Advanced Innovation HUB

उन्नत नवोन्मेष अभिकेन्द्र

INDIAN ASSOCIATION OF PHYSICS TEACHERS

Regional Council - 6, Rajasthan

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Foreword

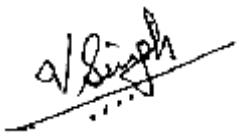
It is with great pleasure that I write this foreword. Experimental science is the Achilles heel of science education in our country and is given short shrift. The emphasis on theory has a led to a skewed scientific environment. The present work comes as a breadth of fresh hair.

I am familiar with some of the experiments and remedial activities undertaken by the Innovation Hub. They are not the typical run of the mill experiments compelling the students to repair to nuts and bolts physics laboratories and go through the drudgery. On the contrary, they pose a challenge to the student inviting her to think and innovate. Attempting (even unsuccessfully) one of these experiments is an excellent exercise in what education experts call "active learning or inquiry". It is an effective instructional method, indeed the cornerstone of successful physics education. The book comes as a breadth of fresh air.

The experiments were designed by enthusiastic members led by our colleagues in Rajasthan (RC-6). The experiments cover statistics, sound, optics and magnetism. There are descriptions of experiments in modern physics, usually a difficult topic. The only lacuna I find is a separate, well considered article on safety in physics experiments.

In view of the new education policy of the Government of India, we need to have more emphasis on the vocational training. This innovation hub can be very well be used as a training centre for learning to design and fabricate small models through commonly available materials and components. I applaud the efforts of Prof. Y K Vijay and the late respected Prof Babu Lal Saraf.I wish success to the team for the wonderful efforts to serve the teaching community, an important goal of IAPT.

"Door meten, tot weten" – through measurement to knowledge is a saying which adorned the entrance of the laboratory headed by the discoverer of superconductivity, Kammerlingh Onnes. I wish this innovative book all success.



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MESSAGE

The initiation of the Innovation Hub at India International School, with an intention to harbour the Scientific temperament amongst the millennial has proved fruitful as it serves the need of the hour where innovation along with the pragmatic approach to teaching and learning go a long way in bringing about joyful learning.

For an institution to have a dedicated corner for Centre for Innovation in Science Teaching (CIST) is appreciable and commendable where fundamental Science principles are displayed through working models. The faculty can now bring their students to enjoy learning through doing.

IIS started it with a modest beginning of 20 models, which has now extended to 40 models. This speaks volumes of its success story.

I take this opportunity to congratulate Prof. Y.K. Vijay, Director, IISU, and wish him to lead this concept and them with other faculty in this IIS Network.

Dr. Ashok Gupta

Preface

Innovation is a gift of nature for every one, each individual likes to do things, activity or express ideas, which may be unique and useful for others. In the growing society, quality of life, the value of education, has importance of traditional ways of learning as well as, make a leading role in identifying any one to be distinguishable.

In order to enhance the creativity and skill in Education of Basic Science and Engineering, we believe that Centre like INNOVATION HUB is very essential part of a Quality Education, where visitor can get a feel that how the great scientific innovations might have evolved through small efforts of the beginner.

The Innovation Hub, is an independent place of Learning, inspiration, motivation, recreation, discussion, observation, information, imagination and thinking.

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प्रस्तावना

नवीन आविष्कार प्रकृति का वरदान होते हैं। वे प्रत्येक व्यक्ति को नवीन कोशिशें करने, विचार व्यक्त करने और उन्हें दूसरों के लिए उपयोगी बनाने के लिए प्रेरित करते हैं। प्रगतिशील समाज में लोगों के जीवन स्तर के उत्थान हेतु शिक्षा के मूल्य हमें यह बताते हैं कि व्यक्तिगत तौर पर सीखने व सोचने के सामान्य तौर तरीकों से हटकर हमें कुछ करना चाहिए।

युवा वर्ग में रचनात्मकता एवं कौशल के उत्थान हेतु नवोन्मेष अभिकेन्द्र जैसे केन्द्र बहुत उपयोगी होते हैं। यहां आकर व्यक्ति को यह लगता है कि किस प्रकार छोटे-छोटे प्रयास एक बड़ा कार्यरूप ले लेते हैं।

नवोन्मेष अभिकेन्द्र, सीखने, प्रेरित होने, प्रेरणा प्राप्त करने, समझ को पुर्नव्यवस्तित करने, विचार करने, प्रेरणा प्राप्त करने, सूचना प्राप्त करने, कल्पना करने तथा विचार करने हेतु एक आधार केन्द्र हैं।

यहां आकर कुछ सीखने हेतु आप आमंत्रित हैं।

प्रो. (डॉ.) वाई.के. विजय

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Objectives and Need

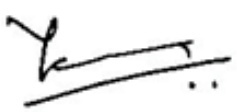
"I wasn't dreaming of developing the GPS," says Professor Emeritus Dan Kleppner, who in 1960 helped invent the hydrogen maser, an atomic clock that's now at the heart of satellite-based global positioning systems. "With basic research, you don't begin to recognize the applications until the discoveries are in hand," he says. "In my view, basic science is the best thing that mankind pursues--not so much because it leads to new applications but because it leads to new understanding. For me, there's no greater pleasure than the joy of discovery."

Research is considered as a major component of innovation and a key to the development of modern societies. However, fundamental research, which essentially aims at improving our understanding of Nature, is often questioned about its specific role. In practice, fundamental research has led to many important applications that, almost without exception, were not anticipated at the time that the work was undertaken. Most applications cannot be foreseen; and, the period between a fundamental discovery and eventual applications is often very long compared to the criteria normally used by investors.

It is of course well known that fundamental studies of electromagnetic fields by Hertz and Maxwell underpin radio and television, developments that they clearly could not have imagined. The laser also falls into that category. The first working laser was built by Theodore Maiman in 1960. This idea came directly from atomic physics and, in particular, from principles of stimulated emission discovered by Einstein several decades before. With the subsequent development of gas lasers, these intense and coherent light sources found applications in experimental physics, enabled holographic and interferometric studies, and later were used for range finding and surveying.

But the most important applications came with the development of solid state lasers and their use in fibre optic communications. Lasers are now used throughout the world in medicine, in consumer electronics, and in scanning and printing technology. Modern communications and data storage technologies depend on laser optics and in the next decade or so, optronic laser-based computers will supersede the electronic systems of today.

So to develop a momentum in the minds of young students they need to see the objects working in this direction. Innovation HUB is a unique place for such type of activities. We invite you all (Faculty members and students) to visit and get enthralled.



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लक्ष्य एवं निमित्त

प्रोफेसर डान कैपलर जिन्होंने 1960 में हाइड्रोजन मेसर के विकास में प्रमुख योगदान दिया था, का कहना है कि ''मैंने जीपीएस को विकसित करने की बात नहीं सोची थी''। यह तकनीक आज सैटेलाइट द्वारा ग्लोबल पोजिशनिंग प्रणाली का हृदय है। वह आगे कहते हैं कि आप नहीं जानते कि आज की मूलभूत रिसर्च किन प्रणालियों व मशीनों के आविष्कार का कारण बनेगी। अतः समाज में मूलभूत अनुसंधान जारी रहने चाहिए क्योंकि यह हमें चीजों की समझ विकसित करने में मदद करते हैं। अविष्कार करने या उससे जुडे रहने से बड़ी इस दुनिया में कोई प्रसन्नता की बात नहीं हो सकती है।

नवोन्मेष का मूल अनुसंधान ही है जो कि समाज के उत्थान का कारक बनता है। हालांकि मूलभूत अनुसंधान प्रकृति के बारे में हमारी समझ विकसित करता है, लेकिन इसके विशिष्ट रूपों की उपयोगिता अभी भी विचार विमर्श का विषय है। व्यवहारतः मूलभूत अनुसंधान ही विशिष्ट अनुप्रयोगों के विकास का कारण बनता है चाहे इन दोनों के विकास में समयान्तराल कितना ही हों।

उदाहरणार्थ हर्टज और मैक्सवैल द्वारा प्रतिपादित विद्युत चुम्बकीय सिद्धान्त रेडियो और टेलीविजन का मूल है, जो उन्होंने नहीं सोचा होगा। लेजर भी कुछ इसी प्रकार का उदाहरण है, 1960 में थेयोडोर ममन ने लेजर का आविष्कार किया जो आइन्सटीन द्वारा प्रतिपादित सिद्धान्तों पर आधारित था। आज लेजर चिकित्सा, अनुसंधान, रक्षा, सिविल यांत्रिकी तथा अन्य क्षेत्रों में जो योगदान दे रह है उस समय सोचा भी नहीं गया होगा।

अतः युवा मस्तिष्क को चीजें काम करती दिखाई दे तथा उनके मूल सिद्धान्त आसानी से समझ में आयें इसे ध्यान रखते हुये नवोन्मेष अभिकेन्द्र की स्थापना की गई है।

हम आप को सीखने व प्रेरित होने के लिए आमंत्रित करते हैं।

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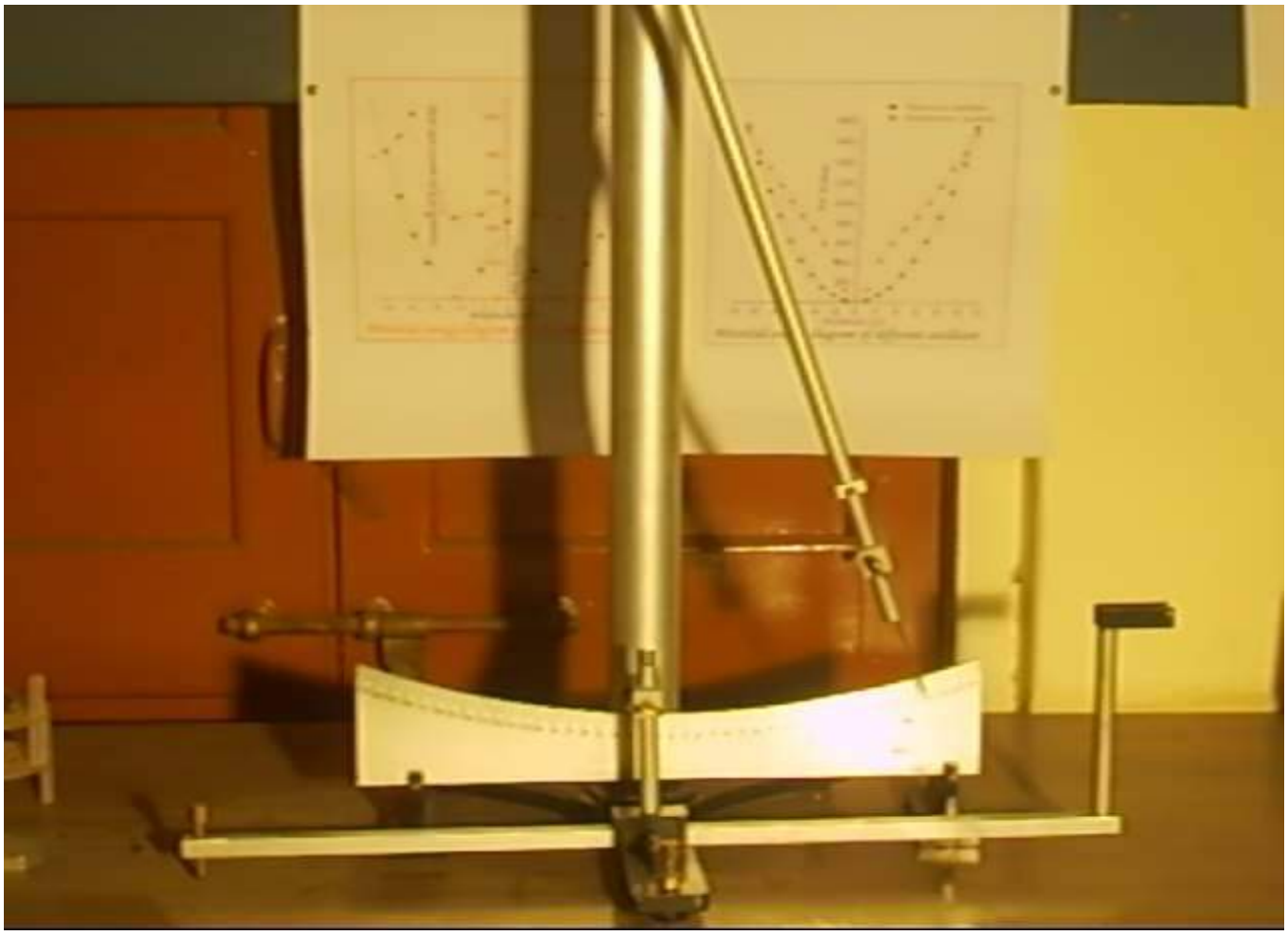
Contents

Contents

An-harmonic Oscillator

- In Harmonic Oscillator : Restoring Force $F = - k x$
- In An harmonic Oscillator : $F = - k x + c/x^2$
- In this arrangement, a bar pendulum with a magnet clamped at the bottom and another magnet fixed at the stand.
- The bar pendulum with two combined restoring forces, one due to gravity and other due to magnetic interaction results in non linear restoring force.
- Thus Potential Energy Diagram is non parabolic
- Time period becomes amplitude (x) dependent.



Angular Momentum Conservation

- When a wheel spins about it's axis, it acquires an angular momentum, depending upon mass distribution and angular speed.
- When we hold it in our hand and try to change the axis of rotation, we feel additional force called torque.
- When we sit on a freely revolving chair, keeping the rotating wheel in our hand and try to change the axis of rotation, the reaction force on our body is responsible to rotate the chair in opposite direction.
- Thus the any change in angular momentum causes the torque.

