The newspaper of the physics community

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interactions

Institute of Physics

Turnaround for British physics

Ayala Ochert reports the views of an international panel on UK physics and astronomy.

The state of physics and astronomy research in the UK has markedly improved in the last five years, thanks to substantial increases in investment, according to an international panel of world-renowned scientists. But the panel warns that increased levels of funding must continue, otherwise this improvement may not be sustained.

Last October the 14-strong panel, which includes two Nobel prize-winners, visited the UK at the invitation of the Engineering and Physical Sciences Research Council (EPSRC), the Particle Physics and Astronomy Research Council (PPARC), the Institute of Physics and the Royal Astronomical Society. They were asked to assess the quality of UK physics and astronomy research and to compare it to that in other leading scientific nations. This was the second visit of its kind; the first was in 2000.

The panel took in 12 university physics and astronomy departments and the CCLRC Rutherford Appleton Laboratory, and spoke to staff, postdocs and PhD students. It published its findings in the report International Perceptions of UK Research in Physics and Astronomy 2005.

"Compared to what I saw five years ago, my impression was much better. The overall mood was much more positive. The difference was really striking," said Jürgen Mlynek of the Helmholtz Association, Germany, chair of the international panel and one of five panel members who took part in the 2000 review.

The report puts this more positive atmosphere down to the substantial increases in investment in infrastructure. The budget for science in the UK more than doubled between 1997 and 2005, including £1 bn for the Science Research Infrastructure Fund.

The panel also praised the increase in stipends for PhD students to an "acceptable level". But it expressed concern over the training of PhD students because of the short duration of the UK PhD. This was undermining the ability of graduates to compete with their international counterparts, said the panel, which recommended an in-depth review of graduate-level education.

The high morale noted by the international scientists may come as a surprise to those reading headlines about the closure of physics departments, but the panel was not complacent on this issue. It was "deeply concerned" and said that a continuation of the trend would threaten the UK's ability to produce enough physics graduates.

Diamond Light Source

Construction of the Diamond Light Source – the panel praised investment in the science infrastructure.

"The overall mood in physics departments is much more positive than five years ago."

Career prospects for postdocs had not improved since 2000, and the environment for nurturing young academic talent is "not ideal", the panel said. And while it noted that the number of women professors in physics departments had increased from 1% to 4% since 2000, in some there were no female faculty at all, which it called a "sorry state of affairs".

World-class research

The international scientists also looked in detail at each of the subfields of physics and astronomy. The UK has an outstanding international reputation in astrophysics and solar system physics, which is "poised for a very productive decade", they said. Nuclear physics and particle physics in the UK are also world class.

But they found room for improvement in other areas – atomic physics needs to recover its leadership position; there needs to be more experimental work in quantum information and computing; nanoscience research lacks coherence and surface science is patchy, the report said. While soft matter research in the UK is "vibrant", the panel was disappointed to find that few physics students get exposed to research in this important field.

Biophysics has been rejuvenated in the last five years, but much of that research is being conducted in biology rather than physics departments, according to their report. The panel also felt that interdisciplinary research in general was not sufficiently valued.

A significant amount of research council money is tied up with specific initiatives, and the panel expressed concern that this could be a "creeping trend that would undermine the opportunities of physicists and astronomers to follow their instincts". The panel also encouraged EPSRC to award more rolling grants.

Some of the investment in infrastructure of recent years has gone towards the development of the UK's central laboratories, and the panel was impressed by the major expansion of the ISIS neutron source, as well as the construction of the Diamond synchrotron light source.

Sir John Enderby, president of the Institute, welcomed the report. "The panel's finding of improved morale within departments is most encouraging for the future of UK physics and astronomy," he said. But he added: "The perennial concerns that the panel raised – short-term contracts for postdocs, the lack of female academics and dwindling provision for undergraduate physics – are worrying. The Institute, in consultation with the physics community and the research councils, will explore solutions to these problems."

http://policy.iop.org/International_Review

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HIGHLIGHTS

Special relativity website wins award

An Einstein Year website, www.thegreatrelativityshow.com, has won an award in the Pirelli Relativity Challenge, an international competition to find the best multimedia explanation of special relativity. The site is an interactive journey featuring a humorous dialogue between an animated Einstein character and his glamorous assistant, Mimi. The characters first appeared in four short films produced by Fulcrum TV, which aired on Channel 4 last year. The website was a collaboration between the Institute of Physics and the film's producers, and won a special prize for the Most Humorous Presentation.

The Pirelli Foundation launched the Relativity Challenge to mark World Year of Physics 2005. It runs alongside their annual *Internet*ional Award for science communication using multimedia technology.

Famelab seeks talent in science communication

Famelab – a competition to find the country's most talented science communicators – is now into its second year, and regional auditions are due to start in March. Organised by the Cheltenham Science Festival and NESTA, with backing from Channel 4, Famelab aims to identify the most promising talent in science communication as part of its drive to improve the public understanding of science.

The overall winner will receive a £2000 prize and a "development deal" – the opportunity to work on an idea with a television producer that will be pitched to Channel 4. The two runners-up will receive £750 each and the 10 finalists will win a weekend masterclass in science communication.

Hopeful contestants are invited to turn up to one of the first auditions ready to give an exciting and engaging three-minute talk on a science topic in the morning and, if they are successful, a five-minute talk on a different topic in the afternoon. The national finals will be held in Cheltenham in June.

www.famelab.org

Science teachers juggle with ideas

At the end of November science teachers from across Europe converged on CERN to spend a week exchanging ideas. The Science on Stage 2005 programme was packed with talks and workshops, on everything from juggling with LED clubs to jumping Doppler cows. In between, each country's delegation had an exhibition stand. "Ingenious ideas using simple apparatus were used to demonstrate a plethora of enthralling experiments to reinforce key scientific concepts, which I cannot wait to try out in the classroom," said Joanne Lord, a teacher at Queen Elizabeth Grammar School in Wakefield. The British delegation plans to produce a resource to share with other teachers the tips they picked up.

www.scienceonstage.net

Einstein Year in pictures

Einstein Year – which officially came to an end on 31 December – proved to be a huge success and engaged thousands of people in talking about physics, taking part in physics-inspired events and websites and hearing about physics on the radio, television and in the press. A full evaluation is due to be published in the spring, but impressions so far suggest it has been one of the Institute's most successful initiatives, stimulating interest in the whole of physics and its applications.

The highlights of the year can now be viewed in pictures at www.einsteinyear.org/eyinpictures. The website features memorable images of the year's activities, such as this one of a child making friends with one of the props used in the Move Over Einstein exhibition, commissioned for Einstein Year.

Schools hit by lack of specialists

By Heather Pinnell

The crisis in physics education in England and Wales is deepening, according to a report published in November. Alan Smithers and Pamela Robinson of the University of Buckingham's Centre for Education and Employment Research found that 24% of 11–16 comprehensive schools do not have a single teacher who has studied physics to any level at university.

The report also showed a correlation between a teacher's level of qualification in physics and their pupils' achievement in exams, which helps to explain the 38% drop in entries to A-level physics since 1990.

The study, which looked at 10% of English and Welsh secondary schools, further education and sixth form colleges, revealed that only 38% of those teaching physics to 14–18-year-olds had physics as their main subject of qualification. More teachers qualified in physics were aged over 50 (31%) than aged 30 or under (17%).

