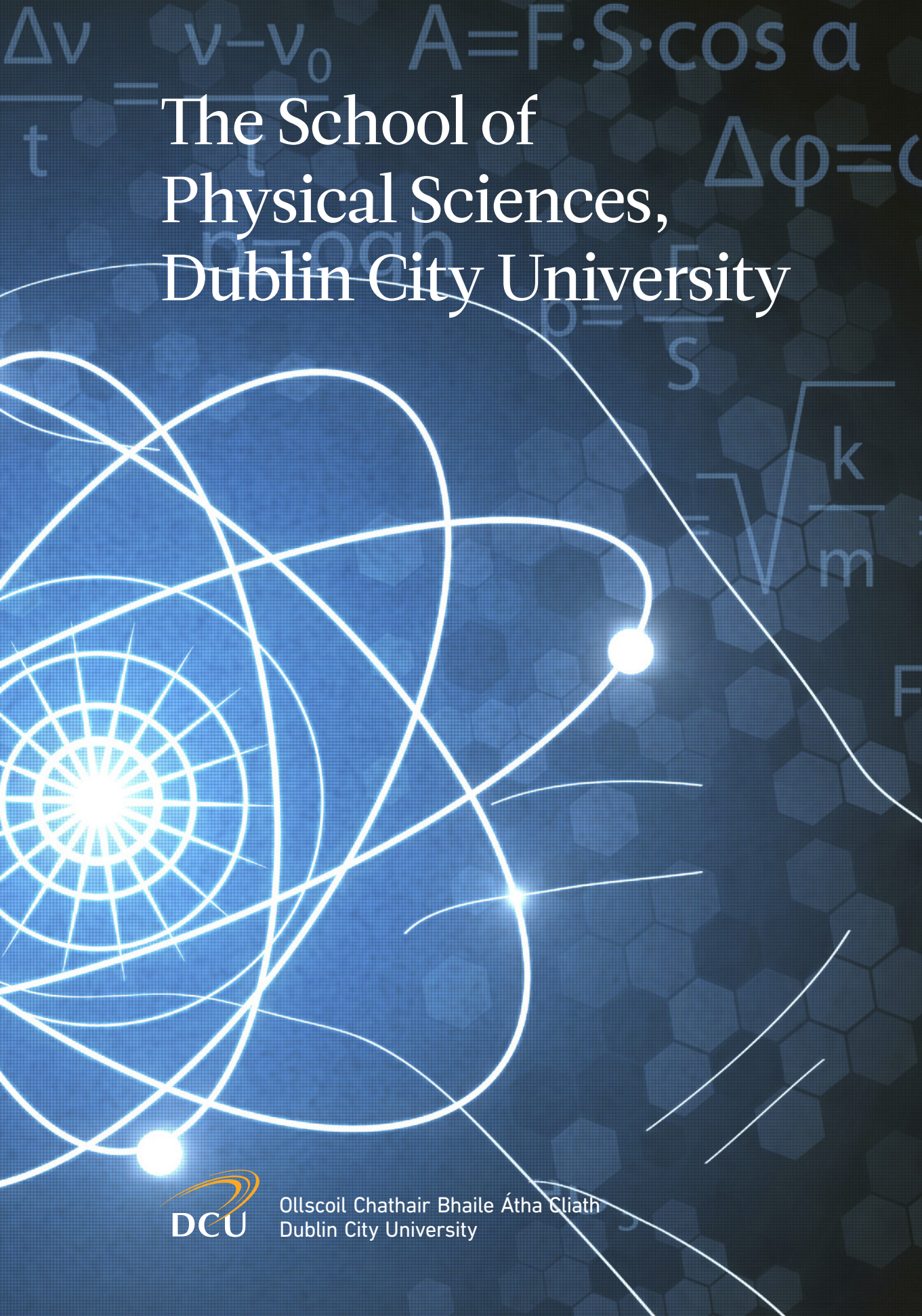
The School of Physical Sciences, Dublin City University



