The Lausanne Centre for Ultrafast Science (LACUS)

Majed Chergui

Fundamental and practical challenges facing our society can be addressed by new methods and thus approached from a new perspective. Examples of present day challenges are energy conversion, biology, medicine, new materials, *etc.*

Over the last decade, ultrafast technology has made enormous progress, opening a large variety of new research fields and applications. Examples include table-top high-harmonic generation sources of vacuum ultraviolet to soft X-ray radiation that allow new forms of spectroscopy and diffraction, lab-based sources of ultrashort electron pulses and new sources of intense terahertz radiation, *etc*. All of these tools have opened new directions in materials science, chemistry, and biology.

The EPFL has a large community of ultrafast scientists, most of them participating in the NCCR:MUST (Molecular Ultrafast Science and Technology) and it includes both experimental and theoretical teams from Chemistry, Physics, Life Sciences, and Engineering, developing new methods as well as using them in various applications. The complementarity of these various groups in terms of methods, technology and science and the availability of world-class facilities have led to the creation of the Lausanne Centre for Ultrafast Science, or LACUS (which means “lake” in Latin). It was launched on June 3, 2016 at the Rolex centre of the EPFL, with the participation of distinguished international speakers such as Theodor Hänsch (München), Shaul Mukamel (UC-Irvine), and Villy Sundström (Lund).

The research areas covered by LACUS are very diverse, spanning from fundamental to applied research. In addition, several EPFL groups have been pioneers in ultrafast science as witnessed by the number of ‘first’ achievements. LACUS pools in the expertise in the development and the use of advanced ultrafast laser, X-ray and electron technology, and associated methods, along with the EPFL theory groups. It also aims at complementing and strengthening existing Swiss scientific infrastructures. The quickly evolving field of X-ray science with the advent of free-electron lasers (FEL) calls for the development of new ultrafast laser techniques. LACUS offers an ideal platform for such developments, while complementing SwissFEL by covering lower photon energies and offering more flexibility in terms of pulse duration, repetition, flux, as well as allowing complementary experiments using ultrashort pulses of Electrons.

One of the missions of LACUS is to enable cutting-edge ultrafast science and technology and their applications by means of world class experimental set-ups that are out of reach of the resources of a single group. LACUS provides to the EPFL community frontier electron and light sources of various pulse duration, going from the THz range to the vacuum ultraviolet and the soft X-ray range. It also envisions unusual combinations of tools: *e.g.* THz pump/XUV probe or IR pump/XUV, photons with electron pulses, photons and scanning tunnelling microscopy (STM), *etc.*

The present edition of CHIMIA samples a selection of articles showing the capabilities of LACUS such as: the new Harmonium facility for ultrafast photoelectron spectroscopy of gases, liquid solutions and solids (time- and angle-resolved photoelectron spectroscopy or tr-ARPES), the swissFEL facility, the deep-UV spectroscopy capabilities at the LOUVRE lab, the sum-frequency methods to probe interfacial structure and dynamics, the femtosecond laser machining of materials and theoretical methods. These papers exemplify the capabilities of the methods by recent results of studies on molecules, solid materials and proteins. This selection of articles is far from exhaustive as LACUS includes several other groups, such as, unique in Switzerland, those developing and using ultrafast electron diffraction and microscopy (F. Carbone and U. Lorenz), in addition to the groups using pulsed Terahertz and optical domain radiation for probing the charge carrier dynamics in solar materials (J. E. Moser and A. Hagfeldt), ARPES (H. Dil), frequency combs (T. Kippenberg) and theory (U. Röthlisberger).

In summary, LACUS represents a truly interdisciplinary centre dedicated to the development of new methods of ultrafast science methods and techniques and their applications in chemistry, photonics, materials science, and engineering. It also bridges the lab-based activities in X-ray science with those at the Paul-Scherrer-Institut using the Swiss Light Source synchrotron or soon, the swissFEL free electron laser. Finally, LACUS is open to the Swiss ultrafast science community within the NCCR: MUST and beyond.

Professor Majed Chergui
Laboratoire de Spectroscopie Ultrarapide (LSU) *http:///lsu.epfl.ch/* and
Lausanne Centre for Ultrafast Science (LACUS) *http:///lacus.epfl.ch/*
Ecole Polytechnique Fédérale de Lausanne
ISIC, FSB, Station 6
CH-1015 Lausanne, Switzerland
E-mail: Majed.Chergui@epfl.ch

The Editorial Board of CHIMIA expresses its deep gratitude to Prof. Majed Chergui for organizing this fascinating issue on LACUS, introducing a pioneering facility at EPFL, enabling cutting-edge, interdisciplinary science open to the Swiss ultrafast science community.