RocketSTEM

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NASA's MAVEN and India's MOM ready to launch

Robotic invasion of Mars underway

Private sector sending humans to the Red Planet

Remembering Scott Carpenter

Top 10 must-see list for new astronomers

Tweeting from the ISS

Astronaut Karen Nyberg (@AstroKarenN) posted this photo on Oct. 28 along with the following on twitter: "W/ departure of #ATV4, aft docking port empty. We move our Soyuz there Fri making room for @AstroRM & @Astro_Wakata pic.twitter.com/lpatsjbAoA."

Two days later she followed that with another tweet: "Up early to suit up, get in Soyuz, undock from MRM1 nadir & fly around to dock at SM aft. Making parking spot for @AstroRM & @Astro_Wakata."

Earlier in the month the Expedition 37 crew members posed for an in-flight crew portrait in the Kibo laboratory. Pictured above (clockwise from lower left) are Fyodor Yurchikhin, Sergey Ryazanskiy, Karen Nyberg, Oleg Kotov, Luca Parmitano and Michael Hopkins.

Photos: NASA/Expedition 37 crew

Contents

Also Inside:

Sorry we missed you on Halloween, but we've still got a treat for you. Yes, another issue of RocketSTEM, just one month removed from the last one. Call it feeling ambitious, or just plain insanity, but here it is. This issue shines the spotlight on Mars and humanity's attempts to better understand the Red Planet.

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On the Cover: *An artist's concept shows NASA's MAVEN spacecraft in orbit around the Red Planet, with a fanciful image of her home planet in the background.*
Image: NASA/Goddard Space Flight Center

Titan's northern lakes resemble Earth's salt flats

With the sun now shining down over the north pole of Saturn's moon Titan, a little luck with the weather, and trajectories that put the spacecraft into optimal viewing positions, NASA's Cassini spacecraft has obtained new pictures of the liquid methane and ethane seas and lakes that reside near Titan's north pole. The images reveal new clues about how the lakes formed and about Titan's Earth-like "hydrologic" cycle, which involves hydrocarbons rather than water.

While there is one large lake and a few smaller ones near Titan's south pole, almost all of Titan's lakes appear near the moon's north pole. Cassini scientists have been able to study much of the terrain with radar, which can penetrate beneath Titan's clouds and thick haze. And until now, Cassini's visual and infrared mapping spectrometer and imaging science subsystem had only been able to capture distant, oblique or partial views of this area.

Several factors combined recently to give these instruments great observing opportunities. Two recent flybys provided better viewing geometry. Sunlight has begun to pierce the winter darkness that shrouded Titan's north pole at Cassini's arrival in the Saturn system nine years ago. A thick cap of haze that once hung over the north pole has also dissipated as northern summer approaches.

The images are mosaics in infrared light based on data obtained during flybys of Titan on July 10, July 26, and Sept. 12, 2013. The colorized mosaic from the visual and infrared mapping spectrometer, which maps infrared colors onto the visible-color spectrum, reveals differences in the composition of material around the lakes. The data suggest parts of Titan's lakes and seas may have evaporated and left behind the Titan equivalent of Earth's salt flats. Only at Titan, the evaporated material is thought to be organic chemicals originally from Titan's haze particles that once dissolved in liquid methane. They appear orange in this image against the greenish backdrop of Titan's typical bedrock of water ice.

"It turns out that Titan's north pole is even more interesting than we thought, with a complex interplay of liquids in lakes and seas and deposits left from the evaporation of past lakes and seas," said Jason Barnes, a participating scientist for the instrument at the University of Idaho, Moscow.

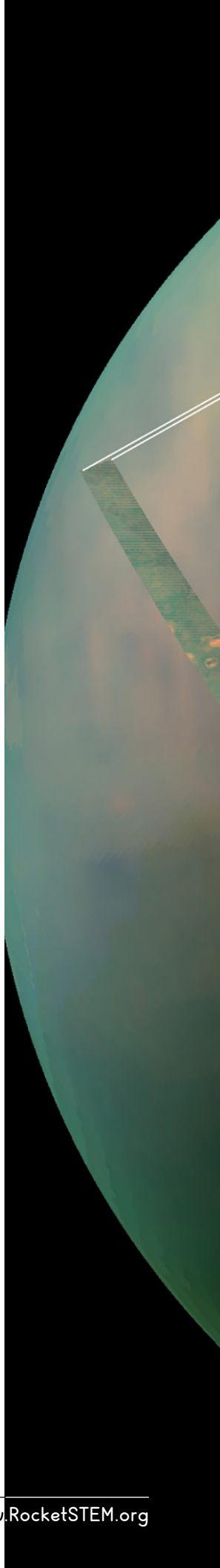
The near-infrared images from Cassini's imaging cameras show a bright unit of terrain in the northern land of lakes that had not previously been visible in the data. The bright area suggests that the surface here is unique from the rest of Titan, which might explain why almost all of the lakes are found in this region. Titan's lakes have very distinctive shapes -- rounded cookie-cutter silhouettes and steep sides -- and a variety of formation mechanisms have been proposed. The explanations range from the collapse of land after a volcanic eruption to karst terrain, where liquids dissolve soluble bedrock. Karst terrains on Earth can create spectacular topography such as the Carlsbad Caverns in New Mexico.

"Ever since the lakes and seas were discovered, we've been wondering why they're concentrated at high northern latitudes," said Elizabeth (Zibi) Turtle, a Cassini imaging team associate based at the Johns Hopkins Applied Physics Laboratory, Laurel, Md. "So, seeing that there's something special about the surface in this region is a big clue to help narrow down the possible explanations."

Launched in 1997, Cassini has been exploring the Saturn system since 2004. A full Saturn year is 30 years, and Cassini has been able to observe nearly a third of a Saturn year. In that time, Saturn and its moons have seen the seasons change from northern winter to northern summer.

"Titan's northern lakes region is one of the most Earth-like and intriguing in the solar system," said Linda Spilker, Cassini project scientist, based at NASA's Jet Propulsion Laboratory, Pasadena, Calif. "We know lakes here change with the seasons, and Cassini's long mission at Saturn gives us the opportunity to watch the seasons change at Titan, too. Now that the sun is shining in the north and we have these wonderful views, we can begin to compare the different data sets and tease out what Titan's lakes are doing near the north pole."

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency.



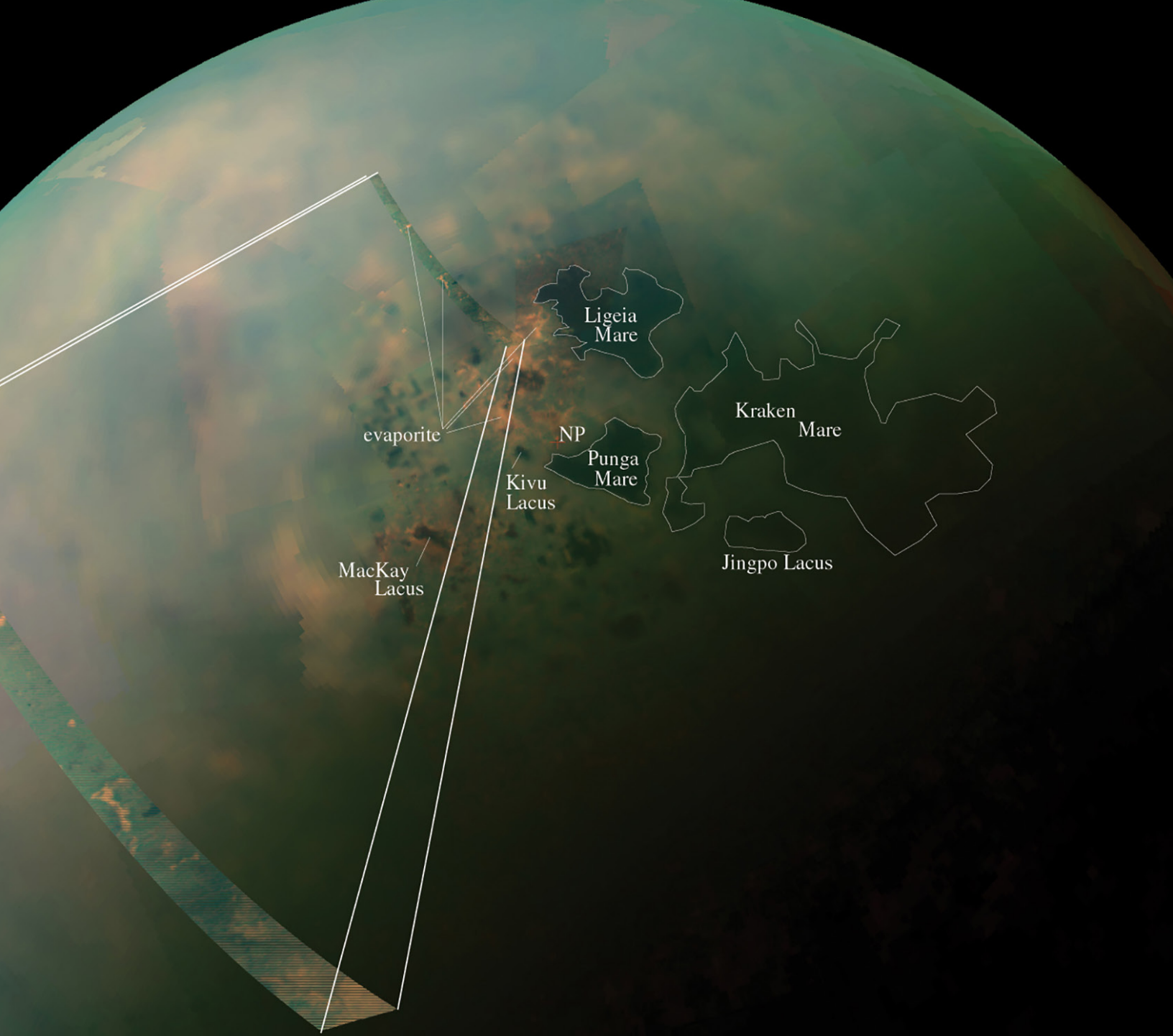


Image: NASA/JPL-Caltech/University of Arizona/University of Idaho

The rocket (top) created a mound of exhaust and a cloud of dust as it took off.

Photo: NM Student Launch Program

Spectators waiting for the SL-7 launch (center) line the rim of a small ridge on the remote, 28-square-mile Spaceport America property in southern New Mexico.

Photo: Loretta Hall

Jerry Larson, president of UP Aerospace, inserts a payload canister (bottom) in the SpaceLoft 7 rocket while team member Dan Hanle watches.

Photo: NM Student Launch Program

Students send experiments to space on suborbital flight

By Loretta Hall

Gasps, whistles, and cheers burst from 300 observers as the SpaceLoft 7 rocket blasted into the sky from Spaceport America in southern New Mexico. Among the crowd were 60 students, ranging from middle school through university level, who watched the rocket carry experiments they had designed and built.

"That feeling of seeing something you built fly up into space is incredible," said 13-year-old Emerson Schoeppner. He and other students at Camino Real Middle School and La Academia de Dolores Huerta Middle School, both in Las Cruces, New Mexico, developed experiments using algae.

"Students were asked to propose experiments using algae because NASA is interested in technologies that enable humans to live and work in space," said Dr. Patricia Hynes, director of the New Mexico Space Grant Consortium, which conducts the Student Launch Program. "Algae can remove carbon dioxide from the atmosphere inside the space station. It can produce crude oil which can be refined into bio-fuels for aviation, another research area of NASA's. Algae is also nontoxic, inexpensive, and can be used by students without much risk to their health."

UP Aerospace personnel attached each student team's experiments to Plexiglas shelves that would fit in aluminum payload canisters. *Photo: NM Student Launch Program*

The students used two types of algae, growing samples of each type in a nutrient-rich liquid and in agar gel. Control samples stayed in the schools, while experimental samples rode the rocket. The students had to design containers for the samples that would not leak during the spaceflight. They placed the algae samples in the containers two months before the flight so the containers could be sent to UP Aerospace's headquarters in Highland Ranch, Colorado. There, the rocket manufacturer bolted the containers to 9-inch-diameter Plexiglas plates and then attached a stack of plates to the base of one of seven 10-inch-tall aluminum cylinders that would comprise the rocket's payloads. After each metal canister was closed, it was spun to balance it and verify that the contents were securely fastened.

Two days before the flight, UP Aerospace workers prepared the cylinders for insertion into the rocket at Spaceport America. A credit-card-size opening in the side of each canister provided access so the students could inject the liquid and gel growth mediums through tube systems they had designed.

At eight o'clock the morning of June 21, 2013, the 20-foot-long SpaceLoft 7 (SL-7) rocket shot off the launching pad, reaching a speed of Mach 5 (about 3,800 miles an hour) on its way to an altitude of 74 miles—a record for both UP Aerospace and Spaceport America. The experiments it carried experienced 17 g's of force and four minutes of microgravity. At the end of its 15-minute flight, the rocket's payload section parachuted to the ground 23 miles from the launch pad, at its target site on White Sands Missile Range. The recovery team loaded it onto an Army helicopter, flew back to Spaceport America, and circled the crowd at the observation post on its way to the launch control center a mile and a half away. After the UP Aerospace team removed five canisters containing other customers' payloads, the helicopter carried the rocket section to the observation post. There, students watched as the two remaining canisters were removed and opened, and each team's experiments were taken out and turned over to the students.

"Some of the experiments leaked during flight and the algae were 'disadvantaged,'" Hynes reported. "But by July 1, all flown cultures, including the 'disadvantaged,'

were reproducing similarly to the controls on the ground."

Besides the two experiments from middle school teams, the rocket carried five experiments from high school and university students. For instance, a team at Cobre High School in Silver City, New Mexico, designed a flexible container for liquid experiments. The students sewed layers of heat-resistant Nomex and water-resistant Gore-Tex into a pouch and closed it with a waterproof zipper. Filled with water for the test flight, the pouch was wrapped with an absorbent mat in case it leaked. In their post-flight report, the students wrote, "After the flight while completing the de-integration process, no water leakage on the Pigmat material was detected. Only a few drops of water was left in the form factor. It is theorized that the water vaporized due to exposure to high temperatures or because of the lapsed time between pre-launch preparation and time of flight."

Students at Las Cruces High School and Dona Ana Branch Community College sent bean sprouts on the rocket. During the flight, their instruments recorded a number of factors including humidity levels, carbon dioxide levels, and temperature. They planned to plant the sprouts from the experimental and control groups and monitor their growth and productivity.

A team of seniors in New Mexico State University's Electrical and Computer Engineering Department tested their design for a common power-data bus that could supply electricity to student payloads and collect data from the experiments. To date, student experiments requiring electric power have used batteries.

The students were excited to see their experiments fly into space and examine them after their safe return. "I woke up at two in the morning to come here, so I was ready," Schoeppner said. "That feeling of success—just awesome."

Two days before the launch, students could add critical materials to their experiments through an opening in the side of the payload canister. *Photo: NM Student Launch Program*

Another exciting aspect of this launch was that it was sponsored by NASA and carried experiments for several government agencies and commercial companies alongside the students' payloads.

"This flight was under NASA's Flight Opportunities program," said Christine Anderson, executive director of the New Mexico Spaceport Authority. "We used to have the Shuttle that would carry experiments and mature technology, and we don't have that anymore. That's the reason why NASA developed this particular program. We're happy that their first flight of that was here, and we had a number of customers for the payloads for that vehicle."

NASA reserved space for its own payload on the rocket it purchased for the flight. The Suborbital Flight Environment Monitor is designed to monitor and record onboard environmental conditions throughout the flight. The information will be useful in planning future missions, which the instrument will also monitor.

The Federal Aviation Administration tested an Automatic Dependent Surveillance-Broadcast System device on the flight. The system will be used on aircraft and rockets to ensure they share airspace safely. The Department of Defense, Virginia-based Control Dynamics, the Italian engineering firm DTM, and several commercial enterprises also flew experiments or other cargo on the rocket.

The June 2013 flight was the eleventh launch by UP Aerospace from Spaceport America. It was the seventh to use the company's SpaceLoft rocket, while the other four involved test vehicles made by other companies. For the first time, this SpaceLoft vehicle was equipped with a de-spin system designed to quickly slow the rocket's bullet-like spin after it left the atmosphere. It used a set of weights attached to the rocket by cables. When the system was activated, the weights swung outward and slowed the rocket's spin much as figure skaters do by extending their arms.

SL-7 was the first UP Aerospace flight sponsored by NASA's Flight Opportunities Program and the program's first suborbital spaceflight that carried student experiments. Flight Opportunities Program Executive L.K. Kubendran took the opportunity to make his first visit to Spaceport America. "Our goal is to fly more payloads, and eventually more student payloads," he said. "On one side, we want to mature technology for spaceflights in the future. On the other side, we also want to encourage and foster industry to develop [flight

Crew members carry the rocket's recovered payload section from the Army helicopter to the launch control center two hours after liftoff. *Photo: UP Aerospace Inc./Krista Minor*

technology] that's faster and that's cheap, so that in the end, we'll have a lot more companies flying commercial spaceflights. NASA would just be one of the many paying customers, not the only customer."

New Mexico's Student Launch Program is unique. Since 2009, 827 students have participated in the program, sending a total of 76 experiments on five suborbital flights. "This is the only educational initiative in the country that gives students access to a commercial launch complex on a consistent basis," Hynes said. However, Kubendran explained that students have other NASA-sponsored opportunities to experiment in conditions of extremely high altitude and microgravity. Some projects fly on helium balloons that float at altitudes above 20 miles for up to 20 hours. Others fly on a modified Boeing 727 owned by Zero-G Corporation, which follows a series of vertical parabolic arcs, achieving 30 seconds of microgravity at the top of each arc.

