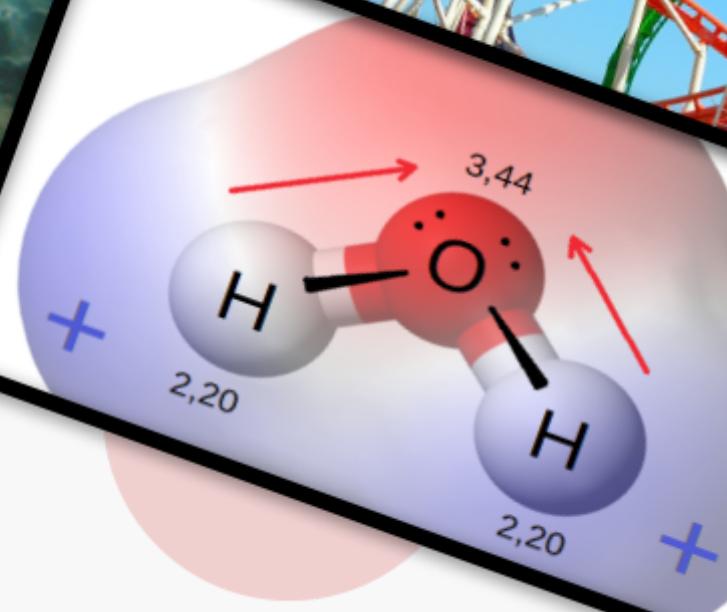
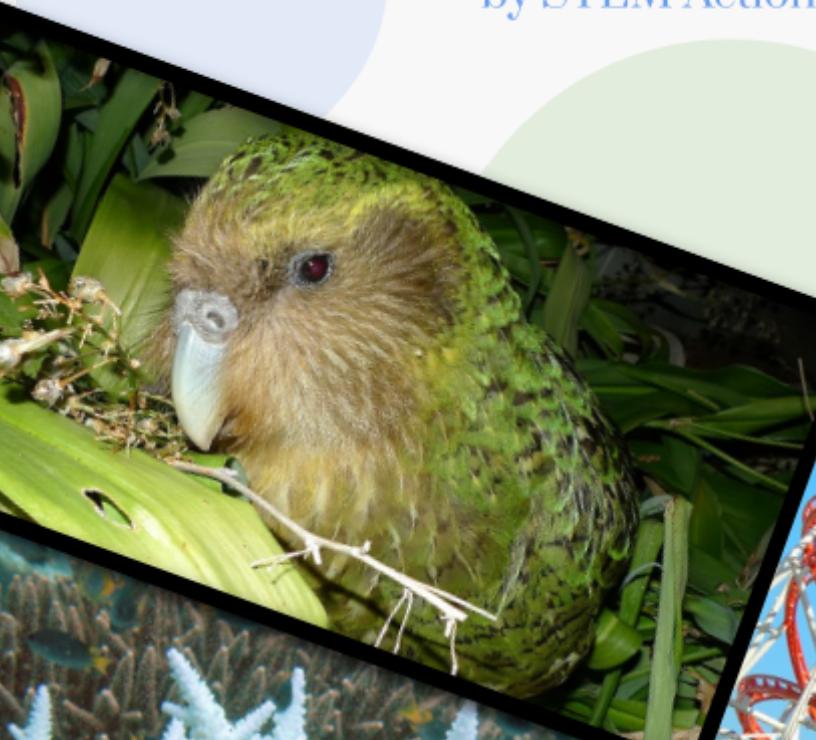


SEEKING SCIENCE

by STEM Action Teen Institution

A MONTHLY
STEM NEWSLETTER



DATA CLUSTERING

VECTOR MATH

SEA PIGS

and more...

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Table of Contents

| | |
|---|----|
| Deja Vu: The Mystery of Familiarity | 4 |
| A Flightless Bird: The Kākāpō Bird | 6 |
| Clustering in Data Mining | 8 |
| The Enigmatic Momentum of Photons | 11 |
| Vector Math in 3D Video Games | 13 |
| What are Logic Gates? | 15 |
| The Placebo Effect - The Power of the Mind | 17 |
| Extremophile Organisms: Thriving Against the Odds | 19 |
| The Physics Behind Roller Coasters | 21 |
| The Properties of Water | 23 |
| Coral Bleaching | 25 |
| The Vampire Einstein Tile | 27 |
| Reverse Psychology | 29 |
| Quantum Theories | 30 |
| Scotoplanes: Pigs of the Sea | 32 |
| Nitinol: The Alloy of The Future | 34 |
| The Mystery of Pi | 36 |
| Technology Transfer From Astronomy To Industry | 38 |
| All About Superclusters | 40 |

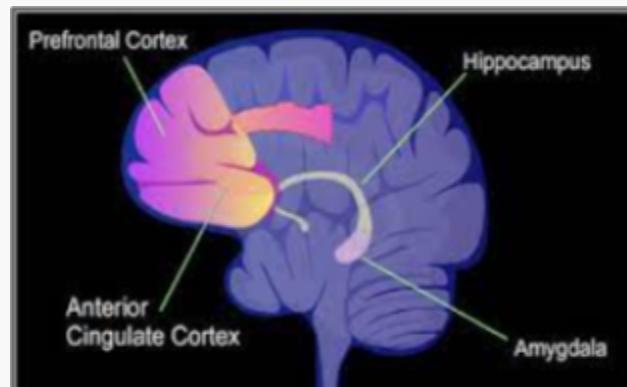
Deja Vu: The Mystery of Familiarity

Arthur Liang

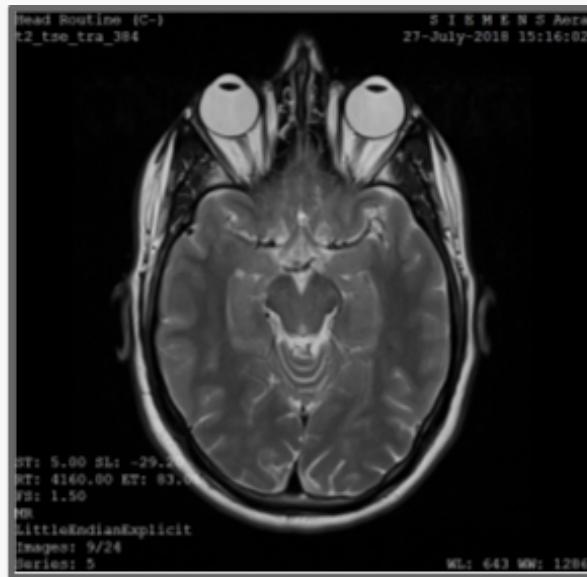
The term “Deja Vu” is derived from the French translation for “already seen.” Most people will experience this fascinating phenomenon without genuinely knowing how or why it occurs. People will randomly and spontaneously feel like they have already encountered a certain event in the past, even if they have not.

Scientists believe that deja vu occurs as a temporary malfunction or “glitch” in the brain’s system of memory. The human brain forms memories using two separate processes: familiarity and recollection. Familiarity is a feeling of recognition, while recollection involves recalling specific memories. Usually, one needs to recall the memory before one can identify it as familiar. Deja vu occurs when the familiarity process accidentally kicks in before the recollection process, leading to a false perception of familiarity in a situation never encountered before.

