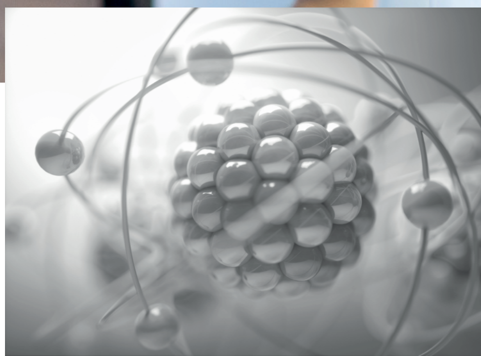
DCU
Ollscoil Chathair
Bhaile Átha Cliath
Dublin City University

Final Year Degree Projects

2019

DÁMH NA HEOLAÍOCHTA AGUS SLÁINTE
FACULTY OF SCIENCE AND HEALTH

Introduction

It is my great pleasure to introduce this booklet which summarises the recent activities and achievements of the Final Year physics students from our honours BSc degree programmes (Applied Physics, Physics with Biomedical Sciences and Physics with Astronomy) in the Academic Year 2018/19, in both their Integrated TRAining (INTRA) placements in Y3, as well as their final year degree projects in Y4.

The material in this booklet has been prepared by the students themselves and coordinated by Prof Enda McGlynn. I would like to especially thank Ms Marie Leahy and Ms Katy Halpin and their colleagues from the DCU Marketing Department for the production and design of the booklet. Sincere thanks also to Mr Pat Wogan of the School of Physical Sciences for assistance with graphics.

This booklet aims to provide information about the range of skills acquired by our Physics students. They are excellent problem-solvers, in both experimental and theoretical domains, based on their deep disciplinary knowledge and understanding combined with up-to-date mathematical, coding and computing skills. They also master key generic and transferable skills in the areas of oral and written communications, project planning and management.

My School of Physical Sciences colleagues and I firmly believe that this range of skills makes them the epitome of the modern "T"-shaped graduate. The DCU physics graduates are ideally positioned for employment across the industrial and enterprise sectors, in roles including research, development and translation.

If you have any enquiries, or would like to discuss ways in which your organisation could work with the School of Physical Sciences in the future, either in terms of INTRA placements or Final Year degree projects, please contact me using the contact details below.

Yours sincerely,

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Overview of Programmes

Overview of Applied Physics Programme

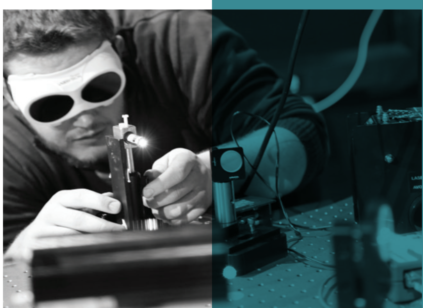
Year 1		Year 2		Year 3		Year 4	
Semester 1	*Semester 2*	*Semester 1*	*Semester 2*	*Semester 1*	*Semester 2*	*Semester 1*	*Semester 2*
Motion and Energy	The Universe	Quantum Physics 1	Linear Algebra	Laboratory	INTRA	Degree Project and Professional Skills	Degree Project and Professional Skills
Light and Optics	Electricty and Magnetism	Relativity, Nuclear and Particle	Electro - magnetism	Quantum Physics 2		Solid State Physics	Plasma Science
Computing	Thermal Properties	Vibrations and Waves	Solid State Physics 1	Statistical Physics		Quantum Electronics	Signal Processing
Laboratory	Programming	Electronics	Renewable Energy	Wave Optics		Electro-dynamics	Nano-technology
Calculus	Calculus	Calculus of Several Variables	Advanced Programming	Differential Equations		Applied Spectroscopy	Medical Diagnostics
Chemistry	Laboratory	Laboratory	Space Science and Tecnology	Semi-conductors		Image Processing and Analysis	Computational Physics
			Laboratory	Stellar Physics			

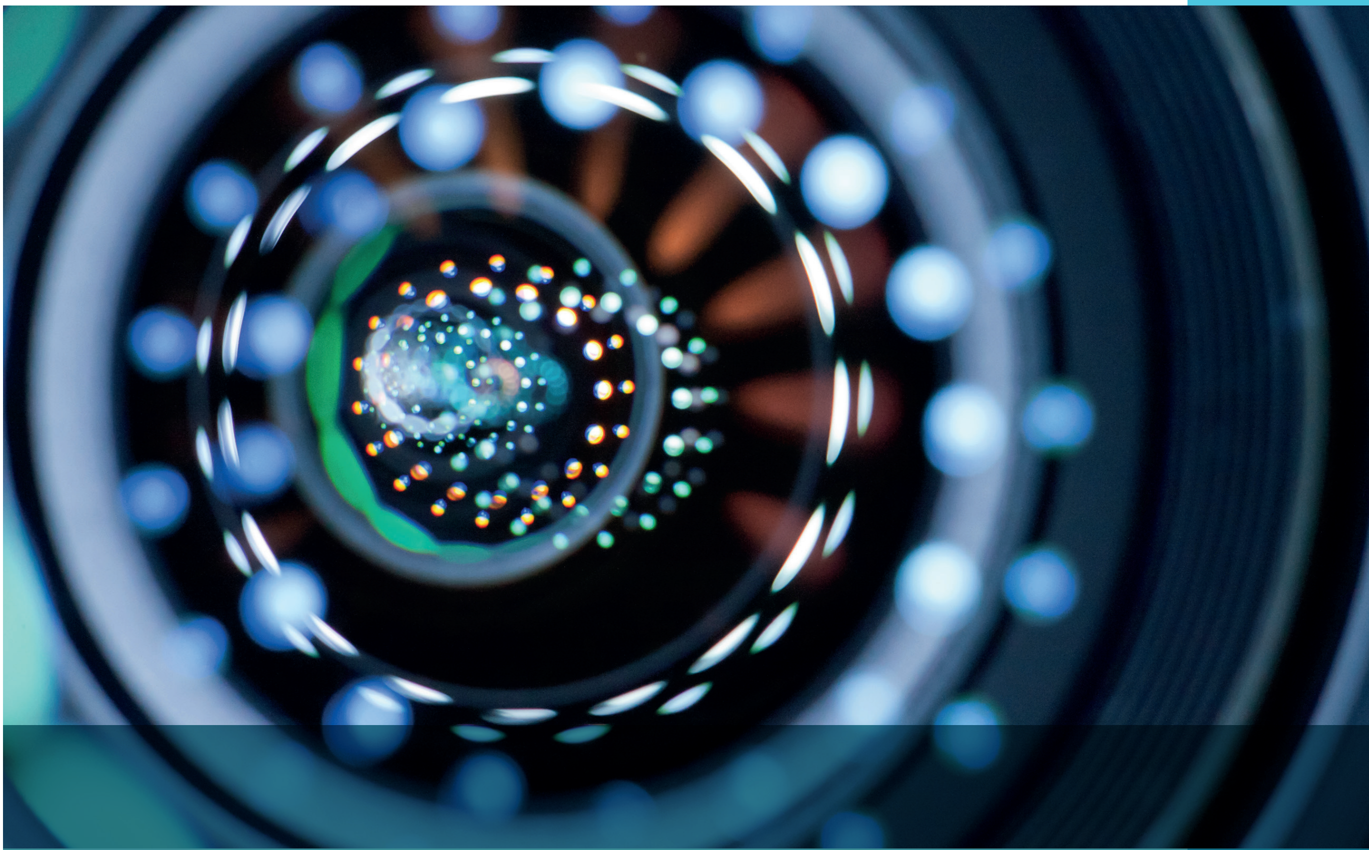
Overview of Physics with Biomedical Sciences Programme

Year 1		Year 2		Year 3		Year 4	
Semester 1	*Semester 2*	*Semester 1*	*Semester 2*	*Semester 1*	*Semester 2*	*Semester 1*	*Semester 2*
Motion and Energy	Understanding the Body	Quantum Physics 1	Linear Algebra	Laboratory	INTRA	Degree Project and Professional Skills	Degree Project and Professional Skills
Light and Optics	Electricty and Magnetism	Physiology	Electro - magnetism	Quantum Physics 2		Advanced Biomaterials	Plasma Science
Computing	Thermal Properties	Vibrations and Waves	Solid State Physics	Statistical Physics		Quantum Electronics	Medical Diagnostics
Laboratory	Programming	Electronics	Biomechanics	Wave Optics		Image Processing	Digital Signal Processing
Calculus	Calculus	Calculus of Several Variables	Advanced Programming	Differential Equations		Applied Spectroscopy	Microfluidics
Chemistry for Health	Laboratory	Laboratory	Space Science and Tecnology	Relativity, Nuclear and Particle			Computational Physics

