

# GALACTIC CAFE



Bimonthly magazine  
of Nakshatra, IIT BBS

July '21

Contains article on  
**Time Travel** : Fiction vs Reality.

See how **ISRO** successfully  
conducted 3rd test on **Vikas Engine**.

Know about a **galactic archaeologist**  
who dug into the history of Milky way.

# MESSAGE FROM NAKSHATRA

Hello everyone!

Warm greetings from the members of Nakshatra. We present to you the July edition of Galactic Cafe, the bimonthly magazine of Nakshatra.

The magazine contains articles about astronomical bodies and events, recent space news, puzzles, quizzes and much more.

We, at Nakshatra, strongly believe astronomy is a wonderful experience, and we would like to do our part in enabling more people to understand and enjoy this experience with us. Thus, we have been doing our best to bring you good quality content and do our best to bring you more of the same, as we like to see every challenge as a new opportunity to grow.

We have also been putting an effort towards making your interaction with astronomy more engaging and fun by providing quizzes and crossword puzzles, which are included in the magazine along with its solutions (which will be provided in the next edition). You can also give your valuable feedback, helping us improvise the magazine because we believe “Everything is connected”.

We hope you enjoy reading the magazine.

Thank you!

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# TIME TRAVEL - FICTION VS REALITY

*By Omkar Sawant*

Almost all stories and movies related to space, cosmos, and science fiction seem to be obsessed with the idea of Time Travel. Also, this is the most discussed topic among physicists. But are all the ideas that are presented in the form of fiction practical? Well, fictional concepts which are based on a well-established theory may be practical while baseless fiction has a high possibility of being impractical. Einstein said, "Time measured along different trajectories is affected by differences in either gravity or velocity – each of which affects the time in different ways".

Time travel to the future is still theoretically possible, but the real problem is time travel to the past. Now, as per Einstein's Theory of general relativity, it is impossible for a thing to exist which is traveling at or greater than the speed of light. So it states that traveling to the past would be impossible. Time can be stretched and squeezed but time cannot turn back. Also, time travel to the past would arise in several debated paradoxes.

A very famous paradox arising due to time travel to the past is The Grandfather Paradox. If a person travels to the past and kills his grandfather, then it creates a paradox for the existence of his parents as well as himself. So, if the Grandfather paradox is correct, time travel to the past is impossible.

The Butterfly paradox states that any change in history made by a time traveler will affect all the following events. This paradox is shown in the 1985 movie series 'Back to the Future'. But, it is still very dramatic and is designed such that it keeps the viewer in suspense.

But if we consider Novikov's self-consistency Principle, time travel to the past may not create any paradoxes even if a time traveler tries to modify the history. It states that reality is a quantum superposition of various activities happening in the numerous parallel universes. So, if a time-traveler goes to the past, he may enter in one of the many parallel universes and if an event exists that would cause any change in the past whatsoever then the probability of that event occurring in other universes is zero. As a result, the superposition will not affect reality. Hence it would be impossible to create time paradoxes. Following Novikov's Principle, physicists have found out clever theoretical ways which are consistent with Einstein's Relativity Theory and make time-traveling to the past possible.

Specific types of motion in space might allow time travel into the past and future if the following geometries and motions were possible:

### **1) CTC: Closed Time-like Curve**

A wormhole is a path that shrinks space time. A wormhole which has two openings and travel is possible through it is called as a Transversable Wormhole.

Transversable Wormhole can be created in one of two ways:

1. One end of the wormhole would have to be accelerated to a significant portion of the speed of light, then brought back to the origin point. Due to time dilation, the accelerated wormhole entrance ages less than the stationary one as seen by an external observer.
2. One end of the wormhole is to be placed at a higher gravitational field than the other entrance and then returning it to a position near the other entrance. Assume that you take an entrance of a wormhole with you to a very high gravitational field and bring it back to the first entrance after some time, now there is a time difference between the two entrances due to time dilation caused by gravity, and if jump from one entrance, you will come out of the other entrance, you will be able to travel back in time.

Even if we create such a wormhole today, we won't be able to travel to a time before the creation of the wormhole.

## **2) Alcubierre Warp Drive:**

An interesting theory is the Alcubierre Warp Drive (also known as Warp Drive or Time Warp). It is based on a solution of Einstein's Field Equations in General Relativity as proposed by a Mexican theoretical physicist Miguel Alcubierre. It states that an aircraft can achieve an apparent faster than light travel if a configurable energy-density field lower than that of vacuum (ie. Negative mass) could be created. Rather than exceeding the speed of light within a local reference frame, a spacecraft would transverse distances by contracting space in front and expanding space behind it, resulting in a travel, faster than the speed of light.

