

PHYSICS ON MERSEYSIDE

The newsletter of the Merseyside Branch of the Institute of Physics

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2007–2008 IOP Merseyside Branch officers

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Steve Barrett wins Nations and Regions Board prize

It's nice to be able to report another prize awarded within the branch. Each year the Nations and Regions Board awards prizes to members for distinguished work for their branch, and one of the three 2007 prizes has gone to Dr Steve Barrett, vice-chair of the Merseyside Branch.

Steve has served the committee for more than 10 years and has acted in the roles of honorary secretary, newsletter editor and treasurer. He has also served the Institute on the Thin Films and Surfaces Group committee. He has been a key player in the success of the branch over a long period and has been an important link between the branch and the university physics department. The smooth running of many branch activities owes much to his tireless efforts. Unfortunately, under the new constitution, Steve will have to step down at the next AGM – a serious loss to the branch.

Steve's outreach activities have become justifiably famous. The Liverpool Physics Olympics for sixth-form students (p4) has been running since 1992 and is as popular as ever. At the event, organised by Steve and held on a Saturday in October each year,



Dr Steve Barrett, who has won a Nations and Regions Board prize for his work in the branch.

120 sixth-formers compete in experimental tasks. Its success has spread and there are now parallel events held as far away as the US, Australia and Europe.

The Annual Physics Teachers Conference, held at Liverpool University, brings together A-level physics teachers from the north west to provide a forum for discussion and to contribute to their continuing professional development. Under Steve's guidance it has become a major national conference, and IOP Physics Enhancement Project students have attended for the last two years. The visit by local teachers

to CERN is also one of Steve's innovations, with 2007 being the third (led by Dr David Joss).

Steve supervises A-level physics students on the Nuffield Science Bursary Scheme, who spend a month gaining new skills and an appreciation of physics teaching and research in a university environment. The students he supervised in 2007 (with Mike Houlden) won the north-west prize and are going to the national finals.

Steve's voluntary activities to promote physics are too numerous to mention. Many refer to the popularity of his "Fools physics" talk first delivered in 2004 and since then to other branches. His passion for astronomy has also led him to build his own observatory, and typically he has encouraged local teachers and pupils to gain hands-on experience there. In May this year, Steve will deliver a lecture to the branch about his experience of observing the 2006 total eclipse in Libya.

So congratulations, Steve, on your well deserved award, which will be presented on the 25th of April. The chief executive of the Institute of Physics, Dr Robert Kirby-Harris, will present the award.

David Cox, editor

The 2008 branch AGM is on 3 April See insert for details

Branch programme: spring 2008

Unless stated otherwise, talks start at 6.30 p.m. Refreshments are available from 6.00 p.m.

UoL = University of Liverpool (www.liv.ac.uk/maps); SSRC = Surface Science Research Centre (building #47 on map); CLT = Chadwick Lecture Theatre (building #42); ShT = Sherrington Lecture Theatre (building #25).
DL = Daresbury Laboratory, near Warrington (www.scitech.ac.uk/About/Find/DL/Introduction.aspx); LMI = Liverpool Medical Institution, 114 Mount Pleasant, Liverpool (www.lmi.org.uk/location.html). Please note, new parking arrangements apply at the university (see www.liv.ac.uk/about/visiting).

19 March

DL (Merrison Lecture Theatre) 6.30 p.m.
Prof. Larry DeLucas, University of Alabama (speaker's host: Prof. Samar Hasnain)
Space flight and research on the International Space Station (sponsored by STFC Daresbury Laboratory and the Institute of Physics)



This presentation will illustrate Dr DeLucas' personal experiences as an astronaut on the Space Shuttle *Columbia*. The United States Microgravity Laboratory-1 flight, Mission STS-50, on which Dr DeLucas was a payload specialist, launched on 25 June 1992 and was the longest space-shuttle mission at that time (14 days). More than 30 different experiments were conducted in materials processing and fluid dynamics.

