Space News Update

— February 17, 2017 —

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1. NASA’s Juno Mission to Remain in Current Orbit at Jupiter

NASA’s Juno mission to Jupiter, which has been in orbit around the gas giant since July 4, 2016, will remain in its current 53-day orbit for the remainder of the mission. This will allow Juno to accomplish its science goals, while avoiding the risk of a previously-planned engine firing that would have reduced the spacecraft’s orbital period to 14 days.

“Juno is healthy, its science instruments are fully operational, and the data and images we’ve received are nothing short of amazing,” said Thomas Zurbuchen, associate administrator for NASA’s Science Mission Directorate in Washington. “The decision to forego the burn is the right thing to do – preserving a valuable asset so that Juno can continue its exciting journey of discovery.”

Juno has successfully orbited Jupiter four times since arriving at the giant planet, with the most recent orbit completed on Feb. 2. Its next close flyby of Jupiter will be March 27.

The orbital period does not affect the quality of the science collected by Juno on each flyby, since the altitude over Jupiter will be the same at the time of closest approach. In fact, the longer orbit provides new opportunities that allow further exploration of the far reaches of space dominated by Jupiter’s magnetic field, increasing the value of Juno’s research.

During each orbit, Juno soars low over Jupiter’s cloud tops – as close as about 2,600 miles (4,100 kilometers). During these flybys, Juno probes beneath the obscuring cloud cover and studies Jupiter’s auroras to learn more about the planet's origins, structure, atmosphere and magnetosphere.

The original Juno flight plan envisioned the spacecraft looping around Jupiter twice in 53-day orbits, then reducing its orbital period to 14 days for the remainder of the mission. However, two helium check valves that are part of the plumbing for the spacecraft’s main engine did not operate as expected when the propulsion system was pressurized in October. Telemetry from the spacecraft indicated that it took several minutes for the valves to open, while it took only a few seconds during past main engine firings.

“During a thorough review, we looked at multiple scenarios that would place Juno in a shorter-period orbit, but there was concern that another main engine burn could result in a less-than-desirable orbit,” said Rick Nybakken, Juno project manager at NASA’s Jet Propulsion Laboratory (JPL) in Pasadena, California. “The bottom line is a burn represented a risk to completion of Juno’s science objectives.”

Juno’s larger 53-day orbit allows for “bonus science” that wasn’t part of the original mission design. Juno will further explore the far reaches of the Jovian magnetosphere – the region of space dominated by Jupiter’s magnetic field – including the far magnetotail, the southern magnetosphere, and the magnetospheric boundary region called the magnetopause. Understanding magnetospheres and how they interact with the solar wind are key science goals of NASA’s Heliophysics Science Division.

"Another key advantage of the longer orbit is that Juno will spend less time within the strong radiation belts on each orbit,” said Scott Bolton, Juno principal investigator from Southwest Research Institute in San Antonio. “This is significant because radiation has been the main life-limiting factor for Juno.”

Juno will continue to operate within the current budget plan through July 2018, for a total of 12 science orbits. The team can then propose to extend the mission during the next science review cycle. The review process evaluates proposed mission extensions on the merit and value of previous and anticipated science returns.

The Juno science team continues to analyze returns from previous flybys. Revelations include that Jupiter's magnetic fields and aurora are bigger and more powerful than originally thought and that the belts and zones that give the gas giant’s cloud top its distinctive look extend deep into the planet’s interior. Peer-reviewed papers with more in-depth science results from Juno’s first three flybys are expected to be published within the next few months. In addition, the mission's JunoCam – the first interplanetary outreach camera – is now being guided with assistance from the public. People can participate by voting on which features on Jupiter should be imaged during each flyby.

“Juno is providing spectacular results, and we are rewriting our ideas of how giant planets work,” said Bolton. “The science will be just as spectacular as with our original plan.”

JPL manages the Juno mission for NASA. The mission’s principal investigator is Scott Bolton at Southwest Research Institute in San Antonio. The Juno mission is part of the New Frontiers Program managed by NASA's Marshall Space Flight Center in Huntsville, Alabama, for the Science Mission Directorate. Lockheed Martin Space Systems, Denver, built the spacecraft. JPL is managed for NASA by Caltech in Pasadena, California.