"We have done three to four flight weeks every year on the Zero-G platform," Kubendran said. "We hope to continue that on an ongoing basis. That gives an opportunity for the students to develop the experiment, build the experiment, fly the experiment, and to be in zero gravity with it"

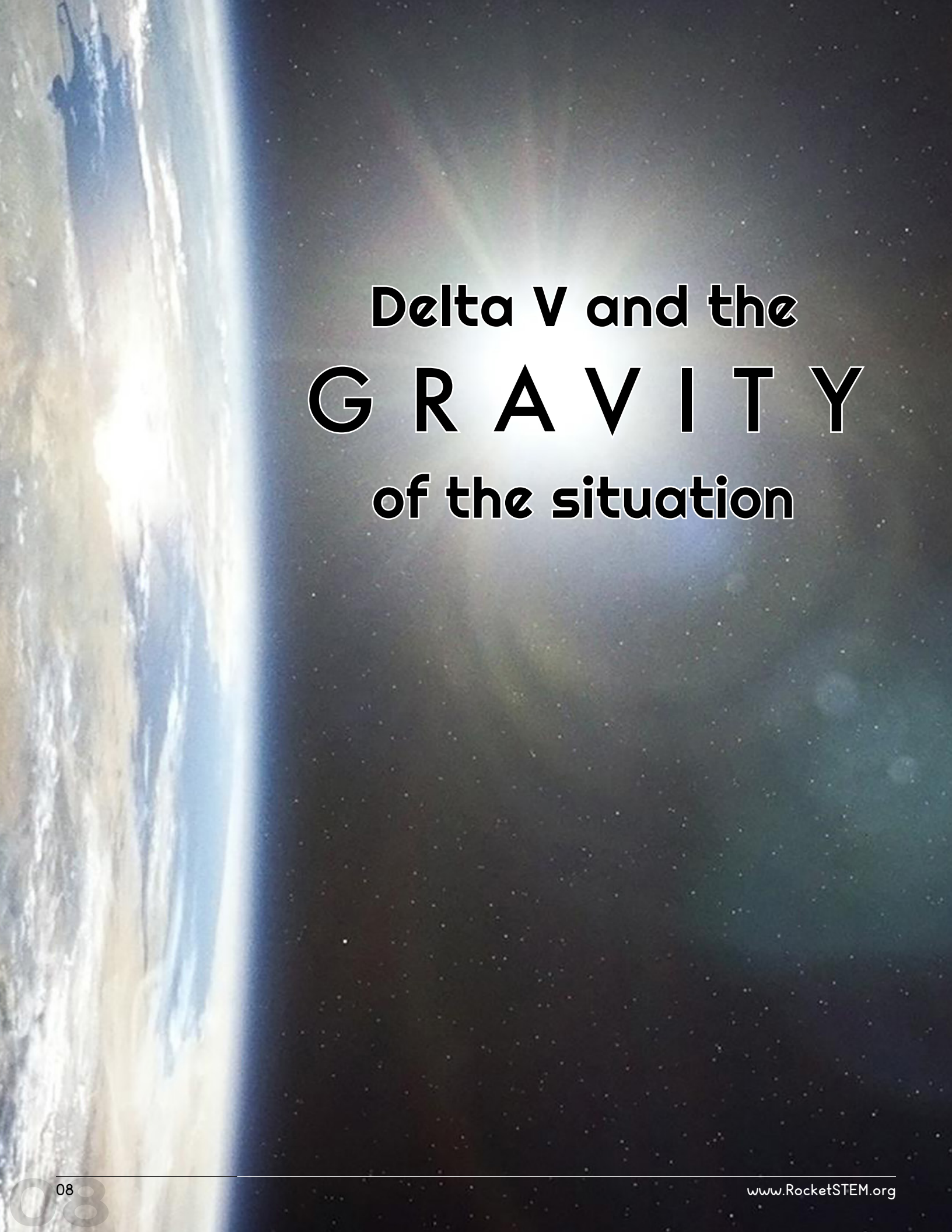
New types of spacecraft being developed by Virgin Galactic and XCOR will offer additional possibilities when they are ready for operation. NASA already has contracts with both of those companies. "Obviously, with UP Aerospace, you've got to send the experiments alone," Kubendran told the crowd as they waited for the SL-7 payloads to be brought back to Spaceport America. "But when Virgin Galactic and XCOR start flying, maybe there's an opportunity for the researchers in this audience to fly with their payload into space. That's coming in the near future."

Other opportunities for students and educators nationally:

- Education programs sponsored by NASA, www.nasa.gov/offices/education/programs/descriptions/All_Alpha.html.
- The Student Spaceflight Experiments Program, http://ssep.ncesse.org.
- Student contests sponsored by the National Space Society, www.nss.org/contests.

About the Author: *Loretta Hall is the author of Out of this World: New Mexico's Contributions to Space Travel and the website www.NMSpaceHistory.com.*

Photo: Loretta Hall



Delta V and the GRAVITY of the situation

Photo: Gravity. Warner Bros./Esperanto Filmoj/Heyday Films

In the recent film release, "Gravity," astronauts are left stranded at the Hubble Space Telescope (HST) after a pretty horrific accident. Since one of the astronauts was wearing a Manned Maneuvering Unit (MMU), they used the nifty apparatus to get to the International Space Station (ISS). We like this movie, even though many space blogs have been written about how this feat is virtually impossible, simply because of the different orbital heights and orbital inclinations.

The verdict: impossible!

So the question is whether there is a way to find out if the accusation is true? I mean it's not like there's a Pre-Calculus class out there in America that is actually running a S.T.E.M. project that calculates Delta V, is there? Well, guess what? There really is.

As it turns out, The Learning Community Charter School (TLCCS), a High School in Albuquerque, NM, has a Pre-Calculus class that is running a S.T.E.M. for the Classroom Delta V project. They even have an app for it! Moreover, they presented their findings to their class on October 17, 2013.

Now the question is can we use their app to determine the required Delta V that our hapless astronauts need? Sure we can! Let's plug in some numbers and find out how.

Note: *For this exercise, we will ignore the orbital inclination and destination positioning. Uh...don't ask.*

The equations needed are a bit sticky, but they work nicely, especially in a spreadsheet.

$$\Delta v_{Periapsis} = \sqrt{\frac{\mu}{r_1}}\left(\sqrt{\frac{2r_2}{r_1 + r_2}} - 1\right)$$

$$\Delta v_{Apoapsis} = \sqrt{\frac{\mu}{r_2}}\left(1 - \sqrt{\frac{2r_1}{r_1 + r_2}}\right)$$

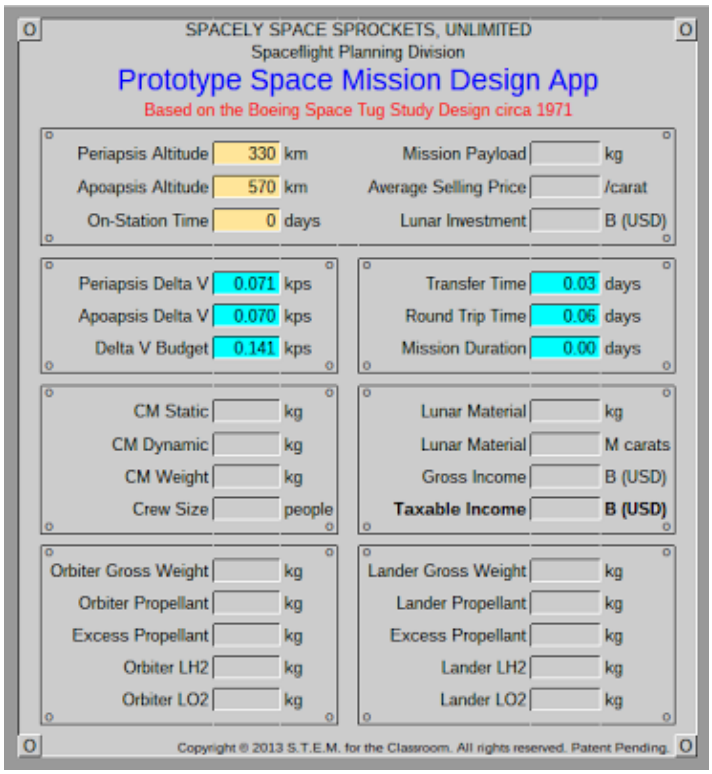
Here's some technical terms to match what the students had to work with: the periapsis is the lowest point of an elliptical orbit, while the apoapsis is the highest point.

Since the astronauts start at the higher orbital altitude, and try to thwart their momentum instead of applying an opposite thrust, we'll only concentrate on the Apoapsis Delta V.

First things first: if you what to change your orbital altitude, you must know the orbital altitudes that you want to change from and to. Looking up the particulars of HST and the ISS, we get that the HST Orbital altitude is 354 miles and the ISS Orbital Altitude is 205 miles (your mileage may vary, since their orbits are decaying).

Of course, we have to always first convert everything to S.I. units for the app. Therefore, since one mile equals 1.609 km, The HST orbital altitude is at 570 km and the ISS orbital altitude is 330 km.

We're now set to tackle the question. To the ~~Batmobile~~ app!



Click this link to go the app: http://bit.ly/s4cGRAVITY

The link above is to a working copy of the Delta V App that S.T.E.M. for the Classroom has created for TLCCS students to use in their Pre-Calculus projects.

The inputs are: Periapsis: 330 and Apoapsis: 570 (we can ignore the On-Station Time).

The output is: Apoapsis Delta V is 0.070 kps, or 70 mps. Not much of a change needed, huh? But can the MMU handle it?

The MMU is rated at 24.4 mps. Since 24.4 is no where near 70, we therefore can safely conclude that the MMU does not have the capability of reaching the ISS from the Hubble.

Too bad this kind of stuff isn't taught at a High School somewhere, huh? Oh wait. There is a High School out there somewhere that is trying their best to provide students with relevant math topics after all. This entire lesson was taught at TLCCS, and will continue to be taught, along with other innovative and fun S.T.E.M. stuff geared for Pre-Algebra, Algebra 1 and Algebra 2 classes.

Besides, wouldn't this lesson be better than wasting time on Standardized Tests? Isn't this a better way of getting students to a deeper level of understanding in mathematics and critical thinking?

By the way, the movie has great human drama and has got some great special effects. However, what's projected on the screen simply ain't happening. Our students proved as much given all the above.

For a more in-depth treatment of this high school project by Joe Maness & Rich Holtzin visit www.stemfortheclassroom.com.

How long before we get there?

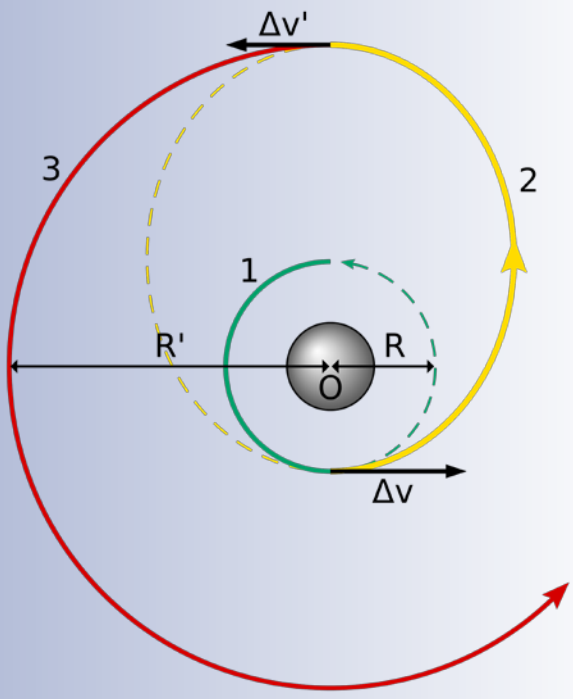
Vocabulary

- *Apoapsis Delta V Burn:* The rocket firing at the highest point of a Transfer Orbit.
- *Periapsis Delta V Burn:* The rocket firing at the lowest point of a Transfer Orbit.
- *Transfer Time:* The time between apoapsis and periapsis Delta V rocket firings.

Narrative

Getting from one orbital altitude to another not only takes delta v, it also takes time. It isn't as simple as aiming yourself and firing your rocket. Orbital mechanics is a ballet in space, where the lower your orbit the faster you go, and vise versa.

Any change in orbital velocity and you wind up in an elliptically-shaped orbit, instead of the fairly stable circular orbit.



Source: www.wikipedia.org/wiki/Hohmann_transfer_orbit

Transferring from one orbit to another is accomplished by changing a circular orbit (represented in by the green and red circles in the image above) into an elliptical orbit (represented by the yellow curve). The Transfer Time is the time it takes for the spacecraft to follow the path of the yellow curve.

To get from one orbit to another, we must push ourselves off, and then brake when we get there. We coast in between these two maneuvers. We can calculate how much time we will coast from one point in space to another.

Photo: Gravity. Warner Bros./Esperanto Filmoj/Heyday Films

Analysis

The equation to calculate the transfer time from one orbital altitude to another is given by one of the Hohmann Transfer Orbit Equations:

$$T_s = \pi \sqrt{\frac{(r_1 + r_2)^3}{8\mu}}$$

where

- T_s is Transfer Time in seconds
- r_1 is the smaller orbital radius
- r_2 is the larger orbital radius
- μ (mu) is Earth Standard Gravity = 9.80665 m/s^2
- π (pi) is the constant 3.14159265358979323846264338327950288419716939937...

The number π (pi) is involved in the equation because we are actually going around in circles.

Example

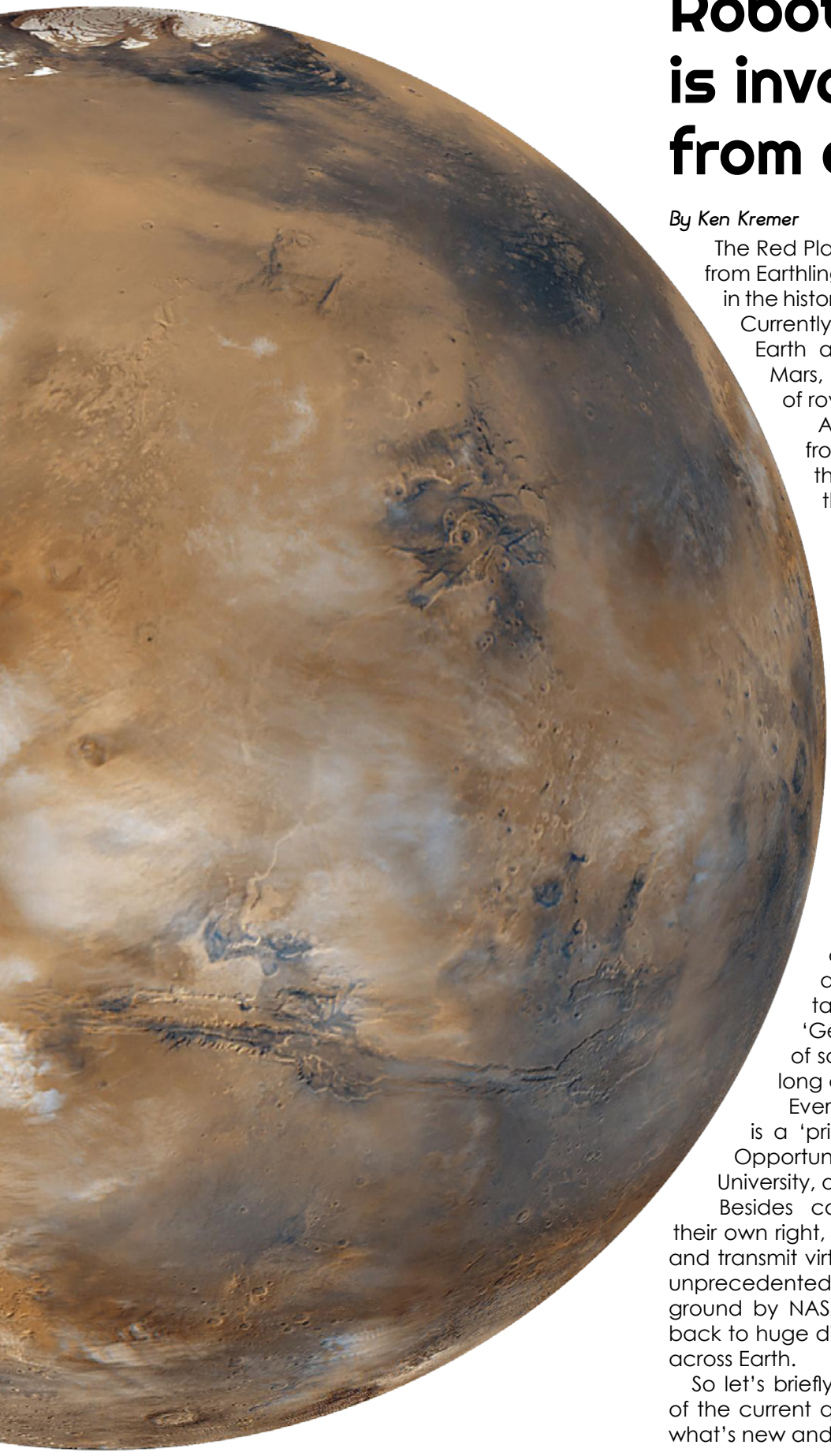
Let's suppose you want to go from the Hubble Space Telescope (HST) to the International Space Station (ISS). How long would it take to get there?

The orbital radius is simply the sum of the orbital altitude plus the radius of the Earth. So for the HST (r1), we get 6,708.14 km, and for the ISS (r2) we get 6,948.14 km.

Plugging everything in the equation, we get 2,673 seconds of transfer time. If we divide that by sixty (seconds per minute) we get 44.55 minutes.

Conclusion

It takes about half an orbit to transfer between two orbital altitudes that are not that far apart.



Robotic armada is invading Mars from all directions

By Ken Kremer

The Red Planet is getting a whole lot of attention from Earthlings right now, and it's like never before in the history of humanity and space exploration. Currently, an armada of five spacecraft from Earth are actively exploring the vicinity of Mars, including a trio of orbiters and a duo of rovers.

All but one of those space probes is from NASA. The lone exception being the Mars Express (MEX) orbiter from ESA, the European Space Agency. And later this Fall, two additional probes - NASA's MAVEN and India's Mars Orbiter Mission (MOM) - will blast off to embark on long interplanetary voyages in search of new Martian discoveries beginning late in 2014.

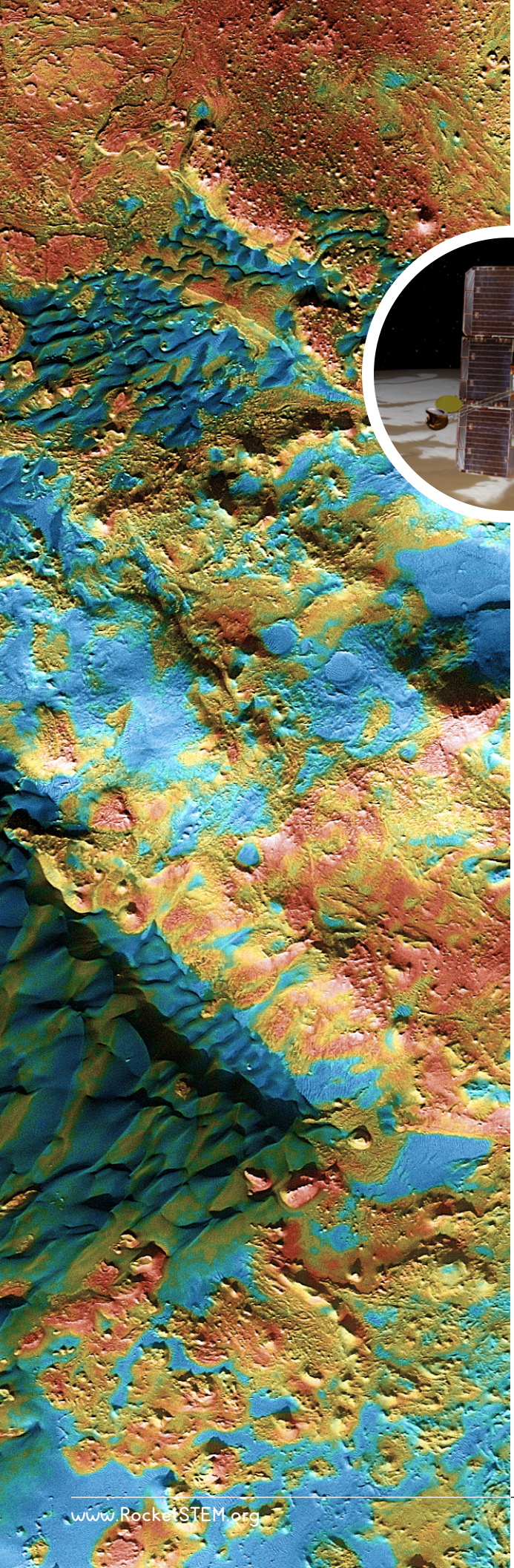
Joining MEX, NASA has two orbiters and two surface rovers plying the Martian skies and plains. Circling overhead are Mars Odyssey (MO) and Mars Reconnaissance Orbiter (MRO). Trundling below are the Martian sister rovers, Opportunity and Curiosity.

