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## PhD position

### Structural and electronic response of molecular materials to THz excitation probed by ultrafast optical & X-ray techniques

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Institut de Physique de Rennes, University of Rennes 1, France

(starting October 1st 2018, net salary ~1.4 k€)

Classically phase transitions in materials have been driven by changes of external control parameters like temperature and pressure. More recently light has been used to drive phase transitions faster (because of the use of short light pulses) and especially differently since femtosecond pulses could couple to electronic degrees of freedom before the system can move.

The disadvantage of electronic excitation is that energy redistribution takes place very rapidly thus limiting in many cases its primary interest. For this reason we are interested in exploring an even newer way to control phase transition: intense THz pulses. Such pulses can last only a fraction of a ps and have extremely high electric field, reaching ~1 MV/cm [1,2].

Coupling directly to relevant structural degrees of freedom, such excitation might allow for finer control of the outcome. Indeed interesting coherent controls of phase transitions have been theoretically and experimentally proposed [3,4].

The scope of the thesis will be to develop THz excitation using the already available femtosecond spectroscopy laboratory, to apply to systems of interest in our group and to complete these studies by complementary experiments at X-ray Free Electron Laser (XFELs) [5,6]. The structural and electronic response of molecular materials to THz excitation will be probed on the timescale of atomic motions by using ultrafast X-ray diffraction and time-resolved crystallography at X-FEL and by time-resolved optical and X-ray spectroscopies. The goal of the PhD is to reach THz control of the physical properties of materials

#### References

- [1] Hirori, ..., Tanaka, Single-cycle terahertz pulses with amplitudes exceeding 1 MV/cm generated by optical rectification in LiNbO<sub>3</sub>, *Appl. Phys. Lett.* 98, 091106 (2011)
- [2] Kampfrath, Tanaka, Nelson, Resonant and nonresonant control over matter and light by intense terahertz transients, *Nature Photonics*, 7, 680 (2013)
- [3] Qi, ..., Rappe, Collective Coherent Control: Synchronization of Polarization in Ferroelectric PbTiO<sub>3</sub> by Shaped THz Fields, *PRL* 102, 247603 (2009)
- [4] Mankowsky, ... Cavalleri, Ultrafast Reversal of the Ferroelectric Polarization, *PRL* 118, 197601 (2017)
- [5] Harmand, ..., Cammarata, Achieving few-femtosecond time-sorting at Hard X-ray Free Electron Lasers, *Nature Photonics* 7: 3138-3146 (2013)
- [6] Lemke, ..., Cammarata, Coherent structural trapping through wave packet dispersion during photoinduced spin state switching, *Nature Communications* 8, 15342 (2017)

#### Context

The successful candidate will work in the ultrafast spectroscopy laboratory and participate in experimental campaigns on large facilities around the world. The group is heading a

French-Japanese Joint research Institute<sup>1</sup>, which the thesis will be directly connected to. Prof. Tanaka (Kyoto University) world expert in intense THz pulses is part of such institute and will closely collaborate on this project.

Our team is young and dynamic, a third being foreign, English is the working language.

The scholarships include full social security coverage and a net salary of ~1.4 k€. Students have no teaching obligations. If interested, successful candidate can apply to a teaching assistant position during the first or second year of PhD. The University offers French courses for foreigners and hosts an international Erasmus Mundus program.

The student should obtain their PhD degree within the 3 years of the financial support (before Oct 2021).

Rennes is a medium size French city less 1.5 hour train ride from Paris, offering a relaxing lifestyle with many cultural and sport activities.

### **Requirements:**

- M.Sc. degree in physics
- Good understanding of Physics
- Good experimental skills
- Good team player
- Prior hands-on experience with diffraction and/or laser spectroscopy will be a strong asset

### **Timeline:**

- March 2018 announcement of the position
- March - May 2018 candidate pre-selection.
- June 2018 selected candidates interviews
- End of June 2018 selection of candidate awarded position

### **Selected Publications of the group:**

- Phys. Rev. Lett. 105, 246101 (2010)
- Nature Photonics 7, 215 (2013)
- Phys. Rev. Lett. 113, 227402 (2014)
- Chem Science, 8, 4978 (2017)
- Nature Communications, 8, 15342 (2017)

### **Interested candidates are encouraged to contact (before end of may):**

Dr Marco Cammarata ([marco.cammarata@univ-rennes1.fr](mailto:marco.cammarata@univ-rennes1.fr))

Dr Laurent Guerin ([laurent.guerin@univ-rennes1.fr](mailto:laurent.guerin@univ-rennes1.fr))

Curriculum Vitae, motivation letter, university marks and manuscripts (master thesis, experimental reports, etc) might be joined to the email

### **Further information:**

<https://ipr.univ-rennes1.fr/en/materials-and-light-departement>

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<sup>1</sup> [http://www.chem.s.u-tokyo.ac.jp/users/lia\\_im-led/index-e.html](http://www.chem.s.u-tokyo.ac.jp/users/lia_im-led/index-e.html)