OCTOBER 2003

BIOGRAPHY

Marie Curie: a lifetime of radioactivity

DESY VISIT

Nexus crew descends on Hamburg

WAVE THEORY

Researchers study wave phenomena

nexus news

The Student Newsletter of the Institute of Physics

BEAGLE 2 MISSION

IS THERE LIFE ON MARS?

nexus news

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Institute of Physics PUBLISHING

Letter from the editor

Well, it's the start of another term at university and as some of you may know I have succeeded Sam Rae as student liaison officer at the Institute. Sam is doing what most of the working masses want to do, he is returning to student life. This time round Sam is studying to pursue a career in science communication. We all wish him the best.

There has been a lot happening over the past few months and in this issue of *Nexus News* we have reports on the International Conference of Physics Students (p6) and the Nexus trip to DESY (p4). A trip to the Eden project in Cornwall is also under way, so look out for the report in the spring issue.

Coming up in the next few weeks we have the Young Physicists' Conference, which will be taking place in Bristol. This is proving to be a popular event, so book your place now to avoid disappointment.

In our biography section, Deborah Telfer details the life and loves of the extraordinary Marie Curie (p11), and in "Mission improbable" (p8) James Drewitt examines the conditions required for intelligent life to flourish on extrasolar planets.

A new feature starting in the next issue will be a letters page for you to air your opinions, so I'm looking forward to hearing from you.

Don't forget, if you would like to become a student representative of your university, a Nexus committee member or if you would like to contribute to *Nexus News*, please don't hesitate to get in touch.

Shavinder Kalcut, editor/student liaison officer

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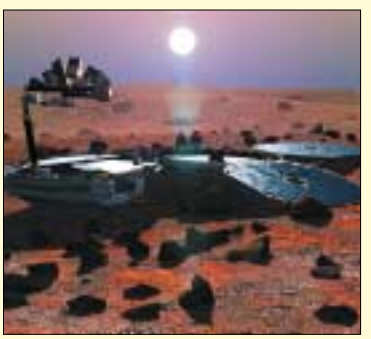

Cover image: This is a computer-generated representation of the Beagle 2 lander on Mars. Photo: Beagle 2. All rights reserved.

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Get your voice heard in *Nexus*

Do you have something that you want to get off your chest? The next issue of *Nexus News* will feature a letters page for those of you who have an opinion to air. If you need an incentive, a £20 prize goes to the letter of the issue. Letters on any topic are welcome, so get scribbling. Send your post to Shavinder Kalcut, student liaison officer (shavinder.kalcut@iop.org).

Liverpool hosts welcome event

The Merseyside branch of the Institute is staging a welcome event for undergraduates at universities in the Merseyside area. The meeting will take place at at 2.30 p.m. on 19 November at the Surface Science Research Centre, University of Liverpool. A buffet lunch will be provided for attendees.

Following a special request from an undergraduate, the branch has booked several speakers who share a common link: they all graduated in physics. The range of successful career paths represented at this welcome event is an indication of the variety of interesting jobs available to physicists.

After the talks there will be informal discussions with the speakers and career information will also be available. All physics undergraduates are warmly invited to attend. The event will also be of interest to sixth-form students considering a career in physics. Teachers who would like to bring a party of students are advised to contact David Martin (davidm@liv.ac.uk) as soon as possible. For more information e-mail liviop@amarks.co.uk.

PhDs train the Hercules way

HERCULES, the higher European research course for users of large experimental systems, is an annual meeting that is aimed at PhD students and organized by the Graduate Training Committee based in

Back on the learning curve

Those who can, teach – or at least that's how the advertising slogan goes. The problem is that, despite the new financial incentives offered, teaching is still failing to attract enough physics graduates to instruct the next generation of science pupils.

Enter stage left the Undergraduate Ambassadors Scheme (UAS), the brainchild of Simon Singh who is perhaps best known as the author of *Fermat's Last Theorem* and *The Code Book*, among others. His idea is a simple one. As an optional final-year assessed module, UAS students are placed in a local school for one day a week assisting with the teaching of physics to a range of year groups.

The teacher benefits by having an extra pair of skilled hands to help with the lesson and the UAS student benefits by getting first-hand experience of front-line teaching. Not only do the school pupils have access to a "specialist" physicist to help them in understanding the subject, but they also have an opportunity to quiz the UAS student on what it's like to study and live in a university environment.

The scheme actively encourages the placement student to take some of the lessons. Supervised by the teacher, the student has the opportunity to prepare and take lessons that (we hope) their undergraduate lectures have prepared them for, and find out whether a career in teaching might be for them.

School pupils have access to a "specialist" physicist to help them understand the subject, and an opportunity to find out what life is like in a university environment.

As one of the first four physics undergraduates to take part in the scheme, I spent 10 weeks in a local school assisting with a year-eight and a lower-sixth group. For the year-eight class, my role was largely that of classroom assistant, which meant helping pupils with practicals and supervising some of the lesser- and more-able pupils working together in small groups.

For the lower-sixth group, I was actively involved in giving the lesson, which included teaching wave physics over a five-week period.

I also managed to arrange a trip to the undergraduate physics laboratories at the University of Surrey so that the pupils could do some experiments with equipment that the school didn't have access to, such as a spectrometer.

The academic year 2002/3 was the inaugural year of the scheme, with the University of Surrey being the first physics department to offer the module to its students. However, Southampton University already offers the module to its mathematics students. The number of physics departments offering the scheme is set to increase in the forthcoming academic year, with around a dozen departments currently looking to offer the module to their students.

For any undergraduate who has ever considered teaching after graduation, the UAS provides the perfect opportunity to give teaching a go without having to commit to a year-long PGCE course. It's also a refreshing break from the cycle of lectures, tutorials and exams that most assessed modules consist of and provides the opportunity to broaden your skills away from a campus environment.

Paul Canning

Grenoble, France. The next meeting will take place on 22 February – 2 April 2004.

