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PDEU PANDIT DEENDAYAL ENERGY UNIVERSITY
Formerly Pandit Deendayal Petroleum University (PDPU)
SOT SCHOOL OF TECHNOLOGY

# PHYSITIEN

*Department Of Physics Newsletter*

*Inside these pages...*




## ARTICLES

From superdeterminism to blackholes, explore the wonders of astrophysics through the array of articles listed within.

## INTERVIEW

Dive into the depths of astronomy with Dr. Brijmohan Thakore

## RIDDLES

Brainstorming for riddles is always a great way to gain knowledge. Test your wits in the riddle section.

## FUN FACTS

Mind boggling facts that are sure to peek your interest.

## PUBLICATIONS

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## DEPARTMENTAL ACTIVITIES

Various activities going on in the Physics department

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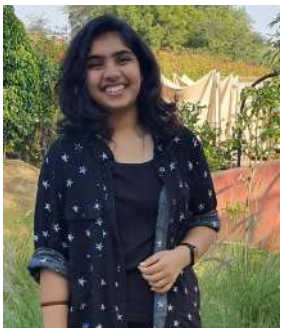
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# Welcome Address

*I am ecstatic to announce the first issue of Physics department newsletter PHYSITIEN, with Astrophysics as its first theme. This issue will try to unravel some of the mysteries of our universe in the form of diverse articles, fun facts and riddles. Our newsletter also contains "Interview" section where our students have interviewed Dr. Brijmohan Thakore, an eminent researcher in Astrophysics and Astronomy. This section will give our readers an insight in the life journeys of prominent personalities in Physics, thus, inspiring our many budding and young minds. This newsletter encompasses departmental activities of our faculties and students. I would like to compliment the newsletter editorial board consisting of faculties and students from each batch, who have worked in unison to bring this first issue to you all.*

Dr. Satyam Shinde
(HoD, Physics)

# From Editorial Board

"The most incomprehensible thing about the universe is that it is comprehensible. And this is the miracle of the human mind, to use its constructions, concepts, and formulas as tools to explain what one sees, feels and touches. So, try to comprehend a little more every day and simply do not stop questioning. Worry not about what you cannot answer because curiosity has its own reason for existence." These are the golden words by Albert Einstein which beautifully summarize the simplicity in complexity that is innate to the nature of Physics. Physics is a subject that especially aids to the curiosity of those inclined towards it and otherwise may seem beyond baffling.

With this Newsletter, PDEU's Department of Physics aims to encourage its fellow budding Physics scholars, readers, and writers to explore new concepts and ideas of Physics. We are eager to incentivise students with encapsulated write-ups to learn and push their knowledge bars. Thus, we hope that this new initiative will be an essential step in igniting and shaping fresh and curious Physics minds.

The first edition of Physics Newsletter is an exquisite compilation of some precise and admirably written articles, a scholarly interview of an esteemed professor Dr. Brijmohan Thakore, and some refreshing sections of riddles, amusing fun facts, and glimpses of a few departmental activities. The current Newsletter issue revolves around the theme of Astrophysics, a field of science that is not only popular amongst the physicists but also fascinates the commoners. Circling around this theme, we have riddles and fun facts which will be a knowledge-boosting column for you.

Thus, we look forward to inspiring you to write for our next issue and provide us with your unanswered questions to get them answered in the upcoming issue. We appreciate the efforts of all our team members who have so elegantly worked for the compilation of this issue.

*Keep Reading, Exploring, Writing, and Sharing!*

Prof. S. Sundar Manoharan (Director General, PDEU)

Prof. Sunil Khanna (Director SoT, PDEU)

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# Space Debris

By Krina - M.Sc. batch

Trash, junk, waste..... yes!! You read it right. Humans are very well aware of these words on the earth but to prove their accomplishments in space, they gave these expressions to that amazing world as well. From as large as a discarded rocket to as small as a microscopic chip, these non functional artificial objects called SPACE DEBRIS OR SPACE JUNK. NASA's Orbital Debris Program Office estimates that there are currently over 21,000 fragments larger than 10 centimeters in orbit. Particles between 1 and 10 centimeters might number about 500,000, and those under 1 centimeter could exceed 100 million. And all that traffic can lead to disaster. With the increasing number of launches comes a growing space debris challenge. Most of the accumulation of space debris is expected to happen in orbits low around the Earth, at an altitude of 800 to 1,000 kilometers, because those orbits are highly populated. Does the piece of junk really affect spacecrafts and satellites ?A number of space shuttle windows have been replaced because of damage caused by paint flecks. On Monday 2 July, the CryoSat-2 spacecraft was orbiting as usual, just over 700 kilometres above Earth's surface. but that day, a piece of space debris was hurtling uncontrollably towards the €140-million satellite, which monitors ice on the planet. As engineers tracked the paths of both objects, the chances of a collision slowly increased — forcing mission controllers to take action. On 9 July, ESA fired the thrusters on CryoSat-2 to boost it into a higher orbit. Just 50 minutes later, the debris rocketed past 4.1 kilometres a second.This kind of manoeuvre is becoming much more common each year, as space around Earth grows increasingly congested.Space agencies have begun taking steps to mitigate the problem.A Japanese company launched one such initiative recently. Called Elsa-D, the mission intends to demonstrate a space debris removal system.On March 22, 2021, a Soyuz rocket put 38 payloads into space. Among them was 'The End-of-Life Services by Astroscale demonstration mission' (Elsa-D), developed by a Japanese company called Astroscale.It is the world's first commercial mission to demonstrate a space debris removal system.

Elsa-D consists of two spacecraft: a 175-kg "servicer" and a 17-kg ``client". Client is the fake debris that the 'servicer' will have to release, grab, and

repeat. The solution involves steps to clean up the mess, mitigate damage, and avoid future debris. There are systems in place to track the debris and avert disasters. Various space organisations have been working on reducing the amount of trash by adopting better designs of rockets and other objects. For example, making rockets reusable could vastly cut down waste.Space trash is often attracted by Earth's gravitational pull. It is pulled lower and lower until it finally reaches Earth's atmosphere. Most objects burn up when they enter Earth's atmosphere due to the compression of atmospheric gases, but larger objects can reach the Earth intact. But most of them fall into the ocean, simply because Earth is mostly covered by water.According to NASA website, an average of one catalogued piece of debris has fallen back to Earth each day over the last 50 years. But there has not been any significant damage. Let's hope that the upcoming generation can see crystal clear and shielded space.

# Energy from blackoles: Fact or Fiction?

By Sanhit Mehta, Shlok Shah, Asit Dave, Arth Thakkar - 18 Batch

**History and background:**

To this day, blackholes remain one of the most perplexing and mind bending notions in modern physics and perhaps the biggest predictions of Einstein's theory of general relativity. These systems are formed when a star can no longer support itself against its own gravitational collapse, thereby compressing to a point where normal space-time breaks down and collapses totally into a singularity - a single one-dimensional point of infinite density. This singularity sits inside a region called the event horizon - the point at which the gravity around the black hole is so strong, not even light-speed is sufficient to achieve escape velocity.

Sucking in everything around them, even light, these monstrosities harness enough power to warp even gravity.

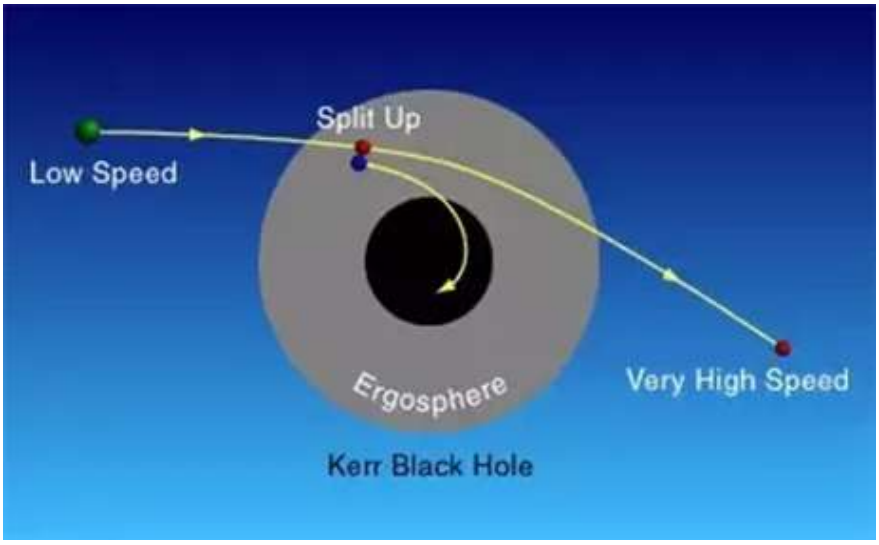
Even more fascinating is the fact that the energy

> **“Can the energy from blackholes be harnessed?”**

supplied by black holes is practically boundless. Because they suck everything in as fuel, and space has no shortage of food, black holes have incredibly long life spans.
To get specific, a black hole with the mass of our sun would likely survive $10^{67}$ years. However, the supermassive black holes at the center of our galaxy and most are far larger than this.
Keeping these facts in mind, one obvious question comes to mind:
"Can the energy from blackholes be harnessed?"
The answer, at least in principle, is yes and has been theorised by arguably one of the greatest mathematical physicists and Nobel laureate, Roger Penrose. The means to do so are described in what is called the Penrose process. The Penrose process is theorised by Roger Penrose as a means whereby energy can be extracted from a rotating black hole. That extraction can occur if the rotational energy of the black hole is located not inside the event horizon but outside in a region of the Kerr spacetime called the ergosphere in which any particle is necessarily propelled in locomotive concurrence with the rotating spacetime.

