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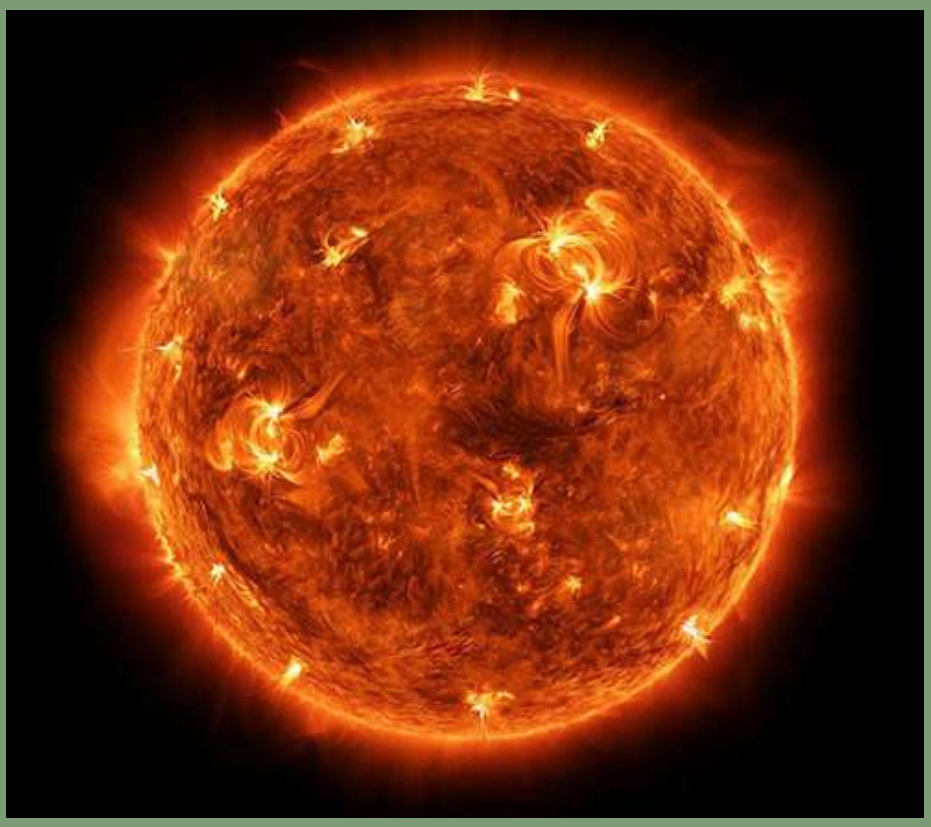
Formerly Pandit Deendayal Petroleum University (PDPU)

SOT SCHOOL OF TECHNOLOGY

Volume No. 2

PHYSITIEN

DEPARTMENT OF PHYSICS NEWSLETTER



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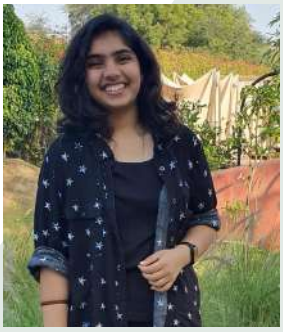

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FROM EDITORIAL BOARD

If you want to find the secrets of the universe, think in terms of energy, frequency, and vibration - ***Nikola Tesla***

PDEU's Department of Physics is truly encouraged by the feedback received from peers and well-wishers for our first edition. Hence, we are delighted to bring you the second edition of the newsletter – Physitien Vol. 2. Nikola Tesla, one of the greatest inventors, once said: "*If you want to find the secrets of the universe, think in terms of energy, frequency, and vibration.*" Those golden words were exemplified by scientists with time, and the importance of one of the pillars, Energy, was felt.

Our theme for the second edition is 'Energy', and through it, we attempt to provide an impeccable compilation of some beautifully drafted articles, a scholarly interview of an esteemed professor **Dr. Ajay Thakur (IIT-Patna)**, a collection of research abstracts published by PDEU faculties and students at two international conferences organized by the department of Physics. One, **International Conference on Condensed Matter and Device Physics - 2021 (ICCMDP-2021)** Sep 11-13, 2021, and other in collaboration with the department of Chemistry **International Symposium on Materials of the Millennium: Emerging Trends and Future Prospects (MMETFP-2021)** Nov 19-21, 2021 followed by a glimpse of our departmental activities. Over the last 150 years, our homes, offices, and factories depended on fossil fuels as their major source of energy. As a result, we now face pollution and climate change on a global level, along with other harmful impacts. With the help of the selected theme, we would like to emphasize the need of the hour to discuss alternate and sustainable energy.This paradigm shift to clean energy is about making an investment for our future towards sustainability. "*Replacing traditional sources of energy completely with renewable energy is going to be a challenging task. However, by adding renewable energy to the grid and gradually increasing its contribution, we can realistically expect a future that is powered completely by green energy*" - Tulsi Tanti.

FROM EDITORIAL BOARD

First, have a definite, clear practical ideal; a goal, an objective. Second, have the necessary means to achieve your ends; wisdom, money, materials, and methods. Third, adjust all your means to that end.

–Aristotle

Therefore, a critique of recent developments in Energy Storage is created to make the readers aware of the contemporary research. Alongside the conventional methods used to generate energy, we have collected and presented some unique ways to harvest electrical energy, which may allow you to learn about creative approaches made in this field.

We are extremely delighted to bring the current academic achievements of our department's alumni i.e. their admittance to prestigious national and international institutions. This can be attributed to their constant efforts, strong will, perseverance and guidance from the departmental faculties. Our Alumni Base is expanding year by year and we would like to highlight their achievements in this 2nd issue so that they can be "torchbearers" for their juniors, making their path more aligned.

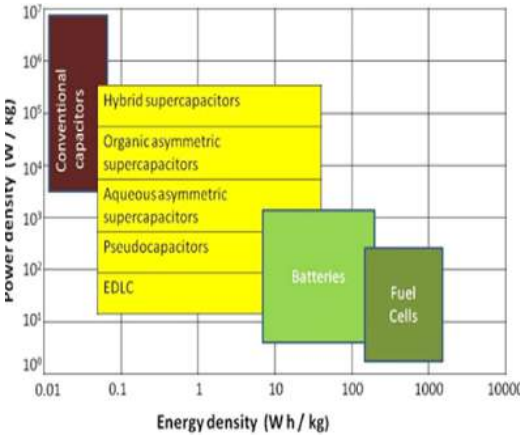
Thus, we look forward to inspiring you to learn about prospects in the field of Energy and motivating you to write for our next issue. We appreciate the efforts of all our team members who have so diligently worked to compile this issue. We hope you will enjoy reading the our content.

Keep Reading, Exploring, Writing, and Sharing!

SUPERCAPACITOR: STUDY AND CHARACTERISATION

YASH SENJALIYA, M.SC. PHYSICS, SEM II

A supercapacitor or ultracapacitor is an electrochemical capacitor that has an unusually high energy density when compared to common capacitors. They are of particular interest in automotive applications for hybrid vehicles and as supplementary storage for battery electric vehicles. They typically store 10 to 100 times more energy per unit volume or mass than electrolytic capacitors, can accept and deliver charge much faster than batteries, and can tolerate many more charge and discharge cycles than rechargeable batteries.



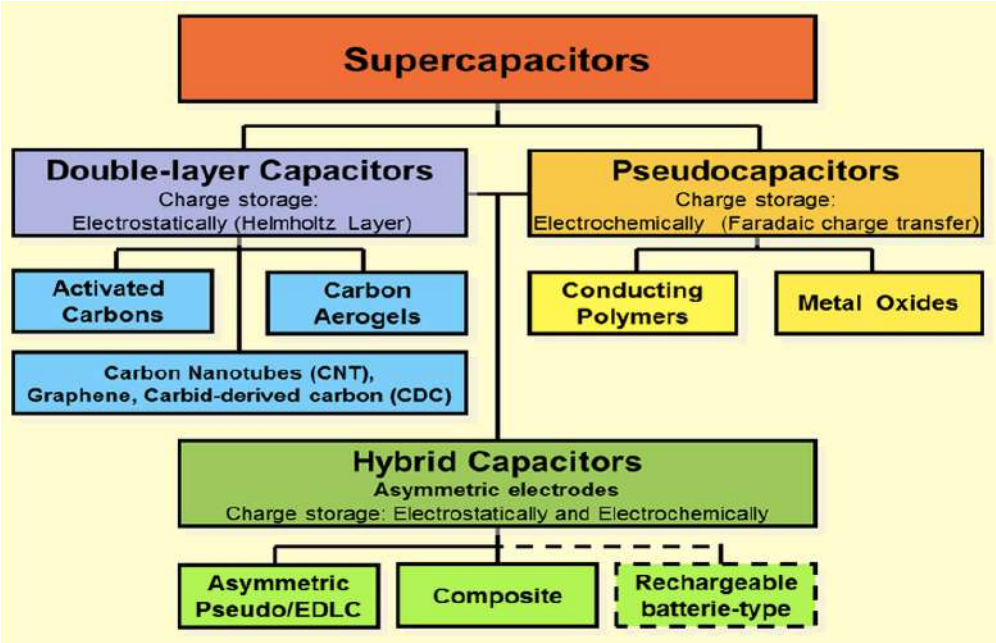
Storage device characteristics	Super capacitor	Capacitor	Battery
Charging time	1 – 30 s	$10^{-3} < t < 10^{-6}$ S	1 < t < 5 h
Discharging time	1 – 30 s	$10^{-3} < t < 10^{-6}$ S	T > 0.3 h
Energy density (Wh/kg)	1 – 10	< 0.1	10 – 100
Life time (Cycle number)	10^8	10^6	1000
Power density (W/kg)	10,000	> 1,000,000	< 1000
Charge / discharge efficiency	0.85– 0.98	> 0.95	0.7 – 0.85

The supercapacitor has emerged as a promising electrochemical energy storage device. Its excellent performance, easy handling, and stability have gained remarkable attention. In comparison with batteries, it delivers high-power density and cyclic stability. This is basically due to its charge storage mechanism, where ions get adsorbed at the electrode surface during charging and get released while discharging. This makes it different from batteries, where repeated redox reactions lead to poor stability and low-power density. Supercapacitor works similarly to the conventional capacitor, where two conductors are separated by a dielectric medium.The capacitance arises from the separation of charges at the conductor surface. In supercapacitor, the conductors have been replaced by the porous electrode, which provides efficient surface areas for the adsorption of ions.

WORKING:

In a supercapacitor, there is no conventional dielectric. Both plates are soaked in an electrolyte and separated by a very thin insulator. When the plates are charged, an opposite charge forms on either side of the separator, creating what's called an **electric double layer.** This is why supercapacitors are often referred to as double-layer capacitors. Electrochemical capacitor has two electrodes, separated by a separator, which are electrically connected to each other via the electrolyte. When voltage is applied, and plates get charged, an opposite charge forms on the either side of the separator creating an electric double layer.

Types of supercapacitors



Why SUPERCAPACITOR?

Supercapacitors store more energy than ordinary capacitors by creating a very thin, "double layer" of charge between two plates, which are made from porous, typically carbon-based materials soaked in an electrolyte. Power backup by charging a bank of up to four supercapacitors in case of a power failure. It can handle 4.5 V to 35.0 V input voltage and over 10 A of charge/backup current.

CHARACTERISTICS:

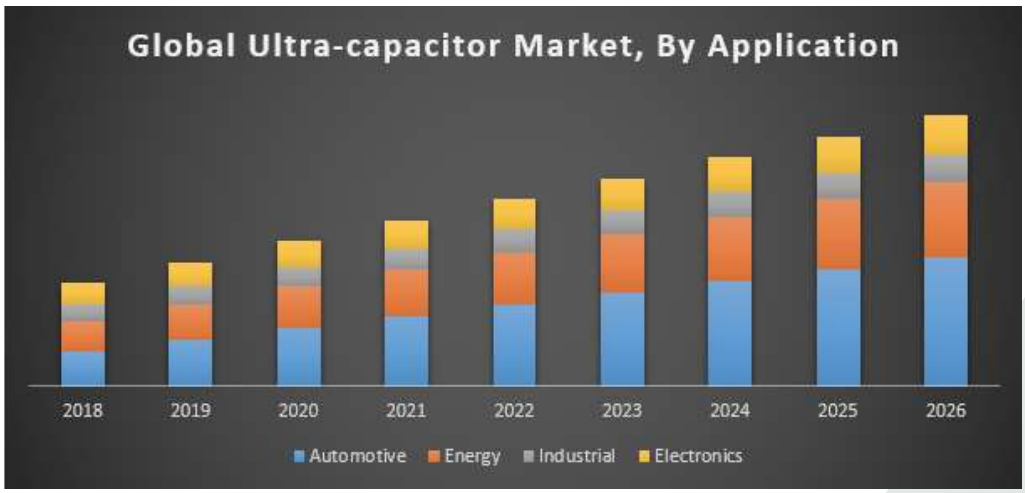
Charge/Discharge Time: Milliseconds to second
Operating Temperature: -40°C to +85C°
Operating Voltage: Aqueous electrolytes ~1V; Organic electrolytes 2 – 3V
Capacitance: 1mF to >10,000F
Operating Life: 5,000 to 50,000 hrs (a function of temperature and voltage)
Power Density: 0.01 to 10 kW/kg
Energy Density: 0.05 to 10 Wh/kg
Pulse Load: 0.1 to 100
Pollution Potential: No heavy metals

Future Applications:

As always, talk about supercapacitor technology isn't without discussing plans for the future. We're getting very close to standalone supercapacitor batteries.

Researchers at the University of Central Florida successfully created a prototype supercapacitor battery that takes up a fraction of the space of lithium-ion cells, charges more quickly, and can recharge 30,000 times while still working like new.

Other innovations set to change the capacitor business include designing ECs with graphene to create lightweight supercapacitors with energy-storage capabilities between 150 F/g and 550 F/g, at a fraction of the price of current EC designs. Even though, it's a concept still being explored.

