The newspaper of the physics community

July 2006

interactions

Institute *of* **Physics**

UK physics ponders next steps

Peter Main discusses the implications of the government's latest strategy document.

Two years ago, the government announced a 10-year strategy for science and innovation, including substantial new investment in the infrastructure of science in the UK. This March, it published *Next Steps*, which fleshes out some of the detail of how it plans to deliver that strategy. There is much in this new document for the physics community to chew on.

In particular, physicists and astronomers have been pondering the proposal for the Particle Physics and Astronomy Research Council (PPARC) to merge with the Council for the Central Laboratory of the Research Councils (CCLRC) to create a new Large Facilities Council (LFC). Just as significant, if not more so, was the announcement in *Next Steps* of ambitious targets for the number of specialist physics teachers and the numbers of students taking physics A-level.

The first of these proposals has, unsurprisingly, received the most attention. The idea behind it is to create a single research council with responsibility for all the large facilities used in the physical sciences. There was also the suggestion that funding for the research that uses the facilities might be separated from the funding for the facilities themselves. That would mean that all physicists, no matter what their subject area, would go to the Engineering and Physical Sciences Research Council (EPSRC) to fund their experiments.

This last suggestion has caused the most consternation, as we told Keith O'Nions, director general of the Research Councils UK, at a town meeting of the physics and astronomy community at the Institute in June. On the whole, physicists and astronomers acknowledged that a new LFC could be valuable, but there was a resounding "no" to the suggestion that funding for the exploitation of large facilities – including telescopes, accelerators, neutron sources and the like – should be transferred to EPSRC.

As the Institute wrote in its formal response to the government consultation, there are potential benefits to an LFC. It could give strategic direction to the development of large facilities, both in the UK and abroad, which has been lacking. Such a council could also take on board fusion and nuclear physics, the latter of which has been neglected in recent years. For example, an LFC could coordinate our entry into the FAIR project in Germany, which is the number one priority for the nuclear physics community.

The government is also keen to maximise the overall economic benefits to the country of these large facilities. Having a single body to coordinate knowledge transfer initiatives and work with local and national agencies would make a lot of sense. In fact, as several at the June town meeting pointed out, a large physical sciences facility has the potential to stimulate the regeneration of an economically deprived region.

Diamond Light Source Limited 2006

Aerial view of the Diamond synchrotron at Harwell – the largest UK-funded facility to be built in 30 years.

"To separate the funding of large facilities from their exploitation would be a bad idea and could lead to the creation of white elephants."

To separate the funding of large facilities from their exploitation would be a bad idea and could lead to the creation of white elephants. Also, one mustn't overlook the very different cultures of the research councils. PPARC has an excellent track record of supporting the sort of long-term projects that are typical of particle physics and astronomy. EPSRC, on the other hand, works on shorter timescales and is more nimble on its feet, responding quickly to new research opportunities. While putting the whole of physics research in one place might look neat on paper, in practice this would likely create tensions between the different priorities of the various parts of the physics and astronomy communities.

The other message that came out strongly was the need for an LFC to be driven by the scientific community. New facilities and experiments must be evaluated by panels of scientists, and those likely to use the facilities must be intimately involved in their design and creation.

While the proposal for an LFC might now seem the most pressing for the physics community, in the long run it's the announcement of targets for specialist physics teachers that is likely to be the most significant for us all.

On the whole, physics research is healthy, but sadly the same cannot be said of the teaching of physics in schools. The problem is that there simply aren't enough specialist physics teachers. Last year we finally managed to persuade the government to count the number of physics teachers and, when they looked, the answer came back shockingly low. Just 19% of science teachers are physics specialists, and one-quarter of 11-16 schools don't have a single physics specialist on their staff. *Next Steps* announced a target of 25% physics specialists by 2014. This may not sound like a huge increase, but the number of new trainee physics teachers is very low, and many physics teachers are set to retire in the next decade. So this apparently modest target will be very difficult to achieve.

You can rest assured that the Institute will keep its eye firmly on this ball, continuing to do what we can to improve the situation and to press the government to do the same. Physics can only continue to flourish in this country if it is well supplied with budding young physicists, so this is an issue that should concern us all.

Peter Main is the Institute's director of education and science.

CONTENTS

"Einstein's image combines two popular stereotypes of the scientist: unworldy saint and dotty sinner."
Christopher Payling, p8

"It was an absolute shambles. The MPs were just there to add a veneer of democracy."
David Jenkins on the House of Commons Science and Technology Select Committee, p5

HIGHLIGHTS

Brown dwarfs' companions revealed

The Spitzer infrared telescope, launched by NASA three years ago, has revealed that planetary systems can form around the very small faint stars known as brown dwarfs. This means that a brown dwarf close to our solar system could be orbited by a planet capable of sustaining life, explained Spitzer project scientist Michael Werner in a lecture to the Institute's Wales Branch in May. Spitzer operates in the infrared at 200–300 μm and must be cooled to a temperature of a few degrees kelvin to eliminate unwanted infrared radiation from the telescope and its instruments. This, combined with a new generation of sensitive infrared detectors, has enabled astronomers to take spectacular pictures and make spectral measurements of a wide range of objects. It has revealed that large, well developed galaxies existed much sooner after the Big Bang than theorists had assumed. Its spectroscopic observations of ejecta from the comet Tempel 1, produced by NASA's Deep Impact mission, have also shown that the early solar system was chemically quite complex, said Werner.

A new angle on entanglement

Experiments demonstrating that the quantum mechanical understanding of the relationship between position and momentum also extends to the angular momentum and angle of light were described in a talk to the Institute's Scotland Branch on 9 June. In the lecture, Miles Padgett of the University of Glasgow described his own research on the application of quantum entanglement to the demonstration of Heisenberg's uncertainty principle as applied to the angular momentum of light. He also discussed the disagreement between Einstein and Bohr about the moment when a photon "decides" its polarisation, how this was resolved by Alain Aspect in 1982, and the ghost interference observed more recently by Yanhua Shih using a source producing pairs of entangled photons. Following the lecture, there was a discussion about the philosophical consequences of quantum entanglement.

High impact for Institute journals

The journals of the Institute of Physics continued to increase their impact in 2005. Sixteen of the Institute's journals saw an increase in their impact factor – a measure of how often research published in the journals is cited. These included the *Journal of Physics G: Nuclear and Particle Physics* (up by 42%), *Plasma Physics and Controlled Fusion (*24%) and the *Journal of Micromechanics and Microengineering* (22%). *New Journal of Physics* increased by 16%, while *Nuclear Fusion*, jointly published by the Institute and the International Atomic Energy Agency, increased by 44%. *Physica Scripta*, a journal of the Royal Swedish Academy of Science published jointly with the Institute, saw its impact factor increase by 88%. All the titles in the Institute's Journal of Physics series saw increased impact factors last year.

Winning words on environmental physics

Three students have taken the top places in an essay competition run by the Institute's Environmental Physics Group. Sally Brown (right), a PhD student at Southampton University, won the first prize of £500 for her essay on coastal erosion. The standard of entries was so good that the judges decided to award a second prize of £200 to final-year MSci student Emma Turner (left) from Imperial College, who wrote about ice cores and Milankovitch theory, and a £100 third prize to Liverpool University undergraduate Jennifer McClure, who tackled the northern lights and global warming.