**Ergosphere:**
Ergosphere is a term basically associated with a rotating black hole. As proposed by Remo Ruffini and John Archibald Wheeler, it is a region located outside the event horizon of a rotating black hole. It is named so because it is theoretically possible to extract energy and mass from this region, a property which distinguishes it from the event horizon (which is also called the region of no return).The shape and size of an ergosphere depends on the black hole's speed of rotation or its angular momentum. Basically, it takes an oblate spheroidal shape: extending to a greater radius along the equator of the black hole and touching the event horizon at the poles. The reason that can be attributed for such a shape, as mentioned before, is the change of angular momentum of the black hole, being zero at the poles and maximum at the equator.This rotation not only affects the shape of the ergosphere, it even twirls and twists the spacetime around it, whose rate reduces with distance from the event horizon. This phenomenon is called the frame dragging effect. It is analogous to a fork rotating on a flat linen sheet, and the sheet getting distorted with it. As a consequence of this happening, an object inside an ergosphere cannot appear stationary to an outside observer, unless it moves faster than the speed of light.But the speed required for an object to look stationary decreases away from the event horizon and there comes a point when the speed becomes negligible. A locus of all such points forms what is called the ergosurface or the static limit.

**Rotating Black Hole Systems: Extraction of Energy**




This is where the Penrose process comes in, that at ergosphere, where frame-dragging is at its strongest, could be exploited to extract energy. Since stars are rotating in space, in order to preserve conservation of momentum, the black hole itself must have a non-zero rotational angular momentum. Theories explaining the process of harnessing energy from a black-hole comprises; Blandford and Znajek proposing a potential way in which to exploit the magnetic field of a rotating black hole for the purposes of energy extraction and Roger Penrose proposed a way in which to extract energy from a black hole by conservation of momentum.

In the Penrose process the premise is that if an object in an ergosphere but not at the event horizon broke apart, with one piece heading towards the center of the black hole and the other piece heading out, the piece that left the black hole would emerge with more energy than it would have entered with, implying on the conservation of momentum.

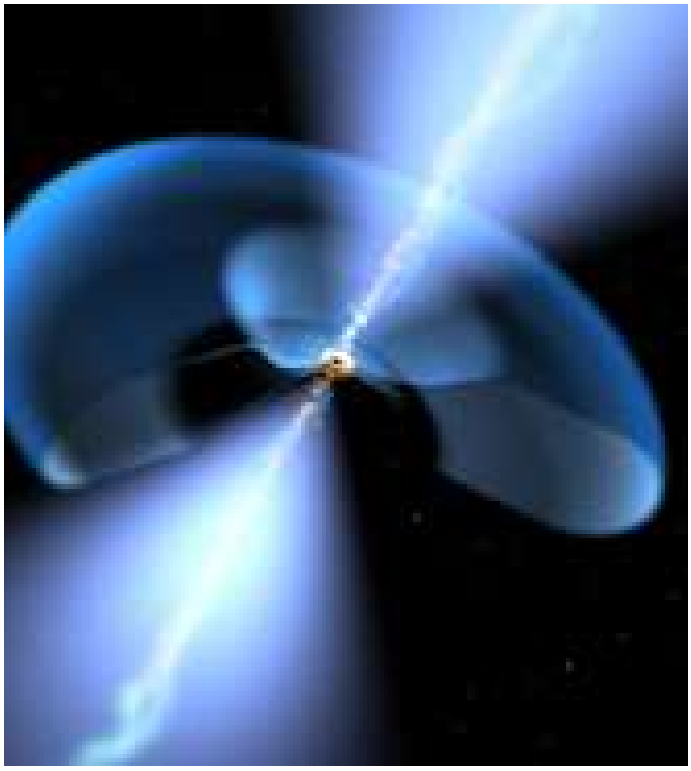
Both processes impede how important is the spinning of black hole to the extraction of energy out of it.

**The process:**

Imagine that you slip into a whirlpool, you will notice that you start moving with the flow of water no matter how much you resist. Now, instead of just floating along for a ride you think of paddling in the direction of the flow of water. You will perceive your speed to be dramatically increased than the speed at which you could normally swim. Nevertheless, you will fall into the center of the whirlpool eventually, as you would in a black hole. However, there is a possibility of you escaping the fall if you could leave something behind!

In theory, using the above analogy, when a lump of matter (let's say, a rocket) enters the ergosphere it starts spinning around the black hole at very high speeds. In this region, nothing can move opposite to the spin of a black hole (unless you cross the cosmic speed limit), and thus, all the matter/photons move in the direction of the black hole's spin. The rocket, therefore, revolves around the black hole in order to gain the rotational energy from it. When the engine is fired, the situation becomes analogous to paddling yourself in the

direction of the flow of water in a whirlpool. The rotational energy gives a much stronger boost which allows the rocket to leave the ergosphere by dropping some mass into the black hole. The momentum of the two pieces of matter can be arranged such that one of them escapes to infinity while the other falls past the event horizon into the black hole.
The part of the rocket escaping the ergosphere is then said to have greater mass-energy than the original piece of matter and on the other hand, the infalling part will acquire negative mass-energy. Although the momentum and energy remain conserved, the effect is that more energy can be extracted than provided originally.
Coincidentally, this example is shown in the movie “Interstellar” where they use a blackhole’s gravitational force to slingshot their rocket at a higher speed to make up for lost fuel. Hence, it would be safe to assume that such techniques could be utilised to make interplanetary travel possible in the future.
There is a caveat, physicists believe that the maximum energy gain possible by a single particle via this process is 20.7%, in the case of an uncharged black hole. Therefore, we still have a long way to go before we can develop systems that can efficiently harness the energy from blackholes.



## Pulsar and quasar : the major source for investigating fundamental physics of matter and forces of nature.

By Dhyanvi Rao - 19 Batch

During the 1960s, the disclosure of two new phenomenon, pulsars and quasars, marked an important phase in astrophysics and their research started yielding significant outcomes.

Even though both these phenomena are derived from the collapse of ultra-dense celestial objects; nonetheless, they are different wonders. Quasars are associated with galactic centres, and pulsars are associated with the end point of the life-cycle of some stars.

**Quasars :**

Quasars are the best examples of coincidental or surprise discoveries. It was around the 1940's when radio telescopes had started studying radio signals from the cosmos. We detected radio signals from every direction, and later on combining these detected materials with visualised data, we found the existence of stars, galaxies, supernova remnants and various other unclassified objects. One of these objects looked like highly luminous cores that were identified as "Quasar – Quasi-Stellar Radio Source". Basically, what we're talking about is something that looks like a star and gives off a radio signal. Unlike other celestial data, quasars needed a vast amount of data analysis and conceptual and literary understanding, to be found and understood completely. Dutch American astronomer Marteen Schmidt played a major role in the understanding of the first visually studied quasar. In 1963 he recognized that the emission pattern for 3C 273 (the brightest quasar) was due to the redshift of the of the hydrogen atoms.

Quasars are currently accepted to be the extremely luminous cores of distant galaxies. Each quasar is much brighter than one complete galaxy that comprises of billions of stars. But its size resembles that of our solar system. So, if you take its size, and consider how bright it is, a quasar emits extremely large amounts of energy. One of the only energy sources strong enough to power quasars are supermassive black holes (black holes with mass much larger than that of our Sun). Summarizing this we can say that, a quasar is a shell of super-heated gas surrounding a supermassive black hole. And with these discoveries we set foot into a new chapter of astrophysics.

> **"Initially, when you stumble on something new, you're really working in a fog, you can see a few things through the fog, but not many. And goodness, haven't we moved a long way in 50 years?"**

**Pulsars :**

Pulsars, on the other hand, were also later discovered during the experimentations that were done in accordance to discovering the existence of radio galaxies. Pulsars are fast rotating neutron stars, that are left behind after a supernova. The first ever denotation of a pulsar can be traced back to 1967, when Antony Hewish and Bell Burnell were working on radio galaxies. Hewish had approached the method of array recording on sheets of paper with a movable pen, to find out more information related to the intensity of radio emissions. But some of the

recorded data in the chart looked like some kind of a disturbance that neither resembled that of a radio galaxy nor just a simple noise in the background. It was also seen to follow a pulsating pattern and after enough observations, it was proposed to be emitted due to a white dwarf or a neutron star that was undergoing periodic oscillations. These newly discovered celestial phenomenon was named “Pulsar – Pulsating Radio Source”. In an interview of national geographic, Bell Burner expressed her excitement during the discovery of the pulsar by saying : “Initially, when you stumble on something new, you’re really working in a fog, you can see a few things through the fog, but not many. And goodness, haven’t we moved a long way in 50 years?”
To understand how pulsars come to be, we must take the law of Angular Momentum into consideration. Law of Angular Momentum, in simple language, states that when a rotating object shrinks in size but retains the original large amount of mass, it will lead to faster rotation of that object. Similar thing occurs when a neutron star is formed. When a massive star dies in a supernova and the remaining iron core collapses to form a fast-spinning neutron star. Taking into consideration the mass and density of these neutron stars, their magnetic field proves to be multiple times stronger than that of Earth. This in turn leads to these neutron stars releasing high energy beams at the poles, which when detected on earth is recorded as a pulse, thus given the name – Pulsar.
*"For a neutron star to emit as a pulsar, it has to have the right combination of magnetic field strength and spin frequency"* says Feryal Ozel, a professor of astronomy and astrophysics at Arizona State university, stated in an interview.

**Diving deeper into importance of pulsars :**
Pulsars are awesome astronomical apparatuses for researchers to examine a wide scope of marvels. pulsars give researchers data about the physical science of neutron stars, which are the densest material known to mankind. Some pulsars also prove extremely useful because of the precision of their pulses. There are many known pulsars that blink with such precise regularity; they are considered the most accurate natural clocks in the universe. As a result, scientists can watch for changes in a pulsar's blinking that could indicate something happening in the space nearby. It was with this method that scientists began to identify the presence of alien planets orbiting these dense objects. Because pulsars are moving through space while also blinking a regular number of times per second, scientists can use many pulsars to calculate cosmic distances. Pulsars have been used to test aspects of Albert Einstein's theory of general relativity, such as the universal force of gravity. There are multiple experiments currently searching for gravitational waves via this pulsar method.

