PHYSICA

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DEPARTMENT OF PHYSICS

NANDA NATH SAIKIA COLLEGE

Physicists are made of atoms.
A Physicist is an attempt by an atom to understand itself.
-Michio Kaku

Departmental Annual Magazine

Department of Physics
Nanda Nath Saikia College
Titabar, Assam

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Editorial

Unraveling the Mysteries of the Universe: A Journey through Modern Physics

In the vast expanse of the cosmos, humanity's quest for knowledge continues to push the boundaries of understanding. From the tiniest particles to the grandest galaxies, the field of physics serves as guide on the extraordinary journey. Welcome to the first edition of our Physics Magazine "***PHYSICA***". This issue promises an exhilarating journey through the latest developments in physics, where groundbreaking research and cutting-edge technologies converge to reshape our understanding of reality.

The universe itself is a canvas of dynamic forces and breathtaking phenomena. Physicists decode these high-energy messengers, they unveil the dramatic overture of cosmic phenomena, offering glimpses into the formation of galaxies, the dynamics of black holes, and the echoes of the Big Bang itself. In the realm of infinitesimal particles, quantum microscopy has emerged as a mesmerizing melody, unlocking the secrets of the subatomic world. Researchers are revealing the complexities of matter at the quantum level by stretching the frontiers of what is perceivable which provides a broad perspective on fundamental processes and opens doors for revolutionary applications in medicine, materials science, and other fields.

The nuclear realm continues to resonate with promise and potential, offering a fusion of fission and fusion technologies that harmonize with our energy needs. Amidst the global chorus for sustainable solutions, the hydrogen revolution takes center stage, harmonizing our pursuit of clean energy with scientific innovation. This symphony of progress explores the intricate symmetries of hydrogen's potential, from fueling emission-free vehicles to energizing entire cities. As physicists orchestrate novel ways to produce, store, and utilize hydrogen, the prospect of a greener future crescendos, amplifying the hope for a harmonious coexistence with our planet.

As we navigate the intricacies of the physical world, our Physics Magazine encapsulates the excitement of discovery and the awe-inspiring revelations that come with understanding the universe. Join us as we unravel the fabric of reality and embark on a journey that challenges our perceptions and ignites our curiosity. The world of physics awaits – let's explore together.

Wish you a happy reading!

Dr. Prathana Borah
Asst. Professor
Department of Physics,
N. N. Saikia College, Titabar

Content:

Hydrogen Economy

The phrase "hydrogen economy" describes a plan to use hydrogen as a low-carbon energy source, replacing petrol in transportation and natural gas in heating. Around 86% of all energy used globally comes from burning fossil fuels, generating 35 billion tons of carbon dioxide annually. Energy and environmental issues at a global level are important topics now. It is necessary to construct clean energy systems in order to reduce the production of CO_2. Hydrogen is the simplest and most abundant element on earth. It is attracting attention since the only byproduct is water, whether it is burned to generate heat or mixed with air in a fuel cell to generate electricity. However, hydrogen cannot be created in its pure form on Earth; it must be created from other substances like water, natural gas, biomass, alcohols, or other molecules. In each scenario, energy is required to transform them into pure hydrogen. Because of this, hydrogen is essentially more of an energy carrier or storage medium than an energy source. Low boiling point (-259.2°C) and exceptionally low density in both the gas (0.090 kg/m^3) and the liquid state (0.07085 kg/L). Because of low density, hydrogen has an extremely high heating value on a unit mass basis. It is used as energy directly in fuel cells to generate electricity, power and heat.. It is theoretically possible to create it from water using a non-fossil energy source (such as solar, geothermal, or nuclear energy) and then burn it back up to create water in a closed chemical cycle without releasing any carbonaceous pollutants. Hydrogen has the ability to transmit energy from its source to its destination using underground pipes and to serve as a storage component for renewable energy sources. Hydrogen can be extracted from water, biomass, fossil fuels, or a combination of the three. Currently, natural gas serves as the main fuel for producing hydrogen, contributing around 75 percent of the 70 million tons of dedicated hydrogen produced annually worldwide. This makes up around 6% of the world's natural gas consumption. A variety of technical and economic considerations, with gas prices and capital expenditures being the two most significant, affect the cost of producing hydrogen from natural gas. Between 45% and 75% of manufacturing expenses are accounted for by fuel expenditures, which are the major cost factor. In electric cars or buses with a fuel cell that turns hydrogen into energy, this is one of the most potentially useful uses for hydrogen. Fuel cells are appealing because they outperform the internal combustion engines they can replace in terms of efficiency, while the latter can still be used if preferred with hydrogen fuels. If the hydrogen is produced from low-carbon energy sources like renewable sources, then the CO_2 emissions can be decreased to zero. Hydrogen may be helpful for storing renewable energy from intermittent sources, such as wind energy, when there is little demand for electricity.

