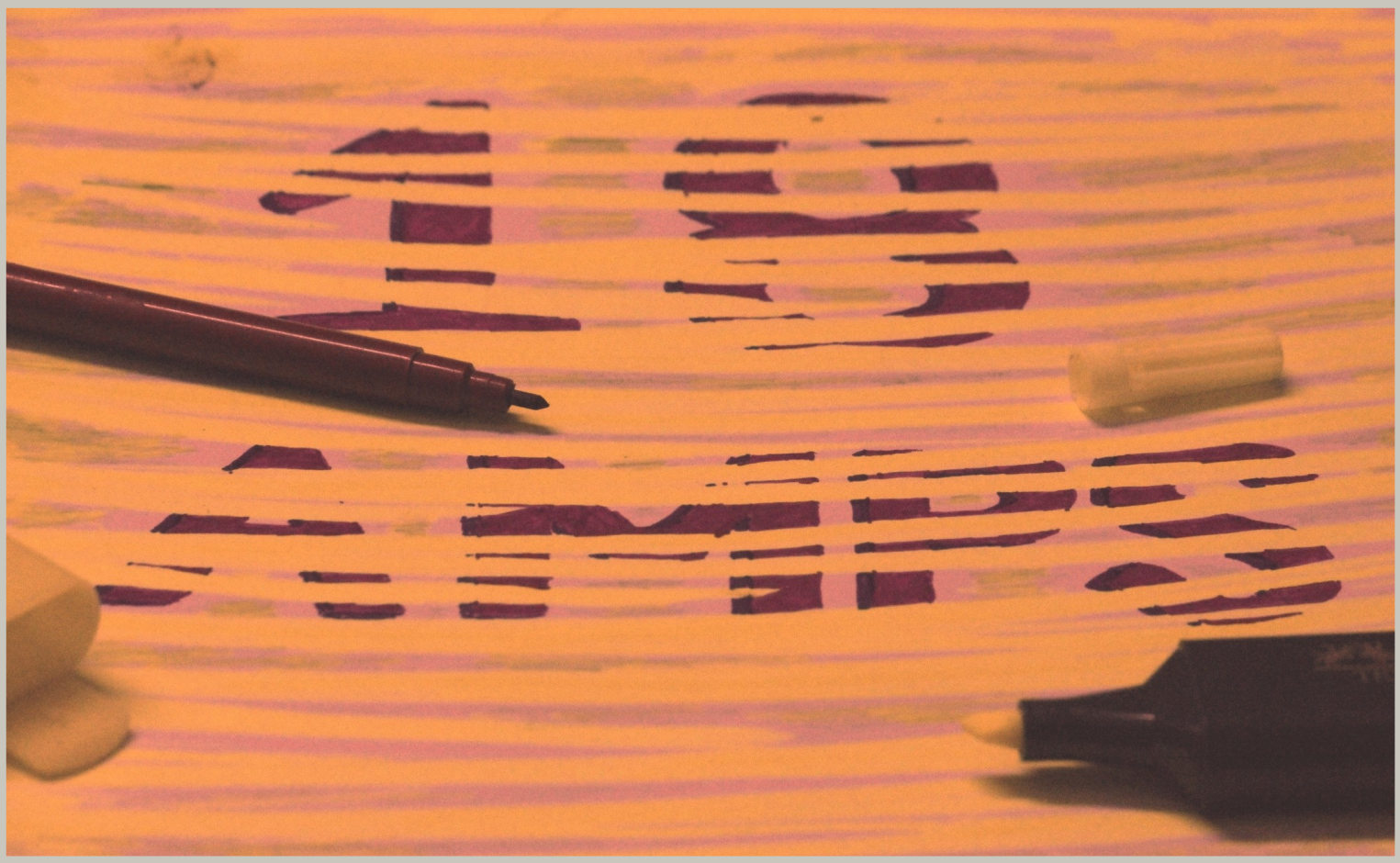
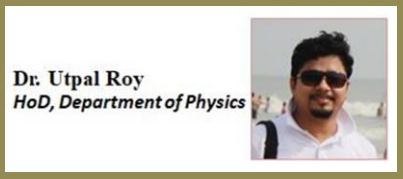


Annual Magazine of Physics Society
IIT Patna

'18 amps

Message from HOD



A hearty and joyous welcome to all readers to the second issue of the Physics Society annual magazine – '18 amps. Needless to say, this has turned out to be one of the signature activities of the department. This magazine is the forum for the members of the department to summarize our yearly activities, exchange ideas, get acknowledged and receive feedback.

The Department of Physics was established and started its activity from 2008. Initially, it was to train undergraduate engineering students. Then, we initiated Ph. D program after a year. M. Tech program in Nanoscience and Nanotechnology has been running since 2012. A two year M. Sc. program in Physics is also in place since 2016. Our department has a distinguished record in both teaching and research. Total sixteen esteemed faculty members of the department are actively involved in research and development in challenging areas of both Theory and Experiment. We have state of the art research facilities in the department to support our academic programs and research. Our Ph.D program is quite successful. Most of the graduated students have become the faculty in various reputed Institutes of Higher education in India. Others are pursuing their post- doctoral researches in abroad. **S**tudents of the department are engaged in regular seminar activities. Over the last few years, department has been arranging a number of workshops, conferences, schools and various outreach activities: the theme being Global Excellence and Local Relevance. The largest one is the "International Conference on Quantum & Atom Optics (ICQAO-18)" during December 16-18, 2018 with a large number of eminent speakers from India and abroad.

Physics society is keen to get engaged in organizing several workshops, conferences and regular lectures by the students and outside visitors. The society also conducts several cheering programs which includes sports activities, cultural events etc. Physics Society will soon expand its activities by creating digital forum and allowing more members to register, arranging science and technology fest etc.

I would like to close my remarks by congratulating all the members of the society and paying heartfelt thanks for making this magazine published on time. I am also extremely happy to unveil it during ICQAO-18. Let the activities of physics society soar high and reach attention of millions in coming years too.

With best wishes,

Dr. Utpal Roy

Message from faculty advisor

Dr. Jobin Jose
Faculty Advisor, Physics Society

Esteemed faculty colleagues and friends of Department of Physics, IIT Patna and readers,

Let me introduce you to the second edition of annual magazine of physics society (’18 amps). Inherited by the success and wide acceptance of the previous edition, ’17 AMPS, we bring the new version in an attractive and refreshing form. This magazine primarily comprises of articles from members of the physics society. Besides, it also showcases summary of the programs we organized in the previous year, which all tasted success.

The year 2017-18 was indeed an exciting year in the Physics department. The members organized several activities with vigour and enthusiasm. Some of them include the workshop: “Advances in Physics: From Concepts to Applications”, interaction session with eminent researcher and academician Prof. H. C. Verma on his experiences in educational system, release of annual magazine ’17 amps etc. We also had a celebration to mark 125th birth anniversary of eminent physicist S. N. Bose on the research scholar day. In short, this year was a memorable and most remarkable one in the diary of physics society and Department of Physics.

The society is also conducting weekly seminar by student members on interesting research topics. It was only because of the sincere co-operation and help from the students and faculty colleagues; we could host series of successful events. I express my sincere gratitude to the HoD of Physics Dr. Utpal Roy, other faculty colleagues, staffs and students members for their support and invaluable participation. Heartfelt thanks to the general body team of the Physics Society for their harmonious effort to make every event successful. Certainly the students as well as other members of the department do benefit from all these activities and my heartfelt wishes for all the future endeavors of this society.

Best Regards
Dr. Jobin Jose

Message from President

Mr. Lagen Kumar Pradhan
President, Physics Society

I welcome all of you with great interest to our second issue the Physics society magazine "Annual Magazine of Physics Society ('18 amps). Also, it is my immense pleasure to congratulate all the members for the completion of two year of the physics society at IIT Patna. The overwhelming success of the first issue of the Physics Society Magazine ('17 amps), which drives us to bring a new version with new scientific ideas contributed by the students and faculty members. Hence, I would like to present the brief introduction about the '18 amps.

The academic year 2017-18 was the most stirring for the Physics society, IIT Patna. A lot of exciting moments were captured by the Physics Society. In this academic year, we organized several events such as workshop on Advances in Physics: From Concepts to Applications for the B.Sc. and M. Sc. students, interaction session with the great physics teacher of the country Prof. H. C Verma, celebration of the 125^{th} birthday ceremony of the S. N Bose etc. The society is also actively involved in the departmental activities i.e. fresher day and teacher day celebration, annual departmental sports meet, weekly seminar by the students. Hence, it requires remembrance all the happiest moments of the society which will provide intrinsic energy to individuals to continue further and take the department and institute name in the global level. In brief, the magazine consists of message from HOD physics (IIT Patna), faculty advisor and president of the society, articles contributed by the student and faculty members and followed by the various events.

Finally, I would like to thank our honorable director (IIT Patna), HOD physics, Faculty advisor of the society and the members of the physics society for their valuable suggestions and support to the physics society in various ways.

Best Wishes

Mr. Lagen Kumar Pradhan

Contents

About IIT Patna

Indian Institute of Technology Patna is one of the new IITs established by an Act of the Indian Parliament on August 06, 2008. The year 2018 marks the celebration of decennial of establishment of IIT Patna.

Patna which was known as Patliputra has been a center of knowledge since long has been attracting visitors and scholars from many parts of the world such as China, Indonesia, Japan, Korea, Sri Lanka, among others. This has been a land of visionaries. Some of the legends from this region include Lord Gautam Buddha, Lord Mahavir, Guru Gobind Singh, the famous astronomer Aryabhatta and the first President of India, Dr. Rajendra Prasad.

IIT Patna has ten departments: These are Computer Science & Engineering, Electrical Engineering, Mechanical Engineering, Chemical and Biochemical Engineering, Civil & Environmental Engineering, Materials Science & Engineering, Chemistry, Physics, Mathematics and Humanities & Social Science departments. IIT-Patna campus is located at Bihta which is approximately 40 km from Patna. The Institute has developed modern facilities that are fully equipped with the state-of-the-art facilities (equipment software and machines) that are routinely used to train and educate students in the following programs:

- B. Tech in five disciplines: Computer Science and Engineering, Electrical Engineering, Mechanical Engineering, Civil Engineering and Chemical Engineering.
- M. Tech in multi-disciplinary streams with eight specializations:
  - Mechatronics jointly offered by Departments of Mechanical and Electrical Engineering,
  - Mathematics & Computing jointly offered by Departments of Mathematics and Computer Science & Engineering.
  - Nano Science & Technology jointly offered by Departments of Physics and Chemistry,
  - Computer Science and Engineering offered by Department of Computer Science & Engineering,
  - Communication System Engineering offered by Department of Electrical Engineering,
  - Mechanical Engineering offered by Department of Mechanical Engineering,
  - Civil and Infrastructure Engineering offered by Department of Civil & Environmental Engineering and
  - Materials Science and Engineering offered by Department of Materials Science and Engineering.
- ✓ Budding research scholars are admitted in the Ph.D. program of this Institute in all ten (10) departments.

Research activity in IIT Patna has been published in high-quality and peer-reviewed national and international journals. Please browse individual faculty member webpage for more information. Faculty members of IIT Patna have been also participating in national and international conferences of repute. Recently, IIT Patna has been ranked as the **19th best engineering college** in the recently released ranking by the Human Resource Ministry, Govt. of India (NIRF).

About Department of Physics

The department of Physics at IIT Patna was established and started its activities in August 2008 to train undergraduate engineering students. In July 2009, the department initiated Ph. D. program in various frontier fields of Physics. M. Tech program in Nanoscience and Nanotechnology has been started since July 2012. The department is also offering 2 year M. Sc. program in Physics from July 2016. The department is committed to engaging in high-quality research and the pursuit of excellence in teaching. Currently, there are 16 faculty members, 7 staffs, 48 research scholars, 18 M. Tech students and 17 M. Sc students present in the department. The faculty members of the department are actively involved in research and development in challenging areas of both theory and experiment. Currently, the main research emphasis of the department comprises of Condensed Matter Physics (Experiment & Theory), Optics (Experiment & Theory), Nanophotonics & Nanoplasmonics, Biophysics, High energy Physics and Atomic & Molecular Physics.

