DCU research project proposals for Notre Dame interns – January 2014

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Spiropyran Functionalized Gold Nanoparticles for Photo-induced Assembly and Chemical Sensing

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The optoelectronic properties of gold nanoparticles (Au NPs) can be tailored by functionalization with chromophores of specific properties and functions resulting in light-modulated organic-inorganic nanohybrid materials [1]. Assembled as two- or three-dimensional architectures, these hybrid materials poses novel electrical, optical, and photochemical properties. The photoresponsive shell encapsulating the nanoparticle core offers exciting opportunities for the design of novel photon-based devices for sensing, switching, and drug delivery while offering the possibility of light-trigger assembly and disassembly.

In this context, one chromophore of choice consists of spiropyran (SP). SPs are organic photochromic compounds that upon irradiation with UV or visible light, isomerise between the closed and open forms [2-4]. Under dark conditions, the majority of spiropyran molecules exist in their "closed" spiro form (colorless and nonpolar). When excited with UV light, spiropyrans undergo photoisomerization to the "open" merocyanine form (highly polar and zwitterionic), absorbing in the visible region (Fig.1). Metal ions and other chemical charged species can influence this isomerisation process by associating with the open form through the electron-rich oxygen (Fig.1). In contrast, visible light produces a high concentration of the closed form that does not posses binding abilities. The use of light to control charge density and to trigger chelating properties offers unique opportunities for photo-induced assembly/disassembly and binding/releasing of guest species as these processes are reversible and can be controlled externally in a non-invasive manner.

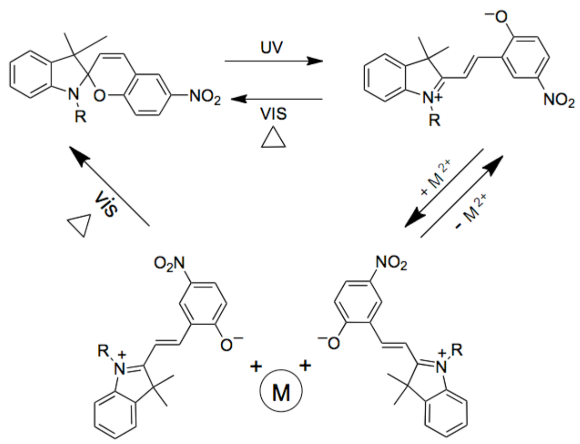

Figure 1. Photochromic properties of spiropyran derivatives.

It was previously shown that when gold nanoclusters (Au NCs) were functionalized with SPs, the fluorescence intensity of the Au NCs could be reversibly modulated via UV or visible light [5]. This was due to fluorescence resonance energy transfer (FRET) from the Au NCs to the open-ring state merocyanine of the spiropyran molecules (Fig 2A).

In a different approach, a sulfur-containing spiropyran dye was used for the light-triggered self-assembly of Au NPs [6]. Herein, a spirothiopyran, which has photochromic properties, was used as an initiator for aggregation (Fig 2B). Photoisomerization of the chromophore promoted covalent binding of its thiolate moiety onto the Au NPs surface. This binding neutralized the surface negative charge of the Au NPs and promoted aggregation. This method avoided pre-functionalisation of Au NPs and produced Au NPs aggregate with tunable size (30–500 nm) and narrow size distribution.

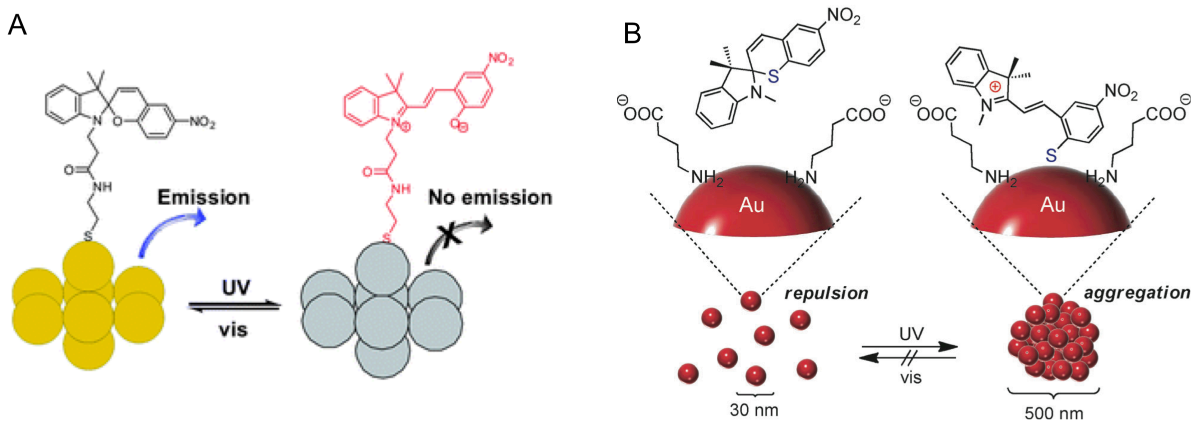

Figure 2. A: Photo-modulated fluorescence of Au NCs using UV/Visible light; B: Light-induced aggregation of Au NPs.

In this project, Au NPs of different sizes and optical properties will be functionalized with spiropyran derivatives in a new manner. The optical properties of the novel SP-Au NPs under different illumination conditions will be characterized by UV-Vis and fluorescence spectroscopy. Chemical linkage of such NPs to relevant chemical species such as metal ions and aminoacids will also be studied together with their influence on the optical properties of the SP-Au NPs.

The photo-induced assembly of Au NPs through metal ion bridges (eg. Ca^{2+}, Mg^{2+}) will be also explored. It is expected that in this manner, supramolecular nanoclusters with a photo-reconfigurable nature will be produced. The resultant nanocluster should be stable as a result of multiple MC$\cdots$$Me^{2+}$$\cdots$MC bridges but disassemble into smaller NCs, including NPs by the reverse (MC → SP) isomerization mediated by visible light. The assembly/disassembly processes will be monitored by UV-Vis spectroscopy and transmission electron microscopy (TEM).

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Marine Pockmark Investigations

Recent mapping within INFOMAR (the **IN**tegrated Mapping **FO**r the Sustainable Development of Ireland's **MAR**ine Resource) by the Marine Institute and the Geological Survey of Ireland has provided Ireland with marine datasets of an unprecedented quality. This is, above all, relevant in coastal areas where the resolution of the sonar data and the density of sediment samples allow researchers to add value to baseline datasets and generate new research in supplementary areas of common interest. In general, Irish bays are important drivers of the economy of the nearby regions in such diverse aspects as aquaculture, recreational, commercial navigation, archaeology, fishing, and many others. Investigations of coastal marine ecosystems, carbon cycling (and therefore greenhouse emissions), marine pollutants, and gas related geo-hazard investigations can be beneficial in understanding the enviro-socio economical issues of these settings.

Through our involvement with INFOMAR and ship-time awarded to us through the Marine Institute's Ship-Time Programme we have accumulated sediment and core samples from around the coast of Ireland, including cores from "pockmark" areas on the Malin Shelf, Dunmanus and Dublin Bays. With diameters of up to 2000m and depths reaching 45m pockmarks are interesting and important components of seabed morphology. Pockmarks are one of the geological fingerprints of fluid and gas flow and are contributors to the global methane cycle but no attempt has been made to estimate their isolated input. A lack of knowledge about oceanic methane sinks and sources makes it very difficult to speculate about overall oceanic contribution to the methane global cycle. Dr. Kelleher's group, in collaboration with the GSI has mapped pockmark spatial distribution using acoustic seabed classification maps available through INFOMAR. In addition, extensive seabed coring and under water video have been applied to a gas pockmark region in Dunmanus Bay. Planned research emanating from the collection of these samples can be subdivided into three separate but complimentary studies:

1. The geochemical, geophysical and mineralogical study of shallow marine sediments to provide environmental mapping of sediments in bays and estuaries around Ireland.
2. A study of carbon cycling and chemical/physical characteristics in marine shallow gas pockmarks.
3. Investigations into the fate, molecular transitions and cycling of Terrestrial Organic Carbon (TOC) in coastal to shelf sediments.