This vision can become a reality if hydrogen can be produced from domestic energy sources economically and in an environmental-friendly manner. Fuel cell technology should also become mature and economical so that fuel cells and fuel cell vehicles can gain market share in competition with conventional power generation sources and transportation vehicles. In that way, the entire world would benefit from lower dependence on oil and coal as the major sources of

energy and improved environmental quality through lower carbon emissions. However, before this vision can become a reality and the transition to such an economy can take place, many technical and social challenges must be overcome.

Ms. Kashmiri Baruah
Asst. Professor
Department of Physics,
N. N. Saikia College, Titabar

Some Fascinating quotes of Physics

1. The beauty of Physics lies in its simplicity and its ability to explain the complex world we live in.
2. Physics is the poetry of Reality.
3. Physics is not just a subject; it is a way of seeing the world.
4. Physics is pleasurable
5. The whole world is governed by the law of physics.
6. Physics is elegant but still messy as a subject.
7. Quantum physics shows us that we're all one.
8. The most important thing that physics teaches us is that everything is energy.
9. Everything in this world can be understood through Maths and physics.
10. God operates the laws of physics.
11. Only a bad teacher can make physics boring.
12. Physics concerns itself with the troubles created by nature.

Mr. Hemanta Tanti
Faculty, Dept. of Physics

Quantum Nature of Light

The nature of light has been a fascinating subject for scientists to study. In the 19th century, light was established as electromagnetic wave. But Electromagnetic Theory of Light failed to explain optical phenomena such as blackbody radiation and photoelectric effect. In blackbody radiation, a blackbody (an object that absorbs all incident radiation) emits radiation across a wide range of frequencies. In photoelectric effect, electrons are emitted from the surface of a material when it is illuminated with light.

Classical Physics couldn't explain characteristics of these two phenomena. And that's when Quantum Physics came into play. In 1900, Max Planck proposed the Planck's quantum hypothesis; according to which light comes in discrete bundles of energy known as 'quanta'. Energy of each quantum is directly proportional to its frequency, as given by the equation $E = hv$, where E is energy, v is the frequency of the light, and, h is Planck's constant. Planck's hypothesis was able to explain characteristics of blackbody radiation. In 1905 Einstein proposed that light is made up of particles named 'photon'. Energy of each photon is given by the equation $E = hv$. Einstein successfully explained photoelectric effect with his photon concept. In 1923, Compton Scattering provided experimental evidence for the particle nature of light. The current understanding of light in quantum physics is based on the concept of wave-particle duality. Light is both electromagnetic wave and photons. Wave-like properties of light are observed in phenomena like interference and diffraction. And optical phenomena such as blackbody radiation and photoelectric effect show the particle nature of light. Like other quantum particles, photons too can exist in superposition states, where they simultaneously occupy multiple possible states. The description of light in the context of quantum physics is encompassed by quantum field theory, particularly quantum electrodynamics (QED). Quantum optics, a branch of physics that studies the interaction between light and matter at the quantum level, is exploring the quantum nature of light and fascinating optical phenomena such as photon counting, photon entanglement, quantum interference, and is leading to technologies like quantum cryptography and quantum computing.

Ms. Seema Ahmed
5th Semester, Dept of Physics

Chandrayaan-3

Chandrayaan-3, the highly anticipated third lunar mission by the Indian Space Research Organisation (ISRO), marks an important milestone in India's ambitious space exploration endeavor. Chandrayaan-3 mission has launched from the Satish Dhawan Space Centre in Sriharikota at 2.35 pm (July 14). Chandrayaan-3's launch has gone exactly according to plan. It's expected that the Chandrayaan-3 will land on the moon's surface on 23 August 2023.

