

LANBRIA

The newsletter of the Lancashire and Cumbria Branch of the Institute of Physics

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Editor's lines on the leaves

This month *LANBRIA* brings you not one but two interviews with key physics researchers at Lancaster University. Louisa Reynolds has been extremely busy talking with Laura Kormos (in the particle physics division) and Oleg Kolosov (experimental condensed matter division). Readers with good memories will remember that *LANBRIA* interviewed Laura in the June 2006 issue. This time the emphasis is on her work for the

T2K experiment in Japan.

Just as remarkable, *LANBRIA* brings you a theatre play review, kindly provided out of the blue by John Bowers, and a book review. *LANBRIA* is always delighted to receive articles from readers and we also welcome comments. Since the last issue Tony Lenton has been in touch to provide his expert advice on aerials for Freeview and a warning of a "digital" aerial scam.

Do support the AGM and the monthly lecture programme. Ideas for future talks are always welcome, as are suggestions for making the branch work better. These should be sent to the chair or the secretary.

I hope you enjoy this 34th issue of the newsletter.

Chris Bowdery

● Correction to Issue 33 (p6): for "Our Ladies and All Saints" read "Our Lady and All Saints", the school in Parbold.

Remarks from the chair

The year so far has been successful, with many interesting evening lectures, though the attendance at some has been a little disappointing. If you have any suggestions for changes to our arrangements to increase the frequency (or probability) of your own participation, I would be glad to receive them.

As I write this we are looking forward to the imminent visit by the Institute president Prof. Dame Jocelyn Bell Burnell. This was added to our programme as an extra meeting, in collaboration with the Science Faculty at Lancaster University, when Dame Jocelyn asked that the local branch should be involved in her lecture during a visit to it at Lancaster. In the International Year of Astronomy this gave us a marvellous opportunity to enhance the lecture series by adding such a distinguished speaker to our programme. During the afternoon Dame Jocelyn will present prizes to young people in our area who have performed very highly in their 2008 A-level physics examinations, and we hope that meeting her will inspire them to aim for similar success during their own physics careers.

Another event we are looking forward to is the AGM in May. Two years ago the Institute revised its regulations for continuity of service on the branch committee, in particular introducing a rule limiting members to nine years in any 13. The effect was to require a simultaneous complete change of branch officers. I have been very grateful since then for the continuing participation in committee meetings of some former officers "in attendance", who can recollect methods and ideas from past events and give us guidance on many aspects of our activities.

However, to go forward now the branch needs some new people to continue the evolutionary process, both as ordinary committee members and as prospective future officers. Whether you are a newly joined student member or a retired person with a lifetime of experience in physics, please consider if you could help. The commitment of time and effort need not be great, though of course we are very glad when it is. The rewards are intangible but very real. For example, I recently helped out at a science event for primary schoolchildren,



Prof. Dame Jocelyn Bell Burnell visited Lancaster University (p7).

and the huge enthusiasm they showed in performing the simple physics experiments we displayed was very gratifying. I came away feeling that it was a day very well spent. There is no need to become involved in such outreach activities of course.

So, if you want the Lancashire and Cumbria Branch to prosper, please get involved with whatever contribution you can make, large or small. Contact any of the officers or committee members to discuss how you could participate. Or if you are currently unable to help directly with the committee work, come to the AGM and tell us how you want the branch to proceed in the coming year.

Ian Saunders

Lancaster team's key role in T2K

High-energy particle physics (HEP) is one of the most active areas of physics today, and Lancaster University plays a key role in international research.

Research in HEP at Lancaster has directed its energies into three main projects. ATLAS is a detector based at the Large Hadron Collider at CERN. It will be involved in searches for the Higgs boson and investigating the origin of mass and extra dimensions of space. The DZero project, based at Fermilab, studies charge-parity (CP) violation in the quark sector by exploiting the ability of the neutral B meson to transform spontaneously into its anti-self. The third operation, the long-baseline neutrino experiment T2K, is another international collaboration and is due to start operation this year. The neutrino beam spans the 295 km width of Japan, from production in Tokai to the Super-Kamiokande neutrino detector at Kamioka. I went to see Dr Laura Kormos at Lancaster University to find out about the role of her team for T2K.

"Here at Lancaster we've built a chunk of the near detector ND280 at 280m downstream of the neutrino production target," Dr Kormos explained. As well as playing a lead role in the assemblage of the electromagnetic calorimeter ECal that fits inside ND280 and measures the state of the neutrino beam close to the start of its journey across Japan, Lancaster's main role in T2K has been to build an important piece of ECal – the downstream calorimeter DS-ECal that will take most of the neutrino beam.

