Navi Mumbai Science Foundation

EdUREKA

Education for Spirit of Science

Volume 4, Issue: No. 1 **January-March 2022**

Mission Shakti

The anti-satellite missile lifting off on 27 March 2019 from Abdul Kalam Island as part of Mission Shakti

Navi Mumbai Science Foundation

[Regn. No.: Maha/2592/10/ (Thane)
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This is a quarterly e-magazine published by Navi Mumbai Science Foundation, a society engaged in spreading science education and scientific temperament among students of Navi Mumbai region for the last one decade. The magazine will mainly cover activities and articles on science education useful to students, teachers & society at large.

Contents .....

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Views expressed in the magazine are from authors and editor may not agree with it.

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From Editor's Desk!!....

Editor's Corner

Dear Readers, students and teachers, we continue with our endeavor to bring articles to you which will give you a different perspective to things that you already know or introduce you to new concepts. Walking in that direction, this time we bring you articles written by people who have devoted their lives to science and science popularization.

First article deals with our great luminary, Prof. C.V. Raman, the great Luminary and the only Indian to get Nobel Prize (in science) while working in India. This article by Dr. A.M. Bhagwat, deals with his life and achievements.

The second article is part of the series which deals with great discoveries without much equipment or sophistication. It continues with the measurement distance as a function of time and the development of the relationship $S = \frac{1}{2} at^2$.

We bring an article by two young students of class VII and X on the life of a honey bee. They discuss the lifecycle, their daily activities and characteristics. The description is more in the form of a story than a textbook documentary.

We then have an article from a young teacher of a college, who explains the integration of botany and zoology in the form of a story of peepal tree which is a nuisance on the walls of our houses and apartment complexes (specially terraces), but we do not find the same peepal trees in such abundance on the ground.

Finally, my favorite topic, science experiments. But this time I bring you an experiment conducted by our DRDO on India's missile program and its achievements. This program is called Mission Shakti which has put India in a unique club of few selected countries.

This issue will end with some announcements and news items and preparation for the next one.

Sir C. V. Raman: His life sketch, works & achievements

(A wholly home-grown Indian Scientist)

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National Science Day Celebration in India

February 28 is celebrated as National Science Day (NSD) in India. It commemorates the discovery of "Raman Effect" on February 28, 1928, which led to Sir C.V. Raman winning the Noble Prize in the year 1930[9].

In 1986, the National Council for Science and Technology Communication (NCSTC) asked the Government of India to designate February 28 as National Science Day which the then Govt. of India accepted and declared the day as National Science Day in 1986. The first National Science Day was celebrated on February 28, 1987[9].

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Part I. His birth & education [2,5,6,7,10]

Chandrasekhara Venkata Raman (abbreviated as C. V. Raman) was born on November 7, 1888, in Tiruchirappalli, Tamil Nadu, with a silver spoon of knowledge to feed him. He was the second child (amongst eight) of Shri Chandrasekhar Iyer and Smt. Parvathi Ammal. With a father who was a professor of physics and mathematics (in a college in Vishakhapatnam), and a mother who came from a family of Sanskrit scholars, Raman exhibited the qualities of a gifted child right from an early age. He thus grew with an academic atmosphere at home.

C. V. Raman was an intelligent and brilliant student since his early childhood. From his early age, Raman had a great interest in science and mathematics. Little Raman took great interest in physics and started learning more and more about physics concepts and theory. At the age of 11, he passed his matriculation and 12th class at the age of 13 on a scholarship.

He studied at the Hindu College, Visakhapatnam, and the Presidency College, Madras. He entered Presidency College, in 1902, and passed his B. A. examination in 1904 with Physics and English, winning the first place and the gold medal in physics. After this, he wanted to complete his master's degree from the United Kingdom but due to some health issues, he stayed here. At that time, he was the only student who received the first division. In 1907, C.V. Raman did his Master's in Physics from the same college at the age of 19, obtaining the highest distinctions and a gold medal, breaking all the previous records.

While studying for his M.A. degree, he published his first research (academic) paper in Philosophical Magazine at the age of 18. It was about the behaviour of light. **It was the first research paper ever published from Presidency College.** During his student days he conducted many researches and published his papers in many reputed magazines.

With little other opportunities available to scientists in India in those days, he appeared & passed the Financial Civil Service (FCS) exam in 1907 and topped it. He took up this line because of his father's interest in it. He was posted at Calcutta (now called Kolkata) as assistant accountant general. In 1907, he also got married to Lokasundari Ammal and had two sons, namely, Chandrasekhar and Radhakrishnan.

Part II. His service period [2,4,5,6]

At Kolkata, he came in contact with an eminent scientist named **Dr. Mahendralal Sarkar** who was the secretary of Indian Association for the Cultivation of Science. This contact with Dr. Sarkar proved a turning point in the life of this young scientist.

Though his job was very hectic, he went to the laboratory at the Indian Association for Cultivation of Science, in his spare time after office hours, to pursue his research interests. At times, he continued his research work even at night due to his core interest in science. His areas of research were acoustics and optics.

Though the facilities available in the laboratory were very limited, he continued his research and published his findings in leading international journals

including 'Nature', 'The Philosophical Magazine', and 'Physics Review', to mention a few.

