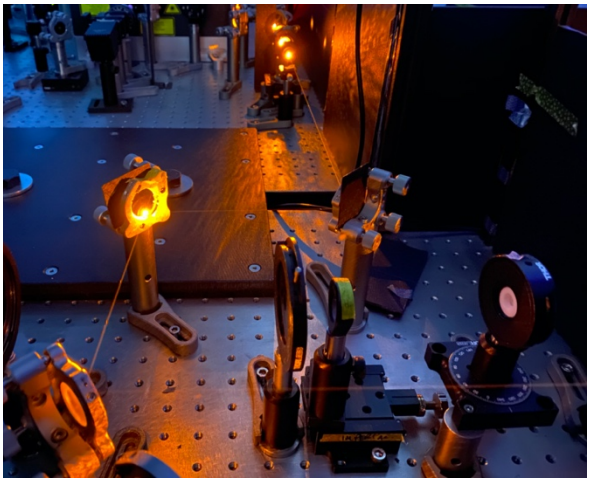
Investigating Molecule–Environment Interactions with Ultrafast Laser Spectroscopy

About the project or challenge area: Absorption of light by molecules initiates a fascinating correlated dance of electrons and nuclei that underpins many important photochemical reactions, such as the primary steps of photosynthesis or a *cis-trans* isomerisation that initiates vision. The outcomes of such photoinduced reactions are determined by how the electronic structure of constituent molecules changes by absorption of light, their time-dependent interactions (on femtosecond ($1x10^{-15}$ s) to picosecond ($1x10^{-12}$ s) timescales) with adjacent chromophores and rapid fluctuations of the surrounding environment. Using state-of-the art multidimensional optical spectroscopies (see link below) and tailored laser light pulse sequences we can take snapshots of an ensemble of thousands or millions of molecules at a time, and thus deduce the timescale and pathway(s) of energy flow between molecules in liquids or solids. From this vital information, we can derive the key inter-molecular interactions required for robust and efficient natural photochemical reactions and use this as inspiration for the next generation designer man-made chemical or protein systems. The project will involve looking at molecular interactions of chromophores in unusual solvents such as ionic liquids or inside model proteins that only incorporate a limited number of light absorbing molecules.



Why choose this opportunity? The focus of your project will be on photochemistry and ultrafast laser spectroscopy which will provide an excellent platform to learn about the fundamental molecular-level interactions of molecules with their environment. Your work in this area can make a real impact on global challenges solar energy capture and storage, by developing a greater understanding how molecules transfer energy between each, and the environment influences the outcome of the photochemical reaction. You will develop and increase your expertise in broad analytical skills and spectroscopic techniques, whilst becoming familiar with the fundamentals of ultrafast laser chemistry. Furthermore, this project will require your collaboration with other members across other research groups, thus improving your teamwork and networking skills. You will furthermore be developing a range of additional transferable skills, including presentation, scientific writing, and project and time management. Finally, you will be interacting with students from all over the world learning from their culture and skills, adding to your professional and personal development.

Full training will be provided for all aspects of this project. You will be embedded in the Supervisor's research group, who will provide support. In addition, you will be assigned a mentor for the duration of your project, who will provide extra support and help you to identify any additional training needs or opportunities.

About you: You will have skills and knowledge in general physical chemistry, spectroscopic and analytical methods, data analysis, teamwork and time management. These skills are desirable but not essential.

Bench fees: A bench fee of £4000 is required.

How to apply: Applications are accepted throughout the year and you should complete the online application form for Chemistry (MSc by Research).

Supervisor: Your supervisor for this project will be Tom Oliver, Proleptic Associate Professor of Chemistry and Royal Society University Research Fellow in the School of Chemistry. You can contact him by email tom.oliver@bristol.ac.uk

Find out more about your prospective research program: This review article explains the unique aspects of multidimensional ultrafast laser spectroscopy:

Recent advances in multidimensional ultrafast spectroscopy, R. Soc. Open Sci., **5**, 171425 (2018). http://dx.doi.org/10.1098/rsos.171425