If successful, the summer research student will contribute to a geochemical study of shallow marine sediments, sediment cores and marine pockmarks. He/she will be involved in an unprecedented investigation of the physical and chemical characteristics of Irish coastal pockmarks. Sediment grab samples and cores will be used to investigate:

- the origins of these pockmarks and their contribution to carbon cycling,
- past climatic conditions,
- potential compounds for biotechnology and hydrocarbon sources.

The research will involve the identification of marine lipids that will provide valuable information regarding the origin, transport pathways and alteration and transformation processes of organic matter in marine pockmark sediments. He/she will attempt to apportion the main organic matter sources in the surface and core sediments of Dunmanus Bay. Comparisons between pockmark and non-pockmark areas will also be made such that the influence, if any, of pockmark formation on organic constituents can be investigated.

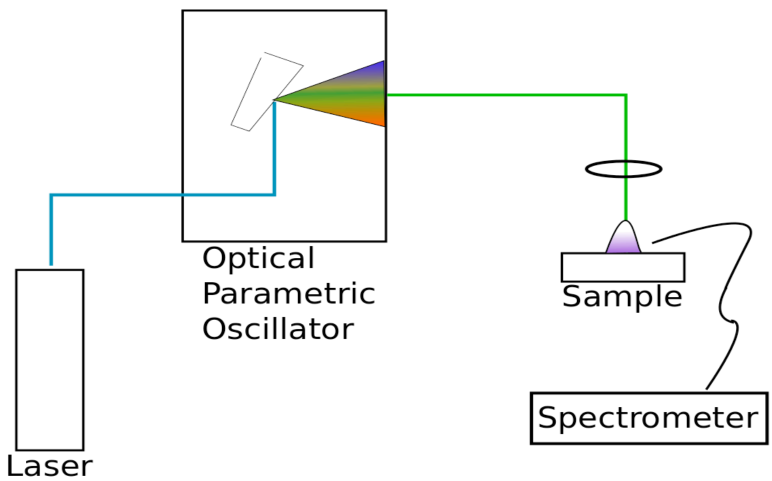
“Resonant Laser Induced Breakdown Spectroscopy (R-LIBS) for the Classification of Fossilised Rock Formations”

T. J. Kelly and J. T. Costello

The classification of materials is of great importance to a number of disciplines. In just one historical example, the failure on the bulkheads of the titanic was due (in part) to an inability to classify the amount of impurities in the steel use for the bulkheads. More recently, efficient and rapid detection of trace amounts of chlorine goes a long way in classifying whether or not an unattended package contains plastic explosives.

Ultimately, a highly sensitive, non-destructive method of analysing a material's composition is desired. Laser Induced Breakdown Spectroscopy (LIBS) is a standard approach for classifying materials be they solid, liquid or gas [1]. Recently, LIBS was deployed on the surface of Mars as part of the Mars Rover in the search of hydro-carbons which will elucidate further the question as to whether there is water or even life on Mars [2]. LIBS involves using a laser to create an ionized vapour on the surface of a large sample to create a plasma. The spectrum of light emitted from the plasma is characteristic of the elemental composition of the sample, effectively a chemical fingerprint. LIBS turns out to be a highly selective, accurate, largely non-perturbing method of elemental characterisation requiring no sample preparation and with the potential for remote (or stand-off) detection (useful if one needs to deal with corrosive, toxic, etc. materials.

In this project, a process known as Optical Parametric Oscillation (OPO) will be used to create highly tunable laser light. The wavelength of the light will then be chosen to correspond to a resonance of a known element within a solid sample which we expect to lead to a greater detectability of trace elements within a sample – a much improved limit-of-detection. To start, a series of aluminium targets with known magnesium impurities will be studied to optimise the resonant LIBS process [3]. However, the ultimate goal (once the resonant techinique is optimised) will be to perform elemental analysis on melted basalt and granite samples found along the Irish coastlines with a view to increasing the detectability of potassium, iron, sulfur and sodium in these rocks [4]. These three elements are indicitive of fossilisation of organic material within rock formations. It is hoped that this technique will eventually lead to a non-destructive way of determining the presence of fossils in rock formations.



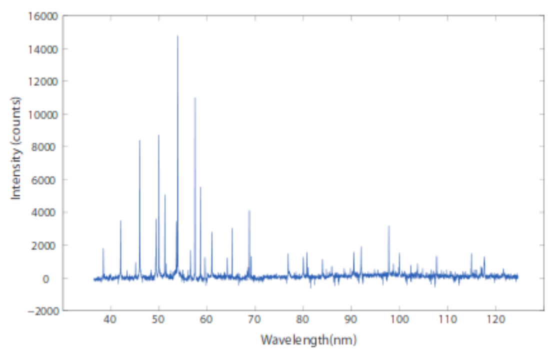


Fig 1: On the left, the proposed experimental setup and above a typical VUV LIBS spectrum taken with a steel sample [1].

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Modelling growth of ZnO nanowires – effects of wire shadowing on growth

Dr. Enda McGlynn, School of Physical Sciences and National Centre for Plasma Science and Technology (enda.mcglynn@dcu.ie)

ZnO is a promising semiconducting material with many exciting applications and a strong propensity to grow in nanostructured form. ZnO nanostructures display a wide range of morphologies which are sensitive to growth parameters such as temperature, substrate type and the method used to generate source species [1]. Because of this sensitivity and morphological diversity, a greater theoretical understanding of the growth process is required in order to reproducibly grow specific ZnO nanostructure morphologies, especially on an industrial scale.

Our group has undertaken a number of theoretical/ computational studies of ZnO nanowire growth via the Vapour Phase Transport (VPT) growth method and reasonable overall agreement between theory and experiment has been found, e.g. in terms of average nanowire properties such as length, diameter etc. [2-4]. However, experimental results also show a substantial degree of scatter in physical quantities such as nanowire lengths [4] and the origin of this scatter is at present still unclear.

One physically plausible possibility is that the scatter in nanowire lengths is related to shadowing effects/competition for available source material amongst closely spaced nanowires and some experimental data support this hypothesis [4]. The summer intern project proposed here is to develop a theoretical/computational model and to test this hypothesis, building on the existing studies performed in our group and adding to these by incorporating the effects of shadowing/competition into those models, e.g. perhaps by Monte-Carlo techniques.

This summer intern project would suit a physics, engineering, materials science or physical chemistry student with an interest in nanoscience and an interest and ability in mathematics and computational science.

Further details can be obtained by contacting Dr. Enda McGlynn by email, at the email address given above.

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Naughton Fellowship Summer Research Experiences for Undergraduates program

Research Topic: Teaching and assessing through physics by inquiry in the classroom

Supervisor: Dr. Eilish McLoughlin, Director CASTeL, School of Physical Sciences.

Inquiry as a teaching pedagogy has been proposed in science education as a means to increase interest and engagement in science. Many studies have identified instructional models of inquiry within the classroom, such as following the scientific method of investigations, or the 5E (or 7E) frameworks. However, it is clear that inquiry practices differ greatly between classrooms and between teachers.

It is therefore surprising to learn that there are "few research studies that actually examine teachers' instructional practices in inquiry classrooms" (McNeill and Krajcik 2008). "Publications thus far have tended to summarize or gloss over inquiry practices as "doing science," "hands-on science" or "real-world science" rather than concretely describing what teachers and students are really doing in the classroom. By unpacking what is so often camouflaged under an ambiguous and encompassing label through examining teachers' classroom practices, educators will be better able to pinpoint how students learn scientific inquiry or for that matter, science content" (Poon, 2012).

This project will contribute to the research of the CASTeL research centre in DCU, whom coordinate two FP7 funded projects in Inquiry Based Science Education, which are focussed on developing teacher education programmes for the teaching, learning and assessment of inquiry. (ESTABLISH 2010-2014, SAILS 2012-2015). A key part of this research is to examine teachers' instructional and assessment practices in inquiry classrooms across Europe.