When these publications came to the notice of the then Vice-Challenger of Kolkata University, Sir Ashutosh Mukherjee, he appointed C. V. Raman as the first Palit Professor of physics in the University in 1917.

In 1933, Raman became the first Indian director of the Indian Institute of Science in Bangalore and continued there till 1948. Since 1948 he served as Director of the Raman Institute of Research at Bangalore, established and endowed by himself. He continued to work there till he breathed his last.

In 1947, Raman was appointed as the **first National Professor** by the new government of independent India. He sponsored the establishment of the **Indian Academy of Sciences** in 1934 and served as its President since inception. He was also the President of the Current Science Association in Bangalore, which publishes Current Science (India). He also founded the *Indian Journal of Physics* and trained hundreds of students who found important posts in universities and government in India and Myanmar.

Other investigations carried out by Raman, at Indian Institute of Science, Bangalore, were: his experimental and theoretical studies on the diffraction of light by acoustic waves of ultrasonic and hypersonic frequencies (published during 1934-1942), and those on the effects produced by X-rays on infrared vibrations in crystals exposed to ordinary light.

Part III. His works, awards & honours [1,2,3,4,5,6,7,8,10]

As noted above, Raman had started publishing his research findings right from his college days. The journals of repute, wherein he published his research papers, were proof enough for the quality of work reported.

Besides optics, he was deeply interested in acoustics - the science and study of sound. His interest in diverse fields of science is borne by the fact that, in 1928, he wrote an article on the theory of musical instruments for the 8th Volume of the *Handbuch der Physik*. His contributions to the mechanical theory of bowed, stringed and other musical instruments like violin, sitar, cello, piano, *veena, Tanpura* and *mridangam* have been very significant. He explained in detail how these musical instruments produce harmonious tones and notes.

Among his other interests have been the optics of colloids, electrical and magnetic anisotropy, and the physiology of human vision.

His works leading to Nobel Prize in Physics

In 1922, he published his work on the "Molecular Diffraction of Light", the first of a series of investigations with his collaborators (specially, his student, K. S. Krishnan) which ultimately led to his discovery, on the 28th of February, 1928, of the radiation effect which bears his name ("A new radiation", *Indian J. Phys.*, 2 (1928), 387), and which gained him the 1930 Nobel Prize in Physics. In his studies, Raman used a spectrograph that he had developed himself.

In the following paragraphs, we will find a few simple descriptions of his work that led to his winning the Nobel Prize.

One day, in December, 1927, when he was busy in laboratory, he got the news that the well-known physicist A. M. Compton was awarded the Nobel Prize for demonstrating that the nature of X-rays undergoes a change when passed through matter.

This effect came to be known as the "Compton Effect." Encouraged by this discovery, Raman continued his experiments on light rays and ultimately proved that they too get scattered. His discovery enabled for the first time, the mapping of possible levels of energy gains of molecules and atoms of a substance and thus discovered their molecular and atomic structure. This discovery of the scattering of light led to the development of a simple alternative to infra-red spectroscopy, namely, Raman Spectroscopy. This effect has beenstated in a few simple ways as listed below.

i) Raman Effect happens when molecules of a medium scatter light. The spectrum of scattered light varies with the nature of the transparent medium used to scatter the light. Raman Effect has proved to be of great scientific value and with its help the structure of several hundred compounds has now been established.

ii) that when light traverses a transparent material, the deflected light changes its wavelength and frequency. This phenomenon, a hitherto unknown type of scattering of light, which they called "modified scattering", was subsequently termed the Raman effect or **Raman scattering.**

iii) when a beam of coloured light enters a liquid, a small fraction of the light scattered photons (approximately 1 in 10 million) can be scattered with an energy different (usually lower) from those of the incident photons - these are Raman scattered photons. They have a different colour. Raman showed that the nature of this scattered light is dependent on the type of sample present.

Raman further explained that the blue colour of the ocean was a result of the scattering of sunlight by the molecules of the water – a reasoning which differed from that put forth by his contemporaries, i. e., that the blue colour of the

sea was due to the reflected Rayleigh-scattered light from the sky. For his pioneering work on scattering of light, C.V. Raman won the Nobel Prize for Physics in 1930.

This historical discovery of C.V. Raman gives spectroscopy a unique identification, which relies on these 'fingerprints,' & is used in laboratories all over the world to identify molecules and to analyze living cells and tissues to detect diseases such as cancer.

All the major honours, that he received in his life time are chronologically listed below:

- In 1924, he was elected as a **Fellow of the Royal Society** early in his career.

- in 1929, he was knighted by the title "**Sir**" by the British Empire.

- in 1930, he won the **Nobel Prize in Physics**.

- in 1941, he was awarded the **Franklin Medal** (it is a science and engineering award presented by the science museum called Franklin Institute of Philadelphia, Pennsylvania, USA).

- in 1947, he became independent India's first **National Professor**.

- in 1954, he was awarded the **Bharat Ratna,** the highest civilian award in India.

- In 1957, he was awarded the **Lenin Prize** for Strengthening Peace among People.

- In 1961, **member of the Pontifical Academy of Sciences**, Vatican City.