About the Physics Society

Society and clubs are an integral part of the integrity of any institution. It provides an appropriate platform for the exchange of ideas as well as the academic growth. With the aim to float such a platform, with Physics at its core, we the students of the department of Physics at IIT Patna resolved the inception of Physics Society at our campus. The Physics Society is a group formed under the aegis of the department of Physics, IIT Patna. Membership to the society is open to anyone who has an interest in Physics and presently, it includes all the students and faculty members of the Department of Physics.

The objective of the Society is multifaceted. It looks forward to generating an atmosphere that fosters a scientific temper. It provides a platform for those interested in Physics to share and discuss the ongoing activities and scholarly work in the field. The Society also aims to organize outreach programs to generate awareness among the local community. The activities will ensure that the members develop leadership experience and use their knowledge in the area to contribute to the community.

With above objectives, the Physics Society was established on 30th of January, 2016. A committee was formed with Mr. Rajnish Kumar, a senior research fellow as its President to look after the needs of the organization. The inauguration was celebrated by the students, staffs and faculty members of the department with great zeal of enthusiasm. We were highly privileged to have Prof. Pushpak Bhattacharyya, the director of IIT Patna and Prof. Ratnamala Chatterjee, eminent faculty at the department of Physics from IIT Delhi as our chief guests. They illuminated our spirit by their mesmerizing lecture. Head of the department Dr. Utpal Roy delivered a motivational speech and introduced the department to all of us. It was followed by a talk from the president of Physics Society Mr. Rajnish Kumar who introduced the office bearers of the society to us. A grand lunch was arranged by the department.

Articles

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Evolution of Cosmological View

Since ancient time to modern era the most intriguing thing for humans was mystery of the universe, it inspired so many poets and artist to their ultimate heights. When human was living as hunter-gatherer under the blanket of stars and planets, the sky watching and pattern recognition of stars with curiosity was the best example of human ability of observations. Origin of first noticed constellation is likely goes to prehistoric era when people used to relate somehow in their stories and myths but the first documented information is found in Aratus's (a Greek didactic poet, 270 B.C.) poem *Phaenomena,* still watching constellation in night sky is full of curiosity and imagination. Study of creation, evolution and fate of the universe is called cosmology. Cosmology is made of two Greek words Kosmos means "world" and logia means "study of". According to the NASA cosmology is defined as "The scientific study of large scale properties of universe as a whole". It is tough to say that when did human start to imagine and explain the picture of universe but a serious and remarkable depiction was given by Greek philosopher Aristotle (340 B.C.). In the book "On the heavens" Aristotle explained with an appropriate argument that earth was round sphere rather than flat disc, the solid reason behind this concept was the round shape (rather than elliptical) of shadow of earth during lunar eclipses , which would be only true if earth was sphere. Another argument was Greeks observed that northstar appeared lower when it is observed from equator or in distant ocean when ship was observed then sail appeared first then hull. According to the Aristotle picture the earth was at the center and the sun, the moon, the planets and the stars moves around it. This view was elaborated by Ptolemy in second century AD as a complete cosmological picture. The earth was at the center surrounded by eight spheres. The sphere carried the moon, the sun, the five planets (known at that time) and the stars. Cotemporary to this there were so many models prevailing at different places of the world.

In ancient India Aryabhatta (476-550CE), Varahmihira (505CE),Brahmagupta(598-668CE) and many more philosopher of that era contributed to realize the real picture of universe. Aryabhatta was author of two books 'Aryabhatiya' and 'Aryabhattasiddhanta'. In these two books he stated that the Earth rotates on its own axis which cause the westward movement of stars, he also suggested that shape of earth was sphere and its circumference was 29,967km. Aryabhatta was the first one who mentioned that shining of the moon is because of reflection of light from the earth. Relatively clear and simpler model was proposed by Nicholas Copernicus in 1514 and according to that picture the Sun was stationary, the Earth and planets move around the sun. But idea of Aristotle and Ptolemy was accepted by church doctrine and Copernican's picture was against it so this model was not accepted. In 1593 Giordano Bruno was influenced by Copernican model and he extended that model as stars are distant sun and they were surrounding by their exoplanets in the infinite universe and there was no celestial body at the center of universe. Bruno's proposal was against catholic doctrine that's why he was burned alive, but his death was not gone waste and his model was taken seriously by two great astronomers of the history of cosmos, Johannes Kepler and Galileo Galilei. Eventually Aristotalian/Ptolemic picture got rejection in 1609, in that year Galileo started

using telescope which was invented by Hans Lippershey in Holland but used by Galileo for skywatching. Copernican picture was supported and extended by Johannes Kepler, he propounded that Earth and planets were not moving on circular path but elliptical path, there was no any mathematical proof behind this idea but was on ad hoc till 1687 when Newton's "*Philosophiae Naturalis Principia Mathematica* " was published. Newton's work was most remarkable in the history of mankind, in his published work he explained the motion of planets and developed appropriate mathematical model to describe and predict their dynamic behavior. He propounded three laws of motion what today known as Newton's laws of motion and another landmark proposal was theory of gravitation. These laws explained the force, velocity, acceleration of objects and how motion was independent of mass.

The motion of free falling body was experimentally observed by Galileo , in his experiment he observed the time duration of free falling object without air resistance and he got acceleration was same for different masses i.e. motion was independent of mass. Newton's theory of gravity stated that a common force was acting among two bodies because of their mass which was called gravitational force, it was directly proportional to the multiplication of value of masses and inversely proportional to the square of distance between them. This force was responsible for motion of planets around the sun, falling of objects towards earth and this force bund every massive object of the universe.

But Newton's explaination was not enough to satisfy human curiosity, there were still countless questions arising in people's mind like – how & when was universe created? What was the size of satrs and diatance between them? Why were stars twinkling ? and many more which caused the restless effort of human beings to know about the universe.

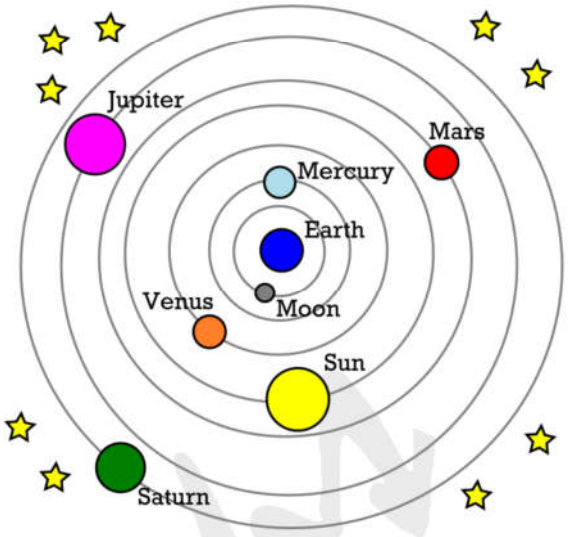

FIG 1. Ptolemic model of universe.

The groundbreaking model came into existance in 1929 when Edvin Hubble observed that there were so many other galaxies existed and recessional velosities of neibour galaxies were increasing with their distances from the earth which was called Hubble's law and concluded with proper supporting evidence that universe was expanding. Two years before Hubble's publication Georges Lemaitre had prosed theoratical grounds of expanding universe and he was first one who derived what now it called as Hubble's law. And he also proposed "hypothesis of primeval atom" leter on which was called "Big Bang theory". The question may arise, how velocities of moving galaxies was observed? The answer is hidden in Doppler's law what we have studied in our highschool cource. In case of sound wave frequency of sound increases when source come towards observer and decrease when go far away from the observer. The same concept apples in case of electromagnetic radiadion coming from distant sources , when source goes far away then frequency decreases and visible spectrum shifts towards red so it is called redshift similarly when source come towards observer friquency increases which is called blueshift.

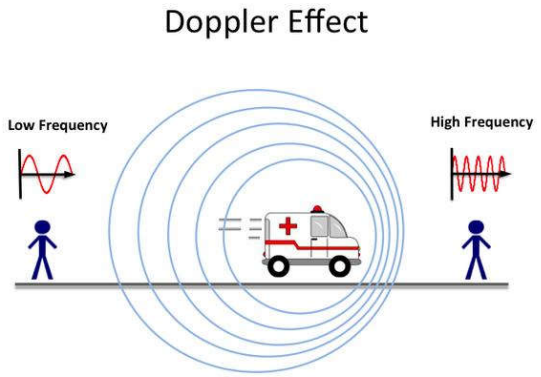

FIG2. Observed frequency of two observers**.**

Radiations are observed not only in visible range but also in different ranges of electromagnetic wave. Telescopes using visible range are called optical telescope and using radio frequency range are radio telescopes similarly infrared telescopes, Gamma-ray telescopes and many more.

The vastness and peculiarity the universe is far away from common man perception. The nearest star Proxima Centauri is approximately 4.24 light-years away from the earth i.e. the glimpse what observes was 4.25 years ago. In our Milky Way Galaxy there are more than one hundred billion stars and its size is approximately 100,000 light years. If we will have Space Shuttle of speed of light , will take 100,000 years to go from one end to another end of our Galaxy. In observable universe the estimated number of galaxies is 200 billion to 2 trillion.

REFERENCES

[1]. Jayant Narlikar“ A Journey through the universe, National Book Trust” (2004).

[2]. Stephen Hawking “A Brief History of Time, Bantam Books” (1998).

Multiplexed Holographic Solar Concentrator

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To meet our present energy crisis conversion of solar energy into useful electrical power through solar cells is considered to be most viable, economical and nature friendly way of alternative source of energy.

Ever since photovoltaic cells had made their way for use in terrestrial applications, there had been a temptation to use concentrated sunlight so as to reduce the cost of the involved photovoltaic systems.[1]

Solar concentrators usually consist of external systems associated with PV cells generally consisting of parabolic mirrors, or lens that concentrate the amount of sunlight falling on the PV cell.This increases the overall efficiency of the cells.

Conventional concentrators like Fresnel lens, parabolic lens concentrate the entire spectrum portion of solar radiation which is not utilized by absorber, causes overheating. They are usually bulky and often require sun-tracking apparatus.Therefore, spectrum splitting and concentrating the solar radiation of specific wavelengths was proposed.

Ludman [2] for the first time proposed the use of holographic solar concentrator for PV power generation. Holographic optical elements (HOE's) can be efficiently used for controlling and directing the radiation of Sun. These diffracting optical elements can simultaneously perform the twin function of dispersion of solar spectrum into its constituent color and their concentration on solar cell of matched band gap. HOE's to be used as dispersing concentrating system (equivalent to combination of grating and lens.) are fabricated using the principle of Holography.

Lens,gratings, beam splitters, mirrors, etc., can be realized using the method of holography. Recording of superposition of a spherical wave front coming out of a coherent point source and a coherent plane wave gives rise to an off-axis zone plate which is regarded as a holographic lens, whereas, recorded interference pattern due to superposition of two planes coherent waves lead to realization of a grating.

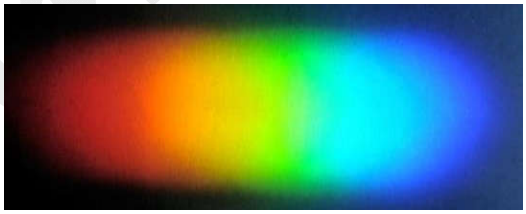

FIG. 1 Spectrum of mercury vapour lamp diffracted through a holographic lens

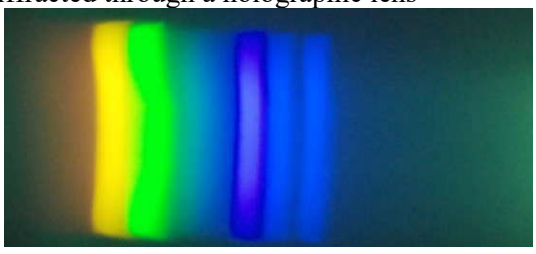

FIG. 2spatially separated focused line spectrum obtained from a compound holographic dispersion concentrating system.

