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Dynamics, Control and Energy Transfer at Terahertz Frequencies.

The timescales of interest in chemical and biological science span a wide range, from ultrafast local reaction chemistry (femtosecond to nanosecond), to much slower, long range dynamics (tens of milliseconds to seconds). It is the coupling between these different timescales that governs reaction dynamics. In particular, it is the motion occurring at terahertz (THz) or far-infrared frequencies, and more importantly the coupling between these motions, that control reaction dynamics.

In this project we are planning to build on Leeds continued position as a global leader in THz technology (http://www.leeds.ac.uk/site/custom_scripts/spotlight/terahertz.php) to develop a range of multidimensional THz spectrometers based on amplified Ti:sapphire laser technology. These multidimensional spectrometers will be based on similar principles to 2D-NMR, and use a series of well controlled, THz pulses to probe the long-range coupling between THz active modes directly in a number of materials. In particular, this project will concentrate on the coupling between modes in two types of compounds; 1) organic explosives such and pentaerythritol tetranitrate and 2) compounds that exhibit an optically induced, solid-state phase transtion. Furthermore, this project will then develop methods to steer and control local reaction chemistry by directly influencing this coupling, using very intense THz pulses to probe chemical dynamics, gaining an insight into chemical processes by exploring unknown regions of the free energy landscape and developing a fundamental understanding of reaction pathways to control chemical and biological reactions.

This project will also involve the development of complementary measurements at a range of international user facilities including ALICE (http://www.stfc.ac.uk/research/particle-physics-and-particle-astrophysics/alice-dl/), FELIX (http://www.ru.nl/felix/), Diamond (www.diamond.ac.uk/) and the Central Laser Facilities (www.clf.stfc.ac.uk/).

The project has the potential to develop in many different directions and will require a student with a degree in Chemistry/Physics/Engineering or a related subject with a willingness to engage in genuinely interdisciplinary research. The project will require that the student gain a working knowledge of multiple areas with specific emphasis on instrument development and theoretical calculations to support spectral interpretation, in addition to methods in analytical and physical chemistry. Experience in computer programming would also be an advantage although experience in all these areas is not a pre-requisite.

Please contact Dr Andrew Burnett (A.D.Burnett@leeds.ac.uk) for further details about this opportunity.

Suggested References and Reading Materials.

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