# JRCentral

*Who Said Is Not Important, What Said Is Important*

## Aerospace & the Year Ahead

January Issue

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# Acknowledgement

We are deeply grateful to Prof. (Dr.) Balvinder Shukla, Hon'ble Vice Chancellor, Amity University Uttar Pradesh, for giving us the valuable opportunity to share our project and the vision behind this magazine with her. Her kind encouragement and keen interest in our initiative strengthened our confidence and reminded us of the importance of curiosity and collaboration in research. Her words of appreciation and motivation continue to inspire us to carry this endeavor forward with greater enthusiasm.

We extend our sincere thanks to Dr. W. Selvamurthy, President of Amity Science, Technology and Innovation Foundation & Director General of Amity Directorate of Science and Innovation, for giving his precious time to our magazine. His thoughtful feedback and insightful suggestions helped us refine our initial vision, offering new perspectives on how to take this initiative ahead with clarity and purpose. We deeply value the time, encouragement, and guidance he shared with us at this important beginning.

We also express our heartfelt thanks to Dr. Sanjay Singh, Head of Department, for providing the facilities and a supportive environment that made it possible to bring this idea to fruition. Our deepest gratitude goes to Dr. V. R. Sanal Kumar, whose mentorship, knowledge, and constant encouragement have been invaluable throughout this journey. His guidance has not only shaped the essence of this magazine but also inspired us to approach research and creativity with deeper understanding and purpose.

## President
## Shivansh Rana

It is with great pride and enthusiasm that I present the New Year Edition of the Research Club Magazine as we begin Volume 2, following the successful completion of Volume 1 (2025) with five insightful issues. This milestone reflects the dedication, creativity, and academic excellence of our contributors and members.

The past year laid a strong foundation of meaningful research and thoughtful exploration. As we step into this new volume, we are committed to expanding opportunities, elevating the quality of our content, and showcasing authentic and impactful work to a global audience.

I extend my sincere appreciation to the editorial team and all contributors for their unwavering efforts. May this new year inspire fresh ideas, continued growth, and greater achievements as we move forward together in our pursuit of knowledge and innovation.

— ***Shivansh Rana***
**President, JRCentral**

# 05 Vice President Sameeha Khan

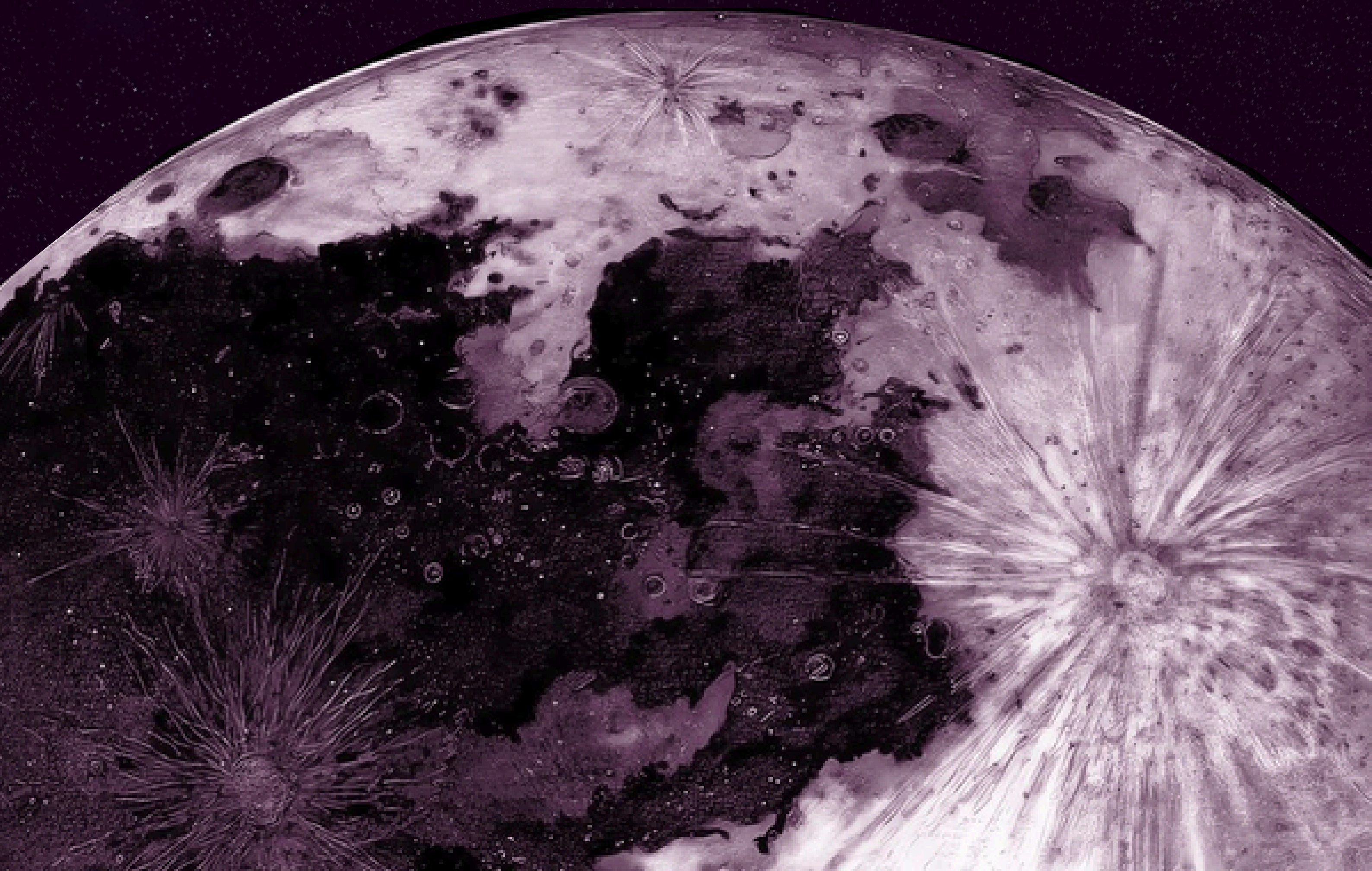
As we open Volume 2 of our magazine, this first issue feels less like a beginning and more like a continuation of something steadily built with care, curiosity, and commitment. Looking back at Volume 1, I feel immense pride in how far we have come — from ideas taking shape to pages filled with thoughtful research, creativity, and dialogue. None of this would have been possible without the dedication of our team, the guidance of our mentors, and the encouragement of every reader who chose to engage with our work.

Volume 1 allowed us to explore, experiment, and find our voice. It taught us how collaboration strengthens ideas and how consistency turns ambition into reality. Every article written, reviewed, and read became part of a foundation we now stand on with confidence.

As we step into a new year and a new volume, we do so with greater clarity and purpose. While we celebrate what has been achieved, we also look ahead to unfamiliar questions, evolving themes, and unexplored perspectives. Volume 2 represents our willingness to move forward — stronger, more thoughtful, and open to the unknown pages that lie ahead.

Thank you to everyone who has supported us, believed in this initiative, and grown alongside it. We look forward to continuing this journey together, carrying the spirit of the past into a future full of possibility.

*— Sameeha Khan*
Head of R&D, JRCentral



# Editor's Note
Rishita Manuja

Welcome, fellow enthusiasts, to another exciting edition of Aerospace & the Year Ahead! As we step into a new cycle, the aerospace industry finds itself at a thrilling crossroads, buzzing with innovation and poised for unprecedented advancements. It's a privilege to serve as your Editor-in-Chief this month as we delve into the trends and trajectories that will define our shared passion in the coming year.

The past year has laid robust groundwork, from the burgeoning satellite internet constellations transforming global connectivity to the continued push for sustainable aviation solutions. Looking forward, we anticipate a significant acceleration in the development of urban air mobility, bringing the dream of everyday aerial transport closer to reality. Space exploration, too, is set to reach new heights, with ambitious missions to the Moon and Mars continuing to capture our imaginations and push the boundaries of human endeavor.

This edition aims to provide you with insightful analyses, expert opinions, and thought-provoking articles that illuminate exciting developments. We hope you'll find inspiration and knowledge within these pages, fueling your own engagement with this dynamic field.
The future of aerospace is not just about technology; it's about the brilliant minds, the collaborative spirit, and the unwavering dedication that propel us forward.

