

# Dreamarks

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E-MAGAZINE



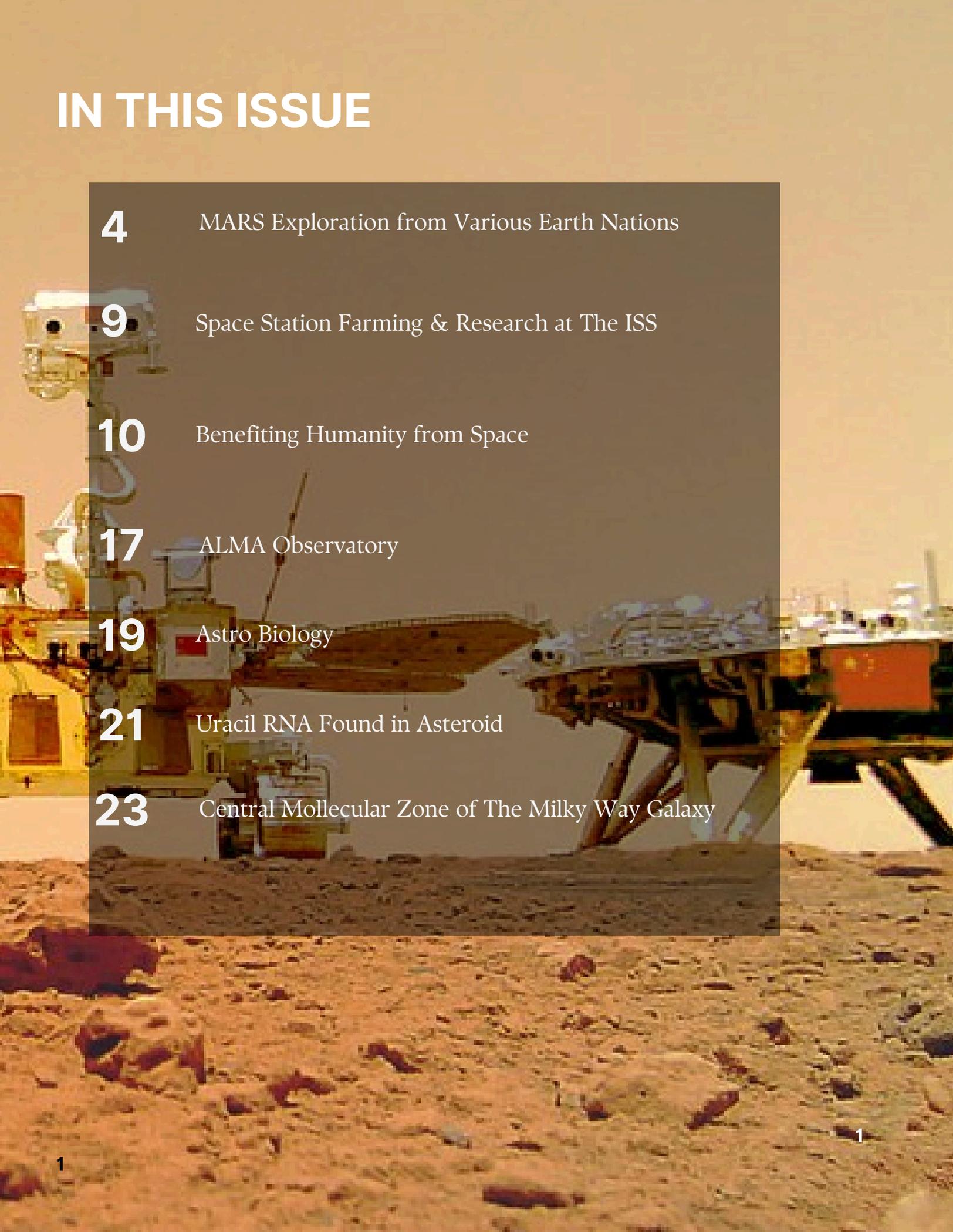
Unravel The Mystery of the Crimson Sphere

Astro Biology &  
Chemical Trace at  
The Deep Space



Helping Humanity  
From Space Research

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# Dreamarks Magazine

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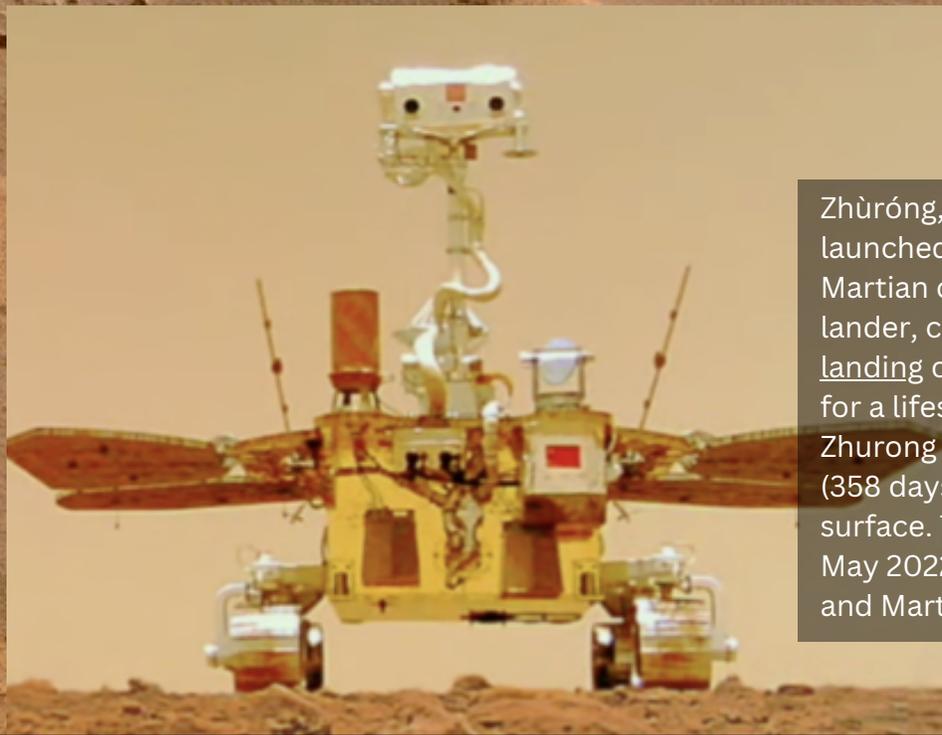
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Zhùróng, rover from Tianwen-1 mission launched on 23 July 2020 and inserted into Martian orbit on 10 February 2021. The lander, carrying the rover, perform a soft landing on Mars on 14 May 2021. Designed for a lifespan of 90 sols (93 Earth days), Zhurong was active for more than 347 sols (358 days) after its deployment on Mars's surface. The rover became inactive on 20 May 2022 due to approaching sandstorms and Martian winter.

## The Evolving Deep Space Universe

When we saw a burst of light shone at the sky, not many of us realizes that it was a sign of death of a star that was brightly sent through the deep space, which was happening more than 6 billion lightyears afar. This was called as Hypernova, a forming of new blackhole from previously a bright star, that has probably lived for trillions of years ago, but the sending of the emitted lights has just caught by our eyes, thanks to the eternal light processes that shone flaming through the black vasts of empty exospaces.

The Universe keep on evolving, and now space scientist has found various form of astro biology subtrates and chemical molecular reactions that are processes when a new protoplanetary system are forming. The Discovery was made since 2013 by ALMA Scientist (Atacama Large Millimeter/Submilimeter Arrays) Telescope Sets, in Chile. Parts of The European Space Organizations (ESO) that also working together with NASA and Japan Space Agency, and Funded by National Research Center of Kanada, National Space Science of Taiwan, and Korea Astronomy & Space Science Institute (KASSI).

