Contents

In the News

Story 1:
Astronomers Discover Colossal 'Super Spiral' Galaxies

Story 2:
Science Papers Reveal New Aspects of Pluto and its Moons

Story 3:
Cold Atom Laboratory Doing Cool Research

Departments

The Night Sky
ISS Sighting Opportunities
Space Calendar
NASA-TV Highlights
Food for Thought
Space Image of the Week
1. Astronomers Discover Colossal 'Super Spiral' Galaxies

A strange new kind of galactic beast has been spotted in the cosmic wilderness. Dubbed "super spirals," these unprecedented galaxies dwarf our own spiral galaxy, the Milky Way, and compete in size and brightness with the largest galaxies in the universe.

Super spirals have long hidden in plain sight by mimicking the appearance of typical spiral galaxies. A new study using archived NASA data reveals these seemingly nearby objects are in fact distant, behemoth versions of everyday spirals. Rare, super spiral galaxies present researchers with the major mystery of how such giants could have arisen.

“We have found a previously unrecognized class of spiral galaxies that are as luminous and massive as the biggest, brightest galaxies we know of," said Patrick Ogle, an astrophysicist at the Infrared Processing and Analysis Center (IPAC) at the California Institute of Technology in Pasadena and lead author of a new paper on the findings published in The Astrophysical Journal. "It’s as if we have just discovered a new land animal stomping around that is the size of an elephant but had shockingly gone unnoticed by zoologists."

Ogle and colleagues chanced upon super spirals as they searched for extremely luminous, massive galaxies in the NASA/IPAC Extragalactic Database (NED), an online repository containing information on over 100 million galaxies. NED brings together a wealth of data from many different projects, including ultraviolet light observations from the Galaxy Evolution Explorer, visible light from Sloan Digital Sky Survey, infrared light from the Two Micron All-Sky Survey, and links to data from other missions such as Spitzer and the Wide-field Infrared Survey Explorer, or WISE.

"Remarkably, the finding of super spiral galaxies came out of purely analyzing the contents of the NASA/IPAC Extragalactic Database, thus reaping the benefits of the careful, systematic merging of data from many sources on the same galaxies," said George Helou, a study co-author and the executive director of IPAC. "NED is surely holding many more such nuggets of information, and it is up to us scientists to ask the right questions to bring them out."
Ogle, Helou and their colleagues expected that humongous, mature galaxies called ellipticals -- so named for their football-like shapes -- would dominate their search within NED for the most luminous galaxies. But a tremendous surprise lay in store for the scientists.

In a sample of approximately 800,000 galaxies no more than 3.5 billion light-years from Earth, 53 of the brightest galaxies intriguingly had a spiral, rather than elliptical, shape. The researchers double-checked the distances to the spiral galaxies and saw that none were nearby -- even the closest lay some 1.2 billion light-years away. With the correct distance estimates in hand, the stunning properties of this newfound batch of whirlpool-shaped galaxies came to light.

Super spirals can shine with anywhere from eight to 14 times the brightness of the Milky Way. They possess as much as 10 times our galaxy's mass. Their gleaming, starry disks stretch from twice to even four times the width of the Milky Way galaxy's approximately 100,000 light-year-wide disk, with the largest super spiral spanning a whopping 440,000 light-years. Super spirals also give off copious ultraviolet and mid-infrared light, signifying a breakneck pace of churning out new stars. Their star formation rate is as high as 30 times that of our own run-of-the-mill galaxy.

According to established astrophysical theory, spiral galaxies should not be able to attain any of these feats because their size and star-making potential are limited. As spiral galaxies grow by gravitationally attracting fresh, cool gas from intergalactic space, their masses reach a tipping point in which any newly captured gas rushes in too rapidly. This headlong gas heats up and prevents subsequent star formation in a process known as "quenching." Bucking this conventional wisdom, though, super spirals remain unquenched.

