# Coherent Control of Atoms in the Extreme Ultraviolet and Attosecond Regime by Synchrotron Radiation

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Quantum manipulation of populations and pathways in matter by light pulses, so-called coherent control, is currently one of the hottest research areas in optical physics and photochemistry. In the last two decades, coherent control of a quantum system has been extensively studied using optical lasers which provide phase-locked sequential pulses. Moreover recent advent of the high harmonic laser source and seeded free electron lasers (FELs) has enabled the coherent control at extreme ultraviolet (XUV) regions. We report on a new route to coherent control in the XUV and attosecond regime. Our method is based on the potential use of undulator radiation as longitudinally coherent wave packets, which has been hidden in the incoherent nature of the radiation pulse.

The experiments were carried out at the 750-MeV UVSOR-III storage ring. We used the pairs of 10-cycle radiation wave packets with attosecond-controlled spacing emitted from the tandem undulator consisted of twin APPLE-II type devices [Fig. 1a]. Based on the wave packet interferometry scheme, we succeeded in controlling the population [1] and orbital alignment [2] in photoexcitation of helium atoms in the XUV region by tuning the time delay between the two wave packets at the attosecond level [see Fig 1b]. Since our technique uses a synchrotron light source, it is extendable as far as hard x-ray. This new capability of synchrotron light sources will open up the possibilities of probing and controlling ultrafast phenomena [3] in a wide range of atomic and molecular processes as well as in a variety of materials.

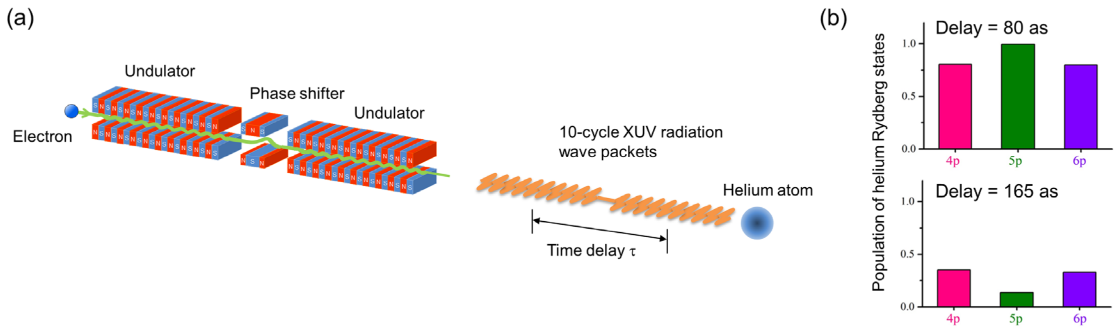


**FIGURE 1.** (a) Experimental scheme for the population control. The relativistic electron emits a pair of 10-cycle wave packets. (b) The population of excited state is controlled by tuning the time delay between the wave packets at the attosecond level.

## REFERENCES

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