Coupled Oscillations

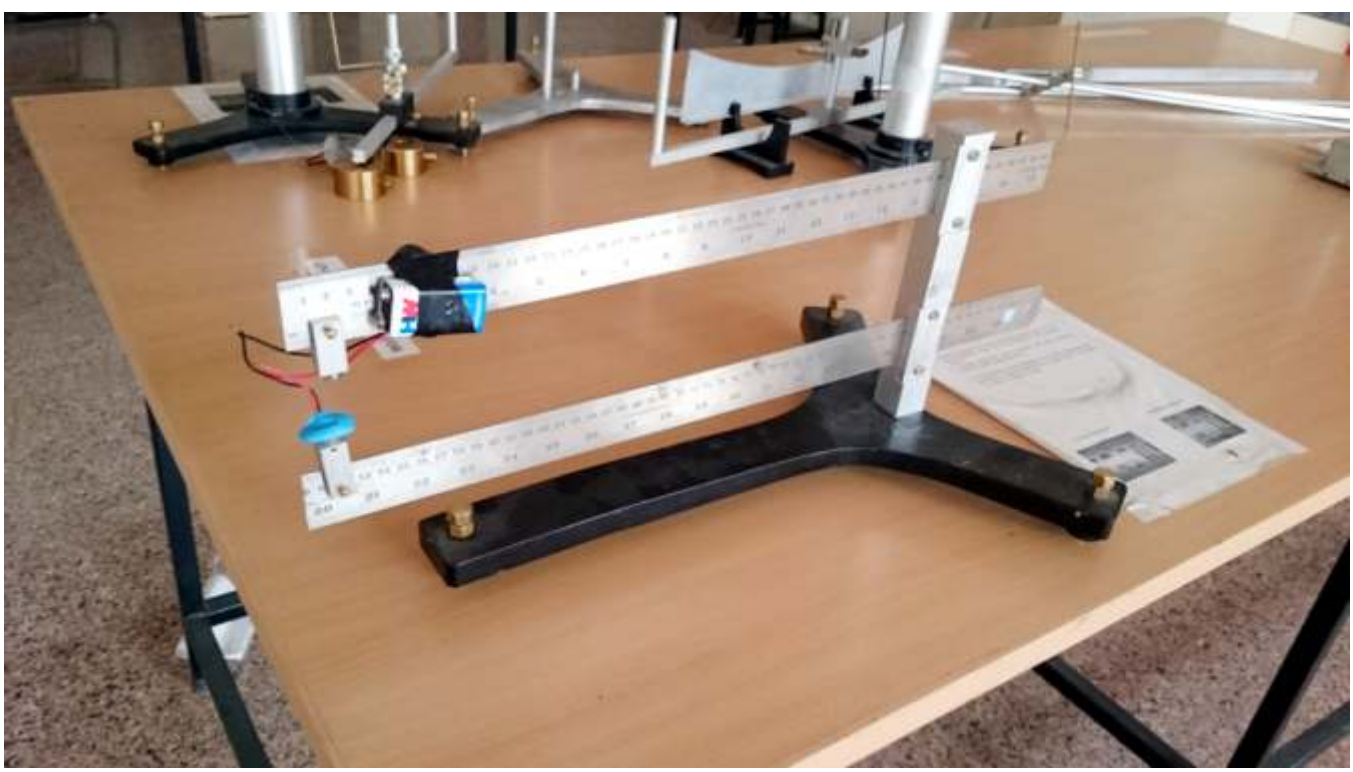
- When several oscillators are suspended from a flexible spring held in horizontal plan.
- The oscillator when displaced along the linear direction to the neighbor, energy transfer is in longitudinal direction and when it displaced perpendicular to the neighbor, the coupling is transverse.
- The energy transfer is maximum and fast in the identical oscillators, when number of ball is same.
- The energy transfer is very little and slow when number of balls on the oscillators are different.

Demonstration of Bohr Orbit's

- The low frequency waves set up in a circular loop, through one feeding point results into the stationary waves in the Circular loop.
- By adjusting the frequency, one can set up the stationary waves in the fundamental and higher modes.
- One can find the steady states in this set up when the circumference has integer multiple of wavelength

Doppler Effect

- When the source of sound or the observer of sound are in relative motion (approaching or departing each other), there is apparent change in frequency of the source. It appears to increase when they are approaching each other or decrease when they depart away.
- If a source of sound with frequency (1-3 kHz) is mounted on a vibrator on a low frequency (1-2 Hz), the variation in the frequency is audible.
- This phenomenon is demonstrated using a strip Oscillator.
- In optics the effect is observer as red shift or blue shift when the star is going away from earth or approaching.



Equilibrium with Magnets

- When the ring magnets having their similar poles facing to repeal each other, are held on a non magnetic rod as shown in Figure 1.
- This arrangement looks like magnetic spring, whose pitch is variable.
- The bottom one supports the weight of all above it, while the magnetic repulsion amongst each one is same.

Figure 1, 2 and 3

Importance of Curved Surface

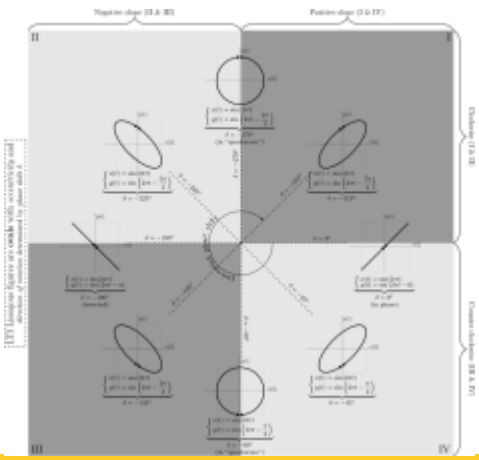
- When a two dimensional plan surface is subjected to deformation at any point, it results into curved surface.
- The gravitational force field is a similar surface of space and time as two dimensional space.
- The dynamics of massive bodies on such a surface results into gravitational force.
- A stretched rubber membrane Model is developed to visualize the interesting dynamics.
- As the moving ball approaches the centre its velocity increases, analogues to the concept of BLACK HOLE.

Kundt's Tube

- When a electronic buzzer of constant frequency is used for producing sound and the fitted in a PVC pipe having T type connection, dividing the amplitude of sound waves equally traveling in opposite directions.
- The resulting sound coming out of the another T joint as arranged in Figure, where the path length of one direction is fixed and other path length is variable.
- When the path difference is even multiple of wavelength, one gets loud sound and several maximum sound positions can be observed.
- The difference of two maximum sound position gives the value of wavelength.

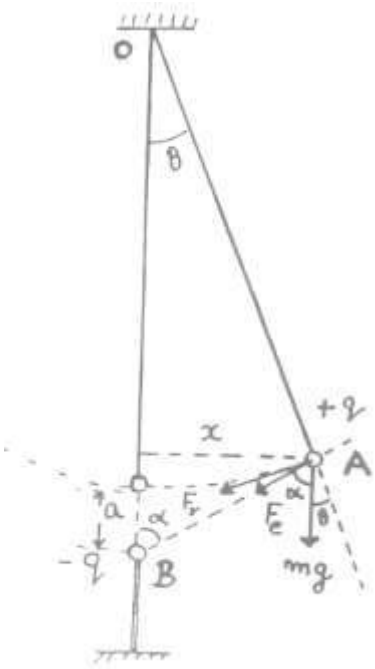
Lissajous Figures

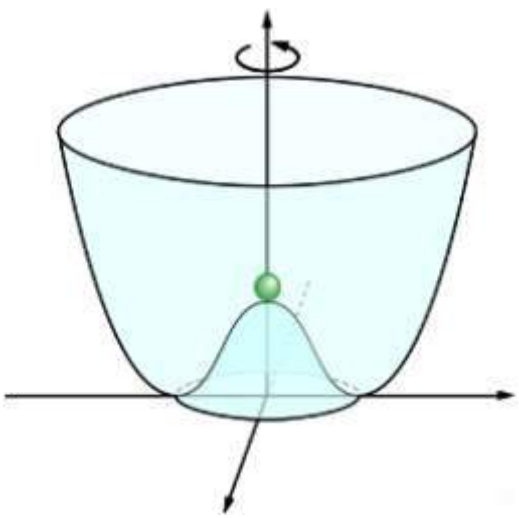
- The superposition of two Simple Harmonic Motions (SHM), perpendicular to each other, results into line, elliptical or circular figures known as Lissajous Figures.
- When the frequency of two sources is equal the figure is stable, depending upon their relative amplitude and the phase.
- This figures can be visualized using two bar pendulums as Coupled Oscillators, superposing the motion on a convex lens, light source fixed away from focus and the image shows amplitude, phase and dynamics.
- This can also be realized using two strip oscillators. On one a pen is attached and other paper is used to draw figures.



Lorentz Oscillator

- Lorentz proposed that the oscillating electric field of the electromagnetic wave will set the electron into harmonic motion.
- A simple pendulum, due to gravity has linear restoring force for small amplitude only.
- In the laboratory a bar pendulum with point suspension and permanent magnet attached to it results into a very close to Lorentz's atomic model.





Circular Pendulum

Random Pendulum

Manual Lift with 1/8 Effort

- Using a 4 Pulley system and single rope A load of 120-160 kg can be lifted by a single person's effort.
- Normally a one can lift or pull 15-20 kg with single hand.

Maxwell's Top

- Maxwell observed the rotational motion of a top and how the spin and precision motions are related.
- In the wooden top the centre of mass can be raised up or down by putting the additional disc on the shaft of the top, the spin and precision motion is varied.
- In the steel top, when the curvature of the disc changed up-ward or down-ward, the centre of mass moves up or down.

Measure Your Weight

- A Tube of a Car is filled with Water with a capillary tube of 5 mm diameter is held vertically, keeping the other end open to atmosphere.
- In this arrangement, when you stand on the flat top, the water level rises in the capillary.
- The vertical height is calibrated and found to be linear in the range 5kg to 120 kg.

Motion in Inclined Plan

- When we roll a ball on an inclined plan, it has kinetic energy due to linear motion and rolling.
- When the motion is in vertical plan, minimum the kinetic energy required to complete the circle 2mgR.
- This could be demonstrated on the set up very well.
- One can also the dynamics after collision with another ball at rest.

Magnetically Coupled Oscillator

- Two Strip Oscillators mounted on a rigid pillar when free to oscillate in horizontal plan is free from Gravity.
- Permanent magnets mounted on free ends act as coupling: an additional restoring force.
- Two modes of Oscillation: (1) In Phase and (2) Out of Phase are easily visualized.
- Complete energy transfer from one oscillator to other can be realized.

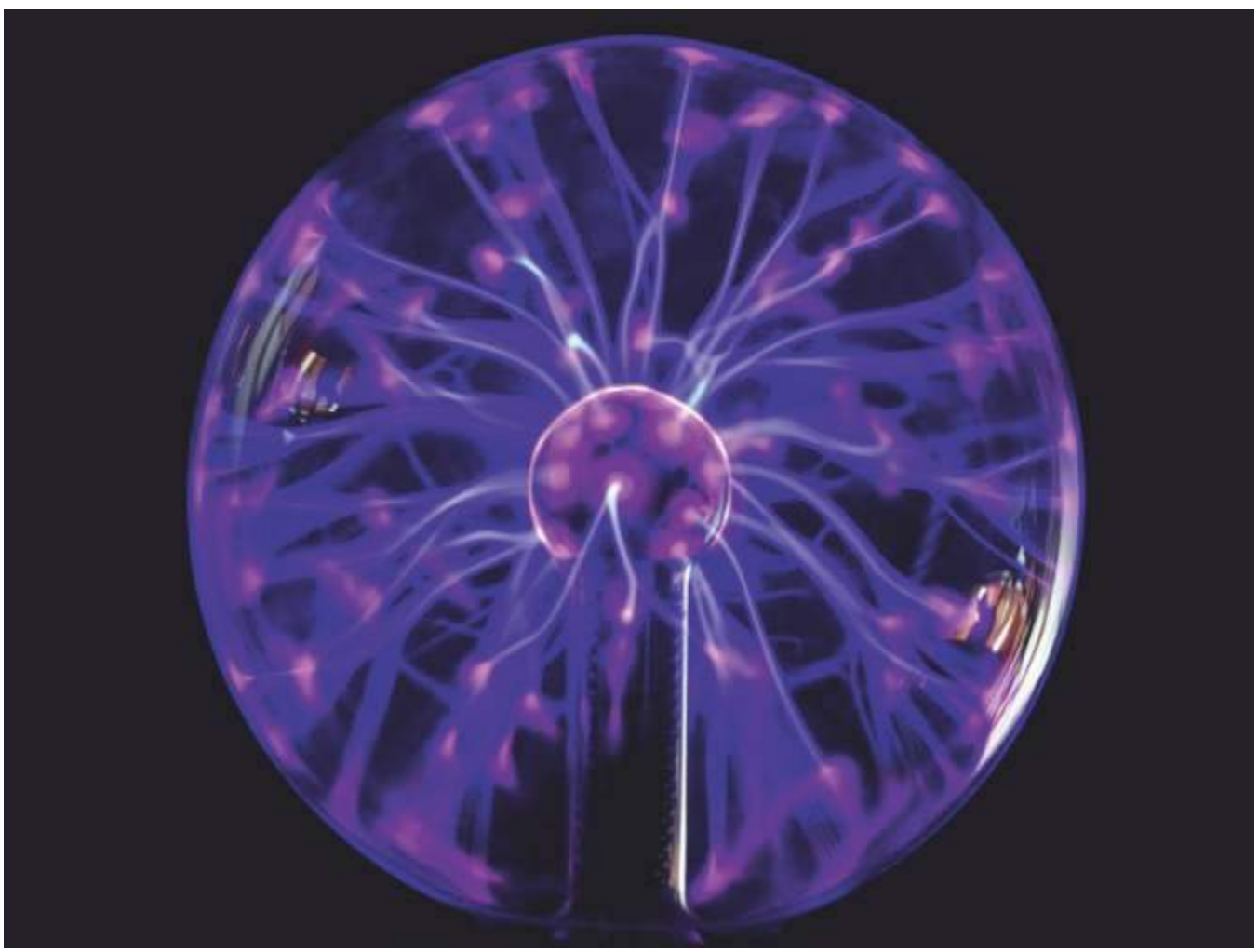
Coupled Oscillator system

Mechanical Transmission Line

- 20 Identical Oscillators are mounted on a steel tap with equal spacing.
- In this arrangement, when any oscillator is disturbed, the disturbance moves to the neighboring oscillator, shows the torsion wave propagation in one dimension.
- Reflection of wave from open end and close end easily visualized.
- Phase and the speed of the progressive wave Clockwise/ Anticlockwise can be realized.