- From 1987 onwards, India celebrates "**National Science Day"** on February 28 every year to **commemorate the discovery of the Raman Effect on Feb. 28, in 1928, in his honour.**

- In 1998, Raman's discovery was **posthumously** recognized by The American Chemical Society, the Indian Association for the Cultivation of Science and a few other learned societies **as an International Historic Chemical Landmark.** Their aim is primarily to serve the broad public interest. A plaque marking this event, as described below, was installed at the Indian Association for the Cultivation of Science at Jadavpur, Kolkata, on December 15, 1998. Its contents are reproduced below ad verbatim.

"At this institute, Sir C. V. Raman discovered in 1928 that when a beam of coloured light entered a liquid, a fraction of the light scattered by that liquid was of a different colour. Raman showed that the nature of this scattered light was dependent on the type of sample present. Other scientists quickly understood the significance of this phenomenon as an analytical and research tool and called it the Raman Effect. This method

became even more valuable with the advent of modern computers and lasers. Its current uses range from the non-destructive identification of minerals to the early detection of life-threatening diseases. For his discovery Raman was awarded the Nobel Prize in physics in 1930."

In 1970, he received a major heart attack while working in the laboratory. He took his last breath at the Raman Research Institute on 21st November 1970.

Part IV. His personal qualities and International Fame [2,3,4,5,7]

C.V. Raman is one of the most renowned scientists produced by India. **He was the first Indian scholar who studied wholly in India and also received the Nobel Prize.**

He was a **Physicist, Nobel Laureate, and a Bharat Ratna** who was instrumental in India's growth in the field of Science and Physics. His contribution to science and innovative research helped India and the World. He contributed to the building up of nearly every Indian research institution in his time.

During his tenure at the Kolkata University, he received worldwide recognition for his work in optics and scattering of light. **He also travelled abroad widely delivering lectures about his discoveries and researches.**

Raman has been honoured with a large number of honorary doctorates and memberships of scientific societies.

Raman was a born genius and a self-made man and scientist with deep religious convictions. His interests were wide and deep and so were his contributions to the human knowledge and development.

Dr. C.V. Raman was one of the great legends from India whose hard work and determination made India proud. He proved that, if a person really wants to pursue his/her desires, nobody can stop. **His countrymen will always remember him as a great Scientist who put India on the world map of science.**

Jagdish Mehra, a biographer, states that "Educated entirely in India, Raman did outstanding work at a time when the small Indian community worked almost entirely in isolation and only a few made science as a career. In fostering Indian science, Raman emerged as one of the heroes of the Indian political and cultural renaissance, along with …… Mahatma Gandhi and Jawaharlal Nehru."

Part V. References

1. C. V. Raman: Wikipedia, the free encyclopedia.

2. Comprehensive essay on Chandrasekhar Venkata Raman (1888 A.D. – 1970 A.D.)! Article by Mohita Negi (https://www.yourarticlelibrary.com › essay › c-v-raman...).

3. Sir Chandrasekhara Venkata Raman: Biographical.

(https://www.nobelprize.org/prizes/physics/1930/raman/biographical/).

4. C.V. Raman, Indian physicist. https://www.britannica.com/biography/C-V-Raman.

5. C.V. Raman Biography: Early Life, Career, Awards and Achievements.

https://www.jagranjosh.com/general-knowledge/chandrasekhara-venkata-raman-cv-raman-biography-1573042778-1

6. C. V. Raman Biography.

https://www.iloveindia.com/indian-heroes/cv-raman.html.

7. C. V. Raman and the Raman Effect: International Historic Chemical Landmark.

https://www.acs.org/content/acs/en/education/whatischemistry/landmarks/ramaneffect.html#citation.

8. The Pontifical Academy of Sciences - Wikipedia, the free encyclopaedia.

9. National Science Day - Vikaspedia

10. BHARAT RATNA SIR C. V. RAMAN, 1888 – 1970.
https://www.bfitdoon.com/blog/100-2/

This article is only a compilation of information from various sources on Internet (listed under references). It is intended to demonstrate that a genius continues to be a genius irrespective of which part of the world he/she is born.

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The above article is a humble tribute to the great genius “Sir C. V. Raman” in whose honour India celebrates Feb. 28, as “National Science Day” each year. His original contributions put India on the world Map of Science. Navi Mumbai Science Foundation has started celebrating “National Science Day” under its banner from the year 2020 onwards.

Great discoveries without sophisticated equipment

Great discoveries without sophisticated equipment - III

$S = \frac{1}{2} at^2$.

A usual two storied apartment complex is a about 20 m high. If a student is standing on the top of this building and drops a ball, what is the time taken for the ball to reach the ground?

The time of travel of this ball is close to 2 seconds.

As we had seen in the previous two issues, that invention of instruments which can measure in milli-second or less is only about few decades old. Hence, during the flight of the ball, from the top to the bottom of the building, it is not possible to make more than 3 observations.

In order to determine a relationship between any two parameters, with reasonable confidence, it is conventional that around seven observations are made. Under these conditions it is difficult to determine the relationship between the displacement s and time of travel t. However, it was in the year 1604 that this relationship was developed.

