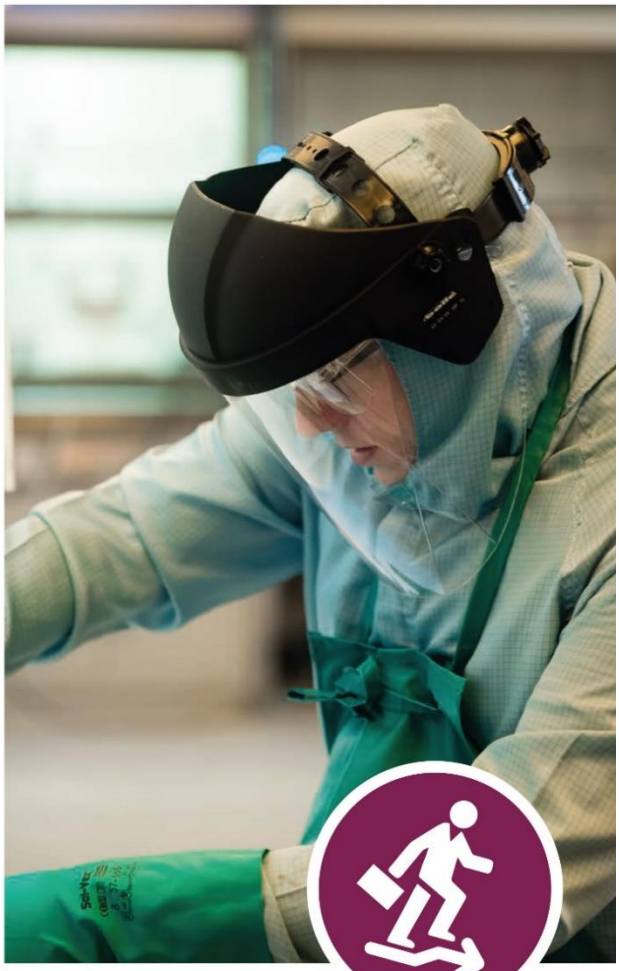
The Ogden Trust

making physics matter



Summer Internships Programme

The Ogden Trust Summer Internships Programme 2020

As part of its programme of continuing support for Ogden alumni, the Ogden Trust has arranged a series of internships for the Trust has arranged for a series of internships this summer in academic research and outreach.

Details of all available internships are given below. The level of detail varies depending on what the host organisation has provided. If there are links given, use them!

Unless otherwise stated, the following conditions apply:

Eligibility
Ogden undergraduates (including those in their final year) and those at the end of a gap year (either pre- or post-university) are eligible to apply. University research departments are likely to prefer students who have already completed one year of undergraduate study but may consider other enthusiastic but less experienced applicants. If there are any special requirements or exclusions, these will be noted as part of the internship listing.

Duration
Internships are six weeks long and will generally take place between mid-June and mid-September 2020.

Contract
Successful candidates will be required to co-sign an Agreement between themselves, The Ogden Trust, and the host organisation to confirm the terms of the internship and the responsibilities of all parties. On completion of the internship, the intern will be required to submit to the Trust a diary, explaining in layman's terms the nature of the work conducted and, more importantly, giving the intern's impressions of life doing that kind of work and the lessons learned over the internship period. In addition, the intern may be required by his/her host organisation to submit an academic paper, create resource material, or write a commercial report. The Ogden Trust does not require a copy of these documents but would be interested to know what the intern has completed.

Remuneration
The rate is £60 per day up to a maximum of five days per week. For Central London placements, the rate is £70 per day. This will be paid without the deduction of tax or national insurance but may form part of the student's overall taxable income for the year 2020/21.

Payments
Interns will be paid at the end of their internship once their diary, a timesheet and feedback form has been submitted on Flexigrant. An endorsement form also needs to be submitted from their host organisation to confirm appropriate conduct during the internship. **Internship payments will be processed by the Trust. We aim to make payment within three weeks of receiving the required paperwork (if paperwork is not received before 31 December 2020, the bursary will not be paid).**

Application and selection
Applicants must register for Flexigrant to enable them to submit an application https://ogdentrust.flexigrant.com/startapplication.aspx?id=3714 by the closing date. The Application form includes your reference, which must also be received by the closing date, so please invite your referee to participate with plenty of notice. If you have any difficulties with the form or think you have made a mistake after submitting it, please contact Veronica by email: **veronica.leacock@ogdentrust.com.**

Suitable candidates will be selected from the information provided, and their details passed to the appropriate host organisation for final approval. The host organisation will conduct a telephone interview with the candidate before making a final decision; some may request a face-to-face interview. Places will be offered in late April/early May and all applicants, successful or not, will be contacted.

Closing date
The closing date for receipt of applications at the Ogden Trust office is **Sunday 5 April 2020.**

For more information about payments, accommodation, dress code, written submission, etc. please read the *Information for Ogden Trust Alumni Interns 2020* document.

UNIVERSITY OF BIRMINGHAM

UB1 - Name of project: Designing a novel light Dark Matter experiment: ***Optimisation and Sensitivity***
Supervisor's name: Prof Kostas Nikolopoulos
Supervisor's email: K.Nikolopoulos@bham.ac.uk
Specific dates: By mutual agreement

Project outline
It is established from a variety of astrophysical observations and precise measurements of the Cosmological Microwave Background that 84.5% of the matter content of our Universe consists of non-baryonic cold Dark Matter (DM). Although the nature of DM is currently unknown, many theories beyond the Standard Model (SM) predict massive neutral particles, that could play the role of DM. In parallel, significant experimental effort is devoted to searches for DM particles.

Many of these experiments, aiming to detect dark matter particles by directly observing a few of their extremely rare interactions with normal matter, are located in deep underground facilities to avoid interference from other particle sources. The University of Birmingham is strongly involved in the NEWS-G experiment, in SNOLAB (Canada), aspiring to identify Dark Matter candidates using a novel detector, and we are currently also designing a next generation experiment, that could be potentially installed at the Boulby Underground Facility in the UK. In this project, the design of this new experiment will be optimised and its sensitivity to detect DM particles will be investigated with detailed computer simulations.

Skills required/expected from the students.
Basic familiarity with computer programming essential.

Skills and what future career
Knowledge about the current topics of research in particle physics and particle astro-physics. Understanding of the operation principles and physics of particle detectors, and their various applications (e.g. particle physics experiments, medical imaging, etc). Skills in computational techniques, and experience with simulation and data analysis software widely used in particle physics and beyond (e.g. data science). Several career paths open-up: a) fundament research, b) applied research, c) data science, and d) medical imaging and similar professions.

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UB2 - Name of project: Designing a novel light Dark Matter experiment: ***Studies on a prototype***
Supervisor's name: Prof Kostas Nikolopoulos
Supervisor's email: K.Nikolopoulos@bham.ac.uk
Specific dates: By mutual agreement

Project outline
It is established from a variety of astrophysical observations and precise measurements of the Cosmological Microwave Background that 84.5% of the matter content of our Universe consists of non-baryonic cold Dark Matter (DM). Although the nature of DM is currently unknown, many theories beyond the Standard Model (SM) predict massive neutral particles, that could play the role of DM. In parallel, significant experimental effort is devoted to searches for DM particles.
Many of these experiments, aiming to detect dark matter particles by directly observing a few of their extremely rare interactions with normal matter, are located in deep underground facilities to avoid interference from other particle sources. The University of Birmingham is strongly involved in the NEWS-G experiment, in SNOLAB (Canada), aspiring to identify Dark Matter candidates using a novel detector, and we are currently also designing a next generation experiment, that could be potentially installed at the Boulby Underground Facility in the UK. In this project, a prototype detector operating at the Boulby

Underground Laboratory will be investigated experimentally, to inform the design optimisation and sensitivity to DM particles of this new experiment.

Skills required/expected from the students.
Interest in practical work at the laboratory (including clean-rooms)

Skills and what future career
Knowledge about the current topics of research in particle physics and particle astro-physics. Understanding of the operation principles and physics of particle detectors, and their various applications (e.g. particle physics experiments, medical imaging, etc). Skills in vacuum/gas systems, nuclear electronics, and data analysis software widely used in particle physics research and industrial applications. Several career paths open-up: a) fundament research, b) applied research, c) data science, and d) medical imaging and similar professions.