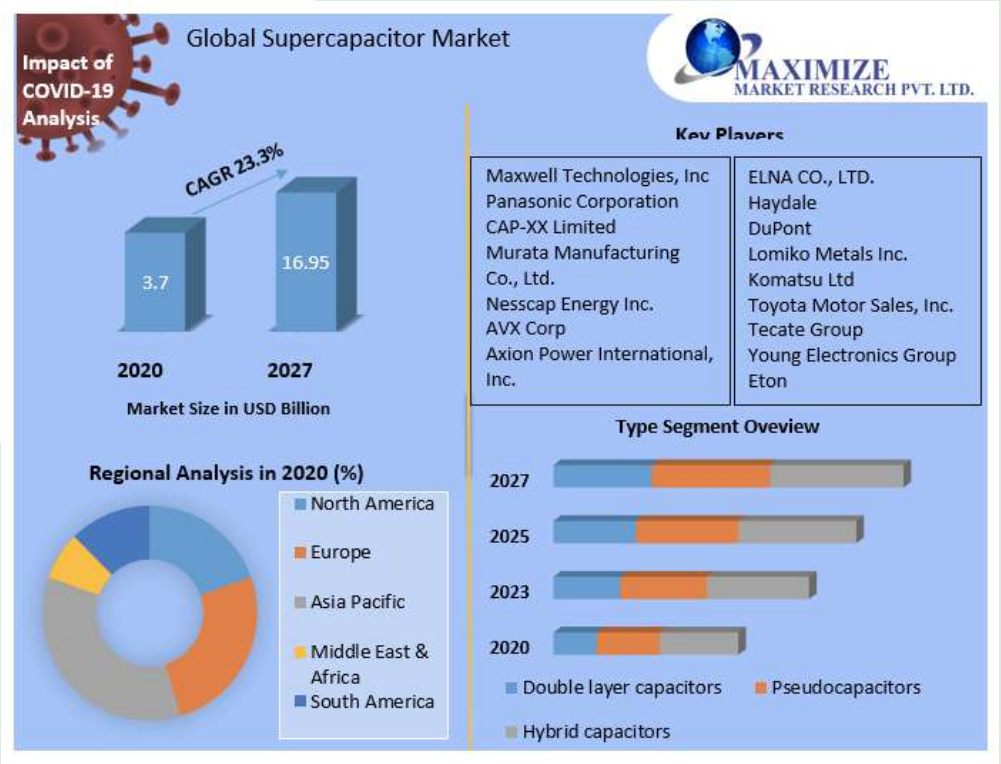


Realistic applications:

The most promising future of supercapacitors is the combination of a double-layer charging interface with existing energy-storage technologies. By adding EC technology to fuel-cell applications, companies have been successful in rapidly improving the charge/discharge cycle performance of hybrid- and electric-vehicle applications. Many cities using hybrid technologies for public transit have also seen an improvement in overall energy storage and charge cycles when coupling their energy systems with things like supercapacitor-based engine starters and charging station.

The closest future application for supercapacitors is in energy storage and rapid charging. Many applications of this type have already hit the market, and are changing how we think about energy storage.

The realization of a commercially viable, standalone supercapacitor battery may be further off into the future. Still, supercapacitor applications that have been achieved are an exciting realization of part of an age-old technology that is only getting better with time.



THE PHYSICS AND PHILOSOPHY OF ENERGY

SANHIT MEHTA, SHLOK SHAH, ARTH THAKKAR, ASIT DAVE, AND NISARG TRIVEDI

Introduction:

While talking about the subject of energy viz a viz physics, one automatically thinks of connotations that align with energy production, storage mechanisms, and technology to produce or harvest renewable energy. A philosophical treatment of the subject which has been at the center of thought of various philosophies for aeons is often missed and with it the fact that these philosophies happen to have the physics of energy interwoven in them. This article is an honest attempt to try and explore this facet.

Indic philosophy has always emphasized the importance of various forms and sources of energies even going to the extent of alluding to a holy status. Various ancient scriptures, for instance, Vedas, Puranas, and Upanishads; find mention of shlokas written regarding ascertaining due importance to energy and its manifestation across the universe.

While treating and contemplating the subject of energy, both from a philosophical and scientific standpoint, the West has always considered it to be an omniscient quantity/variable, i.e, a given.

The eastern and Indic philosophy, in particular, adopts a different line of treatment of the subject. Vedas, Upanishads, Puranas, and numerous other such scriptures are rife with references to the fact that energy is an all-pervasive quantity, and depending on the limitations of our faculty of senses, we can perceive some of them. The idea of "Panchtatva", or the fieve sacred elements is one example of the same idea being furthered. The "Panchtatvas" namely, "Prithvi" - Earth; "Varuna/Jal" - Water; "Agni" - Fire; "Vayu" - Air; and "Akasha" - Space/Ether. It is held that all creation is a combination of these elements and hence they are revered. Physics has gone on to establish with scientific accuracy that all that we see is nothing but a manifestation of some form or combination of various energies.

Not only that, the Vedas have entire sets of "shlokas" and "sanhitas" mentioning facts like the Sun being the primary source of energy for all life on our planet, the energy contained in water, and geothermal energy to name a few. Hence, these scriptures also happen to have mentions of renewable sources of energy hinting at the fact that we were conscious of these phenomena albeit on an elementary level. Energy and Indian **Philosophy**:

Eternal questions about humanity and the role of sapient life in the universe are in the subject area of philosophy, but the field of Physics has a lot to deal with them at a close range. Several prominent physicists were strongly addicted to Indian philosophy. Anna Sidorova-Birukova of M.V. Lomonosov Moscow State University has explained in her paper titled, Theoretical Physics and Conceptual Coherence, about the compatibility between the way physics defines the concept of energy and the way Indian sages perceive it. According to the latter, energy is the building block of all objects and beings in the Cosmic Dreams of God, a phrase used by the Yogis to refer to the universe. An analogous concept can be discerned in the physical definition of Energy, wherein 'light' or electromagnetic radiation is described as the most elementary interaction.

The concept of Samanya or 'common essence' is said to be eternal and existing in the form of substance, property, or action. These are no other than the three forms of energy in physics: energy of rest, interaction, and motion.

According to the Yogis, meditation enables them to see their bodies as a manifestation of vibrating light, rather than a solid mass. These vibrations provide energy to the cells of the body and eventually provide life in it. Moreover, according to them, thoughts are like ripples and waves in the mind, that assist in carrying information throughout the body.

The sound of the prayer 'AOUM' goes through the entire sound spectrum, starting from the maximum open "A" and going through the lowest at "M". Vibrations of the sound of "M" in the 'yogic kriya' called Brahmerie intend to revive each and every cell, fill it with energy and make the body ready for meditation. Such a technicalor physiological approach to communicating with God is characteristic of Indian thinking and incorporates the notion in which energy is apprehended in real life and in science.

Mention of Energy in Vedas:

Vedas describe energy by the name of —Agni. Agni, when translated, takes the form of fire or heat i.e. a form of energy. 200 SÊktas (verses) have been devoted to Agni in Rigveda. As per the mythology, Agni is said to devour its parents (matter) soon after birth pointing to nothing but the conversion of matter into energy.

Aitareya Upanishad (part of Rigveda) upholds:

agniÌ sarvÈ devatÈÌ'

agnirvai sarvÈ devataÌ.

sarvadevatyo agniÌ

All material bodies in the universe originated from Agni (energy).

Energy is behind the birth of all material worlds.

Energy involves entire material creation.

Rigveda also talks about principles such as Conservation of Energy and Equivalence of Mass-Energy:

उपेंमसृक्षि वाज॒युर्वंच॒स्यां चनों दधीत ना॒द्यो गिरों मे ।
अ॒पां नपांदाशु॒हेमां कु॒वित्स सु॒पेशंसस्करति॒ जोषिंष॒द्धि
(Rigveda 2.35.1)

Translating: "Desiring food, I put forth this laudatory hymn; may the sounding and swift-moving grandson of the waters bestow abundant food upon me his worshipper; may he make us of good appearance, for verily he is propitiated by praise."

Verse tries to hold upon the conservation of energy by translating it from one form to another quoting that heat from Sun causes the evaporation and rain, which help trees to grow and through the process of photosynthesis, the chemical reactions cause the production of food i.e. Fruits and Vegetables.

श्रु॒धी हवंमिन्द्र॒ मा रिंषण्य॒: स्यामं ते दा॒वने॒ वसूंनाम् ।
इ॒मा हि त्वामूर्जों व॒र्धयंन्ति वसूयव॒: सिन्धंवो॒ न क्षरंन्तः॥
(Rigveda 2.11.1)

Translating: Indra, hear (my) invocation; disregard it not; may we be (thought worthy) of the gift of your treasures; these oblations, designed to obtain wealth, flowing (abundantly) like rivers, bring to you augmented vigor.

Here the energy is described to be the augmenter of physical prosperity. It is also described as non-depleting which is nothing else but points out the principle of equivalence of mass-energy. The energy is a catalyst to prosperity and is not depleted like the flow of a river.

Vedic Scriptures also have a mention of ajÈ. ajÈ is described as dark matter contained in the dark holes of the Universe. It is said to be present in all animals, a„va(sun), gau (earth), and avi (magnetosphere of earth or intermediate space between sun and earth). AjÈ in Atharvaveda is described as agni (energy). Dark matter radiates dark energy. Yajurveda and Atharvaveda also maintain that ajÈ was born from perturbation of agni and he saw agni first and gods became gods due to ajÈ. This all points out that dark matter is the source of origin of stars and planets in the universe.

FROM HYDROCARBONS TO HYDROGEN : TOWARDS A SUSTAINABLE FUTURE

KHUSHALI JOSHI, M.SC. PHYSICS, SEM IV

Hydrogen (H2) production is a latent feasibility of renewable clean energy. The industrial H2 production is obtained from reforming of natural gas, which consumes a large amount of non renewable energy and simultaneously produces greenhouse gas carbon dioxide. Therefore, developing efficient and the gradual intensity of global energy crisis, hydrogen (H2) is one of the most sustainable and clean energies for replacing fossil fuel energy. **Prime Minister Narendra Modi announced the launch of the National Hydrogen Mission on India's 75th Independence day, saying that the aim is to make the country a global hub for the production and export of green hydrogen. Reliance Industries Ltd (RIL), the largest private sector oil and gas company in the country, plans to go green.** The company recently announced its plan to become a net carbon zero firm by 2035. It aims to replace transportation fuels with clean electricity and hydrogen with the current cost of green hydrogen produced by electrolysis estimated at around 350 Rs. per kg, India's green hydrogen plan is to more than halve to 160 Rs. per kg by 2029-30. India has already set a target of achieving 450 GW renewable energy by 2030. The replacement of fossil fuels with a clean energy storage medium such as H2 is the most pressing challenge in the world.

What is green hydrogen and will it power the future?

Humanity is facing an uphill battle, when it comes to preserving our planet in order to avert that we needs to stop global temperature from rising 1.5 degrees celsius above. Pre industrial levels to do this global carbon emissions need to drop to zero by 2050. The advantage of green hydrogen is that it is a clean burning molecule meaning that it can help us to decarbonize a range of sectors that have proved hard to clean up in the past. This includes the chemical, iron and steel industries as well as transportation especially long haul.

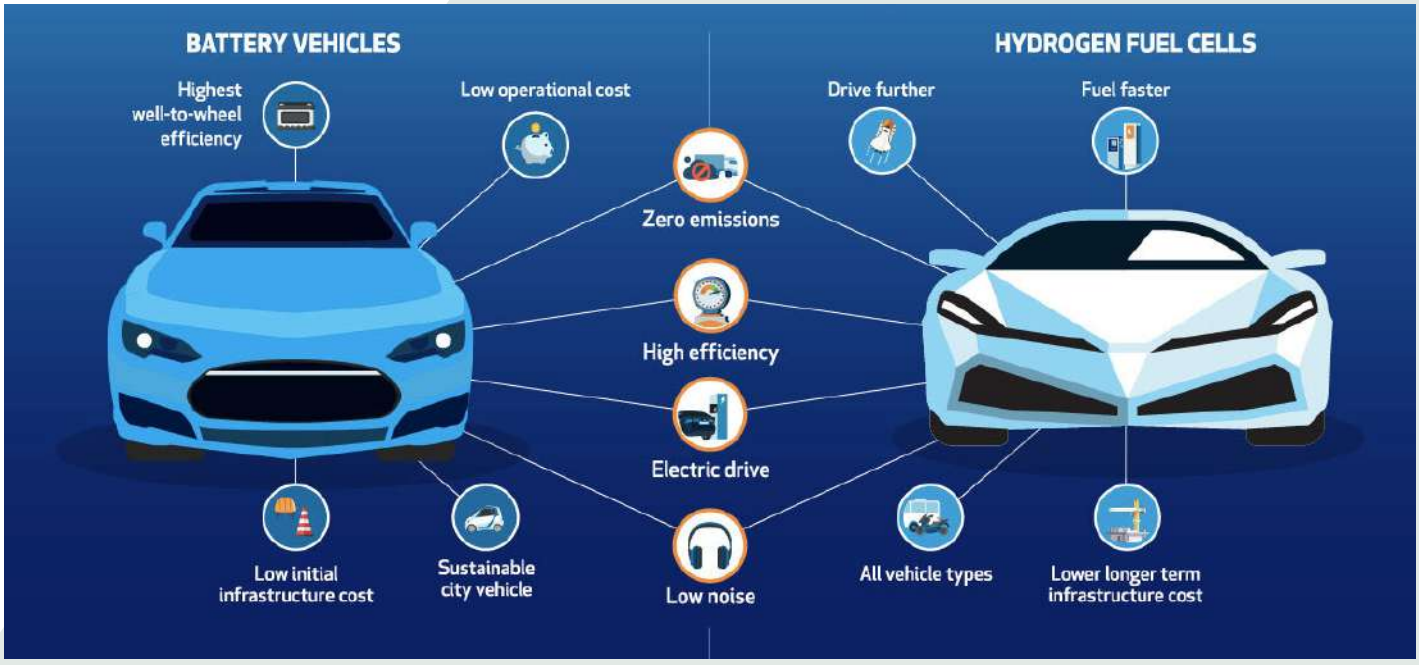
Hydrogen can also be used to heat our homes and store renewable electricity that would otherwise be wasted. If we are serious about decarbonization, which have zero carbon emission there is no choice but using hydrogen renewable energy can get you so far actually up to 50 to 60 reduction in total emission in the world because hydrogen is very reactive. A number of other challenges remain including the lack of infrastructure to transport and store it and the fact that fuel cells which convert hydrogen to usable energy for cars are still very expensive still solutions are coming and overcoming some of these challenges could propel the hydrogen market to 2.5 trillion in direct revenues by 2050. The difference between a battery electric vehicle and a hydrogen fuel cell vehicle is that hydrogen fuel cell vehicle get about five times better energy storage per unit volume and weight. Experts believe that hydrogen fuel cell vehicles can be especially effective when it comes to long haul trucking and other hard to electrify sectors such as freight shipping and long haul air travel all applications where using heavy batteries would be inefficient. It gets to the point with a truck an 18 wheel truck that using a lithium battery would be almost ridiculous your entire truck would have to be a lithium battery to make it practical or else the truck driver would have to be charging up the truck all the times instead of driving it but adoption of hydrogen fuel cell vehicles has been slow globally there were more than 18000 hydrogen fuel cell vehicles on the road at the end of 2019.

By comparison there were 7.2 million electric cars on the road today only three car companies offer hydrogen fuel cell passenger vehicles. Honda, Hyundai, Toyota and they all cost around 60 thousand dollars that's twice.

Hyundai along with Toyota and its truck subsidiary Hino are also working on hydrogen fuel cell trucks france's oil and gas giant total recently invested in hydrogen fuel cell truck and bus startup Hyzen motors and Nikola motors has said that it will begin consumer production of its hydrogen fuel cell truck in 2023 but one company not convinced of the advantages of the fuel cell truck is Tesla. Tesla is instead working on an electric semi truck which it hopes to start delivering in 2021. CEO Elon Musk has even gone as far as calling fuel cell technology mind-bogglingly stupid a big barrier to the adoption of hydrogen fuel cell vehicles has been a lack of fueling station infrastructure because even though fuel cell cars refuel in a similar way to conventional cars they cant use the same stations worldwide there are only 407 operational hydrogen stations today the majority are located in Europe followed by Asia and finally North America in the U.S. There are just over 40 hydrogen fuel stations with all but one in California you have to build stations you have to build refining capability you have to have the trucks that can move hydrogen to the stations of the pipes under the ground to move them to the stations aside from the infrastructure one point that is frequently brought up as a problem with hydrogen fuel is its inefficiency.

