

# MACROCOSM

*Exploring the universe*

## Indian Heritage

Sushruta, an ancient hero of Indian medicine

Flashbacks of

## NEWS FLASH

IISC has developed an alternative to treat skin cancer

## ELON MUSK

real-world Iron Man



Department of Physics and Physical Sciences  
Kalindi College, University of Delhi

「Scientist of the month」



Elon Musk



*"When something is important enough, you do it even if the odds are not in your favor."*

*- Elon Musk*

**These are the inspirational words of our Scientist of the Month - Elon Musk.**

Born in South Africa, Musk grew the hunger for knowledge very early in his life. By the time he was 9, he had read the entire encyclopedia and was teaching himself to code, which he later used to build a game and sell the same for \$500. By the age of 17, he realized the pool of opportunities in the USA and moved to Canada to obtain further education in Physics and Economics.

During the 90's internet boom, Elon Musk dropped out of Ph.D. at Stanford and started working on Zip2, a virtual map software. With the help of some investors, Elon Musk became the sole developer, working at nights to keep the website accessible during the day. Zip2 was bought for over \$300 million, which he invested in his startup "X.com" which was later renamed PayPal. Later, PayPal was acquired by eBay.

Musk strongly believes that the human species cannot survive without developing interplanetary life systems. One crucial factor in interplanetary travel was monetary support. Elon Musk found SpaceX with a vision to produce lower-cost rockets and eventually set up colonies on Mars.

Interestingly, the first 3 launches of SpaceX failed drastically. The funds were just enough to try one last launch and it worked. Now, SpaceX has developed reusable rockets as well. Through years of research and of trial and error, SpaceX has been able to bring back safely, stage 1 rockets for reuse. This results in a reduction of launch costs by over 40%. Not only this, SpaceX is the first company to berth its vehicle with ISS.





Even though SpaceX is a huge success and is seemingly achieving primary goals, Elon Musk didn't stop here.

There were a lot of worldly problems yet to be resolved. Musk acquired lead investor role in electric car company "Tesla" whose "master plan", as iterated by Musk in 2006 was:

1. Build a sports car.
2. Use that money to build an affordable car.
3. Use that money to build an even more affordable car.
4. While doing the above, also provide zero-emission electric power generation options.

While his plan is a huge success, the low-cost Tesla model - Model 3 became the highest-selling electric car in history. Elon Musk is not the one who

settles. He went on to establish other companies like "The Boring Company" which bores into the ground to create faster travel routes. He also found "HyperLoop" for faster travelling based on the concept of incorporating reduced-pressure tubes in which pressurized capsules ride on an air cushion driven by linear induction motors and air compressors.

His other creations include "OpenAI" whose aim is to make AI so widely accessible that AI wouldn't be able to gain too much power. "Neuralink", whose concept is to combine the human brain with AI is founded by him.



Elon Musk is the person who was able to achieve all this because he was able to overcome his fears- the fear of failure, fear of judgment and what not! He established companies after companies, took calculated risks, and maintained a healthy balance between persistence and relinquishment. On this account, the key take-away from this edition's Scientist of the month is that **"Failure is an option".**

## Anisha Author's Bio

*She is a Physics Student with a future in Astronomy. She like observing and understanding different perspectives and then to express them through her writings.*



# A Colloquy with

---

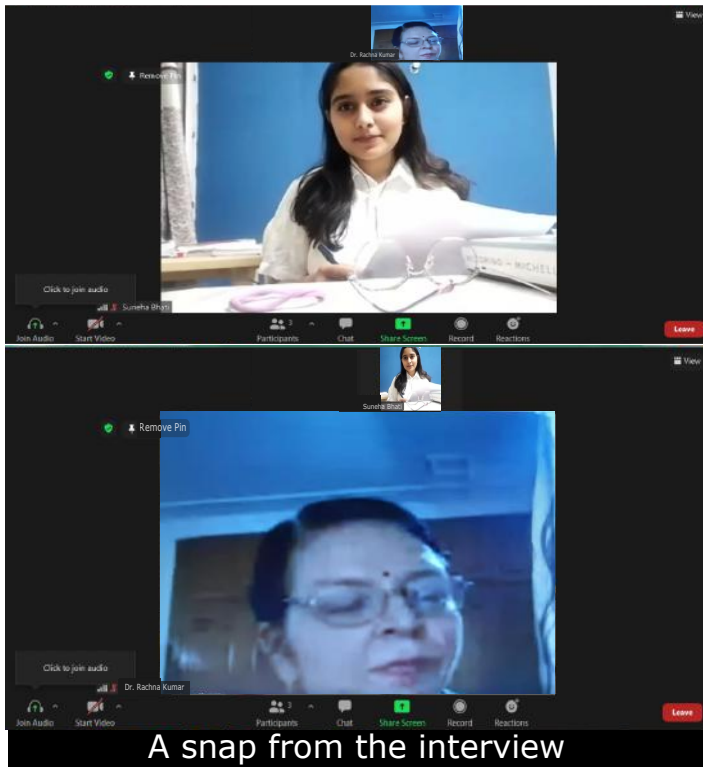


**The woman who graduated when women were not supposed to have the scientific temperament. A former DRDO scientist and now a professor in DU.**

## Back in the years you graduated, women were not supposed to have the scientific temperament. How did your journey towards science begin?

The women having scientific temperament dates back to old times but women choosing the Engineering profession was not all that common in my days of choosing a career. Delhi College of Engineering (now DTU) took admission on the basis of XII PCM in those days and I could have secured a seat but I did not choose that path.

My father, who was himself interested in Science Writing, was friends with ISRO scientists who were behind designing the first Indian Satellite 'Aryabhata'. My meetings and discussions with them played a key role in me choosing Physics. I have experienced in life, whenever we tell the people our stream, they are awestruck. More than often there is a comment, '*Oh, Physics, I was never able to understand it!*', That is our moment of triumph and solace for spending endless hours in understanding formulas and derivations.



A snap from the interview

## You are the most senior teacher in the Physics Department of our college. What was your career path?

I started my career, teaching at Rajdhani College. After a few months, I got the permanent Class I, Scientist B position in the Solid State Physics Laboratory (DRDO). However, teaching remained my first passion so after serving there for about four years, I joined Kalindi College. Thereafter during my time at Kalindi, I pursued higher degrees - PhD and Postdoctoral work.

## Out there in this field is remarkable competition, how did you maintain your consistency?

Anybody can maintain consistency but definition remains the same- Hard work and willingness to take the extra load. One has to keep pace with the latest developments otherwise one tends to be outdated in a very short time

## What has been your most precious work over the years? Would you like to describe it?

All my works are dear to my heart as I have learnt through all of them whether it is research work at DRDO, Maastricht University, AIT or research projects at Kalindi that if you do anything with involvement, it will keep your interest alive.

**I learnt from your profile that you have worked at DRDO as Scientist B, how was your work experience at DRDO? Would you like to elaborate more about the role you had there while working?**

I worked in the field of Mercury Cadmium Telluride Photoconductive Infrared Detectors and had three published research papers from that work. The students who want to join a research Laboratory should assess their research acumen. At the Undergraduate level, they can associate themselves with research projects. They should familiarize themselves with the literature Survey, read published research work and acquire good knowledge of computer and coding languages. Research labs like DRDO have a strong team and disciplined atmosphere. There are weekly appraisal meetings of the groups and you have to describe your continual progress of the week.

**with  
supervisor  
and  
co-surper**



**PhD times  
in  
Netherlands**

**We all know that you took your PhD from the Netherlands. How did you think of going to a foreign country in the times when globalization was not common? How was your experience in the Netherlands?**

I was accepted for carrying out research in Europe after a rigorous interview process. These preparations require base work of months. Many teachers in our college have done one degree from abroad recently also. So it is doable if you follow the procedure to the hilt. My Supervisor Prof Cen Hemker, a Dutch scientist and Co-Supervisor Dr Suzette Beguin, a French scientist were leading our world-renowned lab. The things I learnt there were methodical book-keeping and reproducibility of results.

Since I had three published papers from DRDO, my supervisor got one year of the course work waived off for which I would have to learn the Dutch language. So the work you do at some stage of life proves useful at some other stage.

**In 2009 you joined Asian Institute of Technology, Bangkok, you worked there as visiting faculty for 2 years and completed your post-doctorate. Was it challenging there?**

In Thailand, there is a big challenge of language, most of the Universities use and publish in Thai. So I joined the Asian Institute of Technology, an international university, similar to IITs here. The commute distance was a challenge, 2 hours from one side. I had to learn the work from the essential base level, it takes you nearly six months to get familiarise with the work being carried out. So one has to keep oneself abreast of new developments and have patience. Research Publications continue to be an essential part of academic life and they prove useful to ascend the career path.



**Mam, we just know that you have taught many batches in Kalindi College. But, when did you start teaching at Kalindi College? All of us would be very interested in knowing-how was Kalindi like when you joined?**

I joined Kalindi in 1991. The course started in 1990 and there was very few apparatus and we had to establish different labs from the very beginning. We were teaching many courses at the same time because the strength of the staff was very less back then. Although the infrastructure has evolved over time, the ethos of the college remains the same.

**You have been a student yourself in Delhi University and now you are a professor at the same University. How do you see the future of girl students of Delhi University in science?**

Yes, I have done my undergraduate and postgraduate degree with Hindu College. Delhi University is a very versatile place. It makes you equipped for life whether you continue in India or abroad. Many of our Alumina are teaching in universities or schools, have gone abroad for further degrees, are in research labs and continue to make us proud and we have great hopes from your batches too. Moreover, girl students are at advantage today as there are many positions for girls only. The research is being promoted at the undergraduate level. There are seminars/ workshops and now Webinars to attend and get you familiar with advances in state of art research areas. The students should fully exploit all these facilities to their advantage. Work, which is done with involvement and sincerity never goes waste in life, it always comes back taking you to the next level.

**Would you like to say something to the students based on your experience?**

I have told many tips in the previous questions. Be truthful and committed to your work. Try to gain as much experience as you can in your stay at Kalindi. Have faith in your parents and the Supreme Power and something good shall come in your life. Most of the scientists, who made a mark, came from compromised back-grounds. In Physics we maximize parameters subjected to constraints. Constraints are there in every life, try to achieve maximum subjected to them



# **Indian Heritage**



## **Sushruta**

**The father of Indian Medicine  
and Plastic Surgery**

Sushruta was an ancient Indian physician known as the main author of the treatise *The Compendium of Suśhruta*. Today he is known as the “Father of Indian Medicine” and “Father of Plastic Surgery” for inventing and developing surgical procedures.

If the history of science is traced back to its origin, it probably starts from an unmarked era of ancient time. Although the science of medicine and surgery has advanced by leaps and bounds today, many techniques practiced today have still been derived from the practices of the ancient Indian scholars.

All the basic principles of surgery such as planning precision, hemostasis, and perfection find important places in Sushruta's writings on the subject. He has described various reconstructive procedures for different types of defects. All of Sushrut's work is compiled in *Sushruta Samhita*.

## Early life

Little is known of Sushruta's life as his work focuses on the application of medical techniques and does not include any details on who he was or where he came from. Even his birth-name is unknown as “Sushruta” is an epithet meaning “renowned”. He is usually dated to the 7th or 6th centuries BCE but could have lived and worked as early as 1000 BCE; although that seems unlikely as Charaka lived shortly before him or was a contemporary. He has been associated with the Sushruta mentioned in the *Mahabharata*, the son of the sage Visvamitra, but this claim is not accepted by most scholars.

