Spring 2011, Number 1

Department of Physics Newsletter

UNIVERSITY OF OXFORD

Welcome to the first edition of the Department of Physics Newsletter. In this edition, we describe some of the wide range of research currently being carried out in the Oxford Physics Department, and also describe some of the other activities where we seek to engage the public in science and communicate with potential future physicists. I hope you enjoy reading it. If you have passed through Oxford Physics as an undergraduate or postgraduate student, or in any other capacity, we would welcome future contributions from you. Please contact **newsletter@physics.ox.ac.uk**

Lance Miller

INSIDE THIS EDITION:

www.physics.ox.ac.uk

Oxford Physics creates new solar-cell technology

Henry Snaith

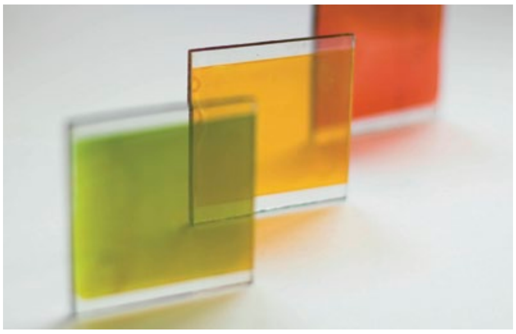
The ability to cheaply and efficiently harness the power of the Sun is crucial to trying to slow down climate change. Solar cells aim to produce electricity directly from sunlight, but are currently too expensive to have significant impact. A new "spin-out" company, Oxford Photovoltaics Ltd, has recently been created to commercialise solid-state dye-sensitised solar cell technology developed at the Clarendon Laboratory.

In conventional photovoltaics, light is absorbed in the bulk of a slab of semiconducting material and the photogenerated charge is collected at metallic electrodes. The materials used in the new dye-sensitised technology do not perform well as solid films: however, by creating a multi-component nanostructured composite, where each component has a specific functionality, very effective solar cells can be created.

The basic technology operates by a principle similar to the initial stages of photosynthesis in plants. Light is absorbed in a dye molecule located at the junction between an n-type metal oxide and a p-type organic semiconductor. Following light absorption, photoinduced charge transfer takes place to generate free electrons, which contribute to a current in an external circuit. The original dye-sensitised solar cell used a liquid electrolyte as the "p-type" material.

The work at Oxford has focused on effectively replacing the liquid electrolyte with p-type organic semiconductors. This solid-state system offers great advantages in ease of processing and scalability.

Over the next two to three years, Oxford Photovoltaics will scale the technology from laboratory to production line, with the projected market being photovoltaic cells integrated into windows and cladding for buildings.



Solar cells created by Oxford Photovoltaics can be printed onto glass or other surfaces

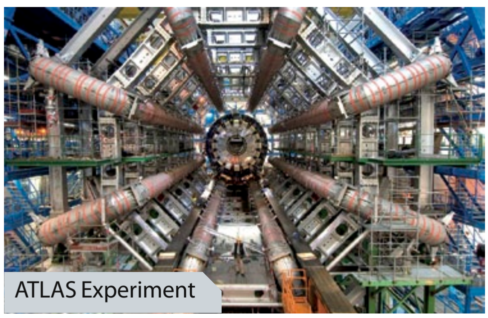
ATLAS closes in on Supersymmetry

Alan Barr

The Large Hadron Collider at CERN operated extremely successfully during 2010. The Oxford group – which has had an impressive record during the design, construction and commissioning phases of the ATLAS experiment – is now leading many aspects of the ATLAS physics analysis programme. Our recent results include investigations into proton structure, the physics of electroweak bosons and strong interactions, Higgs boson searches, and searches for new "exotic" particles.

Some of the most interesting recent results include our first searches for Supersymmetric particles. Supersymmetric theories predict the existence of heavy partner particles that would be produced in the proton-proton collisions at the LHC. Such particles will rapidly decay, leading to distinctive final states involving "missing" momentum – the result of unobserved, weakly interacting massive particles (WIMPs).

Continued on page 2...



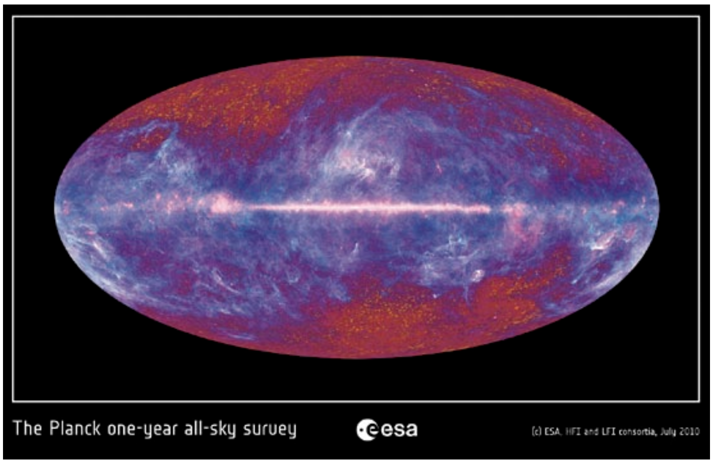
ATLAS Experiment

First results from Planck

Joanna Dunkley

The start of this year saw the first results released from ESA's Planck satellite. Measuring tiny fluctuations in the Cosmic Microwave Background (CMB) radiation, Planck's goals include investigating the very first moments in the universe, and better understanding the origin of cosmic structure. Launched in May 2009 together with the Herschel observatory, Planck scans the microwave sky from a stable point a million miles from Earth. It is the successor to NASA's WMAP satellite, observing the anisotropies in the CMB with higher resolution and improved sensitivity. Researchers at Oxford, Jo Dunkley, Joe Silk and Charmaine Armitage-Caplan, are involved in analysis for both of Planck's scientific instruments.

Planck not only sees the relic signal from the Big Bang in the distant background, but also a wealth of microwave signals from our own Milky Way, and from more distant galaxies. These first results focus on this set of "foreground" signals. Billions of light years away, Planck has found a new set of massive clusters of galaxies, the largest structures in the universe. They are rare and their number is a sensitive probe of the expansion rate of the universe, and how much matter it contains. Planck has also seen the gas and dust from distant galaxies in which stars are born, telling us about when and where the first stars formed in the universe. Much more locally, within the Milky Way, Planck has taken a closer look at almost 1000 clumps of the very cold dust that represent the first stages of star-birth in our own galaxy. The new data also provides stronger evidence for the origins of a diffuse glow in the Milky Way, coming from dust grains spun up to several tens of billions times a second by collisions.



The Planck one-year all-sky survey

Planck now continues to survey the universe, with the next data release due early 2013, promising exciting cosmological results.

Climate change and extreme weather probed by citizen science

Myles Allen

Greenhouse gas emissions due to human activity substantially increased the odds of damaging floods occurring in England and Wales in autumn 2000 according to new research by Oxford Physics graduate student Pardeep Pall and co-authors.

The floods of autumn 2000 damaged nearly 10,000 properties, with insured losses estimated at £1.3 billion. Using a detailed computer climate model, the team simulated the weather in autumn 2000, both as it was, and as it might have been had there been no greenhouse gas emissions since the beginning of the 20th century. This was then repeated thousands of times, using a global volunteer network of personal computers participating in the **climateprediction.net** project, to pin down the impact of emissions on extreme weather. The team fed the output from these weather simulations into a flood model, and found that 20th century greenhouse gas emissions roughly doubled the odds of floods occuring in autumn 2000.

As was said in the press release, "whether or not a flood occurs in any given year is still an 'Act of God', but we are beginning to see how human influence on climate may be starting to load God's dice".