# Exoplanets

By Deepa Trivedi - 20 Batch

Exoplanets are planets that orbit a star other than our Sun. The prefix ‘exo’ means ‘outside’. Astronomers have confirmed more than 4,000 exoplanets orbiting distant stars. They found first two exoplanets orbiting a pulsar in 1992.they can be hot enough to boil metal or locked in deep freeze. They can orbit their stars so tightly that a ‘year’ lasts only a ‘few days’. They can orbit orbit two suns at once and some of them are sunless rogues, wandering through the galaxy in permanent darkness.

There are four types of exoplanets exist:

**1. Gas giant**

A gas giant is a large planet mostly composed of helium and/or hydrogen. These planets, like Jupiter and Saturn in our solar system, don’t have hard surfaces and instead have swirling gases above a solid core. Gas giant exoplanets can be much larger than Jupiter, and much closer to their stars than anything found in our solar system. The known Gas giant is ‘51 Pegasi b’. More variety is hidden within these broad categories. Hot Jupiter, for instance, were among the first planet types found – gas giants orbiting so closely to their stars that their temperatures soar into the thousands of degrees


**2. Super earth**

Super-Earths is a class of planets unlike any in our solar system are more massive than Earth yet lighter than ice giants like Neptune and Uranus, and can be made of gas, rock or a combination of both. They are between twice the size of Earth and up to 10 times its mass. Super-Earth is a reference only to an exoplanet’s size is larger than Earth and smaller than Neptune but not suggesting they are necessarily similar to our home planet. The true nature of these planets remains shrouded in uncertainty because we have nothing like them in our own solar system and yet, they are common among planets found so far in our galaxy.

**3. Neptunian**

Neptunian exoplanets are similar in size to Neptune or Uranus in our solar system. Neptunian planets typically have hydrogen and helium-dominated atmospheres with cores or rock and heavier metals. The known Neptunian exoplanet is 'Kepler-1655 b'. They likely have a mixture of interior compositions, but all will have hydrogen and helium-dominated outer atmospheres and rocky cores. We're also discovering mini-Neptune, planets smaller than Neptune and bigger than Earth. No planets of this size or type exist in our solar system.


**4. Terrestrial**

In our solar system, Earth, Mars, Mercury and Venus are terrestrial, or rocky, planets. For planets outside our solar system, those between half of Earth's size to twice its radius is considered terrestrial and others may be even smaller. Exoplanets twice the size of Earth and larger may be rocky as well, but those are considered super-Earths. They are Earth sized and smaller, composed of rock, silicate, water or carbon. Further investigation will determine whether some of them possess atmospheres, oceans or other signs of habitability.

**How do we detect Exoplanets?**

There are five significant methods to detect exoplanets:

**I. Direct imaging:**

The exoplanet is imaged directly using large telescopes fitted with adaptive optics and coronagraphs. The technique is most sensitive to the warmer, bright (young) and massive exoplanets on wide and/or eccentric orbits (large sky projected separations). The separation from the host star allows for spectra to be obtained directly and allows for the direct measurement of the luminosity.

**II. Radial velocity:**

The exoplanet is detected by measuring the Doppler shift in the host star light, a consequence of the gravitational affects between the two bodies. The technique is most sensitive to exoplanets with a large mass orbiting close to their host star perpendicular to the plane of the sky. The radial velocity technique allows for a minimum mass (dependant on orbital inclination) to be calculated.

**III. Transits:**

The exoplanet is detected by measuring a periodic decrease in the flux received from the host star, as a consequence of the exoplanet transiting in front of the host star. The transiting technique is most sensitive to large exoplanets orbiting

close to their host star stars and provides an accurate determination of the planetary radius relative to the host star.

**IV. Microlensing:**

The exoplanet is detected by measuring characteristic light curve changes caused by changes in the lensing effect observed when a star with a planet passes in front of a distant star. The technique is limited to distant one-time events and by the lack of accurate determinations of the planet and orbit parameters. It is however a very valuable technique due to the lack of strong radii or mass biasses making it ideal for statistical population studies.

**V. Transit timing variations:**

The exoplanet is detected by observing a change in periodic phenomena due to the presence of an exoplanet. Examples include a change in transit time (known as TTV) of one planet, due to the presence of others in multiple-planet systems and pulsar timing, where anomalous movement (measured at radio wavelengths) can be used to infer the presence of a planet.

**Latest reports about Exoplanets:**

- A newly discovered, Neptune-like planet some 90 light-years away might possess a robust atmosphere – and perhaps even a 'tail.'
- NASA's Hubble Space Telescope is giving astronomers a rare look at a Jupiter-sized, still-forming exoplanet that is feeding off material surrounding a young star.
- Our nearest neighboring star, Proxima Centauri, has a bad habit: frequently erupting in potentially damaging flares.

# Introduction to Superdeterminism: where the effects always have a cause.

By Abhishek A. Gor

Einstein said God, doesn't play dice with the Universe. You all must have heard or read about the term spooky action referring to the entanglement at the distant. This famous term of Einstein's "spooky action" comes from a letter he wrote to Max Born in 1947 he explains the term in the following letter he wrote. Which clears that he did not refer the term "spooky action" to entanglement but to the measurement update.

Einstein had a little thought experiment, lets say you have a beam of electron pointed to a screen with the hole in it, the beam gets diffracted, and

approximately it goes with the same probability in all the directions, according to quantum mechanics we say this wave function is some approximation with spherically symmetry. But now when we go and measure the electron in some particular position, suddenly we have to update this wave function. And particle has to know in some sense that it is only at one point and not at the other point. So if we understand this wave function collapse as a physical process it's clearly non-local and that's what Einstein was worried about. Because upon measurement, a spread out wave function must suddenly localize, instantaneously. Of course Einstein would worry that this was not compatible with special relativity. *He didn't like anything faster than the speed of light.*

**In quantum mechanics if you take updating of wave function as a physical process, it has this non-locality. We know today that there isn't any information that can be transmitted faster than light, on the level of observables.**

In quantum mechanics if you take updating of wave function as a physical process, it has this non-locality. We know today that there isn't any information that can be transmitted faster than light,on the level of observables. {See non signaling theorem}

But wave function collapse/update/reduction is instantaneous that is what stands in the way of a local realist interpretation of quantum mechanics. It is the root of all problems. Here when we say locality in the terms of quantum field theory, it is in the sense that propagation in space time is continuous and obeys the speed of light limit and no non local interactions.

The problem is the following. If we make the, measurement local let's think of a simple experiment without double slits or diffraction or interference, but the electron's position or momentum or mixture of them can be measured. And the wave function has to collapse into the right Eigen state upon measurement and it will be different state that it has to collapse into depending upon what you will measure. So if you want the collapse to be local then the wave function in some sense has to know what will be measured before it actually reaches the detector. If you only stop the collapse at the time that the particle actually hits the detectors if you want to do it by the local interaction with the detector then we end up with the spooky action that Einstein was worried about.

This means that the evolution of the prepared state from the time of preparation to the time of detection will depend on the measurement settings. And if the evolution is determined by hidden variables this means the theory is Superdeterministic.
So superdeterminism is a hidden variable theory at the time of measurement correlated with the detector settings.
The most distinctive features of Superdeterministic theories are that they violate Statistical Independence. The Violation of statistical independence generically require non-local correlations. Since the theory should be (Einstein)-local, these correlations were either inscribed in the initial condition of the universe, locally created in the distant past, enforced by local consistency condition in the future.

**As it is typically expressed, this means that the probability distribution of the hidden variables (λ), ρ(λ), is not independent of the detector settings. If we denote the settings of two detectors in a Bell experiment as a and b, we can write this as $\rho(\lambda|a,b) \neq \rho(\lambda)$ .**

Violating Bell's inequality tells us that at least one of the assumptions of the theorem must be violated. They can not tell us which one. Superdeterministic theories by assumption give rise to exactly the same violation of Bell's inequality. Doing the same experiment over and over again will not teach us anything new. Bell type tests can not rule out superdeterminism. Violation of Bell's inequality are a corollary of that, not the starting point. The starting point is the need for a local wave function collapse. This also means that the measurement process is necessarily not linear. Eigen states of pointers states remains Eigen states but the superposition of those Eigen state don't remain superposition. Just like let'ssay we send the photons to a beam splitter the photon may go either right side or the left side. It will end up in the superposition of this possible measurement outcomes. We can also send these photons only to the left side but that will give you photons only in the left side. We can also send these photons only to the right side but that will give you photons only in the right side. But if we produce superposition that is sum of left side and right side the outcome will not be it being measure at left and it being measured at right. So clearly if we want to explain measurement process by dynamical theory it has to be non-linear.

Quantum Mechanics is an emergent theory. The measurement postulate is an effective description for a process in an underlying, more fundamental theory. That theory is what is being looked. The underlying theory needs to be Superdeterministic and non-linear.

The idea is supported by the apparent similarity between the classical liouville equation $\partial\rho/\partial t = \{H, \rho\}$ and the Neumann Dirac equation $i\hbar\, \partial\rho/\partial t = [H, \rho]$. Former refers to density and the later refers to density operator.

How can it be tested? Once there is a full model, for all Superdeterministic theories identical measurement setups will lead to identical measurement out comes. This is not the case in quantum mechanics. Look for auto correlations in time series of measurement outcomes that according to quantum mechanics should be uncorrelated. This will require small and cold systems in which measurements can be repeated in rapid sequence.

Currently handful of scientist are working on Superdeterministic theories (only 5) and according to them these are not interpretations of quantum mechanics. They are more fundamental theories from which quantum mechanics derives.

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(2) Sandro Donadi, S. Hossenfelder, “A Superdeterministic Toy Model” arXiv:2010.01327 [quant-ph]
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# Nuisance of space debris: Can Laser Ablation be a solution??