DCU

Ollscoil Chathair Bhaile Átha Cliath
Dublin City University

About us

The School of Physical Sciences undertakes to meet the scientific and career goals of our undergraduate students by providing top tier classroom, laboratory and computer/IT facilities. We also offer exciting and internationally competitive research opportunities. The School was established in 1980 and graduated its first B.Sc. (Hons) class and its first postgraduate research student in 1985. Since then, almost 1000 students have graduated from the School at B.Sc., M.Sc. and Ph.D. levels. We take great pride in the achievements of all of our graduates and many have gone on from DCU to play key roles nationally and internationally in research, education, industry and other professional domains.

Today the School has 15 academic staff members, in addition to technical, IT, administration and emeritus staff. There are around 200 undergraduate students studying on denominated undergraduate physics degree programmes, in addition to around 40 postgraduate research students studying towards M.Sc. or Ph.D. degrees and the School also teaches service courses to students studying in various disciplines right across the university. The School also hosts various research visitors from around the world, funded by a range of sources, including Fulbright scholarships. We believe that the totality of the School's activities provides a student-centred, dynamic, supportive and exciting environment in which to work and study. Two of DCU's four National Research Centres, in Plasma Science and Technology (NCPST) and Sensors (NCSR) and DCU's largest Science Foundation Ireland Centre (Biomedical Diagnostics Institute) were established by School Professors and the School remains a major contributor to these and other key research areas in the university.

The School's activities strongly align with and support the overall University Strategic Plan in terms of academic excellence, educational transformation, engagement with enterprise and translation of knowledge for societal and economic benefit.

Teaching and Learning

The School has a long tradition of providing a first class education in physics at both undergraduate, taught postgraduate and research postgraduate levels. This is embodied in the range of programmes offered by the School at undergraduate level, specifically B.Sc. (Hons.) Programmes in (i) Applied Physics, (ii) Physics with Biomedical Sciences and (iii) Physics with Astronomy, all accredited by the Institute of Physics, UK. This is in addition to an Undergraduate Certificate in Fundamentals of Plasma and Vacuum Studies and a taught postgraduate programme, the M.Sc. in Plasma and Vacuum Technology. The School also contributes strongly to a range of other undergraduate and postgraduate taught programmes in the area of Science Education, as well as providing service teaching to programmes across the university. Finally, the School has recently established a structured PhD programme for research postgraduate structured education, to reflect the recent developments in 4th level education.

Undergraduate Programmes	**Year established**
B.Sc. in Applied Physics (AP)	1980
B.Sc. In Physics with Astronomy (PHA)	2003
B.Sc. In Physics with Biomedical Sciences (PBM)	2007

The School contributes in a substantial and ongoing manner to the DCU key strategic objective of transforming our students' lives by equipping them to flourish in 21st Century society, and equipping them based on academic excellence in terms of disciplinary provision via the programmes above, as well as pro-actively engaging with the constituent DCU and Faculty strategic plans for teaching/learning to bring on-stream new content and methodologies which enhance and enrich the overall student experience. These activities also contribute to our translation, enterprise and engagement principles, which form a core part of DCU's vision to be internationally recognised as the University of Enterprise.

Key areas of focus in our vision for Teaching and Learning in the School include:

Interaction between Teaching and Research

- Final year Physics students carry out research projects which are embedded across the Research Groups in the School.
- The Year 3 Laboratory programme for Physics with Biomedical Sciences students is embedded in the Microfluidics Research Group of the School of Physical Sciences and the BDI.
- The School of Physical Sciences is working with the Centre for Advancement of STEM Teaching and Learning (CASTeL) to embed assessment strategies within physics and science education modules, informed by the EU research project, SAILS.
- The School of Physical Sciences and CASTeL are also working to integrate research in effective science communication with undergraduate and postgraduate learning.

