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SENSE N' SCIENCE

Into the depths of spacetime

Gravity and the curvature of the space time fabric
-By Tishya Patel

Discover and Research on Habitable Planets
-By Esha Dalal

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A Tribute to Our Inspiration Albert Einstein

Editors Note

Space is studied as a branch of physics - it's a continuum with three dimensions with various directions and positions. Physical space is frequently conceptualized in three linear dimensions in classical physics. While modern physicists believe it to be a component of spacetime, an infinite four-dimensional continuum.

To most, space simply means our Solar System and the universe. In this edition of Sense N' Science magazine we have taken the opportunity to dig deeper into the vast universe we call space. We, the editors, the core team and your fellow students, have put together a compilation of fascinating research that you so preciously hold.

"I don't pretend to understand the universe–it's much bigger than I am."

-Albert Einstein

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GRAVITY AND THE CURVATURE OF SPACE AND TIME

Tishya Patel
IBDP 1

We have always intuitively felt that time and space are completely different and absolute unchanging quantities. In a sense our previous understanding made us believe that there is a single universal clock and ruler that tick and measure the same regardless of the frame of reference of the observer or regardless of relative velocities.

You would be surprised, but this concept is far from the truth....according to Einstein's theory of special relativity time and space AREN'T absolute but can slow down or change depending on your velocity! This theory also states that space and time cannot exist independently and can be considered to be a combined quantity i.e. SPACE-TIME. Another way to state this is that Einstein shattered the universal clock hoax and revealed that everyone carries their own clock with them that ticks differently depending on their relative speed to each other. This is essentially a form of TIME TRAVEL that is REAL!!!

The most fascinating result from this discovery that, time and space can be morphed and changed depending on velocity led to one of the most remarkable theories of modern physics, i.e. General relativity. This is the theory that explains how gravity works Einstein proposed that spacetime itself is the reason for gravity. He stated that mass bends spacetime and this bending is the reason for gravity. But what does this "bending" mean?

It means that the universe is like a fabric of spacetime on which mass is placed and hence it bends according to the mass. Other objects on the fabric of space follow these curves along the fabric created due to the mass, and accelerate.....this phenomenon is what gravity is. Essentially Einstein combined space, time curvature, and acceleration to form a beautiful elegant view of the universe that scientists even today study to understand completely making us appreciate not only Einstein's genius but also the beauty of the elegant universe.

