St Benedict's SCIENCE NEWS *Monthly*

Welcome to the November 2022 issue

SCIENCE NEWS *Monthly* is produced by the Science Department, St Benedict's Catholic Secondary School, Bury St Edmunds, Suffolk, UK.

SPECIAL NOBEL PRIZE EDITION

Every year, in the first weeks of October, a very few lucky scientists, authors and economists get a phone call. For some, the phone rings in the middle of the night. For others, the middle of the day. On the other end of the line is someone with a Swedish accent who informs them they have won a Nobel Prize. Almost instantly, these individuals become celebrities. They will give talks, go to fancy parties and meet the King of Sweden. But why is it such a big deal?

The awards are named for an inventor, **Alfred Nobel**. During his life, this man was best known for inventing dynamite, a type of explosive. It made him a wealthy man. And when he died in 1896, Nobel left money from his fortune to establish five yearly awards — the Nobel Prizes.

Nobel's will directed that one award go to recognize outstanding literature. Another should reward the fostering of international peace. Nobel also wanted to reward scientific discovery. So three awards would celebrate discoveries or inventions in physics, chemistry and physiology or medicine. Later, an award for contributions to Economic Science was introduced. All six awards would come with a cash prize. That prize is now about 10 million Swedish krona (around £800,000, depending on the exchange rate in any given year). If there are more than one winner in a category, they split the money equally.

The first set of Nobel Prizes was handed out in 1901. Now, the Nobel Prize "*is reckoned the world championship of science. It's the most prestigious prize worldwide,*" says Nils Hansson. He is a medical historian at the Heinrich-Heine University in Dusseldorf, Germany. Winners, he notes, "*are celebrated like stars, and their research gets a lot of attention.*" The prize is also notable for being international. These awards can go to scientists anywhere, not just in Nobel's home country of Sweden.

However, there has been (and still is!) criticism of the Nobel committee for the lack of diversity among those to whom Prizes are awarded. Between 1901 and 2018, only 12 of the 211 total winners in physiology or medicine have been women. Only five women over that period have ever won the Nobel Prize in chemistry. Just three have won it in physics. For minority scientists, the numbers are even worse. No black scientist has ever taken home a Nobel Prize.

But things are changing: Important scientific societies, such as the National Academy of Sciences in the United States and the Royal Society in the United Kingdom, now let in more women and people of colour. These societies help scientists get recognized by their peers. And the more women and minorities that become recognized, the more likely they are to receive a Nobel Prize. Between 1901 and 2001, only 10 women received a Nobel Prize in science. Within the next 15 years, another eight won them. That is still not entirely fair, but it is certainly better than it was.

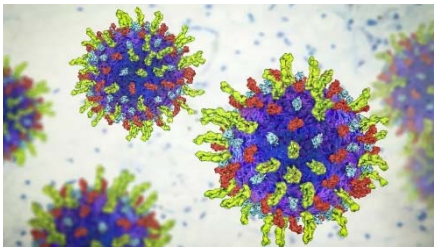
Another thing the Nobel committee might have to address is that it only gives awards in three areas of science, whereas science has broadened considerably into many different disciplines that produce ground-breaking theoretical and practical work.

This year's prize winners are featured on the back pages of this edition.

The following news was spotted by our own Dr R Davies (Science Technician).....

HEALTH - Cancer-killing virus shows promise in patients

A new type of cancer therapy that uses a common virus to infect and destroy harmful cells is showing big promise in early human trials, say UK scientists.



We generally think of viruses as harmful, even deadly, but even a hundred years ago it was realised that we might be able to turn viruses to our advantage – especially the treatment of cancer. Because viruses need to seek out cells and "invade" them in order to survive and multiply, could they be "programmed" to invade cancer cells and destroy them?

