Ollscoil Chathair
Bhaile Átha Cliath
Dublin City University

SCHOOL OF PHYSICAL SCIENCES

# Final Year Degree Projects

2018

# Introduction

It is a great pleasure to introduce this booklet which summarises the recent activities and achievements of the final year Physics students in the School of Physical Sciences from all three of our honours B.Sc. degree programmes (Applied Physics, Physics with Biomedical Sciences and Physics with Astronomy) in the academic year 2017/18, in both their Integrated TRAining (INTRA) placements in 3rd year, as well as their final year degree projects in 4th year.

The material in this booklet has been prepared by the final year Physics students themselves, coordinated by Prof. Colette McDonagh. I would like to especially thank Ms. Katy Halpin and her team from the DCU Communications and Marketing Office for the production and design of the booklet. Sincere thanks also to Mr. Pat Wogan of the School of Physical Sciences for assistance with photographs and images.

This booklet aims to provide further and more detailed information about the range and type of skills our Physics students and graduates acquire, including excellent problem solving skills in both experimental and theoretical domains, based on their up-to-date and deep disciplinary knowledge and understanding linked with mathematical, coding and computing skills, as well as a range of key generic and transferable skills related to oral and written communications, project planning and management.

My colleagues and I in the School of Physical Sciences firmly believe that this range of skills make them the epitome of the modern "T"-shaped graduate and ideally position them for employment across a wide range of industrial and enterprise sectors, engaging in roles including research, development and translation.

If you have any enquiries, or if you 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 email address below.

Yours sincerely,
Prof. Enda McGlynn

Enda McGlynn

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# Overview of Programmes

## Overview of Applied Physics Programme

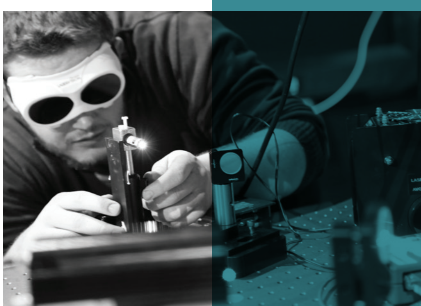
| Year 1 | | Year 2 | | Year 3 | | Year 4 | |
|---|---|---|---|---|---|---|---|
| *Semester 1* | *Semester 2* | *Semester 1* | *Semester 2* | *Semester 1* | *Semester 2* | *Semester 1* | *Semester 2* |
| Motion & Energy | The Universe | Quantum Physics 1 | Linear Algebra | Laboratory | INTRA | Degree Project & Professional Skills | Degree Project & Professional Skills |
| Light & Optics | Electricty & Magnetism | Relativity, Nuclear & Particle | Electro - magnetism | Quantum Physics 2 | | Solid State Physics | Plasma Science |
| Computing | Thermal Properties | Vibrations & 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 & Tecnology | Semi-conductors | | Image Processing & Analysis | Computational Physics |
| | | | Laboratory | Stellar Physics | | | |

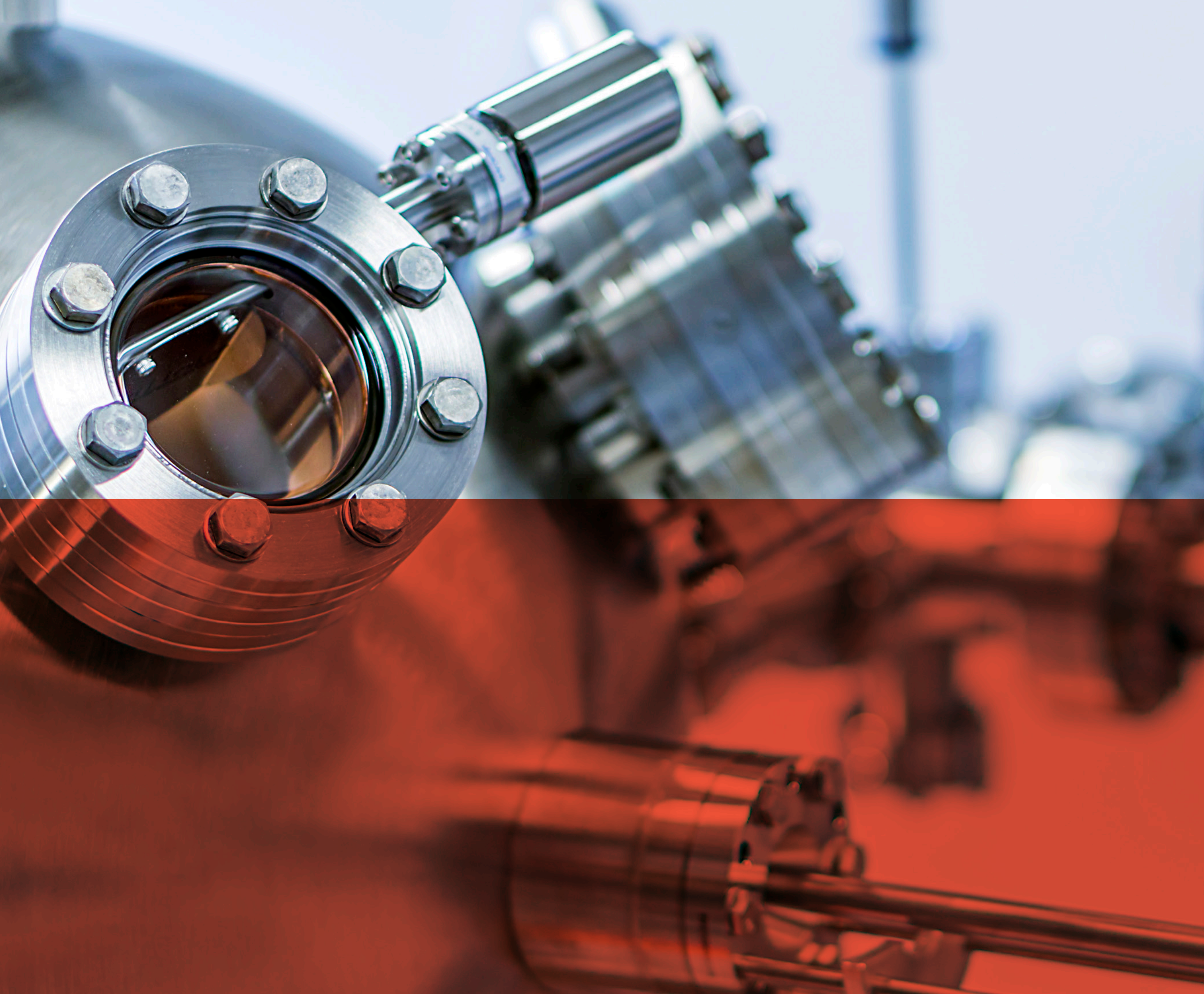
## Overview of Physics with Biomedical Sciences Programme

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

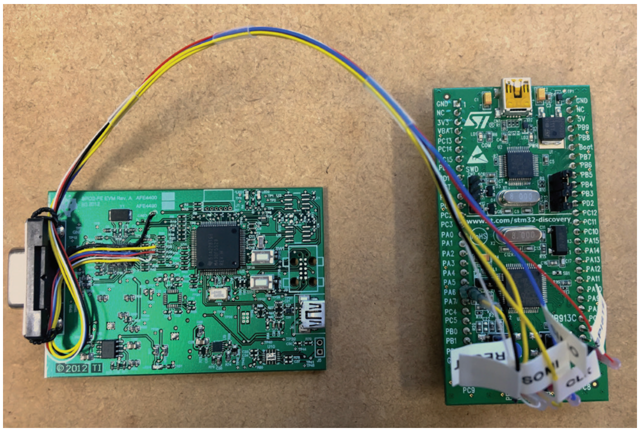




# Student Profiles & Projects

# The Development of a High-Resolution Signal Acquisition System Applied to Optical Touch Detection

Emma Branigan



In the development of cutting edge technology it is typically necessary to test materials and key principles in a laboratory setting with equipment that is flexible and reconfigurable. This is the background to my project which is concerned with the development of a gold-standard optical detection device capable of capturing light pulses that have traversed the cover glass of a touch system by total internal reflection. This system was constructed by writing a communication protocol in C for a microcontroller unit to send and receive information to a chip that would convert the analog data to a digital signal. Through this communication link it was possible to adjust gain settings and other relevant parameters that would ensure a high signal-to-noise ratio. It is hoped that the device will enhance both the precision and accuracy of the optical metrology measurements carried out by Rapt Touch for their touch detection interfaces.

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I'm currently preparing to conclude my final year of study with the Applied Physics class in DCU. As part of my 3rd year INTRA placement, I worked as an intern alongside the Advanced Engineering team with Rapt Touch Ltd. I thoroughly enjoyed the challenges I was assigned and dynamic working environment. The programming and critical thinking skills I have gained as part of my placement have been invaluable, particularly in the undertaking of my final year project. As a result of my work with the Rapt Touch team, I am hoping to pursue a taught Master's degree in Engineering following the completion of my undergraduate studies.

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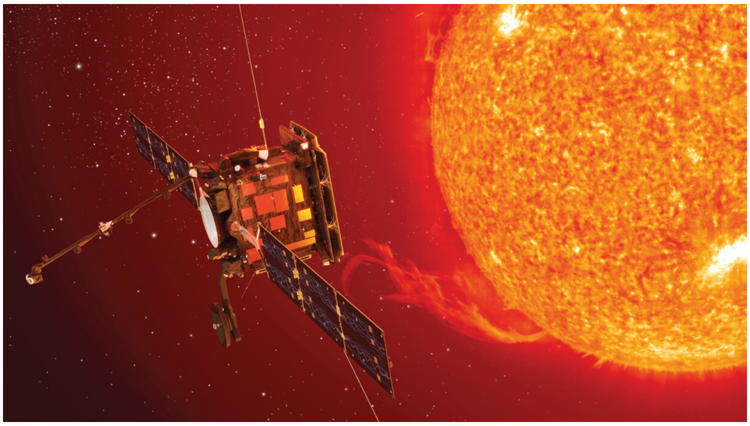
# Analyzing Thermal Control Coatings for Commercial Satellites

Stephenie Brophy Lee





My project is based on the analysis of ENBIO's coatings, focusing on SolarBlack. A thermal control coating is a protective skin used for spacecraft and satellites and is designed using a combination of several laws of physics. These laws determine the relationship between a spacecraft's equilibrium temperature and its optical properties, specifically the amount of light it will absorb/reflect. SolarBlack consists of black calcium phosphate and is applied to the spacecraft surface with ENBIO's patented CoBlast process, which ensures a durable bond under the extreme conditions of outer space. My project looks at how one can optimise a thermal control coating by varying different physical properties, such as the relationship between the roughness of a surface with its emissive abilities. The use of Thermal Control Coatings on commercial satellites and spacecraft can prolong the mission's lifetime to allow for optimum performance and increase the chances of a successful mission.