A vital hint about the potential origin of super spirals is that four out of the 53 seen by Ogle and colleagues clearly contain two galactic nuclei, instead of just one as usual. Double nuclei, which look like two egg yolks frying in a pan, are a telltale sign of two galaxies having just merged together. Conventionally, mergers of spiral galaxies are destined to become bloated, elliptical galaxies. Yet Ogle and colleagues speculate that a special merger involving two, gas-rich spiral galaxies could see their pooled gases settle down into a new, larger stellar disk -- presto, a super spiral.

"Super spirals could fundamentally change our understanding of the formation and evolution of the most massive galaxies," said Ogle. "We have much to learn from these newly identified, galactic leviathans."

Other authors of the new study are Lauranne Lanz of IPAC and Cyril Nader, an undergraduate student at the University of California, Los Angeles, who worked on this project during a summer internship at IPAC.

NASA's Jet Propulsion Laboratory, Pasadena, California, manages the NASA/IPAC Extragalactic Database (NED) for NASA's Science Mission Directorate, Astrophysics Division, Washington. NED operations are conducted at the Infrared Processing and Analysis Center (IPAC) at the California Institute of Technology in Pasadena. Caltech manages JPL for NASA. The NED archive is at http://ned.ipac.caltech.edu

Source: NASA
A year ago, Pluto was just a bright speck in the cameras of NASA’s approaching New Horizons spacecraft, not much different than its appearances in telescopes since Clyde Tombaugh discovered the then-ninth planet in 1930.

But this week, in the journal Science, New Horizons scientists have authored the first comprehensive set of papers describing results from last summer’s Pluto system flyby. “These five detailed papers completely transform our view of Pluto – revealing the former ‘astronomer’s planet’ to be a real world with diverse and active geology, exotic surface chemistry, a complex atmosphere, puzzling interaction with the sun and an intriguing system of small moons,” said Alan Stern, New Horizons principal investigator from the Southwest Research Institute (SwRI), Boulder, Colorado.

After a 9.5-year, 3-billion-mile journey – launching faster and traveling farther than any spacecraft to reach its primary target – New Horizons zipped by Pluto on July 14, 2015. New Horizons’ seven science instruments collected about 50 gigabits of data on the spacecraft’s digital recorders, most of it coming over nine busy days surrounding the encounter.

The first close-up pictures revealed a large heart-shaped feature carved into Pluto’s surface, telling scientists that this “new” type of planetary world – the largest, brightest and first-explored in the mysterious, distant “third zone” of our solar system known as the Kuiper Belt – would be even more interesting and puzzling than models predicted.

The newly published Science papers bear that out; click here for a list of top results.

“Observing Pluto and Charon up close has caused us to completely reassess thinking on what sort of geological activity can be sustained on isolated planetary bodies in this distant region of the solar system, worlds that formerly had been thought to be relics little changed since the Kuiper Belt’s formation,” said Jeff Moore, lead author of the geology paper from NASA's Ames Research Center, Moffett Field, California.

Scientists studying Pluto’s composition say the diversity of its landscape stems from eons of interaction between highly volatile and mobile methane, nitrogen and carbon monoxide ices with inert and sturdy water
“We see variations in the distribution of Pluto’s volatile ices that point to fascinating cycles of evaporation and condensation,” said Will Grundy of the Lowell Observatory, Flagstaff, Arizona, lead author of the composition paper. “These cycles are a lot richer than those on Earth, where there’s really only one material that condenses and evaporates – water. On Pluto, there are at least three materials, and while they interact in ways we don’t yet fully understand, we definitely see their effects all across Pluto’s surface.”

Above the surface, scientists discovered Pluto’s atmosphere contains layered hazes, and is both cooler and more compact than expected. This affects how Pluto’s upper atmosphere is lost to space, and how it interacts with the stream of charged particles from the sun known as the solar wind. “We’ve discovered that pre-New Horizons estimates wildly overestimated the loss of material from Pluto’s atmosphere,” said Fran Bagenal, from the University of Colorado, Boulder, and lead author of the particles and plasma paper. “The thought was that Pluto’s atmosphere was escaping like a comet, but it is actually escaping at a rate much more like Earth’s atmosphere.”