In the flight of ball, vertically downwards there is only one force which acts on the ball. Gravity. The force of gravity cannot be modified and hence there is no way to slow down the travel of the ball to get more readings. But, if one has a path of travel, which is not vertical, but at an angle □ with the horizontal, then g, the acceleration due to gravity, can be multiplied by a factor sin□. This can be used to slow down the travel to a value, desirable by the person conducting the experiment. This allows many observations along its path downwards.

https://www.google.com/search?q=galileo%20experiments%20inclined%20slope&tbm=isch&ictx=1&tbs=rimg:CRhpOyy9i_13nIggYaTssvYv95yoSCRhpOyy9i_13nERxsQcn62sV6&client=firefox-b-d&hl=en&sa=X&ved=0CAEQiRxqFwoTCPi6tfKDpfUCFQAAAAAdAAAAABAD&biw=1171&bih=575#imgrc=2tN9F5CK6nPcPM

However, this was only half the solution. If you remember this was the time when there were no clocks. The sand clock had least count of an hour and sun dials had at best 15 seconds. In which time ball would have rolled down the inclined plane.

Now comes the innovation. Time is measured by clocks, which are dependent on any repetitive process. Be it pendulum, Earth's rotation around its axis, revolution around sun, and in modern times wavelength of radiation etc. But if you did not have any of these, one has his/her own heart beat to use as time scale, or pulse feeling. But the last two are not very regular to be used as time clock. But using simple sound notes, practiced thoroughly, can be used as a unit of time.

And this is what was used four centuries ago. Experimentalists sang a simple sequence of notes and another person counted the number of notes between any two events. Like release of ball and its reaching the end of the inclined plane.

The unit of time was the musical tone. It was later that the experimenters were not sure if it will assure the reader, of their invention, if singing is used for measuring time. Hence, it was replaced by counting water drops, leaking from a pot at a uniform rate.

But as in every experiment, carried out for the first time it is not easy to analyse the data, to obtain a meaningful information from it. Suppose one obtains a data, as listed in the table. The units are arbitrary, as in those days concept of cm or inch too did not exist.

Time	**Distance**
1	33
2	**130**
3	298
4	**526**
5	824
6	**1192**
7	1620
8	**2104**

With a data like this, it was not obvious to the researchers on the correlation. They tried various operations like d_2-d_1, d_3-d_2…. Or d_2-d_1, d_3-d_1…. Then

Using division as the operation, like d_2/d_1, d_3/d_2…. But nothing made sense. Till finally they carried out the operation d_2/d_1, d_3/d_1….

Which resulted in numbers which were very close to squares of integer or the number in the "time" column. Then with more empirical data, the relation between distance and time was obtained as $s=\frac{1}{2}at^2$. The most commonly used relationship in mechanics.

These were the times when no one knew how to draw graphs or even if someone had drawn it, most of the people did not know how to read the language of graphical representations.

STUDENTS' CORNER

'A Day in the Life of a Honey Bee'

Ansh Pandey[1] and Anjali Pandey[2]

[1]Std. VII, Podar International School Ambernath, [2]Std X Holy Writ School, Badlapur, Maharashtra

Buzz is a just 32 days old forager honey bee, resident of a Hive Colony. In this age Buzz has lot responsibilities toward her society. She has to go out daily with her sisters and friends to search and collect, nectar from the flowers. Sounds easy enough, right? Wrong! In order to collect enough nectar to fill a bee's carp stomach, bees have to visit many flowers, getting only a little from each. Buzz believes that this is a rather nasty trick that plants play on them bees. They produce just enough nectar to lure them in, but never enough to satisfy their needs. What kick the they get out of this trick, buzz does not know, but she is sure irked about it. Unknowingly, Buzz transports pollens of flowers from one to another, aiding to the cross pollination, an important method of sexual reproduction in plant life. Probably, it is the cost of nectar paid to the flowers by Buzz[1]. Nevertheless, she collects the nectar from flowers with the help of a long straw-like structure called 'proboscis', a special apparatus of her mouth and also takes some pollen in her pollen basket (Figure 1) and takes it back to the hive, where honey and bee bread are made using these materials.

