

# RocketSTEM

Volume 1 • Number 3 • October 2013

Cygnus  
heats up  
commercial  
space race

LADEE on way  
to study lunar  
atmosphere

Recognising  
the night sky

Voyager leaves  
the solar system

The first European  
woman in space

Space geek  
Seth Green







## United Launch Alliance celebrates 75th successful launch

An Atlas V rocket carrying the Advanced Extremely High Frequency-3 (AEHF-3) satellite for the United States Air Force lifted off from Space Launch Complex-41 at Cape Canaveral Air Force Station in Florida early in the morning of Sept. 18. It was United Launch Alliance's ninth launch of an ambitious 12 mission schedule for the year.

"Today's successful launch was the 75th since ULA was formed nearly seven years ago, the 40th Atlas V mission, and the fourth ULA launch in the last two months," said ULA vice president Jim Spornick. "The ULA team and our many mission partners emphasize a one-launch-at-a-time focus on mission success, along with a strong commitment to continuous improvement. These elements together are the keys to launching our customer's missions successfully at this unprecedented tempo in a reliable and cost-effective manner."

ULA's next launch is the Delta IV GPS IIF-5 mission for the Air Force scheduled Oct. 17 from CCAFS in Florida.

*Image: United Launch Alliance/Pat Corkery*

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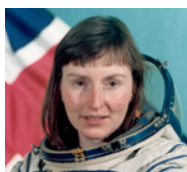
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After a long summer hiatus, we are back with the third issue of RocketSTEM magazine. This issue marks the last of our large quarterly issues. Instead we will be producing smaller monthly issues through the rest of 2013. Our fourth issue will be released in early November.

This digital publication is available for free download as a PDF file.

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**On the Cover:** A false color infrared image of the Orbital Sciences Corporation Antares rocket, with the Cygnus cargo spacecraft aboard, taken Sep. 18 as it launched from Pad-0A of the Mid-Atlantic Regional Spaceport (MARS) at NASA Wallops Flight Facility, Virginia.

Image: Bill Ingalls



# Space Briefs

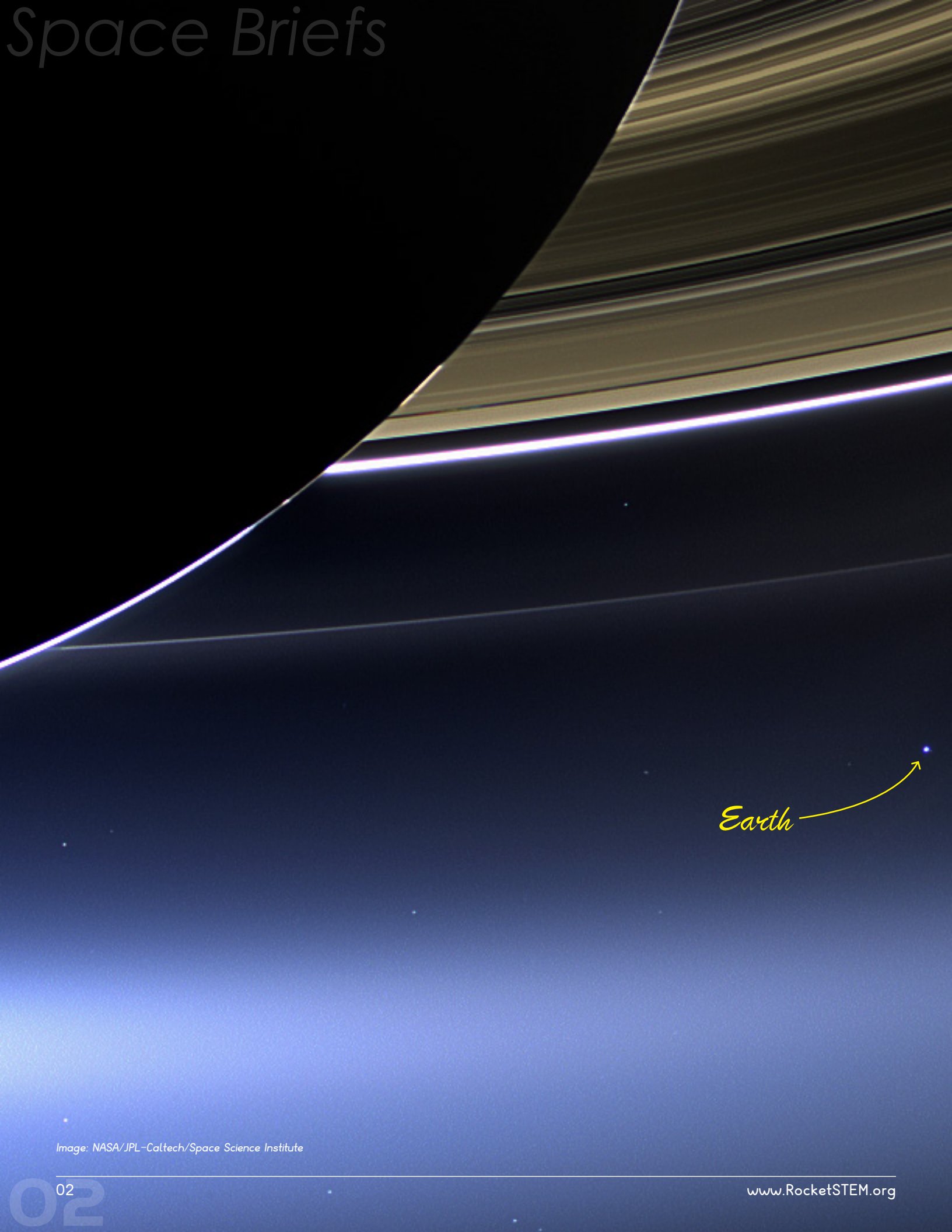


Image: NASA/JPL-Caltech/Space Science Institute





# Cassini images Earth beneath Saturn's rings

NASA's Cassini spacecraft captured color images of Earth and the moon from its perch in the Saturn system nearly 900 million miles (1.5 billion kilometers) away on July 19. Meanwhile, MESSENGER, the first probe to orbit Mercury, took a black-and-white image from a distance of 61 million miles (98 million kilometers) as part of a campaign to search for natural satellites of the planet.

In the Cassini images Earth and the moon appear as mere dots -- Earth a pale blue and the moon a stark white, visible between Saturn's rings. It was the first time Cassini's highest-resolution camera captured Earth and its moon as two distinct objects.

"We can't see individual continents or people in this portrait of Earth, but this pale blue dot is a succinct summary of who we were on July 19," said Linda Spilker, Cassini project scientist, at NASA's Jet Propulsion Laboratory in Pasadena, Calif. "Cassini's picture reminds us how tiny our home planet is in the vastness of space, and also testifies to the ingenuity of the citizens of this tiny planet to send a robotic spacecraft so far away from home to study Saturn and take a look-back photo of Earth."

Pictures of Earth from the outer solar system are rare because from that distance, Earth appears very close to our sun. A camera's sensitive detectors can be damaged by looking directly at the sun, just as a human being can damage his or her retina by doing the same. Cassini was able to take this image because the sun had temporarily moved behind Saturn from the spacecraft's point of view and most of the light was blocked.

"It thrills me to no end that people all over the world took a break from their normal activities to go outside and celebrate the interplanetary salute between robot and maker that these images represent," said Carolyn Porco, Cassini imaging team lead at the Space Science Institute in Boulder, Colo. "The whole event underscores for me our 'coming of age' as planetary explorers."

In the MESSENGER image, Earth and the moon are less than a pixel, but appear very large because they are overexposed. Long exposures are required to capture as much light as possible from potentially dim objects. Consequently, bright objects in the field of view become saturated and appear artificially large.

"That images of our planet have been acquired on a single day from two distant solar system outposts reminds us of this nation's stunning technical accomplishments in planetary exploration," said MESSENGER Principal Investigator Sean Solomon of Columbia University's Lamont-Doherty Earth Observatory in Palisades, N.Y. "And because Mercury and Saturn are such different outcomes of planetary formation and evolution, these two images also highlight what is special about Earth. There's no place like home."

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. JPL designed, developed and assembled the Cassini orbiter and its two onboard cameras. The Johns Hopkins University Applied Physics Laboratory in Laurel, Md., designed and built MESSENGER under NASA's Discovery Program. NASA's Marshall Space Flight Center in Huntsville, Ala., manages the program for the agency's Science Mission Directorate in Washington. JPL and APL manage their respective missions for NASA. The California Institute of Technology in Pasadena manages JPL for NASA.

To view the MESSENGER images, visit: <http://go.nasa.gov/16Vnt5G>.







# LADEE on mission to study Moon's thin atmosphere

NASA's LADEE observatory launches aboard the Minotaur V rocket from the Mid-Atlantic Regional Spaceport at the Wallops Flight Facility, Friday, Sept. 6, 2013, in Virginia.

*Image: NASA/Carla Cioffi*





Image: NASA EDGE

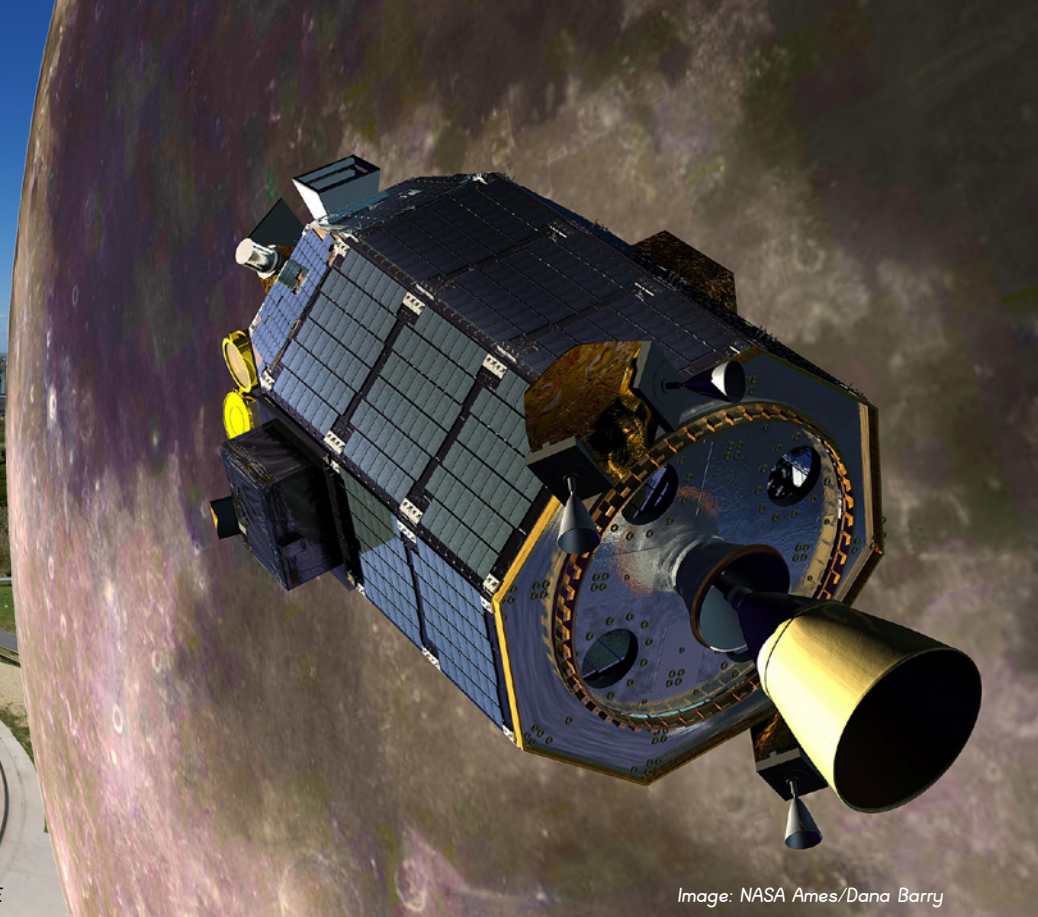


Image: NASA Ames/Dana Barry

The Minotaur V rocket (left) that will carry NASA's LADEE awaits launch from Pad 0B at NASA's Wallops Flight Facility at Wallops Island, Va. An artist's concept (right) of the LADEE spacecraft orbiting the moon and preparing to fire its maneuvering thrusters to maintain a safe orbital altitude.

### By Emory Stagmer

Did you know the moon has an atmosphere?

I wouldn't be surprised if you didn't. Until just a few years ago nobody did. It's not much. You can't breathe it. We think it's mostly dust. But we don't know exactly what's in it or how it works. How does an atmosphere operate when the days are 28 earth days long? That's  $14 \times 24 = 336$  hours of daylight followed by 336 hours of night time. How does an atmosphere work when the gravity is  $1/6$  that of Earth? How does an atmosphere work when it's bombarded by the sun's solar wind at a million miles an hour? How does an atmosphere work when the sunlit portion of the moon is +120 degrees C (hot enough to boil water) and the dark areas are -170 degrees C (cold enough to freeze air)? Those are the kinds of questions NASA is trying to answer with the LADEE satellite, the Lunar Atmosphere and Dust Environment Explorer.

Technically the atmosphere on the moon is called a 'surface

boundary exosphere'. "Surface Boundary" means that it goes all the way down to the surface. But it's a trillion times thinner than the air we breathe here on Earth. It's so thin that the molecules in it basically never touch each other. It's thinner than the 'air' at the height of the International Space Station's orbit 250 miles up.

The Earth's magnetic field protects our atmosphere from the sun's 'solar wind' – not wind like we normally think of it, but a plasma of charged particles, most of them single protons. A single proton is the nucleus of a hydrogen atom. When it doesn't have any electrons with it we call that an ion and write it "H+". And it turns out there are lots of oxygen atoms on the moon. When one of these H+ ions comes in contact with an oxygen atom, they form a pair written as OH and called a hydroxyl. Add a second hydrogen and you get H<sub>2</sub>O, better known as a water molecule. Is there water on the moon? Yes, there is! These OH and H<sub>2</sub>O molecules make up a part of the moon's atmosphere.

The other big part – we think – of the moon's exosphere is dust. Ever see a shooting star at night? That's a bit of rock from space burning up in the Earth's thick atmosphere. If that bit of rock hit the moon, the exosphere there isn't enough to slow it down much less burn it up, and it hits the moon at many thousands of miles per hour. When that happens a lot of dust gets kicked up, and how much depends on how big the rock is and how fast it's going. But scientists don't really know just how much dust or what it's really made of – that's the "Dust Environment" portion of LADEE's name.

LADEE launched from the eastern shore of Virginia on September 6, 2013 at 11:27 at night (Eastern Time). The countdown and launch went perfectly, and the Minotaur V rocket put LADEE into an almost perfect orbit. The launch was very bright and was seen by thousands of people from North Carolina to Maine. The launch took place at the NASA Wallops Flight Facility and the rocket was built and flown by a joint effort of the Air Force and





Image: NASA Ames

NASA's John Grunsfeld (left) talks during a NASA Social at the Wallops Flight Facility. Also, a crowd at NASA's Ames Research Center (above) awaits the launch broadcast for Ames' LADEE mission.



Image: NASA/Carla Cioffi

the Orbital Sciences Corporation. The Minotaur V lifts off very quickly – rocket reached mach 1 in 20 seconds! The first stage burned out in 57 seconds and was travelling at mach 4. There are some great videos of the launch on YouTube.

NASA invited television and newspaper reporters as you would expect, but there are 50 people for something called a "NASA Social" as well. They come from as far as

Oregon, Oklahoma, and Texas! They come from all walks of life including teachers (one of whom is streaming live to his classroom!) welders, photographers, sales and marketing, and a tattoo artist. I was one of those invited. I post lots of stuff about space on Twitter and Facebook and I signed up when NASA announced the opportunity on Twitter (the twitter handle is @NASASocial). I highly recommend trying to go to one of these NASA Social events – I have been to a few and seen two rocket launches and met 6 astronauts.

There was one other 'uninvited' guest at the launch. A frog was evidently in the water used to cool the area around the rocket launch pad and was 'rocketed' up into the sky when the Minotaur V lifted off. A picture of him was taken by an automated camera set up by NASA photographer Chris Perry. The frog is now tweeting about his experiences on twitter @RocketFrog1.

Anyone can participate in the science of LADEE. The MeteorCounter app for smart

phones allows for anyone to count the number of meteors entering Earth's atmosphere. That's an important number to know since the moon and Earth fly through the same area of space together. If you're counting the number of meteors entering earth's atmosphere, you're basically also counting the number of meteors hitting the moon (remember the dust?). Since these meteors can be as small as a grain of sand, the impact on the moon won't be visible from earth (it's much too small), but they can make a bright streak in the Earth's atmosphere. All you need to help out there is a smart phone and a blanket or lounge chair. Look up at night and count the meteors.

A meteor impact on the moon can be visible on earth with a telescope as small as 8" in diameter for meteors as small as a walnut! So if you have a telescope or a smart phone, you can also participate in LADEE science!

For more information on LADEE, visit NASA's LADEE webpage at <http://www.nasa.gov/ladee>

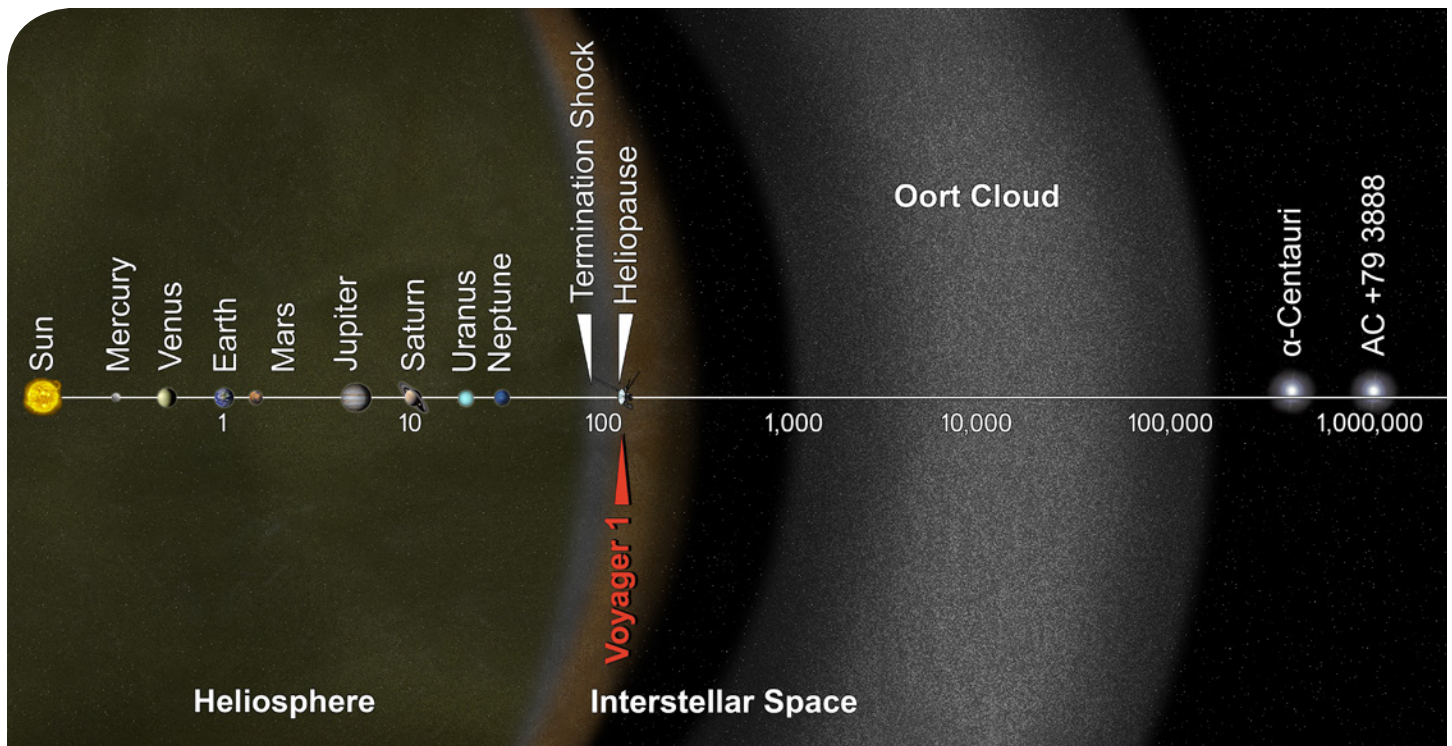
*Into the unknown!*

# Interstellar adventure begins for Voyager 1





Image: NASA/JPL-Caltech



**Voyager goes intersellar:** This artist's concept puts solar system distances in perspective. The scale bar is in astronomical units, with each set distance beyond 1 AU representing 10 times the previous distance. One AU is the distance from the sun to the Earth, which is about 93 million miles or 150 million kilometers. NASA's Voyager 1, humankind's most distant spacecraft, is around 125 AU. Scientists believe it entered interstellar space – the space between stars – on Aug. 25, 2012. *Image: NASA/JPL-Caltech*

The hotly contested question has been answered: Voyager 1 is humanity's first object to enter interstellar space! The historic announcement came from NASA after a year of review into 2012 and 2013 data points from the intrepid probe. Officially, Voyager 1 entered interstellar space on 25 August 2012.

### The debate

For over a year, scientists have questioned the analysis of data points returned from Voyager 1 as it passed through a new and unique region on the outskirts of the solar system.

Specifically, the debate centered around the question of whether Voyager 1 was in a previously unknown region at the outer-most edge of the solar system (known as the heliopause) or whether Voyager 1 had actually crossed the barrier into interstellar space.

On 25 August 2012, Voyager 1 registered an abrupt, durable change in the density of the energetic particles it was traveling through.

Initially, as reported by NASA on 4 December 2012, it was determined that this shift in particle density was

the mark of Voyager 1's full entrance into a new region of the heliopause, called the magnetic superhighway, at the outer-most edge of the solar system.

It is now understood that this was a far more significant date and moment than first thought.

### Gift of a Coronal Mass Ejection

In March 2012, five months before Voyager 1 would record the particle density change in August, a Coronal Mass Ejection (CME), a massive expulsion of charged particles, released from the sun. While seemingly routine at the time, the CME event could now be held as one of the most important and significant CMEs in recorded history.

Thirteen months after the CME event, on 9 April 2013 (just over seven months after the August particle density change was recorded), the charged particles associated with the CME event reached Voyager 1 – which was at a distance of 17 hours 05 minutes 58 seconds light-travel time from Earth.

When the CME charged particles reached Voyager 1, its Plasma Wave Instrument recorded the event and transmitted the data back to Earth. It is what scientists saw in these data points that was nothing short of stunning.

When the CME particles reached the plasma cloud around Voyager 1, the plasma cloud began oscillating (vibrating) at a particular pitch that allowed scientists to determine the density of the plasma field surrounding the intrepid little probe.

*Authored by Chris Gebhardt, this article appeared first at NASASpaceFlight.com.*



The results: the plasma was 40 times denser than what Voyager 1 reported when it was in the outer layer of the heliopause of the solar system.

Moreover, the density matched all expectations of the plasma density of interstellar space.

