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SEEKING SCIENCE

by STEM Action Teen Institution

A MONTHLY
STEM NEWSLETTER

QUATERNIONS

HOW IS CHEESE MADE?

SPACE JUNK

and more...

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Arthur Liang	*Lead Editor*
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Owen Chen	*Marketing Co-Manager*
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Denise Lee	*Senior Designer*

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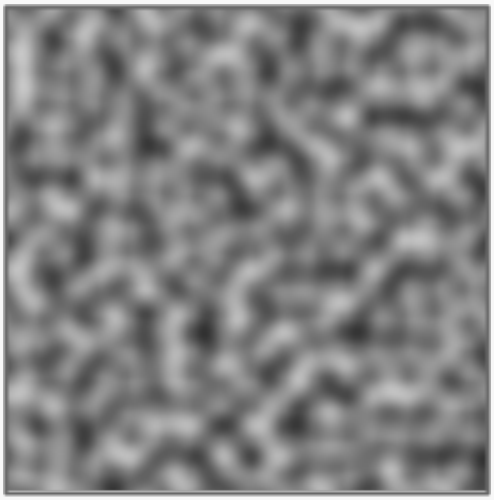
3D Video Game Mathematics: Procedural Generation, Quaternions

Brian Wang

While indulging in games such as Minecraft, has the thought of the procedurally generated world ever come to mind? How is it possible that there are trillions if not infinity amounts of blocks generated from a set of digits or, more famously known, as a “seed”? The mathematics used for such a big procedure comes from already developed formulas that game developers now use. As a continuation from the last seeking science article, the math behind procedural generation for video games, as well as rotational mechanics for these instances will be discussed.



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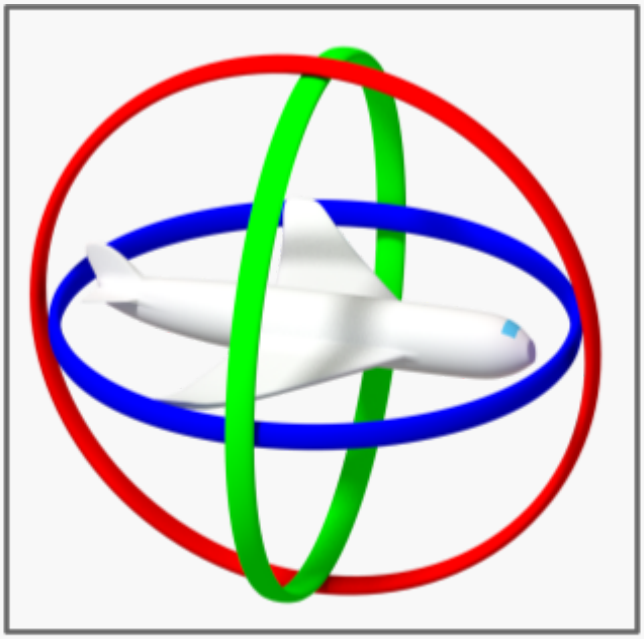
As a foremost topic for 3D video game math, procedural generation will be considered. This type of generation used to create a world starts off as what’s known as perlin noise, a rather (TV) static-looking fog generated from a noise function. When the developer calls this function, usually they pass in parameters that define the minimum number, maximum number, and the seed of a random generation. The function returns back digits that simulate a generated plane, as long as you call this function in a 2D array fashion, where you do two different loops. Using these digits, a game can create a plane with different heights and different terrain, which in minecraft’s case, is simply generating a block at a certain height for each loop.

In the case of a much more popular function in different games where random generation creates rotational based props, quaternions are used. To define what these

are, a quaternion is a mathematical function used to rotate objects, which replaced an older version of rotation called Euler Angles. Quaternions don't face some of the same bugs that Euler Angles produce and also work great for rotations, though it may be hard to understand. Math with quaternions typically involve complicated trigonometry or matrices. However, this math will mostly be already done in Unity, so it can be as simple as using premade functions such as ".LookRotation" or ".Slerp". By combining these functions with in-game local and global rotations, a game can achieve great rotational based gameplay.



"Plane in gimbal" by Georg Eckert. Licensed by Wikimedia Commons, under CC BY 4.0
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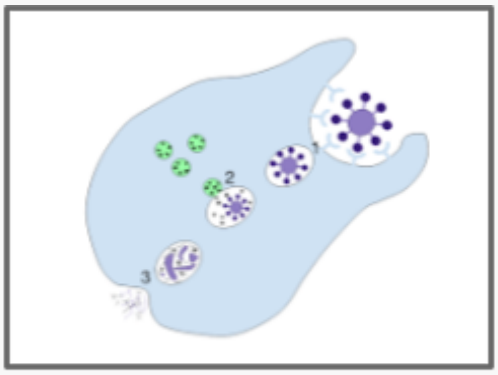
The Intricacies of the Human Immune Systems

Eddie Zhang

The human immune system is a highly intricate defense mechanism that shields our bodies from a diverse range of pathogens. It functions through a combination of innate and adaptive elements that work together to provide protection. This essay aims to present an overview of the immune system's components, functions, and exceptional ability to detect and eliminate harmful agents.

Composed of the innate and adaptive immune systems, the immune system defends against pathogens. The innate immune system serves as the immediate, nonspecific defense, while the adaptive immune system mounts specific responses tailored to encountered threats.

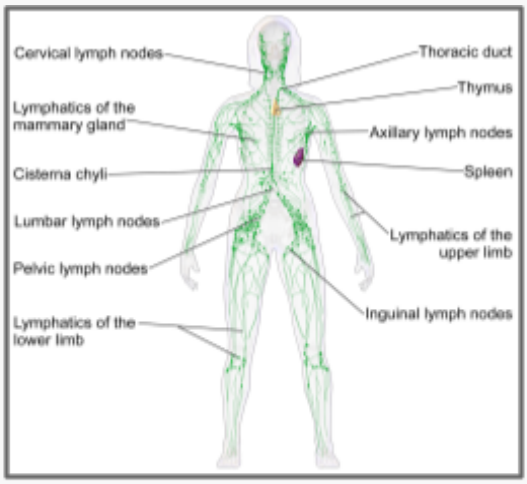
The body's physical barriers, such as the skin and mucous membranes, act as the initial line of defense by preventing pathogen entry. Furthermore, chemical barriers in body fluids aid in neutralizing and eliminating pathogens. Essential components of the innate immune system include innate immune cells like phagocytes, natural killer cells, and dendritic cells, which play vital roles in engulfing and eliminating pathogens.



"Phagocytosis" by Mango Slices. Licensed by Wikimedia Commons, under CC BY-SA 4.0 https://commons.wikimedia.org/wiki/File:Phagocytosis.svg

The adaptive immune system employs specialized cells to launch targeted responses. T lymphocytes (T cells) coordinate immune responses by interacting with

other immune cells, while B lymphocytes (B cells) produce antibodies that neutralize or mark pathogens for destruction.



