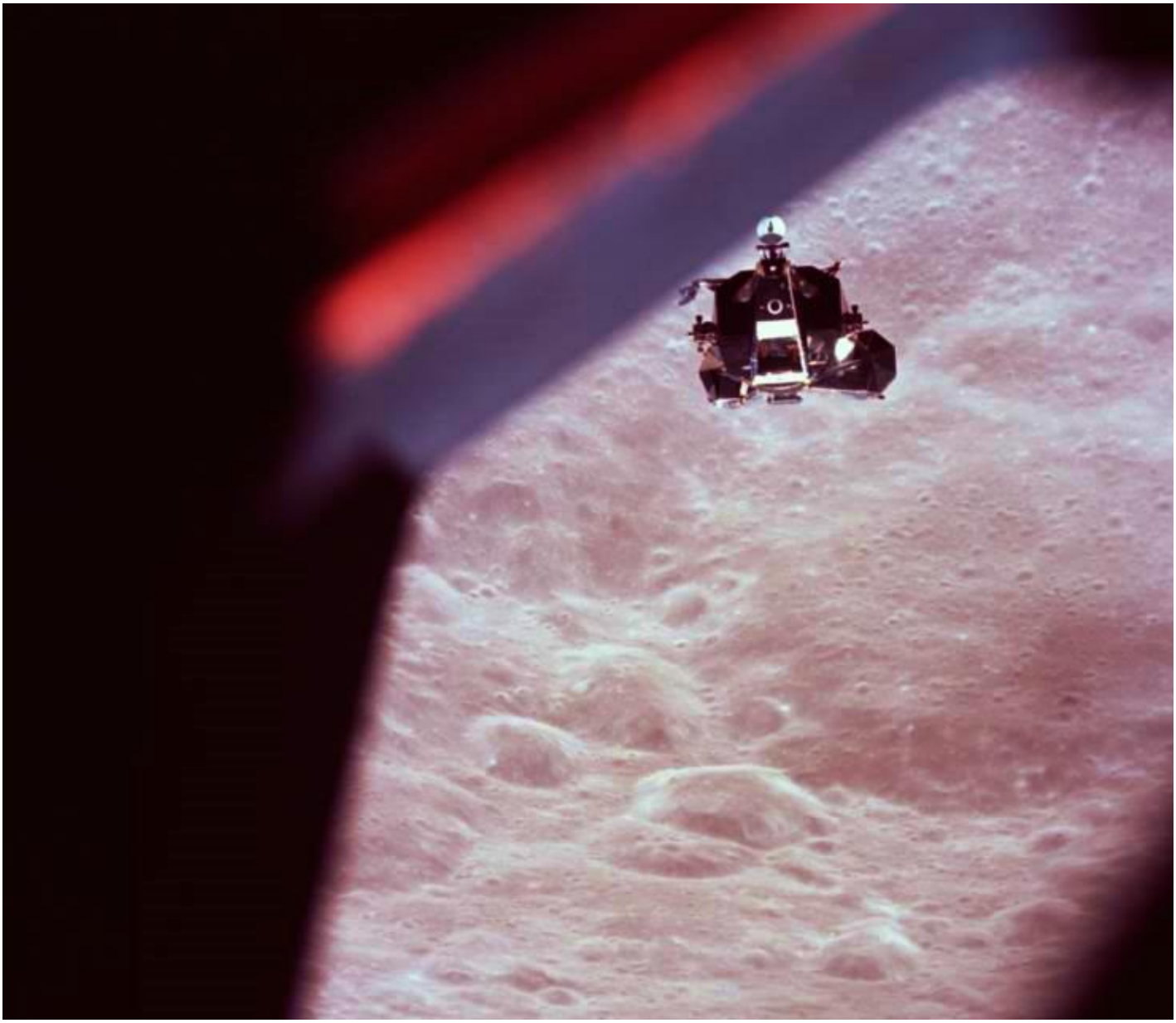
Space News Update

— June 18, 2019 —

Contents

1. Astronomers Might Have Found Apollo 10's "Snoopy" Module



The Snoopy lunar module, closing in on the Charlie Brown command module. Credit: NASA / Project Apollo Archive

On May 23, 1969, astronauts aboard Apollo 10 jettisoned the Snoopy lunar module and headed for Earth. That's the last time humans set eyes on Snoopy — now, astronomers may have rediscovered this fascinating artifact of space history.

Fellow of the Royal Astronomical Society astronomer Nick Howes shared the possible discovery recently at Cheltenham Science Festival. Howes, who began the search for Snoopy in 2011, said in a recent Sky News report that he is 98% certain that the object in question is, in fact, Snoopy. However, it will require follow-up observations to conclusively prove (or disprove) this conclusion.

Astronomers started the hunt in 2011 using the Faulkes North Telescope in Hawai'i, the Faulkes South Telescope in Australia, and data from the Catalina Sky Survey, located outside of Tucson, Arizona. The break came last year during observations taken at the Mt Lemmon and other survey observatories, with the discovery of the small Earth-crossing asteroid 2018 AV2. Orbiting the Sun once every 382 days, 2018 AV2 spends most of its time trailing Earth in its orbit around the Sun. Two factors grabbed astronomers' attention:

its low orbital inclination (less than 1°) relative to the ecliptic, and its low speed, less than a kilometer per second relative to Earth's orbital velocity.

Other factors also led to the conclusion that 2018 AV2 is likely to be Snoopy. It's already listed as an artificial object on the International Astronomical Union Minor Planet Center's Distant Artificial Objects page. According to Howes, the object's brightness also corresponded to "a size in the right ballpark." In addition, Howes says he had received mail "from a trusted astronomer at the Arizona Sky Survey indicating that JPL teams had also worked on it, and it looked like it was in the right place in 1969."

Apollo 10: Prelude to History

Often forgotten between the dramatic Apollo 8 mission around the Moon and the first crewed Moon landing of Apollo 11, Apollo 10 was still a vital mission. After Apollo 9 tested the lunar module in space for the first time in Earth orbit, Apollo 10 acted as a dress rehearsal for the Moon landing. The astronauts flew the lunar module down to within 14.5 kilometers (9 miles) of the lunar surface. The module was named "Snoopy" after the Peanuts comics strip character, while the corresponding command module was named Charlie Brown.

Snoopy's trajectory was unique among the Apollo missions. Unlike in the five missions that landed on the Moon, the Snoopy lunar module was ultimately jettisoned into an orbit around the Sun.

False Alarms

There have been several false finds over the years in the hunt to recover Snoopy. Around 2015 astronomers were convinced that the small near-Earth asteroid WT1190F was in fact the lost lunar module. WT1190F struck Earth in the Indian Ocean near Sri Lanka on November 13, 2015, and is now thought to have been the trans-lunar injection stage from the 1998 Lunar Prospector mission.