The group's vice-chair, Peter Hodgson, said: "One of the aims was to promote environmental physics, the contribution it makes and the satisfaction of working in this field, and I think it achieved that."

Teachers take time out to learn

By Catherine Wilson and Chris Shepherd

This spring the Institute held its two annual conferences for teachers – the Stirling Physics Meeting for teachers in Scotland on 31 May, and the Annual Physics Meeting for teachers in England and Wales on 8 June at Rugby School. Between them they attracted nearly 400 teachers of physics.

The conferences are a chance for teachers to discuss educational developments, get new ideas for the classroom and hear about some current physics applications or research. The Stirling meeting included an exhibition of resources for physics teaching and a lecture by Sir Christopher Llewellyn-Smith, director of the UK Atomic Energy Authority Culham Division, which is leading the UK's fusion research. His talk on energy and sustainability was one of the highlights of the day for delegates.

The Stirling meeting also featured an entertaining talk on famous scientists and their discoveries by the meeting's former organiser, Jack Woolsey, and a presentation by James More of Balwearie High School, Kirkcaldy, on Scotland's new Curriculum for Excellence. This is being developed by the Curriculum Review Group set up by Scottish education ministers and covers children aged 3 to 15. A talk on the complementary work on the 15–18 curriculum being undertaken by the Scottish Qualifications Authority was given by John Sharkey, a member of its Physics Review Group.

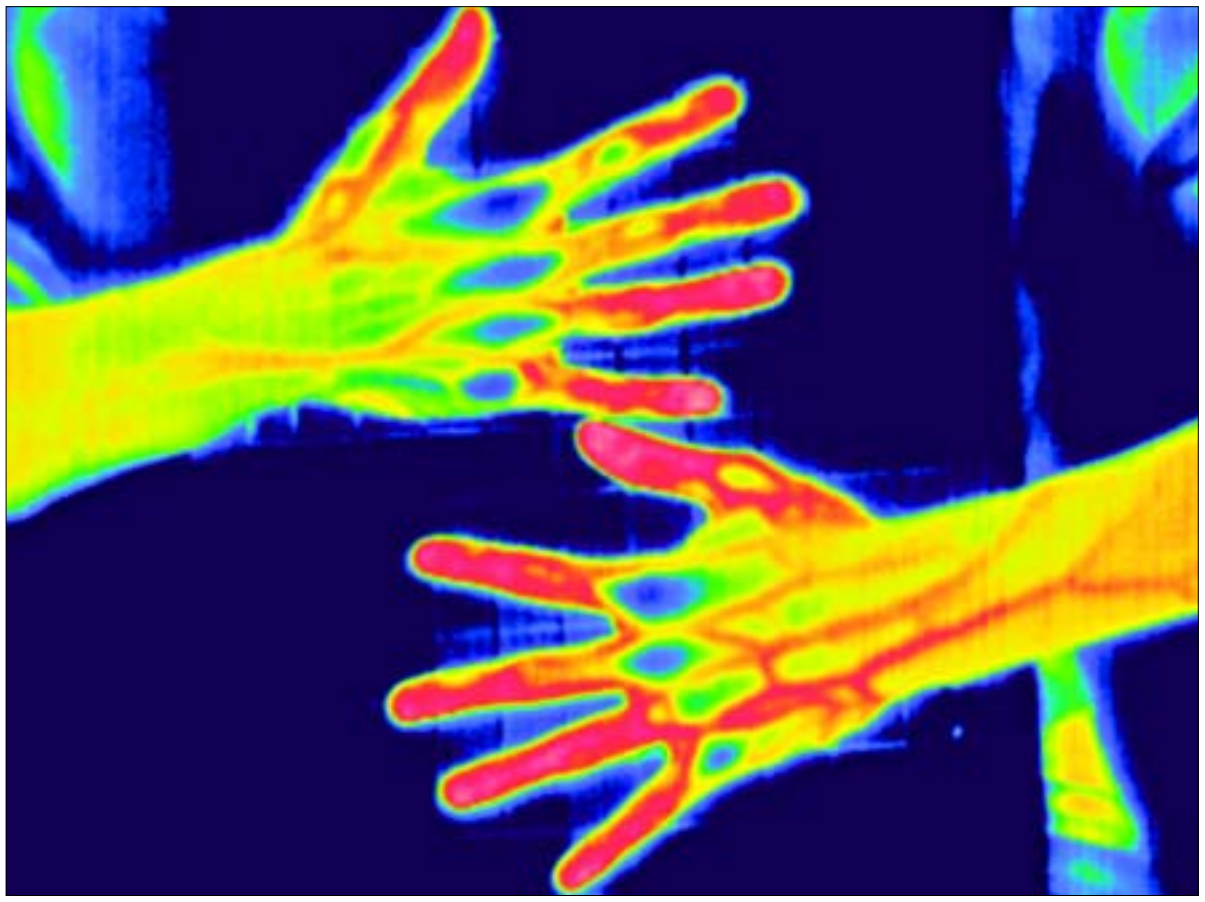
John Girkin of Strathclyde University's physics department described some of the latest research involving physics for diagnostic medicine, including the early detection of dental caries using lasers and LED sources. The teachers were also given a preview of a new medical physics teaching resource produced by the Institute's Medical Physics Group (see below).

At the Rugby meeting, delegates heard Edward Gomez from Cardiff University's physics and astronomy department describe the Faulkes robotic telescope – a facility which has its operations centre at the department in Cardiff and is linked to telescopes in Hawaii and Australia. It is available for schools and colleges to make remote astronomical observations.

Suzanne Farid, a lecturer in biochemical engineering from University College London, explained the crucial role of physics in the mass production and purification of drugs, while Ian Lawrence of Birmingham University's School of Education provided a guide to the pitfalls and best use of software modelling tools for education. There were also workshops on astrophysics, materials sciences and the philosophy of science, as well as handouts of free software and inexpensive practical materials.

The Rugby meeting included discussions on curriculum changes in England and Wales, teacher recruitment, and coursework and plagiarism.

Medical physics brought to life



Reading palms: a slide on the medical physics CD shows how thermography can reveal a patient's blood flow.

A new CD designed to help teachers present medical physics to GCSE science students was sent out by the Institute to every secondary school, sixth-form college and further education college in the UK last month.

The CDs – containing up-to-date images, such as scans and photos of medical physicists at work – come with a resource pack including a textbook, posters and teachers' book with lesson plans and worksheets. Some materials – especially the large set of colour images – can be adapted for use with younger or older students.

The packs were developed by the Institute's Medical Physics Group and funded by the Institute, the Engineering and Physical Sciences Research Council and the Institute of Physics and Engineering in Medicine. The medical physicists who created it consulted extensively with teachers to get the content right.

Chair of the Medical Physics Group, Adam Gibson of University College London, said he became concerned some years ago that much of the teaching material on medical physics was dated and lacked content on some of the latest advances in the field.

Some older material describes the use of cobalt-60 machines for scans, but this has safety implications and the radiation doesn't penetrate very far into the body, says Gibson. "Nowadays we would produce X-rays using a linear accelerator. Most hopitals have two or three accelerators of the type used to do particle physics 20 or 30 years ago."

