School of Physical Sciences

Final Year Physics Class 2017: Student Profiles & Projects

DCU
Ollscoil Chathair Bhaile Átha Cliath
Dublin City University

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 2016/17, in both their Integrated TRAining (INTRA) placements in 3rd year, as well as their final year degree projects in 4th year.

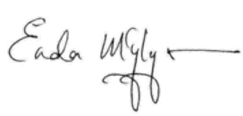
The material in this booklet has been prepared by the final year Physics students themselves, coordinated by Prof. Colette McDonagh. I would like to especially thank Ms. Katy Halpin and her team from the DCU Communications and Marketing Office for the production and design of the booklet. Sincere thanks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



Head, School of Physical Sciences,
Dublin City University

Programme Overviews

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 Mechanics	Linear Mathematics	Laboratory	INTRA	Degree Project	Degree Project
Light & Optics	Waves & Electricity	Relativity	Electro -magnetism	Quantum Physics		Solid State Physics	Plasma Science
Computing	Thermal Properties	Vibrations & Waves	Solid State Physics	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	Materials growth
Chemistry	Laboratory	Laboratory	Laboratory	Semiconductors		Image processing	Medical diagnostics
							Non-linear modelling

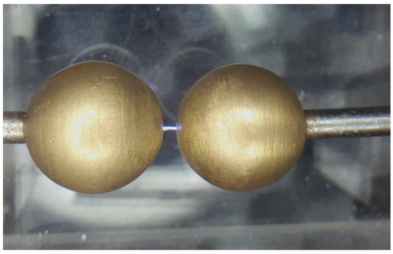
Overview of Physics with Astronomy Programme

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 Mechanics	Linear Mathematics	Laboratory	INTRA	Degree Project	Degree Project
Light & Optics	Waves & Electricity	Relativity & Nuclear	Electro -magnetism	Quantum Physics		Image Processing	Plasma Science
Computing	Thermal Properties	Vibrations & Waves	Solid State Physics	Statistical Physics		Mechanics	Signal Processing
Laboratory	Programming	Electronics	Renewable Energy	Wave Optics		Electro -dynamics	Astrophysics & Cosmology
Calculus	Calculus	Calculus of Several Variables	Advanced Programming	Differential Equations		Applied Spectroscopy	Galactic Astronomy
Chemistry	Laboratory	Laboratory	Laboratory	Stellar Physics			Materials growth
			Space Science & Technology	Astronomical Techniques			Non-linear modelling

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 Mechanics	Linear Mathematics	Laboratory	**INTRA**	Degree Project	Degree Project
Light & Optics	Waves & Electricity	Physiology	Electro -magnetism	Quantum Physics		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	Laboratory	Relativity & Nuclear			Materials growth
							Non-linear modelling

Student Profiles & Projects



Project	Guglielmo Marconi and Early Systems of Wireless Communication
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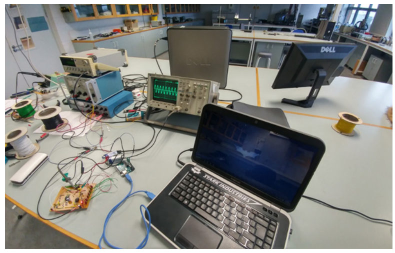
Supervised by	Dr. Jean-Paul Mosnier

Personal Details

I am currently a final year undergraduate, studying Applied Physics. During my INTRA I worked in-house under the supervision of Dr Bert Ellingboe, undertaking a research role. As part of this INTRA, I was tasked with examining the third-year experiment, Blackbody Radiation. The aim of this exercise was to determine the fault in the experiment that resulted in values different from those that were expected. Having determined possible causes I then had to research and implement a solution to remedy the problem for the future third year students. Outside college, I have many other interests including technology, board games as well as caving, having been an active member of the DCU Caving Club since my second year.

Project Summary

For my final year project, I had to conduct research into the early advances made into wireless technology. In particular, the work of Guglielmo Marconi. Using that information, I then had to build a working example of a Marconi transmitter and receiver. They will serve as a working exhibit in the loft of the physics building here in DCU, aptly named the Marconi Building. The pair will function as an interesting feature on open days, in hopes of sparking an appreciation for physics in the visitors, and to show just how applicable the underlying physical principles discovered over a century ago are to our modern age of information and inter-connectivity.



Project Construction of an ultrasonic detector for identification, monitoring and logging native species of bats

Name Mark Angelo C. Bungcayao

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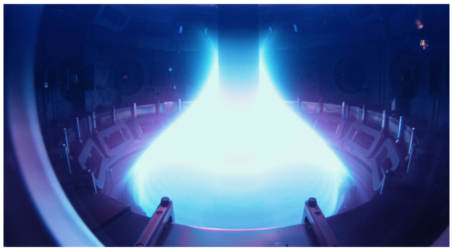
Supervised by Prof. Kevin McGuigan (Royal College of Surgeons in Ireland, RCSI and adjunct Professor, DCU)

Personal Details I am currently in my final year, studying Physics with Biomedical Sciences. Physics is probably not the easiest course to do especially in college level but I am enjoying the course structure, especially the engineering and INTRA modules. My INTRA was with Pilot Photonics LTD, an engineering company that specializes in manufacturing optical frequency combs, a key enabler for the next generation of high density optical networking transmission solutions. I've gained a lot of valuable experience during my work experience and was finally given the chance to apply what I've learnt in my modules especially the laboratory skills. I've learnt a lot of things from the manufacturing process of different devices to quality control. I would like to do a Masters course after my degree, but first I need to pass my exams.

