MSc Projects 2014-2015

version 2 – 24/11/2014 – added project 130

No	Group	Title	1st Supervisor	2nd Supervisor
1	ASTRO	Modelling the radio emission from hot chromospheric solar flares sources	Dr. Paulo Simões	Prof. Lyndsay Fletcher
2	ASTRO	Solar prominence catalogue: analysis of large-scale prominence properties over more	Dr Nicolas Labrosse	Dr Jonathan Taylor
3	ASTRO	Two-dimensional radiative transfer models of cool solar coronal loops	Dr Nicolas Labrosse	Prof Lyndsay Fletcher
4	ASTRO	Stellar flare statistics	Prof Lyndsay Fletcher	Dr Matthew Pitkin
5	ASTRO	EUV spectroscopy of solar flare footpoints	Prof Lyndsay Fletcher	Dr Nicolas Labrosse
6	ASTRO	Lyman lines during solar flares: analysis of EVE observations	Prof Lyndsay Fletcher	Dr Nicolas Labrosse
7	ASTRO	The temperatures of solar flares from the Solar Dynamics Observatory /EVE	Dr. Hugh Hudson	Prof Lyndsay Fletcher
8	ASTRO	electron-moderated plasma chemistry of low-energy discharges	Dr D Diver	

9	ASTRO	plasma body forces in gas bubble evolution	Dr D Diver	
10	ASTRO	Genetic Algorithms for breeding solutions to differential equations	Dr D Diver	
11	ASTRO	Field-aligned flows in MHD	Dr D Diver	
124	ASTRO	Pulsar telescope antenna noise and pattern modelling	Prof Graham Woan	Dr Hamish Reid
130	ASTRO	Modelling wind velocity fields using "lidar" data	Prof Martin Hendry	Peter Clive (Sgurr Energy)
12	IMAGING CONCEPTS	Use and abuse of microscope objective lenses	Dr Jonathan Taylor	Prof Andrew Harvey
13	IMAGING CONCEPTS	Compressive sensing for heart imaging	Dr Jonathan Taylor	Prof Andrew Harvey
14	IMAGING CONCEPTS	Microdroplets as miniature lenses	Dr Jonathan Taylor	Prof Andrew Harvey
15	IMAGING CONCEPTS	Remote sensing of rough surfaces	Prof Andy Harvey	Dr Patrick Kelliher
16	IMAGING CONCEPTS	3D shape profiling of rough surfaces	Prof Andy Harvey	Dr Patrick Kelliher
17	IMAGING CONCEPTS	Multispectral nailfold capillaroscopy	Prof Andy Harvey	Marieke vander Putten/Patrick Kelleher
18	IMAGING CONCEPTS	Fourier Ptychographic Microscopy	Prof Andy Harvey	Dr Jonathon Taylor / Pavi Konda

19	IMAGING CONCEPTS	3D imaging with extended depth of field - experiment	Prof Andy Harvey	Dr Guillem Carles & Paul Zammit
20	IMAGING CONCEPTS	Oximetry of the eye/brain	Prof Andy Harvey	Dr Laurence Brewer
21	IMAGING CONCEPTS	Instantaneous 3D Image Capture Via Computational Imaging	Prof. Andy Harvey	Dr Guillem Carles & Paul Zammit
22	IMAGING CONCEPTS	Diffusion of oxygen in retinal blood vessels	Prof Andy Harvey	Dr Laurence Brewer
23	IMAGING CONCEPTS	Determination of blood-oxygen saturation in the retina	Prof Andy Harvey	Javier Ramos
24	IGR	Characterisation of hydroxide-catalysis bonds	Dr Karen Haughian	Dr Marielle van Veggel/ Prof Sheila Rowan
25	IGR	A monolithic interferometer for measuring creep in fused silica	Dr. Marielle van Veggel	Dr Giles Hammond
26	IGR	Measurements of eddy current damping for gravitational wave detector suspensions	Dr Liam Cunningham	Dr Giles Hammond
27	IGR	Gravitational waves from binary black hole mergers	Ik Siong Heng	Dr Matthew Pitkin
28	IGR	Classifying graviational wave transients	Dr Ik Siong Heng	Dr Jade Powell
29	IGR	Exploring the gravitaitonal wave sky	Dr Ik Siong Heng	Prof Martin Hendry
30	IGR	Measuring the optical absorption of silicon wafers and getting rid of that pesky noise	Dr Angus Bell	Dr Iain Martin

31	IGR	Labview control of an instrument for optical absorption	Dr Angus Bell	Dr Iain Martin
32	IGR	Demonstrating and characterising the intensity noise of a stable laser and helping	Dr Angus Bell	Prof Ken Strain
33	IGR	Characterising and frequency stabilising a 1550 nm laser, and testing and	Dr Angus Bell	Prof Ken Strain
34	IGR	Characterisation of thin film coated cantilevers	Dr. Peter Murray	Dr. Iain Martin
35	IGR	Gravitational wave audiation : Simulating the cosmic symphony	Dr Chris Messenger	Dr Morag Casey
36	IGR	Studying the dynamics of optical springs	Dr Bryan Barr	Prof Ken Strain
37	IGR	Observing transients with the Large Synoptic Survey Telescope	Dr Ik Siong Heng	Prof Martin Hendry
38	IGR	Exploring the possibilities of imaging and laser beam position stabilisation with the	Dr. Borja Sorazu, Dr. Alan Cumming	Prof Ken Strain
39	IGR	Acoustic coupling in sensitive interferometric measurements	Dr Borja Sorazu	Prof Ken Strain
40	IGR	Measuring the speed of light: citizen science for the International Year of Light	Dr Giles Hammond	Prof Martin Hendry
41	IGR	Speedmeter Interferometry to Outperform Heisenberg	Dr Stefan Hild	Dr Christian Graef, Dr Sebastian Steinlechner
42	IGR	Analog filters revisited: improving a less than popular experiement!	Dr Henry Ward	Dr David Robertson

43	IGR	Visualising interference in MHz heterodyne interferometry	Dr Henry Ward	Dr David Robertson / Dr Christian Killow
44	IGR	Cosmic calibration of gravitational wave detectors	Dr Ik Siong Heng	Dr Matthew Pitkin & Dr Chris Messenger
45	MCMP	Magnetic domain walls in nanowires with interfacial exchange interaction	Dr Stephen McVitie	Dr Donald MacLaren
46	MCMP	Investigating spin ice arrays and magnetic monopole behaviour	Dr Stephen McVitie	Prof Robert Stamps
47	MCMP	Pulsed Laser Deposition of Functional Oxide Thin Films	Dr Donlad MacLaren	Dr Stephen McVitie
48	MCMP	Characterising atomic-scale strain in ferromagnetic thin films	Dr Kerry O'Shea	Dr Donald MacLaren
49	MCMP	Modelling ferromagnetic oxide nanostructures	Dr Kerry O'Shea	Dr Donald MacLaren
50	MCMP	Simulating the Electron Spectroscopy of Nanoscale Metamaterials	Dr Donald MacLaren	Dr Gary Paterson
51	MCMP	Correlating the degree and length scale of cation ordering in a thin film ferromagnetic [illegible]	Dr Ian MacLaren	Dr Damien McGrouther
52	MCMP/IGR	Quantification of nanoscale compositional fluctuations in dielectric	Dr Ian MacLaren	Dr Iain Martin
53	MCMP	Free magnetic charges in artificial spin systems	Prof Robert Stamps	Dr Stephen McVitie
54	MCMP	Magnetic skyrmions and spin textures	Prof Robert Stamps	Dr Stephen McVitie

55	MCMP	Graphics processor acceleration for numerical modelling of spin textures in	Prof Robert Stamps	Dr Stephen McVitie
56	MCMP	Fabrication of nano-scale Plasmonic structures	Dr Damien McGrouther	Dr Ian MacLaren
57	MCMP	Measuring periodicity and order in magnetic systems	Dr Damien McGrouther	Dr Yoshi Togawa, Dr Stephen McVitie
58	NPE	Testing of the new Hamamatsu H12700 Multipixel PMT using the Laser Testing Facility	Dr Douglas MacGregor	Dr David Mahon & Dr Seian Jebali
59	NPE	Testing of the new Hamamatsu H8500 Multipixel PMT using the Laser Testing Facility	Dr Douglas MacGregor	Dr David Mahon & Dr Seian Jebali
60	NPE	Physics and Finance	Prof David Ireland	Dr B McKinnon
61	NPE	Modelling the scintillation light collection efficiency of a He gas scintillator	Dr John Annand	Dr David Hamilton
62	NPE	Investigation of the timing performance and effective threshold levels of the NINO	Dr John Annand	Dr Kenneth Livinstone
63	NPE	Investigation of the pulse shape and amplitude of 4He gas scintillations produced	Dr John Annand	Dr David Hamilton
64	NPE	Measurement of Polarization Observables. Analysis of data from Jefferson	Dr Ken Livingston	Dr Daria Sokhan
65	NPE	Radiation Testing of Muon Tomography Detector Components	Dr Douglas MacGregor	Dr David Mahon & Dr Seian Jebali
66	NPE	Design of a 3D portable radiometric systems	Dr Bjoern Seitz	Dr David Hamilton

67	NPE	A comprehensive model of the response of silicon Photonmultipliers	Dr Andrew Stewart	Dr Bjoern Seitz
68	NPE	Scintillation Materials for Medical Imaging Applications	Dr Bjorn Seitz	Dr Andtrew Stewart
69	NPE	Speedup the Muon Tomography Software Using Parallel Computing	Prof David Ireland	Dr Guangliang Yang
70	NPE	Distributed Programming with RabbitMQ for Muon Project	Prof David Ireland	Dr Guangliang Yang
71	NPE	Exciting mesons and baryons	Dr Derek Glazier	Dr Daria Sokhan
72	NPE	The Strange World of Hyperons	Prof David Ireland	Dr Bryan McKinnon
73	NPE	Development of a Compton Camera for Radiometric Depth Profiling in Nuclear	Dr David Hamilton	Dr Bryan McKinnon
74	NPE	Simulation of Anti-neutrino Monitoring of Nuclear Reactor Power Levels	Dr David Hamilton	Dr Seian Al Jebali
129	IAEA / NPE	Various projects	Dr Iain Darby / Prof Ralf Kaiser	TBD
75	OPTICS	Real-time 3D video with a single camera	Dr Matt Edgar	Dr Graham Gibson
76	OPTICS	Generalised refraction	Dr Johannes Courtial	Stephen Oxburgh
77	OPTICS	Designing optical fullerene potentials	Dr Johannes Courtial	Dr Neal Radwell

78	OPTICS	Geometrical imaging unconstrained by wave optics	Dr Johannes Courtial	Stephen Oxburgh
79	OPTICS	A lens with a complex focal length	Dr Johannes Courtial	Stephen Oxburgh
80	OPTICS	3D video feedback	Dr Johannes Courtial	Dr Graham Gibson
81	OPTICS	3D Imaging of Light and Darkness	Dr Sonja Franke-Arnold	Dr Neal Radwell
82	OPTICS	Focus on polarisation structures	Dr Neal Radwell	Dr Sonja Franke-Arnold
83	OPTICS	Polarisation imaging	Dr Sonja Franke-Arnold	Dr Neal Radwell
84	OPTICS	Imaging at distance	Prof. Miles Padgett	Reuben Aspden
85	OPTICS	Investigating 'hydrodynamic shielding' using optical tweezers	Dr David Phillips	Dr Graham Gibson Prof Miles Padgett
86	OPTICS	Characterisation of intensity masking techniques	Dr J Romero	Prof Miles Padgett
87	OPTICS	Assessing the stability of optics experiments built using 3D printed mounts.	Dr Graham Gibson	Prof Miles Padgett, Reuben Aspden
88	PPE	Higgs boson search in WH->lvbb	Dr Adrian Buzatu	Dr Aidan Robson
89	PPE	Physics at a Linear Collider	Dr Aidan Robson	Dr Dan Protopopescu

90	PPE	Ultra Fast Readout System for Medipix X-ray Imaging Detector	Dr Dima Maneuski	Prof Craig Buttar
91	PPE	CP-violation in c-hadron decays	Dr Michael Alexander	Dr Paul Soler
92	PPE	CP-violation in b-hadron decays	Dr Michael Alexander	Dr Lars Eklund
93	PPE	ATLAS strip thermal tests	Dr Andy Blue	Prof Craig Buttar
94	PPE	Thin silicon pixel module fabrication using wafer-to-wafer bonding for ATLAS upgrade	Dr Richard Bates	Dr Marielle van Veggel
95	PPE	Measurement & modelling stresses in LHC silicon detector modules	Dr Richard Bates	Dr Liam Cunningham
96	PPE	Top-Antitop modelling studies	Prof Anthony Doyle	Dr Andrea Knue
97	PPE	Feasibility of a Compton Camera using silicon and cadmium-telluride detectors	Prof Paul Soler	Dr Dima Maneuski, Dr Ryan Bayes
98	PPE	Jet substructure studies with high pile-up	Dr Deepak Kar	Prof Anthony Doyle
99	PPE	Characterisation of Medipix X-ray Imaging Detector	Dr Dima Maneuski	Prof Val O'Shea
100	PPE	Particle counting detector for scientific applications	Dr Dima Maneuski	Prof Craig Buttar
101	PPE	Experimentally distinguishing quarks and gluons at the LHC	Dr Andy Buckley	Dr Chris Pollard

102	PPE	Data compression for high speed silicon sensor systems	Prof Craig Buttar	Dr Richard Bates
103	PPE	Tier-3 elastic overflow to the Grid via DIRAC submission	Prof David Britton	Dr Gareth Roy
125	PPE	Monte Carlo Generators for NA62	Prof David Britton	Dr Dan Protopopescu, Prof Ian Skillicorn
126	PPE	Understanding the top quark using LHC data	Dr Mark Owen	James Ferrando / Tony Doyle (TBC)
127	PPE	nuSTORM Near Detector Interaction Studies	Dr. Ryan Bayes	Prof. Paul Soler
128	PPE	Simulation Studies of the Muon Ionization Cooling Experiment	Dr. Ryan Bayes	Prof. Paul Soler
104	PPT	LHC phenomenology of dark sectors	Dr Christoph Englert	Dr David J Miller
105	PPT	Higgs self-coupling studies in weak boson fusion processes	Dr Christoph Englert	Dr David J Miller
106	PPT	Renormalization Group Effects for Effective Higgs Physics	Dr Christoph Englert	Dr David J Miller
107	PPT	From gluons to gravitons	Dr Chris White	Dr David Miller
108	PPT	The decay constant of the B* meson	Prof Christine Davies	Dr Jonna Koponen
109	PPT	GUT Models without supersymmetry	Dr David Miller	Dr Chris White

110	PPT	Coloured partners for the Higgs Boson	Dr David Miller	Dr Chris White
111	PPT	The mass of the excited Bc meson	Prof C Davies	Dr J Koponen
112	PPT	Exploring the path integral formulation of quantum mechanics	Prof Christine Davies	Dr Jonna Koponen
113	QT	Quantum Entanglement	Dr Sarah Croke	Prof Steve Barnett
114	QT	Quantum Security	Dr Thomas Brougham	Prof Steve Barnett
115	QT	Tensors in optics	Prof Steve Barnett	Dr Fiona Speirits
116	QT	Chiral interactions in optics	Prof Steve Barnett	Robert Cameron
117	QT	Quantum two particle interference	Prof Steve Barnett	Dr Vaclav Potocek
118	SCHOOL	Threshold concepts within a Physics undergraduate degree	Dr Eric Yao	
119	SCHOOL	Quality of Student-generated Content from PeerWise Repositories Used in Physics 2	Dr Morag Casey	Dr Nicolas Labrosse
120	SUERC	Re-appraising the heat flow from Scottish Granites	Dr Tim Kinnaird	Prof David Sanderson
121	SUERC	You are what you eat : investigating the use of low level gamma spectrometry in studies of food authencity.	Dr Lorna Carmichael (SUERC)	Prof David Sanderson

122	SUERC	You are what you eat : investigating thermoluminescence and photostimulated luminescence as potential tools in food authentication.	Dr Lorna Carmichael (SUERC)	Prof David Sanderson
123	SUERC	Photon counting statistics and limits of detection for single grain and multigrain luminescence dating of fluvial sediments	Dr Tim Kinnaird (SUERC)	Prof David Sanderson

Project 1

Group Astronomy & Astrophysics

Project name Modelling the radio emission from hot chromospheric solar flares sources

Supervisor Dr. Paulo Simões

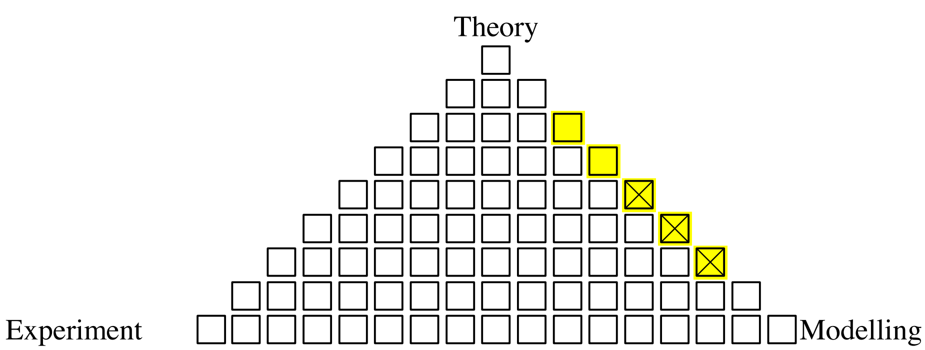
Backup Supervisor Prof. Lyndsay Fletcher

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The objective of this project is to study radio emission from hot, dense plasma in solar flares, using simulations of electrons emitting synchrotron and bremsstrahlung radiation. The chromosphere in solar flares is strongly heated to temperatures up to 10 million K, as readily seen in extreme ultraviolet and X-ray images. However, the consequences of these hot, dense compact regions for radio emission have not been explored. The hot chromospheric plasmas are located where the magnetic field is stronger than typically found in the corona and which means that intense radio emission is expected. The student will use flare modelling softwave to calculate the radio emission for a range of conditions and evaluate if this emission would be observable with current or future radio telescopes. The project is suitable for a student interested in numerical simulations and keen on programming. The project will be carried out in (IDL programming language), and it would be an advantage to have taken the honours astronomy HEA or IOR courses.

Project 2

Group A&A

Project name Solar prominence catalogue: analysis of large-scale prominence properties over more than a solar cycle

Supervisor Dr Nicolas Labrosse

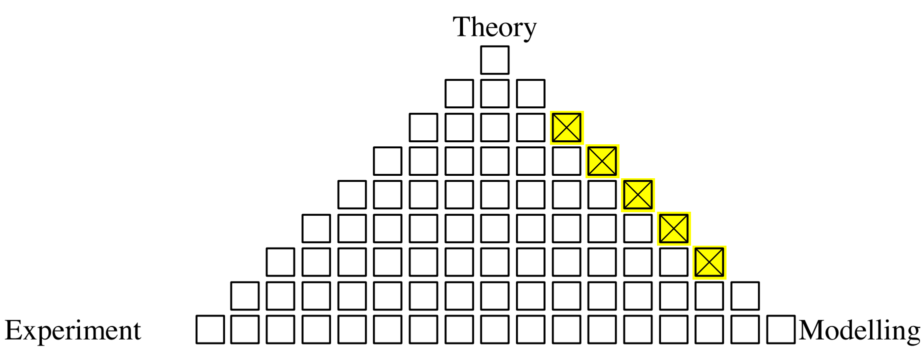
Backup Supervisor Dr Jonathan Taylor

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

A solar prominence catalogue is being developed (and is close to completion), based on automatic feature recognition and advanced image processing. Depending on the length of the project and the student's interest, the goals will be one or more of:
•Assist with the prominence image reconstruction and tracking over successive frames.
•Use this catalogue covering 12 years of SOHO/EIT prominence observations to derive the evolution of the prominence main characteristics over a whole solar cycle and identify any link with flares and Coronal Mass Ejections.
•Adapt the image processing algorithm to other space-based instruments.
During the project the student will learn: 1) basic physics of solar prominences, 2) basics of image processing, 3) how to analyse data from space-based observatories, 4) how to search the literature to identify relevant research papers. This is an observational (data analysis, image processing) computer-based project involving algorithm development (feature-tracking). A willingness to engage with programming is essential.

Project 3

Group A&A

Project name Two-dimensional radiative transfer models of cool solar coronal loops

Supervisor Dr Nicolas Labrosse

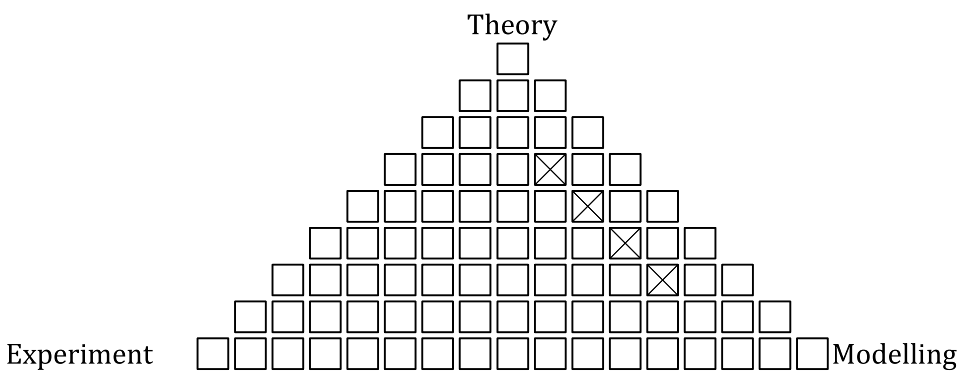
Backup Supervisor Prof Lyndsay Fletcher

Suitability 20 credit no 30 credit no 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The aim of the project is to develop a better understanding of cool solar chromospheric structures, and gain new insight on the physical conditions in these regions of the solar atmosphere. The chromosphere can be thought of as composed of bundles of small magnetised loops. These small loop structures are represented in our models by 2D cylindrical objects. We perform radiative transfer calculations to compute the spectrum emitted under various physical conditions. The predicted spectrum can then in principle be compared with observations. This is a computational project which also aims to produce a new set of data to help observers interpret their observations.
This is a computer-based project using a radiative transfer code developed in FORTRAN. A good understanding of radiative transfer basics is needed, from independent reading, or the Honours astronomy 'Circumstellar Matter' course. An ability to understand FORTRAN codes is preferable.

Project 4

Group A&A

Project name Stellar flare statistics

Supervisor Prof Lyndsay Fletcher

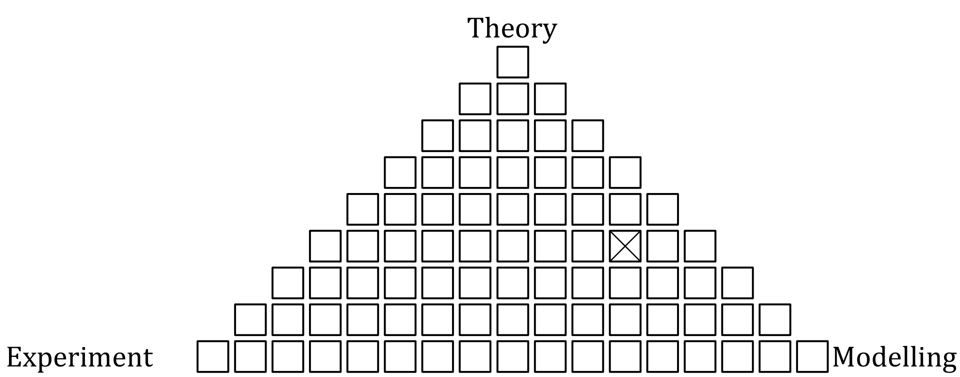
Backup Supervisor Dr Matthew Pitkin

Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Data from the Kepler satellite is a great resource for finding large numbers of stellar flares. It could therefore provide much new information on the statistics of stellar flare properties, such as the distribution of flare energies and rates. Software has been developed to automatically find flares, but this has yet to be applied to the majority of Kepler data. This project would first require applying this search software to identify a large number of flares. Using the identified flares we would develop a way to classify their characteristics, such as their energies, and uncover their distributions.

Project 5

Group A&A

Project name EUV spectroscopy of solar flare footpoints

Supervisor Prof Lyndsay Fletcher

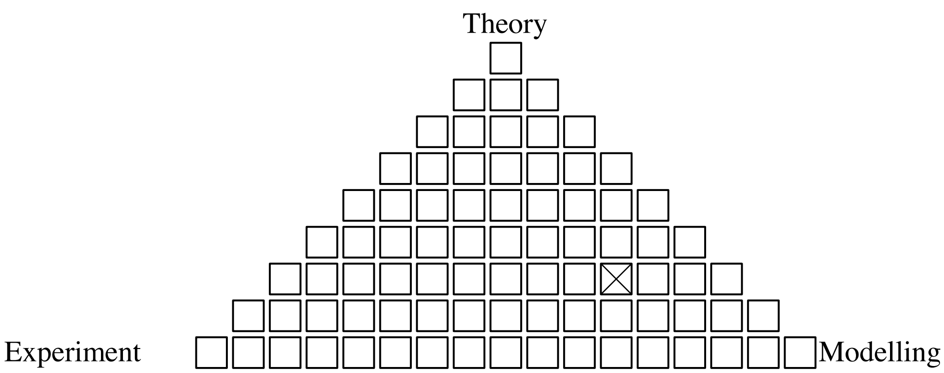
Backup Supervisor Dr Nicolas Labrosse

Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

During a solar flare, the Sun's atmosphere receives an energy flux on the order of 10^{11} watts m^2, focused into patches known as footpoints. As a result of this energy input the atmosphere heats rapidly, and starts to expand. It may also become turbulent, a suggestion supported by recent observations of large linewidths observed in the solar chromosphere by the Extreme Ultraviolet Imaging Spectrometer onboard the Hinode spacecraft. In this project, the student will use the EIS software to measure line widths in flares and to examine relationships between line widths and other properties of the flare plasma such as its density or Doppler shift, and to deduce the timescale on which line broadening appears and dies away. The project is particularly suitable for a student who has taken the 'Astronomical Data Analysis' course, and who is keen on data analysis and programming. It will involve the use of professional, and self-written software in the IDL programming language

Project 6

Group Astronomy & Astrophysics

Project name Lyman lines during solar flares: analysis of EVE observations

Supervisor Prof. Lyndsay Fletcher

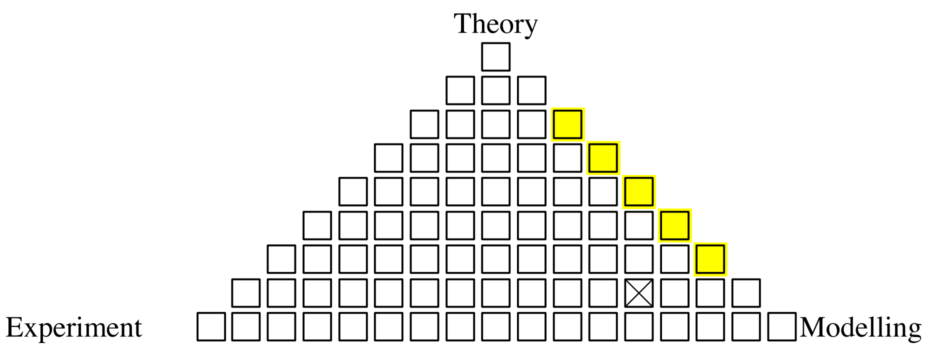
Backup Supervisor Dr. Nicolas Labrosse

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for “theoretical physics” no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The Extreme Ultraviolet Variability Experiment on NASA’s Solar Dynamics Observatory is a ‘Sun-as-a-Star’ instrument that records the EUV and UV spectrum from the whole Sun every 10 seconds. It has observed of solar flares in the part of the spectrum containing high-order members of the hydrogen Lyman series, as well as the Lyman continuum. Such observations are rarely. As part of an ongoing research project into the deduction of the physical properties of the plasma in solar flares, the student will work on these data, including isolating the flare spectral signatures, correcting them for instrumental effects, fitting spectral line profiles and measuring Lyman series intensities. A longer project might also involve comparison of these results to theoretical predictions. The programming will be done in MATLAB or the similar IDL programming language: the student must enjoy coding, have an interest in solar physics or astrophysics, and it would be beneficial to have completed the honours astronomy ADA course.

Project 7

Group Astronomy & Astrophysics

Project name The temperatures of solar flares from the Solar Dynamics Observatory /EVE instrument

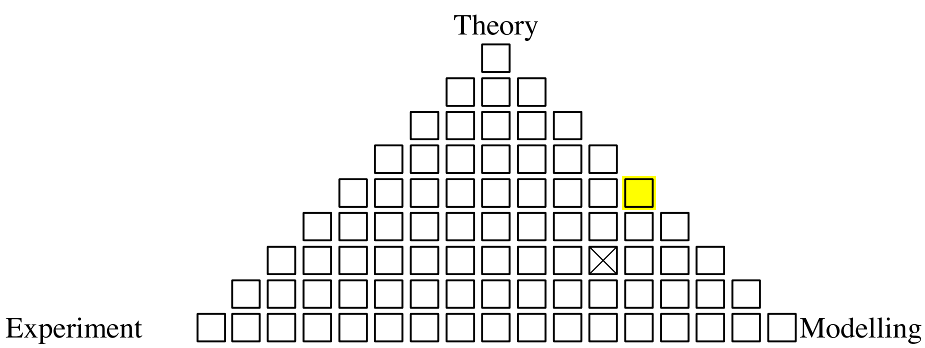
Supervisor Dr. Hugh Hudson

Backup Supervisor Prof. Lyndsay Fletcher

Suitability 20 credit yes 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single check. (For example, checking the highlighted box would indicate a project that includes equal components of theory and modelling with no experimental component)



Project description (length should not exceed remainder of page)

The EUV Variability Experiment (EVE) on the Solar Dynamics Observatory measures the extreme ultraviolet spectrum of the 'Sun as a star'. During solar flares, spectral lines emitted by highly ionised iron in the solar corona become visible. In this project, the temperature of the flaring plasma as the flare evolves will be determined by, looking at the ratios of a series of iron lines. The goal is to determine flare heating and cooling timescales, and finding out whether higher temperature flares heat and/or cool faster than lower temperature flares.

This project is suitable for a student who has taken the 'Astronomical Data Analysis' course as it will call on basic ideas about background and signal-to-noise ratio, as well as temperature diagnostics from emission line ratios. The project will involve a substantial amount of programming, and the intention is that this will be done by the student in MATLAB. The opportunity also exists for the student to use IDL and learn about remote data access from the Virtual Solar Observatory.

Project 8

Group A&A

Project name electron-moderated plasma chemistry of low-energy discharges

Supervisor D A Diver

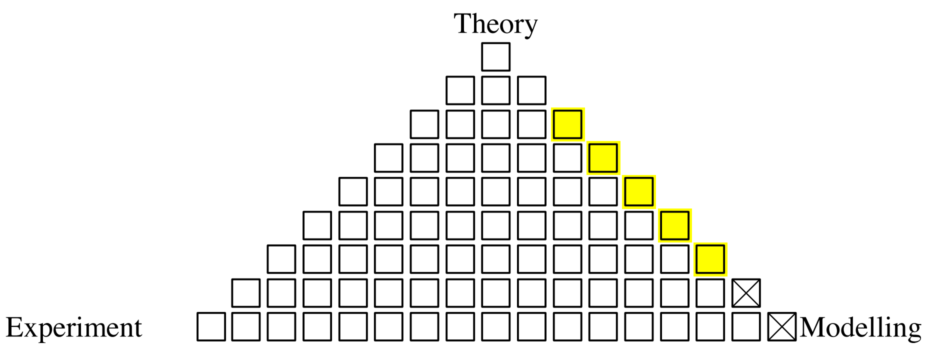
Backup Supervisor

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Atmospheric plasma discharges are complex chemical systems in which a mixture of neutrals, radicals, positive and negative ions and free electrons are constantly interacting. The electron-moderated chemistry can create atomic and molecular pre-cursors that enable non-thermal chemical pathways to be explored. This unique chemistry accompanied by low thermal burden has fuelled the recent growth in atmospheric plasma discharge experiments across the plasma community, with diverse applications including plasma medicine. A zero-dimensional simulation (ie at a point in space) has been developed to model the evolution of around 15 molecular species in approximately 45 reactions, in order to explore the reactivity of the plasma. This project will extend the simulation in two very significant ways: (i) the code will incorporate competitive species diffusion and a temperature gradient, to go beyond the simple 'solution at a single point' approach; and (ii) the effect on a variable electron temperature will be examined, once (i) is implemented, in order to see if profiling the electron energy can be beneficial.

Project 9

Group A&A

Project name plasma body forces in gas bubble evolution

Supervisor D A Diver

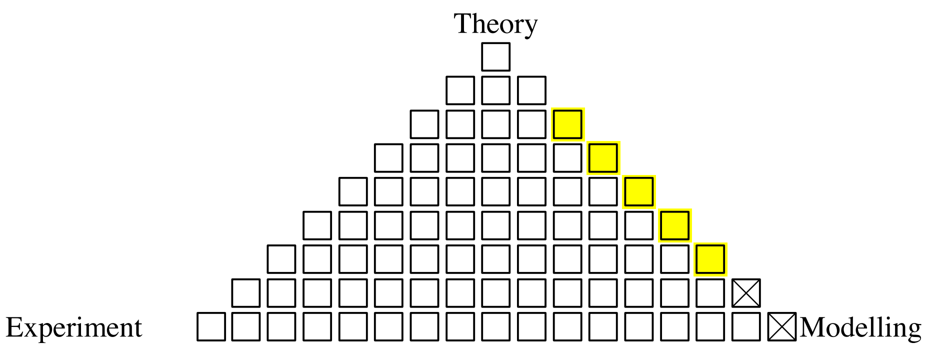
Backup Supervisor

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

This project addresses the efficient calculation of the electrostatic field arising from distributed free charge on a discrete electron-plasma-bubble boundary, constrained by fixed, imposed boundary conditions that offer a potential gradient in one direction, but repulsive potential in all others. The self-consistent evolution of this bubble and associated self-field as the body forces distort the charged particle distribution, driving it to a potential minimum are is the key goal in this numerical study. The whole system conserves both charge and energy, so that as the bubble deforms and translates, the surface potential changes (altering the electrostatic energy of the system), and its center of mass acquires a speed, altering the global kinetic energy. We shall explore the accuracy and efficiency of such a calculation strategy in modelling the evolution of short electron bursts in hollow-cathode geometries, with a view to applications in beam formation in lightning discharges (including sprites).