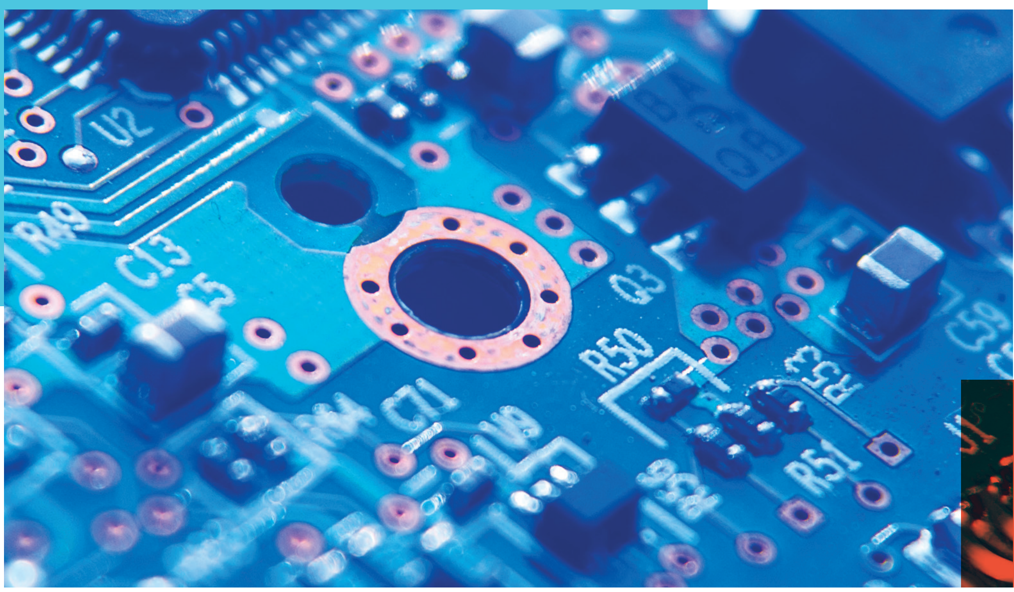
Overview of Physics with Astronomy Programme

Year 1		Year 2		Year 3		Year 4	
Semester 1	*Semester 2*	*Semester 1*	*Semester 2*	*Semester 1*	*Semester 2*	*Semester 1*	*Semester 2*
Motion and Energy	The Universe	Quantum Physics 1	Linear Algebra	Laboratory	INTRA	Degree Project and Professional Skills	Degree Project and Professional Skills
Light and Optics	Electricty and Magnetism	Relativity, Nuclear and Particle	Electro - magnetism	Quantum Physics 2		Image Processing	Plasma Science
Computing	Thermal Properties	Vibrations and Waves	Solid State Physics 1	Statistical Physics		Mechanics	Signal Processing
Laboratory	Programming	Electronics	Space Science and Tecnology	Wave Optics		Electro- dynamics	Extragalactic Astrophysics and Cosmology
Calculus	Calculus	Calculus of Several Variables	Advanced Programming	Differential Equations		Applied Spectroscopy	Topics in Astrophysics
Chemistry	Laboratory	Laboratory	Laboratory	Stellar Physics			Computational Physics
				Astronomical Techniques			





Student Profiles and Projects



Design and Construction of a low-cost Temperature Controlled Resistor Bath for Metrological Applications

Duré Basit

At the NML, temperature calibrations are performed using resistance bridges in conjunction with standard resistors. These standard resistors are used in laboratories maintained at a temperature of 20 °C ± 2 °C. This variability in temperature has significant implications on the stability of resistor values, and thus measurement uncertainty. My project aims to address this issue through the fabrication of a resistor bath of suitable dimensions for applications with the NML which will maintain standards resistor at a more stable temperature. Even a system capable of maintaining a temperature of 20 °C ± 1 °C would influence the combined uncertainty of the system and is worth obtaining. In order to achieve this the system design utilises a thermoelectric cooler controlled by a temperature regulation circuit to maintain the temperature of transformer oil within a stainless-steel housing. The ability of this system to improve the calibration procedures in the Temperature and Humidity section of NML has implications that reach far into Irish industry.

I am currently in the final year of my BSc in Physics with Biomedical Sciences. I completed my INTRA placement at the National Metrology Laboratory, a subdivision of the National Standards Authority of Ireland. My role was within the Temperature and Humidity Metrology Section, there I was responsible for performing commercial temperature calibrations of many different temperature measuring standards and equipment. Over the duration of my placement I gained many skills such as temperature mapping, characterisation of standards and uncertainty measurement and analysis. After I graduate, I intend to further my education in areas of physics that I find most interesting, such as optics and advanced processing technologies.

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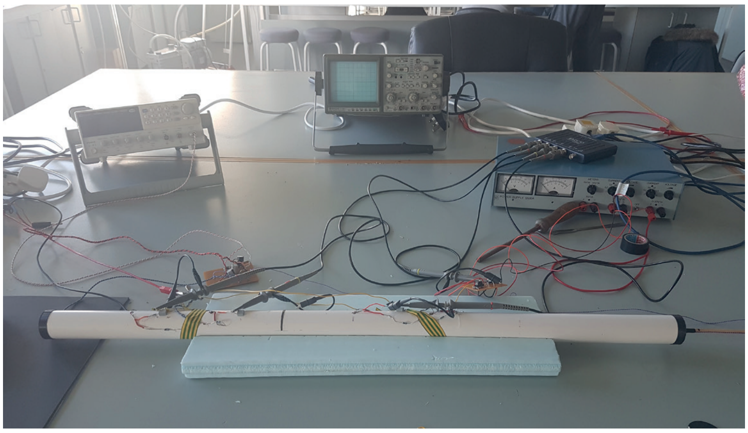
Acoustic and Computational demonstration of Avoided level crossing

Helen Boylan



I chose this project because I find quantum mechanics intriguing, particularly its counter-intuitive behaviour. Here the avoided crossings in the acoustic system are modelled off those of a quantum infinite square well split into two regions. Avoided crossings occur in coupled systems, in this case I will experimentally demonstrate an avoided crossing in an acoustic system, consisting of two coupled PVC tube sections. One section has a fixed length, while the other has a variable length. Coupling between these tube sections is controlled by plastic apertures with a variable hole size, the hole size will dictate the strength of coupling between the two systems. Once coupling is introduced, level splitting occurs. We can force these levels closer and closer together but they will never cross, they will repel away from each other. I will also model computationally the coupled masses on springs system for comparison.

Final year student, studying Physics with biomedical science. As someone who has always been curious about science and medicine, my course provided me with an insight into both, but more importantly, how indispensable the application of physics in medicine has been, particularly in areas such as diagnostics and prosthetics / orthotics. My intra placement was with the Fraunhofer research centre, working in microfluidics. Microfluidics is the science of controlling and manipulating fluids within the range of micro to picolitres. My main duties included manufacturing and testing microfluidic discs to be used in the detection of biomarkers in cardiovascular disease. The discs were highly integrated with the purpose of carrying out an extensive immunoassay to detect these cardiac biomarkers.

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An Elementary Introduction to Stochastic Financial Modelling and The Black-Scholes Theory

Conor Boyle

My project is primarily centered around how to model seemingly unpredictable random motion. The specific area being in financial modelling. Using Geometric Brownian Motion as the fundamental basis behind the Black-Scholes option-pricing model, the program aims to be able to forecast possible future value(s) of a stock or financial option. Based on the historical stock data of any desired company, the average continuous growth and the volatility of the stock's price can be used when making these predictions. Upon completion, the goal is to develop a web application that will make the program more accessible, particularly for educational purposes surrounding stochastic modelling.

The DCU School of Physical Sciences has brought me a long way since I first started back in 2015. From my time here on INTRA as a laboratory assistant to now fully developing my own project, it's been quite the journey. I came into the Applied Physics stream through Common Entry Science, allowing me to get a taste of all areas of science across the board before I decided on what I wanted to study permanently. The knowledge gained, and the skills learned have been invaluable. It really helps putting the theory I learn into practice and has given me an entirely new perspective on the world around me. Something I'd like to take with me to industry.

