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1. Falcon 9 succeeds in middle-of-the-night launch and landing

A Japanese communications satellite rode a Falcon 9 rocket into space from Cape Canaveral early Friday, reaching an on-target orbit as the launcher’s first stage booster nailed a high-speed landing on a platform in the Atlantic Ocean, logging another achievement for SpaceX’s cost-cutting reuse initiative.

The successful satellite deployment marks the Falcon 9’s fifth consecutive flawless flight in less than five months, and the rocket’s 24th mission overall.

The rocket achieved its primary and secondary objective on Friday’s launch, placing the JCSAT 14 communications satellite into orbit, and returning its booster stage to a purely experimental landing on a specially-outfitted ship floating in the Atlantic Ocean.

The 229-foot-tall (70-meter) Falcon 9 lit its nine Merlin 1D first stage engines, throttled up to 1.5 million pounds of thrust, and climbed away from Cape Canaveral’s Complex 40 launch pad at 1:21 a.m. EDT (0521 GMT) Friday.

Lighting up a starry sky over the Central Florida marshlands, the Falcon 9 pivoted east from its launch pad, its blazing orange exhaust extending hundreds of feet behind it in a spectacle easily visible across the region.

The rocket surpassed the speed of sound about a minute after takeoff and streaked into the stratosphere before dropping its first stage at the mission’s 2-minute, 41-second point.

The Falcon 9’s single-engine second stage ignited moments later to continue driving into orbit with the JCSAT 14 communications satellite, a new broadcasting platform for Tokyo-based Sky Perfect JSAT Corp.

Around the same time, cold gas nitrogen thrusters on the first stage flipped the 15-story booster around and pointed it tail first, beginning a sequence of maneuvers to land the rocket on an ocean-going platform in the Atlantic Ocean.

A few minutes later, the first stage ignited three of its main engines for a re-entry braking burn.

The first stage booster, guided by GPS satellite navigation and steered with engine thrust and aerodynamic grid fins, aimed for SpaceX’s landing platform, or drone ship, positioned about 400 miles (650 kilometers) east of Cape Canaveral.

SpaceX said before Friday’s launch that a successful landing was unlikely because “the first-stage will be subject to extreme velocities and re-entry heating,” more severe conditions than the Falcon 9 encountered on its last launch.

But live video from the drone ship and a nearby boat showed the Falcon 9 rocket illuminating the vessel’s deck — about the size of a football field — as the booster approached the platform, dubbed “Of Course I Still Love You” after a sentient planet-sized starship in Iain Banks’ sci-fi novels.
Three of the booster’s kerosene-fueled engines fired up again in the final seconds of its descent, before settling on the landing ship.

“This is recovery, the Falcon has landed,” exclaimed a member of SpaceX’s launch team.

Images from the drone ship showed the rocket ended up near the bullseye painted on the deck.

The booster’s intact recovery gives SpaceX a 3-for-7 record in its vertical landing attempts, which began in January 2015 with a crash landing on the drone ship. Engineers resolved several problems that plagued the untried recovery maneuvers, including an insufficient supply of hydraulic steering fluid, a stuck engine valve, and a disjointed landing leg, before logging the first successful touchdown at sea April 8 after a launch with a Dragon supply ship heading for the International Space Station.

JCSAT 14 needed to go to a much higher orbit, requiring extra speed and fuel from the first stage engines. That meant the rocket would descend back through the atmosphere faster, with less fuel to slow down for the final approach to the vessel.

In other words, the rocket had to slam on the brakes to nail the landing.

Instead of the single-engine landing burn directly above the drone ship, the rocket fired up three engines to slow itself for touchdown, tripling the deceleration experienced by the booster in the final moments of the flight. And the recovery maneuver omitted a “boostback” burn to direct the rocket toward the vessel.

Elon Musk, the company’s founder and CEO, said on Twitter: “May need to increase size of rocket storage hangar.”

SpaceX has three previously flown Falcon 9 boosters in stock now — including one that returned to landing at Cape Canaveral in December — with plans to fly one of the vehicles a second time this summer.

No company has returned orbital-class rocket booster casings and engines to a vertical landing before. SpaceX hopes to slash the cost of space launches by reusing the Falcon 9’s first stage.