There are many possible causes of this erroneous processing occurring in our brains. One theory states that deja vu could be caused by a discrepancy between the sensory and perceptual input received by the brain and the speed at which the brain processes this input. Another theory arises from the fact that the hippocampus seems to show increased activity during deja vu experiences as observed through MRI scans. It is believed that the occasionally increased hippocampus activation can trigger a sense of familiarity.



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Factors such as stress, fatigue, and emotional state can affect the frequency of déjà vu experiences. These factors impact the brain's ability to process information and recall memories, which may subsequently lead to episodes of déjà vu.

A Flightless Bird: The Kākāpō Bird

Cody Duan

Also known as the owl parrot, the kākāpō birds are large, nocturnal, and ground-dwelling. Typically found on the mainland of New Zealand, these birds are green parrots with owl-like faces. These unique birds have many quirky qualities that make them beloved.



"Kakapo Sirocco 1" by Chris Birmingham. Licensed by Wikimedia Commons, under CC BY 2.0.
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Kākāpō birds have a very distinct way of breeding. Every night for about two to three months, the males usually find a bowl-like area with low-growing vegetation and let out a deep, low-frequency “boom” sound every one to two seconds. These “booms” can be heard from 300-400 meters away on flat land and up to 5 km on mountains. After about 20-30 “booms,” the birds will let out a “ching” sound that lets females track down the exact location.

In Māori mythology, birds often have much cultural and spiritual value. The kākāpō bird’s fine, green feathers made for great clothing, and only people of high status wore these. Consisting of about 11,000 feathers, such attire came at a grave cost. In addition to the superb clothing qualities, the kākāpō bird’s meat made it a prime target. Over time, the population size diminished due to the overexploitation of these birds.

Today, kākāpō birds are critically endangered. Habitat loss and the introduction of new predators caused a catastrophic decrease in these birds. The reproduction rate of these birds is also unstable, for they only breed every two to four years when the rimu trees produce much fruit. Furthermore, each female will only hatch one to four eggs, some of which may be eaten by predators such as rats. Luckily, organizations such as the Kākāpō Recovery Programme saved the population.

The people in New Zealand adore these birds. Their friendly and curious personalities are loved. It explains why efforts are so high to preserve this species.



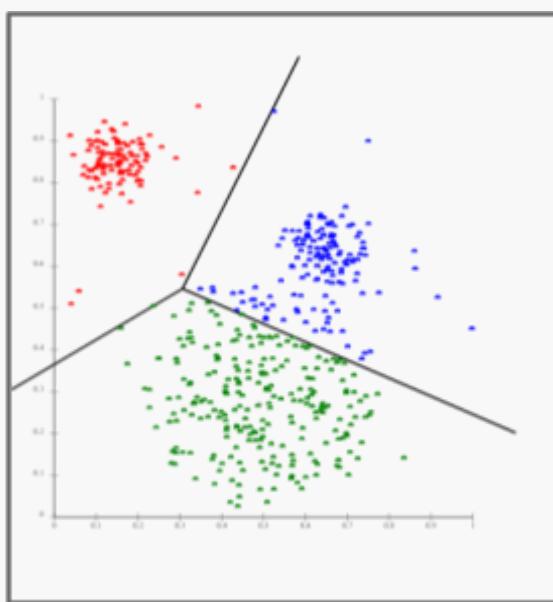
"Kakapo chicks (8528275645)" by Dianne Mason.
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Clustering in Data Mining

Edward Huang

In the modern world, data driven decisions are key for success. Business entities like Netflix and governments such as the one in Los Angeles all rely on recording immense amounts of data, and then finding patterns within that data in order to make informed decisions that will allow them to benefit or target the most amount of people as possible. The act of finding patterns and insights from data is known as “data mining”, and one of the key tasks of data mining is clustering.

Clustering is the way computers can find groups of similar or homogenous individuals in a large dataset. This can be thought of as taking a large graph containing many points, and finding “clumps” of points where many of those points are close together. Segmentation of a large dataset into multiple small groups of similar individuals allows businesses to identify specific, unique populations of people and their interests.

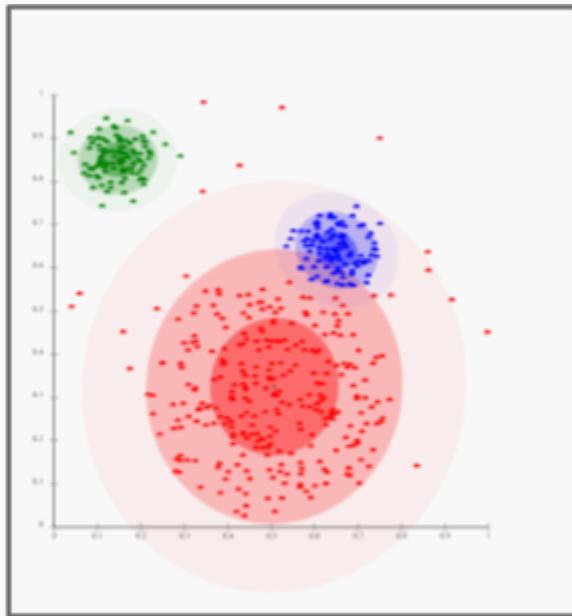


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Additionally, clustering algorithms can allow segmentation of datasets including multiple variables. In the example of a 2D graph with numerous points, each point represents an individual relating two variables, the x-axis and the y-axis. However, most cases require clustering on datasets with more variables, and in some cases, with datasets that have 10 variables or more. While we humans can easily identify clumps of points on a 2D graph due to our pattern-finding brains, we cannot do the same for a 10 dimensional dataset, so we must rely on algorithms to do the work for us.

One algorithm is the K-means algorithm, which will cluster a dataset into k clusters, where k is a pre-picked number. For example, if we have 2D graph of numerous points, running the K-means algorithm with $k = 10$ will result in the algorithm finding 10 clusters of points. After selecting a value for k , the first step that the algorithm will do is to randomly generate k points in the graph, which will be called *centroids*. From there, assign each point on the graph to its nearest centroid. This will partition and cluster the points into k clusters, but the end result will most likely be incorrect. The next step is to take each cluster and find the average position, which can be thought of as the center of mass, of all of the points in that cluster. These positions now act as the new centroids, and the algorithm repeats itself, once again assigning every point to the centroid that is closest to it. This repeats over and over again until the point is reached where each centroid no longer moves. In this case, we have successfully found our k clusters, and the algorithm terminates.



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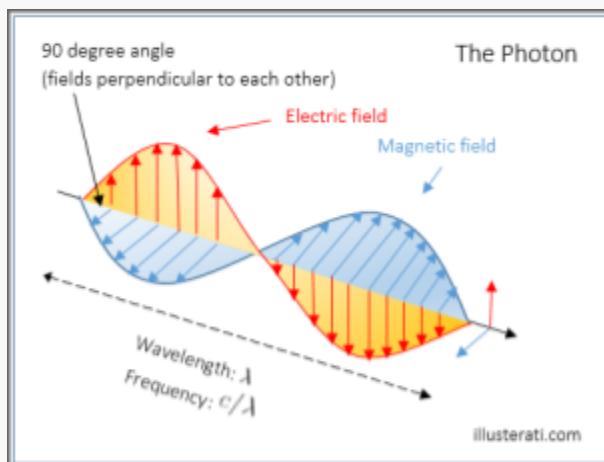
The K-means algorithm is one of many clustering and data-mining algorithms that large entities use to find important patterns within large datasets. Because of algorithms like these, companies like Target can easily segment their large population of customers into a small number of homogenous groups, and then target those specific groups with advertisements and products that will increase sales and revenue. This is just one of many applications of cluster analysis, and data mining proves to be one of the most essential processes for large corporations and governments .