DS-ECal

Measuring $2 \times 2 \times 0.5 \text{ m}^3$, the DS-ECal contains 34 layers of lead separated by layers of parallel plastic scintillator bars (alternating each layer to form a 3D mesh) doped with "fluors", molecules that produce showers of light in response to the charged particles and photons that are the product of neutrino interaction with the lead. Threaded through each scintillator bar is a WLS



Dr Kormos with a prototype of the ECal electromagnetic calorimeter.



ECal on a lorry: Laura Kormos (centre) with Lancaster University colleagues Peter Ratoff (right) and Ian Mercer (left).

(wavelength-shifting) fibre that transports the light by internal reflection. It works just like ordinary fibre-optic cables but changes the wavelength of the light to green, the colour most easily detected by the multipixel photon counters (MPPCs) at either end of each fibre. The signals at the ends of the fibres are channelled and read by a computer to reconstruct the shape of the lepton and photon showers that describe the identities and energies of the particles that interact with the lead. Dr Kormos' team is responsible for the testing of each part of the DS-ECal and the development of the software to reconstruct the paths of neutrino products inside it.

Dr Kormos explained the history of neutrino research that led to T2K. The prediction of the flux of neutrinos that

would reach Earth from the nuclear fusion reactions in the Sun had already been confirmed by observation at the Sudbury Neutrino Laboratory in Ontario, Canada, but as three different flavours – electron, muon and tau neutrinos. It was known that the Sun only made the electron type, so where had these other neutrino types come from? "We know that the Sun is producing nu-e. But we know that on Earth what we detect is not all nu-e. So even though it's producing a pure nu-e phase, there must have been some quantum-mechanical admixture of states in there." Observations at Super-Kamiokande indicated that neutrinos have mass and the Super-K data are consistent with the "neutrino oscillation" hypothesis.

If we consider neutrino oscillation in two neutrino mass

eigenstates (1 and 2) and two weak eigenstates (electron and muon neutrino) only: when an electron neutrino is produced in a reaction, it exists in a superposition of mass eigenstates 1 and 2. Each of these states contains a certain amount of the weak eigenstates electron neutrino and muon neutrino. But as the muon parts of mass eigenstates 1 and 2 are in antiphase they cancel, leaving only the "electron-ness" of the neutrino, with the "mu-ness" cancelling out. As a neutrino travels through the body of the Sun, the mu-ness and electron-ness of the neutrino oscillate, changing the quantum-mechanical probability that we will find it as an electron neutrino or a muon neutrino. "In a chart of nu-mu disappearance flux, evidence of neutrino oscillation can be seen as a dip. The position of the dip tells us the mass difference of the neutrino types and the depth of the dip gives the mixing angle."

Mixing angles and CP violation

The way that the weak eigenstates and mass eigenstates are related is described by a matrix that in two dimensions looks like an ordinary rotation matrix with a "mixing angle". When we consider the tau-eigenstate and the third mass eigenstate, the equations become a lot more complicated but the matrix can be broken down into three rotation matrices, each with a different rotation (mixing) angle, and θ_{13} is the smallest and most difficult to measure.

Always appearing with θ_{13} in the equations is a complex quantity called delta, which is thought to be a violator of CP symmetry. "If matter and antimatter are produced equally in every interaction, then shortly after the Big Bang they would all have annihilated each other. So where did all the antimatter go? We need CP violation to explain that." To measure the mixing angle θ_{13} and to understand the nature of the parameter delta are two of the aims of scientists at T2K.

Louisa Reynolds

Microscopy advances get physical

Dr Oleg Kolosov is a materials scientist from Kiev who pioneered the technique of ultrasonic force microscopy (UFM), as well as using it to develop specific materials. He joined the Lancaster physics department as a reader in experimental condensed matter physics in 2006.

The development of the scanning tunnelling microscope by Heinrich Rohrer and Gerd Binnig for IBM Zurich won them the Nobel Prize in Physics in 1986. It was the first example of scanning probe microscopy (SPM), and worked by allowing electrons to tunnel across the gap between a sample and a sharp tip attached to a scanner, measuring the amount of current that gets through.

Force interactions

Binnig went on to work with Cal Quate at Stanford, where they developed the scanning force or atomic force microscope (AFM) by looking at other force interactions between tip and surface, rather than current only. These days tip deflections of the order of picometres (10^{-12} m) caused by atomic forces are measured by bouncing a laser beam over a cantilever that carries the tip and acts as a spring.