Project 10

Group A&A

Project name Genetic Algorithms for breeding solutions to differential equations

Supervisor D A Diver

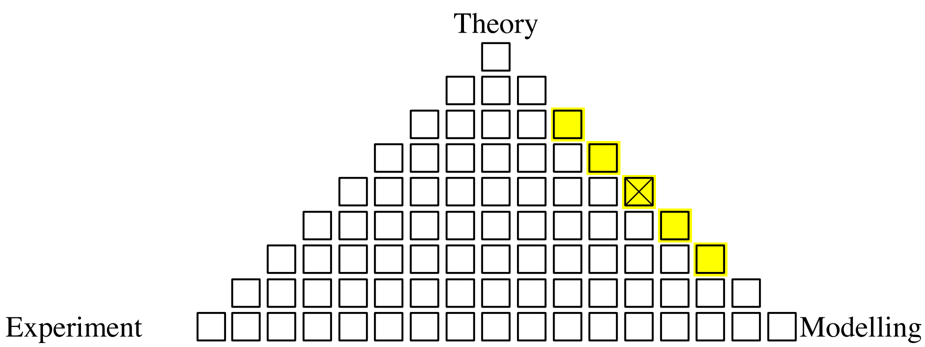
Backup Supervisor

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Genetic algorithms (GA) use a Darwinian approach to generating solutions to a penalty-driven problem. GAs are the most efficient multi-parameter search strategies that can be employed numerically. A possible solution to a defined problem is expressed as a character string which encodes all of the features of the solution to the problem: for exampe, the solution to an ODE can be written as a concatenation of the numerical values of the function (evaluated at the desired values of the argument), together with the boundary conditions (which can be written directly at the ends of the string). In this format, the string is the analogy to DNA. The goodness-of-fit is expressed in terms of how close to the actual solution is one such string when translated. A collection of such potential solutions is designated as the parent population, and variants are generated by breeding from them. The resultant population is ranked according to fitness, and the process repeats until a satisfactory fit to the original ODE is found. This technique works well for stiff problems, and has real potential to work for PDEs too: project targets.

Project 11

Group A&A

Project name Field-aligned flows in MHD

Supervisor D A Diver

Backup Supervisor

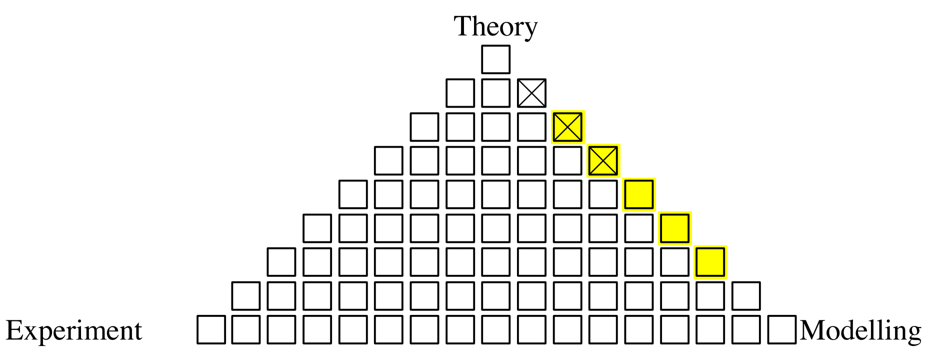
Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance

Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Magnetohydrodynamical plasmas are characterised by long-wavelength, low-frequency fluid behaviour in which the magnetic field plays a signficant role in modifying the hydrodynamics. In this project, we will explore the unique context of field-aligned flows, in which the bulk fluid flow is parallel or anti-parallel to the magnetic field u=fB, which allows significant simplification, making the fluid incompressible (div u = 0), and creating the concept of 'negative inertia' in which the fluid flow profile in restricted channels behaves counter to intuition. We will explore analytically the implications for a variety of flow contexts, ranging from simple Bernoulli flow to the analogies with classical potential flow, in which the fluid circulation becomes identified with the current density. This project will contain a significant amount of mathematical analysis, rather than numerical modelling (though there will be scope for adjusting the relative balance).

Project 12

Group Optics

Project name Use and abuse of microscope objective lenses

Supervisor Dr Jonathan Taylor

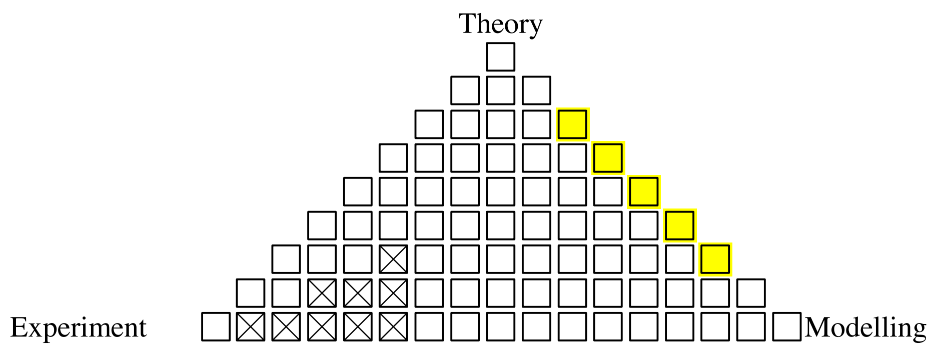
Backup Supervisor Prof Andrew Harvey

Suitability 20 credit yes 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Microscope objective lenses are very carefully designed to perform extremely well when used in the way they were intended. How well do they behave when they are misused?

A question of particular interest is what happens when they are used to form an image of an object that is not in the standard focal plane of the objective. This is important for example when imaging in multiple planes simultaneously. This project will quantify the image quality as a function of focal shift, through a combination of experiment and computer analysis of acquired images.

The student will design and construct an apparatus for obtaining images at different focal shifts, and analyze the resultant images in order to characterize the performance of the lens. The project is suitable for a student who has and aptitude for optics experiments and is competent at computer programming for data analysis.

Project 13

Group Optics

Project name Compressive sensing for heart imaging

Supervisor Dr Jonathan Taylor

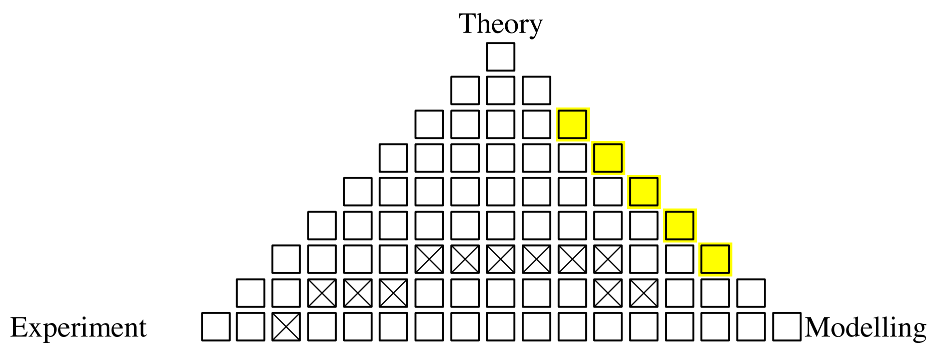
Backup Supervisor Prof Andrew Harvey

Suitability 20 credit yes 30 credit yes 40 credit yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Compressive sensing allows fast imaging using a single-pixel detector… but what if we didn't even need to create an image at all? This project will use compressive sensing concepts to detect, analyze and "lock in" to the motion of the heartbeat in a zebrafish, using a system that can be implemented without the need for computer control.

The project could be primarily experimental, involving optics and electronics skills and programming an embedded microcontroller in order to analyze the signals. This would suit a student with an aptitude for practical experiments and an interest in electronics.

Alternatively it could involve more theory/modelling, running computer simulations to evaluate different strategies that could be used in an experimental implementation. This would suit a student with a more mathematical background who is experienced in the use of a programming language such as Matlab or Python for solving problems in physics.

Project 14

Group Optics

Project name Microdroplets as miniature lenses

Supervisor Dr Jonathan Taylor

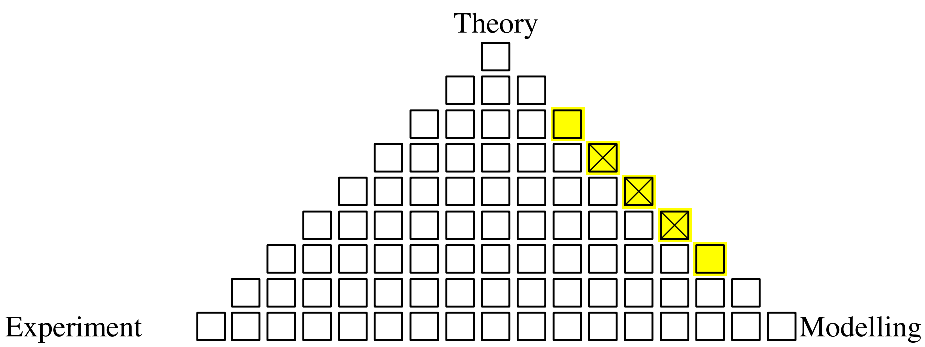
Backup Supervisor Prof Andrew Harvey

Suitability 20 credit yes 30 credit yes 40 credit yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Microscopic oil droplets can be manipulated using focused laser beams ("optical tweezers"), can be sculpted into different shapes by using optical tweezers to manipulate the droplet, and can even be linked by nano-"pipes" to perform chemical reactions on an attolitre scale. However the droplet itself will act as a microscopic lens, which will focus the light and affect how the droplet behaves in the tweezers.
This project will investigate this refocusing of the light through theoretical analysis and computer modelling, and attempt to create an improved numerical model for this light-matter interaction.
A 20 credit project could involve theoretical characterization of the problem to determine the circumstances in which our current simple ray optics model breaks down. Longer 30 and 40 credit projects would develop improvements and corrections to the current model in order to better model the effects of the tweezers on the droplets. Experience with Python or Matlab programming languages essential.

Project 15

Group Imaging Concepts

Project name Remote sensing of rough surfaces

Supervisor Prof Andy Harvey

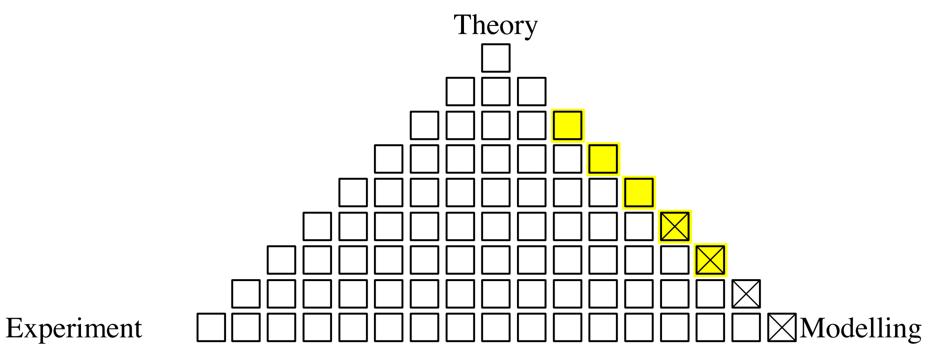
Backup Supervisor Patrick Kelleher

Suitability 20 credit yes 30 credit no 40 credit no 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off campus required no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single check. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that includes equal components of theory and modelling with no experimental component)



Project description (length should not exceed remainder of page)

This project runs in semester 2/3 only

In the field of remote sensing large amounts of data is acquired at multiple wavelength over large spatial areas and/or time series. Understanding and interpretation of these large data sets is achieved by using a small sample of known spectra to create "training sets" that are used in conjunction with data processing algorithms to classify the data into distinct classes, allowing it to be interpreted and used for various purposes. Further developing physical models to explain variations within and between the various classes has to the potential to create newer, more interesting methods of quantifying large data sets. In this project the student will be given access to time-series data and tasked with testing and optimising various algorithms. The project has scope for the student to use numerous approaches to the processing of such data. The project consists entirely of computational work and the student will have the opportunity to improve their programming, algorithm development and general computational skills.

Project 16

Group Imaging Concepts

Project name : 3D shape profiling of rough surfaces

Supervisor Prof Andy Harvey

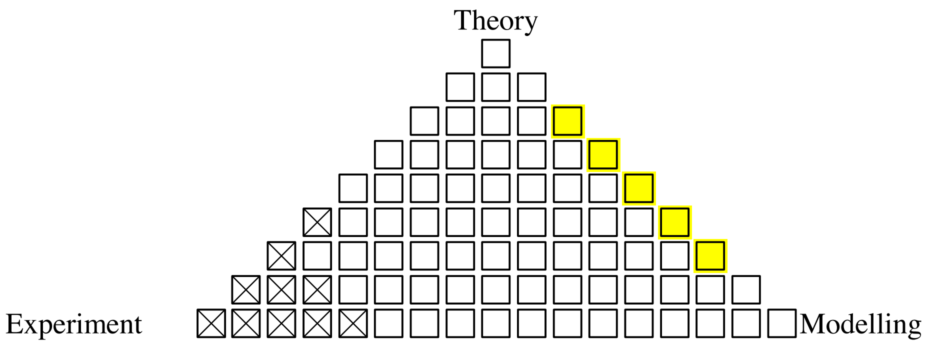
Backup Supervisor Patrick Kelleher

Suitability   20 credit yes   30 credit yes   40 credit yes   60 credit (MSc) yes

Suitable for "theoretical physics" no

Off campus required no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single check. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that includes equal components of theory and modelling with no experimental component)



Project description (length should not exceed remainder of page)

This project runs in semester 2/3 only

The convenience and accuracy of remote optical methods of measuring the spatial profile of surfaces make it an active area of research. Traditional methods rely on complex mechanical setups or elaborate illumination schemes, but recent advances in microelectromechanical (MEMS) systems have enabled the creation of compact surface profiler designs. This project will employ a MEMS projection system and a camera to create just such a device. This will then be used to implement novel phase-shifting algorithms for the recovery of various surface profiles. Characterisation of rough surfaces (e.g. roads) are of particular interest, but other objects, such as faces, are also possible. The student will gain experience of practical optics and instrumentation, as well as algorithm development

Project 17

Group Imaging Concepts

Project name : Multispectral nailfold capillaroscopy

Supervisor Prof Andy Harvey

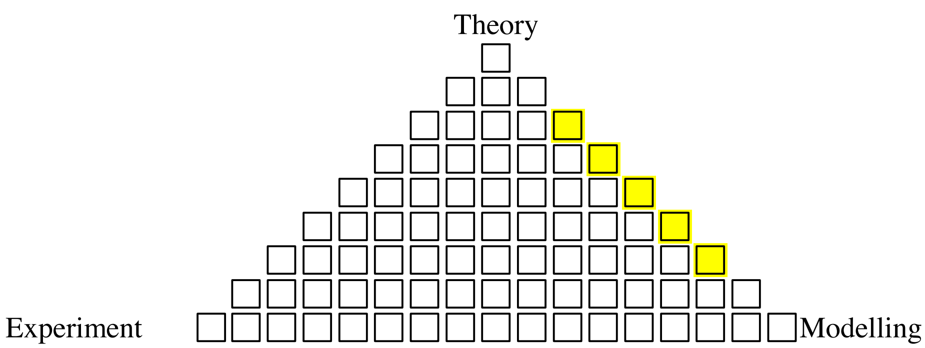
Backup Supervisor Marieke vander Putten/Patrick Kelleher

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off campus required no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single check. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that includes equal components of theory and modelling with no experimental component)



Project description (length should not exceed remainder of page)

This project runs in semester 2/3 only

Nailfold capillaroscopy (NFC) is a well-established technique to visualise the superficial microvasculature within the nail-fold. NFC is used for the diagnosis of diseases involving microvasculature abnormalities, such as connective tissue diseases and systemic sclerosis. The aim of this project will be to construct a working microscope capable of imaging the microvasculature. The standard NFC technique will then be extended to multiple wavelengths in order to assess the potential for oximetry, e.g., measurement of blood oxygenation in vivo.

Project 18

Group Imaging Concepts

Project name : **Fourier Ptychographic Microscopy**

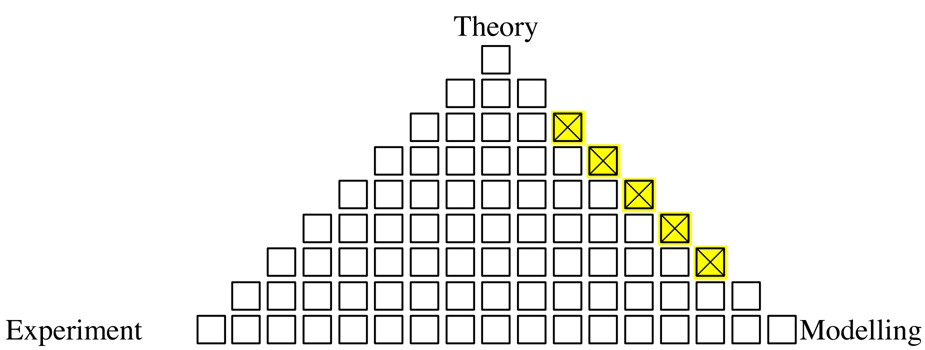
Supervisor Prof Andy Harvey

Backup Supervisor Dr Jonathon Taylor + Pavi Konda
Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off campus required no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single check. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that includes equal components of theory and modelling with no experimental component)



Project description (length should not exceed remainder of page)

The student will research the use of a new technique that enables high resolution microscopy images to be assembled using a low-resolution microscope. Fourier Ptychography is a technique that iteratively stitches together a number of variably illuminated, low-resolution intensity images in Fourier (spatial-frequency) space to produce a widefield, high-resolution complex sample image. It is a technique to image in very high resolution with a low numerical aperture lens system. There are few problems which degrade the performance of this system. In this work we are trying to look at the source and solution to artefacts in the final image formed. First hand knowledge in fourier optics is recommended. Modelling will be done in Matlab.

Project 19

Group Imaging Concepts

Project name : **3D imaging with extended depth of field - experiment**

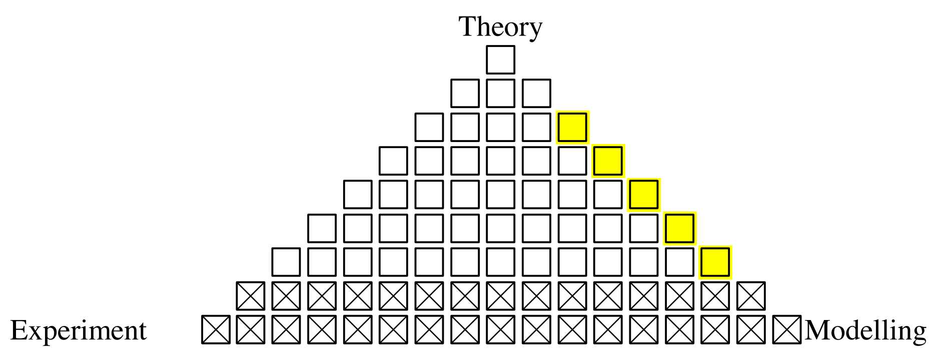
Supervisor Prof Andy Harvey

Backup Supervisor Dr Guillem Carles & Paul Zammit
Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off campus required no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single check. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that includes equal components of theory and modelling with no experimental component)



Project description (length should not exceed remainder of page)

Complimentary Kernel Matching is a computational imaging technique able to detect defocus and range across the field-of-view from image texture. The technique requires the acquisition of two images with dissimilar optical characteristics. The project will assess the potential use of chromatic aberration to acquire these images using a colour detector array. The student will mainly work at the laboratory to image broad-band objects with phase-encoded optics. The student will subsequently reconstruct the obtained colour images and assess the accuracy of defocus measurement from registration of the colour planes. This project might include simulation of the experiments using optical design software.

Project 20

Group Imaging Concepts Group

Project name Oximetry of the eye/brain

Supervisor Prof Andy Harvey

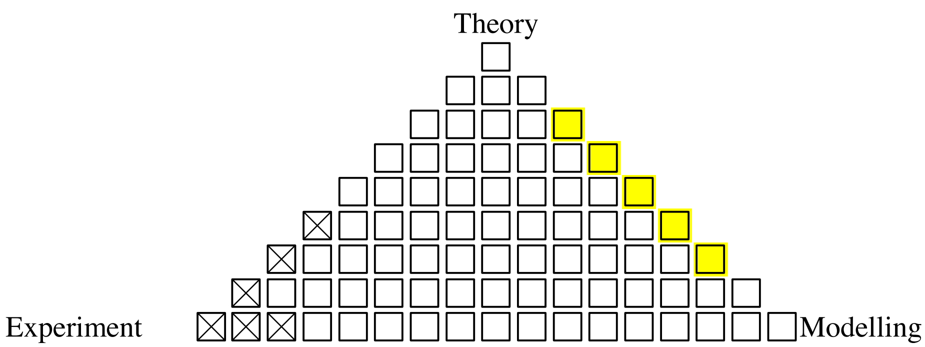
Backup Supervisor Dr Lauence Brewer

Suitability 20 credit no 30 credit no 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The student will explore the use of a novel optical technique employing laser speckle to measure the oxygenation of blood in a layer behind the retina called the choroid. The choroid is an important vascular component of the eye, delivering 85% of the blood to the retina and is closely coupled to the brain. The student will assemble a phantom choroid and the optics to measure its oxygenation using laser speckle oximetry. If successful in the phantom eye there is the possibility of testing this technique on an ex vivo eye. The interested student should should ideally have experience constructing an experimental apparatus in a laboratory setting, some background using lasers and optics and a good knowledge of the programming language Matlab for data analysis.

Project 21

Group ICG

Project name Instantaneous 3D Image Capture Via Computational Imaging

Supervisor Prof. Andy Harvey

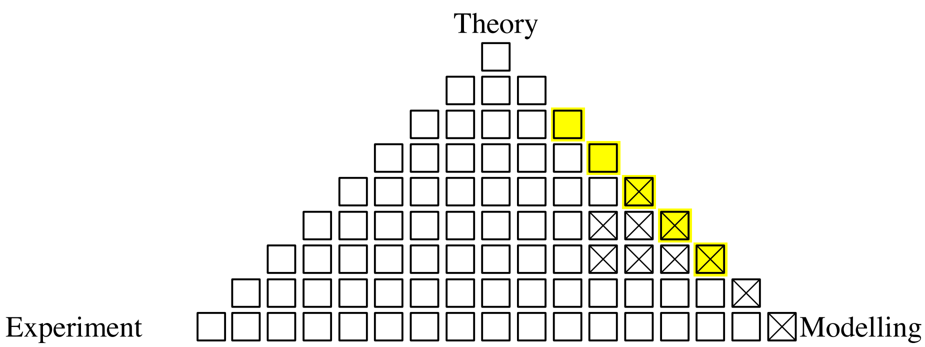
Backup Supervisor Guillem Carles & Paul zammit

Suitability 20 credit yes 30 credit no 40 credit no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Computational imaging permits the depth of field of an optical system to be extended by roughly an order of magnitude - see Dowski and Cathey (doi: 10.1364/AO.34.001859). Recently, we have developed a technique called Complimentary Kernel Matching (CKM) which exploits this property for instantaneous 3D image capture. This is of relevance to various fields including gaming, virtual reality, microscopy and more.
During the course of this project, the student will learn the theory underlying computational imaging which is based on Fourier optics and that behind CKM. The student will then investigate through modelling the applicability and performance of CKM under different coding and imaging strategies. In order to consolidate the conclusions of this study, experimental data can be either provided or taken by the student depending on the student's aptitude and progress. Knowledge of the experimental procedure and 'real-world' applications of this technique is nonetheless necessary in order to perform realistic modelling.

Project 22

Group Imaging Concepts Group

Project name Diffusion of oxygen in retinal blood vessels

Supervisor Prof Andy Harvey

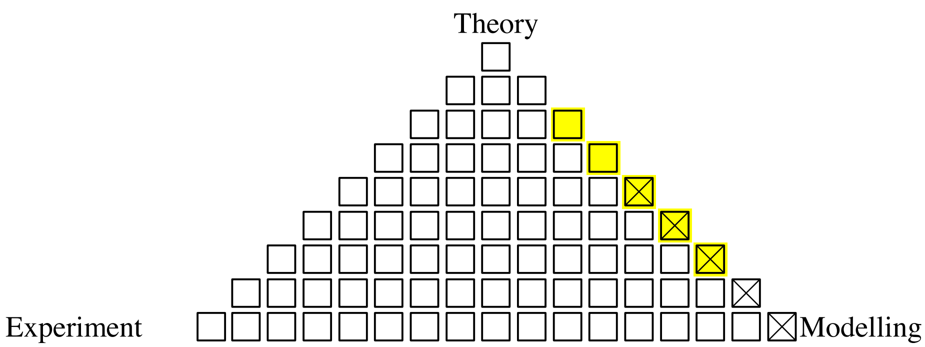
Backup Supervisor Dr Laurence Brewer

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

In the human retina, two blood vessels that have different oxygenations often join to form a single blood vessel. Because the blood flow is laminar, oxygen diffuses from the higher oxygenated blood on one side of the vessel to the less oxygenated blood on the other side, until equilibrium is reached. This project will model this process using Fick's law of diffusion to better understand how oxygen is distributed in the retinal vasculature.The model will involve computer simulations of the process taking account of this velocity profile and the random diffusion of oxygen in the blood stream.The interested student should be able to programme in a high-level language such as Matlab. This is a theoretical project that will use data already generated by researchers in the Imaging Concepts Group. Students will have the opportunity to see the flow cell experiments to understand how the data is generated.

Project 23

Group Imaging Concepts Group

Project name Determination of blood-oxygen saturation in the retina

Supervisor Prof Andy Harvey

Backup Supervisor Javier Ramos

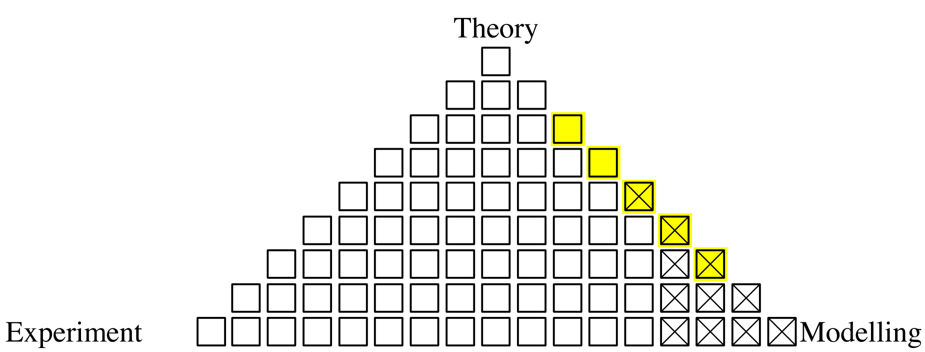
Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance

Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

It is well known that blood varies in colour with oxygenation, for example it is bright red in arteries and darker red in veins. The student will develop algorithms for retinal-vessel oximetry based on multispectral images of retinal vessels and devise methods to increase robustness and accuracy of this oximetry. The student will develop a model for the physics of light propagation in the retina and use this model to explore how to increase the accuracy of oximetry. This will employ a combination of analytical algorithms and Monte-Carlo modelling. The project will employ a large library of multispectral images of retinas and artificial eyes and there will be the opportunity to conduct experimental validation of algorithms, although this is not essential.

The student should have an interest in mathematical modelling in, for example, Mathematica or MATLAB.

Project 24

Group Institute for Gravitational Wave Research

Project name Characterisation of hydroxide-catalysis bonds

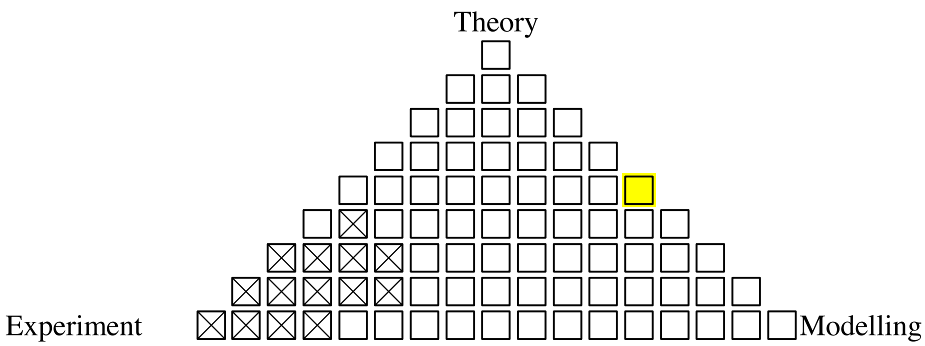
Supervisor Karen Haughian

Backup Supervisor Marielle van Veggel/ Sheila Rowan

Suitability 20 credit yes 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single check. (For example, checking the highlighted box would indicate a project that includes equal components of theory and modelling with no experimental component)



Project description (length should not exceed remainder of page)

Hydroxide catalysis bonding is a technique used in the construction of quasi-monolithic mirror suspensions in gravitational wave detectors. Using this technique the mirrors are chemically bonded to silica prisms, 'ears', which are welded to thin silica fibres.
The reason for using this technique is that the bond has very similar properties to the silica used and can be made extremely thin, which means any noise introduced by the bond is kept at a minimum.
Currently we are looking at hydroxide catalysis bonding and indium bonding of silicon and sapphire as future generation gravitational wave detectors will possibly operate at cryogenic temperatures with mirrors made of these materials.
We are always looking to further understand and optimise the bond properties and procedures and the chemistry behind it.
The aim of your project would be to further characterise hydroxy-catalysis and/or indium bonds, in terms of strength, thickness or thermal conductivity, to help develop the bonding procedure for future generation detectors.
The project is mostly experimental and will involve learning to work with chemicals, surface characterisation equipment, strength testing machines and cryostats.

Project 25

Group Institute for Gravitational Research

Project name A monolithic interferometer for measuring creep in fused silica

Supervisor Dr. Marielle van Veggel

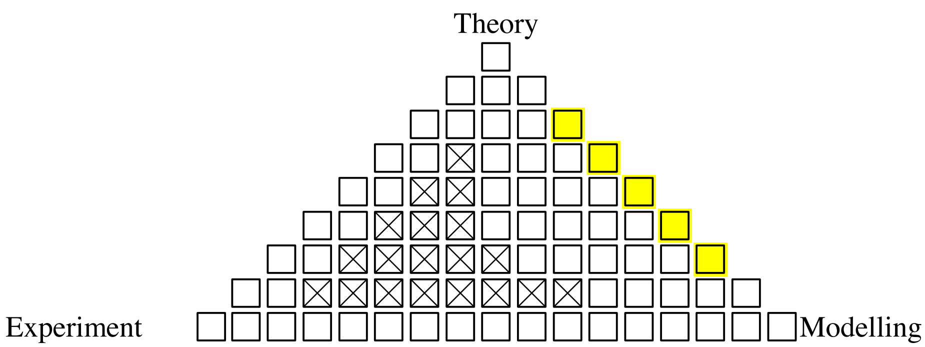
Backup Supervisor Dr Giles Hammond

Suitability 20 credit yes 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Test mass suspensions in gravitational wave detectors utilise hydroxide catalysis bonding of fused silica to produce monlithic components of exceptional low thermal noise performance. As advanced LIGO undergoes commissioning there is significant interest to measure these bonds under an applied stress in order to test their long term stability.

This project will setup a high precision Michelson interferometer with bonded components for maximum stability. One of the end mirrors of the interferometer will be part of a suspension which will allow a stress to be aplied to the bond. By monitoring the stability of the interferometer, at a stress level x10 higher than normally used in detector suspensions, we will look for creep events in the bonds. The work will combine expertise in vacuum systems, building/testing electronics, and looking at environmental factors including temperature and tilt stability in the laboratory over long timescales.

Project 26

Group IGR

Project name Measurements of eddy current damping for gravitational wave detector suspensions

Supervisor Dr Liam Cunningham

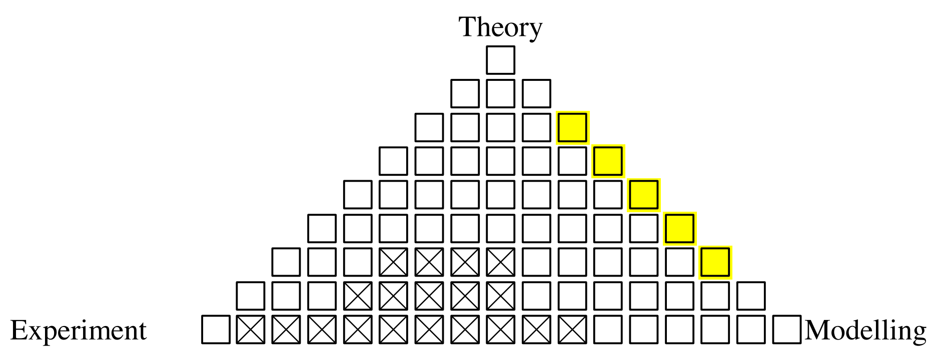
Backup Supervisor Dr Giles Hammond

Suitability 20 credit yes 30 credit no 40 credit no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The Institute for Gravitational Research is involved with several Gravitational Wave projects around the world (aLIGO, KAGRA, GEO-HF). As part of our collaboration with the Albert Einstein Insitute (AEI) in Hannover we are designing a prototype monolithic fused silica suspension with 100g test masses. The interferometer will be used to develop novel opto-mechanical techniques that can be applied to full scale experiments in the future.
The project will involve building a small pendulum incorporating a passive eddy current damping system and calculating the damping constant for bobs made of different materials moving at a range of velocities. Comparison with models in ANSYS finite element software will be used to design optimum dampers. The pendulum will be sensed with a commercial vibrometer which measures velocity and monitored with Labview.

Project 27

Group IGR

Project name Gravitational waves from binary black hole mergers

Supervisor Ik Siong Heng

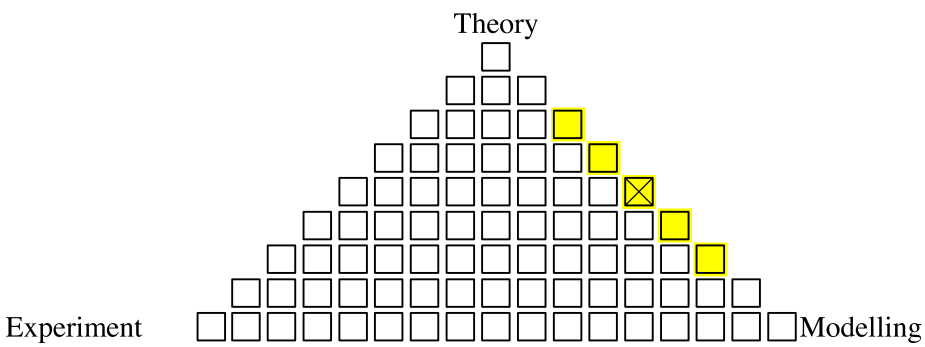
Backup Supervisor Matthew Pitkin

Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The detection of gravitational waves will allow us to observe phenomenon not accessible through current astronomical observations. For example, will allow us to directly probe a black hole and shed light on the internal structure of neutron stars. It is also possible to use gravitational waves to test Albert Einstein's General Theory of Relativity. There are alternative treatments of gravity that can have visible effects on the expected gravitational wave signal.

