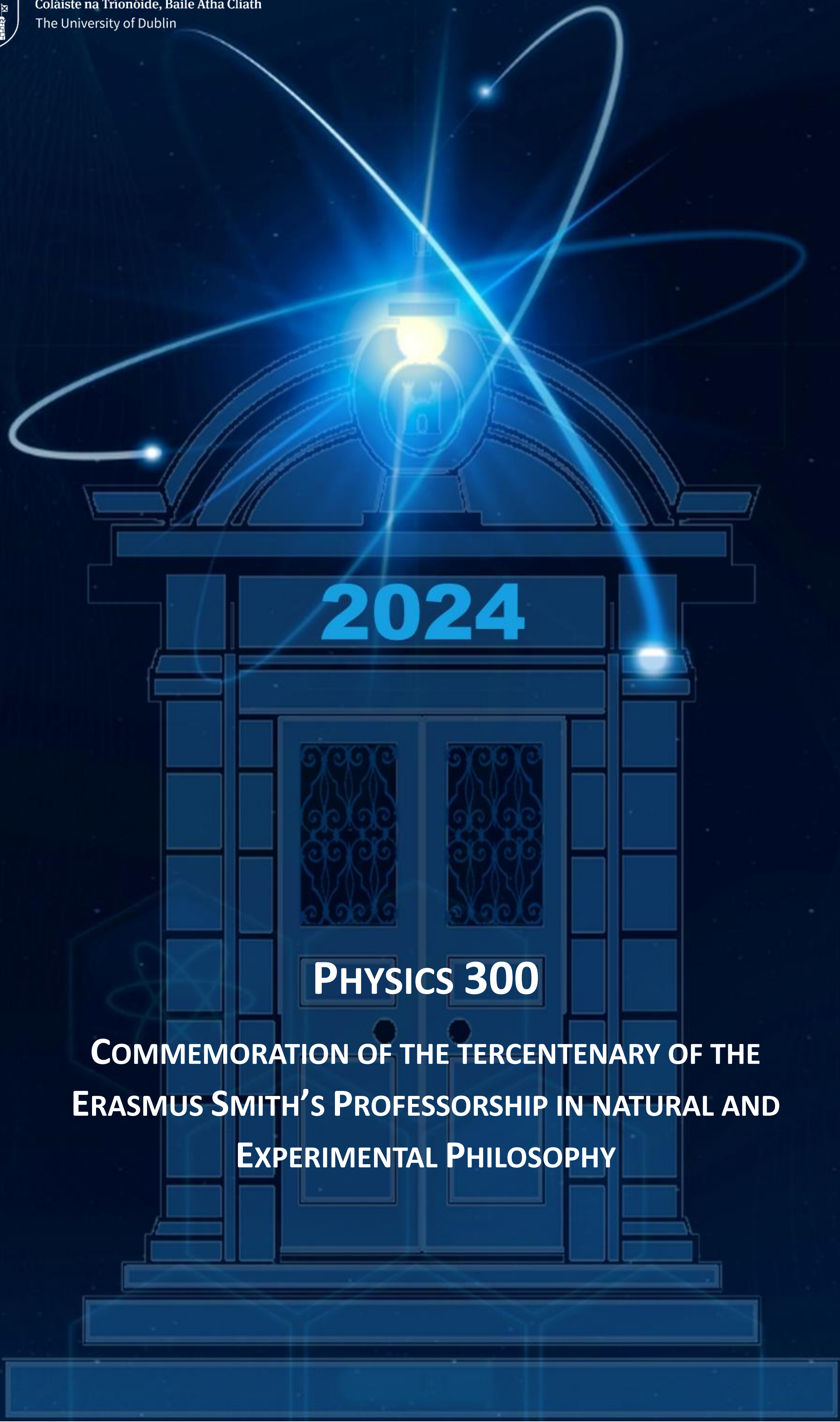
Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin



PHYSICS 300

COMMEMORATION OF THE TERCENTENARY OF THE ERASMUS SMITH'S PROFESSORSHIP IN NATURAL AND EXPERIMENTAL PHILOSOPHY

Foreword

Physics 300 is a celebration of the tercentenary of the establishment of the Erasmus Smith's Professorship in Natural and Experimental Philosophy in 1724. This marks the beginning of the formal teaching of Physics in Trinity College Dublin.

Over the past three centuries graduates and academics from Trinity Physics have left a rich scientific legacy. As part of Physics 300 we have collected items and articles to reflect on their work and achievements. Our aim is not to be exhaustive but rather in broad strokes to recall some of their outstanding contributions to Physics. We hope you enjoy the exhibits and if we have piqued your curiosity, in this short catalogue you will find further information on each exhibit, and a brief history of the twenty-two Erasmus Smith's professors since 1724. Other exceptional historical graduates remembered are George Stoney, John Joly, Thomas Preston and Edward Hutchinson Synge.

Many of our graduates and Erasmus Smith's Professors have been the subject of the Trinity Monday Memorial Discourse. The lectures are available on-line and provide a concise summary of the lives and works of these physicists. A full list is provided at the end of the catalogue. In 2024 the Memorial Discourse will be presented by Prof. Werner Blau, in which he will recall two of our more recent globally renowned Trinity Physicists, Daniel Bradley and Brian Henderson. They played a critical role in shaping the modern School of Physics.

We are indebted to our colleagues Denis Weaire, Eric Finch and Vincent McBrierty for their books and articles which have been invaluable sources for the summary contributions in this catalogue. A list of historical books and volumes of poetry by members of the School of Physics is also provided.

Finally, a word of thanks to those who helped to create the exhibits, contributed to the catalogue and developed our website, in particular Charles Patterson, Christopher Smith, Daniel Keane, Igor Chunin, James Lunney, Patrick Murphy, Alan O'Meara and Ken Concannon.

Louise Bradley

Chair of the Physics Tercentenary Committee, 2024

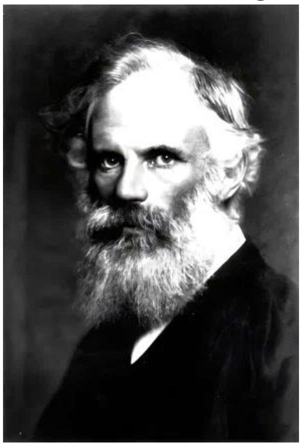
Contents

A Short History of the School of Physics (1724-2024)

Richard Helsham

The School has a long and distinguished history. A convenient starting point is 1710, when it was resolved "*that ground be laid out in the south-east corner of the physick garden sufficient for erecting an Elaboratory and anatomical theatre thereupon*". However, Trinity graduates had already made their mark upon the subject. An example is William Molyneux, whose *Dioptrica Nova* (1692) was the first book on optics in the English language.

The original Erasmus Smith's Professor, Richard Helsham, was Jonathan Swift's doctor; he was the first to lay out Newton's methods in a form suitable for the undergraduate, and his *Lectures in Natural Philosophy* were used for a hundred years in college. The book has been republished for the millennium by the School of Physics and is available from the Institute of Physics Publishing, Bristol, (U.K. ISBN 1 98 706 174). In his time the instrument collection numbered hundreds of items. Today many fine instruments remain, but principally from the late 19th century. The Physics Antique Instruments Catalogue can be viewed on the School of Physics webpages.



George Francis Fitzgerald

In the 19th century the College enjoyed a golden age of contributions to physics, mainly of a mathematical nature. The roll-call of distinguished names includes MacCullagh, Hamilton, Lloyd, Preston and Fitzgerald. Fitzgerald is best known for the Lorentz-Fitzgerald contraction, but he was a widely influential figure as the leader of the international team who known as the Maxwellians. His uncle, George J Stoney, another Trinity graduate, gave the electron its name, before it was experimentally discovered. It was largely due to Fitzgerald's advocacy that our Physical Laboratory was built in 1906 just five years after his death. In 2001 the building was renamed *The Fitzgerald Building* in his honour.

The Physical Laboratory in 1906

The Fitzgerald Building’s fine lecture theatre is where Erwin Schrödinger delivered his famous lecture serious entitled *‘What is Life?’* in which he expressed his hypothesis about the molecular structure of genes. These lectures and the subsequent book inspired Francis Crick and James Watson to pursue genetics and the structure of DNA.

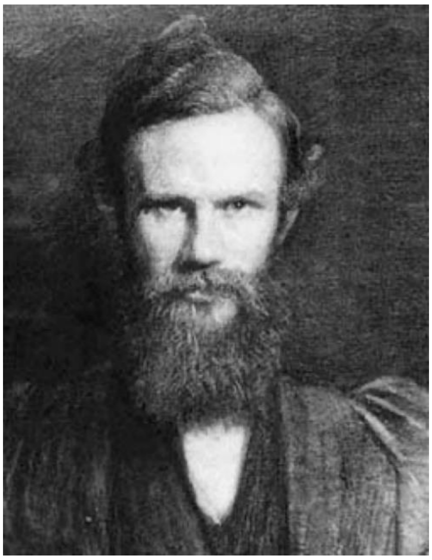
The leading figure of twentieth-century physics in Trinity was Ernest Walton, whose 1932 experiment ('splitting the atom') with John Cockcroft at the Cavendish Laboratory in Cambridge was one of the milestones of the modern subject and earned them the Nobel Prize. He returned to Trinity in 1934, but there was little funding for scientific research until more recent times, when vigorous research programmes developed. These have placed Trinity Physics at the head of the subject in Ireland, with a leadership role in European science. Known as the *School of Physics* since 2005, it is part of the Sami Nasr Institute for Advanced Materials (SNIAM) built in 2000 and the Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN) constructed in 2006.

Ernest T. S. Walton

Sami Nasr Institute of Advanced Materials

CRANN

George Francis Fitzgerald– ‘our friend of brilliant ideas’



The life and work of George Francis Fitzgerald is celebrated in a short volume edited by Denis Weaire [1]. It contains five articles which were originally published in the European Review [2] that focus on his life, membership of a circle known as the Maxwellians, which included Fitzgerald, Oliver Lodge, Oliver Heaviside and others, his correspondence with Heinrich Hertz and his contributions to industry and technology. The article on the Maxwellians by Bruce Hunt of the University of Texas is an abridged version of his book with that title [3]. This article draws on these references.

The story of the Maxwellians begins in 1878 when Oliver Lodge, then at University College London, came to Dublin for the meeting of the British Association for the Advancement of Science (BA) in August of that year and met Fitzgerald for the first time. Both men were 27 years old and over more than two decades of friendship they formed a strong personal bond, eventually signing their letters to each other with their greek initials, φ and λ. The Scottish physicist, James Clerk Maxwell at the University of Cambridge, had published his *Treatise on Electricity and Magnetism* in 1873, yet it would be many years before the theoretical and practical implications of this work would be appreciated by scientists and engineers. Maxwell died in 1879 aged just 48, leaving it to others to explore his work. Oliver Heaviside, just a year older than Fitzgerald and Lodge, was briefly a telegraph engineer in Newcastle. He ‘retired’ at the age of 24 for health and personal reasons and spent the next 20 years living with his parents in London and Devon. Heaviside worked in isolation on Maxwell’s equations, reformulating them in a way that is recognisible as the four vector equations which now bear Maxwell’s name. Heaviside began to correspond with Fitzgerald and Lodge following the 1888 meeting of the BA in Bath. Heaviside was not present at the meeting. However, Lodge took one side in a controversy over the design of lightning conductors, a dispute which Heaviside was also involved in. Since Heavside and Lodge were in agreement, they were natural allies. According to Hunt [3], Heaviside and Lodge met in person only once and Heaviside and Fitzgerald, twice. Nevertheless, a regular correspondence with Heavside by post continued for many years.

One of the most important issues of the day in physics was the possibility of generating electromagnetic waves. In early 1888, Lodge was experimenting with sudden electrical discharges through conducting wires which set up electromagnetic waves around the wire and caused a faint glow in the air, enabling Lodge to measure the wavelength of the waves. That summer, on holiday in the Alps, Lodge became aware of the work of Heinrich Hertz in Karlsruhe. By this time Hertz was able to generate electromagnetic waves in air, reflect them off walls as well as measuring their wavelength. Fitzgerald was president of the BA at this time and he used his presidential address at the Bath meeting of the BA to draw attention to

Hertz's results. By January 1889, Fitzgerald and his assistant, Frederick Trouton, had succeeded in reproducing Hertz's observations in Dublin and correspondence between Fitzgerald and Hertz has been preserved [2].

Hertz had succeeded in demonstrating generation of electromagnetic waves with wavelengths of a few metres in air (radiowaves) by means of sudden electrical discharges. Electromagnetic waves with such long wavelengths were not as familiar as light waves with wavelengths shorter than 1 µm. In the late 19th century it was believed that all waves propagated in a medium – air for sound waves, water for water waves and 'the ether' for light waves. In 1887 two American physicists, Alfred Michelson and Edward Morley had performed the famous Michelson-Morley optical interferometry experiment which was designed to detect the ether. However, they had failed to observe the effect that they believed would demonstrate the presence of an ether.

Inspired by some accounts of the BA meeting in Bath in September 1888, Heavside succeeded in deriving an expression for the electric field created by an electric charge in motion. Compared to the spherically symmetric field created by an electric charge at rest, the field due to the charge in motion was reduced along the direction of motion by a factor, $\sqrt{(1-v^2/c^2)}$, where v/c is the ratio of the speed of the charge to the speed of light. A few days after receiving a letter from Heaviside on this topic, Fitzgerald, visiting London, called to visit Heaviside on the 8th February 1889.