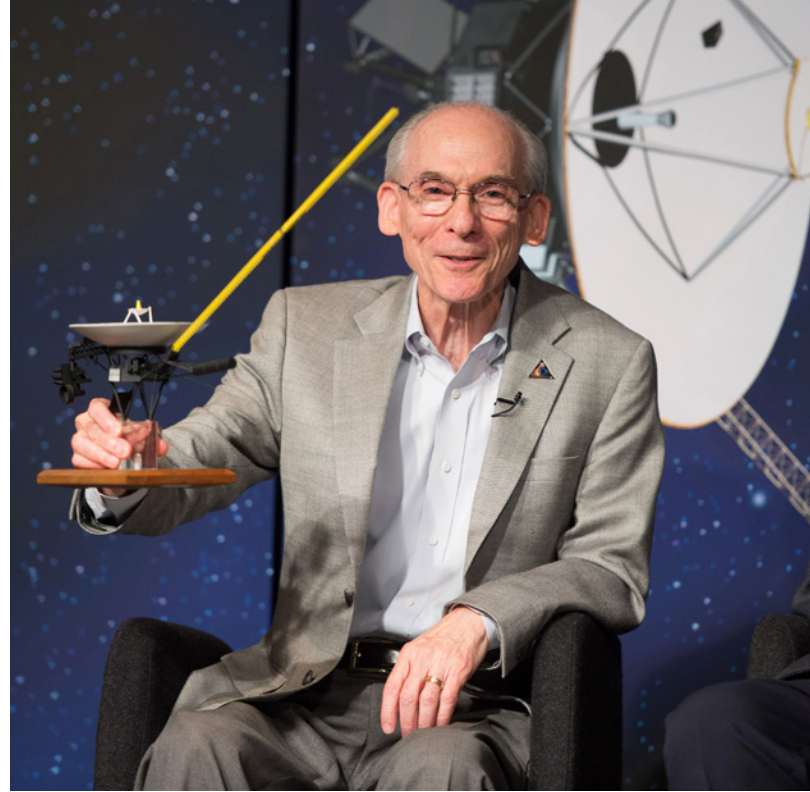
"We literally jumped out of our seats when we saw these oscillations in our data – they showed us the spacecraft was in an entirely new region, comparable to what was expected in interstellar space, and totally different than in the solar bubble," stated Don Gurnett, lead plasma wave science team member from the University of Iowa.

"Clearly we had passed through the heliopause, which is the long-hypothesized boundary between the solar plasma and the interstellar plasma."

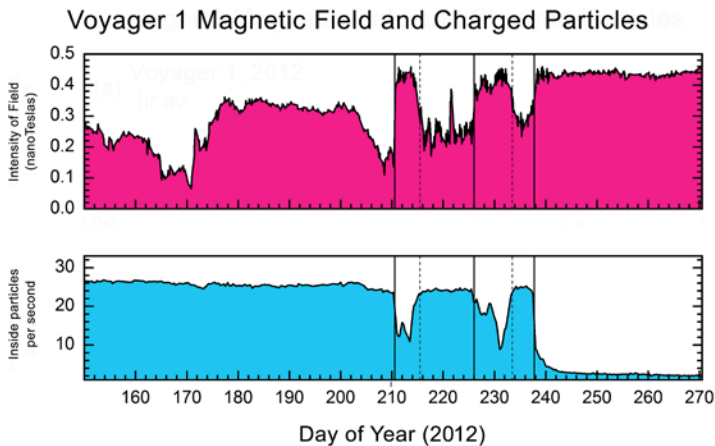
With this new data in hand, scientists then went back into the Voyager 1 data archives from 2012 and were able to discern a similar set of oscillations from the October–November 2012 timeframe. Working backward, the science team determined that the oscillations in the plasma density field first appeared in late August 2012.

The abrupt, durable change in the density of the energetic particles around Voyager 1 on 25 August 2012 was much more than the probe's entrance into the magnetic superhighway. It was the date that Voyager crossed the boundary into a space where no probe had gone before: interstellar space.

"Voyager has boldly gone where no probe has gone before, marking one of the most significant



Ed Stone, Voyager project scientist, California Institute of Technology, holds a model of NASA's Voyager spacecraft during a news conference held Sept. 12 to discuss the Voyager 1 spacecraft officially venturing into interstellar space. *Image: NASA/Carla Cioffi*



This graphic tracks the behavior of the sun's magnetic field and a population of charged particles as the Voyager 1 spacecraft traveled through space in 2012. The top graphic (magenta) shows the intensity of the magnetic field in nanoteslas. These data come from Voyager's magnetometer. The bottom graphic (blue) shows the prevalence of lower-energy charged particles that originate from inside our heliosphere, which is the bubble of charged particles around our sun. These data come from the cosmic ray instrument. Each time Voyager 1 entered this new region called the 'magnetic freeway,' the population of these inside particles dropped. After Aug. 25, the magnetic field intensity has held steady at the same elevated level and the population of inside particles hit an all-time low and has not changed.

*Image credit: NASA/JPL-Caltech/GSFC/University of Delaware*

technological achievements in the annals of the history of science, and adding a new chapter in human scientific dreams and endeavors," said John Grunsfeld, NASA's associate administrator for science in Washington.

For the record, Voyager 1 traversed the distance of 121.6882 Astronomical Units (AUs) to the boundary to interstellar space in 34 years 11 months 20 days (5 September 1977 to 25 August 2012).

With this historic passage, Voyager 1's mission in interstellar space stands to last at least 7 more years, as the probe has enough power to continue transmitting data about this unexplored region of space back to Earth until at least 2020.

But equally as impressive as the uplifting and positive milestone we now understand Voyager 1 to have reached for humankind is the fact that the probe reached this mark with functioning scientific equipment – something no one truly envisioned happening in 1977 when Voyager 1 began what became its multifaceted mission.

## An engineering testament

Voyager 1 was built to be a robust and sturdy spacecraft, one capable of surviving its encounters with the intense radiation and gravitational fields of the solar system's giants: Jupiter and Saturn.

But more importantly, Voyager 1 was built to be an instrument of science. Its large, 12ft antenna reflectors were the largest graphite epoxy antennae made for a spacecraft at the time of its launch.

Three deployable booms carried most of the



spacecraft's scientific instruments, including the Ultraviolet Spectrometer, the Cosmic Ray experiment, the Plasma experiment, the Photopolarimeter, and the Low-Energy Charged Particle experiment.

A second, longer boom carried a series of magnetometers and two whip antennae for the plasma radio experiment.

Furthermore, all of Voyager 1's experiments were designed to be compact, lightweight, and draw as little power as possible. During periods of interplanetary cruise and high-science data accumulation, data not immediately transmitted back to Earth was designed to be stored on a digital tape recorder with about 536 megabits capacity (about 67 megabytes), enough to hold roughly 100 images.

But the truly remarkable aspect of Voyager 1, and the main element that enables the probe's continued mission today, is its power source: three Radioisotope Thermoelectric Generators (RTGs) located on the third deployable boom.

An impressive feat of engineering at the time, each of the three cylindrical RTGs on Voyager 1 were built with six layers of four 2-inch diameter plutonium (238) oxide encapsulated in a thin shell of iridium. These shells of iridium were in turn wrapped in graphite yarn and stacked in graphite cylinders.

Each ball produced about 100 watts of thermal energy at launch, for 2,400 watts of thermal power from each RTG.

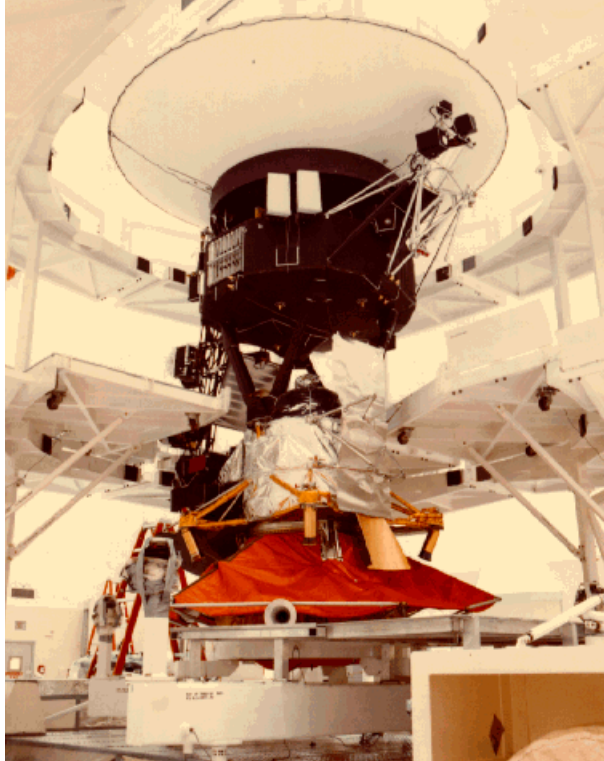
However, like all spacecraft, the power source underwent changes and modifications in the development process.

In fact, during development, it was recognized that the thermocouples (designed to convert the contrast in temperature between the hot plutonium and cool space environment into electricity) were degrading far too quickly in the very warm RTG cylinders.

This led to the suggestion that the thermocouple legs be coated with silicon nitride to prevent sublimation of thermocouple material that was causing electrical shorts, which reduced power output.

This careful engineering resulted in robust RTGs on Voyager 1 that have been in continuous operation for over 36 years, though they are only producing about 60% of their original output as of today due to the radiation- and temperature-induced degradation of the thermocouples.

But even with the robust power source, none of



Voyager before launch in the SAEF II at KSC. Image: NASA

Voyager 1's instruments would have been able to return any data without the complex control of the probe's six interlinked computers.

Voyager 1's Computer Command System (CCS) was designed by engineers to control the sequences of activities to be carried out by the spacecraft; the Flight Data Subsystem (FDS) was designed to control the acquisition and downlink of data; and the Attitude and Articulation Control System (AACS) was designed to control the attitude of the spacecraft and orientation of the science scan platform.

Additionally, the electronics of Voyager 1 had to be radiation-hardened to survive the probe's planned encounter

with Jupiter.

With all of this forethought and complex engineering, the Voyager 1 spacecraft has been essentially remade since its launch as various systems issues forced mission controllers to improvise and the probe completed its primary mission in 1980.

Upgrades to the indispensable Deep Space Network have also enabled continued communication and tracking with Voyager 1 at greater distances than were possible when the spacecraft was first launched.

## Trek through the solar system

Voyager 1's mission began on 5 September 1977 with its launch aboard a Titan III-C rocket from the Cape Canaveral Air Force Station in Florida.



Artist rendering showing the Voyager spacecraft on their grand tour through the solar system. Image: NASA/JPL-Caltech



Observations of the Jovian system began on 6 January 1979 and resulted in the discovery of Jupiter's rings, a study of the intensity of the planet's radiation belts, and the discovery of the existence of volcanic activity on Io.

Study of the Jovian system for Voyager 1 concluded on 13 April 1979, at which point NASA realigned the probe for its encounter with Saturn in 1980.

By this point, NASA had to decide whether to use Voyager 1 for a proximity flyby of Saturn's moon Titan, and thereby eliminate the probe's ability to continue on to the outer-most planet – at the time – Pluto, or to do a calculated flyby of Saturn to preserve the possible up-close study of Pluto.

Ultimately, it was decided that Titan was of a greater scientific value than Pluto, and Voyager 1's trajectory was altered for a close-up examination of this Saturnian moon.

Observation of the Saturnian system began on 22 August 1980 and resulted in a close pass of Titan, which altered Voyager 1's trajectory out of the ecliptic plane of the solar system in a "northerly" direction of travel.

With the chance of any further planetary encounters nullified, Voyager 1 was repurposed for an extended mission to study the outer reaches of the solar system for as long as its instruments continued to function.

On 14 February 1990, the probe's cameras were turned back toward the solar system, and Voyager 1 took the instantly immortal family portrait of the solar system.

The family portrait was the first ever family photo of the solar system, and is the source of the famous "Pale Blue Dot" photograph of Earth – the farthest photo of Earth ever taken.

The portrait is, in actuality, a composite image of 60 photographs obtained on 14 February 1990 from a distance of 6 billion kilometers from Earth at approximately 32-degrees above the ecliptic plane.

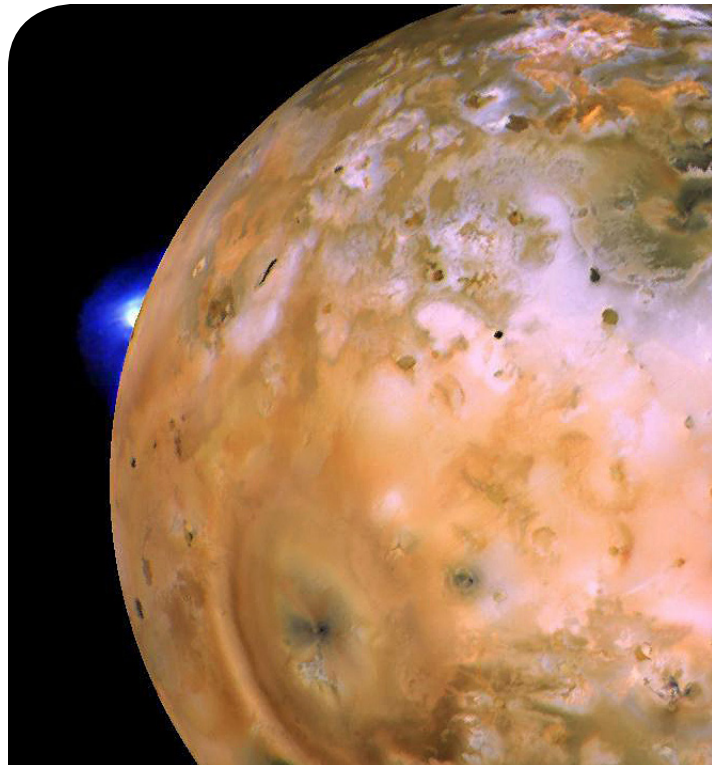
The family portrait depicts six of the eight planets of the solar system along with the sun. Only Mercury and Mars were not visible due to proximity to the sun and scattered sunlight in the optics, respectively.

Pluto, which is no longer considered one of the major planets, was not included in the photograph due to its distance from the sun and low light reflectivity.

On 17 November 1998, Voyager 1 officially became the farthest human-made object in the solar system when it overtook the Pioneer 10 probe at a distance of 69.4 AU from the sun, a status it has maintained and will maintain for decades to come.

With the probe's longevity looking promising, NASA repurposed Voyager 1 yet again for the Voyager Interstellar Mission (VIM) – a mission to map the outer boundary of the solar system and explore the interstellar medium outside of the solar system.

As part of the program, NASA tasked Voyager 1 with finding the termination shock (the moment when the sun's solar wind suddenly drops from hypersonic speeds to subsonic speeds), mapping the heliosheath



Voyager 1 image of Io showing active plume of Loki on limb. A heart-shaped feature southeast of Loki consists of fallout deposits from active plume Pele. *Image credit: NASA/JPL/USGS*

(a turbulent region beyond the termination shock where the solar wind is disturbed and acted upon by the force of the interstellar medium), and mapping the heliopause (the boundary between the solar system and interstellar space).

Voyager 1 crossed the termination shock in December 2004 and officially entered the heliosheath.

Six years later, scientists confirmed that Voyager 1 had reached the area where the sun's solar wind is turned sideways by the interstellar medium pushing against the heliosphere – the sun's direct area of influence.

This area, called the heliopause, is the area where the solar wind drops to zero in relation to the outward push of the sun's influence. Voyager 1 entered this area in June 2010.

On 15 June 2011, scientists working with the probe announced that Voyager 1 was expected to cross the barrier into interstellar space between 2015 and 2017, though it could be "at any time."

One year and two months after this announcement, Voyager 1, still functioning after 35 years in the harsh environment of space, crossed into the interstellar medium and became humanity's first interstellar explorer.

As of today, Voyager 1's RTG power source continues to power the probe's still-functioning instruments and is expected to do so until 2020-2030 – meaning Voyager 1's exploration of interstellar space will occur, barring a collision with an unknown object, for at least 7 more years.



## Radio bursts discovered from beyond our galaxy

Astronomers, including a team member from NASA's Jet Propulsion Laboratory in Pasadena, Calif., have detected the first population of radio bursts known to originate from galaxies beyond our own Milky Way. The sources of the light bursts are unknown, but cataclysmic events, such as merging or exploding stars, are likely the triggers.

A radio burst is a quick surge of light from a point on the sky, made up of longer wavelengths in the radio portion of the light spectrum. A single radio burst was detected about six years ago, but researchers were unclear about whether it came from within or beyond our galaxy.

The new radio-burst detections -- four in total -- are from billions of light-years away, erasing any doubt that the phenomenon is real. The discovery, described in the July 4 issue of the journal *Science*, comes from an international team that used the Parkes Observatory in Australia.

"Short radio bursts are really tricky to identify," explained Sarah Burke Spolaor of JPL. "Our team had to search 11 months of data covering a large sky area to find them."

Spolaor developed the software used to seek single pulses in the radio data and pick out genuine signals from local interference sources -- such as cell phones, spark plugs and aircraft. This amounted to an enormous and complex computational task.

Dan Thornton, lead author of the new study from England's University of Manchester and Australia's Commonwealth Scientific and Industrial Research Organization, said, "The radio bursts last for just a few milliseconds and the farthest one that we detected was 11 billion light-years away."

The findings open the door to studying an entirely new class of eruptive cosmic events and can also help with cosmology mysteries, for example, about the nature of matter in the universe.

Our sky is full of flares and bursts of varying natures. For instance, gamma-ray bursts are thought to occur when stars collapse into black holes. They are routinely detected by a network of telescopes on the ground and in space, including NASA's Swift and Fermi. When one telescope in the network detects a burst, it can notify others to quickly slew to the target for coordinated observations.

The newfound radio bursts, while likely of a different origin than gamma-ray bursts, also consist of light waves generated by powerful events happening at great distances. Researchers would like to develop systems similar to the gamma-ray burst networks of telescopes to follow up quickly on radio bursts, but this is more challenging because radio waves are slowed by gas in space. Time is needed to process the radio observations and tease out the short-lived bursts.

On the other hand, the fact that radio waves are impeded as they travel through space to reach us offers benefits. By studying how the radio waves have been slowed, scientists can better understand baryonic matter, the material that gets in the way. Baryonic matter is what makes up people and planets and everything you see. The rest of the universe consists of mysterious substances called dark matter and dark energy.

Exactly what is triggering the release of the radio waves is unknown. Theories include colliding neutron stars or black holes; evaporating black holes; and stellar explosions called supernovae. The new data do not fit nicely with any of these scenarios, leaving the scientists perplexed.







## radio bursts

*noun*

a brief emission of intense radio waves from a star, etc.





An integrated MUOS satellite stands vertical in Lockheed Martin's Sunnyvale, Calif., facility.  
*Image: Lockheed Martin*



# Lockheed Martin supplying advanced GPS, secure communication satellites

By Sherry Valare

Launched just over a century ago, Lockheed Martin, a global security and aerospace company, has become a major force behind an array of advanced technology systems that have made their way into our everyday lives. It was started on modest foundations, when a man and a pair of brothers started to put the pieces of their steadfast vision and purpose together.

One half of the formula was Glenn L. Martin. Motivated by flight legend Orville Wright to bring his groundbreaking idea for a new aircraft design to life, he found a church and used it as a garage to build his creation. Destiny started brewing four months later, when brothers Allan and Malcolm Lockheed created AlcoHydro Aeroplane Company, later renamed Lockheed Aircraft Company. This determined and forward thinking trio of men collaborated intermittently through the years, and in 1995, the company was officially deemed Lockheed Martin. Some of its current and next generation projects include the NASA family of Great Observatories, MUOS (Mobile User Objective System) secure communications satellite, and GPS (Global Positioning System) technology.

Two components of the NASA family of Great Observatories the Hubble and Spitzer telescopes were built, integrated and operated by Lockheed Martin. Their combined observations over the years have produced a number of fascinating images that take us back in time to show us some of the earliest galaxies in the universe, galaxies in all stages of development, and the births and deaths of many stars and planets.

According to Buddy Nelson of Lockheed Martin, "The Hubble

Space Telescope (HST) was launched in 1990 and observes the universe in multiple wavelengths; from infrared through visible light and into the ultraviolet region of the spectrum. HST has imaged some of the earliest galaxies formed after the Big Bang and defined the limits of their age, learned how they came to be, and observed stars in the last stages of their lives. HST has

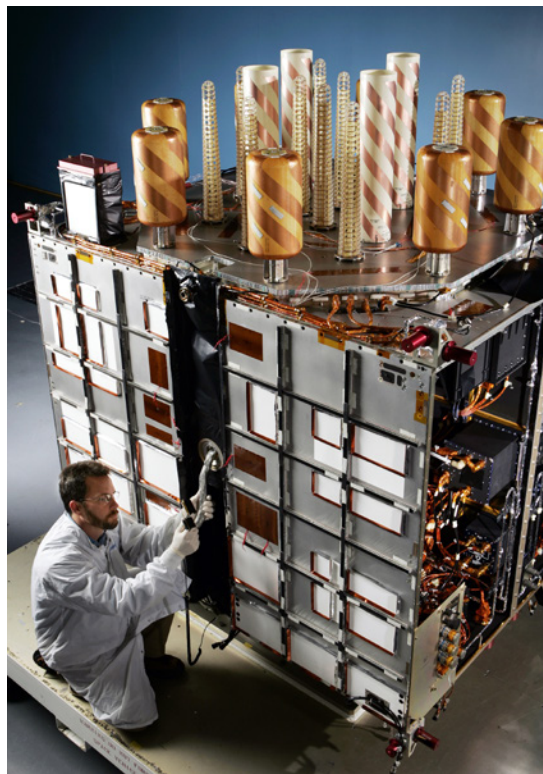
With Spitzer, astronomers have determined that Earthlike planets form around many, if not most of the nearby Sunlike stars in our galaxy, suggesting that the potential for life might be more common than previously thought. In looking at our own galaxy – the Milky Way galaxy – the observatory has given astronomers valuable insights by revealing where new stars are forming. In addition, the infrared eyes of Spitzer are ideal for studying distant planet forming disks, and characterizing planets beyond our Solar System."

The images these telescopes have produced over the years display the beauty and power our universe possesses. Hubble and Spitzer both remain in operation, continuing to watch the sky and make exciting new discoveries.

Lockheed Martin is also heavily involved in operations on the ground. On the morning of July 19th, 2013, an Atlas V in the 551 configuration stood on the launchpad at Cape Canaveral Air Force Station in Florida, topped by a capsule packed tightly with the second Mobile User Objective System (MUOS 2) payload.. The heaviest Atlas V payload to date punched through the low, dark cloud ceiling and successfully placed MUOS2 into orbit. The MUOS

secure communications satellites—which will reside in geosynchronous orbit 22,000 miles above Earth will replace the Ultra High Frequency (UHF) FollowOn system.

The entire geosynchronous constellation at completion will consist of four satellites, plus one in-orbit spare. They are expected to be fully operational by 2015, and are projected to extend Ultra High Frequency (UHF) narrowband communications availability far



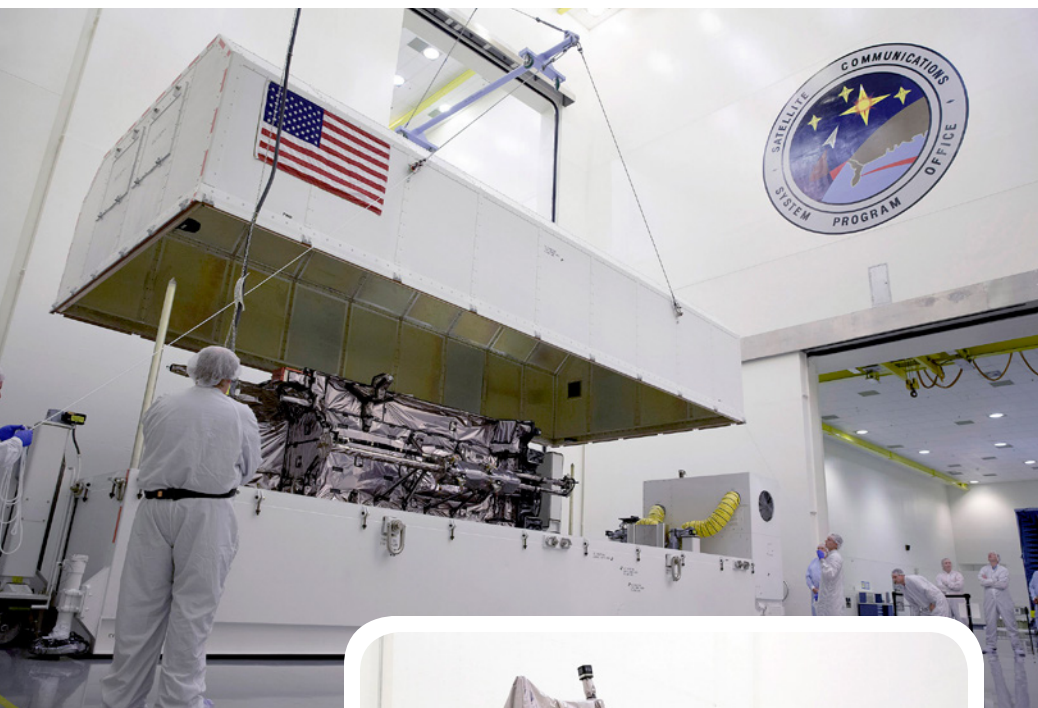
A Lockheed Martin engineer works on a GPS IIR-M satellite.