Project Summary My final year project was a "Construction of an ultrasonic detector for identification, monitoring and logging native species of bats". Various bat species can be identified by their peak ultrasound echo location emission. The main aim of this project is to construct an electronic bat detector and a data logger system which can identify the different frequencies emitted by bats and record the data over a period of time.
I found a circuit online in www.elektprmagazine.com that can detect multiple frequencies at the same time with amplitude recovery. I modified the given schematic using an Arduino and set specific LEDs to light up for each species of bats found in Ireland. I really enjoyed my project because it amalgamated what I've studied in my electronics to programming modules.

Project Comparison of plasma flow measurements on the MAST tokamak with simulation.

Name Daniel Canning

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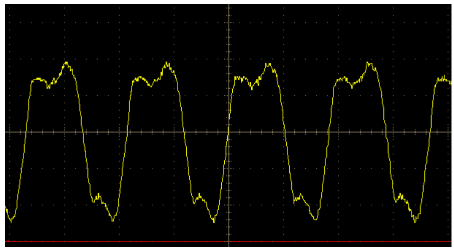
Supervised by Dr. Huw Leggate

Personal Details

I am a final year Physics with Astronomy student, currently preparing the final steps towards finishing my degree.
For my INTRA placement I worked as a research assistant in BDI, located on campus in DCU. While working there I worked as part of a team, researching the many microfluidic platforms designed in BDI. While working there, I gained valuable knowledge and experience that I feel will aid me greatly in my future career. I have also worked many part time jobs throughout college, as a waiter and as a shop assistant.
In my spare time I like to read and listen to music, I also like to play sports such as soccer and frisbee.

Project Summary

For my final year project I compared plasma flow simulations I did on my own PC with experimental data obtained by my supervisor at the MAST tokamak in Culham, England.
The simulations were done on a linux system using the OSM-DIVIMP-EIRENE set of fluid simulation codes. The purpose of these simulations is to try and understand the physics of plasma flow, and to aid in the advancements of nuclear fusion technology, a much safer and cleaner source of nuclear energy. This could have a great impact on the future of our planet, and potentially reduce the effects of global warming.
After completing my project, I have a new-found interest in plasma science, and would be very keen to continue researching this topic after college.



Project Construction of an Uncompensated Langmuir Probe

Name Lauren Connell

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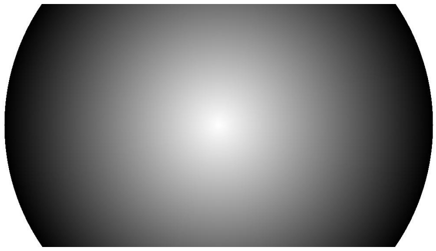
Supervised by Dr. Paul Swift

Personal Details

I am a final year student of Physics with Astronomy. I have worked teaching talented children Astronomy in CTYI for the past two years. For my INTRA placement, I went on a field trip to ESA Madrid where we were given an insight into the day-to-day workings of ESA and how to use some software such as Aladdin and TopCat, in relation to data from space telescopes. We then created and presented a poster based on our INTRA experience to the physics faculty members. Not only was the INTRA placement an unforgettable opportunity to truly experience the field, but the work aspect and presentation gave a better understanding of the work expected and how to handle our workload and deadlines.

Project Summary

My project was based around the Langmuir Probe. A Langmuir probe is a scientific instrument comprising of some form of wire/metal and an electric potential across it. There are two types of Langmuir probes, one for each Plasma type; radio frequency (RF) and direct current (DC). The aim of this project was to measure the harmonics of the Langmuir probe in order to be able to use a DC probe on RF plasma and reproduce the same data as that of a DC probe with DC. plasma. A harmonic is some integer multiple of the fundamental frequency. If we could use both probes for any plasma then it would save on time and the need for multiple probes in a confined space such as on a scientific satellite.

Project Characterising exoplanet atmospheres with the chromatic Rossiter-McLaughlin effect

Name Aishling Dignam

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Supervised by Dr. Ernst De Mooij

Personal Details I am a final year student in Physics with Astronomy in DCU. I thoroughly enjoy this course and would highly recommend it to anyone interested in space. For my INTRA I participated in a field trip to the European Space Astronomy Centre (ESAC) in Madrid, Spain. This was a fantastic opportunity to obtain an insight into the space industry and how such an enterprise operates. Each day we were given talks about the work done in ESAC and we analysed some data from the high energy telescopes Fermi, MAXI and Swift. I made a poster demonstrating what I learned when I was at ESAC. I also made a Monte Carlo simulation of radioactive decay as part of my INTRA. Additionally, I have been a member of DCU Archery Club and have competed for the university.

Project Summary For my project I characterised exoplanet atmospheres using the chromatic Rossiter-McLaughlin effect. The chromatic Rossiter-McLaughlin effect is evident in systems where a planet transits across a star. As a star rotates, one side is moving towards the observer causing a shift in the light towards longer wavelengths called red shift and the opposite side is shifted towards shorter wavelengths and is called blue shift. As the planet transits across the star it blocks part of the light coming from the star. This causes the mean value for redshift and blueshift to be varied from its original value. To measure this, a model of a star and planet system was created. The spectrum of this system was obtained. This model was applied to data obtained from the planet HD189733b. The data was analysed to find characteristics of the planet's atmosphere.

Project Development of Quantitative Schlieren Imaging Capability

Name Philip Early

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Personal Details

I am a final year student of Physics with Biomedical Sciences. As part of INTRA, I have completed an internship with the Biomedical Diagnostics Institute (BDI) and I was then hired there as a Research Assistant for several months. In the BDI I gained a great insight into research on point of care diagnostic devices by designing, building and experimental testing microfluidic platforms. I also got the chance to be co-author on published papers from my work. In addition, I have had the opportunity to complete an internship with Bell Labs-Nokia located in Dublin. Here I supported research into thermal management specifically using microfluidics, and learned how fluid dynamics can be used to transfer heat.

