Space News Update
— March 22, 2019 —

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1. LIGO Just Got a Big Upgrade, Will Begin Searching for Gravitational Waves Again on April 1st

In February of 2016, scientists at the Laser Interferometer Gravitational-wave Observatory (LIGO) made history by announcing the first-ever detection of gravitational waves (GWs). These ripples in the very fabric of the Universe, which are caused by black hole mergers or white dwarfs colliding, were first predicted by Einstein’s Theory of General Relativity roughly a century ago.

About a year ago, LIGO’s two facilities were taken offline so its detectors could undergo a series of hardware upgrades. With these upgrades now complete, LIGO recently announced that the observatory will be going back online on April 1st. At that point, its scientists are expecting that its increased sensitivity will allow for “almost daily” detections to take place.

So far, a total of 11 gravitational wave events have been detected over the course of about three and a half years. Ten of these were the result of black hole mergers while the remaining signal was caused by a pair of neutron stars colliding (a kilonova event). By studying these events and others like them, scientists have effectively embarked on a new era of astronomy.

And with the LIGO upgrades now complete, scientists hope to double the number of events that have been detected in the coming year. Said Gabriela González, a professor of physics and astronomy at Louisiana State University who spent years hunting for GWs:

"Galileo invented the telescope or used the telescope for the first time to do astronomy 400 years ago. And today we’re still building better telescopes. I think this decade has been the beginning of gravitational wave astronomy. So this will keep making progress, with better detectors, with different detectors, with more detectors."

Located in Hanfrod, Washington, and Livingston, Louisiana, the two LIGO detectors consist of two concrete pipes that are joined at the base (forming a giant L-shape) and extend perpendicular to each other for about
3.2 km (2 mi). Inside the pipelines, two powerful laser beams that are bounced off a series of mirrors are used to measure the length of each arm with extreme precision.

As gravitational waves pass through the detectors, they distort space and cause the length to change by the tiniest of distances (i.e. at the subatomic level). According to Joseph Giaime, the head of the LIGO Observatory in Livingston, Louisiana, the recent upgrades include optics that will boost laser power and reduce “noise” in their measurements.

For the remainder of the year, research into gravitational waves will also be bolstered by the fact that a third detector (the Virgo Interferometer in Italy) will also be conducting observations. During LIGO’s last observation run, which lasted from November 2016 to August 2017, Virgo was only operational and able to offer support for the very end of it.

In addition, Japan’s KAGRA observatory is expected to go online in the near future, allowing for an even more robust detection network. In the end, having multiple observatories separated by vast distances around the world not only allows for a greater degree of confirmation, but also helps narrow down the possible locations of GW sources.

For the next observation run, GW astronomers will also have the benefit of a public alert system – which has become a regular feature of modern astronomy. Basically, when LIGO detects a GW event, the team will send out an alert so that observatories around the world can point their telescopes to the source – in case the event produces observable phenomena.

This was certainly the case with the kilnova event that took place in 2017 (also known as GW170817). After the two neutron stars that produced the GWs collided, a bright afterglow resulted that actually grew brighter over time. The collision also led to the release of superfast jets of material and the formation of a black hole.
According to Nergis Mavalvala, a gravitational wave researcher at MIT, observable phenomena that are related to GW events have been a rare treat so far. In addition, there’s always the chance that something completely unexpected will be spotted that will leave scientists baffled and astounded:

"We’ve only seen this handful of black holes out of all the possible ones that are out there. There are many, many questions we still don’t know how to answer... That’s how discovery happens. You turn on a new instrument, you point it out at the sky, and you see something that you had no idea existed."

Gravitational wave research is merely one of several revolutions taking place in astronomy these days. And much like the other fields of research (like exoplanet studies and observations of the early Universe), it stands to benefit from the introduction of both improved instruments and methods in the coming years.

Source: Universe Today
2. Galactic center visualization delivers star power

Want to take a trip to the center of the Milky Way? Check out a new immersive, ultra-high-definition visualization. This 360-movie offers an unparalleled opportunity to look around the center of the galaxy, from the vantage point of the central supermassive black hole, in any direction the user chooses.

