The newspaper of the physics community

November 2006

interactions

Institute of Physics

Reading under threat of closure

Ayala Ochert reports on the campaign to save Reading University's physics department.

The future of yet another university physics department hangs in the balance as the council of Reading University decides this month whether to approve the closure of its 33-strong department.

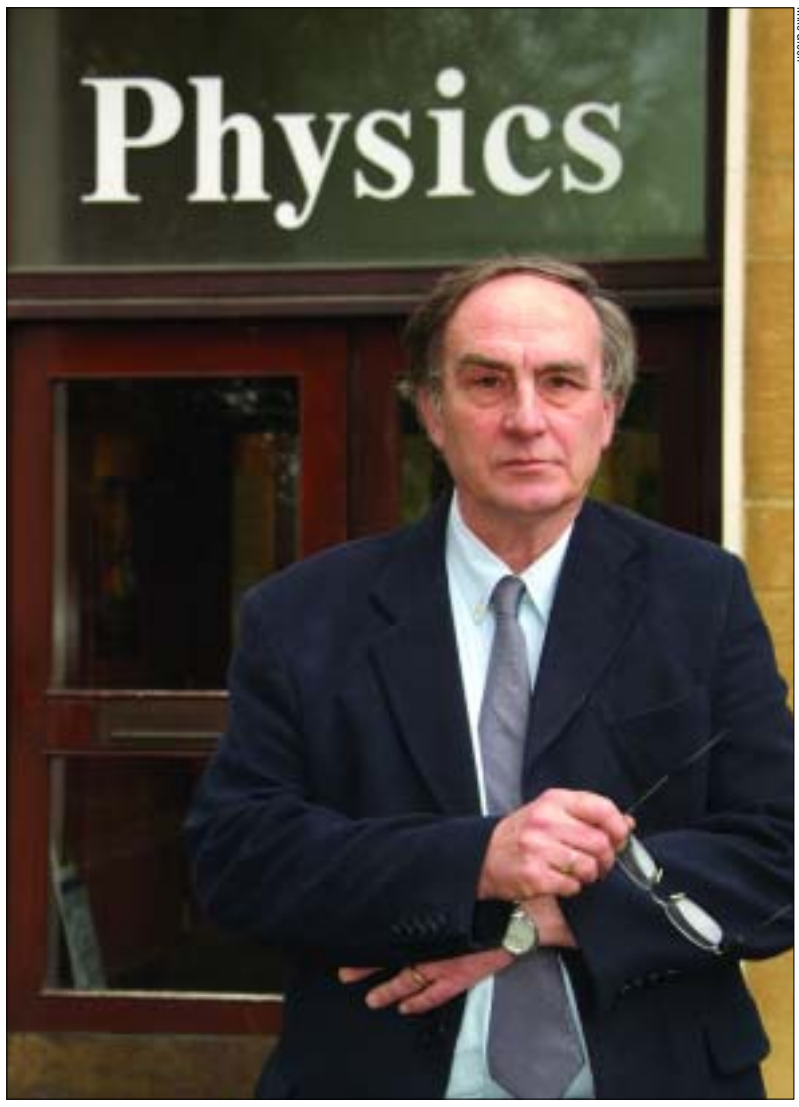
The management of the university announced the proposed closure on 29 September, saying that: "The university regrets having to make this recommendation [but], in order to maintain and build on our academic strength in the department of physics, we would need to invest in a way which is not feasible in the present climate… Budgetary constraints mean that it is not practicable to strengthen the department as much as would be necessary."

The university said that it would not be recruiting any new students after this year's intake and that the department would close no later than July 2010. Research and teaching in various areas of physics, such as meteorology, environmental science and nanoscience, would continue at the university, it added.

The Institute of Physics has criticised the plans and has been attempting to intercede on behalf of the physics department. Chief executive Robert Kirby-Harris and director of science and education Peter Main met with the university's vice-chancellor, Gordon Marshall, on 9 October to persuade him to reconsider. They pointed out that, in the last few years, the department has attracted £5m in investment – money that would be wasted if the department closed. In particular, £300 000 has been earmarked for refurbishing undergraduate laboratories, and £1m has been set aside to develop Reading as a centre of excellence for physics teaching and learning, together with Leicester and the Open University. It was to be the UK's only such centre of excellence in physics.

Main called Reading's proposal to close physics "ill-judged and precipitous", while Kirby-Harris said it was "short-sighted" given that measures to increase student numbers have not yet been given a chance to work. Main added that: "Reading is in the vanguard of innovation in physics teaching, so it's a particularly severe blow."

Physics students at the university have taken the news hard and staged a protest outside the senate meeting on 11 October. "No-one has given us any reasons as to why the department is closing. We're here today to ask for an explanation and to try to get the vice-chancellor to change his mind," said Simon Stacey, president of the university's physics society. "I was hoping to go on to do a PhD at Reading after I graduate this year. Now I'm not sure if I will be able to do that," he added. However, the student's protests were in vain as the senate voted 36 to 16 in favour of the proposal. The final decision will be made by the university's council on 20 November.



Mike Green

Prof. John Blackman contemplates the closure of his physics department.

Joining the students was head of department John Blackman. Referring to another recent department closure, he said: "If closing mechanical engineering was the thin end of the wedge, then this is going over the cliff. It's going to say that this university can't cope with the physical sciences."

Staff and students also felt misled by the university as a review of physics earlier this year led them to believe that the subject was safe. According to Reading's student union: "University senior management have gone against the recommendations of a previous exhaustive review that reported that there should be a continuation of the physics department, that additional funding for staff would be committed and that a strong viable physics presence was key to fulfilling the university's corporate plan."

Blackman says that as recently as March of this year the university planned to add three new posts to the physics departments, but it was hit by a financial crisis soon after. "The last two years have been actually very good for physics at Reading, with lots of new initiatives and developments. It is very sad that this is all being destroyed by a financial crisis whose origin is far removed from us."

Students have already collected a petition of more than 1500 names in support of keeping the department open. One prospective student added: "Please don't shut it. I wanted to do physics at Reading next year." However, the university made the announcement just hours before its open day, and chose to keep the department's doors shut to "avoid disappointment".

Interim solution required

The Institute has also criticised the government for not doing more to protect physics departments under threat of closure. "University vice-chancellors are operating in an environment that is controlled by the choices of 17-year-olds. Funding follows student numbers and so the future of Britain's science base rests on the university choices of sixth-formers," said Main. He pointed out that allowing such closures undermines the government's own 10 year strategy for science and innovation. "How can they have a meaningful long-term strategy when a university vice-chancellor can make a unilateral decision in this way?" He called for interim measures to keep departments open and to give longer-term projects a chance to work. This month, the government announced funding for various projects to stimulate demand in science subjects, including the Institute's own Stimulating Physics programme (see p 3).

Since 2001 30% of physics departments in the UK have merged or closed. The possibility of yet another closure has attracted widespread dismay, inside and outside the field. Reporting in *The Times*, the columnist Anjana Ahuja, who has a PhD in physics from Imperial College, wrote: "For the first time last summer more teenagers took an A-level in media studies than in physics. When Britain winds up as the call centre of the universe, at least we'll be able to read about it."

WHAT YOU CAN DO

Reading University's council meets on 20 November to consider the proposed closure. Members can help exert maximum pressure to keep the department open.