More information on the Juno mission is available at http://www.nasa.gov/juno and http://missionjuno.org

Follow the mission on Facebook and Twitter at http://www.facebook.com/NASAJuno or http://www.twitter.com/NASAJuno

Source: NASA Return to Contents

2. Dawn Discovers Evidence for Organic Material on Ceres

NASA's Dawn mission has found evidence for organic material on Ceres, a dwarf planet and the largest body in the main asteroid belt between Mars and Jupiter. Scientists using the spacecraft's visible and infrared mapping spectrometer (VIR) detected the material in and around a northern-hemisphere crater called Ernutet. Organic molecules are interesting to scientists because they are necessary, though not sufficient, components of life on Earth.

The discovery adds to the growing list of bodies in the solar system where organics have been found. Organic compounds have been found in certain meteorites as well as inferred from telescopic observations of several asteroids. Ceres shares many commonalities with meteorites rich in water and organics -- in particular, a meteorite group called carbonaceous chondrites. This discovery further strengthens the connection between Ceres, these meteorites and their parent bodies.

"This is the first clear detection of organic molecules from orbit on a main belt body," said Maria Cristina De Sanctis, lead author of the study, based at the National Institute of Astrophysics, Rome**.** The discovery is reported in the journal Science.

Data presented in the Science paper support the idea that the organic materials are native to Ceres. The carbonates and clays previously identified on Ceres provide evidence for chemical activity in the presence of water and heat. This raises the possibility that the organics were similarly processed in a warm water-rich environment.

Significance of organics

The organics discovery adds to Ceres' attributes associated with ingredients and conditions for life in the distant past. Previous studies have found hydrated minerals, carbonates, water ice, and ammoniated clays that must have been altered by water. Salts and sodium carbonate, such as those found in the bright areas of Occator Crater, are also thought to have been carried to the surface by liquid.

“This discovery adds to our understanding of the possible origins of water and organics on Earth,” said Julie Castillo-Rogez, Dawn project scientist based at NASA's Jet Propulsion Laboratory in Pasadena, California.

Where are the organics?

The VIR instrument was able to detect and map the locations of this material because of its special signature in near-infrared light.

The organic materials on Ceres are mainly located in an area covering approximately 400 square miles (about 1,000 square kilometers). The signature of organics is very clear on the floor of Ernutet Crater, on its southern rim and in an area just outside the crater to the southwest. Another large area with well-defined signatures is found across the northwest part of the crater rim and ejecta. There are other smaller organic-rich areas

several miles (kilometers) west and east of the crater. Organics also were found in a very small area in Inamahari Crater, about 250 miles (400 kilometers) away from Ernutet.

In enhanced visible color images from Dawn's framing camera, the organic material is associated with areas that appear redder with respect to the rest of Ceres. The distinct nature of these regions stands out even in low-resolution image data from the visible and infrared mapping spectrometer.

"We're still working on understanding the geological context for these materials," said study co-author Carle Pieters, professor of geological sciences at Brown University, Providence, Rhode Island.

Next steps for Dawn

Having completed nearly two years of observations in orbit at Ceres, Dawn is now in a highly elliptical orbit at Ceres, going from an altitude of 4,670 miles (7,520 kilometers) up to almost 5,810 miles (9,350 kilometers). On Feb. 23, it will make its way to a new altitude of around 12,400 miles (20,000 kilometers), about the height of GPS satellites above Earth, and to a different orbital plane. This will put Dawn in a position to study Ceres in a new geometry. In late spring, Dawn will view Ceres with the sun directly behind the spacecraft, such that Ceres will appear brighter than before, and perhaps reveal more clues about its nature.