*— Rishita Manuja*
Editor-in-Chief, JRCentral


ARTICLES
ACHIEVEMENTS

Bhavya soni (Content editor) 1st Year (AIAE)

# BEYOND THE SHOCK: A NEW LOOK AT SUPERSONIC HEATING

**Supersonic flight pushes both air and engineering to their limits. As an aircraft crosses the speed of sound, intense compression of air leads to rapidly rising temperatures around its surface, placing strict constraints on design and performance. While shock waves have traditionally been seen as the primary cause of this heating, recent research reveals that a hidden flow layer closer to the aircraft plays an equally important role**

**In real airflows, viscosity forces the air touching an aircraft's surface to slow down to zero velocity. At the same time, the air farther away continues to move at supersonic speed. This unavoidable transition means the flow must pass through Mach 1, forming a continuous Mach-1 surface around the aircraft known as the sonic jacket (or sonic ring in two-dimensional cases). The distance between the aircraft surface and this sonic jacket called the standoff distance plays a crucial role in controlling heating**

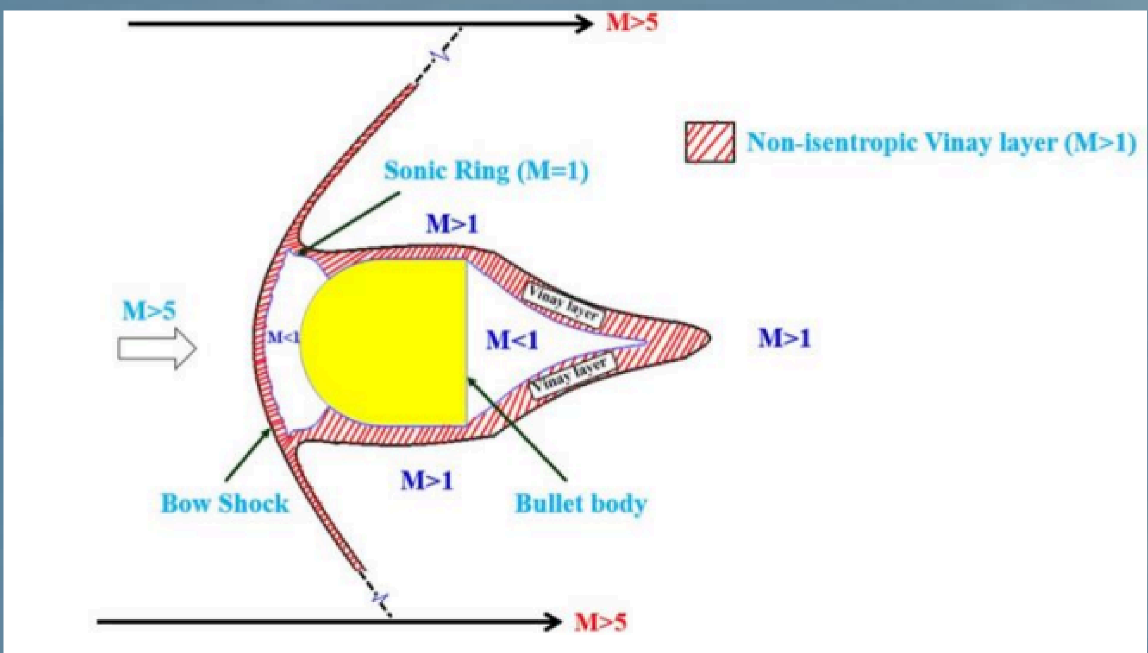



**Fig.1 Demonstration of Non-isentropic Vinay Layer**

Between the bow shock and the sonic jacket lies the Non-Isentropic Vinay Layer, a thin but highly influential region. In this layer, entropy changes rapidly due to streamtube flow choking and viscous effects. These sharp entropy changes generate entropy waves, which are carried toward the aircraft surface. Unlike shock heating, which occurs suddenly, entropy waves cause sustained thermal loading, significantly increasing surface temperatures.

The importance of the Vinay Layer becomes clear when examining the Concorde aircraft. Numerical simulations show that in certain regions, especially near the cockpit windows, the sonic ring lay very close to the fuselage. This small standoff distance allowed entropy waves from the Vinay Layer to reach the surface with high intensity, contributing to Concorde's heating challenges.

This new perspective suggests that future supersonic aircraft need not depend solely on advanced materials for thermal protection. By actively shaping the flow field and increasing the standoff distance of the sonic jacket, engineers can reduce aerodynamic heating at its source. Looking beyond shock waves, the Vinay Layer emerges as a promising pathway toward safer and potentially revived supersonic flight.

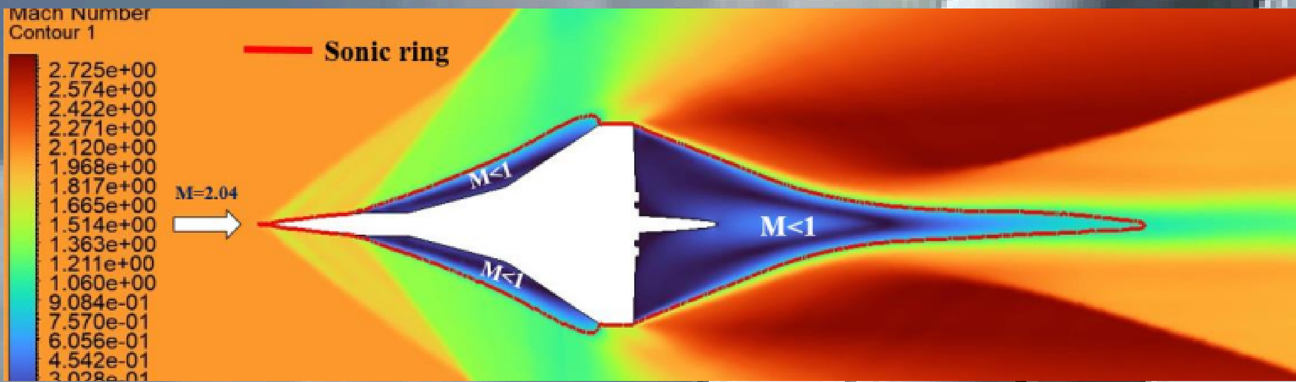



Fig. 2: In silico demonstration of the Sonic Ring (2D Case) of a Concorde aircraft.

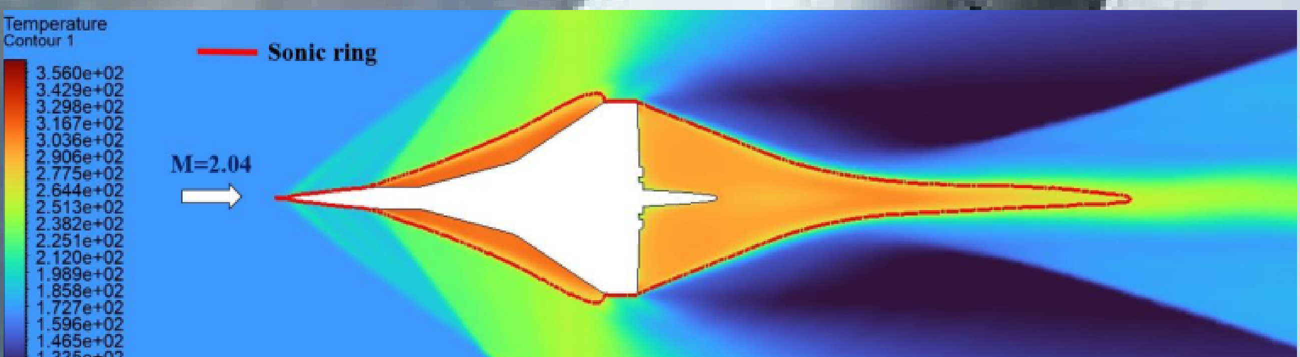


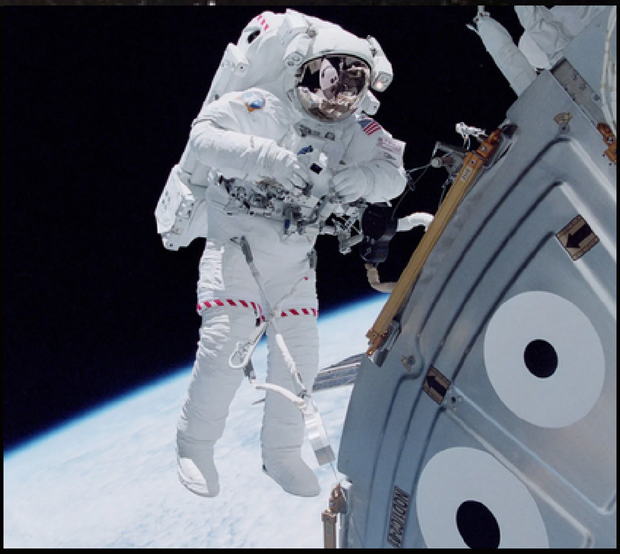

Fig. 3: In silico demonstration of the temperature contour around the Concorde aircraft.



