St Benedict's SCIENCE NEWS *Monthly*

Welcome to the September 2023 issue

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ROSALIND FRANKLIN – RECOGNISED AT LAST

The EAGLE pub on Cambridge's Bene't Street is one of many historic old inns in the city dating back to the 14th century. But the Eagle's history is, perhaps, the most intriguing of all. At Saturday lunchtime on 28th February 1953, one of the pub's regulars, Francis Crick, walked in and announced to all present that he and his colleague, James Watson, had *"just discovered the secret of life!"*

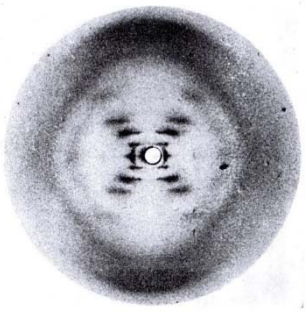
What they had actually discovered, of course, was the 3D molecular structure of deoxyribonucleic acid – DNA.

For nigh on two generations, it was the two names of "Crick" and "Watson" that were cemented in the public's mind as the discoverers of the structure of DNA, as though it was solely their project. In 2001, a "Blue Plaque" scheme was launched in Cambridge and, in due course, the Eagle erected a plaque commemorating the achievement of Crick and Watson.

However, slowly but surely, more of the DNA story was coming to the general public's attention. This was demonstrated graphically in 2017 when someone scrawled graffiti on the Eagle's plaque that said "+Franklin".

This prompted the commissioning of a new "Blue Plaque" commemorating the work of Crick and Watson, but with the notable addition of the following: *"This breakthrough relied on data from Rosalind Franklin, Maurice Wilkins and other scientists."*

Franklin was born on July 25, 1920, in London, to a wealthy Jewish family who valued education and public service. At age 18, she enrolled in Newnham Women's College at Cambridge University, where she studied physics and chemistry. After Cambridge she went to work for the British Coal Utilization Research Association where her work on the porosity of coal became her Ph.D. thesis, and later it would allow her to travel the world as a guest speaker. In 1946, Franklin moved to Paris where she perfected her skills in X-ray crystallography, which would become her life's work. Although she loved the freedom and lifestyle of Paris, she returned after four years to London to accept a job at King's College, with Maurice Wilkins.



Unknown to Franklin, Watson and Crick saw some of her unpublished data, including the beautiful "photo 51," shown to Watson by Wilkins. This X-ray diffraction picture of a DNA molecule was Watson's inspiration (the pattern was clearly a helix). Using Franklin's photograph and their own data, Watson and Crick created their famous DNA model. Franklin's contribution was not acknowledged at the time, but after her death in 1958 Crick said that her contribution had been critical.

She died at the tragically young age of 37 from ovarian cancer. It is possible that her work in close proximity to X-ray radiation may have triggered the disease.

CHEMISTRY - What's the highest temperature water can freeze and the lowest it can boil on Earth?

Ice can form on Earth at temperatures above 0 degrees Celsius, and water can boil below 100 C. Here's how.

The temperatures at which water boils or freezes can change depending on pressure and other factors. So where on Earth do we need to go to find water's coolest boiling temperature and warmest freezing temperature? For water's lowest boiling temperature, we must look for the place with the thinnest air.

If you carry a bucket of water to the top of a mountain, it will boil at a lower temperature than it will at sea level. That's because the less the atmosphere pushes on a pot of water, the less heat energy the water requires to vaporize, or turn into steam. Naturally, the highest location on Earth — the summit of Mount Everest, at 29,031 feet (8,849 meters) — is where water boils the coldest, at 68°C, according to the Lunar and Planetary Institute. It's hot water — but it would make a terrible cup of coffee, as water needs to be at least 87°C to make a decent brew. Same for tea, by the way.

So where does water freeze at the highest temperature? That's a little trickier. For pure water, at least, the temperature at which its molecules settle into the rigid, crystalline structures of ice crystals vary relatively little with pressure. Water's freezing point on Earth is always around 0°C. However, ice at sea level can form if the air temperature is above the freezing point, thanks to radiative cooling. For generations, this phenomenon has allowed residents of desert locations to make ice without electricity or freezing temperatures. People living in what is now Iraq and Afghanistan would fill shallow pools with water before a cloudless night and wake up to ice, despite the air temperature being a few degrees above freezing. That's because the air above the pool is very dry, which encourages the water to evaporate, Roberts told Live Science. The evaporating water brings heat with it, cooling the liquid left behind.