Although this method is consistent with Einstein's Field Equations, the construction of such a drive requires the creation of a negative energy density meaning exotic matter. As of now, we have no knowledge about the presence or past existence of such exotic matter.

Until recently, most studies of time travel have been based upon the theory of General Relativity. Quantum Version of time travel requires physicists to figure out the time evolution equations for density stating the presence of closed time-like curves. Some physicists also believe that time is just an illusion and our reality is a complex set of events that we experience in forms of past, present, and future.

## **3) Cryopreservation:**

Another possible way to reach the future will be through Cryopreservation or Cryonics ie. to preserve a human body at a very low temperature to about -130 °C, the human can be revived in the future without him aging much and with considerable memory retention. This is not exactly time travel, but it will allow a person to travel to the past.

The major problem is that, as of now, we humans cannot control time as a 4th dimension. Just like how we live in a 3D world, we can move objects, interpret what we see, etc. But all of it is restricted to the 3 dimensions only. But if we consider a being who can interpret till the 5th dimension, that being may be able to visualize time as a physical dimension and to him, time travel would be something like taking a walk in the dimension of time. He would be able to understand and interpret all the parallel universes simultaneously. He will have full control over his timeline and hence he can also control everyone's existence. He can alter history via 5D time travel, he can communicate backward or forwards in time with the use of gravity as gravity is the only force that can travel across all 5 dimensions.

Now, comparing all of this to the fiction seen in books and movies. We can conclude that all the baseless fiction, lacks foundation and which contradicts well-established physics laws is without any doubt a very false idea. But many a times, fiction is based on the ideas given by a physicist, and this idea is used as a foundation to shape the entire story. A very good example is the 2012 movie Interstellar which was based on 100% facts and scientific principles but part of the story was made dramatic with no answers to certain happenings. Even though right now it may feel like fiction, in the future, part of it could be true in some or the other form.

So, Science Fiction could be true but science fiction is necessary not only for entertainment purposes but also for the creation of new ideas that keep mankind innovative and progressive. You never know which of these fictions could actually be a reality!!

NEWS

# A GALACTIC ARCHAEOLOGIST DIGS INTO THE MILKY WAY'S HISTORY

*By Jahnavi Sai Ganta*

***Astrophysicists now have the data and models to uncover subtle imprints from our galaxy's past.***

A glance up at the night sky reveals a broad swath of light. Described by the ancients as a river, as milk, and as a path, among other things, the band has been visible in the heavens since Earth first formed. In reality, this intriguing line of light is the center of our galaxy, as seen from one of its outer arms.

Understanding the structure of the Milky Way has long been challenging. The solar system sits on the outer edges of one arm in a disk of material, and no one can see across the dense center to the other side. But today, scientists know its shape and structure in detail: the spiral arms wrapping around the galaxy's center, its central bulge packed with stars and a gargantuan black hole, and its fainter, fluffy halo of stars farther out, as if our galaxy were cocooned within a stellar cotton ball. They also know that an even more diffuse cloud of dark matter extends farther out still, revealed by the motions of the stars.

Even just a decade ago, scientists knew the motions of, and the distance to, only a small number of stars in our galactic neighborhood, and so had only a partial picture of the Milky Way's evolving structure. But the latest telescopes, including the European Space Agency's Gaia that launched in 2013, have dramatically opened up our view to most of the galaxy.

Their data reveal faraway clumps and streams of stars that, like fossils, offer hints about the galaxy's complex history.

Amina Helmi of the Kapteyn Astronomical Institute in Groningen, the Netherlands, is a leading galactic archaeologist studying these remnants of past events, including the most momentous one: a massive, slow-motion impact with another galaxy that occurred some 10 billion years ago, in the Milky Way's youth.