About two months later, Fitzgerald visited Lodge in Liverpool where they mulled over the results of the Michelson-Morley experiment. This experiment and its principles are well known to undergraduate physicists. It supposes that light propagates with a certain velocity with respect to the ether and that when an observer is in motion with respect to the ether, then the light velocity with respect to the observer will depend on that relative motion. The experiment consists in splitting a light source into two beams in an apparatus which is in motion with respect to the ether. One beam is supposed to travel across the ether flow and back and the other upstream and downstream in the ether. The key expressions derived in the analysis of the experiment contain factors similar to the factor involving the ratio derived by Heaviside for the electric field strength created by an electric charge in motion.

According to Hunt [3], while in discussion with Lodge, Fitzgerald had the brilliant idea that the null result of the Michelson-Morley experiment could be explained by a contraction of the apparatus in its direction of motion in the ether, similar to the reduction in electric field strength along the direction of motion when an electric charge is in motion. In a letter to the relatively new American journal, Science, entitled, '*The Ether and the Earth's Atmosphere*' and dated 2nd May 1889, Fitzgerald wrote [4],

'I HAVE read with much interest Messrs. Michelson and Morley's wonderfully delicate experiment attempting to decide the important question as to how far the ether is carried along by the earth. ... I would suggest that almost the only hypothesis that can reconcile this opposition is that the length of material bodies changes, according as they are moving through the ether or across it, by an amount depending on the square of the ratio of their velocity to that of light. We know that electric forces are affected by the motion of the electrified bodies

relative to the ether, and it seems a not improbable supposition that the molecular forces are affected by the motion, and that the size of a body alters consequently.'

This contraction in the length of a body in motion has become known as the Fitzgerald-Lorentz contraction. The degree of contraction when the body is in motion at speed, v, is the Lorentz factor $\gamma = 1 / \sqrt{(1 - v^2/c^2)}$, with its obvious connection to the factor found by Heaviside. Independently, Hendrik Lorentz in Leiden came to the same conclusion and published a paper entitled, '*The relative motion of the earth and the aether*' in 1892 [5]. This proposal gave the correct expression for contraction of bodies in relative motion predicted by Einstein's special theory of relativity. It was based on the erroneous notion of interaction of matter with an ether. In 1904 Lorentz published his famous paper entitled, '*Electromagnetic phenomena in a system moving with any velocity smaller than that of light'* [6] which contains the Lorentz transformation of special relativity. The mathematical factor for the degree of contraction is the same Lorentz factor, but the accepted explanation concerns the geometry of space-time and that light travels in free space at the same speed in all frames of reference. There is no need to invoke a medium such as the ether to explain the propagation of light in free space.

We have discussed the main events in Fitzgerald's scientific life, however he also was much concerned with the applications of scientific discovery in industry. David Attis' contribution to the focus articles on Fitzgerald and the Maxwellians [2] is on Fitzgerald's work in technology. With Hertz' demonstration of generation of electromagnetic waves in air in 1888, telegraphy over transmission lines would soon be replaced by wireless telegraphy. Alexander Graham Bell had introduced the telephone in 1876. The Italian Gugliemo Marconi would come to England in 1896 seeking investment in his wireless communication experiments. Marconi's mother was Annie Jameson of the Irish whiskey distilling family and by 1898 Marconi had come to Ireland where he transmitted the world's first live commentary on a sporting event at the Kingstown yacht race. Marconi used equipment from Fitzgerald's laboratory for the event. Marconi went on to quickly establish transatlantic wireless telegraphy between Cornwall in England and Newfoundland in Canada and Clifden and Ireland to Nova Scotia in Canada.

Otto Lilienthal had pioneered flight in his gliders near Berlin. Fitzgerald took an active interest in flight and purchased a glider from Lilienthal in 1895. His efforts at flying in College Park in Trinity are recorded in many photographs.

The latter half of the 19th century saw establishment of physical laboratories at leading universities in Britain, beginning with William Thomson's (Lord Kelvin) laboratory at Glasgow University in the 1850's. In 1899 the Board of Trinity College appointed a committee to look into introducing Electrical and Mechanical Engineering into the undergraduate engineering degree. This led to appointment of a further Science Committee. Fitzgerald sought a sum of £250,000, but the College's annual income at that time amounted to just £80,000 and the Committee was asked to submit a more economical report. Tragically, Fitzgerald died on 22nd February 1901 aged just 49 while recovering from an operation on a stomach ulcer and did not live to see the completion of the Physical Laboratory. Completion of the laboratory was left to John Joly and others, funded by a donation by Lord Iveagh, chairman of Guinness brewery and completed in 1906. The laboratory is now known as the Fitzgerald Building.

Hearing of Fitzgerald's illness, Heavside had written to Lodge saying that he was, '*grieved to hear of the illness of our friend of brilliant ideas*'. Afterwards, Heaviside wrote of Fitzgerald, '*He had, undoubtedly, the quickest and most original brain of anybody*.' He continued, '*That was a great distinction; but it was, I think, a misfortune as regards his scientific fame. He saw too many openings. His brain was too fertile and inventive. I think it would have been better for him if he had been a little stupid – I mean not so quick and versatile, but more plodding. He would have been better appreciated, save by a few*'.

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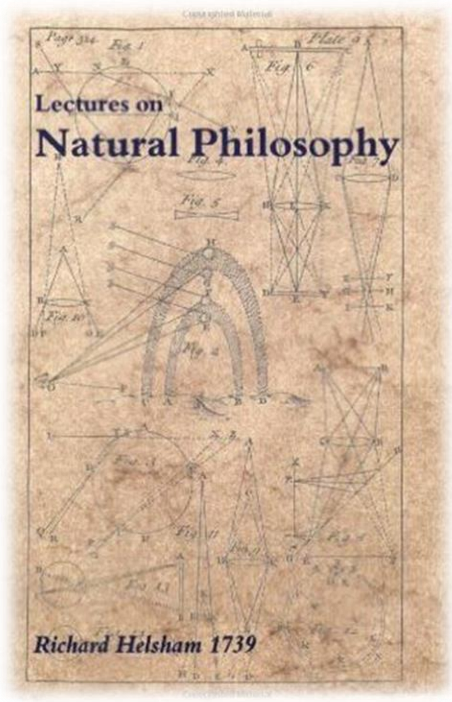
Richard Helsham: A Course of Lectures in Natural Philosophy



History: *'A Course of Lectures on Natural Philosophy'* by Richard Helsham was first published, posthumously, in 1739 by his former pupil and friend Bryan Robinson. To place the lectures in context, Daniel Dafoe's '*Robinson Crusoe'* had been published in 1719 and Jonathan Swift's *'Gulliver's Travels'* in 1726. Isaac Newton's revolutionary '*Principia'* and '*Opticks'* were first published in 1687 and 1704 in Latin and English, respectively, but were hardly suited for study by undergraduate students. By the time of his appointment as Erasmus Smith's Professor of Natural and Experimental Philosophy in 1724, Helsham had been delivering his lectures to students for 13 years without payment. They were an early attempt to make Newton's science and philosophical arguments about the nature of matter and its interactions accessible to students. The lectures were reprinted 11 times in seven editions in Dublin, London and Philadelphia, the last being selected parts of the lectures, in 1834, almost 100 years after the first edition was published. A softback reprint of the fourth edition was issued to mark the Millennium with an introduction by Denis Weaire and Patrick Kelly of Trinity College and David Attis of Princeton University. It is published by CRC Press (ISBN 1898706174) and is available from the School of Physics. The front cover illustration is shown above.

Contents: The 23 lectures cover physics topics familiar to any high school or early undergraduate student: attraction and repulsion of bodies, motion, collisions of elastic bodies, gravity, pullies, friction, hydrostatics, sound, light, colour and vision. The lectures contain many practical instructions on how to perform experiments, but with no illustrations. Present day students have an advantage over Helsham's students since methods of experimental investigation, development of theories to explain experimental results, the fundamental nature of light and matter are now well understood and widely accepted. In the opening paragraph of his first lecture, Helsham berates '*philosophers of former ages'* for '*disregarding experiments, the only sure foundation whereon to build a rational philosophy, ...*' He continues, '*Whereas the philosophers of later times, …, betook themselves to experiments and observations; and from thence collected the general powers and laws of nature, …, which were utterly inexplicable on the foot of hypotheses*.' In this approach he was in accord with Newton. His philosophical ideas were based on experiment rather than '*creatures of the brain'*, as he put it. Robinson added a preface to the lectures adapted from Newton's *Opticks* in four rules for philosophising:

''Rule 1 – More causes of natural things are not to be admitted, than are both true and sufficient for explaining their phenomena.

Rule 2 – Of natural effects therefore of the same kind of same causes are to be aligned, as far as it can be done.

Rule 3 – The qualities of bodies which cannot be increased or diminished, and which agree to all bodies in which experiments can be made, are to be reckoned as qualities of all bodies whatsoever.

Rule 4 – In experimental philosophy propositions collected from the phenomena by induction, are to be deemed, notwithstanding contrary Hypotheses, either accurately or very nearly true, till other phenomena occur, by which they may be rendered either more accurate or liable to exceptions''.

The first and second rules are a reformulation of the philosophical principle known as Occam's razor in which explanations based on the smallest number of elements are preferred. The fourth rule can be likened to the modern scientific method. This approach advocates a cycle of learning which begins with observation, generation of theories (or hypotheses), testing by experiment, analysis, conclusion.

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Helsham’s Lodestone and Magnetism in Magnetite

The inscription on Helsham’s Lodestone reads: *‘The Gift of his Excel (Excellency) Thomas Lord Wyndham, Baron of Finlas (Finglas) Lord Chancelour (Chancellor) and one of the Lord Justices of Ireland to Trinity College near Dublin’*

Lodestone: A lodestone is a rock that is rich in the mineral magnetite and has become magnetised naturally. Lodestones have been known to have the property that they attract iron since antiquity. The lodestone in Trinity’s School of Physics instrument collection was donated to Richard Helsham by the Lord Chancellor, Thomas Wyndham, Baron of Finglas. In its pure form, magnetite exists as shiny black crystals and its chemical formula is Fe_3O_4. It is unusual in that it retains its magnetised state well above room temperature. The gritty, black crystals which accumulate in a magnetic trap in domestic heating systems are largely composed of magnetite.

The word ‘lode’ comes from old English and means way or journey. In the ancient world, compasses made with lodestones were used for navigation. This was done by marking the lodestone with the North direction, the lodestone was then placed on top of a piece of cork in a water basin. Under these conditions, the lodestone rotates to face magnetic North. Humans have used Lodestones for centuries, dating back even as far as the 6th century BC. The Lodestone was humanity’s first introduction to the world of magnetism. The earliest reference from Europe is in the 6th century BC by Greek philosopher Thales of Miletus, who is often credited with discovering lodestone’s attraction to iron. Thales’s explanation for the magnetic abilities of the lodestone was the belief that they possessed souls. In the Lushi Chunqi, a classical Chinese text from the 2nd century BC, the attraction of iron to a lodestone is stated. In the Lunheng, a Chinese text published in 80 AD, the first mention of a needle’s attraction to a lodestone is mentioned.

The magnetism of lodestones was investigated by William Gilbert in the 16th century. He devised the rule that like poles repel, unlike poles attract and defined the term *‘pole’*. Gilbert noted that an iron bar brought into contact with a lodestone could be magnetised. Practically shaped, less expensive magnets were produced this way. Stacking these new magnets increased their magnetic intensity and rendered lodestones obsolete. Gilbert observed that a magnet exerts its force of attraction on iron without surface contact, as well as through thin sheets of other metals. This is expressed later in Faraday's idea of a '*field of force*' around a magnet, the magnetic field. Lodestones are mentioned in Helsham's *Lectures on Natural Philosophy*, Lecture III on the topic of Repulsion and Central Forces, where he says, '*For if the disagreeing pole of a lodestone be moved towards a magnetical needle floating on water, the needle will recede; and the nearer the stone is brought to it, with the greater violence and precipitation will it fly off; the repelling power, like the attractive, exerting itself with greater vigor at smaller distances*'.

Magnetite: Magnetism in magnetite retains its fascination for physicists to this day. The atomic structure, ferrimagnetism and electric conductivity of magnetite are complex. In 1939, the Dutch chemist, Evert Verwey, discovered an abrupt change in the atomic structure and electric conductivity of magnetite at 120 degrees Kelvin (-150 C). The microscopic origin of magnetism is the 'spin' on magnetic ions in the material. In the case of magnetite, these are several kinds of iron ion. Essentially, each magnetic ion behaves as a microscopic bar magnet with its poles oriented in some direction. A magnetised material has a majority of its spins oriented in a specific direction. Magnetisation of the various ion types in magnetic oppose each other. However, they have different magnitudes resulting a net magnetisation. This is known as ferrimagnetism.

The fundamental unit which is repeated in a magnetite crystal below 120 Kelvin contains 120 atoms and its electrical resistance increases 100 fold below this temperature. The large number of atoms and tendency to form microscopic domains, which are microscopic crystalline regions with different spatial orientations, made it difficult to determine the atomic structure. In 2012, Paul Attfield at the University of Edinburgh used a micron sized crystal containing just one of these domains to determine the crystal structure for the first time. It reveals a structure named '*trimerons*' by Attfield in which zig-zag chains of three iron ions interact strongly. In 2000, magnetic resonance spectroscopy was used by the Japanese physicist, Moriji Mizoguchi, to observe spins of individual magnetic ions in magnetite and in 2014, following the work of Attfield, Charles Patterson in the Trinity School of Physics performed calculations which analysed the magnetic resonance data of Mizoguchi to reveal the connection between the crystal structure and electron and spin distribution in magnetite.

