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SCIENCEWISE

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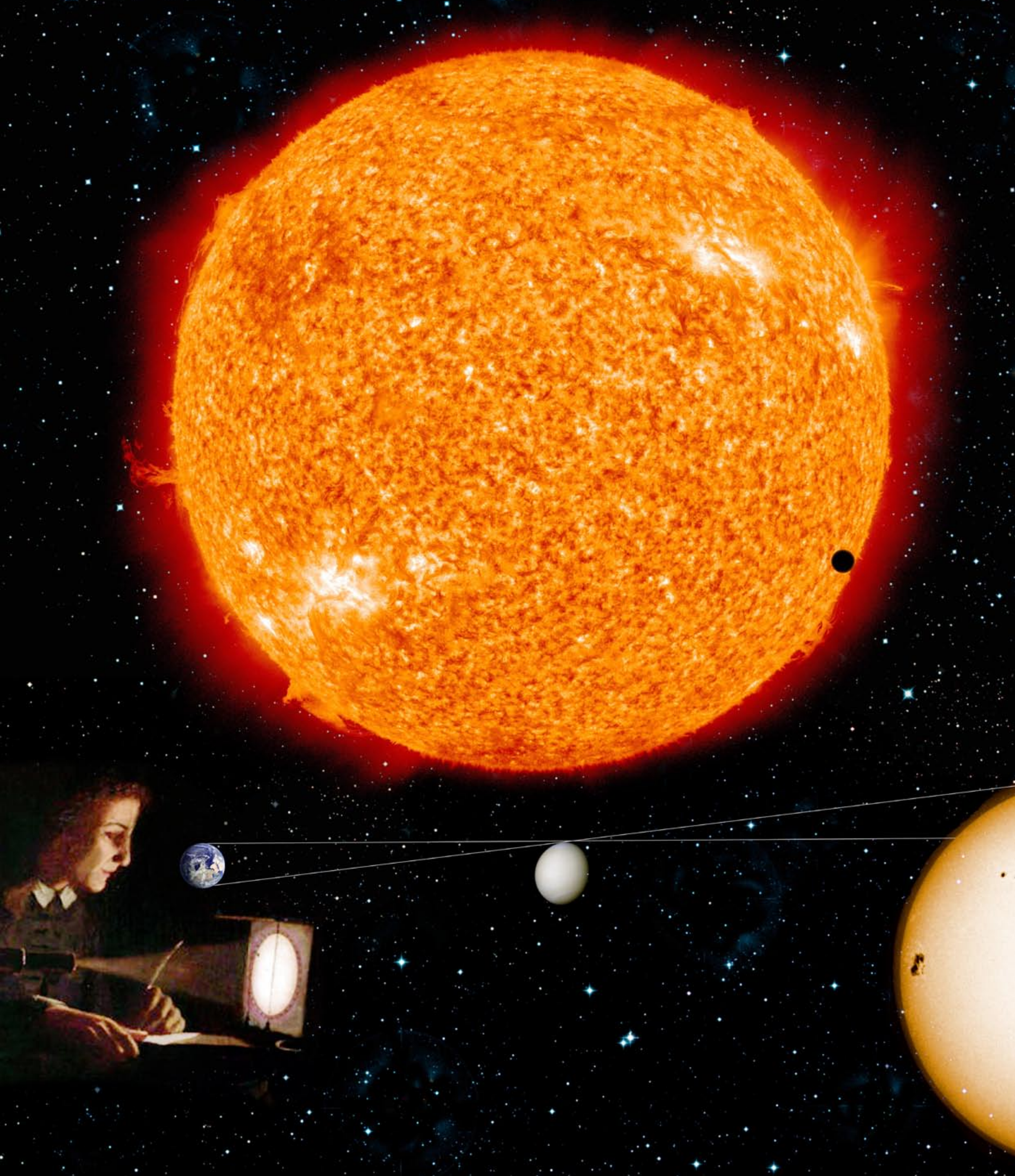

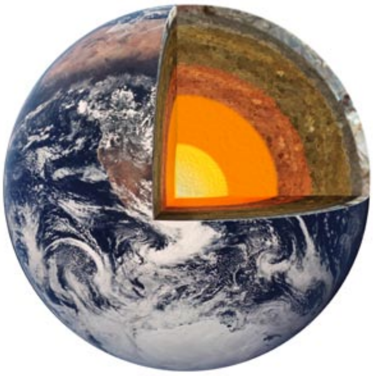

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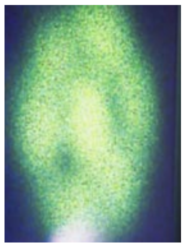

Transit of Venus


Dr Tim Wetherell

I hope lots of you were able to see the transit of Venus this June because unfortunately it was your last chance this lifetime. But why all the fuss about such transits?

