AIS
तेजस्वी नावधीतमस्तु

Listening to lightning strikes from around the globe

by Pulkit Gupta, Page 5

Sense N' Science

Volume 5, December 2020


"Science is
the key to our
future, and if
you don't believe
in science, then
you're holding
everybody back"
-Bill Nye
RNA

Editors' Note

Who has seen the wind?
Neither I nor you:
But when the leaves hang trembling,
The wind is passing through.

Who has seen the wind?
Neither you nor I:
But when the trees bow down their heads,
The wind is passing by.

-Christiana Rosetti

Just like the wind, science is everywhere. Science pervades the universe, intertwined with it at its most root levels. Invisible to us just like the wind, yet guides us to a better understanding of life. It helped us progress from a primitive to the prospering lifestyle we are currently enjoying. Without science, we would still be stuck striking rocks together to make fire. Without science, we would have never been able to put a man on the moon. We are proud to present the 5th edition of Sense N' Science and show you the keen minds of the scientists at Ahmedabad International School.

The COVID-19 pandemic changed our lives this year. Being stuck inside caused us to look inwards for entertainment and hope. Exploring scientific themes has been one way AIS students have used these times to enrich their minds, and now we turned these efforts and interests into our science magazine. We thank all the teachers and students who contributed and aided us for this issue. In times where science is evolving everyday to cope with reality, let us read up on some of these interesting topics.

Teacher In Charge
Meenu Gupta

Editors
Kush Agarwal, Trisha Saini, Aryan Singh

Proofreader
Shreeya Patel

Graphic Designers
Himani Majithia, Kavya Harlalka

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Lightning strikes around the world

By: Pulkit Gupta (12 IB)

Thunder and lightning are very common phenomena for us all, and it is something many like to admire and others like fear. Over the centuries, there have been several things that have been discovered and explained, however how lightning behaves is still somewhat of a mystery to us all, leaving us to rely on theories. Several experiments have been conducted since the kite experiment conducted by Benjamin Franklin.

Lightning is "a sudden electrostatic discharge during an electrical storm." Air acts as an insulator between the positive and negative charges in the cloud and between the cloud and the ground. When there is a big enough build up of these opposite charges, the insulating capacity breaks causing the rapid discharge of electricity. There is a state of temporary equilibrium established between the charged regions in the atmosphere. Lightning causes there to be the creation of electromagnetic waves like that of gamma rays, radio waves, flashes of visible light in form of black-body radiation, and others.

Something many of us do not know about this natural phenomenon is that each burst of lightning creates electromagnetic waves that circle around the Earth captured between the surface of the Earth and a boundary about 60 miles up. Some of these waves which have the right wavelength, combine together and increase in strength to create a Schumann resonance.

To understand this, we must first know about the ionosphere. This is the region of the Earth's atmosphere that starts at around 37 miles above the surface going up to hundreds of miles. This is ionized by solar radiation, which causes the electrons to get dislodged from neutral gas atoms, hence creating positively charged ions. Therefore, the ionosphere becomes conductive and is able to trap these electromagnetic waves rather than allowing them to dissipate.

At any given time there are around 2000 thunderstorms around the world, producing approximately 50 lightning flashes per second. Therefore, all these flashes of lightning at any time, cause the earth to behave like an electric circuit. Some of this electrical activity is in the form of standing waves of electricity which is known as the Schumann resonance. These resonances occur in the extremely low frequency (ELF) range.

The vertical lightning channels behave like huge antennas that radiate electromagnetic energy at frequencies below 100 kHz. Our atmosphere is continuously resonating with the radio frequency of 7.83 Hz, along with weaker frequencies at 14.3, 20.8, 27.3 and 33.8 Hz, of the Schumann resonance. This resonance is very useful to analyse the weather, environment, and helpful in determining the atoms and molecules existing in earth's atmosphere.

www.youtube.com/watch?v=OzWBxt_TOWk

The Perfect Drug

By: Tanisha Mehta (9 C)

What is a drug ? It is a medicine or other substance which has a physiological effect when ingested or otherwise introduced into the body. There are hard drugs and soft drugs - examples of hard drugs are alcohol, cocaine, heroin, methamphetamine and nicotine while examples of soft drugs are cannabis, DMT, LSD, mescaline and psilocybin. Hard drugs are drugs that lead to physical and psychological addiction and potentially death. Making, selling, or using drugs other than for approved medical purposes is illegal in most countries. Soft drugs are not thought to cause physical or psychological addiction or dependence to the extent of hard drugs. This doesn't mean they are safe.

Soft drugs like cannabis are used for medical treatments in countries which are legal. For example cannabis is used in countedries like America to treat depression, anxiety, insomnia and many more psychological problems. Cannabis calms the human mind so it helps in treating psychological problems. Hard drugs are easily addictive whilst soft drugs aren't. You can't get addicted to soft drugs.

In the past researchers have noticed the most positive result by a drug has been by MDMA which is also known as ecstasy or molly. In chemistry MDMA is nothing but $C_{11}H_{15}NO_2$. Which is 3,4-Methylenedioxymethamphetamine, it is a soft drug. It is used as a stimulant and is consumed by mouth; these are sold by the medical stores in the form of tablets. MDMA is most often available in tablet or capsule form and is usually ingested orally. Ecstasy traffickers consistently use brand names and logos as marketing tools and to distinguish their product from that of competitors.

The logos may be produced to coincide with holidays or special events. Among the more popular logos are butterflies, lightning bolts, and four-leaf clovers. It is also available as a powder and is sometimes snorted, taken as a liquid, and it is occasionally smoked but rarely injected.MDMA stimulates the release of the neurotransmitters such as serotonin from brain neurons, producing a high that lasts from 3 to 6 hours, but it's length can be variable based on the user. The drug's rewarding effects vary with the individual taking it, the dose, purity, and the environment in which it is taken. MDMA can produce stimulant effects such as an enhanced sense of pleasure and self-confidence and increased energy.

Its psychedelic effects include feelings of peacefulness, acceptance, and empathy. There are also side effects such as irritability, depression, aggression and impulsiveness, muscle tension, problems with sleep, anxiety, memory deficits, loss of attention, nausea and decreased appetite.

www.wikipedia.org, www.drugs.com/illicit/mdma.html, www.google.com

Can you spot the words?

A	G	R	A	V	I	T	Y	M	A	G	N	E	T	I	C	A	T	T	R	A	C	T	I	O	N
B	E	A	K	E	R	T	Y	U	I	O	Y	R	W	Y	R	W	R	H	D	L	O	E	G	W	V
F	L	A	S	K	E	T	U	I	O	T	G	R	Y	O	Y	T	E	W	P	W	U	W	W	V	W
E	L	E	C	T	R	O	C	H	E	M	I	S	T	G	J	L	U	I	O	P	Y	E	T	W	C
Y	Y	T	H	I	O	N	T	O	S	N	T	U	H	E	R	P	E	T	O	L	O	G	Y	X	F
C	U	V	E	T	T	E	I	M	M	U	N	O	O	G	Y	N	T	F	D	W	T	Y	U	E	F
M	O	T	I	O	N	G	T	Y	I	F	T	U	D	T	O	N	L	W	R	D	T	U	Q	B	D

Words to spot -

- Gravity
- Magnetic Attraction
- Flask
- Beaker
- Electrochemist
- Cuvette
- Immunology
- Motion
- Herpetology

By: Ananyaa Shah (8 C)

Dyson sphere

By: Mannit Bhatt (9 B)

A Dyson sphere is a hypothetical mega structure that is used to encompass and efficiently use the energy of a star. In lay man's terms a dyson sphere is a structure that humans will build for getting practically infinite energy. For us humans the star that we use to build a dyson sphere on will be the sun as it is the closest star. The step of moving from the nuclear age (which is what we are coming into now) to harnessing the power of the sun is as big a step for humans if not a bigger step than it was for our ancestors to discover fire. This is essentially the first step towards an interstellar civilization. The first thing that we need to know about a Dyson sphere is that it is not as practical to build as a variant of it called a Dyson swarm. This is due to the fact that if any asteroids crash into the structure it will get destroyed.

A Dyson swarm is basically a group of satellites that are similar to mirrors. In order to build this structure, we would need a lot of materials and in order to get those we would have to largely disassemble a planet. This is, because even if we were to use every inch of resources available on the planet and use them efficiently we would likely only be able to launch as much mass as mount Everest out of the atmosphere which is a meager accomplishment compared to what we are trying to build. Mercury is the closest planet to the sun and is very rich in metals and therefore will be the most suitable.

The atmosphere there is very hostile so we would want to automate as much as possible. One big hurdle that we will face in order to build this megastructure is getting enough energy to do it. It's almost as if you would require a dyson sphere to make a dyson sphere.

This is where we would take advantage of exponential growth, the first satellite would provide the energy to make the second one. Those two for two more, then eight, sixteen and after 60 iterations we should be done. This will be the beginning of a lot more projects like forming colonies on other planets, travelling to other stars and even terraforming planets. As mentioned before this will be the very beginning of turning humans into an interstellar species.

www.youtube.com/watch?v=pP44EPBMb8A

CRISPR - A Game Changer

By: Kush Agarwal (11 IB)

CRISPR, short for Clusters of Regularly Interspaced Short Palindromic Repeats may sound as science fiction at first, but it is in fact a testament of the unstoppable development of science. CRISPR uses a specialized type of a protein called a Cas9 protein to edit DNA, the code for any form of life. The Cas9 protein acts as molecular scissors, cutting DNA and adding new pieces as specified by scientists.

