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South West Branch

PHYSICS SOUTH-WEST

The newsletter of the South West Branch of the Institute of Physics

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Festival turns modern

The South West Branch's annual Festival of Physics was held on 21 March at Redland Green School, Bristol.

This year it had a culturally modern feel, evident in each of the four presentations (all of which are reported in the centre pages of this newsletter). Possibly as a consequence, there were more young people in attendance than in recent years.

The first speaker, Prof. David MacKay, gave us an insight into the mathematics of renewable energy. MacKay's sums most definitely do "add up", but the amounts of land and sea required are revealed to be vast.

We were treated to a multicultural feast by our fourth and final speaker, Dr Roger Moses, and in-between we saw how the rise of the internet is changing science journalism and even adding to the methodology of scientific inquiry itself.

Dr Chris Lintott (right) presents Fiona Mabin of Exeter School with a variety of Institute goodies for their SciCast Physics entry.

After lunch the annual general meeting was held as well as many interesting discussions and demonstrations, and some scientifically excellent short films made by schools for the SciCast Physics competition.

Special thanks go to John Peck for taking the photos at the festival and at the Hunt lecture.

Roger Brewis, editor

Physics group communicates

An interim committee met on 30 January to discuss possible future events at the Institute of Physics. As part of the discussion the group's aim was solidified: "To support members in promoting an awareness of the role physics has in society."

Committee posts were also decided: Averil Macdonald, (chair and *MyIOP*); Martyn Bull (secretary); Alun Vaughan (treasurer); Bob Fairbrother and Bob Boutland (newsletter); Paul Millar (web); Keith Williams (link to the education group); Laura Grant (members survey); and Francisca Wheeler (committee member). The chair of the committee will also be a member of the Institute's external engagement committee.

The group: (front – left to right): Paul Millar, Prof. Averil Macdonald, Laura Grant; (middle): Keith Williams, Bob Boutland, Martyn Bull, Francisca Wheeler, Prof. Bob Fairbrother; (back): Prof. Alun Vaughan.

Also at the meeting was Elizabeth Jeavans from the Institute's Engaging the Public team and Claire Copeland, science support officer from the Department of Higher Education and Research.

The group is now live and intending members can sign up via *MyIOP*. A newsletter is in progress for group members.

Bob Boutland

Sustainable energy fuels festival

Starting off the Festival of Physics and kicking quite a few energy myths into touch was David MacKay, professor of natural philosophy in the Department of Physics at the University of Cambridge. Based at the Cavendish Laboratory, MacKay is an expert in information theory, inference and learning algorithms.

His subject de jour was disinformation in the realm of sustainable energy and correcting it. "Sustainable energy: without the hot air" is also the title of his book.

"We're often told," commented MacKay, "that huge amounts of renewable power are available – wind, wave, tide and so forth, but we need numbers, not adjectives."

In Britain, about 90% of our energy is from fossil fuels, which is a larger proportion than many advanced industrial countries. The limitations on finite fossil-fuel resources are well discussed, as are the concerns about who we depend on for them, while the issue of CO_2 emissions appears to be the defining problem of our century.

Can we remedy the situation by switching to sustainable energy? MacKay set out to answer that question and he did so in a lively, engaging and comprehensive fashion.

He clearly considered much of modern advertising to be "greenwash". Is the Toyota Prius really "green" when you

Prof. David MacKay was the first to give a talk: "Sustainable energy: without the hot air."

compare its fuel consumption to more modest cars? Is the A380 Airbus even slightly so, when it is no better than a 12% improvement on the Boeing 747?

MacKay set out to compare consumption to potential production. He introduced a unit of kilowatt per hour, per person, per day. Although this even left a professional audience a little blank, it did provide some stark comparisons. Car use might require 40 kW/person/day but if you covered 10% of Britain with wind farms that would only provide 20 kW/person/day.

Lest he be misunderstood, MacKay declared himself "pro-wind, but also pro-arithmetic". Nevertheless, this immediately showed the scale of the problem, before we even got started on the energy costs of the heating and cooking that we require (maybe 40 kW/person/day), all the stuff that we buy, including disposing of it later (around 50 kW/person/day) and its transportation (10 kW/person/day).

