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Fundamentals of Attosecond Optics

Zenghu Chang

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Attosecond optical pulse generation, along with the related process of high-order harmonic generation, is redefining ultrafast physics and chemistry. A practical understanding of attosecond optics requires significant background information and foundational theory to make full use of these cutting-edge lasers and advance the technology toward the next generation of ultrafast lasers. **Fundamentals of Attosecond Optics** provides the first focused introduction to the field. The author presents the underlying concepts and techniques required to enter the field, as well as recent research advances that are driving the field forward.

A stand-alone textbook for courses on attosecond optics and the interaction of matter with ultrafast, high-power lasers, the book begins with basic theory and gradually advances to more complex ideas. Using both semi-classical models and quantum mechanics theories, the author explains foundational concepts and mechanisms including femtosecond lasers, high-order harmonic generation, and the technological leap that inspired attosecond pulse generation. The book introduces techniques for generating attosecond train using the basis of high-order harmonics, followed by an explanation of gating methods for extracting single isolated pulses.

Chapters examine the connection between attosecond pulses and high harmonic generation, the use of driving lasers as key tools in attosecond generation, the mechanism of chirped pulse amplification, and the generation of few-cycle pulses. The book looks at carrier-envelope phase stabilization and the theoretical foundations for single atom and dipole phase response. It discusses propagation effects, introducing several approaches for improving phase matching; attosecond pulse generation and characterization, covering attosecond pulse train and single isolated pulses; and several examples of experimental applications for attosecond pulses.

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