This discovery came to fore in 2017, when a team of researchers led by Mikihiro Shibata of Kanazawa University and Hiroshi Nishimasu of the University of Tokyo released a GIF showing CRISPR in action. CRISPR itself is a piece of DNA. This technology was discovered after observing the action of the Cas9 protein in bacteria. Certain microorganisms called phages are viruses which attack bacteria. They work by injecting their own DNA into bacteria. The bacteria whose defences are unable to discern the rogue DNA starts to replicate it, and as a result, more such phages are created, eventually infecting other bacteria. However, some bacteria do survive this process, the survivors store the rogue DNA into a "storage archive" of DNA, called CRISPR. When the virus attacks again, the stored DNA is copied and transported to the Cas9 protein. The protein compares the stored DNA with the new invading DNA. If a match is found, the invading DNA is cut out and the bacteria is protected.

Scientists soon figured out that the entire mechanism is programmable, and moreover the Cas9 protein is extremely accurate, akin to a DNA surgeon. Although extremely complex in its working, in a simplified light, scientists can leverage this technology to cut out specific parts of useful genomes, put it into the Cas9 protein and use that to stitch it into the DNA of cells. Alternatively, this can be used to cut out specific parts of a genome, helping in treating diseases which are caused by certain sequences in the DNA of humans.

www.youtube.com/watch?v=jAhjPd4uNFY, www.youtube.com/watch?v=6tw_JVz_IEc, www.livescience.com/58790-crispr-explained.html

Lascap Triangle

By: Charmi Vasani (9 D)

Lascap Triangle

$$1$$
$$1\ 1$$
$$1\ {}^{3}/_{2}\ 1$$
$$1\ {}^{6}/_{4}\ {}^{6}/_{4}\ 1$$
$$1\ {}^{10}/_{7}\ {}^{10}/_{6}\ {}^{10}/_{7}\ 1$$

Pascal Triangle

$$1$$
$$1\quad 1$$
$$1\quad 2\quad 1$$
$$1\quad 3\quad 3\quad 1$$
$$1\quad 4\quad 6\quad 4\quad 1$$

Lacsap's fractions are a series of numbers that arrange to form a triangle, similar to that of Pascal's triangle. Both triangles do not include negative numbers and have rows that start and end with 1. The difference however, is that Pascal's triangle consists of integers while Lacsap's triangle has fractions. The patterns in the Pascal triangle are not all necessarily found in Lacsap's triangle. The aim is therefore to investigate the different patterns in this triangle and find the next two rows in the triangle. We should then be able to find the general statement for En(r) where n is the row number and r is the element number. This general statement can be used to find any fraction, when given the row and element number.

Lacsap triangle is a reversed Pascal triangle. This focuses mainly on finding the relationship between the number of row n and the numerator n and also the relationship between the element of a row r and the denominator D . Through this, a general statement base for En(r)on N and D are supposed to be stated and explained. For this task various technologies, such as Geogebra, MathType and calculators are needed in order to produce more organized pieces of work and clearer graphs and diagrams.

The following rules are used to construct Lacsap's triangle:

- Lacsap's triangle is a triangular array of numbers.
- There are n entries in the nth row. The entries are staggered relative to the previous row, similar to Pascal's triangle.
- The first and last entries in each row are 1
- Each entry is equal to the product of the numbers above it to the left and to the right. If no entry is written, treat it as 1 (the multiplicative identity).

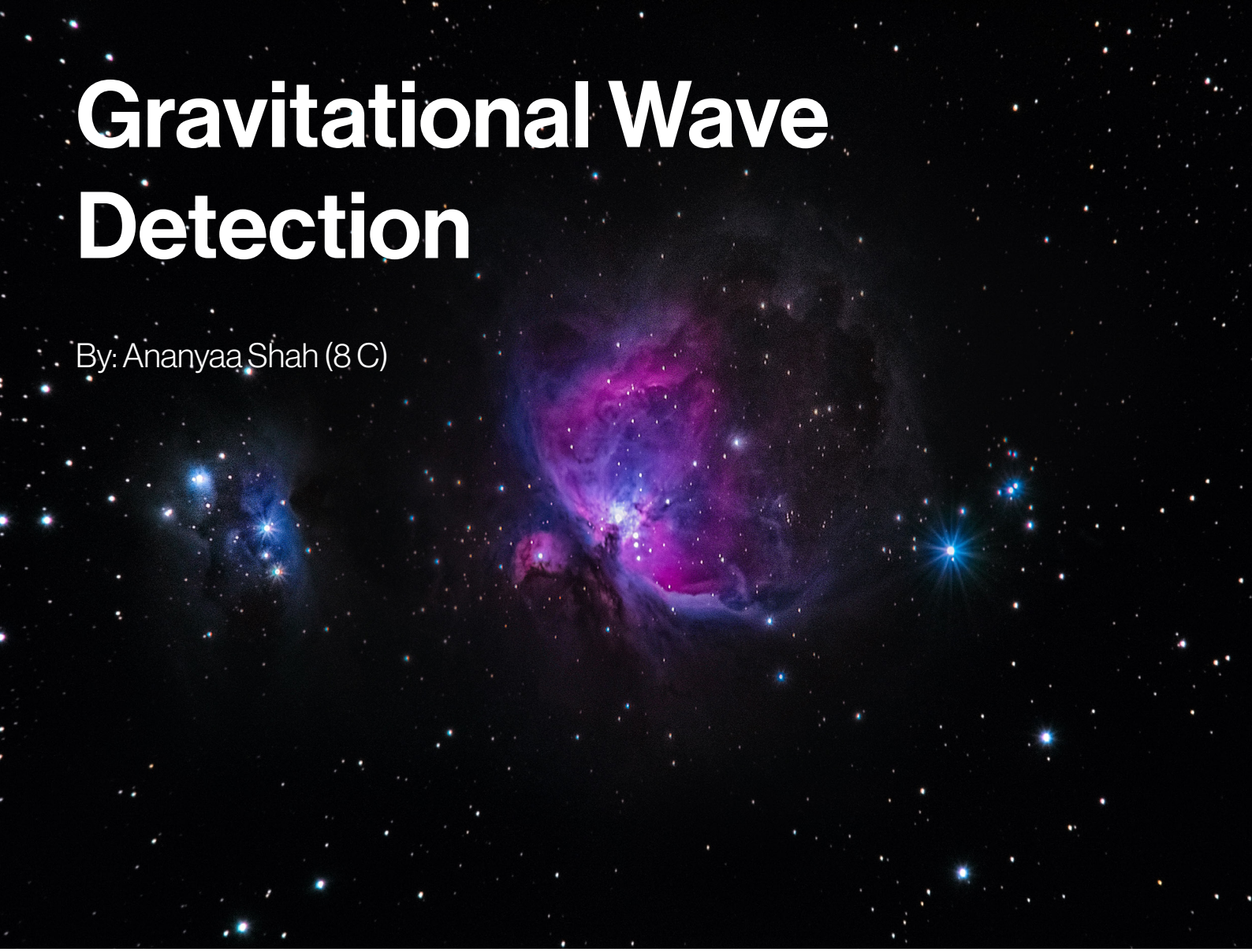
The Symphony Of Science

By: Trisha Gandhi (8 B)

What is science?
Have you ever wondered what is science,
ever tried to discover what is science?
Is it the little birds that wake playfully every morning,
is it the pretty little flowers that blossom every spring?
Is science the loud music coming out of a little speaker,
or is it a bubbling solution getting mixed into a beaker?
Is it an ice cube melting into water,
or a mother giving birth to a little daughter?
Is science the brain that has so many memories,
or is it the universe with thousands of energies,
which has is the night sky full of stars?
or is it the engine and the brakes of a car,
Is it the breaths I take every second,
or the weird and curious thoughts coming to my mind every moment?
Is it the food that my mom makes for me every day,
or is it the enormous sun giving out its hot rays?
Is it a brand-new invention that a scientist invents,
or is it the diffusion of a perfume's scent?
Science is the new discoveries you make every day,
its feeling and presence will never fade away.

Gravitational Wave Detection

By: Ananyaa Shah (8 C)



Gravitational waves are ripples in space time and are created when objects with mass move. This concept was predicted by Albert Einstein in 1916 on his theory for general relativity. It is not collected from an object but the motion of the object. Einstein believed that something special happens when a planet orbits each other. He said that when this occurs it forms ripples, like when a stone is tossed into the water which causes a few ripples. Gravitational waves are invisible but travel very fast. It travels by the speed of light. Gravitational waves can occur when : a star explodes, planets orbit around each other, when 2 black holes orbit each other and merge.

Now the question arises how exactly are these waves detected. A machine called LIGO (Laser Interferometer Gravitational-Wave Observatory) is a large-scale physics experiment and observatory which helps to detect cosmic gravitational waves and to develop gravitational-wave observations as an astronomical tool. On September 14 of 2015 LIGO physically sensed the undulations in spacetime caused by gravitational waves generated by two colliding black holes 1.3 billion light-years away. This discovery will go down as one of the greatest scientific discoveries seen by humanity.

While the processes that generate the waves are extremely violent and destructive, till the time it reaches Earth they are thousands of billions of times smaller ! In fact, by the time gravitational waves from LIGO's first detection reached us, the amount of space-time wobbling they generated was a 1000 times smaller than the nucleus of an atom! Such inconceivably small measurements are what LIGO was designed to make. What a fascinating world we live in!

