COGITO137

THE THOUGHT CAPSULE

DEC 2020 | ISSUE V

"Inventas Vitam Juvat Excolisse Per Artes"

HEPATATIS C

CRISPR

BLACK HOLE

THE RAMAN EFFECT

"FOR THE GREATEST BENEFIT TO HUMANKIND"

Cogito137 The Thought Capsule

DESIGN BY SHREYASH PRAMOD BORKAR

EDITOR'S NOTE

Cogito137 brings to you it's first themed issue, centred around: "*Inventas vitam juvat excoluisse per artes*." This Swedish inscription on the reverse side of all Nobel Prizes can be loosely translated into, "And they who bettered life on earth by newfound mastery." A word for word translation of the same means "inventions enhance life which is beautified through art".

As the cover design suggests, it is an issue themed around explaining the science behind the Nobel Prizes 2020. While we honour the scientists and their contributions in their respective fields, leading to the prizes, we mourn the loss of a scientist who was not a Nobel laureate, but devoted his short lifespan to the popularisation of art and science, through various public engagements - Dr. Alexander 'Sasha' Kagansky. Team Cogito137 mourns his sudden demise and as an ode to his memory, we have uploaded an interview of his on our YouTube channel. We had the opportunity to feature an excerpt on the same in our launch event.

In this issue, we have three articles which attempt to simplify the science and their societal impact, of the Nobel Prizes awarded in Physics, Chemistry, and Physiology and Medicine, by Ranadeep Ghosh Dastidar, Debojyoti Ghosh and Maithili Dutta, respectively, who have recently graduated with their BS-MS degrees from IISER Kolkata. In addition, we have a biographical piece in Odia by Barnali Das, about the first Indian to receive a Nobel Prize - Dr. CV Raman, and another article explaining the 'Raman Effect' - for which he was awarded the Nobel Prize.

We generally try to tailor our content for a very general readership. However, this issue might prove to be slightly deviant, given that it attempts to simplify Nobel-winning sciences, but is intelligible to people with a higher secondary level background of science. Soon after the Nobel Prizes were announced, we organised a series of public lectures and panel discussions with speakers and panellists based in India and abroad. The entire 'Nobel in focus' series, organised in collaboration with the Science Club of IISER Kolkata, is available on our YouTube channel.

2020 has been an eventful year for all of us, to say the least. On one hand we might consider ourselves fortunate in some contrived way to be a part of the generation which survived and is still battling a pandemic that will shape human evolution and history in the years to come. On the other hand, we empathise with the several misfortunes that have befallen on people throughout the year.

From January, to December
This has been a year, to remember

Happy 2021 everyone!

Arunita Banerjee
Chief Editor, Cogito137

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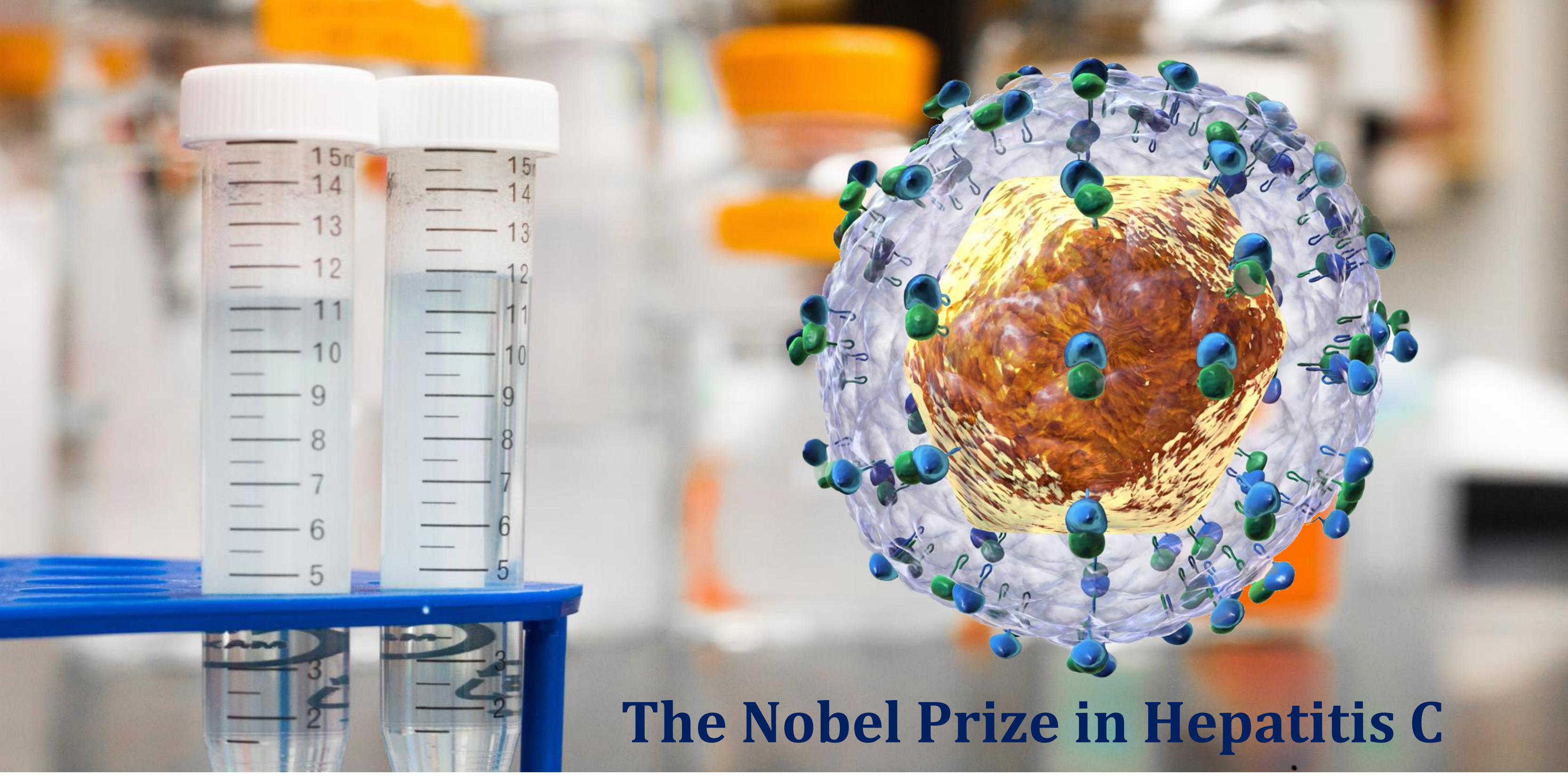


The Nobel Prize in Hepatitis C

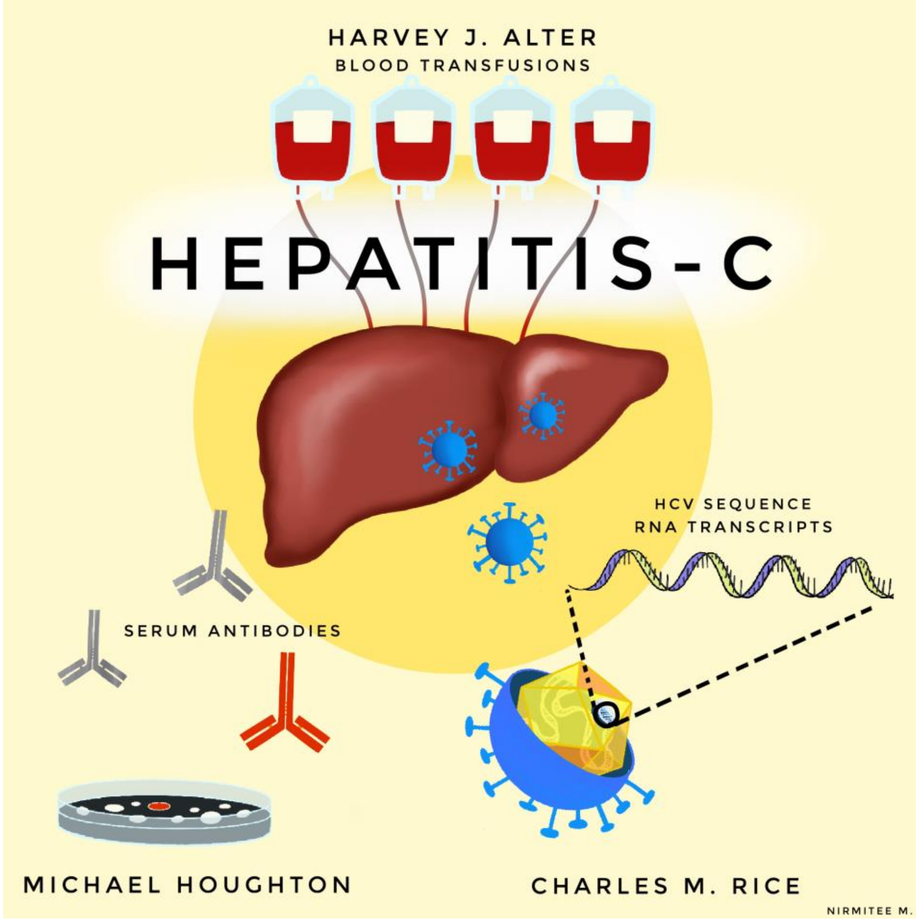
By Maithili Datta

This year the Nobel Prize came with a lot of joy to the scientific community. On one hand we got CRISPR as a revolutionary discovery, on the other hand, the hope to eliminate the Hepatitis C virus got accelerated. The HCV which killed millions of people worldwide can now be suppressed and that brings a way to get rid of this deadly illness.

'Hepatitis-C', a phrase once enough to create mass panic among people in the late 1900s, is still the most common chronic blood-borne infection in the United States with approximately 170 million people infected by this virus worldwide annually. Hepatitis is the medical term for liver inflammation where the word is a combination of Greek words for liver and inflammation. It is primarily caused by viral infections, but environmental factors and alcohol consumption play a role behind the onset of this disease. There are five common types of hepatitis viruses, termed as A, B, C, D and E. Among them hepatitis B and C create chronic and lifelong infections that can lead to serious liver disease. The hepatitis C virus (HCV) keeps mutating rapidly, making it difficult to create an effective vaccine. The HCV is the leading cause of cirrhosis (late stage of scarring of the liver), and hepatocellular carcinoma (a type of cancer).

The three Nobel Prize awardees this year, Harvey J. Alter, Michael Houghton and Charles M. Rice contributed to the fight against this blood-borne disease revealing the cause of the remaining unexplained cases of chronic hepatitis. HCV was initially isolated from the serum of a person with 'non-A, non-B' hepatitis in 1989 and stated as the sole reason for approximately 90% of the above-mentioned unexplained hepatitis in the U.S. The Hepatitis C virus is an RNA virus that belongs to the *Flaviviridae* family and it replicates in the hepatocytes (chief functional cells of the liver). Continuous cell-to-cell spread and rapid production of the virus along with the lack of T-cell immune response to HCV antigens accelerate the viral infection. Frequent HCV mutations have made the search for an HCV vaccine challenging. As it blood-borne disease, the risks of transmission include intravenous drug use, high-risk sexual activity, solid organ transplantation from an infected donor, occupational exposure, haemodialysis, household exposure, birth to an infected mother, and intranasal cocaine use. According to the U.S. The chronicity of HCV was found to be lower in younger individuals and in women.