Shreya Sharma, 1st Year (AIAE)

# Human Spaceflight, Space Stations and Exploration Programs

Human spaceflight reflects humanity's desire to explore beyond Earth while advancing science and technology. Through space stations and exploration programs, space has evolved from a distant frontier into an active center of research and international cooperation. From the earliest observations of the night sky, space has symbolized curiosity, courage, and the drive to exceed known limits. Human spaceflight is not only about rockets and astronauts but also about human ambition and scientific progress.



Over time, the focus of space missions shifted from short-duration flights to long-term stays in orbit. This transition was essential for understanding how the human body and mind adapt to microgravity, radiation, and isolation—critical factors for future deep-space missions. Space stations, such as Salyut, Skylab, and especially the International Space Station (ISS), represent major achievements by allowing astronauts to live and work in space for extended periods. Built through international collaboration, the ISS serves as a microgravity laboratory supporting research in medicine, materials science, fluid dynamics, and Earth observation, while shaping preparations for missions to the Moon and Mars.

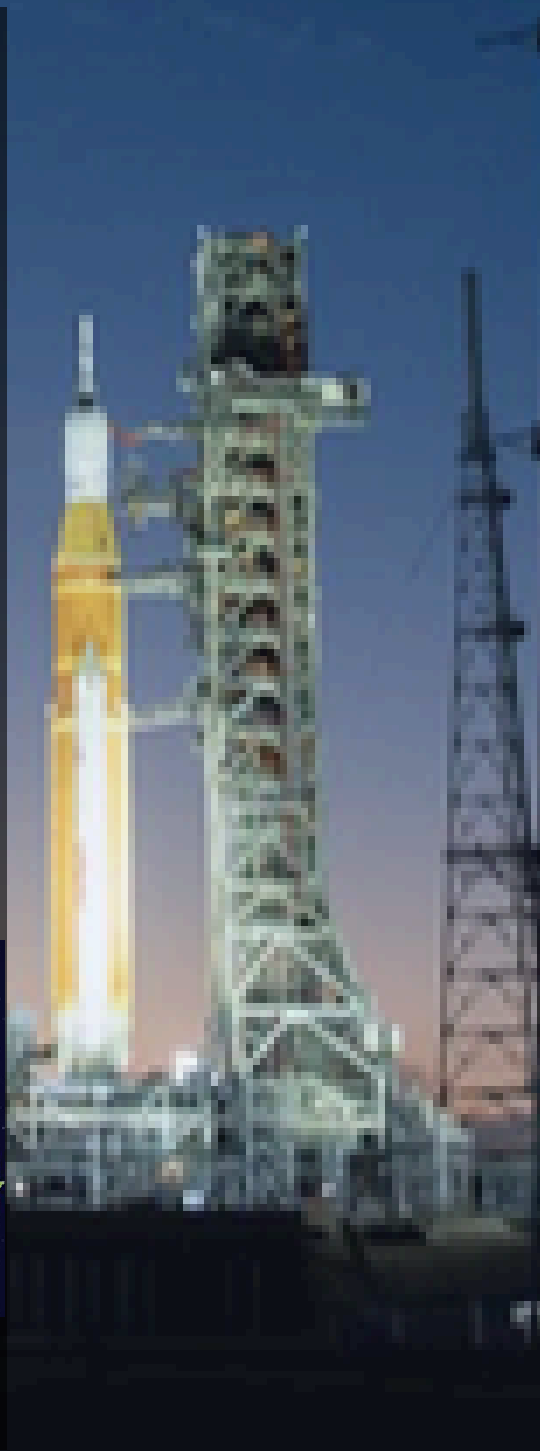
Modern human spaceflight aims to take humanity farther than ever before. Agencies including NASA, ESA, Roscosmos, ISRO, and CNSA are developing missions focused on lunar exploration, Mars, and deep space. Programs like NASA's Artemis seek to establish a sustainable human presence on the Moon as a stepping stone to Mars, alongside growing contributions from private companies through reusable launch vehicles. Despite challenges such as radiation exposure, psychological stress, and high costs, the future of human spaceflight lies in collaboration, innovation, and sustainability, inspiring future generations while expanding human presence beyond Earth.

Vanya Verma, B.Tech 1st Year (AIAE)

# Artemis II: Taking Humans Back Into Deep Space

For the first time in more than 50 years, humans are preparing to travel beyond Earth's orbit again—and Artemis II is the mission that makes it possible. Part of NASA's Artemis program, Artemis II is not just another spaceflight; it is a powerful reminder that humanity is ready to return to deep space and take the next big step toward the Moon and beyond.

Artemis II will carry four astronauts aboard the Orion spacecraft on a journey around the Moon. Unlike the previous Artemis I mission, which flew without a crew, this mission puts human lives at the centre of the test. Every system inside Orion—air, water, navigation, communication, and power will be tested under real deep-space conditions. It's a mission built on trust: trust in technology, trust in science, and trust in the people who will guide the spacecraft millions of kilometres from home.



The astronauts won't land on the Moon this time. Instead, Orion will swing around it in a wide loop, flying farther than any crewed spacecraft has ever gone. During the journey, the crew will take manual control of the spacecraft, monitor on-board systems, and ensure everything works exactly as it should. These hands-on tests are crucial, because future missions will depend on this reliability when astronauts actually step onto the lunar surface.

Safety is at the heart of Artemis II. The mission will closely examine how astronauts cope with long durations in deep space, exposure to radiation, and the physical and mental demands of the journey. One of the most intense moments will come at the end, when Orion re-enters Earth's atmosphere at extremely high speeds. The spacecraft's heat shield must protect the crew as temperatures rise dramatically—proving that humans can safely return from lunar distances.

Beyond the science and engineering, Artemis II carries deep emotional and symbolic meaning. It represents a new chapter in space exploration—one that values diversity, international cooperation, and long-term exploration rather than short visits. The Artemis program aims to send the first woman and the first person of color to the Moon, inspiring a generation that sees space as a place for everyone.

Ultimately, Artemis II is about more than going around the Moon. It's about rebuilding humanity's confidence in deep-space travel and reminding us that exploration is part of who we are. By taking humans back into the vastness beyond Earth, Artemis II brings us one step closer to living, working, and dreaming beyond our home planet.

Shashank Kumar Tiwari, 2nd Year (AIAE)

# UPCOMING SPACE MISSIONS AND LAUNCH CAMPAIGNS

## OVERVIEW

The period from 2024 to 2030 is expected to be one of the most dynamic eras in the history of space exploration. National space agencies including NASA, ESA, ISRO, JAXA, and CNSA along with private players such as SpaceX, Blue Origin, and Rocket Lab, are gearing up for a series of ambitious missions. These efforts span lunar exploration, deep-space probes, human spaceflight, and planetary science. The decade will be characterized by unprecedented cooperation between governments and private industries, fueled by advancements in rocket reusability, autonomous spacecraft systems, and sustainable mission architectures.

## The Artemis Era

NASA's Artemis Program serves as the cornerstone of human exploration beyond Earth in the 2020s. The Artemis II mission, planned for 2025, will be the first crewed lunar flyby using the Orion spacecraft, testing life-support systems in deep space. Following this, Artemis III, targeted for 2026 or 2027, aims to land astronauts near the Moon's south pole, an area rich in water ice that could support future habitation. Supporting these missions is the construction of the Lunar Gateway, a small modular space station that will orbit the Moon and act as a logistics hub for both robotic and crewed missions.

## Expanding Horizons

While the Moon serves as a proving ground, Mars remains humanity's ultimate target. The NASA–ESA Mars Sample Return mission, expected to launch by 2028, will attempt to retrieve rock samples collected by the Perseverance rover and return them to Earth for detailed analysis. Similarly, China's Tianwen-3 mission aims to conduct its own sample return operation using a dual-spacecraft system consisting of an orbiter and lander. Meanwhile, SpaceX is developing the Starship system, which could serve as a cargo transport vehicle for future crewed Mars missions.