This fellowship will focus on identifying perspectives of teaching physics by inquiry in a second level Irish classroom versus the theoretical models of inquiry. In order to address these perspectives, this project will review literature that reports on characteristics and modes of inquiry science from both theoretical and practical perspectives. Through collaboration with 2-3 local second level physics teachers, the researcher will investigate characteristics of inquiry/how inquiry is scaffolded for student learning and what assessment is used in the classroom to determine student learning in terms of the development of conceptual knowledge and skills.

In addition, CASTeL will host its biennial Science and Mathematics Education conference on 25-26 June 2014 and this event will be co-hosted with SAILS project and bring together over 200 educators and teachers from across Europe to share inquiry practices in the classroom. This occasion will offer a unique opportunity for the successful fellow to engage with practitioners from across many countries and discuss teaching and assessing through physics by inquiry in the classroom and will inform the work of this project. It is expected that the findings from this project will contribute to the work of this group to develop a taxonomy and pedagogical framework for inquiry-based science education in practice.

This project is particularly suited to students undertaking the Major in Physics Education Program.

Naughton Fellowship Project Proposal

School of Physical Sciences, Dublin City University

Lampros Nikolopoulos

Title: Theory of atomic systems under FEL radiation[1]

Scientific background

Coherent radiation in the Vacuum Ultraviolet (VUV) was generated in February 2000 at Deutsches Elektronen-Synchrotron (DESY) in Hamburg, based on the Free Electron Laser technique. It was the first VUV/FEL source in the world, offering coherent radiation in the range of 80 - 180 nm (high energetic photons) with a peak brilliance 10^3 larger than the most modern synchrotron sources existing at that time. Phase II of the FEL started operating in 2005 in the VUV and the soft X-ray wavelength regime from 100 down to 6 nanometers [1]. Until 2009 it was the only available facility of its kind, until another FEL source started its operation at LCLS, California. Since then, other countries are developing their own X-ray sources [Japan-SACLA (2012), Italy-Fermi (2012), Switchzerland-SwissFEL (planned for 2016). Furthermore, in addition of these sources, in Hamburg, through a multinational project a European-XFEL source is under construction (planned to operate 2016) which will provide radiation with unique properties. Briefly, X-FEL will provide coherent radiation in the hard X-ray wavelength (6 - 0.1 nm) with an enhancement of the peak brilliance, compared with the best storage ring-based synchrotrons, of about 9 orders of magnitude and pulse duration is expected to be of the order of 50-100 fs.

X-ray sources are of great importance in a number of research areas not restricted to physics or chemistry sciences (i.e. atomic,molecular physics, clusters, plasma, condensed-matter physics) but to biology and medicine sciences (molecular biology, bioimaging,..). *The fact that this short-wavelength radiation is coherent, intense and of short duration allow to explore, for the first time, new manifolds of states of complex systems (ranging from small quantum systems to large biological structures) in an atomic-scale time resolution down to few femtoseconds.*

More specifically and from the atomic physics point of view, the inside regions of multielectron atomic and molecular systems can be probed by direct interaction of the radiation with the tightly bound electrons of the inner shells. This is in contrast with the radiation in the regime of long-wavelength lasers where only the outer electrons are affected no matter how intense is the field. Therefore, for multielectron atomic systems under FEL radiation the degree of complexity is increased since there is significant probability of exciting inner-shells electrons, additionally to those of the outer shells (optical shells), thus making theoretical approaches based on 'frozen' core-electrons inappropriate.

Research on laser-matter interactions in realistic applications requires in depth knowledge of sophisticated theoretical methods, advanced computational techniques and the ability to make connections between approaches to problems with various settings.

Formally, the dynamics of an atomic or molecular system with N-electrons with an electromagnetic field, at the quantum level, is described by the time-dependent Schrödinger Equation (TDSE) [2],

$$i\frac{\partial}{\partial t}\psi(\mathbf{r}_1,\mathbf{r}_2,...\mathbf{r}_N;t) = \left[H_0 + \sum_{i=1}^{N}\mathcal{E}(\mathbf{r}_i,t)\hat{e}\cdot\mathbf{r}_i\right]\psi(\mathbf{r}_1,\mathbf{r}_2,...\mathbf{r}_N;t).$$

where H_0 is the Hamiltonian of the atomic/molecular system, $\mathbf{r}_i, i = 1,2,...,N$ represent the position of the i-th electron while $\mathcal{E}(\mathbf{r},t)$ represents the time-dependent EM field. From a mathematical point of view the TDSE is a multidimensional partial differential Equation (PDE) in space and time. The dimensionality in space depends on the number of electrons. This latter fact makes almost impossible to solve ab-initio the TDSE, even numerically, when more than 2-electrons are

[1] Free-Electron Laser

involved. In addition, at the current stage of FEL radiation, the field $\mathcal{E}(\mathbf{r}, t)$ suffers from strong amplitude and phase fluctuations. The latter characteristic adds an extra complication in the description of the interaction of FELs with atomic systems.

Project description

The purpose of the present project is to study the effects of the stochastic fluctuations of an x-ray FEL field on the dynamics of the innermost 1s-shell electron of the neon atomic system (see Fig. 1). This study will concentrate to the ionization yield and electron's kinetic energy spectrum.

In the present case we'll be following an alternative quantum description of the dynamics, by considering the Liouville equation for the density matrix of the system [3]:

$$i\frac{d}{dt}\rho(\mathbf{r}, t) = [H(\mathbf{r}, t), \rho(\mathbf{r}, t)].$$

The stochastic variations of the field will be modelled as a Gaussian, stationary stochastic processes in the dipole approximation. Thus, the TDDM equations become a system of stochastic differential equations (due to field's stochastic variations) and appropriate techniques needs to be adopted. The assumption of stationarity simplifies considerably the mathematical aspects of the problem and an averaging technique can be followed avoiding the use of alternative, computationally demanding direct techniques (Monte Carlo).

It is worth noting that in viewing, the TDDM equations as a system of partial differential equations the present problem is formally equivalent to stochastic problems that frequently appears in risk analysis of finance market.

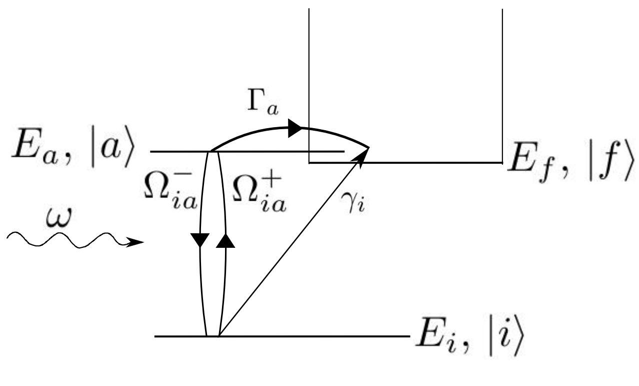

Figure 1: A simplified two-level view of the process that is taking place. The 1s-core electron of neon ($|i\rangle$) interacts with the x-ray radiation of frequency ω and neon is excited to the 3p ($|a\rangle$) state. Two of the most domininant possibilities for the excited electron is to be de-excited back to the ground state $|i\rangle$ or to be ejected (Auger electron) accompanied by a fluorescence photon $\omega_R \neq \omega$ (see refs. [3],[4]).

In solving the stochastic TDDM equations for this system in the x-ray field, the student will work as follows:

1. Will come into contact with the density matrix approach as an alternative of the incomplete description of TDSE in terms of the state wavefunction.
2. Will analytically formulate the density matrix equations in terms of stochastic ordinary differential equations (SODE).
3. Will develop a model for the stochastic variations of the electric field of an the x-ray FEL field.
4. Will write a code for the solution of a system of the obtained SODE.

Skills required: The skills required for the present project is a basic knowledge of the quantum mechanics concepts, programming languages (f77 or f90 or C++ or C) and UNIX/Linux/Mac OSX operating systems. Since, eventually, the project may also depend heavily on the development of a theoretical framework around the solution of the TDDM equation it is suited for students with strong interest in the theoretical/computational aspects of atomic physics.

Keywords strong light-matter interactions, free-electron laser, FLASH,LCLS,XFEL, density matrix, stochastic differential equations, Auger transitions

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Study and development of solid state electrodes: from screen printed sensors to wearable on-fabric designs.