One return flight per year for each of us would require carpeting an area one and a half times the size of Wales with wind turbines, which brought a smile to this largely English audience. Offshore wind farms would do better in terms of harvesting the energy, but not enormously so. To get an energy income of around 50 kW/person/day would need an area of sea twice the size of Wales, being one-third of all of our shallow seas.

So would wave or tide power be any better? If we used all of the wave power available, MacKay calculated that we could cover the energy costs of our food and farming at 15 units. Tidal power from the Severn Estuary would cause us to require decimals on this scale, at 0.8. Tide can provide a modest improvement on wind in terms of energy per square metre, but how could we access it on the country-sized scales that are required to make a difference?

We were prompted to consider a lot more, from house insulation to population reduction, to the amount of available uranium in mines, oceans and rivers. Heat pumps, as used in a refrigerator, could pump heat from the garden to the house. Carbon capture doubles the cost of power stations and costs 25% of your energy.

The Jevons Paradox dates from 1865, and points out that, if we make a given energy-using device more efficient, the consumer will simply consume something else, and this is likely to be just as energy hungry. We have to seek frugality first, but where is the consumer who wants to?

With solar power, we eventually found something that might help significantly. Panelling all south-facing roofs in the UK would barely scrape a 5 kW/person/day, enough to cover our "need" for gadgets, but tiling 5% of Britain's land area scores a whopping 50 kW/person/day, and a Germany-sized patch of the Sahara would satisfy everyone in Europe – and, we might suppose, could make some North African leader even richer than Bill Gates.

There followed questions about the cost of wind farms and nuclear (each relatively small, suggested MacKay), the inefficiency of converting chemical energy to electricity and the problems of fluctuating supply when you are dependent on nature. Pumped storage would require a lot of new lakes, but it would be relatively easy, for example, to recharge electric cars at times of peak energy production.

One question chillingly asked was when and if we might expect an energy supply catastrophe. Probably not in 2016, suggested MacKay, so probably 2030.

Roger Brewis, editor

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

Tuesday 31 August 2009

E-mail your material to chair-sw@physics.org

Lintott sheds light on Galaxy Zoo

Everyone interested in astronomy and cosmology has heard of Dr Chris Lintott. Lintott is Fulford junior research fellow in physics at Somerville College, Oxford, where his subject is astrochemistry, but he is best known for being co-presenter of *The Sky at Night* with the legendary broadcaster, Sir Patrick Moore.

It was therefore quite a coup for the branch to have Lintott give the key pre-lunch talk at the 2009 Festival of Physics on the increasingly famous project known as Galaxy Zoo.

Traditionally, new galaxies had been discovered and photographed at a leisurely rate. As the rate of discoveries accelerated, so professors began to delegate that first still-important visual examination to the unsuspecting post-doc.

Chris Lintott shows a diagram by Esher to explain expanding space.

This approach came up short when Fermilab became seriously involved. The Sloan Digital Sky Survey (SDSS), as the Fermilab website tells us, completed its first phase of operations in June 2005, having "imaged more than 8000 square degrees of the sky in five bandpasses, detecting nearly 200 million celestial objects, and it measured spectra of more than 675 000 galaxies, 90 000 quasars and 185 000 stars. Not only is this survey extremely ambitious, but it is also extremely accessible, the data being released to the scientific community and the general public in annual increments.

The SDSS uses a dedicated, 2.5 m telescope on Apache Point, New Mexico, equipped with two powerful special-purpose instruments. One is a 120 Mpixel camera that can image 1.5 square degrees of sky at a time, about eight times the area of the full Moon. The other is a pair of spectrographs fed by optical fibres that can measure spectra of (and hence distances to) more than 600 galaxies and quasars in a single observation. A custom-designed set of software pipelines keeps pace with the enormous data-flow from the telescope."

While the discovery of the galactic redshift is casually credited to Edwin Hubble, Lintott points out that this is not so. This led me later to discover that it was Vesto Slipher at Flagstaff who had by 1917 discovered, in relation of course to fairly local galaxies, that redshifts outnumbered blueshifts by more than five to one, had asserted confidently in 1913 that, "we have at the present no other interpretation for" a blueshift, and, "hence we may conclude that the Andromeda Nebula is approaching the solar system". He had even calculated that the Earth had a velocity relative to the mean of these observations being 700 km/s, anticipating more modern findings from the anisotropy in the microwave background.

