



Tomorrow The Big M: Why menopause is a taboo subject

Science Today

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When the death of the sun brings an end to our Earth



DR WILLIAM REVILLE

UNDER THE MICROSCOPE

Can Earth survive the last sundown? Some suggest it can

IN ABOUT FIVE billion years from now our sun will slowly start to die. It has long been predicted that when this happens the sun will swell into a giant star called a red giant, which will envelop and vaporise the Earth. Of course, the human race will not survive this event unless we have by then long since succeeded in leaving Earth to live in a more hospitable region of space. Recent observations suggest it is possible that the physical Earth may survive the red giant phase of the sun, and even, under some theoretically conceivable, but highly improbable, circumstances, remain habitable by humans for several billion more years, but nobody is suggesting that Earth will remain habitable by humans beyond that.

The sun is a nuclear fusion reactor that fuses hydrogen into helium, releasing enormous amounts of energy in the process. As it uses up the hydrogen, it gets hotter and brighter and burns the remaining fuel faster.

The sun grows 10 per cent brighter every 1.1 billion years. In one billion years from now, the sun's heat will vaporise all liquid water on Earth's surface and all life on land will die. Mars will also heat up, frozen carbon dioxide and water will vaporise into the atmosphere creating a greenhouse effect, heating the planet to a point similar to Earth today and possibly creating a future temporary home for life.

About 5.5 billion years from now all the hydrogen in the core of the sun will have fused into helium and the core, no longer supported against gravitational collapse, will begin to contract. This contraction will heat a shell around the core until hydrogen begins to fuse within it. This will greatly expand the outer layers of the sun, causing the star to become a red giant.

In 7.5 billion years from now, the sun will be 256 times its current size. A strong stellar wind will carry away one-third of the mass of

the sun. The sun will expand and contract a number of times in its red giant phase before settling down into a small white dwarf star. This will have a mass of about 54 per cent of the present mass of the sun, but will only be about the size of the Earth. It will shine brightly at first but will gradually grow ever dimmer.

As the sun swells up, it will engulf Mercury and Venus, but the fate of the Earth is less clear. The reduction of the mass of the sun will weaken its gravitational pull on the earth and the Earth's orbit will move outward from the sun.

However, recent calculations suggest that some of the Earth's orbit will still traverse the outer layers of the swollen sun and this will gradually "reel in" the Earth until it is vaporised by the sun. Other scientists argue that the loss of mass from the sun will so weaken its gravitational pull over time that the earth will escape vaporisation.

One fantastic possibility for ensuring that the Earth is saved has been made by Dan Korycansky of the University of California. He proposes that the Earth could be pulled further away from the sun using the gravitational force of a large asteroid – "it can be done by harnessing the gravitational effects of a large asteroid that passes by the Earth. The Earth's orbit is nudged gradually outwards away from the encroaching sun. By doing this incrementally every 6,000 years or so, it might be possible for life on Earth to survive for another five billion years and escape the wrath of the sun's first red giant phase".

Astronomers have now announced the discovery of a planet that seems to have survived the puffing up red giant phase of its home star. There is therefore reason to hope that Earth too could survive the dying swelling sun. The planet orbits a faint star in the constellation Pegasus, about 4,500 light

years from Earth. Before the star became a red giant and lost half its mass, the planet orbited it at about 90 million miles. The loss of gravitational pull from the reduced mass red giant star pushed the planet into an orbit nearly twice as far away.

Of course there is no hope in the longer term that life can continue to inhabit the Earth – what we are discussing is whether or not the physical planet Earth can survive. If it does survive and if humanity successfully finds another home elsewhere in space, the charred remains of Earth will become a famous place of pilgrimage for humans, the birthplace of the human race, perhaps the only intelligent life in the universe.

Dr Reville is associate professor of biochemistry and public awareness of science officer at UCC – understandingscience.ucc.ie

Are we living in a 3D sinkhole?



DICK AHLSTROM

The idea of a world of up to 10 dimensions will be discussed tonight at the annual Hamilton lecture organised by *The Irish Times* and the Royal Irish Academy

WE LIVE IN a three-dimensional world, but suppose for a moment that there are actually four dimensions or five or six, or even more.

