News

Plus... more news from the world of maths

BOOKMARK

Conjecture to theorem to fame to fortune? *(17/08/2006)*

The buzz is building in the mathematical community. It looks more and more likely that Grigori Perelman's proof of the Poincaré conjecture is correct and that he has solved a problem that has eluded the best mathematical minds for more than a century. When Perelman first posted his proof on the web in 2002 many thought this would be just another failed attempt, but since then it has survived intense mathematical scrutiny and appears to close to being accepted as correct.

Now the rumour mill has gone into overdrive. Word on the mathematical street is that he will receive the Fields Medal (thought of as the maths equivalent to the Nobel prize) next week at the International Congress of Mathematics in Madrid. And not only mathematical glory awaits him. The Poincaré Conjecture is one of the seven Millennium Problems named by the Clay Institute, and if Perelman has proved it he is eligible for the $1 million prize. So if the rumours are right, Perelman's fame and fortune are just around the corner.

That is all very exciting, but there is something that may get Perelman even more column inches in the press (he has already made the front pages): Perelman has a history of not accepting prizes. It seems that not only may he refuse the $1 million Clay prize, he may refuse the Fields medal too. This would make him the first to refuse the Field's Medal, and the first not only to win the Clay prize, but also the first to turn it down.

Regardless of whether Perelman accepts the accolades that may come his way, the biggest news for most mathematicians is whether his work is finally accepted as correct and whether we can start calling the Poincaré Conjecture, the Poincaré Theorem, after all this time.

The world of mathematics waits with baited breath....

- You can read more about the Poincaré Conjecture, the Fields Medal and the Clay Millennium Problems on *Plus*
- There is an excellent article about the history of Perelman's proof in the latest issue of the *Notices of the American Mathematical Society*
- You can read more about the maths rumour mill in an article in the New York Times.

How to board an airplane relatively fast (02/08/2006)

You'd think that boarding a plane is an easy thing to do: get on, find your seat and sit down. But reality is never like that: there's always that woman whose oversized make−up bag doesn't fit into the overhead locker, the business man who has to fold up his jacket with utmost precision and the family of five that try out every possible seating arrangement before settling down. But now some new research, reported in the *New Scientist* last week, shows that it's not all down to a few annoying individuals. "Enplaning", as airlines call it, really is a complicated business and it takes some complicated maths to model it: Einstein's theory of relativity.

Einstein's theory postulates that time passes differently depending on how you move through space: a person travelling in a space rocket at high speed, for example, will have aged less on his or her return than the people who stayed back on Earth (see *Plus* article What's so special about special relativity?). The key for airline boarding lies in the behaviour of an object in free−fall: Einstein's theory predicts that it will follow the path that takes longest to travel, where the time is measured from the point of view of the moving object.

Eitan Bachmat and his team from the Ben−Gurion University of Negev in Israel realised that, even though plane passengers usually aren't in free−fall, airline boarding involves maximisation of time in a way that can be modelled by Einstein's theory for free−falling objects. They applied their model not to the usual four−dimensional space (three space dimension and one time dimension) but to a new two−dimensional space based on the passengers' seat allocations and their position in the queue.

Having devised their model, the scientist checked to see if boarding passengers in a certain order, for example those in the last rows first, can make boarding any quicker. What they found is that the "last rows first" technique adopted by many airlines is no better than seating passengers randomly. In fact, getting passengers to queue in a random order is surprisingly efficient. The best option, in terms of boarding time, would be to assign to each passenger a specific place in the queue, but this is rather unrealistic as passengers are unlikely to respond well to such regimental techniques. In practise, the most efficient way of queuing takes into account the order *within* the rows: getting window seat passengers to board first and isle seat passengers to board last seems to work pretty well. The scientists also found that the time it takes to board a plane is proportional to the square root of the number of passengers.

This is the first application of Einstein's theory outside of physics and, according to Bachmat, one of the first scientific studies of airline boarding. So far, airlines have taken preciously little notice of the scientific studies, rather surprisingly given the great amount of money hinging on turn−around time of planes. But what many people would really like to know is whether the all−out−chaos approach of budget airlines that don't allocate seats is any more efficient than traditional ways of boarding. Unfortunately, Bachmat's model doesn't cover this. It's a whole different dimension.