I'm Stephenie, I'm from Limerick, I am a DCU student ambassador and I'm a final year student in Physics with Astronomy. In 2017 I embarked on a field trip with my class to Geneva as part of DCU's INTRA programme. We analysed live data in the Integral Satellite Data Centre and went on a day trip to CERN. After this, I completed a 3-month internship in ENBIO. Based in DCU's Alpha Campus in Glasnevin, ENBIO is an Irish company that focuses on the development and commercialisation of its patented surface enhancing technologies. ENBIO have collaborated with ESA and Airbus Defence & Space to develop two thermal control coatings: SolarBlack, and SolarWhite, both of which are on the Solar Orbiter satellite, due for launch in 2019.

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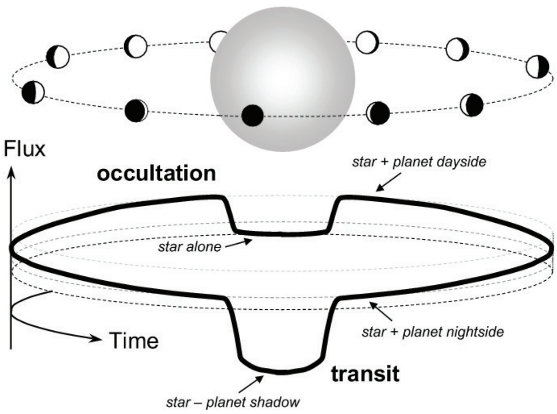
# Measuring Near Infrared Thermal Emission of Exoplanets Using LIRIS Secondary Eclipse Observation




Helena Burke

This project is aimed to study a planet's data taken from the Long-slit Intermediate Resolution Infrared Spectrograph (LIRIS) near infrared instrument situated at the William Herschel Telescope on La Palma, Canary Islands. For this particular project the planet of interest was WASP-33b, located in the northern constellation of Andromeda. The data from LIRIS was used to measure the thermal emission from the planet and to then constrict the spectral energy distributions. Corrections were then made due to errors contained in the instrument itself. The data was reduced to gain the light curve of the planet. From there a secondary eclipse model was fit to obtain information on the thermal emission of the planet.

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The past, almost four years, have been an experience and a half studying Physics with Astronomy in DCU. Through the years the course has included modules in general physics as well as astronomy based modules. A highlight of college was the INTRA, which included a trip to Geneva, Switzerland. In Geneva we visited the INTEGRAL Science Data Centre (ISDC) to discover what astrophysicists do with the data obtained from the INTEGRAL. This trip included daily talks from lecturers at the University of Geneva about various telescopes and the astronomical phenomena related to them. From the INTRA we created code to see the transit of the secondary eclipse of an exoplanet.

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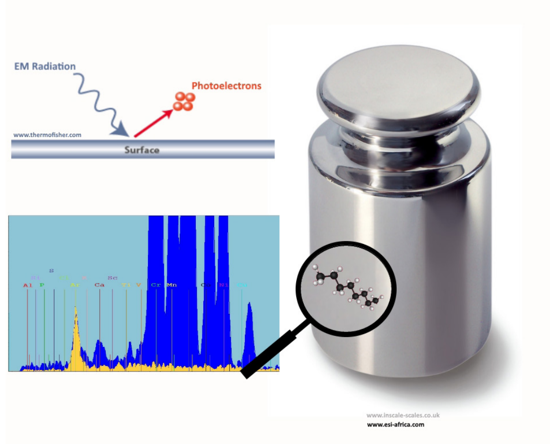
# Characterization of Adsorption Effects on Stainless Steel Mass Standards

Kevin Byrne




Mass is globally represented by physical artefacts. Calibrated standards are cross compared to each other in a traceable ladder of certification all the way to the artefact definition of the kilogram residing in Paris. The NML has many stainless-steel mass standards and many precautions are taken to prevent contamination. The aim of my project is to identify contaminant species on the surface of these standards and to track mass stability after contaminant removal. Multiple spectroscopic analysis techniques will be implemented both directly on to the standard surface (XRF/XPS) and on solutions created by refluxing the samples with common solvents (DI Water/Ethanol/Acetone). The stability of the samples will then be tracked through mass comparison to compare the effect of solvent use on measurement uncertainty. The results of the project will be used to improve the standards that are Ireland's representations of the unit of mass, against which mass standards and balances across the country are calibrated.

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I am currently in my final year of my degree – Physics with Biomedical Sciences. I have experience in the biomedical devices sector through working in Waters Technologies. There I held roles in the analyser build and instrument assembly stages of mass spectrometer instrument production. Last year I completed my INTRA placement in the National Metrology Laboratory (NML). I worked in the electrical and dimensional sections, carrying out many calibrations and receiving qualifications in measurement analysis. I took part in multiple projects including building a working model of a watt balance, making porosity measurements on additively manufactured samples for research on bone scaffolds and the design and test stages of a 100VDC national reference standard. After I graduate, I intend on furthering my education and working in an area relevant to medical physics or biomedical engineering.

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# Analysis of the Optical Emission from PSR J2032-4127

Niall Cawley

My project is centered around the binary star system PSR j2032-4127, This system comprises of a Be-type star and a compact central object which has several theories surrounding its nature. The central object has a disk of matter surrounding it. These two stars are in a highly elliptical orbit and only come within relative proximity to one another once every 50 years and at this time the disk of mass surrounding the central object is disturbed and the emission from the star changes accordingly. These systems are not unique and several more like them exist with differences and similarities. Understanding the fundamental driving forces of these systems is vital in our quest for a universal understanding of all the objects in the night sky and beyond.

Greetings all, my name is Niall Cawley and I'm a student in the School of Physical Sciences of DCU, in the Physics with Astronomy programme. DCU has been an amazing help in propelling me into the world of research which I hope to continue into and so forth to greater things. The amazing effort by the school to enable us to travel to CERN and to ISDC, an astronomy facility in Geneva, have truly inspired all of us and enlightened us to the possibilities for our own paths in the future. The school and colleges' attitude to competitiveness is a uniquely driven environment that spurred us all on to excel in our own strengths.

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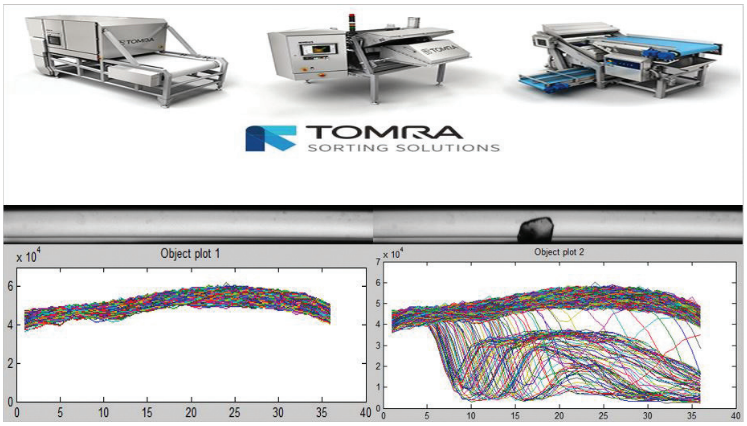
# Machine Vision Utilising Ultraviolet and Infrared Spectroscopy for Detection in Industrial Optical Sorters




Daragh Comisky

My project is in partnership with Tomra Sorting Solutions and aims to develop a more effective means of foreign material detection in industrial optical sorters for the food industry. I wish to achieve this with the design of a hybrid infrared & ultraviolet based imaging system. The research and design will be based on developing a small-scale prototype setup as proof of concept. The rest of the project consists of improving the software utilizing image processing techniques to find the most accurate approach for detection. If successful, this research will lead to the implementation of this technology to improve the accuracy of foreign material detection of the sorters, with the underlying intention being to reduce loss of profit caused by discarded product.

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I will soon be completing my final year of a BSc in Applied Physics at DCU. As part of my INTRA placement I worked as an intern at Tomra Sorting Solutions for 8 months. While there my focus was research & development of modern technologies for industrial optical food sorters. I worked on multiple projects such as the development of programs for data analysis in MATLAB, the design and creation of prototype electronic circuitry, and a project concerned with the spectral analysis of materials to determine their optical properties. I have also worked on the setup and use of a quality control standard for lighting systems using machine vision applications, and in the testing of new cameras for possible use in newly develop machines. Upon completing my degree, I hope to work in industry while completing a part-time engineering masters.

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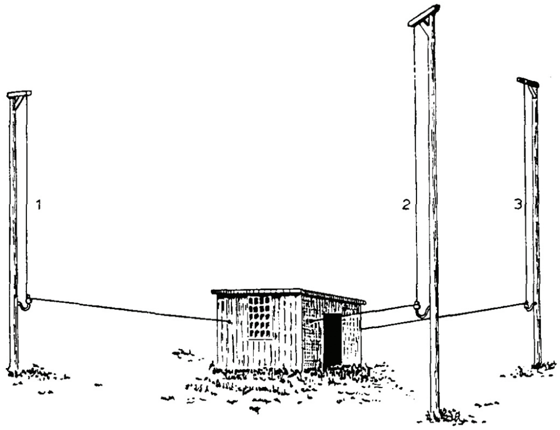
# Construction of a Phased Antenna Array

Eoghan Conlon O'Neill




My project is to assess the feasibility of constructing arrays of phased antennae with the second year students in labs. This includes the construction of the necessary radio transmitters and receivers.