All that is known for certain about him is that he practiced medicine in northern India around the region of modern-day Varanasi (Benares) by the banks of the Ganges River. He was regarded as a great healer and sage whose gifts were thought to have been given by the gods. According to legend, the gods passed their medical insight down to the sage Dhanvantari who taught it to his follower Divodasa, who then instructed Sushruta.

The practice of surgery was already long established in India by the time of Sushruta but in a less-advanced form than what he practiced. He significantly developed different surgical techniques (such as using the head of an ant to sew sutures) and, most notably, invented the practice of cosmetic surgery. His speciality was rhinoplasty, the reconstruction of the nose, and his book instructs others on exactly how a surgeon should proceed.



## **Ophthalmic Surgery**

Sushruta specialized in Ophthalmic surgery (extraction of Cataracts). The practice of surgery has been recorded in India around 800 B.C. This need not come as a surprise because surgery (Shastrakarma) is one of the eight branches of Ayurveda the ancient Indian system of medicine. The oldest treatise dealing with surgery is the Shushruta-Samahita (Shushruta's compendium). Shushruta who lived in Kasi was one of the many Indian medical practitioners who included Atraya and Charaka. Shushruta was one of the first to study the human anatomy. In the Shushruta Samahita he has described in detail the study of anatomy with the aid of a dead body.

Shushruta's forte was rhinoplasty (Plastic surgery) and ophthalmology (ejection of cataracts). Shushruta has described surgery under eight heads Chedyā (excision), Lekhya (scarification), Vedhya (puncturing), Eśya (exploration), Ahrya (extraction), Vśraya (evacuation) and Sīvyā (Suturing).

## **Anatomy**

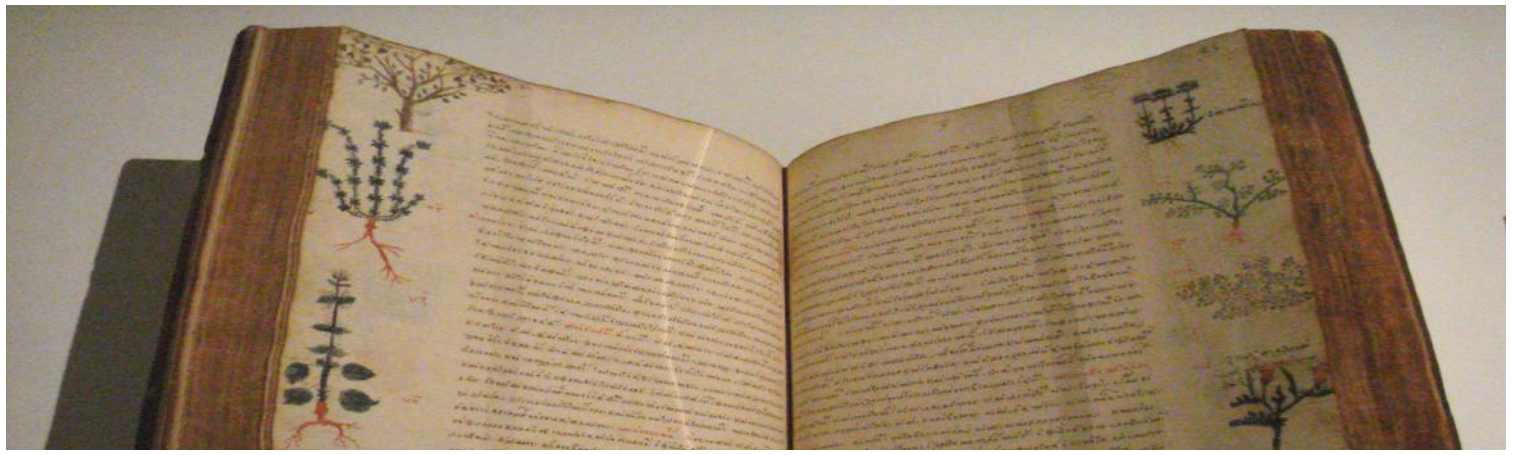
Shushruta was only one of the earliest pioneers in surgery in the world but also one of the earliest ones to study human anatomy. In his Samahita, he described in detail the study of anatomy with the use of a dead body. He has described the following in his Samahita, "For these purposes, a perfectly preserved body must be used. It should be the body of a person who is not very old and did not die of poison or severe diseases. After the intestine has been cleaned, the body must be wrapped in bast (the inner bark of trees), grass or hemp and placed in a cage (for protection against animals). The cage should be placed in a carefully concealed spot in a river with a fairly gentle current, and the body left to soften."

## **Plastic Surgery:**

Perhaps the greatest contribution of Shushruta was the operation of rhinoplasty (restoration of a mutilated nose by plastic surgery). The detailed description of the rhinoplasty operation in the Shushruta Samahita is amazingly meticulous and comprehensive. There is evidence to show that his success in this kind of surgery was very high, which attracted people from all over the country and perhaps even from outside.

Cutting off of the nose and ears was one of the common modes of punishment in the early Indian kingdoms. Shushruta moved by his intense humane approach to life and equipped with superb surgical skills, did the operation of rhinoplasty with remarkable skills, grace, and success. The details of the steps of this operation, as recorded in the Shushruta Samahita, are amazingly similar to the steps that are followed even today in such advanced plastic surgery.

Indian medical tradition also goes back to Vedic times when the Ashwinikumars, who were practitioners of medicine were given divine status. We also have a god of Medicine called Dhanvantari. In historic times the earliest recorded treatise on medicine in India viz., the Shushruta Samahita is dated around the 8th century B.C. Plastic surgery, dentistry, operation of cataracts, were pioneering advances, in the field of medicine.



## Ayurveda

This is the indigenous system of medicine in India. Ayurveda literally means 'the science of living' (longevity). Ayu means life and Veda means knowledge. The origins of this system of medicine are lost in the hoary past, and the body of knowledge that comes under the heading Ayurveda constitutes ideas about diseases, diagnosis, and cure, which have been accumulated over the ages past. According to Charaka, a noted practitioner of Ayurveda in ancient India: "A physician who fails to enter the body of a patient with the lamp of knowledge and understanding can never treat diseases. He should first study all the factors, including environment, which influence a patient's disease, and then prescribe treatment. It is more important to prevent the occurrence of disease than to seek a cure".

These remarks may appear rudimentary today, but they were made by Charaka, some 20 centuries ago in his famous Ayurvedic treatise Charaka Samahita. The treatise contains many more such remarks which are held in reverence even today. Some of them are in the fields of physiology, aetiology and embryology. Charaka was the first physician to present the concept of digestion, metabolism and immunity. According to him, a body functions because it contains three dosha or humours, namely, bile, phlegm and wind. These doshas are produced when dhatus, namely blood, flesh and marrow, act upon the food eaten. For the same quantity of food eaten, one body, however, produces dosha in an amount different from another body. That is why one body is different from another. For instance, it is more weighty, stronger, more energetic.

Further, illness is caused when the balance among the three doshas in a human body is disturbed. To restore the balance Charaka prescribed medicinal drugs. Charaka also knew the fundamentals of genetics. For instance, he knew the factors determining the sex of a child. A genetic defect in a child, like lameness or blindness, he said, was not due to any defect in the mother or the father, but on the ovum or sperm of the parents, which is today an accepted fact.

The medical system of Ayurveda draws heavily from the doctrines developed in the Charaka-Samahita. The main quality which Ayurveda has borrowed from Charaka is its aim of removing the cause for illness and not just curing the disease itself. In Ayurveda, there are no such things as instant relievers, pain killers or antibiotics. The herbs used in Ayurvedic remedies do not operate against the body's metabolism, their effect is registered gradually and hence there are minimum side-effects. The constituents of Ayurvedic medicines are largely based on organic matter. The absence of fast registering inorganic compounds which are at times corrosive contributes to the absence of side-effects from Ayurvedic medicines.

Knowledge of this art was spread among sages,hermits and medicos who roamed from place to place. Those who practiced solely this art were called Vaidyas and they generally belonged to the Brahmin caste. Knowledge of this art was passed from generation to generation. But it remains surprising how this vocation did not obtain the the status of a separate caste. The absence of a caste, wherein this body of ideas could get crystallized and changeless which incidentally could ensure their preservation, along with the absence of a system for regular education and training for practitioners of the art has resulted in its gradual though partial withering over a period of time. The above two lacunae also resulted in the emergence of quackery and made it difficult to distinguish bonafide practitioners from quacks in absence of professional standards. These lacunae have been identified in modern times and recently, organized efforts have been launched to revive and nourish this flagging discipline

**Nitya Jain**

**Author's Bio:**

*Nitya, a girl next door just exploring her personality and working towards just a small vision of making people understand that we are just packets of energy so just chill and meditate.*

©macrocosm



# Career Corner



**After graduation in  
Physics**

After completing B.Sc. in Physics, various opportunities are available for Physics students.

Either they can opt for further studies and be a scientist, researcher or can have a job as a lecturer, radiologist, etc.

## Jobs Opportunities after B.Sc. Physics:

Many industries and research centers hire physicists which imply that students can go for several employment roles after Graduation.

- 1. Physics Lecturer:** One can pursue B.Ed. after B.Sc. to become a lecturer in schools and organizations.
- 2. Lab Assistant:** While studying Physics, scholars work enough in laboratories and have expertise in it. They can work as a lab assistant in several firms, clinics, institutes.
- 3. Content Developer:** To analyze, review, and write the content related to Physics.
- 4. Medical Physicist:** A physics student can serve in the medical field such as Radiotherapy, Radiology, and Nuclear medicine.
- 5. Academic counselor:** B.Sc. Physics graduate can join any school or college as a advisor or counselor to help students with their academic queries.

## Higher Education after B.Sc. Physics:

Higher Education in Physics can lead to a better job opportunity and help you attain better in-depth knowledge. Candidates can enroll in M.Sc. by taking entrance exams like JAM, JEST, TIFR, NEST, etc.

### Eligibility for Masters:

- > Candidates should have a minimum 50-60% marks in Physics Honours.
- > An interview would be conducted after the written test.

## Renowned Institutes, colleges and universities students can apply at

### Research Institutes:

#### 1. Harish Chandra Research Institute (HRI)

It is a research institute situated at Allahabad

#### **Selection Procedure:**

*Candidates for M.Sc. program are selected through the Joint Entrance Screening Test (JEST), followed by an interview.*

#### 2. S. N. Bose National Centre for Basic Sciences (SNBNCBS)

It is a research institute which has collaborated with the University of Calcutta for the Integrated Ph. D program. The institute is situated at Kolkata.

#### **Selection Procedure:**

*Candidates can be selected by any of these examinations followed by an interview.*

1. JEST
2. NGPE

### **3. Indian Association for the Cultivation Of Science (IACS)**

It is a deemed University.

#### **Selection Procedure:**

*For taking admission in Masters / Integrated Masters – Ph.D. program, the candidates have to clear Masters Pre Interview Screening Test (MPST).*

### **4. Institute of Mathematical Sciences (IMSc)**

It is a research institute in Chennai.

