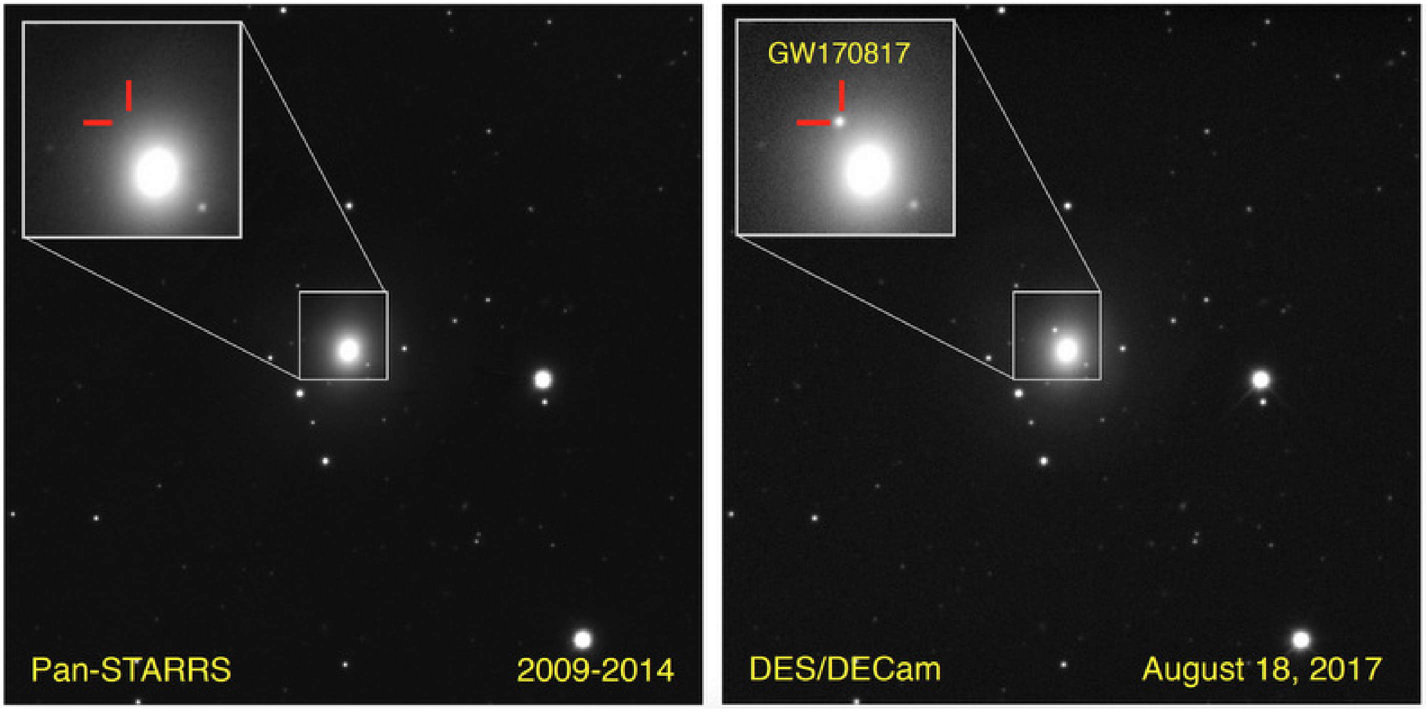
Space News Update

— October 17, 2017 —

Contents

1. First Cosmic Event Observed in Both Gravitational Waves and Light



About 130 million years ago, in a galaxy far away, two neutron stars collided. The cataclysmic crash produced gravitational waves, ripples in the fabric of space and time. This event is now the 5th observation of gravitational waves by the Laser Interferometer Gravitational wave Observatory (LIGO) and Virgo collaboration, and the first detected that was not caused by the collision of two black holes.

But this event — called a kilonova — produced something else too: light, across multiple wavelengths.

For the first time in history, an astronomical phenomenon has been first observed through gravitational waves and then seen with telescopes. In an incredibly collaborative effort, over 3,500 astronomers using 100 instruments on over 70 telescopes around the world and in space worked with physicists from the LIGO and Virgo collaboration.

Scientists call this “multimessenger astronomy.”

“Together, all these observations are bigger than the sum of their parts,” said Laura Cadonati, LIGO’s Deputy Spokesperson at a briefing today. “We are now learning about the physics of the universe, about the elements we are made of, in a way that no one has ever done before.”

“It will give us insight into how supernova explosions work, how gold and other heavy elements are created, how the nuclei in our body works and even how fast the universe is expanding,” said Manuela Campanelli, from the Rochester Institute of Technology. “Multimessenger astronomy demonstrates how we can combine the old way with the new. It has changed the way astronomy is done.”