SwRI’s Randy Gladstone of San Antonio is the lead author of the Science paper on atmospheric findings. He added, “We’ve also discovered that methane, rather than nitrogen, is Pluto’s primary escaping gas. This is pretty surprising, since near Pluto’s surface the atmosphere is more than 99 percent nitrogen.”

Scientists also are analyzing the first close-up images of Pluto’s small moons—Styx, Nix, Kerberos and Hydra. Discovered between 2005 and 2012, the four moons range in diameter from about 25 miles (40 kilometers) for Nix and Hydra to about six miles (10 kilometers) for Styx and Kerberos. Mission scientists further observed that the small satellites have highly anomalous rotation rates and uniformly unusual pole orientations, as well as icy surfaces with brightness and colors distinctly different from those of Pluto and Charon.

They’ve found evidence that some of the moons resulted from mergers of even smaller bodies, and that their surface ages date back at least 4 billion years. “These latter two results reinforce the hypothesis that the small moons formed in the aftermath of a collision that produced the Pluto-Charon binary system,” said Hal Weaver, New Horizons project scientist from the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, and lead author of the Science paper on Pluto’s small moons.

About half of New Horizons’ flyby data has now been transmitted home – from distances where radio signals at light speed need nearly five hours to reach Earth – with all of it expected back by the end of 2016.

“This is why we explore,” said Curt Niebur, New Horizons program scientist at NASA Headquarters in Washington. “The many discoveries from New Horizons represent the best of humankind and inspire us to continue the journey of exploration to the solar system and beyond.”
3. Cold Atom Laboratory Doing Cool Research

On a sun-drenched hill in Southern California’s San Gabriel Mountains, researchers are making progress on an experimental facility that could create the coldest known place in the universe.

The Cold Atom Laboratory (CAL), developed at NASA’s Jet Propulsion Laboratory, Pasadena, California, will probe the wonders of quantum physics when it launches to the International Space Station. The CAL facility recently hit a milestone of making an ultra-cold quantum gas with potassium, a high-tech feat that puts it on track for launch next year. The planned flight to space is in August 2017.

"Studying gases that have been cooled down to extreme temperatures is key to understanding how complexity arises in the universe, and allows us to test the fundamental laws of physics in a whole new way," said Robert Thompson, project scientist for the Cold Atom Laboratory at JPL.

Researchers with CAL are interested in a state of matter called a Bose-Einstein condensate, which happens when all the atoms in a very cold gas have the same energy levels. Like dancers in a chorus line, the atoms become synchronized and behave like one continuous wave instead of discrete particles.

On Earth, gravity limits how long scientists can study Bose-Einstein condensates because this form of matter falls to the bottom of any apparatus used to study it. In microgravity, such condensates can be observed for longer periods of time. This would allow scientists to better understand the properties of particles in this state and their uses for tests of fundamental physics. Ultra-cold atoms in microgravity may also be key to a wide variety of advanced quantum sensors, and exquisitely sensitive measurements of quantities such as gravity, rotations and magnetic fields.

Using lasers, magnetic traps and an electromagnetic "knife" to remove warm particles, CAL will take atoms down to the coldest temperatures ever achieved.

In February, the team created their first ultra-cold quantum gas made from two elemental species: rubidium and potassium. Previously, in 2014, CAL researchers made Bose-Einstein condensates using rubidium, and were able to reliably create them in a matter of seconds. This time, the cooled rubidium was used to bring potassium-39 down to ultra-cold temperatures.

"This marks an important step for the project, as we needed to verify that the instrument could create this two-species ultra-cold gas on Earth before doing so in space," said Anita Sengupta, the project manager for CAL, based at JPL.

"We were able to cool the gases down to about a millionth of a degree Kelvin above absolute zero, the point at which atoms would be close to motionless," said JPL's David Aveline, the CAL testbed lead.

That sounds inconceivably cold to mere mortals, but such temperatures are like tropical beach afternoons compared to the ultimate goal of CAL. Researchers hope to cool atoms down to a billionth of a degree above absolute zero when the experimental facility gets to space.

