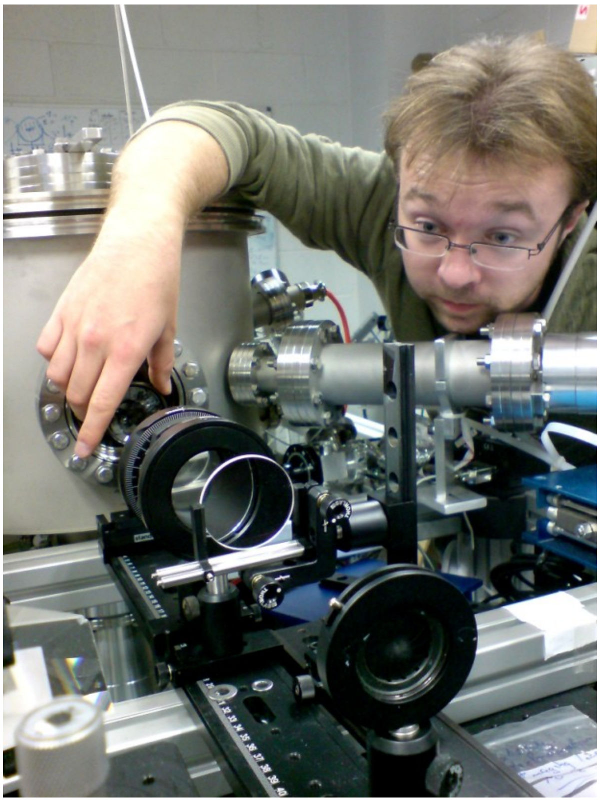
School of
Physical Sciences

Physics research at DCU encompasses nanoscience, photonics, astronomy and physics education. Specific research areas include intense laser matter interactions, experimental, applied and computationa plasma physics, materials, optical sensors, semiconductors, surface and interface physics, microsystems with emphasis on microfluidic lab-on-a-chip technologies, physics education and astrophysics. Much of the work is carried out in collaboration with researchers elsewhere in the European Union and is supported by a variety of national and European programmes. School staff play a significant role in major research centres based in DCU, such as the National Centre for Sensor Research, NCSR (www.ncsr.ie), the Biomedical Diagnostics Institute, BDI (www.bdi.ie) and National Centre for Plasma Science & Technology, NCPST (www.ncpst.ie), with BDI and NCPST operating under the direction of School Professors. In addition to the funds to establish these centres, school staff have won substantial funding from Science Foundation Ireland and the EU totalling well in excess of 10 million euro.

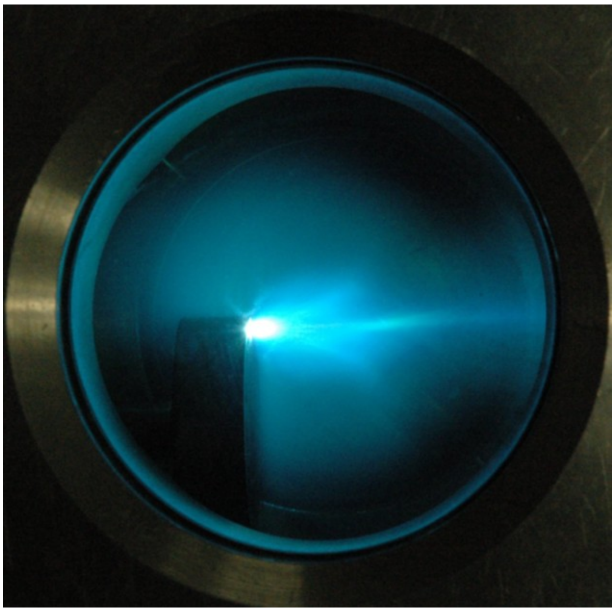
The Centre for Laser Plasma Research (CLPR)

Prof. J. T. Costello, Prof. E.T. Kennedy,
Dr. J. P. Mosnier, Dr. P. van Kampen

The CLPR laboratory has attained a position of international leadership through its research on the application of laser-generated plasmas to problems in atomic and materials physics. In recent years the programme has expanded to include laser-plasma sources development, laser-plasma diagnostics and pulsed laser deposition of novel semiconductor materials. The group has played an important role in many national and international research collaborations including a new international research programme on the development of femtosecond (10^{-15} seconds) pump-probe facility involving the unique short wavelength Free Electron Laser under construction at DESY in Hamburg. The CLPR is a key part of the National Centre of Plasma Science and Technology and is divided into a range of laboratories focussed on Pulsed Laser Deposition , Laser plasma diagnostics,
Laser plasma light source development and femtosecond laser interactions with atoms, molecules and plasmas.



