The newspaper of the physics community

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interactions

Institute *of* **Physics**

Big questions for tiny science

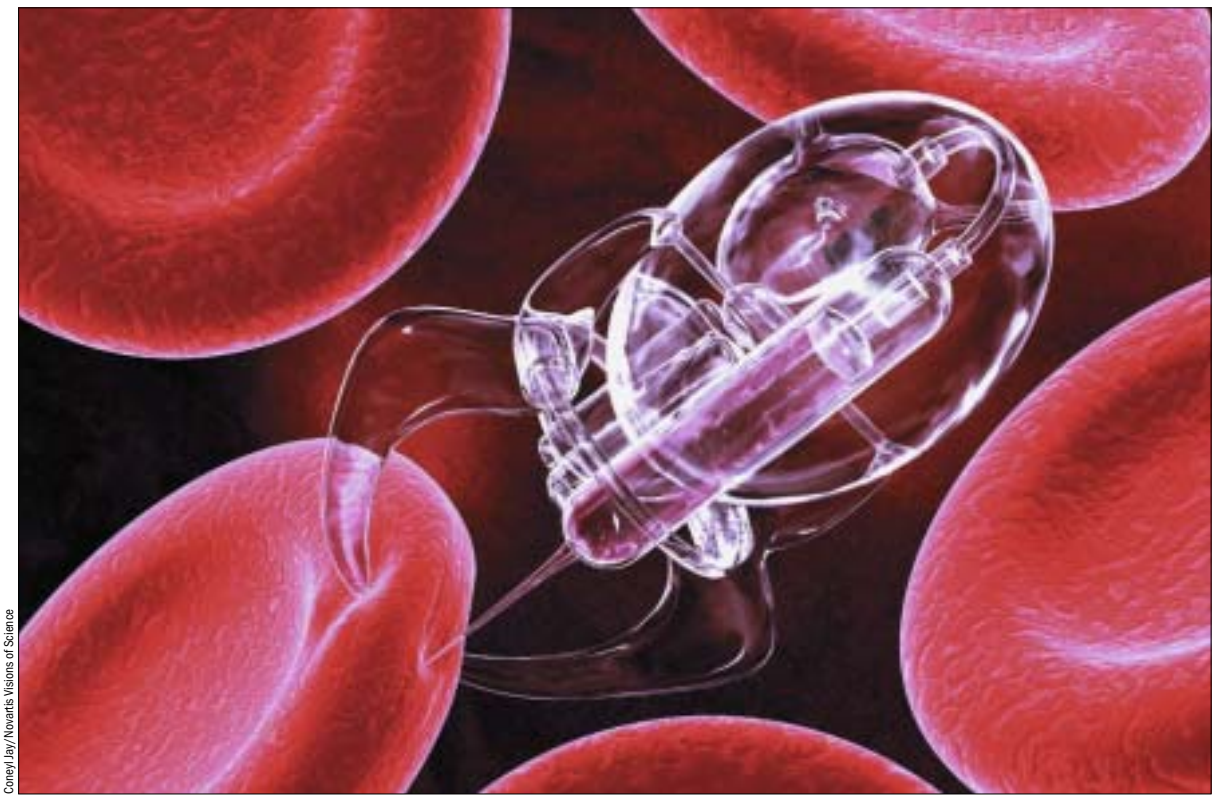
Ayala Ochert asks why nanotechnology is suddenly at the top of everyone's agenda.

This time last year, just as newspaper headlines were warning that the world would end in "grey goo", science minister Lord Sainsbury commissioned a report into the potential benefits and risks of nanotechnology for society. Led by the Royal Society and the Royal Academy of Engineering, a nanotechnology working group has spent the year in consultation with scientists, environmental groups and the public and is about to issue its final report.

The consultation is one of the biggest and most in-depth, but it is by no means the only recent investigation of its kind. In the last few years there has been a proliferation of meetings, hearings and reports by governments and civil-society groups.

Last May the Institute produced its own report, *Nanotechnology: Planning for the Future Now*, and in March it organised a hearing on the subject at the European Parliament. Physicists have, of course, been talking about the science of nanotechnology for decades – Richard Feynman famously predicted its emergence in his 1959 talk "There's Plenty of Room at the Bottom" – but now it's also a hot topic outside the lab.

This new attention may not be quite what scientists had been hoping for – discussion has focused on nanotechnology's potentially negative consequences, and people have begun asking whether it could be "the next GM". Nevertheless, Ann Dowling, chair of the nanotechnology working group, is hopeful: "A number of the groups we talked to said that now is the time for various forms of public engagement on nanotechnology and that with GM any consultation happened too late. But nanotechnology is not quite developed enough to be in the marketplace, so no-one's got preconceptions about it."



Coneyl Jay/Novartis Visions of Science

Nanobots that cure disease may be science fiction, but nanotechnology could be used for targeted drug delivery.

Given the huge sums being invested, it's not surprising that nanotechnology has come under close scrutiny.

"Grey goo" panic

The alarm about nanotechnology was first raised last January by the ETC group – a Canada-based environmental organisation – in its report *The Big Down*. It focused on the frightening potential of nanotechnology to create a so-called "grey goo" scenario. First highlighted by Eric Drexler in his influential 1986 book *The Engines of Creation*, this is the possibility that self-replicating nano-sized robots could reproduce out of control, eventually using up all carbon-based material on Earth until nothing remains but grey goo. The report also called for a complete moratorium on the commercial production of nanomaterials. Last April, after reading it, Prince Charles expressed his concerns about nanotechnology to the Royal Society.

Drexler's ideas also inspired *Jurassic Park* author Michael Crichton to write his 2002 novel *Prey*, in which the world is terrorised by self-replicating nanobots. But Drexler himself is much more interested in the potential of these tiny "assemblers" to create any conceivable product at virtually no cost, and he has recently backed away from the "grey goo" idea (see p2).

Most scientists involved in nanotechnology research think that the focus on nanobots is unrealistic – they are far off in the future if they are feasible at all. But they do believe that there is the potential for significant benefits from nanotechnology, especially for the economy. Already nanomaterials are being used to make materials that are ultra-lightweight and strong or with special properties, such as stain resistance. Clinical trials are under way using nanotechnology for targeted drug delivery, and there are expectations that it will lead to even smaller and faster computers with larger memories.

Predictions like these have attracted governments to invest heavily in nanotechnology in the hope that it will help them gain competitive advantage in the global marketplace. The U.S. National Nanotechnology Initiative includes £2 bn a year, Japan will spend £650 m this year, and the Sixth European Framework programme has set aside £850 m over four years for nanotechnology research. Given the huge sums being invested, it's not surprising that nanotechnology has come under close scrutiny.

Despite the early hype there are signs that the discussion has evolved – away from "science fiction" scenarios and towards more immediate risks and benefits. Last July, Greenpeace commissioned a report on nanotechnology from Imperial College, London. It concluded that nanotechnology could lead to more environmentally friendly technologies, but also voiced concern over the potential toxicity of free nanoparticles and called for a moratorium on their release.