#### **Selection Procedure:**

*NBHM exam (There are a range of national written tests that are accepted toward an application towards the IMSc Graduate program: JEST, NBHM (National Board for Higher Mathematics, GATE, NET, BINC and JGEEBILS (Computational Biology); NBHM [National Board for Higher Mathematics] (Mathematics); JEST (Theoretical Computer Science); JEST, CSIR-UGC, GATE (Theoretical Physics).*

### **5. NISER (National Institute of Science Education and Research) and CEBS (Center for Excellence in Basic Sciences)**

#### **Selection Procedure:**

*These institutes conduct NEST (National Entrance Screening Test), an online examination to give admission to students who want to go into any of the following courses M.Sc. biology Program, M.Sc. physics program, M.Sc. chemistry program, and M.Sc. mathematics program. Application opens in January.*

### **6. TIFR (Tata Institute of Fundamental Research)**

#### **Selection Procedure:**

*The institute conducts TIFR GS (Tata Institute of Fundamental Research Graduate School) examination to admit students. University offers M.Sc. - PhD programs in the fields of Physics, Chemistry, and Biology. The selection process consists of an interview after the written test.*

## **Colleges:**

#### **1. Presidency University, Kolkata**

*Candidates are selected in Master of Science Degree Program on the basis of marks obtained in Presidency University Master Entrance Test (PUMDET).*

#### **2. St. Xavier college, Mumbai**

*It is affiliated with the University of Mumbai. The course offered is M.Sc. in Physics (Astrophysics). Candidates are required to clear St. Xavier entrance test to get admission.*

#### **3. Madras Christian College**

*The college is affiliated to the University of Madras. Admission for M.Sc. program is based on the entrance exam but this year the entrance exam will not be conducted.*

#### **4. BITS (Birla Institute of Technology & Science, Pilani), Pilani**

*Birla Institute of Technology & Science, Pilani is a deemed university. Admission for M.Sc. in BITS Pilani is done on the basis of BITSAT.*

#### **5. VIT ( Vellore Institute of Technology)**

*Vellore Institute of Technology is a private university located in Vellore, Tamil Nadu, India. There is no entrance exam for admission in M.Sc. Admission is done as per the performance of the candidate in B.Sc.*



## Universities:

1. University of Delhi
2. Jawaharlal Nehru University
3. Banaras Hindu University
4. Pune University
5. University of Hyderabad
6. Jadavpur University
7. University of Calcutta
8. Jamia Millia Islamia

## Courses available for Masters related to Physics:

- M.Sc. in *Materials Science and Engineering*
- M.Sc. *Vacuum Sciences*
- M.Sc. *Acoustics*
- M.Sc. in *Applied Physics*
- M.Sc. in *Physics*
- M.Sc. *Applied Electronics*
- M.Sc. in *Atmospheric Science*
- M.Sc. in *Nanotechnology*
- M.Sc. in *Astronomy/Planetary Science/Astrophysics*
- M.Sc. in *Aeronautics*
- Master in *Atomic and Molecular Physics*
- M.Sc. in *Particle/Nuclear Physics*
- M.Sc. in *Geophysics*
- M.Sc. in *Molecular Physics*
- M.Sc. in *Optical Physics*
- M.Sc. in *Medical Physics*
- M.Sc. in *Biophysics*
- M.Sc. – M. Tech

One can also opt for an integrated course of M.Sc. - M. Tech in Physics. It is a 4 years dual degree course which is offered by some reputed universities e.g. IIT Bombay, IIT Jodhpur. By opting for this course, one can enhance subject knowledge and develop technical skills as well.

## Government Jobs:

There are different government jobs that require a specialty in Physics. One can apply for ISRO, DRDO and in several institutes as research associates, Technical assistants, Scientific Officer, etc. Various institutes release their official notice for recruitments.

## One can also look into other top Academic courses other than Physics:

- **Master of Business Administration:** It will help to gain technical, managerial, and leadership skills. Having this degree creates great employment opportunities in management positions.
- **Master of Computer Applications:** It is a job-oriented course which will help you to pursue a career in Information Technology or equivalent field. But you should have mathematics as a subject up to 12th standard to enroll in this course.
- **Data Science:** It can be an attractive career. You can get employed as a Data Scientist, Marketing analyst, data analyst, etc. Data science has become one of the most demanding sort-after courses in the present time.
- **Bachelor of Education:** Post this degree, you will get offered a teaching job in Schools, Coaching Centers, Education Consultancies, etc.
- **Diploma in Radiology:** One year or two-year diploma is offered by several institutions e.g. AIIMS, IIT Kharagpur, etc. It will help you get employed as a Medical physicist.
- **Diploma in Computer Programming:** It will help you work as an app developer, Software Engineers, Web Designers, etc.
- **Diploma in Creative Writing:** A diploma in this field will give you an opportunity to work as a content writer in any Physics Magazine or Newspaper.

## Tips to build CV: Something for 1<sup>st</sup> and 2<sup>nd</sup> year

**From a science student perspective, I would say a CV/resume is required by some colleges if you want to apply in them and some organizations demand that to hire.**

A resume is a document that depicts one's qualifications. It comprises columns of education, professional experience and extracurricular activities among other sections which need not be emphasized. Filling education part is easy but professional experience and extracurricular isn't especially at the time when you are applying for a college/organization. "What did I do in my college?" that question baffles then.

## **Here are some points I found which makes a student's resume stupendous.**

- Participation in activities that show leadership quality.
- Getting work experience (internships). Internships such as the content writer of science and project manager etc. Doing three internships from outside college leaves a remarkable impact.
- Attending webinars as that shows a student's enthusiasm.
- Involvement in at least 2 projects is a must.
- Participation in poster presentations.
- An average record of CGPA is adequate for the academic record.
- The most important thing to have several good skills. Programming (Python, C/C++ , MATLAB, etc.) is an advised skill by most Professors.

## **Prasashti Shukla and Suneha Bhati**

### **Authors' Bio:**

*Prashasti Shukla is a student of Physics Hons in DU. She is an avid reader and loves to read novels and articles. She loves to write her thoughts in a creative manner.*

*Suneha Bhati is a student of Physics Hons in DU. She is a voracious reader and loves to write articles on lifestyle, sci-fi, fiction, movie reviews and book reviews*

# **What does the expansion of the universe mean?**

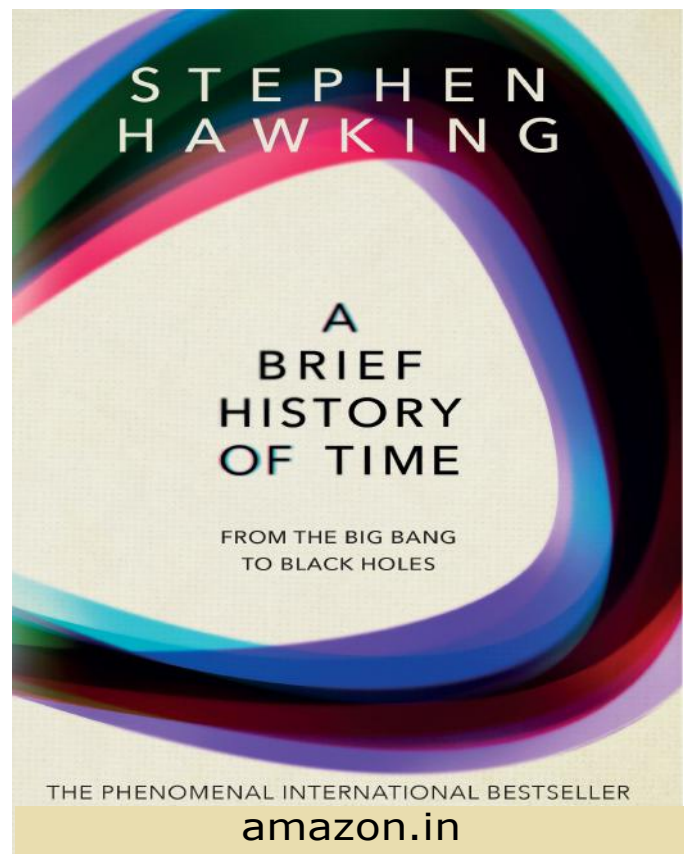


**We could reach Big freeze if the expansion of the universe continues forever.**



If you have ever read the book, *A Brief History of Time* - Stephen Hawking, you have seen the 3rd chapter, called '**the expanding universe**,' which makes you more curious to go into the depth and understand the real meaning of the expansion of the universe. If anyone says that the universe is expanding at an accelerating rate, **what does it mean actually? Is it going somewhere? Or is it increasing?**

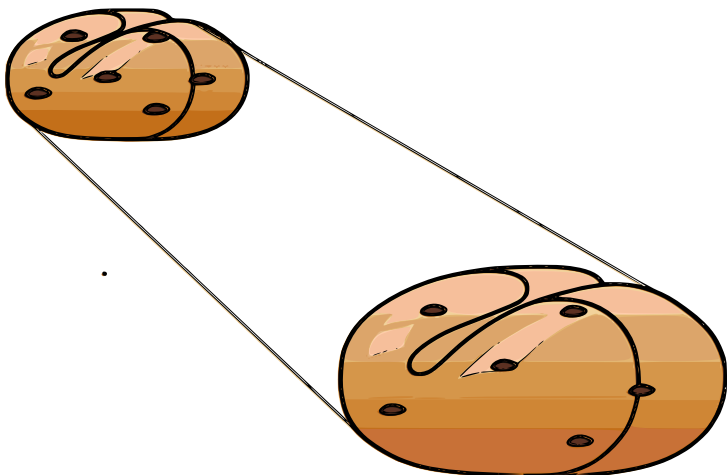
To get the answers, you have to dive into the fascinating theories of cosmology and understand how these things have been understood. The word 'universe' itself is a whole, enclosing everything in it, from the particle to a giant black hole.



The most accepted theory to explain the evolution of the universe from a point -sized object called the singularity to the present observable universe, in which we're discussing these topics - **the Big Bang**. There was nothing before the universe, no planets, no stars, no black holes, no galaxies, and not even time. Just a point-sized object called **singularity** was there, which had infinite mass and density. So, what happened was that singularity underwent a phenomenon called **cosmic inflation**, which expanded the universe by a huge factor and explains why we are here today.

The most crucial theory that is in the compatibility of the Big Bang is the **Hubble-Lemaître law or Hubble's Law**, according to which *the galaxies are moving away from earth with velocities that are proportional to their distances, meaning, the far ones are going farther away from us*. Hence, it explains the basis of the expansion of the universe.

## EXPLAINING THE REAL MEANING



One of the famous analogy, which explains the expansion is the - **raisin bread dough** - if you have observed the bread dough, you have probably observed that whenever the bread rise, it expands, and the raisins present inside the dough move farther away relative to each other, but they're still inside that dough. That's how the universe is also expanding.

**Still didn't get my point?** Let me give you a broader idea. So, consider the raisins as all the galaxies and celestial bodies present in the universe and dough as space. Now, just like raisins move away from each other, the galaxies are moving away from each other, and far moving galaxies are moving farther. But, they're not moving out of the space just like the raisins don't move out of dough.