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UB3 - Name of project: A novel detector for Neutron Spectroscopy: ***detector optimisation***
Supervisor's name: Prof Kostas Nikolopoulos
Supervisor's email: K.Nikolopoulos@bham.ac.uk
Specific dates: By mutual agreement

Project outline
The concept of neutron spectroscopy dates back to neutron discovery in 1932. Despite several attempts towards an efficient neutron spectroscopy system, such measurements remain cumbersome and detailed neutron spectra are sparse both in scientific laboratories and industrial sites. To-date the most widely used method relies on detectors utilising Helium-3.
However, these detectors only provide combined slow and fast neutron flux measurements, while energy measurements for fast neutrons is plagued by so-called "wall effect" - the recoiling proton escapes the gas volume. Furthermore, the popularity of such detectors led to a disproportionate demand for 3He with respect to its availability, which resulted in a dramatic price increase. We are developing an inexpensive, simple, robust, and reliable fast neutron spectroscopy system particularly sensitive in the 1-20 MeV range, based on the novel concept of the Spherical Proportional Counter. In this project the detector layout will be optimised using simulations for measurements in research laboratories and hospitals. The results of the projects are expected to be published in a peer-reviewed journal.

Skills required/expected from the students.
Basic familiarity with computer programming essential.

Skills and what future career
Understanding of the operation principles and physics of particle detectors, and their various applications (e.g. particle physics experiments, medical imaging, etc). Skills in computational techniques, and experience with simulation and data analysis software widely used in particle physics and beyond (e.g. data science). Several career paths open-up: a) fundament research, b) applied research, c) data science, and d) medical imaging and similar professions.

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UB4 - Name of project: A novel detector for Neutron Spectroscopy: ***measurements***
Supervisor's name: Prof Kostas Nikolopoulos
Supervisor's email: K.Nikolopoulos@bham.ac.uk
Specific dates: By mutual agreement

Project outline
The concept of neutron spectroscopy dates back to neutron discovery in 1932. Despite several attempts towards an efficient neutron spectroscopy system, such measurements remain cumbersome and detailed neutron spectra are sparse both in scientific laboratories and industrial sites. To-date the most widely used method relies on detectors utilising Helium-3.

However, these detectors only provide combined slow and fast neutron flux measurements, while energy measurements for fast neutrons is plagued by so-called “wall effect” - the recoiling proton escapes the gas volume. Furthermore, the popularity of such detectors led to a disproportionate demand for 3He with respect to its availability, which resulted in a dramatic price increase. We are developing an inexpensive, simple, robust, and reliable fast neutron spectroscopy system particularly sensitive in the 1-20 MeV range, based on the novel concept of the Spherical Proportional Counter. In this project, a prototype detector will be characterised, and actual measurements will be analysed. The results of the projects are expected to be published in a peer-reviewed journal.

Skills required/expected from the students
Interest in practical work at the laboratory (including clean-rooms) and some interest on data analysis would be beneficial.

Skills and what future career
Understanding of the operation principles and physics of particle detectors, and their various applications (e.g. particle physics experiments, medical imaging, etc). Skills in data analysis, in vacuum/gas systems, nuclear electronics, and data analysis software widely used in particle physics research and industrial applications. Several career paths open-up: a) fundamental research, b) applied research, c) data science and d) medical imaging and similar professions.

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UB5 - Name of project: Schrödinger‘s Cat in an Interactive Box – ***a Quantum Outreach Installation***
Supervisor name: Dr Markus Gellesch
Supervisor email: m.gellesch@bham.ac.uk
Dates: By mutual agreement
Weblinks: https://www.strontium-birmingham.org/
//www.birmingham.ac.uk/research/activity/physics/quantum/cold-atoms/index.aspx

Project outline
Telling people about cutting-edge research is important on many levels. But how to tell them about Quantum Technology without scaring everyone away by saying “quantum”?
Our approach to this question is this project, a “museum-in-a-box”-style interactive experience (see https://museuminabox.org for reference). Instead of a museum, we will put Schrödinger‘s Cat in the box – a virtual cat, to be clear The main inner component of the box is a Raspberry Pi single-board computer. It is connected to audio speakers and in this case also visual output. Any output is triggered with 3D printed models tagged with a NFC chip brought near an NFC reader connected to the Raspberry Pi. The complete installation will provide interactive and engaging content on quantum physics fundamentals and examples of quantum technology.

The internship will comprise the experimental realisation of the interactive installation and developing the content with the help of the project lead. Creating the content brings the challenge of breaking down fundamentals of quantum technology to a level easily accessible for a general lay audiences. The same time, work in this field has been done before and a thorough assessment of existing approaches to audio/visual explanation of quantum physics and quantum technology will be part of this project. Part of the project will involve collaborating with a creative artist who has worked with us before on a quantum technology outreach project: http://quantumclocks.the-comic.org/.
The project work is embedded in the outreach activities of the Clock Team of the Cold Atom Research Group at the University of Birmingham.

Skills required/expected from the students (sorted by relevance):
Enthusiasm for explaining science topics to a lay audience
Independent and goal oriented working style
Programming in Python
Basic understanding of quantum physics (ideally Quantum Physics I lecture series or similar)
Creating presentations/slide shows
Basic experiences with CAD design software, Experience in working with a Raspberry Pi

Skills and what future career
Insights and understanding of outreach as an important skill; particular for a future academic career
3D printing, programming an interactive piece of outreach art
Insights on state-of-the-art quantum metrology research lab
Collaborative working with artists

… and what future career path they might take if they enjoy the internship.
Academic career path in STEM subjects, Science Communicator, Science Journalism

UB6 - Name of project THz dielectric properties of materials
Supervisor's name Dr Miguel Navarro-Cía
Supervisor's name m.navarro-cia@bham.ac.uk
Weblink: https://www.birmingham.ac.uk/staff/profiles/physics/navarro-cia-miguel.aspx
Dates: available from mid of June 2020 until mid of August 2020

Project outline
The frequency range between 0.1 and 3 THz holds promise for a myriad of applications such as high-speed communication and remote sensing. Hence, a great deal of effort has been carried out in recent times toward the development of the components and systems operating in such frequency range [1]. However, any new device and foreseen application will struggle to deliver the expected performance and impact due to the lack of material and channel characterization at those frequencies.
The students will carry out a comprehensive campaign of measurements to extract the dielectric properties of standard materials (fabric, metal, brick, plastic, glass, etc.). The student will use the existing time-domain spectrometer [2] along with a retrieval algorithm for transmission measurements. The student may code an equivalent algorithm for reflection measurements suitable for highly absorbing materials. The project is suitable for a student that likes a good mixture of modelling and hands-on tasks.
Webpage: http://www.birmingham.ac.uk/staff/profiles/physics/navarro-cia-miguel.aspx

[1] Journal of Physics D: Applied Physics 50 043001, (2017)

[2] MenloSystems TERA K15

Skills required/expected from the students
Basic knowledge of electromagnetism, computer literacy (Matlab, Mathematica, Python, etc.) and some lab experience.

Skills and what future career
Lab skills, Programming skills, Data processing: Future career path they might take if they enjoy the internship Pursue an academic career (MRes, PhD) in Physics, Material Science or Electrical and Electronic Engineering.
Pursue a career in high-tech companies related to security, automotive and quality control sectors that are considering terahertz technology their future non-destructive testing method.

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UB7 - Name of project: Development of mini-far-Infra Red LIDAR
Name of Institution: University of Birmingham (UoB), School of Physics and Astronomy
Supervisor's name: A Kaplan
Supervisor's email: a.kaplan.1@bham.ac.uk
Dates: By mutual agreement (total of 6 weeks)

Project outline
Our lab in collaboration with Leonardo (Edinburgh) develops industrial applications for range-finding in the far-Infra Red. This project focuses on LIDAR – Light Imaging Detection and Ranging.
This application allows to measure distance between an observer and target. The most precise LIDAR employs laser which sends a laser beam and collects light reflected from a target. In the visible spectrum, LIDAR demonstrates excellent precision and can achieve submicron resolution. They used in military for missile guidance, in space for satellites navigation, in geology for mapping surfaces, and in

many other applications where fast and precise measurement of distances are needed. Yet, the rangefinders operating in the visible range commonly suffer from the limitation imposed by the atmospheric scattering, limiting the extension of their useful range of operation. The LIDAR in far-IR negates the scattering effects and can extend the range of measurable distances to tens of kilometres. However, there are a very few such devices are available on the market and they are expensive and suffer from low precision and accuracy.

We offer an opportunity to join our group developing a novel far-IR LIDAR which aims to deliver relatively inexpensive and accurate instrument.

