

CURIOUS?

IFLSCIENCE

WAS KING RICHARD III
FOUND IN A CAR PARK
UNDER A BIG 'R'?

HOW OLD IS MATH?

JULY 2026



WHAT IS ARCHAEOASTRONOMY?



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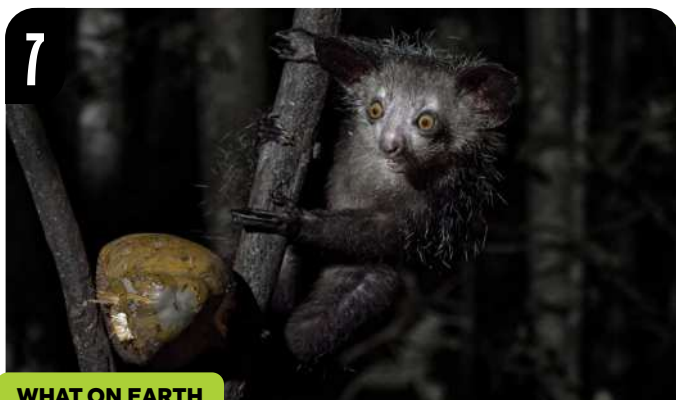


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WHAT IS ARCHAEOASTRONOMY?

What did ancient people know about astronomy and how did they use it? Stephen Luntz investigates.

JULY 2026

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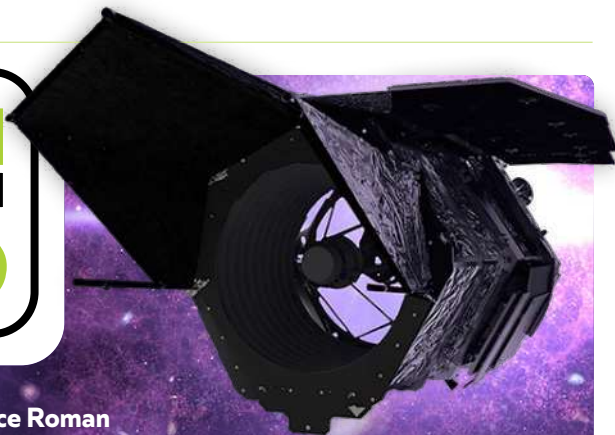
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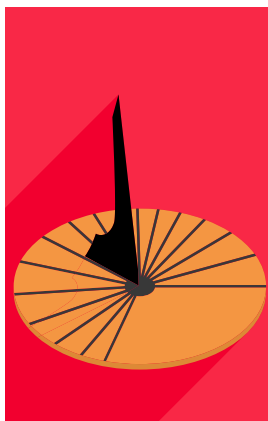
Fly With Nancy Grace Roman

NASA's next great space observatory, the Nancy Grace Roman Telescope, is due to launch next month and you can send your name into space along with it. Named after NASA's first chief astronomer and the "mother of Hubble", the telescope has a field of view 100 times larger than Hubble and will see the cosmos in infrared light, like JWST. Unlike JWST, which was built to peer deep into space, Roman is built as a panoramic survey and its giant field of view will map millions of galaxies. Its mission is to build a massive statistical census of distant worlds that will help us answer fundamental questions on dark matter and dark energy. **Submit your name here** and it will be added to a SD card that will travel with Roman to its destination 1 million miles away. Submissions close July 12, 2026.



The Astronauts Wear Prada

It's not just the devil that wears Prada; Artemis astronauts will also wear designer duds to space. The partnership between Axiom Space and Prada was announced back in 2024 with the Axiom Extravehicular Mobility Unit (AxEMU) spacesuit that astronauts would wear for future spacewalks. Now, Axiom has utilized the Italian fashion house's expertise in engineered knitting and innovative design to reveal the suit they will wear under the AxEMU suit when they explore the lunar surface for the first time with Artemis IV, currently scheduled for 2028. The new Liquid Cooling and Ventilation Garment (LCVG) was designed using advanced 3D modeling techniques to allow the astronauts maximum mobility while keeping them cool and ventilated inside the much bulkier EV spacesuits, wicking away heat and expelling it into space. The high fashion doesn't stop there: sunglasses brand Oakley is designing the visor for the accompanying helmet.

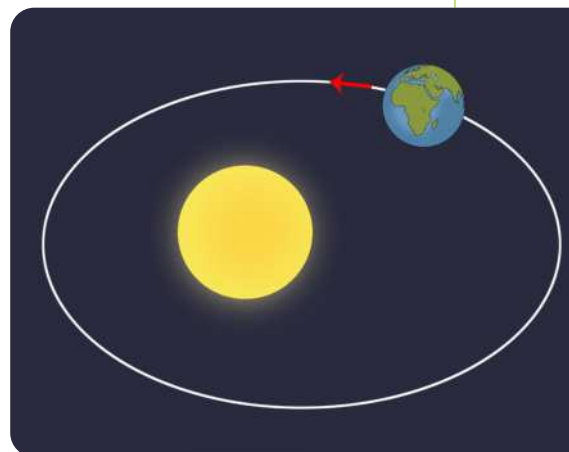


Zero-Shadow Day

Noon, also known as a zero-shadow day, is a unique astronomical event that occurs twice a year when the Sun passes directly overhead at local solar noon. During this time, vertical objects cast little or no shadow because the Sun is positioned at the zenith. It only lasts for a fraction of a second at exactly solar noon, but the shadow's effect lasts for a minute or two. The phenomenon happens only in locations within the tropics, between the Tropic of Cancer and the Tropic of Capricorn. In Hawai'i, where it is called Lāhainā Noon, it will occur on July 16.

Earth's Aphelion

On July 6, Earth will be at its farthest point from the Sun – its aphelion – at a distance of around 1.0167 astronomical units, or AU. AU is the average distance between Earth and the Sun, about 152 million kilometers (94 million miles). This distance differs by about 3 percent during Earth's orbit because it is slightly elliptical rather than perfectly circular. Technically, this marks the moment that the Sun is the smallest in the sky – but at a 3 percent difference, it's barely noticeable. It's just fun to know it!



Bee Smart

Whether bees could do math has been a contentious subject in insect research; however, scientists recently found that bees can solve surprisingly complex problems using learning and trial-and-error. In experiments, bees were able to complete tasks to earn food rewards, even discovering quicker and more efficient solutions than those demonstrated to them. What impressed researchers was that some bees were able to figure out the task without direct training, and then other bees learned by watching them. These findings suggest that bees possess cognitive abilities that bely their tiny brains. It also reminds us that even the smallest creatures can display remarkable problem-solving skills.

The Challenger

Prime Video is finally a go on production for new TV series, *The Challenger*, starring Kristen Stewart as Sally Ride, the first American woman and LGBTQ+ person to fly into space. Adapted from Meredith E. Bagby's *The New Guys: The Historic Class of Astronauts That Broke Barriers and Changed the Face of Space Travel*, the limited series tells the story of the first-ever fatal accident involving a US spacecraft in flight, when the Space Shuttle Challenger broke apart 73 seconds into flight in 1986, killing all seven astronauts on board. Ride made history when she first flew on Challenger in 1983 and again in 1984. She was also the only astronaut to later be part of the investigation into the disaster. It was Ride who pinpointed the problems with the Challenger's O-ring rubber seals that became brittle and exploded due to record-low temperatures on launch day, which ultimately turned out to be the reason for the explosion. The show is slated for a late 2026 or early 2027 release.



WHAT'S UP?

VISITING AN ASTEROID

Knock knock, we're here to take a sample.