By Dr. Prahlad K. Baruah

**‘Irresponsible’: Nasa chides China as rocket debris lands in Indian Ocean**
**- The Guardian, May 9, 2021**

**Space Debris Punches Hole in International Space Station’s Robotic Arm**
**- ScienceWire, June 2, 2021**

**Low Earth Orbit has more junk than operational Satellites: Report says unsustainable space behaviour continues - India Today, June 1, 2021**

The abovementioned recent headlines make it clear how space debris has become a nuisance in space exploration. The blame game between the major space organizations over who is contributing more space debris attests to the growing concern that it can have serious repercussions. Now, what really is space debris? Well, space debris, sometimes also known as space junk, is basically the man-made objects in space which is in the earth's orbit, mostly the lower earth orbit, but is no longer functional. It has been a major cause of concern for space agencies as it jeopardises the future space missions. Many space stations including the international space station (ISS) have already been working on various aspects of dodging debris that is gradually descending towards the earth. However, these efforts have proved to be scant in terms of mitigating the problem of space debris. Space debris, even if very small in size (~ mm order) has the potential to wreak havoc and can severely impact the functionality of a satellite. Moreover, as these tiny fragments of space debris are difficult to track, the damage caused by it can also be very challenging to address. With many of the satellites nearer to the earth's atmosphere providing crucial information pertaining to our environment and other vital statistics, the threat posed by space debris can no longer be dodged.


Till date, there have been numerous attempts towards the removal of space debris. These include the idea of the use of an artificial drag to lower the unwanted objects and then its removal from the earth's orbit, laser-based methods, etc. Among these, laser-based methods for the removal of debris appear to be very promising. Initially, scientists were looking mostly into the removal of the debris from ground-based laser systems using big sized optics in which large energy is delivered onto objects many kilometres above us in the earth's orbit. The process of

removal of material using high power laser, in general, is commonly known as laser ablation. The irradiation of high laser energy onto the objects leads to the enormous rise in temperature and this leads to generation of plasma of the target object. This ultimately leads to the annihilation of smaller objects and reduction in the orbital velocity of slightly larger ones, resulting in its coming to the lower orbits and finally getting burned up in the earth's atmosphere. However, the large distance between the ground based laser system and the tiny objects is space demands extremely high degree of accuracy and has therefore hampered the prospects of this method. With an aim towards overcoming this disadvantage associated with ground-based laser systems, recently, there have been efforts towards the removal of debris using space-based laser systems. In addition, laser ablative generation of thrust to divert the trajectory of space objects also has strong prospects and is being seriously considered. In fact, there have been reports of new architectures such as orbital solar-powered debris sweeper which along with the tracking of space objects moving at huge velocities can also be used for its de-orbiting. With the advancement in laser technology it is expected that laser ablation, due to the plethora of process parameters it provides, will go a long way towards mitigating the problem of space debris and will provide us a clearer space in the near future.

# Neutrino Detector: A key to Unlock the Mystery of our Universe

By Dr. Sheetal Rawat

In Jan 2020, the BOREXINO collaboration reported the direct observation of neutrinos produced in the carbon-nitrogen-oxygen (CNO) fusion cycle in the Sun with the solar neutrino detector. This essays the potential of neutrino detectors to unravel the uncertainties about the composition of the sun's core and offer insights into the otherwise unreachable regions of the Universe, such as distant supernovae or the interiors of stars.

Stars in our universe are fueled by and evolve through nuclear fusion reactions. Both the CNO cycle and the *pp* chain are associated with the production of energy and the emission of a rich spectrum of electron neutrinos. Several percent of the energy released in such reactions is carried away by the neutrinos. In case of the sun, 60 billion or so neutrinos pass through each square centimeter of the earth's surface per second. Neutrinos are tiny, neutral, subatomic particles.

THE BOREXINO NEUTRINO DETECTOR
Source: The Borexino Collaboration. Nature 587, 577–582 (2020).

They were first postulated by Wolfgang Pauli in the early 1930s in the weak interaction process of β-decay. However, their actual observation had to wait until 1953 when Reines and Cowan recorded interactions of anti (electron) neutrinos emitted by a reactor in a cadmium doped liquid scintillator detector. This highlights the point that the neutrino detectors will play an instrumental role in future discoveries pertaining to the detection and origin of various types of neutrinos. Nature provides us with solar neutrinos emitted by the sun, atmospheric neutrinos produced by the interaction of cosmic rays in the atmosphere, cosmological neutrinos produced by a variety of deep space violent events, geological neutrinos produced by nuclear decays in the earth core as well as neutrinos produced in beta decay.

A detector observes particles by the way they interact with its constituent particles. Due to the weakness of neutrino's interactions, they are barely deterred from their path even when they have to pass through the entire body of the Earth. This is where the problem lies. We can only detect the presence of a neutrino in our experiment if it interacts. And neutrinos interact in two ways: charged-current interactions where the neutrino converts into the equivalent charged lepton and neutral-current interactions where the neutrino remains a neutrino, but transfers energy and momentum to whatever it interacted with. In principle, charged-current interactions are easier to work with, because electrons and muons have characteristic signatures in particle detectors and are thus fairly easy to identify. Various different detector technologies have been

used in neutrino experiments over the years, depending on the requirements of the particular study.

Desirable features of a neutrino detector will typically include several of the following:

- low energy threshold, so that low-energy neutrinos can be detected and studied (especially for solar neutrinos);
- good angular resolution, so that the direction of the detected particle can be accurately reconstructed (especially for astrophysical neutrinos);
- good particle identification, so that electrons and muons can be well separated (essential for oscillation experiments);
- good particle identification, so that electrons and muons can be well separated (essential for oscillation experiments);
- good time resolution, so that the time evolution of transient signals can be studied (essential for supernova neutrinos, and important for other astrophysical sources);
- good time resolution, so that the time evolution of transient signals can be studied (essential for supernova neutrinos, and important for other astrophysical sources);

It is not possible to have all of these things in one detector – for example, detectors with very low energy thresholds tend not to have good angular or energy resolution. Neutrino physicists will select the most appropriate technology for the aims of their particular experiment. But one thing is for sure, due to the small interaction cross-section of neutrinos, neutrino detectors have to be massive. One such detector is the Borexino neutrino detector (in the pic below). It is located underground at the Laboratori Nazionali del Gran Sasso in Italy, where the cosmic muon flux is suppressed by a factor of ~106. It detects light produced when solar neutrinos scatter off electrons in a large vat of liquid scintillator — a medium that produces light in response to the passage of charged particles. It is also wrapped in the thermal insulation to control temperature variations in the detector. This helps to take the highly precise measurements needed to detect solar neutrinos produced by the Sun's secondary solar-fusion cycle.

Thus, detection of CNO neutrinos offers the chance to resolve the elemental composition of the Sun's core. With precise engineering and technology in detector field, it can pave a way to unravel the mystery of other stars in the universe.

# ARTIFICIAL INTELLIGENCE TO ADDRESS INTERNAL AND EXTERNAL SECURITY

By Dr. Brijesh Tripathi


Figure 1: Satellites for input data collection

Artificial intelligence is a field of computer science that focuses on creating intelligent software tools with a high potential to disrupt all sectors including industry, security and governance. Recently, the role of artificial intelligence has been increasing for the internal and external security of smart countries across the globe. There is an ever-increasing pressure on establishments to address socio-political and economic problems that are linked to security issues. In order to handle these needs, trained manpower is urgently needed and that sets a target for educational institutions to come up with an interdisciplinary course on artificial intelligence. The course should include conceptual approaches from conventional knowledge of science, technology and humanities and connect them with modern approaches to address security needs through artificial intelligence. In a recent paper, Fischer and Wenger (Swiss Pol. Sci. Rev. 27(1):170-179) have presented two science and technology based approaches as summarized below:

**Approach 1: Micro-politics of design and development**

This approach needs collection of large amounts of data (e.g., Fig. 1) that reflects the values, assumptions and political biases of millions of people and use the data to train machine learning algorithms to gain insights for bottom-up and top-down governance decisions. This would certainly help to address internal security issues.

**Approach 2: Co-production**

This approach needs use of science and technology with idiomatic flexibility in taking decisions to address the world politics. Modern technological approaches such as deep learning and neural network programming (e.g., Fig. 2) are required. This approach definitely needs understanding of the interplay among market dynamics, technological uncertainty, international political perceptions, and arms race across the globe.

Adaption of both the approaches is the need of the hour but it requires a very careful assessment of technological maturity of artificial intelligence systems ready for deployment. As per the predictions of scientific community if the advancements in machine learning continues then human-level or even super-intelligent artificially intelligent systems would be available in the near future. Currently available artificial intelligent systems are subhuman in terms of intelligence capability but these are already capable of being risky in a number of narrow domains, mostly with regard to privacy, discrimination, crime automation or armed conflicts (R. Yampolskiy, AI Risk Skepticism, arXiv:2105.02704v2 [cs.AI]). Super-intelligent artificial intelligent systems are anticipated to be much more dangerous and might have high capability of causing a lot of harm, which includes posing an existential risk for the humanity itself. Expert assessment of the decisions taken by such systems is mandatory. Such expert assessment would keep away the risk of accidental decisions occurring due to unsafe artificial intelligence systems.