The 66 Antennas at ALMA was highly enabling the scientist to detect and explore the deep space and managed to captured images from Central Mollecular Zone (CMZ) of the Milky Way, the vast Galaxy where planet Earth exist, with the accuracy of millimeter and submillimeter, equipped for capturing nano images such as microbes and molecular structures. With these groundbreaking tools, many inventions can now be made from the space explorations that has been done since exactly one centuries ago since the first rocket was launched by Robert H. Goddard.

*Gina M. Almi*

**Editor-in-Chief**

# MARS EXPLORATION

## *Challenges That Built History*

**For more than 60 years, NASA has pursued answers to one of the biggest questions in science: Was — or is — Mars a habitable world?**

"Each new lander or rover mission has presented new landing-system design challenges not faced by the ones that came before," said Rob Manning, an engineering fellow at NASA's Jet Propulsion Laboratory in Southern California. Manning has worked on all NASA Mars rovers and landers since Pathfinder in 1997.

"The Viking team had minimal landing-site information before sending the spacecraft to Mars. After their success, the next challenge was lowering the costs, which spawned the idea of using air bags for Mars Pathfinder, and that success then also enabled the Spirit and Opportunity rovers to land," he said.

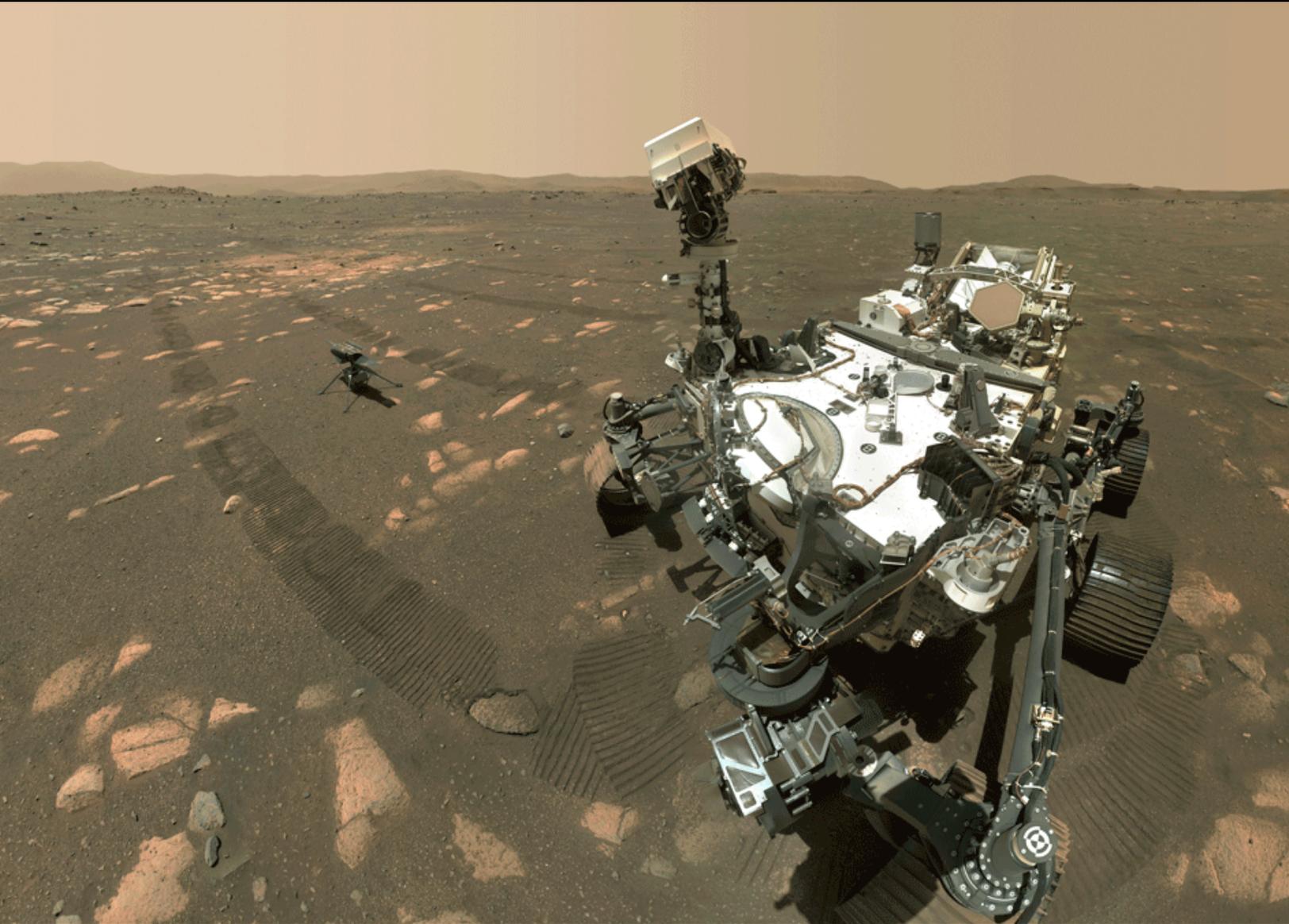
After that, for Curiosity and Perseverance, "bigger rovers with grander capabilities, we had to invent the sky crane maneuver, and then new navigation techniques that enabled us to land at sites previously considered too risky."

When choosing a landing site, scientists conduct a rigorous pre-launch process to identify a location with terrain safe for landing, but with the right features to address mission goals of science discovery and help pave the way for future robotic missions, and potentially, future Mars astronauts.