To replace those retiring, and to ensure that at least one quarter of every school's physics teachers is qualified in the subject, physics teacher training output would have to rise from 450 to 750 teachers per year, said the report. However, while government incentives have gone some way to attract more graduates into teaching science, most of these have been graduates in biology or combined science. The intake of physics graduates onto PGCE courses has actually fallen since the early 1980s.

In addition, one quarter of trainee teachers with a degree in physics were training to teach maths rather than science. In most state schools, physics graduates working in the science department are required to teach some biology and chemistry up to GCSE. The report cites this as a possible reason why physicists are choosing to teach maths instead.

Nevertheless, the government's response to the Smithers report emphasised that it was meeting its own targets for a general increase in PGCE science entrants. This showed that it was "in denial", according to the Institute's director of education and science, Peter Main. Some see a return to separate sciences at Key Stage 4 as the only solution, but the Institute is focusing its efforts on securing separate government targets for physics, chemistry and biology specialists in teacher training, he said.

Meanwhile, support for non-specialist physics teachers must be stepped up, said Main. "The number of trained physicists entering teaching will not be large enough to repair the damage for the foreseeable future. Professional development for non-specialists must be seen as a priority."

Young physicists meet in Dublin

Paul Sharp

Mark Lewney gets excited about the physics of music at the Young Physicists Conference in Dublin.

Nearly 100 people went to Trinity College Dublin on 25–27 November 2005 for the seventh Young Physicists Conference and the first to be held in Ireland. The annual conference brings together physicists in the early stages of their careers to network, share experiences and gain vital skills.

Music emerged as a theme of the weekend. There to explain the subtle connections between music, the universe and everything was Mark Lewney, winner of last year's FameLab competition (see "Highlights"), with his talk "Rock guitar in 11 dimensions: strats, strads and superstrings".

Lewney, who now works in the UK Patent Office, did his PhD at Cardiff University on the acoustics of the guitar. His talk covered the physics of harmonics, and he used his guitar skills to show the link between Vivaldi, Strauss and Queen. Lewney also waxed lyrical on the nature of the scientific enterprise. "Science is about drawing a map which explains our existence. Without it, we're as lost and uncertain as a caveman in a thunderstorm," he mused.

Another musical highlight was the traditional Irish Seisiun, an evening of performances by the delegates.

The power of the voice was also explored in the two conference workshops, which focused on how to use your voice and body language when giving a presentation – a vital skill for physicists. Several delegates put what they had learned into practice in the lecture competition. The undergraduate winner was Tom Whyntie of Cambridge University with "Life, the universe and the neutron?" and the postgraduate winner was Keith Lambkin of University College Dublin with "Gulliver's travels and Kepler's mistaken identity".

The most popular lecture was "The physics of beer", given by Bill Graham, a physics professor at Queens University, Belfast. He explained how the "head" is formed and, as this was Dublin, also delved into the physics of Guinness.

For the first time, the conference featured a debate. The motion proposed was: "Science does not pay." After vigorous discussion, delegates concluded that science does, in fact, pay – by benefiting society.

Visualising the beauty of science

Ayala Ochert reports on the première of a stunning "science show without words".

Giant smoke rings and sound waves made of flames wowed the audience at the première of the new science show Visualise, performed in the Wales Millennium Centre in Cardiff on 6 December.

Subtitled "The Beauty of Science", the show was the last big celebration of Einstein Year. The performance emphasised sound and vision, and contained no spoken explanations. Instead, its aim is to inspire the audience with the beautiful patterns in the world around us. It was commissioned by the Institute and NESTA (the National Endowment for Science, Technology and the Arts), and created and performed by the company Science Made Simple.

"The show is unlike anything we've done before," said Debbie Syrop, who performs the entire piece. "It is full of visually stunning science demonstrations – ones that really make people go 'wow'. The live element really adds to the excitement and means every performance is unique."

Against a continuous musical soundtrack, the show intersperses live demonstrations – like rotating a tall flame inside a wire-mesh cylinder to create a spectacular glowing vortex – with projected images from the natural world. These are often simple, but beautiful – peas boiling in a saucepan, ice crystals on a window, a knot in a piece of wood.

In a more interactive section, the audience's own sounds are "translated" into wave-like patterns made from a row of flames, to the delight of the children in the audience.

In the most impressive section of the show, Syrop is joined by several other performers, who use dustbins turned into drums to shoot huge smoke rings across the audience.

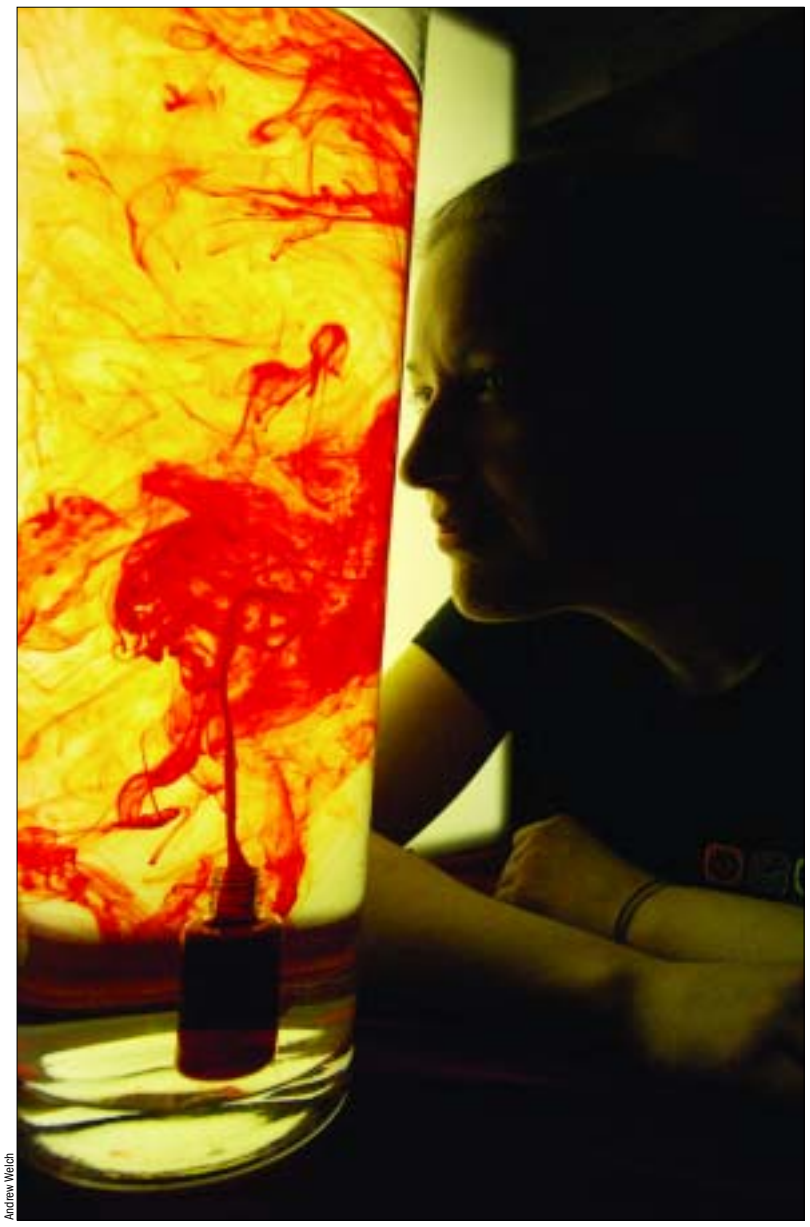
The idea for the show came from Wendy Sadler, director of Science Made Simple, after she saw some impressive demonstrations at the European science festival Physics on Stage. "The demos really got the audience talking and I wondered, could we do an entire science show without words?" said Sadler. She realised the potential not only to move people but also to reach many different audiences, regardless of the language they speak or their age.