The spacecraft literally form an invasion fleet embarked on a coordinated attack plan that's directed by an elite group of highly talented engineering and science 'Generals' so as to reap every last drop of scientific research possible - and for as long as possible.

Every one of these unique spacecraft is a 'priceless asset' as Prof. Steve Squyres, Opportunity's Principal Investigator of Cornell University, or lead scientist, is fond of saying.

Besides conducting breathtaking science in their own right, the MO, MRO and MEX orbiters relay and transmit virtually all of the gorgeous photos and unprecedented research data collected on the ground by NASA's Curiosity and Opportunity rovers back to huge dish antenna receiving stations spread across Earth.

So let's briefly review the history, goals and results of the current quintet of our Martian fleet and learn what's new and upcoming in the near term.



Mars Odyssey

NASA's Mars Odyssey orbiter sets a new record for longevity with each passing day and has worked longer at the Red Planet than any other spacecraft in human history.

It was launched on April 7, 2001 atop a Delta II rocket from Cape Canaveral Air Force Station, Florida. After an interplanetary journey of hundreds of millions of miles, it arrived at Mars way back on Oct. 24, 2001 and fired its main engine to brake the crafts speed and allow it to be captured by Mars and enter a highly elliptical orbit.

The previous Martian record holder was the Mars Global Surveyor (MGS) orbiter which operated in orbit from Sept. 11, 1997 to Nov. 2, 2006 until contact was lost following a computer glitch.

A technique known as aerobraking was used over the next three months to fly Odyssey through the upper atmosphere of Mars and utilize drag to gradually lower the crafts altitude and eventually enter its science mapping orbit.

Odyssey has made numerous high impact scientific discoveries along the way since science operations began in February 2002. Within a few months, Odyssey made the key discovery of the entire mission when it found that the polar regions harbored substantial caches of water ice within a meter of the dry surface of Mars.

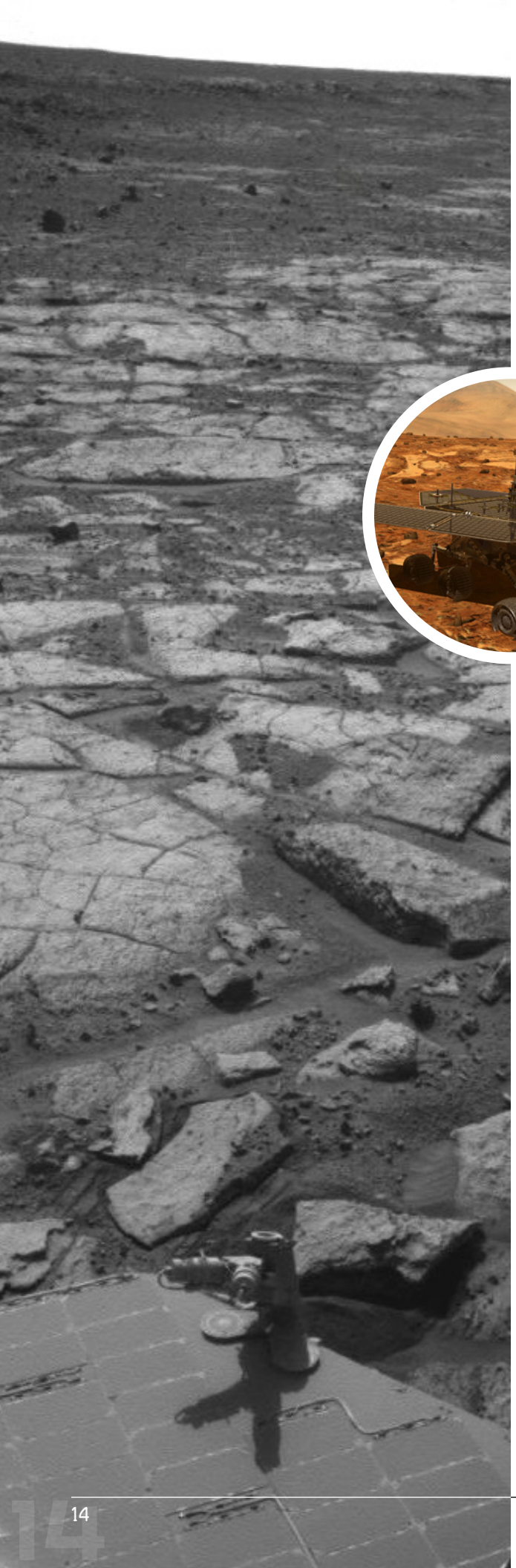
The detection of water – in the form of hydrogen — from orbit using the crafts Gamma Ray Spectrometer led directly to the proposal for the Phoenix mission which confirmed the discovery in 2008. Phoenix landed directly on top of vast sheets of frozen water ice in the northern polar region of Mars and scooped up samples of ice for analysis by the landers science suite.

Odyssey also relayed most of the science data from Spirit, Opportunity and Phoenix and is continuing that task for the new rover Curiosity.

Mars Odyssey is equipped with three primary science instruments;

- THEMIS (Thermal Emission Imaging System), for determining the distribution of minerals, particularly those that can only form in the presence of water;
- GRS (Gamma Ray Spectrometer), for determining the presence of 20 chemical elements on the surface of Mars, including hydrogen in the shallow subsurface (which acts as a proxy for determining the amount and distribution of possible water ice on the planet); and,
- MARIE (Mars Radiation Environment Experiment), for studying the radiation environment.

Odyssey completed a survey of the radiation environment to determine the radiation-related risk to any future human explorers who may one day go to Mars and globally mapped the amount and distribution of many chemical elements and minerals that make up the Martian surface. Such data helps explain how the planet's landforms developed over time, provides clues to the geological and climatic history of Mars, informs about the potential for finding past or present life and where are the best locations to search for life and send future landers.



Opportunity

Nearly a decade ago, NASA's pair of identical twin sister rovers – christened Spirit & Opportunity- bounced to daunting airbag-cushioned landings on opposite sides of the Red Planet for what was supposed to be merely 90 day missions, or maybe a little bit longer scientists hoped. They were launched by Delta II boosters a few weeks apart from the Florida Space Coast during the summer of 2003.

Today, Opportunity celebrates a truly unfathomable achievement, approaching Year 10 on Mars since she rolled to a bumpy stop on January 24, 2004 inside tiny Eagle crater. Spirit continued roving and exploring for over six years until she unexpectedly died in a hidden sand trap.

And as of late summer 2013, Opportunity had just arrived at the base of the first Martian mountain she will ever climb - named Solander Point. Heretofore, the robot has visited numerous craters big and small. Craters offer a window into the past history of Mars.

After investigating the mountains base, Opportunity will eventually scale Solander in search of the chemical ingredients that could sustain Martian microbes. It's expected to be a super sweet spot for science, potentially loaded with clays and hydrated mineral veins and making the most remarkable findings yet about the planets watery past - thus building upon a long string of previously unthinkable discoveries due to her totally unforeseen longevity.

"Regarding achieving nine years, I never thought we'd achieve nine months!" Principal Investigator Prof. Steve Squyres of Cornell University told RocketSTEM.

As of November 2013, Opportunity has surpassed 3480 Sols, or Martian days on the surface. She is now 119 months into the 3 month primary mission - that's 39 times beyond the 90 day "warranty." With her 6th ultra frigid Martian winter approaching, the golf cart sized rover remains healthy, has snapped over 185,000 images and driven over 23 miles.

The resilient, solar powered Opportunity robot is roving around beautiful Martian terrain that is remarkably Earth-like and where life sustaining liquid water once flowed billions of years ago.

Opportunity is currently located at the western rim of huge Endeavour crater where she made landfall in August 2011. 14 mile (22 km) wide Endeavour Crater features terrain with older rocks than previously inspected and unlike anything studied before.

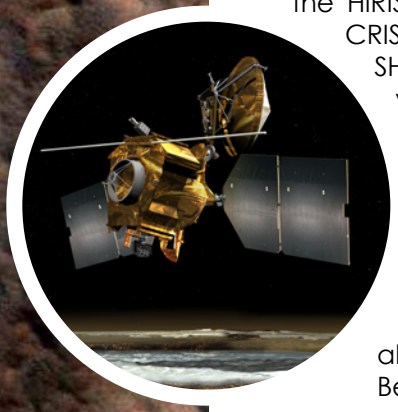
Since then she spent most of her time investigating a low rise along the eroded rim named Cape York, where she discovered phyllosilicate clay minerals on Mars for the first time in history.

At Cape York, the rover investigated "Esperance" rock during Spring 2013. It was loaded with clay minerals that form in neutral water - more conducive to life - that ranks as one of the "Top 5 discoveries of the mission" according to Squyres.

Opportunity is now investigating the foothills of Solander before ascending the north facing slopes by year's end to soak up the sun for the life giving solar arrays during the six month long Antarctic-like winter.

Mars Reconnaissance Orbiter

MRO is NASA's biggest and most powerful orbiter circling Mars. It was launched on August 12, 2005 atop an Atlas V rocket from Florida, and achieved orbit over seven years ago on March 10, 2006. Like its smaller cousin Mars Odyssey, it used several months of aerobraking maneuvers to attain its final science orbit to preserve precious fuel and extend the mission lifetime.



MRO is equipped with six science instruments, including the HiRISE high resolution camera and two others, the CRISM mineral mapping spectrometer and the SHARAD subsurface radar hunting for signatures of water and internal geological structures.

The torrent of spectral data and tens of thousands of imagery from MRO has completely revolutionized our understanding of the Red Planet.

HiRISE is the largest diameter telescope ever sent on a mission to deep space. It's like having a spy camera at Mars and sports a resolution of about 1 foot from an altitude of about 200 miles.

Besides science, the high resolution HiRISE camera was used to hunt for safe landing sites for all the recent rovers and landers over the past seven years. And CRISM was a significant aid as well in selecting the most scientifically compelling landing sites based on the spectral data searching for clues to water and minerals that could support Mars life.

And after the rovers safely touched down, the HiRISE images are also used in real time to track and direct the robots along safe and swift driving paths with the best science return and also avoid potentially deadly quagmires, as much as possible.

HiRISE is so powerful that it even captured the iconic images of Phoenix and Curiosity during their parachute assisted descents to the surface.

Recently, NASA approved the use of CRISM to capture special new high resolution spectral scans of minerals that are absolutely crucial for directing the long lived Opportunity rover's hunt for signatures of habitability atop the intriguing mountain named Solander that she will soon ascend.

New CRISM observations centered over Solander Point were acquired during August 2013, according to Ray Arvidson, who is the mission's deputy principal scientific investigator from Washington University in St. Louis, Mo.

Photos and renderings:

Page 12: Mars Global Surveyor acquired this global map of Mars in September of 2000 (NASA/JPL/MSSS). Page 13: Arabia Dunes (NASA/JPL-Caltech/ASU). Rendering of Odyssey orbiting Mars (NASA/JPL). Page 14: Opportunity's Nav Camera took this photo on Sol 3391 (NASA/JPL-Caltech). Rendering of Opportunity (NASA/JPL-Caltech). Page 15: The Serpent Dust Devil of Mars (NASA/JPL-Caltech/Univ. of Arizona). Rendering of Mars Reconnaissance Orbiter (NASA/JPL-Caltech). Page 16: Hebes Chasma photographed by Mars Express (ESA/DLR/FU Berlin/G. Neukum). Rendering of Mars Express (ESA/Medialab). Page 17: Point Lake Outcrop in Gale Crater (NASA/JPL-Caltech/MSSS). Self portrait of Curiosity (NASA/JPL-Caltech/MSSS).

Mars Express

The Mars Express spacecraft is Europe's first mission to the Red Planet. It was launched on June 2, 2003 atop a Russian Soyuz rocket from the Baikonur Cosmodrome in Kazakhstan and attained orbit on December 25, just prior to the arrivals of Spirit and Opportunity. The probe has worked magnificently ever since.

It is equipped with eight science instruments from a variety of European nations. The High Resolution Stereo Camera (HRSC) from Germany has provided thousands of fabulous color images from all over Mars with a two meter resolution. The Visible and Infrared Mineralogical Mapping Spectrometer (OMEGA) spectrometer from France discovered deposits of phyllosilicate clay minerals from orbit. The Sub-Surface Sounding Radar Altimeter (MARSIS) from Italy discovered subsurface water and complements the SHARAD radar instrument on MRO.

MAVEN

MAVEN (Mars Atmosphere and Volatile EvolutioN Mission) is NASA's next mission to Mars and scheduled to lift off on Nov. 18, 2013 from Cape Canaveral, Florida. Read complete details about MAVEN in the story starting on page 22.

Mars Orbiter Mission

MOM counts as India's first ever mission to Mars. It is due to blastoff on India's Polar Satellite Launch Vehicle (PSLV) from Srihanikota, India during a launch window that runs from Nov. 5 to Nov. 19. The orbiter is a technology demonstrator equipped with cameras and atmospheric spectrometers. NASA is providing communications and navigation support through the Deep Space Network (DSN). Read complete details about MOM in the story starting on page 20.

The nations of Earth plan even more exciting missions to Mars later this decade, We'll describe them in a future issue of RocketSTEM.

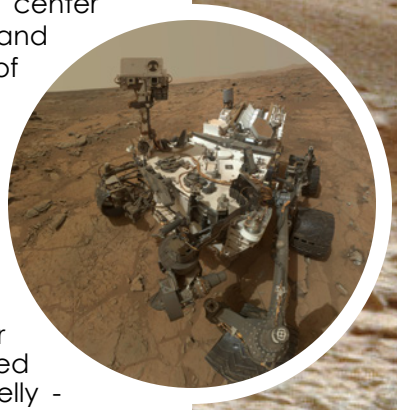
Curiosity

NASA's mega Mars rover Curiosity is celebrating 1 Year on the Red Planet since the dramatic, nail biting touchdown on Aug. 6, 2012 by reveling in a string of groundbreaking science discoveries demonstrating that Mars could once have supported past life - thereby accomplishing her primary science goal - and with a promise that the best is yet to come!

"We now know Mars offered favorable conditions for microbial life billions of years ago," said the mission's project scientist, John Grotzinger of the California Institute of Technology in Pasadena, CA.

"Curiosity has landed in an ancient river or lake bed on Mars," Jim Green, Director of NASA's Planetary Science Division, told RocketSTEM.

As 2013 comes to a close, the six wheeled robot is now speeding onwards towards Mount Sharp, the huge 3.4 mile (5. 5 km) high mountain dominating the center of her Gale Crater landing site - and which is the primary destination of the mission.



During Year 1, Curiosity has transmitted over 190 gigabits of data, captured more than 71,000 images, fired over 75,000 laser shots to investigate the composition of rocks and soil and drilled into two rocks for sample analysis by the pair of state-of-the-art miniaturized chemistry labs housed in her belly - SAM and CheMin.

"From the sophisticated instruments on Curiosity the data tells us that this region could have been habitable in Mars' distant past," Green told me. "This is a major step forward in understanding the history and evolution of Mars."

Mount Sharp still lies roughly 4 miles (6 kilometers) distant – as the Martian crow flies - and the rover should arrive there sometime in the Spring of 2014 if all goes well.

The lower reaches of Mount Sharp are comprised of exposed geological layers of sedimentary materials that formed eons ago when Mars was warmer and wetter, and much more hospitable to microscopic life.

"We hope those enticing layers at Mount Sharp will preserve a broad diversity of other environmental conditions that could have affected habitability." says Grotzinger.

Read more about Curiosity's adventures in the January 2013 and April 2013 issues of RocketSTEM, as well as in future issues.

Generations of windblown sediments on Mars

By Paul Geissler

This colorful scene is situated in the Noctis Labyrinthus region of Mars, perched high on the Tharsis rise in the upper reaches of the Valles Marineris canyon system.

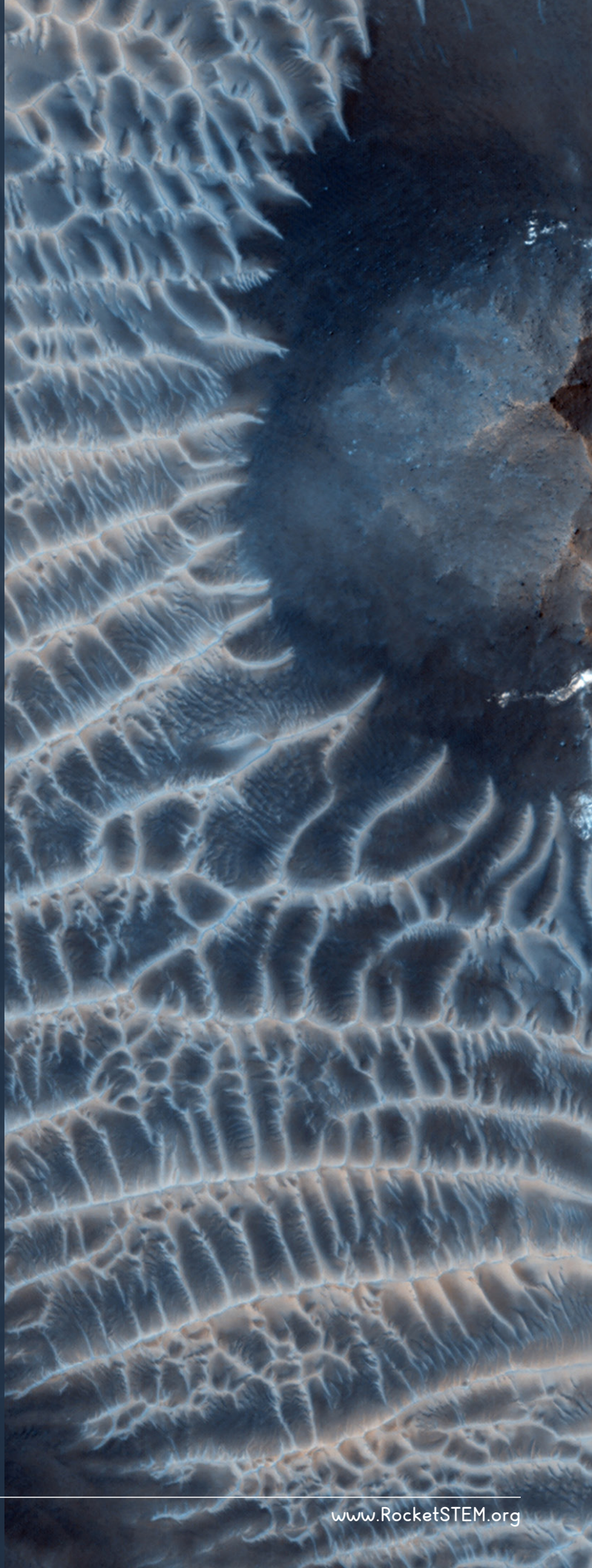
Targeting the bright rimmed bedrock knobs, the image also captures the interaction of two distinct types of windblown sediments. Surrounding the bedrock knobs is a network of pale reddish ridges with a complex interlinked morphology. These pale ridges resemble the simpler "transverse aeolian ridges" (called TARs) that are common in the equatorial regions of Mars.