Image: Lockheed Martin

also found that almost all galaxies with bright, active centers have supermassive black holes feeding off the galaxy's matter. Stars and planetary systems in the making, planets around distant stars, and the destructive power of cosmic impacts have also been witnessed by this amazing telescope.

"Launched in 2003, the Spitzer Space Telescope views the universe in infrared light, which is largely blocked by the Earth's atmosphere.





A massive C-17 aircraft delivered a full-sized, functional GPS III satellite to CCAFS in Florida on July 19 so that the facilities and pre-launch processes could be tested, further reducing risk and gaining efficiencies. The first GPS III flight satellite is expected to launch in 2015.

Image: Lockheed Martin

beyond 2025. The first MUOS satellite was launched in 2012. It has been providing secure voice, video, and data connections to mobile users.

Following the Atlas V launch, a C17 aircraft touched down on the runway at Cape Canaveral Air Force Station, carrying the GPS III NonFlight Satellite Testbed (GNST) – a fully functional, full-sized prototype of the next generation GPS (Global Positioning System). It was conducting a “dress rehearsal” to test the prelaunch processing activities that the first GPS III flight space vehicle (SV 01) will endure.

The “dress rehearsal” started at Lockheed Martin’s GPS III Processing Facility in Denver, Colorado, where the GNST went through production and testing. It was packed onto the Air Force C17 aircraft from Buckley Air Force Base and put through a dry run of the flight activities. The offloading of the satellite from the plane that took place that afternoon is another step in process.

The start-to-finish dry run is how the Air Force discovers the strengths and weaknesses in the procedures they have in place, so that any risks taken are with the prototype instead of the real thing.

Vice President for Lockheed Martin’s Navigation Systems mission area, Dr. Keoki Jackson explained, “All future GPS III satellites will follow this same path, so the GNST was a smart initiative to help us discover and resolve any issues in advance, implement production efficiencies, and ultimately save a tremendous amount of time and money in the long run.”

This successful deployment of this constellation of satellites is critical for the Air Force. Military personnel and civilians use GPS navigation constantly – in fact, it is nearly impossible for anyone to go through an entire day without somehow using this technology. The simplest example is on your cell phone – a device that has become like an artificial body part for many people where time is synchronized across all networks, despite the carrier. GPS technology makes that happen.

The GPS system that is currently in



operation reached its goals in 1995 – which is incredibly outdated considering the speed at which we have advanced technologically.

GPS III is a significant program for the Air Force, as it will replace these aging satellites and strengthen their ability to meet the growing demands of military, commercial and civilian users. Accuracy of the satellites will be three times greater and they will include enhancements that extend the life of the spacecraft 25% further than that of their predecessors.

In order to fully comprehend the significant impact this constellation of satellites has on our daily activities, let's take a look at what would happen if the current GPS satellites ceased to exist with no replacement. Take into consideration this fact: our global infrastructure is dependent on GPS technology without it, we would crumble. It is a necessity and our world is entirely dependent on it to function properly. Not only is it relied on by a plethora of different networks for communications, it is also used by systems you may not



The fully-integrated MUOS satellite is encapsulated in the launch vehicle payload fairing. *Image: Lockheed Martin*

even know about, such as ATM machines. You will find it rooted in nearly every U.S. military asset you can think of that keeps our armed forces safe and effective. Increased productivity is boosted over an enormous fraction of our economy; from aviation, roads and highways, and surveying – to industries that may not seem as

obvious like farming, mining, and construction industries.

Lockheed Martin is currently contracted to produce the first four satellites in the GPS III constellation (SV 0104), and has received procurement funding for longlead components for the fifth, sixth, seventh and eighth satellites (SV 0508). Lockheed Martin is the prime contractor on the project, and the Global Positioning Systems Directorate at the U.S. Air Force Space and Missile Systems Center leads the GPS III team.

Today, Lockheed Martin has grown into a company that employs around 118,000 people around the globe. It continues to stand out amongst its competitors, as it has been the brains behind many indispensable projects. This legacy the Lockheed brothers and Glenn L. Martin set in motion so many years ago, is alive and blossoming. It is hard to comprehend that it came from such humble beginnings when it has turned into a dominant player in this industry.

For more information about Lockheed Martin, visit their website at [www.lockheedmartin.com](http://www.lockheedmartin.com).

## Contest offers students chance to help design spacecraft

Did you know that Lockheed Martin is an active backer of STEM fields? In many different ways, they are helping to shape the minds of tomorrow. Their programs are reaching out to students and educators across the nation to involve them in the future of aerospace.

Earlier this year, NASA and Lockheed Martin announced the Exploration Design Challenge, an exciting way for K-12 students to get involved. Protecting astronauts from the radiation exposure acquired during long duration spaceflight is a problem that has to be conquered if humans are to travel into deep space.

Lockheed Martin is the prime contractor to NASA for the Orion Multi-Purpose Crew Vehicle, designed to house astronauts as they leave low Earth orbit and venture out into the unknown.

High school students are encouraged to show off their ideas at designing the shielding that will protect a sensor inside the capsule from the radiation.

"The Exploration Design Challenge is a tremendous opportunity for NASA and Lockheed Martin to offer students across the United States a practical, hands-on opportunity to address and solve issues related to deepspace exploration and to be connected to the Orion program and the much anticipated EFT1 test flight," said James H. Crocker, Lockheed Martin Space Systems vice president and general manager of Civil Space programs.

"Plus, this is taking STEM studies to another level, which is key, considering the aerospace industry's imperative to inspire and cultivate its future workforce as current engineers and scientists approach retirement," added Crocker.

The winner will be awarded with the honor of watching the Orion capsule lift off with their design aboard Orion when Exploration Flight Test 1 (EFT1) launches in September, 2014.



## What would we want to know if we landed on Jupiter's Europa?

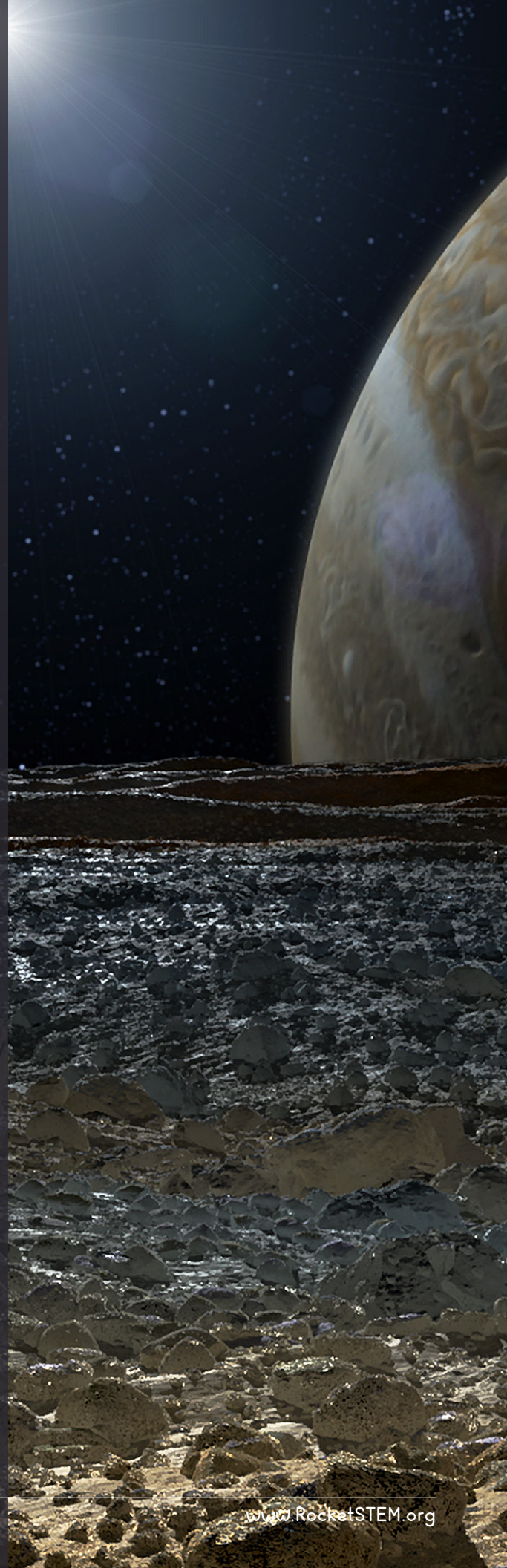
Most of what scientists know of Jupiter's moon Europa they have gleaned from a dozen or so close flybys from NASA's Voyager 2 spacecraft in 1979 and NASA's Galileo spacecraft in the mid-to-late 1990s. Even in these fleeting, paparazzi-like encounters, scientists have seen a fractured, ice-covered world with tantalizing signs of a liquid water ocean under its surface. Such an environment could potentially be a hospitable home for microbial life. But what if we got to land on Europa's surface and conduct something along the lines of a more in-depth interview? What would scientists ask? A new study in the journal *Astrobiology* authored by a NASA-appointed science definition team lays out their consensus on the most important questions to address.

"If one day humans send a robotic lander to the surface of Europa, we need to know what to look for and what tools it should carry," said Robert Pappalardo, the study's lead author, based at NASA's Jet Propulsion Laboratory, Pasadena, Calif. "There is still a lot of preparation that is needed before we could land on Europa, but studies like these will help us focus on the technologies required to get us there, and on the data needed to help us scout out possible landing locations. Europa is the most likely place in our solar system beyond Earth to have life today, and a landed mission would be the best way to search for signs of life."

The paper was authored by scientists from a number of other NASA centers and universities, including the Johns Hopkins University Applied Physics Laboratory, Laurel, Md.; University of Colorado, Boulder; University of Texas, Austin; and the NASA Goddard Space Flight Center, Greenbelt, Md. The team found the most important questions clustered around composition: what makes up the reddish "freckles" and reddish cracks that stain the icy surface? What kind of chemistry is occurring there? Are there organic molecules, which are among the building blocks of life?

Additional priorities involved improving our images of Europa - getting a look around at features on a human scale to provide context for the compositional measurements. Also among the top priorities were questions related to geological activity and the presence of liquid water: how active is the surface? How much rumbling is there from the periodic gravitational squeezes from its planetary host, the giant planet Jupiter? What do these detections tell us about the characteristics of liquid water below the icy surface?

"Landing on the surface of Europa would be a key step in the astrobiological investigation of that world," said Chris McKay, a senior editor of the journal *Astrobiology*, who is based at NASA Ames Research Center, Moffett Field, Calif. "This paper outlines the science that could be done on such a lander. The hope would be that surface materials, possibly near the linear crack features, include biomarkers carried up from the ocean."





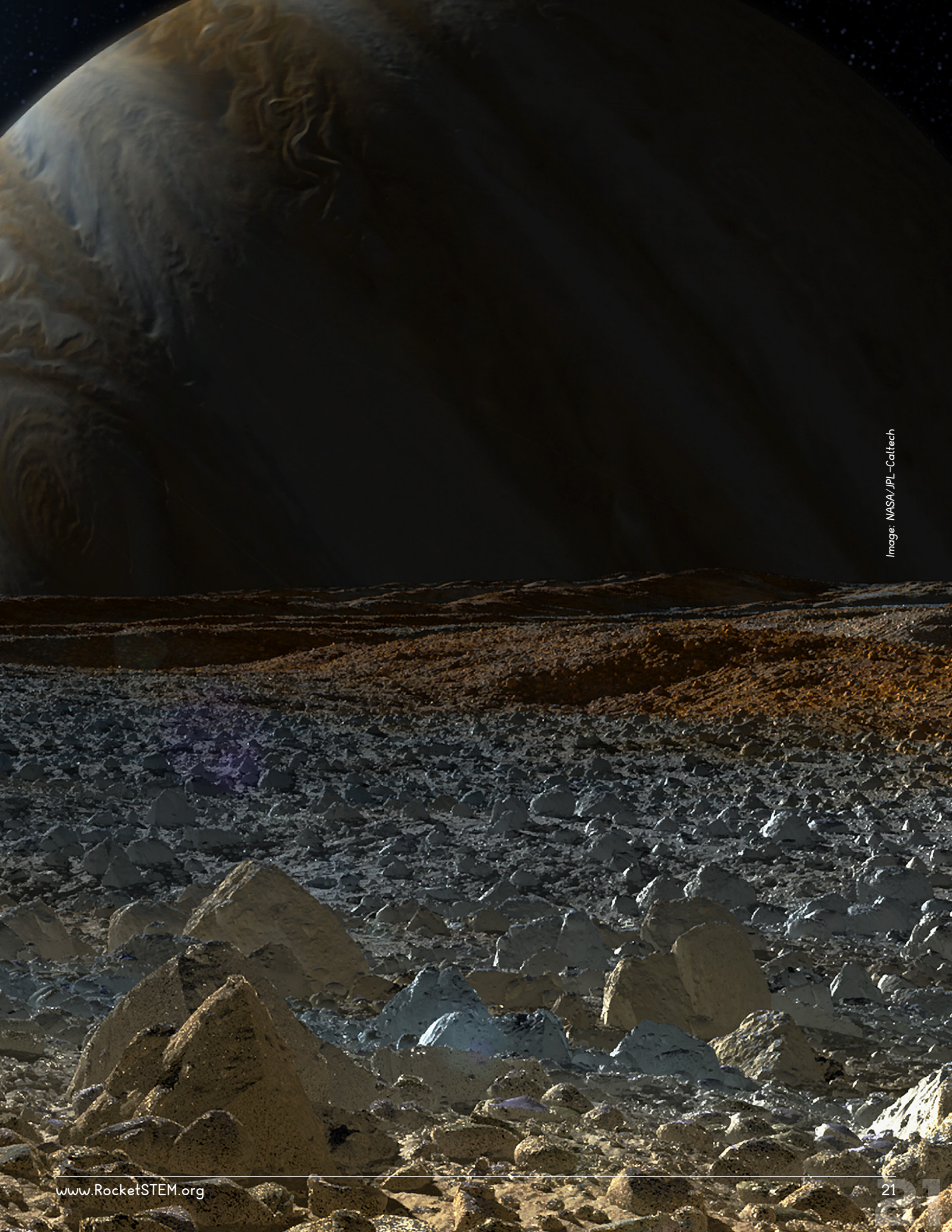


Image: NASA/JPL-Caltech



# Being a cosmonaut was 'just a job' for history-making Helen Sharman

By Andrew R. Green, Bsc (Hons) FBIS, FRAS

The following article is an account of several meetings, chats and short interviews I have had with the first Briton in space, Helen P. Sharman

I first met Helen over 15 years ago at the University of Sheffield when I attended a lecture organised by the University of Sheffield's Chemistry Society at which she told an enthusiastic audience about her "Journey Into Space" on the Juno mission with the Russian Soviet Union. I have since met Helen several times.

At our initial meeting her lecture began with an introduction from a former member of the current university Chemistry Society who reminded us that the University of Sheffield was where Helen had taken a degree in chemistry a few years ago (I had done my degree in the building next to hers), he then continued his introduction by embarrassing Helen with production of her 3rd year dissertation project which he offered to anyone willing to buy him a pint of beer.

Helen introduced her talk by stating that being a cosmonaut was as she put it "just a job" (What a job to have, I thought!). After leaving University Helen went on to work in industry and began her working career with GEC but then moved in a different direction by taking a job with Mars confectionery in their ice cream department, a fact that did not go unnoticed by the media who readily printed headlines such as "Girl from Mars blasts off to the stars" and "Mars girl blasts off for the galaxy" after her selection for the mission into space, much to Helen's amusement.



Helen Sharman's official cosmonaut portrait

I also wanted to know why the mission had been named JUNO as book and online accounts don't seem to explain so I asked Helen, "It was a clever marketing associate who came up with the name. In ancient Rome, Juno was the goddess who watched over women and marriage. My Flight was seen as a marriage of East and West like the Apollo Soyuz Mission so the name stuck.

Why become an astronaut/cosmonaut?. This was a question that she would ask herself many times in the months to come, but it was an unusual way by which she actually did become our first space traveller. Whilst driving home one evening from work Helen had been

flicking through the radio stations in the car when she heard an advert that made her really listen. "Astronaut wanted no experience necessary". Helen made a mental note and later sent in the application form (As did many thousands of others) yet after many interviews, psychological analysis and medical examinations, Helen was selected along with Timothy Mace from the Army Air Corps as the two candidates for the mission. Both were then given only 4 days notice to resign their jobs, sell their cars and head for Star City, a military and cosmonaut training facility of 4-5 thousand people just 1 hour's drive from Moscow.

When the media had initially realised that a Briton was going into space enthusiasm grew, after all it was something new and exiting, yet when the pair met the then prime minister Margaret Thatcher her response was typical "We the British don't do that sort of thing" so no government funding was forthcoming. The entire mission would have to rely on corporate sponsorship if it was to be a success. (This attitude does not seem to have altered in my view, even the Union Jack no longer flies on Europe's most successful launcher Ariane).

After the shock of arriving in an establishment where no one spoke any English, Helen and Timothy's ability to learn foreign languages quickly (A fact that played a part in their initial selection) came to the fore. Helens personal instructor could not speak a word of English at all and one of the pairs lecturers had even started a class by saying

"Bon jour, J'mapelle" (my name is) in French as he had trained the crew before Helens, that just happened to have a French crew member. The routine was by now familiar, each day dawned early and was set out methodically. Two hour's of lectures on mathematics and lectures on astronomy (carried out in a planetarium) were followed by a short interlude and then more studies every day for almost 18 months.

Helen explained that the Russian instructors thought that the Russians were better than the Americans and that Russian cosmonauts were also far superior to their American counterparts, as they had to do "99 exams", both Helen and Timothy thought that this was a joke, that is until exam time came round, and they realised how serious the instructors had actually been.

Throughout the lecture Helen had an underlying philosophy "Keep your eyes on the end goal and keep going until you get there" which no matter what you do in life or work seems like pretty sound advice. And it certainly worked in this case.

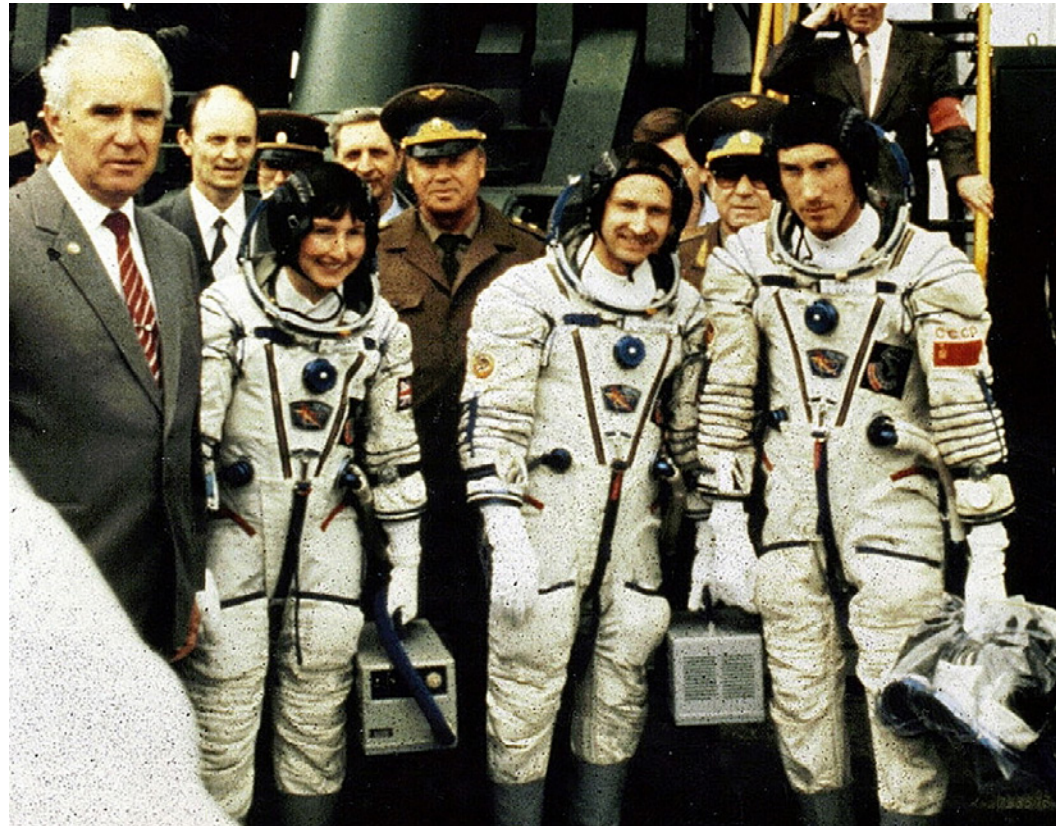
The training proper for the mission began in the Soviet version of the American KC-135 which is the aircraft that flies huge parabolic curves in order to simulate a weightless environment (A lot of Apollo 13 The movie was filmed in the NASA aircraft), something that Helen really enjoyed, Helen resumed "The Russians believe the best people to fly in space are women, although leg-less ones would be better (Just like being in the Union bar on a Friday night I thought) but in all seriousness she explained that legs are really useless in space anyway and that it was a real possibility that we could see a disabled person fly on a space mission some time in the near future.

What do the Soviets call their equivalent "Vomit Comet" I asked?

"The Russians do not actually have a name for this particular aircraft. The difference between the Russian and American version lies in the fact that the Russian aircraft is

a modified cargo plane, and when flying the parabolic curve it does not afford as much time weightless as the US version. There is also another problem because when manoeuvres such as this are being carried out, not only are the crew floating but all the aircraft's oil and hydraulic fluid are experiencing the same effect so we had to return to base regularly to have the plane serviced and for safety checks every time we used it".

shed with Christmas lights on, it was trust that played a key role in not only Helens particular mission but also each and every mission past, present and future. However even more training was required and Helen spent many hours strapped into a gyroscope being turned round and round upside down all in an attempt to confuse her vestibular system in the inner ear (organs that aid balance and that are sensitive to movement and acceleration)



The Soyuz TM-12 crew. (from left) Helen Sharman. Anatoly Artsebarsky & Sergei Krikalyov. pause before heading to the spacecraft for launch to the Mir space station.

Helen recalled how the Russians are very good at planning for all eventualities, for example. Although on returning to earth the mission was supposed to land on solid ground her training taught her how to survive in the sea for 3 days (A real possibility if a forced re-entry occurred) and there were times when she thought, how will this technology get us into and out of space?, there were also many times when Helen and Timothy thought of giving up and quitting the program. Although the technology is "Poor" and mission control resembles a

into making her sick. Helen though never once vomited and she never did suffer from any sort of motion sickness at any stage of her training or during the mission proper.

Eventually selection time arrived and after the 99 exams Helen was chosen in preference to Timothy as prime crewmembers for the mission. Her role was to be that of a mission specialist in charge of experiments, and once the reality of being Britain's first citizen in space had sunk in she went on to meet the other two members of her crew along with their families



in an attempt to bring them closer together so they could tell what each was likely to do.

Back in Star City more mundane chores had to be done, Helen had to be fitted for her space suit. "It's the best made to measure outfit that I've ever had" she enthused but then it's hardly surprising seeing as she was measured in 72 different places before the suit was made. Once in the suit Helen explained how difficult it was to stand upright because the shoulders and the sides of the suit have wire in them for support and durability, "When you see them (the cosmonauts) on their way to the launch pad the look

education and certain laws that she had encountered. The one which came to mind was one of the Newtonian laws of motion, "every action has an equal and opposite reaction", this would be so true once the rocket she was to fly on had lifted off from the Baikonur Cosmodrome at Tyuratam near Vladivostok in eastern Russia. The thrust being ejected from the rocket so powerful that it overcomes any problem of gravity.

"The launch is exiting not having done one before but it's also rather mundane" Helen recounted, the reason being that the crew are strapped into their seats many

docking had to be aborted and a manual docking carried out and we had minor problems with other equipment also. That is what space flight is like, and your training prepares you for all the possible malfunctions that may take place. You are aware that you could be killed at any time, I'm catching the train back down to London this evening and something could happen on that, it's something you try to put out of your mind".

