2020 Physics Honours Projects - Other

1. Characterisation of aerosol-printed platinum electrode array

Supervisors: Dr Tatiana Kameneva, Professor Paul Stoddart

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Most bionic devices are tested *in vitro* on a bench or in animal experiments prior to being approved in a clinic. For example, one of the initial steps in the development of a neural prosthesis is testing stimulation strategies and recording neural activity using an electrode array *in vitro*. Aerosol jet printing is a novel technique that primarily focuses of printed electronics. This technique allows precise and noncontact deposition of nanoparticles.

The aim of this project is to print platinum electrode array using aerosol jet printer. The second part of the project involves characterisation of the array properties, such as conductivity and topography. Depending on the student's progress, there may be an opportunity to test this array *in vitro.*

The project would suit someone with an interest in gaining experience in aerosol jet printing for medical bionics applications. The student should have strong analytical skills and should also have an interest in working in a multidisciplinary environment.

2. Using advanced signal processing techniques to minimise noise in muscle sympathetic nerve activity data

Supervisors: Dr Tatiana Kameneva, Associate Professor Elisabeth Lambert

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Microneurography technique was developed over 40 years ago in order to record sympathetic traffic in peripheral nerves supplying the skeletal muscle vascular bed in humans. Direct recording of multiunit efferent muscle sympathetic nerve activity (MSNA) has been used extensively to evaluate sympathetic neural drive in the healthy state as well as in a number of conditions. Sometimes, the quality of the recording is not satisfactory, and the raw data cannot be used in analysis.

The aim of this project is to use advanced signal processing techniques to filter data from artefacts, noise, offsets, artificial trends and shifts. This will allow to salvage the data and use it in a post-processing analysis.

The project would suit someone with an interest in gaining experience in signal processing of biological data. The student should have strong analytical skills and should also have an interest in working in a multidisciplinary environment.

3. Rotational slip in nano-confined fluids

Supervisors: Prof. Billy Todd and A/Prof. Federico Frascoli

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Project Description: Slip is a phenomenon that occurs when a flowing fluid has non-zero flow velocity at the interface between the fluid and a stationary solid wall. Conventional fluid dynamics models generally assume the slip is zero at this interface (i.e. there is no relative velocity between the fluid and the wall at the interface). Recently however, this has been questioned due to recent observations at the nanoscale. It is now a subject of considerable interest since it has wide-ranging implications from the observed enhanced flow of water in carbon nanotubes through to earthquake prediction and modelling. Several theoretical models have been proposed to predict the non-zero slip of fluids at solid surfaces, including an extremely accurate one developed by Prof Todd and co-workers [1-5]. So far only linear translational slip has been considered. In this project, we will apply our theoretical formulation to compute the rotational slip of molecularly structured fluids. It is always assumed that molecules do not rotate at a fluid-solid interface, but this assumption is almost certainly not true in general and may be extremely significant in potentially important nanofluidic situations. This project will be the first time such a slip has been computed via statistical mechanical means and verified by non-equilibrium molecular dynamics simulation.

[1] Prediction of fluid velocity slip at solid surfaces. J.S. Hansen, B.D. Todd and P.J. Daivis. *Physical Review E* **84**, 016313 (2011).

[2] Slip flow in graphene nanochannels. S. K. Kannam, B.D. Todd, J.S. Hansen and P.J. Daivis. *The Journal of Chemical Physics* **135**, 144701 (2011).

[3] Slip length of water on graphene: Limitations of non-equilibrium molecular dynamics simulations. S. K. Kannam, B.D. Todd, J.S. Hansen and P.J. Daivis. *The Journal of Chemical Physics* **136**, 024705 (2012).

[4] Interfacial slip friction at a fluid-solid cylindrical boundary. S. K. Kannam, B.D. Todd, J.S. Hansen and P.J. Daivis. *The Journal of Chemical Physics* **136**, 244704 (2012).

[5] How fast does water flow in carbon nanotubes? S.K. Kannam, B.D. Todd, J.S. Hansen and P.J. Daivis. *The Journal of Chemical Physics* **138**, 094701 (2013).