# The Rise of Commercial and International Launch Campaigns

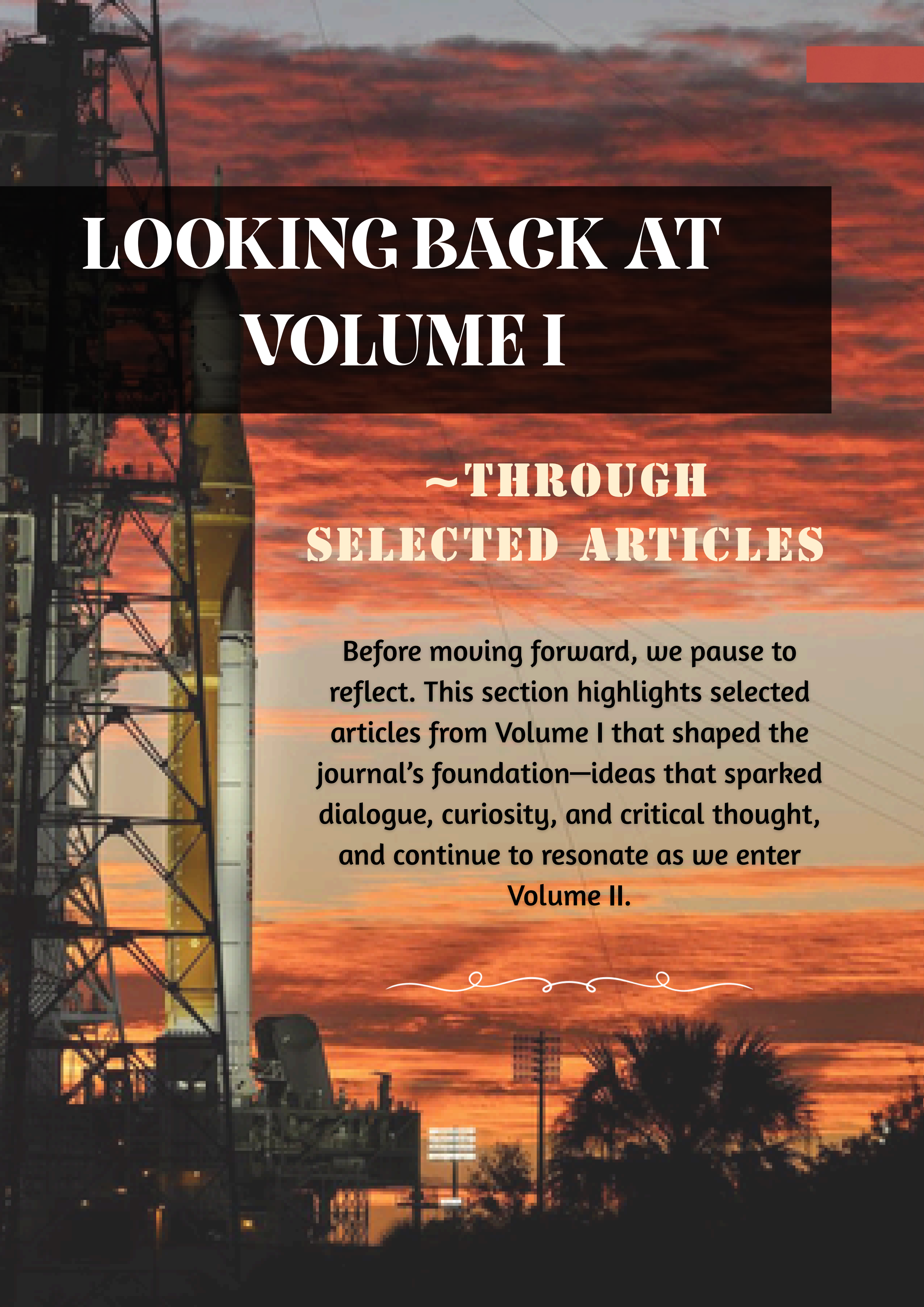
The coming decade will also see the rapid expansion of commercial launch activity. Companies like SpaceX, Blue Origin, and Rocket Lab are deploying next-generation rockets designed for reusability and versatility. SpaceX's Starship aims to support Starlink deployments and lunar cargo missions, while Blue Origin's New Glenn targets heavy payload delivery for both government and private customers. India's ISRO is preparing for Gaganyaan, its first crewed orbital mission, which will establish its entry into human spaceflight.

## Deep Space Exploration

Beyond the Moon and Mars, several planetary missions are advancing our understanding of the outer solar system. NASA's Europa Clipper, scheduled for launch in 2025, will study Jupiter's icy moon Europa in search of subsurface oceans and signs of habitability. The Dragonfly mission to Titan (launching in 2028) will deploy a drone-like rotorcraft to investigate the moon's methane lakes and prebiotic chemistry. Meanwhile, ESA's JUICE mission, launched in 2023, is en route to study the Jovian moons Ganymede, Callisto, and Europa. Future Venus missions like VERITAS and DAVINCI will focus on atmospheric and geological exploration, possibly redefining our understanding of Earth's twin planet.

## Innovations in Launch Vehicle Design:

The success of these missions depends heavily on next-generation rockets. NASA's Space Launch System (SLS) will provide the power for crewed lunar missions, while Starship represents a leap forward in cost-effective reusability and heavy-lift capability. Blue Origin's New Glenn aims to compete in the commercial heavy-lift segment, and ISRO's GSLV Mk III will support both orbital crew flights and satellite launches.



# LOOKING BACK AT VOLUME I

## ~THROUGH SELECTED ARTICLES

Before moving forward, we pause to reflect. This section highlights selected articles from Volume I that shaped the journal's foundation—ideas that sparked dialogue, curiosity, and critical thought, and continue to resonate as we enter Volume II.

# LOOKING BACK AT VOLUME- I

# SELECTED ARTICLES

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Sameeha Khan, 2nd Year (AIAE)

# Pistol Shrimp snaps SHOCKWAVE!

At just 3-5 cm long, the pistol shrimp carries one disproportionately large claw that functions like a biological weapon. This claw is not designed for pinching but for producing extreme fluid dynamic forces. It works like a cocking mechanism: when pulled back, the claw's "hammer" creates a small chamber that fills with water, and when released, the hammer slams forward in under a millisecond, forcing a narrow jet of water out at speeds of around 25 m/s.

This rapid flow causes the local pressure in the water to drop below the vapour pressure, generating a cavitation bubble. The bubble expands outward from the claw, then collapses violently as surrounding water pressure overwhelms it. This collapse releases a shockwave loud enough to interfere with sonar and pressures near 80 kPa at close range.

The collapse is also accompanied by extreme heating. The rapid adiabatic compression of gas inside the bubble can reach temperatures exceeding 5,000 K, similar to the Sun's surface. This produces a faint burst of sonoluminescence, which is when light is generated by an imploding bubble.

For prey, the shockwave's impulse is enough to stun or kill instantly. For engineers, the pistol shrimp is a natural demonstration of extreme fluid dynamics with high-velocity jets, cavitation physics, and energy focusing, all powered by muscle. The pistol shrimp's claw is one of nature's most clever devices for focusing energy in water.

## FUN FACT

At 218 decibels, its snap is one of the loudest biological sounds on Earth, rivalling the sounds made by whales

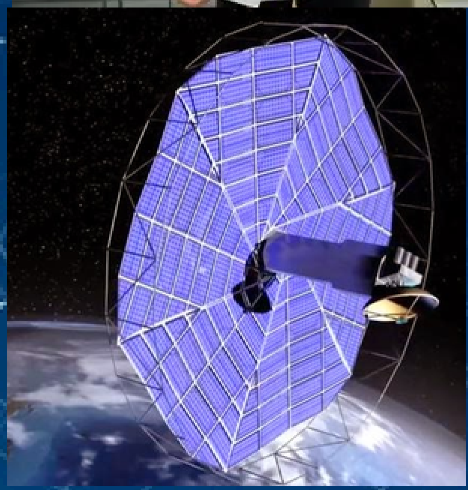
Vanshita Vats, 2nd Year (AIAE)

# Folded paper & Space Flight

In the vacuum of space, every centimeter matters. Satellites must be compact enough to fit inside a rocket, yet large enough to gather energy, collect data, or shield sensitive instruments once deployed. Engineers have found an unlikely design partner for this challenge: the ancient art of origami.

One of the most remarkable techniques adapted for aerospace is the Miura fold, developed by Japanese astrophysicist Koryo Miura in the 1970s.

This folding pattern allows a flat sheet to collapse into a fraction of its size and then unfurl smoothly in a single motion.



Unlike conventional folding, it distributes stress evenly, reducing the risk of creases or damage to delicate materials.

NASA, JAXA, and ESA have explored origami-inspired mechanisms for solar panel arrays, deployable antennas, and space-based telescopes. Solar sails like JAXA's IKAROS have demonstrated how these folds can carry spacecraft across interplanetary distances using nothing but the pressure of sunlight. The same principles are now influencing designs for large, lightweight mirrors and next-generation starshades.

The beauty of origami in space engineering lies not just in its elegance but in its efficiency. A structure folded in a Miura pattern can expand to several times its stowed size with minimal mechanical complexity, reducing weight and potential failure points.

By merging centuries-old craftsmanship with cutting-edge engineering, origami is reshaping how we think about spacecraft design. It is a reminder that sometimes, the solutions to the most modern problems can be found in the folds of ancient ideas.

Anmish Verma, 4th year (AIAE)

# COSMIC BREATH: ANCIENT INDIAN TIME CYCLES AND THE SCIENCE OF THE UNIVERSE

Ancient Indian cosmologists developed one of the most elaborate frameworks of time in human history. To encode it for memory, they described the universe as the rhythmic breath of Maha Vishnu — expansion with exhalation, contraction with inhalation. This metaphor ensured that complex calculations were preserved across generations by embedding physics-like concepts within a narrative accessible to all.