Giusy Matzeu and Dermot Diamond

The chemical composition of body fluids contains crucial information about the state of health of a person. While many efforts have been already directed to develop novel systems for real time analysis of blood and urine, there is still a pressing need for solutions to non-invasively monitor other fluids like sweat [1]. For example, the real time tracking of sodium levels is a valuable tool to assist clinicians in the diagnosis of Cystic Fibrosis [2]. Similarly, athletes could reap many benefits from an optimal strategy for re-integrating liquids, which could be informed by continuously measuring the amount of minerals lost in sweat [3].

Ion Selective Electrodes (ISEs) are potentiometric sensors designed to detect specific ions in blood that have great potential for wearable applications [4]. The development of screen printed electrodes as substrate has been proved so far to be advantageous in terms of cost, reproducibility, and miniaturization [5, 6]. Measuring the potential bias between reference and working electrodes it is possible to detect the concentration of an analyte of interest, like sodium in this specific case. In order to introduce sensing capabilities in wearable platfroms, electrodes need to be built on fabric [7]. Employing materials usually used in the development on lithium ion batteries [8] might allow exploring completely new applications.

This project involves the fabrication of solid-state Na^{+} ISEs and the evaluation of their response characteristics such as selectivity, linear range, dynamic response, sensitivity, and stability. Sensors will be first realised, tested and optimised on screen printed substrates. A feasibility study will be then conducted to examine the suitability of transferring the design on fabric. At this stage, it will be essential to find the best textile for the realisation of the electrodes, and then develop an optimum design in terms of detection power and stability, both of which will be assessed through bench trials. Depending on these intermediate results and through continuous evaluation, the electrode design and fabrication procedure will be progressively refined and improved. Finally the wearable sensors for sweat analysis will be integrated in a wireless potentiometric platform that will be developed in our laboratories in collaboration with the engineers' team.

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Membrane Adsorbers for Selective Separation of Glycoproteins

Dr. Jenny Lawler, School of Biotechnology, Dublin City University

Biopharma companies are putting increased focus on the development of technologies for selective separation/purification of glycoproteins – such manufacturing excellence is a key driver in the health technologies area. When a therapeutic protein is manufactured, there are usually a number of different glycoforms present, distinguished by different chains of sugars on their surface – leading to completely different efficacies and retention times in the body. Currently, proteins on the market are a mixture of glycoforms, with high batch to batch variability. In the coming years, regulatory bodies such as the FDA will insist on full glycoprofiling of any protein produced by manufacturers.

The current state of the art for glycoprotein separation is the implementation of a number of different chromatography steps, with affinity chromatography using specially developed lectins best able to select for individual glycoforms. However, the future of the biopharmaceutical industry is in the implementation of disposable technologies. Cost effective disposable alternatives for virtually every unit operation in bioprocessing is now readily available – with the notable exception of chromatography columns.

Membrane adsorption technology is a promising alternative to chromatography operations [1]. Membranes are routinely used for separation of proteins on the basis of size and charge and are well established in the biopharma industry. Membrane separations are a platform science, with applicability in many key research areas. Large companies such as Merck Millipore, Sartorius and Pall have recently launched membrane adsorber ranges and are continuing to expand in research and development in this area.

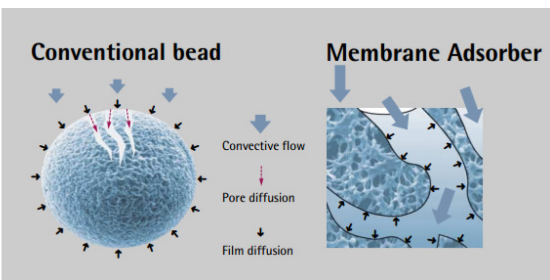

Figure 1: Bead -v- Adsorber system [2]

This project will allow the student to work with a postdoctoral researcher and MSc student on the development of novel polymeric brush membranes with immobilized glycospecific lectins, allowing the selective separation of mixtures of glycoproteins. This is an inherently scaleable, low energy, cost effective alternative to affinity chromatography columns, with a strong commercial potential.

The student will gain experience in polymer chemistry, lectin immobilization, membrane preparation via the NIPS (non-solvent induced phase separation) method, glycoprofiling, and membrane characterisation using techniques such as FTIR (Fourier Transform Infrared Spectroscopy), SEM (Scanning Electron Microscopy), and DMA (Dynamical Mechanical Analysis).

[1] Valerie Orr, Luyang Zhong, Murray Moo-Young, C. Perry Chou, Recent advances in bioprocessing application of membrane chromatography, Biotechnology Advances, Volume 31, Issue 4, July–August 2013, Pages 450-465

[2] http://microsite.sartorius.com/en/biotechnology/laboratory/products_applications/membrane_adsorbers/literature/pdfs/Fischer-F_2004_Faster_to_pure_product.pdf

Naughton Internships at UCC for students from the University of Notre Dame

Jimmy Murphy

1. HMRC: Ocean Energy Systems

Design and integration of marine renewable energy devices into the electricity grid system. There are a large number of active research projects in progress and the intern will be assigned to one of these for a specific research task. For further information on HMRC see http://www.hmrc.ucc.ie

Dominic O' Sullivan

2. Building Automation and Control Systems

Building Automation and Control Systems (BACS) have been used for the last 20 years to optimise and manage the day-to-day operations of large facilities. During this time a number of different hardware and software manufacturers have entered into this lucrative space with proprietary products designed to solve specific problems. This has led to a situation where a number of different BACS can be operating within a single facility controlling various systems and producing significant quantities of data. This data can be difficult to access due to the closed proprietary nature of the individual applications and so a single central repository of all the available building automation and control network system information is difficult to achieve. The purpose of this research is to establish the validity of utilising an OPC framework to coalesce the disparate information sources that can exist within a facility into a unified database than can be easily accessed and manipulated by a facility manager.

The student is to support this work through the investigation of utilising a universal OPC driver to access information directly from a programmable logic controller (PLC) that is used to control an air handling unit (AHU). The data will then be stored in a database system. This will give a student a significant insight in to the operation and control of air handling units as well as practical experience in the implementation of the OPC Data Access specification.

Emanuel Popovici

3. neuro-BAN

In the iBAN-Med project we aim to use a number of sensors to monitor and quantify some of the parameters on the Expanded Disability Status Scale(EDSS) for a neurological condition called multiplesclerosis. We intend to use a number of Wireless Inertial Units to build a body area network for monitoring the EDSS. This type of monitoring can be used to give a feedback for a number of neurological conditions or can be potentially used in rehabilitation. We will use C to program and to collect the data as well as machine learning algorithms. Some integration with other sensors within the body area network(EMG, EOG, EEG, etc) will also be key in providing an accurate decision support system. Collaboration with medical staff will also be part of the project.

4. iBAN-Play

In the iBAN-Play project we aim to build a body area network used for gesture recognition for gaming or for serious things such as helping children with disabilities to get better access to toys. A number of sensors(wireless inertial measurement units, EPIC sensors, etc) will be integrated within the body area network and used to generate intelligent interfaces for interacting with toys(micro robots, humanoid robots, etc). We will use embedded C and graphical interfacing(ARM based embedded platforms) to demonstrate the technology.

5. Wireless Sensor Networks for Energy Control and Optimisation

The aim of this project will be to deploy a wireless sensor network in a small wind farm setup which is built using some scaled wind-turbines. The wireless sensor network will sense for example data such as wind speed, and orientation which can be used in both modelling and optimisation of the energy output. Another goal of this internship is to develop the basic infrastructure for a centralised data collection using a web interface.

Padraig Cantillon-Murphy

6. Magnetic compression for colon repair after colorectal cancer surgery

The goal of this work is to develop a magnetic ring assembly consisting in two coupled magnetic components, for post- operative fusion of the human colon. It is hypothesised that a minimally- invasive alternative to suturing or stapling severed colon using magnetic components will improve patients outcomes, reduce anaesthesia and complications and decrease healthcare costs. Colorectal cancer is the third leading cause of cancer-related death in the western world. Iterative prototypes will be constructed using 3D rapid prototyping. Integration of biodegradable films (e.g., PLA) into the final assembly will be examined.

