Bell Burnell Graduate Scholarship Scheme – Physics Project

PROJECT TITLE: Quantum technologies exploiting topology

Lead Supervisor: Dr. Charles Downing

Profile Webpage: https://experts.exeter.ac.uk/24273-charles-downing

Co-Supervisors: Prof. Misha Portnoi (University of Exeter https://experts.exeter.ac.uk/169-misha-portnoi)

Project details: The mathematics underpinning topological matter is of a large and growing interest, especially since the Nobel Prize in Physics was awarded in 2016 to the British theoretical physicists Thouless, Haldane and Kosterlitz "for theoretical discoveries of topological phase transitions and topological phases of matter".

At its heart, topological physics allows one to explain the behavior of complicated systems very simply, usually through some important number: a so-called topological invariant. A famous example is in the much celebrated quantum Hall effect, where the resistance in the material surprisingly plateaus at certain integer values (please see the figure below). This intriguing phenomenon can be understood elegantly through topological numbers known as Chern numbers. We have so far only talked about conventional materials, which are primarily governed by the behaviour of their constituent electrons. However, much less is known when it is the particle of light (the photon) which instead plays an important role in the system.

In the field of quantum nanophotonics, we are concerned with nanoscale materials where the light-matter interaction is decisive. In particular, in the strong light-matter coupling regime, electrons and photons may hybridize to form a new particle, carrying desirable traits of both of its component parts. This sets the stage for the proposed project, which aims to make fundamental mathematical advances in topological quantum nanophotonics. Namely, inspired by the success of topological theories in describing electronic systems, we will develop theories to describe and exploit topological light at the nanoscale. We will develop new topological invariants capable of describing bosonic particles such as light, and create models which explain how topological light may be used in the next generation of quantum technology, including quantum circuitry, communications and information.

Project specific entry requirements: Standard entry requirements for a PhD in physics please

Potential PhD programme of study: PhD Physics

Location: Physics Building, Streathamn Campus, Exeter

Please direct project specific enquiries to: Dr. Charles Downing at c.a.downing@exeter.ac.uk for more details.

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Please ensure you read the entry requirements for the potential programme you are applying for.

To Apply for this project please click on the following link - **APPLY HERE**

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