The numbers themselves are staggering and highly structured:
1 mahāyuga (great cycle of four yugas) = 4.32 million years
1,000 mahāyugas = 1 kalpa, equivalent to 4.32 billion years (a “day of Brahma”)
1 night of Brahma = 4.32 billion years (dissolution period)
1 full day-night cycle = 8.64 billion years
360 such days = 1 Brahma year = 3.11 trillion years
100 Brahma years = 311 trillion years,
the lifespan of the manifested universe before a reset

By comparison, the Earth is ~4.54 billion years old, and the observable universe is ~13.8 billion years old. The alignment of a Brahma “day” (4.32 billion years) with planetary and cosmic scales is scientifically striking, even if derived from symbolic reasoning rather than telescopes.

In modern physics, the Big Bang describes a hot, dense origin of space-time itself. Some cyclic models, such as conformal cyclic cosmology or oscillatory universes, propose repeated expansions and contractions — remarkably close in spirit to the ancient breath metaphor. Current evidence favors eternal expansion due to dark energy, but the cyclic concept remains mathematically viable.

This synthesis reveals more than coincidence: it shows that ancient Indian scholars, blending mathematics, cosmology, and psychology, encoded insights into a durable symbolic framework. The “breath of Vishnu” stands as both poetry and proto-science — a timeless bridge between human imagination and cosmic reality.

Mehak Mehan , 2nd Year (AIAE)

# FOUR DIVINE BEAST OF CHINA

Chinese mythology is diverse, with its figures ranging from the Jade Emperor, Nuwa (the goddess who created the earth and humans), to Sun Wukong (the Monkey King who traveled to the West). Today, we are talking about the Four Divine Beasts of Chinese mythology. These four creatures have various names, including "Four Guardians," "Four Gods," "Four Symbols," and "Four Auspicious Beasts." They are Azure Dragon (青龙), Vermilion Bird (朱雀), White Tiger (白虎), and Black Tortoise (玄武).

The Four Beasts represent the four cardinal directions (East, South, West, North). They are believed to guard the universe from chaos and imbalance from all four directions. But their representation is not only limited to direction—they are also associated with an element (Wood, Fire, Metal, Water), a season, and specific virtues. These beasts are believed to have existed since the immortal realm and to ward off evil in the human real.

The Azure Dragon is the protector of the East and is represented by the Wood element. It is often depicted in vibrant blue-green color, symbolizing spring and renewal. The Azure Dragon is believed to control rainfall and promote the growth of crops. It is often seen as a noble guard of life and vitality.

The Vermilion Bird resides in the South and is symbolized by Fire. Often portrayed as a radiant phoenix with fiery red feathers, it represents summer, passion, prosperity, and transformation. It is believed to purify the world of darkness by spreading light with its wings.

The White Tiger is a fierce and majestic beast that symbolizes strength, courage, and protection, and its white fur depicts purity. It stands as the guardian of the West, with Metal as its element. Linked to autumn and the harvest, its presence reflects order and justice in mortal society.

Lastly, the Black Tortoise watches over the North and is associated with the Water element. It is depicted as a tortoise entwined with a snake, which represents endurance, stability, and wisdom. With winter as its season and quiet as its personality, it is a powerful protector that holds vast knowledge.

Together, these Four Divine Beasts form the four Chinese Symbols, protecting the mortal world and universe from unseen dangers in Chinese mythology.

Sameeha Khan 2nd Year (AIAE), *Bhavya Soni 1st Year (AIAE)*

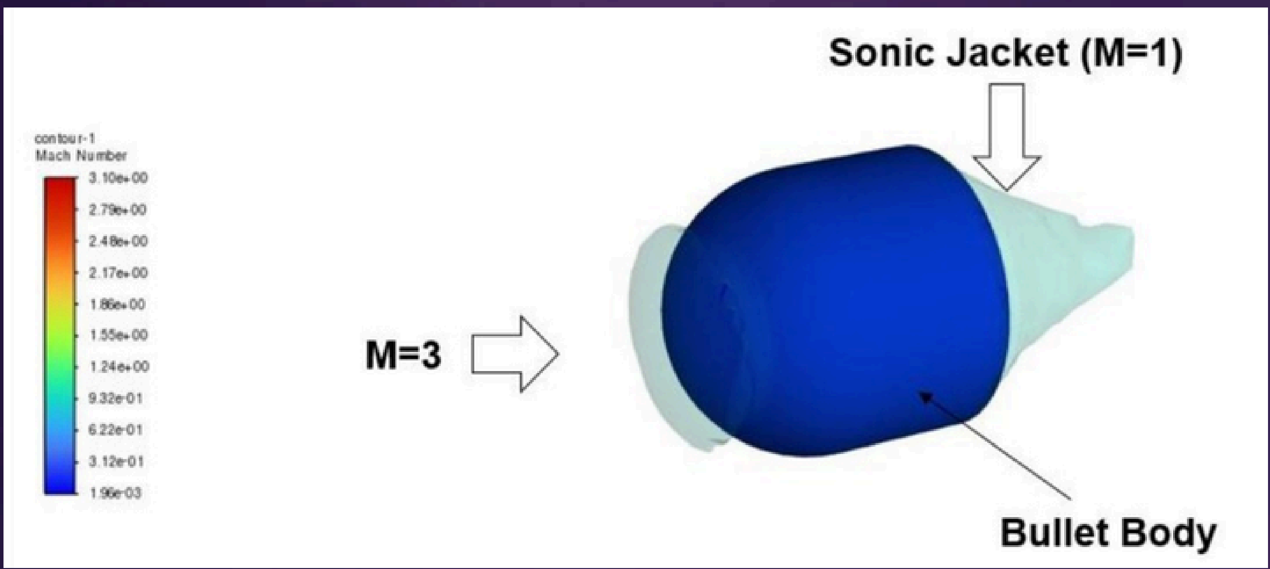
# SONIC RING : *The veil of Mach 1*

When an object races through the air at several times the speed of sound, the familiar rules of aerodynamics begin to break down. At these hypersonic velocities, air is no longer a smooth, invisible medium; it becomes a dense, reactive field of compressed gas, shock waves, and heat. In this extreme environment, researchers have uncovered a subtle but transformative phenomenon: the "Sonic Ring."

The Sonic Ring describes a region where the surrounding air reaches sonic conditions (Mach 1) not directly on the surface of a vehicle, but slightly away from it. Because all real fluids are viscous, the air just next to a solid body slows to zero velocity, forming what is known as the no-slip boundary layer. As we move away from the surface there lies a band of points where the airflow locally attains the speed of sound. Connecting these points forms a continuous ring, or in three dimensions, a "Sonic Jacket," that envelops the vehicle like an invisible acoustic shell.

This region is not just a curios event; it governs how energy and heat move around a vehicle traveling at hypersonic speeds. As the freestream flow turns around the body, it compresses and produces strong shock waves. These shocks generate entropy waves—disturbances that carry thermal energy—resulting in intense aerodynamic heating. The standoff distance of the Sonic Ring, or the gap between the vehicle surface and the Mach 1 contour, determines how close this high-entropy zone lies to the structure. A smaller standoff distance means the hot, compressed gas sits closer to the surface, amplifying heating and thermal stress.

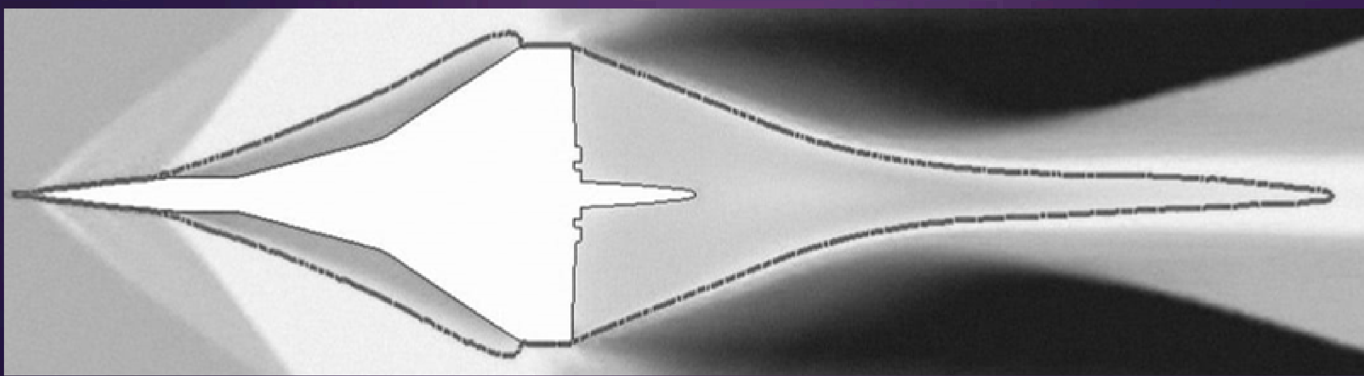
The physics behind this phenomenon are rooted in the principle of streamtube choking, where localized compression forces the flow to reach sonic conditions. This process, driven by variations in temperature, viscosity, and pressure ratio, defines the formation and stability of the Sonic Ring.