The course consists of two weeks of common lectures, following which each participant takes one of two streams, either Neutron and Synchrotron Radiation for Physics and Condensed Matter or Neutron and Synchrotron Radiation for Biomolecular Structure and Dynamics. There is some cross-over between the two streams. About 40 lectures and 14 practicals will be undertaken at the host institutes in Paris and Grenoble.

Attendees of the HERCULES meeting in Grenoble snow-shoe their way to lectures.

Nexus member Thomas Weller attended the course for 6 weeks during March and April. "The time that we spent on beamlines and instruments was the most unique and exciting aspect of the course. Most memorably I worked on the only diffractometer in the world that is fully optimized for magnetic neutron diffraction studies under very high pressures at the

Destination DESY

DESY is an electron synchrotron research centre established in 1959 in Hamburg, Germany. In June, 16 Nexus members descended on the city to visit the facility and find out more about its work.

Our visit to DESY began with a talk about its history, working practices, underlying physics and current research. It is a publicly funded national research centre and employs more than 1500 staff. Additionally, the accelerators are used by 3400 scientists from 35 countries in fields as diverse as chemistry, geology, biology, medicine, materials science and physics.

In the accelerators, particle beams are raised to a high energy level and then forced to collide. Examining the collision debris can give physicists clues to the origin of matter and the universe. In 1993, experiments at the HERA ring accelerator revealed details of the internal proton structure. Ongoing studies are also looking at nucleon spin and symmetry breaking, to provide an understanding of fundamental forces.

DESY is also a synchrotron source. Electrons give off synchrotron radiation as they accelerate round a cyclotron. Synchrotron radiation is useful in many fields of research since it is extremely bright, intense and well focused. It covers a wide range of the electromagnetic spectrum and is generated in short bursts. In the DORIS and PETRA storage rings, synchrotron radiation provides a means to study a variety of samples on an atomic level.

There is an international consensus that a linear collider (LC) should be the next large-scale particle-physics resource. This equipment could achieve higher energies than is possible in existing facilities, thus providing support to theories of physics beyond the Standard Model, such as supersymmetry. DESY is currently carrying out feasibility studies of a 33 km long superconducting collider, and we saw some of the test structures used in the investigations. DESY staff seemed very positive about the proposition to host the LC, despite strong competition from the US and Japan.

The long weekend gave us plenty of time to discover the highlights of Hamburg. Our hostel was located in the lively yet relaxed area of Altona, which bustles with bars, shops and restaurants within staggering distance (an empirical observation). The cuisine range was cosmopolitan and we sampled some of the Greek, Italian and Portuguese offerings during our stay. With such choice, it was difficult to decide on a restaurant. The length of time taken to make this decision increased exponentially with the number of physics students involved. An extra complication was introduced by our unfulfilled quest for culture in the form of sauerkraut.

Synchrotron source: electrons give off synchrotron radiation as they accelerate round a cyclotron.

Hamburg is Germany's second-largest city, offering numerous attractions to suit every taste, from shopping on Neuer Wall to the red-light district in Reeperbahn, as well as Germany's largest seaport, a large lake and local beach. Our explorations included an open-top bus tour, a cruise on the Alster Lake and ascending (by lift) to the 18th century St Michaelis church.

The highlights of our trip included drinking in the red-light district until 3 a.m. on the Saturday night, followed by shopping at the open-air fish market early on Sunday morning and visiting the Museum of Hamburg and the Kunsthalle art gallery. My fatigue on Sunday may have explained the visions I had in the market of strange men throwing fish from trailers, giant rabbits and table dancing to a Robbie Williams tribute. Or perhaps that was a genuine representation of German culture.

Many universities can arrange overseas work placements, which are a good opportunity to gain experience in applying your physics knowledge, as well as honing linguistic skills. These skills are highly regarded by employers. Several Nexus members already on work placements in Germany provided a helpful translation service for those of us whose German didn't stretch beyond *Eine bier, bitte*.

The trip was a great way to meet students from other universities and to compare teaching and research methods. Our group was made up of people from all over the UK, including Edinburgh, London, Surrey, Loughborough, Nottingham, Warwick and Cambridge.

For further information about DESY, visit www.desy.de.

Laboratoire Leon Brillouin on the outskirts of Paris," he said. Extracurricular activities involved skiing, snow shoeing, climbing and drinking. For more information and an application form, visit www.grenoble.cnrs.fr/hercules/index.html.

Nexus to visit the London Eye

Nexus is organizing a trip on the London Eye on Wednesday 29 October at 5 p.m. We have hired a private capsule, which allows us to skip the queue. If you would like to join us, contact Shavinder Kalcut, student liaison officer (shavinder.kalcut@iop.org). Places will cost £11, which is the normal rate for an individual, but less than the price per person for a private capsule.

Benefit from our know-how

Is your physics society amazing, boring or just plain average? Or maybe you don't even have one. Nexus wants to know. If you are interested in starting up a physics society or are refurbishing your present one, Nexus can help with grants for trips, advice in the form of the *Physics Student Society Guide,* and provide some encouragement. For more information, contact Shavinder Kalcut, student liaison officer (shavinder.kalcut@iop.org).

Opportunities in PPP Group

Calling all students working with flexible media, materials and colour. The Printing, Packaging and Paper making (PPP) Group of the Institute has several opportunities for students working in the field of developing technologies such as digital printing, ink-jet printing, electrical-circuit printing, active packaging and smart materials. On offer is the chance to present your work, obtain an annual bursary of £500 and win an annual prize of £300. For more information on the PPP Group, please go to groups.iop.org/PR/ or contact Dilwyn Jones, group secretary (dilwyn.jones@physics.org).

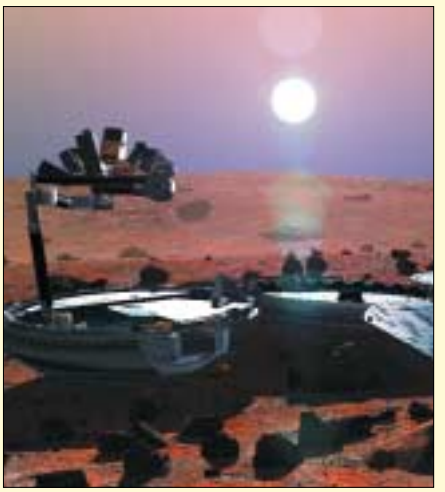
Bristol to host the next YPC

The city of Bristol is the venue for this year's Young Physicists' Conference (YPC), which takes place on the weekend of 21–23 November.