Although Helen was still strapped tightly into her seat, she could no longer feel her back on it but felt as if the straps that were holding her in place, were, somehow, doing their job a little more efficiently. During the launch Helen had also lost some 2 litres of sweat and was ready to have a drink, and with so little space inside a Soyuz-T space craft they had to take it in turns. During the first few hours in orbit the crew had to change into their flight suits which are in fact specially designed so that they produce no dust what so ever, important as any dust could impair respiratory functions or even damage the space craft itself.

During the two days before the docking with Mir was completed, the crew's bodies underwent many changes, changes induced by their new environment; "The eyes have trouble focusing on distant objects for a while" we were told. Another problem encountered during space travel is the chemical imbalance of the body's hormone system, which results in the kidney's compensating by losing urine to try and restore the balance. Gravity, something that Helens University lecturers had told her never played a part in anything other than on earth, still has an effect whilst a space craft is in orbit. As the space craft orbits, it is in fact in a state of perpetual free fall as gravity pulls it around the globe, Mir itself has to have its orbit boosted every few months in order to stop it crashing back down to earth. Helen told of how she had discussed this with astronomers and physicists alike and that they had all come to the same conclusion that, no matter where you are in



East meets West: Anatoly Artsebarsky, Helen Sharman and Sergei Krikalyov.

hunched up, this is not because they have had too much vodka to drink or that they are tired due to lack of sleep, it's just that the wire makes movement so difficult".

The seat in which Helen and all cosmonauts sit is also made to measure but at the base there is a gap of about 4-5 cm where ones back fits. Helen continued, "Because your spine stretches in the weightless environment this little gap is essential to allow for the 2cm or more stretch that the spine will experience, I liked that, it made me feel taller for a time".

When the time for the launch approached Helen couldn't help herself thinking back to her

hours before the launch itself, "It's not scary" she told the by now enthralled, captive audience "As there is no unknown, you feel really prepared". At launch the acceleration builds, drops then builds yet again as the various stages of the rocket are used up and after approximately 8 minutes a bang is heard and orbit is attained.

I took the time to ask Helen about the launch phase of the mission and her on orbit rendezvous with Mir were there any problems?

"The mission I took part in had its problems too; we had an O2 leak during the launch which had to be sorted out quickly in the spacecraft as we lifted off. The automated





A triumphant Sharman is helped from the Soyuz Decent module after returning to Earth on May 26, 1991.

the universe, gravity will still play a role whether it be in earth orbit or around some far distant galaxy so you are probably never really weightless at all.

The docking with Mir was something of a problem as the usual automated docking system failed and a manual docking had to be carried out. After two days of chasing Mir they had finally hard docked and transfer could begin. Helen was allowed in first and was greeted by the two crew members who were already aboard the station, crew members that would after 6 more days return to earth in the same capsule as Helen. The first impression Helen had of Mir was how big it actually was (Mir was two modules smaller whilst Helen was aboard, than when Mike Foale had his well-documented problems a few years later) and was relieved that she could finally have a good stretch. "Every day is a bad hair day in space" she told everyone, this

was shown graphically with a slide of Helen floating around with her hair resembling some out of control seventies Afro from a Startsky and Hutch programme.

As already mentioned, Helen was to carry out various experiments in her role as mission specialist and these included observations on germinating potato seeds, and another in which plant seeds germinated surrounded by magnets. Others included earth observation, growing large protein crystals which can't be done on earth and her favourite where ceramic oxides are placed on photographic film which are then exposed to the vacuum of space. This apparently leads to the production of super conductors. Helen believes that the future of space flight lies in orbiting factories where new materials can be produced and utilised for the space industry. Metals can be mixed in space whereas on earth they cannot, leading to the

manufacture of super alloys. On her trip there was time for play though and on the station were items of amusement such as a guitar and keyboard (The idea of spending 6 months listening to someone who cant play either doesn't seem too appealing though) and a cassette player for real music, but the most used things aboard the station are obviously the windows, where the earth can be viewed passing by.

In the Mir station the air is filtered through lithium chlorate canisters which replenish the oxygen but just as important is the fan that circulates it. This is essential because there are no convection currents in space, therefore without a fan the air would not move and a cosmonaut or astronaut could quite easily suffocate on their own expelled carbon dioxide. When any item goes missing on Mir Helen suggested the most likely place to find it would be the air intakes that are dotted around the station, a





Aboard the Mir space station. Helen Sharman and Sergei Krikalyov pose with Mir cosmonauts Viktor Afanasiyev and Musa Manarov.

slide illustrated this as we could clearly see a film canister, hair brush and even a tooth brush stuck up against one.

When any cargo is sent up into space, the materials they are made from have to be checked very carefully. A problem encountered in the past on Mir was the out gassing caused by certain plastics. On earth this is not a problem as the atmosphere carries any toxins away but on a space station this could have serious consequences. One item that also caused a stir was the Mir weighing scales, stupid idea I hear you say but these scales measure mass not weight by means of a bouncing spring that moves when it is sat on.

One of the original crew that had been aboard for 6 months was using a piece of apparatus that was designed to draw blood back into his legs in preparation for his

now near return to gravity on earth, anyone who has seen Wallace and Gromit in the Wrong Trousers and can recall the trousers Wallace ended up wearing, will have a good idea as to what the ones on Mir look like, though they did suit Wallace much better. This particular member of the Mir crew also, as Helen found out, had an affinity for oranges and after 6 months without even seeing one, you would feel if he did find one that he would eat it straight away but when he was presented with one that Helens crew had smuggled in, he was so pleased to see it he actually played with it for 2 days before he could actually bring himself to eat it at all.

The toilet is something that everyone wants to know about and the one aboard Mir is essentially the same design as that on the shuttle but the one on Mir can recycle more waste and any urine can

be converted back into drinking water in an emergency situation, something the audience did not seem too keen on. The sleeping arrangements are by way of a bunk system and as Helen said "It's basic but sleeping in space is the most natural way to have a rest and be comfortable". She was even lucky enough to have her own window complete with meteoroid impact chip caused by an errant meteor the week before. Each 24 hour period resulted in 16 orbits of the earth each with associated sunrise and sunset. Helen, although disappointed with how brown the land surface of the earth was from space was amazed at the clouds and how blue the oceans were, in fact she commented "It's a blue I've never seen before or since" and no doubt that anyone who has flown in space could tell exactly the same story. "The sunrise was



magnificent, and you could clearly see the curvature of the earth from 100Km up".

Was it always the plan that you would only fly one mission I asked, and if so why?

"Yes, because this was a commercial mission, it was, from the outset a one off. Money and support meant that it could not be anything else. Our own government were not interested in funding us and only the money raised by our industrial sponsors, could have financed such a trip, so in response to your question it was only ever going to be a one off mission".

Soon Helen began to explain how only after 8 days you do begin to miss your family and friends and told of how she felt for her colleagues who had been up there for 6 month's already. Studies have actually shown that the optimum time to spend in space is 3 months and it is important that the right type of person is chosen for long duration missions such as those that may one day take us to mars.

By now though the mission was complete and preparations were underway for a hand over of the station to the two crew members with whom Helen had arrived and the return of Helen and the departing crew.

During the launch phase of the mission Helen had experienced 3.5 G or 3.5 times the gravity of earth but on re-entry she would experience 4.5 G. The re-entry fortunately, went as planned and although they drifted just off the landing zone, they nevertheless made a flawless landing in northern Kazakhstan. When the rescue team arrived, the capsule was rolled over and the hatch opened up. The inrush of air felt good and once the crew had been hauled out of the craft Helen was in for another surprise. The crewman who had just spent 6 months in orbit just stood up and walked around as if he had never been in space at all something Helen commented on as "Being hard to believe".

The mission was finally over and Helens closing comments were



Helen Sharman with Tim Mace, her backup from the United Kingdom.

"Well, that's that. It was a job and I was lucky enough to do it, I was just in the right place at the right time"

I finished our latest meeting by asking Helen if she though ISS was viable

"Certainly, but only with the joint co-operation of other countries and their involvement with the International Space Station project. Mir was an important space platform ISS even more so, I only

hope that the certain partners don't try to take everything over. Space is for the benefit of us all not just a select few".

Today,. Helen is someone of a reclusive person, preferring privacy to a life of the thrust of fame which it has to be said her choice. She is, and always will be the first Briton in space, and she is from my home city, so I have more than one reason to be proud of her.



## Cold brown dwarfs blur line between stars and planets

In 2011, astronomers on the hunt for the coldest star-like celestial bodies discovered a new class of such objects using NASA's Wide-Field Infrared Survey Explorer (WISE) space telescope. But until now, no one knew exactly how cool the bodies' surfaces really are. In fact, some evidence suggested they could be at room temperature.

A new study using data from NASA's Spitzer Space Telescope shows that while these so-called brown dwarfs are indeed the coldest known free-floating celestial bodies, they are warmer than previously thought, with surface temperatures ranging from about 250 to 350 degrees Fahrenheit (125 to 175 degrees Celsius). By comparison, the sun has a surface temperature of about 10,340 degrees Fahrenheit (5,730 degrees Celsius).

To reach these surface temperatures after cooling for billions of years, these objects would have to have masses of only five to 20 times that of Jupiter. Unlike the sun, the only source of energy for these coldest of brown dwarfs is from their gravitational contraction, which depends directly on their mass. The sun is powered by the conversion of hydrogen to helium; these brown dwarfs are not hot enough for this type of "nuclear burning" to occur.

The findings help researchers understand how planets and stars form.

"If one of these objects were found orbiting a star, there is a good chance that it would be called a planet," said Trent Dupuy, a Hubble Fellow at the Harvard-Smithsonian Center for Astrophysics and a co-author of the study, appearing online in the journal *Science Express*. But because they probably formed on their own and not in a planet-forming disk orbiting a more massive star, astronomers still call these objects brown dwarfs even if their mass is of planetary size.

Characterizing these cold brown dwarfs is challenging because they emit most of their light at infrared wavelengths and are very faint due to their small size and low temperature.

To get accurate temperatures, astronomers need to know the distances to these objects. "We wanted to find out if they were colder, fainter and nearby, or if they were warmer, brighter and more distant," explains Dupuy.

Using Spitzer, the team determined that the brown dwarfs in question are located at distances 20 to 50 light-years away.

To determine the distances to these objects, the team measured their parallax -- the apparent change in position against background stars over time. As Spitzer orbits the sun, its perspective changes and nearby objects appear to shift back and forth slightly. The same effect occurs if you hold up a finger in front of your face and close one eye and then the other. The position of your finger seems to shift when viewed against the distant background.

But even for these relatively nearby brown dwarfs, the parallax motion is small. "To be able to determine accurate distances, our measurements had to be the same precision as knowing the position of a firefly to within 1 inch from 200 miles away," explained Adam Kraus, professor at the University of Texas at Austin and the study's other co-author.

The new data also present new puzzles to astronomers who study cool, planet-like atmospheres. Unlike warmer brown dwarfs and stars, the observable properties of these objects don't seem to correlate as strongly with temperature. This suggests increased roles for other factors, such as convective mixing, in driving the chemistry at the surface.

For more information about Spitzer, visit <http://spitzer.caltech.edu> and [www.nasa.gov/spitzer](http://www.nasa.gov/spitzer).







## **brown dwarf**

*noun*

a celestial object intermediate in size between a giant planet and a small star, believed to emit mainly infrared radiation.

Image: NASA/JPL-Caltech

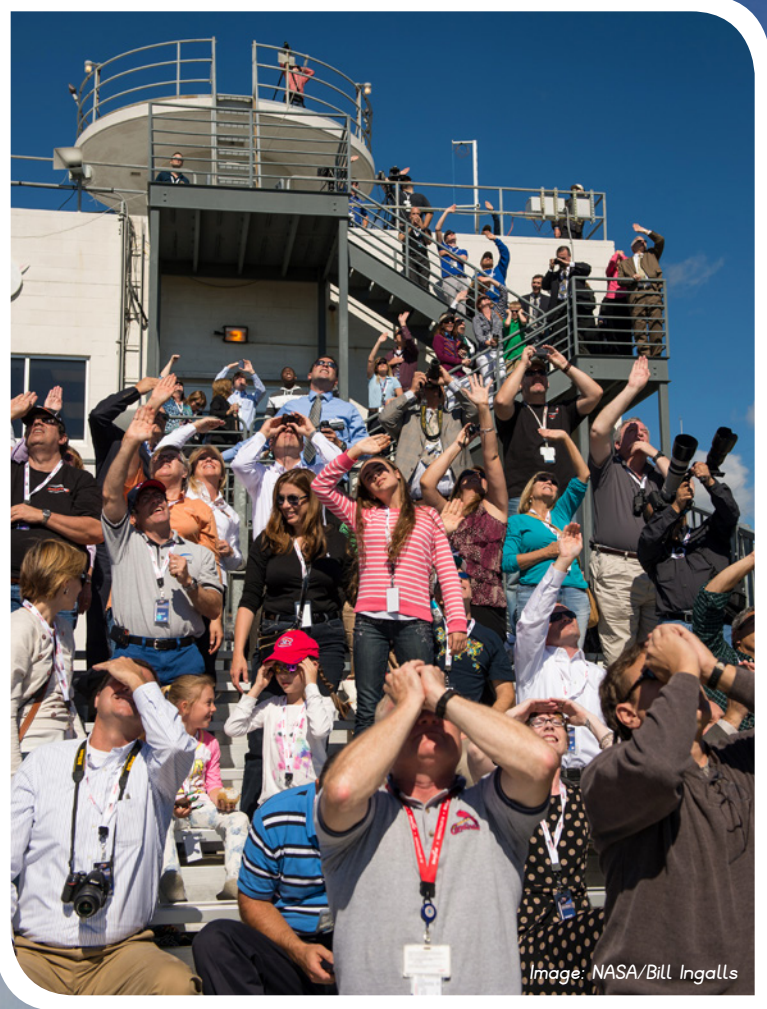


# Antares delivers Cygnus to ISS



Image: Anthony Fitch







By Ken Kremer

The new 'Commercial Space Era' received a resounding boost today when a privately developed Antares rocket lofting the first ever Cygnus commercial cargo resupply craft thundered to space from America's newest launch pad at NASA Wallops along the Eastern Shore of Virginia.

The history making launch marks the first time that a spacecraft launched from Virginia is blazing a path to the International Space Station (ISS) – thereby scoring a milestone achievement to keep the orbiting lab complex stocked up with supplies and science experiments from American soil. This is the maiden flight of Cygnus.

Move over SpaceX ! Your space competition from Orbital Sciences has arrived!

It was a 'picture perfect' blastoff for the two stage Antares booster at 10:58 a.m. EDT this morning (Sept. 18) from the commercial Mid-Atlantic Regional Spaceport Pad-0A at NASA's Wallops Flight Facility in Virginia.

The blastoff of Antares was stunningly beautiful with intensely bright flames spewing from the rockets rear. And the incredibly loud roar of the first stage engines reverberated widely and wowed hoards of spectators gathered throughout the local viewing area in Chincoteague, Va. – and woke late sleepers some folks told me later today!

The rumbling thunder of Antares sounded as loud as a space shuttle.



An artist rendering of the Cygnus spacecraft approaching the International Space Station. *Image: Orbital Sciences Corporation*

Antares and Cygnus were built by Orbital Sciences Corporation and its team of industrial partners using seed money from NASA's COTS commercial transportation initiative aimed at fostering the development of America's commercial space industry to deliver critical and essential supplies to the ISS.

America lost 100% of its capability to send humans and cargo to the ISS when NASA's Space Shuttles were



Front view showing docking mechanism and hatch of Cygnus module in this full scale, high fidelity mockup of the Orbital Sciences/Thales Alenia spacecraft gives a feel for it being similar in size to a small room. *Image: Ken Kremer*

retired in 2011. Orbital Sciences and their competitor SpaceX, were awarded NASA contracts to restore the unmanned cargo resupply capability.

Thales Alenia Space in Italy designed and constructed the 17 foot ( 5 meter) long Cygnus module under contract with Orbital.

"Thales Alenia has actually built 50% of the pressurized modules currently comprising the ISS," said Luigi Quaglino, Thales Alenia Senior Vice President.

"This is a historic accomplishment for commercial spaceflight with the picture perfect launch of Antares and Cygnus headed for the space station," said Alan Lindenmoyer, NASA's program manager for commercial crew and cargo, at a post launch briefing for reporters at NASA Wallops.

In fact this was the heaviest cargo load ever delivered to the ISS by a commercial vehicle, said Frank Culbertson, former astronaut and now Orbital's executive Vice President responsible for the Antares and Cygnus programs.

A revolutionary new day has dawned in space by opening up new pathways enabling space exploration And it's not a moment too soon given the continuing significant reductions to NASA's budget.

COTS was aimed at revolutionizing how we reach space by privatizing routine space operations that thereby allows NASA to focus more on exploration beyond low earth orbit, getting people back to the Moon and beyond to deep space destinations including Asteroids and Mars.

Today's Antares launch is the culmination of the COTS contract that NASA awarded to Orbital back in 2008.

"Today marks a milestone in our new era of exploration as we expand the capability for making cargo launches to the International Space Station from American shores," said NASA Administrator Charles





The Cygnus cargo spacecraft is just a few feet away from the International Space Station's Canadarm2.

Image: NASA

Bolden in a statement. "Orbital's extraordinary efforts are helping us fulfill the promise of American innovation to maintain our nation's leadership in space."

The Cygnus spacecraft is healthy and successfully unfurled its life giving solar panels starting 1.5 minutes after separation from the second stage that took place about 10 minutes after launch, said Culbertson.

Antares placed Cygnus into its intended orbit of about 180 x 160 miles above the Earth, inclined at 51.6 degrees to the equator, Orbital said.

Cygnus is traveling at 17,500 MPH and is on its way to rendezvous with the space station Sunday, Sept. 22. The cargo vessel will deliver about 1,300 pounds (589 kilograms) of cargo, including food, clothing, water, science experiments, spare parts and gear to the Expedition 37 crew.

The flight, known as Orb-D1 is a demonstration mission to prove that Cygnus can conduct a complex series of maneuvers in space safely bringing it to the vicinity of the ISS.

Mission controllers at Orbital guided Cygnus to the vicinity of the ISS on Sept. 22 during the initially planned docking attempt.

But only after carrying out a series of 10 complicated maneuvering tests proving that the vehicle can safely and reliably approach the station up close would NASA and the ISS partners grant permission to dock.

However as Cygnus was in the final stages of approach, a communications error forced an abort. NASA and Orbital then decided to delay the 2nd attempt about a week to Sept. 29 due to impending Sept. 25 Soyuz launch and docking with the next human crew of three US and Russian astronauts.

At last the Cygnus spacecraft put on a spectacular space ballet - and was no worse for the wear spending an extra week in free space due to the easily fixed communications glitch.

ISS astronauts Karen Nyberg (NASA) and Luca Parmitano (ESA) successfully grappled Cygnus with the station's Canadian built robotic arm and berthed the capsule at an earth facing docking port on the Harmony module on Sunday, Sept 29.

The pair were working at two robotics work stations from inside the Cupola and Destiny modules. They used the stations 57 foot long (19 m) Canadarm2 to snare Cygnus at a distance of about 30 feet (10 meters). They gradually motioned the arm closer and coupled Cygnus to the ISS.

Hatches to Cygnus were opened the next day on Sept. 30 after completing leak checks.

The Antares first stage is powered by dual liquid fueled AJ26 first stage rocket engines that generate a combined total thrust of some 750,000 lbs - originally built in the Soviet Union as NK-33 model engines for the Soviet era moon rocket.

The upper stage features an ATK Castor 30 solid rocket motor with thrust vectoring. Antares can loft payloads weighing over 5000 kg to LEO. The 2nd stage will be upgraded starting with the 4th Antares flight.

"Antares next flight is scheduled for December sometime between the 8th and 21st, said Frank Culbertson, former astronaut and now Orbital's executive Vice President responsible for the Antares and Cygnus programs. Eight operational Cygnus flights to the ISS from NASA Wallops are planned through 2016.



# Seth Green has his eye on space

By Nicole Solomon

Despite being one of the hardest working actors in Hollywood, Seth Green still finds time to stay current on NASA missions and dreams of going into space one day. With three TV shows currently on the air – Dads, Robot Chicken and Family Guy – he's only a few clicks of a remote away from your living room.

Seth recently took a few moments from his busy schedule to answer some light-hearted questions.

**Q:** *Marvel or DC comics?*

**Seth:** I'm a hard split. Spider-Man and Batman are my favorites.

**Q:** *Star Wars or Star Trek?*

**Seth:** I've always been partial to Star Wars. It's a larger universe that's more accessible.

**Q:** *Aliens or robots?*

**Seth:** Robots.

**Q:** *Superheroes or supervillains?*

**Seth:** I'll try to be compassionate to where the villain is coming from, but you should only use your powers for good.

**Q:** *Hotter Star Trek character: Orion slave girl or the Borg's 7 of 9?*

**Seth:** 7 of 9. I'd be an excellent ambassador in human, Borg relations.

**Q:** *More fun to build things, or to destroy them?*

**Seth:** Build. But blow stuff up whenever you get the chance.

**Q:** *Favorite astronaut, scientist, engineer or inventor?*

**Seth:** I'm kind of on an Elon Musk, Ray Kurzweil, Dean Kamen kick these days.

**Q:** *Favorite Planet?*

**Seth:** Earth. Maybe visit Earth 2. And I'm still pushing for spring break on Mars.

**Q:** *Favorite space agency?*

**Seth:** I deeply love NASA. I'm excited about Planetary Resources. I cannot wait to fly with Space X.

**Q:** *Favorite space mission?*

**Seth:** The one in the future that I'm on.

**Q:** *If you could travel to Mars what five things would you take with you?*

**Seth:** 3D bio-printer, plenty of seeds and robots, strong wifi, and the Missus.

**Q:** *If you were on a long space journey, what food and beverage could you not live without?*

**Seth:** Tang and astronaut ice cream.

**Q:** *What astronaut would you date?*

**Seth:** I'm already married to the perfect co-pilot.

**Q:** *When you gaze at the stars at night, how many constellations can you point out and name?*

**Seth:** I'm not good at that, but I have a few phone apps that know EVERYTHING.

**Q:** *Why are you excited about space exploration?*

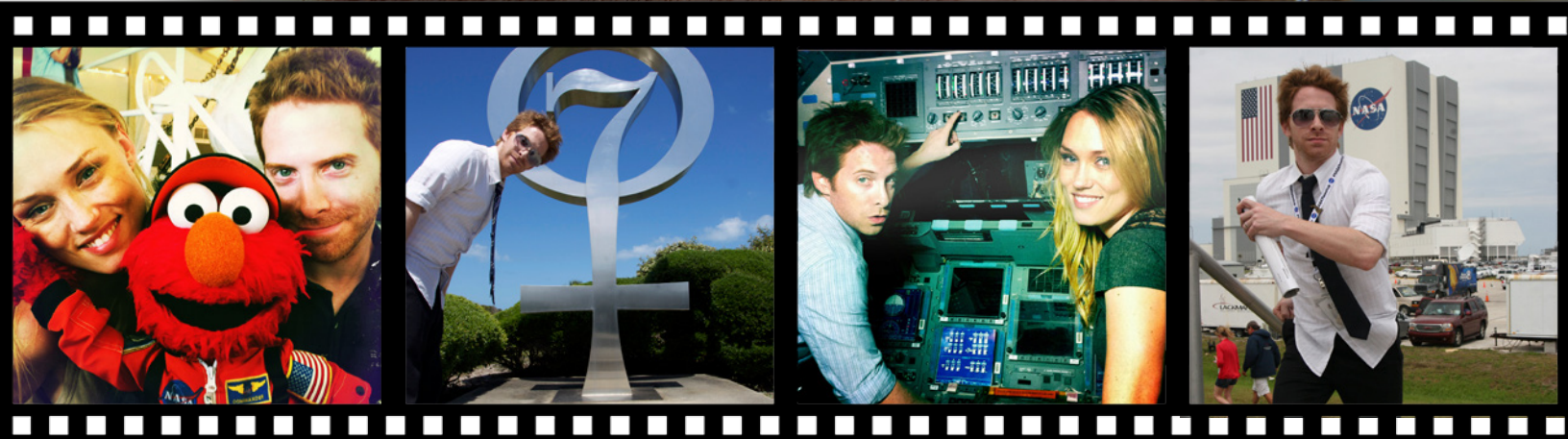
**Seth:** There's so much we have yet to understand about where we are. Pushing further out into our galaxy will help close that gap.