Members of the public can still participate in follow-up studies looking at other weather events: more details are at **http://weather*at*home.org**. A report of the research, "Anthropogenic greenhouse gas contribution to flood risk in England and Wales in autumn 2000", was published in the journal *Nature* on 17 February 2011.

www.ox.ac.uk/media/news_stories/2011/110216.html

Floods in south Oxford in 2003

ATLAS closes in on Supersymmetry

Continued from page 1...

In collaboration with our ATLAS colleagues, we have produced the world's most sensitive searches for Supersymmetry. The new results represent a significant squeeze on the allowed model space – indeed they start to eat away at the region for which the Supersymmetric WIMP could explain the cosmological dark matter. The theory is still far from excluded, but it is rewarding to see that even with our first data-set, and with (so far) half of the design beam energy, we can meaningfully constrain the space of interesting models. At the time of writing we have just started the 2011 run, during which we expect to increase the number of proton-proton collisions by a factor of about 100.

LHCb comes of age

Malcolm John

Over 18 years has passed since the concept of a B-meson detector at the Large Hadron Collider (LHC) was first presented at CERN. "LHCb", as it became known, has grown from hand-drawn sketches to a fully functioning, state-of-the-art experiment that is rapidly demonstrating its scientific merit.

In the 7 TeV proton-proton collisions, B-mesons are produced at an unprecedented rate. LHCb must identify their decay amongst up to 300 tracks that emanate from each collision. It had been uncertain if B-physics at a hadron machine was even possible, but after the first year of running – when the detector has regularly operated beyond its design – it is clear that this pioneering experiment has a prosperous future.

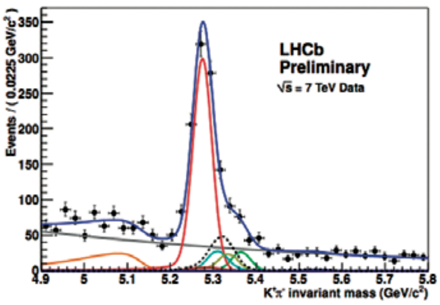
Every prestigious career starts with a promising debut and LHCb has displayed exactly that during the winter conference season. With the data accumulated during just a couple of months of concentrated running last autumn, a slew of results are now available for public digestion.

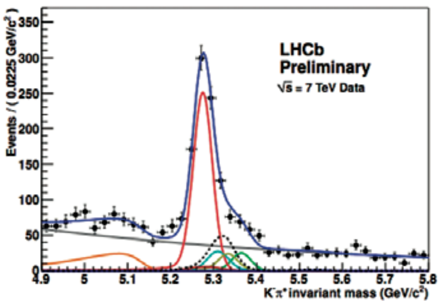
The first result was measurements of heavy-quark production in the new TeV energy regime. The b-quark cross section turned out similar to prediction but the corresponding result for charm quarks was surprisingly high. Its abundance strongly motivates searches for rare charm processes in parallel to the B-physics programme.

An example of LHCb's ability to examine B mesons comes from their decay to a pair of lighter mesons like a kaon/pion pair. This decay exhibits a "CP-violation" asymmetry that can be seen from simply counting the number of K+π– compared to K–π+; see figure below. This has been measured by two older experiments running for most of the last decade. LHCb has achieved this result with just two months of running!

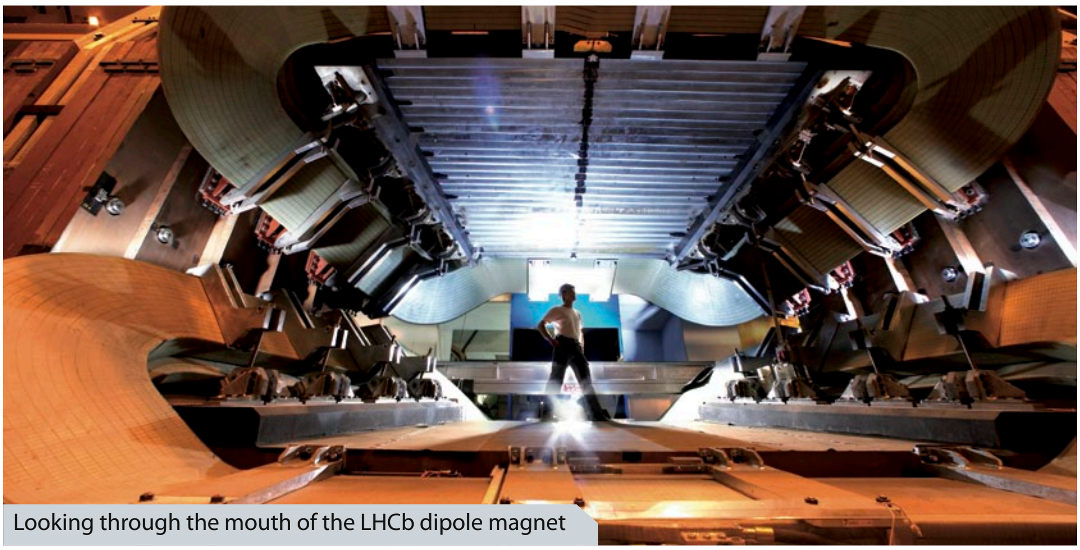
One of the strongest statements from B-physics will come from the observed enhancement (or not) of the rate that B-mesons decay to just two muons. In the Standard Model this is predicted to occur three times in a billion, whereas Supersymmetry might increase this by a factor of 10. In 2010, LHCb has reached sensitivities comparable with the best limits from long-established rivals; again, with just a few months of data-taking.

The LHCb dataset will increase 30-fold in the next 20 months, heralding a new era in heavy-quark science. Oxford physicists are at the forefront of this field and will fully participate in the exploitation of this blossoming experiment for many years to come.





Above left: Observing CP violation by comparing neutral B-meson decays to K+π– (left) with K–π+ (right). A clear difference in the relative size of the red histograms is a direct manifestation of a matter-antimatter asymmetry.