The conference will include undergraduate and postgraduate lecture and poster competitions, as well as trips and guest lecturers. The fee is £40 for accommodation and most meals. For more information contact Joseph Hines, the Institute's graduate liaison officer (joseph.hines@iop.org; tel.+44 (0)20 7470 4845).

Is there life on the red planet?

The Beagle 2 project is the British led effort to land on Mars as part of the European Space Agency's Mars Express Mission launched in June. The spacecraft will carry a lander communications package to support Mars lander missions taking place between 2003 and 2007. The spacecraft is due to land on Mars on Christmas day. Its purpose is to search for the presence of water, carbonate minerals and organic residues, which would indicate the presence of life on Mars (see p8). The project comes at a time when Mars is closer to the Earth than it has been for some 60 000 years, giving excellent images from telescopes and satellites.



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Lectures and courses

4 November
Leak detector fair
Courtyard Hotel, Northampton, UK. Organized by the Vacuum Group of the Institute of Physics. E-mail: dawn.stewart@iop.org.

6 November
Current research in magnetism
E-mail: dawn.stewart@iop.org.

11 November
Sustainable energy solutions
Institute of Physics, London, UK. Organized by the Energy Management Group of the Institute of Physics. E-mail: dawn.stewart@iop.org.

12 November
Low-temperature techniques course
Aston Business School, Management Development Centre, Aston Triangle, Birmingham, UK.

This one-day meeting is held primarily for newcomers to the field of low-temperature experimental research. A series of five talks will be given by experts in the fields of cryogenic handling, thermometry, superconductivity, measurement and control, and cryogenic techniques below 1 K. Basic experimental methods are discussed along with tips on how to design experiments that are more specific to your own research. The talks are accompanied by an extensive set of notes for future reference. E-mail: dawn.stewart@iop.org.

26 November
Measurement of pressure in vacuum systems
Institute of Physics, London, UK. Organized by the Vacuum Group of the Institute of Physics. E-mail: dawn.stewart@iop.org.

4 December
Mathematical modelling in tribology. Help or hindrance
E-mail: dawn.stewart@iop.org.

14–16 January 2004
AFPAC conference (physical acoustics)
E-mail: jasmina.bolfek-radovani@iop.org.

AN ICPS TO REMEMBER

Jessica Thatcher tells us of the success of ICPS 2003.

This August, 250 physics students from 20 different countries flocked to Odense, Denmark, to attend the ICPS – the International Conference of Physics Students. The students that attended ranged from first-year undergraduates to final-year PhDs.

The conference is linked to the International Association of Physics Students. The purpose of this organization is to encourage physics students around the globe in their scientific and professional work and to promote international relations through organized trips and cultural exchanges.

This year the conference was held at the University of Southern Denmark (SDU) and Christian Janfelt and his team provided a full schedule of lectures, excursions and parties. Participants were invited to present a lecture or a poster at the conference, and prizes were given for the best ones.

This year's winners were John Livesey of St Andrews University, Scotland, for his lecture entitled "Optical atom guidance: from cold clouds to light pipes", and Tomislav Terzic of Zagreb, Croatia, with a poster called "Extra dimensions – large versus small", presented in the cartoon-style of *The Simpsons*.

Guest lectures

As well as students' presentations, guest lecturers were invited to speak at the conference. "Communicating the unmeasurable" by Prof. Eugene Polzik explained the inability to measure quantum states and discussed the applications of quantum entanglement and teleportation. The subject areas of biology and physics were combined in "Physics of life – as a matter of fat" by Prof. Ole G Mouritsen. This lecture looked at molecular structures and the material properties of lipids. "Missions to Mars" by Prof. Jens Martin Knudsen challenged us to question the uniqueness of planet Earth in having life. He discussed the possibilities of manned missions to Mars and life in other parts of the galaxy. The 1975 joint Nobel prizewinner Prof. Ben R Mottleson spoke on Bose–Einstein condensation in cold confined clouds of neutral atoms, covering the behaviour of atoms at nanoKelvin temperatures.

As well as spending time at the university, students ventured out into the city of Odense for some sightseeing. There were also organized trips further afield to Copenhagen to visit physics-based companies and institutes. The choices included the Niels Bohr Institute, which carries out research into quantum optics and glaciology; MIC (Mikroelektronik Centret), a research centre for advanced nanotechnologies; and Risoe, an institute for biotechnology, energy research, materials research and more. I visited Risoe and in its refreshing working environment it was great to see the departments of wind power, fuel cells and polymer solar cells, as well as a materials research area. In Copenhagen I took a boat trip around the city, visited the hippie community of Christiania and went to the Tivoli fairground park.

In the evenings there was plenty of entertainment. Barbecues, bars and discos kept students up until the early hours of the morning, but the highlight of these had to be the national party. Students had brought food and drink typical of their own country to share with everyone. As well as food, there were plenty of strange drinks: blue steaming Croatian concoctions and Danish wine that tasted of furniture polish. The students of SDU even whipped up some liquid-nitrogen ice-cream.

I think I can speak for many of the students that attended the ICPS when I say that the conference was a great event. ■

LA OLA

A study by Hungarian scientists could lead to a greater understanding of crowd behaviour says **Renato Losio**.

Who says you need huge amounts of money to get good research results? Sometimes a couple of tickets for a football match – it need not be a premiership game – and a video camera are sufficient. If you want to study waves, just get down to your nearest football stadium. Forget for a moment the standing, longitudinal and transverse waves you studied as an undergraduate, I'm talking about *La Ola*, the sweeping mass of fans rising in sequence round a stadium during a football match – a phenomenon we know as the Mexican wave.