The CD also explains the use of positrons in medicine, adding a fourth category of radiation to the alpha, beta and gamma rays often described in older syllabuses.

Survival of the physicists

Students emphasise the importance of physics for saving energy, reports *Heather Pinnell*.

Four physics students attempted to live a "carbon-neutral" existence for five days while camping out at the Cheltenham Science Festival last month. Their aim was to show how a knowledge of physics can help in saving energy and reducing carbon dioxide emissions.

The project, Camp Energy: Survival of the Physicists, was organised by the Institute and enlisted the help of postgraduate students Michelle Cain and Andrea Taroni and undergraduates Anthea Cain and Tom Whyntie. While living out their experiment under the public gaze, the four also explained their project to passers-by and gave them pledge cards to sign to commit themselves to living more sustainably.

Like the contestants on television's *Big Brother*, the four were on view 24 hours a day and faced daily challenges, set by the Institute. These included building and using a solar cooker; making bio-diesel from vegetable oil; making a crystal radio and listening to a bicycle-powered entertainment system; and building a hot tub using an old bath, a radiator and coppiced charcoal. The students also minimised their "food miles" by eating produce grown locally as far as possible.

There were the inevitable obstacles, such as discovering that they needed a manufactured part to make the hot tub work. Nevertheless, despite such technical hitches, the four came quite close to being carbon-neutral during the festival.

Caitlin Watson, the Institute's physics in society manager, who assisted the campers during the festival, explained: "It was trying to draw attention to how physics is part of the solution to the so-called energy crisis and to show that having even a small understanding of physics can help people to make decisions that will have an impact on the bigger things, like climate change and energy demand. You can't be completely carbon neutral in a week, but you can reduce your carbon footprint as much as possible. The key thing is that we engaged with several thousand people during the week."

David Burges

Geared up for making a solar oven are (left to right): Michelle Cain, Andrea Taroni, Tom Whyntie and Anthea Cain.

The camp provided a welcome outdoor attraction at the science festival, most of which was housed inside the town hall. Both adults and children enjoyed interacting with the camp by making miniature windmills or by pedalling on a bicycle to generate enough power to raise a ping-pong ball with a fan. Also popular was a solar-powered water feature, which could be turned off by blocking out the sunlight to the solar battery.

Michelle Cain said: "It wasn't the most comfortable camping experience I have had but it was a really enjoyable experience and we learnt a lot about energy use." The campers also kept a blog describing their progress.

Trying to highlight how physics is relevant to an area of public concern, like climate change, appeared to have been successful, said Watson, who plans to hold similar events in the future.

www.campenergy.org

Rethink on A-level reforms expected

Extensive lobbying by the Institute on changes to physics A-levels seems to have paid off, with the Qualifications and Curriculum Authority (QCA) revising its proposals for the criteria to be used for developing syllabuses and assessment arrangements. The QCA had more than 10 times more submissions on science than for any other subject, including large numbers of teachers who used the Institute's detailed response in making their case.

The Institute was particularly concerned that the QCA's plans would drastically overload the first year of A-level relative to the second, discouraging potential A-level students. It also expressed concern at the plan to reduce assessment units from six to four.

Initial feedback from the QCA indicates that it has taken these concerns on board and will recommend that six units of assessment instead of four should be retained, while addressing the issue of overloading at AS-level.

Professionals air nuclear options

Nuclear power can meet the UK's energy needs safely, reliably and cost-effectively, and there are practical solutions to the problem of nuclear waste, according to representatives from the nuclear industry who spoke at a conference organised by the Institute's Energy Management Group last month. The event, "Practical Options for a Nuclear Renaissance", attracted more than 60 delegates, who heard arguments in favour of the retention and expansion of nuclear facilities.

Ian Hore-Lacy of the British Nuclear Group and representing Westinghouse UK said the industry worldwide had about 12 000 reactor-years of nuclear experience, and accidents such as Three Mile Island and Chernobyl had come quite early in that accumulation of expertise.

Describing the size and quality of available uranium ores, he dismissed as "nonsense" the idea that there is not enough uranium available to embark on nuclear new build. The numbers often quoted were based on current estimates of economically recoverable resources, which are being constantly revised upwards as technologies and prices change, said Hore-Lacey.

Nigel Donaldson, also from the British Nuclear Group, said the energy resources available from coal are 842 terawatt years (TWy), from oil 305 TWy, from gas 170 TWy and from uranium 44 TWy with no recycling but 4000 TWy with multiple recycling.

Gérard Ellia of the nuclear reactor construction company Areva described its European Pressurised Water Reactor (EPR), which he said is more efficient than earlier models and has enhanced safety features, including being resistant to aeroplane crashes.

Kevin Hesketh of Nexia Solutions – which provides research, clean-up and decommissioning for nuclear plants – described the UK's involvement in a 10-nation forum, Generation IV Advanced Reactor Systems, which is developing new reactor designs for use from 2030 and beyond.

Some of the latest thinking on how to deal with radioactive waste was described by Sarah Vines of Nirex. The company had learnt a lot of lessons about waste since the early 1980s, she said, and it believed there are credible options that would allow this generation to deal with the nuclear waste that is currently accumulating. Nirex is responsible for disposal of intermediate-level waste, but so far there has been no long-term solution for high-level waste.

Nirex is starting to develop a solution for waste that includes spent fuel and the current stockpiles of uranium and plutonium. Based on a Swedish design which has undergone international review, it involves placing the waste in copper canisters with cast-iron seals surrounded by bentonite clay in a deep repository. Nirex believes there would be no long-term risk to the future population from this solution.

IN BRIEF

● **Last month Lab in a Lorry** – the Insitute's travelling science laboratory – joined science trucks from all over Europe that converged on Technopolis, the Flemish Science Centre in Belgium, for the 2006 conference of the European Network of Science Centres and Museums (Ecsite).

The science trucks came in all shapes and sizes and contained interactive demonstrations and exhibits on everything from ecology to code breaking. Lab in a Lorry was the only one that offered visitors the opportunity to use real scientific kit to do experiments that explore physics concepts.

Science communication professionals from all over the globe visited the lorry, which was positively received. The delegates said it was encouraging to know that there are people who are so passionate about sharing their experience and knowledge of physics that they are willing to volunteer their time on the lorries.

NEWSMAKERS

The Queen's Birthday Honours List recognised several physicists in June, including Carole Jordan, the Institute's vice-president for science, who becomes a Dame. Council members Seton Bennett and Helen Reynolds received a CBE and MBE, respectively. Richard Palmer, senior publisher with the Institute's journals division, received the MBE. Fellows Christine Davies and Andrew Fabian both received the OBE.

Lord Browne of Madingley – a physicist and group chief executive of BP – was among the 44 new fellows of the Royal Society elected in May. A number of physics professors were also made fellows, including: Stephen Barnett of the University of Strathclyde; John Eland of Oxford University; Charles Foxon of Nottingham University; Richard Jones of Sheffield University; Michael Lockwood of Southampton University; Ruth Lynden-Bell of Queen's University, Belfast; Jerrold Marsden of Caltech; Raymond Ogden of Glasgow University; Michael Proctor of Cambridge University; Peter West of King's College London and David Woodruff of Warwick University.