Dr DeLucas will describe the science experiments performed on past space-shuttle missions and the International Space Station, and he will provide some snapshots of practical

living on a space mission. Finally he will discuss the future of space exploration and show a video and images of the Earth taken by his crew on STS-50 and other astronauts.

This is a public lecture and attendance is by application. It is open to IOP guests, STFC staff and A-level science students from local schools. IOP guests should reply by e-mail to Louise. Butcher@iop.org. Tickets will be issued on a first come, first served basis. Attendance is limited to 150. The lecture will be followed by a mixer (Laboratory Atrium 7.30–8.30 p.m.).

3 April

UoL, CLT, 6.30 p.m.
Prof. Tom Choularton, School of Earth, Atmospheric and Environmental Science, University of Manchester
Climate change: recent developments in the science
Following the Fourth Assessment Report from the IPCC there has been refinement both in the degree of certainty to which recent climate change can be attributed to greenhouse gases from fossil-fuel burning and to the predictions of future climate change. In this talk, advances that have made the attribution of recent climate change clearer will be discussed.

The physical processes controlling climate change will be presented and the extent to which future predictions can be made and the uncertainties in those predictions will be described. Some of the recent media controversies will also be discussed. Finally, Prof. Choularton will present his view of the major challenges for future research in this area.

The Merseyside Branch Annual General Meeting will take place after the lecture (see AGM insert for details).

25 April

UoL, ShT, 6.30–8.00 p.m.
Prof. Allan Chapman
The heavens on Merseyside: 1618 to 2008

From the early 17th century, western Lancashire became one of Britain's centres of excellence in astronomical



research. Jeremiah Horrocks at Much Hoole was Europe's next great planetary astronomer after Kepler. Victorian Liverpool was the home of William Lassell, another great planetary astronomer, and after 1881 the Liverpool Astronomical Society became the prototype of the British Astronomical Society.

Allan Chapman is a well known writer and TV personality with a brilliant style that holds his audiences spellbound. This event is hosted by the Liverpool Astronomical Society and the Institute. It is a public lecture and no booking is required.

15 May

UoL, SSRC, 6.30 p.m.
Dr Steve Barrett, University of Liverpool

A total eclipse of the Sun: a personal view

Standing in the Moon's shadow during a total eclipse of the Sun, especially the view of the solar corona, is one of nature's most awe-inspiring experiences. In this talk, Dr Barrett will try to convey something of the experience of seeing an eclipse from the Sahara Desert in Libya in 2006, including attempts to capture it with photographs and video. He will also outline some of the background behind the why, when and where of solar eclipses.

18 June

UoL, CLT
Merseyside Institute of Physics Teachers Network Annual Conference: physics can be fun

This is a full day of talks, workshops and discussions aimed at those of us who are not physics specialists but still get lumbered with some tricky stuff to teach at KS3 and 4. There'll be inspiring ideas to take back to the classroom. To book, e-mail Lucas.lht@blueyonder.co.uk.

19 June

UoL, CLT, 6.30 p.m.
Robert Fosbury, head of the Space Telescope European Coordinating Facility (ESA)
How astronomers image the sky
This is a public event, as part of the Astronet conference, and is co-sponsored by the Institute. Most of us have marvelled at the stunning colour images of the sky now produced by astronomers. But how are they made and what do they tell us about our universe? In this illustrated talk, Robert Fosbury will take you on a tour of some of the impressive array of cameras available to research astronomers, both in space and at remote and spectacular sites on the ground. He will show how the various images of an astronomical object or field are combined to reveal such appealing rich colours. Are these colours real and how do we interpret them?

Astronet is a five-year EU-funded project devised by Europe's major research funding agencies to deliver a detailed plan to develop European astronomy and space science over the next 20 years. The roadmap is led by astronomers at Liverpool JMU and ends in September. As the cornerstone of the consultation of the astronomical community, **a symposium will be held on 16–19 June in Liverpool's new waterfront convention centre.** Around 400 professional astronomers from Europe and farther afield are to attend.