Contact: John Costello Tel: 01 7005304, Email: john.costello@dcu.ie
Jean-Paul Mosnier Tel: 01 7005303
Email: jean-paul.mosnier@dcu.ie



The Optical Sensors Laboratory (OSL)

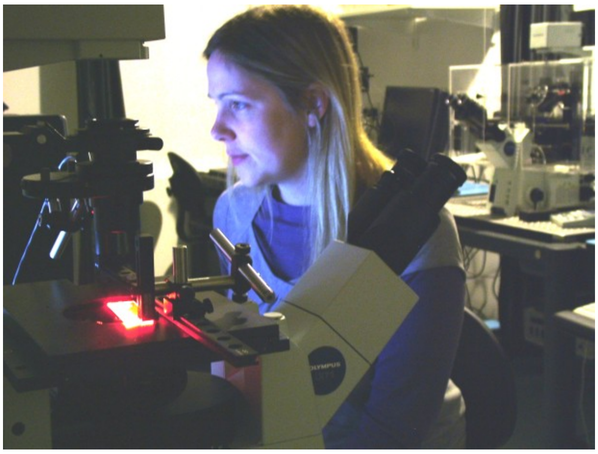
Professor Brian MacCraith,
Professor Colette McDonagh

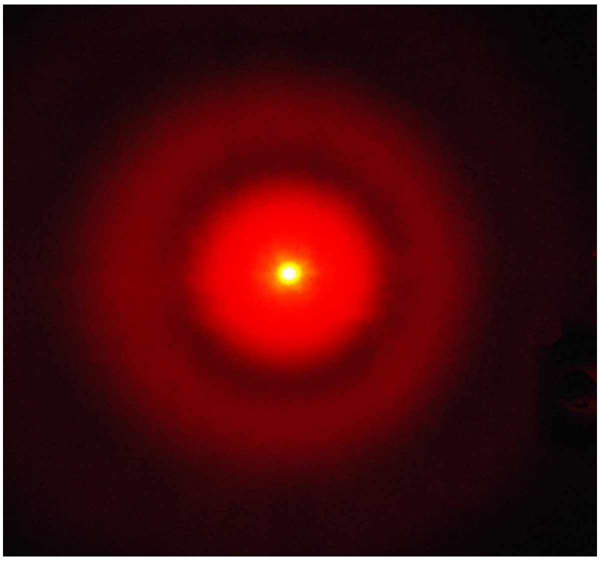
Researchers in the Optical Sensors Laboratory work on the development of optical solutions to real-world measurement problems in application areas such as environmental monitoring, biomedical sensing and food safety. Advances in optoelectronics are combined with new materials to produce novel devices which undergo rigorous testing and characterisation. Projects are varied and are often very multidisciplinary in nature, ranging, for example, from software modelling of optical waveguide structures to the development of wearable breath sensors for monitoring cardiorespiratory function in elite athletes. Research activity is concentrated mainly on the use of planar waveguides and novel sensor platforms for chemical sensing and biosensing with particular emphasis on the following areas:

- optical biochips for medical applications
- Use of plasmonics and high brightness nanoparticles for enhanced optical biosensors
- NP-based intra-cellular diagnostics
- microsystems/lab-on-a-chip
- sol-gel-based optical sensors for biomedical and environmental applications
- planar lightwave circuits and integrated optic structures