Such concentrating holograms have thin film geometry and light weight. They do not require tedious processing for their mass production like conventional concentrators and are cost

effective.

The other type HOEs can be recorded using proper recording geometry and find their applications in coherent imaging, fiber optical communication, speckle metrology, laser printers, scanners, barcode readers, avionics etc.

Multiplexing

Collection of light from moving sun which exhibits a broad spectral range of wavelength is a complex process. For a conventional imaging concentrator, only ray's incident within acceptance angle 'θ' from the axis of the concentrating system can be focused on a solar cell. Thus light rays coming from a cone of angle 2θ can be accepted by a concentrator.

A single holographic lens has limited acceptance angle similar to that of conventional lenses which is approximately 3-4 degrees. Therefore, diffraction efficiency of thick phase transmission holographic lens falls rapidly with change in angle of illumination by collimated sun rays. This leads to mandatory requirement of Sun tracking for achieving desired efficiency of PV cell throughout the day time.

HOE's have capability to perform a range of functions in one element. That means in a single layer of film we can record more than one interference pattern by changing the angle between two light beams. This is called Angular Multiplexing. Several concentrators can be made in a single layer of recording film each corresponding to different positions of Sun at interval of few degrees.

Similarly, Spatial Multiplexing is also useful in sun tracking [2]. Several concentrators are recorded at different positions of recording film and all will focus at same place.

Hence combination of these two solves the problem of sun tracking without using any mechanical movement. It is sufficient to go for one-dimension tracking with hologram.

Present design consideration [3] ensures that by properly optimizing processing parameters of several multiplexed HoloLens like film thickness and depth of refractive index modulat

desired wavelength range can be achieved with appreciable acceptance angle. Five angularly multiplexed holographic lens can track approximately 30 degrees of solar swing (6 degrees each). If such angularly multiplexed HoloLens are fabricated spatially separated from each other so that 1st set takes care of morning sun, 2nd set takes care of noon sun position and 3rd set takes care of afternoon sun position then solar tracking for the entire day can be held without any movable mechanical part supported with electronics system.

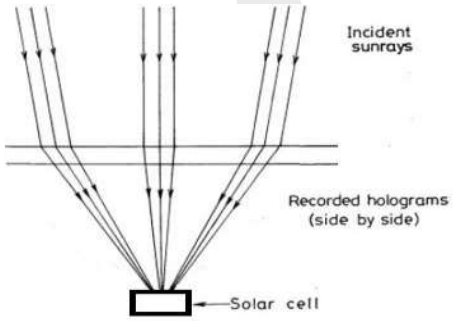

FIG. 3. Three spatially multiplexed hologram concentrating at same Solar cell.

With the aid of theoretically computed design, results showthat by controlling the hologram thickness, fringe spacing and depth of refractive index modulation, quite high diffraction efficiency can be achieved over the entire useful spectrum of the sun [4].

REFERENCES

[1]. J. C. Brown and J. A. Harte, "Holography in the Undergraduate Optics Course," American Journal of Physics, 37, 44 (1969).

[2]. Ludman, J.E., "Holographic Solar Concentrators", Appl. Opt. 21, 3075 (1982).

[3]. P. Kumar, H L Yadav, "optimisation of processing parameters of multiplexed holographic solar concentrator for sun tracking with maximum efficiency" MSc Thesis (2017).

[4]. Hull, J.L., Lauer, J.P., Broadbent, D.C., "Holographic solar concentrator", Proc. SPIE, 692,68(1987).

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A Route to Green Synthesis: Microwave Synthesis

There is chemistry behind the improved rate of reaction and efficiency of the reaction with microwave irradiation than the simple furnace heating. However, mechanism of chemical reaction in microwave oven is not well understood yet. Furnace heating is usually used for chemical reaction in which a temperature gradient would be set up between the container wall and the middle of the sample. Thus, energy used is not utilized properly. Moreover, interfaces are created when there are multiple precursors which give rise to unpredictable thermal gradients inside the container. Thus, it is difficult to predict the outcome of the chemical reaction in case of furnace heating. Also, the rate of reaction is slow in furnace heating and that has been the historic reason for the use of catalysts. As microwave delivers energy in controlled manner and there is strong electric field which can locally catalyze chemical reactions, it is imperative to use microwave for chemical synthesis. As mentioned if we use microwave, one can avoid using catalyst which can make synthesis a green synthesis. Moreover, a selective reaction where one reagent responds to microwave and other one remains inert is also possible.

Microwave is an electromagnetic wave whose frequency is in the range of 300 MHz to 30 GHz. Generally microwave ovens come in frequencies like 2.45 GHz, 5.8 GHz, 22 MHz and 125 MHz. In case of conventional heating, heat transfer from vessel wall to the material and vice versa depends on the thermal conductivity of the solvent and precursor as well. For microwave case though, thermal conductivity does not play significant role. However, their marginal role cannot be ruled out. Microwave absorption depends on the (a) dielectric constant, (b) dipole moment, (c) dielectric loss, (d) tangent delta and (e) dielectric relaxation time. Higher the microwave absorption, higher is the penetration depth. Interestingly, dielectric properties are also a function of effective temperature.

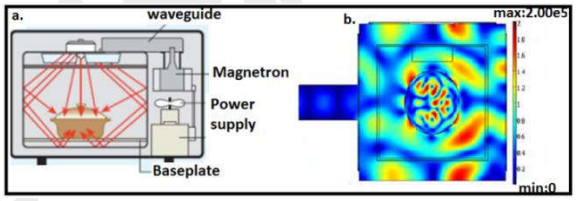

FIG.1 (a)Schematic diagram of microwave oven (b) COMSOL simulated field distribution inside a microwave oven (Inserted from Ref: T. Santos, L. C. Costa, M. Valente, J. onteiro, J. Sous, Electromagnetic Field Simulation in Microwave Ovens: a Tool to Control thermal Runaway, Excerpt from the Proceedings of the COMSOL Conference 2010 Paris).

Geometry and orientation of polar molecules will play vital role as electric field component of microwave will force it to align in its own direction. This will act as catalyst for the chemical reaction. Polarity in the system become very important if we are using microwave irradiation as it helps to couple with microwave, larger the polarity better is the coupling efficiency of system with microwave and thus more is the temperature rise and faster is the rate of reaction. In summary, microwave processing can be very uniquely tailored for an improved quality of synthesis through chemical process.

Magnetic Tape Recorder

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In 21st century, it is very common to use audio or video conference media for conveying messages to save time and travel cost along with the development of stronger collaboration and increased productivity from corporate sector to educationalinstitute.

These advantages and positive impact in human society is only plausible now a days for the pioneer Thomas Edison, inventor of "Phonograph," in the USA in 1877.[1] Following that mechanical recorder invention, there have been enormous researches on designing magnetic recorder including telegraphone, analog magnetic recorder, digital magnetic recorderetc.

Magnetic recording mainly depends on the imposition of a magnetic field, obtained from an electrical signal, on a magnetically disposed medium that becomes magnetized. The magnetic medium employed in analog recording is magnetic tape. Tape heads consist of circular rings of ferromagnetic materials with an opening where the tape touches it. So the magnetic field can induce magnetization to the suspended small magnetic materials on the tape. A coil of wire around the ring carries the current to produce a magnetic field proportional to the signal to be recorded. If an already magnetized tape is placed beneath the head, according to the Faraday's law of induction it easily induces voltage in the coil. Thus the same head can be used for recording andplayback.

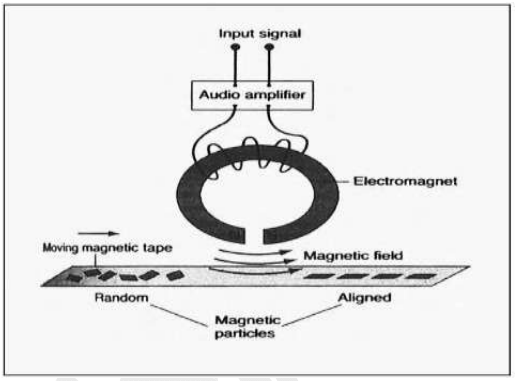

FIG 1. Diagram of analog magnetic recorder

For digital data processing electrical signals first converted into binary numbers which encodes the corresponding sample voltage with proper time interval.[2] Now researches are going on to get materials to be used as core material of recording media which has magneto-resistive properties , basically spin dependent. These materials may enhance the processing speed and storage capacity for the fulfillment of human quest.

REFERENCES

[1]. Masanori Kimizuka, "Historical Development of Magnetic Recording and Tape Recorder" National Museum of Nature and Science Systematic Examination of Technology Report, 17, 20 2012.
[2]. Magnetic Recording: Analog Tape ©2014 Jay Kadis (For educational useonly)
[3]. http://what-whenhow.com/physics/magnetism/

Relativity in Daily Life: Secret of Gold Color

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In discussion of special relativity, you occasionally encounter a claim like "The effects of special relativity is applicable only for matter to particle physicists and others working with extremely high energies and velocities. Relativity has no consequences in everyday life". Well, these days, anybody who relies upon the Global Positioning System (GPS) to navigate their car or the airliner in which they're travelling uses both special and general relativity, because without correction for their effects, GPS would be so inaccurate to be useless. But GPS is currently discovered, and it is really challenging because the relativistic corrections are both complicated and hidden from the user in the software in the receiver and on board the satellites. But there is an effect of special relativity which wasexisting, if not noticeable, by the ancients: the yellow gleam of gold.

Now the question is, why do most metals appear silver in colour, but what gives gold that Mellow Glow?

It is really surprising that the answer of this question relies from the quantum theory, but most of the people will be surprised to know about the answer comes from relativistic considerations into the picture. So we are talking quantum relativistic effects.

With an atomic number of 79, gold is in the last row of the periodic table containing stable elements, the electrons of the gold atom are subjected to an intense electrostatics attraction. At this point, importance of the relativistic effect comes into the picture. It is important to realize by using the naïve Bohr "Solar system" model of the atom for the moment , electrons in the 1s orbit with a velocity v of 1.6×10^{8} m/s to have sufficient kinetic energy to avoid "falling into" the nucleus . This is more than half the speed of light (v= 0.58c) which, according to Einstein's equation

$$m_{rel}=\frac{m_e}{\sqrt{1-\frac{v^2}{c^2}}}=1.22m_e. \qquad (1)$$

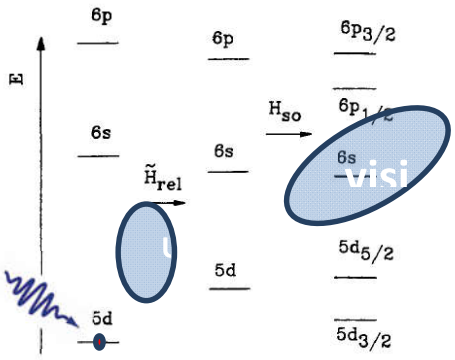
The Bohr radius,

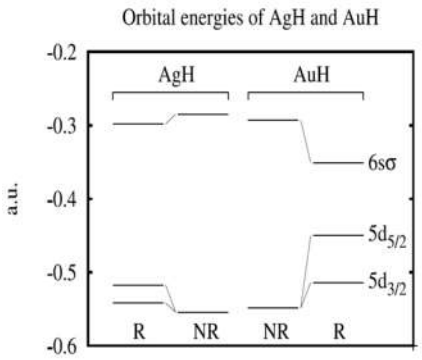
$$(a_0)_{nl}=\frac{\hbar}{m_e c\alpha}, \qquad (2a)$$

$$(a_0)_{rel}=\frac{\hbar}{m_{rel}c\alpha}=\frac{(a_0)_{nl}}{1.22}, \qquad (2b)$$

$$\frac{(a_0)_{rel}}{(a_0)_{nl}}<1. \qquad (2c)$$

The electron's mass will be increased (or, in more modern terminology, momentum) by about 20%. Quantum mechanics has replaced the Bohr orbits with a probability distribution of the electron's position, with orbital radius was interpreted as the distance from the nucleus where the peak probability occurs. As a result, the relativistic increase in mass of the electron causes a relativistic contraction of its orbit. The radius of an orbit with constant angular momentum shrinks proportionately as the electron's mass increases.