Summer 2014 REU Projects at DCU

Characterisation and Optimisation of Pumping Technologies for Integration into Microfluidic Analytical Systems

John Cleary and Dermot Diamond, NCSR

Microfluidic technology has gained increasing interest from the research and industrial sectors over the past 20 years. The ability to use and manipulate fluids at the micro level holds a number of significant advantages; the advent of inkjet printing technology is a noteworthy example. Other examples can include the continuous monitoring of key chemical targets for individuals suffering from diseases, or real-time detection of contaminants being emitted into the environment from industrial entities.

Although this technology is intuitively attractive, controlling fluids at this scale can result in a number of challenges which include bubble formation, cohesive/adhesive factors, reproducible mixing of fluid streams, and unwanted effects from high/low fluid rate and pressures. One significant element of a microfluidic sensing system that can result in such non-ideal conditions is the fluid handling device(s).

Autonomous instruments for monitoring key environmental water quality targets such as nutrients[1] (phosphate, nitrate, ammonia) and pH[2] have been developed and are under assessment through laboratory and field-based testing. A critical aspect of this research is the optimisation of the components and materials used within the sensing platform. Features such as the pumping system with corresponding components such as pumps (peristaltic/syringes), tubing, valves, need to be considered with respect to cost, robustness, and reliability over long operating lifetimes.

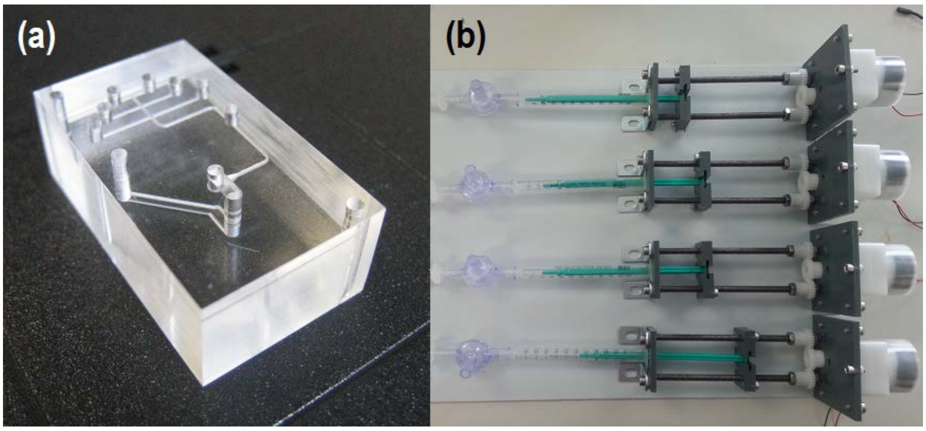

Fig. 1. (a) A microfluidic chip used for environmental phosphate analysis. (b) Custom built syringe-based pumping array.

This project examines the features and effects of various pumping technologies for microfluidic applications (as part of an ongoing study) along with associated factors within an autonomous detection system. In addition to pumping features such as flow characteristics (flow rate and reproducibility, self-priming capability, minimal pulsation of flow during the pump cycle), the project will consider other features including cost, durability, and ease of integration. The emphasis in this project will be on the real issues related to keeping the sensor platform operating autonomously over time.

[1]. Cleary, J., Maher, D., and Diamond, Dermot (2013) Development and deployment of a microfluidic platform for water quality monitoring. In: Mukhopadhyay, Subhas C. and Mason, Alex, (eds.) Smart Sensors for Real-Time Water Quality Monitoring. Smart Sensors, Measurement and Instrumentation . Springer-Verlag, Berlin Heidelberg 2013, pp. 125-148. ISBN 978-3-642-37005-2

[2]. Cleary, J., Cogan, D., Phelan, T., and Diamond, D. (2013) Microfluidic analyser for pH in water and wastewater. In: CEST2013 The 13th International Conference on Environmental Science and Technology, 5-7 Sept 2013, Athens, Greece.

Integration of Hydrogel-Based Valves for Fluid Control in Microfluidics

Simon Coleman, Dermot Diamond, National Centre for Sensor Research

The development of fully integrated microfluidics devices is still limited by the lack of robust components for fluid control. Diamond and co-workers in the Adaptive Sensors Group at DCU have carried out extensive research in the area of ionogels and their applications. An interesting aspect is the incorporation of ionogels with the chromophoric molecule spiropyran, resulting in a photoswitachable material. These ionogels show great promise as they do not require invasive stimuli. One application for this gel is as valves within microchannels in a microfluidic systems[1,2] as the opening/closing of the valve would be controlled by simply applying white light. These gels will be integrated into a microfluidic manifold from micro-milled PMMA (poly methyl-methacrylate) layers. A membrane will be incorporated into the design to separate the microvalve and flow channel to ensure reproducibility and protect gel from harsh chemical environments. This project will involve the subsequent characterisation of the microvalve performance within this manifold.

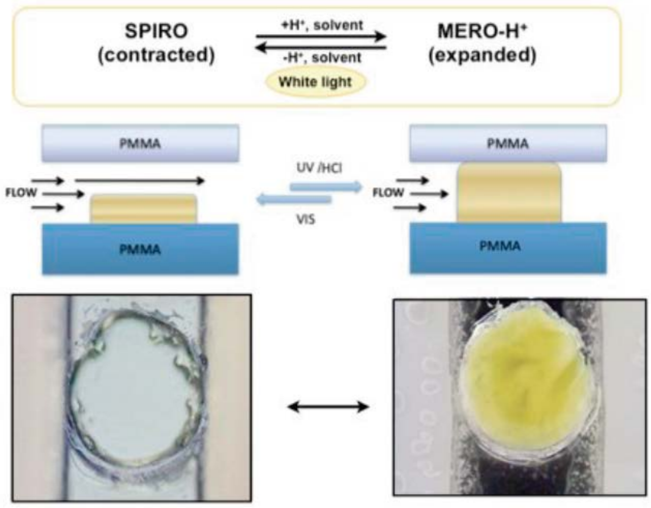

Fig. 1. (a) Scheme of a photo-switchable polymer matrix and schematic of the valve actuation. (b) Ionogel micro-valve in opened (left) and closed (right) state [2].

This project will investigate the following areas:

- Actuation of the microvalves by white light irradiation using LEDs.
- Measuring the change of horizontal and vertical dimensions while swelling and shrinking using optical microscopy within a microfluidic manifold.
- Evaluation of the closing kinetics mechanism as a function of the ionic liquid while exposing to white light irradiation.
- Evaluation of the gel behavior under various physical conditions.

References

[1]. Benito-Lopez, F., and Byrne, R., Răduţă, A.M., Vrana, N.E., McGuinness, G., and Diamond, D. (2010) Ionogel-based light-actuated valves for controlling liquid flow in micro-fluidic manifolds. Lab on a Chip, 10 (2). pp. 195-201.

[2]. Czugala, Monika and Maher, Damien and Burger, Robert and Fraser, Kevin J. and Ducree, Jens and Diamond, Dermot and Benito-Lopez, Fernando (2012) Portable Lab-on-a-Disc system integrating photo-switchable micro-valves for in-situ aquatic environmental monitoring. In: 16th International Conference on Miniaturized Systems for Chemistry and Life Sciences, µTAS 2011 (MicroTAS) Conference, 28 Oct - 1 Nov 2012, Okinawa, Japan.