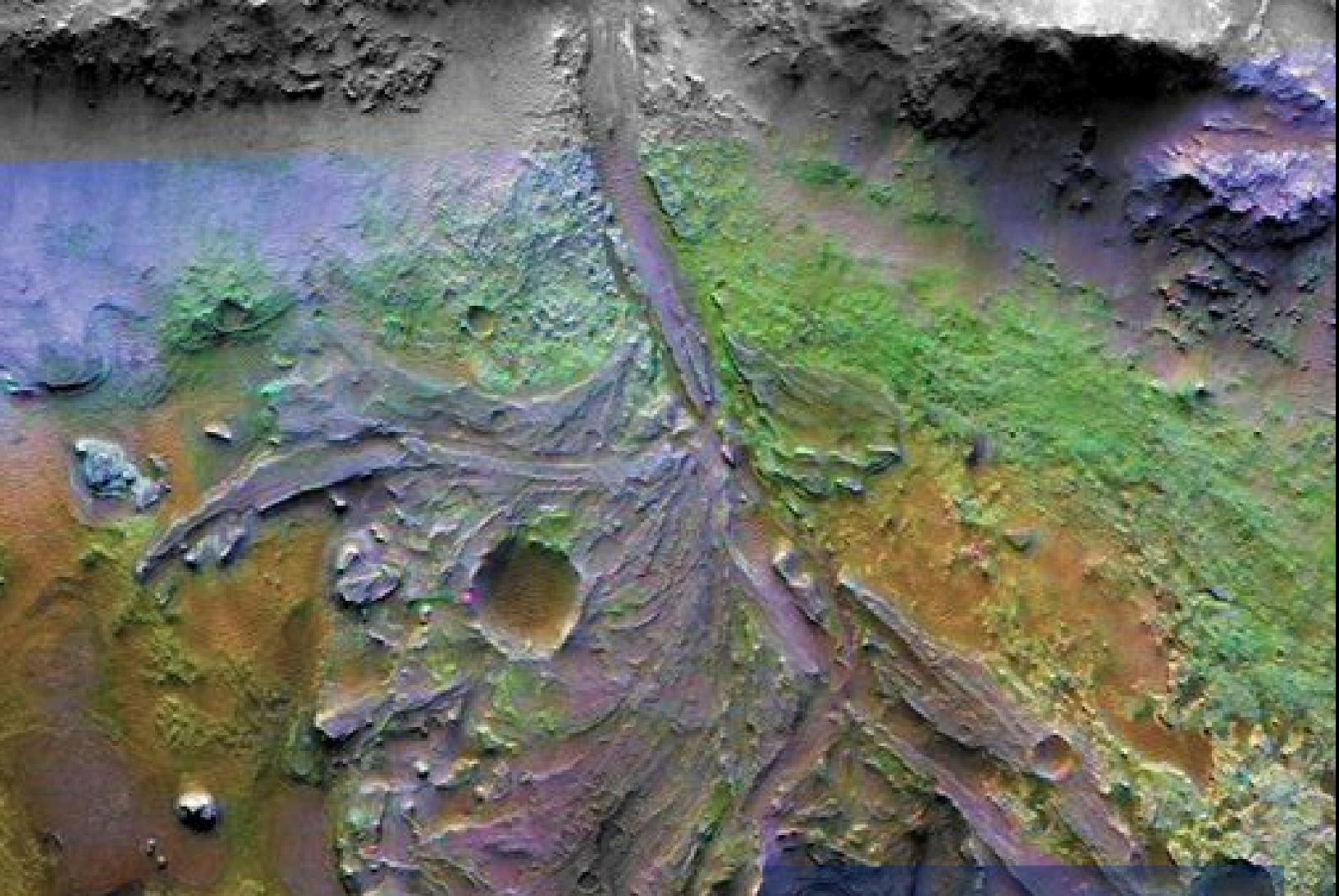
# PERSEVERANCE

*The Fastest Rover Explorer at Mars*

NASA's Perseverance Mars rover took a selfie with the Ingenuity helicopter, seen here about 13 feet (3.9 meters) from the rover in this image taken April 6, 2021, the 46th Martian day, or sol, of the mission by the WATSON (Wide Angle Topographic Sensor for Operations and eNginEering) camera on the SHERLOC (Scanning Habitable Environments with Raman and Luminescence for Organics and Chemicals) instrument, located at the end of the rover's long robotic arm (Image credit: NASA/JPL-Caltech/MSSS)

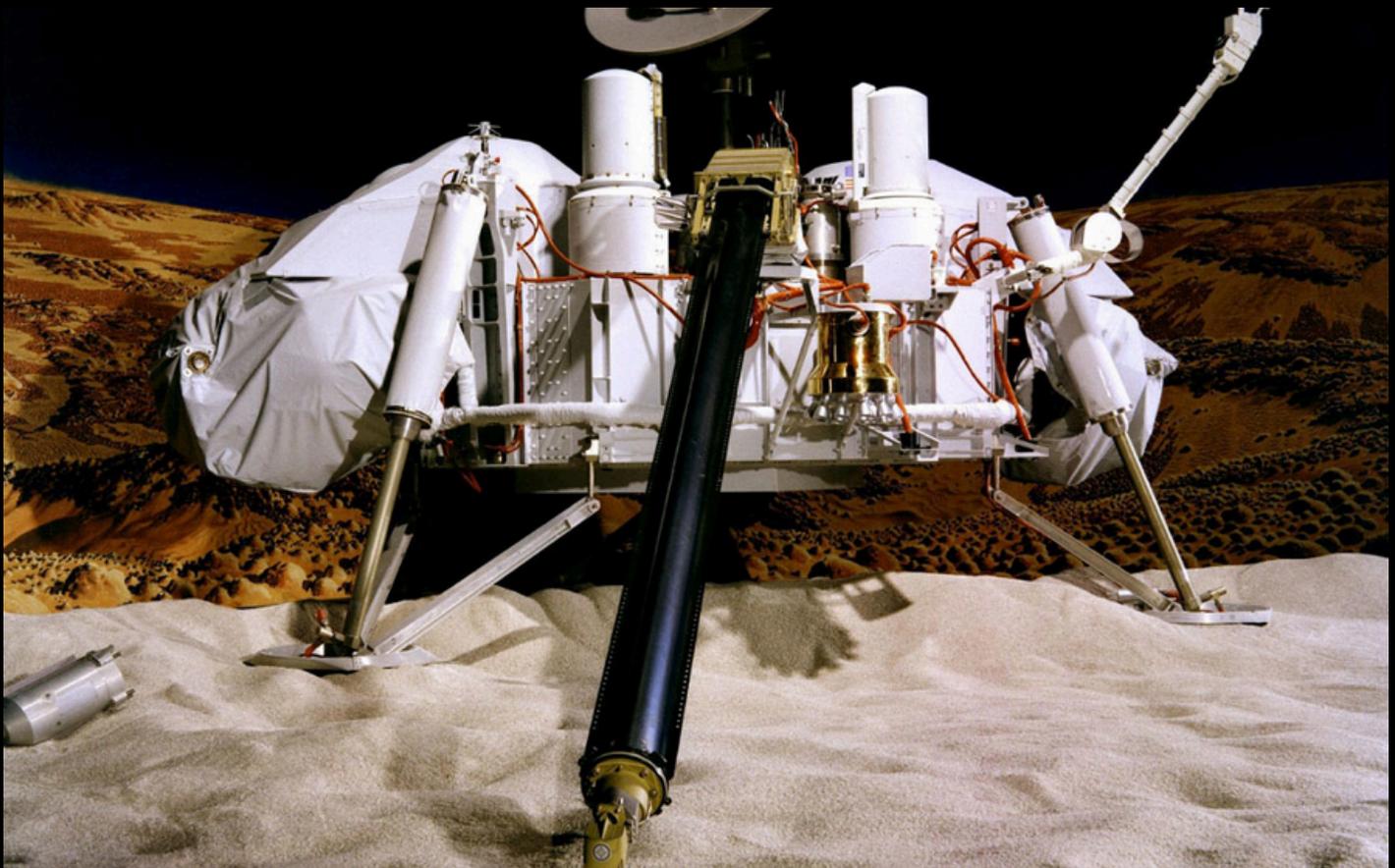


[Perseverance rover — Everything you need to know | Space](#)



Mars 3 was a robotic space probe of the Soviet Mars program, launched May 28, 1971, nine days after its twin spacecraft Mars 2. The probes were identical robotic spacecraft launched by Proton-K rockets with a Blok D upper stage, each consisting of an orbiter and an attached lander.

After the Mars 2 lander crashed on the Martian surface, the Mars 3 lander became the first spacecraft to attain a soft landing on Mars, on December 2, 1971. However, it failed 110 seconds after landing, having transmitted only a gray image with no details.[4] The Mars 2 orbiter and Mars 3 orbiter continued to circle Mars and transmit images back to Earth for another eight months