For centuries it has been possible, using Kepler's laws of planetary motion, to calculate the relative dimensions of the solar system in terms of the distance from the Earth to the Sun, now known as the astronomical unit. The trouble is that until recently, no one knew just how big an astronomical unit actually was.

The rare occasions that Venus transits across the Sun's face offered a solution to this problem. Two observers at two widely spaced locations on the Earth would both see Venus touch the Sun's edge at slightly different times due to parallax. Now, if you know how far apart the observers are you can calculate the sides of the triangle and determine the distance to the Sun.

In this edition we're running a special pull out centre section devoted to one of the unluckiest people in science and his adventures trying to do just that during the two Venus transits of the 18th century. If you didn't get to see the transit and are feeling a bit miffed about it, perhaps his story will offer some comfort.

NTS


Clouded Out

The unluckiest man in science and the transit of 1761

See page 10

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SCIENCEWISE
Offsets its paper consumption with contributions to native tree planting programs.

Cover Image: Transit of Venus

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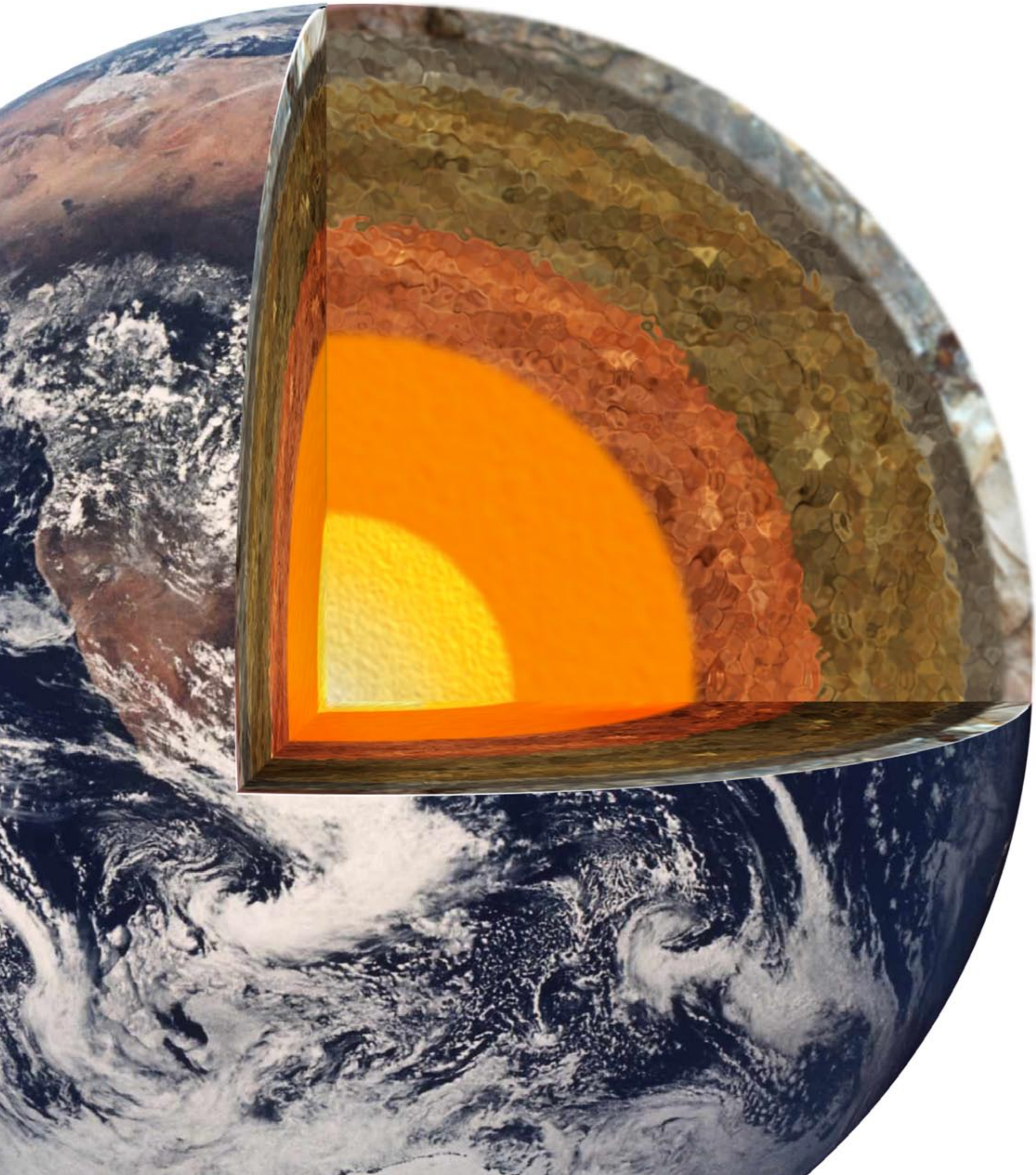
Journey to the Earth

Exploring the planet's inner core



centre of the

As the Earth formed from the hot dust and gas that surrounded the infant Sun, the heavier elements such as iron and nickel fell towards the centre. The outer rocky layers then cooled and solidified forming an insulating blanket trapping in much of the heat of the core. So it makes perfect sense that our planet should have the hot iron core it does today. However at some point in the past, the iron and nickel at the centre of the Earth began to solidify into a solid ball and that requires a little more physics to understand.