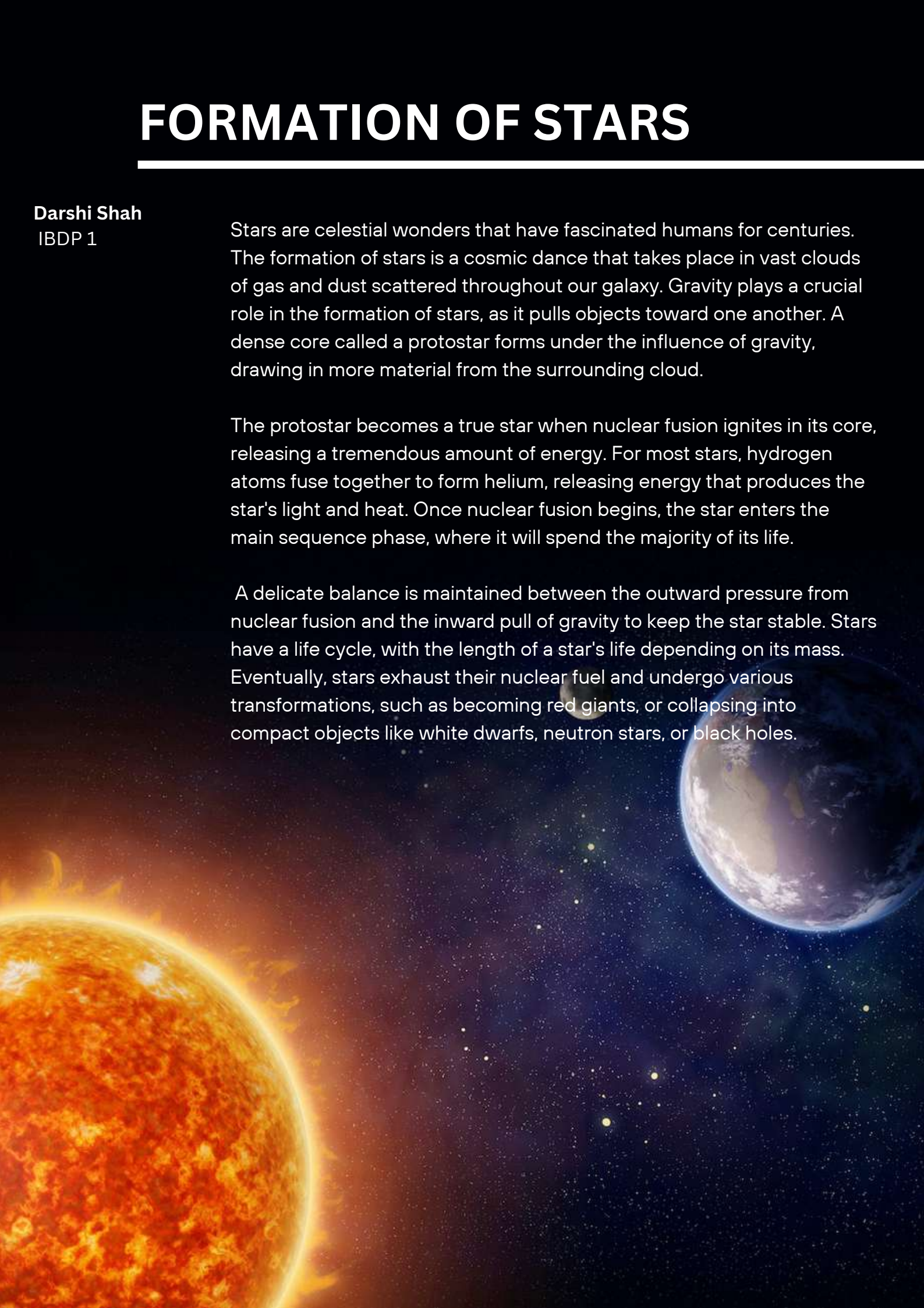
FORMATION OF STARS

Darshi Shah
IBDP 1

Stars are celestial wonders that have fascinated humans for centuries. The formation of stars is a cosmic dance that takes place in vast clouds of gas and dust scattered throughout our galaxy. Gravity plays a crucial role in the formation of stars, as it pulls objects toward one another. A dense core called a protostar forms under the influence of gravity, drawing in more material from the surrounding cloud.

The protostar becomes a true star when nuclear fusion ignites in its core, releasing a tremendous amount of energy. For most stars, hydrogen atoms fuse together to form helium, releasing energy that produces the star's light and heat. Once nuclear fusion begins, the star enters the main sequence phase, where it will spend the majority of its life.

A delicate balance is maintained between the outward pressure from nuclear fusion and the inward pull of gravity to keep the star stable. Stars have a life cycle, with the length of a star's life depending on its mass. Eventually, stars exhaust their nuclear fuel and undergo various transformations, such as becoming red giants, or collapsing into compact objects like white dwarfs, neutron stars, or black holes.



INTERSTELLAR EXTINCTION

-Darshi Shah
IBDP 1

Interstellar extinction is a cosmic mystery that involves the interstellar medium, which is filled with tiny particles, dust, and gasses that act as cosmic speed bumps for light, making it dimmer and changing its color. This phenomenon is similar to how a streetlight's appearance changes when it passes through a foggy window.

Some regions have more dust and gas than others, and when starlight passes through these areas, it interacts with the particles in the medium. The smaller dust particles scatter the light in different directions, making it weaker and altering its path. Interstellar extinction affects starlight in two main ways: dimming and reddening.

Dimming occurs when some of the starlight gets absorbed and scattered by the interstellar medium, making it less bright than it originally was. Reddening occurs when the dust in the interstellar medium scatters shorter wavelengths of light more than longer wavelengths, making stars appear more red. In conclusion, interstellar extinction adds an extra layer of magic and challenge to the study of the cosmos. Scientists use advanced tools and telescopes to understand these cosmic hurdles and unveil the secrets of the universe.