The TARs are still poorly understood, and are variously ascribed to dunes produced by reversing winds, coarse grained ripples, or indurated dust deposits. HiRISE observations of TARs have so far shown that these bedforms are stable over time, suggesting either that they form slowly over much longer time scales than the duration of MRO's mission, or that they formed in the past during periods of very different atmospheric conditions than the present.

Dark sand dunes comprise the second type of windblown sediment visible in this image. The dark sand dune seen just below the center of the cutout displays features that are common to active sand dunes observed by HiRISE elsewhere on Mars, including sets of small ripples crisscrossing the top of the dune. In many cases, it is the motion of these smaller ripples that drives the advance of Martian sand dunes. The dark dunes are made up of grains composed of iron-rich minerals derived from volcanic rocks on Mars, unlike the pale quartz-rich dunes typical of Earth.

This image clearly shows the dark sand situated on top of the pale TAR network, indicating that the sand dunes are younger than the TARs. Moreover, the fresh appearance of the sand dunes suggest that they are currently active, and may help shape the unusual TAR morphology by sandblasting the TARs in the present day environment.

The original image was acquired on Aug. 31, 2013, by the HiRISE (High Resolution Imaging Science Experiment) instrument aboard NASA's Mars Reconnaissance Orbiter (MRO). HiRISE is operated by the University of Arizona, Tucson.



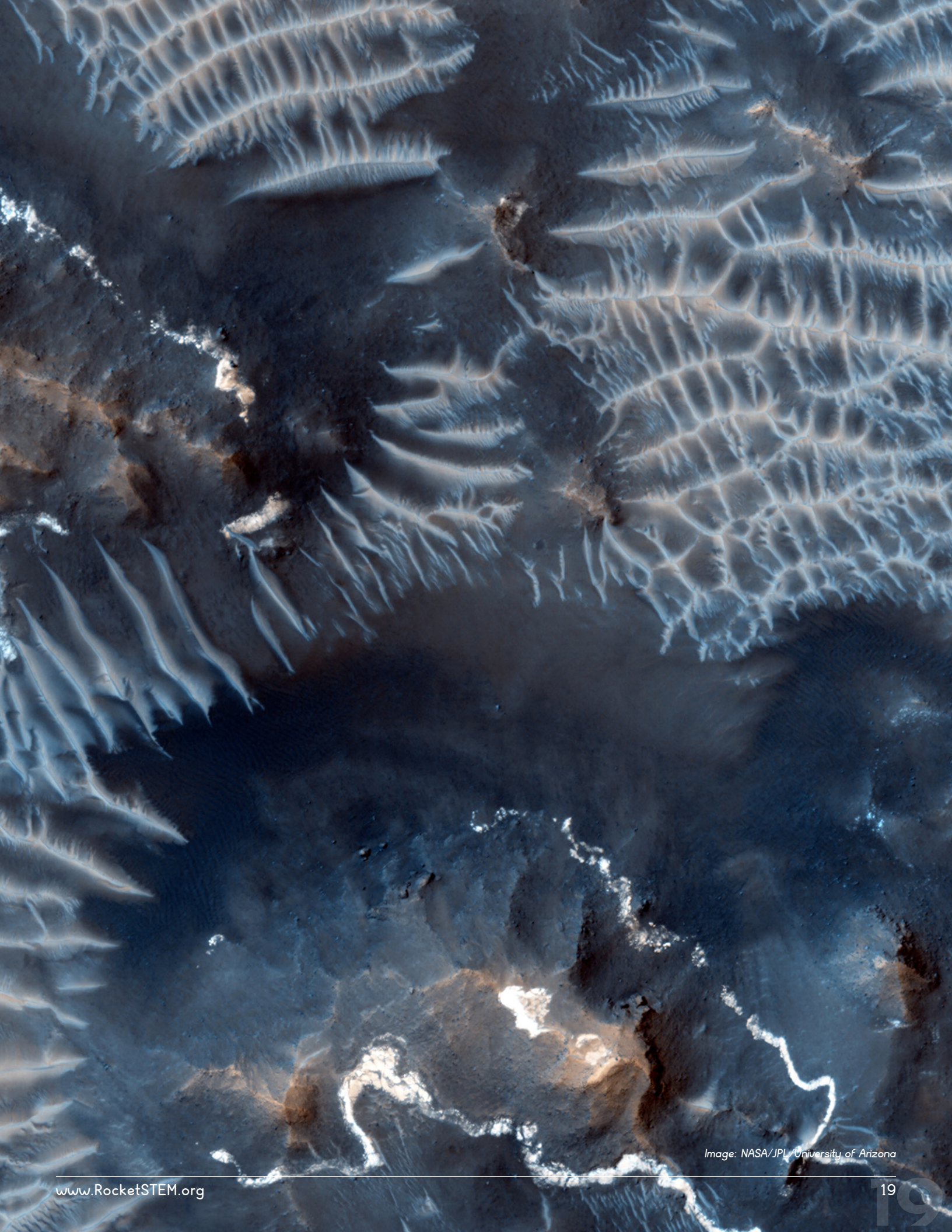
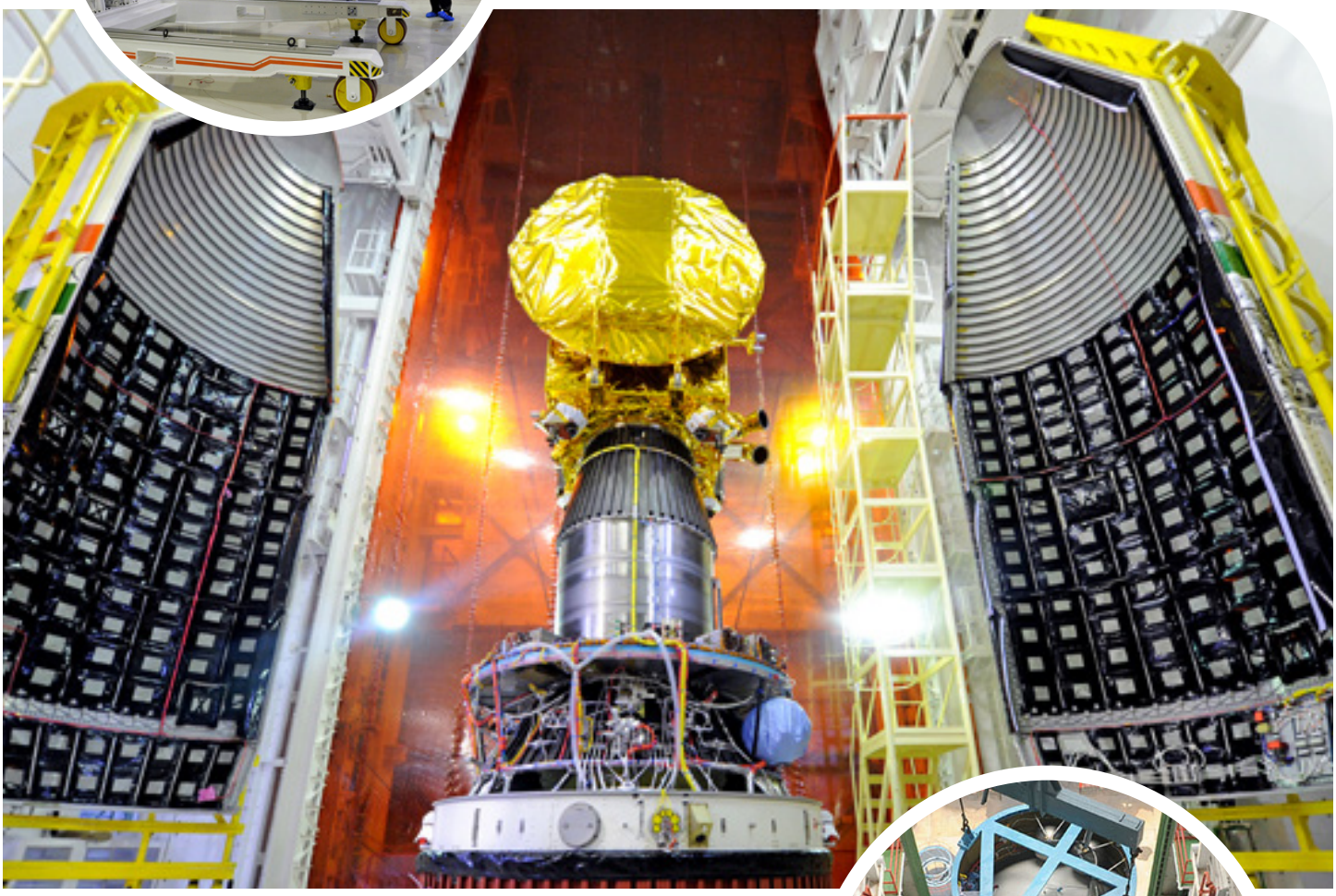


Image: NASA/JPL/University of Arizona

India launching MOM to study Mars



India's Mars Orbiter Mission spacecraft (top) is prepared for a prelaunch test at the Satish Dhawan Space Centre SHAR, Srihairkota in India. The MOM spacecraft (center) is attached to the fourth stage of PSLV-C25 and readied for heat shield closure. The second stage of the PSLV-C25 rocket (bottom) is hoisted into place within the spaceport's Mobile Service Tower. *Photos: ISRO*

By Ken Kremer

India is gearing up for its first ever space undertaking to the Red Planet - the Mars Orbiter Mission, or MOM - which is the brainchild of the Indian Space Research Organization, or ISRO.

Among other objectives, MOM will conduct a search for potential signatures of Martian methane - which could stem from either living or non living sources. The historic Mars bound probe also serves as a forerunner to bolder robotic exploration goals.

If all goes well India would become only the fourth nation or entity from Earth to survey Mars up close with spacecraft, following the Soviet Union, the United States and the European Space Agency (ESA).

The 1,350 kilogram (2,980 pound) orbiter, also known as 'Mangalyaan', is slated to blast off as early as Nov. 5 atop the more powerful, extended XL version of India's highly reliable four stage Polar Satellite Launch Vehicle (PSLV) from a seaside launch pad in Srihanikota, India.

MOM is outfitted with an array of five science instruments including a multi color imager and a methane gas sniffer to study the Red Planet's atmosphere, morphology, mineralogy and surface features. Methane on Earth originates from both biological and geological sources.

ISRO officials delayed the launch about a week due to poor weather arising from remnants from Tropical Cyclone Phaillin in the South Pacific.

'Mangalyaan' completed final prelaunch tests and rocket integration at ISRO's Satish Dhawan Space Centre SHAR, Srihairkota on the east coast of Andhra Pradesh state following shipment from ISRO's Bangalore assembly facility on Oct. 3.

MOM's launch window extends about three weeks until Nov. 19 - which roughly coincides with the opening of the launch window for NASA's next mission to Mars, the MAVEN orbiter.

NASA is providing key communications and navigation support through the agency's Deep Space Network (DSN).

The PSLV-C25 rocket (above) undergoing launch rehearsal with the Moible Service Tower retracted. The MOM spacecraft (below) is being integrated to the fourth stage of its rocket. *Photos: ISRO*

As India's initial mission to Mars, ISRO says that the mission's objectives are both technological and scientific to demonstrate the nation's capability to design an interplanetary mission and carry out fundamental Red Planet research with a suite of indigenously built instruments.

MOM's science complement comprises the tri color Mars Color Camera to image the planet and its two moons, Phobos and Deimos; the Lyman Alpha Photometer to measure the abundance of hydrogen and deuterium and understand the planets water loss process; a Thermal Imaging Spectrometer to map surface composition and mineralogy, the MENCA mass spectrometer to analyze atmospheric composition, and the Methane Sensor for Mars to measure traces of potential atmospheric methane down to the ppm level.

It will be of extremely great interest to compare any methane detection measurements from MOM to those ongoing from NASA's Curiosity rover - which found ground level methane to be essentially nonexistent - and Europe's planned 2016 ExoMarsTrace Gas Orbiter.

MOM's design builds on spacecraft heritage from India's Chandrayaan 1 lunar mission that investigated the Moon from 2008 to 2009.

The 44 meter (144 ft) PSLV will launch MOM into an initially elliptical Earth parking orbit of 248 km x 23,000 km. A series of six orbit raising burns will eventually dispatch MOM on a trajectory to Mars around late November.

Following a 300 day interplanetary cruise phase, the do or die orbital insertion engine will fire on September 21, 2014 and place MOM into an 377 km x 80,000 km elliptical orbit. It arrives about the same time as NASA's MAVEN orbiter.

The $69 million 'Mangalyaan' mission is expected to continue gathering measurements at Mars for at least six months and perhaps ten months or even longer.

NASA's MAVEN Mars orbiter with both solar arrays fully deployed at Lockheed Martin's RAL facility near Denver. *Photo: Lockheed Martin*

NASA's MAVEN orbiter set to launch on quest to study Mars atmosphere

By Ken Kremer

MAVEN (Mars Atmosphere and Volatile EvolutioN Mission) is NASA's next mission to Mars. After a decade of hard work by dedicated science and engineering teams, it is scheduled to lift off on Nov. 18, 2013 from Cape Canaveral, Florida on an Atlas V 401 rocket. The 903 kilogram (2000 pound) probe will arrive at the Red Planet in September 2014 after a 10 month interplanetary voyage.

It is the first spacecraft from Earth devoted to investigating and understanding the upper atmosphere of Mars. The purpose is to study specific processes and determine how and why Mars lost virtually all of its atmosphere billions of years ago and what effect that had on the history of climate change and habitability.

"MAVEN's goal is determining the composition of the ancient Martian atmosphere and when it was lost, where did all the water go and how and when was it lost," said Bruce Jakosky in an interview at the Kennedy Space Center. Jakosky, of the University of Colorado at Boulder, is the MAVEN Principal Investigator.

Scientists hope measurements from MAVEN's suite of nine science instruments will help answer critical questions like whether the Martian atmosphere was once substantial enough to sustain liquid water on its surface and support life.

I personally inspected MAVEN inside the clean room at the Kennedy Space Center with chief scientist Bruce Jakosky, just prior to the partial shutdown of the US government on Oct. 1. In an ultra rare viewing opportunity the solar panels were fully unfurled.

"MAVEN is on schedule and under budget" said Jakosky in an interview as we stood a meter away from the nearly fully assembled spacecraft. "The solar panels look exactly as they will be when MAVEN is flying in space and around Mars. To be here with MAVEN is breathtaking. Its laid out in a way that was spectacular to see!"

The US government shutdown temporarily stopped all work but the mission was granted an "emergency exemption" after three days of no work.

"We are working toward being ready to launch on Nov. 18," Jakosky told me. "We think it's very feasible."

MAVEN's finding are key to understanding when and for how long Mars was much more Earth-like compared to today's desiccated Red Planet.

"The major questions about the history of Mars

center on the history of its climate and atmosphere and how that's influenced the surface, geology and the possibility for life," said Jakosky.

"MAVEN will focus on understanding the history of the atmosphere, how the climate has changed through time, and how that influenced the evolution of the surface and the potential for habitability by microbes on Mars."

"We don't know the driver of the change."

"Where did the water go and where did the carbon dioxide go from the early atmosphere? What were the mechanisms?"

"That's what's driving our exploration of Mars with MAVEN," said Jakosky

MAVEN carries nine sensors in three instrument suites. The Particles and Fields Package, provided by the University of California at Berkeley with support from CU/LASP and NASA's Goddard Space Flight Center in Greenbelt, Md., contains six instruments to characterize the solar wind and the ionosphere of Mars. The Remote Sensing Package, built by CU/LASP, will determine global characteristics of the upper atmosphere and ionosphere. The Neutral Gas and Ion Mass Spectrometer, built by Goddard, will measure the composition of Mars' upper atmosphere.

MAVEN will execute five deep dip maneuvers during the first year, descending to an altitude of 78 miles. This marks the lower boundary of the planet's upper atmosphere.

MAVEN has sufficient fuel on board to continue observations for more than a decade.

Inside the Payload Hazardous Servicing Facility at Kennedy Space Center in Florida. engineers and technicians perform a spin test of the MAVEN spacecraft. The operation is designed to verify that MAVEN is properly balanced as it spins during the initial mission activities. *Photo: NASA/Kim Shiflett*

The spacecraft will function as an indispensible orbital relay by transmitting surface science data through the "Electra" from NASA's ongoing Curiosity and Opportunity rovers as well as the planned 2020 rover.

Interestingly, the ''emergency exemption" was granted because of MAVEN's additional secondary role as a communications relay for Curiosity and Opportunity - and not because of its primary science mission.

"MAVEN is required as a communications relay in order to be assured of continued communications with the Curiosity and Opportunity rovers," Jakosky said.

Although NASA has two functioning orbiters circling the Red Planet at this moment, they are getting old, are far beyond their original design lifetimes and suffer occasional glitches. And there is no guarantee of continued operation.

"The rovers are presently supported by Mars Odyssey launched in 2001 and Mars Reconnaissance Orbiter launched in 2005. Launching MAVEN in 2013 protects the existing assets that are at Mars today," Jakosky told me.

If Mars Odyssey and/or Mars Reconnaissance Orbiter were to fail, then the rovers mission operations would be severely curtailed and could even be terminated prematurely - in a worst case scenario.

And without MAVEN, there would be no point in launching NASA's planned 2020 rover since there would be no way to transmit the science data back to Earth.

"There is no NASA relay orbiter at Mars planned post-MAVEN," Jakosky noted.

If MAVEN has to launch later in December 2013 or is forced to be postponed to the next launch window opportunity in 2016, both the communications relay capability and the missions atmospheric science objectives would have been very badly impacted.

"A delay in the launch date by more than a week past the end of the nominal launch period, or a delay of launch to 2016, would require additional fuel to get into orbit. "

"This would have precluded having sufficient fuel for MAVEN to carry out its science mission and to operate as a relay for any significant time," Jakosky elaborated.

"Launching in 2013 allows us to observe at a good time in the eleven-year solar cycle."

If all goes well, NASA's MAVEN orbiter and India's MOM (Mars Orbiter Mission) will "work together" to help solve the mysteries of Mars atmosphere, Jakosky told me.

"We plan to collaborate on some overlapping objectives between MAVEN and MOM. We have had some discussions with the MOM science team."

"At the point where we [MAVEN and MOM] are both in orbit collecting data we do plan to collaborate and work together with the data jointly. We agreed on the value of collaboration and will hold real discussions at a later time," he noted.

The Mars Society:
Humans to Mars in a decade

By Nicole Willett

A long time ago in the Milky Way Galaxy, Chris McKay, Penelope Boston, and Carol Stoker were on Planet Earth contemplating all things Mars. These three scientists, graduate students at the University of Colorado, decided to form a group called the Mars Underground and hold annual meetings to explore the science behind putting humans on Mars. One day, Robert Zubrin, an aerospace engineer, attended a meeting of the Mars Underground and was inspired to start the Mars Society. In 1998 the Mars Society was officially formed as a non-profit organization whose goals include the human exploration and settlement of Mars.

The thought of one day standing on the Red Planet and looking out over the landscape may be beyond the imagination of some, but not to the members and friends of the Mars Society. We at the Mars Society believe that "it takes a village," and we are utilizing that concept to send humans to the Red Planet. As an entirely volunteer organization, we have accomplished many great things since our inception.

The goal is simple – explore and send humans to Mars.