**Q:** *The universe. Will it end in fire or ice?*

**Seth:** From all the information I've heard the total universe will eventually destroy itself. But we'll probably see some amazing things before that happens.










## centaur

*noun*

small solar system body with a semi-major axis between those of the outer planets

Image: NASA/JPL-Caltech





# WISE finds mysterious centaurs may be comets

The true identity of centaurs, the small celestial bodies orbiting the sun between Jupiter and Neptune, is one of the enduring mysteries of astrophysics. Are they asteroids or comets? A new study of observations from NASA's Wide-field Infrared Survey Explorer (WISE) finds most centaurs are comets.

Until now, astronomers were not certain whether centaurs are asteroids flung out from the inner solar system or comets traveling in toward the sun from afar. Because of their dual nature, they take their name from the creature in Greek mythology whose head and torso are human and legs are those of a horse.

"Just like the mythical creatures, the centaur objects seem to have a double life," said James Bauer of NASA's Jet Propulsion Laboratory in Pasadena, Calif. Bauer is lead author of a paper published online in the *Astrophysical Journal*. "Our data point to a cometary origin for most of the objects, suggesting they are coming from deeper out in the solar system."

"Cometary origin" means an object likely is made from the same material as a comet, may have been an active comet in the past, and may be active again in the future.

The findings come from the largest infrared survey to date of centaurs and their more distant cousins, called scattered disk objects. NEOWISE, the asteroid-hunting portion of the WISE mission, gathered infrared images of 52 centaurs and scattered disk objects. Fifteen of the 52 are new discoveries. Centaurs and scattered disk objects orbit in an unstable belt. Ultimately, gravity from the giant planets will fling them either closer to the sun or farther away from their current locations.

Although astronomers previously observed some centaurs with dusty halos, a common feature of outgassing comets, and NASA's Spitzer Space Telescope also found some evidence for comets in the group, they had not been able to estimate the numbers of comets and asteroids.

Infrared data from NEOWISE provided information on the objects' albedos, or reflectivity, to help astronomers sort the population. NEOWISE can tell whether a centaur has a matte and dark surface or a shiny one that reflects more light. The puzzle pieces fell into place when astronomers combined the albedo information with what was already known about the colors of the objects. Visible-light observations have shown centaurs generally to be either blue-gray or reddish in hue. A blue-gray object could be an asteroid or comet. NEOWISE showed that most of the blue-gray objects are dark, a telltale sign of comets. A reddish object is more likely to be an asteroid.

"Comets have a dark, soot-like coating on their icy surfaces, making them darker than most asteroids," said the study's co-author, Tommy Grav of the Planetary Science Institute in Tucson, Ariz. "Comet surfaces tend to be more like charcoal, while asteroids are usually shinier like the moon."

The results indicate that roughly two-thirds of the centaur population are comets, which come from the frigid outer reaches of our solar system. It is not clear whether the rest are asteroids. The centaur bodies have not lost their mystique entirely, but future research from NEOWISE may reveal their secrets further.

The paper is available online at: <http://iopscience.iop.org/0004-637X/773/1/22/>.

JPL, managed by the California Institute of Technology in Pasadena, managed and operated WISE for NASA's Science Mission Directorate. The NEOWISE portion of the project was funded by NASA's Near Earth Object Observation Program. WISE completed its key mission objective, two scans of the entire sky, in 2011 and has been hibernating in space since then.

For more information about the WISE mission, visit: [www.nasa.gov/wise](http://www.nasa.gov/wise).



# Masten's Xombie rocket tests new precision landing software

A year after NASA's Mars rover Curiosity's landed on Mars, engineers at NASA's Jet Propulsion Laboratory in Pasadena, Calif., are testing a sophisticated flight-control algorithm that could allow for even more precise, pinpoint landings of future Martian spacecraft.

Flight testing of the new Fuel Optimal Large Divert Guidance (G-FOLD) algorithm for planetary pinpoint landing is being conducted jointly by JPL engineers in cooperation with Masten Space Systems in Mojave, Calif., using Masten's XA-0.1B "Xombie" vertical launch and landing experimental rocket.

"The collaboration between JPL and Masten to test G-FOLD is a great example of how we hope to further the exploration of the solar system while building up the industrial base needed to advance future space endeavors," said Christopher Baker, a campaign manager for the program.

Current powered-descent guidance algorithms used for spacecraft landings are inherited from the Apollo era. These algorithms do not optimize fuel usage and significantly limit how far the landing craft can be diverted during descent. The new G-FOLD algorithm invented

by JPL autonomously generates fuel-optimal landing trajectories in real time and provides a key new technology required for planetary pinpoint landing. Pinpoint landing capability will allow robotic missions to access currently inaccessible science targets. For crewed missions, it will allow increased precision with minimal fuel requirements to enable landing larger payloads in close proximity to predetermined targets.

Masten Space Systems launched the Xombie July 30 from the company's test pad at the Mojave Air and Space Port. JPL and Masten are planning to conduct a second flight test with a more complicated divert profile, pending data analysis.

To simulate a course correction during a Martian entry in the July test, Masten's Xombie was given a vertical descent profile to an incorrect landing point. About 90 feet into the profile, the G-FOLD flight control software was automatically triggered to calculate a new flight profile in real-time, and the rocket was successfully diverted to the "correct" landing point some 2,460 feet away.

"This flight was an unprecedented free-flying demonstration of the on-

board calculation of a fuel-optimal trajectory in real time," said Martin Regehr, acting task lead for the Autonomous Descent Ascent Powered-Flight Testbed at JPL.

Masten Space Systems is one of seven suborbital reusable launch companies contracted by NASA's Flight Opportunities Program to fly experiments in sub-orbital space to verify new technologies work as expected in this harsh environment.

NASA Dryden also aided development of Curiosity's "sky crane" landing system by conducting two series of pre-launch flight tests of its landing radar, the first under a helicopter in 2010 and a follow-on series with the radar housed in a Quick Test Experimental Pod mounted under the wing of a Dryden F/A-18 in June 2011. The 2011 tests focused on the on-chute acquisition portion of the Mars Science Laboratory's entry into the Martian atmosphere, when the spacecraft was suspended from its parachute. Data collected from the flights were used to finesse the mission's landing radar software to ensure that it was calibrated as accurately as possible prior to Curiosity's landing.





A Xombie technology demonstrator from Masten Space Systems ascends from its Mojave pad on a test flight.

*Image: NASA/Masten*



# Starting in astronomy beginner's guide to stargazing

By Mike Barrett

## recognising the night sky

When you look up into the night skies you will see a myriad of twinkling stars. With all of the stars in the sky you would have thought it would be impossible to recognise individual ones, but you would be wrong. Of course, nobody can recognise all of them but by starting to see patterns in the skies you can start to pick out individual stars and constellations and learn to navigate your way around.

Going back thousands of years in time our ancient relatives used the stars to help navigate and needed to find a reliable way of determining which star was which and where it should be in the sky. To do this they started visualising patterns in the sky that meant things to them. Almost everybody in the northern hemisphere will have seen The Plough or Big Dipper in the Constellation Ursa Major. If you follow the line of the last two stars in up in the sky you will see the Pole Star or Polaris. This is the first important lesson in Astronomical Navigation: Polaris moves very little, almost standing still, all the other

## pole star

The Pole Star (Polaris in the Northern hemisphere) stays at a fixed location in the sky and all the other stars rotate around it.

stars in the Northern hemisphere appear to rotate around it. Polaris is always in the North so having found Polaris you can always tell which way you are going on a dark night.

As astronomers we all like clear

dark nights with no light pollution, but there is one time when having some light pollution can help you. With lighter skies there are less stars visible which in turn means that you can only see the brightest stars. These stars are the ones that are used to create the patterns in the sky to define the various constellations. The patterns are like a join-the-dots puzzle where you draw lines between dots to realise the image. However in the case of the night skies there are a lot of dots that you don't connect so having lighter skies means you see fewer stars and you can recognise the patterns more easily.

Having found the right conditions to start our learning experience where do we start? I find that it is best to start with something that you can easily recognise and then move on from there to surrounding objects. For instance taking the above example we followed The Plough to Polaris. Polaris is the brightest star in the Ursa Minor constellation and is the end of the handle of the 'little dipper'. Not everything will be instantly recognisable so it makes good sense to jump to another area of the sky that you can easily find. I have identified a number of easily recognised constellations to use as a starting point. A good example of this is Cassiopeia which is represented as a 'W' which can be clearly seen in most conditions.

I often use Cassiopeia to orientate myself as the Plough is sometimes hidden from my view. Starting by looking at the first two stars of the 'W' and forming an equilateral triangle your sight drifts down to the Double Cluster, and beyond that to an inverted 'Y' which is the constellation Perseus.

Coming back to Cassiopeia the last 3 stars form a triangle which I use as an arrowhead to follow to 4 bright stars in a line. This is the constellation of Andromeda. From Andromeda I locate the second bright star from the left, Mirach, and then turn at right angles. Moving along this line I see a slightly dimmer star, then continue the same distance again and I can now see the Andromeda Galaxy on a clear dark night.

So starting with one easy to remember constellation and then using pointers to get to another part of the heavens is a good way to learn the skies, but what if you live in a heavily light polluted area, or there is a bright moon lighting the sky?

In these circumstances I find it best to start looking for the brightest stars in the sky. In the summer and Autumn these will be Vega, Deneb, Altair and Arcturus. In Winter and Spring these will be Betelgeuse, Rigel, Aldebaran, and Capella. From these stars you can start to see the constellations surrounding them, Betelgeuse and Rigel are the two brightest stars in Orion, Aldebaran is to the east in Taurus with Capella just north and east.

Getting back to where we started with the connect-the-dots it often takes a lot of imagination to see the form of the constellation. Cassiopeia is supposed to represent a seated, vain, queen but is depicted in the sky as a 'W'. Easy to remember and spot, but hardly resembling a seated queen with a hand mirror. If we were to name the constellations today it may have been named after a fast food chain starting with 'M'. More apparent is the constellation Cygnus (The Swan) where the outline of the



swan is clearly visible. On a bright full moon night you may only be able to see one or two stars in Cygnus, but as the days pass and the moon wanes, more and more stars come into view until you can see the entire swan and wing tips.

If you are lucky and live in or visit an area where the skies are really dark, with no moon, then you will be able to see millions of stars in our galaxy, the Milky Way. The Milky Way is a spiral galaxy and our Solar System resides in one of the spiral arms. This can be thought of like a plate, when you look at it from on top you can see the whole surface, but when you look at it from the side you will just see the edge. Looking at the Milky Way is like looking at a plate edge on. As the Milky Way is not solid like the plate we can see stars further away in the galaxy shining through. These are often quite dim stars, but the combination of the millions of stars illuminates the vast area of sky giving the appearance of a cloud. The Milky Way is a band that sweeps across our Summer and Autumn night skies cutting through the constellations of Cassiopeia, Cygnus, and Sagittarius.

If you can see the Milky Way well than picking out the constellations can become a little tricky as you will be able to see so much more in the dark skies. This can sometimes make picking out the bright stars forming the symbolic structures problematic, one of the good reasons to start the learning process in light polluted skies.

Having discovered the way to learn the layout of the skies you need help to identify them. This is where star charts come into play. Star charts are the maps of the sky, normally printed in a book, they show the relative positions of the constellations. Just like maps they help you navigate around the stars. In this modern day we live mainly in an online society, and astronomy has also found a place in the electronic annals of computers

and the Internet. Star charts can be found online in a number of different formats, but as with road maps they are somewhat static images.

The next evolution is planetarium software which can show you dynamically the sky at any location in the world, at any time to help you learn and discover the wonders to be seen. You don't need to wait until the sun sets to start exploring. Of course this planetarium software provides an ideal view of the sky without factoring in light pollution, seeing conditions or the weather.

enable you to point the device at the sky and will tell you exactly what you are looking at. Mobile planetarium software is really great for when you are learning, particularly when you are not quite sure what you are looking at. All you have to do is point the device towards the area of the sky you are interested in and it will tell you what you are looking at.

There is a school of thought that says the mobile planetarium software is for lazy people who don't want to learn the sky properly.



The Milky Way is clearly visible just over the ridge line of Cheap Mountain in West Virginia.

*Image: Walter Scriptunas II*

All of these will combine to give you a less than ideal experience when you go outside to look at the real thing. This software does not have to be expensive, indeed Stellarium and Cartes Du Ciel are both excellent, free packages and will run on multiple computer platforms.

Computers are not the only digital system to be of use in astronomy, the evolution of the mobile devices has redefined star recognition in the same way that Satellite Navigation revolutionised driving. There are a number of applications available for smartphones and tablets that

It is true that reliance on technology is not always a good thing as witnessed by people relying on their SatNav completely and getting lost when it fails.

Technology is a great tool to help with learning, but should never be a substitute for basic knowledge and skills. Learning anything 'the hard way' is always more rewarding than depending on something or someone else to do it for you. By all means seek out help from experts and all other resources, but try and learn the basics for greater self satisfaction.



# cygnus the swan

By Mike Barrett

Cygnus, The Swan, is a majestic and easy to identify constellation in the northern hemisphere. This is best viewed in summer and autumn when it rises overhead in the night skies. Cygnus is a great naked eye constellation with lots of detail and great objects within it as you start to use more powerful optical devices.

The brightest star in the constellation, Deneb, is magnitude 1.25 the third brightest in the region. Deneb combines with Vega (in Lyra) and Altair (in Aquila) to form the summer triangle. These 3 stars are the first to appear in the darkening sky after sunset.

Deneb is also the head of an asterism called the Northern Cross which forms the body and the first part of the wings of the swan. The stars in this cross are the brightest ones in the constellation and can be seen even in the most light polluted areas.

As you move to darker locations you will be able to see more stars in the constellation which extend the wings of the swan right out to the wing tips. Cygnus is one of the constellations that is easy to visualise, and once you have found it you will never forget it.

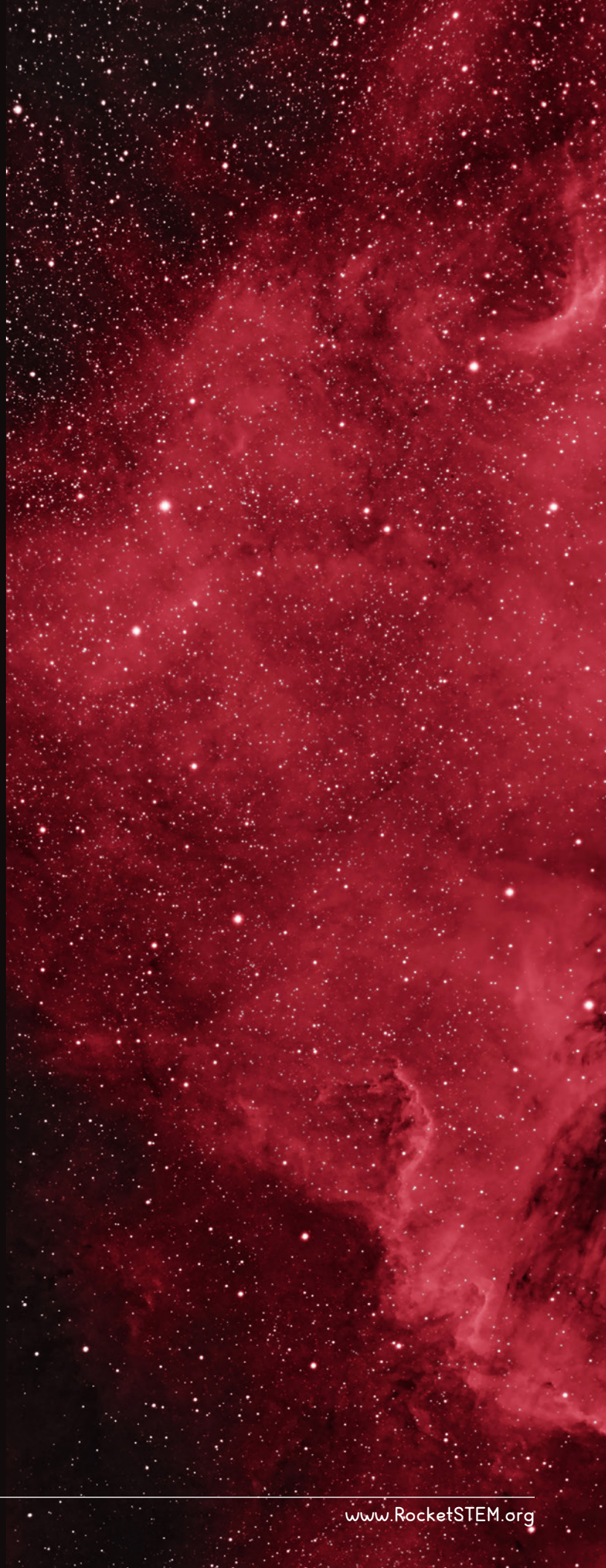
In the darkest viewing spots when there is no moon you will be able to see our galaxy, The Milky Way, running through Cygnus. It will appear as a cloud starting at the horizon, going up through Cassiopeia then Cygnus and on to the other horizon in Scorpius. The cloud-like appearance comes from the millions of faint stars in our galaxy combining to create the dim light.

If you now grab a pair of binoculars you will see the detail of the Milky Way. Stars will pop into view that were not visible with your naked eyes. Even in the binoculars though there will seem to be a fuzzy cloud created by the fainter stars.

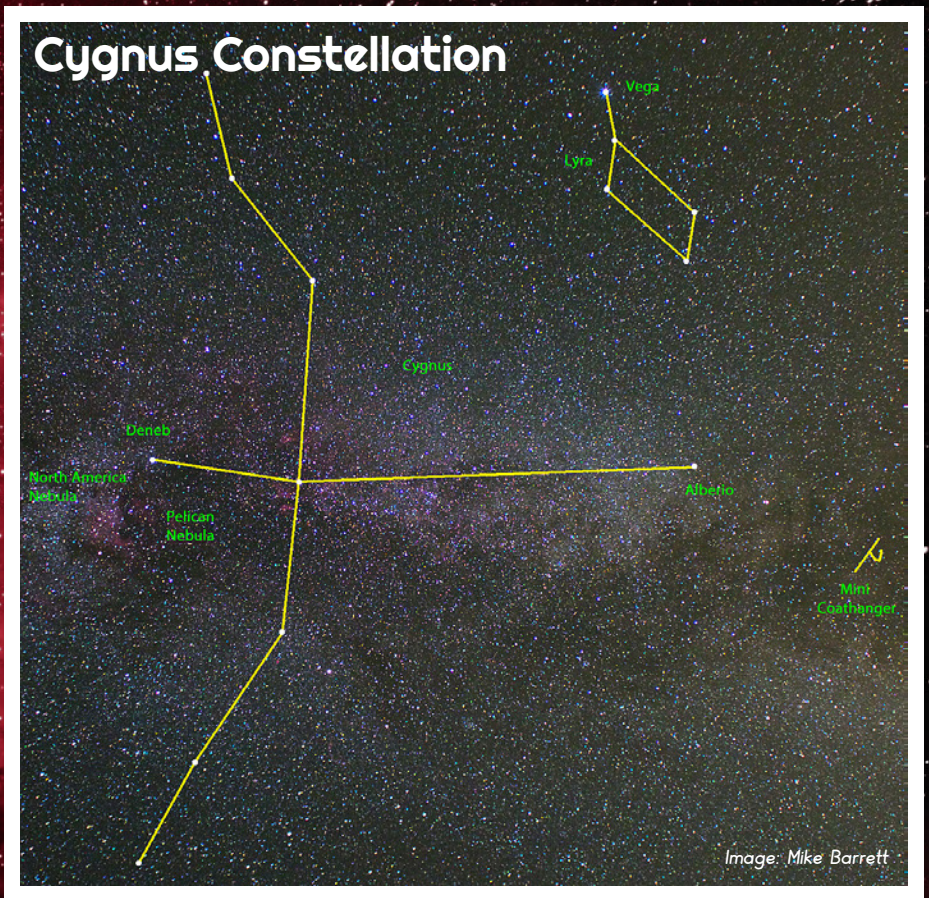
If you sweep the binoculars down to the head of the swan you will find the star Alberio. Star is not quite the right term as Alberio is one of the most spectacular double stars in the skies. With a steady hand and a good pair of binoculars you should be able to separate the two stars. The main star is yellow, but the smaller star is electric blue.

Switching to a telescope makes the demarkation between these stars much more noticeable and can really bring out the colours nicely.

There are a lot of deep sky objects in the constellation, but by far the most interesting are NGC 7000 and IC 5070: The North America and Pelican Nebulas. These can be seen from very dark locations using telescopes and appear a very faint foggy regions, but are best observed photographically. The nebulas are huge, the North America nebula is over four times the size of the moon, but very faint. These are star forming emission nebulas of ionised hydrogen. These nebulas lie between Deneb and Epsilon Cygnus.







The North American Nebula is an emission nebula in the constellation Cygnus.

Image: Dave Smith/[www.astro snaps.co.uk](http://www.astro snaps.co.uk)



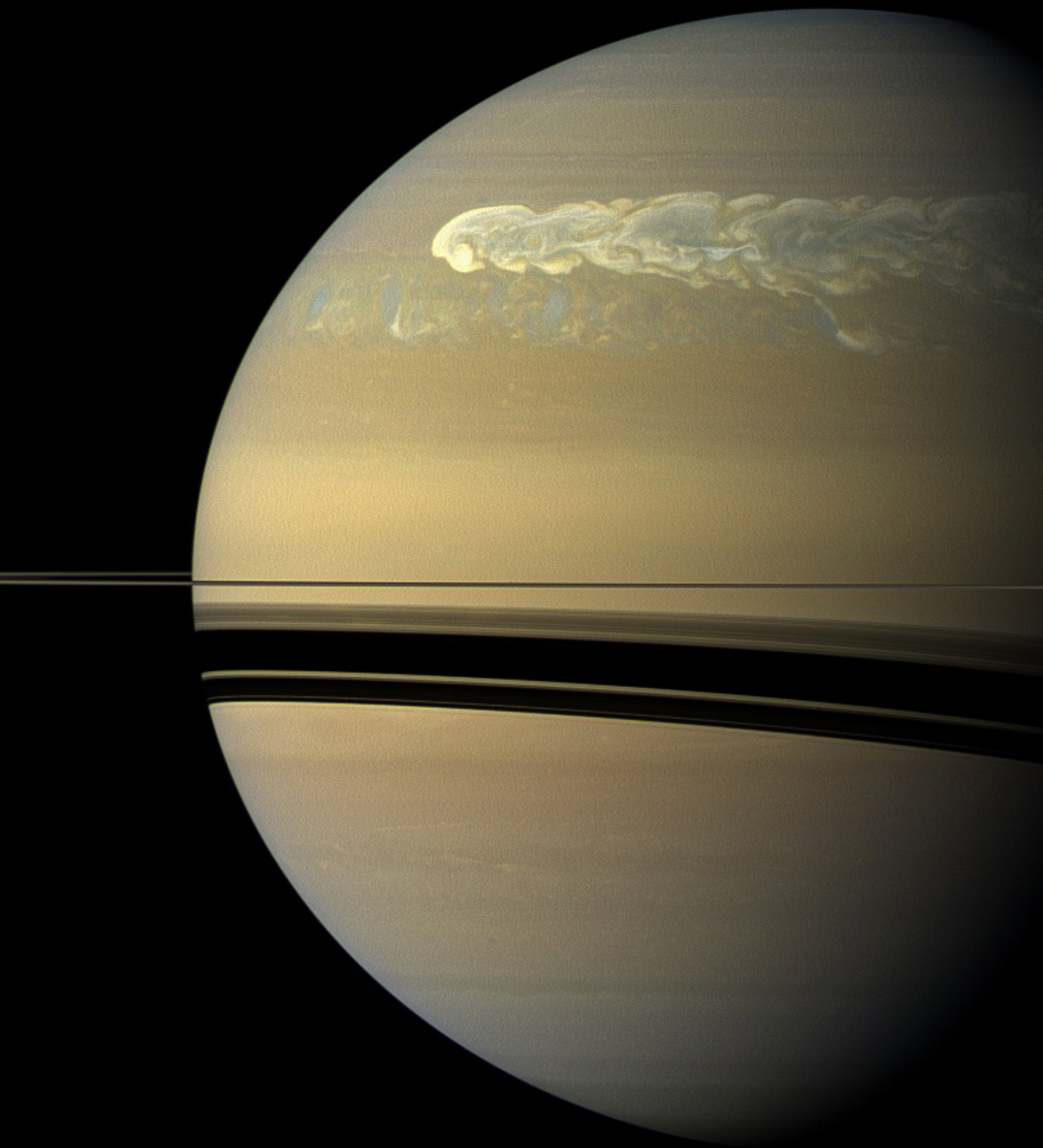


Image: NASA/JPL-Caltech/SSI/Univ. of Arizona/Univ. of Wisconsin



# Saturn's monster storm surprises

A monster storm that erupted on Saturn in late 2010 - as large as any storm ever observed on the ringed planet -- has already impressed researchers with its intensity and long-lived turbulence. A new paper in the journal *Icarus* reveals another facet of the storm's explosive power: its ability to churn up water ice from great depths. This finding, derived from near-infrared measurements by NASA's Cassini spacecraft, is the first detection at Saturn of water ice. The water originates from deep in Saturn's atmosphere.