DISCOVERY AND RESEARCH ON HABITABLE PLANETS

Esha Dalal
IBDP 1

Scientists have been captivated by the search for habitable planets outside of our solar system for many years due to the vastness of space. The discovery of exoplanets, or planets circling stars other than our sun, intensified the hunt and brought in a new phase of space research. When researchers discovered the first exoplanet circling a star similar to our sun in 1995, it was a significant discovery. Since then, many exoplanets have been found thanks to technological developments like the Kepler and TESS observatories.

Astronomers have identified a handful of these finds to be in the "habitable zone," commonly known as the 'Goldilocks Zone', which is the area surrounding a star where the conditions for life to exist are optimal and there is a very high chance that life does exist. This finding is both humbling and empowering. To determine whether an exoplanet is potentially habitable, scientists examine its composition, research its orbit, and study its atmospheres.

Finding planets that resemble Earth is only one aspect of exploration; another is comprehending the complex relationships between many elements that determine whether a planet can support life. The finding of habitable exoplanets will have a significant impact on how we perceive the universe and our role in it. It makes us think about the uniqueness of our own planet and sparks curiosity about the possibility of extraterrestrial life.

THE HOLOGRAPHIC THEORY

Anahita shastri
GSEB-11

Juan Maldecena proposed the concept of the holographic universe, which posits that our universe is a hologram with a distant two-dimensional surface containing all necessary data. This theory has been widely accepted and has been used to explain various physics phenomena. Two theories were developed, one including gravity, known as the Ads theory or Anti de Sitter space theory, and the other, the CFT theory or conformal field theory.

Maldecena believed that the duality would hold true for other theories with one extra dimension, possibly even those describing a 4-D spacetime dimension similar to ours. This duality has been largely successful in studying quantum-mechanical behavior of particles and fields at the surface of a volume, where gravity plays no role.

This theory has played a significant role in explaining the black hole information loss, which was discovered by Stephen Hawking in 1974. Hawking discovered that black holes emit slight amounts of radiation over time, eventually disappearing as this energy bleeds away from the event horizon. This theory has been used to answer questions about whether black holes destroy information and to better understand the early epoch in our universe's history, called inflation.

In conclusion, the holographic universe theory has been instrumental in explaining various physics phenomena and has provided a more accurate understanding of the universe.

THE MULTIVERSE THEORY

Maanil Parikh
GSEB 11th Science

There is a multiverse theory which suggests that there exists many observable universes as ours. It became widely popular after its appearance in the Marvel cinematic universe,and there are a plethora of speculations about the same.

Assuming the space-time fabric is flat in which there are only a finite number of ways in which the particles can be arranged. This fabric then must start repeating itself after some point. This repetition is what we call parallel universes. One more such idea comes from the well known string theory, which suggests the possibility of many other dimensions other than our three-dimensional space .

The multiverse theory even suggests there may exist other universes which may or may not have the same laws of governance as ours. In these universes, we could be seeing other versions of ourselves and our reality. In some parallel universes, we may be the same people with same choices while in some alternate universes we might be taking different paths.

The multiverse theory has fascinated physicists, scientists, students, directors and generally anyone who is interested in astronomy. All we know right now is that there is a possibility of a multiverse existing. Hence, if in this world you are studious and a bookworm, you might be athletic in an alternate world.

Dreaming Big: Space Colonization on Mars

Kahaan modi
8D

With advancements in technology and the determination of space agencies worldwide space colonization is a dream that could become a reality. In fact, many scientists think that it could be the key to the long term survival of the species. Inspired by the spirit of Dr. Sarabhai, the man who dared to dream big, we can explore and wonder about the realm of space colonization.

The best place to start according to scientists is Mars. Several missions,like SpaceX's Starship and NASA's Artemis program, have an aim to explore Mars and pave the way for future colonization efforts. Its atmosphere contains carbon dioxide, which can be converted into breathable air.Scientists are exploring ways to harness this resource for human survival. Researchers are developing protective materials, advanced spacesuits, and technologies to extract water from Martian soil.