Neutron stars are the crushed leftover cores of massive stars that long ago exploded as supernovae. The two stars, located near each other in a galaxy called NGC 4993, started out between 8-20 times the mass of our sun. Then with their supernovas, each condensed down to about 10 miles in diameter, the size of a city. These are stars composed entirely of neutrons and are in-between normal stars and black holes in size and density — just a teaspoon of neutron star material would weigh 1 billion tons.

They spun around each other in a cosmic dance until their mutual gravity caused them to collide. That collision produced a fireball of astronomical proportions and the repercussions of that event arrived at Earth 130 million years later.

“While this event took place 130 million years ago, we only found out about this on Earth on August 17, 2017, just before the solar eclipse,” said Andy Howell from the Las Cumbres Observatory, speaking at a press briefing today. “We’ve been keeping this secret the whole time and we’re about to bust!”

At 8:41 am EDT, LIGO and Virgo felt the early tremors of the ripples of spacetime, gravitational waves. Just two seconds later, a bright flash of gamma rays was detected by NASA’s Fermi space telescope. This allowed researchers to quickly pinpoint the direction from which the waves were coming.

Alerted by an Astronomers Telegram, thousands of astronomers around the world scrambled to make observations and begin collecting additional data from the neutron star merger.

This animation shows how LIGO, Virgo, and space- and ground-based telescopes zoomed in on the location of gravitational waves detected August 17, 2017 by LIGO and Virgo. By combining data from the Fermi and Integral space missions with data from LIGO and Virgo, scientists were able to confine the source of the waves to a 30-square-degree sky patch. Visible-light telescopes searched a large number of galaxies in that region, ultimately revealing NGC 4993 to be the source of gravitational waves.

“This event has the most precise sky localization of all detected gravitational waves so far,” Jo van den Brand, spokesperson for the Virgo collaboration, said in a statement. “This record precision enabled astronomers to perform follow-up observations that led to a plethora of breathtaking results.”

This provides the first real evidence that light and gravitational waves travel at the same speeds – near the speed of light — as Einstein predicted.

Observatories from the very small to the most well-known were involved, quickly making observations. While bright at first, the event faded in less than 6 days. Howell said the observed light was 2 million times brighter than the Sun over the coarse of the first few hours, but it then faded over a few days.

The Dark Energy Camera (DECam), which is mounted on the Blanco 4-meter Telescope at the Cerro Tololo Inter-American Observatory in the Chilean Andes was one of the instruments that helped localize the source of the event.

“The challenge that we face every time that the LIGO collaboration issues a new observational trigger is how do we search for a source that is rapidly fading, was possibly faint to begin with, and is located somewhere over there,” said Marcelle Soares-Santos, from Brandeis University at the briefing. She is the first author on the paper describing the optical signal associated with the gravitational waves. “It’s the classical challenge of finding a needle in a haystack with the added complication that the needle is far away and haystack is moving.”

With the DECam, they were quickly able to determine the source galaxy, and rule out 1500 other candidates that were present in that haystack.

“Things that look like needles are very common, so we need to make sure we have the right one. Today, we are certain we have,” Soares-Santos added.

In the very small department, a small robotic 16-inch telescope called PROMPT (Panchromatic Robotic Optical Monitoring and Polarimetry Telescope) — which astronomer David Sand from the University of Arizona described at “basically a souped-up amateur telescope,” — also helped determine the source. Sand said this proves that even small telescopes can play a roll in multimessenger astronomy.

The well known is led by Hubble and several other NASA and ESA space observatories, such as the Swift, Chandra and Spitzer missions. Hubble captured images of the galaxy in visible and infrared light, witnessing a new bright object within NGC 4993 that was brighter than a nova but fainter than a supernova. The images showed that the object faded noticeably over the six days of the Hubble observations. Using Hubble's spectroscopic capabilities the teams also found indications of material being ejected by the kilonova as fast as one-fifth of the speed of light.

“This is a game-changer for astrophysics,” said Howell. “A hundred years after Einstein theorized gravitational waves, we've seen them and traced them back to their source to find an explosion with new physics of the kind we only dreamed about before.”

Here are just a few of insights this single event created, using multimessenger astronomy:

*** Gamma rays**: These flashes of light are now definitively associated with merging neutron stars and will help scientists figure out how supernova explosions work, explained Richard O'Shaughnessy, also from Rochester Institute of Technology and a member of the LIGO team. “The initial gamma-ray measurements, combined with the gravitational-wave detection, further confirm Einstein's general theory of relativity, which predicts that gravitational waves should travel at the speed of light,” he said.