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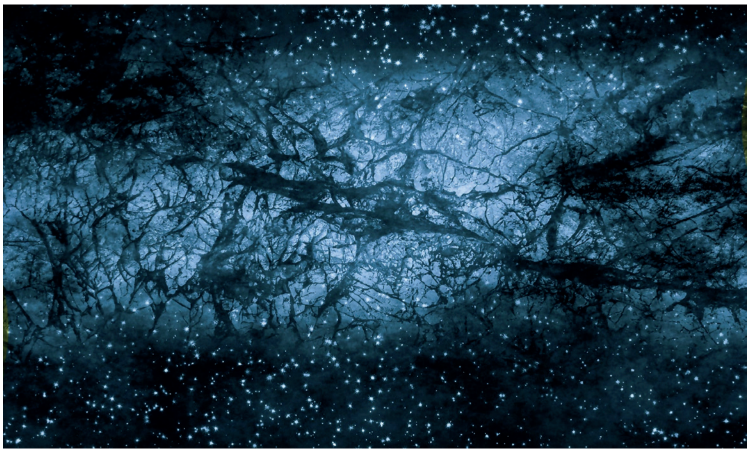
Dark matter in Our Galaxy

Dillon Breen



One of the most intriguing discoveries of the 20th century, in relation to the perception of the Universe, is that ordinary baryonic matter is not the dominant component in the cosmos. The solution behind this revelation remains a mystery, however, it is believed that another bizarre form of material exists, known as dark matter, which is roughly five times more abundant than ordinary matter.

My project's intent is to estimate the effect of a spherical distribution of dark matter in the Milky Way galaxy and distinguish the differences as compared to recent observational data taken from the ESA's Gaia archives. These variations are gathered through the modelling of matter distribution and furthermore, the calculation of galactic rotational curvature. Over the course of completion, this project has allowed me to further development my physics knowledge while offering improvement upon my skill set in mathematical modelling and programming.

While having no prior experience in the physical sciences discipline, but a passion for the unknown, pursing Physics with Astronomy was a complete leap of faith for me. The final months of my last academic semester are now closing in and no alterations would be made to my course selection.

Studying at DCU has offered me many opportunities to professionally develop, particularly via INTRA. In addition to visiting the European Space Astronomy Centre as part of the placement program, I obtained a position as a Laboratory Assistant in the Dublin Institute for Advanced Studies working in the field of Cryogenics, advancing my programming and critical thinking skills. I aim to conclude my studies with a taught MSc. in Data and Computational Science.

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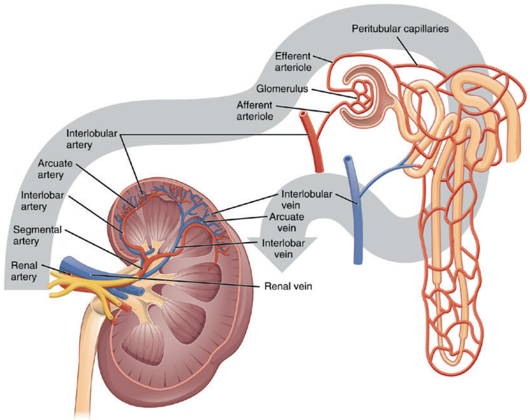
Glomerular Filtration rate measurement for the living kidney program

Ivan Briody



My project is to create a piece software that can measure the rate of how much blood filters through a person's kidneys, in particular the part of the kidney called the glomerulus. This rate is then used as a factor for determining if a kidney from a living donor is healthy enough to be transferred to another person. The rate is calculated by injecting a radioactive substance into the potential donor intravenously and taking blood samples at later time intervals. These samples are centrifuged and measured using a gamma counter. These measurements are then computed to give a measurement for the glomerular filtration rate in millilitres per minute. If this rate is above the given value then the kidney is deemed viable provided all the other tests carried out are satisfactory.

My name is Ivan and I am currently in my final year of study in physics with biomedical sciences. For my INTRA placement I was lucky enough to have worked in Beaumont hospital gaining valuable knowledge of how the physics I have learned over the last four years is applied in a medical environment. The main areas where I worked were nuclear medicine, neuro-physics and clinical engineering. During my time here I was fortunate enough be given the opportunity to undertake my final year project with them. In the future I would like to hopefully find employment in the medical sector.

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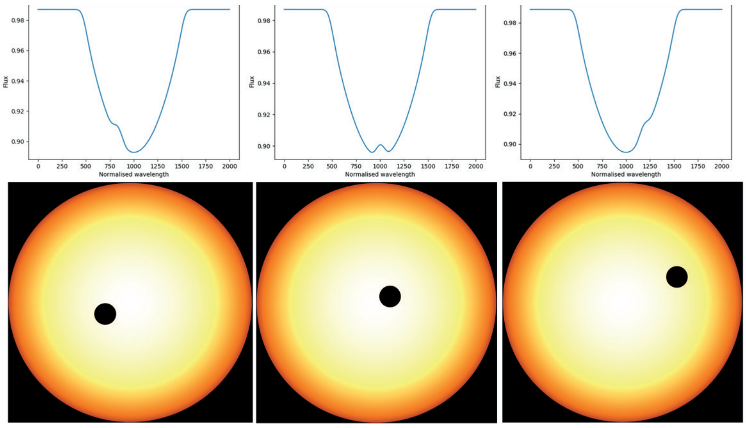
Characterising exoplanet atmospheres with the chromatic Rossiter-McLaughlin effect

Luis Alberto Canizares



As a result of the Doppler effect, a star rotating with an axis perpendicular to the observer will notice that half of the star appears to be red-shifted and the other half, blue-shifted. This particular effect generates a very specific velocity profile. A body of radius Rp passing in front of the star will distort such velocity profile in a particular way. This effect is known as the Rossiter-McLaughlin effect. The effect has shown to depend on the size of the planet and investigating different wavelengths will result in the planet change in size. Such a change is attributed to the thickness of the atmosphere and gives insight to clouds, hazes and the effects of Rayleigh scattering. The basis of my project is to create a pipeline that simulates a transiting planet and is able to investigate the atmosphere of the planet by comparing the simulated data to real data.

Having finished my first degree in Mechanical Engineering, I decided to pursue my dream of becoming an astronomer and now I am in final year of Physics with Astronomy at DCU. As a DCU student, I co-founded the Space and Robotics Club (SPARC) where we organise all sorts of events. Then I was a part of the team of students that built the I-LOFAR telescope and was awarded the Naughton Fellowship to do research at the University of Notre Dame, publishing my first research note in the American-Astronomical-Society (RNAAS). My ambition is to do a PhD in astronomy. Astrophotography is my other passion and have been published in places such as Astronomy Ireland, RTE.ie and the Enterprise and Innovation 2018-2027 report by the Irish Government.

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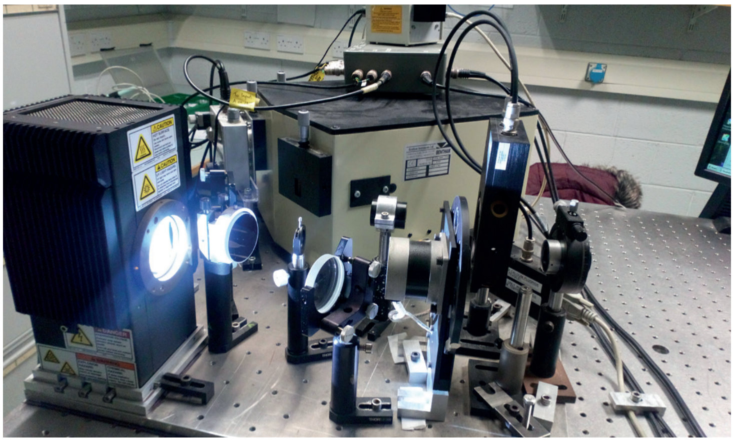
Optical Monitoring of Molecular Absorption on Oxide Surfaces and Plasmonic Structures

Mairead de Gras



In this project, a reflectance anisotropy spectrometer is used to monitor changes in the optical response of gold dimers, because of an atomic layer of molecules that is deposited on the plasmonic structure. Variation in the plasmonic resonance frequency and the refractive index around the particles should be seen due to the absorption of molecules on these dimers. This is possibly an effective sensing technique because it does not depend on previous intensity measurements of the light, and the high electric field enhancement between the dimers will be sensitive to refractometric changes.

I am currently in my final year of Applied Physics. Studying at DCU has been a stimulating and rewarding experience. I did my INTRA in the physics laboratories at DCU, my placement consisted mostly of experimental research. The main experiment I worked on focussed on estimating the luminosity of the sun. the solar irradiance of on the earth's surface is an important source of energy and understanding its characteristics is useful for many practical applications. Next year, as I enter the workforce I hope to work closely with solar technology and other forms of renewable energy.