The laboratory has attained international prominence in the field of optical chemical sensors and biosensors. OSL researchers are currently developing optical biochips for use in medical diagnostics as well as working closely with industry towards the development of advanced sol-gel-based sensors for commercialisation in the near future. The laboratory plays an important role in the National Centre for Sensor Research (NCSR), which is a world renowned, large-scale, multidisciplinary research centre focused on the fundamental science and applications of chemical sensors and biosensors. Its state-of-the-art facility comprises custom-designed laboratories, clean-rooms, a polymer micro fabrication suite, a biohazard facility and a range of other support laboratories. OSL plays a key role in the Biomedical Diagnostics Institute (BDI) which was established in 2005 with SFI funding and focuses on the development of next generation biomedical diagnostic devices and in the National Biophotonics Imaging Platform (NBIP) which was set up in 2008 under the Irish government-funded PRTLI programme.

Contact: Colette McDonagh, Tel: 01 7005301, Email: osl@physics.dcu.ie





The Plasma Research Laboratory (PRL)

Prof. M. M. Turner, Dr. A. R. Ellingboe,
Dr. P. Swift

The Plasma Research Laboratory (PRL) focuses on both experimental and computational aspects of radio frequency plasmas, which are used as ion sources in fusion research and for plasma processing in many industrial applications. RF plasma sources are developed and optimised and the fundamental physics of plasma generation and stability are investigated. Electrical and laser diagnostics are also developed and sophisticated computer simulations are used to compare the experimental data to theory. The laboratory leads the Irish Association in the European fusion development programme. PRL fusion research is concerned with negative ion sources for neutral beam injection heating of magnetically confined fusion experiments. The laboratory is an important part of the National Centre for Plasma Sciences and Technology.
Contact: Sarah Hayes, Tel: 01 7005948, Email: Sarah.Hayes@dcu.ie

The Plasma Research Laboratory (PRL)

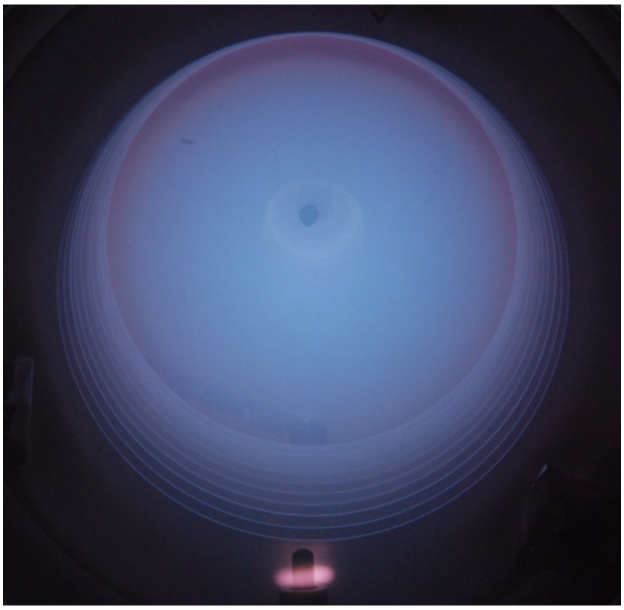
Dr. A. R. Ellingboe

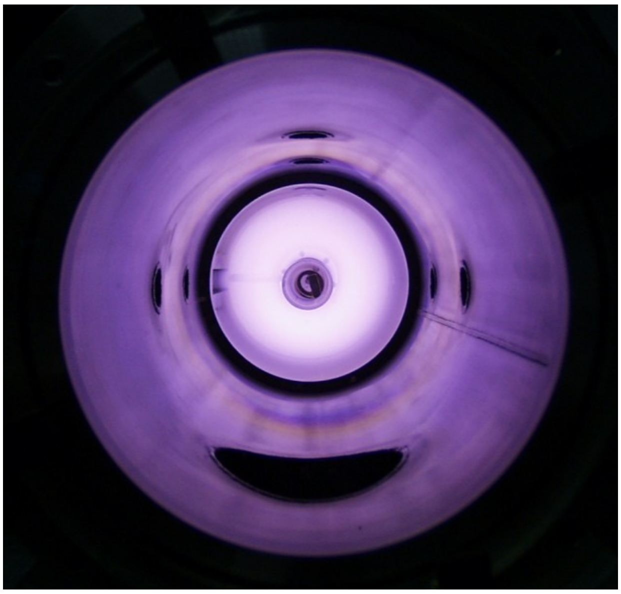
The Plasma Research Laboratory (PRL) is engaged in the engineering-physics of radio-frequency plasma sources and their applications.
The group focuses on the experimental development of advanced plasma sources, the associated support systems, diagnostics, and computational modeling. Key applications of the plasma sources include Solar-Cell and Computer-Chip manufacturing, sterilization, and fusion energy research.
The partially ionized plasmas studied in the group have become ubiquitous in modern manufacturing due to the exotic gas-phase chemistry that is present; A 30,000ºC chemical activation temperature can be achieved with the gas at room temperature, so even 'soft' materials like plastics and clothing can be treated.