A Hungarian research group developed a mathematical model to interpret and quantify the behaviour of the wave. Illes Farkas and Tamas Vicsek of Eotvos University in Budapest and Dirk Helbing of the Dresden University of Technology reported their results in *Nature* (2002 **419** 131). Their findings were so interesting and unusual that *Science News*, the BBC, CNN, *The New York Times* and ABC covered the researchers' findings.

The research group analysed videotapes of a total of 14 Mexican waves in football stadia holding more than 50 000 people. Vicsek and his colleagues applied numerical models (originally used to describe waves in heart tissue) and generalized them to simulate this human social behaviour. The program is written in Java under the Gnu General Public Licence (you can even download it from the researchers' website at angel.elte.hu/wave).

Every supporter in the stadium is described as an "excitable unit" in one of three states: active (standing), refractory (passive) or excitable (resting). A slope of distance versus time gives the average speed of the wave. "It rolls in a clockwise direction at a speed of about 22 ± 3 seats per second," said the researchers at the department of biological physics. But there is a threshold below which *La Ola* could not begin. "Triggering a Mexican wave requires a critical mass of initiators."

The study could be useful claims the research group. "In violent street incidents associated with demonstrations and sporting events, it is essential to understand the conditions under which small groups can gain control of the crowd," they concluded. ■

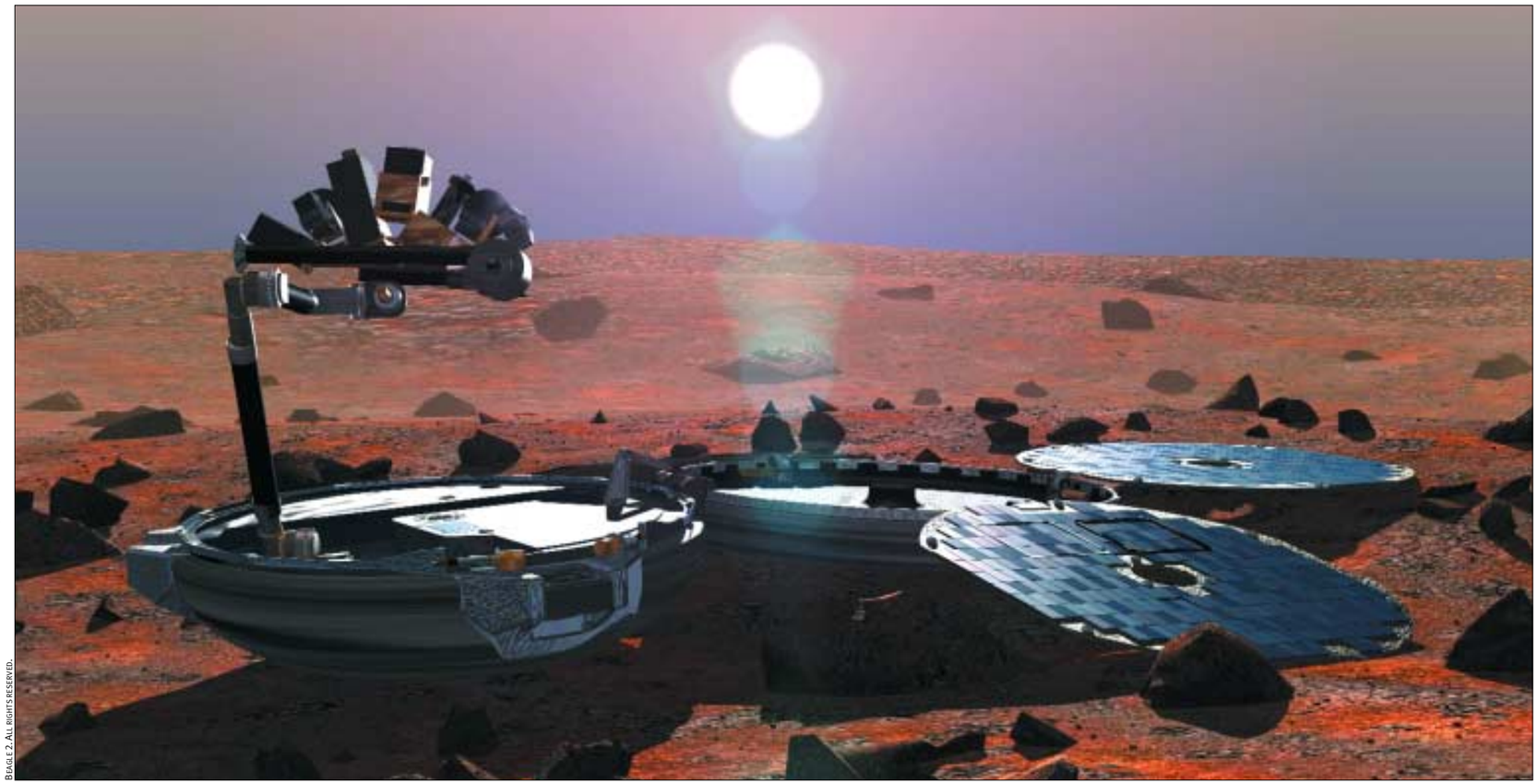
Could there really be life on Mars? The hunt is on as British scientists launch Beagle 2. **James Drewitt** looks at the case for life existing on other planets.

MISSION IMPROBABLE

Are we alone in space? This is probably one of the most important questions that we can ask and yet it seems to be the most difficult to verify. I have attended a number of lectures on this subject, some at my physics department at Aberystwyth University, one by Sir Patrick Moore also at Aberystwyth and another by Prof. Jens Martin Knudsen at this year's International Conference of Physics Students in southern Denmark. Each lecture attempted to explain the evidence of life existing elsewhere in the universe.

"It would be a waste of space if planet Earth were the only one with life," said Knudsen. He went on to say that if a huge library lay between the Sun and the Earth and this library were filled completely with books, then the total number of stars visible from Earth alone would be the sum of all the letters in all of the books. So that's quite a lot of stars.

In the Milky Way alone there are 200 billion stars and the same number of galaxies are visible from Earth. When stars are formed in nebulae, the galaxy's rotation produces an angular momentum that causes dust particles in nebulae to be thrown outwards, perpendicular to the axis of rotation. As a result, most stars formed in galaxies such as the Milky Way have their own solar system.