Eliminating the photographer (05/07/2006)

Photographing artwork is a subjective business. The photographer has to make aesthetic decisions on lighting and the angle from which the picture is taken, based on his or her aesthetic instincts. But accurate representations of paintings and sculptures are important for scholars, collectors and other art lovers who view them in books, museum archives and on websites.

To get around the problem of subjective photography, the Andrew W. Mellon Foundation has awarded a grant of $855,000 to the Rochester Institute of Technology and the colour scientist Roy Berns. The scientists will use maths to build a system that photographers can use in situ to eliminate subjective decisions.

The main part of the project will be to build an instrument that can capture information about an object's geometry and colour and measure how these depend on lighting. This involves reducing the painting or sculpture to its most basic optical blueprint, and stripping it of any attributes that are down to subjective perception. Additional instruments that can gather information on the gallery's shape will also be developed later on in the project. Using mathematical models from computer graphics software, the piece of art can then be rendered as it is when viewed in real life, bypassing any input of the photographer.

You can find out more in the RIT press release.

Nano fractals (31/05/2006)

Fractals are abundant in Nature and even molecules can have a fractal structure. Now, scientists from the University of Akron in Ohio and Clemson University have created the largest man−made fractal molecule at the nanoscale. And they even captured an image of it. The molecule is made up of six rings, each composed of six smaller rings, each of which is in turn each made up of six smaller rings, and so on, giving rise to the self−similarity and incredibly intricate structure that makes a fractal.

These new man−made molecules are extremely precise and could be used to engineer new kinds of photoelectric cells, molecular batteries and energy storage. The molecules are about twelve nanometres wide, a nanometre being a billionth of a metre. This is pretty small to you and me but, apparently, it's big on the nanoscale. One of the scientists involved even called it huge. To see an image of the molecule enlarged a million times and to find out more, read the University of Ohio's news release. The scientists' work was published in the journal Science.

Taking a leaf out of Nature's book (31/05/2006)

Computer networks, connecting people, organisations and places, are becoming increasingly complex. So complex, in fact, that many are starting to buckle under their load. The huge amount of information sent through networks and the increasing complexity of this information can overwhelm particular nodes in the network, and before you know it your files have disappeared or your printer connection has failed.

Nature, on the other hand, has no such problems: ant colonies and bee hives are networks of thousands of individuals engaged in complicated communal tasks, and evolution has made sure that these networks function perfectly. The BISON project, funded under the European Commission's FET (Future and Emerging Technologies) initiative of the IST programme, has been set up to learn from these little animals.

The project takes its inspiration from the techniques used by ants to find their way to and from food sources, and by fireflies' ability to synchronise their flashing. Using computer models of these animals' behaviour, the project scientists developed algorithms that can optimally route information through a constantly changing network, and synchronise important network functions.

Although most of the project's work is not yet ready for commercial use, initial tests seem very promising. Maybe a bug in the system isn't that bad after all. To find out more read the IST's news release.

The million Dollar questions (17/05/2006)

If you'd like to have a go at solving one of the most tricky and important open questions in maths and get rich in the process, then the QEDen web site is worth a look. The site has been set up with the ambitious goal to solve the Millennium Prize Problems, seven of the most difficult unsolved problems in maths. The Clay Mathematics Institute has promised a million Dollars to anyone who solves one of the problems, but so far solutions remain elusive.

QEDen is designed to be "an online playground for the mathematically and scientifically minded people on the internet to converge and wrap their minds around the toughest problems yet to face the planet". As yet, its "progress thermometer" is firmly stuck at zero. But, who knows, maybe *you* could deliver a vital clue. And, don't worry, if you solve the problem, all the money is yours alone.

You can find out more about these problems in the *Plus* articles How maths can make you rich and famous and How maths can make you rich and famous: part II.

Maths maps musical emotion (17/05/2006)

Music makes emotion and maths underpins music. But can the emotional part of music be captured by maths? To find the answer to this question Elaine Chew, assistant professor of industrial and systems engineering at the USC Viterbi School of Engineering, set up a graduate course called "Computational Modelling of Expressive Performance" to look for answers. The aim of the course is to teach students how to use tools from engineering and computation to understand our emotional responses to music.