One of the world's leading cosmologists wants you to consider just such a possibility as she delivers a lecture on the subject in Dublin this evening.

Prof Lisa Randall, of Harvard University, is in Dublin to deliver the annual Hamilton Lecture, organised by the Royal Irish Academy and *The Irish Times* and sponsored by Depfa Bank.

One of the world's most cited authorities on particle physics and the first female theoretical physicist to gain tenure at Harvard, Randall last year featured among *Time* magazine's 100 most influential people.

Her work on string theory and the geometry of space-time looks at the intriguing theory that we may be living in a three-dimensional "sinkhole" in a universe that has higher dimensions.

Such warped geometry could explain the relative weakness of gravity that we experience on Earth, as evidenced by the ease with which we can pick up a ball from the ground or use a small magnet to pick up a paperclip despite the planet's gravitational force.

The problem has hounded particle physics for decades, but Randall argues that if the geometry of space-time is warped, gravity could be weak in some regions, like ours, and strong in others, solving the apparent discrepancy we see on Earth.

Tonight in Dublin, she will explore the possibilities of higher dimensions above the familiar three that we see and feel.

"In the talk, I will focus on the idea of extra dimensions. I want people going out [of the auditorium] with the idea that there may be more beyond the standard model," Randall said prior to her lecture.

Her plan is to discuss a wide range of issues, talking about what particle physics is, and how this fits in with the theories assembled to help explain both atomic theory, which looks at the smallest of things, and also the structure of the universe, the largest of things.

The title of her talk, *Warped Passages: Unravelling the Mysteries of the Universe's Hidden Dimensions*, perfectly describes her plan for the evening. It also is the title of her remarkable book, which helps general readers to understand the newest ideas in the complex world of physics.

"One of the challenges I personally feel is I am trying to explain a difficult thing," she says, attempting to connect the theoretical concepts that describe how the universe is structured with astronomical observations and the experimental discoveries being made by particle colliders based in Europe and the US.

A star of her presentation tonight is the new €4.2 billion Large Hadron Collider, built on the French Swiss border by Cern, the European Organisation for Nuclear Research. She will explain how the new collider, which will smash particles together at tremendous temperatures and energies, will help explain matter and possibly provide proof that the universe contains more than three dimensions.

"As particle physicists, we believe there is more out there," she says.

She will ask those attending the talk in the Burke Lecture Theatre, Trinity College, Dublin, to imagine a two-dimensional creature living in a two-dimensional world and then transplant the entity into our three-dimensional existence.

She will then ask people to take themselves from our three-dimensional existence into one where there were different universes, each with a unique set of rules.

Randall's talk is booked out, but a small number of seats may become available before the talk begins at 7.30pm.

(Additional reporting by Claire O'Connell)

The Hamilton lecture celebrates Ireland's greatest scientist, William Rowan Hamilton (1805-1865), who on October 16th, 1843, discovered a new form of algebraic computation that he called quaternions



Social genes are more successful

DICK AHLSTROM

An Irish geneticist has discovered that genes that work together to achieve a common result also tend to sit close to one another on the genome

BIRDS OF A FEATHER flock together – and so, it seems do genes. Important research from Trinity College, Dublin, has shown that separate genes, whose proteins interact, often tend to be located close by one another within a person's genetic blueprint. The interacting genes form "clusters" and being near neighbours increases the chance that the cluster will be passed on to the next generation.

The work by Dr Aoife McLysaght and Takashi Makino appeared in the print edition of the prestigious journal, *Molecular Biology and Evolution* recently. The research focused on the idea that while genes within the DNA carry information, the actual structure of the genome also encodes biological information.

"The genome isn't just like a bag of genes or genes on a string," says McLysaght. She found that gene proximity on the genome has a biological function. "The genes beside one another are more likely to be connected."

McLysaght lectures in genetics in the Smurfit Institute of Genetics and in 2005 won one of the highest accolades given by research-funder Science Foundation Ireland – a SFI President of Ireland Young Researcher Award, presented by President McAleese.