In this computational project, we will test different analysis techniques and characterise their performance for binary black hole merger different waveforms. The results of these tests are potentially interesting to the international gravitational wave community and lead to a publication. This project will build on Matlab skills acquired in earlier years. Depending on how the project progresses, familiarity with the linux environment and knowledge of python and shell scripting will also be helpful.

Project 28

Group IGR

Project name Classifying graviational wave transients

Supervisor Ik Siong Heng

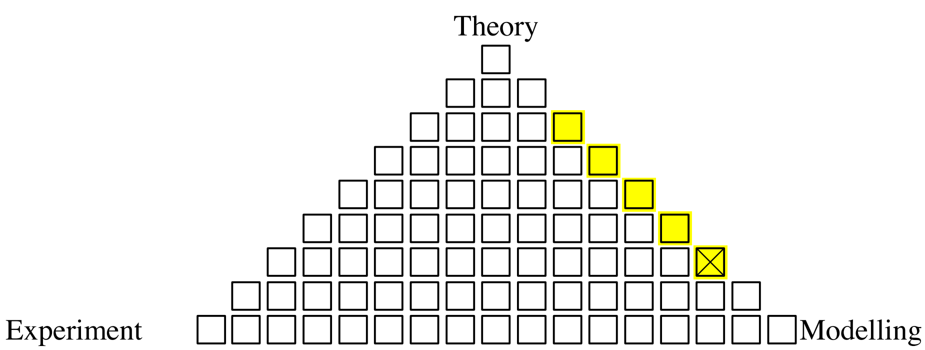
Backup Supervisor Jade Powell

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Data from gravitational wave detectors often suffer from periods of spurious transient noise. Such noise sources can have distinct features depending on their origin.

In this computational project, we study the properties of these noise transients and classify them using Bayesian model selection. Such an approach can lead to insight to on the behaviour of the detector and shed light on the physical processes involved. This project will use developed algorithms, run on computing clusters, and require familiarity with the linux environment as well as knowledge of python and shell scripting.

Project 29

Group IGR

Project name Exploring the gravitaitonal wave sky

Supervisor Ik Siong Heng

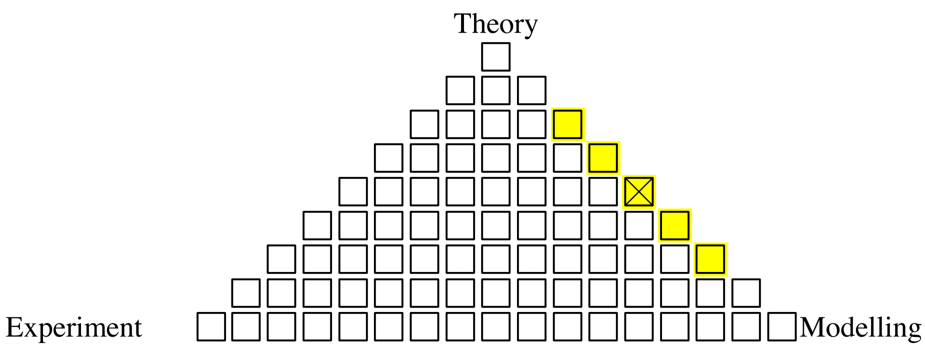
Backup Supervisor Martin Hendry

Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The estimation of the signal sky location is a vital component for multimessenger astronomy with gravitational waves. For example, observing a gamma ray burst occur in the same sky location as a gravitational wave source will provide strong evidence that gamma ray bursts are driven by the merger of two neutron stars or a neutron star and a black hole.

In this computational project, we will use a novel statistical technique (mixed MCMC) developed by the IGR to estimate the sky location of gravitational wave sources, characterising the performance of mixed MCMC using a standard catalogue of simulated sources. This project will build on existing Matlab code. Therefore, competence with Matlab is essential.

Project 30

Group IGR

Project name Measuring the optical absorption of silicon wafers and getting rid of that pesky noise

Supervisor Angus Bell

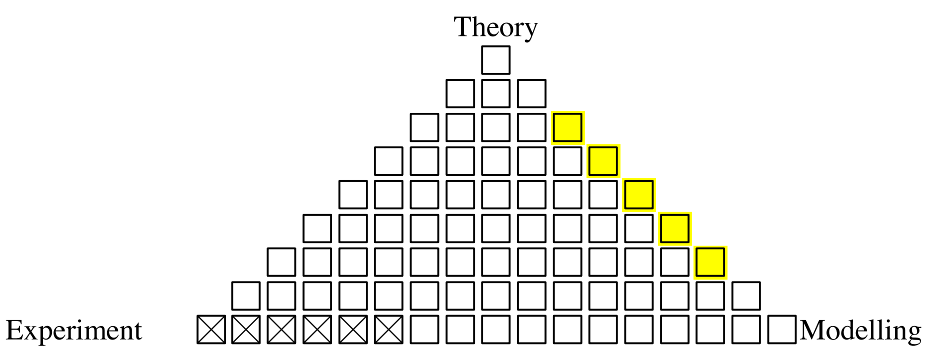
Backup Supervisor Iain Martin

Suitability 20 credit yes 30 credit yes 40 credit no 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

We have a system that we use to measure low levels of optical absorption in silicon. The system relies on the fact that a small thermal lens is created in a material when it absorbs light and that will cause a reference laser beam to be deflected. Unfortunately, the reference laser is also deflected by air currents in the room, which gives false signals or noise. This project will allow the student to make measurements on several different types of sample as well as characterising the noise in the measuring machine and designing shielding to minimise noise from air currents. For students who enjoy computer modelling there may be scope to work on the modelling of the response of the samples to temperature and provide theoretical ouputs of the signal as a function of temperature.
This project is only available in the first semester.

Project 31

Group IGR

Project name Labview control of an instrument for optical absorption

Supervisor Angus Bell

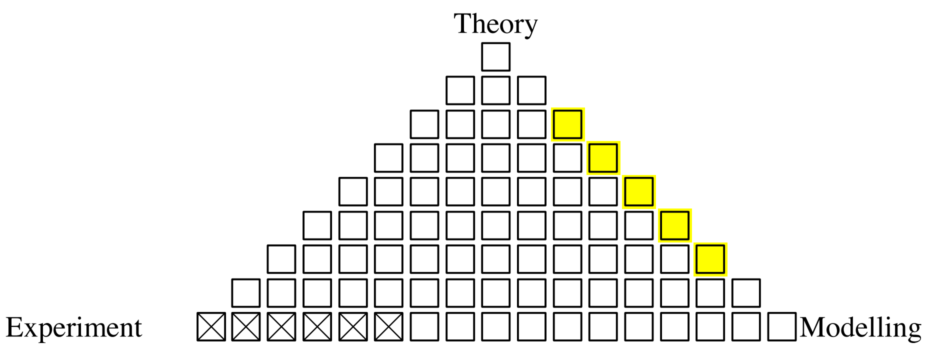
Backup Supervisor Iain Martin

Suitability 20 credit yes 30 credit yes 40 credit no 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

In the IGR we do a lot of measurements of the optical absorption of materials. Much of this is automated using various individual Python scripts. Each script runs a single type of measurement, such as looking at the signal from the sample as a function of time, or as a function of power. This project will allow a student to create a single Labview program that will pull together the functionality of the different Python scripts into a single program. The individual scripts control various different lab instruments and allow the reading in of data over various serial interfaces. The student will use their program to measure the absorption of various different samples and obtain real data.
This project is only available in the 2nd semester.

Project 32

Group IGR

Project name Demonstrating and characterising the intensity noise of a stable laser and helping to reduce that noise

Supervisor Angus Bell

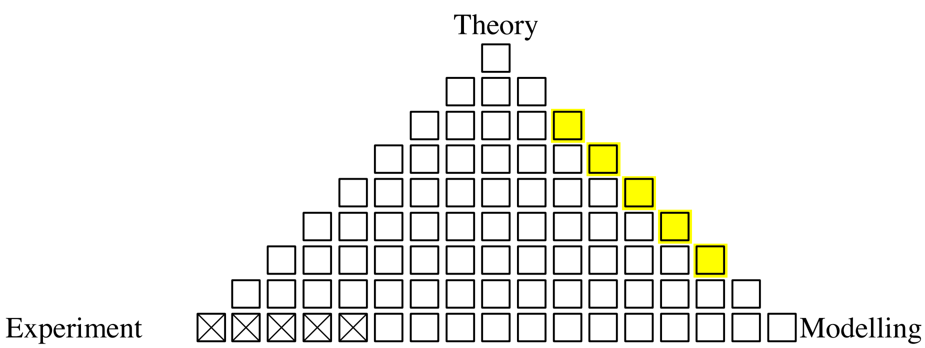
Backup Supervisor Ken Strain

Suitability 20 credit yes 30 credit yes 40 credit no 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The IGR is about to put together a laser system with very low intensity and frequency noise. This will be the workhorse laser for our interferometry reseach towards future gravitational wave detectors. This project will allow a student to work with other members of the IGR on putting together the parts required for an intensity feedback servo for that system. The student will help put together the optical components required to sample some of the light from a fibre coupled laser and direct it to a detector. They will also put together appropriate electronic components to amplify the signal from the detector and then use that signal as the input to a servo system to reduce the intensity noise.
This project is only available in the first semester.

Project 33

Group IGR

Project name Characterising and frequency stabilising a 1550 nm laser, and testing and characterising a feedback servo-control loop.

Supervisor Angus Bell

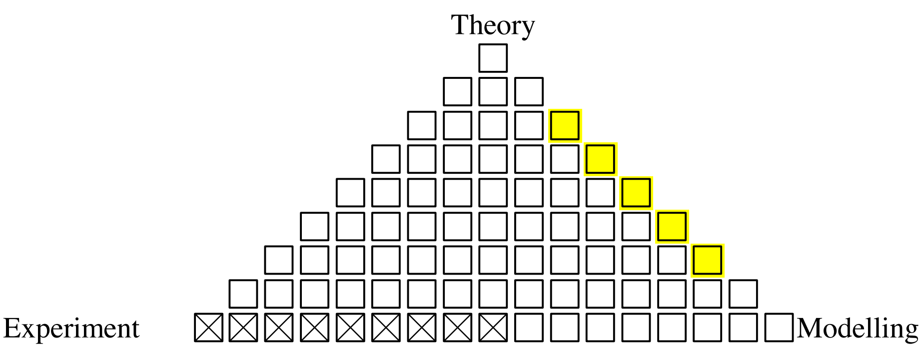
Backup Supervisor Ken Strain

Suitability 20 credit yes 30 credit yes 40 credit no 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The IGR is about to put together a laser system with very low intensity and frequency noise. This will be the workhorse laser for our interferometry reseach towards future gravitational wave detectors. In this project the student will work with other members of the IGR to build an optical system that directs some light from a fibre coupled laser to a suitable frequency reference, such as a silicon etalon. They will then look into obtaining an error signal from this by using a frequency modulator provided, and then optimise the electronic feedback servo to provide the best frequency lock of the laser to the reference. The project can also be extended to look at other frequency references, such as high finesse Fabry-Perot cavities and could include the modelling of the response of these cavities

This project is only available in the 2nd semester.

Project 34

Group Institute for Gravitational Research

Project name Characterisation of thin film coated cantilevers

Supervisor Dr. Peter Murray

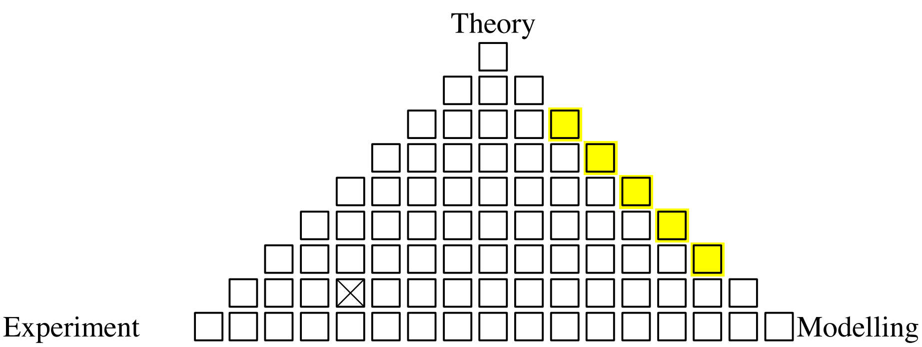
Backup Supervisor Dr. Iain Martin

Suitability 20 credit yes 30 credit yes 40 credit no 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks.



Project description (length should not exceed remainder of page)

Thermal noise associated with the highly reflective mirror coatings are expected to set a limit, at the most sensitive frequency range, of the advanced Gravitational Wave Detectors currently under construction. In order to further develop coatings a series of mechanical and optical requirements have been set, and complicating things, many of the properties of materials being considered are not fully characterised.

This project will focus on the study of different thin film coatings applied to both silicon and fused silica subsrates and students will be able to gain exerience in experimental measurements using a variety of techniques, for example; energy dispersive x-ray flourecense spectroscopy, or EDXRF (a non-destructive analytical technique used in the elemental analysis of samples), drop shape anaylsis (the concact angle between a liquid drop and a sample surface can be used to calculate the "surface free energy"), as well as ellipsometry, atomic force microscopy and profiling machines to measure the thickness, composition and to study the surfaces of these thin film coatings.

Project 35

Group IGR

Project name Gravitational wave audiation : Simulating the cosmic symphony

Supervisor Chris Messenger

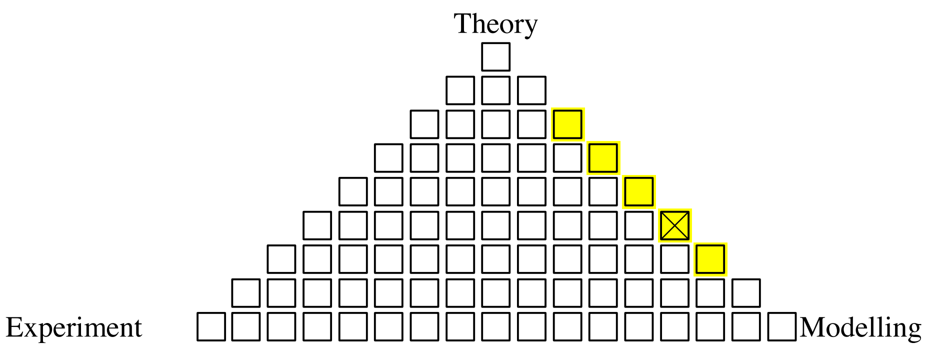
Backup Supervisor Morag Casey

Suitability 20 credit no 30 credit no 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Gravitational waves (GWs) are often said to be analogous to sound waves and the reasons are mainly 2-fold. Ground-based GW detectors are sensitive in a frequency range that strongly overlaps with that of the human ear and GW detectors are, in general, sensitive to nearly all spatial directions. This project will aim to design and write the software required to simulate, in audible sound, the superposition of populations of the main GW sources in the universe. This is to be used as part of a science-outreach tool for the promotion of GWs to the general public whereby the participant is played the audio simulation of the GW universe in order to mimic what GW detectors are trying to "hear". Of key importance will be the use of stereo sound effects (phase and time delays) in simulating GW source directionality. The student will take on the second phase of this project and aim to develop the interactive software tools needed to make this a widely used outreach resource.

Project 36

Group IGR

Project name Studying the dynamics of optical springs

Supervisor Bryan Barr

Backup Supervisor Ken Strain

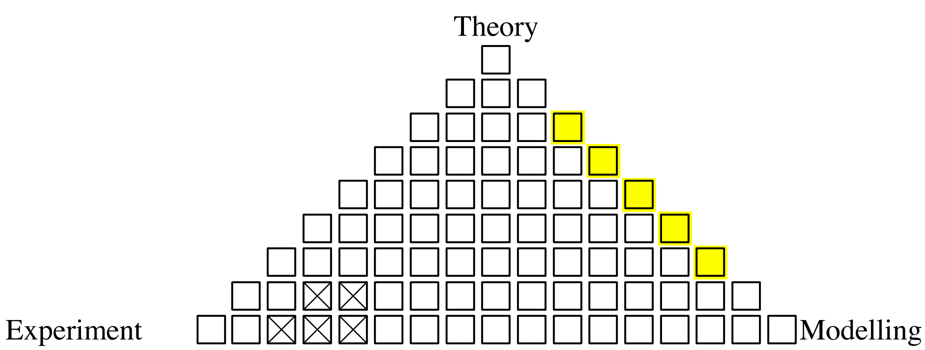
Suitability 20 credit no 30 credit no 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance

Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks.



Project description (length should not exceed remainder of page)

Gravitational wave detectors require sensitive displacement measurements based on laser interferometry. Current and future interferometers employ such high light power (~1MW) that the radiation pressure, acting on the freely-suspended mirrors of the interferometer, produces an effect called "optical rigidity" where the first-order dynamical effect is that of a spring, that can be as stiff as diamond (but made of light).

PhD student Neil Gordon has designed a test system that provides for several optical springs to be formed in a resonant cavity system and we are in a position to characterise the interactions.

In this project the student will work with Neil and the rest of the team in the Glasgow 10m interferometer lab*, to learn the relevant technques for characterisation and measurements, and some associated modelling. The project is flexible in nature, but requires some investment in learning new physics and experimental technques, so is only offered at 40 credits. This is an excellent research opportunity and may lead to publishable work.

* A substantial part of the work will be carried out in this lab, which is a clean-room. It is necessary to wear clean-room clothes and laser safety training will be required. Speak with Neil or the supervisors if you are in doubt about this, or to see the lab and working conditions before deciding. This project is only available for one student.

Project 37

Group IGR

Project name Observing transients with the Large Synoptic Survey Telescope

Supervisor Ik Siong Heng

Backup Supervisor Martin Hendry

Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
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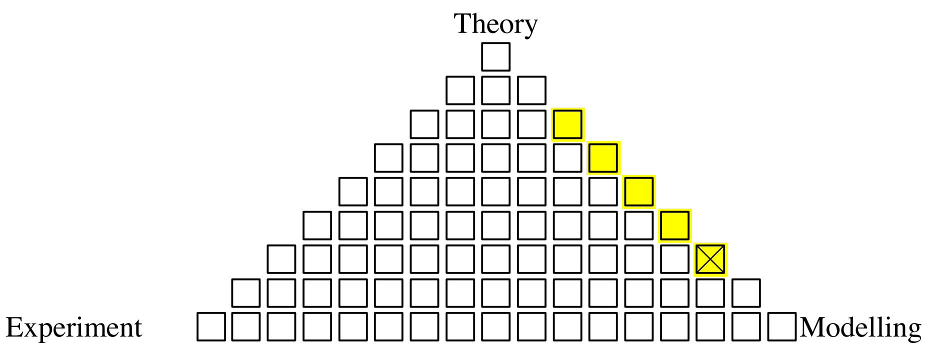

Project description (length should not exceed remainder of page)

The Large Synoptic Survey Telescope (LSST) will produce an unprecedented wide-field astronomical survey of our universe using an 8.4-metre ground-based telescope. The LSST, with its repeated, wide-area coverage of the night sky will enable the discovery and analysis of a wide range of astrophysical transients such as gamma ray bursts, X-ray flashes and supernovae.

In this computational project, we will use light curves for transients associated with gravitational wave sources to model their observed variability as the LSST surveys the sky. The aim is to characterise how well the LSST can observe optical transients in its nominal survey mode and determine how well it can observe optical counterparts to gravitational wave signals and distinguish them from other transient phenomena.

Project 38

Group IGR

Project name:Exploring the possibilities of imaging and laser beam position stabilisation with the Raspberry Pi Camera

Supervisor Dr. Borja Sorazu, Dr. Alan Cumming

Backup Supervisor Prof. Ken Strain, Dr Giles Hammond

Suitability 20 credit yes 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance

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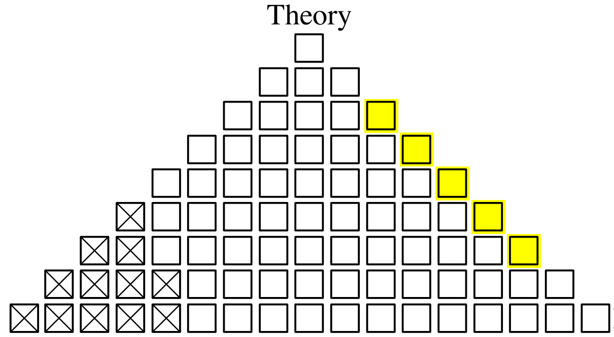

Project description (length should not exceed remainder of page)

The Raspberry Pi (Pi) is a low cost credit-card sized computer with processing power, portability, programming capabilities etc. that make it a contender for applications previously reserved only to microcontrollers. The IGR is developing Pis for cost effective sensing and control applications. We offer related projects for students to exploit the potential of the high resolution Pi camera module. The camera is sensitive to IR, and has a native 5 megapixel resolution, capable of 2592 x 1944 pixel static images and supports high definition video at frame rates of up to 90 frames per second, opening up many potential uses in low cost control systems, possibly using multiple Pi camera systems.

IGR's interest forms two project strands (for either a pair of 20/30 credit students, or a single 40 credit student):
1) A sizable online community has already explored possibilities for use of the camera module for various imaging applications and we would like to further tap into this. The student will be able to work on the implementation of a temperature/brightness monitor of laser heating of fused silica as part of our state of the art fused silica fibre pulling machine, which is used to fabricate the silica fibres that will suspend the very high quality mirrors of the next generation of ground based gravitational wave detectors. Another aspect that may be explored is applying the Raspberry Pi for dimensional characterisation of the resulting silica suspension fibres.
2) The Raspberry Pi camera sensor is sensitive to the infrared laser light (1064 nm) used in our interferometer experimental facilities. We plan to develop a system for monitoring the position of a laser beam, and therefore allowing the beam position to be stabilised. A digital servo system would be developed to control the beam using an actuator consisting of loudspeaker drives acting on springs that are connected to steering mirrors.

Students will investigate these areas of imaging with the Pi-Camera, looking to explore its capabilities, extend its use by interacting with the Pi-community and writing new code to exploit the full potential of the hardware.
In all projects the student should have interests in the areas of programing (The Pis are Linux based, and use Python, C++. Integration with LabView may also be required), circuits, systems and control (the Circuits and Systems course is useful, but not essential).

Project 39

Group IGR

Project name Acoustic coupling in sensitive interferometric measurements

Supervisor Borja Sorazu

Backup Supervisor Ken Strain

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance

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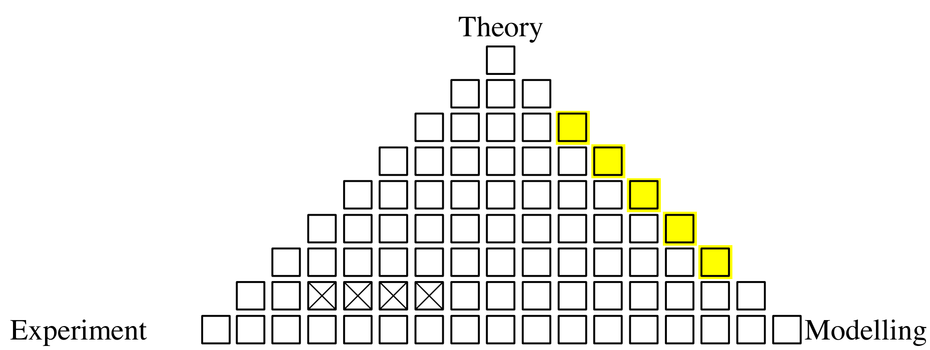


Project description (length should not exceed remainder of page)

Gravitational wave detectors use interferometry for sensitive displacement measurements. Sound can affect the measurement in various ways that are difficult to characterise since sounds with ~1m wavelengths bounce around in the lab, creating multi-path interference effects.

In this project the student will

a) learn the relevant measurement techniques
b) carry out measurements on a model system consisting of loudspeakers and microphones and apply similar techniques to those used for digital room correction.
c) measure how an optical mount vibrates in reaction to sound
d*) investigate the coupling of sound to a beam of laser light in air
e*) investigate the coupling of sound to the walls of a 1m vacuum tank
* - these more advanced topics apply in the case of longer projects and/or would provide parallel strands for a pair of students working on the same project. At 20 credits, the project can be carried out in S1 or S2.

Measurements will be carried out using an state of the art data collection and digital signal processing system. The student should have interests in the areas of circuits, systems, signals and information.

Project 40

Group Institute for Gravitational Research

Project name Measuring the speed of light: citizen science for the International Year of Light

Supervisor Dr. Giles Hammond

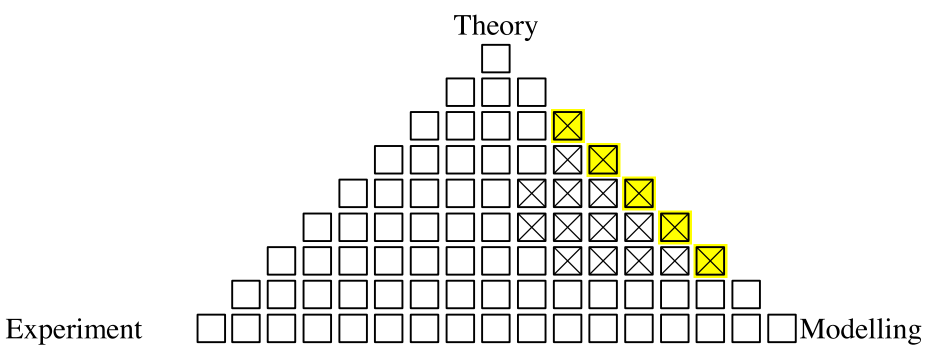
Backup Supervisor Prof. Martin Hendry

Suitability 20 credit yes 30 credit yes 40 credit no

Suitable for "theoretical physics" no

Off-campus work required? yes

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

2015 is the International Year of Light and to celebrate we are proposing a recreation of the classic Roemer delay experiment. Ole Roemer (1676) noted a perioidic variation in the eclipses of Io and in a brilliant piece of deduction argued this was due to the changing distance between Earth and Jupiter. He thus was the first to make an estimate of the speed of light.
The project will focus on laying thegroundwork for a citizen science project to be run in 2015. There will be components of modelling/theoretical work where the Roemer delay will be calculated from the ephemeris of the earth-sun-jupiter system. There will be the opportunity to write code to extract the speed of light, given observations at different longitudes, in addition to planning the optimum time for observation across different countries. Some observing of the eclipses of Io might also be possible at Acre Road to test the feasability of the project with bincolulars/small telescopes.

Project 41

Group IGR

Project name Speedmeter Interferometry to Outperform Heisenberg

Supervisor Stefan Hild

Backup Supervisor Christian Graef, Sebastian Steinlechner

Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
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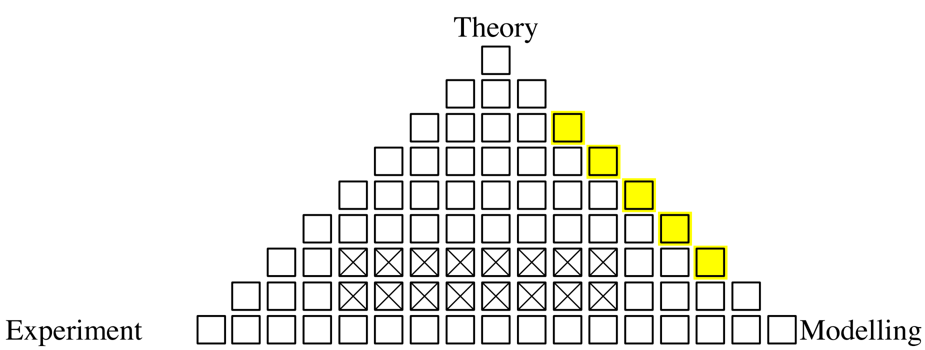


Project description (length should not exceed remainder of page)

The world's first Sagnac Speedmeter (SSM) is under construction in one of Glasgow University's IGR labs. It is theoretically capable of outperforming the Heisenberg uncertainty principle, and our proof of principle experiment seeks to establish the SSM's capabilities. This student project will focus on the continuing development of sub-systems and analysis of the SSM. A number of areas are open to investigation. There is a strong experimental focus within the SSM group, but there are also opportunities for modelling work. The project can include working with lasers, designing and building electronic circuits for processing signals or controlling systems, fiber optics for guiding and cleaning light for the interferometer, in air optics, and Matlab modelling. The project allows for the student to focus on their preferred area.

Project 42

Group IGR

Project name Analog filters revisited: improving a less than popular experiement!

Supervisor Henry Ward

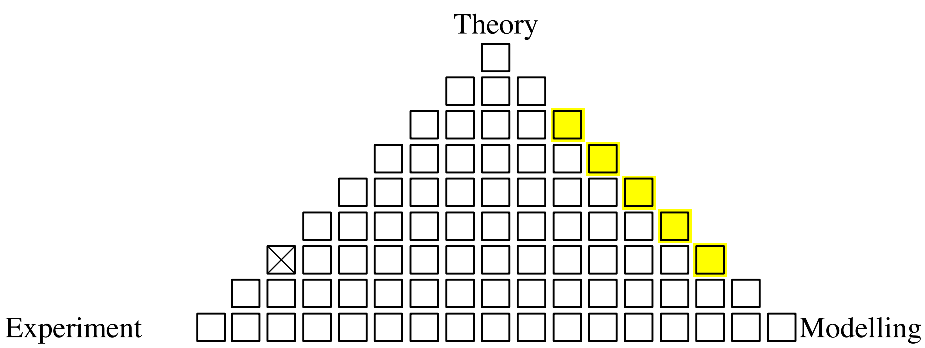
Backup Supervisor David Robertson

Suitability 20 credit yes 30 credit no 40 credit no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The Analogue Filters experiment in the Honours lab has been in its current form for rather a long time. While it complements key parts of the Circuits and Systems course, making the circuit response measurements can tend to consume a lot of time and certainly limits the range of circuit types that can be studied.
We propose to bring the experiment up-to-date, using a recently introduced computer-driven all-in-one device - the National Instruments VirtualBench. The challenge of the project is to develop (in LabView) software to do Bode and Polar plotting in essentially real-time, so that the effects of varying circuit topologies and component values can be readily investigated. The project will also develop an additional part to the experiment - the investigation of impulse responses - that will complement the Laplace transform part of the course.
The end result will be a revised experiment, and re-written experiment guide, that will be deployed from next year.

Project 43

Group IGR

Project name Visualising interference in MHz heterodyne interferometry

Supervisor Henry Ward

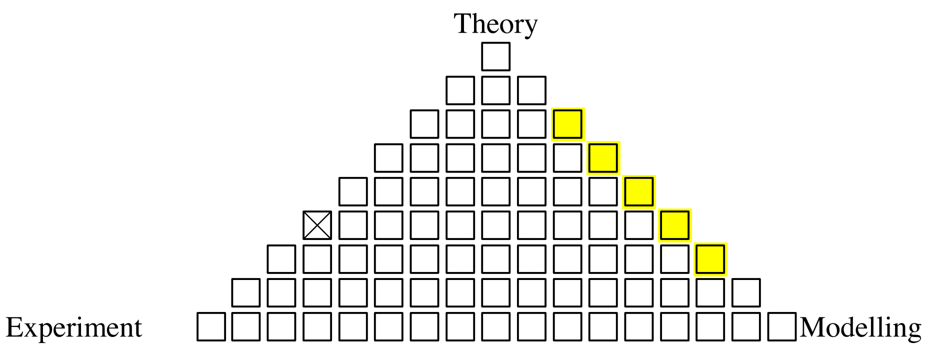
Backup Supervisor David Robertson / Christian Killow

Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Heterodyne interferometry is often used for precision measurement of very small displacements. In such an interferometer two lasers beams that are relatively offset by a small frequency shift are interfered. One beam acts as the reference; the other beam travels the additional path that is to be monitored. Path length changes then cause a corresponding phase shift of the heterodyne beat note formed at the photodiode that detects the interfering beams. Spatially sensitive measurements of the beat-note phase shift in the interference pattern carry information about relative beam alignment and about relative spatial properties. If the frequency offset is small (close to dc, for example) the interefence pattern can be inspected by eye and recorded using a simple camera. Very sophisticated high-speed cameras can be used if the heterodyne frequency is in the kHz region. But for large frequency offsets, well into the MHz region, direct visualisation becomes impossible. This project will explore - and demonstrate - a possible experimental approach that will solve this problem.

Project 44

Group IGR

Project name Cosmic calibration of gravitational wave detectors

Supervisor Dr Ik Siong Heng

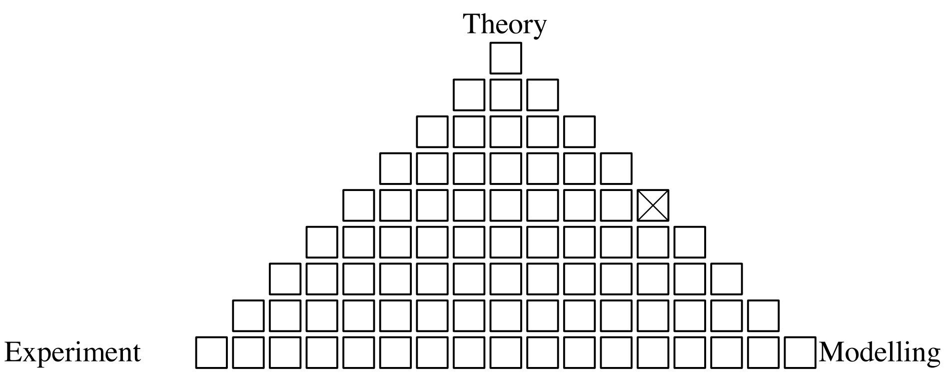
Backup Supervisor Dr Matthew Pitkin & Dr Chris Messenger

Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Calibrating gravitational wave detectors currently must be performed by direct manipulation of the detectors. However, there may exist inspiralling compact binary sources for which enough is known about them that they can be used as external detector calibrators. This project involves simulating detector data containing compact binary signals as using Bayesian parameter estimation methods to estimate how well the calibration can be recovered. This can expand to involve the use of multiple detectors and multiple signals.

