DEPARTMENT OF PHYSICS

Fourth Year Research Projects

2015/16

SECOND ROUND

Table of Contents

Health and Safety

Undergraduate students need to undergo appropriate safety training for their projects. The University Occupational Health & Safety Arrangements state:

16.4 Supervision of Students

- Departments recognise that most undergraduate students are initially untrained in matters of health and safety, therefore, Academics will provide information, instruction, training and "such supervision as is necessary", for all aspects of coursework, to ensure, so far as is reasonably practicable, the health and safety of both postgraduate and undergraduate students;

- Coursework will cover, practical work, project work, fieldwork, work placements and any other aspect required of students by their courses;

- Departments will record the means of delivery of the health and safety programme for each course, each year;

- Academic Supervisors will determine the appropriate level of supervision, based on an assessment of risks of the research or teaching activity etc. and documented training received by students; Academic Supervisors will personally provide necessary supervision, unless others are identified by the relevant risk assessment.

An Undergraduate safety induction training record is required to be completed for each project student. Please ensure that the training is completed and the form returned to Shirley Wylie before the project work begins. (see Appendix 1)

With thanks,

Mr Ron Weston

Nanoscience Division

Predicting Solvation Thermodynamics of Bioactive Molecules

Project Supervisors: (1) Prof. Maxim V. Fedorov, (2) Dr. Neil Hunt & Dr. David Palmer

Project Description:

The project will study solvation thermodynamics of bioactive molecules by novel computer modelling methods.

One of the main causes of the unacceptable attrition rate in drug discovery is the failure of molecules to reach the market place because they have the wrong physico-chemical properties to allow them to be orally administered to patients. Indeed, as many as 40% of all drug failures on the market have been attributed to these problems.

Experimental high-throughput measurements of physico-chemical properties of bioactive molecules (solubility, pKa, logP, etc) are traditionally used to screen candidate drug molecules. However, such experiments are expensive, time-consuming and can only be applied to molecules that have already been synthesized. An alternative approach is to use computer simulations to calculate the properties of putative drug molecules.

Recently we developed a highly efficient method for predicting solvation thermodynamics parameters of bioactive molecules in a view of potential medical and environmental applications. The method is based on a molecular theory of solutions, Reference Interaction Sites Model (RISM). The student will have the opportunity to be involved into large-scale computational screening of thermodynamic properties of drug-like molecules and agrochemicals by this new method.

Reference: *Kerns, E. H. & Di, L. (2008), Drug-like properties: concepts, structure design and methods: from ADME to toxicity optimization, Academic Press;*

Additional references will be provided.

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0%**
	Theo:	**30%**
	Comp:	**70%**

Suitability: MPhys, BSc

Recommended Classes/Pre-requisites: *Topics in Atomic, Molecular & Nuclear Physics (PH459)*

Additional comments: *Suitable for Masters-level students with good computer skills and an interest in chemical/molecular physics or biophysics. This is an excellent opportunity for students to get experience in novel state-of-the-art methods of molecular modelling.*

Safety Training Requirements: *none*

Effects of Salts on Surfactant Solutions

Project Supervisors: (1) Prof. Maxim Fedorov, (2) Dr. Neil Hunt

Project Description:

The project is focused on molecular-scale simulations of effects of ions on the stability of surfactant solutions. Aqueous surfactant solutions are widely used in many industries; however, we are particularly interested in surfactants used for enhanced oil recovery (EOR).

In this project we will use Molecular Dynamics simulations for understanding molecular-scale effects of dissolved inorganic salts on stability of aqueous surfactant solutions. We plan to use large-scale supercomputer simulations to investigate thermodynamics of ion and surfactant solvation in water; physico-chemical properties of surfactant/salt solutions at high temperature and pressure; the role of ions and counter-ions such as naturally occurring in sea water and ion effects on the phase diagram of surfactant solutions.

The student will get experience with High Performance Computing (HPC) applications in chemical physics and use of HPC in development of advanced EORs. The computational part of the project will be done with use of the ARCHIE-WeST HPC facilities (www.archie-west.ac.uk).

Key Reference (if applicable): *(book) Israelachvili, J.N., 2011. Intermolecular and surface forces. Academic Press, Burlington, MA.*

(book) Frenkel, D., Smit, B., 2002. Understanding molecular simulation. Academic Press.

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0 %**
	Theo:	**50 %**
	Comp:	**50 %**

Suitability: MPhys, BSc, BSc (Phys with Teaching), BSc (Maths Physics)

Recommended Classes/Pre-requisites: *Topics in Atomic, Molecular & Nuclear Physics (PH459)*

Additional comments: *Solid background in theoretical physics and statistical mechanics is strongly required. Some experience with computations and/or data analysis would be a plus.*

Safety Training Requirements: *None*

Uncovering the Early Stages of Protein Folding

Project Supervisors: (1) Dr. Neil Hunt, (2) Prof. Maxim Fedorov

Project Description:

The aim of this project is to use state of the art ultrafast laser based techniques to examine physical aspects of the topical subject of protein folding.

Proteins are of fundamental importance in biology as they play key roles in the life of every living organism. Proteins can be described as linear polymers of amino acids and their properties are determined by the structure of this polymer chain. Proteins tend to adopt only a limited number of spatial arrangements, the most common of which are the α-helix, a coil-like structure, the planar β-sheet motif and the random coil. Besides the obvious importance of folding in determining the properties of proteins, in recent years it has emerged that serious diseases, such as Alzheimer's, Diabetes and Creutzfeldt-Jakob disease, are associated with incorrect (mis-folded) protein conformations. The mechanism by which a protein undergoes changes in structure is therefore of great interest.

So far, the physics of protein folding are not fully understood. There is a general consensus that the final, fully folded, form of the protein is reached *via* a series of intermediate structures that exist for very short periods of time (10^{-12}-10^{-3}s) This project will examine these intermediate structures using a combination of Fourier transform infrared (FTIR) absorption spectroscopy and ultrafast 2D-IR spectroscopy. By examining short chain polypeptide models, we will build up a library of IR spectra under a range of conditions. The project will then progress to studies of isotopically-labelled peptides in order to gain site-specific information relating to the structure, dynamics and, ultimately, folding processes of these model proteins. If successful, there is scope to expand the project to larger protein systems.

