RICC Usage Report for Fiscal Year 2011

Project Title:

Development of a terawatt sub-10-fs laser system and its application

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Report

1. Background and purpose of the project, relationship of the project with other projects

To probe the ultrafast motion of electrons inside an atom, an intense isolated attosecond pulse is required, to generate which, a high-power sub-10-fs laser pulse as a high-order harmonic (HH) driver is necessary. In this research, we have already succeeded in development of a 1.1-TW, 9.9-fs Ti:sapphire laser system and have applied the fundamental field and its second harmonic field to synthesize a two-color laser field from which an intense attosecond pulse can be obtained.

2. Specific usage status of the system and calculation method

We have used RICC to numerically solve the time-dependent Schrödinger equation (TDSE) to simulate generation of HH fields in rare gas atoms such as argon or neon. From the HH spectra, we can estimate the characteristics of attosecond pulses such as their pulse duration. TDSE can be even used to optimize the two-color laser field that is applied to generate an intense isolated attosecond pulse.

3. Result

By optimizing a two-color laser field, we have shown that a sub-12-fs fundamental field superposed to a second harmonic field with a wavelength shorter than 380 nm can yield an intense isolated attosecond pulse. Using these parameters, one can easily synthesize a two-color laser field for intense attosecond pulse generation in a laboratory.

4. Conclusion

RICC has been applied to simulate generation of intense attosecond pulses using a two-color laser field by solving the TDSE. The results can even predict many details about the characteristics of the attosecond pulses, which helps save a lot of time in a laboratory to optimize a two-color laser field.

5. Schedule and prospect for the future

So far, we have had enough simulation results for generation of an intense isolated attosecond pulse. Our next scope is generation of HH fields and attosecond pulses with an ultrahigh repetition rate by which observation of rare physicochemical events becomes possible. We have already started our experimental work, and as soon as further simulation becomes necessary to make experiments easier or to explain a newly observed phenomenon, we will use RICC again. The required new simulation will possibly consider how the fundamental field is changed after driving HH fields to consider its potential application as a next HH driver.

Fiscal Year 2011 List of Publications Resulting from the Use of RICC

[Publication]

1. A. Amani Eilanlou, K. L. Ishikawa, Y. Nabekawa, H. Takahashi, and K. Midorikawa, "Simulation of intense IAP generation with a two-color field," *IEEJ Trans. EIS*, 2012 (Submitted).

[Proceedings, etc.]

[Oral presentation at an international symposium]

[Others]

2. A. Amani Eilanlou, Y. Nabekawa, K. L. Ishikawa, H. Takahashi, and K. Midorikawa, "Observation of frequency modulation of high-order harmonic fields and its application in isolated attosecond pulse generation," The 12th symposium on Extreme Photonics Research, Saitama, June 2011 (Poster).
3. A. Amani Eilanlou, K. L. Ishikawa, Y. Nabekawa, H. Takahashi, and K. Midorikawa, "Optimizing a two-color laser field for isolated attosecond pulse generation," The 58th Spring Meeting, The Japan Society of Applied Physics and Related Societies, Kanagawa, March 2011.