Syrop says the result is a science show unlike any other. "Science shows tend to be very information-oriented. We too often try to interest people by giving them answers to their questions.

"Visualise is completely different – we are purely trying to communicate the sense of awe and wonder that scientists feel when they are confronted with the intricate way the world works. It's the excitement of seeing a pattern forming and trying to work out what's happening."

"Certainly the show raises a lot more questions than it answers, but that's the point. We want people to be so intrigued that they go and find out the answers for themselves."

In March, Visualise will be performed in Grahamtown, South Africa, and Science Made Simple has plans to tour with the show more widely this year.



Andrew Welch

In Visualise, Debbie Syrop (above) makes use of patterns in nature to convey the beauty of the physical world.

IN BRIEF

● **Lord Wakeham,** chairman of the House of Lords Economics Affairs Committee, was the guest speaker at a meeting organised by the Institute's Energy Management Group on 28 November. Wakeham addressed a capacity audience on the importance of considering economic factors when developing policies to deal with climate change – the subject of a recent House of Lords report.

Economics needs to be considered when weighing up the options of how to respond to climate change – both the costs of various technologies and their impact on economic growth, said Wakeham. In his view, this meant that there should be a considerable increase in investment in carbon-free technologies and that the UK's nuclear capacity should be retrieved.

● **The Holweck Medal and Prize** has been awarded to Philippe Monod, director of research at the Ecole Supérieure de Physique et de Chimie Industrielles in Paris for his outstanding contributions to the understanding of highly correlated electrons in condensed matter.

The Holweck Medal and Prize is given to French and British physicists in alternate years. It was instituted jointly by the Institute and the French Physical Society in 1945 in memory of Fernand Holweck, director of the Curie Laboratory of the Radium Institute in Paris, who was tortured and killed by the Gestapo in occupied France.

The medal was presented by the Institute's president, Sir John Enderby, following a lecture given by Monod at Bristol University on 12 December. In the lecture, he touched on topics ranging from early work on Brownian motion, to electron spins, spin glasses and oscillations in living matter.

Small firms look at ways to succeed

By Sue Fryer

On 21 November, the Institute held the latest in its series of "Successful SMEs" events. The meeting explored a wide range of sources for finance and funding of small- to medium-sized technology-based companies, and discussed the challenges and pitfalls they face.

Of particular concern to SMEs was the "equity gap" – companies face difficulties securing funding in the region £100 000 to £2 m. David McMeekin, director of Company Guides and the London Technology Fund, explained that in this region investors regard the risks to be too high compared with the potential rewards.

The meeting included advice from experts in the field of venture capital and from business angels. Ken Cooper of the Small Business Service also gave an overview of government-supported funds, including the UK High Tech Fund and regional venture capital funds, which have been developed to help fill the equity gap.

Students hold alternative debate

by Caitlin Watson

In December, around 300 students aged 14–19 took part in a debate about how to manage the country's legacy of nuclear waste, created from the last 50 years of nuclear power and research.

These Debates with a Difference were one of the final activities of Einstein Year and followed a format that has been used in the past to get young people talking about controversial issues, ranging from stem cell research to the future possibilities of nanotechnology.

The "difference" is that participants spend a whole day exploring the issues creatively through role play, research, discussion and by questioning experts rather than relying on preconceived ideas.

The debates were designed to feed into the public consultation being run by the Committee on Radioactive Waste Management (CoRWM) on how best to deal with existing stores of radioactive waste. The committee is due to give its recommendations to government in July.

On the first day of the debates more than 150 students took part at the Life Science Centre in Newcastle, the Glasgow Science Centre and the Sellafield Visitor Centre. After a morning of exploring what nuclear waste is and its possible effects, the students eagerly took part in a Eurovision-style video-link between the three venues.

The students were asked to rank the criteria that CoRWM should use to assess the different options for managing radioactive waste. At the end of the day, they rated short-term public safety as the most important and cost as the least important.

On the second day of the Debate with a Difference, students gathered at W5 in Belfast and Thinktank in Birmingham. This group of students ranked security just above short-term public safety but also put cost at the bottom of their list of priorities. One student remarked: "Surely the cost of public safety shouldn't matter."

On both days, the most heated discussion surrounded the relative importance of short- and long-term public safety. "We need to concentrate first on our current public, but the long-term public is important too. We need to make sure we don't take shortcuts that come back on us," said another student.

Discussions also centred on the pros and cons of the three options for managing radioactive waste that CoRWM is considering: long-term interim storage, deep geological disposal and phased deep geological disposal.

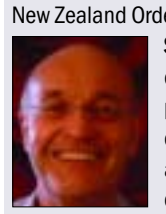
After a final vote, the students opted overwhelmingly for phased deep geological disposal because it allows radioactive waste to be monitored over the long term.

The debates were coordinated by ecsite-uk, the science centre and museums network, with funding from NESTA (National Endowment for Science, Technology and the Arts).

www.scizmic.net

NEWSMAKERS

Michael Pepper, professor of physics at Cambridge University, has been made a Knight Bachelor in the New Year's honours list, for his services to physics. William Stirling, pro vice-chancellor of Durham University, was awarded the CBE. Paul Callaghan of the University of Wellington, was made a principal companion of the New Zealand Order of Merit.



Stan Cowley, professor of solar-planetary physics at the University of Leicester, has been awarded the gold medal of the Royal Astronomical Society for his outstanding contribution to geophysics.

Haley Gomez, from Cardiff University's School of Physics and Astronomy, has won the Royal Astronomical Michael Penston Prize for the best PhD thesis in astronomy and astrophysics. Her thesis was on the origin of cosmic dust.

Physics departments must welcome women

By Heather Pinnell

There is cause for both "optimism and pessimism", said a panel that visited UK physics departments to assess how welcoming they are to women.

The Women in Physics Site Visits Scheme was set up by the Institute in 2003. Every department in the UK and Ireland was contacted, and 40% requested a visit. An external panel of physicists then conducted visits between 2003 and 2005. They spent a day looking around the departments and talking to staff and students. Each visit was followed up with a confidential written report to the department head, and a final report of the scheme is about to be published.

The aim was to offer friendly advice rather than to conduct a formal audit, and to highlight good practice. Most departments said they found the visits helpful, and for many they were a catalyst for discussion of gender issues. The report notes: "The majority of departments had a great deal of trouble providing gender disaggregated data, indicating that the idea of looking for evidence of dissimilar treatment was a new one to them."

This lack of evidence sometimes led to myths about the reasons for the under-representation of women. In one university with a below-average intake of women, it was suggested that "girls did better than boys, and so would go to Oxbridge instead", and in another that a higher-status neighbouring university took all the female applicants. The evidence did not support these ideas.

Many departments had a long-hours culture, which disadvantaged women particularly. The report recommends that productivity and output should be valued more than working excessive hours, and it recommends much greater transparency in appointments, recruitment to PhDs, promotion, and in the allocation of duties.

Departments varied substantially in how they treated staff who had taken a career break – one university forbad promotion committees from knowing that a person had taken such a break, leaving them with unexplained gaps in their CVs.