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The Pitch Drop

After years of obscurity the Trinity pitch drop demonstration became an overnight sensation. The pitch tar was placed in the funnel in the School of Physics in October 1944, beginning what is now a 70 year continuously running demonstration. While appearing solid at room temperature, pitch tar flows very slowly with a drop falling from the end of the funnel approximately once in a decade. It is not known who started this demonstration, but they clearly had patience. The Trinity pitch tar demonstration is one of only three such experiments in the world and until the 11th July, 2013 no one had seen a drop drip. The University of Queensland had missed filming their drop falling in 2000 as a result of bad luck; the camera was offline at the time. In 2013 Shane Bergin and Stefan Hutzler captured the drop falling in Trinity, becoming the first to record this rare moment. The time-lapse video attracted global media attention including RTÉ News, the *Huffington Post*, the *Wall Street Journal*, *New Scientist* and the *National Geographic*. In recognition of its global fame the pitch tar demonstration has been on display in the college library since 2014 but has returned to its permanent home in the School of Physics in time for the tercentenary.

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Tercentenary Commemoration Medal

The silvered brass medal depicts on the obverse three of our most celebrated Erasmus Smith's Professors of Natural and Experimental Philosophy, one from each of the three centuries of Physics in Trinity College Dublin.

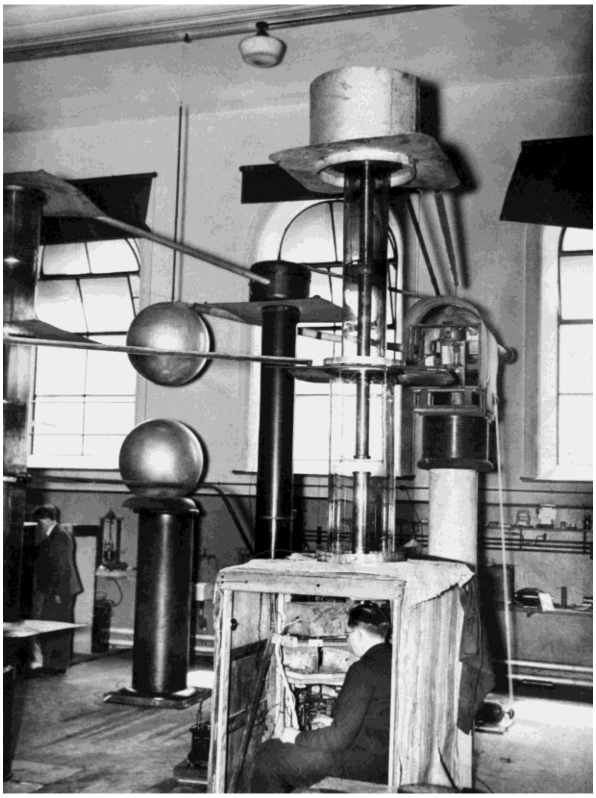
From left to right: Richard Helsham 1683 - 1738, George Francis FitzGerald 1851 - 1901 and Ernest Thomas Sinton Walton 1903 - 1995.

The Latin inscription, Fax Viva Scientiae, means A Living Beacon of Knowledge.

On the reverse side we have the tercentenary icon, a depiction of the front door of the School of Physics Fitzgerald building constructed in 1905. Many students started their journey in physics by walking through this door. The door is flanked by the Trinity coat of arms and a representation of the lithium atom with its three electrons. Walton collaborated with John Cockcroft to split the lithium atom paving the way to the atomic age. Walton won the Nobel prize in Physics in 1951.

The commemoration medal was designed by Christopher Smith.

E.T.S. Walton – Nobel Laureate



ETS Walton inside the observation hut under the accelerator.

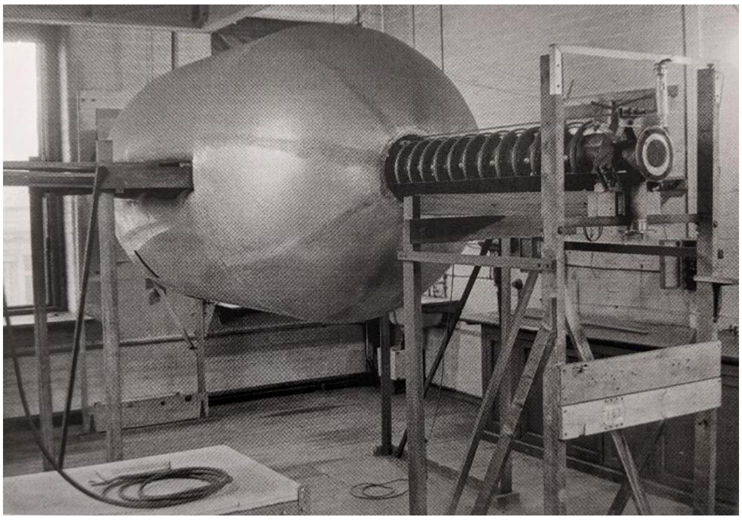
A brief summary of the career of Ernest Thomas Sinton Walton is provided in the section on the Erasmus Smith's professors of natural and experimental philosophy. While studying for his PhD in Cambridge with Ernest Rutherford, Walton worked on the development of particle accelerators. This led to the Cockcroft-Walton linear accelerator described in their first Nature paper in February 1932. They reported accelerating protons from a discharge in hydrogen to a velocity of 1.16 x 10^9 cm/s.

Soon after on April 14, 1932 Walton observed the signature of alpha particles after bombarding a lithium target: the lithium broke into two helium nuclei. Walton described this moment "We had rigged up a scintillator screen of willemite. If there were any fast particles coming out they would produce scintillations in this material. I left the control bench – the apparatus was giving voltages of something of the order of six or seven hundred thousand volts – and I crawled across the room on my hands and knees in order to avoid the high voltages and went into a little hut that we had built under the apparatus. We were quite safe from these high voltages and also shielded from the X-rays that were being produced in the apparatus. When I looked in through the microscope I could see a whole lot of little stars suddenly appearing and just as suddenly disappearing."

As Walton explained "… a proton was going into the nucleus of an atom. Now a proton has a mass of one unit on the atomic scale. Some of the lithium atoms, in fact the majority of them, have a mass of seven units. So when you add one to seven you get eight units. A lot of surplus energy is available and the atom that has been formed in this way immediately blows asunder and two-alpha particles come out, each of them of mass four; and they come out in opposite directions with the same velocity."

Lithium + Hydrogen = Helium + Helium + Excess Energy (17 meV)

This was the first time that Einstein's mass/energy $E=mc^2$ was verified directly in nuclear reaction. c is the speed of light so when even a small mass, m, is destroyed a very large amount of energy, E, is released. Their experiment also verified Gamov's predictions of quantum



Van de Graaff particle accelerator at TCD in the 1950s.

The accelerator tube with the specially shaped metal conductor Einzel lenses.

tunnelling using the new theory of wave mechanics. The Nobel Prize citation reads their work "profoundly influenced the whole subsequent course of nuclear physics [and] stands out as a landmark in the history of science."

Walton returned to the Physics department in Trinity in 1934. In the 1950s he constructed, with his colleague in physics Bobbie Elliott, a van de Graaff particle accelerator for inducing nuclear reactions. In this device the large metal conductor is charged up to a very high voltage by using an insulating conveyor belt to carry positive charge on to the conductor. Positively charged protons or heavier atoms are produced by ionisation inside the large conductor and are accelerated to ground potential by the electric field in the accelerator tube, which is displayed in the Fitzgerald Library. The specially shaped metal conductors inside the tube act as Einzel lenses to refocus the particle beam at each stage.

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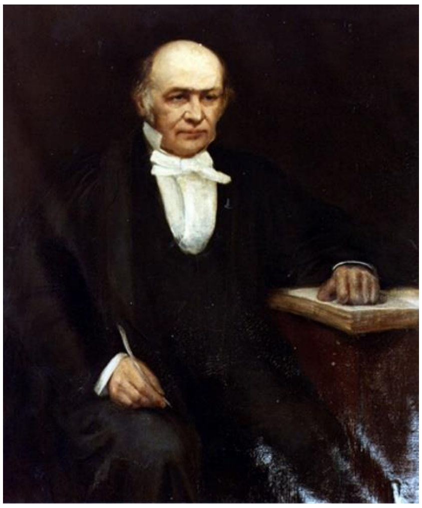
Sir William Rowan Hamilton (1805 – 1865)



William Rowan Hamilton (1805–1865) is considered to be one of the world's greatest mathematicians and physicists. His life and work have been extensively described by others [1-4]. Hamilton was a child prodigy. He displayed an extraordinary aptitude for languages from a very young age and when he was sixteen his uncle gave him a copy of Bartholomew Lloyd's textbook in preparation for going to university, which stimulated his interest in mathematics. In 1823 he began his studies in Trinity College Dublin and he came first in every examination and received "optimes" (a rarely awarded distinction) during his studies.

While still an undergraduate student, in 1827 Hamilton was appointed Andrews' Professor of Astronomy, which came with the title Royal Astronomer of Ireland. He moved to Trinity's observatory at Dunsink but focussed on his mathematical research rather than astronomical observations. He welcomed the opportunity to base himself in this rural location on the outskirts of the city, away from the distractions of college life, where he could concentrate on his own research interests [5]. It is here that he carried out his work on quaternions, optics and dynamics, for which he received international recognition.

In 1832 Hamilton undertook a mathematical analysis of the wave surface that describes the propagation of light in a biaxial crystal [7]. Based on this study he discovered conical refraction. Hamilton's theory predicted two manifestations of conical refraction. First, unpolarized light incident on a biaxial crystal at certain angles would be refracted to form a hollow cone of rays; this light would then emerge from the crystal in the form of a hollow cylinder. Second, rays of light travelling in certain directions within the crystal would be refracted on emergence to form a hollow cone of rays. Humphrey Lloyd, the tenth Erasmus Smith's professor, performed experiments to confirm the findings. This was the first time that an effect arising from the wave nature of light and Fresnel's theory had been mathematically predicted before being experimentally observed. "Its announcement electrified the scientific community of the day. Airy called it "perhaps the most remarkable prediction that has ever been made" and it would later be commonly compared to the subsequent prediction and discovery of the planet Neptune by Adams and Leverrier" [1]. He was awarded the Royal medal of the Royal Society in 1835, Michael Faraday was also awarded the medal that year. In the same year, Hamilton was knighted at the age of 30. Conical refraction is described in the following contribution in this catalogue and is exhibited in the Fitzgerald Library.

In the following years Hamilton worked on dynamical systems and developed what is known as the Hamiltonian formalism to describe the time evolution of a system. As remarked by David Spearman, perhaps the most important influence was that on Erwin Schrödinger, who received a thorough grounding in Hamiltonian dynamics from his professor, Friedrich Hasenöhrl [8]. The Hamiltonian formulation is a central component of Schrödinger's wave theory description of quantum mechanics.

Hamilton is also known for his discovery of quaternions. A "ureka" moment occurred on 16th October, 1843 while walking along the Royal Canal. "An undercurrent of thought was going on in my mind, which gave at last a result, whereof it is not too much to say that I felt at once the importance. An electric circuit seemed to close; and a spark flashed forth, the herald (as I foresaw, immediately) of many long years to come of definitely directed thought and work……nor could I resist the impulse –unphilosophical as it may have been – to cut with a knife on a stone of Brougham Bridge, as we passed it, the fundamental formula." A commemorative plaque with his famous formula for quaternion algebra; $i^2 = j^2 = k^2 = ijk = -1$ marks the location on Broome Bridge. A quaternion is a 4D complex-number, and just as a complex number was the sum of a number and an imaginary, a quaternion is the sum of a number and a line in space. Hamilton was the first to distinguish these by the terms 'scalar' and 'vector'. Quaternion algebra is used for the calculation of rotations for solid bodies. At the time of their discovery their modern day applications could not have been imagined - satellite navigation, space travel, robotics, animation and computer game programming. Quaternions were first used by NASA to effect rotations as part of the guidance, navigation and control systems on the 1981 Space Shuttle launch and are now used for account for the altitude of almost every spacecraft [9].

It is a mark of Hamilton's international standing that he was the first foreign member elected to the National Academy of Science (USA) in 1865. The only other Foreign Associate in Ireland has been Michael Coey, the twenty-first Erasmus Smith's Professor [5].

Hamilton's work continues to be influential after almost two centuries. In 1943 Schrödinger is quoted in *The Irish Times, "I daresay not a day passes – and seldom an hour – without somebody, somewhere on this globe, pronouncing or reading or writing or printing Hamilton's name"* [6]. This remains as true now as it was eighty years ago.