The Institute of Cancer Research and the Royal Marsden NHS Foundation Trust have carried out a clinical trial and they presented their findings at the recent ESMO (European Society for Medical Oncology) conference in Paris. Krzysztof Wojkowski, a 39-year-old builder from west London, is one of the patients who took part in the ongoing phase one safety trial, run by the Institute of Cancer Research and the Royal Marsden NHS Foundation Trust. He was diagnosed in 2017 with cancer of the salivary glands, near the mouth. Despite surgery and other treatments at the time, his cancer continued to grow. *"I was told there was no options left for me and I was receiving end-of-life care. It was devastating, so it was incredible to be given the chance to join the trial."* A short course of the virus therapy appears to have cleared his cancer. *"I had injections every two weeks for five weeks which completely eradicated my cancer. I've been cancer-free for two years now."*

The virus therapy uses RP2, a specially modified version of the herpes virus which normally causes cold sores. The injections, given directly into the tumour, attacks cancer in two ways - by invading the cancerous cells and making them burst, and by activating the immune system. About 40 patients have tried the treatment as part of the trial. Some were given the virus injection on its own. Others also received another cancer drug - called nivolumab - as well. Lead researcher Prof Kevin Harrington told the BBC the treatment responses seen were *"truly impressive"* across a range of advanced cancers, including cancer of the gullet (oesophagus) and a rare type of eye cancer.

"It is rare to see such good response rates in early stage clinical trials, as their primary aim is to test treatment safety, and they involve patients with very advanced cancers for whom current treatments have stopped working," he said. *"I am keen to see if we continue to see benefits as we treat increased numbers of patients."*

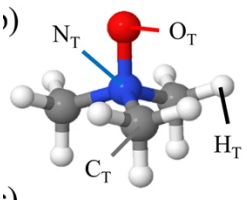
https://www.bbc.co.uk/news/health-62833581

OCEAN BIOLOGY - How fish survive the extreme pressures of life in the oceans

A chemical in the cells of marine organisms enables them to survive the high pressures found in the deep oceans, according to a study by the University of Leeds (UK) published in the journal *Communications Chemistry*.

All life requires that magic molecule H_2O – water, whether its life in the air, on land, or in the ocean. Without water in our bodies and cells, the biochemical processes necessary for life would not work. Under normal or atmospheric pressure, water molecules form a tetrahedron-like network using special chemical bonds, called ***hydrogen bonds***. At high pressure, though, the network of water molecules begins to distort and change shape. When this happens to the water inside living cells, it prevents vital bio-chemical processes from taking place – and kills the organism. So how can life thrive in the high pressure environment of the deep ocean?

The deeper sea creatures live, the more inhospitable and extreme the environment they must cope with. In one of the deepest points in the Pacific – the Mariana Trench, 11 kilometres below the sea surface – the pressure is 1.1 kbar or eight tons per square inch. That is a 1,100-fold increase of the pressure experienced at the Earth's surface. Professor Lorna Dougan, from the School of Physics and Astronomy at Leeds, said: *"Life has adapted to survive and thrive in environmental extremes. In the depths of the oceans, organisms live under extreme high pressures that would destroy human life. These high pressures distort the liquid water that resides in all life, resulting in detrimental impacts to the biomolecules that underpin all biological processes."*