Project 45

Group MCMP

Project name Magnetic domain walls in nanowires with interfacial exchange interaction

Supervisor Stephen McVitie

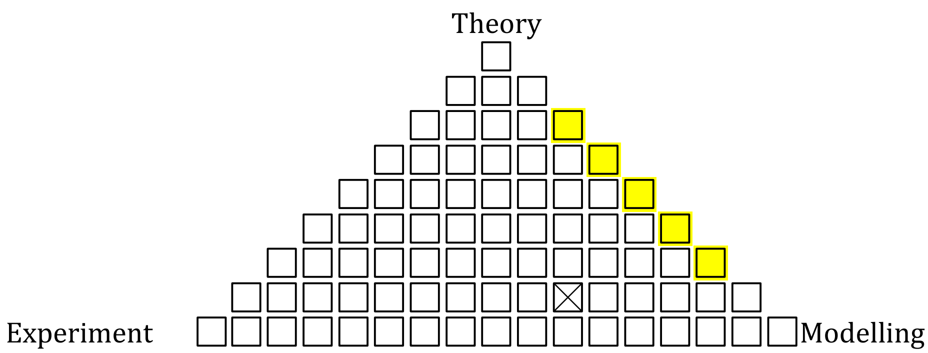
Backup Supervisor Donald MacLaren

Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Domain wall behaviour in single layer thin film nanowires has been the subject of intense research over the last decade. Many different systems have been investigated and in this project we are interested in materials where the magnetic film thickness is of the order of a few nanometres and an extra energy contributes to the system via an interfacial exchange interaction known as Dzyaloshinskii–Moriya interaction.
Of particular interest here is how the domain wall phase diagram is modified in the presence of this interaction. The project will involve modelling the domain wall structures with and without the DM interaction using micromagnetic software. Furthermore materials will be prepared using a pulsed laser deposition system and investigated using magnetic imaging in the electron microscope.

Project 46

Group MCMP

Project name Investigating spin ice arrays and magnetic monopole behaviour

Supervisor Stephen McVitie

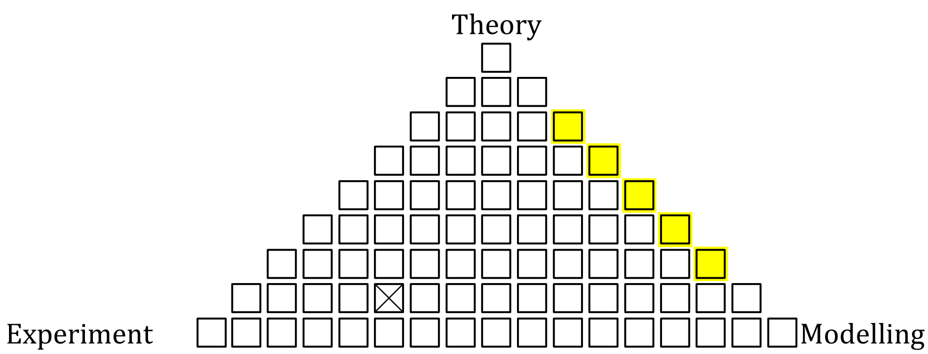
Backup Supervisor Bob Stamps

Suitability 20 credit yes 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Water ice has interesting configurational properties due to bond frustration resulting in a residual entropy in the system. Analogous systems can be realised in magnetic structures where the spin magnetic moment replaces the bond and such systems are termed artificial spin ice structures. These are arrays of nanostructred magnetic islands where the behaviour of the frustrated spin structure is of considerable interest. At the nodes of the array there can exist a net magnetic charge and these are often referred to being analgous to magnetic monopoles. One exciting possibility may be the visualisation of "wandering" magnetic monopoles. In this project we will be studying spin ice arrays using magnetic imaging in the transmission electron microscope. Understanding the acquired data and subsequent digital processing of the images will be the main part of the project with a view to characterising the behaviour of the spon ice arrays. Additionally micromagnetic modelling of arrays will also be perfomed to assist with the imaging processing procedures.

Project 47

Group MCMP

Project name Pulsed Laser Deposition of Functional Oxide Thin Films

Supervisor D MacLaren

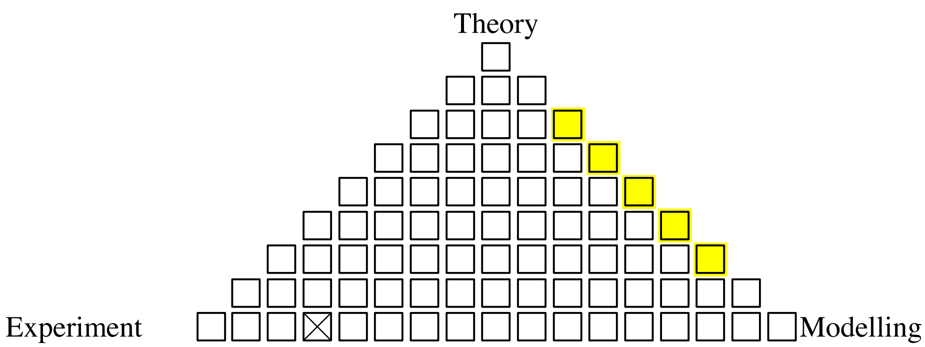
Backup Supervisor S McVitie

Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The pulsed laser deposition technique is ideal for depositing the complex materials now being proposed as being essential to the next generation of microelectronics. It uses an intense UV laser to ablate targets in a vacuum chamber and produce a plasma plume of energetic species that coat a nearby sample. However, even atomic-scale defects, strain and impurities can impair material performance and the optimal fabrication conditions are simply unknown in most cases. This project will assist in the commissioning of the new deposition system and will characterise the nanometric structure of multi-component oxide materials for technological applications. A combination of atomic force microscopy and transmission electron microscopy will be used to characterise the samples and the goal of the project is to determine the optimal deposition conditions - laser power and pulse repetition; sample temperature; gas pressure; etc. - for the subsequent fabrication of thin film devices. The project will suit highly motivated students with an interest in hands-on practical work and materials physics/chemistry.

Project 48

Group MCMP

Project name Characterising atomic-scale strain in ferromagnetic thin films

Supervisor Dr. K. O'Shea

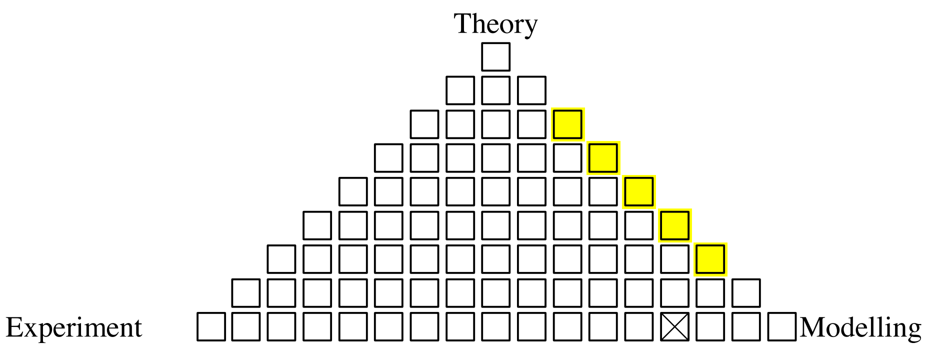
Backup Supervisor Dr. D. MacLaren

Suitability 20 credit yes 30 credit no 40 credit no

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Next generation electronic devices are based on the layering of very thin films of single crystal material to generate enhanced functionality. The layers of material involved must be closely matched in terms of their lattice dimensions in order to achieve high quality film growth. However, small differences are inevitable, which can lead to strain effects, crystal distortions, and ultimately, undesirable magnetic and electronic properties.

This project is aimed at characterising the strain induced within thin crystalline films caused by a lattice mismatched substrate, using electron microscopy. The majority of the project work will involve analysing atomic resolution images of the crystal structure and calculating shifts in atomic positions as the result of strain. Chemical analysis by electron energy loss spectroscopy may also be involved and there will be opportunities for hands-on electron microscopy work. The materials involved are technologically relevant and will give students an insight into current nanotechnology research.

Project 49

Group MCMP

Project name Modelling ferromagnetic oxide nanostructures

Supervisor Dr. K. O'Shea

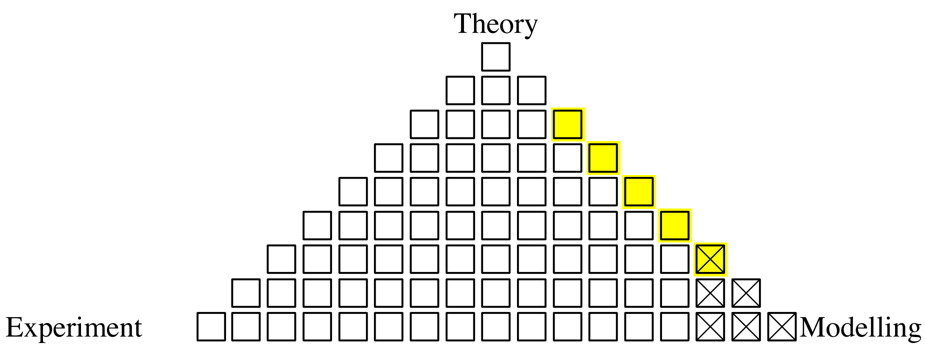
Backup Supervisor Dr. D. MacLaren

Suitability 20 credit yes 30 credit yes 40 credit yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The amount of data generated globally is said to be doubling every year, which leaves us with a burning question of how we will cope with future demands for data storage. One solution may lie in transition metal oxides due to their vast array of useful magnetic and electronic properties. However their complex chemistry has made the realisation of devices highly challenging, and a full understanding of multifunctional oxide systems is still lacking.

This project will focus on the micromagnetic simulation of ferromagnetic oxide nanostructures using existing software. This work will support experimental research into such materials using electron microscopy and there may be opportunities for hands-on experimental work. The materials involved are technologically relevant and will provide students with an insight into current nanotechnology research.

Project 50

Group MCMP

Project name Simulating the Electron Spectroscopy of Nanoscale Metamaterials

Supervisor Dr. Donald MacLaren

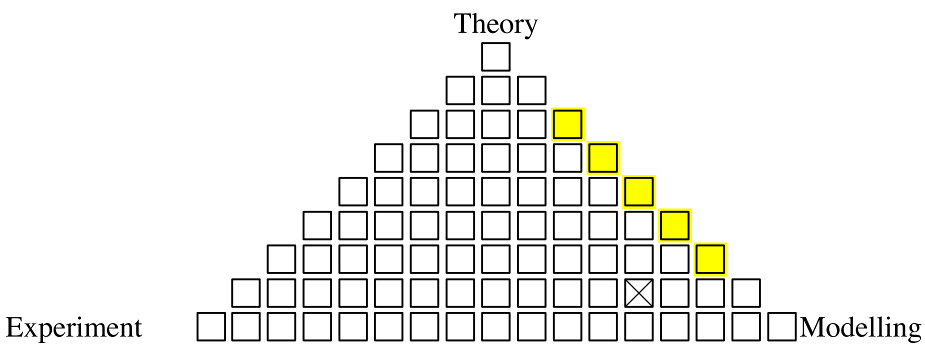
Backup Supervisor Dr. Gary Paterson

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Metamaterials are patterned nanomaterials that have potential applications in areas including optoelectronics, sensing, biomedicine, communications and even Harry Potter-style invisibility cloaks. They can be investigated at high spatial and energy resolution using electron energy loss sprectroscopy (EELS), a technique based on electron microscopy. In EELS measurements, the energy lost by a high energy electron passing through a sample is measured as a function of energy. The energy loss can be related to the dielectric properties of the sample which, in a metamaterial, is dependent on the precise size, shape and dielectric environment of the structure.
This project will consist of simulating the EELS data of different metamaterials and comparing the results with experimental results collected using a state-of-the-art electron microscope. The simulation software is written in Matlab and the analysis software is written in mostly in Python. Knoweledge of these languages is of great benefit and a willingness to do programming is essential.

Project 51

Group MCMP

Project name Correlating the degree and length scale of cation ordering in a thin film ferromagnetic insulator with its magnetic ordering

Supervisor Ian MacLaren

Backup Supervisor Damien McGrouther

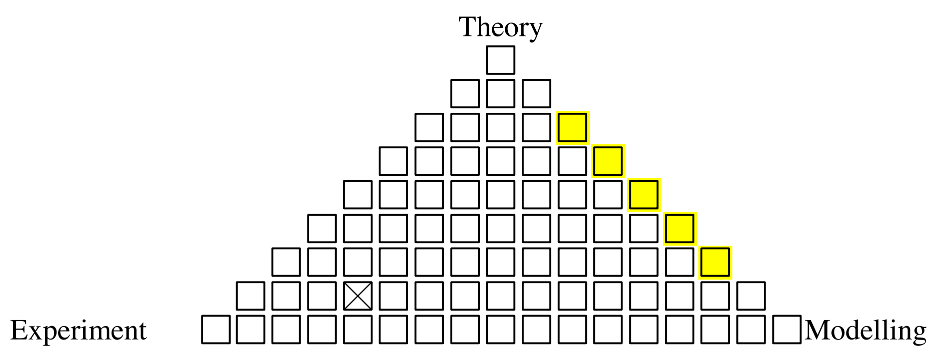
Suitability 20 credit yes 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? yes

Project balance

Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Perovskites are a particularly flexible class of oxides with the formula ABO3. Typically, magnetic ions placed on the B-site in the structure order so that the magnetic moment is antiparallel to that on all neighbouring B-sites, so that the material is antiferromagnetic at room temperature. In some perovskites, however, it is possible to mix two different ions on the B-site, and if these have different magnetic moments, and they order appropriately, then a residual magnetic moment will be left at room temperature (i.e. a ferrimagnetic ordering). La2MnCoO6 is one such material, and it appears that the magnetic ordering is enhanced by growth as a thin film under appropriate conditions.

You will work on acquiring atomically resolved images and electron energy loss spectrum images from films grown on two different substrates. You will process the data to determine quantitatively the degree of ordering and its length-scale. You will perform Lorentz imaging of the magnetic domain structure and correlate this to the ordering.

Project 52

Group MCMP/IGR

Project name Quantification of nanoscale compositional fluctuations in dielectric multilayer mirrors

Supervisor Ian MacLaren

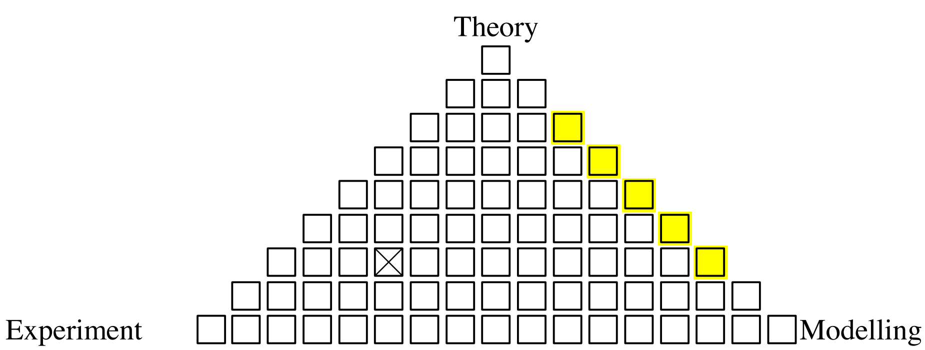
Backup Supervisor Iain Martin

Suitability 20 credit yes 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Multilayer dielectric mirrors are essential to high precision interferometry. This is key to the development of the next generation of gravitational wave detectors beyond advanced LIGO for even higher sensitivity. Thus, continued improvement of the coatings for the mirrors is one key area of research for gravitational wave researchers.
In this project, you will work with electron energy loss spectroscopy using the spectrum imaging technique to record spectra at ~ 1 nm resolution from candidate mirror coatings, you will process the resulting data to separate the real spectra from extraneous contributions. You will also record high quality spectra from standard materials of known composition in order to determine cross sections for different absorption edges in the electron energy loss spectrum. You will then use these cross sections to convert the processed spectrum images of the coatings into quantitative maps of the composition and thereby be able to visualise and quantify the nanoscale chemical fluctuations.

Project 53

Group MCMP

Project name Free magnetic charges in artificial spin systems

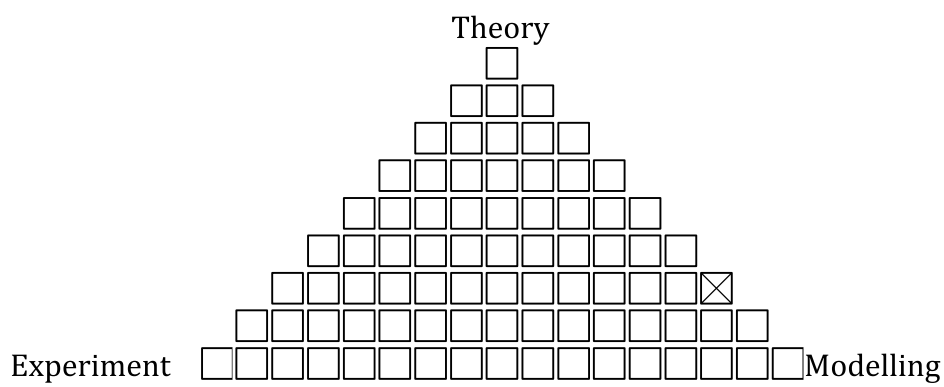
Supervisor Stamps

Backup Supervisor McVitie

Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single check. (For example, checking the highlighted box would indicate a project that includes equal components of theory and modelling with no experimental component)



Project description (length should not exceed remainder of page)

Linus Pauling noted in 1935 that there should be a residual entropy in water ice at absolute zero due to bond frustration imposed by the geometry of crystalline ice. The problem can be represented easily using arrows to describe hydrogen position within bonds. The arrows can also represent spin magnetic moments, and materials exist with crystalline structure such that geometrical frustration prevents the simultaneous minimisation of all pairwise interactions between spins. As a result, there is a residual entropy at zero temperature as in water ice, and in some geometries, a classical analogy to a magnetic monopole.

We have found that it is possible to describe some aspects of spin ice using Monte Carlo simulations. In this project, the goal will be to study how one can create a 'gas' of magnetic monopoles, and manipulate them using geometrical constraints. The student will become familiar with basic concepts for computational simulation, and gain experience using python based computational tools.

Project 54

Group MCMP

Project name Magnetic skyrmions and spin textures

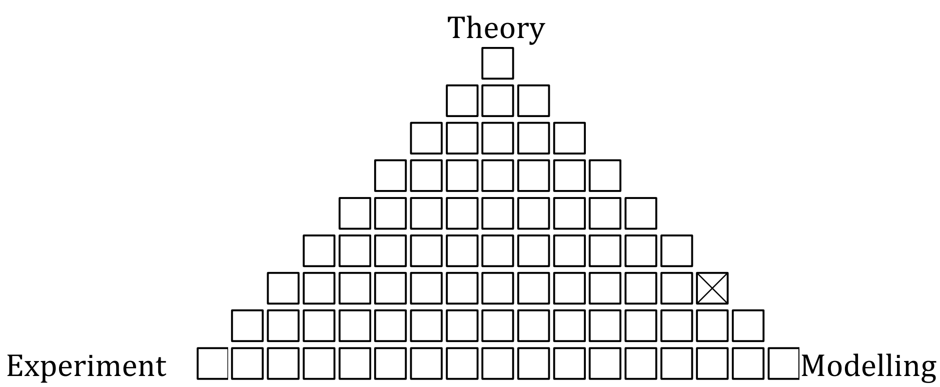
Supervisor Stamps

Backup Supervisor McVitie

Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single check. (For example, checking the highlighted box would indicate a project that includes equal components of theory and modelling with no experimental component)



Project description (length should not exceed remainder of page)

Exotic magnetic orderings are possible in certain symmetry allowed classes of crystalline solids. A particularly interesting ordering is called a skyrmion, which is a localised double twist composed of non-collinear spin magnetic moments. Most recently, it was discovered that conduction electrons in skyrme metal magnets can efficiently transfer spin angular momentum to lattices of skrmions. This phenomena is quite new, but attracting great attention due to potential applications in spin electronics.

The goal of this project is to create computer simulations of skyrmion lattice melting. You will gain experience with computer simulation of complex systems, and develop methods for manipulating and controlling skyrmion flow in nanostructures.

Project 55

Group MCMP

Project name Graphics processor acceleration for numerical modelling of spin textures in nanostructures

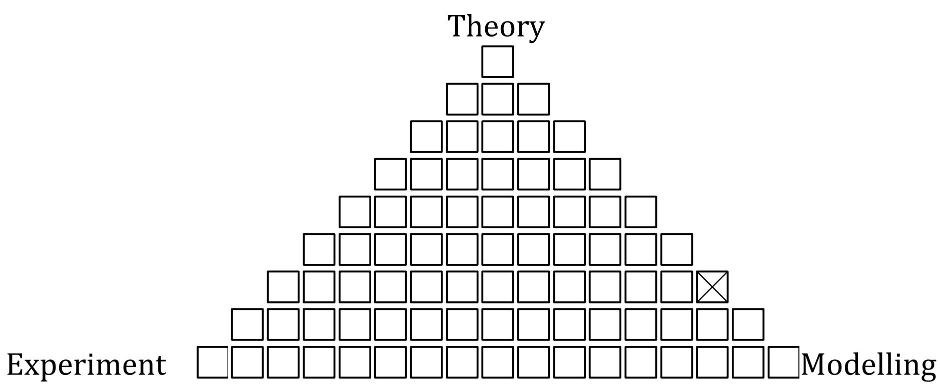
Supervisor Stamps

Backup Supervisor McVitie

Suitability 20 credit no 30 credit no 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single check. (For example, checking the highlighted box would indicate a project that includes equal components of theory and modelling with no experimental component)



Project description (length should not exceed remainder of page)

Competition between electronic interactions in magnetic nanostructures can lead to the appearance of unusual and complex magnetic configurations. In many cases, these configurations serve as models in which analogues to exotic theoretical structures can be realised and studied numerically and, sometimes, experimentally. An example is a meron, which can be characterised by its topological charge. This structure has been predicted, and observed, in sub-micron cylindrically shaped magnetic heterostructures.

In this project, you will explore a class of unusual spin textures, such as merons, using a numerical simulation technique for determining magnetic configurations in nanostructures. You will become familiar with python programming, and develop analysis and visualisation packages needed for understanding data produced from a GPU enabled finite difference simulation code.

Project 56

Group **MCMP**

Project name **Fabrication of nano-scale Plasmonic structures**

Supervisor **Dr Damien McGrouther**

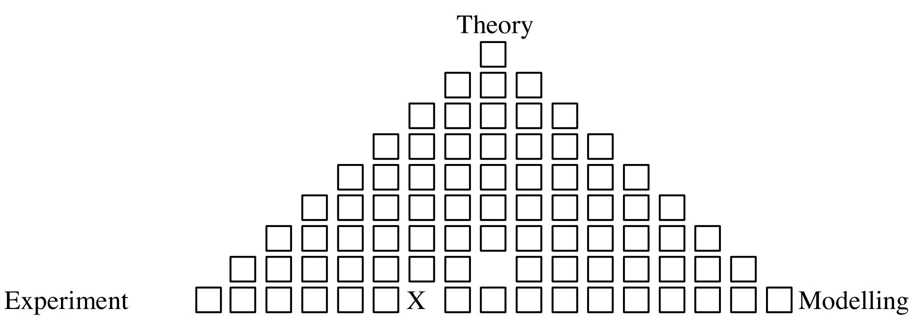
Backup Supervisor **Dr Ian MacLaren**

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Have you ever wondered why Gold or Copper have the colours that they do while most other metals have a silver reflective appearance. The answer to this lies with electronic band structure and Plasmons, quantised collective oscillations of conduction electrons. Patterning materials such as gold on sub-100 nanometre lengthscales has a huge effect on their optical appearance. For example by forming nano-particles of gold they change to having a strong red colour. Control of plasmons is currently a very active and hot research area. Aside from changing optical properties and behaviour, the electromagnetic fields of the plasmons could also be exploitable for control of charged particles.
In this project you will learn how to deposit thin films of metals and measure their thickness by atomic force microscopy. You will then design patterns for etching into the films using our Focused Ion Beam (FIB) / Scanning Electron Microscope (SEM) system. There will be a chance to check their quality in both the SEM and transmission electron microscope (TEM). Your successfully fabricated structures will then be investigated at the EPFL, Lausanne in Swizerland as part of an international research collaboration.

Project 57

Group **MCMP**

Project name **Measuring periodicity and order in magnetic systems**

Supervisor **Dr Damien McGrouther**

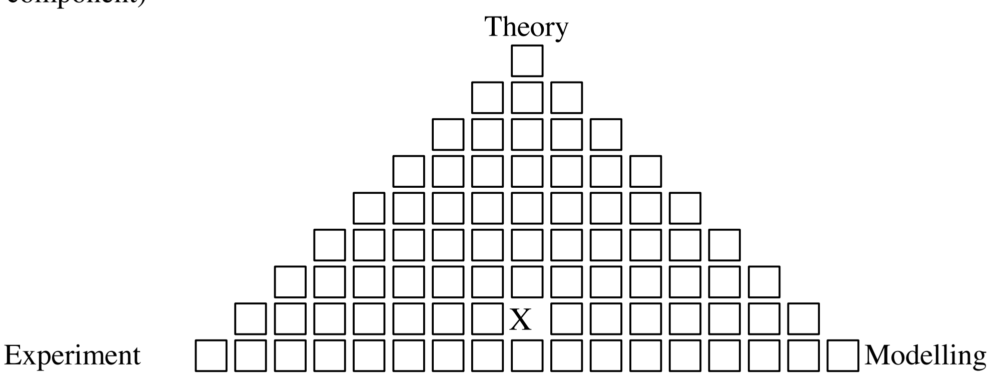
Backup Supervisor **Dr Yoshi Togawa, Dr Stephen McVitie**

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Ordering and periodicity of magnetism at length scales below 100 nm is a feature of many interesting material systems. For example, in Type II Superconductors, hexagonal close packed arrays of flux vortices form when magnetic field strengths in a certain range are applied. In chiral magnetic crystals, ordered lattices of magnetic Skyrmions can be formed. Order and periodicity can also be induced in simple magnetic films intentionally through the use of nano-patterning techniques.
The MCMP group has long specialised in imaging nanoscale magnetic structures. However, for ordered and periodic structures the development of small angle electron scattering (SAES) techniques would be a very useful tool. In this project you will perform simulations and use analytical expressions to model periodic magnetic structures. From these you will calculate the corresponding SAES diffraction patterns. In order to check your predictions, for simple magnetic films, there will be a chance to use the FIB to create nano-patterns and measure real SAES patterns using our £2.4 million Transmission Electron Microscope (TEM).
To find out more about the research and instruments of the MCMP group, please see: http://www.gla.ac.uk/schools/physics/research/groups/mcmp/

Project 58

Group Nuclear Physics

Project name Testing of the new Hamamatsu H12700 Multipixel PMT using the Laser Testing Facility (LTF)

Supervisor Dr Douglas MacGregor

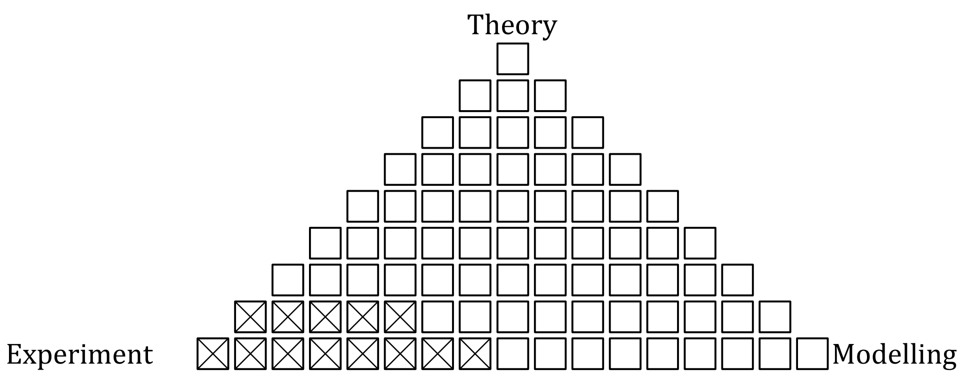
Backup Supervisor Dr. David Mahon & Dr. Seian Jebali

Suitability 20 credit yes 30 credit yes 40 credit no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The Nuclear Physics Experimental group is currently building a large scale muon detector to image the contents of nuclear waste containers
stored at Sellafield. The technology is based on Muon Tomography (MT) which uses cosmic-ray muons to create 3D images of volumes. A large number of the Hamamatsu H8500 multipixel photmulitplier tubes (PMT) will be used in the detector. However, Hamamastu is planning to stop producing these PMTs in favour of the more efficient new H12700 PMTs. A systematic study on the difference between these H12700 and the H8500 in terms of PMT gain, efficiency and dark current is vital if the new H12700 PMTs are to be used in future. The prospective student will use the Laser testing facility (LTF) to study and characterise the H12700 and compare it with the H8500.

Project 59

Group Nuclear Physics

Project name Testing of the new Hamamatsu H8500 Multipixel PMT using the Laser Testing Facility (LTF)

Supervisor Dr Douglas MacGregor

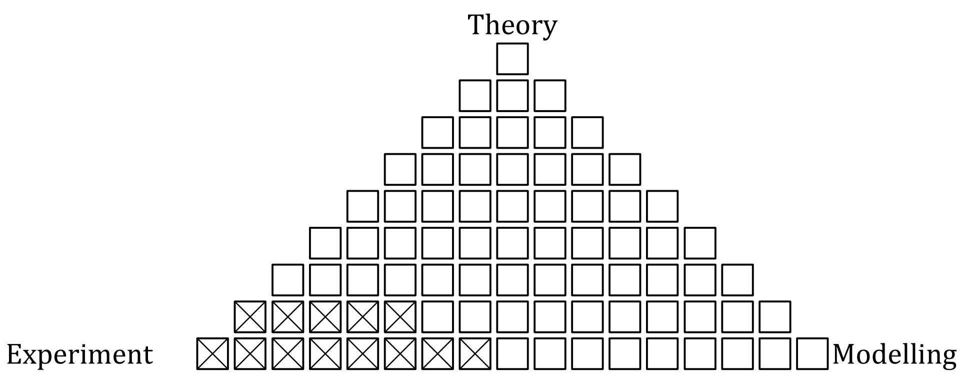
Backup Supervisor Dr. David Mahon & Dr. Seian Jebali

Suitability 20 credit yes 30 credit yes 40 credit no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The Nuclear Physics Experimental group (NPE) is currently building a large scale muon detector to image the contents of nuclear waste containers stored at Sellafield. The technology is based on Muon Tomography (MT) which uses cosmic-ray muons to create 3D images of volumes. A large number of the Hamamatsu H8500 multipixel photmulitplier tubes (PMT) will be used in the detector. These devices are of a major importance to the success of the project and therefore, a quantitative studies on the properties and the performance of each of these PMT is required. The prospective student will use the Laser testing facility (LTF) to study and characterise these new H8500 PMTs. The student will need to co-ordinate with another project student who will be testing a newer version of those PMTs, the Hamamatsu H12700.

Project 60

Group Nuclear Physics

Project name Physics and Finance

Supervisor Prof D Ireland

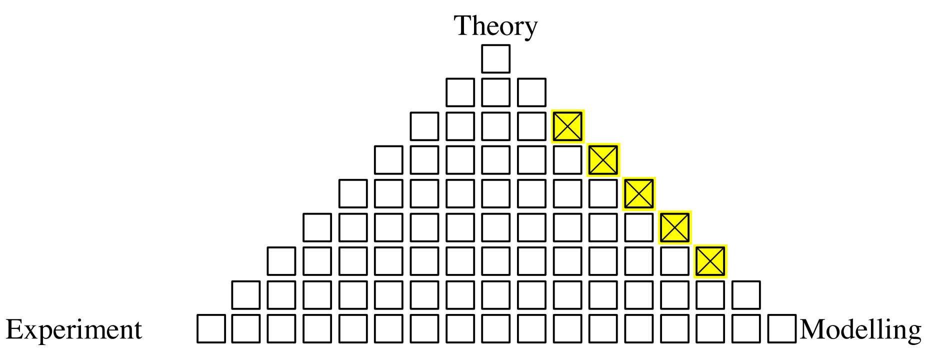
Backup Supervisor Dr B McKinnon

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The analogy between statistical physics and economics has given rise to the field of "econophysics", and seen many PhD-qualified physicists hired by financial companies. Indeed, the pioneers of quantitative economics directly imported the idea of thermodynamic equilibrium from physics to describe the balance between supply and demand. Unfortunately (as can be seen from unpredictable market crashes), this does not exactly match reality and it is highly likely that the real economy is a system that is far from equilibrium.
The project will explore how concepts in physics can be used in economics. A desirable side-effect will be a greater appreciation of statistical mechanics! In particular, it will involve developing models using "agents" that are programmed to interact with each other in fairly simple ways, to investigate whether these models exhibit any of the features of the real economy, such as the distribution of wealth. It involves mainly computational work and knowledge of, or a keen desire to learn, C++ would be helpful.

Project 61

Group NPE

Project name Modelling the scintillation light collection efficiency of a He gas scintillator

Supervisor Dr John Annand

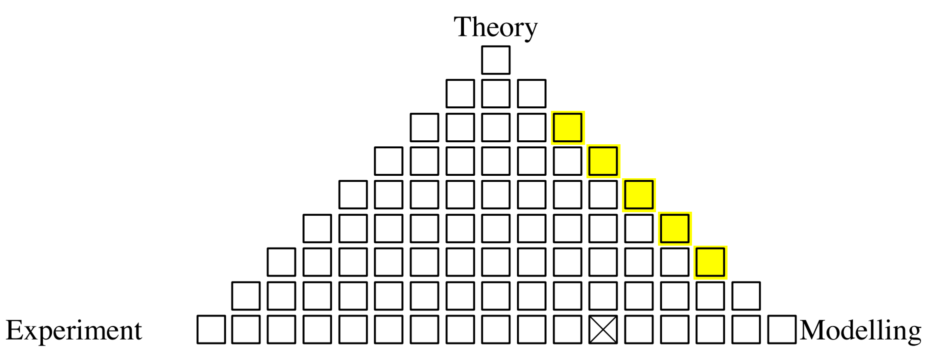
Backup Supervisor Dr David Hamilton

Suitability 20 credit yes 30 credit yes 40 credit no 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Monte Carlo simulations of scintillation light transport within the target will be made using Geant-4. The efficiency of light collection will be calculated as a function of position within the gas-scintillator cell. The effects of changing the characteristics of reflective coatings, the geometry of the cell and the size of the light collection devices (PMTs) will be investigated. Calculations will be made on a Linux based workstation.

Project 62

Group NPE

Project name Investigation of the timing performance and effective threshold levels of the NINO discriminator chip

Supervisor Dr John Annand

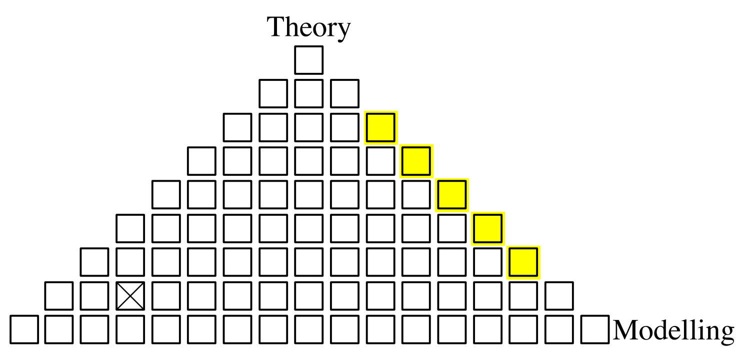
Backup Supervisor Dr Kenneth Livinstone

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Investigation of the timing performance and effective threshold levels of the NINO discriminator chip for a variety of input pulse shapes. Pulse forms from different types of particle detector: organic scintillator, scintillator with wavelength-shifting strip readout, He-gas scintillator, lucite Cherenkov and Pb-Glass Cherenkov will be fed into an amplifier discriminator card based on the NINO chip from CERN.
The timing resolution, with respect to an external trigger counter, and the effective dynamic range for discrimination will be recorded using a custom NP DAQ system. The recorded data will then be analysed on a Linux workstation using software based on the CERN ROOT system.