26 June

UoL, CLT
Annual Liverpool Physics Teachers Conference

This is a popular and informative free event for physics teachers. Speakers cover a range of topics interspersed with discussions and hands-on activities, and the chance to question a panel of physicists. Feedback from previous years states that the events provide a very good opportunity to network and try new experiments and software. For information and downloads, see www.liv.ac.uk/~iop/PTC.

Capital of Culture 2008 programme of events



At the stroke of New Year 2008, Liverpool officially took the title of European Capital of Culture. A range of events is planned across the region during the year, and the Merseyside Branch will be there to demonstrate that science, and especially physics, is an important part of culture.

The first event sees the return of Allan Chapman to Merseyside on 25 April to enlighten us about "The heavens on Merseyside: 1618 to 2008". This event will be open to the public and held in the Sherrington Lecture Theatre.

Planning is also under way for two Physics Day events on 21 and 22 November. It is proposed

to host a series of lectures by eminent figures in different fields of physics, covering where the forefront of research has reached today and what they expect the future to hold. There will be some sessions for practising physicists and some for the general public. Watch this space for more up-to-date information.

Stepping away from the more traditional talks and lectures, some web-based events will be starting up over the year. The history of science in Liverpool also comes to life on a website, and there will be downloadable walking tours of people and places who have contributed to

physics, and science in general, in Liverpool. If you prefer your physics in musical form, the University of Liverpool is staging *BIG BANG!* the musical, with financial support from the Institute. It will be run in July for schools and again in September for general audiences, to coincide with the British Association festival. See www.liv.ac.uk/physics/bigbang for further details.

In one of the more unusual experiments in physics communication, the branch is working with a theatre group to develop a street theatre performance. This will premiere

at Liverpool's Brouhaha festival, and if all goes well it will then move on to Edinburgh. For anyone who would like to get involved, there will also be opportunities for physics busking throughout the year.

With this diverse range of activities, there should be something for everyone. However, whatever the medium, we should remember that the underlying physics is a valid cultural activity in itself. Here's to a successful year, and many thanks to all of those who have made this programme possible. **Louise Butcher**, north-west regional officer

SciCast hopes to gain more momentum in 2008

On 4 January, when many were still recovering from the festive season, the first SciCast competition closed. Unfortunately, and perhaps predictably, many entrants left it to the last minute to send in their work. So as I write, Jonathan Sanderson at NESTA is still struggling to get all of the videos up and running on the website (www.planet-scicast.com).

That said, there has been a paucity of videos from northern England with only three for Merseyside. We have a judging team here on Merseyside ready to go, but in view of the small entry numbers it has been decided to join forces with Lanbria, Manchester and Yorkshire. This will mean that we have about nine films to consider, but there will still be a winner for each branch. It appears that most films have been submitted in areas where local events have taken place.

In principle this format has a lot going for it. Students often find the laws of physics presented as dull facts. It is not then surprising that they come to think of the subject as being the domain of experts: they can emulate their work but not contribute to it. This view contrasts with many other subjects where personal contributions are encouraged and valued. SciCast can develop student ownership of the science presented and provide scope for personal innovation. Having to teach a topic or theory really challenges your own understanding, so making a video is a good way of injecting into physics education some of the teaching methodology that is more commonly associated with other subjects.

I would urge all members, particularly those with school connections, to promote the next round of SciCast. The competition has been designed



Jonathan Sanderson has the ASE meeting firmly in his sights.

to avoid the expense and disruption of taking groups out of school, which should be of particular benefit to small schools or youth groups. Groups can be of any age or mixed age and expensive equipment is not a requirement or an advantage. Primary schools wishing to take part should be assured that the age and expectations of teams will be taken into account.

Children will get a great kick out of seeing their films on the website, and judging is based on the subject and its explanation, creativity and use of the media.

