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President Barack Obama signed a budget measure Friday giving NASA more than $17.6 billion for the year, fully funding the space agency's heavy-lift Space Launch System and Orion exploration capsule while falling short of NASA's request to pay for commercial space taxis. The space agency's top line budget is $17.65 billion in the spending bill, which runs until the end of September and was passed by Congress earlier this week. The $1.1 trillion budget covers the entire federal government. The appropriations bill has its roots in a framework budget compromise reached by House and Senate leaders in December. Lawmakers ironed out the details of the budget over the last month before unveiling the document Monday night.

Congress gave NASA a funding level just shy of the White House's request of $17.72 billion, but the appropriation pads the space agency's deep space exploration programs, setting the Orion multipurpose crew vehicle's budget at $1.2 billion and the Space Launch System's funding line at $1.6 billion, more than $200 million more than NASA said it needed to meet a 2017 launch date for an unmanned test flight. The Orion spacecraft and Space Launch System are the centerpieces of NASA's plans for human missions to an asteroid and eventually Mars. In a legislative report accompanying the budget, Congress refused to commit to NASA's proposed asteroid redirect mission to retrieve a 500-ton rock from solar orbit, guide it around the moon with a robotic spacecraft, then send astronauts to visit it aboard Orion crew capsules. Lawmakers wrote that NASA needs to justify the asteroid initiative and provide detailed cost estimates before winning congressional support. The extra money for SLS will "maintain critical forward momentum" on the program, legislators wrote in the budget report. A loser in the budget is the commercial crew program, which began funding industrial partners in 2010 and aims to develop a privately-owned rocket and spacecraft to transport astronauts to and from the International Space Station in low Earth orbit by the end of 2017. After the space shuttle, NASA is turning to the private sector for crew and cargo transportation to the space station, while the government focuses on missions beyond Earth orbit. NASA asked Congress for $821 million, a figure NASA Administrator Charlie Bolden said last year is required to keep the commercial crew program on track to support an operational transport service in 2017. The fiscal year 2014 budget calls for $696 million in commercial crew funding, above last year's $525 million budget but short of what NASA requested. The bill directs NASA to hold $171 million of the $696 million in reserve until officials complete an independent cost-benefit analysis of the commercial crew program taking into account the total U.S. government investment in the project and the expected operational life of the space station. NASA is pursuing the commercial spaceflight program as a public-private partnership in the mold of the agency's development of private cargo vehicles to resupply the space station. Boeing Co., SpaceX and Sierra Nevada Corp. are currently in funded Space Act Agreements with NASA worth $1.1 billion. Under the cost-sharing arrangement, NASA approves monetary awards to each company upon the completion of preset milestones, such as flight tests, engine firings, or design reviews. This summer, NASA plans to select one or more companies to complete development of their crew spacecraft and fly demonstration missions to low Earth orbit before the vehicle is certified for NASA astronauts. Since its inception, the commercial crew program has received less funding each year than requested by NASA. The rest of NASA's divisions receive funding near requested levels, except for the agency's space technology directorate, which gets $576 million. That is $167 million less than NASA wanted. Space operations, which includes the International Space Station, receives $3.78 billion in fiscal year 2014 and NASA's science programs get $5.15 billion. Both figures are within a few percent of NASA's request.

Source: Space Flight Now

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Astronomers have discovered a distant quasar illuminating a vast nebula of diffuse gas, revealing for the first time part of the network of filaments thought to connect galaxies in a cosmic web. Researchers at the University of California, Santa Cruz, led the study, published January 19 in Nature. Using the 10-meter Keck I Telescope at the W. M. Keck Observatory in Hawaii, the researchers detected a very large, luminous nebula of gas extending about 2 million light-years across intergalactic space. "This is a very exceptional object: it's huge, at least twice as large as any nebula detected before, and it extends well beyond the galactic environment of the quasar," said first author Sebastiano Cantalupo, a postdoctoral fellow at UC Santa Cruz.