Skills required/expected from the students

We look for candidates that enjoy working in a lab environment with a lot of hands-on experience. We expect from candidates to know the fundamentals of electronics, computer control of instruments and have a liking for optics. The project is for individuals which have affinity to implement physics into industrial and commercial applications.

We will give our interns support in understanding of the range finding basics, extend their knowledge of very fast electronics, teach precise optics alignment and introduce into optical design and principles the far-IR optics.

The project for Y2 and Y3 students oriented to experimental work and applications development.

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University of BRISTOL

UBR1 - Name of project: Physics at Lepton Colliders
Supervisor's name: Prof Joel Goldstein
Supervisor's email: Joel.Goldstein@bristol.ac.uk
Dates: by mutual agreement

Project Outline

Many physicists believe that the next major particle physics facility should be an electron-positron collider. The physics programme will complement that of the LHC, focusing on precision measurements of the Higgs boson, top quark and other particles, looking for signs of physics beyond the standard model. There are a number of proposals on the table, including The International Linear Collier (ILC) in Japan, the Compact LInear Collider (CLIC) at CERN, and the Circular Electron Positron Collider (CEPC) in China. This is a particularly exciting time, as major political decisions in early 2019 should clarify which of these machines is most likely to be built.

Experiments at such a collider will have to make measurements with unprecedented accuracy to reach the goals of the collider physics programme. One of the biggest challenges will be to know the locations of all of the particle tracking elements to an accuracy of a few microns, which will require the development of new techniques building on experience gained at the LHC.

This project will look at the tracking performance of proposed detectors at these colliders, focusing on simulations of experiments at whichever machine seems politically the most likely.

Good computing skills are required

UBR2 - Name of project: Testing Mu3e Pixel Modules
Supervisor's name: Prof Joel Goldstein
Supervisor's email: Joel.Goldstein@bristol.ac.uk
Dates: by mutual agreement

Project Outline
Bristol has recently joined the Mu3e experiment, which will use the latest developments in silicon pixel sensors to track electrons from muon decays. The silicon pixel detector modules will be produced in the UK, and the Bristol group are responsible for testing the detector components during and after the production of the modules.

In this project you will work with the development test system which is set up in the lab in Bristol. You will use silicon modules to commission the test system and develop and implement test algorithms and procedures.

Good laboratory and computer skills are required. Experience with electronics would be useful.

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UBR3 - Name of project: Modelling Top Quarks at the LHC
Supervisor's name: Dr Emyr Clement & Prof Joel Goldstein
Supervisor's email: Joel.Goldstein@bristol.ac.uk ; emyr.clement@bristol.ac.uk
Dates: by mutual agreement

Project Outline
Precision measurements of top quark properties at the LHC are often limited by our knowledge of the theoretical modelling of top quark production and decay, rather than by our understanding of the detectors we use to measure these properties. To improve the precision of our measurements, we must improve our understanding of these theoretical details. This project will work directly on this task by using recent measurements from the LHC experiments to assess how our limited knowledge in various aspects of the modelling of top quark production affects our planned measurements, and how we can profit from existing analyses to improve our grasp on these issues.

Good computing skills are required, and experience with C/C++ is useful.

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UBR4 - Name of project: Upgrading trigger board for teaching labs and outreach projects
Supervisor's name: Dr David Cussans, Dr Paolo Baesso
Supervisor's email: David.Cussans@bristol.ac.uk; paolo.baesso@bristol.ac.uk
Dates: by mutual agreement

Project Outline
Our group has designed a trigger board that is currently used in teaching labs, in the demonstration spark-chamber and in the cosmic muon telescope.

The latest version of the board accepts up to 6 inputs and provides a trigger when a specific combination of the inputs is present. The configuration of the unit is based on programmable electronics (FPGA) hosting a softcore microprocessor which is accessible via a serial interface (USB).

We want to expand the trigger board by adding some useful features, such as a display or a touchscreen, and improve the user interface. This requires connecting the hardware and writing some low-level code to get it to work.

The project is lab-based and will involve working with both hardware and software. It will offer an opportunity to learn valuable skills in both hardware (I2C interface, debugging tools) and software (C code) as well as providing a glimpse of the mysterious world of firmware.

This project is ideal for any DIY electronic enthusiast.

Basic knowledge of electronic hardware and programming would be preferred but not essential as long as any lack of experience is offset by a will to learn.

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UBR5 - Name of project: Rare Kaon Decays
Supervisor's name: Dr Helen Heath
Supervisor's email: Helen.Heath@bristol.ac.uk
Dates – by mutual agreement

Project Outline

The NA62 experiment at CERN is studying very rare decays of charged Kaons. https://na62.web.cern.ch/na62/Home/Home.html. The principle aim of the experiment is to measure the decay to a pion and two neutrinos that is predicted to occur ~1 in 10,000,000,000 events. NA62 has been taking data for a few years and will also be running this summer.

The NA62 data set can also be used to study medium rare kaon decays one example is the Kaon decay to a muon, two pions and a neutrino (the Kμ4 decay) that happens ~1 in 100,000 events. This project will look at algorithms to measure this decay with the main challenge being to discriminate the event from the much more common decay to three pions. This project will involve using the NA62 software framework to refine selection algorithms on simulated events and then apply these to data.

Skill required: Good computing skills are required
Skills gained: computing and analytical skills
Career paths: academic, research, financial, engineering.

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UBR6 - Name of project: Fast online neural networks at LHCb
Supervisor's name: Dr Daniel O'Hanlon and Prof Jonas Rademacker
Supervisor's email: Jonas.Rademacker@bristol.ac.uk; daniel.ohanlon@bristol.ac.uk
Dates – by mutual agreement

Project Outline

In Run 3 of the LHC, the LHCb experiment will take data without an initial fast hardware pre-selection step, and the full event will be read out at 40MHz, via fibre optic links, to the surface computing farm. This provides the opportunity to operate on the full event in software, with much more advanced selection requirements than are possible in hardware. The challenge however is to maintain usable physics output by running these advanced selection algorithms in as little time as possible.
Neural networks, particularly convolutional and recurrent networks, provide a promising avenue by which to operate on information from the whole event, and provide generic information for downstream physics algorithms. Nevertheless, the inference time and efficiency of neural networks depends on numerous factors and is comparatively under-studied. However, several structural advances in recent years - such as weight sparsity, attention mechanisms, and weight discretisation - have the potential to significantly decrease inference latency, at little accuracy cost compared to more complicated networks.

In this project you will learn how to use simulated Run 3 LHCb data and modern Python machine learning libraries (TensorFlow/Keras and/or PyTorch) to investigate strategies for reducing neural network inference latency on CPUs, for online physics analysis purposes.

UBR7 - Name of project: Detecting dark matter with superconducting nanowires
Supervisor's name: Dr Jim Brooke
Supervisor's email: James.Brooke@bristol.ac.uk
Dates – by mutual agreement

Project Outline

Superconducting nanowires are very thin "wires" of superconducting material deposited on a substrate. They are used extensively in quantum computing and information and represent the state of the art in single photon detection. However, recent exciting proposals have suggested they may also be sensitive to direct interactions of light (sub MeV) dark matter. A dark matter interaction with electrons in the superconductor will release very small amounts of energy, but sufficient to break the Cooper pair and cause the wire to transition very briefly to a non-superconducting state. The sub-MeV mass range of dark matter is not well covered by existing detectors and therefore this technology is an exciting prospect for future dark matter searches. The project will involve simulation of potential future nanowire detectors and estimating their sensitivity to different dark matter signals.

Good programming and analysis skills will be required and developed over the course of the project.

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UBR8 - Name of project: Novel reconstruction techniques for "New Physics" searches at LHCb
Supervisor's name: Dr Kostas Petridis, Dr Daniel O'Hanlon
Supervisor's email: konstantinos.petridis@bristol.ac.uk; daniel.ohanlon@bristol.ac.uk
Dates – by mutual agreement

Project Outline

Measurements involving the transition of a b-quark into an s-quark are extremely sensitive probes of physics beyond the Standard Model. Decays of B hadrons (bound states of quarks involving a b-quark) such as or are perfect examples of such transitions. The LHCb experiment is optimised to detect electrically charged particles, such as muons and charged pions. However, reconstructing neutral particles, such as π^0s, is more challenging. The goal of this project would be to develop novel techniques of reconstructing π^0 in or decays using the kinematic and topological properties of the decays in order to enhance the performance of the detector.