From the Bohr theory, we would expect that the effect to be significant only for the innermost electrons, but due to quantum mechanics, it will strongly affect electrons in s and p orbitals even in outer shells, because their probability density remains high near the nucleus. The higher angular momentum orbitals (d, f and g) have their probability peaks farther expand from the nucleus and hence are less affected by relativistic contraction.Due to stronger screening of the nuclear attraction by **s** and p shells, the d, f and g shells will have a slightly relativistic expansion and destabilization.

From the quantum perspective, it can be explained the colour of metals such as silver and gold is mainly due to absorption of photons by d orbital electrons. This proton absorption results in d electrons jumping to s orbital. In case of silver, the 4d→ 5s transition has an energy corresponding to ultraviolet photons to enable the transition. Therefore, photons with frequencies in the visible band are not absorbed. With all visible frequencies reflected equally, silver has no color of its own: silver appears as a shiny, white metallic substance. In case of gold, the relativistic contraction of the s orbitals causes their energy levels to shift closer to these of the d orbitals (which are less affected by relativity). As a result, shifts of photon absorption (primarily due to the 5d→ 6s transition) from ultraviolet region going down into the lower energy and frequency blue visual range. A substance which absorbs blue light will reflect the rest of the spectrum: the reds and greens which, combined, result in the yellowish hue we call *golden*.

Non Relativistic gold looks like silver

Multiferroic Materials and their Device Application

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In the modern society, researchers are looking for the multifunctional and smart materials in different devices applications. Multiferroic material is one of the best options which possess more than two ferroic properties. It has simultaneously both ferroelectric and ferromagnetic properties. It has brought into attention of many researchers due to its large number of applications such as (i) AC/DC field magnetic field sensors (ii) Microwave resonators (iii) Microwave Phase shifter (iv) Multiferroic magnetic recording head (v) Random access memory and multi state memory[2]. After 2005, digital data retrieves from magnetic storage media using the technique magnetoresistance (MR). But, with the increase in density of storage device, the size of sensor should also be scaled down in order to read data from small magnetic bit.

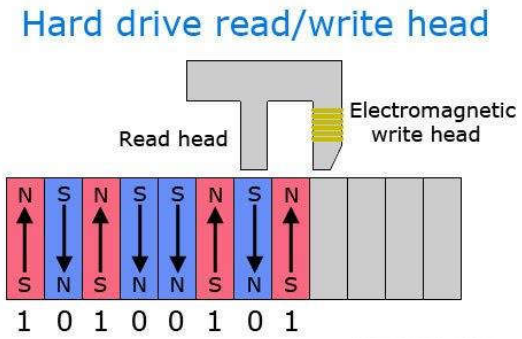

FIG.1. Writing of data using magnetic field.[2]

The small size of sensor creates more complicacy which could be resolved by using multiferroic head sensors[3]. Magnetoelectric (ME) effect in multiferroic material is the best replica of MR materials. Magnetic memory data is written by switching the magnetization state by applying the external magnetic field. Reading of data by magnetic head exploit the change in magnetoresistance required more energy in the form of magnetic field to read the data. Hence, the multiferroic magnetoelectric materials open new path for read/write head and data storage. This problem can be resolved by using ME materials. Ferroelectric property of ME materials possess faster writing and energy efficient due to frequent change in polarization which can be use in ferroelectric random access memory application. The multifunctionality of the multiferroic ME materials can be apply for the multistage memory devices with electrical writing and magnetic reading operations[1]. This novel device can be design by using exchange bias phenomenon. The ferromagnetic and magnetoelectric have four combinations of memory states which use in the tunnel junction to resolve the problems.

References

[1]A.Roy, R.Gupta and A. Garg, Advances In Condensed Matter Physics 926290,1-12(2012).
[2]. N.Ortega, A. Kumar, J. F. Scott, R. S. Katiyar, J. Phys.: Condens. Matter 27, 504002- 504039(2015).
[3].H. Palneedi, V.Annapureddy, S. Priya, J. Ryu, Actuators 5, 1-33(2016)

The Mystery of the Quantum World

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Let us start our journey back to the foundation of quantum physics. The essential need of some revolutionary change in Thomsan's classical model led to the emergence of famous and path breaking idea of Niels Bohr. His idea was if the electromagnetic energy of light is quantized- that is restricted to definite portions of one, two, three, or more light quanta- is not it reasonable to assume that the mechanical energy of atomic electrons is quantized, too, that it can assume only a discrete set of values, the intermediate values being prohibited by some yet undiscovered law of nature. Rutherford's α-scattering experiment stood in direct contradiction of what would be expected based on Thomsan's atomic model. The theoretical impossibility of the experimentally proved Rutherford model of an atom resonated with Bohr's feeling that if the em energy is quantized, mechanical energy must be quantized too. In fact, when an atom is emitting light quantum with the energy hv, its mechanical energy must decrease exactly by this amount. Since the atomic spectra consist of a series of discrete, sharply defined lines, the energy differences between various possible states of an atom must also have sharply defined values, and so must the absolute energies of these states themselves. This leads to the idea that atomic mechanism is somewhat similar to an automobile gearbox. This constitutes the whole idea behind Bohr's formulation. Then come in the scenario L. de Broglie. Being a connoisseur of chamber music, he chose to look at an atom as some kind of musical instrument that, depending on the way it is constructed, can emit a certain basic tone and a sequence of overtones. Since by that time Bohr's electronic orbits were fairly well established as characterizing different quantum states of an atom, he chose them as a basic pattern for his wave scheme. He imagined that each electron moving along a given orbit is accompanied by some mysterious 'pilot waves' (now known as de Broglie waves) spreading out all along the orbit. The first quantum orbit carried only one wave, the second two waves, the third three, etc. Thus the length of the first wave must be equal to the length of the first quantum orbit, the length of the second wave must be equal to the half of the length of the second orbit. In general, the nth quantum orbit carries n waves with the (1/n)th length of the orbit each. The results given mathematically by his theory is equivalent to Bohr's original quantum condition and brings in nothing physically new-nothing, that is but an idea: the motion of the electrons along Bohr's quantum orbits is accompanied by mysterious waves of the lengths determined by the mass and the velocity of the moving particles. If these waves represented some kind of physical reality, they should also accompany particles moving freely through space, in which case their existence could be checked by direct experiment. In fact, if this motion of electrons is always guided by de Broglie waves, a beam of electrons under proper conditions should show diffraction pattern. This has been proved simultaneously by Sir George Thomson in England and G. Davisson and L. H. Germer in the U.S.A.

Creating the revolutionary idea that the motion of atomic particles is guided by some mysterious pilot waves, de Broglie was too slow to develop a strict mathematical theory of this phenomenon, and, in 1926, about a year after his publication, there appeared an article by an Austrian physicist, Erwin Schrödinger, who wrote a general equation for de Broglie waves and proved its validity for all kinds of electron motion. While de Broglie's model of the atom resembled more an unusual stringed instrument, or rather a set of vibrating concentrical metal rings of different diameters, Schrödinger's model was a closer analogy to wind instruments; in his atom, the vibrations occur throughout the entire space surrounding the atomic nucleus. This kind of vibrations was studied in theoretical acoustics many years ago, and, in particular, Hermann van Helmholtz in the last century. The equation written by Schrödinger for de Broglie's waves is very similar to the well-known wave equations for the

propagation of sound and light (i.e. em waves) waves, except that for a few years there remained the mystery of just *what was vibrating*. Simultaneously with the Schrodinger paper on wave mechanics in the *Annalen der physik,* a paper by Werner Heisenberg dedicated to the same subject and leading to exactly same results. They started from entirely different physical assumptions, used entirely different mathematical methods, and seemed to have nothing to do with each other.

Schrödinger visualized the motion of atomic electrons as being governed by a system of generalized three-dimensional de Broglie waves surrounding the atomic nucleus, whose shapes and vibration frequencies were determined by the field of electric and magnetic forces. Heisenberg, on the other hand, devised a more abstract model. He treated the atom as if it were composed of an infinite number of linear 'virtual' vibrators with frequencies coinciding with all possible frequencies that the atom in question could emit. Thus, whereas in Schrödinger picture the emission of a spectral line with the frequency $\nu_{m,\ n}$ was considered a 'cooperative result' of two vibration functions $\Psi_m$andΨ_n. inHeisenberg's model the same spectral line was emitted by an individual vibrator which we may call $V_{m,n}$. The unexpected identity of the results either obtained by Schrödinger's wave mechanics and Heisenberg's matrix mechanics, which seemed to have nothing in common in physical assumptions or in mathematical treatment, was explained by Schrödinger in one of his subsequent papers. He succeeded in proving that his wave mechanics was mathematically identical with Heisenberg's matrix mechanics and in fact, one could derive either from the other. In spite of the fact that the new quantum theory either in wave-or-matrix form, gave a perfect mathematical description of atomic phenomena, it failed to illuminate the physical picture. What physical meaning should be ascribed to these mysterious waves, to these baffling matrices?

Since in atomic and nuclear physics the notion of classical linear trajectories inevitably fails, it is apparently necessary to devise another method for describing the motion of the material particles. Here Ψ-functions come to our aid. They do not represent any physical reality. The de Broglie waves have no mass such as we find in the case of electromagnetic waves, and whereas, in principle, one can buy half a pound of red light, there does not exist in the world an ounce of the de Broglie waves. They can be described as 'widened mathematical lines'. They guide the motion of particles in quantum mechanics in the same sense as the linear trajectories in the classical mechanics. However, as we do not consider the orbits of planets in the Solar System as some kind of railroad tracks that force Venus and Mars and our Earth to move along elliptical orbits, we may not consider the wave-mechanical continuous functions as some field of forces, which influences the motion of electrons. The de Broglie-Schrödinger wave functions (or rather, the square of their absolute values) just determine the *probability (Born's probabilistic interpretation)* that the particle will be found in one or another part of space and will move with one or another velocity.

The mechanistic worldview of classical physics was based on the notion of solid bodies moving in empty space. This notion is still valid in the region that has been called the 'zone of middle dimensions', where classical physics continues to be a useful theory. Both the concepts- that of empty space and that of solid material bodies are deeply ingrained in our habits of thoughts, so it is extremely difficult for us to imagine a physical reality where they do not apply. And, yet this is precisely what modern physics forces us to do. The concept of solid objects was shattered by atomic physics, the science of the infinitely small.

At the turn of the century, several phenomena connected with the structure of atoms and inexplicable in terms of classical physics were discovered. The first indication that atoms had some structure came from the discovery of X-rays; soon after their discovery, other kinds of radiation were discovered which are emitted by the atoms of so-called radioactive substances. The phenomenon of radioactivity gave definite proof of the composite nature of atoms, showing that the atoms of radioactive substances not only emit various types of radiation, but also transform themselves into atoms of completely different substances.

When Rutherford bombarded atoms with these alpha particles, he observed that the atoms turned out to consist of vast regions of space in which extremely small particles- the electrons-moved around the nucleus, bound to it by electric forces. Soon after the emergence of this 'planetary' model of the atom, it was discovered that the number of electrons in the atoms of an element determine the element's chemical properties. The interaction between the atoms gives rise to the various chemical processes, so that all of chemistry can now in principle be understood on the basis of the laws of atomic physics.