The standard cosmological model of structure formation in the universe predicts that galaxies are embedded in a cosmic web of matter, most of which (about 84 percent) is invisible dark matter. This web is seen in the results from computer simulations of the evolution of structure in the universe, which show the distribution of dark matter on large scales, including the dark matter halos in which galaxies form and the cosmic web of filaments that connect them. Gravity causes ordinary matter to follow the distribution of dark matter, so filaments of diffuse, ionized gas are expected to trace a pattern similar to that seen in dark matter simulations. Until now, however, these filaments have never been seen. Intergalactic gas has been detected by its absorption of light from bright background sources, but those results don't reveal how the gas is distributed. In this study, the researchers detected the fluorescent glow of hydrogen gas resulting from its illumination by intense radiation from the quasar. "This quasar is illuminating diffuse gas on scales well beyond any we've seen before, giving us the first picture of extended gas between galaxies. It provides a terrific insight into the overall structure of our universe," said coauthor J. Xavier Prochaska, professor of astronomy and astrophysics at UC Santa Cruz. The hydrogen gas illuminated by the quasar emits ultraviolet light known as Lyman alpha radiation. The distance to the quasar is so great (about 10 billion light-years) that the emitted light is "stretched" by the expansion of the universe from an invisible ultraviolet wavelength to a visible shade of violet by the time it reaches the Keck Telescope. Knowing the distance to the quasar, the researchers calculated the wavelength for Lyman alpha radiation from that distance and built a special filter for the telescope's LRIS spectrometer to get an image at that wavelength. "We have studied other quasars this way without detecting such extended gas," Cantalupo said. "The light from the quasar is like a flashlight beam, and in this case we were lucky that the flashlight is pointing toward the nebula and making the gas glow. We think this is part of a filament that may be even more extended than this, but we only see the part of the filament that is illuminated by the beamed emission from the quasar." A quasar is a type of active galactic nucleus that emits intense radiation powered by a supermassive black hole at the center of the galaxy. In an earlier survey of distant quasars using the same technique to look for glowing gas, Cantalupo and others detected so-called "dark galaxies," the densest knots of gas in the cosmic web. These dark galaxies are thought to be either too small or too young to have formed stars. "The dark galaxies are much denser and smaller parts of the cosmic web. In this new image, we also see dark galaxies, in addition to the much more diffuse and extended nebula," Cantalupo said. "Some of this gas will fall into galaxies, but most of it will remain diffuse and never form stars." The researchers estimated the amount of gas in the nebula to be at least ten times more than expected from the results of computer simulations. "We think there may be more gas contained in small dense clumps within the cosmic web than is seen in our models. These observations are challenging our understanding of intergalactic gas and giving us a new laboratory to test and refine our models," Cantalupo said.
3. Wake Up, Rosetta!

It’s being called “the most important alarm clock in the Solar System” — this Monday, January 20, at 10:00 GMT (which is 5:00 a.m. for U.S. East Coasters like me) the wake-up call will ring on ESA’s Rosetta spacecraft, bringing it out of hibernation after over two and a half years in preparation of its upcoming and highly-anticipated rendezvous with a comet. The wake-up will incite the warming of Rosetta’s star trackers, which allow it to determine its orientation in space. Six hours later its thrusters will fire to stop its slow rotation and ensure that its solar arrays are receiving the right amount of sunlight. Using its thawed-out star trackers Rosetta will aim its transmitter towards Earth and, from 500 million miles (807 million km) away, will send a thumbs-up signal that everything is OK and it’s time to get back to work. From that distance the transmission will take 45 minutes to reach us. Rosetta’s first signal is expected between 17:30 – 18:30 GMT (12:30 – 1:30 p.m. ET). Once we’re assured all is well, Rosetta has a very exciting year ahead!

After nearly a decade of soaring through the inner solar system, flying past Mars and Earth several times and even briefly visiting a couple of asteroids (2867 Steins on September 5, 2008 and 21 Lutetia on July 10, 2010) Rosetta is finally entering the home stretch of its mission to orbit the 4-km-wide comet 67P/Churyumov-Gerasimenko. Once Rosetta enters orbit around the comet — the first time a spacecraft has ever done so — it will map its surface and, three months later in November, deploy the 220-lb (100-kg) Philae lander that will intimitely investigate the surface of the nucleus using a suite of advanced science instruments. (Watch a video here of how all this will happen... using Legos!). With Philae firmly attached to the comet, Rosetta will follow it around the Sun as it makes its closest pass in August 2015 and then heads back out towards the orbit of Jupiter. Rosetta will provide the most detailed observations ever of a comet’s composition and dramatic evolution as it encounters the heat and energy of our home star.

