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The Student Newsletter of the Institute of Physics

WORKING ABROAD

A WORLD OF OPPORTUNITY

nexus news

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Institute of Physics PUBLISHING

Letter from the editor

Spring is upon us! As you start thinking about revising for the end-of-year exams, Nexus is arranging a strong timetable of events and trips over the summer to help you relax after the academic exertions.

If you fancy your breaks short, sweet and informative then come to Grenoble with us at the end of June (p3). Or if surfing and beaches are more your style, sign up for the next trip to the Eden Project in Cornwall (p3). In fact this edition has a bit of an overseas feel to it with an article from a student at Loughborough University on his year of work experience at Germany's Max Planck Institute (p8), and a piece arguing that developing countries have to play their part in space science (p7).

Well, it's been a long time since the last edition, and much has happened. Check out the review of the Young Physicists' Conference for 2003 (p10) and the results of the student society awards (p4).

The biggest news is that the Institute of Physics has decided to offer means-tested student bursaries of £1000 from 2006 to ease the burden of the new top-up fees. There's an article exploring the ins and outs of top-up fees on p5, but this doesn't mean that we think we have all the answers! Nexus wants to hear what you as physics students think about the subject.

The next edition of *Nexus News* will be out in June. E-mail me if you'd like to contribute an article or a book review.

Shavinder Kalcut, editor/student liaison officer

Contents

Cover image: Work placements and sandwich years make a world of opportunity available to you – don't miss out. See the cover story on p8.

Nexus makes a visit to Eden

Towards the end of last summer Nexus took a group of students to the Eden Project in Cornwall. The event proved so successful that Nexus is organizing another trip to the botanical paradise for the summer of 2004.

Our accommodation for the weekend was a little youth hostel on the edge of a cliff overlooking the sea and the beach. The trip began with an impressive buffet at a local pub called The Watering Hole, which happened to be situated on the beach in the picturesque town of Perrenporth. A steep climb up the hill to the hostel left the students with an appetite for breakfast the next morning made in true student style by members of the Nexus committee.

The Eden Project itself has two "Biomes". One contains a humid tropics climate consisting of plants and vegetation from rainforests and oceanic islands, while the other concentrates on warm temperate regions of the world. After a day exploring the domes, buying souvenirs and dodging the sprinklers we headed off towards Charlestown for dinner – home to a relatively unspoilt Georgian port and the backdrop to various pirate films.

Would you Adam and Eve it: the Eden Project.

Students work on topping up their tans.

The trip finished with a stint around St Ives the following day where students could do some sightseeing, visit the Tate Gallery or just sit on the beach.

For more information about the next trip to Eden e-mail shavinder.kalcut@iop.org.

Calendar of events

24–27 July

Nexus trip to Grenoble, France

Take a long weekend off in July with a trip to visit the Institut Laue-Langevin (ILL) and the European Synchrotron Radiation Facility (ESRF) in the south-east of France with like-minded Nexus members.

The trip will encompass a day visit to the centres on the Friday followed by a tour of the surrounding areas on the Saturday. The approximate fee for the trip will be £40 to include accommodation, breakfast, dinner and tours. All you need to pay for is transport out there and your lunch! For more information about the trip or to register your interest contact shavinder.kalcut@iop.org.

12–18 August

ICPS 2004

The International Conference of Physics Students takes place in Novi Sad, Serbia and Montenegro. To find out more see www.fizika-ns.org.yu/icps/index.html.

For the latest news of events, see http://nexus.iop.org/events/diary.html.

A past president says farewell

It seems like only yesterday that Sue Jackson (now Sue Fryer), then the Institute of Physics' student liaison officer, asked me to join the Nexus committee. In fact, when I finally stepped down from the committee at the recent annual general meeting, someone was kind enough to point out that it was seven years ago.

Nexus has changed a great deal in that time. Initially started as a "working group", when I joined the committee in 1997 Nexus was already beginning to spread its wings with its first organized trips to the Rutherford Appleton Laboratory and later to CERN. The Young Physicists' Conference (YPC) came along soon after that – a weekend that is now a firm fixture in the Nexus calendar. In 2000/1 we began to get more involved in the International Association of Physics Students (IAPS), culminating in our hosting the International Conference for Physics Students in 2001 in Dublin. One should not forget the paintball as well – and it is my hope that one day a team will take the trophy from University College London!

Over the years, many initiatives have been started and Nexus has grown and developed further and faster than anyone could have predicted. In 2002, our 10th anniversary year, we began to take stock of this progress, and examined the role that Nexus should play in the future. These reflections resulted in a new constitution, new Nexus awards and new Nexus society grants. The culmination of the year, of course, was the fantastic anniversary dinner in December. Looking to the future Nexus faces many new challenges, including a new national paintballing competition, a bigger and better YPC and the chance to address issues related to science policy.

In my time with Nexus, I have had the honour and the pleasure of working with some of the best and most inspirational students in the country. As I leave the committee, I would like to thank them for the memories and the friendship – there are too many people to name, but you know who you are! I'd also like to thank the four student liaison officers who have looked after Nexus: Sue Fryer, Julia Maddock (née Rose), Sam Rae and Shavinder Kalcut. The time I've spent as part of the Nexus committee has been immensely rewarding, not to mention fun, and I'm sorry to be leaving. However, the society is in good hands and I'm certain that it will continue to grow – who knows what it will be like in another 10 years?

So, it just remains for the "old man of committee" to say a final thanks to all who've made the past seven years so enjoyable, and to wish Dan, James and the rest of the current committee all the best for the future.

Matt Isherwood

P.S. I still want those Nexus pint glasses....

Meet Nobel prize winners

Every three years there is a week-long meeting of Nobel prize-winning physicists in Lindau, in the German Alps. The next meeting occurs on 28 June – 2 July 2004.

The Institute of Physics has been invited to nominate 10 young postgraduate students (under age 30) to attend the event as representatives of the UK and Ireland. This is a chance to interact with the finest minds in physics – to listen to their lectures, participate in their discussions and get to know them socially.

