PhD in Terahertz Imaging and Spectroscopy

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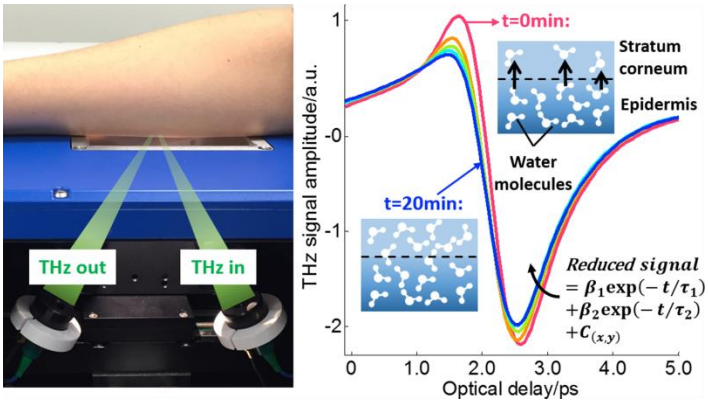
Are you interested in applying physics to benefit medical diagnosis?

Terahertz (10^{12} Hz, THz) pulsed imaging is a new technique with high resolution (about 20 µm) and has only emerged recently as a potential new clinical tool for medical imaging. It is a totally non-destructive imaging modality and, unlike X-ray methods, is non-ionising. A terahertz light pulse is focused onto the sample of interest and then detected coherently. A measurement at a single point is analogous to an ultrasound A-scan, or to radar. Reflections off different layers are used to determine the structure at various depths. Further, THz light is very sensitive to hydrogen bonds, and useful spectroscopic information about the skin can be revealed by Fourier transforming the time-domain pulsed data.



Photograph of *in vivo* THz imaging set up to image the skin on the volar forearm (left). As the skin is occluded, water accumulates in the stratum corneum (outer most layer of skin). During this process the reflected THz signal decreases and can be monitored in real time. The signal before occlusion (red, time zero) and after twenty minutes of occlusion (blue) are highlighted (right.). The system is so sensitive that even occluding for 5 seconds affects the THz response.

In this project, applications of real-time THz imaging of skin will be investigated and developed by the student. For example, it may be possible to use THz to detect early stages of skin cancer, or the lateral extent of tumours that are beneath the skin's surface, but are not yet visible to the eye. Recent work in the group (see Figure) has shown the sensitivity of THz imaging to the water content of the outermost layer of the skin, which can be tracked in real time. The student will exploit recent improvements in instrumentation and analysis methods made by the group to utilise THz spectroscopic imaging for biomedical applications. Background information about this area can be found in our recent review [1].

Prof. MacPherson has recently joined Warwick University and received a Wolfson Merit award to support her research in the UK https://www2.warwick.ac.uk/giving/health/cancer/. For more background information regarding Prof. MacPherson's research interests, please see her Hong Kong Group web page http://bme.ee.cuhk.edu.hk/thzgroup/. For further information do not hesitate to contact Prof. MacPherson directly on e.macpherson@warwick.ac.uk.

This is a fully funded-PhD studentship at standard UK Research Council rates, available with a flexible start date from autumn 2017 onwards, and for a 3.5 year period. The Studentship covers university fees and a living stipend, and is available to UK and EU students. For more information please see http://go.warwick.ac.uk/PhysicsPG or contact the Admissions Tutor, Dr. James Lloyd-Hughes at J.Lloyd-Hughes@warwick.ac.uk.

[1] "Recent advances in terahertz technology for biomedical applications" Q. Sun *et al.*, Quantitative Imaging in Medicine and Surgery 7(3): 345 (2017). DOI: 10.21037/qims.2017.06.02