Acoustic microscopy works in a similar way, applying sound waves to a sample to detect its mechanical response. Dr Kolosov explained: "I was working on acoustic microscopy with polymers and biological materials and I decided that it would be a good idea to combine acoustic and scanning probe microscopy." While working on combining acoustic microscopy with AFM in Japan, Dr Kolosov had been trying to solve a problem. Traditional acoustic microscopy had a resolution at best of the order of the wavelength of light. To increase the resolution he needed to use the tip as a detector of the ultrasonic waves applied to the sample, but the cantilever could not respond to such high frequencies. However, as the amplitude of the vibrations increases you start to get



UFM pioneer, Dr Oleg Kolosov.

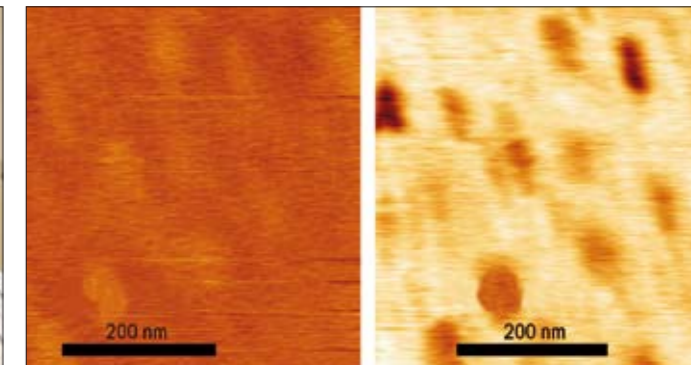


Fig. 1. A single atomic sheet of graphene on a silicon wafer. The topography (left) shows signs of ~ 0.1 to 1 nm high "nano-buckles", whereas ultrasonic force microscopy (right) clearly reveals them and estimates the mechanical stiffness modulus of each nano-buckle.

a low-frequency response because of rectification of the higher frequencies in the tip-sample contact, similar to the rectification in a diode. This low-frequency response is very sensitive to small atomic forces, while the high frequencies are good for indenting because the cantilever becomes stiff at those frequencies. "The amplitude of vibration involved here is only about 5–10 Angstroms and the tip touches the sample most of the time, making UFM quite different from the so-called 'tapping mode AFM', where the tip vibrates with 100 nm amplitude and it touches the sample for only a minute fraction of a vibration period." Dr Kolosov continued to develop the new UFM at the University of Oxford.

After patenting new materials in California by testing libraries of ingredient combinations, he came to the Lancaster physics department, which had already developed a reputation for scanning probe microscopy. Drs Pollock and Hammiche had been exploring thermal microscopy by sending a spectrum of optical waves through samples to test the thermal response, a technique called photothermal microspectroscopy that gave information about the chemistry of material samples.

Dr Kolosov's field now involves testing the physical properties of materials in a similar way, but using a UFM heterodyne principle

instead of a spectrum of light to measure the nanoscale properties of materials.

The heterodyne technique involves the application of two slightly different ultrasonic frequencies to a sample and the tip simultaneously, and measurement of the peak in sample response using the cantilever at a different frequency. Thus, detailed information about the mechanical high-frequency response of the sample can be obtained without having to get a high-frequency response from the cantilever. Using ultrasonics in this way increases temporal resolution so that processes can be observed as they happen.

Revealing properties

UFM has a high enough resolution (2–5 nm) that reveals nanoscale physical properties of very stiff materials like silicon carbide or single atomic sheets of graphene, as he recently demonstrated in collaboration with Prof. Falko (see figure 1). The method is also effective for the scrutiny of soft biological tissue. This is because the application of ultrasound induces superlubricity by detaching thin layers from a surface so that the layers behave like a liquid, dramatically reducing the levels of friction between the tip and the surface. This can improve many nanoelectromechanical systems devices where friction can kill many of the

applications because of the high surface-to-volume ratio.

As well as planning to measure the mechanical properties of vitrified (frozen, live) biological tissue, and the amyloid fibres that occur in the brains of sufferers of Alzheimer's disease, Dr Kolosov will also help to develop a carbon nanotube tip for a scanning probe microscope to increase the resolution still further by increasing the localisation of the thermal responses in the materials under test. "What we would like to do now is expand [UFM] to electrical and thermal properties so that we can measure wave phenomena on a small length scale." It would also allow temporal resolution down to the 300 picosecond scale, and these increases in resolution will enable research, for example, into phase-change memory alloys to improve the density and energy requirements of stored information and to replace flash memory such as that on a memory stick.

I asked Dr Kolosov what is the future for the field of SPM. He asserts that biotechnology, along with advances in IT and energy, are crucial to the development of our society. "To have an effect, we have to have the means and tools for understanding how things operate on a very small length scale," he said. "That is why new methods of SPM are crucial."

Louisa Reynolds

What's the weather like on Venus?