Plasma State

- Fourth state of matter can be realize in laboratory, when A chamber has gas at low pressure, typically at 10^{-2} tor, density is around $10^{17\text{-}18}$ per cc.
- The atoms of gas (inert) can be excited and ionized using a high voltage DC or low voltage RF (100-200 kHz) source.
- The excited and ionized atoms during collision come to neutral and ground state librating light.
- By touching the **Glass Plasma Globe**, we can confine and the enhance the recombination process over the random sparkling.



Plasma Application

- Fourth state of matter can be realize in laboratory, when A chamber has gas at low pressure, typically at 10^{-2} tor, density is around $10^{17\text{-}18}$ per cc.
- In normal atmosphere using High Voltage (10-20 kV), we can generate plasma, having density $10^{20\text{-}22}$ per cc.
- By using Tesla Coil, we can generate pulsating high voltage, to generate the repetitive sparks in air at Atmospheric Pressure.
- Further pressuring the Ionizing Chamber, we can set up the Plasma Shower for sterilization.

Rotational Dynamics

- A bowel of 18” is mounted on a bicycle hub with a free wheel which is driven by chain and paddle system as shown in Figure 1.
- It can be rotated with variable speed.
- A ball is placed in the bowel free to roll.
- Initially the ball rolls with the bowl and reaches around the wall and rises up due to curvature.
- When speed is increased such that it escapes the bowel due to centrifugal force.
- However if we hold it lightly, allow it to roll due to friction and the speed of rotation of bowel is gradually increased, we can set an equilibrium- the rolling ball looks stationary.

Figure 1 The Set Up

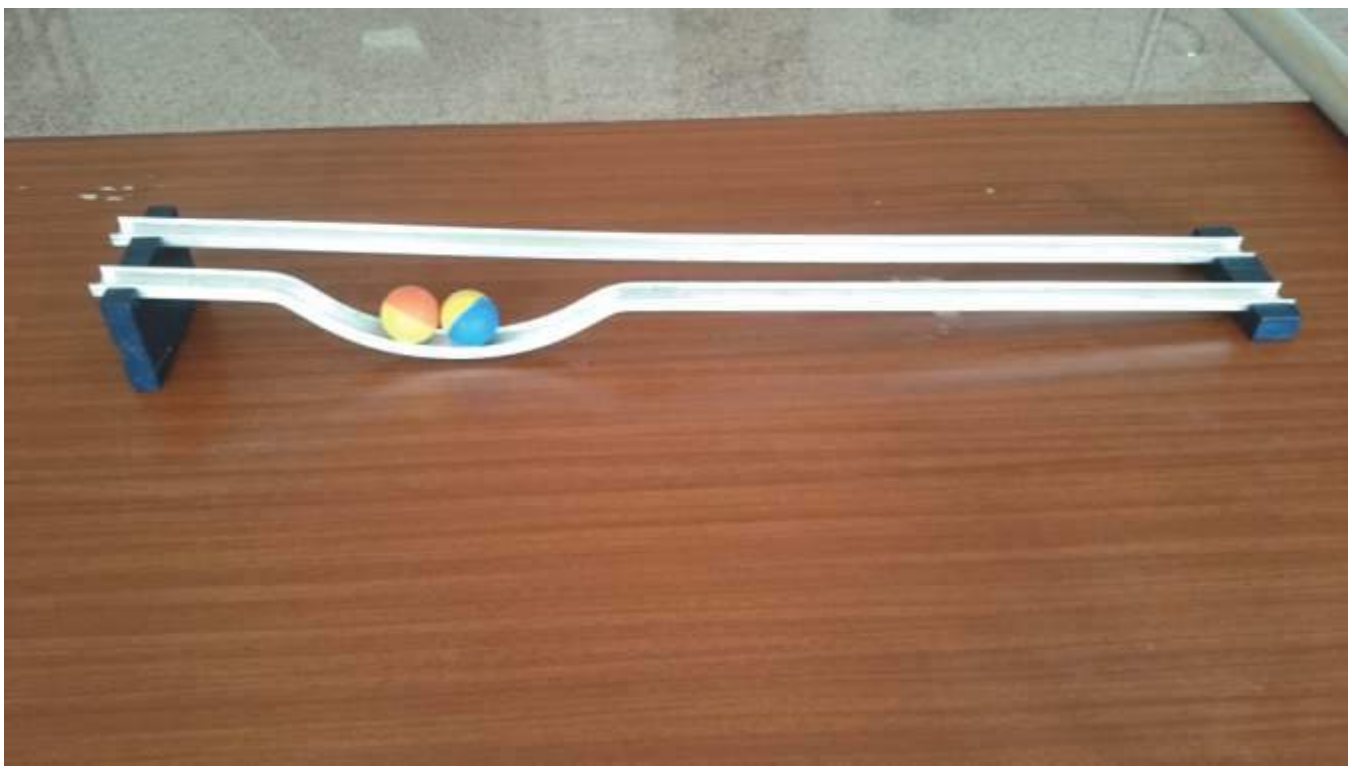
Figure 2 Bowel and Ball both rotating in opposite direction

Reduction of friction

- Contact between two surfaces causes friction.
- This can be reduced by introducing Air Cushion between the surfaces or any lubricant.
- One dimensional motion on V –shaped surfaces having air jets can achieve very low friction.
- Similar magnetic poles on gliders shows, Interaction at a distance during collision (Perfectly Elastic Collision).

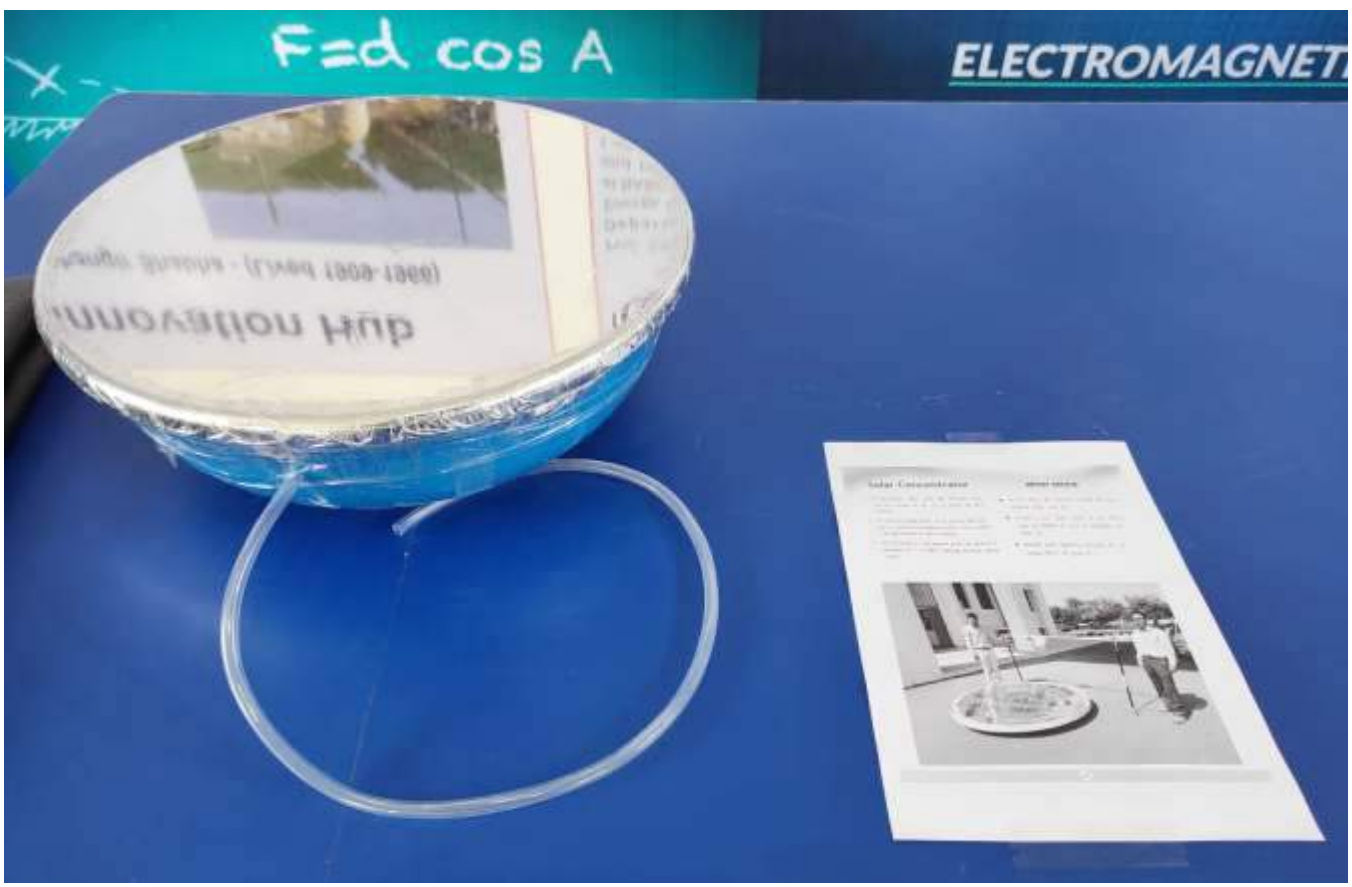
Racing Tracks

- When a body slides on an inclined plan it loses potential energy and gains kinetic energy.
- If two tracks having same slope but different path length, which path is faster?
- But if balls are lolled, it is fascinating to observe, the longer track is faster.
- You can watch repeatedly and observe the difference.



Solar Concentrator

- A Parabolic Disc with 60 mirrors and surface area 16 sq. ft. is built up and tested.
- In this arrangement, on a sunny day at 1 pm, a pressure cooker with 1 liter water can get steam in 30 minutes.
- Performance compared with an electric heater of 1.0 kWh, taking almost same time.



Series of Pendulum

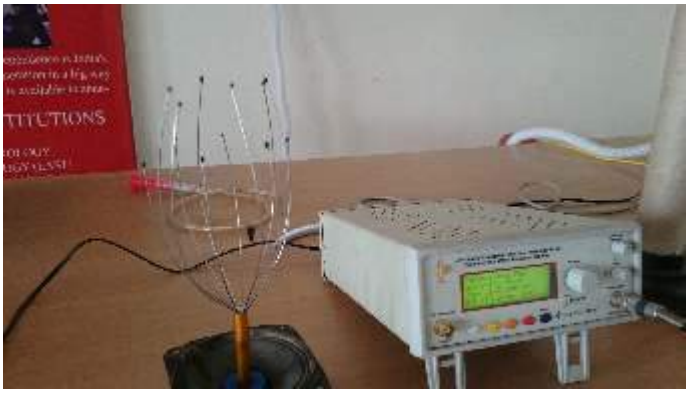
- When a number of pendulums are mounted on a common beam and having different length, their time period are different.
- If we give small displacement to all the pendulums at one time and allow them to oscillate, the collective motion is very fascinating to watch.
- Initially they all start in a line but soon phase difference appear amongst each other, snake like motion starts and soon becomes chaotic and may become coherent a few of them.

Vibration Analysis of a System

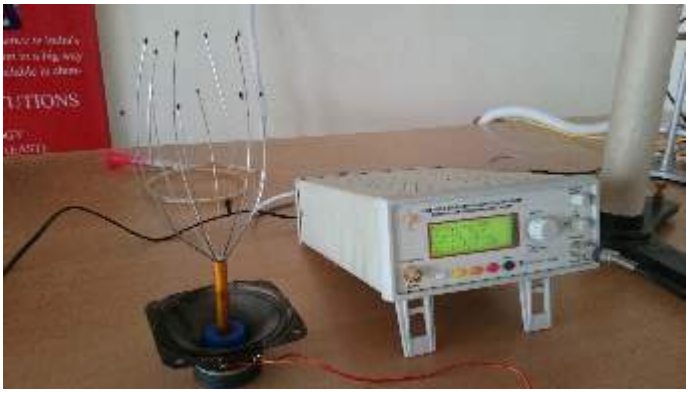
- If a vibrating system has more than one oscillator, as shown in Figure 1, where we have six free oscillators small in size and six big oscillators larger in size. It is available in market as tickling comb.
- The is good demonstration of resonance phenomenon, when we excite by manual disturbance the small ones only all the small ones pick up the energy and when we disturb any large one only large ones pickup the energy.
- When we mount the system on a Electronic Vibrator (speaker-5W) and connect to signal generator, we get two resonance peaks at two different groups of frequencies, like around 110 Hz and 200Hz, with a distribution ±10Hz, for the specific system as shown if Figure 2 and 3.

Figure 1, 2 and 3.