Potential REU Projects for 2014

EMPLOYER DETAILS

Employer:	Trinity College Dublin
Business / Product:	University
Company Address:	College Green, Dublin 2 Ireland
Trainee working place:	Campus of Trinity College Dublin
Programme Contact:	Sandra Kavanagh, Faculty Administrator (Faculty of Engineering, Mathematics and Science)
Tel:	00353-1-896-1474
Email:	kavans14@tcd.ie
Student Supervisor *(if different)*:	Prof. Werner Blau
Email:	wblau@tcd.ie
Website:	http://www.tcd.ie
Number of Employees:	2,936 FTE staff (785 academic staff, 1,496 library, technical, administrative, and support services staff, and 655 research staff)
Nearest Rail / Bus / Airport:	Airport: Dublin International Rail: Pearse Station Bus: Bus Aras

STUDENT REQUIRED

Faculty:	Faculty of Engineering, Mathematics and science
School:	School of Physics
Previous training required:	Practical laboratory class experience in one of the physical sciences
Nationality:	Any
Study level:	3rd year Physics or Chemistry or Material Science degree course
Other requirements:	Motivation for experimental research
Languages:	English

TRAINEESHIP OFFERED

Brief job description (**Kind of work*)***:	***'Green Photonics' -*** *Ultrafast and nonlinear optical processes and applications of 'green' microbiologically synthesised nanocomposites* Photonics technology has become an important part of our daily life, spanning telecommunications, displays, lighting, renewable energy to biomedical sensors and devices. Most active devices rely on inorganic semiconducting compounds. The increasing use of nanostructures has created a concomitant increase in complexity and cost of fabrication equipment. In this proposal, a novel interdisciplinary approach to deal with all the above problems by microbiological fabrication of photonic nanocomposites is taken, which has the additional benefit of addressing lifecycle issues. A range of new fundamental questions will be addressed and answered, e.g. - Is there a fundamental physical or electronic structural difference between microbiologically and synthetically fabricated nanostructures? - Do the microbiologically made nanomaterials have different or better linear, nonlinear and ultrafast properties? - Can biodegradable photonic devices be made and usefully employed? The project will make use of the world-class ultrafast laser facility established in CRANN as well as bio-materials related collaborations with TCD Chemistry, UCD and abroad.
Number of Weeks offered*:*	12 weeks possibly longer
Hours per week:	Full time, i.e. 40
Earliest Start Date possible:	Mid May
Latest End Date possible:	Mid September

Potential REU Projects for 2014

EMPLOYER DETAILS

Employer:	Trinity College Dublin
Business / Product:	University
Company Address:	College Green, Dublin 2 Ireland
Trainee working place:	Campus of Trinity College Dublin
Programme Contact:	Sandra Kavanagh, Faculty Administrator (Faculty of Engineering, Mathematics and Science)
Tel:	00353-1-896-1474
Email:	kavans14@tcd.ie
Student Supervisor *(if different)*:	Dr. Mary Bourke
Email:	bourkem4@tcd.ie
Website:	http://www.tcd.ie
Number of Employees:	2,936 FTE staff (785 academic staff, 1,496 library, technical, administrative, and support services staff, and 655 research staff)
Nearest Rail / Bus / Airport:	Airport: Dublin International Rail: Pearse Station Bus: Bus Aras

STUDENT REQUIRED

Faculty:	Faculty of Engineering, Mathematics and science
School:	Division of Geography
Previous training required:	One of the following: Physical geography, geology, Planetary Sciences
Nationality:	Any
Study level:	Any undergraduate year
Other requirements:	Geographic Information Systems (GIS)
Languages:	English

TRAINEESHIP OFFERED

Brief job description (Kind of work*)*:	Intern will work as part of the Earth and Planetary Surface Processes group in the Department of Geography. Project: A quantitative analysis of surface landforms on Mars. Skills that will be developed: 1. Processing satellite images of Mars. 2. Managing image database in a GIS program. 3. Building digital terrain models of Martian landforms. 4. Collating and analysing data.
Number of Weeks offered*:*	8-12 weeks
Hours per week:	35 hours per week
Earliest Start Date possible:	May 1st 2014
Latest End Date possible:	August 1st 2014

Potential REU Projects for 2014

EMPLOYER DETAILS

Employer:	Trinity College Dublin
Business / Product:	University
Company Address:	College Green, Dublin 2 Ireland
Trainee working place:	Campus of Trinity College Dublin
Programme Contact:	Sandra Kavanagh, Faculty Administrator (Faculty of Engineering, Mathematics and Science)
Tel:	00353-1-896-1474
Email:	kavans14@tcd.ie
Student Supervisor *(if different)*:	Andrew Butterfield
Email:	Andrew.Butterfield@scss.tcd.ie
Website:	http://www.tcd.ie
Number of Employees:	2,936 FTE staff (785 academic staff, 1,496 library, technical, administrative, and support services staff, and 655 research staff)
Nearest Rail / Bus / Airport:	Airport: Dublin International Rail: Pearse Station Bus: Bus Aras

STUDENT REQUIRED

Faculty:	Faculty of Engineering, Mathematics and science
School:	School of Computer Science and Statistics
Previous training required:	Computer Science/Engineering with good programming and mathematical skills, esp. Familiarity with Predicate Logic and functional programming (Haskell, or ML experience ideally).
Nationality:	Any
Study level:	Final-Year undergraduate (Bachelor's level)
Specialisation:	Computer Science/Engineering with good programming and mathematical skills, esp. Familiarity with Predicate Logic and functional programming (Haskell, or ML experience ideally).
Other requirements:	An interest is the applications of logic for reasoning about computer languages, and the development of user-oriented tools.
Languages:	English

TRAINEESHIP OFFERED

Brief job description (Kind of work):	Assist with upgrade and enhancements to a prototype theorem prover (UTP2) under development here at TCD. The theorem prover is written in Haskell, using the wxHaskell GUI library, and expressed as a Haskell literate scriot that doubles as LaTeX sources. The theorem prover is designed to support the development of formal language semantics, in the style of the Unifying Theories of Programming paradigm.
Number of Weeks offered:	10 weeks
Hours per week:	standard (00.09-17.00, 40hrs)
Earliest Start Date possible:	May 19^{th} 2014
Latest End Date possible:	Aug 9^{th} 2014 (supervisor away Jun 23^{rd}-Jul 4^{th}, student will be supervised in this period by senior Researcher)

Potential REU Projects for 2014

EMPLOYER DETAILS

Employer:	Trinity College Dublin
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Company Address:	College Green, Dublin 2 Ireland
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Programme Contact:	Sandra Kavanagh, Faculty Administrator (Faculty of Engineering, Mathematics and Science)
Tel:	00353-1-896-1474
Email:	kavans14@tcd.ie
Student Supervisor *(if different)*:	Graham Cross
Email:	crossg@tcd.ie
Website:	http://www.crann.tcd.ie/
Number of Employees:	2,936 FTE staff (785 academic staff, 1,496 library, technical, administrative, and support services staff, and 655 research staff)
Nearest Rail / Bus / Airport:	Airport: Dublin International Rail: Pearse Station Bus: Bus Aras

STUDENT REQUIRED

Faculty:	Faculty of Engineering, Mathematics and science
School:	School of Physics CRANN Nanotechnology Institute
Previous training required:	Computer programming (Python or C) Basic electronics
Nationality:	Any
Study level:	3rd year physics or mechanical/electric engineer
Other requirements:	Knowledge of the mechanics of materials highly desirable.
Languages:	English

TRAINEESHIP OFFERED

Brief job description (**Kind of work*)***:	The Cross group has recently developed a new method to measure mechanical properties of thin films and biomaterials at the nanoscale. In this project the student will, with the assistance of research staff from Prof. Cross' group, contribute to the code base for new 2.0 generation instruments we have developed around the method. The work will involve implementing Numerical Python code for control and measurement systems. There may also be the opportunity to perform actual experiments at the end of the internship.
Number of Weeks offered*:*	12weeks
Hours per week:	standard (00.09-17.00, 40hrs)
Earliest Start Date possible:	Immediate
Latest End Date possible:	End of 2014

Potential REU Projects for 2014

EMPLOYER DETAILS

Employer:	Trinity College Dublin
Business / Product:	University
Company Address:	College Green, Dublin 2 Ireland
Trainee working place:	Campus of Trinity College Dublin
Programme Contact:	Sandra Kavanagh, Faculty Administrator (Faculty of Engineering, Mathematics and Science)
Tel:	00353-1-896-1474
Email:	kavans14@tcd.ie
Student Supervisor *(if different)*:	Prof. Shane Dillon
Email:	scdillon@tcd.ie
Website:	http://www.tcd.ie
Number of Employees:	2,936 FTE staff (785 academic staff, 1,496 library, technical, administrative, and support services staff, and 655 research staff)
Nearest Rail / Bus / Airport:	Airport: Dublin International Rail: Pearse Station Bus: Bus Aras