Project Summary

My final year project is in collaboration with Nokia Bell labs, where I am adapting a 150 year old technique called Schlieren [shleer-uh n] Imaging by introducing digital technology for light filtering. Schlieren Imaging is a powerful tool for visualising thermal phenomena. It involves a camera that visualises air of different temperatures normally invisible to the naked eye. As light passes through different air densities, refraction occurs, where the path of the light changes slightly which can be carefully filtered to produce an image. The image is typically a grayscale image however I am researching Digital Colour Schlieren by developing colour filters to produce much more detailed images. The colour producing components of a LCD projector were used as a novel filtering method allowing filter designs to be generated using a computer.

Project Touch Identification for Optical Touch Screen Technologies

Name Charlie El Baba

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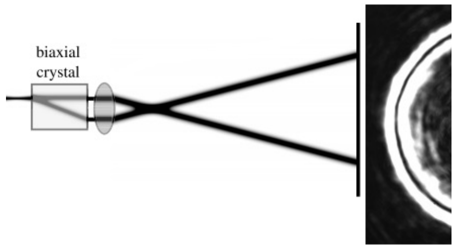
Supervised by Dr. Robert Copperwhite, Prof. Colette McDonagh

Personal Details

I am currently in my final year of study for a BSc in Applied Physics in DCU. My INTRA placement was in Rapt Touch, an IR touch screen company, and I am doing my final year project with the company. The role I undertook in Rapt for my INTRA placement was mostly quality assurance and involved writing programming scripts and file managment. In keeping with my project topic I intend to pursue work after university in a similar field before moving on to a PhD in sustainable energy. Outside of physics, my interests include playing bass guitar and writing screenplays.

Project Summary

The aim of my project was to develop a method by which passive objects (containing no internal power supply) can be detected and identified by Rapt Touch's touch screens. The project utilised properties of the screens themselves to do this and included analysis of the physical properties of the screen, electronic engineering and programming skills. In the course of the project, I researched the main principles of operation of touch screens including how resistive, capacitive and optical touch screens work and the relative advantages and disadvantages of each type. It was an interesting and exciting project in that I learned a lot of useful physics and I really enjoyed working in the company environment and being exposed to the next generation of touch screen technologies.



Project Conical diffraction and refraction in biaxial crystals - generation of exotic laser beams

Name Aaron Fitzgerald

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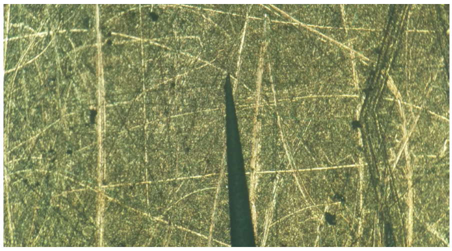
Supervised by Prof. John Costello

Personal Details

I am currently in the final year of a Bachelor of Science in Applied Physics. I completed my INTRA placement in a small subsea engineering company, Cathx Ocean Ltd. My role there was as an R&D Engineer. My duties included data analysis of test runs of the bespoke machine vision camera and laser systems designed and built in-house, and also assisting the Production Team in assembling said systems. Whilst at Cathx Ocean I built a prototype light sensor with an Arduino to measure the LED lighting systems and output the Lux value onto a Putty window. I also have experience working as a General Operative in Industrial sites such as Intel, Alexion and ESB power stations. Outside of college and work, I have a keen interest in hurling, rugby, basketball, cycling and open water swimming.

Project Summary

My project involves developing and testing various experimental set ups to observe an optical phenomenon known as 'Conical Refraction'. Ultimately, this is achieved by having circularly polarised light pass along one of the optical axes of a biaxial crystal. In my set up, I use a Helium-Neon laser passing through a Potassium Gadolinium Tungstate [$KGd(WO_4)_2$] crystal.
The theory of this phenomenon was developed by Hamilton in 1832 before being first observed by Lloyd in 1833. I am comparing the mathematical expressions used in the theory, using MATLAB, with actual results obtained using my set up, i.e. making predictions on the size of the rings formed with actual results. Conical refraction converts the Gaussian laser beam into a Bessel beam. For this reason, there has been a resurgence of interest in recent years in the research of conical refraction for potential applications such as optical trapping.



Project An Investigation into Novel Techniques for the Characterization of Metal Adhesion to Semiconductor Substrates

Name Niall Flanagan

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Supervised by Dr. Justin Bogan and Prof. Greg Hughes

Personal Details

I am a student in my final year of study of Applied Physics. My INTRA placement was with Prof. Greg Hughes and his surface science research group in DCU. My project focused on depositing and characterising thin titanium films onto SiO_2 substrates. The majority of my time was spent running experiments in ultra-high vacuum systems using X-ray photoelectron spectroscopy (XPS) for analysis and an electron beam evaporator for depositing titanium. I thoroughly enjoyed working within the group and collaboratively with other groups in the college. It was a great environment to work in and I learned a lot from the experience. Outside of the lab I can be found either on a track or an ice rink. I have enjoyed a lot of success in athletics and recently ice skating has become my new addiction.

Project Summary

My project aims to determine if using copper alloys such as CuTi and CuMn or thin layers of titanium and manganese as barriers can improve the adhesion of copper to silicon substrates. As part of the project I am investigating different qualitative and quantitative techniques for measuring adhesion. Methods such as the simple peel test and custom built scratch tester along with a Dektak profilometer and image processing techniques are being investigated. Each of these methods are also being applied to samples that have been annealed from 300˚C to 500˚C in the hope of concluding if any of these metal systems have better adhesion over copper. As the size of integrated chips get smaller and the conducting copper lines in them get thinner the adhesion of pure copper is becoming an issue. A system with the same electrical qualities as copper but a better ability to stick would be desirable.