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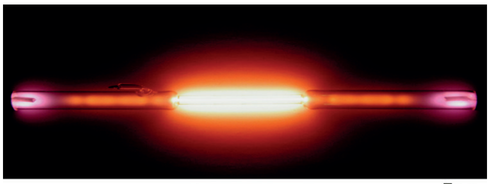
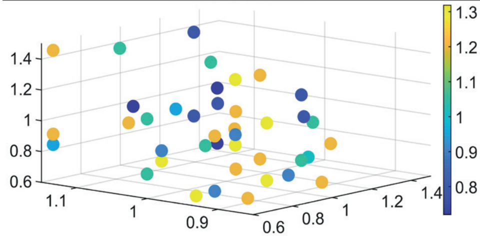
Uncertainty in Low-Temperature Plasma Physics

Rhys Doyle





Computational modelling of complex physical systems have, for many decades, been imperative to the research in various fields. The field of Low-Temperature Plasma Physics is no different. However, issues arise when the input data used in these models is accurately quantified, or even more so when the uncertainty relating to these inputs is unknown. That being said, it is often not sufficient to simply quantify the errors relating to input and output data, it is also important to understand the provenance of such errors. The goal of my project is to first quantify the uncertainty in plasma transport coefficients, which act as inputs to a variety of highly complex plasma models. Secondly, I aim to use sensitivity analysis to assess which collision cross-sections contribute the most each transport coefficients and hence their respective errors.

Four years ago, I made the decision, like all my classmates, to start what has been a journey of discovery in the field of Physics. One of the highlights of the past 4 years was the week I spent in the European Space Astronomy Centre (ESAC). While there I partook in a variety of lectures on the work done at ESAC along with attempting the complete some of this work ourselves. My time in ESAC, as well as different astronomy projects I have undertaken during my degree, have all solidified my love for computational analysis. This finally led me to choose a primarily computational final year project with the hope of beginning a PhD in this field later this year.

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Dynamics of the Earth-Moon system

Sean Dunne

The aim of my project is to create a model for the earth-moon system, which can accurately predict numerical information about the moon's orbit around the earth, at present, and many millions of years into the future and past. The moon is a large satellite when compared to the size of the earth, and the pair are sometimes referred to as a double-planet system. What would appear to be a stable relationship between the two, is in fact dynamic, with the distance of the moon creeping away from the earth at a rate of roughly 3.8 centimetres per year, and the length of the day increasing by 2.3 milliseconds per century. This change is caused by tidal forces generating a torque on the earth which acts to slow its' rotation. Eventually the earth will be 'tidally locked' with the moon, and a day and month will be the same duration.

I am currently in the final year of my Applied Physics degree. My time as a Physics student in DCU has been equal parts challenging and rewarding. In 3rd year I completed my INTRA placement with Rapt Touch Ltd, working within many areas of the company, including Advanced Optics engineering, quality assurance and data analysis. My experience in Rapt Touch gave me a strong appreciation for the vast industry applications of Physics, and greatly improved my programming skills and general computer literacy. Following the completion of my degree, I would like to pursue work in the areas of machine learning/vision or finance.

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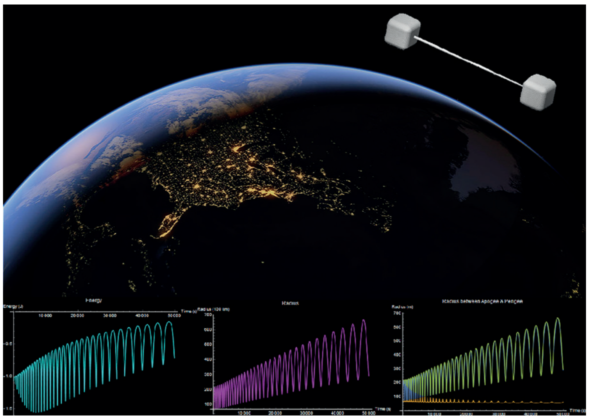
Rocket Free Space Travel

Michael Gaffney



When talking about orbital mechanics, we usually assume all objects to be point masses, without dimensions or internal structure. This, however, only works as an approximation and in reality, any deviation from a point mass can cause slight changes from the usual Keplerian orbits. Effectively exploiting these deviations by strategically altering the shape of a satellite can make it possible to change the radius of its orbit. This would allow the satellite to move through space without the use of rockets as the changes in shape can be controlled using electric motors and tethers, meaning the satellite would not need to carry fuel to make these orbital manoeuvres.

The objective of the project is to develop the best method to exploit these effects by altering the shape of the satellite and to show whether it would be a feasible alternative in preforming orbital manoeuvres.

I chose to study Physics with Astronomy as physics and maths were favourite subjects of mine in school and I have always been fascinated by space. For my INTRA, I visited the European Space Agency Centre in Madrid for a week along with the rest of the class. During our time there, we attended talks on various different missions undertaken by the European Space Agency. I also completed an internship in the National Metrology Laboratory, where I worked on an international project comparing DC picoamp current measurements. During this project I created multiple LabView Virtual Instruments and Visual Basic programs to calibrate and collect data from the electrometers and picoamp source and established the measurement uncertainties associated with the data collected.

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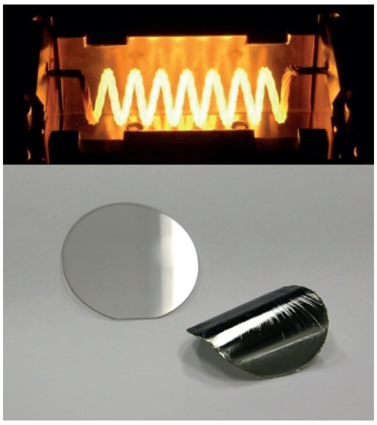
Semiconductor Layer Transfer by Controlled Spalling

Jamie Gilmartin



Semiconductor layer transfer methods play a crucial role within the photovoltaics industry. Layer transfer methods are critical in the evolution of many devices in improving the efficiency of the photon energy conversion within the device, while minimizing the effective cost. This project is designed to demonstrate a technique that can be used in the layer transfer of semiconductors. The simple yet effective process is known as the controlled spalling technique (CST). A tensile stressor layer is deposited onto the substrate and depending on the stress and thickness of the stressor layer, layer transfer (spalling) may occur. This method allows the fabrication of thin free-standing semiconductor films and may have the opportunity to develop idealistic films.

I am currently in the final year of my degree in Applied Physics. Last year I completed my INTRA placement in the National Metrology Laboratory (NML). I worked in the electrical, mass and dimensional departments. As part of my internship I carried out calibrations on various client's equipment for many industries within the country. I also completed several courses in the field of metrology and received qualifications in these areas. I took part in a project designed to test manufacturer's specifications of tachometers to verify lower limit non-compliance. This internship provided me with invaluable skills which apply directly to modern industry. Upon completion of my degree, I would like to further my education or pursue a career in the field of mathematics and finance.

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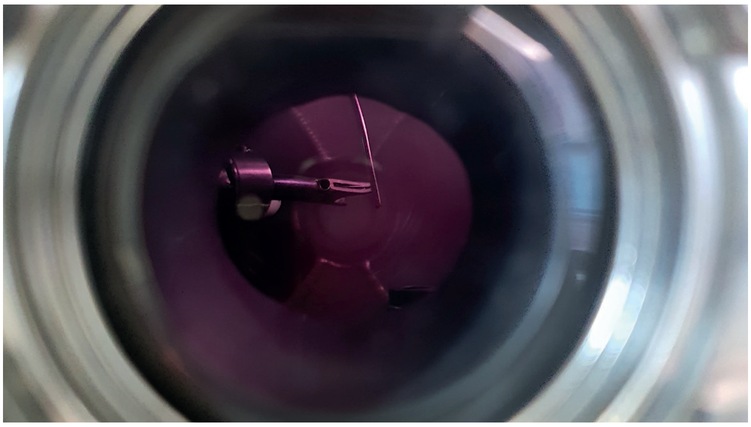
Characterisation of a plasma activation source

Aidan Henry



My project involved the construction of a suitable ion flux probe that I am currently using to characterise a plasma source. The probe has a negative voltage which allows it to draw only the ion current when placed inside a plasma. Ion flux is a crucial parameter in the modification of surfaces with plasma. I took readings for the flux as the pressure in the chamber was varied. After this I varied the power at a constant pressure and again measured the ion flux. The power variation proved to be worth my time as I found a peak in the graph where the ion flux was highest. If the power was too high, the electrons would not spend long enough between the electrodes to ionise the gas to produce the plasma. This caused the peak and could be used in industry to find the ideal operating range for plasma activation.

I am currently in final year of Physics with Astronomy in DCU. For my INTRA in third year I decided to go on the Astronomy field trip to Madrid. Here we visited the ESA base and where given seminars as well as hands on data analysis. During the year we used python to simulate and analyse data from the Cherenkov telescope array. Outside of college I am heavily involved in GAA and play both hurling and gaelic football. After my degree I hope to do a Masters degree but I am still undecided on the area to do it.