That's because by the time that hydrogen fuel is manufactured transported and distributed and transformed to electricity in the fuel cell 70% of its efficiency is lost. This challenge is mitigated somewhat by the fact that hydrogen is very energy dense meaning that it can hold a lot of energy in a small volume when you buy a kilogram of hydrogen you are buying the same amount of energy as buying a gallon of gasoline the difference is when you go to then convert that hydrogen into useful propulsion of your car its about 2 to 3 times as efficient as burning gasoline because its an electrochemical reaction its not combustion so its much more efficient so you can immediately divide today's cost of hydrogen by 2 and a half times so the goal is to get hydrogen powered four vehicle to be down around cost of todays liquid fuels gasoline and diesel along with cost of hydrogen the cost of fuel cell car components and storage also needs to come down. Hydrogen has to be kept under a huge amount of pressure so you do have to have very expensive extremely high pressure tanks .new developments are starting to make fuel cell technology and hydrogen storage a bit more affordable but scaling it will take time.

Hydrogen-powered vehicles have clear advantages in many applications



A company ***Kubogen*** has been working on a new hydrogen storage material so you get basically four to five times more hydrogen in the same space so your tank can be smaller or you can get longer range or any combination of the two and the cost is actually projected to be four to five times cheaper for the entire system than a current 700 bar system and it gets to the point with our material that the only cost factor when comparing a battery vehicle to a hydrogen fuel cell vehicle is the cost of the fuel cell and not the cost of the storage system. Another application for hydrogen that has experts excited is the ability to use it for storing renewable energy.

Mitsubishi long power along with fuel storage company magnum development are working on a project in Utah which promises to build storage facility for 1000MW of clean power partly by keeping hydrogen and salt caverns scheduled to be operational by 2025.the advanced clean energy storage project would be the largest clean energy storage system in the world .they are going to build a very large electrolysis system that will be able to convert renewable power into hydrogen and then they are going to store that hydrogen in that salt dome for long periods of time so that it can be used when the grid needs the electricity instead of when its produced the hydrogen stored in the salt mines will be used by a power plant next door the intermountain power project which is in delta Utah is the last coal fired power plant that's providing power to the state of California and its scheduled to be retired in 2025.

Intermountain power has selected our equipment to repower that power plant with gas turbines but they have asked to make these the first heavy duty gas turbines ever that can provide this power with a mixture of natural gas and hydrogen browning ,the gas turbines will use 30 hydrogen and 70 natural gas but the goal is to use 100 green hydrogen by 2045 phase one of our aces project is going to be capable of 150000 MW hours of energy storage and 150000 MW hours is enough to fuel 30 of an 840 MW power plant and 840 MW is enough power to supply one seventh peak needs of the city of Los Angeles.

Today companies like **NEXTera energy**, EOS energy and even Tesla store excess renewable energy and batteries but there's big drawback. If you are only storing electricity for a short period of time it's much better to store it in battery. You can do that a lower cost as there is better storage efficiency to that of storage process but if you want to store electricity for a long period of time battery storage gets more and more expensive you have to build more and more batteries whereas with hydrogen we can store it underground in large salt domes for long periods of time at very low cost.

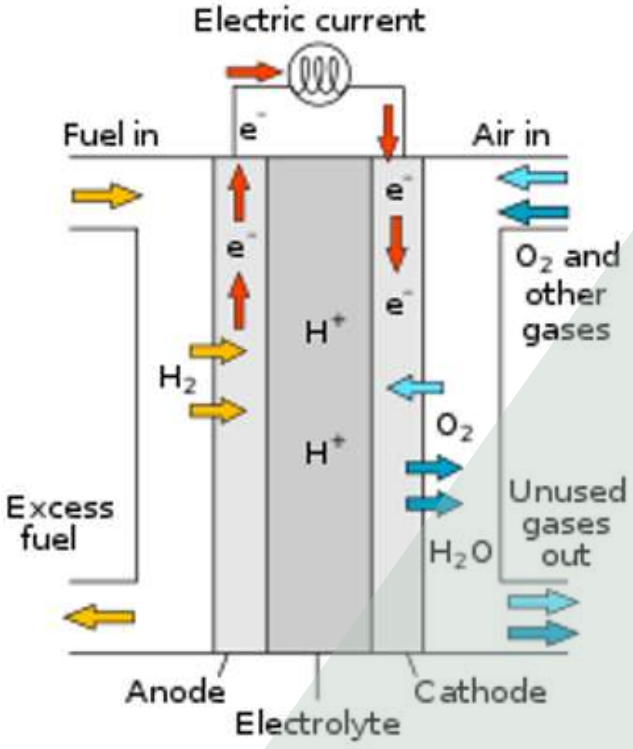
Hydrogen's versatility means it has the potential to disrupt many avenues of our economy from energy production and storage to transportation in industrials in fact analysis think that by 2050.

One study estimates that generating enough green hydrogen to meet a quarter of our energy needs would take more electricity than the world generates today from all sources combined and an investment of 11 trillion dollars in production storage and transportation infrastructure still remain. Analysts say we are moving in the right direction hydrogen production cost which has been dropped from two sources electrolyzer prices are down 50 in five years and the second element which is renewable energy costs which are also down between 50 to 60 percent already and both of them will go down another 60 to 70 percent before the end of the decade as scale of fuel cells in trucks and other applications emerging it all comes down to economics so that's really what the goal is the cost of green hydrogen down where it starts to displace some of these fossil fuels. Many experts believe that green hydrogen is going to be very integral part of our life if we are serious about decarbonization.

HYDROGEN

DEVANG, M.SC. PHYSICS, SEM II

Introduction:
Hydrogen is the most exuberant element on earth but hydrogen does not exist freely in nature, it can be produced from a different method. In electrolysis of water electric current is passing through two electrodes placed in water. At the end of process, we get hydrogen at anode. This is only process which is carbon free if electricity is provided through solar or wind. In another method hydrogen is collected through vaporization of natural gas. If we provide steam to natural gas, after some time it release carbon dioxide and hydrogen gas but this is not carbon free process still at present this is widely used process.



Hydrogen is not a direct source of energy but it is an energy carrier. It can be used to produce energy, to power hybrid vehicles or autonomous energy production systems. Hydrogen is the fuel of the future. In a hydrogen fuel cell, electricity is produced through hydrogen gas.


Equipment & Maintenance Update

Electric Trucks: Under the Hood

Deployment of Hydrogen Fuel Cell Powered Trucks Will Require Fueling Networks, Clear Business Cases

Basically, this is also electrolysis process in which there is electrolyte and anode & cathode is present in it. Now hydrogen gas is provided at anode, it will make chemical reaction with electrolyte and become positive ion by releasing electron. These positive ions attract towards cathode. These free electron produces electricity and at the cathode there is continuous supply of oxygen gas.

So, hydrogen ion combined with this oxygen and forms water. The only emission from a fuel cell is water steam. Hydrogen is thus a clean fuel for cars without emissions of pollutants and greenhouse gases that contribute to climate change.

A little closer to the bottom, commercial industry and NASA have partnered to explore the advantages of hydrogen, not as a rocket fuel, however in a fuel cell system. The Pathfinder and Helios projects were developed by AeroVironment, Inc. below NASA's Environmental Research Aircraft and Sensor Technology (ERAST) program. These experimental long-range unmanned vehicles utilize a hybrid system during which hydrogen fuel cells are replenished by electrical power from solar arrays. throughout the day, solar cells turn out electricity that separates water into hydrogen and oxygen through electrolysis. At night, the fuel cells generate electricity from the stored gases, and the cycle continues. This unique combination offers theoretically indefinite day and night continuous operation.

The Helios unmanned aircraft utilized a hydrogen fuel cell system

The vehicles are created which are using hydrogen as a fuel. It sees hydrogen enter the electric cell from a tank and blend with oxygen to form liquid water in a chemical process, which generates electricity that is accustomed power the motors that drive the wheels. The benefits of those vehicles are It can be fully fueled in three to five minutes. There is No harmful emissions, the only thing to be emitted from a cell is water. it has an impressive range, with a range of around 300 miles per tank, hydrogen cars are on a par with many conventional vehicles.

So, hydrogen is that much of important then why in real follow it is not used? These days, most hydrogen is produced through conventional way, resulting from the combustion of fossil fuels that releases an oversized quantity of carbon dioxide. The main challenge is thus to produce hydrogen using renewable energy sources like wind turbines and solar panels. This is often large step to be taken towards green hydrogen.

Compared with the assembly of hydrogen from fossil fuel, the production of hydrogen through renewable energies is extremely expensive and less efficient. We can store hydrogen in liquid kind. However, liquefaction of hydrogen is too expensive. To liquid hydrogen very low temperature is needed. In addition, hydrogen remains extremely explosive. It should be hold on and transported under high pressure in bulky containers. This poses issues of security, supply and gain that also hinder its use. Because of its extremely explosive nature there are currently only 17 fueling stations in the United Kingdom and every station price £1.3 million to build. one more reason is troubled, the prevailing infrastructure. As a result, hydrogen doesn't occur naturally, it has to be extracted, then compressed in fuel tanks. It then needs to combine with oxygen in a fuel cell stack to create electricity to power the car's motors. That's why hydrogen automotive obtaining no additional success.

RENEWABLE ENERGY STORAGE IN INDIA – ELECTRIC MOBILITY SCENARIO

BRIJESH TRIPATHI, DEPARTMENT OF PHYSICS

India imports >80% petroleum of its total requirements. India spent $112 billion on crude oil imports in 2014–2015, and $125 billion in 2018–2019 [1]. Of India's 2008 national average mode share, 66% was non-motorized transit - walking, biking, and public transit. This value was higher in Category 6 cities (>8 million people), where public transit, walking, and cycling made up 74% of the mode share (44%, 22%, and 8% respectively). In recent times, India's energy infrastructure has attracted attention of wider research community. Energy Storage has come up as one of the important component in India's energy infrastructure development plan. In 2013, Indian Energy Storage Alliance (IESA) estimated that the market potential in India for energy storage systems in renewable energy applications alone would be around 6000 MW by 2020. Recently, after setting-up the renewable energy generation capacity target of 175 GW by 2022, the potential for energy storage has been revised to about 15 - 20 GW. NITI Aayog and RMI estimate that India would require a minimum of 20 Gigafactory-scale battery manufacturing plants, collectively producing approximately 800 GWh of batteries per year by 2030 to support 100 percent Electric Vehicles sales. Renewable energy storage refers to the storage of energy generated from renewable resources (like, solar energy, wind energy, small hydro-electric plants etc.) in the readily available to use form. It includes various storage options (Fig. 1), like, flywheel, batteries, compressed air storage, pumped hydro storage, and chemical fuel based storage, like, hydrogen, methane, methanol, ethanol, propanol etc.

As per India's energy infrastructure development vision [2], key areas for energy storage application include:

- **Integrating renewable energy with distribution and transmission grids;**
- **Setting-up rural micro grids with diversified loads or stand-alone systems;**
- **Developing storage component of electric mobility plans.**

In order to address, the upcoming needs, GoI has come up with National Mission on Transformative Mobility and Battery Storage [3].

Figure 2 shows available technological options for utilization of various energy storage modes for mobility purpose.

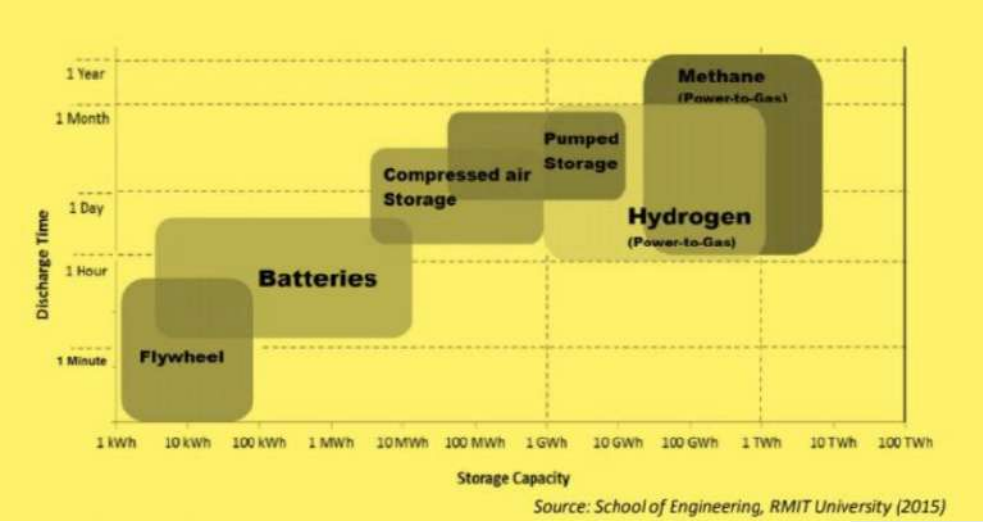


Figure 1: Various energy storage technologies and their comparison.

Figure 2: Available technological options for utilization of various energy storage modes.

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ALPHA PARTICLE DECAY

AZIZ LOKHANDWALA, B.SC. PHYSICS, SEM VI

"THE STRANGE ASPECTS OF ALPHA DECAY HAVE TO BE SIMPLE ENOUGH IN UNDERSTANDING BUT ELEGANT ENOUGH IN ITS FORMULATION"

The nuclear radioactivity has many puzzling aspects and thanks to these features we were able to uncover the hidden mysteries of nature. One can safely state that the base for all the recent development in our understanding of nature at the atomic scale has started with the advent of experiments in the field of high energy physics and the development of theory of relativistic electromagnetism. In this article, we will discuss the fundamental mechanism of the alpha particle decay through the process of tunnelling.

THEORIES OF ALPHA DECAY

The theories which were given in earlier times to explain alpha particle decay were fancy in themselves. The basic question of why alpha particle decay actually occurs was answered after the proposal of various successful theories. Of these many, one theory explained the alpha particle decay by using the tools from Quantum Mechanics. This theory was proposed by Gamow, Gurney and Condon, explaining the energies associated with alpha particle decay based on Quantum Tunnelling. They assumed that the alpha particle as a whole entity is present inside the nucleus, continuously hitting the walls of nucleus. At one instant of their lifetime, although not having enough energy to penetrate the walls of nucleus, they Tunnels! Here, according to my hypothesis, the phenomena of Tunnelling can be a natural outcome of Nuclear Potential Barrier or in general any potential barrier with a quantum particle inside.