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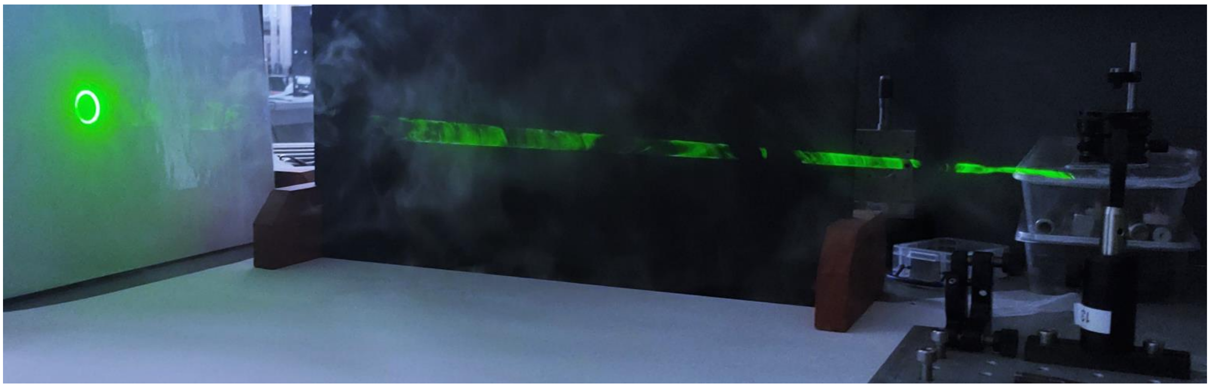
Conical Refraction and the Radiant Stranger



Internal conical refraction is a striking optical phenomenon which arises when a beam of light is incident along one of the optic axes of a slab of transparent biaxial crystal. The beam propagates as a skewed hollow cone inside the crystal, and on leaving the crystal it refracts into a hollow cylinder of light, as shown in Figure 1. Conical refraction was predicted by William Rowan Hamilton in 1832 [1], and experimentally verified by Humphrey Lloyd [2], later that year.

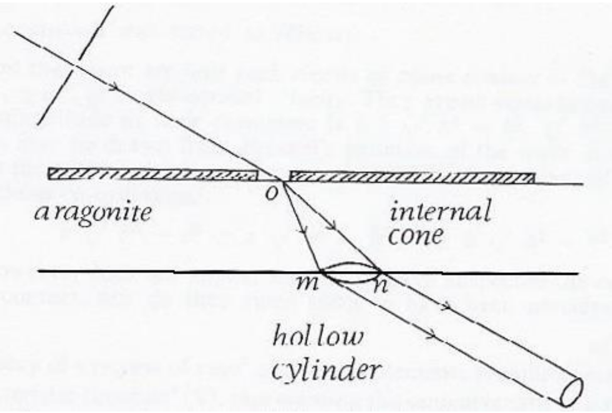


Figure 1. Ray diagram to illustrate internal conical refraction from Ref. 3.

At the time of discovery, conical refraction was widely celebrated: arguably the first example of a mathematical prediction of a new physical phenomenon that was quickly followed by experimental confirmation. A non-technical introduction to physics and the history of conical diffraction is presented in Ref. 4. The year 2005 was the bicentenary of Hamilton's birth, and the School of Physics at TCD took part in the *Year of Hamilton* celebration. James Lunney set up a demonstration of internal conical refraction using a small laser and a high quality synthetic biaxial crystal. This demonstration is now on display in the Fitzgerald Library in the School of Physics. While this demonstration was being prepared, a rare and beautiful 19th century wire model of the ray surface in a biaxial crystal was discovered in the Department of Geology and is also now displayed in the Fitzgerald Library. A large-scale sculpture based on the wire model was constructed in the School of Physics and is wall-mounted in the stairwell of the Fitzgerald Building.

Figure 2. Radiant Stranger: A large-scale sculpture based on the wire model of the ray surface in a biaxial crystal. The sculpture is on display on the second floor of the Fitzgerald Building.

The full description of conical refraction requires a wave optics approach [5, 6], as described by Sir Michael Berry and others, hence the alternative name "conical diffraction". Berry's main result was a paraxial solution for the optical field which can be numerically evaluated at any plane normal to the propagation direction. It shows that the conically diffracted beam has a narrow double-ring profile in the focal image plane and then diffracts to yield a beam which has a maximum on axis and is described by a superposition of 0^{th} and 1^{st} order diverging Bessel beams with opposite circular polarizations (Figure 3)

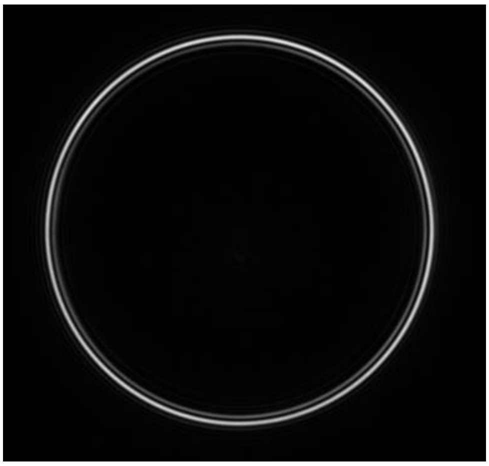


Figure 3. Photograph of a magnified image of the double-ring formed at the focal image plane by internal conical diffraction of a Gaussian laser beam [7].

These calculations were compared with experiment and the agreement was very close [7]. With support from Science Foundation Ireland, John Donegan and James Lunney used a single Gaussian mode laser beam and a high quality synthetic biaxial crystal to reveal the finer details of conical diffraction and explore potential applications [8, 9].

The Radiant Stranger sculpture inspired by conical refraction can be seen on the second floor of the Fitzgerald Building.

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Edward Hutchinson Synge (1890-1957)

Edward Hutchinson Synge is a forgotten member of a famous Irish family. He is the brother of John Lighton Synge, the renowned mathematican, and nephew of the playwright John Millington Synge, whose works include *The Playboy of the Western World*.

Edward (known as Hutchie) was born on June 1st, 1890. He arrived in Trinity College Dublin as a student in 1908, top among the sixteen student who secured "High Places at Entrance". His stellar academic achievements continued with the Townsend Prize in mathematics at the end of his first year, followed by a Foundation Scholarship at the end of his second year. Unexpectedly in 1911 following the death of JM Synge, he inherited almost half of his uncle's estate and withdrew from Trinity without completing his degree. He remained a recluse for the rest of his adult life.

However, his interest in Physics remained, and he published nine articles in *Philosophical Magazine* in the decade spanning 1922 – 1932. These papers cover topics including relativity, microscopy, astronomical observations and remote sensing. In his papers he proposed insightful new methods for high resolution microscopy and innovative telescope designs. However, as an unknown scientist his work did not receive much attention and remained in obscurity. It was many decades later before other scientists independently proposed similar ideas. In 2007 Synge's work was revisited by L. Novoty in *The History of Near-field Optics* [1]. Subsequently, in 2012 J. F. Donegan, D. Weaire and P. S. Florides edited a collection of Synge's publications bringing further recognition to his visionary acheievements [2].

In standard optical miroscopes the resolution is limited by Abbe diffraction limit. In two of his papers Hutchie proposed a practical method for a scanning near-field microscopy (SNOM) which allows for optical imaging with resolution higher than the Abbe diffraction limit [3]. In Synge's publication he was the first to suggest that the rapid scanning could be achieved using the piezoelectric effect [4]. The SNOM was independently rediscovered by IBM in 1984. As envisaged by Synge it works on the principle of scanning a light source of dimensions smaller than the wavelength of light across the sample using the piezoelectric effect while maintaing the source at a very small distance from the sample surface.

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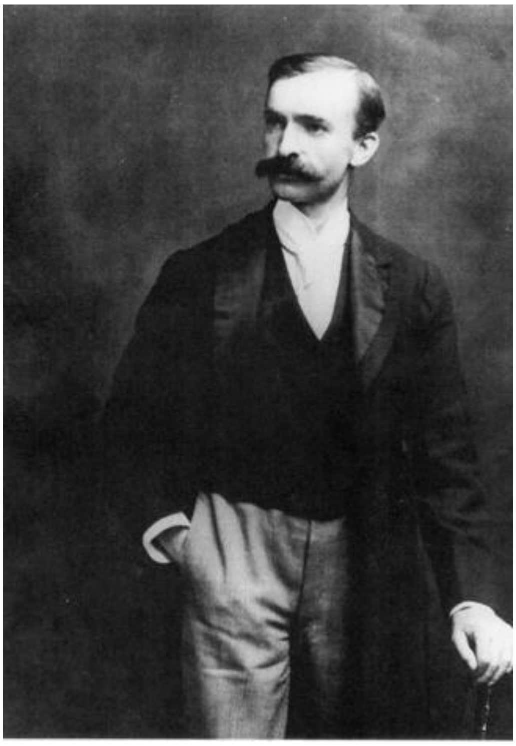
Thomas Preston (1860-1900)



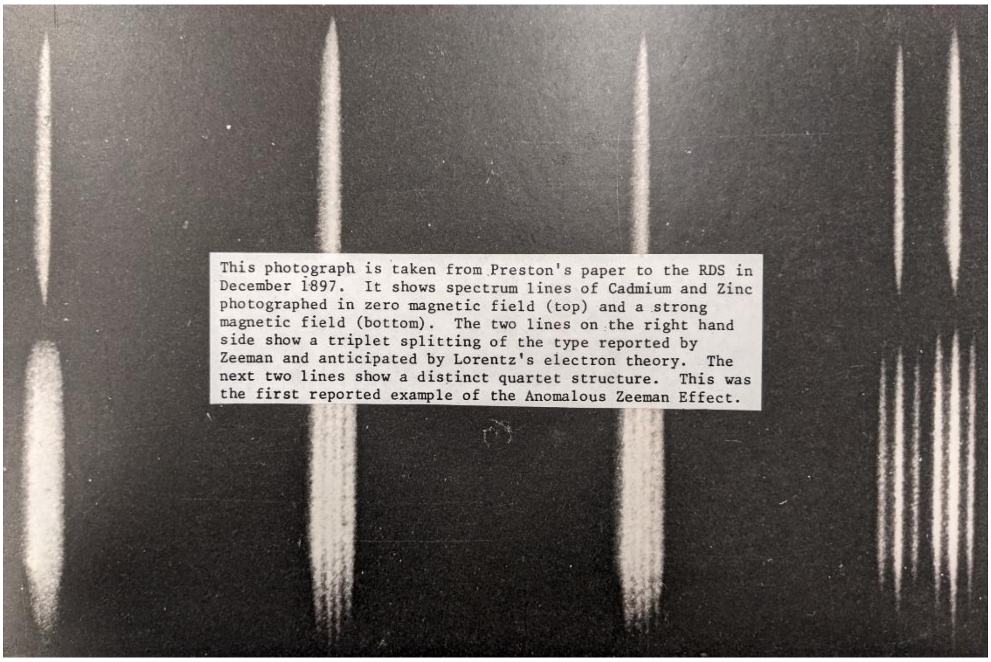
The life and work of Thomas Preston is described in an article by D. Weaire and S. O'Connor [1]. Herein is a short description of Preston's career in physics in Trinity College Dublin and his discovery of the Anomalous Zeeman Effect. Preston was the subject of Weaire's Trinity Monday Memorial Discourse in 1990.

Thomas Preston arrived in Trinity in 1881 and graduated in 1885 in Mathematics and Experimental Sciences. Fitzgerald was appointed the Professor of Natural and Experimental Philosophy the year that Preston arrived. Preston's early postgraduate work was mainly in mathematical physics, though he also carried out some experimental work in Fitzgerald's Laboratory and they remained lifelong friends. Preston became Professor of Natural Philosophy in University College Dublin in 1891.

Preston made his first foray into writing textbooks with W. J. McClelland. They published *A Treatise in Spherical Trigonometry* in 1886. Preston subsequently published two further significant textbooks on *The Theory of Light* in 1890 and *The Theory of Heat* in 1894. As commented by Weaire and O'Connor "Trinity College had been the source of many important textbooks in Physics, going back to the publication of Richard Helsham's lectures in 1739. Preston was following in an established tradition." He received letters of thanks and congratulations from many eminent scientists including Kelvin, Rayleigh, Fitzgerald, Hertz, Stoney, Ball and Michelson. Many subsequent editions of the books were reprinted, and they continued to be used internationally for decades after his death.

During his time in UCD Preston turned increasingly to experimental work. In 1897 he presented photographic evidence of the Anomalous Zeeman Effect in cadmium and zinc in a presentation to the Royal Dublin Society [2]. Preston overtook the work of Michelson, Cotton, Cornu and Zeeman and gained international recognition.

Zeeman had previously reported on the effect of a magnetic field on atomic spectral lines [3,4]. He observed a broadening of the lines and polarization effects. These results provided experimental evidence for the classical electron theory of Hendrik Lorentz who predicted a splitting into three lines. Zeeman's observation of only spectral broadening was due to the limited resolution of his spectrometer. Using a large Rowland spectrometer at the Royal University with a borrowed electro-magnet, Preston photographed "all the (visual) appearances described by Zeeman" as described in his letter in Nature in 1897 [4]. However, Preston noticed that the behaviour of the splitting was more complex that predicted by classical electron theory. He conducted further investigations using a stronger magnet and



obtained photographic evidence of examples which were did not follow the “normal” triplet line splitting predicted by Lorentz [2]. Preston reported “It is clear that the magnetic effect depends not so much on the wavelength of the spectral line as on some hidden quality which we may refer to as the character of the line; for lines of nearly the same wavelength, even of the same substance, show effects which differ remarkably in magnitude and character. Such laws, therefore, as that the broadening of the spectral lines is proportional to the wavelength or to the square of the wavelength are shown to be utterly untenable, unless perhaps it might be possible to group the spectral lines of each substance into sets, so that some law of wavelength might apply to the lines of each set”. Over the next couple of years Preston and others published many papers characterising the anomalous Zeeman effect. However, it was not until the 1920’s that a theoretical explanation was obtained based on spin of the electron and quantum mechanics.