Childcare was a major issue. The report comments: "It was depressing to see how many young, female research assistants and postgraduate students felt that an academic career was not within their compass. The average age of first appointment is 35, posing serious questions for women who may wish to start a family before that age." Among research assistants and postgraduates in particular "there was a widespread feeling...that a successful academic career is not consistent with having a family".

The report recommends that family-friendly policies and flexible working should be given a much higher profile, with the department head leading by example in taking leave.

Most departments had a harassment policy, but this was not always backed up by adequate procedures. The panel also found many instances of inappropriate pictures openly visible in workshops, sometimes where female students were present. Training of all tutors and demonstrators should include gender awareness, it recommends. The panel found that "groups with a strong multinational flavour tended to be more welcoming to women and less likely to revolve around a 'laddish culture'."

Often simple measures, such as including a statement in recruitment literature encouraging women to apply, having women visible at open days, and an encouraging attitude from postgraduate supervisors and group leaders, were highly effective.

For a copy of the report, e-mail saher.ahmed@iop.org.

IOP on Campus in Reading

By Averil Macdonald

On 17 November the physics department at the University of Reading was abuzz as it hosted a delegation from the Institute of Physics. It was the latest visit of the IOP on Campus programme, which was set up in 2004 to encourage better communication between the Institute and academic physicists around the country.

Institute staff, including chief executive Robert Kirby-Harris, were given a tour of the department and learned of its recent recruitment successes and high-profile investments in research infrastructure, such as its new Centre for Advanced Microscopy and the Ultrafast Laser Laboratory.

"The visit was an excellent opportunity to discuss local issues within the broader context of physics nationally," said John Blackman, head of the physics department.

The department's admissions team was also interested to learn about a new Institute initiative to support physics departments in rebranding and marketing their courses. "We've always been pretty open-minded and innovative in how we put our courses together and how we attract students, but any initiative by the Institute to take this further is really useful," said admissions tutor Mo Hilton.

There was a packed lecture theatre for Kirby-Harris's presentation on the Institute's activities. Everyone, from students to retired professors, was surprised by how much was on offer. "I had no idea you could get an individual careers consultation," noted one member.

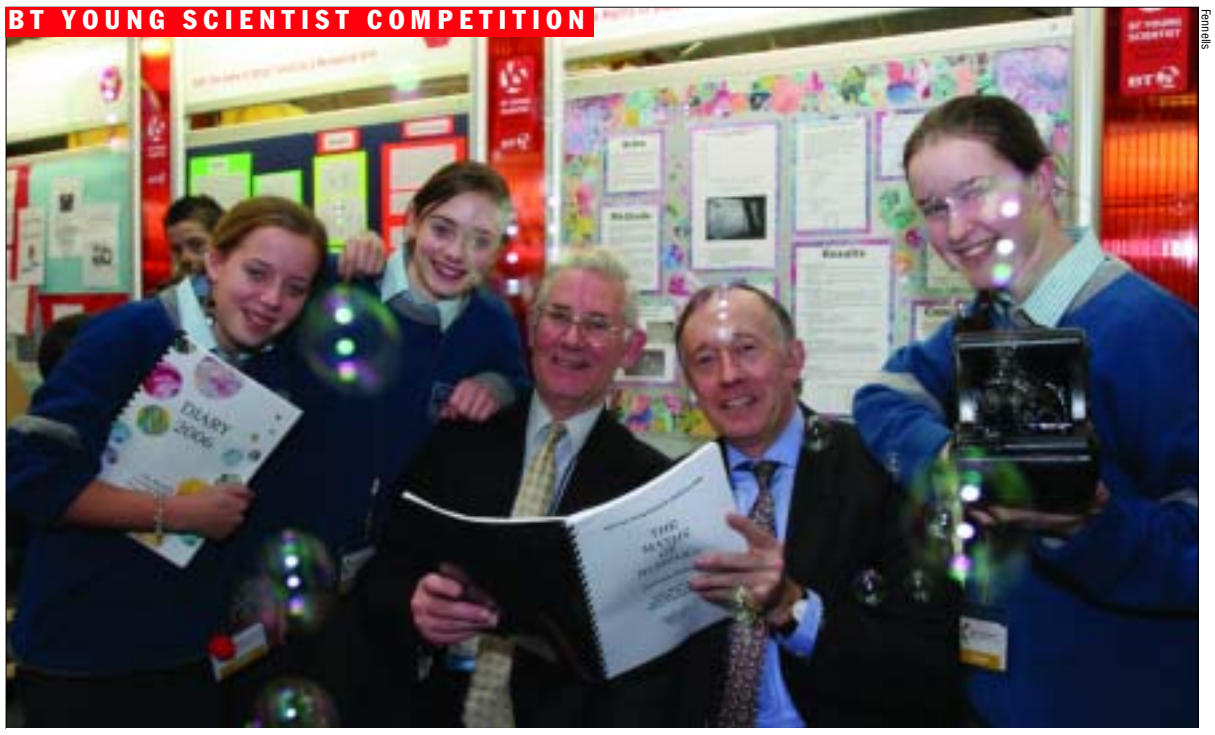
Kirby-Harris and Peter Main, the Institute's director of science, met later with Reading's pro vice-chancellor, Dianne Berry, and its dean of science, David Porter, to discuss issues in physics of importance to the university and the wider world.

The Institute hosted a lunch for all final-year students, offering advice on career planning, and another for postgraduates, postdocs and research assistants, which included individual advice from Yann Amouroux of Institute of Physics Publishing on how to get published.

Academic staff also met Institute staff for an informal discussion on issues in physics today, from nuclear power to the under-representation of women in physics and how to support widening participation in physics.

IOP on Campus has visited four university physics departments since 2004: Heriot-Watt, Kent, Bristol and Reading. Any UK physics department can request a visit by e-mailing **vanessa.crichton@iop.org**.

BT YOUNG SCIENTIST COMPETITION



Fennells

A group of girls from Colaiste Choilm, Ballincollig, County Cork, won the Institute of Physics in Ireland Special Prize for the best physics content at the BT Young Scientist and Technology Exhibition in Dublin last month for their project The Maths of Bubbles. Left to right: Katie O'Donovan, Jennifer Martin, Neil Marks (chair of the Chairs of Branches Committee), chief executive Robert Kirby-Harris and Orla Murphy.

Teachers brush up their physics skills

Topics ranging from "meteorites and moon rocks" to the "physics of road accidents" were covered at a three-day residential course for physics teachers, run by the Institute in December. The event at Oxford University was one of three Physics Update courses held each year. These provide training for physics and science teachers, updating them on innovations in physics and curriculum matters, and opportunities to develop new skills.

As well as lectures on discoveries at the frontiers of physics and its applications, there were "hands-on" workshops in which teachers could learn new IT skills, develop experimental techniques and investigate alternative teaching and learning strategies.

Most of those who attend Physics Updates are teachers in secondary schools or further education colleges and graduates in physics or an associated discipline. The events usually attract about 50 teachers, but 80 people attended the course in Oxford.

Project co-ordinator Leila Solomon said the course had attracted a lot of positive feedback. One newly qualified teacher commented: "I found it both inspiring and educational." Others welcomed the chance to meet other teachers and talk about physics.

The next Physics Update course will be held at the University of Reading on 31 March – 2 April.

For more details on the course, e-mail leila.solomon@iop.org.

'No barriers' to nuclear power

With the UK government poised to reconsider the building of new nuclear power stations, the Institute of Physics and the Royal Society of Chemistry held a joint seminar on 13 December to investigate their potential risks.