110±10Hz



200±10Hz

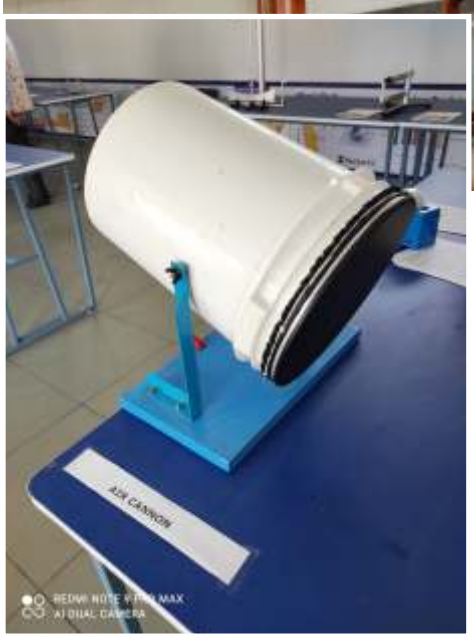


Vortex formation

- When the water is filled in a bottle and inverted on another empty bottle is connected to it through a small opening, the water does not go to empty bottle easily.
- Even if we press the top or bottom bottle only a few bubbles pass through the opening of the bottles.
- If we shake the upper bottle a few times, clockwise or anti-clockwise, the water forms a funnel shaped trajectory for air to pass through upward and water to go to empty bottle.
- The passage time for 1.5 liter water is about 30 second, one can repeat the process, by inverting the bottles.

Air Cannon

Air Cannon is basically a drum 12”x15”with one face is made out of a flexible sheet (Rexene) and other end has a hole of about 4”. When you hit the flexible side with hand or a flexible hammer, air inside gets compressed. So a compressed air packet comes out of the hole and travels in air with some speed, so that the cotton screen kept at about 15-20 feet is disturbed. It take about 1-2 second to see the disturbance on screen while we hear the sound of bang. Similar observation we have when we stand behind the exhaust pipe of car or motor cycle.



The sound travels 332 meters/sec. should take a few mille second to reach screen, but we observe the motion due to moment of air bundle from cannon to screen.

Bouncing Laser Beam from Saline Water: Laboratory Demonstration

The bouncing of Laser beam could be demonstrated with in a tube of size 30cm X 2.5cm X 5.0cm, made of acrylic sheet. A the low concentration saline water used to see the Laser beam shows straight line path as shown in Fig.1. A saturated salt solution about 5 ml is added through a syringe, the beam bounces from the bottom surface as shown in Fig.2 By controlling the glancing angle, we can shift bouncing point Fig.3. The beam touches the bottom surface with in 30 cm tube Fig. 4. This can be achieved by carefully setting up the concentration gradient in saline water.

Fig. 1 Saline Ware low concentration

Fig. 2 Saturated saline solution added using syringe

Fig. 3 Controlling the glancing angle

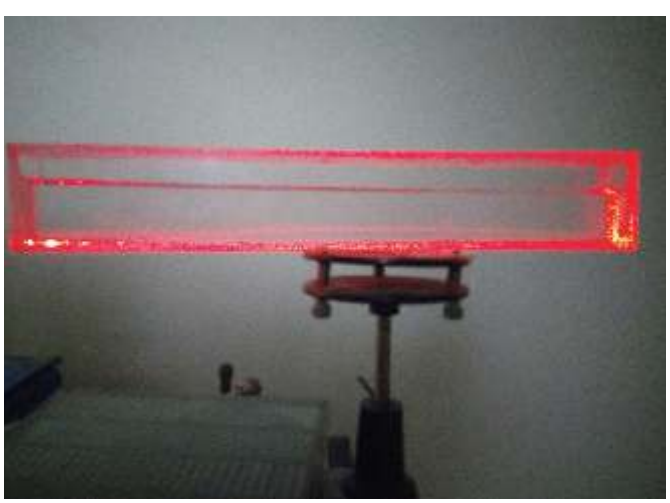


Fig.3 Beam touches the surface again within 30 cm.

Atomic configurations through the floating magnetic dipoles

When the water is filled in a Tray and Button magnets are placed with polarity identical in all caps or table tennis ball. These metal caps, plastic caps or table tennis balls with magnets fixed can float very well in the tray and will repel each other due to magnetic dipole field.

They come to equilibrium show some configuration.

Different configurations can be seen in Rectangle tray or Circular Tray, as shown in Fig. 1. (a), (b), (c) and (d).

Figure 1 (a)

Figure 1 (b)

Figure 1 (c)

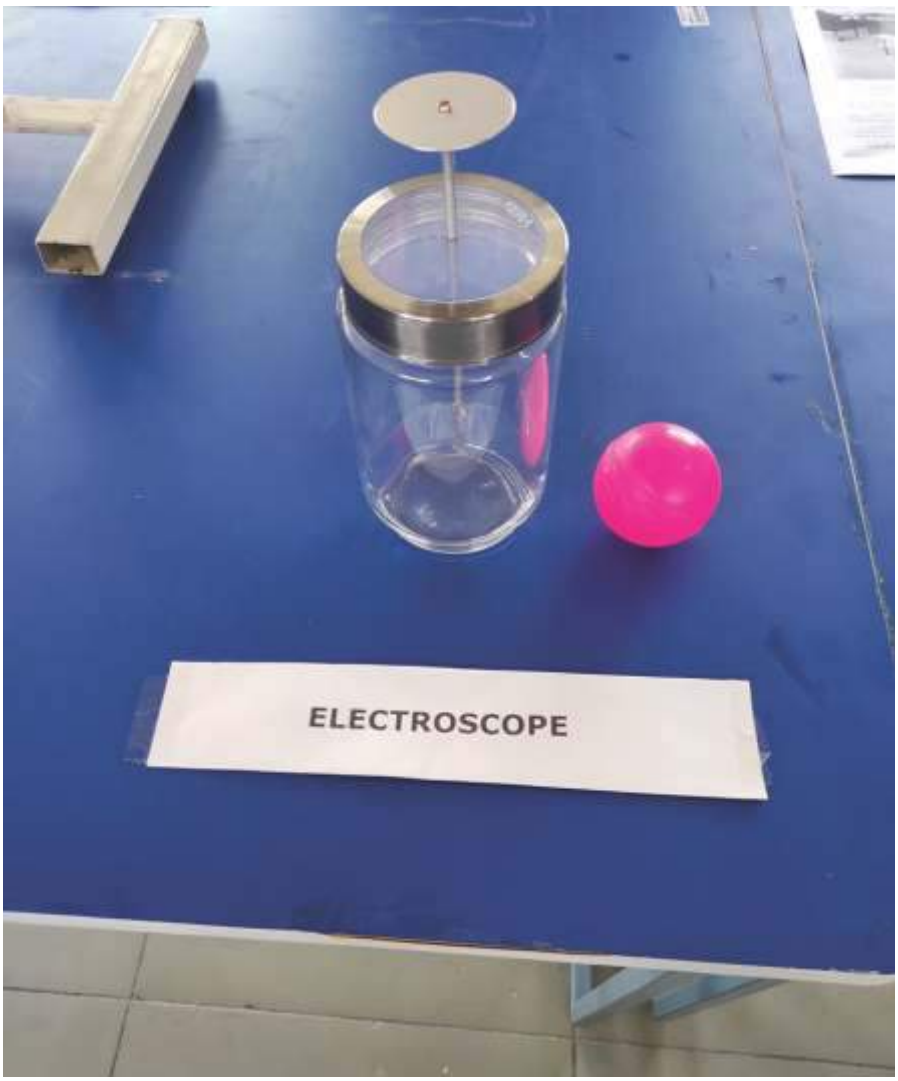
Figure 1 (d)

Electroscope

In order to visualize the Charge , we have a Glass Jar In which two aluminum foils are suspended from a ring And connected to an aluminum road and a disc is Attached out side.

As we rub a plastic ball on any cloth and bring it close to disc the foils are repelled from each other due to Induction of identical CHARGE on them caused by induction.

Due to friction in plastic ball, a few electrons are Removed away so that it becomes partially negatively charged. As we bring it close to Metallic disc, Free electrons are repelled leaving partially negative charge on suspended foils starts repelling. As we touch the metallic disc the induced charge goes to ground.

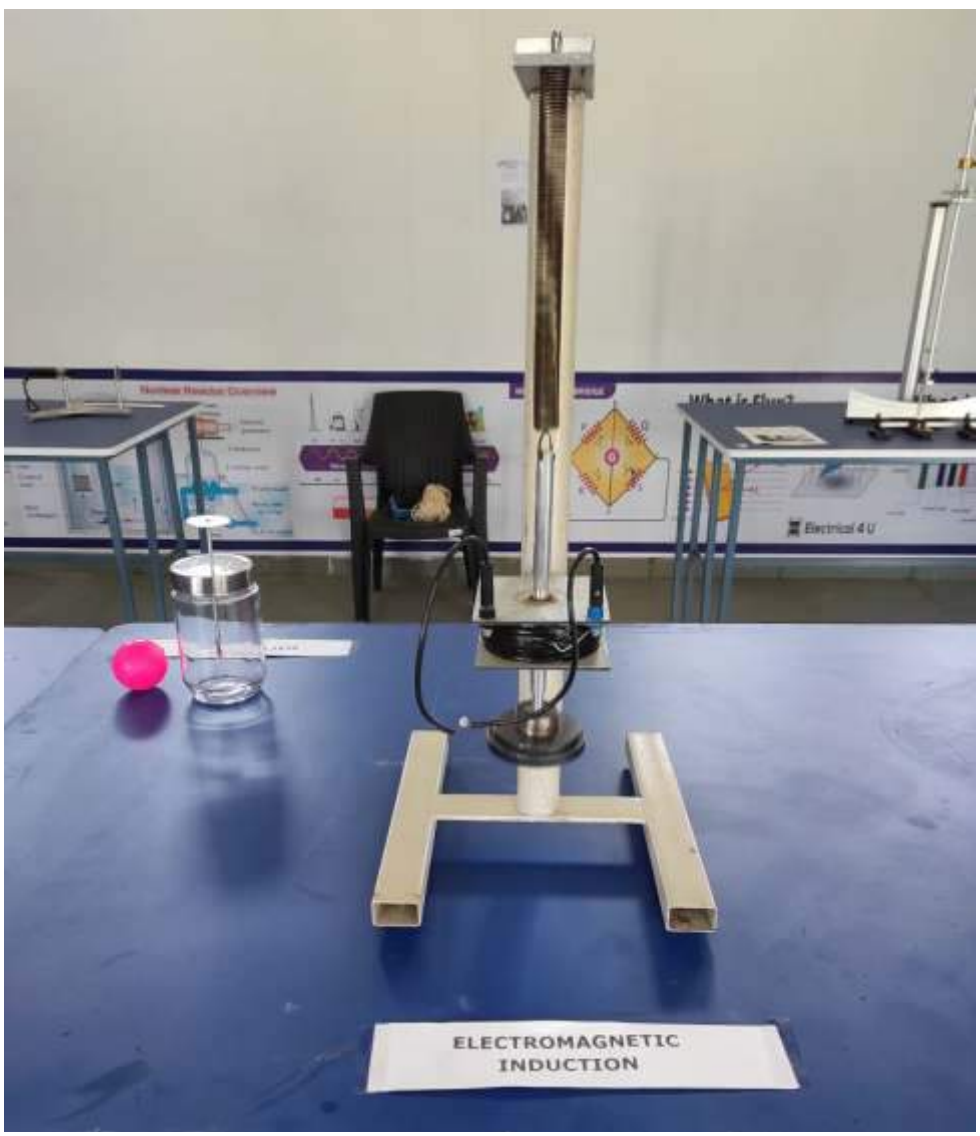


Electromagnetic Induction

We have a Spring- Mass system to oscillate at about 1 Hz. It oscillates in a vertical line around a mean position. WE have attached a strong magnet with its poles along the vertical line. A copper coin about 3000 turns is placed at mean position.

As the Oscillator moves up and down, the magnetic field associated with the coil changes and electric current is generated in the coil as we connected a light emitting diode LED across the coil starts glowing. It glows only half the oscillation cycle and its brightness Reduces as it slows down.

This follows the Faraday's laws of E M Induction.



Meldie's Experiment

In This experiment, a speaker vibrates due to AC source 6 volts from a transformer. These vibrations travels in string generate the wave pattern in limited length and tension in the string.

At a particular setting we can observe at several Locations the string is vibrating with large amplitude And other locations as no vibrations, we call them Anti nodes and Nodes.

This wave pattern with stable situation of nodes and antinodes is called Stationary Wave.

The stationary wave pattern depends upon the Length, tension and string (mass per unit length)

Eddy Currents Experiment

In this experiment, AC current flow through the Bulb And a copper coil about 2000 turns, (28-30 swg) With a bell switch. About 150 iron wires of 12" (bicycle spokes) are kept in 40 mm PVC tube.

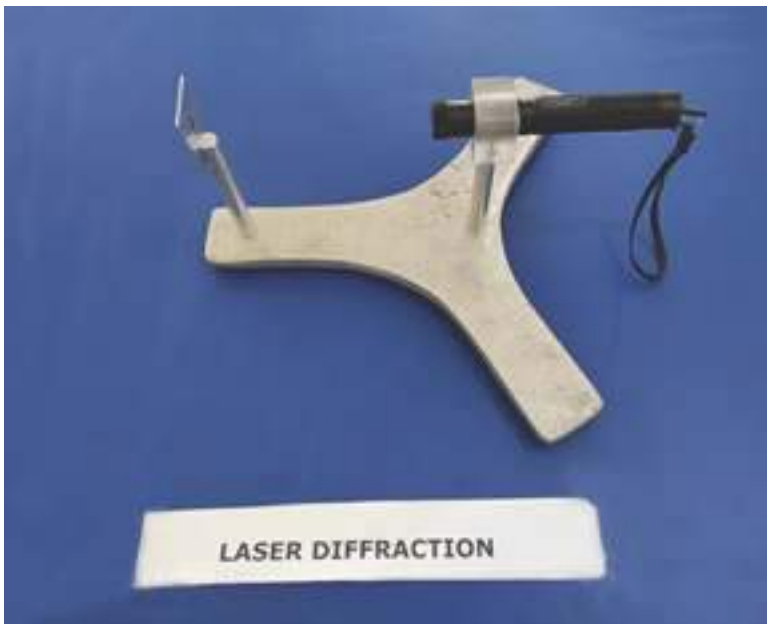
Aluminum rings (bangles) are free to move over the PVC tube. As the switch is ON, the rings jump.