The two researchers were looking for "gene

clusters" in the human genome, closely linked genes whose resultant proteins were known to interact. Protein-to-protein interactions would usually occur where some important biological function was taking place, she says. "Gene clusters should exist. They have been known in bacteria for years, but this has been less clear in higher animals."

They started to search for gene clusters and immediately started to find them, discovering 83 pairs of interacting genes within a short length of DNA just a million steps long. Human DNA has about three-billion steps in total. "We were looking at these interacting genes and where they were located on a chromosome. They were more likely to be near one another."

This startling hit-rate was much higher than might have been expected as a chance occurrence, she says. And this in turn implies a powerful evolutionary advantage linked to clustered genes.

"If they are beside each other on the chromosome, they will be inherited together and transfer as a combination more often than if they were on separate chromosomes," McLysaght states.

"If there is a biological advantage to this, there should be evolutionary pressure to keep them together. That implies there is a

If genes are beside each other on the chromosome, they will be inherited together and transfer as a combination more often than if they were on separate chromosomes, says Dr Aoife McLysaght (above) from TCD's department of genetics.

Photograph: Aidan Crawley

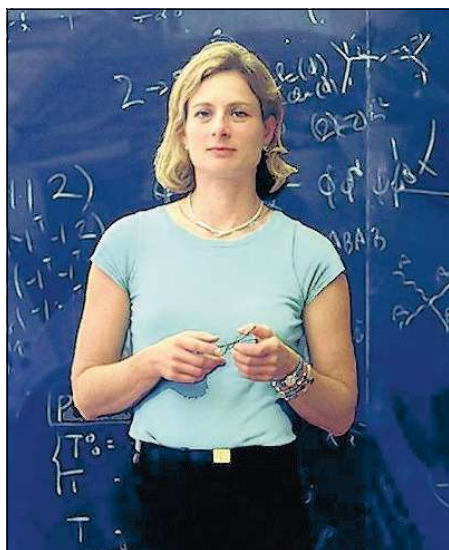
biological meaning to having them close together."

Their search revealed much more. Many of the clusters involved genes that were an important part of the body's immune system, which protects against infection. "We looked at what the genes were and found they were often genes involved in the immune system. We didn't go looking for immune system genes, we were looking for clustered genes and they happened to be immune system genes."

They tended to be a part of the adaptive antibody-based immune response, something that in evolutionary terms emerged at about the time vertebrates started to appear in the fossil record. The adaptive system is well conserved in the vertebrate family but not in the invertebrates, which depend on a system known as the innate immune system.

This implies a powerful evolutionary link between gene clustering and the development of the adaptive immune response. "If this is really important, we should see it in all genomes," she says.

McLysaght's group is now looking at how the clusters evolved and if they evolved in a similar way across genomes. The initial results suggest gene clustering developed more strongly along the human lineage.



Prof Lisa Randall of Harvard University will deliver the annual Hamilton Lecture

ON THE RADAR

The pick of the science news

Brain boost

Surfing the web in middle-age could help keep your brain nimble as it ages, scientists have found.

While frequent reading, crosswords and Sudoku puzzles are believed to keep the brain active and help stave off cognitive decline in later life, using the internet could also be of benefit.

A study at UCLA used functional MRI to track the brain activity of 24 volunteers aged 55 and 76, half of whom were familiar with internet use.

Reading prompted the brains of all participants to light up, but when they tried web surfing the internet-savvy volunteers showed extra activity in areas of the brain that control decision-making and complex reasoning.



New route out of Africa

The Nile Valley may not have been the only route for humans to migrate out of Africa 120,000 years ago, according to new research that points to a "wet corridor" through Libya as a possible route north for early humans.

Using images taken from space as well as rock and fossil evidence, scientists from Bristol

A team from Bristol University discussing a route with Libyan guides in the Sahara, Libya, during a recent study trip.

Photograph: PA

By numbers

84 The time in years it takes Uranus to orbit the sun. New images show seasonal change on the planet.

3 The number of scientists who split this year's Nobel Prize in Chemistry for work on a fluorescent protein from jellyfish that can be used to tag genes and proteins in living cells.

9,000 The number of years ago that the oldest-known case of tuberculosis erupted, off Israel's coast.

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