"Blausen 0623 LymphaticSystem Female" by BruceBlaus. Licensed by Wikimedia Commons, under CC BY-SA 3.0 https://commons.wikimedia.org/wiki/File:Blausen_0623_LymphaticSystem_Female.png

Lymphoid organs, including the bone marrow, thymus, lymph nodes, and spleen, play crucial roles in facilitating immune responses. They filter blood and lymph, supporting the development of immune cells and aiding in the recognition and elimination of pathogens.

Upon encountering a pathogen, the adaptive immune system develops immunological memory, enabling faster and more effective responses upon subsequent exposure. This process involves antigen recognition, cell activation, effector response through antibody production or direct pathogen killing, and the production of memory cells for long-lasting immunity.

Regulatory mechanisms are in place to maintain immune balance. T regulatory cells suppress immune responses to prevent excessive reactions and control inflammation. Cytokines, chemokines, and regulatory molecules coordinate and modulate immune activation, ensuring a controlled immune response.

In conclusion, the human immune system functions as a sophisticated defense mechanism, comprising innate and adaptive components that work together

harmoniously to protect against pathogens. Its ability to detect and eliminate invaders showcases its remarkable complexity. A comprehensive understanding of the immune system's components and functions is essential for researchers aiming to develop strategies to combat diseases and enhance human health.

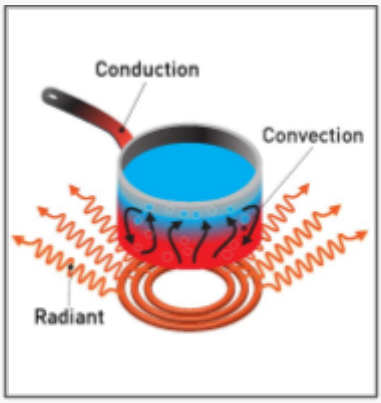
The Science Behind Heat Transfer

Edward Huang

All matter, from a glass of water to a bowling ball, contains energy in various forms. One kind of energy that all matter stores is thermal energy, the energy involved in temperature. Hotter objects contain atoms that have higher thermal energy, while colder objects contain atoms that have less thermal energy. Objects can gain or lose thermal energy, transferring them to other objects. Thermal energy can be transferred between systems in 3 main ways: conduction, convection, and radiation.

One way thermal energy, or heat, can be transferred between two objects is through conduction, which occurs when those two objects are in contact with each other. This happens due to the fact that thermal energy simply refers to how much individual particles move and vibrate. Particles with higher thermal energy vibrate more rapidly and vice versa. Particles can interact and collide with each other, transferring their thermal energy. So, when two objects are placed in contact with each other, particles of each object are able to interact and transfer their thermal energy between the two objects. The overall result is that the object with higher thermal energy will transfer its energy to the object with lower thermal energy, until equilibrium is reached.

The second way that heat can be transferred is convection. Convection typically occurs in liquids and gases, as a result of hotter fluids being less dense than colder fluids. When fluids have more thermal energy, their particles move at a faster rate, essentially expanding the volume the fluid occupies. This phenomenon can best be seen in a pot of



"Heat Radiation Transparent 2 (26046216082)" by Nuclear Regulatory Commission. Licensed by Wikimedia Commons, under CC BY 2.0 https://commons.wikimedia.org/wiki/File:Heat_Radiation_Transparent_2_%2826046216082%29.jpg

boiling water on a stove. The stove heats up the water molecules near the bottom of the pot. This portion of water becomes less dense than the water above it, causing it to float to the top, while colder water sinks down to the bottom. This colder water then gets heated, and the cycle repeats. These cycles are called convection currents, and are responsible for distributing heat across a vast body of fluid.

Radiation is the last form of heat transfer and refers to the electromagnetic radiation that all objects with thermal energy emit. Unlike the previous two heat transfer methods, radiation allows for heat energy to travel without the use of a medium. Infrared waves can simply emanate from a source, converting back into thermal energy once absorbed by another object. A great example of heat radiation is the sun, as it is able to supply us heat despite being many millions of miles away. We can even see this in action through thermal imagery, which is made possible by creating a visual image based on the absorption of these infrared waves.

"Infrared 1080967" by Nevit Dilmen. Licensed by Wikimedia Commons, under CC BY-SA 3.0 https://commons.wikimedia.org/wiki/File:Infrared_1080967.jpg

In conclusion, thermal energy can be transferred and distributed between objects through conduction, convection, and radiation. These three forms of heat transfer can be seen everywhere, from a boiling pot of water on a stove, to the sun.

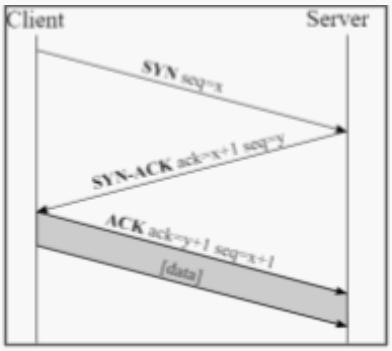
The Two Generals Problem

Arthur Liang

In the world of computer science, there are certain problems that are impossible to solve no matter how strong your algorithm is or how much computing power you have. One of these problems is the Two Generals Problem. This unsolvable problem dives into issues that have to deal with communication and sending messages across a network. The problem can be applied to help develop fault-tolerant and secure systems.

The Two Generals Problem centers around two military generals who have to coordinate and successfully attack at the same time in order to destroy an enemy fort. However, the issue is that they can only send messengers through a hostile area where messages can be delayed or lost. If a general sends a message to propose a time of attack, there is no way to know if the message was received. So you may be thinking that the other general could just send a confirmation back, right? But then there is no way to know if the confirmation went through either. This continues to go back and forth with no way to ultimately 100% coordinate an attack. This makes the problem inherently unsolvable.

Although this paradox cannot be fully resolved, computer scientists have created practical techniques such as redundancy, error checking, and consensus algorithms to prevent the Two Generals situation from ever popping up in a real network. All in all, the Two Generals' Problem remains a theoretical challenge and serves as a reminder about the complexities of reliable communication in certain environments.



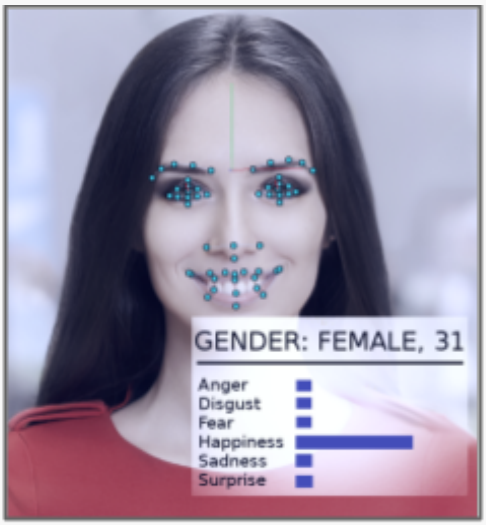
"Tcp-handshake" by Snubcube. Licensed by Wikimedia Commons, under CC BY-SA 3.0 https://commons.wikimedia.org/wiki/File:Tcp-handshake.svg

Facial Recognition

Aidan Hong

Facial Recognition has undoubtedly made a profound impact on our daily lives. From allowing us to unlock phones to virtually replacing boarding passes, its uses are vast. However, the technology behind it is complex, and certain types are more secure than others.