The Institute will pay for the cost of accommodation and the conference-registration fees, but those chosen to go will need to cover their own travel costs (cheap air fares are possible to Zürich in Switzerland and Munich in Germany). You may be eligible for a grant from the C R Barber Trust Fund to help with travel expenses (see http://about.iop.org/iop/ymems/funding.html).

To be considered for a place on this trip of a lifetime, please send Joseph Hines a paragraph telling us why you should be chosen. Please also send a copy of your CV, as well as a paragraph from your supervisor or head of department supporting your application. The deadline for applications is 16 April.

Contact joseph.hines@iop.org for further details if required. More information about the conference is available at www.lindau-nobel.de.

Stay on top of physics news

Nexus News may only come out every few months, but do not fear as *Nexus News Update* fills those terrible gaps between issues. You are automatically subscribed to these fortnightly e-mail bulletins that keep you informed of all the latest news relating to physics students and the Institute of Physics. Look for it in your inbox every other week.

Nexus Awards

The prizes for 2003 were announced at the Nexus annual general meeting. Make sure your university applies for the next set of awards, to be announced in November. Contact shavinder.kalcut@iop.org for an entry form.

Most Improved Society
The newly re-established Edinburgh University Physics Society impressed all with their dedication in the overhaul of their society and managed to boost their membership numbers from 2 to 45. They won £100 for society events.

Best Newsletter
AstroSoc, the University of St Andrews Astronomical Society, won this award for their biannual newsletter containing news and events within the society as well as articles and features on all manner of things astronomical. They won £100 for their Physics Society.

Best Website
This went to FUSION, the Open University Physics Society, for their highly informative and regularly updated website www.oufusion.org.uk.

Best Society
Event Horizon Physics and Astronomy Society at University College London won this award for their outstanding contribution in running lectures and events for the university's physics undergraduates. Event Horizon won two tickets to the Institute of Physics awards dinner and £200 to spend on future society events.

We asked the press secretary of Event Horizon to say a few words about the society.

Event Horizon was founded in 1996 as the UCL Physics and Astronomy Society. No matter how hard we try, we can't shake off that geeky physics image, so we've gone along with it. We've celebrated the fact that we are studying physics and that at times we even enjoy it!

In terms of "geek events", Event Horizon puts on fortnightly educational talks (not "lectures", otherwise no-one would come) by guest speakers on topics that go beyond lecture courses. These range from the physics of DNA to quantum gravity and the fun that you can have with liquid nitrogen. With free coffee and choccie biscuits, it's hard to resist, unless you have two hours of thermodynamics beforehand – then the obvious choice is sleep.

However, our enthusiasm for science doesn't stop there. The society also organizes subsidized day trips to venues of scientific interest such as the National Space Centre in Leicester and the Rutherford Appleton Laboratory.

It's always quite surprising how many people turn up on these trips, since the average physics student seems to be in denial about what it is they're studying. We have also been to the Eden Project, Bletchley Park and the University of London Observatory.

To balance out our science-rich diet, we have socials in and around London (that usually involve alcohol). The annual freshers' pub crawl is the big one where everyone meets everyone else and we all get to laugh at the really drunk people. This year we got cultural, and toured around London on an amphibious bus that drove into the Thames and did a river tour. Previously we have been to quasar, bowling and even the theatre (!).

As the society has grown, so have our ambitions. Last February we set our sights on Paris as the destination of our first international trip. We took a group of students from UCL, Imperial College London and the Open University to the science museum in Paris for a bargain price of £25 thanks to a grant from Nexus. This month we are following that up with a trip to the science museum in Amsterdam!

Our proudest moment has to be winning the Nexus Award for Best Society and two tickets to the awards dinner at The Savoy in London. The award gives us the recognition we deserve after many years of hard work. We must thank all of our past and present committee members who have kept the society running and Nexus for supporting us in what we do.

We look forward to seeing Event Horizon prosper further in the future and hope that our success will inspire other societies to aspire to winning the Best Society award.
Anthea Cain

National debt

Universities need money desperately – and students will have to pay up. **Malika Goonasekera** reports.

There is no denying that universities are chronically underfunded. Significant cuts in the level of public funding over the last 20 years have left an £11 bn shortfall that desperately needs to be addressed. The government narrowly won the second reading of the Higher Education Bill proposing top-up fees, which must pass one last Commons vote before it reaches the House of Lords. But are top-up fees enough to save UK universities?

What are top-up fees?

Since 1998, full-time undergraduates have been charged a fixed amount annually that must be paid up front. Tuition fees for 2003/4 are £1125. To meet maintenance costs, student loans are available with interest linked solely to inflation and repayments calculated at 9% of earnings above £10 000.

Under new proposals set to take effect in 2006, universities will be able to charge variable "top-up" fees of up to £3000. They decide the exact amount for a particular course at their institution. Unlike the present system, top-up fees are payable after graduation and the repayment threshold on fees and student loans is raised to £15 000. Any outstanding debt is cancelled after 25 years. An "Office of Fair Access" will be set up to encourage universities to recruit students from deprived backgrounds.

The poorest 30% of students will see their fees reduced by £1200 and will receive a £1500 maintenance grant. Where course charges are £3000, they can also expect at least £300 from the university itself. Cambridge, Exeter and Imperial College London have announced additional bursaries of up to £4000 to the brightest poor students. Moreover Royal Holloway at the University of London plans to provide bursaries to their most able students, regardless of background.

Why do universities need money?

According to Lord Dearing, an £11 bn cash injection is required to save British universities. Humanities courses cost approximately £10 000 per student annually and science degrees around £15 000, but state funding falls short by about £2800 per student. Money is needed to update lecture theatres, to pay for expensive lab equipment and to fund field trips. The inability to offer competitive salaries has led to the "brain drain" that sees many of our best lecturers and researchers lured abroad.

Some institutions have even been forced to streamline by closing down departments, such as King's College London which recently scrapped its respected chemistry course. Universities will also need to expand their infrastructure if they are to meet the government target of getting 50% of young people into some form of tertiary education.

The effect on science courses

The Royal Society recently evaluated the impact that charging for higher education will have on the sciences. Their conclusion: top-up fees "will damage science" and provide a "disincentive"

The University of Wales Swansea is phasing out unpopular degrees (chemistry, for example).

for studying science that "threatens the prosperity and quality of life of the whole nation and its progress during the 21st century". The society points out that the higher cost of a science degree may also deter some institutions from offering them.