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For "life like us" to be supported it must be on a solid planet (to enable a gas–liquid–solid interface and thus enhance the exchange between molecules) that is not too near its star or too far from a heat source, to ensure that liquid water is present somewhere on the planet – a necessity for life as we know it. The region of space where a star provides sufficient energy for planetary temperatures to be above the freezing point and below the boiling point of water is called the habitable zone. However, liquid water can appear beneath ice sheets on planets and moons that are not in a habitable zone, and possibly in saline lakes where the freezing point of water is lowered by several degrees.

To support life, a planet is required to have a stable and low, elongated orbit. In this way, the planet remains in the habitable zone and temperatures don't fluctuate in a way that would be destructive to any life form. A planet is most likely to have a stable orbit if the stellar system it belongs to consists of only one star. However 50–80% of all stars are in binary or multiple systems. Therefore the number of systems visible from Earth that are able to support life is little more than half of the total number of stars that can be seen.

Another consideration should be the size of the star. If a star is too large, it may burn up all of its hydrogen before life has had a chance to evolve on any orbiting planets. Complex life on Earth, such as animals, plants and fungi, took 1000 million years to evolve. Therefore any star with habitable planets orbiting it must have a life span of more than 1000 million years. Many of these considerations can be entered as probabilities into a formula called the Drake equation and it can be shown that there exists a high probability that complex life could have evolved on many planets in the Milky Way and in the rest of the universe.

It is probable, therefore, that extraterrestrial life could be developing in the same way that life did in the Milky Way, where protons and neutrons formed the

"When ships to sail the void between the stars have been built, there will step forth men to sail these ships." **Johannes Kepler (1571–1630)**

first hydrogen and helium atoms, and then heavier atoms formed dust, rocks and planets until life evolved. But is the existence of DNA on Earth the result of a random accident? Or is it the product of a deeply rooted physical law, in which case life can always form on habitable planets.

It is common for undergraduate biologists to "create life" in their laboratories, mixing the same gasses present in primordial Earth's atmosphere and introducing electrodes that produce sparks to imitate the effect of lightning on these gasses. The products of these experiments are hydrocarbons, which are present in amino acids – the building blocks of DNA.

Channels on the surface of Mars could have been made by water.

There are techniques in use where it is possible to detect planets orbiting other stars and even to determine the composition of these planets' atmospheres. The methods involve observing the Doppler shifts of stars when they wobble due to the gravitational pull of an orbiting planet. However, this method is only good for detecting large gaseous planets close to the star. The detection of Earth-sized planets that are likely to be solid and habitable is, at present, only practical using a method known as transit photometry. In this method, the change in magnitude of a star is measured when a planet transits its star (moves in front of it relative to Earth). The same method can be used to detect the atmospheric composition of the planet using absorption spectra. If the absorption spectrum of a planet corresponds closely to that of Earth then the existence of life is possible.

However, no evidence of life outside of Earth can be as good as direct observation. This has become the main impetus for the exploration of our own solar system, and specifically Mars. There is much evidence that liquid water once existed on Mars but it is not known how long ago that was. The red dust that completely covers the Martian surface is formed from iron oxide, which is a precipitate of the oxidation of the rocks, possibly in the presence of liquid water. There are dry riverbeds all over Mars, which could have been formed by water. Where there was once liquid water, there was the possibility of life. If it can be verified that life did exist on Mars, then it is almost certain that it can be found in the present day, elsewhere in our universe.

ALH84001, 0 is a 4.5 billion-year-old meteorite from Mars that was discovered on Earth. This meteorite has a very special property, which is the strongest evidence so far for extraterrestrial life. The meteorite contains precipitates of carbonates all over it, in every crack and crevice. Inside the carbonates, magnetic Fe_3O_4 (magnetite) has been discovered. Inside some bacteria found on Earth there exists mono-domain magnetite crystals, which, when compared to the magnetite taken from the meteorite, the two samples cannot be distinguished. If this is true, then there is no doubt that there must have once been magnetite bacteria present on Mars.

There are currently several missions to send landers to Mars. One of these missions, Beagle 2, led by a British team of scientists, will allow the first lander ever to dig below the Martian surface. Other landers, which are being sent by NASA in collaboration with Denmark and Germany, will also host experiments to find evidence of life, but only on the surface of the planet.

It is expected that if Beagle 2 (due to land at Christmas) or Athena (due to land in early 2004 and 2007) find evidence for life on Mars, it will still be difficult to convince many people of it. The only solution would be to send manned missions to Mars, but that relies very much on the success of these explorations. ■

Further information

www.beagle2.com

Marie Curie (1867–1934)

CURIE OSITY

Deborah Telfer summarizes the remarkable life of an overachiever who discovered radium and won two Nobel prizes.

There are elements of Marie Curie's life that would not seem out of place in a modern soap opera or a celebrity news story. Forbidden from marrying her first love she finally met and married Pierre Curie. She gave birth to a daughter and became a working mother, but lost her husband in a road accident. Later, accused of having an affair, she was publicly persecuted and fell into a depression. However, despite her natural shyness she learned to court the press to gain the publicity necessary to advance her career. We realize just how unique a woman she truly was when we remember that she was awarded two Nobel prizes, first for physics and then for chemistry, at a time when it was extremely rare for women to be educated to university level.

Born Marya Sklodowska on 7 November 1867 in Warsaw, Poland, Marie later changed her name to the French form. Nevertheless, throughout her life she was loyal to her native country. During her childhood, Warsaw was under the rule of the Russian Czar, so Polish culture was heavily repressed. Indeed, Marie attended a Russian school where the teaching of the Polish language and Polish culture had to be conducted in secret.

Marie received an excellent early education thanks to her father and mother, who were teachers. However, life in Poland was extremely hard for the family. As Russians took over all of the major teaching posts, Marie's father found work increasingly difficult to find, so money was scarce.

STANLEY D BURNS/SPL

On graduating from school at 15, Marie was awarded a gold medal for her academic achievements. However, after all her hard work and having lost her mother to tuberculosis and an older sister to typhus, she became depressed and suffered a breakdown. To help her recover, Marie's father sent her away to spend a year in the country with relatives.