Key Reference (if applicable): *N.T.Hunt, "2D-IR spectroscopy: ultrafast insights into biomolecule structure and function", Chem. Soc. Rev. 38, 1837-1848 (2009) doi: 10.1039/b819181f*

Ratio of effort: Exp/Theo/Comp	**Exp:**	**75 %**
	Theo:	**10 %**
	Comp:	**15 %**

Suitability: MPhys

Additional comments: *Suitable for Masters-level students with an interest in biophysics or chemical physics. The project will be multidisciplinary in nature and will require the student to be proactive in tackling associated new skills and subject matter.*

Safety Training Requirements: *Chemical and Laser Safety*

Optical Modes and Multiple Scattering

Project supervisors: (1) Dr. Ben Hourahine (2) Dr. Francesco Papoff

Project Description:

It has recently been shown that the optical properties of most nano-particles can be understood as arising from the modes of the particle. These are, like the standing acoustic waves of an organ pipe or the wavefunctions of a quantum mechanical particle in a box, distinct solutions of the appropriate wave equations (here, Maxwell's equations). However, if a second particle is brought close by, how does this affect these modes?

Light will then "bounce" between these two particles (multiple scattering), leading to a new set of optical modes which describe the whole composite system. This project will theoretically and computationally study the transition between the isolated and coupled modes of two glass particles as they approach each other.

Key Reference (if applicable):

F. Papoff, B. Hourahine, Geometrical Mie theory for resonances in nanoparticles of any shape, Optics Express, 19, 21432 (2011)

Ratio of Experiment/Theory/Computation:	**Exp:**	**0%**
	Theo:	**50%**
	Comp:	**50%**

Suitability: MPhys, BSc

Optics Division

Observing Beam Propagation by Fluorescence

Project Supervisors: (1) Dr. Aidan Arnold, (2) Dr. Paul Griffin

Project Description:

You will make a thorough investigation of the Beer-Lambert Law (and its generalisation) by imaging the fluorescence (spontaneous emission) of rubidium atoms in a vapour cell to detect the local intensity of laser beams propagating through the cell. Key variables include the beam initial intensity, beam shape, and cell temperature. Possible extensions are the investigation of multiple beam interference, and dynamically scanned beams. The project requires a student with good experimental and analysis skills.

Key Reference: *N. Radwell, M. A. Boukhet, and S. Franke-Arnold, Opt. Express **21**, 22215 (2013).*

Ratio of effort: Exp/Theo/Comp	**Exp:**	**70%**
	Theo:	**20%**
	Comp:	**10%**

Suitability: MPhys

Additional comments: *Lab JA3.04A*

Safety Training Requirements: *Laser safety training required.*

Quantum Measurement in the Jaynes-Cummings Model

Project Supervisors: (1) Dr. Daniel Oi, (2) Dr. John Jeffers

Project Description:

Measurement plays a vital role in quantum information theory. Non-destructive measurement of optical fields is challenging to implement. One method is to couple a two-level atom to a cavity mode and through the interaction extract information from the field via the atomic state. Due to bosonic enhancement, the resulting measurement operators can be complicated and this project will investigate the resulting cavity dynamics.

Key Reference:

Nondemolition measurement of the vacuum state or its complement, D.K.L. Oi, V. Potoček, J. Jeffers, Physical Review Letters ***110****, 210504 (2013)*

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0%**
	Theo:	**50%**
	Comp:	**50%**

Suitability: MPhys, BSc, BSc Maths and Physics, BSc Physics with Teaching

Recommended Classes/Pre-requisites: *Topics in Quantum Theory (PH458)*

Additional comments:

Safety Training Requirements:

Ancilla-driven Quantum Dynamics

Project Supervisors: (1) Dr. Daniel Oi, (2) Dr. Marco Piani

Project Description:

The ability to perform information processing tasks using quantum systems depends on the resources available. In the Ancilla Driven Quantum Computation model, the main resource is a single two-qubit unitary interaction that can drive evolution of a system via coupling to an ancilla. By suitable preparation and measurement of the ancilla, different effects can be applied to the system, but this depends on the form of the interaction. This project would investigate the relationship between the form of the unitary and what can be achieved.

Key Reference:

Ancilla-driven universal quantum computation, J. Anders, D.K.L. Oi, E. Kashefi, D.E. Browne, E. Andersson, Physical Review A ***82****, 020301 (2010)*

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0%**
	Theo:	**90%**
	Comp:	**10%**

Suitability: MPhys, BSc, BSc Maths and Physics, BSc Physics with Teaching

Recommended Classes/Pre-requisites: *Topics in Quantum Theory (PH458)*

Additional comments:

Safety Training Requirements:

Floquet theory for trapped atoms in optical lattices.

Project Supervisor (1) Dr Luca Tagliacozzo (2) Dr Daniel Oi

Project Description

In the last years we have observed an impressive improvement of the experimental control of quantum systems. In particular cold atoms can be trapped in optical lattices and observed individually [1].

In order to obtain such a control the atoms need to be very diluted and thus their only interactions are contact two body collisions. Recently people have proposed to drive the optical lattices periodically in such a way to effectively give rise to novel and interesting types of interactions [2,3].

When the driving is periodic at sufficiently high frequencies one can use the Floquet theory [4] to obtain an effective Hamiltonian that describes the slow dynamic on the top of the fast one. In this project we will review the theory beyond such ideas and compare the effective Hamiltonian with the exact dynamics for very small systems using exact diagonalization techniques for small systems in several exemplary cases.

Key References:

[1] I. Bloch, Ultracold quantum gases in optical lattices. Nature Physics 1, 23 (2005).
[2] A. Eckardt, C. Weiss, M. Holthaus PRL 95 (26), 260404 (2005)
[3] N. Goldman and J. Dalibard Phys. Rev. X 4, 031027 (2014)
[4] https://en.wikipedia.org/wiki/Floquet_theory

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0 %**
	Theo:	**50 %**
	Comp:	**50 %**

Suitability: MPhys, BSc, BSc Maths and Physics, BSc Physics with Teaching

Recommended Classes/Pre-requisites: *Topics in Quantum Theory (PH458)*

Additional comments: The student should be interested in working with numerical techniques and comfortable working with computers. Specific numerical methods will be covered over the course of the project as required. The student should also be comfortable with basic concepts of quantum mechanics.

Safety Training Requirements: No special safety training requirements.

Matrix product state representation of quantum states

Project Supervisor (1) Dr Luca Tagliacozzo (2) Dr Daniel Oi

Project Description

Many body quantum systems, systems made by several identical constituents, like materials, quantum gases, nuclei etc., are exponentially hard to describe. This means that we can at most describe exactly few tens of interacting particles but all interesting collective phenomena tend to appear when several thousand of particles interact strongly. This is at the origin of our incomplete understanding of several interesting effects, such as i.e. high temperature superconductivity.

In some cases, manly for systems organized in one dimensional structures such as wires and spin chains, however, people have been able to find extremely compact descriptions of specific states that allow to study very large systems and observe interesting emerging phenomena.

In this project we will discover one of these descriptions, the matrix product state representation of quantum states [2]. Originally introduced in the context of exactly solvable models [1] it is at the core of the Density Matrix Renormalization Group [3], the current standard tool to perform numerical simulations of 1D strongly correlated quantum systems. We will use this description to perform some simple out of equilibrium dynamics for 1D spin chains.