*** The source of gold and platinum**: “These observations reveal the direct fingerprints of the heaviest elements in the periodic table,” said Edo Berger, from the Harvard Smithsonian Center for Astrophysics, speaking at the briefing. “The collision of the two neutron stars produced 10 times of mass of Earth in gold and platinum alone. Think about how as these materials are flying out of this event, they eventually combine with other elements to form stars, planets, life … and jewelry.”

Berger added something else to think about: the original supernova explosions of these stars produced all the heavy elements up to iron and nickel. Then in the kilonova in this one system, we can see the complete history of how the periodocial table of the heavy elements came to being.

Howell said that when you split the signatures of the heavy elements into a spectrum, you create a rainbow. “So there really was a pot of gold at the end of the rainbow, at least a kilonova rainbow,” he joked.

*** Nuclear physics astronomy:** “Eventually, more observations like this discovery will tell us how the nuclei in our body works,” O'Shaughnessy said. “The effects of gravity on neutron stars will tell us how big balls of neutrons behave, and, by inference, little balls of neutrons and protons — the stuff inside of our body that makes up most of our mass”; and

*** Cosmology**:- “Scientists now can independently measure how fast the universe is expanding by comparing the distance to the galaxy containing the bright flare of light and distance inferred from our gravitational wave observation,” said O'Shaughnessy.

“The ability to study the same event with both gravitational waves and light is a real revolution in astronomy,” said astronomer Tony Piro from the CfA. “We can now study the universe with completely different probes, which teaches things we could never know with only one or the other.”

“For me, what made this event so amazing is that not only did we detect gravitational waves, but we saw light across the electromagnetic spectrum, seen by 70 observatories around the world,” said David Reitz, scientific spokesman for LIGO, at today's press briefing. “This is the first time the cosmos has provided to us the equivalent of movies with sound. The video is the observational astronomy across various wavelengths and the sound is gravitational waves."

Source: Universe Today Return to Contents

2. Webcam on Mars Express Surveys High-Altitude Clouds

An unprecedented catalogue of more than 21 000 images taken by a webcam on ESA's Mars Express is proving its worth as a science instrument, providing a global survey of unusual high-altitude cloud features on the Red Planet.

The low-resolution camera was originally installed on Mars Express for visual confirmation that the Beagle-2 lander had separated in 2003. In 2007 it was switched back on and used primarily for outreach, education and citizen science, with images automatically posted to a dedicated Flickr page, sometimes within just 75 minutes of being taken at Mars.

Last year, with new software, the camera was adopted as a supporting science instrument. Now, the first paper has been published, on detached, high-altitude cloud features and dust storms over the edge, or 'limb', of the planet.

While these limb clouds can be imaged by other instruments or spacecraft, it is not necessarily their main task – they are usually looking directly at the surface with a narrow field of view that covers a small portion of the planet for specialised study. By contrast, the webcam often has a global view of the full limb.

"For this reason, limb observations in general are not so numerous, and this is why our images are so valuable in contributing to our understanding of atmospheric phenomena," says Agustin Sánchez-Lavega, lead author of the study from the University del Pais Vasco in Bilbao, Spain.

"Combining with models and other datasets we were able to gain a better insight to understanding atmospheric transport and seasonal variations that play a role in generating the high-altitude cloud features."

The catalogue of some 21 000 images taken between 2007 and 2016 were examined and 300 identified for the study.

Multiple images separated by a few minutes each were obtained for 18 events as they rotated into view, providing visual documentation of the features from different perspectives.

In general, the cloud features imaged by the camera have peak altitudes in the range of 50–80 km above the planet and extend horizontally from about 400 km up to 1500 km.