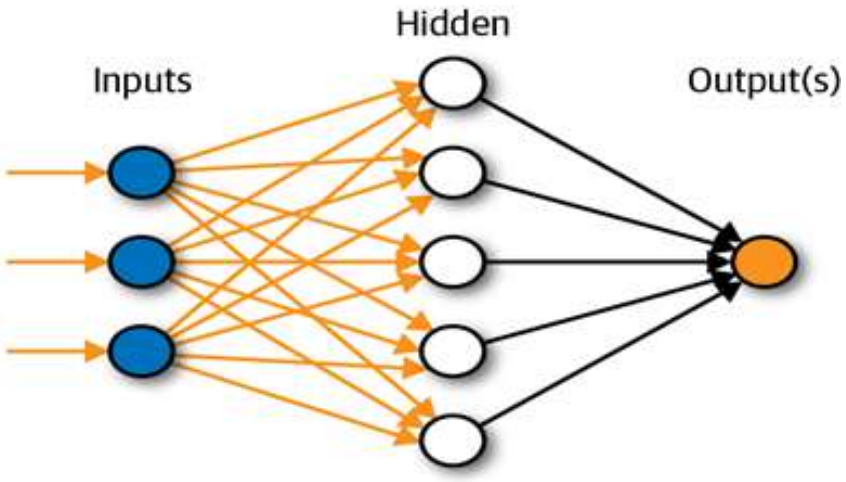
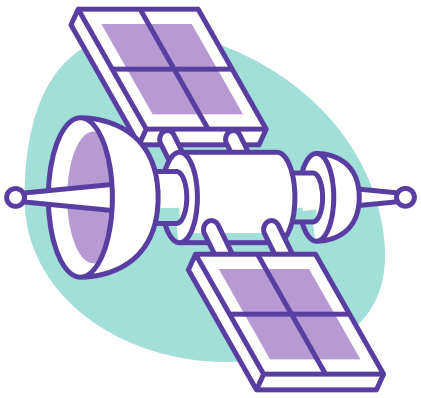



Figure 2: Neural network based programming approach



# IN CONVERSATION WITH DR. BRIJMOHAN THAKORE

By Sanhit and Arth - 2018 Batch

Two of our students majoring in physics, Sanhit Mehta and Arth Thakkar from the 18 batch interviewed Dr. Brijmohan Thakore, a senior professor at the Sardar Patel University whose research interests lie in the field of condensed matter physics and material science. Sir, however, also has an avid interest in astronomy and astrophysics. Given that, he participates and conducts various activities related to observational astronomy.

Here is the interview that sir gave.

**Sanhit:** Good evening sir, Sanhit here and we also have Arth present with us who is my batchmate. Both of us shall be interviewing you for the newsletter published by the department of physics. Thank you for being kind enough and sparing your time to speak with us. We are sure it will be a great insight for our readers.

**Brijmohan sir:** Thank you for having me.

**Arth:** Sir, our foremost question is, what kindled your interest in the field of astronomy and astrophysics given that your academic training and background is in condensed matter physics?

**Brijmohan sir:** I started with observational astronomy way back when I was still in school. During summers, we would sleep on the terrace and I would notice various patterns formed by the stars and I loved noticing them. Eventually, I realized that those patterns would change with time and I would see the same patterns during certain times of the year. That is how I first developed an interest.

I did my masters in physics, my M.Phil in experimental physics and my PhD in theoretical condensed matter physics but my love for astronomy has survived since childhood and I still make it a point to follow and observe celestial events. Astronomy is my first love.

*“The great thing about astronomy is that most observations always happen after nightfall hence whatever profession you are pursuing, you are back home by the evening so you always have the time to look at the sky and wonder at the cosmos.”*

**Sanhit:** Very well said sir, I’m sure all of us have looked at the night sky in our childhoods and have been struck with curiosity and a plethora of questions but somewhere down the line life happens and we lose that spark. Along the lines of what you said sir, how do you manage your time between having a full fledged career in academia as an experimental physicist and following your interest with so much rigor?

**Brijmohan sir:** The fascination to be with stars was always there. And, the great thing about astronomy is that most observations always happen after nightfall hence whatever profession you are pursuing, you are back home by the evening so you always have the time to look at the sky and wonder at the cosmos. I have looked at celestial events like the rings of Saturn, patterns on Jupiter hundreds of times but they still amaze me and keep my love for the subject going.

I try to take every possible opportunity to show these events like eclipses et cetera to my MSc students as well.

**Sanhit:** Are you involved with any groups or activities that are responsible for promoting astronomy amongst young students or even the general population?

**Brijmohan sir:** I am not involved with any such professional groups but I always try to show such events to my college students, young school students and even my friends from other walks of life. Apart from that I also organise popular science lectures and talks related to astronomy for general people. So, although I am not involved with any group, I have a bunch of people associated with me to propagate and popularise astronomy.

**Arth:** What do you think are some challenges that upcoming physics students and physicists face in their professional careers?

**Brijmohan sir:** If you have passion for a particular subject, difficulties don't matter. While pursuing your undergraduate or graduate studies there aren't as many difficulties as such because you have help available to you in terms of your professors and friends. Once you start your professional life, there are some difficulties but if you love a subject enough, you will overcome them.

**Arth:** Upfront looking at the bigger picture, what do you envisage the future of astrophysics in India as?

**Brijmohan sir:** We have a lot of good institutions like IUCAA, IISc, PRL, ISRO and so on where students willing to pursue astronomy or astrophysics can pursue their interests. They have excellent research facilities and faculty. The future of astrophysics and astronomy is very bright in our country.

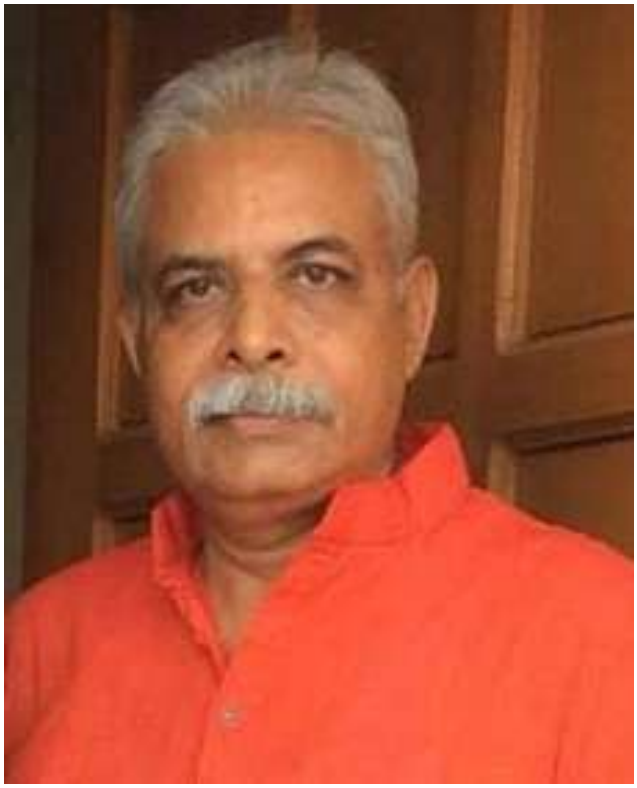
**Sanhit:** What would you say to anyone who says that I am interested in the subject but my job or other commitments do not allow me to pursue it?

**Brijmohan sir:** When I was in college, there was no internet nor did we have so many books. Hence if we had a question, we did not have as many resources as your generation in terms of internet and the vast sources you have at your disposal. There are community science centers in all districts of Gujarat that conduct periodic events related to skygazing and astronomy. Hence, students and other people from different walks of life as well, I would encourage them to make time to attend such an event even once.

**Arth:** Nowadays there is almost a trend amongst young students to fancifully talk about concepts like blackholes owing to the popularity of the concept without understanding the real physics behind. What is your take on this?

**Brijmohan sir:** To any such person my message would simply be, observe and enjoy. Because once you observe, you can know more. You can talk to your teachers, friends and then eventually read more about it. As you observe, your mind will delve into the fascinating science behind the things, why things are the way they are and once you start understanding the science behind it, you'll find that you find the topic more interesting.

**Sanhit:** We know that in ancient times, ours was a civilization that understood these concepts, they observed stars, planetary movements, eclipses and even made calculations regarding the same. Today however, we find ourselves in a situation where the attitude of people towards the sciences has become somewhat ignorant. What is your take on this?



**Dr. Brijmohan Thakore**

*"As you observe, your mind will delve into the fascinating science behind the things, why things are the way they are and once you start understanding the science behind it, you'll find that you find the topic more interesting."*

**Brijmohan:** If you look back on Indian astronomy, you'll find numerous books authored by the likes of Varahamihira, Aryabhatta et cetera. That goes to show that ancient people did have an understanding of the subject. For example, if you calculate the time for the next eclipse to happen according to Surya Siddhanta, a Sanskrit treatise on astronomy, you won't be off by a huge factor compared to modern ways to predict eclipses.

The problem arises when we start comparing astronomy and astrology. We need to have a strong demarcation between the two. Even our calendars are based on astronomy.

**Arth:** Would you like to suggest any book that you think is a must read for our audience?

**Brijmohan sir:** I would not recommend a particular book. In our times, the internet so people recommended a few good books. In today's day and age given the explosion of information, there are plenty of good books, articles etc available to everyone easily. So, I'd suggest taking any one book and try to read it in its entirety. And you need not understand all concepts mentioned at once. If you don't like the book or the subject of the book, take a new one but read.

**Arth:** A lot of great physicists, Erwin Schrodinger, Albert Einstein, Neils Bohr to name a few have on the record stated that Vedic texts like the Upanishads have been a source of inspiration to them. What would you have to say about that?

**Brijmohan sir:** If you undertake a close study of our Vedas, Upanishads and other scriptures you will find that a lot of concepts are mentioned which are very deep, intuitive. A lot of what is mentioned there is now being stated by quantum mechanics. The parallels between the two are drawn wonderfully in a book called The Tao of Physics by Fritjof Capra. Another book that talks about this is The Dancing Wu Li Masters by Gary Zukav.

**Sanhit:** Before we conclude this interview sir, what would be your message to our readers and even people in general?

**Brijmohan sir:** I'd suggest the students to go outside their textbooks. To pass your exams and get a degree, you need to read certain books and topics structured around a particular syllabi. However, real understanding will only come when you go beyond your texts. Although it may not be important from an exam point of view, try reading more about any topic.

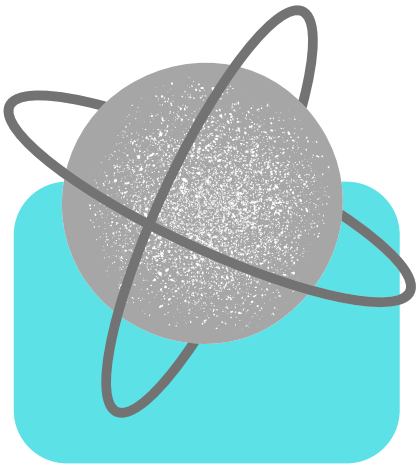
If you read the same topic from different sources, your understanding will be furthered.