An artist's impression of conditions on the surface of Venus showing hot, volcanic plains and clouds made yellow by sulphur compounds. Lightning has recently been detected by the Venus Express spacecraft.

The weather forecast for tomorrow is high-pressure gloom with strong winds but remaining warm and dry – on Venus that is.

In Prof. Fred Taylor's (University of Oxford) fascinating and entertaining talk (on 18 March at the University of Central Lancashire), he covered the history of attempts to predict, measure and understand the climate of Venus.

Venus is in many ways Earth's smaller sister but has a much less forgiving environment, which can provide lessons for Earth's future too.

In 1915 Arrhenius made the first estimate of the temperature on Venus based on the energy balance of incident solar energy with that reflected (much higher than Earth) and radiated as infrared. He estimated ~47°C at the equator and ~10°C at the poles, which is in principle habitable and lead to a lot of "little green men" speculation. However, radio telescopes and early satellites detected high emissions, indicating surface temperatures

of up to 1000 K.

In the 1970s Russians sent the Venera series of probes to Venus. Numbers 7 to 15 landed on the surface. In their short lives (20–120 minutes) they sent back pictures of the surface (a basaltic lava plain), temperature (750 K, ~450 °C) and pressure (92 bar) measurements, and analysis of the atmosphere (96% CO₂, 3.5% N₂, 150 ppm SO₂ and only 20 ppm H₂O); nothing like Earth.

In 2006 the European Space Agency's "Venus Express" arrived in a very elliptical polar orbit that was designed to give a close approach to the north pole and a far one from the south to give a long view. (Venus has little axial tilt, so both poles are similar.) Prof. Taylor and his team are using the data to test atmosphere models, which are useful on Earth, in the extreme conditions of the Venusian atmosphere.

So why is it so hot and the pressure so high? The simplest model of an atmosphere, derivable from physical principles gives:

$$\frac{dT}{dz} = -\frac{g}{C_p}$$

(see figure 1), which gives a temperature versus pressure profile very similar to that of Earth, the higher temperature resulting from the higher pressure. So why is the pressure so high? On Earth the oceans absorb CO₂ and form carbonates, some of which are recycled via volcanoes. However, Venus has very little water, so volcanic CO₂ (and SO₂) are not removed and may be in equilibrium with calcium silicates, as proposed by Urey (1952).

$CaCO_3 + SiO_2 \rightleftharpoons CaSiO_3 + CO_2$

This equilibrium exists at 92 bar, 720 K, remarkably close to the measurements.

So, where's the water? Venus doesn't have any magnetic field so the atmosphere is exposed to the full force of the solar wind, ionising any water and "blowing away" the hydrogen. And the magnetic field? Not known, yet.

The other area of interest is the weather; cloud movements

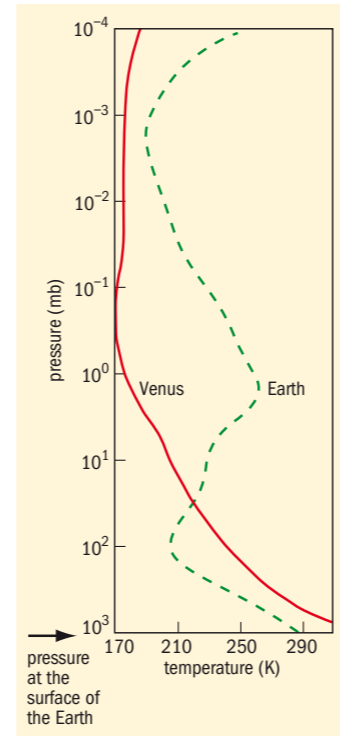


Fig. 1. A profile of atmospheric pressure against temperature for Venus and Earth.

indicate high winds. The spin of Venus is very slow, taking 243 Earth days for one rotation and it is retrograde (if you could see it, the Sun rises in the west). This slow spin means that "air" rising at the equator can then move close to the poles, where it cools and sinks and flows back along the surface to the equator in a classic "Hadley Cell". Thus in the northern Venusian hemisphere the north wind doth blow. (On Earth, this simple model is disrupted by the Coriolis effect, as the winds move to the poles the Earth's surface is moving more slowly under them, causing them to veer eastwards and breaking up the cells into bands, hence UK winds are mainly from the south west and anti-clockwise around a depression.) At the poles on Venus there are strange cloud patterns that are causing great interest and are not convincingly explained.

• At the UK Space Conference in April, Prof. Taylor was given an Arthur C Clarke Lifetime Achievement award.

John Bradshaw

Digital radio goes global with DRM

As part of the branch lecture programme, Oliver (Ollie) Haffenden from BBC Research gave a talk on "Digital Radio Mondiale and the BBC Radio Devon trial" on 10 February at Lancaster University.