Preston was elected a fellow of the Royal Society in 1898 and was awarded the RDS Boyle medal in 1899. Unfortunately, he died at a young age on January 31st, 1900. His work was cut short and consequently his legacy has been somewhat overlooked. Lorentz and Zeeman were awarded the Nobel Prize in physics in 1902.

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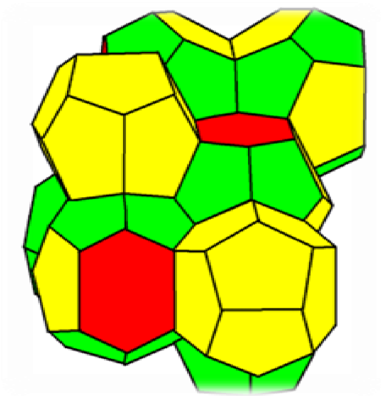
Throwing Shapes

In 1993 physicists Denis Weaire and Robert Phelan discovered, using computer simulations, the lowest energy structure known of an ideal monodisperse foam in the dry limit, i.e., it is the lowest energy arrangement of packed bubbles of equal volume. This structure is now commonly known as the Weaire-Phelan structure. A sculpture representing the Weaire-Phelan structure is on display on the third floor of the SNIAM Building.



The Weaire-Phelan Structure

The Kelvin Structure

History

In 1840, Belgian scientist Joseph Plateau began his investigation into the surface area of foams. It began with oil dropped into a mix of water and alcohol; Plateau noticed that the drops formed perfect spheres in the mixture. Later, using a mixture of soapy water and glycerine, he observed that the foam surfaces formed were minimal surfaces due to surface tension. Plateau calculated that three soap films are stable when meeting at 120^o angles and four soap films are stable when meeting at 109.5^o. The Plateau problem would emerge from these experiments. The problem is to show the existence of a surface of minimal area with a given boundary rule while satisfying Plateau's rules (which include soap films being smooth surfaces, the curvature of a portion of film being constant, and above two angle rules). The question was pondered by scientists at the time; one scientist, Georges Buffon, would use lead shot and peas as models. Later, Belfast born scientist Lord Kelvin proposed the Kelvin problem, asking how space could be partitioned into cells of equal volume with the least surface area between them. In 1887, Lord Kelvin believed he had devised the '*perfect'* foam. Lord Kelvin's *'perfect'* foam structure had truncated octahedra for its cells, with eight hexagonal faces and six square faces, all with a slight curvature to fit Plateau's rules. The convex uniform honeycomb structure, known as the Kelvin structure, had been considered the most efficient solution to the problem for over a hundred years. In 1994, Denis Weaire and Robert Phelan, with the help of computer simulations, published a paper entitled 'A counterexample to Kelvin's conjecture on minimal surfaces.' The Weaire-Phelan structure would exist solely as a mathematical concept for many years, until in 2012, when Dr. Ruggero Gabbrielli realised the concept by fabricating the Weaire-Phelan structure for the first time.

More recently, in 2022, a Japanese research team developed the first polymeric Weaire-Phelan foam using facile synthetic procedures.

Science and Structure

After a century the Weaire-Phelan structure surpassed the Kelvin 'ideal' foam structure with 0.3% less interfacial area. In addition to having a smaller surface area, the Weaire-Phelan structure is also a lower energy arrangement than the Kelvin structure. The Weaire-Phelan structure consists of a repeating unit of eight bubbles with two kinds of polyhedral cells of equal volume. The first polyhedral cell is an irregular pentagonal dodecahedron (12 faces), which makes up two of the eight bubbles, and the second is a tetrakaidecahedron (14 faces made up of hexagons and pentagons), which makes up the remaining six bubbles. Though the Weaire-Phelan structure does not appear naturally, it has been made in a laboratory environment. In 2011, Ruggero Gabbrielli designed a container templated with the geometry of the Weaire-Phelan structure. The container was made with a translucent polymer using a 3D printer. The container was then placed into a solution of Fairy Liquid detergent. Releasing pressurised nitrogen gas from a glass capillary allowed for the production of equal-sized bubbles. Varying the flow rate of the gas meant that bubble sizes could be matched to the template. The experiment found 1,500 bubbles stacked in six layers that conformed to the Weaire-Phelan structure.

Beijing 2008 Olympics

In 2003, China hosted an architectural competition for the design of its national aquatic centre in Beijing. Out of 10 proposals, the '*Water Cube*' was chosen to be built. The Water Cube is made up of 4000 ETFE (a type of polymer) bubbles; seven bubble sizes were used for the roof and fifteen for the wall, the largest of which was nine meters in diameter. The design for the Water Cube is based on the Weaire-Phelan structure. Steel beams are used for the framework of the bubbles, while ETFE is used to cover the surface. The Water Cube was used to host the swimming, diving, and synchronised swimming events in the 2008 Beijing Olympics. In the 2022 Winter Olympics, the Water Cube was referred to as the '*Ice Cube*' and was used to host the curling events.

The Water Cube at Night

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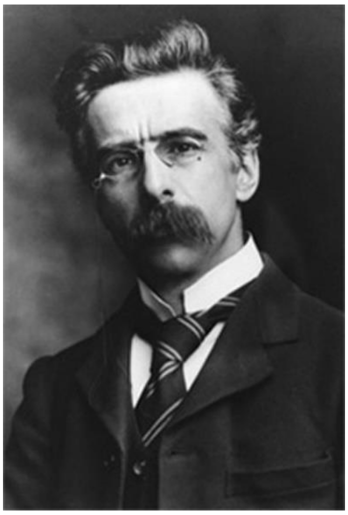
John Joly (1857-1933) - physicist, geologist, engineer



John Joly is considered one of the most distinguished Irish scientist of his time. He made important contributions to geology, physics, engineering, medicine and photography.

John Joly FRS (1857-1933) was born at Holywood, Co. Carlow, the son of the Rev. John Plunkett Joly and Julia Anna Maria Georgiana nee Comtesse de Lusi. Both parents had aristocratic lineages in France, Germany and Belgium. His great grandfather, Jean Jasper Joly, came to live at Carton House near Dublin, the residence of the second Duke of Leinster. A detailed lineage and list of his publications may be found in John Joly's obituary [1]. His life and work are described in some detail in an article by John Nudds [2] on which this is based. Joly's father died while he was an infant and his mother brought John and his two brothers to Dublin. He attended Rathmines School, where his nickname was 'Professor' [2] and he entered Trinity College in 1876, aged 21. He sat his degree examinations in October 1882 and shortly thereafter he was appointed assistant to the professor of Civil Engineering in Trinity. In 1891 he left the Department of Engineering and joined George Francis Fitzgerald, the Erasmus Smith's professor of experimental and natural philosophy in what was then the Department of Natural and Experimental Philosophy and is now the School of Physics. In 1897 the chair of Geology and Mineralogy in Trinity became vacant. Joly's undergraduate degree in engineering included work in mechanics and experimental physics and mining, chemistry, geology and mineralogy. He applied for the chair and was successful, beginning as Head of the Department of Geology in Michaelmas Term 1897, aged 39. Joly had a very wide range of research interests and applied his knowledge as a prolific inventor. He had previously invented instruments useful in geology such as a steam calorimeter for measuring specific heats of minerals by surrounding them with steam and weighing the resulting condensation and a meldometer for measuring the melting points of crystals. Now he began working in physical geology and in particular he began considering methods for estimating the age of the earth.

McDowell and Webb in their history of Trinity College [3] said of Joly that he was, 'Certainly the most versatile and productive, and perhaps the greatest of the scientists that the College has ever produced.' It has also been said that Joly was essentially a physicist. He brought the fundamental understanding and analytic thinking of the physicist to many practical and fundamental problems, the former as an inventor of technologies such as colour photography and the latter in his deep thinking about problems such as the age of the earth and radioactive decay in minerals.

Joly is perhaps best known as the inventor of the 'Joly Process of Colour Photography', which he patented in 1894. It was the first successful method for producing colour photographs on a single plate. Black and white photography had begun around 1839 [4]. In 1861 James Clerk Maxwell had made a colour image of a tartan ribbon using three lanterns with red, green and blue filters, making slides and then projecting the three slides onto a screen to make a colour image. The Joly process used a single filter on which fine red, green and blue lines (of width less than 0.1 mm) had been ruled. Patents for the Joly process were acquired by a group of American businessmen and the Natural Colour Photo Co. Ltd. was formed in Great Brunswick St., Dublin. However, the process had limited commercial success and Joly was forced to fight patent battles in the United States, after which his priority was established. The Autochrome, invented by Auguste and Louis Lumiere was the first commercially successful screen process from 1907 [4].

Joly devoted much of his effort in the ensuing 25 years to estimating the age of the earth. His first paper on the subject was published in 1899 [5]. At that time, estimates of the age of the earth lay in the range 10-20 million years, based on the rate of cooling of the molten earth. Lord Kelvin was a leading proponent of this estimate. Joly based his estimate on the amount of sodium in the oceans and the rate at which sodium is transported to the oceans by rivers, etc. Assuming that that rate had remained constant over time, Joly arrived at an estimate of 90-100 million years. A few short years after the discovery of radium by Pierre and Marie Curie, Joly had turned his attention to implications of radioactive heating within the earth. His paper entitled, 'Radium and the geological age of the earth,' [6] criticised the rate of cooling arguments by Kelvin. Since they omitted heat released within the earth by radioactive decay, they would inevitably underestimate the age of the earth and, Joly noted in closing, 'The hundred million years which the doctrine of uniformity requires may, in fact, yet be gladly accepted by the physicist'. Here he was referring to his estimate based on the salinity of the oceans and his assumption that conditions had remained uniform over that time.

In 1906 Ernest Rutherford used a method for estimating the age of the earth based on radioactive decay of two uranium isotopes to two lead isotopes. Based on their ratios in a rock containing uranium, he estimated the age of the earth to be 3.4 billion years, more than an order of magnitude greater than Joly's estimate. If initially dismayed by the new estimate, Joly realised that 'halos' that he had observed in minerals such as biotite were caused by radioactive decay of heavy elements present in the mineral. Joly's work with Rutherford led to an estimate of rocks from the Devonian period of at least 400 million years [8].

During the first world war Joly contributed many ideas and inventions to the war effort which he sent to the British Admiralty. At that time, Joly also continued his work with radioactivity. Working with Walter Stevens in Dublin, he realised that the practice of that time of applying one or two radioactive sources to a tumour, it was better to use more, smaller sources to reduce injury to the patient by radioactivity as well as saving precious radium. This became known as the 'Dublin method' [9]. Later Joly and Stevenson used glass capillary tubes filled with radioactive radon gas for cancer treatment.

Joly was such a prolific scientist that it is difficult to even mention all of his contributions. He never married. As noted above, his father died while he was an infant and his mother died when he was in his late twenties. He had an enduring friendship with Horatio Dixon, University Professor of Botany on Trinity College. With Dixon he wrote 'The cohesion theory of the ascent of sap in plants', explaining plant transpiration. He was active in climbing and walking and enjoyed holidays in the Swiss Alps. He also had a keen interest in sailing and maritime affairs. He was elected a Commissioner of Irish Lights [10] in 1901 and served for 32 years as commissioner and later senior commissioner. He received many honours for his work. He was elected a Fellow of the Royal Society in 1892, aged 34 and received the Royal Medal of the Royal Society in 1910. He was awarded the Boyle medal in 1911, Ireland's most prestigious scientific recognition. He received the Murchison Medal of the Geological Society in London in 1923 as well as honorary degrees and lectureships. Through Joly's efforts, Lord Iveagh chairman of Guinness brewery donated £24,000 for the erection of a Physical and Botanical laboratory in 1906 and a further £10,000 to equip the Geological laboratory in Trinity College in 1912. According to Nudds [2], Joly remained active in Trinity for the rest of his life, delivering his last lecture just six days before he died, aged 76.

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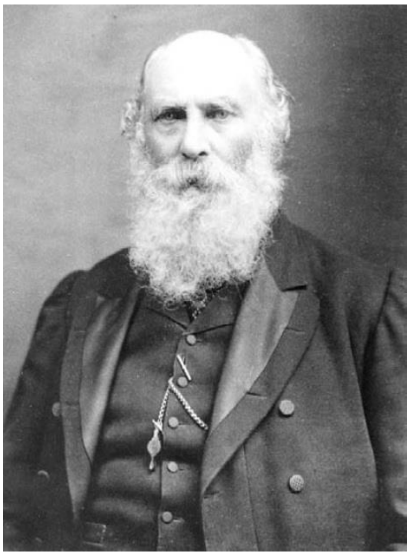
George Stoney (1826-1911) and the charge of the electron



George Johnstone Stoney FRS (1826-1911) was born in the townland of Oakley Park, Clareen, near Birr, Co. Offaly. He was educated at home and then at Trinity College Dublin, where he was awarded a BA degree in 1848. Following his degree he became an assistant to William Parsons the 3rd Earl of Rosse at Birr Castle, close to his childhood home in Co. Offaly. He competed for fellowship at TCD in 1851 but was unsuccessful. However, he was appointed to the chair of natural philosophy (mathematics) at Queen's College Galway in 1852, through the influence of his mentor. In 1857 he returned to Dublin in an administrative post in the Queen's University of Ireland (which was established in 1850, as the degree-awarding university of the Queen's Colleges of Belfast, Cork, and Galway that had been established in 1845). He continued in this post until 1882. He moved to London in 1893 on retirement. He continued his scientific work throughout his working life and continued to publish his scientific ideas into the 1890's. Stoney was electected FRS in 1861 and Royal Society vice-president in 1898. In 1899 he was the first person to be awarded the Boyle medal by the Royal Dublin Society, Ireland's most prestigious scientific award. George Francis Fitzgerald of TCD was the son of his sister, Anne Frances Stoney.