"The new finding from Cassini shows that Saturn can dredge up material from more than 100 miles," said Kevin Baines, a co-author of the paper who works at the University of Wisconsin-Madison and NASA's Jet Propulsion Laboratory. "It demonstrates in a very real sense that typically demure-looking Saturn can be just as explosive or even more so than typically stormy Jupiter." Water ice, which originates from deep in the atmosphere of gas giants, doesn't appear to be lofted as high at Jupiter.

Monster storms rip across the northern hemisphere of Saturn once every 30 years or so, or roughly once per Saturn year. The first hint of the most recent storm first appeared in data from Cassini's radio and plasma wave subsystem on Dec. 5, 2010. Soon after that, it could be seen in images from amateur astronomers and from Cassini's imaging science subsystem. The storm quickly grew to superstorm proportions, encircling the planet at about 30 degrees north latitude for an expanse of nearly 190,000 miles (300,000 kilometers).

The new paper focuses on data gathered by Cassini's visual and infrared mapping spectrometer earlier this year. The team, led by Lawrence Sromovsky, also of the University of Wisconsin, found that cloud particles at the top of the great storm are composed of a mix of three substances: water ice, ammonia ice, and an uncertain third constituent that is possibly ammonium hydrosulfide. The observations are consistent with clouds of different chemical compositions existing side-by-side, though it is more likely that the individual cloud particles are composed of two or all three of the materials.

The classic model of Saturn's atmosphere portrays it as a layered sandwich of sorts, with a deck of water clouds at the bottom, ammonia hydrosulfide clouds in the middle, and ammonia clouds near the top. Those layers are just below an upper tropospheric haze of unknown composition that obscures almost everything.

But this storm appears to have disrupted those neat layers, lofting up water vapor from a lower layer that condensed and froze as it rose. The water ice crystals then appeared to become coated with more volatile materials like ammonium hydrosulfide and ammonia as the temperature decreased with their ascent, the authors said.

"We think this huge thunderstorm is driving these cloud particles upward, sort of like a volcano bringing up material from the depths and making it visible from outside the atmosphere," said Sromovsky. "The upper haze is so optically thick that it is only in the stormy regions where the haze is penetrated by powerful updrafts that you can see evidence for the ammonia ice and the water ice. Those storm particles have an infrared color signature that is very different from the haze particles in the surrounding atmosphere."

In understanding the dynamics of this Saturn storm, researchers realized that it worked like the much smaller convective storms on Earth, where air and water vapor are pushed high into the atmosphere, resulting in the towering, billowing clouds of a thunderstorm. The towering clouds in Saturn storms of this type, however, were 10 to 20 times taller and covered a much bigger area. They are also far more violent than an Earth storm, with models predicting vertical winds of more than about 300 mph (500 kilometers per hour) for these rare giant storms.

The Cassini-Huygens mission is a cooperative project of NASA, the European Space Agency and the Italian Space Agency. JPL manages the mission for NASA's Science Mission Directorate, Washington. The California Institute of Technology in Pasadena manages JPL for NASA. The VIMS team is based at the University of Arizona in Tucson.

For more information about the Cassini mission, visit: [www.nasa.gov/cassini](http://www.nasa.gov/cassini) and <http://saturn.jpl.nasa.gov>.



# Importance of exercise while in orbit

By Anthony Breitbach, PhD, ATC

Human space flight is a physically demanding experience. It poses numerous risks, many of them are very evident, but some are hidden to the naked eye. The most important hidden health challenge is the bone density changes that are brought on by prolonged weightlessness. These bone density changes in the hip and back are very similar to those suffered by women with osteoporosis after menopause. Living in a minimal gravity environment during lengthy missions can set up astronauts for hip and spine fractures similar to those incurred by persons suffering from osteoporosis.

NASA has been concerned about this problem for quite a long time and has held the NASA Bone Summit, bringing in experts to examine the problem. The recommendations from this panel of experts were presented in the Journal of Bone and Mineral

Research in June of 2013. There were four primary recommendations:

- Astronauts need to have quantitative computed tomography (QCT) and hip strength assessments pre- and post-flight to measure changes in bone density and strength.
- Other methods of testing such as dual-energy X-ray absorptiometry (DXA) should also be utilized to track in astronauts' bone density.
- Modifiable risk factors for osteoporosis such as physical activity and nutrition should be optimized in astronauts.
- New pharmacological interventions (Biphosphonates) which slow bone loss should be investigated.

Diet and exercise are important to astronauts, as they are important to persons that are at risk for developing osteoporosis. This involves eating foods which are high in calcium and that are customized to maximize calcium absorption. Exercise regimens involve a significant amount of the astronauts' time in space. They use aerobic exercise and strengthening techniques to help prevent the inevitable bone loss that comes with space travel and weightlessness.

Col. Ron Garan, veteran astronaut who has logged over 178 days in space on the importance of exercise: "The human body is incredibly adaptive and in a low gravity environment it soon realizes that its skeleton is not needed as much in a normal gravity environment. Resistance exercise has been shown to be an effective countermeasure to losses in bone density. On the International Space Station (ISS), our daily required routine included an hour daily of resistance training and an hour daily on the bike or treadmill."

Future NASA projects and missions involving manned space travel will involve longer time in space and the issue of bone density will need to be addressed in those making those missions. Through increased study and planned interventions, it is hoped that these negative effects will be minimized through proper screening, monitoring, diet and exercise. Research that is currently being done at NASA on bone loss and osteoporosis will not only benefit astronauts, but also benefit individuals in the general population suffering from osteoporosis.

Diet and exercise is important to all of us for good health. It will be essential for survival in space travel as astronauts embark on more aggressive and lengthy missions. Innovation and research will be important in developing methods for our astronauts to protect their bones and stay healthy in space.

For information about the research on the ISS go to: [www.nasa.gov/mission\\_pages/station/research](http://www.nasa.gov/mission_pages/station/research).

**About the Author:** Anthony Breitbach, PhD, ATC, is the Director for the Athletic Training Program within the Doisy College of Health Sciences at Saint Louis University.

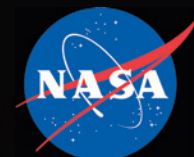


Exercising is a part of the daily routine aboard the International Space Station. Pictured are astronaut Sunita Williams (above), and (following page clockwise, from top left) Karen Nyberg, Dan Burbank, Nicole Stott, Joe Acaba and Ron Garan. Photos: NASA

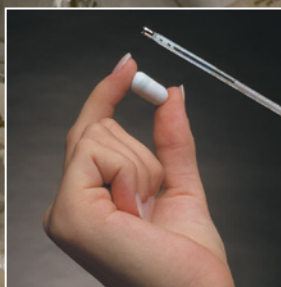
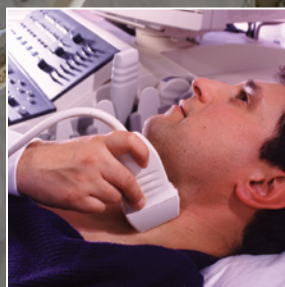








# Health and Medicine Spinoffs



As NASA continues its mission to carry human presence deeper into space and expand our knowledge of the universe, the Agency's efforts also reach into another territory—the inner space of the human body. NASA partnerships are exploring the use of carbon nanotubes to diagnose and treat brain tumors, perfecting fiber optic probes for detecting cataracts that cloud vision, and developing software for recognizing and managing depression. From experiments on the International Space Station to aeronautics research, NASA programs are also resulting in spinoffs that improve fitness, treat disease, and save lives. These resulting medical technologies are among the more than 1,600 NASA spinoffs recorded since 1976.





### **Thermometer Pill Helps Athletes Beat the Heat**

An ingestible thermometer pill was designed to monitor the body temperature of astronauts during space flight. The pill and accompanying data recorder now help Olympians and professional and collegiate athletes avoid dangerous heat-related illnesses during intense workouts.



### **LEDs Alleviate Pain, Speed Rehabilitation**

Tiny light-emitting diode (LED) chips used to grow plants on the International Space Station are now used for wound healing and chronic pain alleviation on Earth and have been successfully applied in cases of pediatric brain tumors and the prevention of oral mucositis in bone marrow transplant patients.



### **Noninvasive Test Detects Cardiovascular Disease**

A NASA team adapted Agency-invented software, originally designed to handle imagery gathered by space probes, to assess ultrasound images of arteries for plaque buildup. The software is now part of a diagnostic system for accurately predicting heart health.



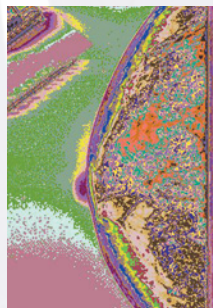
### **Robotics Offer New Surgical Capabilities**

Surgeons are using sensitive, dexterous robotic arm and hand technology—developed with NASA funding for use conducting repairs on the International Space Station—to insert titanium implants during a minimally invasive knee surgery procedure that eliminates the need for traumatic joint replacement.



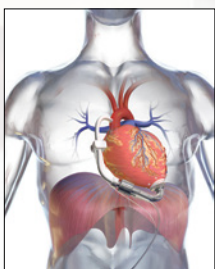
### **Circulation-Enhancing Device Improves CPR**

NASA research into blood pressure—a concern for astronauts adjusting to Earth's gravity after space flight—supported the development of a device that boosts blood flow to the brain during CPR, increasing the number of cardiac arrest patients delivered alive to hospitals by as much as 50 percent.



### **CCDs Enable Clearer, More Efficient Biopsies**

Charge coupled devices (CCDs) used on the Hubble Space Telescope to convert a distant star's light directly into digital images—have been adapted to improve imaging and optics here on Earth. Many NASA-driven enhancements to the manufacture of CCDs have been applied to digital mammography biopsy techniques, using CCDs to image breast tissue more clearly and efficiently.



### **Rocket Engine Technology Keeps Hearts Pumping**

Supercomputer simulation of fluid flow through rocket engines, combined with cutting-edge medical industry collaboration, resulted in a lifesaving heart pump for patients awaiting heart transplants. The MicroMed DeBakey VAD pumps blood throughout the body to keep critically ill patients alive until a donor heart is available and has been successfully implanted in over 445 patients.



### **Corrosive Space Gas Scrubs Surgical Implants**

Atomic Oxygen, the gas that corrodes spacecraft in orbit, can be used to decontaminate orthopedic surgical implants prior to surgery, texture blood to allow the rapid measurement of glucose and other analytes, and roughen surfaces to improve cell adhesion, which is important for the development of new drugs.



### **Polymer Coating Aids Heart Failure Treatment**

A unique, flexible thermoplastic resin developed by NASA scientists researching advanced composites for high-speed aircraft now coats leads for cardiac resynchronization therapy devices, providing physicians greater ability to deliver the leads through difficult-to-access veins and resulting in a 96.4 percent placement success rate.



### **Inline Filter Purifies Dental Water**

The microbial check valve, one of the filtration devices designed as part of the Water Recovery System now onboard the International Space Station, is in widespread use in dental offices, where it prevents back contamination, reducing harmful bacteria in dental water and exposure to patients and staff.

For more information about NASA spinoffs, please visit [spinoff.nasa.gov](http://spinoff.nasa.gov).





The Aletschglacier in Switzerland is the largest valley glacier in the Alps. Image: Frank Paul, University of Zurich



# Soot likely played a role in 1800s glacier retreat

A NASA-led team of scientists has uncovered strong evidence that soot from a rapidly industrializing Europe caused the abrupt retreat of mountain glaciers in the European Alps that began in the 1860s, a period often thought of as the end of the Little Ice Age.

The research last month in the Proceedings of the National Academy of Sciences, may help resolve a longstanding scientific debate.

In the decades following the 1850s, Europe underwent an economic and atmospheric transformation spurred by industrialization. The use of coal to heat homes and power transportation and industry in Western Europe began in earnest, spewing huge quantities of black carbon and other dark particles into the atmosphere.

Black carbon is the strongest sunlight-absorbing atmospheric particle. When these particles settle on the snow blanketing glaciers, they darken the snow surface, speeding its melting and exposing the underlying glacier ice to sunlight and warmer spring and summer air earlier in the year. This diminishing of the snow cover earlier in each year causes the glacier ice to melt faster and retreat.

The Little Ice Age, loosely defined as a cooler period between the 14th and 19th centuries, was marked by an expansion of mountain glaciers and a drop in temperatures in Europe of nearly 1.8 degrees Fahrenheit (1 degree Celsius). But glacier records show that between 1860 and 1930, while temperatures continued to drop, large valley glaciers in the Alps abruptly retreated by an average of nearly 0.6 mile (1 kilometer) to lengths not seen in the previous few hundred years. Glaciologists and climatologists have struggled to reconcile this apparent conflict between climate and glacier records.

"Something was missing from the equation," said Thomas Painter, a snow and ice scientist at NASA's Jet Propulsion Laboratory in Pasadena, Calif., who led the study. "Before now, most glaciologists believed the end of the Little Ice Age came in the mid-1800s when these glaciers retreated, and that the retreat was due to a natural climatic shift, distinct from the carbon dioxide-induced warming that came later in the 20th century. This result suggests that human influence on glaciers extends back to well before the industrial temperature increases."

To help the scientists understand what was driving the glacier retreat, Painter and his colleagues turned to history. The researchers studied data from ice cores drilled from high up on several European mountain glaciers to determine how much black carbon was in the atmosphere and snow when the Alps glaciers began to retreat. Using the levels of carbon particles trapped in the ice core layers, and taking into consideration modern observations of how pollutants are distributed in the Alps, they were able to estimate how much black carbon was deposited on glacial surfaces at lower elevations, where levels of black carbon tend to be highest.

The team then ran computer models of glacier behavior, starting with recorded weather conditions and adding the impact of the lower-elevation pollution. When this impact was included, the simulated glacier mass loss and timing finally were consistent with the historic record of glacial retreat, despite the cooling temperatures at that time.

"This study uncovers likely human fingerprints on our changing environment," said co-author Waleed Abdalati, director of the Cooperative Institute for Research and Environmental Sciences (CIRES) at the University of Colorado Boulder. "It's a reminder that the actions we take have far-reaching impacts on the environment in which we live."







Outside of the annual SpaceFest convention it is rare to see so many astronauts in the same place at the same time.

Image: SpaceFest

## Recollections of SpaceFest V: The ultimate party for space lovers

By Amjad P. Zaidi

"The past is prologue" as I once heard. A once politicised and technology based race to the Moon has yielded innumerable spin-off benefits and technology, but has also served as a prologue to many other events. The birth and rise of the new commercial space industry. International Space Agency cooperation with the construction of the International Space Station. The rising star of the Chinese ambitions to have a presence in orbit and on the Moon. And the benefits of a higher quality life in many ways. I was reminded of all these events in late May when I attended Spacefest V.

Spacefest is THE convention to go to for any "pure stripe, dyed in the wool space enthusiast, astronomy buff" and pretty much anyone who is enthusiastic about space history, exploration and STEM

(Science, Technology, Engineering and Maths). There have been 4 of these events held which have attracted luminaries from the world of science, technology, astronomy and astronautics including some of the legendary Apollo astronauts

Organised by the wonderful Kim and Sally Poor of Novaspace, Spacefest V was held in the tranquil Marriott Starr Pass Resort and Spa in Tucson, Arizona. Known as an astronomy town, there are many side tours to sites of interest such as Kitt Peak Observatory, Pima Air and Space Museum and Biosphere II. The convention itself was held over the 3 day Memorial Day weekend and brought together not only many famous luminaries but a very special group of virtual Facebook friends with whom I had become acquainted over the previous months during planning for this little trip.

The Spacefest V weekend itself opened with a refined VIP reception on Thursday 23rd May, mixing with all the attendees, and old and new friends. Meeting one of the Meteorite Men himself, Geoff Notkin was a joy and a thrill to see an expat Brit pursuing his life's dream in Arizona so successfully. If you haven't already seen his excellent series on the Discovery Channel "Meteorite Men" do check it out. Geoff was welcoming and fun straight off the bat, eager and curious to know, answering every question with humour and detail. A pure delight and a very British gentleman like this author. Entry to view a very special art exhibition was given to appreciate the beautiful and extraordinary space art of such celebrated artists as Lucy West-Binnall, Kim Poor, Pamela Lee and Apollo XII astronaut Alan Bean who is himself a very accomplished



artist. Then came an unexpected surprise; meeting Carolyn Porco, leader of the imaging science team for the Cassini Mission; its namesake probe currently in orbit around Saturn and investigating the Saturnian moons Enceladus and Titan. As a young scientist she also worked with another childhood hero, Carl Sagan on the Voyager missions. She was very keen to get to know our little international army who had travelled so far to come to this event. So much so she even tweeted about us!

## Spacefest V: Day 1

The first proper full day on Friday brought a series of highly informative talks from scientists, astronomers and Apollo alumni. A separate dealer hall ran parallel to the talks housing art memorabilia, books and meteorites for sale as well as an opportunity to meet the legends of the Apollo era. Updates on Project DAWN to asteroids Vesta and Ceres and New Horizons to Pluto were given by Marc Rayman and Leslie Young respectively. Both were highly informative and intriguing. The legendary Sy Liebergot gave the crowd an unparalleled view into the inside workings of NASA Mission Control in the 60s during Apollo's heyday and especially around the mission he was most instrumental in saving; Apollo XIII. As he succinctly put it, it took eight years to make the bomb that blew a hole in the side of Apollo XIII's service module and almost cost the lives of three good men. However it was, as we all have seen, NASA's finest hour.

Continuing the tour I finally met two Moonwalking heroes from my childhood, Dave Scott and Al Bean. For Dave, commander of Apollo XV, I had brought a very special memento; a book of Captain Cook's Journals from his cottage in Fitzroy Gardens, Melbourne Park Australia. Cook was one of Dave Scott's key inspirations. Dave was visibly touched by my gesture and we immediately began talking about Cook's famous voyages rather than his own missions. To say we hit it off would be an understatement as we

continued to chat about Cook and then his own lunar experiences at dinner.

Al Bean: one of the nicest men I have ever met, period. So warm open and welcoming with a ready smile, here was an Apollo XII and Skylab III hero without borders or brash ego. At lunch, he correctly surmised that the experience of walking on the Moon simply enhanced the qualities that were already in the men who went there. Whether it was to run for Senate (Jack Schmitt), actively pursue plans for Mars (Buzz Aldrin), find

to survive and eventually excel - and if we are lucky become closer to who we truly are. The trick is to instil excellence and exactitude in everything we do and have fun doing it, just like Al Bean said.

The day was rounded off by a remarkable and eminent teaming up of Carolyn Porco and Professor Brian Cox (British astrophysicist and current king of BBC science promotion). Both gave a detailed talk on their respective fields and neither dumbed down for this crowd. Carolyn (as expected) stunned us with the latest images



One SpaceFest attendee proudly shows off the autographs on his art print to a group of other attendees.

*Image: SpaceFest*

renewed strength and meaning in their religion (Charlie Duke) or enhance an artist's world (Al Bean himself). Talking to him about his painting experiences we were all surprised at how he has never looked again at the Moon while painting it. It's all from memory and impressions. Exactness and the pride in a painting well finished is his driver and he could take 4-6 months over perfecting one. To him, it is simply a transfer of exacting rigour from being a navy pilot, to a test pilot, astronaut and now a painter. An inspiring lesson we can apply to our lives. We are never static, we adapt and reinvent ourselves periodically

from Cassini's exploration of the Saturnian system. This is truly where scientific observation comes into play as Saturn is in many ways, a micro solar system in itself, with its proto planetary accretion disk analogue (rings). However there is one further thing Saturn provides; beautiful grandeur. Having gazed upon Voyager's images as a child and now the remarkable high res Cassini photos as an adult, I can safely say we truly have a Wonder of the Solar System in our "back garden". Carolyn's photos of Titan and Enceladus wowed the crowd, including some at the time hitherto unpublished data



and unpublished plans. One of which has since come to fruition during the #DayEarthSmiled / #WaveAtSaturn events on Friday 19th July 2013, when for only the 3rd time in history, the Pale Blue Dot of Earth was photographed by Cassini's cameras from 1.44 billion kilometres away.

Brian Cox stepped up the pace and instead of concentrating on a wonder of our Solar System, spoke about the Wonders of our Universe. Not to be outdone, he told us about his work on the Large Hadron Collider and related complex astrophysics principles with everything that we are and know in nature and cosmology today, from the Big Bang theory to cosmic Inflation, dark energy, dark matter and cosmic microwave background radiation. He finished with a deep and meaningful thought (as he is known to do) quoting the Royal Institution of Great Britain;

"It is an undoubted truth, that the successive improvements in the condition of man, from a state of ignorance and barbarism to that of the highest cultivation and refinement are usually affected by the aid of machinery in procuring the necessities, the comforts, and the elegancies of life; and that the pre-eminence of any people in civilisation, is and ought ever to be estimated by the state of industry and mechanical improvement among them."

## Spacefest V: Day 2

Day 2's lectures started off with a bang for me as I sat in on a great talk from one of my literary heroes; Andrew Chaikin. Andrew wrote what is considered to be the cornerstone "go-to" text for anyone who wants to know anything about the US Space Program to the end of the Apollo Program. His book "A Man on the Moon" took 8 years to write with meticulous research from interviews with many involved in that era. Andrew spoke about the political context which fired JFK's "we choose to go to the Moon" speech. He then spoke about the exciting age we live in and the



Sharing a moment with an astronaut, such as Gemini XI and Apollo 12's Dick Gordon (right), is always a highlight of every attendee's trip to SpaceFest.

Image: SpaceFest

rise of "commercial" spaceflight enterprises. From its earliest beginnings, commercial spaceflight is rapidly becoming a growing industry with new players arriving on the scene (Virgin Galactic, XCor, SpaceX, Orbital Sciences, Sierra Nevada etc.). Past it seems is indeed prologue.

At lunch, we talked more about Golden Spike and the race back to the Moon. The time is ripe for a commercial return and Andrew outlined his involvement with Golden Spike; a "railroad" firm with the goal of establishing the first commercial transportation service to the surface of the Moon, using existing technology, leveraging Apollo experience and offering these at prices comparable to robotic missions to a wide variety of customers. With the famed Jim Lovell and Gerry Griffin already on board Golden Spike is on course to lay a new railroad for a permanent lunar return.

Phil Plait (@badastronomer) the renowned blogger, astronomer and science author, packed out his room with his usual mix of humour and logical truth deconstructing

pseudo-science. He also shared the wonder of science outreach and how the general public can be inspired, as they were during MSL Curiosity's remarkably successful but dramatic landing on Mars. Who can forget Times Square in New York, filled to the brim with people of all backgrounds watching as a 1 ton NASA rover landed LIVE on TV ON ANOTHER WORLD! And that was but one landing party for Curiosity as there were so many around the world. As Phil rightly said this was one of the most outstanding moments of his and our lives.