Project 63

Group NPE

Project name Investigation of the pulse shape and amplitude of 4He gas scintillations produced by a 5.5 MeV alpha particle source

Supervisor Dr John Annand

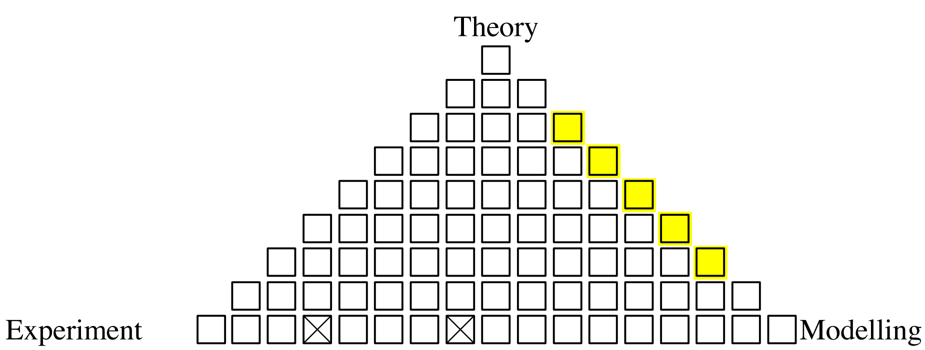
Backup Supervisor Dr David Hamilton

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Investigation of the pulse shape and amplitude of 4He gas scintillations produced by a 5.5 MeV alpha particle source. The characteristics of the signal will be recorded as a function of He pressure and of the concentration of N2 or Xe gas admixtures, which are used to shift the primary UV scintillation to the visible region. Data will be recorded both on a digital oscilloscope and on a custom NP DAQ system. The recorded data will then be analysed on a Linux workstation using software based on the CERN ROOT system.

Project 64

Group Nuclear Physics

Project name Measurement of Polarization Observables. Analysis of data from Jefferson Laboratory (www.jlab.org).

Supervisor Dr Ken Livingston

Backup Supervisor Dr Daria Sokhan

Suitability 20 credit yes 30 credit yes 40 credit yes

Suitable for "theoretical physics" yes

Project description (length should not exceed remainder of page)

Several laboratories around the world are carrying out experiments to measure the spectrum of nucleon resonances using beams of high energy polarized photons, and to solve the puzzle of "missing baryon resonances". The Nuclear Group in Glasgow play a leading role in this programme and are currently analysing data from several big experiments run at Jefferson Laboratory in the USA. We have large data sets taken in the last few years, where high energy (1 - 3 GeV), linearly polarized photon beams were fired at nucleon (proton or neutron) targets and the outgoing charged particles were measured. This project will involve a preliminary analysis of reactions where a pion and recoiling nucleon were produced. The aim is to look at secondary scattering events to measure the polarization of the recoiling nucleon.

The project will be implemented using the ROOT (root.cern.ch) software package on computers running the Linux operating system. There are 3 aspects to the project:
1. Develop an understanding of the polarization observables and the different approaches to their measurement.
2. Develop some familiarity with the Linux operating system and analysis technique.
3. Take an existing analysis and develop it to measure recoil polairzation.

The project involves data analysis and some basic programming in C++. A prior knowledge of Linux, or some programming experience would be desirable.

Project 65

Group Nuclear Physics

Project name Radiation Testing of Muon Tomography Detector Components

Supervisor Dr Douglas MacGregor

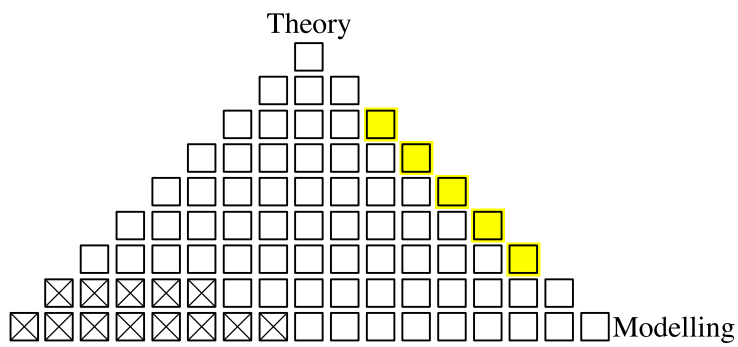
Backup Supervisor Dr. David Mahon & Dr. Seian Jebali

Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? yes

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The Nuclear Physics Group are at the forefront of research into the field of Muon Tomography (MT). We have developed a prototype system that detects cosmic-ray muons to image the contents of Sellafield's nuclear waste containers. The prospective student should investigate the effects of the anticipated radiation levels on the current detector components in preparation for the design of a future industrial system to be deployed on site. Various measurements should be taken on these components prior to, and after, irradiation at the Dalton Cumbria Facility. Studies into the annealment process will also be performed.

Project 66

Group NPE

Project name Design of a 3D portable radiometric systems

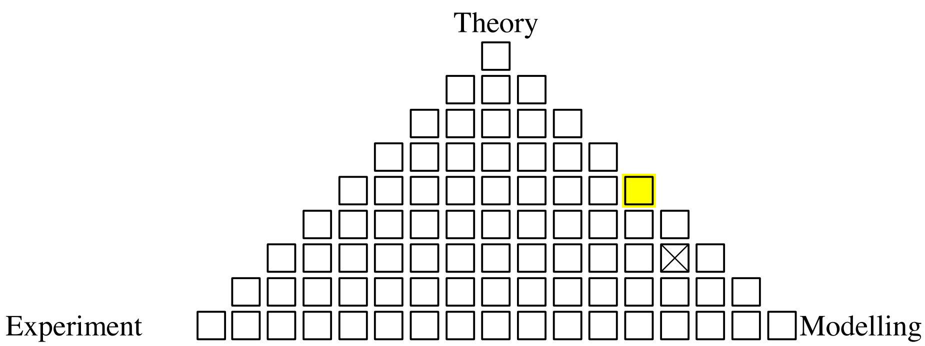
Supervisor Dr Bjoern Seitz

Backup Supervisor Dr David Hamilton

Suitability 20 credit yes 30 credit yes 40 credit no

Suitable for "theoretical physics" no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single check. (For example, checking the highlighted box would indicate a project that includes equal components of theory and modelling with no experimental component)



Project description (length should not exceed remainder of page)

Portable gamma ray spectrometers provide vital information in assessing distribution of radionuclides in the environment. They are particularly important in the aftermath of anthropogenic releases due to nuclear incidents and accidents, e.g. around Fukushima, after Chernobly or along the beaches of the Irish Sea and forests in Dumfries and Galloway. Most systems rely on the assumption of a 2D source distribution. The project aims at designing a detector system which will allow a 3D resonstruction of the radiation environment.

Project 67

Group Nuclear Physics

Project name A comprehensive model of the response of silicon Photonmultipliers

Supervisor Dr Andrew Stewart

Backup Supervisor Dr Bjoern Seitz

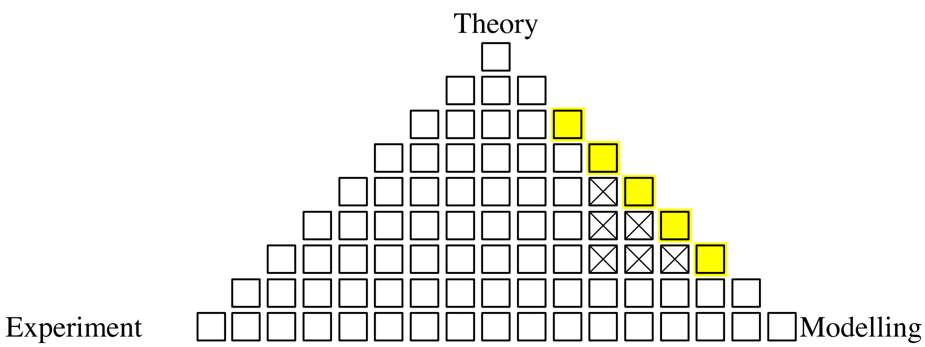
Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance

Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Silicon Photomultiplier (SiPM) have shown great promise as a suitable replacement for conventional vaccuum based PhotoMultiplierTubes (PMT). Their response is inherently nonproportional due to saturation, afterpulsing and crosstalk. Many existing models doe not account for all these effects and are not sufficiently accurate for many applications, e.g. medical imaging for low signals and with time of flight information. In this project, a mathematical model will be developed and implemented into a computer code predicting the performance of industrially available SiPM which takes their full characteristics into account.

Project 68

Group NPE

Project name Scintillation Materials for Medical Imaging Applications

Supervisor Dr Bjorn Seitz

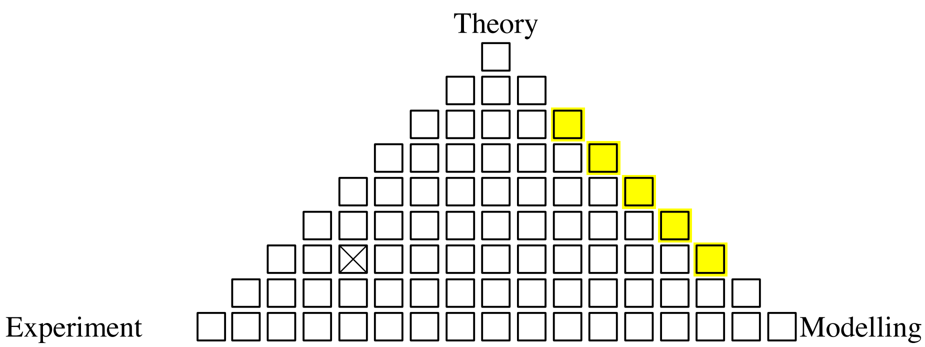
Backup Supervisor Dr Andtrew Stewart

Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Medical imaging modalities frequently rely on the precise detection of ionising radiation. For electromagnetic radiation above 200 keV energy, mostly emitted as gamma rays, dense scintillating materials are used. This project uses novel crystaline scintillation materials to be coupled to state-of-the art semi-conductor visible light photon counters to evaluate their sensitivity and energy resolution for the use in PET and SPECT imaging modalities with special empahsis on their timing properties

Project 69

Group Nuclear Physics

Project name Speedup the Muon Tomography Software Using Parallel Computing

Supervisor Prof. David Ireland

Backup Supervisor Dr. Guangliang Yang

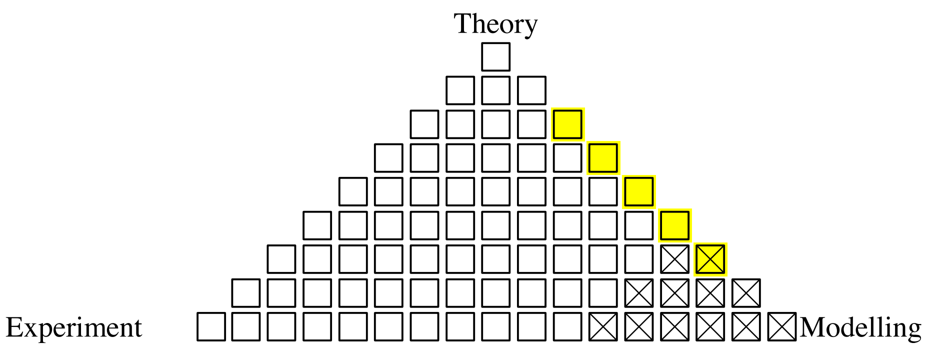
Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance

Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The Nuclear Physics Group are at the forefront of research into the field of Muon Tomography (MT). We have developed a prototype system that detects cosmic-ray muons to image the contents of Sellafield's nuclear waste containers. The necessary software for image reconstruction by using the measured data has been develped and tested. To handle the large amount of data generated by the prototype dtector, it is necessary to use parallel computing techniques to improve the performance of the curent version software.The prospective student should investigate the data transfer efficiency between the high performance computer CPUs and choose the best technoque to do the data communication. The student will have the opportunity to use HPC computers.

Project 70

Group Nuclear Physics

Project name Distributed Programming with RabbitMQ for Muon Project

Supervisor Prof. David Ireland

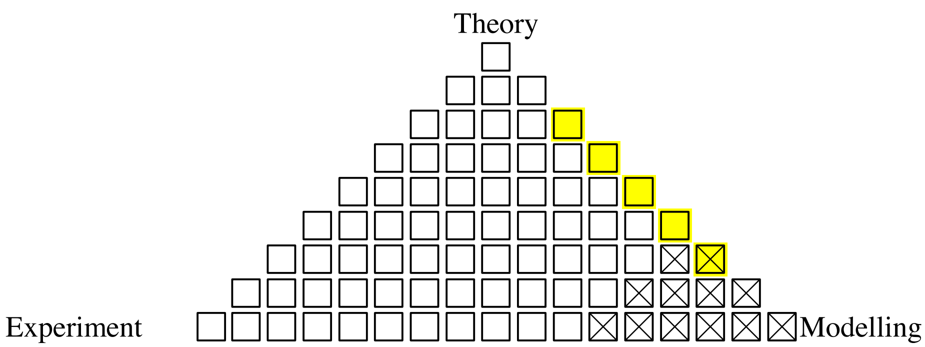
Backup Supervisor Dr. Guangliang Yang

Suitability 20 credit no   30 credit yes   40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Due to the large amount of data to be analyzed for the muon tomography project, parallel processing techniques have to be used to reduce the computing time. Apart from using an expensive high performance computer,distributed computing with RabbitMQ using computers connected by internet is a cheap way to do it. RabbitMQ is open source message broker software that implements the Advanced Message Queuing Protocol (AMQP). AMQP was originated in 2003 by John O'Hara at JPMorgan Chase in London, and widely used by many of the world leading financial companies. The prospective student should investigate the data transfer efficiency between computers and choose the best technoque to do the data communication between computers.

Project 71

Group Nuclear Physics

Project name Exciting mesons and baryons

Supervisor Dr Derek Glazier

Backup Supervisor Dr Daria Sokhan

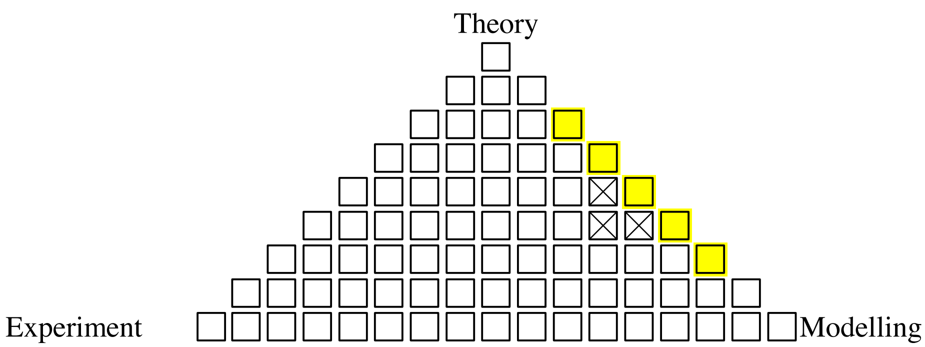
Suitability 20 credit no 30 credit no 40 credit yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance

Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Hadron spectroscopy, which categorises excited states of nucleons and mesons (force carrying particles), is currently a very active field. Many specialised facilities already exist, with several more high profile labs due to come online in the coming years. Given this wealth of data it is incumbent on the experimentalists to look for valuable new ways to search for excited states. This is particularly the case as many predicted and exotic states remain as yet unseen. This project seeks to investigate the photoproduction reaction mechanism as a means of producing excited nucleons in association with different mesonic states. Conservation laws restrict the allowed combinations and can therefore act as a filter for particular combinations of states, which may disentangle them from large backgrounds. Initially this project will use the quantum numbers of known states to predict which combinations should be possible. It will then use real data to search for the combinations predicted and the production of rare states.

This is a 40 credit project that would suit a student with a theoretical and/or software interest.

Project 72

Group Nuclear Physics

Project name The Strange World of Hyperons

Supervisor Prof D Ireland

Backup Supervisor Dr B McKinnon

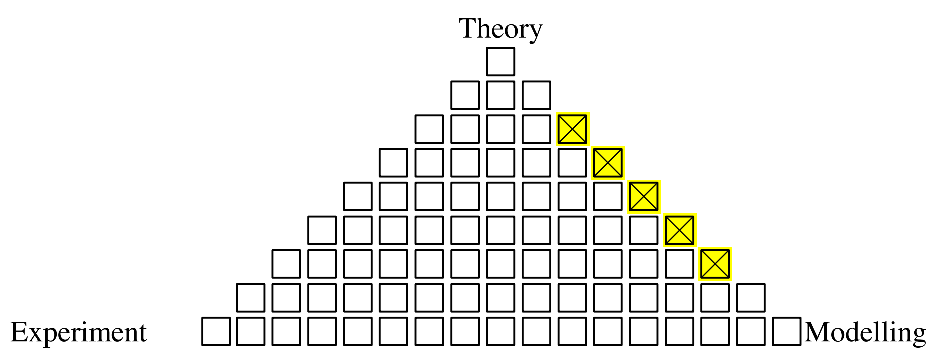
Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance

Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Particles containing one or more strange quarks, are known as hyperons. This project will use real data, collected from the CLAS experiment at Jefferson Lab in the US, to study these particles and their decays. Different statistical methods of maultivariate analysis, for picking out signal events from background events, will be evaluated and compared. The project involves mainly computational work and knowledge of, or a keen desire to learn, C++ would be helpful. The basis of most codes will be the ROOT framework, originally developed at CERN.

Project 73

Group **NPE**

Project name **Development of a Compton Camera for Radiometric Depth Profiling in Nuclear Decommissioning**

Supervisor **Dr David Hamilton**

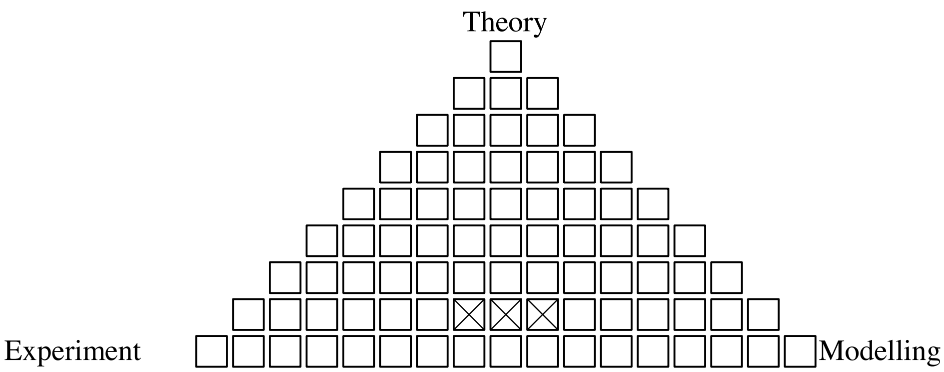
Backup Supervisor Dr Bryan McKinnon

Suitability 20 credit no 30 credit no 40 credit no 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)
This project will investigate the Compton camera technique with an active scatterer as a potential new detector technology for radiometric dose profiling. The question of which type of detector to use as the scatterer and as the gamma-ray detector is completely open. One part of the project will investigate the suitability of different detector technologies for these purposes in the laboratory. The other part will involve developing simulation software to help gain a better insight into the technique and how it can be optimised in terms of depth resolution. The day-to-day work involved in the project will therefore involve a mix of experimental and computational research, and will be very light on theoretical aspects. Knowledge of detector physics, Linux, C++, Root or Geant4 would be an advantage.

Project 74

Group **NPE**

Project name **Simulation of Anti-neutrino Monitoring of Nuclear Reactor Power Levels**

Supervisor **Dr David Hamilton**

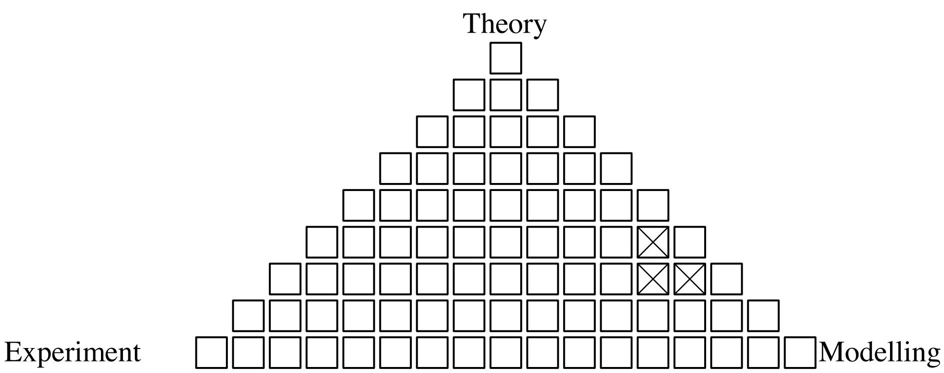
Backup Supervisor Dr Seian Al Jebali

Suitability 20 credit no 30 credit no 40 credit no 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)
This project will investigate a technique to remotely monitor nuclear reactor power levels by detecting anti-neutrinos from decay of the fission products in the reactor. The focus of the project will be the development of the different aspects of a simulation to understand and characterise:

1. the anti-neutrino source term,
2. the inverse beta decay process by which the anti-neutrinos interact with the detector,
3. and finally the interactions in the liquid scintillator detector itself.

This will therefore involve gaining experience with the main nuclear/particle simulation software tools in industry and academia such as MCNP and Geant4.

Project 75

Group Optics

Project name Real-time 3D video with a single camera

Supervisor Dr Matt Edgar

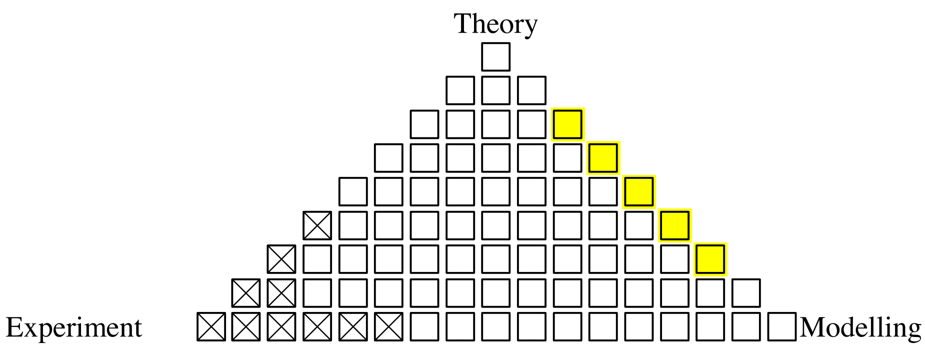
Backup Supervisor Dr Graham Gibson

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

3D pictures are normally produced by stereo imaging - utilising two or more cameras that view the subject from different perspectives simultaneously. A different approach, known as photometric stereo, enables just one camera to be used along with multiple illumination sources and a computer algorithm to calculate the geometric properties of the subject. We hope to be able to utilise a camera (SLR, webcam or high-speed) interfaced within customised software, to extract 3D video of objects in real-time. This research could result in a publication.

Project 76

Group Optics

Project name Generalised refraction

Supervisor Johannes Courtial

Backup Supervisor Stephen Oxburgh

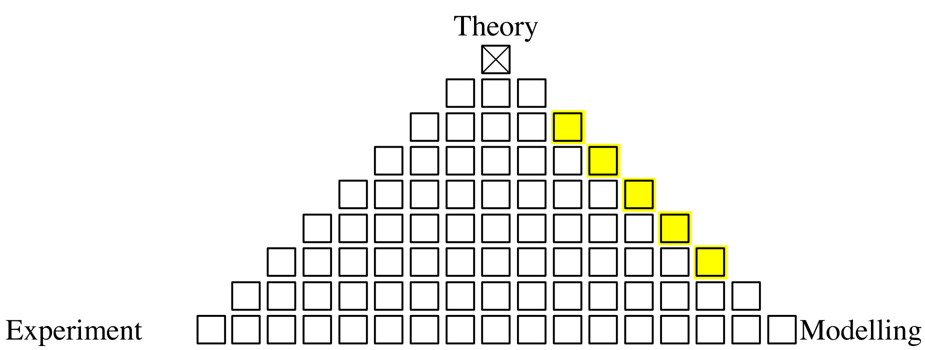
Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance

Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Much of our work is concerned with thin sheets which change the direction of transmitted light rays. The light-ray-direction change is very general, but our current sheets also offset the light rays. The offset is small, and usually invisible, but we would like to eliminate it entirely, thereby achieving generalised refraction.

We will do this in small steps. We will work in the ray-optics limit of wave optics, in which the light rays are perpendicular to the phase fronts. For given incident light-ray fields, we will try to calculate the phase distributions that correspond to the refracted light-ray fields. Once we have done this for a number of fields, we will try to formulate a closed-form expression for this phase distribution for arbitrary incident fields. It is already known that this is not possible for all incident light fields, so it will be interesting to see how this comes out in our expression.

Project 77

Group Optics

Project name Designing optical fullerene potentials

Supervisor Johannes Courtial

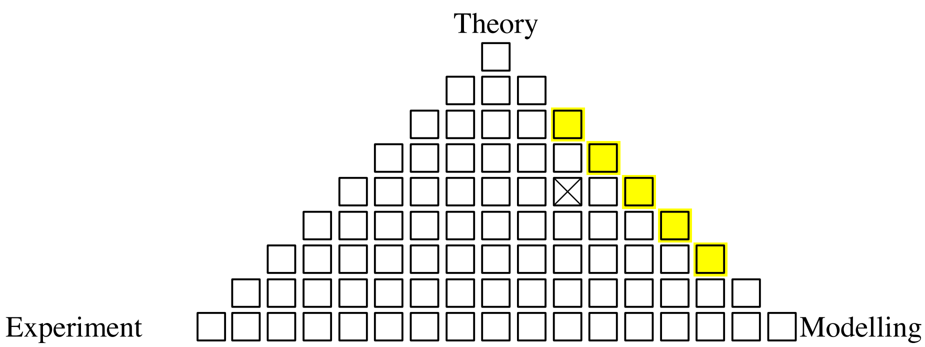
Backup Supervisor Neal Radwell

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

We are collaborating with researchers in Saudi Arabia who are interested in creating optical potentials that mimic the potential electrons find in fullerenes -- spherical sheets of graphene.

We have previously designed and experimentally demonstratred simple superpositions of plane waves that create an optical graphene potential. Now we would like to design simple plane-wave superpositions that create optical fullerene potentials. This is harder to tackle -- in fact, it is not even clear whether or not it is possible at all.

We will use our expertise in simulating light beams and designing holograms to try to design optical fullerene potentials.

Project 78

Group Optics

Project name Geometrical imaging unconstrained by wave optics

Supervisor Johannes Courtial

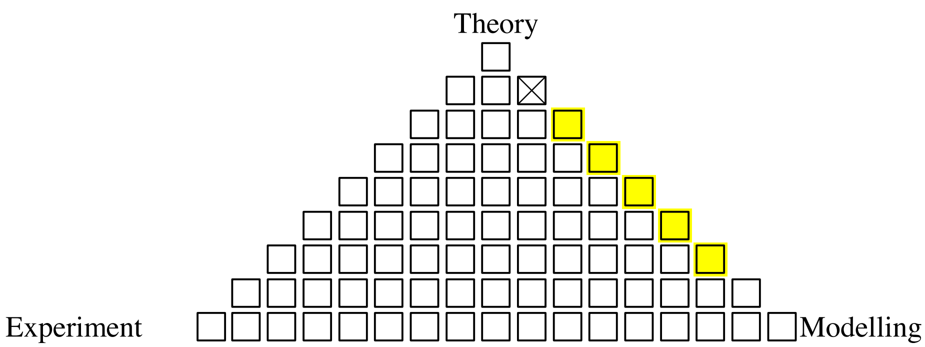
Backup Supervisor Stephen Oxburgh

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

One of our areas of research concerns light fields which look (but aren't actually) wave-optically forbidden. Such light fields can be achieved by introducing tiny discontinuities into wave fronts. Such light can then look wave-optically forbidden because many properties -- and thus limitations -- of light fields have been derived assuming globally continuous wave fronts.

We recently started to study the limits of imaging with components that create such light fields. We started with a thin, planar sheet that can change the direction of transmitted light rays arbitrarily but without offsetting the rays. We currently consider planar sheets that can change the light-ray direction arbitrarily and the light-ray offset. In both cases, the sheets are surrounded by air. The limitations are then very simple in nature, mostly related to the fact that light rays travel in straight lines in air. Any limitations we can derive for such a system are then applicable quite widely.

Project 79

Group Optics

Project name A lens with a complex focal length

Supervisor Johannes Courtial

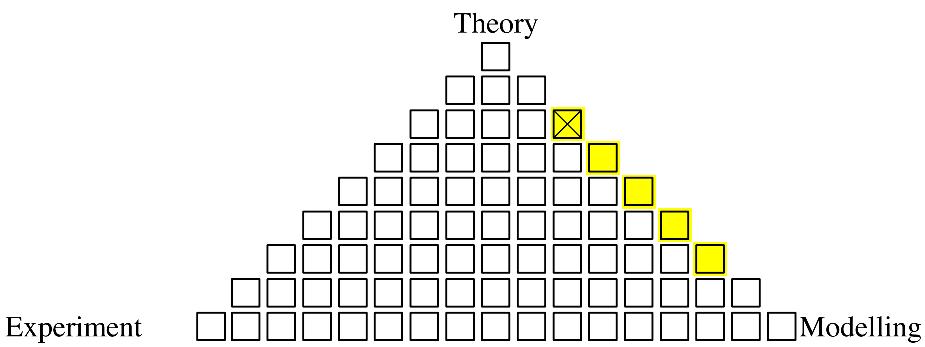
Backup Supervisor Stephen Oxburgh

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

One of our research areas is thin sheets that change the direction of transmitted light rays in very unusual ways. One of those sheets rotates transmitted light rays by an arbitrary, but fixed, angle around the sheet normal.

This project is about describing the effect of such sheets on bundles of light rays. We previously introduced the concept of skew light rays intersecting at complex positions, and we started to derive the equations that describe such imaging due to planar ray-rotating sheets. We also started to study the imaging due to spherical ray-rotating sheets. In the simple cases we studied, the imaging equations are generalisations to complex coordinates of the standard thin-lens equation.

In this project, we will study this imaging for more general cases. This will involve analytical calculations and ray-tracing simulations.

Project 80

Group Optics

Project name 3D video feedback

Supervisor Johannes Courtial

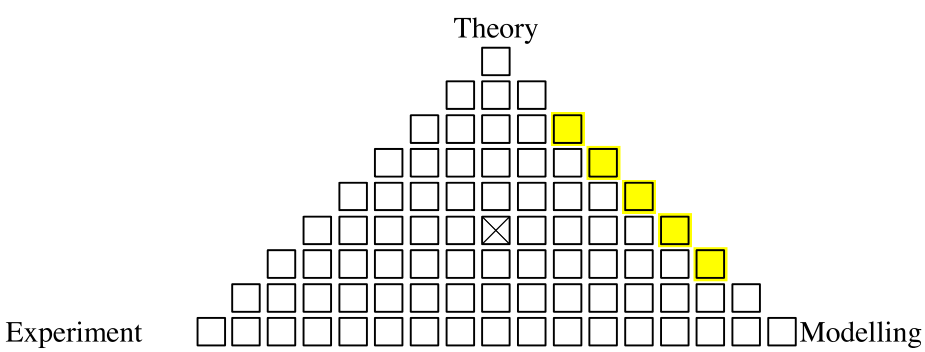
Backup Supervisor Graham Gibson

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Fractals are patterns which consist of small-scale copies of themselves. For example, the branches of a tree look a bit like small trees, and small parts of mountains can look remarkably like whole mountain ranges. Fractal geometry describes many patterns of nature.
The eigenmodes of unstable canonical resonators have a tendency to be fractals. Our own contribution to this discovery was an explanation of the detailed structure of these eigenmodes, in terms of an analogy with video feedback, i.e. a camera pointing at a monitor displaying its current image.
We recently discovered that the eigenmodes in unstable optical resonators are 3D fractals, and this made us think about video feedback again. And it is worth revisiting, as cameras and monitors can now be 3D, so what happens if a 3D camera points at a 3D monitor? Here we plan to answer this question, with simulations and experiments.

Project 81

Group Optics

Project name 3D Imaging of Light and Darkness

Supervisor Sonja Franke-Arnold

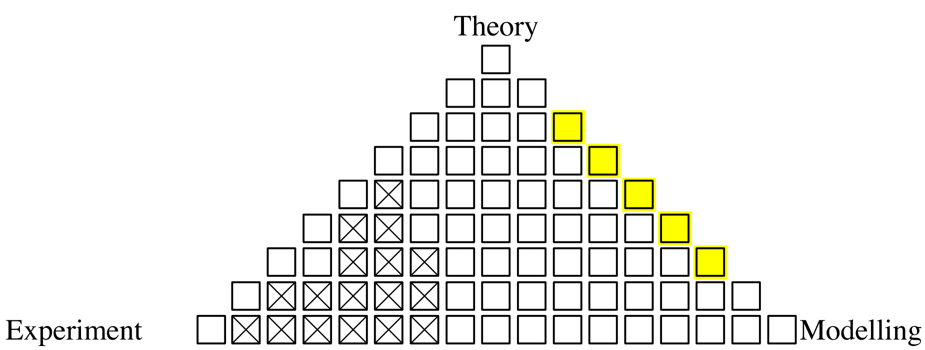
Backup Supervisor Neal Radwell

Suitability 20 credit no 30 credit no 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Shining a light beam through fog, or in our case through an atomic gas, allows to visualise the structure of the light beam. Using SLMs we can generate arbitrary light structures, including light that encorporates optical vortices, i.e. lines of darkness. Our recent work (as part of a student project) on 3D reconstruction of light has been published in Optics Express. We are now workig on a related technique that allows us to visualise the structure of dark vortex lines.
The aim of this project is to investigate systematically the parameters relevant for imaging light and darkness, including intensity (as fraction of the saturation intensity of the medium), polarisation and frequency. In particular you will generate composite images that include the information obtained from both light and dark imaging.