Firstly what is Digital Radio Mondiale (DRM)? It is a digital radio broadcast system for use in the long-, medium- and short-wave bands (100 kHz–30 MHz), which are often referred to historically as the AM bands. Since short waves can travel around the world, mondiale, being French for worldwide, is an appropriate name. Although the bandwidth is only 10 kHz, clever compression techniques allow near-FM sound quality with no background noise. In contrast, the digital audio broadcasting (DAB) system uses frequencies above 30 MHz and it reaches only as far as the horizon of the transmitter. CD-quality sound or a large number of channels of lower quality is possible with DAB.

The challenges

There are a number of challenges for broadcasters wanting to use short waves. Signal propagation around the Earth involves refraction at the ionosphere so that the radio waves "bounce" between this atmospheric layer and the ground (see figure 1). There are multiple paths from the transmitter to the receiver that are constantly shifting, causing reception conditions to vary. Analogue radio broadcasters have to use different frequencies from day to day and these have to be published in tables, which is not very user-friendly.

DRM uses coded orthogonal frequency-division multiplexing. This means that it splits a frequency band into hundreds or thousands of individual subcarriers, with just the right separation between each to ensure that they do not interfere with each other – the orthogonality condition. Each subcarrier transmits so-called symbols using quadrature amplitude modulation (QAM), which conveys data by changing

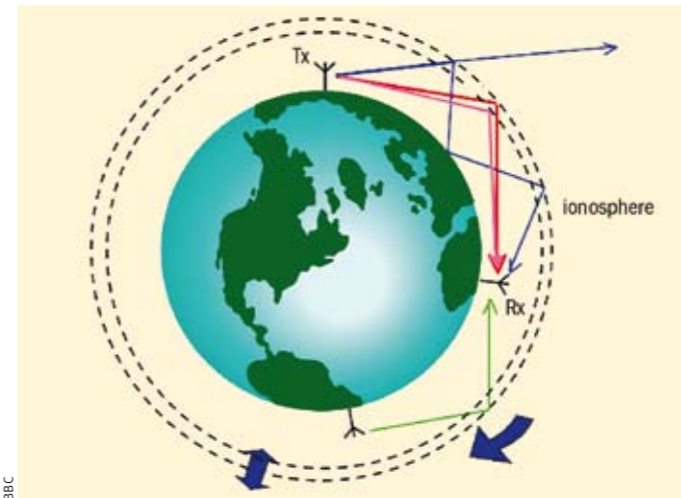


Fig. 1. Signal propagation around the Earth involves refraction at the ionosphere so that radio waves "bounce" between this atmospheric layer and the ground. Copyright BBC (used with permission).

the amplitude of two carrier waves. These two waves are out of phase with each other by 90° and they are therefore called quadrature carriers.

Ollie illustrated the 64-QAM (6 bits of data) method using a so-called constellation diagram, which is a grid of eight-by-eight dots on the complex plane (see figure 2 for an example of 16-QAM). The real and imaginary axes are often called the *in-phase*, or I-axis and the *quadrature*, or Q-axis.

To avoid interference problems due to multiple paths, guard intervals with delay tolerances of about 2.33 ms are inserted between the data symbols. The required signal-to-noise ratio is about 17 dB.

Since 6 bits are used for each subcarrier there is a total bit rate of about 20 kbps per second at most. DRM uses one of the following MPEG-4 audio coding (data compression) techniques along with spectral band replication:

- AAC: good for music and speech; 10–20 kbps (as used on the iPod).
- HVXC: good for clean speech only; 2–4 kbps.
- CELP: good for speech; around 8 kbps (used on mobile phones).

Ollie demonstrated the sound quality of these schemes, with AAC appearing to reproduce high-frequency sounds well. Audio buffs would probably

complain that the sound is more sonic trickery than a true reproduction of the original, but DRM is not intended to be hi-fi.

Power consumption in the receiver is potentially very low if custom integrated circuits are developed. This is because the computing requirements are not steep as the bit rate is modest. The dominant power requirement will be in the audio amplification/loudspeaker driving part of the radio receiver.

Emergency broadcasting

Besides audio, DRM also provides digital data identifying the radio station. Other text data could be used to provide a news service and alternative frequency data for automatic retuning. Its possible uses include standard international broadcasting, emergency broadcasting into disaster areas, and domestic rural-area broadcasting.

Ollie discussed the recently completed BBC Radio Devon trial using the Plymouth transmitter (855 KHz in the medium-wave band). This year-long trial involved selected audience participation as well as a technical evaluation. As expected the signal-to-noise ratio varied throughout the day and the year because ionospheric variations affected the interference from a distant station.