Active research programs study the power coupling to the plasma at VHF and UHF frequencies (10-100 times higher than traditional frequencies) and the affect on plasma chemistry. The plasma chemistry is highly advantageous in application, but the physics is just beginning to be investigated. The systems needed to bring this new technology to industry are being invented, developed, and tested.

Contact: Bert Ellingboe, Tel: 01 7005314, Email: Bert.Ellingboe@dcu.ie

Contact: Sarah Hayes, Tel: 01 7005948, Email: Sarah.Hayes@dcu.ie



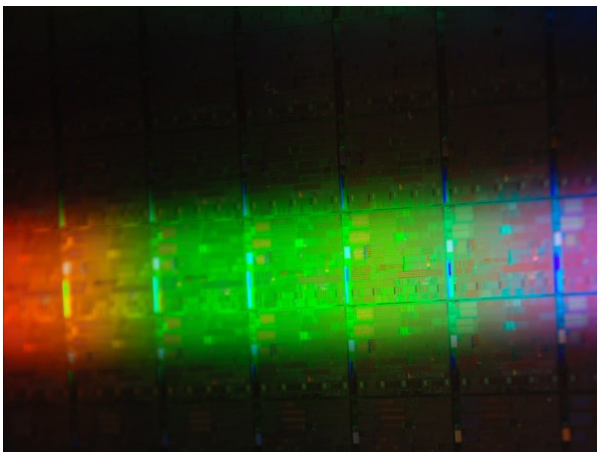


Physics Education Group (PEG)

Dr. E. McLoughlin, Dr. P. van Kampen,
Prof. M.O. Henry

The Physics Education Group are all active researchers in the Centre for the Advancement of Science Teaching and Learning (CASTeL) which focuses on science education at primary, secondary and tertiary level in DCU/St. Patrick's College. We carry out a coordinated program of research, curriculum development, and instruction to improve student learning in physics. The basis of all our work is activity based learning in which the students play a central role in the teaching and learning process. The work of the group is guided by research, through in-depth studies of student understanding where common conceptual and reasoning difficulties are identified and addressed and student attitudes towards physics are monitored. Currently our primary emphasis is on the teaching and learning of basic concepts and understanding of future secondary school science teachers and third level undergraduate students. Teaching methodologies such as problem based learning, guided inquiry and technology in learning, are implemented and evaluated.

Contact Eilish McLoughlin, Tel: 01 7005862
Email: eilish.mcloughlin@dcu.ie



Surfaces and Interfaces Research Laboratory (SIRL)

Prof. G. Hughes, Dr. A Cafolla, Dr. E. McLoughlin

Fundamental studies of surfaces have led to important developments in related areas of applied science such as semiconductor microelectronics, thin films and corrosion science. Surface and interface research at DCU has been generally oriented towards semiconductor materials, although recently the groups' interests have expanded to encompass the behaviour of organic molecules on metal and semiconductor surfaces. SIRL uses a range of spectroscopic techniques including Auger Electron Spectroscopy (AES), x-ray photoelectron spectroscopy (XPS), Scanning Tunnelling Microscopy (STM), reflectance anisotropy spectroscopy (RAS), atomic force microscopy (AFM), low energy electron diffraction (LEED), to investigate the structural, electronic and chemical properties of material surfaces. Particular emphasis is on the preparation and characterisation of clean atomically ordered semiconductor surfaces and on modifying the chemical and physical properties of these surfaces in a controlled fashion. The group are active users of synchrotron radiation sources and several of the present studies involve collaborations with other European laboratories, including groups in Lund, Nottingham and Berlin. The group has also carried out collaborative research projects with the Tyndall Institute and Intel, primarily aimed at investigating the chemical and electrical transport properties of advanced transistor gate dielectrics.

