Internship at NTT Basic Research Laboratories

Yuki Nagakubo
Gonokami Lab, Department of Physics, Graduate School of Science

With the support of the ALPS course, I visited Dr. Hiroki Mashiko at Quantum Optical Physics Research Group of NTT Basic Research Laboratories and stayed for two weeks from February 7 to February 22, 2015. His work of isolated attosecond pulses (IAPs) characterizing inner-shell electron motion of Ne gas atoms[1] has recently published in NTT Press Releases website[2]. Based on this work, he is now trying to observe inner-shell transition of sub-um thick solid sample of Gallium Nitride (GaN). I learned how to perform the experiment.

He demonstrated his pump-probe apparatus using a compact Mach-Zehnder interferometer. In the apparatus an annular mirror splits a fundamental beam of sub-10fs fiber-compressed IR pulses into outer beam pumping and inner beam for probing. Their relative delay is precisely controlled by a piezo-driven stage. Scanning the delay enables us to track variation of XUV (17-23 eV) transmission, therefore ultrafast dynamics of inner-shell electrons of the sample. In addition, he introduced me to a method called Double Optical Gating (DOG) for generating IAPs by high harmonic generation (HHG), which consists of two gating techniques: polarization gating and two-color gating.

Due to lack of exposure time and intensity of the IAP or depletion of the thin sample, we had not yet detected inner-shell electron motion of GaN clearly. However, I understood and impressed by many tricks not referred on his papers, such as his design concept of optical systems miniaturizing vibration-sensitive area, techniques for easily optimizing and stabilizing the fundamental beam, pros and cons of absorption or reflectance spectroscopy, problems and solutions of thin solid samples. I also participated in construction of next generation apparatus for generating and utilizing 1 atomic unit (24 as) IAPs reaching higher energy region of water window (300-400 eV), which let me learn how to build the system, including his idea of vacuum chamber placement and procedures for aligning a toroidal XUV mirror.

I am profoundly grateful to Dr. Hiroki Mashiko, Dr. Katsuya Oguri, other members of Quantum Optical Physics Research Group, Prof. Yamanouchi, Prof. Gonokami and those who support the ALPS program for this valuable experience.

[1] H. Mashiko et al. Nature Communications 5, 5599 (2014).
[2] http://www.ntt.co.jp/news2014/1412e/141216a.html