These laws, however, were not easy to recognize. Every time the physicist asked nature a question in an atomic experiment, nature answered with a paradox, and the more they tried to clarify the situation, the sharper the paradoxes became. It took them a long time to accept the fact that these paradoxes belong to the intrinsic structure of atomic physics, and to realize that they arise whenever one attempts to describe atomic events in the traditional terms of physics. Once this was perceived, the physicists began to learn to ask the right questions and to avoid contradictions. In the words of Heisenberg, 'they somehow got into the spirit of the quantum theory'. Finally, they found the precise and consistent mathematical formulation of this theory. The concepts of quantum theory were not easy to accept even after their formulation. Now quantum theory made it clear that even these particles were nothing like the solid objects of classical physics. The subatomic units of matter are very abstract entities, which have a dual aspect. Depending on how we look at them, they appear sometimes as particles, sometimes as waves; and this dual nature is also exhibited by light, which can take the form of electromagnetic waves or of particles.

This property of matter and of light is very strange. It seems impossible to accept that something can be, at the same time, a particle-i.e. an entity confined to a very small volume-and a wave, which is spread out over a large region of space. The whole development stared when Max Planck discovered that the energy of heat radiations is not emitted continuously, but appears in the form of 'energy packets'. Einstein called these energy packets 'quanta' and recognized them as a fundamental aspect of nature. He was bold enough to postulate that light and every other form of em radiation can appear not only as waves, but also in the form of these quanta.

At the subatomic level, matter does not exist with certainty at definite places, but rather shows 'tendencies to exist', and atomic events do not occur with certainty at definite times and in definite ways, but rather shows 'tendencies to occur'. In the formalism of quantum theory, these tendencies are expressed as probabilities and are associated with mathematical quantities, which take the form of waves. This is why particles can be waves at the same time. They are 'probability waves'. We can never predict an atomic event with certainty; we can only say how likely it is to happen.

At the subatomic level, the solid material objects of classical physics dissolve into wave-like patterns of probabilities, and these patterns, ultimately, do not represent probabilities of things, but rather probabilities of interconnections. A careful analysis of the process of observation in atomic physics has shown that the subatomic particles have no meaning as isolated entities, but can only be understood as interconnections between the preparation of an experiment and the subsequent measurement. Quantum theory thus reveals a basic oneness of the universe. It shows that we cannot decompose the world into independently existing smallest units. As we penetrate into matter, nature does not show us any isolated 'basic building blocks', but rather appears as a complicated web of relations between the various parts of the whole. These relations always include the observer in an essential way. The human observer constitutes the final link in the chain of observational processes, and the properties of any atomic object can only be understood in terms of the object's interaction with the observer. This means that the classical ideal of an objective description of nature is no longer valid. In atomic physics, we can never speak about nature without, at the same time, speaking about ourselves. The mystery continues, but it is time to stop and think again will this mysterious journey of a century ever unravel itself?

REFERENCES:

[1]. L. D. Landau and E. M. Lifshitz**,** Quantum Mechanics,Butterworth-Heinemann; Elsevier, third edition(Reprint), 2017.

[2]. Werner Heisenberg**,** The Physical Principlesof Quantum Theory, Dover Publication, Inc. New York, Republished version, 1930.

[3]. Max Born**,** Atomic Physics, Dover Publications, Inc. New York, Eighth edition, 1969.

[4]. Max Planck**,** The Origin and Development of the Quantum theory, Oxford Univ. Press, 1922.

[5]. George Gamov**,** Thirty Years That Shook Physics, Dover Publication, Inc. New York, 1985.

A Breakthrough for Better Understanding of Gravitational Fields

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Very recently on 26th July, 2018 from the report of Agence France Presse, an international news agency headquartered in Paris revealed that a group of astronomers confirmed the Einstein's key theory of general relativity was right. They observed the gravitational effects of a supermassive black hole on the zipping star passed by it. Their observation confirmed for the first time the prediction of Albert Einstein's theory of general relativity. Einstein's assumptions for the general theory of relativity were:

1. Nature's law holds equally for different frames of references (where acceleration is taken into consideration).
2. Gravitational mass is equivalent to inertial mass.

Properties following the general theory of relativity like bending of light due gravity were posited by this great physicist. As the pitch of the sound wave changes to an observer due to his varying distance with respect to the sound source, similar relations were put for the light that the much large gravitational force could stretch light like the stretching and compression of sound wave take place.

Black hole is one such region in space having intensely high gravitational field such that no matter or radiation can escape ditching it.One such black hole named Sagittarius A^* (Sgr A^*) has a mass 4 million times that of the sun sits at the center of our galaxy, 26,000 light-years from Earth. This black hole is surrounded by a star cluster – the S stars – which attains the mind-boggling speeds when they approach the hole. Astronomers followed one such star names S2 on May 19, 2018 moving with the speed of 25 million km per hour. Its velocity and position were then calculated using a number of instruments and compared with the Einstein prediction of stretching of light by gravity, an effect called gravitational redshift. On the other hand Newtonian mechanics does not support such phenomena of redshift.

Researchers have been benefitted as they can use it to peer behind the black hole. "*I am blown away by Einstein's predictions, by the power of his reasoning which yielded this theory and which has never been faulted*," French astrophysicist Guy Perrin, a member of the consortium, said.

Astronomers used three very large telescope (VLT) named NACO, SINFONI, and more recently GRAVITY[1] to follow the star S2 and were able to detect the gravitational redshift as predicted by Einstein. GRAVITY with the resolution of 50 micro arcseconds: corresponds to the angle at which if a tennis ball be placed on the moon would be visible from Earth. This accuracy made it possible to detect the hour-by-hour movement of S2 as close as possible to the black hole. When S2 passed by Sgr A^* at a distance just 120 times that of the Earth from the Sun, attained an orbital velocity of 8000 km/s: 2.7 % of the speed of light. These extreme conditions subjected S2 star to the effects of general relativity. In the phenomena of redshift, light sources in a gravitational field get affected and a shift in wavelength towards the red part of the spectrum happens which is detected by a measuring instrument. And this was the first time such an effect was measured due to the gravitational field of the black hole. Such information can even help understanding the mass distribution around the black hole.

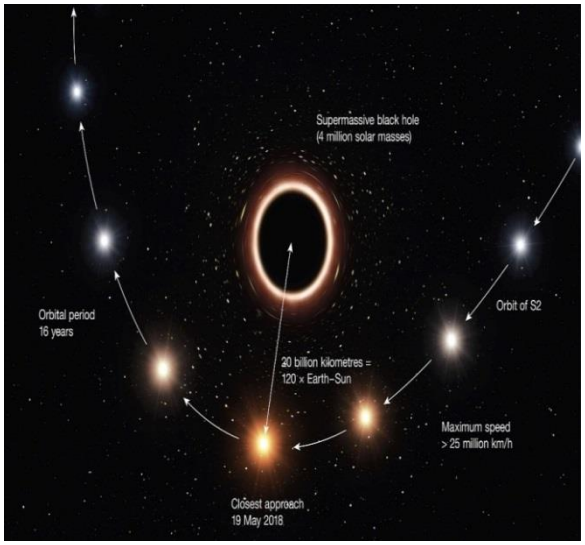

Fig.1 Arrows shows the path of the star S2 as it passes very close to Sagittarius A, a supermassive black hole at the centre of the Milky Way. As S2 got closed to the blackhole, due to its strong gravitational field the color of the star shifted slightly to red, an effect of Einsterin's general thoery of relativity.

These results were obtained by the GRAVITY consortium, led by the Max Planck Institute for Extraterrestrial Physics (MPE) in Germany and also involving the CNRS, the Paris Observatory (PSL), the Université Grenoble-Alpes and several French universities. These findings, the culmination of 26 years of observations using telescopes at the European Southern Observatory (ESO) in Chile, were published by the GRAVITY consortium on 26 July 2018 in *Astronomy & Astrophysics*.

1. GRAVITY is a second-generation Very Large Telescope Interferometer (VLTI) developed by The GRAVITY consortium.

REFERENCES:

[1]"Detection of the Gravitational Redshift in the Orbit of the Star S2 near the Galactic Centre Massive Black Hole", GRAVITY Collaboration, Astronomy & Astrophysics, July 2018. DOI: 10.1051/0004-6361/201833718.

[2].https://www.thehindu.com.https://www.eso.org/public/images/eso1825b/

Solar Energy for Sustainable Future

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According to one estimate world uses approximately $19*10^{15}$Wh/year of continuous power each year and 1.2% area of the Sahara desert [1] covered with solar cell could provide the entire world with all its electrical needs. In simpler words a intercontinental grid connecting all the seven continents distributing energy produced in dessert of Sahara could possibly eradicate energy deficiency in the word. Such conceptual mammoth grid power distribution has its challenge on economical, technological and more so political front. For India it can be implemented as we have Thar Desert which receives 300 days in a year, more than 6 hours a day's sun shine. Taking and approximated Per capita electricity = 1075kWh/year. Total electrical energy consumed is $1.4*10^{15}$Wh/year. To generate this much energywith 15% Efficiency solar cell panel we will require an area of approximately ~ 80*80 km^2 roughly 0.2 % area of country. Thus covering one desert district of Thar region can do the job. Installing solar panel on such scale will be requiring huge capital.

Having environmental advantage on its side Photovoltaic still need to fight cost war for standing a chance against convention energy sources. Lowering the cost is the immediate demand in solar cell field. Cost/Watt is the metric for competitive and acceptability in market. Realizing a solar cell technology incorporating abundant material, with simple techniques could lower the cost and solve the pollution issue associated with energy generation. A host of materials are engineered for application in solar cell including organic material, Plant extract dyes, inorganic material, hybrid organic-inorganic, and semiconductor and compound semiconductors. Techniques as simple as painting are optimized for making new solar cells. Some of most common material like Iron, Copper, Zinc, Tin, Oxygen are taken up for making solar cell devices. Suitable bandgap engineering for enabling them to absorbs more sunlight. These low cost and ambient materials will not only lower cost but also expected to increase life of device. These simple cost lower techniques leave a big void for efficiency enhancement. As we already knew maximum efficiency could go up to 86%, therefore photovoltaic is a field where we can take out as much as we can apply our trick and genius.

Ferroelectric RAM: An Emerging Nonvolatile Memory Technology

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Currently, there are several types of memories devices available in the microelectronic industries for different kind of applications. Generally, memories are broadly divided in to two categories, i.e. volatiles and non-volatiles memories. Volatiles memories are those in which the data is lost after the power remove from the electronic system including dynamic RAM (DRAM) and static random access memory (SRAM). DRAM is an inexpensive memory and can easily retain the data by regularly refreshing its contents with stored data. Therefore, it can be used for large storage capacity systems. However, the speed of SRAM (read and write time) is faster than DRAM and, does not required any refreshing. But, the size of SRAM is more than DRAM. Hence, it is used in small and medium storage capacity applications.

On the other hand, the non-volatile memory can retain the data even when the power is interrupted. The non-volatile memory is divided into two types. One is read only memory (ROM) which can only read the data. Another is random access memory (RAM), which has the ability to read and write the data. Ferroelectric Random access memory (FRAM) is a non-volatile Random access memory as ROM, but it has feature like RAM. It has better features as compare to DRAM such as lower power usage; faster writing performance and large number of write and erase cycles. The operating speed is comparable with the DRAM. The idea of the FRAM was first presented by the researcher in the Bell Laboratory in 1955. In their patents, various structures consist of ferroelectric thin films with semiconductors were proposed and a prototype of ferroelectric gate field effect transistor (FFET) was introduced. In the meantime, FRAM was proposed around 1980, in which the data are stored by the electrical polarization direction in the ferroelectric capacitors and, read out the data using the reversal polarization current. The FRAM was more stable than the FFET. The reliability of the FRAM was further improved by optimization of the deposition condition of the ferroelectric thin films. The FRAM is basically divided into two categories: capacitor type FRAM and FET- type FRAM. The schematic structural diagram of the FRAM is shown in the Figure 1. The structure is similar to DRAM expect the addition of the bit line (BL) and the word line (WL).