Earlier, it was established that there are two main types of hepatitis, named as Hepatitis A and B. The former is transmitted through polluted water or food and it is less likely to affect the patient in long-term, whereas the latter transmits through blood and bodily fluids, leading to chronic conditions which causes serious damage to the health system which further leads to cirrhosis or liver cancer. Blood borne hepatitis causes more than a million deaths per year worldwide. Baruch Blumberg received the Nobel Prize in 1976 for the discovery of Hepatitis B virus that was causing blood-borne hepatitis which opened the path to the development of an effective vaccine. Tests for hepatitis A virus were also developed around this time but the risk factor is quite low in such cases. At that time, Harvey J. Alter was examining samples taken from the patients who had received blood transfusions, at the US National Institute of Health. After the discovery of blood-borne Hepatitis B virus, the number of cases of transfusion-related hepatitis was significantly lowered. Alter stated that a large number of cases remained unexplained and demonstrated that the blood from these



Nobel Prize in Physiology 2020 - Hepatitis-C Virus
(Illustration by Nirmitee M)

hepatitis patients transmits the disease to chimpanzees. The subsequent studies reported that the unknown infectious agent had characteristics of a virus and further investigations defined this disease as a distinct form of chronic viral hepatitis which was then known as 'non-A non-B' Hepatitis.

Although the existence of this hepatitis from an unknown infectious agent had been proven, the identification of the virus was still required. Michael Houghton, then working in a pharmaceutical company Chiron, took the responsibility and created a collection of DNA fragments from the nucleic acids obtained from an infected chimpanzee. Majority of these fragments came from the genome of the chimpanzee itself, but based on their assumption that antibodies against the virus would be present in the blood samples taken from the patients, the blood of human beings consist of serum and blood cells. They collected the serum from the blood samples and investigated it to identify if there are any DNA fragments, from which viral protein of HCV can be synthesised. If yes, that will lead to the conclusion that those DNA fragments are cloned from Hepatitis C virus, which will lead to further conclusion about the presence of Hepatitis C virus in their blood samples. Following this experiment, they found one positive clone and studied that. This study revealed that this clone was derived from the novel RNA virus belonging to the *Flavivirus* family and later, it was named as Hepatitis C virus.

The identification of the virus raised another - question whether the virus alone can infect and cause Hepatitis? Charles M. Rice, researcher at Washington University in St. Louis. Rice, along with other groups working on RNA viruses, speculated that this region at the end of the genome of Hepatitis C virus, which are not yet characterised, may play an important role in viral replication. Rice created an RNA variant of Hepatitis C virus through genetic engineering and injected it into the liver of chimpanzees. The virus was detected in the blood and the pathological changes similar to those occurring in humans, were observed in chimpanzees. This experiment gave the conclusion that Hepatitis C virus alone could cause the unsolved cases of transfusion-generated hepatitis.

This path-breaking discovery was important because for the first time in history, the disease could now be cured. The Nobel Prize in Physiology this year is a landmark achievement as the work will increase the availability of highly sensitive blood tests and eliminate post-transfusion hepatitis in around the world. Their discovery initiated the development of antiviral drugs rapidly against the hepatitis C virus. Hepatitis C remains a major global health concern, but the opportunity now exists to eliminate the disease.

Maithili *is an integrated graduate from the integrated BS-MS program at IISER Kolkata. She is currently pursuing her extended thesis at IISER Kolkata. She works at the protein engineering lab and she is interested in Biochemistry.*

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Coastal sites exhibit red coloured skies in the mornings and at sunsets. Picture taken in Pondicherry.
Photo by: Chinmaya KV

Hues Across the Horizon

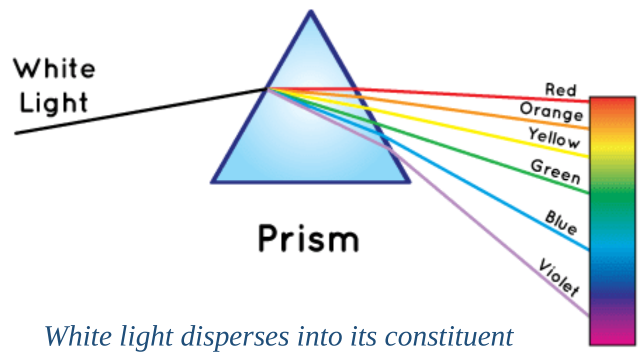
By Chinmaya KV

An entertaining read about simple observations to deep ruminations on the colors in the sky. The article goes down the memory lane from the simple delights of watching a rainbow to the contributions of Prof. C.V Raman, the first Indian scientist who won the Nobel Prize in 1930 for explaining the scattering of light by molecules.

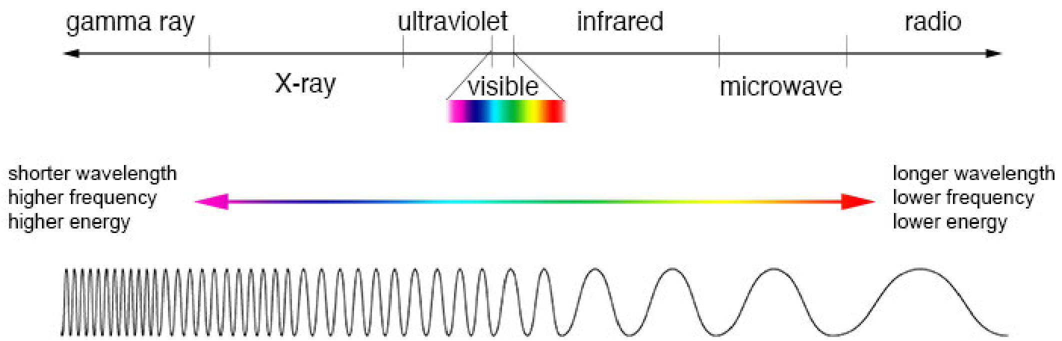
When you wake up early in the morning and look at the sky, it appears as a spectacular blend of red, yellow and blue. Afterwards, in the day, the sky gradually becomes blue and dazzling white follows at noon. In the evening, the same trend occurs in reverse order until it plunges into the darkness of the night.

No doubt, the fascinating display of colours inspired the impressionists to paint their canvases. Scientists got curious to unravel the mystery behind it as well. They understood that the appearance of the colourful sky is due to three simple interplaying factors. Firstly, the sunlight which has different wavelengths of electromagnetic radiations. Secondly, the particles in the Earth's atmosphere that disperse the sunlight to varying amounts and directions. Finally perception of the light by the human eyes.

But before getting into the elaborate discussion, let me invite you to recall the joys of watching rainbows. A fascinating phenomenon happens in nature when sunlight shines from behind the observer



White light disperses into its constituent wavelengths upon passing through a prism



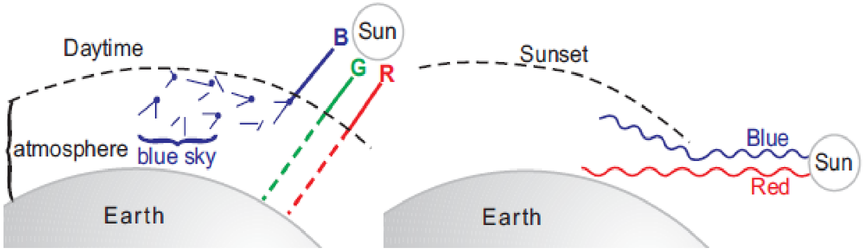
Comparison of wavelength, frequency and energy for the electromagnetic spectrum.

(Credit: NASA's Imagine the Universe)

on the water droplets in the air at a low altitude range. During the course, the light travels from one medium (Air) to another (Water) at some angle. As a result, the light beam bends and splits up into its constituent seven colors. Each color has its frequency and wavelengths while violet has the shortest red longest wavelength. In 1869, Scientist Rayleigh figured out the hidden mathematical rule behind the extent of the scattering of light. He showed that the intensity of the scattered light (energy flowing per unit area per unit time) is inversely proportional to the fourth power of its wavelength. In simple words, the lesser the wavelength the more will be the intensity.

Bees (top) capture minute details of a flower because of ultraviolet vision unlike human beings (illustration by Nirmitee M.)

When sunlight shines towards the air molecules, they absorb and reemit the light in all possible directions. Colors depend on what molecules are present in the atmosphere. Unlike Earth, the blue colored sky is not seen in the daytime on other planets. Recently, NASA's rovers captured the image of the sky of planet Mars. The Martian sky takes on an orange or reddish hue during the daytime. But in the evening, it appears as blue-gray[2]. The particles present in the atmosphere of Mars disperse light differently than those



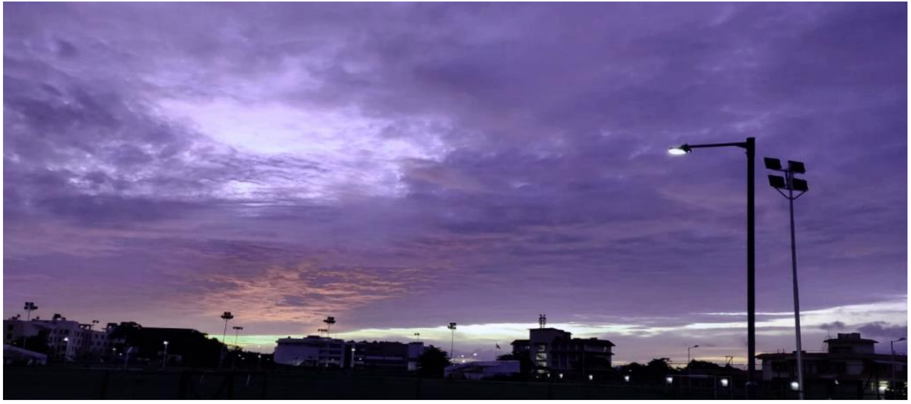
Rayleigh Scattering causes us to perceive a blue sky during daytime and a red sky at sunset. Image Source: Principles of Remote Sensing (Tempfli et al.)[1]

present in the Earth. The atmosphere of Mars consists of carbon dioxide along with the dust particles.

Our earth is predominantly composed of gases like nitrogen (78%), oxygen (21%) etc. by volume. Trace amounts of water vapor and dust particles are also present. Small size particles effectively scatter light

[1] "Principles of Remote Sensing." https://webapps.itc.utwente.nl/librarywww/papers_2009/general/principlesremotesensing.pdf. Accessed 21 Oct. 2020.

[2] "Why Is the Sky Blue? - NASA Space Place." https://spaceplace.nasa.gov/blue-sky/en/. Accessed 21 Oct. 2020.



IISER skies are often a delight to watch. Liliac-violet is an unusual shade observed at dusks.
(photo by: Fazal Kareem)

of low frequencies like violet and blue. The abundant amount of oxygen present in the atmosphere of Earth scatters blue light the most. As a result, the sky looks blue during the day.