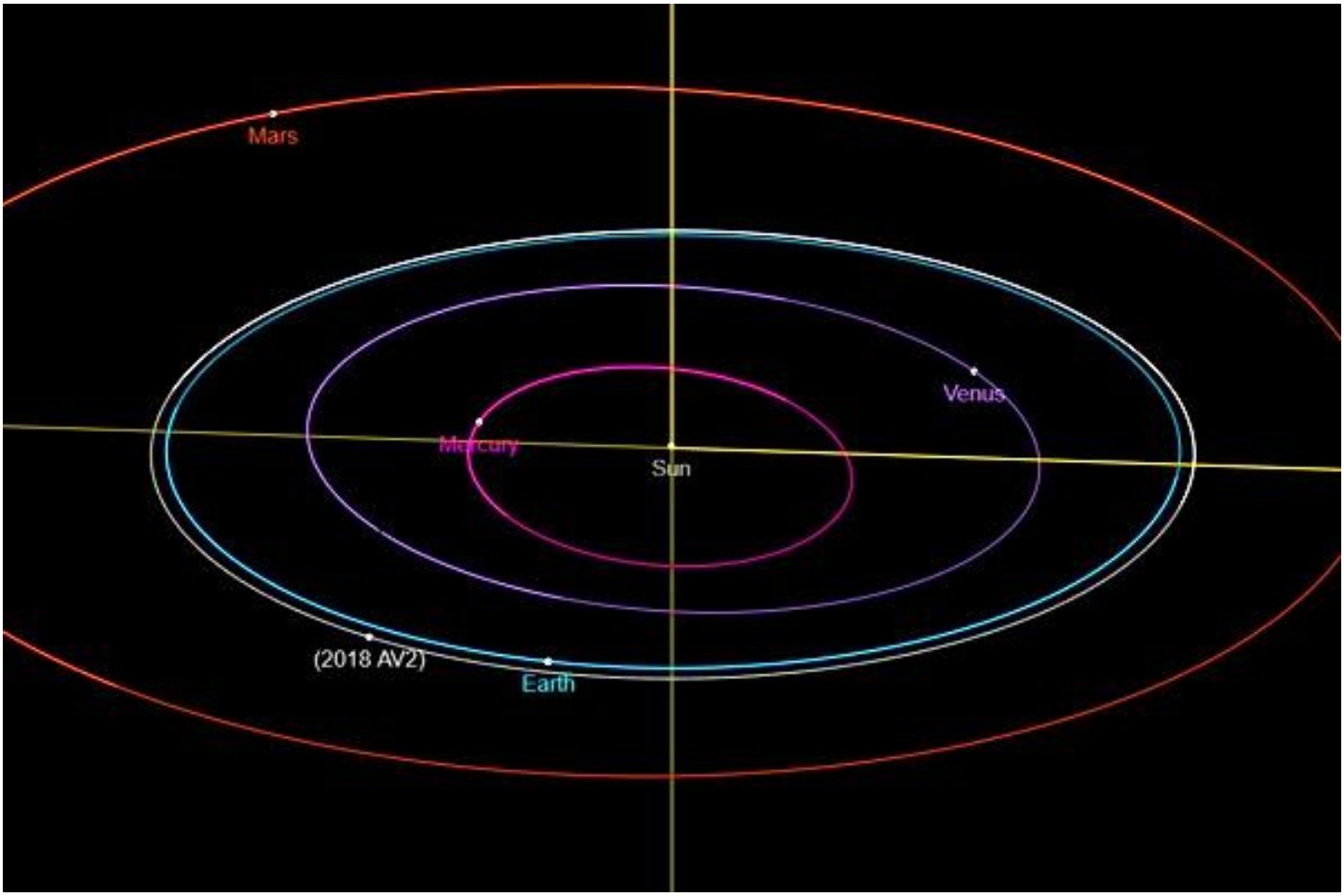
In 2006 one of the first temporary mini-moons of the Earth was discovered, 2006 RH120. As the ranks of near-Earth asteroids has grown in the years since, astronomers have realized that small asteroids are occasionally captured by the Earth-Moon system, following complex orbits around the pair before being ejected back out into solar orbit. These objects may be confused with discarded Space Age hardware, which often follows the same path. For example, asteroid J002E3 was spotted back in 2002, but astronomers soon realized that its spectra matched paint used by NASA in the late 1960s. The object turned out to be a third-stage booster from Apollo 12. Another asteroid, 2013 QW1, turned out to be an upper stage booster from China's Chang'e 2 Moon mission.

Unfortunately, 2018 AV2 is currently 0.374 astronomical units (34.7 million miles) from Earth, making it a faint +29.5 magnitude object. Its next close approach won't come until July 10, 2037, when it will pass 4 million miles from Earth, equivalent to 16 times the Earth-Moon distance.

However, it would theoretically be possible to observe the object now: Howes notes that a Falcon Heavy or Delta IV rocket could traverse the current distance in a year. Another possibility would be to send a small CubeSat along with a future SLS launch, with the purpose of flying by the object to make observations.

Spectral analysis, a radar profile, and other observations would go a long ways towards confirming or rejecting the object's identity. After all, hollow metallic artificial objects react differently to solar heating and radiative pressure (known as the Yarkovsky effect) than solid space rocks.

Certainly, Snoopy is one of the more curious objects man-made objects in solar orbit. Elon Musk's Tesla Roadster, which SpaceX launched into solar orbit via its inaugural Falcon Heavy flight in 2018, probably wins for "most curious." Howes notes that Musk is a big fan of the Apollo program, so maybe a salvage isn't totally out of the question. The module has suffered from a half-century of continuous ultraviolet radiation exposure, but it should be relatively intact.