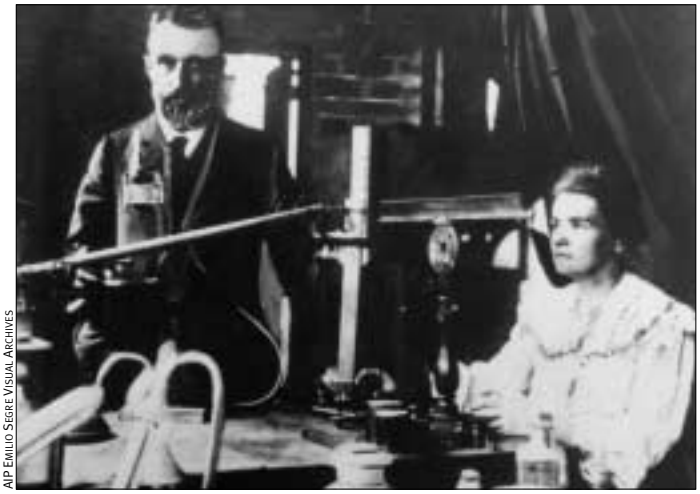
The pact

Marie and her older sister Bronya were keen to further their education, not least from a desire to help support their country, and so they made a pact to fund each other's education. Marie began work as a governess to help Bronya through medical school. During this time she not only continued her own studies but also illegally taught local peasant children. Marie fell in love with the eldest son of the family for whom she worked, but their engagement was forbidden due to her lowly status.

In 1891, just as she was turning 24, Marie was finally able to resume her studies in earnest at the University of Paris. Despite being initially behind her fellow students, Marie's ability and love of learning enabled her to finish top of her class when she completed her physics degree

in 1893. The following year she was awarded a maths degree.

In 1894, Marie met Pierre Curie who, at 35, had already established himself as a prominent physicist – he and his brother having discovered piezoelectricity. Pierre was encouraged by Marie to write up his research, and on completion of his doctorate he was awarded a professorship. Following her marriage to Pierre in 1895, Marie earned a teaching certificate and received funding for a study into the magnetic properties of steel.



AIP Emilio Segrè Visual Archives

Marie and Pierre's laboratory working conditions were very poor.

When their first child, Irene, was born, Marie continued to work and Pierre's father moved in with the family and took care of his granddaughter. Marie was uninterested in housework but documented her child's progress with the same attention to detail that she displayed in her laboratory work.

Marie wished to begin a doctorate and, when Irene was only three months old, she began looking for a research topic that would allow her to continue lab work but did not involve a lot of background reading. She chose Becquerel's radiation. His discovery of radioactivity in uranium had attracted relatively little attention, but Marie was keen to look for this phenomenon in all known elements. Within days of beginning her study she discovered that thorium had radioactive properties and realized that the strength of the radiation was related to the amount of uranium or thorium in a compound. This was highly significant since it indicated that radioactivity occurred on an atomic level and did not depend on the structure of the molecules.

At this stage, Marie made the inspired decision to study the natural ores of thorium and uranium. She detected far higher levels of radioactivity than expected and postulated that they must contain another highly radioactive element. Pierre abandoned his own crystal research to aid Marie and in 1898 they published their discoveries of polonium (which was named after Marie's native country, Poland) and radium.

The Curies began extracting the pure elements from their ores, working in a highly unsuitable shed, which Marie often spoke about when trying to attract more funding for her research. Despite the poor conditions and declining health, Marie and Pierre found pleasure in their work and in each other's company. Their mutual respect and admiration had only increased since their first meeting and they worked well together. When Marie was finally examined for her doctorate, it was declared that her thesis was unprecedented in terms of its contribution to science.

Sadly, the couple did not fully understand the health risks involved in their work. They constantly exposed themselves to the harmful rays of radon gas and radium itself, which fascinated them with its bluish glow. Marie kept radium salts at her bedside while Pierre would carry some around in a test-tube and demonstrate the salts' ability to burn his skin. To this day, the lab books that they used remain dangerously radioactive. A hall at the Royal Institution in London had to be decontaminated 50 years after Pierre spilt a sample of radium during a presentation.

When Pierre found out that he was being considered for the 1903 Nobel Prize for Physics, he asked that Marie be included in the award. Subsequently, they received the prize together with Becquerel for their work on radioactivity. No mention was made of the Curie's discovery of radium to leave the door open for a later chemistry prize. Sadly, Pierre did not live to see Marie receive this award; he was killed in a road accident in April 1906 aged only 48.

Marie dealt with her grief by concentrating on her work and her family – her second daughter Eve was then only a year old. Marie was awarded Pierre's chair and became the first female professor at the Sorbonne. A short time after Pierre's death, Lord Kelvin questioned the assumption that radium was indeed an element. Marie rose to the challenge, eventually producing a sample of the pure element after several months of labour.

At this point in her career, Marie had achieved celebrity status,

"A scientist in his lab is not a mere technician: he is also a child confronting natural phenomena that impress him as though they were fairy tales."

Institut International de Physique Solvay, courtesy of AIP Emilio Segrè Visual Archives

Eminent physicists: Marie Curie is pictured at the first Solvay Congress in Brussels with a number of her peers including: Marcel Brillouin, Albert Einstein, Paul Langevin, Hendrik Lorentz, Jean Baptiste Perrin, Max Planck and Ernest Rutherford, among others.

but hand in hand with this fame came harsh criticism and resentment. Despite being born a Roman Catholic, Marie was the subject of antisemitic feeling from those displeased by the success of a foreign woman. And, in 1911, aged 43, she not only missed being elected into the French Academy of Sciences but found herself at the centre of a scandal.