The Enigmatic Momentum of Photons: Illuminating the Weightless Force

Stephen Hung

Few phenomena in physics are as mysterious and intriguing as the concept of photon momentum. Photons, the fundamental particles of light, have an unusual property: they have momentum despite being massless. This fascinating event calls into question our intuitive understanding of momentum and calls for a closer look at the underlying nature of light and how it interacts with the environment around us.

First of all, what are photons? Photons are elementary particles that carry both wave-like and particle-like properties and appear when charged particles transition from higher to lower energy states, forming electromagnetic waves commonly known as light. Each packet of light energy is encapsulated in a photon in discrete values.



"The Photon" by Chire. Licensed by Wikimedia Commons, under CC BY-SA 3.0.

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Traditionally, momentum is defined as the product of an object's mass and velocity. Photons always travel at a fixed velocity, which is the speed of light, or 3×10^8 m/s. Yet, these particles do not possess any mass, so how can photons possess momentum without having mass?

To comprehend photon momentum, we must look to Albert Einstein's groundbreaking theory of relativity. The famous equation $E = mc^2$ describes how mass and energy are convertible under relativity. Because photons are pure energy, their momentum is derived only from their energy content. Max Planck, a pioneer of quantum theory, established a significant link between a photon's energy and momentum. Planck's formula, $E = hf$, defines a photon's energy (E) as the product of its frequency (f) and Planck's constant (h). This formula can be rewritten as $p = hf/c$ when paired with Einstein's theory of relativity, where p represents the momentum of a photon.

What are the implications of this fascinating discovery? Photon momentum is used in the field of photonics in quantum mechanics. Photonic technologies, such as laser cooling and optical trapping, use photon momentum to manage and control minuscule objects such as atoms and nanoparticles, enabling advances in domains such as quantum computing and nanotechnology.

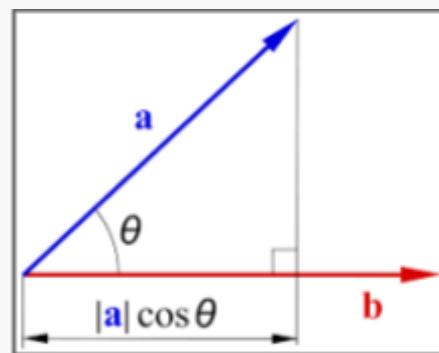
This enigmatic phenomenon continues to captivate and challenge scientists to this day. Photons bring up new areas of inquiry and technological growth by challenging our old concept of motion. Photon momentum research not only advances our understanding of the fundamental physics of light but also finds applications in a wide range of industries, transforming everything from space exploration to quantum computing. As our understanding of photon momentum grows, it is set to shed light on unknown territory, uncovering the secrets of the universe one photon at a time.

Vector Math in 3D Video Games

Brian Wang

The way objects interact with our world requires an abundance of math to derive the various movements and functions of these interactions. While a ball bouncing up and down a regular horizontal road may appear oscillating, on a more slanted surface such as a roof, it bounces based on the angular position of the roof itself, not just the inverse direction of the ball. These math angles are used in video games throughout the world, such as in the Legend of Zelda series, Mario series, etc. As a general package, how these angles interact with one another will cover a large portion of the math needed for game design. More in-depth math for video game design will be covered in another article next month.

To start, it is important to understand the importance of a vector, which in essence is an arrow that points towards where an object is facing. Dot products take into account two vectors, or where two objects are facing, and deduce whether the two vectors are close or far from each other on a scale of -1 to 1 (when the arrows are the same length). When these two vectors face away from each other, the dot product is negative, and positive when they are facing the same direction, and 0 otherwise (if they are both at 90-degree angles). A common use case in video games can be for detecting if one object can see another object. Let's imagine a block facing forwards, and the player facing in all directions at the origin. When the player faces in the same direction as the object, we can deduce that the object can see the player (specific parameters of how close

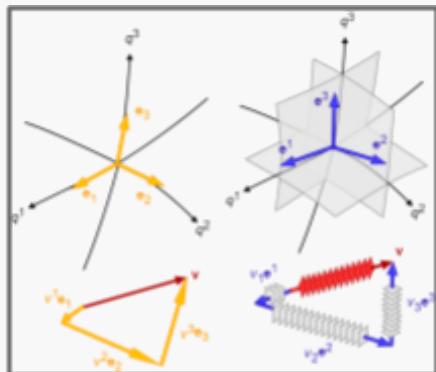


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you want the vectors to face to be able to see is up to you), but when the player faces away from the object, they are then not detected. Keep in mind that the player's vector will be calculated starting from the position of the object and going towards the position of the player, with a max distance of 1.

Cross Products, on the other hand, simply determine the perpendicular vector given two vectors. If one angle was 90 degrees to another angle, then the cross product would be upwards, and if it was a -90 degree angle, the product would be downwards. Furthermore, your fingers can be used to visualize this application. With your thumb facing upwards, curl back all of your fingers, and point the index finger in front, and your middle finger to the left. Your index and middle finger represent where two objects are facing, and the thumb represents the cross product of the two. Keeping the same position, turn your hand 180 degrees, and you can see the cross product goes downwards. Usually in video games, this degree relationship can be used in finding the lighting intensity of shaders. Let's say a camera is facing a circular object (let's say this is

view vector 1), and it bounces off of the normal by 90 degrees, called view vector 2. Now, we have a 90-degree angle that bounces off of the surface of a circle based on where we are looking. Based on how closely this view vector is to the light source vector, we can change the intensity of the lighting. The normal vector of the object can be determined by the cross-product of specific vectors in a certain face that the view vector is facing.



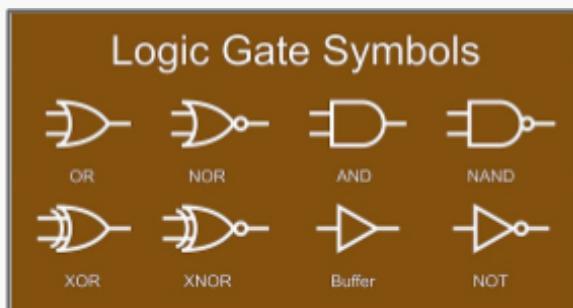
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What are Logic Gates?

Aidan Hong

Logic gates are one of the most critical components of programming. Logic gates allow programmers to set certain conditions that allow a segment of code to execute. Currently, there are seven basic types of logic gates: AND, OR, NOT, XOR, NOR, NAND, and XNOR.

In computers, each conditional only has two outputs: true or false. This can be represented in binary with a 0 representing false and a 1 representing true. Logic gates take advantage of this and set conditions that require a set amount of true/false conditions that allow a portion of code to run.