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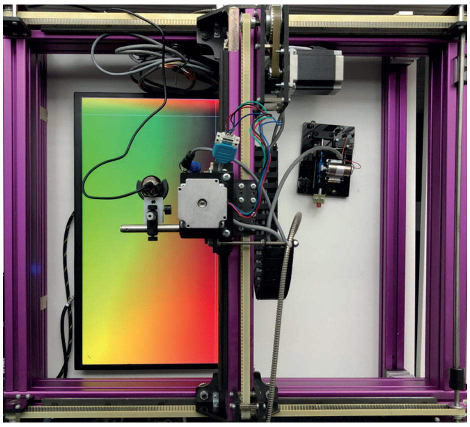
Development of a machine vision positioning system to guide a touchscreen test rig

Maksim Jancenko



The process of optical touchscreen production involves a qualification step, wherein a robotic testing device (an XY machine) is used to determine the underlying accuracy of the sensor. Precise position measurements relative to the screen are required in this step. However, mechanical effects such as motor backlash cause a discrepancy between the moving component's position as known by the machine, and its actual position. The aim of my project is to improve this positional accuracy by introducing a machine vision positioning system. This involves displaying an image on the screen and observing a section of the image using a camera setup. The position of the contact would then be determined based on what the camera sees, and the contact would move towards a desired endpoint. It is hoped that this project will improve the accuracy of Rapt Touch's screen qualification process, leading to a better touchscreen experience.

I am currently in my final year of a BSc in Applied Physics. As part of my INTRA work placement, I worked as an intern in Rapt Touch. While working in Rapt Touch, I had the opportunity to work with the latest in optical touchscreen technologies, working with the engineers to develop robust touchscreen software. It was in Rapt that I discovered my love of engineering and computing. In the future I would love to combine my loves of physics and computer science in the work that I do. In my spare time I enjoy working on programming projects and playing chess (badly).

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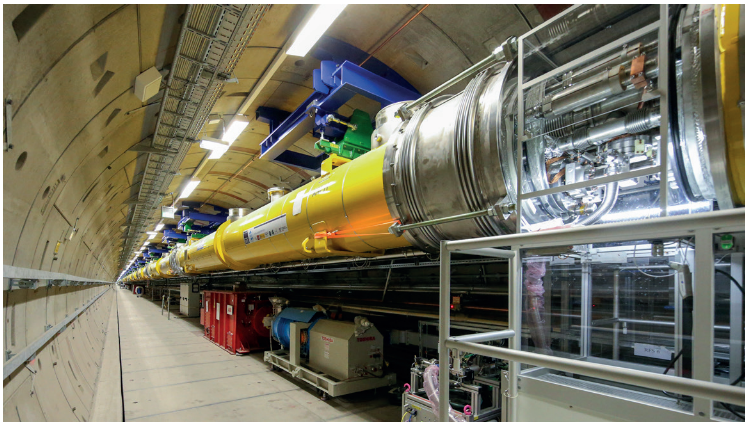
An application of stochastic Brownian motion theory to laser-matter interactions

Aaron Lalor-Fitzpatrick



Brownian motion can be described as a physical phenomenon in which some quantity constantly undergoes small, random fluctuations. It is widely considered the most important continuous time stochastic (random) process and is used to describe models in physics, finance, engineering, and many other areas. This project investigates Brownian motion as a stochastic process as an application of X-ray free electron lasers (XFELs), of which the emitted radiation intensity fluctuates randomly with time as a result of unpredictable starting conditions of the accelerated free electrons. This model will then be applied specifically to a two-level atomic laser system.

The research conducted in this project aims to provide a useful insight into the stochastic behaviour of XFEL beams for a two-level system, finding a potential application in more precise control of short wavelength radiation produced by means of self-amplified spontaneous emission.

Always insatiably curious from a young age, I naturally now find myself in the final year of a BSc degree in Applied Physics, a course that has proven to be as rewarding as it is enlightening.

For the INTRA aspect of my degree I created a fully-functional algorithmic trading program, designed to find and exploit arbitrage opportunities on exchanges with widely varying levels of liquidity – focusing exclusively in the young and exciting cryptocurrency space. Equipped with the valuable problem-solving skills this degree program provides, the next step from here personally is to build upon relevant experience in the software industry, with an end goal of starting my own company, which although demanding provides a unique sense of autonomy.

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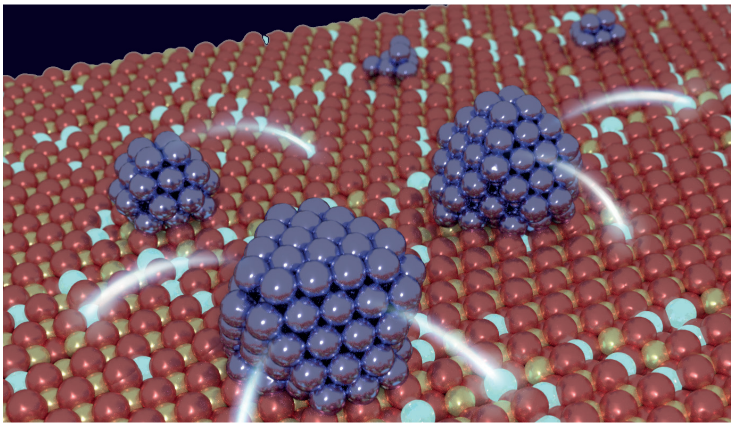
Naoparticle Integration with Microfluidic Systems

Caitlin McFeely



Microfluidics is a sector of medical research which has grown rapidly within recent years due to the ability to create systems which can perform complex medical procedures on a much smaller scale. However, for these systems to complete these tasks the addition of functional materials is often required. This project aims to functionalise a microfluidic system with metallic nanoparticles for DNA capture and detection. Metallic nanoparticles have been shown to have unique electrical, chemical, physical and optical properties which differ from their bulk counterparts and studies have shown their suitability for DNA detection.

The objective of this project is to successfully integrate metallic nanoparticles into microfluidic systems through extensive testing of various surface modification and attachment methods. From there the project aims to see how effective silica nanoparticles are at DNA capture within the integrated microfluidic system.

I am currently completing my final year in Physics with Biomedical Science. Starting in DCU I was originally enrolled in the Common Entry into Science programme. From here I realised that a course in Physics was the way forward for me and I saw PBM as a perfect amalgamation of both Physics and Biology which were my two favourite modules in first year. During my INTRA placement I was fortunate enough to take part in a medical device design project in the department of medical physics in St James' Hospital. Tasks included testing the device and creating new ways for it to operate as well as data analytics. Overall this was an amazing experience and it depicted the role of a physicist within a hospital.

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Eclipsing Binary Stars

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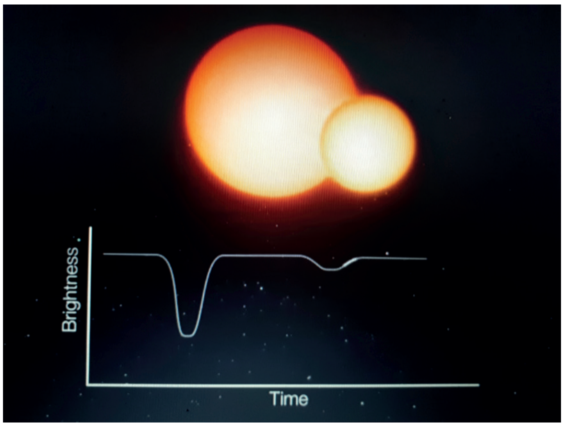

For my project I am modelling the light curve for eclipsing binary star systems using python. The light curves of binary stars with orbital planes appropriately along the line of sight have periodic dips as one stars passes in front of the other. The lengths of the eclipses and the depth of the minima allow for the radii of the stars and the relative effective temperatures to be calculated. The mass ratio of stars in eclipsing binary systems can be determined due to the gravitational interactions, if the distance to the system is known the mass of each star can be determined using angular separations and the centre of mass position of the system.

I am a fourth year student studying Physics with Astronomy. For INTRA I chose the field trip option available to PHA students. The students who chose this option would meet up once a week and talk about the latest papers from arxiv. We worked with ctools to simulate and analyse event data, and we used python to build a phase curve model for exo-planet HAT-P-7b. The model was plotted with Kepler data of the exo-planet. We also took a five day field trip to ESAC in Spain where we got tutorials on ESAsky, XMM-Newton and VO tools Vizier, SIMBAD and Aladin. We also got visit the antenna used by NASA for the Apollo missions.