The orbit of 2018 AV2. Credit: NASA / JPL

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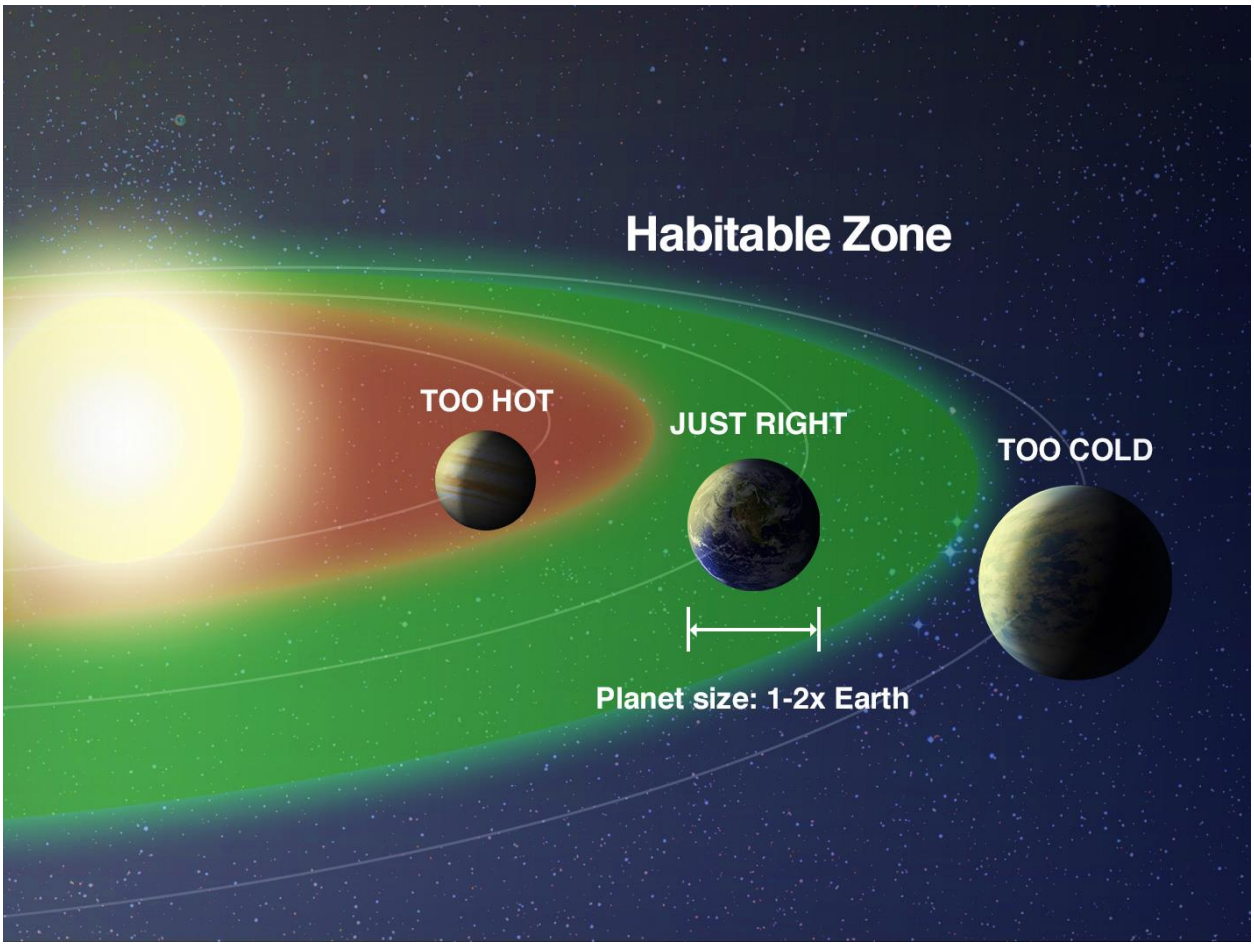
"There's clearly a lot from humankind's first foray in to deep space still out there," says Howes, "and whilst the scientific argument to retrieve them is marginal, I think with Snoopy you have a unique, one-off remnant of our greatest technical achievement . . . One I'd love to show close-up images to [Apollo 10 astronauts] Tom Stafford and the family of Gene Cernan one day."

For now though, it's an interesting idea to consider as we approach the 50th anniversary of the Apollo 11 moon landing, that a part of the precursor mission that made it all possible is still out there, silently orbiting the Sun.

Source: Sky and Telescope Return to Contents

2. New Discovery Shows ‘Habitable Zone for Complex Life’ is Much More Narrow than Original Estimates



A study released today is the first to refine where environments suitable for life, more complex than microorganisms, might be able to exist beyond our own solar system.

Research funded by the NASA Astrobiology Program through the NASA Astrobiology Institute (NAI) concludes that increased levels of toxic gases significantly narrow the habitable zone for complex life. Scientists define the traditional habitable zone as the distance from a star where there is enough heat for liquid water to persist on a planet’s surface.

Life as we know it requires liquid water to survive, and planets within the habitable zone of a star are thought to be the best candidates for supporting microbial life. However, microorganisms are able to thrive in conditions that are not suitable for more complex life. The new study provides the first estimation of a narrow habitable zone for complex life, where planets might be able to support animal-like organisms.

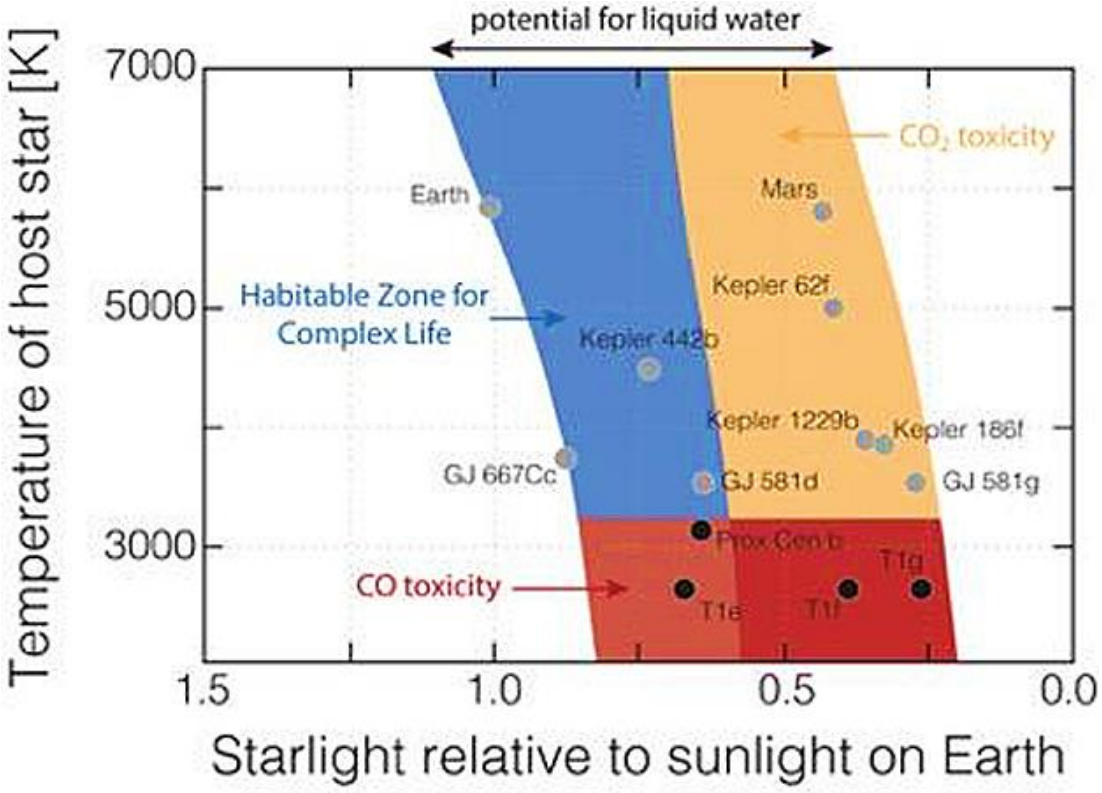
Using models for atmospheric climate and photochemistry, scientists compared predicted carbon dioxide (CO2) and carbon monoxide (CO) levels to previously determined toxicity limits that quantitatively designate the safe zone for macroscopic life on exoplanets.