- Write to Vice-Chancellor Gordon Marshall at **j.v.hattrick@reading.ac.uk**.
- Write to your MP asking him or her to take up the matter with the higher education minister, Bill Rammell MP.
- Write to Bill Rammell MP at **rammellb@parliament.uk**.
- Write to Barry Sheerman MP, chair of the Commons' Education and Skills Select Committee, at **sheerman@parliament.uk**.
- Write to Phil Willis MP, chair of the Commons' Science and Technology Select Committee, at **willis@parliament.uk**.
- Write to Reading MPs Robert Wilson (**robwilsonmp@parliament.uk**) and Martin Salter (**salterm@parliament.uk**).
- Add your name to the student petition at **www.petitiononline.com/RUPhys**.

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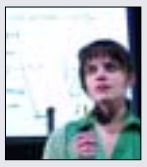
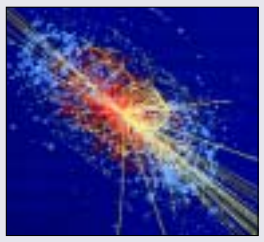


"Physics is seen as hard, and maybe it is, but that's not necessarily a bad thing."
Paul Campbell, p5

"Their work on teleportation has been about fixing what's missing in their lives."
Helen MacBain reviews *Tangle*, p8

HIGHLIGHTS

Filling the holes in the Standard Model



Around 80 people, including groups from Cheltenham and Millfield schools, joined Vince Smith of the University of Bristol as he took them "Hunting for the Higgs Boson" at the Park Campus in Cheltenham. Smith was giving the talk for the Institute's South West Branch, informing and entertaining them as he explained the theory behind the work at CERN. Smith detailed the Standard Model, with its six quarks, six leptons, photons, gluons, bosons and (possibly) gravitons, but explained that the model is "full of holes", hence the need for the new multibillion pound Large Hadron Collider, which is scheduled to begin operation next year. The 27 km machine will collide protons at 99.999999% of the speed of light and will produce 100 terabytes per second of data. Bristol, one of four contributing UK institutions to the project, has as its focus the Compact Muon Solenoid (CMS) detector, which generates its own superlatives – more iron than the Eiffel Tower and a magnetic field with energy equivalent to a 747 in flight – said Smith.

Machine emulates top cricketers

A team at Loughborough University has created a robotic bowler that can rival Shane Warne or Glen McGrath in the way it delivers cricket balls. The inventor of the bowling simulator, Andy West, described the machine at the Institute of Physics conference Physics and Engineering: Synergy for Success in October. "We considered all the things that real players use, such as the orientation of the seam and the speed at which the ball is released to vary how a ball travels when it is bowled," he said. "Real-life bowlers can get tired or injured during extensive training, so the machine is ideal for batsmen to practise with." The simulator, known as the "cricket emulator", can be programmed to bowl any sequence or to repeat the same delivery several times. It is part of a suite of simulation machines under development at Loughborough for a variety of sports.

Energy to meet future challenges

We need to find diverse ways to produce energy and not just rely on one generator, such as nuclear or renewable sources, Maxwell Irvine of Manchester University argued in a talk to the Institute's Lancashire and Cumbria Branch in October. In his lecture, "Energy Issues for the UK: Can We Keep the Lights on and Save the Planet?" Irvine highlighted the effect of government policies, such as privatisation and the "dash for gas" in the late 1980s, and said the margin for back-up had been reduced by decommissioning and not replacing coal and nuclear power stations, while renewables were too intermittent to provide back-up. Meanwhile, domestic consumers could make a difference by actions such as buying energy-efficient appliances. Using only appliances rated A or B for efficiency could save 20% on domestic electricity bills, he said.

Environmental science journal launched

A new open-access journal for the environmental science community – *Environmental Research Letters* (*ERL*) – was launched this year by the Institute, and the first article content became available in October. Although specialist publications for the various branches of environmental research exist, *ERL* is the first open-access journal to cover all of environmental science. *ERL* is intended to serve the whole of the environmental science community, including the wider public as well as specialist researchers. It will carry research letters, perspectives, editorials and news items, and aims to reflect the interdisciplinary nature of environmental science, including topics such as biodiversity, climate change, energy and health. Completely free to read, the journal can now be viewed online.

http://erl.iop.org

How to make biotechnology pay

By Heather Pinnell

Techniques using light of different colours to cut and hold chromosomes and the use of terahertz radiation in cancer screening were among the applications described in the seminar Commercialising Research for Healthcare Biotechnology, held at the Institute in October.

Kishan Dholakia, head of the Optical Trapping Group at the University of St Andrews, said laser beams could be used to slice molecules and move them. The basic research has been around for 30 years, but only now is it breaking into the medical environment. His group has demonstrated an "optical tweezer" smaller than a sewing machine at a fraction of the cost of earlier devices. Other applications of photonics included photoporation – using light to make a temporary hole in a cell to deliver material such as DNA or a drug – and using Raman spectroscopy to test for cervical, lung or prostrate cancer, he said. The group had also integrated lasers into a microchip to sort cells using light.

Vincent Wallace, head of the technology group at TeraView Ltd, described how terahertz radiation (in the far infrared range from 3 mm to 30 mm) could be used in astronomy, security screening and medical imaging. TeraView – a spin-out from the Toshiba Europe Research Laboratory – is trying to reduce the size of its spectrometer from that of a photocopier to a handheld device. It has developed systems for dental imaging and imaging skin cancer and is now working on breast cancer. It has made a device that can look for residual cancerous tissue in breast tumours.

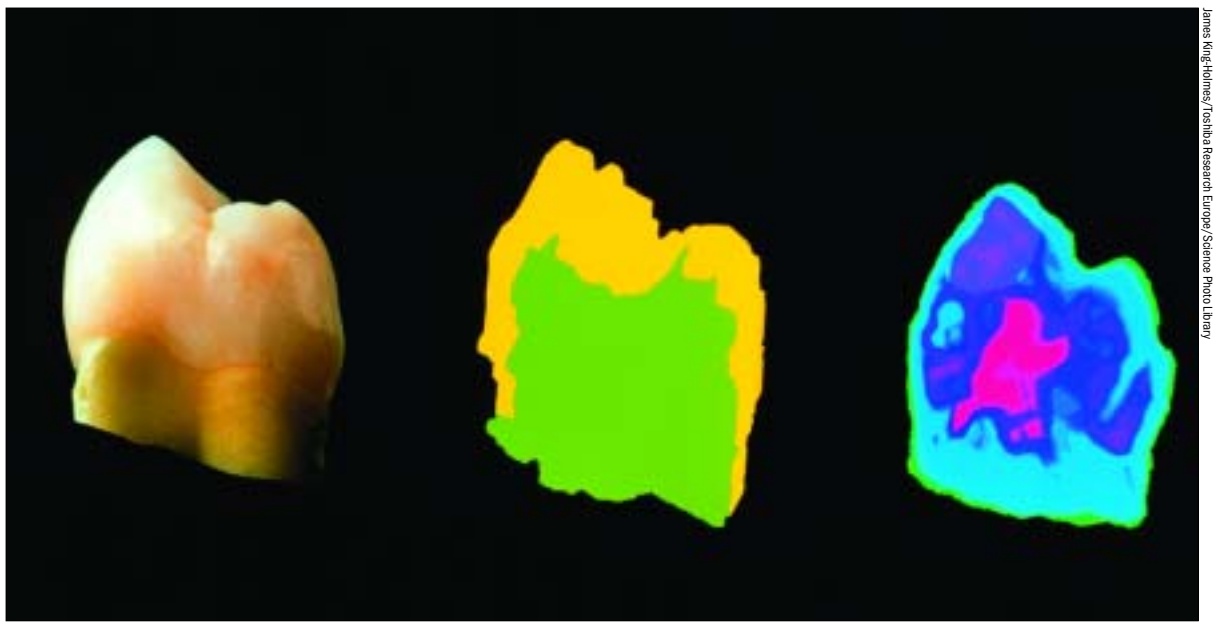
In commercialising ideas in healthcare, Wallace said, researchers had to overcome the inertia of clinicians, which is a result of their training. Pankaj Vadgama, director of IRC Biomedical Materials, stressed the need to understand the priorities of healthcare staff, who have to know if an application will improve patient care, its financial impact and whether alternatives exist. Researchers had, for example, made an uncemented prosthesis for hip replacements, but the National Institute for Clinical Excellence decided it did not provide enough patient benefit, so did not recommend it.