Looking through the mouth of the LHCb dipole magnet

Industrial news from Atomic & Laser Physics

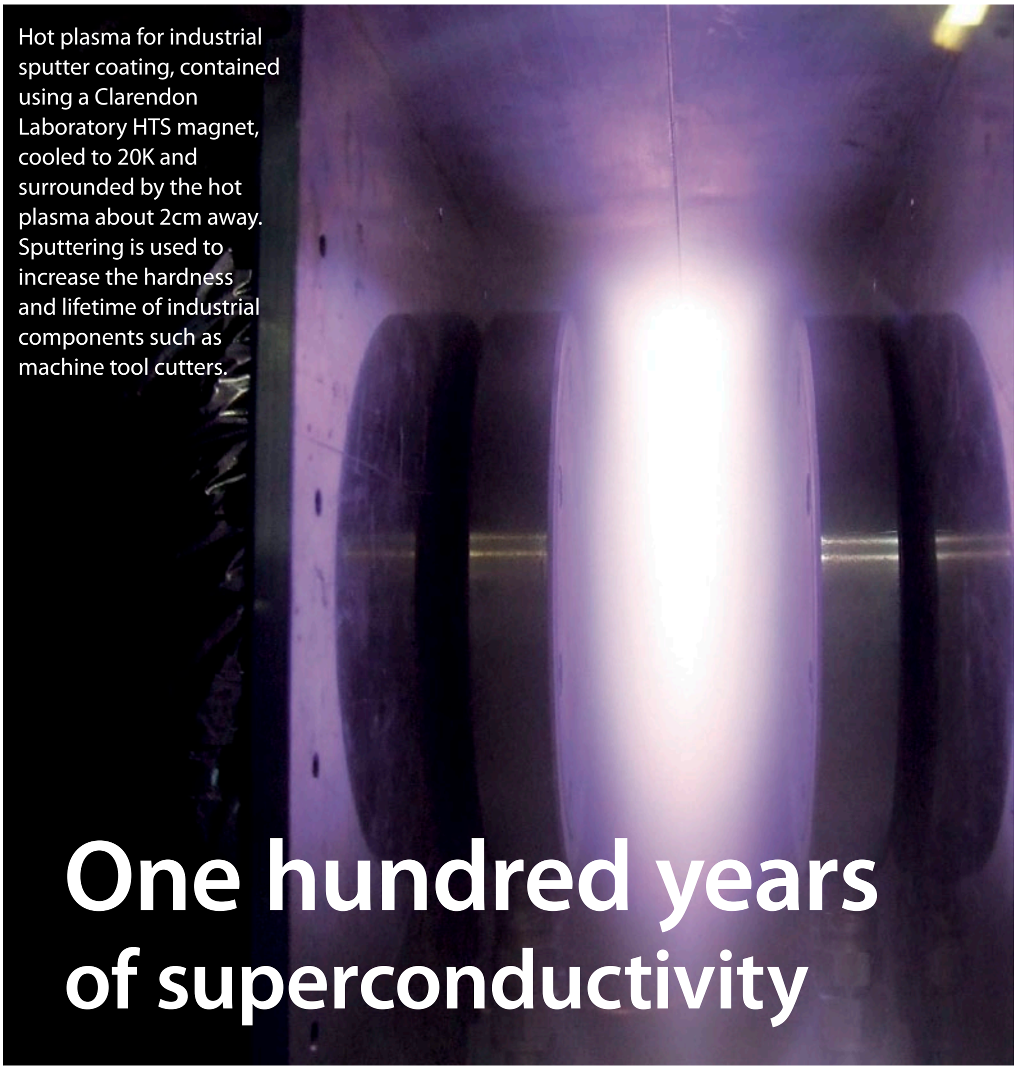
Paul Ewart

An initiative launched in June 2010 to establish closer collaboration between Oxford University and BP has led to a contract between BP and researchers in ALP and Oxford Engineering Science (Prof Richard Stone).

The project will exploit a novel method for measuring gas temperatures developed in the Ewart group that uses Laser Induced Gratings. The technique works by creating a holographic interference pattern with a laser pulse lasting a few nanoseconds. Sound waves generated in this brief excitation travel across the induced grating and modulate its reflectivity at a frequency that is measured by scattering a second laser off the grating. The speed of sound and hence the temperature can then be derived from the measured frequency.

The method is an order of magnitude more precise than other remote measuring techniques and has achieved 0.1% precision.

The aim of the work is to study small evaporative cooling effects when gasoline is injected into engines that can increase their efficiency leading to lower emissions and reduced impact on climate. The work will assist designers of both future gasoline products containing bio-fuels and the next generation of auto-engines, which will be smaller but will deliver the same power with less fuel.



Hot plasma for industrial sputter coating, contained using a Clarendon Laboratory HTS magnet, cooled to 20K and surrounded by the hot plasma about 2cm away. Sputtering is used to increase the hardness and lifetime of industrial components such as machine tool cutters.

One hundred years of superconductivity

Harry Jones

Superconductivity describes the phenomenon where an electric current is able to travel through a material without any resistance – the material is a perfect electrical conductor without any energy loss. The effect was discovered in April 1911 by H. Kammerlingh Onnes at the University of Leiden. Three years earlier, Onnes had managed to liquefy helium, which enabled him to study the electrical properties of mercury, including the total loss of resistivity at 4.15 K.

In 1913, Onnes was given the Nobel Prize for Physics "for his investigations on the properties of matter at low temperatures which led, inter alia, to the production of liquid helium" – no specific mention of superconductivity, notice. In the subsequent 100 years, the Nobel Prize has gone to superconductivity three more times.

Oxford has had a strong effort in superconductivity over many years, particularly for application in magnets. As long ago as 1933, Mendelssohn was writing to *Nature*, from the Clarendon Laboratory, proposing superconducting magnets wound from alloys such as PbBi, for fields of 2 tesla or so for use in adiabatic magnetisation to achieve temperatures as low as 0.1 K.

As ultra-low temperature work grew, ever bigger magnetic fields were needed and the legendary ex-Manchester Tramways generator was obtained for high power magnets and this led to much research on the critical parameters of superconductors, such as critical currents.

In order to supplement these fields, superconducting magnets began to be developed, in the Clarendon, by Martin Wood, who, in 1959 formed the University's first spin out company, Oxford Instruments. In-house magnet development continued and the Clarendon was the first to break the 15 tesla superconducting barrier and had the first operating "hybrid" magnet in the world.

After the discovery of High Temperature Superconductors (HTS) in 1986, the Clarendon built the first serious HTS magnets in the UK and, in the centenary year, is poised to build its first second generation (coated conductor) HTS magnets for applications in surgery.

Looking for superconductivity in an hour-glass

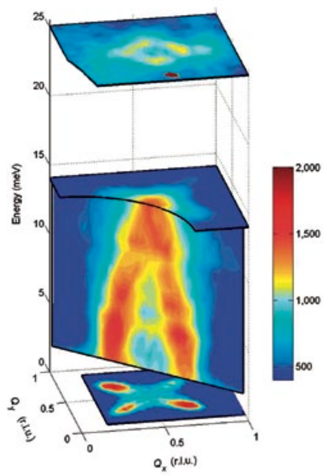
Andrew Boothroyd

Oxford researchers Peter Babkevich, D Prabhakaran and Andrew Boothroyd have uncovered new evidence that dynamic stripe fluctuations play an important role in the copper oxide high temperature superconductors.

In work reported in *Nature,* neutron scattering was used to probe the correlated motions of the atomic magnetic moments in a cobalt oxide compound having a stripe-like magnetic pattern, similar to that found in some copper oxide superconductors.

The experiment revealed a magnetic spectrum which has the same appearance – in the shape of an hour-glass – as found universally in the copper oxide superconductors. The results suggest that magnetic stripes are a key ingredient in the function of the copper-oxide superconductors.

Below: The momentum-resolved magnetic excitation spectrum of hole-doped lanthanum cobalt oxide measured by inelastic neutron scattering. With increasing energy, the four spots of highest intensity first move together and then move apart again, forming the famous hour-glass spectrum.



Light touch makes non-superconductor a superconductor

Andrea Cavalleri

A non-superconducting material has been transformed into a superconductor using light: our team from Oxford, Germany and Japan has observed conclusive signatures of superconductivity after hitting a non-superconductor with a strong burst of laser light.

The material used is closely related to high-temperature copper oxide superconductors, but the arrangement of electrons and atoms normally acts to frustrate any electronic current. In the journal *Science*, we describe how a strong infrared laser pulse was used to perturb the positions of some of the atoms. The compound, held at a temperature just 20 degrees above absolute zero, almost instantaneously became a superconductor for a fraction of a second, before relaxing back to its normal state.

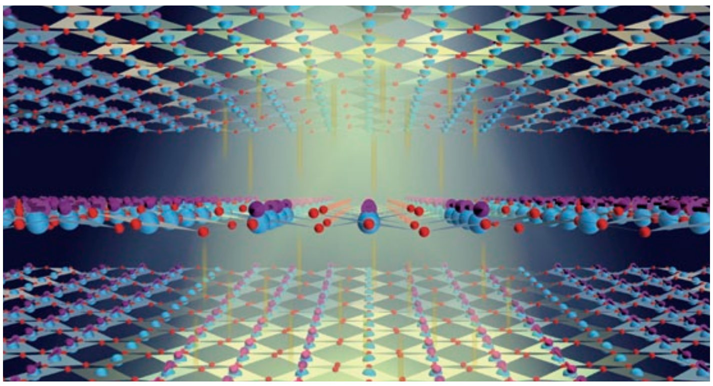
One question now is, can we take a material to a much higher temperature and make it a superconductor? High-temperature superconductors can be found among a class of materials made up of layers of copper oxide, and superconduct up to about –170°C. They are complex materials where the right interplay of the atoms and electrons is thought to "line up" the electrons in a state where they collectively move through the material with no resistance.