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UBR9 - Name of project: Dark Matter searches with LUX-ZEPLIN
Supervisor's name: Henning Flaecher, Dr Ben Krikler & Dr Luke Kreczko
Supervisor's email: Henning.Flaecher@bristol.ac.uk; b.krikler@bristol.ac.uk; L.Kreczko@bristol.ac.uk
Dates – by mutual agreement

Project Outline

The nature of Dark Matter is one of the most intriguing open questions in particle physics and cosmology. One way to search for dark matter is to look for evidence of dark matter particles scattering off nuclei, resulting in ionization and scintillation signals that can be detected. The LUX-ZEPLIN (LZ) experiment in the Homestake mine at SURF, South Dakota, uses 7 tons of liquid xenon as active material and will become operational later this year. In this type of dark matter search one is looking for only a handful of events as evidence of a signal. It is therefore essential to have a precise understanding of possible background sources and the signals they leave in the detector. To prepare for prompt analysis of data once the detector is switched on, LZ is using detailed simulations of background processes and in this summer project you will be analysing simulated data with focus on background modelling and characterisation.

UCL1 - Name of project: Investigating what stars explode as Supernovae.
Supervisor's name: Dr Joanne Pledger
Supervisor's email address: jpledger@uclan.ac.uk
Specific dates (if there are any); otherwise 'by mutual agreement'. By mutual agreement but not working Thursdays as I won't be in to supervise the student.
Website info: http://www.star.uclan.ac.uk/stellar-astrophysics/massive-stars-and-supernovae/ https://www.uclan.ac.uk/staff_profiles/dr_joanne_bibby.php

Project outline
Evolved massive stars are thought to end their lives as explosions called supernovae. However, this has not been confirmed from direct observations and some observations have found no star at the location of a supernova, suggesting they are not responsible for these explosions.
This project will work on observations of evolved massive stars and compare their environments to those of supernovae and use this analysis to calculate the probability that the evolved stars are indeed the source of the supernova.

Skills required/expected from the students
Good computer skills and a willingness to learn new software/techniques. Any experience of Linux based systems is beneficial but not required. A good level of knowledge of Excel is required. Student should also be able to work independently, although support and training will be provided. Any experience of coding is of benefit to a student undertaking this project but not essential.

Skills and what future career
This project would benefit any student undertaking or wishing to undertake an Astrophysics degree or related degree. The student will gain experience in image analysis and will also gain a basic understanding of coding.
The critical thinking skills, team-work skills and experience of a working environment are valuable to all careers in science and engineering.

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DU1 - Name of project: Terahertz imaging using Rydberg atoms
Supervisor's name: Prof. Kevin Weatherill
Supervisor's email address: k.j.weatherill@durham.ac.uk
Dates: by mutual agreement.
Research Website: https://www.jqc.org.uk/research/thz-sensing-and-imaging/

Project outline
In this project we are developing Terahertz (THz) imaging techniques based upon efficient THz-to-optical conversion in atomic vapour. THz technologies, generally defined as operating in the 0.3—10 THz range, bridge the gap between electronic and photonic devices. Because THz radiation is non-ionising and passes readily through everyday materials such as plastics, paper and cloth, it is suitable for use in security and biomedical applications as well finding uses in telecommunications and industrial non-destructive testing. For all these applications, it is highly desirable to have sensitive detectors which are able to operate at high speeds; features that have so far proved elusive in conventional technologies. Atomic THz detectors developed in Durham have already been demonstrated to be faster and more sensitive than other room temperature THz sensors

Skills required/expected from the students
We would expect the student to be highly motivated, able to work in a team environment and interested in experimental physics. A good grasp of basic physics and computer programming skills would be an advantage.

Skills and what future career
The student would gain skills in experimental physics including, lasers and optics, electronics, data acquisition and image analysis, they will also gain the experience of working in a professional research group, conducting world-leading research. They would be fully integrated into the team, attending all group meetings and seminars

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DU2 - Name of project: Terahertz imaging using Rydberg atoms
Supervisor's name: Prof. Kevin Weatherill
Supervisor's email address: k.j.weatherill@durham.ac.uk
Specific dates: by mutual agreement
Website info: https://www.jqc.org.uk/research/thz-sensing-and-imaging/

Project outline
In this project we are developing Terahertz (THz) imaging techniques based upon efficient THz-to-optical conversion in atomic vapour. THz technologies, generally defined as operating in the 0.3—10 THz range, bridge the gap between electronic and photonic devices. Because THz radiation is non-ionising and passes readily through everyday materials such as plastics, paper and cloth, it is suitable for use in security and biomedical applications as well finding uses in telecommunications and industrial non-destructive testing. For all these applications, it is highly desirable to have sensitive detectors which are able to operate at high speeds; features that have so far proved elusive in conventional technologies. Atomic THz detectors developed in Durham have already been demonstrated to be faster and more sensitive than other room temperature THz sensors.

Skills required/expected from the students
We would expect the student to be highly motivated, able to work in a team environment and interested in experimental physics. A good grasp of basic physics and computer programming skills would be an advantage.

Skills and what future career
The student would gain skills in experimental physics including, lasers and optics, electronics, data acquisition and image analysis.
The student would gain the experience of working in a professional research group, conducting world-leading research. They would be fully integrated into the team, attending all group meetings and seminars.

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Imperial College London

ICL1 - Name of project: Magnetic Confinement Fusion – Tokamak Research Projects
Supervisor's name: Dr Yasmin Andrew
Supervisor's email address: y.andrew@imperial.ac.uk
Specific dates: Summer 2020 - dates by mutual agreement

Project outline
Magnetic confinement fusion (MCF), uses deuterium and tritium plasmas heated to temperatures of tens of millions of degrees Celsius. The plasma is confined by powerful magnetic fields, holding it away from

material surfaces, using the toroidal geometry of tokamak devices. A number of summer research projects will be offered linked to current research is strongly linked to the UK's national fusion research programme at the Culham Centre for Fusion Energy (CCFE), on both the Joint European Torus (JET) and the Mega Amp Spherical Tokamak Upgrade (MAST-U), through both experimental study, the development of theoretical models and simulation. We are looking for students to work on our current research projects this summer. Applicants should have a keen interest in fusion, good at working independently and as part of a team and patient with the inevitable delays and problems with cutting edge physics research.

Skills required/expected from the students
We are looking for physics students with strong mathematical skills and some coding experience.

Skills and what future career
These projects will provide a realistic experience of working at the forefront of fusion research in a community of international physics collaboration.

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University of Kent

KU1 - Name of project: Exploring the molecules of life
Supervisor's name: Professor Nigel Mason
Supervisor's email address: n.j.mason@kent.ac.uk
Specific dates: Between mid-June and mid-August

Project Outline
The interstellar medium is a rich chemical factory, with over 180 molecular species identified to date, mostly observed in star-forming regions. Star formation begins in dense molecular clouds, where cold (~10 K) interstellar dust provides the surfaces for atoms and molecules to "freeze-out", forming icy mantles. These icy mantles are the largest molecular reservoirs where chemical reactions, driven by both non-thermal and thermal processes, produce more complex molecules that are subsequently released into the gas phase. Similarly, many of the moons of the planets in the Solar system are covered in ice. Dust grains and these lunar surfaces are irradiated by ions and UV photons leading to the synthesis of larger more complex molecules from the fragmentation of simpler ices.

The student will investigate the physical and chemical properties of such ices in a controlled laboratory environment using ultra-high vacuum chambers and cryogenically cooled substrates to grow interstellar ice/lunar ice analogues. The ices are characterised, in situ, using infrared spectroscopy with mass spectroscopy used to monitor the species released into the gas phase during processing. UV, electron or ion irradiation processing of such ices will be explored to determine the formation of larger molecules during processing.

To find out more, head to the Centre for Astrophysics and Planetary Science at Kent https://research.kent.ac.uk/astrophysics-and-planetary-science/ and Europlanet https://www.europlanet-society.org/

Please specify the skills required/expected from the students.
General laboratory skills and IT (Microsoft Word)

Please specify the skills that will be gained in the placement and what future career path they might take if they enjoy the internship.
This is a spectroscopy-based project, so some knowledge of molecular spectroscopy is welcome. It is an experimental based project so some basic knowledge of vacuum technology and infrared spectroscopy (e.g. experiments in undergraduate labs) would be an advantage but on the job training provided! Data analysis will include some scientific programming (e.g. using Python).

Note: Some of these experiments may be performed at European facilities (e.g. Debrecen, Hungary) and the student will be expected to participate (travel/subsistence costs will be met by existing grants) but student should ensure passport/visa is up to date for EU travel.