Evidence has been accumulating that nanoparticles could be hazardous to health, and there is general agreement that something should be done to contain them. Vyvyan Howard, a toxicologist at Liverpool University with an interest in nanotechnology, points out that nanoparticles behave differently from bulk chemicals and argues that they should be given their own chemical classification number for the purposes of regulation.

While industry may resist any such regulation, Howard believes it is inevitable: "We can all appreciate what the benefits of nanotechnology might be, but we do have to make sure that we're not creating a public health problem. It's in everybody's interests, including industry's, that we get it right."

Reflections, p4

CONTENTS

"A negative reaction to nanotechnology is not inevitable."
Alan Irwin, p4

"I look back now and think: how could I *not* have liked it? It's just so interesting and so fundamental."
Laura Grant on physics, p5

"I wish I had never used the term 'grey goo'."
Eric Drexler, p2

HIGHLIGHTS

Not the end of the world after all

Civilisation is safe, according to Eric Drexler, writing in the August issue of the Institute journal *Nanotechnology*. Drexler has finally put to rest the idea that nanotechnology must involve the creation of dangerous self-replicating machines, as he first warned in his 1986 book *Engines of Creation*. The book, and its infamous talk of "grey goo", spurred fears that have hampered rational public debate about nanotechnology (see p1).

"Self-replicating machines aren't necessary for molecular nanotechnology, and aren't part of current development plans," wrote Drexler in the paper *Safe Exponential Manufacturing*. Later, talking to the science journal *Nature*, he said: "I wish I had never used the term 'grey goo'." Reports based on the article also appeared in *The Times*, the *Guardian*, the *Manchester Evening News* and *The Scotsman*.

Nuclear power goes green

James Lovelock, creator of the Gaia hypothesis, surprised environmentalists with his 24 May front-page article in *The Independent* arguing that only nuclear power can halt global warming. Lovelock said that opposition to nuclear energy is based on "irrational fear fed by Hollywood-style fiction" and entreated his friends in the Green movement to drop their "wrong-headed objection to nuclear energy". He wrote that there is "no chance" that renewable energy sources can provide enough energy in time. Many scientific bodies, including the Royal Academy of Engineering and the Institute of Physics itself, have recently come to the same conclusion.

Giving physics a whirl

A new website for students and schoolteachers is making dull physics lessons a thing of the past. Published by the Institute, *resourcefulphysics.org* contains many fun experiments involving everyday objects – such as seashells, hosepipes and chocolate blancmange – to bring physics to life for 11 to 18-year-olds. A favourite at the Institute is "spin the penny" – it involves opening up a wire coat hanger to form a square, balancing a penny on the tip of the hook, and then spinning the whole thing round while trying to keep the penny in place. It's harder than it sounds, but nicely demonstrates the concept of centripetal force.

Keith Jones, head of physics at Rhyl High School in North Wales, said he uses the website to liven up his lessons: "I test the experiments out in the staffroom and get other teachers to join in – the arts teachers love them as much as the science teachers!"

Fuelling the hydrogen revolution

The world's energy needs are set to double by 2050, and the heat is on to come up with energy sources that won't pump out huge quantities of greenhouse gases. High on the list are hydrogen power and fuel cells, and the Institute is doing its part to hasten their arrival with the publication of *The Fuel Cell Review* (http://fcr.iop.org), a new bimonthly magazine that is aimed at engineers, scientists and industry experts.

The launch issue contains in-depth features on the latest hydrogen-storage materials, telecoms companies' plans to use fuel cells for back-up power when the lights go out, and details of the US Army's evaluation of portable fuel cells for the battlefield. It also has all the latest news on research and development in this exciting and important new area.

www.iop.org/news

Regions are key to innovation

On 11 May, Lord Sainsbury delivered the keynote speech at the Institute's second Key Insight Business Briefing. The event was "standing-room only" as business partners flocked to Portland Place for the chance to listen to – and quiz – the science minister and a distinguished panel, which included second keynote speaker Sir Tom McKillop and Lord Oxburgh, chair of the House of Lords science and technology select committee.

Speaking on the topic of Science, Enterprise and the Regions to the Business Partners Network, Sainsbury emphasised the importance of innovation, which he defined as the "successful exploitation of new ideas". He argued that innovation is crucial for Britain's success and that the regions are vital for successful innovation.

In outlining his vision of Britain as a "key hub in the global knowledge economy", Sainsbury explained that now is the time for action. On the one hand, he said, we have the challenge of globalisation – Britain must compete with countries like Korea, where labour costs are half of those in the UK but the level of education is about the same. On the other hand, the opportunities presented by developments in science and technology enable "high added-value" businesses.

Lord Sainsbury drew a distinction between the generation of scientific knowledge and its exploitation. "Peer review on a national basis is undoubtedly the best way of maintaining the excellence of the science base," he argued, but concluded that the funding of knowledge-transfer initiatives – such as the creation of high-tech business clusters, science parks and technology incubators – is best handed over to the regions.

Sainsbury spoke of the good work already being done by the Regional Development Agencies (RDAs) in encouraging collaboration between businesses and universities. He also noted that, without prompting from government, the RDAs were already spending a considerable amount on science-related activities – to the tune of £250 m in 2002/3. "This is something we are keen to encourage," he said. Many RDAs have established Science and Industry Councils and, by the end of 2004, there will be one in every region of the UK.

The speech drew heavily on the government's Innovation Report, which was published last December. It recommended the development of a Technology Strategy to set priorities and goals for the future, which is due to be published this summer.

http://industry.iop.org

Sir David Wallace, president of the Institute, and Jocelyn Bell Burnell, president of the Royal Astronomical Society (RAS), signed a new collaboration agreement at a ceremony at 76 Portland Place, London, on 11 May. The agreement encourages greater co-operation between the two organisations at every level and opens up a route for fellows of the astronomical society to become chartered scientists through the Institute.

ARM rings a bell with members

The Annual Representatives Meeting (ARM) was held on 12 May at the Institute's London headquarters. Sixty-five members – drawn from Council, the branches, groups and divisions – attended the all-day event to give their input on Institute affairs.

The two main themes discussed were Einstein Year and the Institute's policy positions. The representatives generated numerous ideas for ways that branches, groups and individual members could take part in Einstein Year. Suggestions included holding an event for 11 to 14-year-olds on the physics of bell-ringing, and producing posters for hospitals explaining medical physics.

As a result of requests made at the meeting, the Institute will be developing a series of "template talks" on physics-related topics that members can deliver to groups in their community.

Representatives also came up with a list of issues where they felt that the Institute should develop policy positions. These ranged from mobile phones and waste management to the implications of the expansion of the European Union and the role of physics in wealth creation.

"The policy department is always looking for topics for seminars and reports, and plans to solicit ideas from the membership as a whole on a more regular basis," said Philip Diamond, assistant director, education and science. To achieve this, Diamond plans to recruit new members to the Science Policy Advisory Group, which helps steer Institute policy.

Einstein Year gets a theme tune

An East London rapper is helping promote Einstein Year, reports **Dianne Stilwell**.