Most materials can exist as gas, liquid or solid depending on the temperature and pressure. Water is the most familiar example of this. We cool water and it freezes, heat it and it boils. But the temperature it does these things at also depends on the pressure.

The same is true for iron. So although the iron in the very centre of the Earth is at least as hot if not hotter than that in the liquid outer core, it exists as a solid because the pressure is so high. You know how much an iron anvil weighs. Now imagine ten million of them stacked on top of each other - that's the pressure on every part of the inner core.

Dr Hrvoje Tkalčić leads a research group at the ANU Research School of Earth Sciences, (RSES) who are exploring this inner core.

"Actually one of the problems we face in modelling the Earth's inner core is that it's very difficult to replicate those pressures and temperatures in the laboratory so there's a degree of uncertainty about way iron behaves in such an extreme environment. In addition, we don't even know exactly what the core temperature is," Dr Tkalčić says, "We know it's around 5500°C but it could be several hundred degrees higher or lower than that. And all these factors make it difficult to determine the rate at which the inner core is solidifying."

The only effective way to probe the deep structure of the Earth is to use sound waves, much like a doctor might use an ultrasound scan to examine an unborn baby inside its mother. However to see deep into the Earth the sound energy has to be enormous. The only sources that regularly provide this kind of intensity are earthquakes.

It was just such observations that led Inge Lehmann to discover the inner core back in 1936. She noticed that earthquake shock waves travelling through the centre of the Earth were partially refracted by a region within the core, suggesting that there was a solid/liquid boundary present.

Modern computer power has allowed scientists to refine this technique by simultaneously monitoring the thousands of quakes that shake the globe every year. This data can be used to build up a tomography image of the Earth's interior.

"It's a lot like an X-ray CAT scan in a hospital," Dr Tkalčić says, "Except that we have no control over the wave sources."

"Because the inner core is buried deep within many other layers, these tomographic imaging techniques are not nearly as effective as we'd like in this region," Dr Tkalčić explains, "So instead we create mathematical models of wave transmission through all possible core structures and compare the various configurations to what we actually observe."

Observations of the propagation of shock waves through the Earth also confirm that the outer core is liquid. "Compression waves, like sound, travel through both liquids and solids," Dr Tkalčić says, "But shear waves are lost in a liquid. We can see from the disappearance of such shear waves that the outer portion of the core must be liquid."

Most of the earthquakes that provide scientists with data occur along tectonic plate boundaries and there are more of those in the equatorial regions than near the poles. The RSES team recently installed instruments in Antarctica and in remote areas of Australia to monitor the weaker and less frequent waves with polar sampling of the inner core.

"Some results have suggested that inner core is not perfectly homogeneous, so we're trying to establish more data and investigate what's going on." Dr Tkalčić says, "And it's proving to be a very interesting area of research."

The scientists are hoping to answer questions such as whether the inner core rotates at a slightly different rate to the rest of the planet. If it is indeed asymmetric or inhomogeneous in some way. How it solidifies and what implications all this may have on things like the Earth's magnetic field.

Little green

New book to promote careful thought on environmental issues

An economist might not seem a very probable champion for better environmental practice, but Professor Jeff Bennet of the ANU Crawford School of Public Policy is just that. However, his love of the environment is far from blind. It's science accompanied by a hard edge of economic realism.

Whether we like it or not, the world works on economics. In effect it's the way we distribute and share resources all over the planet. As a result, Professor Bennet believes you can't simply ignore the cost when implementing environmental policy.