Such arrays can be used for radar applications and steered electronically (by using phase shifting), eliminating the need for heavy equipment to steer arrays. Karl Ferdinand Braun was awarded the 1909 Nobel prize for physics for the first demonstration of electronic steering. The downside to this is that more computing power and storage is required, hence rotary arrays were favoured for many years. That said in recent years the cost of computation has decreased dramatically and phased arrays are now experiencing a return to popularity.

I had always had an interest in how things work and in school I enjoyed physics and had an interest in taking further study in the subject. Now that I have made it to final year of my degree (Physics with Astronomy) I have gained a methodology of approaching problems which are new to me.

For my INTRA I took part in the field trip to ESAC (the European Space Astronomy Centre) outside Madrid. At ESAC we took part in field testing of new web based tools and apps for the next generation of astronomers. During the rest of the semester we discussed newly released manuscripts of academic papers in physics and astronomy, and took time to learn python as well.

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# Infra-Red Laser Heating of a Centrifugal Disc for DNA Amplification

Rebecca Cullen

DNA amplification is a method used to obtain a large quantity of DNA, which is then tested to make a molecular diagnosis. DNA testing plays an important role in research; it has a role in medicine, gynecology, forensic science, agriculture, and many more. A wide number of nucleic acid amplification chemistries, such as PCR, LAMP and NASBA, require tightly controlled thermal conditions to operate at best efficiency. Isothermal chemistries, such as LAMP, are particularly appealing for point-of-care diagnostics as it is simple and does not require thermal cycling. Combining these methods to a centrifugal platform can be difficult, as instrumentation and electrical connections are not ideal. My aim in this project is to investigate tackling these problems with alternative methods of heating. In this project, a disc with a black metal torus (aluminum) is used and heated, while rotating, using infra-red heating to test if this system can be used for LAMP DNA amplification.

I chose to study Physics with Biomedical Sciences as I have an interest in the medical applications of science and technology. I knew this course was something I would enjoy. During my INTRA placement I was fortunate enough to work in Beaumont Hospital, Medical Physics, and Clinical Engineering Department. Here I got to work with Nuclear Medicine, Radiology, Theatre and Dialysis. Tasks involved quality assurance of X-Ray equipment, preparation of patient doses in nuclear medicine, and many more. It was such a great experience which inspired me to pursue a career in medical physics. Once my undergraduate degree is complete I intend to continue my studies by completing a MSc in Medical Physics, and possibly a PhD.

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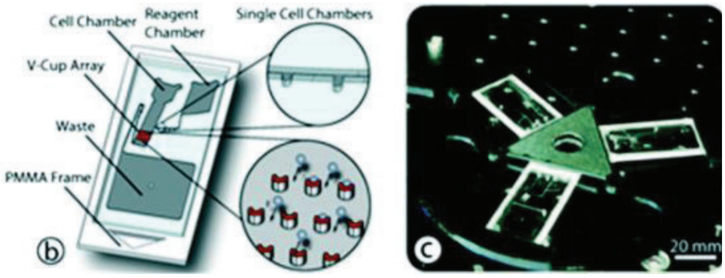
# Label-Free Optical Multi-Parameter Classification of Bladder Cancer Cell Grade at Single Cell Level under Cytology Test Conditions

Conor Devine




The aim for my project is to perform an analysis at single cell level using a centrifugal microfluidic "lab-on-a-chip" platform which features a V-cup array geared for cell capture at a sharply peaked single-occupancy distribution. On-chip conditions will mimic the cytology conditions the cells experience in the central test lab in hospitals. We aim to obtain photonic fingerprints on individual bladder cancer cells, spread across two types of cancer cell: one a high grade cancer cell and one which is close to healthy. This type of analysis is part of work in the point-of-care field which hopes to provide real-time diagnosis for disease. This will hopefully lead to a more tailored approach to disease diagnosis by providing quick and exact answers to the problems in disease diagnosis.

I am currently in the final year of the B.Sc in Physics with Biomedical Sciences. For my INTRA placement I worked as a research assistant in the Microfluidics group in DCU. This involved manufacturing and testing of microfluidic discs and working with v-cup array chips to analyse a variety of cells. This was all part of work undertaken as part of the Biomedical Diagnostics Institute. This was a great experience and provided an insight into the everyday life of a researcher in a fast paced team of scientists. Upon completion of this internship I went straight into another one, this time in finance. Despite not having an experience in the field I was able to quickly adapt and make use of the skills I had acquired both in the duration of my studies and the work done during INTRA. Outside of college I enjoy a variety of sports including football and golf. Upon graduation I plan to pursue a career in business or finance.

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# Accurate Measurement of the Speed of Sound in Gases Using In-Situ Generated White Noise

Conor Fitzpatrick


My project involves measuring the speed of sound in gases such as air, nitrogen and argon using relatively straight forward sound wave theory and equipment. A piece of PVC piping is used as a tube for gas to flow in to, the flow of gas being the source of the noise. Microphones placed inside the tube pick up the noise, the signal of which can be transformed using a Fourier Transform to highlight frequencies of the sound wave that resonate in the tube. The differences in resonant frequencies can then be used to determine the speed of sound in the gas in question. It is a fascinating experiment as it consistently determines an accurate value of the speed of sound, so parameters such as temperature and pressure can also be seen to affect the speed.

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My original inspiration to study physics stemmed from a magazine article that ranked Einstein as the most influential person of the 20th century. I was motivated by seeing that some of the most important discoveries and technological developments were derived from the most fundamental of the sciences. I will soon be graduating from DCU with a Bachelor of Science in Applied Physics, equipping me with valuable skills and knowledge which will hopefully give me an opportunity to contribute to a wide variety of fields. I have acquired work experience in the National Metrology Laboratory during my studies which reinforced how something as fundamental as measurement is of great importance to modern industry.

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# Building and Modelling of a Lorenz Waterwheel

Mark Flood

A Lorenzian (or "chaotic") waterwheel is a physical model that perfectly corresponds to the Lorenz equations. The Lorenz equations are a system of equations which are a simplified description of atmospheric dynamics and weather. A chaotic waterwheel is just like a normal waterwheel except for the fact that the buckets leak. Water pours into the top bucket at a steady rate and gives the system energy while water leaks out of each bucket at a steady rate and removes energy from the system. If the parameters of the wheel are set correctly, the wheel will exhibit chaotic motion. Rather than spinning in one direction at a constant speed, the wheel will speed up, slow down, stop, change directions, and oscillate back and forth between combinations of behaviours in an unpredictable manner. This project will involve the construction of a compact Lorenz waterwheel and the measurement of chaotic motion of this system.

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I am nearing the end of my 4-year degree in Applied Physics and have thoroughly enjoyed my time in the college. I would highly recommend doing the Applied Physics course to any second-level student interested in physics. Being such a diverse course in terms of what modules you cover, it gives you an incredible groundwork on what you can branch off to in the future. Some personal hobbies of mine are golf, playing piano and gaming of all kinds. I held the position of secretary for DCU's Gaming Society and it was great to be a part of the organisation of events and the running of the society.

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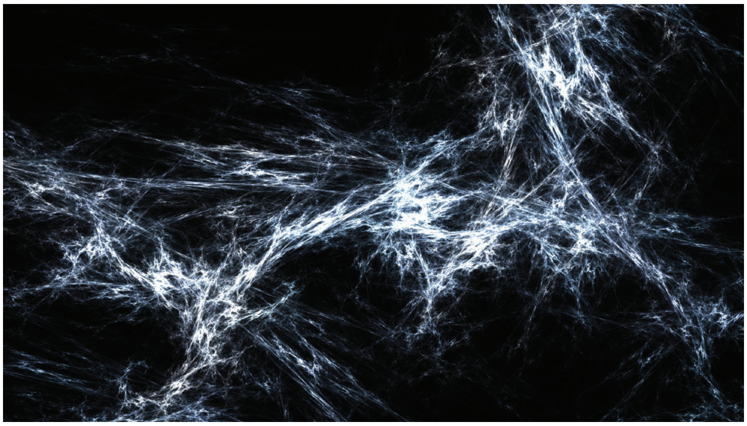
# Artificial Neural Networks in Quantum Mechanics

Andrew Forembski



Artificial Neural Networks (ANNs) are a class of algorithms based on a crude model of biological neurons. They are the key technology behind face, voice recognition systems as well as targeted advertising and self-driving cars.

My project, done in collaboration with Movidius, explores the use of such algorithms in solving differential equations; more specifically the diffusion equation for approximating the ground state of atomic Hydrogen. The key motivation behind this work was to assess the performance and computational cost of an ANN approach in comparison to classical finite difference methods. The research carried out in this project has the potential to expand the use of ANN algorithms in the field of Computational and other domains of Physics.

Admittedly, I find it difficult to be acquiescent of the fact that, four years ago, I was preparing for the Leaving Cert; awaiting the event which would shape my then immediate future. At the time of writing this, I am in the final semester of a BSc degree in Applied Physics; awaiting approval for an IRC (Irish Research Council) application to pursue a Doctorate in Computational Physics. In a way nothing has changed; in a way everything has. Although I am standing at another academic crossroads, it is from a position of far greater experience, a large portion of which was cultivated during my INTRA placement in Movidius (an Intel Company). Movidius develop dedicated hardware and software for portable low power computer vision applications. It was there that I was inspired to pursue a postgraduate degree by research.