One area of science to which CAL will contribute is called Efimov physics, which makes fascinating predictions about the ways that a small number of particles interact. Isaac Newton had fundamental insights into how two bodies interact -- for example, Earth and the moon -- but the rules that govern them are more complicated...
when a third body, such as the sun, is introduced. The interactions become even more complex in a system of three atoms, which behave according to the odd laws of quantum mechanics.

Under the right conditions, ultra-cold gases that CAL produces contain molecules with three atoms each, but are a thousand times bigger than a typical molecule. This results in a low-density, "fluffy" molecule that quickly falls apart unless it is kept extremely cold.

"The way atoms behave in this state gets very complex, surprising and counterintuitive, and that's why we're doing this," said Eric Cornell, a physicist at the University of Colorado and the National Institute of Standards and Technology, both in Boulder, and member of the CAL science team. Cornell shared the 2001 Nobel Prize in physics for creating Bose-Einstein condensates.

At a recent meeting at JPL, researchers associated with the mission gathered to discuss ongoing developments and their scientific goals, which range from dark matter detection to atom lasers. They included Cornell, who, along with co-investigator Peter Engels of Washington State University, is leading one of the CAL experiments. "CAL science investigators could open new doors into the quantum world and will demonstrate new technologies for future NASA missions," said CAL Deputy Project Manager Kamal Oudrhiri at JPL.

"CAL's investigation will generate scientific data that could rewrite textbooks for generations," said Mark Lee, senior program scientist for fundamental physics at NASA Headquarters.

For more information about the Cold Atom Laboratory visit http://coldatomlab.jpl.nasa.gov/

Source: NASA
The Night Sky

Friday, March 18

• As winter turns to spring, Orion declines in the southwest after dark with his Belt roughly horizontal. But when does Orion's Belt appear exactly horizontal? That depends on where you're located east-west in your time zone, and on your latitude. Can you time this event? If you're near your time zone's standard longitude, expect it around 9:15 this evening (daylight-saving time)... more or less.

Saturday, March 19

• Look lower left of the Moon this evening for Regulus, as shown at right. The Sickle of Leo, a backward question mark, extends upper left from there. Much farther lower left shines bright Jupiter.

• Equinox tonight. Spring begins in the Northern Hemisphere at 12:30 a.m. March 20th Eastern Daylight Time; 9:30 p.m. March 19th Pacific Daylight Time; 4:30 March 20th UT/GMT. This is when the Sun crosses the equator, heading north. So in the Southern Hemisphere, fall begins.

Sunday, March 20

• Regulus, brightest star of Leo, stands above the Moon this evening, as shown here. Jupiter is the bright thing farther to the Moon's lower left.

Monday, March 21

• This evening the waxing gibbous Moon forms a smallish triangle with Jupiter and faint little Sigma Leonis, Leo's hind foot (it's 4th magnitude, not shown on the chart). Watch the triangle change shape from hour to hour as the Moon moves eastward along its orbit — and watch the triangle change orientation as it moves across your sky.

Of course they really have nothing to do with each other. The Moon is 1.3 light-seconds from us, Jupiter tonight is 37 light-minutes distant, and Sigma Leonis is 210 light-years in the background.

• Double shadow on Jupiter tonight. Both Io and Europa are casting their tiny black shadows onto Jupiter from 12:23 to 2:31 a.m. Tuesday morning EDT; 9:23 to 11:31 p.m. PDT. The shadows cross Jupiter not far behind the satellites themselves, which are harder to see against the planet's sunlit disk.

Meanwhile, Jupiter's Great Red Spot should rotate across the planet's central meridian around the middle of this period: around 1:34 a.m. EDT; 10:34 p.m. PDT.

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](https://www.nasa.gov/space-station/sightings/).