Before we explore its use cases, we first must understand the technology behind it. There are primarily two types: 3D and 2D. 3D facial recognition involves mapping your face with tiny dots. This is done using an infrared camera, dot projectors, and flood illuminators. By using this, it can create a dot matrix of your face. The more dots there are, the more unique it is to your face. This can also prevent someone from simply holding up a picture of your face to bypass it since it doesn't match the 3D dot matrix. The only way to "fool" it is to have an identical twin or an exact 3D copy of your face.



"Visage Technologies Face Tracking and Analysis" by Abyssus. Licensed by Wikimedia Commons, under CC BY-SA 4.0 https://commons.wikimedia.org/wiki/File:Visage_Technologies_Face_Tracking_and_Analysis.png

2D, on the other hand, only uses an infrared camera and infrared lighting. The primary difference is that dots are not used in this case. As a result, it is possible to use a printed photo of yourself to gain access, or even someone that looks somewhat like you can gain access.

Facial Recognition has many use cases. For example, one of its most prominent use cases is to unlock your phone, tablet, or even your laptop! Additionally, some apps or websites may use facial recognition to grant access to their services. Facial Recognition

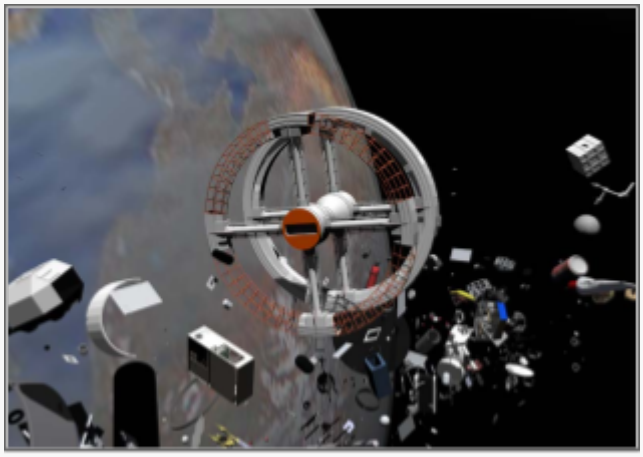
has also made an impact on travel. Now, passports store your facial profile, allowing airlines to grant boarding with your face. Global Entry, a program that allows passengers to get through customs faster, also utilizes this technology. People in this program simply have to scan their face, and are allowed to go through customs.

Facial recognition has made a profound impact on our lives. From device unlocking and replacing logins to revolutionizing the travel industry, its use cases are vast. It will only continue to leave a greater impact on society.

Space Junk

Arick Hong

Have you wondered what happens to satellites after they are done with their mission? Most would assume that NASA could just send a spacecraft to retrieve them, but what actually happens is that it is left behind and ends up becoming a piece of orbital debris, also known as “Space Junk”.



"S4-space-junk-045" by Miguel Soares. Licensed by Wikimedia Commons, under CC BY-SA 4.0 https://commons.wikimedia.org/wiki/File:S4-space-junk-045.jpg

Given the amount of missions NASA does, a lot of space junk does get left behind and eventually sucked into earth’s orbit. It surrounds our planet in a tight ball, with around 130 million pieces of old crafts floating. This is a huge problem for NASA because they need to watch out for space junk when doing missions. Occasionally, orbital debris becomes a risk for space shuttles on missions. NASA can then decide if they want to steer clear of the debris, or just continue with the usual course. Usually, they stick to the normal course, but if it is necessary for safety, a course is picked out and executed. However, in the long term, space junk can eventually surround the Earth and trap us inside if we don’t find a solution soon enough. This will cause disaster as there is no escape from the inside. Humans need to find a solution to remove space junk from space before it's too late.

Orbital debris is surrounding earth fast and we need to do something about it or else it can cause problems and potentially endanger people on Earth. As more missions are being planned and executed by the minute, we must do something before it’s too late.

How is Cheese Made?

Richard Wang

Cheese making has existed for thousands of years and today is still a popular food in people's diets. Since its origin, the cheese-making process has been even more refined. It would be great to know the labor that goes into the making of cheese.

Milk is a universal ingredient in all cheese. However, when it comes to making cheese, manufacturers aren't restricted by the choice of milk. Cow's milk, the most common option, is not the only type of milk used. Other choices include sheep milk, goat milk, and even buffalo milk. Each milk option will result in cheese with different types of fat content and flavor. After that, milk is heated in a process called pasteurization, to kill any harmful bacteria. Subsequently, good bacteria will be added to ferment the milk's lactose into lactic acid. Lactic acid aids in cheese development and also contributes to cheese's distinctive aroma.

"Production of cheese 1" by MatthiasKabel. Licensed by Wikimedia Commons, under CC BY-SA 3.0 https://commons.wikimedia.org/wiki/File:Production_of_cheese_1.jpg

Now, an enzyme called rennet is added. Rennet will cause the milk to turn into a curd which has a yogurt-like texture. The curds get cut, which releases moisture in the cheese. The final texture depends on the size of the cuts that were used. Curds are then heated, releasing more moisture in the process.

Additional ingredients can be added such as spices, herbs, or other additional flavorings. Now comes the shaping process. The cheese is molded into different shapes depending on the cheese that is being made. For instance, mozzarella can be molded

into a ball, parmesan can be molded into a wheel. Other shapes can include a block or pyramid.

Some cheeses will be in their final product at this stage, but others will still have one more step to go. That would be the aging process. Cheese can be aged in a period of days to years. In the process, the cheese is cautiously monitored. Cheesemakers will watch over its humidity and temperature. Whether the cheese was aged or not, it is now ready to eat.

What started as milk, has now become cheese through a fascinating and tedious process. The process is an intricate one and there are countless possibilities within the process that results in a countless number of types of cheese.

The Big Bang Theory

Brandon Pian

Scientists theorize that the origin of the universe was due to the Big Bang. The Big Bang's name was chosen due to the idea of an exploding universe. Before the Big Bang the universe was once a small and dense fireball that later exploded. Due to knowledge of if light existed or not at that time there is a chance the explosion never happened. The Big Bang theory states that the universe was once in an extremely dense and hot state and that it has been continuously expanding and cooling ever since. In the billions of years since the Big Bang, this expansion has led to the continuous expansion and cooling of the universe.

The Big Bang theory was proposed by Georges Lemaître, a Belgian Catholic priest, astronomer, mathematician, theoretical physicist, and professor of physics, in 1931. Lemaître's theory was first proposed when he published a paper stating that the universe was once in a hot and dense state that was constantly expanding and cooling. His theory was based on observations at the Edwin Hubble Observatory, which showed that

galaxies were moving away from each other. This led Lemaître to conclude that the universe was once in a much smaller and denser state.