Of course, before all this can happen Rosetta first has to... WAKE UP! It entered hibernation in July 2011 and has remained silent in a slow spin ever since, with only its computer and some heaters kept running. Waking up from a 31-month nap can’t be easy, so ESA is inviting people around the world to help Wake Up Rosetta (and possibly even win a trip to Germany for the landing in November) by sharing their short movies of how best to awaken a sleeping spacecraft and sharing them to the contest page on Facebook or to Twitter, Vine, or Instagram with the #WakeUpRosetta hashtag.
The Night Sky

**Tuesday, January 21**
- The waning gibbous Moon rises around 11 tonight, then Mars and Spica follow up below it in the next hour and a quarter. By dawn Wednesday morning (the 22nd) the three are posing in the southwest, with Spica and Mars to the Moon’s left and upper left as shown here.
- Jupiter’s Great Red Spot transits around 7:45 p.m. EST.

**Wednesday, January 22**
- The waning Moon rises around midnight tonight very close to Spica, with Mars shining to their upper left. By dawn on the 23rd they move over to the southwest, with Mars now to the Moon’s upper right as shown above.
- Algol is at minimum brightness, magnitude 3.4 instead of its usual 2.3, for a couple hours centered on 1:20 a.m. Thursday morning EST (10:20 p.m. Wednesday PST). Algol takes several additional hours to fade and to rebrighten.
- Okay, you know Algol well. But what about the remarkable galaxies and clusters near it? Now that the Moon is gone from the evening sky, explore the depths around Algol with Sue French’s Deep-Sky Wonders article, maps and photos in the January Sky & Telescope, page 58.

**Thursday, January 23**
- Last-quarter Moon tonight (exact at 12:19 a.m. Friday morning EST). The Moon rises around 1 a.m. local time. To its upper right is the Mars-Spica pair, and rising to its lower left more than an hour later is Saturn. By dawn on the 24th they’re lined up horizontally in the south to southwest.
- Jupiter’s Great Red Spot transits around 9:23 p.m. EST.

**Friday, January 24**
- Mercury has become easy to see; look for it low in the west-southwest as twilight fades. Don’t confuse it with twingly Fomalhaut off to its left in the southwest. Mercury is beginning its best evening apparition since last June for mid-northern skywatchers.
- The Moon rises around 2 a.m. Saturday morning the 25th with Saturn glowing just 1° or 2° from it (as seen from the Americas). They’re high in the south together by dawn, as shown here.

**Saturday, January 25**
- Algol is at minimum brightness, magnitude 3.4 instead of its usual 2.3, for a couple hours centered on 10:09 p.m. EST. It takes several additional hours to fade and to rebrighten.
- Jupiter’s Great Red Spot transits Jupiter’s central meridian around 11:01 p.m. EST.

Source: Sky 2 & 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)

**January 21, Tuesday**
6:15 a.m. - ISS Expedition 38 In-Flight Event with Wakata for the JAXA Space Biomedical Research Office - JSC (All Channels)
1 p.m. - TDRS-L Pre-Launch News Conference - KSC (All Channels)

**January 22, Wednesday**
1:30 p.m. - Video B-Roll Feed of ISS Expedition 39/40 Crew Training (precedes the Crew News Conference) - JSC (All Channels)
2 p.m. - ISS Expedition 39/40 Crew News Conference (Skvortsov, Artemyev, Swanson) - JSC (All Channels)

**January 23, Thursday**
11:25 a.m. - ISS Expedition 38 In-Flight Educational Event with the Alamo Heights High School in San Antonio, TX - JSC (All Channels)
2 p.m. - Mars Exploration Rover Science Briefing - JPL (All Channels)
3 p.m. - Opportunity 10th Anniversary - JPL (All Channels)