NASA-TV Highlights
(all times Eastern Daylight Time)

**Friday, March 18**

4:30 p.m., ISS Expedition 47-48 Soyuz TMA-20M Launch Coverage (Ovchinin, Skripochka, J. Williams; launch scheduled at 5:26 p.m. ET; includes video B-roll of the crew’s pre-launch activities at 4:40 p.m. ET) (all channels)

7:30 p.m., Video File of ISS Expedition 47-48 Soyuz TMA-20M Pre-Launch, Launch Video B-Roll and Related Interviews (all channels)

10:30 p.m., ISS Expedition 47-48 Soyuz TMA-20M Docking Coverage (Ovchinin, Skripochka, J. Williams; docking scheduled at 11:11 p.m. ET) (all channels)

**Saturday, March 19**

12:30 a.m., ISS Expedition 47-48 Soyuz TMA-20M Hatch Opening and Other Activities (Ovchinin, Skripochka and J. Williams) Hatch Opening is scheduled at 12:55 a.m (all channels)

2:30 a.m., Video File of ISS Expedition 47-48 Soyuz TMA-20M Docking, Hatch Opening and Other Activities (all channels)

**Monday, March 21**

12:30 p.m., “What’s On Board” -- Orbital ATK/CRS-6 Science and Technology Briefing (all channels)

2:30 p.m., Prelaunch News Conference for Orbital ATK/CRS-6 (all channels)

Watch NASA TV on the Net by going to the [NASA website](https://www.nasa.gov/).
Space Calendar

- Mar 18  
  [Mar 17] Soyuz TMA-20M Soyuz-FG Launch (International Space Station 47S)
- Mar 18 - Comet P/2015 X6 (PANSTARRS) Perihelion (2.287 AU)
- Mar 18 - Comet 259P/Garradd Closest Approach To Earth (2.332 AU)
- Mar 18 - Comet 309P/LINEAR At Opposition (2.768 AU)
- Mar 18 - [Mar 16] Apollo Asteroid 2016 EL157 Near-Earth Flyby (0.012 AU)
- Mar 18 - Asteroid 27500 Mandelbrot Closest Approach To Earth (2.790 AU)
- Mar 18 - Reginald Daly’s 145th Birthday (1871)
- Mar 19 - Comet 119P/Parker-Hartley At Opposition (3.439 AU)
- Mar 19 - Comet 261P/Larson At Opposition (4.011 AU)
- Mar 19 - Comet C/2013 W2 (PANSTARRS) At Opposition (4.201 AU)
- Mar 19 - [Mar 16] Apollo Asteroid 2016 EN156 Near-Earth Flyby (0.004 AU)
- Mar 19 - [Mar 16] Apollo Asteroid 2016 EO156 Near-Earth Flyby (0.009 AU)
- Mar 19 - Apollo Asteroid 2010 FX9 Near-Earth Flyby (0.018 AU)
- Mar 19 - Amor Asteroid 2016 CX30 Near-Earth Flyby (0.088 AU)
- Mar 19 - Asteroid 73079 Davidbaltimore Closest Approach To Earth (1.168 AU)
- Mar 19 - Asteroid 281 Lucretia Closest Approach To Earth (1.370 AU)
- Mar 19 - Asteroid 13208 Fraschetti Closest Approach To Earth (1.801 AU)
- Mar 19 - Asteroid 12757 Yangtze Closest Approach To Earth (2.121 AU)
- Mar 19 - Asteroid 4559 Strauss Closest Approach To Earth (2.359 AU)
- Mar 19 - Neptune Trojan 316179 (2010 EN65) At Opposition (24.888 AU)
- Mar 20 - Vernal Equinox, 04:30 UT
- Mar 20 - Venus Passes 0.5 Degrees From Neptune
- Mar 20 - Comet 65P/Gunn Closest Approach To Earth (2.888 AU)
- Mar 20 - Comet 304P/Ory At Opposition (3.293 AU)
- Mar 20 - [Mar 18] Apollo Asteroid 2016 FB Near-Earth Flyby (0.039 AU)
- Mar 20 - Asteroid 37582 Faraday Closest Approach To Earth (1.615 AU)
- Mar 20 - 30th Anniversary (1986), Pioneer 7 Distant Flyby of Halley’s Comet
- Mar 21 - Comet 252P/LINEAR Near-Earth Flyby (0.036 AU)
- Mar 21 - Comet 172P/Yeung At Opposition (2.658 AU)
- Mar 21 - Asteroid 3354 McNair Closest Approach To Earth (1.392 AU)
- Mar 21 - Asteroid 5676 Voltaire Closest Approach To Earth (1.937 AU)
- Mar 21 - Asteroid 1132 Hollandia Closest Approach To Earth (1.995 AU)
- Mar 21 - Antonia Maury’s 150th Birthday (1866)