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Even though Lemaître theory was met with skepticism there is numerous amount of information that supports the Big Bang Theory such as cosmic microwave background radiation which is the faint afterglow of the Big Bang along with the abundance of light elements which the theory stated that the early universe was filled with a lot of light elements such as hydrogen, helium, and lithium. These elements can still be observed today leading it to be consistent with the prediction in the theory.

Today the Big Bang theory is widely accepted around the world, though there are still many questions left unanswered. Questions like what caused the Big Bang or what was before it. Even though questions like those remain unanswered for now, the theory of the Big Bang has greatly helped scientists research and understand the universe. The Big Bang theory is still a new and young theory that can be explored and experimented with. With this groundbreaking theory, scientists can learn what the universe was like during, before, and after. The theory helps our understanding of the Big Bang as our knowledge of the universe continues to evolve.

The Science Behind Agriculture

Owen Chen

The increase in human population has caused a food crisis throughout the world. In response to this situation, farmers began to seek and develop new agriculture techniques that can improve the productivity of food to raise the human carrying capacity to another standard.

Organic farming stands out as a sustainable and environmentally friendly approach. It relies on natural methods without any genetic modification or human interference. Farmers also utilize techniques such as crop rotations, composting, and biological pest control to retain the fertile soil for next year's organic farming.By avoiding synthetic chemicals and GMOs, this method reduces the overall environmental impact of agriculture and produces food that is perceived as more natural and healthier.

On the other hand, conventional farming, also known as industrial agriculture, remains a dominant method of food production. This approach involves traditional farming practices, including tilling the fields and planting crops. To boost crop productivity and protect against pests and diseases, conventional farming employs chemical fertilizers and pesticides. While this method has been successful in mass-producing food for society, it has significant downsides. The heavy use of chemical substances leads to soil degradation, water pollution, and a loss of biodiversity, all of which have adverse effects on the environment.

"Tractor Fertilize Field Pesticide And Insecticide" by Aqua Mechanical. Licensed by Wikimedia Commons, under CC BY 2.0 https://commons.wikimedia.org/wiki/File:Tractor_Fertilize_Field_Pesticide_And_Insecticide.jpg

In conclusion, agriculture techniques have not only shaped food production but also significantly impacted the environment we live in. Organic farming represents a sustainable and eco-friendly alternative that promotes soil health and reduces the use of harmful chemicals. Meanwhile, conventional farming, while effective in meeting high food demands, raises concerns about environmental degradation. Agriculture techniques are one of the cornerstones for society's well-being. However, people should be more considerate of the harm agriculture has caused to the environment. By being more considerate, people can aim for the development of new techniques that can benefit both society and nature to ensure the stability of biodiversity.

Dissecting the Brain: Neuroplasticity

Jerry Yang

Our brains have evolved to increase our chances of survival so that we may be able to adapt to situations and come up with more creative solutions. Controlling all our actions and being safe for our memories and encounters, it is a prized possession that we keep protected inside of our skulls, but what happens if it is damaged?

Elyse G. who's turning 61, was MRI scanned during her first year of graduate school, only to reveal that she had an entire part of her brain missing. Even with the lack of an amount of neural tissue, you couldn't point out any difference between her and someone you'd meet on the street. The possible explanation for the missing piece is that around or before the time of her birth, a stroke caused a part of Elyse's brain to die and then disappear, leaving only a void of brain fluid in place of her missing tissue. Elyse looks and acts perfectly normal, yet the fact that she is lacking a temporal lobe in one of her hemispheres and part of her brain stem, she is able to live without brain structures that were considered to be crucial.

Everyday functions are split between areas of our brain, the left lobe generally required for speech. People like Elyse with atypical brains missing entire regions didn't find out until they were adults. This is a probable tribute to the flexibility of the brain and its ability to adapt. Some backup brain parts are retreated to if the main regions are broken down. In this case, Elyse's language activity was shifted to the right portion of her brain, a trick used to deal with damage on the left. This is proof of the brain's elasticity, but it isn't constantly adaptable, and does have its limits to how it can adapt.

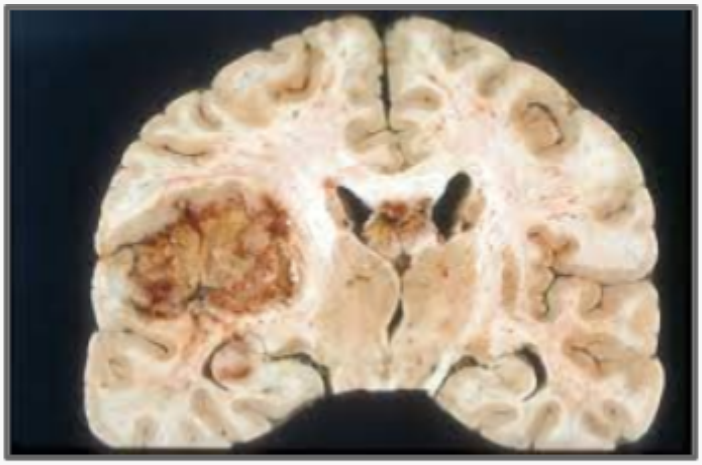
Despite all the loss, many who've had large brain injuries only have minor weaknesses, while those who seem to have small scrapes in their scan slices tend to have noticeable disabilities for their entire life. It is yet to be completely understood and solved about the abilities of our brains and their plasticity.

The Brain Cancer Epidemic

Angela Chin

Brain cancer is a type of cancer that, as its name suggests, attacks one of the most important organs in the human body: the brain. Since its recognition in the 1800s, scientists have been working non-stop on developing an effective cure. So, what exactly causes brain cancer, and what are some possible symptoms?

For starters, the exact cause of cancer may vary depending on the different forms of it. A common reason is the uncontrolled growth of a cell without dividing. If a cell has a genetic mutation, it may never stop growing, therefore creating a tumor. That tumor is especially perilous if it's found in the brain, where it can expand even larger than the brain itself and eventually push it askew.



"Glioblastoma macro" by Sbrandner. Licensed by Wikimedia Commons, under CC BY-SA 4.0
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Symptoms of cancer can, again, vary depending on the area. Some possible symptoms of brain cancer are seizures, head pain, memory loss, and difficulties in speech and vision. Early diagnosis and treatment are crucial to preventing the disease

from worsening. If a tumor is perceptible, it's likely that it can be removed without much difficulty. Radiation therapy and surgery are possible options for the removal of tumors.