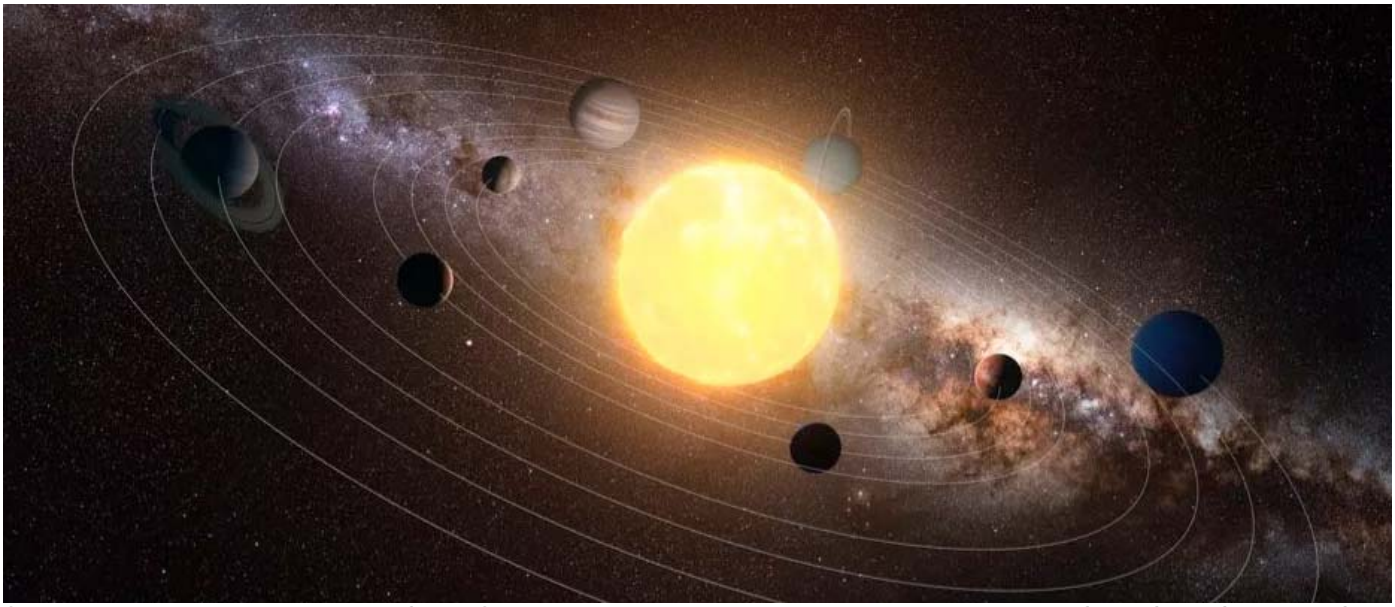


Trimethylamine N-oxide (TMAO)

The molecule found in cells that produces the protective effect against high external pressure is called **TMAO – trimethylamine N-oxide**. Studies have shown that the amount of TMAO in ocean-dwelling organisms increases in line with the depth of their habitat. The researchers used one of the most advanced analytical facilities in the world to investigate how intense pressure alters the hydrogen bonds between neighbouring water molecules. Called the **ISIS Neutron and Muon Source**, the analytical facility at the STFC Rutherford Appleton Laboratory in Oxfordshire was used to fire a beam of neutrons – which are sub-atomic particles – at samples of water with and without TMAO at a range of pressures. At high pressure, the hydrogen bonds in the pure water sample became distorted and less stable and the overall network of water molecules became compacted. The presence of TMAO strengthened and stabilised the hydrogen bonding and maintained the structure of the water molecules.

https://www.sciencedaily.com/releases/2022/09/220928075944.htm

ASTRONOMY - Solar System facts: 5 things everyone should know



Space scientist and presenter of *The Sky at Night* Dr Maggie Aderin-Pocock explains five of her favourite facts about the Solar System:

1. OUR SOLAR SYSTEM IS VAST Our Solar System consists of a wide range of bodies. We have one star – the Sun – that sits roughly at its centre, eight planets orbiting the Sun, five known dwarf planets, including the former planet, Pluto, and over 150 moons that orbit their respective planets, with more being discovered all the time. It's estimated that there are also just under 800,000 asteroids and approximately 3,500 comets with more and more of these being discovered too. Distances in the Solar System are pretty mind boggling too. The average distance between the Sun and Earth is around 150 million km. Out at Saturn the distance is around 10 times that, clocking up to a whopping 1.5 billion km. By the time we get out to Pluto, which sits in a region we call the Kuiper Belt, we are now 6 billion km from the centre of the Sun.

2. MARS WAS ONCE A WATERY PLANET Over the years, we've sent a number of probes to Mars, which has led us to believe that the planet's atmosphere has changed radically over time. In 1971, Mariner 9 was the first mission to go into orbit around the planet. The images that it sent back revealed evidence of water erosion in the form of dried out river tributaries and canyons. This was the first insight into Mars' watery past and these findings inspired the Viking program, a series of two orbiters and landers that documented large flood plains on the Martian surface and found networks of valleys, which indicated that rain must have once fallen on the planet.

3. SATURN IS NOT THE ONLY PLANET WITH RINGS Most of us are familiar with the planet Saturn, which is best known for its amazing and dazzling ring system. However, it is less commonly known that all the planets of the outer Solar System have rings as well. Jupiter, Uranus and Neptune's rings are quite hard to spot but they are there. We are also finding that asteroids can have rings too. Chariklo, an asteroid that is only 250 km in diameter, has a double ring system around it.