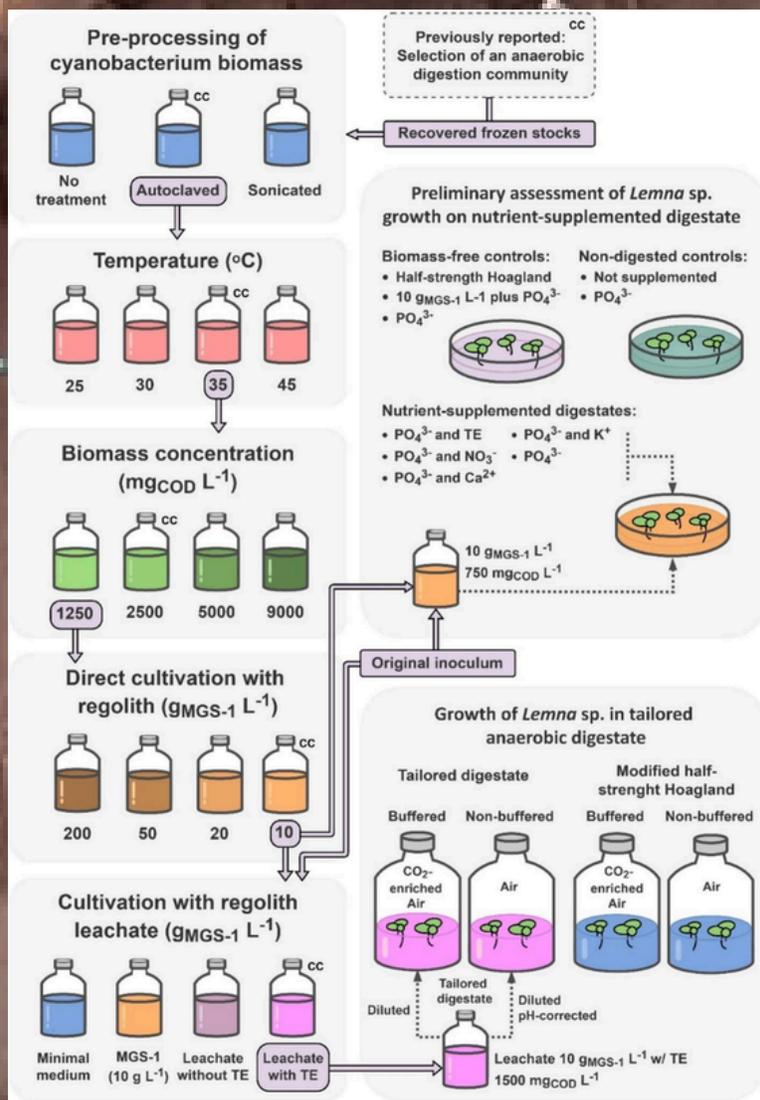
The twin Vikings were the first two U.S. spacecraft to land safely on Mars. Each was transported separately to the Red Planet by its own orbiting spacecraft, which released the lander it was carrying when it was time to begin the landing process.

Both landers touched down north of the Mars equator, with Viking 1 in Chryse Planitia, and Viking 2 in Utopia Planitia. Renowned astronomer Carl Sagan helped choose the landing sites. Viking 1 landed on Mars on July 20, 1976, followed by Viking 2 on Sept. 3, 1976.

Each Viking had three triangular leg structures. Each leg was configured as an inverted tripod with three struts, and a skirted footpad. Once each orbiter was safely in orbit around Mars, the orbiter dropped the lander, and lifting aeroshells helped lengthen the entry, descent, and landing timeline.

To slow the descent, the Vikings used the same type of parachutes we still use on Mars missions. Liquid-fueled, adjustable rocket engines were used for the final descent, while Doppler radars controlled the speed at crucial points in the landing process.

The Vikings' successful landings created a heritage adapted for future landers. While Mars Phoenix and Mars Insight appear to be closest to the Vikings' heritage, all the subsequent NASA Mars landers have been heavily influenced by the Viking design — from entry (heat shields), to descent (parachutes), terminal descent (radars), and landing.



A settlement on Mars would need to be self-sufficient in food production, but crop farming is constrained by the availability of local resources. Producing fertilizer through the anaerobic digestion of cyanobacterial biomass—cultivated using Martian resources such as regolith, water, sunlight, and atmospheric gases (N<sub>2</sub>, CO<sub>2</sub>)—offers a promising solution. The present study aimed to characterize and improve this process and assess the suitability of the resulting carbon-depleted digestate for crop hydroponics. Several process parameters were studied: biomass pre-processing (no treatment, sonicated, autoclaved); operational temperature (25, 30, 35, 45 °C); and substrate concentration (1250, 2500, 5000, 9000 mg COD L<sup>-1</sup>). Autoclaving and 35 °C maximized organic carbon removal. Substrate concentration tests established a linear correlation between biomass input and ammonium output. Martian regolith simulant (MGS-1) was tested as a mineral nutrient source for anaerobic digestion, both when added directly to cultures (10, 20, 50 and 200 g L<sup>-1</sup>) and as a 10 g L<sup>-1</sup> leachate, with and without trace element supplementation. The leachate supplemented with trace elements enabled the highest recovery of phosphate, ammonium, and methane. The bacterial and archaeal communities were characterized throughout testing to assess the contribution of specific taxa to digestion performance. The digestate supported the growth of a candidate space crop, *Lemna* sp., yielding 27 g wet mass per g of cyanobacterial dry mass (roughly half the yield on a standard medium). These findings advance the development of in-situ fertilizer production for sustainable crop farming on Mars.

# Space Stations Farming

A photograph of two NASA astronauts, Jessica Watkins in the foreground and Bob Hines in the background, both wearing blue flight suits. Jessica is wearing clear safety goggles and looking towards the camera with a slight smile. Bob is looking down at a tray of green leafy plants, likely lettuce, which are growing in a hydroponic system. The background shows the interior of a space station with various equipment and structural elements.

NASA astronauts Jessica Watkins, front, and Bob Hines, back, work on XROOTS aboard the International Space Station. This experiment used the station's Veggie facility to test soilless hydroponic and aeroponic plant growth.

NASA

As NASA prepares to return humans to the Moon through the Artemis program and push onward to Mars, sustaining life beyond Earth is more critical than ever.

- Astronauts have grown more than 50 species of plants in space, including tomatoes, bok choy, romaine lettuce, and chili peppers.
- Advanced life support systems are capable of recycling up to 98% of water in the U.S. segment aboard the space station, the ideal level needed for exploration missions.
- Crew health data shows how space affects the brain, vision, balance and control, and muscle and bone density, guiding strategies to maintain astronaut performance during extended missions and improve health on Earth.
- Researchers have sequenced DNA in orbit and are advancing techniques to enable real-time assessment of microbial life in space, which is essential to maintaining astronaut health.

Why this matters:

By growing food, recycling water, and improving medical care in space, NASA is paving the way for future long-duration missions to the Moon and Mars while revolutionizing agriculture and medicine back home.

# HELPING HUMANITY FROM SPACE

Research aboard the orbiting laboratory not only pushes humanity farther into the cosmos but can help address complex human health issues on the ground. By providing a platform for long-term microgravity research, the space station fosters breakthroughs that yield direct benefits to people on Earth.

- Research aboard the space station provides new insights to develop treatments for diseases like cancer, Alzheimer's, Parkinson's, and heart disease by revealing how microgravity alters cellular functions.
- New developments in medicine for cancer, muscular dystrophy, and neurodegenerative diseases have come from growing protein crystals in microgravity with larger, more organized structures.
- High quality stem cells can be grown in greater quantities in space, helping to develop new regenerative therapies for neurological, cardiovascular, and immunological conditions.
- Pioneering efforts in 3D bioprinting, which uses cells, proteins, and nutrients as source material, have produced human tissue structures such as a knee meniscus and heart tissue, a major step toward manufacturing organs in space for transplant patients on Earth.
- Researchers are using miniaturized tissue models to observe how space affects tissues and organ systems, offering new ways to develop and test medicines to protect astronauts on future missions and improve treatments on Earth.
- Photos taken by astronauts have supported emergency response to natural disasters, such as hurricanes, with targeted views from space.
- Instruments mounted on the space station protect critical space infrastructure and provide data on the planet's natural patterns by measuring Earth's resources and space weather.

Why this matters:

Microgravity research is moving us closer to manufacturing human organs in space for transplant and revealing new ways to fight cancer, heart disease, osteoporosis, neurodegenerative disease, and other serious illnesses that affect millions of people worldwide. The station also serves as an observation platform to monitor natural disasters, weather patterns, and Earth's resources.