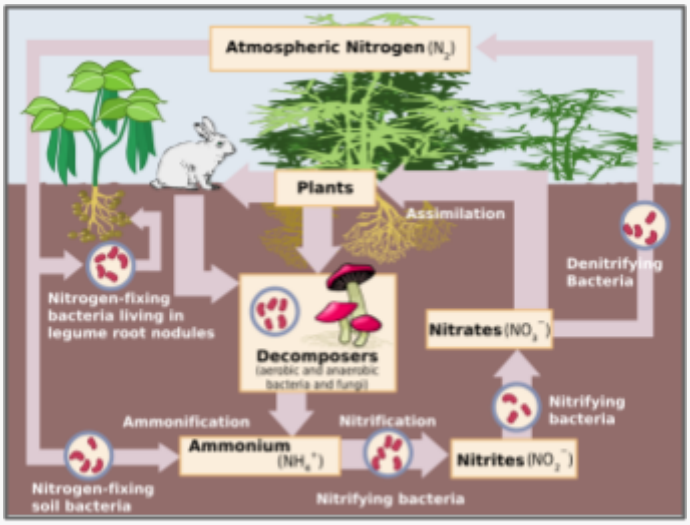
The falling out of one's hair could be a possible indication that the said person has cancer and is going through treatment. Radiation therapy, as mentioned above, not only targets cancer cells but also any other cell it comes in contact with. Hair cells are often lost in the process, evidently resulting in the diminution of hair.

In short, cancer is a malicious disease caused by the infinite growth of cells, with brain cancer being one of the riskier variants. Researchers are always contemplating improved ways of treating it. This investigation will continue for years to come.

The Nitrogen Cycle

Wilson Zhu

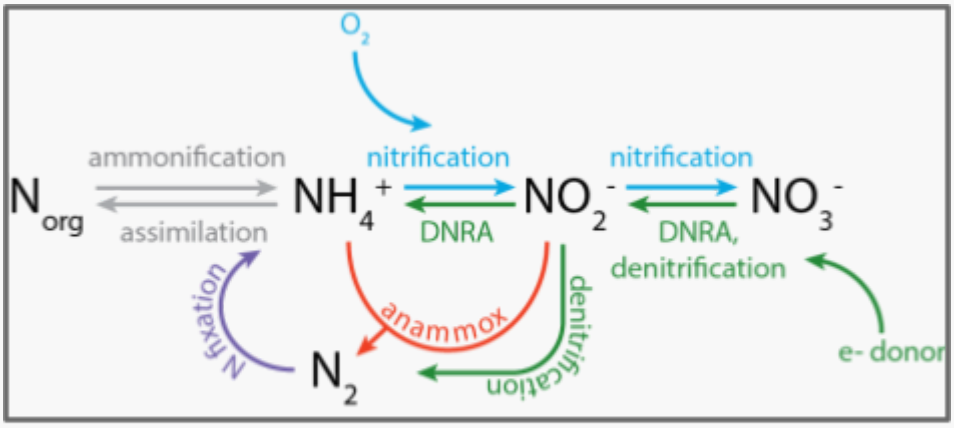
The nitrogen cycle is a biogeochemical cycle where nitrogen is converted into many chemical forms, circulating through the atmospheric, terrestrial, and marine ecosystems. Nitrogen gas exists both in organic and inorganic forms. Organic nitrogen exists in organisms where it circulates through the food chain. Inorganic nitrogen usually is found in the atmosphere. The stages of the nitrogen cycle are nitrogen fixation, nitrification, assimilation, ammonification, and denitrification.



"Nitrogen Cycle" by Environmental Protection Agency. Licensed by Wikimedia Commons, under CC BY-SA 3.0 https://commons.wikimedia.org/wiki/File:Nitrogen_Cycle.svg

In nitrogen fixation, nitrogen in the atmosphere converts to ammonia. During nitrogen fixation, the nitrogen gas deposits into the soil from the atmosphere and precipitation. Also, industrial nitrogen fixation is when humans aid in nitrogen fixation by using ammonia. Then in nitrification, the ammonia is oxidized in the soil and converted into nitrites by Nitrosomonas. Later the nitrites produced previously are then converted into nitrates by Nitrobacter. Nitrification is conducive to the health of plants since the ammonia gas is toxic to plants.

Upcoming is the process of assimilation is the next process where plants take the nitrogen compounds from the soil, using their roots, where the compounds are in the form of ammonia, nitrite ions, and nitrate ions are important in the formation of plants and animal protein. This brings nitrogen into the food web when the consumers eat the plants. Subsequently, the process of ammonification occurs when a plant or animal dies, and the nitrogen in the organic matter is released back into the soil where decomposers, like bacteria and fungi, turn the matter into ammonium. The process creates ammonia and can be further used in other biological processes.



"N cyclers and anammox" by Microbialmatt. Licensed by Wikimedia Commons, under CC BY-SA 4.0
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Lastly, denitrification, the final stage, is when nitrogen compounds go back to the atmosphere by converting nitrate into gaseous nitrogen. This is carried out by the bacterial species Clostridium and Pseudomonas which processes the nitrate to gain oxygen and expends nitrogen gas as a byproduct.

Concisely, the nitrogen cycle is an important cycle that allows the abundant amount of nitrogen in the atmosphere to circulate through plants and animals. Nitrogen is conducive to living organisms since it allows them to complete biological functions. The cycle has multiple stages, which are fixation, nitrification, assimilation, ammonification, and denitrification. Nitrogen-fixing bacteria are used to turn nitrogen gas into nitrogen compounds, which are then absorbed by plant roots and used to create proteins and

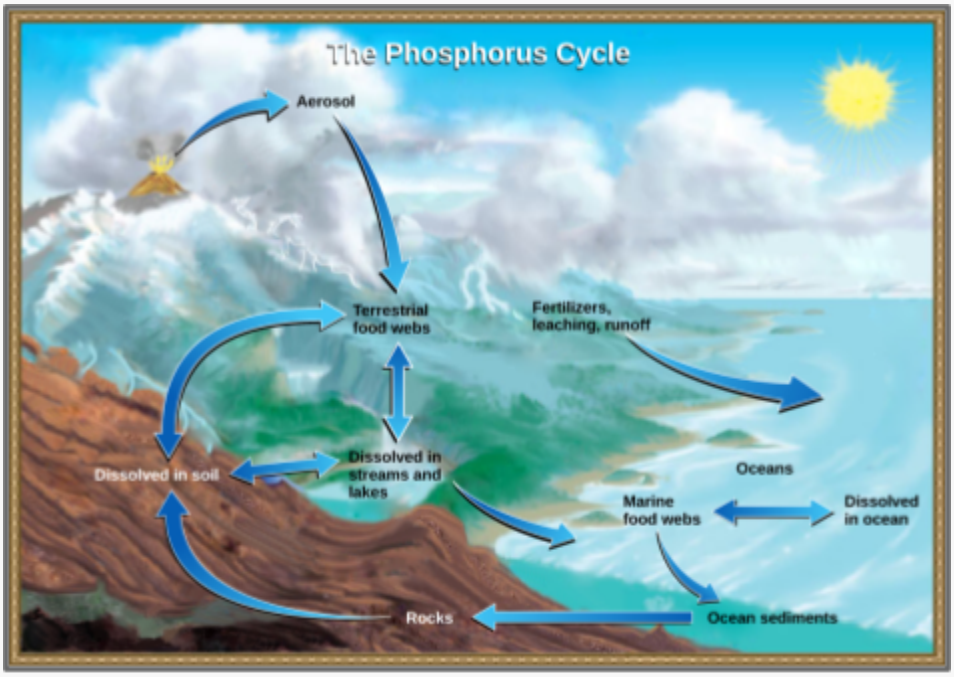
other compounds in the plants. Animals assimilate this nitrogen by consuming plants and other animals. Finally, bacteria and fungi help decompose organic matter, which is released into the soil for further use by plants. Some of the bacteria help turn some of the compounds back into nitrogen gas, which goes back to the atmosphere. These stages of the nitrogen cycle continue to repeat to maintain nitrogen levels in the atmosphere.

