Editorial

This special issue is dedicated to the unprecedented developments in ultrafast science that have taken place in Switzerland over the past decade.

Recent progress in observing matter on femtosecond (1 fs=10^{-15} s) and attosecond (1 as=10^{-18} s) time scales has added the possibility of resolving the elementary quantum-mechanical processes that underlie charge and energy transfer. This progress allows scientists to contribute to the resolution of important open scientific questions with new methods and therefore from a new perspective. Time-resolved measurements indeed directly address the function of matter and materials beyond the insights offered by structural determination alone. Although much of ultrafast science is now addressing basic research questions, the disruptive nature of the concepts and methods that are being developed is already clear. Understanding and controlling matter on sub-femtosecond time scales will open the path to petahertz (1 PHz=10^{15} Hz) information processing, the development of more efficient solar-energy conversion and possibly new functional forms of matter.

Considering the present worldwide state of the art in ultrafast science, it is remarkable to note how many research groups in Switzerland have contributed to define it. This demonstrates the timeliness of the present special issue.

In the last decade, several milestones have indeed been reached, which have permanently shaped the Swiss research landscape. The Swiss Free Electron Laser has taken up its operation in 2017, starting with the hard-X-ray branch Aramis,[1] followed by the soft-X-ray branch Athos.[2] Several laser-based user facilities have opened their doors, such as the Lausanne Center for ultrafast science (LACUS), to which Chimia has dedicated a special issue in 2017,[3] and the FastLab at the University of Berne. Still in 2017, the world record of the shortest pulse of light ever measured has been set in Switzerland[4] and remains valid to this date.

I am very grateful to the authors of the present issue for their contributions that showcase some of the latest developments and breakthroughs in ultrafast science in Switzerland.

These contributions are organized into three groups.

The first three articles describe the forefront of research with short-pulse and short-wavelength lasers, covering the attosecond to femtosecond time domain and ranging from isolated molecules over clusters and nanoparticles to complex biomolecules and liquids.

The next four articles cover the current frontiers of ultrafast dynamics in complex systems, which include the important classes of organic semiconductors and photovoltaic materials that already have real-world applications, the study of the structure and dynamics of surfaces with ultimate temporal resolution and even the application of ultrafast-science techniques to the study of visual processes in living mice.

The final three articles represent the cutting edge of theory on ultrafast time scales. These articles cover the attosecond time scale of purely electronic dynamics, the femtosecond time scale of vibrational dynamics, as well as the description of innovative methods to describe their couplings. The strong coupling of electronic and nuclear motions remains indeed the central challenge in accurately describing ultrafast molecular dynamics – but it also opens the perspective of electronically controlling chemical dynamics, which defines the field of attochemistry. The articles of this special issue therefore also announce a bright future for ultrafast science in Switzerland.

I wish you an enjoyable reading!

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[1] Ch. Milne et. al., *Appl. Sci*. **2017**, *7*, 720, https://doi.org/10.3390/app7070720.
[2] R. Abela et al., *J. Synchrotron Rad*. **2019**, *26*, 1073, https://doi.org/10.1107/S160057751900972X.
[3] M. Chergui, Chimia **2017**, *71*, 5, 265
[4] Th. Gaumnitz et al., *Opt. Exp*. **2017**, *25*, 27506, https://doi.org/10.1364/OE.25.027506.

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