Future trips to Mars could become just as common as flying on an airplane, to begin a new life on Mars. The movie "The Martian" really got me thinking about the subject. Mark Watney's resourcefulness in growing potatoes on Mars was inspiring. Scientists are studying such survival techniques, aiming to make Martian habitats self-sustaining, even though it comes with challenges like extreme temperatures and radiation.

Space colonization is about daring to dream big and can’t be a space race, for which international collaboration is crucial. Mars could be our first cosmic home, and the journey to get there may one day be as accessible as any other travel. So, keep dreaming, keep looking to the stars, and who knows, one day we might have colonies on Mars.

EXPANSION OF THE UNIVERSE

Pearl Shah
10th GB

Space expansion is further studied under a branch of science known as cosmology. Space expansion is a theory which explains the never ending expansion of the universe and how certain stars seem to move away from us. It was first studied by Edwin Hubble in 1925.

This could be explained by the famous analogy which is imagining the universe like a loaf of raisin bread dough. As the bread rises and expands, the raisins move farther away from each other, but they are still stuck in the dough. One more such analogy talks about when you think of the universe from a bigger view and see it as a cosmic fluid. This idea suggests that universe expansion simply means the fluid spreads out so we see things moving farther away without stretching.

With the help of cosmic study we can calculate the rate at which the universe is expanding. This value is needed to calculate the age of the universe, estimate its evolution over billions of years, and understand the force driving it. By studying the cosmos beyond our own planet, we can understand where we came from, where we are going and how physics works under conditions which are impossible to recreate on earth. Specifically, expansion of the universe is important because if the universe stopped expanding it would eventually collapse into a singularity and lead to another Big Bang.

Cultivating the Cosmos: Future of Space Farming

Nityaa Desai
10D

Space exploration has always been an endeavor that captivates the human imagination. As we venture further into the cosmos, the need for sustainable solutions to support long-duration missions becomes paramount. One such solution is space farming, a pioneering field that aims to grow crops beyond our home planet. Traditional methods of resupplying food from Earth are costly, logistically complex, and unsustainable for long-term missions, such as those to Mars or beyond.

Hydroponics and aeroponics are leading techniques in space. CEA systems create controlled environments mimicking optimal conditions for plant growth on Earth, maintaining a stable growing environment in the microgravity of space. Crops like lettuce, spinach, and microgreens are popular choices for space farming due to their high nutritional value & rapid growth. Scientists are also exploring the effects of microgravity on plant growth patterns and their nutrient absorption capacity.

Research continues to expand in this field, paving the way for a sustainable and self-sufficient future in space. Space farming represents a monumental step towards achieving self-sustainability in space exploration. Through innovative techniques and determined research, we are on the cusp of a new era where astronauts can cultivate their own sustenance beyond the confines of Earth.

GLIESE 667CC - IS IT THE ULTIMATE HOPE OF LIFE?