But why do most of the time the sky appears blue instead of violet and indigo? It is notable that the range in the spectrum of light emission from the sun is not constant at all wavelengths. Also, human eyes are biological cameras. They can detect colors wonderfully within the visible range in the electromagnetic spectrum like the bees have the ability to detect UV range frequencies. Human eyes are made up of two types of cells called cones and rod cells. Each of them are sensitive to light of different wavelengths. Our eyes respond more strongly to blue, cyan, and green wavelengths of light than they do to violet. Even though if there is more violet light, it is not enough to overcome the strong blue signal our brains deliver.[3]

This Year 2020, 131st birth anniversary of Prof. CV Raman who was to the first Asian to win Nobel Prize for Physics in 1930 for discovering the Raman Effect.
(Image edited by: Naman Agrawal)

What happens during the sun set? The sunset will appear either yellow or yellowish red when the air is clean but appears redder in the presence of natural or synthetic pollutants. It is because some of the blue light has scattered away hence leaving behind a pure red hue to filter through. Sunsets over the sea may also be orange due to the presence of salt particles in the air. They are effective Tyndall scatterers. While Rayleigh scattering involves particles that are far smaller than the wavelength of light, Tyndall scattering is done by bigger particles called colloids. Hence Tyndall scattering is more intense than Rayleigh.

Some people believe that the ocean looks blue due to the reflection of the sky. Prof. CV Raman established that the blue color of the seas occurs due to the scattering of light by the water molecules. People now know it as Raman scattering. Raman scattering involves a change in the frequency of incident light upon deflection, unlike Rayleigh scattering. The frequency shift is characteristic of the molecule thus can be used for the detection of unknown compounds. Prof CV Raman won the Nobel prize in 1930 for the discovery of Raman effect. He was the first Indian to win a Nobel prize in Science.

***Chinmaya KV** did his Masters in Physics and now he is a long term fellow at Open Academic Research group, CCMB, Hyderabad. His predominant interest is in science communication through writing, interviewing researchers and photography for the public. As a student of science, he has observed that quick comprehension of scientific information is not easy and varies vastly between audiences and individuals, depending on interest and skill-level.*

[3] "Why The Sky Is Blue, According To Science - Forbes." 8 Sep. 2017, https://www.forbes.com/sites/startswithabang/2017/09/08/why-the-sky-is-blue-according-to-science/. Accessed 24 Oct. 2020.

Cogito137
The Thought Capsule

#WIISER

Women in Science
IISER

Cogito137-The thought capsule, is proud to host a showcase of amazing women, excelling at various STEM fields in IISER.

Get in touch with us if you would like to interview any woman faculty from IISERs.

P.S. - Anybody can approach us for conducting the interview, within or from outside the IISER community.

We are extremely delighted to announce that Cogito137 has launched its YouTube channel in October.

Cogito137 welcomes scientific video content creators and offers a platform for you to contribute to the nurturing of society. We are as of now open to video content in 8 languages, namely; Bangla, Marathi, Odia, Assamese, Kannada, Tamizh, Hindi and English.

The videos will be featured under IISER Kolkata's banner on Cogito137's YouTube as well as Cogito137's IGTV.

Do check out our guidelines for the same:- Submission Guidelines
Interested people may join this WhatsApp group:- Cogito137 Video Segment

There is no deadline, submissions can be made perennially and perpetually. Check out our website for details on the editorial guidelines.

Note: No prior experience is required. All those interested and who can commit seriously and work to the best of their abilities are welcome.We only need helpful committed hands interested in making an impact, to create the best content!

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Looking at Nothing: Investigating The Lights from a Black Hole

By Ranadeep Ghosh Dastidar

Being one of the most advanced theories of its time, (and its past) general theory of relativity (GTR) was viewed as a fundamental necessity to account for the discrepancies in Newtonian gravity. Trying to account for the changing precession of Mercury, Einstein's theory ended up unleashing hidden (quite literally) monsters in the extreme gravity. Black holes being probably the most famous example of that. Since the first theoretical proposition of a black hole through GTR, attempts to realize them theoretically and probe observationally, have more often than not raised more questions than answers. However, its journey of a century now, from 1919 to 2020 has paved way for milestones impacting the very foundations of Physics. This year, the Royal Swedish Academy of Sciences decided to award the Nobel Prize to two such milestones, for the proof of the theory of the very existence of the black hole and ingenious methods to observe them.

Our whole universe was in a hot, dense state Then nearly fourteen billion years ago expansion started, wait. . .

Wasn't it only last year the Royal Swedish Academy of Sciences started their Nobel Prize in Physics announcement with the title track of 'The Big Bang Theory' - a popular Television sitcom,, in the mood of it being awarded to physical cosmology and exoplanets?! And yet again the very next year it was again awarded in the subtopic of cosmology and astrophysics. A field which attracted 3.5 Nobles from 1901 to 2000, and already 6 since 2001-2020. Drawing parallels with the show, Prof. Andrea Ghez as the real-life Amy Farrah Fowler becomes only the fourth woman in Physics to be awarded the Nobel Prize. While this year it's remarkable to see the theory and its observation bagging the award together, it also makes the fraction of female laureates in Physics 1.9% (4 of 216 winners)[1]. While hopefully, the long-running trend of "same old white men'' dominating the prizes is diversifying, the trend towards cosmology and astrophysics is getting stronger. While the other fields may not be fancying this, why is it that three awards in the past four years have something or the other to do with "Black Holes''.

It was in the trenches somewhere in the eastern front of Germany, the director of the Astrophysical Observatory in Potsdam, serving as an artillery lieutenant, Karl Schwarzschild came across the recently proposed theory of gravitation only a few months back, in November 2015. In only a couple of months, Schwarzschild would write back to Einstein, giving the first-ever formal and exact solution to his field equation. Contrary to Einstein's beliefs, who considered his field equation for gravity could not be solved exactly, Schwarzschild had proposed a solution for a rather "boring" system - 'how do space and time behave around a spherical, non-charged, non rotating massive object'. While this showed that exact solutions to Einstein's Field Equation do exist, perhaps the biggest implication of it was what happens when that plain and simple object becomes very heavy (say few tens of solar masses), such that the escape velocity from it is more than the speed of light. In fact, any object having finite mass, Schwarzschild's solution, a geometric one (Schwarzschild metric), predicted the existence of a spherical boundary centered around it, at $r_s = 2GM/c^2$ from the center of the object of mass M, within which the gravitational pull is so high that not even light could escape from it, the event horizon. But, for most of our daily massive objects, such a radius is negligible (often less than Planck length), to put things in perspective, if our own Earth was to become so dense it has to be compressed to the side of a peanut!! In the stellar perspective however a large M allows for a more formidable rs, formerly known as "frozen stars'', these bizarre objects would eventually be called "Black Hole", a term coined in confusion by John Wheeler in 1967. Schwarzschild's 'boring system' solution was soon followed by solutions of Einstein's field equation for space around a charged massive object (Hans Reissner and Gunnar Nordström, 1916-18), rotating object (Roy P. Kerr, 1963), and eventually charged-rotating massive objects (Roy Kerr and Ezra Newman, 1965). These were just the tip of an iceberg (or rather the entire

Figure 1*: Amal Kumar Roychoudhari carrying Proger Penrose and Stephen Hawking on his shoulder. In honour of Roychoudhuri equation for basis of Penrose-Hawking singularity, Ref. Sayan Kar, Resonance 2008.*

We couldn't wait for the apple to drop...

[1] *Nobel Foundation Archive, Physics Facts and Statistics,* *https://www.nobelprize.org/prizes/physics/*

Antarctic) for a field which would go on to fascinate Physicists and awe people, probably even beyond our lifetime.

Until the late 1950s, Schwarzschild's solution and others were received with much criticism for it contained 'singularities' when describing massive dense objects. Risking cliché, a very generic and crude way to visualise singularities is assuming it to be holes through a paper (yeah yeah, seen a million times in sci-fi). What Schwarzschild and others before 1960 proposed had two such tears through paper, one at the very center of the object and the other at the boundary of 'no light escape' or better known as the event horizon of an ob ject. This for Schwarzschild's solution lies at a radius of rs from the center of the object. While mathematically perfect and beautiful, singularities are mind-boggling nightmares for Physics. For the simple fact that, all laws of Physics can be expressed as differential equations, and calculus 101 teaches us they make sense only over continuous space (or space-time to be rigorous) and tears through pages aren't quite that favorable. So for Physics and Physicists, all hell breaks loose when they encounter singularities, and skepticism to black holes as described by Schwarzschild, Reissner-Nordstr¨om is understandable. All until the 1960s, a decade which proved to be quite the game-changer for black holes, both theoretically and observationally. Kruskal and Szekeres in the 1960[2], would eventually go on to show that the event horizon singularity arising in Schwarzschild metric was due to a bad choice of coordinate system. In an impressive turn of events, using a hyperbolic coordinate transformation they discovered a single piece of coordinate system in which the space-time around a black hole could be described through continuous and differentiable coordinates, both inside and outside the event horizon. Thus proving the existence of event horizon is not a singularity but a very real boundary!! But what they still failed at was, their new coordinate system still could not account for the other singularity a the very center of black holes (at r = 0, if you may wish). Here comes in the picture our very own city boy from Kolkata (then Calcutta), Prof. Amal Kumar Raychoudhari (commonly called AKR). Working very reluctantly on properties of metal, AKR was always passionate about maths and deeply fascinated by general theory of relativity. Known lesser as one of the early proponents of Big Bang Theory, AKR's biggest contribution to GTR was the very famous Raychaudhuri

Equation[3] $\theta_{,\mu}\nu^{\mu} - a^{\mu}_{;\mu} + \frac{1}{3}\theta^2 + 2(\sigma^2 - w^2) = R_{\mu\nu}\nu^{\mu}\nu^{\nu}$. Published first in 1955, this equation was independently discovered also by the very famous Lev Landau and would go on to change how physicists viewed singularities forever. In a nutshell what this equation says is that, if we consider multiple balls (or dust) traveling directly towards the center of a black hole from multiple directions, all of them can not but converge to a single point at the very center of it. But what the outstanding feature of this was, unlike its successors, the Raychaudhuri equation is a coordinate independent solution for the most generalised mass distribution. Thus contrary to, say, Schwarzschild metric event horizon, this converging point is not

[2] M.D. Kruskal, Phys. Rev. 119, 1743 (1960) and P. Szekeres, Publ. Math. Debrecen, 7 285 (1960)

[3] Raychaudhuri, A. K., Relativistic cosmology I., Phys. Rev. 98 (4) (1955)

a coordinate singularity (one which can be done away with a different choice of coordinates), but a physical (real) one indeed. While Roychoudhari dealt only with dust (non-interacting), it lacked a key ingredient which collapsing masses or stars had, pressure. A star undergoing collapse due to its own gravity is expected to shrink in size, eventually becoming a dense ball of matter, so dense that all its atoms and particles are ripped apart to their constituent neutrons, aptly called neutron stars. Yet another genius and Nobel laureate of Indian origin, back in 1930, however showed that even if after the collapse, such a neutron star was to weigh more than 1.4 times the mass of sun gravity shall further overpower the pressure from neutrons that holds the shape of the star. This limit in his honour (as you already guessed) is called the Chandrasekar limit.