“This is the first time the physiological limits of life on Earth have been considered to predict the distribution of complex life elsewhere in the universe,” said Timothy Lyons, study co-author, distinguished professor of biogeochemistry at the University of California, Riverside’s Department of Earth and Planetary Sciences, and director of the NAI’s Alternative Earths Astrobiology Center, which sponsored the project.

The study has important implications in the search for biological complexity in the universe, and in determining the best places to look for signs of intelligent life or potential evidence of technology.

"This study will shape the development of new technologies, missions, and more powerful telescopes that we will use to search the sky for signatures of life beyond the solar System," said Mary Voytek, NASA Astrobiology Program director.

According to Voytek, studies like this are important in helping us decide where to focus our search, and the instruments we will need. Ultimately this increases the likelihood of finding evidence that Earth isn't the only planet in the vastness of space where life exists.



The habitable zone for complex life (blue) is highly restricted relative to the zone defined by the potential for liquid water, due to toxic buildup of carbon dioxide (yellow) and carbon monoxide (red). This narrower zone excludes many exoplanets including Proxima Centauri b and TRAPPIST-1 planets e, f and g (black dots). Credit: Schwieterman et al. (2019) (*Courtesy Of Christopher Reinhard/Georgia Tech)*

This newly-revealed science is also a critical part of NASA's work to understand the universe, advance human exploration, and inspire the next generation. As NASA's Artemis program moves forward with human exploration of the Moon, the search for life on other worlds remains a top priority for the agency.

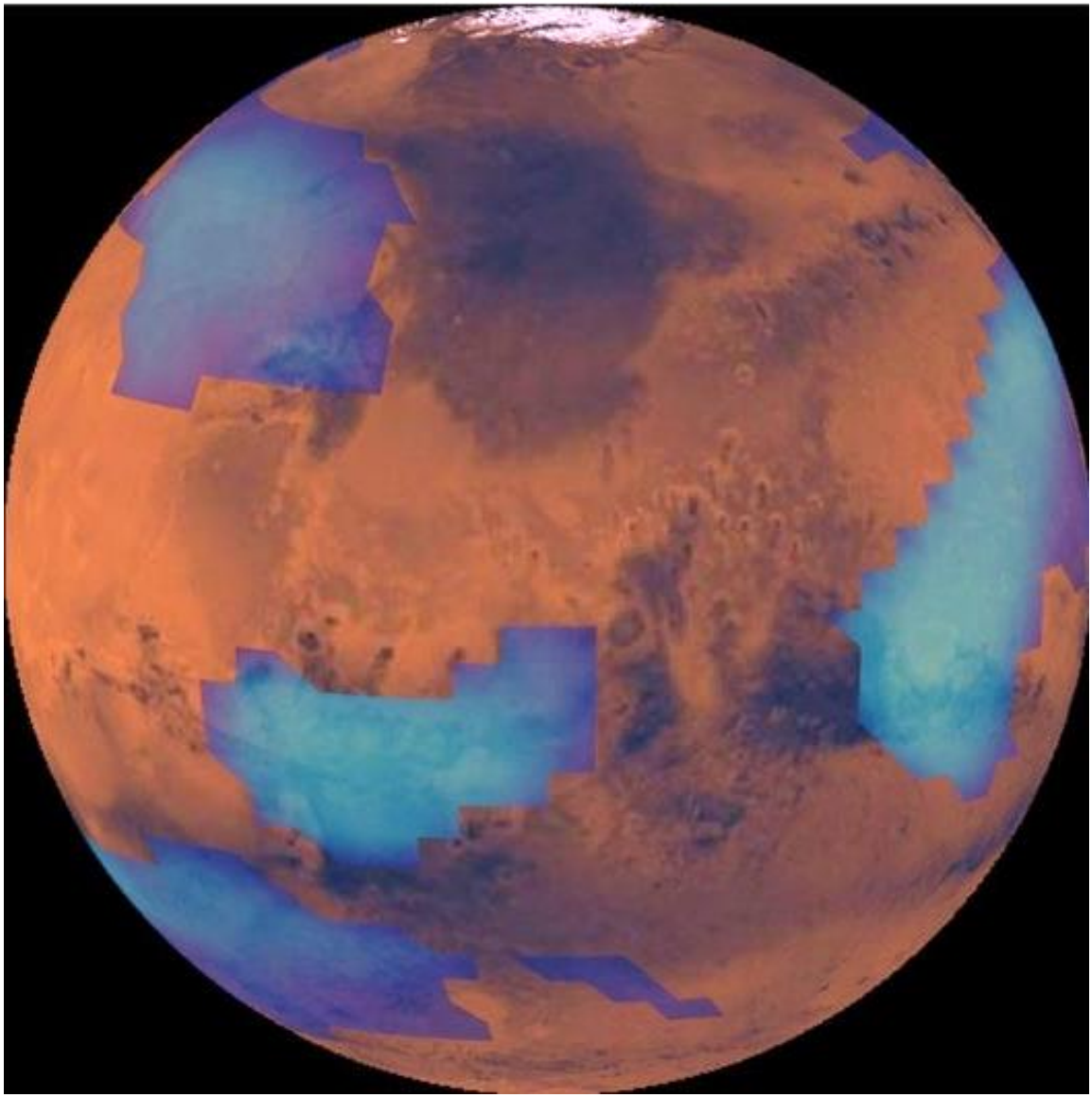
Lead author of the study, Edward Schwieterman, is supported through the NASA Astrobiology Program as a NASA Postdoctoral Program fellow with the Alternative Earths Astrobiology Center at UCR. Timothy Lyons, co-author of the study and Schwieterman's advisor at UCR, is a project co-lead for the new NASA Astrobiology RCN Prebiotic Chemistry and Early Earth Environments Consortium (PCE3). Additional co-authors of the study include Christopher Reinhard, assistant professor at the Georgia Institute of Technology, Stephanie Olson of the University of Chicago, and Chester E. Harman of Columbia University.

The paper, "A Limited Habitable Zone for Complex Life "is published in The Astrophysical Journal and can be found at: https://iopscience.iop.org/article/10.3847/1538-4357/ab1d52

Source: NASA Return to Contents

3. The Meteors Help Martian Clouds Form

University of Colorado at Boulder



Computer simulation of middle altitude clouds on Mars. Credit: Victoria Hartwick

How did the Red Planet get all of its clouds? CU Boulder researchers may have discovered the secret: just add meteors.