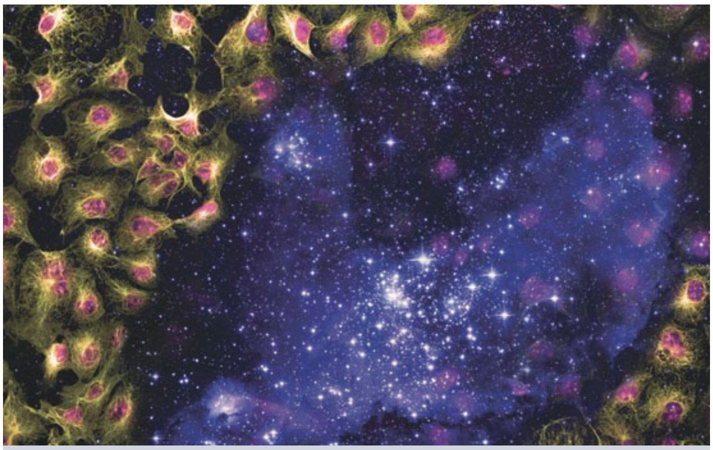
We have shown that the non-superconducting and the superconducting states are not that different in these materials, in that it takes only a millionth of a millionth of a second to make the electrons "synch up" and superconduct. This implies that they were essentially already synched in the non-superconductor, but something was preventing them from sliding around with zero resistance. The precisely-tuned laser light removes the frustration, unlocking the superconductivity. The advance offers a new way to probe how superconductivity arises in these materials, a puzzle ever since high-temperature superconductors were discovered in 1986.

We are hopeful this could also offer a new route to obtaining superconductivity at room temperature. If this could be achieved, it would open up many more technological applications. There is a school of thought that it should be possible, but that some competing order in the material gets in the way. We should be able to explore this idea and see if we can disrupt that competing order. It's certainly worth trying!

www.ox.ac.uk/media/news_stories/2011/111401.html

Below: Light illumination of a non-superconducting insulating ceramic induces superconductive coupling





Biological imaging and astronomy team up

Seamus Holden

Ever since Robert Hooke discovered the cell some four hundred years ago, the light microscope has been central to biological endeavour. However, the spatial resolution of conventional light microscopy is limited by diffraction to around 200 nanometres. A great deal of interesting biology occurs below this scale: for example, individual proteins are a few nanometres in size, and DNA, which contains the cell's genetic information, is an elongated filament only two nanometres thick.

One solution to the diffraction-limit problem, sometimes called pointillism microscopy, is to label a sample with probes which can be "photoswitched" between a bright and a dark state. By switching most of the probes into the dark state, leaving only a few well-separated bright probes, the position of individual bright probes can be localised with a 20 nm precision. By sequentially imaging different probes in the sample and combining their positions, a "super-resolved" image of the sample is obtained.

A major limitation of pointillism microscopy is that it is slow; since only a few probes can be imaged at a time, an extended movie containing thousands of diffraction-limited frames is required to localise enough probes for one super-resolved image, a process that takes a few minutes. Super-resolution imaging of all but the slowest processes in living cells would require much higher time resolution. One step towards this goal is to improve the image analysis algorithms used to localise the probes. This would increase the number of probes recorded per frame, reducing the total number of frames required per image, and increasing the imaging speed. The challenge is to produce an algorithm that can analyse "crowded" images containing many closely spaced bright probes.

We found a solution to this problem from an unlikely source: astronomy. It turned out that astronomers had already dealt with an analogous problem to ours, which was to measure the brightness of individual stars in crowded stellar fields. In recent work (reported in *Nature Methods*), we adapted "crowded field" astronomy algorithms for pointillism microscopy, significantly improving the performance of the technique.

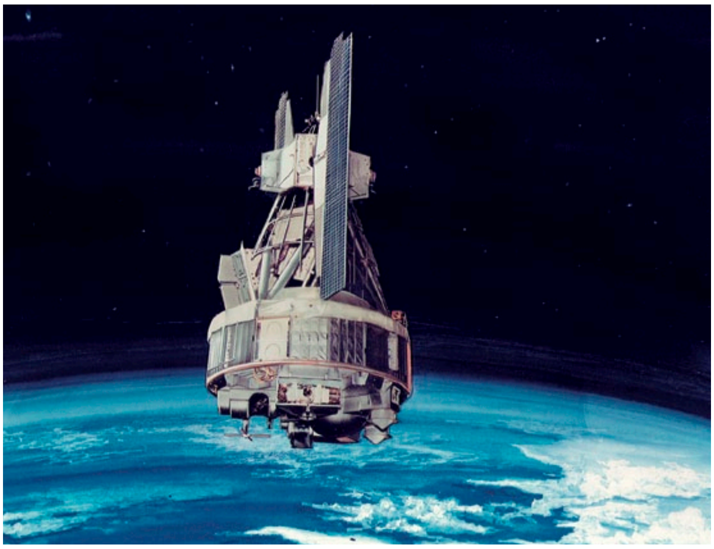
This successful fusion of astronomy and biology is not an isolated occurrence; other astronomy techniques, such as adaptive optics and lucky imaging, are also finding application in microscopy, showing that even between apparently disparate fields, inter-disciplinary research can be very fruitful.

40 Years of Oxford in space

Fred Taylor

In April 2010, past and present members of Atmospheric, Oceanic and Planetary Physics and their collaborators gathered in the Martin Wood lecture theatre for a symposium to celebrate the 40th anniversary of the launch of Nimbus IV, an early American weather satellite. On board this was the Selective Chopper Radiometer, the first of many space instruments developed at Oxford. Since 1970, more than a dozen of our instruments have flown in Earth orbit on a variety of spacecraft, and the techniques spun off to the Meteorological Office and other agencies studying weather and climate. We also have experiments currently operating at Venus, Mars, Saturn, and the Moon, with involvements in others flying to intercept a comet in 2014 and on the forthcoming European mission to study Mercury. That makes a full house – Oxford experiments at every major body in the classical Solar System.

Among other significant achievements that were celebrated were the first British hardware to go to another planet (on Pioneer Venus in 1979), and the first British hardware on Mars in 1999 (albeit as the result of a crash, Mars Climate Orbiter was not supposed to land!). All of the instruments use infrared radiometry and spectroscopy to study the temperature structure, composition, cloud physics and dynamics of atmospheres for climate studies.



A Nimbus spacecraft in orbit (courtesy of NASA). The "sensory ring" carrying the Earth-observing instruments at the base of the structure is 5 feet in diameter. The last Nimbus flew in 1979, and was replaced by a series of larger and more sophisticated spacecraft. Aura, which is about 7 metres long and weighs about 3 tons, is the latest to carry an Oxford-led instrument, the High Resolution Dynamics Limb Sounder (HIRDLS).

Quantum information technologies in Europe

Kamna Pruvost and Joshua Nunn

Oxford leads the European Coordination Action QUIE2T, supporting research into Quantum Information Foundations and Technologies. We'll be at the *fet*11 event in Budapest (**www.fet11.eu**) showcasing our medium and long-term research in superfast quantum computing and ultra-secure quantum communications, including:

Ion Trap Quantum Processors

The traps store individual ionised and laser-cooled quantum atoms, which are used as quantum bits. We'll present three traps developed at Oxford using semiconductor micro-fabrication technology. There will also be a rotating model of a single ion trap from Ulm University, and people will be able to play and experiment with this hands-on device.

Quantum memory

Oxford is developing a quantum memory which can store photons and then release them, a crucial technology for quantum computing with light. Our memory is very simple, consisting of a room-temperature glass cell filled with cesium vapour, and a laser. You'll be able to see the cell at the exhibit, and we'll explain how we stored short pulses of light just a fraction of a nanosecond long.