The Dawn mission is managed by JPL for NASA's Science Mission Directorate in Washington. Dawn is a project of the directorate's Discovery Program, managed by NASA's Marshall Space Flight Center in Huntsville, Alabama. UCLA is responsible for overall Dawn mission science. Orbital ATK Inc., in Dulles, Virginia, designed and built the spacecraft. The German Aerospace Center, Max Planck Institute for Solar System Research, Italian Space Agency and Italian National Astrophysical Institute are international partners on the mission team. For a complete list of mission participants, visit:

http://dawn.jpl.nasa.gov/mission

More information about Dawn is available at the following sites:

http://www.nasa.gov/dawn

http://dawn.jpl.nasa.gov

Source: NASA Return to Contents

3. Radial Acceleration Relation Holds in All Common Types of Galaxies

The distribution of normal matter precisely determines gravitational acceleration in all common types of galaxies, a team led by Case Western Reserve University researchers reports.

The team has shown this radial acceleration relation exists in nearby high-mass elliptical and low-mass spheroidal galaxies, building on last year's discovery of this relation in spiral and irregular galaxies. This provides further support that the relation is tantamount to a new natural law, the researchers say.

"This demonstrates that we truly have a universal law for galactic systems," said Federico Lelli, formerly an astronomy postdoctoral fellow at Case Western Reserve University and currently a fellow at the European Southern Observatory.

"This is similar to the Kepler law for planetary systems, which does not care about the specific properties of the planet. Whether the planet is rocky like Earth or gaseous like Jupiter, the law applies," said Lelli, who led this investigation.

In this case, the observed acceleration tightly correlates with the gravitational acceleration from the visible mass, no matter the type of galaxy. In other words, if astronomers measure the distribution of normal matter, they know the rotation curve, and vice versa.

"But it is still unclear what this relation means and what is its fundamental origin," Lelli said.

The study is published online in Astrophysical Journal today. Co-authors are Stacy McGaugh, chair of the Department of Astronomy at Case Western Reserve, James Schombert, astronomy professor at the University

of Oregon, and Marcel Pawlowski, former astronomy postdoctoral researcher at Case Western Reserve and current Hubble fellow at the University of California, Irvine.

The researchers found that in 153 spiral and irregular galaxies, 25 ellipticals and lenticulars, and 62 dwarf spheroidals, the observed acceleration tightly correlates with the gravitational acceleration expected from visible mass.

Observed deviations from this correlation are not related to any specific galaxy property but completely random and consistent with measurement errors, the team found.

Challenges Result

The tightness of this relation is difficult to understand in terms of dark matter as it's currently understood, the researchers said.

It also challenges the current understanding of galaxy formation and evolution, in which many random processes such as galaxy mergers and interactions, inflows and outflows of gas, star formation and supernovas, occur at the same time.

"Regularity must somehow emerge from this chaos," Lelli said.

To make their discovery, researchers combined different tracers of the centripetal acceleration found in different types of galaxies, from which they made 1-to-1 comparisons.

The kinematical tracers were cold gas in spiral and irregular galaxies, stars or hot gas in ellipticals and lenticulars, and individual giant stars in dwarf spheroidals.

The investigation included so-called ultra-faint dwarf spheroidal galaxies, but due to their lack of light -- which makes them hard to study -- the researchers can't confidently offer a clear interpretation of the radial acceleration relation in these.

Nevertheless, the growing proof of the relation, or natural law, requires new thinking about dark matter and gravity, the researchers said.

"Within the standard dark-matter paradigm, this law implies that the visible matter and the dark matter must be tightly coupled in galaxies at a local level and independently on global properties. They must know about each other," Lelli said. "Within alternative models like modified gravity, this law represents a key empirical constraint and may guide theoretical physicists to build some appropriate mathematical extension of Einstein's general relativity."

