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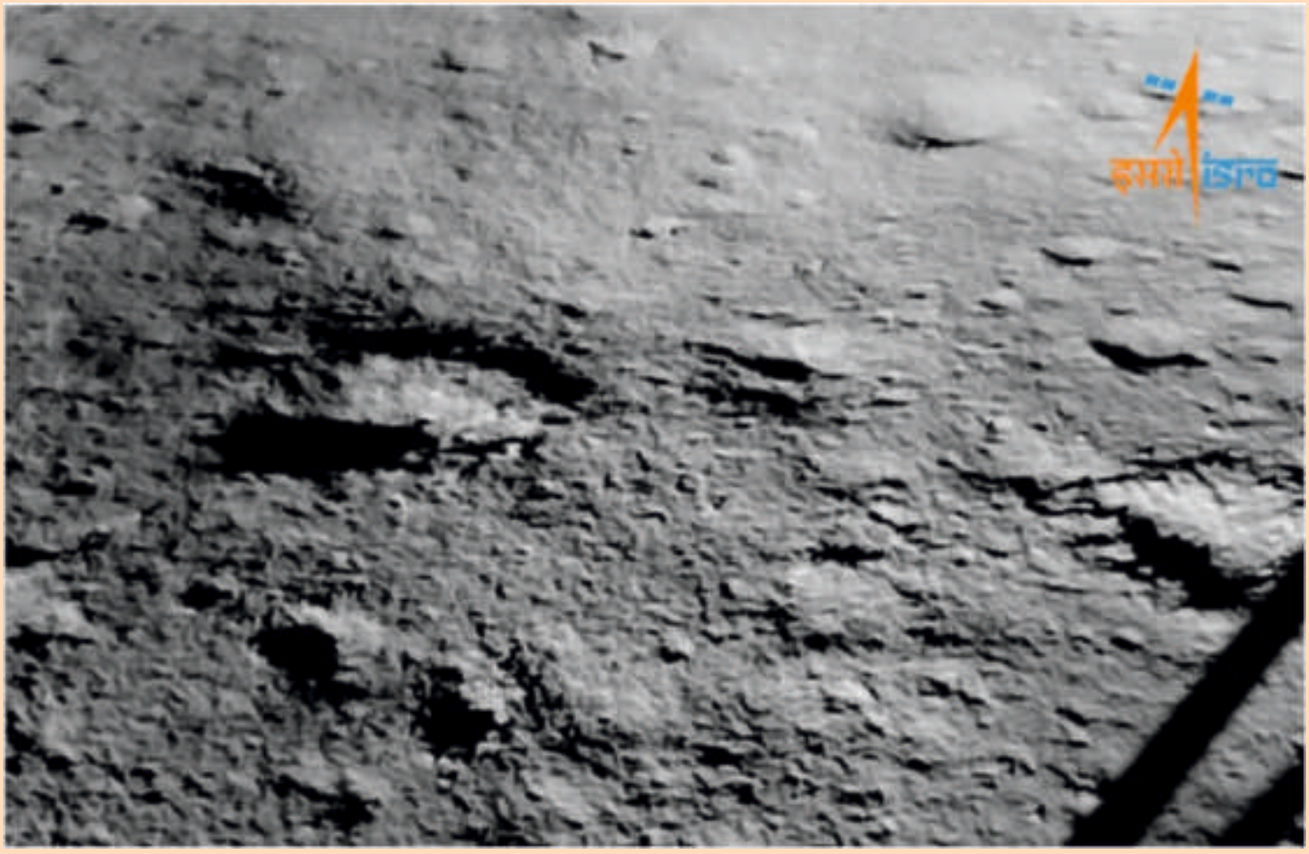

Figure 1: The first image of the moon's surface taken by India's Chandrayaan-3 mission after its historic touchdown on Aug. 23, 2023.

The first images from India's Chandrayaan-3 mission taken after the probe's historic moon touchdown reveal a pockmarked surface near the lunar south pole.

The Indian Space Research Organisation (ISRO) shared the images on X, formerly Twitter, on Wednesday (Aug. 23), about four hours after the Chandrayaan-3 spacecraft completed its smooth descent.

The first set of four images were taken by the lander's Horizontal Velocity Camera as it was nearing the surface of the moon. An additional image from the Landing Imager Camera, shared a little later, shows a glimpse of the landing site, including a portion of the spacecraft's landing leg and its shadow

Link: https://www.space.com/india-chandrayaan-3-first-photos-moon-south-pole

The Story Of Cosmology Through Post Stamps 57

SOLAR ECLIPSE

MYTHS AND LEGENDS

Eclipse has always been associated with legends, myths and symbols which contribute a rich source of inspiration in different cultures and epoch. In many civilizations people had spiritual explanation eclipse which help them to make sense of these seemingly inexplicable, unusual and spectacular event in the cosmos.

Walt Disney Cartoon **Character-Goofy saving his life by predicting vanishing Sun to awe stuck priest**

Miniature sheet **– depicting geometry of the path of the shadow over country and time.** ***Margin*** **illustrate mythological dragon chasing the Sun and Moon**

Se- tenant set of three stamps- **depict a mythological Demon, devouring the Sun at the time of Solar Eclipse**

Se tanent issue- **depicting religious prayer performed at the time of Solar eclipse**

Eclipse Concert, **Bucharest 11 Aug 1999 by Luciano Pavarotti, an Italian Opera Tenor**

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The Bulletin is the official organ of the IAPT. It is a monthly journal devoted to upgrading physics education at all levels through dissemination of didactical information on physics and related areas. Further, the Bulletin also highlights information about the activities of IAPT.

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From the Editor's desk……...

A moment of Glory and Time to Innovate Ahead

Vikram has landed on the moon and Pragyan has started roaming around gathering scientific data. It is indeed a Moment of Glory full of expectations for future. It is a demonstration of the fact that we can do it. It is a demonstration of the fact that India has arrived in the big league. It is a demonstration of our faith in the collective effort of the nation. It is a milestone to emphasize that space exploration has reaped rich dividends for us in sharing the benefits of science for the common man. For us who are part of the STEM force of the country, it provides an opportunity to attract the best minds to pursue science as a career.

IAPT fully realises its responsibilities to turn students from rote learning to exploratory learning. From this month, IAPT has initiated a pilot for such exploration via Indian National Young Physicists' Tournament (INYPT), a unique competition with all the elements of research-based learning through open ended problems. It is different from MCQ approach of most of the competitions around. Starting from the problem statement, it requires class ten students to work with mentors to crack the problem. Once a solution is arrived at, the student is supposed to present its solution and defend the results before the fellow competitors participating in this INYPT, face jurors on the way and learn the lessons of doing research. At the moment, we stand at the lowest rung of the international version of this competition, which is called International Young Physicists' Tournament (IYPT). We hope, that with so many mentors available in our association, it can mark the beginning of what the latestNational School Curriculum Framework 2023 envisages.

It reminds me of the thought-provoking words of Professor Yashpal, who as UGC Chairperson in late eighties started Countrywide Classroom on TV. When we are talking about shedding the load of a school going child, he had a different take. While presenting the famous Yashpal report of 1993 to the then education minister Mr. Arjun Singh, he hit the nail on the head:

It is not the gravitational load of the school bag but instead the pernicious burden of 'non-comprehension' that is more cruel. In fact, …a significant fraction of children who drop out may be those who refuse to compromise with non-comprehension – they are potentially superior to those who just memorise and do well in examinations, without comprehending very much! I personally do believe that "very little, fully comprehended, is far better than a great deal, poorly comprehended."

Time has come to seriously ponder on Prof. Yashpal's diagnosis and implement the cure without delay. As a subject society we have a great responsibility that we stand up and innovate to let this not happen. This is the real call of this moment. ISRO's scientific human resource has firmly underlined the talent which lies in the hinterland of Bharat. I believe in Swami Vivekanand's call: Arise, awake, and stop not till the goal is reached. Let us act without further delay.

During this period of the year, IAPT enters its most busy part of the Calendar. We have our *Annual National Convention*, and the *National Student symposium in Physics*slated to be held in Jaipur and Chandigarh respectively. which brings us together to share our passion for Physics face to face. I invite you to participate in these events. The organisers are working hard to make your participation memorable. Looking forward to meet you.

PK Ahluwalia

PHYSICS NEWS

The first observation of neutrinos at CERN's Large Hadron Collider

Neutrinos are tiny and neutrally charged particles accounted for by the Standard Model of particle physics. While they are estimated to be some of the most abundant particles in the universe, observing them has so far proved to be highly challenging, as the probability that they will interact with other matter is low. A long-standing goal in this field of study was to observe neutrinos inside colliders and particle accelerators. The FASER and SND@LHC collaboration are two distinct research efforts, both utilizing the LHC at CERN. Recently, these two efforts independently observed the first collider neutrinos, which could open important new avenues for experimental particle physics research. The neutrinos detected by Feng and the rest of the FASER collaboration have the highest energy ever recorded in a laboratory environment. They thus could pave the way for in-depth studies of the properties of neutrinos, as well as searches for other elusive particles.

Read more at: https://phys.org/news/2023-08-neutrinos-cern-large-hadron-collider.html

Original paper: Physical Review Letters (2023) DOI: 10.1103/PhysRevLett.131.031801

How a cup of water can unlock the secrets of our universe

Researchers from Queen Mary University of London have made a discovery that could change our understanding of the universe. In their study, they reveal, for the first time, that there is a range in which fundamental constants can vary, allowing for the viscosity needed for life processes to occur within and between living cells. Fundamental physical constants shape the fabric of the universe we live in. Physical constants are quantities with a value that is generally believed to be both universal in nature and to remain unchanged over time for example the mass of the electron, but their origin is unknown. Through evolutionary mechanisms, fundamental constants may be the result of nature arriving at sustainable physical structures. It remains to be seen how the principles of evolution can be helpful to understand the origin of fundamental constants.

Read more at: https://phys.org/news/2023-08-cup-secrets-universe.html

Original paper: Science Advances (2023) DOI: 10.1126/sciadv.adh9024

Ringing protons give insight into early universe

In the middle of the last century, physicists found that protons can resonate, much like a ringing bell. Advances over the last three decades have led to 3D pictures of the proton and significant insight into its structure in its ground state. But little is known about the 3D structure of the resonating proton. Studying the fundamental properties and behaviors of nucleons offers critical insights into the basic building blocks of matter.

When a nucleon is forcibly excited into a higher-energy state, its quarks rotate and vibrate against each other, exhibiting what's known as a nucleon resonance. A group of physicists from Justus Liebig Universität (JLU) Giessen in Germany and the University of Connecticut led the CLAS Collaboration effort to conduct an experiment exploring these nucleon resonances. In the beginning, the early cosmos only had some plasma consisting of quarks and gluons, which were all spinning around because the energy was so high. Then, at some point, matter started to form, and the first things that formed were the excited nucleon states. When the universe expanded further, it cooled down and the ground state nucleons manifested.

With these studies, we can learn about the characteristics of these resonances. And this will tell us things about how matter was formed in the universe and why the universe exists in its present form

Read more at: https://phys.org/news/2023-08-protons-insight-early-universe.html

Original paper: Physical Review Letters (2023). DOI:10.1103/PhysRevLett.131.021901

Soumya Sarkar
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INDIA

Chandrayaan Mission: India's Odyssey to the Moon

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For millennia, humanity has been attracted by the Moon in the wide expanse of the cosmos. The desire to unravel its mysteries has prompted nations and space agencies to embark on daring lunar expeditions. Among these, India's Chandrayaan mission stands out, as an example of the country's scientific skill and perseverance. The journey of Chandrayaan has been fascinating since its inception and has had a lasting impact on our understanding of Earth's nearest cosmicneighbor.

A Historic Launch: India's Leap into Space Exploration

The Indian Space Research Organisation (ISRO) launched Chandrayaan-1, India's first lunarmission, in 2008. This momentous event marked India's entry into deep space exploration, firmlyestablishing the country's place among the world's space faring nations. Chandrayaan-1 set out ona daring journey to study the Moon up close and contribute to global understanding of lunarscience.

Lunar Mapping: Unveiling the Moon's Secrets

One of Chandrayaan-1's primary goals was to generate a three-dimensional map of the Moon'ssurface with extensive information about its topography, mineralogy, and element distribution.The spacecraft, outfitted with sophisticated instruments, carried out a high-resolution mappingmission, exposing the Moon's hidden mysteries with unsurpassed precision.