In addition, the water slowly radiates heat into the sky. While the air near the ground might be just above freezing, the atmosphere higher up can be as cold as minus 40°C on a cloudless night. In this case, heat energy moves from the relatively warm water to the extremely cold night sky. Both mechanisms together can drop the temperature in the pool to 0°C — enough for it to freeze — despite the surrounding air temperature being as warm as 5 C, which is well above freezing.

https://www.livescience.com/chemistry/whats-the-highest-temperature-water-can-freeze-and-the-lowest-it-can-boil-on-earth

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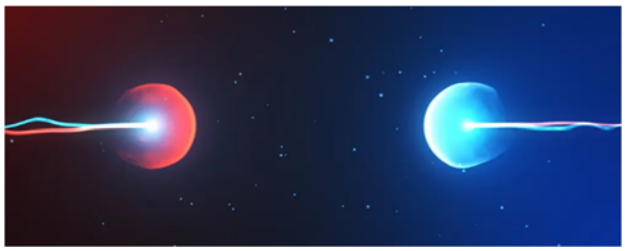
PHYSICS - Scientists get closer to solving mystery of antimatter



Everything in the Universe is made of matter that was created in the Big Bang. Since the 1950s scientists have been intrigued by the existence of the reverse form of this matter: **antimatter**. The thing is, both were created in equal amounts in the Big Bang which formed our Universe. While matter is everywhere, though, its opposite is now fiendishly hard to find.

During the Big Bang, matter and antimatter should have combined and cancelled each other out, leaving nothing but light. Why they didn't is one of physics' great mysteries and uncovering differences between the two is the key to solving it. Somehow matter overcame antimatter in those first moments of creation. How it responds to gravity, may hold the key, according to Dr Danielle Hodgkinson, a member of the research team at CERN in Switzerland, the world's largest particle physics laboratory.

Most antimatter exists only fleetingly in the Universe, for fractions of seconds. So to carry out experiments, the CERN team needed to make it in a stable and long-lasting form. Some theorists have predicted that antimatter might fall up, though most, notably Albert Einstein in his General Theory of Relativity more than a hundred years ago, say it should behave just like matter, and fall downwards. The researchers at CERN have now confirmed, with the greatest degree of certainty yet, that Einstein was right. But just because antimatter doesn't fall up, it doesn't mean that it falls down at exactly the same rate as matter. For the next steps in the research, the team are upgrading their experiment to make it more sensitive, to see if there is a slight difference in the rate at which antimatter falls.

If so, it could answer one of the biggest questions of all, how the Universe came into existence.

https://www.bbc.co.uk/news/science-environment-66890649

WEIRD ANIMALS -This egg-eater may have the biggest gulp of any snake its size!

Snakes are well known for being able to bite off more than they can chew – literally. But it turns out that there is one snake in particular that puts all the others into the shade.

Hulking hunters like Burmese pythons may be famous for scarfing up deer, alligators and other giant prey. But one little African snake may take the title for most outsized meals. The nonvenomous and nearly toothless ***Dasypeltis gansi*** can open its mouth wider than any other snake its size. *D. gansi*, sometimes called the Gans' egg-eater, swallows bird eggs whole. To get the good stuff inside that egg, the snake cracks the shell with its spine. Then, it ingests the egg's gooey contents and spits out the empty shell.

The biggest of these snakes had a head roughly 1 cm (0.4 inch) wide. But it could swallow an egg a whopping 5 cm (2 inches) across. How does the Gans' egg-eater open so wide? The soft tissue between the tips of its left and right lower jaws at the "chin" is super-stretchy. "In Burmese pythons, about 40 percent of [mouth] area is a result of the stretch of the skin between the lower jaws," Jayne says. "But these guys edge out the pythons." About 50 percent of the Gans' egg-eater's maximum mouth size is due to soft-tissue stretch.

Why did this small snake evolve such an impressive ability to open wide? Compared with foods that other snakes eat, such as rodents, an egg is super short. You have a limited ability to have a very long egg. But if you get your mouth wider then you can consume these larger eggs.

https://www.snexplores.org/article/snakes-biggest-gulp-mouth-size-gans-egg-eater

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GENETICS - A new look at Ötzi the Iceman's DNA reveals new ancestry and more.....