Watch NASA TV online by going to the [NASA website](#).
Space Calendar

- Jan 21 - Comet P/2011 U2 (Bressi) Closest Approach To Earth (4.079 AU)
- Jan 21 - Asteroid 251346 (2007 SJ) Near-Earth Flyby (0.049 AU)
- Jan 21 - Asteroid 18125 Brianwilson Closest Approach To Earth (2.353 AU)
- Jan 22 - Comet C/2013 H2 (Boattini) Perihelion (7.499 AU)
- Jan 22 - Asteroid 8837 London Closest Approach To Earth (1.262 AU)
- Jan 22 - Asteroid 204852 Frankfurt Closest Approach To Earth (1.748 AU)
- Jan 23 - [Jan 18] TDRS-L Atlas 5 Launch
- Jan 23 - Comet 293P/Spacewatch Closest Approach To Earth (1.142 AU)
- Jan 23 - Comet P/2011 U2 (Bressi) At Opposition (4.079 AU)
- Jan 23 - Asteroid 2013 YS2 Near-Earth Flyby (0.056 AU)
- Jan 23 - Asteroid 2013 NC15 Near-Earth Flyby (0.069 AU)
- Jan 23 - Asteroid 2955 Newburn Closest Approach To Earth (1.397 AU)
- Jan 23 - Asteroid 8952 ODAS Closest Approach To Earth (1.709 AU)
- Jan 23 - Asteroid 3852 Glennford Closest Approach To Earth (2.169 AU)
- Jan 24 - Comet 293P/Spacewatch At Opposition (1.142 AU)
- Jan 24 - Comet 121P/Shoemaker-Holt Closest Approach To Earth (2.831 AU)
- Jan 24 - Asteroid 25137 Seansolomon Closest Approach To Earth (1.775 AU)
- Jan 25 - [Jan 18] 10th Anniversary (2004), Mars Exploration Rover B (Opportunity), Mars Landing
- Jan 25 - Cassini, Orbital Trim Maneuver #369 (OTM-369)
- Jan 25 - Moon Occults Saturn
- Jan 25 - Comet 80P/Peters-Hartley At Opposition (2.214 AU)
- Jan 25 - Comet P/2012 SB6 (Lemmon) At Opposition (2.661 AU)
- Jan 25 - Comet 121P/Shoemaker-Holt At Opposition (2.831 AU)
- Jan 25 - Asteroid 2 Pallas Occults TYC 6054-00157-1 (11.4 Magnitude Star)
- Jan 25 - [Jan 12] Asteroid 2006 AL4 Near-Earth Flyby (0.051 AU)
- Jan 25 - Asteroid 295565 Hannover Closest Approach To Earth (1.775 AU)
- Jan 25 - [Jan 13] Asteroid 6489 Golevka Closest Approach To Earth (2.728 AU)
- Jan 25 - 20th Anniversary (1994), Clementine Launch (USA Moon Orbiter)

NASA's twin rovers launched separately in 2003 and landed three weeks apart in January 2004. They completed their three-month prime missions in April 2004 and went on to perform extended missions for years. Spirit and Opportunity made important discoveries about wet environments on ancient Mars that may have been favorable for supporting microbial life. Although Spirit ceased communicating with Earth in March 2010, the Opportunity rover continues its work on the Red Planet.

Source: JPL Space Calendar

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Food for Though

Opportunity Rover Starts 2nd Decade by Spectacular Mountain Summit and Mineral Goldmine

NASA’s long-lived Opportunity Mars rover has accomplished what absolutely no one expected. Opportunity is about to embark on her 2nd decade exploring the Red Planet since her nail biting touchdown in 2004. And to top that off she is marking that miraculous milestone at a spectacular outlook by the summit of the first mountain she has even climbed! And that mountaintop is riven with outcrops of minerals that likely formed in flowing liquid neutral water conducive to life – potentially a scientific goldmine.