Coming back to physics, the expansion of the universe means that the galaxies are going away relative to each other as we can observe from the earth, not like the change in position from here to there, or going outside. The thing is that space is also moving, meaning the scale is changing itself. **Thus, the expansion is internal. But, what actually caused this expansion?**

In the previous analogy, **did you guess, what is bread?** - It is **the Dark Energy**, *mysterious energy, which comprises 95% of the observable universe, is the opposition of the gravitational forces, which eventually is responsible for the expansion.* It is the unknown force that makes the interactive galaxies move away from each other and expand within the space.

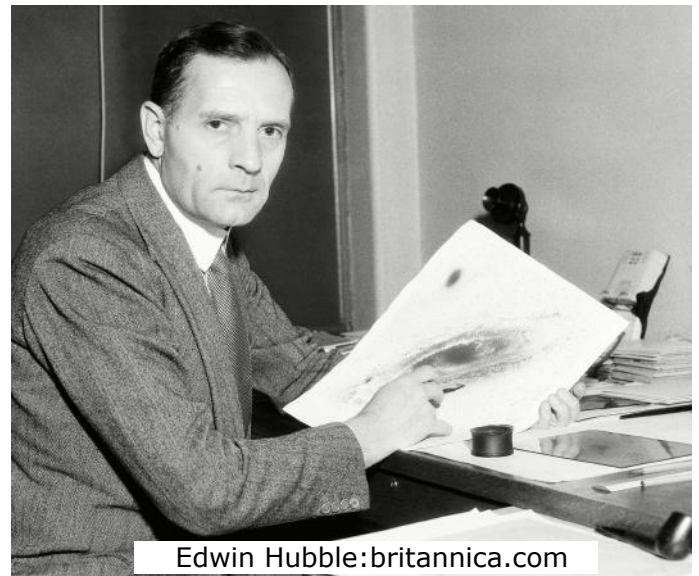
## HUBBLE'S LAW AS AN EXPLANATION

As I have earlier mentioned, Hubble's Law has beautifully explained the expansion of the universe by a mathematical expression.

$$v = H_0 d$$

The velocity, which is also called *speed of separation* ( $v$ ), equals the product of *proper distance* ( $D$ ) and *proportionality constant called the Hubble's Constant* ( $H_0$ ). It implies, when observed from the earth, the galaxies are seen to be moving away with some velocity, and that velocity can be found by the measurements of **redshift**.

The celestial bodies in the universe possess electromagnetic radiation, more precisely, light with it. So, when the light from the object travels to the earth, the spectrum of that radiation is found to be shifted towards the red end of the spectrum - means that the wavelength of the radiation has increased - *indicating that space is expanding, separating the objects at a specific rate.*

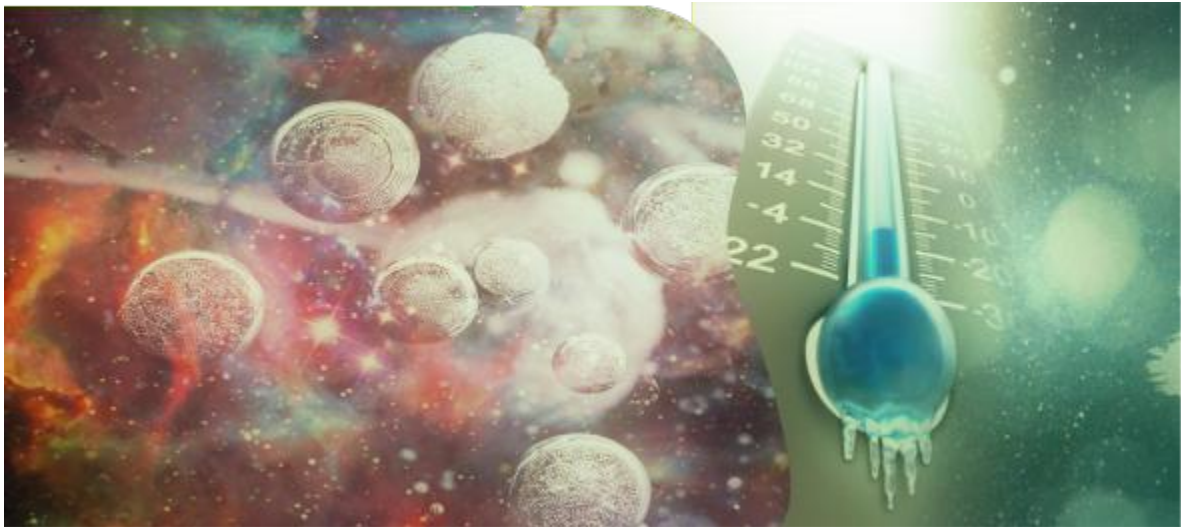


Since the velocity of the receding galaxy is continuously increasing with the cosmological time, we can refer to this with the Accelerating Expansion of the Universe.

So, if you read that the universe is accelerating, then don't get confused, the cosmological redshift is related to the speed of separation, and that eventually accounts for the acceleration, and so the expansion.

# What if the expansion continues forever?

We would reach something called a **Big Freeze**, in which the temperature of the entire universe would fall to absolute zero, leaving the burnt-out stars with traces of white dwarfs, black holes, and neutron stars. According to modern cosmological studies, the expansion may exceed the event horizon. The ultimate fate is still unknown. We only know a bunch of theories. And theories unproven are just the stories.



**Priyanka Kasturia**

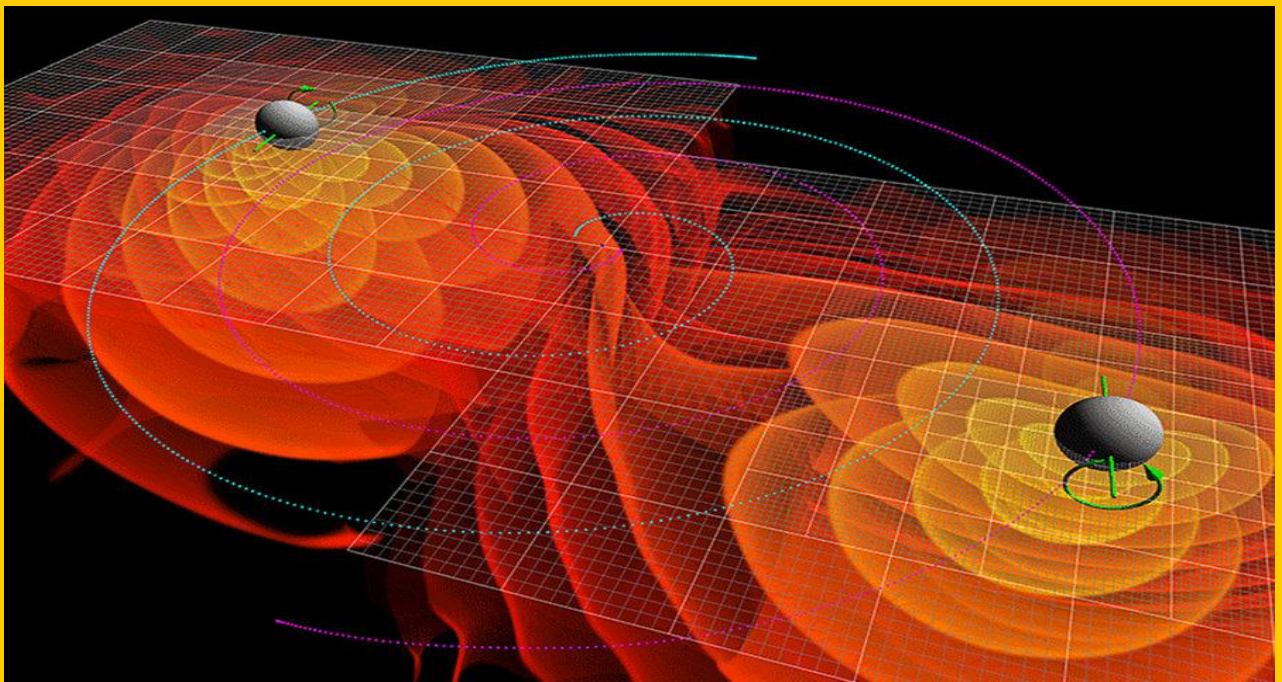
**Author's Bio:**

*Priyanka kasturia is a student of Physics Hons in DU. She is a worldly-wise person, having fascination with space exploration, astrophysics, and cosmology, and also loves to write about them.*

© **macrocosm**



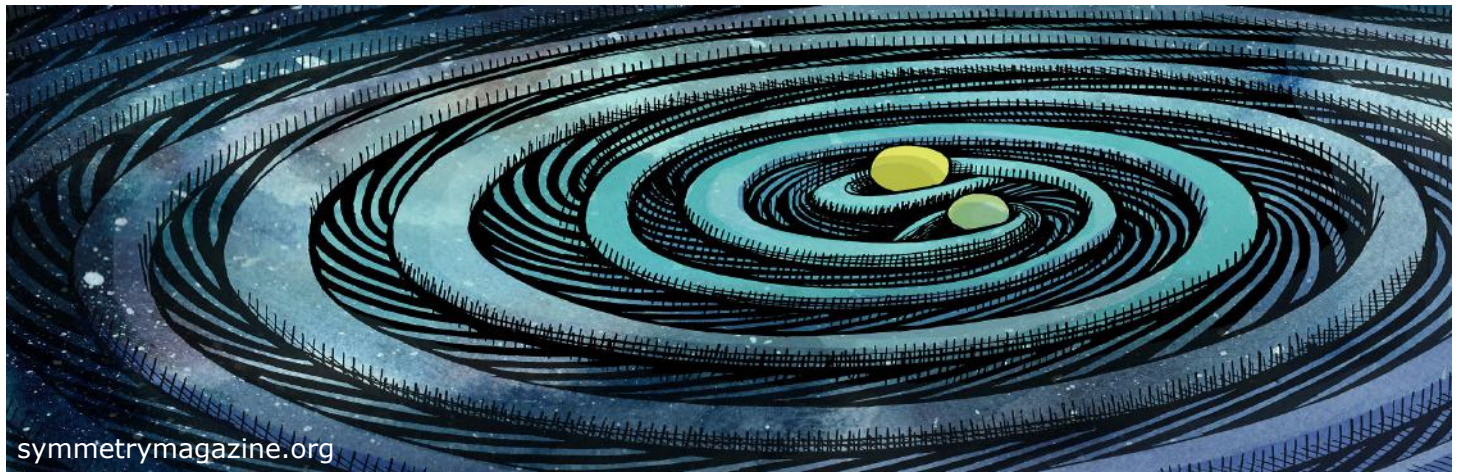
# Gravitational Waves



**It was detected by LIGO in 2015, but predicted back in 1900s by Einstein.**

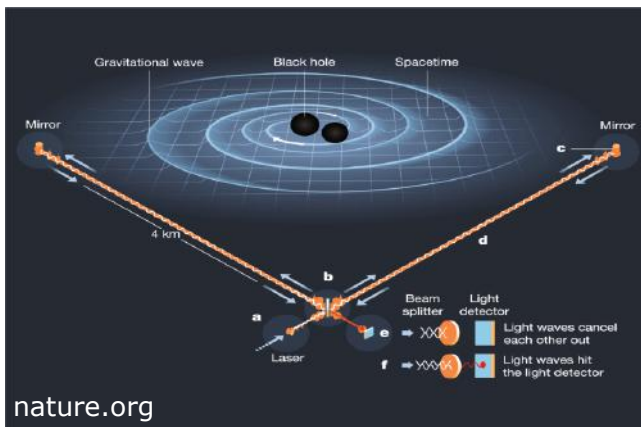
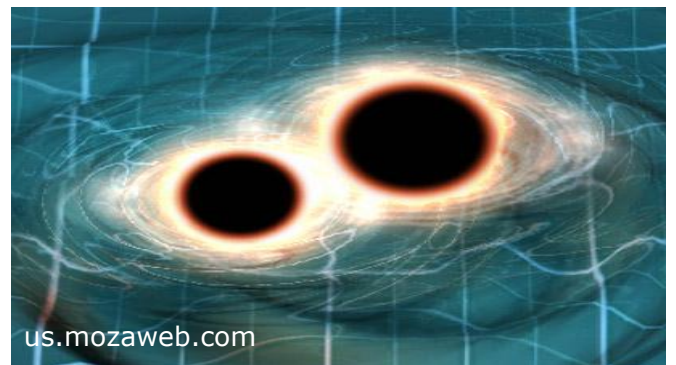


We all have heard about gravitation but **what does the gravitational wave means?** Gravitational waves are disturbances in the curvature of space-time, generated by accelerated masses that propagate as waves outward from their source at the speed of light.