Project Temporal Behaviour of the Poisoning of a DC Planar Magnetron Discharge Target

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Supervised by Dr. Paul Swift

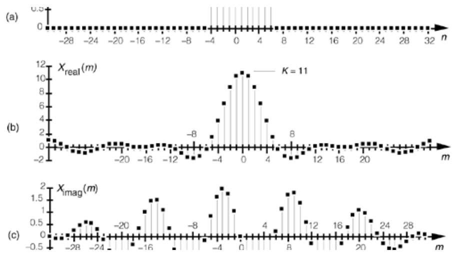
Personal Details

I am currently finishing an undergraduate degree in Applied Physics. My INTRA placement was spent in house at DCU labs. During this time, I worked in the Plasma laboratory where I spent time reverse engineering a matchbox for a plasma system and later working on a spectrometer system. I really enjoyed this and learned a lot of physics. The experience also was valuable to me for my final year project. During this time, I really got to grips with how we can feed information off each other and work as a team. Away from my studies, I am a member of a caving club and have an active interest in film and music.

Project Summary

For my final year project, I chose to work in the same general area of research as I did during my INTRA project. This time I was using plasma techniques for making thin films. Reactive sputtering is a process undergone to develop a compound film on a substrate (target). Thin film deposition techniques play a large part in semiconductor, solar and optical industries. This process is impeded by the effect of "poisoning". This effect hinders uniform deposition of the desired film and reproducibility. My project attempts to characterise the parameters of this effect and provide a theoretical description of the poison curves. With this information "poisoning" can then be avoided to produce higher quality films.

The "poisoning" effect expands from the centre of the magnetron and can be seen in the image above.



Project Deconvolution of Optical Spectra with Wavelet Compression for Compact Storage

Name Aaron Fraher

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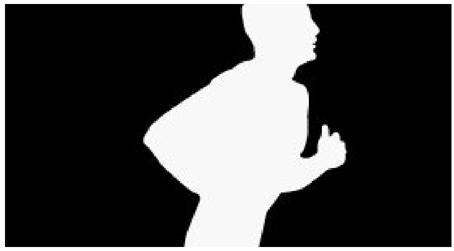
Supervised by Prof. John Costello

Personal Details

I am currently completing my final year of the B.Sc. in Applied Physics in DCU. The B.Sc. in Applied Physics was at the top of my CAO choice list because it's such a broad-based and interesting degree, which allows me to gain an understanding of the fundamentals of how everything works, from Integrated Circuits to aerodynamic principles to financial markets.
My main interests and hobbies are flying airplanes, motorsport, and drumming, and the degree has allowed me to grow my knowledge of these areas massively. My INTRA experience was also incredibly beneficial to my future career prospects. I was an intern in the sales analytics team of a Fortune 1000 semiconductor company, and was responsible for daily reporting tasks, data visualisation, and reporting automation using Excel and other common tools used in the degree.

Project Summary

My final year project involved manipulating and operating on recorded data to gain insights and understandings of how the data was created, or how our measuring techniques change our understanding of it. It was a software project, which involved using a coding language to develop a program which was used to automatically apply data analysis techniques to a large data set. Although simple and somewhat generic, the techniques which are used in the projects are very powerful. Everything from the output of a spectrometer to the price of gold can be classified and stored in a similar way. The importance of "Big Data" and the role it plays in understanding how businesses can drive growth and sales is beginning to be understood by many companies. As a result, software projects like the one which I completed will become more and more relevant to industry and employment prospects in the future.



Project Do You Get Less Wet if You Run in the Rain?

Name Iain Furlong

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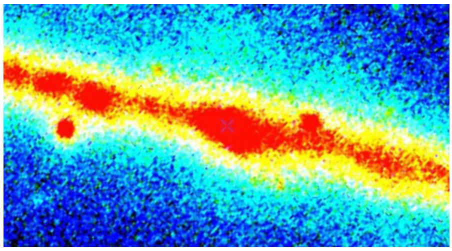
Supervised by Dr. Jean-Paul Mosnier

Personal Details

I am a fourth year Physics with Biomedical Sciences student. During my INTRA placement in third year I spent four months as a Clinical Engineering Technician in the Clinical Engineering Department in the Mater Public Hospital. This placement allowed me to see many different aspects of the clinical environment, and gave me hands-on experience with a diverse range of medical devices. As an engineering technician, my role in the department included carrying out repairs and maintenance of medical equipment in almost every department of the hospital, from dialysis to operating theatres. From the placement I discovered that I am greatly interested in medical devices, and I have aspirations to take this experience and work in the medical field. Outside of college my interests include hurling and music and reading.

Project Summary

Should you run or walk when you get caught out in the pouring rain? It's a situation that everyone has found themselves in at some point in their lives. Instinctively, we feel that the less time that we spend in the rain, the better. But what if there are more aspects to consider? Many scientists and mathematicians have attempted to answer the question of whether or not to run when caught in the rain. For the most part, a seemingly, satisfactory conclusion has been reached – a person running through rain "collects" less water than if they were to walk.
These studies, however, are based on idealised models of the problem and completely neglect the way in which people actually move (biomechanics). In my project I have created a more realistic representation of the problem by including the biomechanical aspect, and acquiring real data using cameras and image processing techniques.



Project Origin of High energy emission from the centre of our Galaxy

Name Alex Garvey

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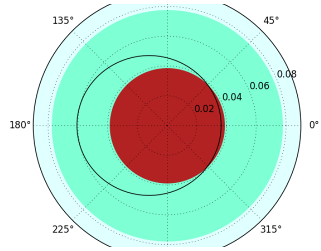
Supervised by Dr. Masha Chernyakova

Personal Details

I am currently a final year student studying Physics with Astronomy. Last year, I decided not to go on the Astronomy trip in order to participate in the mainstream INTRA programme. I did my INTRA at the Biomedical Diagnostics Institute (BDI) during which time I primarily worked on the construction and testing of microfluidic disks. During the summer I also took part in the UCD Summer Internship programme during which I analysed data on Terrestrial Gamma Ray Flashes (TGFs) over Africa. After graduation I hope to do either a Masters or PhD degree. Outside of college my interests include reading, swimming and film.