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KU2 - Name of project: Acoustofluidics: Microfluidics Devices meet Acoustic Levitation
Supervisor's name: Dr Robert Barker (PI) and Dr Matthew Hockley
Supervisor's email address: R.Barker@kent.ac.uk; M.J.Hockley@kent.ac.uk
Specific dates: mid-June to mid-September

Project Outline
Microfluidics is the manipulation of micro volumes of fluid and has been used for a range of disciplines from biology to physics. However, microfluidics suffers from leakages, lack of adaptable geometries and fouling. Researchers have adapted specific applications to solve these issues but there is no universal system to date that can solve these issues.

Acoustofluidics is a novel field focusing on the manipulating fluids with levitation without any direct contact with the fluid. It leverages simple acoustic physics and engineering to manipulate solids and liquids in 3D without the need for a containing vessel, currently this has only been used to suspend objects in mid air and to carry out simple chemical reactions without the need for a container. This project represents an exciting opportunity to bring together two emerging fields in applied physics in order to create a new one with potentially global impact across the sciences, engineering and medicine.

The student will be integrated into our interdisciplinary team, Interfacial Technologies Group. This provides opportunities for the student to learn the application of physics (particularly microfluidics and acoustic levitation) to real-world chemistry, biology and engineering applications. The lab is situated at the University of Kent in the School of Physical sciences composed of groups of chemists, physicists and engineers. Find out more about the group here: https://www.robbarker.co.uk/

Please specify the skills required/expected from the students.
A student on a physics degree course with an interest in electronics and computing is preferred, as well as a willingness to work in a lively transdisciplinary team.

Please specify the skills that will be gained in the placement and what future career path they might take if they enjoy the internship.
The student will be trained in a broad range of skills, ranging from core electronic and acoustic physics/engineering, through to linked computer control systems, understanding and using basic programming for control. Additionally, bioengineering and physical chemistry experience will be gained through working with 3D printing and microfluidics technologies.

This will provide the student with a broad toolkit of skills to enter physical sciences research and development in higher education or industry. Working in such a broad transdisciplinary team will give any physics student an exciting opportunity to apply basic physics concepts to develop solutions to real-world problems.

Lancaster University

LU1 - Name of project: Noise thermometer for millikelvin temperatures
Supervisors' names: Vladislav Zavjalov, Dmitry Zmeev
Supervisors' email addresses: v.zavjalov@lancaster.ac.uk; d.zmeev@lancaster.ac.uk
Dates: by mutual agreement in May-July
Website info: https://www.lancaster.ac.uk/physics/research/experimental-condensed-matter/low-temperature-physics/

Project outline

Thermal motion of electrons in a conductor (the Johnson noise) generates minute fluctuations in the electric current in the conductor. This current strongly depends on temperature and the measurement of the current can be used to extract the temperature of the conductor. Noise thermometry is not used widely in cryogenics but it has a few advantages over other thermometry methods, the main is that very simple physical laws describe its operation, which allows to use noise thermometers as primary thermometers. The main difficulty in building a good noise thermometer is to understand fully all sources of noise in the system and make them small enough to see the measured noise signal. There are a few methods of achieving this: using low-noise SQUID amplifiers, using cross-correlation technique. In this project we want to build and test a robust noise thermometer for work with a dilution refrigerator, a machine which cools down below 10 mK temperature.

Skills required/expected from the students

Basic programming/data processing, basic physics (Ohm's law, Johnson-Nyquist noise) and mathematics (Fourier transformation).

Skills and what future career

Characterization of noise sources in measurement systems, current and voltage noise of amplifiers; building a simple experimental setup, running the experiment and processing data; basic cryogenic skills; working with dilution refrigerator.
Cryogenic electronics is a growing field. Notably, quantum computers require millikelvin temperatures and a dilution refrigerator to operate.

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LU2 - Name of project: Time travelling through the Universe to discover and study primeval galaxies
Supervisor's name: Dr David Sobral
Supervisor's email address: d.sobral@lancaster.ac.uk
Specific dates: 'By mutual agreement, with guideline dates being from early-mid June to the end July/early August.
information: https://xgalweb.wordpress.com; https://xgalweb.wordpress.com/about/; http://www.lancaster.ac.uk/physics/research/astrophysics/observational-astrophysics/

Project outline

The Milky Way, our cosmic home, is just one among about a trillion galaxies in the visible Universe. Galaxies around the Milky Way show an incredible diversity in the number of stars, colours, shapes and sizes, which are a consequence of how they formed and evolved. How did they end up like this? How did our own galaxy form and evolve across almost 14 billion years? How do those processes affect the production of the ingredients necessary for life itself to exist and evolve? At Lancaster, our international team addresses these challenging questions by using some of the best telescopes and cameras, on Earth and in Space. Recently, we have been able to slice the Universe in cosmic time (going back up to 13 billion years) and we have discovered 4000 new distant galaxies (see https://www.youtube.com/watch?v=K9I469U_W5s) which are progenitors of the same kind of galaxies we can see at the present, but seen in a primitive Universe. The intern will join our team and work with this state-of-the-art dataset, discovering how these early galaxies looked like and how large they were (with Hubble space telescope data), what kind of stars were shinning in the past, how many

stars they already had and how galaxies were distributed in 3D in the Universe. The research will also allow to explore how rapidly the early super-massive black holes were growing and to discover different paths through which galaxies form and evolve. For more information on the research, see the youtube video: https://youtu.be/tKb2osj3nkU

Skills required/expected from the students
Proactivity, motivation, curiosity, passion to learn and figure out physical phenomena within our vast Universe, willingness to make new discoveries.

Skills and what future career
Programming (Python), producing attractive data visualisations/graphs, presenting research results, perseverance development, creative solutions, Astronomy knowledge, data-science basic skills. Research (private or public sectors), higher-education, data science, consulting.

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LU3 - Name of project: Electronics for millikelvin experiments
Supervisor's name: Edward Laird
Supervisor's email address: e.a.laird@lancaster.ac.uk
Specific dates (if there are any); otherwise 'by mutual agreement': By mutual agreement. I have funding to extend the project by approximately four weeks, which I hope the candidate can take advantage of.

Project outline

In the ultra-low temperature group, we measure tiny electronic devices at extremely low temperatures, and use them to explore delicate quantum effects such as superposition or superfluidiity. These experiments integrate commercial and custom-made electronic instruments to achieve the best possible sensitivity. I am currently setting a new experiment to measure vibrating carbon nanotubes at low temperature.

This project will construct and characterize the electronics for this experiment, for example a temperature control unit for dilution refrigerators. Depending on the student's preference, the emphasis could be on hardware or software.
See http://wp.lancs.ac.uk/laird-group/ for more information about this research.

Skills required/expected from the students
Basic electronics at the level of the Lancaster undergraduate lab classes.

Skills and what future career

Electronics design and assembly, computer-aided design, programming. Future paths include engineering and further research.

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LU4 - Name of project: Data Mining Social Media for Auroral Science
Supervisor's name: Dr Nathan Case
Supervisor's email address: n.case@lancaster.ac.uk
Specific dates (if there are any): 'by mutual agreement'.

Project outline
The auroras are one of the most beautiful manifestations of space weather. Driven by the solar wind and its interaction with the Earth's magnetosphere, auroras act as a visual tool to investigate the coupling of the solar wind with our near-Earth space environment. They also allow us to study the effects that this coupling can have on natural and technological systems. The brightness and complex behaviour of an aurora, including its dynamics and the location from which it is visible, are all data points to understanding how the Earth's magnetic environment is responding to upstream driving.

To help people see an auroral display for themselves, the AuroraWatch UK service issues free alerts when geomagnetic activity indicates that aurorae may be seen from the UK. AuroraWatch UK is an incredibly popular service, with nearly 200,000 likes on Facebook and over 100,000 followers on Twitter. Four AuroraWatch UK alert levels exist, each corresponding to how likely aurorae are to be seen from the British Isles. These levels are based on magnetic deviations measured at the service's dedicated magnetometers (located in Lancaster, Aberdeen and Shetland). The alert levels have developed over time and have not yet been tested against an observational dataset in any rigorous way.