Source: JPL Space Calendar

Return to Contents
Intentionally lighting a fire onboard a spacecraft might seem like a bad idea. But in order to understand how fire behaves on a spacecraft, and in order to reduce the risk from fire to crew members and equipment, NASA engineers are doing just that. The test, dubbed Spacecraft Fire Experiment, or Saffire, will be conducted on the Orbital ATK Cygnus cargo vehicle, on March 22nd.

The fire will be ignited remotely inside a 3ft. x 3ft. x 5ft. container inside Cygnus, once the craft has delivered its supplies to the ISS and is returning to Earth. Until now, the only combustion tests performed have been small fires aboard the ISS, in microgravity conditions. The containers at the heart of the Saffire experiments will allow the team of engineers conducting the tests to burn larger materials, and get a better understanding of how a larger fire will behave.

The tests will be performed prior to the destruction of Cygnus as it re-enters Earth's atmosphere. Data and images from the fire will be transmitted to the researchers at the Glenn Research Center, home of the Saffire experiment, and shared with international partners.

Jason Crusan is NASA's Advanced Exploration Systems director, and he had this to say about the experiment: “NASA’s objective is to reduce the risk of long-duration exploration missions, and a spacecraft fire is one of the biggest concerns for NASA and the international space exploration community.”

A fire aboard a deep space mission could be disastrous, with no possibility of escape or rescue for crew members. Inside a spacecraft, there’s no way for the heat and pressure generated by a fire to escape. If the fire generates any toxic by-products, they can’t escape either, which creates a very dangerous situation.

The Soviet space station MIR suffered a fire in 1997. The fire lasted either 90 seconds, or 14 minutes, depending on who you ask. American astronaut Jerry Linenger was on-board MIR at the time. Here’s his description of the fire, from his memoir “Off the Planet."

As the fire spewed with angry intensity, sparks – resembling an entire box of sparklers ignited simultaneously – extended a foot or so beyond the flame’s furthest edge. Beyond the sparks, I saw what appeared to be melting wax splattering on the bulkhead opposite the blaze. But it was not melting wax. It was molten metal. The fire was so hot that it was melting metal.
A catastrophic spacecraft fire hit NASA in the early years of the Apollo missions. Apollo 1, which was the first of the manned Apollo missions, never got off the ground. A cabin fire broke out during a launch rehearsal test in January 1967, and killed the entire crew.

“Gaining a better understanding of how fire behaves in space will help further NASA’s efforts in developing better materials and technologies to reduce crew risk and increase space flight safety,” said Gary A. Ruff, NASA’s Spacecraft Fire Safety Demonstration project manager.

There will actually be 3 Saffire tests in 2016. All three will be conducted on Cygnus ships, inside the same containers, but each test will burn different material samples. Three more similar tests are planned for 2018.
A Phoenix Aurora over Iceland

Explanation: All of the other aurora watchers had gone home. By 3:30 am in Iceland, on a quiet night last September, much of that night’s auroras had died down. Suddenly though, a new burst of particles streamed down from space, lighting up the Earth’s atmosphere once again. This time, unexpectedly, pareidoliacally, they created an amazing shape reminiscent of a giant phoenix. With camera equipment at the ready, two quick sky images were taken, followed immediately by a third of the land. The mountain in the background is Helgafell, while the small foreground river is called Kaldá, both located about 30 kilometers north of Iceland’s capital Reykjavik. Seasoned skywatchers will note that just above the mountain, toward the left, is the constellation of Orion, while the Pleiades star cluster is also visible just above the frame center. The new aurora lasted only a minute and would be gone forever -- possibly dismissed as an embellished aberration -- were it not captured in the featured, digitally-composed, image mosaic.

Image Credit & Copyright: Hallgrímur P. Helgason; Rollover Annotation (online version): Judy Schmidt

Source: Astronomy Picture of the Day