Sir John Chisholm, executive chairman of the defence technology company Qinetiq, has been appointed chair of the Medical Research Council for the next four years starting on 1 October.

Dewi Lewis has become an industrial member of the Council for the Central Laboratory of the Research Councils (CCLRC). Lewis is vice-president of physics at General Electric HealthCare. He took up the appointment on 1 April and will serve for three years.

Why we should keep the RAE

Stuart Palmer

"Peer review is the worst method of judging the quality of research – except for all the other methods."

For many years the government has funded university research through the dual-support mechanism – half by direct provision of core funding and half through competitive bidding to external agencies such as the research councils. In 1986 the Research Assessment Exercise (RAE) was introduced to allocate the core funding component selectively, based on the quality of research. This quality related funding (known as QR) has been based on a succession of RAE exercises – in 1990, 1996, 2001 and the latest looming in 2008. In each RAE the level of selectivity has been increased, with more QR funding going to fewer institutions.

The university community is firmly of the view that dual support is invaluable to our research success, but there has long been a debate about the appropriate mechanism for distributing QR and whether the RAE is the best approach. In its recently published document, *Next Steps*, the Treasury announced that it plans to move away from the current system to one based on metrics after 2008. There will now be a national debate, including a consultation due to be completed next October, to identify the most appropriate way forward.

Despite its pitfalls, I believe the present RAE does have many advantages. Because it is based on peer review, it has the confidence of most of the academic community. As Winston Churchill once said of democracy, you could say that peer review is the worst method of judging the quality of research – except for all the other methods. Activity in each subject area is judged by a panel nominated in the main by the community, and since the RAE process takes place every five or so years it is a relatively light touch, with the major load falling on the panel members. It is estimated that the RAE costs around £40 m every five years to inform the distribution of £1 bn annually – much cheaper than the peer-review system used by the research councils.

Without a doubt the RAE has also increased significantly the quality of university research across the UK, with increases in UK publications in internationally rated journals and by citation of UK papers, in addition to the year-on-year improvements in the RAE assessments themselves. Taken collectively across subjects, the RAEs for each university have allowed the construction of research league tables that carry the confidence of the university community as well as the confidence of the students, their parents, business and industry, other research funders and the government. The ratings are also used to inform the decisions for international partnerships, for the attraction of international research funds and the recruitment of overseas students.

The present peer-review dominated RAE does have some disadvantages. It puts considerable pressure on staff to publish before the deadline (December 2007 for the next exercise), and publishers are flooded with last-minute papers and monographs trying to beat the cut. There's even a transfer market in highly sought-after academic staff, rather as you get with star football players. The leading research universities compete to strengthen their research teams, and academic salaries tend to spiral upwards, leading to possible resentment among existing staff.

Metrics must not replace peer review

Although the RAE is financially efficient, there is a cost in terms of time – time of university staff in preparing the submissions and, even more, the subject panel members in their task of reading and evaluating all the publications and other submissions.

The new metrics system proposed by the government suggests that QR be allocated in proportion to the research grant income received from the research councils. But this would automatically lead to an avalanche of applications, since success would bring double reward. It may well be that a basket of metrics, including research grant and contact income plus research student completions and some bibliometric analyses would be appropriate for science, engineering, technology, mathematics and medicine. However, it is difficult to see how such an approach would work for the arts, humanities and social sciences.

The metrics may well work for some science subjects, including physics. Indeed, much of the 2001 RAE for physics was metrics based and led to a "confidential" league table of physics departments. No doubt the physics RAE panel will study the reliability of a metric-based approach alongside the peer review due to take place in 2008.

Few can disagree that the RAE has been beneficial in raising the quality of physics research across the UK. Even if in the future it includes a greater contribution from metrics, I strongly believe that it must also have a peer-review component – otherwise it will be hard to retain the confidence of the community.

Stuart Palmer is deputy vice-chancellor at the University of Warwick and a former head of physics at the university.

focal point: conferences

New plan to increase impact of Institute conferences

Last year the Institute experimented with a new kind of conference – Physics 2005: a Century After Einstein. Unlike the conferences we've held before, this was an international and centrally organised conference covering a wide range of physics. The event was deemed a great success by all who attended.

To build on that success, the Institute's Conferences Strategy Committee (CSC) has developed an approach for delivering its various different types of conferences in a coherent way. It is hoped that this will ultimately lead to greater national and international participation in the Institute's conferences.

To that end, the committee detailed three different levels of conference that the Institute will deliver:

- Level 1 conferences will be directly organised by the CSC rather than by a single group or division, although it will of course work closely with all appropriate groups and divisions to ensure the success of the programme. The committee will also seek involvement from other learned societies that may have an interest in the subject of the conference. These Level 1 conferences might be new international conferences, like Physics 2005, or flagship conferences to celebrate an anniversary. The CSC will also identify any gaps in the Institute's overall conferences programme and organise conferences to cover important areas of physics that might otherwise be missed.
- Level 2 conferences will be broadly the same as those that currently fit within the Institute's existing "full-service" model – in other words, organised by a group or division with full administrative support from the professional services of the conferences department. Any group or division that wishes to bid for an international conference to come to the UK would also fit within this level. Where appropriate, the CSC might also provide additional financial support.
- Level 3 conferences would have no active involvement from the CSC and would be broadly the same as the existing "self-service" and co-sponsored meetings organised by the groups and divisions.

Until now, most groups have opted to run self-service or co-sponsored conferences, even though the conferences department is able to offer its full-service support free of charge to groups and divisions. This means that they are able to take on all the administration of the conference – from booking the venue, to handling registrations and abstract submissions and everything else in between – freeing up the organisers to concentrate on the scientific content.

Many groups opt for the self-service model because it allows them to take advantage of reduced rates at their home institutions. In order to provide support to as many groups as possible, the CSC has now introduced another level of support – the "half-service" conference. This combines all the administrative support of a full-service conference with the all the advantages of a self-service conference.

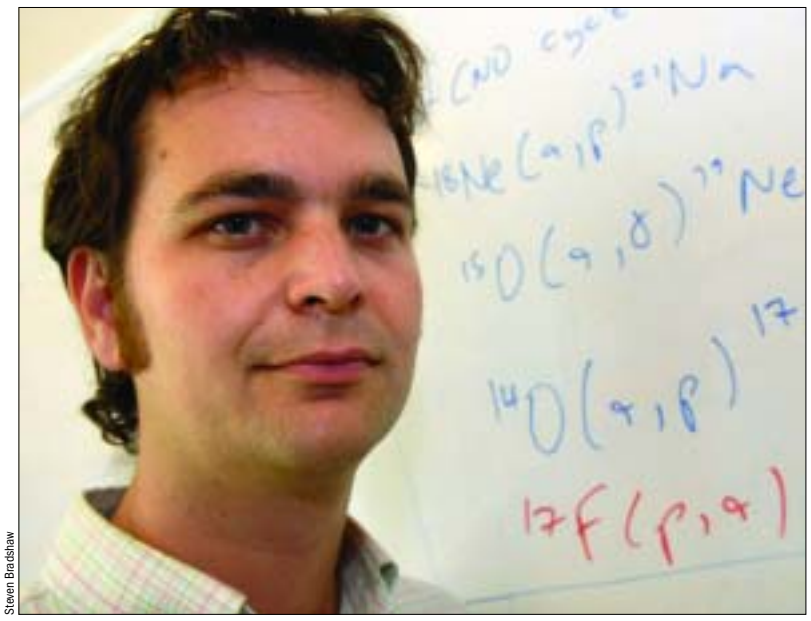
For more information about all the services provided by the conferences department, visit www.iop.org/Conferences.