Water on the Moon: A Groundbreaking Discovery

The discovery of water molecules on the Moon's surface by Chandrayaan-1's Moon MineralogyMapper (M3) was a watershed moment for lunar exploration. This discovery was significantbecause the existence of water has far-reaching ramifications for future human space missions.The discovery rekindled enthusiasm in lunar exploration, making the Moon an even moreappealing location for future space expeditions.

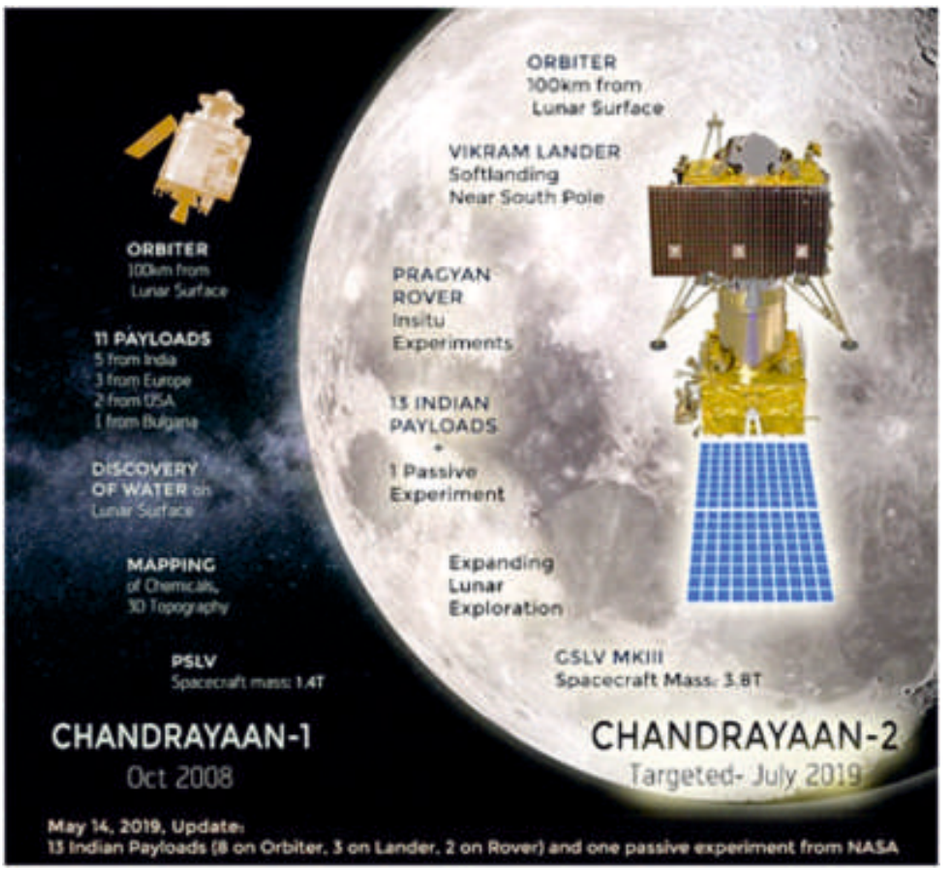
Chandrayaan-2: India's Ambitious Lunar Mission Continues

Chandrayaan-2, which built on the success of its predecessor, was released in 2019, attractingglobal interest once more. The mission's goal this time was to study not only the lunar surface,but also the Moon's unexplored southern polar region. The ambitious Lander-rover missionsought to investigate the distribution of water ice, look for important minerals, and improve ourunderstanding of the Moon's geology.

Vikram's Descent: Triumph and Resilience

The world held its breath as the Vikram Lander approached the lunar surface duringChandrayaan-2's landing attempt. Despite hurdles, the ISRO team displayed extraordinaryperseverance and technical expertise. Despite the loss of communication with the Lander, theorbiter continued to operate, sending crucial data and scientific findings and demonstrating thespirit of India's scientific community.

Chandrayaan-3: Stepping stone towards ISRO's future interplanetary missions



The third and most latest lunar Indian Space Research exploration mission under theChandrayaan programme is Chandrayaan-3 and has been launched on July 14, 2023, at 2:35 p.m.IST, and a 100 km circular polar orbit was successfully injected as part of phase one. On August23, 2023, the Lander and rover are expected to touchdown in the lunar South Poleregion. It has aLander named Vikram and a rover named Pragyan, similar to Chandrayaan-2, but no orbiter. Itspropulsion module functions similarly to a communication relay satellite. The Lander and roverconfiguration is carried by https://commons.wikimedia.org/wiki/File:UPDATES.jpg the propulsion module until the spacecraft reaches a 100 km lunarorbit.The Chandrayaan-3 mission serves as a springboard for ISRO's future interplanetary missions.The core concept is the demonstration of critical capabilities to soft land on the lunar surfacesafely, which the previous mission was unable to accomplish.

The Legacy of Chandrayaan: Inspiring a New Generation

The Chandrayaan missions from India have left an everlasting imprint on the world of spaceexploration. From Chandrayaan-1 to Chandrayaan-3, India's space agency has proved its prowessand dedication to scientific advancement. These missions have not only advanced ourunderstanding of the Moon, but have also encouraged a large number of people to seek careers inscience and technology. The influence of Chandrayaan extends beyond its scientific results. AsIndia continues its journey into space, it has sparked an interest in space exploration among theyounger generation in India and around the world. Because of the mission's success, morestudents are pursuing jobs in science, technology, engineering, and mathematics (STEM),ushering in a new era of scientific innovation and space exploration.

Sources:

https://en.wikipedia.org/wiki/Chandrayaan;
https://www.isro.gov.in/Chandrayaan3_New.html

Chandrayaan 3 landing on South Polar Region of the Moon: Rationale for the choice

S. Rangarajan,

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1. Introduction

The fascination with space is age old, but recently there has been a renewed interest. We are at a threshold of a new era of commercial space of explosive growth. With the increasing population,decreasing/depleting natural resources, humans look for life and resources beyond Earth. The moon, our nearest neighbour, is an obvious choice.

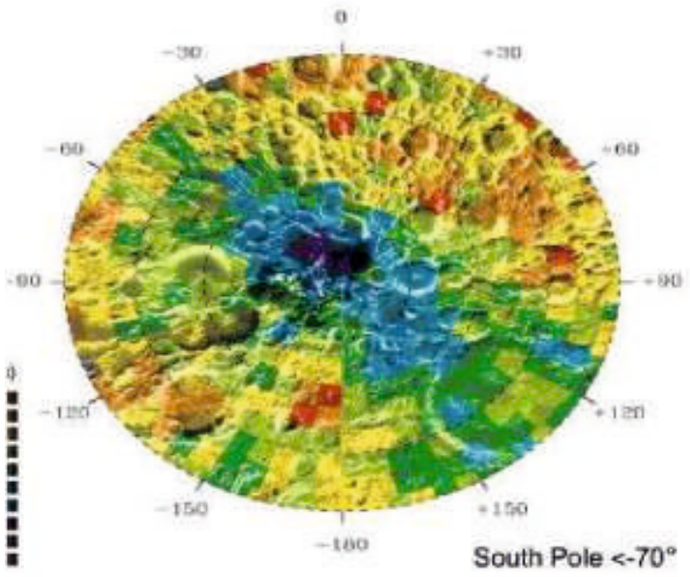
The first wave of lunar exploration five decades ago, focused on landing humans on the Moon and returning them safely to Earth. After Chandrayaan-1 mission of ISRO found water on the Moon, several missions are tasked with prospecting for water ice and other resources. And all these missions are just a prelude for a permanent human presence on the Moon.Scientifically too, the moon holds many unanswered mysteries. With no atmosphere and not much geological churning going on, the moon's surface rocks are around the age of the solar system. For researchers, it is akin to looking at the pristine state of the early universe through these missions. Moon has the profound potential to be a source of new scientific advances as well as economic growth.

Right from the beginning, the Indian space efforts are driven by the application potential as perceived by the users. Chandrayaan series is no exception. The moon mission idea was mooted in the Indian Academy of Sciences meeting in 1999 and based on the inputs from the scientists, the payloads have been designed. Along these lines, Chandrayaan 3 (CH3) was planned keeping in mind the Science requirements, and not for scoring a first ahead of others. However, the timing of this mission opens doors for the Indian private sector to play a key role in the space sector.

Dr. S. Rangarajan is a satellite industry veteran with years of experience in successive leadership roles in the public and private sectors. He was part of the core team that created mission management procedures for ISRO's early satellites. He later became the Director of MCF and ISTRAC and was involved in building a strong team for satellite operations. Throughout his career he has pioneered various satellite applications, including for uniform and ubiquitous education and healthcare delivery.
Dr. Rangarajan did his Ph.D. degree from TIFR, Mumbai. He is passionate about teaching Physics and Mathematics at all levels.

2. Characteristics of the South polar region

At the lunar South Pole, the Sun hovers below or just above the horizon. This, coupled with the undulating terrain, creates temperatures upwards of 50°C during sunlit periods. Even during these periods of illumination, soaring mountains cast dark shadows and deep craters protect perpetual darkness in their abysses. Some of these craters are home to Permanently Shadowed Regions



(PSR) that haven't seen sunlight in billions of years and experience temperatures as low as -200°C. These regions act as traps for an array of volatiles, with each melting and vaporizing at different temperatures, and hold the key to understand the origin of the solar system.

The Moon Impact Probe (MIP) of the Chandrayaan-1 mission in 2008 touched the lunar soil at the Shackleton crater near the lunar south pole and revealed the presence of water ice. Ever since a number of missions have collected corroborative evidence. Notably, NASA's Lunar Prospector Neutron Spectrometer (LPNS) has confirmed low neutron emissions that are consistent with hydrogen-rich deposits covered by desiccated regolith. These hydrogen signatures are possible indications of water in the form of water or hydrated minerals. Possibility of large reservoirs of water can lead to resource mining to reduce the amount of supplies like oxygen and hydrogen—key life sustaining elements and ingredients for rocket fuel—sent from Earth to support humans in deep space.

Figure 1 Neutron Flux in the South polar regions with latitude > 70 deg.

Blue is relatively low and yellow is higher.

Source: NASA

Despite the challenging terrain and the temperature excursions, the potential rewards in terms of resources and scientific discovery make south polar region a target for future missions of almost all space-faring nations. The solar UV rays from the illuminated regions and the plasma electrons from the solar wind, could produce permanent electric fields which need to be studied. The mountain peaks near the pole are illuminated for large periods of time and could be used to provide solar energy to an outpost in that region. A number of rare earth elements and abundance of Helium 3 isotope, needed for nuclear fusion reactors, are some other reasons for the renewed interest.