It was Hubble that gave us the mathematical relationship, with his famous linking of distance to time. In normal space, expansion velocity is obtained by multiplying a Doppler redshift by c, the velocity of light, so an expanding universe with $z>1$ requires more than just matter flying apart. Lintott described the modern notion of expanding space as a "slightly crazy idea", and appropriately used a diagram by Esher in his explanation. Another imaginative metaphor, for the "surface of last scattering", was the Anthony Gormley art installation, "Blind light", which was essentially a box of fog that neatly demonstrates light dispersal.

Modern models can successfully relate the miniscule variations in the cosmic microwave background, less than 1:10 000, to the observed distribution of galaxies, which at larger distances are non-random and weblike, but only by assuming that what we see is only a small part of the matter and energy that really exists. On dark energy, Lintott observed that, "we are not sure if it is dark, not sure if it is energy".

While we have seen from the SDSS that it is now straightforward to map galaxies' positions automatically, allowing Lintott to screen a fly-through of the local universe, computerised pattern recognition is less advanced. This led to the idea of lay classification, internet based – in short, the Galaxy Zoo.

The handedness of a spiral galaxy, we were assured, indicates its direction of rotation. In any case, if these handednesses were not random, it would provoke a fierce debate on the possible cause. So it proved when the Galaxy Zoo results showed a clear excess of anticlockwise galaxies. Efforts were made to associate this anisotropy with that in the cosmic microwave background radiation data, and even to designate this as an "axis of (theoretical) evil".

By the simple expedient of showing classifiers mirror images of galaxies, Galaxy Zoo swiftly wiped away both the asymmetry of results and the furore it had created. It transpired that the anticlockwise excess was a psychological feature, taking the experiment from one science into another, where it continues to provide new findings. The handedness bias was revealed by Lintott as relating to scientific involvement, a "left-brain right-brain" phenomenon.

One key cosmological finding is that two galaxies in proximity tend to spin the same way. Another is that, while spiral galaxies are generally associated with star formation and elliptical galaxies far less so, there are members of each class that play against type.

The public-involvement methodology is proving even richer than this, with plans to look at the Moon, Mars and coronal ejections. Not only that, but images of crows potentially in the process of learning how to bend a twig as a tool and the lay translation of ancient papyrus scrolls are on the cards.

Roger Brewis, editor

Check out the branch website at sw.iop.org

Festival hosts the branch's AGM

The South West Branch's annual general meeting was held this year, as usual, during the Festival of Physics.

Given that the Institute of Physics no longer asks its branches their view of constitutions, and given that we haven't upset anyone recently, this was a standard affair with few surprises. The new chair, James Annett, reported on branch activities during the past year, and these have been reported in some detail in past newsletters.

The outgoing, time-limited treasurer, Neil Purves, reported once again that finances were sound. But what was this? No grant from our parent organisation? Well, not until we spend what we have already been given.

It turns out that we have been careful with your money. Partly this is plain, old-fashioned frugality, and partly that we could spend more – on lectures, events and outreach – if we had more volunteers, both on the committee and engaged in specific tasks. So, please volunteer, particularly if you wish to see activity in areas that we currently do not reach.

Prof. Annett, the chair of one year's standing, was confirmed for another year, as was the secretary, Dr Edward Ratzer. Neil Purves continues as committee member but was timed out as treasurer, so we are seeking a new volunteer. For this role you must be a corporate member.

Continuing on the committee is Patrick Butterly, a very active member in Devon and Cornwall. Also, teacher Sally Divall and student Valentina Squitieri, though neither was present to confirm it, also continue. We welcomed, in her absence, new committee member Dr Hilary Summerfield, whose experience in industry will be most welcome. The new committee will take over from the old one later this year.

The chair thanked volunteers Peter Ford, Vincent Smith, Roger Moses, Mike Wilson and John Peck, along with myself, who continue to give valuable help, despite having served the new maximum allowance of nine years on the committee – and in some cases much more.

Under any other business, two excellent suggestions for blue plaques were offered. One being Oliver Heaviside, with strong links to Torquay and William Prout, who is buried near the Cotswold Way.

Finally, concerns were raised regarding the new *MyIOP* system for providing information. Members would like to be given details of speakers, topic, date and time when they receive the initial e-mail rather than having to sign in to see if it is of any interest to them.