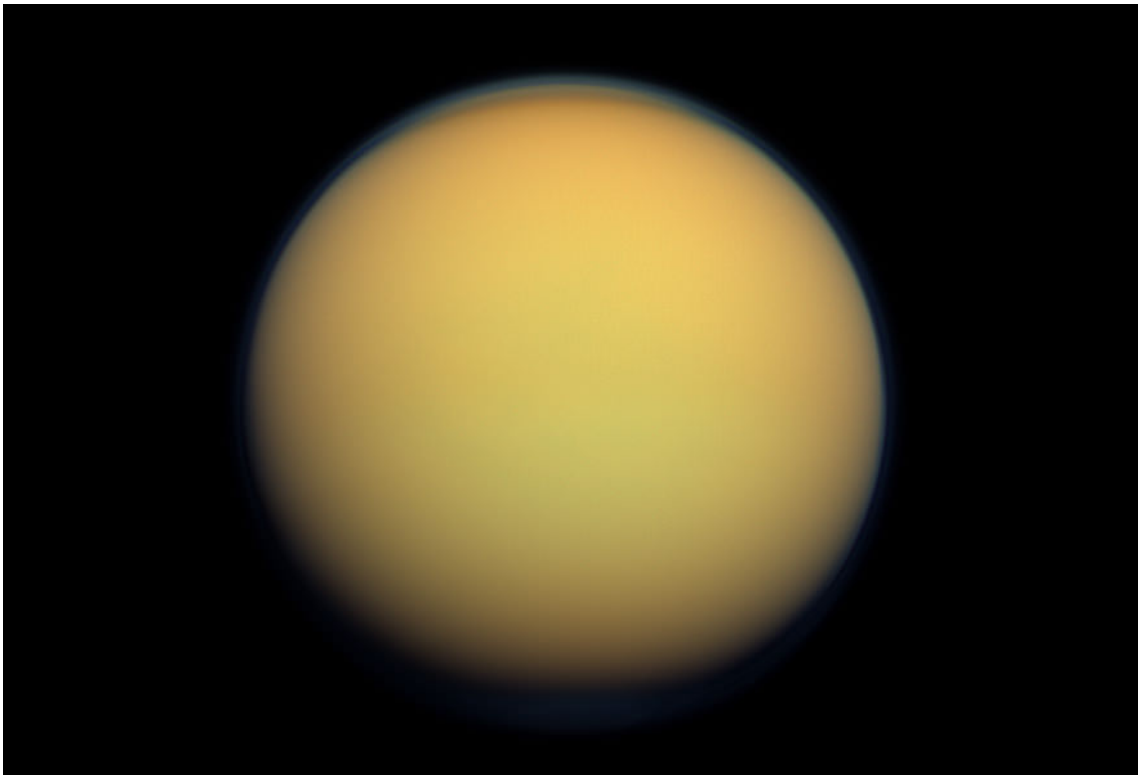
In order to understand the nature of the clouds – for example, if they were primarily composed of dust or icy particles – the team compared the images with atmospheric property predictions detailed by the Mars Climate Database. The database uses temperature and pressure information to indicate if either water or carbon dioxide clouds could be capable of forming at that time and altitude.

The team also looked at the weather report generated from images by NASA's Mars Reconnaissance Orbiter, and in some cases had additional corresponding observations obtained from other sensors on ESA's Mars Express.

Source: ESA

Return to Contents

3. Scientists Find Evidence of Extreme Methane Storms on Titan



Saturn's largest moon, Titan, is a mysterious place; and the more we learn about it, the more surprises it seems to have in store. Aside from being the only body beyond Earth that has a dense, nitrogen-rich atmosphere, it also has methane lakes on its surface and methane clouds in its atmosphere. This hydrological-cycle, where methane is converted from a liquid to a gas and back again, is very similar to the water cycle here on Earth.

Thanks to the NASA/ESA *Cassini-Huygens* mission, which concluded on September 15th when the craft crashed into Saturn's atmosphere, we have learned a great deal about this moon in recent years. The latest find, which was made by a team of UCLA planetary scientists and geologists, has to do with Titan's methane rain storms. Despite being a rare occurrence, these rainstorms can apparently become rather extreme.

The study which details their findings, titled "Regional Patterns of Extreme Precipitation on TitanConsistent with Observed Alluvial Fan Distribution", recently appeared in the scientific journal *Nature Geoscience*. Led by Saun P. Faulk, a graduate student at UCLA's Department of Earth, Planetary, and Space Sciences, the team conducted simulations of Titan's rainfall to determine how extreme weather events have shaped the moon's surface.

What they found was that the extreme methane rainstorms may imprint the moon's icy surface in much the same way that extreme rainstorms shape Earth's rocky surface. On Earth, intense rainstorms play an important role in geological evolution. When rainfall is heavy enough, storms can trigger large flows of water that transport sediment into low lands, where it forms cone-shaped features known as alluvial fans.

During it's mission, the *Cassini* orbiter found evidence of similar features on Titan using its radar instrument, which suggested that Titan's surface could be affected by intense rainfall. While these fans are a new discovery, scientists have been studying the surface of Titan ever since Cassini first reached the Saturn system in 2006. In that time, they have noted several interesting features.

These included the vast sand dunes that dominate Titan's lower latitudes and the methane lakes and seas that dominate it's higher latitudes – particularly around the northern polar region. The seas – Kraken Mare, Ligeia Mare, and Punga Mare – measure hundreds of km across and up to several hundred meters deep, and are fed by branching, river-like channels. There are also many smaller, shallower lakes that have rounded edges and steep walls, and are generally found in flat areas.