Stoney is best known as the originator of the name, 'electron', for the fundamental unit of electric charge. J. G. O'Hara has written an account of Stoney's work [1] on the kinetic theory of gases, emission of radiation of specific wavelengths by molecules through interaction of molecular vibrations with the ether and, especially, systems of units and values of fundamental physical constants, which led to his naming of the electron and many other topics.

Stoney was a member for at least 40 years of a British Association (BA) committee on electrical standards which sat between 1862 and 1912. Other distinguished members of the committee included William Thomson and James Clerk Maxwell [1]. In a paper first read at the Belfast meeting of the BA in 1874, Stoney introduced his own system of units based on three quantities which he designated, V_1, G_1 and E_1. V_1 is a velocity and is equal to the speed of light in free space (then believed to be its velocity in the ether), G_1 is the gravitational constant and E_1 is the fundamental unit of electric charge, now the charge of the electron. Stoney's estimate of the fundamental unit of charge was calculated using the amount of hydrogen gas released when water was 'electrolysed' by passing an electric current through it. Stoney's work on the kinetic theory of gases had previously led him to estimate of the number of gas molecules contained in a cubic millimetre [2]. Then, making the assumption that the quantity of electric charge contained in the hydrogen chemical bond was the fundamental charge, measuring the volume of hydrogen gas released by electrolysis and the quantity of electric current passed through the electrochemical cell, he was able to deduce the magnitude of the electric charge per chemical bond.

Regarding the unit of electric charge, Stoney commented [3],

'And, finally, Nature presents us, in the phenomenon of electrolysis, with a single definite quantity of electricity which is independent of the particular bodies acted on. To make this clear I shall express 'Faraday's Law' in the following terms, which, as I shall show will give it precision, viz—for each chemical bond which is ruptured within an electrolyte a certain quantity of electricity traverses the electrolyte which is the same in all cases. This definite quantity of electricity I shall call E_1. If we make this our unit quantity of electricity we shall probably have made a very important step in our study of molecular phenomena. Now the whole of the quantitative facts of electrolysis may be summed up in the statement that a definite quantity of electricity TRAVERSES THE SOLUTION FOR EACH CHEMICAL BOND THAT IS SEPARATED'.

The value that he arrived at was 10-20 ampere (which was at that time a unit of charge rather than electric current, as it is today). This was about one sixteenth of the modern value of 1.6 x 10^{-19} Coulomb. Millikan's famous oil drop experiment, in which electric charges on microscopic oil drops were measured, gave a more accurate value (within 0.6% of the currently accepted value) and was performed in 1909.

Communication between scientific communities of important new results is not always perfect. When the German physicist Hermann Ebert claimed in 1894 that, 'Von Helmholtz, on the basis of Faraday's law of electrolysis, was the first to show in the case of electrolytes that each valency must be considered charged with a minimum quantity of electricity, the 'valency-charge,' which like an electrical atom is no longer divisible.', Stoney strongly defended his claim to priority in identifying the electron as the fundamental unit of charge on the basis of electrolysis. In a letter to Philosophical Magazine [4] in 1894 he stated that he had already 'pointed out this remarkable fact', first at the Belfast meeting of the British Association in August 1874 and had read the same paper again before the Royal Dublin Society on 16 February 1881 and published the idea in the proceedings of that meeting and in Philosophical Magazine in May 1874 [3]. Helmholtz's announcement was made in his Faraday Lecture on 5th April 1881, subsequent to Stoney's addresses.

Stoney is best known for coining the name, 'electron', for the fundamental unit of electric charge. However, his scientific work ranged over many branches of physical science including physical optics, solar physics and astronomy, atmospheric physics, acoustics and molecular physics [1]. He clearly had great physical insight and imagination. This can be seen especially in his work on the origins of molecular spectra in which he proposed that electrons moving in elliptical orbits and interacting with the ether were responsible for emission of electromagnetic waves [5]. This last paper on the topic was published in 1891, two years after the publication [6], by his nephew, G. F. Fitzgerald, of the idea that bodies moving through the supposed ether contract in the direction parallel to their motion via mechanical forces, which has has become known as the Lorentz-Fitzgerald contraction, although the origin of the effect is explained instead by Einstein's special theory of relativity.

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Erasmus Smith's Professors of Natural and Experimental Philosophy

Erasmus Smith set up a trust for the advancement of education in Ireland. An endowment from this trust enabled Trinity College Dublin to establish and fund the Professorship of Natural and Experimental Philosophy.


Richard Helsham
1724-1738


Caleb Cartwright
1738-1743


William Clement
1745-1759


Hugh Hamilton
1759-1769


Thomas Wilson
1769-1786


Matthew Young
1786-1799


Thomas Elrington
1799-1807


William Davenport
1807-1822


Bartholomew Llyod
1822-1831


Humphrey Llyod
1831-1843


James MacCullagh
1843-1848


Robert Vickers Dixon
1848-1854


Joseph Allen Galbraith
1854-1870


John Robert Leslie
1870-1881


George Francis FitzGerald
1881-1901


William Edward Thrift
1901-1929


Robert William Ditchburn
1929 -1946


Ernest Thomas Sinton Walton
1946-1974


Brian Henderson
1974-1984


Denis Lawrence Weaire
1984-2007


John Michael David Coey
2007-2012


Jonathon Coleman
2022-present

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Richard Helsham 1724-1738

Richard Helsham was born in Kilkenny city in 1682. His father, Joshua Helsham, was mayor of Kilkenny (1692 - 1694). Helsham entered Trinity College Dublin in 1698, was elected a Scholar in 1700 and graduated BA in 1702, MA in 1705, MB (medicine) in 1710 and MD (medicine) in 1713. He was elected a Fellow of Trinity College in 1704 and became a senior Fellow in 1714. He became the first Erasmus Smith's Professor of Natural and Experimental Philosophy in 1724, which marked the beginning of professorships of physics in Trinity College. In 1730 he resigned his Fellowship and married Jane Putland, the widow of Dublin banker Thomas Putland, on the 16th of December. In 1733 he was appointed Regius Professor of Physic (medicine). Helsham was personal physician and close friend to Jonathan Swift, author of *Gulliver's Travels.* He wrote of Helsham, referring to him as *'The most eminent physician of this city and kingdom.'* [1] Helsham and his colleague, Bryan Robinson, consulted on Dublin's water supply and proposed a plan to improve it. In return, Helsham was granted the honour of freedom of the city. Helsham died on 1st August 1738 of a stomach tumour. Robinson published Helsham's lectures posthumously as *'Helsham's Course of Lectures on Natural Philosophy*' (1739). These were based on the work of Isaac Newton, but with an appealing simplicity of approach for undergraduates. It was used until 1849. Michael Clancy (writer, 1704-1776) wrote of Helsham, 'The only man to whom I owed any obligations, while I was at the university.'

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Caleb Cartwright 1738-1743

Caleb Cartwright was born around 1696 in Cork. He entered Trinity College on 7th July 1716. He graduated BA in 1720, MA in 1723 and DD (divinity) in 1735. He was elected a Fellow in 1724. He was Donegall Lecturer in Mathematics (1735-1738) and the second Erasmus Smith's Professor of Natural and Experimental Philosophy (1738 – 1743). He became Senior Dean in 1737. He died on 25th August 1763.

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William Clement 1745-1759

William Clement was born in Co. Monaghan in 1707. He entered Trinity College on 28th April 1722, aged just 14, and became a Scholar in 1724. He graduated BA in 1726, MA in 1731 and was elected a Fellow in 1733 and Senior Fellow in 1743. He graduated MB (medicine) in 1747 and MD (medicine) in 1748. He lectured on botany (1733-1763). He was the third Erasmus Smith's Professor of Natural and Experimental Philosophy (1745 to 1759). From 1750-1759 he was the Donegall Lecturer in Mathematics and he served as Vice-Provost from 1753 to 1782. In 1761 he was appointed Regius Professor of Physic (medicine). He was elected Member of Parliament (MP) for Trinity College in 1761 and MP for Dublin city (1771 to 1782). In the 18th Century, Fellows of the College were expected to be celibate. Clement, however, was 'secretly married' to Mary Coxe around the time that he was elected a Fellow. Later he obtained a royal dispensation to be married to Mary. He died on January 15th, 1782, and is buried in the chapel of Trinity College.

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Hugh Hamilton 1759-1769

Hugh Hamilton was born in Co. Dublin on 26th March 1729. His Father was Alexander Hamilton, who was Member of Parliament (MP) for Killyleagh. He entered Trinity College aged 14 on 17th November 1742. He graduated BA in 1747 and MA in 1750 and was elected a Fellow in 1751. He graduated BD in 1759 and DD (Divinity) in 1761. His book '*De sectionibus conicis tractatus geometricus*' (1758), concerning properties of conic sections, was well received. Euler in his book '*the Analysis of Infinties*' wrote '*There are but three perfect mathematical works; these are by Archimedes, Newton, and Hamilton.'* He was Erasmus Smith's Professor of Natural and Experimental Philosophy (1759 to 1769). He published philosophical essays on vapours, comets, and mechanics (1767) and in 1784 an essay in which he attempted to prove the existence of God. His textbook '*Four Introductory Lectures on Natural Philosophy*' was used in Trinity and Cambridge for fifty years. He was one of the founding members of the Royal Irish Academy. He became Dean of Armagh helping improve Armagh city by establishing a piped water supply and a county hospital. In 1796 he was appointed Bishop of Clonfert. He married Isabella Wood in 1772 and they had five sons and two daughters. He died on 1st December 1805 and was buried at St Canice's cathedral in Kilkenny. His descendants include Clive Staples Lewis, John Millington Synge and John Lighton Synge, academics and playwright, respectively.

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Thomas Wilson 1769-1786

Thomas Wilson was born in Co. Donegal in 1726 and educated in Co. Dublin. In 1743-1744 he enrolled in Trinity College at the age of 17. He became a Scholar in 1746 and graduated BA in 1748, MA in 1753, BD in 1758 and DD in 1764. He was elected a Fellow (1853) and served as Erasmus Smith's Professor of Natural and Experimental Philosophy from 1769 to 1786. He served as the Archbishop King's Lecturer (1785) and in 1786 became the Church of Ireland rector at Ardstraw, Co. Tyrone. He died on 22nd September 1799.

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Matthew Young 1786-1799

Matthew Young was born in 1750 in Castlerea, Co. Roscommon. He entered Trinity College in 1766 and became a scholar in 1769. He graduated BA in 1772, MA in 1774, BD in 1782 and DD in 1786. He was elected a Fellow in 1775. His tutors, Henry Ussher and Richard Murray, inspired his interest in physics. He is described as a 'staunch Newtonian' defending Newton's theory of sound in *'an enquiry into the principal phenomena of sounds and musical strings.'* He was the sixth Erasmus Smith's Professor of Natural and Experimental Philosophy (1786 - 1799). A collection of his lectures, *'An Analysis of the principles of Natural Philosophy',* was published in 1800. As one of the founding members of the Royal Irish Academy (RIA), he published several papers on topics such as algebra, optics, hydrodynamics, and Gaelic poetry in *Transactions of the Royal Irish Academy*. He had a keen interest in Irish literature. His translations of Irish manuscripts were the first Gaelic scholarship produced by the RIA. He married Anne Cuthbertson and they had several children. He was appointed Bishop of Clonfert in 1798 and died on 28th November 1800.

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Thomas Elrington 1799-1807

Thomas Elrington was born near Dublin on 18th December 1760. He entered Trinity College on 1st May 1775, aged 15, and became a scholar in 1778. He graduated BA in 1780, MA in 1785, BD in 1790 and DD in 1790. He was elected Fellow of Trinity College in 1781 and became Senior Fellow in 1795. He was the first Donnellan divinity lecturer (1794), Archbishop King's Lecturer in Divinity (1795), Donegall Lecturer in Mathematics (1790-1795), Erasmus Smith's Professor of Mathematics (1995-1799) and seventh Erasmus Smith's Professor of Natural and Experimental Philosophy (1799-1807). He edited several books, the most important of which was *'Euclidis Elementorum Sex Libri Priores, Cum Notis'* (1788). His own work includes *Sermons on Miracles* and *Letters on Tythes*.

He was granted permission by the chief secretary to break the rule of celibacy for Fellows and married Charlotte Preston in 1799. They had two sons and an unknown number of daughters. In 1801 he facilitated the transfer of 20,000 volumes from the Fagel library to the College library (a private Dutch library from the 17th and 18th centuries and an important asset of the College library today). He was one of five College Fellows to support the passing of the act of union in 1800. He became Church of Ireland rector of Ardtrea, Co. Armagh in 1806 but was recalled to Trinity in 1811 when he was chosen as Provost by the Lord Lieutenant of Ireland, the Duke of Richmond. He retired from Trinity in 1820 and became Church of Ireland Bishop of Limerick and later Leighlin and Ferns. He died on 12th July 1835 from paralysis, said to have been induced by sea sickness. His portrait hangs in the Fitzgerald Building in Trinity College.