On 19th September 1991 two German tourists were enjoying a walk high in the Ötztal Alps on the Austrian–Italian border. To their alarm they came across a dead body, half-frozen into the ice up to its torso. They assumed that it must the body of a recently deceased climber. However, when it was finally removed from the ice and taken for a post mortem, the body was found to be the mummified remains of a man who had died *"about 4000 years ago."* The body would become known to history as **Ötzi the Iceman**.

In 2012, scientists compiled a complete picture of Ötzi's genome; it suggested that the frozen mummy found melting out of that glacier in the Tyrolean Alps had ancestors from the Caspian steppe. But something didn't add up. The Iceman is about 5,300 years old. Other people with steppe ancestry didn't appear in the genetic record of central Europe until about 4,900 years ago. Ötzi *"is too old to have that type of ancestry,"* says archaeogeneticist Johannes Krause of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. The mummy *"was always an outlier."*

Krause and colleagues put together a new genetic instruction book for the Iceman. The old genome was heavily contaminated with modern people's DNA, the researchers report in the journal *Cell Genomics*. The new analysis reveals that *"the steppe ancestry is completely gone."*

But the Iceman still has oddities. About 90 percent of Ötzi's genetic heritage comes from Neolithic farmers, an unusually high amount compared with other Copper Age remains, Krause says. The Iceman's new genome also reveals he had male-pattern baldness and much darker skin than artistic representations suggest. Genes conferring light skin tones didn't become prevalent until 4,000 to 3,000 years ago when early farmers started eating plant-based diets and didn't get as much vitamin D from fish and meat as hunter-gathers did, Krause says. As Ötzi and other ancient people's DNA illustrate, the skin colour genetic changes took thousands of years to become commonplace in Europe.

"People that lived in Europe between 40,000 years ago and 8,000 years ago were as dark as people in Africa, which makes a lot of sense because [Africa is] where humans came from," he says. *"We have always imagined that [Europeans] became light-skinned much faster. But now it seems that this happened actually quite late in human history."*

https://www.sciencenews.org/article/new-otzi-iceman-dna-ancestry-genome

ARCHAEOLOGY - Stage that once hosted William Shakespeare found in King's Lynn

St George's Guildhall in King's Lynn is the oldest working theatre in the UK, dating back to 1445. During recent renovations, timber floorboards were found under the existing auditorium, and they have been dated back to the 15th Century. The theatre claims documents show that Shakespeare acted at the venue in 1592 or 1593. Could these boards be the very ones on which William Shakespeare, as a young aspiring actor, trod?

The floorboards were uncovered in September during a renovation project at the Guildhall. They had been covered up for 75 years after a replacement floor was installed in the theatre. Dr Jonathan Clark, an expert in historical buildings, was brought on board to research the venue. *"We wanted to open up an area just to check, just to see if there was an earlier floor surviving here. And lo and behold, we found this,"* he says, pointing through a temporary trapdoor. A couple of inches below the modern floor are what he believes to be boards trodden by the Bard, each 12in (30cm) wide and 6in deep.

Dr Clark used a combination of tree-ring dating and a survey of how the building was assembled *("really unusual as the boards locked together and were then pegged through to some massive bridging beams"*) to date the floor to between 1417 and 1430, when the Guildhall was originally built. *"We know that these [floorboards] were definitely here in 1592, and in 1592 we think Shakespeare is performing in King's Lynn, so this is likely to be the surface that Shakespeare was walking on,"* he says.

Dr Clark believes this is a hugely important discovery because not only is it the largest 15th Century timber floor in the country, but it would also be the sole surviving example of a stage on which Shakespeare acted. There has been much academic debate over the years about whether Shakespeare did act in King's Lynn, but experts say the discovery is significant.

Tiffany Stern, professor of Shakespeare and early modern drama at the University of Birmingham, tells the BBC: *"The evidence he was there has to be patched together but is quite strong."* It was *"very likely"* that he was a member of the Earl of Pembroke's Men because they performed his plays Henry VI and Titus Andronicus, and they did visit King's Lynn in 1593, she says.