Einstein Year has attracted some venerable backers – Lord Sainsbury, Sir Patrick Moore, Sir Harry Kroto. It can now add another, somewhat less expected name – rapper DJ Vader. The 22-year-old John Vader, who hails from Tower Hamlets in London, has written a "relativity rap" that the Institute plans to use in its promotion of next year's events.

The Einstein Year team at the Institute came across DJ Vader's song *Einstein (not enough time)* on his website (www.vadercrewkiller.com) and asked if they could use it to help make physics and Einstein accessible to a young and streetwise audience.

"I was looking on the Web for songs that have been written about Einstein to help make the topic more relevant to young people," said Caitlin Watson, Einstein Year coordinator. "I came across the Vader track and thought: this is something really different. Next year we are going to be taking physics across the country and we hope that this track by DJ Vader will help bring the subject to new areas and new people." The team also plans to use the track as background music for a computer game that they are creating for Einstein Year.

DJ Vader was inspired to "mix" his record after spotting a quote from Einstein on a greeting card in a record shop. It read: "When a man sits with a pretty girl for an hour, it seems like a minute. But let him sit on a hot stove for a minute and it's longer than any hour. That's relativity."

"I thought, yeah, I like that, and I jumped on the idea," explained Vader. "My song is about a boy who wants more time with his girl. He wants to travel at the speed of light – because that's when time freezes – so he can spend more time with her."

DJ Vader hopes that his music will inspire young people to be more interested in learning about physics.

When he's not making music, Vader works with teenagers who have behavioural problems in Bow, East London, so he was delighted when the Institute got in touch. "I didn't really pick up on this at school. But stuff like light speed and time-travelling are pretty cool. If my music helps get kids interested in learning then that makes me happy. I was naughty when I was at school – I was suspended 15 times and expelled once – but that is a bad waste of education," he said.

The Institute has identified young people, especially 11 to 14-year-olds, as its main target audience for Einstein Year, and encourages members to get involved by arranging local activities for schools, youth groups and other community-based organisations. "Einstein Year will only be a truly national event if everyone gets involved," said Institute chief executive Julia King. "We really want all the members to think about what they can do to help communicate their passion for physics."

www.einsteinyear.org

Einstein Year grant scheme, p6

Institute plaque salutes inventors

An Institute of Physics commemorative plaque was unveiled on 10 June at the former site of the old Ediswan Lamp Works in Ponders End, north London. The plaque recognises Sir Joseph Swan, inventor of the incandescent lamp; Sir James Dewar, inventor of the vacuum flask; and Sir Ambrose Fleming, inventor of the diode valve. The idea for the plaque came from Dennis Hill, a member of the London and South East branch.

Science: a step ahead of crime

By Michelle Cain

Image matters more than substance when giving scientific evidence in court, according to Allan Jamieson, speaking at the seminar "Science and crime: keeping one step ahead", which was held at the Institute's headquarters on 10 June. The event was jointly organised by the Royal Society of Chemistry, the Institute of Biology and the Institute of Physics to highlight to policy-makers the key role of science in law enforcement.

"The more confident the expert appears, the more likely it is that the jury is going to believe them," said Jamieson, director of the Forensic Institute. "Dabble in this field at your peril, because it's not the science alone that determines if you're a good forensic scientist. You must be able to communicate that science to a jury." Standards already exist for the sort of evidence that can be presented in court. But Jamieson says that it is vital that similar standards are set for the way that evidence is presented. "In my opinion, there are very few occasions where it is more important that the public understands science than when they sit on a jury and have to adjudicate the evidence that's being touted by experts," he said.

Alan Pratt, a senior Home Office scientist, spoke to the policy-makers about how physics has revolutionised the way the police combat crime. Imaging systems have revolutionised fingerprint identification, which was extremely time-consuming when carried out manually. "Less lethal" weaponry based on physics has been developed – for example, the tasers that have been trialled by the UK police. Physics is also crucial in protecting against terrorism, says Pratt, because it can be used to design buildings that are explosion resistant.

Ethics was a theme of several of the evening's talks. Among the questions posed was: does CCTV impinge on the public's right to anonymity and, if so, is this a small price to pay for a powerful tool in the fight against crime? The seminar also heard that that police in the UK can add those arrested (but not convicted) to their national DNA database. This is something that few people are aware of, said Gloria Laycock of the Jill Dando Institute of Crime Science, who chaired the seminar. She pointed out that approximately one-third of all middle-aged men have a criminal record, so this issue is not one that just affects serious criminals.

IN BRIEF

● **Mike Boswood** has been appointed non-executive chairman of the Institute of Physics Publishing. The president and chief executive officer of Thomson Legal & Regulatory International, Boswood is the first person from outside the Institute to be appointed to the position. He has held several senior posts at Elsevier Science.

● On 9 June **Julia King**, chief executive of the Institute, officially opened the David Bullet Laboratory for Nanofabrication at the University of Bath. The facility, which was funded by the Royal Society and the Wolfson Foundation, will house a state-of-the-art clean room. The building was named in honour of the late David Bullet, former head of the physics department at Bath.

● Small but successful physics-based companies were showcased at a meeting of the Institute's **Business Partners Network** on 7 June. At the meeting, "Successful SMEs, spin-outs and start-ups", firms spoke of the importance of managing intellectual property and the need to work with other companies, particularly those with expertise in marketing and distribution – an area of weakness for many technology start-ups.

NEWSMAKERS

On 13 June **David Wallace**, president of the Institute, received a knighthood for his services to UK science, technology and engineering. **Anthony Leggett** of the University of Illinois, US, received a knighthood for services to physics. **John Pendry** of Imperial College, London was also knighted for his services to science. Other Institute members recognised with MBEs were **Malcolm Jones** (for services to the defence industry), **Peter Smith** (for services to scientific administration), and **Vince Smith** (for services to physics). **John Mainstone**, of the University of Southern Queensland in Australia, was also awarded the Order of Australia Medal for his services to education in the fields of physics and atmospheric research.

On 28 May the Royal Society announced the election of 44 new fellows. Among them were **Donal Bradley** and **Edward Hinds** of Imperial College, London; **Malcom Longair** of the Cavendish Laboratory in Cambridge; and **Alan Martin** of the University of Durham.

Heather Reid, a.k.a. "Heather the Weather", the face of BBC Scotland's weather reports, has won this year's Chairs of Branches prize. Reid has been an active member of the Scottish branch and has worked tirelessly to promote interest in science over the last decade, particularly to children.

Is nanotechnology the next GM?

Alan Irwin

"The physics community must engage positively with the public and not appear dismissive or remote."

Amid all the excited talk about nanotechnology, there is one issue that just won't go away: how will the wider public react to these new research proposals and applications? Putting it more bluntly, will nanotechnology become the new GM, generating public scepticism, political uncertainty and contentious decision-making? Lord Sainsbury recently reassured the House of Commons select committee on science and technology that the government was "trying to learn the lessons" from GM food. But what are these lessons and can they really be learnt? I believe that social science has some insight to offer here.

As a social scientist, and having conducted empirical research into public attitudes to science and technology, my first response is that a negative reaction to nanotechnology is not inevitable. The public is not simply anti-technology, as a quick comparison between responses to information technology and the GM issue will confirm. The question then is: why a broadly positive assessment of one technology and a sceptical evaluation of the other?