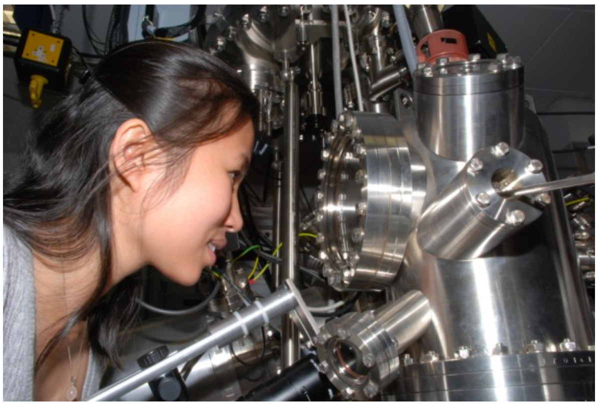
Contact: Greg Hughes, Tel: 01 7005390, Email: Greg.Hughes@dcu.ie

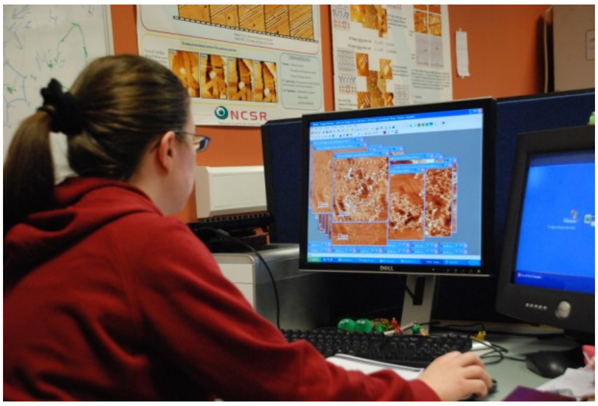
Astronomy and Astrophysics Group

Dr. L. Norci, Prof. Evert Meurs

Astronomy, literally the discipline that gives names to the stars, is perhaps the most ancient of the sciences with evidence that prehistoric people were already studying the night sky. Modern astronomy employs concepts and techniques from the physical sciences to try to explain what is observed in the sky and therefore is more often referred to as astrophysics. More and more powerful telescopes, observing deeper and deeper in the universe, have provided us with an ever changing view of the world around us. Astrophysics has learned to investigate some of the most extraordinary phenomena: from the source of energy that powers the stars to the origin of the Universe. The Astrophysics group at DCU has a diversified research activity both observational and computational in nature. Research interests include: Gamma-ray Bursts: optical spectroscopy and monitoring with the Robotic Eye Mount telescope and X-ray studies with the Swift satellite; optical spectroscopy of evolved massive stars; high energy population synthesis simulations of starburst regions; spectroscopy of high redshift lensing galaxies.

Contact: Laura Norci Tel: 01 7007375
Email: Laura.Norci@dcu.ie

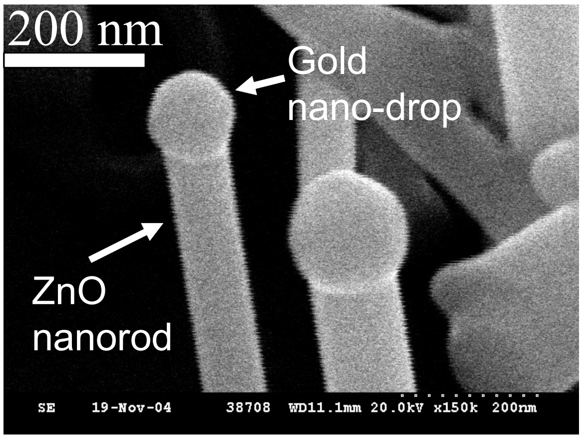




The Semiconductor Spectroscopy Laboratory (SSL)