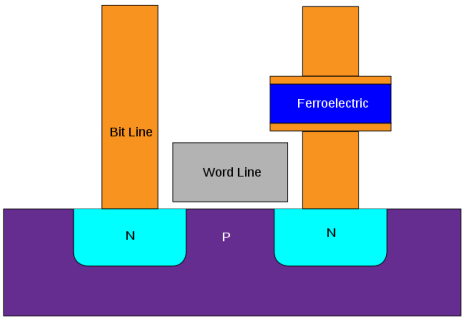

FIG. 1. Schematic structure of the FRAM

In the capacitor type of FRAM cell, the data are stored by the polarization direction of the ferroelectric thin film and read out by using the reversal polarization current. Therefore, the optimization of the material properties is required to enhance the performance of the device. The different parameters (such as P_r: remanent polarization, E_c: Coercive field) of the ferroelectric thin film should intensively

analyzed. The general hysteresis loop of the ferroelectric material is shown in the Figure 2.

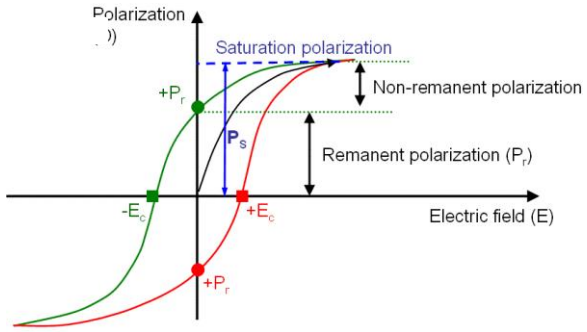

FIG. 2. Schematic diagram of Ferroelectric hysteresis loop

The following characteristics are required for the ferroelectric thin film to use in the FRAM. The remanent polarization should be large such that large reversal polarization current can be derived from the small area capacitor. The dielectric constant should be low, because the large dielectric constant material creates high displacement current which hinders the detection of the reversal polarization current. The coercive filed should be low for low voltage operation. Degradation of the ferroelectric thin film should be low as possible, which affect the overall performance of the device during the operation. There are several materials have been used in the FRAM fabrications such as PZT, SBT, (Bi, La)$_4$Ti$_3$O$_{12}$ (BLT). Currently, the market of FRAM is continuous increasing rapidly due to its better performance as compare to existing technologies. Several companies (i.e. Fujitsu (Japan), Texas Instruments (USA) etc.,) have initiated the fabrication of the ferroelectric random access memory (FRAM) devices.

REFERENCES:

[1]. Hiroshi Ishiwara, Ferroelectric Random Access Memories, Journal of Nanoscience and Nanotechnology, 12, 7619–7627, 2012.

[2]. H. Kohlstedt, Y. Mustafa, A. Gerber, A. Petraru, M. Fitsilis, R. Meyer, U. Böttger and R Waser, Current status and challenges of ferroelectric memory devices, Microelectronic Engineering 80 (2005) 296–304.

[3]. Yoshihisa Kato and et al, Overview and Future Challenge of Ferroelectric Random Access Memory Technologies, Japanese Journal of Applied Physics 46, 4B, 2007, 2157–2163.

Emergency Committee of Atomic Scientist

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To start with I want to quote some parts of the final speech of Charlie Chaplin from his famous film 'The GreatDictator',

"...We all want to help one another. Human beings are like that. We want to live by each other's happiness - not by each other's misery. We don't want to hate and despise one another. In this world there's room for everyone and the good earth is rich and can provide for everyone. The way of life can be free and beautiful, but we have lost the way. Greed has poisoned men's souls - has barricaded the world with hate - has goose-stepped us into misery and bloodshed. We have developed speed, but we have shut ourselves in. Machinery that gives abundance has left us in want. Our knowledge has made us cynical, our cleverness, hard and unkind. We think too much and feel too little. More than machinery we need humanity. More than cleverness, we need kindness and gentleness. Without these qualities, life will be violent and all will be lost..."

With the progress of science and technology, the abuse of it took its shape parallelly. With its tremendous reward mankind was able to know how to use the fire, how to make far places nearer, how to live in a safer place and so on and so forth. Keeping pace with time it moves forward to the society where we belong now. It is for the upliftment of standard of living, not for destruction. The misleading of science can cause a severe damage to the society. The atomic bombing on Hiroshima and Nagasaki on 6th and 9th August'1945 bears the evidence of it. At that time the whole world was engaged in saber rattling. Many scientists stood against this barbaric situation. One of these attempts to promote peace worldwide was the foundation of 'Emergency committee of atomic scientist (ECAS)' by Prof. Albert Einstein and Prof. Leo Szilard in the year 1946. Along with them Prof. Harold Urey, Prof. Hans Bethe, Prof. Thorfin Hoggness, Prof. Philip Morse, Prof. Victor Weisskopf and Prof. Linus Pauling were the members of this committee[1].

The common people were unaware of ill effect of atomic bombing until two atomic bombs were dropped. The soul motto of this committee was to inform general public about the international policy and make them aware of how much catastrophe atomic weapon can do. The committee made a list called 'Statement of purpose' which is as follows,

1. Atomic bombs can now be made cheaply and in large number. They will become more destructive.
2. There is no military defense against atomic bombs, and none is to be expected.
3. Other nations can rediscover our secret processes by themselves.
4. Preparedness against atomic war is futile and, if attempted, will ruin the structure of our social order.
5. If war breaks out, atomic bombs will be used, and they will surely destroy our civilization.
6. There is no solution to this problem except international control of atomic energy and, ultimately, the elimination of war[1,2].

After its formation ECAS became a part of'Federation of American Scientists' which was an organization formed by scientists related to Manhattan Project with the agenda to make the world a secure place. ECAS also asked for support to 'National Committee of on Atomic Information', a group of 60 American national organization whose motto was the better communication between atomic scientists and the public.[1]

In a telegram Prof. Albert Einstein said, "*Our world faces a crisis as yet unperceived by those*

possessing power to make great decisions for good or evil. The unleashed power of the atom has changed everything save our modes of thinking and we thus drift toward unparallel catastrophe." He realized that "*A new type of thinking is essential if man is to survive and move to higher levels.*" [3] So he paid more attention on proper education and make people aware about atomic power rather than proposing in change in Government policy. To do so a bulk amount of money was needed. He appealed to the several hundreds Americans to make of $ 200,000 fund for campaigning, lecture tours, to warn people against atomic war and consequences of extreme nationalism. He sent letters in many languages to student groups, social organizations, educational organizations, science organizations and so on and to individuals in more than sixty countries for sharing discussions on mutual issues. The committee was able to collect huge fund and was successful to some extend to achieve their goals. The committee made several films. They also organized conferences with the agenda of creation of world government. However their main focus was intact.[1]

After 5 years of activity ECAS was finally disbanded in the year 1951, leaving a great impact and ethical values of Science to the society. According to Prof. Linus Pauling in his book 'No more war!' the cause of cease of this committee was mainly lack of funds in those years and the strain on Prof. Einstein. Prof. Pauling said, "*Perhaps my own work for world peace would not have been very effective if I had not been invited to become a member of the board of trustees of the Emergency Committee of Atomic Scientists … Before then, I had made some public talks about nuclear weapons and nuclear war; but it was Einstein's example that inspired my wife and me to devote energy and effort to pacifist activities.*"[1]

Time passes, Science and technology advances over time, but situation has not changed. The saber rattling is still going on. The Government is keeping main focus on nuclear weapon rather than all round constructive development. It's time to ask ourselves whether we want peaceful use of science or the destruction, after millions years of civilization will we let the system which produces those *'unnatural men - machine men with machine minds and machine hearts!' to* destroy the whole world with a single button or resist the evil power to create a peaceful place for our successor, will we support war or stand by 'International Campaign to Abolish Nuclear Weapons (ICAN)'.

REFERENCES

[1]. The Pauling Blog (https://paulingblog.wordpress.com/2010/08/04/the-emergency-committee-of-atomic-scientists/)
[2]. *Nature* **159**, 837 (21 June 1947)
[3]. Turn The Tide (http://archive.is/Azpg)

Graphene: The Wonder Material

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Carbon is the richest element in the periodic table that has lots of its allotropic form which exist in all dimensions. Diamond and graphite is its allotropes in three dimensional forms (3D), carbon nanotube which is 1D allotrope of carbon and even its 0D also exist in nature in the form of fullerene. What about 2D allotrope form of carbon? Does it exist? These types of thoughts always came into the mind of all researchers who had worked on carbon allotropes. Many scientists were theorized about the graphite single layer but they didn't come into the conclusion, finally in 2004, the 2D allotropic form also exists in nature in the form of graphene, when a single layer of graphite was extracted. This was totally an accidental discovery by Andre Geim and Konstantin Novoselov at the University of Manchester. This discovery led them to the winning of Nobel Prize in Physics in 2010 for groundbreaking experiments regarding the two-dimensional material graphene.

Graphene has honeycomb like structure in which three sp^2 hybridized σ states arrange themselves in x-y plane and the angle between the two adjacent states is 120° which makes the hexagonal geometry of graphene and make it stable material. The P_z orbital (i.e, π-state) aligned in the z-direction. The electrons in this orbital are loosely bound and hence hop easily into the nearest neighbor atoms. Graphene has created great interest due to its unique electronic properties viz. the linear band structure. This linear band structure shown, unlike metals and semiconductors, allows smooth transition of the Fermi energy from the hole-side to the electron-side by the simple application of voltages on the gate dielectric. The bulk of the research work done on graphene based systems highlights the charge transport properties in the system like the quantum Hall regime, Klein tunnelling. While the gate tunability combined with ultra-high mobility (200000 cm^2/Vs) at room temperature is the key parameter for many novel applications. These properties of graphene make it very wonder material in the physics. The optical, electrical and mechanical properties are totally unexpected in the comparison of other existing materials.

It has been proposed that the 2D material has superior properties in comparison to their bulk counterpart and graphene is the one of the best example for this statement. After the discovery of graphene, around 700 2D materials have been predicted to be stable and most of them are synthesized. Hence we say that Graphene opens the new field in the research for other researchers. According to the report, the global market for graphene is expected to reach around US$360 million by 2025, because the graphene is now going to be use in many electronic devices, battery energy, and composites markets and so on. Graphene is going to be used in products that we used in our daily life. So we can say that the graphene quickly become the wonder material in the field of physics just due to its fascinating properties and also very easy to handle.

Laser-Induced Breakdown Spectroscopy (LIBS)

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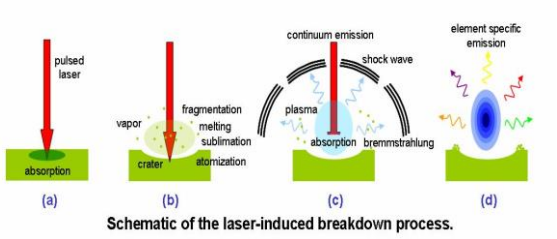
Laser-induced breakdown spectroscopy (LIBS) is a relatively new version of atomic emission spectroscopy made possible with the invention of the laser. It is also known as laser induced plasma spectroscopy (LIPS). This phenomenon was first reported in 1963 by Maker et al. This analytical technique is based on optical detection of certain atomic and molecular species by monitoring their emission signals from the laser-induced plasma. The LIBS technique has demonstrated a unique versatility: little or no sample preparation, fast, remote and real-time analysis.

In the laser-induced breakdown spectroscopy (LIBS) an intense laser beam is focused on the surface of a target which generates a micro plasma. This process is divided in to three regions, (i) interaction of the laser beam with the target material resulting in the evaporation of the surface layers; (ii) interaction of the evaporated material with the incident laser beam resulting in an isothermal plasma formation and expansion; and (iii) anisotropic adiabatic of the laser pulse, whereas the last regime starts after the termination of the laser pulse.This is schematically shown in figure below:



Schematic of the laser-induced breakdown process.

When the laser power density exceeds the breakdown threshold value of the solid surface plasma emission occurs. Although different materials have different breakdown thresholds, an optical plasma is produced when the laser power density exceeds several megawatts per centimetre squared (10^6- 10^9W/cm^2). This plasma has been used for sampling, atomization, excitation, and ionization in analytical atomic spectroscopy.