3. Exploration and exploitation of the South polar region

The elliptical, polar orbit of NASA's Lunar Reconnaissance Orbiter (LRO) is closest to the Moon during its pass over the South Pole region. Through its thousands of orbits in the last decade, LRO has collected the most precise information about the South Pole region, offering scientists precise details about its topography, temperature and locations of likely frozen water. NASA has designed the Artemis program to collaborate with commercial and international partners and establish the first long-term presence on the Moon. The international efforts would focus on:

- Exploration of lunar history

- Solar system evolution
- Water/ ice resource mapping and quantitative studies
- Lunar base establishment
- Cryofuel for launches from Moon
- Space commer

4. Chandrayaan 3 site selection

ISRO has prepared a large repertory of images in south polar regions based on the orbiter data of CH2, as well as imagery from other sources. With its vast experience of processing satellite remote sensing data, Digital Terrain Models were created. The candidate landing sites were arrived at by trade off studies, balancing ease of landing, ease of exploration using the rover, the science requirements,lunar

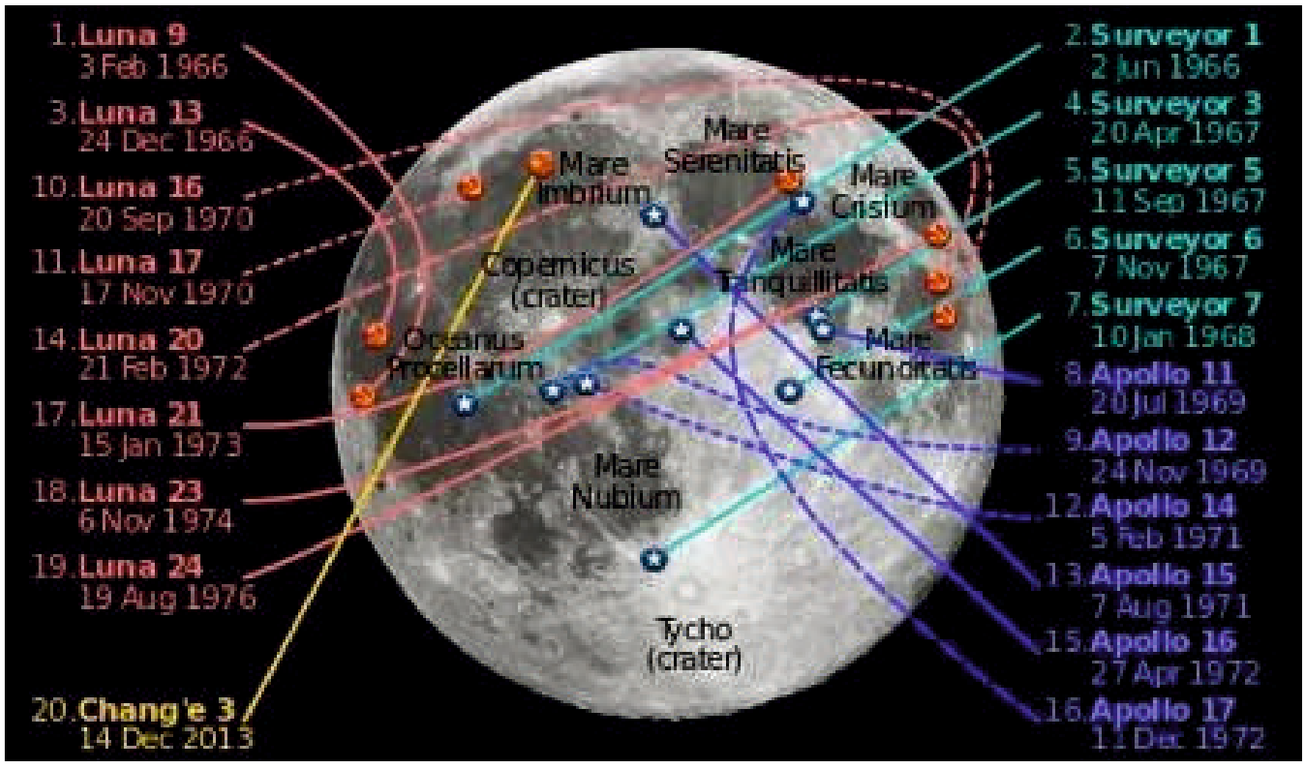


Figure 2 Landing sites of earlier missions

surface slopes, rock distribution, light intensity and maximum temperature.Engineering capabilities, like pin point landing from a powered descent, and engineering constraints like maximum landing speeds were taken into consideration.

It was decided to land on the side of Moon facing the Earth for ease of communications. The final choice of 69.37° S latitude and a longitude of 32.35°E met all these considerations. It was also closer to the South pole than any of the previous landings on the Moon (including those on the far side). Figure 2 gives some of these details.

5. Payloads and expected Science

The exploration of the region around the landing site is carried out by a number of payloads, designed to meet the scientific goals set for the mission.

- **CHaSTE** carries out measurements of thermophysical properties of lunar surface. For example, it has already measured the temperature profile of the top soil and found a steep temperature gradient of -1.5 deg/mm of depth. This opens out a great new possibility of electric generation using Seebeck effect.
- **ILSA** measures seismicity around the landing site which would help to model the structure of the lunar crust and mantle. On the third day itself an event of considerable magnitude has been recorded
- **RAMBHA-LP** is a Langmuir probe to measure the surface plasma density. The temporal variation of electron and ion density will help understand the electric fields near lunar surface due to solar radiation
- **APXS** is intended to get the in situ mineralogical composition by using alpha particle bombardment and analysing the X ray spectrum
- **LIBS** uses a laser beam to breakdown and analyse the elemental composition of the lunar soil. It discovered the presence of Sulphur in the lunar surface.

6. Summary

The Indian Moon mission has evolved steadily triggered by the national scientific objectives, modulated by the findings of international missions and began with an orbiter mission and a Moon impact probe. The discovery of water in regions close to the south pole was a milestone that led to a focus on this region for revival of Moon missions by all the international agencies. Technologies were developed to handle the difficult terrain in this region, as well as the extreme temperatures encountered here. The stage was then set for ISRO to attempt Chandrayaan 2 mission to explore the south pole region with a variety of payloads for further exploration. Though its lander crashed on the Moon's surface, this mission provided ample data for planning its successor as a mission capable of handling faults and contingencies. Chandrayaan 3 chose a landing site closer to the south pole than any other lander. The capability to pin point and soft land was proven in this mission. The in situ observations of thermal, physical and chemical properties will help in understanding this region as a future lunar base, with a huge potential for resource mining and commercial exploitation.The data from the variety of instruments on the lander as well as from the rover will provide invaluable data on south polar region for the global scientific community.

Supernova Neutrinos & Their Analysis Using SNOwGLoBES Software

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Abstract

In this article, we present the interaction of matter with supernova neutrinos, various techniques to detect them, and the importance of their study. A stand-alone software tool SNOwGLoBES is used to understand the effects of various detectors and configurations in detecting these supernova neutrinos.

1. Introduction

The discovery of neutrino oscillations [1] brought a significant breakthrough by revealing that neutrinos possess mass - a fact absent in the current standard model [2] of particle physics. This study aims to explore how neutrinos, which are present everywhere in the universe, can illuminate the characteristics of cosmic objects like supernovae. Using the stand-alone software tool SNOwGLoBES, we examine the diverse ways in which neutrinos from supernovae interact with detectors on Earth, considering various configurations.

Neutrinos were proposed by Pauli to explain the continuous energy spectrum of electrons in the β-decay of nuclei. Neutrinos are fermions having spin ½, no electrical charge and exceptionally low mass. They come in three flavours: electron-neutrino (ν_e), muon-neutrino (ν_μ), and tau-neutrino (ν_τ), each corresponding to one of the three charged leptons: the electron (e), the muon (μ), and the tau (τ). Unlike other particles, neutrinos do not interact via electromagnetic or strong interactions; instead, they only participate in weak interactions and, due to their mass, in gravitational interactions.

Supernova, on the other hand, is a collapse resulting in an explosion of the mantle of a star when it has exhausted all its nuclear fuel. Neutrinos produced inside the core of a supernovae are called supernovae neutrinos. Approximately 10^{58} neutrinos and antineutrinos of all flavours are emitted during this process, carrying away a whopping 99% of the gravitational binding energy (around 10^{53} ergs) of the exploding star.

The reason neutrinos can efficiently carry away such an enormous amount of energy lies in their unique interaction properties. Unlike photons, which interact via electromagnetic interactions and get trapped inside the collapsing star in the early stages of a supernova, neutrinos interact only weakly with matter. This allows them to escape more effectively and carry away the immense energy released during the supernova.

2. Interaction with Matter

Neutrinos interact with matter [3] via the exchange of massive vector bosons, $W^{\pm}$ and Z^0. These interactions are called weak interactions. These interactions can be classified:

a. Based on the boson involved:

i. Neutral Current (NC): Neutrino interactions involving exchange of Z^0 bosons are called neutral current (NC) interactions. Here, neutrinos interact with atoms of the detector, scattering the atoms and leaving them with some observable energy.

ii. Charged Current (CC): Neutrino interactions involving exchange of $W^{\pm}$ boson are called charged current (CC) interactions. Here, neutrinos interact with atoms of the detector, producing a charged lepton that can be further detected.

b. Based on the type of scattering:

i. Elastic Scattering: When the final state of a nucleon does not change after neutrino scattering, it is called elastic scattering. The CC elastic scattering is called quasi-elastic scattering as in case of lepton the flavor change takes place whereas in case of nucleon its charge changes (see Quasi-elastic Scattering equations in Table 1). Thus these interactions are named quasi-elastic, not elastic.

ii. Inelastic Scattering: When the final state of a nucleon changes after neutrino scattering, it is called inelastic scattering.

A table of different types neutrino interactions and corresponding general interaction equation is as follow:

Type of Interaction	**Interaction Equation**[#]
Neutrino–Electron Elastic Scattering	$\nu_l + e^- \rightarrow \nu_l + e^-$
Neutrino–Electron Quasi-elastic Scattering	$\nu_\mu + e^- \rightarrow \nu_e + \mu^-$
Neutrino–Nucleon Elastic Scattering	$\nu_l + N \rightarrow \nu_l + N$
Neutrino–Nucleon Quasi-elastic Scattering	$\nu_l + n \rightarrow p + l^-$
Neutrino–Nucleon NC Deep Inelastic Scattering	$\nu_l + N \rightarrow \nu_l + X$
Neutrino–Nucleon CC Deep Inelastic Scattering	$\nu_l + N \rightarrow l^- + X$

Table 1: Types of neutrino interactions with matter and corresponding interaction equations

Here, l is electron (e), muon (μ), tau (τ); N is proton (p), neutron (n) and X is a set of all the final hadrons.
[#]Interactions are written exclusively for neutrinos and not for their antiparticles. However, it is possible to describe the same interactions for anti-neutrinos while ensuring that all conservation laws are preserved.

3. Detection of Supernova Neutrinos

Existing technology can not actually detect neutrinos. Neutrinos interact via weak interactions with the matter but present neutrino detectors mostly use electromagnetic interaction properties to detect the final particles (corresponding charged lepton) produced after weak interaction and from that construct the characteristics of interacting neutrinos.

An ideal supernova neutrino detector should have the following qualities:

- Very-very large size so that a huge number of neutrino interactions can be observed
- Sensitivity to all three neutrino–antineutrino flavours
- Low energy threshold to observe the whole energy spectrum of neutrinos
- Good angular resolution such that the direction of incoming neutrinos, and hence the supernova, can be deduced
- Good time resolution so that the supernova collapse mechanism can be studied more precisely

With present technology, to make a detector having all these properties is not possible. But various neutrino detectors are sensitive to a particular flavour of neutrinos, or a particular type of neutrino interaction which can provide us with useful information about the supernova neutrinos. Neutrinos' interactions with matter are mentioned in Table 1. The most common interactions seen in neutrino detectors are:

a. Inverse Beta Decay (IBD): $\nu_e + n \rightarrow p + e^-$

b. Elastic scattering of electrons by neutrinos: $\nu_l + e^- \rightarrow \nu_l + e^-$; here l is e, μ, τ.

The IBD interaction does not provide us with any knowledge about the direction of incoming neutrinos but from elastic scattering interactions one can have information about the direction of incoming neutrinos by the conservation of momentum calculations.

Broadly, based on the technology used, supernova neutrino detectors [4] are:

- **Scintillation Detectors:** The material used in such detectors produce a flash of light, i.e. scintillation, when a charged particle passes through them. Photo-multiplier tubes (PMTs) are used to process and enhance such signals. Usually, the material used is hydrocarbons and since they are rich in protons, these types of detectors are mainly sensitive to inverse beta decays.
  Examples of neutrino scintillator detectors are Baksan, LVD, Borexino, KamLAND, NOνA.

- **Water Cherenkov Detectors:** These detectors detect charged particles by the rings of light they produce called Cherenkov light emission. These types of detectors are basically sensitive to IBD, as water has a large number of protons and neutrino-electron scattering interactions.
  Examples of water Cherenkov neutrino detectors are Super-Kamiokande, IceCube, Irvine–Michigan–Brookhaven (IMB) Detector.

- **Liquid Argon Time Projection Chamber (TPC) Detectors:** In these detectors, incoming electron-neutrino, after interaction with argon (Ar) atom, produces electron as:

$$\nu_e + {}^{40}\mathrm{Ar} \rightarrow e^- + {}^{40}\mathrm{K}^*$$

and,

$$\bar{\nu}_e + {}^{40}\mathrm{Ar} \rightarrow e^- + {}^{40}\mathrm{Cl}^*$$

In TPCs, the ionised electrons are drifted by a strong electric field. These electrons will ionise the liquid argon and signals are observed as they pass through the argon chambers and when they are collected on final cathode wire planes.
Example of liquid argon neutrino detectors: ICARUS (Imaging Cosmic And Rare Underground Signals) experiment, MicroBooNE.