The purpose of the Mars Society is to further the exploration and settlement of the Red Planet. We will accomplish this through:

- Public outreach fostering Mars pioneers
- Worldwide support for government-funded Mars research and exploration
- Private-enterprise Mars exploration and settlement

The time has come for humanity to journey to the planet Mars. We're ready. Though Mars is distant, we are far better prepared today to send humans to the Red Planet than we were to travel to the Moon at the commencement of the space age. Given the will, we could have our first crews on Mars within a decade.

The reasons for going to Mars are powerful.

We must go for the knowledge of Mars. Our robotic probes have revealed that Mars was once a warm and wet planet, suitable for hosting life's origin. But did it? A search for fossils on the Martian surface or microbes in groundwater below could provide the answer. If found, they would show that the origin of life is not unique to the Earth, and, by implication, reveal a universe that is filled with life and

The Mars Society's **prototype Mars habitat** in Utah

probably intelligence as well. From the point of view learning our true place in the universe, this would be the most important scientific enlightenment since Copernicus.

We must go for the knowledge of Earth. As we begin the twenty-first century, we have evidence that we are changing the Earth's atmosphere and environment in significant ways. It has become a critical matter for us better to understand all aspects of our environment. In this project, comparative planetology is a very powerful tool, a fact already shown by the role Venusian atmospheric studies played in our discovery of the potential threat of global warming by greenhouse gases. Mars, the planet most like Earth, will have even more to teach us about our home world. The knowledge we gain could be key to our survival.

We must go for the challenge. Civilizations, like people, thrive on challenge and decay without it. The time is past for human societies to use war as a driving stress for technological progress. As the world moves towards unity, we must join together, not in mutual passivity, but in common enterprise, facing outward to embrace a greater and nobler challenge than that which we previously posed to each other. Pioneering Mars will provide such a challenge.

Furthermore, a cooperative international exploration of Mars would serve as an example of how the same joint-action could work on Earth in other ventures.

We must go for the youth. The spirit of youth demands adventure. A humans to Mars program would challenge young people everywhere to develop their minds to participate in the pioneering of a new world. If a Mars program were to inspire just a single extra percent of today's youth to scientific educations, the net result would be tens of millions more scientists, engineers, inventors, medical researchers and doctors. These people will make innovations that create new industries, find new medical cures, increase income, and benefit the world in innumerable ways to provide a return that will utterly dwarf the expenditures of the Mars program.

We must go for the opportunity. The settling of the Martian New World is an opportunity for a noble experiment in which humanity has another chance to shed old baggage and begin the world anew; carrying forward as much of the best of our heritage as possible and leaving the worst behind. Such chances do not come often, and are not to be disdained lightly.

We must go for our humanity. Human beings are more than merely another kind of animal, we are life's messenger. Alone of the

The Mars Society's **Mars Desert Research Station**

creatures of the Earth, we have the ability to continue the work of creation by bringing life to Mars, and Mars to life. In doing so, we shall make a profound statement as to the precious worth of the human race and every member of it.

We must go for the future. Mars is not just a scientific curiosity; it is a world with a surface area equal to all the continents of Earth combined, possessing all the elements that are needed to support not only life, but technological society. It is a New World, filled with history waiting to be made by a new and youthful branch of human civilization that is waiting to be born. We must go to Mars to make that potential a reality. We must go, not for us, but for a people who are yet to be. We must do it for the Martians.

Believing therefore that the exploration and settlement of Mars is one of the greatest human endeavors possible in our time, we have gathered to found this Mars Society, understanding that even the best ideas for human action are never inevitable, but must be planned, advocated, and achieved by hard work. We call upon all other individuals and organizations of like-minded people to join with us in furthering this great enterprise. No nobler cause has ever been. We shall not rest until it succeeds."

Mars: A Bridge to the Stars

Becoming a space faring civilization is the goal of millions of other Earthlings as well. If one pays attention to the universe around him, it is impossible to deny its ability to cause breathtaking humility. We long to explore, to expand, to go out and touch a piece of another planetary body. This longing is what encouraged NASA and their supporters to stand behind the Apollo missions to the Moon. President John F. Kennedy said, "We choose to go to the Moon not because it is easy but because it is hard." We need to find that will again. The interest in going out and exploring and settling Mars is obvious. One indication is the fact that when the Mars One project opened applications for a trip to Mars, there were 78,000 applicants in just two weeks. Other clues are the sheer number of private organizations that are being created dedicated to human Mars exploration. Inspiration Mars is one example. Its founder, Dennis Tito, believes so wholeheartedly in a humans-to-Mars mission that he is funding the first two years of the project himself.

The Mars Society's Projects

So, how do we expect to accomplish this? The Mars Society is involved in many projects, including but not limited to holding annual conventions, the establishment of an Education Task Force for public outreach, the 2013 STEM Education Event at the annual convention, maintaining websites, Red Planet Pen (a biweekly educational blog), Red Planet Radio (a monthly podcast), a speakers bureau, the University Rover Challenge, the new Youth Rover Challenge, and Mars analog research.

Mars Society Founder Robert Zubrin

The Mars Society has two analog research stations: the Mars Desert Research Station (MDRS) and the Flashline Mars Arctic Research Station (FMARS). Analog Research Stations are laboratories for learning how to live and work on another planet. Each is a prototype of a habitat that will land humans on

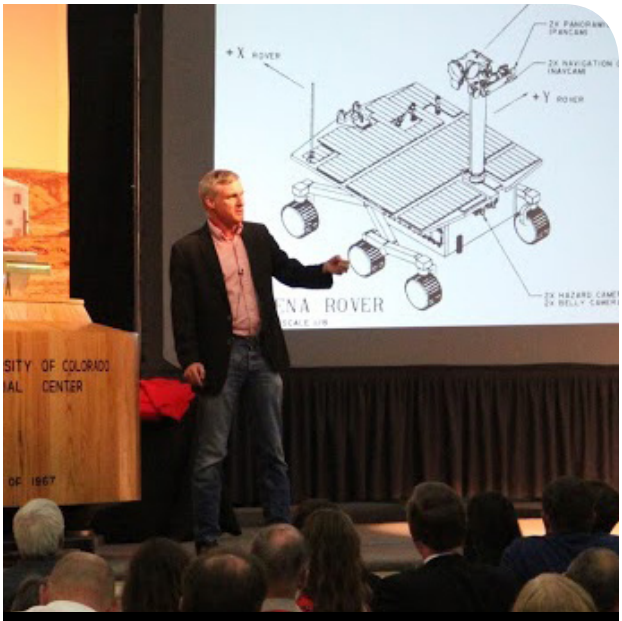


The Mars Society's **2013 STEM Education Event**

Mars and serve as their main base for months of exploration in the harsh Martian environment. Such a habitat represents a key element in current human Mars mission planning.

STEM Education & Outreach

The Mars Society recently established an Education Task Force in order to reach out to teachers, students and Mars enthusiasts in general. The intended goal is to bring a comprehensive Mars curriculum to the general public, as well as hosting STEM activities and events that are based on the Mars Society's mission: Human exploration and settlement of the planet Mars. Humans are going to Mars. When we do it, it is important that everyone will understand our new home.



2013 Mars Pioneer Award recipient and convention banquet keynote speaker Dr. Steve Squyres.

Nicole Willett is the Education Director for The Mars Society. Along with Deputy Director of Education, Chuck McMurray, the education website is maintained and updated regularly. This website includes a bi-weekly blog, the Red Planet Pen, news and updates, links for teachers and students, a video library, a reading list, and much more. Part of our outreach includes hosting events in person or via the internet. If you would like to have a personalized event at your school or organization please contact us.

The Mars Society Convention

The Mars Society held its 16th Annual International Mars Society Convention on the campus of the University of Colorado in Boulder from August 15-18, 2013. The annual four-day event consisted of key experts, scientists, journalists and policy-makers to discuss the latest news on Mars exploration and efforts to promote a humans-to-Mars mission in the coming years.

Many notable speakers gave presentations, including Dr. Robert Zubrin, President and Founder of the Mars Society, Dennis Tito, Inspiration Mars, Dr. Mark Geyer, NASA's Orion mission, and our keynote speaker Dr. Steve Squyres, Mars Exploration Rover Principal Investigator.

STEM Education Event

Because the Mars Society is dedicated to the human exploration and settlement of Mars, we promote educational outreach in STEM subjects. At the convention in Boulder, we hosted a special 2013 STEM Education Event. The one day program was free of charge for children through the age of 18. Participating children were also welcome to attend other lectures and discussions during the international convention.

The 2013 STEM Education Event included a variety of interactive activities, presentations, and special guest speakers for the children. Chris Nie from CUSEDS hosted interactive programs, such as alka-seltzer rockets to Mars, making Mars craters, digging for a Martian fossil, yummy Mars-mallows and others. The Mars Foundation was on hand to give a 3-D printing demonstration on how we could build habitats on the Red Planet in the near future. Deputy Director, Chuck McMurray launched the Youth Rover Challenge to the public. Also, Mars Society President, Dr. Robert Zubrin, addressed the audience about the importance of Mars education.

Please visit marssociety.org for more information or volunteer opportunities. Visit the Mars Society's YouTube Channel to watch all of the plenary talks and keynote speaker, Dr. Steve Squyres, from the 16th Annual Mars Society Convention. If you would like to get involved with STEM outreach for the Mars Society, contact nicolew@marssociety.org.

Inspiration Mars plans for human slingshot

By Sherry Valare

Mars seems to be the hottest vacation destination for interplanetary travel right now. With many plans floating around to send rovers, orbiters, even human missions to orbit and settle, Mars is a hot topic in space travel discussions right now. Dennis Tito, the first person to travel to space as a tourist with a purchased ticket, vacationed aboard the International Space Station for eight days in 2001. Earlier this year, Tito announced his plans to give two people the opportunity of being the first to take in the sight of Mars, firsthand.

At 23, Tito was an Engineer working at NASA's Jet Propulsion Laboratory, responsible for the design of trajectories for the Mars and Venus Mariner Spacecraft missions. Though his career has not always centered around space, his passion certainly did. His initiative, "Inspiration Mars", has an ambitious blueprint mapped out for seeing a two person crew (one male, one female) travel to Mars. Landing on the surface of the planet is not on the itinerary. Instead, they will orbit within 100 miles of Mars' surface, then use the planet's gravitational influence to slingshot the vehicle

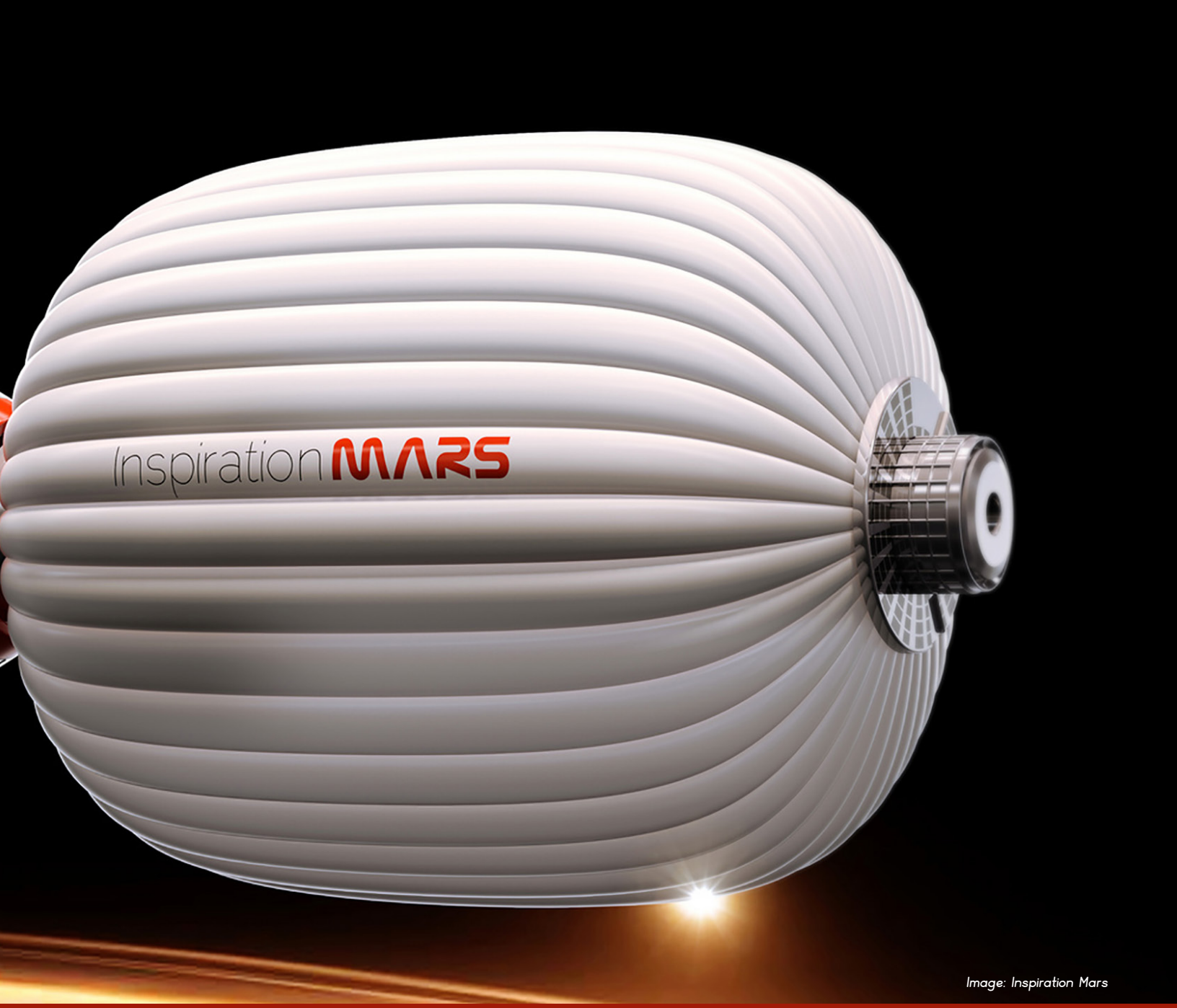


Image: Inspiration Mars

on a safe journey home. Every 15 years, the planets align, opening a window that allows for a minimal round-trip travel time of 501 days. Therefore, the target launch date is January 5, 2018. After 2018, this chance at reduced travel time will not occur again until the year 2031.

"Experts have reviewed the risks, rewards and aggressive schedule, finding that existing technologies and systems only need to be properly integrated, tested and prepared for flight," said Taber MacCallum, chief technology officer for Inspiration Mars.

Aside from the primary goal of reaching Mars and returning to Earth safely, Inspiration Mars also hopes to gain the interest of STEM students and provide scientific, educational and engineering opportunities using NASA inspired technologies.

With a growing team of partners supporting this project both financially and logistically, Inspiration Mars has the realistic potential of breaking new ground in deep space travel. The success of this mission could be the turning point that sends us out of low earth orbit and into the unknown.

"When nations boldly follow opportunities, rooted in curiosity and guided by technological innovation, they grow, prosper, learn and lead. And this is what makes a nation great," said Dennis Tito, chairman of the Inspiration Mars Foundation. "This is 'A Mission for America' that will generate knowledge, experience and momentum for the next great era of space exploration. It will encourage and embolden all Americans to believe, again, in doing the hard things that make our nation great, and inspire the next generation of explorers to pursue their destiny through STEM education."

Mars One betting colonizing planet will be great television

By Amjad P. Zaidi

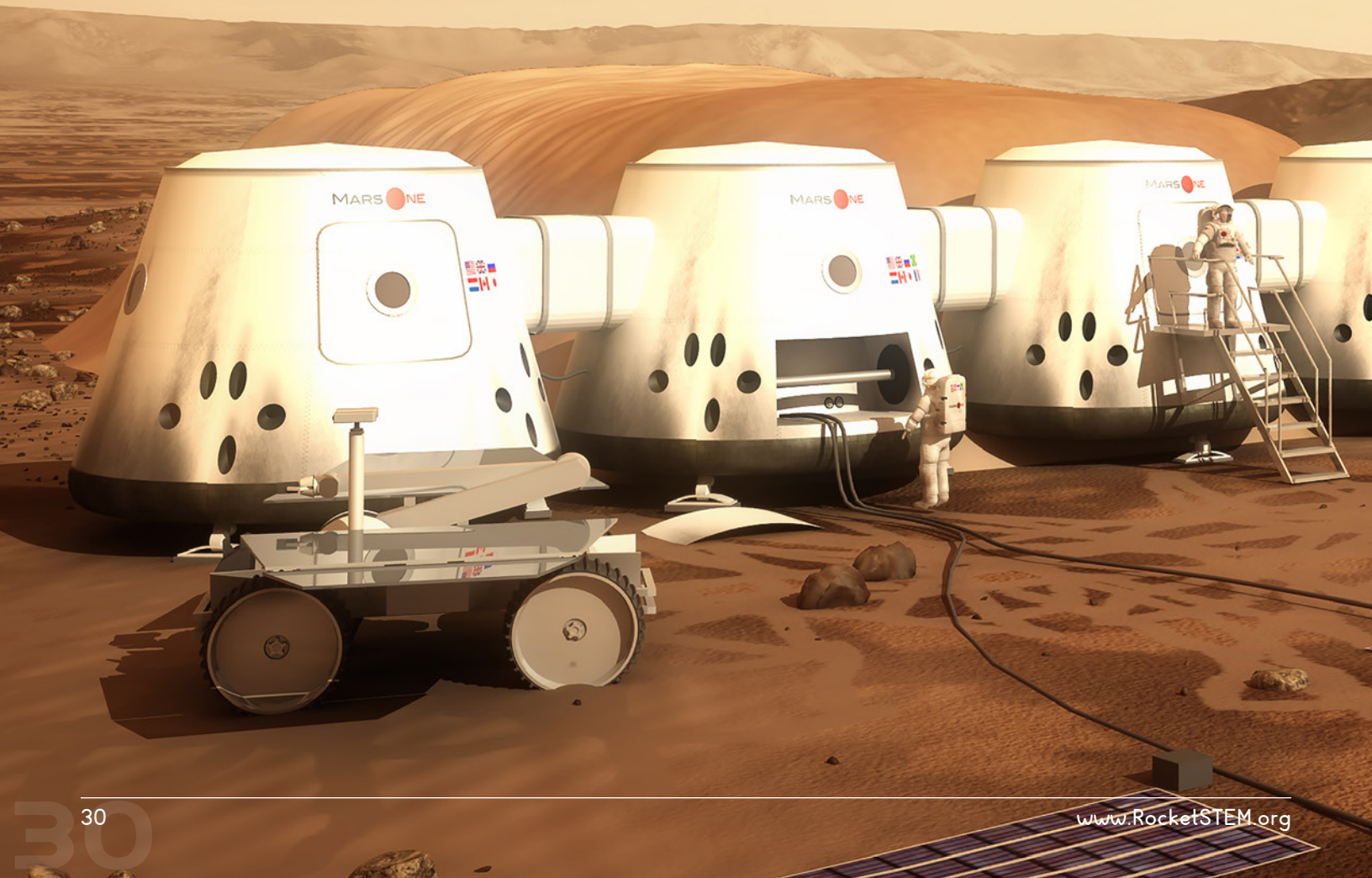
Mars One is a non-profit foundation, co-founded by Bas Lansdorp and Arno Wielders, to establish a human presence on Mars. The prime difference Mars One has over similar peer programs is its unique strategy; this is a one way ticket for a permanent "homesteading" community in an apolitical and international long term plan, thus removing a costly return trip.