### But what causes this gravitational wave?

The answer is Gravitational waves are 'ripples' in space-time caused by some of the most violent and energetic processes in the Universe. The strongest gravitational waves are produced by cataclysmic events such as colliding black holes, supernovae and colliding neutron stars.



Gravitational waves are constantly passing Earth; however, even the strongest have a minuscule effect and their sources are generally at a great distance. How do we know that gravitational waves exist? In 2015, scientists detected gravitational waves for the very first time. They used a very sensitive instrument called LIGO (Laser Interferometer Gravitational -Wave Observatory).

These first gravitational waves happened when two black holes crashed into one another. Gravitational waves carry information on the motions of objects in the universe. Since the universe was transparent to gravity moments after the Big Bang and long before light, gravitational waves will allow us to observe further back into the history of the universe than ever before.

**Shubhangi Sharma**

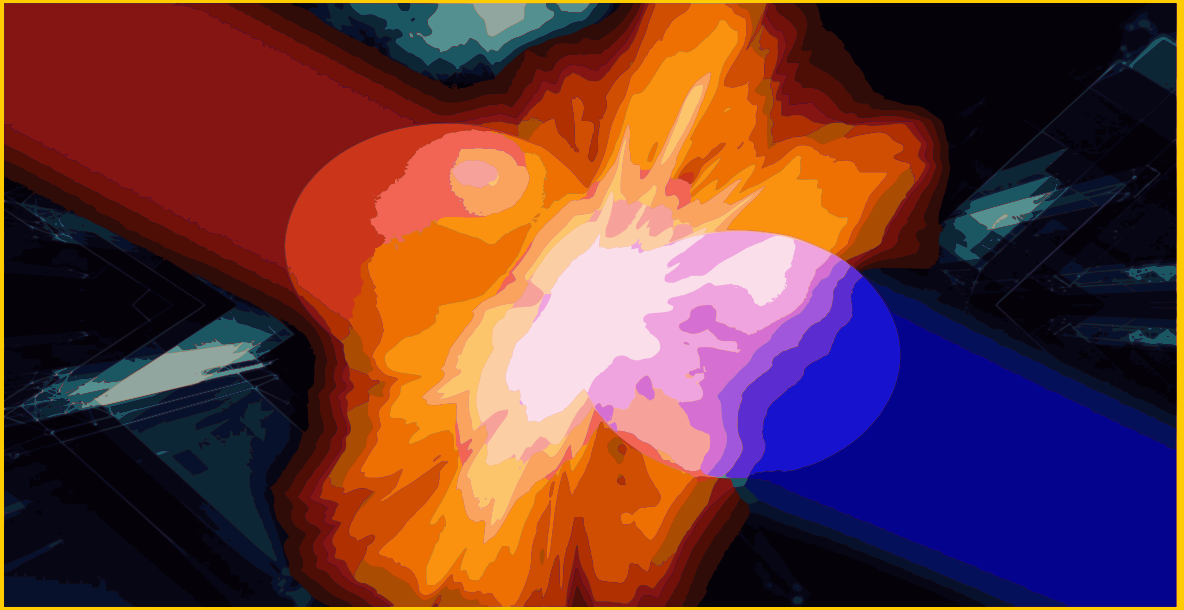
**Author's Bio:**

*shubhangi Sharma is a student of Physical Sciences. She loves reading books and witing articles on different subjets.*

© **macrocosm**

# **When the Matter meets Antimatter- Annihilation**

---



**"If you meet your anti-self, don't shake hands! You both would vanish in a great flash of light."**

**S**cientists have hypothesized that both particles and antiparticles were released in equal proportion during the Big Bang. But soon, the amount of matter formed by the fusion of particles became much higher than the antimatter.

**In fact, the present universe has only 1% of the antimatter, and the reason for it is still unknown.**

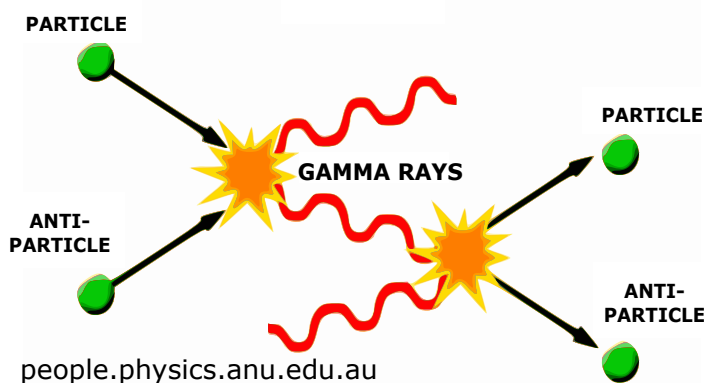
To find answers to these questions, let's understand the concept of antimatter and its interaction with the matter to understand its mystery better.

Well, you would have probably heard '**the antimatter**' in the book and film Angels and Demons, in which Professor Langdon tried to save Vatican City from an antimatter bomb. While thinking about the antimatter, a few questions arise in my mind, **How much energy do the antimatter hold? Would it be safe to produce it? What would happen if the matter interacts with it?**

## What is the Antimatter?

**ANTIMATTER** - "the identical opposite of the matter" - means, the substance or you can say, the entities that look the same as the matter, having identical dimensions and mass, but the charge and quantum spins are opposite, and they consist of the **ANTIPARTICLES**. **And, what are the antiparticles?**

The matter is made up of atoms, having an electron with a negative charge, proton with a positive charge, and a neutron. So, the antimatter should have an anti-electron with a positive charge, antiproton with a negative charge, and a neutron. These anti-electrons and antiprotons, which are the identical opposite of electrons and protons, are called the antiparticles.



Basically, when matter and antimatter interact with each other, then, this process releases the energy in the form of gamma rays, and the particles vanish. So, if you collide an electron and a positron (anti electron). The collision produces the two gamma rays, and then the colliding particles disappear.

## Matter - Antimatter Annihilation

If you read page no. 75 of the book "**A Brief History of Time**" - By Stephen Hawking, a line is written in it, "**However, if you meet your anti-self, don't shake hands! You both would vanish in a great flash of light**".

## But why did they disappear?

We know that the moving particle has a De Broglie wavelength. Henceforth, the electron and positron both have a wave connected with them. But, the wavelength of the positron has a phase reversal of 80 degrees.

This particular line gives you a hint on what would happen when matter and antimatter would come in contact with each other.

So, the physical contact or you can say the collision between matter and antimatter releases a tremendous amount of energy, and that phenomenon is known as the **annihilation**. When these two interact with each other, destructive interference occurs, resulting in minimized resultant amplitude, and they become invisible.

This annihilation between any particle and its antiparticle gives rise to different proportions of intense photons (as gamma-rays), neutrinos, and sometimes less-massive particle-antiparticle pairs, and emerges out in the form of ionization radiation, which is a kind of electromagnetic radiation.

So, when this **ionization radiation** interacts with the surrounding matter, it absorbs the energy present, and that energy is observed in the form of heat and light. The amount of heat released in this whole process is proportional to the total mass of both matter and antimatter, which is explained by **Einstein's mass-energy** equivalence.

The annihilation is a rare process as the antimatter is rare in the universe. It was assumed that during the Big Bang, both matter and antimatter were produced in equal quantities, but somehow antimatter got miniscule in comparison to matter.

## Priyanka Kasturia

### Author's Bio:

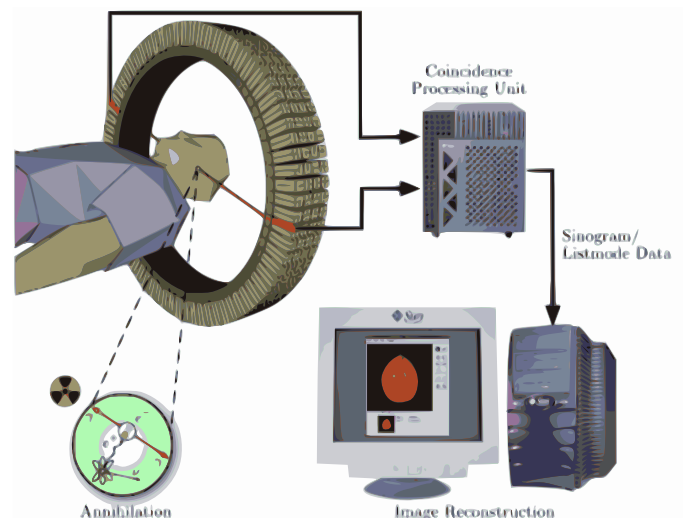
*Priyanka kasturia is a student of Physics Hons in DU. She is a worldly-wise person, having fascination with space exploration, astrophysics, and cosmology, and also loves to write about them.*

© **macrocosm**

It was further hypothesized that the annihilation could be the reason for this asymmetry, but if that was so, then the matter could also so have disappeared.

This problem isn't figured out yet, but we have found some applications for it, which includes **PET scan**, in which the chemicals are released on the human body that produces positrons so that the electron in the human body annihilates with it to produce gamma rays.