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William Davenport 1807-1822

William Davenport was born in 1772 in Capel St, Dublin. He enrolled in Trinity College on 6th November 1787, aged 15. He became a Scholar in 1791 was elected a Fellow in 1795. He graduated BA in 1792, MA in 1796 and DD in 1808. From 1807 to 1822 served as the eighth Erasmus Smith's Professor of Natural and Experimental Philosophy. He was Archbishop King's Lecturer in 1815. He was Director of the Armagh Observatory and incumbent at the parish of Clonfeacle, Co. Tyrone, from 1815 until his tragic death in 1823.

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Bartholomew Lloyd 1822-1831

Bartholomew Lloyd was born in 1772 in New Ross, Co. Wexford. He enrolled in Trinity College on 28th June 1787, aged 15 and became a Scholar in 1790. He graduated BA in 1792, MA in 1796, BD in 1805, and DD in 1808. He became a Fellow in 1796 and the Donnellan Lecturer in 1807. He was appointed the Erasmus Smith's Professor of Mathematics in 1813, despite being a Junior Fellow at the time. He began reforming the teaching of mathematics, introducing the latest developments in mathematics from French mathematicians such as Laplace and Poisson. In 1822 he became the Erasmus Smith's Professor of Natural and Experimental Philosophy, serving until 1831. He was appointed Archbishop King's Lecturer in 1823 and 1827.

Lloyd was appointed Provost of Trinity College in 1831. His reforms included: reorganising the tutorial system, introducing three academic terms, excluding certain professors from tutorial duties and increasing their salaries. Opposition arose as one of those who stood to benefit was the incoming Erasmus Smith's Professor of Natural and Experimental Philosophy and Lloyd's son, Humphrey, was a leading candidate. Humphrey would later also become Provost. The increase in salaries was greatly beneficial as professors could focus on lectures and research rather than needing additional work to make a living. Lloyd also approved the construction of new buildings in Front Square, the construction of a magnetic observatory, and the distinction between pass and honours courses. Sir William Rowan Hamilton claimed that Lloyd's *'Treatise on analytic geometry'* (1819) inspired him to pursue his scientific career. He was married to Eleanor McLaughlin and they had four sons and six daughters. Lloyd died suddenly on 24th November 1837 and is buried in the College chapel. His portrait hangs in the Fitzgerald Building in Trinity College.

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Humphrey Lloyd 1831-1843

Humphrey Lloyd was born in Dublin on 16th April 1800 to Bartholomew Lloyd (a future Provost of Trinity) and Eleanor McLaughlin. He was educated at White's School in Dublin and enrolled in Trinity College on 3rd July 1815, aged 15, becoming a Scholar in 1818. He graduated BA in 1820, MA in 1827, BD and DD in 1840. He was elected a Fellow in 1824. In 1831 he succeeded his father as the tenth Erasmus Smith's Professor of Natural and Experimental Philosophy, serving until 1843.

He worked mainly in the field of optics, making his most notable discovery in 1833. William Rowan Hamilton had earlier predicted that a ray of light emerging from a biaxial crystal would be refracted into a cone of rays, a phenomenon known as conical refraction. Lloyd was able to observe conical refraction from a crystal of the mineral aragonite. A demonstration of conical refraction can be seen in the current Tercentenary Exhibition. He assumed responsibility for the magnetic observatory in Trinity and carried out magnetic surveys of Ireland under the auspices of the British Association and the Royal Society. Observing stations were set up in Britain and India to take geo-magnetic measurements such as vertical and horizontal components of the Earth's magnetic field and its inclination. In 1841, along with James McCullagh and Thomas Luby, he recommended that a school of civil engineering be established in Trinity, which was achieved later that year. From 1846 to 1851 he served as the president of the Royal Irish Academy. In 1867 he was elected as the Provost. He encouraged research as a principal function of the College. His publications include *'A treatise on light and vision'* (1831), '*Lectures on the wave theory of light*' (1836 and 1841), and '*The elements of optics*' (1849). Over his career he published 8 books and 64 papers. He married Dorothea Bulwer in 1840; the couple had no children. He died on 17th January 1881 in the Provost's house. His portrait hangs in the Fitzgerald Building in Trinity College.

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James MacCullagh 1843-1848

James MacCullagh was born in 1809 in Landahussy townland, Co. Tyrone. His father, also James MacCullagh, was a farmer. He was educated at the parish school in Castledamph and in Strabane, Co. Tyrone. He enrolled in Trinity College in November 1824, aged 15, becoming a Scholar in 1827. He graduated BA in 1829, MA in 1836. After two failed attempts, he was elected a Fellow in 1832. In 1835 he was appointed the Erasmus Smith's Professor of Mathematics. He earned LLB and LLD degrees in 1838. He was appointed Erasmus Smith's Professor of Natural and Experimental Philosophy in 1843, serving until 1847. In 1841, along with Humphrey Lloyd and Thomas Luby, he recommended the establishment of a school of civil engineering in Trinity. His career was cut short by his tragic death, aged 38.

MacCullagh is mainly known for his work on optics, but also on geometry. His most important contribution to optics was, *'An essay towards a dynamical theory of crystalline reflexion and refraction'* (1838) which provided a framework for accurately describing a broad range of physical optics. The paper begins by defining a new concept, what was later named the curl of a vector field, by James Clerk Maxwell. His most important contribution to geometry, '*On surfaces of the second order'*, was published in 1843.

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Robert Vickers Dixon 1848-1854

Vickers Dixon was born in Dublin on 22nd October 1812. He enrolled in Trinity College in 1827, aged 15. He graduated BA in 1833, MA in 1839, BD and DD in 1862. In 1838 he was elected a Fellow of the College. He served as Erasmus Smith's Professor of Natural and Experimental Philosophy from 1848 to 1854. Dixon was a Fellow and professor during the Irish famine (1845-1852). In 1849 he published a book '*A treatise on heat*'. In 1853 he became rector of Clogherny parish in Co. Tyrone and sometime after that, the Archdeacon of Armagh. He died on 14th May 1885.

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Joseph Allen Galbraith 1854-1870

Joseph Allen Galbraith was born in Dublin on 29th November 1818. His father was a Scottish Presbyterian and merchant who died while he was a child, leaving him to support himself. He enrolled in Trinity College on 3rd November 1834, aged 16. He graduated BA in 1840, MA in 1844 and was made a Fellow in 1844. In 1845 he was elected to the Royal Irish Academy and in 1846 made a deacon of the Church of Ireland. He served as Junior Dean from 1847-1848. In 1854 he was appointed Erasmus Smith's Professor of Natural and Experimental Philosophy and served until 1870.

As Erasmus Smith's professor, he and Samuel Haughton created a series of manuals on physics and mathematics, which were eventually introduced as textbooks to schools and colleges in Ireland and England and continued to be printed into the 1900's. Galbraith was a popular professor and would often invite student groups to his summer home for discussion. In 1851 Galbraith and Haughton constructed an 11-metre Foucault's pendulum to replicate the famous experiment performed in Paris. During the 1860s, he along with Samuel Haughton, performed multiple land surveys of Dublin to prove that a canal system was the best option for the city's water supply. This was in opposition of the proposed Vartry reservoir scheme.

He became active in Irish politics in the early 1860's and he is credited with inventing the term, 'Home Rule'. He helped found the Home Government Association in 1870. He listened avidly to speeches by Daniel O'Connell. He was a freemason and served as Grand Chaplain of the Freemasons in the 1850s. His political views affected his career in Trinity. After serving as Erasmus Smith's professor, he did not hold an office in Trinity College until 1880, when he was finally elected Senior Fellow. He was an active member of the Irish National League founded by Charles Stewart Parnell in 1882. He died on 20th October 1890.

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John Robert Leslie 1870-1881

John Robert Leslie was born in 1831 near Timoleague, Co. Cork. He enrolled in Trinity College on 1st July 1847, aged 16. He graduated BA in 1852, MA in 1856, DD in 1862 and earned Fellowship in 1858. He served as the Erasmus Smith's Professor of Natural and Experimental Philosophy from 1870 to 1881. In 1871 the moderatorship curriculum for physics was improved. Two moderatorships were offered, one in Experimental Science (physics, chemistry, and mineralogy), and another in Natural Science (geology, zoology, and botany). This moderatorship structure persisted until 1955.

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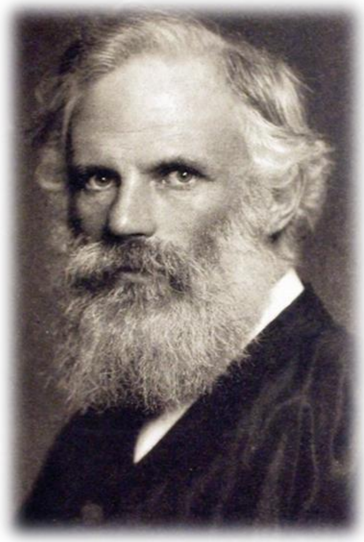
George Francis Fitzgerald 1881-1901



George Francis Fitzgerald was born on 3rd August 1851. He grew up in Monkstown, Co. Dublin. His father, William Fitzgerald, was a curate in the Church of Ireland in Monkstown and his mother, Anne Frances, was the sister of George Johnstone Stoney, the Irish physicist known for introducing the term *electron* and a graduate of Trinity College. He did not attend school but was tutored by Mary Ann, sister of George Boole along with his brothers and sisters. Fitzgerald proved himself to be an exceptional student in arithmetic and algebra. He began studying mathematics and experimental philosophy at 16 in Trinity. He graduated in 1871, top of his class. Fitzgerald became a Fellow in 1877 and was appointed Erasmus Smith's Professor of Natural and Experimental Philosophy in 1881.

Following his graduation, Fitzgerald spent his time studying the works of Hamilton, Lagrange, and Laplace. Maxwell published his equations of electromagnetism during this period. Fitzgerald, together with Oliver Heaviside and Oliver Lodge (the 'Maxwellians' of the book by Bruce Hunt) spent much of the rest of his life pursuing an understanding of light. Fitzgerald helped lay the basis of wireless telegraphy when he concluded that an oscillating electric current produces electromagnetic waves. This was verified experimentally by Heinrich Hertz.

Fitzgerald's name is associated with the Lorentz-Fitzgerald contraction in the special theory of relativity by Einstein. The Michelson-Morley experiment in the 1880s resulted in failure to detect the existence of the ether, a medium in which light was believed to exist. Fitzgerald in 1889 and, later, Hendrik Lorentz in Leiden, proposed that a body in motion through the ether is shorter (contracted) than when at rest. This contraction was proposed to explain the failure to detect the presence of the ether by Michelson and Morley. Subsequently, Lorentz developed the idea of a Lorentz transformation in which the geometry of space-time itself depends on relative motion rather than the mechanical effect initially proposed by Fitzgerald and Lorentz.

When Fitzgerald was appointed Erasmus Smith's professor, he used a disused chemical laboratory to begin teaching Experimental physics as there was no teaching of practical physics in Dublin at that time. Fitzgerald also had a strong belief in education once stating that *'The function of the University is primarily to teach mankind'* then further stating *'Are the Universities to devote the energies of the most advanced intellects of the age to the instruction of the whole nation, or to the instruction of the few whose parents can afford them an - in some places fancy - education that can in the nature of things be only attainable by the rich?'* [3]. In 1898 he was the Commissioner of National Education in Ireland with hopes of reforming education by introducing more practical topics for primary education. Fitzgerald also wished for the 'modernisation' of Trinity College and supported women in higher education. Fitzgerald was secretary of the Royal Dublin Society for 8 years and attended meetings of the British Association, now known as the British Science Association. He was awarded Fellowship of the Royal Society in 1883 and the Royal Medal of the Society in 1899 (awarded to those who make outstanding achievements in their field). Fitzgerald married Harriette Mary Jellett in 1885, daughter of the Provost of Trinity. They had five daughters and three sons. He died on 22nd February 1901, after an operation due to a digestive complaint. His portrait hangs in the library of the Fitzgerald Building in Trinity College.

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William Edward Thrift 1901-1929

William Edward Thrift was born on 28th February 1870 in Halifax, Yorkshire. He moved to Dublin during his childhood as his father was an officer in the Inland Revenue. He entered Trinity College, aged 19, in 1889. In his Junior Freshman year (1890), he earned a scholarship in mathematics. He graduated BA in 1893, top of his class, with gold medals in mathematics and experimental science. He was elected a Fellow in 1896. Thrift was assistant to his predecessor, George Francis Fitzgerald. After Fitzgerald's early death, Thrift was appointed 16th Erasmus Smith's Professor of Natural and Experimental Philosophy, serving from 1901 to 1929.

Though the new Physical Laboratory facilities designed by Fitzgerald were completed in 1906, research stagnated during Thrift's tenure. Ernest Walton recalled that the lectures given by the department were a decade out of date. While he had a distinguished undergraduate career, his strengths were in administration and in sports rather than academic research. Thrift served as Vice-Provost from 1935-7 and as Provost from 1937-42. He was a director of Trinity's social services company, a charity, which acquired property to house the poor; he was the first chairman of the Dublin University Central Athletic Committee (1919-37) after its revival; he was an accomplished cyclist, winning many races; he served as the TD for the constituency of Dublin University (1922-37) until university representation was abolished in 1937. He was a council member for the Royal Dublin Society (1902-42). He died on 23rd April 1942.

