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From Theory to Reality: Progress and Challenges in Free-Electron Laser Development

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Message from the Guest Editor

Over recent years, developing and applying ultrashort coherent radiation pulses has made tremendous progress. The advent of ultrashort light sources and attosecond metrology has greatly advanced the understanding of electron motion in atoms and molecules. Ultrafast electron motion can be encountered in many quantum systems. Therefore, the application of ultrashort radiation pulses encompasses a broad range of fields, extending from chemical sciences to condensed matter physics. Recently, free-electron lasers (FELs), generating ultrashort pulses with high peak power from the extreme ultraviolet region to the hard X-ray region, are opening a multitude of new scientific opportunities towards the exploration of molecular and atomic structures in the areas of applied physics, chemistry, biology, material science, etc., where employing the coherent powerful ultrashort pulse in the short wavelength range is essential. In this respect, this Special Issue invites manuscripts that theoretically and experimentally address the current challenges in these domains. All theoretical, numerical, and experimental papers are accepted. Topics include, but are not limited to, the following:

- Ultrashort free-electron laser pulse generation.
- Enhanced self-amplified spontaneous emission (ESASE) free-electron laser.
- Generation of coherent free-electron laser radiation.
- Hard X-ray and soft X-ray self-seeding free-electron laser.
- Echo-enabled and high-gain harmonic generation free-electron laser (EEHG and HGHG).

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