By combining NASA Ames supercomputer simulations with data from NASA's Chandra X-ray Observatory, this visualization provides a new perspective of what is happening in and around the center of the Milky Way. It shows the effects of dozens of massive stellar giants with fierce winds blowing off their surfaces in the region a few light years away from the supermassive black hole known as Sagittarius A* (Sgr A* for short).

These winds provide a buffet of material for the supermassive black hole to potentially feed upon. As in a previous visualization, the viewer can observe dense clumps of material streaming toward Sgr A*. These clumps formed when winds from the massive stars near Sgr A* collide. Along with watching the motion of these clumps, viewers can watch as relatively low-density gas falls toward Sgr A*. In this new visualization, the blue and cyan colors represent X-ray emission from hot gas, with temperatures of tens of millions of degrees; red shows moderately dense regions of cooler gas, with temperatures of tens of thousands of degrees; and yellow shows of the cooler gas with the highest densities.

A collection of X-ray-emitting gas is seen to move slowly when it is far away from Sgr A*, and then pick up speed and whip around the viewer as it comes inwards. Sometimes clumps of gas will collide with gas ejected by other stars, resulting in a flash of X-rays when the gas is heated up, and then it quickly cools down. Farther away from the viewer, the movie also shows collisions of fast stellar winds producing X-rays. These collisions are thought to provide the dominant source of hot gas that is seen by Chandra.

When an outburst occurs from gas very near the black hole, the ejected gas collides with material flowing away from the massive stars in winds, pushing this material backwards and causing it to glow in X-rays. When the outburst dies down the winds return to normal and the X-rays fade.

The 360-degree video of the Galactic Center is ideally viewed through virtual reality (VR) goggles, such as Samsung Gear VR or Google Cardboard. The video can also be viewed on smartphones using the YouTube
Moving the phone around reveals a different portion of the movie, mimicking the effect in the VR goggles. Finally, most browsers on a computer also allow 360-degree videos to be shown on YouTube. To look around, either click and drag the video, or click the direction pad in the corner.

Dr. Christopher Russell of the Pontificia Universidad Católica de Chile (Pontifical Catholic University) presented the new visualization at the 17th meeting of the High-Energy Astrophysics (HEAD) of the American Astronomical Society held in Monterey, Calif. NASA’s Marshall Space Flight Center in Huntsville, Alabama, manages the Chandra program for NASA’s Science Mission Directorate in Washington. The Smithsonian Astrophysical Observatory in Cambridge, Massachusetts, controls Chandra’s science and flight operations.

Source: Phys.org
3. OSIRIS-REx sees Bennu spewing stuff into space

Asteroid Bennu regularly ejects surface particles into space, scientists from NASA's OSIRIS-REx mission announced today. The discovery puts Bennu in a class of so-called "active asteroids," and marks the first time a spacecraft has ever seen the phenomenon first-hand. Principal investigator Dante Lauretta called the discovery "one of the biggest surprises of my scientific career." Mission scientists also provided updates on Bennu's rotation rate and the plan to collect a sample of regolith from the surface next year.

Surface spewing

The mission updates came from a newly released Nature paper (paywalled), a presentation at the 50th Lunar and Planetary Science Conference at The Woodlands, Texas, and a call with reporters today. OSIRIS-REx first saw the phenomenon in optical navigation camera images on 6 January 2019, and has since seen it occur 10 more times. Each ejection event can involve dozens or hundreds of particles ranging in size from millimeter-sized sand grains up to several-centimeter cobbles. The ejection speeds have varied from a few centimeters up to about 3 meters per second, meaning that some material falls back to the surface, some enters orbit briefly, and some escapes Bennu's gravity entirely.

BENNU PARTICLE EJECTION

This view of asteroid Bennu ejecting particles from its surface on 19 January 2019 was created by combining two images taken by OSIRIS-REx's NavCam 1 imager: a short exposure image (1.4 ms), which shows the asteroid clearly, and a long exposure image (5 sec), which shows the particles clearly. Other image processing techniques were also applied, such as cropping and adjusting the brightness and contrast of each layer.