**Sanhit:** That is very insightful and very true sir. Once again thank you so much for sparing your time and letting us pick your brain. It was wonderful getting a chance to speak with you.

**Brijmohan sir:** My pleasure and I wish you and all your readers the best of luck with all your future endeavors.

# Fun Facts

By Krina and Khushali - M.Sc. Batch



1. Neutron stars, which are left over from the deaths of massive stars in supernova explosions, are so dense that just a bowl full of neutron star material has more mass than the Moon.

2. If two pieces of the same type of metal touch in space, they will bond and be permanently stuck together. This amazing effect is called cold welding. It happens because the atoms of the individual pieces of metal have no way of knowing that they are different pieces of metal, so the lumps join together.

3. Olympus moon, which is 3 times higher than the Mount Everest, is the highest mountain known to man and is located on Mars.

# Fun Facts

4. Gamma-ray bursts can release more energy in 10 seconds than our Sun will in its entire life. Nothing in the Universe rivals the power unleashed during a gamma-ray burst, a brief but incredibly intense flash of high-energy radiation.

5. If our sun become a BLACKHOLE, it's radius will shrink to 3km!! its current radius is 700,000km!

6. -280°c temperature can not exist in the universe. The minimum possible temperature that can be attained in the universe is absolute zero or -273.15°c.

# Riddles

By Shlok - 2018 Batch

1) I am the goal of an initiative taken by ISRO in 2007.
The main motive behind my creation is to ensure the expedition of sapiens into the macrocosm,
but geez! Got delayed owing to some unprecedented invasion.....

2) I am a phenomenon associated with a sudden explosion of energy caused due to disturbance of magnetic field lines near a sun spot.
At times, I am also accompanied by release of plasma from the sun's atmosphere and generate an enthralling light show in the sky when I interact with Earth's upper atmosphere.

3) I am a bizarre ubiquitous entity,
Defying gravity is the reason for my peculiarity.
Some people say that I am a constant, some say that I may vary, But my composition is still a mystery.
Some also consider me as the fifth fundamental force,
Am I a hot topic of research, oh, of course!

# Riddles

4) I am a brightly colored shell of gas present around a hot luminous core, formed when a red giant's atmosphere has been dissipated.
I mark the transition of a medium sized star from a red giant to a white dwarf.
But I am a misnomer, as I have nothing to do with the name ascribed to me.

5) I am a planetary-mass object.
Neither have I had a family, nor a home.
Either I have been ejected from a planetary system, or formed on my own.
I am not gravitationally bound, hence, keep on wandering around like a vagabond.

6) I am an event associated with Earth's natural satellite.
Occurring for the second time in a month and fourth time in a season is why I get a name different from that given to me for my usual occurrence.
Because of my infrequent happening, people use me to describe a rare event.

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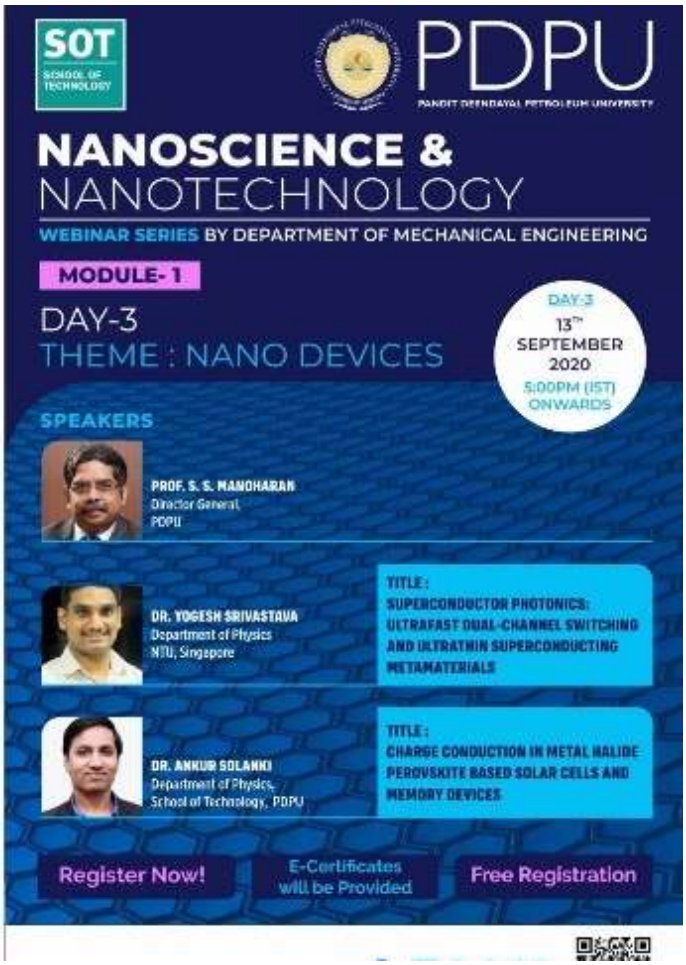
| Dr. Rohit Srivastava | Ruchita Shah, Rohit Srivastava and Jigisha Patel (2021), "Study of regional heterogeneity of cloud properties during different rainfall scenarios over monsoon dominated region", Journal of Water and Climate Change vol. 12, No. 4, pp 1086-1106, June 2021, doi: 10.2166/wcc.2020.178 (Impact factor: 1.25) |
| Dr. Rohit Srivastava | Ruchita Shah and Rohit Srivastava (2020), "Effect of Ocean Warming on Cloud Properties over India and Adjoining Oceanic Regions", Pure and Applied Geophysics, vol. 177, No. 17, pp. 5911-5925, doi: https://doi.org/10.1007/s00024-020-02607-9. (Impact factor: 1.65) |
| Dr. Rohit Srivastava | Ridhesh Goti, Bhashin Thakore and Rohit Srivastava (2020), "Measurement of cloud properties using a self-designed cloud chamber", The first International Symposium of Earth, Energy, Environmental Science, and Sustainable Development, E3S Web of Conferences, vol. 211, article number 02006, doi: 10.1051/e3sconf/202021102006. (Impact factor: 0.52) |
| Dr. Rohit Srivastava | Ruchita Shah, Rohit Srivastava and Jigisha Patel (2020), "Modelling the influence of different rainfall scenarios over heterogeneous regions using regional climate model", International Conference on Contemporary Computing and Applications (IC3A), IEEE Proceedings, pp. 59-64, doi: 10.1109/IC3A48958.2020.233672. (27-04-2020) |
| Abhishek A. Gor | Chetna C. Chauhan, Tanuj M. Gupta, Reshma A. Nandotaria, Abhishek A. Gor, Charanjeet Singh Sandhu, Kanti R. Jotania, Rajshree B. Jotania; Structural, morphological, magnetic hysteresis and dielectric properties of cobalt substituted barium–lead hexagonal ferrites for technological applications, Ceramics International, 2021. |

# Departmental Activities

By Yashvi - 2019 Batch
and Deepa - 2020 Batch




Webinar series: "Nanoscience & Nanotechnology" ; Day 3 on "Nano Devices" was organised by the department of mechanical engineering on September 13,2021 and the speakers were: Prof. S.S. Manoharam (Director General, PDEU); Dr. Yogesh Srivastava (NTU, Singapore) and Dr. Ankur Solanki (Assistant Professor, PDEU).


Webinar on "Effective Scientific Writing and Strategies of Research Papers Publications in High Impact Journals" was organised by Dr. Ankur Solanki (Assistant Professor,PDEU) & Dr. Prahlad Baruah (Assistant Professor,PDEU) on November 28, 2020. The speakers were Professor Stephen Skinner, Ershad Abubacker, Dr. Tomasello Gaia.

Dr. Sheetal Rawat (Assistant Professor, PDEU) from department of Physics was one of the winners who was presented with the best poster award during the Faculty Research Review Symposium which was organised by Research & Development cell, PDEU on March 5,2021.



Webinar on “Blue Light Emitting Diodes” was organised by Dr. Anup Sanchela (Assistant Professor,PDEU) on March 30, 2021 .


Webinar on “Science innovations: PDEU way” was jointly organized by the department of Physics, Chemistry and Mathematics, moderated by Dr. Poonam Mishra on April 25, 2021 and the speakers of this event were Dr. Brijesh Tripathi (Associate Professor,PDEU) and Dr. Rama Gaur (Assistant Professor,PDEU) .

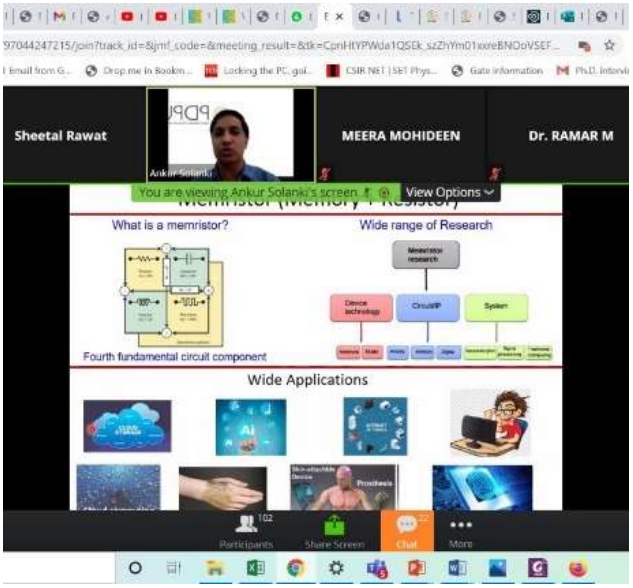

Webinar on "Amazing Earth: Space to Surface" was organized by was organised by Dr. Rama Gaur and Dr. Poonam Mishra as the moderator on May 22,2021 and the speakers invited were: Dr. D Ram Rajak (Scientist, ISRO) and Dr. J. Brahma (Assistant Professor, PDEU).