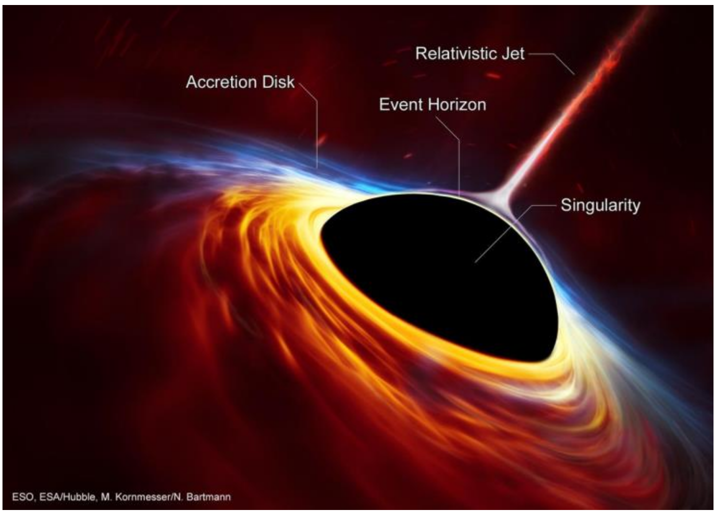


***Figure 2**: The various basic characteristics of a black hole. Penrose was the first to show that singularity is a physical necessity for a black hole. The accretion disk and relativistic jets are two very prominent energy sources detectable from near a black hole. Source: ESO*

Thus, for a massive star undergoing collapse, we not only need to consider its trajectory but also the thermodynamics of it. This is where the brilliance of Roger Penrose kicks in (1965), building on Raychaudhuri equation, and generalised form on Einstein field equation including thermodynamic effects he showed that, if the space is infinite, and light becomes trapped inside a bounded region, a singularity is inevitable within it. In other words, if any particle was to enter such a bounded region, its trajectory over space and time would eventually blow up or become undefined eventually. And lo and behold, a collapsing star with more than 1.4 solar masses provides just the boundary, in the form of an event horizon in a very real universe. Penrose's close buddy and an other genius beyond limits, Stephen William Hawking would build on this and go on to show for a finite space, all particles must eventually trace back to one single point in space and time, maybe a bang?! This theory eventually would merge and come to be known as the Penrose-Hawking singularity theorem. While Hawking showed one of the biggest revelations of GTR, the Big Bang, Penrose had indeed shown "that black hole formation is a robust prediction of the general theory of relativity". Maybe in a fantasy world, Hawking and AKR were still alive and possibly shared the 2020 Nobel Prize with Penrose. But, for fact, this year holds another beauty when theory and observation shared the prize.

The 1960s was not only a theoretician's paradise, around the 1950s and early '60s (1963 to be precise) the all-sky radio survey, an effort by the European observatories to map the sky for objects in the radio frequency, noted a distinguished bright source '3C 48'. What was fascinating was this radio source object seemed to be invisible in the optical sky, meaning the visible spectrum. By the end of the decade, hundreds more like it would be added to that list. Maarten Schmidt, a

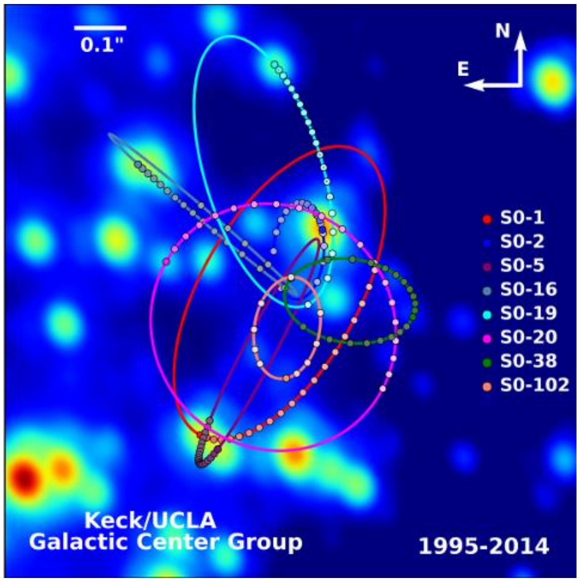


Figure 3*: Orbits of some of the closest star orbiting the supermas sive compact object, a blackhole Sagittarius A* at the center of milky way galaxy. Source: observations by Galactic Center Group, Keck tele scope/UCLA.*

dutch astronomer observing 3C 48 using the Hale Telescope in the United States and Parkes Radio Telescope in Australia, was able to finally obtain a visible counterpart and its optical spectrum. While optical spectrums were supposed to yield the constituents of an astronomical source, hence its redshift (or blueshift) compared to on Earth spectrum of those elements and eventually the distance of the objects. 3C 48 was set to follow an entirely different course. An object which was surely a stellar object (star-like thingy), did not constitute any known element ever found in a star. Even if it did, the rate at which it was receding (redshift in the spectrum) was way beyond anything else ever observed. Further interferometric observations revealed, not only was it brighter than any galaxy (yes, the entire galaxy!!) ever observed, it was smaller than 1 light-year in size. They were hence called quasi-stellar objects, or a more familiar nickname 'Quasar'. Only a theoretical fantasy then, the most accepted explanation we know today was given pretty soon in 1964 by Edwin Salpeter and Yakov Zal'dovic. Supermassive black holes at the center of a galaxy feeding in on its nearby stars, or what's technically called accretion disks. The feeding is so violent and gigantic, that it would emit radiations of energy in the radio frequency, energy more than any physical explanation ever perceived of, some a thousand times more than that of our entire galaxy!! While theoreticians were gradually packing up to understand a single black hole of a few tens of solar masses, here we already had observed supermassive black holes ranging from a few million to some hundreds of millions solar masses size.

After innumerous observations in radio and optical frequency, using some of the very famous observations like the deep field image from Hubble Space Telescope, we now know that most (if not all) galactic centers have such supermassive black holes at their centers, some feeding actively and some not so much. Our own Milkyway is no exception, falling in the former category, a supermassive compact radio source in the night sky. Observed first at the National Radio Astronomy Observatory, United States, found near the star Sagittarius, named aptly by one of its first observers, astronomer Robert Brown because the radio source was 'exciting', Sagittarius A*[4]. Thus, it became the nearest and the most obvious source to look at and study. But how do you "look at" something like a black hole, which you can't see? Well, you obviously don't. Further unlike quasars, Sagittarius A* is not an active galactic nucleus and hence we do not

4 Goss, W. M.; Brown, Robert L.; Lo, K. Y., The Discovery of Sgr A*. Astronomische Nachrichten. 324 (1) (2003)

have the luxury to study its accretion disk too. What's studied is its presence, the impact of the supermassive black hole on its nearby visible stars at the center of our galaxy. As pain staking as it sounds, thousands of stars at the center of our Milky way are studied, and most of them individually, one by one. Two rival groups who pioneered this mammoth task made quite an impact. One led by Prof. Andrea Ghez at the University of California, Los Angeles, and the other, an alumnus of the same university, Prof. Reinhard Genzel, director Max Planck Institute of Extraterrestrial Physics, Germany. Although having access to two of the best telescopes in the world, Keck Observatory in Hawaii (Ghez group) and Very Large Telescope (very honest name!) in Chile (Genzel group), the task was not as straightforward. Just like any photograph, astronomical observations are victims of blur rings. Imaging the very center of the galaxy was hard enough, even for the best telescopes, but the images further blurred due to continuously changing Earth's atmosphere. To start with, Genzel used a well known and standard technique, called speckle imaging. Wherein, multiple snapshots of the same data were superimposed to avoid the blurring caused by Earth's atmosphere. Later, both would move on to a very innovative observational technique called adaptive optics. A laser pointed to infinity, originating at the observatory, serves as what you may call a pseudo star. Since the disruptions in this pseudo star due to atmosphere, can be accurately tracked by the laser pointer corrections, the same corrections are implemented for an observed star. this enhanced the observations many folds.

In Prof. Genzel's word, the two did not have a particularly friendly relationship[5], but the rivalry achieved something very much desired, two groups arriving at the same results independently. One of the striking observations made by both was a star, orbiting "nothing" with a 16 year time period at 2.55% the speed of light. Around the end of last decade, working independently the German group reported the mass of this supermassive

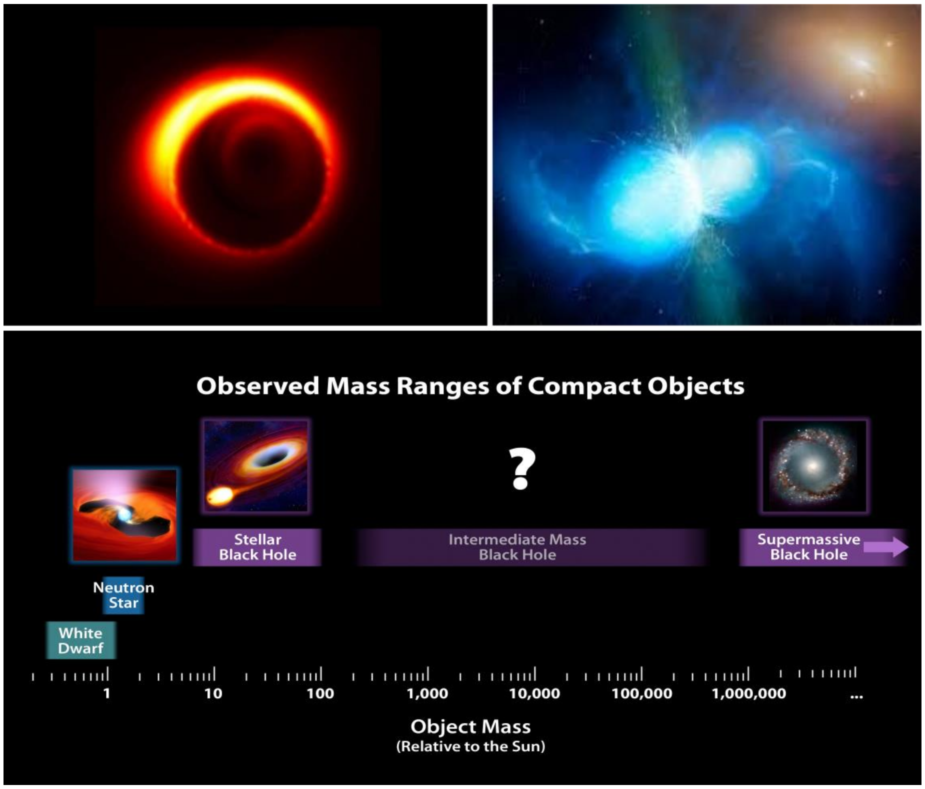


Figure 4: *We are in the golden age of astrophysics and cosmology. Top left, an artist's impression of a direct image of Sagittarius A*. Top right, artist's impression of two neutron star mergering, detected in 2017. Bot tom, a huge missing part of the puzzle is black holes of thousands of solar mass range, existance of which was hinted just this year.*

5 Interview conducted by Grolle, J. and Seidler C., Spiegel International, Nobel Prize Winner: It's Unbelievable All That's Going On at the Moment in Astronomy, (2020)

black hole to be 4.21 ±0.38 million solar masses, the American counterparts reported a 3.7 ±0.2 million solar masses, all confined in a 44 million kilometer diameter. To put in perspective, around 4 million suns compressed in a sphere having a diameter less than the distance from Earth to Mars. A truly supermassive compact object at the center of our galaxy indeed.