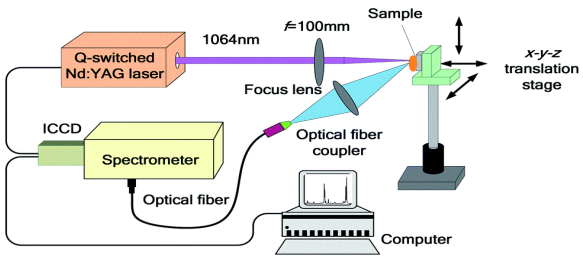


Figure 1: Schematic of laser induced breakdown spectroscopy setup

A typical LIBS system consists of a pulsed laser system and a spectrometer with a wide spectral range and a high sensitivity, fast response rate, time gated detector. This is coupled to a computer which can rapidly process and

interpret the acquired data. As such LIBS is one of the most experimentally simple spectroscopic analytical techniques, making it one of the cheapest to purchase and to operate. The LIBS plasma is weakly ionized plasma in which the ratio of electrons to other species is small .The formation of laser induced plasma on a metal target in an ambient gas depends on different parameters like laser wavelength, laser power density, surface state and nature, gas pressure and nature, and interaction geometry. Many spectroscopic tools like emission spectroscopy, laser induced fluorescence, absorption spectroscopy, mass spectroscopy, ion probe method, Michelson interferometry etc are used for the characterization of the photo fragmented species in plasma. Of these the nonrestrictive methods to study the laser plasmas are mass spectrometry and optical emission spectrometry.Opticalemissionspectroscopictechniqueisconcernedwiththelightemittedby electronically excited species in laser induced plasma produced in front of the target surface. Also optical emission measurements are useful for species identification and in situ monitoring during deposition. Useful information about the elemental composition of the target material can be obtained from the analysis of the emissions emanating from the plasma plume.

Applications of Laser Induced Breakdown Spectroscopy:

LIBS has been applied to various fields such as metallurgy, environmental problems, organic molecules, solution or colloidal phase, combustion processes, nuclear industry, and geology. Among the applications of LIBS, elemental composition analysis of metallurgical samples has been the most popular. Recent applications, however, are more inclined to environmental samples and liquid samples which include biological specimens. The range of potential applications is unequalled by any other analytical technique and is due to its many well-known advantages, which include simplicity, lack of sample preparation for the analysis of gases, liquids, and solids, simultaneous multi-element detection, ability to detect high and low z elements, good sensitivity for many elements, only optical access to the target is required standoff analysis capabilities. These advantages permit application of LIBS to real-world analysis needs that cannot be addressed by conventional analytical methods.

References:

1."Laser-induced breakdown spectroscopy (LIBS): fundamentals and applications" Andrzej W Miziolek; V Palleschi; Israel Schechter.

2.David A. Cremers & Rosemarie C. Chinni (2009) Laser-Induced BreakdownSpectroscopy—Capabilities and Limitations, Applied Spectroscopy Reviews, 44:6, 457-506, DOI:10.1080/05704920903058755

Science Poem: Part-on Model

Chalo aaj charcha karte hai axar ki gunja-isspr,
*Mile jo hamko naye **Kan** hain, prayogon ki aajma-iss pr.*
***Kanadi** ne bola akhand hai yah, khand na iska ho payega,*
*Dekhte hi **Parmanu** aa gya, **Kan** kahan tik payega.*

*Samay toh badla log na badle, khol di **Parmanu** ki kaya*
***Thamson** ne aa khbar kiya, **Parmanu** pr hai **Electron** ki saya.*
***Proton** ko khoja, **Neutron** bhi dekha, **sanrachana** ki khwahish pr,*
*Mile jo hamko naye hai, **Kan** prayogon ki aajma-iss pr.*

*Lagta tha **Proton** akhand hai, **Neutron** toh iska bhai hai,*
*Usi samay **Feynman** ne bola, suno yaar badhayi hai,*
*Bahut **Kanon** se milkar banta, yah nahi akela hai,*
***Proton** bana **Partanon** se, bahut bada ghamela hai.*

***Electron-Proton DIS,** ab yah dava karta hai,*
***Proton** bana hai **bindu-kanon** se, **Quarks** ko darshata hai.*
***Quark** ki sankhya six hai, iske **anti** bhi fix hai,*
***Valence** aur **Sea Quark** toh, ek duje ke mitra hai.*

Quark bana hai dono se, Anti-quark, Sea se banta hai,
Ab aate hai Proton pr jisme, teen ka khela rahta hai.
Up, Down, Strange hai ye, Proton na adbhut hota hai,
Charm, Bottom, Top chhor diya, inka Mass adhik hota hai.

***Up Down** kr na paate, **Proton sanveg** ka santulan,*
*Ab toh **Gluon** aa gaya hai, laker apni paltan.*
*Aadhe me **Quark** hai rahte, aadha **Gluon** ka hota hai,*
*Ab toh yah pol khul gayi, **Proton** me kya-kya hota hai.*

Yahi tak manav na ruka, apni iss farma-iss pr,
***Kan** me **Mass** kahan se aaya, janane ki gunja-iss pr.*
***Higgs** bolata aakar yah, mai **Mass** sabhi ko deta hun,*
Lekin ab toh prashn hai yah, mai kahan se leta hun.

Manav ne bhi than liya hai, uski koshish jari hai,
*Kahan se aaya **Higgs** yah,ab toh iski baari hai.*
*Manushya hai jigyashu itna, tb tk **Kan** ko todega ,*
Toot na jaye khud jb yah, tab hi isko chhorega.

Kan= Particle,

Sanveg=Momentum

Parmanu= Atom,

Sanrachana=Structure

bindu-kanon=Point-like Particles

Santulan =Balanced

Jigyashu=Eagerness

Adbhut=Strange

Axar=Akhand
=Unbreakable

***Gunja-iss** =Possibility,*

***Aajma-iss**=Attempt*

- ManavendraPratap Singh

'18 amps

Activities

Workshop on "Advances in Physics: From Concepts to Application-2017"

Department of Physics, Indian Institute of Technology Patna organized a workshop on 'Advances in Physics: From Concepts to Applications' on July 20-21, 2017. So far, Department of Physics, IITP has organized a number of workshops for school students and KV teachers, as part of the outreach activities of the department. We have got overwhelming response from students' feedback for these workshops.

This workshop, aiming B. Sc. and M.Sc. Students, was the first of its kind at IIT Patna. Total 40 selected students from different IITs, IISERs, Universities from all over the country have registered for the workshop. The venue of the workshop was R-102 of Block 09 (Tutorial Block) of IIT Patna, Bihta. Inaugural function of the workshop began at 9.30 AM on 20th July 2017 in R-102 of Tutorial block, IIT Patna with lighting of the lamp followed by institute song. Prof. P. K. Mukherjee, Professor, Ramakrishna Mission Vivekananda University and ex-senior Professor, Indian Association for the Cultivation of Science, Kolkata has graced the function as distinguished chief guest of the inaugural function.

Dr. Jobin Jose, Faculty Adviser of Physics Society introduced the workshop to the participants. Dr. Utpal Roy, Head, Department of Physics addressed the gathering with his encouraging words and introduced the department to the audience. Dr. Sanjoy Kumar Parida Acting Director, IIT Patna shared his words about the institute.

The Chief Guest, Prof. P K Mukherjee, addressed the audience and gave an inspiring lecture on "Advancement in atomic and molecular structure: A chronological development". His insightful oration took the audience through the evolution of atomic and molecular structural data evaluation and interpretation. The workshop will have lectures by faculty members of Department of Physics, IIT Patna on several fundamental and advanced level topics. There was also a session of research lab visit by the participants in the Department of Physics. Faculty members along with the research scholars have coordinated the session, which gave participants an insight about current research activities. The two-day workshop had its valedictory function on 21st July 2017 and Prof. Dolly Sinha, Pro-VC of Patna University, was the chief guest for the event. A report on the workshop was published in the Indian Science Cruiser (Vol. 31, No. 4, July 2017).

Fresher's day Celebration 2017-18

The 23rd of August 2017 and 14th September 2018 were marked as a memorable day for the fresher's as the Physics society celebrated the fresher's day in the department. The fresher's party was organized with a great fun and masti to enhance the fraternity among seniors and juniors. All the events were artistically and beautifully presented in colors as well as in style. The president of Physics society Mr. Jayanta Bera addressed the society and its activities to the newcomers. The audience was kept enthralled for three hours by mind blowing performances in the form of introductions from juniors, dancing, singing, mimicking etc. Seniors put up various stunning performances to entertain and encourage our juniors. Based on the performance from the juniors, Mr. Gaurav Pandey (Ph.D.) was crowned as "Mr. Fresher "and Miss. Pragya Tiwari (Ph. D.) as "Miss Fresher" in 2017 fresher party. Similarly Mr. Harshit Gauttam (M. Sc) and Miss Sherlin P James (M.Sc) were selected as "Mr. Fresher" and "Miss Fresher" of the year 2018 respectively. The evening was filled with joy, laughter, music, enthusiasm, excitement and happiness. The program concluded with vote of thanks followed by cake cutting ceremony and refreshment. The program ended leaving behind sweet memories that will be cherished lifelong.

Teachers' day Celebration 2017-18

In India, 5th September is celebrated as Teachers' day as a mark of tribute to the contribution made by teachers to the society. 5th September is the birthday of great Dr. Sarvapalli Radhakrishnan, a well-known diplomat, scholar, President of India and above all a renowned teacher. The program was organized under the banner of the Physics society, held in the block 9 of academic complex. The celebrations were set out with the felicitation of Dr. Sarvapalli Radhakrishnan followed by a divine group song invoking the blessings of God. The performance by the students on the stage exclusively for teachers was a memorable one. The students took great efforts and ensured that faculty members enjoy every minute of the program. On request of the students, the faculty members of the department addressed the gathering, enlightened the students with their vast experiences and congratulated for the celebration. The head of the department congratulated and praised the efforts of the students for organizing the Teacher's day. He enlightened the audience by reminding the role of the teacher as an integral part of the society for their immense contribution in the development of the individual as well as to the nation. Finally, the program came to an end with a cake cutting ceremony, a group photo session, and with small refreshment. The entire program was planned, arranged and executed by the students under the guidance of the faculty advisor of the Physics society.

National Science day Celebration 2018

National Science Day is celebrated in India on 28 February each year in order to commemorate the invention of the Raman Effect by Indian physicist Sir Chandrasekhara Venkata Raman on the same day in 1928. For his discovery, Sir C.V. Raman was awarded the Nobel Prize in Physics in 1930. To add excitement, this year marked the celebration of 125th birth anniversary of eminent physicist S. N. Bose. We are deeply privileged to announce that this year the national science day was organized in an outspread manner by the Physics Society, Department of Physics in the Senate hall, in administrative building. It was a whole day long program spanning over three sessions. The National Science day was celebrated to develop scientific spirit and to encourage scientific ideas among students, staffs and faculty members of the institute. Guests of honors of the day were Prof. Saurabh Basu (IIT Guwahati), Dr. R. K Kotnala (NPL Delhi) and Prof. Amitava Datta (University of Calcutta).

The program started with an opening lecture by Prof. Amitava Datta on "Symmetry and Supersymmetry. Prof. Saurabh Basu delivered an exciting lecture taking the audience through the life of S. N. Bose. It was followed by a small tea and snacks session. Dr. R. K Kotnala introduced the concept of the hydroelectric cell. Also, he demonstrated the process of energy generation through hydroelectric cell. A lecture competition was held just after the short break where all the research scholars of the department (2nd year onwards) vividly presented their research work within 5 minutes each. A lunch was arranged in front of the senate hall. Then, a poster presentation session among the research scholars was arranged and judged by our honorable guests and faculty members of the department of Physics. Finally, the certificate and prized distribution was held and follow by the valedictory session with vote of thanks.