As well as successes in biotechnology, there had been failures, such as an intophoresis method for glucose monitoring, which had not worked. He said it was important to accept these and keep going.

Mike Cooper, chemistry technology manager at GE Healthcare Life Sciences, said the company had focused on radiochemistry in the 1990s but had predicted that the market would shift towards fluorescence, where new breakthroughs would be made. In 1995 it created a start-up based in Carnegie-Mellon University in the US, which exploited pigments used in early 20th century photography and made them bio-useable as reagents for fluorescent probes. It also set up facilities in Cardiff and, by 2006, cyanine dyes provided £20m per year in business for GE Healthcare.

Andrew Mackie, head of life sciences at IP Group plc, said there was a funding gap in bringing ideas to the market. His company helped universities or departments to create and nurture spin-out companies and had formed 48 of these since 2000. Finding the money to start spin-outs was less difficult than getting follow on funding to sustain them, he said. The creation of spin-outs had seen steady growth until 2001, but numbers have since fallen. In a panel discussion, speakers said researchers might be wary of creating companies that could not attract sustainable funding, or that the dip represented a return to reality after a time when investors ran with any idea.

Chairman Chris Lowe, director of the Institute of Biotechnology, Cambridge, led a debate on whether the UK was on target to be the world leader in biotechnology by 2015.



James King-Holmes/Toshiba Research Europe/Science Photo Library

Terahertz images of a tooth showing enamel (yellow), dentine (green) and an internal cavity (pink).

Nobel winners are cosmology's stars

The Institute has welcomed the award of this year's Nobel Prize for physics to John Mather and George Smoot for their discovery of the form of the cosmic microwave background radiation (CMBR) and its variations. The Royal Swedish Academy of Sciences, which confers the awards, said their detailed observations had "played a significant role in the development of modern cosmology into a precise science".

Commenting after the Nobel prize-winners were announced in October, Michael Rowan-Robinson, professor of astrophysics at Imperial College, London, said: "Mather and Smoot's work was among the most significant discoveries in astronomy of the last century."

John Mather is senior astrophysicist at the NASA Goddard Space Flight Center in the USA and George Smoot is professor of physics at the University of California, Berkeley. Their observations were made using the COsmic Background Explorer (COBE) satellite, launched in 1989. Mather was the driving force behind the COBE project and was also in charge of the satellite's instrument for investigating the spectrum of the CMBR. Determining the shape of the spectrum was a crucial part of the experiment – Big Bang theory predicted that it should have the characteristic form for radiation emitted by a black body. The first nine minutes of observations showed that the CMBR has a perfect black-body spectrum, and the findings were announced to worldwide acclaim in January 1990.

George Smoot was responsible for the instrument that was designed to look for tiny variations in the temperature of the CMBR. These could explain why matter is not spread out uniformly across the universe and would show where matter had begun to aggregate in the early universe, allowing stars and galaxies to form. The experiment involved measuring variations as small as one hundred-thousandth of a degree celsius.

TV drama for teachers who want to keep girls on board

Heather Pinnell reports on a new DVD on how to keep girls interested in physics.

Romance, reviving the interest of a bored science class and reaching out to a disaffected female student occupy actors Helen Baxendale and James Fleet in a drama about keeping girls interested in physics that is to be shown on Teachers' TV this month. They appear in *Saving Nellie*, commissioned by the Institute along with *Key Stage 3/4 Science: Girls in Physics* – a documentary demonstrating good practice through a sample lesson.

Both programmes, due to be aired in November, will be available on a DVD that will be sent to any school that requests a copy. The DVD also contains a report reviewing the relevant research – *Girls in the Physics Classroom* – commissioned by the Institute and published earlier this year, and *Girls in the Physics Classroom: A Teachers' Guide for Action*, which draws on the review and on *Yes She Can* – a report on schools that have successfully attracted girls into A-level physics.

The guide says girls are more likely to continue with physics post-16 if there is an expectation that anyone can do physics, it is taught in a way that engages with young people's interests, focuses on ideas rather than disconnected facts and when young people understand its relevance.

Despite early studies showing that single-sex schools' success in enhancing girls' achievement could be down to social class and selection, recent work has shown a residual effect – particularly in science – that cannot be explained in this way. These findings in *Girls in the Physics Classroom* are picked up in the guide.

Girls tend to prefer a collaborative to a competitive approach, it says, and often express uncertainty in their answers in class in deference to the group or because they are not interested in "closed" questions. Teachers can mistakenly interpret this as lack of understanding. They need to ensure that girls are not relegated to the role of note-takers in experiments and they should not be afraid to use everyday analogies in teaching, using contexts familiar to both sexes, it says.

Printed copies of the guide are being sent out this autumn to all secondary schools, further education and tertiary colleges in England, Wales and Northern Ireland (including independent schools), and to Science Learning Centres and local education authorities. While noting that only 14% of girls who gained an A or A* in physics GCSE or double award science went on to sit physics A-level in 2005, the guide stresses that the problem is not insoluble and that the teacher's role is pivotal.

"Many of the suggested changes simply represent good classroom practice and are likely to support boys as well as girls in their learning," the guide notes. Daniel Sandford Smith, the Institute's education manager, agrees. "On the whole, good teachers of physics will be good teachers for girls and for boys," he said. "A lot of this is what good teachers do anyway. The DVD strives to remind people what good teaching looks like. It's about getting this on teachers' agendas and raising awareness that it's still an issue. It's not easy, but we believe teachers can make a difference."

***Saving Nellie* will be broadcast on 6 November on Teachers' TV.**

Russell Watkins

The camera catches Helen Baxendale and James Fleet in *Saving Nellie*.

Call for study of nanotech safety

An assessment of the hazards associated with nanoparticles should be conducted and precautions implemented, according to participants in a workshop that was organised by the Royal Society of Chemistry and NANOsafeNET in partnership with the Institute of Physics and the Institute of Materials, Minerals and Mining. Views from the workshop will inform recommendations made to the Council for Science and Technology's nanotechnology review.

The review is examining the government's progress on actions it promised in response to the 2004 report *Nanoscience and nanotechnologies: opportunities and uncertainties*. Delegates were alarmed by the potential for unknown effects to be as great as with asbestos. They felt existing regulation was sufficient, but believed precautionary research should be coordinated by Research Councils UK.

Institute's new degree in focus

The Higher Education Funding Council for England (HEFCE) has launched a series of initiatives worth £18m aimed at increasing the numbers taking degrees in science, technology, engineering and mathematics. According to higher education minister Bill Rammell, lack of demand among young people to study these subjects has been behind the recent spate of closures of physics and chemistry departments.