Diamond qubits

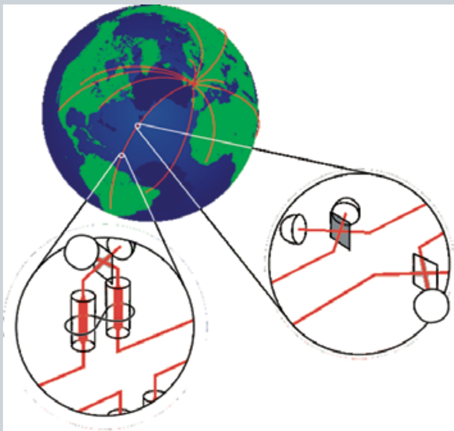
We all know diamond is an amazing material; it's even perfect for quantum computing! Qubits embedded in diamond are protected from noise, allowing operation in ambient conditions. These qubits are also the world's smallest magnetic sensors. Along with the University of Stuttgart we will showcase a millimetre-sized device with millions of these tiny sensors.

QKD

We'll showcase the latest developments in quantum key distribution – which allows guaranteed-secure quantum communication – from Swiss firm IDQUANTIQ, including a demonstration of six encrypted links at Siemens in the Netherlands.

Quantum random number generators

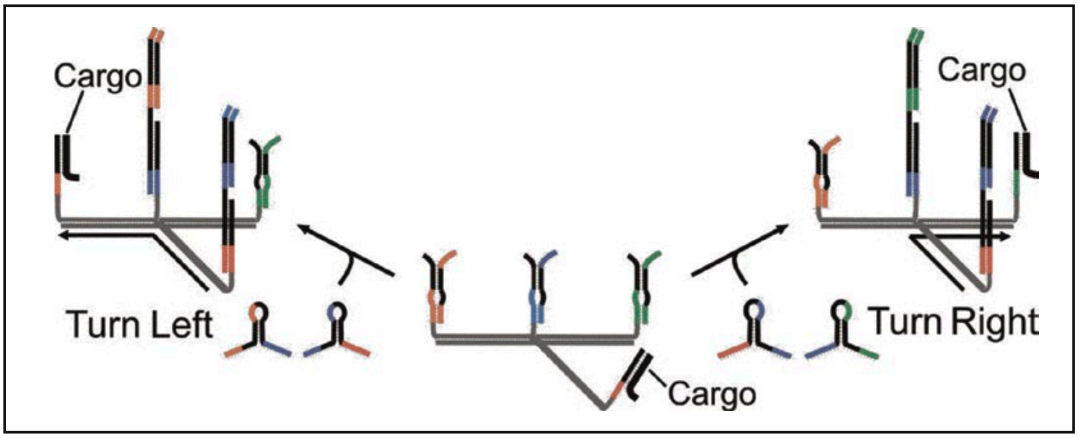
These devices exploit the fundamental randomness of quantum physics to output random numbers for cryptography, gaming and research. A "Quantum Roulette" will allow visitors to play to win prizes!



Quantum networks could span the globe providing ultrasecure telecoms

DNA nanotechnology

Andrew Turberfield and Ard Louis



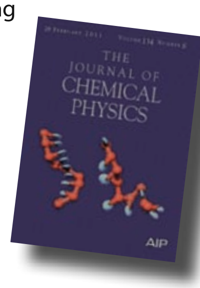
A schematic of a programmable molecular robot made of DNA

Oxford researchers are harnessing the specific pairing of DNA bases to create dynamic structures at the nanoscale. Short strands of DNA can be bought (online!) and by carefully designing their sequences, coaxed into a wide variety of well-defined shapes by exploiting the physics of hybridisation. DNA can also act as an addressable glue to join components, it can provide scaffolding support for other nano-structures and it can even act as fuel for molecular engines. Potential applications of this technology include chemical assembly lines, electronic circuits and responsive drug delivery systems.

Andrew Turberfield is one of the pioneers of this emerging field of DNA nanotechnology and with Jon Bath and students in his group in the Clarendon Laboratory has recently published two papers, in *Nature Nanotechnology* and *Nano Letters*, describing DNA-fuelled molecular motors. Shelley Wickham, who has just defended her DPhil, reported a DNA walker that can walk autonomously along a 100 nm long prefabricated track in 16 consecutive, precisely controlled steps. Atomic force microscopy allowed collaborators in Kyoto University to make the first real-time observations of these steps. Richard Muscat designed a "programmable molecular robot" that can carry a molecular cargo along a pre-programmed trajectory through a branching system of tracks. One of the long-term goals of this work is to create cell-scale modular architectures that could be programmed into a molecular assembly line to create an autonomous molecular manufacturing system.

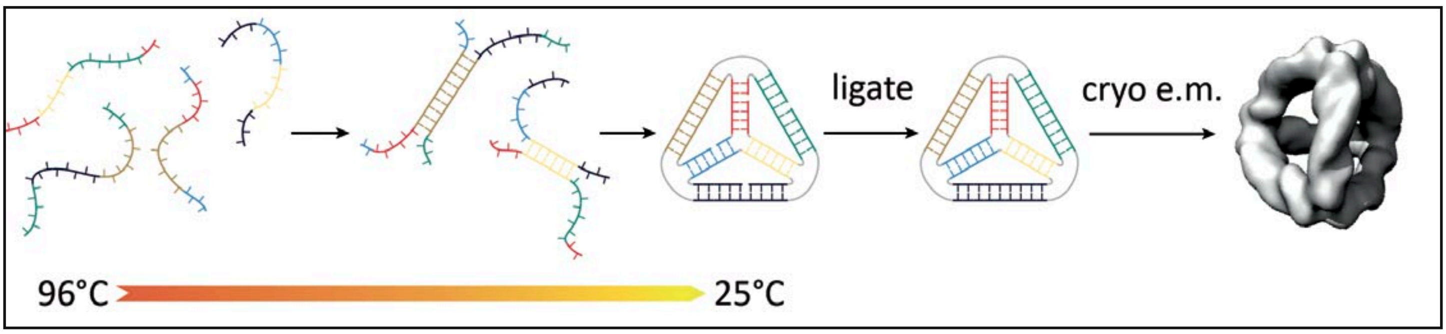
When Ard Louis joined the Rudolf Peierls Centre for Theoretical Physics in 2006, he began, inspired by work in the Turberfield group, a project to model DNA nanostructures, with his long-standing collaborator Jonathan Doye from Physical Chemistry and DPhil student Tom Ouldridge. Their goal was to develop a coarse-grained model that is simple enough to be tractable, but complex enough to capture structural, thermodynamic and mechanical properties of DNA that are crucial to DNA nanotechnology. By focusing on the basic physics of single strands, double strands, and the transitions between them, they were able to describe a number of the underlying physical processes that are exploited when experimentalists make things from DNA. Their first success was a computer simulation of the complete cycle of DNA tweezers, one of the first molecular machines constructed by self-assembly by Andrew Turberfield and collaborators. A detailed description of the method was selected for the cover of the *Journal of Chemical Physics*.

There is now a very active collaboration between theorists in the Rudolf Peierls Centre, in Theoretical Chemistry and the experimental DNA group in the Clarendon Laboratory. By using computer simulations, many processes that are inaccessible to experimental measurement can be carefully examined. At the same time, detailed analysis of the experiments helps constrain and improve the theoretical models. DNA is a wonderful material with which to build, and DNA self-assembly is a meeting point for soft matter physics, nanometre-scale engineering and molecular biology.



A picture of the DNA model created by Tom Ouldridge et al.