LIGO.caltech.edu, www.spaceplace.nasa, www.en.wikipedia.org

Emerging Biotech

By: Khushi Patel (11 IB)

When you hear the term biotechnology, all you can think of as a layman would be biology linked with technology. Well, that's it you're right! A wordy way of representing biotechnology would be, the use of an organism or a part of the organism to be modified using technology to make a new product or a process. In todays world biotechnology mainly relies on the DNA technology — the sequencing and cutting-pasting of the DNA strand. To understand this thoroughly let me give you an example, you all might have heard about beer brewing right? That's also an example under usage of biotechnology here tiny fungus also known as yeast is disposed into a solution of barley sugar, the solution undergoes a process known as fermentation. The product obtained is the alcohol which is found in the beer. This example here explains the process of biotechnological use which is using an organism — the yeast — making a by-product for human consumption. Knowing more and more about current advancements we can see that they have been used In products we use in our everyday life such as alcohol and antibiotics like penicillin.

This year has caused many problems, but one thing which has benefited the world of technology is the process of Whole Genome Synthesis, here the researchers use software to design genetic sequences and this ability of writing our own genome helps in curing many genetic diseases, and currently has helped investigators gain insight into how these viruses spread and cause diseases just like the ongoing coronavirus.

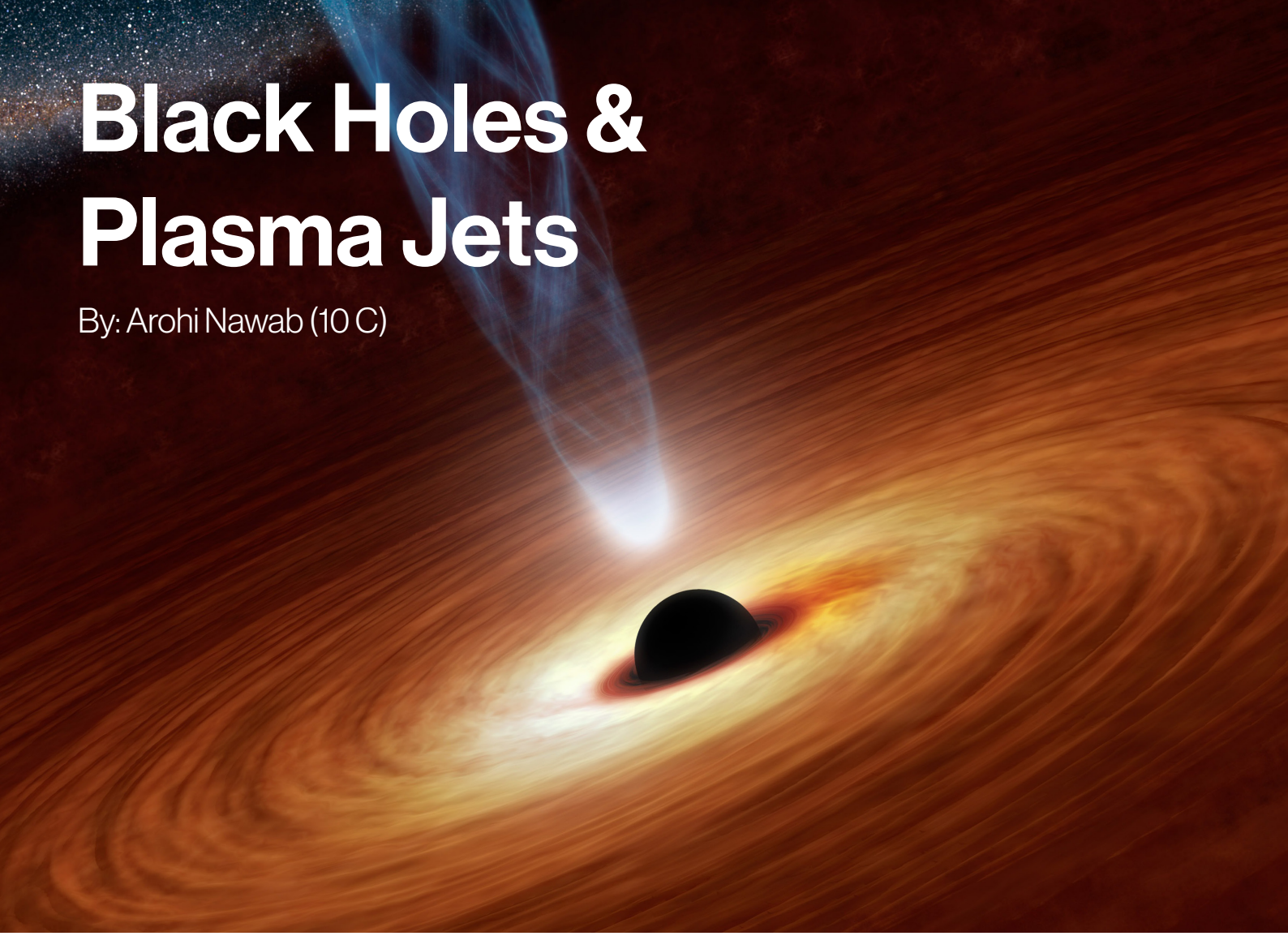
Nowadays Biotechnology mainly focuses in the field of medicine; multinational pharmaceutical companies like Pfizer, Johnson and Johnson etc have been developing new treatments to fight back rare and complex diseases, and genetic tests have been conducted to identify if inherited diseases can be cured or not. Alternatively, biotechnology also operates in the field of agriculture, energy and environmental science.

Everything has ups and downs and so does biotechnology. It has the potential to provide its best to the people and the society but it has its drawbacks too. Not only biotechnology but all the other types of new inventions have their own downsides. It is necessary to analyse and test the biotechnological innovations before they are released for general use. They have to be approved by clinical trial labs and have to be certified by the government to be marked as safe and effective before their release. Ethical questions are also raised by the society which cannot be ignored, such as the use of animals like rats for testing. Societal concerns are present in all fields as mentioned above, every new release has its own downside, here the downside are ethical issues which may stop the release of that particular method or tool. Problems like harm to the environment, bioterrorism, production safety and lastly ethical issues are taken into consideration. All in all technology has no such harm until used effectively, if overuse or illegal usage is done it might harm us and the surroundings.

www.scientificamerican.com/article/whole-genome-synthesis-will-transform-cell-engineering/, www.khanacademy.org

Black Holes & Plasma Jets

By: Arohi Nawab (10 C)



Most galaxies in the universe host supermassive black holes at the centre, a region of space where gravity is so strong that no object can escape, including any form of light. This is because matter has been squeezed into a tiny space. This can happen when a star is dying. Because no light can get out, we cannot actually see black holes. They are invisible. When a black hole and a star are close together, high energy light is made. Space telescopes with special tools can study how stars that are very close to black holes act differently from other stars.

The largest black holes are called "supermassive". These could have a mass of more than 100 suns together. The supermassive black hole at the centre of our milky way galaxy is called Sagittarius-A. It has a mass equal to 4 million suns.

Scientists have observed jets of high-energy plasma shooting away from the cores of black holes, which are formed by matter managing to escape ingestion, which means they don't get "eaten" by the great vacuum of the black hole. This matter is also referred to as "ionised matter".

Interestingly, these plasma jets start off with a curved shape which resembles 'bell-bottom pants'. This is said to be caused by magnetic fields present in the disk around the black hole which accelerates the jet particles outward. They also accelerate close to the speed of light. The ionised matter now streams into space and starts to glow with visible light. Scientists believe that the earth and our whole existence is due to a long ago explosion that formed black holes.

Famous scientists like Stephen Hawking have studied black holes to understand the minutest workings of our universe. The discovery of black holes and plasma jets was a breakthrough in scientific history.

www.prezi.com/7g82zsbwlxjr/black-holes/, www. https://www.nasa.gov/audience/forstudents/k-4/stories/nasa-knows/what-is-a-black-hole-k4.html, www.fackts.wordpress.com/2019/01/25/amazing-facts-about-our-universe/

Binary Numbers

By: Shivang Gosai (9 GB)

The binary number system has only two digits: 0 and 1. The prefix in the word "binary" is a Latin root for the word "two" and its use was first published in the late 1700s. The use of the binary number system is based on the fact that switches or valves have two states: open or closed (on/off).

Currently, one of the primary uses of the binary number system is in computer applications. Information is stored as a series of 0s and 1s, forming strings of binary numbers. An early electronic computer, ENIAC (Electronic Numerical Integrator And Calculator), was built in 1946 at the University of Pennsylvania and contained 17,000 vacuum tubes, along with 70,000 resistors, 10,000 capacitors, 1,500 relays, 6,000 manual switches and 5 million soldered joints. Computers obviously have changed a great deal since then, but are still based on the same binary number system. The binary number system is also useful when working with digital electronics because the two basic conditions of electricity, on and off, can be represented by the two digits of the binary number system. When the system is on, it is represented by the digit 1, and when it is off, it is represented by the digit zero.

To convert a binary number to a decimal number, add up the place values that have a 1 (place values that have a zero do not contribute to the decimal number conversion).

The binary number 10110011

= 128 + 0 + 32 + 16 + 0 + 0 + 2 + 1

= 179 in the decimal numbers.

Software developers, network analysts, and computer security analysts are just some of the people who need to really understand binary. The binary number system (also called base 2) is used by computers to store numbers and to perform arithmetic. A software developer that understands binary will write code that compensates for the limitations a computer has when doing arithmetic. A network analyst will use binary to divide and configure networks with subnet masks.

Euler's Identity

By: Aryan Singh (11 IB)

$$e^{i\pi} + 1 = 0$$

What makes a mathematical equation beautiful? For some, it is the ease with which it describes the universe around us and for others, it is the simplicity of it. With these different opinions, why is the Euler's Identity consistently renowned as the most beautiful equation in the world?