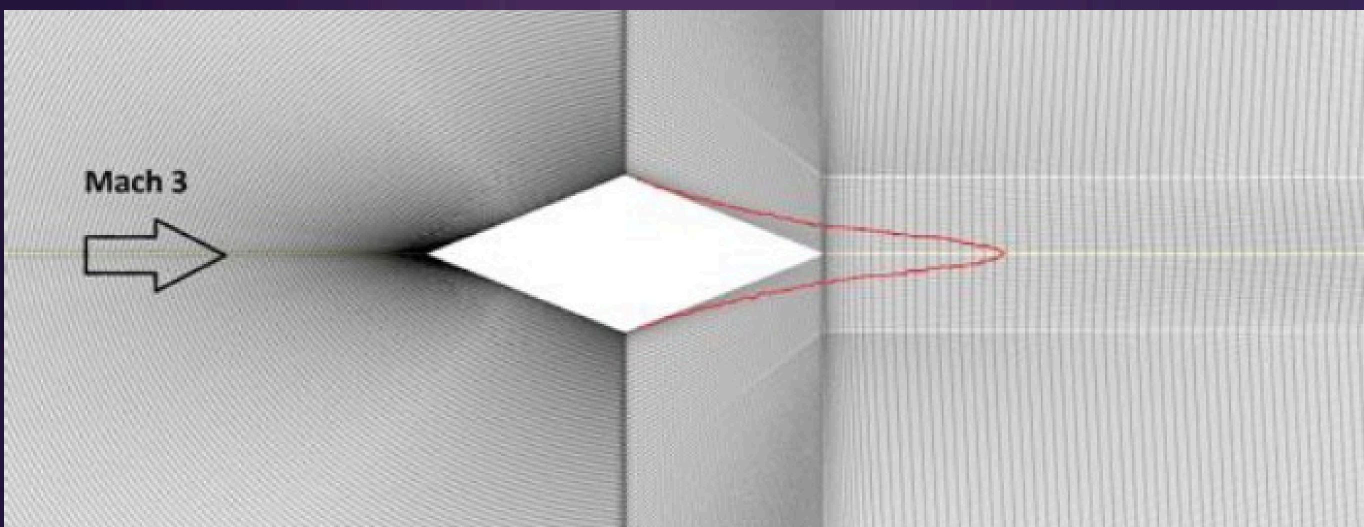


If the total-to-static pressure ratio exceeds a critical limit, the flow cannot accelerate further and “chokes,” creating a sonic barrier. Around this threshold, the ring manifests as a delicate transition zone between subsonic and supersonic regimes.

By manipulating the standoff distance through geometric shaping or by adjusting flow parameters such as gas composition or temperature, engineers could potentially control the position of the Sonic Ring. Moving it outward could expand the protective buffer of air between the hot, shock-dominated zone and the vehicle surface, reducing heat transfer and material stress. Bringing it closer might enhance lift and flow attachment, improving aerodynamic performance in certain regimes.

The Sonic Ring thus represents both a scientific insight and an engineering opportunity. It unites fluid mechanics, thermodynamics, and geometry into a single framework that explains how hypersonic vehicles interact with the air that resists them. Understanding the Sonic Ring could redefine how we design and protect vehicles in the unforgiving frontier of hypersonic flight.





Suraj Krishna, 5th year (AISST)

# INDIA'S CONTRIBUTION IN DEFENCE TECHNOLOGY

**From being an Import oriented country of critical technologies to developing advanced indigenous platforms. India came a long way, owing success to all project leaders such as Dr. A. P. J. Abdul Kalam, Dr. Homi J. Bhabha, Dr. Vikram Sarabhai, Dr. V. S. R. Arunachalam, and many more prominent personalities. The vision of Atmanirbhar Bharat (Self-Reliant India) and the Make in India initiative have accelerated this journey, ensuring that the country not only secures its borders but also contributes to global defence markets.**


**One of the most significant achievements is the development of indigenous missile systems in the famous IGMDP program. The Agni and Prithvi series established India's strategic deterrence, while the BrahMos supersonic cruise missile, developed jointly with Russia, is among the fastest and most precise in the world. The Akash surface-to-air missile further strengthens India's air defence.**

Fig: Dr. A. P. J. Abdul Kalam (above)
Dr. Homi J. Bhabha (Right)
Dr. Vikram Sarabhai (Extreme Right)

Suraj Krishna, 5th year (AISST)

In aerospace, the Tejas Light Combat Aircraft (LCA Mk1, Mk2 being built) showcases India's engineering excellence, while the Prachand Light Combat Helicopter is designed for high-altitude operations. Naval strength has been boosted with the INS Arihant, India's first indigenously built nuclear-powered submarine, and advanced warships like the INS Vikrant, the country's first indigenous aircraft carrier. ISRO further developed critical cryogenic technologies for it's series of launch vehicles which provides launching capabilities of military and research satellites at sustainable costs.

Anti-Satellite (ASAT) Tests were also tested to safeguard interests in space against enemy probes. AI, Laser technology, Sensor Fusion, Advanced platforms are being developed by DRDO, HAL, ISRO, Other PSUs, MSME startups, etc. TDF and iDEX platforms are there to promote research in the field. Defence exports are rising Rapidly showcasing India's Rise in the Defence Technology

Molly Dua, B.Sc Biotechnology (Honors/Research)

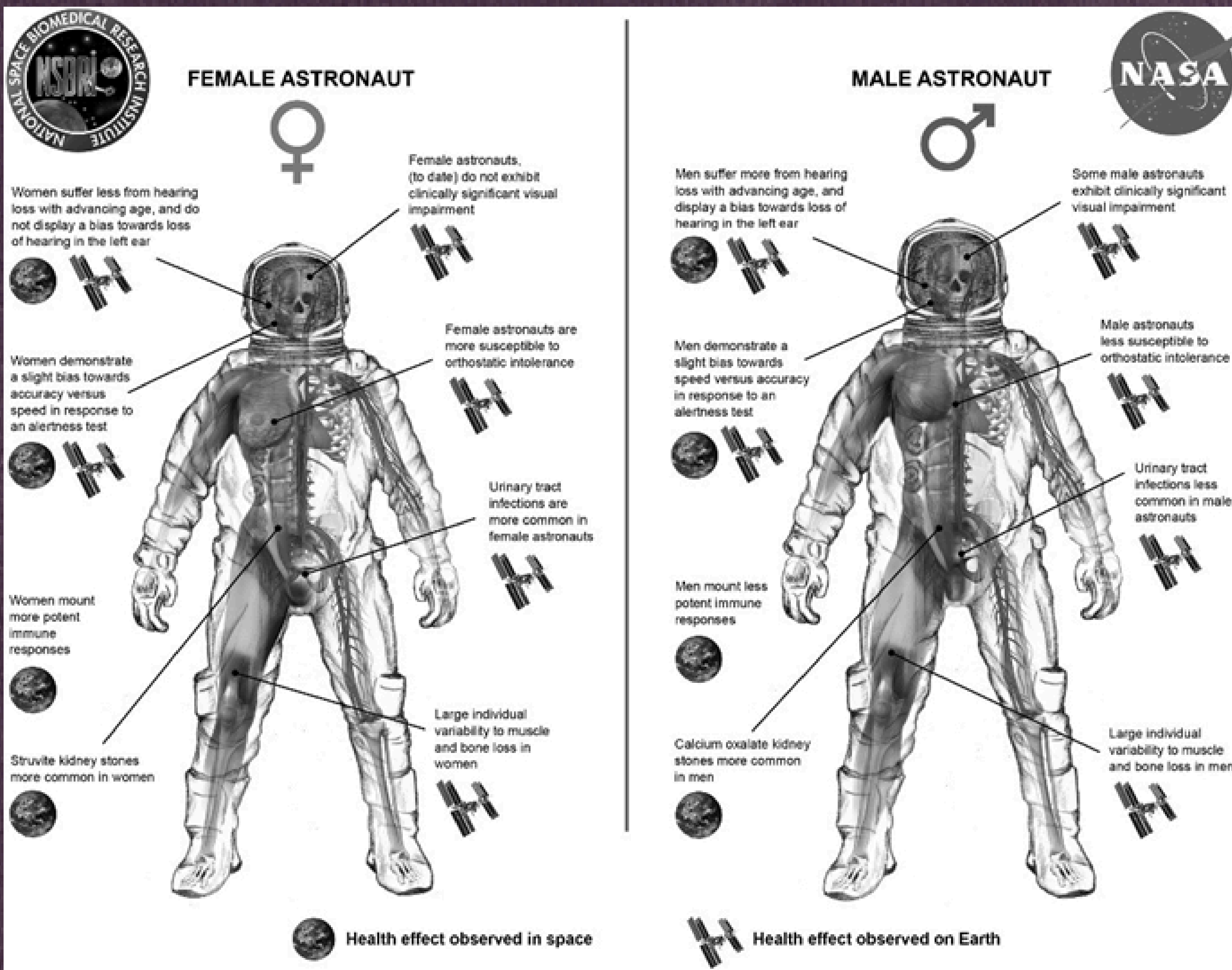
# *WOMEN IN STEM AND SCIENCE: THE SCIENCE WE STILL NEED*