Musk said last month about half of the Falcon 9’s missions will fly profiles that require a booster landing at sea. Only launches to low Earth orbit, with relatively light payloads, have enough fuel margin to return to land on the ground.

“IT’ll still take us a few years to make it smooth and make it efficient, but I think it’s proven that it can work,” Musk told reporters in an April 8 press conference after SpaceX’s first rocket landing at sea. “There probably will be some (landing) failures in the future, but we’ll iron those out and get to the point where it’s routine to bring it back.”

Musk said landing on a ship at sea requires less fuel, but is technically more daunting.

“It’s sort of like a carrier landing vs. a land landing,” he said last month. “It’s a tinier spot, and it’s moving.”

As SpaceX celebrated the landing, the Falcon 9’s upper stage pressed on, shutting off its main engine about nine minutes after liftoff after reaching a preliminary parking orbit.

The engine re-ignited approximately 26 minutes after liftoff, switching on and off like clockwork for a one-minute burn to deliver JCSAT 14 into a highly elliptical geostationary transfer orbit.

Source: Spaceflight Now
2. Pluto’s Interaction with the Solar Wind is Unique, Study Finds

Pluto behaves less like a comet than expected and somewhat more like a planet like Mars or Venus in the way it interacts with the solar wind, a continuous stream of charged particles from the sun.

This is according to the first analysis of Pluto’s interaction with the solar wind, funded by NASA’s New Horizons mission and published today in the *Journal of Geophysical Research – Space Physics* by the American Geophysical Union (AGU).

Using data from the Solar Wind Around Pluto (SWAP) instrument from the New Horizons July 2015 flyby, scientists have for the first time observed the material coming off of Pluto’s atmosphere and studied how it interacts with the solar wind, leading to yet another “Pluto surprise.”

“This is a type of interaction we’ve never seen before anywhere in our solar system,” said David J. McComas, lead author of the study. McComas, professor of astrophysical sciences at Princeton University and vice president for the Princeton Plasma Physics Laboratory. “The results are astonishing.” McComas leads the SWAP instrument aboard New Horizons; he also led the development of SWAP when he was at the Southwest Research Institute (SwRI) in San Antonio, Texas.

Space physicists say that they now have a treasure trove of information about how Pluto’s atmosphere interacts with the solar wind. Solar wind is the plasma that spews from the sun into the solar system at a supersonic 100 million miles per hour (160 million kilometers per hour), bathing planets, asteroids, comets and interplanetary space in a soup of mostly protons and electrons.
Previously, most researchers thought that Pluto was characterized more like a comet, which has a large region of gentle slowing of the solar wind, as opposed to the abrupt diversion solar wind encounters at a planet like Mars or Venus. Instead, like a car that's part gas- and part battery-powered, Pluto is a hybrid, researchers say.

So Pluto continues to confound. “These results speak to the power of exploration. Once again we’ve gone to a new kind of place and found ourselves discovering entirely new kinds of expressions in nature,” said SwRI’s Alan Stern, New Horizons principal investigator.

Since it’s so far from the sun – an average of about 3.7 billion miles, the farthest planet in the solar system – and because it’s the smallest, scientists thought Pluto’s gravity would not be strong enough to hold heavy ions in its extended atmosphere. But, “Pluto’s gravity clearly is enough to keep material relatively confined,” McComas said.

The researchers were able to separate the heavy ions of methane, the main gas escaping from Pluto’s atmosphere, from the light ions of hydrogen that come from the sun using the SWAP instrument.

Among additional Pluto findings:

- Like Earth, Pluto has a long ion tail, that extends downwind at least a distance of about 100 Pluto radii (73,800 miles/118,700 kilometers, almost three times the circumference of Earth), loaded with heavy ions from the atmosphere and with “considerable structure.”
- Pluto’s obstruction of the solar wind upwind of the planet is smaller than had been thought. The solar wind isn’t blocked until about the distance of a couple planetary radii (1,844 miles/3,000 kilometers, about the distance between Chicago and Los Angeles.)
- Pluto has a very thin boundary of Pluto’s tail of heavy ions and the sheath of the shocked solar wind that presents an obstacle to its flow.

Heather Elliott, astrophysicist at SwRI and co-author on the paper, notes, “Comparing the solar wind-Pluto interaction to the solar wind-interaction for other planets and bodies is interesting because the physical conditions are different for each, and the dominant physical processes depend on those conditions.”