Now, for some, this equation might not look like much. You would think what's so special about this? Well, first things first, this equation is simplistic to its core. Even a non-mathematician can understand what is happening here. That is part of its charm. Another part of it would be the highly recognizable symbols used in the equation. 1 and 0, the most commonly used numbers in mathematics worldwide and us Indians hold a special part for 0 in our hearts as it was discovered by our very own Aryabbhata. Now, as I am sure, most of us have heard of pi, an infinite irrational number which shows the ratio between the circumference and the diameter of a circle (3.14159265358…). It is often regarded as the single most important constant in the entire universe! Most of us mathematicians grew up trying to memorize the maximum number digits of pi.

Now the remaining 2 symbols might not be that commonly known. That is e and i. However, they both form the fundamental basis of mathematics. The constant "e" is known as Euler's number (the same man who derived this exquisite identity) and is an essential quantity in mathematics as it denotes the base of the natural logarithm. On the other hand, "i" represents the phenomenon known as complex numbers or imaginary numbers - numbers which are the square root of negative numbers. But wait! Isn't that impossible? That's the beauty of this constant as it allows us to perform calculations with the impossible and this constant has helped discover new branches of mathematics and integrate it with other areas of study such as electric engineering.

So after combining all of these essential quantities, what is our final result. What grand total do we achieve after combining these legendary numbers. 0. Nothing! And that is what is so exquisite about it. Before Euler, no one was able to combine all of these 5 and only these 5 constants into an equation. But Euler did it. Scholars have even gone so far as to call this the proof of the existence of God! According to a study by UCL, the mathematical beauty present within this equation activates the same part of the brain as pieces of art or music.

I hope this article helped you understand the beauty and the simplicity of this equation and I implore you to look further into the equation and discover new territories of mathematical beauty.

www.livescience.com/51399-eulers-identity.html

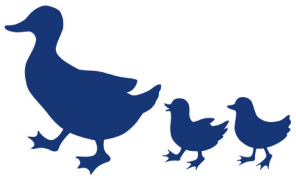
JOKES!

Red Alert! Red Alert!

$$\frac{NaOH}{NaCl}$$

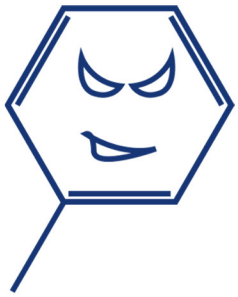
The base is under a salt!

What did the quantum duck say?



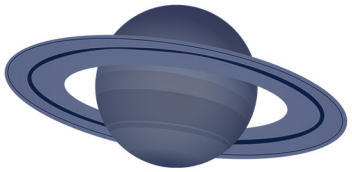
Quark!

What do you call a rude acid?



A-mean-oh Acid!

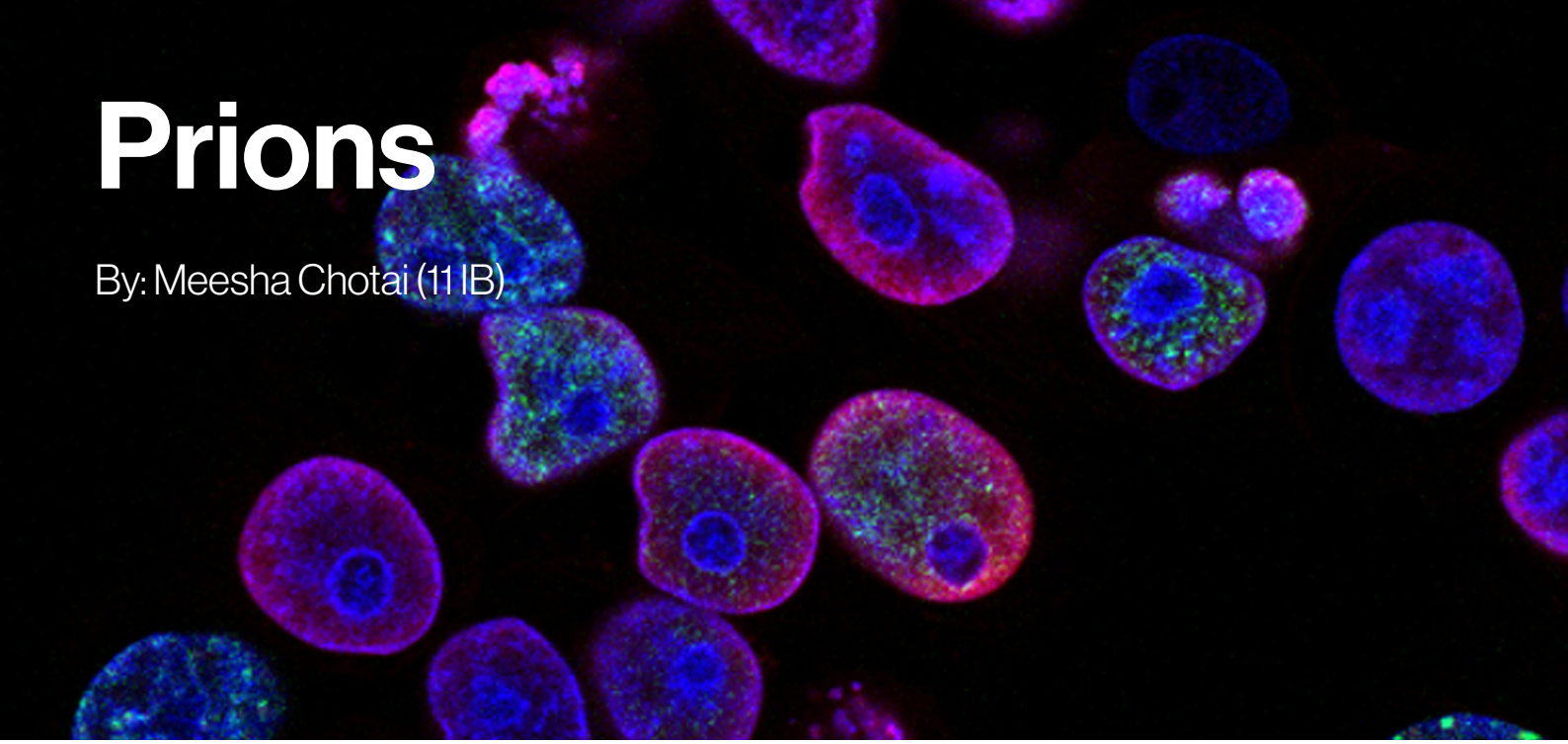
How do astronauts organize a party?



They planet!

What do you do with a dead scientist?

If you can't Helium or Curium, you might as well Barium...



Prions

By: Meesha Chotai (11 IB)

In the 18th century, a disease called 'Scrapie' began to spread amongst sheep throughout Europe, causing unnatural behaviour and wool loss. Considered endemic to Europe and not a pressing issue, its causes remained mostly unknown until the 1940s when the first case appeared in North America, prompting scientists to research the causes of the disease and eventually discover a new type of infectious particle altogether.

When over 1500 sheep contacted Scrapie after receiving a vaccination containing scrapie-contaminated lymphoid tissue in the 1940s, it was proven to be both transmissible and neurodegenerative. It was found to cause spongiform encephalopathy, or a condition in which 'holes' develop in the brain tissue, giving it a sponglike appearance.

Based on prior information about other neurodegenerative diseases, researchers assumed the infectious agent was a virus or a genetic mutation. Hence, they exposed a contaminated sample to UV radiation - UV radiation breaks down nucleic acid, effectively disabling the functioning of both DNA and viruses if they are exposed to it. However, the radiation had no effect on the infectious properties of the sample, indicating that the disease was not caused by a mutation or a virus. This perplexed scientists until finally a protein was proposed to be the infectious agent in 1967 by a pair of scientists named Pattison and Jones. Research progressed rapidly after that and finally a hypothesis was proposed in 1982 by Stanley Prusiner: the prion hypothesis.

So, what are prions and how do they infect mammalian cells?

The term 'prion' is an abbreviation for 'proteinaceous infectious particle': the prion is a misfolded form of the PrP protein - found often on cell membranes in the brain - that is capable of misfolding other PrP proteins in the vicinity as well. Consequently, the condition spreads throughout cells in the brain and causes spongiform encephalopathy, inducing erratic behaviour and multiple other infections. Prion diseases can be transmitted vertically through inheritance of the mutant genetic code or horizontally through the ingestion of contaminated spinal fluid from an infected individual, since both methods will ultimately introduce misfolded PrP proteins into the system of the individual being infected.

In fact, the PrP protein is not limited to Scrapie - it is found in the correctly folded form in most mammals. Prions occur in these mammals as well, causing conditions such as Creutzfeldt-Jakob disease, Mad Cow disease, and fatal familial insomnia. A looser definition of prions is also used, indicating that they are any misfolded protein as long as they can propagate. These other prions are even useful to yeast cells during reproduction, opening up a new avenue of uses for prions once scientists have fully understood their mechanisms.

www.scientificamerican.com/article/what-is-a-prion-specifica/, www.prionalliance.org/2013/11/26/what-are-prions/, www.britannica.com/science/prion-infectious-agent, www.britannica.com/science/scrapie, www.ncbi.nlm.nih.gov/pmc/articles/PMC33918/, www.ncbi.nlm.nih.gov/pubmed/6801762, https://www.sciencedirect.com/topics/neuroscience/scrapie

Schrodinger's Cat Paradox

By: Shreeya Patel (10 C)

Have you ever wondered what would've happened if you did something differently? Have you ever thought that a different set of events could've happened if something was changed? Schrodinger's Cat Paradox explains just that - how there are multiple possibilities but our actions lead up to one event only.

In 1935, Ernest Schrodinger came up with a hypothetical experiment while conversing with Albert Einstein. This experiment was to prove the flaws in implying the Copenhagen interpretation of Quantum Mechanics in everyday life. The Copenhagen interpretation, which was devised by Niels Bohr and Werner Heisenberg, stated that once the wave function (i.e. the total number of possible states an object exists in) of an object is measured, its superposition - i.e. the position of existing in all possible states - will collapse and the object will be forced into only one of the states of its wave function. In other words, until something isn't measured, it exists in multiple states, but once it is observed, it is forced into one specific state.