4. VENUS ALSO EXPERIENCES GLOBAL WARMING Even though Mercury is the closest planet to the Sun, it has night-time temperatures that plummet to -180°C. The coldest temperature recorded on Earth to date was -89.2°C at the Soviet Vostok station in Antarctica. On the day side of Mercury, the side that faces towards the Sun, the temperatures can reach a scorching 450°C, which gives us an average temperature of 135°C. The average temperature on Venus is around 450°C. When cooking a pizza at home, you would probably set your oven to about 220°C. Venus is more than twice as hot as this – so cooking there would be a disaster! To understand why Venus is hotter than Mercury, we need to look closely at the atmospheres of the two planets. Mercury, like the Moon, has virtually no atmosphere. Venus, in contrast, has a very thick atmosphere, which is mainly made up of carbon dioxide (CO_2). CO_2 is contributing to major climate changes on Earth, but here it accounts for less than 1 per cent of the gases in the atmosphere. Venus is also suffering from global warming but at an extreme level. The temperature on the planet is much higher than we would expect because CO_2 makes up a whopping 95 per cent of the atmosphere.

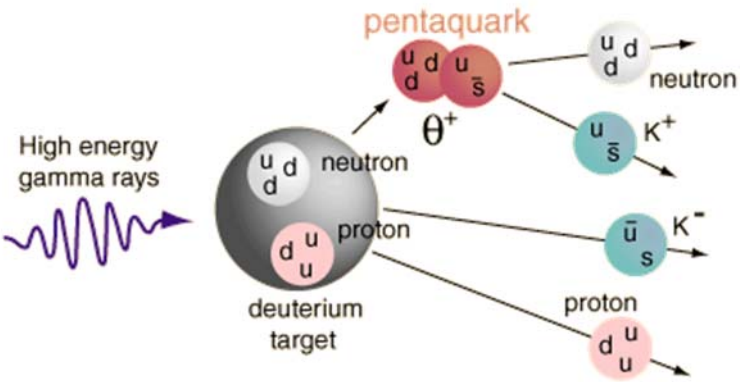
5. URANUS ROTATES ON ITS SIDE The Earth's axis is tilted by a reasonable 23 degrees, this is just enough to make things interesting. The tilt gives us our seasons in the Northern and Southern hemispheres. However, compared to Uranus, Earth's tilt is paltry. Uranus' axis is tilted by a staggering 98 degrees and literally spins on its side. None of the other planets have such a pronounced tilt. It is thought that perhaps Uranus suffered a cataclysmic impact in the past, which knocked it onto its side. Voyager 2 is the only spacecraft that has ever flown past Uranus, so perhaps it's time we sent another probe out there to take a closer look!

https://www.sciencefocus.com/space/solar-system-facts-5-things-everyone-should-know-about-our-cosmic-neighbourhood/

QUANTUM PHYSICS - team of physicists finds signs of a new type of matter

The question *"What is matter made of?"* goes right back to the ancient Greeks and resulted in many different theories over the centuries. The English chemist, John Dalton, in the first decade of the 19th century proposed the first really scientific atomic theory. But then the question became *"What are atoms made of?"* The breakthrough came in 1897 when the English physicist JJ Thomson discovered the **electron**, the first subatomic particle – then came particles that make up the atom's nucleus: the **proton** and **neutron**. But what could these be made of? In the 1960s came the discovery of **quarks**, the building blocks of protons and neutrons.

Most of the observable mass of the universe comes from quarks that combine to make the familiar proton and neutron and a bevy of other particles that interact far more strongly than electrons. These strongly interacting particles are known collectively as **hadrons**. Until recently, all hadrons could be understood as combinations of a quark and an antiquark, or combinations of three quarks, like the proton. In spite of this, it has long been suspected that other quark combinations are possible—what amounts to new forms of matter.



In a paper published in the journal *Physical Review D*, physicists Tim Burns of Swansea in Wales and Eric Swanson at the University of Pittsburgh(US) argue that the data they have obtained from the Large Hadron Collider at CERN can be understood only if a new type of matter exists. *"We have a model that explains the data beautifully, and for the first time, incorporates all the experimental constraints,"* Burns said. The explanation requires the existence of several new particles that consist of four quarks and one antiquark, called **"pentaquarks."** The conclusion raises the possibility that other pentaquarks are possible, and that a whole new class of matter is at the cusp of being discovered.

https://phys.org/news/2022-09-team-physicists-pentaquark-states.html

ARCHAEOLOGY - Ancient footprints reveal 'Irish Sea Serengeti'

A sandy stretch of the north-west England coast at Formby is already known to be home to one of the largest collections of prehistoric animal tracks on Earth. Now, a perfectly formed human footprint that is 8,200 years old has been discovered. As well as adding to the collection, researchers also found the oldest prints were formed much earlier than thought. The first date back almost 9,000 years and the youngest of the prints are medieval - about 1,000 years old.