# Crystallizing Proteins in Space Station Laboratory

Determining the protein structure by X-ray diffraction requires the diffraction pattern from a protein crystal. The better a crystal diffracts X-rays, the more accurately this method can determine the structure of the protein. Since 2005, the Kristallizator program from the State Space Corporation (ROSCOSMOS) has created single protein crystals especially suited for this analysis. Growing the crystals in microgravity significantly improves their quality and allows for greater three-dimensional resolution during analysis.

One outcome of the Kristallizator studies has been the growth of crystals that helped determine the structure of a target for anti-tuberculosis drugs. According to the U.S. Centers for Disease Control, more than 1 million people die from tuberculosis annually. It is difficult to treat because tuberculosis bacteria quickly adapt to medications.

This ROSCOSMOS study revealed that the channel in the center of the molecule where the components of the reaction are bound changes its diameter during the reaction. Understanding this process could help scientists develop a treatment. PCG research from many countries is showing promise for creating medications and treatments for a variety of diseases, including Duchenne Muscular Dystrophy (DMD), a currently incurable genetic disorder.

A Japan Aerospace Exploration Agency (JAXA) study of the crystal structure of the protein associated with DMD provided hints for compounds that could inhibit it. Yoshihiro Urade, professor at the University of Tsukuba in Tsukuba, Japan, used those hints to design several promising compounds, including TAS-205. A 2015 study verified the safety of TAS-205 for use in humans, and a clinical trial in human patients was completed in 2017. The research team estimates the drug may slow the progression of DMD by half, potentially doubling the lifespan of many patients.

# Nitric Oxide Analyzer



*Former European Space Agency (ESA) astronaut Thomas Reiter undertakes science activities for the Nitric Oxide Analyzer experiment in 2006.*

*Image credit: ESA*

Nitric oxide, or nitrogen monoxide, as it is properly called, is both a good and bad molecule, found almost everywhere as an air pollutant that is produced by vehicle exhaust and industrial processes burning fuel. Nitric oxide is a contributor to the damage of the ozone layer and easily converts into nitric acid—which may fall as acid rain. Intriguingly, tiny amounts of nitric oxide are released locally in inflamed tissue of humans and other mammals.

Tracing it back to its source can reveal different diseases. Former European Space Agency (ESA) astronaut Thomas Reiter undertakes science activities for the Nitric Oxide Analyzer experiment in 2006. Image credit: ESA A lightweight, easy-to-use device monitors levels of asthma control leading to more accurate medication dosing, reduced attacks, and improved quality of life. In people with asthma, inflammation in the lung adds nitric oxide to exhaled air. Measuring the gas can help to diagnose the disease and may prevent attacks if the levels of nitric oxide indicate that medication should be adjusted. Nitric oxide is also an interesting molecule on the space station.

Dust and small particles floating around in weightlessness can be inhaled by the astronauts, possibly triggering inflammation of the airways. It also plays a role in decompression sickness that may arise from spacewalks. The European Space Agency (ESA) uses a lightweight, easy-to-use, accurate device for measuring nitric oxide in exhaled air.

The aim is to investigate possible airway inflammation in astronauts and act before it becomes a health problem. Following its development by the Swedish company Aerocrine AB and ESA, the device has been found beneficial in space exploration and everyday use on Earth. NIOX MINO® is now used by patients at health centers. They can monitor levels of asthma control and the efficiency of medication—leading to more accurate dosing, reduced attacks and improved quality of life

# Plasma Crystal Experiment

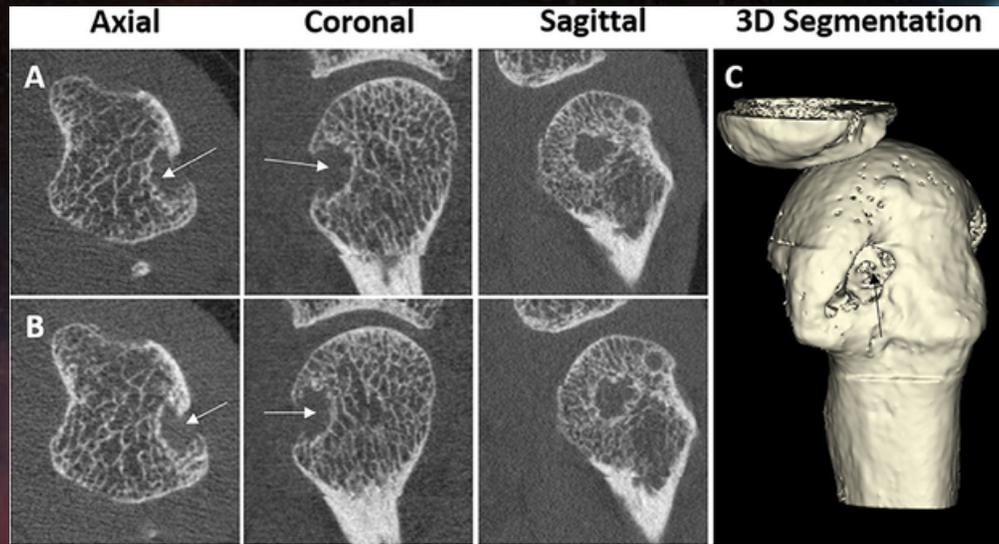
**A unique form of matter could help disinfect wounds, neutralize bacteria, help people heal faster, and even fight cancer—and its potential for human health is now well understood, thanks to research on the International Space Station. The microgravity environment provides a powerful method for studying plasmas, one of the four states of matter along with liquid, solid and gas. The Plasma Kristall Experiment (PK-3 Plus) lab, a Russian-German collaboration, provided new insight into an unusual type of matter known as plasma crystals.**



*Russian cosmonaut Oleg Kotov, Expedition 30 flight engineer, inspects the Plasma Kristall Experiment laboratory, enclosed in black housing, in its new home in the Poisk Mini-Research Module 2 of the International Space Station.  
Image credit: RKK-Energia*

Plasma studies reveal applications to disinfect chronic wounds, neutralize bacteria, boost tumor inactivation, and jumpstart plant growth. Because it is a charged gas, plasma can permeate many materials, spreading evenly and quickly. It can disinfect surfaces, and has been proven to neutralize drug-resistant bacteria like methicillin-resistant *Staphylococcus aureus* within seconds. In more than 3,500 examples in several clinical trials, physicians found plasmas can disinfect chronic wounds and help wounds heal faster. Other research has shown that along with chemotherapy, plasma treatment efficiently fights cancer; it can boost tumor inactivation by 500 percent, compared with just chemotherapy. Plasmas can even jumpstart plant growth. For the researchers involved in PK-3, the technical challenges of space-based research provided the knowledge base for the medical spin-offs, according to Professor Gregor E. Morfill, director at the Max Planck Institute for Extraterrestrial Physics in Garching, Germany. Without space station research, some team members would never have been involved in plasma medicine. The PK-3 lab was designed to study complex or “dusty” plasmas, which get their name from the presence of small, solid particles mixed into the plasma’s charged gases. These particles can dramatically change the behavior of a plasma, and sometimes the particles even form crystalline structures. Dusty plasmas are found near artificial satellites, occur in Earth’s upper atmosphere, and can be produced in lab settings. Physicists favor them because they are relatively easy to control and provide a unique view of physics at the single-particle level. But they can be difficult to study on Earth, because the planet’s gravity affects the way dust particles settle and how they crystallize. This isn’t the case on the space station, however. Investigations with PK-3 Plus created dusty plasmas containing argon or neon gas as well as micron-size particles. The gas molecules received an electric charge so they would ionize and form a plasma, and then particles were injected into it. A laser lit up the sample while a camera recorded the particles moving through the plasma and organizing themselves in crystal structures.