The series of pilot projects was announced on 10 October at a high-profile press conference at the Institute of Physics. The Institute took the opportunity to highlight its new physics-based degree, called Integrated Sciences. It is just one of a number of projects being developed as part of the £1.8m HEFCE-funded Stimulating Physics programme (see *Interactions*, May 2006).

The new degree combines core physics courses with courses on the applications of science in the modern world. Four universities – East Anglia, London South Bank, Leicester and Surrey – will be enrolling students in Integrated Sciences from September 2007. Each of the four will offer a slightly different "flavour" of the degree.

While most physics degrees require students to have taken A-levels in both physics and mathematics, the new course will be more flexible in its requirements. It is designed for students who wouldn't normally take a physics degree but who are nevertheless interested in the science and have an aptitude for it.

The course was welcomed by employers such as ICI. "We fully support the Institute's initiative," said Peter Palasz, a senior associate at the company. "Modern-day companies need graduates who have multidisciplinary qualities and are not just experts in one field. Students will have the opportunity to learn key technical skills required in industry, and industry will want to recruit this new breed of graduate."

It is expected that the course will be especially suitable for those who plan to train as science teachers, but it will also be a route into physics for those without traditional A-levels. Students of Integrated Sciences will be able to go on to study for a further two years to achieve an MPhys or MChem degree.

At the press conference the Royal Society of Chemistry also announced its £3.6m HEFCE-funded Chemistry for the Future programme. This will include a pilot project that will take school students to their local university, where they will be able to use the state-of-the-art equipment in their chemistry laboratories. The Royal Academy of Engineering and a consortium of mathematics societies also announced pilot projects in those subjects.

IN BRIEF

● **Four new national and regional officers** have been appointed by the Institute and will start this autumn and winter. Angharad Thomas took up her post as the national officer in Wales in October, Esther Haines starts as regional officer for East Anglia on 6 November and Louise Butcher will be the regional officer for the North West from 4 December. David Wilkinson takes up his post as regional officer in the Midlands on 2 January. The new posts are in addition to the regional officers for the North East (Alex Brabbs) and the South West (Alison Rivett), and the existing national officers for Scotland (Alison McClure) and Ireland (Alison Hackett and Sheila Gilheany, the policy officer).

Council decided to establish the new posts to ensure greater representation of the Institute in the nations and regions.

● **The Welsh Assembly's *Review of Science Policy in Wales*** was published in September, following extensive consultation.

The Institute of Physics in Wales made a submission to the review in February 2006, recommending student bursaries for talented students from Wales to take undergraduate studies in science at a Welsh institution; postgraduate scholarships to be offered on a competitive basis to attract bright PhD students to Wales from any country; and funds to attract research "stars" to, or back to, Wales.

The review group did not take up these recommendations but did urge stronger support for science, including the appointment of a chief scientist for Wales and an industry-led Science and Technology Advisory Council.

NEWSMAKERS

Sam Dolan, a postgraduate student undertaking research on black holes in the astrophysics group at the Cavendish Laboratory, Cambridge, is the Institute's POST fellow for 2006. He is working on placement to the Houses of Parliament for the three-month fellowship at the Parliamentary Office of Science and Technology, during which he will prepare a briefing paper for MPs and peers on electricity infrastructure in the UK.

Keith Mason has been appointed as the first chief executive designate of the Large Facilities Council and **John Wood** has been appointed as its director-designate of international relations. Mason is currently chief executive of the Particle Physics and Astronomy Research Council (PPARC) and Wood is chief executive of the Central Laboratory of the Research Councils (CCLRC). The new Large Facilities Council will bring together the work of PPARC and the CCLRC, and the nuclear physics work of the Engineering and Physical Sciences Research Council.

Open question for science publishing


Jerry Cowhig

"Why would a library pay for a journal if its clients can get all the articles free online?"

The World Wide Web, a mere 15 years old, has changed science publishing more dramatically than any other advance since the first journals appeared more than 300 years ago. Today original articles and data are available almost universally at the desktop. But supply creates demand, and some people are now calling for all papers to be available online to all, free of charge. This is the basis of the open-access movement.

Open access means making original papers freely available online, either through the journal's publisher (OA publishing) or by the author depositing the paper on another website (OA self-archiving).

The costs of OA publishing are met typically by author charges, and research has shown that the article charge needs to be in the range of $3000-4000. Much of the support for open access comes from funding bodies, which argue that research paid for by the public should be publicly available. They also regard publisher subscriptions as a block to a wider readership and a route to unjustified profits. Some funding bodies are willing to pay the author charges for OA publishing; some even insist on it.

Despite this momentum, the viability of OA publishing is uncertain. Two of the best-known OA publishers – the US Public Library of Science (with seven highly publicised journals) and the UK-based BioMed Central (with more than 150) – are both making substantial losses. Meanwhile, some journals that started as open access have converted back to the traditional subscription model.

Authors themselves are often reluctant to pay article charges. Moreover, academic institutions that publish a large number of papers calculate that they would pay more under an OA model than they currently do to buy subscriptions. At the same time, commercial companies that read a lot of papers but publish few, such as those in the pharmaceutical industry, would pay less than at present towards the overall costs of science publishing.

The second form of open access is self-archiving in a repository. Here a published article is posted on a university's or a national library website. In both the US and Europe there is pressure from funding bodies and legislators to require such deposit, if not on publication then certainly after six or 12 months.

In fact, most publishers already permit authors to archive their papers in this way although few authors currently do. Publishers fear that such free access could undermine subscriptions if it were universal. Why would a library pay for a journal if its clients can get all the articles free online? In physics we have 15 years' experience of arXiv for pre-prints, and the effect on the Institute of Physics has been a greatly reduced readership of articles in high-energy physics journals.

Publishers' work is considerable and costly. There is editing, managing peer review, marketing, distribution, electronic loading and tagging, reference linking, navigation, archiving – not to mention the imprimatur of the journal, which gives the author recognition. If open access threatens the existence of favoured peer-reviewed archival journals, then authors and science itself will be the losers.

Essential subsidies

Here at the Institute, moreover, publishing generates a surplus, helping to keep down member subscriptions. Most of our journals remain subscription-based but we have also been involved with open access for many years. Indeed, we created one of the first open-access author-pay journals – *New Journal of Physics*, launched in 1998 in collaboration with the German Physical Society. Editorially, the journal works well with a good impact factor of 3.6; it also provides authors and funders seeking open access with a strong reputable journal in which to publish. But, until now, subsidies from the two societies have been essential, and the journal will only begin to meet its annual costs next year.

We have just launched another author-pay journal, in environmental science (see p2), and all our conference proceedings are free online too. Moreover, all papers in our subscription journals are accessible free of charge for 30 days after publication. And within the subscription model we often license our complete range of journals to groups of institutions or whole countries, thereby achieving open access for all workers at a central cost without the need for author payments.

As a learned society we will continue to publish professionally, and in a way that guarantees care of our authors' papers from the day of submission and in perpetuity. As publishing models evolve we will stay vigilant and aware, secure in our traditions yet agile in experimentation.

Jerry Cowhig is managing director of Institute of Physics Publishing.

focal point: careers

New service in continuous professional development

This July the Institute of Physics took the unusual move, for an institution of its kind, of appointing a full-time Continuous Professional Development (CPD) manager. This represents a significant commitment by the Institute to CPD and, I hope, a major enhancement to the services it provides to members.

What exactly is CPD, you may well ask, and why does the Institute consider it so important? Many activities that you already take for granted as an integral part of your professional life – attending conferences and seminars, mentoring and peer review – are all CPD. But there is more to the idea than that. It includes anything that improves your knowledge and skills or develops qualities that better enable you to carry out your professional role. In other words, CPD is lifelong learning in the workplace.