Key References:

[1] I. Affleck, T. Kennedy, E. H. Lieb, H. Tasaki, Comm. Mat. Phys. 115 477 (1998)
[2] D. Perez-Garcia, F. Verstraete, M.M. Wolf, J.I. Cirac, Quantum Inf. Comput. 7, 401 (2007)
[3] White S. PRL 69, 2863 (1992)

Ratio of effort: Exp/Theo/Comp		
	Exp:	**0 %**
	Theo:	**50 %**
	Comp:	**50 %**

Suitability: MPhys, BSc, BSc Maths and Physics, BSc Physics with Teaching

Recommended Classes/Pre-requisites: *Topics in Quantum Theory (PH458)*

Additional comments: The student should be interested in working with numerical techniques and comfortable working with computers. Specific numerical methods will be covered over the course of the project as required. The student should also be comfortable with basic concepts of quantum mechanics.

Safety Training Requirements: No special safety training requirements.

Modelling scanning near-field microscopy

Project Supervisors: (1) Dr. F. Papoff, (2) Dr. B. Hourahine

Project Description:

Scanning Near Field Optical Microscopes have been essential to investigate the optical properties of nano particles and nano cavities with a resolution higher than the diffraction lengths typical of conventional microscopes. One of the most remarkable recent developments has been the detection of the magnetic component of light at visible frequencies. This impressing ability has however highlighted the fact that the response of these microscopes depends crucially on the coupling between the metallic tip of the microscope and the nano structure investigated. In this project we aim to model this important effect and this will enable us to disentangle the properties of the nano structure investigated from those of the metallic tip.

Key References:

M. Burresi et al.,Magnetic Light-Matter Interactions in a Photonic Crystal Nanocavity, Phys. Rev. Lett. 105, 123901 (2010)

N. Caselli et al., Deep-subwavelength imaging of both electric and magnetic localized optical fields by plasmonic campanile nanoantenna, Sci. Rep. 5, 9606 (2015)

K. Imura et al., Plasmon modes in single gold nanodiscs, Opt. Exp. 22, 12189 (2014)

Ratio of effort: Exp/Theo/Comp	**Theo:**	**50%**
	Comp:	**50%**

Suitability: MPhys, BSc, BSc Maths and Physics, BSc Physics with Teaching

Recommended Classes/Pre-requisites:

Additional comments:

Safety Training Requirements:

Computational Modelling of X-ray Free Electron Lasers

Project Supervisors: (1): Dr. Brian McNeil, (2) Dr. Gordon Robb

Project Description:

X-ray Free-Electron Lasers (XFELs), such as the LCLS at SLAC in California [1] and SACLA at Spring-8 in Japan, use high energy electron bunches, produced by particle accelerators, to generate intense pulses of X-rays within a long magnet called an undulator [2].

The spatial and temporal resolution available from the high brightness ultra-violet to x-ray pulses generated by these XFELs, is making feasible the observation and ultimately the potential to control ultra-fast, optionally non-linear processes in all forms of matter. With the ability to probe correlated electronic processes within atoms at short timescales, to measure how electrons and nuclei re-organise themselves, either individually within atoms due to external stimulus, during molecular bond making and breaking, or while undergoing subtle catalytic or biological processes, we can begin to unravel how all matter functions at this fundamental level.

The supervisor of this project Dr Brian McNeil works closely with the UK's Accelerator Science and Technology Centre, along with international collaborators in this field. In the UK he is closely involved with the proposed CLARA facility based at Daresbury near Warrington [3]. Previously, good project students have obtained a summer studentship working there.

Starting from the basic working equations that describe the FEL process, the student will gain an understanding of how an XFEL works. You will then use numerical methods to solve the simplest case. This will involve solving equations describing the electron trajectories through the combined undulator and light fields, while simultaneously solving the equation that describes how the light field is driven by the electrons. Initially a code like MATLAB can be used. The student may wish to then use a lower-level language like Fortran, C or Java (your choice), to solve the same or extended equations describing further effects (e.g. harmonic light generation) and then present the solutions in a meaningful way using available plotting packages.

The skills that you will learn are generic to a working theoretical/computational physicist and will prepare you well for a future career in this field. A good student should be able to take the analysis further and begin looking at more advanced topics. This will be like performing ‘numerical experiments’. From these, it may be possible to predict new effects that can enhance or extend current XFEL performance.

Key Reference (if applicable):

[1] https://portal.slac.stanford.edu/sites/lcls_public/Pages/Default.aspx

*[2] B.W.J. McNeil & N.R.Thompson, 'X-ray free-electron lasers’, Nature Photonics, **4**, 814, 2010*

[3] http://www.stfc.ac.uk/ASTeC/Programmes/38749.aspx

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0%**
	Theo:	**25%**
	Comp:	**75%**

Suitability: MPhys, BSc, BSc (Maths Physics)

Safety Training Requirements: *Normal office/computer user induction.*

Programming a Gaussian-beam calculator with MATLAB

Project Supervisors: (1) Dr. Elmar Haller, (2) Prof. Dr Stefan Kuhr

Project Description:

The properties of Gaussian laser beams can be shaped by optical components, such as lenses, pin-holes, or wave plates and the propagation of the beam can be calculated analytically. For everyday lab-work it is extremely helpful to determine the expected shape and polarization of a laser beams before constructing the beam path on an optical table.

The goal of this project is to create a software program, which calculates the propagation of a Gaussian beam. The program should be written in the language MATLAB, and it should provide a simple interface for the user, which allows for a direct manipulation of the optical components with a computer mouse. The resulting program needs to be well documented and it will be published on the internet at MATLAB Central. The student will learn about the analytical description of Gaussian beams, the design of user interfaces, and the programming language MATLAB.

Ratio of effort: Exp/Theo/Comp	**Exp:**	**5%**
	Theo:	**30%**
	Comp:	**65%**

Suitability: MPhys, BSc, BSc Maths and Physics,

Additional comments: *The student should be familiar with basic programming and user interfaces (languages: Matlab).*

Safety Training Requirements: *None.*

Quantum enhanced imaging

Project Supervisors: (1) Dr. John Jeffers, (2) Dr. Wojciech Roga

Project Description:

The goal of the project is to apply quantum coincidence (ghost) imaging to modern digital imaging techniques and analyse their features.

In this project you will work on:

- Modern digital imaging techniques, including image perfecting and image enhancement.
- Application of quantum entanglement and other forms of correlations in photonic system to imaging (features of coincidence imaging).
- Applications of the imaging techniques e.g. data compression, biological imaging.

You will learn to use the following techniques:

- Fourier optics.
- Matrix analysis.
- Numerical simulations (Matlab).