To counter this, Alan Johnson, the minister for higher education, has claimed that universities will waive fees for "unpopular" courses such as physics and chemistry to encourage applications with "almost racing certainty". It is believed that some universities may subsidize the sciences by charging the full whack for popular degrees, such as English and Law, although none have yet declared their intent to do so.

Furthermore, the Institute of Physics has just announced that it will make available means-tested bursaries of up to £1000 a year to all physics undergraduates.

How much will the universities charge?

Top-up fees are capped at £3000 until 2010, and even then an Act of Parliament will be required to raise them. The elite of Britain's universities, represented by the Russell Group which includes Oxford, Cambridge and Imperial, have already stated that they will charge near the top end of the scale. In fact, unhappy at being unable to impose their own, higher fees, the Russell Group has already begun to lobby parliament to have the cap removed.

The reaction so far

There is no doubt that the new proposals are a much fairer system than that now in place. They will leave graduates with comparatively smaller repayments that start once they earn a higher wage and parents will no longer bear the cost of their children's education. Only the amount the student borrows is larger.

This does not stop the National Union of Students (NUS) opposing fees, warning that they will create "an elitist system" and massive debt – as much as £64 000 for better-off medical students, says the British Medical Association. Even poorer students, who tend to be more debt averse, would find top-up fees a disincentive, according to research.

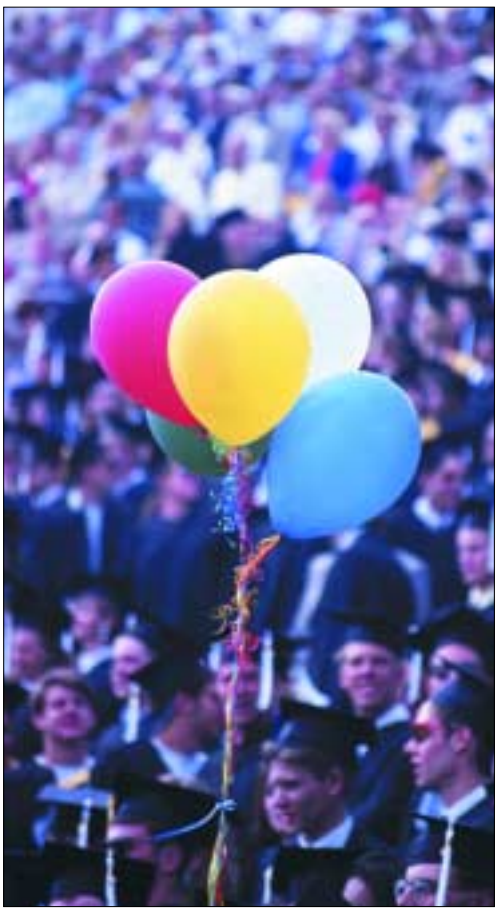
Top-up fees should generate just under £1 bn each year. Yet even Charles Clarke, the education secretary, admits fees alone will not be enough to meet the £11 bn funding deficit. So what are the alternatives?

A graduate tax has long been discounted as it would take too long to show any return. The Association of University Teachers, the NUS and most academics back the Liberal Democrats who would like to increase general taxation. Since higher education never tops the list of public spending, however, it would be difficult to sanction such a raise.

The Conservative Party advocates scrapping fees and reducing the student intake so that universities can remain state-funded, while Labour MP Frank Dobson posits charging fees in line with the fees for independent schools. John Johnson, a higher education consultant, suggests graduate employers should contribute more as they benefit the most from skilled, numerate graduates – an unsurprisingly unpopular idea with the Confederation of British Industry.

Meanwhile, more universities may follow the example of the London School of Economics and recruit more overseas students who pay the full market rate, reducing the intake of home students. Imperial, which recently negotiated bursaries sponsored by CitiGroup, believes forging closer links with business is the way forward. On the other hand, the University of Wales Swansea has opted to focus its resources on popular degrees, such as English, history and computing, and phase out others (chemistry, for example), which may set a worrying trend for the future.

What is clear is that, while most universities see top-up fees as a step in the right direction, they alone will not solve the problem. ■



Ballooning costs: even the new tuition fees will not raise enough money to meet the £11 bn funding deficit in higher education.

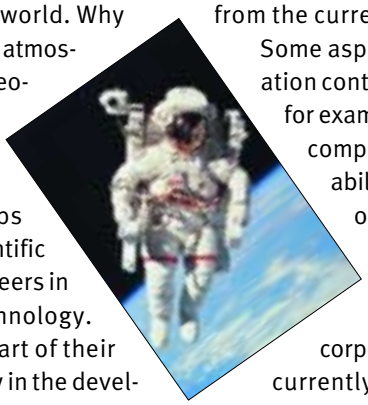
What would you do? E-mail your ideas to shavinder.kalcut@iop.org.

The case for space

Countries can only develop fully by investing in space science, says Nigeria's **Oke Olumuyiwa Oladunni**.

Atmospheric physics and space exploration are part of basic space science and astronomy. The principle underlying all space science is that the sky is the laboratory where physical laws and theories are applied, tested and refined for a wide range of physical conditions that can be unattainable on Earth. This may lead to the discovery of new physical laws and stimulate the development of new technologies.

Space science in general is now widely seen as a major growth point in basic physical science and plays an indispensable role in the development of science throughout the world. Why should developing countries invest in research in atmospheric physics and space exploration? Initially, people study astronomy because of its fascination and challenges, but observations of the sky have also led to discoveries that have had a major impact on daily life. Space science helps tremendously in raising the general level of scientific awareness, and draws young minds towards careers in physical sciences and associated areas of technology.



Countries that see science as an essential part of their future wealth and well-being participate actively in the development of space science. Any modern observatory requires not only space scientists, but also skilled engineers and technicians in electronics, optics, mechanics, computers and software in order to function. It requires advanced industrial capabilities and precision engineering.

The technologies of space science and nuclear science determine the economic and military power of a nation. Any country without these potentials can be classified as underdeveloped. Development does not mean the ability to purchase ready-made products of space technology. Development is the unfolding of peoples' imaginations and liberation to begin to assert authority and self-reliance in carrying out human activities.