Jonathan is the guru behind all of the work that you see on the website. I first met him at one of his seminars in Birmingham and was impressed by his enthusiasm for the project. We were able to arrange for him to come to the Institute drop-in room at the Association for Science Education conference held at Liverpool University in the first week of January. This gave him the opportunity to meet many physics teachers during the three days and show off some of the videos already formatted.

Films submitted now will be judged next January, but please don't leave it to the last minute. This year we expect SciCast to take off in big style.

David Cox, Merseyside SciCast coordinator

Students' Physics Olympics is another success



LIVERPOOL PHYSICS OLYMPICS



The 2007 Liverpool Physics Olympics for sixth-form students was held at Liverpool University on Saturday 13 October and was yet again a resounding success. In the competition, teams of four students take part in a number of events that require teamwork, problem solving and perhaps just a little bit of physics. Last year's winning students came from Calday Grange Grammar School in West Kirby (below left). Second place went to King's School in Chester (centre) and third place was awarded to St Peter's School in York (right).



Physoc combines fun and physics

What a whirlwind of a first term in office as the Physoc chair.

To kick off the year we led a pub crawl where we showed off the good-looking new recruits to the streets of Liverpool.

Then we hired out the Camel Club in Liverpool and filled it with ghosts and ghouls for the Physoc Halloween party. Mid-term relief came in the form of a joint outing with the bowling society, where we showed off our skills to knock down some pins. To round off the year we had a free Christmas party for members at Hannah's Bar.

But enough of our fun and frolics. We organised some brain food, too, in the form of the rejuvenated "Lunchtime



Having some ghostly fun at last year's Physoc Halloween party.

lectures". There were three lectures last term, and each had a free buffet lunch provided. The first was a very passionate discussion about nuclear power with Lynn Moran. Then there

was a look at gravity with "The unsolved problem" by Mike Houlden. Finally, Andy Newsam wowed us with his spectacular pictures of and from the Liverpool Telescope in his talk "Dynamic astronomy", which finished the year off nicely. One of the students said that the lectures made them "remember what inspired them to do physics in the first place".

Next term we hope to host another three lectures, as well as a trip to Daresbury and a tour of the clean rooms and super computer in the Oliver Lodge, which are all normally out of bounds to the undergraduates. So far so good, I think!

Rachel Ashley, Physoc chair

The deadline for your contributions to the September 2008 issue of this newsletter is: Monday 21 July

E-mail your materials to davidcox@physics.org or iop@liv.ac.uk

Liverpool astrophysicists scoop research award

A team of astrophysicists from Liverpool John Moores University's (JMU) Astrophysics Research Institute (ARI) have scooped this year's prestigious Times Higher award for research project of the year.

The project, which involved rapidly designing and building a new instrument for the Liverpool Telescope (called RINGO) and using it to study gamma-ray bursts, was reported in last months' newsletter and published in *Science* in March 2007. In judging the team's project, "Measuring gamma-ray bursts", Prof. Peter Atkins said: "We were impressed by the extent of teamwork involved in achieving a successful outcome." Fellow judge Prof. Philip Esler, chief executive of the Arts and Humanities Research Council, said that the team had made a



The JMU astrophysicists collect their research project of the year award at a ceremony held in London.

"brilliantly innovative discovery into the fundamental nature of the universe that could have profound impacts in the decades ahead".

Accepting the award at a ceremony in London's Grosvenor House Hotel on 29 November, Prof. Carole Mundell, leader of the gamma-ray burst science team, said: "This recognises the dedication and teamwork of

our instrument scientists and observational and theoretical astrophysicists." Prof. Iain Steele, leader of the ARI instrumentation team, commented: "When we made our case, the university immediately recognised the scientific importance of our proposal and approved fast-track development of the instrument."

Prof. Chris Collins, who

supported the research and nominated the team, said: "This is a wonderful achievement and a great credit to our team of talented astronomers and technical staff." The award builds on Prof. Mike Bode's original vision for using large robotic telescopes to catch transient events in the universe.