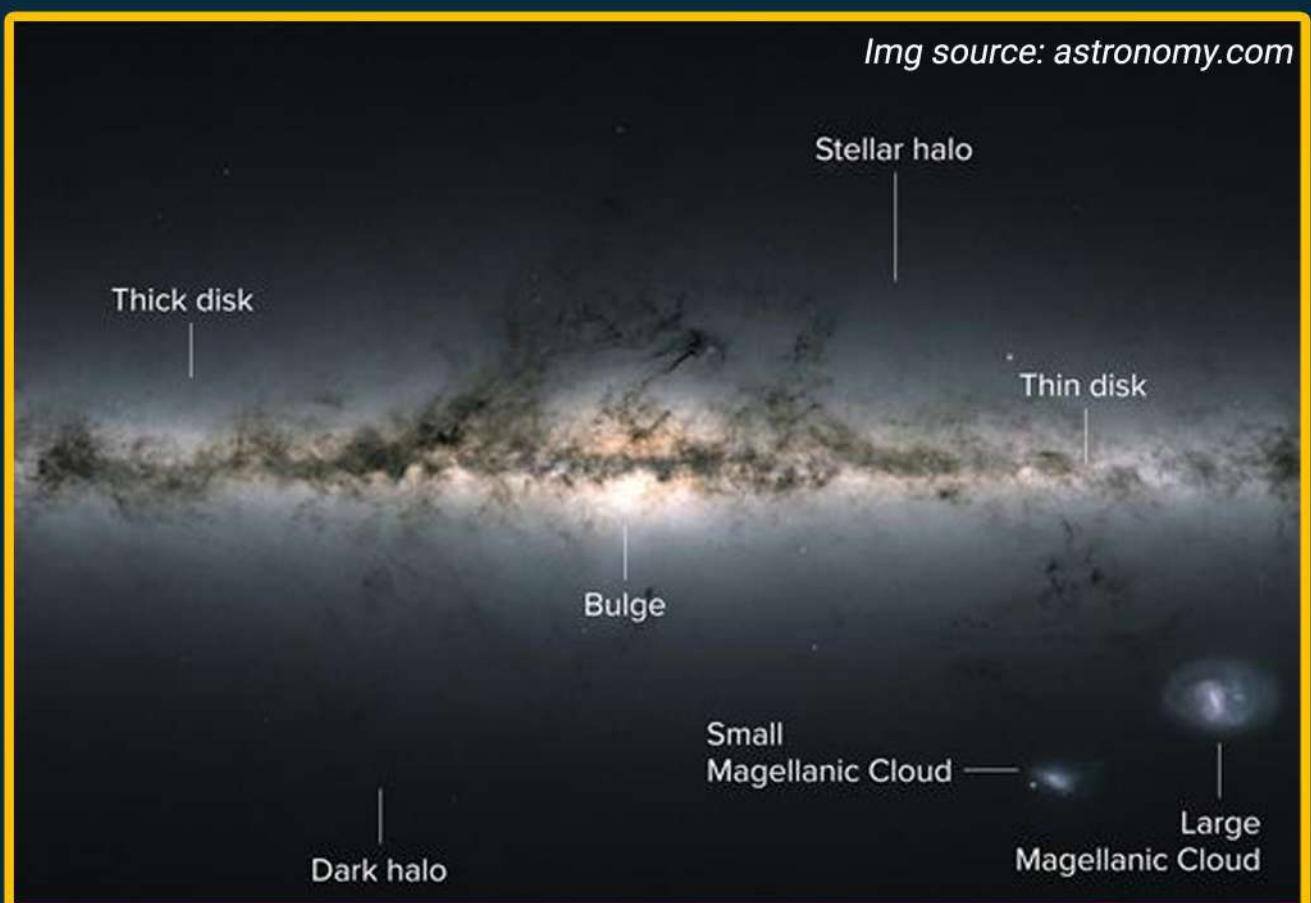
Helmi argues that our galaxy's disk, halo and wispy streams of stars bear evidence of this galactic collision and other long-ago events. Yet despite this past tumult, the Milky Way's past is comparatively peaceful, Helmi notes — it assembled mostly by birthing new stars from cooling gas and from older stars, rather than by dragging other galaxies into its maw. Galactic archaeology is to reconstruct the history, the sequence of events, that led to the formation of the Milky Way. In archaeology, you use the remains, or the leftovers, or the artifacts, of different civilizations or events. In this case, the leftovers are stars, so we use stars to try to figure out how the Milky Way was put together. Stars remember where they came from, they have memory of their origins. They used this technique to study the history of our very own galaxy. The way stars move, their ages and their chemical compositions tell us about where they were born.



*Img source: astronomy.com*

They found that this event perturbed the Milky Way so much that many of the stars present at the time ended up in the puffed up, or hot, thick disk. They afterwards showed that the thick disk, which contains roughly one-fifth of the stars in the galaxy, probably was also formed in the event. That's because galaxies in the past were likely gas-rich, so when you had a massive merger like that, it would pull gas clouds together, making high-density regions that trigger a lot of star formation. And we do see that star formation peaked at the same time as the merger, substantially growing the Milky Way's disk.