In November 2000 a report from Lancaster University noted that the public saw information technology as user-friendly (at least for some of us), under the control of the individual, visible and external to the body, susceptible to effective regulation and offering clear personal benefits. GM technology, meanwhile, is often seen by members of the public as invisible, internal to the body, not susceptible to individual control, and offering benefits to industry but not necessarily to the consumer.

Statements that there are no known risks lead the wider public to ask about the unknown risks – about the limits to current knowledge and understanding. Trust also plays an important role in the public's assessment of new technologies. In the case of GM food, routine scepticism was expressed about the motivations and interests of government, scientific and industrial bodies, as well as those who claim to speak for "the public".

Nanotechnology appears to have certain features in common with GM, but the way that issues are framed and presented is very important. What this means for the physics community is that it must engage positively with questions from the public rather than appearing dismissive or remote. There can be a certain tendency for scientists and engineers to fall back into familiar habits – expressing irritation with the mass media and its high-profile statements of the "grey goo" variety and with the general lack of "public understanding" of science. It is just a short step from there to the adoption of what can seem to be a defensive posture: criticising the media for its irresponsibility, making apparently patronising statements about public ignorance, and asserting that only the experts really understand the issues.

However, these are early days for nanotechnology. Many people have not even heard of it, let alone formed a well rounded opinion of the costs and benefits. Nevertheless, it is reasonable to predict that, as with GM technology, questions will be asked about its ethical implications (especially regarding health and the human body), its controllability, its long-term effects, its known and unknown consequences, and its impact on our quality of life.

My experience of this field suggests that responses will not all be negative. The possibilities for medical progress and improved quality of life are likely to be well received. In contrast to certain sections of the media, members of the public generally express rather measured and tentative views on science and technology. They see themselves as asking reasonable questions and looking for reassurance. It would be highly damaging for the future of nanotechnology if such hesitant contributions were treated as an attack on science or a matter for high-handed dismissal.

The select committee made its own recommendations for the way forward, including calling on scientists to make themselves heard within these discussions. This is quite right; this as a societal debate within which scientists should assume a major role. Too often scientific organisations stand apart from the discussion or adopt the role of impartial referee rather than key player. Institutions are also inclined to view public comments and assessments, no matter how cautiously expressed, as a challenge or threat to science – even as anti-science – rather than a necessary part of social and technological progress. Public discussion should not be viewed as a "one off" – as a hurdle to be cleared before getting on with the race. This is not about quick-fix solutions; it is a long-term process of intelligence gathering, improved interaction and thinking ahead before problems arise.

Will nanotechnology be the next GM? Only if we fail to learn these lessons from the past.

Alan Irwin is professor of sociology and pro-vice-chancellor for research and enterprise at Brunel University in London. In September he will move on to the University of Liverpool to become dean of social and environmental studies.

focal point: diversity

Not just a women's issue

It is a disappointing fact that the proportion of women in the UK studying physics and in physics-based employment remains low – at best, women make up just 20% of A-level and undergraduate students. And the proportion gets lower still with increasing seniority – the so-called "leaky pipeline" effect. Although numbers are starting to rise, in 2000 just 4% of physics professors in the UK were women. Yet the consequences for the subject as a whole are far-reaching. It is not simply a matter of equal opportunities, there is a pressing need for a general "brain gain" in physics in this country.

Back in May of last year, the Institute formally launched the Women in Physics programme, a new initiative to address – in a focused manner – the under-representation of women. I was soon appointed as programme leader and, together with Council's **Women in Physics policy committee**, I've spent the last year starting to look at the reasons behind the trend – which is not universal to all countries – and to come up with ways to reverse it.

We have been busy linking up with other stakeholders, including the Royal Society, the American Physical Society and the **Athena Project**. We recently completed a survey of 1000 Institute members, which revealed that only 40% of those taking a career break – usually to have children – returned to their employer.

The shortage of women is, of course, just one part of a much wider problem: a general lack of diversity in physics. According to Universities & Colleges Admissions Service statistics, fewer people from ethnic-minority backgrounds choose to study for a degree in physics than any other science subject. (The issue is not quite that simple, though – some African and Asian ethnic groups are actually over-represented in physics. Clearly, more research is needed here.) Another important issue we need to address is the accessibility of physics to people with disabilities.

Improving all forms of diversity is a high priority for the Institute. So, in April of this year, Council agreed to formalise its commitment, and the Women in Physics programme and policy committee evolved into the **Diversity in Physics programme** and policy committee. Our new mandate is to understand – and work to remove – the barriers to entering physics that face people from ethnic-minority backgrounds and to explore the particular problems facing people with disabilities. This does not imply any lessening of our commitment to the issue of women in physics – we will continue to give it our staunch attention.

We've only just begun and there is much work ahead for the Diversity programme. But we're looking forward to a future where anyone with the interest and the talent has the opportunity to become a physicist. When that time comes – and I hope it isn't too far away – we'll all be better off.

Wendy Kneissl is the Institute's Diversity in Physics programme leader. For more information visit http://diversity.iop.org.

profile: Laura Grant

One-tenth education, nine-tenths inspiration

A woman on a mission to change the image of physics.

By Ayala Ochert

Ron Davies Photography

A model physicist: Laura Grant shows children that physics can be fun.

"I hated physics at school," says Laura Grant, then she thinks better of it. "Actually, 'hate' is too strong a word. Let's say I found it 'quite dull'." However she puts it, the 23-year-old admits that it's an odd thing to say considering that she then went on to study physics at university. But once there, says Grant, "I fell in love with it". Now she's made it her job to help children realise what she only discovered once she'd left school – that physics is, as she puts it, "brilliant". She is currently working on a PhD to identify new ways to change attitudes towards physics.

Grant had been turned down for vet school, but on the day her A-level results came through she got a call from Liverpool University: would she like to study physics instead? Surprised, and not a little flattered, she went along to check out their physics department. "Physics wasn't even on my radar screen because I hadn't done maths A-level," recalls Grant. "But then I discovered that a lot of the stuff that we did in chemistry at school, and which I was inherently interested in, actually turned out to be physics."

She took the plunge, but without maths her first year was tough. She had caught up by the second year and was starting to really appreciate physics. Before long her attitude towards the subject had completely changed. "I look back now and think: how could I *not* have liked it? It's just so interesting and so fundamental," she says.

As an undergraduate Grant began to take part in physics outreach projects and, during the summer of her second year, she took part in a touring "science show". Although the shows were just for fun – they included sketches like *Who Wants to be a Scientist?* (based on the TV show *Who Wants to be a Millionaire?*) and a "physics karaoke" – they seemed to have a real impact. A teacher at one school later reported that the uptake for physics A-level the next year was the highest they'd ever seen. Impressed, Dominic Dickson, head of the science communication unit in Liverpool's physics department, asked if she would like to stay on for a PhD, evaluating science shows and talks. She agreed.

"I'm looking at shifts in the affective and cognitive domains, which basically means shifts in attitude and understanding," explains Grant. Alongside her PhD work, Grant has also set up her own firm – GetSet – which she uses to tour the country, giving talks, doing shows and developing new ways of inspiring children of all ages about physics.