# 3D Peripheral Quantitative Computed Tomography Bone Scanner

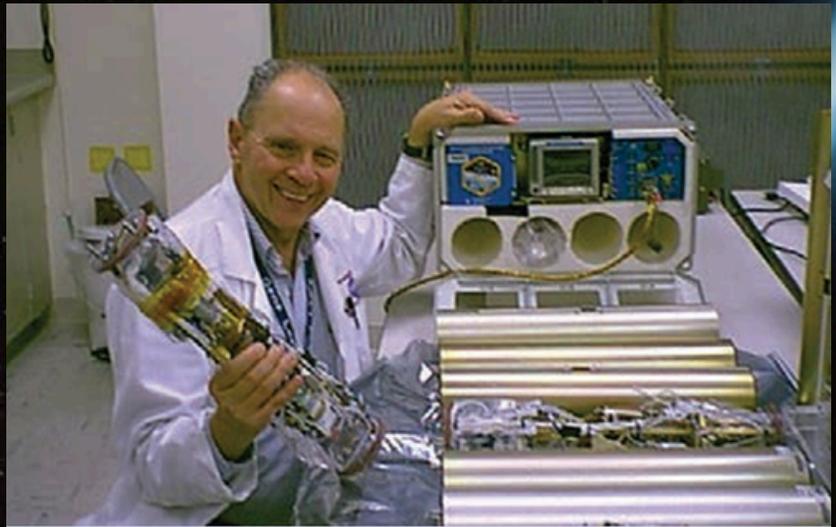


ESA's Early Detection of Osteoporosis in Space (EDOS) experiment has been testing skeletal adaptation to long-term space exposure by using 3-D peripheral quantitative computed tomography (3DpQCT) as a technique for detection of bone structure. It has been providing a detailed evaluation of the bone loss and Early detection of osteoporosis, and the development of more effective treatments, link astronauts to patients on Earth. Xtreme CT distal radius.of kinetics of recovery after flight. ESA supported the development of the enhanced 3-D scanner by the Institute for Biomedical Engineering in Zürich and Scanco Medical as part of ESA's Microgravity Applications Programme (MAP).

The scanner is providing high-quality, 3-D images of living bone structures as part of this ground experiment. This is backed up by analysis of bone biochemical markers in blood samples. One important element that has derived from this research into bone loss in space is the successful commercialisation of the 3DpQCT scanner, of which ESA supported the development, for a non-invasive/in vivo technique for observation of bone structure.

The EDOS project has been assessing the efficiency of such a technique and will contribute to the development of a reference technique to perform an early detection of osteoporosis on Earth in a unique way. These improved diagnostics in the early stages of such a medical condition may prove extremely important in development of more effective countermeasures to the effects of osteoporosis. In 2006, according to the International Osteoporosis Foundation, 8.9 million fractures were estimated worldwide. The project will continue within the EDOS-2 project, which will commence in collaboration with Russia in spring 2015 in conjunction with the first one-year mission.

# Micro Encapsulation Electrostatic Processing Systems



*Dr. Dennis Morrison poses with the Microencapsulation Electrostatic Processing System flight hardware that was used on the International Space Station to produce microcapsules for cancer treatment delivery.*

*Image credit: NASA*

Using the distinctive, microgravity environment aboard the International Space Station, a particular series of research investigations is making further advancements in cancer therapy. A process investigated aboard the space station known as microencapsulation is able to produce tiny, liquid-filled, biodegradable micro-balloons containing specific combinations of concentrated anti-tumor drugs. Using specialized needles, doctors could deliver these micro-balloons, or microcapsules, directly to specific treatment sites within a cancer patient, effectively revolutionizing cancer treatment. The microgravity environment has allowed for the development of devices on Earth to create microcapsules that could aid in drug delivery.

Dr. Dennis Morrison of NASA's Johnson Space Center used the microgravity environment aboard the space station for microencapsulation experiments as a tool to develop the Earth-based technology, called the Microencapsulation Electrostatic Processing System-II (MEPS-II), to make the most effective microcapsules. The technique for making these microcapsules could not be done on Earth, because the different densities of the liquids would layer.

But in space, microgravity brought together two liquids incapable of mixing on Earth (80 percent water and 20 percent oil) in such a way that spontaneously caused liquid-filled microcapsules to form as spherical, tiny, liquid-filled bubbles surrounded by a thin, semipermeable, outer membrane. In space, surface tension shapes liquids into spheres. Each molecule on a liquid's surface is pulled with equal tension by its neighbors. The closely integrated molecules form into the smallest possible area, which is a sphere. In effect, the MEPS-II system allowed a combination of liquids in a bubble shape because surface tension forces took over and allowed the fluids to interface rather than sit atop one another. Studying the samples upon return to Earth allowed scientists to understand how to make a device that could create the same microcapsules on Earth.

# Ethylene Reduction Device for Food & Plant Preservation



*Cosmonaut Valery G. Korzun, Expedition Five mission commander, studies mizuna lettuce as part of the Rastenyia-2 investigation.*

Plant growth on ISS has global impacts on Earth. Understanding the effects of gravity on plant life is essential in preparation for human exploration beyond low-Earth orbit. The ability to produce high-energy, low-mass food sources during spaceflight will enable the maintenance of crew health during long-duration 30 missions while having a reduced impact on resources necessary for long-distance travel. The Advanced Astroculture™ (ADVASC) investigation, led by Weijia Zhou, Ph.D., of the Wisconsin Center for Space Automation and Robotics, University of Wisconsin-Madison, explored the benefits of using microgravity to create custom crops that can withstand the inhospitable climates of space, resist pestilence, and need less volume to grow. ADVASC was performed over several International Space Station (ISS) expeditions, growing two generations of *Arabidopsis thaliana* (rapidly growing, flowering plant in the mustard family that has been grown on many space missions), and soybean plants, from seed to seed in space using the ADVASC payload, an autonomously operated plant growth unit. The ability to grow plants from seeds through several generations has proven to be challenging in space and is critical in developing hardware and operational concepts to take human explorers farther beyond low-Earth orbit.

While serving as a unique plant-growth chamber, the ADVASC hardware design has also contributed to national security, cancer-fighting pharmaceuticals and educational tools for students. ADVASC's novel air scrubber was designed to remove ethylene from the chamber atmosphere, thus allowing longevity of the produce. Ethylene is a naturally occurring, odorless, colorless gas given off by plants that hastens the ripening of fruits and the aging of flowers, encouraging decay. Comprised of carbon and hydrogen in closed growing environments, like on a spacecraft or in a terrestrial greenhouse, ethylene builds up quickly and plants mature too fast. Removing ethylene, therefore, is important to preserving crops not just in space, but also on Earth, where grocers and florists have an interest in reducing the gas that ultimately shortens the shelf life of their products. The ethylene-reduction device, also called the ethylene "scrubber," draws air through tubes coated in thin layers of titanium dioxide. The insides of the tubes are exposed to ultraviolet light, which creates a simple, chemical reaction, converting the ethylene into trace amounts of water and carbon dioxide, both of which are actually good for plants.

# ALMA OBSERVATORY

The 66 ALMA antennas can be arranged in different configurations, where the maximum distance between antennas can vary from 150 metres to 16 kilometres, which gives ALMA a powerful variable “zoom”. It is able to probe the Universe at millimetre and submillimetre wavelengths with unprecedented sensitivity and resolution, with a vision up to ten times sharper than the [Hubble Space Telescope](#), and complementing images made using the [VLT Interferometer](#).