Webinar: "Lecture series on Astrophysics" organized by Dr. Sheetal Rawat (Assistant Professor, PDEU); Dr. Abhishek Gor (Assistant proferssor,PDEU) and Dr. Prahlad Baruah (Assistant Professor,PDEU) on June 19,2021. The speakers for the event are Dr. Mansi Dhuria (Inspire Faculty IITRAM); Dr. Indu Kalpa Dihingia (postdoctoral fellow, IIT Indore), and Dr. Joby P. Kochappan (postdoctoral fellow, Asia Pacific Centre).

Educational webinar on “Climate Change: Vital Signs of the Planet" was organised by Dr. Rama Gaur and Dr. Poonam Mishra as the moderator on 8th May 2021 and the Speakers invited were Dr. Abha Chabra (Scientist, SAC, ISRO) and Dr. Sheetal Rawat (Assistant Professor,PDEU).

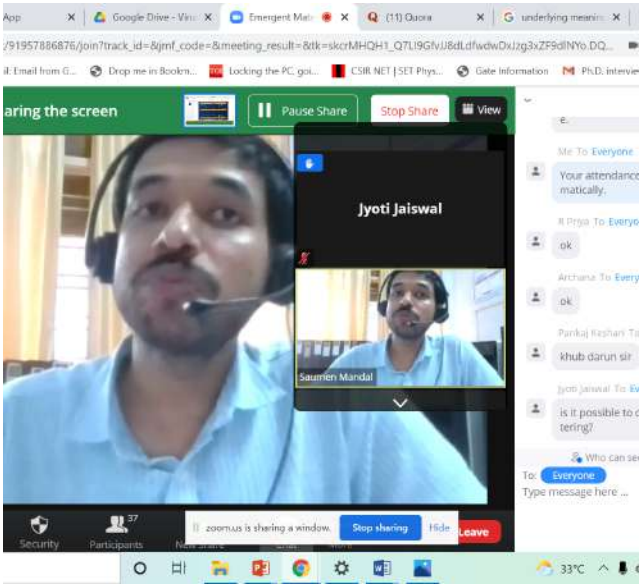


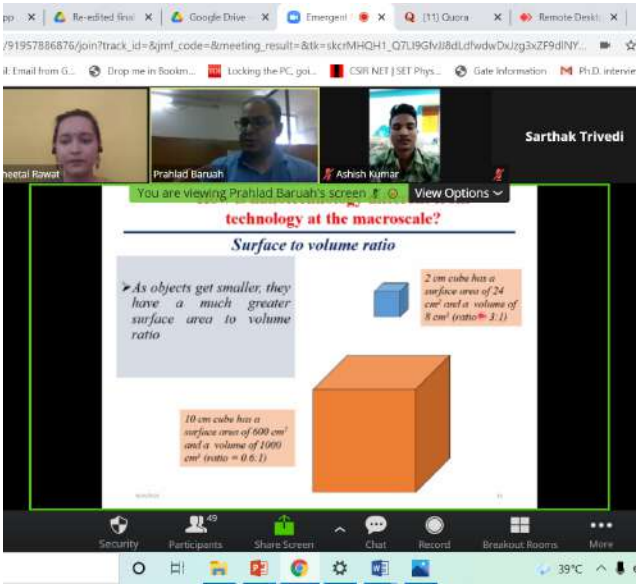
Webinar on "Emerging Facets of Material Science" was organised by Dr. Rama Gaur and Dr. Syed Shahabuddin on 29th May 2021 and the speakers of the event were: Dr. Ankur Solanki (Assistant Professor,PDEU) and Dr. Prahlad Baruah (Assistant Professor,PDEU).

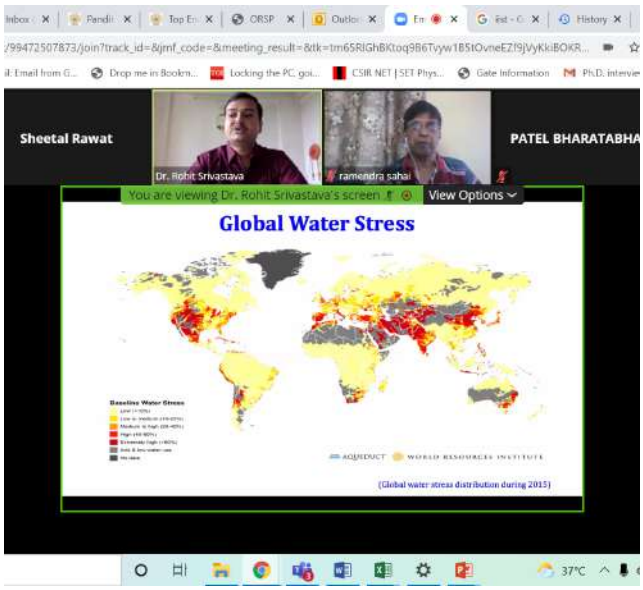

A 3 days Workshop on "Advanced Physics of Emerging Materials and Electronic Devices-2021" was organized by Dr. Ankur Solanki and coordinated by Dr. Sheetal Rawat and Abhishek Gor on 21st June 2021. We had total 9 speakers from eminient institutions including 3 speakers from our department : Dr. Prahlad Baruah, Dr. Brijesh Tripathi, Dr. Anup Sanchela.

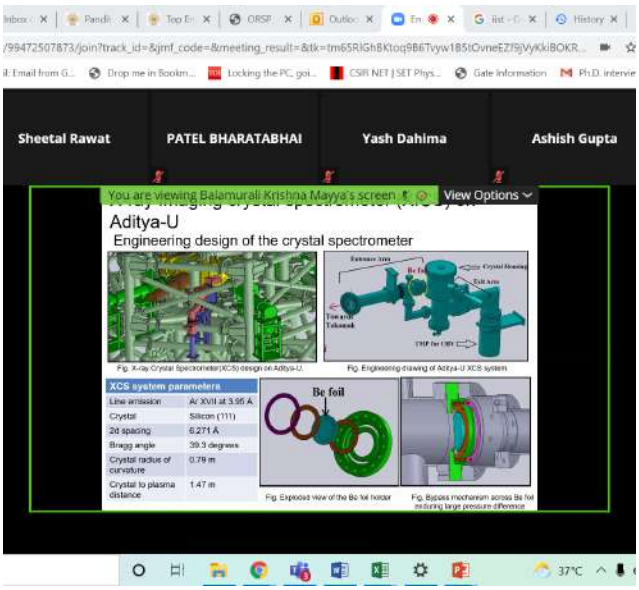

| 21/06/2021 – Monday | | |
|---|---|---|
| Time | Title | Speaker |
| 3:00 pm | Welcome Note | Dr. Sheetal Rawat, PDEU |
| 3:10 pm | Introduction | Dr. Ankur Solanki, PDEU |
| 3:15 pm | Fundamental Aspects of Nanomaterials | Dr. Prahlad K. Baruah, PDEU |
| 4:15 pm | Synthesis of Nanomaterials and Growth of Thin Films | Dr. Saumen Mandal, NIT Suratkal |
| **22/06/2021– Tuesday** | | |
| 2:00 pm | Microscopic Techniques for Materials Characterization | Dr. Pramod Kumar, J C Bose UST |
| 3:00 pm | X- Ray Diffraction Method: Principles and Characterization of Advance Materials | Dr. Amar Srivastava, LPU |
| 4:00 pm | Break | |
| 4:15 pm | Atomic Force Microscopy/Scanning Probe Microscopy | Dr. Kunal Bose Application Scientist Concept Scientific Instruments (CSI), France |
| **23/06/2021– Wednesday** | | |
| 2:00 pm | Solar Cell Manufacturing: Silicon & Perovskite Technology | Dr. Brijesh Tripathi, PDEU |
| 3:00 pm | Fabrication and Application of Transparent Oxide Semiconductor $BaSnO_3$ Thin Film Transistors. | Dr. Anup Sanchela PDEU |
| 4:00 pm | Break | |
| 4:15 pm | Ensuring High Performance and Reliability in a PV Module | Dr. Parth Bhatt Senior Reliability Engineer |



A PhD counselling webinar was successfully organized by our department titled "Emerging Research Opportunities @ Department of Physics, PDEU" on June 25th, 2021. This time speakers were our senior faculties Dr. Rohit Srivastava (Associate Professor, PDEU) and Dr. Balamurli Mayya (Assistant Professor, PDEU).

Webinar on “Mechanics of Superconductivity” was organized and coordinated by Dr. Anup Sanchela on the 1st of July, 2021 from 11:00 am to 1:00 pm. Two key speakers Dr. Anil Yadav and Dr. Santosh Kumar gave a wonderful oration that was very much educative for the audience.

# STUDENT ACTIVITIES

## Sanhit Mehta: [Major: Physics, Batch: 2018]

During the past year, I got a chance to serve as the president of the music club of our university, Offbeat. I've been associated with the club for around 4 years now.As president my role was to ensure smooth functioning of the club and everyone involved in it as well as to ideate and execute the events, we held throughout the year along with other members of the core committee. Given that our terms coincided with the university functional in a virtual mode, it served as a great learning curve for everyone. I'm fortunate that I got such an opportunity. Apart from that I took an introductory course on R programming from Johns Hopkins University on Coursera.I'm currently doing a course on General Relativity on MIT OCW.
I also had a chance to participate in a project to model the chaotic dynamics of a Tokamak. In particular, using the Lorenz equations and Runge Kutta method to reconstruct the dynamics of the system


## Shlok Shah: [Major: Physics, Batch: 2018]

The last three years in PDEU played an important role in my life, as I took my first step in the field of research.In my second year itself I got a chance to work with Dr. Dishant Pandya (Department of Mathematics, PDEU) and my seniors to work on a research project. We generated exact solutions of Einstein's field equations for anisotropic compact stellar objects, in various theoretical frameworks. Eventually, our first research article got published in the journal of Astrophysics and Space Science.
Also, under the guidance of Dr. Pandya, I, along with my senior, presented our work on Einstein's Clusters in the first Mathematical Modelling, Computational Intelligence Techniques and Renewable Energy (MMCITRE), 2020, held in Pandit Deendayal Petroleum University. I have also worked on an Action Research project for PDEU's transdisciplinary research magazine, CURIOSITAS. Apart from this, I have been a part of Brahmand- The Astronomy Club of PDEU since past 3 years. I have served as the Content Writing Head of Brahmand and in second year and as a Content Advisor in my third year.