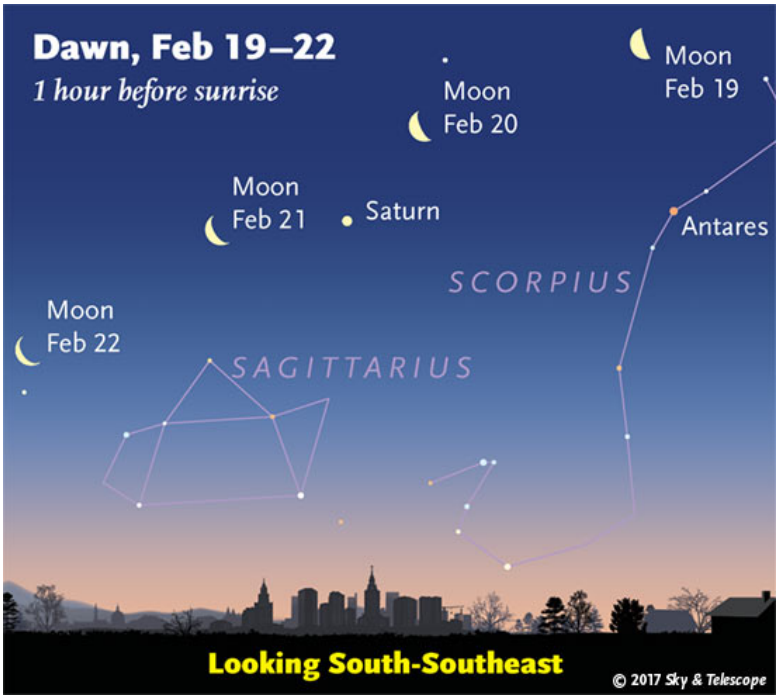
The team's research so far has focused on galaxies in the nearby universe. Lelli and his colleagues plan to test the relation in more distant galaxies, just a few billion years after the Big Bang. They are hoping to learn whether the same relation holds during the lifetime of the universe.

Source: Spaceref.com Return to Contents

The Night Sky

Friday, February 17

• The Big Dipper stands on its handle in the northeast around 9 p.m. In the northwest, Cassiopeia also stands on end at about the same height. As spring approaches, the Dipper will rise higher and Cassiopeia will move lower.



Saturday, February 18

• Last-quarter Moon (exact at 2:33 p.m.). Before dawn on Sunday the 19th, look for the Moon in the south-southeast, as shown here. Antares and upper Scorpius are below and to the lower right of it, respectively. Saturn is farther to the Moon's lower left.

Sunday, February 19

• On Monday and Tuesday mornings the 20th and 21st, you'll find Saturn glowing steadily near the waning Moon, as shown here.

• This is the time of year when Orion stands highest in early evening. So does Lepus the Hare under his feet! Explore the telescopic deep-sky sights around Lepus's ears (just below Rigel) with Sue French's Deep-Sky Wonders article, chart and photos in the February *Sky & Telescope*, page 54.

Monday, February 20

• Right after dark, bright Capella crosses near the zenith. Face northwest at that time and look 20° down from Capella. The brightest star there is Alpha Persei (Mirfak). Around and upper left of it is the Perseus OB1 Association, a loose swarm of modestly bright stars about the size of your thumbtip at arm's length. They show well in binoculars.

• Ten degrees north of Alpha Persei, and 8° west of the Perseus Double Cluster, is an interesting binocular star cluster that wasn't even recognized as such until the mid-1950s. It wasn't brought to amateurs' attention until 1977 (though some of us had noticed it independently!). Today it's known as Pazmino's Cluster, a.k.a. Stock 23. See Mathew Wedel's Binocular Highlight column and chart for this and other clusters overshadowed by the famous Double Cluster in the February *Sky & Telescope*, page 43.

Source: Sky & Telescope

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ISS Sighting Opportunities

For Denver:

Date	Visible	Max Height	Appears	Disappears
Sat Feb 18, 6:33 PM	< 1 min	11°	11° above SW	10° above SSW

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

NASA-TV Highlights

(all times Eastern Daylight Time)

Friday, February 17

6 p.m., Replay of the "What's On-Board" Science Briefing for CRS-10 Mission (all channels)

8 p.m., Replay of the Prelaunch News Conference for CRS-10 Mission (all channels)

9 p.m., Replay of the NASA News Briefing on Launch Complex 39A (all channels)

Saturday, February 18

4 a.m., Replay of the "What's On-Board" Science Briefing for CRS-10 Mission (all channels)

5:30 a.m., Replay of the Prelaunch News Conference for CRS-10 Mission (all channels)

6:30 a.m., Replay of the NASA News Briefing on Launch Complex 39A (all channels)