Prof. M. Henry, Dr. E. McGlynn

Semiconductors lie at the core of information and communications technology. Increasingly research is being focused on the use of nanostructured semiconductor materials for next generation devices. Researchers in SSL contribute to research in these areas by studying the growth mechanisms of semiconductor nanostructures and by characterising these structures using optical and electronic spectroscopic methods to study the key critical properties of the semiconductor structures used in electronic and optoelectronic devices. Much of this work is carried out at very low temperatures where the material properties of the semiconductor are most clearly revealed. Facilities in the group include vapour phase growth apparatus for nanostructure growth, high performance spectrometers, a high field superconducting magnet and an excellent range of cryogenic equipment. The topics studied include the analysis of nanostructured wide band-gap semiconductors such as ZnO and GaN grown using vapour phase transport and pulsed laser deposition, in addition to impurity and defect analysis in a variety of semiconductors and the study of quantum dots in group IV and III-V materials. The laboratory, which is funded by various grant agencies including Science Foundation Ireland (SFI), plays an important role in the National Centre for Plasma Science and Technology at DCU and is a participant in international experiments at CERN, where radioactive isotopes are used for the exploration of impurity characteristics in semiconductors.

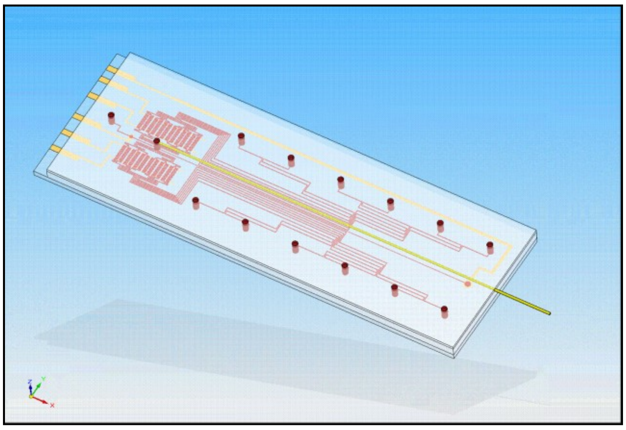


Contact: Enda McGlynn, Tel: 01 7005387, Email: Enda.McGlynn@dcu.ie.

Microsystems Group

Prof. J. Ducree

"There is plenty of room at the bottom" was the title of the classic talk that Richard Feynman, winner of the 1965 Nobel prize, gave on December 29th 1959 at the California Institute of Technology. Since then, the breathtaking speed of miniaturization in the semiconductor industry has unravelled convincing evidence for truth behind his hypothesis. Over the recent decades, also the field of micro-electro-mechanical-systems ("MEMS") has emerged from a byproduct of the semiconductor industry to an independent research field and global, multi-billion-dollar business of its own. Airbag sensors in the automotive industry, ink-jet printheads as well as an increasing number of components in modern mobile phones and other gadgets such as Wii are prominent examples of how microsystems already pervade our life (styles). In close collaboration with the Biomedical Diagnostics Institute and the National Centre for Sensor Research, the microsystems group in Physics explores novel applications of MEMS in various fields of the life sciences which are deemed the leading technology in the 21st century. In a highly interdisciplinary environment, we develop microfluidic lab-on-a-chip platforms for next-generation point-of-care diagnostics, cancer and pharmaceutical research.