Name: Tianwen-2 goes to see 469219 Kamo'oalewa

Appearance: Space probe attempting to land on tiny space rock

Location: Between 14.5 and 38.6 million kilometers (9-24 million miles) away from Earth

lunar craters, some scientists think that it's the result of another celestial object having **collided with the Moon**, throwing out a fragment of rock that would end up as the quasi-satellite. But we don't know for certain – which is where Tianwen-2, a Chinese space probe, comes in.

We've visited asteroids before – what's so special about this one?

First, just because you've visited one asteroid doesn't mean you have visited them all – they aren't McDonald's. Second, 469219 Kamo'oalewa is of particular interest because it's a quasi-satellite of Earth.

What's that?

It's a kind of space object that orbits the Sun for the same amount of time as Earth does, sticking reasonably close to the planet as it does so. As a result, it appears as though it orbits our planet like a natural satellite, such as the Moon. We've got eight of them in total; 469219 Kamo'oalewa was first spotted back in 2016, and the latest was only discovered **last year**.

Oh, that's actually pretty neat. So, how did it end up like that?

The leading theory is equally neat – that 469219 Kamo'oalewa is actually a chunk of the Moon. Based on its patterns of reflected light and simulations involving

How is Tianwen-2 going to help?

Sometime this month, the probe is set to land on the asteroid and take samples from it, eventually returning them to Earth in 2027 for scientists to analyze, and hopefully determine the asteroid's origins based on its composition. If the mission succeeds, it'll be the first time ever that humanity has brought back samples from a quasi-satellite of Earth.

Does success look likely?

It'll be tricky for sure, mainly because 469219 Kamo'oalewa is teeny tiny compared to the asteroids that we've previously sampled, with a diameter somewhere between 40 and 100 meters (131-328 feet). Latching on to such a small object is going to require a lot of precision.

I'll be keeping my fingers crossed.

Us too!

WHAT IS ARCHAEOASTRONOMY?

How do we know what past peoples knew about astronomy and how they used it?

By Stephen Luntz



There are few areas of science more overrun with pseudoscience than archaeoastronomy – the study of what ancient people knew about astronomy and how they used that knowledge. One misleading or outright fraudulent report about ancient spaceships or how the pyramids line up with the planets follows another on social media or the wrong parts of YouTube, but that doesn't mean there isn't genuine research on the topic. If you're tired of wading through the lies but interested in the question of how the ancients saw the skies, let's consider: what do we really know and how do we know it?

Ancient objects vs living cultures

Some ancient cultures left us plenty of information about their astronomical knowledge in the form of writing. Much has been lost in disasters like the burning of the Library of Alexandria, but even a few surviving scientific texts may tell us most of what we want to know. The much more challenging cases involve primarily verbal cultures, or those where no one knows how to read any surviving texts.

Dr Duane Hamacher is Associate Professor of Cultural Astronomy at the University of Melbourne, and director of the Buruh Program exploring Indigenous Australian knowledge of the skies. Hamacher has published work revealing that Aboriginal Australians in the continent's southeast were the first to recognize that certain red giants are variable stars whose **brightness pulses**, long before European or Chinese astronomers did. He also led research making the astonishing claim that, prior to colonization, Tasmanian Indigenous stories about the sky contained a record of the stars' positions **12,000 years ago**.

“PRETTY MUCH ANYTHING YOU BUILD WILL ALIGN WITH A STAR AT A CERTAIN TIME OF YEAR.”

Hamacher told IFLScience the field of Archaeoastronomy is divided into two broad classes, referred to as green and brown based on the covers of the proceedings of the first conference in the field. “Green archaeoastronomy [usually from Asia and Europe] is where there are no records, no stories about it: just the object,” Hamacher told IFLScience.

The most famous example is the UK's Stonehenge, whose giant megaliths are positioned so the Sun shines on the central **Altar Stone** on the summer solstice. This has been taken to indicate an understanding of the apparent movement of the Sun 5,000 years ago. Other examples are considerably smaller, such as the **Nebra Sky Disk**, a bronze disk about 30 centimeters (12 inches) across, and the oldest known depiction of astronomical phenomena at approximately 3,600 years old.

Brown archaeoastronomy, which flourishes in the Americas and Hamacher has pioneered in Australia, occurs where a living culture can tell its stories, and these can often be matched to physical remains. Unfortunately, these Indigenous cultures have usually been so damaged by colonization that only fragments of the ancient knowledge survive. Hamacher admits somewhat ruefully that the work often involves navigating conflicting accounts, where some elders will say no one knows whether an ancient site like Australia's **Wurdi Youang** was used for astronomical purposes, but others will claim they do.

Tracking the Sun and Moon

Green archaeoastronomy almost entirely relates to the movements of the Sun, and occasionally the Moon. The people who built structures like Stonehenge or Egypt's **Nabta Playa** may have known a lot about the movements of the planets, and even something of the stars, but it's usually impossible to infer that reliably from surviving structures.

Claims that the Pyramids of Giza, for example, were positioned to line up with Orion's belt or some other set of stars circulate online, but Hamacher says there is no way to really know.

“Pretty much anything you build will align with a star at a certain time of year,” Hamacher told IFLScience. Without a record of why a particular star and time carried significance, there is no way to know if an alignment was deliberate or coincidental.

The problem is even worse for the planets' multi-year cycles. Perhaps some hole in a rock really was drilled so the light of Venus would shine through on a day of particular significance, but it's unlikely we will ever know. At best, an object may have some carvings that can be interpreted as indicating an association with a particular object, but the link is seldom clear; a dozen interpretations are plausible.

Even the fact the Sun's light falls between two stones on a day of particular significance – such as a solstice or equinox – isn't a reliable indication the stones were placed

for that purpose. If you assemble a circle of stones, the rising or setting Sun will shine through gaps at several points in the year. If the gaps are wide, it might do that over several days. If one of those periods coincides with the longest or shortest day, it might represent careful planning by people who had watched the skies carefully for years before they started building, or it might be sheer chance.

In these cases, Hamacher told IFLScience, the best approach is statistical: collect data from as many structures that can be traced to a particular culture as possible and look for patterns.

MOST COMMENTATORS WERE SIMPLY TOO RACIST TO ACCEPT THE POSSIBILITY AFRICANS HAD BEATEN GALILEO TO SOMETHING SO IMPORTANT.

Despite these doubts, it's not surprising that the apparent movement of the Sun was important enough to build monuments that tracked its place in the annual cycle. Knowing the number of days from the solstice or equinox was important for knowing when to plant crops, or how long food stocks would need to last. Monuments that tracked the Sun probably had religious significance but were likely practical first.

Sifting through stories

Talking to representatives of a culture can expand our knowledge dramatically, but Hamacher stresses the process seldom lends itself to clear answers.

A memorable example involved the Dogon people of West Africa. In the 1930-50s, anthropologist Marcel Griaule reported a striking level of knowledge among the Dogon; for example, that they were aware of the Galilean Moons of Jupiter, the rings of Saturn, and Sirius's companion stars.

Years later, books popularizing Griaule's work created a storm in Europe and North America. The possibility the Dogon had once built telescopes to witness these things attracted some attention, but most commentators were simply too racist to accept the possibility Africans had beaten Galileo to something so important. Instead,

fantasies that extraterrestrials had visited the Dogon, but ignored the rest of the planet, sold millions of books.

A far more plausible explanation, that the knowledge had been transmitted by French astronomers visiting the area for the solar eclipse of 1893, is preferred by most scientists. Nevertheless, it's not hard to find those who remain today convinced the Dogon were uniquely beloved of aliens.