Andy Newsam, branch secretary

Lecture sheds light on the Sun

More than 200 sixth-form students, accompanying teachers and branch members attended the recent sixth-form Christmas lecture. Dr Lucie Green from the Mullard Space Science Laboratory of University College London gave a lively and stimulating lecture entitled "Living in the Sun's atmosphere". This was part of the programme for the International Heliophysical Year, which includes among its aims the investigation of the violent processes that take place on the Sun and how much life on Earth is affected by the Sun's changes.

Dr Green began her talk with a brief outline of the known structure of the Sun. Features such as the core, radiative zone, convective zone, photosphere, chromosphere and corona were outlined and illustrated, while information about temperatures, nuclear fusion and gamma-ray emission was given. Dr Green then focused on the Sun's surface and "atmosphere". She explained how this atmosphere expanded into space, forming the solar wind, and outlined the impact on the Earth's magnetic field.

Dr Green then concentrated on sun spots, solar activity and



Dr Green delivers the popular sixth-form Christmas lecture.

flares. She mentioned that 12 space missions are currently observing the Sun's activity, and with some beautiful photographs and diagrams she was able to illustrate the structures seen in the Sun's atmosphere. The magnitude of coronal mass ejections and their correlation with sun spots were illustrated, as was their variation in frequency with the Sun's cycle.

The lecture continued with more detailed information about two of the latest space missions: HINODE and STEREO. HINODE is a Japanese probe designed to observe the magnetic field in the Sun's photosphere. STEREO, as the name suggests, is a programme being conducted by

two satellites in solar orbit. The investigation aims to provide a better understanding of the evolution and structure of the Sun's magnetic activity.

Dr Green concluded with some illustrations of how we on Earth are affected by the Sun's activity. The solar wind continually collides with the Earth's atmosphere, and plasma from the Sun streams into our magnetic field causing the auroras. Flares and coronal mass ejections have also been known to damage satellites. Although astronauts on the space station (inside the Earth's magnetic field) would be protected from radiation, if missions to the Moon or to Mars were undertaken, precautions would be required. Other Earth-bound species besides us are affected by solar activity. Birds that navigate using the Earth's magnetic field are sometimes confused during periods of intense solar activity.

The lecture was well received. Although the large numbers inhibited the number of public questions, Dr Green was besieged after the lecture by a stream of individual enquiries. **David Starling**, committee member

MERSEYSIDE PHYSICS TEACHER NETWORK NEWS

11 March 4.30-5.30 p.m.

Life in space

What's it like to work and live on an orbiting space station? Will we succeed in sending a manned mission to Mars? These and countless other questions will be discussed when Dr Alexander Martynov of the Russian space city Korolev visits Liverpool. Dr Martynov worked for Russia's Mission Control Centre from 1968 until 1992 and has designed re-entry modules and controlled their flights to provide soft landings on Earth, Mars, Venus and other planets of the solar system.

This lecture is aimed at science teachers and will be held at St Francis Xavier's College. To book places, e-mail lht@blueyonder.co.uk.

● Other network activities booked so far (all at the Discovery CLC on the Wirral and aimed at KS3-4 science teachers):

26 February Waves

8 April Energy

10 June Virtual Physics Lab

(software for classroom use)

Dirac equation becomes simpler

On 22 November a larger than usual audience heard Peter Rowlands talk about a new form of the Dirac equation that he has developed. This talk has already been given to the South West Branch and was enthusiastically reported in their newsletter.

One of the major discoveries of the last 50 years has been the Standard Model of particle physics. This shows that the fundamental building blocks of matter – the quarks and leptons – are all fermions that can be grouped into only three families. More than three seems to have been ruled out.

The correct relativistic differential equation to describe fermions was first written by Dirac in the 1920s, and it has been a source of fear to generations of postgraduate students who have had to grapple with its complicated mathematical structure of four-component wave functions (spinors) and non-commuting 4×4 gamma matrices. Doing calculations with it is a nightmare. Rowlands' claim is that this traditional form of this important equation has a huge amount of redundancy, and its complex structure prevents us from seeing some new insights into how the universe works.