At the moment, the scientists have not yet used any of the information they have gathered recently about the ancient merger history of the Milky Way to try to estimate how much dark matter there is in and around it or how it's distributed, but they will in the near future.



For example, if you're convinced that certain stars came from the same object, and they're located in different regions of the galaxy, that can be used to calculate the gravitational pull of the Milky Way and the dark matter distribution in it. Measuring the motions of stars on the sky is extremely challenging. Before Gaia (space telescope), we had the measurements of about 2 million stars nearby, from a mission called Hipparcos in the '90s. Now it's 2 billion. Then there's the volume: The volume of space we can measure the motions in is a factor of 100 in radius larger now. And it's a factor of 1,000 more precise. It's a vast amount of data of exceedingly high quality.



Img source: astronomy.com

It's just been completely transformational. This research would not have been possible without Gaia. It has changed the way we understand the Milky Way. There are several planned surveys that will soon see the light that will measure the chemical abundances of hundreds of thousands of stars, particularly in the halo of the Milky Way.

In a few billion years, the Milky Way will merge with the Large and Small Magellanic Clouds. Roughly a billion years after that, the galaxy will also merge with Andromeda. That's going to be a major change for the Milky Way. This is an object that has basically the same mass, and when two galaxies of the same mass merge, you typically make an elliptical galaxy, a rounder structure with no disk or spiral arms. And since it's likely both galaxies will still have lots of gas then, that will lead to lots of star formation. So the sky is going to look completely different.





# ISRO Successfully Conducts 3rd Test on Vikas Engine

(By Sakshi Shashikant Yeole)

After land, sea, and air, countries rushed to explore the vastness of space. Thus, an upcoming indigenous crewed mission will place India in the center of this race.

Gaganyaan is an Indian crewed orbital spacecraft to be the formative spacecraft of the Indian Human Spaceflight Programme. Indian Human Spaceflight Programme, initiated in 2007 by the Indian Space Research Organization (ISRO) aimed to develop a technology needed to launch a crewed orbital spacecraft into Low Earth Orbit of 300-400km.

The mission was accepted and announced by Prime Minister Narendra Modi on the Independence Day of 2018. In May 2019, the design of the crew module has been completed. Defense Research and Development Organization (DRDO) will provide support for Human Space Missions with critical human-centric systems and technologies.

Rs.10,000 crore Gaganyaan mission aims to send a crew of three Indian astronauts (also called 'vyomnanuts') into space for about a week and safely return them to earth. This first indigenous spacecraft cum crew module is developed by Hindustan Aeronautics Limited.

Gaganyaan is a three-stage project-

1. The first uncrewed flight, Gaganyaan 1 is planned to launch in 2022.

2. The second uncrewed flight, Gaganyaan 2 is planned to

Gaganyaan 2 is planned to launch in 2022-2023

3. The first crewed flight is planned to launch in 2023.

The testing phase was expected to begin in December 2020 and the first crewed mission was to be undertaken in December 2021. However, on 11 June 2020, it was announced that the overall launch of the Gaganyaan has been delayed due to the COVID-19 pandemic in India.



An Img of Vikas Engine

Img source: wikipedia.org

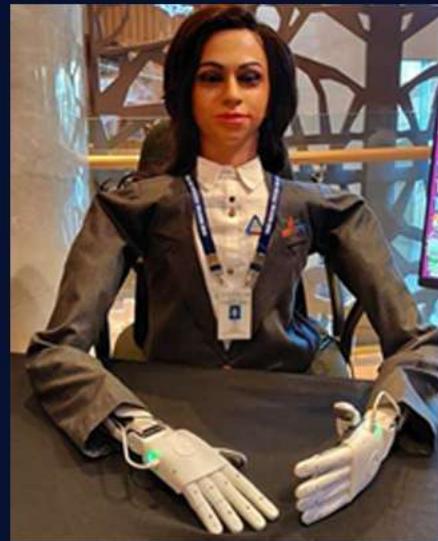


The tests and experiments for the vision seen began long back. The trials for crewed space missions began in 2007 with a Space Capsule Recovery Project (SPRE) which was launched and recovered using a PSLV rocket. This was followed by the Crew Module Atmospheric Re-entry Experiment and the Pad Abort Test on 5th July in 2018. The Pad Abort Test was successfully conducted to see how fast and effectively the crew module could be released safely in the event of an emergency. ISRO recently, on 14th July 2021, successfully conducted the third long-duration hot test of the liquid propellant Vikas Engine for the core L110 liquid stage of the human-rated GSLV MkIII vehicle, as part of the engine qualification requirements for the Gaganyaan Programme. This enables India to develop heat-resistant materials, technology, and procedures necessary for human space travel.