The main aim of this summer project is for the student to build a scientifically useful dataset of auroral observations made from across the British Isles, which can then be used to test and improve the accuracy of the AuroraWatch UK alerts.

https://www.lancaster.ac.uk/physics/research/astrophysics/space-and-planetary-physics/
https://aurorawatch.lancs.ac.uk/

Skills required/expected from the students

Essential for the role:
A keen interest in physics, particularly in space physics, proven ability to work independently on a task, including being able to undertake self-driven research when needed, Strong numerical skills, Strong computer literacy skills (e.g. email, word processing, spreadsheet management), Experience of writing and present reports and/or presentations (though this will be developed as part of the placement)

Desirable for the role:
Experience in computer coding (e.g., Python, IDL), Background knowledge of the aurora or space physics topics, Interest in public outreach

Skills and what future career

The student will develop their scientific knowledge in the following areas:
Understanding of space weather, including its drivers and impacts. What auroras are and how they are formed, including the role of geomagnetic storms and substorms. How we measure the effects of space weather, including the use of satellites and ground-based instruments, and how we record geomagnetic activity levels.
Additionally, they will develop the following transferable skills:

Data management: Gain experience of working with a variety of large data sets (e.g. *AuroraWatch UK* activity index, citizen science observations, solar wind and geomagnetic indices), including tackling data storage and curation issues. Scientific methodology: Develop experience of using statistical analyses on real data sets. Computer coding: Utilise and adapt pre-written code (IDL/Python) to undertake such analyses. Report writing: Write a scientific report to make evidence-based recommendations for changes to a system. Oral presentation**:** Present their findings to the Space & Planetary Physics group in the form of a short (10-15 min) presentation. Public outreach**:** Student may be asked to write a blog post on the AuroraWatch UK blog, for consumption by AuroraWatch UK followers, about the work they've undertaken.

Future career paths may include research/academia (e.g. PhDs, professional researcher), data science, software programming, science policy, science communication/education.

UNIVERSITY OF LEEDS

UL1 - Name of project: Let there be light: illuminating electromagnetism
Supervisor's Names: Dr Mike Ries
Supervisor's Email: M.E.Ries@leeds.ac.uk
Dates: by mutual agreement
Weblink: https://eps.leeds.ac.uk/physics/staff/4130/dr-mike-ries
https://eps.leeds.ac.uk/physics-research-groups/doc/physics-education

Project Outline

This project will look at ways of supporting the second-year undergraduate electromagnetism course through creating additional support material. You will investigate the use and effectiveness of different approaches, from instructional videos through interactive webpages and apps to traditional pen and paper. After deciding on the best type of support material, you will then choose a topic from within the electromagnetism syllabus, create the material and finally write a feedback questionnaire to later asses its effectiveness.

In this project you will learn about physics education research and consider what the best learning and teachings methods are, and how to assess the effectiveness of new materials and approaches.

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UL2 - Name of project: What can you do with a physics degree?
Supervisor's Names: Dr Alison Voice
Supervisor's Email: A.M.Voice@leeds.ac.uk
Dates: by mutual agreement
Weblink: https://eps.leeds.ac.uk/physics/staff/4136/dr-alison-voice
https://eps.leeds.ac.uk/physics-research-groups/doc/physics-education

Project Outline

Many of our students don't have a good appreciation of the range of jobs you can do with a physics degree. So this project seeks to solve that! Building on a prototype 'Careers Web App' developed last summer, this project will extend and enhance the facilities of the app. You will talk with students to find out what they want. You will liaise with physics staff and careers officers to gather information and advice. You will search the internet to find information about jobs and internships open to physics students.

The existing app asks students core questions about their career preferences such as: Do you want to work in a lab? Do you want to work with clients? Office based or travelling? Blue-sky or industrial applications? Public-facing or behinds the scenes? Dress smart or casual? It then links to relevant job suggestions and information. Your role will be to enhance this facility, adding links to case studies, jobs and internship adverts.

This project develops your research skills, creativity, organisation and project management to produce a working product for wide dissemination to physics students from 1st year to final year, to help them survey the 'world of physics' and help them make smart choices to advantage them in their future career.

UL3 - **Name of project:** helps students make a successful transition to university?
Supervisor's Names: Dr Alison Voice & Dr Rob Purdy
Supervisor's Email: A.M.Voice@leeds.ac.uk; R.Purdy@leeds.ac.uk
Dates: by mutual agreement
: https://eps.leeds.ac.uk/physics/staff/4136/dr-alison-voice
https://eps.leeds.ac.uk/physics/staff/4128/dr-rob-purdy
https://eps.leeds.ac.uk/physics-research-groups/doc/physics-education

Project Outline

Arriving at university can be overwhelming for some students. What will it be like? Am I good enough? Will I fit in? Will I make good friends? The overall aim of the project is to inform and influence the teaching and support provided to students on a physics degree to enhance their sense of wellbeing, enjoyment and success. This project will analyse data from recent surveys of Physics students at five universities across the UK to look for key factors influencing students' sense of belonging and success.

Training will be provided in statistical data analysis. You will also research published literature on how students settle into university. You will gain research and data analysis skills and help to contribute to the success of future generations of physics students.

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UL4 - **Name of project:** Revising Physics: What are the Best Techniques to Learn for Exams?
Supervisor's Names: Dr Rob Purdy
Supervisor's Email: R.Purdy@leeds.ac.uk
Dates: by mutual agreement
Weblink: https://eps.leeds.ac.uk/physics/staff/4128/dr-rob-purdy
https://eps.leeds.ac.uk/physics-research-groups/doc/physics-education

Project Outline

Revision for exams is a vital skill for any Physics student. In order to support students better, it is important to understand the different revision techniques currently employed by students, at A-level and in university, to find out what works and in what context? When should revision be undertaken, and is it to enhance memory or understanding?

This project will explore the published literature on revision techniques, and survey students, in order to establish the strengths and weaknesses of differing approaches to revision and how staff can best support student learning during the revision period. This information can be used to put measures in place to support future Physics students.

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UL5 - **Name of project:** Is this a physics exam or "Life in the UK" test? Is cultural proficiency is required to succeed in physics?
Supervisor's Names: Erin McNeill & Dr Emma Pittard
Supervisor's Email: E.McNeill@leeds.ac.uk & e.c.a.pittard@leeds.ac.uk
Dates: by mutual agreement
: https://eps.leeds.ac.uk/physics/staff/6143/erin-mcneill
https://www.llc.leeds.ac.uk/staff/emma-pittard
https://eps.leeds.ac.uk/physics-research-groups/doc/physics-education

Project Outline

Physics used a list of command words, vocabulary and key phrases in exams and coursework to evaluate a student's knowledge of the subject, often using examples of real-life situations. However, people from different cultural backgrounds will use different words to describe these everyday events. For example, the question "determine the stiffness of the bonnet of a car" would be confusing to someone who uses the word "bonnet" to describe a baby's hat and "hood" to describe the hinged cover

over the engine of a car. This question not only requires understanding of the physics word “stiffness” but also the cultural understanding of the word “bonnet”.

This project will look at past exams and coursework to determine if they require cultural understanding to answer the questions. The aim is to create a best practice guide for exams and coursework that minimizes the need for cultural understanding to answer questions, making it more accessible to students from all backgrounds.

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UL6 - **Name of project:** A ‘3D’ characterisation of job roles in Physics, fit for the dynamic 21st Century
Supervisor’s Names: Dr Samantha Pugh
Supervisor’s Email: S.L.Pugh@leeds.ac.uk
Dates: by mutual agreement
Weblink: https://eps.leeds.ac.uk/physics/staff/4127/dr-samantha-pugh
https://eps.leeds.ac.uk/physics-research-groups/doc/physics-education

Project Outline
From how we personalise our smart phone through to the growth in personalised medicine, in the modern world we are able to take ownership and make decisions relating to what works best for us. This notion of adaptability also translates to employment where employers need people competent in situations but adaptable to a rapidly changing environment. And employees need to be able to take ownership of their own development in order to better find their way through this dynamic employment environment.
This internship would involve interviewing a range of employers from the physics sector using a new model that is far more able to capture the complexity of job roles.

You will create briefings expressing the detail of each specific job role they discuss with their respective interviews. The briefings will be added to the library of job roles on the website https://www.sdduonline.leeds.ac.uk/dynamic-development/game-board-library/.
We will support you in learning the new model, learning interviewing technique and in arranging interviews with employers. We will also look to publish the results. And of course, you will get to meet a number of employers which may well help you to decide the next steps you want to take in your career!