Chew pursues a successful career as a pianist along side her research, and so is perfectly qualified. But as she admits, teaching the course is a challenge, as students need expertise from a huge range of different disciplines. They need to use tools from music theory, cognitive science, artificial intelligence, experimental psychology, signal processing and neuroscience, to name but a few. Not many students have the necessary pre−requisites, but some of those that do have now put an exhibition of their projects online.

One pair of students have created "emotiongrams" that map musical characteristics to colour patterns to capture their emotional impact. Another project involves analysing scores of silent movies that have been specifically created to evoke certain emotions, and yet another one involves a system that allows you to add extra rules to a musical score and observe whether this changes the impact on your feelings.

You can read about all the projects on the course website. *Plus* has a number of articles on the mathematics of music, which you can find in our archive under keyword or topic "maths and music".

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29 steps to universal (26/04/2006)

Think of a number, any number, and see if you can write it as the sum of square numbers: $13 = 2^2 + 3^2$, $271 = 1^2 + 1^2 + 10^2 + 13^2$, $4897582 = 6^2 + 95^2 + 2211^2$...

In 1770, Lagrange proved that every positive integer, no matter how large, can be written as a sum of at most four squares, $x^2 + y^2 + z^2 + t^2$. In the centuries since, mathematicians searched for other *universal quadratic forms* which could represent all the positive integers. Another 53 expressions, including $1x^2 + 2y^2 + 3z^2 + 5t^2$, were found by Ramanujan in 1916. So many such universal forms exist, but how can you predict if a particular quadratic form is universal?

Now the brilliant young mathematician Manjul Bhargava and his colleague Jonathan Hanke have found a surprisingly simple result that completely solves the problem of finding and understanding universal quadratic forms. They found a shortcut to deciding if a quadratic form is universal to check if the form represents every single positive integer, you only have to check it represents a mere 29 particular integers, the largest of which is 290. Bharghava and Hanke then went on to find every universal quadratic form (with four variables), all 6,436 of them. You can read about this surprising result in Ivars Peterson's excellent article in *Science News*.

Apart from Bhargava's brilliance as a mathematician (he was one of the youngest people to be made a full professor at just 28), he is also an accomplished musician. Both number theory and tabla playing may be viewed as the study of patterns, Bhargava told Peterson. "The goal of every number theorist and every tabla player," he explains in the article, "is to combine these patterns, carefully and creatively, so that they flow as a sequence of ideas, tell a story, and form a complete and beautiful piece."

If you're struggling with a sum of squares, try out this useful applet by Dario Alpern.

Security from outer space (19/04/2006)

Radio waves from distant astronomical objects could in the future help to keep your email and credit card transactions secure. Japanese researchers are proposing to use the signals emitted by *quasars* as random number generators, which are an important tool in cryptography.

Quasars (from quasi−stellar radio source) are sources of immense amounts of electromagnetic energy, much more than is emitted by the brightest stars. Exactly what quasars are made of and why they emit so much energy is still a mystery, but scientists believe that supermassive black holes may play a part in powering them.

The important point for cryptography is that the radio signals emitted by quasars are impossible to predict. If you measure the strength and frequency of these signals over a given period, say between 3 and 4 pm next Thursday, you end up with a string of numbers that, to all intents and purposes, is random.

Randomness is highly sought−after in cryptography. Suppose that I want to send you a secret message which consists of a string of numbers, for example the PIN of my credit card. One way of encoding it would be to use another string of numbers, known to both you and me, as a *key*: I add every number in my message to the corresponding number in the key, thus creating a new string. I then send you the new string, which you decode by subtracting from each number the corresponding number in the key. Even if someone did manage to intercept the message, he or she would need the key to decode it. It might be possible to guess the key if its numbers follow a particular pattern, but if they are random the chances of guessing the key are practically zero. (This technique is an example of a so−called *one−time pad*.)

Unfortunately it is extremely difficult to artificially generate number sequences that are genuinely random. This is why Ken Umeno and his colleagues from the National Institute of Information and Communications Technology in Tokyo suggest to make use of the random radio signals from quasars: sender and recipient would only need to agree which quasar to monitor, and when to monitor it. The signals detected in the agreed period would give rise to the random sequence that serves as key. The two parties would not even need their own observation equipment, as the radio signals can be broadcast over the internet. "Concerning potential users, I suggest international financial institutions, governments and embassies," Umeno told the *New Scientist*.