Jane Lowe is the Institute's conferences manager.

profile: David Jenkins

A philosopher–scientist with tricks up his sleeve

Ayala Ochert meets a young nuclear physicist with broad horizons.


Steven Bradshaw

David Jenkins finds thinking laterally helps him to make connections.

David Jenkins didn't plan on being a physicist when he went to university. He imagined that his joint degree in physics and philosophy would turn out something else. But that is what he became. At the age of 32 he has returned to his *alma mater*, the University of York, where he is in charge of one postdoc and two PhD students and controls a budget of more than £300,000 for experiments in nuclear physics.

Studying philosophy has given Jenkins a slightly different perspective, he says. "I would say that I tend to take a broader view of physics. I think that people can often get a very narrow vision because of the way we train physicists in this country. People become very specialised very quickly," he says.

Jenkins' work ranges across several areas in nuclear physics. He studies nuclear structure, looking at the properties of the nucleus and the shapes of nuclei. He is also involved in some innovative work trying to build "molecules" out of nuclei, creating new and exotic shapes by putting alpha particles together. And he also works in nuclear astrophysics, looking at the nuclear reactions that created the elements we see on Earth.

"I try to see connections between different fields and work more at the edges of fields rather than right in the middle. Sometimes it's a bit more risky but you can get quite interesting things out of it," says Jenkins.

He has also been making connections with areas beyond science. Last year, for Einstein Year, he collaborated with composer Gerard Power to create a piece of music for string quartets, "Four forces", that was inspired by quantum mechanics. A musician himself, Jenkins is keen to do more collaborations of this type and he laments the fact that scientists and artists seem to be so mistrustful of each other.

Most of the other public projects involving science that Jenkins has been involved in have been more down to earth. As the Institute's higher education representative at York and as an active member of the Yorkshire Branch, last year Jenkins organised a space-themed family fun day at the university, which attracted more than 300 people. Equally well attended was the visit by two Russian cosmonauts that he arranged. As an Einstein Year ambassador, Jenkins was also given a large box of physics tricks that he has been taking to schools all over his local area, performing his one-man show "Science of Sport, Science of Music". "One of the most important things that a show like this achieves is that the kids get the idea that scientists are normal people," he says.

His latest project is the installation of a robotic telescope on the roof of York's physics building. He hopes that it will enhance the teaching of astrophysics to undergraduates. "If you're doing first-year astrophysics and you're talking about the planets, it might be nice to have a homework exercise to take a photo of Mars," explains Jenkins. He also plans to train students to go into local schools and show younger students how to make observations with the telescope.

There is currently no nuclear physics facility in the UK but, ironically, this was one of the things that attracted Jenkins into the field. It meant lots of travel and the chance to work abroad. He has done research in the US, Canada, Finland, Sweden, France, Germany and Poland.

"People can often get a very narrow vision because of the way we train phyicists."

Nevertheless, he and others in the UK nuclear physics community are hopeful that the proposed new Large Facilities Council (see cover) will provide a way to invest in new facilities abroad, such as the German FAIR accelerator, or perhaps one day a nuclear facility in this country.

Jenkins takes an active interest in how political decisions affect science. In 2004 he took part in the Royal Society's MP–Scientist Pairing Scheme, shadowing Selby MP John Grogan for a week in Westminster. It was an eye-opening experience, says Jenkins. He found himself disappointed at the level of debate in the House of Commons select committee for science and technology. "My impression was that it was an absolute shambles. The MPs seemed to be there just to add a veneer of democracy." In stark contrast, he was surprised to find the House of Lords committee members to be very well informed and knowledgeable.

In 2007 Jenkins will take the next step in his career to become a lecturer in physics at York, but he plans to continue with his "extracurricular" activities. This year he is participating in NESTA's Crucible programme, which aims to inspire young scientists into thinking about their work in new ways. Jenkins believes that such an exercise is just as valuable as teaching and research. "In a university there's pressure to have verifiable outputs, but that's not necessarily the best use of all your time. These things can easily be seen as extras, but they shouldn't be really," he concludes.

OBSERVATIONS

Scientist and communicator Maggie Aderin describes her experiences on Crucible, a NESTA programme aimed at opening scientists to new ways of thinking.

December 2004

After 10 years as a scientist in academia and industry, I'm looking to expand my horizons. I hit the web and discover Crucible, a NESTA initiative to encourage scientists to look at the bigger issues affecting them. The information is a bit vague, but I guess I'll find out more if accepted.

January 2005

I dance around the room when I get the e-mail confirming that I've been accepted. There will be three Crucible weekends. The first is in Edinburgh on globalisation, a subject I don't know too much about.

April 2005

I'm a little apprehensive as I arrive in Edinburgh; the "more detailed information" that I was hoping for never did materialise, so I'm not sure what to expect. There are 25 of us and we've each been asked to prepare a poster that sums up our life and work. The variety is amazing, from accessibility in public places to climate change modelling. At the end I feel quite transformed. Despite our different backgrounds, everyone has one thing in common – we're all looking for more and to gain a better understanding of the world and, perhaps, to change it.

July 2005

This weekend is in London (my home territory) and is on science in society (right up my street). Since our last meeting I've been quite active in public engagement thanks to a PPARC small award, so I feel that I have more to offer. The venue is fantastic – a stone's throw from the river and next to the National Maritime Museum and Royal Greenwich Observatory. We start with a talk on how scientists interact with the media. The panel includes a scientist who experienced the good and the bad sides of the press when his work on genetically engineered mice hit the newsstands, and a very direct science journalist who tells us how the "journalism machine" works.

Sunday morning my head's a bit fuzzy (I was in the bar till 3 a.m. continuing the day's discussions). First there's an "Ethical Fitness" session. The thought of any sort of fitness today fills me with dread, but it's very absorbing, helping us to define and solve moral dilemmas. I discuss a difficult situation that I faced with someone working on a project that I manage. After lunch we get a tour of the observatory – a real treat for me as I built my first telescope as a teenager.

On Monday we take a catamaran to parliament to hear from and get to grill Lord Hunt, Ian Gibson MP and David Cope, director of the Parliamentary Office of Science and Technology. We discuss the plight of university researchers and what is being done to encourage people into science careers. I don't like some of their responses, but Crucible has been teaching me that if I don't like something, instead of complaining I need to do something about it. In this setting it really seems possible.

September 2005

At a Commons reception I have my photo taken with Heinz Wolf, a hero of mine who helped stimulate my interest in science as a child.

October 2005

The final meeting is at Dartington Hall, Somerset. On Friday I go for the intriguingly named "Sound Safari". We wander through the grounds, ending with a 20-minute stop in a wood where we just listen. I find this incredibly relaxing as I have a tendency to fill every minute of the day.