The Dogon example is illustrative, because even where ancient cultures survive, they have now almost always had contact with outsiders. Establishing whether astronomical knowledge developed internally, or came from outside, can be tricky.

“WHEN YOU DEAL WITH
KNOWLEDGE SYSTEMS LIKE
THIS, YOU’RE NEVER GOING
TO HAVE THE CERTAINTY OF
PHYSICS OR CHEMISTRY.”

Where possible, archaeoastronomers seek written accounts from anthropologists and other visitors to communities before such encounters were common, but Hamacher notes that this has its own frustrations.

“When you go through their records, you find that a lot of anthropologists and linguists were people with no training in astronomy,” Hamacher said. “Consequently, they conflate things, confuse things and get a lot wrong.”

One of Hamacher’s more significant conclusions was missed by an anthropologist who assumed that the “red star” a culture spoke to him about was Mars. It took some astronomical knowledge to realize that people who depended on knowing the seasons would not talk about Mars that way, whose location in the sky varies from year to year. On the other hand, the references made sense if they referred to **Antares**.

Aside from their own ignorance, many anthropologists and explorers placed little weight on the astronomical knowledge of the people they spoke with and paid it little attention.

Hamacher told IFLScience he was working on a paper about Samoan astronomy. One potentially very significant report appeared in a paper written 60 years after the author had

visited the islands. The Samoans told their visitor about a specific star that had done something dramatic enough they related it at length, but he could neither work out which star they meant, nor why it mattered. Just two sentences were devoted to the mystery.

“I’m spending 30 pages to unpack what those two sentences were talking about,” Hamacher told IFLScience. (Hopefully we’ll get to report the outcome soon.)

“When you deal with knowledge systems like this, you’re never going to have the certainty of physics or chemistry,” he lamented.

The story is just the start

This certainly is not an area of science suited to those who need definitive answers. Nevertheless, it has the potential to yield immensely exciting and significant outcomes.

Māori stories tell of a king who sailed far to the south to seek the source of what we now call the Aurora Australis and encountered walls of ice. This has been proposed as evidence the Māori visited Antarctica long before Europeans claim to have discovered it, a conclusion with many implications.

Hamacher is equally interested in the fact that the tale refers to the auroras making sounds. He notes that the Māori were not alone in this; many cultures in the far north also report sounds accompanying auroras. It took modern observers until 2023 to report the same thing, and offer up **one explanation**.

Not every living culture wants to divulge its hard-earned knowledge, particularly to someone associated with those who nearly destroyed it. However, Hamacher told IFLScience Indigenous communities around Melbourne invited him to work with them through the local Land Council, hoping to preserve and make sense of what survives. Sometimes the outcome leads to a tourism program or shows at the Planetarium.

For those interested but can’t quite make it to Australia, examples of what Hamacher and colleagues have learned in cooperation with Indigenous elders can be found at **Aboriginalastronomy.com.au** and **Burunh.org**.

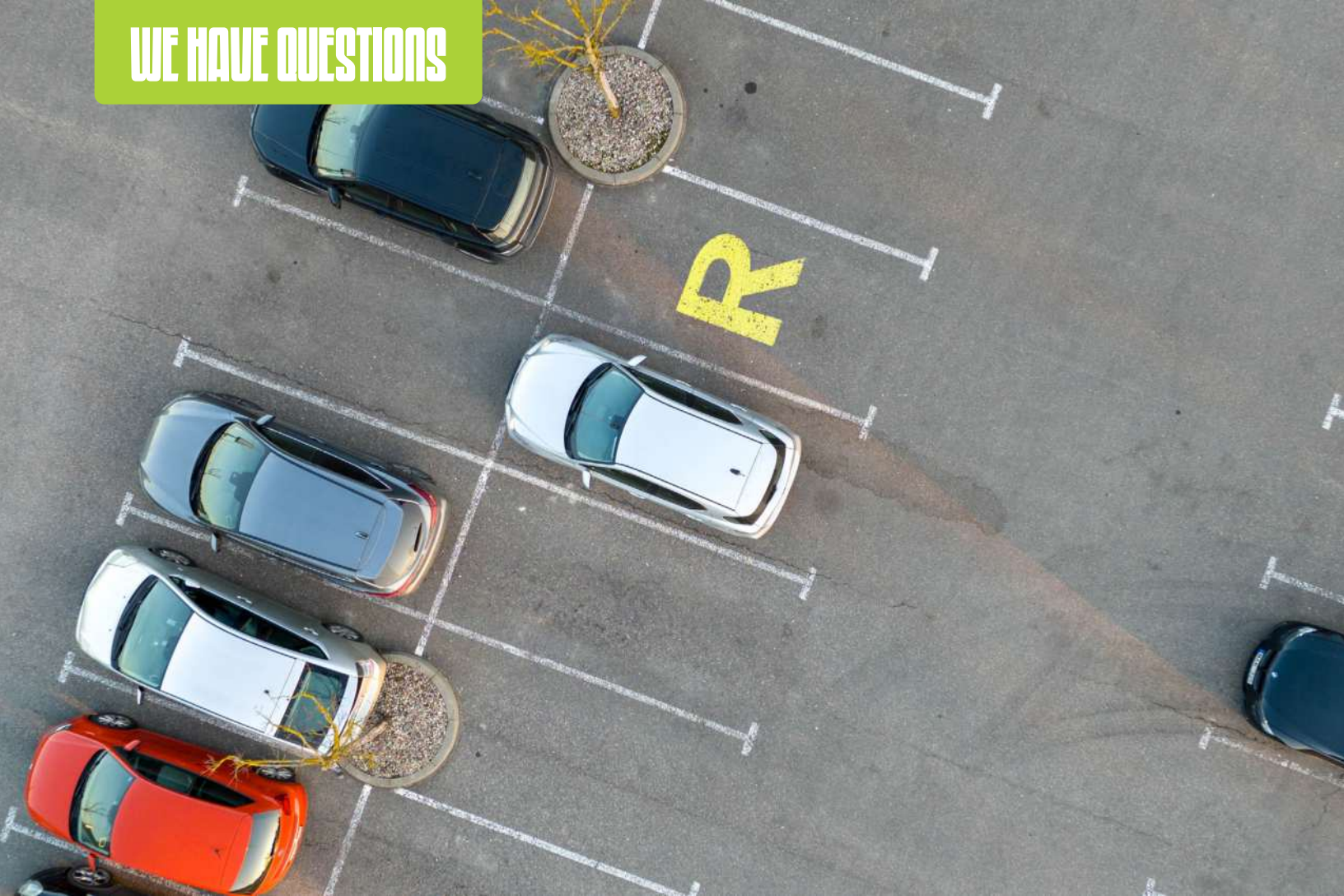


WHAT ON EARTH



THE WORLD'S WEIRDEST PRIMATE

It's thought the name aye-aye may come from the phrase "I don't know" in Malagasy, and it's a good fit for these peculiar primates. Nocturnal with bat-like ears, guard hairs that can make it double in size, and opposable big toes, they are one of our stranger-looking relatives. And that long middle finger? You don't even want to know **what they use it for...**



WAS RICHARD III REALLY FOUND IN A CAR PARK UNDER A BIG “R”?

There was something ironic about his burial place. It just wasn't what everyone thinks.

By Rachael Funnell

In 2012, a skeleton was excavated in a car park in Leicester that would prove to be one of the greatest archaeological discoveries of all time. Scientists had been searching in the presumed site of the Grey Friars friary in search of a lost English monarch: King Richard III. In a **2014 paper**, analyses of the remains and those of known relatives confirmed the skeleton was that of “The Lost King” with 99.999 percent accuracy.

