Senior Research Associate in superconducting qubits with moveable junctions

**JOB DESCRIPTION**

Job vacancy:

<table>
<thead>
<tr>
<th><strong>Job Title:</strong></th>
<th>Senior Research Associate</th>
<th><strong>Present Grade:</strong></th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Department/College:</strong></td>
<td>Physics</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Directly responsible to:</strong></td>
<td>Prof. Edward Laird and Dr Jon Prance</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Supervisory responsibility for:</strong></td>
<td>Partial responsibility for graduate and MPhys students</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Other contacts**

**Internal:** members of the Physics Department

**External:** Other scientific collaborators
We are seeking a committed researcher to integrate mechanical resonators into superconducting qubits.

Coupling between a mechanical resonator and a qubit is a key to controlling single phonons, to creating ultra-sensitive detectors for force and displacement, and ultimately to studying mesoscopic quantum superpositions of millions of nucleons. However, it is difficult to make the coupling strong enough to overcome decoherence. In this project, we will study the ultimate limit of strong coupling, by incorporating the moving element into the qubit itself. We will do this using Josephson junctions made from vibrating carbon nanotubes and graphene, which are optimal for strong coupling because they have very low mass and high quality factor. The ultimate aim is to create a matter-wave interferometer according to the scheme outlined in [1]. Along the way are a host of exciting experimental possibilities that come from strong coupling between mechanics and superconductivity, including phonon lasers, mechanical Shapiro steps, mechanical parametric amplifiers, and ultra-sensitive SQUID-based force sensors.

This project takes advantage of newly purchased equipment and will use the nanofabrication facilities of the Quantum Technology Centre, the electronic and cryogenic facilities of the Low Temperature Physics group and a vibration-isolated laboratory in the IsoLab facility at Lancaster. For more information about this research area see

http://wp.lancs.ac.uk/laird-group/
https://www.lancaster.ac.uk/physics/isolab/

Our recent high-profile papers in this field include

This post is initially funded until the end of February 2025.

Major Duties:

- Fabricate graphene and/or carbon nanotube mechanical resonators.
- Incorporate them into superconducting circuits to realise Josephson junctions, SQUIDS, and qubits.
- Detect mechanical vibrations via the superconducting device, characterize the coupling between the mechanical and superconducting degrees of freedom, and study how each affects the other.
- Realise, if possible, the displacemon protocol for creating a matter-wave interferometer on a chip.
- Analyse data and publish results in peer-reviewed journals.
- Disseminate project results including presenting to project partners and at conferences.
- Support the production of arising IP.
- Support students working on quantum electronics and nanomechanics.