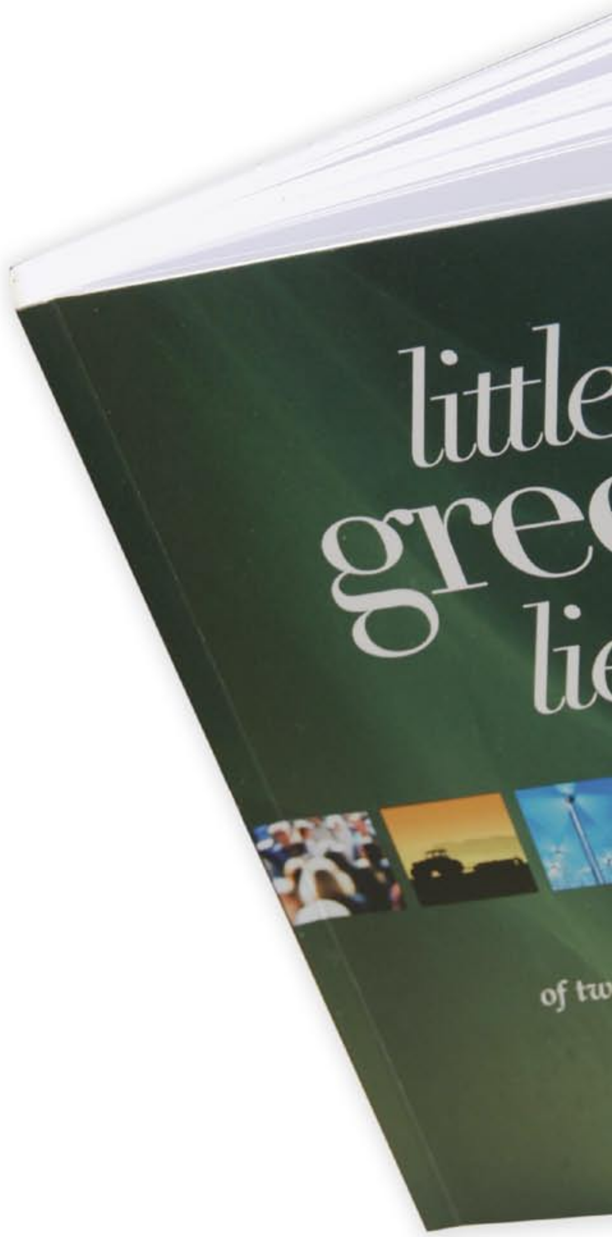
"You might imagine that each thing we do to help the environment is automatically a good thing," Professor Bennet says, "But with every action comes a cost not only in money but in human and environmental resources. There are often very significant opportunity costs that are simply ignored."

What's an opportunity cost? Imagine that you've been left $1000 in the will of a distant relative. You stuff it in the mattress where it's safe and there it sits. But you could have put in a term deposit and earned $50 a year. That lost $50 a year is what economists call an opportunity cost. Essentially it's what else you could have done with the money.

So for example if you subsidise biofuel production with a billion tax dollars that's a billion dollars that you didn't spend say on solar or wind energy. Professor Bennet's argument is not that we shouldn't spend the money, but that we should thoroughly examine all ways to do so and all the consequences of each of those ways.

Professor Bennet has assembled twelve of what he sees as the most significant examples of narrow environmental thinking into a book Little Green Lies, published by Connor Court Publishing.

"Current environmental debate is too narrow. It focuses on very specific issues seen in isolation. The goal of this book is to encourage people to take the blinkers off and think about the broader consequences." Professor Bennet says.



lies

One area of particular interest is biofuels. Whilst it's definitely good to burn less fossil fuel, government subsidies have created a huge increase in crops grown for ethanol production. This in turn has changed land use, increased food prices and even in places allowed such crops to expand into areas that were previously environmental reserves. "The question here is not so much 'is it good to reduce fossil fuel use' as 'is this the best way to channel those resources," Professor Bennet explains. "Could those same subsidy dollars be more effective if applied to perhaps wind power, hybrid cars or public transport?"

Another interesting issue is population. Clearly there has to be a limit on human population, but what's the best way to achieve that? Countries like China have tried to solve the problem with a one child policy but that has created its own problems such as gender based infanticide. "If you look at developed countries, even those which are predominantly Catholic such as Italy, you see very low birth rates," Professor Bennet says, "Yet in the developing world they're off the scale. The data suggests that if you take a dollar spent on enforcing child limitation policies and instead spend it on education and opportunity for girls, you'll get just the result you want with far less problems."

These are just a couple of examples of issues that turn out to be far more complex than they first appear and that are discussed at length in Little Green Lies.

However Professor Bennet didn't undertake this project simply as an academic exercise. "It's actually very important that we fully understand the facts before we begin setting up policies on environmental issues," he says, "The danger I see is myths, that sound good and sensible on the surface of it, becoming the basis for government policy. Because the consequences of this are far from harmless. Every dollar, person hour and resource we devote to a flawed policy, is one that can't be used elsewhere to do real good in the environment."

Royalty is not

What epigenetics in bees can tell us about human health

Over the past few decades there have been great leaps made in our ability to map and interpret the DNA sequences that make up the genome of many organisms, including humans. It's led to a common perception is that one's genome will dictate every aspect of one's life, from longevity and disease to success or failure in any given endeavour. Movies like Gattaca explore what might happen if this unshakable faith in the pre-destiny of genetics were taken to extremes in human society.

However as is so often the case in science, the real story is far more complicated that the hype. Although genes are undeniably crucial in shaping an organism's development, their expression can be changed dramatically by environmental factors. A phenomenon known as epigenetics.

Professor Ryszard Maleszka from the ANU Research School of Biology is one of the world's foremost authorities on the epigenetics of honey bees. "Within the honey bee you have a perfect example of epigenetics at work," Professor Maleszka says. "Every bee in the hive has an identical genome yet drones (male bees), queens and workers are very different organisms. For example, the Queen is larger, she's fertile, and she has vastly greater longevity that the workers."