Roger Brewis, editor

Keeping physics in the public eye

Joe Winters explains his role.

After the annual general meeting we got a privileged insight into the workings of the Institute of Physics. This year, we were treated to a look into the world of Joe Winters, senior press officer at the Institute.

The commissioning of a new satellite may not sound like interesting news but "NASA launches search for second Earth" definitely is. An interplanetary probe-mounted electromagnetic defence against the solar wind has greater headline currency as a "force field".

Winters asked and largely answered a number of questions. What do press officers do? What do science journals do? And crucially, what makes science into news in different media?

We heard of a developing trend in the internet age. Newspapers feel able to economise on staff as their background research becomes easier. As a consequence, we live in a cut-and-paste world, where any source deemed reputable is cloned many times.

This brave new world gives a press release a greater power, as reporters increasingly depend on what they are fed – for good or ill. It often means that errors or distortions don't get checked. Was the headline "Jodrell Bank to close" simply a failure to read the press release properly? Or was it, as someone later mused, that it was thought to be a subsidiary of Northern Rock?

Science expertise is expensive: "the better science journalists are being laid off," said Winters. Your humble editor has no such fears then.

Winters introduced us to *Flat Earth News* a book by Nick Davies. This, my own instant research tells me, is revealed by Peter Preston in the *Guardian* as a "vibrant tirade against the sins of modern journalism". Davies has created the word "churnalism" for this phenomenon, and I note that it has already spawned the web-based Churner prize. All a far cry from the dogged multiyear investigation by "Woodstein" into Watergate.

Winters clearly demonstrated that he is doing a good job of keeping physics in the news.

Roger Brewis, editor

Indian science closes festival

To close this year's Festival of Physics in Bristol, Dr Roger Moses led us through more than 4000 years of Indian science, with effigies of Ganesh, "god of new beginnings", and Shiva, watching over the proceedings.

Indian astronomy, we heard, had a lengthy history before Aryabhata, around 500 AD. It provided a systematic treatment of the known planets, identifying their orbits as ellipses, producing correct values for the ratios of their orbital radii, and recognising that their light is reflected. In his writings, reported Moses, we find a value of π as 3.1416, the most accurate among the ancients, of the year's length as 365 days, 6 h, 12 min and 30 s, and effectively the first published use of zero.

Satyendranath Bose has a condensate and a set of particles named after him, while Acharya Jagadish Chandra Bose developed the earliest semiconductor.

We heard of Vikram Sarabhai, considered as the father of the Indian space programme, and the early introduction of satellite television in India; of Vinod Dham, the father of Pentium processing; and of India's current remote-sensing lunar satellite, Chandrayaan-1.

Roger Moses on Indian science.

We learned of Venkata Raman, discoverer of the Raman effect, and of his nephew, Subrahmanyan Chandrasekhar, after whom is named the Chandrasekhar limit on the mass of white dwarf stars. Chandrasekhar, observed Moses, effectively invented astrophysics. The name appropriately means "holder of the Moon" in Sanskrit.

Abdus Kalem, the first Muslim Nobel laureate in science, is the sole Pakistani Nobel laureate. He is credited with the electro-weak theory, alongside Glashow and Weinberg. Finally, from 2002 to 2007, Dr Abdul Kalam, popularly known as the "missile man of India" for his work on the development of ballistic missile and space rocket technology, served as the 11th president of India.

Roger Brewis, editor

Hugh Hunt gets Bath spinning

Two of my favourite "revivalist" ideas in physics are the smoke-ring model of fundamental particles of William Thompson, Lord Kelvin, and the vortex bundle explanation of magnetic force lines by James Clerk Maxwell. Each relies upon rotation, and unfortunately the discredited aether, to answer fundamental questions in physics. How then could I resist travelling to Bath for a lecture demonstration on "Science in a spin" on this year's designated No Smoking Day, Wednesday 11 March?

Left: Dr Chris Budd (right), pictured with Dr Hugh Hunt, demonstrates gyroscopic orientation during Bath Taps into Science. Right: Hunt demonstrates another remarkable gyroscopic orientation.

The lecturer at Bath's University Hall was Dr Hugh Hunt, senior lecturer in engineering at the University of Cambridge and fellow of Trinity College. Engineer, applied mathematician, physicist and supreme educator, Hunt entranced and informed his audience with demonstrations of remarkable effects using rotating objects of a mostly mundane nature, and then explained each and every one.