Other cryptography experts, however, think that quasar cryptography won't catch on any time soon. No encryption technique is trustworthy until someone has had a good go at breaking it, and quasar cryptography hasn't yet been tried and tested. Maybe now is the time to learn how to mimic radio waves from outer space: you could become master of the key to the world's secret communications.

To find out more read the *New Scientist* article Your secrets are safe with quasar encryption.

Frequently flipping fields (29/3/2006)

In the past news story, Core business, we reported on research that the Earth's magnetic field may be in the early stages of a polarity reversal. These geomagnetic flips have occurred hundreds of times in the last 160 million years, and as the last one was 780,000 years ago many researchers think we are overdue for the next reversal. Until recently it was thought that the frequency of these polarity reversals was random, following a Poisson distribution. However Italian physicists have found that the process is better described by a Levy distribution a distribution used for processes that exhibit "memory" of past events. So the pole reversals are not independent events, and this information should inform models of the magnetic dynamo process believed responsible. But as for when the next flip is due, that still remains a mystery.

You can read about the strange magnetic fields of Uranus and Neptune in Untangling a magnetic mystery, and about the important role of the magnetic field in the Sun in The dynamic sun. You can also find out more about the Poisson distribution in On the ball.

Happy Pi Day to you! (14/3/2006)

Write the date March 14th in the date format used in the US and you get 3.14 which makes it Pi Day! *Plus* is celebrating by reflecting on the ubiquitous usefulness of this number to mathematics, pondering its many unsolved mysteries, and of course eating an appropriately shaped pi pie (pie are squared you know). How will you be celebrating? If reciting digits of pi is to be your pi party trick, then make sure you read Remembrance of numbers past from issue 31.

"If a billion decimals of pi were printed in ordinary type, they would stretch from New York City to the middle of Kansas. Only fortyseven decimal places of pi would be sufficiently precise to inscribe a circle around the visible universe that didn't deviate from perfect circularity by more than the distance across a single proton."
− from The Riciculously Enhanced Pi Page

Gravity kills dark energy? (16/02/2006)

In 1998, scientists found that the rate at which the universe expands is accelerating. This was extremely puzzling, as none of the standard theories could account for the acceleration. So scientists decided that something unknown and mysterious must be responsible, and they called it *dark energy*. But now three scientists claim that we may not need dark energy after all, but that the acceleration can be explained by a modified model of gravity. They altered the equations from the theory of general relativity in a way prescribed by cosmological theories based on a universe with more than four dimensions. When applied to short distances (on the cosmological scale), the differences between the old and new models are not noticeable, however, on ultra large distances the new equations predict the accelerated expansion. Moreover, the researchers say, the predictions match observations extremely well and don't conflict with other observations.

You can find out more about the new model for gravity on Physicsweb, and more about dark energy in *Plus* article New light shed on dark energy.

Small, cool planet found (27/01/2006)

Scientists have found the smallest extrasolar planet yet. The inspiringly named OGLE−2005−BLG−390Lb orbits a red dwarf about 22,000 light years away, close to the centre of the Milky Way. Its mass is between 2.8 and 11 times that of the Earth's mass, possibly making it the least massive planet that has ever been found outside our own solar system. It's about 2.6 times as far away from its star than the Earth is from the Sun. This distance, together with the fact that the star is a lot smaller and less bright than our Sun, means that temperatures on this icy, rocky planet are somewhere around −220° too cold for life as we know it.

The planet was discovered using a new technique called *gravitational microlensing*. Until now, planets were spotted by the way their gravitational pull makes their host star wobble, a technique which uses the *Doppler effect* (see *Plus* article Brave young worlds). But for this to work, the planet has to be massive enough or close enough to its star to exert the necessary pull. Consequently, all planets found so far are much more massive than OGLE−2005−BLG−390Lb.