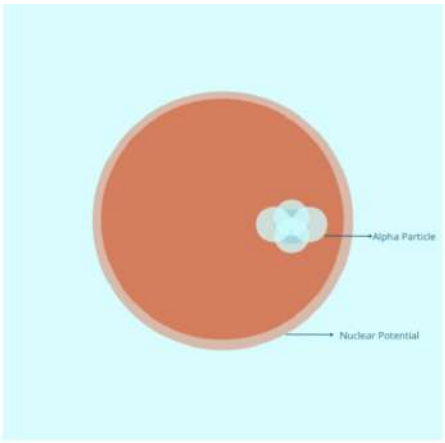


Fig 1.0—Alpha Particle as an entity inside the nucleus

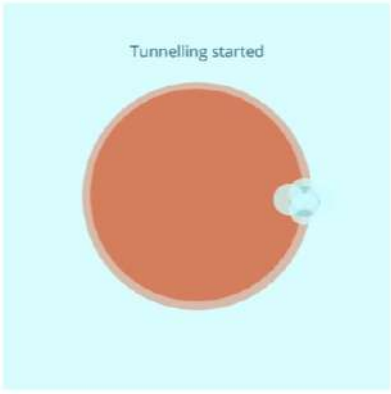


Fig 1.1— Alpha particle tunnelling through the nuclear potential barrier

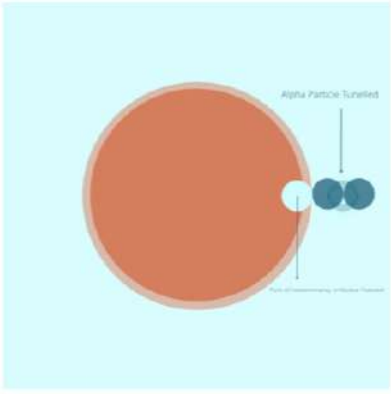


Fig 1.2—Tunnelling, leaving a point of indeterminacy in the nuclear potential barrier

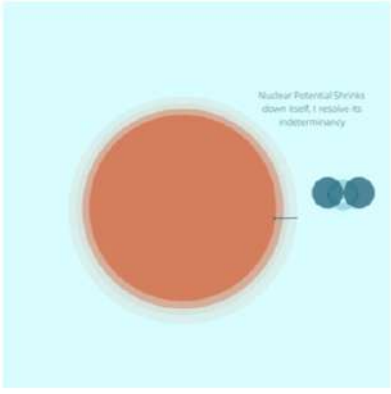


Fig 1.3—Reduction in size of the barrier, to fill the indeterminacy

QUANTUM TUNNELLING

Consider a particle in a finite potential well (Fig). Now, here I make a proposition as follows,

Proposition: Assume that nuclear potential V (r, θ, φ, t) is having Laplacian like nature.

The assumption which I've made here is in itself a bit disconcerting for all of us and the physicist community.The assumption however is made on observed analysis and can be understood as follows.

For 1-D case if a potential V(x) satisfies Laplace's equation

$$\nabla^2 V(x) = 0,$$
$$\text{then } V(x) = m\,x + b.$$

Here m, b are determined from the boundary condition of V(x).

Now, if we take

$V(x + 1) = m(x + 1) + b$ and $V(x - 1) = m(x - 1) + b$,

then,

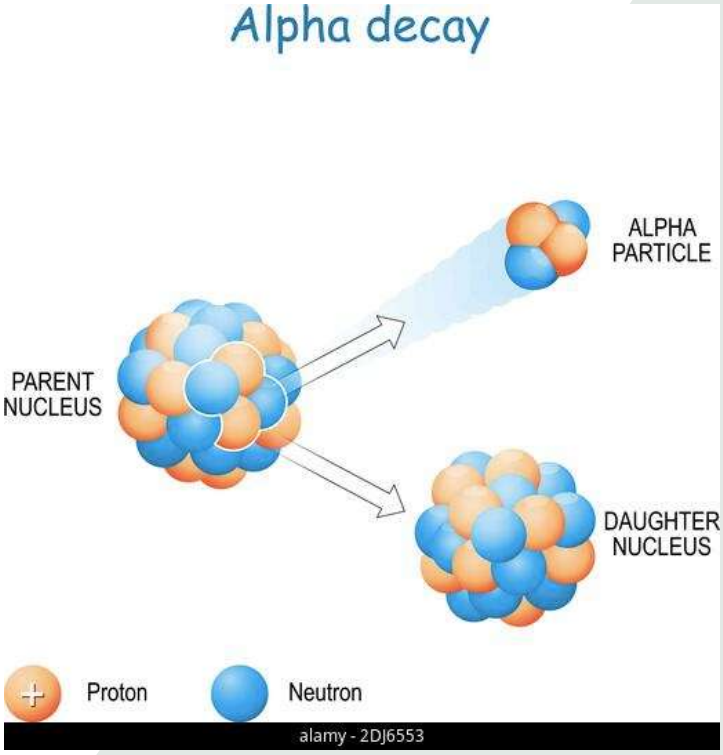
$$\frac{V(x+1)+V(x-1)}{2} = mx+b = V(x)$$

However, in the assumption I've clearly written that V(x) for our nuclear potential is having Laplacian like nature.

Now, the benefit of this assumption is, the average value of V at two neighbourhood points around point P is equal to value of V at that point P.

But, you must notice, that although our assumption made us assume the nature of V, it inculcates the dependence of t in V explicitly. The reason is that the radioactivity is a stochastic process, there are other possibilities too, and here the possibilities are now replaced by the states of nucleus after the particle inside it has tunnelled through the barrier of nucleus.

Now, owing to this nature of V, it is just a matter of plugging this V to the time dependent Schrödinger's equation and solving it with appropriate boundary conditions. To discuss the math of this is not the aim of this article, but to give its physical point of view is definitely our matter of interest.



PHYSICAL SIGNIFICANCE OF ASSUMPTION

Suppose the alpha particle has tunnelled through the nuclear potential barrier at say point P. Now, for this point P, for sometime V is indeterminate. To understand this, you can take the analogy. If you hit your wall which is thin enough with a metal ball many times, the ball will penetrate through the wall but now, there is a hole in the wall, right!.

But do we observe such holes in the nuclear potential well, No, right!. Here comes the proposition in the role. Because the nuclear potential itself is having Laplacian like nature, it will shrink the wall in time interval which is practically un- observable because of the principle of Uncertainty. This shrinking will be because of the average-behaviour assumption. As at point P the nuclear potential is now indeterminate but it has to still have its Laplace's like assumed behaviour. So the neighbourhood points on this nuclear potential comes close to point P, and the new neighbourhood points are then defined. This exactly means that nuclear potential of the observed daughter nuclide must be less compared to the parent nuclide which is actually what we observe.

INTERVIEW

Dr. Ajay Thakur, IIT Patna

Two of our students majoring in physics, Sanhit Mehta and Arth Thakkar from the batch of 2018 interviewed Dr Ajay Thakur, a senior professor at the Indian Institue of Technology, Patna whose research interests lie in the field of condensed matter physics. The research activity in his group focuses on Physics motivated exploration of Sustainable Functional Materials and Technologies. Sir, am also collaborating with science and engineering department faculty members in our Institute towards developing applications in the domains of Energy, Environment, Cell manipulation using Micro-Robotics.
Here is the interview that sir gave.

Sanhit: Good morning sir, Sanhit here. 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.

Ajay sir: Thank you for having me.

Sanhit: Tell us something about your journey sir.

Ajay sir: I did my undergraduate studies at the University of Mumbai with, bachelors in physics with electronics and instrumentation of applied components. Then, I went on to do my masters from IIT-B. I got my doctorate from TIFR. TIFR was an accelerating journey of my life, I was motivated by professors from there. Coursework, faculty, workshops, symposia at the institute all helped steer my interest. In my opinion, every five years you must switch fields. Possible drawbacks are, citations may get affected, and recognition might take longer. On the other hand, the positives are, a steep learning curve and, you get to learn a lot more. My time at TIFR involved working with sub-zero temperatures using cryogens and, vortex physics. My Postdoc at NIMS Japan involved manipulating flux lines.

When I joined IIT Patna, it was new so facilities were limited. Hence, we started looking at new and interesting materials, oxides in particular, which have low Seebeck coefficients. We also started exploring their multiple applications and how they can make engines more efficient. We also developed techniques to increase the Seebeck coefficient of such oxides successfully. I have also worked on photovoltaics and making solar cells more efficient.

Arth: Your views on coal shortage and how can India become less dependent on coal power?

Ajay sir: A way to approach the problem of coal shortage is, like kWh, we could think about kilo-watt-year. Current approximations are 18 terra watt years of energy consumption globally and increasing with the advent of 5G, IoT, and other such technologies while the number of known coal reserves is only 900 terra watt years. That leaves us with a maximum of 40-50 years. If we consider nuclear energy, uranium is 250-300 terra watt years, which gives us 10 years. Fossil fuels, oil in particular is 240 terra watt years.

This seems like a tough situation, doesn't it? The energy available from the Sun is 23000 terra watt years per year, waiting to be tapped. A lot of efficient technologies are being developed which are capable of scaling with time. If we consider 10% efficiency, it just requires us to populate 0.1% of the Earth's surface with solar cells to harness this energy. In principle, 1% of the Sahara desert populated with solar cells can take care of the energy requirements of the planet year-round. Hence, solar energy is impossible to turn a blind eye to. Young researchers could focus on technologies like hydrolysis and the development of catalysts to boost hydrogen production through hydrolysis. In particular, seawater hydrolysis must be focused on so that freshwater is available for other uses.

" *The energy available from the Sun is 23000 terra watt years per year, waiting to be tapped. Solar energy is impossible to turn a blind eye to.* "

Sanhit: What is your take on the future of how condensed matter physics can contribute to the field of energy and advice for young students wishing to enter the field?

Ajay sir: Curiosity is paramount. There is interesting physics behind various day-to-day phenomena. Working of refrigerators to heating of oil are just a few examples. A formal approach would be to take a paper on E&M, focusing on classical and quantum mechanics. Post that, one could pick up a solid-state physics textbook amongst them, Charles Kittle is a good starting point. You could then move to Principles of Condensed Matter Physics by Chekin and Lewbinski. Try and look for internships in labs working on problems in the field of your interest, doesn't matter however small, the experience matters. Since a hands-on approach is irreplaceable.

Arth: Could you shed some light on the off-grid water harvesting and cold storage systems you are involved in developing?

Ajay sir: Off-grid water harvesting focuses on trapping moisture from the environment. Such techniques have a lot of scopes since novel harvesting methods can prove to be environmentally sound. Biomass gasification-based atmospheric water harvesters, also have a chance of commercialization.

Sanhit: It was a wonderful experience speaking to you sir.

Ajay sir: My pleasure, it is always good speaking to young students.

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DEPARTMENTAL ACTIVITIES

INTERNATIONAL CONFERENCE ON CONDENSED MATTER AND DEVICE PHYSICS-2021

International conference on Condensed Matter and Device Physics- 2021 was organized by the Department Of Physics in hybrid mode. The aim of the ICCMDP was to provide opportunity for the global participants to share their ideas and experience in person with their peers from different parts of the world. The conference included discussion sessions to explore research opportunities and future collaborations.

The ICCMDP 2021 conference was based on the recent advances in physics and materials.

TOPICS INCLUDED:

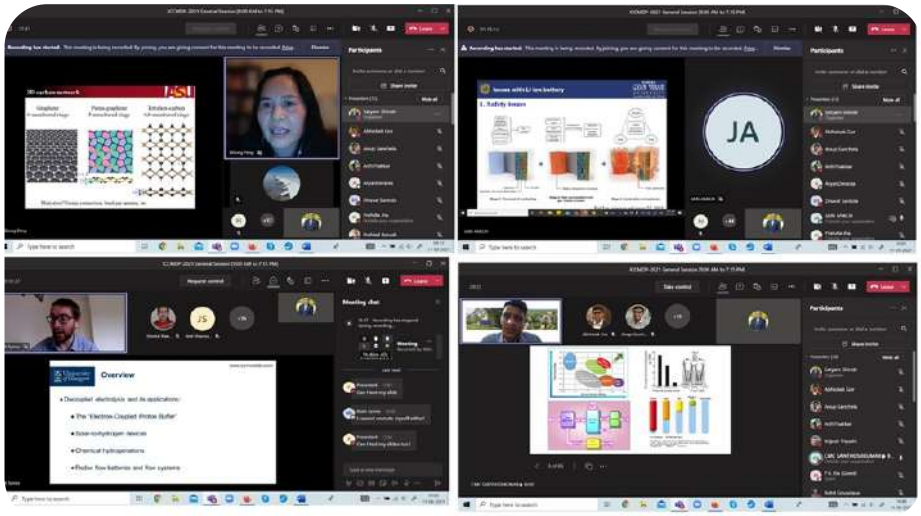
- Crystal Growth and Characterizations
- Soft Condensed Matter
- Nanomaterials, Biomaterials and their Applications
- Novel Conductors, Insulators and Semiconductors
- Electronic/Optical/Magnetic/ Thermal Materials, Properties and Devices
- Organic/Inorganic/Hybrid Materials and Devices
- Sensors and Actuators

DEPARTMENTAL ACTIVITIES

TOPICS .....

- Liquids, Glasses, Amorphous Systems and Polymers
- High Pressure Materials Science
- Radioactive and Nuclear Materials
- Photovoltaic and Thermovoltaic Devices
- Computational Materials Science
- Green Materials and their Scope
- Hydrogen Energy Storage Materials
- Modelling and Simulation of Materials and Devices
- Emerging Materials and Devices

Glimpses from ICCMDP-2021



DEPARTMENTAL ACTIVITIES

News Paper Covergae of ICCMDP-2021

પંડીત દીનદયાળ એનર્જી યુનિવર્સિટી ખાતે ICCMDP 2021 આંતરરાષ્ટ્રીય કોન્ફરન્સનું આયોજન

અમદાવાદ, શુક્રવાર

વધતા પ્રદૂષણના સ્તરને કારણે આબોહવા પરિવર્તનના જોખમને જોતા, હાઈડ્રોજન ઉર્જા આધારિતમા.જાખું (Infrastructure) વિજ્ઞાનીઓ, સંશોધકો, ભંડોળ એજન્સીઓ, નીતિ નિર્માતાઓ અને સરકારોનું ધ્યાન આકર્ષિત કરી રહ્યું છે.

આ ક્ષેત્રમાં આગામી પડકારોનો ઉકેલ લાવવા અને પંડિત દીનદયાળ એનર્જી યુનિવર્સિટી (PDEU), ગાંધીનગર ખાતે ભૌતિકશાસ્ત્ર વિભાગદ્વારા સંભવિત ઉકેલોની ચર્ચા કરવા માટે, ૯ થી ૧૧ સપ્ટેમ્બર ૨૦૨૧ દરમિયાનઈન્ટરનેશનલ કોન્ફરન્સ ઓન કન્ડેન્સ્ડ મેટર અને ડિવાઈસ ફિઝિક્સ (ICCMDP 2021) પર ૩દિવસીય આંતરરાષ્ટ્રીય કોન્ફરન્સનું આયોજન કરવામાં આવ્યું હતું.

આ કોન્ફરન્સને GUJCOST, DST, ગુજરાત સરકાર તરફથી અને સંરક્ષણ સંશોધન અને વિકાસ સંગઠન (DRDO), ભારત સરકાર તરફથી નાણાકીય સહયોગ પ્રાપ્ત થયેલો છે. ચર્ચાનું મુખ્ય કેન્દ્ર મટિરિયલ્સનાવિકાસની વિવિધ પદ્ધતિઓ, તેમના ગુણધર્મોનો અભ્યાસ અને હાઈડ્રોજન જનરેશન અને સ્ટોરેજ પદ્ધતિઓ સહિત તેમની ઉપયોગિતાઓપર હતું. કોન્ફરન્સનો વિચાર યુવાન સંશોધકોને તેમની કુશળતા દર્શાવવા અને તેમની રુચિઓ શેર કરવાની તક મળે તે માટે એક મંચ પૂરું પાડવાનો હતો. PDEU નોભૌતિકશાસ્ત્ર વિભાગ, PDEU ના વિઝન અને મિશનને અનુરૂપ દ્વિ-વાર્ષિક કોન્ફરન્સનું આયોજન કરશે.