While it may seem it is about time for the oldest branch of science to put to rest. It's only recently more and more breakthroughs are coming. It was only 2015 when we heard what the tune of gravity sounds like, gravitational ripples spreading like waves creating an entirely new branch of Gravitational Wave Astronomy. Only a couple of years back when, for the first time ever, we heard the waves and saw the act of the same astronomical event when two neutron stars merged. Only last year, when we photographed a real black hole in action, and only this year, when we got hints about intermediate-mass black holes (heavier than Schwarzschild and Penrose's, lighter than Andrea and Reinhard's). It is only now, the modern telescopes let us see way way more than we already expect. So when we look up at the sky, we always have more questions than answers.

*I am **Ranadeep Ghosh Dastidar**, most commonly known as Rana. I graduated from IISERk this year itself, completing my MS thesis at CESSI, and currently a first-year graduate student at Purdue University in the United States. While I like research, my predilection for the fancy popularistic Physics words is more (hence got carried away by the starts and stuff). I hate to read but love to speak. So nonstop talking gives the greatest satisfaction, followed very closely by cooking and eating. My academic interests on the other hand lie with astrophysics, which lets me speak a lot, travel and manage my own time in the name of sky observations.*

YouTube

Dr Kagansky's short interview conducted on 25th of September 2020, by Arunita Banerjee from Team Cogito137.

The cloud-nine of CRISPR

By Debjyoti Ghosh

The article gives a brief overview of one of the most path-breaking discoveries of interdisciplinary sciences in the 21st century - the CRISPR-Cas9 system.

This year, the Nobel Prize in Chemistry is awarded for discovering gene technology's one of the most invaluable tools – the CRISPR genetic scissors. Prof. Emmanuelle Charpentier from Max Planck Institute of Infection Biology, Berlin and Prof. Jennifer Doudna from the University of California, Berkeley published this revolutionary finding in 2012[1].

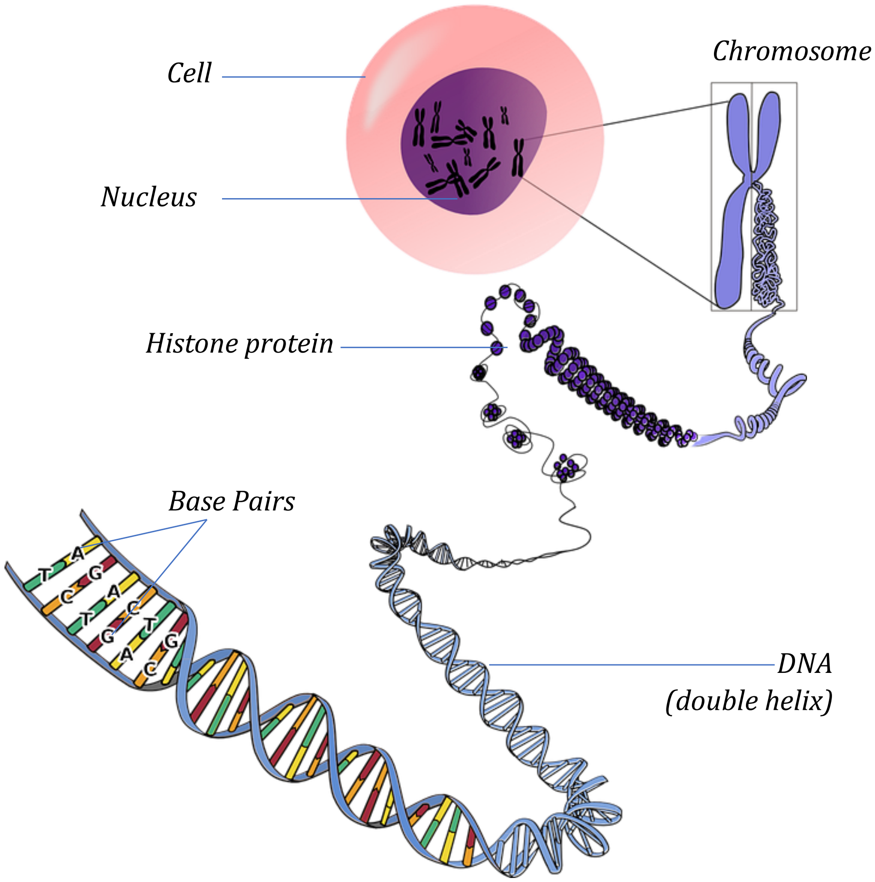
CRISPR is a powerful RNA-guided DNA[2] targeting platform for genome editing, imaging and alteration at the transcription level. This technology can precisely manipulate any genomic sequence identified by a small region of guide RNA. The outcome of the process is a huge boon in terms of the difficulty in understanding

Prof. Emanuelle Charpentier (left) & Prof. Jennifer Doudna (right)

[1] *Jinek M., Chylinski K., Fonfara I. et al. A Programmable Dual-RNA–Guided DNA Endonuclease in Adaptive Bacterial Immunity, SCIENCE 337 (6096), p. 816-821 (2012), https://doi.org/10.1126/science.1225829*

2 Watson J., and Crick F. Molecular Structure of Nucleic Acids: A Structure for Deoxyribose Nucleic Acid, Nature 171, p. 737–738 (1953), https://doi.org/10.1038/171737a0 gene functions responsible for disease developments. The technology also provides scope to figure out rectification of the disease-causing changes inflicted by the viral attack on the host system such as bacteria etc.

Many bacteria such as *Streptococcus*, *Staphylococcus*, and *Saccharomyces, etc. and* similar organisms like archaea have their immune systems encoded by CRISPR loci and the CRISPR-associated (*Cas*) genes to provide immunity against invading virus called bacteriophage and transfer of foreign DNA molecules called plasmids**.**



All hereditary information is stored in cells in the form of genomes. Cells contain chromosomes which in turn carry long fibres called chromatin made up of DNA (building blocks called nucleotides, which are organic macromolecules).

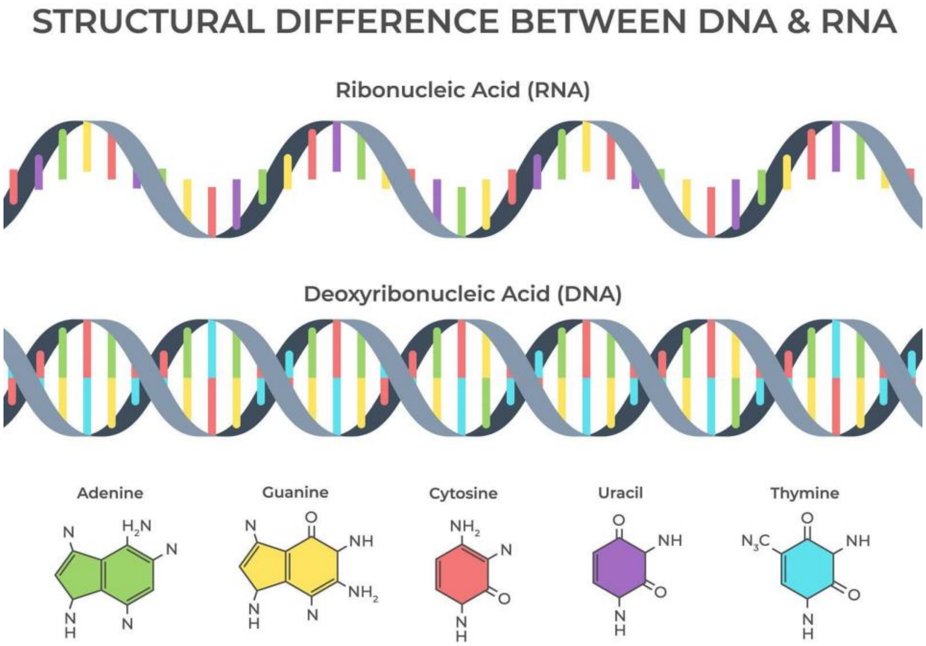
(Source: iStock)

All hereditary information in a cell is contained in the genome. The genome consists of DNA and RNA. DNAs get converted into RNA through a process called transcription. RNAs make different types of proteins by the translation process. DNA and RNAs are giant organic macromolecules made up of nucleotides. CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats. It is a specialized region of DNA with two distinct characteristics – the presence of repeated sequences of nucleotides and interlaying spacers.

Spacers are the genetic information of the invading bacteriophages[3]. Once the spacers are inserted in the CRISPR region of DNA, transcription begins and eventually forms CRISPR RNA (crRNA). The resultant crRNA guides a DNA cleaving protein called nuclease (Cas9) to

Artist's impression of bacteriophages attacking a bacteria. The singular globular green coloured structure is bacteria where the ones in yellow are viruses. Bacteria are unicellular microscopic organisms whereas viruses that attack them are called bacteriophages. *(source:Pininterest, credit:unknown)*

3 Doudna J.A. and Charpentier E. The new frontier of genome engineering with CRISPR-Cas9, Science, 346 (6213) (2014), https://doi.org/10.1126/science.1258096



Picture showing molecules that make up DNA and RNA - the genetic material building all life-forms
(Source: iStock)

cut down the invading viral DNA sequence, thereby preventing further infection. Interestingly, Cas9 doesn't cleave randomly. Specific motifs called PAMs (Protospacer adjacent motifs) serve as indicators. They sit adjacent to the target DNA sequences, thereby helping the Cas9 nuclease detect and chop off the intended target[4]. Such efficient cleaving features of the CRISPR-Cas9 system raised the prospect of using this system as an efficient and accurate genome editing tool.

The first-ever demonstration of this technology was seen by Prof Rodolphe Barrangou and a team at Danisco, a food ingredients company in 2007 using *Streptococcus thermophilus* as the model system (an extensively used bacteria in dairy industries)[5].

In 2012, scientists demonstrated that crRNAs could be constructed to guide the Cas nucleases to any DNA sequences. The Cas9 nuclease was the first and the most prevalent of all Cas nucleases implicated. Subsequently, the scientists coined the defense mechanism as the 'CRISPR-associated protein 9 (Cas9) system.

Some of the recent findings involving the CRISPR system tell us about the impact of the amazing discovery. Now, identifying viral strains in blood serum, urine and saliva[6]; removing a heart disease in an embryo[7]; editing thousands of genes at once in a single experiment is possible[8]. Altering the genome of crops to make them resilient against droughts is happening through CRISPR technology[9]. It would certainly have taken several more years down-the-line without CRISPR.