The size and shape of the picture-perfect human footprint that has been found suggest it belonged to a young man - perhaps a teenager. Strangely, this adolescent foot had the very distinct protrusion of a bunion on its little toe. It is known as a "tailor's bunion" and is caused by the little toe dragging on the ground when the subject is sitting down.

The findings, published in the journal *Nature Ecology and Evolution*, tell the story of a coastal environment that transformed over thousands of years, as sea levels rapidly rose and humans settled permanently by the water. Dr Alison Burns of the Department of Archaeology and Geography at Manchester University (UK) is lead author of the paper. She explains that as the sea erodes away layers of this ancient, compressed mud on Formby Beach, it can reveal new layers of footprints. The deeper the layers, the earlier they were formed. *"What's amazing is that we've tracked a major ecosystem change solely by looking at the footprint record - with no bones or fossils."*

Prof Jamie Woodward from the University of Manchester and a co-author of the paper, says *"The oldest footprints date to a time when the coastline was 30km away and the tidal muds here were teeming with animals - aurochs, herds of red deer, roe deer and also predators like wolves and lynx that are now extinct in the UK."* He and Dr Burns, along with their colleagues, verified the ages of the tracks by carbon-dating seeds extracted from cores of this ancient, compressed mud.

Altogether there are 31 footprint beds, which point to a period of dramatic change in this ecosystem. *"Up to about 6,000 years ago, there was a very diverse landscape with all those animals,"* says Prof Woodward. *"Then after about 5,500 years ago, we see lots of human footprints, some deer and dogs, but not much else. So what we're seeing - through the footprints - is a landscape transforming with sea-level rise, and also with the arrival of agriculture that probably put a lot more pressure on this ecosystem."*

https://www.bbc.co.uk/news/science-environment-63036911

THE ART OF SCIENCE - AI image generators will help artists, not replace them

It is still a controversial question even with the increasing sophistication of Artificial Intelligence: can computers create art? Or is art to be held as the sole preserve of the human mind? Maybe, but there is a significant body of opinion that machine learning models are the latest in a long line of technological innovations that artists can use to express their creativity.

As AI image generators, such as OpenAI's popular DALL-E and DALL-E2, become more widespread, some forecast the death of human artforms. But this notion could be premature. AI could make illustration more accessible, creating more creators and actually revitalising visual art. For years, artist Steve Coulson wanted to make his own comic. *"The problem has always been – I can't draw,"* he says. But in 2022, Coulson published a beautiful comic called *Summer Island*. The 40-page folk-horror story about a sea god festival features detailed illustrations with a coherent visual style— all created with the help of artificial intelligence.

The past year has seen an explosion of machine learning models that generate digital images from natural language prompts. These AI systems use a method called 'diffusion'. This creates random dots and then shapes them into a picture according to the semantic information it receives. Type in a description like *"The royal skateboard of England on display among the Crown Jewels at the Tower of London"* and the AI system will return multiple images of... approximately that.

The systems aren't perfect, sometimes returning errors or biased results, but their accuracy and quality are often breath-taking. They also mean that illustrators and others could automate basic prototyping or even generate a final product for many different kinds of illustration tasks. All this raises the question: will we still value human skill and creativity in visual art?

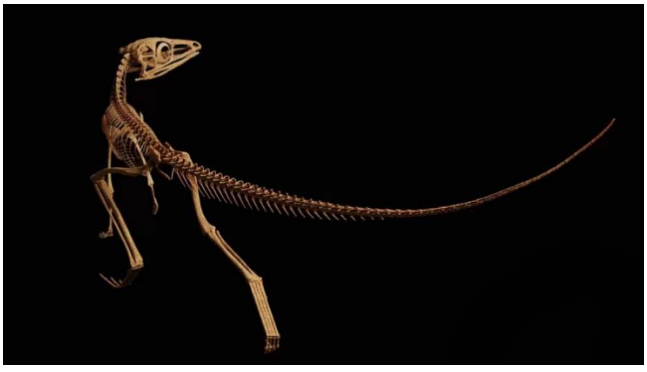
The short answer is emphatically yes! Human creativity is different. Machines imitate, remix, and generate art accidentally, not with any human intentionality. Some might quibble and claim that human art is also imitation and remixing, but the process is entirely different. That is what sets humans apart and makes them unique.