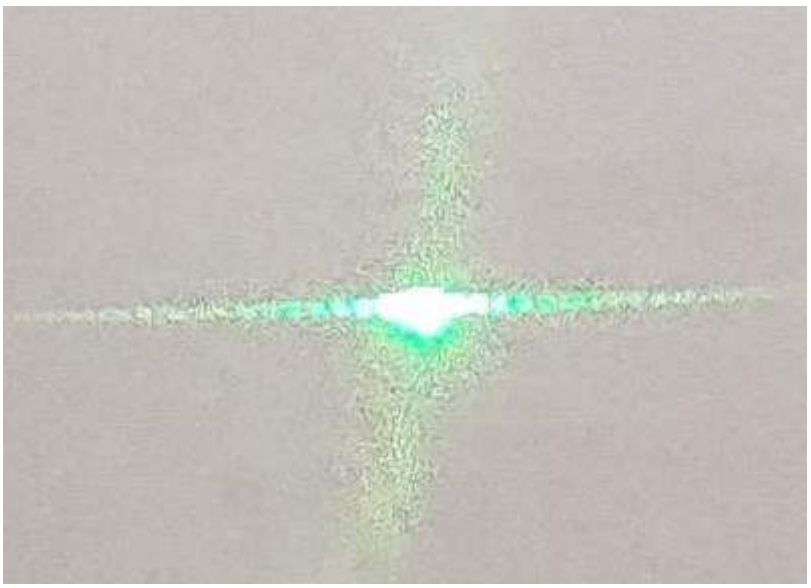
Due to AC current, alternating magnetic field is Generating across the PVC tube, that generates current In the aluminum rings. Called Eddy currents. This also generate magnetic Field to oppose the ac field due to Lenze's effect, responsible for the levitation of aluminum rings.

Diffraction of Light using LASER

A 100 mW, 532 nm LASER source is used to observe the propagation of light in straight line. We can see a bright spot on the wall even in day light as very bright green spot. If we spray some water or keep smoke in the path of beam, can observe the scattering on light from tiny obstacles, called Kindle Effect.

If we place a narrow slit in the path of beam, made out of two razor blades, we call as single slit the on the wall we observe the diffraction pattern as shown in figure. Series of maxima and minima up to 10th order are visible.





Atwood's Machine

A Pulley System with two Masses

M1=M2

They don’t move?

M1 is not equal to M2

Observe!

Effective Acceleration of

(M1+M2)

$a = g[(M1-M2)/(M1+M2)]$

Balancing Ball

A ball can balance it self on a water jet

It gets a tangential force due to water jet therefore rolls and lifts

It follows Bernoulli's law for dynamical equilibrium

Foucault Pendulum

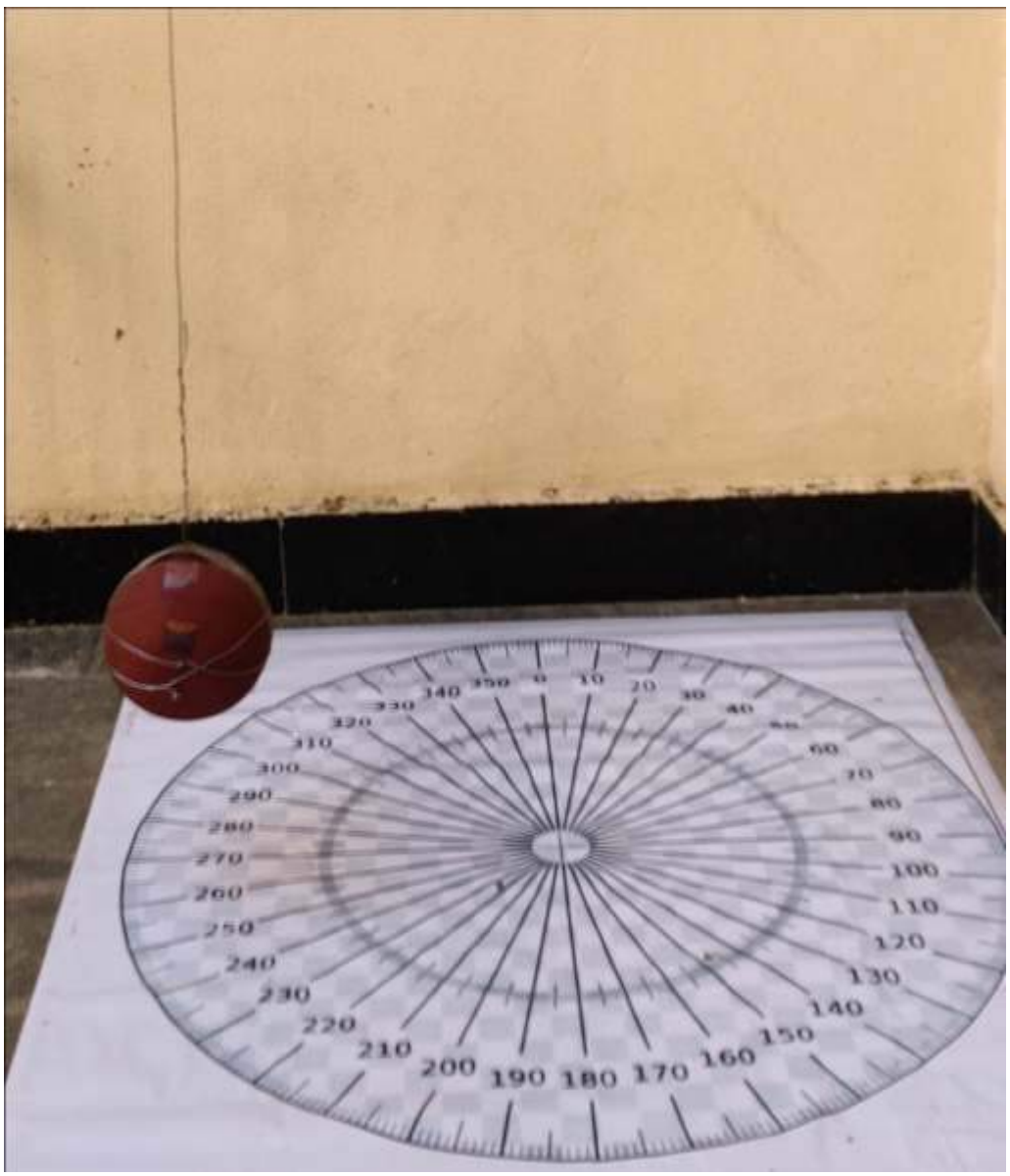
Unique experiment to give direct evidence of the Earth's rotation.

About 7 degree/hour

Time period=8.6 sec.

Length= 20 meter

Mass=16 kg



Science of Flame

Any flame has a temperature (about 1200-1800oC), free atoms or molecules, ions and photons, we call it as plasma. The flame is generated by thermo ionization process, basically atoms and molecules are excited and ionized by the exothermic reaction of any fuel and oxygen of the atmosphere. The flame whether, it is neutral, or charged is the basic question, which can be answered through such experiment.

We have setup the experimental arrangement with two parallel aluminum plates and high voltage power supply (5KV) as shown in Fig.1. When the high voltage is not applied or kept at zero field, the flame is not deflected. However when the positive terminal is at right side the deflection of the flame is on left side. When the red terminals of the HV supply interchanged, the deflection of the flame is in opposite direction. As evident by the experiment the Flame is positive charged.

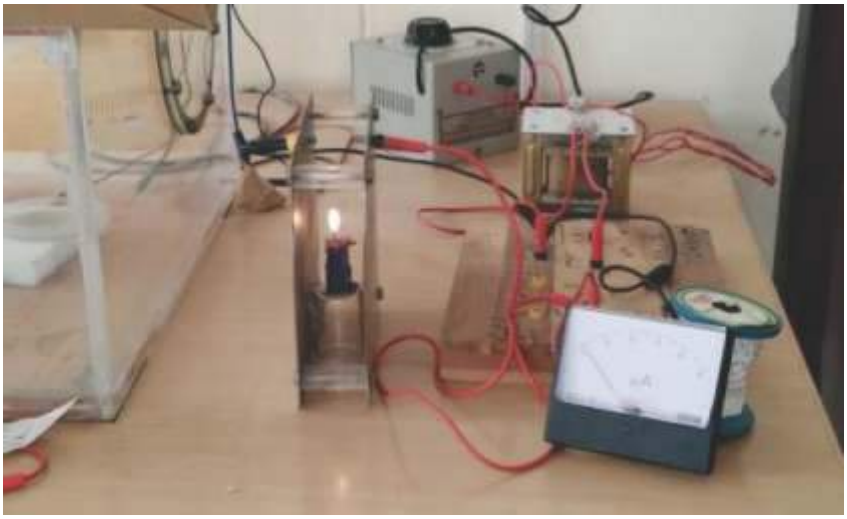


Fig. 1 Zero field

Fig. 2 Forward field

Fig. 3 Reverse field

Analysis of a Vibrating system

The Vibration analysis of a system can be very well using such setup. When the experimental demonstrations it has been observed when an electric or mechanical system is excited with the periodic frequency nearly same as that of its natural frequency, the amplitude of oscillation increases and it's become maximum when the frequency of driven force matches with the natural frequency of the system [1]. This condition is called resonance & the frequency at which this occurs is called naturalfrequency.

A vibrating system may have more than one oscillator, as shown in Figure 1, where we have two sets of oscillators: six small oscillators & six large oscillators in terms of their length. It is available in market as tickling comb.

If we excite any one small oscillator manually all the small ones pick up the energy and when we disturb any large one only large ones pickup the energy.

Figure 1

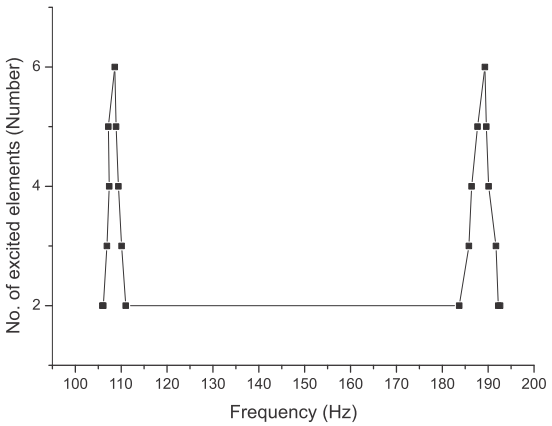


Figure 2

Conclusion: If we plot graph of frequency vs number of excited elements,two resonance peaks for two different groups of frequencies, like around 110 Hz and 190 Hz, with a distribution

±5Hz is obtained for the specific system as shown if Figure 2 . This is a good apparatus to demonstrate the phenomenon of resonance and width of resonance.

Thermodynamics

Thermo- Dynamics is basically motion due to heat

Phenomena in Nature

Movement of

WIND AND CLOUDS due to

SOLAR RADIATION

In this model, LAMP SHADE moves due to movement of the HOT AIR

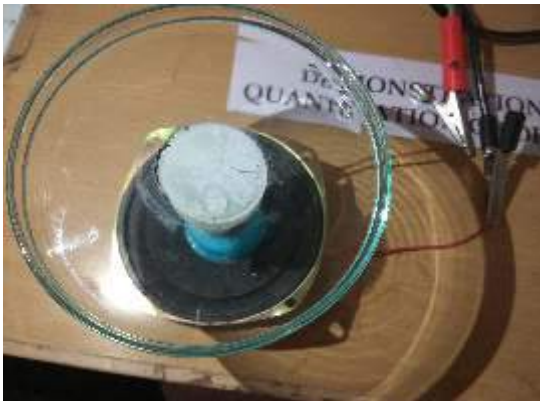
Because of HEAT of the Electric Bulb

Demonstration of waves on the surface of water: A quantitative experiment on stationary waves

A glass peltry dish diameter 10 cm is mounted through a spring on a speaker. The speaker is connected to a audio frequency signal generator. The peltry dish is filled with water, depth about 3-5 mm as shown in Fig. 1 When signal generator is tuned at different frequency, stable patterns are seen. One can count the number rings in 5 cm, giving the value of wavelength at the resonance frequency. As the frequency increases the value of wavelength decreases as evident in the Fig. 2(a) and (b). The preliminary data recorded, shows that the velocity of waves on water surface are having value about 30 cm/s.