The scanner picks up those gamma rays of the energy of 1.022MeV to produce the body's image.



large.stanford.edu

***But, if you touch or interact with large amount of antimatter, then it would be catastrophic for you.***



# **Comet NEOWISE**

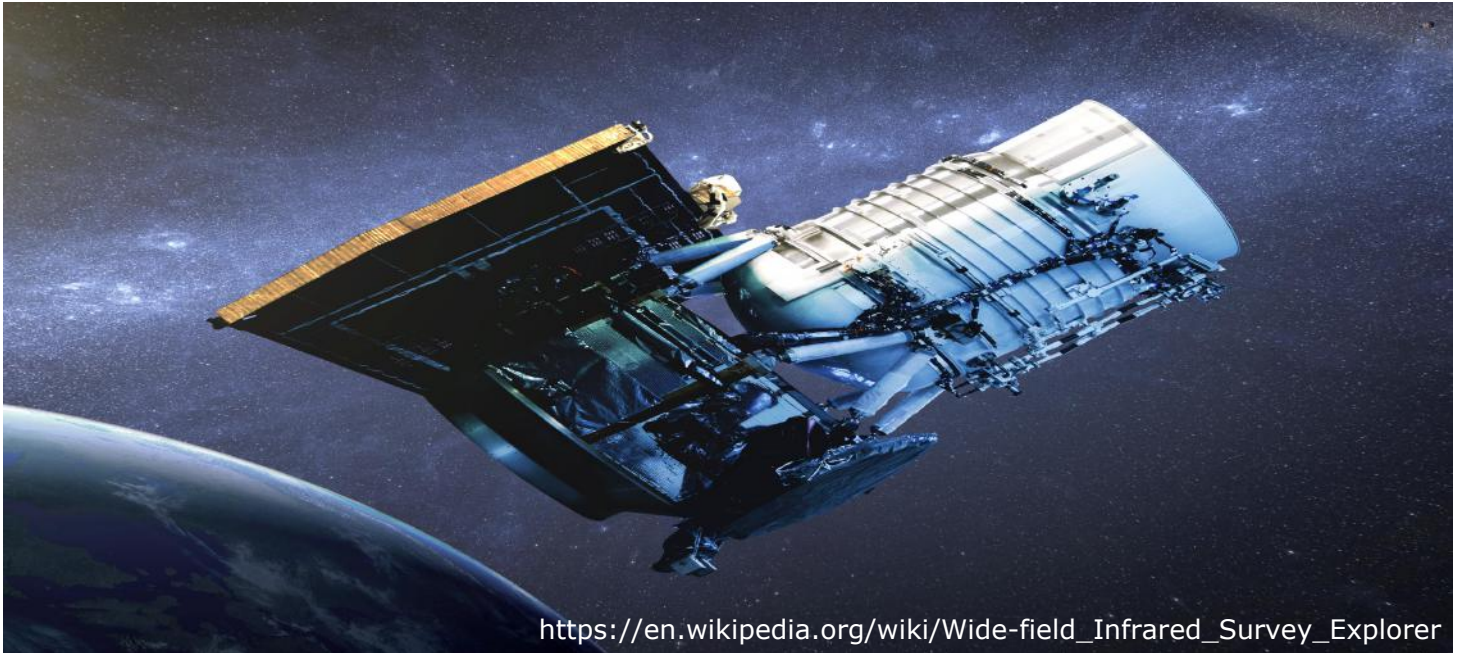


**On March 27, 2020, it was discovered by a team using the WISE space telescope under the NEOWISE program.**

**C/2020 F3 (NEOWISE) or Comet NEOWISE** is a comet with a near-parabolic orbit discovered on March 27, 2020, by NEOWISE.

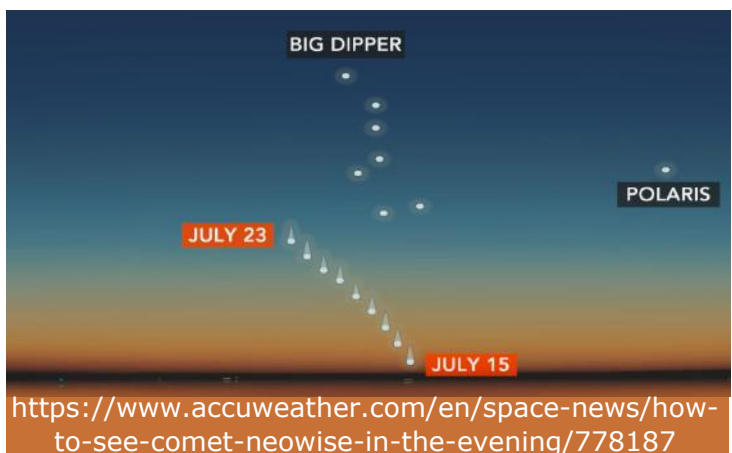
It is known for being the brightest comet in the northern hemisphere; bright enough to have been visible to the naked eye. It was widely photographed by professional and amateur observers and was even spotted by people living near city centers and areas with light pollution.

On March 27, 2020, it was discovered by a team using the WISE space telescope under the NEOWISE program and in a span of three days, it was classified as a comet and was named after NEOWISE on April 1.



The comet cruised just inside Mercury's orbit on July 3, 2020. This very close passage by the Sun cooked the comet's outermost layers, causing gas and dust to erupt off the icy surface and creating a large tail of debris. And yet the comet had managed to survive this intense roasting—this is what excited the skywatchers.

From July 14, the comet became visible to the naked eye in the evening sky. For those who watched from India, at north-western sky—20 degrees from the horizon, it could be seen after sunsets. The sight of the comet fascinated everyone for about 20 minutes of 20 consecutive days before it reached a distance from where it was and would no longer be seen.



**Srishti Agarwal**

**Author's Bio**

*Srishti Agarwal is a student of physics honours in Delhi University. She loves to write articles on science fiction and astronomical events.*

© **macrocosm**

**Stop watching watch  
because it won't tell  
you what time is**



**Time is a dimension because we can  
show different positions in space at  
different times.**



# EXISTENCE

Don't google my title - What I want to contemplate in my bold letters is watch is just a physical representation of, passing of time. **So If chiming clocks can't define time**

**then what does?** Time is a dimension because we can show different positions in space at different times. It is also called measurement and we all can relate to it. For instance, think about how we can celebrate our birthdays, it is because we measured years by time.

Yet time is the most unknown of all unknown things as once said by Aristotle. Perhaps for understanding it, we should start with our existence, I mean think of it, we and time must have originated somewhere. Since *the Big Bang (the evolution of the universe)* happened, the time has been like an arrow.

I said, "**arrow**" reason being, it is unidirectional and that can be explained by the Second law of thermodynamics. The second law of thermodynamics states that entropy in a closed system can either increase or can remain constant.

# ENTROPY

And the universe started at a point which had a very low entropy (the measurement of randomness) therefore by the law, it has been moving to a higher Entropy situation since then, giving rise to galaxies, planets, stars and us. If I think, **what if the universe started at high Entropy?** Then we wouldn't have been discussing the universe because there would have been no us and no time. **Now could you make out how we and time are interlinked?**

I am of the opinion that while thinking of this interlink, most of you would have thought about the past and future. So, I have a question to ask- **why do we think that they are different while scientists consider them identical? Is it because we can remember the past and not the future?** Yes, I suppose and perhaps we develop an illusion that time is moving. It can be explained using the only law that perceives the past and the future differently, Second law of thermodynamics.

To grasp it, think of something you broke like, a glass. Initially, the glass was at low entropy that is a state of order and less randomness and when you broke it. It smashed into a huge number of pieces which is a state of high disorder or high Entropy, in comparison to the former situation. Here once broken, you cannot repair the glass into what it was before. In short, a physical system has changed from low entropy configuration to high Entropy configuration and it is irreversible. That is what creates an effect of, passing of time for us. And, that's how we think that the past is different and the future is yet to come.



# RELATIVITY

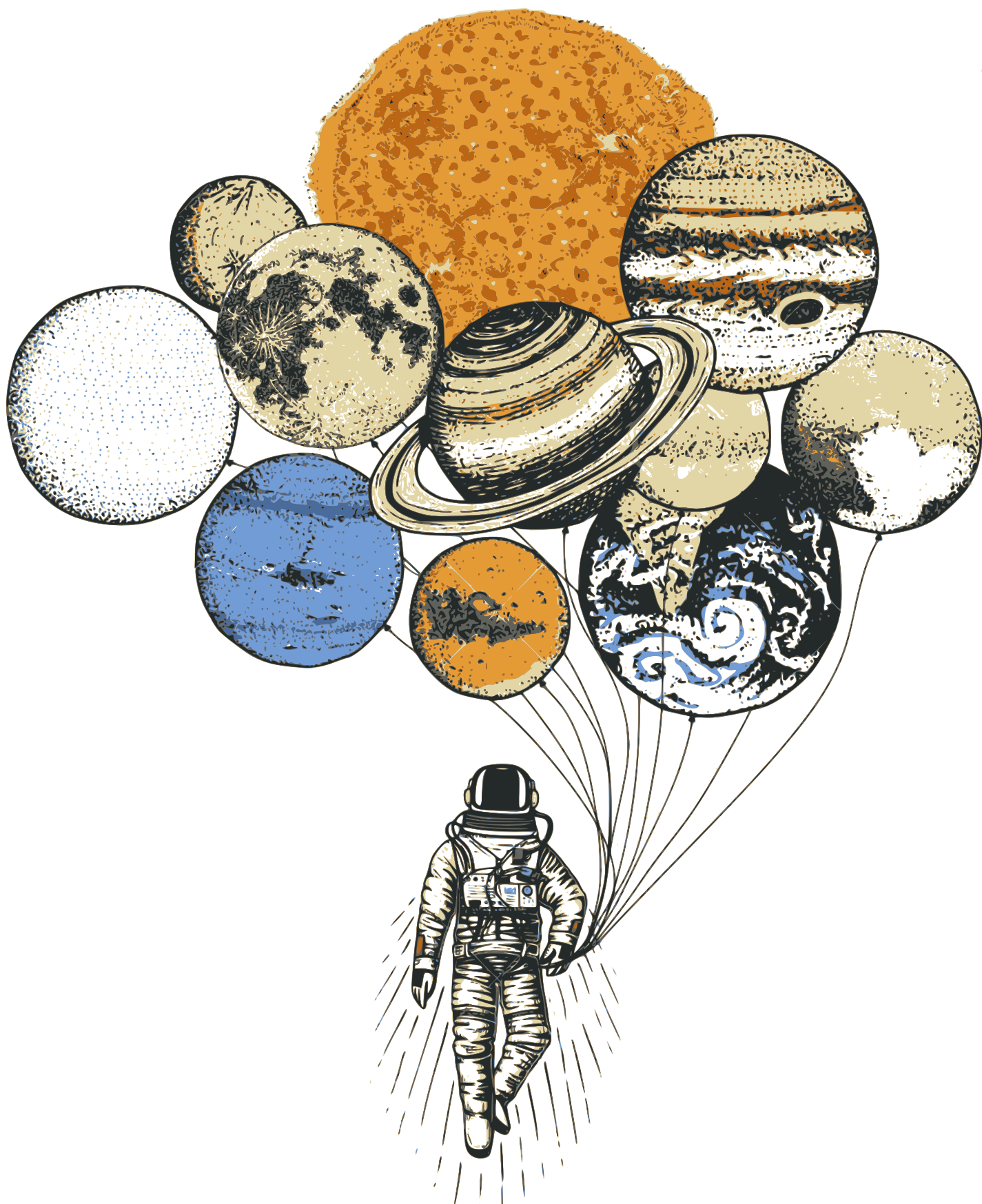
But, what if the person next to you says that a certain situation happened before the other and you are contradicting it. The thing is you both would be right. Because it is possible that a certain thing that has happened in the other person's past is yet to happen in your future or maybe, it is not present anywhere for you. What I want to deduce here is that time is relative. The rate at which it passes may vary according to the observer (frame of reference). Einstein gave the theory of relativity which introduced time dilation that means as speed increases the time slows down.