Gravitational microlensing uses a different approach: as a star passes in front of a more distant reference object, its gravity acts like a lense and increases the object's brightness for a period of a few weeks. If the moving star has a companion planet, then this gives the brightness an extra spark. Although this is the third exoplanet discovered using gravitational microlensing, it's the first one of such low mass. Scientists think that these small worlds are much more common in the universe than was previously assumed. To find out more and see some pictures read this article from the European Southern Observatory.

Football physics (25/01/2006)

Nicholas Linthorne and David Everett from the University of Brunel, UK, have worked out the optimum angle for a footballer to launch a throw−in it's 30 degrees to the horizontal, 15 degrees less than textbooks normally state. The two filmed a player throwing the ball at angles between 10 and 60 degrees and then used biomechanical software to measure velocity and angle in each case. Using the equations that describe the flight of a spherical object, they calculated the optimum launch angle to be 30 degrees. Thrown at this angle, the ball has the best chance to fly all the way to the penalty area, giving other players a great opportunity to score. And it goes even further if it's launched with a backspin at an even lower angle.

The same methods can be used for any other sport involving the throwing of a ball. Next, Linthorne will calculate the optimum angle at which to take a goal kick. To find out more, read their paper Release angle for attaining maximum distance in the soccer throw−in, or look at Nicholas Linthorne's homepage.

US law is Euclidean (16/01/2006)

This is what one James Robbins found out when he stood trial for drug dealing in New York last year. US law decrees that selling drugs within 1000 feet of a school carries extra penalties. Unfortunately, Robbins had been caught within that radius, so his lawyer decided simply to change the metric. He argued that the *Euclidean* metric, which measures distances along straight lines between points, should be replaced by a "Taxicab metric", which measures distances along the roads a taxi, or a pedestrian, has to take to get from point to point. After all, students from the school in question are unlikely to walk through brick walls. According to this new metric, Robbins was 1254 feet away from the school: 764 feet north along Eighth Avenue and 490 feet west along 43rd Street. Alas, judge and jury were unimpressed by this mathematical trickery and Robbins lost.

Einstein is proved right (16/01/2006)

Unlike human celebrities, equations have to prove their merit to be famous. Now Einstein's $e=mc^2$ has done just that. An experiment conducted by US researchers from the National Institute of Standards and Technology and the Massachusetts Institute of Technology, showed that e differs from mc^2 by at most 0.0000004, proving beyond doubt that the equation is indeed correct.

The equation, which just celebrated its 100th birthday, is part of Einstein's special theory of relativity and relates energy (e) to mass (m) and the speed of light (c). The recent experiment is the most precise and direct test of the equation ever conducted. Its results were published in the journal *Nature*. You can find out more about the experiment in this news release. To see special relativity in action, read *Plus* article What's so special about special relativity?. Another *Plus* article, Spinning in space, describes how the general theory of relativity is put to the test.

Symmetry, dance and sexual selection (29/12/2005)

There are not many concepts that are fundamental to both maths and sex, but symmetry is one of them. In maths the study of symmetry forms the basis of a vast field called *group theory* and can be exploited to understand the patterns inherent in nature and the abstract world. On the other hand, scientists have long suspected that the symmetry of a person or animal's body is an indicator of health and strength and therefore desirability as a potential mate. Now anthropologists from Rutgers, The State University of New Jersey, got together with computer scientists from the University of Washington to put this hypothesis to the test.

The researchers got 183 Jamaican teenagers to dance to a popular tune with infrared reflectors fixed to 41 locations on their bodies. The reflectors made it possible to exactly measure the dancers' movements. These were then fed into a computer, which reproduced the dancers as faceless, gender−neutral and same−size figures on the screen. Peers of the dancers were asked to evaluate the dancing ability of each computer generated dancer.

The results of the study, published in *Nature*, show that good, symmetrical dancers were rated most attractive. Moreover, girls rate symmetry higher than boys do. This makes sense since it's all about potential offspring, and females invest a lot more in this they better choose their mate carefully.

This is the first time that scientists managed to devise an experiment which separates dancing ability from other features that contribute to attractiveness. So if you are not perfectly symmetrical, don't dispair: you may still win them over with your brilliant mathematical mind.

To find out more read the Rutgers press release.