Key References:

1. *Leonid P Yaroslavsky, Advanced Digital Imaging Laboratory Using MATLAB, IOP Publishing, Bristol 2014.*
2. *Joseph W. Goodman, Introduction to Fourier Optics, Roberts & Company Publ. Englewood, Colorado 2005.*
3. *Jeffrey H. Shapiro · Robert W. Boyd , The physics of ghost imaging , Quantum Inf Process (2012) 11:949–993*

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0%**
	Theo:	**50%**
	Comp:	**50%**

Suitability: MPhys, BSc, BSc Maths and Physics, BSc Physics with Teaching

Recommended Classes/Pre-requisites:

Candidate must have taken and passed well (>=65%) the following courses:

- *Quantum Physics and Electromagnetism (year 3)*
- *Computational Physics (year 2)*
- *Linear Algebra and Differential Equations (year 2)*

Additional comments: *The project is mainly theoretical with possible collaboration with experimental groups.*

Safety Training Requirements: *None*

Plasmas Division

Simulation and measurement of two-dimensional periodic surface lattice

Project Supervisors: (1) Prof. Adrian W. Cross, (2) Dr. Craig W. Robertson

Project Description:

The main goal of the project is to study the interaction between two-dimensional (2D) periodic surface lattice (PSL) structures and electromagnetic waves. The primary objectives are: 1/ Theoretical study of electromagnetic wave propagation through a cylindrical 2D periodic surface lattice; 2/ Develop a CST Microwave Studio computer model of electromagnetic wave interaction with the 2D PSL; 3/ Experimental study of the transmission of electromagnetic radiation through the cylindrical 2D periodic surface lattice.

The properties of a periodic structure will be measured using a Vector Network Analyser. Experimental measurements will be compared with CST Microwave Studio simulations of the transmission of electromagnetic radiation through the structures**.**

Key Reference (if applicable):

*[1] I.V. Konoplev, A.J. MacLachlan, C.W. Robertson, A.W. Cross and A.D.R. Phelps, 'Cylindrical periodic surface lattice as a metadielectric: Concept of a surface-field Cherenkov source of coherent radiation' Phys. Review A., **84**, art. 022902, 2011.*

*[2] I.V. Konoplev, A.J. MacLachlan, C.W. Robertson, A.W. Cross and A.D.R. Phelps, "Cylindrical, periodic surface lattice-Theory, dispersion analysis, and experiment, Applied Physics Letters, **101**. 121111, 2012.*

Ratio of effort: Exp/Theo/Comp	**Exp:**	**20%**
	Theo:	**30%**
	Comp:	**50%**

Suitability: PH550 M.Phys.

Additional comments:

Safety Training Requirements:

Design and simulation of a millimetre wave source based on a pseudospark produced electron beam

Project Supervisors: (1) Prof. Adrian W. Cross, (2) Dr. Huabi Yin

Project Description:

A project is proposed to design, simulate and numerically model a Backward Wave Oscillator (BWO) driven by a pseudospark (PS) electron beam. The BWO is based on the interaction between an electron beam and the negative spatial harmonic of a corrugated slow wave structure. The energy velocity in the slow-wave structure moves opposite to the phase velocity of the negative spatial harmonic. If the electron beam is synchronised with the negative spatial harmonic then the energy of the electron beam transfers to the field in the backward (with respect to the direction of beam propagation) direction [1].

A pseudospark (PS) is an axially symmetric, self-sustained, transient, low pressure (typically 50-500 mTorr) gas discharge in a hollow cathode/planar anode configuration, which operates on the low pressure side of the hollow cathode analog to the Paschen curve [2]. A useful property of this type of discharge is the formation of an electron beam during the breakdown process. During a PS discharge, low temperature plasma is formed as a copious source of electrons and can be regarded as a low work function surface that facilitates electron extraction [3]. Because of the special geometry and discharge mechanism, the electron beam from a PS discharge can propagate without an external magnetic guiding field due to the existence of an ion-focusing channel. The ion-focusing channel is formed due to the background gas ionization by the front of the electron beam itself. For generation of high frequency radiation in millimetre wave and sub-millimetre wave region this beam is ideal due to its small beam size, compactness and long lifetime. The project will involve the design of a millimetre wave BWO using analytical theory with the beam/wave interaction modelled using the numerical simulation code MAGIC.

Key Reference (if applicable):

[1] S. E. Tsimring "Electron Beams and Microwave Vacuum Electronics", Wiley Series in Microwave and Optical Engineering, John Wiley and Sons Inc, ISBN-13-978-0-470-04816-0, (2007).

[2] H. Yin, A. W. Cross, W. He, A. D. R. Phelps, K. Ronald, D. Bowes, C.W. Roberson "Millimeter wave generation from a pseudospark-sourced electron beam". Phys. Plasmas 16 (2009).

[2] D. Bowes, H. Yin, W. He, A.W. Cross, K. Ronald, A.D.R. Phelps, D. Chen, P. Zhang, X. Chen and D. Li, "Visualization of a Pseudospark-Sourced Electron Beam", IEEE Transaction on Plasma Science, 42, 10, pp2826-2827, (2014).

Ratio of effort: Exp/Theo/Comp	**Exp:**	**20%**
	Theo:	**30%**
	Comp:	**50%**

Suitability: PH450 BSc

Additional comments:

Safety Training Requirements:

Ion Acceleration in Relativistically Intense Laser- Solid Interactions

Project Supervisors: (1) Prof. Paul McKenna, (2) Dr. Ross Gray

Project Description:

By focusing petawatt-scale pulses of laser light to intensities exceeding 10^{20} Wcm^{-2}, solid density matter is heated to temperatures of >10^{9} K on timescales of 10's of femtoseconds. Under these conditions the solid target at the focus of the laser quickly evolves into an exotic state of matter called a *relativistic plasma,* as electrons in the material are accelerated to velocities approaching the speed of light. In this regime we are able to observe in the laboratory and in simulations Einstein's special theory of relativity at work. In plasmas with these extreme temperatures where electrons are approaching the speed of light, they gain additional mass due to the increasing Lorentz factor, g. These more massive electrons induce a reduction of the fundamental electron plasma frequency which defines the minimum frequency of electromagnetic radiation that can propagate in the plasma. This change in plasma frequency means that as g increases the plasma will become suddenly transparent to certain laser frequencies. Our understanding of so-called "relativistic induced transparency" is rapidly evolving and may have important implications for fundamental physics and for so called laser-driven ion acceleration. To date the acceleration of ions by lasers has been mostly studied in plasmas which are opaque to the laser. Now we are beginning to explore through simulations and experiment if the process of ion acceleration is enhanced when the plasma becomes relativistically transparent making it no longer opaque to the laser.