Teaching Enhancement Framework

- The School is partnering with CASTeL to provide support for science laboratory tutor training and peer mentoring for postgraduate students to enhance the undergraduate student laboratory experience and ease the transition from second to third level education.

Generation 21 and Enhanced Employability

- The School is working to integrate key elements of Professional Development in the Years 1 - 4 Laboratory/Project modules for the Physics programmes, to include CV training, interview skills and practice interviews, Scientific writing and Science communication.
- The School works with an External Advisory Panel which includes academic, enterprise and industry representatives and which informs future developments in our Physics programmes.

Pioneering developments in STEM Education and Interdisciplinarity

- The School and CASTeL are involved in international collaborations in the teaching and learning of introductory and intermediate level university physics which will allow developments in the School to be guided by international educational research. One example is the 'guided inquiry' approach which is being used by the School for the teaching of electromagnetism. A further instance is the collaboration with the School of Mathematical Sciences in a research-led teaching project to enhance the learning of differential equations by physics students.

- The School is also working with CASTeL to develop the use of visualisations and alternative representations in STEM education in the Science Education (SE) physics and chemistry laboratory, again allowing developments in the School to be guided by international research developments.

21st Century Learning

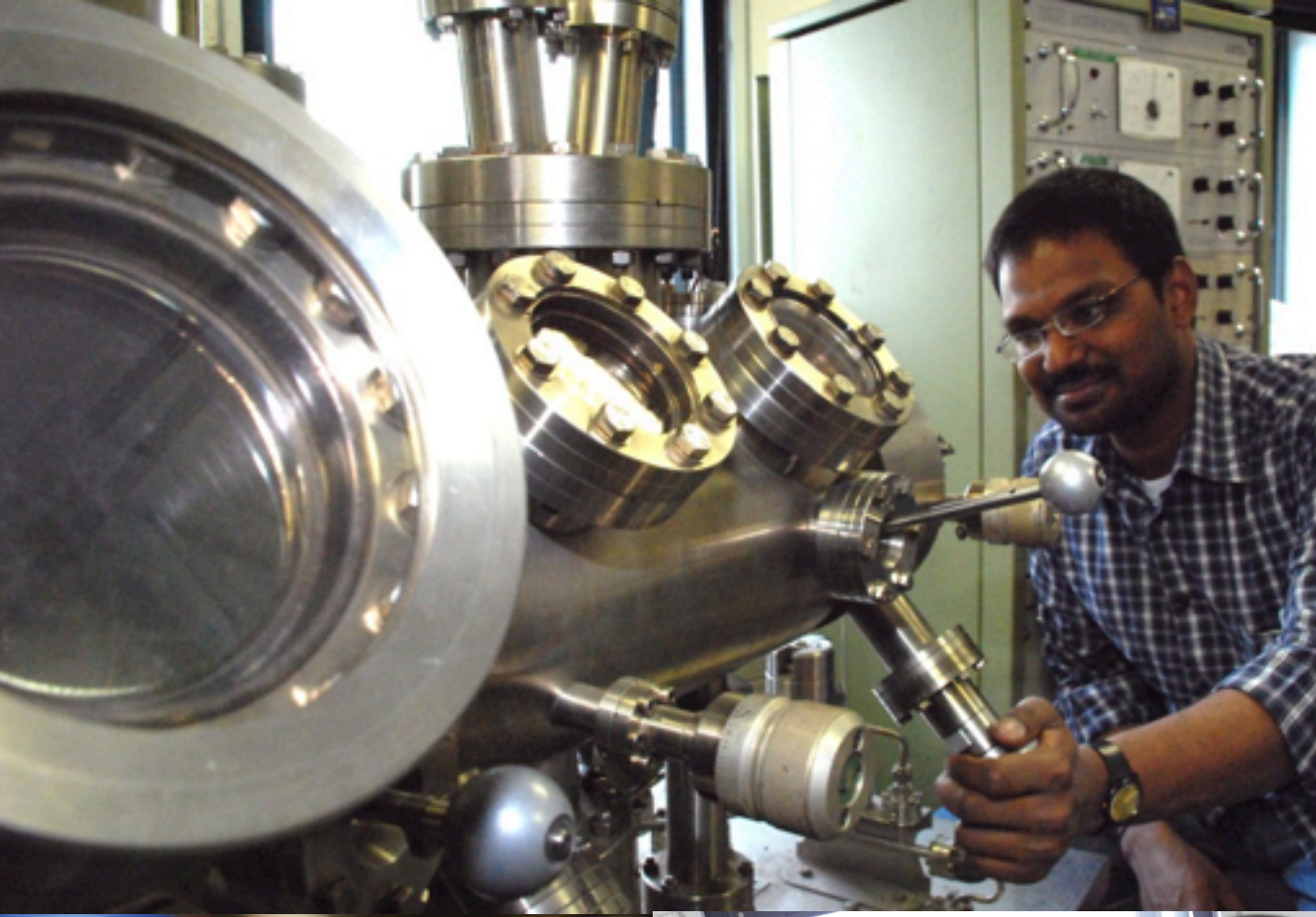
- With CASTeL, the School is integrating research in blended and digital learning with teaching and learning practices for Science Education students.
- The School is reviewing and updating its online, blended Undergraduate Certificate in Fundamentals of Plasma and Vacuum Studies and the taught postgraduate programme, the MSc in Plasma and Vacuum Technology.