https://www.sciencefocus.com/news/ai-image-generators-will-help-artists-not-replace-them/

PALAEONTOLOGY - Scottish fossil revealed to be pterodactyl ancestor

In the 1900s in Lossiemouth, near Elgin, Moray (Scotland) a collection of fossils, known as the **Elgin reptiles**, was assembled. They date to a time during the Triassic period, about 230 million years ago, when Scotland was largely a desert within the supercontinent Pangea. The fragile fossils are "locked" inside sandstone blocks which has prevented scientists from being able to examine the fossils in any detail.....until now.

Researchers used powerful X-ray scans to examine the fossils, especially one of a creature called ***Scleromochlus***. This small, scampering Triassic reptile is, scientists say, the ancient cousin of the great, winged pterodactyl. The findings are published in the journal *Nature*.
"We just didn't understand just how much we were missing until we did these scans," lead researcher Dr Davide Foffa, from National Museums Scotland, said. Dr Foffa and his colleagues worked closely with the Natural History Museum, in London, where much of the Elgin collection is now held, to scan and study seven fragile, sandstone-entombed specimens of *Scleromochlus*. Until now, it has been difficult to draw useful information from the fossils. But they piqued the palaeontologist's interest because they date to a murky and critical point in the fossil record - about 10 million years before the first fossil **pterosaurs**. (Pterosaurs were a genus of the first flying reptiles. They are often referred to as pterodactyls, but these may themselves be classed as a separate genus.)



What has always puzzled palaeontologists is the fact that all the fossil pterosaurs so far found already have wings and are therefore adapted for flying. It has been difficult to understand how that adaptation arose. Now, with details of the *Scleromochlus* revealed, we may have the "missing link" between earlier ground-dwelling reptiles and the later flying species. The fine anatomical details revealed by the X-ray scans - including the shape of its jaw and upper thigh bone - have allowed the scientists to correctly place *Scleromochlus* on the pterosaur family tree, revealing that the first flying reptiles evolved from small ground-dwelling ancestors that probably ran around on two legs.

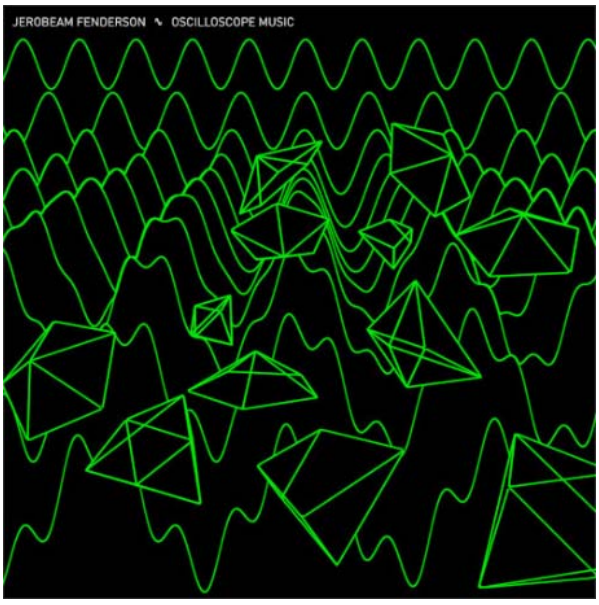
https://www.bbc.co.uk/news/science-environment-63146271

The following news was spotted by our own Mr M Tanguay (Senior Science Technician).....

WEIRD MUSIC – Jerobeam Fenderson: oscilloscope music!

Following the invention of the first true electricity generator by Michael Faraday, in 1831, scientists at last had a reliable and stable source of direct current electricity to work with. Early high-speed visualisations of electrical voltages were made with an electro-mechanical oscillograph that produced a paper trace. Then in 1897 the German physicist, Ferdinand Braun, developed the cathode-ray tube (CRT) and the first oscilloscope was built.

On the CRT screen varying electrical voltages are displayed as a two-dimensional plot of one or more signals as a function of time. The main purposes are to display repetitive or single waveforms on the screen that would otherwise occur too briefly to be perceived by the human eye. The displayed waveform can then be analysed for properties such as amplitude, frequency, rise time, time interval, distortion, and others. Oscilloscopes are used in the sciences, medicine, engineering, automotive and the telecommunications industry. But whoever thought that they might be used in music? One man did.....**Jerobeam Fenderson**.