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MANCHESTER 1824
The University of Manchester

MU1 - **Name of project:** First observations for L-Band All Sky Survey (L-BASS).
Supervisor’s name: Prof. Ian Browne; **Co-Supervisor:** Peter Wilkinson
Supervisor’s email address: (Ian.Browne@manchester.ac.uk),
Specific dates: by mutual agreement
Location: Jodrell Bank Observatory (http://www.jodrellbank.manchester.ac.uk/research/)

Project outline
After many decades of radio astronomy activity are there any exciting discoveries to be made? Perhaps! An American experiment, ARCADE-2, consisting of carefully calibrated antennas flown on a balloon to get above most of the Earth’s atmosphere, claims that there is an unexplained radio background emission which only becomes visible at low radio frequencies. L-BASS is a project designed to test whether or not this claim of an unexplained radio-background is true. The L-BASS project will produce a very accurately calibrated map of the sky at a frequency around 1.42GHz (L-Band). The mapping will be done using two 3m long horn antennas which will be deployed this summer at Jodrell Bank.

An Ogden student would join our small team to commission the instrument and make the first observations. Tasks would include: the recording of scans across the sun for calibration purposes, testing the repeatability of elevation scans and production of the first sky maps. Ideally potential students

had some undergraduate experience, be happy to use test equipment under guidance and be able to carry out simple data analysis. At the end of the project the student should have acquired a working knowledge of radio receivers and antennas. They will become confident with the use of sophisticated test equipment, useful if they proceed to do other radio astronomy projects and radio frequency measurements in general.

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MU2 - Name of project: Commissioning a cosmic-ray detector
Supervisors: Prof. Ralph Spencer and Dr Justin Bray
Email: ralph.spencer@manchester.ac.uk, justin.bray@manchester.ac.uk
Dates: by mutual agreement

Project Outline
Low-frequency radio telescopes, designed to study radio emissions from our galaxy and beyond, are also outstanding instruments to study the interactions of cosmic rays in the atmosphere. The Murchison Widefield Array (MWA; www.mwatelescope.org/) and its planned successor at the same site, the Square Kilometre Array (SKA; www.skatelescope.org/), will measure the radio emissions from individual cosmic rays with unprecedented precision, giving us new insights into the composition of these cosmic rays and hopefully into their still-unknown origin.

To use the MWA and SKA for this purpose, they must be operated with a co-located array of particle detectors. With the aid of past Ogden students, we have developed a suitable design for these particle detectors and will be constructing eight of them over the first half of 2020. Before shipping them to the MWA site in Western Australia, we plan to operate them together at Jodrell Bank Observatory, to confirm that they can operate together to detect showers of high-energy particles from cosmic rays, and we invite students to carry out this work with us.

The students will be responsible for deploying an array of particle detectors at Jodrell Bank Observatory, collecting data with them, and searching the data for cosmic-ray events, thus commissioning the array as a working instrument. They will simulate the development of particle cascades from cosmic-ray interactions and compare these simulation results with the data, in order to reconstruct the properties of the cosmic rays. At the end of the project, the particle detectors will be shipped to Australia, and the team there informed of the results of the students' work.

Skills required/expected from the students
Keen interest in physics, particularly particle physics; programming experience, preferably with Python. Hands-on electronics experience is desirable but not essential.

Skills and what future career
Operating scientific instrumentation, data analysis, computer simulation, analogue and digital electronics. Understanding the physics of particle detectors, cosmic rays and particle cascades. Future career paths might involve research in physics or astronomy, or employment in industries including electronics, nuclear power or data science.

OX1 - Project Title: Understanding the microstructure of the economy: Maximum entropy mechanisms and the emergence of stable distributions in economic data:
Institute for New Economic Thinking (INET) at the Oxford Martin School, University of Oxford
Supervisor's Name: Prof. Dr. J. Doyne Farmer
Supervisor's Email: Doyne.Farmer@inet.ox.ac.uk
Dates: By mutual agreement
Web page: https://www.inet.ox.ac.uk/research/programmes/complexity-economics/

Project outline
Many economic and socio-economic variables follow heavy-tailed distributions. This has important consequences for economic modelling and the interpretation of the data in question. How do these distributions come about? While a large number of candidate mechanisms have been considered in the literature, recent approaches have proposed self-organising mechanisms based on entropy maximization in large-scale systems under speci c constraints (maximum entropy approach). Of particular interest in this regard is the L_evy alpha-stable distribution, which is found in, e.g. productivities (see our recent working paper https://arxiv.org/abs/1910.05219). Working with _rm-level variables, this project will consider the distributions of various variables and their possible emergence through maximum entropy mechanisms, and assess implications for socio-economic systems, data collection, and economic policy. The internship will form part of this project; the intern will work in collaboration with other researchers on the project.

Skills required/expected from the students
Experience with statistical modelling is essential.
An interest in economics is desirable. Experience with data analysis would be welcome but is not essential.
Skills and what future career
The project focuses on economic statistics but includes aspects of complexity science and applied mathematics. It would be interesting for a student who aims to pursue a PhD in complex systems science, in computational economics, or applied mathematics.
However, it may also be useful for anyone interested in data science.

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OX2 - Name of project: Pricing and interdiction in the global energy supply chain
Supervisor's Names: Professor Doyne Farmer (Primary), Lucas Kruitwagen (Secondary)
Supervisor's Email: Doyne.Farmer@inet.ox.ac.uk; lucas.kruitwagen@smithschool.ox.ac.uk
Specific Dates: By mutual agreement

Project Outline
In this project, students will contribute to the understanding of geospatial sensitive intervention points in the transition to a post-carbon economy. Students will use a newly assembled dataset of the world's fossil fuel infrastructure, including oil, gas, and coal supply; transport and transformation infrastructure; and point demand (i.e. cities and power stations). This data has been arranged into a network architecture based on geospatial proximity. Students will use this network formulation to generate novel research insights to help accelerate the transition to a post-carbon economy. Further information about the Oxford Martin Programme on the Transition to a Post-Carbon Economy can be found here: https://www.oxfordmartin.ox.ac.uk/post-carbon/.

Research outputs will be developed according to the student's interest but may include A) an analysis of the network arrangement's prescience in the price movements of oil, gas, and coal; or B) game theoretic analysis of network interdiction. The former research topic will help demonstrate the embeddedness of energy markets in real infrastructure: articulating the path dependence of energy transitions on the built environment and demonstrating the utility of the infrastructure network arrangement. The latter research

topic will help policy makers, NGOs, and other public actors' direct efforts to accelerate the transition to a post-carbon economy by identifying their best strategies in a two-player interdiction game that manifests in real infrastructure and greenhouse gas emissions.

Skills required/expected from the students
Students are expected to have a baseline proficiency in Python. Technical skills and experience in the following would be beneficial: network analysis; network interdiction problems; game theoretic analysis; geospatial analysis; and cloud- and large-scale computing. Domain knowledge in energy systems and/or energy economics would also be an asset. Students must be passionate about the mitigation of climate change.

Skills gained and future career
Students will gain technical skills according to their preference of research topic. These skills may include any of the beneficial technical skills listed above. Students will gain domain knowledge in energy systems. They will also develop professional skills including research project management and visual- and oral communication. The domain knowledge, data science, and professional skills they will develop in this internship are highly sought after in all manner of future career paths, including academic research, policy, and finance.

Queen Mary
University of London

QM1 - Name of project: Teaching physics with ATLAS Open Data
Supervisor's name: Dr Seth Zenz
Supervisor's email address: s.zenz@qmul.ac.uk
Specific dates: by mutual agreement
Website: https://www.qmul.ac.uk/spa/outreach/in-school/school-activities/research-in-schools/our-projects/atlas-open-data/

Project outline
We seek a summer intern to help develop the use of ATLAS Open Data in schools. The dataset comes from the ATLAS experiment at the Large Hadron Collider (LHC), and is used as one of the projects within the Physics Research in School Environments (PRiSE) programme: 16-17 year old students receive an initial introduction to data analysis at the LHC, and over the following months develop their own analysis of the data, eventually producing posters and talks on their work. The successful candidate will expand this programme, updating it for the new ATLAS dataset being released and developing new materials to support students in more complex projects. They will work with ATLAS experts adapt the dataset into a form that can be distributed to students and provide examples in python of how the data can be analysed and understood.

Skills required/expected from the students.
Python programming experience required

Skills and what future career
The intern will learn about particle physics research, as well as modern data tools for the analysis of large datasets. This could be useful either for academic research in physics, or for the analysis of data in a range of industries, including social media and finance.

Outreach Internship Placements

OSU1 - Name of project: Physics Outreach Internship
Supervisor's name: Heather Campbell
Supervisor's email: h.campbell@surrey.ac.uk
Specific dates (if there are any); 'by mutual agreement'.