However, not every significant discovery is always thoroughly infallible. It is often challenging to deliver the CRISPR-Cas9 system to cells in necessary quantities without considering the clinical applications. Though scientists claim it to be 100% efficient and accurate, but it still

4 Jiang F. and Doudna J.A., CRISPR–Cas9 Structures and Mechanisms, Annu. Rev. Biophys. 46, p. 505-529 (2017), https://doi.org/10.1146/annurev-biophys-062215-010822

5 Deveau H., Barrangou R., Garneau J. E. et al. Phage Response to CRISPR-Encoded Resistance in Streptococcus thermophilus, Journal of Bacteriology 190 (4), p. 1390-1400 (2008), https://doi.org/10.1128/JB.01412-07

6 Gootenberg J.S., Abudayyeh O.O., Lee JW. et al. Nucleic acid detection with CRISPR-Cas13a/C2c2. Science, 356 (6336), p. 438-442 (2017), https://doi.org/10.1126/science.aam9321

7 Ma, H., Marti-Gutierrez, N., Park, SW. et al. Correction of a pathogenic gene mutation in human embryos. Nature 548, 413–419 (2017). https://doi.org/10.1038/nature23305

8 Sadhu, M.J., Bloom, J.S., Day, L. et al. Highly parallel genome variant engineering with CRISPR–Cas9. Nat Genet 50, 510–514 (2018). https://doi.org/10.1038/s41588-018-0087-y

9 Wang, T., Zhang, H. and Zhu, H. CRISPR technology is revolutionizing the improvement of tomato and other fruit crops. Hortic Res 6, 77 (2019). https://doi.org/10.1038/s41438-019-0159-x

hasn't scaled up to such extreme heights. Applications like human germline[a] editing have raised serious ethical and societal objections[10]. They can be used to enhance desirable traits instead of curing diseases, which can be put to bad usage[11].

Certainly, such a revolutionary finding has improved the scope of research in ways that were impossible to venture into earlier. Just as the efficient-and-accurate CRISPR-Cas9 system removes the detrimental genes, CRISPR technology has made life a tad easy for scientists by significantly reducing the time duration for finding solutions to the existing problems. However, a huge scope still exists to know more about it. The technology is as inspirational as the words of Prof. Jennifer Doudna - "The more we know, the more we realize there is to know"[12]

***Debjyoti Ghosh** is currently a project student in the Department of Biological Sciences at IISER Kolkata. He is an enthusiast in synthetic biology (specifically protein engineering). He completed his BS-MS here in July 2020. Interestingly, football is his gravest addiction and he seems to find time for his other interests besides his research.*

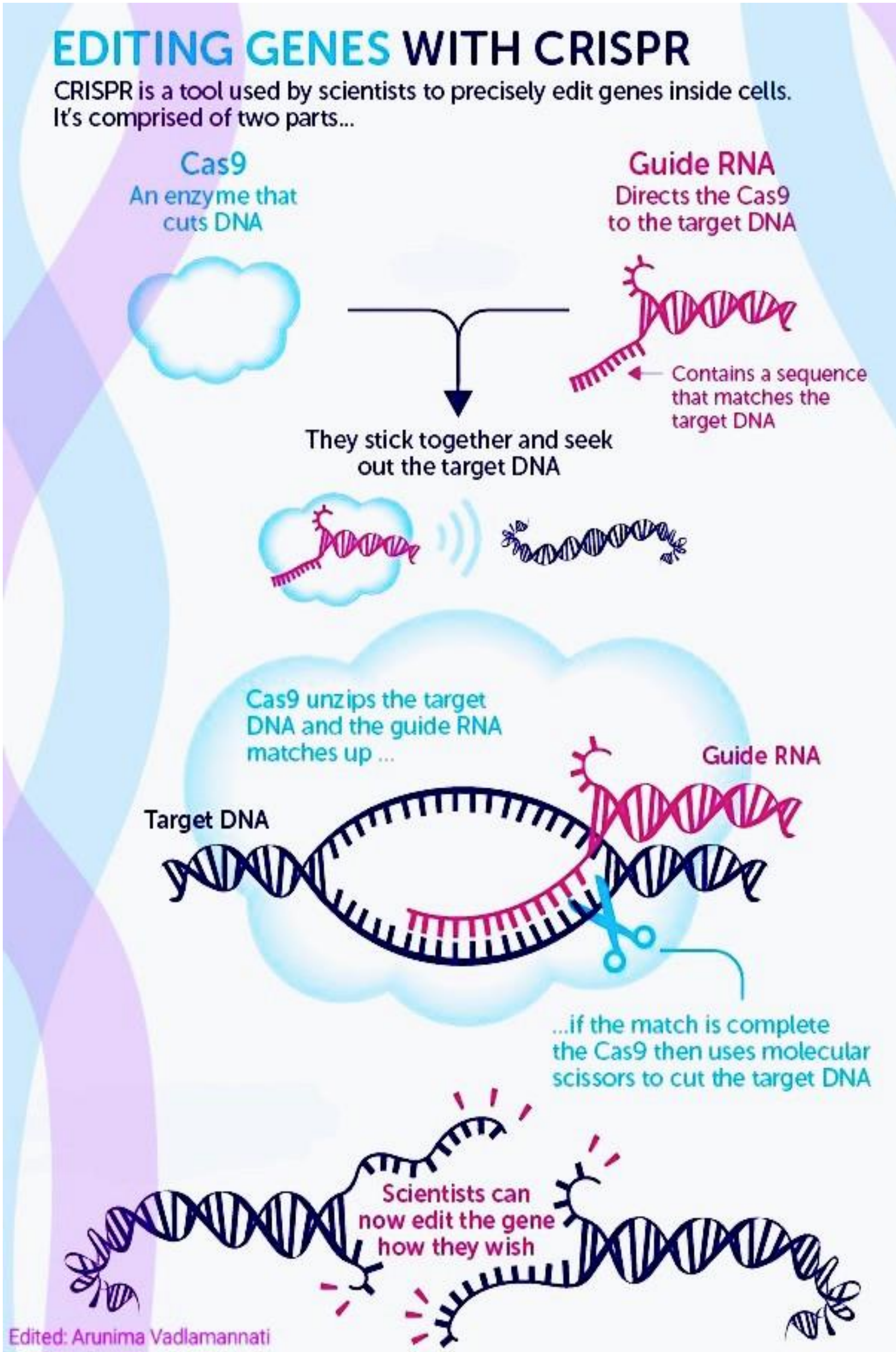


Photo credit: Cancer research UK

Endnote:

***a. Human germline editing:** It is a bioengineering methodology by which the genome of an individual is edited in such a way that the change is inheritable. This can be achieved by genetically altering the germ cells, such as the egg and the sperm.*

***Editor's Note :**Here is a funny take on crispr issue. Hope you all enjoy!* Acapela on crispr!

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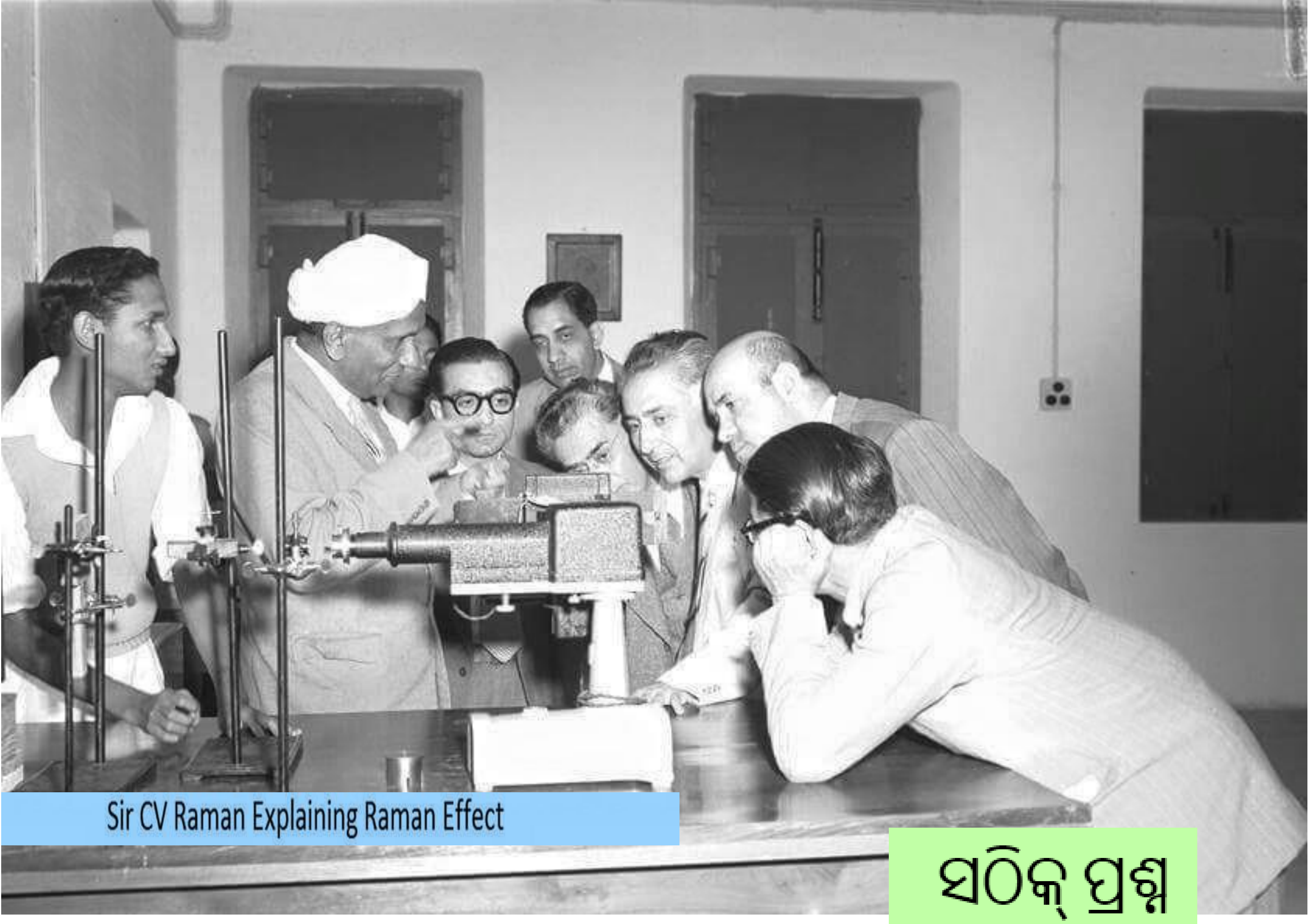
10 Isasi R., Kleiderman E. and Knoppers KM. Editing policy to fit the genome? Science 351 (6271), p. 337-339 (2016), https://doi.org/10.1126/science.aad6778

11 Human Genome Editing - Science, Ethics and Governance, The National Academic Press, Chapter 6, p. 137-162 (2017), https://www.nap.edu/read/24623/chapter/8

12 Hayden EC. Human genome at ten: Life is complicated, Nature 464, p. 664-667 (2010), https://doi.org/10.1038/464664a



Sir CV Raman Explaining Raman Effect

ସଠିକ୍ ପ୍ରଶ୍ନ

ବର୍ଣ୍ଣାଳୀ ଦାସ(Barnali Das)