In this case, the UCLA scientists found that the alluvial fans are predominantly located between 50 and 80 degrees latitude. This puts them close to the center of the northern and southern hemispheres, though slightly closer to the poles than the equator. To test how Titan's own rainstorms could cause these features, the UCLA team relied on computer simulations of Titan's hydrological cycle.

What they found was that while rain mostly accumulates near the poles – where Titan's major lakes and seas are located – the most intense rainstorms occur near 60 degrees latitude. This corresponds to the region where alluvial fans are most heavily concentrated, and indicates that when Titan does experience rainfall, it is quite extreme – like a seasonal monsoon-like downpour.

As Jonathan Mitchell – a UCLA associate professor of planetary science and a senior author of the study – indicated, this is not dissimilar to some extreme weather events that were recently experienced here on Earth. "The most intense methane storms in our climate model dump at least a foot of rain a day, which comes close to what we saw in Houston from Hurricane Harvey this summer," he said.

The team also found that on Titan, methane rainstorms are rather rare, occurring less than once per Titan year – which works out to 29 and a half Earth years. But according to Mitchell, who is also the principal investigator of UCLA's Titan climate modeling research group, this is more often than they were expecting. "I would have thought these would be once-a-millennium events, if even that," he said. "So this is quite a surprise."

In the past, climate models of Titan have suggested that liquid methane generally concentrates closer to the poles. But no previous study has investigated how precipitation might cause sediment transport and erosion, or shown how this would account for various features observed on the surface. As a result, this study also suggests that regional variations in surface features could be caused by regional variations in precipitation.

On top of that, this study is an indication that Earth and Titan have even more in common than previously thought. On Earth, contrasts in temperature are what lead to intense seasonal weather events. In North America, tornadoes occur during the early to late Spring, while blizzards occur during the winter. Meanwhile, temperature variations in the Atlantic Ocean are what lead to hurricanes forming between the summer and fall.

Similarly, it appears that on Titan, serious variations in temperature and moisture are what triggers extreme weather. When cooler, wetter air from the higher latitudes interacts with warmer, drier air from the lower latitudes, intense rainstorms result. These findings are also significant when it comes to other bodies in our Solar System that have alluvial fans on them – such as Mars.

In the end, understanding the relationship between precipitation and planetary surfaces could lead to new insights about the impact climate change has on Earth and the other planets. Such knowledge would also go a long way towards helping us mitigate the effects it is having here on Earth, where the changes are only unnatural, but also sudden and very hazardous.

And who knows? Someday, it could even help us to alter the environments on other planets and bodies, thus making them more suitable for long-term human settlement (aka. terraforming)!

Source: Universe Today

Return to Contents

The Night Sky

Tuesday, October 17

• Draw a line from Altair, the brightest star high in the southwest after dark, to the right to Vega, high in the west and even brighter. Continue the line half as far onward, and you hit the Lozenge: the pointy-nosed head of Draco, the Dragon, with orange Eltanin as the tip of his nose.

Wednesday, October 18

• Algol is at minimum light this evening for a couple hours centered on 10:14 p.m. EDT.