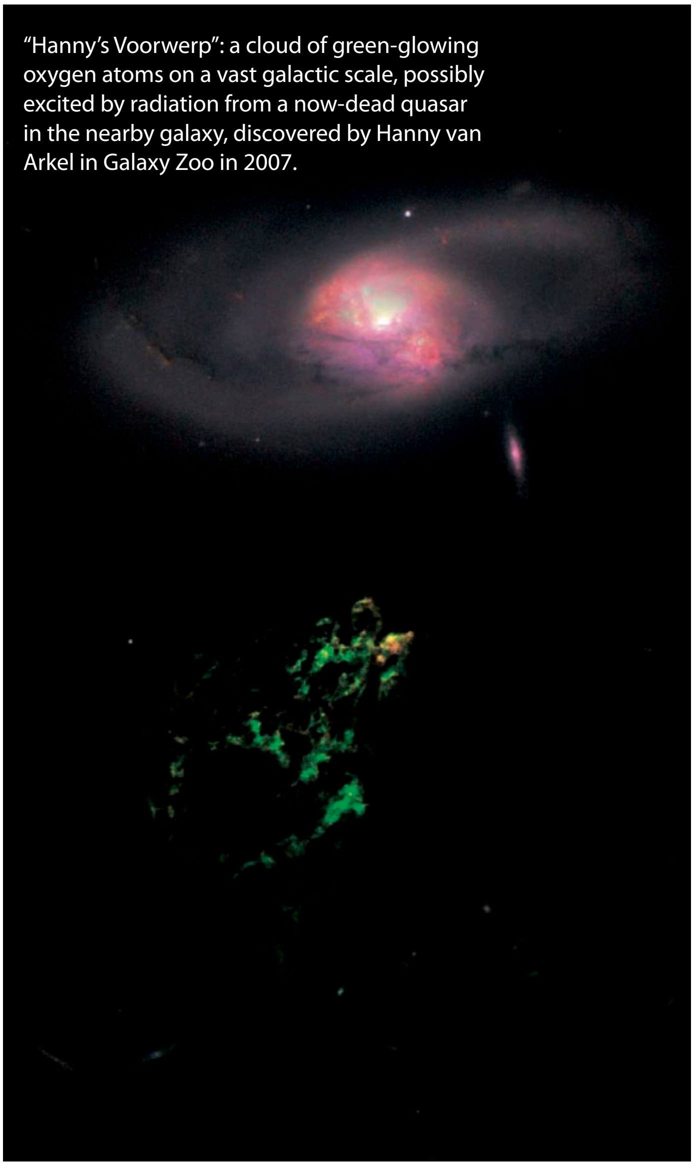
Self-assembly of DNA tetrahedra



Welcome to the

Zooniverse!

Large surveys of the sky have transformed the way that astronomers work. Whereas in the past you'd be lucky to get enough telescope time to study a handful of galaxies, everyone now has access to hundreds of thousands of systems. With the next generation of instruments likely to generate terabytes of data each and every night, we're at risk of drowning under a flood of data.



"Hanny's Voorwerp": a cloud of green-glowing oxygen atoms on a vast galactic scale, possibly excited by radiation from a now-dead quasar in the nearby galaxy, discovered by Hanny van Arkel in Galaxy Zoo in 2007.

Chris Lintott

Part of the solution lies in more efficient, cleverer computer packages, but sometimes there's no substitute for the human brain. Oxford has led the development of online "citizen science" programmes, which use the web to recruit hundreds of thousands of volunteers to assist researchers in sorting through their images.

The first project, Galaxy Zoo (**www.galaxyzoo.org**), launched in 2007 and has proved wildly successful, producing more than 20 papers and generating follow-up efforts with major facilities including the Hubble Space Telescope. Galaxy Zoo is now only one of eight projects which make up the "Zooniverse", sending volunteers to explore the Moon, search for solar storms and even hunt for planets.

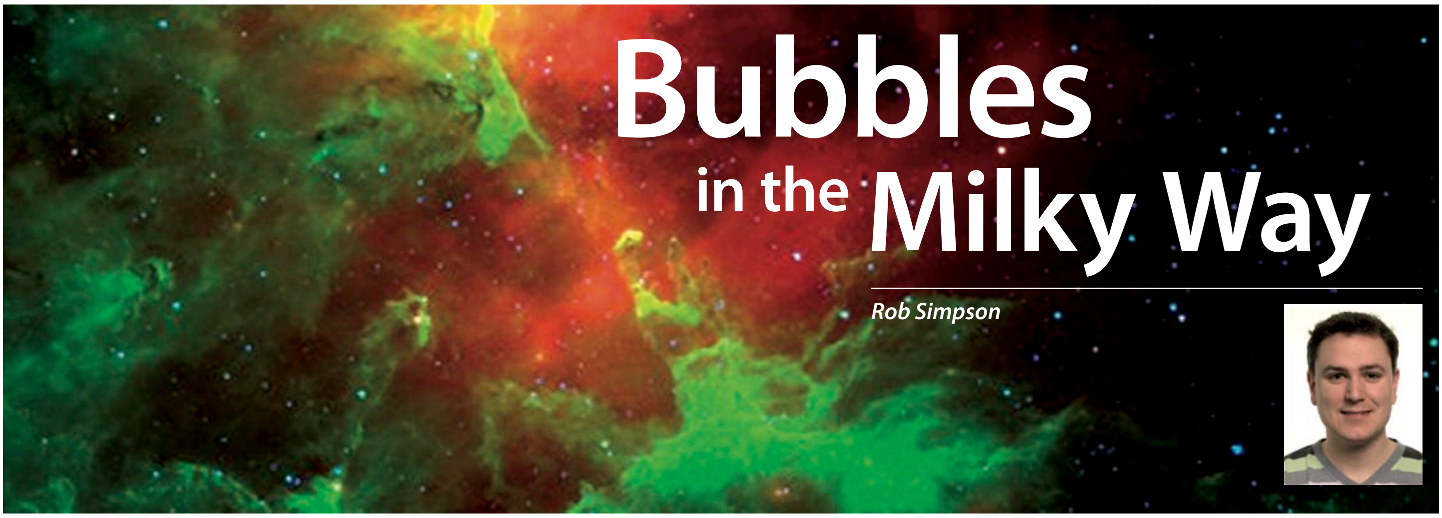
This last project, which uses data from the 100,000 stars monitored by NASA's Kepler space telescope, has successfully unearthed 47 new planet candidates missed by the machines.

The future, though, is in humans and machines working together, as with our supernova project. Data from the Palomar Transient Factory telescope in California is sorted by computer, and likely supernovae automatically uploaded to the website. By sorting through the candidates by eye, astronomers following up with larger telescopes can make the most of their time.

This kind of live intervention in the process of observing will only become more necessary with time, and the success of these pioneering projects might be the sign of things to come.

www.zooniverse.org

Oxford has led the development of online "citizen science" programmes, which use the web to recruit hundreds of thousands of volunteers to assist researchers in sorting through their images.



Bubbles in the Milky Way

Rob Simpson

IMAGE © NASA/JPL-CALTECH/M. POVICH

The Milky Way Project is an online citizen science project from the Zooniverse (the creators of Galaxy Zoo). Using data from the Spitzer Space Telescope, the project asks volunteers to locate beautiful bubbles, and a variety of other interesting phenomena, in the dust and gas that lies between stars (the interstellar medium). The Milky Way Project is asking the public to help map star formation in our galaxy, as many of these objects have not been catalogued before.

The images from Spitzer literally shed a new light on some well-known regions of the galaxy, such as the Eagle Nebula (M16), pictured here. These iconic "pillars of creation" were made famous by Hubble, and are stunning when viewed in the infrared.

There are some amazing astronomical gems hidden throughout these images, waiting to be found – indeed our volunteers have started to highlight them on our community discussion site Milky Way Talk (**http://talk.milkywayproject.org**). These include never-before-seen galaxies, star clusters, supernova remnants and planetary nebulae. The project aims to map out such finds and use the public's discoveries to make follow-up observations. The site might even discover something totally unexpected.

