Applications are invited for the following a PhD studentship for the following project within Trinity College Dublin, School of Physics and AMBER.

Quantum model of filament growth in memory junctions: applications to neuromorphic computing

Project description: The brain contains an incredibly large number of neurons that exchange signals through synapses. Not all neurons are simultaneously active but only a small fraction, depending on the task being performed and this is one of the reasons the brain functions in such an energy-efficient manner. It is the pursuit of this efficiency that drives the rapidly-developing field of neuromorphic computing, which aims to imitate nature and design a machine that can process, store and transmit information with minimal energy expenditure. Nanowire networks possess key characteristics displayed by neurons and are, most likely, the building blocks of future neuromorphic computers. However, one major obstacle is that when signals are driven in a dense network they travel through very many avenues rather than unidirectionally through a well defined path. Consequently, too many wires are unnecessarily involved in what could have been achieved with a fraction of the total if we were able to instruct the network to channel the signal through only a single path. In this project, we will establish the exact conditions a nanowire network must satisfy to disperse signals through a single track, i.e., uni-dimensionally. As demonstrated in Ref [1], a single-path current flow tend to occur in networks when thin conducting filaments are formed across individual wire junctions. Therefore, understanding the conditions for the formation of such a filament at junction level can explain what happens at a macroscopic scale. This will lay the foundation for solid-state neuromorphic devices that can emulate brain-like functionalities and perform cognitive tasks without activating the entire network but only with what is minimally required. The project aims to apply concepts of Condensed Matter Theory to establish the atomistic conditions required by the network to transport all information through a single channel. This will involve the implementation of transport calculations in low-dimensional systems with special emphasis on the non-linear behaviour of resistive switching devices.

Requirements: The candidate must have or expect to obtain a first or 2.1 Hons degree in Physics or any related subject. Previous research experience through a MSc in not required but desirable.

Desired abilities: Excellent mathematical and computational skills are required; Solid background in Solid State Physics is expected;

Keywords: Transport properties of Condensed Matter; Condensed Matter Theory; Resisitive Switching; Complex Networks; Spintronics; Neuromorphic Computing

How to Apply: Send a CV including the names and contact details of two references to Prof. Mauro Ferreira (ferreirm@tcd.ie), School of Physics, Trinity College Dublin.

Closing Date: The post will be advertised until the position is filled

This position is funded by Trinity College Dublin's Provost Award. The AMBER research centre, as a community of researchers, welcomes its responsibility to provide equal opportunities for all. We are actively seeking diversity in our research teams and particularly encourage applications from underrepresented groups.

References:

[1] “Emergence of winner-takes-all connectivity paths in random nanowire networks”, Nature Communications 9, 3219 (2018)