Fig. 1 Shows a signal generator sinusoidal (1-100 Hz)

(a) 25 Hz



(b) 35 Hz

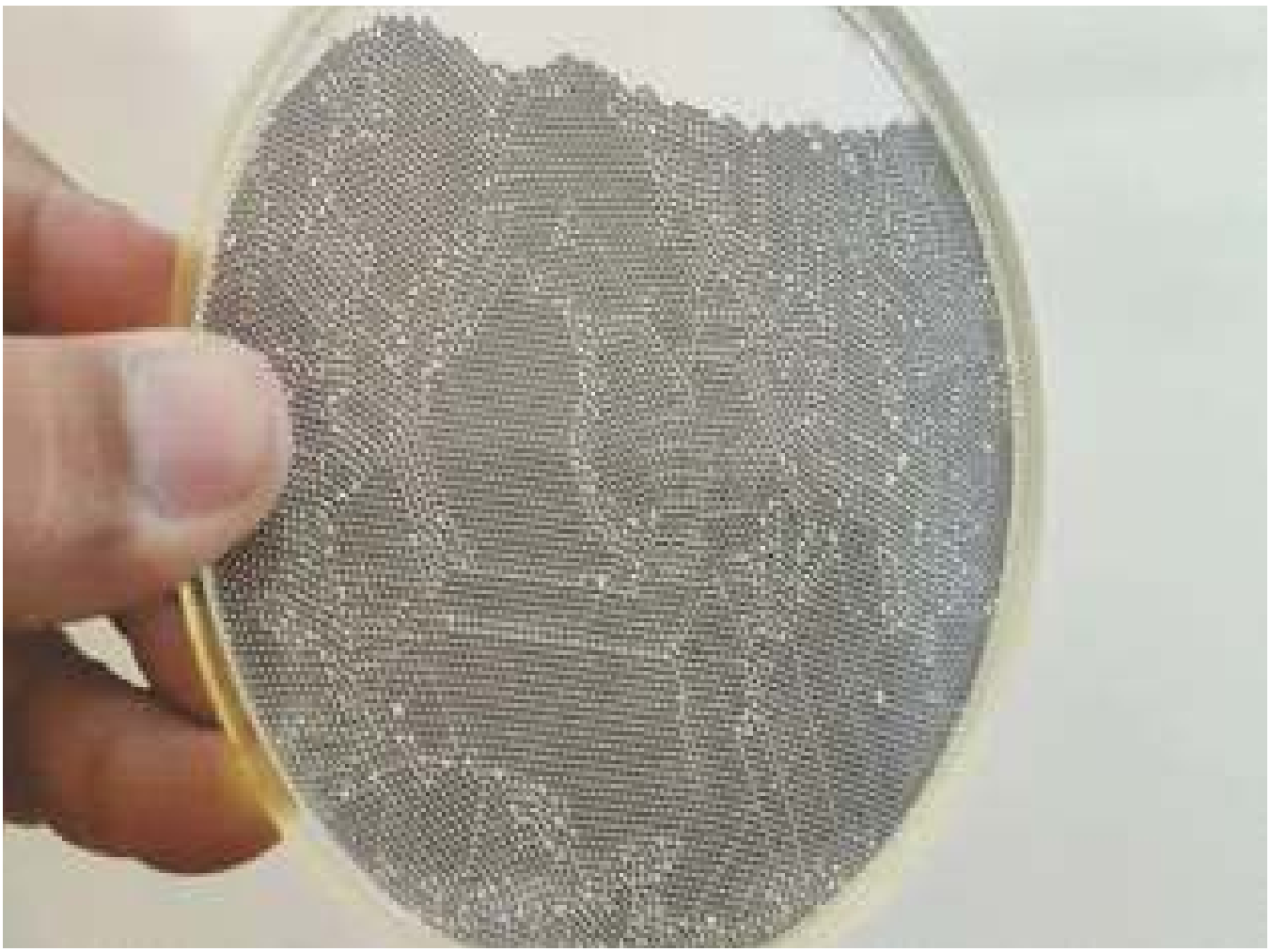
Fig.2 Shows the stationary wave with stable pattern at certain frequency

Atomic arrangements and Defects

In this model, 10,000 steel balls of 1mm size are placed between two parallel sheets so that they are free to move with in the ring and do not ride one over the other.

Once held vertically, these settle under gravity in random packing of hard spheres.

These show arrangement of balls systematic and randomly analogous to atomic arrangements crystalline and defects, like vacancy, dislocations, grain boundaries and phases.



Magnetic Oscillator

In this bar pendulum, we have an aluminium pipe with two magnets at the ends. It is suspended from a steel ball to have point suspension. At the bottom another magnet attracts the hole bar keep suspended.

When we displace, it oscillates about mean position for a long time.

The amplitude gradually decreases and frequency increases Basic character of Magnetic Oscillator.

Mechanical Model for Demonstration of Raman Effect

The Raman Effect is known as interaction of photons with atomic electrons to exchange in phase or out of phase.

In this model a bar pendulum is analogous to a photon and a spring mass system oscillator representing independent atom interacting with magnetic interaction.

The bar pendulum comes in vicinity of oscillating magnet, interacts in phase or out of phase analogous to stock and anti-stock lines observed by Sir C V Raman

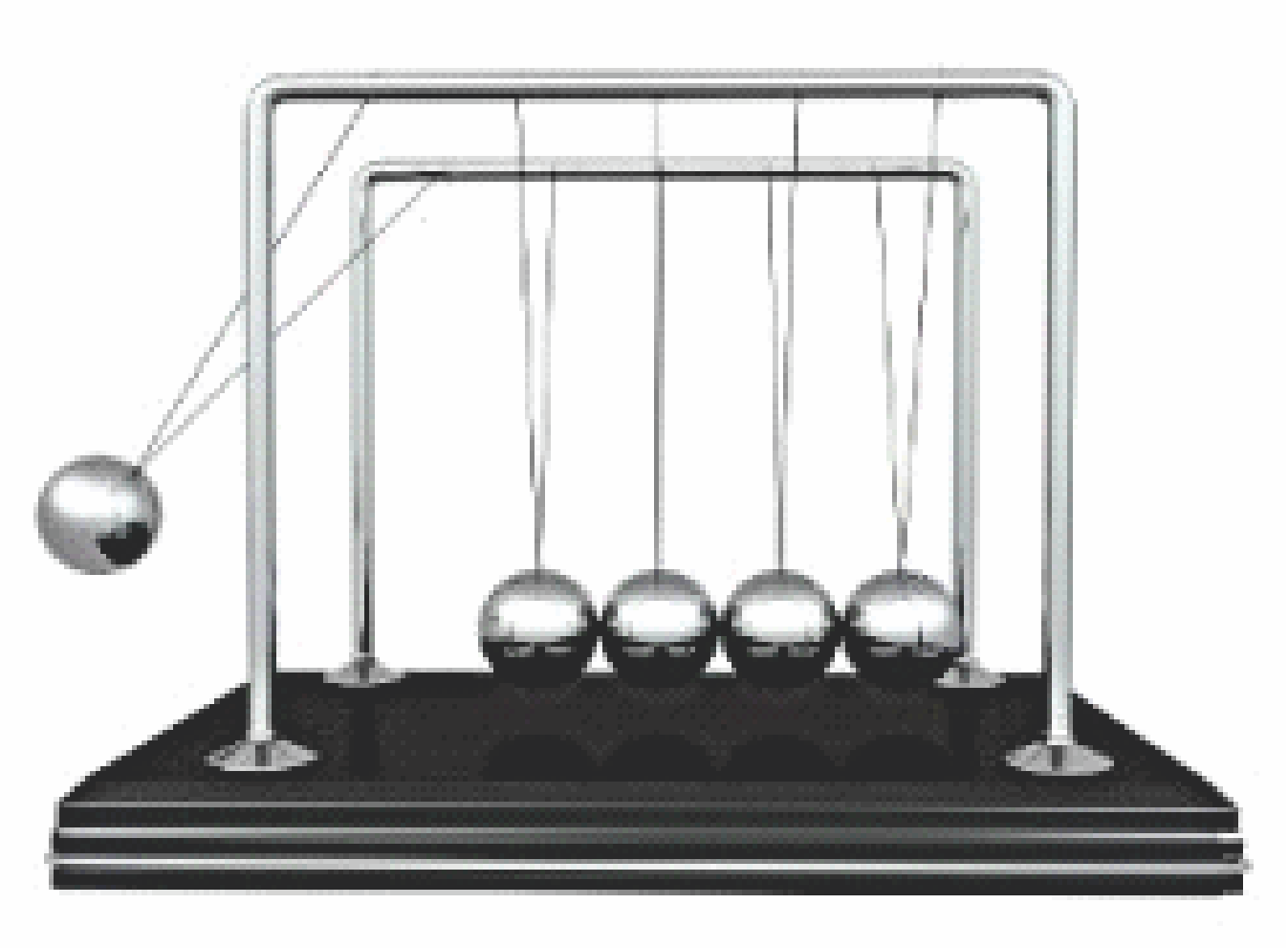
Newtons Credle

This is a set of five balls each suspended with two threads such that, when they are at rest, touch each other.

When we take out one and release free, it collides with the rest balls, only the last one comes out of collision.

If you try with two or three, the out going will also two or three.

It shows conservation of momentum and energy together.



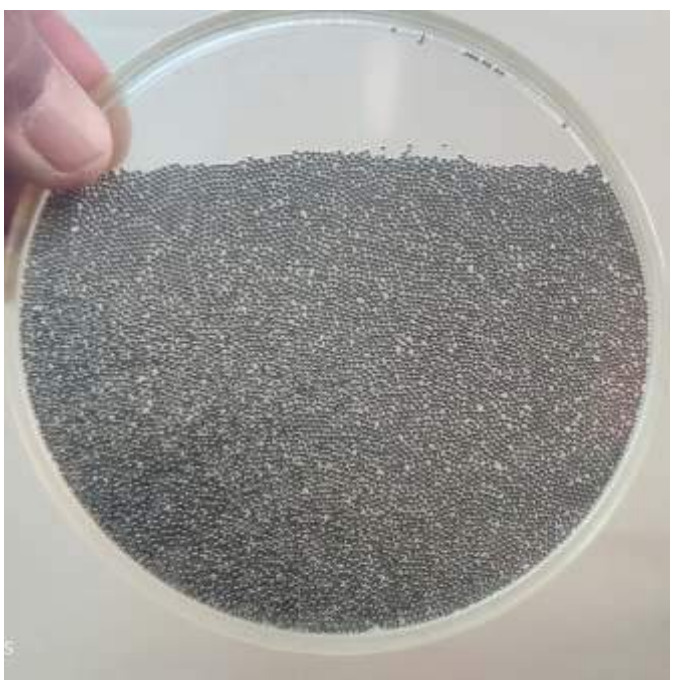
Non Crystalline Structure Model

In this model, we have mixture of steel balls 1mm(90%) and 0.8mm(10%).

These pack up in different way: we call it as non crystalline phase as there no regular ordering of larger clusters.

This model resembles with nano crystalline atomic crystals with no defects of dislocation and vacancy type.

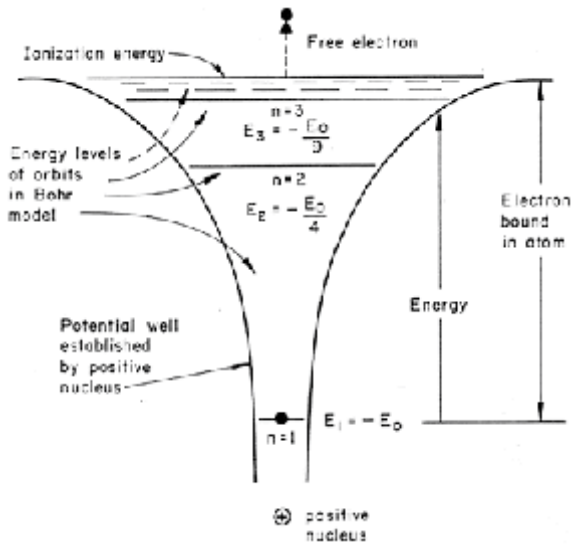
Top one is reflection mode and bottom is transmission mode photo analogous to SEM and TEM.

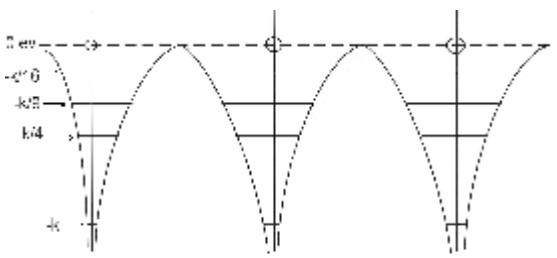


Potential well

In magnetic oscillator, the potential energy diagram is similar to electronic energy levels around atoms and we can use this model to explain electrons around nucleus with attractive potential.

When we take more than one magnets at the bottom, the behavior is similar to periodic potential of atoms and introduce concept of bound and free electrons.





Isolated Atom, its corresponding potential well and the discrete energy level of the electron trapped in such a potential well. (Atoms are well separated and no mutual interaction)

Rotation Dynamics on Bicycle rim and circular pendulum

The pendulum has oscillatory motion, however when they are mounted on a Bicycle rim and rotated, like a Roller Coaster or Circular swings in amusement parks.

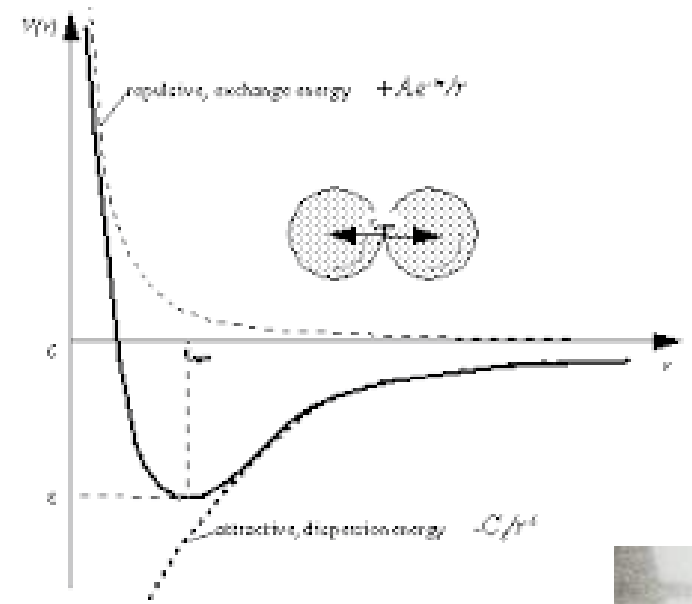
This kind of motion has Centrifugal force on balls also have oscillatory motion due to gravity.