What was more, he achieved something fundamentally important in the pedagogy of physical science by introducing mathematical modelling to his lay and school-student audience in a simple and natural way. We met force proportional to acceleration and the sigma and Lorentz notations required to sum individual "point" effects; we met a formula for the path of a boomerang that told us something unexpected about its flight path. We had vector addition of velocities and even of rotations. The lecture is reported in this article.

Later, over a bowl of pasta, several of us debated fundamental issues of truth in physical science and back at home this led me to delve further into the role of "spin" in modern physics.

Spin in quantum mechanics, I know, is closely mathematically analogous to mechanical spin, but not completely so, with electron spin, for example, being key to the Pauli exclusion principle and to the understanding of the periodic system of chemical elements. More unexpected was the amount of current theoretical and experimental work on vortices, most particularly at the Department of Applied Mathematics and Theoretical Physics at Cambridge. Dr David Tong, for example, has done interesting work on quantum vortex strings.

Vortices in certain systems, it turns out, are self-organising, and those in superfluids are quantised, discoveries that would have pleased Kelvin and Maxwell. Vatistas at Concordia in Canada has used patterned vortices to model the peculiar polygonal atmospheric vortices at the Earth's poles, both experimentally in the laboratory and theoretically, using a model of vortex atoms that dates back to J J Thompson.

The message of the Bath Taps lecture was that spin is important. "How can we," Hunt asked his audience, "get spin back into the A-level syllabus?"

Bath in a spin

Hunt opened his lecture "Science in a spin" to Bath Taps into Science with a cute demonstration showing that a rubber ball is a poor model for light. Bouncing it obliquely between two parallel firm surfaces, it ignored the rule about the angle of incidence being equal to the angle of reflection and instead returned after three surface impacts to the thrower.

If you already feel that you need to witness this event, Hunt has a website at www.hughhunt.co.uk that has all the videos that you will need. In the auditorium he demonstrated that the first bounce imparted spin and this had a profound influence on the second impact, and then he too bounced around the room letting each audience section see the effect close up.

We moved on to the spinning top that, as we know, doesn't fall over, and he showed the same effect in a rolling bicycle wheel. In a demonstration that brought the most gasps from the appreciative audience, Hunt whirled a 150 g tennis ball around his head on a string and showed – by passing the string through a metal tube – that the tension in the string was sufficient to lift a 2 kg weight.

Hunt then brought out a small turntable to demonstrate two important effects, either of which, we were to discover, would allow a telescope to orient itself in space. The first was the arms-out-arms-in effect used so impressively by figure skaters.

The second involved changing the direction of the axis of the gyroscope to re-orient the larger body. For this Hunt had a powered gyro, but the demonstration was of course much more persuasive with a bicycle wheel, coloured in bands so that the direction of spin was visible to all.

The second "ooh" moment came with a slo-mo of a falling cat (all complaints to NASA). How does a cat fall on its feet? Now we know. Even from a height of less than 3 ft, held upside down, and without any initial angular momentum to make use of, the cat twists its front-end one way and its rear the other. We watched the replay intently, perhaps to see if the cat would really unscrew itself. As if it had been following the lecture to that point, and had understood every word and equation, the cat increased the angular momentum of its rear by twisting it not so much along an axis but like a propeller. Like Hunt turning one way with arms out and then the other with arms in, the cat got its feet back in place, with the whole thing lasting less than half a second.

Hunt ended with a series of boomerang throws. The formula suggested, perhaps surprisingly, that the flight path would not increase with a faster release, and, sure enough, the device returned more quickly but with the same path radius. On the other hand, shifting adhesive blobs further out along the arms – increasing the moment of inertia – did result in a bigger circle.

"Never," stated Dr Chris Budd from the chair, "give a lecture immediately following on from Hunt." We loved it all.

Roger Brewis, editor

Pasta, photons and education all on the menu

The Hugh Hunt lecture (as reported in the article opposite), was arranged by Dr Chris Budd of Bath Taps into Science, and is supported by the South West Branch of the Institute of Physics.

So it was that, later that evening, I found myself eating pasta with Hunt and Budd, together with Dr Peter Ford, renowned past-chair of the South West Branch and recipient of an MBE for lectures just as captivating as Hunt's, and its current chair, Dr James Annett of Bristol University.