Project Summary

The centre of our galaxy is located approximately 8kpc away and is home to our nearest Supermassive Black Hole, Sagittarius A*. Our Galactic centre is a prime area for research due to its proximity and due to the information we can collect from it in regards to galactic nuclei and black holes. In recent years, much of the research done on our Galactic centre has been focused on the high-energy emission and it has been discovered that these spectra can be well described by interactions between highly relativistic protons diffusing in the central regions with the interstellar medium. The purpose of my project was to write a Monte Carlo code to trace relativistic photon diffusion from the Galactic centre. Analytical solutions to the diffuse equation have already been carried out in past works, however, these solutions follow very specific cases whereas the Monte Carlo method allows for arbitrary configurations.



Project Life on Proxima b

Name Robert Garvey

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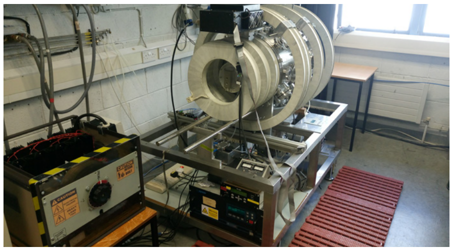
Supervised by Dr. Eamonn Cunningham

Personal Details

I am currently a final year student studying Physics with Astronomy in Dublin City University. For my INTRA I decided not to go on the astronomy trip as I wanted to gain experience in a working environment. I worked in the Biomedical Diagnostics Institute (BDI)-my main role consisted of the building and testing of microfluidic discs, over the course of my Intra I was also given the opportunity of designing a disc in SolidWorks and assisting in the development of a new spin stand for the testing of microfluidic discs. After graduation I hope to go on to do either a Masters or a Ph.D. Outside of College my interests include reading and swimming.

Project Summary

My final year project is about a recently discovered earth sized exoplanet, Proxima b, which has been found orbiting within the habitable zone of our nearest neighbour star Proxima Centauri, which is only around 4 light years away. Proxima Centauri is a red dwarf star with Luminosity much lower than that of the sun- however as Proxima b is very close to the star (about 5% of the distance from the sun to the earth) it receives a similar amount of solar radiation to the Earth. This suggests that the planet could have similar surface conditions to that of the Earth and be suitable for life. This project involved looking at the probable conditions acting on the planet and estimating the effect that these conditions may have on the planet's surface conditions.



Project Measurements of Ion Acoustic Waves in the Diffusion of an RF Plasma

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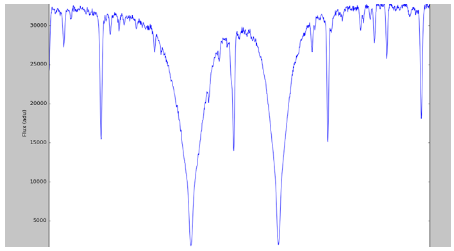
Supervised by Dr. Bert Ellingboe

Personal Details

I am a final year student studying Physics with Astronomy. I originally came to DCU to study computer science, and later transferred to the School of Physical Sciences to pursue a lifelong interest in science. As part of the third year programme I had the chance to visit European Space Astronomy Centre (ESAC) in Madrid to learn from astronomers and engineers how they plan and operate the ESAs many science missions. In addition, over the last few years I've had the opportunity to intern for some time at the Plasma Research Laboratory in DCU, working alongside their researchers on current research subjects. In particular, this work focused on Helicon Wave characterisation and Engineering Physics topics.

Project Summary

Acoustic waves are longitudinal pressure variations that occur in many fluids. In air, we recognise them as sound waves, but they can also occur in comparatively low pressure, high energy plasmas. In plasmas, atoms are ionized into electrons and ions which can interact with electric and magnetic fields. In pressure waves, the electrons will effectively oscillate around the much larger ions, following their propagation. We call these Ion-Acoustic waves. Given the comparatively high temperature of the components, these waves have a far higher sound speed than sound waves in air. My project involves the Measurement and Characterisation of these Ion Acoustic waves in an RF Plasma. This phenomenon occurs in a very wide range of plasmas, including those used in Industrial Processing and Astronomical plasmas and as such, accurately describing and understanding them is of great value.



Project High-spectral resolution search for exoplanet atmospheres

Name Artur Lipinski

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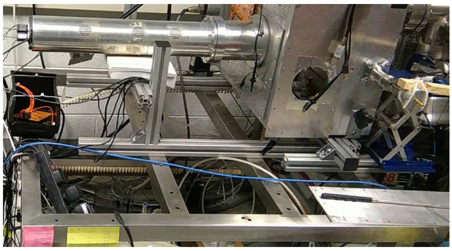
Supervised by Dr. Ernst de Mooij

Personal Details

I am currently in my final year of the B.Sc. in Physics with Astronomy. I intend to follow up this study in the form of a MSc or PhD course. While I was in my penultimate year of my degree I chose to have my INTRA in the Biomedical Diagnostics Institute (BDI) based in DCU. During my INTRA placement I was a Research Assistant and my primary role was building and testing microfluidic disks, working on various R&D projects and assisting other researchers in their work. Upon completion of my work placement I have gained an insight into other fields of science and manufacturing processes of biomedical devices which allowed me to vastly improve my technical, problem solving and team working skills. Outside college I enjoy going to the gym, swimming and photography.

Project Summary

The aim of my project was to use archival spectra of the planetary transit of HD 189733b to measure the absorption of sodium & potassium using different techniques. The goal was to compare different methods of measuring the absorption and determining which one is best to search for atoms and molecules in exoplanet atmospheres. During the transit, starlight filters through the planet's atmosphere and at wavelengths where the atmosphere can absorb light (such as Sodium D doublet) the starlight gets absorbed in the upper part of the planet's atmosphere causing a small drop in the flux at certain wavelengths which we are able to detect using ground-based telescopes. Since the exoplanet that I was analysing is a hot-Jupiter, the sodium and potassium doublets were expected to be the two of the strongest lines in its atmosphere.