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Robert William Ditchburn 1929-1946

Robert William Ditchburn was born on 14th January 1903 in Waterloo, Lancashire. He attended Bootle Grammar School where his father was headmaster. Aged 16 he earned a scholarship to Liverpool University. He graduated BSc Hons in 1922. He did his PhD in the Cavendish Laboratory, Cambridge working on the absorption of light by potassium vapours. After his PhD, he applied for Fellowship in Trinity College Dublin, the first instance where candidates from other universities could apply. Ditchburn was successful and criteria for election to Fellowship now included submitted work already completed and the candidate's future promise. He was appointed Erasmus Smith's Professor of Natural and Experimental Philosophy in 1929, serving until 1946.

Ditchburn immediately took on reorganisation of the experimental physics course. He submitted a report to the College Board, giving the course greater structure, doubling the time Senior Sophisters spent doing research work, and reducing the experimental work done by theoretical physicists, instead requiring additional coursework and reading on relativity and quantum mechanics. Ditchburn published 35 papers on subjects including vacuum technology, the uncertainty principle, the retina of the eye, the refugee problem, and continued his work on the absorption of light by potassium vapours, during his tenure as Erasmus Smith's professor. He was elected a member of the Royal Irish Academy in 1930. He returned to England in 1946 as head of the physics department at Reading University, until 1968. His textbook, *'Light'* (1953), was a standard text on the subject for many years. He died on 8th April 1987.

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Ernest Thomas Sinton Walton 1946-1974

Ernest Thomas Sinton Walton was born on 8th October 1906 in Dungarvan, Co. Waterford. His father was a Methodist minister leading the family to move every three years. While studying at Methodist College Belfast he excelled in science and mathematics. He entered Trinity College in 1922 on a sizarship. He graduated BA in 1926 and MA in 1927 and was awarded the MacCullagh prize. Thereafter he was accepted as a research student under the supervision of Ernest Rutherford in Cambridge. Rutherford had worked on transmutation of nitrogen into oxygen when bombarded with alpha particles. Walton suggested artificially producing charged particles to induce the transmutation by accelerating particles using high voltages. Walton's work on generation of high energy electrons contributed to development of the betatron particle accelerator in 1929. Walton was awarded his PhD in 1931. In 1932 Walton and John Cockcroft, working together in Cambridge, succeeded in producing artificial nuclear disintegration, for the first time. This 'splitting of the atomic nucleus' by accelerated protons initiated a new branch of physics in particle acceleration and verified Einstein's relation $E = mc^2$, relating the energy and mass of a particle and the speed of light. Walton and Cockcroft won the Nobel Prize for physics for this work in 1951.

Walton returned to Trinity in 1934 where he was elected to Fellowship without exam on the merit of his published work and appointed professor in Experimental physics soon after. He became the 18th Erasmus Smith's professor of Natural and Experimental Philosophy in 1946. Walton built up the Trinity physics department, hiring several new lecturers. He was known as an excellent teacher, explaining complex topics in understandable terms. New undergraduate syllabuses were created in the late 1950s, including nuclear physics, acceleration of charged particles, and modern solid-state physics. The number of students in the department increased, so that lectures had to be duplicated. In 1950 Walton and Robert Elliot built a Van de Graaff accelerator in Trinity, however its success was limited by available resources and damp weather.

Walton was invited to participate in scientific war work, both in Britain and the United States. The latter invitation was to join the Manhattan project, which led to the development of the atomic bomb. Walton had strong pacifist views and declined both invitations; later he was a member of the Pugwash Group (and president of the Irish section), a society of scientists concerned about the threat of nuclear weapons to humanity. Walton died in Belfast on 25th June 1995 after inspiring generations of physicists at home and abroad. His portrait hangs in the Fitzgerald Building in Trinity College.

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Brian Henderson 1974-1984

Brian Henderson was born on 26th March 1936 in Doncaster, Yorkshire. He was educated at Maltby Grammar School before continuing his education at the University of Birmingham. He obtained a BSc in 1958 and a PhD in 1960. He worked as a senior science officer in Harwell Atomic Energy Research Establishment in 1962 before joining Keele University in 1968. In 1974 he became the 19th Erasmus Smith's Professor of Natural and Experimental Philosophy in Trinity, serving until 1984, was elected a Fellow in 1976. He was a solid-state physicist working on spectroscopic properties of point defects and paramagnetic ions in condensed matter. Shortly after his arrival, Henderson secured a grant for £30,000 to purchase research equipment, a sum unheard of at Trinity at that time. Henderson introduced extended project work for Senior Sophisters replacing their Laboratory classes. Henderson strongly supported the founding of the Dublin University Physical Society. He moved to Strathclyde University in Scotland in 1984. He left the Trinity physics department flourishing through hiring a significant number of new academic staff, something that was unimaginable for the department decades before. He died on 20th August 2017.

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Denis Lawrence Weaire 1984-2007

Denis Weaire was born in 1942. He was a student and Fellow at Clare College, Cambridge where he graduated with a BA in 1964 and a PhD in 1968. He worked in the United States at Harvard and Yale before taking up professorships in Heriot-Watt University and University College Dublin. In 1971 while at Harvard University with Michael Thorpe, they developed the Weaire-Thorpe model for computation of the electronic structure of amorphous silicon. Weaire was appointed Erasmus Smith's professor of Natural and Experimental Philosophy in October 1984, a position he held until 2007. Weaire's research interests include computational physics, amorphous materials, electronic structure, magnetic devices, soft condensed matter, history of science and especially, properties of foams.

Weaire was elected a Fellow of the Royal Society and a Member of the Royal Irish Academy. He served as president of the European Physical Society from 1997 to 1999. He was also vice-president of Academia Europaea and the Institute of Physics. In 1994 he co-founded Magnetic Solutions Ltd, a company still in operation which sells a wide range of magnetic products. In 2002 he received the Cecil Powell Memorial award from the European Physical Society. In 2005 he was awarded the Cunningham Medal from the Royal Irish Academy. He received the Hollingweck Medal from the Institute of Physics and French Physical Society in 2008. In 1984 he helped organise the first physics conference on foams.

Weaire has authored over 350 publications. This includes several books such as *'The Physics of Foam'* with Stefan Hutzler, *'The Pursuit of Perfect Packing'* with Tomaso Aste, and *'George Francis Fitzgerald.'* His most notable publication comes from a 1994 paper regarding the structure of foam. The *'Weaire -Phelan'* structure overturned conjectures on the structure of the minimal energy foam structure by Lord Kelvin a century before. The Weaire-Phelan structure has the minimal energy structure of any known foam structure of equal-sized bubbles in three dimensions. The structure was used in the building of the Beijing National Aquatic Centre built for the 2008 Beijing Olympics. Weaire retired in 2007 and continues to work with the foams and complex systems group in Trinity College.

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John Michael David Coey 2007-2012

Michael Coey was born in Belfast in 1945. In 1966 he received his BA from Cambridge and in 1971 received his PhD from the University of Manitoba. Coey's thesis was on the *'Mossbauer Effect of ^{57}Fe in Magnetic Oxides'*. Shortly after receiving his PhD he was appointed to a position with the Centre National de la Recherche Scientifique in Grenoble, France where he investigated metal-insulator transitions in NiS and $Ti_{40}O_7$. Coey moved to Trinity in 1978. In 1987 he was awarded a ScD by Trinity College and began working as the professor of experimental physics. He co-founded Magnetic Solutions Ltd in 1994. From 1984 to 1994 he co-ordinated the Concerted European Action on Magnets. He was appointed Erasmus Smith's Professor of Natural and Experimental Philosophy in 2007, serving until 2012.

His books include: *'Rare-earth Iron Permanent Magnets'* (1996), *'Permanent Magnetism'* with Ralph Skomski (1999). One of his most influential works in the field is an iron-based rare-earth magnet, $Sm_2Fe_{17}N_3$, which he discovered alongside his graduate student Sun Hong. He was a founding scientist of the Science Foundation Ireland funded Centre of Research on Adaptive Nanostructures and Nanodevices (CRANN) and Centre for Advanced Materials and Bioengineering Research (AMBER). New funding streams spurred development of the Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN) and the Science Gallery, conceived by Coey. In 2003 he became a Fellow of the Royal Society and in 2005 he was awarded the Gold Medal of the Royal Irish Academy. Coey has over 800 publications, mainly in the field of magnetism, condensed matter, and materials science and is one of Ireland's most cited scientists. His portrait hangs in the Fitzgerald Building in Trinity College.

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4. *J.M.D. Coey at the Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN) in Dublin, Ireland. Courtesy of John Kelly.*

Jonathan Nesbit Coleman 2022-present

Jonathan Coleman was born in 1973. He graduated BA Mod. in 1995 and PhD in 1999 at Trinity College, where he worked with Werner Blau in experimental nanoscience. He became a lecturer in Trinity in 2001. He was appointed professor of chemical physics in 2012 and Erasmus Smith's Professor of Natural and Experimental Philosophy in 2022. The chair had been vacant since Michael Coey's tenure ended in 2012. He was elected a Member of the Royal Irish Academy in 2015. He was the Science Foundation Ireland researcher of the year in 2011.

Coleman's research interests include nanomaterials, carbon nanotubes, nanowires and two-dimensional (2D) nanosheets. His most notable work is on liquid phase exfoliation, a method of separating atomically thin layers of two-dimensional materials in solution. These layers have important applications in many fields including electronics and catalysis, thin films, coatings, and composites. This was pioneered by his research group in 2008. This method is currently used to produce over 60% of the world's graphene, which consists of single layers of carbon in a honeycomb network. He is one of the most cited material scientists globally and the most cited physicist in Ireland.

Sources

1. Trinity Research (2019), Professor Jonathan Coleman, TCD, https://www.tcd.ie/research/profiles/?profile=COLEMAJ
2. Amber Centre (Accessed July 2023), Jonathan Coleman, In Amber Centre, https://ambercentre.ie/people/jonathancoleman/
3. Research Gate (Accessed July 2023), Jonathan Coleman, In Research Gate https://www.researchgate.net/profile/Jonathan-Coleman
4. Image of Jonathon Coleman*, Downloaded from https://www.ria.ie/jonathan-nesbit-coleman*

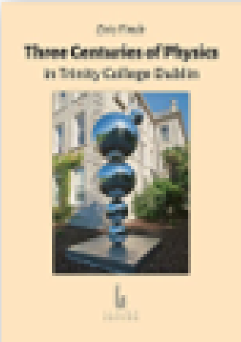
Trinity Monday Memorial Discourses

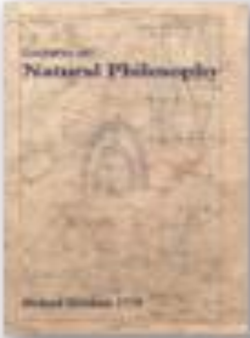
Over the decades Trinity Physics Graduates, Scholars and Fellows have been remembered and honoured in Trinity Monday Memorial Discourses. The presenters have captured the essence of the character and legacy of these wonderful scientists.

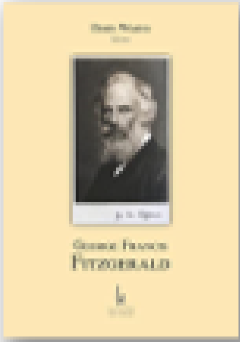
A list of the available Discourses on Trinity Physicists is given below. and we invite you to read more at https://www.tcd.ie/Secretary/FellowsScholars/discourses/. In 2024 the memorial discourse will be presented by Prof. Werner Blau. He will recall two Trinity Physicists from the recent past, Daniel Bradley and Brian Henderson. Both men played pivotal roles in determining the direction of the School of Physics in the later part of the twentieth century.

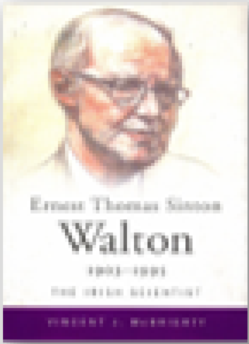
Year	Speaker	Discourse
2023	W. Blau	Lights of Change – Trinity Physics in the 1980s under Brian Henderson (1936-2017) and Daniel Bradley (1928-2010)
2015	J. Lunney	James MacCullagh
2012	V. McBrierty	E.T.S. Walton *Nobel Laureate*
2009	P. Florides	John Lighton Synge
2007	P. Wyse Jackson	John Joly
2005	I. McGovern	William Rowan Hamilton
2000	J.M.D. Coey	George Francis Fitzgerald
1990	D. Weaire	Thomas Preston
1986	J.V. Luce	William Molyneaux
1984	G.L. Herries-Davies	Robert Stawell Ball
1981	T.D. Spearman	Humphrey Lloyd
1968	Lord Rosse	William Parsons *Third Earl of Rosse*
1958	J.H.J. Poole	John Joly

Historical Books by Trinity Physics Academics

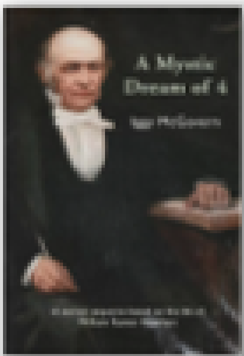








Poetry Collections



Available to purchase through the School of Physics online from various outlets.
https://www.tcd.ie/physics/books/