Reaching that impressive degree of confidence involved our old friend DNA. Once a molecule confined to laboratories, its significance has leaked into our wider lives, touching everything from forensic investigations to wildlife crimes, but it's not a silver bullet, so says **Professor Turi King**, author of *The Secrets Of Our DNA*, who led the genetic branch of the search for King Richard III.

And as for that rumor he was found under a big “R”? It's an urban myth, but there was something ironic about the location of his final resting place.

How did you get involved in the search for King Richard III?

TK: I got this email basically saying, “We're going to be doing this excavation; we're looking for the remains of somebody who's quite famous who is buried in downtown Leicester. And we need somebody to lead on the genetic side, but also about how to excavate if we're going to potentially be looking at ancient DNA. I can't tell you who it is.”

I had a pretty good idea who this might be because I'm from Canada, but when I first arrived in [the UK] my aunt, who was lovely, one of the first things she did when I got here was she took me to the Bosworth battlefield because she was so interested in Richard.

Why is digging up an old skeleton so complicated?

TK: If you're going to be excavating and you want to do DNA analysis on human remains, you have to do it under what's known as clean conditions, which I think is quite amusing, because obviously excavating doesn't tend to be clean. But what you're worried about is ancient DNA.

Whilst we're alive, we've got nice long strands of DNA, loads of it. And there are things that will come along and nick your DNA, but your body just has repair mechanisms that put those back together again. But after death, that's not happening. So, DNA in human remains starts to fragment into shorter and shorter fragments. It's very, very damaged. All you need to do is breathe on these remains or touch them, and you're putting tons of your DNA all over it and that's going to swamp out any signal of ancient DNA.

So, it was Dr Jo Appleby, who was our lovely osteologist, and me excavating in full CSI suits, face masks, and gloves. Then it was a case of them leading on the genetic and statistical analysis to prove that these were his remains.

How did you find the right skeleton in a friary full of skeletons?

TK: Richard Buckley was the perfect person to lead this excavation because he's excavated in friaries before. We already know from the historical information that Richard III was buried in the choir of the Church of the Gray Friars of Leicester. There's historical documentation about that.

We've got a [search] area which has got a lot of buildings on it, so we can't excavate there, but there are three open areas, two of which are car parks and one of which is a playground for a school next door.

We begin excavating in the City Council car park, and it's got a section for social services and child protection which – given that Richard III is supposed to have killed his two nephews to come to the throne – there's a certain irony.

Six hours, 34 minutes in, as the trench is going in, Matthew Morris, who's our site director, spots a little bit of bone. He wants to make sure if this is just a random bit of bone or if it is attached to anything – and it's actually attached to a skeleton. There's an articulated skeleton under there. So, Jo and I, we start uncovering it on the 4th of September 2012.

What clues can help identify a skeleton?

TK: It's a historical missing person's case. If you go missing, what are people looking for? What do we know about Richard III? Well, he died in battle, but we don't necessarily know that he'll have battle injuries on the skeleton – you could bleed to death in battle and there might be nothing on the skeleton.

We know he's aged 32 when he died. Then there's the whole thing about this curved spine. Now, a lot of that comes down to Shakespeare. [He] calls him a "hunchback," which is obviously a term we don't use these days, but we're kind of keeping it in our minds that yes, he might have a spinal abnormality.

When Jo uncovers this individual, she can't tell because he's in the soil. She can't tell whether or not it's kyphosis, which is the forward curve of the spine, or scoliosis, which is a sideways curve of the spine. But you can tell there's some sort of curve to the spine that's going on, and he's got battle injuries, and he's looking like he's about the right age.

That's where the hard work really starts, because excavations are only part of a project. The huge bit of the project is all the post-excavation analysis to be able to prove that these were his remains.

And what about the rumor he was under a big "R" painted on the carpark?

TK: Gigantic myth. There was an "R" in the car park. I was joking on the very first day – because I grew up with the *Indiana Jones* movies – so I'm like, "Oh, you know, *Indiana Jones* number three. X never, ever marks the spot. He'll probably be right under there," as I kind of swan off to my forensics conference. But no, he was found about a day and a half more into the car park.

It's become this massive urban myth that he was found under the R. He wasn't, I'm afraid.

Why do these lost kings always make it so darn difficult to find them, eh? 🌟



Hungry for more CURIOUS questions?
Head to the **We Have Questions** podcast for new episodes monthly.

SCIENCE FACT OR FICTION:

HOW OLD IS MATH?

Math is pretty important, but where does it come from?

Dr Katie Spalding investigates.



There are many things that separate humans from other animals, but perhaps one of the most impressive – not to mention incredibly useful – is our ability to do math. We can calculate trajectories of projectiles; work out multiple theories of relativity; we can even invent things like the Cox-Zucker machine, if we like, for no reason other than to elicit smirks from the arithmetic geometry crowd.

Math is important, is the point. So it's worth asking: where does it come from?

It's a harder question to answer than you might expect.

In the beginning

If you're asking how far back in history math goes, you're first going to have to figure out what you mean by "math" – and it's not as simple as you might think.

"That's in fact an interesting question," says **Dr Mathieu Ossendrijver**, professor of the

history of ancient science at the Free University of Berlin. "How far back can you go and identify mathematical practices, mathematical knowledge? It is, I would say, a matter of debate."

Basic numeracy, after all, is something plenty of animals have demonstrated: rats can count, more or less; crows understand zero better than plenty of human societies throughout history; even bees seem to have a level of numerical ability that can rival that of early grade-school kids. If we're taking this level of math as our baseline, then humans have been doing it since... well, probably before we were human at all.

"I do believe that numerical thinking evolved in a previous species, most probably in *Homo erectus*," Fabio Macchiardi, a professor in the University of California, Irvine's Laboratory of Molecular Psychiatry, Psychiatry & Human Behavior, **told IFLScience last year**. It was a surprise, even to him – "I was not expecting

to arrive at such a conclusion," he said – but just as with bees and bonobos, it seems the evidence is there if you know how to look.

Take the Acheulean axe, for example: a style of weapon and tool dating back almost 2 million years, and one which is set apart from its peers by a striking symmetry. It's not much by modern standards, of course, but just the creation of such an object "required an expansion of working memory capacity, allowing for both abstract thinking – necessary for mentally rotating an object – and better retention of information needed for complex cognitive and spatial-motor tasks," pointed out Macchiardi and his coauthors in **a paper** at the time.

"ARCHAEOLOGISTS FIND THESE ARTIFACTS LIKE, SAY, ANTLERS OF A DEER WITH MARKINGS ON THEM. THEY SEEM TO COUNT SOMETHING – BUT [WE] DON'T KNOW WHAT IS [BEING] COUNTED."

It's far from the case that our *H. erectus* ancestors were performing feats of calculus, of course – truth is, we don't even know how they conceptualized numbers at all. Did they know they were doing geometry when they carved their axes? Could they count? We don't know – but from both physical evidence and modern reconstructions of early hominin brains and genomes, it seems evident that they at least had the right equipment up there to make it work.

Scratches in the bone

Potential is one thing, but it's not unreasonable to ask for more. When do we start getting evidence that humans were actually *doing* math, rather than just maybe being able to?

We're perhaps on firmer ground here, but the answer will still disappoint anybody hoping for

high-level theorems. “Nowadays, historians of science and mathematics try to avoid modern definitions of science,” Ossendrijver cautions. For example, “the skills of counting, and doing elementary computations like adding, subtracting, multiplication – that’s also mathematical practice, right? Mathematics is not only like the mathematics you learn in school, or scholarly scientific mathematics with proofs.”