ALMA is the world’s most powerful telescope for studying the Universe at submillimetre and millimetre wavelengths, on the boundary between infrared light and the longer radio waves. However, ALMA does not resemble many people’s image of a giant telescope. It does not use the shiny, reflective mirrors of visible- and infrared-light telescopes; it is instead comprised of many “antennas” that look like large metallic satellite dishes.

ALMA comprises 66 antennas, 54 of them with 12-metre diameter dishes, and 12 smaller ones, with a diameter of 7 metres each. ALMA 12-metre antenna dimensions:

- Height: 1470 cm
- Dish diameter: 1200 cm

# ALMA OBSERVATORY

The most visible part of each ALMA antenna is the dish, a large reflecting surface. Most of ALMA's dishes have a diameter of 12 metres. Each dish plays the same role as the mirror of an optical telescope: it collects radiation coming from distant astronomical objects, and focuses it into a detector that measures the radiation. The difference between this and an optical telescope is the wavelength of the radiation detected. Visible light, captured by optical telescopes, makes up just a small part of the spectrum of electromagnetic radiation, with wavelengths between roughly 380 and 750 nanometres. ALMA, in contrast, will probe the sky for radiation at longer wavelengths from a few hundred micrometres to about 1 millimetre (about one thousand times longer than visible light). This is known, perhaps unsurprisingly, as millimetre and submillimetre radiation, and lies at the very short-wavelength end of radio waves.

This longer wavelength is the reason why ALMA's dishes are not mirrors, but have a surface of metallic panels. The reflecting surfaces of any telescope must be virtually perfect: if they have any defects that are larger than a few percent of the wavelength to be detected, the telescope won't produce accurate measurements. The longer wavelengths that ALMA's antennas detect mean that although the surfaces are accurate to within 25 micrometres — much less than the thickness of a single sheet of paper, the dishes do not need the mirror finish used for visible-light telescopes. So although ALMA's dishes look like giant metallic satellite dishes, to a submillimetre-wavelength photon (light-particle), they are almost perfectly smooth reflecting surfaces, focusing the photons with great precision.

# The History and Science Development of Astro Biology

**Astrobiological research makes a number of simplifying assumptions when studying the necessary components for planetary habitability.**

**Carbon and Organic Compounds:** Carbon is the fourth most abundant element in the universe and the energy required to make or break a bond is at just the appropriate level for building molecules that are not only stable, but also reactive. The fact that carbon atoms bond readily to other carbon atoms allows for the building of extremely long and complex molecules. As such, astrobiological research presumes that the vast majority of life forms in the Milky Way galaxy are based on carbon chemistries, as are all life forms on Earth. However, theoretical astrobiology entertains the potential for other organic molecular bases for life, thus astrobiological research often focuses on identifying environments that have the potential to support life based on the presence of organic compounds.

**Liquid water:** Liquid water is a common molecule that provides an excellent environment for the formation of complicated carbon-based molecules, and is generally considered necessary for life as we know it to exist. Thus, astrobiological research presumes that extraterrestrial life similarly depends upon access to liquid water, and often focuses on identifying environments that have the potential to support liquid water.<sup>[17][18]</sup> Some researchers posit environments of water-ammonia mixtures as possible solvents for hypothetical types of biochemistry.

# The History and Science Development of Astro Biology

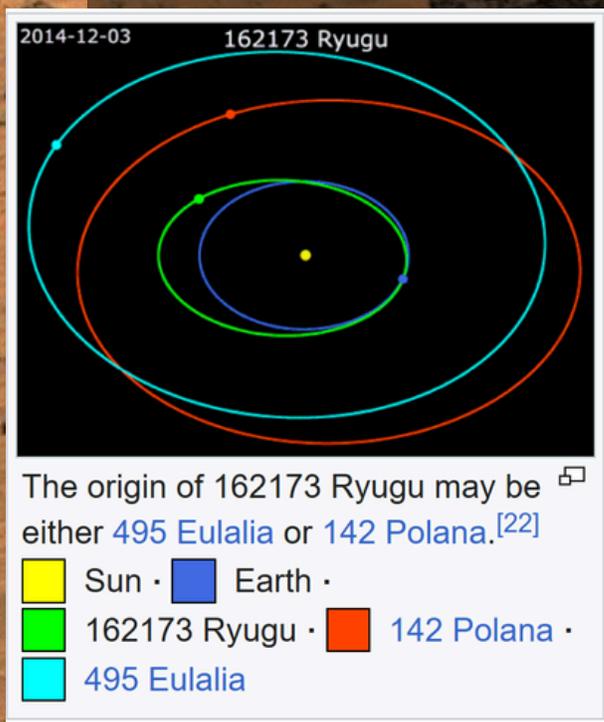
Astrobiological research makes a number of simplifying assumptions when studying the necessary components for planetary habitability.

**Environmental stability:** Where organisms adaptively evolve to the conditions of the environments in which they reside, environmental stability is considered necessary for life to exist. This presupposes the necessity of a stable temperature, pressure, and radiation levels; resultantly, astrobiological research focuses on planets orbiting Sun-like red dwarf stars. Because very large stars have relatively short lifetimes, meaning that life might not have time to emerge on planets orbiting them; very small stars provide so little heat and warmth that only planets in very close orbits around them would not be frozen solid, and in such close orbits these planets would be tidally locked to the star; whereas the long lifetimes of red dwarfs could allow the development of habitable environments on planets with thick atmospheres.

**Energy source:** It is assumed that any life elsewhere in the universe would also require an energy source. Previously, it was assumed that this would necessarily be from a Sun-like star, however with developments within extremophile research contemporary astrobiological research often focuses on identifying environments that have the potential to support life based on the availability of an energy source, such as the presence of volcanic activity on a planet or moon that could provide a source of heat and energy.

# The Research of Astro Biology Founding on Ryugu Asteroid

The Ryugu asteroid, also known as 162173 Ryugu, is a near-Earth object and potentially hazardous asteroid of the Apollo group. It was discovered on May 10, 1999, and is approximately 900 meters (3,000 feet) in diameter. The asteroid was named after Ryūgū-jō, a magical underwater palace in Japanese folklore. In June 2018, the Japanese spacecraft Hayabusa2 arrived at Ryugu, where it took samples and left them on Earth in November 2019. The samples were returned to Earth on December 5, 2020, and revealed the presence of organic compounds such as uracil and vitamin B3. These findings support the theory that errant space rocks like Ryugu could have brought life to Earth billions of years ago.



Variations in the concentrations of N-heterocyclic molecules including uracil between A0106 and C0107 samples may be related to the possible differences in the degree of alteration processes induced by energetic particles such as ultraviolet photons and cosmic rays since material in Chamber C may have been ~1m below the surface of Ryugu for several million years.

Organic molecules in the surface materials would have experienced energetic processes more extensively than those in the subsurface materials, which potentially causes preferential degradation of molecules at the surface. Uracil is not strong against surface energy cosmic ray and ultra violet photons. While uracil in the sub surface (~5 cm) on planetary bodies can be protected by the surface minerals such as calcium carbonate, calcium sulfate, and kaolinite from radiolysis.