Bennu is now one of about a dozen active asteroids that share at least some characteristics with comets. The OSIRIS-REx team doesn't know what's causing Bennu particles to suddenly jump off of the surface. The first step in understanding the process is to trace the flying particles' paths back to their sources.
The discovery was a surprise because these ejection events weren't detected from Earth, though there was at least some speculation ahead of OSIRIS-REx's arrival that Bennu might be an active asteroid. Upon learning that Bennu was active, NASA performed an analysis using orbital debris models for Earth orbit to see if the particles posed any danger to OSIRIS-REx, and determined the spacecraft was safe.

Another interesting bit of trivia is that the particle ejections could, in theory, be associated with an annual meteor shower here on Earth; such a shower would happen in September, in the southern hemisphere.

**Rotation rate**

One of the mission's major goals was to measure the Yarkovsky effect, a force caused by the asteroid's continual absorption of solar radiation and re-radiation of heat as it rotates in and out of sunlight. The Yarkovsky effect is one part of a larger effect called YORP that can alter an asteroid's trajectory, which is important for tracking potentially hazardous near-Earth asteroids.

Bennu's rotation rate has been increasing since 1999, and now, OSIRIS-REx observations have concluded that this increase is caused by the YORP effect. Just how much of an impact does this force have on Bennu? Every 1.5 million years, its rotation rate will double! Scientists believe YORP can eventually spin asteroids fast enough to break them apart, and it could be a contributing factor behind Bennu's particle ejections, though Lauretta cautioned it's too early to tell.

**Sample collection**

As we've previously noted, Bennu is much more rugged than expected. Ground-based radio astronomy led the OSIRIS-REx team to believe the surface was mostly covered in centimeter-size particles, which informed the design of TAGSAM sample collector. The team now knows Bennu is covered in boulders, 200 of which have been found to have diameters greater than 10 meters.
BENNU LIMB DETAIL

This image shows a view across asteroid Bennu’s southern hemisphere and into space, and it demonstrates the number and distribution of boulders across Bennu’s surface. The image was obtained on 7 March by the OSIRIS-REx PolyCam camera from a distance of about 5 kilometers. The large, light-colored boulder just below the center of the image is about 7.4 meters.

Fortunately, there appear to be a few fine-grained "regolith ponds" 10 to 20 meters across that might be ideal for sample collection:

REGOLITH POND ON BENNU

This trio of images acquired by NASA’s OSIRIS-REx spacecraft on 25 February approximately 1.8 kilometers from the surface shows a wide shot and two close-ups of a region in Bennu’s northern hemisphere. The wide-angle image (left), obtained by the spacecraft’s MapCam camera, shows a 180-meter-wide area with many rocks, including some large boulders, and a “pond” of regolith that is mostly devoid of large rocks. The two closer images, obtained by the high-resolution PolyCam camera, show details of areas in the MapCam image, specifically a 15-meter boulder (top) and the regolith pond (bottom). The PolyCam frames are 31 meters across.

That’s a smaller target than the OSIRIS-REx team had originally planned to hit. The team is already calling the eventual collection activity a “bulls-eye tag”; if the spacecraft was a dart simply aiming for a dartboard before, it’s now trying to hit the bulls-eye.

Fortunately, the spacecraft’s guidance and navigation performance at Bennu has been much better than expected. Coralie Adam, the OSIRIS-REx flight navigator for KinetX Aerospace, said OSIRIS-REx’s positioning at Bennu is better than GPS back on Earth. OSIRIS-REx will continue to survey Bennu throughout 2019, and begin conducting detailed reconnaissance of potential sample sites this fall. Sample collection is still on track for July 2020.

Source: Planetary Society
The Night Sky

Friday, March 22

• Immediately after dark, Sirius shines brilliantly in the south-southwest before the rise of the waning gibbous Moon (for most of North America). Lower left of Sirius, by about a fist at arm's length, is the triangle of Adhara, Wezen, and slightly fainter Aludra, counting from right to left. They form Canis Major's hind foot, rear end, and tail tip, respectively.