The crewed orbiter Gaganyaan is planned to launch using Geosynchronous Satellite Launch Vehicle Mk III (GSLV Mk III). About 16 minutes after liftoff from the launch pad in Sriharikota, the rocket will inject the spacecraft into an orbit 300–400 km (Low Earth Orbit) above Earth. When ready to land, its service module and solar panels will be disposed of before re-entry. The capsule would return for a parachute splashdown in the Bay of Bengal.

India has managed to bring together countries for its ambitious plans to send humans to space. Russia and France are providing key training and equipment needed to carry out the mission. As selection criteria require test pilot experience, any females will not be part of the first Indian crewed spaceflight. The first crewed flight will consist of a crew of three with one backup and this team of Four Indian Air Force pilots underwent training in Russia with the Russian space agency.

underwent training in Russia with the Russian space agency.



*Img of Vyommitra,  
Humanoid Robot*

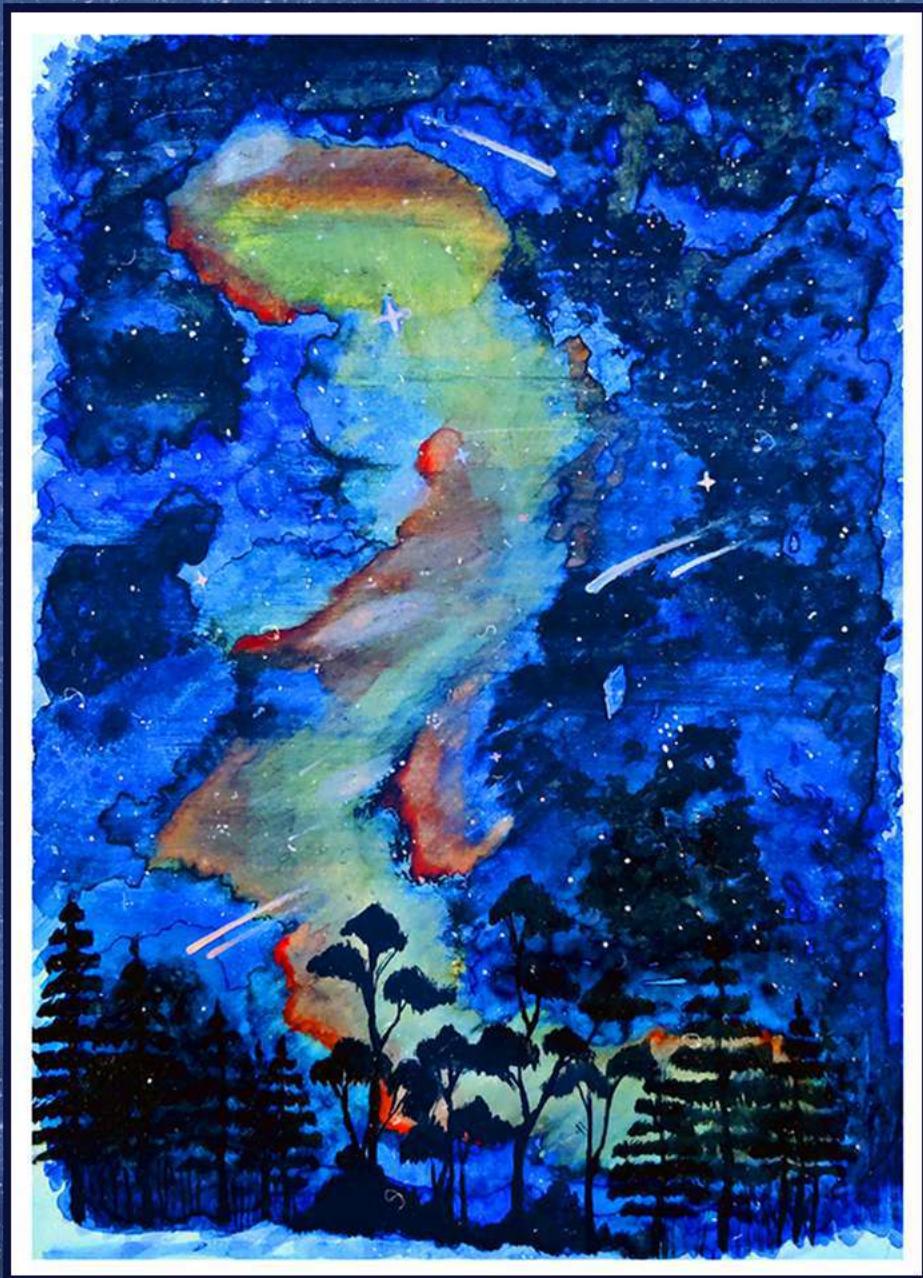
*Img source: indianexpress.com*

Unlike other nations that have carried out human space flights, India will not fly animals into space. Instead, as announced on 22nd January 2020, India will fly a female-looking humanoid robot named Vyommitra who will accompany the other astronauts on the mission. It can detect and give out warnings if environmental changes within the cabin get uncomfortable to astronauts and change the air condition.