Communicating maths (28/12/2005)

Plus is committed to communicating maths to a general audience, and so we are pleased to see that a maths communicator, George Szpiro , has been honoured by the prestigious Descartes Prize for Excellence in Science Communication. George Szpiro received the €5000 prize for his book *Mathematik für Sonntag Morgen* (*Mathematics for Sunday mornings*), a collection of fifty mathematical stories which grew out of his monthly column in the Swiss national newspaper *Neue Zürcher Zeitung*. The stories cover a wide variety of maths topics in an engaging and understandable way, and his column must be one of the very few appearing in a major paper and entirely devoted to maths. The book is due to be published in English next year under the title *Secret Life of Numbers: Fifty Easy Pieces on How Mathematicians Work And Think*

The Descartes Prize for Science Communication is awarded by the European Commission and was launched in 2004 to complement the Descartes Prize for Excellence in Research. A maximum of five laureates share a €250,000 award and five finalists, of which Szpiro is one, receive €5,000 each. To find out more visit the Descartes Prize website.

Monkey maths (15/11/2005)

Neurologists have long known of a curious effect called "semantic congruity", which occurs when people are asked to make numerical comparisons, and which until now was thought to be a linguistic effect. Now, cognitive neurologists from Duke University have found the same phenomenon in monkeys, and this suggests that the mechanism underlying numerical perception is the same for humans and monkeys, and that it is independent of language.

Show a person two small animals, a fly and a mouse for example, and you'll find that they are quicker in answering the question "which is smaller?" than the question "which is larger?". Similarly, show them two large animals like a horse and a giraffe, and they will answer the question "which is larger?" quicker than "which is smaller?". The same occurs when you ask people to make any other type of numerical comparison. It seems reasonable to assume that this effect arises because of the way our brain converts words into meaning, in other words that it depends on the mechanisms underlying language. To test this hypothesis, Jessica Cantlon and Elizabeth Brannon decided to put a group of Macaque monkeys to the test. They showed them two groups of dots on a computer screen, and communicated the questions by colours: the background of the screen was blue when the monkeys were asked to choose the group with more dots, and red if they were to choose the smaller group. The reward for getting it right was a sweet drink.

The monkeys did not only do surprisingly well at choosing the right set of dots, they also displayed an astonishingly large semantic congruity effect. And since they don't have language, this is not a linguisitic phenomenon. The researchers take this as an indication that numerical perception works along the same lines in humans as it does in non−humans, and that it is indeed independent of language.

Wobbling in unison (09/11/2005)

The events of the 10th of June 2000 must be every engineer's worst nightmare. After two years of work and £18,000,000 the *Millennium Bridge*, a foot bridge over the river Thames in London, finally opened. Spanning 330 metres, this elegant bridge was hailed as a triumph of modern engineering and thousands of people arrived to take the symbolic walk between London's north and south. You'd expect a little swaying from a bridge looking that light and sleek, but to everyone's horror the bridge soon started to wobble so intensely from side to side that pedestrians started to stagger about like passengers aboard a fishing vessel.

How could this have happened? Engineers had taken into account all the stresses that were likely to act on the bridge. Surely, people walking on the bridge could only generate such a wobble if they made a conscious effort to walk in step, which they clearly hadn't done.

It seems that Steve Strogatz from Cornell University may have found the answer to this riddle. Using non−linear dynamics, popularly known as chaos theory, he constructed a mathematical model which predicts that a dramatic wobble can indeed occur suddenly, once a critical number of pedestrians walk on the bridge. The problem, according to Strogatz, is that the bridge was designed to be flexible, and that its natural frequency is very similar to that of people walking. With as many as 2,000 people on the bridge at a given time, it's not surprising that a small number of them will accidentally walk in sync and produce a wobble. Once this number reaches a critical level, the wobble will become strong enough to force everyone else into walking in stepjust as if they were on a ship at sea. And then, of course, the problem gets compounded and the wobble escalates. Strogatz calculated that the critical number of people is as low as 160, and that number was confirmed by other scientists who independently developed a similar model.

Strogatz is not an engineer, but his field of expertisethe collective behaviour of oscillators occurring in natureequipped him perfectly to study the human element of bridge walking, the only factor that the engineers hadn't properly understood. If his theory proves to be correct, then such embarrassing, and potentially dangerous, situations could in future be avoided from the outset.