These findings offer clues to the magnetized plasmas that one might find around other stars, said McComas. “The range of interaction with the solar wind is quite diverse, and this gives some comparison to help us better understand the connections in our solar system and beyond.”

Source: NASA
In the late 1500s, the Italian scientist Galileo Galilei conceived of an experiment that changed a foundation of physics. He mulled — and by some accounts actually tested — what would happen if two spheres with different weights were dropped at the same time from the Leaning Tower of Pisa.

At the time, the prevailing theory of gravity, developed almost 2,000 years earlier by the Greek philosopher and scientist Aristotle, attributed the speed of falling object to its proportional weight, with heavier objects falling faster than lighter ones.

Galileo believed that mass was immaterial to an object's falling speed. All would hit the ground at the same time no matter how much they weighed. From that, he deduced that in a vacuum, all bodies would fall at the same speed, an idea that underpins Albert Einstein's general theory of relativity, published 100 years ago.

The concept, called the equivalence principle, has been well tested on Earth, but scientists wonder if it breaks down when measurements are precise enough.

Putting the principle under a proverbial microscope is the goal of a French-backed space experiment called, appropriately, Microscope. The 668-pound satellite flew as a secondary payload aboard a Soyuz rocket which launched last week from Europe's Kourou, French Guiana, spaceport.

Microscope contains two cylindrical test masses — one made of titanium and the other a platinum-rhodium alloy — which will be electrostatically levitated and stabilized so sensors can measure accelerations equal to a millionth of a billionth of Earth's gravity. Experiments on Earth have been about 100 times less sensitive, mostly because of random, seismic vibrations from naturally occurring and human activities.
"We expect to open a new window beyond Einstein," Microscope lead scientist Pierre Touboul wrote in an email to Discovery News.

If the equivalence principle breaks down, the door opens for new physics to complement general relativity, maybe a new type of interaction or a new type of particle for this interaction, he said.

"If there is no violation, this is a new constraint for quantum gravity theory, and we open the way to perform a better physics experiment," in space, Touboul added.

ANALYSIS: Hawking: Gravitational Waves Could Revolutionize Astronomy

"Any violation of the equivalence principle would be of vital importance," the French space agency CNES wrote in a summary of the experiment posted on its website.

"It would be the first sign of new physical phenomena … which are not explained by our standard physics model. It would thus bring into question our knowledge at the interface between the field quantum theory and relativity theories of gravitation, as well as the application of these theories to astrophysics and cosmology," CNES said.

Scientists plan to compare the relative motion of the Microscope masses for two years. The instrument was switched on this week, the start of a two-month checkout. Science operations are slated to begin in July.

Source: Space.com
The Night Sky

Friday, May 6

• Double shadow transit on Jupiter. Both Callisto and Io cast their tiny black shadows onto Jupiter's sunlit face from 12:38 to 1:42 a.m. EDT tonight (9:38 to 10:42 p.m. PDT).

• New Moon (exact at 3:30 p.m. EDT; 12:30 p.m. PDT).

Saturday, May 7

• Twenty or thirty minutes after sunset, try to catch the hairline crescent Moon just a few degrees above the west-northwest horizon, as shown here. Binoculars will help! Is this the youngest Moon you've ever seen? It's only about 28 hours from new as seen from the East Coast, 31 hours from new as seen from the Pacific time zone. (Calculate its age at the time of your sighting from the time of yesterday's new Moon, above.)

   Aldebaran is a few degrees above or upper left of the delicate Moon. Which of the two is less difficult to see in binoculars? With the unaided eye?

Sunday, May 8

• The waxing crescent Moon hangs rather low in the west at dusk. Look left of it for orange Betelgeuse and lower right of it by a similar distance (from North America) for orange Aldebaran, as shown above.

Monday, May 9

• Mercury crosses the face of the Sun today for users of safely filtered telescopes across most of the inhabited world. See Get Ready for May 9th's Transit of Mercury and May 9th Transit of Mercury: Everything You Need to Know.

• At dusk, the thickening Moon shines near Gamma Geminorum, the brightest star in the four feet of Gemini, as shown at top. Look below the star and Moon for Betelgeuse, the last of Orion's bright stars to sink away as winter recedes into the past.