Currently a few countries monopolize the development of space technology. This has led to a continued inequality and widening of a huge technological gap. South Africa, India, China, Indonesia, Brazil and others have been making frantic efforts to join the space club. This has resulted recently in the attainment of a high level of technological development in these countries. On the other hand, African countries in particular are completely passive to the development of basic space science. This no doubt is responsible for their poor technological development. Basic space science has been linked to the development of radio and satellite communication, television, telex, faxes, telephone, electronic mail, accurate weather forecasts, aeroplanes, remote-sensing techniques and many others.

The end of the 20th century has seen major developments in space research throughout the world. Currently there are large-scale building programmes for massive, ground-based telescopes; and among the many discoveries of tomorrow, perhaps new forms of energy or something revolutionary will emanate from the current intensive research in basic space science.

Some aspects of atmospheric physics and space exploration contribute to areas of more immediate practicality, for example training in industry, medicine, defence and computers. The economy of a country depends on its ability to compete technologically with other developed nations. Seventy per cent of US universities offer degrees in astronomy; forty per cent of students who attain higher degrees in astronomy eventually take jobs in industry. The corporation Milltech, founded by radio astronomers, currently builds the millimetre components generally used for the communications industry. Computer programs used to control telescopes, and to make maps from interferometers, have found wide application in industry.

Another practical use concerns space science and medicine which share the problem of imaging the inaccessible. Some of the image-reconstruction techniques of radio astronomy are now used in healthcare. Finally there are computers, which are indispensable in both theoretical and observational astronomy.

Several problems have contributed to the very slow growth of basic space science in developing countries. One is that policy makers think that space science is unaffordable, and has no immediate value. It is, however, obvious that economic development based on the application of technologies imported from industrialized countries without any attention to science and research has been the bane of most underdeveloped nations. Furthermore, the lack of a science culture in most developing countries is another major setback in the development of its space research. There is a need to establish a space research centre to coordinate current efforts in universities and to popularize science in the developing countries of the world. ■

Foreign affairs

When it comes to a year abroad, **Michael Banks** has been there and done that. Let him persuade you to take the plunge.

Spending a year abroad working or studying can be immensely gratifying. However, at first the thought of going abroad for a year can be daunting, not just exciting. I have just completed a year in Germany at the Max-Planck-Institut für Festkörperforschung (the Max Planck Institute for Solid State Research) in Stuttgart. This took place as the "sandwich year" between my second and final years at Loughborough University, where I am studying for a Diploma in Industrial Studies (DIS).

The first thing to remember about working abroad is that you will need some time to settle in, and how long this takes depends on how much support you get. I was fortunate to have a fellow countryman in the department who helped me to settle in much more quickly. I worked mainly on building a cryostat set-up for specific heat studies from commercially available equipment. The project was in its infancy when I arrived, and I was lucky to play an integral part in its development over the year (and beyond) that it took. This was a little different from a four-hour laboratory experiment at university!

Going from sitting in lectures to working in a world-class institute is a strange experience. There are no professors to chase you for work, or study friends to solve problems with; it's just you and your supervisor, who is usually very busy. Some things can't be taught and you have to learn them for yourself. You have to solve problems patiently on your own, work unsupervised sometimes, and follow things up independently. Most of all, when three weeks of work turn out to be useless, you have to keep at it, and always be optimistic.

The initial learning curve when you go abroad is more exponential than linear, and time must be allowed to take a step back and absorb everything. The step from student to researcher is a big one, as anyone with experience of a PhD will agree; learning another culture and way of working is just as big a step, so the challenge of doing both at the same time should not be underestimated – nor should the benefits be undervalued.

Life outside the laboratory takes just as much effort as inside, and you must make friends with people from another culture. Not being able to use your own language can at first make things more difficult, but in the end it is very rewarding.

If there are other students at your place of work, you'll probably settle in better and find a common resolve. Obviously if you are studying then you will be with students anyway, and many universities abroad are increasing the number of degrees and diplomas with English as their main language. This makes it easier for British students to benefit from projects such as the European Community Action Scheme for the Mobility of University Students (better known as ERASMUS).

The best period of your year abroad comes once you have settled in and got used to the fact that you won't have to do exams in June! As long as the work you are doing interests you, this is when you soak all the experience in and really develop new skills – skills that can't be learned in the lecture room. In my first six months I was learning software packages and programming languages, as well as learning about the cryostat and obtaining papers and a lot of information. It was only in the remaining six months that I was increasing my knowledge of physics significantly and taking in some of the physics I was learning from the other departments.

I was lucky that the Max Planck Institute has many good departments that are carrying out a great deal of research at the cutting edge of condensed-matter and experimental low-temperature physics. This has helped me in the last year of my DIS immensely, especially in the final-year project where the skills I have learned have helped me understand and research it effectively.

Depending on the field of work and where you go, you may be able to visit other centres and research establishments during your time abroad. For example, I went to Institut Laue-Langevin (ILL) in Grenoble, France, for a few days to help carry out neutron experiments. From an undergraduate's point of view this was a fantastic opportunity to see how a major scientific centre works, and to absorb some of the physics happening there. I also went to conferences like the annual conference of the Deutsche Physikalische Gesellschaft (DPG), the German equivalent of the Institute of Physics, and gave a presentation of my work at the Max Planck Institute at the International Conference for Physics Students (ICPS) in Odense, Denmark. All of these activities help you get involved in the scientific community.

Scientists at the Max Planck Institute work at the cutting edge of condensed-matter and experimental low-temperature physics.

Michael Banks, Amitabh Das and Ren Xiao Ming at the institute.

Working for an international research centre is fascinating in other ways, too. I spent time with people from all over the world, including China, India, Estonia, Russia – the list is virtually endless. One person even came from Israel and had previously studied in Iraq. As you can imagine, you can learn a lot from them and their experiences, both scientifically and personally, as well as making great friends and potential contacts.

A year abroad will also help when you are applying for jobs. The number of candidates coming out of universities with 2:1s or better is ever-increasing, and you need something that makes you stand out from the crowd. Experience of another country and the ability to speak another language make you more employable, and prove to companies that you can be internationally mobile in an increasingly multinational world.