The meeting, Future Nuclear Power: Addressing the Barriers, attempted to examine all potential areas of risk – health dangers to local populations, terrorist threats, nuclear waste – as well as public perceptions of these risks.

Peter Zimmerman of the Department of War Studies at King's College London said he was convinced that the risk of terrorists developing a dirty bomb is a real one. However, at present, that risk comes mostly from the waste generated from weapons manufacture, not from civil nuclear power, he went on.

Neil Chapman of the University of Sheffield looked at the various options for handling nuclear waste from new reactors. He said that a consensus is emerging that deep geological disposal is the way forward, and pointed out that the UK will need such a repository in any case to deal with existing nuclear waste. "Future waste could be incorporated into those plans that are being considered for current waste," he told the audience.

One of the big concerns about nuclear power has come from the clusters of childhood cancers around Seascale and Dounreay. But Bryn Bridges, of the Genome Damage and Stability Centre at the University of Sussex, said that a new study about to be published showed "no indication of any effect on childhood cancers in any of the vicinities [around nuclear reactors]".

Such a study is unlikely to make public concerns disappear, but Malcolm Grimston, associate fellow at Chatham House, noted that public opinion has been moving towards nuclear in recent years, from a low of three-to-one against in 2001.

The nuclear industry has historically been seen as secretive and untrustworthy, and this must change, he said. "There are no real barriers to new build in terms of public perception, as long as people are treated honestly and seriously."

profile: Tony Sherborne

Learning from film to bring science to life

Ayala Ochert meets a man who says teachers should watch more TV.

David Bebber

Tony Sherborne designs computer games to motivate children to learn.

Last year Tony Sherborne took a seminar from a celebrated Hollywood script doctor, but the former physics teacher wasn't trying to break into a career as a screenwriter. He was trying to learn what all good filmmakers know – how to grab an audience's attention and keep them hooked.

"Only half our learning is cognitive. The other half is emotional, yet that side is entirely overlooked in traditional science education," says Sherborne, who is now creative director at the Centre for Science Education at Sheffield Hallam University. He has also been awarded a fellowship from the National Endowment for Science, Technology and the Arts (NESTA) to "explore new ways of making science lessons relevant, contemporary and unforgettable".

As a teacher, Sherborne always tried to make his lessons unforgettable – he once took his class to Alton Towers to teach them about g-forces and acceleration. Now he has devoted himself to developing even more exciting lessons for others to deliver. In 2002, for Science Year, he created *SciFiles* – a series of computer games in the style of the *X Files* and *CSI* – to convey some really hard-to-teach ideas. For one game, Sherborne enlisted the help of a filmmaker to create a thrilling story about ghost hunting to teach electromagnetic induction. (Some think that ghost sightings may be the result of magnetic disturbances causing electromagnetic induction in the brain, leading to hallucinations.)

"We were playing off the children's interest in *CSI* and *X Files* and being involved in a story. In order to push the plot forward they had to reason things out or complete a task," he explains. This results in children being much more motivated to learn.

His own motivation comes from a need to make up for the boredom he experienced in the north London private school he attended. (It was an "exam factory", he says.) Sherborne carried on with science at Cambridge, but rapidly gravitated away from physics towards psychology, which led him into teaching. After university, he discovered popular science books and science documentaries, which kindled a new-found love for science. "There's this gap between the science out there in the real world, which is made quite fascinating by popular science, and what goes on in the classroom. I can't accept that gap. I can't see why it has to be that way."

After eight years teaching physics, he decided that he was not a "natural teacher" and would be better off playing to his strengths, which lie in designing learning experiences. Recently he's been involved in developing a new science curriculum and GCSE syllabus. Thanks to him, the syllabus beginning in September will include a section on special relativity.

"We won't be asking them to do time corrections, but they'll look at it in terms of how science works. It's an example of how developing theories in science involves a creative leap of the imagination."

Sherborne has also been working with the Institute on a set of resources to help teachers with the new GCSE. Called SimPhysics, they are based on the popular computer game *SimCity*. The first one – SimEnergy – follows a day in the home of a family living on a carbon quota, and rewards those who can save energy through better insulation or those who generate it using renewable sources. The physics is interwoven throughout the game – for example, players can measure the solar intensity at various places before deciding whether to invest in a solar panel. It's contemporary, it's relevant and it teaches the core principles of energy conservation and transfer as well as the science of climate change, says Sherborne.

"There's a gap between real science – which is fascinating – and what goes on in the classroom."

But building interactive computer games takes time, which is a problem if you want the science to be really topical. So two years ago Sherborne came up with Science UPD8 – innovative lesson plans based on what's in the news that can be e-mailed to teachers every week. When actor Leonardo di Caprio bought a hybrid-electric car, Sherborne created a lesson plan in which teenagers had to storyboard an advert for Toyota featuring the star. "It was a task that naturally led to some motivated learning and fun, and the kids remember it. The teacher can build on that and go more deeply into the concepts," he says. More than 4000 teachers have now signed up to receive UPD8s.

Sherborne plans to write a book for teachers distilling the principles he is learning from filmmakers, TV producers, actors and even advertisers about how to engage an audience. "Teaching can be incredibly creative. If there was less government prescription about what to teach and how, I think that would sell teaching to more physicists and you'd find physics teachers more eager to continue."

OBSERVATIONS

Andrea Fesmer of the Institute's Merseyside Branch describes how she spent Einstein Year helping children across the country to hunt for asteroids.

Most physicists can tell you who or what inspired them to do physics. As a physics teacher, I'm always on the lookout for those people or projects that will inspire my own pupils to become physicists. About seven years ago I found such a project – the National Schools Observatory (NSO), run by the Astrophysics Research Institute (ARI) at Liverpool John Moores University. It gives schoolchildren the chance to use a multimillion pound robotic telescope, sited on La Palma in the Canary Islands and accessed via the Web. I've seen dozens of young faces light up at NSO – children are amazed that they're allowed to use such an expensive piece of equipment. Last year Andy Newsom of ARI and I got an Einstein Year grant to produce a Hunting for Asteroids workshop that would make full use of the telescope.

11 February

The workshop is mainly for use at the new City Learning Centres (CLCs), which have state-of-the-art computer facilities. Last week was our first training day, for CLC managers from northern England. They got more and more enthusiastic as the day wore on and predicted that their centres would be overwhelmed with demand from schools. Today I'm in Hackney with Andy to train CLC managers from London. They take more convincing than their northern colleagues but all are on board by the end. At the actual workshops there will be a real astronomer on hand to answer children's questions.

7 March

Today is the official launch of the Hunting for Asteroids workshop at Saints Peter and Paul CLC in Widnes, next to the school where I teach. The local MP and junior education minister Derek Twigg has come along to join in the hunt with some local schoolchildren. He's delighted at finding an asteroid until I tell him that there are actually two and he needs to keep looking. By this time most of the children have found both and are celebrating. Local journalist Adrian Short was overheard saying: "If only I'd done projects like this at school, I would probably have studied physics."

14 March

It's Einstein's birthday, and we're expecting most of the CLCs to run the workshops today. Andy and I are running four in Widnes. The girls seem to enjoy the workshops as much as the boys – they're just as competitive and as vocal when they discover the asteroids.

30 June

I'm here at Liverpool's physics department for a conference organised by the Merseyside Branch aimed at A-level physics teachers. I was here a couple of weeks ago, talking to non-specialist teachers of physics. One teacher attended the earlier conference and had tried out the workshop with his school's entire Years 7 and 8. He's been recommending it highly, which makes my job a lot easier.