Project Characterization of a High VHF Matchbox and Power Splitter

Name Conor Mathews

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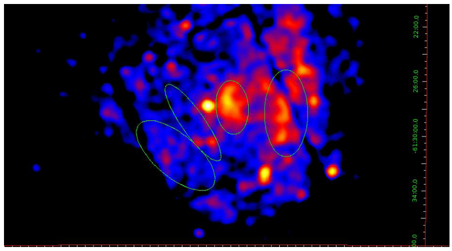
Supervised by Dr. Bert Ellingboe

Personal Details

I am currently a fourth year student in Applied Physics. I developed an interest in physics from secondary school. For INTRA I worked on a project aimed at helping secondary school students learn about physics. This project involved designing experiments to explain what was happening during different physical phenomenon. These experiments were made to be interesting and fun. I also helped to write the accompanying notes and diagrams for explaining different phenomena in a simple manner. After I graduate I intend to do a Masters in either teaching or engineering. In my spare time I take a keen interest in all sports. I play several different sports myself.

Project Summary

For my project I was characterizing a power splitter and matchbox for plasma physics applications. The power splitter is used to supply equal amounts of power to each plasma tile. For maximum efficiency the plasma load impedance must be matched to our source load impedance. For this we use the matchbox which is made up of a shunt and series capacitor. By adjusting the capacitance we can match the load and source. When an ideal match is achieved, 100% of the power will be delivered and zero power will be reflected. Obtaining a good match is very important for power efficiency and to protect the source from reflected power. An automatic match of the source and load impedance can be obtained by characterizing the matchbox.



Project Studies of the Spectral Morphology of Supernova Remnant G292.2-0.5 with XMM-Newton Observations.

Name Samuel McKeague

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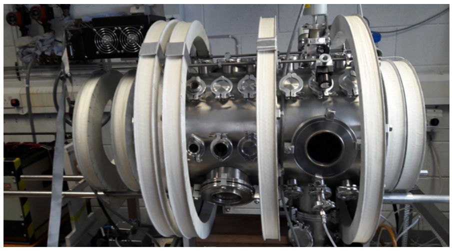
Supervised by Dr. Masha Chernyakova

Personal Details

I am a final year student of Physics with Astronomy. For my 3rd year INTRA, I went on a trip to ESAC (European Space Agency Centre) outside of Madrid. During this trip, we were given classes by ESAC members on a variety of topics such as major projects that ESA have conducted and tutorials on various types of astronomical data analysis. This trip helped me decide that I would like to pursue research in the field of astronomy and astrophysics after my BSc. I worked on a six-month internship with ABB Ireland as an addition to my INTRA working in R&D on new spectroscopic technology. During my time in DCU I have been an active member of DCU Games Society and was a member of the committee during my second year.

Project Summary

The goal of my final year project was to conduct an X-ray spectral analysis of the supernova remnant G292.2-0.5 to discern whether thermal and non-thermal x-ray emission are present within the remnant. I conducted the analysis using XMM-Newton Science Analysis Software (SAS) on a Linux Ubuntu based virtual machine. I studied two observations of the supernova remnant, one from 2003 and another from 2011 to see if there is any change in the spectral morphology within a relatively small timescale of several years. By analysing the spectra of four different regions of the supernova remnant, testing spectral models that correspond to thermal and/or non-thermal emission, I was able to determine the presence of both types of x-ray emission and from the characteristics of these emissions I could make estimations as to the age and structure of the supernova remnant.



Project Characterization of a Helicon-wave plasma source

Name Rachel Moloney

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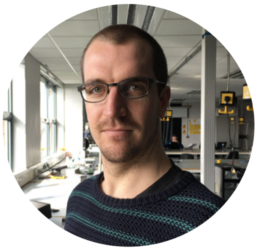
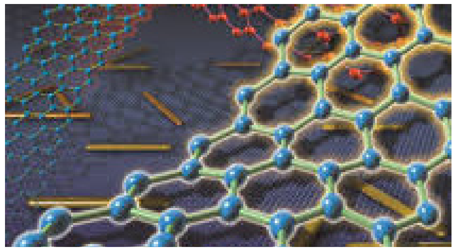
Supervised by Dr. Bert Ellingboe

Personal Details

I have always had a fascination with space and the wonders of our universe. Having not studied Science in secondary school, higher education and a career in this field was not an option. I decided to return to education as a mature student in order to pursue a BSc in Physics with Astronomy (whilst continuing my long-term job) and here I am now in my final year. During each of the summer breaks and for my INTRA placement, I held the position of research intern with the Plasma Research Laboratory in DCU under the supervision of Dr. Ellingboe. My final year project is a continuation of this research. After graduation, I hope to continue my studies in pursuit of a PhD and a career in plasma research, specifically in the area of plasma propulsion.

Project Summary

Plasma is used for many applications: in semiconductor processing, thick and thin film deposition and etching, fusion research, medical instrumentation sterilisation, and spacecraft propulsion. My project takes a look at the characteristics of the most efficient method of coupling power to a plasma; the Helicon-wave plasma source. This is becoming the more preferred option for many plasma applications. Helicon-waves are bounded whistler waves - when lightning strikes, the energetic electrons that it releases excite standing waves in the ionosphere that bounce between the magnetic poles before returning to the earth's surface as an audible whistle-like sound in radio frequency. In the laboratory, Helicon waves are produced in a vacuum chamber using an RF antenna and large magnetic coils, where the time-varying magnetic field and electron density are measured. The aim of my project is to determine the dispersion relation of the Helicon waves, which can be calculated using this data.