On Saturday we meet some NESTA fellows who've got funding to follow their dreams – truly extraordinary people like Martha Fleming, an artist investigating complex techniques in scientific observations.

On Sunday we review progress. Crucible has changed how I interact with the world. I feel that I can make a difference to things that matter to me, and Crucible has shown me some ways of getting this done.

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

interactions

Editor Ayala Ochert, **Assistant Editor** Heather Pinnell, **Art Director** Andrew Giaquinto
Institute of Physics, 76 Portland Place, London W1B 1NT, UK. Tel: +44 (0)20 7470 4800 ; fax: +44 (0)20 7470 4991; e-mail: interactions@iop.org; Web: http://www.iop.org

LETTER FROM

...the fundraising manager

Have you made your will yet? If you're under 45, the chances are you haven't. Apathy, uncertainty about the process, and a reluctance to contemplate one's own mortality are some of the reasons why many delay putting pen to paper. Others may simply assume that their nearest and dearest will automatically benefit from what they leave behind, but this may not always be the case.

Of those of us who have made a will, 14% will leave a bequest to charity, yet 68% of the UK population regularly give to charity during their lifetime. After we've ensured that those who mean most to us have been taken care of, why do so few make provision for a cause that also means something to us? A legacy will almost certainly be the largest charitable gift you'll ever bestow. And because it's exempt from inheritance tax a legacy is an excellent way of reducing the tax burden on your estate.

Legacies are an important source of income for the charitable sector. They were worth over £1.5 billion last year – almost as much as charities received from the lottery and corporate sponsorship combined. The average residuary legacy (a percentage of an estate once all other debts, fees and gifts have been paid out) is worth an impressive £32 000 – so it's not surprising that the charitable sector is very keen to ensure that people are fully aware of the benefits of making a will and including a charitable bequest.

As a charity, the Institute depends on the generosity of people who share our commitment to promoting physics and supporting physicists. As a member, you already support us through your subscription, by volunteering for Institute activities and contributing to the Institute's publications and networks. But a legacy could help us do more.

If you're a regular reader of *Interactions*, you'll know that physics in the UK is facing a big threat, with falling A-level enrolments and a severe shortage of specialist physics teachers. The Institute is committed to confronting this crisis with ambitious projects like the Undergraduate Bursary Scheme, which aims to increase the numbers of young people studying physics, and the popular Lab in a Lorry programme, which tours the country inspiring young people. But projects like these demand significant resources.

If you wish to leave a legacy to the Institute, we'll ensure that your gift will help future physicists follow in your footsteps.

Robert Carter is the Institute's fundraising manager. If you would like a leaflet explaining how your legacy can benefit the Institute, e-mail robert.carter@iop.org.

No love for nuclear

Jack Simmons and Terri Jackson ("Letters", May and June) both talk of expected increases in "economically recoverable" sources of uranium as prices rise. But here lies a key controversy between economics and science.

For the extraction of gem-quality natural diamonds, the yield is a paltry 80–240 mg per tonne of rock mined, yet diamonds are economically recoverable because to buyers they are "the ultimate gift" when expressing love and commitment. But where mining for energy fuels is concerned, the criteria are entirely different to that for decorative gem stones.

Extraction always means losses, and the losses are greater the lower the concentration of the wanted species in the matrix. The energy cost of extracting 1 kg of uranium is found by dividing the specific energy by the yield and mass fraction of uranium in the ore. Storm and Smith summarised all references from the nuclear industry on the energy used in mining and milling and the chemical processes needed for extraction of uranium oxide for ore grades down to 0.01%.

From this straightforward analysis, the energy cost for extracting grades above 0.2% is low, substantiating the statement that the "fuel costs of a reactor are only a few per cent of its overall costs". For grades below 0.2%, however, the energy required climbs rapidly – Storm and Smith's "energy cliff". By 0.01% the energy cost exceeds 1 TJ per Mg of original ore, comparable with the energy generated at a nuclear power station.

The 4.2 Mg of reported reserves of uranium are all above the 0.01% threshold (some only just). We would be ignoring the profound fundamentals of processing chemistry if we were to base a major build programme for nuclear power on the idea that mere shifts in price will make poorer ores energetically worth recovering.

Unless more high-grade ores are discovered, the reserves of uranium we have are it.

Simon Roberts
London SW8

Sloppy thinking

Glancing through the Strategic Plan insert in the May issue of *Interactions*, I noticed a quote from Peter Main in the article entitled "Promoting physics for everyone".

Following a survey result that physics graduates earn £100 k more than arts graduates, Main says that the government needs to be aware that students doing arts degrees are barring themselves from well paid jobs in the future.

This seems to me a good example of the kind of sloppy thinking that a physics education is supposed to correct. Such a conclusion would only be justified if the input samples were identical, which is highly unlikely. It seems to me that students at the lower end of the ability range are likely to preferentially choose non-science subjects, so any salary difference might well be down to an intrinsically higher ability of physics graduates and not to the physics training itself. There could also be differences in the pattern of career choices of people who study different subjects.

This is also an example of the "big scary number" principle beloved of politicians and journalists. £100 k sounds a lot, but over a 40-year working life it's only £2.5 k a year, which is not an especially large number and certainly wouldn't justify the conclusion that whole high-paying job categories are excluded to arts graduates. As an average figure it gives little clue about any differences at the top, or indeed the bottom, of the salary range.

Personally I think the reason for people to study physics is because it's fascinating and enjoyable. Trying to draw in students who don't enjoy it with dubious promises of higher salaries seems to me to be a bad way to proceed.

Stephen Burke
Oxford

Primary people

I was delighted to see the article on our primary outreach website (http://teachingphysics.iop.org/primary_outreach) in the May issue of *Interactions*. However, I would like to point out that the team working on the project also includes Dr Richard de Grijs and Dr David Lidzey, as well as David Mowbray, Ann Marks and myself.

Gillian Gehring
Sheffield

Positive on energy

Jon Ogborn ("Why school science gets energy wrong", June) is on the right track. Some 40 years ago, I was challenged to talk about the laws of thermodynamics to humanities undergraduates. I formulated a series of short talks based on the ideas of "You can't get something for nothing", "In the real world you always have to pay over the odds" and "You can never quite get all you want".

I would also argue that an approach based on the notion of "paying over the odds", starting with friction and moving on, does facilitate a secondary school understanding of the Second Law – perhaps even for biologists!

John Bevan
Appleby, Cumbria

Jon Ogborn argues that energy cannot be taught properly until A-level or undergraduate level. That may be true if we rely on mathematical modelling, but physics can be taught as "natural philosophy" without the maths, allowing key concepts to be taught much earlier.

Frank Allen
Warrington

Great expectations

It's great that the students from the Outer Hebrides enjoyed the lectures put on during the Institute's Physics in Perspective course ("Observations", May 2006), but they ain't half going to have a shock when they reach university and realise the material covered in their three or four-year degree is nowhere near as well taught or interesting.

The moves by the Institute to enthuse school and sixth-form students are to be applauded, but please don't forget to continue this through to the point of graduation. Otherwise these "additional" students will leave university wondering where the fun has gone from physics.

Peter Bowyer
Taunton, Somerset

We'd like to hear from you. Please send your letters to interactions@iop.org or the address above. Letters may be edited for length.