5 September

Back to school. I had a busy summer with more workshops alongside my summer job working as education adviser to Spaceport. Hunting for Asteroids has been such a success that it's just been extended beyond CLCs, so all schools will now be able to access the telescope.

21 November

The local CLC has invited children from around Halton to listen to a Russian cosmonaut and a space scientist talk about the Russian space programme. As they speak, there's the same buzz of excitement that I've become used to seeing at the workshops. I feel a twinge of sadness as Einstein Year draws to a close, but I remind myself that we've had more than 3000 children hunting for asteroids, and being inspired by physics.

If you would like to hunt for asteroids, visit www.schoolobservatory.org.uk/asteroids. To contribute to **OBSERVATIONS** send an e-mail with your idea to interactions@iop.org.

Institute *of* **Physics**

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interactions

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LETTER FROM

...a mentor

Last August I got a call asking if I would act as a mentor to women applying for fellowship of the Institute. This made sense as women make up just 4% of fellows, and I've been encouraging the Institute to promote the many successful but largely unrecognised women physicists out there. I also knew that women often doubt their own value and can need more active encouragement to apply. I myself would never have become a fellow had I not been practically pushed into it.

I was a little hesitant at first as I am no longer actively involved in physics research, but I was reassured that I would receive full training as a mentor, as well as ongoing support. The training took the form of a comprehensive briefing pack and an interactive online seminar – a first for me.

I was soon matched up with a mentee – a woman who holds a very senior post in a major international technology-based company. When she sent me the elements of her application for fellowship – her draft CV and professional review – I was impressed. But when we spoke she tended to focus more on what it did not contain than what it did and to apologise for what she saw as her shortcomings rather than selling her very considerable strengths. Her other professional activities, such as her involvement with her local Learning and Skills Council, also strengthened her case.

I compared my mentee's CV and professional review against the Institute's criteria for fellowship and saw ways that it could be improved – by using more evidence and phrasing it more confidently – and spotted entire areas that she had completely overlooked, such as her major industrial collaborations. I think this is natural. Once we've achieved an objective, we tend to forget it immediately and focus on what comes next or what we have still to achieve. So it can help to have an independent but supportive person to highlight past achievements.

My mentee has now submitted her application, and I hope that our sessions have helped her to present herself in the best possible light and boosted her self-confidence. I found the experience very rewarding and I'm looking forward to repeating it. I would highly recommend mentoring to other fellows – men and women alike. It allows you to update your own skills while providing an invaluable service to other members.

Julie Corbett is a member of the Institute's Council. For more information about mentoring, visit http://careers.iop.org/mentoring.

Defending defence

I am sorry to hear of David Greenwood's reaction to AWE's presence at the Institute of Physics careers fair in October ("Letters", December 2005). While he may not approve of our mission to maintain the UK's nuclear deterrent, our vision is to be a world-class centre of scientific and technical excellence, and in doing so we employ more than 250 physicists.

As an active recruiter of graduate physicists, AWE was pleased to be involved in the careers fair.

Caroline Handley
AWE Aldermaston

I do not work for AWE, but David Greenwood's letter in December's *Interactions* really infuriated me. If he had taken the time to investigate its stand further, some of his preconceptions may have been dispelled. His subsequent assassination of the Institute's careers fair aggravated me further. I have been involved in the organisation of similar events, and appreciate the time and hard work putting it together; I would have been bitterly disappointed to have received such derogatory comments.

I only hope that, if he continues his career in physics, Mr Greenwood learns to appreciate the efforts of his fellow physicists.

Paul Johnson
Uttoxeter, Staffordshire

Get practical, physics

I am saddened, but not surprised, to learn that physics teaching is on the retreat. I read physics at university in the early 1960s and was employed in industry as a physicist/engineer for most of my working life.

It was the practical aspects of the subject that inspired me. I fear that this potential source of inspiration to today's students is being lost as research at universities appears to have become ever more esoteric, focusing on finding the origins of the universe or identifying ever smaller subatomic particles.

In the 1950s and 1960s it was clear that physics was the "mother of engineering" but I doubt that the up and coming students in our schools today still see it that way.

Until physics regains her proper position as the matriarch of all engineering disciplines, I fear the retreat will continue. That is sad because a physicist's approach to problem solving could bring much fresh thinking to the practical world of engineering.

David Haspel
Matlock, Derbyshire

Wrong assumptions

May I correct some erroneous assumptions made by speakers at the Challenges and Solutions conference ("How to solve our energy crisis", November 2005)?

First, public opinion in the UK is not against nuclear power. A 2005 MORI poll shows opposition to nuclear power has been reduced by half since 2001. And a BBC poll of nearly 9000 people after the programme *If the Lights Go Out* gave a 76% backing for nuclear power.

A Royal Academy of Engineering report in 2004 estimated that nuclear costs 2.3p/kW h, which is comparable to electricity produced by gas-fired plants. Nuclear electricity generators are also more than three times less dependent on fuel costs than gas-fired generators.

With gas prices rising rapidly, the advantage of nuclear power will be even more marked.

Terri Jackson
Bangor, Northern Ireland

We've got soul

Thank you for the December 2005 edition of *Interactions* – excellent as usual. I was glad to see the front page article about the developing world. So physicists have got soul after all!

Mike Hill
Reading

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.

notices

NEW FELLOWS

David Hinde, Brynley James, Robert Kelsall, Hazel Rymer.

NEW MEMBERS

Sharon Ashbrook, John Austing, Paul Bird, Sumit Biswas, Marco Borghesi, Derek Brown, Clair Collins, Nigel Crawley, Ana De Paula, Marcus Donnelly, Ilias Drouzas, Steven Franklin, Rodolfo Gambini, Lindsey Gaunt, Simon Haining, Daniel Hatton, Aled Jones, Semiu Kareem, Graham Kemp, Paul Messenger, Christopher Morriss, Barry O'Connell, James Ollier, Brian Pugsley, James Rhodes, Debidulal Roy, Chandan Sarkar, Muhiddin Sheriff, Edward Stephens, Ben Van Well, Elizabeth Veitch, David Wall, Alan Walton, Jianjun Yu.

IN MEMORIAM

C H Baxter, Robert Nigel Bell, Alexander C Brown, John Dugdale, Jan Evetts, Ivan Fisher, Alan Foster, Edward Green, Kenneth Harwood, Ian McColl, Alec Radcliffe, Donald Richardson Joseph Roberts, David John Robertson (Aylesbury), Bimalendu Roy, Adolf Schallamach, Harry Schecter, Harry Scholefield, V Subramanian (New South Wales), Mary Troughton, Charles Edington Williams.

ANNOUNCEMENTS

● **The Institute's Schools and Colleges Lecture for 2006** – entitled "Gravity, gas and stardust" – will begin its tour of England, Scotland and Wales throughout 2006 on 10 March in Durham. This year's lecturer is Pete Edwards from Durham University. Check the website for venues and dates: http://teachingphysics.iop.org/events/student_events/schools_lecture.

MEMBER OFFER

● **Online subscription prize draw**
H Trodahl from Wellington, New Zealand, is November's prize-draw winner and Jonathan Dowling from Louisiana, USA, is December's winner. They will each receive 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.