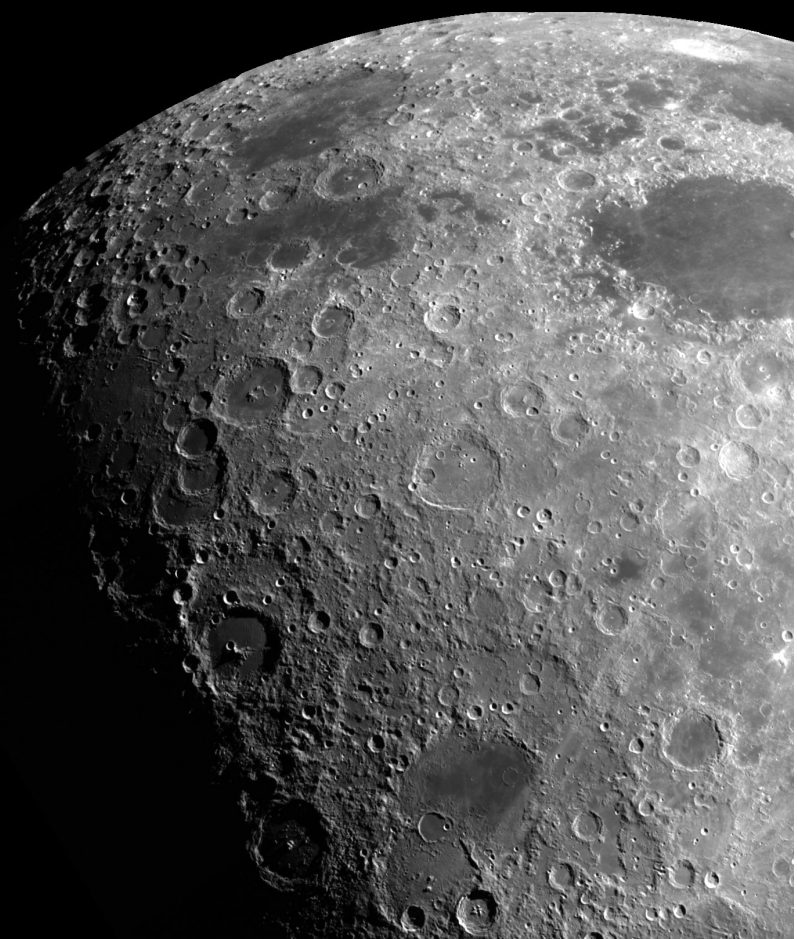
Schrodinger set out to prove this wrong, as he believed that the Copenhagen interpretation can be applied for quantum mechanics but not for everyday life. He, therefore, came up with a thought experiment, or paradox, as it's more widely known. This involved locking a cat inside a box with a radioactive substance, a Geiger counter, a sharp object, and a flask of poisonous gas. The experiment goes as such; if the Geiger counter (a device to monitor radioactivity) detects radioactivity (a single atom decaying), it would trigger the sharp object to break the glass and release the poisonous gas. This gas should kill the cat, but until the box isn't opened and observed, nothing can be said about the cat. According to the Copenhagen interpretation, the cat should be both dead and alive simultaneously, but when the box is opened and checked, the cat can only be either alive or dead, not both. This posed the question, "when does a quantum system stop existing as a superposition of states and become one or the other?". There were many interpretations of the question, one of them being the Many-worlds interpretation. Hugh Everett explained that after the box is opened there are two possibilities, but they are completely separate and they do not merge, so once the box is opened, the cat can either be alive or dead, but they are two separate events that branch as the box is opened.

Later, other experiments were done to both challenge and back the paradox, like Wigner's friend paradox, but Schrodinger had put a great effect on the way quantum mechanics was viewed, to say the least.

www.wtamu.edu/~cbaird/sq/2013/07/30/what-did-schrodingers-cat-experiment-prove/, www.youtube.com/watch?v=UjaAxUO6-Uw

A Year Of Chandrayaan

By: Sanya Gangwani (8 GB)



India has hit another milestone with completing one year with the Chandrayaan-2 being in the Lunar Orbit, the Chandrayaan-2, launched on 22nd August, 2019, is a follow up mission of the Chandrayaan-1, which was launched in 2008. The Chandrayaan-1 confirmed the presence of lunar water at the poles of the moon. The Chandrayaan-2 entered lunar orbit on 20th August, 2020, and since then has found out a lot of useful information. As per ISRO's words, all eight payloads of the probe are working well and it hasn't landed but has characterised a few places for future probes to land on the moon. It has successfully finished 4,400 trips around the moon and also has covered about 1.5 million square miles of the Moon's terrain. It is said by ISRO officials that it has enough fuel to last 7 years in space.

An area of interest on this natural satellite is the Balmer-Kapteyn basin region, it includes a 'light plains' deposit of Lunar soil that shows the changes which occur after a meteorite hits the surface of the moon. The Chandrayaan-2 has also spotted small scale tectonic landforms called Lunar Lobate Scarps, mission officials think of them to be young features of the Moon, but there isn't much that can be said about these due to their small size. Signatures of Argon-40 have also been detected in the moon confirming the observations of the Apollo moon programs of the 1960s and 1970s).

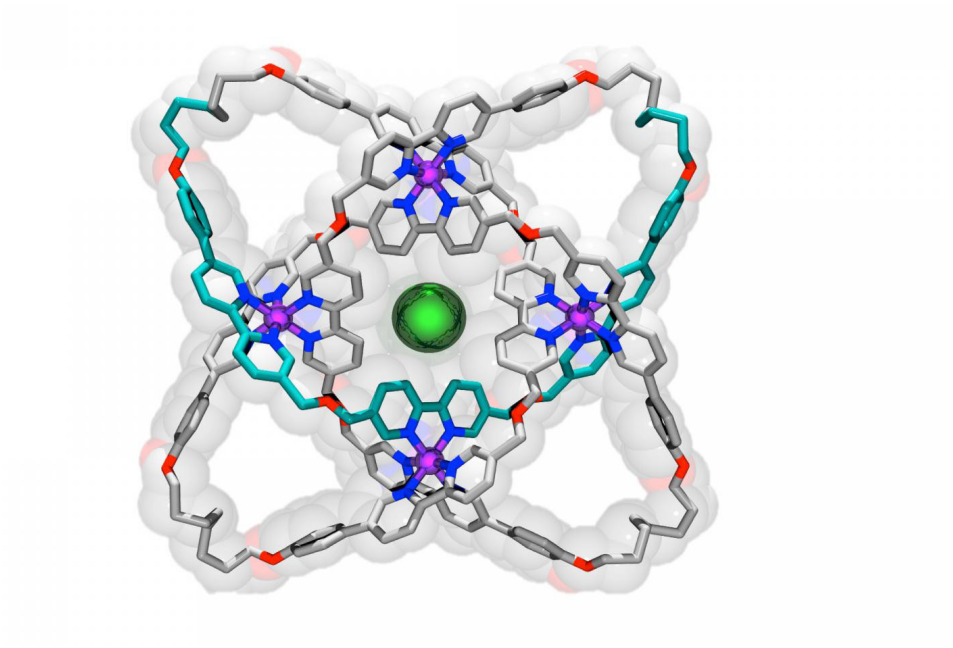
The Orbital Radars on the Chandrayaan-2 are continuing to gather observations of lunar water-ice at the poles of the moon. Mission officials are yet to confirm where this lunar water can be found and in which form it can be found. The Chandrayaan-2 is also indirectly monitoring Solar activity which gives additional information to the Mission officials about how space weather affects the Earth. On the 29th of May this year, the sun let out it's second most strong flare of heat and the rays of this were caught by the Chandrayaan-2's X-ray device.

That was most of what one of our country's most amazing devices has done.

isro.gov.in/chandrayaan-2-completes-year-around-moon,

“Never Ending” 2-D Molecular Knots

By: Shreeya Patel (10 C)



Linking molecules together is a common task in the world of chemistry, but weaving them together comes as a challenge. Defying the odds, David A. Leigh and his colleagues at the University of Manchester have created what is arguably the most complex knot of molecules made yet. Not only that, it is the first 2-D knot ever made, making its significance even greater.

Knots are often seen in DNA and other polymers or molecules made of repeated subunits connected in a long chain, but chemists can manufacture a specific kind of knot by guiding the molecule to move on a desired path.

The researchers at University of Manchester worked on tying molecular knots when they came up with the project. They explained that zinc or iron ions are used with tetrafluoroborate anions to create templates, which are used as a base of grids like these. While working on the project, they realized that the grids crystallized in layers and created something that “looked like the black squares on a chess board.” The dangling ends of each grid reached from square to square, but weren’t long enough to reach from layer to layer, so the edges were connected together to create an endless loop. If the ends were connected to other grid ends via disulfide bonds, and the templates were removed, they could make layers of woven molecular material.

Numerous 3-D molecular structures have been made, but this is the first of its type. Being only 4 nm thick but hundreds of μm across, molecular fabric like this has many applications, one of them being that it can separate large ions from smaller ones, and it is quite similar in nature to textile.

One of the most interesting things about the endless knot is that it is actually a well known pattern in many religions; it is one of the eight auspicious symbols in Buddhism and Hinduism, the smallest Chinese knot and one of the most repeated designs in Celtic interlace, but is the most complicated and hard to replicate with atomic strands.