Chandrayaan-3, developed by the Indian Space Research Organisation (ISRO), aims to further expand our knowledge of the lunar surface, conduct advanced experiments, and continue the exploration of the Moon's mysteries. The mission is equipped with cutting-edge scientific instruments and technologies that will facilitate comprehensive scientific research.

One of the primary objectives of Chandrayaan-3 is to land a rover on the lunar surface. This rover will be equipped with advanced instruments to analyze the composition of the lunar soil, study the Moon's geology, and search for water ice in the permanently shadowed regions of the South Pole. By studying these regions, scientists hope to gain valuable insights into the history and evolution of the Moon, as well as the potential for future human missions.

Chandrayaan-3 is also expected to enhance our understanding of lunar resources, such as helium-3, which could potentially serve as a valuable source of clean energy in the future. Moreover, the mission will provide crucial data for planning future lunar missions, including manned missions, further cementing India's position in the global space exploration landscape.

The successful launch of Chandrayaan-3 today is a testament to the hard work, dedication, and expertise of the ISRO team. Their relentless pursuit of excellence and commitment to pushing the boundaries of space exploration has propelled India into the League of Nations at the forefront of scientific and technological advancements.

Ultimately, Chandrayaan-3 holds the promise of expanding our understanding of the Moon, unlocking its mysteries, and paving the way for future lunar missions. It exemplifies humanity's inherent desire to explore and discover, driving us forward in our quest to unravel the secrets of the cosmos.

Sri Partha Protim Borah
3rd Semester, Dept. of Physics

Quantum Microscopy

Quantum microscopy based on quantum phenomena, such as a photon or electron entanglement, measures particles and their properties at the atomic scale. Most microscopes employ light or laser to illuminate and see semi-transparent or transparent materials. Although certain samples can withstand high radiation levels, others are very delicate and are destroyed by high intensity of light, making it difficult to analyze them.

The simplest solution is to decrease the light intensity. But unfortunately, doing so can make the image noisy and fuzzy, which might conceal important features that could otherwise provide the observer with valuable information. Quantum microscopy overcomes this challenge by restoring the image of the material using constructive interference of entangled photons. It combines a quantum source that produces hyper- entangled space-polarized photons, a lens- less interference microscope with a wide field of vision, and a single photon avalanche diode array camera, to realize particles at the atomic level.

The first microscope was invented by Dutch lensmaker Zacharias Janssen around the turn of the 17th century. This innovation led to the discovery of cells and bacteria. In 1981, Heinrich Rohrer and Gerd Binnig of the IBM Zurich Laboratory developed the scanning tunneling microscope based on complicated quantum models, a new limit to the scale of microscopy, taking it from the micro to the nano-scale, representing a quantum microscope revolution.

Quantum microscopy's ability to provide numerous characterization and imaging modalities offers promising new insights into the behavior and structure of materials at the nano to the quantum scale**.** Mechanical Properties of Patterned Films: Examining acoustic behavior at the nano-scale using quantum microscopy reveals details on stress and strain for objects with length scales as small as a few nanometers that are difficult or impossible to obtain using physical and mechanical characterization techniques. Materials Properties and Dynamics: The electrical, magnetic, and elastic characteristics of nanostructured media and quantum materials can be investigated via their fermi- to pico-second temporal response using ultrafast laser pulses. Quantum Microscope as an MRI for Molecules: Quantum Microscopy enables scientists to investigate and examine how DNA folds and winds inside a cell and how medications function inside bacteria or cells. It generates images of each atomic ion, even in a liquid solvent, and characterizes the biological reaction without interfering with it. Scientists long anticipated such an imaging technique to harmlessly view molecular interaction and cellular structure without invasive intervention.