It can also take up postures suited for launch and tasks and take commands. ISRO will also launch a data relay satellite that will help maintain contact with the Gaganyaan mission ahead of the final manned flight.

If completed the mission successfully, India will become the fourth nation to conduct independent human spaceflight after Russia, United States, and China. The mission will enable ISRO to achieve higher levels of reliability in launch and satellite technology. This mission will pave a way for continuous India's presence in space.

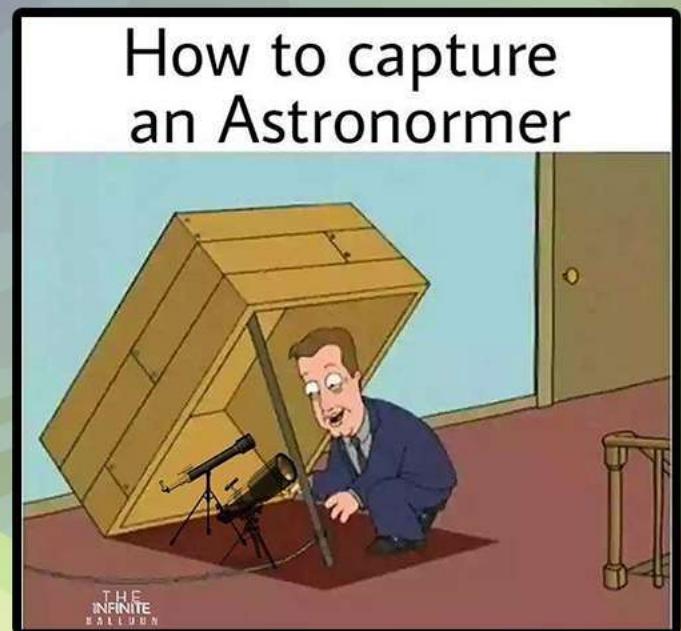
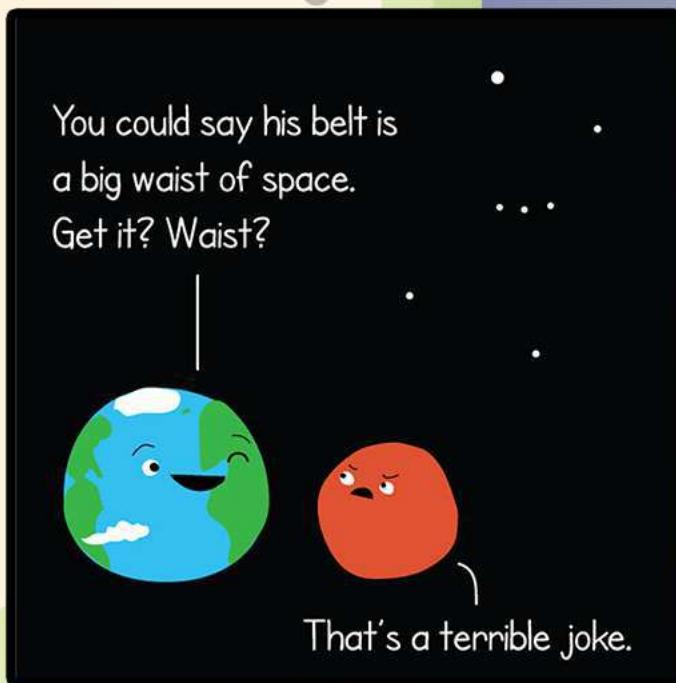
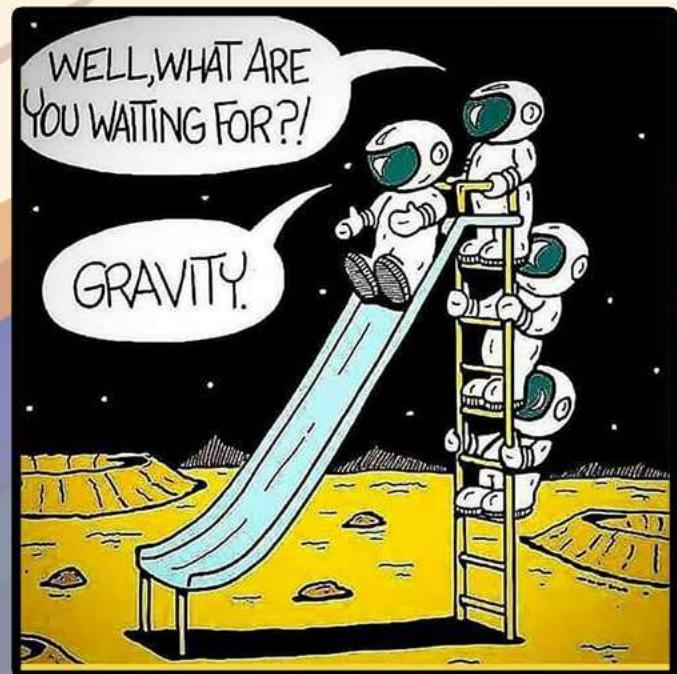
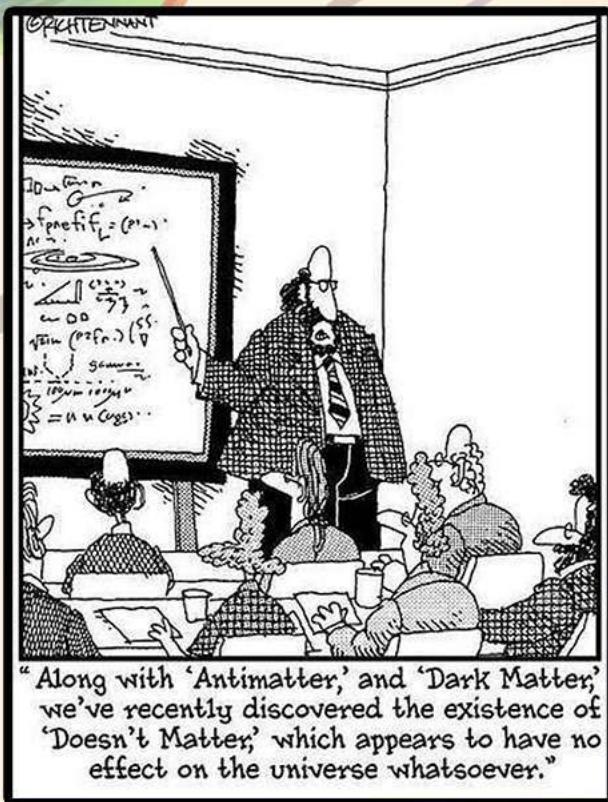
# Astro Gallery