FEBRUARY 06

Conflict in the Cosmos: the Turbulent Scientific Life of Fred Hoyle
Talk by Dr Simon Mitton – writer, broadcaster and biographer.
London & South-East Branch
Rutherford College, Theatre 1, University of Kent, Canterbury
7 February
http://london.iop.org/meetings.html

Unlocking the Neanderthal's Secrets: the New Science of Biomolecular Archaeology
Lecture by Dr Matthew Collins of the University of York.
Yorkshire Branch
Leslie Downs Lecture Theatre, Ferens Building, University of Hull
7 February
http://yorkshire.iop.org/iop-london/Events

Great Balls of Fire
Lecture by Dr Chris Warrick, education outreach manager, UKAEA Culham.
Midland Branch
Large Lecture Theatre, Poynting Physics Building, University of Birmingham
7 February
l.long@bham.ac.uk

The History of High Speed Photography
Talk by Dr Bill Proud of the University of Cambridge.
London & South-East Branch
76 Portland Place, London W1
8 February
http://london.iop.org/meetings.html

New Challenges for Particle Accelerators in the 21st Century
Talk by Prof. Michael Poole, director of ASTeC, CCLRC Daresbury Laboratory.
Merseyside Branch
Surface Science Research Centre, University of Liverpool
9 February
http://merseyside.iop.org
Suitable for sixth formers

At the Heart of Matter: Quarks, Leptons and Bosons
Lecture by Prof. Peter Watkins, University of Birmingham.
Midland Branch
Hayward Lecture Theatre, St Peter's School, Compton Road West, Wolverhampton
9 February
c.wormley@physics.org

From the Light Bulb to Quantum Computing: 100 Years of Quantum Theory
Talk by Dr Martin Lavelle of the University of Portsmouth.
South-West Branch
Elwes Building, University of Gloucestershire, Park Campus
9 February
http://sw.iop.org/Events.htm

Ultrasound in the Processing of Industrial Soft Materials
Conference bringing together industrialists and academics to examine future uses of ultrasound.
IOP Physical Acoustics Group/Food Chain CIC/Industrial Centre of Particle Science and Engineering/University of Leeds
University of Leeds
9–10 February
www.ultrasound06.com
For industrialists and academics

Physics and Music
Lecture by Prof. Murrary Campbell of the University of Edinburgh.
IOP in Scotland
Royal Society of Edinburgh, Stirling Street, Edinburgh
14 February
d.t.reid@hw.ac.uk

Measuring the Ages of Mountains and Sand Grains
Talk by Prof. Simon Kelley, Earth Science, Open University.
London & South-East Branch
Church Lecture Theatre, Open University, Walton Hall, Milton Keynes
14 February
http://london.iop.org/meetings.html

Computer Modelling: Approaching Reality
Talk by Prof. Richard Catlow of the Royal Institution.
South-West Branch
HH Wills Laboratory, University of Bristol
14 February
http://sw.iop.org/Events.htm

Dealing with Spent Nuclear Fuel
Talk by Neil Stagg of BNFL.
Lancashire & Cumbria Branch
George Fox Building LT1, Lancaster University
15 February
http://lancashire.iop.org/liopcal_05-06.htm

CONFERENCE

Biodielectrics: Theories, Mechanisms and Applications
This year's conference focuses on the interaction of electric fields with biological materials.
Dielectics Group
University of Leicester, UK
10–12 April
http://conferences.iop.org/BID
Reduced fee for members

The Search for Gravitational Waves
Talk by Dr Sheila Rowan of the University of Glasgow.
IOP in Ireland
Queen's University Belfast
15 February
http://ireland.iop.org/program.html

What Does it Take to be a Competent Graduate Physicist?
Programme of speakers giving perspectives on the skills they expect in a competent graduate physicist.
Higher Education Group
76 Portland Place, London W1
15 February
http://conferences.iop.org/CGP
Reduced fee for members

Using Gravity's Lenses
Talk by Dr Ian Browne of the University of Manchester.
IOP in Ireland
National University of Ireland, Galway, Ireland
15 February
http://ireland.iop.org/program.html

What's the Use of Chaos?
Lecture by Prof. Chris Budd of the University of Bath.
South Central Branch
Lecture Theatre 1-01, St Michael's Building, University of Portsmouth
16 February
http://scentral.iop.org/portsmouth.html

Using Gravity's Lenses
Talk by Dr Ian Browne of the University of Manchester.
IOP in Ireland
Trinity College Dublin
17 February
http://ireland.iop.org/program.html

Physics in Perspective
A study course for sixth formers and college students.
Education Department
University College London and the Institute of Education, London WC1
19–21 February
leila.solomon@iop.org
For sixth-form and college students

ONE-DAY MEETING

Film Deposition and the Control of Interfaces for Spintronics
Meeting focusing on the materials issues of spintronics.
Ion and Plasma Surface Interactions Group
76 Portland Place, London W1
1 March
http://conferences.iop.org/FDC
Reduced fee for members

Why Do We Like Some Foods and Hate Others? The Science of Taste of Flavour
Talk by Dr Peter Barham of the University of Bristol.
Yorkshire Branch
Department of Physics and Astronomy, University of Sheffield
21 February
http://yorkshire.iop.org/iop-london/Events

Mirror Images, Antimatter and Time Reversal
Talk by Prof. Peter Kalmus of Queen Mary, London University.
London & South-East Branch
76 Portland Place, London W1
22 February
http://london.iop.org

Contracts and How to Win Them
Half-day conference including business advice.
Consultancy Group
76 Portland Place, London W1
22 February
http://conferences.iop.org/CONT
Open to members of the Institute or Joint Consultancy Forum bodies

Synchronisation: from Brainwaves to Light Waves
Talk by Prof. Paul Rees of the University of Wales, Swansea.
Wales Branch
Large Chemistry Lecture Theatre, Cardiff University
22 February
http://wales.iop.org/Programme.html

Towards Safer Design: a Boundary Approach
Lecture by Prof. Ferri Aliabadi of Imperial College.
London & South-East Branch
The Lindop Building, University of Hertfordshire, Hatfield
23 February
http://london.iop.org/meetings.html

Rainbows
Talk by Prof. John Inglesfield of Cardiff University.
Manchester Branch
Schuster Building, Manchester University
27 February
http://manchester.iop.org

String and Sticky Tape Experiments
Talk by Prof. Ron Edge of the University of South Carolina.
London & South-East Branch
Rutherford College, Theatre 1, University of Kent
28 February
http://london.iop.org/meetings.html

Black Holes, Wormholes and Time Travel
Talk by Jim Al-Khalili of the University of Surrey.
Midland Branch
Lecture Theatre, Department of Physics, University of Warwick, Coventry
28 February
http://midland.iop.org/calendar.htm

Was the Early Universe a Perfect Liquid?
Lecture by Prof. John Nelson of the University of Birmingham.
Midland Branch
Large Lecture Theatre, Poynting Physics Building, University of Birmingham
28 February
http://midland.iop.org/calendar.htm

Juggling: Theory and Practice
Lecture by Colin Wright of Solipsys Ltd.
South Central Branch
Lecture Theatre Pevensey 1, University of Sussex, Brighton
28 February
http://scentral.iop.org/brighton.html

MARCH 06

Geomagnetic Reversals: One of Life's Big Mysteries
Talk by Prof. John Shaw of the University of Liverpool.
Merseyside Branch
Surface Science Research Centre, University of Liverpool
2 March
http://merseyside.iop.org

Festival of Physics
Annual general meeting and festival.
South-West Branch
HH Wills Laboratory, University of Bristol
4 March
http://sw.iop.org/Events.htm