Marie had grown close to fellow physicist Paul Langevin – they were among the first to appreciate the merits of quantum theory and Einstein's relativity – but Paul was married. After his desk was broken into, love letters allegedly written by Paul and Marie (but possibly somewhat altered or forged) fell into the hands of Paul's wife. This provided ammunition for Marie's critics and she was condemned for having stolen a French woman's husband. Finally the Langevins divorced and public attention dwindled. Paul eventually returned to his wife, and years later Marie's granddaughter married Paul's grandson before either knew of their grandparents' scandal. Although their grandchildren now believe that it is likely that an affair took place between Marie and Paul, no-one can be certain.

X-ray potential

At the height of the scandal, Marie received word of her second Nobel prize for the isolation of pure radium. Soon after, she became seriously ill and was forced to rest. She began working again one year later when she supervised the building of the Radium Institute in Paris.

When war broke out in August 1914, Marie realized the life-saving potential of using X-rays to assist medical operations and she sprang into action. She opened 200 X-ray stations during the war years and trained 150 female technicians. Among these women was Marie's mature and competent daughter Irene, who was only 17 years old. Marie was keen to support France during this difficult time, so she began collecting radon gas, which could be used in hospitals to fight cancerous tumours.

After the war, in 1919, Marie's laboratory at the Radium Institute was ready. Now she needed to obtain research funding. Thankfully, in 1920, she was interviewed by an influential US journalist named Missy Meloney – who later became a close friend – and subsequently arranged two publicity tours and a massive fund-raising effort in the US, with tremendous success. Her unassuming attitude and dedication captivated the American people, and the Radium Institute became one of the leading centres for nuclear research. A year before her death, Marie witnessed her daughter and son-in-law discovering artificial radioactivity in this institute. The discovery ensured a future Nobel prize for Irene.

On the 4 July 1934 aged 66, Marie died of leukaemia. Her ashes lie with those of her husband in the dome of the Pantheon in Paris – she is the first woman to have been laid to rest there for her own merits. Just weeks before her death Marie had trekked part of the way up Mount Blanc to watch a sunset. Her love of the outdoors and physical activity meant that she had always been strong and able to endure some of the illnesses resulting from her work. She did not, therefore, fully appreciate the dangers involved in her work, even when fellow lab workers became ill. However, Marie Curie was not an uncaring person, indeed, her services to humanity are innumerable.

In terms of her scientific achievements, Marie Curie may be a daunting role model but perhaps we may aspire to achieve the balance that she maintained in her life. Despite her devotion to her work, she was also a loving wife and mother who never ceased helping others through her teaching, fund-raising and war work. She assisted many young women who sought an education, and remained loyal to her homeland. It is remarkable to think that this woman, who strove throughout her life to help others, made scientific discoveries that have benefited and will continue to benefit countless more in the future. ■

Einstein's Luck

John Waller

March 2003, Oxford University Press, 320pp, £18.99, ISBN 0 1986 0719 9.

Einstein is an icon so popular and appealing that publishers try to add his name to almost everything. So it is no surprise then that the new (US) edition of *Fabulous Science* has been retitled *Einstein's Luck: The Truth Behind Some of the Greatest Scientific Discoveries*.

It was, however, an unnecessary marketing strategy. Written by John Waller, a research fellow at the Wellcome Trust Centre for the History of Medicine at UCL, the book is an entertaining tour of the controversies behind famous discoveries. "Each of the six major scientists examined [in the book] manipulated their

experimental data to fit preconceived notions of how things really are," writes Waller. He is not talking of the latest misconducts in science, but of icons of the last few centuries. "Right for the wrong reasons", they fitted their results to a favoured model. In fact, some important scientific theories were initially accepted only because the scientists were less than honest about their experimental results and took the credit owed to others: for example, Eddington threw out two-thirds of his data when he proved Einstein's theory of general relativity.

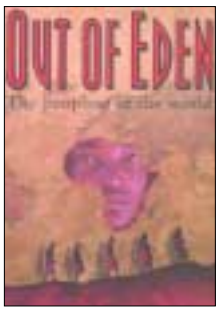
This is a required (and funny) read for any student considering a career in research.

Out of Eden

Stephen Oppenheimer

July 2003, Constable & Robinson, 448pp, £18.99, ISBN 1 8411 9697 5.

The question of how the world was peopled is a controversial one, and in this book the author tries to challenge existing views. Previously it has been shown that every living person on earth can be traced through his or her mitochondrial DNA (mtDNA) to an African "Eve" who lived more than 150 000 years ago. Stephen Oppenheimer, however, argues that there was only one exodus, that all non-Africans



descend from a group of humans that left Africa 80 000 years ago, and that all non-Africans today can be linked through their mtDNA to this "out of Africa" Eve. He then attempts to prove that this exodus followed a path across the mouth of the Red Sea to South Asia, then moving on to Australia and later into Europe and finally reaching the Americas.

The author acknowledges the difficulty of his task in the face of the proliferation of theories offered by other experts in genetics, archaeology, palaeontology and climatology, and argues that the evidence from each field must be combined to form a complete theory. Despite this, it does seem at times that Oppenheimer is allowing himself to select data that fits his theory, and to ignore that which does not. In highlighting the propensity (as he sees it) of "great grey elephant" academics to take a stance that sets them against the *status quo*, and then spend their careers defending their incorrect position, Oppenheimer runs the risk of placing himself in that same bracket.

However, his first book, *Eden in the East: The Drowned Continent of South-East Asia*, also contained controversial views, which have since gained acceptance in the field. With his latest work, he continues to challenge the orthodoxy and offers a contribution to the search for the complete answer to our genetic history.

Despite the fact that this 448 page book can be heavy going at times, you are left in no doubt as to the depth of study in this field and the expertise of the author.

Stephen Robins

Faster Than the Speed of Light

João Magueijo

February 2003, Heinemann, 320pp, ISBN 0 4340 0948 2.

Faster Than the Speed of Light is the story of the development of the variable speed of light (VSL) theory, but it also sets in context many of cosmology's great developments and is surprisingly invective of scientific incompetence.

Scientists are often encouraged to write a history of their contribution to human thought, but few manage to achieve this as compellingly as Magueijo. The VSL theories are by no means accepted, and this makes it easier to understand the rejection and struggles described in the book. Magueijo makes the account very personal, relating the highs and the lows of the venture, while retaining a wry sense of humour throughout.