"NV 0501 Byers Social4" by Zelakolase. Licensed by Wikimedia Commons
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First, we have the AND gate. The AND gate outputs 1 if and only if both conditions are true. The NAND gate works the opposite way: It outputs 1 if a 0 is present in any condition. Next, we have the NOT gate. The NOT gate reverses the condition. A 1 outputs a 0, and vice versa. NOT gates are the simplest logic gates. The OR gate works similarly to the AND gate, except that it only needs one “1” to output a 1. Conversely, the NOR gate requires two “0” to output a 1. XOR is a special type of OR gate. Like an OR gate, it requires one “1” to output a 1, but having 2 outputs a 0! The XNOR gate is the opposite – two of the same condition output a 1, and having only one “1” or “0” outputs a 0. With

logic gates, programmers can set special conditions. These are typically used in if-else statements. For example, a programmer can set a condition that only permits users that meet certain criteria to access a portion of their app or website.

The most critical part of programming is logic gates. There are 7 basic types of them: AND, OR, NOT, XOR, NOR, NAND, and XNOR. These gates allow programmers to set certain types of conditions. Without these logic gates, the online world as we know it would be vastly different.

The Placebo Effect - The Power of the Mind

Eddie Zhang

The placebo effect is an intriguing phenomenon that underscores the complex relationship between the mind and the body. It refers to the positive therapeutic outcomes experienced by individuals who receive inactive treatments, such as sugar pills or saline injections, due to their belief in the treatment's effectiveness. The placebo effect challenges conventional notions of medicine and offers profound insights into the mind's ability to influence physical well-being.

While the mechanisms behind the placebo effect are not yet fully understood, several theories have been proposed. One theory suggests that the mind's expectation and belief in a treatment's effectiveness trigger the release of endorphins and other neurotransmitters, resulting in pain relief or other symptomatic improvements. Another theory states that the placebo effect involves the activation of the brain's reward pathways, which can stimulate the production of natural chemicals that alleviate discomfort or enhance healing processes. Furthermore, recent research has demonstrated that the placebo effect can also influence the immune system, inflammation levels, and brain activity, further underscoring the mind-body connection.



"Neurotransmitters" by ScientificAnimations.com. Licensed by Wikimedia Commons, under CC BY-SA 4.0.

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The placebo effect significantly impacts medical practice, clinical trials, and patient care. In clinical trials, where a placebo is often used as a control group, it becomes crucial to account for the placebo effect's potential impact on treatment outcomes. The magnitude of the placebo response varies across individuals and conditions, and understanding these variations can improve the design and interpretation of clinical studies. Moreover, healthcare providers can utilize the power of the placebo effect by leveraging effective communication, patient trust, and empathy. By optimizing the patient-provider relationship, healthcare professionals can enhance treatment outcomes and promote healing beyond the mere administration of medication.

As our understanding of the placebo effect deepens, new avenues of research emerge. Investigations into the neurobiology and genetics underlying individual variations in placebo response hold promise for tailoring treatments to specific patients. Moreover, exploring the sociocultural factors that shape placebo responses can provide insights into the impact of cultural beliefs, rituals, and contextual cues on healing processes. By revealing the intricacies of the placebo effect, we can broaden our knowledge of the mind-body connection and develop more effective therapeutic approaches.

Extremophile Organisms: Thriving Against the Odds

Kenny Wu

Life on Earth is incredibly diverse and adaptable, capable of thriving in the most extreme environments. Extremophile organisms are an example, they defy our assumptions through thriving in environments that were formerly thought to be hostile. These exceptional beings have developed special adaptations that allow them to endure in settings that contradict our conceptions of what it is to be alive. Extremophiles provide important insights into the limits of life's adaptability and the possibility of discovering life outside of Earth because of their extraordinary resilience.

To begin, extremophiles exhibit their remarkable adaptations in a variety of severe situations. In heated environments like geothermal hot springs or deep-sea hydrothermal vents, thermophiles thrive. These organisms that thrive in heat have developed specific enzymes and heat shock proteins that keep them stable in high temperatures. They use



"Extremophiles Berkeley" by Kolopres. Licensed by Wikimedia Commons under CC BY-SA 3.0.
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high temperatures for metabolic operations since most proteins would otherwise be damaged. In addition, thermophiles have strong cell structures, including heat-resistant membranes and enzymes that can work in very hot environments. These modifications enable them to make use of the resources and energy found in their harsh environments.

On the other hand, psychrophiles are creatures that have adapted to extremely cold places, such as the Arctic regions. They create antifreeze proteins that stop the growth of ice crystals inside their cells. These proteins enable psychrophiles to endure freezing temperatures by attaching to ice crystals and preventing their development. Furthermore, psychrophiles contain special fatty acids in their cell membranes that ensure normal membrane function even in extremely cold temperatures. Because of their adaptability, they can function normally under freezing situations.

All in all, extremophile organisms amazed scientists with their adaptability and tenacity. Scientists can discover a lot about the mechanisms underlying these remarkable organisms' adaptations, and the possibility for life to exist in habitats that were once thought to be unsuitable. Extremophile organisms' distinctive enzymes, protein molecules, and chemicals also have promising industrial and research uses.

The Physics Behind Roller Coasters

Riley Lee

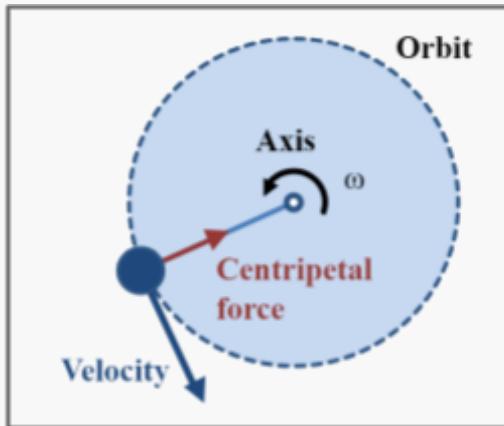
Roller coasters, the epitome of exhilarating amusement park attractions, combine engineering ingenuity with the laws of physics to deliver heart-pounding thrills. These gravity-defying rides are a testament to the understanding and application of fundamental scientific principles. By exploring the workings of roller coasters, we can uncover the secrets behind their spine-tingling maneuvers.



"Olympia Looping - steel roller coaster" by Spielvogel. Licensed by Wikimedia Commons, under CC BY-SA 4.0.
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At the heart of every roller coaster ride lies a force that pulls everything toward the Earth. The force is gravity. Gravity is an important role in roller coasters as it helps create potential and kinetic energy. With potential and kinetic energy, the roller coaster ride becomes more exciting and thrilling. Potential and kinetic energy can also determine the ride's speed, height, and pressure it holds. Many roller coasters use a type of launch mechanism to start the ride, like magnetic propulsion, hydraulic systems, and more. Magnetic propulsion and hydraulic systems are common, but effective launch mechanisms. While the coaster is traveling from hills to twists, turns, and loops, two important forces play a role, inertia, and centripetal force. Inertia is an important force

because it is the resistance of an object to change in states of motion and inertia can help keep riders in their seats as sharp turns or rapid turns take place. Centripetal force is important because it allows the coaster to move across the tracks smoothly without flying off the path.