Astronomers have long observed clouds in Mars' middle atmosphere, which begins about 18 miles (30 kilometers) above the surface, but have struggled to explain how they formed.

Now, a new study, which will be published on June 17 in the journal *Nature Geoscience*, examines those wispy accumulations and suggests that they owe their existence to a phenomenon called "meteoric smoke"--essentially, the icy dust created by space debris slamming into the planet's atmosphere.

The findings are a good reminder that planets and their weather patterns aren't isolated from the solar systems around them.

"We're used to thinking of Earth, Mars and other bodies as these really self-contained planets that determine their own climates," said Victoria Hartwick, a graduate student in the Department of Atmospheric and Ocean Sciences (ATOC) and lead author of the new study. "But climate isn't independent of the surrounding solar system."

The research, which included co-authors Brian Toon at CU Boulder and Nicholas Heavens at Hampton University in Virginia, hangs on a basic fact about clouds: They don't come out of nowhere.

"Clouds don't just form on their own," said Hartwick, also of the Laboratory for Atmospheric and Space Physics at CU Boulder. "They need something that they can condense onto."

On Earth, for example, low-lying clouds begin life as tiny grains of sea salt or dust blown high into the air. Water molecules clump around these particles, becoming bigger and bigger until they form the large puffs that you can see from the ground.

But, as far as scientists can tell, those sorts of cloud seeds don't exist in Mars' middle atmosphere, Hartwick said. And that's what led her and her colleagues to meteors.

Hartwick explained that about two to three tons of space debris crash into Mars every day on average. And as those meteors rip apart in the planet's atmosphere, they inject a huge volume of dust into the air.

To find out if such smoke would be enough to give rise to Mars' mysterious clouds, Hartwick's team turned to massive computer simulations that attempt to mimic the flows and turbulence of the planet's atmosphere.

And sure enough, when they included meteors in their calculations, clouds appeared.

"Our model couldn't form clouds at these altitudes before," Hartwick said. "But now, they're all there, and they seem to be in all the right places."

The idea might not be as outlandish as it sounds, she added. Research has shown that similar interplanetary schmutz may help to seed clouds near Earth's poles.

But she also says that you shouldn't expect to see gigantic thunderheads forming above the surface of Mars anytime soon. The clouds her team studied were much more like bits of cotton candy than the clouds Earthlings are used to.

"But just because they're thin and you can't really see them doesn't mean they can't have an effect on the dynamics of the climate," Hartwick said.

The researchers' simulations, for example, showed that middle atmosphere clouds could have a large impact on the Martian climate. Depending on where the team looked, those clouds could cause temperatures at high altitudes to swing up or down by as much as 18 degrees Fahrenheit (10 degrees Celsius).

And that climactic impact is what gets Brian Toon, a professor in ATOC, excited. He said that the team's findings on modern-day Martian clouds may also help to reveal the planet's past evolution and how it once managed to support liquid water at its surface.

"More and more climate models are finding that the ancient climate of Mars, when rivers were flowing across its surface and life might have originated, was warmed by high altitude clouds," Toon said. "It is likely that this discovery will become a major part of that idea for warming Mars."

Source: University of Colorado Return to Contents

The Night Sky

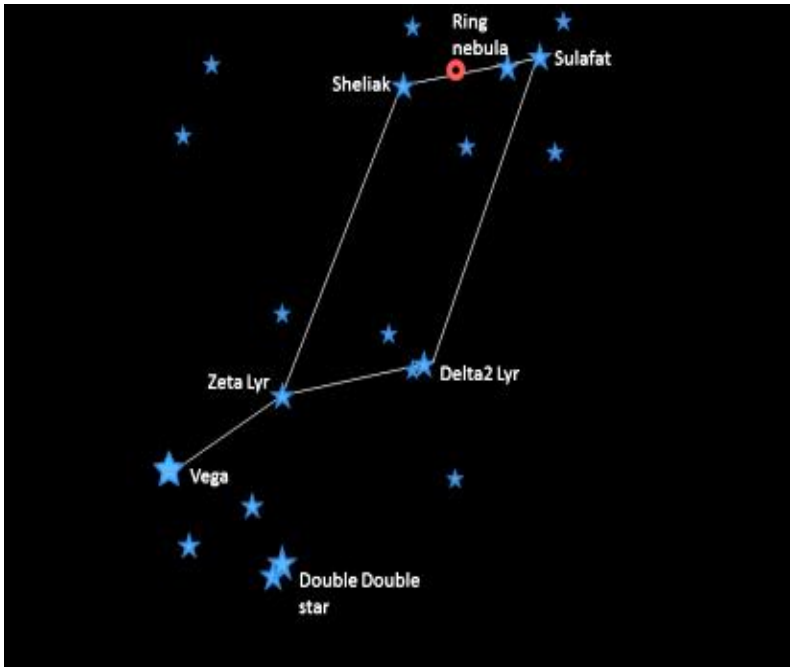
Tuesday, June 18

• As twilight fades, use binoculars to try catching Mercury and Mars just ½° apart low in the west-northwest. Mercury is by far the brighter of the two. Mars is actually fainter now than Pollux and Castor, which glimmer a little more than a binocular field of view to their upper right.

• On the opposite side of the sky after dark, the waning gibbous Moon shines with Saturn, which is 3,450 times farther away.

Wednesday, June 19

• Here it is two days from official summer. But as twilight fades, look very low in the north-northwest for wintry Capella very out of season. The farther north you are, the higher it will appear. You may need binoculars. If you're as far north as Montreal or a Portland (either Oregon or Maine!), Capella is actually circumpolar.



Lyra Constellation Credit: Museum of Applied Arts and Sciences

Thursday, June 20

• After dark Vega is the brightest star shining very high in the east. Barely lower left of it is 4th-magnitude Epsilon Lyrae, the Double-Double. Epsilon forms one corner of a roughly equilateral triangle with Vega and Zeta Lyrae. The triangle is less than 2° on a side, hardly the width of your thumb at arm's length.

Binoculars easily resolve Epsilon. And a 4-inch telescope at 100× or more should resolve each of Epsilon's wide components into a tight pair.

Zeta Lyrae is also a double star for binoculars; much tougher, but plainly resolved in any telescope.

Delta Lyrae, a little below Zeta, is a much wider and easier pair, tinted reddish orange and blue.

Friday, June 21

• The solstice arrives at 11:54 a.m. EDT, when the Sun is farthest north for the year and begins its six-month return southward. Official summer begins in the Northern Hemisphere, winter in the Southern Hemisphere. For us northerners, this is the year's longest day and shortest night.