The objective of this project is to investigate the onset of relativistic induced transparency in dense plasmas irradiated by ultra-intense laser pulses and the subsequent effect on ion acceleration. This involves simulating the response of the plasma electrons and ions to the fields created at the focus of the laser pulse, using a particle-in-cell code running on a high performance computer. As well as performing analysis on the simulation data using tools such as MATLAB.

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0%**
	Theo:	**20%**
	Comp:	**80%**

Suitability: BSc, BSc Maths and Physics

Recommended Classes/Pre-requisites:

Additional comments:

Safety Training Requirements:

Laser pulse compression in underdense plasma

Project Supervisors: (1) Prof. Zhengming Sheng, (2) Dr. Feiyu Li

Project Description:

Plasma as the fourth state of matter is pervasive in space, laboratory, and also in our life. It is formed when bounded electrons are released from atoms (such as by the high electric fields of a laser pulse) to become free electrons so that the system is made of free electrons and ions. The plasma as a medium exhibits distinct electric and magnetic properties, different from those in normal gas and solid targets. Recently with the development of chirped pulse amplification (CPA) technology, one can produce ultrashort and high intensity laser pulses. Such laser pulses can find wide applications including charged particle acceleration, high power X-ray radiation, advanced laser fusion, and the creation of high energy density matter etc.

Currently, typical high power laser pulse duration is about 40-50fs. For some applications, one needs to the laser pulse duration can be further reduced to less than 30fs. It is found that the plasma as a nonlinear medium can be used to compress the high intensity laser pulse. The main task of this project is to find suitable plasma parameters to compress the laser pulse duration. This includes the effect of plasma density inhomogeneity. The student will use a one-dimensional particle-in-cell (PIC) code to study this problem.

Key References:

1. H. Y. Wang et al., Phys. Rev. Lett. 107, 265002 (2011).

2. O. Shorokhov et al., Phys. Rev. Lett. 91, 265002 (2003).

3. Z. M. Sheng et al., Phys. Rev. E 62, 7258 (2000).

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0%**
	Theo:	**20%**
	Comp:	**80%**

Suitability: MPhys, BSc, BSc Maths and Physics, BSc Physics with Teaching

Recommended Classes/Pre-requisites: *Some basic knowledge on computer programming such as C, C++, or Fortran and software for visualisation such as MATLAB would be helpful, but not essential.*

Additional comments: *No*

Safety Training Requirements: *No*

Numerical simulation of laser interaction with magnetised overdense plasma

Project Supervisors: (1) Prof. Zhengming Sheng, (2) Dr. Feiyu Li

Project Description:

Recently with the development of chirped pulse amplification (CPA) technology, one can produce ultrashort and high intensity laser pulses. Such laser pulses can find wide applications including charged particle acceleration, high power X-ray radiation, advanced laser fusion, and the creation of high energy density matter etc.

In intense laser solid interaction, it is found that free electrons at the solid surface can be driven into oscillation with relativistic high speeds by the incident laser pulse. As a result, high harmonics of the laser pulse will be produced. In the meanwhile, some quasi-static magnetic fields up to 100MG will be produced around the solid surface. Such magnetic field cannot be measured directly. But this magnetic field may change the high harmonics generation, which may provide an indirect measurement of the magnetic field. The aim of this project is to investigate how the magnetic field at the solid surface can change the spectrum and efficiency of high harmonics generation. A one-dimensional particle-in-cell (PIC) code developed by the supervisors will be used to study this problem.

Key References:

1. R. Lichters, J. Meyer-ter-Vehn, & A. Pukhov, Phys. Plasmas 3, **3425 (1996).**
2. H.-C. Wu, Z.-M. Sheng et al., Phys. Rev. E 75, 016407 (2007).
3. U. Wagner et al., Phys. Rev. E 70, 026401 (2004).
4. M. Tatarakis et al., Nature (London) 398, 489 (2002).

Ratio of effort: Exp/Theo/Comp

Exp:	0	%
Theo:	20	%
Comp:	80	%

Suitability: MPhys, BSc, BSc Maths and Physics

Recommended Classes/Pre-requisites: Some basic knowledge on computer programming such as C, C++, or Fortran and software for visualisation such as MATLAB would be helpful, but not essential.

Additional comments: No.

Safety Training Requirements: No.

Excitation of Heavy Atomic Species for ITER

Project Supervisors: (1) Prof. Nigel Badnell, (2) Prof. Bob Bingham (tbc)

Project Description:

The development of the ITER device for magnetic fusion requires the use of much heavier elements (Kr, Xe, W etc) than have traditionally been used, such as at the JET device.

Consequently, spectroscopic diagnostic modelling at ITER, which is already being simulated, requires atomic data where relativistic effects are likely much larger than have been seen before. The goal of the project is to assess the degree of importance of relativistic effects of relevance to ITER diagnostics. This will entail computational calculations of atomic data with varying degrees of treatments of relativistic effects viz. non-relativistic vs relativistic wavefunctions, the importance of the Breit interaction and the validity of its Pauli approximation at `low'-charge.

Key Reference (if applicable): *http://www.iter.org/*

Ratio of Experiment/Theory/Computation:	**Exp:**	**0 %**
	Theo:	**30 %**
	Comp:	**70 %**

Suitable for: MPhys

Additional Comments: *Familiarity with Unix (e.g. Linux) working environment and good computing skills in general.*

Safety Training Requirements:

Atomic Processes for Astrophysical Plasmas

Project Supervisors: (1) Prof. Nigel Badnell, (2) TBC

Project Description:

Collisions of electrons and photons with atoms, ions and molecules play a fundamental role in unfolding our understanding of the origin and evolution of the Universe. Knowledge of atomic collision processes permits investigations of past and present states of galaxies, gas clouds, stars and other objects via spectroscopy. In particular, the state of matter in each object the distribution of temperature and density, chemical composition, flow velocities, and the like may be determined. This kind of information is deduced from the spectra of the objects through diagnostic analysis in which models incorporating the full physics of the object confront the observations. It is these models which we seek to support.

In recent years, a wealth of XUV satellite spectra of solar (SOHO, Hinode/EIS, STEREO, SDO) and astrophysical (Chandra, XMMNewton, HST, FUSE) plasmas of the most varied sources (e.g. the solar corona, stellar atmospheres, supernova remnants, AGN, comets) have shown the richness in spectral lines and the potential for plasma diagnostics.

