Research Subjects: Experimental studies of atomic, molecular, and optical physics

Members: Hirofumi Sakai and Shinichirou Minemoto

Our research interests are as follows: (1) Manipulation of neutral molecules based on the interaction between a strong nonresonant laser field and induced dipole moments of the molecules. (2) High-intensity laser physics typified by high-order nonlinear processes (ex. multiphoton ionization and high-order harmonic generation). (3) Ultrafast phenomena in atoms and molecules in the attosecond time scale. (4) Controlling quantum processes in atoms and molecules using shaped ultrafast laser fields. A part of our recent research activities is as follows:

(1)Orientation dependence in multichannel dissociative ionization of OCS molecules [1]

With 800-nm, 25-fs elliptically polarized ionization pulses, we observe molecular frame photoelectron angular distributions (MF-PADs) correlated with different dissociative ionization channels: $OCS^+ \rightarrow S^+ + CO$, $CO^+ + S$, $CS^+ + O$, and $O^+ + CS$. We find that the asymmetry in the MF-PAD depends on the specific dissociation channel and the laser intensities. For the dissociation channel leading to the production of O^+, the OCS molecules are more likely to be ionized when the electric field points toward the O atom, while for other dissociation channels, they are more likely to be ionized when the electric field points toward the S atom.

(2) Ar 3*p* photoelectron sideband spectra in two-color XUV + NIR laser fields [2]

We performed photoelectron spectroscopy using femtosecond XUV pulses from a free-electron laser and femtosecond near-infrared pulses from a synchronized laser, and succeeded in measuring Ar $3p$ photoelectron sideband spectra due to the two-color above-threshold ionization. In our calculations of the first-order time-dependent perturbation theoretical model based on the strong field approximation, the photoelectron sideband spectra and their angular distributions are well reproduced by considering the timing jitter between the XUV and the NIR pulses, showing that the timing jitter in our experiments was distributed over the width of $1.0^{-0.2}_{+0.4}$ ps. The present approach can be used as a method to evaluate the timing jitter inevitable in FEL experiments.

This work was done as a collaborative study with researchers from KEK, Kyoto University, Institute of Solid State Physics (The University of Tokyo), Japan Synchrotron Radiation Research Institute, and RIKEN SPring-8 Center.

[1] Yusuke Sakemi, Shinichirou Minemoto, and Hirofumi Sakai, "Orientation dependence in multichannel dissociative ionization of OCS molecules," Phys. Rev. A **96**, 011401(R) (2017) (6 pages).

[2] Shinichirou Minemoto, Hiroyuki Shimada, Kazma Komatsu, Wataru Komatsubara, Takuya Majima, Tomoya Mizuno, Shigeki Owada, Hirofumi Sakai, Tadashi Togashi, Shintaro Yoshida, Makina Yabashi, and Akira Yagishita, "Ar 3*p* photoelectron sideband spectra in two-color XUV + NIR laser fields," J. Phys. B **51**, 075601 (2018) (8 pages).