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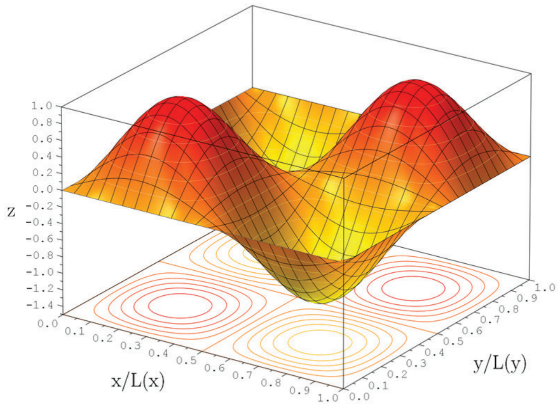
# A New Application of the Relaxation Method for Finding Quantum Bound States

Ciaran Frain




The Schrodinger equation is used to describe the behaviour of particles in quantum mechanical systems. In most real-world scenarios it is not possible to obtain solutions to this equation analytically, and instead numerical analysis techniques must be used. My final year project was computational and was based on a recent research paper which proposed a new algorithm based on a mathematical technique more commonly used in electrostatics adapted for use in solving the Schrodinger equation. It is capable of taking an arbitrary potential field and, using a variational-relaxation algorithm, to calculate the corresponding wavefunctions and energy levels of a particle placed in that potential. My goal was to develop code using python to implement this technique and test its effectiveness and accuracy for a range of different potentials. This project was an excellent opportunity to further develop my knowledge of quantum physics, mathematical modelling, and my skills in programming.

Studying Physics with Astronomy in DCU has been an extremely rewarding experience for me. For my third year INTRA I went on the astronomy field trip to Geneva where I visited the Integral Science Data Centre (ISDC) and CERN. I attended daily talks from staff at the ISDC and took part in programming workshops where I worked on code to analyse exoplanetary transit data. I also had the opportunity to visit the INTEGRAL satellite telemetry centre and speak with the scientists working there. I have enjoyed my time in this course tremendously and I can gladly recommend it to anyone with an interest in astronomy.

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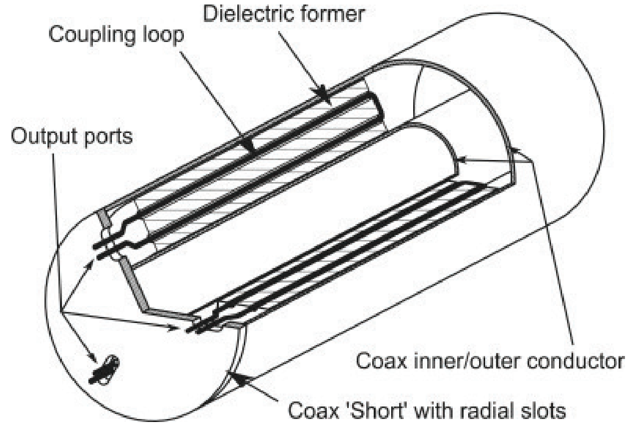
# Modelling the Power Transfer of a PSTLD Using Scattering Matrices

Seán Glavey




In the semiconductor industry plasmas have many uses, one of which is to etch silicon wafers which are then used to produce the transistors in your phones and computers. My project looks into the work of Dr. Ellingboe and his team who produced a system that allows the plasma etching machines to be run at higher frequencies and hence lower power requirements. Such a system would be of huge interest to the semiconductor manufacturers of the world. In particular my project pertains to the system used to achieve these higher frequencies. Using a scattering matrix approach, the system can be characterised by discrete blocks for which a scattering matrix is calculated. These matrices contain information about parameters ranging from the phase of the power waves flowing through the block to how the power waves themselves change as a function of dielectric constant. The aim of my project is to use this approach to gain a greater insight into the underlying physical phenomena present in the system.

Up until my final year of secondary school, I really hadn't fully made my decision on what I wanted to do in college. I decided to do a PLC course in Pre-University Science to try to see if science in general was for me. After successfully completing the PLC, I decided to use it to do a BSc in Applied Physics. I am now in my final year. As part of my degree I was given the chance to work in the Plasma Research Laboratory in DCU, under the supervision of Dr. Bert Ellingboe which made up my INTRA. My final year project is based on the work I did as part of my placement. After I complete my degree I would like to pursue a PhD in plasma physics with respect to nuclear physics.

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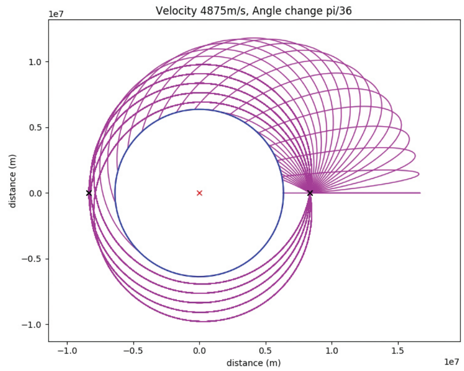
# Modelling a Lunar Transfer Orbit

Emma Goodwin




When humans landed on the Moon many of the calculations were completed by hand, but nowadays computer simulations can be used to model whole missions from beginning to end. My project is the creation of a computational model of a lunar transfer orbit, the path a spacecraft may take to get to the Moon. In this I take the 2-D case and starting in a Low Earth Orbit (LEO) I propagate the spacecraft incrementally considering the gravity of both the Earth and Moon. To initiate the transfer, I inject velocities at certain points to start the journey and to slow the spacecraft down into a lunar orbit. I can also change the parameters such as distance and mass of the celestial bodies to model journeys to other planets. This project allowed me to expand my programming skills as well as giving me experience on modelling a real system in code.

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In my four years of being in the Physics with Astronomy course, I have completed various research projects and work experiences. I took part in a Summer Research Programme in my 2nd year in which I undertook a project that investigated the origin of high energy emission from the Galactic Centre. I wrote a Monte Carlo code in C++ that followed individual protons and calculated the resulted emission. During my 3rd year, I travelled to Geneva with my classmates to study at the INTEGRAL Data Science Centre where I took part in live monitoring of the data coming in from the INTEGRAL Satellite as well as computational coursework projects. Outside of college work, I enjoy archery, playing Gaelic football, and reading.

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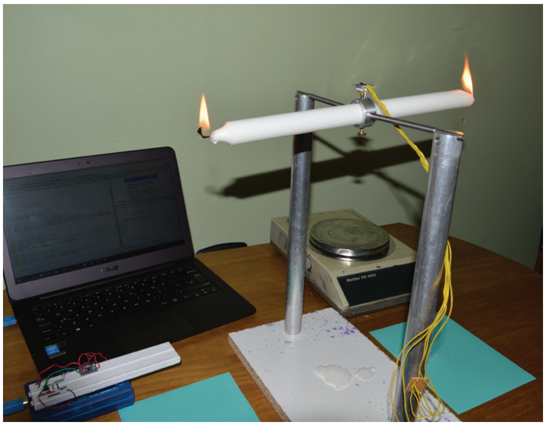
# Flaming Oscillator Dynamics

Eleanor Martha Hulm



Interesting physical phenomena are often presented qualitatively under the guise of magic and trickery. This project examines, quantitatively, the curiosity of a candle see-saw or “motor stearique”- a system which consists of a candle lit at both ends allowed to oscillate around a pivot. This oscillatory motion is due to more wax falling from the lower end than the higher, thus meaning the centre of gravity continuously shifts from right to left. This entailed the design and manufacture of such a system whose behaviour is analyzed using an accelerometer/gyroscope MPU6050 interfaced with an Arduino. Data obtained from the experimental setup is compared against the analytical model proposed by Theodorakis and Paridi and tested for its validity – with altered variables in the system. This multifaceted project was suited to me as I’m interested in design and electronics.

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I’m a final year Physics with Astronomy student. My INTRA entailed a week’s experience processing raw astronomical data at the INTEGRAL data centre in Geneva, where we were also given presentations on a plethora of fascinating astronomical topics. We had the opportunity to visit CERN too, which was fantastic. After this, I travelled the west coast of America and the Great Mohave Desert working with sustainability, electronics, construction and the arts. My work includes cheffing, and tutoring in physics, maths and guitar. I’ll be working in a jazz lounge in San Francisco before seeking an internship. I’ve learned many great skills during this degree which I aim to put to use to tackle some of the many problems our world faces today. Outside of physics and technology, my interests include funk, sustainability and social justice.

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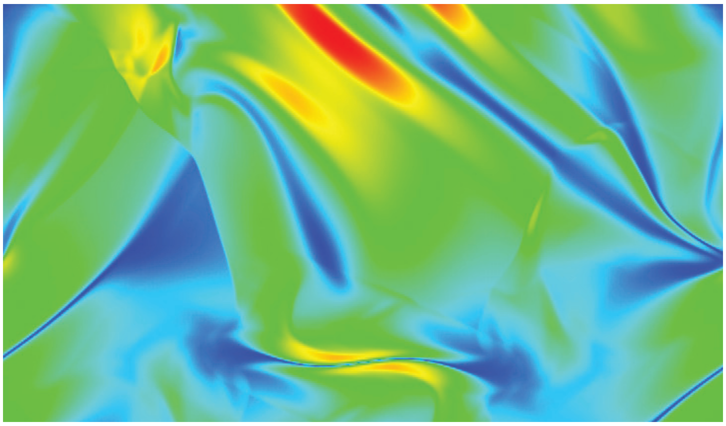
# The Orszag-Tang Vortex: A Case Study in Multifluid Magneto-hydrodynamic Turbulence



Feljin Jose

Magnetohydrodynamics (MHD) is the study of interactions between magnetic fields and electrically conducting, non-magnetic, moving fluids. Such effects are negligible in most ordinary fluids because they are poor electrical conductors. However, gas atoms lose electrons at high temperatures and become good conductors called plasmas. Due to the nature and complexity of the problem, it is essential to test the codes we use to model MHD systems. The Orszag-Tang Vortex is such a test and has only been modelled for ideal MHD where the plasma is assumed to be a perfect conductor. My project uses my supervisor's MHD code (HYDRA) to study the effects on the Orszag-Tang vortex if we introduce different forms of electrical resistance to the system. The results of this project would create a standard result under a pre-defined initial conditions for non-ideal MHD code like the original Orszag-Tang Vortex does for ideal MHD.

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I chose to study Physics with Astronomy because Physics, Maths and Applied Maths were the subjects that I liked the most in school and I have thoroughly enjoyed this course. For my INTRA, I went to the Integral Science Data Centre in Geneva for a week with the rest of my class where I got an opportunity to learn from astrophysicists and engineers at the cutting edge of astronomy research. I also carried out projects on exoplanet transits and X-ray binaries back in DCU. I have not yet decided my next career step but I have a wide variety of interests ranging from transport planning to data science and have begun searching for graduate opportunities in several different industries.