આમંત્રિત ચર્ચાઓમાં ડીએકટી, ટેટ્રાપોડ્સ, નેનોફોટોનિક્સ, હાઈડ્રોજન જનરેશન અને સ્ટોરેજ સહિત મટિરિયલ્સના સંશોધનના સૈદ્ધાંતિક અને પ્રાયોગિક પાસાઓ શામેલ હતાં.

પ્રખ્યાત વક્તાઓમાં મુખ્ય અતિથિ તરીકે પોલેન્ડના પ્રો.ક્રીઝ્ઝટોફ જાન કુઝિડલોવ્સ્કી એડાયટોમ્સના ફ્યુચુલ્સ ની ઉપકરણો માટેનીઉપયોગિતાઓ વિષે ચર્ચા કરી હતી.

આઈઆઈટી-બોમ્બે તરફથી પ્રો.શોભા શુક્લાએ નેનો ફોટોનિક ડિવાઈસ ડેવલપમેન્ટ પદ્ધતિઓ પર ચર્ચા કરી.

જાપાનના પ્રો.તાકાયુકી ઈચિકાવાએ ઊર્જા સંપાત અને સંવેદના માટે ટાઈટેનિયમ આધારિતમટિરિયલ્સ વિશે ચર્ચા કરી. સિંગાપોરના પ્રોફેસર સમ ઝે યીને સોલાર સેલ એપ્લીકેશન માટે હેલાઈડ પેરવોસ્કાઈટ મટિરિયલ્સની સમજ આપી હતી. યુ.એસ.એ.ના પ્રો.રવીન્દ્ર પાંડે અને ડો.સિહોંગ પેંગે લિથિયમ-આયન બેટરી સહિત ઉર્જા સંગ્રહમાં ઉપયોગ માટે ક્વોન્ટમ મિકેનિકલ ગણતરી પદ્ધતિનો ઉપયોગ કરીને મટિરિયલ્સના સંશોધનની ચર્ચા કરી.

ડેનમાર્કના પ્રો.યોગેન્દ્ર મિશ્રાએ એડવાન્સ ટેકનોલોજી માટે સ્માર્ટ મટિરિયલના વિકાસ વિશે સમજાવ્યું. સ્વીડનના ડો.માઈકલસિવજાર્વીએ અમારા અંડરગ્રેજ્યુએટ, અનુસ્નાતક અને સંશોધન વિદ્વાનોને ઊર્જા અને પર્યાવરણીય મટિરિયલના ક્ષેત્રમાં નવીનીકરણના માર્ગો વિશે સમજ આપી. યુ.કે.ના પ્રો.માર્ક ડી. સિમેસે પાણીના વિભાજન આધારિત હાઈડ્રોજન જનરેશન પદ્ધતિ માટે ડીકપલ્ડ ઈલેક્ટ્રોલિસિસ સમજાવ્યું. CSIR CERI, ચેન્નઈના ડો.સંતોષકુમાર ભાટે ફ્યુઅલ સેલ્સના વિકાસ વિશે ચર્ચા કરી છે.

જીટીયુના વિદ્યાર્થીઓ અને તમામ ક અંગદાન જાગૃતિ સંદર્ભે પ્રતિજ્ઞા

અમદાવાદ, શુક્રવાર

ગુજરાત ટેક્નોલોજીકલ યુનિવર્સિટી (જીટીયુ) , અંગદાન ચેરીટેબલ ટ્રસ્ટ , મીડિયા ક્લબ અને ઈન્સ્ટિટ્યૂટ ઓફ કિડની ડીસીઝ એન્ડ રીસર્ચ સેન્ટરના સંયુક્ત ઉપક્રમે આગામી ૧૭ સપ્ટેમ્બરના રોજ માનનીય પ્રધાનમંત્રીશ્રી નરેન્દ્રભાઈ મોદીના જન્મદિવસની ઉજવણીના ઉપક્રમે અંગદાનને પ્રોત્સાહન મળે તે અર્થે પ્રતિજ્ઞા લેવામાં આવશે.

આ સંદર્ભે જીટીયુના કુલપતિ પ્રો. ડો. નવીન શેઠે જણાવ્યું હતું કે, અંગદાન બાબતે સમાજમાં જાગૃત્તિ કેળવાય અને વધુને વધુ લોકો અંગદાન કરવા માટે પ્રેરાય તે અર્થે જીટીયુ દ્વારા આ ઉમદા નિર્ણય લેવામાં આવ્યો છે. જે આગામી દિવસોમાં સમાજસેવાનું ઉત્તમ ઉદાહરણ પૂરું પાડશે. જીટીયુના કુલસચિવ ડો. કે. એન. ખેરે પણ તમામ સંલગ્ન કોલેજોને લોકસેવાના આ ભગીરથ કાર્યમાં સવિશેષ રીતે સહયોગી થવા માટે જણાવ્યું છે.

વર્તમાન સમયમાં હૃદય અને ચક્ષુદાન બાબતે મહદઅંશે જાગૃકતા કેળવાયેલ છે. પરંતુ બ્રેન ડેડ વ્યક્તિના અન્ય અંગો

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ક્લાઈમેટ ચેન્જના જોખમો સામે ઉકેલ અંગે પીડીઈયુ ખાતે ત્રિદિવસીય આંતરરાષ્ટ્રીય કોન્ફરન્સ યોજાઈ

ગાંધીનગર, તા.૧૬

સતત વધતા જતા પ્રદૂષણના સ્તરને કારણે થઈ રહેલા આબોહવા પરિવર્તનના જોખમના સંદર્ભે હાઈડ્રોજન ઊર્જા આધારિત ઈન્ફ્રાસ્ટ્રક્ચરના મહત્વ જેવા વિષયે ગાંધીનગરની પંડિત દિનદયાળ એનર્જી યુનિવર્સિટી ખાતેના ભૌતિક શાસ્ત્ર વિભાગ દ્વારા તાજેતરમાં ત્રણ દિવસની આંતરરાષ્ટ્રીય કોન્ફરન્સનું આયોજન કરવામાં આવ્યું હતું. તા.૯ થી ૧૧ સપ્ટેમ્બર દરમ્યાન યોજાયેલી આંતરરાષ્ટ્રીય કોન્ફરન્સમાં ક્લાઈમેટ ચેન્જ જેવા પડકારો સામે સંભવિત ઉકેલોની ચર્ચા કરવામાં આવી હતી. આ કોન્ફરન્સમાં સવાસો જેટલાં યુવા સંશોધનકારો જોડાયાં હતાં અને વિવિધ વિષય તેમના સંશોધન રજુ કર્યા હતાં.

પીડીઈયુ ખાતે યોજાયેલી ઈન્ટરનેશનલ કોન્ફરન્સ ઓન કન્ડેન્સ્ડ મેટર એન્ડ ડિવાઈસ ફિઝિક્સમાં મુખ્ય અતિથિ વક્તા પોલેન્ડના પ્રો.ક્રીઝ્ઝટોફ જાન કુઝિડલોવ્સ્કીએ ડાયટોમ્સના ફ્યુચ્યુલ્સની ઉપકરણો માટેની ઉપયોગિતાઓ અંગે ચર્ચા કરી હતી. આ સાથે આઈઆઈટી-મુંબઈ તરફથી પ્રો.શુભા શુક્લાએ નેનો ફોટો ડિવાઈસ ડેવલપમેન્ટ પદ્ધતિઓ પર પ્રકાશ પાડ્યો હતો. જાપાનના પ્રો.તાકાયુકી ઈચિકાવાએ ઊર્જા સંપાત અને સંવેદના માટે ટાઈટેનિયમ આધારિત મટિરિયલ્સ વિશે જ્યારે સિંગાપુરના પ્રો. સમ ઝે યીને સોલાર સેલ એપ્લિકેશન માટે હેલાઈડ પેરવોસ્કાઈટ મટિરિયલ્સની સમજ આપી હતી. યુએસએના પ્રો. રવીન્દ્ર પાંડે અને ડો.શિહોંગ પેંગે લિથિયમ આયર્ન બેટરી સહિત ઊર્જા સંગ્રહમાં ઉપયોગ માટે ક્વોન્ટમ મિકેનિકલ ગણતરી પદ્ધતિનો ઉપયોગ કરીને મટીરીયલ્સના સંશોધન અંગે જ્યારે ડેનમાર્કના પ્રો.યોગેન્દ્ર મિશ્રાએ એડવાન્સ ટેકનોલોજી માટે સ્માર્ટ મટિરિયલના વિકાસ અંગે અને સ્વિડનના ડો.માઈકલ સિવજાર્વીએ યુવા સંશોધનકારોને પર્યાવરણીય મટિરિયલના ક્ષેત્રમાં નવીનીકરણના માર્ગો વિશે સમજ આપી હતી. યુકેના પ્રો.માર્ક ડી. સિમેસે પાણીના વિભાજન આધારિત હાઈડ્રોજન જનરેશન પધ્ધતિ માટે ડીકપલ્ડ ઈલેક્ટ્રોલિસિસ અને ચેન્નઈના પ્રો.સંતોષકુમારે ફ્યુઅલ સેલ્સના વિકાસ અંગે સમજાવ્યું હતું.

ગાંધીનગરમાં PDEUમાં હાઈડ્રોજન ઊર્જા અંગે પરિસંવાદ યોજાયો

વધતા પ્રદૂષણના સ્તરને કારણે આબોહવા પરિવર્તનના જોખમને જોતા, હાઈડ્રોજન ઉર્જા આધારિત માળખું (Infrastructure) વિજ્ઞાનીઓ, સંશોધકો, ભંડોળ એજન્સીઓ, નીતિ નિર્માતાઓ અને સરકારોનું ધ્યાન આકર્ષિત કરી રહ્યું છે.

આ ક્ષેત્રમાં આગામી પડકારોનો ઉકેલ લાવવા અને પંડિત દીનદયાળ એનર્જી યુનિવર્સિટી (PDEU), ગાંધીનગર ખાતે ભૌતિકશાસ્ત્ર વિભાગદ્વારા સંભવિત ઉકેલોની ચર્ચા કરવા માટે, ૯ થી ૧૧ સપ્ટેમ્બર ૨૦૨૧ દરમિયાનઈન્ટરનેશનલ કોન્ફરન્સ ઓન કન્ડેન્સ્ડ મેટર અને ડિવાઈસ ફિઝિક્સ (ICCMDP 2021) પર ૩દિવસીય આંતરરાષ્ટ્રીય કોન્ફરન્સનું આયોજન કરવામાં આવ્યું હતું. આ કોન્ફરન્સને GUJCOST, DST, ગુજરાત સરકાર તરફથી અને સંરક્ષણ સંશોધન અને વિકાસ સંગઠન (DRDO), ભારત સરકાર તરફથી નાણાકીય સહયોગ પ્રાપ્ત થયેલો છે. ચર્ચાનું મુખ્ય કેન્દ્ર મટિરિયલ્સનાવિકાસની વિવિધ પદ્ધતિઓ, તેમના ગુણધર્મોનો અભ્યાસ અને હાઈડ્રોજન જનરેશન અને સ્ટોરેજ પદ્ધતિઓ સહિત તેમની ઉપયોગિતાઓપર હતું.

કોન્ફરન્સનો વિચાર યુવાન સંશોધકોને તેમની કુશળતા દર્શાવવા અને તેમની રુચિઓ શેર કરવાની તક મળે તે માટે એક મંચ પૂરું પાડવાનો હતો. PDEU નોભૌતિકશાસ્ત્ર વિભાગ, PDEU ના વિઝન અને મિશનને અનુરૂપ દ્વિપ્રવાર્ષિક કોન્ફરન્સનું આયોજન કરશે.

આમંત્રિત ચર્ચાઓમાં ડીએકટી, ટેટ્રાપોડ્સ, નેનોફોટોનિક્સ, હાઈડ્રોજન જનરેશન અને સ્ટોરેજ સહિત મટિરિયલ્સના સંશોધનના સૈદ્ધાંતિક અને પ્રાયોગિક પાસાઓ શામેલ હતાં.

પ્રખ્યાત વક્તાઓમાં મુખ્ય અતિથિ તરીકે પોલેન્ડના પ્રો.ક્રીઝ્ઝટોફ જાન કુઝિડલોવ્સ્કી એડાયટોમ્સના ફ્યુચુલ્સ ની ઉપકરણો માટેનીઉપયોગિતાઓ વિષે ચર્ચા કરી હતી.

આઈઆઈટીપ્રબોમ્બે તરફથી પ્રો.શોભા શુક્લાએ નેનો ફોટોનિક ડિવાઈસ ડેવલપમેન્ટ પદ્ધતિઓ પર ચર્ચા કરી. જાપાનના પ્રો.તાકાયુકી ઈચિકાવાએ ઊર્જા સંપાત અને સંવેદના માટે ટાઈટેનિયમ આધારિતમટિરિયલ્સ વિશે ચર્ચા કરી.

DEPARTMENTAL ACTIVITIES

Important dates and time schedules :

> “Energy is liberated matter, matter is energy waiting to happen.”
>
> - Bill Bryson.