• Jupiter's Great Red Spot should transit the planet's central meridian (the line from pole to pole down the center of the planet's disk) around 1:21 a.m. EDT tonight; 12:21 a.m. CDT. Meanwhile Europa, the smallest of Jupiter's Galilean moons, crosses the planet's disk tonight from 11:32 p.m. to 1:57 a.m. EDT, followed closely by its tiny black shadow from 12:04 to 2:32 a.m. EDT.

For timetables of all the Red Spot's transits this month and all the interesting phenomena of Jupiter's moons, see the June *Sky & Telescope*, page 50.

Source: Sky and Telescope

Return to Contents

ISS Sighting Opportunities (from Denver)

No Denver Area Sightings of ISS through Friday Jun 28, 2019

Sighting information for other cities can be found at NASA's Satellite Sighting Information

NASA-TV Highlights (all times Eastern Time Zone)

June 19, Wednesday

- 7:10 a.m. – International Space Station In-Flight Interviews with Fox Business News' "Maria in the Morning" Program with Maria Bartiromo; Fox interview begins at 7:20 a.m. EDT (All Channels)
- 10:30 a.m. – International Space Station In-Flight Event for the Canadian Space Agency with Canadian Media and astronaut David Saint-Jacques of CSA – (Public Channel with interpretation; Media Channel in native language)

June 20, Thursday

- 6:45 a.m. – NASA Invites Your Viewers to Share Their Apollo Stories (Media Channel)

Watch NASA TV online by going to the NASA website.