Popping back to the dealer room I introduced myself to Fred Haise. Fred was one of the Apollo XIII crew and Enterprise Shuttle commander/ test pilot during the earliest days of the Shuttle program in the late 70s. Here was another man who was still sharp as a tack and energised. His role as a STEM ambassador and educator has inspired many. We talked about his dedication to completing the Infinity Science Centre in Mississippi, a centre of learning with interactive exhibits for children and adults alike. Fred truly understands the need to



inspire and educate the children of today to follow STEM subjects. They are the engineers and scientists of tomorrow and without them, our ability to innovate and progress will diminish.

Dan Durda: Another renaissance man who regaled me with talks of his work with XCor Aerospace. He gave a sparkling talk on his flying jets and booking flights on Virgin Galactic's SpaceShipTwo and XCor's Lynx as a payload specialist primarily to do science. However the largest portion of his talk was around comets and asteroids. Given the recent pass of Asteroid DA14 and the Chelyabinsk meteorite strike his talk generated much interest. With over 20 years of experience in the field of collisional and dynamical evolution of Near Earth and Kuiper Belt objects, Dan outlined the reason for the Sentinel Mission. The Sentinel Mission is the brainchild of Rusty Schweickart's B612 Foundation offering the public a chance to fund a privately owned and operated mission to launch an infrared telescope in a solar orbit. This telescope will track and map asteroids and other NEOs (Near Earth Objects) that prove a danger to our planet. Suffice to say the timing of this mission could not be better given rising public awareness that we live in a cosmic shooting gallery. To find out more about B612's proposal visit <http://b612foundation.org/sentinelmission/>

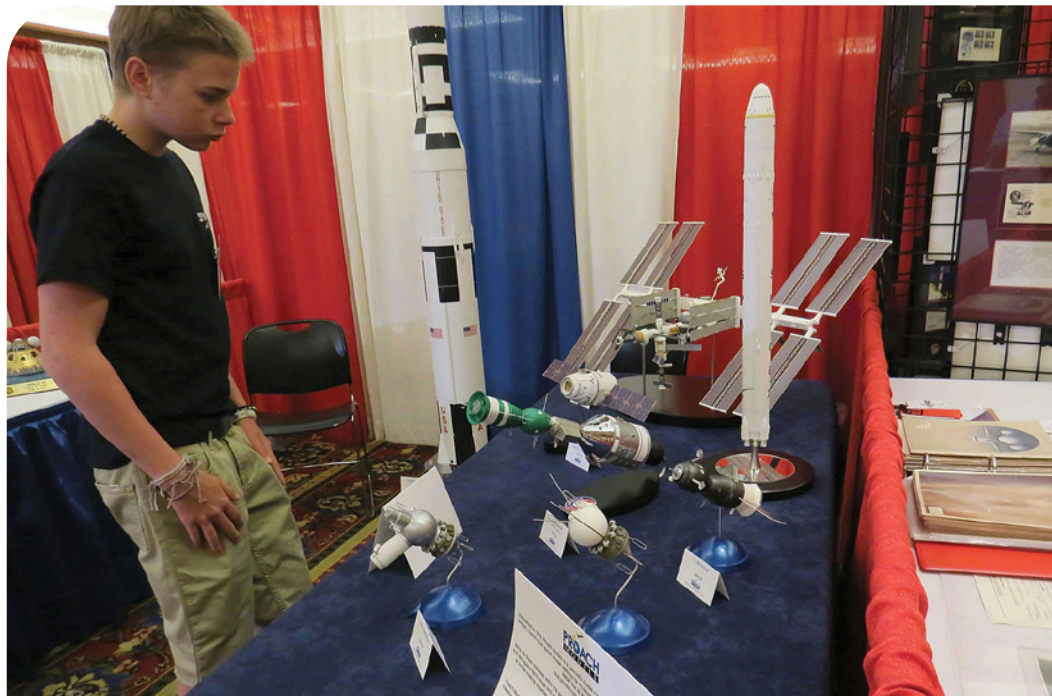
Britney Schmidt: A post-doctoral astrobiologist in the Planetary Science field, Britney gave fascinating insights into a mission to Europa, one of Jupiter's most exciting satellites with the promise of extremophile life existing there. She spoke about how the orbit of Io and Jupiter's own immense magnetic field, has huge bearing on Europa itself giving it tidal energy. Understanding Earth's geological cycles also helps us create an analogue for Europa's ecosystem too. Britney then laid out a compelling case for visiting Europa; thanks to its warm salty oceans and high energy, the mediums are

there for extremophile life to exist, perhaps in a proto state. You can view more about her proposed mission at [www.europa.seti.org](http://www.europa.seti.org).

What followed later that evening was quite possibly the most emotional moment of my life, next to being present at the final Shuttle launch. A simple photo opportunity with childhood heroes, many of whose lives and lunar missions through NASA I have followed and read about time after time while growing up. To be sharing a picture with them was the proudest and most epic memory from that event.

The Spacefest V Banquet followed with many of my friends being seated with and chatting

the rocks and took forever to come back down, before being bounced up in the air again. We also talked at length about his interest for geology, which under the tutelage of Professor Lee Silver grew into a passion for the benefit of Apollo XV's mission. Dave actively campaigned against Deke Slayton's (then head of the Astronaut Office) misgivings to trade abort propellant on the descent stage of the Lunar Module for a telephoto lens! Clearly Dave realised the scientific value of where he was going. He also remembered my gift to him the previous day of Captain Cook's journals and was already enjoying reading them greatly.



Exacting scale models of nearly every spacecraft were on display.

Image: SpaceFest

away with these legends. My choice; Dave Scott. Dave was most notably Commander of Apollo XV, the first "J" mission and the first to stay on the Moon for 3 days delivering a truly magnificent scientific mission. But that was not his only mission, he flew side seat in the almost disastrous Gemini VIII alongside one Neil Armstrong and was a key part of Apollo X. Dave became the first off world driver on Apollo XV as he demonstrated with the famous lunar rover. He remarked at dinner that "that car kicked like a mule" over

Dave also told my banquet table how he and James Irwin discovered a chunk of the Moon's original crust. Later called "The Genesis Rock" it helped transform our theoretical understanding of how the Moon was formed. Our table also included a group of Swiss schoolchildren who come to Spacefest every year. They were clearly engaged and asking many intelligent and mature questions of Dave about the nature of the Universe, the Moon, his experiences on it and the Earth itself. It felt like a torch was



being passed to the future. What was clear was how engaged Dave was in inspiring children to take up STEM subjects and study hard. Who knows, perhaps among them, and many others like them would be the first human to return to the Moon or set foot on Mars...

During the banquet was perhaps the most touching moment of the night for me. On the 51st anniversary of his Aurora VII Mercury flight, Scott Carpenter was given a rousing dedication and standing ovation. As one of the astronauts left alive today from that pioneering program, he showed true courage as a test pilot during his one and only mission.

Latter day critics have claimed he almost exhausted his propellant forcing an early mission abort and

### Spacefest V: Day 3

Feeling the effects of the 2 previous days, many of us "Spacefesters" were flagging but dragged ourselves down for breakfast, sitting with any number of astronauts, scientists and speakers we liked. This was the greatest thing about this event. No egos, no cliques, just people with a passion for space, science and astronomy intermingling and chatting about their favourite passions, whether they are a Moonwalker or a schoolchild.

So straight after breakfast it was onto the Apollo Moon Panel with a full and frank discussion of the Apollo program, its successes and failures and most of all, its legacy.

XII), Fred Haise (Apollo XIII and Shuttle Enterprise ALT) and Bruce McCandless (Shuttle missions STS-41B and STS-31). With such minds on board, it was a glimpse into history and a bygone era where we truly took risks, faced great dangers but also experienced the greatest rewards bestowed upon humanity. There was also a lot of good natured ribbing among the Apollo guys as they reminisced about the heady days of the 60's but took pains to inspire and encourage the schoolchildren in attendance.

After the panel discussion, a return to the dealer room led to the most momentous meeting with Gene Cernan. As commander of Apollo XVII, LMP on Apollo X and flew the right hand seat on Gemini IX (with Tom Stafford), this man was well trained and a capable scientist on the Moon for 3 full days. Like Dave Scott he is an explorer and it is clear that since his return his fervour for exploration has only increased. Gene is a special man and one of the earliest and most powerful Space and STEM outreach ambassadors. He took time with everyone to meet, greet and talk to them fully. Even for me, an old kid from London he wanted to hear about what drove my passion to be here. He even recorded a unique video message for my three young nephews back home.

Scott Carpenter. I never thought I would get a chance to meet one of the original heroes of the Mercury program. For anyone in love with that era, this was when NASA was in its infancy. Taking teetering steps forward before falling to the ground and picking themselves up again. Everything was new, had to be invented or wasn't even conceived of yet. Carpenter himself had appeared weak due to age all weekend and his frailty had not escaped me. I was feeling very guilty about asking to meet him. Physical frailty is one thing, mental agility is another. This man is still sharp as a tack. He pronounced my name perfectly, then stopped me dead in my tracks querying if it was of Farsi origin. Not many people



There was no lack of reading materials available for purchase by attendees of the event.

Image: SpaceFest

re-entry, but I believe the data from his flight was invaluable and informed every subsequent US mission: that back-up systems (human pilots) could correct and compensate for technological failures.

This was a touching moment for an elderly and frail legend, which brings home how many of these legends are left in the world today.

Most of the key astronauts of that era were in attendance. With Professor Brian Cox moderating the Q&A it was clear that he was one of us – giddy with excitement at even spending 5 minutes with these living legends.

The panel included Walt Cunningham (Apollo VII), Jim McDivitt (Gemini IV and Apollo IX), Dick Gordon (Gemini XI and Apollo





Inspiring the next generation: David Scott and Amjad Zaidi at the Spacefest V Banquet.

*Image: Amjad P. Zaidi*

would even know of Farsi and while I may not be, the fact that this astronaut from the 60s asked about it astounded me. A well-travelled and learned man.

By this time only the few dedicated stragglers of Spacefest remained. Wandering around the exhibition hall I couldn't help but pick out a few giclee art mementoes alongside some other "swag". Meeting Brian Cox again, we talked about his next BBC show which is starting to take shape. We also discussed at length the state of manned US space program, how we can improve science outreach to the public to make them more aware of the wider world of science and how much their lives depend on space activities. Soon enough, as I knew it would the moment had arrived to bid farewell to a very special group of friends as we parted ways. It was clear that for many of us this had been a life changing experience.

A dash back for the final talk was delivered by good friend Nick Howes, UK's own outreach dynamo, comet hunter and Faulkes Telescope Pro-AM manager. Nick related how the effect of news reporting over the discovery of Comet C2007Q3 changed his life. The incredible sighting and break-up of the comet while it was being captured led to a media frenzy and brought his work to the attention of many, opening up the chance to work with NASA, ESA, and the LARI

program with the famed Lowell Observatory in Flagstaff. But the real icing on the cake was his work on Project Snoopy, the on-going hunt for Apollo X's Lunar Module Ascent Stage, which was sent off into orbit around the sun and is still out there somewhere. Engaging again with school students to look for this speck among the stars is a huge challenge but an exciting one. Even Gene Cernan, LMP of Apollo X is firmly on board with finding his little ship again. Learn more about The Search for Snoopy here! <http://www.faulkes-telescope.com/news/2413>.

### The epiphany moment...

Personally, I had a strong feeling this would happen since having to give up my seat to Spacefest IV last year. Everything since had been building to these 3 days in Tucson. Research, meticulous planning and significant investment had gone into not only getting me here but to make this the most epic space themed holiday ever.

It is sobering to know that we live in an age where soon there will be no more humans who can share the experience of having walked on another world. It is even more saddening to know that there are some who doubt this recent history, and I personally make it my mission to inform and educate others of this, the most remarkable achievement in all of human history. Consider this: there are 7 billion people alive today

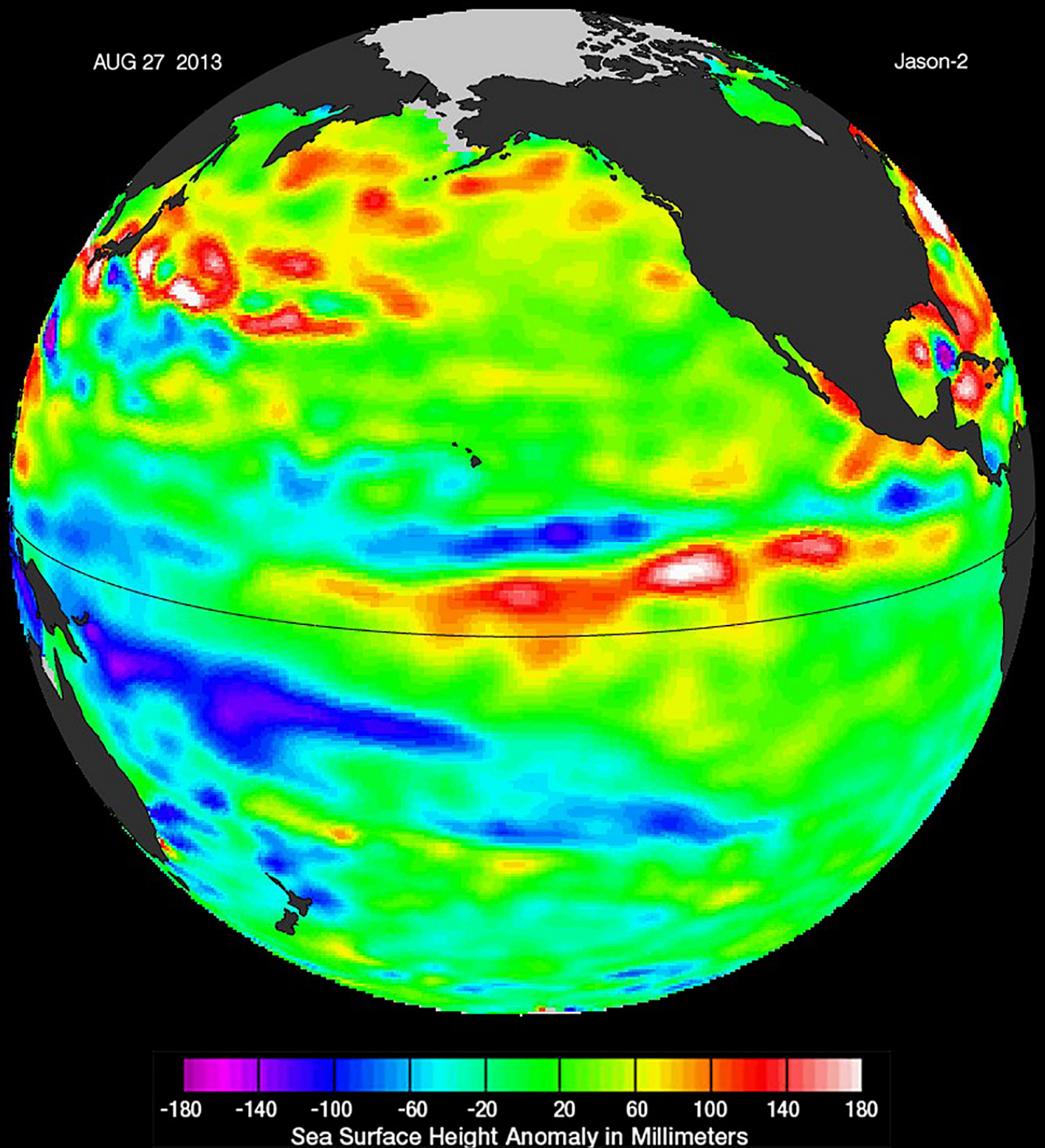
on our Pale Blue Dot, of which only 12 actually walked on the surface of another world in those heady days of the late 60s and early 70s. Of those 12, only 8 remain alive today to tell the tale which was reminded to us by the early passing of the first man on the Moon, Neil Armstrong last year.

The unexpected dimension was sharing this all with a wonderful group of global space friends. It's no surprise then than that this trip has energised us to do more, to reap what has been sown. Having met such legendary people I am firmly of the opinion that it is up to each and every one of us to change the world for the better, through raising awareness of STEM education and space exploration. These impinge on everyone's lives on a daily basis. We can simply choose to take a passive backseat role in our future and not invest in STEM education, or support it actively, any way we can. Firing children's and adults imaginations, through education and inspiration, reigniting their natural human curiosity will be the way forward to all our futures. To create the next generation of leaders, scientists, engineers and astronauts of tomorrow. To build a better world for our progeny and finally a move towards being a multi planetary species.

Many of us have now returned back to a life where the vagaries and troubles of an ordinary world await to grasp at our energies. Home. It must take on a new meaning for me. It's not what I've returned to. It's not a place, city, or date in time. To me, it's a state of mind. Home is with the friends and "space family" I met and made who share my belief in building a better world; bridging today to tomorrow's world and humanity's manifest destiny in space. Home is the journey to that bright tomorrow. Home is with an army of visionaries. We are virtual. We are global. We are legion. And our home is ahead and above us. Humanity's manifest destiny in space awaits.

It truly does seem that Spacefest has shown us that past is prologue.





This image of sea surface heights in the Pacific Ocean from NASA's Jason-2 satellite shows that the equatorial Pacific Ocean is in its 16th month of being locked in what some call a neutral, or "La Nada" state.

Image: NASA/JPL-Caltech/Ocean Surface Topography Team



# 'La Nada' climate pattern lingers

New remote sensing data from NASA's Jason-2 satellite show near-normal sea-surface height conditions across the equatorial Pacific Ocean. This neutral, or "La Nada" event, has stubbornly persisted for 16 months, since spring 2012. Models suggest this pattern will continue through the spring of 2014, according to the National Weather Service's Climate Prediction Center.

"Without an El Niño or La Niña signal present, other, less predictable, climatic factors will govern fall, winter and spring weather conditions," said climatologist Bill Patzert of NASA's Jet Propulsion Laboratory, Pasadena, Calif. Long-range forecasts are most successful during El Niño and La Niña episodes. The "in between" ocean state, La Nada, is the dominant condition, and is frustrating for long-range forecasters. It's like driving without a decent road map -- it makes forecasting difficult."

The near-normal conditions are shown in a new image (as areas shaded in green), based on the average of 10 days of data centered on Aug. 27, 2013.

For the past several decades, about half of all years have experienced La Nada conditions, compared to about 20 percent for El Niño and 30 percent for La Niña.

Patzert noted that some of the wettest and driest winters occur during La Nada periods.

"Neutral infers something benign, but in fact if you look at these La Nada years when neither El Niño nor La Niña are present, they can be the most volatile and punishing. As an example, the continuing, deepening drought in the American West is far from 'neutral,'" he said.

The height of the sea water relates, in part, to its temperature, and thus is an indicator of the amount of heat stored in the ocean below. As the ocean warms, its level rises; as it cools, its level falls. Yellow and red areas indicate where the waters are relatively warmer and



Artist's concept of the Jason-2 spacecraft in space.

Image: NASA/JPL-Caltech

have expanded above normal sea level, while green (which dominates in this image) indicates near-normal sea level, and blue and purple areas show where the waters are relatively colder and sea level is lower than normal. Above-normal height variations along the equatorial Pacific indicate El Niño conditions, while below-normal height variations indicate La Niña conditions. The temperature of the upper ocean can have a significant influence on weather patterns and climate. For a more detailed explanation of what this type of image means, visit: <http://sealevel.jpl.nasa.gov/science/elninopdo/latestdata/>.

This latest image highlights the processes that occur on time scales of more than a year, but usually less than 10 years, such as El Niño and La Niña. These processes are known as the interannual ocean signal. To show that signal, scientists refined data for this image by removing trends over the past 20 years, seasonal variations and time-averaged signals of large-scale ocean circulation.

NASA scientists will continue to monitor this persistent La Nada

event to see what the Pacific Ocean has in store next for the world's climate.

The comings and goings of El Niño, La Niña and La Nada are part of the long-term, evolving state of global climate, for which measurements of sea surface height are a key indicator. Jason-2 is a joint effort between NASA, the National Oceanic and Atmospheric Administration (NOAA), the French Space Agency Centre National d'Etudes Spatiales (CNES) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). JPL manages the U.S. portion of Jason-2 for NASA's Science Mission Directorate.

In early 2015, NASA and its international partners CNES, NOAA and EUMETSAT will launch Jason-3, which will extend the timeline of ocean surface topography measurements begun by the Topex/Poseidon and Jason 1 and 2 satellites. Jason-3 will make highly detailed measurements of sea level on Earth to gain insight into ocean circulation and climate change.

For more on NASA's satellite altimetry programs, visit: <http://sealevel.jpl.nasa.gov>.



# Can SpaceShipTwo fly up to space?

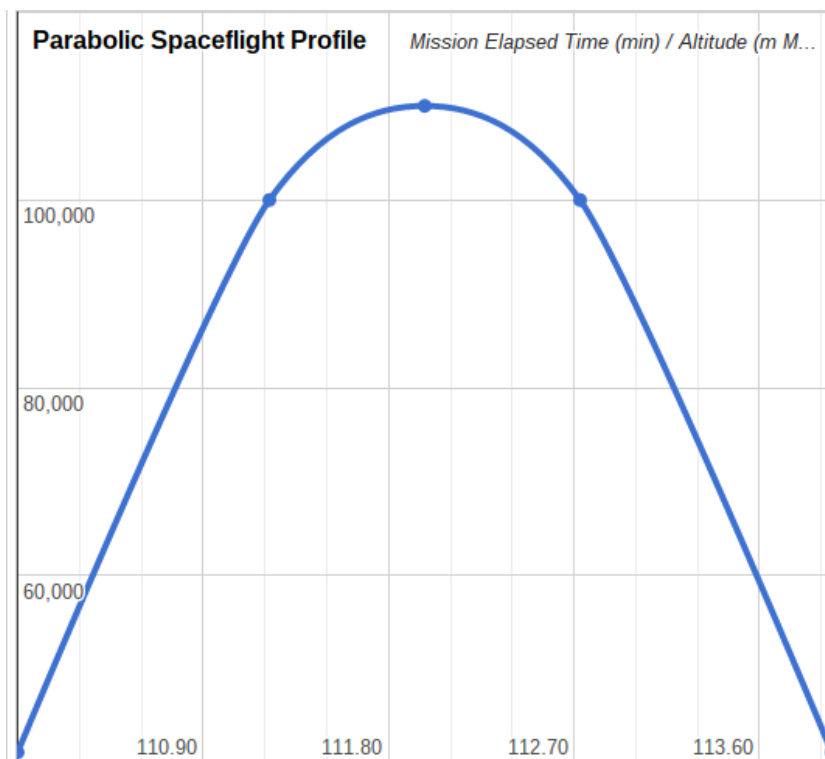
## Vocabulary

- **Parabola:** The graph of a quadratic equation, which for this project is in the shape of an upside-down capital "U"
- **Quadratic Equation:** The equation that creates a parabola when graphed
- **Vertex:** The maximum (or Minimum) point on a parabola

## Narrative

If a baseball is thrown into the air to another ball player, it will continue moving upward after it leaves the ball player's hand. The ball will eventually reach a maximum height (which we can calculate), and then drop back down to the other player's glove.

Virgin Galactic's SpaceShipTwo (SS2) follows a flight profile very similar in nature. Can we figure out how high the spacecraft went? Why, I'm glad you asked!



For a more in-depth treatment of this high school project by Joe Maness & Rich Holtzin visit [www.stemforthe classroom.com](http://www.stemforthe classroom.com).



Image: Virgin Galactic





That baseball (spacecraft) follows a nice parabolic curve, and can be described using a quadratic equation:

$$h = at^2 + v_0t + h_0$$

where

- $a$  is a constant =  $-4.9$
- $v_0$  is the initial velocity
- $h_0$  is the initial height

## Analysis

The SS2 parabolic spaceflight profile shows that the rocket engine cutoff is at a certain Mission Elapsed Time (MET) and height above Mean Sea Level (MSL). This is equivalent to the state a baseball is in at the moment a player releases it into the air.