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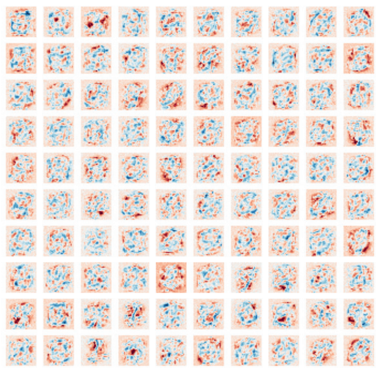
Applications of Artificial Neural Networks in Quantum Many Body Problems

George Mihailescu



The many-body problem is the general name given to an abundance of physical macro/microscopic systems that are made of a large number of interacting particles. The state space required to represent a system must be able to represent all possible super-positions of particles, which is typically exponential in size. This means that, in principle, an exponential amount of information is required to fully encode any generic many-body quantum state. There are many modern approaches such as Matrix Product States used to handle the computational complexity. Despite the success of these methods, unexplored regimes exist. This is due to the difficulty in finding a general strategy to reduce the exponential complexity down to its most essential features, which ultimately resides in the realm of dimensionality reduction and feature extraction. Artificial neural networks are one of the most successful techniques in tackling these problems. My final year project allows me to explore different machine learning architectures in tackling such problems.

Currently, I'm a final year Physics with Biomedical Sciences student. DCU is rife with exciting opportunities if you're willing to get involved! I've been honored to represent the university for two years as a Student Ambassador. I've also acted as a founding member and chair of the Space and Robotics Club and participated as a caller – and later supervisor – of the DCU Access telethon campaign, raising money to allow disadvantaged students the opportunity to obtain a third level education. I was fortunate enough to partake in two internships during my time in DCU; one in the Fraunhofer Project Centre working on microfluidics discs and another developing machine learning algorithms and computer vision techniques for my INTRA placement in Insight Centre for Data Analytics.

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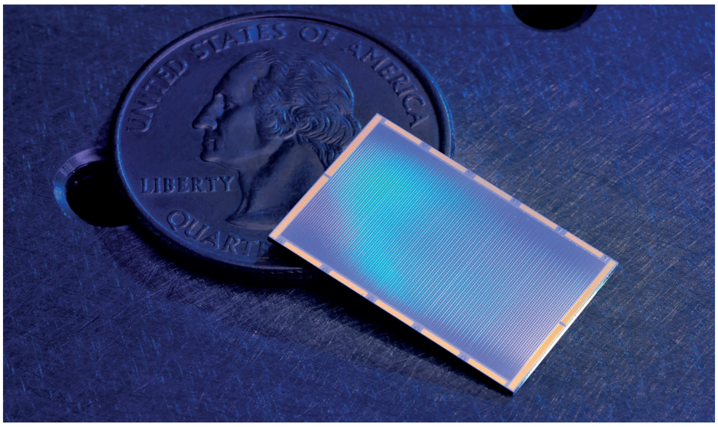
Polyphase filterbank simulations for the readout of the next generation of astronomical detectors

Michael Moore



This project, in collaboration with the MKID group in DIAS, is aimed at simulating the readout process of a new generation of astronomical detectors known as Microwave Kinetic Inductance Detectors, or MKIDs for short. MKIDs are superconducting cameras typically operated at cryogenic temperatures. This means that MKIDs have very low noise thresholds. These detectors can perform amazingly where conventional CCD cameras fail, such as the direct imaging of exoplanets, or possibly the detection of dark matter. My simulations provide a way in which to safely test a number of different algorithms for the reading out of these detectors using a technique known as a polyphase filter bank. Essentially, this is an advanced filtering algorithm that allows for real-time data cleaning during observations, allowing these detectors to take up to one million images per second.

Having loved science and maths in school, studying Physics with Astronomy in DCU was a no-brainer, giving me experience in subjects from pure physics and maths to computer programming and astronomy. I've also made great friends here that I would never have met otherwise. In third year, as part of DCU's INTRA program, I was accepted on a seven-month internship at Allianz Ireland as a Claims Data Analyst. I loved the work; as someone who loves maths and finding patterns as well as coding, this was absolutely the job for me, and I learned more than I could fit on this page. The experienced I gained during INTRA helped me land a graduate role as a data scientist at AIB.

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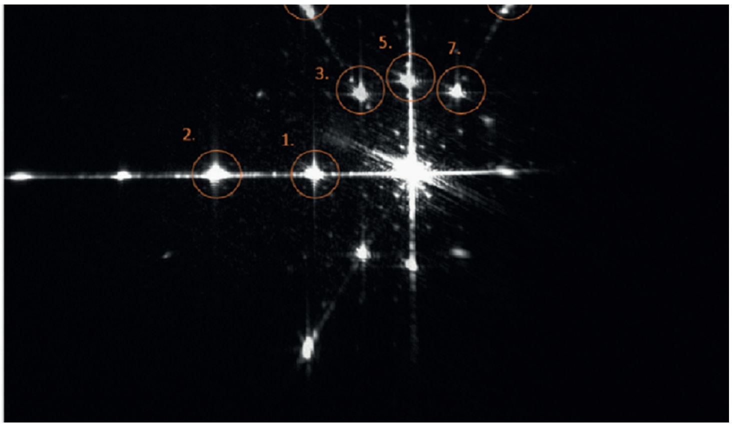
High-Speed Imaging using Time-Multiplexed Structured Detection

Pierre Murchan



The project I am currently undertaking is titled, 'High-speed Imaging using Time-Multiplexed Structured Detection'. This is a technique which permits an increase in frame rate capture of a conventional camera by converting optical images from the spatial domain to the frequency domain. These domains are linked through what is called the Fourier Transform (FT). The FT of an image can be formed using a diffraction grating. Using a device called a spatial light modulator, 'N' distinct diffraction gratings of varying frequency and orientation can be created at a display rate of up to 1 kHz. In this way, the FT of the image can be projected to and stored in different parts of the camera's sensor. Therefore, each frame captured using the camera contains 'N' FTs which can be used to recover the original image, thus increasing the frame rate of the camera by a factor of 'N'.

My desire to undertake the Physics with Biomedical Sciences degree has not only been driven by curiosity, but also by a willingness to seek challenging and fulfilling experiences. In third year, I spent 6 months working as a research intern with the biomechanics team at the Sports Surgery Clinic, Santry. There I was tasked with collecting, processing and analysing biomechanical data. This internship greatly appealed to me as I was required to engage with clients daily, which is a rare opportunity in a role in physics. This degree program has equipped me with multi-disciplinary, theoretical and practical skills which I hope to apply throughout my career. DCU has also helped nurture my passion for athletics, giving me the opportunity to represent Ireland on the world stage over 5000m.

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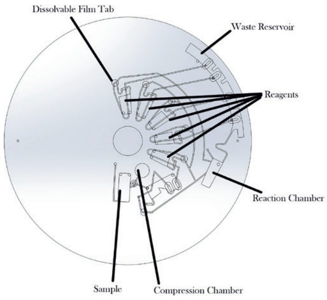
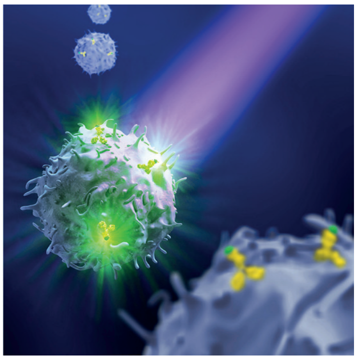
Investigations into assay optimization and microfluidic implementation for detection of Human Sepsis and associated biomarkers

Adam Murphy





My project follows on from my internship with the FPC@DCU during INTRA. Sepsis is the dysregulation of the body's auto-immune response to an infection, and there has been a steady increase in the number of reported cases. Sepsis can be difficult to diagnose due the generalized nature of its bio-markers, and the need for time consuming laboratory analytics to detect it.

My project aims to investigate the optimization of an immunoassay capable of producing a reliable lower detection limit for sepsis biomarkers, and the implementation of this immunoassay onto a centrifugal microfluidic disc, composed of various valves, reservoirs, and microchannels. The flow of sample and reagents is controlled by the centrifugal force caused by rapid rotation. We hope to create a point of care device that can be used "in the field", for populations and/ or locations which don't have ready access to more complex bench-top devices.

I began my college experience in Common Entry Science before deciding to specialise in Applied Physics at the end of my first year.

I have always had an interest in every aspect of science, having always believed a focus on the interdisciplinary to be of the utmost importance. I believe Applied Physics has allowed me to fully realise this by equipping me with skills and knowledge that are applicable in the working world, but also translate neatly into the other sciences. For my INTRA internship, I received the opportunity to work as a member of the jointly-operated "Fraunhofer Project Centre" (FPC@DCU), where I was able to apply the experience I had garnered over my 3 years at DCU.