Just upper left of Aludra, forming a 3rd- and 4th-magnitude arc 7° long, are the three uppermost stars of the constellation Puppis. No, it's not a puppy, despite following right behind the Big Dog. It's the Poop Deck (stern) of the giant ancient constellation Argo Navis, the ship of Jason and the Argonauts. These three stars are the only stars of Argo readily visible naked-eye from mid-northern latitudes.

And just 1.4° upper right of the middle one, a small scope or good binoculars will show the 6th-magnitude open cluster M93. Look for before the Moon rises and lights the sky! See the story of M93 in the March Sky & Telescope, page 48.

Saturday, March 23

• Once the waning gibbous Moon is well up in the southeast very late this evening, use binoculars to help pick out Beta and Alpha Librae, both about 3rd magnitude, to its left and right respectively. They're each about 4° or 5° from the Moon.

Alpha (Zubenelgenubi) is a wide double star for binoculars: magnitudes 2.8 and 5.1, separation 4 arcminutes. The fainter component is now above or upper right of the brighter one.

Sunday, March 24

• This is the time of year when Orion declines in the southwest after dark, with his Belt roughly horizontal. When does Orion's Belt appear exactly horizontal? That depends on where you're located east-west in your time zone, and also on your latitude.

Can you time this event? If you're near your time zone's standard longitude, expect it around 9 this evening (daylight-saving time)... more or less.

Monday, March 25
• This is the also time of year when the dim Little Dipper juts to the right from Polaris (the Little Dipper's handle-end) during late evening. The much brighter Big Dipper curls over high above it by then, "dumping water" into it. They do the reverse water dump on fall evenings.

**Tuesday, March 26**

• Before and during tomorrow morning the 27th, you'll find the Moon shining near Jupiter.

**Source:** [Sky & Telescope](http://example.com)

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ISS Sighting Opportunities

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Sighting information for other cities can be found at NASA’s [Satellite Sighting Information](https://www.nasa.gov/)

NASA-TV Highlights
(all times Eastern Daylight Time)

**March 22, Friday**
6:30 a.m. – Coverage of International Space Station U.S. spacewalk with astronauts McClain and Hague. Spacewalk begins at 8:05 a.m. EDT and will last about 7 hours. (All Channels)
4:30 p.m. – Orbiting in the Danger Zone: Behind the Scenes of the Van Allen Probes’ Final Maneuver (All Channels)

**March 23, Saturday**
8 a.m., 4 p.m., 8 p.m. – Replay of the Orion Launch Abort System Attitude Control Motor Qualification Hot Fire Test (All Channels)
9 a.m., 5 p.m., 9 p.m. – Replay of the Orbiting in the Danger Zone: Behind the Scenes of the Van Allen Probes’ Final Maneuver (All Channels)

**March 24, Sunday**
7 a.m., 1 p.m., 7 p.m. – Replay of the Orion Launch Abort System Attitude Control Motor Qualification Hot Fire Test (All Channels)
8 a.m., 2 p.m., 8 p.m. – Replay of the Orbiting in the Danger Zone: Behind the Scenes of the Van Allen Probes’ Final Maneuver (All Channels)

**March 25, Monday**
10 a.m. - International Space Station Expedition 59 In-Flight Event for the Canadian Space Agency with Flight Engineer David Saint-Jacques of CSA (Public Channel with interpretation; Media Channel in native language)