Jerobeam Fenderson is a sound artist and electronic technician, based in Austria. His Oscilloscope Music project is an audio-visual experience, where images are drawn with sound. Waveforms are fed simultaneously into a set of stereo speakers and the X/Y-inputs of an oscilloscope. The identical signal is observed by both listening and looking at it. The process of creating sounds that look good rules out most conventional methods of synthesis and mixing, but at the same time opens up a mesmerizing dimension of synthetic geometry.

The images produced and displayed on the oscilloscope screen are not just the usual waveforms, but complex geometric patterns and even characters and faces!

The image on the left (above) is from the album "Oscilloscope Music" (2016). The track list includes titles such as "Dots", "Lines", "Blocks", "Spirals", "Planets", "Asteroids" and "Circles".

https://jerobeamfenderson.net/

ANTHROPOLOGY - Here's where jazz gets its swing

"It don't mean a thing if it ain't got that swing", so the saying goes. For decades, fans of jazz music have debated why some songs have swing — the characteristic swaying feeling that compels feet to tap and heads to bop. Now, scientists may finally have an answer to Louis Armstrong's classic song *"What Is This Thing Called Swing?"* and the secret lies in the timing of jazz soloists.

After listening to original and digitally tweaked piano recordings, jazz musicians were more than seven times as likely to rate music as "swinging" when the soloist's timing was partially delayed with respect to the rhythm section, researchers report in the journal *Communications Physics*.

"In jazz, musicians are trained to swing eighth notes, or extend the duration of their downbeats — every other eighth note — and shorten the beats in between to create a galloping rhythm. But the technique on its own doesn't explain swing," says physicist Theo Geisel, of the Max Planck Institute for Dynamics and Self-Organization in Göttingen, Germany. *"Computer-generated jazz songs with swung eighth notes still lack the style's swaying feel."*

Musicians were nearly 7.5 times as likely to judge music as more swinging when the soloists' downbeats were minutely delayed with respect to the rhythm section, but not their offbeats. *"Most of the musicians couldn't put their finger on what was causing the effect"*, says Geisel. *"Professional jazz musicians who have played for many years apparently have learned to do this unconsciously."*

https://www.sciencenews.org/article/jazz-music-swing-rhythm-timing

NOBEL PRIZES - 2022

https://www.nobelprize.org/

ECONOMIC SCIENCE

Ben Bernanke, Douglas Diamond and Philip Dybvig

"for research on banks and financial crises"

This year's laureates in the Economic Sciences have significantly improved our understanding of the role of banks in the economy, particularly during financial crises. An important finding in their research is why avoiding bank collapses is vital.

https://www.nobelprize.org/prizes/economic-sciences/2022/press-release/

LITERATURE

Annie Ernaux

"for the courage and clinical acuity with which she uncovers the roots, estrangements and collective restraints of personal memory"

In her writing, Ernaux consistently and from different angles, examines a life marked by strong disparities regarding gender, language and class. Her path to authorship was long and arduous.

https://www.nobelprize.org/prizes/literature/2022/press-release/

PEACE

Ales Bialiatski (Belarus)

The human rights organization: Memorial (Russia)

The Center for Civil Liberties (Ukraine)

The Peace Prize laureates represent civil society in their home countries. They have for many years promoted the right to criticise power and protect the fundamental rights of citizens. They have made an outstanding effort to document war crimes, human right abuses and the abuse of power. Together they demonstrate the significance of civil society for peace and democracy.

By awarding the Nobel Peace Prize for 2022 to Ales Bialiatski, Memorial and the Center for Civil Liberties, the Norwegian Nobel Committee wishes to honour three outstanding champions of human rights, democracy and peaceful co-existence in the neighbour countries Belarus, Russia and Ukraine. Through their consistent efforts in favour of humanist values, anti-militarism and principles of law, this year's laureates have revitalised and honoured Alfred Nobel's vision of peace and fraternity between nations – a vision most needed in the world today.