What triggers this change during the development of the larvae is a substance known as royal jelly. If a larvae is fed with royal jelly it will develop into a queen, if fed on honey and sugar it will become a worker. You might be tempted to think this is just a case of a better fed baby growing fatter than a malnourished one, but it's not. The queen has major physiological differences such as special membranes that are resistant to oxidation damage (which probably explains her longevity), and she has large ovaries whereas workers have none.

The turning point in larva development occurs at about four days. If the larva is fed on royal jelly for just four days it will become a queen. No amount of royal jelly will turn an older larva into a queen and no subsequent deprivation of jelly will stop a four day old queen developing into her adult form.

in the blood

But how can these dramatic epigenetic development changes occur when the nature of an organism is hard wired into its DNA?

The answer lies in a process called methylation. The DNA code is comprised of four building block molecules known as base pairs. Different patterns of these pairs along the DNA strand constitute different genes. During methylation a molecule with a methyl group attaches itself to one of these base pairs (usually cytosine). This doesn't damage or alter the DNA itself but it does effectively switch off aspects of a particular gene's expression.

Substances in royal jelly inhibit methylation of "worker" genes in the bee larvae allowing the organism to develop into a queen. Professor Maleszka's research group proved this to be the case by using a methylation inhibiting compound on larvae that were fed only on honey. With inhibited methylation, the majority of the larvae developed into queens even without royal jelly.

"Usually in science things are far more complicated than we first imagine and often when we test an idea the results aren't as clear as we'd like," Professor Maleszka says, "So when we ran these experiments and all the queens developed from larvae in which methylation was inhibited it seemed too good to be true!"

Although this work is interesting in its own right, it also has far reaching implications for human health. The DNA methylation mechanism in bees is the same as that in humans and it's know that methylation plays an important role in many diseases including cancer.

"We really need to begin looking beyond the fixed genome to understand many of the current health problems society faces like obesity and diabetes," Professor Maleszka explains, "There are rarely single genes that code for a given disease, it's more like a complex network of gene expression that's heavily modified by environmental factors."

"The reality of epigenetics is fairly obvious if you think about it. Every cell in the human body has the exact same DNA yet there are many very different types of cells such as nerve, bone, muscle. Epigenetic factors usually in the embryonic stage, dictate these quite different development paths. Likewise it's becoming increasingly obvious that environmental factors such as diet will have a huge bearing on the ultimate health outcomes for an individual."

These environmental factors make the interpretation of a genome test on an individual more difficult. For example, even though a DNA test may tell you that you have genes susceptible to lung cancer whether or not you ultimately develop that cancer depends on environmental factors. If you smoke two packets of cigarettes a day even good genes might not save you, whereas if you eat well and never smoke, you might have terrible genes and still remain perfectly healthy.

Clouded Out

Were you clouded out for the transit of Venus? Many people were so we thought we'd share with you the story of Guillaume Le Gentil who's experiences may make you feel a little less mistreated by the universe.

Guillaume was an eighteenth century French astronomer who wanted to measure the distance from the Earth to the Sun by observing the transit of Venus. The observations had to be made simultaneously from at least two widely spaced locations on the Earth.

In 1760 Guillaume allocated himself an observing position in the French Colony of Pondicherry, India and set out full of enthusiasm to observe the transit that was predicted for the following year. If you think international travel is a hassle now, imagine what it was like back then!

After several months eating maggot infested biscuits in a creaky, crowded and smelly wooden ship he finally arrived off the Indian coast. However whilst he was at sea, yet another war had broken out between the French and the English and he discovered that English forces occupied his port of destination.

An agonising farce ensued during which he sought another destination but the confusion of war and difficulties with the ship meant that when the day of the transit came, poor old Guillaume found himself at sea on a beautiful clear day but was unable to make any meaningful observations due to the rolling deck.

However, our hero was not a man of feint heart. He decided that since this was only the first transit of the pair he'd wait around for the second, which was after all only eight years away. No point going home, by the time he got there it would be almost time to return.

Eight years later as the time of the second transit drew near, Guillaume decided that he'd head for Manilla in the Philippines as that would be an excellent vantage point and should offer a safe landing. Unfortunately when he arrived the Spanish authorities were anything but helpful so he was forced to head back to India in great haste.

When he arrived back in India, it seemed like his luck had changed. The French had ousted the English from Pondicherry and he was there in plenty of time to set up an observatory. And that's exactly what he did.

For a month before the transit the sun rose every morning into a beautiful clear blue Indian sky. Then as he sat with his telescope on the morning of the transit the clouds rolled in and he saw absolutely nothing. The moment the transit was over, the skies cleared and the sun shone through. No doubt Monsieur Le Gentil made colourful use of the French language that day!