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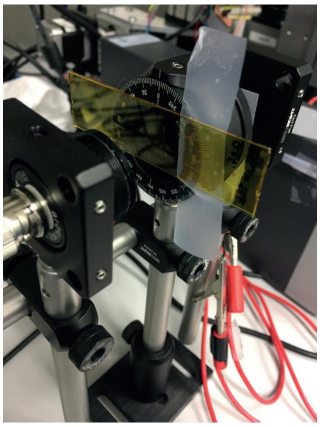
The Fabrication of a Low-Cost High-Volume NIR Polarizer Using Liquid Crystal Polymer and Dichroic Dye

Daniel Murphy



Polarizers are integral to a plethora of consumer electronic devices. Commercial pressures have greatly increased the requirement for fabrication techniques which are more flexible, robust and inexpensive, particularly in the manufacture of consumer electronic devices. My project explores two fabrication methods to achieve this, involving the research, development and fabrication of two NIR polarizers using a combination of liquid crystal polymer (LCP) and dichroic dyes.
Several processes are investigated including nanoimprint lithography, which show promise as effective alternatives to current complex and expensive fabrication methods, producing a body of knowledge on the end-to-end processes from concept to manufacture, available to researchers. This is the project scope, however the precise application of these polarizers in Rapt technology is commercially sensitive information which cannot be disclosed. It is hoped developments based on my project provide significant added value and features to the touch sensor technology offered by Rapt Touch in the future.

I'm currently in the final year of my Physics with Astronomy degree, which included an INTRA placement with Rapt Touch, a role which highlighted the synergies between Physics and Engineering/ Technology industries. There, I worked on projects involving the optimisation of software performance, developing programs in various languages, such as Python and Go. I developed methods to enhance data collection, data analysis, operation and maintenance of network servers and nodes, designed and implemented software tests. This experience has allowed me to appreciate the application of Physics in the commercial world, enhancing my technical, critical thinking and problem-solving skills in the process. As a result of the challenge, engagement, enjoyment and development garnered from my degree and internship, I hope to pursue a career in Advanced Technologies.

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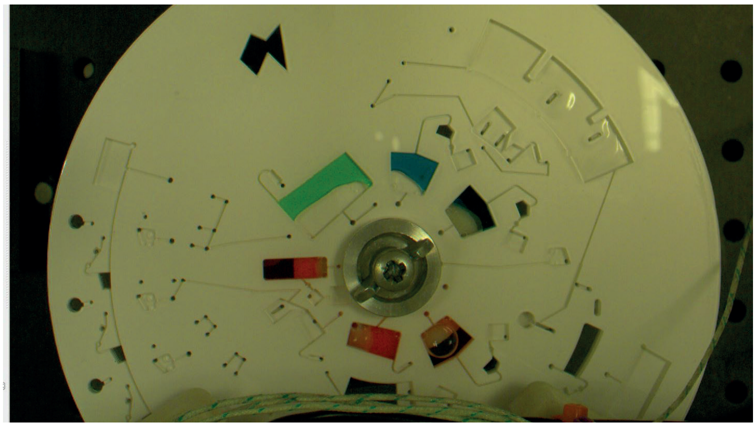
Investigations into assay optimization and microfluidic implementation for detection of canker causing plant pathogen Clavibacter michiganensis subsp. michiganensis

Michael Murray



Clavibacter michiganensis subsp. Michiganensis (Cmm) is a plant bacterial pathogen that has a devastating impact on global tomato crop production. An easy-to-use lab-on-a-disc (LOD)device that requires an input sample of the leaf could rapidly, remotely, accurately, and cheaply, identify the presence of Cmm in the field would enable better crop management for growers, help maximise yields, and add security to the global food supply. An LOD is similar to a compact-disc shaped device with small channels and chambers that, when rotated by an electric motor, generate a centrifugal force which manipulates the various liquids that are loaded near the centre of the disc. In my project I am helping to develop a LOD that will take a leaf sample, extract DNA, and use an constant-temperature DNA amplification protocol in conjuntion with optical detection methods to accurately detect the presence of Cmm (if it is present) in the sample.

I am in my final of Physics with Biomedical Sciences. While at DCU I have undergone two work experience placements. My first one was in the summer of 2017, after the second year exams, at the FPC@DCU. There I learned the microfabrication techniques used to manufacture prototype centrifugal microfluidic discs, this involved using CO2 laser-cutters, a robotic knife, and clean-rooms. INTRA placement was as an intern employed at RAPT Touch- this was my. There I learned the basic principles of infrared touch screens and gained hands-on experience with software development for embedded electronic systems. After my exams I plan to embarque on a J1 graduate visa in Boston, where hopefully I will find employment in a field related to my degree.

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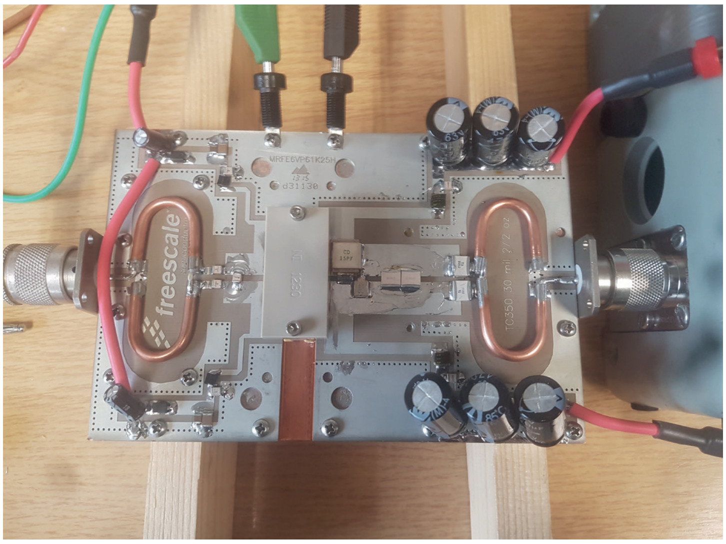
Power electronics for cellular communication technologies

Hannah Ní Reachtnín



The main objective of this project was to build a radio frequency (RF) power amplifier. Power amplifiers are commonly used to convert low power signals to high power signals. RF power amplifiers are used in base stations as they require high power. A laterally doubly diffused metal oxide semiconductor (LDMOS) is used to convert the signals. This is a type of transistor, typically made from silicon. The purpose was to set up the circuit to produce a kilowatt of power at a frequency of 500 MHz. The prime objective is to test the limits of the transistor and specifically what are the advantages and disadvantages of the LDMOS.

I have always had an interest in science and it wasn't till I was in 4th year of secondary school that I found my passion to study physics. Our school provided us with many classes from topics about the solar system to dissecting frogs. After searching for the right course, I came across Physics with Astronomy and have enjoyed the past 4 years. A highlight of my college experience was INTRA, which was a trip to the European Space Agency Centre (ESAC) in Madrid. For that week we got to experience what life is like after college and the day to day challenges of a physicist.

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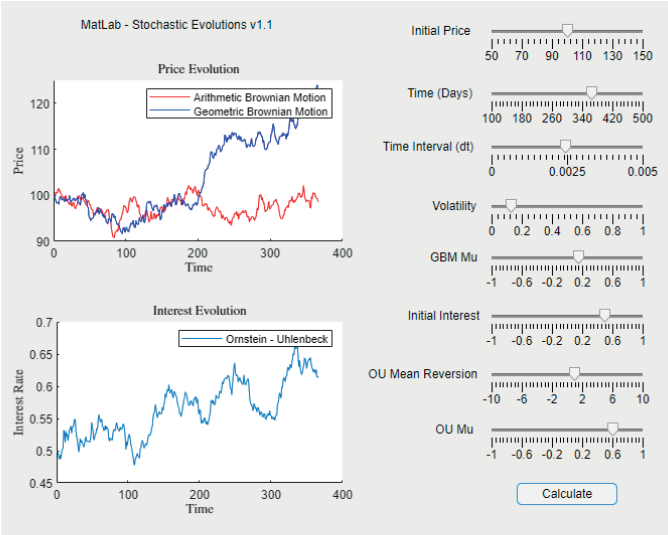
Brownian Motion: Advanced Ornstein Uhlenbeck theory and applications to financial modelling

Joe O'Connor



My project is a strictly computational project, it begins with introducing the Ornstein-Uhlenbeck model at a basic level and applying it to measure stochastic fluctuations in interest rates - in coincidence with using models such as Geometric Brownian Motion, the Merton Jump-Diffusion Model and the Heston Stochastic Volatility Model to model stochastic jumps in share prices.