The process also created several other types of knots; including a 258-atom-long molecule in the form of an endless knot which has 7-way crossings. The team used nuclear magnetic resonance and crystallography to confirm that they had made endless knots.

www.nature.com/articles/d41586-020-03579-5, www.nature.com/articles/s41557-020-00594-x, cen.acs.org/materials/Chemists-weave-molecular-fabric/98/i48

Falling Bodies

By: Anika Chopra (9 B)

What do we really pay for at a roller coaster theme park? An arrangement that allows us to survive. Because whether or not we understand how gravity works, we have an innate fear of what it does. What if the roller coaster changes direction, launching me way into orbit? What if I fall?All of us have pondered these questions once upon a time, although not all of us will not readily admit it. If it were not for an extraordinary gentleman called Galileo Galilei who lived about four hundred years ago, the physics behind this phenomenal ride would have been a mystery to us.

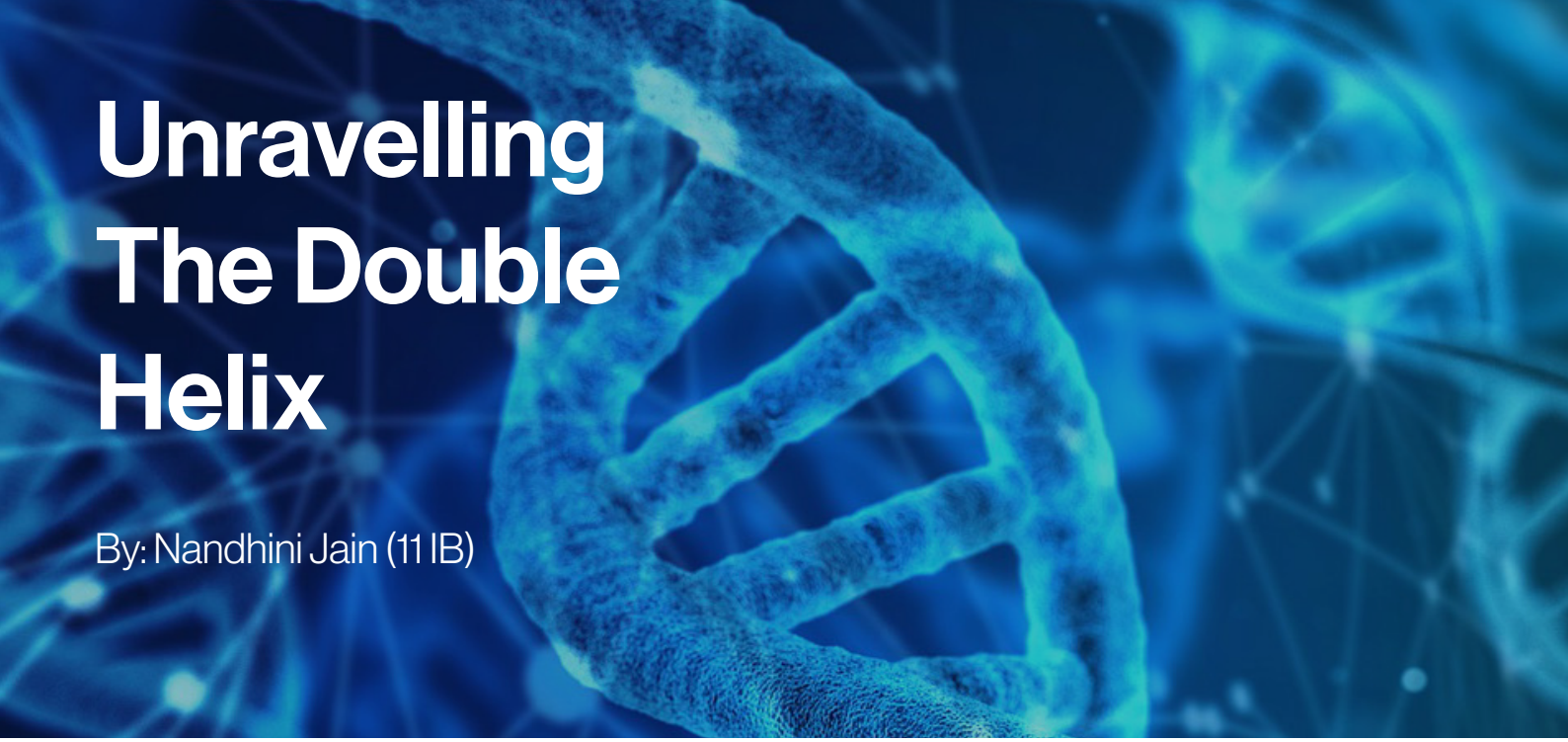
In the 4th Century BCE, Greek philosopher Aristotle asserted that heavy objects fall faster than lighter ones. No one in Ancient Greece questioned his assertions. Only in the 17th Century did Galileo Galilei, an Italian astronomer and mathematician realize that all bodies, regardless of their weight, should fall at the same constant acceleration in vacuum. Note that the word vacuum i s of great importance. Dropping two objects of different masses from a height will cause the heavier object to fall faster than the lighter one because of external forces such as air resistance.

Galilei couldn't produce a vacuum but he could imagine one. Picturing a heavy body attached to a lighter, compound body, he thought about whether the lighter body will slow down the motion of the heavier one. If the lighter body did slow down the heavier one, common sense would suggest that the heavy body alone would fall with greater acceleration. However, the heavy body alone was lighter, which led him to believe that mass had nothing to do with the acceleration of an object in the absence of air resistance. This disproved the long-held view of heavier objects falling faster than lighter ones. He then conducted a magnificent series of experiments with two spheres and an inclined plane, recording his observations in his book Two New Sciences.

In 1971, American astronaut Dave Scott demonstrated Galileo's ideas about falling bodies by showing that a hammer and a feather reach the ground at the same time on the Moon, which has almost no atmosphere to cause drag.

The Law Of Falling Bodies was discovered by Galilei, refined by Newton, and theorized by Einstein.

Mechanical Universe, Caltech, 'The Science Book', published by DK



Unravelling The Double Helix

By: Nandhini Jain (11 IB)

Existence of DNA molecules was known for long but what wasn't was how it stored genetic information and how that information was inherited. The structure and working of the molecule was unknown. James Watson and Francis Crick, who we know as the discoverers of the double helix model, were rather unpopular in the field of science until they took up the challenge to uncode the DNA structure. But were they the only one in the race? No, obviously not, other scientists that were also doing similar research included Rosalind Franklin and Maurice Wilkins.

The research was initiated by a renowned physicist Maurice Wilkins at Kings, however the research gained its speed when Franklin, a talented crystallographer moved to Kings college to work with colleague Wilkins on the DNA model. The conflicted relationship between two scientists, who had the notion that they respectively were leading the research, caused friction and disagreements that resulted in delaying in their formulating a model. Eventually, they agreed to work independently. On the other hand Pauling and Watson and Crick from their study of the components of a nucleotide came to a conclusion that the DNA was some sort of Helix. A few days from then Watson went to London to hear Franklin's report, and came back with a vague memory of certain measurements from her talk. Crick and Watson decided to build a model. It was a triple helix made of sugar and phosphate and the nucleotides attached on the exterior.

When the model was out, Franklin immediately rejected their effort as she found the measurements to be wrong (looks like Watson got the numbers wrong) and prohibited them to work on the model. However, Wilkins, without Franklin's consent, managed to help Watson and Crick by giving them Franklin's picture of the x-ray crystallography of DNA - Franklin's photo 51 . This was the last lap of the race, from the first look of Photo 51, Waston was certain that the diffraction was that of a helix - a double helix structure it was.

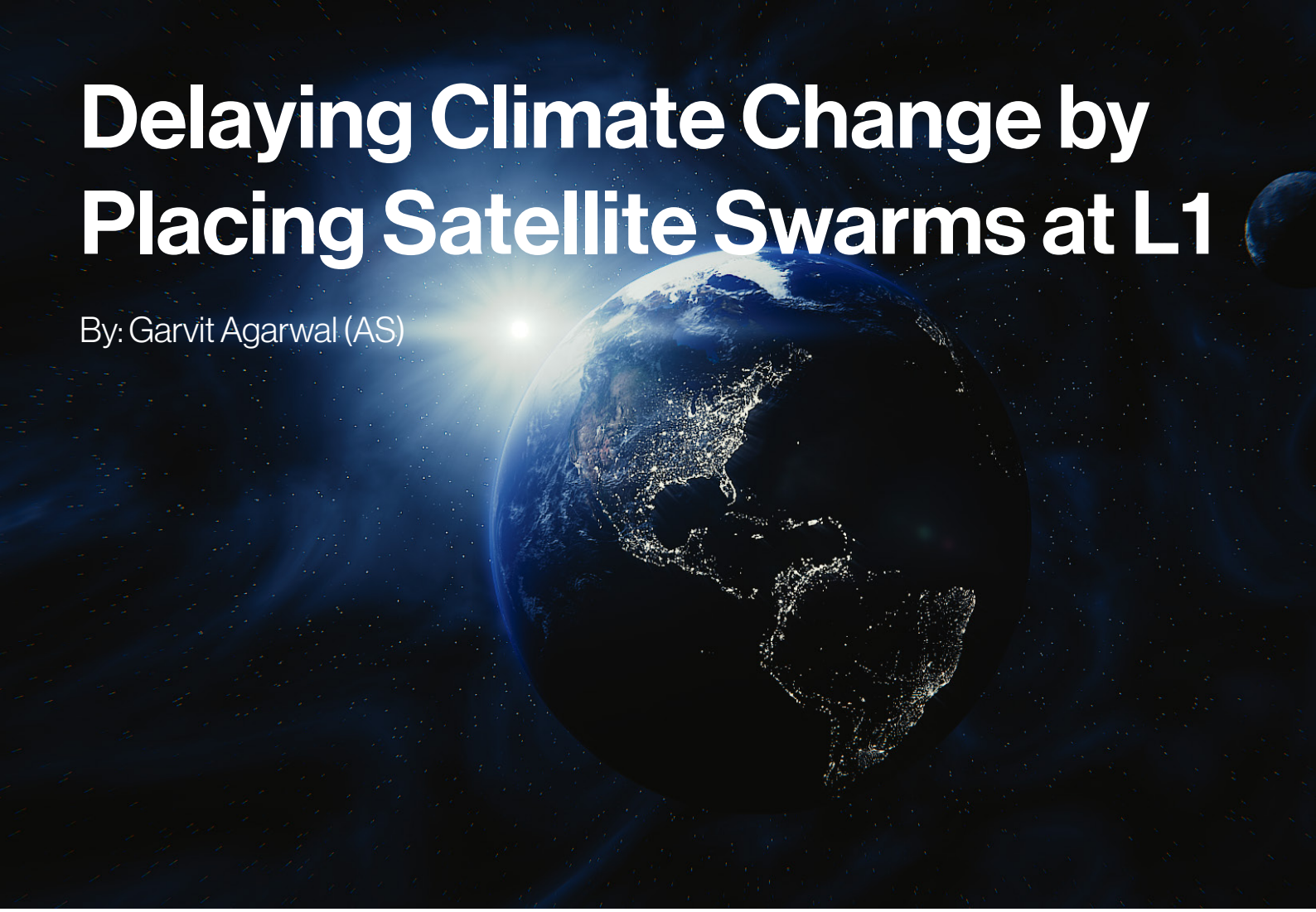
Watson and Crick began working on the model underground. In the process, Crick managed to get an imperative insight on the DNA symmetry from Franklin's report which she herself has missed, this suggested the two strands ran in opposite directions (3' to 5' and 5' to 3'), this cleared another of their misunderstandings regarding placing the nucleotides outside. With Rosalind's measurements, the two in no time were able to set the backbone, now the only puzzling part was the placement of the nucleotides. How could they fit in the restricted space between the strands? Here when the finding of Ervin Chargaff proved to be helpful, he found that the number of Adenine bases equaled that of thymine and likewise with cytosine and guanine.