Structured PhD Programmes

- The School launched its Structured Ph.D. Programme in the academic year 2015/2016.
- We are collaborating with other Schools in the Faculty on the development and implementation of an accredited postgraduate training module in Laboratory tutoring.

Entrepreneurship/Engagement

- The School works proactively with the INTRA Office to maximise the benefit of the INTRA experience, including fostering longer term engagement, e.g. 4th year projects and research collaborations.
- The School encourages students to engage with DCU's student entrepreneur start-up competition, UStart, and supports students who enter this event and other such events.



Research and Scholarship

The research activities within the School of Physical Sciences are well aligned with DCU's reputation as being Ireland's University of Enterprise through strong active links with academic research and industrial and enterprise partners. The research conducted in the School contributes, both in terms of the core foundation of academic excellence valued by the university, as well as contributing to our translation, enterprise and engagement principles. The research activities span experimental and theoretical studies of Intense Laser-Matter Interactions, Astronomy, Experimental, Applied and Computational Plasma Physics, Nanomaterials and Semiconductors, Surface and Interface Physics, Optical Sensors, Biosensors and Microfluidics and Physics Education Research.

These activities can be grouped into the following four research areas:

Atomic Physics and Astronomy Research (Prof John Costello, Dr Jean-Paul Mosnier, Dr Patrick Hayden, Dr Masha Chernyakova)

The Atomic and Laser Plasma Group is one of the few research groups, globally, to gain competitive access to the world-leading short wavelength Free Electron Laser (FEL) facilities in Germany and in Stanford in the US. The group has recently made seminal contributions in atomic physics using X-ray FELs in prestigious journals such as Nature Physics, Nature Photonics, and Nature Communications. The DCU Astrophysics Group focuses on high-energy astrophysics and works in close collaboration with Irish and international astrophysical research groups – including Dublin Institute for Advanced Studies (DIAS), University College Dublin (UCD), ISDC (Switzerland) and APC (France).

Materials and Plasma Physics Research (Prof Miles Turner, Prof Greg Hughes, Prof Enda McGlynn, Dr Tony Cafolla, Dr Bert Ellingboe, Dr Paul Swift, Dr Robert O'Connor)

The Plasma Group works extensively with engineers in academia and industry to exploit its research endeavours which include the development of optical plasma diagnostics and the use of plasmas for thin film growth. The Plasma Research Laboratory is currently commercialising its technologies, engaging with world-leading manufacturers and equipment providers, and focusing on the application of high frequency plasma sources for advanced display and semiconductor device manufacturing. It also has an interest in more exotic plasma applications in the field of magnetically confined plasmas for generating energy by nuclear fusion.