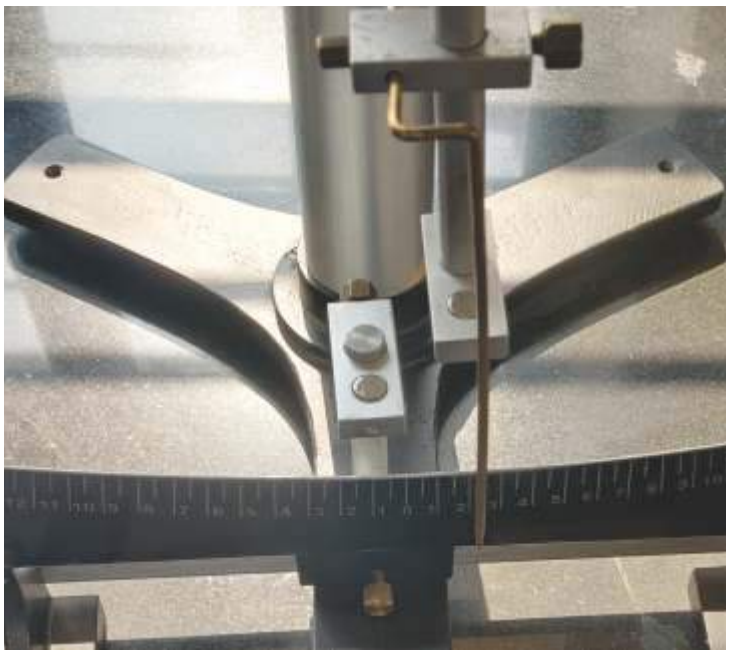
The combined effect gives you a thrill of variable speed while rotating with constant angular speed.

Vander Wall Potential

The bar pendulum with two combined restoring forces, one due to gravity bringing the bar towards the center and other due to magnetic interaction results in repulsive force due to identical magnetic poles, keeps the bar away from the center where the two forces balance.

In this set up one magnet is clamped to bar and other is fixed at the stand, therefore the equilibrium will be on both sides from center.





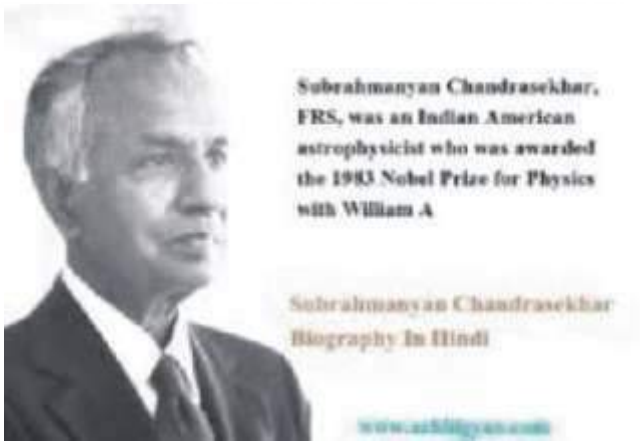
Innovation Hub

In Collaboration with

Indian Association of Physics Teachers (IAPT) RC-6 And
CDPE University of Rajasthan, Jaipur

Innovation Hub

Subrahmanyan Chandrasekhar - (Lived 1910-1995)

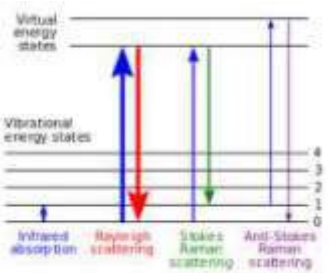


He was one of the great astrophysicists of our time. He showed that white dwarf stars cannot grow beyond a certain mass: the same mass that triggers the explosion of supernovae, the most brilliant display in the sky. He introduced : Neutron stars and Black Holes.

Innovation Hub

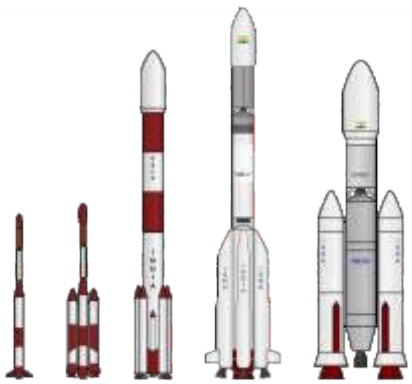
C V Raman - (Lived 1888-1970)

'fingerprint' for the substance the light is Raman showed that the energy of photons serves a he was awarded a Nobel Prize in 1930 for in-elastically important scattered from, has become one of the as the discovery of Raman Effect. scattered spectroscopic methods for chemical characterization as Raman spectroscopy.



Innovation Hub

Vikram Sarabhai - (Lived 1919-1971)



He was awarded with Shanti Swarup Bhatnagar Medal in 1962 and Padma Bhushan in 1966. Space program has been one of the most significant ventures of Sarabhai. It exposed him to the new vistas of space science with the launching in1957 of Sputnik-I.

INSAT B

Chandrayan Mission, Mars Mission and 108 Satellite launching

We are proud of success of

in space using Indian Rocket Technology.

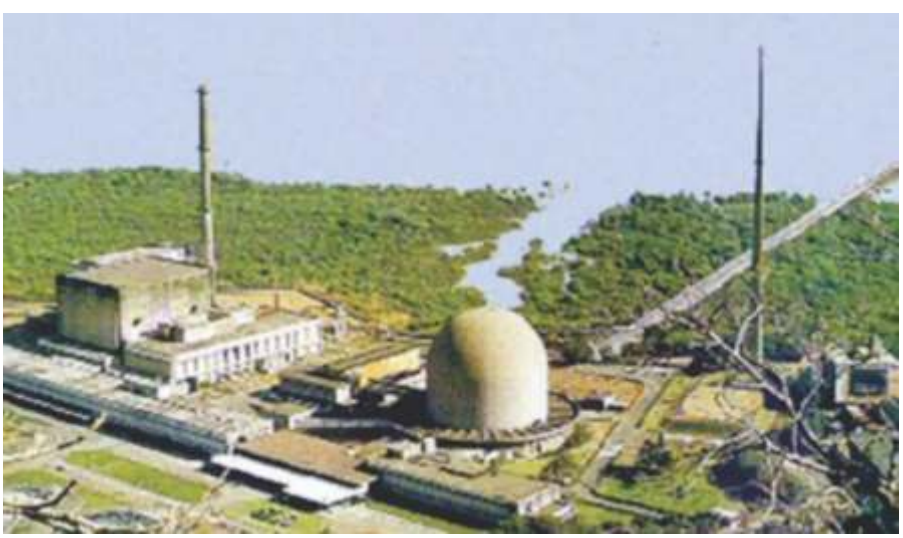
Innovation Hub

Periodic Table of Elements

Innovation Hub

Homi Jehangir Bhabha - (Lived 1909-1966)

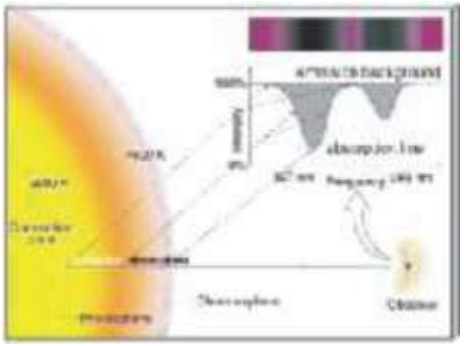
He was awarded Padma Bhushan 1954
Some of the most significant ventures
of H. J. Bhabha has been BARC & TIFR Mumbai.



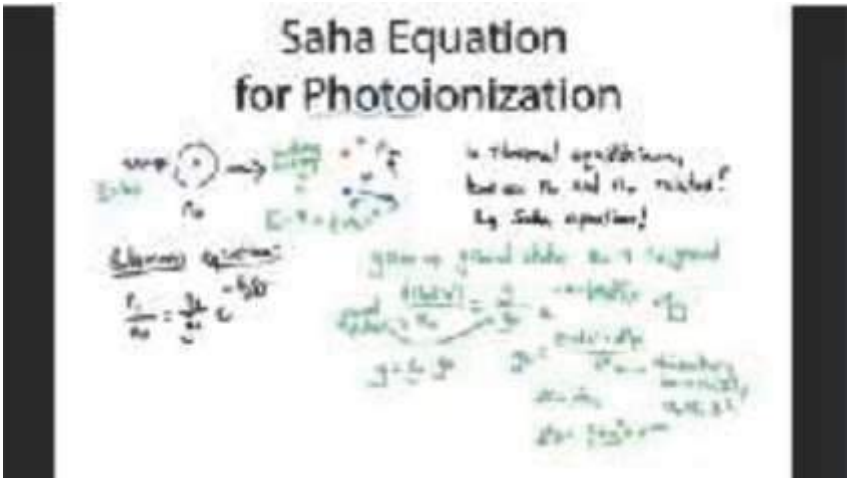
Atomic Power Station at BARC
RRCAT and VECC as prominent centres Technology development
several institutions like RAPP, IGCAR, We are proud of our Indian Nuclear and of
of Department of Atomic Energy

Innovation Hub

Megh Nad Saha - (Lived 1893-1956)



Meghnad Saha's best-known work concerned the thermal ionisation of elements, and it led him to formulate what is known as the Saha equation. Origin of light from Sun and Stars.

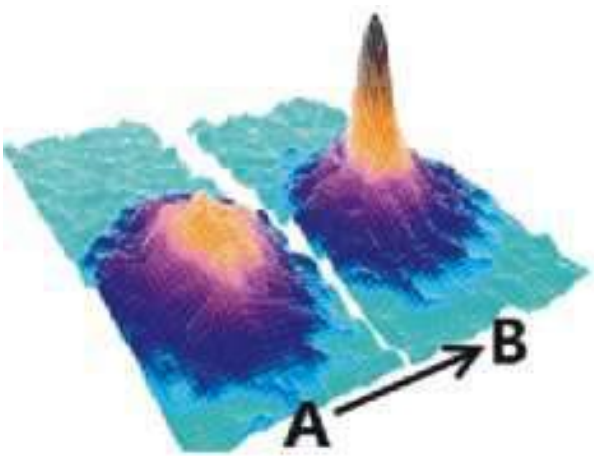


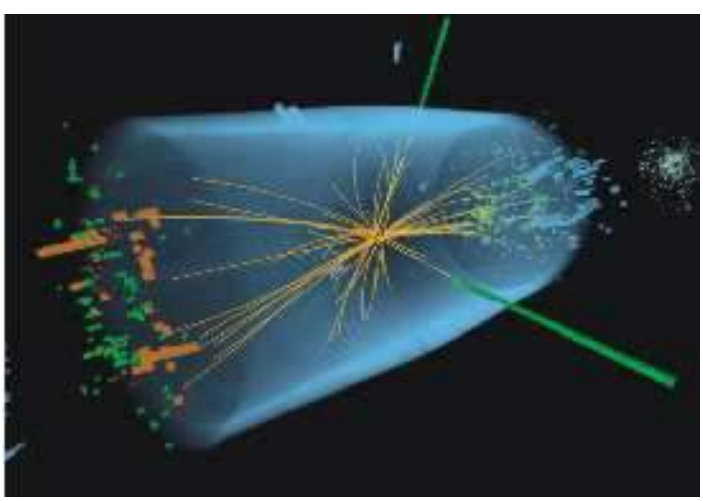
He established Saha Institute of Nuclear Physics, Kolkata.

Innovation Hub

Satyendra Nath Bose - (Lived 1894-1974)

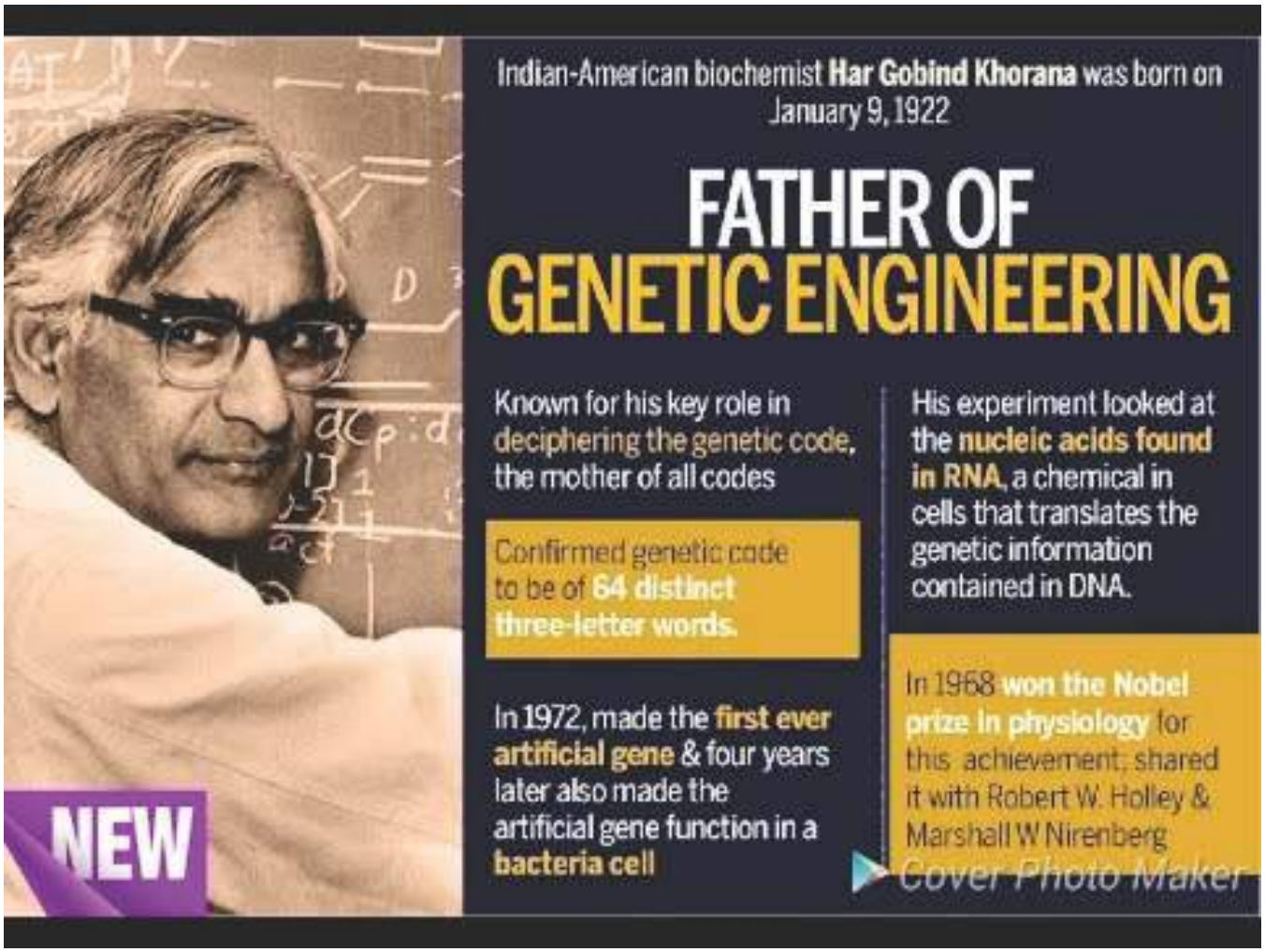
He was awarded India's second highest civilian award, the Padma Vibhushan in 1954. He is best known for his work on quantum mechanics in the early 1920s, providing the foundation for Bose Einstein statistics, Fifth state of Matter as Bose Einstein condensate and Higgs Bosson. CERN now has little to do with S.N. Bose. July, 2012 - A Higgs boson-like entity is spotted at the Large Hadron Collider.