I developed an app within Matlab to allow a user to input various relevant variables to demonstrate these methods, and also to use real-time date from Yahoo! finance to calculate the predictions based on real data. Lastly, the method is then built and developed upon by using machine learning - specifically neural networks to test the accuracy of the data and attempt to correlate results to improve the accuracy and calculations of the predictions.

I am currently a final year student of the BSc in Applied Physics in DCU. After my degree I plan to undertake the MSc in Mathematical Modelling and Self-Learning Systems in University College Cork. During my degree I developed an interest for programming - specifically machine learning. After this, my subsequent career steps will be in the areas of artificial intelligence, coding with c# and various other programming routes.

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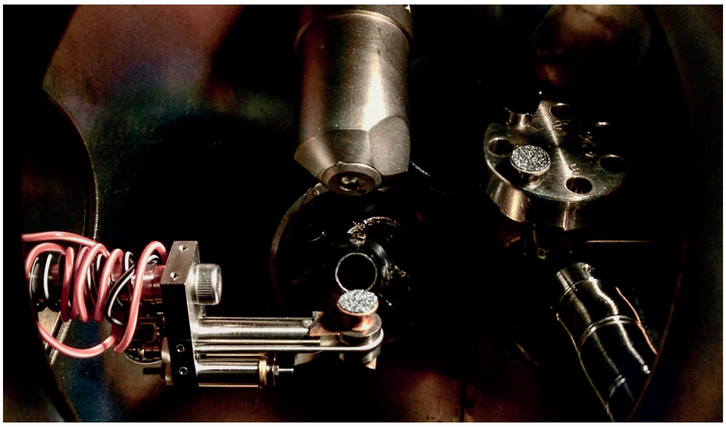
Investigating the vapour phase deposition of Self-Assembled Monolayers under ultra-high vacuum conditions

Shane O'Donnell



Fabrication techniques for the semiconductor industry have enabled ever-smaller devices but now face limits in creating nanoscale devices. Self-assembly has emerged as a promising alternative fabrication technology for nanoscale systems.

The use of self- assembled monolayers (SAMs) is a versatile bottom up semiconductor fabrication technique. By using various SAM molecules the electronic and morphological properties as well as interfacial phenomena of a given surface can be tuned. The aim of my project is the vapour phase deposition and characterisation of a self-assembled monolayer within ultra-high vacuum.

Previously SAMs have been formed through liquid phase deposition which requires the immersion of a substrate in a solution of the liquid SAM molecule. This approach requires many hours for the molecules to self-organise, whereas vapour phase deposition has the potential to form highly controlled monolayers within minutes.

I'm a final year student in Applied Physics and I have enjoyed every challenge and opportunity which has come my way and I would gladly do it all again. Along the way I've been equipped with skills and knowledge in physics which will hopefully give me the opportunity to make a contribution to a variety of fields.
My INTRA placement was a valuable experience in which I worked with the surface science research group in DCU. My placement was centred around the operation of an x-ray photoelectron spectroscopy system which is the analysis technique at the core of the research carried out by the group. Upon completing my undergraduate degree I hope to pursue further education and beyond that possibly a career in the renewable energy industry.

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Building and testing a hand-powered ultralow-cost paper centrifuge

Patrick Reade

Medical devices used for diagnostics and treatment today are expensive, both in terms of cost and power. This can have a damaging effect on the quality of healthcare provided in low-resource settings around the world. The medical centrifuge is used to separate blood to allow it to be analysed. This is achieved by spinning the samples at high speeds, causing the fluid to separate into segments of different densities. A new research paper has created an ultralow-cost centrifuge made from paper, capable of replicating the same results as a laboratory centrifuge. The cost of manufacture is just 20 cents. My project aims to create this device and examine the physics behind it, while also aiming to try and replicate the promising results. Furthermore, I aim to evaluate the design and investigate how the design may be improved.

My four years in DCU studying Physics with Biomedical Sciences has given me the perfect platform to enter the next stage of my development. During my time here, I have gained invaluable knowledge across all aspects of science, particularly physics and the biomedical industry. My experiences here have nurtured my ambition to work in the biomedical industry. An integral reason for this was my time spent working as a Clinical Engineering Intern in The Mater Misericordiae University Hospital on my INTRA. This experience allowed to gain an insight into the role engineers and physicists play in a hospital. Having seen practical applications of the theories I have studied in college has only helped to motivated me further to pursue a career in this field.

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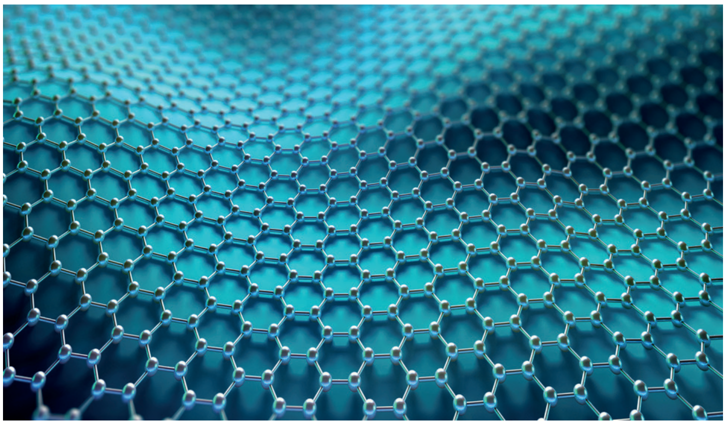
Investigation of Graphene Oxide Membrane Technologies for Applications in Fluidic Systems

Julian Walsh



With growing advancements in medical technologies, it is becoming easier to quickly and accurately diagnose complex diseases. There has been much interest in the development of Point-of-Care testing techniques, which allow for rapid sample preparation and analysis, and offer significant cost benefits over traditional outsourced methods.

The aim of this project is to build on existing experimental techniques for testing of nucleic acids, in particular extraction of DNA from solutions for sample preparation. The main focus is on the incorporation of thin graphene oxide membranes for filtration and flow control in a centrifugally powered Lab-on-a-Disc system. This would provide a cost effective means to rapidly extract usable DNA from small sample volumes, and offer benefits both time-wise and monetarily when incorporated in medical testing procedures.

Around four years ago I chose to study Applied Physics at DCU based on my perpetual desire to investigate and learn about everything I saw around me. As one would expect, much of my time since then has been spent doing exactly that – developing experimental research skills while studying a wide variety of interesting subjects. As part of my degree, I found an INTRA placement at the Fraunhofer Project Centre, based in DCU, working to develop microfluidic systems for various applications. During this time, I became interested in fluid dynamics, as well as the uses of microfluidic technologies for chemical and biological analysis. While I have always had a passion for electronic engineering and computational physics, it was these new found interests that ultimately led me to my choice in final year project.

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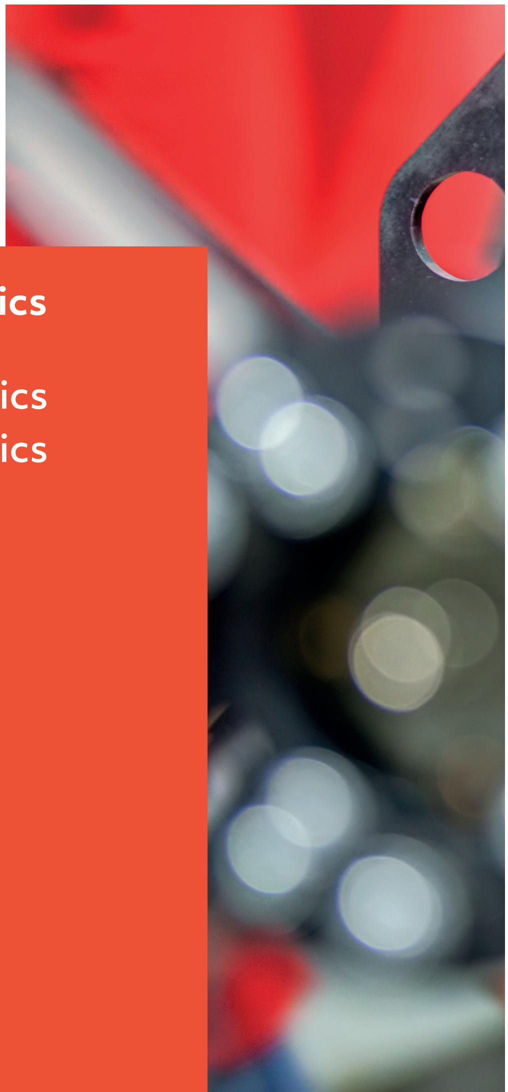

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