These are the discussions that remind me why I slave for hours over a hot keyboard. These were erudite people with a passion for physics and for communicating it in an exciting way. We ranged widely over why light doesn't behave as a super-bouncy ball, the education of mathematical physicists, and some howlers in the explanation of science.

One of Hunt's favourites, if that is the right word, is the set of incorrect explanations given for the lift on an aircraft wing. Another is the late (and justly eminent) professor of electrical engineering, Eric Laithwaite, who holds an especially painful place in Hunt's heart for his advocacy of the belief that rotation reduces the effect of gravity, this more than a decade after Laithwaite's death and apparently 34 years after the offending statement.

Laithwaite's second Royal Institution Christmas lecture in 1974 was the heretical one, and it can be viewed at www.gyroscopes.org/1974lecture.asp. You can also view a really interesting chapter from his book, *Engineer Through the Looking Glass*, on the peculiar – and strangely similar – behaviours of gyroscopes and electric currents.

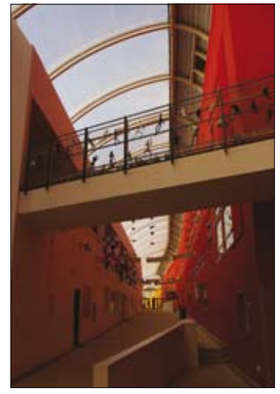
We discussed a further heresy, whether there was indeed any reliable evidence for the particle photon, before turning to more practical considerations.

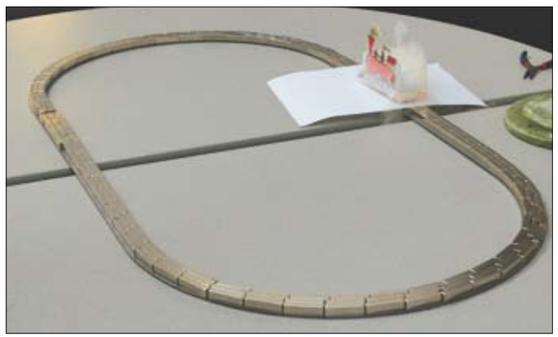
A deep passion for education unified the table. We discussed how entry tutors for physics courses will, in many universities, look first at the result for A-level maths, and the therefore worrying proposal to take mechanics out of the latter's syllabus. We were more sympathetic to the live proposal for a parallel GCSE in "practical maths". We fell out over whether to encourage more students to take A-level maths. On the one hand, maths is a unique skill and we want more people to develop it. The syllabus has become more accessible over recent years, "easier" if you will, but it needed to. On the other hand, maths is a unique skill and perhaps not suited to everyone. We heard of the high rate of the highest grades, but also of the bright humanities students devastated by their fourth result, the maths grade, being two or three steps below the excellence of their other ones. We heard of the "I like algebra" test to determine suitability.

When we left for home that evening we were all better informed. Compulsive educators will always insist on educating their peers.

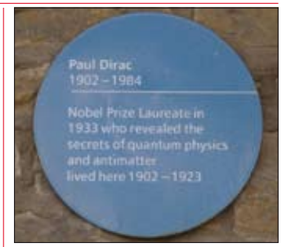
Roger Brewis, editor

Festival of Physics closes its doors for another year





Top left: the futuristic facade of Redland Green School was the venue for this year's Festival of Physics with a rare (distant) image of Roger Brewis approaching. Top right: this light, airy covered walkway leads to the lecture hall. Bottom left: relaxed discussions where old friends and new contacts are one of the nice aspects of the festival. Bottom right: magnetic levitation was one of the demonstrations.



The blue plaque on Paul Dirac's former residence in Bristol.

Festival of Ideas comes to Bristol

The Festival of Physics, the main theme of this issue, was not the only show in town this spring. The University of Bristol is celebrating its centenary with Bristol Festival of Ideas (April–June) with many famous names from science and elsewhere giving lectures.

Two of special interest to physicists were Leonard Susskind, one of the grand old men of string theory, on "Darwin and the cosmic landscape", and Graham Farmelo on "Paul Dirac: Bristol's Einstein". We hope to have reports on both lectures in the next newsletter.

Visit www.ideasfestival.co.uk for more information.

Roger Brewis, editor