Thursday, October 19

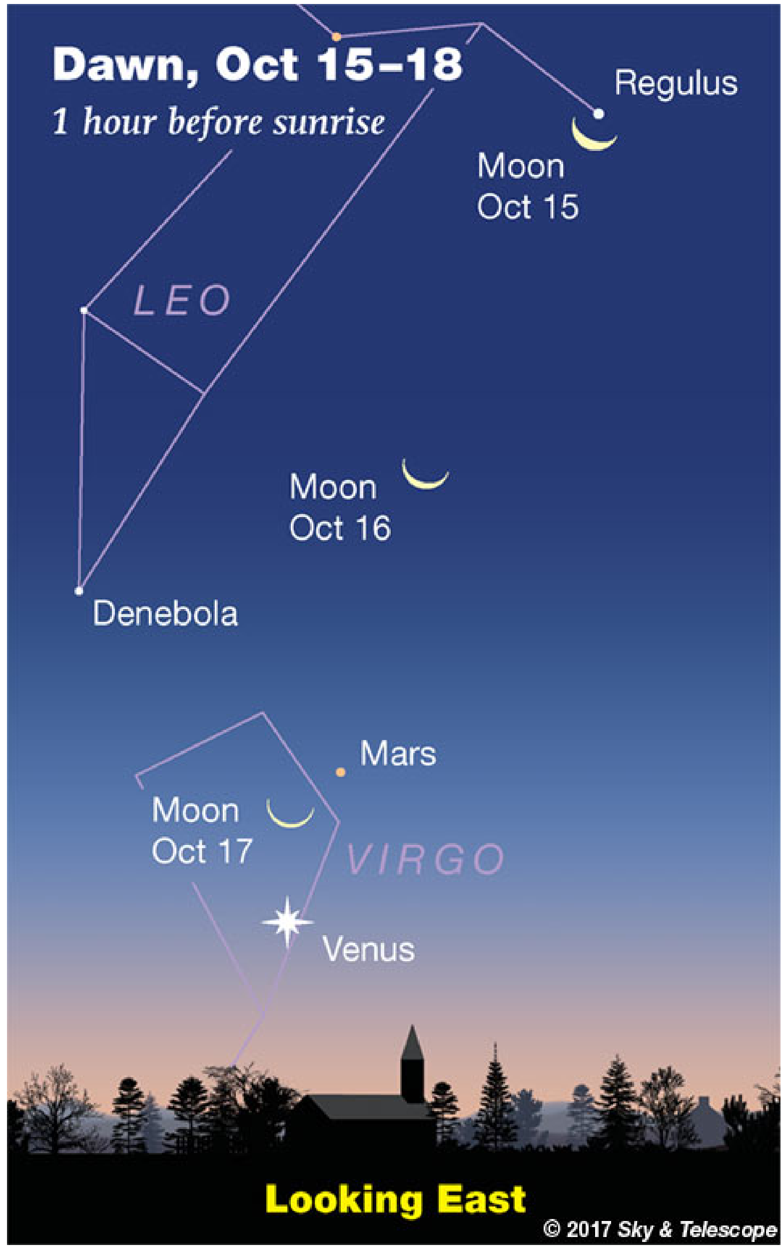
• The modest Orionid meteor shower is active for the next few nights in the early-morning hours. The shower's radiant is near Orion's Club, low in the east after midnight and high in the south by the beginning of dawn. The sky will be free of moonlight.

• New Moon (exact at 3:12 p.m. EDT).

Friday, October 20

• Look for Capella sparkling low in the northeast this week. Look for the Pleiades cluster about three fists at arm's length to its right. These harbingers of the cold months to come rise higher as evening grows late.

Upper right of Capella, and upper left of the Pleiades, the stars of Perseus stand astride the Milky Way. Upper left of Perseus is Cassiopeia.



Source: Sky & Telescope

Return to Contents

ISS Sighting Opportunities

For Denver:

Date	Visible	Max Height	Appears	Disappears
Mon Oct 16, 6:54 PM	4 min	57°	33° above WNW	10° above SE
Tue Oct 17, 7:38 PM	1 min	11°	11° above SW	10° above SW
Wed Oct 18, 6:47 PM	2 min	22°	22° above SW	10° above S

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

NASA-TV Highlights

(all times Eastern Daylight Time)

3:30 p.m., Thursday, October 19 - Coverage of the RS-25 Rocket Engine Test Firing (Starts at 3:45 p.m.) (all channels)

6:30 a.m., Friday, October 20 - Coverage of ISS Expedition 53 U.S. Spacewalk #46 (Spacewalk begins at 8:05 a.m. ET, expected to last 6 ½ hours; Bresnik and Acaba) (all channels)