In 2006, four researchers, using GLIMPSE data, found 600 bubbles by eye. The Milky Way Project has already had 18,000 people take part, drawing almost a million objects onto the infrared images of our galaxy. You can see a running count of these drawings on the site's homepage.

With this greater data set, and the combined effort of the Zooniverse community, we hope to discover and learn more about the origin and life of stars.

www.milkywayproject.org

Climateprediction.net launches the weather*at*home project

Myles Allen

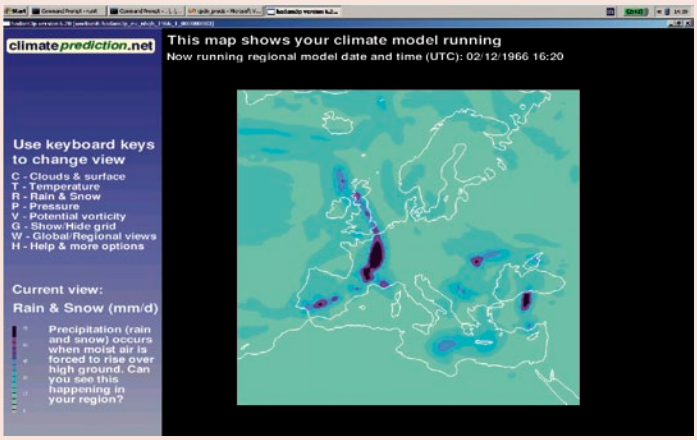
Climateprediction.net is a long-standing citizen science project launched in 2003 using public volunteered computing to perform Monte Carlo climate model simulations.

In November 2010, the project launched its latest series of experiments, called weather*at*home, in which members of the public run a regional climate model developed at the UK Met Office on their home PCs to simulate the impact, if any, of climate change on the risk of extreme weather. The weather*at*home experiment was developed with support from Microsoft Research and the launch was supported by the Guardian newspaper and website. It is a collaboration between the Department of Physics, the School of Geography and the Environment, the Oxford e-Research Centre, the Met Office, the University of Cape Town and Oregon State University, and is initially focusing on three regions of the globe: Europe, Western US and Southern Africa.

There is a tendency in the popular press to blame any instance of extreme weather on climate change, whereas the reality is of course more complicated: climate change will increase the risk of some weather events, reduce the risk of others, and have no discernible impact at all on many. The challenge is working out which is which, so that people can work out what they should expect more of in the future versus those events that are just plain bad luck. The **climateprediction.net** team published the first results from a pilot study testing the weather*at*home design, reported under "Science News".

http://climateprediction.net

Below: A screenshot from the **climateprediction.net** web site.



Telescope evenings

"We had the most amazing time", "The talk was excellent" and "Awesome" were just some of the comments about a recent public telescope evening. The event included a visit to the observatory, where the Moon and Jupiter were visible through the Philip Wetton Telescope, a presentation about supernovae and an opportunity to discuss astronomy and astrophysics with members of the Department.

There were a total of 14 school nights for 310 young people and eight public nights with more than 300 visitors between November and April.

A number of new activities were designed to encourage discussion including a "Scale of the Universe" display and an astrophysics card game based on the popular "Top Trumps". School students also helped with Departmental research by identifying galaxies in Galaxy Zoo workshops.

Oxfordshire Science Festival

Thank you to all who were involved in the Oxfordshire Science Festival. The Department was represented at local schools, the "Wow How" science fair and in a series of public lectures. At the launch event in Bonn Square it is estimated that more than 250 people came to the Physics at Oxford stall to explore the standard model through "particle zoo" toys and the scale of the universe on a floor display across the length of the square.

A new team also presented the Accelerate! show about particle physics and accelerator science at Fitzharry's School in Abingdon to enthusiastic audiences of Year

10 and 11 students. The show was originally developed with a grant from the Science and Technology Facilities Council. The show has also been delivered as part of the ever-popular Particle Physics Master Classes during March and on Saturday 30 April 2011 for Oxford May Music.

The British Physics Olympiad

The British Physics Olympiad is in its third year at Oxford and is continuing to see an increase in participants, particularly from state schools. The competitions involve students competing in challenging physics papers to test their problem solving skills. Teachers feel that the papers help to "stretch and challenge" their students, who could win certificates and book prizes and a chance to compete in the International Physics Olympiad Competition with participants from 82 other countries. This year over 7000 students took part in the GCSE, AS, A2 and experimental papers. Fifteen of the top students from the A2 paper will also participate in a Physics Training Camp, which is being held at the Department for the first time this year.

Public lecture series

A monthly public lecture series has been set up following the success of four lectures that took place during the Oxfordshire Science Festival. Each event attracted around 60 visitors and we now have a mailing list of more than 150 people who want to be kept informed about future events at the Department. Dr Neil Bowles will begin the series with his talk "Oxford Physics – Exploring the Moon" on Monday 4 April, followed by Dr Mason Alexander Porter's talk on "The Physics of Social Networks" on Monday 9 May 2011. Future lectures will be presented on the first Monday of the month at 6pm in the Martin Wood Lecture Theatre.

www.physics.ox.ac.uk/about-us/outreach

Siân Owen

The UNIQ/Sutton Trust summer school

Wade Allison and Carrie Leonard-McIntyre

For the past 10 years, the Department of Physics has organised a residential week-long summer school, financed by the Sutton Trust, aimed at improving access to physics undergraduate courses.

Selection of students was based on the Trust's criteria: parents without higher education; parents in non-professional occupations; school in the lowest 40% acorn addresses; and school in the lowest 40% progression to higher education; as well as an agreed minimum GCSE record.

Since 2010 the course has been rebranded UNIQ, a University of Oxford programme, although the content remains the same: a free course with accommodation in Colleges in July for 36 Year 12 students currently studying at UK state schools.

The course is designed and delivered by lecturers and post-doctoral researchers, with the help of current students who act as mentors. The theme is encouragement through personal contact, with a full range of academic and social activities, including lectures, laboratory studies, tutorial discussions, internet investigations and visits to research laboratories.

Wade Allison has now handed over coordination to Steve Biller and Alexander Schekochihin, to organise future programmes that will encourage potential students to realise that Physics could be accessible and interesting for them.

www.ox.ac.uk/admissions/undergraduate_courses

Energy Science and Climate Change competition

Nick Jelley


Gabriel on location in Brazil

For the last few years a series of lectures on Energy Science and Climate Change have been organised by the Physics Department. These have been aimed at raising awareness among undergraduates of all disciplines of the challenges accompanying global warming and the need for low carbon sources of energy. The energy company npower has sponsored an essay competition associated with this series of lectures for the last couple of years.

The winner of the Energy Science and Climate Change essay competition last year, Gabriel Davies (Balliol), spent nine weeks last summer researching alternative energy sources in South America. He looked into the feasibility of growing elephant grass on the plateaus in the northeast of Brazil as a feedstock for lignocellulosic production. Funding for this project came from his essay prize and also from Balliol and BP Biofuels.

Gabriel concluded that the climate, topography and soil of the area are ideally suited for the growing of elephant grass and that this crop has the potential to be commercially very competitive with existing fuels. Such a crop would also have the advantage of not being in competition with food production, which is proving the bane of biofuels based on grain and palm oil. Research in this area is clearly going to be of growing importance.

Public Lectures in 2010-2012

28 May 2010: The Cherwell-Simon Lecture, **Prof Sir Michael Pepper:** "Semiconductor nanophysics – the engineering of physics".

19 November 2010: The Sciama Lecture, **Prof Marek Abramowicz:** "Astrophysical black holes and $E=mc^2$".

22 November 2010: The Hintze Lecture, **Prof Marek Abramowicz:** "Spinning up the black hole".

21 January 2011: The Hintze Lecture, **Prof Alex Szalay:** "Extreme dataintensive computing in astrophysics".

1 March 2011: The Halley Lecture, **Prof Michel Mayor:** "Other worlds in the universe? The quest for Earth twins".

20 May 2011: The Cherwell-Simon Lecture, **Prof David Gross:** "The frontiers of fundamental physics".

27 May 2011: The Sciama Lecture, **Prof Kip S Thorne**: "Black-hole research: a new golden age".

21 June 2011: The Hintze Lecture Series, **Prof Michael Green**: "String Theory – a unifying principle in theoretical physics".