His proposal is that the Dirac equation can be written in a much simpler algebraic form using nilpotent concepts. Formally, a nilpotent is a



Peter Rowlands' intriguing talk about his development of a new and simpler version of the Dirac equation attracted a large audience.

repeated operation that yields zero, but one can also think of it as a non-zero solution of the equation $A^2 = 0$. A familiar equation of this form is $E^2 - p^2 - m^2 = 0$, where E is energy, p is momentum (a vector $\mathbf{p} \cdot \mathbf{p} = p^2$) and m is mass.

In his talk, Rowlands showed how to write a nilpotent solution to this equation using quaternions ijk and a multivariant vector, \mathbf{p} (that includes spin). Quaternions have long been out of fashion, but here they provide a neat and elegant tool to inject the necessary mathematics into the nilpotent solution.

He then showed that the quaternions did the job of the 4×4 Dirac gamma matrices, and, when you take the usual step in quantum mechanics of replacing E and p with differential operators, you end up with a nilpotent operator that seems to do everything that the Dirac equation can but is

mathematically simpler.

A feature of nilpotents is that they can be multiplied by an arbitrary scalar function yet retain their nilpotent properties. Also, by definition, two identical nilpotents multiply to zero – just the behaviour needed for identical fermions. This nilpotent form of the Dirac equation has the Pauli principle built in.

To prove his point, Rowlands transformed the nilpotent into spherical polar co-ordinates and, in a few lines of algebra, derived the full energy level scheme for the hydrogen atom, which included the fine structure due to the spin-orbit coupling and relativistic mass increase. To those who have only seen this done using perturbation theory, this was an impressive demonstration.

Many other points were quickly mentioned, but there was no time for detailed exposition. The basic idea is that the “three-ness” that



Rowlands (left) is introduced by the vice-chair, Steve Barrett.

we see in the world and the Standard Model (three types of charges, three fundamental symmetries CPT, even the three dimensions of space, etc) are all related to the quaternions ijk , which can have multiple interpretations. Even the vacuum can have three different nilpotent structures that leave the fermionic Dirac nilpotent unchanged.

Rowlands passed round a copy of his new book, *Zero to Infinity*, recently published by World Scientific, which sets out in great detail all of this material and much more.

After the talk, Prof. Mike Poole said that this was one of those lectures that will stay in the mind for a long time because it presented familiar material in a completely new and unexpected way. The audience showed their appreciation of the talk with a round of applause.

Mike Houlden, committee member

Medical implants rely heavily on surface physics

Dr Rachel Williams from Liverpool University's departments of Clinical Engineering and Ophthalmology gave a lecture approved for postgraduate medical education in November at the Liverpool Medical Institution (LMI). She said that medical implants have mechanical and engineering aspects and must work in their biological environment. Any deficiencies and the device will fail.

The biological response depends on the surface physics, and the chemistry and topography can be modified to control the cellular response



Robert Gillies (LMI), Dr Rachel Williams (centre) and Prof. Mike Poole.

to implanted materials. Silica nanoparticles decrease unwanted cell adherence and can inhibit the growth of cells (e.g. behind artificial lenses). Bacterial infections around coated orthopaedic implants

can be lessened, as can fungal infections (e.g. thrush) on the dentures of susceptible people, and nanoparticle ridges can help to fix some implants.

Age-related macular degeneration is a major cause

of blindness and her research aims to create a monolayer sheet of cells that can be placed (like a carpet) under the retina to replace the damaged cells. Clotting of vascular stents placed to widen narrowed blood vessels can be slowed by a suitable coating that encourages the healthy endothelial cells to cover it, creating a more normal lumen.

An orthopaedic surgeon stressed the importance of implant research: an ageing population will need more and longer-lasting implants.