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

Return to Contents

Space Calendar

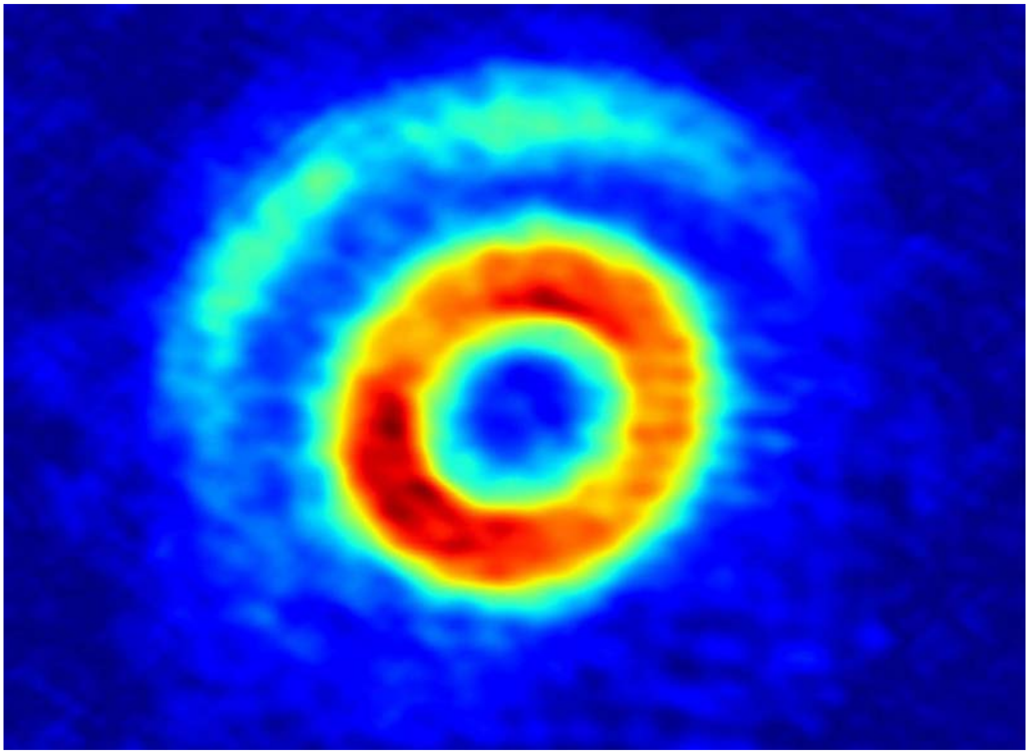
- Oct 17 - SkySat 8-13/ COPPER 2/ CPOD A & B/ MinXSS 2/ RANGE A & B Minotaur-C-XL-3210 Launch
- Oct 17 - Moon Occults Asteroid 21 Lutetia
- Oct 17 - Comet 73P-BL/Schwassmann-Wachmann At Opposition (1.217 AU)
- Oct 17 - Comet 73P-AQ/Schwassmann-Wachmann At Opposition (1.284 AU)
- Oct 17 - Comet 47P/Ashbrook-Jackson At Opposition (1.925 AU)
- Oct 17 - Comet 340P/Boattini Closest Approach To Earth (2.496 AU)
- Oct 17 - Comet 65P/Gunn Perihelion (2.910 AU)
- Oct 17 - [Oct 16] Apollo Asteroid 2017 TE5 Near-Earth Flyby (0.003 AU)
- Oct 17 - [Oct 17] Apollo Asteroid 2017 TW5 Near-Earth Flyby (0.008 AU)
- Oct 17 - [Oct 16] Apollo Asteroid 2017 TU3 Near-Earth Flyby (0.021 AU)
- Oct 17 - Amor Asteroid 2011 PT Near-Earth Flyby (0.058 AU)
- Oct 17 - Asteroid 4511 Rembrandt Closest Approach To Earth (1.360 AU)
- Oct 17 - Asteroid 7554 Johnspencer Closest Approach To Earth (2.760 AU)
- Oct 17 - Dwarf Planet 136199 Eris At Opposition (95.192 AU)
- Oct 17 - 5th Anniversary (2012), Novato Meteorite Fall in California (Hit House)
- Oct 18 - [Oct 12] 50th Anniversary (1967), Venera 4, Venus Landing
- Oct 18 - Mercury Passes 1.0 Degrees from Jupiter
- Oct 18 - Comet C/2017 O1 (ASASSN) Closest Approach To Earth (0.720 AU)
- Oct 18 - Comet 73P-AR/Schwassmann-Wachmann At Opposition (1.302 AU)
- Oct 18 - Comet 73P-AG/Schwassmann-Wachmann At Opposition (1.303 AU)
- Oct 18 - Comet 73P-U/Schwassmann-Wachmann Closest Approach To Earth (2.169 AU)
- Oct 18 - Comet P/2015 F1 (PANSTARRS) At Opposition (3.372 AU)
- Oct 18 - Comet 351P/Wiegert-PANSTARRS At Opposition (3.490 AU)
- Oct 18 - [Oct 17] Apollo Asteroid 2017 TX5 Near-Earth Flyby (0.012 AU)
- Oct 18 - [Oct 16] Apollo Asteroid 2017 TD5 Near-Earth Flyby (0.029 AU)
- Oct 18 - Aten Asteroid 2006 TU7 Near-Earth Flyby (0.048 AU)
- Oct 18 - Kuiper Belt Object 202421 (2005 UQ513) At Opposition (47.229 AU)
- Oct 18 - 40th Anniversary (1977), Charles Kowal's Discovery of Chiron
- Oct 18 - Pascual Jordan's 115th Birthday (1902)
- Oct 18 - 120th Anniversary (1897), Delhi Meteorite Fall in India
- Oct 18 - Carl Kiess' 130th Birthday (1887)
- Oct 18 - 170th Anniversary (1847), John Hind's Discovery of Asteroid 8 Flora
- Oct 19 - [Oct 12] 50th Anniversary (1967), Mariner 5, Venus Flyby
- Oct 19 - Uranus At Opposition
- Oct 19 - Comet 73P-P/Schwassmann-Wachmann At Opposition (1.342 AU)
- Oct 19 - [Oct 17] Apollo Asteroid 2017 TA6 Near-Earth Flyby (0.017 AU)
- Oct 19 - [Oct 13] Apollo Asteroid 2017 TG2 Near-Earth Flyby (0.051 AU)
- Oct 19 - Asteroid 8489 Boulder Closest Approach To Earth (2.432 AU)
- Oct 20 - Comet 337P/WISE Closest Approach To Earth (2.766 AU)
- Oct 20 - Comet C/2015 V1 (PANSTARRS) At Opposition (3.307 AU)
- Oct 20 - Comet C/2015 V1 (PANSTARRS) Closest Approach To Earth (3.307 AU)
- Oct 20 - Comet 228P/LINEAR At Opposition (3.438 AU)
- Oct 20 - Apollo Asteroid 2017 SH14 Near-Earth Flyby (0.036 AU)
- Oct 20 - [Oct 13] Apollo Asteroid 2017 TO2 Near-Earth Flyby (0.036 AU)
- Oct 20 - Amor Asteroid 2017 SY20 Near-Earth Flyby (0.048 AU)
- Oct 20 - Aten Asteroid 2014 UR Near-Earth Flyby (0.064 AU)
- Oct 20 - Asteroid 11836 Eileen Closest Approach To Earth (0.779 AU)
- Oct 20 - Asteroid 30439 Moe Closest Approach To Earth (1.658 AU)

