高次高調波によるアト秒 X 線パルスの増幅
Amplification of X-ray attosecond pulses

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研究成果概要

In 2020, as a continuation of our research performed in 2019, we have further investigated the amplification of attosecond pulses in helium. Initially, the research has been based on the single-electron numerical solution of the time-dependent Schrödinger equation (TDSE) for atomic processes in intense laser fields. The simulations performed with helium as amplifying medium provided interesting insight of the physical processes involved in the experimentally observed amplification around 100 eV, far from the ionization threshold of helium. In particular, from our simulations it could be understood how having He^+ ions in excited states results in a decisive effect for parametric processes at high photon energies to be efficient in high-harmonic generation with helium. The results from our numerical simulations are therefore an important step for the understanding and realization of full coherent plasma X-ray lasers seeded by parametric amplifyied high-harmonics. An article reporting both theoretical and experimental results was published [C. Serrat, J. Seres, E. Seres, T-H. Dinh, N. Hasegawa, M. Nishikino and S. Namba, "Parametric attosecond pulse amplification from high order harmonic generation in He^+ far from the ionization threshold.", Optics Express 28, 24243 (2020)], and an online presentation on the results was presented at the 2020 OSA High-brightness Congress, 23 – 25 March 2020, Prague, Czech Republic.

With the aim of going beyond the single-electron approximation, we are presently using real-time time-dependent density functional theory (RT-TDDFT). Such theory is currently widely used with a high success in computational chemistry studies, and we expect that, although such approximation is less exact that the previous solution of the Schrödinger equation, it will allow us to consider processes including interactions between the different electrons in systems with more than one electron, such as helium. We have made several tests by using different software packages available that implement RT-TDDFT, in particular we have tested OCTOPUS and NWChem. We have observed that OCTOPUS is a possible candidate for this type of simulations to be performed at the shared memory machine at Kyoto, while our first tests show that NWChem would most optimally be executed in a distributed memory system instead.

発表論文（謝辞あり）

“Parametric attosecond pulse amplification far from the ionization threshold from high order harmonic generation in He^+”,

C. SERRAT, J. SERES, E. SERES, T. H. DINH, N. HASEGAWA, M. NISHIKINO, AND S. NAMBA, Opt. Exp. **28**, 24243 (2020).