However, if I could give one piece of advice, it would be to learn as much of the native language as possible before you go, because this will help you settle in much more easily. Also you will be accepted more quickly by your colleagues if you speak their language as much as you can.

Going abroad for a year is not for everyone, since you have to be prepared to leave your friends and family behind. But the Internet means that communication is much easier and faster than it used to be, and making friends in the country where you are working or studying is culturally enriching.

In conclusion, I would say that spending a year abroad is a fantastic experience, one that is more than worthwhile and will contribute to your professional and personal development. My experience is of course selective and does not represent all views, but most people who have done it would say it is a worthwhile venture and would recommend it to anyone.

So bite the bullet and go for it! If you are not too sure you could always try to do six months, or maybe a summer project. At the end you will definitely feel it was the right decision, but do be prepared to put the work in. ■

BRISTOL FASHION

The Young Physicists' Conference for 2003 occurred on 21–23 November in Bristol. **Digby Tarvin** took part.

Bristol University was the main conference site, and most of the participants stayed at a nearby youth hostel in the heart of Bristol's vibrant quayside. The hostel was the meeting place for those arriving on Friday 20 November, and locating it proved to be the first challenge of the weekend. The facilities were clean and comfortable, the only hiccup being a room with an unusable bathroom because of a blocked and nearly overflowing toilet – a room to which naturally I had been allocated.

Most of the conference events were at Bristol University.

On arrival, participants were greeted by the conference organizer, the Institute of Physics' graduate liaison officer Joseph Hines. On completion of the registration formalities, we retired upstairs to the dining room for a hearty dinner, then headed out for a night on the town.

Saturday commenced with a fascinating visit to the Rolls-Royce Marine Systems site in nearby Filton, supervised by Cat Gardner of Aberystwyth University. Places on the visit were limited and names had to be submitted in advance, so having registered late I was not expecting to be able to go. However, I got lucky.

The weather was a little inclement on the coach ride to the site, but it did not dampen our enthusiasm – even when huddling in the rain outside the main gate while Cat attempted to contact our guide on her mobile phone.

After a wait, which was no doubt much shorter than it seemed, our guide John Clark, chief development engineer, met us. Once through the gate he led the way down a long road past numerous large and impressive-looking facilities supporting systems such as the engines for the Harrier Jump Jets.

At the end of the road was the main object of the visit, a building where the new, soon to be released MT30 marine gas turbine engine was developed. This engine is an adaptation for marine use of the tried and tested kerosene-based engine technology powering the aircraft on which many of us will have travelled.

Rolls-Royce labs are a lot better funded that your average academic institution. The facilities looked like a cross between the foyer of a luxury hotel and the bridge of the *Enterprise*. Our guide revealed that the building doubled as a showroom for clients with large budgets, which went some way towards explaining why so much money had been spent on the comfort of engineers.

After a brief presentation on the MT30, we were led to the test rig, past the huge air-intake ducts, to clamber over the engine itself. From here we were shown the control room from which the MT30 is operated. But before we knew it, it was time for us to leave.

During the ride back the coach was filled with the sound of a radio commentary on some sporting event in Australia, which England was apparently winning.

At Bristol University we joined the other conference participants for a buffet and browsed the company exhibits. Present were representatives from Institute of Physics Publishing (IOPP), QinetiQ, British Nuclear Fuels Ltd and the National Physical Laboratory.

The afternoon programme included a guided tour of the university's physics department, a lecture on particle acceleration in space by the university's Martin Hardcastle and a talk by IOPP's Nina Couzin on how to get a paper published. The culmination of the afternoon was a highly entertaining debate led by Radio 4's resident science expert, Quentin Cooper, covering topics ranging from identity cards to Oswald the Lucky Rabbit.

Eats, shoots and floats

On Saturday evening we gathered for our conference dinner at The Shoots Floating Bar and Restaurant, then retired to a pub called The Greenhouse.

For most of us Sunday started with an early (for students) morning breakfast at the hostel, followed by packing our bags and vacating our rooms prior to the trip back to the university.

First came the undergraduate and postgraduate lecture competitions. The postgraduate section was won by Jim Grozier of Sussex University with his talk on pear-shaped neutrons and Andy Higgenbotham for his talk on bungee jumping.

This was followed by a twin-track session. Young professionals and postgraduates were catered for with a presentation from Keith Milmer of Ashridge on managing your manager. For undergraduates there was a session on job hunting by Rosemary Lowe of Bristol University's Careers Advisory Service, who covered both employment and postgraduate-study options.

The conference concluded with a lecture on atomic force microscopes and nanotechnology by Mervyn Miles of the Interdisciplinary Research Collaboration (IRC). ■

Carl Sagan (1934–1996)

Superstar

Carl Sagan did more than anyone else to popularize the wonders of science, argues **Khee Gan Lee**.

Today, with the availability of satellite television, the greatest exposure to science a layperson receives will typically be through scientific television channels such as the Discovery Channel. And it is easy to forget that science programming used to be virtually absent from terrestrial television. Into this void stepped the astronomer Carl Sagan, who with his pioneering television series *Cosmos* became known to millions of television viewers across the world as the public face of science.

Sagan, born in 1934, had a childhood in the melting-pot that is Brooklyn, New York City. A descendant of East European émigrés, Sagan grew up in a working-class family; but his parents, although not highly educated, were careful to provide an intellectually rich environment. There were always intellectual and political discussions in the living room; they bought a small piano and encouraged the boy to listen to classical music.

Epiphany

When Sagan was five, he started wondering what the stars were: "I asked my parents, they didn't know; I asked the friends of my parents, they didn't know" (from Keay Davidson's *Carl Sagan: A Life*). His mother asked him to look up the answer in the local library: "I asked the librarian for a book on stars. She came back and gave me a book...it was filled with pictures of people like Jean Harlow and Clark Gable...I gave it back to her and said, 'This isn't the kind of stars I had in mind.' She then went and got the right kind of book...I sat down on a little chair, and turned the pages until I came to the answer. And the answer was stunning...the stars were suns, but so far away that they were just little points of light...the scale of the universe suddenly opened up to me. [It was] kind of a religious experience. [There] was a magnificence to it, a grandeur, a scale which has never left me. Never left me."