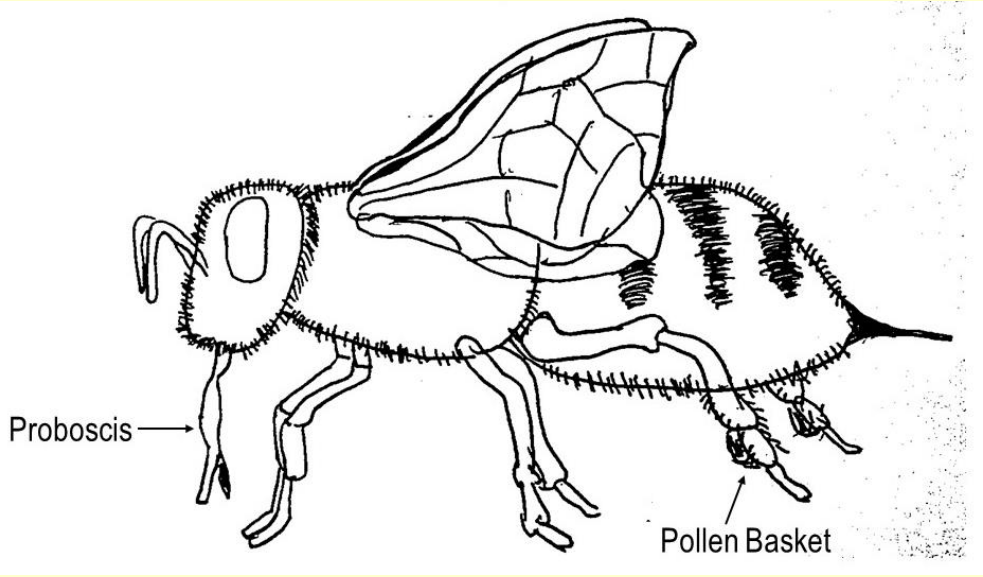

Figure 1 The Forager Bee - Buzz

She does not stop to mull over any questions or stop to take a break as winters are close and it is very important for the honey stock to be filled before winters. Because in winters there are fewer flowers from which she and her sisters

can collect nectar. Bees are also unable to forage. Most members of the bee colony are able to survive winters with the help of honey that they use as food[1].

Once she reaches the hive, she has to go through a security check by her sister guard bees. The guard bees can distinguish between the members of their own hive and foreigners because of their strong sense of smell. But then again, most bees have a strong sense of smell. Buzz prides herself on being able to find nectar with the help of her strong sense of smell. After going through the security check, buzz passes all the nectar she has collected to her sister Apis, who is a 12–17-day old processor bee. Buzz is aware of the modalities due to the fact that in early age, she had also performed such duties[2]. Due to their young age, processor bees have the ability to produce more enzymes for breaking down the nectar into simple sugars such as glucose and fructose. Next, this partially processed nectar is transferred to another group of processor bees who further add more enzymes into it. This process is repeated several times till most of the nectar is converted into simple sugars. This final product is called honey and it is stored in the hexagonal containers made of bee-wax. Bee wax (Cera alba) is also made by honey bees in the eight wax producing glands located in the abdominal part of the bees.

The honey thus prepared still has a substantial amount of water, enough to promote growth of bacteria or fungus. To dehydrate the honey and make it thick, some bees flap their wings around it to maximize the evaporation of the water. When the honey is finally ready, it is sealed with the bee-wax.

Buzz, however, doesn't stay to watch the entire process. She leaves the hive after giving nectar to her friend Apis, and goes on to inform other bees about the whereabouts of nectar so that they don't waste their time roaming around.

To do this, she does either a special Waggle dance or the Circle dance after returning to the hive. The circle dance, as the name suggests, involves Buzz moving in a circle near the hive[4] (Figure 2 A). It means that the honey is nearby, within a range of approx. 50 to 150 meters. Whereas, in the waggle dance, Buzz moves in a straight line waggling its body back and forth, vibrating its wings, and then taking a 'U' turn towards the left and then again waggling in a straight line followed by a 'U' turn towards right and this process continues. In the end, the direction in which the she moves is an indication for other bees to follow in the same direction. If she goes straight in the direction of the hive, it indicates other bees to go in the direction of the sun. If she turns to the right or left of the hive, she does so by maintaining a certain angle of deviation from the

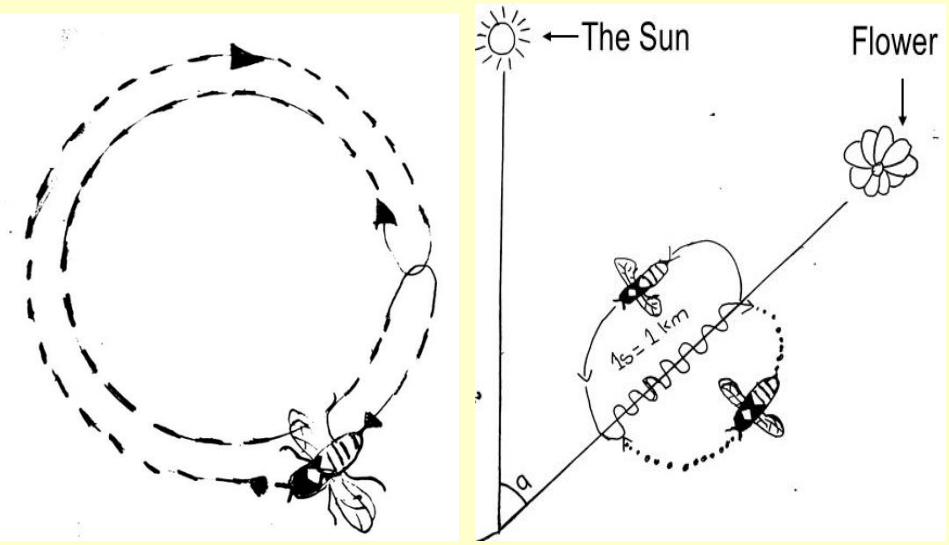

Figure 2. A. The Circle Dance B. The Waggle Dance

direction of the sun, so that the precise direction is conveyed to other bees[4] (Figure 2 B). The faster she waggles; more is the number of flowers in that direction. Similarly, the longer her waggle is, the longer is the distance they have to travel.