The Materials Group is carrying out pioneering work on optical properties of defects in semiconductors using radioactive isotopes at the CERN labs, undertaking ground-breaking work on high-k dielectrics which will impact on future electronic device development and researching the use of sunlight to split water for hydrogen fuel production. Research on the characterisation of organic nanostructures on metal and semiconductor surfaces with the intent of producing functionalised surfaces for nanolithography or sensor applications is also undertaken.

Sensor and Microfluidic Research (Prof Colette McDonagh, Prof Jens Ducrée, Dr Niall Maloney)

The Optical Sensors Laboratory develops optical solutions to real-world measurement problems in biomedical sensing. In recent years, the main focus has been on the development of fluorescence-based sensors. The Microfluidic Platforms Group leads the field of centrifugal microfluidic 'Lab-on-a-chip' systems for a range of applications including biomedical diagnostics and environmental monitoring. These cost-efficient chips fully automate multi-step sample preparation, management of multiple reagents and sensitive detection in a sample-to-answer fashion, thus meeting the techno-economical requirements of a range of typically decentralised applications in biomedical point-of-care diagnostics, environmental monitoring, food screening and life-science laboratories.

Education Research (Dr Eilish McLoughlin, Dr Paul Van Kampen)

Physics staff have played a leading role in the establishment of the CASTeL which is a multidisciplinary research team focused on enhancing science and mathematics education at all levels, supported by evidence-based research and contributing to international good practice. CASTeL members, comprising of scientists, mathematicians and educationalists from Dublin City University and St. Patrick's College Drumcondra, lead and participate in formal and informal STEM education projects, nationally and internationally, which are focussed on inquiry based science teaching, learning and assessment.

Physics academics play a significant role in a number of Research Centres at DCU, including the National Centre for Sensors Research (NCSR), the National Centre for Plasma Science and Technology (NCPST), the Biomedical Diagnostic Institute (BDI) and the aforementioned CASTeL.

The School demonstrates a very strong performance in relation to academic excellence and outputs. In the last 5 years, the School has successfully competed for > €10 million of research funding from Science Foundation Ireland (SFI), Enterprise Ireland (EI), EU and national and

international industry. Recent outputs include the publication of > 250 peer-reviewed papers (last 5 years) and the School currently has > 40 postgraduate research students registered for M.Sc./Ph.D. programmes. Overall the School's performance in research is institutionally leading and on a par with the levels associated with the elite Russell Group of Universities both in terms of academic output quantity and quality, as well as funding levels. The research activities within the School are therefore strong contributors to the core academic excellence targets and are thus central to the delivery of DCU's vision of being a research-intensive University of Enterprise with a focus on translating knowledge into benefits for society and the economy and will continue to be so. These research activities further contribute to how the University translates research through engagement with enterprise.

Translation, Enterprise and Engagement

The School works actively to engage with enterprise and industry, and to translate many aspects of its research knowledge into societal and economic benefits for Ireland and beyond, as part of DCU's vision of being a research-intensive University of Enterprise. Engagement with enterprise and industry as part of the teaching programmes includes the well-established DCU 3rd year internship programme, INTRA, with the majority of our undergraduate students undertaking a placement in enterprise as part of this programme. The INTRA programme can also lead on to 4th year projects and there has been a noticeable increase in this avenue of engagement in recent years, with 25% of 4th year projects in the academic year 2014/15 coming from continuations of INTRA projects. Companies/external bodies involved in projects recently include Tomra, Ocean Optics and the National Metrology Laboratory.

Furthermore, our External Advisory Panel, which includes enterprise and industry representatives, will inform future developments in the Physics programmes, as well as engaging in broader discussions on industry needs and opportunities, including INTRA, 4th year projects and research themes.