- **Heavy Nuclei Detectors:** An example of such a detector is the HALO detector which uses lead (Pb) as a target. Here neutrino interactions are as follows:

$$\nu_e + {}^{A}\mathrm{Pb} \rightarrow e^{-} + {}^{A}\mathrm{Bi}^{*}$$

and,

$$\nu + {}^{A}\mathrm{Pb} \rightarrow \nu + {}^{A}\mathrm{Pb}^{*}$$

Here, A means that interaction happens for all the isotopes of lead. In both cases, the excited state nuclei de-excite via the emission of neutrons which is detected by ^{3}He proportional counters.

4. Importance of Supernova Neutrinos

The study of supernova neutrinos is important because of the following reasons:

- **Insights into Core-Collapse Supernova [5] Mechanism:** Supernova neutrinos are produced in enormous quantities during the core-collapse of massive stars. Neutrinos play a fundamental role in carrying away a significant portion of the gravitational energy released during the collapse, influencing the supernova's dynamics and determining its outcome, whether it results in a neutron star or a black hole. By studying their properties, such as energy spectra and time evolution, scientists can gain crucial insights into the complex physical processes occurring within a supernova.

- **Neutrino-Neutrino Interactions:** Inside a core-collapse supernova, neutrino densities are extremely high, leading to a phenomenon called neutrino-neutrino interactions. These interactions have a measurable impact on neutrino emission and can affect the overall neutrino signal detected on Earth. By studying these interactions, researchers can better understand neutrino properties, the behaviour of dense matter in extreme environments, and its implications for astrophysical phenomena.

- **Probing Neutrino Properties:** The nature of the neutrino spectra emitted during a supernova depends on various neutrino properties, including their masses and oscillation parameters such as θ_{13} and the mass hierarchy [1]. Analysing the neutrino signals from a distant supernova allows scientists to deduce these properties, providing valuable insights into the fundamental nature of neutrinos and their significance in the universe. Such studies contribute to our understanding of neutrino physics and the broader implications for particle physics.

- **Testing the Standard Model and Beyond:** The study of supernova neutrinos provides a unique opportunity to test our present understanding of the Standard Model of particle physics, which describes the fundamental particles and their interactions. Any discrepancies between the observed neutrino behaviour and the predictions of the

Standard Model could indicate the presence of new physics beyond our current understanding. Therefore, by analysing the neutrino signals from supernovae, researchers can search for evidence of exotic phenomena and gain insights into the universe's more profound mysteries.

5. SNOwGLoBES Software

SNOwGLoBES (SuperNova Observatories with GLoBES) [6] is a software and a database package that can calculate the expected event rates of neutrinos. It is a free public software for computing interaction rates and distributions of observed quantities for supernova burst neutrinos in a common detector. It provides very simple data packages that can be used for tests of observability of physics signatures in current and future detectors, and for evaluation of relative sensitivities of different detector configurations. This software uses only the front-end part of GLoBES (General Long Baseline Experiment Simulator) [7], which is event rate calculation, not the oscillation sensitivity part. It is not a Monte Carlo simulation or an event generator. It is basically a mean event rate calculator designed primarily for supernova neutrinos, but it works for neutrinos having energy less than the tens-of-MeV range.

The differential event rates of observed particles for a given neutrino interaction process for a realistic detector can be calculated as:

$$\frac{dN}{dE'} = \int_0^\infty \int_0^\infty dE\, d\hat{E}\, \varphi(E)\, \sigma(E)\, k(E - \hat{E})\, T(\hat{E})\, V(\hat{E} - E')$$

Here, E: Neutrino Energy; Ê: Produced Particle Energy; ϕ(E): Neutrino Flux; E′: Measured Product Particle Energy; σ (E): Total Cross Section of the Process; k (E − Ê): Energy Distribution of the Produced Particle; T (Ê): Threshold of Detector; V (Ê − E′): Energy Response of Detector

The calculation in the above equation is done by SNOwGLoBES. It allows for precise interaction rate estimates for expected and detected events and for different detector configurations and theoretical flux models.

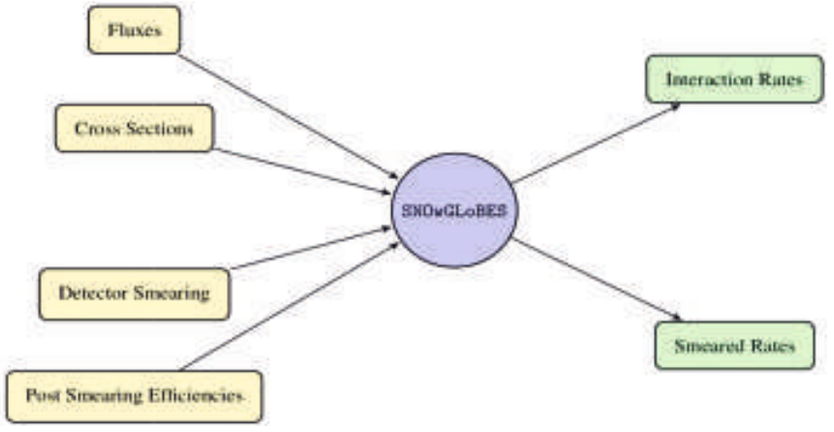

Figure 1: Flow of information in SNOwGLoBES software.

As shown in Figure 1, SNOwGLoBES takes:

- Neutrino flux differential spectra
- Cross-sections for relevant channels
- Smearing matrix for given detector configuration which includes both interaction product distributions and detector response
- post-smearing efficiencies

and gives out:

- interaction rates (as function of neutrino energy)
- smeared rates (as function of detected energy) i.e. the spectrum that would actually be observed in a detector

For detailed step-by-step instructions on installing and using the software, visit puhep.org.

6. Visualising Fluxes, Cross-Sections and Event-Rates

SNOwGLoBES can easily be installed on Linux operating systems by following the simple instructions given in their GitHub repository. This software allows us to visualise the neutrino event rates, cross sections and various flux models for different detector configurations.

a. **Fluxes:** Instead of flux, fluence (i.e. flux integrated over the time of the burst) v/s energy of different flavours of neutrinos in traditional flux models like Livermore [8] and GVKM [9] is shown in Figure 2.

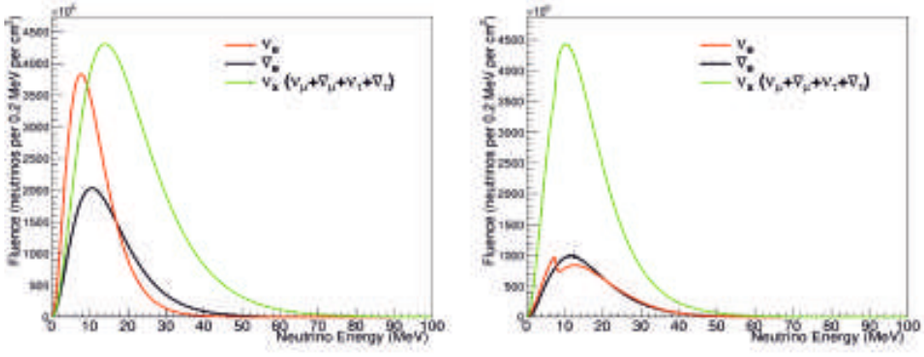

Figure 2: Graph between fluence and neutrino energy for traditional flux models of Livermore (left) and GVKM (right).

Modern pinched-thermal [10] forms of flux can also be visualised which are based on Garching parametrization and one can choose luminosity, average energy and pinching parameter of each neutrino flavor.

b. **Cross-Sections:** SNOwGLoBES enables us to visualise cross-sections of various relevant processes in a material as a function of neutrino energy. The distributions of interaction products are taken into account in the smearing matrices. Smearing matrices convert incident neutrino energies from the flux file to the energies deposited in the detector in the simulation results for a given channel and detector.

It is clear from Figure 3, that in water, inverse beta decay (IBD) has the highest cross-section for low-energy neutrinos. One can predict that most events that a detector, having water as a detecting material, will detect would happen through the IBD process.
In liquid argon-type detectors, the most prominent interaction/channel will be the CC interaction of neutrinos with argon atoms.

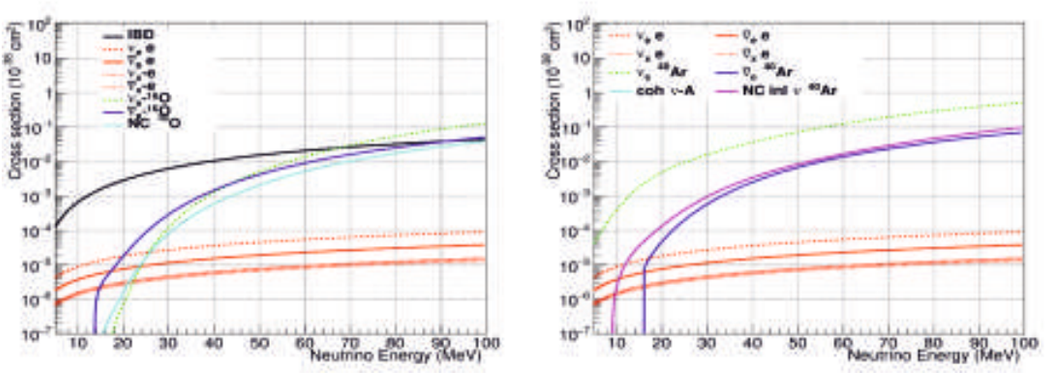

Figure 3: Graph between neutrino cross-section and neutrino energy in water (left) and Liquid Argon (right).

c. **Event Rates:** Event rates via various channels/interactions for the GVKM flux model in an Argon detector (17 kilo-tonne) and HALO2 [4] detector are shown in Figure 4.

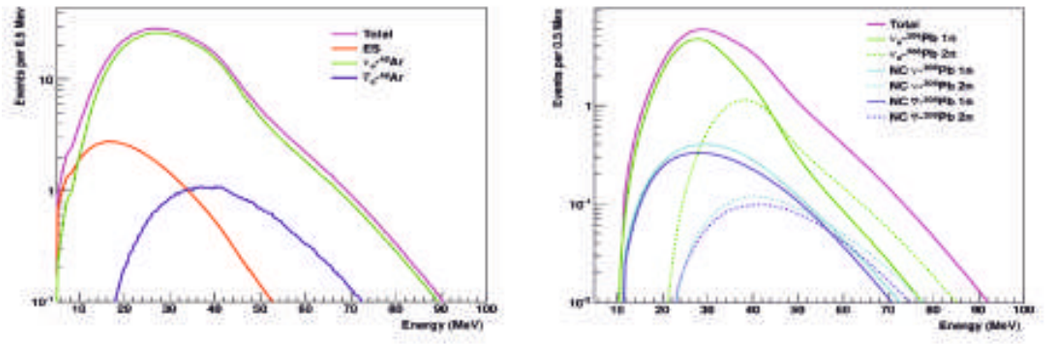

Figure 4: Graph between event rate of neutrinos and their energy in argon detector of 17 kilotons (left) and HALO2 detector (right).

From Figure 4, one can conclude that for lower-energy neutrinos elastic scattering channels dominate in a liquid argon-type detector whereas higher-energy neutrinos interact with argon atoms to produce electrons.
And, for a lead-based detector, charged current interaction of electron neutrino with lead nuclei is a more dominating channel than neutral current interactions.
Moreover, one can compare event rates of the same or different types of interactions in different detector configurations as shown in Figure 4.
It is clear from the graphs in Figure 5 that event rates for ν_e-e and $\bar{\nu}_e$-e interactions will be higher in the HALO2 detector than the HALO1 detector (both are Argon-based detectors).