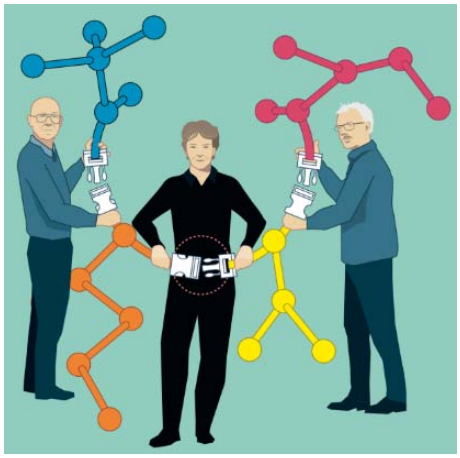
https://www.nobelprize.org/prizes/peace/2022/press-release/

The youngest person ever to have been awarded a Nobel Prize was a woman called Malala Yousafzai who, in 2014 aged just 17, was awarded the Peace Prize jointly with Kailash Satyarthi.

The citation read: *"for their struggle against the suppression of children and young people and for the right of all children to education"*

In 2013, TIME magazine named Malala one of "The 100 Most Influential People in the World." On her 16th birthday she spoke in the United Nations. In her speech Malala called for the equal right to education for girls all over the world, and became a symbol of this cause.

CHEMISTRY



Barry Sharpless and Morten Meldal; Carolyn Bertozzi

"for the development of click chemistry and bioorthogonal chemistry"

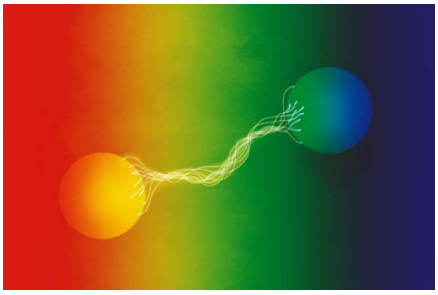
The Nobel Prize in Chemistry 2022 is about making difficult processes easier. Barry Sharpless and Morten Meldal have laid the foundation for a functional form of chemistry – *click chemistry* – in which molecular building blocks snap together quickly and efficiently. Carolyn Bertozzi has taken click chemistry to a new dimension and started utilising it in living organisms.

Chemists have long been driven by the desire to build increasingly complicated molecules. In pharmaceutical research, this has often involved artificially recreating natural molecules with medicinal properties. This has led to many admirable molecular constructions, but these are generally time consuming and very expensive to produce.

"This year's Prize in Chemistry deals with not overcomplicating matters, instead working with what is easy and simple. Functional molecules can be built even by taking a straightforward route," says Johan Åqvist, Chair of the Nobel Committee for Chemistry.

https://www.nobelprize.org/prizes/chemistry/2022/press-release/

PHYSICS



Alain Aspect; John F. Clauser; Anton Zeilinger

"for experiments with entangled photons, establishing the violation of Bell inequalities and pioneering quantum information science"

The ineffable effects of quantum mechanics are starting to find applications. There is now a large field of research that includes quantum computers, quantum networks and secure quantum encrypted communication.

One key factor in this development is how quantum mechanics allows two or more particles to exist in what is called an entangled state. What happens to one of the particles in an entangled pair determines what happens to the other particle, even if they are far apart.

In the 1960s, John Stewart Bell developed the mathematical inequality that is named after him. This states that if there are hidden variables, the correlation between the results of a large number of measurements will never exceed a certain value. However, quantum mechanics predicts that a certain type of experiment will violate Bell's inequality, thus resulting in a stronger correlation than would otherwise be possible.

https://www.nobelprize.org/prizes/physics/2022/press-release/

PHYSIOLOGY OR MEDICINE

Svante Pääbo

"for his discoveries concerning the genomes of extinct hominins and human evolution"

Humanity has always been intrigued by its origins. Where do we come from, and how are we related to those who came before us? What makes us, Homo sapiens, different from other hominins?

Through his pioneering research, Svante Pääbo accomplished something seemingly impossible: sequencing the genome of the Neanderthal, an extinct relative of present-day humans. He also made the sensational discovery of a previously unknown hominin, Denisova. Importantly, Pääbo also found that gene transfer had occurred from these now extinct hominins to Homo sapiens following the migration out of Africa around 70,000 years ago. This ancient flow of genes to present-day humans has physiological relevance today, for example affecting how our immune system reacts to infections.

https://www.nobelprize.org/prizes/medicine/2022/press-release/