Plugging that information into the quadratic equation allows us to calculate the time the spacecraft reached maximum altitude, and the maximum altitude itself. All we have to do is find the vertex of the parabola, since that is the point of maximum height. Once we find the time at maximum altitude, we can finally use that to calculate the maximum altitude.

$$\text{vertex}_t = \frac{-v_0}{2a}$$

and

$$\text{vertex}_h = a(\text{vertex}_t)^2 + v_0(\text{vertex}_t) + h_0$$

where

- $\text{vertex}_t$  is the time (after rocket burnout) at maximum height
- $\text{vertex}_h$  is the maximum height

## Example

Let's suppose that the SS2 rocket burnout time is at 110 min MET at an altitude of 135,000 ft MSL with a velocity of 2,600 mph. Will it reach space, which is to say, will it go above 62 miles?

First, as always, we must convert our input into S.I. Units:

$$v_0 = 135,000 \text{ ft} = 41,148 \text{ m}$$

$$h_0 = 2,600 \text{ mph} = 1,162 \text{ mps}$$

$$\text{Space} = 62 \text{ mi} = 100 \text{ km} = 100,000 \text{ m}$$

So,

$$\text{Time of Maximum Altitude} = \text{Rocket Burnout Time} + \text{vertex}_t = 111.98 \text{ min}$$

$$\text{Maximum Altitude} = \text{vertex}_h = 110,027 \text{ m}$$

## Conclusion

As a result of the spacecraft breaking the 100,000 m barrier, the space tourists aboard this particular parabolic spaceflight would have all proudly earned their Astronaut Wings.



# Go where no student has gone before

## S.T.E.M. projects for launching student minds into space

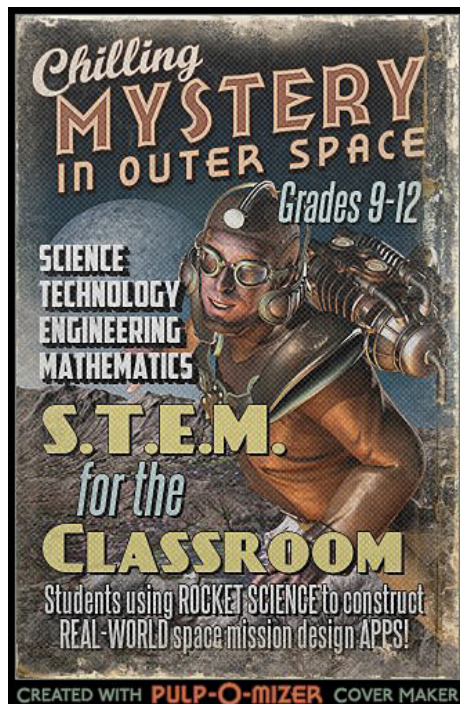
By Joe Maness and Rich Holtzin

Imagine yourself a high school student, say, 9th through 12th grade, taking math courses entailing astronautics or aerospace projects. Most projects usually run about six weeks. You are part of a team of three or four other students and collaboration is imperative. Even though you may have an inherent fear or dislike of higher math, the detailed lesson plans you'll be working with are clear, concise, and cool. The projects also entail the best of the best astronautics and aerospace industries, like Boeing, R.E.L. (Skylon), Bigelow, and Virgin Galactic. There is one more thing about these projects geared mainly to Pre-Algebra, Algebra 1 and 2, and Pre-Calculus: each denotes an exclusive S.T.E.M. problem created for your high school.

Welcome to the world of astronautics and aerospace, where they don't call it rocket science for nothing! What you'll be experiencing is indeed the real McCoy in the guise of a tangible academic exercise.

The above description applies to our S.T.E.M. for the Classroom program. While some advocates for S.T.E.M. projects think or assume students should eventually choose similarly related fields as future employment, we feel differently. In our view, students taking S.T.E.M. courses can choose any line of employment or academic field and still profit from the experience. The cognitive discipline and academics is that exceptional and far reaching!

How did these imaginative projects come about? While most S.T.E.M. projects average just a few days, ours were designed for half-semester or quarters. The intrinsic concept correlates to developing and implementing a robust, comprehensive, and sustainable New Space commercialization program. Moreover, the conviction



that best describes our ideology utilizes reuse and commonality to achieve affordable and profitable spaceflight operations.

Our approach to sustainable rocketry in all aspects was itself influenced by a movie, *October Sky*, released in 1999 (and based on the book, "Rocket Boys," by Homer Hickam). The narrative was centered on a trio of high school students in a backwoods West Virginia coal-mining community, who became interested in launching rockets. One of the students, Homer, grew up to eventually become a NASA engineer, while the other two chose to work in non-S.T.E.M. fields. We were smitten with this film for many reasons. Primarily, we realized its greater potential for seeding minds with elemental constructs for all that follows in life and chosen vocations.

As for the apt title of this article, given the recent successful prototype of our Algebra 2 class during the 2012-2013 school year, those students did indeed boldly go where they never thought they could or would. The courses

to follow, now well beyond the prototype phase, include the aforementioned Pre-Calculus project about to be launched in the fall which will extend through 2014.

Here's an example of one of our new Algebra 2 projects (<http://www.stemfortheclassroom.com/2013/07/the-bell-curve.html>) featuring the portion of the text under "Analysis" could suffice as an insight of what the project entails.

Which brings us to our thesis of teaching: To offer high school students at all Socioeconomic Status (S.E.S) levels engaging S.T.E.M. projects at no cost. All that's needed is an Internet connection, which most schools already provide. Our hands-on projects challenge students to step out of their comfort zone by designing real-world space missions using real-world spacecraft data, thereby gaining a better understanding of all four S.T.E.M. facets. As it turns out, designing and planning a space mission for the projects entails the use of the various mathematical concepts and equations students typically learn in high school classes.

We also boldly set out on this path and wanted to find a way to give back to the community something totally innovative and highly stimulating. Ergo, a pragmatic approach to education that made better sense and would maintain a student's interest. Now that we know the classes thus far taught were so well received by our students, we believe even more in the synergy of our S.T.E.M. concept. Additionally, there can be a 100% success rate for all those students to follow. This claim cannot be fostered by typical testing methods mandated for most school programs!

What is our pragmatic approach given our version of S.T.E.M. projects? While the abstractions of mathematics involved in astronautics and aerospace can be



daunting, only the basics of rocketry equations and mathematics are applied (i.e., algebra, geometry, linear equations, quadratics, square roots, natural logarithms, trigonometry, and pre-calculus). Students will also be required to develop a space mission app using a spreadsheet, develop a slide show using presentation software, embed said documents in a website that they build, and then demonstrate everything in a presentation done in front of their class.

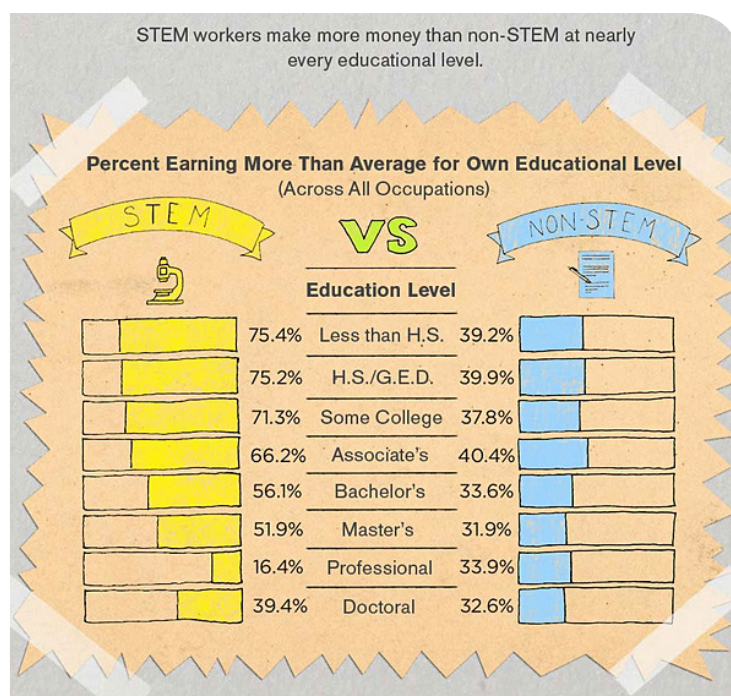
But let's consider where bold students are indeed going and what they think about these projects ahead of them. In short, how do they feel about undertaking such projects? The usual and invariable questions from most students are, "Why do we have to do all this extra work?" and "Why do we have to do all of this S.T.E.M. stuff anyway?" Some might even exclaim, "This is so lame; so not me!"

While we have no answer for the last statement, a legitimate explanation does exist for the other two questions we struck upon while conducting our research. It still shows that the more S.T.E.M. projects that students can be exposed to, the better their earning potential, regardless the education level or occupation.

Having said all of that, we have to acknowledge that there may be legitimate arguments that many schools place too much emphasis on S.T.E.M. projects and not enough on the Humanities or Social Studies or other non-S.T.E.M. academic disciplines. We also agree that those subjects are an integral part of a well-rounded education. The adage, "One cannot learn or do mathematics if one cannot read first" is certainly true.

However, in our defense as an astronautics-based organization, it is natural for us to focus on S.T.E.M.

projects. We also revere the value of practical education on all levels. This is why we press on with myriad and distinctive learning convictions along such lines, and not just reliance on continued testing that we feel is too rampant in our schools today. For those who say that our society focuses too much on education as a way to get a high paying job instead of a viable reward unto itself, we wholeheartedly concur. The focus on money in our society has also led to questionable behavior on the part of the few that affect the many.



Partial infographic from [www.onlineengineeringdegree.com/stem-shortage/](http://www.onlineengineeringdegree.com/stem-shortage/)

Likewise, we believe in the Star Trek scenario, where you do a job because you like the job and because you can grow as a human being, not because of how much it pays. This is why we try to make our S.T.E.M. projects stimulating even if we do have a warped sense of what's fun (all Star Trek puns intended). Besides, most of the students who completed the prototype courses said they had fun working out the parameters of each project. Imagine that: students actually enjoying doing math! Live long and work the problems, indeed!

One final note worth repeating: we are not trying to encourage every student to go into S.T.E.M. related fields. On the contrary, we feel that exposing students to empirically-based projects provides for a well-rounded education, regardless what direction they go after High School. We want to help the teacher to encourage students to look beyond the textbook and to achieve something real-world that often lies outside a student's comfort zone. This way students will always bring their particular talent to the projects, whether it involves art, writing, history, or any other academic subject.

Conclusion: S.T.E.M. for the Classroom's site list featured on our website ([www.stemforthe classroom.com](http://www.stemforthe classroom.com)) is only the start of our current offerings geared to a High School level of education. Namely, Pre-Calculus-Astronautics projects (conceived for Boeing, in four six-week units), and Pre-Algebra, Algebra 1 and 2-Aerospace projects. These single unit projects (about six-weeks) feature parabolic spaceflight (conceived for Virgin Galactic), orbital spaceflight (conceived for R.E.L.), a space station design (conceived for Bigelow), and spacecraft

landing (conceived for Spaceport America, near Las Cruces, New Mexico). These URLs reveal the entire presentation for students, but also provide a specific lesson plan for teachers.

In short, we worked out everything for any math teacher who is willing to put forth a little effort to take his or her students higher, literally. Other future S.T.E.M. projects are also listed, including plans to introduce Elementary and Secondary levels of a similar nature, meaning all these envisioned projects are intended for above and beyond the earth's atmosphere.



# Students learn about physics from energetic demonstrations

Middle school student Nina-Simone Brown had the chance to experience Newton's third law of motion in an exciting yet unusual way Monday morning.

For those who dozed off in their middle school science class: For every action there is an opposite and equal reaction.

And there was plenty of action when FMA Live! Forces in Motion swept into Hardy Middle School's gym Monday, bringing Newton's three laws of motion and the law of universal gravity to life in a performance with hip-hop music and moves, bright lights and live science demonstrations. Short videos featured Sir Isaac Newton (1643-1727) channeling his explanation of the laws through an actor.

Nina-Simone, 13, and her partner faced off against two other Hardy eighth graders in a dunk-tank contest – Hardy Assistant Principal Loren Brody sat underneath a tank of applesauce.

The students used giant slingshots to aim blue and red balls – called apples – at a target to release the tank of applesauce onto Brody.

"It was all about the reaction when you hit the target," Nina-Simone said. "I think my favorite part was my part because I got to see my assistant principal get drenched in applesauce. And I was the one to hit the target to make it fall, so it was pretty cool."

The FMA in the program's title stands for force = mass X acceleration. The program is a partnership between Honeywell Hometown Solutions, the charitable arm to Honeywell, the technology invention



With the help of a student participant, "FMA Live!" crew members explain Newton's first law of motion at Hardy Middle School in Washington on Sept. 16th, 2013. "FMA Live!" travels across the country and has reached nearly 300,000 students. Image: NASA/Jay Westcott

and manufacturing company, and NASA.

The program is part of NASA and Honeywell's strategy to encourage more students to think about careers in STEM – science, technology, engineering and math.

Leland Melvin, NASA's associate administrator for education and a former astronaut and pro football player, said to get students motivated about science and math education, you first have to catch their attention and get them interested. Melvin made two trips to the International Space Station, in 2008 and 2009. He majored in chemistry and later earned a master's degree in materials science engineering.

"Once they're interested, they get inspired, they take the harder classes, they believe they can do it when they see people hip-hop dancing and singing and moving to the beats that they do now," Melvin said. "So you bridge this social side, this entertainment side, with the hardcore engineering side, and they're merged together and they believe they can do it."

He said part of his job is to merge private industries, government agencies and the education system to focus on interesting students in math and science and to help them succeed in college.

"We're in one big happy family together to make sure that we don't lose kids to dropping out of school, not believing in themselves, and women and minorities not believing they can do STEM," Melvin said. "So these are always ways we can work together as a family to get that STEM pipeline going."

Patricia Pride, Hardy principal, said students have been in class for about three weeks and have begun learning about lab work and the scientific method.

"I think this will be more of a precursor for the year," Pride said. "The programming aligns pretty well with the common core curriculum and just the middle school science curriculum as is."

Honeywell Hometown Solutions President Tom Buckmaster said with 70 percent of American students below target proficiency levels for

Authored by Jessica Wray,  
this article appeared first  
at [www.SHFWire.com](http://www.SHFWire.com).





A teacher gets dunked with apple sauce (top photo) during a performance of "FMA Live!" at Hardy Middle School in Washington on Monday, Sept. 16. With the help of a student participant (bottom photo), "FMA Live!" crew members explain Newton's second law of motion during the same performance. "FMA Live!" is a program sponsored by NASA and Honeywell that teaches Newton's three laws of motion mixed with dance and music.

*Images: NASA/Jay Westcott*

science and math, it's become vital to get children interested and excited about the subjects.

"We thought about what it would take to enliven the classroom, create a more dynamic conversation, empower teachers, create excitement among students, and we landed on a concept of an old-fashioned traveling road show that was updated to be hip-hop and powerful and high energy," Buckmaster said.

Pride, who taught science for 11 years, said programs and action

shows like FMA Live! help students see the relevance of the science they're learning with real-life application.

"It gives some excitement, it gives some energy to what some students unfortunately would think of as 'Oh, my gosh. I've got to go to science class,' and it really puts things – like it says – in motion," she said.

The show at Hardy was the first of a planned 30-show tour. The next stop is Philadelphia.

For more information about FMA Live!, visit: [www.fmalive.com](http://www.fmalive.com).

## NASA chooses Hampton Roads school team for microgravity experiment

Students at the New Horizons Governor's School for Science and Technology (GSST) in Hampton, Va., will have the chance to design a microgravity experiment that may some day fly on board the International Space Station (ISS).

GSST was one of 14 schools across the country picked for the opportunity by the High school students United with NASA to Create Hardware (HUNCH) Extreme Science Program, based at NASA's Johnson Space Center in Houston. The first step in the process is to determine what sort of experiment might meet the needs of the ISS.

After they come up with the concept local students will design, fabricate and document their idea. Then comes the real exciting part - to help make sure their experiment works in space's weightless environment, three of the students and a teacher will fly with their project onboard the Zero Gravity Corporation's G-Force One plane. That is scheduled to happen in April of next year at Ellington Field in Houston.

The local HUNCH program, which is run by the Engineering Directorate at NASA's Langley Research Center also in Hampton, has partnered with more than a half dozen local schools to fabricate real-world products for NASA and put students' science, technology, engineering and mathematics (STEM) skills to good use.

The Governor's School for Science and Technology serves the approximately 490,000 residents of the Virginia peninsula, from the Chesapeake Bay to Williamsburg.

For more information about the NASA HUNCH program, visit: [www.nasahunch.com/](http://www.nasahunch.com/).



## Deep Impact comet hunter mission comes to an end

After almost 9 years in space that included an unprecedented July 4th impact and subsequent flyby of a comet, an additional comet flyby, and the return of approximately 500,000 images of celestial objects, NASA's Deep Impact mission has ended.

The project team at NASA's Jet Propulsion Laboratory in Pasadena, Calif., has reluctantly pronounced the mission at an end after being unable to communicate with the spacecraft for over a month. The last communication with the probe was Aug. 8. Deep Impact was history's most traveled comet research mission, going about 4.7 billion miles (7.58 billion kilometers).

"Deep Impact has been a fantastic, long-lasting spacecraft that has produced far more data than we had planned," said Mike A'Hearn, the Deep Impact principal investigator at the University of Maryland in College Park. "It has revolutionized our understanding of comets and their activity."

Deep Impact successfully completed its original bold mission of six months in 2005 to investigate both the surface and interior composition of a comet, and a subsequent extended mission of another comet flyby and observations of planets around other stars that lasted from July 2007 to December 2010. Since then, the spacecraft has been continually used as a space-borne planetary observatory to capture images and other scientific data on several targets of opportunity with its telescopes and instrumentation.

Launched in January 2005, the spacecraft first traveled about 268 million miles (431 million kilometers) to the vicinity of comet Tempel 1. On July 3, 2005, the spacecraft deployed an impactor into the path of comet to essentially be run over by its nucleus on July 4. This caused material from below the comet's surface to be blasted out into space where it could be examined by the telescopes and instrumentation of the flyby spacecraft. Sixteen days after that comet encounter, the Deep Impact team placed the spacecraft on a trajectory to fly back past Earth in late December 2007 to put it on course to encounter another comet, Hartley 2 in November 2010.

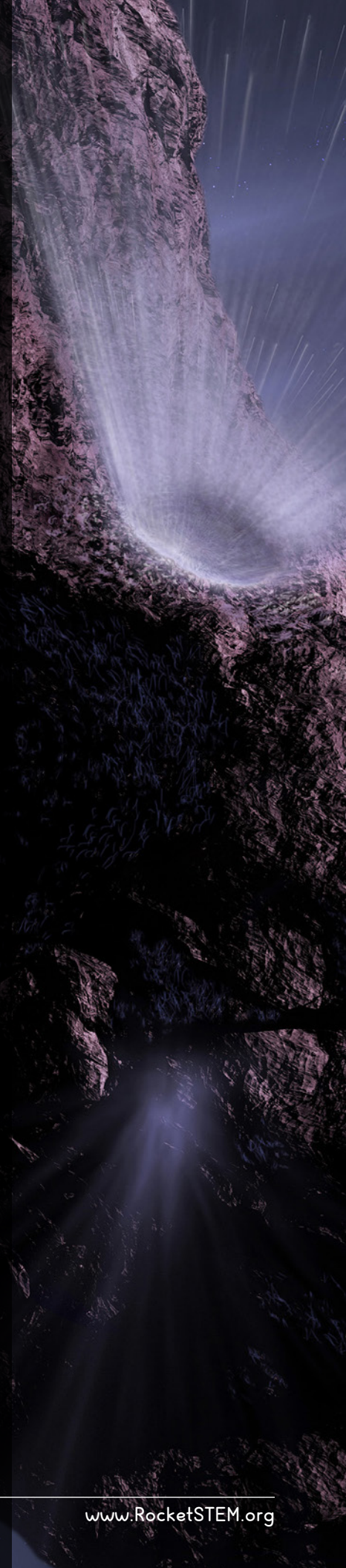
"Six months after launch, this spacecraft had already completed its planned mission to study comet Tempel 1," said Tim Larson, project manager of Deep Impact at JPL. "But the science team kept finding interesting things to do, and through the ingenuity of our mission team and navigators and support of NASA's Discovery Program, this spacecraft kept it up for more than eight years, producing amazing results all along the way."

The spacecraft's extended mission culminated in the successful flyby of comet Hartley 2 in 2010. Along the way, it also observed six different stars to confirm the motion of planets orbiting them, and took images and data of Earth, the Moon and Mars. These data helped to confirm the existence of water on the moon, and attempted to confirm the methane signature in the atmosphere of Mars.

In January 2012, Deep Impact performed imaging and accessed the composition of distant comet C/2009 P1 (Garradd). It took images of comet ISON this year and collected early images of ISON in June.

After losing contact with the spacecraft last month, mission controllers spent several weeks trying to uplink commands to reactivate its onboard systems.

"Despite this unexpected final curtain call, Deep Impact already achieved much more than ever was envisioned," said Lindley Johnson, the Discovery Program Executive at NASA Headquarters, and the Program Executive for the mission since a year before it launched. "Deep Impact has completely overturned what we thought we knew about comets and also provided a treasure trove of additional planetary science that will be the source data of research for years to come."





# comet

*noun*

a celestial object consisting of a nucleus of ice and dust and, when near the sun, a "tail" of gas and dust particles pointing away from the sun.



*Image: NASA/JPL/Univ. of Maryland/Pat Rawlings*



# FINDERs keepers: Technology developed for outer space is saving lives on Earth

By Nicole Solomon

When natural disasters topple buildings, search and rescue teams immediately set to work freeing victims trapped beneath the wreckage. Speed is of the essence. The sooner victims are located, the greater the chance of a successful rescue.

The Department of Homeland Security and NASA's Jet Propulsion Laboratory have developed a new radar-based technology dubbed "Finding Individuals for Disaster and Emergency Response" (FINDER), to aid in detecting victims buried in rubble.

FINDER is based on the technology NASA's Deep Space Network uses to monitor the movements and location of its spacecraft millions of miles away.

"FINDER is bringing NASA technology that explores other planets to the effort to save lives on ours," said Mason Peck, chief technologist for NASA and principal advisor on technology policy and programs. "This is a prime

example of intergovernmental collaboration and expertise that has a direct benefit to the American taxpayer."

The state-of-the-art device uses low-power microwave radar waves to detect the heartbeat or breathing of victims, even through 30 feet of concrete and steel. FINDER can locate people in the wreckage even if they are unconscious. Best of all, the unit is small and lightweight, making it optimal for any sort of disaster scenario.

"It's a small but very powerful piece of technology," said Peck.

"This is a great project to work on," said James Lux, task manager for FINDER at JPL. "A lot of things we do at NASA are very complex and hard to explain, but this project is simple and has great results. To be contributing to something that is going to save lives is really neat. That's what I'm in business for."

The sponsoring agency for the demonstration was the Fairfax County Fire and Rescue Department. For more information, visit: [www.fairfaxcounty.gov/fr](http://www.fairfaxcounty.gov/fr) and [www.firstresponder.gov](http://www.firstresponder.gov).



Jim Lux, JPL Task Manager for FINDER (top photo) and Mason Peck, Chief Technologist for NASA (bottom), discusses the prototype technology during a demonstration of the device at the Virginia Task Force 1 Training Facility.

Images: Nicole Solomon





## Expedition 36 Soyuz landing

The Soyuz TMA-08M spacecraft with Expedition 36 Commander Pavel Vinogradov, Flight Engineer Alexander Misurkin and Flight Engineer Chris Cassidy (sitting far left) landed in a remote area of Kazakhstan on Sept. 11. They returned to Earth after five and a half months serving aboard the ISS.

*Images: NASA/Bill Ingalls*





## Expedition 37 launch

The Soyuz TMA-10M rocket launched from the Baikonur Cosmodrome in Kazakhstan on Sept. 26, carrying Soyuz Commander Oleg Kotov, NASA Flight Engineer Michael Hopkins (left, middle) and Russian Flight Engineer Sergei Ryazansky to the ISS. Their Soyuz rocket launched at 2:58 a.m. local time.

*Images: NASA/Carla Cioffi*