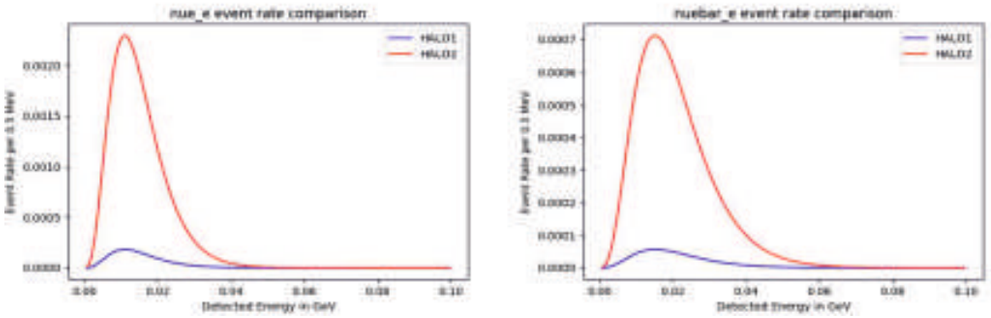

Figure 5: Graph of comparison of event rates for $\nu_e - e$ (left) and $\bar{\nu_e} - e$ (right) interactions in HALO1 and HALO2 detector configurations.

7. Conclusion

The study and detection of supernova neutrinos hold tremendous potential for unravelling the mysteries of supernovae, gaining deeper insights into neutrino behaviour, and probing the fundamental laws of physics. This research has provided a valuable introduction to utilising the SNOwGLoBES software for simulating neutrino detection experiments, encompassing flux models, cross sections, and event rates. By comprehending these critical factors, researchers can make informed decisions while designing their experiments, leading to more accurate and precise measurements.

This work aims to inspire fellow researchers to explore the fascinating world of neutrinos remotely, using the powerful SNOwGLoBES software and offers readers a chance to start their journey of scientific discovery in this captivating field. If you're eager to learn more, one of the authors (HS) invites you to check out a detailed master's thesis. This will help you understand how to use the SNOwGLoBES software for this interesting topic.

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Article

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Relevance of Physical Science in Social Science- (Part-I)

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1. Introduction

In the early days, there was no demarcation line between various subjects. People with mathematical backgrounds were entering and working in different fields when there was no nomenclature like Physics, Chemistry, Biology, Economics etc. Mathematicians did studies on the motion of heavenly bodies. People like Copernicus, and Bernoulli were also doing some work on economics and finance. Later on, Newton, Halley, Quesnay etc. also contributed to economics. Physical science systematically established its presence after Newton. Later on, Social science was established and in this way, many specialised subjects sprung up. After that when people from one branch started working in different branches was called interdisciplinary work. Then such established works were given new names like Biophysics, Geo-physics, Socio-physics, Econophysics, Phynance, Biochemistry, Physical Chemistry etc. It suggests there must be some common factor, or relevance between different fields to keep them in a bond. The motive behind writing on such a subject is to bring out the relevance between physical science and social science, which led to binding them together. The subject is quite vast and in this piece of work, I discuss only 'Econophysics'.

1.1 Value of Money and Monetary Reform

Nicolaus Copernicus (1473 – 1543) is known as a mathematician and astronomer, physician but not as an economist. Mathematics is the oldest of science and mathematicians were generally working in the field of astronomy when there was no systematic physics. With the knowledge of their mathematics, they were able to apply it to economic problems. During 1516–21, Copernicus was the economic administrator of Warmia, including Olsztyn (Allenstein) and Pieniężno (Mehlsack). During that period, he had written a manuscript, Locationesmansorumdesertorum (Locations of Deserted Fiefs), to populate those fiefs with industrious farmers and so bolster the economy of Warmia. His fields of interest were Mathematics, Astronomy, medicine and economics. Copernicus had advised King Sigismund, on monetary reform. He also participated in discussions in the East Prussian diet (parliament) [1] about coinage reform in the Prussian countries. Recommendations of Copernicus were tried by leaders of both Prussia and Poland to stabilize a currency. Gresham's Law, ' "bad" (debased) coinage drives "good" (un-debased) coinage out of circulation was written in a study on the value of money, Monetaecudendae ratio in 1526 by Copernicus, which predates by 70 years of before Gresham wrote. He also formulated a version of the quantity theory of money.

1.2 Origin of Gold Standard

Sir Isaac Newton (1642-1727) is known as a great mathematician and physicist. His explanation of gravity and his investigations into the properties of light had a profound impact and he is rightly regarded as one of the greatest scientists of his or any other generation. However, not many people know that he spent 30 years of his career at the Royal Mint [2]. Newton has spent a precious thirty years of his life contributing to economics, by reforming the coinage of England. He was also the master of the mint from 1699 to 1727, who overvalued Gold so that Gold became a standard in Great Britain.

Newton estimated that 20 percent of the coins taken in during The Great Recoinage of 1696 were counterfeit, while he was warden of the Royal Mint. Counterfeiting was high treason, punishable by the felon's being hanged, drawn and quartered. Despite this, convicting the most flagrant criminals could be extremely difficult. He conducted more than 100 cross-examinations of witnesses, informers, and suspects between June 1698 and Christmas 1699. Newton successfully prosecuted 28 coiners. [Wikipedia-20.04.2012]

Newton has also entered the stock market. He sold early in the South Sea Bubble of 1720 after doubling his investment and remarked that he could "calculate the motions of the heavenly bodies but not the madness of people." However, he was tempted back in again a few months later when he saw the market continue to climb exponentially.

He bought at the top of what was probably the worst stock market crash on record, losing a fortune of £20,000.

1.3 The actuarial foundations of life assurance

Edmond Halley (1656-1742) was the first to predict the return of the comet named after him, the Second Astronomer Royal Fellow and Secretary of the Royal Society. In 1691, Halley suggested that such a transit of Venus would be an ideal situation to make measurements from all locations of the Earth. Besides his work on astronomy, he laid the actuarial foundations of life assurance. In 1693, astronomer Edmond Halley created a basis for underwriting life insurance by developing the first mortality table [3]. He combined the statistical laws of mortality and the principle of compound interest. However, this table used the same rate for all ages. In 1756, Joseph Dodson corrected this error and made it possible to scale the premium rate to age. He laid the actuarial foundations of life assurance"[Ref-Westminster abbey]

1.4 Expected utility hypothesis & Bernoulli's formulation

Daniel Bernoulli (1687-1759) initiated a theory called the expected utility hypothesis in 1738. It is a theory of utility in which the "betting preferences" of people about uncertain outcomes (gambles) are represented by a function of the payouts, the probabilities of occurrence, risk aversion, and the different utility of the same payout to people with different assets or personal preferences. This theory could explain some popular choices that seem to contradict the expected value criterion, occurring in the contexts of gambling and insurance. Under expected utility theory, the people, who like to avoid risk, prefer what is surely available despite how much less it is. However, the people, who can take a risk, choose the high gain but riskier thing, maybe like gambling.

Bernoulli's formulation: Daniel Bernoulli proposed that a mathematical function should be used to correct the expected value depending on probability. This provides a way to account for risk aversion, where the risk premium is higher for low-probability events than the difference between the payout level of a particular outcome and its expected value. Bernoulli's paper was the first formalization of marginal utility, which has broad application in economics in addition to expected utility theory. He used this concept to formalize the idea that the same amount of additional money was less useful to an already-wealthy person than it would be to a poor person [4].

1.5 Physiocrat's Model

Francois Quesnay (1694-1774) was a physician, and a country surgeon, who applied his ideas of blood circulation to economic circulation, accordingly his economic model is known as Physiocrat's model. Galen's idea of blood circulation is that blood has a one-way flow from the heart to the organs where it is consumed. Quesnay's thinking is based on the systemic circulation of blood rediscovered by William Harvey in 1628. Circulation of blood became conclusive when Malpighi discovered the capillaries in 1661. Quesnay argued that blood was recycled. The interesting analogy in economic theory is that as for Galen arterial blood from the heart and venous blood from the liver is consumed by all organs, but for Harvey 'blood is recycled', so in neoclassical economics commodities flow one way to be destroyed by producing personal utility and in classical economics at least the output of "productive" labour is input to the next economic circle.

Quesnay in his early sixties, around 1750, became interested in economics. According to his thinking, the economic circle of commodities is similar to the blood circle. According to Quesnay, the heart plays the same role as agriculture in the social and economic system [2].

Quesnay's argument about "unproductive labour" was one of the central propositions in Classical economic theory from Adam Smith to John Stuart Mill. According to Adam Smith 'a widening of markets leads to increased production with decreasing unit costs because of a deepening of the division of labour and induced inventions refers only to mass production'. However, it did not apply to France because the artisans had a made-to-order production and the production of luxury goods offers normally no economies of scale. Smith intended to dedicate Quesnay to the "Wealth of Nations" had Quesnay not died before.

Quesnay's assertion that the future of France lay in agricultural development and not in the extension of present industrial structures is an analytical masterpiece not equalled. Quesnay's economic theory is normally based on the texts, which are read from the point of view of today's mainstream neoclassical theory.

1.6 Social Physics

Lambert Adolphe Jacques Quetelet (1796 – 1874): Quetelet was an expert in both natural and social science. He

had expertise and contributed significantly in the field of meteorology, demography, astronomy, mathematics, statistics, sociology, criminology and history of science. More importantly, he was one of the first people in introducing statistical methods to the social sciences. Quetelet was the enunciator of the word 'social physics', named so because he had applied probability and statistics to 'social science'. Social phenomena have a lot of complexity. He thought of measuring the variables it is associated with. He had tried to and aimed at understanding social phenomena such as crime rates, marriage rates or suicide rates using statistical laws and wanted to explain the values of these variables. His book Essai de physique Sociale, was published in 1835. It has also an English translation and is titled Treatise on Man; literally, its meaning is "On Man and the Development of his Faculties, or Essays on Social Physics".

1.7 Science of Society

Isidore Auguste Marie François Xavier Comte (1798 – 1857) Comte studied at École Polytechnique in Paris and then at the medical school at Montpellier.

Comte's positivist vision of sociology – August Comte was quite a visionary personality, who had predicted Biophysics, Geophysics, Sociophysics and Econophysics. He had developed a systematic classification of all sciences, including inorganic physics (astronomy, earth science and chemistry) and organic physics (biology and, for the first time, physique sociale, later renamed sociologie). In this way, he had almost unified all branches of science. Comte re-invented "sociologie,"(sociology) and introduced the term as a neologism, in 1838 (which has introduced by Emmanuel Joseph Sieyès in 1780). Comte had originally introduced the term "social physics," but it was appropriated by Adolphe Quetelet and he did not like to introduce it as he disagreed with Quetelet's collection of statistics. In his work 'The Course in Positive Philosophy' and 'A General View of Positivism he first described the epistemological perspective of positivism' There were five volumes, out of which the first three were devoted to physical sciences already in existence (mathematics, astronomy, physics, chemistry, biology), and the latter two emphasised the coming of social science. In this regard, Comte is regarded as the first philosopher of science [5]. He was also the first to distinguish natural philosophy from science. According to Comte, the physical sciences had necessarily to arrive first, before humanity could adequately channel its efforts into the most challenging and complex "Queen Science" of human society (sociology) itself.

1.8 Supply and Demand

Antoine Augustin Cournot (28 August 1801 – 31 March 1877) was a mathematician who worked at the University of Grenoble. He had earned a doctoral degree in mathematics, with mechanics as his main thesis supplemented by astronomy. He had also done some work in economics. His theories on monopolies and duopolies are quite famous. He was in favour of trying mathematical formulas in economics. In his book 'Researches on the Mathematical Principles of the Theory of Wealth' published in 1838, he used the application of the formulas and symbols of mathematics in economic analysis. He is famous for deriving the first formula for the rule of supply and demand as a function of price. His supply and demand curves predate that of Alfred Marshall by roughly thirty years.

Cournot is credited with the "one monopoly profit" theorem, which says that a monopolist can extract only one premium for being a monopolist, and getting into complementary markets does not pay. That is, the total profits a monopolist could earn if it sought to leverage its monopoly in one market by the extra profits it could earn anyway by charging more for the monopoly product itself. An exception occurs when the monopolist's market is price-regulated (Baxter's Law) [4].

Nowadays the works of Cournot are recognized in econometrics. Cournot also inspired Léon Walras to study political economy and was instrumental in his equilibrium theory.