**Table 1 | Qualitative and quantitative summary (in ppb) of uracil and other N-heterocyclic molecules identified in the Ryugu samples (A0106, C0107) and Orgueil meteorite**

	A0106	C0107	Orgueil		Orgueil <sup>c</sup>	Murchison <sup>d</sup>	Murray <sup>d</sup>	Tagish Lake <sup>d</sup>
	Hydrolyzed	Hydrolyzed	Unhydrolyzed	Hydrolyzed	H <sub>2</sub> O and HCOOH extracts	H <sub>2</sub> O extracts	H <sub>2</sub> O extracts	H <sub>2</sub> O extracts
Uracil	11 ± 6 <sup>a</sup>	32 ± 9	92	140	73	15	37	4
Imidazole-2-carboxylic acid	6	9 ± 1	12	12	-	19	14	4
Imidazole-4-carboxylic acid	17 ± 3	19 ± 3	136	218	-	90	99	19
Nicotinic acid	49 ± 1	99 ± 4	602	715	-	91	626	108
Picolinic acid	n.d. <sup>b</sup>	n.d.	n.d.	n.d.	-	-	-	-
Isonicotinic acid	49 ± 20	62 ± 23	237	203	-	53	307	118
Nicotinamide	n.d.	n.d.	214	n.d.	-	10	-	-
Isonicotinamide	n.d.	n.d.	38	n.d.	-	3	-	-
Picolinamide	n.d.	n.d.	n.d.	n.d.	-	1	-	-

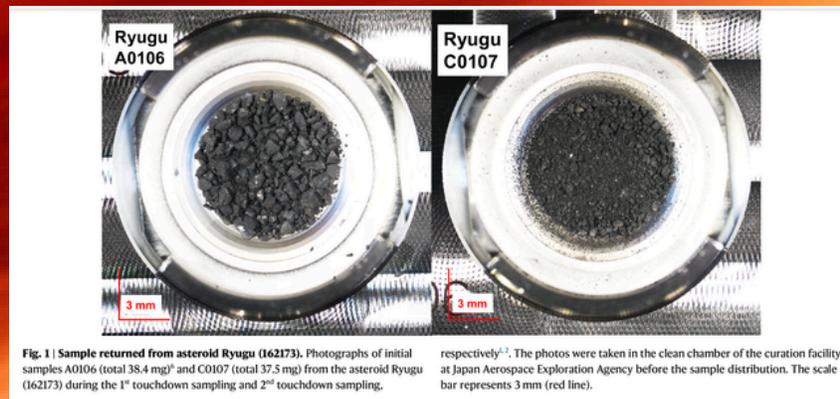
<sup>a</sup>Averaged value with an error on two measurements.

<sup>b</sup>Not detected.

<sup>c</sup>Sampled at 20 cm depth.

# The Research on Asteroid Founding of Uracil – RNA

**Uracil (/ˈjʊərəsɪl/) (symbol U or Ura) is one of the four nucleotide bases in the nucleic acid RNA. The others are adenine (A), cytosine (C), and guanine (G). In RNA, uracil binds to adenine via two hydrogen bonds. In DNA, the uracil nucleobase is replaced by thymine (T). Uracil is a demethylated form of thymine.**



Uracil that was formed extraterrestrially has been detected in the Murchison meteorite, in near-Earth asteroid Ryugu, and possibly on the surface of the moon Titan.<sup>1</sup> It has been synthesized under cold laboratory conditions similar to outer space, from pyrimidine embedded in water ice and exposed to ultraviolet light.

Uracil is colourless, crystalline organic compound of the pyrimidine family that occurs as a component of ribonucleic acid (RNA), a molecule involved in the transmission of hereditary characteristics. The RNA molecule consists of a sequence of nucleotides, each containing a five-carbon sugar (ribose), a phosphate group, and a nitrogenous base. Uracil is one of four nitrogenous bases found in the RNA molecule: uracil and cytosine (derived from pyrimidine) and adenine and guanine (derived from purine). Deoxyribonucleic acid (DNA) also contains each of these nitrogenous bases, except that thymine is substituted for uracil. During the synthesis of an RNA strand from a DNA template (transcription), uracil pairs only with adenine, and guanine pairs only with cytosine.

The detection of uracil, one of the four nucleobases in ribonucleic acid, in aqueous extracts from Ryugu samples. In addition, nicotinic acid (niacin, a B3 vitamer), its derivatives, and imidazoles were detected in search for nitrogenheterocyclic molecules.

The observed difference in the concentration of uracil between A0106 and C0107 maybe related to the possible differences in the degree of alteration induced by energetic particles such as ultraviolet photons and cosmic rays. The present study strongly suggests that such molecules of prebiotic interest commonly formed in carbonaceous asteroids including Ryugu and were delivered to the early Earth.

# Central Molecular Zone (CMZ) of The Milky Way Galaxy

The Central Molecular Zone (CMZ) of the Milky Way is the way station that primarily controls how much gas flows from the disk of the Galaxy towards the central nucleus. While this region is well documented to have extreme gas properties that clearly distinguish it from the rest of the Galaxy, the properties of the bulk molecular gas at high angular resolution are relatively unexplored. Band 3 data from the ALMA (Atacama Large Millimeter/Submillimeter Array) large program ACES (ALMA CMZ Exploration Survey) reveal the highly filamentary nature of CMZ molecular gas at high resolution ( $3''$  or  $0.1\text{pc}$ ) across the entire CMZ. Visual inspection of these data suggests that there are at least two general classes of elongated structures, which we identify as: i) large-scale ( $10\text{ pc}$ ) filamentary structures (LFs) and ii) a ubiquitous population of small-scale (about  $1\text{ pc}$ ) filamentary structures (SFs). We present detailed morphological and kinematic properties towards three structures in each category, as well as their association with magnetic fields and the correlation of  $\text{HNCO } 4(0,4)-3(0,3)$  with other molecular species. Our investigation reveals that these structures are largely coherent in position-position-velocity space. The alignment with the magnetic field structure is mixed, with some parallel, some perpendicular, and some intermediate alignments. We find that LFs likely trace pieces of contiguous CMZ orbital structures and are a manifestation of global CMZ dynamics. The second class, SFs, are pervasive and may be the result of complicated turbulence and shearing dynamics in the CMZ gas flows, as seen in numerical simulations.

# Central Molecular Zone (CMZ) of The Milky Way Galaxy

The Milky Way's central molecular zone (CMZ) spans the innermost 1600 light-years of the galaxy (for comparison, the Sun is 26,600 light-years away from the galactic center) and includes a vast complex of molecular clouds containing about sixty million solar-masses of molecular gas. The gas in these clouds exists under more extreme physical conditions than elsewhere in the galaxy on average, with higher densities and temperatures, more intense pressures, magnetic fields, and turbulence, and higher cosmic-ray abundances and ultraviolet and X-ray radiation. The CMZ is therefore a unique laboratory for studying star formation: not only are these conditions rarely observed in the rest of the Milky Way, they appear to be similar to the conditions in extremely luminous star forming galaxies in the early universe and offer an indirect glimpse into understanding the cosmic history of star formation not otherwise currently possible. However there is a puzzle: the star formation rate in the CMZ is much less than would be expected, barely one-tenth of a solar-mass per year.

# Central Molecular Zone (CMZ) of The Milky Way Galaxy

# The Womb of Stars

The birthplaces of stars are understood to be the densest regions in giant molecular clouds (GMCs), called 'clumps,' whose characteristic sizes are one to 10 light-years. These clumps fragment further into gravitationally bound 'cores' whose characteristic sizes are about ten times smaller; individual stellar systems can then form from the cores. The nature of the transitions between these evolutionary stages requires large surveys of both star-forming and non-star-forming structures across the hierarchical continuum of relevant scales and physical conditions. CfA astronomers Cara Battersby, Eric Keto, Daniel Callanan, Nimesh Patel, Qizhou Zhang, and Volker Tolls and their colleagues have released the CMZoom survey, a complete and unbiased map of the high density gas in the region. High density regions are quantified by the amount of molecular hydrogen gas along their lines-of-sight and are characterized by having so much dust that the visible light is completely blocked.

The survey was the result of a large, 550-hour Submillimeter Array program and resulted in new catalogs of the compact cores in the region. There are 285 separate cores that were unambiguously discovered; another 531 have more tentative identifications.

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