For Generation of Tera-watt attosecond X-ray laser pulse

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X-ray free-electron lasers (XFELs) are excellent tools for the study of ultrafast phenomena in atoms and molecules in the fields of biology, material science, chemistry and physics. XFEL facilities can currently supply femtosecond XFEL pulses with a few tens of gigawatt power, generated in the self-amplified spontaneous emission process. However, these pulses are not sufficiently fast to follow the dynamics of electrons in atoms, molecules and nanoscopic systems in their real time. To follow the electronic motions, an intense attosecond X-ray pulse is demanded. Such pulses would allow the investigation of phenomena that have not been previously explored in ultrafast science and X-ray nonlinear science. One of the immediate applications of such a pulse is the observation of real-time changes in the probability distribution of the electron's position. This apparent holy grail of diffraction experiments, paves the way to 4D imaging with picometer spatial and attosecond temporal resolutions.

Here, we discuss a new scheme for a terawatt attosecond x-ray pulse in X-ray free-electron laser controlled by a few cycle IR pulse, where one dominant current spike in an electron bunch is used repeatedly to amplify seeded radiation to a terawatt level. The generated attosecond x-ray pulse is synchronized to the driving few cycle pulse, well suited to the pump-probe experiments in the study of ultrafast dynamics. The viability of this scheme is demonstrated in simulations using Pohang accelerator laboratory (PAL)-XFEL beam parameters.

Also in this talk, the recent activities at CASTECH under Max Planck Center for Attosecond Science are also reviewed.