The project aim is to support atomic physics calculations needed to keep pace with observational capability, in order to enhance the scientific returns from these costly missions.

http://www.apapnetwork.org/

Key Reference (if applicable): *Foster et al "The Challenges of Plasma Modeling: Current Status and Future Plans" Space Sci. Rev. v157 13554 (2010) http://link.springer.com/article/10.1007/s1121401097321*

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0%**
	Theo:	**30%**
	Comp:	**70%**

Suitability: MPhys, BSc, BSc (Maths Physics)

Additional comments: *Familiarity with Unix (e.g. Linux) working environment and computing skills will be helpful.*

Safety Training Requirements: *N/A*

Stochastic Particle Heating of Charged Particles by Plasma Waves

Project Supervisors: (1) Dr. Bengt Eliasson, (2) Dr. Kevin Ronald

Project Description:

Plasmas are ubiquitous in space and laboratory. The Earth is surrounded by a plasma layer, the so-called ionosphere, which shields us from radiation and energetic particles from the sun, and in the laboratory, plasmas are artificially created and studied with application to magnetic confinement fusion and basic research. A plasma is an ionised gas in which there are free electrons and ions so that the gas is electrically conducting. The Earth's ionosphere is magnetized by the geomagnetic field, and in the laboratory, an external magnetic field is used to confine the plasma and prevent it from escaping to the walls. The acceleration of charged particles by electromagnetic waves can lead to chaotic motion of the particles and a rapid heating of the magnetised plasma due to the complicated motion of the particles. This is important for heating of particles in the laboratory, in magnetic confinement fusion devices, in the solar corona, in the Earth's ionosphere, etc., where collisions between particles are relatively rare. Stochastic heating is therefore different from Ohmic heating which is due to collisions between particles.

The project involves at building a numerical model for stochastic heating of charged particles (electrons and/or ions) in magnetized plasmas by using test-particle simulations, and to use the numerical model to study some different cases where stochastic heating takes place. A theoretical derivation and understanding of the mathematical models is also part of the project.

Key Reference: *J. M. McChesney, R. A. Stern, and P. M. Bellan (1987) Observation of fast stochastic ion heating by drift waves, Phys. Rev. Lett. 59, 1436-1439.*

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0%**
	Theo:	**50%**
	Comp:	**50%**

Suitability: MPhys, BSc, BSc Maths and Physics

Additional comments: *Experience in simulations using Matlab (or any other programming language) and good theoretical skills are beneficial.*

Safety Training Requirements:

Simulation of Electromagnetic Waves in Magnetized Plasmas

Project Supervisors: (1) Dr. Bengt Eliasson, (2) Dr. Kevin Ronald, Dr. David Speirs

Project Description:

Plasmas are ubiquitous in space and laboratory. The Earth is surrounded by a plasma layer, the so-called ionosphere, which shields us from radiation and energetic particles from the sun, and in the laboratory, plasmas are artificially created and studied with application to magnetic confinement fusion and basic research. A plasma is an ionised gas in which there are free electrons and ions so that the gas is electrically conducting. The Earth's ionosphere is magnetized by the geomagnetic field, and in the laboratory, an external magnetic field is used to confine the plasma and prevent it from escaping to the walls. The plasma changes the propagation characteristics of electromagnetic waves, and the magnetic field breaks the symmetry and makes the plasma anisotropic. Electromagnetic waves such as radio waves can be reflected from and interact with the plasma in the ionosphere, and microwaves are used to study artificially created plasma in the laboratory. The plasma and the magnetic field also introduces a number of new wave modes in addition to the usual electromagnetic waves in vacuum. Hence, the propagation of electromagnetic waves into a plasma is a non-trivial problem.

The project aims at building a numerical model of the propagation of electromagnetic waves into a magnetised plasma, to study the propagation and nonlinear interactions between the electromagnetic wave and the plasma. Through similarity principles, the physics of a plasma can be scaled so that ionospheric physics with length-scales of the order 10 km or more can be studied in the laboratory with length-scales of the order 1 m, and vice versa. Hence, the project has relevance to the study of microwaves propagating into magnetically confined plasma (an experiment currently under construction at Strathclyde), as well as to existing experiments involving radio waves injected into ionospheric plasmas from ground-based transmitters or from satellites surrounding the Earth and other planets in the Solar system.

Experience with programming in Matlab or other simulation languages is beneficial.

Key Reference (if applicable): *Bengt Eliasson: Full-scale simulations of ionospheric Langmuir turbulence. Modern Physics Letters B 27(8), 1330005 (27 pages), doi:10.1142/S0217984913300056 (2013).*

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0%**
	Theo:	**30%**
	Comp:	**70%**

Suitability: MPhys, BSc, BSc (Phys with Teaching), BSc (Maths Physics)

Design of a Brewster Window for a W-band Gyro-TWA

Project Supervisors: (1) Dr. Wenlong He, (2) Dr. Liang Zhang

Project Description:

A W-band gyrotron-travelling wave amplifier (gyro-TWA) based on a helically corrugated waveguide and a cusp electron gun is currently being studied. It is predicted to achieve an output power of 5 kW over a wide frequency band of 90 - 100 GHz. For an amplifier the microwave window, which separates the high vacuum side from the atmospheric pressure outside must couple in or out the microwave power with minimum absorption or reflection, and is one of the critical components for the successful operation of the gyro-TWA.

In this project, a Brewster-type microwave window will be studied using analytical theory. Numerical simulations Brewster-type microwave window will be carried out using CST Microwave Studio. A corrugated waveguide that maintains the Gaussian-like HE mode required for the Brewster window will also be designed and simulated. The design goals of the Brewster window are 10% bandwidth at a centre frequency of 95 GHz, small insertion loss and a reflection of less than -20 dB for the operating band. If the design meets the requirement, the Brewster window will be manufactured and measured using a Vector Network Analyser (VNA).

Key References:

[1] Wenlong He, Craig R. Donaldson, Liang Zhang, Kevin Ronald, Paul McElhinney and Adrian W. Cross, "High Power Wideband Gyrotron Backward Wave Oscillator Operating towards the Terahertz Region", Physical Review Letters, 110(16):165101, 04, 2013.

[2] Paul McElhinney, Craig R. Donaldson, Liang Zhang and Wenlong He, "A High Directivity Broadband Corrugated Horn for W-band Gyro-devices", IEEE Transactions on Antennas and Propagation, vol. 61, no. 3, pp. 1453-1456, 2013.

Ratio of effort: Exp/Theo/Comp		
	Exp:	**20%**
	Theo:	**30%**
	Comp:	**50%**

Suitability: MPhys, BSc, BSc Maths and Physics

Additional comments:

Safety Training Requirements: *High voltages will **not** be used and X-ray emission will **not** be generated during this project although a risk assessment will need to be completed in semester 1.*

Design and Measurement of a Mode Converter for a Microwave Amplifier

Project Supervisors: (1) Dr. Wenlong He, (2) Dr. Craig Donaldson

Project Description:

A microwave amplifier in the form of a gyrotron traveling wave amplifier is being studied at the University of Strathclyde. The amplifier uses the interaction between a rotating electron beam and a low power microwave signal to amplify the microwaves to high power over a wide bandwidth. In order to have the correct interaction a low power microwave signal needs to go through a mode converter to change from a $TE_{1,1}$ mode to a $TE_{3,1}$ mode.