International Conference on Condensed Matter and Device Physics - 2021			Organized by: Department of Physics, School of Technology, Pandit Deendayal Energy University, Gandhinagar 382426 Gujarat, India
9-11 September, 2021			
	DAY 1 : 9th Sep, 2021	DAY 2 : 10th Sep, 2021	DAY 3 : 11th Sep, 2021
TIME		**Session Chair:** Dr. Mohit Tyagi, Bhabha Atomic Research Center, Mumbai	**Session Chair:** Prof. P. K. Jha, M. S. University, Vadodara
9:00-9:45	**Inaugural Session**	**Prof. Ravindra Pandey;** Michigan Technological University, USA **Talk Title:** *Interface driven properties of low-dimensional materials*	**Dr. Xihong Peng;** Arizona State University,USA **Talk Title:** *Material research using quantum mechanics computational methods, in application to low dimensional nanostructures and Li-ion batteries*
9:45-10:30	Keynote Address: **Prof. Krzysztof Jan Kurzydlowski,** Bialystok University of Technology: Bialystok, Poland and Warsaw University of Technology, Warsaw, Poland; **Talk Title:** *Diatoms frustules - Nature built material and devices*	**Dr. Diveah N. Srivastava;** CSIR-Central Salt & Marine Chemicals Research Institute, Bhavnagar **Talk Title:** *Prospects of polymer composite electrodes*	**Prof. Ankur Jain,** Suresh Gyan Vihar University, Jaipur ,Visiting Professor, Hiroshima University, Japan **Talk Title:** *Bismuth and Antimony Chalcogenides for Energy Applications*
10:45-11:00	*Tea Break*	*Tea Break*	*Tea Break*
	Session Chair: Prof. Mihir Joshi, Saurashtra University, Rajkot	**Session Chair:** Prof. R. B. Jotania, Gujarat University, Ahmedabad	**Session Chair:** Prof. Utpal S. Joshi, Gujarat University, Ahmedabad
11:00-11:45	**Dr. V. N. Mani;** C-MET, Hyderabad **Talk Title:** *Role of Nano Electronic Materials And Devices For Advanced Electronic Applications -A BIRD's EYE VIEW*	**Prof. Sanjay Puri;** Jawaharlal Nehru University **Talk Title:** *Kinetics of Phase Transitions: Surface-directed Spinodal Decomposition*	**Prof. A. K. Tyagi;** Homi Bhabha National Institute **Talk Title:** *Design of electro-active materials by structure-property correlation*
11:45-12:30	**Prof. Shobha Shukla;** IIT - Bombay **Talk Title:** *Fluorescent 3D nanostructure fabrication using femto-second laser lithography*	**Dr. Ramjanay Choudhary;** UGC DAE Consortium for Scientific Research, Indore **Talk Title:** *Strain engineering of electronic and magnetic properties of transition metal oxides*	**Prof. Ravi Kumar;** National Institute of Technology, Hamirpur **Talk Title:** *Development of p type Transparent conducting oxides materials*
12:30-2:00	*Lunch Break*		*Lunch Break*
	Session Chair: Dr. Deepak Verma, Ahmedabad University	**Session Chair:** Dr. Rajesh Kushwaha, Physical Research Laboratory, Ahmedabad	**Session Chair:** Dr. Vaibhav Kalvhrestha, CSMCRI, Bhavnagar
2:00-2:45	**Dr. Takayuki Ichikawa;** Hiroshima University, Japan **Talk Title:** *Various Functions of Ti-based Materials for Energy Conversion and Storage*	**Dr. Somnath C Roy;** IIT-Madras **Talk Title:** *Morphology dependent charge transport in single TiO2 and CuO nanostructures*	**Prof. Mark D. Symes,** University of Glasgow, United Kingdom **Talk Title:** *Decoupled Electrolysis for Water Splitting and Beyond*
2:45-3:30	**Prof. Sam Tze Chien;** Institute of Advanced Studies, Nanyang Technological University Singapore **Talk Title:** *Advanced Photovoltaic Concepts in Halide Perovskites*	**Prof. Yogendra Mishra,** University of Southern Denmark **Talk Title:** *Tetrapods based Smart Materials for Advanced Technologies*	**Dr. Hai Jun Cho;** Research Institute for Electronic Science, Hokkaido University, Japan **Talk Title:** *Utilization of anisotropic materials in thermal management technologies*
3:30-4:20	**Parallel Oral Sessions** Session 1 Session 2 Session 3 Session 4 (Links of each session is provided in separate schedule)	**Parallel Oral Sessions** Session 1 Session 2 Session 3 Session 4 (Links of each session is provided in separate schedule)	**Parallel Oral Sessions** Session 1 Session 2 Session 3 Session 4 (Links of each session is provided in separate schedule)
4:20-4:30	*Tea Break*	*Tea Break*	*Tea Break*
	Session Chair: Dr. Rajbir Sharma, Geetanjali Institute of Technical Studies, Udaipur	**Session Chair:** Dr. Anil Kumar Gourishetty, IIT Roorkee	**Session Chair:** Dr. Charu Lata Dubey, Central University of Gujarat, Gandhinagar
4:30-5:15	**Dr. Shrikant Saini;** Kyushu Institute of Technology, Japan **Talk Title:** *Halide perovskite for thermoelectric applications*	**Dr. Mikael Syvajarvi;** JMS Center for Research Utilisation | Alminica AB, Sweden **Talk Title:** *From energy and environmental materials to devices to innovation avenues*	**Dr. Santoshkumar D. Bhat;** CSIR-Central Electrochemical Research Institute, Chennai **Talk Title:** *Development of Polymer Composite Membrane Electrolytes for Fuel Cells*
5:15-6:15	**Parallel Oral Sessions** Session 1 Session 2 Session 3 Session 4 (Links of each session is provided in separate schedule)	**Prof. D. G. Kuberkar;** Saurashtra University **Talk Title:** *Resistive switching studies in multiferroic thin film devices*	**Parallel Oral Sessions** Session 1 Session 2 Session 3 Session 4 (Links of each session is provided in separate schedule)
6:15 - 7:15	**Parallel Oral Sessions** Session 1 Session 2 Session 3 Session 4 (Links of each session is provided in separate schedule)	**Parallel Oral Sessions** Session 1 Session 2 Session 3 Session 4 (Links of each session is provided in separate schedule)	Valedictory Function, Certificate Distribution and Tea

DEPARTMENTAL ACTIVITIES

International Symposium on Materials of the Millennium: Emerging Trends and Future Prospects (MMETFP-2021) 19-21 November, 2021

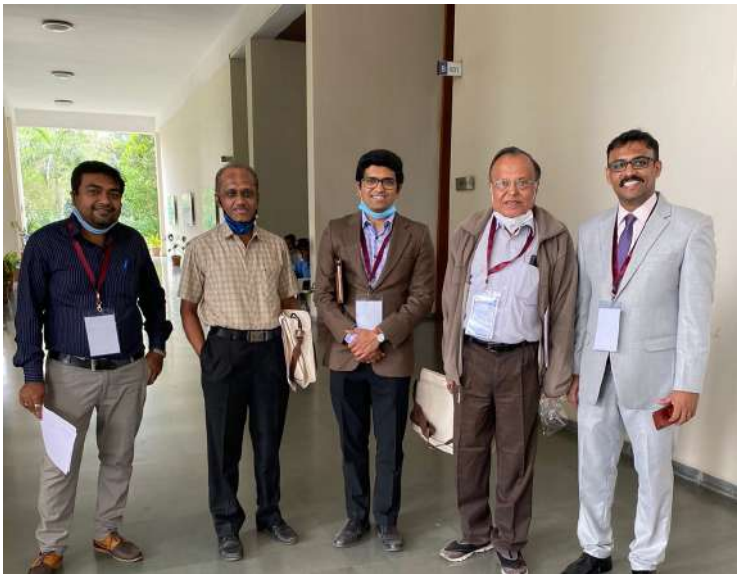
Materials play an important role in developing various technologies aiming at the safety of the environment, exploration of renewable energy sources as well as enrichment in the quality of life. New materials are being explored as well as traditional materials are tailored/ engineered by the researchers for effective use in various fields including but not limited to aerospace, energy sector, medical/ healthcare, environment, construction, transportation etc. The aim of the symposium, MMETFP-2021 organized by the Department of Chemistry and Physics was to provide a platform to the national scientists, scholars and industrialists to share each other's progress, knowledge and outlook on materials.

Theme of the Symposium:

- Design and Rational Synthesis of Functional Materials
- Emerging Trends in Nanostructured Materials, Thin films and Devices
- Advanced Materials for Energy Applications
- Combating Antimicrobial Resistance by Biomaterials (CARB)

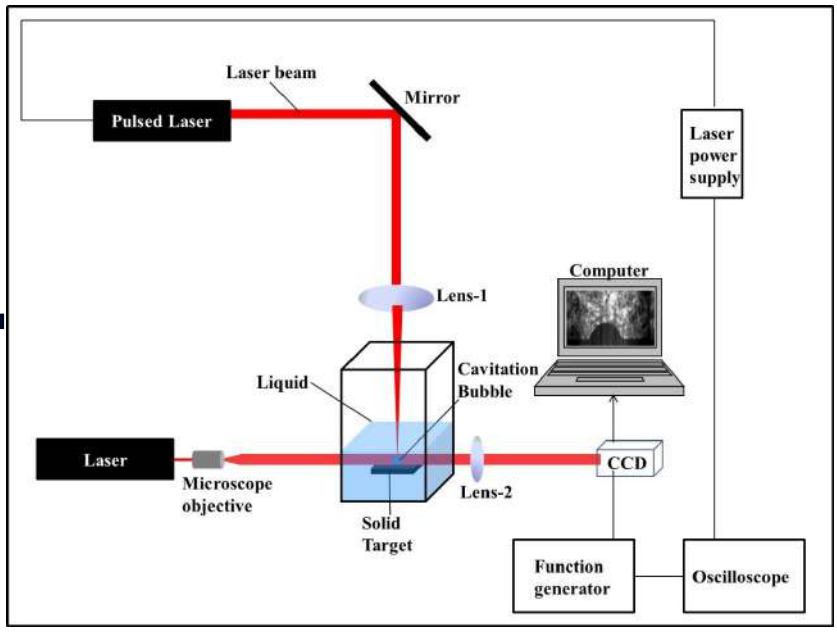
DEPARTMENTAL ACTIVITIES

Glimpses from MMETFP-2021



DEPARTMENTAL ACTIVITIES

Dr. Prahlad Kumar Baruah has received the Best Oral Presentation Award for his research paper titled, ***"Estimation of Extreme Conditions in Pulsed Laser Ablation of a Solid in Liquid Ambient via Beam Deflection and Shadowgraphy Technique"*** at the National Conference on Plasma Science and Applications- PSA 2021 organized by Plasma Science Society of India (PSSI) and SVNIT from 20-21 December, 2021.



Mr. Kavil Mehta has received the Best Poster Award for his research paper titled, ***"Probing the Cavitation Bubbles Produced during Laser Ablation of Copper Immersed in Liquid under Tightly Focused Conditions using Shadowgraphy Technique"*** at the International Symposium on Materials of the Millennium: Emerging Trends and Future Prospects from 19-21 November, 2021.

Participation of our students in ICCMDP-2021

Abstracts

Investigation of the effect of tight focusing on the dynamics of nanoparticle synthesis via laser ablation in liquid

Kaushik G. Patel, Kavil Mehta, Ashwini K. Sharma, Alika Khare, Prahlad K. Baruah

Synthesis of nanoparticles possessing unique properties is driving the innovations of the twenty-first century. These nanoparticles due to their small size can be easily functionalized for applications in a variety of fields such as biomedicine, sensing technology, energy harvesting, agriculture, etc. In this context, the technique adopted for the synthesis of nanoparticles is a crucial factor as the properties of the nanoparticles are primarily dependent on it. Among the various available techniques, pulsed laser ablation in liquid (PLAL) is one of the most efficient techniques for obtaining pure nanoparticles in colloidal form without the use of any harmful chemicals. A pulsed laser beam irradiates the surface of a solid target immersed in liquid, and the end product in the form of colloidal nanoparticles is obtained after some transient dynamics. The properties of nanoparticles are influenced by the dynamics that take place at the solid-liquid interface. As a result, it is critical to investigate the dynamics associated with PLAL in order to comprehend the origin of nanoparticle properties and in order to improve the productivity and controllability of nanoparticles synthesized via PLAL. With this in view, the present work focuses on the effect of tight focusing of a pulsed laser on a solid copper target immersed in distilled water. The details of the experimental setup and the results obtained will be discussed in the conference.

Structural, optical and dielectric properties of barium hexagonal ferrites

Abhishek A. Gor, Soumya Gupta, Mrunali Jani, Chetna C. Chauhan, Tanuj Gupta, Rajshree B.Jotania4

M-Type hexaferrite $BaFe_{12}O_{19}$ was prepared via green synthesis route using moringa oleifera flower extract, and calcined at 1100°C for 4 hours. The XRD analysis shows the formation of M phase. The FTIR analysis shows the formation of Fe-O bonds. UV-VIS spectroscopy is done to find the optical band gap in this region. The frequency dependent dielectric phenomenon was observed in dielectric measurements. The sample shows promising result as potential photocatalyst as under 1 hour of sunlight exposure it reduced chemical oxygen demand (COD) of tertiary cleaned waste water from 55 to 5.

Participation of our students in ICCMDP-2021

Abstracts

Robust half metallic ferrimagnetic behavior and thermoelectric response of newly discovered Full-Heusler compound Mn2SiRh: DFT Study

Pratik D. Patel, Jalaja B. Pandya, Satyam M. Shinde, Sanjay D. Gupta, Prafulla K. Jha

Ferromagnetic Heusler compounds have been successfully emerging to fulfill the gap in demand for future technologies like thermoelectric and spintronics devices. In the present study the effect of disorder on the electronic, magnetic and thermoelectric properties of Full-Heusler compound Mn2SiRh has been investigated using density functional theory approach. Most common disorder in this kind of compound is due to binary mixing. We have considered the B2 type disorder of Si-Rh mixed Mn2SiRh compound, obtained by swapping of Rh and Si atoms. After structural optimization, we have found that the present disordered structure has positive cohesive and formation energy confirming the chemical stability of the compound for future experimental synthesis. B2 type disordered structure retains the half-metallic nature of the compound with drastically increased spin-polarization to the previously reported ordered structure. Furthermore it is observed that the Half-metallicity is robust against the range of lattice constants from 5.63 to 6.20 Å under influence of strain. The Seebeck coefficient specifies n-type behavior of this compound and maximum power factor for this compound observed as 12.3×1011w/K2m at 800K. The obtained results on thermoelectricity for this compound show its applicability for recovery of waste heat at high temperature.

Quantum Coulomb Blockade Phenomena in single-electron transistor based on Graphene quantum Dot

Ali Moulhim, Brijesh Tripathi, Manoj Kumar

Graphene quantum Dots (GQD) is a quantum-coulomb blocked regime, where both of coulomb interaction and confined energy play a crucial role that affect on electron transport through the transistors based on these dots. In this paper, the constant interaction model is employed to calculate the addition charge energy of GQDs, and the dependency of addition charge energy on the number of electrons and the GQD's diameter is studied. Finally, the stability diagram of SET based on GQD is modeled and plotted.

Participation of our students in ICCMDP-2021

Abstracts

A Computational Study of the Ozonolysis of Acenaphthylene

Harshil Shah, Jalaja Pandya, Satyam Shinde, Rohit Srivastava

Polycyclic aromatic hydrocarbons (PAHs) play a major role in atmospheric ozonolysis process. One of the reasons to study PAHS and their reaction in the atmosphere is to determine their role and effect on human health. Here we have studied one such PAH, Acenaphthylene and its reaction with atmosphere ozone. Acenaphthylene and Ozone molecule was studied using Density Functional Theory along with one of the ozonolysis product, Acenaphthylene-oxide and Oxygen. Gaussian software was used to perform these calculations. The Structural, Frontier molecular orbital, Electrostatic potential and Frequency analysis was carried out for these molecules. We calculate electronic chemical potential (μ) Acenaphthylene of (μ= -1.96 eV) and ozone (μ= -2.05 eV) and this data obtain the condition that reaction is take place. We also calculate electronegativity (χ), hardness (η) and softness (S), chemical potential (μ) of the reactants and products. These quantities are help us to provide a basis for the feasibility of the reaction.

Study of Plastic Composite Based Scintillator for Nuclear Battery Application

Divya Pandya, Shrey Upadhyay, Dhyanvi Rao, Mansi Patel, Sheetal Rawat, Brijesh Tripathi

Plastic composite based scintillators consists of polymer matrix like p-m-m-a with metal halides (light and heavy metals) embedded in them. Recently this has attracted a lot of attention in the physics community for the development of luminescent or high photon yield based on such composites. Plastic scintillators involving nanocrystals results in efficient, fast and reabsorption free scintillation process. By combining the light emission from such scintillating materials with advanced high efficiency photovoltaic devices, one can develop a source of electrical energy that can run on nuclear power uninterrupted for a long time duration; referred to as nuclear battery in this paper. Recently there has been reports of such power generations applications. In this paper the report focuses on theoretical linkage between the photon yield and size of nanoparticles for four different scintillating materials embedded in the matrix; along with study of other characteristic properties of the materials.