Recent breakthroughs in quantum microscopy have shown great promise in overcoming traditional technology barriers and providing superior imaging quality. Quantum microscopy will allow the development of new studies in different fields of science. A notable example consists of the discovery of the shape of DNA since the double helix structure had only been demonstrated by theoretical calculations but had never been realized. These discoveries will

open up a new world of possibilities for discovering and understanding the nature of objects. For this reason, quantum microscopy is and will be an excellent tool for those who want to see beyond their eyes.

Ms. Nirmali Saikia,
5th Semester, Dept. of Physics

Nuclear Fuel

Nuclear fuel is any material that can be consumed to derive nuclear energy. The most common type of nuclear fuel is fissile elements that can be made to undergo nuclear fission chain reactions in a nuclear reactor. The most common nuclear fuels are 235 U and 239 Pu. Not all nuclear fuels are used in fission chain reaction.

PRODUCTION OF NUCLEAR FUELS: However, nearly half the world's mines now use a mining method called in situ leaching. This means that the mining accomplished without any major ground disturbance.

Groundwater with a lot of oxygen injected into it is circulated through the uranium ore, extracting the uranium. The solution with dissolved uranium is pumped to the surface.

Both mining methods produce a liquid with uranium dissolved in it. This is filtered and the uranium then separated by ion exchange precipitated from the solution, filtered dried to produce a uranium oxide concentrate ,which is then sealed in drums. This concentrate may be a bright yellow color, hence know as `yellow cake´, or if dried at high temperatures it is khaki.

The uranium oxide is only mildly radioactive.

ADVANTAGES OF NUCLEAR FUELS:

1. Helps generate electricity.
2. Low fuel costs (Uranium 235).
3. Water vapor is the only emission.

DISADVANTAGES OF NUCLEAR FUELS

1. Cause thermal pollution of waterways
2. Difficult to safely dispose of nuclear (radioactive) wastes.

Sri Mridupaban Das
3rd Semester, Dept. of Physics

Cosmic rays

Cosmic rays are energetic particles that traverse through space and reach Earth. They primarily originate from the Sun and other sources within our Milky Way galaxy. However, the particles with the highest energies come from beyond our galaxy. Protons make up the majority of cosmic rays, accompanied by helium nuclei and a small amount of heavier nuclei. These particles travel close to Light's speed and can interfere with electronic components in satellites. When primary cosmic rays collide with atoms in the upper atmosphere of Earth, they generate additional particles known as secondaries. These secondary particles contribute to the complex composition of cosmic rays that reach our-planet. Cosmic rays were discovered by Victor Hess in 1912 in balloon experiments, for which he was awarded the Nobel Prize in Physics in 1936.

The origins of cosmic rays remain a subject of active research there is strong evidence that some are produced in our own galaxy (the Milky Way) in supernova remnants. At the highest energies, cosmic rays likely originate outside our galaxy, in even more energetic environments such as the surroundings of giant black holes at the center of distant galaxies.

Cosmic rays are part of the naturally occurring radiation dose that people receive throughout their lives. Because Earth's atmosphere absorbs most of the energy of cosmic rays, only a small fraction reaches ground level. Earth's magnetic field also deflects many of the original primary cosmic rays before they reach the atmosphere, providing further protection.

Continuing to identify the multiple origins of cosmic rays will help us to understand these most extreme parts of the universe and also to use these naturally occurring particle accelerators and the particles they produce to answer fundamental physics questions.

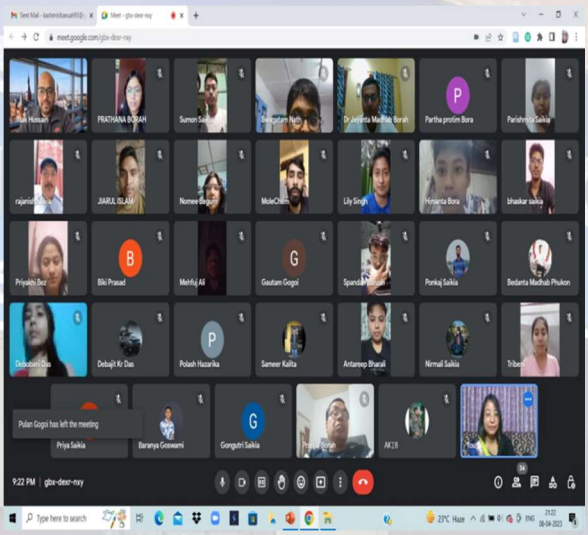
Ms. Tribeni Das,
5th Semester,, Dept. of Physics

Departmental Activities
(2022-2023)

Celebrating Science Day:

Educational trip: As a part of the extension activities, major students are taken to different reputed research organisations like CSIR-NEIST, Tocklai and AAU.