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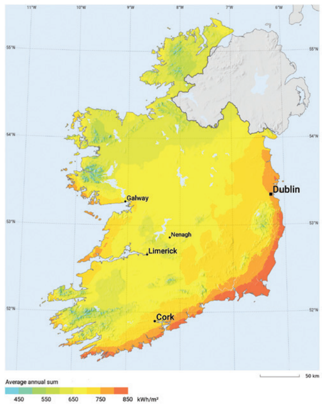
# Analysis of Solar Energy for Ireland using a Climate Reanalysis Dataset

Eoghan Keany




My final year project is in collaboration with Met Eireann & is essentially a statistical analysis of the Mera climate reanalysis data set. Climate reanalysis is an approach used to produce meteorological datasets for climate monitoring and research. They are created using a forecast model and a data assimilation system to produce a data set of the weather throughout Ireland. Using Python I constructed a program to find the errors in the solar radiation outputs from the reanalysis dataset compared to observation data from 20 solar radiation stations around Ireland. Scenes of global flooding & severe weather have highlighted the impact that climate has on our lives. Thus, the importance of understanding how this dynamic system operates is of vital importance, both economically & for society in general.

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During my INTRA placement I spent six months as a Mechanical & Electronic Engineer as part of the Greentherm.ltd team, a company that specializes in the design & implementation of renewable energy systems. This placement allowed me to experience many aspects of the operation & management of a project with many variables and also gave me hands on experience with the practical applications of physics. As an Engineer my main role in the team consisted of physically bringing the renewable solutions to life by either drawing AutoCAD drawings or ordering parts or designing the electronic controls & programing the (Programmable Logic Controllers).

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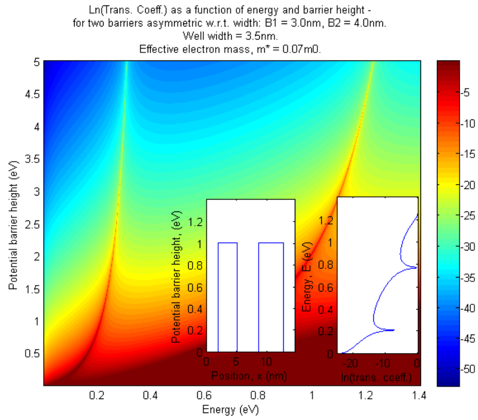
# Transmission of Waves Through Periodic, Quasi-Periodic, and Random One-Dimensional Potentials

Thomas Keogh




In 1924, Louis de Broglie proposed that matter, in analogy with light, would exhibit wave-particle duality. The wave-like behaviour of matter, such as electrons, is described by the Schrödinger equation and gives rise to intriguing phenomena such as quantum tunnelling. My FYP involves developing MATLAB code, to study the effects of wave propagation through one-dimensional potentials. In my project I use the transfer matrix method to solve the Schrödinger equation for particles tunnelling through multiple potential barriers, the critical parameter here being the transmission coefficient, key for an understanding of the transport properties of nanoscale systems e.g. molecules or nanowire. I aim to demonstrate that the band structure of solids can be understood as an emergent property of the periodicity of the crystal lattice. Additionally, I'm motivated to understand the effects of breaking this periodicity, so as to gain insight into how impurities and other crystallographic defects affect electron transmission.

For as long as I can remember I've always been profoundly fascinated by science. In particular, I find the quantitative nature of physics has always been especially appealing. So having taken all of the science subjects at Leaving Certificate and getting the maximum grade in Physics – Applied Physics at DCU was the natural progression for me. As someone who was captivated by all aspects of science, I decided that I would apply for a position in the MPCE department at Beaumont Hospital, becoming the first ever Applied Physics student to secure a placement there for INTRA. Whilst there, I worked primarily in Nuclear Medicine assisting the Medical Physicist in preparing radiopharmaceutical injections. Crucially, through this work I gained an appreciation of the importance of quality assurance and quality control in the clinical environment. Outside of college I enjoy sea fishing and reading history.

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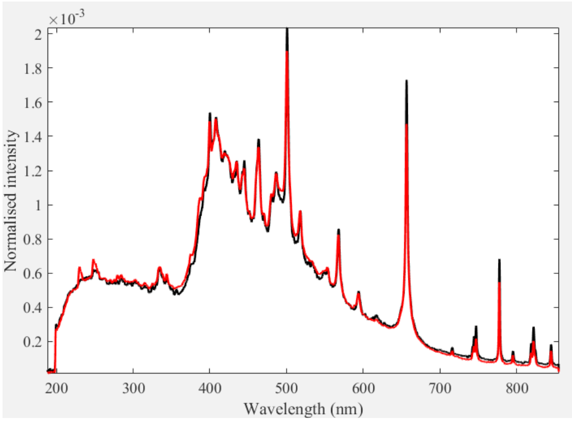
# An Investigation of Liquid Samples Using LIBS

Liam Lawlor




The goal of my project is to analyse a sample of Coka Cola and a different sample of Pepsi using Laser Induced Breakdown Spectroscopy (LIBS) in order to identify the difference between them. LIBS is when a high powered laser, in my case a class-4 Nd:Yag laser, to turn a sample into a plasma and then analysing the light from that plasma using a spectrometer to find out what and how many atoms are in each sample which is how the samples are differentiated. Principal Component Analysis was also used to further show the difference between the samples by analysing the variance in the raw data. This project can be used to quickly and efficiently identify the differences in materials or can even be used in industry for identification and quality control which in turn can have a huge economic benefit.

Within the next year I will graduate with a Bachelors in Applied Physics from DCU. I've had three different projects within DCU. The first being a volunteer internship working on an Optical Demonstration kit under Mr. Henry Barry. The second was my INTRA project developing a Fourier Optics experiment for Advanced Third Year Labs in DCU. On this project, I was supervised by Dr. Robert O'Connor and Dr. Tony Cafolla. The third project is my current, final year project. After graduation, I intend to obtain an internship in an external company for a year before moving on to hopefully do a Masters or Ph.D. Additional to my interests in Physics, I have a strong interest in martial arts having competed in fencing competitions representing DCU.

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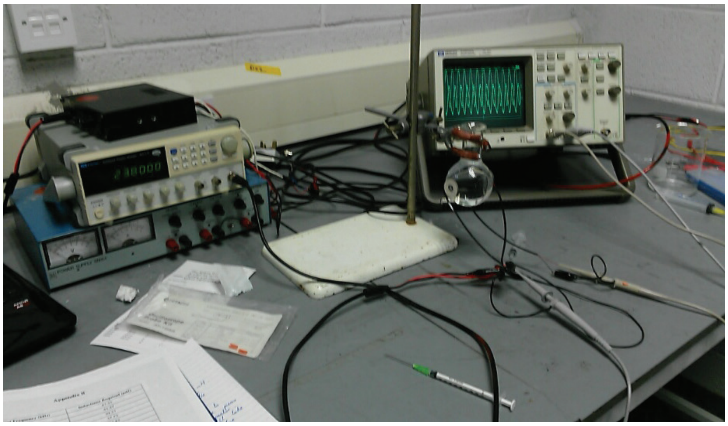
# Design and Construction of an Experimental Setup to Observe Sonolumin-escence

Oisín Mallon



Sonoluminescence or 'Star in a Jar' is a phenomenon whereby sound energy is directly converted into light. The project involves designing an experimental setup to show this effect, which can be done by driving two sound waves through opposite ends of a glass flask containing water. When these sound waves are set to the resonating frequency of the flask, it results in formation of a bubble in the water, an effect called cavitation. The sound waves cause the bubble to expand, and then collapse, in a reaction so violent that when the molecules inside the bubble collide, a burst of light is emitted. The process happens a few thousand times per second, giving the appearance of a constant emission of light, or a 'Star in a Jar'.

I am currently in my 4th of studying Physics with Biomedical Science. I carried out my INTRA placement in St Vincent's Private Hospital as a trainee medical physicist. The placement is a good introduction to how physics can be applied in a clinical environment. The work involved research, testing and calibrating many different medical devices within the hospital. There is also the option of carrying out research projects in the areas of diagnostic radiology. The placement is very relevant to anyone studying a physics degree, as there is a vast amount of knowledge of physics involved in such a workplace. I gained invaluable hands-on experience from the placement that allowed me to work after INTRA as an engineer in a company that manufactures biomedical devices.

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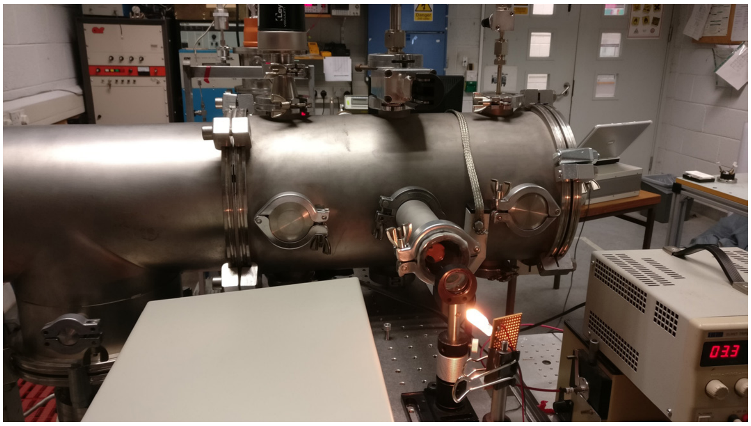
# Construction and Characterisation of an Absorption Spectroscopy System for the Detection of NO

Steven Marron



Acidification of animal slurry offers a method to reduce ammonia emissions and improve air quality in regions of intensive agriculture. A possible method of nitric acid production is by use of a so-called electron beam sustained discharge. Such a discharge produces NO which can then be used to produce $HNO_3$. It is necessary then to be able to measure the concentration of NO in the discharge chamber. One way of measuring the concentration of a gas is by absorption spectroscopy and it is the aim this project to construct and characterise an absorption spectroscopy system to be used in the yet-to-be developed plasma discharge system to be used to produce NO. This includes assembly of the vacuum system, gas delivery and optical detection system.