Participation of our students in MMETFP-2021

Abstracts

Flexible Metal Halide Perovskite Solar Cells

Mansi Patel, Manish Khemnani, Brijesh Tripathi, Ankur Solanki

Solar energy is the cleanest and most abundant renewable energy source available on earth. With the rapid development in materials engineering and device structure, halide perovskite based single junction flexible solar cells have captured the attention with high power conversion efficiency (PCE) >21%. The excellent optical properties such as high absorption coefficient (10^5 /cm-3), tunable bandgap, fast charge separation, longer diffusion lengths, long charge carrier lifetime have made them popular for optoelectronic applications. Their solubility in solution make them easier and low cost processing. The family of perovskite materials adopt the chemical formula ABX3, where A represent organic/inorganic cations (CH3NH3+,C2H5NH3+,HC(NH2)2+, etc.), B represent heavy metals (Pb2+, Sn2+, Eu2+, Cu2+,..) and X represents halides (I-, Cl-, Br-). PCE has improved by developing various device structures from mesoscopic sensitization to planner p-i-n or n-i-p junction and by varying the composition from single to double, triple and quarter cation as well as halide anions. However, these perovskites are prone to environmental stress factors such temperature, humility and toxicity. Here we briefly present the overview of hybrid perovskites, materials synthesis, various device architectures, electrical/optical properties, and challenges to improve the power conversion efficiency for the commercialization perspectives.

Hybrid Perovskite based Memristor Devices

Muskan Jain, Raj Ankit, Dhanajay kumbhar, Ankur Solanki

Memristor is being considered as the fourth fundamental two terminal circuit element after The Resistor, Capacitor and Inductor. With the recent advances in technology humans are switching to flexible devices, which gives rise to “Flexible Memristors” that increases its applications .i.e., Neuromorphic computing, Resistive Switching Memory, Logic gates and operations. HOIP i.e., Hybrid Inorganic and Organic Metal Halide Perovskite materials shows some memresistive properties i.e., less weighable, flexible, compatible, stretchable and low power consuming, therefore HOIP based Memristors is drawing attention for applications in next generation high - density information storage technology and also in healthcare technology and Internet of Things (IoTs). In reference to this, for the making of flexible Memristor we need to select flexible materials such as substrates, interfaces and learning of various mechanisms for resistive switching and growth methods of perovskite is required. Applications of Memristor as an artificial synapse and light - induced resistive switching and logic gates has been selectively and efficiently reviewed. Stability factors are briefly discussed in the end and the progress and challenges in the field of perovskite based flexible Memristors are also concluded.

Participation of our students in MMETFP-2021

Abstracts

Light yield and efficiency studies of a large size GGAG:Ce single crystal scintillator

Sheetal Rawat, Mohit Tyagi, G. Anil Kumar

Ce doped GGAG:Ce (Gadolinium Gallium Aluminium Garnet) scintillator is equipped with high effective Z (55), high density (6.7 g/cm3), and light yield of 55,000 ph/MeV, making it as a strong contender for gamma spectroscopy where detection efficiency is of paramount importance [1]. In the present work, we have carried out detailed light yield and absolute detection efficiency studies of a large size cylindrical GGAG scintillator having dimensions of 45 mm diameter and 48 mm height. The large size single crystal of GGAG:Ce was grown using Czochralski technique and weighs 500 gm. Light yield studies of the single crystal were performed by testing the effect of annealing, Teflon paint coatings, spectralon and Teflon tape layers. After optimizing the mentioned parameters, the total detection (TDE) and photo peak (PE) efficiency data was obtained by keeping 137Cs source above the detector assembly at various distances for the duration of 1000s. GEANT4 Monte Carlo simulations were also done by simulating the experimental measurement conditions.
Keywords: GGAG, Light yield, detection efficiency, simulation, GEANT4.

Probing the Cavitation Bubbles Produced during Laser Ablation of Copper Immersed in Liquid under Tightly Focused Conditions using Shadowgraphy Technique

Kavil Mehta , Kaushik G. Patel , Ashwini K. Sharma , Alika Khare , Prahlad K. Baruah

Pulsed laser ablation in liquid has emerged as an efficient technique to synthesize nanoparticles (NPs), especially noble metal NPs. The main advantage of synthesizing NPs by this method is that bare as well as functionalized NPs can be synthesized with great ease. Noble metal NPs have proven to be extremely useful in the fields of biomedicine, sensing technology, energy storage, etc. The properties of such NPs strongly depend on the transient dynamics that occur at the solid-liquid interface as the laser pulse irradiates the solid target. Hence, in order to control the properties of the NPs and increase their productivity, it is crucial to study the dynamics associated with the technique. Keeping this in mind, a study has been conducted to understand the effect of tight focusing of the pulsed laser beam on the dynamics of cavitation bubbles produced during pulsed laser ablation of a copper target immersed in distilled water using shadowgraphy technique. The results reveal novel dynamics of the formation of cavitation bubbles due to the breakdown of the liquid in addition to the bubble attached to the target. The analysis of such bubbles is carried out and its evolution is studied. The details of the experimental setup and the results will be discussed in the conference.

Glimpses from Pandit Deendayal Badminton League(PDBL-2021)

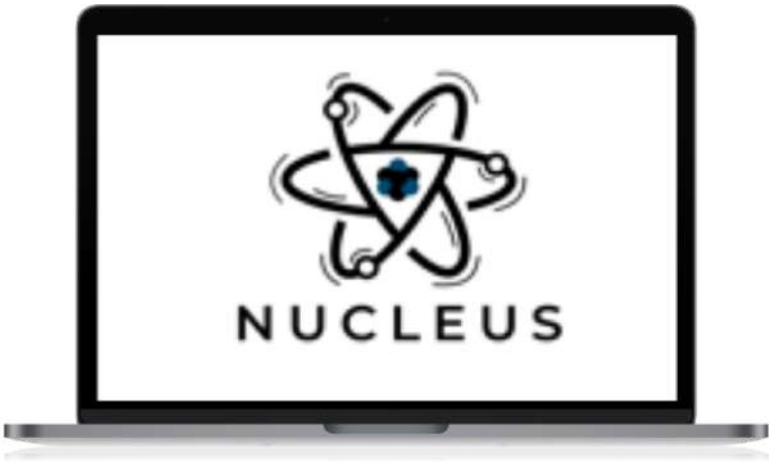
Big congratulations to **Dr. Prahlad Baruah and Dhaval Santola** for being part of the winning team at PDBL 2021. The event was graced by Ms. Parul Parmar (Former World number -1 in badminton Paralympic).

DEPARTMENTAL ACTIVITIES

PHYSICS department is delighted to announce it's very own hobbies club

NUCLEUS

The club was formed with an idea to develop a community of like-minded individuals in the University with a zest to explore and zeal to learn more about the vast world of Physics. We as a club believe in making physics a fun subject and making students of various disciplines be able to access, experience and enjoy the holistic ideas of Physics.

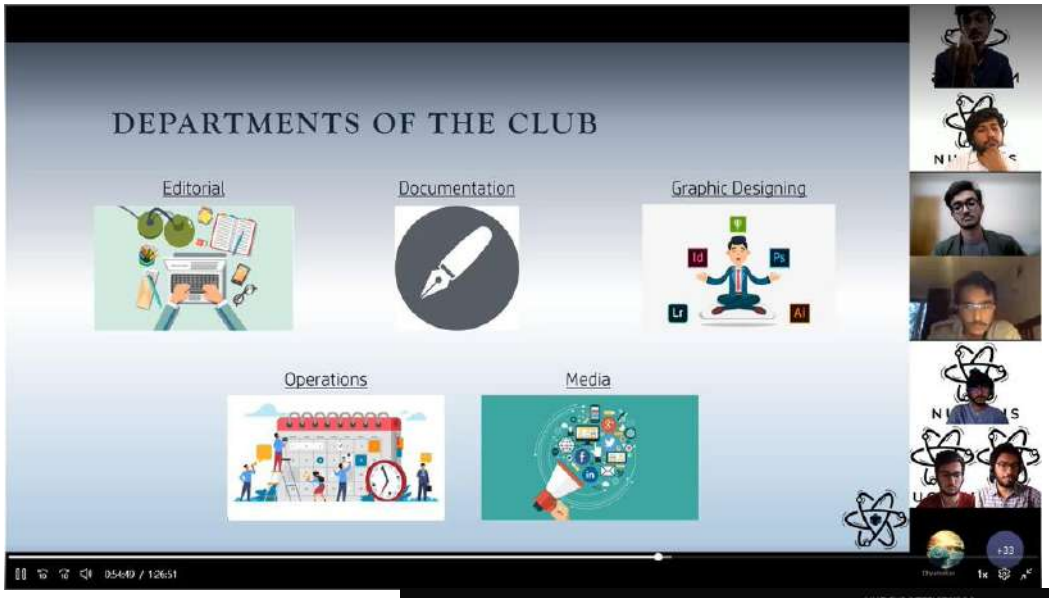


Nucleus held 3 events this semester. They were Introductory Session, Interviews and Guest lectures- Rekindling Minds.

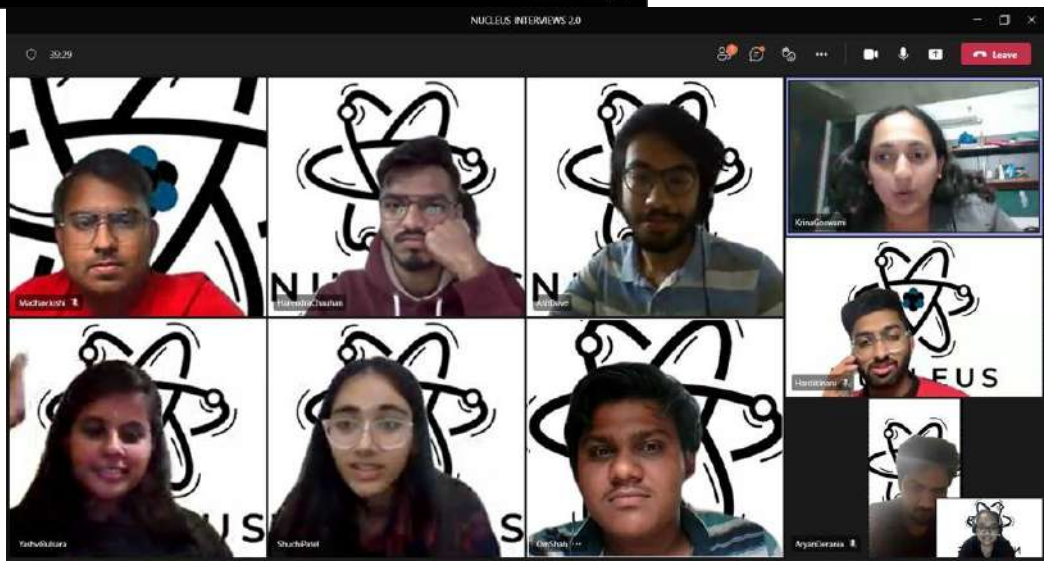
Introductory Session

The event was held on 9th October. The main objective of this event was to introduce the club to the people and clear any doubts and assumptions about the club; and kindle a spark of interest in people's mind about physics. Dr. Prahlad Baruah (Club Mentor) and Dr. Satyam Shinde (Head of Department, Physics) also joined the session. It was pretty interactive and the participants really enjoyed the game session.

DEPARTMENTAL ACTIVITIES



Introductory session of Nucleus, which was aimed at introducing the ideas and objectives of the club

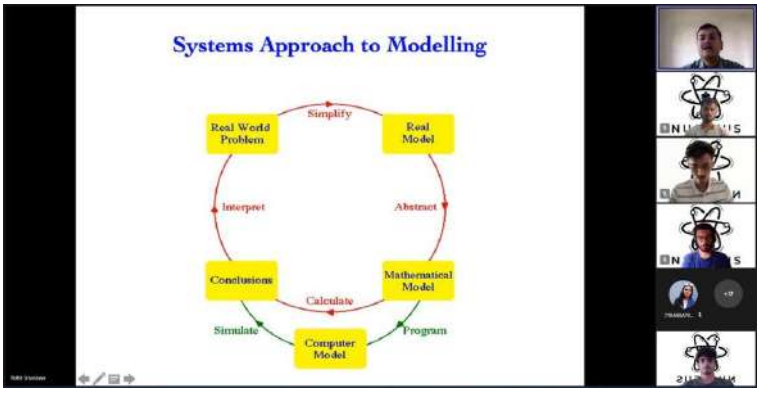


Member recruitment interviews for different departments of Nucleus

Interviews

Interviews were held on 16th and 17th October. The objective of this was to select and assemble a team of diligent and enthusiastic people to take the club forward. The heads of Editorial department, Operations and Documentation department were also selected through this. The interviewees were given a choice for their preferred departments. The environment of the interviews was very easy going, so the interviewees were very comfortable.

DEPARTMENTAL ACTIVITIES



The first ever event of Nucleus - Rekindling Minds
Lecture delivered by Dr. Rohit Srivastava from the Department of Physics

Rekindling Minds - Guest lecture on the introduction of DFT by Dr. Satyam Shinde (Head of the Department of Physics)

Rekindling Minds

This event was held on 12th and 13th November. The objective of this event was to let participants gain more knowledge about the topics that may seem difficult but are very interesting if understood properly. The event went on for two days. On Day 1, we had Dr. Satyam Shinde as our guest speaker who gave a lecture on Introduction to DFT as a tool for Computational Material Science. He talked about various aspects of DFT theory and it was indeed an informative session. On Day 2, we had Dr. Rohit Srivastava as our guest speaker and he gave a lecture on Challenges in modelling the atmosphere and ocean. He briefed everyone about history of climate changes and also provided evidences for the same. Additionally, the challenge of changes seen in carbon dioxide levels over years was also taken into light. Overall, he discussed about the current problems, changes being seen and methods to study these.

RECENT DEVELOPMENTS

RECENT DEVELOPMENTS IN ENERGY STORAGE

Renewable energy sources (RESs) are being extensively employed to address issues related to oil depletion, increasing energy demand, and global warming. Their strong dependence on weather conditions emphasizes a double-folded variability, both in space and over time. To overcome this inherent intermittency, energy storage systems (ESSs) represent a key factor to provide the required additional flexibility. Energy storage is not new. Batteries have been used since the early 1800s, and pumped-storage hydropower has been operating in the United States since the 1910s. But the demand for a more dynamic and cleaner grid has led to a significant increase in the construction of new energy storage projects, and to the development of new or better energy storage solutions. Long-duration energy storage holds great potential for a world in which wind and solar power dominate new power plant additions and gradually overtake other sources of electricity. Wind and solar only produce at certain times, so they need complementary technology to help fill the gaps.

Nowadays, remarkable progress has been made in the field of various energy storage and conversion devices, i.e., lithium-ion batteries (LIBs), lithium-metal batteries (LMBs), lithium-sulfur batteries (LSBs), sodium-ion batteries (SIBs), sodium-metal batteries (SMBs), magnesium-ion batteries (MIBs), zinc-ion batteries (ZIBs), electrochemical capacitors (ECs), Also, Europe and China are leading the installation of new pumped storage capacity – fuelled by the motion of water.