After this, Buzz continues to collect nectar and take it back to the hive all day long and returns to the hive an hour before sunset, deciding to call it a day then for she can't see well in low light and might get lost. Following this daily routine Buzz, in her entire life span, contributes to production of one and half teaspoonful sweet and precious honey. On average 20000-80000 forager bees like Buzz reside in the hive colony and contribute to the annual production of approximately 50kg of honey from a bee hive.

But buzz doesn't have a carefree life like you imagine. She is not a new bee and has seen the world. She is aware of the fact that every day, there is a risk of losing her home. Buzz is a brave bee and duty bound to sacrifice herself to protect her hive colony, if and when the time comes. But that doesn't mean, she is not scared or that she does not see the risks. No matter where her hive is, there are always some animals who might attack the beehive for the honey. More than any other animals, humans seem to be biggest threat, as they can reach everywhere. She has seen humans take out beehives, squeeze honey out of hives and leave the poor members of that colony homeless and foodless.

We must know these people as beekeepers. And we must know the days' worth of hard work of bees like buzz as 'the honey' we eat.

References:

1. https://www.sciencefocus.com/nature/how-do-bees-make-honey/
2. https://honeybee.org.au/education/wonderful-world-of-honey/how-bees-make-honey/
3. https://youtu.be/sAKkjD3nEv0
4. https://youtu.be/nZlEjDLJCmg

TEACHERS' CORNER

The Hidden Story of Peepal?

Suyash Sawale & Shashibhal Pandey*
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The art of learning has countless methods which can be used while teaching. But the classroom offers students more opportunity to observe their teachers rather than a place to observe nature, full of scientific amaze. It is this scientific observation at right time, at right place which can help the learning process.

If you carefully observe the flora present in your surroundings like gardens, parks, on walls and roofs, the plants growing on the roofs and walls can be easily noticed. Mostly, these are Peepal saplings growing on the roofs and walls of some buildings (Figure 1). Curious minds can ask question, how this seed might have flown in and lodged itself in crevices on the side of the walls and taken root there. Its fellow seeds must have landed few meters away on the fertile soil, but failed to take root. This observation compels you to think, why did the Peepal tree take up hard way, clinging to the side of rock or wall, and ignored a potentially better life offered, on the flat soil? We have got an interesting answer, that we think is worth sharing with the readers of EduREKA. It will help students to understand the wonderful interaction between plants and animals. It will help students understand how plants interact with animals in their ecosystem / surroundings.

The Peepal plants, have learned to make best use of animals for mutual benefit. On one hand they use higher animals for the dispersal of seeds and in turn provide them with nutritive fruits, on the other hand they use Fig wasps for transportation of their pollens and in turn nourish their embryos.

Throughout the year, a lot of fruits and seeds fall down on the ground yet not a single Peepal sapling is seen growing under another Peepal tree. One obvious reason is that plants avoid intraspecific competitions for resources in the same area. Due to this habit, plant progeny gets better chance to thrive.

Figure 1. Peepal (*Ficus religiosa*). A. Fruit B. Plant

However, unlike animals, plants lack any locomotory organs to assist them in moving away from the location to disperse the seeds. Therefore, many plants use animals with well-developed locomotory organs to assist in dispersal of the seeds - this is called "zoochory". When the seeds are carried through animal body surface, the phenomenon is specified as Epizoochory. In peculiar cases like that of Peepal, transportation of seeds for the dispersal is also accompanied by its processing through digestive system of carrier animal (1)

To understand this, let's take a simple example. Imagine, you have hired a container for transport of curd from Haryana to Coimbatore and the transit duration is two days by road. Instead of making curd and have two day old curd delivered or making curd from milk in Coimbatore, one can be innovative and load milk in the container having inbuilt mechanism for processing milk to curd, so that consumer will get curd delivered in Coimbatore after two days. This way one can save 16 hours of time, in general taken for conversion of milk into curd after inoculation of primary culture.

Like other Figs, Peepal seed also possesses a hard covering that does not allow it to simply germinate in soil, like other seeds. In natural conditions, it is unable to germinate. The hard-external covering of the seed is penetrable only by a certain acid and digestive enzymes. These digestive enzymes and acid are unavailable in the environment. Such acids and enzymes are present inside the gut of certain frugivores namely, birds, monkeys and squirrels. When the fruits are consumed by these frugivores; the hard-external seed covering is exposed

to the eroding properties of the enzymes and acids. Thus, external covering is removed and the partially processed seed is passed out in the faeces of animal/bird. The seed is now able germinate upon exposure to water and nutrients present in the fecal matter and environment. The frugivores are forager by nature and therefore unknowingly helping such plants in the seed dispersal. Therefore, Peepal plans are often seen on walls and roof, the places where some bird, monkey, and squirrel might have defecated in the past [3].