Michael Dobson, director of the Shakespeare Institute in Stratford-upon-Avon, says: *"The uncovering of the actual boards really trodden by Shakespeare's troupe during their tours of East Anglia should be far more significant to archaeologists of the Elizabethan theatre than is the conjectural replica of the Globe theatre erected near the real, long-demolished Globe's foundations in central London in the 1990s."*

https://www.bbc.co.uk/news/entertainment-arts-67007980

ORNITHOLOGY - Godwit stuns experts with four-day round trip to Norfolk

A migratory bird has "stunned" experts by flying a round trip of more than 2,000 miles in four and a half days! The bird, named Clive in memory of the group's founder, was one of five bar-tailed godwits tagged in the project, which is supported by the RSPB, the Wildfowl and Wetlands Trust and Natural England. When it set off from the Wash, the team believed it was heading for Mauritania in West Africa, about 2,500 miles away, which would be its normal migratory route. But they were in for a surprise.

Instead it flew an "incredible loop" back to where it started which "stunned the team". The bar-tailed godwit flew from The Wash in Norfolk, via Birmingham, North Wales, Ireland, France, the Bay of Biscay near Spain and back again – over 2000 miles in just four and a half days. It was tracked using a GPS tag in a project the RSPB said was a UK-first.

Ornithologist Nigel Clark said the journey revealed the bird's migrations were *"a lot more complex than we ever imagined or would have predicted". "It is absolutely incredible what this project is already revealing about the increasing hazards faced and choices birds have to make on their long and challenging migrations,"* said Dr Clark, from the Wash Wader Research Group (WWRG). Experts believed the bird was trying to navigate around a rapidly approaching unseasonable storm.

The project is an attempt to learn more about the journeys of the UK bar-tailed godwits, as well as the role of the network of England's east coast wetlands. These critically important sites sit on the East Atlantic Flyway, one of just eight "superhighways" for migratory birds around the globe, used by millions of birds each year. *"For some - like the bar-tailed godwit - we don't know much about where they go when they're not here,"* said Dr Guy Anderson, migrants recovery programme manager at the RSPB. The bird is expected to remain on The Wash for a few weeks to fatten up before another migration attempt.

https://www.bbc.co.uk/news/uk-england-norfolk-67008557

MORE WILD BIRDS – Who's a pretty boy then!

Parrots are exceptional talkers. They can learn new sounds during their entire lives, amassing an almost unlimited vocal repertoire, even mimicking human speech. But is this just a curiosity, or could it have some evolutionary benefit for the birds?

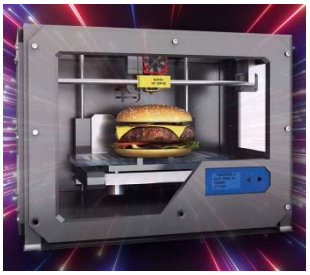
Humans have complex and flexible vocal repertoires, but we can still recognize each other by voice alone. This is because humans have a **voice print**: our vocal tract leaves a unique signature in the tone of our voice across everything that we say. Other social animals also use vocal cues to be recognized. In birds, bats, and dolphins, for example, individuals have a unique "signature call" that makes them identifiable to members of the group. But signature calls encode identity in only one call type. To date, almost no evidence exists for animals having unique signatures that underly all calls made by an individual. In other words, almost no animals are known to have a voice print.

That surprised Simeon Smeele, a doctoral researcher at the Max Planck Institute of Animal Behaviour who studies how parrots use their exceptional vocal abilities to socialize in large groups. Smeele wondered if parrots, possessing the right anatomy coupled with a need to navigate complex social lives, might have evolved voice prints, too. To find out he travelled to Barcelona where the largest population of individually marked parrots exists in the wild. The monk parakeets there are invasive and swarm the city's parks in flocks that number hundreds of birds. A monitoring program run by Museu de Ciències Naturals de Barcelona has been marking the parakeets for 20 years, with 3000 birds individually identified so far – a boon for Smeele and his study on individual voice recognition.

Armed with shotgun microphones, Smeele and colleagues recorded the calls of hundreds of individuals, collecting over 5000 vocalizations in total, making it the largest study of individually-marked wild parrots to date. Importantly, Smeele re-recorded the same individuals over two years, which revealed how stable the calls were over time. To test if voice prints were at play, Smeele turned to a machine learning model widely used in human voice recognition, which detects the identity of the speaker using the timber of their voice. They trained the model to recognize calls of individual parrots that were classed as "tonal" in sound. Once the model was trained on an individual, they then tested to see if the model could detect the same individual from a different set of calls that were classed as "growling" in sound. The model was able to do this three times better than expected by chance, providing evidence that monk parakeets have a voice print, which Smeele says *"could allow individuals to recognize each other no matter what they say."*

https://www.sciencedaily.com/releases/2023/10/231003202004.htm

FUTURE SCIENCE – Could *Star Trek* replicators become reality?