Project Outline
This internship will be exploring and improving current physics outreach at the University of Surrey. As well as, bringing exciting new ideas to develop activities around their particular branch of physics they are interested in e.g. quantum mechanics. The intern will be working primarily with SEPnet/Ogden Public Engagement and Outreach Manager. https://www.surrey.ac.uk/department-physics/outreach

Skills required: Enthusiasm
Skills gained: Verbal communication, Written Communication, Organisation, experience developing workshops, potentially data analysis and creative thinking.

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OKU1 - Name of project: Physics Outreach Intern
Supervisor's name: Hannah Tonry
Supervisor's email address: h.l.tonry@kent.ac.uk
Specific dates (if there are any); otherwise 'by mutual agreement' (between mid-June to mid-September)
By mutual agreement between mid-June to 9th August

Project Outline
This project will be working with the School of Physical Sciences outreach team, primarily with the Ogden Outreach Officer, to run the summer events programme as well as help develop new workshops, particularly around Space. The biggest event during the internship will be Kent Space School 2020 which is a 3-day residential so the intern will be asked to help prepare for this and also help run it.

We're looking for a student who could potentially bring new and exciting ideas to help create and develop new workshops alongside the team. The outreach team cover physics, forensics and chemistry, and though this particular project will focus on physics, there will be a chance to work in all 3 disciplines over the internship if desired.

The skills gained from outreach are regarded highly by employers and the intern will be able to play to their strengths at the same time as learning new skills. All activities undertaken will be fully supported by outreach team and the intern will meet/work with people from different scientific disciplines and backgrounds.

Skills required/expected
No specific skills required. This project is open to students who already have a keen interest in science communication and to those who have never done any science communication at all and want to learn some new skills. Must be able to pass a DBS check.

Skills gained and what future career path
The skills you'd gain experience in are communication, workshop development, event planning, event management, organisation and teamwork. The skills gained in this placement will be transferable to most careers.

If you enjoy the internship, it could lead you to a variety of paths within science communication, university outreach and public engagement, museum roles, events management etc.

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OUB1 - Name of project: Ogden Outreach Internship
Name of Institution: University of Birmingham (UoB), School of Physics and Astronomy
Supervisor's name: Dr Maria Pavlidou (M.Pavlidou@bham.ac.uk)
Name of student: to be chosen internally from UoB
Dates: Monday 15 June 2020 to Friday 24 July 2020 (total of 6 weeks)

Project Outline
The intern will assist in all the outreach events of the department during these dates. They will also complete new resources for teachers or for new outreach workshops as well as finalise the questions for the Big Physics Quiz 2021. Finally, they will organise and run activities during our physics experience week, and they will assist in supervising our physics summer school students.
Web page: https://www.birmingham.ac.uk/schools/physics/outreach/index.aspx

Skills required/expected from the students
Strong communication and organisation skills, ability to explain physics concepts to any audience and any level.

Skills that will be gained in the placement
Creative thinking, ability to multi-task, ability to solve problems on the spot and to be prepared for anything.

Future career path they might take if they enjoy the internship
Teaching career, outreach and science communication.
Ultrafast Dynamics and Processes Lab

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OPU1 - Name of project: The Tactile Universe: Gravitational Waves
Supervisor's name: Dr Jen Gupta
(co-supervisors: Dr Nic Bonne, Dr Coleman Krawczyk, Dr Laura Nuttall)
Supervisor's email address: jennifer.gupta@port.ac.uk
Specific dates (if there are any): by mutual agreement

Project Outline
The Tactile Universe is a public engagement project at the University of Portsmouth to create methods and resources for opening up current astronomy and astrophysics research topics to the blind and visually impaired community. So far, the Tactile Universe has focused on topics in galaxy evolution and

formation, but this project will form part of the next stage of the Tactile Universe, where we will be expanding to cover gravitational-wave research.

Predicted by Albert Einstein in 1916, but only first detected in 2015, gravitational waves are at the forefront of current astronomy research and represent an exciting topic to develop vision-impaired accessible teaching resources for. The project will involve working alongside the Tactile Universe team and the ICG gravitational-wave research group on the development of tactile and audio resources relating to aspects of gravitational-wave theory and detection (such as how gravitational-wave detectors work, or why two or even three gravitational-wave detectors is always better than one). Specific tasks will be decided by mutual agreement with the intern, but could include creating tactile models of gravitational-wave signals that can be 3D-printed, developing and testing a secondary school workshop about gravitational waves that is accessible for visually impaired students, or adapting existing gravitational-wave demos to be accessible for VI audiences.

Applicants can learn more about the Tactile Universe project and its existing work and resources at www.TactileUniverse.org, or on twitter at @TactileUniverse.

Skills required/expected from the students
Previous outreach experience is not essential; however, the intern will be expected to have an interest in engaging with school and public audiences. Some coding experience would be useful if the intern is interested in creating new tactile models.

Skills gained and future career
The intern will develop their outreach and communication skills in the placement and gain an understanding of how to develop public engagement activities that are tailored to the specific needs of the target audience. Depending on the final nature of the project, there is the opportunity to develop their programming skills. If they enjoy the internship they may wish to pursue a career in outreach and public engagement, informal education (e.g. museums) or teaching.

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Northumbria University NEWCASTLE

NUSTEM

ONU1 - Name of project: Physics Outreach Summer Assistant
Supervisor's name: Dr Antonio Portas
Supervisor's email address:
Specific dates: 8th June 2020 to 17th July 2020

Project outline
The Ogden Physics Outreach Assistant Summer Intern will involve supporting a range of physics driven outreach events targeted mainly at secondary school students and their teachers under the supervision of the Ogden Science Officer based at Northumbria University.
The Intern will actively be engaged in planning and supporting delivery of activities in a range of diverse events such as the School Physicist of The Year Awards, Physics days at the University, as well as an Industrial visit under the Connect Physics programme targeted a female students keen on physics . Examples of duties include, but are not limited to, management of data, evaluation form collection, simple data processing, brochures / postcards design and designing and delivering a short outreach activity.

NUSTEM is a university group aimed at encouraging more young people, particularly females and other under-represented groups, to choose physical sciences, technology or engineering as a career. The project works closely with the young people themselves and also their families and teachers (key influencers) to highlight the wide range of career paths and real-world applications of science, technology and engineering. To find out more about the group please visit nustem.uk

Skills required/expected from the students.
Students will have a physics background and good communication skills. They should be able to explain physics/science ideas to others and be able to develop practical resources to support their explanation. They should also be comfortable using software packages such as Excel and PowerPoint and a creative flare would be beneficial. Importantly, they will have enthusiasm and a genuine commitment to deliver positive results to young people.

Skills and what future career
By the end of their placement, we envisage the candidate to show:
Awareness of their science communication skills through outreach activities.
Enhancement of presentation, data analysis and creative thinking skills.
Further understanding of different career paths related to physics, in particular the areas of teaching, academic research and science communication.

CREATE YOUR OWN INTERNSHIP

CYOI: Create Your Own Internship/International Internship

Have you found the perfect summer work experience or research project but don't have the money to fund it? This year, The Ogden Trust is ring-fencing some of its internship budget for placements that you find yourself that relate to your degree, specialism, or future career plans.

These Create Your Own Internships will be funded on the same basis as the Ogden advertised placements - £60 per day for a maximum of 30 days during the summer. Internships located in central London will be paid at £70 per day, and there will not be any more supplements. The funds will be allocated on a competitive basis once all applications have been received – it is not currently possible to say exactly how many will be awarded. Funding for these internships is not available if the positions are paid or attract funding from another source.

Alumni may find placements or summer schools abroad during the break; these International Internships are not funded through an educational bursary. Instead, applicants can apply for a contribution of up to 50% of the travel costs, up to a maximum of £1,000.

You should apply for this funding using the standard internship application form as the other internships. There is a space on the form for you to explain why the position you have secured will be useful to you, and to give the contact details of your host supervisor or organisation. The Ogden Trust will need to confirm the details and suitability of your placement.

Successful Create Your Own and International Internship applicants will be required to provide the same written work as the other interns. The terms of your payment will also be the same and will involve your host organisation signing a straightforward Agreement to protect all three parties (you, them, us). A simple feedback form and timesheet will also need to be completed. Copies of all three will be available on Flexigrant, so you can discuss this with your potential host organisation.

The closing date for applications is **Sunday 5 April**. International Internship applications will be considered within three weeks of their submission and the applications for Create Your Own Internships will not be considered until after the closing date.