-Artwork by Harsh Jain

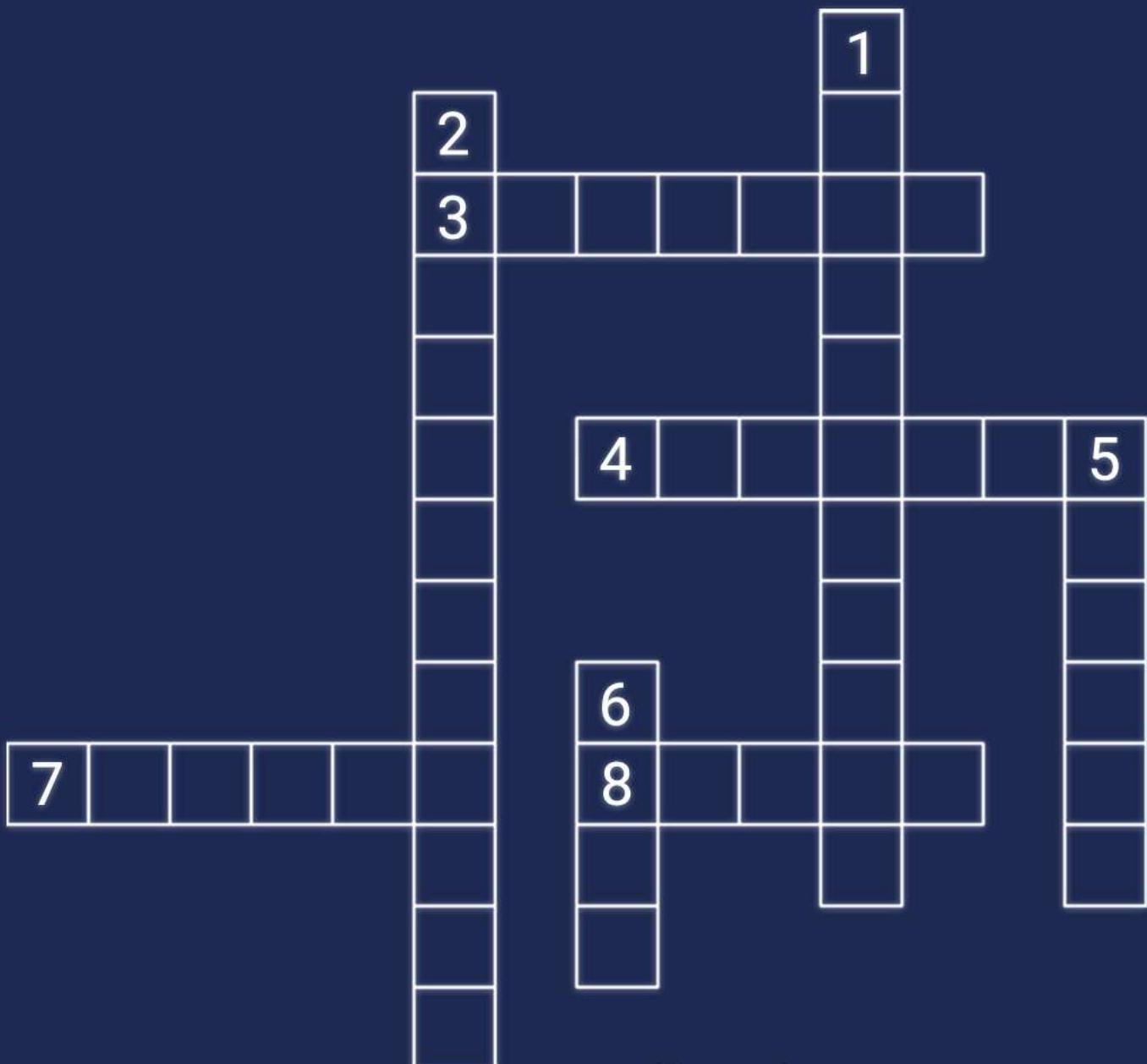
Remember those childhood fantasies of traveling between galaxies, counting the stars, and wondering about their existence whilst sitting on our rooftops and looking up at the night sky in the cool night breeze, the simplicity, peace, and serenity of those days. With beautiful trees providing for a horizon, the sky above us a window to the universe with multitudes of galaxies and an ocean of stars is a sight calling you back to the serenity of those days, to embrace it with arms widespread.

# ASTRO JOKES



# CROSSWORD PUZZLE

(By Pravendra Patel)



Email your answers to:  
[secyastronomy.sg@iitbbs.ac.in](mailto:secyastronomy.sg@iitbbs.ac.in)

## Across:

---

3. The day on which the sun's direct rays crosses the celestial equator.
4. \_\_\_\_\_ are the brightest things in the universe.
7. Name the planet whose axis is almost parallel to its orbital plane, making it spin nearly on its side.
8. The dark center of the sunspot.

## Down:

---

1. Which part of the sun can be seen with the naked eye?
2. \_\_\_\_\_ is the science of the physical connections between the sun and the solar system
5. It is the term which describes the alignment of three celestial bodies.
6. \_\_\_\_\_ is the farthest space probe ever to be powered by solar arrays.

# **Fastest Solvers of previous edition**

## **Crossword:**

1. Soumendra Priyadarshree Barik 19GT06002
2. Das Vicky Manojbhai 18EE01046
3. Mukku Mounika Reddy 19ME01031
4. Ayushi Gupta 19CE01021

# **Answers to the previous edition**

## **Crossword:**

- |                 |               |
|-----------------|---------------|
| 1. Interstellar | 5. Methuselah |
| 2. Rigel        | 6. Kardashev  |
| 3. Triangulum   | 7. Panspermia |
| 4. Goldilocks   | 8. Alphard    |

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# GALACTIC CAFE

“We are not simply in the universe,  
we are part of it,  
we are born from it.”

Neil deGrasse Tyson

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our newsletter or our activities, please drop  
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