ଏସିଆ ମହାଦେଶରେ ବିଜ୍ଞାନରେ ପ୍ରଥମ ନୋବେଲ ପୁରସ୍କାର ବିଜେତା, ଯାହାଙ୍କର ଆଲୋକ କ୍ଷେତ୍ରରେ ହୋଇଥିବା ଯୁଗାନ୍ତକାରୀ ଗବେଷଣା ଆଜି ମଧ୍ୟ ବହୁ ଗବେଷକଙ୍କ ପାଇଁ ଉଲ୍ଲେଖନୀୟ ସୋପାନ | ବାଲ୍ୟ ଜୀବନରୁ ଅସାଧାରଣ ପ୍ରତିଭାଧାରୀ ମଣିଷ ପରବର୍ତୀ ଜୀବନରେ ସଫଳତାର ଶିଖରରେ ପହଁଚି ଆମ ମାନଙ୍କ ପାଇଁ ଏକ ଆଦର୍ଶ ସାଜିଛନ୍ତି | ଏହି ମହାନ ବୈଜ୍ଞାନିକ ଜଣକ ହେଉଛନ୍ତି ଚନ୍ଦ୍ରଶେଖର ଭେଙ୍କଟ ରମଣ |

"'କମ୍ପଟନ୍ ପ୍ରଭାବ' (Compton Effect) ପାଇଁ ଏକ ଚାକ୍ଷୁଷ ଅନୁରୂପ ରହିବା ଆବଶ୍ୟକ। ଆମେ ନିଶ୍ଚୟ ଏହାକୁ ଅନୁସରଣ କରିବା ଉଚିତ ଏବଂ ଆମେ ସଠିକ୍ ରାସ୍ତାରେ ଅଛୁ। ଏହା ମିଳିବ ଏବଂ ନିଶ୍ଚୟ ମିଳିବ। ନୋବେଲ ପୁରସ୍କାର ଜିତିବା ଜରୁରୀ। " ଏହି ଶବ୍ଦଗୁଡ଼ିକ ଥିଲା ଜଣେ ଆତ୍ମବିଶ୍ୱାସୀ ଗବେଷକଙ୍କ ନିଜ ଛାତ୍ରକୁ | ସେହି ମୁହୂର୍ତ୍ତରୁ ଏକ ସମ୍ମାନଜନକ ପୁରସ୍କାର ପାଇଁ ଅପେକ୍ଷା ଆରମ୍ଭ ହେଲା | 1930 ନୋବେଲ ପୁରସ୍କାର ସେ ଜିତିବେ ବୋଲି ଏତେ ନିଶ୍ଚିତ ଥିଲେ ଯେ ସେ ବିଜେତା ଘୋଷିତ ହେବାର ଚାରି ମାସ ପୂର୍ବରୁ ସ୍ୱିଡେନକୁ ଟିକେଟ କାଟି ସାରିଥିଲେ। ଏହି ଗବେଷକ ଜଣକ ହେଲେ ସି.ଭି. ରମଣ (ଚନ୍ଦ୍ରଶେଖର ଭେଙ୍କଟ ରମଣ-Chandrasekhara Venkata Raman) |

କିଏ ଜାଣିଥିଲା ଚନ୍ଦ୍ରଶେଖର ରାମନାଥନ୍ ଅୟର (Chandrasekhara Ramanathan Iyer) ଏବଂ ପାର୍ବତୀ ଅମ୍ମଲ (Parvathi Ammal) ଙ୍କ ଆଠଟି ସନ୍ତାନ ମଧ୍ୟରୁ ଦ୍ୱିତୀୟଟି ମାତ୍ର 42 ବର୍ଷ ମଧ୍ୟରେ ଦେଶର ଗୌରବ ହେବ। ମାତ୍ର 11 ବର୍ଷ ବୟସରେ ମାଟ୍ରିକ୍ ଏବଂ 13 ରେ ଯୁକ୍ତ ଦୁଇ ପରୀକ୍ଷାରେ ଉତ୍ତୀର୍ଣ୍ଣ ହୋଇଥିବା ଏହି ଅତୁଳନୀୟ ଶିଶୁ 7 ନଭେମ୍ବର 1888 ମସିହାରେ ମାଡ୍ରାସ୍ ପ୍ରେସିଡେନ୍ସି, ବ୍ରିଟିଶ୍ ଇଣ୍ଡିଆର ତିରୁଚିରାପଲିରେ ଜନ୍ମଗ୍ରହଣ କରିଥିଲେ (ବର୍ତ୍ତମାନ ଏହା ତାମିଲନାଡୁ, ଭାରତ)।

1902 ମସିହାରେ, ସେ ପ୍ରେସିଡେନ୍ସି କଲେଜରେ ଯୋଗ ଦେଇଥିଲେ ଯେଉଁଠାରେ ତାଙ୍କ ପିତାଙ୍କୁ ଗଣିତ ଏବଂ ପଦାର୍ଥ ବିଜ୍ଞାନ ଶିକ୍ଷକତା ପାଇଁ ବଦଳି କରାଯାଇଥିଲା | 1904 ରେ, ସେ ମାଡ୍ରାସ ବିଶ୍ୱବିଦ୍ୟାଳୟରୁ ବି.ଏ. ଡିଗ୍ରୀ ହାସଲ କଲେ ଏବଂ ପଦାର୍ଥ ବିଜ୍ଞାନରେ ସ୍ୱର୍ଣ୍ଣ ପଦକ ଜିତିଲେ | 18 ବର୍ଷ ବୟସରେ, ସେ ସ୍ନାତକୋତ୍ତର ଛାତ୍ର ଥିବାବେଳେ, ସେ ତାଙ୍କର ପ୍ରଥମ ଗବେଷଣା ପତ୍ରକୁ 1906 ମସିହାରେ ବ୍ରିଟିଶ ପତ୍ରିକା ଫିଲୋସୋଫିକାଲ୍ ମାଗାଜିନ (Philosophical Magazine) ରେ ପ୍ରକାଶ କରିଥିଲେ। ତାଙ୍କର ଦ୍ୱିତୀୟ ଗବେଷଣା ପତ୍ର ପ୍ରକାଶିତ ହେବା ପରେ ଯେତେବେଳେ ପ୍ରସିଦ୍ଧ ଲର୍ଡ ରେଲି (Lord Rayleigh) ତାଙ୍କ ସହ ଯୋଗାଯୋଗ କରିବାକୁ ଚେଷ୍ଟା କରିଥିଲେ ଏବଂ ଭୁଲ୍ ରେ 'ପ୍ରଫେସର ରମଣ ' ଭାବେ ସମ୍ବୋଧନ କରିଥିଲେ | ତେବେ 1907 ମସିହାରେ ସେ ପଦାର୍ଥ ବିଜ୍ଞାନରେ ସ୍ନାତକୋତ୍ତର ଉପାଧି ହାସଲ କରିଥିଲେ।

ଯେହେତୁ ସେ ସମୟରେ ଏକ ବୈଜ୍ଞାନିକ ବୃତ୍ତି ଏତେ ଆକର୍ଷଣୀୟ ନଥିଲା, ରମଣ 1907 ମସିହାରେ ଭାରତୀୟ ଅର୍ଥ ବିଭାଗରେ ଯୋଗ ଦେଲେ। ସେ ସାର୍ ଜଗଦୀସ୍ ଚନ୍ଦ୍ର ବୋଷ (Jagdish Chandra Bose)ଙ୍କୁ ଏକ ସାକ୍ଷାତ୍କାରରେ ଏହା ସ୍ପଷ୍ଟ କରିଦେଇଥିଲେ ଯେ ସେ ତାଙ୍କ ଭଳି ପଦାର୍ଥ ବିଜ୍ଞାନ ମଧ୍ୟ ଜାଣିଥିଲେ। କେହି କେହି ଏହାକୁ ଆତ୍ମବିଶ୍ୱାସ ବୋଲି କହିଥିଲେ, କେହି କେହି ଏହାକୁ ଗର୍ବ ବୋଲି କହିଥିଲେ, କେହି କେହି ଏହାକୁ ଅହଂକାର ବୋଲି ମଧ୍ୟ କହିଥିଲେ କିନ୍ତୁ ଏହିପରି ସେ ସବୁ ବ୍ୟକ୍ତିତ୍ୱର ମିଶ୍ରଣ ଥିଲେ।

ଯଦିଓ ତାଙ୍କୁ ଚାକିରି ସ୍ଥଳରେ ଅଧିକ ସମୟ ଦେବାକୁ ପଡୁଥିଲା, ସେ କଲିକତାରେ ଇଣ୍ଡିଆନ୍ ଆସୋସିଏସନ୍ ଫର କଲଟିଭେସନ୍ ଅଫ୍ ସାଇନ୍ସର ଲାବୋରେଟୋରୀରେ ପରୀକ୍ଷାମୂଳକ ଅନୁସନ୍ଧାନ ମଧ୍ୟ କରୁଥିଲେ | ସେହି ବର୍ଷ ସେ ଲୋକସୁନ୍ଦରୀ ଅମ୍ମଲ (Lokasundari Ammal)ଙ୍କୁ ବିବାହ କଲେ। ସେମାନଙ୍କର ଦୁଇପୁତ୍ର ଥିଲେ ଚନ୍ଦ୍ରଶେଖର ରମଣ (Chandrasekhar Raman) ଏବଂ ରେଡିଓ-ଜ୍ୟୋତିର୍ବିଜ୍ଞାନୀ ଭେଙ୍କଟ୍ ରମନ୍ ରାଧାକ୍ରିଷ୍ଣନ୍ (Venkatraman Radhakrishnan)। ସି.ଭି. ରମଣ 1983 ମସିହାରେ ପଦାର୍ଥ ବିଜ୍ଞାନରେ ନୋବେଲ ପୁରସ୍କାର ପାଇଥିବା ସୁବ୍ରମଣ୍ୟମ ଚନ୍ଦ୍ରଶେଖର (Subrahmanyan Chandrasekhar)ଙ୍କ କକା ଥିଲେ ।

1921 ପୂର୍ବରୁ, ସେ ଏବଂ ତାଙ୍କ ଛାତ୍ରମାନେ ମୁଖ୍ୟତଃ ତିନୋଟି କ୍ଷେତ୍ର- ଆଲୋକ ବିଜ୍ଞାନ, ଧ୍ୱନି ବିଜ୍ଞାନ ଏବଂ ଜ୍ୟୋତିର୍ବିଜ୍ଞାନରେ କାର୍ଯ୍ୟ କରିଥିଲେ | ତାଙ୍କ ପିତାଙ୍କ ପରି ରମଣ ଭାଓଲିନ (violin) ମଧ୍ୟ ବଜାଉଥିଲେ। ସଂଗୀତ ଏବଂ ଧ୍ୱନି ବିଜ୍ଞାନ ପ୍ରତି ତାଙ୍କର ଗଭୀର ଆଗ୍ରହ ଥିଲା । 1918ରେ ରମଣଙ୍କର ଏକ ସର୍ବୋତ୍କୃଷ୍ଟ କୃତି ବାହାରିଲା ଯାହା ଭାଓଲିନ ପରିବାରରେ ଥିବା ବାଦ୍ୟଯନ୍ତ୍ରର କମ୍ପନ ଉପରେ ଆଧାରିତ ଥିଲା ।