STUDENT REQUIRED

Faculty:	Faculty of Engineering, Mathematics and science
School:	School of Genetics and Microbiology
Previous training required:	General biological laboratory experience and an interest in Microbiology. All other training will be provided.
Nationality:	Any
Study level:	At least two years of a undergraduate degree in biological science
Other requirements:	An interest in bacterial gene regulation would be advantageous but not necessary
Languages:	English

TRAINEESHIP OFFERED

Brief job description (**Kind of work*)***:	The student will be conducting laboratory experiments to understand how anaerobic growth influences the gene expression of key *Salmonella* pathogenesis factors
Number of Weeks offered*:*	10weeks
Hours per week:	30-40 hours per week
Earliest Start Date possible:	25th May 2014
Latest End Date possible:	8th August 2014

Potential REU Projects for 2014

EMPLOYER DETAILS

Employer:	Trinity College Dublin
Business / Product:	University
Company Address:	College Green, Dublin 2 Ireland
Trainee working place:	Campus of Trinity College Dublin
Programme Contact:	Sandra Kavanagh, Faculty Administrator (Faculty of Engineering, Mathematics and Science)
Tel:	00353-1-896-1474
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Student Supervisor *(if different)*:	Dr Vladimir Dotsenko
Email:	vdots@maths.tcd.ie
Website:	http://www.tcd.ie
Number of Employees:	2,936 FTE staff (785 academic staff, 1,496 library, technical, administrative, and support services staff, and 655 research staff)
Nearest Rail / Bus / Airport:	Airport: Dublin International Rail: Pearse Station Bus: Bus Aras

STUDENT REQUIRED

Faculty:	Faculty of Engineering, Mathematics and science
School:	School of Mathematics
Previous training required:	N/A
Nationality:	Any
Study level:	3rd or 4th year undergraduate
Other requirements:	Essential: some knowledge of algebra on the university level (e.g. first two years of a maths or computer science degree) Desirable: experience with functional programming (e.g. Haskell or LISP)
Languages:	English

TRAINEESHIP OFFERED

Brief job description (**Kind of work**):	The trainee will be involved in solving a research problem about operads, an algebraic device that captures formal properties of operations with many arguments (binary, ternary, etc.). It will involve a mixture of theoretical reasoning and computer experiments, and is primarily aimed at applicants who are interested in pursuing mathematics or *theoretical* computer science for an academic career at a later stage. The trainee will also be involved in the reading seminar of the existing internal summer internship programme for maths students at TCD.
Number of Weeks offered*:*	10 weeks
Hours per week:	35 hrs per week
Earliest Start Date possible:	June 1, 2014
Latest End Date possible:	August 1st

Potential REU Projects for 2014

EMPLOYER DETAILS

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Company Address:	College Green, Dublin 2 Ireland
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Programme Contact:	Sandra Kavanagh, Faculty Administrator (Faculty of Engineering, Mathematics and Science)
Tel:	00353-1-896-1474
Email:	kavans14@tcd.ie
Student Supervisor *(if different)*:	Prof. Rachel C. Evans
Email:	raevans@tcd.ie
Website:	http://www.tcd.ie
Number of Employees:	2,936 FTE staff (785 academic staff, 1,496 library, technical, administrative, and support services staff, and 655 research staff)
Nearest Rail / Bus / Airport:	Airport: Dublin International Rail: Pearse Station Bus: Bus Aras

STUDENT REQUIRED

Faculty:	Faculty of Engineering, Mathematics and science
School:	School of Chemistry
Previous training required:	Previous practical laboratory experience desirable
Nationality:	Any
Study level:	Minimum second year undergraduate studies in chemistry
Other requirements:	Preference given to candidates with demonstrable practical experience in spectroscopy (UV/Vis absorption, fluorescence, *etc.*) and data analysis.
Languages:	English

TRAINEESHIP OFFERED

Brief job description (Kind of work*)*:	The trainee will join a vibrant, international team whose research interests are focused on the design and characterisation of sophisticated functional organic-inorganic hybrid materials for applications ranging from optical sensing, to solar energy conversion to biomaterials. (For further information on our research, please visit our website: http://sites.google.com/site/drrachelcevans) We have recently demonstrated that self-assembly is an elegant method for the fabrication of extended conjugated polyelectrolyte(CPE)-polyoxometalate(POM) supramolecular hybrid networks with attractive light-harvesting properties for the new generation of solar cells. The trainee will carry out a new research project to establish how the individual chemical composition and structure of the CPE and the POM control the organisation and properties of the resulting hybrid networks that they form. To achieve this, the trainee will gain experience in a variety of instrumental techniques, including UV/Vis absorption, infrared and fluorescence spectroscopy, linear dichroism and dynamic light scattering. The ultimate goal of the project aim is to determine a set of structural guidelines that will be used to predict structure-property relationships in hypothetical CPE-POM hybrid networks.
Number of Weeks offered*:*	10-12 weeks
Hours per week:	37.5 hours per week
Earliest Start Date possible:	03/06/2014
Latest End Date possible:	As above

Potential REU Projects for 2014

EMPLOYER DETAILS

Employer:	Trinity College Dublin
Business / Product:	University
Company Address:	College Green, Dublin 2 Ireland
Trainee working place:	Campus of Trinity College Dublin
Programme Contact:	Sandra Kavanagh, Faculty Administrator (Faculty of Engineering, Mathematics and Science)
Tel:	00353-1-896-1474
Email:	kavans14@tcd.ie
Student Supervisor *(if different)*:	Prof. Peter T. Gallagher
Email:	peter.gallagher@tcd.ie
Website:	http://www.tcd.ie
Number of Employees:	2,936 FTE staff (785 academic staff, 1,496 library, technical, administrative, and support services staff, and 655 research staff)
Nearest Rail / Bus / Airport:	Airport: Dublin International Rail: Pearse Station Bus: Bus Aras

STUDENT REQUIRED

Faculty:	Faculty of Engineering, Mathematics and science
School:	Astrophysics Research Group (School of Physics)
Previous training required:	Physics, mathematics, computer science, or engineering student with programming experience in Interactive Data Language (IDL) or similar language. Experience with shell scripts and/or PHP desirable, but not essential.
Nationality:	Any
Study level:	3rd or 4th year Undergraduate
Other requirements:	Understanding of image processing, databases, solar physics
Languages:	English

TRAINEESHIP OFFERED

Brief job description (**Kind of work*)***:	The TCD Solar Physics Group runs a popular website called www.SolarMonitor.org that serves near-realtime images of the Sun from a number of NASA, NOAA and ESA satellites to over 3,500 visitors each day. We require a summer intern to work on the backend software to improve the stability and functionality of the website. The intern will work closely with members of the group on IDL code to process and archive data from a multitude of solar and space weather databases around the world.
Number of Weeks offered*:*	10-12 weeks
Hours per week:	35 hrs per week
Earliest Start Date possible:	1 June 2014
Latest End Date possible:	As above

Potential REU Projects for 2014

EMPLOYER DETAILS

Employer:	Trinity College Dublin
Business / Product:	University
Company Address:	College Green, Dublin 2 Ireland
Trainee working place:	Campus of Trinity College Dublin
Programme Contact:	Sandra Kavanagh, Faculty Administrator (Faculty of Engineering, Mathematics and Science)
Tel:	00353-1-896-1474
Email:	kavans14@tcd.ie
Student Supervisor *(if different)*:	Dr. Naomi Harte
Email:	nharte@tcd.ie
Website:	http://www.tcd.ie
Number of Employees:	2,936 FTE staff (785 academic staff, 1,496 library, technical, administrative, and support services staff, and 655 research staff)
Nearest Rail / Bus / Airport:	Airport: Dublin International Rail: Pearse Station Bus: Bus Aras