Finally we had a demonstration

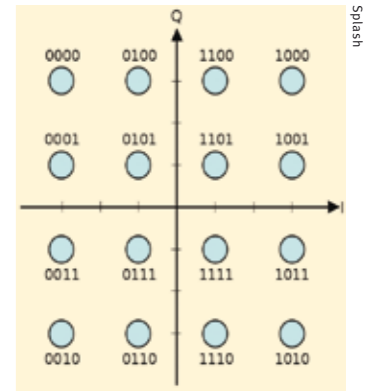


Fig. 2. A constellation diagram of a 16-QAM scheme with Gray code (from Wikipedia).

of Theseus, a test network of DRM receivers around Europe that are always listening to DRM transmissions and which can be accessed over the web. Contact Ollie (see below) if you are interested in using or contributing to Theseus.

So DRM exists and broadcasters are already using it. The BBC World Service and Deutsche Welle are collaborating on an 18-hour-a-day service. DRM receivers can be purchased, and although they are not on sale in UK shops at the moment, they can be bought on the web (visit www.drm.org for a list of available receivers).

DRM has the capability of allowing good-quality radio transmissions to be broadcast around the world. It is user-friendly and needs only modest power at the receiver. It is not intended to replace the current DAB digital radio services that are now familiar in this country. Whether it will become the main system for the BBC World Service and other international broadcasters remains to be seen. A range of alternatives are also available, including FM transmitters in the target audience countries, and the choice of broadcasting for each region will need to be assessed on an on-going basis.

Chris Bowdery & Louisa Reynolds

• Ollie Haffenden can be contacted at BBC Research, Kingswood Warren, Tadworth, Surrey KT20 6NP or by e-mail at oliver.haffenden@rd.bbc.co.uk.

Branch members get the picture

In the March issue of *LANBRIA* (p6) I expressed concern that some TV aerials would need to be replaced in order to watch digital terrestrial TV (Freeview). This followed a conversation that I had in 2005 with an aerial contractor who informed me that my main roof aerial was not a wideband one and so it would not work with digital transmissions. It was a conventional low-cost aerial that was installed in 1986 and it has worked fine for analogue TV.

Tony Lenton has written in to point out that most viewers in the Granada and Border TV regions should not need to change their aerials. It appears that there is some confusion that needs to be dispelled and even a digital aerial scam to be avoided.

Firstly, it is technically correct that digital terrestrial TV (DTTV) signals can cover a wider range of frequencies than are used for the analogue TV service, and a wideband aerial rather than a narrowband one



Chris Bowdery

An example of narrowband aerial (top) and a wideband one (right).

would be needed to receive them. However, in the Granada and Border TV regions (except in the Isle of Man) the DTTV frequencies to be used are all compatible with the narrowband aerials currently used for analogue TV. So the advice that

I received back in 2005 was incorrect in practice. This has been confirmed to me by the experience of branch members who have switched to Freeview. The following Ofcom website provides full details of the frequencies, power outputs and

polarisations for the multiplexes of all DTTV transmitters in the UK. Choose the relevant pdf file at www.ofcom.org.uk/tv/ifi/tech/dsodetails/.

Secondly, although reputable aerial contractors sometimes refer to wideband aerials as “digital” aerials, the unscrupulous part of the trade has been conning the public into purchasing unnecessary, expensive, new wideband aerials under the slogan “digital aerials for digital TV”. It needs to be made clear that technically there is no such thing as a digital aerial – analogue and digital TV can be picked up by the same aerial.

Tony tells me that a website exists at www.paras.org.uk to counter the digital aerial scam by providing reliable advice to the public. Do check it out.

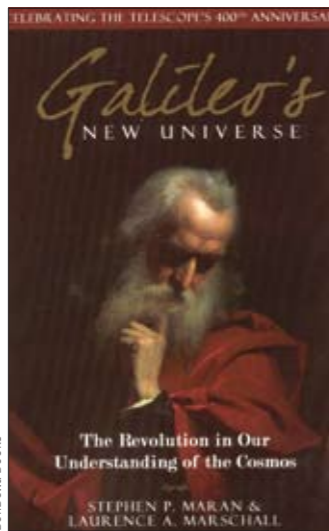
Thanks to Tony for getting in touch. If you have additional information or experience that you wish to share, contact me at chris.bowdery@physics.org.

Chris Bowdery

Book discovers Galileo's Universe

In the autumn term of 2008 Larry Marschall visited Lancaster University's physics department and gave a talk on Pluto to the branch. His new book, co-written with Stephen Maran, will delight all who heard him speak. *Galileo's New Universe* is 168 pages full of Galileo's astronomical discoveries with his *perspicillum* (telescope) and the latest information on these same topics. It is timed to celebrate the 400th anniversary of Galileo's first nocturnal adventures, as part of the International Year of Astronomy.