I've always been passionate about aviation and through my study of Applied Physics I have developed strong analytical and problem solving abilities. My INTRA placement gave me an opportunity to begin working within the aviation industry. I completed my INTRA placement as a load controller and flight dispatcher at Dublin Airport where I have also been working part time during my final year. My work experience gave me an opportunity to further develop the skills I had learned in DCU, while also developing a strong appreciation of the challenges associated with working in a customer focused industry. Outside of college and work I enjoy cycling, working with computer hardware as a hobby. After completing my degree I plan to pursue a career as a commercial pilot.

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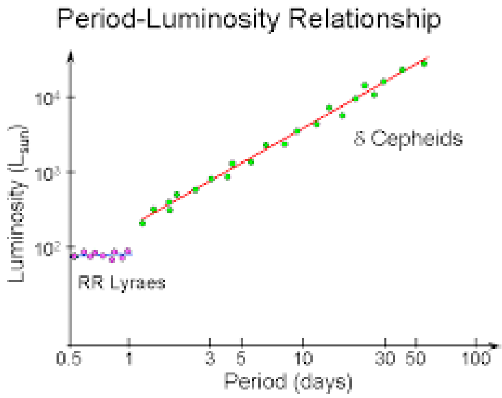
# Cepheid Variable Stars and the Period-Luminosity Relationship

Shane McCann




Cepheid variables are a class of star whose radii (and thus, their luminosities) vary periodically over time, i.e. they expand and contract/ brighten and dim over very regular cycles. Upon their discovery over 100 years ago, it was noted that there was a strong, fixed relationship between the period of a Cepheid variable, and its average luminosity/ brightness. A brighter Cepheid will have a longer period, and vice versa, which is known as the Period-Luminosity (PL) relationship.

This makes them incredibly important in astronomical distance measurement, as once the period of a Cepheid is known, its brightness can be deduced from the PL relationship. Once a star's brightness is known, its distance can be easily calculated, making Cepheids an extremely useful "standard candle" for distance measurement.

The method does, however, come with major obstacles, as astronomers have spent the last 100 years attempting to fine-tune the PL relationship, a task made difficult due to the number of factors on which it depends, e.g. metal content, nearby binary star, to name but a few. The aim of my project is to investigate the PL relationship, and its reliability in estimating large distances.

Currently, I am studying for final year Physics with Astronomy, with brief experience in astronomical data analysis due to a third year visit to the ISDC (INTEGRAL Science Data Centre) for Astrophysics in Versoix, near Geneva, Switzerland, where we focused mainly on high energy astrophysics. I also have a huge interest in sport, and have played for the DCU Soccer team since 1st year, as well as various clubs outside of college.

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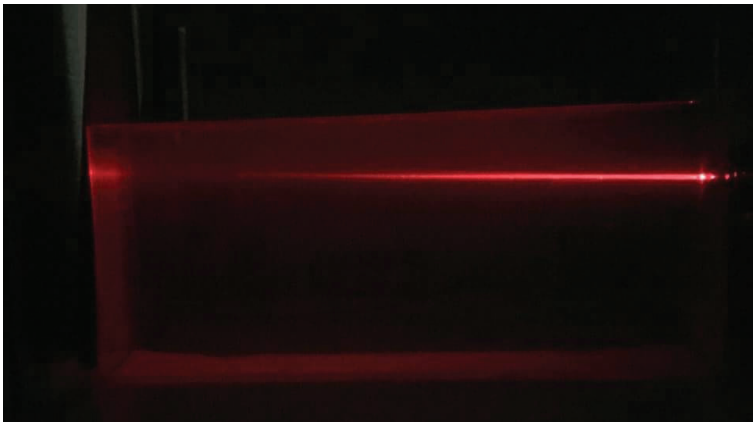
# Diffusion Measurement using Laser Deflection



Adam McGrath



As you introduce a substance such as salt or sugar into water, the molecules dissolve and disperse through the water until they come to a state of rest or equilibrium. By increasing the concentration of these substances, the refractive index within the water should change and such measurements can be determined using the deflection of a laser beam. A camera can then be used to record the refracted laser line from the initial point of when a substance is introduced into the system until it comes to rest. The main targets for my project are to create a setup using a laser and a camera which is capable of measuring refraction changes throughout a solution and then analyzing the results to determine diffusion rates of different substances as they dissolve in water.

I decided to study Physics with Biomedical Science in DCU because I always had a strong interest in physics and biology while I was in school, and this course allowed me to incorporate both simultaneously. For my INTRA placement I worked for 8 months in TOMRA Sorting Solutions. During this period, I really took a step forward in my data analysis skills and also my knowledge of optics. It was also good to experience first-hand of what it is like to work in a specialized environment linked directly to my course. After I complete my final year in DCU I will continue to further my knowledge of physics by doing a masters and possibly a PhD.

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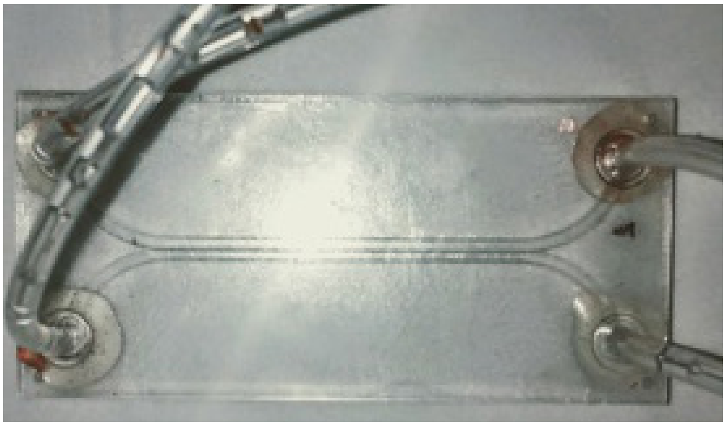
# Fluid Flow Control in a Microfluidic System Using Phase Guides and Viscous Drag Effects

Rónán McKevitt



My project is rooted in the field of microfluidics. It involves designing and fabricating a device that would allow for the movement of two fluids meeting at an interface by 'driving' only one of them. From there the device would then by tailored such that the driven fluid would cause turbulence in the other fluid. This turbulence would potentially give rise to dean forces (vortices in the fluid), which would allow for several applications, of most interest being size separating of suspended objects without the need for external devices. Over the course of this project I have cultivated a number of skills – using solidworks to design devices, operating fabrication machines (knife cutter, laser cutter, milling machine etc.), and even a small bit of programming in an attempt to model the fluid interactions.

My name is Rónán, I've spent the last three and a bit – soon to be four years – working towards a qualification in Physics with Biomedical Sciences. My initial plan was to use this degree as a launch pad to go on to study for a Medical Degree. It was that interest that led to me choosing to spend my INTRA working on a project in St. James' Hospital. Specifically, I spent around four months there working on a project developing an occupancy sensor for patients in the MISA (Mercer Institute for Safe Aging) building. I've yet to decide if I want to go on to study Medicine or attempt to find work in Medical Physics.

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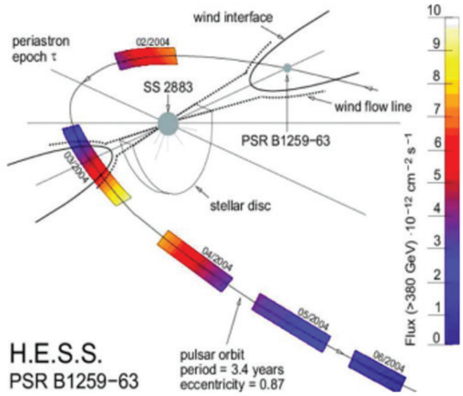
# Study of the Optical Data to Unveil the Origin of One of the Most Unusual Flares in TeV Sky

Oxin McKittrick




My final year project aims to provide an analysis and ideally a solution to the very-high energy (VHE) astronomical anomaly that is the binary source PSR B1259-63. This source has been observed to release a TeV flare once every 3.4 years and is only one of 5 binary sources (known to date) visible in this high energy band. The flare is linked to the periastron passage of the binary members, meaning this phenomenon occurs when the pulsar comes in contact with the rotating disk of the Be star. Through the observations linked with the H-alpha line widths one can monitor the changes within the disk in search of an explanation. A solution to this problem will shed some light on the fundamental relationship of binary systems in this VHE band and how energies of such high magnitude are generated, VHE astronomy is only beginning to become accessible ahead of the completion of the Cherenkov Telescope Array.

Presently, I am in my final year of Physics with Astronomy. For my third year INTRA module I opted for a course trip to Geneva with the emphasis on receiving hands-on experience. We monitored/applied data analysation methods to search for gamma-ray sources with the use of the INTEGRAL telescope. Furthermore we attended daily lectures and completed programs capable of finding planet transits & x-ray binaries. Following on from this I attained a job as a paid intern for Mercator Solutions (now Accelya) based in Dubai, U.A.E., a company dedicated to creating software systems for airline use, encompassing both cargo and passenger based big-data systems. I was mainly based in R&D for the purpose of researching augmented reality and its use cases within the company.

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# Investigating the Detection Limits and Range for Large Scale Integrated Immunoassays towards Multi-Marker Cardiovascular Disease Detection using Novel Valving Technology

Joanne McSorley

I chose this project because cardiovascular disease is the single greatest cause of death in the Western world and the early detection of this disease has the potential to save millions of lives. My project is not a cure for CVD disease by any means but I like the idea of working towards a goal with a real purpose and meaning behind it. The largely integrated microfluidic disc within my project carries out an extensive immunoassay for the detection of cardiac biomarkers by automating and shortening the process performed on a bench top. The project has been in progress for a number of years and my role is to achieve data to prove the reproducibility of this disc with the potential of publishing the data if the immunoassays are successful with comparison to the existing standards set on the benchtop.

My degree in Physics with Biomedical Sciences has given a greater understanding of the biomedical industry with particular emphasis on physics. There are many important physics applications within the biomedical industry including diagnostics, treatment as well as innovation behind new equipment and devices. During my third year I experienced a 6-month placement with one of the world's largest Pharmaceutical companies that has guided my future career path. I will be starting a position in Technical Services in consumer healthcare in September 2018. DCU has given me the opportunity to gain an extensive knowledge within Physics and I won't forget that moving forward in my career.