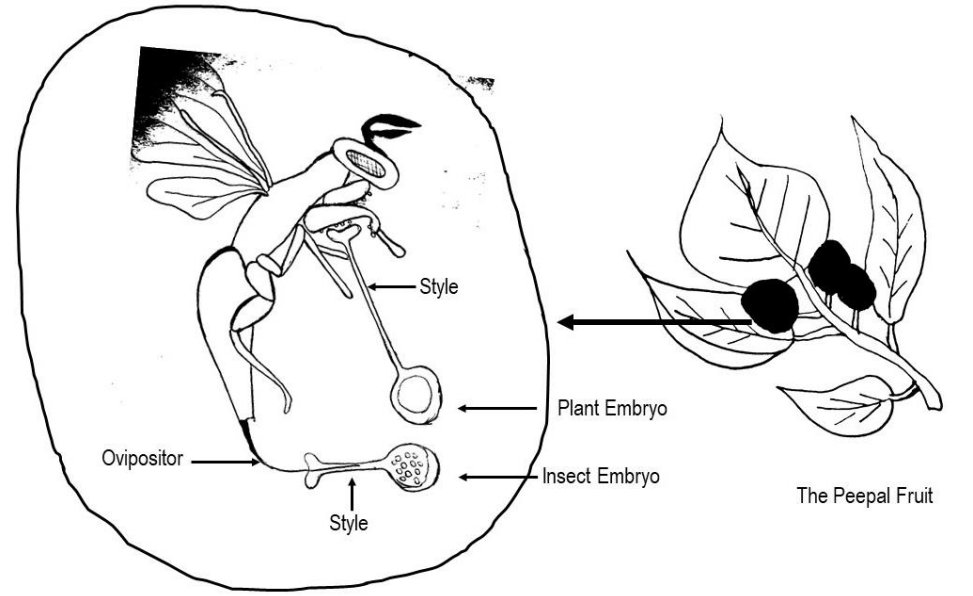

Figure 2 Left- Fig wasp on two different sized style inside the Peepal fruit. Right- Peepal fruit

Like Peepal, seeds of raspberries and blackberries need to be abraded in a bird's gizzard or eroded by digestive acids before water and air can enter the seed and germination can begin. To grow these plants from seed, gardeners soak the seeds in sulphuric acid or scrape them with a file or sandpaper. Interestingly, Peepal can germinate not only on the walls and roofs, but also in the crotch of a branch and send roots down to the forest. The growing roots twine around the host tree, and ultimately, engulf, strangle and replace it. Looking at mature Peepal tree, with its smooth trunk hurtling towards the sky, one would never know if it conceals the ghost of another tree that supported it as seedling [3].

Each Peepal tree has a unique species of fig wasp inhabiting on the tree. This association of Peepal with the wasps for the purpose of pollination, dates back to about 75 million years, that is when the Fig first evolved, probably in Eurasia. Peepal and the wasp are totally dependent on each other in all the corners of the world [2]. The wasp facilitates pollination in the fig fruit. Peepal flowers have two types of flowers with different length of style. The one, with longer style stigma receives pollen from the thorax of the female wasp. At the same time, this female wasp is laying eggs in the ovary of nearby flowers having smaller

style. Longer-styled flowers are more likely to produce seeds and shorter-styled flowers are more likely to produce a pollinator offspring [4] (Figure 2). Thus, the Peepal nurture their own embryo and that of wasp in two different ovaries of flowers.

Reference:

1. **Daneshvar M H (2019).** In vitro and in vivo seed germination of Ficus religiosa L. https://www.researchgate.net/publication/335577009 In vitro and in vivo seed germination of Ficus religiosa L.
2. Marris E. (2016) https://www.nationalgeographic.com/science/article/eden-in-a-fig-tree-in-the-peruvian-rainforest?loggedin=true
3. Caughlin et al (2012) Sacred fig trees promote frugivore visitation and tree seedling abundance in South India. CURRENT SCIENCE, VOL. 102, NO. 6, 25.
4. Yu H and Compton S G, (2012) Moving Your Sons to Safety: Galls Containing Male Fig Wasps Expand into the Centre of Figs, Away From Enemies. PLoS ONE 7(1):e30833

Mission Shakti.

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On 27th March 2019, India joined the elite club of few nations to successfully launch mission Shakti, in the very first attempt. It was a day to celebrate the great achievement. But let us see why it is such a great event.

The anti-satellite (ATSAT) program, Mission shakti was planned in secrecy over several months. The project had to be kept secret as no country would like India to have this capability.

What is the technical challenge? Let us imagine a piece of paper 2 cm x 2 cm kept at a distance of 1 m from you. You have a needle with which you have to pierce the paper, by throwing the needle like a javelin (the way our Olympics champion had thrown it) . You can now feel the difficulty of piercing the paper with that needle, if this piece of paper is kept at 750 m away from you, the size is reduced to 1mm x 1mm and also it is moving at a speed of 18 m/s (65 km/h).

But this is what Indian experts achieved, and that too in the first trial. A satellite, orbiting around 280 km above the surface of earth at the speed of about 7.5 km/s (25,000 km/h) was knocked out by a rocket fired from India's rocket launching station.

A satellite was launched for this purpose on 24 January 2019, for the purpose of this event. This satellite was in a low earth orbit of under 300 km at the height of about 280 km, above the surface of earth. It was travelling at 7.4 km/s.

The anti-satellite missile lifting off on 27 March 2019 from Abdul Kalam Island as part of Mission Shakti

The satellite was moving in a radius of 6400 + 280 km = 6680 km, covering a circumference of 42,000 km with a speed of 7.4 km/s. Thus completing the orbit every 5,672 s which is 94 minutes.