STUDENT REQUIRED

Faculty:	Faculty of Engineering, Mathematics and science
School:	Dept of Electronic and Electrial Engineering
Previous training required:	Undergraduate degree programme in Electronic Engineering, about to start last year of degree.
Nationality:	Any
Study level:	Completed 3 or 4 years in Electronic Engineering. Subjects studied to include digital signal processing (DSP)
Other requirements:	Programming experience in Matlab Outgoing, willing to interact with wider research group.
Languages:	English

TRAINEESHIP OFFERED

Brief job description (Kind of work*)*:	Working in support of ongoing research in the Sigmedia Group in the School of Engineering at TCD. See www.sigmedia.tv for group overview. Student will work on a project in speech or image processing according to previous experience/interest or strengths. Work mostly PC based, developing algorithms and programming in Matlab
Number of Weeks offered*:*	10-12 weeks as appropriate
Hours per week:	35 hrs per week
Earliest Start Date possible:	26^{th} May
Latest End Date possible:	29^{th} August

Potential REU Projects for 2014

EMPLOYER DETAILS

Employer:	Trinity College Dublin
Business / Product:	University
Company Address:	College Green, Dublin 2 Ireland
Trainee working place:	Campus of Trinity College Dublin
Programme Contact:	Sandra Kavanagh, Faculty Administrator (Faculty of Engineering, Mathematics and Science)
Tel:	00353-1-896-1474
Email:	kavans14@tcd.ie
Student Supervisor *(if different)*:	Prof. Stefan Hutzler
Email:	School of Physics
Website:	www.tcd.ie/physics/foams
Number of Employees:	2,936 FTE staff (785 academic staff, 1,496 library, technical, administrative, and support services staff, and 655 research staff)
Nearest Rail / Bus / Airport:	Airport: Dublin International Rail: Pearse Station Bus: Bus Aras

STUDENT REQUIRED

Faculty:	Faculty of Engineering, Mathematics and science
School:	School of Physics
Previous training required:	Physics, (Engineering with physics background)
Nationality:	Any
Study level:	Second or third year undergraduate
Other requirements:	N/A
Languages:	English

TRAINEESHIP OFFERED

Brief job description (**Kind of work*)*:	Experimental laboratory work concerning the physics of foams
Number of Weeks offered*:*	10-12 weeks
Hours per week:	35 hours per week
Earliest Start Date possible:	Beginning of May
Latest End Date possible:	End of August

Potential REU Projects for 2014

EMPLOYER DETAILS

Employer:	Trinity College Dublin
Business / Product:	University
Company Address:	College Green, Dublin 2 Ireland
Trainee working place:	Campus of Trinity College Dublin
Programme Contact:	Sandra Kavanagh, Faculty Administrator (Faculty of Engineering, Mathematics and Science)
Tel:	00353-1-896-1474
Email:	kavans14@tcd.ie
Student Supervisor *(if different)*:	Dr. James Murray & Ms. Lois Lee Dekkers
Email:	james.murray@tcd.ie
Website:	http://www.tcd.ie
Number of Employees:	2,936 FTE staff (785 academic staff, 1,496 library, technical, administrative, and support services staff, and 655 research staff)
Nearest Rail / Bus / Airport:	Airport: Dublin International Rail: Pearse Station Bus: Bus Aras

STUDENT REQUIRED

Faculty:	Faculty of Engineering, Mathematics and science
School:	School of Biochemistry and Immunology
Previous training required:	Basic biochemical laboratory training. Cell culture and Western immunoblotting experience would be an advantage
Nationality:	Any
Study level:	Any undergraduate year
Other requirements:	N/A
Languages:	English

TRAINEESHIP OFFERED

Brief job description (**Kind of work*)*:	A mini-project is available in the Cell Growth and Survival Signalling (CGSS) laboratory of Dr. James Murray to investigate the affect of an experimental autophagy inhibitor on the rate of mitochondrial degradation following activation of mitophagy in neuronal cells. The student will culture cells in vitro, treat them with selected chemical compounds and then monitor the affects on expression of autophagy and mitophagy marker proteins by SDS-PAGE and Western immunoblotting. General practical techniques will include maintaining a written record of experiments, making buffers, measure protein concentrations and working with advanced digital imaging platforms. The student will also be expected to contribute to the general running of the laboratory, including stocking of consumables, disposal of waste and cleaning of workstations.
Number of Weeks offered*:*	10 weeks
Hours per week:	35 hours per week
Earliest Start Date possible:	16^{th} June 2014
Latest End Date possible:	22^{nd} August 2014

Potential REU Projects for 2014

EMPLOYER DETAILS

Employer:	Trinity College Dublin
Business / Product:	University
Company Address:	College Green, Dublin 2 Ireland
Trainee working place:	Campus of Trinity College Dublin
Programme Contact:	Sandra Kavanagh, Faculty Administrator (Faculty of Engineering, Mathematics and Science)
Tel:	00353-1-896-1474
Email:	kavans14@tcd.ie
Student Supervisor *(if different)*:	Prof. Michael Peardon
Email:	mjp@maths.tcd.ie
Website:	http://www.tcd.ie
Number of Employees:	2,936 FTE staff (785 academic staff, 1,496 library, technical, administrative, and support services staff, and 655 research staff)
Nearest Rail / Bus / Airport:	Airport: Dublin International Rail: Pearse Station Bus: Bus Aras

STUDENT REQUIRED

Faculty:	Faculty of Engineering, Mathematics and science
School:	School of Mathematics
Previous training required:	Two years undergraduate training with strong mathematical background.
Nationality:	Any
Study level:	Completed second year undergraduate or higher.
Other requirements:	Some programming (C/C++) experience helpful
Languages:	English

TRAINEESHIP OFFERED

Brief job description (**Kind of work***)*:	An introduction to research in numerical simulation and Monte Carlo estimation, with applications in quantum field theories or statistical mechanics.
Number of Weeks offered*:*	10 weeks
Hours per week:	standard (00.09-17.00, 40hrs)
Earliest Start Date possible:	12th May 2014
Latest End Date possible:	4th August 2014

Potential REU Projects for 2014

EMPLOYER DETAILS

Employer:	Trinity College Dublin
Business / Product:	University
Company Address:	College Green, Dublin 2 Ireland
Trainee working place:	Campus of Trinity College Dublin
Programme Contact:	Sandra Kavanagh, Faculty Administrator (Faculty of Engineering, Mathematics and Science)
Tel:	00353-1-896-1474
Email:	kavans14@tcd.ie
Student Supervisor *(if different)*:	Hongzhou Zhang
Email:	hozhand@tcd.ie
Website:	http://www.tcd.ie
Number of Employees:	2,936 FTE staff (785 academic staff, 1,496 library, technical, administrative, and support services staff, and 655 research staff)
Nearest Rail / Bus / Airport:	Airport: Dublin International Rail: Pearse Station Bus: Bus Aras

STUDENT REQUIRED

Faculty:	Faculty of Engineering, Mathematics and science
School:	School of Physics
Previous training required:	General Physics
Nationality:	Any
Study level:	Junior/Senior Sophisters (3rd/ 4th year undergraduate students)
Other requirements:	N/A
Languages:	English

TRAINEESHIP OFFERED

Brief job description (**Kind of work*)***:	**The development of cathodoluminescence detection in the Scanning Electron microscope** Cathololumminescence (CL) is the process of light emission due to energetic electron bombardment and it is a conventional analytical method material characterisation. We have recently integrated a novel fibre based CL detection system with a scanning electron microscopy. The task of this project is to further improve the detection efficiency and design practical approaches for quantification of detection geometry. The candidate is expected to finish a literature review on the approaches for the fibre tip modification and conduct experiments to modify the fibre using mechanical polishing as well as heat treatment to improve the detection efficiency. It is also possible to work on the focused ion beam workstation to fabricate photonic structures on the tip. Hands-on trainings on the operation of the scanning electron microscope, nanomanipulator, and spectrometer will be available to the student. The student will be actively involved in relevant research activities in the group and hopefully make contributions to the characterisation of nanosensors using the improved CL setup.
Number of Weeks offered*:*	12 weeks
Hours per week:	standard (00.09-17.00, 40hrs)
Earliest Start Date possible:	01/04/2014 – flexible
Latest End Date possible:	31/10/2014 - flexible