- Oct 20 - Asteroid 4446 Carolyn Closest Approach To Earth (2.679 AU)
- Oct 20 - Christopher Wren's 385th Birthday (1632)

Source: JPL Space Calendar Return to Contents

Food for Thought

Astronomers find potential solution into how planets form



The quest to discover how planets found in the far reaches of the universe are born has taken a new, crucial twist.

A new study by an international team of scientists, led by Stefan Kraus from the University of Exeter, has given a fascinating new insight into one of the most respected theories of how planets are formed.

Young stars start out with a massive disk of gas and dust that over time, astronomers think, either diffuses away or coalesces into planets and asteroids.

However, scientists are still searching for a complete understanding of how these early formations come together to form asteroid-sized objects. One reason has been that drag in the disk produced by surrounding gas makes the grains move inward toward the star - which can in turn deplete the disk rapidly in a process known as "radial drift."

In the new research, the team use high powered telescopes to target the star V1247 Orionis -, a young, hot star surrounded by a dynamic ring of gas and dust.

The team produced a detailed image of the star and its surrounding dust disc, shown in two parts: a clearly defined central ring of matter and a more delicate crescent structure located further out.

The region between the ring and crescent, visible as a dark strip, is thought to be caused by a young planet carving its way through the disc. As the planet moves around in its orbit, its motion creates areas of high pressure on either side of its path, similar to how a ship creates bow waves as it cuts through water.

These areas of high pressure could become protective barriers around sites of planet formation; dust particles are trapped within them for millions of years, allowing them the time and space to clump together and grow.

Professor Kraus said: "The exquisite resolution of ALMA allowed us to study the intricate structure of such a dust-trapping vortex for the first time. The crescent in the image constitutes a dust trap that formed at the outer edge of the dark strip.

"It also reveals regions of excess dust within the ring, possibly indicating a second dust trap that formed inside of the putative planet's orbit. This confirms earlier computer simulations that predicted that dust traps should form both at the outer edge and inner edge of disc gaps.

"Dust trapping is one potential solution to a major stumbling block in our theories of how planets form, which predicts that particles should drift into the central star and be destroyed before they have time to grow to planetesimal sizes."

Dust-trapping vortices and a potentially planet-triggered spiral wake in the pre-transitional disk of V1247 Orionis is published in *Astrophysical Journal Letters*.

Source: Phys.org Return to Contents

Space Image of the Week

Puerto Rico from the Space Station

NASA astronaut Joe Acaba photographed Puerto Rico from the cupola of the International Space Station on Oct. 12, 2017. Sharing the image with his followers on social media, he wrote, "Finally a chance to see the beautiful island of Puerto Rico from @Space_Station. Continued thoughts throughout the recovery process."

Acaba, whose parents were both born in Puerto Rico, joined NASA as a member of the 2004 class of astronauts and is on his third mission to the space station as a Flight Engineer on the Expedition 53/54 crew.

Image Credit: NASA

Source: NASA

Return to Contents