7:30 a.m., NASA EDGE: Live Pre-Launch Program on SAGE-III Mission (NTV-1 (Public))

8:30 a.m., CRS-10 Launch Commentary (all channels)

12 p.m., CRS-10 Mission Post-Launch News Conference (all channels)

2 p.m., Replay of the CRS-10 Mission Post-Launch News Conference (all channels)

6 p.m., Replay of the CRS-10 Mission Post-Launch News Conference (all channels)

Monday, February 20

7:30 a.m., Rendezvous and Capture of the SpaceX CRS-10 Dragon Cargo Craft at the ISS (Grapple is scheduled at 9 a.m.) (all channels)

11:30 a.m., Coverage of the Installation of the SpaceX CRS-10 Dragon Craft on the ISS (all channels)

Watch NASA TV on the Net by going to the NASA website.

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Space Calendar

- Feb 17 - Cassini, Distant Flyby of Titan
- Feb 17 - Comet 73P-BN/Schwassmann-Wachmann Perihelion (0.976 AU)
- Feb 17 - Comet 188P/LINEAR-Mueller Perihelion (2.565 AU)
- Feb 17 - Comet 316P/LONEOS-Christensen At Opposition (2.988 AU)
- Feb 17 - Comet C/2016 A1 (PANSTARRS) Closest Approach To Earth (4.795 AU)
- Feb 17 - Apollo Asteroid 2017 BW Near-Earth Flyby (0.012 AU)
- Feb 17 - Asteroid 61189 Ohsadaharu Closest Approach To Earth (1.687 AU)
- Feb 17 - Asteroid 9357 Venezuela Closest Approach To Earth (2.011 AU)
- Feb 17 - Asteroid 9860 Archaeopteryx Closest Approach To Earth (2.394 AU)
- Feb 17 - Asteroid 1537 Transylvania Closest Approach To Earth (2.555 AU)
- Feb 17 - 40th Anniversary (1977), Discovery of Life Living at Geothermal Vents on Pacific Ocean Floor
- Feb 18 - UPDATED [Feb 17] Dragon CRS-10/ SAGE 3/ ALTAIR 1 Falcon 9 Launch (ISS)
- Feb 18 - Comet 73P-BO/Schwassmann-Wachmann Perihelion (0.975 AU)
- Feb 18 - Comet 73P-AU/Schwassmann-Wachmann Closest Approach To Earth (1.491 AU)
- Feb 18 - Comet 300P/Catalina At Opposition (3.406 AU)
- Feb 18 - Asteroid 14 Irene At Opposition (8.5 Magnitude)
- Feb 18 - Apollo Asteroid 2016 CA138 Near-Earth Flyby (0.059 AU)
- Feb 18 - Amor Asteroid 2017 BL123 Near-Earth Flyby (0.095 AU)
- Feb 18 - Asteroid 85047 Krakatau Closest Approach To Earth (1.111 AU)
- Feb 18 - Kuiper Belt Object 55565 (2002 AW197) At Opposition (44.641 AU)
- Feb 18 - Octave Chanute's 185th Birthday (1832)
- Feb 18 - Baha ad-din al-Amili's 470th Birthday (1547)
- Feb 19 - Comet 73P-AK/Schwassmann-Wachmann Closest Approach To Earth (1.485 AU)
- Feb 19 - Comet P/2016 A2 (Christensen) Closest Approach To Earth (3.474 AU)
- Feb 19 - NEW [Feb 17] Comet 66P/du Toit At Opposition (3.731 AU)
- Feb 19 - Dwarf Planet Ceres Occults TYC 0631-01025-1 (12.1 Magnitude Star)
- Feb 19 - Asteroid 15 Eunomia At Opposition (8.9 Magnitude)
- Feb 19 - Asteroid 149244 Kriegh Closest Approach To Earth (1.181 AU)
- Feb 19 - Asteroid 9000 Hal Closest Approach To Earth (1.673 AU)
- Feb 19 - Asteroid 2169 Taiwan Closest Approach To Earth (1.775 AU)
- Feb 19 - Asteroid 4169 Celsius Closest Approach To Earth (2.687 AU)
- Feb 19 - Klim Churyumov's 80th Birthday (1937)
- Feb 19 - Joseph Kerwin's 85th Birthday (1932)
- Feb 20 - Comet P/2017 A2 (PANSTARRS) Closest Approach To Earth (1.687 AU)
- Feb 20 - Comet 330P/Catalina Closest Approach To Earth (2.271 AU)
- Feb 20 - Comet 147P/Kushida-Muramatsu Closest Approach To Earth (2.320 AU)
- Feb 20 - Comet 219P/LINEAR Perihelion (2.365 AU)
- Feb 20 - Comet P/2007 S1 (Zhao) At Opposition (3.163 AU)
- Feb 20 - Asteroid 9770 Discovery Closest Approach To Earth (1.085 AU)
- Feb 20 - Atira Asteroid 2010 XB11 Closest Approach To Earth (1.155 AU)
- Feb 20 - Asteroid 1284 Latvia Closest Approach To Earth (1.668 AU)
- Feb 20 - Asteroid 3131 Mason-Dixon Closest Approach To Earth (1.844 AU)
- Feb 20 - Asteroid 224693 Morganfreeman Closest Approach To Earth (2.232 AU)
- Feb 20 - Asteroid 1877 Marsden Closest Approach To Earth (3.650 AU)
- Feb 20 - Kuiper Belt Object 148209 (2000 CR105) At Opposition (60.058 AU)
- Feb 20 - 15th Anniversary (2002), San Michele Meteorite Fall (Hit Building in Italy)
- Feb 20 - 20th Anniverary (1997), Galileo, Europa 6 Flyby