As he grew older, Sagan began to read science fiction. Then, as now, science fiction abounded with tales of life forms from other worlds, of intrepid explorers wandering through unknown expanses of the universe. His reading catalysed in him a fas-

Sagan helped the development of the Mariner 2 probe to Venus.

cination with the possibility of extra-terrestrial intelligence, a fascination that would play a huge role in his professional life. In the late 1940s and early 1950s, when Sagan was maturing, the atomic age had already started, and the two superpowers were gearing up for confrontation. Science fiction was rapidly turning into science reality.

Foundation

In high school, Sagan was a brilliant student. In a working-class school where few of his schoolmates would enter university, Sagan had decided that he was going to be an astronomer, and he was working single-mindedly towards it. However, he had an extroverted side to his personality as well. He often acted in school plays, and was a member of his school's debating club. In 1951, when he was 17, Sagan entered the University of Chicago, Illinois, where less than a decade previously the world's first nuclear reactor was activated.

The University of Chicago, then as now one of the top universities in the US, abounded with brilliant students. Sagan, although a budding astronomer, was motivated by his interests in extra-terrestrial life to teach himself chemistry and biology in addition to physics. His enthusiasm seemed to know no bounds. Even as an undergraduate, Sagan displayed a remarkable sense of *chutzpah*, often writing to distinguished scientists to discuss his interests. Once he even popped unannounced into Linus Pauling's office in the California Institute of Technology to discuss his opinions on the origin of life.

After three years as an undergraduate, Sagan was accepted into the University of Chicago's graduate astronomy programme under Gerard Kuiper, the distinguished planetary astronomer. As a graduate student, he made overtures to the public, writing articles in newspapers and giving public lectures. He even got his name mentioned in the *New York Times*, to the irritation of some of the senior staff, including distinguished astronomers such as Subramanyam Chandrasekhar and Geoffrey Burbridge. In addition to honing his academic knowledge, Sagan seemed to be preparing for another aspect of his future career.

Lift-off

After his doctorate, Sagan won a fellowship at the University of California, Berkeley, in 1960. Then, space exploration was still in its infancy, and we knew much less about the planets. There was plenty of work to be done in the field, even as the first interplanetary probes blasted off into space, fuelled by the ideological cold war on Earth between the superpowers.

Much of Sagan's early work was concentrated on the formation of organic molecules, the building-blocks of life, both on early Earth and the other planets. As part of this, he developed an early greenhouse theory of Venus' climate. He was also involved in the development of the Mariner 2 space probe to the planet, which confirmed his greenhouse theory, effectively killing off hopes that it might harbour life.

In 1963, Sagan got an assistant professorship at Harvard University, no mean achievement for a 29 year old. There he continued studying the formation of life on the early Earth. In addition, he collaborated with his former student Jim Pollack to study "the waves of darkening", or periodic changes in brightness, observed on the surface of Mars. While their hypothesis that these were due to huge geological ridges proved to be incorrect, it led them to anticipate the general characteristics of Martian terrain years before detailed surveys were available. In 1968, Sagan moved to Cornell University, Ithaca, New York. There, his career would change in a way unprecedented for a scientist. He would slowly become a celebrity.

Outreach

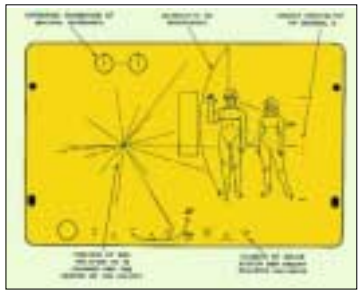
In 1966, Sagan co-wrote *Intelligent Life in the Universe* with Soviet scientist I S Shklovskii, which sold 25 000 copies and received good reviews in general. This book speculated on intelligent civilizations in the universe, a theme that would be repeated in much of his later writings. A greater success was *Cosmic Connection* in 1972, which was broader in nature, dealing with topics ranging from evolution to space exploration. This book received a more general readership compared with *Intelligent Life*, which had more of a cult appeal. Rave reviews were received from mainstream media such as *Time* magazine and the *Washington Post*, which helped establish his name as a popular-science writer. Over the next 25 years he would publish more than a dozen science books, many of which became bestsellers and are still in print.

In 1973, Sagan won another break in his rise to popularity, when he was invited as a guest on the US chat show *The Tonight Show with Johnny Carson*. His charisma and bubbly enthusiasm gave him a stage presence not usually associated with scientists. In addition, he had a desire to educate the viewers, yet was

willing to treat them as intelligent people, in contrast with the usual image of scientists as snooty and condescending geniuses. Over the next 13 years, he would be invited on the show 26 times.

Prime time

Most scientists would have shied away from the glare of such publicity, but Sagan had the vision to harness his fame to expose an even wider audience to science: he would create a popular science television series. *Cosmos* was born. In the 1970s, such a concept was utterly strange, even quixotic. There were only a few TV channels a viewer could choose from; with such limited airtime available, there was seemingly no room for something as apparently dull as science.



Sagan spearheaded the project to create plaques and records to be carried by the Pioneer probes.

Awe-inspiring: the Great Nebula in Orion.

Enter Carl Sagan. The 13-part series, hosted by Sagan himself, premiered in 1980. The scope was no less than epic: from the ancient library of Alexandria to the furthest reaches of the universe, science was brought to life via the best visual effects available and Sagan's charisma. Millions of viewers were exposed to the magic of science for the first time. *Cosmos* was the pioneering science TV series, and the scientific TV channels of today owe their existence to Sagan's brainchild. The companion book of the same name became the best-selling popular science book of all time.

While he was a prolific science writer, Sagan only wrote one piece of science fiction: *Contact*. The novel tells the story of the female radio astronomer Eleanor Arroway, and the events occurring after the first radio signals from an intelligent extra-terrestrial civilization are received. Sagan richly wove questions about science and humanity's place in the universe into the plot. The novel was later given the Hollywood treatment, and turned into a feature film starring Jodie Foster in 1997.