Project Tight Binding Calculations of the Electronic Properties of Graphene Nanoribbons

Name Neasán Ó Conghaile

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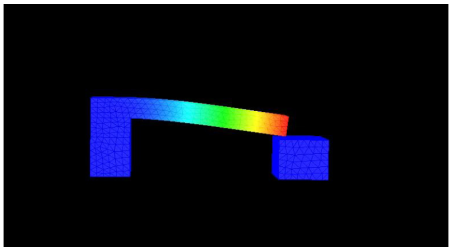
Supervised by Dr. Tony Cafolla

Personal Details

I am currently in my final semester of fourth year of a Bachelor of Science Degree course in Applied Physics here at DCU. I spent eight months of third year working in research and development for the renewable energy company Smart M Power. During my time there I worked on designing and implementing smart grid infrastructure in Tallaght, Co. Dublin. My work there was primarily focused on programming and networks, with some field installation work. My previous experience includes working as a sound engineer, a bike mechanic, and a ferry crewman. I enjoy scuba diving and am a member of DCU Scuba. Next year I hope to find work in the renewable energy industry.

Project Summary

Graphene is a two-dimensional material, composed of a single atomic layer of carbon atoms bonded in a hexagonal mesh structure. Since its isolation in 2004 graphene has become one of the most productive and exciting areas of research in materials science, due to its unique physical properties. One of these is an extremely high electron mobility, which has led to much investigation into the possibility of using graphene in ultra-fast next generation computing applications. Other applications of graphene include nanoscale chemical sensors and the fabrication of novel composite materials. My final year project involved computational modelling of electron propagation in narrow strips of graphene called nanoribbons (GNRs). In order to investigate the electronic properties of GNRs, I wrote MATLAB code and ran calculations to model the band structure for ribbons of various widths and edge shapes. I also investigated GNRs under strain, and doped with impurity atoms such as Boron.



Project	Feasibility Study of the MEMS Micro-Reed Switch
Name	Cian Ó Dálaigh
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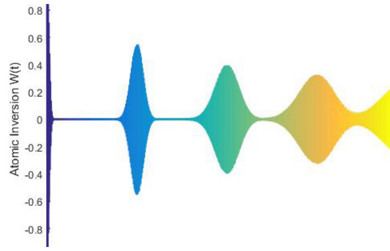
Supervised by	Prof. Enda McGlynn, Padraig Fitzgerald (external) & Jan Kubik (external)

Personal Details

I am currently in the final year of my studies of Applied Physics in DCU. I completed an 8 month INTRA placement with Analog Devices International during my third year of study. ADI specialise in creating fast, effective and innovative solutions in the areas of Analog to Digital convertors, Digital to Analog convertors, Sensors and is expanding into the Microelectromechanical systems (MEMS) sector. During my time in ADI I was performing the duties of a process engineer in the strip department. My responsibilities included monitoring the performance of the strip tools, the design of in-line data-driven chemical concentration prediction software and some developmental project work. During my four years in the college I have been heavily involved with Clubs & Socs, acting as chairperson for the GAA Handball club for three consecutive years.

Project Summary

As a continuation of my INTRA, ADI approached me regarding the completion of an industry based project for the company. The goal of the project was to identify the feasibility of miniaturising the traditional magnetic Reed switch using currently available MEMS technology by reviewing the current literature and creating a model for the closing force of the system. Access to a sub mm Reed switch is highly desirable in the medical and automotive industries where device size and power consumption are at a premium. Possible applications in the medical industry are zero power switches for in ear hearing aids and actuators for miniature pill cameras. The miniaturisation of the reed switch would provide the framework for other size sensitive applications to take advantage of a zero power switch.



Project	Quantum Theory of the Harmonic Oscillator and Electromagnetic Field
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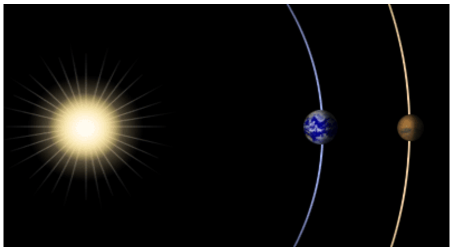
Supervised by	Dr. Lampros Nikolopoulos

Personal Details

I am currently a final year student studying for my BSc in Applied Physics. For my INTRA in my third year, I undertook a 9 month work placement in Tomra Sorting Solutions where I held a position as a research and development intern. Here I learned many important skills while improving on others and also gained invaluable experience working for a multinational corporation. Upon graduation I intend to continue my studies by pursuing a PhD in atomic and laser physics. Aside from learning new physics, my hobbies include caving, rock-climbing and photography, which take me to many different competitions and locations, throughout the country and abroad.

Project Summary

Many experimental observations in physics such as the absorption and emission of radiation by atoms cannot be described by a classical theory of electromagnetic fields (classical electrodynamics). This theoretical project is focused on the study of the quantum electromagnetic field.
The concept of a photon is naturally derived and it is found that electromagnetic fields are not continuous but instead are made up of these particles. Using these results, the interactions of the quantum field with a simple atomic system (known as Jaynes-Cumming model) are studied and, in particular, the differences between the field in its most quantum and least quantum states are investigated.
The quantum electromagnetic field is formulated as a collection of quantum harmonic oscillators, hence its inclusion in the title of the project. Applications of this project lie in the field of quantum optics, quantum information and nanophotonics.



Project Modelling and analysis of Mars' orbit.