Innovation Hub

Har Gobind Khorana - (Lived 1922-2011)



He was awarded Nobel Prize in Medicine (1968) His major contribution in Cloning and Gene engineering of new plants and animals are integral to the expanding use of DNA analysis to understand gene-based human diseases as well as human evolution

Innovation Hub

A. P. J. Abdul Kalam - (Lived 1931-2015)

(15 October 1931 – 27 July 2015)

11th President of India from 2002 to 2007

- He spent four decades as a scientist and administrator at the Defence Research and Development Organisation (DRDO) and Indian Space Research Organisation (ISRO)
- He is known as Missile Man of India for development of ballistic missile and launch vehicle technology.

A Nuclear Bomb, Shakti I,
Test site : Pokhran : Rajasthen
Period : 11-13, May 1998
Number of tests: 5

Test Type : Underground tests
Device type : Fission/fusion
Max. Yield : 43-45 kilotons of TNT

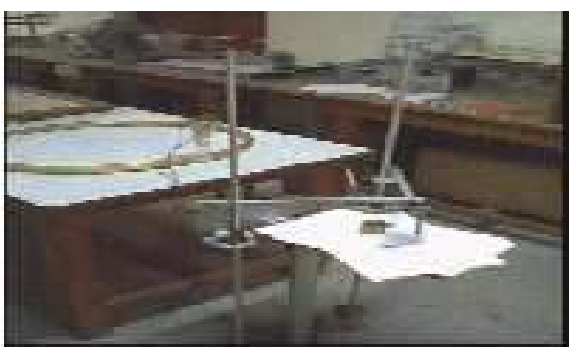
Innovation Hub

Prof Babu Lal Saraf - (Lived 1929-2009)



Prof Saraf has served the Department of Atomic Energy, Government of India at BARC, Mumbai for 10 years and University of Rajasthan, Jaipur for 20 years.

He has been a MASTER EXPERIMENTALISH throughout and developed several Innovating Laboratory Experiments for Physics teaching in the country as well as abroad.

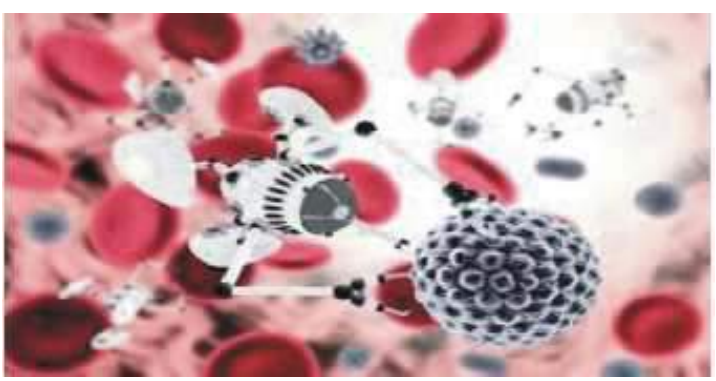



A few of them are : Linear Air Track, Torsional Transmission line, Coupled Oscillators and Lissajou's Figure Generation.

Innovation Hub

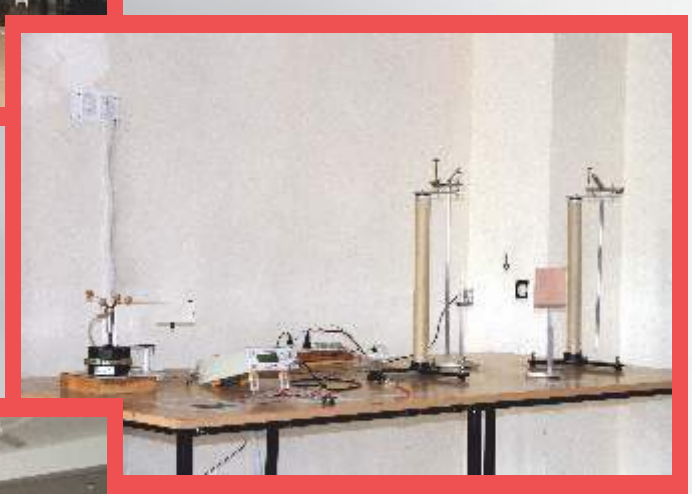
Prof C N R Rao

On 16 November 2013, the Government of India announced his selection for Bharat Ratna, the highest civilian award in India. He worked on structural chemistry, synthesized and characterized many materials as Nano Technologist.



VIVEKANANDA GLOBAL UNIVERSITY, JAIPUR

1st Innovation HUB was installed at
Vivekananda Global University, Jaipur
Contact : Prof. Y. C. Sharma, 9664075093



Hans Raj Mahila Maha Vidyalaya Jalandhar

This was the second Innovation Hub, installed during April, 2018, under the supervision of Dr. Minakshi Siyal, Senior Member of IAPT, and HOD Physics.
Contact: 09872957342

SV Public School, Jaipur

Third Innovation Hub was installed during August 2018 with a set of 20 innovative models.
Contact: Rita Taneja 9829046709

Rani Laxmibai Mahila Mavidhyalaya, Parola, Jalgaon

Fourth Innovation Hub was installed at the Rani Laxmibai Mahila Mavidhyalaya, Parola, Jalgaon, Maharashtra during December 2018.
Contact : Dr. D R Patil 09860335029

Amity University, Noida

Fifth Innovation Hub was installed at Amity University, Noida, during January 2019. They have planned to use these demonstrations for the DST Inspire Camps.
Contact : DR. D K Awasthi 09818038430

Govt. College, Kota

Sixth Innovation Hub was installed at Government College Kota, during February 2019. They have planned to use these demonstrations.

Contact : Dr. R N Soni 09413651088

Kanya Maha Vidyalaya, Jalandhar

7th Innovation Hub was installed at the K M Vidyalaya, Jalandhar during April 2019.
Contact: is Dr. Neetu Verma, Department of Physics, IAPT Life Member

Regional Institute of Education, Bhubaneswar

8th Innovation Hub was installed at Regional Institute of Education Bhubneshwar, Oodisha during March,2019. They have planned to use these demonstrations and teachers training Program.

Contact : Dr. S K Dash 08895478337

Bajaj Science Centre, Wardha

9th Innovation Hub was installed at Rahul Bajaj Science Foundation, Wardha, Maharashtra, during July 2019.
Large number of students and teachers visit this place each year.
The cordinator : Govind Kumar Lakothia 09579194076

GLA University, Mathura

10th Innovation Hub was established at the Department of Physics, GLA University, Mathura, UP, during July 2019.
They have procured full set of 25 demonstration setup and using them for students and faculty up gradation.
Contact : Prof Anuj Vijay 09897311995

University of Kota, Kota

11th Innovation Hub was installed at the Department of Physics, University of Kota, during July 2019.
A complete set of 25 experiments were installed. It was inaugurated, by Prof S N Joshi, Ex Director CEERI Pilani.
Coordinator: Dr. Ghanshyam Sharma 09414787629

IIS University, Jaipur

12th Innovation Hub was installed at the IIS University, Jaipur, in the IIS School Campus under the guidance of Prof Y K Vijay, Director, Center for Innovation in Science Teaching (CIST) during September 2019.
Contact Person is Dr. Rajbahadur 9461673766

Avaneshika, Jaipur

A Few models of Innovation Hub are procure by Anvesika Jaipur .

Cordinator G S Maneria 09928536600

Models are:

- Lorentz Oscillator
- Bohr Orbitals
- Racing Track
- Motion in inclined plane
- Vertex formation
- Series of Pendulum

SS Jain Subodh College, Jaipur

14th Innovation Hub was installed at Department of Physics, SS Jain Autonomous College , Jaipur during August 2019, with a limited number of demonstrative set up and a few self developed models.

Coordinator is Dr. Balram Tripathi 09460067015

Amity University, Jaipur

15th Innovation Hub was installed at the Amity University Jaipur Campus, during December 2019.

Contact person is Dr. P S Raju 09784978334

Pune University, Pune

16th Innovation Hub was installed at the Science Centre Savitri Devi Phule University Pune, Maharashtra, during February 2020.

Contact Person Dr. Dilip G Kanare 07597278983

Science Park, Chandrapur

17th Innovation Hub was installed at the Science Centre Chandrapur, Maharashtra, during February 2020.

Contact person is Prof Dilip G Kanare 07597278983

Regional Institute of Education, Ajmer

18th Innovation Hub was installed at the Regional College of Education, Ajmer, during March 2020.
Complete set of 25 models were installed and are being used by students and teachers.
Contact Person is Prof S V Sharma 09414029449

Bansur PG College Bansur

19th Innovation Hub was installed at the Bansur PG College Campus, during February 2020.
The have set up all models in a space of over 1000 sq.ft. circular Hall of height 20 ft.
Contact person: Mr Ajay Gujar 09990427475

Prayan Innovation

20 the Innovation Hub has been set up at the Prayan Innovation, Sanganer Jaipur.
All the models are fabricated here and one set is kept as master set up for up gradation.
Contact person is K C Sharma 09460151009

D A V College, Bathinda

This Innovation Hub was established on 23 December, 2020 at the D A V College, Bathinda. This has complete set of 25 demonstrating set up covering different aspects of Science of motion, oscillations, waves , forces and plasma useful for activity based learning.

Contact Person: Dr. Kulwinder Singh Mann Contact No. 9417325696

Amity University, Raipur

This Innovation Hub was Established, on 19th February, 2021. A total set of 30 different working models were setup. This was inauguration by the Vice Chancellor Prof R K Pandey, Amity University Chattisgarh, Raipur, with several faculty members and administrative stall ans students. Working of all models were explained by Prof. Y K Vijay.
Contact Preson: Prof. Roshan Methew HOD Physics, Amity Univ. Raipur M: 9179840317

Rawat Public School, Pratap Nagar, Jaipur

This innovation hub was established at the Rawat Public School, Pratap nagar, Jaipur on 27th February 2021. ON occasion of Science Week celebration.
A complete set of 30 working models for teachers and students for learning fundamental science principles are installed and demonstrated.
Contact Person is Mr. Narendra Rawat M: 9887512702

Ben-Hur Public School, Pilibhit UP

24th Innovation Hub was established at the Ben- Hur Public School Pilibhit UP on 6th March, 2021. It has 30 working models of different fundamental concepts all quantum science to bring in visible range, like charge, atomic configuration, Bohr orbitals, wave propagation, em induction black hole, Doppler effect etc.
Contach Person is Mr Narendra Gangwal 8126311542

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Innovation Hubs Established Till Today

1.	Vivekananda Global University	61
2.	Hans Raj Mahila Maha Vidyalaya, Jalandhar	62
3.	SV Public School, Jaipur	63
4.	Rani Laxmibai Mahila Mavidhyalaya,Parola, Jalgaon	64
5.	Amity University, Noida	65
6.	Govt. College, Kota	66
7.	Kanya Maha Vidyalaya, Jalandhar	67
8.	Regional Institute of Education, Bhubaneswar	68
9.	Bajaj Science Centre, Wardha	69
10.	GLA University, Mathura	70
11.	University of Kota, Kota	71
12.	IIS University, Jaipur	72
13.	Avaneshika, Jaipur	73
14.	SS Jain Subodh College, Jaipur	74
15.	Amity University, Jaipur	75
16.	Pune University, Pune	76
17.	Science Park, Chandrapur	77
18.	Regional Institute of Education, Ajmer	78
19.	Bansur PG College Bansur	79
20.	Prayan Innovation	80
21.	D A V College, Bathinda	81
22.	Amity University, Raipur	82
23.	Rawat Public School, Pratap Nagar, Jaipur	83
24.	Ben-Hur Public School, Pilibhit UP	84

Fabrication work carried out at Prayan Innovations, Jaipur by Sh. K. C. Sharma, Retired Senior Technician from CDPE, University of Rajasthan, Jaipur.

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