As the next transit would be over a century later there was nothing for the poor man to do but throw his hands up in disgust and head for home. But his troubles were far from over. His journey was delayed by a terrible bout of dysentery and when he finally boarded ship, it was damaged in a storm and forced to land at a small island off the Indian coast. Still suffering from dysentery, Guillaume was too sick to re-board so had to wait for the next ship to call there – and the service was anything but regular.

It took him 11 torturous years to get back to his native France. Imagine his surprise when he finally got home and discovered that in his absence he'd been declared legally dead. His house and possessions had been taken by relatives, his wife had remarried and in his seat at the academy had been given to someone else.

However, it's said that persistence does eventually pay off and if there was ever a man of persistence that was Guillaume. With the help of the King Louis XVI, he regained his job and some of his possessions. He also fell in love and remarried and for the remaining 21 years of his life he and his new wife lived very happily together in France.

There's irony here too. At least part of Guillaume's motivation for observing the transit was to make a name for himself. And two and a half centuries later here you are reading his story and I bet you can't name any of the other successful observers. So in a way, Guillaume had the last laugh.

The unluckiest man in science

and the transit of 1761

Volume 9 No.3 - Winter 2012

HATs off to

Large gaseous planets orbiting close to their parent star are known as hot Jupiters and form the target for the HAT south project - a collaboration between the Max Planck Institute for Astronomy, Princeton University, The Australian National University, and the Pontificia Universidad Catolica de Chile

science

The amazing deductions scientists are able to make about exoplanets

If you've just read the previous article on the historical significance of the transit of Venus you might be tempted to think that in these days of radar range finding such events would be of little scientific significance, however that's not the case at all. Transits are still a vital to research though for the most part, the transits scientists are now turning their telescopes towards are not within our own solar system but those taking place across the faces of distant stars.

Dr Daniel Bayliss from the ANU Research School of Astronomy and Astrophysics is one of the lead scientists in the HAT-South Project – an international effort to locate large Jupiter-like worlds orbiting distant stars. Essentially the project comprises a network of telescopes around the globe that between them, are able to monitor a patch of the southern sky round the clock. Data is collected on the brightness of millions of stars and the scientists look for the tell-tale dip in intensity caused by a large planet passing in front of them.

It's not quite as easy as it sounds though. The odds are stacked against you from the start because to see a transit an observer has to be exactly edge on to the plane of the planet's orbit. Since the planes are randomly aligned relative to us we miss the majority of such events. Added to that, many stars exhibit periodic brightness variations driven by other mechanisms and just like our sun, most stars also have star spots that can cause minor dips in luminance.

Careful study of a star's spectrum can usually eliminate inherent variability as a cause of the dips. Likewise star spots can be eliminated if the dips in intensity persist for several cycles.

"Because Earth based astronomers are limited by the atmosphere, the systems we have are really only well suited to looking for large planets orbiting close to their parent stars," Dr Bayliss says, "But we also have complementary space missions such as the Kepler space telescope that are engaged in a search for smaller Earth-like planets."

A space based telescope can achieve fantastically accurate photometry (measurements of a star's brightness) because it isn't limited by the atmosphere. But it's not just the size of Earth-like planets that makes them hard to see from the ground.

We expect that such planets would orbit their stars in what's known as the Goldilocks Zone. Far enough away not to roast but close enough that liquid water can exist. The Earth takes a whole year to orbit the Sun so it would take a distant observer at least four years of continuous photometry to conclusively establish our existence. If the parent star is fairly dim like a red dwarf the Goldilocks zone is closer and the orbits shorter, but they would still take months to complete. Earth based telescopes can only operate on clear nights so for all the HAT-south observatories to be cloud free for years on end is a tall order. However, HAT south transit observations have lead to the discovery of several large Jupiter-like planets in close, fast orbits.

Discovery of such planets is not the end of the science though, it's just the beginning. "It's great to find these hot Jupiter systems," Dr Bayliss says, "But what we really want to know is what the nature of these planets is and how they formed."

The relative diameter of a transiting planet can be calculated by size of the light dip, bigger planets cause a larger drop. But to translate that proportion into actual kilometres you have to know the diameter of the parent star. That information comes from its luminosity and spectral type. We know for example that a star of the same age and spectral type as the sun that has a slightly greater inherent brightness must be slightly bigger.

Because hot-Jupiter type planets are large they cause the parent star to wobble slightly as they orbit. These wobbles are not necessarily visible as positional changes because the stars are so distant, but they do show up in the spectra as the lines are Doppler shifted by the star's movement. From the size of the star and the size of the wobble, the mass of the orbiting planet can be calculated. And if you know its diameter and mass you have its density.

"One of the really surprising things we've discovered is just how light these planets seem to be," Dr Bayliss explains, "They're so light we don't believe they have the type of rocky core planets like Jupiter do. That makes their existence so much more of a mystery."