The concept of lifelong learning is central to the idea that we are moving towards an "information society" or "knowledge economy" in which a country's wealth is related to its intellectual capital.

Few people these days can rely on a linear career path – we now have more frequent changes of job or career. This adds to the importance of ongoing development, particularly for those engaged in the scientific, engineering, technological and knowledge-based professions that are at the heart of this new economy.

Structured CPD has other benefits for the individual. It can help them attain career goals by identifying and filling any skills gaps. It can make working life more interesting by providing opportunities to learn new things. And, in some cases, it can be a protection because it allows individuals to demonstrate that they are maintaining professional competence – an increasing demand in a more regulated, and litigious, society.

The Institute is still in the process of developing its CPD programme, but in September the Membership and Qualifications Board agreed to the following plan:

- It will set up a voluntary, points-based professional development scheme, with certification for successful participants.
- It will provide online tools to support members. A key element in the usefulness of CPD for individuals is the opportunity to plan, record and reflect on their own skills needs and development.
- It will create a system for endorsing external training providers who are able to offer specific benefits to members.
- It will develop its own training courses to provide additional development opportunities for members. A survey is currently underway to assess potential requirements for this service.

Building on our existing careers resources, we also plan to develop a dedicated careers, CPD and web recruitment portal. This will be one-stop shop that will include a members' CV bank and a mentor/mentee matching service, along with a wealth of other careers resources.

You will begin to see evidence of these activities over the coming months, and full implementation of a CPD programme by this time next year. In the meantime, comments, queries and offers of help are more than welcome.

Stephanie Richardson is the Institute's Continuous Professional Development manager. Questions and comments may be sent to cpd@iop.org.

profile: Paul Campbell

Taking on a real physical challenge

Ayala Ochert meets one man going the extra mile for physics.

David Bebber

Paul Campbell plans to run across the Sahara desert in the gruelling Marathon des Sables in 2008.

Like many physicists, Paul Campbell is worried about the spate of closures of physics departments in the UK. In fact, he had only been at Robert Gordon University for two years when it closed its door to physics students in 2000. But he's going further than most to do something about it – 250 km further, to be precise, and by foot in six days, across the Sahara desert.

In 2008 Campbell plans to run the Marathon des Sables, the world's most gruelling foot race. The purpose of his run, he says, is to raise awareness about the challenges and rewards of a career in physics, with the goal of encouraging more young people to consider studying physics at university.

What does physics have in common with running across a desert? Quite a lot, according to Campbell. "The whole idea behind the marathon is to say, physicists like challenges. Physics is seen as hard, and maybe it is, but that's not necessarily a bad thing. What I'm saying is, I'm a regular Joe and I'm going to try to do this. With the right preparation and guidance, I'm sure I'll make it. That's the way physics works as well. Some of the problems are hard, for sure, but that's what makes it rewarding in the end."

He's keen to emphasise the true rewards of a career in physics. Campbell, who is now a senior lecturer at the University of Dundee, is working on a technique that uses ultrasound to treat cancer, without the need for surgery. "The thing about our technique is, it's physics, so it applies to all matter. It doesn't matter if it's prostate cancer or breast cancer – it's completely generic."

The idea is to generate a lot of publicity for his run, come 2008, so that as many young people as possible hear his message about the rewards of physics. Campbell knows all about the power of the media to get a message across. Last year his ultrasound work was splashed across the newspapers and television, and he's keen now to extend his 15 minutes of fame for the good of physics.

The ultrasound technique itself is known as "sonoporation", and it came out of his work at Ninewells Hospital with Sir Alfred Cuschieri, the well known key-hole surgeon. Cuschieri has gathered a team of physicists and engineers around him and he challenges them on a regular basis with such questions as "How can we make surgery totally non-invasive?" The answer to this question turned out to be: by using ultrasound.

Physicists have known for at least 20 years that high-dose ultrasound can make cell membranes more permeable, allowing in molecules that wouldn't normally enter, and that this effect is enhanced when there are bubbles of contrast agent. Campbell concluded that, if they could understand the mechanism behind this process, it might open up some new avenues for clinical application.

"The idea behind the marathon is to say: physicists like challenges."

Determining the mechanism proved immensely technically challenging – Campbell had to find the perfect optical trapper to hold the bubble in place while imaging the process with a military high-speed camera capable of taking 200 million frames per second. The bursting of the bubble took up just eight of those frames, but it revealed something wonderful. The bubbles rapidly inflate and then just as rapidly implode and, in doing so, release microscopic jets of fluid into the cell. "It's a way of automatically micro-injecting fluid into the tissues so, in principle, you can use it to squeeze in the chemotherapeutic of your choice," explains Campbell.

Tangible impact

The potential impact of his work hit home last year, when the story was splashed across the news. Immediately the letters from cancer patients started pouring in, offering themselves as volunteers to receive the revolutionary treatment. It was disheartening to have to turn them away – it will be some years before the technique will reach human trials – but it also spurred Campbell on. "It reinforces everything that brings you into this area in the first place. You think you might have some tangible impact of people's lives."

It also reminds him of the power of physics and why the country needs more physicists. "What I want to do is share with kids my experiences with physics and what I get out of it and the rewards it brings. It's not just the intellectual rewards, but there are real tangible benefits to the world at large when you're a physicist."

OBSERVATIONS

Michelle Cain, a PhD student in meteorology at the University of Reading, describes the two weeks she spent studying the weather in the west African country of Niger.

8 August

I arrived in Niamey, Niger, greeted by torrential rain and the loudest thunder I have ever heard. But this is all to be expected as I'm here to study the development of the monsoon with the African Monsoon Multidisciplinary Analyses (AMMA) field campaign. This is the second year of my PhD and my first time in Africa.

11 August

Tonight I had my first flight on the BAE146 (the UK's atmospheric research aircraft). It was a night flight, flying northeast of Niamey. Even though it was dark, I was excited to finally get on a proper research flight. I was following various different quantities on the computer in real time (ozone, carbon monoxide, humidity), so I could see what kind of air we were passing through. We also dropped lots of radiosondes, which are meant to give a vertical profile of the atmospheric conditions, but for some reason the 'sondes weren't working properly at first. There was mild panic when we weren't able to measure the lower wind structure – one of the main aims of the flight – but, fortunately, they started working when we lowered our flight level. If they hadn't, I think we would have just gone home, which would have been a real anticlimax. As it turned out I was still buzzing with excitement when we got back to the hotel after midnight. Unfortunately the bar was closed.

13 August

I have had a look at the initial data from the flight, and there appear to be clear boundaries between air masses over wet and dry soil. Some of the researchers are particularly interested in soil moisture effects on the atmosphere, so it's fantastic to be able to discuss the flight data with them. Everyone is so interested and excited about the data – it's infectious. This is lucky as I have to find a thesis somewhere in all of this.

15 August

Today I went on a dawn flight. As a mere secondary mission scientist, I didn't have to get the bus until 4 a.m. for the 5.30 a.m. take-off. The airport is only a few minutes from the hotel, but there is a lot to prepare.

Dawn was truly spectacular, quite a contrast to flying in the dark. The clouds were beautiful – I saw distinctive cloud streets, where rows of convective clouds line up with the lower level winds – something that I learnt about when I first started my PhD. In this case, they were lined up with the monsoon flow. We flew some legs in the boundary layer – the region where the surface friction is important to the air flow – which was quite amazing. There was quite a bit of turbulence but our view below was crystal clear as we went right down to 500 feet. We kept our eyes peeled for elephants over a national park south of Niamey, but no luck there.