Meanwhile, the bridge was fixed without chaos theory: after 91 dampers, similar to shock absorbers in cars, were fitted at a cost of almost £9 million, it safely reopened in February 2002.

The 2005 Nobel prize in physics (05/10/2005)

The 2005 Nobel prize will be shared by three physicists, all working in the field of optics. One half of the £728,000 prize goes to Roy Glauber from Harvard University, who is credited with laying the foundations of quantum optics. His work, which goes back to the 1960s, uses quantum electrodynamics to establish the difference between laser light, which has one specific frequency and phase, and "thermal" light sources, such as light bulbs, which exhibit a mixture of frequencies and phases.

The second half of the prize will be shared by the two physicists John Hall, from Colorado University, and Theodor Hänsch, from the Max Planck Institute in Germany. The two used laser−based techniques which can measure the colour of light that comes from atoms with amazing precision. With such precise measurements, it is possible to see whether natural constants change over time, improve the technology behind GPS system and build atomic clocks whose inaccuracy amounts to no more than one second in the age of the universe (see *Plus* article Just a second for more on atomic clocks). Next, the two want to use their techniques to analyse antimatter.

Find out more on the official Nobel prize website.

Tenth "planet" has a moon (03/10/2005)

Recently, *Plus* reported on the discovery of what some people believe is the solar system's tenth planet (see Close to home). Now it has transpired that this object has a moon. This is not only "inherently cool", as Mike Brown, the astronomer in charge, puts it, but could also settle the argument about whether or no "Xena" (nick−named thus by Brown after the TV warrior princess) does deserve to be called a planet or not. As we reported in Brave young worlds, the sticking point in the planet debate is the size: too small and it's just an asteroid, too large and it may be a star. But now the orbit of the moon, called "Gabrielle" can be used to calculate both masses.

To find out more and to see a picture of Xena and Gabrielle, visit this *New Scientist* site.

− Newton is best known for his work in mathematics, physics and astronomy. He laid the foundations of differential and integral calculus, established the theory of universal gravitation and the three laws of motion. His book *Philosophiae naturalis principia mathematica* is held by some to be the greatest science book ever written.

You can read more about Newton's life and work on the Newton Project website and the MacTutor History of Mathematics website.

Small Earth−like planet found (16/06/2005)

Another extrasolar planet has been found, and it resembles the Earth more than any other planet found so far. As reported in issue 34 of *Plus* (see Brave young worlds), most of the planets circling stars which are not in our solar systems are extremely large − about 20 times as massive as the Earth − and so are very different from Earth.

This new discovery, however, is thought to be just seven or eight times the mass of the Earth, and, like the Earth, is thought to have a rocky surface. The planet orbit circles a star called Gliese 876, "only" 15 lightyears away in the constellation of Aquarius. It was already known that Gliese 876 had two planets, which were detected by the gravitational pull they exert on their star, causing it to wobble. However, the scientists discovered that the gravitational influence of the two planets could not account for all the wobbling of the star, and further observation proved that the third planet exists.

The planet is so close to its sun, which has one third the mass of ours, that it orbits it in just under two days. This makes the planet extremely hot, with a surface temperature of about 200^{o}C, which makes life very improbable.

Read more about this discovery in the University of Berkeley's press release.

Animal perfection *(02/06/2005)*

Do you spend half your life looking for things? Then your dog and a good dose of randomness might be able to help you out. Research conducted by a team of French physicists shows that animals search for things according to a special pattern: first they run quickly from where they are to a new place, which they then search slowly and randomly. Once they have finished searching there, they again revert to the first phase and run quickly and directly to a third place, etc, etc, until their search is successful.

More surprisingly, there seems to be a clear relationship between the two phases of the search: the time spent in the second phase is equal to the time spent in the first phase raised to a certain power. The researchers found that this relationship actually minimises the time needed to find the item. The technique, if employed by humans, might not only help to recover countless single socks, but also have more serious uses, for example in the search for avalanche victims.

Read more in the New Scientist article "Animals forage with near−perfect efficiency".

Plus is part of the family of activities in the Millennium Mathematics Project, which also includes the NRICH and MOTIVATE sites.