In this project, a mode converter will be studied using analytical theory. Numerical simulations will be carried out using CST Microwave Studio. This converter is a four-fold helical corrugated waveguide. Initially this will be studied and measured using a vector network analyser (VNA), at X-band frequencies ~9 GHz.

In year 2 of the project the converter will be scaled down in size to operate at a much higher frequency in the W-band, at ~ 94 GHz. In both applications the converter will have to operate over the amplifiers bandwidth range of 10GHz and have a high conversion efficiency whilst maintaining a low reflection coefficient.

Key Reference: *He W., Donaldson C.R, Zhang L., Ronald K., McElhinney P., and Cross A.W., "High power wideband gyrotron backward wave oscillator towards the terahertz region", Phys. Rev. Letts, 110, art 165101, (2013).*

Ratio of effort: Exp/Theo/Comp

Exp:	**25%**
Theo:	**25%**
Comp:	**50%**

Suitability: MPhys

Additional comments:

Safety Training Requirements: *High voltages and X-ray emission will **not** be required for this project although a risk assessment will need to be completed in semester 1.*

Monte Carlo Simulation and Cooling Performance of the MICE Step V Laboratory Experiment.

Project Supervisors: (1) Dr. Kevin Ronald, (2) Dr. Alan Young

Project Description:

A Neutrino Factory based on a muon storage ring represents the ultimate tool for the study of neutrino oscillations, including the potential discovery of leptonic CP violation. It is also the first step towards the construction of a $\mu^+\mu^-$ collider. Ionisation cooling of muons can make a significant contribution to both the performance (up to a factor of 10 in neutrino intensity) and cost (as much as 20%) of a Neutrino Factory. This potential benefit has motivated the undertaking and construction of the Muon Ionisation Cooling Experiment (MICE), a significant undertaking that has various key stages in its physical implementation. There are various potential lattice configurations currently under consideration for MICE Step V – the final operating configuration for the experiment. Simulating and evaluating these potential configurations is currently a critical activity in order to implement a successful MICE Step V experiment. The aim of this project is therefore to conduct a variety of simulations using the MICE Analysis User Software (MAUS), a Monte Carlo Simulation Tool which predicts the trajectories of the muons through a complex system of magnetic fields, solid beamline objects and accelerating cavities, to determine and evaluate the most suitable Step V lattice configurations and operating conditions, and to define the performance requirements of key detectors to ensure a successful MICE experiment and first practical demonstration of ionisation cooling.

Key Reference: *Adams D. et al, 2013, 'Characterisation of the muon beams for the Muon Ionisation Cooling Experiment' Euro. Phys. J. C,* ***73,*** *art. 2582*

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0%**
	Theo:	**30%**
	Comp:	**70%**

Suitability: MPhys, BSc, BSc Maths and Physics, BSc Physics with Teaching

Additional comments:

Safety Training Requirements:

High-Power Microwave Sources

Project Supervisors: (1) Dr. Phil MacInnes, (2) Dr. Kevin Ronald

Project Description:

High-power microwave sources, developed for a range of applications, are of significant interest, both in industry and the academia, with new sources showing increases in achievable output frequency and power capacity. In particular this project will investigate sources based on free electron physics whereby the kinetic energy in an electron beam provides the free energy to excite a powerful electromagnetic wave.

The aim of this project is to perform a design study, investigating the current state of the art of a particular class of high power microwave source. This would involve understanding the theoretical principles underpinning the operation of the source(s) and include a review of published results. Numerical simulation, both of the passive components and the active device, will be used to evaluate the potential output power, operating frequency, bandwidth and the dependence of these performance characteristics on the adjustment of various control parameters in a given design.

Over the course of the project the student will have the opportunity to gain experience working with a range of numerical-simulation codes and their applicability to different stages in source design. The student will also have the opportunity to develop skills working with the numerical solver package MatLab – some pre-existing experience with MatLab would be beneficial but is not required. Similarly there is access to Maple / Excel etc.

It is unlikely that the project will include experimental work. However, should promising results arise from the simulations early on, there is some scope for manufacture and passive testing of parts. In this case the experimental component would be unlikely to exceed 10% of the total work.

Ratio of effort: Exp/Theo/Comp	**Exp:**	**0%**
	Theo:	**30-40%**
	Comp:	**60-70%**

Suitability: MPhys, BSc, BSc Maths and Physics, BSc Physics with Teaching

Additional comments: *This project may be run simultaneously with 2 students in parallel.*

Safety Training Requirements:

Institute of Photonics

Modelling Non-linear Processes in Micro-waveguides

Project Supervisor (1) Dr. Michael Strain, (2) Dr. Nicolas Laurand

Project Description:

Waveguides with sub-micron cross-sectional dimensions have proven extremely successful in non-linear optical applications. By using materials with high refractive index, such as silicon, light can be confined into ultra-small volumes, producing extremely high local field intensities. If these materials also exhibit an optical non-linearity, i.e. their susceptibility\refractive index is a function of the strength of the optical field, then a wide array of devices can be designed. For example, ultra-fast photonic switches can be created that are triggered using optical pulses (i.e. without the need for electronics) with potential applications in optical signal processing. Non-linear processes can also create new wavelengths of light in a device, for example allowing a signal input at λ_1 to be broadcast on a wide range of new wavelengths, simply by propagating through a non-linear device. Finally, these devices can take a single laser wavelength input and, through self-phase modulation, generate a supercontinuum of light.

The effects of dispersion in non-linear waveguides are critical in the design of these devices. The refractive index as a function wavelength of nanowire waveguides exhibits a strong dependence on the waveguide geometry. The dispersion induced by the waveguide in turn induces variation in the non-linear optical processes in the waveguide. In order to achieve efficient operation, a balance must be achieved between increasing the field intensity by reducing the waveguide cross sectional area and finding the optimal waveguide dispersion regime.

In this project the student will use numerical tools to model the dispersive behaviour of nanowire waveguides in a variety of materials. This analysis will then underpin further calculation of the non-linear effects in nanowire waveguides, with particular reference to self-phase modulation and four wave mixing processes. The student will write customised simulation codes to probe the behaviour of these waveguides and compare their results with experimental demonstrations.