22 August

It's finally time to return to the UK. The science finished last Thursday, earlier than planned. At first glance the AMMA data seems to be full of interesting things to investigate. So what will my thesis be about? I could study where the air comes from throughout the monsoon season, to get a better feel for the regional dynamics. Then I could look at the nocturnal flows, which appear to transport biogenic chemicals away from the vegetated region. Or perhaps that flight over Lagos, which would be a great case study of an anthropogenic pollution plume. There's more than enough to choose from. Deciding what questions to tackle may prove the hardest part of this PhD.

If you would like to contribute to **OBSERVATIONS** please send an e-mail with your idea to interactions@iop.org.

interactions

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LETTER FROM

...the diversity coordinator

Here at the Institute, we're always telling people about the great opportunities a physics degree offers. Some graduates may end up working deep underground, searching the galaxy for dark matter; others, who want to apply their knowledge of physics to helping people, may become medical physicists; and those concerned about environmental issues may go on to research the next new energy source.

We have plenty of examples of the exciting and challenging careers on offer but, being physicists, we'd really like some hard data. If you're a final-year physics undergraduate, that's where you come in. Each year around 2500 students graduate with a physics degree in the UK. At the moment we simply don't know what happens to them – what route their careers take, whether they stay in physics, how much they earn. So last year the Institute began a longitudinal survey – one that follows a set of individuals over the long term – to find out. With this information, we can do a better job of promoting physics at university to potential students.

All final-year UK physics undergraduates were contacted this spring and asked to tell us a bit about themselves. We plan to contact them on a yearly basis to build up a picture of their careers and earnings. For example, is there a difference in the types of careers that men and women go into? Is there a difference in the career choices between the different ethnic groups? How about salaries? Is there a gender pay gap in physics? And what challenges are faced by people with disabilities?

Each year, for five years, a new cohort of students will be recruited into the study. Because 2500 graduates per year is not a huge number, to get meaningful results we need as many people as possible to fill out the questionnaire. So, physics undergraduates, we need your help! In return we'll enter you in a prize draw with the chance of winning four top prizes of £500. And, if that's not enough of an incentive, consider the good you will be doing for the physics community.

This month we'll be contacting all final-year physics undergraduates in the UK and Ireland. So, when you get your e-mail, click on the link and spend a few minutes filling out the online questionnaire. Or, if you work in a university department, please encourage your students to complete the survey – after all, we're doing this to help and support physics departments like yours.

Saher Ahmed is the Institute's diversity programme coordinator. The survey is completely anonymous. For more information, e-mail saher.ahmed@iop.org.

Setting a bad example

I was seriously considering attending the Institute event entitled Engineering and Physics: Synergy for Success – until, that is, the organisers used as their seminal example the "Manhattan atomic bomb project that could never have succeeded without such cooperation". Utterly outrageous. The Institute might as well have used the Nazis' atomic bomb project as an example of synergy since it pre-dated the US-led project (which, by the way, was responsible for the deaths of 214 000 innocent civilian men, women and children, as well as initiating the nuclear arms race with the Soviets).

Gabriel Berry
Reading

Equal in death?

May I suggest that, to help with identification, deceased members have all forenames listed in "In Memoriam" rather than just one . Many of us of a certain age knew fellow scientists more by initials than forenames. I note that you sometimes give a location town which is not necessarily that of previous employment. We may all be equal in death (and maybe in life) but a title – Dr, Sir, Prof. – can aid recognition of a former colleague.

Derry Jones
Bingley, West Yorkshire

Editor replies: The issue of uniquely identifying members listed in "In Memoriam" has come up frequently. Whenever we have more than one member with the same name, we endeavour to provide additional information to help others recognise them. In light of your suggestion, we will now include the person's title and middle initials wherever possible. Unfortunately, we can only include the town listed in the deceased member's database entry, which is usually their last home address.

Write to interactions@iop.org or the address above. Letters may be edited for length.

OBITUARY

Oliver Heavens (1922–2006)

Oliver Heavens, a pioneer in laser research, was born in south London and went straight from school to work with the Electrical Research Association, researching aircraft engines. A part-time student at Birkbeck College, in 1945 he gained a first-class degree in physics and subsidiary mathematics.

In 1947 he became an assistant lecturer at Reading University while working for a PhD on the properties of thin films, which was expanded into the book *Optical Properties of Solid Thin Films*. He was appointed as Reader in Physics at Royal Holloway College in 1957.

He spent 1959–60 working in the US with Nobel laureate Charles Townes on lasers. He strongly advocated ruby as a lasing material, which was the key to developing the first working laser. His work on lasers and thin films earned him an international reputation. His 1964 book, *Optical Masers*, suggested research applications, but he quickly saw their potential for everyday uses.

In 1964 he became the first head of York University's physics department. He was a Council member of the Institute of Physics, a fellow of the Optical Society of America and treasurer of the European Physical Society. A gifted raconteur and convivial companion whose interests included rock-climbing, skiing, sailing and chamber music, he outlived his son Ian, and leaves a widow, Eva, and sons Steven and Alan.

Remembered by **Michael Woolfson.**

notices

NEW BUSINESS AFFILIATES

Association of Industrial Laser Users, Cambridge Knowledge Transfer, IRC Biomedical Materials, Michelson Diagnostics, Pascal Technologies, Pro Laser Consultants, TeraView, Venner Shipley LLP.

NEW MEMBERS

Daniel Adridge, Richard Baker, Martin Booth, Steven Bowen, Jane Bromley, Alan Brooks, Yuriy Butenko, Gregory Cabailh, Daren Caruana, Geoffrey Case, Martin Chambers, Catherine Chandler, Declan Coleman, Adam Correia, Irene D'Amico, Rachel Davies, Natalie Draper, Hosam El-Ocla, William Feline, Laura Grieve, Peter Hooper, Matthew Horsley, Robert Johnstone, Robert Kerr, David Lancaster, Karl Lyons, Gerardus Markx, Owen Matthews, Justyn Maund, Michael Mayo, Cormac McGuinness, Timothy Mercer, Daniel Mitchard,Donna Moor, Sarah Muscat, Tom Page, James Perkins, Wing Pong, Stephen Pragnell, David Robson, Martin Sahlen, David Sheel, Susan Sorber, Marta Szluinska, Yuen Tsang, Jonathan Underwood, Leah Wallace, Mark Whittaker, Rangareddy Yaramreddy.

NEW FELLOWS

Andrew Evans, Kristel Fobelets, Alistair Hart, Martin Jones, Richard Jones, James McGuigan, Maureen Neal, Massimo Noro, Simon Phillpot, Jennifer Richards, Anthony Turner, Peter West, Dao Zhang.

IN MEMORIAM

Dr Timothy G. Cooper, Ronald Downey, Edward Fairley, Sidney Scregg, Martin Ward (Coventry).

ANNOUNCEMENTS

● **The Institute's Awards Dinner 2007** will be held at the Savoy Hotel in London on Thursday 18 January 2007. Members are invited to apply for tickets at a cost of £97 (inclusive of VAT, pre-dinner drinks and wine). For further information please contact Sorayah Afful at sorayah.afful@iop.org. Cheques should be made payable to The Institute of Physics. Applications for tickets should be received by Friday 8 December 2006.