I was particularly fascinated to learn that Galileo was so afraid of rivals claiming to have made his discoveries before he did that he wrote them down enciphered in letters to fellow astronomers. The intention was to reveal the decryption key at a later stage, long after anyone would claim that they had discovered the same thing and not told the community. Kepler was impatient and tried



BenBella Books

unsuccessfully to decrypt the secret sentences. Amazingly he mistakenly deduced that Galileo had found two moons around Mars, when Galileo had communicated his findings that Saturn had three parts (actually rings around Saturn). Kepler was right, but the moons of

Mars were not found until 1877. Kepler then did this again with another message – this time deducing that Galileo had seen a red spot on Jupiter, when in fact Galileo had discovered the phases of Venus and proved it must orbit the Sun. Jupiter's Great Red Spot was not found until the 18th century.

To get the best out of this book, which is an easy read and understandable by the general public, you will probably want access to the internet to search for photos of the Moon, the Sun, Venus, Jupiter, Saturn and the Milky Way. None is included in the book, probably to keep the price down, and there are no URLs given, but a quick Google search will find lots of them. There is an extensive bibliography if you want to discover more.

The book is published in paperback by BenBella Books (Dallas, 2009): ISBN 978-1-933771-59-5.

Chris Bowdery

Visit the Lancashire and Cumbria Branch website at

<http://lancashire.iop.org>

The life and loves of a genius: Einstein play is worth a look

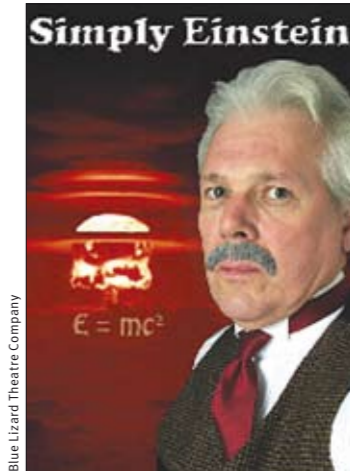
Simply Einstein is the latest production by the Blue Lizard Theatre Company based in Lancaster. Its first performances were well received by full houses at the Heron Theatre in Beetham, Cumbria.

Actor Steve Ashton's performance as Einstein is a well-researched but mischievous portrayal of genius bumping along among incidents of family, love and domestic life, against a background of changing political events in Europe in the 1930s. Ashton also makes a serious attempt to convey the principles of

Einstein's most important work.

On stage, Einstein is not a solitary figure as an ingenious use of animated back projection fills the stage with a range of characters. Galileo, Darwin, Schrödinger, Planck, Hitler, Einstein's wife Mileva, his children – legitimate and illegitimate – are all swept along in the tide of his preoccupation with his scientific theories. Animation is also well used to illustrate the scientific principles.

The audiences emerging from the first performances were enthusiastic, amused and certainly better informed



Blue Lizard Theatre Company

about the life and work of this great scientist.

Venues for forthcoming performances of *Simply Einstein* include the Daresbury Laboratory on Friday 18 September at 7.00 p.m. and Alston Hall, Preston, on Sunday 4 October at 6.30 p.m. Information about further performances, which I am sure would be enjoyed by physics students of all ages and more general adult audiences, can be found at www.bluelizardtheatre.co.uk. Blue Lizard can be contacted at info@bluelizardtheatre.co.uk.

John Bowers

Prof. Bell Burnell visits Lancaster University

The Institute president Prof. Dame Jocelyn Bell Burnell came to Lancaster University on Wednesday 8 April to give a lecture on pulsars to the Faculty of Science and Technology.

As a postgraduate student, Dame Bell Burnell played a key role in pulsar discovery and she has kept a close eye on every development since then. One interesting fact is that the radio signals from pulsars reaching Earth are extremely weak. This means that no extragalactic pulsar has yet been found. In fact pulsars have not yet been



Chris Bowdery

From left: Christopher Jackson, Joceyln Bell Burnell, Mary Smyth (faculty dean), Peter May, Simon Lock and Helen Cammack.

detected on the far side of our own galaxy.

At the end of the talk, the branch took the opportunity to present prizes to the top AQA A-level physics students from June 2008: Helen Cammack (Runshaw College), Simon Lock (Kirkbie Kendal School), Christopher Jackson and Peter May (both Lancaster Royal Grammar School). Each of them received a copy of the book *Do Polar Bears Get Lonely?*, a book token and a branch certificate printed on special canvas photo “paper”.