With all these contributions, in 1953 Watson and Crick had unravelled the semiconservative model of DNA that could explain not only the storing of genes but also their mutability and inheritance. This discovery was accepted promptly by scientists around the globe. In 1962 Watson and Crick had been given the nobel prize for their work. Sadly Franklin, whose research was borrowed without permission, wasn't given any due credits.

www.biointeractive.org/classroom-resources/double-helix, www.biologydictionary.net/double-helix/

Delaying Climate Change by Placing Satellite Swarms at L1

By: Garvit Agarwal (AS)



Climate change is plaguing our planet. The result of not paying attention to the problem will make our planet inhospitable. Venus is a good example of what happens when climate change gets out of hand. Its surface temperature is higher than that of Mercury, even though it is much farther from the sun. The consequence of our surface temperature rising by just 1.5-degrees celsius would be devastating for life here on Earth. Cyclones, droughts, and floods will get more frequent, while timely rainfall will be a thing of the past.

It is no surprise to counteract climate change, people have come up with some absurd ideas, one of which is blocking out the sun using a swarm of satellites. We know that blocking out the sun will help curb temperatures from rising. A volcanic eruption large enough can block out the sun's rays from reaching the surface; this allows the Earth to radiate more energy than what it is receiving hence reducing global temperatures. For the satellites to be able to block out the sun, they must be in a position where they are always between the Earth and the sun. The swarm would not block out the sun completely, but only reduce the light that reaches Earth. There is a point, Lagrange 1 (L1), where the gravitational pull of the Earth and the sun cancel out. It allows any satellite in L1 to be in the right position to block the sun.

You must be wondering, "This idea seems great! Why don't we implement it? "

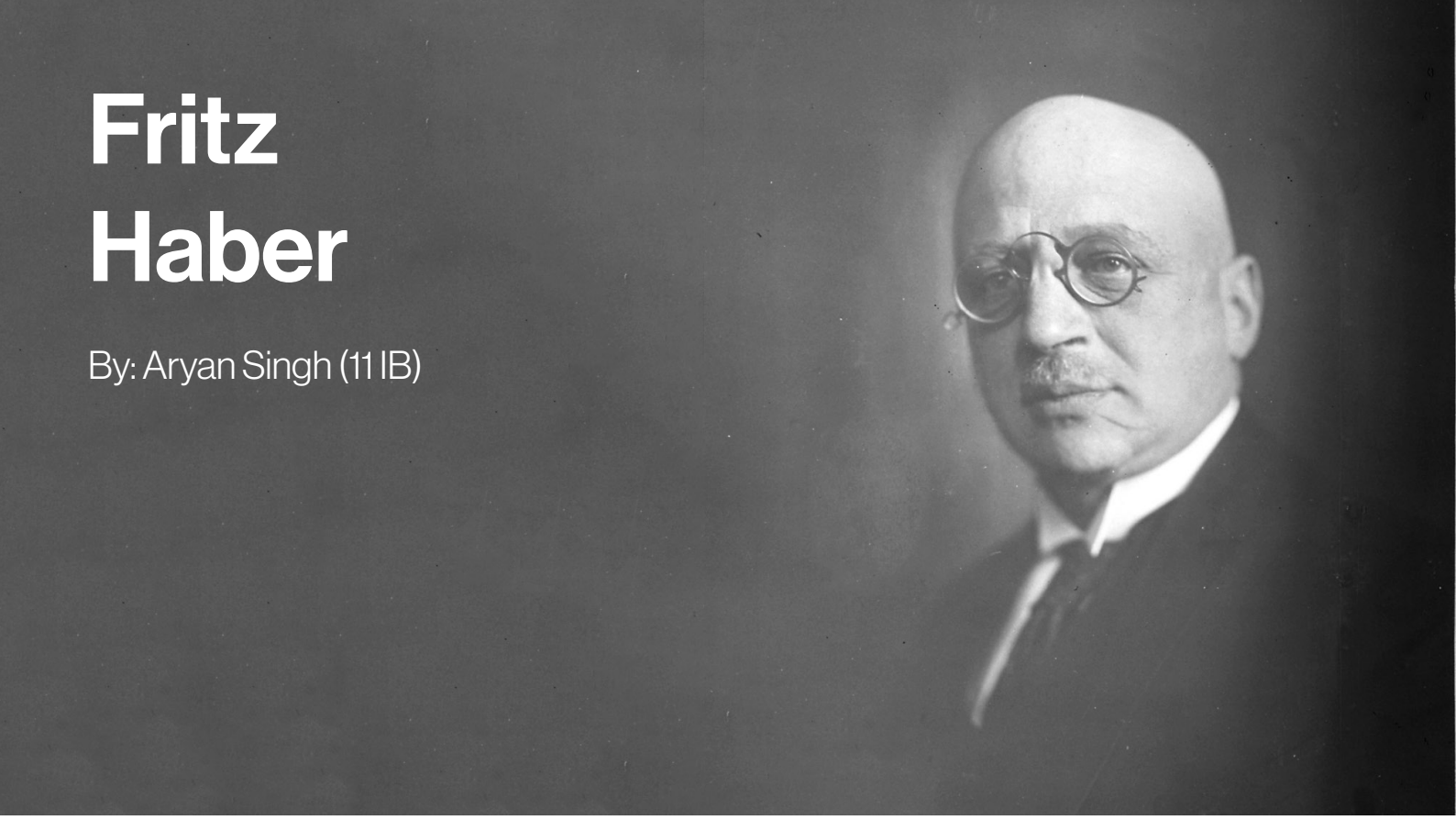
The L1 is a point of unstable equilibrium. Small disturbances can remove the satellites from the orbit. This will require the satellites to use active orbit correction increasing the complexity of the endeavor. The truth is the cost of placing a satellite swarm large enough to reduce the Earth's exposure to the energy released by the sun would be astronomical. Even if the cost was not considered the effect of blocking the sun's rays on local ecosystems and climate can not be modeled with existing computational power. This may result in some countries benefiting while others suffer. The plant life will also face severe consequences.

This makes other options like direct carbon capture or trying to reduce our carbon emissions a more fruitful means of averting climate change. It is always cheaper to not burn fossil fuels than creating a swarm of satellites to block out the sun.

www.esa.int/Science_Exploration/Space_Science/L1_the_first_Lagrangian_Point

Fritz Haber

By: Aryan Singh (11 IB)



Fritz Haber. Genius or evil? Nobel-prize winning scientist or war criminal? Or even … both?

Haber was a meek scientist born in modern day Poland in 1968 who rose up the ranks in the academic world to become a professor. He was awarded the Nobel Prize in 1918 for his work on nitrogen fixation, leading to a process called Haber Process. What is the Haber Process? It was a revolutionary step forward in the field of nitrogen fixation. By making such a process, Haber was able to produce huge amounts of ammonia which was vital in the fertilizer industry and is still used heavily today. In the modern world, 500 million tons of ammonia is produced annually due to the Haber Process, which is enough to feed 40% of the world's population.

So, how does it work? In order to make ammonia, Nitrogen (which is obtained from the air through the process of fractional distillation) and Hydrogen (which is obtained from natural gas) is needed. There are certain conditions required for the Haber Process to be set into motion. One is that the pressure of both the gases must be increased to 200 atm (2026500 Pascals) in order to increase the rate of the reaction. After the gases have been pressurised, they are passed through a tank which has a temperature of 450 degrees celsius and finely divided iron which acts as a catalyst (a substance which increases the rate of reaction). Increasing the rate of reaction by the increase in pressure, increase in temperature, and the presence of a catalyst, is the only way this process is feasible otherwise the yield of ammonia becomes too little and the reaction is too slow to make a difference. Finally, the ammonia produced is liquefied and collected.