Women make up only about 11-12% of all astronauts who have travelled to space. But that small percentage has made a huge impact. Women bring diversity in thought, background, and perspective- qualities that further humanity and technology. From Valentina Tereshkova, the first woman in space in 1963, to Christina Koch and Jessica Meir's all-female spacewalk, women have steadily shaped how we understand life beyond Earth through an arduous and groundbreaking journey. In recent years, research on women's health in space has been conducted to understand how microgravity and radiation affect the female body in physiological functions such as menstruation, fertility, hormone regulation and long-term health.

Of note, one study showed that the radiation exposure during deep-space travel can destroy some of a woman's primordial follicles. This could reduce ovarian reserves by almost 50%, affecting fertility. Researchers are now exploring ways to prevent this, through novel methods such as oestrogen replacement therapy, oocyte cryopreservation, and cortical tissue freezing- all of which can directly protect the reproductive health of our astronauts. Microgravity also affects the hypothalamic-pituitary-gonadal axis, disrupting ovarian function and reducing oestrogen production. This can disturb menstrual cycles and harm bone and cardiovascular health.

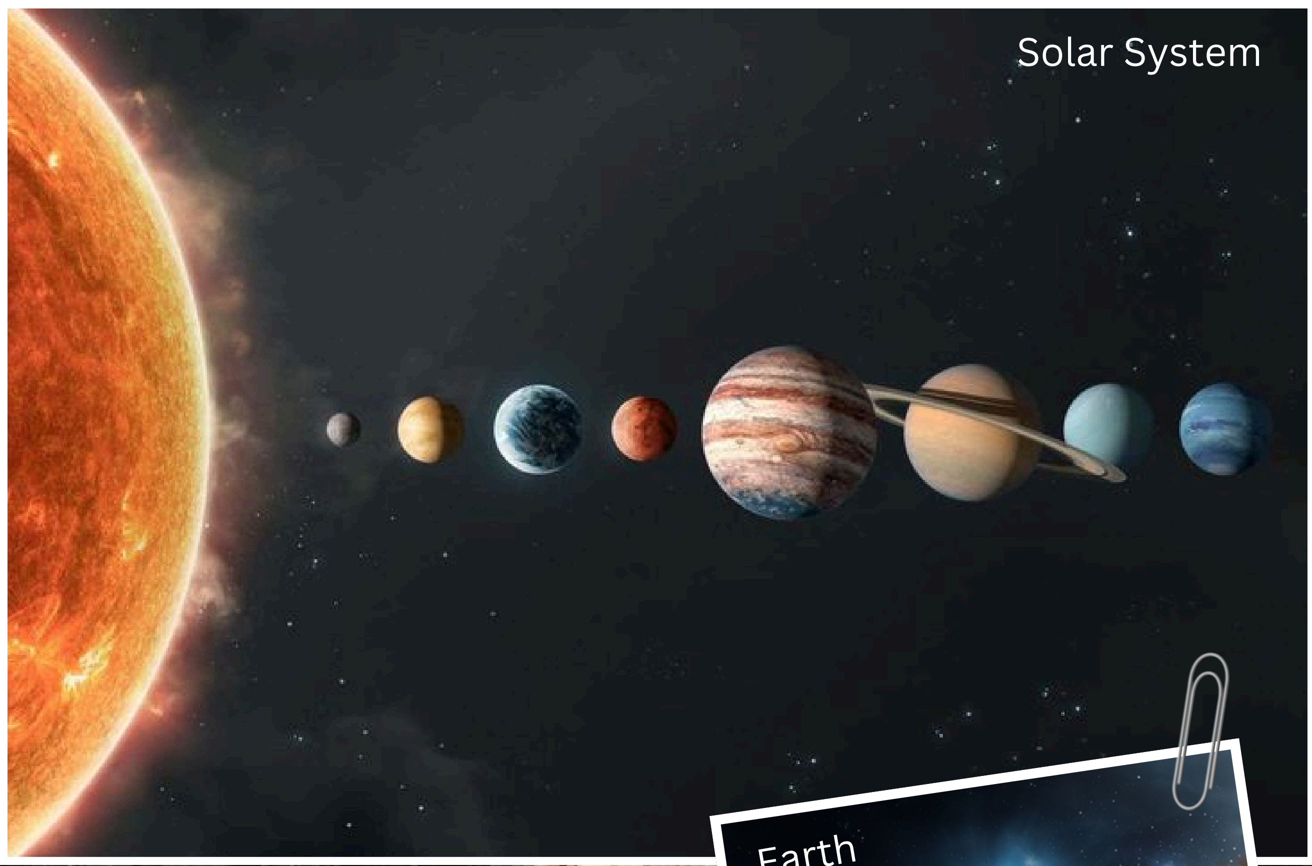
A recent mission of Blue Origin flight (New Shepard NS-31) with Amanda Nguyen furthered our understanding of womens' health. Nguyen, a bioastronautics research scientist and former MIT Media Lab Fellow, carried experiments from MIT's Women's Health Program (WHx), Space Exploration Initiative (SEI), Multifunctional Metamaterials Lab (MIT META), and Self-Assembly Lab into orbit. Her major focus included biological sciences and health. One of these projects was a wearable ultrasound patch - Conformable Ultrasound Breast Patch (cUSBr-Patch). This patch provides real-time imaging, helping track bone and muscle changes in women astronauts during space missions.

There's still a lot left to be ascertained about space's effects on female health but these studied lead the budding (Shockingly, yes) efforts. With each passing day, Women scientists and astronauts are building a more complete picture of what it means to be human, in STEM and in SPACE.




Key differences between men and women in cardiovascular, immunologic, sensorimotor, musculoskeletal, and behavioural adaptations to human spaceflight

Bhumika Rawat B.tech 3rd Year AIAE




# *Why Planets Wear Different Colours: A Scientific Diagnostic, Not a Cosmic Coincidence*




Images of planets often feel like postcards from space — Mercury’s dull grey, Venus glowing softly in yellow, Earth painted in blue and white, and Mars standing out in red. In reality, planetary colour is one of the most powerful clues scientists have to understand what a planet is made of, how its atmosphere behaves, and how it has evolved over time. Colour, in planetary science, is not decoration; it is information reflective of planetary habitation.

Mercury’s dark grey appearance is a direct result of exposure. With almost no atmosphere to protect it, sunlight strikes the surface unfiltered. Over billions of years, impacts from tiny meteoroids and constant solar radiation have altered the surface — a process known as space weathering — gradually darkening it and reducing its ability to reflect light.

fig - Jupiter(Hubble space telescope)

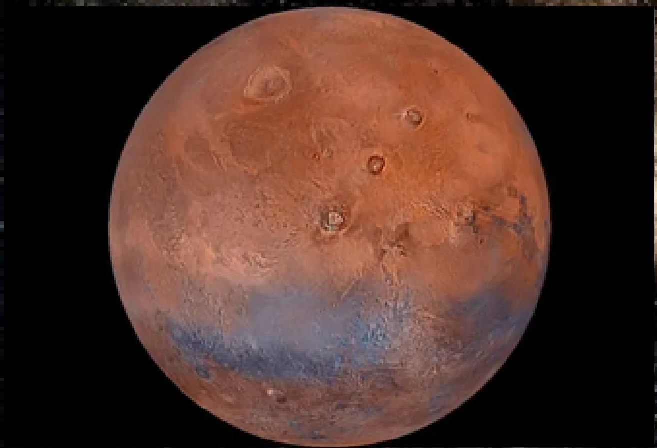


fig - Mars(NASA Gallery)

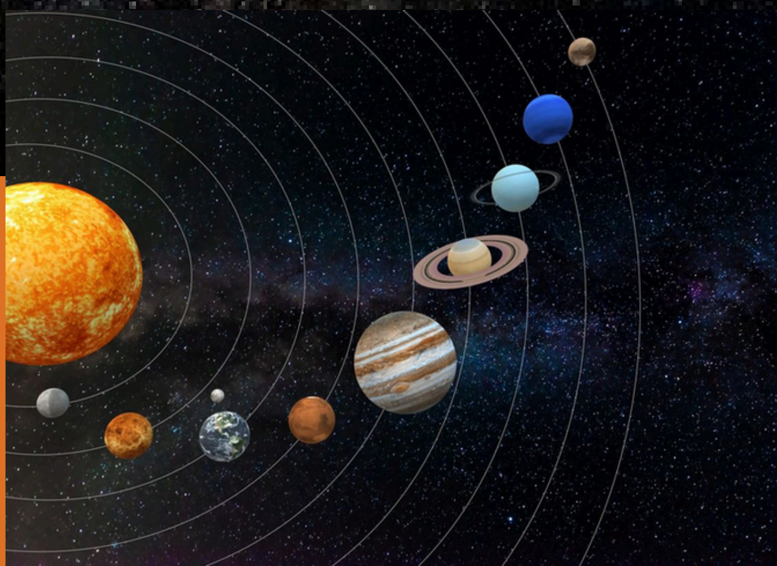
**Mars** is famous for its red hue, long associated with rust. The planet is coated in fine dust rich in iron oxides, formed through chemical interactions involving iron, oxygen, and small amounts of water in Mars's past.