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

JULY 2006

UK Workshop on Positron Physics and Applications
Topics will include atomic physics, condensed matter and materials physics.
Materials and Characterisation Group
Dundee University
4 July
www.iop.org/Our_Activities/Groups_and_Divisions

Quantum Complexities in Condensed Matter
Experimental results and theoretical insights on novel quantum ground states.
ECOM COST P16 Initiative/Institute of Physics Low Temperature Group/Cavendish Laboratory
Cambridge University
4–7 July
www-qccm.phy.cam.ac.uk
Registration required

ONE-DAY MEETING

Engineering and Physics: Synergy for Success
Papers and keynote speakers on interdisciplinary research and collaboration between physicists and engineers.
Engineering Physics Group
76 Portland Place, London W1
5 October
www.iop.org/Conferences
Registration required

Environmental Electrostatics 2: Measurement Methods in Electrostatics
Historic methods and modern instruments used in environmental electrostatics will be discussed.
Environmental Physics Group
76 Portland Place, London W1
5 July
www.iop.org/Conferences
Registration required

Spectroscopy and Dynamics Across the Spectrum
A meeting on the use of novel techniques to investigate chemical physics.
Molecular Physics Group
York, UK
6 July
c.mayhew@bham.ac.uk
Registration required

CONFERENCE

BRSG: 50th Jubilee Meeting
Two-day event including invited speakers and oral presentation.
Magnetic Resonance Group
University of Nottingham
5–6 September
www.iop.org/Conferences
Registration required

Physics Update Course
Course for practising teachers of physics.
Education Department
Sheffield University
7–9 July
www.iop.org/Our_Activities/Schools_and_Colleges
Booking required

BEAMS 2006
Conference on high-power particle beams.
Atomic Weapons Establishment/co-sponsored by Institute of Physics
St Catherine's College, Oxford
9–13 July
http://www.iop.org/Conferences
Booking required

Carbon 2006
Science of carbon materials.
British Carbon Group
Robert Gordon University, Aberdeen
16–21 July
http://www.carbon2006.org
Registration required

Nanomaterials: Small-scale Life-changers
Seminar at Euroscience Open Forum.
Royal Society of Chemistry/Institute of Physics Policy Department
Deutschen Museum, Munich, Germany
17 July
www.esof2006.org
Registration required

Plasma 2006
Symposium on the intrinsic Josephson effect in high-T_c superconductors.
Institute of Physics Superconductivity Group/ESF Arrays of Quantum Dots and Josephson Junctions Programme
76 Portland Place, London W1
17–19 July
http://aqdjj.lboro.ac.uk
Registration required

AUGUST 2006

Theoretical and Experimental Magnetism Meeting
Workshop on current research on magnetism in condensed matter physics.
Magnetism Group/Centre for Materials Physics and Chemistry
The Cosener's House, Abingdon, Oxford
3–4 August
d.t.Adroja@rl.ac.uk
Registration required

SEPTEMBER 2006

Physics by the Lake
Theory of condensed matter summer school.
Theory of Condensed Matter Group
St Martin's College, Ambleside, Cumbria
3–15 September
www.physicsbythelake.org
Booking required

Photon 06
Speakers, tutorials and exhibition.
Institute of Physics/UK Consortium for Photonics and Optics
University of Manchester
4–7 September
www.photon06.org
Registration required

Quantum Physics of Nanostructures
Talks on nanoscale quantum effects in particles, quantum dots and nanowires.
Nanoscale Physics and Technology Group
Falcon Hotel, Stratford-Upon-Avon
18–20 September
http://nprl.bham.ac.uk/QPN
Registration required

SCHOOLS LECTURE 2006

Gravity, Gas and Stardust
Various venues throughout England, Scotland and Wales
July – December 2006
An interactive presentation by Dr Peter Edwards of Durham University. Aimed at 14–16-year-old students, it covers such questions as: how and when did our universe begin, how did it evolve and how will it end?
Education Department
www.iop.org/Our_Activities/Schools_and_Colleges

Combustion of Biofuels
Discussions on current research.
Combustion Physics Group
E.ON UK Power Technology, Ratcliffe-on-Soar, Nottingham
19 September
www.iop.org/Our_Activities/Groups_and_Divisions
Registration required

RGA Users Meeting
Free workshop-style meeting for users of residual gas analysers.
Institute of Physics Vacuum Group/ASTeC Vacuum Science Group/CCLRC/SS Scientific Ltd/ISIS
Daresbury Laboratory, Warrington
20 September
www.rgausers.org
Registration required

ONE-DAY MEETING

Physical Acoustics Tutorial Day and AGM
Tutorials on ultrasound-phased arrays and therapeutic applications, experimental noise and artefacts, and statistical energy analysis.
Physical Acoustics Group
76 Portland Place, London W1
21 September
www.iop.org/Conferences
Registration required

Imaging in the Eye III: Technologies and Clinical Application
Forum for scientists and clinicians.
Optical Group
76 Portland Place, London W1
22 September
www.iop.org/Our_Activities/Groups_and_Divisions

OCTOBER 2006

Is it Possible to Keep the Lights On and Save the Planet?
Talk by Prof. Maxwell Irvine of Manchester University.
Lancashire and Cumbria Branch
Frankland Colloquium Room, Lancaster University
11 October
www.iop.org/Our_Activities/Local_Branches

ONE-DAY MEETING

Computational Magnetism
Talks will cover computational techniques focused on micromagnetism, Heisenberg models and ab-initio methods.
Computational Physics Group
76 Portland Place, London W1
13 December
www.iop.org/Conferences
Registration required

Careers Fair
For science, technology and engineering students and recent graduates.
Professional Standards Department
Dynamic Earth Centre, Holyrood Road, Edinburgh
11 October
www.iop.org/Our_Activities/About_Careers_in_Physics

NOVEMBER 2006

Low Temperature Techniques Course
Basic techniques for new researchers.
Low Temperature Group
Aston Business School, Birmingham
8 November
www.iop.org/Conferences

Careers Fair
For science, technology and engineering students and recent graduates.
Professional Standards Department
76 Portland Place, London W1
8 November
www.iop.org/Our_Activities/About_Careers_in_Physics

CONFERENCE

Dielectric Materials: Structure and Field-induced Effects
The focus will be on structure and field-induced effects in materials and devices across the electromagnetic spectrum.
Dielectrics Group
University of Surrey
26–28 March 2007
www.iop.org/Conferences
Call for abstracts

Experimental Techniques in Semiconductor Research
Aimed at people new to research and at updating 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/Events
Booking required

CONFERENCE

Sensors & their Applications XIV
This series provides an opportunity to discuss the latest results in sensors, instrumentation and measurement.
Instrument Science and Technology Group
Liverpool John Moores University
11–13 September 2007
www.iop.org/Conferences

Young Physicists Conference
For physics students and young professional physicists.
Nexus
University of Birmingham
24–26 November
www.iop.org/Our_Activities/Supporting_Students_with_Nexus/Events
Booking required

Physics Update Course for Teachers
Talks and workshops for practising teachers of physics.
Education Department
Cambridge University
8–10 December
www.iop.org/Our_Activities/Schools_and_Colleges
Booking required

notices

NEW BUSINESS AFFILIATES
Deloitte & Touche, Tesla Engineering, GlaxoSmithKline, BBC, Department for Transport, Radiological Protection Institute of Ireland, Cambustion, Digital Projection, Farfield Scientific, Innos, Keithley Instruments, Panasonic Broadband Communications Development Laboratory, Sirius Optics, Thermo Electron (Cambridge), Thermo Electron Corporation (Radiation Measurement and Protection), UTEK Europe, Vectra Group, BOS Consulting Engineers, SES Technology, StratoCirrus, Technopreneur.