The Numbers

Mars One aims to be funded and supported by a global audience in a reality TV format generating interest and income for preparation, transits and life on Mars. As of September 2013, over 200,000 have applied for crew selection aiming to make the first landing in 2023. The company has mapped out the multi-year mission risk categories in terms of loss of human life and cost overruns, estimating a budget of $6 billion over the 10 year program.

The Technology

Feasibility studies including approaches to global private space companies (from SpaceX to Surrey Satellite Technologies Ltd.) have generated interest to potentially supply the integrated components from



existing third party technologies and make this venture a reality. Of course it remains to be seen if all these components are proven and their program is viable.

The Training

Six teams of four will be selected for analogue Mars Training and Testing until launch in 2022. Core disciplines will be in component repair, self-sustenance and medical training. Through 2016-20 missions will be launched to establish technical viability, satellite communication and deliver "intelligent" rovers. These will build habitats using in-situ resources and remotely sent living and life support units.

The Journey

Combined transit habitats and landers are the crews' homes for the seven month voyage. Carrying supplies of food and water, recycling technology and backups are not needed. The crews' will sleep, live and prepare en route with radiation protection shelters provided. Their experiences will be documented for the global audience as "humanity's greatest journey".

The New Martians

Over 2023-24 the first crews aim to arrive at fully functioning modular habitats where they will live, work and settle permanently. Crew and habitat redundancy is vital as the Mars One premise rules out abandonment. Life at the habitat will be filmed and transmitted to global audiences back on Earth with new crews arriving periodically to expand the population and capability of the growing settlement.

A New Home

At the outset, immediate obstacles are the inevitable third party delays which will impact scheduling. The technology gap for long term interplanetary transits and permanent off world settlements is another challenge. Plus the question remains, when will the settlement become self-sustaining? This is important given the ever increasing human lifespan and the potential for offspring on Mars.

Yet, there are years of experience in analogue testing environments such as Biosphere II and AMASE in 2006. Lansdorp's and Wielders' plans may be possible on a longer timescale. If we can adapt to live life in harsh inhospitable environments, humanity will have taken its first steps to becoming a multi-planetary species.

You may learn more about Mars One by visiting http://www.mars-one.com/en.

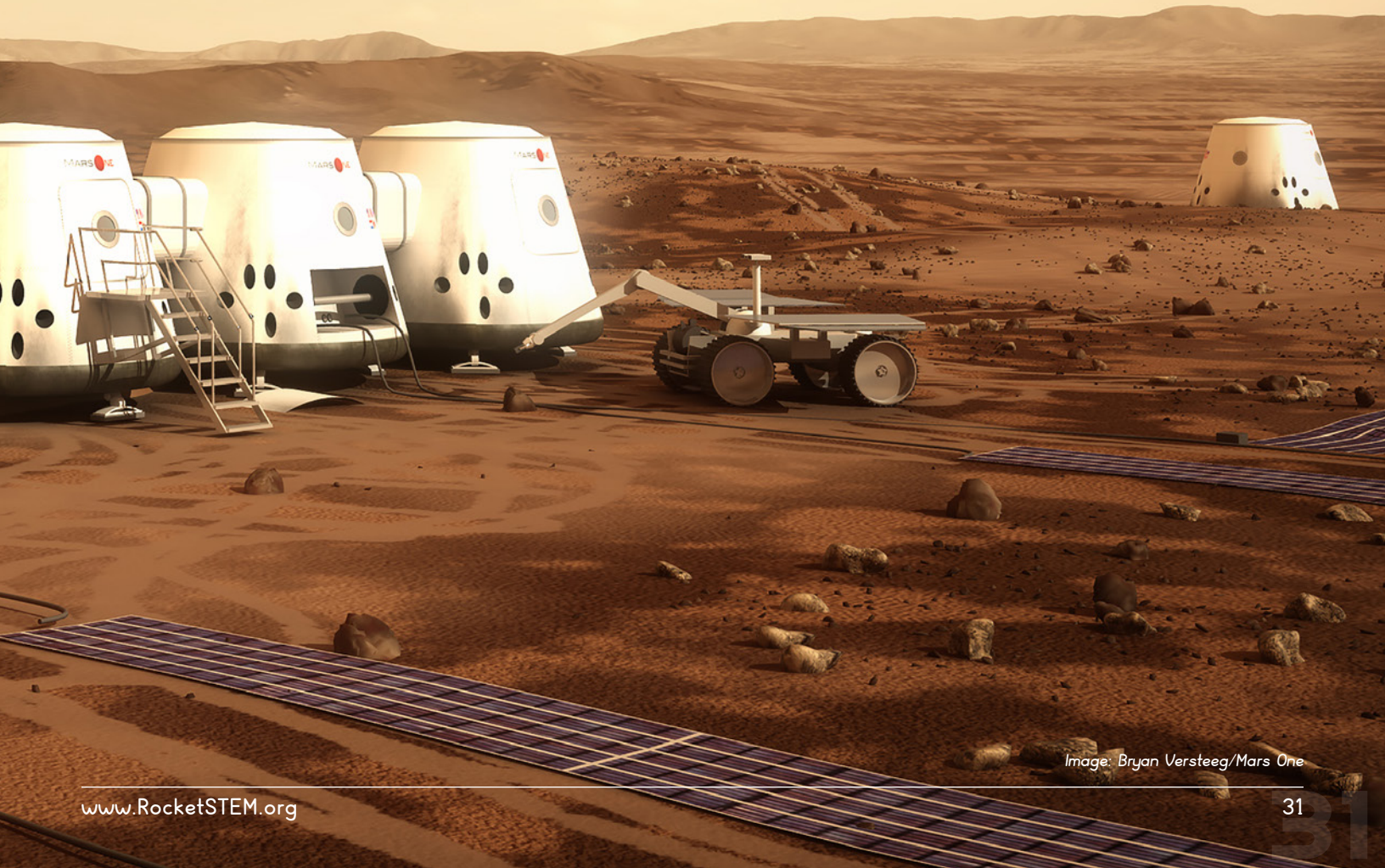
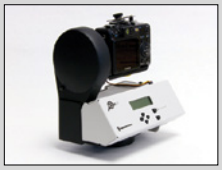


Image: Bryan Versteeg/Mars One

National Aeronautics and Space Administration

Mars Spinoffs

In 1997, NASA's Sojourner robot became the first rover to explore the surface of Mars. NASA has since launched other successful rover missions, gathering precious information in preparation for an undertaking that has long captured people's imaginations—a manned mission to Mars. The challenges such an enterprise poses have necessitated new technologies that are not only bringing us closer to the Red Planet, but also improving life on Earth. Life-saving robots, panoramic cameras, and pathogen-detecting sensors are just a few of the remarkable spinoffs to emerge from these efforts, with many more sure to come before the first human sets foot on Martian soil.



Mars Cameras Make Panoramic Photography a Snap

Mars rover technology inspired the Gigapan robotic platform for consumer cameras. Using photographic stitching software, the platform automates the creation of digital panoramas containing incredible detail.

Anthrax Detector Protects Air Supplies

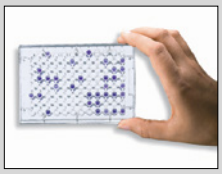
Designed originally as a bacterial spore detection system for Mars-bound spacecraft, the technology in the Anthrax Smoke Detector tests airborne particles for weaponized anthrax. The device is being used at airports, office buildings, and post offices worldwide.

Portable Device Analyzes Rocks and Minerals

NASA funded research into the next generation of scientific instruments for materials analysis—an important component of future Mars rover missions to study the Red Planet's surface. The resulting analyzer provides fast identification of rocks and minerals, useful for chemical, pharmaceutical, and forensics applications.

Voltage Sensors Monitor Harmful Static

Concern over static electricity damaging components on the Mars rovers led to the development of tiny sensors, small enough to be worn on clothing, for monitoring voltage changes near sensitive instruments, fuel operations, avionics, or anywhere a jolt of static electricity could prove harmful.



Cell Analysis Tools Support Drug Discovery

Research into space-grown plants—a potential food supply for astronauts on a long mission to Mars—inspired the creation of technology for measuring thousands of cell traits at once, assisting in the evaluation of new drugs by providing critical information on how drugs affect specific cells.

Advanced Sensors Boost Optical Communication, Imaging

Powerful photodetectors are necessary for laser communications—a way that Mars colonists might one day phone home. NASA supported development of a small, energy-efficient sensor capable of detecting single photons and now commercially available for multiple light sensing applications, such as night vision goggles.

Mars Mapping Technology Brings Main Street to Life

Publically accessible, geospatial views of cities—including every road, alley, and freeway—are now created with the help of 3-D data-generation software invented by NASA for imaging and navigation of the surface of Mars. The 3-D city maps are used for municipal and commercial applications.

Sensors Provide Early Warning of Biological Threats

Powerful NASA biosensor technology has been incorporated into a water analyzer that can alert organizations to potential biological hazards in water used for agriculture, food and beverages, showers, and at beaches and lakes—within hours, instead of the days required by conventional laboratory methods.

Tough Textiles Protect Public Safety Officers

Multilayer textiles created for the airbags that cushioned the landings of the Mars Pathfinder and rovers have enabled the creation of body armor—more comfortable than traditional protective gear yet comparable to rigid steel plates—for public safety officers and the military.

Intelligent Robot Braves Battlefront to Save Lives

NASA expertise developed while building the Mars rovers has allowed for the creation of tough, highly mobile tactical robots with the ability to search dangerous or inaccessible areas, helping keep soldiers and first responders out of harm's way.

Image: NASA/JPL-Caltech

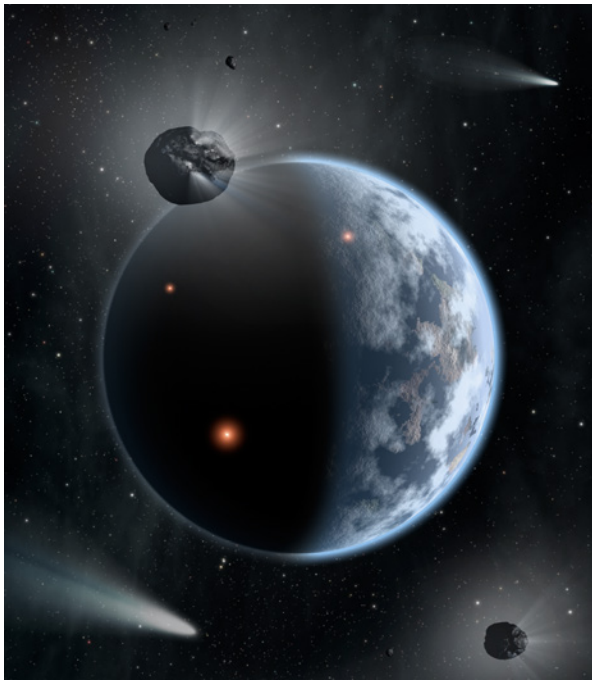
Planets rich in carbon may be waterless worlds

Planets rich in carbon, including so-called diamond planets, may lack oceans, according to NASA-funded theoretical research.

Our sun is a carbon-poor star, and as result, our planet Earth is made up largely of silicates, not carbon. Stars with much more carbon than the sun, on the other hand, are predicted to make planets chock full of carbon, and perhaps even layers of diamond.

By modeling the ingredients in these carbon-based planetary systems, the scientists determined they lack icy water reservoirs thought to supply planets with oceans.

"The building blocks that went into making our oceans are the icy asteroids and comets," said Torrence Johnson of NASA's Jet Propulsion Laboratory in Pasadena, Calif, who presented the results recently. Johnson, a team member of several NASA planetary missions, including Galileo, Voyager and Cassini, has spent decades studying the planets in our own solar system.



This artist's concept illustrates the fate of two different planets: the one above is similar to Earth, made up largely of silicate-based rocks with oceans coating its surface. The one on the left is rich in carbon and dry. Chances are low that life as we know it, which requires liquid water, would thrive under such barren conditions.

Image: NASA/JPL-Caltech

"If we keep track of these building blocks, we find that planets around carbon-rich stars come up dry," he said.

Johnson and his colleagues say the extra carbon in developing star systems would snag the oxygen, preventing it from forming water.

"It's ironic that if carbon, the main element of life, becomes too abundant, it will steal away the oxygen that would have made water, the solvent essential to life as we know it," said Jonathan Lunine of Cornell University, Ithaca, N.Y., a collaborator on the research.

One of the big questions in the study of planets beyond our solar system, called exoplanets, is whether or not they are habitable. Researchers identify such planets by first looking for those that are situated within the "habitable zone" around their parent stars, which is where temperatures are warm enough for water to pool on the surface. NASA's Kepler mission has found several planets within this zone, and researchers continue to scrutinize the Kepler data for candidates as small as Earth.

But even if a planet is found in this so-called "Goldilocks" zone, where oceans could, in theory, abound, is there actually enough water available to wet the surface? Johnson and his team addressed this question with planetary models based on measurements of our sun's carbon-to-oxygen ratio. Our sun, like other stars, inherited a soup of elements from the Big Bang and from previous generations of stars, including hydrogen, helium, nitrogen, silicon, carbon and oxygen.

"Our universe has its own top 10 list of elements," said Johnson, referring to the 10 most abundant elements in our universe.

These models accurately predict how much water was locked up in the form of ice early in the history of our solar system, billions of years ago, before making its way to Earth. Comets and/or the parent bodies of asteroids are thought to have been the main water suppliers, though researchers still debate their roles. Either way, the objects are said to have begun their journey from far beyond Earth, past a boundary called the "snow line," before impacting Earth and depositing water deep in the planet and on its surface.

When the researchers applied the planetary models to the carbon-rich stars, the water disappeared. "There's no snow beyond the snow line," said Johnson.

"All rocky planets aren't created equal," said Lunine. "So-called diamond planets the size of Earth, if they exist, will look totally alien to us: lifeless, ocean-less desert worlds."

The computer model results supporting these conclusions were published in the Astrophysical Journal last year (http://arxiv.org/abs/1208.3289). The implications for habitability in these systems were the focus of the Division of Planetary Sciences meeting.

“Conquering fear is one of life’s greatest pleasures and it can be done in a lot of different places.”

— Scott Carpenter, May 1, 1925 – October 10, 2013

Photo: NASA via Retro Space Images

Scott Carpenter:
A tribute to a curious but ordinary superman

By Amjad P. Zaidi

One of only two remaining Mercury Program Astronauts from the 60's, Scott Carpenter, sadly passed beyond the veil on Thursday, October 10, 2013 following a stroke in September. He was 88 years of age. Carpenter was one of the earliest pioneers in the infancy of the Space Age. He was the second American to cross the threshold into orbital space on his MA-7 "Aurora 7" spaceflight and the sixth man overall. He also held the unique distinction of being not only an astronaut but an aquanaut following his NASA career in the US Navy's various Sea Lab projects.

For each last step, there is a first step. Born in Boulder, Colorado on May 1, 1925, Malcolm Scott Carpenter was impressed by planes at the age of five when his father took him to his first airshow. His love of flight grew as he continued to build and fly model balsa wood plane kits as a boy. He gained a Bachelor of Science degree in Aeronautical Engineering from the University of Colorado, before entering flight school with the U.S. Navy at Pensacola, Florida and Corpus Christi, Texas. After the Korean War where he flew aerial anti-submarine surveillance and patrols, Carpenter enrolled at Patuxent River's Navy Test Pilot School in Maryland. Following this, he was assigned as an Air Intelligence Officer on the USS Hornet. During this time he received special orders to report to Washington D.C. for an unnamed meeting. That meeting led to his selection in Project Mercury on April 9, 1959, which was instituted as the newly formed NASA's first step to catch up to the Soviets who had taken an early lead in the rapidly escalating Space Race.

Scott Carpenter recieves a call from President John F. Kennedy while aboard the U.S.S. Intrepid after his recovery from his Aurora 7 spaceflight.

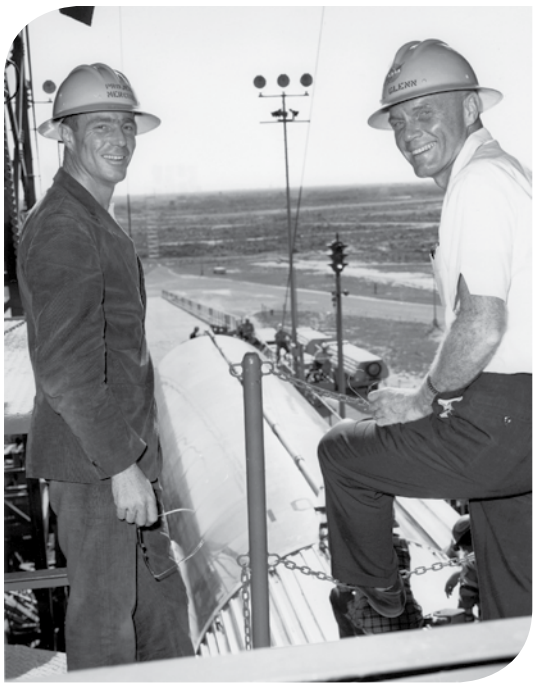
Photo: NASA via Retro Space Images

What followed is fabled history. The exhaustive raft of testing of 110 candidates down to what are now known as the "Original Seven" and Carpenter formed part of that elite fraternity of Mercury Astronauts. Their every move was recorded and lauded by the public at large as the nascent American Space Program took its initial steps forward. Due to his communications and navigation experience Carpenter was back-up on his good friend John Glenn's orbital flight. Upon launch, as Glenn cleared the tower, Carpenter's words of "Godspeed John Glenn" were recorded and have echoed through the years of spaceflight history. Carpenter repeated this goodwill message when Glenn went into orbit again aboard the Shuttle in 1998.

On May 24, 1962, Carpenter's own flight dubbed "Aurora 7" launched and completed three orbits of the Earth. His mission; to prove a human could work in space. This was an important link in the chain of events which ultimately resulted in a manned landing on the moon just seven short years later. For the first time

he demonstrated humans could perform tasks, experiments, communications, navigation and eat solid food in space. Due to some technical faults, inadvertent errors during the mission, all of which Carpenter compensated for, Aurora 7 came home safely but overshot the target landing zone due to fuel mismanagement during the mission. He was found by rescuers almost 5 hours late, 1000 miles southeast of Cape Canaveral, coolly relaxing in the life raft alongside his spacecraft. Ever the gentleman astronaut he even offered his rescuers food and water from his survival kit.

As with many space explorers who are comfortable with the risk of space exploration, Carpenter had remarked that his mission realised a long held dream and that "This is something I would gladly give my life for". In today's modern world of Google Earth and armchair exploration, we should remember that back then it took a special kind of person to ride fire into the heavens to expand knowledge at risk of their own life. Unlike many of his Mercury astronaut peers who were recovered and debriefed after their space shots relatively quickly, Carpenter had time for introspection and reflection on the events and meaning of his experience on Aurora 7. Carpenter was also blessed with a curious and philosophical mind. Peering through the small periscope of Aurora 7 into the endless night outside, Carpenter remarked,



Brothers in arms; astronauts Scott Carpenter (left) and John Glenn (right).