Passionate about physics

Grant clearly loves what she does, which makes all the difference. In 2003 she became one of the Faraday Lecturers for the Institution of Electrical Engineers and developed a talk on forensic science. And in 2002 she was awarded the Institute's own Physics Communication Fellowship. Out of that came "Too Hot to Handle", a talk on fusion for 14 to 16-year-olds. Though it's a challenging subject for that age group, they do get it, she says. "I don't think you have to dumb things down; in fact, I think that's the worst thing that you can do because that age group does not respond well to being patronised." In the main, though, her work is not so much about education as inspiration. "I've never trained as a teacher and I don't go around telling teachers how to do their job. What I do is primarily for entertainment. If they learn something as well, that's just a bonus," she said.

"I don't go around telling teachers how to do their job. What I do is primarily for entertainment."

Grant's unusual route into physics isn't the only thing that sets her apart from the crowd. A female physicist who has also been a model, she's far from the stereotype many people have of scientists – a fact that helped her get chosen as a role model by NOISE, a campaign funded by the Engineering and Physical Sciences Research Council to raise awareness of science among young people. Modelling wasn't nearly as much fun as physics, she says, and she has no plans to do any more in the future. (Yet, much to her annoyance, when her picture appeared in the newspapers a couple of years ago – she was the girlfriend of Craig Phillips, the winner of the first series of Channel 4's *Big Brother* – the caption read: "Laura Grant, model", not: "Laura Grant, physicist".)

Next year she embarks on a visiting fellowship at Graphic Science, a communications company based at the University of the West of England, where she'll continue her evaluation of science events. While her life so far hasn't exactly gone according to plan, she has no regrets: "Everything's turned out so well for me. I'm really enjoying what I'm doing right now and I feel I've landed on my feet," says Grant. "I think I would have been bored as a vet."

OBSERVATIONS

Chris Poole is a DPhil student in Oxford. In March he spent a week at the 49th European Study Group with Industry, where industrialists pick the brains of some of the best mathematicians.

Monday

Normally on a Monday morning I'd be in my office on Little Clarendon Street, but today, like dozens of other applied mathematicians, I took a detour to Oxford's Mathematical Institute for "the mother of all study groups".

The day began with presentations from the industrialists. One in particular piqued my interest – Thermal Ceramics UK, who make insulators for use in industry, were having problems with their fibre production. Their existing set-up involved blasting a jet of high-temperature "melt" onto a rapidly rotating cylinder. The trouble was that this produced unwanted "shot" – tiny spherical beads of glass.

I came to my first study group last year so I had an idea what to expect. Back then I worked on a problem involving bubbles in ice cream, which made use of mathematical techniques I know something about. I knew this ceramics problem would be more of challenge as I was less familiar with the maths. In the afternoon I started out on the melt problem. A brainstorming session had begun – as a PhD student I was a bit intimidated at first, but I soon started throwing my own ideas into the hat. Could a Rayleigh-Taylor instability be causing the shot to develop, we wondered? At dinner, and later at the Royal Oak pub, the discussion continued.

Tuesday

I poked my head into one of the other rooms, but after coffee returned to the "melt" room – only to discover that everyone was out in the car park. My supervisor Jon Chapman had attached a drill to a tin and was pouring water onto it as it rotated. The others looked on to see what would happen to the water. We repeated the experiment with washing-up liquid, which we had worked out has a Reynolds Number close to that of the melt. (Intriguingly, it didn't fly off as a mist, but coated the drum and then came off as a jet or sheet.)

The day concluded with a highly entertaining talk on brewing by Adnams. They shone a white light through a glass-ended barrel and posed an interesting mathematical problem: why did the beer in the barrel appear bright red? The Tyndall effect was mooted as a possible culprit, the beer acting like the sky in a Hawaiian sunset.

Wednesday

Back in the melt room we tried to reconcile what we'd seen in the car park with our predictions. Someone suggested that a good analogy for the behaviour of the melt was treacle dripping from a ceiling. We continued through the afternoon before meeting up for a mid-week progress report. After dinner we turned our minds to wider issues with a debate on ethics in mathematics.

Thursday

There was much frenetic writing as we got ready for our presentation on Friday. Later, those of us who still had the energy retired to the Royal Oak for last orders.

Friday

Today the industrialists returned for their results. They all seemed pleased with our progress – Thermal Ceramics told us they could build on our ideas. The National Air Traffic Service were particularly happy: the mathematicians showed them that one of their key assumptions was totally wrong! After a gruelling week I left with a sense of relief, but also a sense of achievement. It had been tiring but enjoyable, and certainly different from my usual routine. Now what is it that they say? A change is as good as a rest? Well...perhaps.

Would you be interested in a physics study group? If so, please contact **Sue Fryer** at sue.fryer@iop.org. If you'd like to write about your experiences for **OBSERVATIONS**, please e-mail interactions@iop.org.

interactions

Editor Ayala Ochert, **Senior Production Editor** Laura Churchill, **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://members.iop.org

LETTER FROM

...the editor

Welcome to the first edition of *Interactions*, the new member newspaper of the Institute of Physics. I hope you enjoy it.

Communicating with members has always been among the Institute's highest priorities. In the 1940s the wartime *Notes and Notices* was spawned to keep members informed about Institute activities. Over time it became *Physics Bulletin*, which then transformed into *Physics World* in 1988. A decade and a half on, *Physics World* is bursting at the seams with the latest advances in physics, and the Institute now publishes six other magazines and more than 40 journals.

As physics has grown, so has the Institute, and the four short pages of Institute Matters merely scratched the surface of the Institute's many activities. So the idea for *Interactions,* a fully fledged member newspaper, was born. Whether it's Lord Sainsbury speaking to our Business Partners Network (p2), a rap artist getting on board with Einstein Year (p3), or our commitment to opening up physics to everyone (p4), *Interactions* aims to keep you informed about everything the Institute is doing. We also plan to keep you up to date with issues that matter to the entire physics community, like the future of nanotechnology (pp1 and 4).

One of the Institute's objectives, set out in the Strategic Plan 2004–2008, is to "engage and support the whole physics community". In this spirit, we've included an experiment on our back page to help members inspire children about physics. And, as physicists know better than most, grown-ups need to have fun too, so there is also a puzzle for you to get your teeth into. If that's not challenging enough for you, why not send in one of your own? You could win a bottle of champagne or your choice of £30 worth of Institute of Physics merchandise (including the rather stylish t-shirts pictured on the right).

As its name suggests, *Interactions* wants to hear from you. So, whatever it is you are doing – whether you are active in research, working in industry or, like Laura Grant (p5), spreading the word about physics to young people – drop us a line. You can post personal news on our noticeboard (p7) or write a letter for this page. We'd love to hear what you think about this first issue and hope you are looking forward to the next one in September.

Ayala Ochert is editor of *Interactions*. You can contact her with letters, comments and ideas at interactions@iop.org.