Source: JPL Space Calendar

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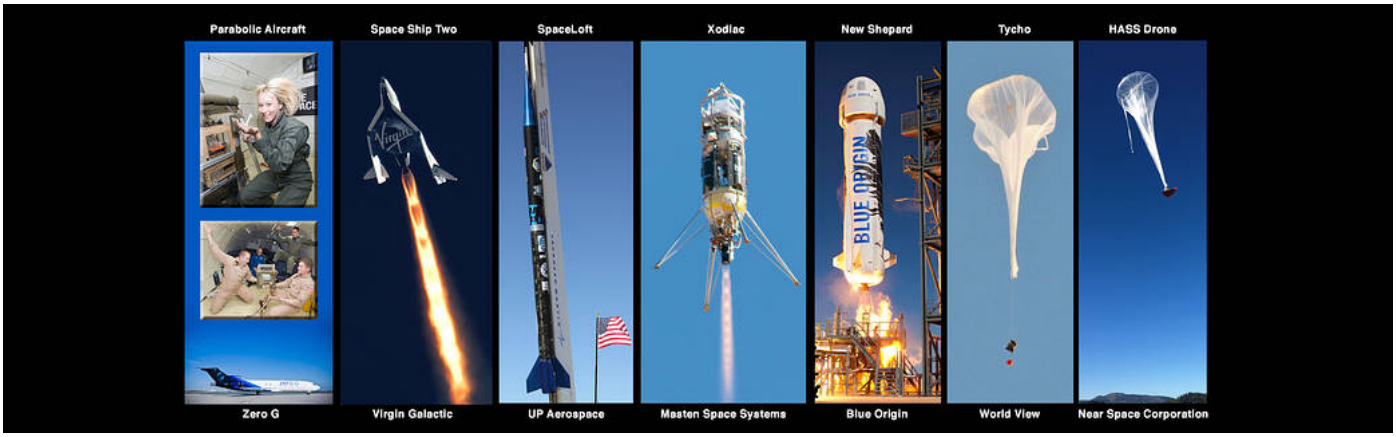
Food for Thought

NASA Selects New Technologies for Flight Tests for Future Space Exploration



NASA has selected five space technologies to test on low-gravity-simulating aircraft, high-altitude balloons or suborbital rockets. The opportunity to fly on these vehicles helps advance technologies closer to practical use by taking them from a laboratory environment to the real world.

The selections were made for NASA's Flight Opportunities program which organizes chances to fly and selects experiments for NASA support twice each year. The program selects promising space technologies to test through relatively low-cost ways that simulate spaceflight or just reach the edge of "space" on commercial suborbital launch vehicles, reduced gravity aircraft and high-altitude balloon flights.