WANTED

● Nominations for the 2007 Sir Arthur Clarke Awards for achievement in UK space research and exploration, with categories for corporate/team and individual achievement, and special awards for students and those working in education, journalism, outreach and inspiration. Anyone can nominate an individual, team or organisation at www.clarkeawards.org. Closing date: 31 December.

MEMBER NEWS

● **Stephen Powell** has been appointed to the board of the Licensing Executives Society International, the global professional organisation for those working in technology transfer.

MEMBER OFFER

● **Online subscription prize draw**
Joe Miller from North Perth, Australia, is August's prize-draw winner. He wins a 512 MB data stick. For your chance to win a data stick, pay your membership subscription online at http://members.iop.org when you receive your subscription notice.

Visit whatson.iop.org for full details of all Institute of Physics events.

NOVEMBER 2006

Low Temperature Techniques Course
Five talks for those new to research.
Low Temperature Group
Aston Business School, Birmingham
8 November
http//groups.iop.org/LT

Careers Fair
For science, technology and engineering students and recent graduates.
Professional Standards Department
76 Portland Place, London W1
8 November
http://careers.iop.org/careers_fair

Climate Change: How Do We Tell it is Really Happening?
Talk by Ellie Highwood of the University of Reading.
South Central Branch
Lecture Theatre 1-01, St Michael's Building, University of Portsmouth
8 November
http://scentral.iop.org/portsmouth.html

Saving the Cutty Sark
Talk by Prof. Chris Bailey of the University of Greenwich.
London and South East Branch
The Lindop Building, College Lane Campus, University of Hertfordshire
8 November
http://london.iop.org/meetings.html
Booking required

Energy Options
Talk by Prof. Max Irvine of the University of Manchester.
South West Branch
HH Wills Lab, University of Bristol
9 November
http://sw.iop.org/Events.htm

ONE-DAY MEETING

Magnetic Resonance of Materials
BRSG Christmas meeting to highlight advances in combining magnetic resonance techniques with periodic calculations.
BRSG: The Magnetic Resonance Group
76 Portland Place, London W1
6 December
www.iop.org/Conferences
Registration required

lab in a lorry
get connected to science

Lab in a Lorry – the interactive mobile laboratory for 11–14-year-olds – will be touring the UK and Ireland throughout 2006. For details on how to register your interest, or to volunteer, see **www.labinalorry.org.uk.**

Organic Semiconductors: Lighting up the Future
Talk by Ifor Samuel of the University of St Andrews.
Institute of Physics in Scotland
Royal Society of Edinburgh, Edinburgh
14 November
http://fhada.phy.hw.ac.uk/~phydtr/iop/samuel.html

Nano, Nano!
One day seminar on nanotechnology.
Institute of Physics in Ireland/Engineers Ireland
Engineers Ireland, Clyde Road, Ballsbridge, Dublin
14 November
http://ireland.iop.org
Booking required

Science Week 2006: Superstrings
Lectures and recitals by Prof. Brian Foster of Oxford University and violinist Jack Liebeck.
Institute of Physics in Ireland
Royal Dublin Society Library, Dublin, and University of Limerick
14 & 15 November
http://ireland.iop.org/superstrings.html
Booking required

Nanotechnology: Challenging Chips and Crime
Talk by Russell Cowburn of Imperial College London.
London and South East Branch
76 Portland Place, London W1
15 November
b.j.harker@open.ac.uk
E-mail to confirm attendance

Rock Guitar in 11 Dimensions
Talk by Mark Lewney.
Midland Branch
Huntingdon Hall, Worcester
15 November
01905 611 427
Booking required

The Fast Track to Fusion Power
Talk by Prof. Sir Christopher Llewellyn Smith of UKAEA Culham.
South West Branch
HH Wills Laboratory, University of Bristol
15 November
http://sw.iop.org/Events.htm

Electromagnetic Surfaces: From Butterflies to Battleships
Talk by Prof. Roy Sambles of the University of Exeter.
IOP in Wales
Callaghan Lecture Theatre, University of Wales, Swansea
16 November
http://wales.iop.org

Experimental Techniques in Semiconductor Research
For new and established researchers.
Semiconductor Physics Group
East Midlands Conference Centre, Nottingham
17 November
www.iop.org/Conferences

Key Insight Business Briefing: Health Technologies
Speakers from government and industry, followed by panel discussion.
Business and Innovation Department
76 Portland Place, London W1
20 November
www.iop.org/Our_Activities/Business_and_Innovation
Booking required

Why Alcohol and Water Don't Mix
Talk by Jinghua Guo of the University of California, Berkeley.
Institute of Physics in Ireland
University of Limerick, Ireland, Queens University, Belfast and Trinity College, Dublin
20, 22 & 24 November
http://ireland.iop.org/program.html

ONE-DAY MEETING

Computational Magnetism
The meeting will cover the range from the atomic scale up to micrometres and will include talks on micromagnetism, Heisenberg models with dipolar interaction and ab-initio methods.
Computational Physics Group
76 Portland Place, London W1
13 December
www.iop.org/Conferences
Registration required

Where on Earth am I? An Introduction to Global Positioning Satellite Systems
Talk by Malcolm Cornwall of the University of Brighton/Open University.
London and South East Branch
Rutherford Lecture Theatre 1, University of Kent
21 November
http://london.iop.org

Viewing Conditions for the Printing Industry
Half-day meeting with speakers.
Printing, Packaging and Papermaking Group
London College of Communication, SE1
21 November
pj.green@lcc.arts.ac.uk
Registration required

Probing the Mind with Magnetism
Talk by Lauren Stewart of University College London.
South Central Branch
Lecture Theatre M, University of Surrey
22 November
http://scentral.iop.org/guildford.html

Marine Energy
Talk by David Kerr of Sir Robert McAlpine Ltd.
South West Branch
HH Wills Laboratory, University of Bristol
22 November
http://sw.iop.org/Events.htm

Michael Faraday and Electromagnetism
Lecture by Peter Ford of Bath University.
South Central Branch
Lecture Theatre B, Department of Physics, Southampton University
23 November
http://scentral.iop.org/southampton.html

Sounds Amazing: the Physics of Medical Ultrasound Imaging
Talk by Liz Parvin of the Open University.
Midlands Branch
St Peter's School, Wolverhampton
23 November
c.wormley@physics.org

Celebration of the 125th Anniversary of the Department of Physics at Liverpool University
Talks by retired staff of the department.
Merseyside Branch
Chadwick Lecture Theatre, Liverpool University
23 November
http://merseyside.iop.org

Young Physicists' Conference
Annual conference for physics students and graduates in early career.
Nexus/Young Professionals' Network
Birmingham University
24–26 November
www.iop.org

Evolutionary Photonics: Taking Design Inspiration from Nature
Lecture by Peter Vukusic of the University of Exeter.
Institute of Physics in Ireland
National University of Ireland, Galway, Queens University Belfast, Trinity College Dublin
27 & 29 November, 1 December
http://ireland.iop.org/program.html

Student Conference and AGM
Conference for students, whether Institute members or not.
Printing, Packaging and Papermaking Group
76 Portland Place, London W1
28 November
http://groups.iop.org/pr

Pleasure Perfected: How the Physical Properties of Chocolate Provide Exactly What the Lady Loves
Talk by David Peters of Cadbury Schweppes.
Midland Branch
Large Lecture Theatre, Poynting Physics Building, University of Birmingham
28 November
http://www.ph.bham.ac.uk/prospective/schools
Booking required

The Hitchhiker's Guide to Making Your Own Universe
Talk by Peter Jones of the University of Birmingham.
Midland Branch
Drama Studio, De Lisle Catholic Science, College, Loughborough
28 November
m.petty@lsaltd.co.uk