Nick Clitherow, LMI representative

Teachers go subatomic at CERN

A group of eight teachers and two science communicators was accompanied by scientists from the University of Liverpool in a branch-sponsored visit to CERN in Geneva. This was a unique opportunity for local teachers to meet with scientists working at some of the most exciting frontiers of science.

After visiting the MICROCOSM exhibition centre to learn about the history of CERN and the outstanding questions that motivate physicists to study matter at its most fundamental level, the group was taken on a tour of the ISOLDE radioactive ion-beam experiment.

ISOLDE scientist Dr Magda Kowalska explained how exotic nuclear beams are produced, before giving an excellent tour of the facility, showing experiments where the beams are used in a variety of applications from measuring nuclear masses, deformations and fundamental interactions to



The group of local teachers and scientists enjoying their visit to CERN.

understanding the properties of solid-state materials.

The group was then taken deeper into the subatomic realm by Dr Mark Tobin and Tony Smith from the University of Liverpool, who are working on one of the four key high-

energy physics experiments at CERN – the Large Hadron Collider beauty experiment (LHCb). Mark and Tony talked enthusiastically about their work on the vertex locator (VELO). The VELO is a precise particle-tracking detector in the

LHCb experiment. At its heart are 84 half-moon-shaped silicon detectors, and each one is connected to its electronics via a delicate system of more than 5000 wires.

These sensors will be located very close to the collision point of accelerated proton-antiproton beams that are circulating deep under the Swiss-French border. The VELO will play a crucial role in detecting beauty quarks, which will help in understanding the imbalance of matter and antimatter in the universe.

The group was shown round the assembly area for the VELO before being taken down into the underground cavern where the enormous scale of the complete LHCb experiment could be appreciated. This was a marvellous chance to see the detectors before the Large Hadron Collider is switched on later this year.

David Joss, committee member

Security of data may depend on quantum mechanics

In a very informative lecture held on 8 January at Daresbury Laboratory for an audience of members of both the Manchester and Merseyside branches of the Institute, Prof. Stephen Barnett of Strathclyde University summarised the threat of, and the potential solution to, the basis of all secure information transmission.

Prof. Barnett opened his talk by reminding the audience that the concept of money is no longer based on coins, notes, bullion or any other material objects but on the electronic transmission of data between people and cash machines or between financial institutions around the globe. If that transmission is not secure, such that transactions between two parties cannot take place without an eavesdropper intercepting and potentially interfering with the data, then money is worthless.

Prof. Barnett proceeded to give a very clear introduction to the basic ideas behind the secure transmission of

information, from the exchange of messages in a box with mechanical locks and keys to the electronic equivalent using encryption algorithms. Public key cryptography, based on very large prime numbers, is considered to be secure due to the mathematical difficulty of factorising very large numbers that are the products of two prime numbers.

For instance, using a brute-force method to decrypt a transmission encrypted with a 40 bit key (a number of size 2^{40} , or about 10^{12}) would only take a few days on a personal computer. Larger keys, such as 128 or 1024 bit keys, would take exponentially longer to crack. This means that transmissions between banks are secure, provided that the encryption keys are long enough – if it takes more than a few million years of computer time to crack a code it can be considered safe. At this point, quantum mechanics enters the story.

A quantum computer is capable of parallel processing in the true sense of the phrase.

Quantum mechanics allows a system to exist in more than one state at a time (a superposition of states), so a quantum computer can produce an output that is not simply a single value calculated from a set of inputs but a superposition of output states. In principle, this means that a quantum computer could be used to factorise an arbitrarily large prime number very quickly, and effectively crack the encryption algorithms that are in current use. This won't happen in the next few years because the technology of quantum computing is still in its infancy, but it will happen. It is expected that the development of new quantum encryption methods will keep encryption a step ahead of decryption and so ensure that the transmission of data remains safe and secure.

A lively question-and-answer session followed the talk, indicating that the audience was suitably intrigued by the ideas presented and the (lack of) security of their money in the bank.