Key Reference (if applicable):

1. *Q. Lin, O. J. Painter, and G. P. Agrawal, "Nonlinear optical phenomena in silicon waveguides: modeling and applications.," Opt. Express, vol. 15, no. 25, pp. 16604–44, Dec. 2007.*
2. *J. Leuthold, C. Koos, & W. Freude, "Nonlinear silicon photonics," Nature Photonics, 4(8), 535–544, 2010.*
3. *A.C. Turner, M.A. Foster, A.L. Gaeta, M. Lipson, "Ultra-low power parametric frequency conversion in a silicon microring resonator," Optics express, 16, (7), p. 4881-7, 2008.*

Ratio of effort: Exp/Theo/Comp

Exp:	**0%**
Theo:	**50%**
Comp:	**50%**

Suitability: MPhys, BSc

Additional comments: *Some previous experience of Matlab would be beneficial but not essential.*

Safety Training Requirements: *N/A*

Appendices

Safety induction training record for Undergraduate students undertaking project work

This form **MUST** be completed by student and supervisor and returned **before** student enters a laboratory and by 27th November 2015 at the **latest.**

1) I have read and understood the '*Local rules for the Safe Use of Lasers*' (available from https://moss.strath.ac.uk/physics/Safety/Laser%20Information/Local%20Rules/130222_LocalRulesLaserSafety_Append.doc) ❑ **N/A** ❑

Others: ……………………………………………………………………

……………………………………………………………………………

2) I have attended the following safety training lectures:

Physics Laser Safety ❑ **N/A** ❑

Others: ……………………………………………………………………..

……………………………………………………………………………

3) I have received an induction in the use of the local safety systems and access controls in rooms:

……………………………………………………………………………

4) I have received an induction in operating the following devices and/or instrumentation (e.g. laser)

…………………………………………………………………………..

…………………………………………………………………………..

5) I received an induction in the following techniques:
Laser beam alignment procedures ❑ **N/A** ❑

Others: ……………………………………………………………………

……………………………………………………………………

Signature of student: .... Date: ....

Name (print): ....

Signature of supervisor: .... Date: ....

Name (print) ....

Please return this completed form to Students Office, JA 8.31

Project allocation request form 2015/16

(To be returned by the student to Students Office JA 8.31 by 4pm 29/09/15)

Student Name: **Student Number:**

Project title:		
Supervisor's signature: **Supervisor's name:**		**This project has been discussed by us, and we have agreed that it is appropriate for the student to undertake the work.**
Student's signature:		
Preference:		**For student to choose on completion of the form**

Project title:		
Supervisor's signature: **Supervisor's name:**		**This project has been discussed by us, and we have agreed that it is appropriate for the student to undertake the work.**
Student's signature:		
Preference:		**For student to choose on completion of the form**

Project title:		
Supervisor's signature: **Supervisor's name:**		**This project has been discussed by us, and we have agreed that it is appropriate for the student to undertake the work.**
Student's signature:		
Preference:		**For student to choose on completion of the form**

Note: where several allocation request forms are submitted for the same project, I will choose the successful student by lot.

Projects allocated will be announced on Thursday 1st October 2015 – *Daniel Oi*

Project Timetables

PH450

Taken in 4th year by MPhys and BSc Physics
Optional for BSc Physics with Teaching and BSc Mathematics and Physics students

14th September 2015 Project booklet available to students

Students will receive project handbook with project request page.

15th September – 29th September 2015 Students choose projects

Students should visit supervisors and draw up a shortlist of 3 potential projects in order of preference from 1 to 3. Each project request must be signed and dated by both the student and the supervisor and submitted to the student office, JA8.31.

4pm 29th September 2015 Deadline for submission of Project choice form to JA8.31

1st October 2015 Official start of Projects

Project allocations announced at 12 noon through Myplace. Students who have been unsuccessful in getting their choice of project will receive an updated booklet for a second round.

16th October 2015 Literature review complete

Students submit literature survey and a risk assessment for project. The literature review will usually take the form of the Final Report's introductory chapter.

27th November 2015 Completed safety form to be returned to JA 8.31 by this date

18th January 2016 Progress report with aims of project to be returned by students to JA 8.31 by this date

23rd March & 30th March 2016 Project Talks 1-5 pm in parallel Sessions

Each student will be given a 15-minute slot. The expectation is that students will talk about their project for 10 minutes and then be questioned by the audience for 5 minutes.

25th April 2016 Project reports submitted

Project reports to be submitted as Word or PDF format through MyPlace and then passed through Turnitin for plagiarism detection. In preparing the report, please be aware that supervisors can advise on up to 10 pages of material, to help with the style of writing and content, but not to correct physics.

Week beginning 23rd May 2016 Viva week

Each viva will be about 35 minutes long, with 5 minutes for the student to outline their project work and 30 minutes of questions about project content.

Project Information for Continuing 5th Year Students

PH 550

Taken in 5th year by MPhys Physics students. The expectation is that students will continue with the project started in 4th year.

Week beginning 21st September 2015 Meeting with supervisor during Week 1

23rd October 2015 Progress report to be returned by students to JA 8.31 by this date

2nd December 2015 Project Talks 1-5 pm in parallel sessions

Each student will be given a 15-minute slot. The expectation is that students will talk about their project for 10 minutes and then be questioned by the audience for 5 minutes.

14th December 2015 Deadline for draft project paper to supervisor for feedback before 21st December 2015

8th January 2016 Project papers submitted

Project papers to be submitted as PDF format through MyPlace and then passed through Turnitin for plagiarism detection.

The final report for PH550 is a paper in the format of Physical Review Letters (see MyPlace for examples):

- 1 page title sheet, 4 pages for the paper and references
- Prof O'Donnell wrote in answer to one student struggling to keep the paper within the 4 page limit, *"part of the challenge of paper-writing is to develop your (self-) critical facility. The task of preparing work for publication is not so much one of condensation as of selection. You don't have to include everything that you did in the project, in fact, you will probably need to leave something out."*
- Instead reference as much as you can. By all means have a longer version of the report for yourselves, for example, with full derivations, for the viva, but this is not what the supervisor and examiners will mark.

Paper writing will form part of the PH551 Research Skills class

Week beginning 18th January 2016 Vivas

Each viva will be about 35 minutes long, with 5 minutes for the student to outline their project work and 30 minutes of questions about project content.

Plagiarism

Plagiarism most commonly involves the passing off of another person's work as your own and is regarded as a form of academic dishonesty. Plagiarism more often than not involves the copying of another person's work, be it a figure, text, experimental data or homework for example and not acknowledging the source of the work. Plagiarism can be avoided by suitable referencing.

For more details on plagiarism please see the University Handbook and follow this link http://www.strath.ac.uk/media/ps/cs/gmap/plagiarism/plagiarism_student_booklet.pdf for guidelines on plagiarism. If you are unsure of any aspect of this, please contact the department. The department will make extensive use of software capable of detecting plagiarism. The Department will use the anti-plagiarism software Turnitin (https://turnitin.com/static/index.php) to check for plagiarism. Any student caught plagiarising another person's work may be reported to the University Disciplinary committee.

Index of Project Titles