The School also strongly encourages and supports all physics students in enterprise engagement and translation activities and two examples of enterprise engagement include two of the School's PhD graduates, Dr Conor Coyle and Dr Colm Fallon who won Accenture's 'Best Technology Enabled Solution' in the company's 'Leaders of Tomorrow' Awards Scheme in 2012 for a mobile phone enabled domestic security monitoring system, as well as recent successful involvement of a 4th year Applied Physics student, Mr. Shane Hamilton, in DCU's student entrepreneur start-up competition, UStart.

DCU Physics graduates Conor Coyle (L) and Colm Fallon (R) receive a merit award at EI's Think Outside The Box awards in 2012 for their domestic security concept "HOWL"

Ms. Claire O'Connell, Ph.D. student, receiving the award for Best Video at the DCU "Tell it Straight" Science Communication competition 2015.

In demonstrating translation of research and enterprise engagement with research, the School is also very active in a number of different areas. The primary focus of the Physics Education research activity within the School is to translate research in the development of novel and effective teaching methodologies in science and mathematics into practical teaching strategies both through the education of teachers and the development of educational resource materials. Physics academics have played a leading role in research initiatives with have attracted substantial funding from national, EU and industrial sources. This expertise in the School is a core element of the DCU-based CASTeL research centre, which is the national leader in this area and which is spearheading the development of STEM education which forms a key element of the DCU Incorporation process under the Strategic Plan. Currently, CASTeL is working closely with Intel Ireland and other companies in a number of STEM-related projects.

Further examples of enterprise and industrial engagement and translation in areas of the School's research strengths include the development of long term research relationships with Intel and Lam Research in plasma science and technology and surface science characterisation of materials for advanced semiconductor device manufacture. There is also a strong link to Gen Ltd, Suwon, Korea in the plasma area. The focus of these research interactions has been the translation of basic scientific knowledge into practical strategies for integrating new processing technologies into device fabrication protocols. These activities have attracted significant research funding from SFI and EI programmes as well as substantive equipment donations from the industrial partners and provide a strong basis for the development of further industrial engagement as the challenges of advanced manufacture become increasingly complex. This area of activity has been a key contributor to the success of the DCU-based National Centre for Plasma Science and Technology.