Thus the reader can imagine that one has the opportunity every 94 minutes to shoot it down when it is over head, moving with speed of 7.4 km/s.

Also when the satellite is orbiting at 6680 km radius, with velocity of 7.4

km/s, it has a radial acceleration (outward) of 8.2 m/s^2. The gravitational acceleration, radially (inward) is 9.8 m/s^2. Thus the net acceleration is 1.6 m/s^2 inward. Assuming that the velocity downward is 0, to begin with, it will take 350,000 s for the satellite to hit the ground surface, which is about 4 days. Hence, additional systems are set up, to burn rocket fuel to maintain the orbit 6680 km.

However, if the satellite is orbiting at 8.1 km/s, then the two accelerations will balance each other. However, it would mean that there will be shorter time available to hit the target and hence an optimum speed of the satellite was chosen at 7.4 km/s.

A rocket was launched from ground which reached the satellite in 168 seconds. In order to reach 280 km in 168 seconds, the acceleration required is about 30 m/s^2 (which includes 10 m/s^2 to counter the acceleration due to gravity). It is left for the reader to calculate the force required to accelerate about 20 ton rocket with such large accelerations to reach these heights.

Also in 168 seconds of flight of the rocket, satellite moves by about 1200 km. Thus the launch is to be planned with such a precision that the satellite and the rocket meet at the same time and the amount of error allowed is 10 cm (time delay of 13μs). Reader can imagine the accuracy achieved by Indian scientists and engineers to achieve this precision.

Why is it important for India? This experience is a very helpful event in planning defense of India against enemy missiles which might be moving towards India.

Reference: https://en.wikipedia.org/wiki/Mission_Shakti

https://en.wikipedia.org/wiki/File:DRDO%27s_Ballistic_Missile_Defence_interceptor_being_launched_for_an_ASAT_test_on_27_March_2019.jpg

Activity question

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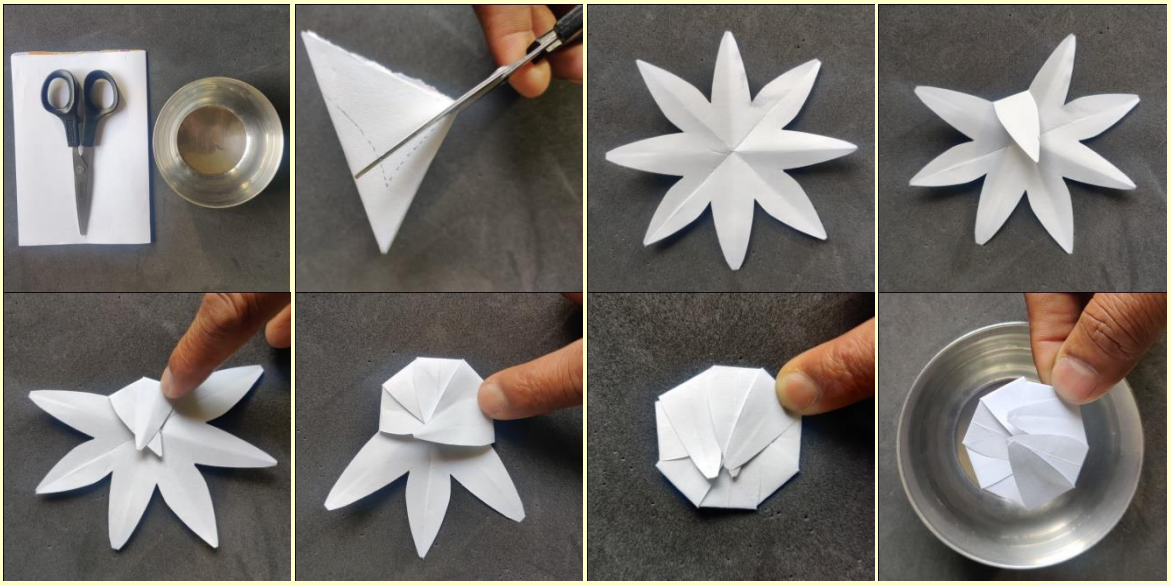
One day I am playing with craft some materials. I made a flower having a few petals. My sister came to me, as she does always, started folding petals one by one. Finally, my paper flower looked like that you see in the figure. Then, she asks me to place this in a bowl with water. Amazing**!!! Find out what happened?**



Even, I tried same with Hair oil, cooking oil etc. Now, going to try with all other possible options too. **C**an you help me to get an answer for, **Why this happen so?**

Forthcoming events of NMSF

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I. National Science Day 28 Feb 2022

II. International Day of Mathematics 14th March 2022

Events I & II conducted in collaboration

with

Karmaveer Bhaurao Patil College, Vashi.

DON'T MISS IT

Coming up in Next issue (January-March 2022)

1. Do the ray diagrams in our text books, match the numbers?
2. Report on Science Utsav 2022
3. Student's corner
4. Teacher's page
5. Activity question AND MUCH MORE……

DO YOU HAVE ANY INTERESTING EDUCATIONAL STORY TO TELL? JUST SEND YOUR STORY TO US AT edureka.nmsf@gmail.com for putting in EduREKA.
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