Photo: NASA via Retro Space Images

"From that view … you are a long way away. Everything you see gives you satisfaction of the expectation which involves curiosity. The most important driver in everything we did then was curiosity. Can we make machines do this? Can we put our bodies through this? It's revelatory. Addictive. Beautiful beyond description. To have been in space is very satisfying of one's curiosity. It's instructive. It's marvellous."

At the time, some may have perceived those comments and qualities to be extraneous for a test pilot / astronaut, favouring engineering rigour and zero margin of error during those early missions. Consequently, Carpenter never flew in space again. In later years his curiosity and philosophical mind have become more appreciated by his peers.

Following NASA, Carpenter's curious mind to banish unknowns led him to meeting with the French oceanographer Jacques Cousteau. He saw many parallels, between deep space and the deep ocean, with transferable skills, technologies and parallel experiences. But more personally for him, like with his Mercury flight, working beneath the waves to satisfy his curiosity would remove any "unreasoned fears", just as he had done above the clouds on Aurora 7. As part of the Navy's Sea Lab II experiment, Carpenter spent 30 days in spring 1965 on the ocean floor of La Jolla as an aquanaut, proving humans could survive in this environment. At one point during his time under the waves, he even spoke by phone to the crew of Gemini 5 orbiting far overhead. Old Mercury Seven buddy Gordo Cooper was no doubt happy to hear him. His work on the ocean floor has yielded cross benefits for NASA too as Carpenter became

the Navy/NASA liaison for underwater zero gravity training – or neutral buoyancy, which has become mandatory for NASA EVA astronaut training. For this work, Carpenter was awarded the Navy's Legion of Merit medal.

In his later years after retiring from the Navy, Carpenter has remained active on various projects utilising his aerospace and oceanic engineering expertise. From enhancing ocean resource usage, to consulting on underwater, diving and submersibles, and lecturing on the future of technology developments and impacts, Carpenter has remained an active contributor to the quality of our lives here on Earth. Not stopping there, he has also authored three books, one of which is his memoirs "For Spacious Skies" which he wrote with his daughter Kris Stoever. Carpenter remained a staunch advocate of manned spaceflight, and pushing our exploration to Mars.

"We need a goal other than the International Space Station. We need to get cracking on a manned flight to Mars, because that is going to capture the interest, support and imagination of people who pay for spaceflight…We need to go to Mars… Mars is interim, but for now that is a goal that NASA and the country and the planet can live with enthusiastically".

Looking back, Carpenter remarked that he and John Glenn bonded over common interests, mutual respect and being Air Force boys. Upon hearing of his great friend's passing, the last remaining torchbearer of that age, Mercury astronaut John Glenn paid tribute with his friend's simple words and remarked "Godspeed, Scott Carpenter". Carpenter himself has remarked that he believes he is very fortunate to have lived life during a time when there were so many unknowns to be solved during this century. That has pleased him immensely as he was always a very curious person and he has had a lot of satisfied curiosity in his time.

Astronaut Scott Carpenter completes a water egress test in preparation for his Mercury space mission.
Photo: NASA via Retro Space Images

Meeting Carpenter at Spacefest V in May 2013 in what turned out to be his twilight months, was a special privilege and for myself, the highest honour, to meet a member of the Original Seven. Meeting Scott himself, who truly understands the wider more nuanced experiences of manned spaceflight, the continuing importance of manned exploration and the questing nature of humanity, was even more special to me. The hallmark of his character, curiosity, still burned brightly in his alert eyes even though his health was visibly failing. I briefly asked him about what lessons he has taken with him on his explorations of the ocean and space. Scott merely whispered, as if sharing a secret.

"Be led by your curiosity. And never forget the fun of learning and discovery. It can take you places you have never dreamed."

Words from a curious but ordinary superman that will stay with me forever. May fair winds be at your back Star Voyager for you have returned to the place where we all came from. You are stardust. We thank you for your bravery, your discoveries, your humanity and your continuing inspiration.

Godspeed, Scott Carpenter.

One year later:

Endeavour still awing the people throughout Los Angeles

Story by Mary Kanian
Photos by Julian Leek

Controversy marked every step of Endeavour's path to Los Angeles. From the beginning it was the old wrangling over which coast was the right coast – the 'Left' Coast or the East Coast? And did L.A. even deserve one of these precious birds?

The answer to the questions posed all the way along became crystal clear to those lucky enough to follow the majestic machine through the streets of L.A. or view the television coverage in October of 2012.

But back then it was how would the neighborhoods of central and south-central Los Angeles receive the behemoth rolling thru their communities and necessitating the removal of hundreds of trees and disrupting traffic flow for days, even weeks, as preparations were made for the parade of the century in this city.

Plans initially called for the public to be contained a block away from Endeavour as she made her way along – which proved to be impossible and totally unnecessary.

As a precaution, a pressure washing firm was engaged to follow Endeavour along the route to quickly wash away any eggs, tomatoes or paintballs that could be fired from a rowdy crowd. Such low expectations of people whose hard earned tax monies had also been used to make these space expeditions possible.

All these issues and concerns of the worthiness of Los Angeles to receive a shuttle were readily and soundly dispelled in the wildly enthusiastic yet totally respectful reception that greeted Endeavour every inch of the way.

Despite the delays that sometimes occurred along the way while wires were raised higher and tree branches were trimmed the additional few inches to clear her path, the people waited, and waited, into the night to have their

moment with something greater than themselves, yet something that was part of them and they part of it.

People brought entire families to see this greatest achievement of mankind and their country. They brought newborns, the elderly and handicapped in wheelchairs, children from school; they dotted rooftops, hung from billboards and balconies, hoisted kids on shoulders to see history passing within reach of eyes and they respected authority. When the police asked them to move back or stay out from under Endeavour's wings, all complied.

Everyone – but everyone, including police and moving officials – raised their cameras, cell phones, iPads or whatever they had to capture the scene all the way along the route 24/7 for three wondrous days.

It was a tremendous privilege to be among the crowds these wondrous three days, days that reminded all of the way our space program had united the world in what could be achieved when we call upon the very best in all of us from the people of our world.

It was the same feeling we had, those of us old enough to remember Neil Armstrong setting foot on the moon for the first time in history back in 1969 – the first human step off the planet and into a new era – and now here we are again, marking another step in the right direction for humankind.

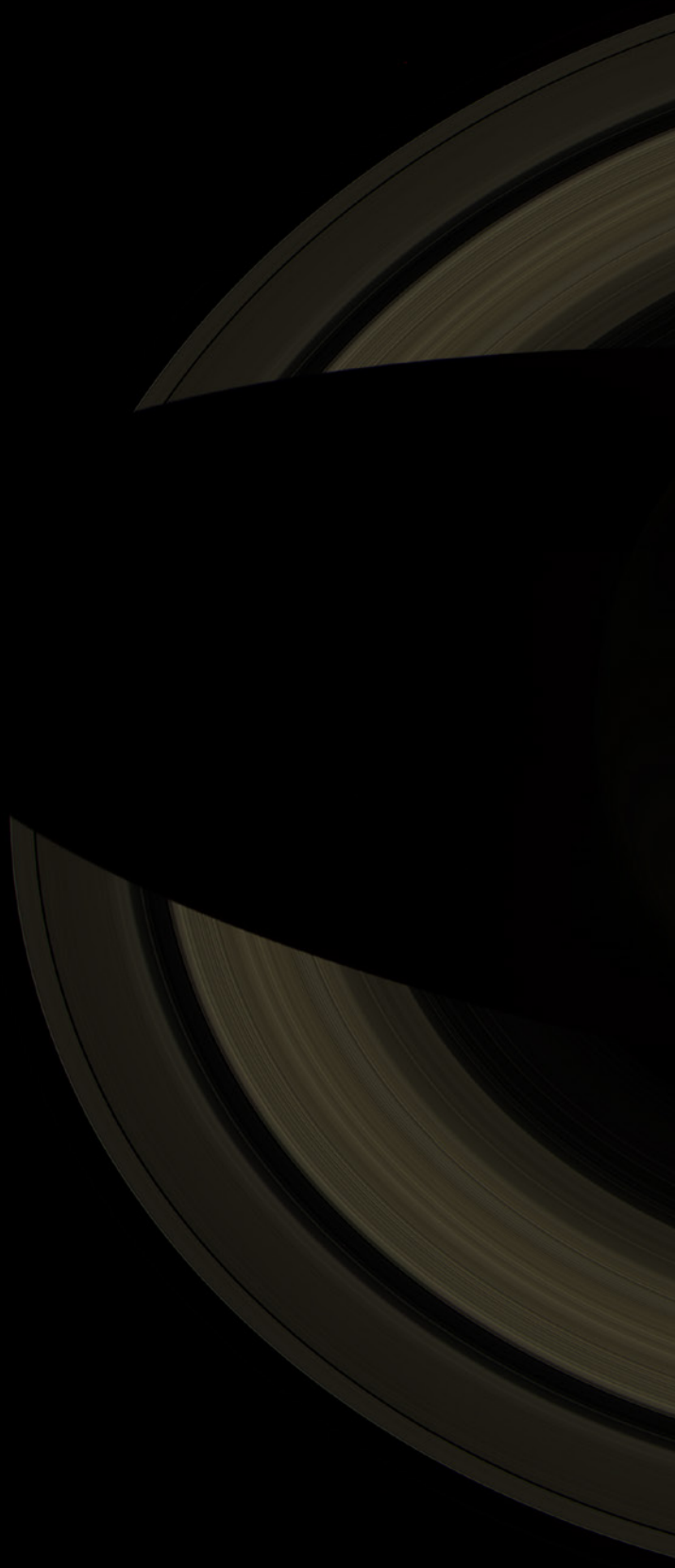
The Endeavour story, one year later, echoed last year's story in a number of ways: low expectations in the turnout and enthusiasm of the people of Los Angeles, California Science Center's concerns about publicizing an event which would be severely hamstrung by the government shutdown and budgetary constraints.

But, like last year, the real story was the people. They came enthusiastically and in droves. They came singly and in groups; from multi-generational families, neighborhood groups, schools, the handicapped. All arrived by whatever means they could muster. Like the United States itself, every race, creed, color and tongue could be seen and heard. A turn-out much like last year's parade through the streets.

Smiling faces and faces filled with pride that turned to awe as they entered the presence of Endeavour itself.

The uncertainty we had felt earlier dissipated like fog in the presence of sunlight as we joined the crowd to snap photos of the great bird and the shining faces of those who had come to see her and pay their respects to this great "Endeavour" who had successfully completed her 26th Mission – that of arriving in Los Angeles to lend her example in teaching and leading other generations to their own discoveries.

Cassini swings high above Saturn to take a portrait



It's a view as good as gold. A loop high above Saturn by NASA's Cassini spacecraft revealed this stately view of the golden-hued planet and its main rings. The observation and resulting image mosaic were planned as one of three images for Cassini's 2013 Scientist for a Day essay contest. The contest challenges students to study three possible targets and write about which one they think will yield the best science. Today is the last day for U.S. submissions and the Cassini mission has already started working on picking the best essays.

This natural-color view – seen as human eyes would have seen it – was obtained on Oct. 10, 2013. It shows off the differently colored bands of weather at Saturn. A bright, wavy stream of clouds around 42 degrees north latitude appears to mark some of the turbulent aftermath of a giant storm that reached its violent peak in early 2011. The mysterious six-sided weather pattern known as the hexagon is also visible around Saturn's north pole.

When Cassini arrived in 2004, more of the northern hemisphere sported a bluish hue and it was northern winter. The golden tones dominated the southern hemisphere, where it was southern summer. But as the seasons have turned and northern summer has begun, the colors have begun to change in each hemisphere as well. Golden tones have started to dominate in the northern hemisphere and the bluish color in the north is now confined to a tighter circle around the north pole.

Cassini is currently in a special set of tilted orbits known as "inclined orbits" that allow the spacecraft to swing up over the north pole and below the south pole. Cassini was tilted as much as 62 degrees from the plane of Saturn's equator in April of this year and will continue to work its way back down again till early 2015. Much of Cassini's tour has involved orbits around the equatorial plane, where most of Saturn's rings and moons are located.

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. JPL, a division of the California Institute of Technology, Pasadena, manages the Cassini-Huygens mission for NASA's Science Mission Directorate in Washington. The Cassini orbiter and its two onboard cameras were designed, developed and assembled at JPL. The imaging team consists of scientists from the United States, the United Kingdom, France and Germany. The imaging operations center is based at the Space Science Institute in Boulder, Colo.

For more information about Cassini and its mission, visit: www.nasa.gov/cassini and http://saturn.jpl.nasa.gov.

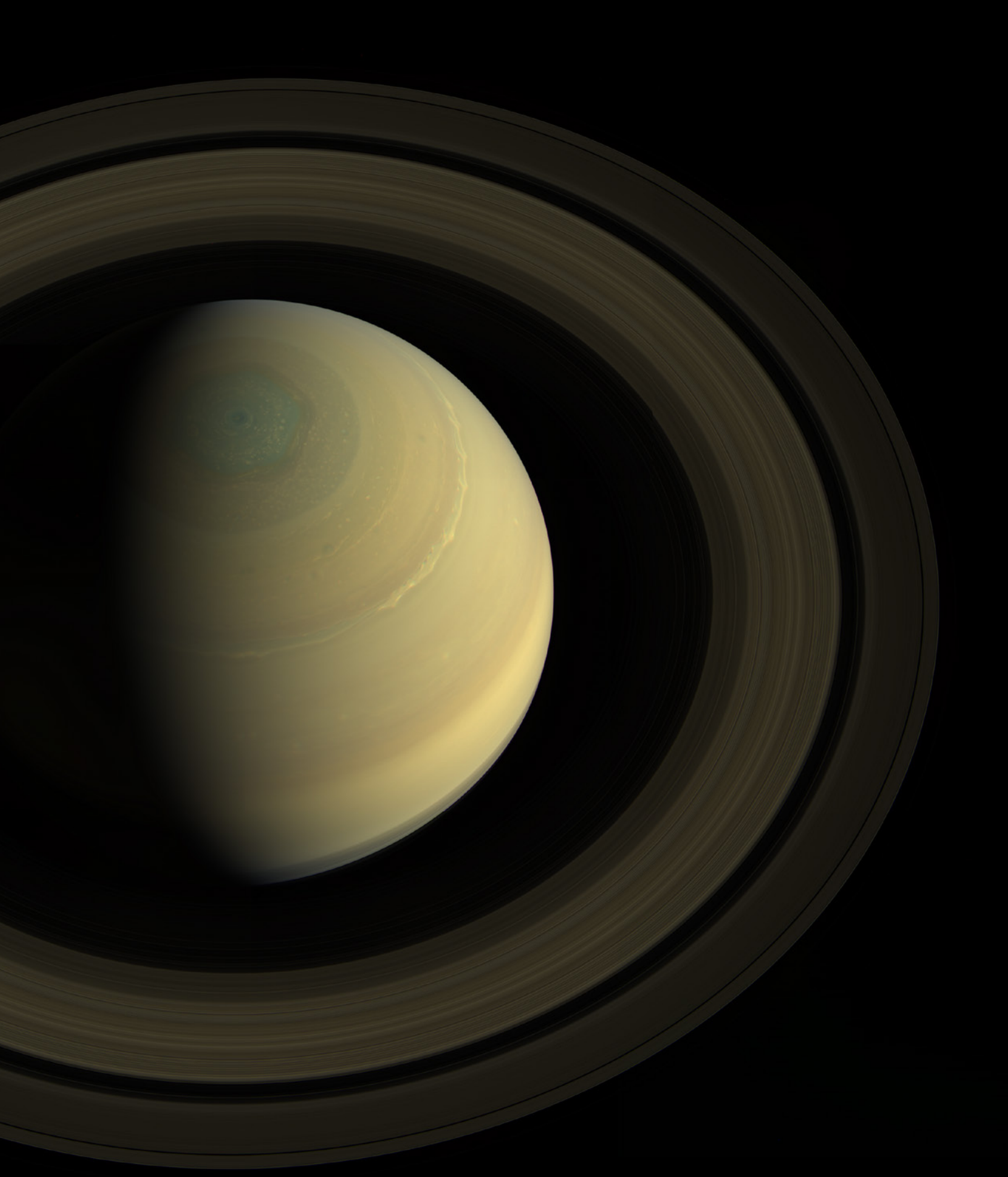


Image: NASA/JPL-Caltech/SSI/Cornell

Starting in astronomy

beginner's guide to stargazing

By Mike Barrett

top 10 must see list for backyard astronomers

It is very difficult to draw up a Top 10 list in any subject, in astronomy it is even more difficult due the the huge number of prospective candidates for the list. I have made it somewhat easier by restricting the list to things that beginners may view with relatively basic equipment.

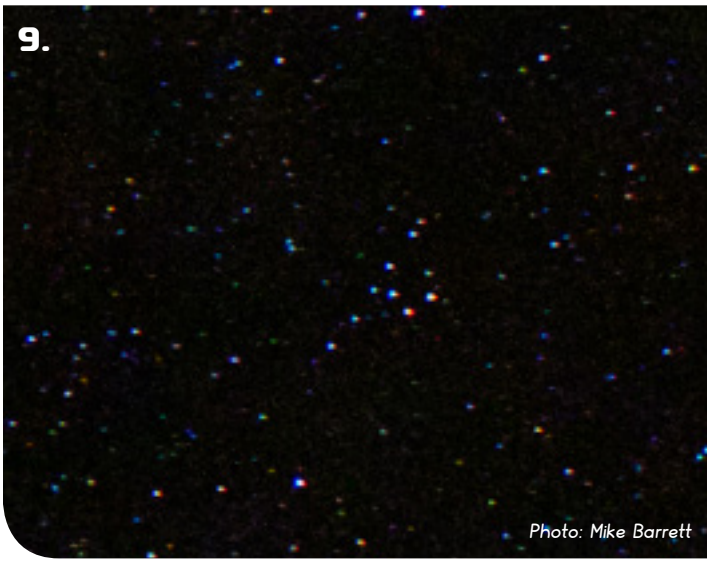
My list is based on my own thoughts and as a result of a (sometimes heated) discussion betweem fellow astronomers in my local astronomy club. As you progress in the hobby your list will change dramatically as your abilities improve and you learn more about our Universe. However the following are good representative examples of the astronomical objects readily available to beginners:

10. albireo double star

Albireo is the star at the head of the swan in the constellation of Cygnus. Only it is not 'the' star, but a pair of stars! Albireo is probably the easiest double star to view in the sky, it is certainly one of the most impressive. Seen with the naked eye it appears to be a single star, indeed with a pair binoculars you would be hard pressed to split them, but a telescope of medium power will allow you to see both stars easily. The primary star of the pair is a bright orange, whilst the secondary is an electric blue.