1.9 Entropy as a measure of volatility

Rudolf Clausius (1822 - 1888) - After schooling, Clausius had gone to university in Berlin to study history, but switched to science. He became a professor of physics, first in Zürich and then later in Wurzburg and Bonn. According to Clausius, 'heat does not pass spontaneously from a colder to a hotter body'. This was the original statement of what has become known as the Second Law of Thermodynamics. Clausius further developed the idea that heat must tend to dissipate and in 1865, he introduced the term "entropy" as a measure of the amount of heat gained or lost by a body divided by its absolute temperature. An equivalent statement of the Second Law is that the entropy of an isolated system can never decrease: it can only either increase or remain constant. The concept of

entropy can be applied to describe the nonlinear dynamics of volatility. To study stock market volatility by applying concepts of physics, significant literature has already proven to help describe financial and economic phenomena [6].

1.10 Mathematical Method in Economics

William Stanley Jevons (1835-?) A natural scientist, was also a prolific writer on logic and economics. His book, The Theory of Political Economy (1871) was the beginning of the mathematical method in economics. He was the first person to enunciate the "final" (marginal) utility theory of value [2]. This marked the opening of a new period in the history of economic thought. His marginal utility theory of value was explained in his book 'General Mathematical Theory of Political Economy'. According to Jevons, the utility or value to a consumer of an additional unit of a product is inversely related to the number of units of that product he already owns, at least beyond some critical quantity. He also published a book 'A Serious Fall in the Value of Gold in 1863'. Other publications were The Coal Question (1865), Principles of Science (1874), The Theory of Political Economy (1871) and The State in Relation to Labour (1882)

The theory of utility was practically formulated around 1860 and according to him, "philosophy would be found to consist solely in pointing out the likeness of things." In his paper "A General Mathematical Theory of Political Economy", published in the Journal of the Statistical Society, he asserted that the degree of utility of a commodity is some continuous mathematical function of the quantity of the commodity available, together with the implied doctrine that economics is essentially a mathematical science. This led to the start of the Neoclassical Revolution in economics.

Applied economics: His opinion was that economics is a science. Therefore, he had some works on practical economics like A Serious Fall in the Value of Gold (1863) and The Coal Question (1865), which recognised him as a front rank writer on applied economics and statistics. His other works are Money and the Mechanism of Exchange (1875), a Primer on Political Economy (1878), The State in Relation to Labour (1882), Methods of Social Reform and Investigations in Currency and Finance (published after his death), The Principles of Economics: a fragment of a treatise on the industrial mechanism of society, and other papers (1905).

In his work "Commercial Crises and Sun-Spots", Jevons studied the statistics relating business cycles with sunspots. He argued that weather depends on sunspots and crops depend on weather, which may be the cause of the crises in the economy. He had constructed a logical machine through which the conclusion derivable from any given set of premises could be mechanically obtained. He had designed the "Logic Piano", a mechanical computer he designed and had built in 1869.

1.11 Micro Economics and Income Distribution

Vilfredo Pareto (1848-1923): Pareto was a civil engineer until his mid-forties. His interest in economics was developed only after that. Besides, he was a sociologist, political scientist and philosopher. The topic of his Ph. D thesis was "The Fundamental Principles of Equilibrium in Solid Bodies". It might have influenced him for his interest in equilibrium analysis in economics and sociology. He became a lecturer on economics and management at the University of Florence leaving his engineering job. He was a liberal and was attacking any form of government intervention in the free market. His contributions to economics are

- Income Distribution
- Pareto efficiency
- Pareto Principle etc

According to him, income follows a Pareto distribution, which is a power law probability distribution. Pareto gathered many data on the wealth and income of individuals of different countries through different centuries and found quite interesting results. He plotted the data on graph paper, with income on one axis, and the number of people with that income on the other, and it was striking to note that the picture is nearly the same everywhere in every era. It was very fat on the bottom where the mass of men live, and very thin at the top where sit the wealthy elite. Mandelbrot's summary regarding the curve is

"At the bottom of the Wealth curve, Men and Women starve and children die young. In the broad middle of the curve, all is turmoil and motion: people rising and falling, climbing by talent or luck and falling by alcoholism, tuberculosis

and other kinds of unfitness. At the very top sit the elite of the elite, who control wealth and power for a time – until they are unseated through revolution or upheaval by a new aristocratic class".

Pareto Principle –It was observed by Pareto in 1906 that twenty percent of the population owned eighty percent of the property in Italy, later it was generalised by Joseph M. Juran into the Pareto principle (also termed the 80-20 rule). In 1909, he showed the Pareto distribution of how wealth is true "through any human society, in any age, or country". The Pareto chart is a statistical tool that graphically demonstrates the Pareto principle or the 80-20 rule [2].

1.12 Financial Mathematics and Stochastic Processes.

Louis Bachelier [1870-1946] was a French mathematician and is considered a pioneer in the study of financial mathematics and stochastic processes (now called Brownian motion). Modelling stochastic process was part of his PhD thesis 'The Theory of Speculation' (1900) [2]. In his thesis, the evaluation of stock options has been discussed by use of Brownian motion. It is historically the first paper to use advanced mathematics in the study of finance. He developed the theory of diffusion processes which was published in prestigious journals. Bachelier's book 'Le Jeu, la Chance, et le Hasard' (Games, Chance, and Randomness), published in 1914 was one of the best sellers. It is to be noted that Bachelier's work on random walks was more mathematical and predates Einstein's celebrated study of Brownian motion by five years.

1.13 Relevance of Brownian Motion in the Stock Market

Albert Einstein(1879 – 1955) If two factories produce the same sort of goods, other things being equal, that factory will be able to produce them more cheaply which employs fewer workmen- i.e., that, with methods of production as they are today, only a portion of the available labour can be used. While unreasonable demands are made on this portion, the remainder is automatically excluded from the process of production. This leads to a fall in sales and profits. Businesses go smash, which further increases unemployment and diminishes confidence in industrial concerns and therewith-public participation in the mediating banks; finally, the banks become insolvent through the sudden withdrawal of accounts and the wheels of industry therewith come to a complete standstill. (Albert Einstein, 1934)

Einstein's paper on Brownian motion was on the motion of small particles suspended in a stationary liquid. This paper showed that the Brownian movement could be construed as firm evidence that molecules exist. Nowadays Brownian motion is relevant in the analysis of the stock market as it has desirable mathematical characteristics, where statistics can be estimated and probabilities can be calculated. M.F.M Osborne showed that the logarithms of common-stock prices, and the value of money, can be regarded as an ensemble of decisions in statistical equilibrium and that this ensemble of logarithms of prices, each varying with time, has a close analogy with the ensemble of coordinates of a large number of molecules. Using a probability distribution function and the prices of the same random stock choice at random times, he was able to derive a steady-state distribution function, which is precisely the probability distribution for a particle in Brownian motion. A similar distribution holds for the value of money, measured approximately by stock market indices. Sufficient, but not necessary conditions to derive this distribution quantitatively are given by the conditions of trading, and the Weber-Fechner law. It was shown in his paper that prices in the market did vary similarly to molecules in Brownian motion. R.N.Mantegna showed that the daily variations of the price index are distributed on a 'Levy' stable probability distribution and that the spectral density of the price index is close to one expected for a Brownian motion.

William Smith also applied Einstein's theory using the method of regulated Brownian motion to analyse the effects of price stabilization schemes on investment when demand is uncertain. He investigates the behaviour of investment when the price is random but subject to an exogenous ceiling, and with the aid of the mathematics of regulated Brownian motion, demonstrated that price controls mitigate the response of investment to changes in price, even when controls are not binding.

Albert Einstein: Physicist, Investor: Albert Einstein and his scientific achievements are world-renowned. Less well-known are his successes as a stock market investor. However, it turns out that, in less than 20 years, he and his adviser turned a few thousand dollars into more than $250,000. A share certificate signed by the world's most famous physicist, discovered in the US, fetched €28,000 in December 2005 in Berlin. It reveals that Einstein's 60 shares in May Department Stores alone doubled in value in six years. [From the Independent: Posted by Eddy on December 18th, 2005 at 6:35 pm]

Experimental Physics workshop

Venue: IIITA-AkhilIAPT Anveshika, IIIT Allahabad, Pryagraj
Date:09-10 August 2023 from 9:00 AM to 01:00 PM
No of Participants: 80
No of faculties/instructor Involved: 5
Resource Person: Dr Akhilesh Tiwari, Associate Professor (Physics)
Dr Pramod Kumar, Associate Professor (Physics)

On August 9thand10th 2023, a group of eager XIthand XIIthgrade students from KendriyaVidyalaya, Jhalwa embarked on an enthralling two-day educational excursion to 'Innovation Hub' of the Indian Institute of Information TechnologyAllahabad (IIITA)-Akhil IAPT Anveshika Lab. The objective of this enlightening journey was to introduce the students to the captivating realm of physics through innovative experiments, offering them hands-on experiences to deepen their understanding of fundamental concepts.The students' journey into the world of physics commenced with a warm welcome from the IIITA-AkhilIAPTAnveshika Lab team. The morning began with an insightful introductory session, acquainting the students with the lab's mission and the significance of practical learning in physics. The students engaged in a series of captivating experiments designed to stimulate their curiosity. The "Air Cannon" experiment had them mesmerized as they discovered the principles ofair pressure. The "Racing Track" experiment provided them with first-hand experience in understanding the concept of velocity."Harmonic Oscillation." Pendulums swayed rhythmically, demonstrating the concepts of periodic motion. The "Plasma Sphere" experiment illuminated the mysterious behavior of electromagnetic fields. The "Crystal Structure" experiment took them on a journey into the atomic arrangement within solids, unveiling the secrets of crystalline formations. The students also witnessed the "Rotational Dynamics of a Bicycle Wheel," marveling at the principles of angular momentum and rotational inertia. The "Analysis of Vibration System" experiment showcased the intricacies of mechanical vibrations and their applications, igniting curiosity about the unseen forces shaping our world. The captivating "Lissajous Figures" experiment brought the synchronization of oscillations to life, captivating the students with its visual representation.The visit was a testament to the power of hands-on learning. The students were exposed to a diverse range of physics experiments that went beyond textbooks, inspiring a new level of interest and understanding. From mechanical wonders like the bicycle wheel experiment to the ethereal beauty of Lissajous figures, the students absorbed the practical application of complex principles. The two-day educational visit of KVJhalwa students to the IIITA- Akhil IAPT Anveshika Lab was an immersive experience that deepened their understanding of basic physics concepts. The hands-on experiments provided valuable insights, leaving the students not only with newfound knowledge but also with a burning curiosity to explore the world of physics further. Such educational initiatives serve as catalysts for nurturing young minds passionate about science and innovation. The journey was witnessed with the great presence of great Educationist Prof. K B Pandey, Ex-VC Kanpur University, and Ex- Chairman UPPSC.

Akhilesh Tiwari,
Coordinator

Golden Jubilee Celebration of IAPT Innovation Hubs in India

The journey of Innovation Hub as Science Gallery with the theme: Play Enjoy and Learn, through the innovative experimental models has started from Jaipur to HMV College Jalandhar, Punjab, in April 2018, initiated by Dr. MinakshiSiyal. In the last five years, the IAPT RC-6 has taken it up to design developed and installed in over 50 institutions across INDIA.

The concept of science through experimental demonstration has been a legacy of late Prof. B L Saraf and Prof. D P Khandelwal pioneer builder of the IAPT, since 1984 and even the leading Centre for Development of Physics Education at University of Rajasthan, Jaipur has been a key source of inspiration and motivation.

Innovation Hub

We have developed over 50 working models so far and any institution can chose any 5,10,20 or 30 models to be housed in a Hall, size 500-1000 sq. ft.

A set of flexes of the fundamental discoveries and contributions of Indian scientists has been compiled and displayed.

Handouts and literature has been developed on each models with operating instructions and parameters.

All innovation hubs are personally installed, demonstrated and Training is provided to teachers for further use.

Prof. Y. K. Vijay, Director – Centre for Innovation in Science Teaching (CIST) IIS University Jaipur, has been Vice-Chancellor, Vivekananda Global University Jaipur, Professor, Department of Physics, Director, Centre for Development of Physics Education, and Director, Centre for Non-conventional Energy Resources at the University of Rajasthan, Jaipur, India. He received his M.Sc. degree in Physics and a PhD degree from the University of Rajasthan, Jaipur (India) in 1975 and 1980 respectively. He has spent one year at Uppsala University Sweden. Prof. Vijay is a passionate science teacher who has led the development of many innovative working models for teaching and learning Physics through simple instruments as INNOVATION HUB.