11 November 2011: The Sciama Lecture, **Prof Martin Rees**.

6 June 2012: The 1st Philip Wetton Lecture, **Prof Roger Davies**: "Telescopes of the future".

www.physics.ox.ac.uk/events

Comings...

PROF RAMIN GOLESTANIAN is a theoretical condensed matter physicist, and has research interests ranging from macroscopic manifestations of the quantum fluctuations of vacuum (the so-called Casimir Effect) to collective properties and phase behaviour of soft and biological matter.

PROF LESLEY GRAY joined the Atmospheric, Oceanic and Planetary Physics sub-department as Professor of Climate Physics in October 2010. She was previously at the Reading University Meteorology Department and the Rutherford Appleton Laboratory. Lesley is part of the National Centre for Atmospheric Sciences (NCAS), funded by the Natural Environment Research Council (NERC). Her research expertise is in the climate and variability of the ozone layer, ~10-50 km above the Earth's surface, and impacts on present and future surface weather and climate.

DR LUCA GUIDONI, a CNRS researcher from the University of Paris-Diderot, is visiting the Clarendon for a year, working with the Ion Trap Quantum Computing group. His visit is funded by an EPSRC Visiting Researcher Grant and he will be a Visiting Fellow at Balliol College.

DR ULRICH HAISCH joined the Particle Theory group in 2011.

DR THORSTEN HESJEDAL started in October 2010, working on Molecular Beam Epitaxy growth of novel systems.

PROF MINARU KAWAMURA is Professor of Electrical and Electronic Engineering at Okayama University of Science, Japan, where he studies NMR quantum computing, and is visiting Atomic and Laser Physics for six months.

PROF PARTHA MAJUMDAR will be a Senior Visiting Fellow at Jesus College in 2011.

PROF TIM PALMER joined the Department as Royal Society 2010 Anniversary Research Professor working on climate physics. Until 2012 he will be working jointly at the European Centre for Medium Range Weather Forecasts in Reading.

PROF ANDREI SERYI took over the Directorship of the John Adams Institute for Accelerator Science (JAI) in August 2010, succeeding Professor Ken Peach. The JAI is jointly hosted by the Departments of Physics in the University of Oxford and Royal Holloway, University of London. The institute is a Centre of Excellence in the UK for advanced and novel accelerator technology. It provides expertise, research, development and training in accelerator techniques, promotes advanced accelerator applications in science and society, including a linear electron-positron collider, a neutrino factory and upgrades to the LHC, novel light sources and medical applications, and has a strong education and training programme. The JAI has more than 30 academic, research and technical members and about 20 research students.

DR BRIAN J SMITH joined Atomic & Laser Physics in April 2010 as part of a major strategic investment by the Department in Quantum Information Science, as part of the EPSRC science and innovation programme. The Oxford Centre focuses on Quantum Coherence and is the hub of a three-centre consortium involving Cambridge and Imperial College. Brian's work in experimental, optical and quantum physics aims to harness the peculiar quantum nature of photon interactions for information processing and metrology.

DR LAURE ZANNA is a new University Lecturer in climate physics, interested in understanding the dynamics of climate change using a combination of theory, a hierarchy of models, and observational analysis.

and goings...

PROF DOUGLAS ABRAHAM retired in 2010, but remains an emeritus member of the Department.

PROF MYLES ALLEN took up a Statutory Professorship in Geosystem Science in the School of Geography and the Environment, aiming to develop the University's already strong range of activity on the impacts of anthropogenic and natural climate change. For the first five years he will continue to work 35% in Atmospheric, Oceanic and Planetary Physics.

PROF DONALD BLACKWELL, Savilian Professor of Astronomy 1960-1988, passed away in December 2010, aged 89. In his early career, Prof Blackwell studied the Sun, using aircraft, balloon and mountain-top observations. This led to the development of a substantial programme in "laboratory astrophysics", accurately measuring atomic transitions needed for understanding the astrophysics of the Sun and other stars. Prof Blackwell was president of the Royal Astronomical Society, 1973-1975.

PROF FRANK CLOSE retired in 2010 but remains an emeritus member of the Department.

PROF ROBIN DEVENISH retired in 2010.

PROF BRIAN FOSTER is taking up an 80% appointment as Alexander von Humboldt Professor at the University of Hamburg and Deutsches Elektronen-Synchrotron, retaining his chair in Oxford as a 20% appointment.

PROF MIKE GLAZER retired in 2010.

PROF PETER RENTON retired in 2010.

and awards...

PROF MYLES ALLEN was awarded the Appleton Medal and Prize of the Institute of Physics.

PROF KATHERINE BLUNDELL was awarded the Royal Society Rosalind Franklin Award in 2010.

PROF JOCELYN BELL BURNELL was awarded the 2011 Grote Reber Gold Medal.

PROF TONY BELL was awarded an Advanced Investigator European Research Council Grant.

PROF JAMES BINNEY was awarded the Dirac Medal of the Institute of Physics.

PROF JOHN CARDY was awarded the Boltzmann Medal by the International Union for Pure and Applied Physics.

DR JÖRN DUNKEL was awarded the Gustav Hertz Award of the German Physical Society (DPG) for 2011.

PROF SIMON HOOKER was awarded the 2010 John Dawson Award for Excellence in Plasma Physics Research by the American Physical Society.

DR LEIGH FLETCHER and **DR SUGATA KAVIRAJ** were awarded Royal Astronomical Society Winton Capital Awards, for their work in planetary physics and astrophysics respectively.

DR ACHILLEFS KAPANIDIS, DR JOANNA DUNKLEY and **DR GIANLUCA GREGORI** were awarded European Research Council Starting Independent Researcher Grants.

PROF DAVID MARSHALL has been invited to deliver the Victor Starr Lecture at MIT.

PROF TIM PALMER has become President of the Royal Meteorological Society and was awarded the Carl-Gustav Rossby Research Medal of the American Meteorological Society for 2010.

DR MIHA RAVNIK was awarded the 2010 Glenn H. Brown Prize by the International Liquid Crystal Society.

PROF DAVID SHERRINGTON was awarded the Blaise Pascal Medal in Physics by the European Academy of Physics.

PROF IAN WALMSLEY was awarded the 2011 Joseph F. Keithley Award for Advances in Measurement Science by the American Physical Society.

For the latest news on development of the Oxford Physics Department, see **www.physics.ox.ac.uk/about-us**

PRINTED BY PARK LANE PRESS ON FSC CERTIFIED & 100% RECYCLED PAPER, USING FULLY SUSTAINABLE, VEGETABLE OIL-BASED INKS, POWER FROM 100% RENEWABLE RESOURCES AND WATERLESS PRINTING TECHNOLOGY. PRINT PRODUCTION SYSTEMS REGISTERED TO ISO 14001: 2004, ISO 9001: 2008 AND EMAS STANDARDS AND A CARBON FREE STATUS BY OFFSETTING ALL SITE EMISSIONS THROUGH THE DEFRA AND DECC RECOGNISED CHARITY PURE.
DESIGN: WWW.CATHERINECHARNOCK.CO.UK

Waterless Printing. Naturally

RECYCLED Made from recycled material FSC® C013343

East side
Department of Physics
Clarendon Laboratory
Parks Road
Oxford OX1 3PU

Tel: +44 (0)1865 272200

West side
Department of Physics
Denys Wilkinson Building
Keble Road
Oxford OX1 3RH

www.physics.ox.ac.uk

UNIVERSITY OF OXFORD