Let's say you're hungry. Wouldn't it be great to walk up to an appliance, tell it what food you want and have that food appear magically in front of your eyes? In the TV franchise Star Trek, this is possible with a piece of technology known as a "replicator." Getting to a future where this tech exists, though, might take a bit of imagination and invention.

The replicator's superfast lasers convert incoming matter into energy. Then, they change it back into matter. *"On a fundamental level, there is nothing that prevents you from building a replicator-like machine,"* says Gianluca Sarri. He's a quantum physicist who works with lasers at Queen's University Belfast in the United Kingdom. But a replicator is just not a top priority at the moment, he says. All that conversion of matter to energy back to matter again would require a lot of energy. Plus, there's no way to currently make an object appear within seconds. What's more: Right now food can be generated in a much simpler way — by cooking. However, there might be situations where the fuss of cooking is just not practicable – say on a long space voyage. So spacefarers might instead **print that meal with a 3-D printer**.

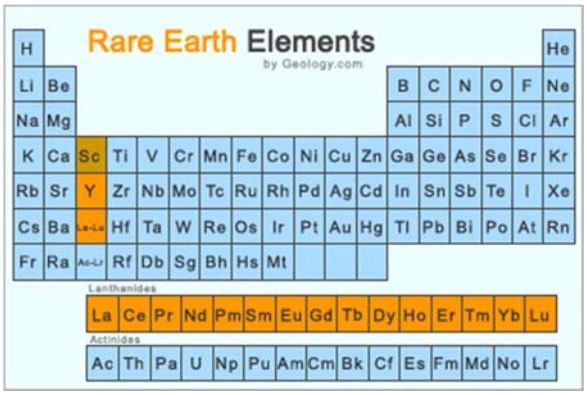
Today's 3-D printers are similar to regular printers, notes Jonathan Blutinger. Just as normal printers must be fed cartridges of ink, 3-D printers must be fed cartridges of printing material. Blutinger is a design engineer. While at the Creative Machines Lab at Columbia University in New York City, he helped create a 3-D printer that acts like a digital chef. *"The printer will not allow you to make something from nothing,"* he says. *"You need to start with the right base ingredients."*

Blutinger's group recently started with ingredients for a "cake." They put graham-cracker paste, strawberry jam, peanut butter, Nutella, cherry drizzle, banana puree and frosting into the food printer. The printer assembled and cooked the ingredients with lasers to make a slice of cake. The cake tasted great, Blutinger says, but it was definitely a unique experience because the flavours came in "waves."

https://www.snexplores.org/article/could-star-trek-replicators-exist

GEOLOGY – Why are rare earth elements so rare?

There are 17 rare earth elements on the periodic table, but a better name for them would be the “troublesome earths.” Here’s why.



Rare earth elements have a number of useful properties that make them highly sought after by the tech and energy industries. This collection of 17 metals includes the 15 metallic elements found at the bottom of the periodic table, as well as the elements yttrium and scandium. The most valuable of these are neodymium, praseodymium, terbium and dysprosium, which act as superstrong miniaturized magnets, a vital component of electronics, including smartphones, electric car batteries and wind turbines. However, their limited global supply is a big worry for governments and corporations that need these metals to continue manufacturing all sorts of modern essentials. But why are the rare earth elements so rare?

It turns out, they're not really that rare! A U.S. Geological Survey study on the “crystal abundance” of different elements — meaning how much is available if you average out Earth’s crust — found that most of the rare earths are in the same order of magnitude as common metals like copper and zinc. They’re certainly not as rare as metals like silver, gold and platinum.

The problem is this: although the elements are fairly common, they’re very difficult to extract from their natural sources. Typically, metals concentrate within Earth’s crust due to different geological processes, such as lava flow, hydrothermal activity and mountain formation. However, the unusual chemistry of the rare earth elements means that these metals don’t generally collect together under these extraordinary conditions. Consequently, traces of these elements are spread across the planet, making mining for these materials particularly inefficient.