Indeed, the earliest evidence of math is so subtle as to look like an accident. “Archaeologists find these artifacts like, say, antlers of a deer with markings on them,” explains Ossendrijver. “They seem to count something – but [we] don’t know what is [being] counted.”

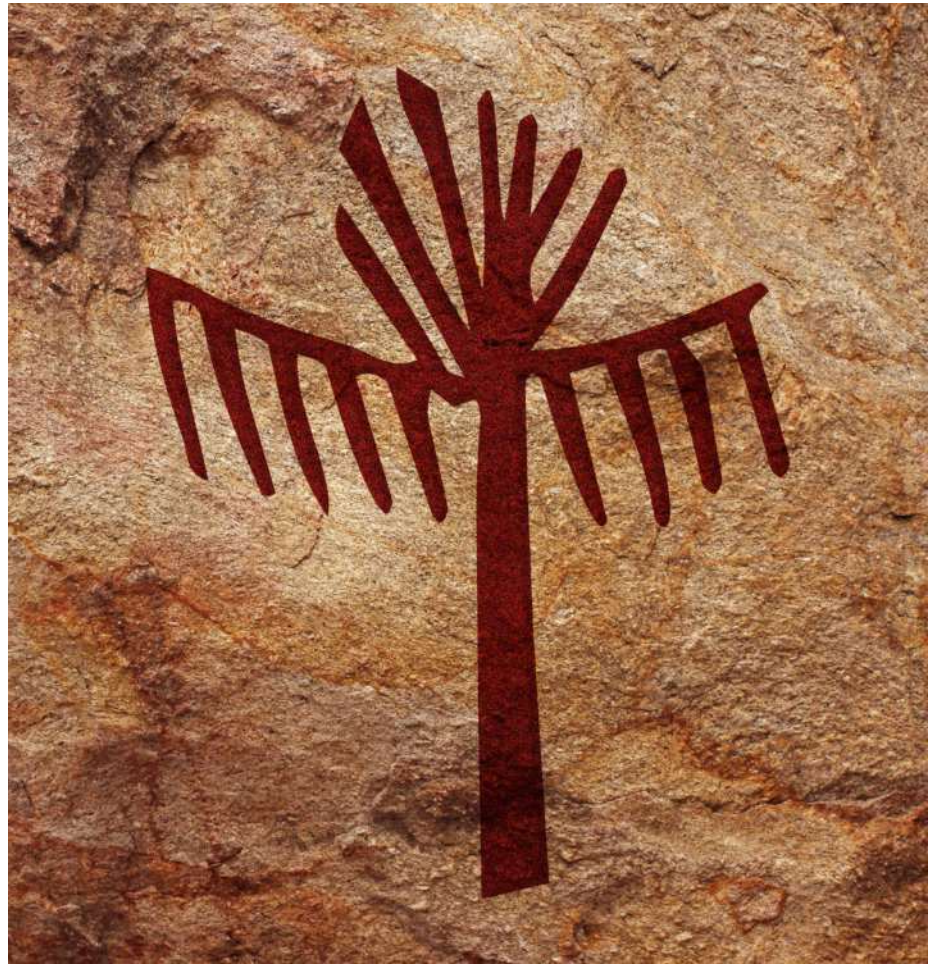
Probably the earliest evidence of this type comes not from our own species, but a cousin. Artifacts from some 60,000 years ago show that Neanderthals likely had some kind of concept of numbers, scratching as they did uniform lines into bones and caves across Europe for reasons we can now only guess at.

This tradition was enthusiastically continued by *H. sapiens*: relics like the Lebombo bone, left in the mountains between South Africa and Eswatini some 43,000 years ago, have convinced some experts that these early humans were also doing math, albeit a pretty simple version of it. “It was very basic,” says Yosef Garfinkel, a professor in the Archaeology Institute of the Hebrew University of Jerusalem. “But they did not need more than this [...] It seems to me to be the basic need of hunter and gatherer societies: how many animals were hunted, or how many times the moon completed a cycle.”

Prime examples

It seems to have taken quite some time to make the leap from counting to more complex mathematical ideas – but perhaps not as long as you might expect. A mere 23,000 years after the Lebombo bone was scratched into existence, another potential mathematician was busy doing close to the same thing up in the Ishango region of modern-day Democratic Republic of the Congo – but with an important and fascinating twist.

“The Ishango bone appears to have been more than a simple tally,” writes mathematician and math historian George Gheverghese Joseph in his 2010 book *The Crest of the Peacock*:



Non-European Roots of Mathematics. Contained within its superficially arbitrary notches are in fact some surprisingly complex patterns: “The markings on rows (a) and (b) each add up to 60,” Joseph points out; “Row (b) contains the prime numbers between 10 and 20 [...] Finally, row (c), where subgroups (5, 5, 10), (8, 4), and (6, 3) are clearly demarcated, has been interpreted as showing some appreciation of the concept of duplication or multiplying by 2.”

From the Ishango bone, we can see more than just counting. Addition, duplication, and identifying prime numbers are all pretty complex ideas, cognitively speaking; so too is the invention of a base 10 number system, which also seems to be evident in the notches. It would be enough to rewrite what we know about early human mathematical abilities – if not for one small problem.

As exciting as the marks on the Ishango bone are, their original purpose remains a

mystery – and without that information, it’s impossible to say whether we’re looking at a sophisticated mathematical tradition, a collection of fortuitously arranged notches on an old bone, or something in between the two. Jean de Heinzelin de Braucourt, the geologist and explorer who first excavated the bone, saw some kind of mathematical game in its patterns; later experts have since suggested that it might be a seasonal or lunar calendar, or a record of local rituals. We just don’t know the truth – and we should be wary of jumping to conclusions based on our own modern mathematical ideas.

“In the absence of records, conjectures about the mathematical pursuits of early human beings have to be examined in the light of their plausibility, the existence of convincing alternative explanations, and the quality of evidence available,” cautions Joseph. “A single bone may well collapse under the heavy weight of conjectures piled upon it.”



"A single bone with suggestive markings raises interesting possibilities of a highly developed sense of arithmetical awareness," he writes. "[But] it does not provide conclusive evidence."

Decorative division

Later developments are similarly reliant on inference and deduction. **Earlier this year**, Garfinkel and his student Sarah Krulwich proposed something fairly controversial: that the floral decoration adorning pots from the Halafian culture of northern Mesopotamia, dating back some 8,000 years in the past, was in fact evidence of mathematical thought.

"The flowers indicate mathematical knowledge," Garfinkel tells IFLScience. With petals consistently and deliberately arranged in groups of four, eight, 16, and 32 – and no other numbers, except for very occasional accidents – the decoration "reflects a high level of mathematical awareness," Garfinkel and Krulwich wrote at the time.

It's not just evidence of a cognitive leap. This kind of ability reflects how human society itself was changing by 6,000 BCE: "I think that the history of math reflects the needs of people," explains Garfinkel. "Early agricultural societies, [with] cultivated communal fields, needed to develop division abilities. Urban societies need to develop multiplication abilities, as they control larger communities."

The birth of complex math

Indeed, it would take the dawn of urban civilization before math as we know it finally hit the scene. "My own research [...] is primarily in Babylonian mathematics," Ossendrijver tells IFLScience. "That began with the invention of cuneiform writing in Mesopotamia, around 3,300 BC – because the earliest text that we call cuneiform, or actually proto-cuneiform, is accounting."