All the models of innovation hub are fabricated by Mr. K C Sharma, Retd. From CDPE.

The List of Innovation Hubs installed at different institutions includes, Government and Private Schools, Colleges, universities, IISER, IIEST and Science Museum and Adventure Parks.

1. Vivekananda Global university Jaipur
2. Hans Raj MahilaMahaVidyalaya Jalandhar
3. SV Public School Jaipur
4. Rani LaxmibaiMahilaMahavidyalayaParolaJalgaon
5. Amity University Noida
6. Govt. College Kota
7. KanyaMahavidyalaya Jalandhar
8. Regional Institute of Education, Bhubaneswar
9. Bajaj Science Centre Wardha
10. GLA University Mathura
11. University of Kota, Kota
12. IIS University Jaipur
13. Anaveshika Jaipur
14. SS Jain Subodh College Jaipur
15. Amit University Jaipur
16. Pune University Pune
17. Scince Park Chandarpur
18. Regional Institute of Educaation, Ajmer
19. Bansur PG College Bansur (Alwar)
20. Pryan Innovation Sanganer Jaipur
21. DAV CollgeBathinda
22. Amity University Raipur
23. Rawat Public School, Pratap Nagar Jaipur
24. Ben Hur Public School Pilibhit UP
25. Adventure Park, New Kufri, Shimla
26. Midnapore College, Midnapore, WB
27. SD College Barnala Punjab
28. Govt Model Sr Dec School, Thana Kalan HP
29. DPS School, RudrapurUttrakhand
30. Dr H N Regional Science Centre Hosur, Karnataka
31. IIS School Sitapura Jaipur
32. IISER Kolkata, West Bangal.
33. Sri VaishnavVidyapeeth University Indore MP
34. IPS Academy, Khandawa road, Indore Madhya Pradesh
35. Mahrawal Government Sr. Sec. School, Dungarpur, Rajasthan
36. Veer Bala Government Girls College, Dungarpur
37. Guru Nanak Public School, Ballarsha, Maharashtra
38. Marwadi University, Rajkot, Gujarat
39. Maharani College Jaipur
40. Government Senior secondary school, Charatgarh HP
41. Government Senior secondary school, Basderah
42. IIIT Allahabad Prayagraj Uttar Pradesh
43. Government Model Senior Secondary School, Amb HP
44. Government Model Senior Secondary School, Mubarikpur HP
45. Government Model Senior Secondary School, Saloh, HP
46. Government Senior Secondary School, Takoli, HP
47. Government Senior Secondary School, Dhundala, HP
48. Government Senior Secondary School, Kangar, HP
49. Government Senior Secondary School, Pubwal, HP
50. Government Senior Secondary School, Samoor Kalan, HP
51. Government Senior Secondary School, Basal, HP
52. Government College, Dharmshala Himachal Pradesh
53. Indian Institute of Engineering Science and Technology, Shibpur, Kolkata WB
54. Inter University Accelerator Centre, New Delhi

Y K Vijay

Report

POLLEX IX– Ninth Signature Workshop of the IAPT-APhO cell (Patna Aug 4-5-2023)

The atmosphere was electrifying as over 300 (317 to be precise) eager students packed a large hall to attend the inauguration of the two-day signature workshop of the IAPT-APhO cell at the Shoshit Samadhan Kendra (SSK) in Patna on August 4. Prof Vijay Singh delivered the keynote address highlighting the glorious saga of the Indian Olympiad effort. Additionally, he sketched the large number of choices students have in science post higher secondary school. Prof. Ravi Bhattacharjee, the doyen of the Indian APhO effort, Coordinator (2006-2023) described how proper planning and procedural understanding are the *sine qua non* in every experimental task. The talk was illustrated with concrete examples of the Large Hadron Collider and the James Web Space Telescope. Prof. Utpal Roy, IIT Patna got the students enthused with a simplified and comprehensible presentation of Quantum Technologies: Quantum Computing Cryptography and Teleportation. The students performed experiments in physics and chemistry in the afternoon, eagerly supported by resource persons and the teachers of the schools from where these students had come. It provided an excellent opportunity for the resource persons to interact with the teachers and they learnt much from it. Prof. Pramendra Ranjan Singh, Principal, Narayan College, JP University. led a chalk and talk session on fundamental physics.

Additionally, Prof. Ravi Bhattacharjee led them through a diagnostic session with questions posed by him and answers provided by students in a give and take oral exchange.

The next day began with a one-hour official diagnostic test, The famous Force Concept Inventory has been translated into Hindi earlier by two of us (the authors of this article) – and is on the website of the American Physics Teachers Association. It is this Hindi version which was administered to students. Some students had difficulties with terms and they were clarified. It also helped us understand how to reword some parts of the Hindi translation. Prof. Santosh Kumar of Pataliputra University and an erstwhile member of IAPT, conducted an interactive session where he showed videos of phenomena and posed puzzles to students and asked students to solve them. Prof. Manoranjan Kar, IIT Patna, conducted a long interactive session on errors and measurements. He had students measure various lengths and times and pointed out the errors one makes in these simplest of undertakings. It was an eye opener. Additionally, students had questions on how they should study physics and which books they should use.

Prof. Kar gamely answered them. Prof. Vijay Singh gave a talk on scaling laws in the Natural World. Students pursuing Biology found it very useful. The afternoon session was once more on experiments. Finally, the diagnostic test conducted in the morning was discussed by Prof. Pramendra Ranjan Singh and Dr. Himanshu Pandey..

As mentioned earlier there were 317 students. They had come from 21 different schools across Bihar, eastern rural UP and some from W. Bengal. There were equal number of boys and girls. Most sessions were interactive and students were enthused and fully engaged. The feed backs were very encouraging. In addition to the major resource persons, the teachers accompanying the students – formed an additional pool of resource persons. Special mention must be made of the teachers of SSK in particular the Vice Principal Girish Sinha. The event was organized jointly by the IAPT-APhO cell (Bihar Chapter), IAPT Bihar Regional Council (RC-19) and the Shoshit Damadha Kendra (SSK).

The valedictory session was held at 4 pm on the 5th. The top 15 students in the Diagnostic Test were feted. Once again, the doyen of the APhO effort in India, Prof. Ravi Bhattacharjee delivered an inspirational speech mixing it with information about the APhO program. Dr Himanshu Pandey, the Principal of SSK delivered a vote of thanks.

We may note that:

Shoshit Samadhan Kendra (SSK) is a residential CBSE school for the most underprivileged and exploited section of Bihar, namely the Musahar community. The students are selected from all 38 districts of Bihar at a young age and fully supported and privately funded by the Kendra till higher secondary stage. It is a venture unique to India, a shining example of how, we educationists, can bring our principles into practice. The father of our nation, Mahatma Gandhi would have been proud of such an initiative.

POLLEX stands for Phenomena based Olympiad Level Experiment. Pollex also refers to the “thumb" and it is the evolution of our “opposable” thumb which complements the other four fingers and bestows tool handling abilities on us humans. POLLEX has become the signature workshop of the Asian Physics Olympiad cell of IAPT, an activity which introduces students and teachers at the Pre-University level and UG level to challenging experiments and theories.

Himanshu Pandey
Vijay A Singh

Announcement

IAPT Exemplar RC Award-2023

We congratulate the recipients of IAPT Exemplar RC Award-23.
Shreshtha: RC 01 (Delhi & Haryana)
Uttama: RC 12A (Bangalore)
Ananya (Special Mention): RC-08B (Mumbai) (Exceptional achievement: Impressive increase in student enrolment for IAPT National Standard Examinations)
On behalf of IAPT, I sincerely thank our esteemed jury members, Dr. C. Vijayan (Retd Professor, Dept of Physics. IIT Madras, Chennai) and Dr. Manjit Kaur, (Retd. Professor, Dept of Physics, Panjab University, Scientist, LHC CERN) for their efforts to complete the task of evaluation.

Rekha Ghorpade
General Secretary

National Graduate Physics Examination

(NGPE) Part-C

Centre: Shri Vaishnav Vidyapeeth Vishwavidyalaya Indore

National Graduate Physics Examination is a prestigious national examination conducted by Indian Association of Physics Teachers (IAPT) every year since 1987. This exam aims to assess the theoretical and experimental knowledge of physics among graduate-level students across India. NGPE - 2023 received the immense participation, with a total of 5,724 enrollments from 226 centers across the country. From this pool of talented students, top 1% have been declared as National toppers while the next 1% state wise have been declared as State toppers Over all the top 25 examinee from the entire country were identified to take part in NGPE - 2023 Part C (An examination in experimental skill) at a designated center.

Shri Vaishnav Vidyapeeth Vishwavidyalaya honored to host this year's NGPE – 2023 Part-C (Final round in experimental skill) of this examination. To ensure the smooth conduct of NGPE Part C, several committees were formed at SVVV Indore. The committee members were nominated from experienced faculty members, administrative staff, and volunteers. The experienced faculty members from institutes other than SVVV Indore were also the part of working team.

Regular meetings were conducted with IPAT post bearers to discuss the progress of NGPE Part C preparations and arrangement. These meetings provided an opportunity to address any concerns, exchange ideas, and seek guidance from experienced individuals in the field of Physics education. The collaboration with IPAT post bearers helped to ensure that the NGPE Part C examination adhered to the highest standards and met the expectations of the Physics teaching community.

The NGPE Part C examination focused on practical aspects of Physics, testing the students' ability to apply theoretical concepts to real-life scenarios. The design of experiments was carefully crafted to evaluate the candidates' scientific knowledge, critical thinking skills, and problem-solving abilities. The experiments covered a wide range of topics, providing a comprehensive assessment of the students' understanding of Physics principles. In all the following four experiments with 6 sets each were designed and developed to conduct the eaxamination.

Experiment- 1: To plot the intensity profile at various distances from the end of the optical fiber and to find the acceptance angle and numerical aperture of the optical fiber.
Mentor: Dr. J T Andrews, SGSIITS Indore
Internal Faculty: Dr. Aarti Sharma & Dr. Manvendra Kumar, SVVV Indore

Experiment-2: To Design a regulated power supply using Zener diode to deliver 5.3 V, 30 mA to the given load.
Mentor: Dr. Preet Jain, SVVV Indore
Internal Faculty: Dr. Nitu Katariya & Shriraz Hussain SVVV Indore

Experiment-3: To find the wavelength of the laser beam using a thin wire A of known diameter and then to find the diameter of the wire B of unknown thickness.
Mentor: Dr. Usha Singh, IPS Academy, Indore
Internal Faculty: Dr. Shweta Mishra & Dr. Ravi Vanshpal SVVV Indore

Experiment-4: To measure the total emittance from four different surfaces of a given solid block and to plots the radiated power at different temperatures to validate Kirchhoff's law of thermal radiation.
Mentor: Dr. J T Andrews, SGSIITS Indore
Internal Faculty: Dr. S.Thakur & Pragya Palod SVVV Indore

To guide the candidates for the NGPE - 2023 Part C examination, a comprehensive manual was prepared for each experiment. The manual contained detailed instructions, guidelines, and information about the experiments, including safety measures. The manual served as a valuable resource for both the candidates and the examiners, ensuring a standardized and consistent examination process.

Dr. Vasant Sathe, Center Director, UGC-DAE, CSR, Indore, inaugurated the NGPE Part C program on June 3, 2023 at Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore. Dr. Upinder Dhar, Vice Chancellor, SVVV Indore welcomed all the dignitories and participants. Dr. P K Dubey, Coordinator NGPE and Member IAPT executive council, provided the audience with insights into the various activities conducted by IAPT-RC-09. Dr. B.P. Tyagi, Chief Coordinator (Examination) IAPT, delivered a brief overview of NGPE, highlighting its objectives and significance. In the Keynote address, Dr. Sathe emphasized the importance of scientific excellence and the cultivation of a scientific temperament among students.Dr. Uttam Sharma Prof & Head, Department of Physics, SVVV and Convener NGPE - 2023 (Part-C) proposed the vote of thanks. Along with the participants of NGPE (Part C), Dr. Santosh Dhar, Dean Research ,SVVV, HOIs and HODs of Institutions constituted by SVVV, and Academicians from various institutes of Indore were also present in the inugration ceremony. On Sunday June 4, 2023, sharp at 9 am, Prof. B P Tyagi first took a briefing session of the participants. Out of 25 participants only 10 examinees

could reach Indore for the examination. Some of them might have missed their trains because of severe train accident in Odisha on 2.6.23. All the participants were divided into four groups to perform the four experiments…….