The difficulty Is magnified by the fact that the rare earth elements form extremely stable compounds within their ores, making extraction of the pure element very difficult. You have to put a lot of energy and chemical intensity into the extraction processes, which is laborious and expensive. Some researchers are working on new methods to recycle and extract these valuable metals from old electronics and industrial wastes to reduce the pressure on current supplies; others are trying to reproduce the unusual magnetic and electronic properties in new compounds to provide an alternative to these elusive metals and which could shepherd in more accessible and human-made compounds that behave like rare earth elements. For the time being, though, there’s no substitute for the troublesome rare earths, even as demand skyrockets.

https://www.livescience.com/planet-earth/geology/why-are-rare-earth-elements-so-rare

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IMPOSSIBLE MATHEMATICS? Think again!

Mathematicians armed with supercomputers have finally identified the value of a hefty number that was previously thought to be impossible to calculate.

The number, known as the **"ninth Dedekind number"** or D(9), is actually the 10th in a sequence. Each Dedekind number represents the number of possible configurations of a certain kind of true-false logical operation in different spatial dimensions. (The first number in the sequence is D(0), which represents zero dimensions. This is why D(9), which represents nine dimensions, is the 10th number in the sequence.) Dedekind numbers get increasingly large for each new dimension, which makes them increasingly difficult to pin down. The eighth Dedekind number, which follows the same rules for eight dimensions, was calculated in 1991. But due to the jump in computing power needed to calculate the ninth, some mathematicians deemed it impossible to calculate its exact value.

But now, two unrelated studies from separate research groups — the first submitted to the preprint server arXiv on April 5 and the second submitted to the same server on April 6 — have done the impossible. The studies — each using a supercomputer but running different programs — both produced the exact same number. The newly identified value for D(9) is **286386577668298411128469151667598498812366**. As numbers go, this is not a world-beater – but it is how it has to be calculated that takes all the computing power.

Dedekind numbers were first described by German mathematician Richard Dedekind in the 19th century. The numbers are related to logical problems known as "monotone boolean functions" (MBFs). Boolean functions are a kind of logic that can take as an input just one of two values — 0 (false) and 1 (true) — and spit out only those two values. In MBFs you can swap a 0 for a 1 in the input, but only if it allows the output to change from a 0 to a 1, not from a 1 to a 0. This concept can be pretty confusing for non-mathematicians. But it is possible to visualize what is going on by using shapes to represent the Dedekind numbers for each dimension. For instance, in the second dimension, the Dedekind number relates to a square, while the third can be represented by a cube, the fourth and higher by hypercubes and so on.

https://www.livescience.com/physics-mathematics/mathematics/mathematicians-finally-identify-seemingly-impossible-number-after-32-years-thanks-to-supercomputers

EARTH SCIENCE – Where on Earth does the Sun shine most brightly?

Forget Arizona or Florida or the Mediterranean or Oz. Sun worshippers should head to South America's Atacama Desert. The sunlight there is more intense than anywhere else on Earth. Its brightness beats super-sunny spots, such as Mount Everest. Sometimes, it even rivals conditions on Venus.

A high-altitude plateau in the Atacama straddles parts of Chile, Bolivia, Peru and Argentina. Satellite data had suggested this area — the Altiplano — gets the most intense sunlight on Earth. But satellites look down from afar. It's important to check such claims with on-the-ground data, says Raúl Cordero. A physicist, he works at the University of Santiago in Chile. His team wanted to know: *"How good are these [satellite] estimates?"* To answer that, the team brought two shipping containers to the Chilean Altiplano and set up a small observatory. It's been measuring sunlight there since 2016. The team used a pyranometer. This palm-sized instrument can detect not only visible light, but also ultraviolet and near-infrared wavelengths.

On average, some 308 watts of solar energy hits each square metre (about 11 square feet) of land. This amount is what the satellite measurements had suggested. It's also higher than light recorded near Mount Everest's summit. The team shared its findings in the *Bulletin of the American Meteorological Society*. The researchers also noted bursts of especially intense sunlight. Each typically lasted just a few minutes. The researchers think they happen when thin clouds scatter light toward the ground. One event in January 2017 blasted the site with a whopping 2,177 watts per square meter! That was more than seven times the site's average. It actually rivalled the sunlight hitting Venus. And that's surprising because Venus is more than 40 million kilometres (25 million miles) closer to the sun than Earth is.