ଏ.ଏସ୍.ଆଇ (ASI- Astronomical Society of India) ର ବୈଠକରେ ସେ ଲୋକପ୍ରିୟ ବକ୍ତୃତା ପ୍ରଦାନ କରିଥିଲେ ଯାହା ସୋସାଇଟିର ପତ୍ରିକାରେ ପ୍ରକାଶିତ ହୋଇଥିଲା । ଏ ବକ୍ତୃତା ଦୂରବୀକ୍ଷଣ ଯନ୍ତ୍ର ଏବଂ ତା ସାହାଯ୍ୟରେ କରାଯାଇଥିବା ଜ୍ୟୋତିର୍ବିଜ୍ଞାନିକ ପର୍ଯ୍ୟବେକ୍ଷଣରେ ବିବର୍ତ୍ତନ (diffraction) ଏବଂ ବ୍ୟତିକରଣ (interference) ଘଟଣାଗୁଡ଼ିକ ଉପରେ ଆଧାରିତ ଥିଲା | ଏହିପରି, ସେ ଏକ ଚନ୍ଦ୍ରଗ୍ରହଣ, ଶୁକ୍ର ଏବଂ ବୃହସ୍ପତି ଉପଗ୍ରହ ଉପରେ ଏକ ଛୋଟ ଦୂରବୀକ୍ଷଣ ଯନ୍ତ୍ର ସାହାଯ୍ୟରେ ପର୍ଯ୍ୟବେକ୍ଷଣ ମଧ୍ୟ କରିଥିଲେ।

1921 ମସିହାରୁ ଆରମ୍ଭ କରି, ରମଣ ଏକ ନୂତନ ବିଷୟ, ଆଲୋକ ବିଜ୍ଞାନ ଉପରେ ଧ୍ୟାନ ଦେବା ଆରମ୍ଭ କଲେ ଏବଂ ପରବର୍ତ୍ତୀ ଦୁଇ ବର୍ଷ ମଧ୍ୟରେ ସେ ଏହି ବିଷୟରେ 42 ଟି ଗବେଷଣା ପତ୍ର ପ୍ରକାଶ କଲେ, କେତେକ ସହକର୍ମୀଙ୍କ ସହିତ | ସତ୍ୟ ଖୋଜିବା ପାଇଁ ଏପରି ନିଷ୍ଠାପର ପ୍ରୟାସର ଫଳାଫଳ ତାଙ୍କୁ ଅପେକ୍ଷା କରିଥିଲା | ଉଲ୍ଲେଖନୀୟ ବୈଜ୍ଞାନିକଙ୍କ 21 ଟି ବୈଧ ସୁପାରିଶ ମଧ୍ୟରୁ 1930 ନୋବେଲ ପୁରସ୍କାର ପାଇଁ ରମଣଙ୍କୁ 10 ଥର ପ୍ରସ୍ତାବ ଦିଆଯାଇଥିଲା ଏବଂ ସେଠାରେ ସ୍ପଷ୍ଟ ବିଜେତା ଥିଲେ | ଆବିଷ୍କାରର ମାତ୍ର ଦୁଇ ବର୍ଷ ପରେ ହିଁ ସେ ନୋବେଲ ପୁରସ୍କାର ପାଇଲେ ଯାହା ଏକ ବିଶେଷ ଉପଲବ୍ଧି। ଆଲୋକର ବିସରଣ (diffusion) କାର୍ଯ୍ୟ ଏବଂ ରମଣ ପ୍ରଭାବ ପାଇଁ ତାଙ୍କୁ ପୁରସ୍କୃତ କରାଯାଇଥିଲା | ତାଙ୍କ କାର୍ଯ୍ୟରେ ତାଙ୍କ ଛାତ୍ର କେ. ଏସ୍. କ୍ରିଷ୍ଣନ୍ (K. S. Krishnan) ପ୍ରମୁଖ ଭୂମିକା ଗ୍ରହଣ କରିଥିଲେ।

Nobel prize ceremony 1930

ତାଙ୍କର ଏହି ଛାତ୍ର, 1925 ମସିହାରେ ଏହା ପର୍ଯ୍ୟବେକ୍ଷଣ କରିଥିଲେ ଯେ, ଯେତେବେଳେ ଆଲୋକ ତରଳ ପଦାର୍ଥ ଦେଇ ଗତି କରେ, ସେତେବେଳେ ସାଧାରଣ ପ୍ରତ୍ୟାସ୍ଥ ପ୍ରକିର୍ଣ୍ଣନ (elastic scattering) ବ୍ୟତୀତ ଅନ୍ୟେକ ପ୍ରକିର୍ଣ୍ଣନ ରେଖା ଦେଖିବାକୁ ମିଳେ। ଏହି ଅନ୍ୟେକ ପ୍ରକିର୍ଣ୍ଣନ ରେଖା ସମ୍ବନ୍ଧୀୟ ଗବେଷଣା ପ୍ରସିଦ୍ଧ ରମଣ ପ୍ରଭାବକୁ ଆଗେଇ ନେଇଥିଲା ଯାହାକି ପଦାର୍ଥ ଦ୍ୱାରା ଆଲୋକର ଅପ୍ରତ୍ୟାସ୍ଥ ପ୍ରକିର୍ଣ୍ଣନ (inelastic scattering), ଅର୍ଥାତ୍ ଶକ୍ତିର ଆଦାନପ୍ରଦାନ ଏବଂ ଆଲୋକର ଦିଗରେ ପରିବର୍ତ୍ତନ କୁ ଦର୍ଶାଏ |

ବିଜ୍ଞାନ କ୍ଷେତ୍ରରେ ଅବଦାନ ହେତୁ ରମଣଙ୍କୁ ଅନେକ ପୁରସ୍କାର ପ୍ରଦାନ କରାଯାଇଥିଲା | ସେଗୁଡ଼ିକ ହେଉଛି ରୟାଲ୍ ସୋସାଇଟି ଫେଲୋ (Fellow of the Royal Society - 1924), ମ୍ୟାଟେଉଚି ପଦକ (Matteucci Medal - 1928), ନାଇଟ୍ ବ୍ୟାଚେଲର୍ (Knight Bachelor - 1930), ହ୍ୟୁଜ୍ ପଦକ (Hughes Medal - 1930), ପଦାର୍ଥ ବିଜ୍ଞାନରେ ନୋବେଲ ପୁରସ୍କାର (Nobel Prize in Physics - 1930), ଭାରତ ରତ୍ନ (Bharat Ratna - 1954), ଲେନିନ୍ ଶାନ୍ତି ପୁରସ୍କାର (Lenin Peace Prize - 1957) | ଏହି ମହାନ ବୈଜ୍ଞାନିକଙ୍କ ଦ୍ୱାରା ରମଣ ପ୍ରଭାବର ଆବିଷ୍କାର ପାଇଁ ପ୍ରତିବର୍ଷ 28 ଫେବୃଆରୀରେ ଭାରତରେ ଜାତୀୟ ବିଜ୍ଞାନ ଦିବସ ପାଳନ କରାଯାଏ |

ବାଙ୍ଗାଲୋରରେ ନିଜ ପରୀକ୍ଷାଗାରରେ କାମ କରୁଥିବା ବେଳେ ହୃଦ୍‌ଘାତର ଶିକାର ହୋଇ 21 ନଭେମ୍ବର 1970 ରେ ଏହି ମହାନ ବୈଜ୍ଞାନିକଙ୍କର ମହାପ୍ରୟାଣ ଘଟିଲା । ଆମ ପାଇଁ ଛାଡିଯାଇଥିବା ତାଙ୍କର ବାର୍ତ୍ତା "ସଠିକ୍ ପ୍ରଶ୍ନ ପଚାର, ପ୍ରକୃତି ତା'ର ରହସ୍ୟର ଦ୍ୱାର ଖୋଲିଦବ।"

Editor's Note: (Summary in English)

Nobel laureate in Physics 1930 for his work on the scattering of light and for the discovery of the effect named after him, the Raman effect, C.V Raman not only inspired masses to embrace the brilliance of science but also encouraged them to always ask the right questions. He emphasized the importance of asking the right questions and nature would pave the way to unravel its mysteries. This article delves into the life and achievements of Sir Chandrasekhara Venkata Raman.

ବର୍ଣ୍ଣାଳୀ ଦାସ_(Barnali Das) ଭୌତିକ ବିଜ୍ଞାନ ବିଭାଗ, IISER, କଲିକତା ବିଶେଷ ଆଗ୍ରହ – ଚିତ୍ର ଆଙ୍କିବା, ଗୀତ ଗାଇବା, ନୃତ୍ୟ କରିବା, ବିଜ୍ଞାନ ପ୍ରବନ୍ଧ ଲେଖିବା ହେଉଛି ତାଙ୍କର ଅନେକ ରୁଚି ମଧ୍ୟରୁ କିଛିଟା।_

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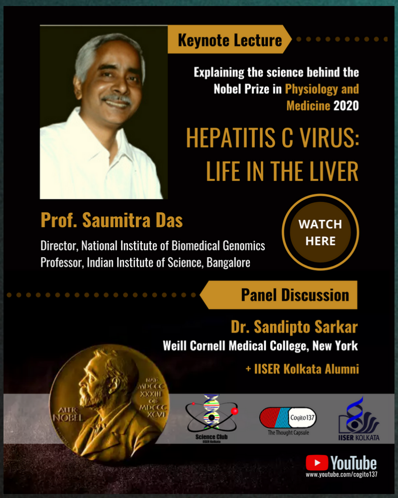

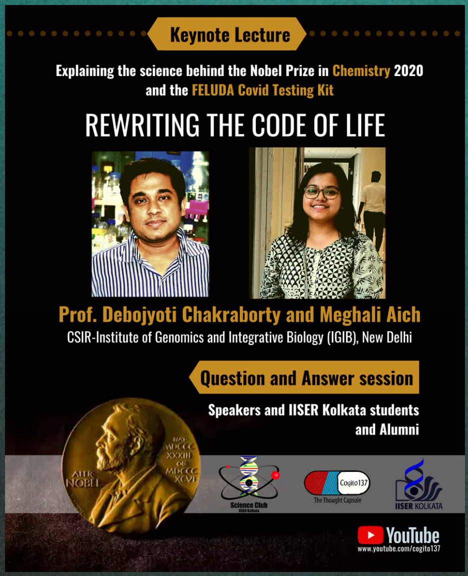

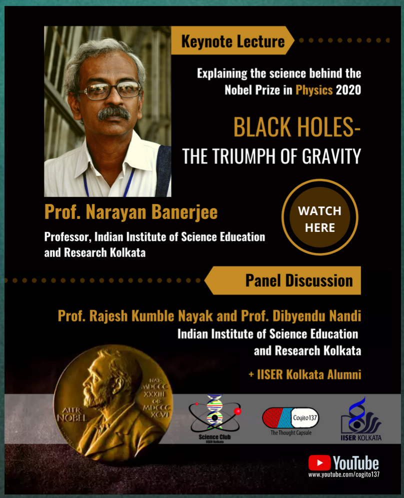

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