Devshree Shah
10 GB

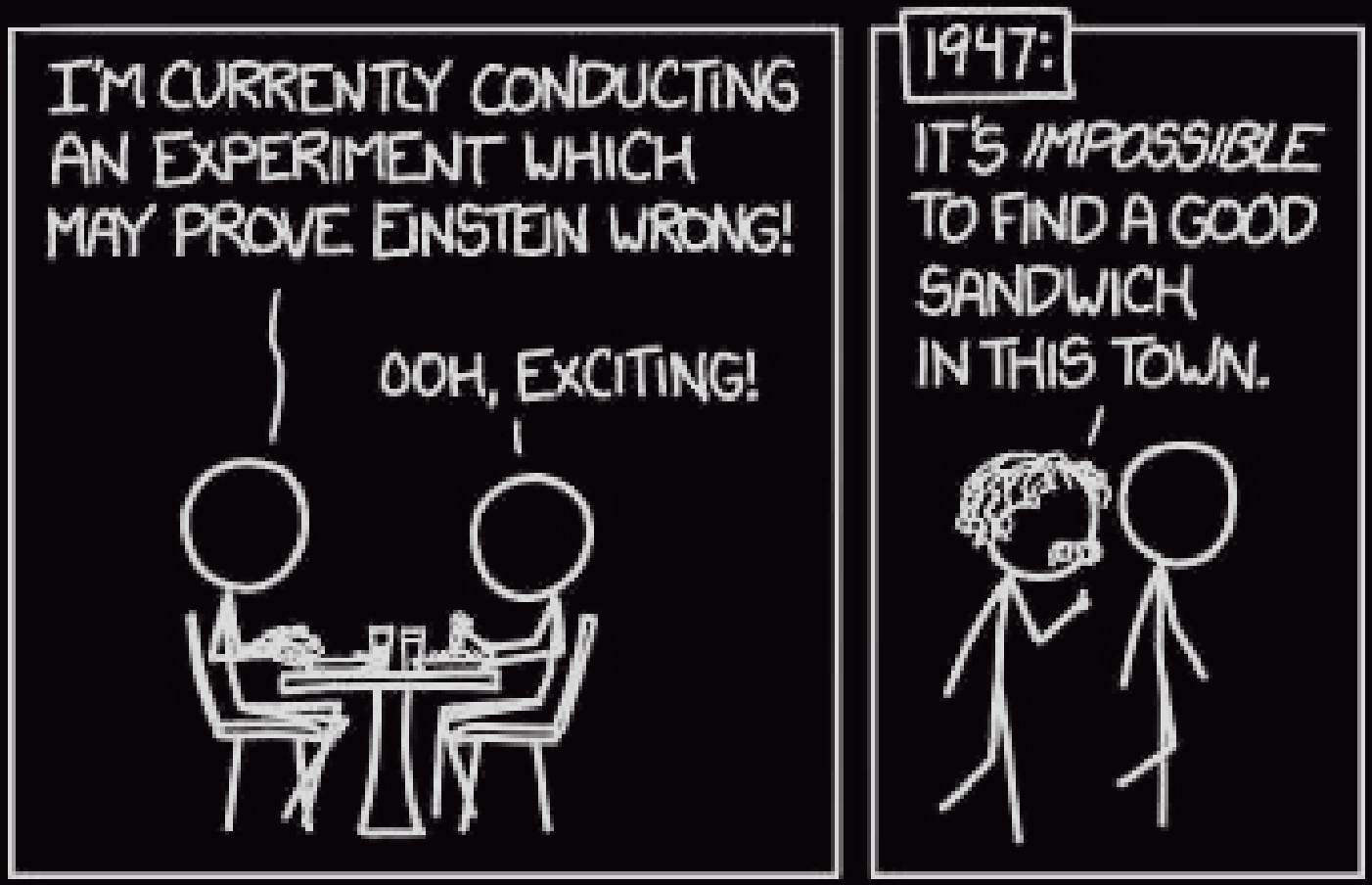
Life on other planets than Earth is a profound question that could change our understanding of the universe. The solar system was once thought to be a barren wasteland, with rocky neighbors being too dry and cold like Mars or too hot and hellish like Venus. However, life is not that simple, and it is possible even in harsh conditions. Exoplanets outside our solar system have been proven to be habitable, with the "habitable zone" being the distance from a star at which liquid water could exist on orbiting planets' surfaces.

One prime candidate for life on Gliese 667CC is believed to be composed of rocky materials similar to Earth, large enough to retain a molten core for the generation of a magnetic field. Due to its short distance from its central star, one year on Gliese 667CC is only 28 earth days long. The planet is likely tidally locked, meaning only one side receives light from the star, making that side much hotter.

The atmosphere on Gliese 667CC is similar to Earth but 4.5 times more massive or heavier than Earth. If life were to exist there, it would differ significantly from life on Earth. The planet receives about 90% of the light we do, but almost all of it is light with longer wavelength and shorter frequency.

The surface of Gliese 667CC is likely covered in rocky land masses and oceans, with most of its infrastructure requiring solar energy. As the planet is tidally locked, building most of its infrastructure that requires solar energy, such as agriculture on the hotter side, would be beneficial.

Comic Strip


I'M CURRENTLY CONDUCTING AN EXPERIMENT WHICH MAY PROVE EINSTEIN WRONG!
OOH, EXCITING!
1947:
IT'S IMPOSSIBLE TO FIND A GOOD SANDWICH IN THIS TOWN.

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