"These selections allow companies and academia to demonstrate technologies of interest to NASA in a much more realistic environment than what they could get in ground-based simulation facilities," said Stephan Ord, the program technology manager for NASA's Flight Opportunities program. "This program is a valuable platform for NASA to mature cutting-edge technologies that have the potential of supporting future agency mission needs."

Two topics were included in this call for research. Under the first topic, which requested demonstration of space technology payloads, NASA selected four proposals:

- **Protein-Drop Pinning in Microgravity**
  Amir Hirsa, principal investigator, Rensselaer Polytechnic Institute, Troy, New York
  Demonstration of a system for maintaining protein solutions in liquid samples involved in the study of diseases such as Parkinson's and Alzheimer's without using a container, which often influences scientific measurements.
- **Rapid Calibration of Space Solar Cells in Suborbital Environments**
  Justin Lee, principal investigator, The Aerospace Corporation, Los Angeles
  Demonstration of an automated solar cell calibration platform, using a device attached to a high-altitude balloon to capture the solar spectrum and characterize the performance of the solar cells at high altitude up to 22 miles.
- **Guided Parafoil High Altitude Research II**
  Garrett "Storm" Dunker, principal investigator, Airborne Systems, Pennsauken, New Jersey
  Demonstration of a new parafoil design that can be used for precision delivery or mid-air retrieval of scientific payloads, tested from a high-altitude balloon. Once the parafoil is deployed at 60,000-foot altitude, it will select its landing point and perform an automatic precision landing.

- **Strata-S1 – Refining a Testbed to Evaluate the Behavior of Regolith Under Microgravity Conditions**
  Adrienne Dove, principal investigator, University of Central Florida, Orlando
  Demonstration of a regolith compression mechanism with transparent tubes, which contain beads and pebbles that simulate regolith, to evaluate behavior at various gravity levels during suborbital flights.

Under the second topic, demonstration of vehicle capability enhancements and onboard research facilities for payload accommodation, NASA selected one proposal:

- **BioChip SubOrbitalLab: An Automated Microfluidic and Imaging Platform for Live-Cell Investigations in Microgravity**
  Daniel O'Connell, principal investigator, HNU Phototonics LLC, Kahului, Hawaii
  Demonstration of an automated platform to visualize in real time how live cells will react to the different phases of a rocket launch. Cell cultures with fluorescent genes will be pumped through channels and recorded by an optical microscope camera during flight.

Awards will be made for payload integration and flight costs, as well as limited payload development costs. These investments take technologies from the laboratory to a relevant flight environment, facilitate technology maturation, validate feasibility and reduce technical risks and enable infusion of key space technologies into multiple future space missions. The next call for proposals in this series, called the REDDI Flight Opportunities, will be released by the spring of 2017.