Contact: Prof. Jens Ducree, Tel: 01 7005377, Email: jens.ducree@dcu.ie

Theoretical atomic, molecular and optical physics (AMO)
Dr. Lampros Nikolopoulos

The general field of laser-matter interactions is characterized by impressive progress in laser technology. Light sources with pulses of ultrashort duration of less than 10 femtoseconds (1 fs = 10^{-15}s) are now worldwide available. Intensities as high as 10^{18} W/cm^2 (and more) are provided by the Ti:Sapphire laser (780 nm ~ 1.59 eV) with a field strength larger than the strength of the Coulomb interaction in atoms and molecules. Coherent new light sources at the extreme-ultraviolet regime of attosecond duration (1 attosecond = 10^{-18} s) are paving the way to the new area of attophysics. At the same time strong coherent, tunable free-electron lasers (FLASH-FEL) provide very strong fields at the short-wavelength regime (~ 6 nm/206.6 eV, 2009) and soon sources of even shorter wavelengths (~ 0.1 nm) will start operating (LCLS/2009). The new light sources are able to probe the inner-shell dynamics of multielectron atomic and molecular systems through non-linear electromagnetic interactions. The research is focused in the ab-initio study of these fundamental interactions by means of the lowest-order perturbation theory (LOPT) and direct solution of the time-dependent Schrodinger equation (TDSE), the latter being from numerical point of view a multidimensional partial-differential equation in time and space. Implementation of high performance computing techniques and development of sophisticated algorithms is an essential part of the research involved in reaching the target. Outcomes of the research (i.e. the influence of factors such as pulse envelope, bandwidth, and carrier phase) are of high practical value at the experimental level and at a more general perspective for ultrafast and/or strong processes that arise in physics, electronic engineering, chemistry and in many areas of the life sciences.
Contact : Dr. Lampros Nikolopoulos,
Phone: 01 7005300
Email : Lampros.Nikolopoulos@dcu.ie

Organic Photonic Materials and Devices
Dr. T. Kobayashi

The past decade has seen intense research efforts for the development of organic gain media. To take full advantage of colour tunability and cost effectiveness of organic materials, both the improvement of physical characteristics of luminescent materials and cavity structure that facilitates low threshold operation are sought. We investigate self-assembled cylindrical microresonators, which present some advantages over other structures: low-threshold operation associated with their high cavity quality factors, the possibility of integration with optical waveguides as well as ease of fabrication. What makes such microcavities even more attractive is the desired cavity quantum electrodynamic effects such as an enhancement of stimulated emission, which could lead to further reduction of laser threshold, a prerequisite for the development of practical amplification devices.
Contact: Takeyuki Kobayashi,
Tel: 01 7006120,
Email: Takeyuki.Kobayashi@dcu.ie

About the School of Physical Sciences

The School of Physical Sciences at Dublin City University has a high standing within Ireland and wide international recognition for much of its research activity. It is based in purpose-built accommodation which provides first-rate custom-designed facilities for undergraduate and postgraduate teaching and research. At this time, the school has eighteen academic staff positions, five technical staff, school secretary, an IT manager and additional research staff (including postgraduates, postdoctoral researchers and research officers/technicians) of approximately eighty.

Postgraduate Study

A number of funded full-time research positions are available in our research groups each year and for a current list of postgraduate positions available, please log on to www.dcu.ie/physics/

Entry Requirements

To register for a Postgraduate programme, a candidate must normally have obtained a primary degree classification equivalent to Higher Second Class Honours or above, from an approved University or an approved equivalent degree-awarding body, or have an approved equivalent professional qualification in an area cognate to the proposed research topic. Initially, all such candidates will be registered for a Master's degree. For further information, http://www.dcu.ie/prospective/postgraduate_research.shtml

Accommodation

Our Postgraduate Centre offers high quality accommodation for over 100 postgraduate students in the heart of the research community on campus and are available for postgraduates on a 12 month licence. To apply for postgraduate accommodation, log on to www.roomsatdcu.com.

IRCSET Embark Initiative

Our staff is available to support a prospective postgraduate student's application for the Embark Initiative's Postgraduate Research Scholarship Scheme, which is designed for either Masters or Doctorate level researchers in the sciences, engineering or technology. IRCSET also offer Enterprise Partnership Awards in conjunction with participating partners. In total the 2006 programme has funded 219 new entrant Masters or Doctorate level researchers in the sciences, engineering and technology from both first and second calls. For further information on these schemes, Log on to *http://www.ircset.ie/grant_schemes/postgrad.html*

For further information on opportunities for research in the School of Physical Sciences at DCU, please contact:

Dr. Tony Cafolla,
Research Convenor
School of Physical Sciences
Dublin City University,
Dublin 9
Tel: 353 1 7005332
http://www.dcu.ie/physics/
Email: *cafolla@dcu.ie*