The Phosphorus Cycle

Eason Fan

The phosphorus cycle serves an important function in any ecosystem. Phosphate is an important substance in maintaining life. It is involved in processes such as using carbohydrates and fats, transfer of energy in plants, or cell division. It is vital to understand the phosphorus cycle because of its major effect on agriculture and its control of nutrient availability.

Phosphate, the form that phosphorus can be commonly found in, is an ionized form of phosphorus and is also more available. Phosphate first starts as minerals inside rocks found in mountains or other geologic structures. The rocks slowly release phosphate from weather and erosion. Next, water carries down the phosphate into an underground phosphate reserve or directly carried into the ocean.



"Figure 46 03 07" by CNX OpenStax. Licensed by Wikimedia Commons, under CC BY 4.0 https://commons.wikimedia.org/wiki/File:Figure_46_03_07.jpg

When phosphate enters an underground reserve, it will enter into the food chain or leach back into the ocean. If it enters the food chain, plants will first take up the phosphate. After, the phosphate will be consumed by animals or the plant dies out before being consumed.

Once the animals or plants die, decomposers will rapidly retrieve the phosphate and put it back into the soil. Without the decomposers, phosphate would just stay inside the soil. Decomposers are also key to maintaining soil quality. Next, the phosphate will go back into an underground reserve.

If phosphate is carried into the ocean, it will end up in underwater reserves. The phosphate is brought back to the surface through geological uplift. Once it ends up at the surface, the cycle continues.

Understanding this process is significant to efficiently develop strategies to conserve the environment. Policymakers and conservationists need to understand ecological processes such as the phosphorus cycle.

Space Mining: Unveiling the Door to Limitless Resources

Ryan Zhu

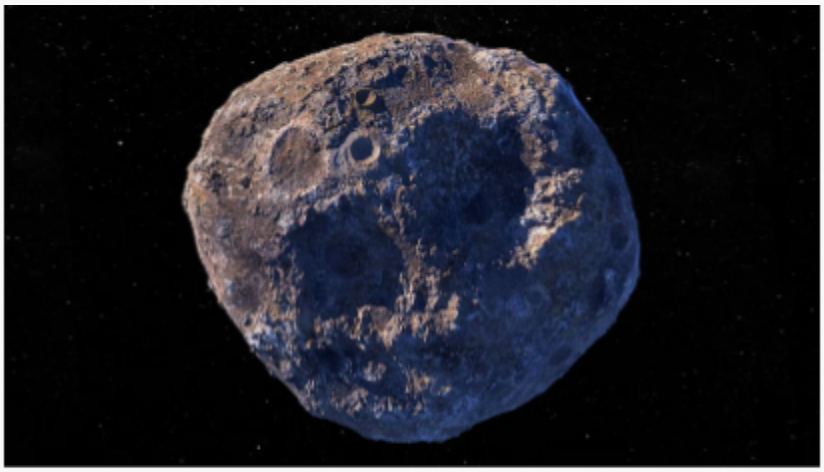
With the continuous depletion of the earth's resources and the advancement of human science and technology, space mining will become an important field in the future. This is the door to limitless resources before us. From the Moon to asteroids and beyond, exploring and exploiting their treasures is ushering in a whole new era for humanity.

First, let's talk about the purpose of space mining. Due to the limited resources of the earth and the ever-increasing demands of humans, the relative abundance of asteroid ores makes it possible for asteroid mining to provide almost unlimited resources. The asteroid belt is thought to be rich in rare metals such as gold, palladium, platinum, etc., and other valuable minerals. These minerals are rare and difficult to mine on Earth. By harvesting these valuable resources on asteroids, huge boosts can be given to technological and economic development.

"Artist's impression of exiled asteroid 2004 EW95" by European Southern Observatory. Licensed by Flickr, under CC BY 2.0 https://www.flickr.com/photos/esoastronomy/41336328904

However, space mining also faces enormous challenges. At present, technology is still in its infancy, and the first thing that needs to be solved is technology. For example,how can we efficiently transport resources in space? How do you ensure the

stability of mining facilities? There are too many problems that require a lot of research and development to solve, which leads to the next challenge: the high cost of space mining. However, despite the high cost, the profits he brings in are astronomical. An asteroid called 16 Psyche contained $700 trillion worth of gold, enough to net every person on Earth about $93 billion. And with countries getting serious about space mining, these problems should ease up soon.



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At the same time, we must also face ethical and legal issues. The international community needs to develop a clear set of rules and provisions to ensure the fair, legal, and sustainable development of space mining. We need to protect the ecological balance and harmony of the universe while exploring and developing resources.

In the future, space mining will play a pivotal role. It will not only provide a continuous supply of resources but also promote the progress of science and technology and the development of human civilization. However, we must proceed carefully to ensure the sustainability and legality of space mining. Only in this way can we realize the cosmic dream of mankind and create a more prosperous and better future.

How Do Credit Cards Work?

Cody Duan

In this day and age, cashless interactions are becoming more and more common. Pulling out a card and inserting it into the machine when paying for groceries is much easier than taking out cash, but how does it work?

The process begins with swiping the card's magnetic stripe, inserting the chip into the reader, tapping the card on the card reader, or tapping the phone with a mobile payment option like Apple Pay or Google Pay. Each method contains the card information through the magnetic strip, chip, or another small, embedded chip that emits electromagnetic waves. Once the card information is transferred, it undergoes encryption, which protects sensitive information during the transaction. Encryption methods include encoding the data into a cipher, making it unreadable to unauthorized parties.

The encrypted card data is then sent to the payment processor or acquiring bank, which forwards the information to the card network or company. The card network routes the transaction to the cardholder's bank. The cardholder's bank receives the transaction

request and checks the available funds, credit limit, and the card's status. If the funds are available or the credit limit is not exceeded, the issuing bank sends an approval message back to the merchant via the payment processor. Then the merchant completes the transaction

After the transaction is completed, the clearing and settlement process begins. The funds from the cardholder's account are transferred to the merchant's account through various financial institutions, payment processors, and card networks and may take a couple of business days to complete. Throughout the entire process, detailed records of the transaction are maintained by the merchant, payment processor, card network, and the cardholder's issuing bank. These records help in resolving disputes, tracking financial activity, and maintaining accurate accounting records.