Tuesday, May 10

• Three zero-magnitude stars shine after dark in May: Arcturus high in the southeast, Vega much lower in the northeast, and Capella in the northwest. They appear so bright because each is at least 60 times as luminous as the Sun, and because they're all relatively nearby: 37, 25, and 42 light-years from us, respectively.

Source: Sky & Telescope
ISS Sighting Opportunities

For Denver:

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

NASA-TV Highlights
(all times Eastern Daylight Time)

TBD, Monday, May 9 - Live Feed from NASA’s Solar Dynamics Observatory (SDO) of Mercury Transit of the Sun (NTV-2 (Education))

6 a.m., Monday, May 9 - Live Interviews with NASA Scientists (Alex Young, Yari Collado-Vega and Stephen Rinehart) about the Rare Transit of Mercury (NTV-3 (Media))

10 a.m., Monday, May 9 - Space Station Live (NTV-1 (Public), NTV-2 (Education))

10:30 a.m., Monday, May 9 - Live Panel Discussion on the Science behind the Mercury Transit (NTV-1 (Public))

NASA is inviting media and viewers around the world to see a relatively rare celestial event, with coverage of the Monday, May 9 transit of the sun by the planet Mercury. Media may view the event at NASA’s Goddard Space Flight Center in Greenbelt, Maryland.

Mercury will appear as a small black dot as it crosses the edge of the sun and into view at 7:12 a.m. The planet will make a leisurely journey across the face of the sun, reaching mid-point at approximately 10:47 a.m., and exiting the golden disk at 2:42 p.m. The entire 7.5-hour path across the sun will be visible across the Eastern United States – with magnification and proper solar filters – while those in the West can observe the transit in progress after sunrise.

Exact time of NASA’s broadcast are TBD.

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

- May 06 - [May 05] Cassini, Titan Flyby
- May 06 - [Apr 29] Space Day
- May 06 - [May 06] JCSat 14 Falcon 9 Launch
- May 06 - Comet C/2015 B2 (PANSTARRS) Perihelion (3.370 AU)
- May 06 - Comet 121P/Shoemaker-Holt At Opposition (3.890 AU)
- May 06 - Atira Asteroid 434326 (2004 JG6) Closest Approach To Earth (0.825 AU)
- May 06 - Robert Dicke's 100th Birthday (1916)
- May 06 - 120th Anniversary (1896), 1st Successful Flight of a Large Unmanned Heavier-Than-Air Craft (Langley Aerodrome No. 5)
- May 07 - Comet C/2014 M1 (PANSTARRS) Closest Approach To Earth (4.871 AU)
- May 07 - Asteroid 2 Pallas Occults TYC 1125-00398-1 (11.9 Magnitude Star)
- May 07 - Asteroid 2713 Luxembourg Closest Approach To Earth (1.805 AU)
- May 07 - Asteroid 3534 Sax Closest Approach To Earth (2.117 AU)
- May 07 - Asteroid 3106 Morabito Closest Approach To Earth (2.919 AU)
- May 07 - Kuiper Belt Object 90568 (2004 GY9) At Opposition (38.459 AU)
- May 07 - Raymond Lyttleton's 105th Birthday (1911)
- May 08 - Moon Occults Aldebaran
- May 08 - [May 06] Aten Asteroid 2016 JC6 Near-Earth Flyby (0.033 AU)
- May 08 - Apollo Asteroid 2014 JR5 Near-Earth Flyby (0.020 AU)
- May 08 - [May 03] Amor Asteroid 2016 HH19 Near-Earth Flyby (0.041 AU)
- May 08 - Apollo Asteroid 2010 KP10 Near-Earth Flyby (0.076 AU)
- May 08 - Asteroid 284996 Rosaparks Closest Approach To Earth (1.758 AU)
- May 08 - Asteroid 1154 Astronomia Closest Approach To Earth (2.254 AU)
- May 09 - [May 03] Mercury Transits The Sun
- May 09 - Cassini, Orbital Trim Maneuver #449 (OTM-449)
- May 09 - Comet 100P/Hartley Closest Approach To Earth (1.043 AU)
- May 09 - Comet 116P/Wild Closest Approach To Earth (1.340 AU)
- May 09 - Comet P/2016 G1 (PANSTARRS) At Opposition (1.428 AU)
- May 09 - Comet C/2016 B1 (NEOWISE) Closest Approach To Earth (2.996 AU)
- May 09 - Comet P/2015 C1 (Totas-Gibbs) Closest Approach To Earth (2.999 AU)
- May 09 - [May 06] Apollo Asteroid 2016 JS Near-Earth Flyby (0.004 AU)
- May 09 - [May 02] Amor Asteroid 2016 EE158 Near-Earth Flyby (0.100 AU)
- May 09 - Apollo Asteroid 2063 Bacchus Closest Approach To Earth (0.878 AU)
- May 09 - Asteroid 4690 Strasbourg Closest Approach To Earth (1.209 AU)
- May 09 - Asteroid 85197 Ginkgo Closest Approach To Earth (1.499 AU)
- May 09 - Asteroid 3140 Stellaflane Closest Approach To Earth (2.282 AU)
- May 09 - Asteroid 8958 Stargazer Closest Approach To Earth (1.761 AU)
- May 09 - Asteroid 51826 Kalpanachawla Closest Approach To Earth (2.321 AU)
- May 09 - Asteroid 3351 Smith Closest Approach To Earth (2.609 AU)
- May 09 - Vance Brand's 85th Birthday (1931)