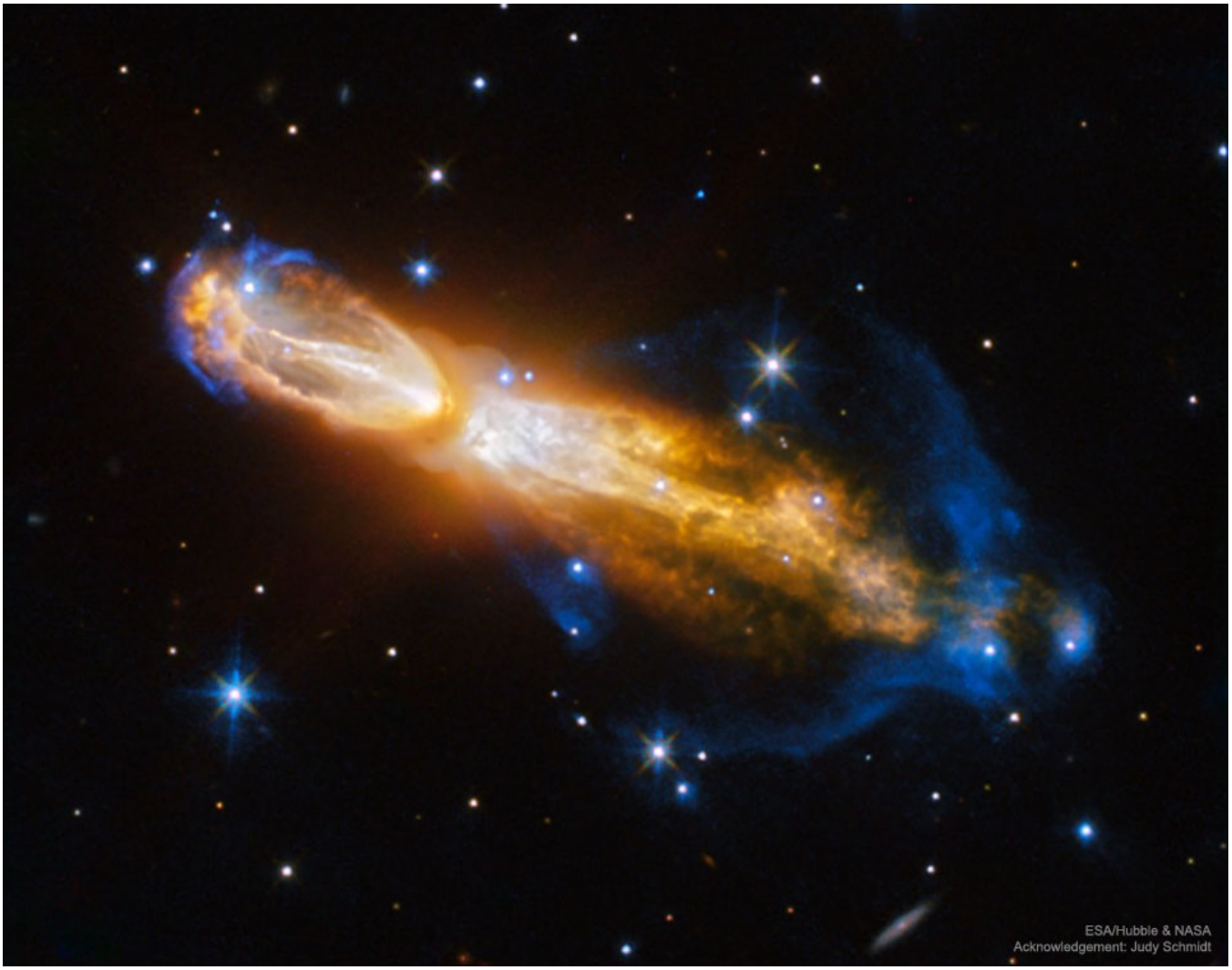
The Flight Opportunities program is funded by NASA's Space Technology Mission Directorate in Washington and managed at NASA's Armstrong Flight Research Center in Edwards, California. NASA's Ames Flight Research Center in Moffett Field, California, manages the solicitation and selection of technologies to be tested and demonstrated on commercial flight vehicles.

For more information on NASA's Flight Opportunities program, visit:

http://www.nasa.gov/directorates/spacetech/flight_opportunities/index.html

Source: NASA Return to Contents

Space Image of the Week



The Calabash Nebula from Hubble

Explanation: Fast expanding gas clouds mark the end for a central star in the Calabash Nebula. The once-normal star has run out of nuclear fuel, causing the central regions to contract into a white dwarf. Some of the liberated energy causes the outer envelope of the star to expand. In this case, the result is a photogenic proto-planetary nebula. As the million-kilometer per hour gas rams into the surrounding interstellar gas, a supersonic shock front forms where ionized hydrogen and nitrogen glow blue. Thick gas and dust hide the dying central star. The Calabash Nebula, also known as the Rotten Egg Nebula and OH231.8+4.2, will likely develop into a full bipolar planetary nebula over the next 1000 years. The nebula, featured here, is about 1.4 light-years in extent and located about 5000 light-years away toward the constellation of Puppis.

Image Credit: NASA, ESA, Hubble, MAST; *Acknowledgement:* Judy Schmidt

Source: Astronomy Picture of the Day

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