Also, time runs slower wherever gravity is strongest. So if your twin is travelling in a spaceship with nearly the speed of light and comes back after some years you will notice that he would have aged less in comparison to you. In an observable manner, let's take an example of you travelling in a train moving with a high velocity, you will notice that, watch on the platform would seem to be moving slowly and then as if its hands have ceased to move. And so the watch ceases to tell you what time is.

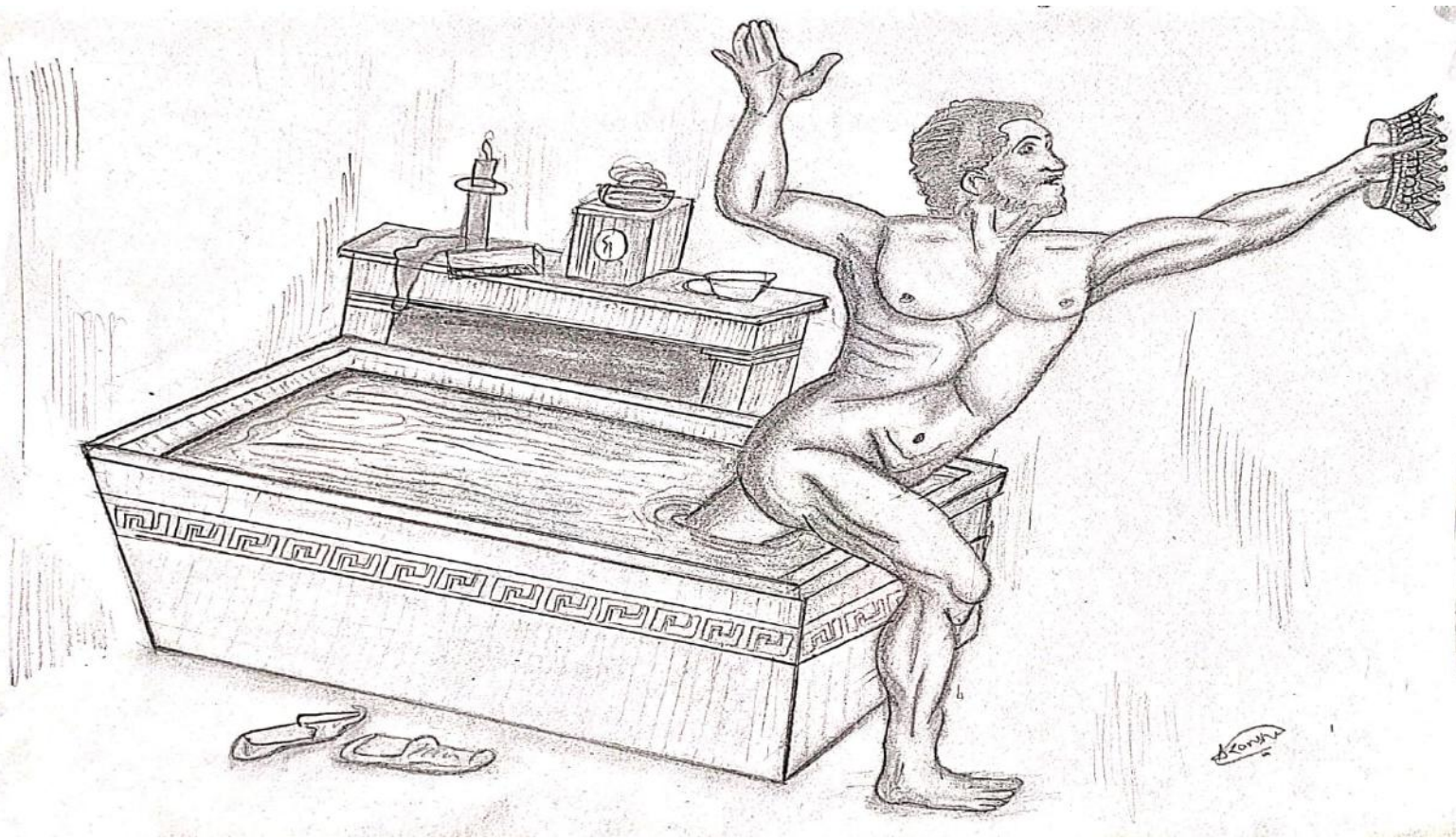
**Suneha Bhati**

**Author's Bio:**

*Suneha Bhati is a student of Physics Hons in DU. She is a voracious reader and loves to write articles on lifestyle, sci-fi, fiction, movie reviews and book reviews*



# Virtuosity



**Archimedes (288 BC - 212 BC) was a famous mathematician, physicist, engineer and astronomer.**

He is known for giving Archimedes principle, accurate approximation of pi ( $\pi$ ), innovative machines such as to raise water known as Archimedes Screw. One of his famous anecdotes is about how he invented a method to determine the volume of irregular objects.

Archimedes was told by King Hiero II of Syracuse, to determine the volume of Silver used for the crown made of gold. He had to determine the volume without any damage to the crown. He kept thinking about the solution. One day while bath, he noticed that level of water rises when he got in. He immediately realized that this effect could be used to determine the volume. The amount of water displaced would be equal to the volume of the crown itself. Then Archimedes was on the ninth cloud, so excited with his discovery that he had run without any clothes on the road and kept yelling "Eureka, Eureka, I have found it" This anecdote is still famous and known as Eureka.

**Drawing: Akansha Gupta**

**Story: Prasashti Shukla**

*Akansha Gupta is a physics student. She's sweet and charming girl with great creative and art skills.*

*Prashasti Shukla is a student of Physics Hons in DU. She is an avid reader and loves to read novels and articles. She loves to write her thoughts in a creative manner.*



# Curves of Physics







Aditi.

©macrocosm



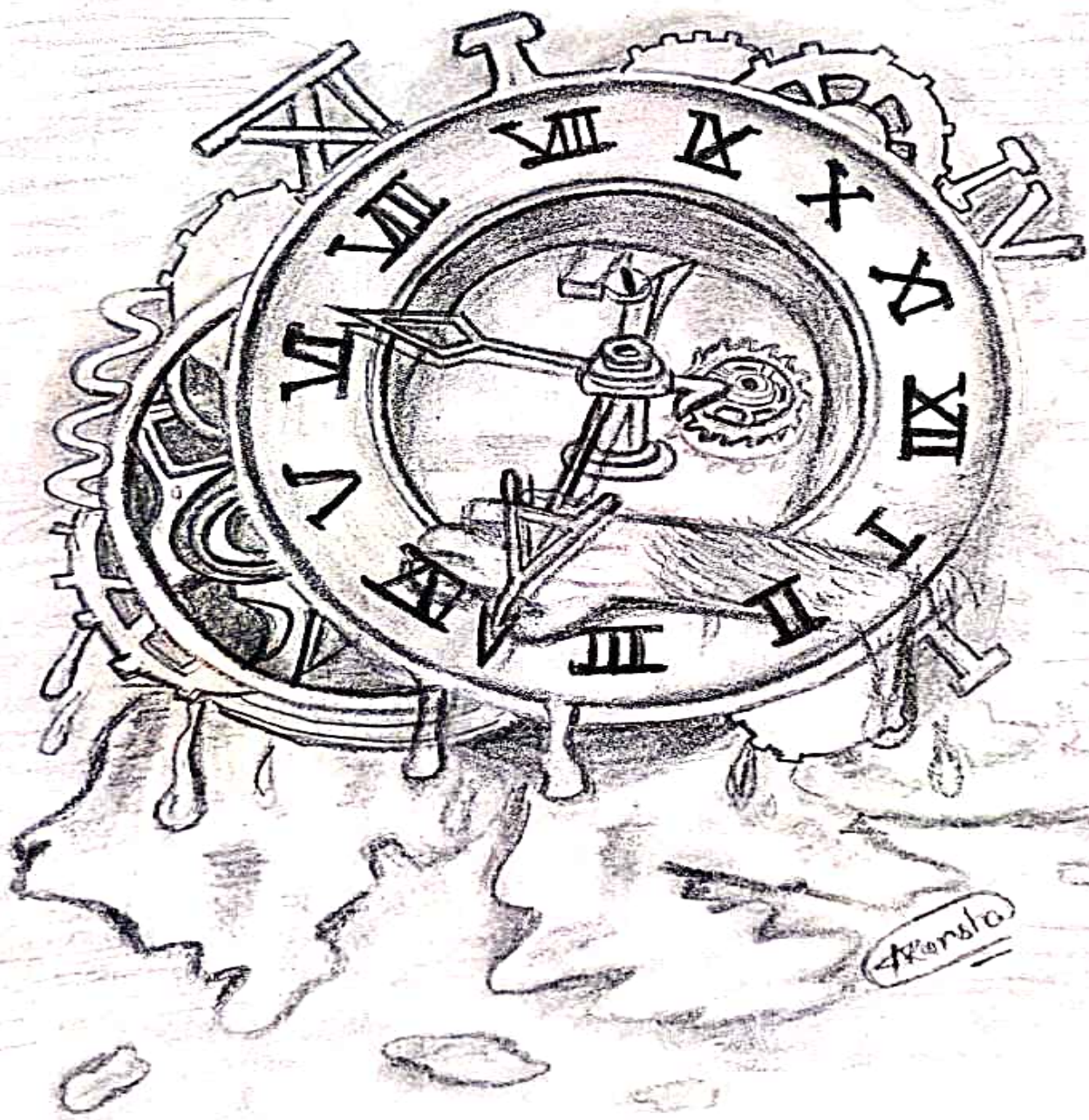


Aditi

## **Aditi Artist's Bio:**

*Aditi is pursuing English Honours and she's a delectable penchant for all things space, sky and galaxies. She loves reading and painting.*





**Akansha Gupta**  
**Artist's Bio:**

*Akansha Gupta is a physics student. She's sweet and charming girl with great creative and art skills.*

# News Flash

of the month

## News flash

### News flash

Let's be scientific and read some breaking news

#### headlines

1. Merging of two black holes
2. water on sunlit surface of the moon.
3. Tezpur University invites proposals of scientific models
4. How geologists reveal information about the solar system

### Merging of two black holes



### News flash

Let's be scientific and read some breaking news

#### headlines

1. Merging of two black holes
2. water on sunlit surface of the moon.
3. Tezpur University invites proposals of scientific models
4. How geologists reveal information about the solar system

### Merging of two black holes



### News flash

Let's be scientific and read some breaking news

#### headlines

1. Merging of two black holes
2. water on sunlit surface of the moon.
3. Tezpur University invites proposals of scientific models
4. How geologists reveal information about the solar system

### Merging of two black holes





## **PSLV-C49 is set to launch EOS-01 from Satish Dhawan Space Centre, Sriharikota**

Polar Satellite Launch Vehicle will launch EOS-01 and nine international customer satellites. This launch is scheduled for November 07, 2020, subject to change according to weather conditions. EOS-01 is an earth observation satellite purporting for application in agriculture, Forestry and disaster management support. The live telecast of this launch will be available on ISRO's official social media handles.

## **IISC has developed a bandage with magnetic nanofibres that kills skin cancer cells with heat**

Researchers at the Indian Institute of Science have developed a bandage made up of magnetic nanofibres to treat skin cancer by providing heat to the tumor cells. They used a unique blend of magnetic nanoparticles made from an oxide of iron,  $\text{Fe}_3\text{O}_4$ , and polycaprolactone. This treatment has been cancer in the lab. It can be considered as an alternative treatment to surgery or chemotherapy in the future.