All in the family

My husband, daughter, her husband and two of my granddaughters are all scientists – three of them physicists. For my recent birthday, instead of presents I asked for cash so that I could help the Institute with its planned bursary scheme for physics students. The country badly needs physicists, and at my age I need no more objects to collect dust. I enclose a modest cheque.

Marjorie Leigh-Dugmore
Sutton Coldfield, West Midlands, UK.

Member benefits

During a recent visit to London I visited the headquarters of the Institute of Physics and was made most welcome. All my requests were attended to speedily and efficiently. I was very pleased to see the facilities available in the Members Room.

Ashe Kaufman
Jerusalem, Israel.

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.

Einstein Year Grant Scheme

Einstein Year is the UK and Ireland's contribution to the international celebrations marking World Year of Physics.

einstein year – Explore, Discover, Invent - Physics

Einstein Year is a unique opportunity to enthuse young people about physics and to highlight the contribution of contemporary physics to society.

To support individuals organising physics-based outreach activities during Einstein Year, the Institute of Physics is offering grants of up to £1500.

Application forms and further information for the first round of the Einstein Year grant scheme are now available online at www.einsteinyear.org/get_involved/funding. The closing date for the first round is 24 September 2004. The second round will be in early 2005.

OBITUARY

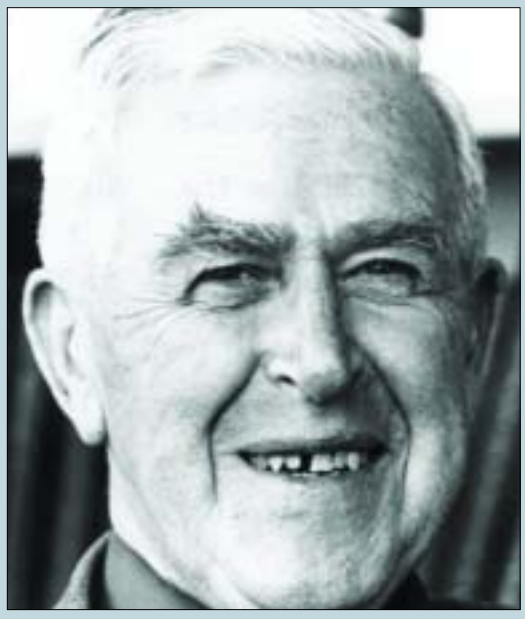
David Shoenberg 1911–2004

David Shoenberg was the first research student in the Mond Laboratory in Cambridge when it opened in 1933 and the last survivor of the pioneers who introduced low-temperature physics to England.

He was born in St Petersburg, the son of Isaac Shoenberg, an electrical engineer who installed the first radio broadcasting network in Russia. The family moved to England in 1914, when David was three years old, and in due course Isaac became research director at EMI, where he developed the world's first high-definition television system.

With encouragement from his father, David studied physics at Cambridge and in 1932 he graduated with a first-class degree from Trinity College. He immediately began working on single crystals of bismuth with Peter Kapitza at the newly built Mond Laboratory. But, in 1934, after a trip to Moscow, Kapitza was detained by the Soviets, and Shoenberg found himself without a supervisor. He continued his work on bismuth, in particular investigating the newly discovered de Haas–van Alphen (dHvA) effect – a low-temperature magnetic phenomenon, then thought to be an anomalous property of bismuth.

Shoenberg renewed contact with Kapitza in 1937 when he spent a year at his new institute in Moscow. Returning to Cambridge, he began work on superconductivity, a newly revived field of research. His work in this area – using a finely ground mixture of mercury and chalk to measure the depth of penetration of a magnetic field and its variation with temperature below 4K – remains a classic investigation.



Shoenberg: pioneer of low-temperature physics.

After the war, Shoenberg continued to work on superconductivity, this time as director of low-temperature research at Cambridge. He was aided here by Kapitza's old assistant Emil Laurmann and a keen following of new research students, myself among them. In 1952, after writing his influential book *Superconductivity*, Shoenberg's interest was aroused by Jules Marcus's discovery of the dHvA effect in zinc and its implication that the effect might be more generally observable.

He went on to develop several techniques to bring out the dHvA effect in numerous other metals. Perhaps his most important work was in the area of fermiology – using the dHvA effect as a powerful probe of the Fermi surface of a metal. He continued his work in this area until his retirement in 1978 – his 1984 book *Magnetic Oscillations in Metals* is a magisterial summary of the field as he left it.

Except for his visits abroad – he was an enthusiastic traveller and spoke fluent Russian – Shoenberg never left Cambridge. He was awarded the MBE in 1944 for his war work at the Mond and was made a fellow of the Royal Society in 1953. He was always available to give advice and was never ashamed to ask for it. He was kind and quietly humorous. David Shoenberg inspired affection among all who knew him, particularly his research students, who enjoyed the hospitality that he and Kate, his wife of 63 years, bestowed. He was still grieving her passing just seven months earlier when he died on 10 March aged 93.

Remembered by **Sir Brian Pippard**.

To get listed here, go to whatson.iop.org and submit your event

What's On in Physics is the Institute's online calendar for the physics community. It has information on the many interesting meetings, lectures and conferences held throughout the UK and elsewhere.

JULY 04

Electronics 2004 – various courses
University of Oxford Electronics & Telecoms, Oxford, UK
Check website for details of dates
www.conted.ox.ac.uk/cpd/electronics

Materials for Displays
Institute of Physics conference, London, UK
2 July
http://conferences.iop.org/MFD

Chemical Physics: Perspectives and Prospects for the Future
Institute of Physics Chemical Physics Group, University Paris-Sud (Orsay), France
5–8 July
www.chemicalphysics.org.uk

ICPE/SAIP International Physics Education Conference 2004
InterAction Conferencing, Durban, South Africa
5–8 July
www.interaction.nu.ac.za/icpe2004

Contact Mechanics
Institute of Physics Stress and Vibration Group, Bristol, UK
7 July
http://groups.iop.org/SV

Vibrational Spectroscopy
Gordon Research Conferences, Roger Williams University, Bristol, RI, USA
11–16 July
www.grc.org

Multi-Body Dynamics: Monitoring and Simulation Techniques
Wolfson School of Mechanical & Manufacturing, Loughborough, UK
12–13 July
www.lboro.ac.uk/mbd

22nd International Laser Radar Conference
ICLAS, Matera, Italy
12–16 July
www.imaa.cnr.it

Pattern Recognition, Detection, Classification and Monitoring
Institution of Mechanical Engineers, Liverpool, UK
13 July
www.imeche.org.uk

Contact–Collaboration–Co-ordination: A seminar on running multidiscipline projects
Institute of Physics Consultancy Group, London, UK
14 July
http://physics.iop.org/IOP/confs/CCC

Public speaking: Effective speechcraft
CustomerClix, London, UK
15 July
www.customerclix.com/Training_courses_london.html

Recycling Meeting
Institute of Physics Printing, Packaging and Papermaking Group, Aylesford, UK
15 July
E-mail w.sampson@umist.ac.uk

Effective Communications
Skillstudio Limited, London, UK
16 July
www.skillstudio.co.uk