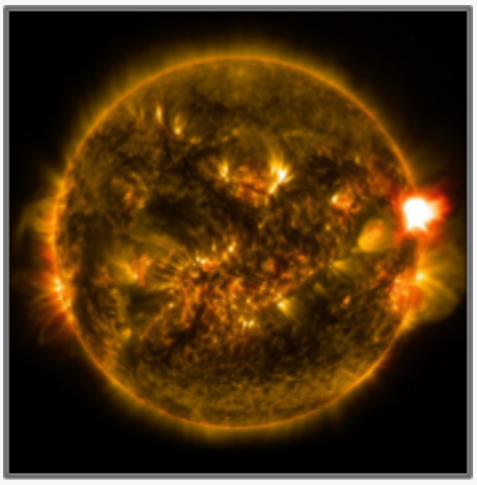
A seemingly instantaneous credit card transaction involves a series of steps done by multiple parties working together. The system ensures the security and efficiency of electronic payments, allowing consumers and businesses to rely on the convenience and speed of cashless transactions in today's society.

Aurora Borealis

Natalie Dai

The Aurora Borealis, known as the Northern Lights, is a natural light display in Earth's sky. It usually displays vibrant patterns of lights that appear as curtains, rays, spirals, or dynamic flickers.

The process of it begins with the sun, which continuously emits a stream of charged particles known as the solar wind. These particles are primarily electrons and protons traveling at high speeds. Periodically, the sun experiences more significant activity, such as solar flares, which are similar to enormous explosions on the surface of the sun. These activities release an even larger number of charged particles into space. When the particles reach Earth's atmosphere it initiates aurora activity.



Another effect the sun has on the auroras is when massive explosions on the sun occur, coronal mass ejections. When these explosions occur, they release huge clouds of billowing plasma. Once these clouds arrive and interact with Earth's magnetic field, geomagnetic storms are created. Both coronal mass ejections and solar flares can cause the natural phenomenon, Aurora Borealis, to be more intense.

These natural light displays may show up in many different patterns and colors. This occurs when energy is transferred from charged particles from the sun colliding with the atoms and molecules in Earth's atmosphere. This energy causes the atmospheric particles to become temporarily excited, moving to higher energy states. As the excited atoms and molecules in the atmosphere return to their lower energy states, they release

the excess energy in light. Different types of atoms and molecules emit specific light colors when they return to their normal states. For instance, oxygen emits green and red light, while nitrogen emits blue and purple light. The characteristic wavy patterns and curtains of light of the auroras are actually caused by the lines of force in the Earth's magnetic field.

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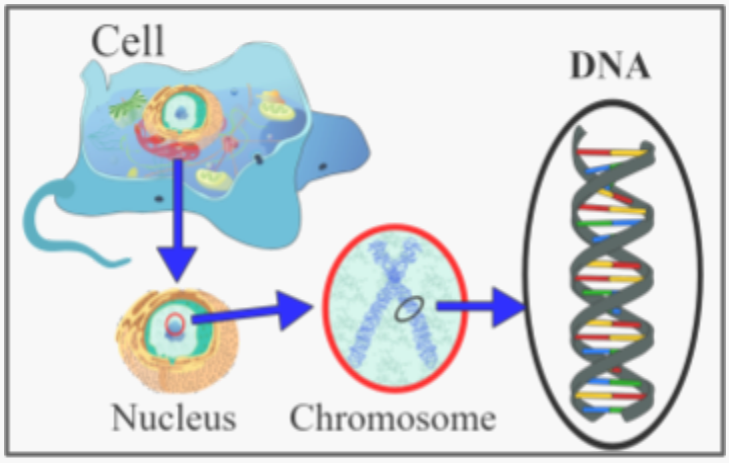
These collective atoms and molecules form one of the most ethereal beauties of astrology. This celestial display can be usually observed in high-latitude regions near the northern parts of Greenland and Norway. The Aurora Borealis are most vivid during the night skies of these countries since they have little to no light pollution.

Concerns of Cloning

Denise Lee

Reproductive cloning is the creation of a substance by duplicating DNA. Our technology is so advanced that cloning beings and different species is possible. All we need is the DNA.

Cloning has been around since the late 1970s. The first successful experiment on cloning was in 1997 when they cloned Dolly the sheep. Cloning can help prevent extinction, bring back extinction species, increase food production, and help couples who want children. Jurassic Park is one of the most famous franchises that show reproductive cloning. They cloned dinosaurs to prevent the extinction of the dinosaurs, but creating man-made species backfired, and the dinosaurs turned on the humans. We haven't started using reproductive cloning because men should never play god as more significant problems will come. Every time someone tries to play god, karma comes back to hit them. Cloning is creating organisms, but it is not ethical. According to National Geographic, "To make a clone, scientists transfer the DNA from an animal's somatic cell into an egg cell that has had its nucleus and DNA removed. The egg develops into an embryo that contains the same genes as the cell donor. Then the embryo is implanted into an adult female's uterus to grow."



"Eukaryote DNA-en" by Radio89. Licensed by Wikimedia Commons, under CC BY-SA 3.0
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As easy as this process sounds, it is very dangerous as it took scientists 276 attempts to get Dolly right. The process is not safe or accurate. National Geographic also states that “they still have not cloned a human... because it is difficult to produce a viable clone. In each attempt, there can be genetic mistakes that prevent the clone from surviving... There are also ethical concerns about cloning a human being.” Cloning is unethical, and the probability of abuse is very high. Once someone believes they have the power of god they could start abusing their power and that may lead to world domination.

The Sperm Whale

Riley Lee

Have you ever heard of Sperm Whales? Sperm Whales are amazing sea animals of the deep and humans have found Sperm Whales interesting and special with their huge gigantic size, unique features, and important roles in the ecosystem. Without Sperm Whales, our oceans would not be as healthy as they are today.

Sperm Whales are the largest toothed whale on Earth and can grow up to 60 feet long. A special feature that Sperm Whales have is their huge head. Sperm Whale heads are so huge that it is one-third of their body. With Sperm whale heads being so big, they are known to have the biggest brain of any animal. Sperm Whales are social creatures and stick together in groups called pods. Communication is also really vital for Sperm Whales as it helps them communicate with other sperm whales and find food. Sperm whales make clicking noises while they communicate with others and these clicking noises are so loud that they can travel long distances.

"Mother and baby sperm whale" by Gabriel Barathieu. Licensed by Wikimedia Commons, under CC BY-SA 2.0
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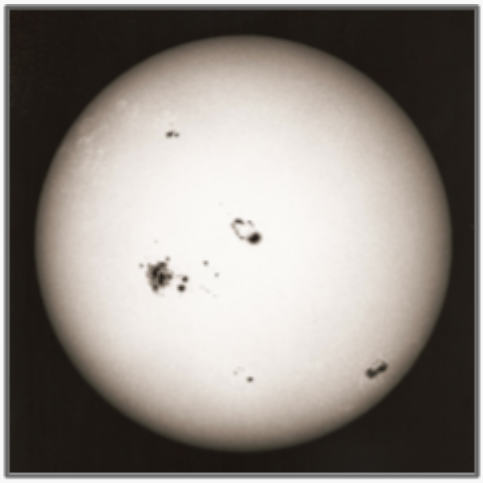
Sperm Whales play a very crucial role in the ecosystem as they help maintain balance. Sperm Whales are top predators that eat animals like squids and fish. As they do this, they make sure that animals don't overpopulate. Another crucial thing Sperm Whales do is help create the oxygen that comes from the water. While Sperm whales play crucial roles, they have been facing danger their whole life from being overfished for oil and their blubber to getting tangled in fishing nets and getting hurt or poisoned from pollution.