In the absence of rock, it is possible for large gaseous planets to form around accumulations of ice. But ice in such close proximity to a star is a real-life snowball in hell scenario. It simply wouldn't last for long enough to accumulate its gaseous envelope.

"What we think is happening here is that these large gaseous planets are forming around icy cores beyond what we call the snow line, a distance from the star at which ice is stable. Then some mechanism is driving them inwards." Dr Bayliss says.

One good candidate for this mechanism is the existence of two or more large planetary bodies in unstable orbits. A close-miss can perturb one planet sending it spiralling inwards towards the parent star. But is there any evidence for the existence of multiple planets in such systems?

The answer is yes. Sometimes they can be detected as additional dips in the light curve but often we're not that lucky. The chances of both large bodies continuing to orbit in the same plane and hence both transiting from our perspective is very small. Also a large planet in a slow moving distant orbit doesn't produce nearly such an easily detectable wobble on the central star as it does when it orbits close and fast so they're generally hard to see that way too.

There is however yet another way large distant planets reveal their presence and that is perturbation of the orbits of inner planets. In fact this is exactly the way in which Neptune was discovered, by the small perturbations it caused in the orbit of Uranus. By looking very carefully at the exact timings of the transits of the closer planet, scientists can sometimes detect small perturbations in the precise moment the light dips. Combining that data over many cycles they can sometimes reveal the tell tale signs of additional invisible planets in the system.

Just when you might think there was nothing else that could be squeezed out of such data, comes the concept of exoplanet weather. Deducing details of the atmosphere of a distant hot Jupiter sounds too fantastic to be true but here's how it works.

As the planet passes in front of the star and again slips behind it you can see changes in the spectrum. Hot Jupiters have big diffuse atmospheres that are relatively transparent so as they pass in front of their star you can see absorption lines from their constituent gasses. As they go round the back of the star you see the spectral signature of their reflected light disappear. You can use the characteristics of these spectral lines to deduce the temperature and composition of the planet's upper atmosphere.

Orbital mechanics dictates that such planets are tidally locked, in other words they always keep the same face towards the central star just as our own moon always keeps the same face towards us. This means that one side is intensely heated whilst the other faces the icy cold of space. Now if you look at the spectrum of the planet whilst it's on one side of the star then look again when it's on the other it's possible to deduce how much heat is transferred from the hot side to the cold. And that when combined with the density and composition of the atmosphere tells you something of the winds distributing the heat to the dark side.

Science, especially an observational science like astronomy, is very much like a detective story. Piecing together little clues to build up a picture of what's really happening. The amazing deductions made by today's exoplanetary scientists would no doubt impress even Sherlock Holmes.

The HAT south telescope cluster at Siding Spring NSW - one of six such identical installations around the world. Each contains four 180 mm f2.8 Takahashi astrographs covering an area of sky around 8° square.

Mode 2

Doubling the capacity of our communications networks

Currently around 95% of all the world's long-distance communications travel through hair-thin glass optical fibres. These fibres are contained in bundles that run across continents and under the world's oceans.

Thirty years ago when the first fibre networks were installed, their primary use was for the transmission of digitised telephone calls and faxes, but today, things are different. An exponentially growing demand for web services means that the bulk of fibre optic traffic comprises data transfer between different computers over the internet. To cope with this expansion in demand, engineers transmit several signals at once down the same fibre using different wavelengths of light. In effect, this has increased the capacity of existing networks by several orders of magnitude, without the need to lay any more fibre.

Because the fibres in very long distance transmission systems can only operate over a relatively narrow spectral range, there are physical limits to how many different wavelengths can be used simultaneously. As a result, we are now reaching a situation where even multi-wavelength transmission will not cope with increasing demand. The limits on the capacity of existing multi-wavelength fibres are expected to be reached within less than a decade.

Just because you can't add more channels by adding more colours doesn't mean that there is no potential for improvement though. Two ANU researchers, Professor John Love and Nick Riesen are currently working on novel systems for injecting multiple signals into fibres separated by what are known as modes.

A mode essentially describes the possible ways a beam of light can move along a fibre by reflecting off the walls. Existing optical fibres have a very small central light-guiding core region, typically about 10 microns in diameter and are designed to carry just one mode with negligible distortion and attenuation.

However if the fibres were able to support two or more modes simultaneously and the modes were independent of one another, this would mean that in principle the overall capacity of the fibre could be easily doubled, trebled, etc. by adding more modes.

One of the major obstacles in achieving this in practice is getting the different modes into the fibre and separating them at the end without mixing them all up in the process. It is this area that forms the focus of the work at ANU.

Using specially designed couplers, the researchers have shown that it's possible to bring two or three single mode fibres together and inject each of their signals into separate modes within a single fibre. At the other end, a similar device extracts the modes and channels them into separate detectors.

An ingenious feature of this new coupler is that it avoids signal dropouts caused by interference nulling that would occur if existing couplers were employed in this task.