Winnie the Pooh, the Neutron Electric Dipole Moment and the Mystery of the Universe's Missing Antimatter
Talk by Philip Harris of the University of Sussex.
South Central Branch
Lecture Theatre Pevensey 1, University of Sussex
28 November
http://scentral.iop.org/brighton.html

Storage Tank Condition Monitoring Using Piezoelectric Transducers
Lecture by Stephen Williams of the Welding Institute.
London and South East Branch
76 Portland Place, London W1
29 November
b.j.jarker@open.ac.uk
E-mail to confirm attendance

Energy Futures: The Hydrogen Scenario
Talk by Prof. Keith Ross of Salford University.
South West Branch
HH Wills Laboratory, University of Bristol
29 November
http://sw.iop.org/Events.htm

Applied Superconductivity
Invited speakers and short talks.
Superconductivity Group
76 Portland Place, London W1
29 November
jh403@msm.cam.ac.uk

Fabulous Physics
Joint schools event with SETPOINT Lancashire.
South Central Branch
Leyland Business Centre
30 November
http://lancashire.iop.org

DECEMBER 2006

Formation and Chemical Evolution of Galaxies
Talk by Prof. Jean Brodie of the University of California.
Institute of Physics in Ireland
National University of Ireland Galway, Cork Institute of Technology, National University of Ireland, Maynooth, Ireland
4, 6 & 8 December
http://ireland.iop.org/program.html

CONFERENCE

Nuclear and Particle Physics Divisional Conference
First joint meeting of the Nuclear Physics, High Energy Particle Physics and Gravitational Physics groups and the newly formed Astroparticle Physics Group.
Nuclear and Particle Physics Division
University of Surrey
3–5 April 2007
www.iop.org/Conferences

Quantum physics is given a theatrical spin

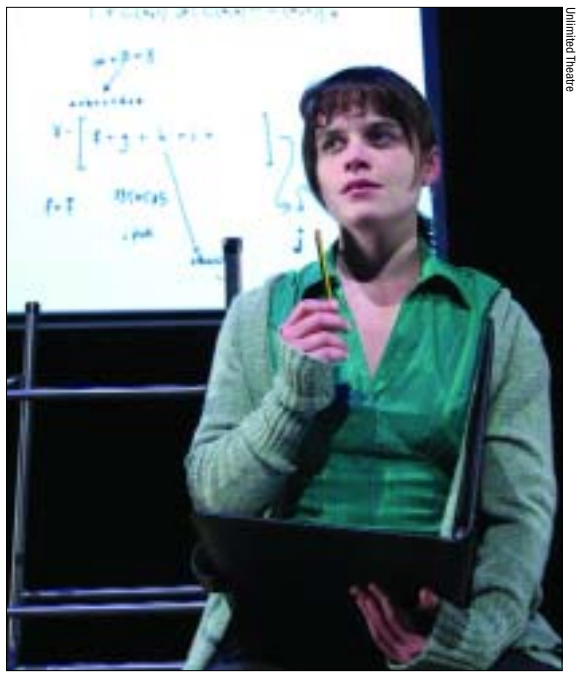
A new play on teleportation is more style than substance, but does convey the wonder of physics, says *Helen MacBain*.

Billed as a mixture of quantum physics and urban myth – with promise of a teleporting orange – I was intrigued to see what *Tangle*, the current production from Unlimited Theatre, would serve up. Despite a few notable exceptions, like *Copenhagen* and *The Life of Galileo*, it's still not often that physics and theatre go together. The physics in question here is quantum entanglement – a phrase I suspect most of the theatre-goers at Jackson's Lane in London had never heard before the show.

The story begins with Flora, a pet groomer from L.A., who has hired private detective Malcolm to help her track down her Uncle Carlos, who disappeared several years ago. He could be dead but Flora, a great believer in her sixth sense, "feels that he's still alive". During the investigation the pair end up in a secret laboratory under Wimbledon Common, where they meet Hamish and Jocelyn, two physicists working on teleportation.

The set and the cast of *Tangle* is minimal – three tables, a few stools and chairs and, of course, an orange. The four actors dart across the stage and move the furniture around to take us in seconds from Wimbledon (where stools on tables make up laboratory equipment) to Malcolm's seedy office in L.A., complete with evocative clouds of smoke and low desktop lamps.

At first it's a bit difficult to follow the story as the performers move about at a frenetic pace. It's almost like watching a cartoon and, well, a bit of a tangle. But after the initial introductions of the characters everything slows down and the story starts to unfold. Jocelyn, separated from her brother at birth, takes us through a long probability equation to explain what she thinks are her chances of finding him. We learn from her workings, which are projected onto a large screen as she describes each variable, that he was adopted at the age of three because her family couldn't cope. His new family were American and whisked him away to the other side of the globe – to L.A. It's here that you start to make connections between what she is saying and the earlier five second scene in the private detective's office.



Unlimited Theatre

Meanwhile, Hamish is mourning his murdered wife, Karen, and has thrown himself into his work of trying to prove that it's possible for him to teleport himself. He hopes that if he can achieve this his body will remain unchanged but his grief over the loss of Karen will be erased in the process. At the end of the show he does manage to overcome his sadness, but not through teleportation. There is a small moment when he believes he has been transported through space without moving, but Jocelyn is on hand to tell him dryly that he in fact walked. It's a touching moment between the two as we realise that their work on teleportation and quantum entanglement has been more about fixing what's missing in their lives than finding fame in a great discovery.

Quantum entanglement, described by Einstein as "spooky action at a distance", is a phenomenon in which the quantum states of two objects have to reference each other, even if they are some distance apart. This is portrayed in *Tangle* through the actions and words of Malcolm and Jocelyn. They eat an orange in exactly the same way, and use exactly the same words but in conversations that take place on different sides of the world. It's all timed perfectly so that Jocelyn and Malcolm say the same lines at the same time. We never find out for sure whether they are indeed long lost brother and sister, as we have come to suspect, or whether they are just entangled in a "spooky" way.

Einstein described quantum entanglement as "spooky action at a distance".

Other twists in the story are just a bit strange. For example, Malcolm has cockney accent even though he's lived in America for most of his life. It's supposed to be the result of a near-death experience – he was struck by lightning at the age of five. It's perhaps added to convince us that he s related to Jocelyn, but is a bit far-fetched and in my view unnecessary.

One of the highlights for me was a monologue by Jocelyn. After a bust-up with Hamish, whom she suspects is planning to take all the glory for their discoveries, she tells him why she continues to work for him. It's not for the fame or the fortune that they'll gain if they become the first scientists to teleport an object, it's for the sheer pleasure of pursuing the mystery and coming up with imaginative ways to solve and explain problems. The audience was silent throughout the speech and seemed genuinely caught up in her passion for physics.

While the play doesn't actually include an in-depth explanation of quantum mechanics or teleportation, it does create a sense of wonder around physics. And, if you watch it in Leeds at the end of this month, you can also catch an after-show discussion of the physics with Prof. Vlatko Vedral of the university.

I won't give away what happens to Uncle Carlos. As for the teleporting orange, well, with a lot of smoke, some very well positioned spotlights and excellently timed blackouts, we see it "levitate" from one side of the stage to the other. Possibly it had some help from a darkly clothed actor, but this is physics and you never know what's possible.

Helen MacBain is the Institute's press officer. For information on tour dates for *Tangle*, visit www.unlimited.org.uk.

particles