**Venus** presents the opposite situation. Its surface is permanently hidden beneath an extremely thick blanket of clouds. The pale yellow or cream colour we see comes entirely from the way these clouds scatter sunlight.

**Earth's** colour is the most complex and dynamic in the Solar System. Blue tones arise mainly from the scattering of sunlight in the atmosphere, while oceans absorb red wavelengths, reinforcing the blue appearance. White clouds reflect large amounts of sunlight, constantly reshaping Earth's look. Because Earth's colour depends on liquid water, weather systems, and life itself, scientists consider it an important reference when searching for habitable planets beyond our Solar System.

fig - Venus(Magellan spacecraft)
a

**Jupiter and Saturn** display striking bands of yellows, browns, and reds. Uranus and Neptune owe their blue tones to methane gas, which absorbs red light. Saturn's moon Titan glows orange due to thick organic smog formed by reactions between methane and nitrogen high in its atmosphere.

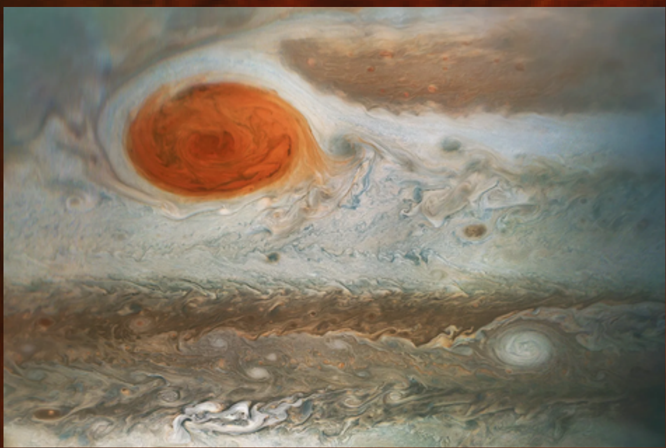


Despite decades of exploration, planetary colour remains an active area of research. A larger question emerges: how much of a planet's history, chemistry, and even potential habitability can be decoded from colour alone?

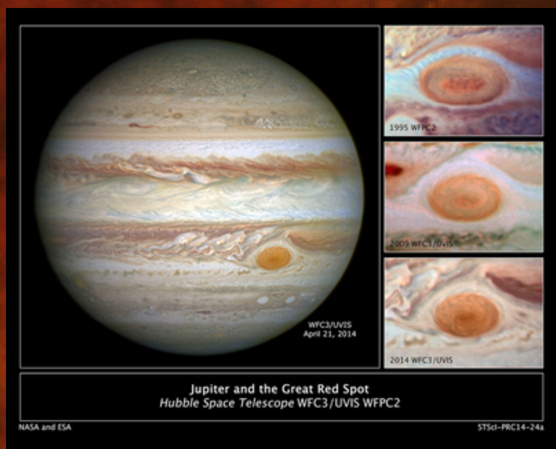
Anushka Singh, NIT Calicut, B.tech Chemical Engineering

# EXTREME PLANETARY ATMOSPHERES

On Earth, weather feels intuitive. Warm air rises, winds respond to pressure differences, and storms evolve over days. Yet across the Solar System, atmospheres exist in conditions so extreme that these familiar ideas entertain scrutiny. Pressures can exceed those at the bottom of the Earth's oceans, temperatures can melt lead, and storms can persist for centuries. (Yadav et al. 2024) Studying such atmospheres is not just an exercise of curiosity, but rather it is central to understanding planetary evolution, climate stability, and the environments of worlds beyond Earth. (Read & Lebonnois)



NASA JPL – Jupiter's Great Red Spot (enhanced color from Juno)




NASA Hubble full-disk storm view

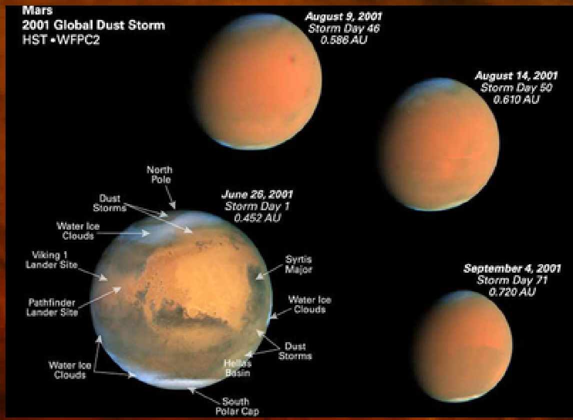
## JUPITER: WEATHER WITHOUT A SURFACE:

Jupiter's atmosphere is a striking example of atmospheric physics. (Ingersoll et al.) Composed primarily of hydrogen and helium, it lacks a solid surface and extends deep into the planet, transitioning from cold upper layers to hot, dense regions thousands of kilometres below. Unlike Earth, Jupiter emits more energy than it receives from the Sun, and this internal heat drives vigorous convection throughout the atmosphere. This energy sustains powerful east-west jet streams and massive vortices, including the Great Red Spot, which has persisted for centuries. (Yadav et al. 2024)

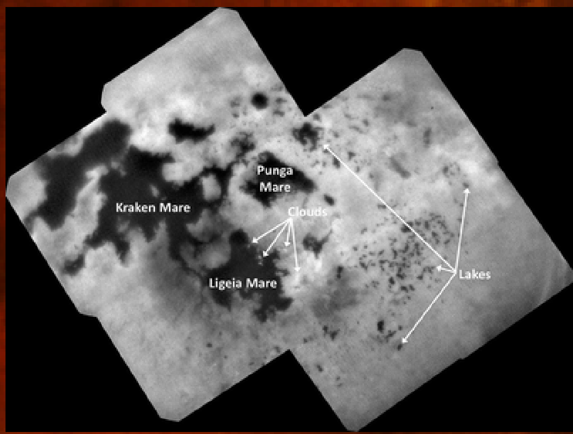
Modern models of Jupiter's atmosphere treat it as a fully compressible system, coupling fluid motion with radiative transfer and chemistry across pressures spanning many orders of magnitude. (Yadav et al. 2024) These studies show that vertical momentum transport and wave-mean flow interactions allow storms to remain stable far longer than terrestrial weather systems — a reminder that "weather" behaves very differently when gravity, rotation, and energy input are pushed to extremes.

## OTHER WORLDS, OTHER EXTREMES

Mars, however, presents an opposite case. (Haberle et al.) Its thin carbon-dioxide atmosphere has little thermal inertia, allowing rapid temperature swings and planet-encircling dust storms. Anyone who has felt dust lifted easily on a windy day can appreciate how, on Mars, even weak winds can mobilize fine particles and reshape the climate.




Titan, Saturn's largest moon, feels strangely familiar yet alien. Its dense nitrogen atmosphere supports clouds, rain, and lakes — not of water, but of methane. (Lorenz et al.) The same physical principles that govern Earth's hydrological cycle operate here, simply with different working fluids and temperatures.




Saturn's atmosphere, though similar in composition to Jupiter's, is colder and less massive. (Ingersoll et al.) It still hosts deep convection, strong zonal winds, and episodic global storms, highlighting how internal heat and rotation continue to shape atmospheric behaviour across gas giants.

## BEYOND THE SOLAR SYSTEM

Observations and models of hot Jupiter exoplanets show that intense stellar radiation can heat upper atmospheres enough to drive large-scale atmospheric escape. (Khodachenko et al. 2024)

These extreme cases extend the lessons learned from our Solar System and provide context for interpreting the growing diversity of planetary atmospheres detected around other stars.

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