NEW MEMBERS
Brett Candy, Katrina Cartwright, Julia Davies, Ram Deshmukh, Andrzej Gagola, Paulo Guimaraes, Keren Hamilton, Christopher Harding, Simon Lawson, Christopher Morriss, Sithi Muniandy, Yisau Odusote, Vanessa Ohlendorf, Razib Rashedin, Adrian Roberts, Christopher Russell, James Sadler, David Spence, Jizhong Sun, Philip Symes, Roelof van Silfhout, Annabel White, Benjamin Worthy, Jian-Yong Xiang, Serena Davies, Mark Heslop, George Tsangaris.

NEW FELLOWS
Charles Cotton, Peter Dinsdale, Stefan Estreicher, Arnold Francis, Francis Ling, Rogerio Ramos.

IN MEMORIAM
Michael Tinker, David Cook (Edinburgh), Sheik Ibrahim, Raymond Easterbrook, Bill Storey.

ANNOUNCEMENTS
● **The Institute's Optical Group** became a full member of the European Optical Society (EOS) on 1 July. All members of the Optical Group can now register as full individual members of the EOS at no additional cost.
● **Details of how chartered engineers** can join the International Register of Professional Engineers are available in a leaflet from the Engineering Council UK. Registration brings the right to use the title IntPE, recognition of qualifications in several countries and membership of many national engineering organisations. Visit www.engc.org.uk/documents/UKEMFIntPE.pdf or e-mail international@engc.org.uk.
● **The Institute's Potential Energy blog** is still thriving as three writers explore the issue of nuclear energy, so if you're unclear about nuclear, go to http://potentialenergy.iop.org to follow their investigations.

MEMBER OFFER
Online subscription prize draw
John R Maclean from Dalkeith, Midlothian, is May's prize-draw winner. He wins a 512 MB data stick. For your chance to win one, pay your membership subscription online at http://members.iop.org when you receive your subscription notice.

Capturing the image of science on film

Where do mad scientists in the movies come from and how do they survive? *Christopher Frayling* explains.

Metropolis (Fritz Lang 1926)

Most of the scientists portrayed on the big screen have been mad, bad or dangerous to know. The roll-call includes doctors Frankenstein, Jekyll and Strangelove, and goes right back to the origins of cinema as a fairground entertainment.

The pioneer French animator Georges Méliès featured numerous top-hatted, umbrella-waving astronomers and engineers in his early shorts, and they all came over as vaudeville turns. The first-ever version of Frankenstein was made in 1910, for Edison's studio; the "creature" of the novel turned into a pantomime "monster", who emerged from an alchemist's cauldron.

There were a few ever-so-noble 1930s and 1940s biopics such as *Louis Pasteur* and *Madame Curie*, the latter film (1943) described by one critic as "*Mrs Miniver* with test-tubes". These were the sorts of films that attracted Academy Awards, and gave work to contracted character actors who liked dressing up in labcoats and mutton-chop whiskers and looking through microscopes. But, mostly, films have told audiences that science and technology are likely to be very bad for them.

Do these images matter? How do they relate to the "agendas of anxiety" presented daily by the media? Why is it that although the particular science may change – poison gas in the 1920s, medicine in the 1930s, nuclear physics in the 1950s, biology since the 1980s – the stereotype has remained so constant?

Forty years ago, David Wade Chambers conducted a celebrated project in which he asked 4807 schoolchildren aged 5–11 in the Montreal area to draw a scientist, without hesitating. Their gut-reaction was, especially among the 9–11 year-olds, to resort to the off-the-shelf cultural stereotype: Einstein hair, coke-bottle spectacles, white labcoat, bubbling glassware and in some cases a door marked "secret". (This *was* at the height of the Cold War.) The scientists were also male (only 28 out of 2000 girls surveyed drew a female).

A couple of years ago, in preparation for my book *Mad, Bad and Dangerous? The Scientist and the Cinema* (Reaktion, 2005), I arranged a similar, smaller-scale test at a school in England. I honestly thought the findings would have changed. After all, in recent years heroic scientists – albeit mavericks who take on the establishment – have become much more common in film, not to mention the gung-ho attitude towards technological progress in *Star Trek*, *Star Wars* and countless comic-book derivatives.

I was wrong. Roughly the same proportion of 9–11 year-olds drew lunatic or manic scientists in white labcoats – although there were more female lunatics, the scientists were younger and more punkish and they wore branded T-shirts or shoes. The style of drawing owed much to cheap sci-fi animation and a new character had appeared: the laboratory rat. Also, the stereotyping seemed to be starting younger – among the 7–9 year olds. Here was a clue perhaps. The 1960s movie stereotype had migrated towards children's cartoons, comics, computer games and stand-up comedians (Eddie Murphy as *The Nutty Professor*, Steve Martin as *The Man With Two Brains*).

For my book, I've tried to track the origins of the stereotype's main components: the hair, the disability, the labcoat and the glassware, because these are evidently cultural phenomena. The person who actually taught the children science was a woman, she didn't wear a labcoat or spectacles, bubbling glassware was discouraged and there were no laboratory rats. So the stereotype is being carried by the culture rather than by personal experience.

The frizzy hair of course comes via Albert Einstein – symbol of the brilliant but unruly brain beneath it. Even in the era of Stephen Hawking, Einstein still has the highest recognition factor worldwide of any scientist of the modern era. A survey in 2000 of American academics placed him as the second most significant figure of the millennium, after Gutenberg. His playful and awe-inspiring image has come to stand for the good eccentric scientist who may be incomprehensible but is somehow doing good for us all. Einstein's kindly and wise eyes were copied for the design of ET's; his forehead was the inspiration for Yoda's in *Star Wars*.

"The stereotype of the scientist is being carried by the culture rather than by personal experience."

He's an icon even for those who think relativity is something you share with your uncles and aunts.

Einstein's image neatly combines the two great popular stereotypes of the scientist: unworldly saint and dotty sinner. Saint because he gave us a completely new vision of the universe. Sinner because his ideas inspired the ultimate horror – his first *Time* magazine cover superimposed his face on a mushroom cloud.

The hair has survived on such amiable, eccentric film characters as the original Doctors Who, Doc Brown in *Back to the Future* (1985), and Einstein the down-home matchmaker in *IQ* (1995). In this film Uncle Albert is introduced to a garage mechanic, Ed.

Ed: You're Albert Einstein!

Einstein: Thank you.

Ed: Wow – may I say what a great fan I am of yours?

Einstein: Thank you.

Ed: That thing you wrote about light being bent by gravity, and the whole relativity thing. Man, this is jivin'. I'm still trying to figure it out.

Einstein: Me too...

Christopher Frayling is rector of the Royal College of Art.

particles