Publication of '17 amps

The 6th April 2017 was the pride moment for all the members of the Physics Society. On this day, the first issue of the Physics Society magazine (*'17 amps*) was published in the presence of the chief guest Prof. P. C. Deshmukh (IIT Tirupati), Dr. Amarendra Narayan (Patna University), HOD Physics Dr. Utpal Roy, faculty advisor of the physics society Dr. Jobin Jose, president of the society Mr. Rajnish Kumar, faculty members of the department and students. Prof. Deshmukh delivered a lecture on GTR component of planetary precession. The students of the department actively participated in the inaugural ceremony of *'17 amps*. The contents of the magazine include the message of the HOD department of Physics, Faculty advisor of the society, and president of the physics society, twelve scientific articles, and different events of the society (i.e. workshop, fresher day, teacher day, national science day and weekly seminar).

Interaction with Prof. H. C. Verma

Physics society of the IIT Patna actively involves in arranging popular lectures of wide spectrum in the institute. Physics society invites eminent professors from different institutes and facilitates a platform for the students to interact and exchange ideas with them. The renowned Physics teacher and outstanding researcher of the country Prof. H. C. Verma visited the department of Physics on 7th August 2018 as a part of workshop for KV teachers. The Physics society arranged a direct interaction session of the student with the Prof. H. C. Verma. He discussed about his experiences in the academia and current teaching method in the educational system. Not to the surprise, he motivated immensely the young minds from different batches (B. Tech, M. Tech, M. Sc, Ph. D and Postdoc). A large number of the students form all the branches (Science & Engineering) actively participated and discussed with Prof. Verma. Finally, HOD physics Dr. Utpal Roy gave a memento to Prof. H. C Verma and concluded the interaction session. That evening, social media was flooded with photographs and selfies of students with Prof. Verma. A few photographs of the interaction session are given below.

Open House Discussion

There was an open house discussion among the students of the department and the faculty members. The interactive session included discussion on teaching methodology, course contents, facilities in the department and most importantly the future directions for the students. It was a truly inspiring session where faculty members wished the students best of luck in their learning endeavor and enlightened them to embark upon the journey of becoming dynamic students. The whole program was designed and arranged by the members of the Physics society department of Physics under the guidance of head of the department Dr. Utpal Roy.

Sports Meet

Sports in themselves are an indispensable part of the study. They are the sources of recreation. To get a relief and a sense relaxation in a life of monotony of routine marked by miseries, hardships, and hurdles, we, the society members have organized a number of sports events throughout the session. On 28th January, 1st and 10th February 2018, Physics society organized sports events which include badminton, table tennis and cricket. All the members of physics society have taken active participation such as students from M. Sc, M. Tech, Ph. D., staff, and teachers. Refreshment was served from the physics society fund and precious moment from the game has been captured.

On 28th –January, a cricket match was played among students, faculties and staffs. Singles, doubles and mixed doubles badminton matches were played from morning 10:00 a. m. to 1:30 p.m. Table tennis was scheduled on 1st February and chess and table tennis were on 10th Feb 2018. The event would not have been such a grand success without such an overwhelming participation from all. Thanks to the organizing team for arranging such wonderful events. We have enjoyed the rhyme and rhythm of physical might, concentration, and precision in those total three days.

Future Plans

1. Regular seminar activities by the students and outside visitors.
2. Arranging various conferences/workshops.
3. Publishing wall magazine.
4. Conducting different events: National Science day,
   Teachers day, Society sports meet, etc.
5. Implementing online member registration and creating digital forum.
6. Departmental Excursion

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General Body of Phyics Society

HoD-Physics:	Dr. Utpal Roy
Faculty Advisor:	Dr. Jobin Jose
President:	Mr. Lagen Kumar
Vice-President:	Mr. Barun Halder
General Secretary:	Mr. Nilanjan Kundu
Treasurer:	Mr. Gour Mohan Das
Sports and Cultural Committee	Mr. Ravichandra Pandey & Mr. Sumit Chahal
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Editorial Members:

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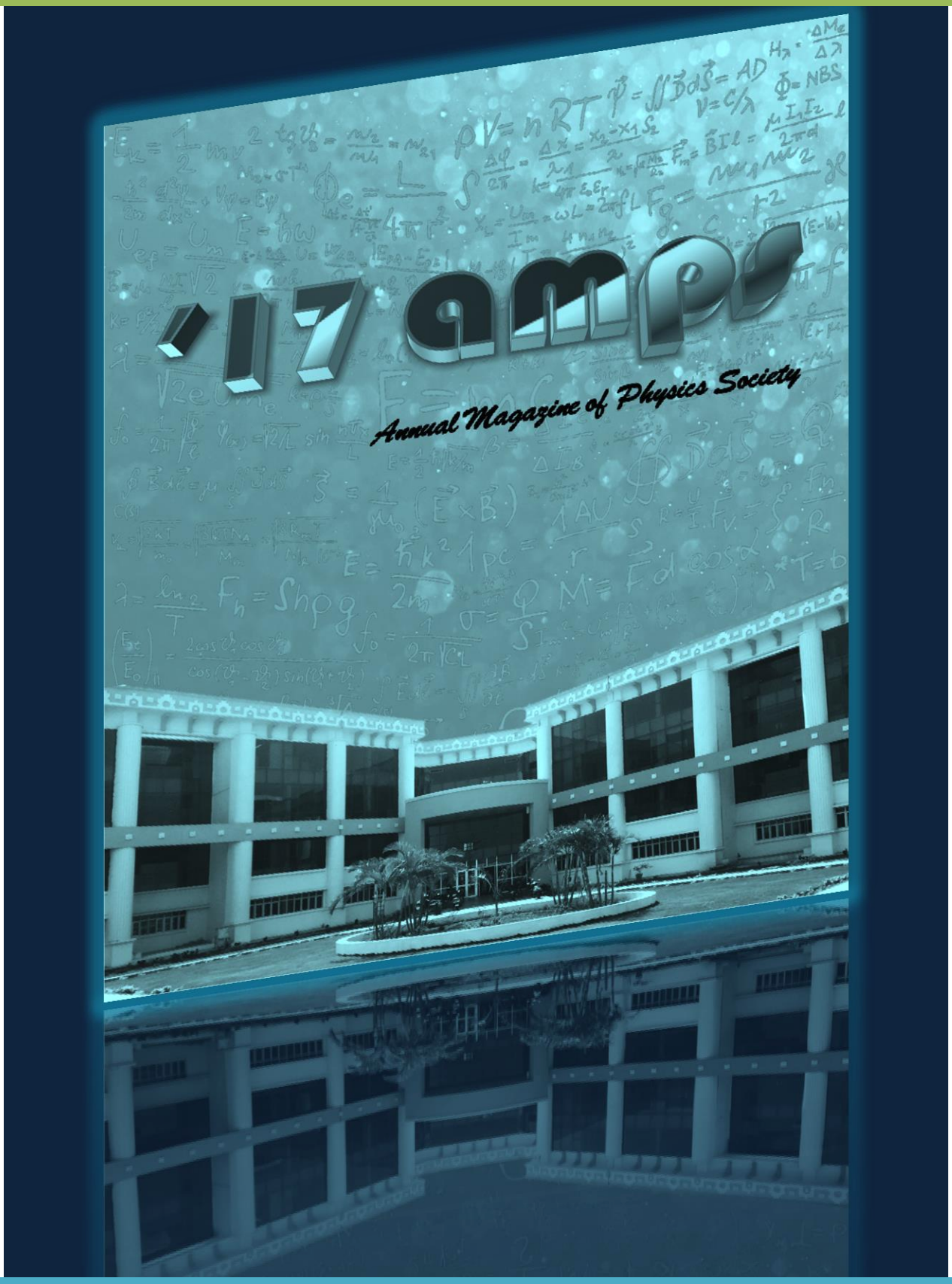
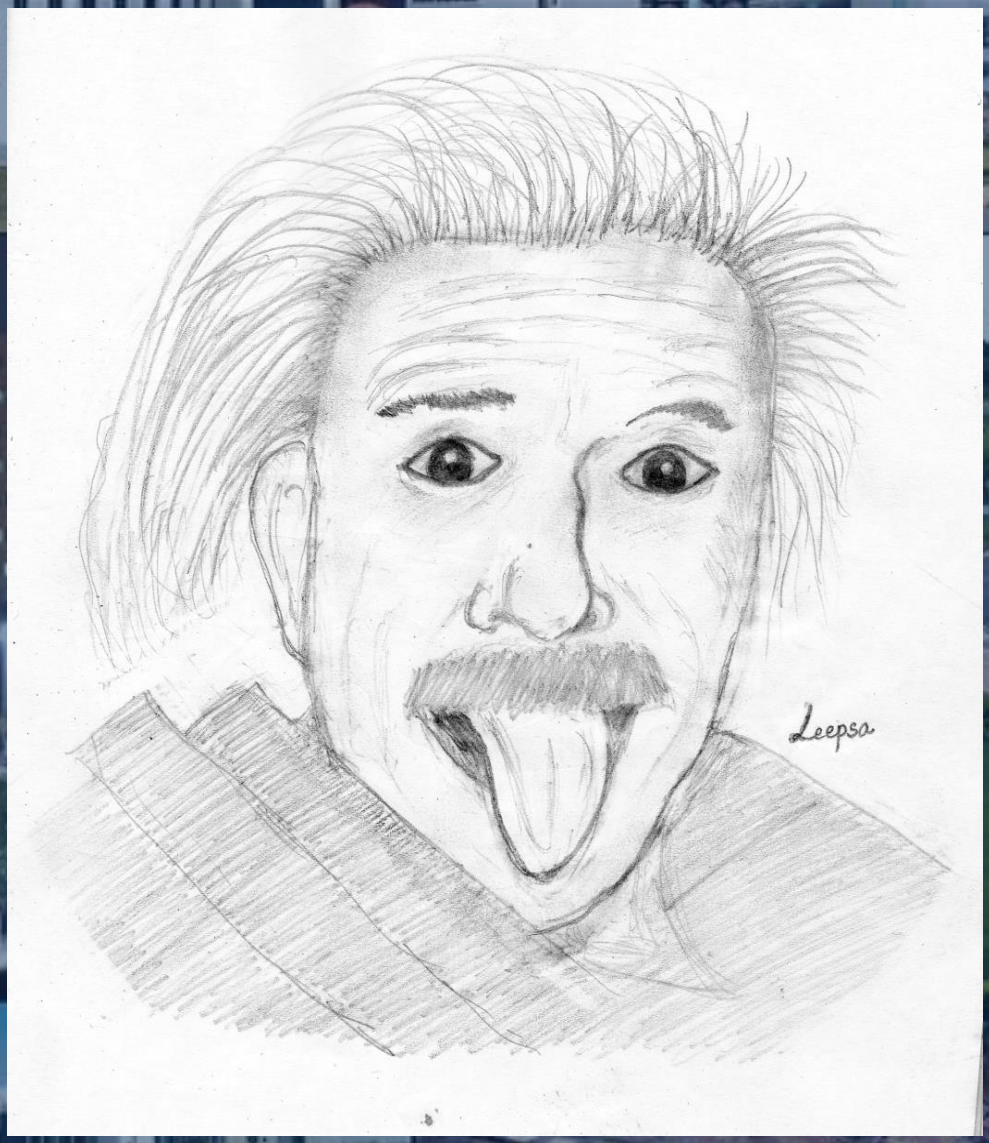
Mr. Vikash Singh Chauhan	Mr. Dixith M
Mr. Barun Halder	Mr. Ranjan Kumar Behera
Ms. Suman Kumari	Mr. Praveen Kumar
Mr. Nishant	Mr. Sumit Chahal
Mr. Rohit Kumar	Mr. Murli Kumar Mangalam

Former President of the Physics Society:

1. Mr. Rajnish Kumar [January (2016)- February(2017)]
2. Mr. Joyanta Bera [March (2017)- October (2017)]

From the gallery...





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