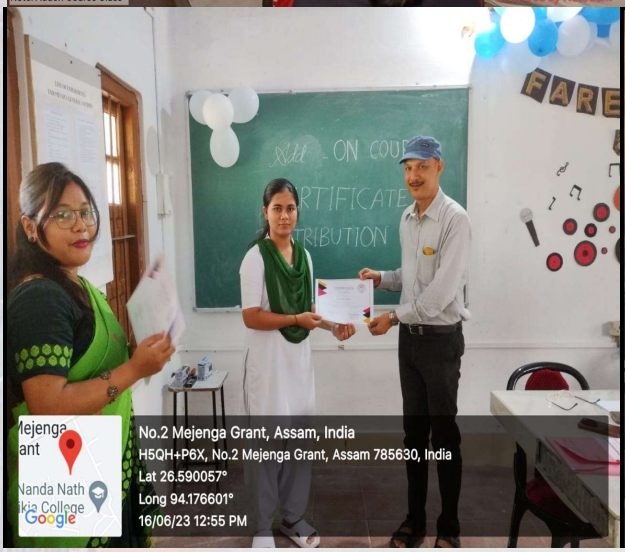
Webinar: "Basic sciences in developing Medical technologies" by Dr. Iftak Hussain, Post Doctoral Research Associate Cornell University, Ithaca New York, USA



3rd cycle of NAAC visit-2023:

Community Teaching at Biki Devi Gattani High School

Add-on Certificate Course :



Inter-Departmental meeting: In accordance with MOU "Strategy for successful implementation of FYUDP as per NEP-2020" NNSC and Mariani College

Parent-Teacher Meet:

World Environment Day Celebration:

Memories of Freshmen social and Farewells

Faculty Improvement Programme

Dr. Rajanish Saikia:

1. One week international workshop on "Academic research writing, copyright and plagiarism" organized by Nanda Nath Saikia College Teachers' Unit in collaboration with department of Botany during 14-19th November, 2022

Mr. Swagatam Deva Nath:

1. One week international workshop on "Academic research writing, copyright and plagiarism" organized by Nanda Nath Saikia College Teachers' Unit in collaboration with department of Botany during 14-19th November, 2022
2. One week FDP on "Academic Writing Using Latex-CCS" organized by Dibrugarh University during 1-7 June, 2023.

Dr. Prathana Borah:

1. 37th National Symposium on Plasma Science & Technology (PLASMA 2022) during 12-14 December, 2022. Paper presented: **"**Effect of Debye Hückel potential in the formation of Dust acoustic wave with dust charge variation",
2. One week international workshop on "Academic research writing, copyright and plagiarism" organized by Nanda Nath Saikia College Teachers' Unit in collaboration with department of Botany during 14-19th November, 2022.
3. Weeklong STTP on "Enhancing Administrative Skills" organized by Teaching Learning Centre, Tezpur University during 24-30 May, 2024
4. Two week Interdisciplinary Refresher Course on "Curriculum and Pedagogy" organized by Teaching Learning Centre, Tezpur University during 07-20 June 2023.

Ms. Kashmiri Baruah:

1. One week international workshop on "Academic research writing, copyright and plagiarism" organized by Nanda Nath Saikia College Teachers' Unit in collaboration with department of Botany during 14-19th November, 2022.
2. Online Month-long Faculty Induction Programme (FIP) organized by Teaching Learning Centre, Tezpur University during 01 February - 02 March 2023 under PMMMNMTT Scheme of Ministry of Education, Government of India.
3. Online Weeklong Faculty Development Program on Academic Writing and Publication organized by Teaching Learning Centre, Tezpur University in association with Doomdooma College, Tinsukia and Raha College, Nagaon during 10-16 May 2023