How many of these separate modes it's possible to squeeze into a single fibre depends on its structure. Existing single mode fibres can accommodate only one. If they were just 10% bigger, that number would be two and 15% bigger would enable several modes to propagate.

Whilst it may not be practical to increase the diameter of existing fibres, it is possible to play tricks with the physics. Reducing the wavelength of the light by 15% achieves essentially the same thing as increasing the size of the fibre because the light itself now becomes 15% smaller.

For existing cross-city and urban transmission systems that mostly use single-mode fibres, the shorter wavelength and mode-selective couplers could provide a practical solution to increasing their capacity. And for most of us, that would mean faster internet.

Existing very long distance fibre systems however are a different story. They require amplification of the light signals at intervals of about 50 km's. This amplification is achieved using specially incorporated impurities within the fibre and is powered by a second laser beam travelling down the outside. Unfortunately this system simply won't work at shorter wavelengths.

This means the "few-mode" transmission option can only work in future long distance systems that are laid with physically larger cores. But if the technology proves its worth on the short networks, there would be a great incentive to lay larger cores in future long distance fibres.

What's in a

The science of taxonomy

By Haylee Weaver

Species are all around us, and taxonomists are the people who allocate names to them. Such names are incredibly important, as they allow people from all over the world to talk about the same species, regardless of language differences. Taxonomy is a strange science because old and new are mixed together: the principles for naming new, never before seen species have their roots in the 18th century. Swedish botanist Carl Linnaeus revolutionized taxonomy by developing the system of binomial nomenclature in the late 1700s. Previously, species were given very long names that were often not very helpful. Linnaeus streamlined the naming process. This helped avoid confusion because even if common names are shared amongst species, each one has a unique scientific name. We still use the Kingdom-Phylum-Class-Order-Family-Genus-Species hierarchy today.

Discovering new species is exciting. While there aren't many geographical places left on Earth to discover, there are still thousands of plant and animal species being discovered every year. To date, we've only managed to name about 1.9 million of the 5 to 10 million animals, plants, and microorganisms estimated to live on Earth. In Australia, we have about 65,000 species of vertebrates (mammals, reptiles, amphibians, fish and birds) yet have only described a little over 8,000 of them. We have lots of invertebrates: probably around 1.4 million species, yet we've only managed to identify around 99,000 species. This pattern holds for plants, fungi and others (like bacteria) too - only small proportions have been identified. So it stands to reason that if you're going to take a walk or a swim in any part of Australia, you're likely to encounter a new species without even knowing it. And it's probably going to be an invertebrate. But what happens when someone finds something they think is a new species?

To name a species, taxonomists must carefully study the specimens and decide where they fit amongst the standard hierarchy of organisms. They then compare the specimens with all other known related species to determine if they are new, or something that has already been described. If they are thought to be new, the specimens are measured, with notes taken on the particular morphology and shape of the animal and its body parts. The measurements of the animal is then carefully compared with the other species that it is thought be related to (usually in the same genus). It's not necessarily taxonomists who are the only ones able to identify species, as many scientists can examine specimens and determine identifications, but it is the taxonomists who write up how and why the specimen is new and give it a name.

Taxonomists adhere to a very strict code of how things are named (for animals it's called the International Code of Zoological Nomenclature). The funny Latin-sounding names often given to the roadrunner and the coyote at the start of the Looney Tunes cartoons are examples of binomials, but are not actually their real names (their names are *Geococcyx californianus* and *Canis latrans* respectively, which are rather less amusing). Binomial names are usually in Latin or Greek and the usage of words and modification of names for use as binomials also has a complex set of rules. Often names are decided based on a feature. One of my favourite names is *Hydromys chrysogaster* (the Australian water rat), which in Latin means 'water-mouse gold-belly'. Species can also be named after the place where they were found, or for a person. While it's very uncool to name a species after oneself (not even Linnaeus did that), you can most definitely name a species after someone else. Colleagues, family members, and famous people – anything goes! The final step in the process is for the taxonomist to write up their formal description of the new species, including measurements, images (photos or line drawings), and justification, in a scholarly journal. This is not only a requirement of the code, but also provides a resource for anyone else who is interested in the particular species described (e.g., for future research).

Taxonomists bring order to the world by categorizing and naming species. As there are so many undescribed species still to discover in the world, perhaps the next time you go bush walking or exploring, you might just stumble across something no one else has ever seen before!

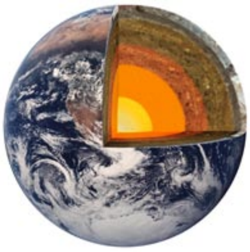
name?

> "Naw mate, I'm the magpie"

Too many magpies: The magpie from Europe, *Pica pica* (left), and the magpie from Australia, *Gymnorhina tibicen* (right), share a common name. Using their scientific names removes any confusion

ANSWERS

SCIENCEWISE



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