While having unique features from their huge size to having an important role in the ecosystem. Sperm Whales are truly fascinating and amazing creations of the ocean. By understanding the roles and important jobs Sperm whales have we can help protect and create a better future for Sperm Whales.

Sunspots

Donia Cao

Sunspots are large areas on the surface of the sun that exhibit strong magnetic fields. They have the potential to generate explosive events like solar flares and coronal mass ejections.



"Sun with sunspots" by Hans Bernhard. Licensed by Wikimedia Commons, under CC BY-SA 3.0 https://commons.wikimedia.org/wiki/File:Sun_with_sunspots.JPG

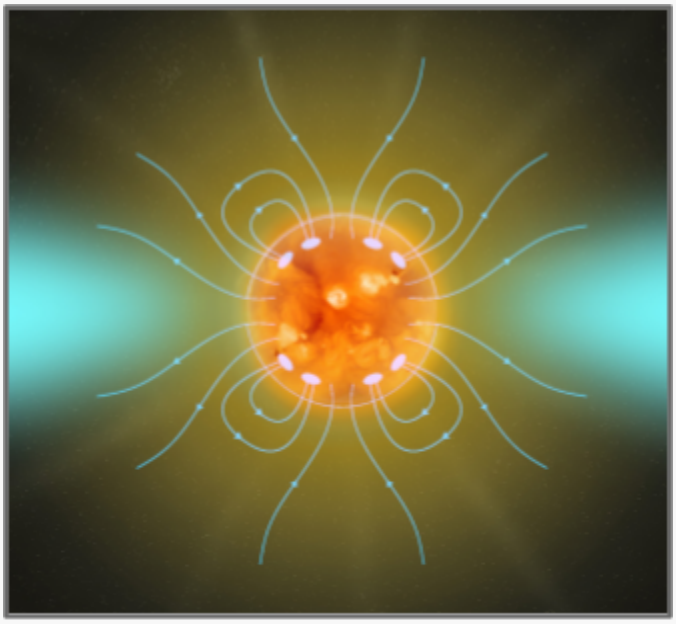
The level of solar activity during the 11-year solar cycle, which is driven by the sun's magnetic field, can be determined by observing the frequency and intensity of sunspots on its surface. Sunspots have long intrigued solar observers, as they provide insight into the sun's complex magnetic interior. According to the European Solar Telescope, these spots form when concentrations of the sun's magnetic field rise to its surface. They consist of a central darker area called the umbra and a surrounding region known as the penumbra.

While the exact process of sunspot formation is not fully understood, the prevailing theory, initially suggested by renowned American astronomer Horace Babcock in 1961, posits that these phenomena are a result of the sun's magnetic field. Scientists continue to study and explore this concept in order to gain a deeper comprehension of sunspots.

According to Royal Museums Greenwich, the sun's magnetic field can be visualized as loops of rubber bands, with one end connected to the north pole and the other to the south pole. This creates a phenomenon known as "differential rotation,"

where different parts of the sun rotate at varying speeds. The equator rotates faster than the poles in this process.

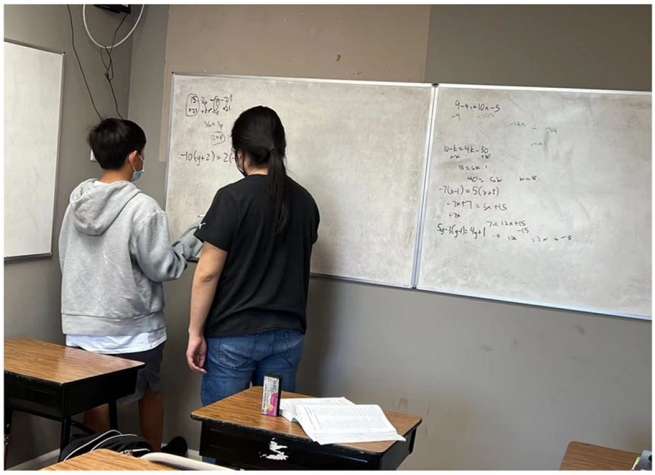
As the sun completes its rotation, there is a gradual coiling and complexity in its magnetic loop structures. Ultimately, these magnetic fields reach a critical threshold where they breach the surface, causing disruptions in the sun's magnetic field. These disruptions appear as pores that have the potential to expand and merge, forming larger proto-spots that eventually transform into sunspots. A group of these sunspots is collectively known as an active region.



"Solar Magnetic Field Lines" by Aza~commonswiki. Licensed by Wikimedia Commons, under CC BY-SA 3.0 https://commons.wikimedia.org/wiki/File:Solar_Magnetic_Field_Lines.jpg

According to the National Weather Service, the magnetic field in active sunspot regions is approximately 2,500 times more powerful than Earth's magnetic field. This significant magnetic force limits the entry of hot, fresh gas from the sun's interior, resulting in cooler and comparatively darker sunspots. The University Corporation for Atmospheric Research explains that if we were to remove a standard sunspot from the sun and position it in the night sky, it would shine as brightly as a full moon.

In conclusion, sunspots are fascinating phenomena that provide valuable insights into the complex nature of the sun's magnetic field. These large areas on the sun's surface, characterized by strong magnetic fields, form when concentrations of the magnetic field rise to the surface. Sunspots consist of a darker central region called the umbra and a surrounding penumbra. While the exact process of sunspot formation is not fully understood, the prevailing theory suggests that they are a result of disruptions in the sun's magnetic field as it reaches a critical threshold. Sunspots are part of the 11-year solar cycle and their frequency and intensity help determine the level of solar activity. Active sunspot regions can have magnetic fields approximately 2,500 times more powerful than Earth's magnetic field. Their presence limits the entry of hot gas, resulting in cooler and darker areas on the sun's surface. Sunspots are significant sources of solar flares and coronal mass ejections, which can have impacts on Earth's space weather. Continued research and exploration of sunspots are crucial for deepening our understanding of the sun and its influence on our planet.



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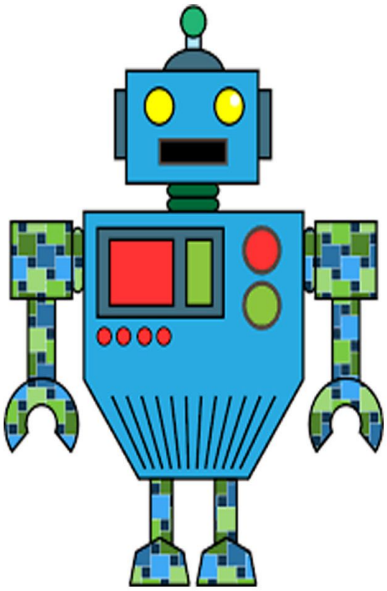

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