Even as he rose to stardom, Sagan was constantly active in scientific work, especially in planetary science. He was involved in the Viking 1 and 2 landing missions to Mars in 1976. In the Pioneer 10 and 11 as well as Voyager 1 and 2 missions, however, he was involved in a less scientific way. These four interplanetary probes were sent on trajectories that would hurl them out of the solar system after they finished their missions, perhaps to be found by intelligent aliens in deep interstellar space, long after human civilization is extinct. Sagan led the effort to create plaques and records to be placed on these spacecraft, as a way of communicating with the aliens.

Crusade

Sagan always presented science as a noble undertaking, a way to understand our place in the immensity of the universe. However, he was at the same time very vocal in debunking and exposing pseudoscience, hoaxes and scams wrapped up in scientific jargon. Despite his fascination with extra-terrestrial life, he was very active in debunking UFO phenomena as little more than mass hysteria and misidentified natural phenomena. He was a leader of the sceptical movement, and wrote frequently in response to various fraudulent claims and hoaxes. Sagan helped combat pseudoscience by educating the public in the true method of scientific inquiry.

As well as looking upwards, Sagan was very concerned about the state of humanity on Earth. Like many scientists, he was a political liberal. He lent his voice to pacifist and environmentalist causes, and saw science as a guiding light for mankind. In the early 1980s, he helped publicize the idea of a "nuclear winter". Previously, it was assumed that after the devastation of a total nuclear war, the survivors would still be able to eke out an existence and slowly rebuild civilization. According to the nuclear-winter theory, however, the smoke and dust from thousands of nuclear blasts would permanently block out sunlight, onsetting a global winter and rendering most life on Earth impossible. This theory made nuclear warfare seem even more horrific and unimaginable, and helped cause the thaw in the cold war.

Supernova

On 20 December 1996, at the height of his powers, Sagan succumbed to a pneumonia infection after battling bone-marrow cancer for two years.

As a scientist, Sagan made many significant contributions, but he was never going to win a Nobel prize. As a person, he could sometimes be arrogant and impersonal. However, it is for his tireless efforts to reveal the beauty and mystery of science to the public that he is most remembered. In this respect, Sagan's contributions to science are inestimable.

He showed the layperson that science is not something sinister and beyond comprehension. Countless young people were inspired, and are still being inspired, to take up scientific careers by his dazzling prose and contagious sense of wonder. Long after his scientific work is superseded by the latest discoveries, these people will continue to make discoveries and educate new generations of scientists. ■

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Galileo's Finger

Peter Atkins

March 2003, Oxford University Press, 388pp, £20.00, ISBN 0198606648.

At first glance you might take "Galileo's Finger" to indicate when "scientific endeavour took a new direction", according to the author Peter Atkins – but no, it's a million times more disgusting than that. Turn a couple of pages and you will be greeted by the actual middle finger from Galileo's right hand, contained in a vessel which is housed in the Institute and Museum of the History of Science in Florence, Italy!

It was apparently detached from Galileo's body on 12 March 1737, when his remains were transferred to the main body of the Santa Croce church, Florence. Now if that doesn't make your stomach turn, you may stand a good chance of actually reading the book.

The book is subtitled *The Ten Great Ideas of Science*, and deals with the 10 central ideas on which modern science has been built: evolution, DNA, energy, entropy, atoms, symmetry, quanta, cosmology, space–time and arithmetic. It is written in an accessible, though often too wordy, way for my science-literature needs, and Atkins has been described as a good candidate for the Nobel Prize for Literature by Richard Dawkins, author of *The Selfish Gene*.

Galileo's Finger has been written for the general science reader with what the sleeve describes as "magical prose". Although considering Atkins spends the first few pages spitting out venom for anything not resembling absolute scientific "fact", I'm not entirely sure he would like his writing described by this non-scientific, "untestable" magic entity.

Much to the disdain of anyone liking the ancient Greek philosophers, he describes them as "utterly but engagingly wrong". Aristotle, who a lot of people deem to be intellectually superior, was in fact "ever magnificently intellectually fertile and magnificently wrong as usual".

His attacks continue into the book and he has a good old rant about God and Creationism, describing "him" as having an "unbounded capacity for designing and building animals with seemingly inexhaustible variations on themes built around the ability to torture, maim, and kill one another". It's not even what he says at times – it's just the way he feels the need to air his "anti-anything non-scientific" issues in what otherwise would be a really pleasant, informative read.

On the plus side, the ideas that I know of in detail (all except evolution and DNA) are well explained and the diagrams are helpful. He also tells you some irrelevant anecdotes about scientists and their endeavour to gain insight into their particular field, but they serve to lighten the read and personalize what are very human triumphs in science and the world.

Galileo's Finger costs £20.00, which works out at a mere £2.00 per modern scientific idea (a lot cheaper than tuition fees). However, I'm sure you could find an equally well written, less cynical book about some of science's great ideas. Although if you are as cynical as Atkins, have some money to spend or simply think that you could ignore the ranting, then I suggest you buy this book. If nothing else you might learn some science that I'm sure you could use to excess as sparkling dinner-time conversation.

Jennifer O'Brien

Maxwell's Demon

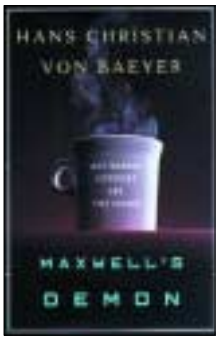
Hans Christian von Baeyer

June 1998, Random House, 256pp, ASIN 0679433422.

Last year I was given the news that I was being posted to Montreal for a six-month placement and, my luck being what it is, those months were to stretch right through one of the coldest winters eastern Canada has experienced for 60 years. It's little wonder that I found myself interested in that intriguing corner of physics, the noble study of thermodynamics.

Maxwell's Demon is a memorable personality – the gedanken gremlin that would sort molecules with higher energies from their lower-energy brethren and effectively make heat flow in reverse. He'd be useful to have around in Montreal.

With this in mind I picked up a copy of *Maxwell's Demon: Why Warmth Disperses and Time Passes*. It presents a lively biography of the Demon and gives a readable account of the development of thermodynamics from the end of the 18th century to the present. A history peppered with memorable personalities and amusing anecdotes, introducing us to the great laws of thermodynamics and their consequences.