Visit to Eskdalemuir Geophysical Observatory
Institute of Physics conference, Eskdalemuir Observatory, UK
17 July
http://conferences.iop.org/EGO

Faraday Discussion 128: Self-Organising Polymers
Royal Society of Chemistry, Leeds, UK
19–21 July
www.rsc.org

Commercialising Research for Nanomaterials
Institute of Physics (Industry & Business), London, UK
20 July
http://industry.iop.org

ISIS-IOP Theoretical Magnetism Meeting
ISIS & Institute of Physics Magnetism Group, The Cosner's House, Abingdon, UK
22–23 July
http://groups.iop.org/MA/events.html

11th International Conference on Intergranular and Interphase Boundaries
Institute of Biology, Queen's University Belfast, UK
25–29 July
www.iob.org

Driven many-particle systems – Hopping particles, granular media and colloidal systems
Max Planck Institute for the Physics of Complex Systems, Dresden, Germany
26–29 July
www.ica1.uni-stuttgart.de/~hans

AUGUST 04

Nanophotonic Materials
SPIE, Denver, USA
2–6 August
www.spie.org

Field Theory of Quantum Coherence, Correlations and Mesoscopics
Euro-Summer School on Condensed Matter Theory, Windsor, UK
9–22 August
www.lancs.ac.uk/users/esqn/windsor04

First Presentation Skills
Skillstudio Limited, Birmingham, UK
10 & 16 August
www.skillstudio.co.uk

Fifth International Symposium on classical and celestial mechanics
Dorodnicyn Computing Center & Moscow Aviation Institute, Velikie Luki, Russia
23–28 August
www.ccas.ru/CCMECH5

Fourth International Conference on Numerical Simulation of Optoelectronic Devices
UCSB, Santa Barbara, USA
24–26 August
www.engr.ucsb.edu/~piprek/nusod04

Physics by the Lake – Theory of Condensed Matter Summer School
Institute of Physics Theory of Condensed Matter Group, Ambleside, UK
29 August – 10 September
www.bath.ac.uk/physics/summer

Theory of Fusion Plasmas
CRPP – EPFL, Varenna, Italy
30 August – 3 September
http://crppwww.epfl.ch

SEPTEMBER 04

DICE2004
Castello di Piombino, Italy
1–4 September
http://omnis.if.ufrj.br/~thomas/DICE2004.html

Effective Communications
Skillstudio Limited, London, UK
3 & 20 September
www.skillstudio.co.uk

Advances in Experimental Mechanics
British Society of Strain Measurement, York, UK
6–8 September
www.bssm.org/conferences.asp

Photon04 is the largest optics event in the UK and the second in the series that began in Cardiff with Photon02. Photon04 is organised by the UK Consortium for Photonics and Optics (UKCPO). See www.photon04.org for more information.

Identification of Dark Matter
University of Sheffield, Edinburgh, UK
6–10 September
www.shef.ac.uk/physics/idm2004.html

Fourth Simulation and Modelling in Medicine
Institute of Physics & Engineering in Medicine, York, UK
7 September
E-mail j.g.truscott@leeds.ac.uk

Public speaking: Protocol for being a Master of Ceremony
CustomerClix, London, UK
9 September
www.customerclix.com/Training_courses_london.html

Fourth International Conference on Inorganic Materials
Elsevier & Solid State Sciences, Antwerp, Belgium
9–21 September
www.im-conference.com

International Conference of Numerical Analysis and Applied Mathematics
ESCMCE & TEI, Chalkis, Greece
10–14 September
www.uop.gr/~simos

DOSGEL 2004: Third International Conference on Radiotherapy Gel Dosimetry
Gent, Belgium
13–16 September
www.dosgel.org

Sixth Annual Conference of the Yugoslav Materials Research Society
Yugoslav Materials Research Society, Herceg-Novi, Montenegro
13–17 September
www.yu-mrs.org.yu

Filler Reinforcement of Rubber
Rubber in Engineering Committee of the Plastics & Rubber Board of the IOM3, London, UK
14 September
www.materials.qmw.ac.uk/reig

15th European Conference on Diamond, Diamond-Like Materials, Carbon Nanotubes, Nitrides & Silicon Carbide
Elsevier, Riva Del Garda, Italy
15–17 September
www.diamond-conference.elsevier.com

Fourth International Conference on Inorganic Materials
Elsevier & Solid State Sciences, Antwerp, Belgium
9–21 September
www.im-conference.com

Second International Conference on Materials Science and Condensed Matter Physics
Institute of Applied Physics, Moldavian State University, Chisinau, Moldova
21–26 September
http://phys.asm.md/mscmp2004

Tribology in Sport
Institute of Physics Tribology Group, London, UK
22 September
http://conferences.iop.org/TIS/index.html

notices

Announcements are free to Institute members. E-mail interactions@iop.org; write to Interactions,76 Portland Place, London W1B 1NT, UK; or fax +44 (0)20 7470 4991
Deadline for next issue: 30 July

NEW FELLOWS

Kwok Kwan Chan, Fred Kingley Elder, Gerard Francis Gilmore, Harry Jones, Fabio Marchesoni, Elisabeth Rachlew-Kallne, Richard Lloyd Rusby.

NEW MEMBERS

Adam Ajao, Michael Bowen-Jones, Will Branford, Demetris Charalambous, Cornelis De Groot, Stephen Field, Mark Ford, Nathan Goodman, Anew Thomas Harker, Rosemary Harris, Theodore Haywood, Katherine Mayes, Colin Mooney, Samuel Alexander Morgan, Huajiang Ouyang, Geoffrey Page, Ian Pedlar-Barnes, Anew Prins, David Scott, Enis Tuncer, Arie Van Bergen, Christopher Martyn Vann, James Wild, Anew Worrall.

IN MEMORIAM

Ian Sharp, Alexander Stark, Maria Yiannoullou.

COUNCIL MEETING

During their meeting on 22 July, Council will discuss the following: branch activities; progress on the Undergraduate Bursary Scheme (http://education.iop.org/Schools/suptstu/ubs.html); plans for Lab in a Lorry (www.labinalorry.org); international policy and the Institute's links with the International Union of Pure and Applied Physics, along with regular reports from boards and committees.

WANTED

- **Senior and chartered membership applications.** Professionals are needed to contribute to the peer-assessment process. If you are in employment, hold CPhys/CEng/CSci status and could contribute a few hours a month, please e-mail panel@iop.org.
- **SET Student of the Year.** Nominations are now being accepted for the SET Awards for science and engineering undergraduates. The competition is open to students who, at the time of entry, are on a first-degree course at a UK university. Nominations may only be made by a student's lecturer. The awards will be presented in September at a major event at the Guildhall, London. Deadline for entries: 23 July. See www.setawards.org/current_yr_awards.htm.