Name Ciaran Rogers

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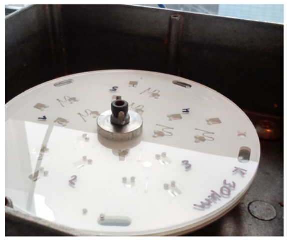
Supervised by Dr. Eamonn Cunningham

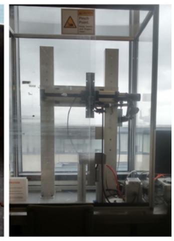
Personal Details

I am a final year Physics with Astronomy student. I have worked in a variety of different fields and disciplines during my time in DCU. My INTRA placement consisted of the fabrication of microfluidic discs for medical purposes, with a focus on cost effective, high throughput designs for implementation in third world countries. I have also interned for several summers at RPS engineering, in which I assumed both research, and practical roles for civil engineering projects around the country. I have also been an instructor of several classes for CTYI (the Centre of Talented Youth in Ireland) for several years. In my spare time, I am an avid cook, particularly baking, with a specific interest in bread making.

Project Summary

The project I elected to undertake consisted of modelling the orbit of Earth and Mars about the Sun, and calculating at any given time, their positions, and the distance between the two planets. Using this model, I then examined different situations in which a rocket could be launched from Earth on a trajectory to Mars, and what effect launching on different dates, or using different orbital transfer methods would have on the duration and energy consumption of the trip. This is a particularly relevant topic for astronomers as the next major landmark for space travel is a manned mission to Mars. These types of models and predictions are integral to sending rovers and eventually human beings to the Red Planet in the future.





Project

Fabrication and Integration of Functional Membranes for Enhanced Centrifugal Microfluidic Flow Control

Name

Natalia Rolinska

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Supervised by

Dr. Rohit Mishra, Prof. Jens Ducrée

Personal Details

I'm currently in my final year of Physics with Biomedical Sciences. After always planning to study medicine, my career plans changed in last years of secondary school where I discovered my fascination with physics. This led me to applying for this course, which is a great mix of the two fields. In the next years I want to gather extensive knowledge and experience in the area of medical physics and technology, and have recently applied for M.Sc. in Medical Devices in University of Strathclyde, Glasgow. I did my INTRA in Tomra Sorting Ltd which, despite not being related to medicine, was a fantastic, enjoyable experience where I developed and improved many technical and personal skills. Outside college I spend a lot of time on drawing, 2D animation, and learning languages.

Project Summary

My project is a continuation of research carried out by a number of previous students. The goal is to achieve sophisticated flow control of biofluids in Lab-on-a-Disk microfluidic devices by integrating selectively dissolvable films into the disk structure. These films are produced by a process known as spin coating, in which a polymer is deposited on a substrate spinning at high rotational velocities. The result is a membrane with thickness ranging from a few to few tens of micrometers, depending on factors such as amount of polymer deposited and substrate's rotational speed. A large part of this project consisted of working with a mathematical model predicting final thickness of membranes for given parameters, so that films of required thicknesses can be reliably fabricated. Different thicknesses require different centrifugal forces and times to dissolve in a rotating LoaD device; thus, flow control can be achieved. Possible applications of such systems include complex bioassays protocols and medical diagnostics.

Project Statistical mechanics and Zombies – preparing for the apocalypse

Name David Scanlon

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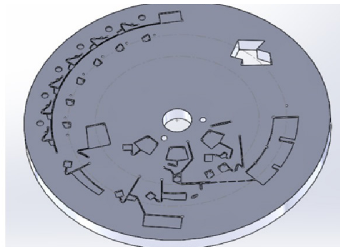
Supervised by Prof. Enda McGlynn

Personal Details

I am in my final year of the Physics with Biomedical Sciences bachelor degree in Dublin City University (DCU). As part of the INTRA program in DCU, I spent five months working in a laboratory at KU Leuven, Belgium with a group focused on studying the effects of deformation on organic tissue using Atomic Force Microscopy (AFM). My work involved, initially gaining an understanding of the subject by reviewing papers written on the topic of AFM, helping Masters students in the university conduct experiments by preparing samples and operating the apparatus, and using the results found to model 3D graphics showing the deformation and various forces applied on the samples. I feel this was a great opportunity to live abroad in a different environment and culture for an extended period of time. I am also a keen athlete focused on distance running and am a member of the DCU athletic academy.

Project Summary

While my project title may seem a bit ridiculous, you would be surprised to know that studying the spread of a zombie virus has many real world comparisons. The project involves modelling the spread of the zombie disease through a population and examining how varying factors can cause the population to die out or continue, and look at the relation to diseases in reality for example Ebola and HIV. The bulk of this work took place using the MATLAB computer program, producing graphical displays showing how the infection would spread through a random population and the development of a population over time. The project also encapsulated the study of actual cities, observing which city would be the safest to live in, should such an outbreak occur in reality, using statistics for the various cities such as population density, the numbers employed in health professions and the sales of firearms.



Project	DNA analysis using microfluidic lab on a chip device
Name	Mark Tutty
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Email	mark.tutty2@mail.dcu.ie
Supervised by	Dr. David Kinahan, Prof. Jens Ducree
Personal Details	I am currently a final year Physics with Biomedical Sciences student in DCU. For my intra work placement I worked in the Biomedical Diagnostics Institute (BDI) working on the manufacture and testing of Microfluidic discs, I am now completing my final year project in Microfluidics based on what I had done while on work placement and am hoping to continue in this line of work after by completing a PhD in this field at some stage. After graduation I plan to travel as much as possible with South America being first on the list. I am heavily involved in sports outside of DCU, primarily GAA.
Project Summary	My goal for this project was to be able to replicate traditional bench top DNA purification tests using a lab-on-a-disc device using silica beads and various reagents. Traditionally, spin columns are used in combination with reagents and are pipetted in a precise order, with the spin columns needing to be centrifuged before each new reagent is added. All of this process can be very time consuming with testing taking upwards of forty minutes for a small sample. The disc I developed aimed to be able to have all reagents and samples initially added to the required chambers at the start of testing and then be spun at precise frequencies to purify the DNA due to the geometry of the disc. This can save a lot of time with a typical test for two samples usually only lasting ten minutes.

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