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Report of MERIT Corporate Internship

Department of Physics D3
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From Dec. 14, 2015 to Mar 31, 2016, I had training as MERIT Corporate Internship program at NTT Basic Research Laboratories in Atsugi City, under the supervision of Dr. Hiroki Mashiko of Quantum Optical Physics Research Group, Optical Science Laboratory.

Dr. Mashiko conducts researches to measure ultrafast physical phenomena by using the generation of Isolated Attosecond Pulse (IAP) generation by Higher Harmonic Generation (HHG) from noble gas excited with laser light. In particular, Double Optical Gating method [1] developed by Dr. Mashiko is one of important technologies for IAP generation. He also studied the measurement of the dynamics of inner shell electrons of neon atoms [2] and the measurement of dipole oscillation in gallium nitride, which is a wide gap semiconductor [3], using IAP generation. These researches lead the world in the measurement of ultrafast physical phenomena using IAP generation.

In my training, I participated in the launch of the experiment system to generate IAPs with shorter pulse duration. Dr. Mashiko's design of experimental system included many brilliant ideas. One of them is the following procedure: split fundamental laser light by using a donut shaped mirror into the probe light that excites the noble gas and the pump light that observes the sample irradiated with IAPs and apply coaxially these two laser lights on the noble gas that radiates IAPs and then on the sample. Here, it should be noted that before the noble gas a time delay is given only to the probe light through the plate of the fused silica so that the probe light and the pump light do not overlap, and that before the sample the same amount of time delay is given only to the pump light in the same way so that these two lights overlap on the sample. Since these two lights travel coaxially in most part, this experiment system is less susceptible to external vibration.

Also, the discussion with Dr. Mashiko about the mechanism of Higher Harmonic Generation and the behavior of electrons in semiconductors excited by Isolated Attosecond Puses was a great stimulus to

me. It gave me the desire to know more about the mechanism of Higher Harmonic Generation and encouraged me to try to understand spectrum theory and functional analysis which are mathematics underlying quantum physics.

Finally, I would like to express my gratitude to Dr. Mashiko, who spent a lot of time for my training, researchers of Quantum Optical Physics Research Group and trainees from other universities, who discussed various subjects and had lunch together with me, and MERIT Corporate Internship Program, which gave me this great opportunity.

References

[1] H. Mashiko, S. Gilbertson, C. Li, S. D. Khan, M. M. Shakya, E. Moon and Z. Chang, "Double Optical Gating of High-Order Harmonic Generation with Carrier-Envelope Phase Stabilized Lasers", Physical Review Letters **100**, 103906 (2008).

[2] H. Mashiko, T. Yamaguchi, K. Oguri, A. Suda and H. Gotoh, "Characterizing inner-shell with spectral phase interferometry for direct electric-field reconstruction", Nature Communications **5,** 5599 (2014).

[3] H. Mashiko, K. Oguri, T. Yamaguchi, A. Suda and H. Gotoh, "Petahertz optical drive with wide-bandgap semiconductor", Nature Physics **12,** 741 (2016).