The Sumerians and Babylonians are most famous, math-wise, for their astronomy – it's perhaps their widest-reaching impact today, bequeathing us the 360 degrees in a circle, the 24 hours in a day, and so on. But compared to more prosaic applications, all that came quite late, Ossendrijver explains: "This is the earliest known writing in the world," he tells IFLScience, "and It's just administrative tablets in which goats, grain, dates, sesame, areas of fields, all kinds of things are recorded, and then maybe different numbers are added up."

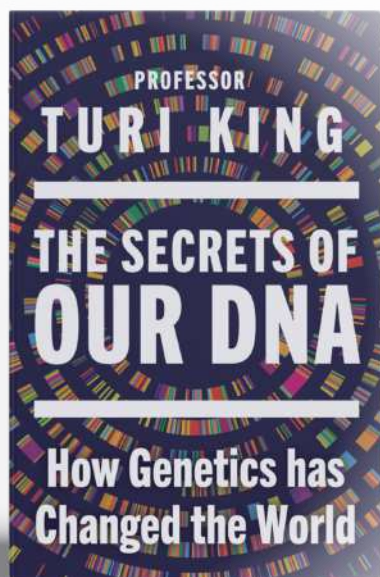
It's from this time period that we get not only working math, but also school math: cuneiform tablets with simple times tables and suchlike inscribed on them, "which the students or the children who went to scribal school had to memorize," Ossendrijver explains, "so that they could do the computations later on in life."

It may have been simple – there were no theorems or proofs; famously, **Babylonian mathematicians** were canny enough to figure out Pythagorean triples, but not the Theorem itself – and it was likely wholly foreign to modern eyes, with its base-60 numerical system and weirdly antagonistic way of presenting problems. But it was also, undeniably, math. And it was everywhere.

From simple accounting to geometry, up to surprisingly complex engineering math and eventually the astronomy that made them so famous, once the Mesopotamians got their teeth into math, they were undeniably addicted. "Most of the evidence we find from Mesopotamia is school mathematics," Ossendrijver says. "But we also find tables that are much more complicated."

"There is 'daily life' mathematics, [which] we find everywhere in Mesopotamia from the old Babylonian period," he tells IFLScience. "[There's] elite mathematics [...] and there's scholarly mathematics."

"Mathematics was embedded in the whole society," he says. "There is a giant leap in the use of mathematics, and [eventually] mathematics becomes super important and complex." 🌟



DNA, the building blocks of life once thought to be the business of scientists alone, has become something of a household name. In this excerpt from *The Secrets Of Our DNA*, Professor Turi King explores how its role has evolved in culture and society and what it can ultimately represent.

Modern genetics is no longer confined to the rarefied world of scientists working in their lab coats, surrounded by the quiet hum of lab equipment, their findings published in scientific journals read only by fellow geneticists. Genetics is now very much a part of the public discourse, regularly working its way into our daily lives, from television dramas, advertisements, the media and politics, to farms, hospitals, law courts, the classroom and the dinner table.

ONE OF THE MOST POWERFUL TOOLS IN MODERN SCIENCE

Despite having worked in the field for nearly three decades, I still marvel at the power of genetics on both a personal and societal level – at where we’ve come from and where we’re heading. From the penny-drop moment Alec Jeffreys experienced when he looked at that X-ray film in his Leicester laboratory in 1984 and saw the renowned first DNA fingerprint, our relationship with DNA changed forever. Now that it could be used to identify us as individuals, it sparked a revolution in genetics that would change the world.

The immigration case of Andrew Sarbah and, later, the murders of Lynda Mann in 1983 and Dawn Ashworth in 1986, in two quiet villages just outside Leicester, became the testing grounds by which DNA identification first proved itself. In the past, the legal system might have taken the partial confession of Richard Buckland as sufficient evidence of his guilt. But Alec Jeffreys’ new method showed that Buckland couldn’t have done it. For the first time, a confession was overturned by DNA evidence and it was DNA that also identified the real killer. The DNA dragnet put in place by David Baker set in train events that eventually led the police to Colin Pitchfork, securing the first-ever conviction using DNA fingerprinting. DNA could prove family links, free the innocent, and it could help convict the guilty. From then on, DNA became a silent witness in many similar cases.

The implications of those cases rippled outwards. When, in 1994, on Prince Edward Island in Canada, Shirley Duguay was murdered, a few strands of cat hair on a coat belonging to her ex-partner became pivotal in the case. For the first time, non-human DNA was admitted as forensic evidence in a murder trial, the killer’s pet implicating him in the crime. Now, not just cats but other animals and plants could ‘testify’ through DNA.

DNA has changed the face of forensic science. But even here, the story is not straightforward. DNA evidence is not infallible. Its interpretation can be flawed, and the repercussions can be life-changing, as we saw in the cases of the Phantom of Heilbronn, Meredith Kercher, and O. J. Simpson.

The wider application of DNA beyond the courtroom was soon realized as well. Sushigate and Horsegate showed that DNA barcoding could not only help map the biodiversity of the world but also protect consumers. When the Horsegate scandal broke in Europe in 2013, the press and the public were alarmed to discover that products they believed to consist purely of beef in fact contained horse meat. DNA testing was not only precise enough to detect the difference between species in processed meat products, but much cheaper and less time-consuming than traditional methods. Molecular tools could now be used to uphold consumer rights, including detecting and removing contaminated items from the food chain that, if left, might have potentially life-threatening consequences.

Some of the greatest crimes are not against individuals, but entire species, as exemplified by the ivory trade. Geneticists began to build databases of elephant DNA, identifying the geographic origin of seized ivory shipments. A tusk seized in Singapore, for instance, could be traced back to a poaching hotspot centring on Zambia. Courts began to hear cases in which these elephants were given their day in court through DNA. Illegal trade in goods, both plant- and animal-based, could now be monitored and government policies instigated on the basis of DNA evidence. In many of these cases, DNA has become a tool of accountability. ✨



Q&A WITH

PROFESSOR TURI KING

AUTHOR OF:

THE SECRETS OF OUR DNA

From identifying the remains of King Richard III to examining the DNA of Adolf Hitler, Prof Turi King's career has demonstrated the many ways in which genetics can open doors into the past. For all its power, however, in her new book *The Secrets of DNA*, she wants to remind readers that DNA isn't always the silver bullet people think it is.

Your work covers the fascinating intersection of genetics and archaeology – what drew you to it?

It was the stories. I did my undergraduate at Cambridge, and I thought I was going to be an archaeologist. I was sitting in a lecture one day, and it was being given by a lecturer called Erika Hagelberg who worked on the Romanov case. This is Tsar Nicholas and his wife and their five children and members of their household who were killed during the Russian Revolution, and their bodies were hidden and not found for decades.

They were found using this combination of osteology. So, they're looking at the bones and genetics [as one of the] first uses of DNA fingerprinting to identify the remains. I was like, "Okay, that's what I want to do".

I was asking the lecturer at Cambridge, "Where should I go if I want to pivot into genetics?" And she said, "Don't stay at Cambridge. Leicester – Professor Sir Alex Jeffreys, the guy who invented DNA fingerprinting, he is there. They have a great master's program." So, I got a scholarship and went up there.

But it was the stories. What I have found when I've been explaining about genetics to people is that they understand it better if you wrap it in a story, because they get drawn in. It makes it an easier way to absorb it, I think.

How big was Jeffreys' discovery of DNA fingerprinting?

It's one of these discoveries where it's really hard to overstate the impact that it has. It was really seismic. So, it's this ability to be able to identify somebody not from an image, not from a fingerprint, like a finger mark, but just from their DNA alone. They don't have to be there. It has completely changed the face of forensics, but also other fields that it's used in.