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# Fabrication and Characterisation of Hydrophobic/ Superhydro-Phobic Films

Carol Murphy

For my fourth year project I researched and carried out several ways to create a hydrophobic surface with the aim of reaching superhydrophobicity. This classification is based on the angle measured between the water droplet and the surface. If this angle is over 150° then the surface is deemed superhydrophobic. The best examples of this phenomenon are found in nature for example the leaves of the lotus plant are classed as superhydrophobic. There is a large range of areas in which such surfaces could be of use such as medical devices as it can influence cell behaviour, and industry as it can be used to prevent rusting. A useful characteristic property of these surfaces is the self-cleaning effect. As water runs off the surfaces it collects any dust or dirt particles. This has a wide range of applications such as on solar panels and windshields of cars or planes.

Kilkenny born, I am currently living in Dublin studying Physics with Biomedical Sciences in Dublin City University. I will finish my final year of college in May 2018, after which I have decided to work for a year before investing in further study either in Ireland or abroad. My INTRA was spent in Vascocare, a company based in Carlow which manufactures medical devices used in surgery. However I am quite interested in the mathematical areas of banking which often look for physics students.

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# The Abundance of the $CH^+$ Molecular Ions in the Interstellar Medium

Ciara Ní Shúilleabháin

My project focuses on the large difference between the observed abundance and the abundance calculated. Back in the 1950's observations began to find other molecules in the Interstellar Medium, many different papers outlined the expected properties and characteristics of the different molecules. In these observations it was found that there was a large discrepancy between the observed abundance and the calculated abundance for a few of the molecules, including the $CH^+$ molecule. Through the decades even as the models have advanced and become more accurate, the error between the extracted and observed abundance has remained. With models created by a pre-existing model, the Meudon PDR code, and observation data from the Hershel Space Telescope I am hoping to bring a fresh perspective on the problem and hopefully gain some insight on it.

I am a student finishing my last year of study in Physics with Astronomy. I truly loved this course and would highly recommend it to anyone with a keen interest in the Universe and everything around them. For my INTRA I participated in the Astronomy Field trip which took us to Geneva, Switzerland. We visited the Integral Science Data Centre just outside of Geneva every day. While there we were given talks on many different topics relevant to current research in Astronomy today. We were also shown the day to day workings of the Integral Telescope. During the trip we were given a tour of CERN. I am currently looking to do a Master's in Cosmology in Leiden University, Netherlands.

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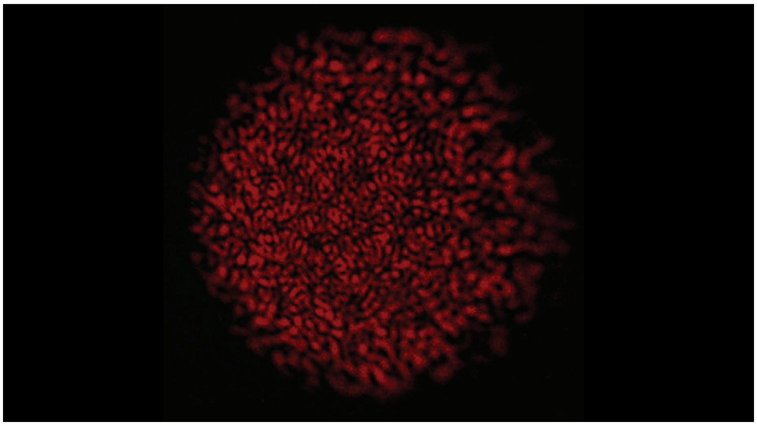
# Refractive Errors in Human Eyesight Examined using the Speckle Pattern Produced by Laser Light

Seán Ó Héir



In the late 1960's it was discovered that while viewing a laser speckle pattern and moving one's head, the speckles would appear to move with the viewer. However, the direction of the apparent movement of the speckles was determined by the physical condition of the viewer's eye. The idea of this project was to recreate the viewing system of the human eye using a DSLR camera. A camera is the equivalent of the eye - instead of a retina, a camera has an image sensor; and instead of an iris, a camera has a controllable aperture etc. By placing additional lenses at varying distances and levels of thickness, eyesight deficiencies were created. Images of the speckle pattern at varying positional points were captured. Using convolution and deconvolution to isolate singular speckles and compiling these pictures into a video, both direction and total displacement of the apparent movement were determined. Analysing the video allowed for the severity of the viewing system's ametropic conditions was to be calculated, and therefore the necessary corrective lens required to resolve the deficiency was suggested.

Studying Applied Physics allowed me to gain a solid understanding of the fundamentals of how and why things are the way they are, and to develop critical thinking and problem-solving skills. I was lucky enough to obtain a 6-month work placement (later extended to 8 months) with MDI Medical Ltd, working as a medical devices technician and researcher in Healthcare IT. This research involved calibration standards for medical-grade monitoring systems in hospital environments. The medical devices environment allowed me to experience the industry from both an engineering and business management point-of-view. It was a fantastic, enjoyable experience where I developed and improved many technical and personal skills. It is my goal to enter the computer sciences and technology industry and further my studies by doing a Masters in some form of computational sciences.

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# Investigation of the Mpemba Effect

Robin Ó Leathlobhair

The final year project I chose to do was the investigation of the Mpemba effect. The Mpemba effect says that under certain conditions hotter water may freeze faster that colder water in the same conditions. The investigation of this can be traced back to the writings of Aristotle when he pondered if such an effect may be true. The effect was then brought to the attention of the modern scientific community in 1969 when Erasto Mpemba, whom the effect is now named after and Denis Osbourne wrote a paper on it. As a schoolboy in Tanzania in 1963 Mpemba noticed that when he placed his warm ice cream mix in the freezer with other students cool mixtures his would always freeze first. This reasoning or even if it definitely happens is still not known and I believe that it would have huge energy and time saving costs for many aspects of industry production. My goal with this project was to test many different parameters and see if it was possible to get a clearer answer of what could cause this effect.

For my INTRA I worked in a large pharmaceutical company and enjoyed my time there thoroughly. I felt that it added greatly to my knowledge of my course Physics with Biomedical Sciences. The aspect of the work that peaked my interest most was the investigation of new unknown effects of various chemicals and drugs. I plan on working in this pharmaceutical company next year and feel as though the chance to do this final year project gave me a lot of freedom to be able to develop my investigatory abilities which will aid me when it comes to working in industry.

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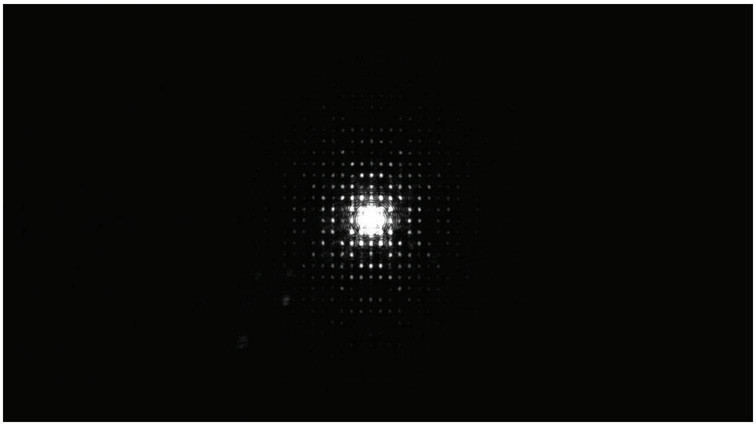
# Developing a Fourier Optics Experiment based on Spatial Light Modulators

Eric Roche



An image can be represented either in real space; denoted by (x,y) or in reciprocal space; denoted by (fx, fy). These two domains are linked by what is called the Fourier Transform. The far field diffraction pattern of any object is the Fourier Transform of that object. Using apertures to simply block selected portions of the reciprocal space images allows said image to be manipulated in ways which is rather difficult or nearly impossible to do in real space. By then forming a second diffraction pattern the real space image which has been filtered can be recovered. This is called spatial filtering. A spatial light modulator is a device which allows programmable patterns to be generated and their diffraction patterns recorded and manipulated. My project involved using this device to generate the Fourier transform of an image. Using a simple aperture, low or high spatial frequencies of the Fourier Transform could be removed. A second spatial light modulator could then be implemented into the set up to reconstruct the real space, and now spatially filtered image.

For the past 3 years, 5 months and 12 days Applied Physics has been my area of study. 6 weeks will mark the end of the semester for my final year in college. My INTRA experience took part in the Physical Engineering department in Maynooth University. Throughout the 4 months I spent in NUIM I worked on designing an optical trapping system using a spatial light modulator, a device which my FYP is based around. Optical trapping involves using a high energy laser to trap and thus manipulate particles on the micro scale. Throughout my placement I learned many skills and gained some valuable insights. After my degree, I'm hoping to move to Canada for a few years. Travelling is something I've always loved, and I feel now is the perfect time to experience a new lifestyle and finally gain some freedom and independence by moving out of my family home.

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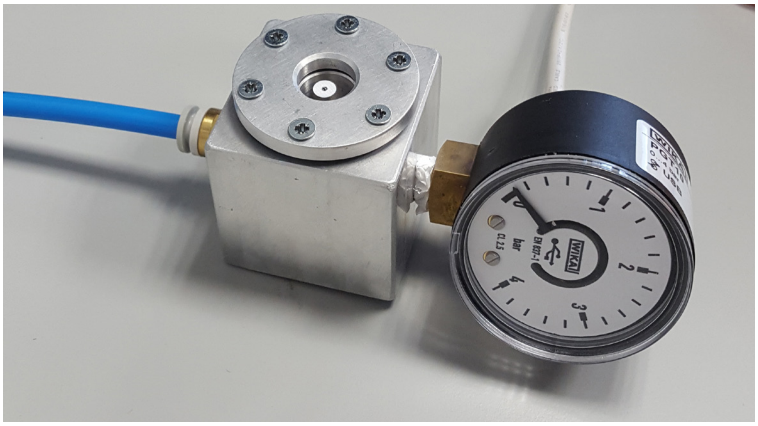
# Manufacture of Membranes using Functional Materials for Enhanced Microfluidics with Applications in Biomedical Diagnostics

Owen Scally




For my project I am making dissolvable films from polymers for integration into microfluidic devices . The goal is to achieve enhanced flow control by producing films of different thickness' and dissolution times that can then be integrated into microfluidic devices so that they can run more sophisticated tests. I am producing the films by the spin coating method, where the polymer is deposited on a disk which is spun at a high speed resulting in a uniform membrane of the polymer being deposited on the disk. Different spin speeds result in different film thicknesses and ultimately dissolution times. The applications that these types of systems are integrated into include reagent storage systems and complex bioassay.