"Centripetal force diagram" by Booyabazooka. Licensed by Wikimedia Commons, under CC BY-SA 3.0.
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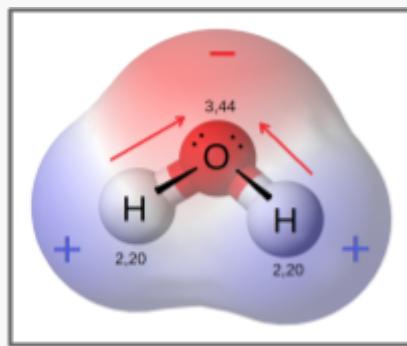
A law that is crucial to the operation of roller coasters is the law of conservation of energy. This law is crucial because this proves that the mechanical energy of a roller coaster stays constant. Energy is never created or destroyed, but it can be transferred or transformed. For roller coasters to be safe and in control, friction, and braking systems are created. The friction role in roller coasters is to maintain control of the roller coaster. The braking systems in roller coasters help slow down the coaster, reducing its kinetic energy and helping maintain a controlled stop at the end of the ride.

Roller coasters are amazing and fascinating because of how much attention is put into engineering and physics to build the ride. To create a roller coaster, you will need to harness, contain, or control the forces of gravity, potential energy, inertia, and centripetal force. Understanding forces, laws, and physics is a huge reason why roller coasters can be created. In conclusion, forces, laws, and physics play a big role in our life.

The Properties of Water

Wilson Zhu

Water is an inorganic compound composed of one oxygen and two hydrogen atoms or H₂O, the oxygen atom forms bonds with the hydrogen. There is also an unequal sharing of electrons between the atoms which these properties classify water as a polar molecule because of the polar covalent bonds. Since the water molecule has a positive side, which is made up of hydrogen atoms, and a negative side, which is made up of oxygen atoms, the hydrogen bonds of the water enable it to draw other water molecules.



"Dipoli acqua" by Riccardo Rovinetti. Licensed by Wikimedia Commons, under CC BY-SA 3.0. https://commons.wikimedia.org/wiki/File:Dipoli_acqua.png

Since water can form hydrogen bonds and is polar, water is a good solvent, which means that it can dissolve many molecules. This is essential because water can dissolve many types of compounds for various chemical processes. Due to this fact, water is sometimes known as the “universal solvent” but the name isn’t completely accurate since there are some substances that don’t dissolve in water e.g. oil, and plastic. Water is generally able to dissolve ions and polar molecules but is unable to successfully dissolve non-polar molecules.

Another important property of water is cohesion. For example, when there are water drops, many of these drops of water stick to one another and create a larger drop of water; this shows the cohesion of water and how it can attract other water molecules around it. The cohesion of water is responsible for surface tension that allows the surface of the liquid to resist rupture under stress. Lastly, water has another property called adhesion. Adhesion is the property of water that allows it to stick to other types of molecules. Adhesion is quite useful for water since it can allow water to transport to different places.



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All things considered, the polarity of the water, being a solvent, cohesion, and adhesion allow water to be one of the most useful compounds for living organisms. For example, photosynthesis in plants is used to create glucose, a type of carbohydrate, and water is needed for this process. It has many usages in living things and can cause many useful chemical reactions that are conducive to living.

Coral Bleaching

Natalie Dai

Our once vibrantly colored coral reefs are being drained of their color. Many of our coral reefs worldwide are now colorless and barren because of coral bleaching. Coral bleaching is a phenomenon that occurs when coral reefs experience environmental stress. It causes the expulsion of symbiotic algae, zooxanthellae, that live within the coral tissues, which is the reason why they lose their color.



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The main cause of coral bleaching is the increase in water temperatures. However other factors that play a part in this are pollution, overexposure to sunlight, nutrient imbalances, and disease. After being bleached, the corals will start to die if the water temperature stays high. However, if the temperature starts to lower, the fastest corals will take 10-15 years to fully recover. With these slow recovery rates, the corals most likely won't make it.

Coral bleaching is more than just an aesthetic loss. The white bleak skeletons, that are left standing, are a starting indicator of a failing ocean ecosystem. Coral reefs are

homes to some of the most biodiverse ecosystems on the planet. Thousands of marine animals rely on coral reefs for food and shelter. The coral reef is also the basis of the marine ecosystem's food chain. With only a few healthy corals left, reproducing will be a struggle. Without the essential backbone of the reef's ecosystem, it might collapse.



"Coral reef at palmyra" by Jim Maragos/U.S. Fish and Wildlife Service. Licensed by Wikimedia Commons, under CC BY 2.0.
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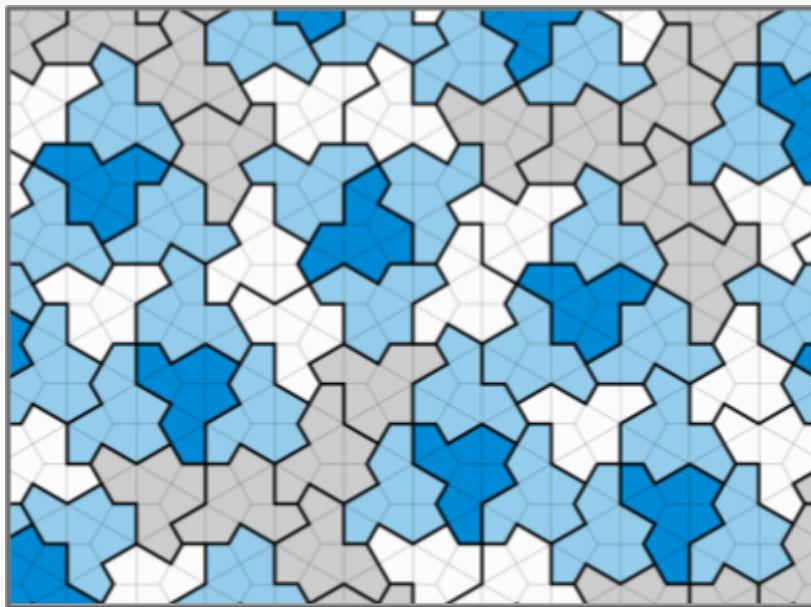
In trying to conserve the reef community, researchers are taking an extra step by giving them a little support. Some are growing corals that can withstand rising water temperatures. Others are cross-breeding the corals to create a super coral. These super corals are supposed to have a higher chance of surviving climate change. After nursing these corals in their labs, the researchers hope to plant them back into the reefs to strengthen them.

These new methods may buy the corals some more time to recover, but not for long. Elevated ocean temperatures are often associated with climate change, particularly the warming of the planet due to human activities such as the burning of fossil fuels. By taking small daily actions like switching to energy-efficient appliances, recycling, and reducing the use of diesel and gasoline, we can help prevent climate change. It is hoped these efforts can be exercised to address the issues of coral bleaching and preserve the natural ecosystem of the corals.

The Vampire Einstein Tile

Jerry Yang

“It’s been just months since researchers reported the first “Einstein” — a single tile that can cover an infinite plane, but only with a pattern that never repeats”, says Emily Conover at ScienceNews. Now skip ahead to a few months later and we get news of a tile shape even more abstract.