Other fields?

When people think about DNA fingerprinting, DNA profiling, they think of crime scenes and cop shows – they get the DNA from the crime scene and out pops the identity of the individual on a database. But actually, the first time it was ever used was in an immigration case.

A woman called Christiana Sarbah was living in London. She was a nurse. She had three of her children here. One of her children,

Andrew, was back in Ghana staying with her estranged husband. He came back into the UK, but the police didn't believe that he was actually her son. There were people working on the case, and they had photographs and all sorts of evidence to show that Andrew was Christiana's son. But it wasn't until they were able to do DNA analysis that it really got brought together.

A woman called Sheona York was working on this case, and she tells this story about how one day she was taking the bus to work, and she looks down at the front page of the newspaper, and there's this article that talks about how you can identify an individual, but also who they're closely related to, from DNA. It's about Sir Alec Jeffreys' discovery of DNA fingerprinting. So, she contacts him and says, would you be able to help with this case?

That's the first time that DNA fingerprinting was ever used, in an immigration case. The really sweet thing about it is that, to this day, Alec will tell you it's the one he's most proud of after everything it's been used for. It's the one he's most proud of because it reunited a family. So that's where I start the book with this discovery of DNA fingerprinting and its first uses.

What do you hope people will take away from the book?

I really hope that people go away with excitement about what DNA can do because the power of it is extraordinary, but I hope they also realize what it can't do. You can't tell what somebody's IQ is going to be by looking at their DNA. Just because DNA is at a crime scene doesn't tell you how it got there, things like that. So, I hope people realize both the power of the DNA but also what it cannot tell us. ✨

The Secrets Of Our DNA
is published by Doubleday
and available now.

WHERE ON EARTH

This is not pollution. You are looking at the puzzling fluid dynamics of the Meeting of Waters, a natural phenomenon seen in Brazil where the Rio Negro and Rio Solimões rivers collide. They eventually form the Lower Amazon River, but the drastically different water properties mean a seemingly impossible divide endures for quite a distance.

By Rachael Funnell



THE MEETING OF WATERS

In Brazil, the Encontro das Águas, or the “Meeting of Waters,” forms a seemingly impossible divide at the confluence of the Rio Negro and Rio Solimões rivers. A fluid wall appears to separate the vastly different waters, casting black against milky brown until they form together to become the Lower Amazon River.

The Rio Negro is named for its blackened waters. They are not polluted but stained with the tannins of plant matter in the Colombian rainforests. The water also contains relatively little sediment, which is why it doesn’t have that muddy quality often associated with rainforest rivers.

If the Rio Negro appears like black tea, then the Rio Solimões is more of a milky latte. Thick with sediments stirred up from water flowing down the Andes Mountains. It runs at a swift **6 kilometers** (3.6 miles) per hour, reaching average temperatures of 22°C (71.6°F). Relatively cool when you compare it to the 28°C (82.4°F) water that flows through the Rio Negro at a leisurely pace of 2 kilometers per hour (1.24 mph).

It’s this dramatic contrast – cool, dense, and fast vs. warm and slow – that explains why the waters of these two rivers appear to clash instead of combining. Their irreconcilable differences mean that instead they share a channel, flowing side-by-side for several kilometers. If only all of life’s disagreements could come together so spectacularly.

Such a spectacle is the Meeting of Waters, in fact, that it’s even visible from space. Hardly surprising when you wrap your head around the sheer volume of water charging into the confluence.

“Six Mississippi’s worth of cafe-au-lait-colored water are converging here with two Mississippi’s worth of black-tea-colored water to produce the greatest hydrologic spectacle on the planet,” said Robert Meade, who spent decades studying rivers for the US Geological Survey, to **NASA**.

“Put in terms of the sheer quantities of water, what we are seeing here is a volume of water at least a dozen times greater than the total of the water falling over the Niagara, Iguassu, and Victoria Falls combined.”

All that power might not be enough to get the waters to mix, but it doesn’t stop wildlife from flitting between tea and coffee. Amazon river dolphins, giant river otters, anacondas, caimans, and numerous fish species all contribute to the bustling ecosystem that calls these curious waters home.

Wildlife thrives here because the water separation creates a unique microhabitat well suited to aquatic species, which brings in larger predatory mammals and birds that hunt along the banks and edge of these currents. 🌟



LISTEN

THE BIG QUESTIONS

Podcast from IFLScience

With over 16,000 new species being discovered each year, the trend shows no signs of slowing down. But new species need new names, so how do we keep coming up with them?

Professor Paul Barrett, palaeontologist at the Natural History Museum, London, is someone who has not only named several species, he's even had one named after him. Rachael Funnell sat down with Barrett to find out how you name a species, who decides what is and isn't allowed, and what can be done if names later come to be a source of ethical quandary.

Available July 16.

READ

THE SERVICEBERRY

Book by Robin Wall Kimmerer

While harvesting serviceberries alongside birds, it occurred to Indigenous scientist Robin Wall Kimmerer that humans have adopted an economy that harms more than it helps. Built upon scarcity, competition, and the hoarding of resources, it rejects the interconnectedness that enables ecosystems to thrive. Is there another way?

Available now.



WATCH

THE ODYSSEY

Movie from Universal Pictures

Homer is believed to have composed *The Odyssey* – considered one of the most important stories ever told – at the end of the 8th century BCE. It tells the story of the complicated hero Odysseus, King of Ithaca, who spent 10 years wandering the seas and land to get home to his kingdom, wife, and son after the 10-year war and eventual fall of Troy. The oldest written extract dates back to around the third century CE during the Roman era. Now, it's getting the Christopher Nolan treatment as an epic fantasy action movie – and yes, there's a cyclops.



WATCH

DISCLOSURE DAY

Movie from Universal Pictures

Is the government covering up an alien conspiracy? It's a question that's probably been asked by millions. Heck, we all like to daydream about it, but it seems that wasn't enough for Steven Spielberg, whose latest flick is all about surveillance, secrets, and extraterrestrials.

In cinemas now.

PLAY

PATHOGENIC

Game from Slug Disco

Become the disease in this visceral 2D shooter game where you play as a lone parasite at war with the human immune system. You can customize your potency as you acquire dozens of unique organelles: flagella for movement, mitochondria for power, secretors for ranged attacks, and spikes for melee combat. The human body doesn't stand a chance.

Available July 16.

READ

I TOLD YOU SO! SCIENTISTS WHO WERE RIDICULED, EXILED, AND IMPRISONED FOR BEING RIGHT

Book by Matt Kaplan

Hungarian physician Ignaz Semmelweis, Italian philosopher, astronomer, and mathematician Galileo, and Nobel laureate Katalin Karikó – what do all three of these pivotal scientists have in common? They were all punished for their discoveries. In this book, Kaplan challenges the scientific community's resistance to new ideas by highlighting the seismic discoveries that were rejected before they were adopted.

Available now.

LISTEN

WE HAVE QUESTIONS PODCAST

Podcast from IFLScience

8 million pickled fish sit in Louisiana's WWII bunkers – why? It's kind of a long story. The director of the Tulane University Biodiversity Research Institute spills the beans about the curious specimens to be found there.

Available July 20.

Seeing A Revolutionary Telescope Being Assembled

Dr Alfredo Carpineti hangs out with PLATO in a clean room pre-simulated space test.

Recently I hopped on a plane to the European Space Research and Technology Centre in the Netherlands to see the final touches on the European Space Agency's upcoming mission, PLATO. PLATO will be nothing short of game-changing when it comes to exoplanets. A planet-hunting space telescope, it is designed to discover and characterize worlds that are just like ours: Earth-sized planets around Sun-like stars.