Project 82

Group Optics

Project name Focus on polarisation structures

Supervisor Neal Radwell

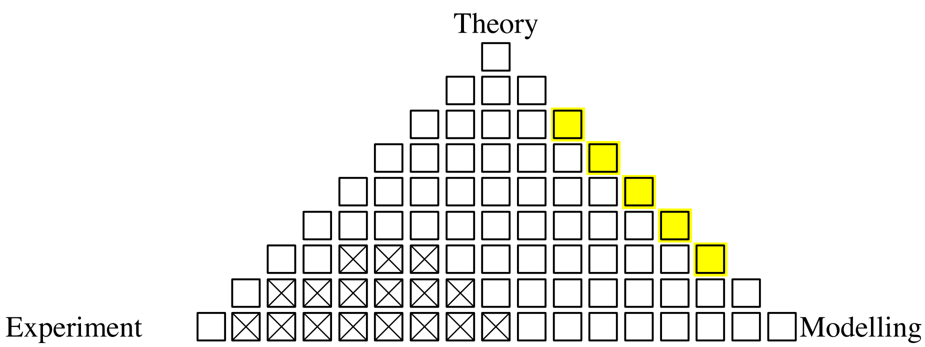
Backup Supervisor Sonja Franke-Arnold

Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

When light is focused very strongly, the usual rules on electric field propagation break down: the electric field vector oscillates no longer perpendicular to the propagation direction, i.e. the light can be longitudinally polarised. This also has effects on reflection. In a summer project this year we have for the first time observed polarisation patterns and orbital angular momentum structure in such a reflected light beam.
In this project you will develop reflection of focused light as a tool to study material properties of the reflecting surface. This includes information on the refractive index of various thin films, e.g. non-reflection coatings, or inhomogeneous material.
You will set up a simple experiment to measure Stokes parameters, take and analyse data via Labview/Matlab, and for a 40 or 60 credit project extend the measurements to include films of different thickness and generalise the methods for anisotropic media.

Project 83

Group Optics

Project name Polarisation imaging

Supervisor Sonja Franke-Arnold

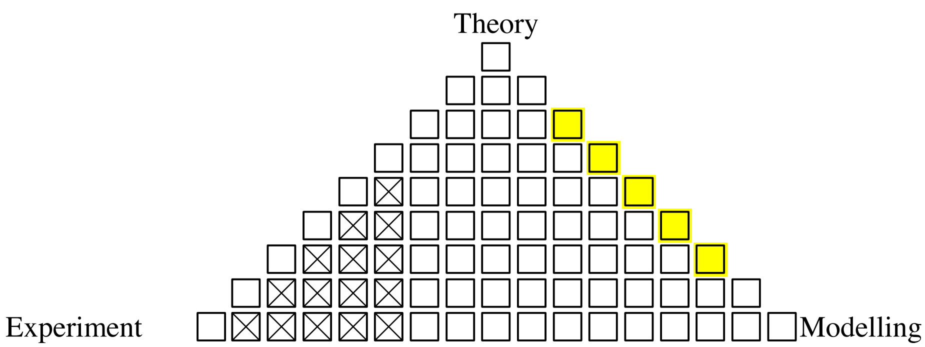
Backup Supervisor Neal Radwell

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Images are usually composed of light at different wavelengths and intensities, while its polarisation plays no role. Is it possible to encode images instead into the polarisation structure of a light beam?
In this project you will use a spatial light modulators (SLM) to convert gray-level images into "polarisation images". Most polarisation optics affects the whole light beam, but SLMs work essentially like arrays of polarisation dependent waveplates that can modify the phase of one polarisation component pixel by pixel.
You will write software in Labview that converts gray-level images into the required patterns for the SLM, implement the SLM in a Sagnac interferometer, and develop methods to capture the polarisation images by measuring Stokes parameters.

For a 60 credit project, image quality will be investigated in more detail and the effect of aberrations will be studied.

Project 84

Group OPTICS

Project name Imaging at distance

Supervisor Prof. M. Padgett, R Aspden

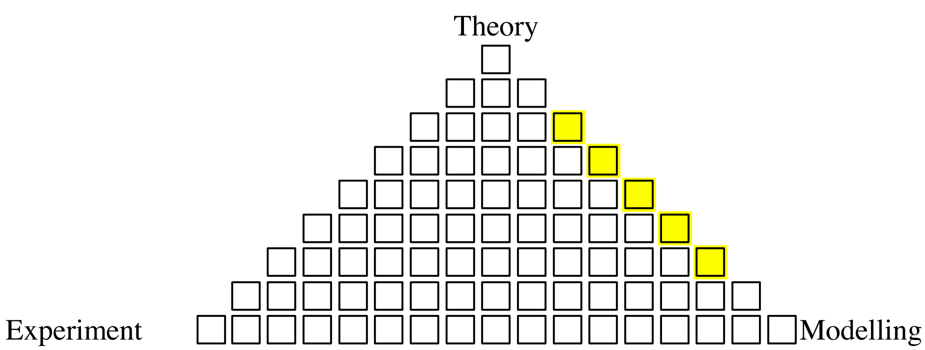
Backup Supervisor

Suitability 20 credit yes 30 credit yes 40 credit no 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

How sharp can you image an object over 30 m? If one could build a perfect imaging system, a point on one plane would appear perfectly as a point on the imaging plane. However, in reality the point becomes blurred due to properties of the imaging optics. The scale of this blurring effect is related to the point spread function of the system and is a combination of factors including the focal length and diameter of the lenses used. The aim of this project will be to model an imaging system with multiple telescopic imaging units using Labview and seek to optimise the physical attributes of the optics to minimise the point spread function. This modelled system will then be built in order to test the hypotheses made using the computer software.

This project will require/develop skills in image processing, LabVIEW programming, and experimental setup.

Project 85

Group OPTICS

Project name Investigating ‘hydrodynamic shielding’ using optical tweezers

Supervisor Dr. D. Phillips, Dr. G. Gibson, Prof. M. Padgett,

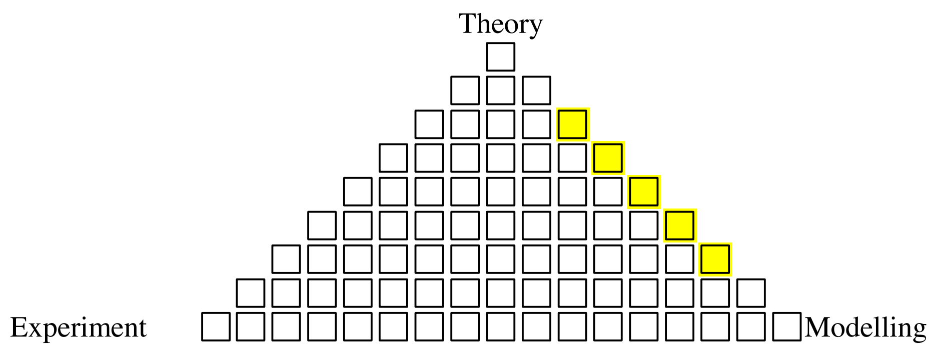
Backup Supervisor

Suitability 20 credit no 30 credit no 40 credit yes 60 credit (MSc) no

Suitable for “theoretical physics” no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

When an object moves through a liquid environment, it creates a disturbance in the surrounding fluid that exerts a force on nearby objects. At the micro-scale, particles ‘jostle’ seemingly randomly due to Brownian motion, but nearby particles exhibit correlated motion due to their hydrodynamic coupling. The aim of this project is to investigate these correlations in networks of optically trapped microscopic particles. How does the coupling change with the configuration of the particles? Is it possible to suppress correlations entirely using particular particle configurations and develop a ‘hydrodynamic shield’? An understanding of this regime is important, for example, to better comprehend the collective swimming behaviour of groups of micro-organisms.

This project will involve conducting experiments, performing data analysis, and comparing results to those found in numerical simulations. All of these will require a high level of LabVIEW programming skill, therefore the applicant should already be proficient in LabVIEW

Project 86

Group OPTICS

Project name Characterisation of intensity masking techniques

Supervisor Dr J Romero, Prof M. Padgett

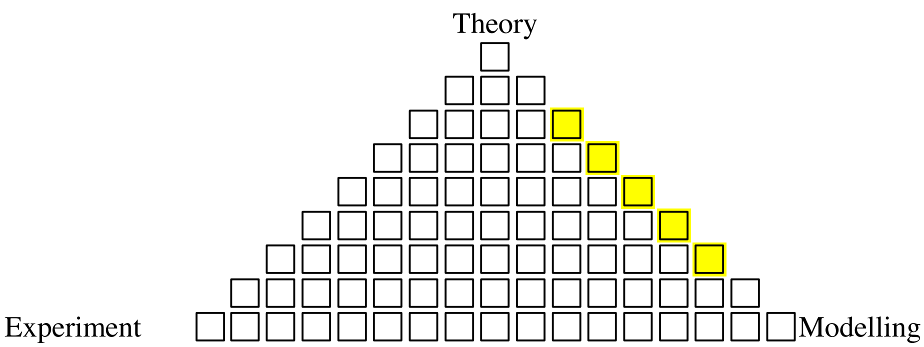
Backup Supervisor

Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Spatial light modulators (SLMs) are devices that allow us to the phase of an incoming light field. Although SLMs are used mostly for tailoring the phase, they can also be used to tailor intensity profiles, albeit at a loss. There are several prescriptions for generating patterns that do intensity modulation. The goal of this project is to compare the performance of these methods, by displaying the patterns in an SLM and looking at the resulting light beam patterns.
This project will develop skills in computational and experimental optics.

Project 87

Group OPTICS

Project name Assessing the stability of optics experiments built using 3D printed mounts.

Supervisor Dr G. Gibson, Prof M. Padgett, R. Aspden

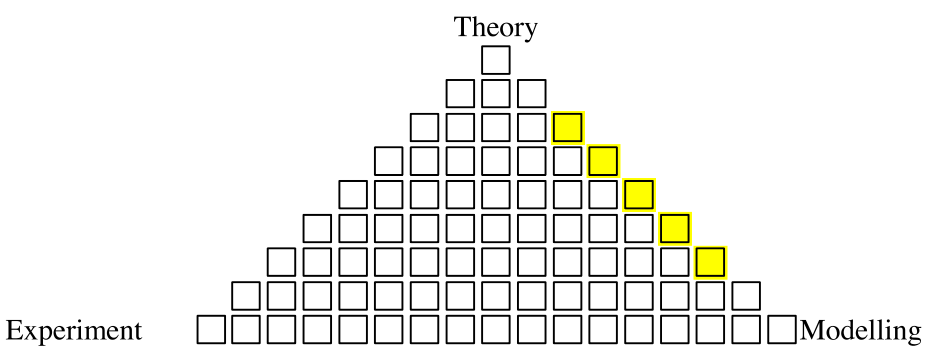
Backup Supervisor

Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Commercial 3D printers are now widely available allowing complex custom designed objects to be fabricated in the home or laboratory. They have found uses in the optics laboratory where custom mirror, lens, filter mounts can be designed, allowing compact experiments to be rapidly configured. An important question is how the performance of 3D printed plastic mounts compares to the metal mounts obtained from commercial suppliers. The aim of this project is to design and 3D print the necessary components to build an interferometer and compare its long term stability to that of a similar setup built from traditional components. Image analysis of the fringe pattern from the interferometer may be used to give a measure of the stability.
This project will require/develop skills in: 3D model design & printing, image processing, LabVIEW programming, and experimental setup.

Project 88

Group PPE

Project name Higgs boson search in WH->lvbb

Supervisor Dr. Adrian Buzatu

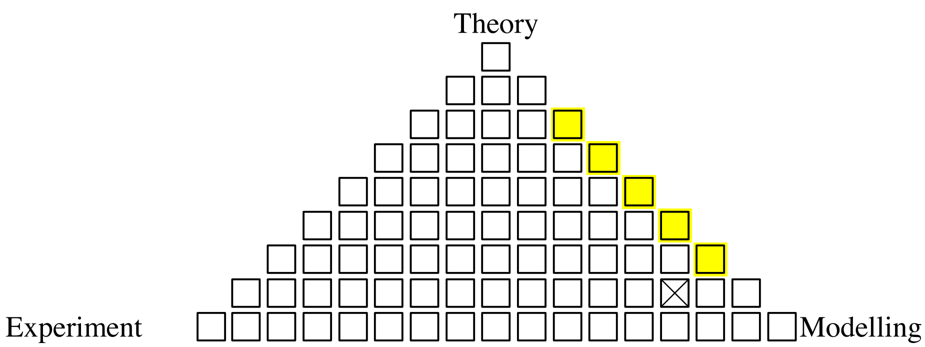
Backup Supervisor Dr. Aidan Robson

Suitability 20 credit yes 30 credit no 40 credit no 60 credit (MSc) no

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

This project is intended for one student and is available only in semester 2.
Though the Higgs boson has been observed decaying to force-carrying particles, it has yet to be observed decaying to matter particles, as the Standard Model theory predicts. We are using data collected by the ATLAS detector at the Large Hadron Collider (LHC) at CERN to search for a Higgs boson produced in association with a W boson and decaying to a pair of b-quarks. Key to improving the sensitivity of this search is improving the resolution of the measured Higgs boson mass, to discriminate between the signal and the many backgrounds. To achieve this goal, we are using various techniques, including artificial neural networks, to improve the b-quark-energy scale and resolution. A software package and techniques have already been developed using Run I LHC data from 2012. In this project the use of such techniques for Run II LHC data from 2015 will be investigated. The project will be heavily dependent on computer programming, largely in C++ and Python, and you must be confident programming in a Linux environment.

Project 89

Group PPE

Project name Physics at a Linear Collider

Supervisor Dr Aidan Robson

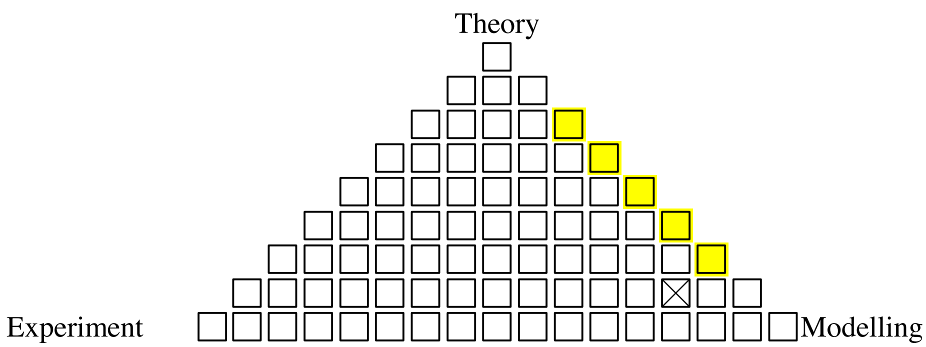
Backup Supervisor Dr Dan Protopopescu

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

This project is intended for one or two students (working on different aspects).
Planning is underway for the next generation of collider to supersede the LHC. An electron-positron collider will provide a clean experimental environment that will allow high-precision measurements of the Higgs boson's properties, beyond those achievable at the LHC. A potential site for the collider has recently been selected in Japan and funding negotiations are ongoing. In this project you will use simulation of one of the next-generation detector concepts. You will look at physics sensitivity and incorporate detector optimisation or reconstruction optimisation according to your own particular interests. You will write a module to fit into an existing software framework, that will select events, write histograms, and perform analysis.
The project will be heavily dependent on computer programming, largely in C++, and you must be confident programming in a linux environment.

Project 90

Group Particle Physics Experimental

Project name Ultra Fast Readout System for Medipix X-ray Imaging Detector

Supervisor Dr. Dima Maneuski

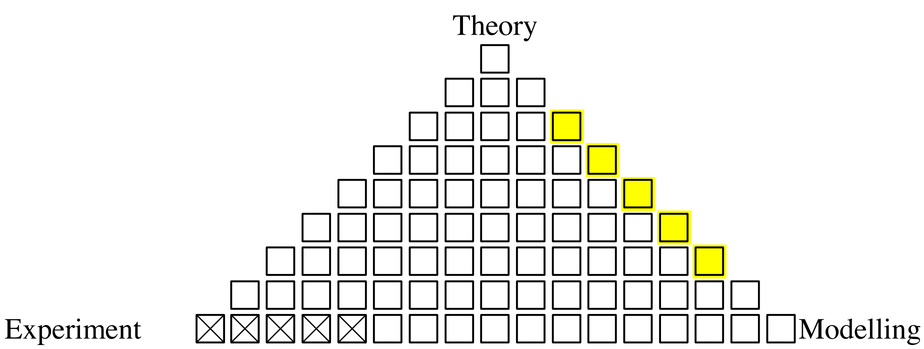
Backup Supervisor Prof. Craig Buttar

Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Medipix is a state-of-the-art multi-pixel detector of radiation. It found applications in many areas of science from monitoring of radiation background at the LHC to Computed Tomography (CT) of small animals for novel drug development. The system comprises of a silicon detector attached to a readout chip designed at CERN and fabricated at IBM facilities.
The aim of this project is to develop a prototype readout system for the chip that is capable of acquiring data at 2k fps, x100 faster than existing systems. Such speeds will enable applications of the systems to deliver new science and discoveries.
On project completion you will have skills to develop complex PCBs, characterise building blocks of any ICs. You will learn ARM processor architecture and acquire knowledge for USB3 interface developments.

Project 91

Group PPE

Project name CP-violation in c-hadron decays

Supervisor Dr Michael Alexander

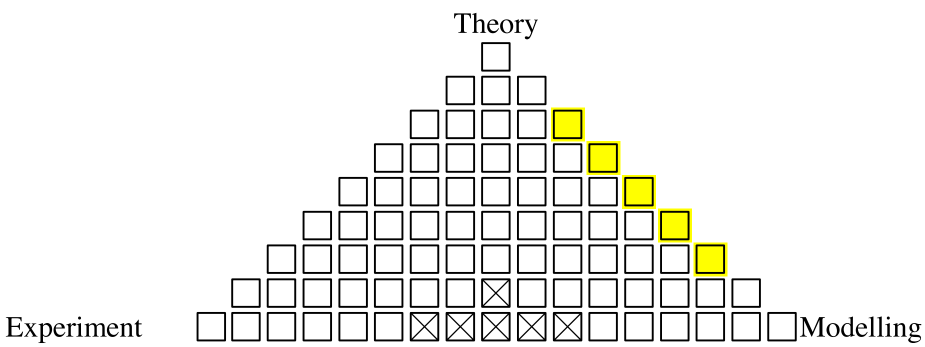
Backup Supervisor Dr Paul Soler

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The LHCb experiment at the Large Hadron Collider (LHC) is specifically designed for high precision measurements of decays of heavy particles involving b and c quarks. The LHC collides bunches of protons at high energy to produce these particles, among many others. In Run I of data-taking LHCb has recorded 3.2fb-1 of data, yielding the largest datasets of these interesting decays in the world.
Decays involving c quarks are predicted by the Standard Model of particle physics (SM) to exhibit only tiny differences between their matter and anti-matter versions. Discovery of greater CP-violation than is allowed by the SM would indicate new physics effects, which may explain the matter-anti-matter asymmetry in the universe today. In this project you will use data collected by LHCb to work towards measuring properties of c-hadrons: CP-asymmetries as a function of their proper-decay-time, and/or their lifetime. Some experience is required of the C++ and python programming languages. Familiarity with the ROOT data analysis package will also be helpful.

Project 92

Group PPE

Project name CP-violation in b-hadron decays

Supervisor Dr Michael Alexander

Backup Supervisor Dr Lars Eklund

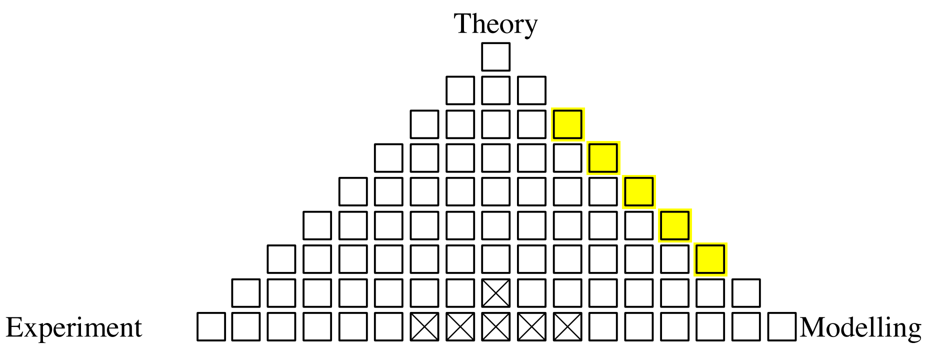
Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance

Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The LHCb experiment at the Large Hadron Collider (LHC) is specifically designed for high precision measurements of decays of heavy particles involving b and c quarks. The LHC collides bunches of protons at high energy to produce these particles, among many others. In Run I of data-taking LHCb has recorded 3.2fb-1 of data, yielding the largest datasets of these interesting decays in the world.

Decays involving b quarks exhibit differences between their matter and anti-matter versions (CP-violation), as predicted by the Standard Model (SM) of particle physics. Discovery of greater CP-violation than is allowed by the SM would indicate new physics effects, which may explain the matter-anti-matter asymmetry in the universe today. In this project you will use data collected by LHCb to work towards measuring properties of b-hadrons: CP-asymmetries as a function of their proper-decay-time, and/or their lifetime. Some experience is required of the C++ and python programming languages. Familiarity with the ROOT data analysis package will also be helpful.

Project 93

Group Experimental particle physics

Project name ATLAS strip thermal tests

Supervisor Andy Blue

Backup Supervisor Craig Buttar

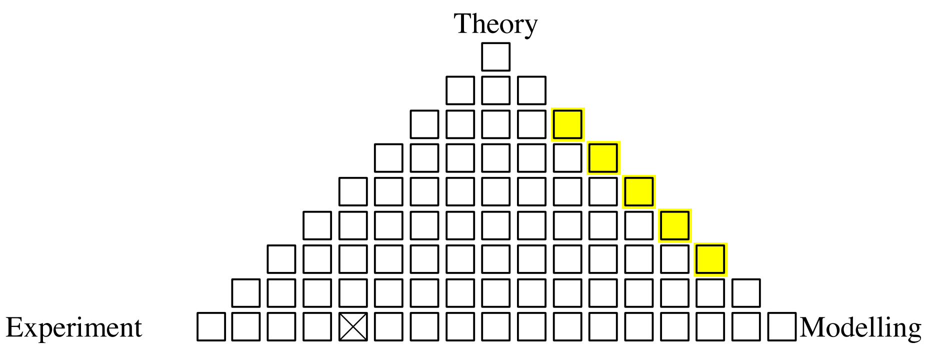
Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance

Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The LHC and ATLAS experiment will undergo an upgrade in 2020 to increase the number of collisions by an order of magnitude, which will extend the physics reach of the LHC programme, known as the high-luminosity LHC (HL-LHC). This will increase the occupancy of the strip detector and the radiation dose that is it exposed to by an order of magnitude. Therefore the strip system will be replaced and research is taking place to this end.

Strip modules are under development in Glasgow and a vigorous test and quality assurance procedure is being worked out. As part of this the robustness of the modules to many thermal cycles and thermal shock (+20 to -30C in 7 seconds) are being developed. The student will work closely with the project supervisor to develop thermal cycling and shock apparatus and protocols. These will be tested with a real ATLAS upgrade module.

Project 94

Group Experimental particle physics

Project name Thin silicon pixel module fabrication using wafer-to-wafer bonding for ATLAS upgrade

Supervisor Richard Bates

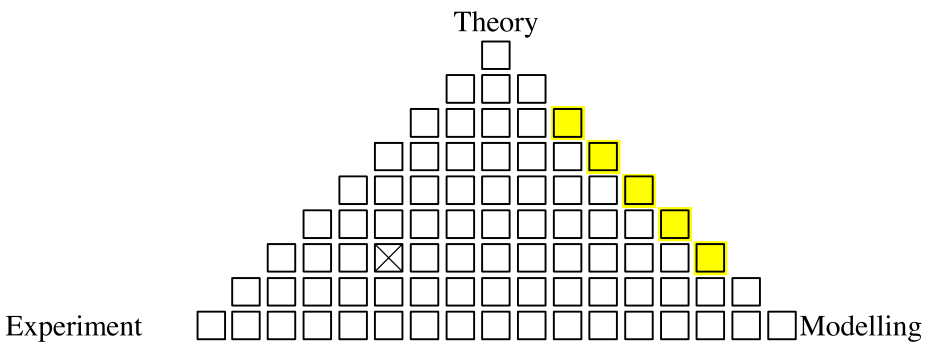
Backup Supervisor Marielle van Veggel

Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The LHC based particle physics experiment based at CERN have had a wonderfully successful start with the discovery of the Higgs boson. To ensure their future physics potential they will undergo upgrades, seeing the replacement of the silicon based tracking systems. The new silicon system will operate with an order of magnitude increase in particle density and radiation dose. Key to the ATLAS tracker physics performance is a thin, cheap pixel module based on silicon sensors bonded to readout chips. A new method to produce modules using wafer-to-wafer bonding will be investigated in collaboration with the IGR group. The technology has been demonstrated on thick substrates and this project will investigate the ability to bond thin substrates working closely with the project supervisors.

The student will develop the bonding and make measurements of the final pixel module.

Project 95

Group Experimental particle physics

Project name Measurement & modelling stresses in LHC silicon detector modules

Supervisor Richard Bates

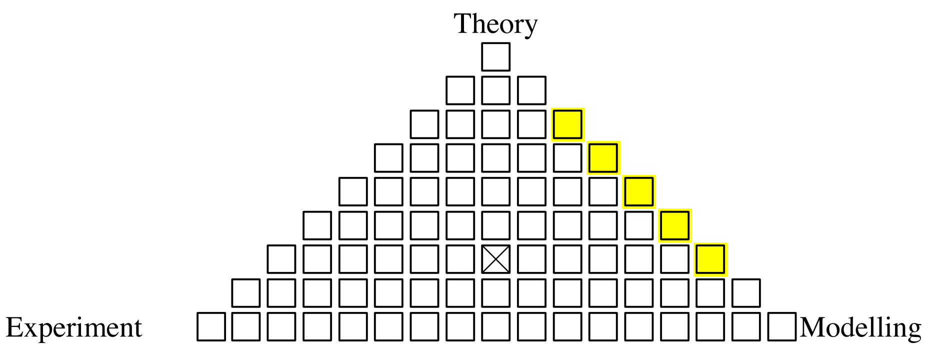
Backup Supervisor Liam Cunningham

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The LHC based particle physics experiment based at CERN have had a wonderfully successful start with the discovery of the Higgs boson. To ensure their future physics potential they will undergo upgrades, seeing the replacement of the silicon based tracking systems. The new silicon system will operate with an order of magnitude increase in particle density and radiation dose. The thickness of the detector module will be only 300um thick. This project will concentrate on gaining understanding about the stresses induced on CMOS chips during detector module construction, which is important in thin module production. Currently we have a project with CEA-LETI based in Grenoble, whereby we are developing ever-decreasing detector masses (removal of bulk silicon) on CMOS wafers and detector sensors. Understanding the stresses on the CMOS chip via measurement and computational methods, such as finite element analysis, will aid device fabrication, and ultimately lead to better physics performance of the silicon detector systems. The student will make measurements in Glasgow and develop such a model.

Project 96

Group **Particle Physics Experiment**

Project name **Top-Antitop modelling studies**

Supervisor **Prof. Dr. Anthony Doyle**

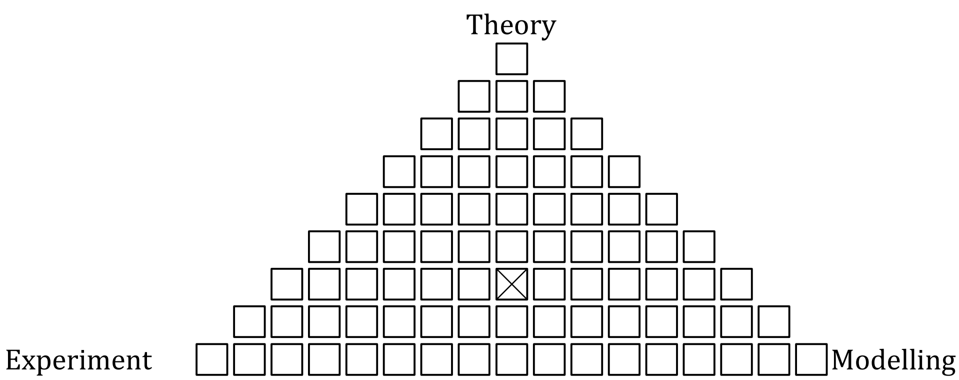
Backup Supervisor **Dr. Andrea Knue**

Suitability 20 credit no 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)
Many searches at the ATLAS experiment located at the Large Hadron Collider (LHC) rely on a good understanding of the top-antitop-quark pair production. The modelling of this background process is therefore of utmost importance. The project proposed aims for an improved understanding of this background by comparing the simulated data to real data and studing the impact of parameter variations of different MC generators on the pt spectrum of the top and ttbar-system.

Project 97

Group PPE

Project name Feasibility of a Compton Camera using silicon and cadmium-telluride detectors

Supervisor Professor Paul Soler

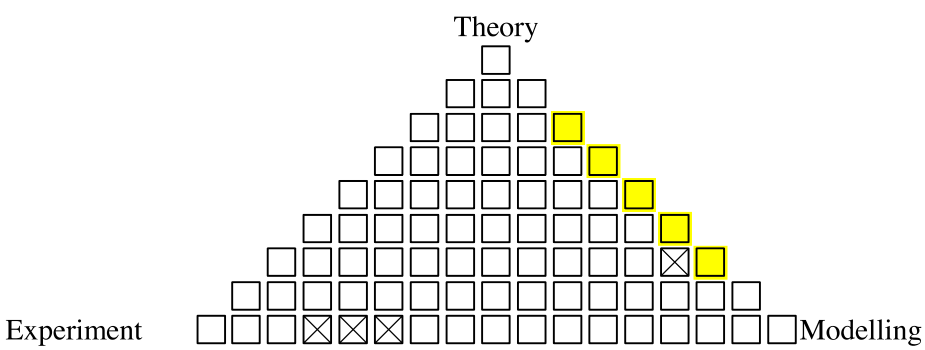
Backup Supervisor Dr Dima Maneuski, Dr Ryan Bayes

Suitability 20 credit yes 30 credit no 40 credit no 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

This project is available for two 20 credit MSci students in the second semester only (due to availability of the equipment). You will assess the feasibility of a new type of Compton camera, in which the position of gamma rays is determined by Compton scattering off a position-sensitive silicon scatterer and its energy is measured using a cadmium-telluride (CdTe) detector. The photon energy measured in the CdTe detector is used to determine the angle of the scattered photon. In combination with the position measured in the silicon detector, you can reconstruct the incident direction of the original photon. In this project you will set up the experiment, you will perform coincidence measurements of the Compton scattered photons in the silicon and CdTe detectors and you will perform a programme of measurements to determine the angular and position resolution of the photons. Time-permitting, you will simulate the experiment with a dedicated GEANT4 simulation to determine its expected performance.

Project 98

Group PPE

Project name Jet substructure studies with high pile-up

Supervisor Deepak Kar

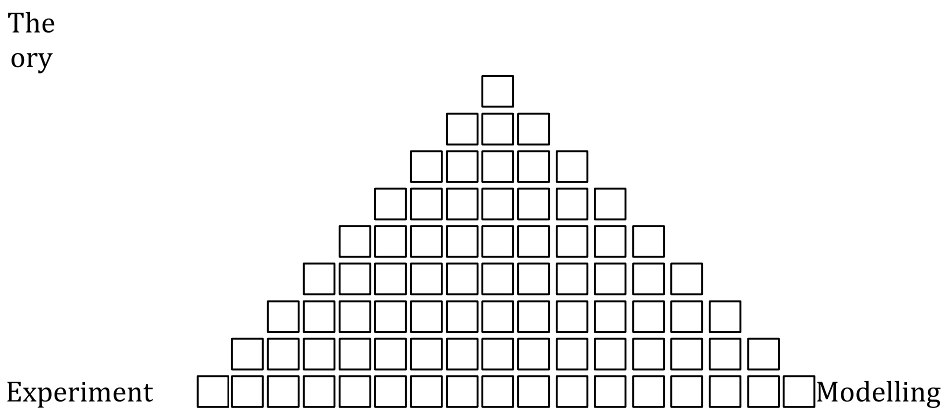
Backup Supervisor Tony Doyle

Suitability 20 credit yes 30 credit yes ***40 credit*** yes 60 credit (MSc) yes

Suitable for “theoretical physics” Yes

Off-campus work required? No

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Boosted particles resulting in a large radius jet are useful probes of new physics at the LHC, specially with higher center-of-mass energies. In this project, we will look at the several algorithms which looks at the internal (sub)structure of of these jets to decide which particle it originated from. However, LHC Run 2 and beyond will have a high rate of multiple proton-proton collisions, there by contaminating our large radius jets. We will test how that will affect the performance of these algorithms.

Project 99

Group Particle Physics Experimental

Project name Characterisation of Medipix X-ray Imaging Detector

Supervisor Dr. Dima Maneuski

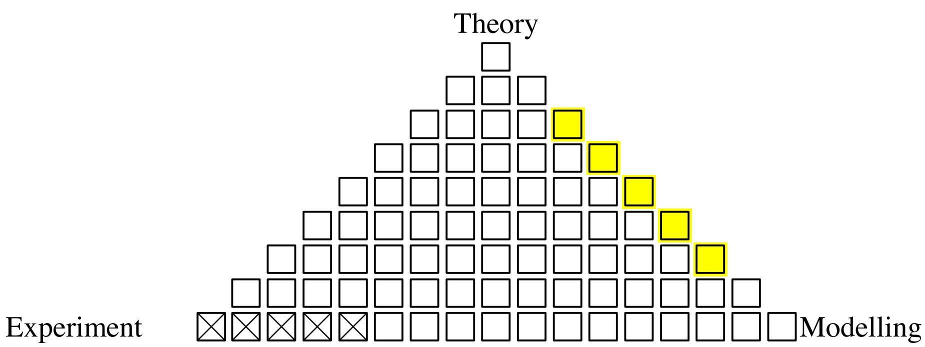
Backup Supervisor Prof. Val O'Shea

Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Medipix is a state-of-the-art multi-pixel detector of radiation. It found applications in many areas of science from monitoring of radiation background at the LHC to Computed Tomography (CT) of small animals for novel drug development. The system comprises of a silicon detector attached to a readout chip designed at CERN and fabricated at IBM facilities. The readout chip communicates with a PC via dedicated prototype readout system developed at Glasgow University. The aim of the project is to characterise the performance of the readout system for an application in X-ray imaging. You shall be looking at characteristics of sub-components of the readout system and optimise their performance and provide feedback for future developments. You will ultimately test Medipix imaging system for micro imaging X-ray radiography.
On project completion you will have clear idea of concepts of essential building blocks of any integrated circuitry. You will gain better understating of radiation detection techniques and complex equipment, enhance your programming and data analysis skills.