I'm currently in my final year of Physics with Biomedical Sciences. For my INTRA work placement I worked as research scientist with Randox Laboratories in their R & D and manufacturing plant in Donegal. During my time there I worked with a team developing early stage Chronic Kidney Disease (CKD) diagnostic tests. My work mainly involved the characterisation and optimisation of the tests being developed. Outside of college I'm heavily involved in many sports teams and when I'm not doing college work spend most of my time training with one of my teams.

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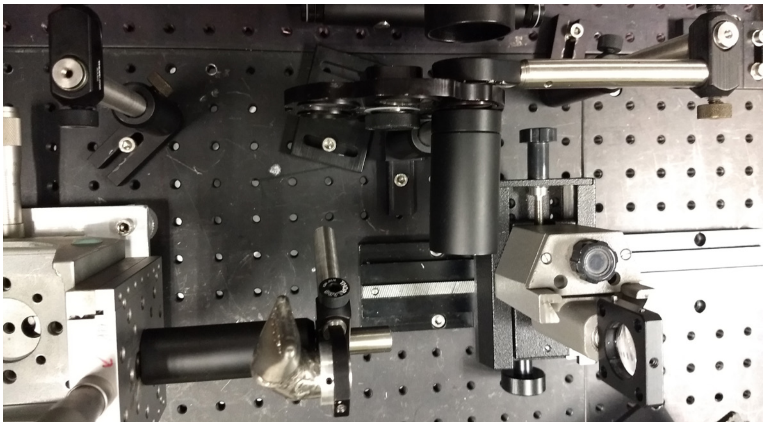
# Air Breakdown with Focused Short (Nanosecond) Laser Pulses

Kyle Shiel



My final year project deals mainly with laser induced breakdown of air. As focussed laser light strikes the air, some of the particles become ionised, which creates free electrons. These electrons collide with more particles in the air, causing them to also become ionised. This ionisation causes a flash of light to be emitted from the particles, which will have differing wavelengths for different atoms or molecules (caused by the different energy levels of the electrons). This is primarily used in industry to analyse the elemental composition of material by recording the wavelengths of light emitted from the substance. This is known as Laser Induced Breakdown Spectroscopy (or LIBS).

For the second semester of my third year I took part in astronomical research in the Geneva Observatory, Switzerland. Using data taken by the INTEGRAL satellite, I wrote and adjusted a python code to read in and analyse this data. This helped me gain valuable programming and data processing skills and gave me a great taste for working in Astronomy and dealing with the manipulation of data in the future. I am now a final year Physics with Astronomy student and believe that this experience will be a significant advantage in my future career.

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# Modeling Traffic Flow on a Motorway: Traffic Jams, Shocks and Rarefactions

Cian Smullen

Congestion in a road network is one of the most serious problems the transport network has as it not only reduces safety but also increases fuel emissions and consumption while seriously damaging the mobility of all vehicles in a network, leading to largely inflated travel times.
For my final year project I am modeling traffic flow on a motorway. The aims of my project are to investigate different solutions to the traffic flow problem using computational techniques and to explore the impact of different initial conditions, for example junctions/slow moving vehicles/congestion, on each model and compare the results.

I am currently finishing a BSc in Applied Physics and intend to pursue further education with a masters in either finance or data analytics. As part of our third year programme, I had INTRA placement with the Plasma Research Laboratory in DCU under Dr Bert Ellingboe which gave me great insight into working in a research team. Out of the academic spectrum I am interested in electronics and computers as well as camping, hiking and travel.

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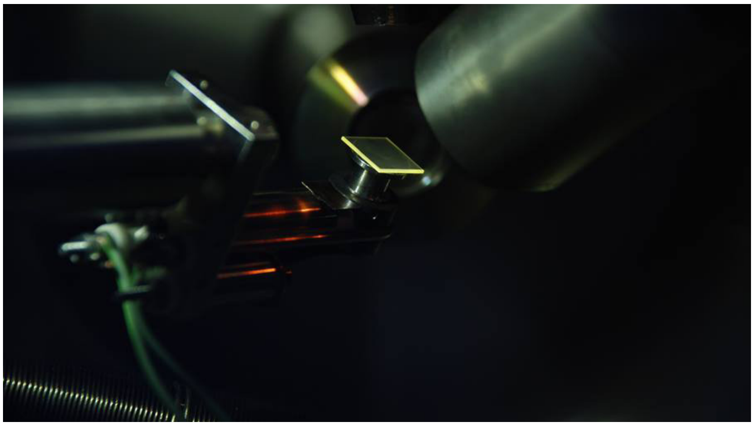
# The Characterisation of $Mn_2V_2O_7$ and its Potential to Split Water under Illumination

Matthew Snelgrove



Over 80% of our energy needs are reliant on fossil fuels. One potential solution to this energy crisis is solar water splitting, a clean, cheap and efficient way to acquire hydrogen fuel. Through a reaction in a semiconductor photo-electrochemical cell (PEC), sunlight is used to split water into hydrogen and oxygen. The photoelectrode component of the PEC, in contact with the liquid, acts as a light absorber and energy converter. Obtaining the right photoelectrode is difficult, and no material to date has demonstrated efficient and sustained water splitting. My project is concerned with the characterisation and testing of the material , one of several metal oxides that may have the right band gap and band edge positions for water splitting. The project involves preparing the material from manganese and vanadium chlorides, before characterising it via X-ray photoelectron spectroscopy, UV spectroscopy, Scanning electron Microscopy and X-ray Diffraction. The material is then tested under illumination to assess its viability as a PEC photoelectrode.

Studying Applied Physics at DCU as an undergraduate has been a challenging but rewarding experience, where I have enjoyed many opportunities throughout my studies. One invaluable experience was my 8-month co-op placement at Analog Devices International. ADI is a major designer and manufacturer of analog, mixed signal and DSP integrated circuits. My role involved assisting engineers with issues arising during the fabrication processes, allowing me to learn many skills concerning manufacturing engineering and semiconductor related technology. Upon graduation, I aim to pursue a research-oriented career by means of postgraduate studies. Outside of academia, I have a passion for mountaineering, where my exploits have taken me from across Ireland and the UK to Scandinavia and Africa.

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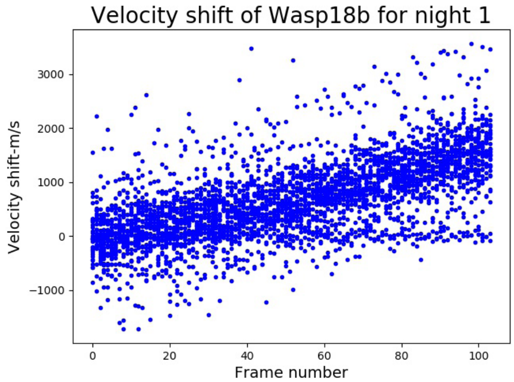
# Searching for TiO/VO in High-Resolution Spectra of Extremely Hot-Jupiters

Karl Sweeney




My project objective is to investigate whether the exoplanet gas giant WASP-18b has a thermal inversion layer which is where within an atmosphere the temperature increases as the altitude increases, similar to that of earth's ozone layer. One of the best theories for this thermal inversion layer is the presence of gaseous Titanium oxide (TiO) and Vanadium oxide (VO) in the upper atmosphere of the gas giant. The observations were given to me in the form of fits files which need to be manipulated so that the data can be corrected and then investigated for the correct elements. This data reduction was performed using python. This could be furthered by searching for other elements within WASP-18b or even investigating a new exoplanet atmosphere.

As a final year student in physics with astronomy I have studied a wide range of subjects from astronomical based programming to electronic engineering. I would recommend this course to anyone with an interest in space. The skills that I've gained from the 3rd year trip to Geneva to Integral satellite data centre (ISDC) have helped me to understand modern astronomy and gave me an insight to the industry of satellite development. We were given talks about astronomical satellites such as fermi, swift and integral by experts that worked with these projects. I also simulated the effects that a exoplanet transit would have on a stars light curve as part of my INTRA which would help me with my final year project.

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**Supervised by:** Dr. Ernst de Mooij

# Optimization of Graphene Oxide Membrane Fabrication and Investigation of Membrane Capabilities

Liam Taafe

The main aims of my project are to optimize the fabrication of graphene oxide (GO) membranes and to study the applications of these membranes. My first semester was spent fabricating the GO membranes, using the vacuum filtration method, whereby the GO liquid solidifies as the liquid is forced through a filter by applying a vacuum. Various fabrication parameters were investigated such as GO volume, water content and vacuum pressure. Once the membranes were made, their individual thicknesses were measured using the 3D microscope, this was to identify which membrane was the most uniform and had minimum thickness. In second semester, once the most uniform membrane had been established, it was time to start looking at the membrane capabilities. Microfluidic discs were designed and manufactured to test the membranes for their competency in water desalination. The membranes were also tested for their use as semi-permeable membranes for solvent separation.

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I am currently in my final year, studying Physics with Biomedical Sciences. For my third year INTRA placement, I worked as a research intern in the department of crystallography and magnetic resonance at the University of Lorraine in Nancy, France. It was a four month internship that was both engaging and challenging and allowed be to improve my problem-solving skills. I was tasked with conducting complex quantum chemical calculations on a specific family of molecules, these calculations were automatized by writing efficient programming scripts. After the results were analysed, regular reports were submitted to my supervisor and presentations were carried out to update other researchers on the progress of my project. The placement was ideal for preparing me for the demands of my current final year project.

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# NOTES

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