The deadline for your contributions to the September 2009 issue of this newsletter is:

Saturday 1 August

E-mail your material to: chris.bowdery@physics.org

Branch news and upcoming events

Holker Garden Festival 29–31 May. Can you help with physics outreach?

Liz Jeavans and a Physics in the Field team will be at the Holker Garden Festival in Cumbria this month. The branch will be providing personnel for the team, which will be performing some exciting outreach activities for the public. If you wish to get involved, contact the branch outreach coordinator, Chris Bowdery (e-mail chris.bowdery@physics.org) or Steve Bailey (e-mail s.bailey@lancaster.ac.uk).

National Science and Engineering Week 6–15 March 2009

Branch members were involved in several events for this year's National Science and Engineering Week organised by the British Science Association (formerly the British Association for the Advancement of Science). Here are the ones that LANBRIA knows about.

At Lancaster University, Phil Furneaux, along with some student helpers, arranged a fun day for schoolchildren with a rockets theme. At GlaxoSmithKline in Ulverston, John Bradshaw, Bob Jones and Chris Bowdery provided physics sessions for schoolchildren, with a van de Graaff generator, rotating chair and sound/waves hands-on activities. A good time was had and LANBRIA's editor even had time to see some amazing owls on display and visit the inflatable planetarium.



Chris Bowdery

An Ulverston teacher gets involved in Science and Engineering Week.

Primary-school science at Blackpool and The Fylde College

Blackpool and The Fylde College organised five days of science, maths and literacy events for primary schools in the Fylde region in March. Ian Saunders and Chris Bowdery agreed to lead the science sessions, a double session each morning with one group and again in the afternoon with another. (The promise of payments for their efforts definitely helped make up their minds.)

The sessions began with an illustrated and interactive talk about sound, including a group test of the children's high- and low-frequency hearing. They then split up into small groups to play with slinkies, build telephones with plastic cups

connected by fishing line, play tunes with "boom whackers" (hollow pipes) and fold paper to make "paper bangers". Finally they regrouped to learn about the Doppler effect with a small loudspeaker on a long, whirling cable. Longitudinal waves then led on to transverse waves and light, the colours of the rainbow projected on the wall, and colour vision and how it is that ducks (a stuffed goose in hand for effect) can see more shades of blue.

The pupil evaluations were very positive. The students were fascinated to learn that the little bones in the ear were evolved from teeth, and the aforementioned duck chromatic superiority. Maybe the Institute of Biology should be topping up our members' pay.

SciCast Physics

Do encourage teenagers (well, anyone) to enter the SciCast Physics competition. The idea is to create a short video (maximum length 2 minutes, 30 seconds) to explain a physics-related idea, concept or device. The current round closes in January 2010, but do not wait until Christmas before entering. For full details, visit www.planet-scicast.com/physics, where already-submitted videos can be viewed.

AGM

Don't forget to come along to the annual general meeting at Lancaster University on 13 May. We need to be quorate to elect the officers and committee. As usual you can be assured that no one who attends will be pressured to join the committee on the night. However, we are always looking for new people to serve, especially as officers must be fellows or members. This year we need a new secretary and next year a new chair. If you are interested, see the separate AGM agenda sheet.

Branch bank account change

The Institute is moving its bank account to HSBC, which means that the branch account will also be changing. If you have any branch cheques (Lloyds TSB) that you have not paid in yet, cash them before the existing account is closed. You have been warned.

Branch summer 2009 programme

Wednesday 13 May, 6.30 p.m.

Lecture followed by AGM. The physics of brain imaging: a window on autism, shopping and learning
Prof. Stephen Swinhenby (Open University)
Lancaster (Cavendish Colloquium Room)

Over the last 40 years, physicists, aided and abetted by engineers and computer scientists, have developed many new ways of studying the living brain. First came structural imaging instruments and then came a new generation of systems that were able to image

brain function.

This talk will review these methods and describe how the enormous magnetic field sensitivity of superconducting quantum interference devices (called SQUIDs) can be exploited to measure the currents flowing in the brain. It will explain how SQUIDs throw light on the neurophysiological basis of autism, and it will outline current studies in the decision-making processes that are involved in shopping and how the brain changes as we learn symbolic mathematics.

Wednesday 17 June, 6.30 p.m.

Space weather
Dr Mick Denton (Lancaster)
Lancaster (Cavendish Colloquium Room; change from programme poster)

The Sun is continually blowing protons and electrons into space. From time to time it "sneezes" and a huge mass of plasma is emitted. If it comes our way it can damage satellites in orbit and even electricity grids on the ground. Understanding and predicting space weather is thus an important subject. Come along and learn all about it.

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