Lasers: From strong-laser-field physics to attosecond science and quantum optics

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ABSTRACT

In the 1960s, the breakthrough of the invention of Continuum Wave (CW) lasers [1] meant to change the course of history on light technology and light-matter interactions leading to countless fascinating discoveries and applications in basic research and technology. Among these is development of two, until recently disconnected, major modern research domains namely "Strong-Laser-Field" physics and "Quantum optics". The former deals with interactions of matter with strong laser fields while the later mainly with interactions of matter with weak laser fields. The research domain of "Strong-Laser-Field" physics led to pioneering discoveries ranging from the development of high energy particle sources to "Attosecond Science" aiming to trace in real-time the electron/nuclear motion in all states matter with temporal resolution 1 attosecond = 10^{-18} second. On the other hand, the research domain of "Quantum Optics" opened the way for fascinating achievements in the field of Quantum Technology advancing studies ranging from quantum communication, information and computation to high precision interferometry applied for the detection of gravitational waves.

The emphasis of the research in the Attosecond Science and Technology (AST) activity of FORTH-IESL is in "Strong-Laser-Field" physics and "Attosecond Science" [2, 3] while the last years is devoted in the connection of these research domains with "Quantum Optics" [4, 5]. Here, I will review the developments of the AST activity in these research directions, emphasizing on the most recent achievements concerning: I) the development of an state-of-the-art table-top pulsed source which delivers attosecond pulses with the highest ever pulse energy, and II) the linking of the two disconnected modern research domains, the "Strong-Laser-Field" physics and the "Quantum Optics".

REFERENCES

[1] Maiman T., 1960 *Nature* **187**:493.
[2] Chatziathanasiou S, Kahaly S, Skantzakis E, Sansone G., Lopez-Martens R, Haessler S, Varju K, Tsakiris G. D., Charalambidis D. and Tzallas P., 2017, *Photonics*, **4**:26.
[3] Orfanos I., Makos I., Liontos I., Skantzakis E., Forg B., Charalambidis D., and Tzallas P., 2019, *APL Photonics*, **4**:080901.
[4] Tsatrafyllis N., Kominis I. K., Gonoskov I. A. and Tzallas P., 2017, *Nature Commun.*, **8**:15170.
[5] Tsatrafyllis N., Kühn S., Dumergue M., Foldi P., Kahaly S., Cormier E., Gonoskov I. A., Kiss B., Varju K., Varro S. and Tzallas P. 2019, *Phys. Rev. Lett.,* **122**:193602**.**