## **Indian-American girl discovered a prospective treatment for COVID-19**

Anika Cherbrolu is a 14-year-old Indian-American girl who has won the 3M Young Scientist Challenge for discovering a compound that can impotent the novel COVID-19. When asked "How would you describe what you accomplished....?" in an interview with The Lily. Her words were - "So I developed a potent ial antiviral for covid-19 infection. I found the molecule from a database of millions of compounds that can bind to the spike protein of the SARS-CoV-2 virus and change its shape. And by changing the shape of the spike protein by attaching the molecule to it, it can stop the virus from infecting human cells, and basically stop the infectivity of the virus in human cells"

## **On the moon, water water everywhere and a drop to drink**

Lunar water is the water is present on the moon. Water found in sunlight and shadow on the moon, as discovered by NASA's SOFIA in 2020. Scientists have also confirmed that there is ice water in the cold, shadowed crater at the moon's poles. Water molecules are also detected in the thin layer of gases above the lunar surface.

## **Quantum Physics milestone: controlled transport of stored light**

Patrick Windpassinger and his team demonstrate how light stored in a cloud of ultra-cold atoms can be transported light stored in a quantum memory over a distance of 1.2 millimeters. Optical quantum memories, which allow for the storage and on-demand retrieval of quantum information carried by light, this is very interesting not only for physics in general, but also for quantum communication, because light is not very easy to capture and if you want to transport it elsewhere in a controlled manner, it usually ends up being lost.

## **A weirdly warped planet-forming disk circles a distant trio of stars**

In one of the most complex cosmic structures yet spotted, three rings of gas and dust circle a trio of stars. The star system GW Orionis, located about 1,300 light-years away in the constellation Orion, includes a pair of young stars locked in a close dance with a third star making loops around both. Around all three stars is a broken-apart disk of dust and gas where planets could one day form.

## **Physicists discover strange new magnetoelectric effect**

Electricity and magnetism are closely related; power lines generate a magnetic field, rotating magnets in a generator produce electricity. Electrical and magnetic properties of certain materials are also coupled with each other. Electrical properties of some crystals can be influenced by magnetic fields—vice versa. The effect was found in a specific type of crystal called a langasite, which is made up of lanthanum, gallium, silicon and oxygen, plus holmium atoms. It plays an important technological role.

## **Sensors on NASA'S Mars 2020 spacecraft answer long-distance call from Earth**

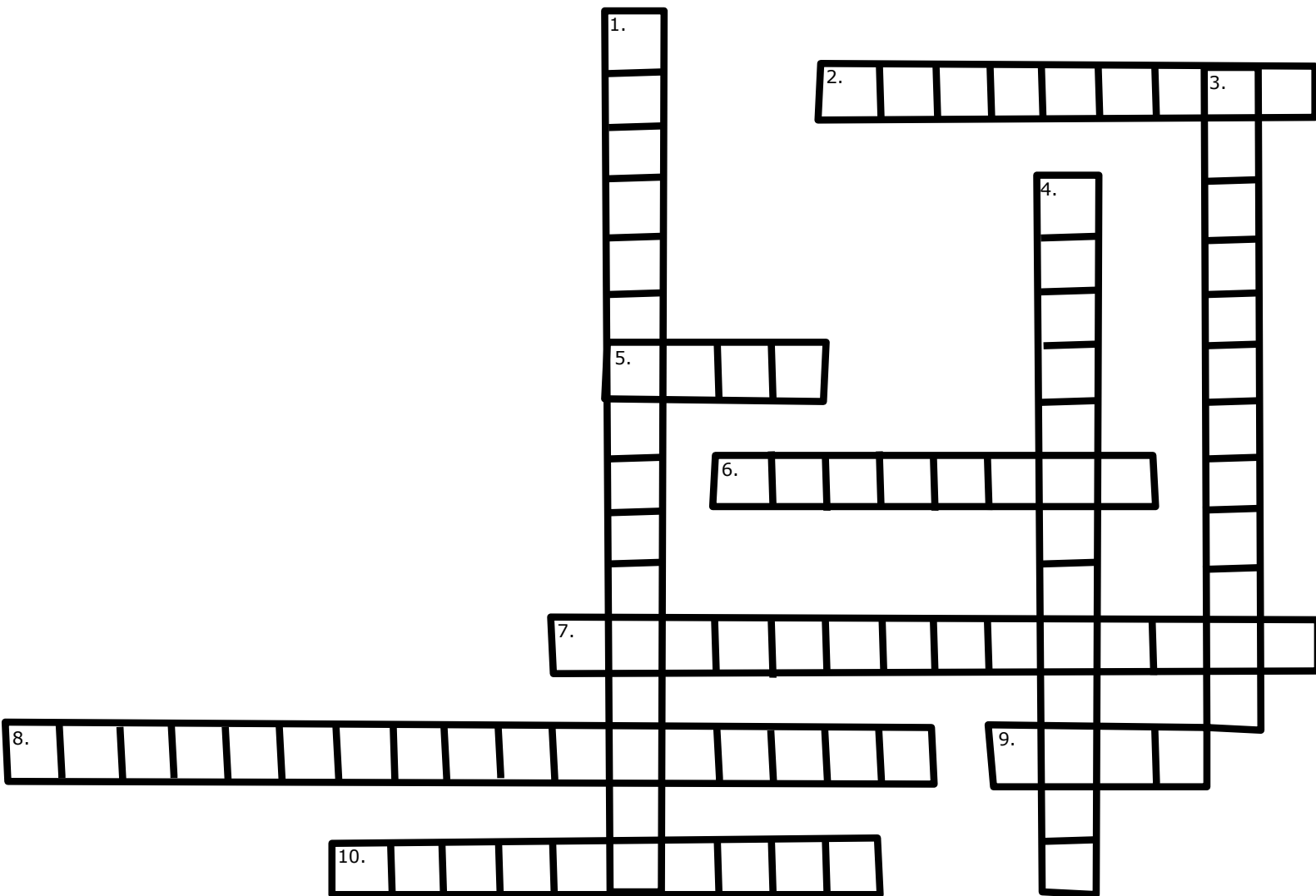
The team members of the Mars 2020 Perseverance rover mission waited for reply from the Mars entry, descent, and landing instrumentation 2 (MEDLI2) suite onboard the spacecraft, which is currently en route to the red planet. MEDLI2 is a collection of sensors that will measure aerothermal environments and thermal protection system material performance during the atmospheric entry phase of the Mars 2020 mission. The Mars 2020 mission is part of a larger program that includes mission to the moon as a way to prepare for human exploration of the Red Planet.

# **Test your** **knowledge**



**Quizzes, Riddles, and Puzzles**

# Crossword



## ACROSS

- 2 The shape of the Blackhole
- 5 First smart contact lenses which will use Augmented Reality
- 6 Largest unit of time
- 7 Working principle of washing machine
- 8 AI that will surpass human intelligence by 2045
- 9 Every single minute these particles interact with the human body
- 10 The farthest we can go in space

## DOWN

- 1 The phenomenon responsible for nuclear fission in the stars
- 3 The working of Positron Emission Tomography (PET) is based on
- 4 The transfer information from one place to another in the form of quantum states.



# Physics Euphoria

**1. The man who knew infinity.**

- a) Srinivasa Ramanujan
- b) CV Raman
- c) Vikram Sarabhai
- d) APJ Abdul Kalam

**2. Who said, "The Earth is our cradle, but we cannot be in the cradle forever"**

- a) Neil deGrasse Tyson
- b) Wernher von Braun
- c) Konstantin Tsiolkovsky
- d) Stephen Hawking

**3. What is the name of the site which has the most stable temperature on the moon?**

- a) Aitken Basin
- b) Mare Tranquillitatis
- c) Descartes
- d) Oceanus Procellarum

**4. Frictionless transportation of the modern high-speed Maglev trains is due to the application of?**

- a) Eddy Currents
- b) Electromagnetism
- c) Magnetism
- d) Electric Field

**5. Which scientist revolutionized Quantum Mechanics by introducing "energy quanta"**

- a) Niels Bohr
- b) Max Planck
- c) Wolfgang Pauli
- d) Erwin Schrödinger

**6. Name the largest particle accelerator in the world.**

- a) Large Hadron Collider
- b) cyclotron
- c) Super Proton Synchrotron
- d) CERN

**7. The world constitutes 99.99% of which matter?**

- a) Dark Matter
- b) Empty Space
- c) Atoms
- d) Plasma

**8.) Light from the star, Alpha Centauri, which is nearest to the earth after the sun, reaches the earth in**

- a) 4.2 seconds
- b) 42 seconds
- c) 4.2 years
- d) 42 years

**9.) Radiocarbon dating technique is used to estimate the age of**

- a) Rocks
- b) Monuments
- c) Soil
- d) Fossils

**10.) Sir C.V. Raman was awarded the Nobel Prize for his work connected with which of the following phenomenon of radiation?**

- A. Scattering
- B. Diffraction
- C. Interference
- D. Polarization

**11) Natural radioactivity was discovered by**

- a) Marie Curie
- b) Ernest Rutherford
- c) Henri Becquerel
- d) Enrico Fermi

**12) How many colours the sunlight spectrum has?**

- a) Three
- b) Seven
- c) Four
- d) Five

**13) Lambert's law is related to**

- a) Reflection
- b) Refraction
- c) Illumination
- d) Interference

**14.) Who invented Radar?**

- a) J. H. Van Tassel
- b) Wilhelm K. Roentgen
- c) P.T. Farnsworth
- d) A.H. Taylor and Leo C. Young

**15.) Where are Mesons found?**

- a) Cosmic Rays
- b) X-rays
- c) Gamma Rays
- d) Laser beam

# **Riddles**

- 1. I'm the one who exerts a force, but not a force itself. I am one of the fundamentals, but not united with others.**
- 2. Only a few could understand me but no one knows what's inside me except gravity.**
- 3. Love the opposite category, hate the same one.**
- 4. We can be each other by inducing ourselves. Who we are?**
- 5. The more you move, the more I resist.**

***Send your answers at "macrocosm.zine@gmail.com". First three to answer correctly will be mentioned in the magazine next month.***

# Introduction to the team

---



***Dr. Punita Verma***  
**Chief Editor**



***Prasashti Shukla***  
**Editor**



***Suneha Bhati***  
**Editor**



***Neeti Gahlot***  
**PR and Advt. Head**



***Partakshi Sood***  
**PR and Advt. Head**



***Priya Mehra***  
**PR and Advt. Volunteer**



***Anisha***  
**Creative Head**



***Priyanka Kasturia***  
**Co-Creative & Graphic Head**



***Tannu Gupta***  
**Graphic Volunteer**



***Akansha Gupta***  
**Art Director**



***Tanisha Chhabra***  
**Fact Checker**



***Nitya Jain***  
**Content Writer**

---



# About the magazine

---

**Macrocosm is a science magazine published by the Department of Physics and Physical Sciences of Kalindi College. To gratify your inquisitiveness, this digital magazine brings you all the dosages of science news, featured articles, and much more.**

---

**For more information  
Contact us at  
[macrocosm.zine@gmail.com](mailto:macrocosm.zine@gmail.com)**

---

**Follow us on Social Media**



**/macrocosm.zine**

**copyrights: Macrocosm**