MEMBER NEWS

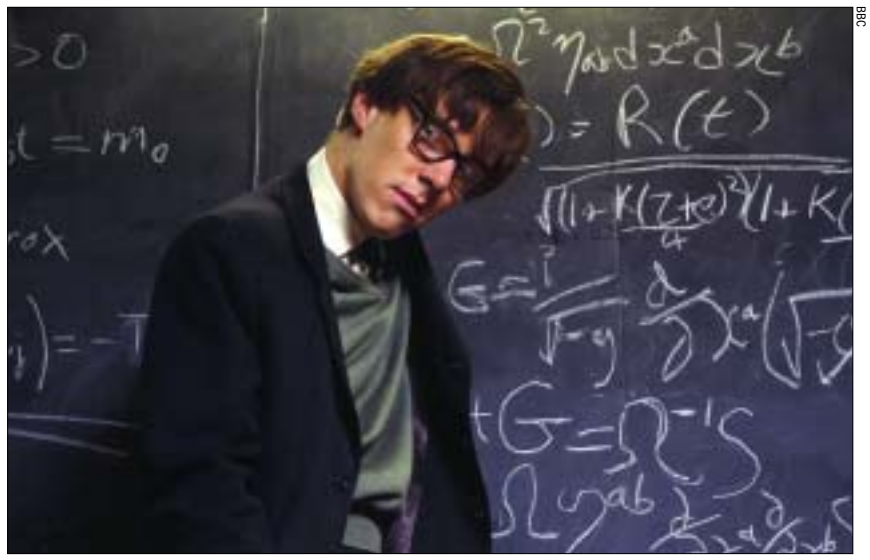
Moved department, retired or left the country? If you have any news to share with fellow members, drop us a line at interactions@iop.org by 30 July and we'll include it here.

FOR SALE/RENT

Free villa in Tuscany. Sounds too good to be true? That's because we made it up! But now that we've got your attention...if you have anything for sale or rent that you'd like to advertise to fellow members, contact interactions@iop.org.

From black holes to silver screens

A film director talks about the highs and lows of producing a television drama based on theoretical physics.


BBC

"Can't say black hole."
"What?"
"You can't say black hole. Definitely not. John Wheeler didn't invent the term until 1968 and this film ends in 1965. You have to say 'gravitationally collapsed object'."
"But that sounds terrible. And besides, everyone knows what a black hole is."
"Not everyone. The French don't. They can't even say the words. In French, 'black hole' means something obscene."

Making a film about theoretical physics and early 1960s cosmology was always going to be different from making conventional television drama, as I discovered for myself during the making of the film *Hawking* (broadcast on BBC Two in April). The film is set during the years 1963 to 1965 – the beginning of a golden age of cosmological discovery that transformed our knowledge of the universe around us.

Just as Hawking and a brilliant new generation of scientists were making sense of Einstein, showing that time (theoretically at least) might have a beginning, two Americans – Arno Penzias and Robert Wilson – were discovering the actual physical evidence of a hot big bang. And that wasn't all. During this revolutionary time in science, there was also great human drama. In 1963, as he was beginning his PhD at Cambridge, Hawking was diagnosed with motor neurone disease and given two years to live. The next two years see him coming to terms with his illness, struggling to find a PhD subject, falling in love with his future wife, falling out with Fred Hoyle and beginning his extraordinary collaboration with Roger Penrose.

Here was a fantastically rich and compelling story. But there was a fundamental problem: how to communicate these ideas? A drama written in the language of theoretical physics would be understood by a very small number of people. Our challenge was to stay true to the fundamental scientific ideas while transmitting these complex and counterintuitive concepts to an audience with no knowledge of the subject.

We began by talking to the people involved. In discussions with Stephen Hawking, Roger Penrose, Arno Penzias and Bob Wilson – sometimes wary, sometimes enthusiastic – the idea for *Hawking* began to take shape. In the process, the writer Peter Moffat, the producer Jessica Pope and I found ourselves listening to some extraordinary stories. Like Penzias's amazing escape from Nazi Germany to England on the Kindertransport trains – one of only 10 000 Jewish children who survived in this way. Or the mysterious clock in Roger Penrose's study at Birkbeck College, which one day decided to run backwards. Penrose failed to fix it but kept it on his wall to encourage his students to take a more broadminded view of time.

Moffat carefully wove such tales into his script. Sadly, some of the best ones had to be left out. The moment when Hawking's condition first became apparent to his family may have been a personal nightmare, but it was a film-maker's dream:

The winter of 1962–63 is the coldest for decades. Snow covers the whole of England. The lake at St Albans, where the Hawkings live, is frozen over. As hundreds of skaters race across the lake, Stephen Hawking collapses on the ice.

After Pope patiently explained that five minutes of snow and ice on this scale would eat up the budget for the whole 90 minute film, this part of the story was relocated, grudgingly, to the Hawkings' back garden.

But often the practical restrictions made for better drama. At one meeting Hawking insisted that he had never talked to any of his friends about his condition. This left us with a huge problem. Drama, unlike documentary, cannot employ a narrator to provide further information – people have to talk, otherwise the audience doesn't know what's going on. Moffat was confident that things would be fine – and he was right. In the finished film, Hawking doesn't discuss his situation with anyone, but the conversations of his friends and family provide all the information we need. The portrayal of Hawking, as well as being more true to life, is also richer and more dramatically effective.

Often the practical restrictions made for better drama.

The research and writing for *Hawking* took 18 months – then came the challenge of production. Staying true to our original ambitions for accuracy, Benedict Cumberbatch, the young actor who played Hawking, visited people with motor neurone disease and worked with a movement coach to refine his physical performance. On the shoot itself, Oisin MacConamhna, Hawking's PhD student, also helped us to get the scientific detail right. (If you freeze-frame the film you will see that the blackboards are covered in totally accurate and contemporaneous equations!)

In the end, four million viewers watched the film – the highest ratings for any BBC Two drama so far this year, let alone one about theoretical physics. To me, this demonstrates the public's appetite for challenging, complex stories. And I hope that we have helped to show viewers that physics is every bit as dramatic and exciting as any of the more usual subjects for drama.

Philip Martin is the director of the BBC Two drama *Hawking*, which was first broadcast on 13 April. Martin also directed the BBC series *Stephen Hawking's Universe*.

particles

Got the blues?

We were asked: Why does tonic water have a blue tinge?
We replied: Don't worry if your gin and tonic looks blue. It's not because you've not had one too many! Tonic water contains small amounts quinine, a bitter compound used in tablet form to prevent malaria. Quinine is also a good fluorophore, which means that it absorbs ultraviolet (UV) light (which we can't see) and re-emits it as blue light (which we can see). In other words, it fluoresces.

The phenomenon is not always easy to see because normal light bulbs don't produce much UV light, and the weak blue glow is usually swamped by the ambient light.

To get a really good view, fill a wine glass with tonic water, retire to a dark room and shine a torch beam through the glass. The effect is stunning! And, if you ever needed an excuse for a G&T, this is surely it.

From Physics Line, a service of the Institute of Physics for BBC Southern Counties Radio.

Shooting star

You are standing at the equator at sunrise. Where must you point a laser cannon to hit the Sun dead centre? (Assume that the Sun is stationary and the Earth's orbit around it is circular.)

The solution will be in the next issue (September). Don't send in your answers, but do send in your own physics puzzles (to interactions@iop.org). If yours gets published, we'll send you a bottle of champagne or £30 worth of your choice of Institute of Physics merchandise.