Steve Barrett, vice-chair



New student rep Rachel Ashley.

Women in Physics benefits from a new student voice

Congratulations to Rachel Ashley who has been elected as the student representative on the Institute's Women in Physics Group committee. Rachel is an undergraduate in the physics department at the University of Liverpool and is the 2007–2008 president of Liverpool Physoc.

This will be a great opportunity for her to be a student voice on a national committee of the Institute.

Ann Marks, IOP council member

ASE reaches the frontiers of science

Early January saw an excellent start to Liverpool's year as European Capital of Culture with the annual conference of the Association for Science Education (ASE). The Institute had a particularly strong presence with the impressive stand in the exhibitor's marquee and the drop-in room in the Surface Science Research Centre.

The three-day conference has a number of themes that run for the duration. This year it was "Earth science and sustainable development", alongside discussions about research in science education, with input jointly from the ASE and the British Educational Research Association. My preference was for the "Frontier science" sessions given by staff from the University of Liverpool and scattered liberally across the entire programme.

I went to some very interesting talks, including "Plasma: the fourth state of matter", given by Prof. James Bradley, "Mega-tsunamis,



Gary Williams addresses the Teachers Network coordinators.

super-eruptions and the hazards of hype" by Dr Peter Kokelaa, and Dr Dominic Dickson's "Einstein: his life and legacy". Dominic (aka Prof. Pringle) presented the "Big Bang science variety show" as part of the social programme for delegates at the halls of residence.

The ASE conference always generates excellent discussions, arguments and inspiration for those of us in science education. The range of talks and workshops on offer never fails to



The Institute's useful drop-in room at the Surface Science Centre.



The plastic pipe demonstration.

impress. However, the best ideas often come from those informal settings, such as chatting after a workshop in discussion with a colleague while fending off a sales representative.

This year my favourite demonstration had already been shown to half of the students in my school. Using the plastic pipe in the image shown on the left, press down with your finger to spin a small section of the pipe so that it rotates about two axes. Surprisingly, the only figure you can see as the pipe spins (X or O) is the one on the side that you flick. Can you explain why?

Lucas Heyhurst, Merseyside network coordinator

The Physicists in Primary Schools Project invites you to play a part

Last September, two training workshops were held for Merseyside Branch members who were interested in taking fun presentations into primary schools. One was hosted by the Department of Physics at Liverpool University and the other by STFC Daresbury Laboratory. The response from both was excellent and thanks are due to all who helped to organise them or took part.

Ten presentations, linked with areas of the National Curriculum, are on the Institute website (www.iop.org). The sessions, which are described in detail, are fun and very much welcomed by the teachers because they excite the interest of the children and link basic science to the world around them.

There are a huge number of primary schools, so training workshops are being held across the UK. So far I have run six,

which have covered Manchester, Sheffield, Cambridge, Cardiff and Merseyside. Nearly 100 attended and almost all who came to the workshops now have contacts with primary schools. Other sessions are planned for Durham, Birmingham, London, Leicester, Sellafield, the Rutherford Appleton Laboratory and many more places.

As an extra resource for those who are uncertain about offering to visit schools, a video is being added to the website for each presentation. These show clips of members of the Sheffield team presenting the sessions in schools. Could you do better?

A many-to-many e-mail network has just been launched so that you can now discuss your experiences with the Sheffield team and others who have used the material on the website. If you would like to join the

network, e-mail me on a.marks@sheffield.co.uk.

If you work in an establishment where there are physicists, chemists and/or engineers who would like to visit primary schools and therefore would be interested in knowing more about the project, do contact me to arrange a workshop. These provide opportunities to take part in some of the ready-made presentations, try the activities and discuss concerns. Young children love science and enjoy doing practical work. Your scientific expertise will be greatly appreciated and the children will have lots of questions for you to answer. You may be surprised to find how much you enjoy it.

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More about the Teachers Network and how the Institute can help your school at <http://teachingphysics.iop.org/>

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website at
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