**March 26, Tuesday**
1 p.m. – Fifth Meeting of the National Space Council (All Channels)

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

- Mar 22 - Mercury Passes 3.4 Degrees From Neptune
- Mar 22 - Comet 264P/Larsen Closest Approach To Earth (1.718 AU)
- Mar 22 - Comet 238P/Read At Opposition (2.914 AU)
- Mar 22 - Comet P/2003 L1 (Scotti) Closest Approach To Earth (4.347 AU)
- Mar 22 - Asteroid 3 Juno Occults UCAC5 506-009319 (12.4 Magnitude Star)
- Mar 22 - Aten Asteroid 2019 EA2 Near-Earth Flyby (0.002 AU)
- Mar 22 - Apollo Asteroid 4581 Asclepius Closest Approach To Earth (0.138 AU)
- Mar 22 - Asteroid 2074 Shoemaker Closest Approach To Earth (0.950 AU)
- Mar 22 - Amor Asteroid 3199 Nefertiti Closest Approach To Earth (1.062 AU)
- Mar 22 - Apollo Asteroid 1685 Toro Closest Approach To Earth (1.265 AU)
- Mar 22 - Asteroid 13123 Tyson Closest Approach To Earth (1.964 AU)
- Mar 22 - Asteroid 35165 Quebec Closest Approach To Earth (2.211 AU)
- Mar 22 - Friedrich Argelander's 220th Birthday (1799)
- Mar 22 - Ulugh Beg's 625th Birthday (1394)
- Mar 23 - Mars Spring Equinox
- Mar 23 - Comet P/2006 F4 Closest Approach To Earth (1.502 AU)
- Mar 23 - Comet P/1999 XN120 (Catalina) Closest Approach To Earth (3.144 AU)
- Mar 23 - Comet C/2017 S3 (PANSTARRS) At Opposition (3.296 AU)
- Mar 23 - Comet 326P/Hill At Opposition (4.258 AU)
- Mar 23 - [Mar 21] Apollo Asteroid 2019 FF Near-Earth Flyby (0.008 AU)
- Mar 23 - [Mar 16] Apollo Asteroid 2019 EK2 Near-Earth Flyby (0.012 AU)
- Mar 23 - Apollo Asteroid 1864 Daedalus Closest Approach To Earth (1.017 AU)
- Mar 23 - Asteroid 7758 Poulanderson Closest Approach To Earth (1.332 AU)
- Mar 23 - Asteroid 8080 Intel Closest Approach To Earth (2.690 AU)
- Mar 23 - Asteroid 37452 Spirit Closest Approach To Earth (3.573 AU)
- Mar 23 - Norman Pogson's 190th Birthday (1829)
- Mar 23 - Pierre Simon Laplace's 270th Birthday (1749)
- Mar 24 - Apollo Asteroid 2005 FC3 Near-Earth Flyby (0.077 AU)
- Mar 24 - Asteroid 16155 Buddy Closest Approach To Earth (1.812 AU)
- Mar 24 - Asteroid 246247 Sheldoncooper Closest Approach To Earth (2.006 AU)
- Mar 24 - Asteroid 12542 Laver Closest Approach To Earth (2.540 AU)
- Mar 24 - Jupiter Trojan 3317 Paris At Opposition (4.325 AU)
- Mar 24-29 - Caltech Space Challenge 2019, Pasadena, California
- Mar 25 - Lingue 1B OS-M1 Launch
- Mar 25 - Comet 128P-B/Shoemaker-Holt At Opposition (3.777 AU)
- Mar 25 - Comet 128P/Shoemaker-Holt At Opposition (3.778 AU)
- Mar 25 - Aten Asteroid 3554 Amun Closest Approach To Earth (1.281 AU)
- Mar 25 - Asteroid 9250 Chamberlin Closest Approach To Earth (1.719 AU)
- Mar 25 - Asteroid 19034 Santorini Closest Approach To Earth (3.568 AU)
- Mar 26 - Amor Asteroid 8034 Akka Closest Approach To Earth (1.088 AU)
- Mar 26 - Dwarf Planet 136472 Makemake At Opposition (51.671 AU)
- Mar 26 - Charles Juels' 75th Birthday (1944)

Source: JPL Space Calendar
Food for Thought

Volunteers wanted to help unlock the secrets of the universe

Scientists are appealing for public help on one of the biggest astronomy projects of the next ten years.

In a new citizen science project launched today—known as AstroQuest—researchers are looking for volunteers to study images of galaxies and figure out which light is coming from which galaxy.