RECENT DEVELOPMENTS

Batteries are now being built at grid-scale in countries including the US, Australia, and Germany. Moreover, Thermal energy storage is predicted to triple in size by 1030 and Mechanical energy storage harnesses motion or gravity to store electricity. As a newly emerging excellent energy storage device, supercapacitors have been widely studied due to their unique advantages. The electrode material is one of the key components that determine the performance of a supercapacitor. With the rising demand for fast-charging technology in electric vehicles and portable devices, significant efforts have been devoted to the development of high-rate batteries.

Flow cell technologies have the potential to provide a cost-competitive alternative to present-day batteries for the bulk storage of electricity. Flow batteries such as these offer energy-storage/delivery efficiencies of 75–85%, with potential differences, across individual cells, of 1.4–1.8 V. Self-discharge of flow batteries is mitigated by the isolated storage of the electrolytes in the charged state. So-called micro-SMES(Superconducting magnetic energy storage) devices (1–10 MW) are commercially available, and over 30 devices with approximately 50 MW of total capacity are installed in different partts of the USA, the application being for good power quality.

Since it is possible to inject and extract current very quickly in and out of superconducting coils, SMEs have been developed for use in high-power devices. Cool thermal energy storage (CTES) has recently attracted interest for its industrial refrigeration applications, such as process cooling, food preservation, and building air-conditioning systems. Last but not least, Hydrogen storage is a significant challenge for the development and viability of hydrogen-powered vehicles.

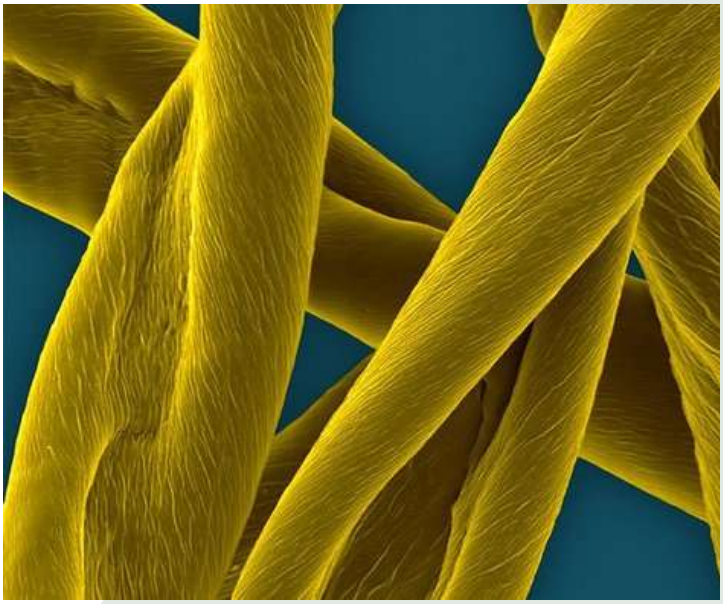
Current onboard hydrogen storage approaches involve compressed hydrogen gas tanks, liquid hydrogen tanks, hydrides, cryogenic compressed hydrogen, metal high-surface-area adsorbents, and chemical hydrogen storage materials. Future energy storage technologies may be expected to offer improved energy and power densities, although, in practice, gains in reliability, longevity, cycle life expectancy, and cost may be more significant than increases in energy/power density per second.

What ?

ARE YOU SERIOUS ?

Get ready to learn about some ways to harvest electrical energy that might blow your mind!

1) Wood:
Humans have used wood as a source of energy for a very long time. But it was Tian Li and her team, from the University of Maryland, who invented a new way to harvest electrical energy from it. They did this by chemically treating wood with sodium hydroxide. This treatment separates lignin from the wood and what remains are naturally aligned cellulose nanofibers. The hydrogen bonds along the remaining cellulose fibers are also broken as a result of the treatment which eventually generates a crystalline structure of perfectly aligned cellulose channels. When placed against a heat source, the Na+ and OH- ions can drift freely along these channels by absorbing heat energy, hence creating a thermal voltage gradient that can be tapped to produce electricity.



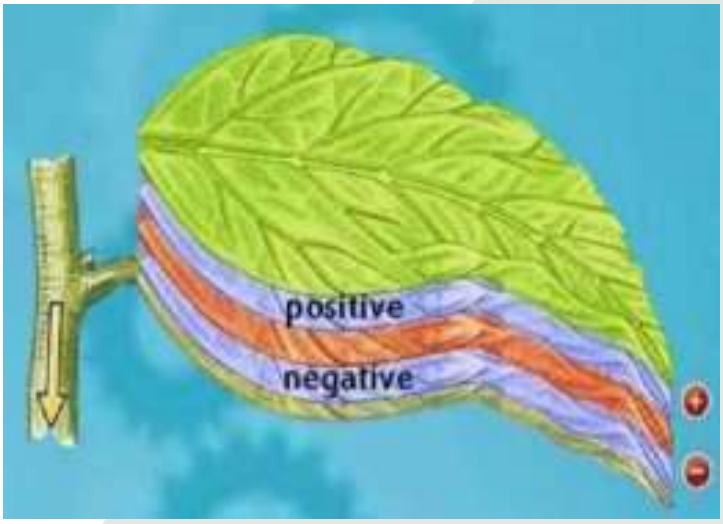
2) Rust:
Scientists Tom Miller (from Caltech University) and Franz Geiger (from Northwestern University) have been successful in harvesting electricity from the most undesirable entity, rust. They deposited a very thin layer of rust (iron oxide), about 10 nanometers thick, on the iron base. The method they used is called physical vapor deposition. Then, they allowed saltwater with different concentrations to run over this rust-coated iron. The ions present in the saltwater attract electrons from the iron beneath the rust layer and cause them to drag along with their flow. Hence, an electric current is generated. This phenomenon is called the electrokinetic effect. The scientists could produce a potential of tens of millivolts from their invention. This discovery could be used to produce electricity in several remote areas on the Earth.

What ?

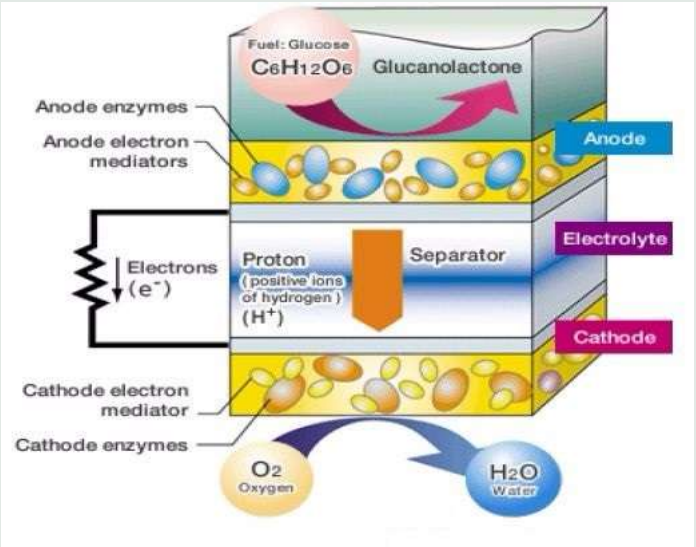
ARE YOU SERIOUS ?

Get ready to learn about some ways to harvest electrical energy that might blow your mind!

3) Trees:
Advancements in the field of nanotechnology have enabled scientists to generate electricity from artificially created trees or plants. In these trees, petioles and branches are fitted with nano piezoelectric elements. These, so-called 'nanoleaves', flap back and forth due to wind. Consequently, mechanical stresses are generated on the petioles and branches, which result in the production of several picowatts of electrical power. In addition to this, photovoltaic and thermovoltaic cells are incorporated into these leaves. These cells convert both solar energy and solar heat that fall on the leaves into electricity. This process can be carried out even during the nighttime. This unique combination of piezoelectric, photovoltaic, and thermovoltaic materials into a single system has enhanced the efficiency of harvesting electricity, that too at a cheaper rate.



4) Organic Compounds (Glucose):
The compound glucose can be exploited to synthesize electricity and the device that would facilitate such a process is called a biobattery. These batteries have an anode, cathode, electrolyte, and separator, all of which are layered on top of the other. The separator ensures that the anode (at the top) and the cathode (at the bottom) remain separated. Oxidation of glucose, using special enzymes like E. Coli, occurs at the anode and electrons and protons are produced. Using the chemical energy stored in the sugar, electrons travel through an external circuit, towards the cathode, whereas the protons travel through the electrolyte and separator towards the cathode (as shown in the figure above). At the cathode, the reduction half-reaction takes place in the presence of oxygen and water is formed. Apparently, bio batteries turn out to be non-toxic and non-flammable sources of fuel and they can be used to power implanted devices in the human body like the pacemaker. About 50 milliwatts of power are produced.

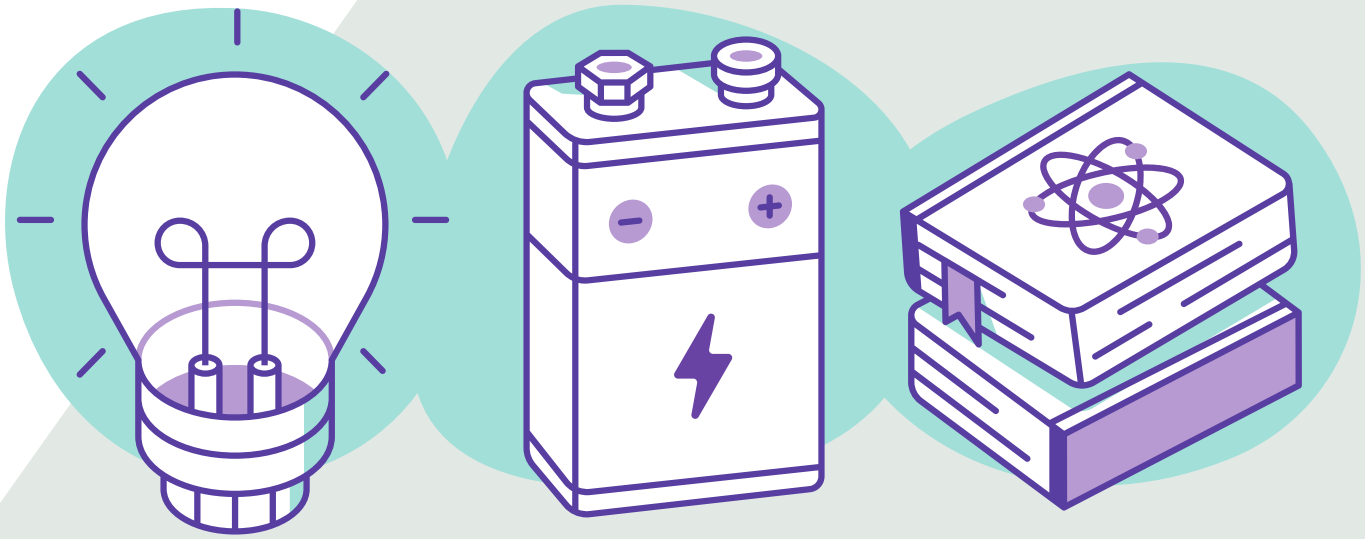


What ?

ARE YOU SERIOUS ?

Get ready to learn about some ways to harvest electrical energy that might blow your mind!

5) High-Performance Clothing — 'Power Felt': A very novel idea in high-performance clothing technology was proposed by nanotechnologist David Carroll of Wake Forest University [6]. He invented a fabric with thermoelectric properties, called 'Power Felt', that could convert body heat and movement into electricity. This has indeed provided a new way to harvest the human body. This energy produced could not only be used to charge a laptop or a phone but also has the potent to change how medical science is practiced. A person's physiology can be studied by measuring changes in the body's temperature and perspiration rate. In addition to that, this material is made of carbon nanotubes and hence is lighter than conventional thermoelectric sources. This has been beneficial for people with Alzheimer's and diabetes; they no longer need to carry bulky sensors with them to estimate sugar levels and make other measurements. This discovery has enormous potential in the field of non-conventional sources of energy and medical sciences.



OUR ALUMNI

MAKING US PROUD!!!

B.Sc. (H.) Physics Batch of 2016 Student details as on January 2022

SR.NO	Name	Course	Institute
1.	Ridhesh Goti	M.S. Astrophysics	Ludwig Maximilian University, Munich, Germany.
2.	Bhashin Thakore	M.S. Astrophysics	Ludwig Maximilian University, Munich, Germany.
3.	Hitansh Shah	Ph.D. Physics	University of Houston, USA.
4.	Shristi Bothra	Master of Engineering Environmental Engineering	University of Ottawa, Canada.
5.	Darsh Patel	Master of Engineering Entrepreneurship and Innovation	McMaster University, Canada.
6.	Ansh Patel	Master of Science (Science and Technology of Nuclear Fusion)	Eindhoven University of Technology, Netherlands.
7.	Manan Shah	M.Sc. Physics	IIT Gandhinagar, India.
8.	Meet Patel	Master of Engineering Innovation and Entrepreneurship	Ryerson University, Canada.
9.	Ravi Gupta	M.Sc. Physics	IIT Mumbai, India.
10.	Shamna Trivedi	Ph.D. Physics	Kansas State University, USA.

OUR ALUMNI

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SR.NO	Name	Course	Institute
11.	Niki Patel	Master of Science in Materials Physics	Brock University, Canada.
12.	Nishit Patel	Master of Science in Geoinformatics	University of Twente, Netherlands.
13.	Velis Patel	M.Sc. Physics	Pandit Deendayal Energy University, India.
14.	Ruchir Patel	M.Sc. Physics	St. Xavier's College, Ahmedabad, India.

B.Sc. (H.) Physics Batch of 2017 Student details as on January 2022

1.	Kunal Bajpai	M.B.A. (Applied)	NTU, Singapore.
2.	Soumya Gupta	M.Sc. Astronomy and Space Engineering	IIT Indore
3.	Namrata Dewani	M.Sc. Physics	PDEU
4.	Nancy Abraham	M.Sc. Physics	University of New Brunswick, Canada
5.	Anjali Patel	M.Sc. Physics	IAR

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SR.NO	Name	Course	Institute
6.	Harshil Shah	M.Sc. Physics	PDEU
7.	Jenish Dhruv	On Break	Preparing for M.B.A.
8.	Kaushik Patel	M.Sc. Physics	PDEU
9.	Vikas Singh	M.Sc. Physics	PDEU
10.	Krutagna Joshi	M.Sc. Physics	IAR

B.Sc. (H.) Physics Batch of 2018 Student details as on January 2022

1.	Dharil Shah	B.Sc. Physics	University of Michigan Ann Arbor.
2.	Priyanshi Patel	B.Sc. Physics	The University of Texas and Austin.
3.	Sanhit Mehta	B.Sc. (H) Physics	PDEU.
		M.Sc. Physics and Astronomy	University of Amsterdam
4.	Asit Dave	B.Sc. (H) Physics	PDEU.
5.	Shlok Shah	B.Sc. (H) Physics	PDEU.
6.	Arth Thakkar	B.Sc. (H) Physics	PDEU.

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