The Science of Climate Change and Global Warming
Talk by Dr Adam Scaife of the Met Office's Hadley Centre.
Yorkshire Branch
Department of Physics and Astronomy, University of Sheffield
6 March
http://yorkshire.iop.org/iop-london/Events

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

The Physics of Woodwind Instruments
Talk and demonstration by Dr David Sharp of the Acoustics Research Group, Open University.
London & South-East Branch
Church Lecture Theatre, Open University, Walton Hall, Milton Keynes
7 March
http://london.iop.org/meetings.html

At the Heart of Matter: Quarks, Leptons and Bosons
Lecture by Prof. Peter Watkins of the University of Birmingham.
Midland Branch
St John Fisher High School, Ashfields New Road, Newcastle-under-Lyme
7 March
http://midland.iop.org/calendar.htm

Negative Refractive Index Metamaterials
Lecture by Dr Martin McCall of Imperial College, London.
IOP in Scotland
Royal Society of Edinburgh, Stirling Street, Edinburgh
7 March
d.t.reid@hw.ac.uk

Soldering and Lead-Free Solders
Talk by Prof. William Plumbridge of the Open University.
London & South-East Branch
76 Portland Place, London W1
8 March
http://london.iop.org/meetings.html

Women Physicists: SET is Fair?
Welcome event for student members of the Women In Physics Group.
Women in Physics Group
76 Portland Place, London W1
8 March
wipg@amarks.co.uk

Brunel
Talk by well known historian of science Dr Adam Hart-Davis.
South-West Branch
Main Hall, University of Bath
8 March
http://sw.iop.org/Events.htm

Materials
Lecture by Dr Diane Talbot of the Institute of Materials, Metals and Mining.
Midland Branch
Lecture Theatre, King Edward VI College, Stourbridge
9 March
http://midland.iop.org/calendar.htm

CONFERENCE

Condensed Matter and Materials Physics (CMMP 2006)
Themes include nanoscience and correlated quantum systems.
Condensed Matter and Materials Physics Division
University of Exeter, UK
20–21 April
http://conferences.iop.org/CMMP06
Reduced fee for members

Key Insight Business Briefing: UK Technology Strategy
Speakers and discussion on strategies for technology in the UK and abroad.
Business & Innovation Department
76 Portland Place, London W1
13 March
http://industry.iop.org

Medical Ultrasound Imaging
Lecture by Dr Elizabeth Parvin of the Open University.
Midland Branch
De Lisle Catholic Science College, Loughborough
14 March
http:/midland.iop.org/calendar.htm

Imaging the Autistic Brain
Lecture by Prof. Steve Swithenby of the Open University.
Midland Branch
Room P8, Department of Physics, Oakham School, Oakham, Rutland
14 March
http://midland.iop.org/calendar.htm

Ripples from the Dark Side of the Universe
Talk by Prof. Jim Hough of Glasgow University.
Lancashire & Cumbria Branch
Cavendish LT, Lancaster University
14 March
http://lancashire.iop.org/liopcal_05-06.htm

CAREERS

Free one-to-one careers advice for all members, at a branch near you throughout 2006
Advice on interview techniques, job search, career breaks, changing career direction, retirement and more. For venues and dates, see:
http://careers.iop.org/mobile-careers
Open to all Institute members

Battle of the physics giants – Einstein vs. Newton

Jim Al-Khalili fights Albert Einstein's corner in a Royal Society debate to select the world's greatest-ever scientist.

I know it's geeky, but I've always loved compiling lists of my top-10 records, books, films, you name it. So when the Royal Society asked me to take part in a debate to choose the greatest-ever scientist, I jumped at the chance. Of course, I realise that science is not a popularity contest, but it sounded like fun as well as a great opportunity for promoting physics.

Now, if you asked me to produce a list of the world's top-10 physicists, it would be tough to put them in order. Kepler or Kelvin? Faraday or Feynman? Heisenberg or Hawking? And what about Dirac, Maxwell or Rutherford? But choosing the two greatest scientists of all time (and here I mean across the whole of science, not just physics) is a no-brainer. Head and shoulders above anyone else are Isaac Newton and Albert Einstein. Both had their *annus mirabilis* while still in their 20s – 1666 for Newton and 1905 for Einstein. Their discoveries during those short periods marked them out as true geniuses as well as changing our view of the universe.

Having embarked on a quest last year to find Einstein's brain for Channel 4 ("Antimatters", March 2005), I was there to defend the cause of Einstein with the help of Mark Lythgoe, my neurophysiologist friend who accompanied me on that journey. Fighting Newton's corner was Sir John Enderby, president of the Institute of Physics and former vice-president of the Royal Society, along with Cambridge historian of science and Newton biographer Patricia Fara.

Even setting aside the eminence of our opponents, we were aware that we had a battle on our hands. While Joe Public might choose Einstein for his sheer iconic status, the several hundred people who had turned up for the debate were going to be harder nuts to crack. They would no doubt be aware of the stature of Newton as the father of modern science – the person who almost single-handedly discovered just about all the physics one learns at school – and they would surely put him ahead of Einstein. The scale of our task became clear when a show of hands at the start of the evening showed Newton to be in the lead by a majority of roughly two-to-one.

In the run-up to the debate, the Royal Society had carried out an online public vote, with the results to be revealed at the end of the evening. Each team began with a short presentation putting the case for their champion. There then followed a good-natured debate on their relative merits: Newton's equations of motion versus Einstein's theories of relativity; Newton's invention of calculus versus Einstein's proof of the existence of atoms (his 1905 Brownian motion paper); the *Principia Mathematica* versus general relativity and cosmology; the father of the scientific method versus the master of space-time. Both transformed our understanding of nature and both made contributions across the whole of physics.

Our case relied on the fact that it is Einstein's universe that we live in, not Newton's. But one member of the audience showed the weakness of this argument by pointing out that if, at some time in the future, someone were to come up with a complete theory of quantum gravity that modifies general relativity, then that person would presumably replace Einstein as the greatest.

To help restore our credibility I threw in this brilliant quote from the physicist Michio Kaku: "All physical knowledge at the fundamental level is contained in two pillars of physics – general relativity and quantum theory. Einstein was the founder of the first, the godfather of the second and paved the way for the possible unification of both."

Clearly, much depends on luck and timing. So it would be unfair on Newton to say that Einstein was greater because he showed the Newtonian view of space and time to be wrong. But, equally, it would be unfair on Einstein to say that Newton had the greater influence on our thinking. After all, he simply was lucky enough to have been around first, when all the discoveries were there to be made.

Mark and I also tried to appeal to the audience on the grounds that Einstein was a nicer bloke, had great hair and didn't die a virgin. Newton certainly did himself no favours with his long-running and bitter disputes with contemporaries Hooke and Leibniz. Whether this helped or not, we cannot tell, but at the end of the debate a second show of hands revealed that the two men were neck and neck.

I was satisfied with that result, as I mentioned later to Sir John Enderby. In fact, had I been given a choice, I would have preferred to defend Newton who, if truth be told, I would place ahead of Einstein. Sir John admitted that he would not have minded arguing for Einstein.

As for the public, the online poll revealed that they are more familiar with Newton's work than I'd given them credit for. The final result was Newton 62%, Einstein 38%.

Our case relied on the fact that it is Einstein's universe that we live in, not Newton's.

Jim Al-Khalili is head of the nuclear theory group at the University of Surrey, where he also holds a chair in the public engagement in science. He is author of several popular science books, including *Quantum: a Guide for the Perplexed*. His Channel 4 documentary *The Riddle of Einstein's Brain* aired last March.

particles