Source: JPL Space Calendar

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Food for Thought

MIT scientists compile list of potential gases to guide search for life on exoplanets

A new approach intended to maximize the chances of identifying planets orbiting nearby stars that support life focuses on creating a comprehensive list of the molecules that might be present in the atmospheres of these exoplanets. Biosignature gases emitted by exoplanetary life forms could be detected remotely by space telescopes, but these gases might have quite different compositions from those in Earth's atmosphere, according to an article in Astrobiology, a peer-reviewed journal from Mary Ann Liebert, Inc., publishers. The article is available free for download on the Astrobiology website until June 5, 2016.

S. Seager, W. Bains, and J.J. Petkowski, MIT (Cambridge, MA) and Rufus Scientific (Cambridge, U.K.), propose that all stable and potential volatile molecules should be considered as possible biosignature gases. In the article "Toward a List of Molecules as Potential Biosignature Gases for the Search for Life on Exoplanets and Applications to Terrestrial Biochemistry," the researchers laid the groundwork for identifying such gases by conducting a massive search for molecules with six or fewer non-hydrogen atoms. They describe how this exhaustive list of small molecules can help enhance our understanding of the limits of biochemistry on Earth.

"This work reminds me of Darwin's voyage aboard The Beagle, exploring the vast diversity of life by sailing around the world," says Nancy Y. Kiang, PhD, Senior Editor of Astrobiology and a scientist at NASA Goddard Institute for Space Studies. "In the search for life beyond our planet, we are currently at a similarly exciting, early but rapidly evolving stage of exploration as the discovery of exoplanets accelerates. Instead of netting strange creatures from the bottom of the sea, the authors here have searched and found thousands of curious, potentially biogenic gas molecules. These will inspire a new body of research into identifying also larger molecules, investigating their origin and fate here, and their potential expression on exoplanets as signs of life."

Source: EurekAlert
55th Anniversary of Shepard’s flight; Computational Facility Named after "Human Computer" Katherine Johnson

Astronaut Alan B. Shepard Jr., in his silver pressure suit with the helmet visor closed, prepares for his Mercury Redstone 3 launch on May 5, 1961. Shepard's Freedom 7 Mercury capsule lifted off at 9:34 a.m. from Launch Complex 5 at Cape Canaveral Air Force Station, and flew a suborbital trajectory lasting 15 minutes and 22 seconds. He became the first American to fly into space.

Fast forward 55 years to May 5, 2016 when NASA celebrated retired mathematician Katherine Johnson by naming a Langley research facility in her honor.

Johnson was once a "human computer" at NASA.

Working at Langley from 1953 until her retirement in 1986, Johnson made a long list of critical contributions including calculating the trajectory of the 1961 flight of Alan Shepard. Johnson is also credited with verifying the calculations made by early electronic computers of John Glenn's 1962 launch to orbit and the 1969 Apollo 11 trajectory to the moon.

Source: NASA/NASA Langley

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