https://www.snexplores.org/article/brightest-sun-south-america-atacama-desert

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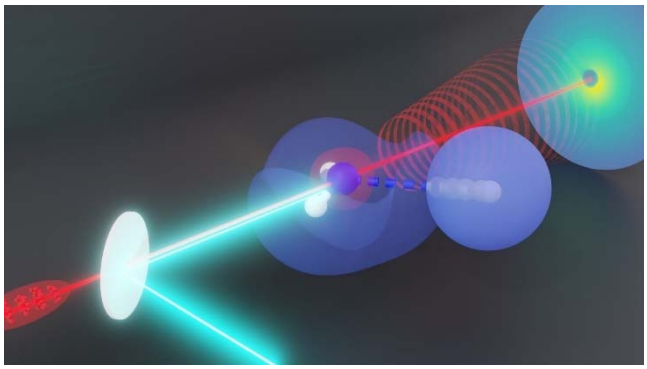
PHYSICS - Researchers catch protons in the act of dissociation with ultrafast 'electron camera'



Proton transfers drive countless reactions in biology and chemistry—think enzymes, which help catalyze biochemical reactions, and proton pumps, which are essential to mitochondria, the powerhouses of cells—so it would be helpful to know exactly how its structure evolves during those reactions. But proton transfers happen super-fast—within a few femtoseconds, one millionth of one billionth of one second. It's challenging to catch them in action.

A team led by researchers at the Department of Energy's SLAC National Accelerator Laboratory and Stanford University used **ultrafast electron diffraction** (UED) to record the motion of hydrogen atoms within ammonia molecules. Others had theorized they could track hydrogen atoms with electron diffraction, but until now nobody had done the experiment successfully. The team led by SLAC scientist Thomas Wolf, put MeV-UED, SLAC's ultrafast electron diffraction camera to work. They used gas-phase ammonia, which has three hydrogen atoms attached to a nitrogen atom. The team struck ammonia with ultraviolet light, dissociating, or breaking, one of the hydrogen-nitrogen bonds, then fired a beam of electrons through it and captured the diffracted electrons.

Not only did they catch signals from the hydrogen separating from the nitrogen nucleus, they also caught the associated change in the structure of the molecule. What's more, the scattered electrons shot off at different angles, so they could separate the two signals. *"Having something that's sensitive to the electrons and something that's sensitive to the nuclei in the same experiment is extremely useful,"* Wolf said. *"If we can see what happens first when an atom dissociates—whether the nuclei or the electrons make the first move to separate—we can answer questions about how dissociation reactions happen."*

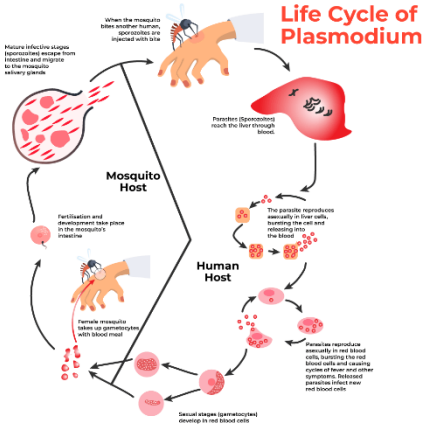
With that information, scientists could close in on the elusive mechanism of proton transfer, which could help to answer myriad questions in chemistry and biology. Knowing what protons are doing could have important implications in structural biology, where traditional methods like X-ray crystallography and cryo-electron microscopy have difficulty "seeing" protons.

https://phys.org/news/2023-10-protons-dissociation-ultrafast-electron-camera.html

MALARIA'S LATEST FOE? BACTERIA.

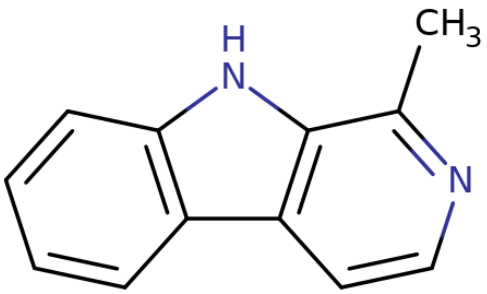
Malaria is an ancient disease and references to what was almost certainly malaria occur in a Chinese document from about 2700 BC, clay tablets from Mesopotamia from 2000 BC, Egyptian papyri from 1570 BC and Hindu texts as far back as the sixth century BC. Such historical records must be regarded with caution but moving into later centuries we are beginning to step onto firmer ground. The early Greeks, including Homer in about 850 BC, Empedocles of Agrigentum in about 550 BC and Hippocrates in about 400 BC, were well aware of the characteristic poor health, fevers and enlarged spleens seen in people living in marshy places. For over 2500 years the idea that malaria fevers were caused by miasmas rising from swamps persisted and it is widely held that the word malaria comes from the Italian *mal'aria* meaning spoiled air.