“We expect we will reach some of the oldest rocks we have seen with this rover — a glimpse back into the ancient past of Mars,” says the rover principal investigator, Steve Squyres of Cornell University, Ithaca, N.Y. “It’s like starting a whole new mission.” Opportunity is nearly at the peak of Solander Point, an eroded segment on the western flank of vast Endeavour Crater that spans some 22 kilometers (14 miles) in diameter. The six wheeled rover reached the top section of Solander on Sol 3512, just before Christmas in December 2013. It’s situated nearly 40 meters (130 feet) above the crater plains. There she began inspecting and analyzing an area of exposed outcrops called ‘Cape Darby’ that scientists believe holds caches of clay minerals which form in drinkable water and would constitute a habitable zone. The science team directed Opportunity to ‘Cape Darby’ based on predictions from spectral observations collected from the CRISM spectrometer aboard one of NASA’s spacecraft circling overhead the Red Planet – the powerful Mars Reconnaissance Orbiter (MRO). Opportunity is using all its cameras and instruments as well as those on the robotic arm to inspect the outcrop area, including the rock abrasion tool, spectrometers and microscopic imager. As reported earlier this week, the rover is also investigating a mysterious rock that suddenly appeared in images nearby the robot. ‘Pinnacle Island’ rock may have been flung up by the wheels. No one knows for sure – yet. It’s the first mountain she has ever climbed along her epic 10 year journey across the plains of Meridiani.

Heretofore she toured a string of Martian craters. See 10 Years Route map below. In mid-2013, the scientists used similar orbital observations to find a rock called “Esperance” – which was loaded with clay minerals and located along another Endeavour crater rim segment called Cape York. Squyres ranked “Esperance” as one of the “Top 5 discoveries of the mission.” The team hopes for similar mineralogical discoveries at Solander. The northward-facing slopes at Solander also afford another major benefit to Opportunity. They will tilt the rover’s solar panels toward the sun in the southern-hemisphere winter sky thereby providing an important energy boost. The power boost will enable continued mobile operations through the upcoming frigidly harsh winter—her 6th since landing 10 years ago. So Opportunity will be moving from outcrop to outcrop around the summit during the Martian winter. As of Wednesday, Jan. 15, 2014, or Sol 3547, the solar array energy production on the rover is 353 watt-hours, compared to 900 watt-hours after landing. But that is sufficient to keep moving and actively conduct research throughout the winter at the mountaintop.

Opportunity’s long and winding road on the Red Planet began when she safely settled upon the alien world on 24 January 2004, following a harrowing plummet through the thin Martian atmosphere and an airbag assisted bouncy landing. She arrived barely 3 weeks after her twin sister, Spirit on 3 January 2004. Today marks Opportunity’s 3551st Sol or Martian Day roving Mars – for what was expected to be only a 90 Sol mission. So far she has snapped over 188,100 amazing images on the first overland expedition across the Red Planet. Her
total odometry stands at over 24.07 miles (38.73 kilometers) since touchdown on Jan. 24, 2004 at Meridiani Planum.

Meanwhile on the opposite side of Mars, Opportunity’s younger sister rover Curiosity is trekking towards gigantic Mount Sharp. She celebrated 500 Sols on Mars on New Years Day 2014. And a pair of new orbiters are streaking to the Red Planet to fortify the Terran fleet- NASA’s MAVEN and India’s MOM.
Space Image of the Week

Spiral Galaxies in Collision

Image Credit: Debra Meloy Elmegreen (Vassar College) et al., & the Hubble Heritage Team (AURA/STScI/NASA)

Explanation: Billions of years from now, only one of these two galaxies will remain. Until then, spiral galaxies NGC 2207 and IC 2163 will slowly pull each other apart, creating tides of matter, sheets of shocked gas, lanes of dark dust, bursts of star formation, and streams of cast-away stars. Astronomers predict that NGC 2207, the larger galaxy on the left, will eventually incorporate IC 2163, the smaller galaxy on the right. In the most recent encounter that about peaked 40 million years ago, the smaller galaxy is swinging around counter-clockwise, and is now slightly behind the larger galaxy. The space between stars is so vast that when galaxies collide, the stars in them usually do not collide.

Source: NASA APOD