# STUDENT ACTIVITIES

## Asit Dave: [Major: Physics, Batch: 2018]

In the course of COVID-19 lockdown, I have rendered several music covers with a band wherein I was involved in its programming and production. In addition to that, I have also made a few tabla covers on different genres of music ranging from folk to western. As a classical tabla player, I have secured my place as a winner of various music competitions. With my passionate inclination towards music, I have also served as a Performers' head of Offbeat.

Recently, I have worked on a pre-internship project that incorporated Gravitational wave source modelling using spherical harmonic modes of gravitational waveforms and its source's data analysis using Fisher matrix analysis.

## Arth Thakkar: [Major: Physics, Batch: 2018]

During the first year of mine at PDPU, I got associated with Sports Committee; responsible for conducting PetroCup, a major trophy around the state and other sports activities in college.
I did write as the reporter for the HTR Issue, printed in context of PetroCup-The Sports Fest of PDEU.
I, last year was named the Secretary of Sports for Ultimate Frisbee! My role as a secretary was to look after team's fitness and practice sessions, sports fixtures, managing the team at national and state level tournaments and look over ground maintenance available for the sports. Owing pandemic crisis, we conducted online fitness sessions, circuits, time management workshops and interactive sessions with the best people in the field of sports.
Apart from that, I took online courses on Data Science and Analytical Studies to delve deeper into the field, which have inclined my interest lately.

# STUDENT ACTIVITIES

**Dharil Shah: [Major: Physics, Batch: 2018]**

In the past 3 years, I took part in the inter-university athletic (track and field) competitions and won several medals. In the first year, I also explored a like-minded community—Brahmand—on campus that helped me find my niche. Later, I became the technical head, and subsequently the tech advisor of Brahmand, both of which helped me develop a strong leadership experience. Additionally, I also had the opportunity to pursue an independent research project with my faculty mentor, on simulating the behaviour of several chaotic, spatiotemporally extended systems, using coupled map lattices.

But, apart from these multifarious activities that I had engaged myself with throughout my time at PDEU—until I decided to take a transfer abroad—I have also published articles based on physics and related philosophies, on my blogging website (thescipost.wordpress.com), which I have continued to update and elaborate intermittently.


## Batch-2018

We had the opportunity to co-found a Physics club, which seems to have helped us fulfill one of our goals: to build a physics community in the university, involving physics students, faculties, and other aspirants.

# STUDENT ACTIVITIES

## Dhyanvi Rao: [Major: Physics, Batch:2019]

After joining PDEU I have had the privilege to study about various fields and gain knowledge in the subject of physics at a much deeper level. First year in the college I worked as a part of the literature club Jharookha. As a part of the club I got the chance to work as a reporter for HRT 2020 and penned down articles on various matches that took place during PetroCup – The sports fest. In the first year I also worked with Dr. Rohit Srivastava, RuchitaShah and an 18 batch student Shrusti Patel on a paper titled " A study on effect of deforestation on varying rainfall pattern over Gujarat region ". Later on I represented PDEU in the 34th Gujarat Science Conference 2020 with this paper in the poster presentation event. In the last two years I took certified web courses on programming languages and creative writing. Recently I took part in Hackathon and worked on topics revolving electic mobility and electric storage system in EV cars. At present I am working under a IBM certified non-paid internship for quantum computation and programming. Moving forward I hope to be a part of many more such ventures and dig deeper in the field of physics.

## Shrey Upadhyay: [Major: Physics, Batch: 2019]

The past year was no doubt a tough year for all of us, but I used the extra time to explore various fields both in academics and extracurricular activities.
I was fortunate enough to start my research work in the field of Quantum Consciousness with one of the top neuroscientist Prof. Dr. Donald Hoffman (University of California). I'm currently working on how Topological Models of microparticles and their fields behave in a localized space-time structure.
The extra time also allowed me to refresh my Chess skills and with enough practice I managed to win a second place in an online tournament on Lichess.
Apart from that I took introductory courses on Astrobiology, Cryptography, Linux and Machine Learning on Coursera.
I also had a chance to participate in webinars on Particle Physics and Standard Model organized my CERN. Also, I attended some sessions on Start Ups and Entrepreneurship.
I'm currently doing a 3-week long course on Stock Market Analysis and Trend Analysis.

## Aziz Lokhandwala: [Major: Physics, Batch: 2019]

My life was all about my ongoing journey in knowing more about nature written sometimes in numbers, datasets, or differential equations. After entering PDEU, in 2019; I've got great exposure to various research fields by professors, which lighted my unknown roads for achieving the ultimate reality. I've presented my article entitled, "Geometrical Analysis for approximating the nth prime number" at a conference(MSIRJ) organised by IMRF which was going to be held in Dubai, but because of COVID, it was organised online. It was organised probably in August 2020. Then over time, I was working on one other article which was presented at the conference held by PDEU (MMCITRE), and the article was published in Scopus index Journal. During these 2 years of journey of mine in PDEU, I've acquired more knowledge in field of Relativity, Electromagnetism, Thermodynamics, Atmospheric Sciences, and Mathematics. Because of my personal interest in the field of Number Theory, and Quantum Physics, I am trying to understand questions that have arisen decades ago, like; "What actually wave-particle duality implies"; "Somehow if we are visited by a time traveller, would laws of physics remain same for her/him"; "What it actually means when someone says entropy of an isolated universe always increases, even if the CMB temperature represents something at thermal equilibrium(the state of maximum entropy)", "How thermal entropy is related with entropy associated with gravitating bodies", "When the sum of squares of n consecutive odd integers yields a perfect square", "Debroglie- Bohm Pilot wave theory". Although from above it seems to as if a kid is just speaking out questions without any prior knowledge about the "Width" and "Depth" of respective fields, after coming to college, I'm actually able to work on these questions by continuous interaction with the Field experts, proper references, books, faculties, seniors, and lots of people who are driving my interest and contributing to my knowledge for allowing me to travel in field of understanding "The Nature" and ultimately understand the "Real Me" who is still wandering in the tides of my life.

# Adieu 2016 and 2017 batch

Take pride in how far you've come. Have faith in how far you can go. But don't forget to enjoy the journey.

*- Michael Josephson*

Be bold, be courageous, be your best.

*- Gabrielle Giffords*

# UPCOMING EVENTS

Last Date to submit abstract is August 15, 2021

For those interested, the call for papers will be submitted on the easy chair website.
The link for the same is attached below :

https://easychair.org/cfp/ICCMDP-2021


## Call for Papers

### OBJECTIVES:

The research area of materials has grown exponentially in recent times, thanks to the innovative, accurate synthesis, sophisticated characterization methods, and high-speed computational facility. The idea of the conference is to provide a platform for young researchers to showcase their expertise and have an opportunity to share their interests.
The topics which are welcome to be presented at the conference are as follows:

- Crystal growth and characterization
- Soft condensed matter
- Nanomaterials, biomaterials and their applications
- Novel conductors, insulators and semiconductors
- Electronic/optical/magnetic/thermal materials, properties and devices
- Organic/inorganic/hybrid materials and devices
- Liquids, glasses, amorphous systems and polymers
- High pressure materials science
- Radioactive and nuclear materials
- Photovoltaic and thermovoltaic devices
- Green materials and their scope
- Sensors and actuators
- Modelling and simulation of materials and devices
- Computational materials science
- Emerging materials and devices
- Hydrogen and electrochemical energy generation and storage
- Proton exchange membranes
- Fuel cell

Articles from other fields related to above topics are also welcome.

## IMPORTANT DATES

| | |
|---|---|
| **Last date for Abstract Submission (Via email)** | 15th August, 2021 |
| **Notification for Acceptance of Abstracts** | 20th August, 2021 |
| **Accommodation request** | 30th August, 2021 |
| **Last date for Registration** | 17th August, 2021 |
| **Last date to submit full manuscript** | 4th September, 2021 |

**LINK FOR REGISTRATION: HYBRID MODE (ONLINE AND OFFLINE, CAN OPT ON REQUEST)**
https://docs.google.com/forms/d/e/1FAIpQLSez0-uimTn1TK7KOp3uWt4YZMfFPwgkSQt4X21M72CxkDn1JQ/viewform

**LINK FOR PAPER SUBMISSION:**
https://easychair.org/conferences/?conf=iccmdp2021

## REGISTRATION

| | Before Due date | After Due date |
|---|---|---|
| International | | |
| **Research Students** | 300 ($) | 300 ($) |
| **Faculties/Industry** | 500 ($) | 500 ($) |
| National | | |
| **Research Students** | 2000 (INR) | 2500 (INR) |
| **Faculties** | 3000 (INR) | 3500 (INR) |
| **Industry** | 4000 (INR) | 4500 (INR) |

## PUBLICATION

The selected manuscripts will be published in the premier peer-reviewed international journal of Hydrogen Energy (IJHE). Rest will be published in the proceedings of the conference.

# PHYSITIEN

*Pandit Deendayal Energy University*

Email ID : *PhysicsNewsletter21@gmail.com*

JULY 2021 VOL-01

Do you have a suggestion or article that you think would be a good fit for our newsletter ?
Or maybe you want to ask any questions regarding the content, astrophysics or physics in general.
Send us a mail.
Your responses will be anticipated and highly appreciated.