“Aperiodic tiling by hats” by AG Caesar. Licensed by Wikimedia Commons, under CC BY 4.0.
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Given the nickname “the hat,” the first ever created Einstein shape relied on a series of tile patterns using the hat shape and the mirrored images of itself. Compared to the original, the new tile also creates an endless pattern, but without shape reflections. Because of the lack of reflections, the new shape could be called a “vampire Einstein,” “Einstein” being German for “one stone,” and the shape not being named after the

world-known physicist Albert Einstein. This shape is a newly added part of a family of other vampire Einsteins recently found by research, dubbed “specters”. Conover explains that “while certain other tiles can be arranged so that they don’t form a repeating pattern, einsteins are special because that’s the only way they can tile”. Before the recent discovery, researchers had already found multiple groups of shapes that tile the plane with non-repeating patterns, but they never knew of a single tile that could accomplish the task.

Explaining how tiles cover infinitely stretching planes without leaving any gaps or overlapping has become a time-honored hobby and fascination for mathematicians. After finding the first Einstein, the researchers wondered if they could accomplish the task of finding a tile that could make a non-repeating pattern without the use of any reflected versions. Using the hat as a starting base, the researchers continued to test and modify the shape, until the new tile, “the hat”, was born.

Reverse Psychology

Richard Wang

Life would feel great if you were able to control somebody without demanding anything. This is the idea, in simple terms, behind reverse psychology. You have likely heard about the term reverse psychology and you are likely a victim or a wielder of this psychological phenomenon. Reverse psychology is a persuasion method that involves saying the opposite of what you want to encourage the person you are manipulating to do what you want. For example, let's say a mom wants her child to pick up their toys, but they won't listen. Instead of asking their child to pick up their toys, they will instead say that they don't have to pick up their toys which leads to the child picking up their toys.

At first glance, it may not logically make sense as this method of receiving obedience may sound counterintuitive. However, it is important to understand the psychological aspect of this persuasion method. Most people want to make independent choices instead of having somebody tell them what to do. They don't want to obey any orders so as a result, when they are told something, they will do the opposite. This is done to preserve a sense of pride and independence

This method involves psychologically manipulating itself and the idea behind that creates disadvantages. Manipulating somebody, especially many times, can cause damage and distrust in your relationship with that person. Some people with lower self-esteem may simply comply with what you say and it ends up causing your whole mind game to backfire. Another reason for backfire is when people can sense that you are using reverse psychology on them, so instead of making an irrational choice of disobeying, they will simply listen to you. Perpetual use of reverse psychology is not the way to go. At that point, it is better to foster a stronger relationship to build trust and obedience for one another. According to ethical guidelines, you must respect one's autonomy.

Quantum Theories

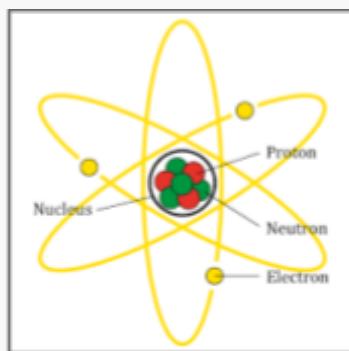
Denise Lee

Quantum physics is both very intriguing and mind-boggling. Quantum physics is the study of the building blocks of nature, matter, and energy. It examines protons, atoms, electrons, and other matter that are nearly impossible to detect. The three most well-known quantum theories are the quantum realm, time travel, and the multiverse.

From many movies, such as Antman, people believe that since our eyes can not see atom-sized objects, there may be a quantum universe. According to Caltech Science Exchange, they state:

Quantum experiments examine very small objects, such as electrons and photons... This may give the wrong impression that quantum phenomena are bizarre or otherworldly...Quantum science closes gaps in our knowledge of physics to give us a more complete picture of our everyday lives.

As fascinating as that may sound, the chances of a quantum universe are very slim, almost impossible. If quantum physics talks about the building blocks of matter, then there can't be organisms in the most fundamental level of matter.



"Atom Diagram" by AG Caesar. Licensed by Wikimedia Commons, under CC BY-SA 4.0. https://commons.wikimedia.org/wiki/File:Atom_Diagram.svg

Avenger's Endgame brought up the idea of using quantum mechanics as a source of time travel. Scientists who major in quantum physics have concluded that time travel is indeed possible by using quantum science. Physicists are exploring the potential of quantum physics, as it may be our best connection to space and time.

Like Marvel, quantum physics brings up the possibility of multiple universes or the Multiverse. The quantum multiverse is when a new universe or timeline is created when a diversion in events occurs. These different versions in those other universes are called variants. Superposition is another term for different, multiple possible states happening all at the same time. It's as if two waves were overlapping. For example, Everything Everywhere All At Once, a movie that won 7 Oscars at the 95th Academy Awards, talks about the multiverse, superposition, and how there are over millions of variants of everyone.



"Multiverse" by Silver Spoon. Licensed by Wikimedia Commons, under CC BY-SA 4.0. <https://commons.wikimedia.org/wiki/File:Multiverse.png>

After watching all these fantastic movies about quantum physics, we start to wish these discoveries were discovered. As we begin to uncover more mysteries in the world, we'll start solving the answer to one of the greatest theories of time and space, quantum theories.

Scotoplanes: Pigs of the Sea

Owen Chen

The ocean's depths conceal wonders, and one of the most curious inhabitants is the sea pig, scientifically known as *Scotoplanes*. These enigmatic creatures dwell in the darkest realms of the ocean, residing at depths ranging from 4,000 to 16,000 feet below the surface. With their unique physical characteristics, mysterious behavior, and vital ecological role, sea pigs have captured the fascination of scientists and enthusiasts alike.

Sea pigs can be described as plump and elongated creatures, showcasing a range of colors from pinkish to purplish hues. Their name derives from the numerous tubular structures resembling legs that adorn their underside. These peculiar structures, known as tube feet, are equipped with tiny sensory nerves, enabling sea pigs to navigate and perceive their surroundings even in the depths of the ocean. These fascinating creatures primarily live in ocean depths ranging between 1,000 to 5,000 meters. Their distribution spans various regions across the world's oceans, from the Arctic to the Antarctic. Due to their preference for deep-sea environments, sea pigs are rarely encountered by humans, leaving much of their behavior and lifestyle shrouded in mystery.

Unlike pigs, sea pigs are not herbivores. Instead, they are detritivores, thriving on organic matter that settles on the ocean floor. The sea pig's modified tube feet serve as efficient feeding appendages, allowing them to examine



"Scotoplanes globosa and crab" by NOAA/MBARI. Licensed by Wikimedia Commons, under CC BY-SA 3.0.
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through sediments and extract decaying matter, microscopic organisms, and bacteria. This unique feeding strategy positions sea pigs as crucial contributors to the recycling of nutrients on the ocean floor, playing a vital role in maintaining biodiversity in the marine biome.

Sea pigs have evolved remarkable adaptations to survive the harsh conditions of their deep-sea habitat. One of their most striking adaptations is their ability to withstand extreme pressure. The immense depths they inhabit subject them to tremendous pressure levels that would prove fatal for most other organisms. Yet, sea pigs possess a jelly-like body structure that enables them to endure these intense pressures. Furthermore, sea pigs possess mysterious defense mechanisms. One example is when sea pigs feel threatened or disturbed, they can release sticky filaments or produce bioluminescent displays, to discourage predators from devouring them.

Sea pigs, with their unusual appearance, mysterious behavior, and indispensable ecological role, embody the marvels that lie beneath the ocean's surface. Although much of this organism's lifestyle remains a mystery. Discoveries of the sea pigs are still being made and enhanced which can lead us to new ideas on how to preserve our biodiversity in the future.