Return to Contents

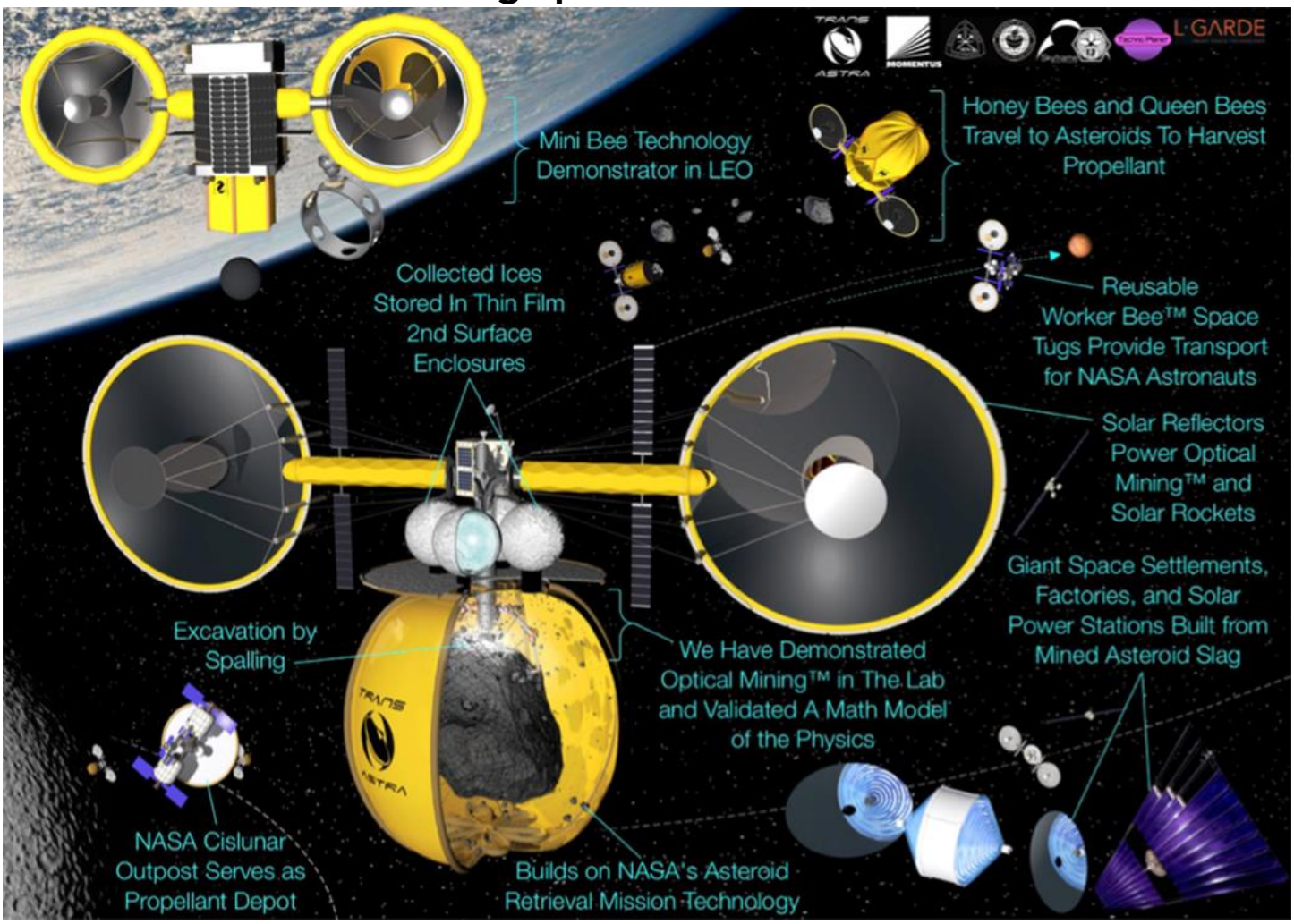
Space Calendar

- Jun 18 - Amor Asteroid 2019 LA5 Near-Earth Flyby (0.047 AU)
- Jun 18 - Apollo Asteroid 2019 LU4 Near-Earth Flyby (0.005 AU)
- Jun 18-19 - International Meeting on Paleoclimate: Changes and Adaptation, Coimbra, Portugal
- Jun 18-20 - 4th Planetary Data Workshop, Flagstaff, Arizona
- Jun 18-20 - Conference: Science in Our Own Backyard - Exploring the Galaxy and the Local Group with WFIRST, Pasadena, California
- Jun 18-21 - Conference: Gaia's View of Pre-Main Sequence Evolution - Linking the T Tauri and Herbig Ae/Be Stars, Leeds, United Kingdom
- Jun 18-21 - 10th Young Researcher Meeting, Rome, Italy
- **Jun 19 - Moon Occults Saturn and Dwarf Planet Pluto**
- **Jun 19 - Mercury Passes 0.2 Degrees from Mars**
- Jun 19 - Apollo Asteroid 2019 LC1 Near-Earth Flyby (0.049 AU)
- Jun 19 - Aten Asteroid 2014 MV18 Near-Earth Flyby (0.078 AU)
- Jun 19 - Aten Asteroid 2014 OL339 Closest Approach To Earth (0.293 AU)
- Jun 19 - Seminar: Binary Black Hole Populations with LIGO/Virgo, Barcelona, Spain
- Jun 19 - Seminar: Late Bursts of Star Formation in Normal Elliptical Galaxies, Barcelona, Spain
- Jun 19 - Colloquium: First Images of a Supermassive Black Hole, Sydney, Australia
- Jun 19 - Lectures: Rock Glaciersi - From Mountain Hikes to the Colonization of Mars / The James Webb Space Telescope and Our New Look at Other Worlds, Tucson, Arizona
- Jun 19-20 - Swiss Square Kilometer Array (SKA) Days 2019, Bern, Switzerland
- Jun 19-22 - Conference: Supermassive Black Holes - Environment and Evolution, Corfu, Greece
- Jun 19-23 - 14th Biennial History of Astronomy Workshop, Notre Dame, Indiana
- Jun 20 - Apollo Asteroid 2019 LB2 Near-Earth Flyby (0.017 AU)
- Jun 20 - Lecture: Such Stuff as Dreams are Made On - Designing Tomorrow's Space Missions Today, Pasadena, California
- Jun 20 - Lecture: Cassini-Huygens and The Lord of the Rings, London, United Kingdom
- Jun 20 - Seminar: Constraints on the Hadron-Quark Phase Transition and the Properties of Twin Stars with GW170817, Barcelona, Spain
- Jun 20 - Seminar: Particle Acceleration in Protostellar Jets - An Observational Approach, Barcelona, Spain
- Jun 20 - Seminar: Primordial Black Holes and their Manifestations in Astrophysical Phenomena, Barcelona, Spain
- Jun 20-22 - Workshop: Building the NASA Citizen Science Community, Tucson, Arizona
- **Jun 21 - Summer Solstice, 15:54 UT**
- **Jun 21 - Spektr-RG (SXG) Proton-M/DM-03 Launch**
- Jun 21 - Aten Asteroid 2010 RX30 Near-Earth Flyby (0.094 AU)
- Jun 21 - Apollo Asteroid 11500 Tomaiyowit Closest Approach To Earth (0.187 AU)
- Jun 21 - Chandra X-ray Observatory 20th Anniversary Event, Framingham, Massachusetts
- Jun 21 - Lecture: Such Stuff as Dreams are Made On - Designing Tomorrow's Space Missions Today, Pasadena, California
- Jun 21-23 - AlienCon, Los Angeles, California
- Jun 21-23 - Ensisheim Meteorite Show 2019, Ensisheim, Alsace, France
- **Jun 22 - Ziyuan 2D (ZY 2D)/ BNU 1/Tianyi 1 MV-1 CZ-4B Launch**

Source: JPL Space Calendar Return to Contents

Food for Thought

Robotic Asteroid Mining Spacecraft Wins a Grant From NASA



Credits: Joel Sercel, TransAstra Corporation

Back in April, NASA once again put out the call for proposals for the next generation of robotic explorers and missions. As part of the NASA Innovative Advanced Concepts (NIAC) Program, this consisted of researchers, scientists, and entrepreneurs coming together to submit early studies of new concepts that could one-day help advance NASA's space exploration goals.

One concept that was selected for Phase III of development was a breakthrough mission and flight system called Mini Bee. This small, robotic mining craft was designed by the Trans Astronautica (TransAstra) Corporation to assist with deep-space missions. It is hoped that by leveraging this flight system architecture, the Mini-bee will enable the full-scale industrialization of space as well as human settlement.

The Mini-bee concept is essentially a technology-demonstrator for a family of flight system architectures known as Asteroid Provided In-situ Supplies (Apis). These systems range in size from the experimental Mini Bee (which weighs 250 kg or 550 lbs.) to the larger Honey Bee and Queen Bee – which would be capable of capturing asteroids measuring 10 and 40 m (33 and 130 ft.) in diameter, respectively.

The Mini Bee utilizes a series of innovative technologies, which includes optical mining method of resource harvesting (aka. laser mining), a spacecraft architecture that relies on sunlight to enable faster spacecraft, and an

asteroid containment system similar to the one that was proposed for NASA's now-scrapped Asteroid Redirect Mission (ARM).

Along with other Arpis concepts, the robotic spacecraft will use the water-based Omnivore solar thermal thruster to find its way around in Earth orbit or deep-space. This revolutionary technology concentrates vast amounts of sunlight into a reaction chamber where it then heats water and other volatile compounds (carbon dioxide, carbon monoxide, methane, ammonia) harvested from asteroids for propellant.

This technology allows for greater flexibility since robotic missions would not need to transport all of their fuel with them and could rely on the same in-situ resource utilization (ISRU) process used to harvest resources to also procure fuel. In this respect, the Omnivore thruster is not unlike the World Is Not Enough (WINE), a steam-powered thruster currently being developed by Honeybee Robotics and the University of Central Florida (UCF).

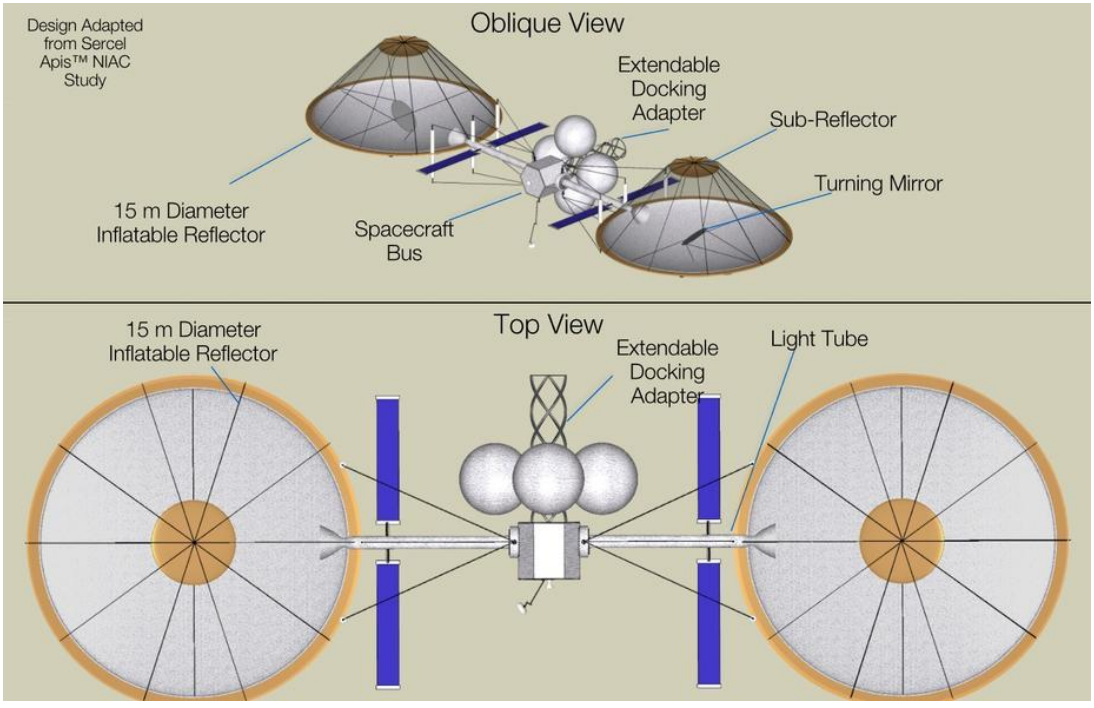
The basic process employed by the Mini Bee is quite simple, but also highly sophisticated. Using the ARM Option A capture bag technology, the Mini Bee will secure a small piece of debris in space. Inflatable solar reflectors will power the optical mining beams, which will then be used to excavate the object (a process known as "spalling"), extract volatiles like water ice, and then store them aboard the spacecraft for transport.