Malaria is caused by infection with protozoan parasites belonging to the genus *Plasmodium* transmitted by female *Anopheles* species mosquitoes. Our understanding of the malaria parasites begins in 1880 with the discovery of the parasites in the blood of malaria patients by Alphonse Laveran. The sexual stages in the blood were discovered by William MacCallum in birds infected with a related haematozoan, *Haemoproteus columbae*, in 1897 and the whole of the transmission cycle in culicine mosquitoes and birds infected with *Plasmodium relictum* was elucidated by Ronald Ross in 1897. In 1898 the Italian malariologists, Giovanni Battista Grassi, Amico Bignami, Giuseppe Bastianelli, Angelo Celli, Camillo Golgi and Ettore Marchiafava demonstrated conclusively that human malaria was also transmitted by mosquitoes, in this case anophelines. The discovery that malaria parasites developed in the liver before entering the blood stream was made by Henry Shortt and Cyril Garnham in 1948 and the final stage in the life cycle, the presence of dormant stages in the liver, was conclusively demonstrated in 1982 by Wojciech Krotoski.



The World Health Organization (WHO) embraced the goal of malaria eradication soon after it was founded in 1948. In 1955, a first Global Malaria Eradication Programme (GMEP) was launched. Although malaria kills many people every year, especially babies and infants, it is a preventable and treatable disease. Preventions include the use of insecticide-treated nets and insecticide sprays. Treatments include various chemotherapies. Historically, though, these have merely helped reduce the disease, not eradicate it. Although much work has been done to produce an effective vaccine, it has not been easy due to the fact that the infective agent is a protozoan organism rather than a virus or bacterium. Currently there is only one approved vaccine that is applicable to babies and infants, although it is not 100% effective.

Now there may be new hope from an unexpected source – a bacterium – and it was found by accident! In a new paper, published in the journal *Science*, researchers show that a naturally occurring bacterium and a chemical it secretes inhibit the malaria parasite's development in mosquitoes—meaning they can't transmit the parasite to humans.



It began at GSK laboratories in Spain, where scientists were working on malaria drugs. To test those drugs, they had a colony of mosquitoes that they regularly infected with *Plasmodium falciparum* [the malaria parasite]. Over time, the researchers were not able to infect these mosquitoes anymore. They looked for possible causes and found that a strain of the bacterium *Delftia tsuruhatensis* [which they named Tres Cantos 1, or TC1] was present in all screened mosquito samples. Tests then showed that if the mosquitoes carried TC1, the development of the parasite in the mosquito was compromised.

Further tests showed that it was not the bacterium itself that rendered the mosquitoes unable to transmit the disease, but a chemical compound that the bacterium secreted. This is called **HARMANE** and is easily available from chemical companies. However, it is important to note that the use of harmane will not eradicate malaria. It will have to be used in addition to all the current preventions and treatments but, using mathematical modelling, it may reduce the disease by as much as 15%.

Bacteria: A New Weapon Against Malaria | Johns Hopkins | Bloomberg School of Public Health (jhu.edu)

WORD(S) OF THE MONTH:

VALENCE ELECTRONS *(noun, "VAY-lance Eel-EK-trons")*

These far-out electrons explain how an atom does what it does. Valence electrons are the electrons in an atom farthest from the nucleus. An element's number of valence electrons helps predict how atoms of that element interact with other atoms – ie., what chemical reactions that element willtake part in.

Atoms consist of three types of particles: protons, neutrons and electrons. Protons and neutrons pack together into a tiny centre — the nucleus. Electrons whiz around the surrounding space. That surrounding space is organized into levels. Electrons fill these levels from the inside out. The level closest to the nucleus fills first, with two electrons. If the atom has more than two, these overflow electrons must go to the next level. Then the next and next, and so on, as each level fills up. Valence electrons are those that live in whichever level is outermost. To be stable, atoms need a complete set of valence electrons to fill their outermost levels. For most elements, that number is eight. Atoms with fewer than eight valence electrons are more likely to take, donate or share another atom's valence electrons.

Consider this example: A neutral chlorine atom has seven valence electrons. A neutral sodium atom has only one valence electron. Neither has a complete set of eight. Losing one electron is "easier" than stealing seven. So that's what sodium does — it donates one electron to chlorine. In doing so, the two atoms form a chemical bond — becoming sodium chloride, which you know as table salt.