Project 100

Group Particle Physics Experimental

Project name Particle counting detector for scientific applications

Supervisor Dr. Dima Maneuski

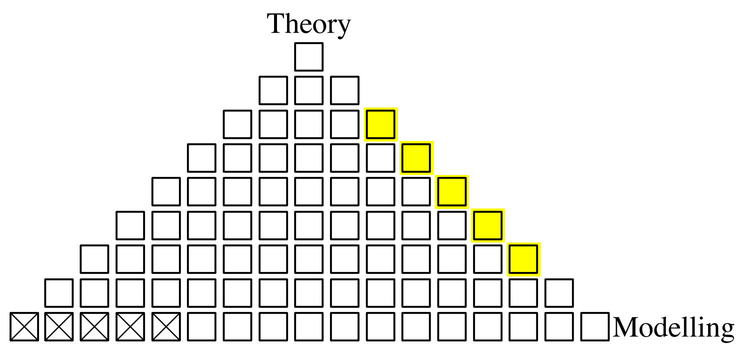
Backup Supervisor Prof. Craig Buttar

Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Detectors developed for the Large Hadron Collider exhibit many excellent properties that make them very attractive to use in areas outside particle physics. Excellent position resolution of strip detectors and good energy resolution of scintillation detectors make them natural choice for the next generation Compton cameras for Single Photon Emission Computed Tomography (SPECT) and electron counting for novel techniques in Electron Microscopy.
In this project you shall take part in characterisation of building blocks of new generation spin-off technologies from particle physics. The work package will include participation in characterisation of silicon photon detectors, development of novel signal processing and digitisation techniques.
On project completion you shall gain better understating of radiation detection techniques and integrated circuits, enhance your programming and PCB development skills.

Project 101

Group PPE

Project name Experimentally distinguishing quarks and gluons at the LHC

Supervisor Andy Buckley

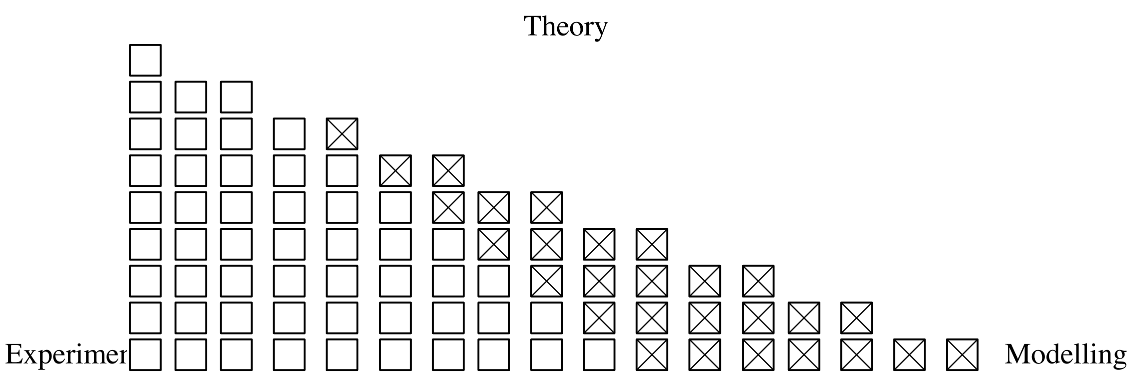
Backup Supervisor Chris Pollard

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Quarks and gluons are the fundamental particles of the strong nuclear force, but the dynamics of that force (quantum chromodynamics) mean that these fundamental particles are never observed in isolation, but only as collimated "jets" of composite particles observable by particle detectors. This project will investigate use of various kinematic observables to study the internal structure of hadronic jets as observed at the Large Hadron Collider, with the aim of experimentally distinguishing quark jets from gluon ones - and understanding the extent to which there is a grey area between these two extremes. This will be done through simulations of high-energy collisions, the theory of QCD structure, and possibly analysis of real data from the ATLAS experiment.

This project is intended for one or two students. It will be heavily dependent on computer programming in the C++ and Python languages, and you must be confident with operating, scripting and programming a Linux computer system.

Project 102

Group PPE

Project name Data compression for high speed silicon sensor systems

Supervisor Craig Buttar

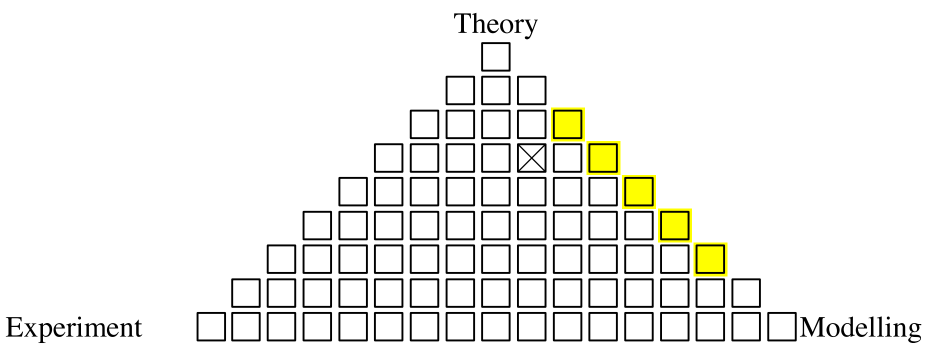
Backup Supervisor Richard Bates

Suitability 20 credit yes 30 credit yes 40 credit yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Silicon sensors systems for particle physics and other imaging applications have to cope with increasing amounts of data at higher readout speeds. This has traditionally been addressed by increasing the bandwidth of the off-dectector readout system. A new way to address this is to take advantage of the increasing functionality within sensor readout chips using on-chip data compression. The characteristics of data from a silicon sensor: position, cluster information, and signal strength need to be taken into account when developing a compression algorithm.
The project will initially look at the case of a silicon strip tracking system with binary readout and look at the efficiency of different data compresion algorithms (fixed packet and pattern overlay compression) and extend this to a pixel system with analog readout.

Project 103

Group PPE/GridPP

Project name Tier-3 elastic overflow to the Grid via DIRAC submission.

Supervisor David Britton

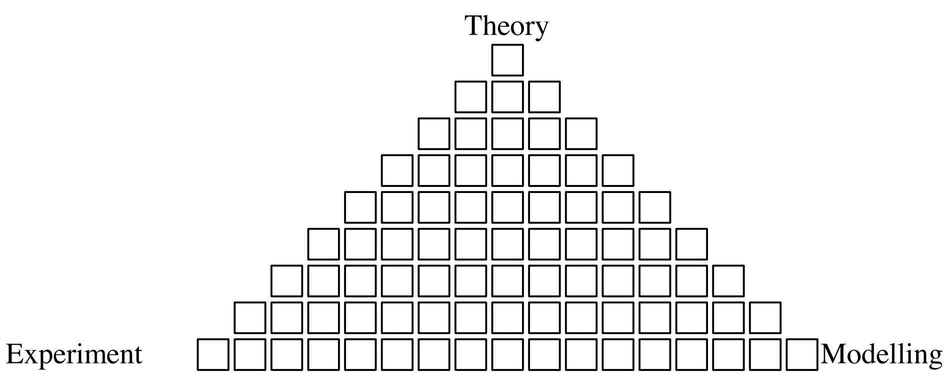
Backup Supervisor Gareth Roy

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Compute resources of the local PPE group can become strained when publication deadlines loom. In this project it is proposed that a method of elastic overflow onto the Glasgow Tier-2 grid site could be made available via the use of DIRAC job submission. DIRAC is a workload management system that submits pilots to compute resources allowing jobs to be pulled to available capacity. The main goal of this project would be to set up a local DIRAC instance at Glasgow and allow physics codes to be submitted run on the Tier-2

Project 104

Group PPT

Project name LHC phenomenology of dark sectors

Supervisor Dr Christoph Englert

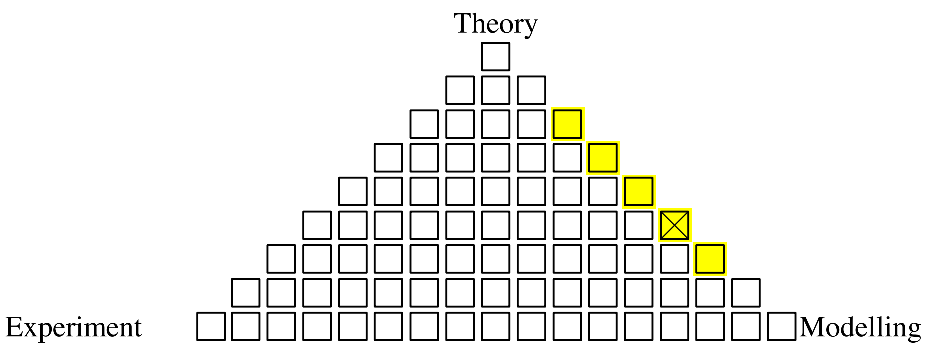
Backup Supervisor Dr David J Miller

Suitability 20 credit yes 30 credit yes 40 credit no

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The dominant fraction of matter in the Universe is invisible. Nonetheless, the Large Hadron Collider (LHC) located at CERN, Geneva, is able to probe certain parameter regions of theoretical models which aim to explain the observed matter-dark matter ratio. In this project LHC signatures of such models will be simulated and investigated and the basic concepts of LHC collider phenomenology will be acquired.

Project 105

Group PPT

Project name Higgs self-coupling studies in weak boson fusion processes

Supervisor Dr Christoph Englert

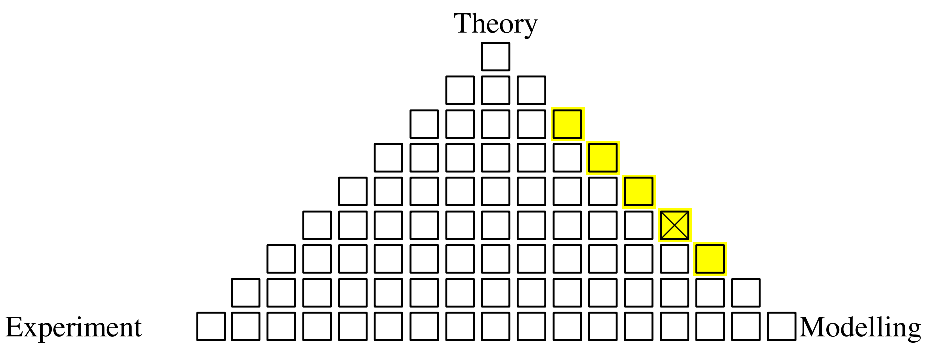
Backup Supervisor Dr David J Miller

Suitability 20 credit yes 30 credit yes 40 credit no

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The last missing piece of the so-called Standard Model of Particle Physics, the Higgs boson, has been discovered last year at the Large Hadron Collider (LHC) at CERN, Geneva. It is a remnant of the mechanism that breaks electroweak symmetry, thus making the weak interactions much weaker than the other fundamental forces that we know of. The symmetry breaking mechanism crucially relies on a self-interaction of the Higgs boson. This self-interaction can be studied in multi-Higgs production processes, on of which is weak boson fusion, where two weak bosons fuse to produce a Higgs pair. In this project the basics of Higgs and LHC collider phenomenology will be acquired and the phenomenology of di-Higgs production will be studied.

Project 106

Group PPT

Project name Renormalization Group Effects for Effective Higgs Physics

Supervisor Dr Christoph Englert

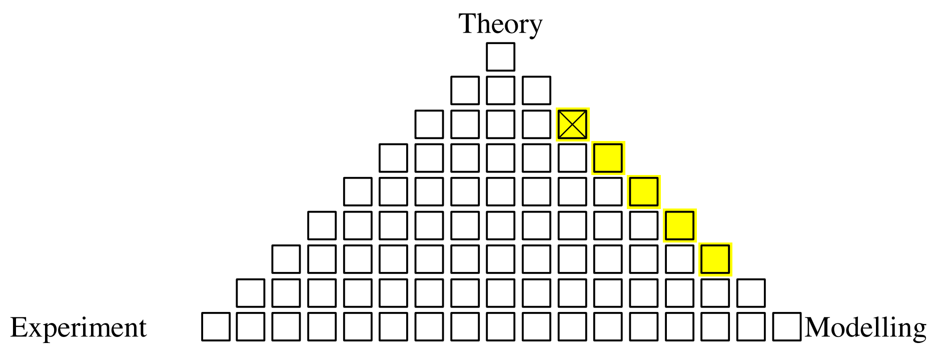
Backup Supervisor Dr David J Miller

Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

After the Higgs discovery in 2012 additional information about the nature of the discovered particle is the focus of Higgs phenomenology during the imminent run 2 at the Large Hadron Collider at CERN.
We know that the so-called Standard Model of Particle Physics is incomplete and we therefore expect new dynamics to show up at energy scales higher than the electroweak scala set by the Higgs mass. If there is a large separation between the two scales we can parameterize deviations from the standard Higgs phenommenology by introducing new effective interation terms to our picture of Particle Physics. As a consequence of particle dynamics, the strengths of these interactions depend on the mass scale at which we probe these terms. In this project the dependence of representative interactions on the energy scale will be worked out and the quantitative effects will be discussed.

Project 107

Group PPT

Project name From gluons to gravitons

Supervisor Chris White

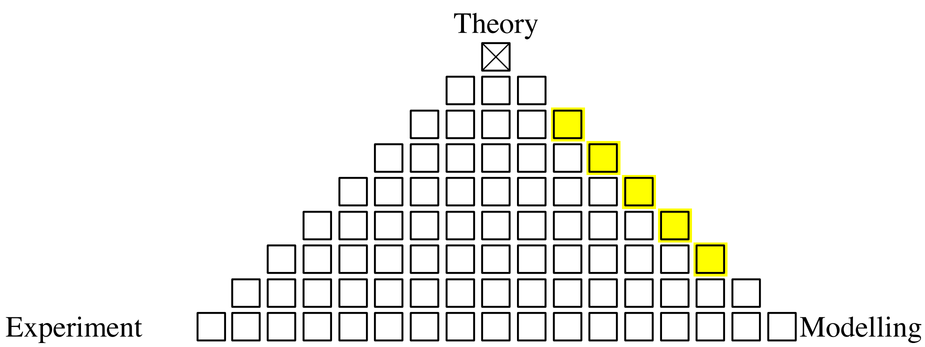
Backup Supervisor David Miller

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Recent research has highlighted intriguing similarities between the theory of quarks and gluons (Quantum Chromodynamics, QCD) and the theory of gravity (General Relativity). The hope is that such insights might provide clues to a long-sought quantum theory of gravity, whilst also revealing deeper structures present in QCD.

This project will examine various aspects of the correspondence between QCD-like theories (a type of quantum field theory known as a non-Abelian gauge theory) and gravity. Possible research avenues include:

* Matching up classical solutions in gravity (e.g. black holes) with gauge-theoretic counterparts.
* Understanding how quantum scattering probabilities are related in both theories.
* Relating non-perturbative quantum behaviour in QCD and gravity.

Project 108

Group PPT

Project name The decay constant of the B* meson

Supervisor Prof. Christine Davies

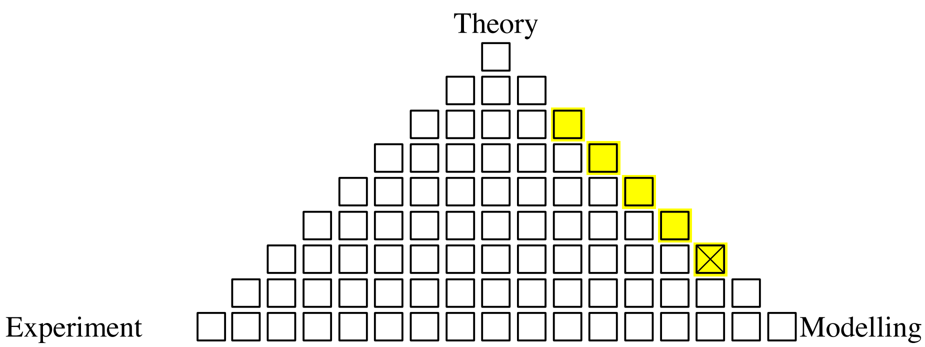
Backup Supervisor Dr Jonna Koponen

Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Mesons which are formed from a bottom quark and either an up, down or strange antiquark are known generically as B mesons. They can have spin 0 or spin 1 depending on whether the quark and antiquark spins are aligned or point in opposite directions. These emsons also decay in a number of ways that provide a useful window into the possibilities for physics beyond the Standard Model. In order to test for this we need to understand how the mesons decay in the Standard Model so that this can be compared to experiment. In Glasgow we have recently done some very accurate calculations for the spin-0 mesons but also have results, not so far analysed, for the spin-1 (B*) mesons. This project would analyse these results to determine the ratio of annihilation decay rates for the B* meson compared to the B. For a 60-credit project it might also possible to generate some further results for analysis.
This project is a computational one. Code modification would be required, rather than writing code from scratch.

Project 109

Group PPT

Project name GUT Models without supersymmetry

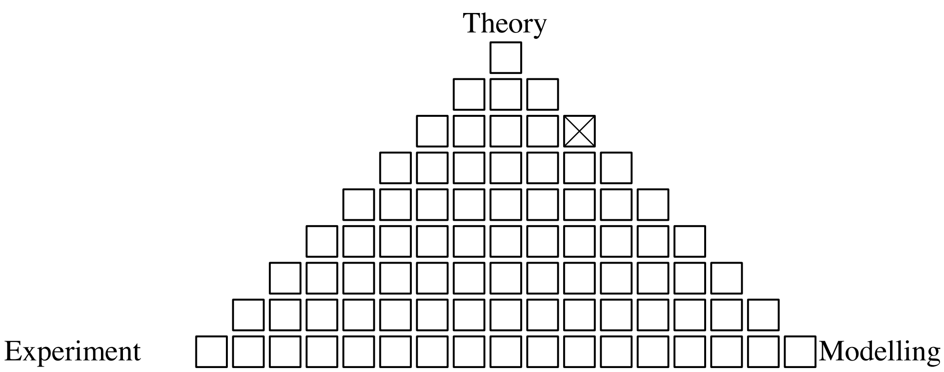
Supervisor David Miller

Backup Supervisor Chris White

Suitability 20 credit no 30 credit no 40 credit yes

Suitable for "theoretical physics" yes

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single check. (For example, checking the highlighted box would indicate a project that includes equal components of theory and modelling with no experimental component)



Project description (length should not exceed remainder of page)

It has been conjectured for many years that the weak, strong and electromagnetic forces are all aspects of one single force that manifests at very high energies. This conjecture has been supported by the amazing convergence of the force strengths at these high energies if one assumes an extra symmetry called supersymmetry. Unfortunately supersymmetry predicts the existence of new particles that should be seen at the LHC, and the absence of these particles leaves supersymmetry in danger of being ruled out. This project will assume that supersymmetry is indeed absent and ask what this means for Grand Unification. Is unification into a single force still possible?

Project 110

Group PPT

Project name Coloured partners for the Higgs Boson

Supervisor David Miller

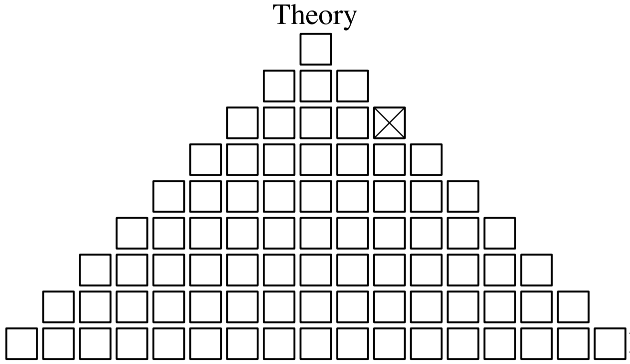
Backup Supervisor Chris White

Suitability 20 credit no 30 credit no 40 credit yes

Suitable for "theoretical physics" yes

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single check. (For example, checking the highlighted box would indicate a project that includes equal components of theory and modelling with no experimental component)

Theory



Experiment Modelling

Project description (length should not exceed remainder of page)

It is interesting to note that the matter particles of the Standard Model come in just the right number and with just the right charges to allow them to be grouped into complete representations of the group SU(5). This may be a sign that the strong, weak and electromagnetic forces can all be described by a single unified force. However, the newly discovered Higgs boson is part of a doublet and we would need 3 more particles to make a complete SU95) representation. This project will conjecture that there is indeed a triplet of particles partnering the Higgs still to be found at the Large Hadron Collider and will ask what consequences there existence would have. This project requires some knowledge of particle physics and the Standard Model.

Project 111

Group PPT

Project name The mass of the excited Bc meson

Supervisor Prof. C. Davies

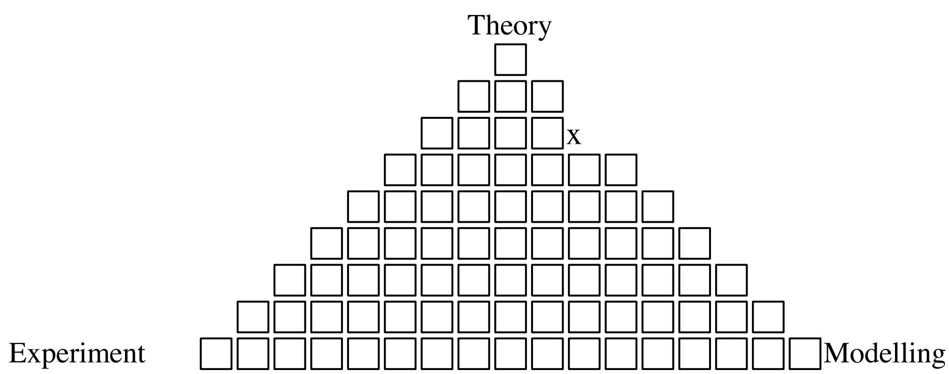
Backup Supervisor Dr J. Koponen

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
A mix of theory and modelling.



Project description (length should not exceed remainder of page)

The Bc meson is made of a bottom quark and charm antiquark. Both of these quarks are rather heavy (the charm quark is roughly the mass of the proton and the bottom quark 4-5 times heavier) and move slowly in bound states. We can then understand their interaction inside the bound state in terms of a potential, V(r) and solve Schrodinger's equation to obtain the mass of the Bc meson in principle. One issue is what functional form to take for the potential. The theory of the strong force, Quantum Chromodynamics, does not directly give us the potential (except for very small distances r) and so we have to work with functions that reproduce well the masses of mesons made from bottom quarks (upsilon mesons) or charm quarks (psi mesons). For these two cases there are a number of mesons, including radial excitations of the ground state, that give information about the potential.
The Bc meson was seen by the CDF experiment in 2005 for the first time. This year the ATLAS experiment has claimed a sighting of the radially excited Bc meson, the Bc^prime. This project would look at a variety of forms for V(r) to see what potential model expectations for this mass would be and see how compatible the ATLAS results are with theoretical expectations.
The project will require coding up an algorithm to solve Schrodinger's equation. A longer project would also study the wavefunctions and predict decay rates for the meson.

Project 112

Group PPT

Project name Exploring the path integral formulation of quantum mechanics

Supervisor Prof. Christine Davies

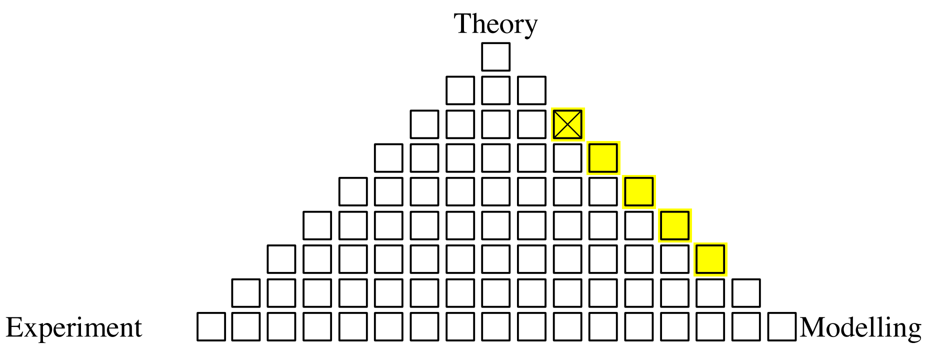
Backup Supervisor Dr jonna Koponen

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

This project will explore how to solve quantum mechanical systems using the path integral approach. In this method the calculation of, for example, the energy eigenvalues of the quantum harmonic oscillator becomes one of determining the value of an integral over a multi-dimensional space using multi-dimensional integrals and 'Monte Carlo' techniques.
The project will start with a simple quantum mechanical example, where exact solutions can be calculated using Schrödinger's equation, and compare results using the path integral method. There are several numerical issues that need to be solved to obtain accurate results from the path integral method and some of these will be studied in more detail. The project is a computational one and so requires either computing experience or a willingness to learn a suitable programming language (Fortran, C or Python).

Project 113

Group Quantum Theory

Project name Quantum Entanglement

Supervisor Dr Sarah Croke

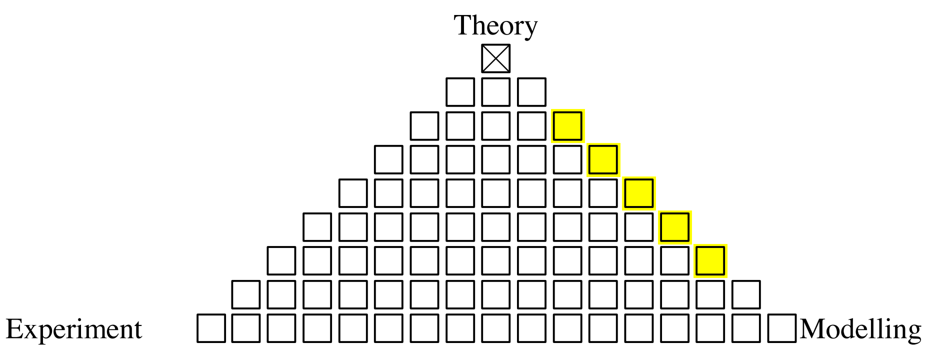
Backup Supervisor Prof. Steve Barnett

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Entanglement is at the heart of many quantum paradoxes, including the famous EPR paradox. It also underlies numerous potential applications in quantum technologies. But what is entanglement? Why is it so mysterious? And how can we demonstrate its existence? A student undertaking this project should have a good grasp of mathematical methods and quantum theory.

Project 114

Group Quantum Theory

Project name Quantum Security

Supervisor Dr Thomas Brougham

Backup Supervisor Prof. Steve Barnett

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance

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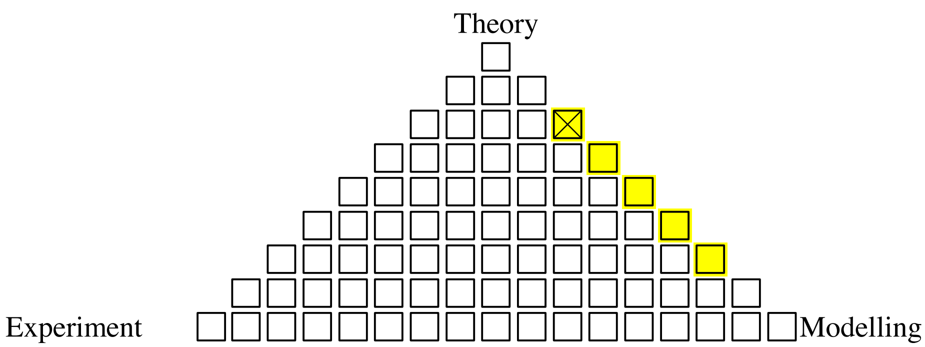


Project description (length should not exceed remainder of page)

Quantum cryprography offers the potential, at least in principle, for provably secure optical communications. This project will model the effects on this ideal of real-world imperfections. A combination of foundational quantum phenomena with communications and information theory. A student undertaking this project should have a good grasp of mathemtical methods and quantum theory.

Project 115

Group Quantum Theory

Project name Tensors in optics

Supervisor Prof. Steve Barnett

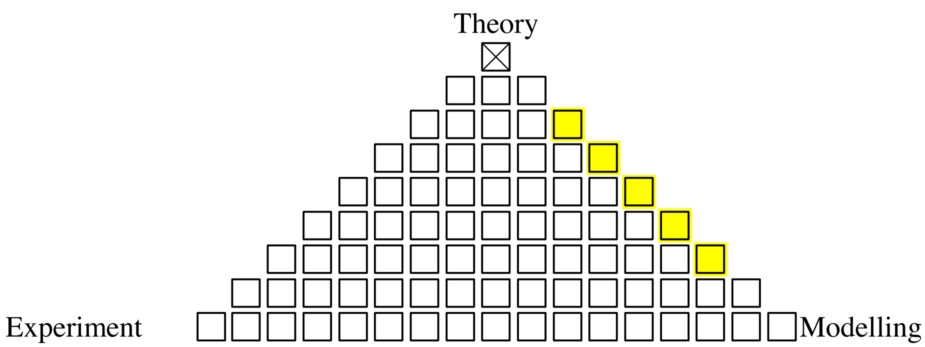
Backup Supervisor Dr Fiona Speirits

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Electromagnetism is a relatvistic theory and its fullest desrciption involves tensors. This allows us to examine phenomena in any chosen coordinate system or frame of reference, including accelerating and rotating frames. This project will investigate some of these ideas including the azimiuthal components of the linear and angular momentum of light fields and how these appear in a rotating frame. A student undertaking this project should have a good grasp of mathematical methods, optics and EM theory.

Project 116

Group Quantum Theory

Project name Chiral interactions in optics

Supervisor Prof. Steve Barnett

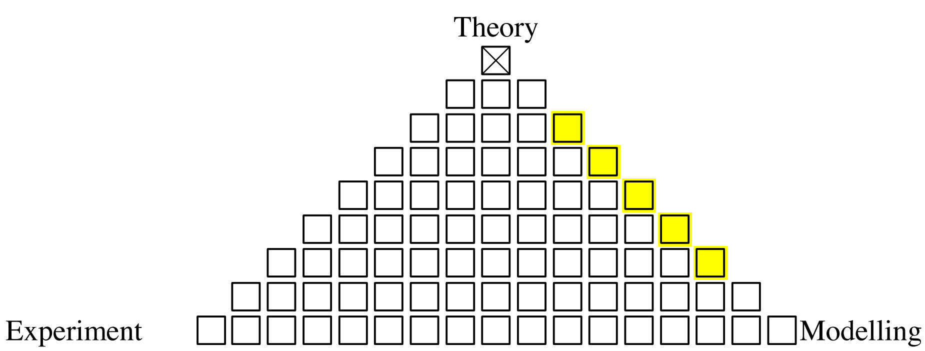
Backup Supervisor Robert Cameron

Suitability 20 credit yes 30 credit no 40 credit no 60 credit (MSc) no

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

This project will run in semester 1 ONLY.

Chiral species, including most organic molecules act differently with left- and right-circularly polarized light. This leads to a wealth of phenomena including the rotation of the plane of polarized light on propagation through sugar soluton. This project will investigate the effects of propagation through such media on fields with exotic polarization structure including azimuthally and radially polarized fields. A student undertaking this project should have a good grasp of optics.

Project 117

Group Quantum Theory

Project name Quantum two particle interference

Supervisor Prof. Steve Barnett

Backup Supervisor Dr Vaclav Potocek

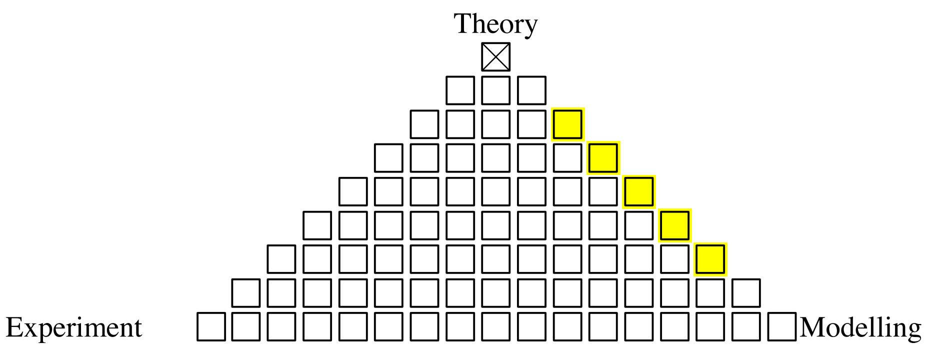
Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance

Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Dirac famously wrote, of optical interfernce, that "each photon then interferes only with itself. Interference between two different photons never occurs." But what does happen when two photons arrive together on a beam-splitter? The result, suprisingly, is that both can end up going in the same direction, "joining hands, so to speak". This project will investigate the origins of this unexpected quantum phenomenon and focus on the very different naturs of two-boson and two-fermion interference. A student undertaking this project should have a good grasp of mathematical methods and quantum theory.

Project 118

Group Physics Education

Project name Threshold concepts within a Physics undergraduate degree

Supervisor Eric Yao

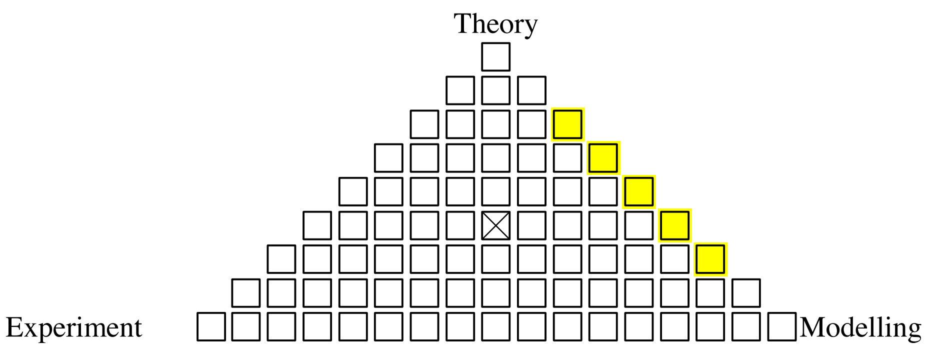
Backup Supervisor Nicolas Labrosse

Suitability   20 credit yes   30 credit yes   40 credit yes   60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The idea of threshold concept is widely adopted within education research as a way of framing the fundamental elements that encapsulate a discipline or a topic. "Threshold concept" is distinct from the idea of "core concept" which can be easily gathered by collecting the course content documents from your core coruses. Threshold concepts are transformative, irreversible, integrative and bounded. As students, often, in the course of undertaking an undergraduate degree, we are too busy being preoccupied by the "core concepts" and, consequently, pay little or no attention to the threshold concepts. Your lecturers and professors, on the other hand, are rather more concerned that you should undertanding the threshold concepts. Although not many will explicitly express it in those terms.   In this project. You will learn basic frameworks of education theory and a variety of different educational research analysis techniques. You will then apply them to reveal the essense of your degree.