Nitinol: The Alloy of The Future

Eason Fan

Nitinol is a shape memory alloy, meaning that it can change its shape based on the temperature. It was first discovered in 1959 by William J. Buehrle by combining nickel and titanium. It has found itself used in many applications such as automatic wing flaps on airplanes or clearing blood vessels.

Nitinol in its normal state is made out of twinned martensite crystal structures. This structure is made out of a rhombus facing the opposite direction. When the material is deformed, the crystals form into a detwinned martensite state with rhombuses now facing the same direction. When you heat the material, it transforms into an austenite state, where instead of rhombuses, it is made out of squares. The key to the memory of the material is that the arrangements of the atoms allow the change of states with little motion.

For example, if you deform a paper clip made out of nitinol, it will change the ratio of twinned martensite and detwinned martensite state in the material. With the heat energy of a lighter, it will now all change to an austenite state and will change again to a twinned martensite state once it is all cool.

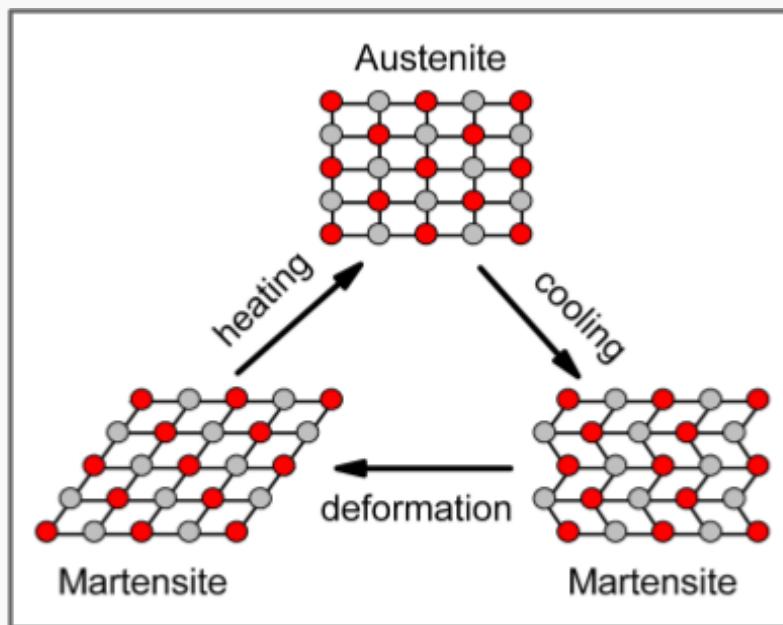


"Nitinol draht" by Petermaerki. Licensed by Wikimedia Commons, under CC BY-SA 3.0. https://commons.wikimedia.org/wiki/File:Nitinol_draht.jpg

Nitinol can also be conditioned so the temperature of when each level a crystal structure forms is greater or smaller. For instance, if you want a tub to

expand at body temperature (36.7 degrees) you can change the ratio of titanium to nickel so the structure changes to twinned martensite at 36.7 degrees.

Using the properties of being able to change its crystal structure at a temperature it can be tuned to super elasticity. With the nitinol being in an austenite state at room temperature, it can be forced into a combination of twined and detwinned martensite while returning to austenite once let go. For example, if you bend a piece of copper wire a tiny bit, it will convert back into the original shape, which means it's an elastic deformation. But if you bend it too much, then it won't bend back meaning it's a plastic deformation. Nitinol takes this to an extreme, being able to bounce back after a turn over 90 degrees. (superelastic response)



"File:NiTi structure transformation.jpg" by Wikimedia, licensed under CC BY-SA 3.0,
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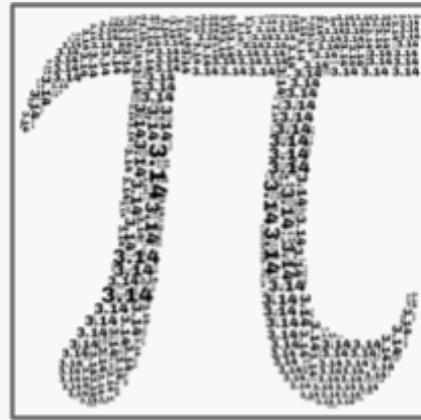
The wide range of applications for this material ensures a promising future with numerous possibilities. It may find itself used for wheels on future Mars missions, or using it in future robotics.

The Mystery of Pi

Aimee Fan

Math is a very important factor in our life. When you are young, you learn math in school. When you are older, you will use math in life. For example, if you want to know the area of the table so you can buy the right tablecloth for it, you will need a Pi.

Pi was a special number that had an interesting history. It was found around 4000 years ago in early Babylon and was probably created for construction. The ratio might not be exact, but it wasn't that easy in the early days to get an exact ratio. At first, Pi was created by a Greek mathematician called Archimedes, who decided the first decimal of Pi as 3.14. As the numbers behind the decimal point begin to increase, there is a need for Pi to expand due to its accuracy. Although it was impossible to give an end to this never-ending number, mathematicians have discovered the first 62.8 trillion digits used to perform the calculation.



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When it comes to the calculation of spheres, circles, or integrals, Pi is very useful. "Pi is often a key ingredient in the solution of a great many problems inspired by real-world phenomena," Mitrea said. "Pi will only increase its relevance as we continue to further our understanding of the world we live in." This furthermore tells us that Pi is an indispensable factor in our life. Pi, which is also known as the Greek letter π , is the ratio of the circumference of any circle to the diameter of that circle. It is pronounced like the word "pie". When it's rounded it is

about 3.14. No matter how big or how small the circle is, the circumference will always be 3.14 times bigger than the diameter.

Back in early 1988, March 14 was observed by San Francisco's Exploratorium science museum worker Larry Shaw. March 14th was chosen because it matches with the number Pi, which is 3.14. Albert Einstein's birthday also happens to fall on this day, so by 2009, the celebration had grown so big that Congress has passed a law to make the date official. In 2010, Pi Day earned its own Google Doodle as another stamp of approval.

Technology Transfer From Astronomy To Industry

Ryan Zhu

Following the International Year of Physics in 2005, the United Nations designated 2009 as the International Year of Astronomy. Like physics, astronomy also has a significant impact on the development of modern science and technology.

Some 300 years ago, the development of astronomy played an important role in the development of Newtonian mechanics. The astronomer Kepler obtained the famous Kepler's three laws when studying the motion of planets. In 1687, Newton closely studied Kepler's three laws and proposed the first complete gravitational theory - the law of universal gravitation, and established Newtonian mechanics. The establishment of Newtonian mechanics led to the development of various mechanisms and machines and promoted the industrial revolution, contributing to the great progress of human society.



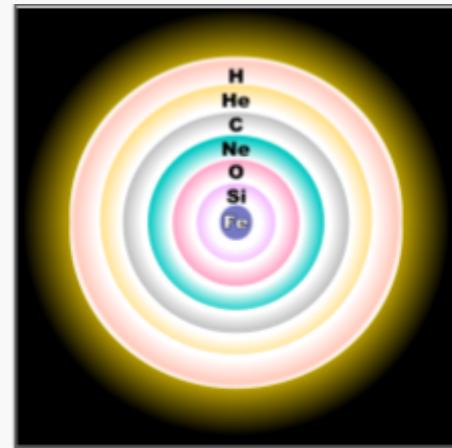
"Astronomy in action" by European Space Agency. Licensed by Wikimedia Commons under CC BY 2.0.
https://commons.wikimedia.org/wiki/File:Astronomy_in_action.jpg

At the same time, the development of astronomy also promoted the development of navigation, as ships in the open ocean relied on astrometry, the measurement of the position of stars, to calculate the position of the ship and the ship's bearings. This allowed for maritime exploration and travel to expand, in turn promoting commercial exchanges in Eurasia and the discovery of new continents.