9. coathanger asterisms

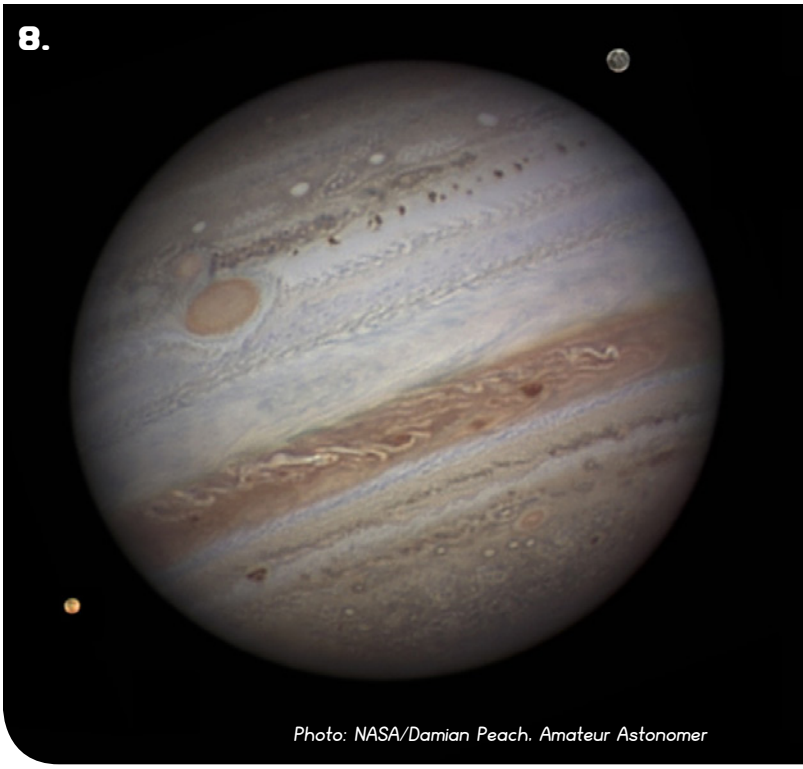
The coathanger cluster, or to give it its proper name Brocchi's cluster, is an asterism in the constellation Vulpecula. This is not readily visible without binoculars but when you spot it you will immediately understand its common name as it looks exactly like an upside-down coathanger. It consists of yellow, orange and blue stars and can be found by following a line up from the bright star Altair to Vega. Once you have found it you will have no difficulty finding it again. The Coathanger is best viewed in binoculars or a small telescope at low magnification as the asterism is quite large.



asterism An asterism is a group of stars that form a pattern in the night sky. These are normally confined to a constellation, but some can span constellations. Each constellation has a main asterism defining the constellation, and some have asterisms within asterisms for example Ursa Major, The Great Bear has within it The Plough. The Summer Triangle is composed of stars from 3 different constellations.

8. jupiter and moons

Of the planets Jupiter, the fifth planet, is the largest in our Solar System. With the naked eye Jupiter appears to be a very bright star. In fact it is the third brightest thing in the night skies after the Moon and Venus. When viewed with binoculars you will be able to see the four main moons orbiting the planet as little dots of light. Viewing through a telescope you will see the moons more clearly, and will start to make out details on the surface. The bands can be seen quite clearly and in wonderful colour. If you time your observation right you will also be able to see the Great Red Spot as the planet rotates.

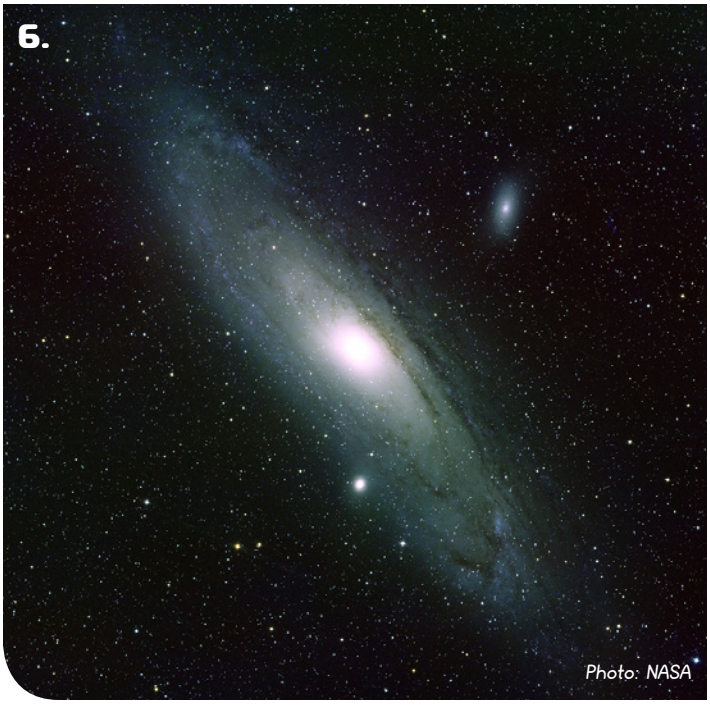


7. orion and orion nebula

Of all the constellations in the night skies the two that are richest in astronomical features and easyiest to pick out are Cygnus and Orion. Cygnus dominates the summer skies whilst Orion rules the winter nights. The constellation itself represents Orion the hunter, and has Betelgeuse at its head, Rigel at its foot and a triplet of stars representing Orion's belt. Just below the belt is the sword of Orion of which the Orion Nebula, M42, is a part. The nebula will be seen to the naked eye as a fuzzy region. A pair of binoculars or small telescope will start to reveal the detail in the nebula, with the stars of the trapezium visible to a high powered optic.

6. andromeda galaxy

The Andromeda Galaxy is the nearest spiral galaxy to us at a distance of two and a half million light years. Andromeda is an easy object to find and can be seen quite clearly on a reasonably dark night. To the naked eye it appears as a faint fuzzy patch in the sky, but in binoculars and telescopes the true structure and beauty of the galaxy becomes evident. If you have a big aperture telescope or imagery equipment you will be able to see even more detail in the spiral arms.



5. perseid meteor shower

The Perseids are a meteor shower that starts mid July and lasts through to the third week of August with the zenith occurring around the 12th August. This is the time of the year to be out at a dark location when you can watch the cosmic fireworks in the heavens. There are a number of meteor showers throughout the year, but the Perseids puts on by far the best show. They are named the Perseids as they all seem to originate from the constellation of Persius.

4. the milky way

Our own galaxy, The Milky Way, has to be a contender for the top 10. It is probably something you have seen on a dark night without realising it, indeed the Milky Way can look like clouds drifting by overhead. if you were to stop and look for a while you would realise that the clouds are moving at the same rate and in the same direction as the visible stars. Then you will come to see that what you are looking at is the light of millions of faint stars combined to give the appearance of a cloud. Using a telescope or binoculars will render some of these stars as individuals, but there will still be thousands combining to form the mysterious galactic mists.

3. the moon

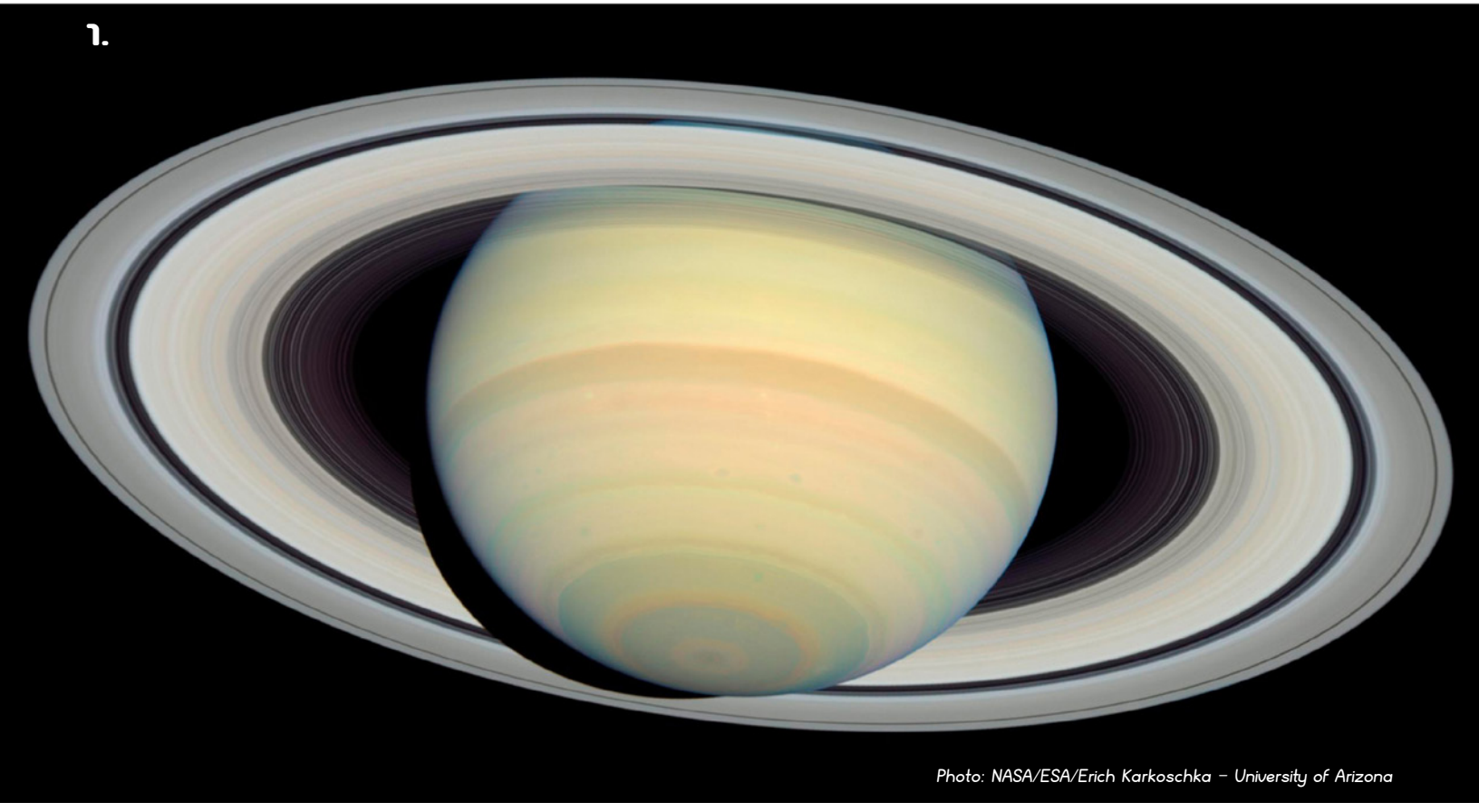
This list would not be complete without the inclusion of the Moon. Often to astronomers the Moon is a nuisance throwing light over the night skies and preventing us looking at deep space objects. However the Moon itself is a fascinating object to study, it is easy to see in the night sky, and often during the day as well. You can view it's detail with binoculars and telescopes to magnify the features of it's surface. One of the best advantages of the Moon is that it is readily visible even in the environs of a light polluted city.

2. the pleiades

The Pleiades is an open star cluster located in the constellation of Taurus the bull. It is also known as the Seven Sisters, and also Messier 45. There are over 1,000 stars in this cluster which is characterised by a number of bright blue stars. The Pleiades is a naked eye object and will be seen as a fuzzy patch from which a few individual stars can be seen, my best view on a dark night revealed 4 stars, but others with me saw 6. Photographically the cluster displays blue nebulosity around the stars drifting off into space. With a low power telescope the beauty of the cluster is observed, with the stars shining like electric blue christmas lights. The Pleiades are easy to spot as they resemble a question mark "?".

1. saturn

Saturn has to be at the top of everyones list purely for the WOW factor of actually seeing it with your own eyes. Saturn is the second largest planet in our Solar System, about 9 times the size of Earth, and is a gas giant. The striking feature of the planet is the system of rings that surround it. Although Saturn can be seen with the naked eye it is best viewed using a telescope. Even a small telescope you will be able to pick out the rings and with a larger telescope you will be able to see the divisions between the rings.



Fiery end for ESA's ATV Albert Einstein

ATV Albert Einstein. Europe's supply and support ferry, after undocking with the International Space Station on 28 October 2013.

Images: ESA/NASA

ESA's fourth Automated Transfer Vehicle cargo ferry, Albert Einstein, completed its five-month mission to the International Space Station by reentering the atmosphere today and burning up safely over an uninhabited area of the southern Pacific Ocean.

Automated Transfer Vehicles (ATVs) are the most complex space vehicles ever developed in Europe and are the largest and most capable resupply ships to dock with the Space Station.

At 20 tonnes, ATV-4 set the record for the heaviest Ariane 5 launch when its mission started from Europe's Spaceport in French Guiana on 5 June, docking with the Station 10 days later. The record cargo of 2480 kg included more than 1400 individual items.

Albert Einstein delivered important cargo to keep the Station operating and to allow the six astronauts on the orbital outpost to perform out-of-this-world experiments.

ESA astronaut Luca Parmitano oversaw the automated docking and was responsible for unloading and storing all the scientific equipment, spare parts, supplies, clothes and food.

A small selection of ATV-4's cargo includes experiments on emulsions that will help industry to create foods and pharmaceuticals with longer shelf-lives, a replacement water pump for Europe's Columbus laboratory, a new water recycler for NASA, a GPS antenna for Japan's Kibo laboratory and 3D-printed space toolboxes.

While docked, ATV-4 performed six reboosts to keep the Space Station in orbit, counteracting the effects of atmospheric drag. Without reboosts by ATV and Russia's smaller Progress vehicles, the Station would eventually fall back to Earth.

Before its departure, astronauts loaded its pressurised module with waste material, freeing up space on the Station. After setting records going up, ATV-4 also set records on its descent: it had the most waste material loaded for the series.

The European ferry undocked on 28 October at 08:55 GMT (09:55 CET) and manoeuvred itself into a safe reentry trajectory about 100 km below the Station.

Albert Einstein performed a series of delicate manoeuvres to reenter below the Station in order for the astronauts to observe the spacecraft's fragmentation in the upper atmosphere, providing unique information on reentry physics.

ATV-4 and its waste burnt up harmlessly in the upper atmosphere on 2 November at 12:04 GMT.

ATVs perform all their manoeuvres, including their autonomous dockings, under close surveillance by their control centre in Toulouse, France, run jointly by ESA and France's CNES space agency.

"The mission went perfectly, which for me and the ATV team or any space mission is a great thing," says Alberto Novelli, ATV-4 mission manager.

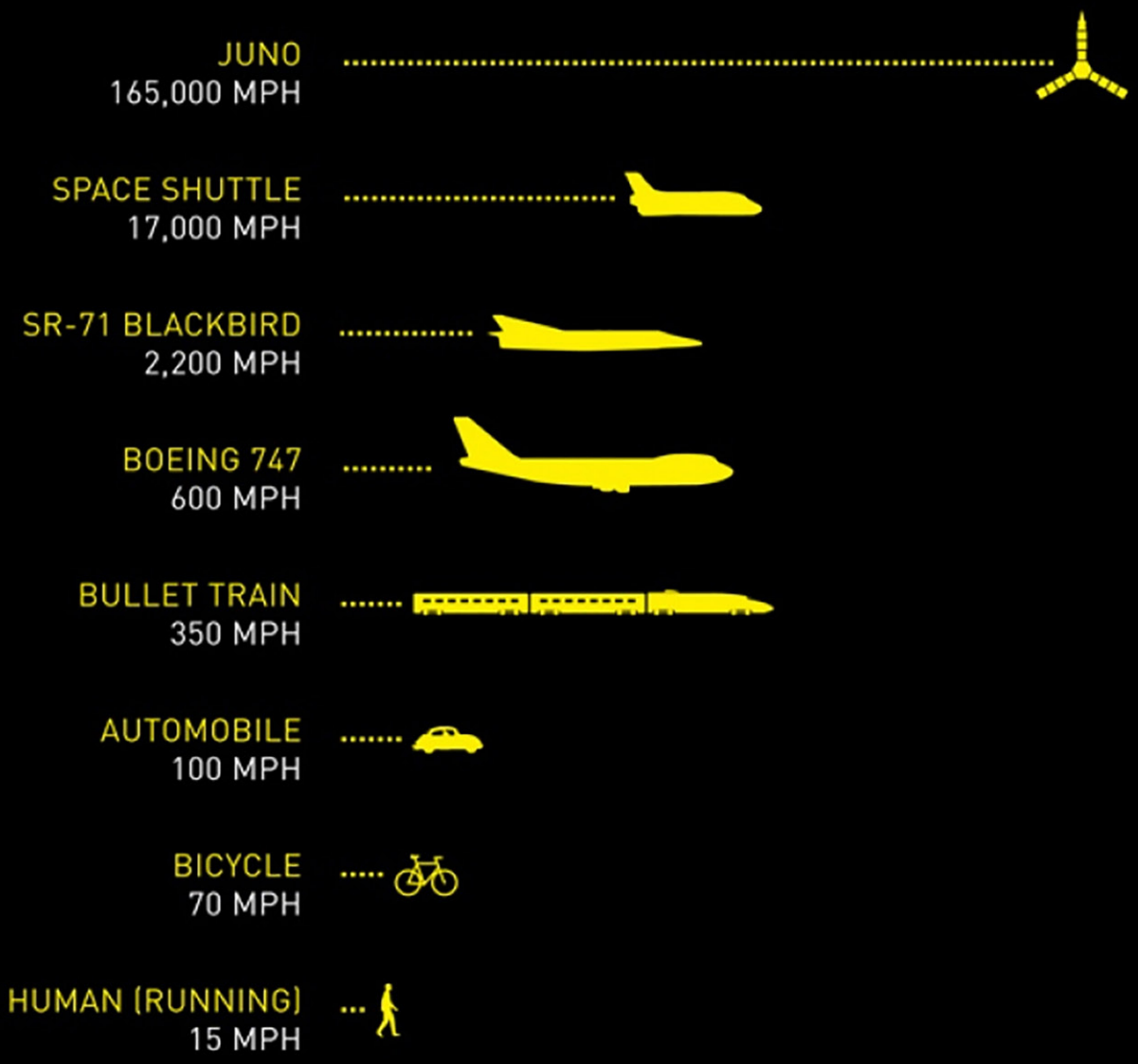
"The smooth running of this fourth mission shows the maturity of the ATV programme and puts ESA's successful track record on the map for future projects."

The next spacecraft in the series, ATV Georges Lemaître, has already arrived by boat at the European spaceport in French Guiana. Loading cargo into the pressurised module will start in March next year. ATV-5's modules will then be combined and placed on its Ariane launcher for launch at the end of June.

With the series of five ATV space vehicles, ESA will have paid its dues for using the Station through to the end of 2017.

ESA is contributing a significant share of the maintenance of the Station to cover the costs related operating its own elements – the Columbus laboratory and its set of experiments and related science equipment – as well as to the regular flights of its astronauts.

HOW FAST CAN JUNO GO?



When arriving at Jupiter, the planet's gravity pulls in Juno faster and faster until the spacecraft reaches a speed of over 250,000 kilometers per hour (150,000 miles per hour) with respect to Earth – making it one of the fastest human-made objects ever. When it arrives at Jupiter, it slams on the brakes, firing its main engine in reverse. After slowing down, Juno can then enter Jupiter orbit.

Juno will cover 2.8 billion kilometers (nearly 1.8 billion miles) during its long, looping voyage. That's 19 times farther than the distance between Earth and the Sun, and 15 times farther than the closest distance between Earth and Jupiter. If Juno were to fly at the speed of a commercial jet, it would take 342 years to complete its journey!

Jet Propulsion Laboratory
California Institute of Technology

Juno's flyby portrait of Earth

This false color composite shows more than half of Earth's disk over the coast of Argentina, South America and the South Atlantic Ocean as NASA's Juno probe slingshotted by on Oct. 9, 2013 for a gravity assisted acceleration to Jupiter. The mosaic was assembled from raw images taken by the Junocam imager. Juno will arrive at Jupiter on July 4, 2016.

Image: NASA/JPL/SwRI/MSSS/ Ken Kremer/Marco Di Lorenzo