I got to walk into the cleanroom (dressed up in the appropriate get-up) to see how the mission team is finishing the assembly of this spectacular instrument. And I've got to admit, the spacecraft is huge.

Imagining that a telescope launched into space is going to be big is not hard. In particular, for PLATO, its unique design – 26 telescopes, each with a 12-centimeter (4-inch) lens – tells you that it ought to be big! I was not ready for how big it actually was, though.

A space telescope is not just the optics, but solar panels, electronics, batteries, and redundancy systems: easy to rationalize as a vague "big" but it's another matter seeing it assembled into a single object.

Just seeing the spacecraft was exciting, but the excitement increased when speaking to the team. We heard from the engineers currently working on this telescope, with those who have put it through the tests to make sure it will survive the journey into space, and with the scientists that will use its data.

What we heard is boundless excitement for a mission that is set to deliver answers on Earth-sized planets and maybe help us find a true Earth-twin. It's not an easy task; even in our own Solar System, we have an Earth-sized planet in the habitable zone that is most definitely not Earth-like.

Venus, with its lead-melting temperature and crushing atmospheric pressure, is a hellish version of our planet. We've also already discovered Earth-sized planets around dimmer and more active stars that have lost their atmosphere, such as TRAPPIST-1 b and c.

PLATO will help expand the catalogue of known worlds that look like those in our Solar System. Will it find Venuses, TRAPPIST-1 bs, or Earths? We do not know. But we can't wait for its launch, expected to take place in early 2027.

If you are curious about our conversations, watch this space. Our exclusive behind-the-scenes mini-documentary and related articles will be out very soon! 🌟



A close-up of PLATO's 26 ultrasensitive cameras.



Alfredo and PLATO keeping clean in the clean room.



Lifting Plato out of the Large Space Simulator



2, 16, 30
NEW THE BIG
QUESTIONS PODCAST
EPISODES!



6
EARTH APHELION

8
MATH 2.0 DAY

2026 JULY

Challenge stereotypes with Disability Pride, go plastic-free for a month, and enjoy the new season of *The Big Questions* while watching some meteors streak across the sky – what more could you want from July?

**DISABILITY
PRIDE MONTH**

11
WORLD POPULATION
DAY



20
SPACE EXPLORATION
DAY

It also doubles up as International Moon Day, celebrating the anniversary of the first successful Moon landing in 1969.



**PLASTIC
FREE JULY**



20
NEW WE HAVE
QUESTIONS PODCAST
EPISODE!

Why are there 8 million pickled fish in a WW2 bunker in Louisiana? It's a good question; luckily, we have an answer.

22
WORLD BRAIN DAY

28
WORLD
CONSERVATION DAY

29
FULL BUCK MOON



30-31
ALPHA CAPRICORNIDS
AND DELTA AQUARIIDS
PEAK

Two mighty meteor showers will reach their peak on July 30. The Alpha Capricornids should put on a display of slow, yellow fireballs, while the Delta Aquariids are set to dazzle with a steady stream of space rocks.

ARE YOU DRAWN TO THE DARKER OR LIGHTER SIDE OF SCIENCE?

Choose how you end each issue. For those who prefer the darker side, Holly Large explores how scientists are hoping to give people hookworms (for a very good reason). If you like your science lighter, discover the delightful tale that unfolded when a young nature lover stumbled upon some frogs far from home.



EXPLORE YOUR SIDE ON FACEBOOK

MEDICINAL HOOKWORMS

Intestinal parasites are the last thing you'd want inside you. Yes, they're just doing what they've evolved to do, but the prospect of some long-ass worm living in your guts, laying eggs and making you feel like rubbish, isn't exactly an inviting one.

The idea that a worm would be introduced deliberately, then, seems pretty bizarre. And yet, some scientists are working on doing exactly that – not to give us all dodgy bowels, but to potentially make us better when we're ill.

"The hookworm has spent millions of years perfecting how to assure long-term survival inside a human host and how to get molecules out of its body and into ours," said Makedonka Mitreva, PhD, the Gordon R. Miller Professor in the John T. Milliken Department of Medicine's Division of Infectious Diseases at Washington University School of Medicine, in a **statement**.

"We asked: What if we could add one more molecule to the roughly 1,000 things the worm already secretes, something therapeutically useful to people?"

And so, Mitreva and colleagues decided to find out if that was possible. The first step was genetically modifying a human hookworm – the first time this has been done successfully – to produce an antibody to tetrodotoxin.

Most well known for being produced by pufferfish, tetrodotoxin is a potent neurotoxin that can lead to **paralysis and death** within a matter of hours. There's currently no antidote for it, but the altered hookworms could make a useful platform for delivering one.

The genetically modified hookworms were then introduced into hamsters, and the results showed that they successfully produced and secreted the antibody; when analyzing blood collected from the infected hamsters, the team found that it could partially neutralize tetrodotoxin. This didn't happen with blood from hamsters that had been infected with non-modified hookworms.

It's a long way off being a perfect science – this **study** was more of a proof of concept. Before there's any chance of genetically modified hookworms being used in humans in this way, scientists will have to make sure that they're safe, with no chance that they can lay eggs inside their hosts.

But should this research progress well, the team hopes that the hookworm platform could be particularly useful for treating inflammatory bowel diseases – like Crohn's and ulcerative colitis – as they suspect more of the secreted molecules hang around in the gut than in the bloodstream.

Okay, worms. Maybe you're not so gross after all.

FROG DETECTIVES

Nothing quite compares to the joy of being a child and tiptoeing through your backyard in search of the critters that live there. There may be fancy butterflies, colorful birds or, as was the case for a 12-year-old nature lover from New Zealand, some very notable frogs at the center of a breakout that happened over 50 years before.

OUTSIDE OF THEIR
USUAL RANGE AND IN
AN AREA WHERE THEY'D
BE GLADLY GOBBLED
UP BY PREDATORS,
IT WAS THOUGHT
THAT THEY HAD LIKELY
DIED... OR HAD THEY?

It was in a creek behind his house in Lower Hutt that Rumi Lourie stumbled upon these frogs, which looked different to the ones he normally saw down by the water. As all good citizen scientists do, he snapped some photos of his find and sent them off to the New Zealand Department of Conservation (DOC).

There, staff discovered that these were Hochstetter's frogs. No biggie, right? They're the most widespread native frog in the country, after all.

But it turns out this actually was big news – Lourie's backyard was hundreds of kilometers south of where the frogs are typically found. So how on Earth did they get there?

The answer takes us back to the 1970s, when frog biologist Dr Ben Bell was living in the area. At that time, he'd been keeping and breeding some Hochstetter's frogs as part of a research project. Then, during a spate of flooding, some of the frogs escaped. Outside of their usual range and in an area where they'd be gladly gobbled up by predators, it was thought that they had likely died... or had they?

Genetic analysis of Hochstetter's frogs collected from Lourie's backyard finally solved the mystery, revealing that they were the descendants of the escapee frogs. They hadn't kicked the bucket after all. In fact, despite the odds being stacked against them, they'd been thriving.

"The fact they've been quietly living and breeding in this busy suburban environment all this time, unknown to people, through weather events and with predators in the area, is really unexpected," said DOC Technical Advisor Tertia Thurley in a **statement**.

"Rumi rediscovering these frogs while out exploring his backyard shows you don't have to go far from home to have incredible nature experiences," Thurley added. "Who knows – maybe the next unexpected discovery is in your backyard?"



The **Darker** Side
of Science



THE **Lighter** Side
of Science