Astronomy also established a calendar based on the law of the earth's movement around the sun, which not only unified the activities of human society but also played an important role in promoting the development of agriculture.

Now, as astronomers delve into the study of stellar luminosity and the seemingly boundless energy radiated by stars over billions of years, they have made a remarkable revelation: the tremendous energy of stars originates from the process of thermonuclear fusion. This fusion occurs within the star, characterized by soaring temperatures, immense pressures, and extraordinary densities. The remarkable discovery of nuclear fusion within the realm of astronomy not only augments our understanding of nuclear physics and holds profound significance in the quest for alternative energy sources. With the Earth's vast reserves of seawater, electrolysis of this abundant resource can yield copious amounts of hydrogen—a valuable raw material for nuclear fusion—rendering it an inexhaustible fuel source for humanity.

These examples merely scratch the surface of astronomy's profound impact on natural science, modern technology, and human society. Therefore, the United Nations' decision to designate 2009 as the International Year of Astronomy was wholly justified, aiming to raise global awareness and appreciation for the field's contributions.



"Evolved star fusion shells" by R. J. Hall. Licensed by Wikimedia Commons under CC BY 2.5.
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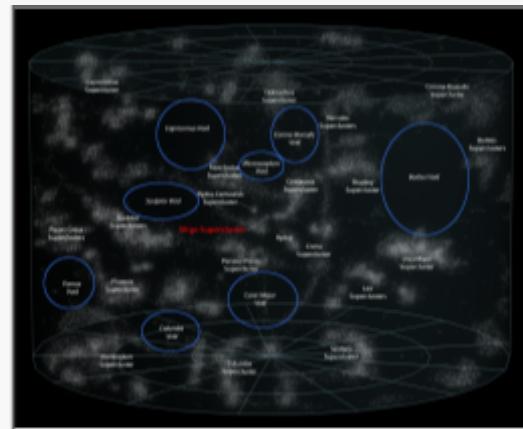
All About Superclusters

Donia Cao

Superclusters are cosmic structures that are formed from the clustering of numerous galaxy clusters. They are among the largest known structures in the universe and have key implications for our understanding of galaxy evolution, dark matter distribution, and the structure of the universe itself. Superclusters provide a framework for studying the cosmos, and their study has the potential to unlock some of the fundamental mysteries of our universe.

The formation of superclusters is driven by the gravitational attraction of galaxies and dark matter. Over time, gravity pulls galaxies and other matter toward each other and into larger structures. This process forms clusters, groups of galaxies that are bound together by gravity, and these clusters then merge to form larger structures - superclusters.

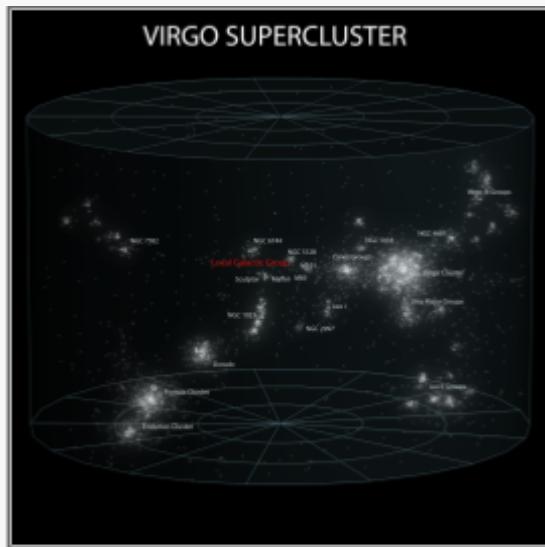
Superclusters can have a wide range of shapes and sizes; some can be several hundred million light-years across and may contain thousands of galaxies. Different superclusters often have distinct characteristics, such as varying degrees of concentration or the presence of hot gas between galaxies. Generally, superclusters are collections of galaxies, dark matter, and hot gas that are held together by the strong force of gravity.



"Galaxy superclusters and galaxy voids" by Andrew Z. Colvin. Licensed by Wikimedia Commons under CC BY-SA 3.0.
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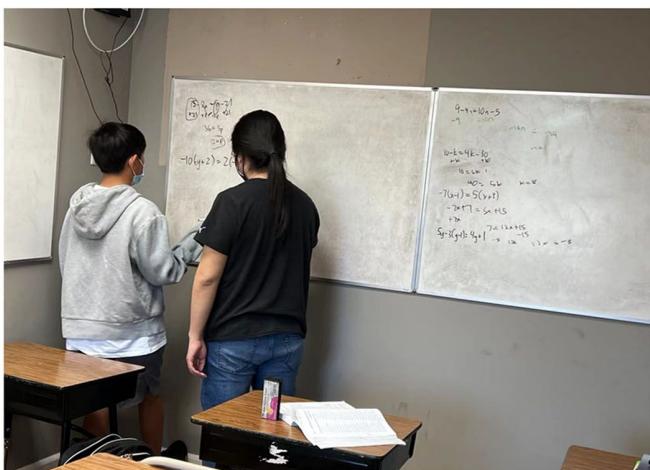
One of the most well-known superclusters is the Virgo Supercluster, which contains 100 galaxy groups and clusters, including the Local Group, which

contains the Milky Way galaxy. The Virgo Supercluster measures approximately 110 million light-years across and is the largest structure within our observable universe. The structure of the Virgo Supercluster is highly complex and contains numerous substructures, including the Virgo Cluster and the Great Attractor.



"6 Virgo Supercluster (ELitU)" by Andrew Z. Colvin. Licensed by Wikimedia Commons under CC BY-SA 3.0.
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The study of superclusters is crucial for our understanding of the large-scale structure of the universe. Superclusters provide clues about the formation of galaxies and the distribution of dark matter, which is an invisible material that makes up most of the universe's mass. Dark matter cannot be directly observed, but its presence can be inferred through its gravitational effects on visible matter. By understanding how dark matter is distributed within superclusters, astronomers can better understand the overall structure of the universe.



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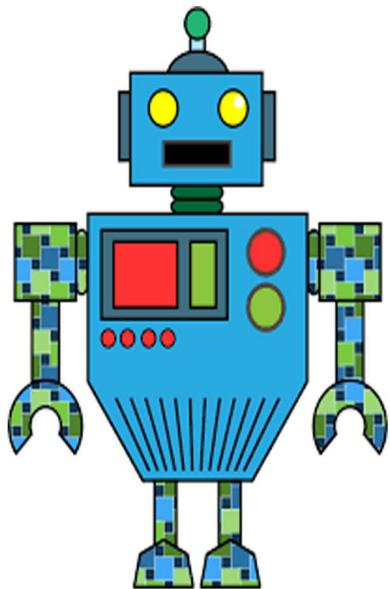
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