To complete the Phase III process, TransAstra needs to push ahead with the development of their Optical Mining Test Bed (OMTB), demonstrate the effectiveness of the Omnivore thruster, the propellant feed system for the thruster, test the technology behind their inflatable solar reflectors, and integrate all of these systems together.

The company is also working on a variant called the Worker Bee, which is designed to serve as an orbital transfer vehicle (OTV) that could transport equipment and other payloads to high Earth orbits, the Moon, and maybe even Mars. These spacecraft would also rely on the omnivore thruster and would essentially be space tugs, providing services to NASA, commercial satellites, and maybe even tourists.

If and when TransAstra completes Phase III, the company will be in a position to propose Mini Bee to a mid-level NASA Technology Readiness Level (TRL) program. If all goes as planned, Mini Bee will validate key systems that could go into a fleet of robotic spacecraft providing everything from asteroid mining and resupply missions to orbital space rides.

The dream of industrializing space and providing affordable cislunar tourism would be one step closer!

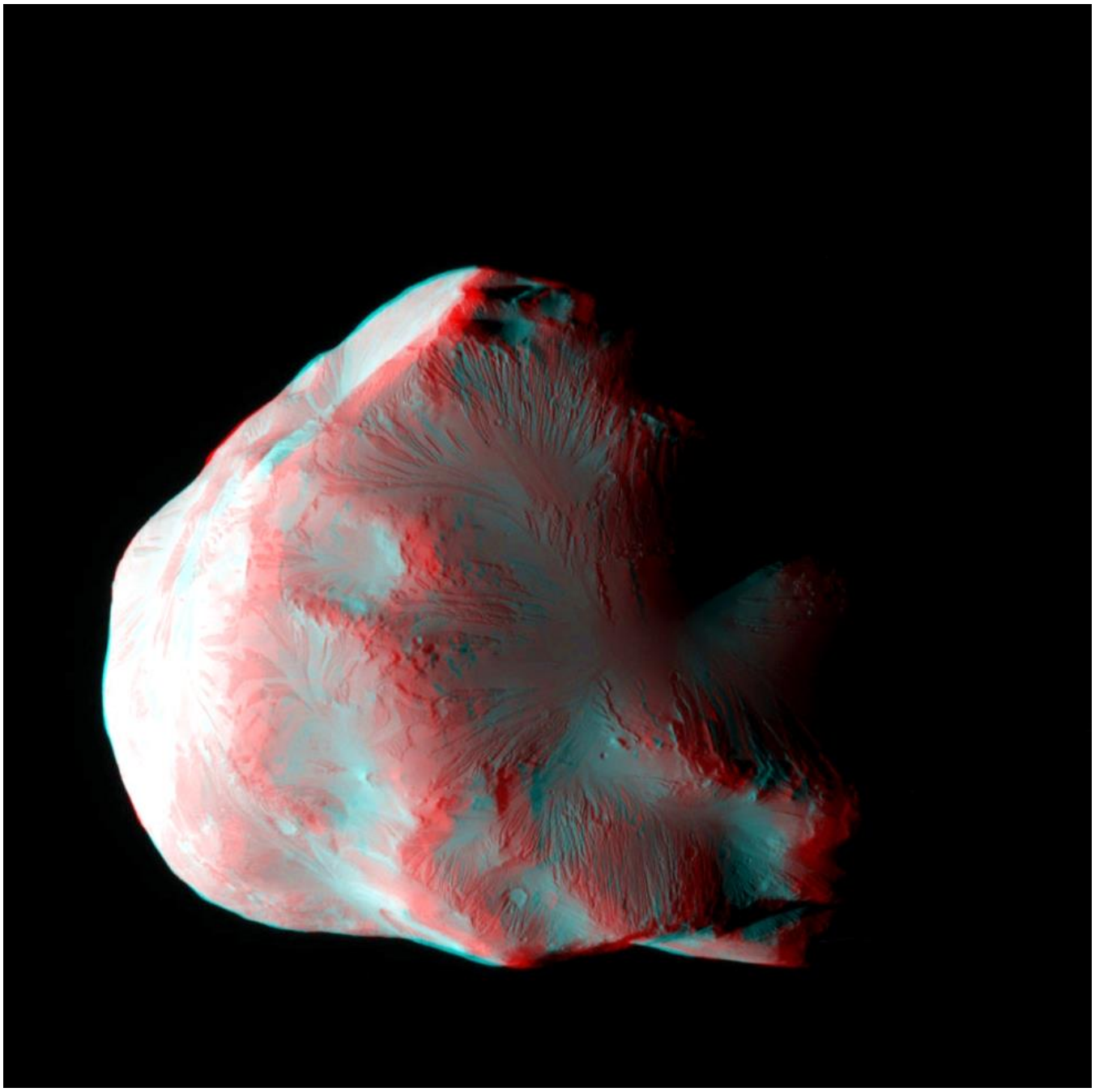


Credit: TransAstra Corporation

Source: Universe Today

Return to Contents

Space Image of the Week



Stereo Helene

Image Credit: Cassini Imaging Team, ISS, JPL, ESA, NASA; Stereo Image by Roberto Beltramini

Explanation: Get out your red/blue glasses and float next to Helene, small, icy moon of Saturn. Appropriately named, Helene is one of four known Trojan moons, so called because it orbits at a Lagrange point. A Lagrange point is a gravitationally stable position near two massive bodies, in this case Saturn and larger moon Dione. In fact, irregularly shaped (about 36 by 32 by 30 kilometers) Helene orbits at Dione's leading Lagrange point while brotherly ice moon Polydeuces follows at Dione's trailing Lagrange point. The sharp stereo anaglyph was constructed from two Cassini images captured during a close flyby in 2011. It shows part of the Saturn-facing hemisphere of Helene mottled with craters and gully-like features.

Source: NASA APOD

Return to Contents