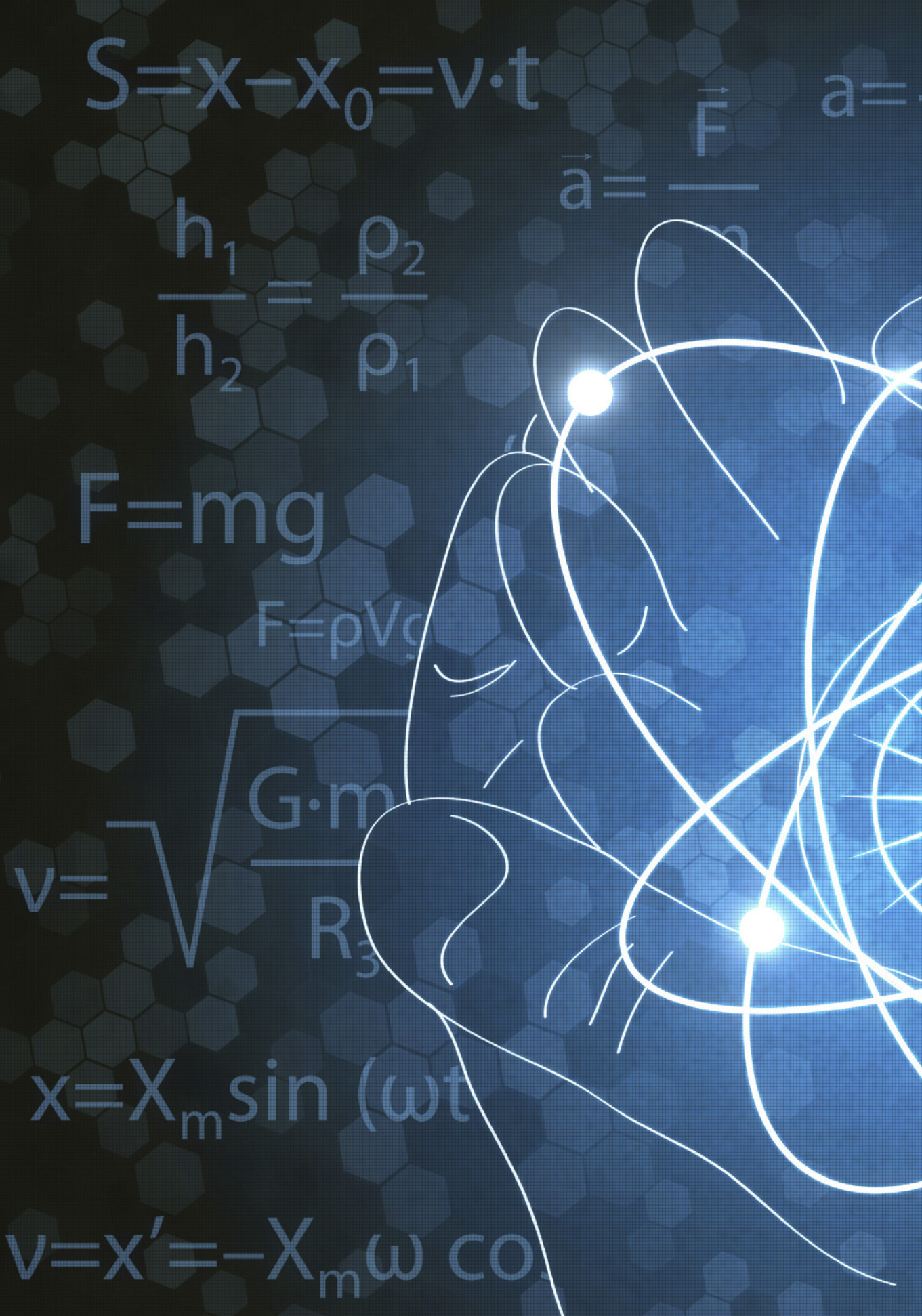
The DCU Microfluidics Platforms Group and the Optical Sensors Laboratory have a successful track record in enterprise and industrial engagement and translation of research, including patents and licensing, particularly in the area of biomedical diagnostics. Much of this work is carried out in the BDI and is focused on developing next-generation optical and microfluidic "Lab-on-a-Chip" (LoaC) platforms geared for performing a broad spectrum of bioanalytical assay formats targeting proteins, nucleic acids, small molecules and cells in a cost-efficient manner for a range of applications in biomedical point-of-care diagnostics, environmental monitoring, food screening and life science laboratories. The expertise of the Optical Sensors Laboratory and the DCU Microfluidics Platforms Group are core elements of the NCSR and the SFI-funded BDI, led by DCU and involving a range of academic and industrial partners. In recent years, researchers in the School have had significant interactions with companies such as Biosurfit, Alere and Analog Devices.

The School has an excellent track record of enterprise and industrial engagement based on its core teaching and research strengths as well as translation of research and intends to further develop and embed the already established linkages and create new industrial collaborations nationally and internationally.

Invitation

We invite you to contact the School in order to find out more or to explore working with us. Please contact:

Professor Enda McGlynn
Head of School of Physical Sciences
E: enda.mcglynn@dcu.ie


$S = x - x_0 = v \cdot t$
$\vec{a} = \frac{\vec{F}}{m}$
$\frac{h_1}{h_2} = \frac{\rho_2}{\rho_1}$
$F = mg$
$F = \rho V g$
$v = \sqrt{\frac{G \cdot m}{R_3}}$
$x = X_m \sin(\omega t$
$v = x' = -X_m \omega \cos$