Project 119

Group School

Project name Quality of Student-generated Content from PeerWise Repositories Used in Physics 2

Supervisor Morag Casey

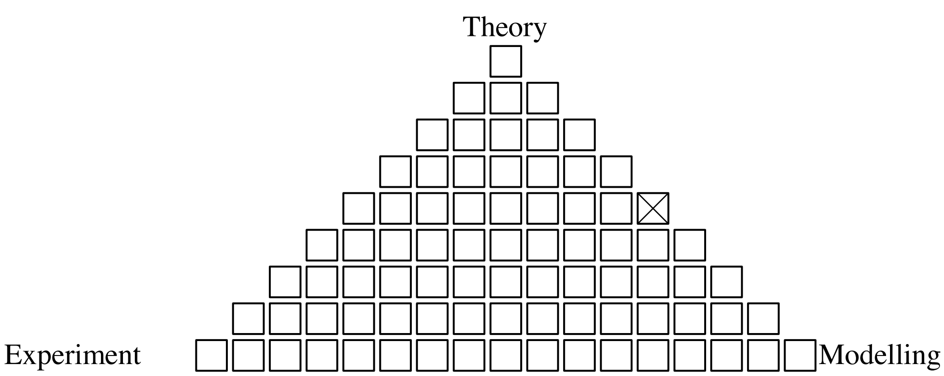
Backup Supervisor N/A

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for “theoretical physics” no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Aspects related to the quality of student-generated multiple choce questions from the PeerWise exercises run in Physics 2 between 2011-12 and 2013-14 will be investigated. Bloom's taxonomy ratins will be used to determine whether or not questions and explanations target the use of higher order cognitive skills. The relationship between student engagement and the quality of materials produced will be looked at. Does a "just-in time" approach to study engender lower quality output? Does the assessment scheme affect the quality of student-generated materials? This project would suit someone(s) with an interest in physics education resesearch and/or teaching. Familiarity with statistical testing would be beneficial. Literature review followed by classification and statistical analyses.

Project 120

Group SUERC Physics Group

Project name Re-appraising the heat flow from Scottish Granites

Supervisor Tim Kinnaird

Backup Supervisor David Sanderson

Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" yes

Project description (length should not exceed remainder of page)

Reducing dependence on carbon based energy resources remains an urgent global problem if the impacts of anthropogenic climate change are to be diminished. Both UK and Scottish Governments have targets to increase renewable energy contributions by 2020. Radiothermal granites are found in Cornwall, northern England and the eastern Highlands of Scotland. Thermal gradients recorded in the 1980's from shallow boreholes suggested that the resource potential of the granites in SW England were greater. However, this evaluation may have underestimated the potential heat flow from the Scottish granites, as a consequence of Pleistocene cooling effects. With this in mind, work will be undertaken to explore the potential of luminescence methods to register time averaged thermal histories over the timescales of glacial cooling cycles with a view to re-examining shallow borehole samples for thermal anomalies. Previous work [1,2,3] has confirmed that TL onset temperature maintains a simple dependence on irradiation temperature under isothermal conditions, and is a sensitive palaeothermometric indicator. This project will apply these methods to rock samples extracted from boreholes pentrating granites in SW England, southwest Scotland, and the Cairnograms, to determine if there is a thermal anomaly consistent with Pleistocene cooling.

[1] Spencer, J.Q., Sanderson, D.C.W., 1994, Radiation Measurements. 23, 465-468.
[2] Spencer, J.Q., 1996. Ph.D thesis, University of Glasgow.
[3] Spencer J.Q., Sanderson D.C.W., Journal of Archaeological Science 39 (2012) 3542-3552

IThe work will be conducted at the Scottish Universities Environmental Reserch Centre in East Kilbride.

Project 121

Group Environmental Physics group - SUERC

Project name You are what you eat : investigating the use of low level gamma spectrometry in studies of food authencity.

Supervisor Dr. Lorna Carmichael (SUERC)

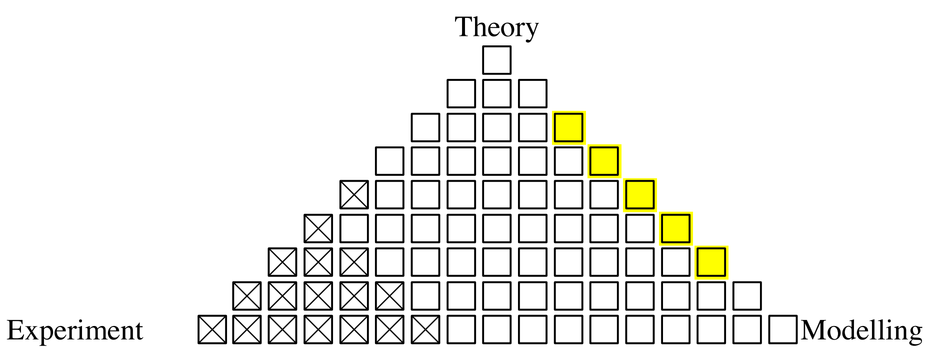
Backup Supervisor Professor David Sanderson

Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? yes

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Consumers around the world are increasingly demanding information on and reassurance of the origin and content of their food. Food manufacturers need to provide and confirm the authenticity and point of origin of food products and their components. Food authenticity testing currently utilises many approaches and techniques which are constantly changing to meet emerging challenges. Scotland has a wonderful 'natural larder' with Scottish salmon and shellfish, Scotch beef and other iconic Scottish products commanding premium prices in global markets. In this project the potential of using low level gamma spectrometry in food autheticity will be examined. The distribution and composition of both naturally occuring and fallout nuclides are both spatially variable, and potentially mopdified by adulteration. Can these be used to help identify the year of production and autheticity of food products? The project will include a literature review and a case study using Scottish produce to appraise potential.

Project 122

Group Environmental Physics group - SUERC

Project name You are what you eat : investigating thermoluminescence and photostimulated luminescence as potential tools in food authentication.

Supervisor Dr. Lorna Carmichael (SUERC)

Backup Supervisor Professor David Sanderson

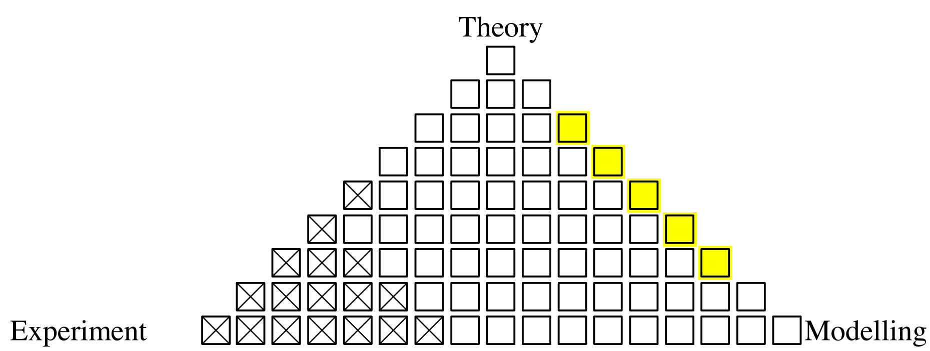
Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? yes

Project balance

Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Consumers around the world are increasingly demanding information on and reassurance of the origin and content of their food. Food manufacturers need to provide and confirm the authenticity and point of origin of food products and their components. Food authenticity testing currently utilises many approaches and techniques which are constantly changing to meet emerging challenges. Scotland has a wonderful 'natural larder' with Scottish salmon and shellfish, Scotch beef and other iconic Scottish products commanding premium prices in global markets. In this project the potential of using stimulated luminescence from mineral impurities in foods as an additional autheticity tool will be explored. It is expected that the student would undertake a desktop exercise to identify ways of applying thermoluminescence and photostimulated luminescence techniques to food autheticity and then undertake a small case study using these methods on samples of Scottish shellfish to appraise potential.

Project 123

Group Environmental Physics group - SUERC

Project name Photon counting statistics and limits of detection for single grain and multigrain luminescence dating of fluvial sediments

Supervisor Dr. Tim Kinnaird (SUERC)

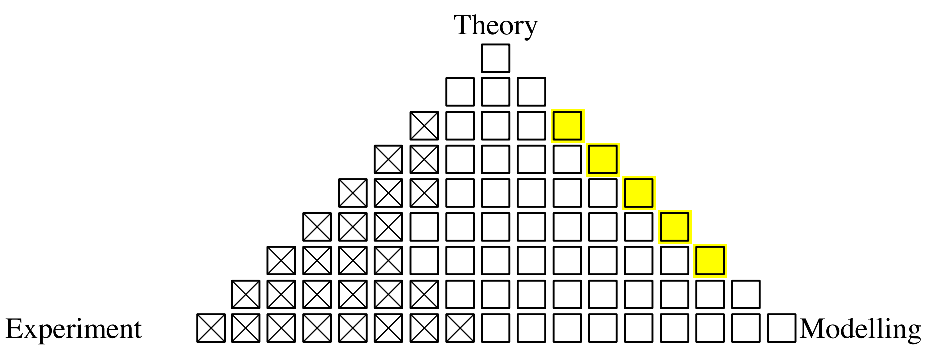
Backup Supervisor Professor David Sanderson

Suitability 20 credit no 30 credit yes 40 credit yes

Suitable for "theoretical physics" no

Off-campus work required? yes

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Optically stimulated luminescence (OSL) dating is today widely applied widely to determining the depositional ages and deposition rates of diverse environmental and archaeological sediments. The underlying principle is that naturally occuring minerals can store energy and information through defect linked charge carrier trrapping in response to ionising radiation exposure in the natural environment. Stimulated luminescence measurements are used to register the extent of trapping and, in combination with known labroatiory radiatio exposure to determine the radiation dose received since an earlier zeroing event in the past. Determination of environmental dose rates is used to evaluate the elapsed time. Where sediments are well zeroed - for example by multiple cycles of exposure to daylight prior to final deposition - the method can give highly accurate and precise dates for events ranging from recent time back to several hundred thousand years. However there are many classes of environmental sediments where incomplete zeroing, and post depositional modifications lead to complex dose distributions, which are modelled to attempt to recover chronological information. Both multi-grain and single grain OSL measurements are used in dealing with such hetergeneous materials, with single photon counting as the method for registering weak luminescence signals.

In developing statistical models for managing data sets from such work it has frequently been assumed that photon counting follows poisson statistics, with random measurement noise broadening uncertainty distributions and limiting detection of weak signals from small samples. Recent work in Poland has questioned whether photon counting errors can be assumed to follow Poisson statistics, particularly at low count rates close to dark count levels, and work is needed both to explore the reasons and origins of additional variance sources operating at levels close to detection limits, and to appraise the impact on dating complex sediments using single grain methods (where many grains may fall beneath phton counting detection limits) and multigrain systems (where heterogeneity may be masked by intra-grain signal averaging) .

SUERC has test data on more than 270 photon counting systems produced for detection of of irradiated foods, and several different systems in use for lumienscence work. In this project the systems and data will be reviewed to assess whether there are relationships between dark count rates and deviations from random variations are low count rate. Work will also be undertaken to characterise systems for single grain analysis, and to compare results from single and multigrain measurements from mixed age sediments from Australian and Mexican rivers. The chronologies of these sediments, are important to understanding the associations between historic flood events and land use, and in suggesting ways of flood mitigation in the future.

[1] Adamiec, G., Heer, A.J., and Bluszcz, A., 2012, Statistics of count numbers from a photomultiplier tube and its implications for error estimation: Radiation Measurements, v. 47, p. 746-751. The work will be conducted at the Scottish Universities Environmental Reserch Centre in East Kilbride.

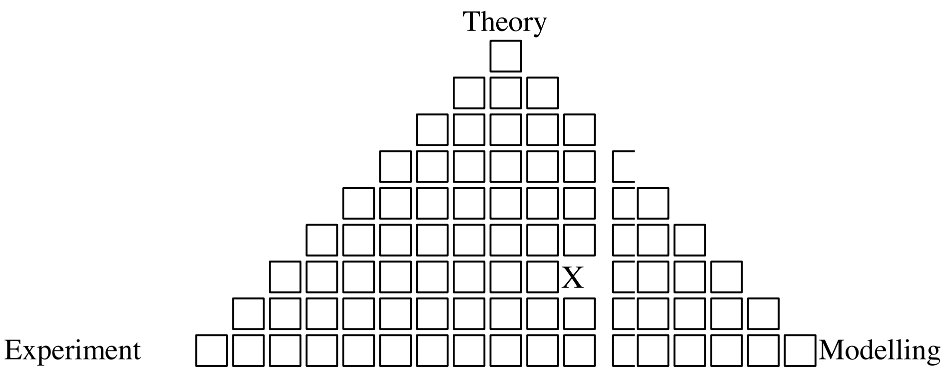
Project 124

Group A&A

Project name Pulsar telescope antenna noise and pattern modelling

Supervisor Graham Woan

Backup Supervisor Hamish Reid
Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) yes
Suitable for "theoretical physics" yes
Off-campus work required? no
Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The Acre Road pulsar telescope has been monitoring the pulsar PSR B0329+54 for several months at 408 MHz, gathering timing data for spindown measurements and long-term pulsar timing. We hope to extend the number of pulsars that can be monitored in this way by improving the sensitivity of the array, and this involves a better understanding of the noise in the system. This project involves modelling the antenna pattern of the array using standard antenna-modelling NEC code (http://en.wikipedia.org/wiki/Numerical_Electromagnetics_Code) in a suitable wrapper such as 4nec2 (http://www.qsl.net/4nec2/). This antenna pattern will depend on the pointing direction and polarization, and the noise in the system is largely determined by spillover into this antenna pattern from ground emission. The second part of this project involves placing this antenna pattern in a simulation of the ground and sky at Acre Road, including the observed sky brightness at 408MHz developed by Haslam et al (eg http://lambda.gsfc.nasa.gov/product/foreground/haslam_408.cfm), to determine how the antenna temperature due to sky noise and spillover varies with hour angle as we track this source (and other sources such as the Crab pulsar). The project can then go on to investigate how this noise can be minimized by adjusting the positions of the antennas in the array.
The student would be happy with coding in a variety of environments and have a familiarity with the basics of antenna theory.
(Background information: Data taken with an Ettus Research software defined radio (https://www.ettus.com/product/details/UB100A-BDL) and recorded using Gnuradio (http://gnuradio.org/redmine/projects/gnuradio/wiki).

Project 125

Group PPE

Project name Monte Carlo Generators for NA62

Supervisor David Britton

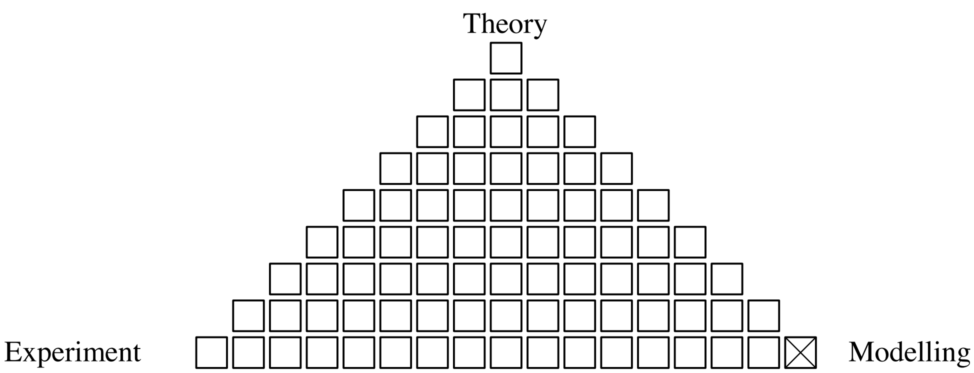
Backup Supervisor Dan Protopopescu, Ian O. Skillicorn

Suitability 20 credit no 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

NA62 is an experiment on the SPS at CERN, aimed to measure the very rare kaon and pion decays. To understand the experimental measurements and how instrumental factors come into play, one must model the physics and the detector via Monte Carlo simulations. This project involves implementing in software the most accurate decay generators found in the theoretical literature, verifying and comparing the code, and understanding how detector acceptance and resolution influence the final results as obtained from the full Monte Carlo.

Good knowledge of Linux, C++ and F77 is required

Project 126

Group Particle Physics Experiment

Project name Understanding the top quark using LHC data

Supervisor Mark Owen

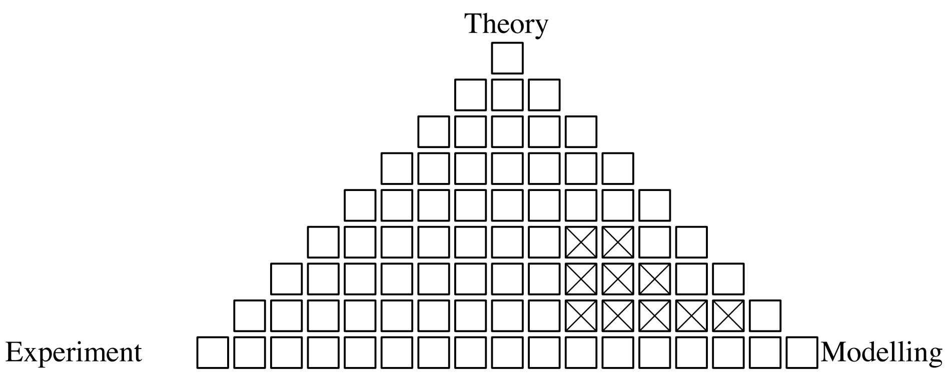
Backup Supervisor James Ferrando / Tony Doyle (TBC)

Suitability 20 credit yes 30 credit yes 40 credit yes 60 credit (MSc) no

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

The top quark is the heaviest known fundamental particle. The high energy of the Large Hadron Collider results in the production of millions of top quark events and these events can be used to see if the top quark behaves as expected by the Standard Model of particle physics. The goal of this project is to make a systematic comparison the results from the ATLAS experiment on top quarks with the predictions available in the state of the art Monte Carlo (MC) generators that provide Standard Model predictions. The project will start by comparing existing ATLAS MC samples to the data results and calculating the level of agreement between the data and the MC. The project could then expand to look at either more advanced MC simulations or to investigate new measurements that could be done on top quark events with the data from the next LHC run.

Project 127

Group PPE

Project name nuSTORM Near Detector Interaction Studies

Supervisor Dr. Ryan Bayes

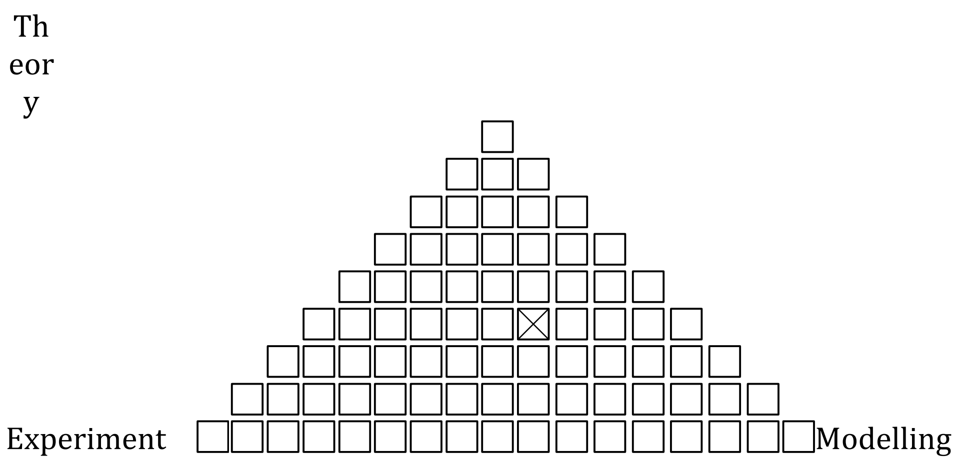
Backup Supervisor Prof. Paul Soler

Suitability 20 credit **no** 30 credit **yes** 40 credit **yes** 60 credit (MSc) **yes**

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Neutrino-nucleus scattering is an important field of study for the understanding of uncertainties in next generation neutrino oscillation experiments. However uncertainties in the available neutrino sources impair these studies making the exploration of new facilities very important. nuSTORM is the most basic implementation of a neutrino production facility using stored muons. This facility is exciting because it will
produce neutrino beams of a type unseen before with a precision in the neutrino spectrum that is not available at any other facility which can be used as an unprecedented probe of nuclear structure. To make the best use of this facility a near detector must be constructed to study neutrino interactions with nuclei. The student will contribute to the design and simulation of such a near detector and will be expected to report on the results of that simulation. This project will require the use of the programming language C++ and python to contribute to the detector simulation and evaluate the results. Prior experience is not necessary, but it will be a great asset.

Project 128

Group PPE

Project name Simulation Studies of the Muon Ionization Cooling Experiment

Supervisor Dr. Ryan Bayes

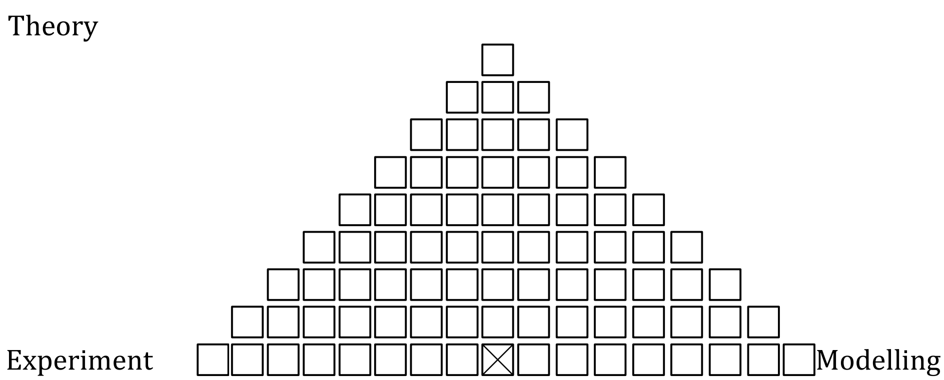
Backup Supervisor Prof. Paul Soler

Suitability 20 credit **yes** 30 credit **yes** 40 credit **yes** 60 credit (MSc) **no**

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)



Project description (length should not exceed remainder of page)

Ionization cooling is a method by which a beam of particles may be restricted in their behaviour suitable for acceleration. It is the only method of beam cooling that can operate on the time scale of a muon decay allowing for the development of muon accelerators such as neutrino factories and muon colliders. MICE (the Muon Ionization Cooling Experiment) exists to demonstrate sustainable ionization cooling for the first time. MICE is now poised to take data exploring the material properties affecting cooling. A student may make a strong impact running simulations to understand the behaviour of the channel under various anticipated running conditions. This project will require the student to use programming languages such as C++ and python to run and evaluate the channel simulation. No prior experience will be necessary, but such experience will be and asset. The student can also expect to learn about a variety of particle detection techniques.

Project 129

Various projects at the IAEA Nuclear Science and Instrumentation Laboratory (NSIL)

Group: IAEA / NSIL

Supervisor: Dr Iain Darby

Email address: i.darby@iaea.org

Second supervisor: Prof Ralf Kaiser

Project description:

The IAEA Nuclear Science and Instrumentation Laboratory (NSIL) carries out R&D projects in detector development, digital electronics, X-ray spectrometry, synchrotron radiation experiments and environmental monitoring. Current projects include UAV-based gamma spectrometry, the development of a portable X-ray and gamma spectrometer and an X-ray fluorescence beam line at the Elettra Synchrotron in Trieste, Italy. The laboratory is located in Seibersdorf, outside Vienna.

NSIL expects to have several spots for internships available over the summer of 2014 that are suitable for MSc thesis work. Internships are funded at 1000 Euro/month, which is suitable to cover the cost of living in Vienna. Topics are developed in discussion with the interns to fit into the overall R&D work of the laboratory. Interested students should contact Dr Iain Darby (i.darby@iaea.org) or Prof Ralf Kaiser (r.kaiser@iaea.org).

Students interested in this project should also contact the MSc project coordinator, Dr Nicolas Labrosse.

Project 130

Group A&A

Project name Modelling wind velocity fields using "lidar" data

Supervisor Martin Hendry

Backup Supervisor Peter Clive (Sgurr Energy)

Suitability 20 credit no 30 credit no 40 credit no 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance

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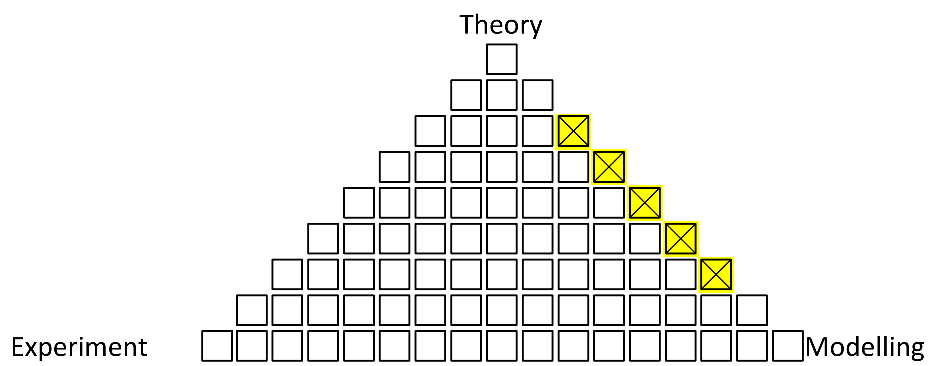

Project description (length should not exceed remainder of page)

Wind energy generation is a growth industry, particularly in Scotland. However, before any wind farm project can be undetaken its projected energy production must be carefully modelled so that finance can be raised to support it. Historically there has been a shortfall between our ability to describe wind conditions on the basis of well-developed theory and our ability to acquire data that matches the detail and precision of the theory using very limited instruments. As a result, various engineering approximations have been adopted, some of which have later been found to be seriously deficient. Recently, however, the adoption of revolutionary new measurement systems such as lidar has provided much richer datasets with which to model wind flow, and this in turn is transforming our ability to predict accurately and precisely the performance of wind turbines.

The aim of this project will be to explore some of the mathematical modelling techniques used to reconstruct 3-D wind velocity fields from lidar data, and seek to improve these techniques by exploiting (where appropriate) similarities with compuational and data analysis methods employed to reconstruct 3-D dynamical fields in theoretical physics and astrophysics problems.

The project will involve some collaboration with scientists at Sgurr Energy, in Glasgow, gaining familiarity with the methods currently being used and better understanding the quality and quantity of data that can be acquired using lidar and other measurements.

University of Glasgow | School of Physics & Astronomy

MSc Projects 2014-2015

Version 1 – 13/02/15

Table of Contents

Active Seismic isolation for high precision laser interferometry

Group: IGR

Supervisor: Dr Stefan Hild

Email address: Stefan.Hild@glasgow.ac.uk

Backup Supervisor: Dr C Graef / Dr S Steinlechner

Suitability 20 credit no 30 credit no 40 credit no 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
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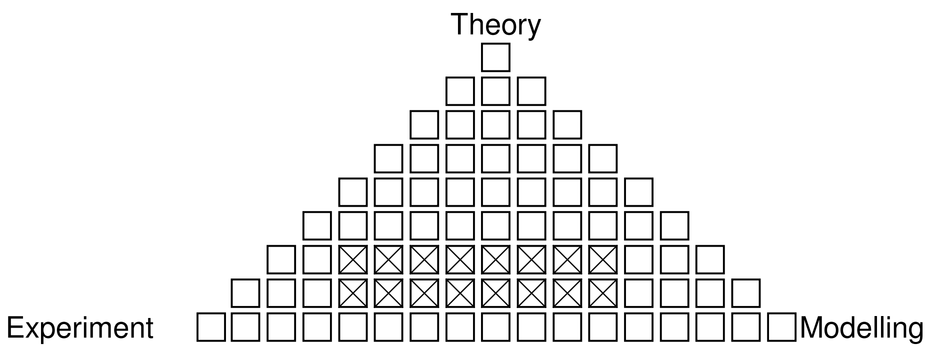

Project description (length should not exceed remainder of page)

The world's first Sagnac Speedmeter (SSM) is under construction in one of Glasgow University's IGR labs. It is theoretically capable of outperforming the Heisenberg uncertainty principle, and our proof of principle experiment seeks to establish the SSM's capabilities. This student project will focus on the continuing development of sub-systems and analysis of the SSM. In particular this project will deal with designing, building and comissioning of an active seimic isolation, which uses seismic senors to create control signals used by an servo control loop to stabilise the movememnt of the experiment setup to sub nm accuracy.

Optimising parameters of advanced interferometer schemes with reduced quantum noise

Group: IGR

Supervisor: Dr Stefan Danilishin

Email address: sdanilis@caltech.edu

Backup Supervisor: Dr Stefan Hild

Suitability 20 credit no 30 credit no 40 credit no 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
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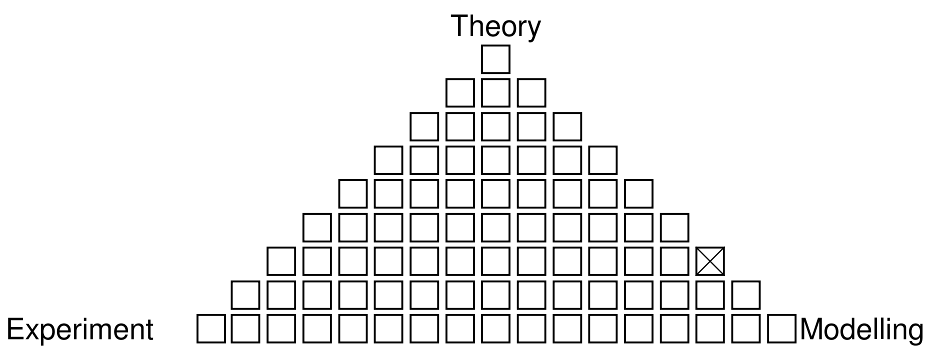

Project description (length should not exceed remainder of page)

Laser interferometers used to detect gravitational waves are perhaps the most sensitive measurement apparatuses created by mankind thus far. They are so sensitive that quantum fluctuations of light are going to be seen by them soon, thereby masking the signal displacement of interferometer's mirrors induced by gravitational waves. Therefore it is crucial to learn how to suppress quantum noise. Using advanced quantum measurement techniques is the way to do this.
In this project, the students are supposed to explore the parameter regimes of advanced interferometer configurations and come up with the optimal parameter sets for them, using standard numerical optimization procedures. Knowledge of scientific calculations software, *e.g.* Matlab/Octave is essential and any experience with Mathematica or basic scientific programming languages like C and Python is helpful, though not vital.

Minimum bias and underlying event in LHC Run 2 data

Group: PPE

Supervisor: Andy Buckley

Email address: andy.buckley@cern.ch

Second supervisor: Kenneth Wraight

Suitability 20 credit no 30 credit no 40 credit no 60 credit (MSc) yes

Suitable for "theoretical physics" no

Off-campus work required? no

Project balance
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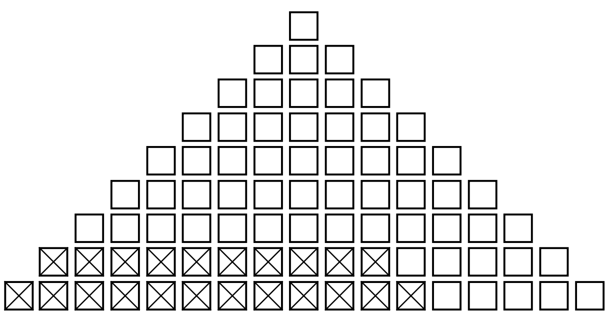
Theory



Experiment Modelling

Project description:

The Large Hadron Collider will resume data-taking in May 2015 at an unprecedented nucleon collision energy of 13 TeV. The first measurements to be made in this "Run 2" phase will be "minimum bias" event characteristics, i.e. energy and particle flows in generic proton-proton collisions. These will test the ATLAS experiment's particle detection systems and establish the overall level of proton constituent interactions – and reveal important new data about the energy dependence of proton collisions. This project will analyse first LHC Run 2 data, in particular to measure the so-called underlying event: the way that bulk proton interactions depend on the most energetic partonic interactions within them. The focus will be on programmatic data analysis and event simulation, and good familiarity with the Linux computing environment and the C++ and Python languages will be important for making progress.

Quark/gluon jet labelling and photon isolation

Group: PPE

Supervisor: Andy Buckley

Email address: andy.buckley@cern.ch

Second supervisor: Chris Pollard

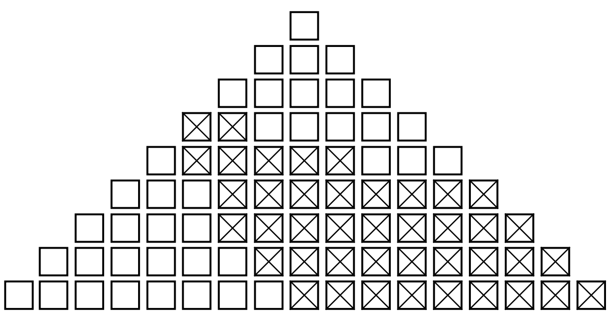
Suitability 20 credit no 30 credit no 40 credit no 60 credit (MSc) yes

Suitable for "theoretical physics" yes

Off-campus work required? no

Project balance
Indicate the relative balance of Theory/Experiment/Computer Modelling with a single or multiple checks. (For example, checking the highlighted boxes would indicate the possible range of the balance between Theory and Modelling for a hypothetical project that involves no experimental component)

Theory



Experiment Modelling

Project description:

At the Large Hadron Collider, protons are hit together with 8 TeV (and soon to be 13 TeV) of energy – roughly 5,000 times their rest mass energies. Rather than a homogeneous splash of particles, these high-energy collisions produce collimated "jets" of particles which reflect the underlying dynamics of fundamental high-energy parton interactions. For many physics studies at the LHC it would be useful to be able to discriminate between final-state jets and interpret them as representing fundamental parton flavours. This project will use simulations of LHC events and a new algorithm for "true" jet flavour labelling to investigate jet signatures which can be used to make such identifications in data, and to study the extension of the algorithm to define "prompt" photons. Correlations will be investigated using techniques from information theory. The focus will be on programmatic data analysis, event simulation, and design of kinematic observables; good familiarity with the Linux computing environment and the C++ and Python languages will be important for making progress.

Project name: Non-standard top phenomenology at the LHC

Group: PPT

Supervisor: Dr Christoph Englert

Email address: christoph.englert@glasgow.ac.uk

Second supervisor: Dr David J Miller

Project description

The top quark, being the heaviest fermion in the Standard Model (SM), is considered to be of seminal importance for the discovery of new physics beyond the SM. In particular, potential non-standard interactions are important in the context of Higgs physics. The project focuses on non-SM extensions of the top and top-Higgs sectors and seeks to devise and classify phenomenological approaches to constrain and potentially observe such modifications. The tasks involved in the project range from Monte Carlo development and implementation of a subset of the mentioned interactions into simulation frameworks to performing realistic hadron-level analyses of collider observables to obtain estimates of the LHC sensitivity yield. Experience with UNIX/LINUX operating systems and a basic knowledge of Quantum Field Theory and the Standard Model of Particle Physics is helpful.