"When you go outside and look up at the night sky, there's a lot of black with all of the stars dotted around," said astrophysicist Dr Luke Davies, from the University of Western Australia node of the International Centre for Radio Astronomy Research (ICRAR).

"But when you look with a really powerful telescope for a long time, you actually see that there are galaxies and stars everywhere, all over the sky.

"It's really, really crowded, and all of these galaxies and stars overlap with each other."

Dr Davies helps lead WAVES—or the Wide Area Vista ExtraGalactic Survey—a million-dollar international project and the biggest spectroscopic galaxy evolution survey ever undertaken.

He said WAVES needs to accurately measure the light coming from millions of galaxies.

"We use sophisticated computer algorithms to make sense of where the light is coming from in these crowded regions," Dr Davies said.

An image of AstroQuest galaxy alongside how it looks in the AstroQuest platform once a citizen scientist has 'helped' the computer to identify what belongs to the main galaxy and what doesn't. Credit: ICRAR/AstroQuest"

"But the computer often gets it wrong. It's simply no match for the human eye and brain."
Dr Davies said professional astronomers have previously looked through all the galaxies and fixed the computer’s mistakes.

"But as more and more galaxies are surveyed, there simply aren't enough people on our team to do it," he said.

ICRAR citizen science project officer Lisa Evans said AstroQuest asks volunteers to take over from professional astronomers and check the computer’s work.

Where the computer has gotten it wrong, volunteers are asked to fix it.

"There's never been a citizen science project quite like this before," Ms Evans said.

"This is the first time we've got people actually painting over the galaxies and drawing in where they are."

Ms Evans has also added game features to AstroQuest, including leaderboards, quests and achievements.

An image of an AstroQuest galaxy alongside how it looks in the AstroQuest platform once a citizen scientist has helped the computer to identify what belongs to the main galaxy and what doesn’t. Credit: ICRAR/AstroQuest

Dr Davies said knowing the amount of light that comes from a galaxy can tell us things like how many stars the galaxy currently has, how many stars it’s forming and how much dust is in it.

He said the team is ultimately trying to learn more about how galaxies in the early Universe evolved into the galaxies that we see today.
"If you map out millions of galaxies and measure all of their properties you can actually see how galaxies change as the Universe gets older. You can then explore how things like where a galaxy lives in the Universe and if it's crashing into other galaxies affect how it evolves with time," he says.

AstroQuest is a chance for anyone who's interested in astronomy to be involved in one of the biggest scientific projects of the next ten years, Dr Davies said.

"You can essentially be at the forefront of scientific research and help out a huge million-dollar international project just by being at your computer and drawing over pictures of galaxies," he said.

Source: Phys.org
Space Image of the Week

Hubble Captures the Brilliant Heart of a Massive Galaxy

This fuzzy orb of light is a giant elliptical galaxy filled with an incredible 200 billion stars. Unlike spiral galaxies, which have a well-defined structure and boast picturesque spiral arms, elliptical galaxies appear fairly smooth and featureless. This is likely why this galaxy, named Messier 49 (M49), was discovered by French astronomer Charles Messier in 1771. At a distance of 56 million light-years and measuring 157,000 light-years across, M49 was the first member of the Virgo Cluster of galaxies to be discovered, and it is more luminous than any other galaxy at its distance or nearer.

Elliptical galaxies tend to contain a larger portion of older stars than spiral galaxies and also lack young, blue stars. Messier 49 itself is very yellow, which indicates that the stars within it are mostly older and redder than the Sun. In fact, the last major episode of star formation within the galaxy was about six billion years ago — before the Sun was even born!
Messier 49 is also rich in globular star clusters; it hosts about 6,000 — a number that dwarfs the 150 found in and around the Milky Way. On average, these clusters are 10 billion years old. Messier 49 is also known to host a supermassive black hole at its center with the mass of more than 500 million Suns, identifiable by the X-rays pouring out from the heart of the galaxy. (As this Hubble image comprises optical and infrared observations, these X-rays are not visible here.)

Source: NASA