Faculty members Dr. S. Thakur, Dr. Shweta Mishra, Dr. Nitu Katariya, Dr. Ravi Vanshpal, Dr. Aarti Sharma, Dr. Pragya Palod, Dr. Manvendra Kumar from the Physics department were assigned to oversee the NGPE Part C examination. The internal faculty members' expertise contributed to the smooth execution of the examination process. Lab Assistants from SGSITS and SVVV assisted the faculty and the students in execution of the examination in experimental skill.

To ensure unbiased evaluation of the candidate's performance, external judges were invited to assess the NGPE Part C experiments. The evaluators, selected on the bases of their expertise and experience, provided valuable insights and evaluations. The involvement of Dr S K Joshi from Ratlam (Retd Prof), Dr. B.D. Shrivastava, Govt. P.G. College Indore, Dr. Y.Choyal, School of Physics DAVV Indore, Dr. J.T. Andrews, SGSITS Indore, Dr. V.K Gupta , Govt. Girls P.G. College Ujjain , Dr. Usha Singh, IPS Academy, Indore and Dr. Manish Joshi, Medicaps University, Indore added credibility and impartiality to the examination process, reinforcing the significance of fair and accurate assessment. Prof Devesh Kumar Tyagi from DAV Post Graduate College Muzaffar Nagar (UP) and the President RC – 4 (UP) and Prof P K Dubey Coordinator NGPE were supervising the entire process of the examination.

Finally on adding the marks of all the parts A, B and C of NGPE-2023, Six Gold medals (One Tie) were declared at the end. Names of the gold Medalists are as follows.

S.No.	Name	Institute Name
1	RINKU	Panjab University Chandigarh
2	HEERAK SHARMA	Indian Institute of Science Education & Research Pune (MS
3	PANCHAJANYA DEY	Indian Institute of Science Bangalore
4	VIVEK GURUNATH SABARAD	Indian Institute of Science Education & Research Pune (MS)
5	SHARDA	Hansraj College DU Delhi
6	ANUBHAV SRIVASTAVA	Indian Institute of Science Bangalore

All the six students will be awarded a cash Prize of Rs. 20000/- and a gold medals in the annul convention of IAPT on 8.10.20 in Jaipur.

At the end Prof. B P Tyagi expressed his thanks to the management of SVVV Indore for allowing the conduct of NGPE - 2023 Part C at Indore and for the entire arrangement for successful conduct of NGPE - 2023 (Part-C).

Uttam Kumar Sharma
Prof and Head of Physics Department
Indore

PK Dubey
National Executive Committee Member SVVV
and Coordinator NGPE

Basic Skills in Experimental Physics

IAPT RC-6 actively organized two-day sessions in the One Week National Faculty Development Program on 'Basic Skills in Experimental Physics' organized by the Physics Department, Daulat Ram College, University of Delhi from July 17-23, 2023.

The event was held in collaboration with University of Delhi's Skill Enhancement Courses Committee, GAD-TLC, under the Ministry of Education's PMMMNMTT scheme at SGTB Khalsa College and Physics Department, Daulat Ram College, DU.

The **Resource Persons** of the workshop, **Prof. Y.K. Vijay**, President - IAPT RC-06 and Director - Centre for Innovation in Science Teaching (CIST), IIS University, Jaipur, and **Dr. Vipin Kumar Jain**, Executive Committee Member, IAPT RC-06 and Associate Professor-Physics & HoD, JK Lakshmipat University, Jaipur conducted interactive workshop on **20th and 21st July 2023**.

Active participation of about 40 teachers of Physics, Electronics and Physical Sciences from about 10 different constituent college of University of Delhi (DU) made two days' workshop very meaningful and mesmerized. Participants were very curious and had long discussions about development of the projects which can be used as teaching ads during their classroom teaching. After attending the workshop, participants could realize that experimental demonstration and hands-on activities during the lecture not only can bring attention of the students but also can develop interest and better understanding of the subject.

Workshop was started with introducing IAPT RC06 activities and contribution of Prof. B.L. Saraf who was highly passionate teacher of experimental physics followed by celebration of Prof. B.L. Saraf Centenary year. Prof. Vijay and Dr. Jain explained scientific concepts with hand-on experiments on measuring Sparking potential and Relative dielectric constant of medium by Hertz Experiment; Behavior of flame in high potential; Refractive Index of liquid by prism; atomic configuration, defects in solids; hanging/ floating magnets; vibration modes; Bohr Model; Concept of nuclear force and α-particle decay with Lorentz Oscillator; Doppler effect and it's applications; Thermal conductivity in solids; Heating effect with resistive wire; Fuse; Electric Bulb and Brightness; Interference in water waves; Interference in thin film using glass slides; LASER and Diffraction with Single slit, double slit, grating, CD and DVD and Concept of data storage; Raman effect; TIR and Optical fiber; generation and storage of hydrogen as fuel, etc. Under Hands-on activity, participants also made models of Manometer (Using pipes and balloon); Submarine dynamics (Using small and larger size plastic water bottles); and Vortex formation using plastic bottles in the workshop to understand the concept of pressure, density, surface tension respectively. Participants were very excited to learn these cost-effective scientific models which are very useful for developing scientific temperament.

Resource Persons Prof. Y.K. Vijay and Dr. Vipin Kumar Jain thanked all the participant for their active involvement during the workshop and invited them to attend **IAPT Convention-2023**, being Chairman and Co-Convener respectively, scheduled on **October 7-10, 2023, at Jaipur**. Dr. Yogesh Kumar, Secretary, IAPT RC01, and Dr. Poonam Jain, EC Member IAPT RC-01 briefed about registering for IAPT Membership as well as activities of IAPT-RC01. The two days' workshop during the one-week FDP ended with vote of thanks delivered by **Prof. Savita Roy, Principal, Daulat Ram College, University of Delhi, Delhi**. Active involvement and enthusiasm of participants, and coordinating team which include Dr. Omwati Rana, Dr. Manoj Giri, Dr. Shivani Agarwal, Dr. Nisha Bala, Dr. Renu Singla, Dr. Nirmala Saini, Dr. Onkar Mangla, etc. made the event a grand success.

Y K Vijay
Vipan Jain

Letter to Editor

I appreciate the attempt by D.Syam and R. Bhattacharya to apply the theoretical knowledge to solve simple problem in an article in July 2023 bulletin. I thank both of you.

Jambu Nandagawe

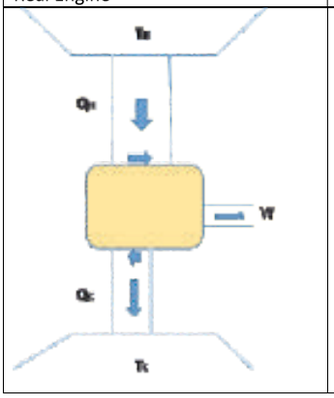
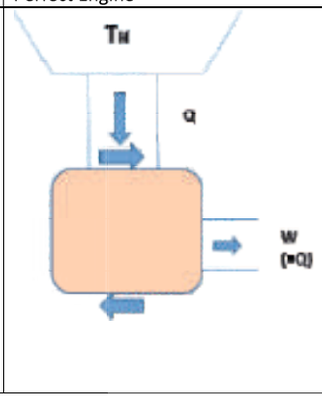
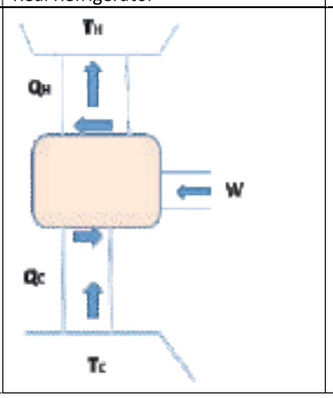
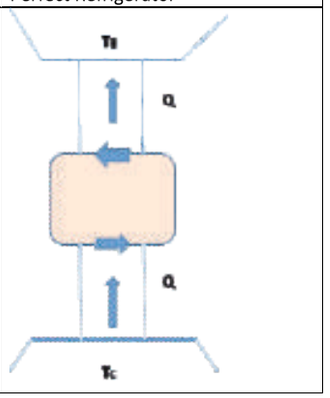
Erratum

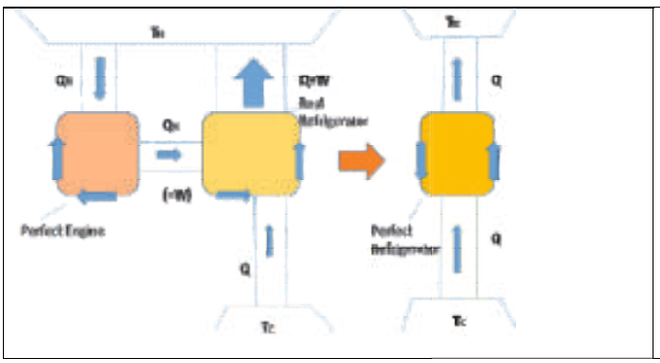
'A Perfect Engine is Equivalent to a Perfect Refrigerator And Vice-Versa', Bull Indian Association of Physics Teachers 15 (July 2023) 210-11

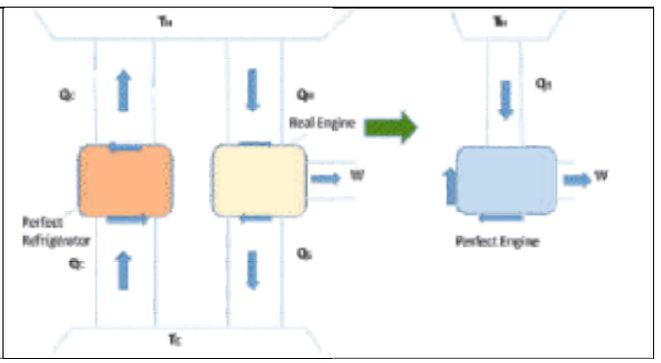
Dulli Chandra Agrawal, Banaras Hindu University; dca_bh@yahoo.com

The Figure 2 in the original manuscript was published in portrait orientation and that's why major portions of the same were missing. Here we are reprinting the fig.

The second law of thermodynamics can also be expressed as 'engine has to be real and one cannot have a perfect engine; also the refrigerator has to be a real one and it can never be a perfect refrigerator'. If a perfect engine could be designed then it is equivalent to having designed a perfect refrigerator and vice-versa. Here we demonstrate below in second row through diagrams the equivalence of each statement.

Real Engine	Perfect Engine	Real Refrigerator	Perfect Refrigerator
			





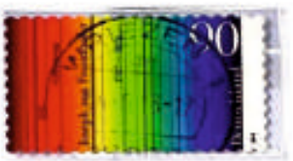
The Story Of Cosmology Through Post Stamps 58

SOLAR ECLIPSE

SCINTIFIC IMPORTANCE

A Total Solar Eclipse is an ideal opportunity for scientist and researcher to study the Sun under conditions, impossible to attain any other time, as crisp lunar shadow revels the corona's inner and middle part in visible light. After discovery of Photography and Spectroscopy and other scientific advancement various important discoveries are made and theories are tested. Some are: property of Solar Maxima, features of Corona, Discovery of chemical element like Helium, Discrepancy between temp between Corona and photosphere, support for the general theory of relativity.

Eclipse of may29,1919, allowed Arthur Eddington to confirm Einstein's prediction of *general relative space time distortion* in a gravitational field by confirming *Gravitational Lensing*



The element Helium was discovered on 18 Aug.1886 by Jules Janssen in the *spectrum* of light from Corona taken during total solar eclipse.

Postally Used Commemorative Cover bearing forever stamp- **of total solar eclipse, June20,2017. These stamps are printed with *thermochromatic* ink consist of two superimposed images.One image show Total Solar Eclipse and second image show full moon, which revel upon warming**

Postal Regd. No. Kanpur City-28/2021-23 Date of printing 01-09-2023 Date of posting 08-09-2023 RNI No. UPENG/2009/29982

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