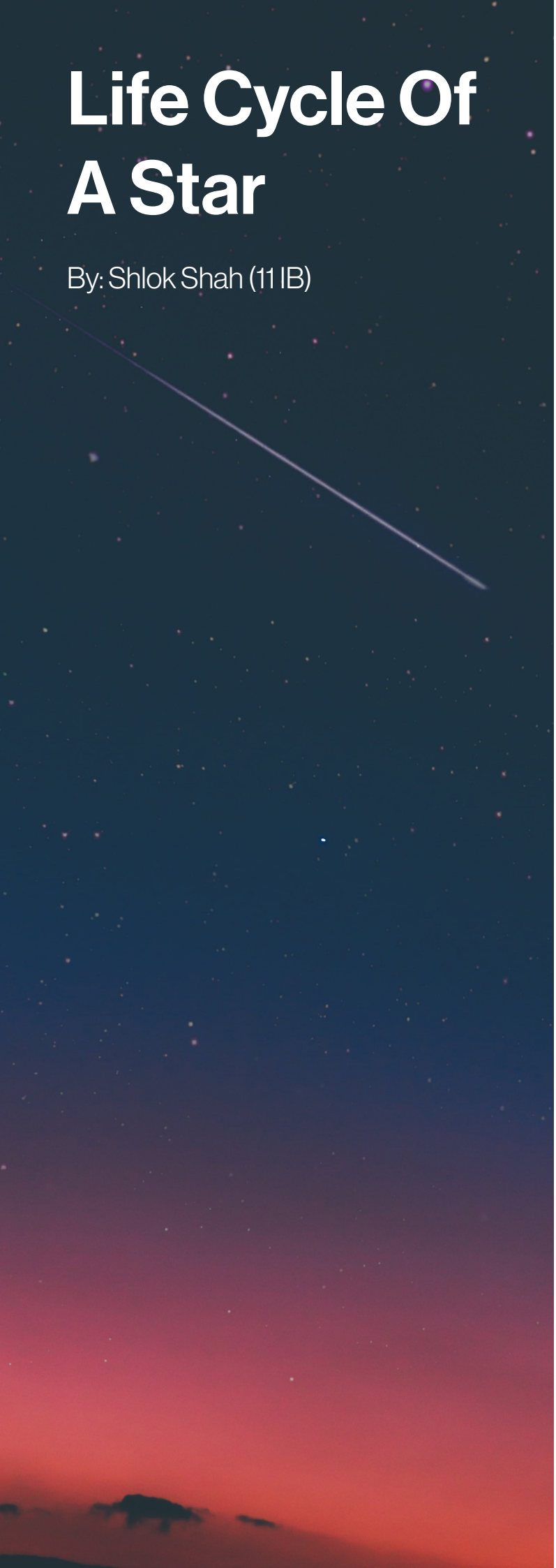
So, after inventing one of the most important processes known to mankind and helping the lives of countless people around the globe, why is he often regarded as an evil entity? The answer lies in one of the most brutal wars ever witnessed on this planet, World War 1. Fritz Haber was assigned to the role of captain in the German army and oversaw the chemical warfare department. He personally contributed to the weaponization of chlorine and advocated for using chemical weapons in the war. He was so devoted to this work that he developed a new chemical relationship called the Haber's rule which related the concentration of a toxic gas and the time it would take to kill a human being. Whilst he was applauded in Germany for his work, he was heavily scrutinized by his scientists of other nations and he was given the title of "The Father of Chemical Warfare".

So, what was he? A great scientist or a despicable criminal? The choice is up to you. I would like to leave you with a quote from Haber and I ask you to think upon it: "During peacetime a scientist belongs to the World, but during war time he belongs to his country."

www.wikiwand.com/en/Fritz_Haber, www.nobelprize.org/prizes/chemistry/1918/haber/biographical/, www.nobelprize.org/prizes/chemistry/1918/haber/biographical/

Life Cycle Of A Star

By: Shlok Shah (11 IB)



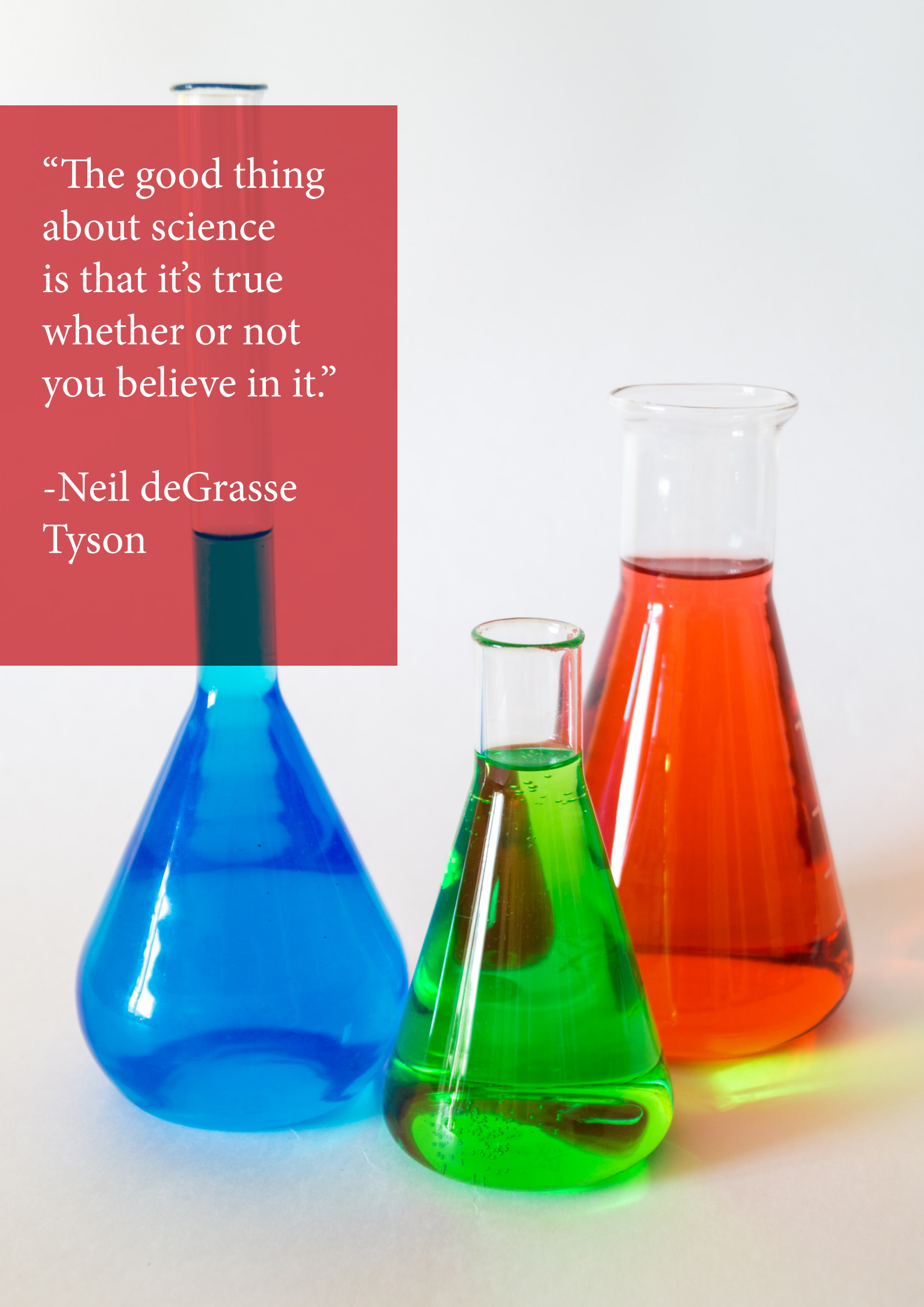
There are mainly two types of stars when they are born they are called an average star or a massive star. These stars are formed when one nebula has gained enough mass that it can collapse under its own gravity. The internal pressure formed in this reaction is enough to trigger the hydrogen down in the core of the nebula to start fusion. As soon as the nuclear fusion begins we say that a star has formed. So what is the difference between a massive star and an average star? An average star can be said to have a mass which is less than that of the sun or 8 times larger compared to our sun. While massive stars have at least 8 times the mass of our sun.

When all the hydrogen in the star has been used then the stars will start to contract as the outward pressure is not equal to gravity. So this contraction in the star will cause all the latent hydrogen in the shell of the star and the helium from the core to fuse again. This will form a red giant in the case of an average star and it will form a Red supergiant in case of massive stars.

After the fusion of helium and hydrogen in average star, the energy released by this process will cause an outward pressure on the envelope of the star which will make the red giant into a planetary nebula, but in this expansion, the core of the star will stay as it is and the envelop will expand into space and will be gone into space in no time. The remaining core will turn into a white dwarf and when the white dwarf will run out of fuel the white dwarf will become a black dwarf.

But the massive star will not have such a peaceful death, in case of the red supergiant it after its death it would be the same case where the outward pressure will no more be the same as the inward pressure and the hydrogen and helium will fuse again, but in case of a supergiant the amount of hydrogen and helium are both in very quantities and so the energy release is also very high which will cause the envelope to explode in this case and it will also leave the core behind. Such an explosion of the envelope of a star is called a supernova. Then the core which is left behind, in this case, has two options: it can either form a black hole or it can turn into a neutron star.

www.space.com/57-stars-formation-classification-and-constellations.html


“The good thing about science is that it’s true whether or not you believe in it.”
-Neil deGrasse Tyson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