It seems that no author aiming to popularize physics can resist introducing ideas such as special relativity without resorting to absurd analogies. Magueijo is no exception, favouring cows as the poor beasts that have to undergo ridiculous experiments. However, Magueijo reveals himself to be adept at elucidating the development of the science and explaining how new ideas emerge and conflict with the science that has gone before. Here he is particularly successful in setting the context for VSL theories and how they relate to seemingly disparate branches of physics.

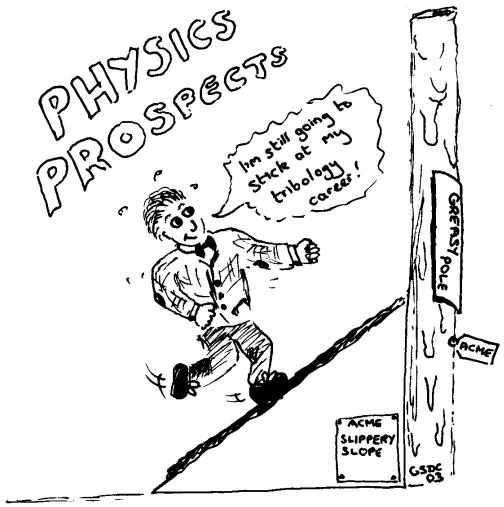
What makes this book stand apart from most other popular-science writing is the criticisms that Magueijo makes. There are many subjects of his vitriolic pen, but most serious is the criticism that he levels at the scientific publishing industry. The extent to which his comments are valid cannot be judged because no-one else has written in this way before. Magueijo may be a brave pioneer – the first person to expose a system that is ludicrous and damaging – but equally he may be embittered by just one bad experience of a system that is generally good. In any case, the manner in which he makes his criticisms adds to the interest of the book. There are few science books that encourage you to examine the study of science, not just the science itself.

This book has much to recommend it. Above all else, it is worth reading for the sheer enthusiasm it inspires about physics, and the excitement and struggles that accompany leading physics research.

Peter Barker

Book competition

This issue we have five copies of *Faster Than the Speed of Light* by João Magueijo to give away (see the review on p14). To win, just answer the following question: **Where was the ICPS held this year?** Send your entry to: Faster Than the Speed of Light competition, Shavinder Kalcut, Institute of Physics, 76 Portland Place, London W1B 1NT, UK. The winners of last issue's competition were Peter Fletcher from Ipswich, Stuart Miller from York and Katherine Brown from Wrexham. Each winner receives a copy of *The Physics Companion*.



Greg Coltman

Last issue's solution

All of the correct answers that were sent in were entered into a draw. Sharon Mitchell from Cornwall wins the first prize of £25. Alex Chin of Cambridge University and Zukaleny Yiwere from Ghana each win £10.

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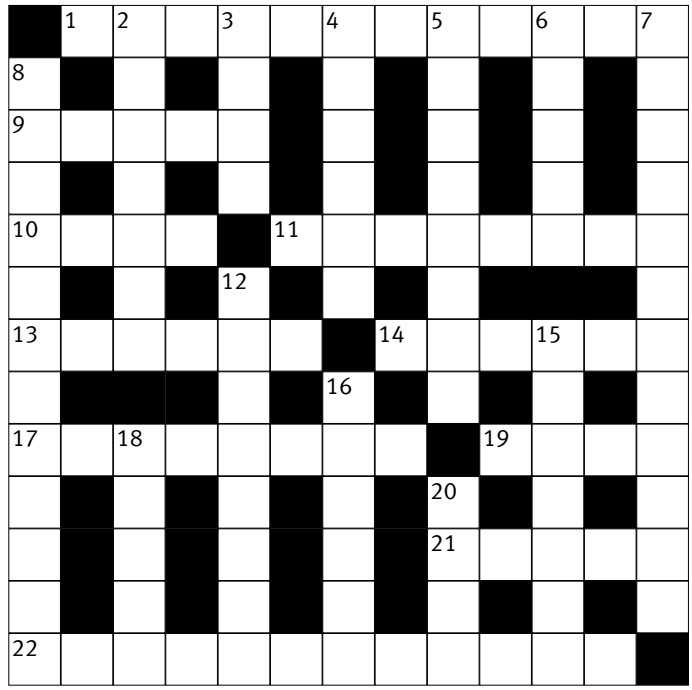
Rubbish-joke corner

A Higgs' boson was passing a church one Sunday and hearing that a service was taking place it decided to go into the church and join in. At the appropriate point in the service, the priest announced that the congregation would now receive Holy Communion, but then nothing happened. After an uncomfortable few minutes of silence the Higgs' boson decided to ask the priest what the hold-up is all about.

The priest answered: "I'm terribly sorry, we thought you were supposed to give mass."

Nexus prize crossword Set by Sam Rae

Send your crossword solutions by fax to +44 (0)20 7470 4848 or by post to Shavinder Kalcut, student liaison officer, Institute of Physics, 76 Portland Place, London W1B 1NT, UK, to arrive no later than 3 December. All of the correct answers will be entered into a draw. The lucky winner will receive £25 and the two runners-up will each receive £10.



Across

1. Applying force(12)
9. Prime Minister succeeding Churchill (5)
10. The Thames at Oxford (4)
11. Watered(8)
13. See 7 down (6)
14. The father of Cyberpunk(6)
17. A fundamental particle with zero charge and rest mass (8)
19. Dither (4)
20. A brief variation in a quantity (5)
21. Used for chemical analysis (5)

Down

2. $CaCO_3$ (7)
3. The ____ Project, a recent Nexus trip went there (4)
4. Initial stage of development (6)
5. Small body orbiting between Mars and Jupiter (8)
6. Eskimo (5)
7. and 13 across. The holy grail of physics (5, 7, 6)
8. Equations describing dynamic systems in terms of momentum (12)
12. Appealing to unwholesome desires (8)
15. A type of mollusc with a radially ribbed shell (7)
16. _____ Fermi, famous physicist (7)
18. Your father's brother, for example (5)
19. Alliance of oil-producing countries (4)

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