The chapters are populated with many interesting characters: Einstein, Boltzmann, Maxwell himself and James Joule, whose spirit of scientific enquiry arose out of his professional interest in brewing better beer for his family business in Manchester (now that's applied physics!).

The origins of the temperature scales are discussed. Von Baeyer speculates that if the "billiard ball" model of heat developed before the other temperature scales, our TV weather reports might've sounded a bit like: "In London this morning, the average kinetic energy of air molecules will be 5.1 sextillionths of a Joule rising to 5.3 sextillionths by mid-afternoon."

Maxwell's Demon reappears throughout the story. Every time scientists think they have killed him off and explained why he can never exist, a new theory comes along to reincarnate him. Von Baeyer includes four inventive obituaries of the Demon written from different viewpoints in the development of the subject.

Further chapters take us through entropy and the relation between thermodynamics and $E = mc^2$ – the only equation appearing in the book. We finish bang up to date with the possible effects of information theory on the Demon and why he still refuses to die.

Invented as a means of usefully sorting thermal noise and channelling its energy, an experimental Demon is finally described in the form of the "optical thermal ratchet" – a successful device, built in 1995 for rectifying Brownian motion.

So although there are good reasons why the Demon can't keep me warm in the depths of the Canadian winter, he did at least distract me from those –40 °C winds for a while.

Kevin Crampton

Book competition

The winners of last term's book competition are Sunday Alabanla from Nigeria, Lawrence Drever from Cambridge, Stewart Wimbush from Dresden, Francis Onyeanu from Nigeria and Amyas Phillips from Cambridge. They all receive a copy of the book *Faster Than the Speed of Light*. This issue we have five copies of the book *A Dictionary of Scientific Quotations* to give away. To win, just answer the following question: **where did Carl Sagan win his fellowship from after his doctorate?** Send your entry to: Book Competition, Shavinder Kalcut, Institute of Physics, 76 Portland Place, London W1B 1NT, UK.

Leon the electron was not sure where he'd been blasted to when the photon struck, but indicators suggested that he was now in one of the atom's degenerate orbitals.

Last issue's solution

All of the correct answers that were sent in were entered into a draw. Susan Kirk of Cambridge was first out of the hat and wins £25. Runners-up Elizabeth Highmore of the Open University and Peter Fletcher from Suffolk win £10 each.

■	a	c	c	e	l	e	r	a	t	i	n	g
h	■	a	■	d	■	m	■	s	■	n	■	r
a	t	l	e	e	■	b	■	t	■	u	■	a
m	■	c	■	n	■	r	■	e	■	i	■	n
i	s	i	s	■	h	y	d	r	a	t	e	d
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i	■	n	■	i	■	r	■	o	■	l	■	i
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s	p	e	c	t	r	o	s	c	o	p	y	■

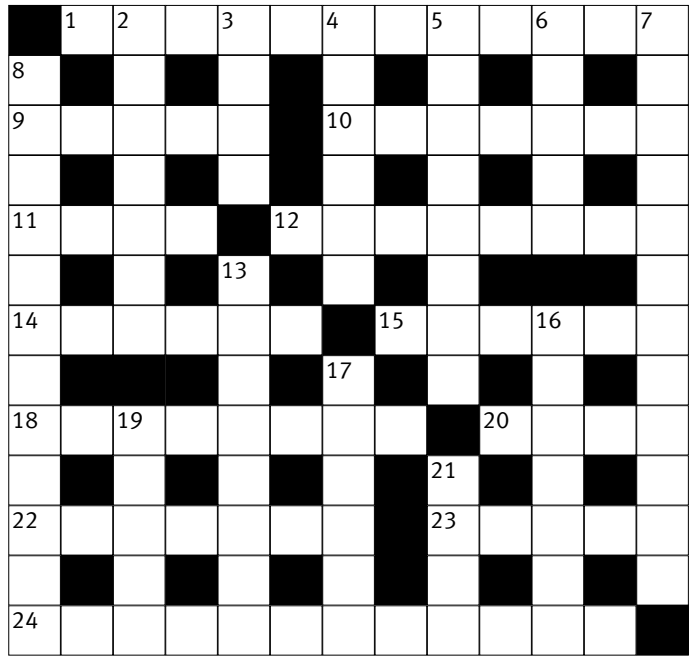
Rubbish-joke corner

Q: What is the difference between Max Factor and a quantum theorist?
A: Max Factor has models that work.

Heisenberg is out for a drive when he is stopped by a traffic cop.
Cop: Do you know how fast you were going?
Heisenberg: No, but I know where I am.

Nexus prize crossword Set by Vinnie

Send your crossword solutions by fax to +44 (0)20 7470 4848 or by post to Shavinder Kalcut, Student Liaison Officer, Institute of Physics, 76 Portland Place, London W1B 1NT, UK, to arrive no later than 10 April. All of the correct answers will be entered into a draw. The lucky winner will receive £25 and the two runners-up will each receive £10.

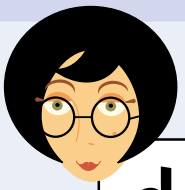


Across

1. Gave off sparks and flashes; exhibited virtuosity (12)
9. Collection of words used to name a person, place or thing (5)
10. A long four-wheeled carriage; collection of episodes aired on one day (7)
11. Greek god of love (4)
12. From womb to tomb; a ..... friend (8)
14. Cloth (6)
15. Pair of electric charges with opposite sign (6)
18. Heat emitting (8)
20. Past Swedish Eurovision winners (4)
22. Buddhist state of supreme enlightenment (7)
23. Producers of Pentium processors(5)
24. Unit of energy in atomic and nuclear processes (8, 4)

Down

2. Unit of electrical charge (7)
3. Bird's home (4)
4. A dry, humorous manner (6)
5. Women's underwear (8)
6. Social aversion; alcoholic drink (5)
7. Bad tempered (12)
8. When waves overlap (12)
13. A billion units of power (8)
16. Wave function of electron indicating probable location (7)
17. Red fruit (6)
19. Slow, mournful song (5)
21. Capital of the Ukraine (4)



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