SIRIUS ASTRONOMER

www.ocastronomers.org — The Newsletter of the Orange County Astronomers

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The Summer Triangle is one of the most famous asterisms of the summer sky. The Triangle is formed by three of the brightest stars in the summer sky, Vega (top), Deneb (lower left), and Altair (right). Contained within the Triangle are many fascinating deep sky objects; this region of the sky alone will keep an observer busy for a whole night! This photo was taken in 1999 by the late John Sanford, a longtime OCA member who contributed greatly to the field of astrophotography.

OCA MEETING

The free and open club meeting will be held June 12 at 7:30 PM in the Irvine Lecture Hall of the Hashinger Science Center at Chapman University in Orange. This month's speaker is Liam Kennedy, who will tell us how technology can enable us to be in closer touch with the International Space Station

NEXT MEETINGS: July 10, August 14

STAR PARTIES

The Black Star Canyon site will open on June 20. The Anza site will be open on June 13. Members are encouraged to check the website calendar for the latest updates on star parties and other events.

Please check the website calendar for the outreach events this month! Volunteers are always welcome!

You are also reminded to check the web site frequently for updates to the calendar of events and other club news.

COMING UP

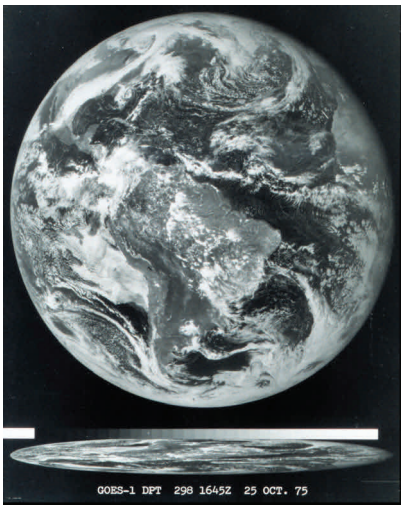
The next session of the Beginners Class will be held at the Heritage Museum of Orange County at 3101 West Harvard Street in Santa Ana on June 5. The following class will be held August 7.

GOTO SIG: TBA
Astro-Imagers SIG: June 9, July 14
Remote Telescopes: TBA
Astrophysics SIG: June 19, July 17
Dark Sky Group: TBA

The "G" in GOES Is What Makes It Go

By Ethan Siegel

Going up into space is the best way to view the universe, eliminating all the distortionary effects of weather, clouds, temperature variations and the atmosphere's airflow all in one swoop. It's also the best way, so long as you're up at high enough altitudes, to view an entire 50 percent of Earth all at once. And if you place your observatory at just the right location, you can observe the *same* hemisphere of Earth continuously, tracking the changes and behavior of our atmosphere for many years.



The trick, believe it or not, was worked out by Kepler some 400 years ago! The same scientist who discovered that planets orbit the sun in ellipses also figured out the relationship between how distant an object needs to be from a much more massive one in order to have a certain orbital period. All you need to know is the period and distance of one satellite for any given body, and you can figure out the necessary distance to have any desired period. Luckily for us, planet Earth has a natural satellite—the moon—and just from that information, we can figure out how distant an artificial satellite would need to be to have an orbital period that exactly matches the length of a day and the rotational speed of Earth. For our world, that means an orbital distance of 42,164 km (26,199 miles) from Earth's center, or 35,786 km (22,236 miles) above mean sea level.

We call that orbit *geosynchronous* or *geostationary*, meaning that a satellite at that distance always remains above the exact same location on our world. Other effects—like solar wind, radiation pressure and the moon—require onboard thrusters to maintain the satellite's precisely desired position above any given point on Earth's surface. While geostationary satellites have been in use since 1963, it was only in 1974 that the Synchronous Meteorological Satellite (SMS) program began to monitor Earth's weather with them, growing into the Geostationary Operational Environmental Satellite (GOES) program the next year. For 40 years now, GOES satellites have monitored the Earth's weather continuously, with a total of 16 satellites having been launched as part of the program. To the delight of NASA (and Ghostbusters) fans everywhere, GOES-R series will launch in 2016, with thrice the spectral information, four times the spatial resolution and five times the coverage speed of its predecessors, with many other improved capabilities. Yet it's the simplicity of gravity and the geostationary "G" in *GOES* that gives us the power to observe our hemisphere all at once, continuously, and for as long as we like!

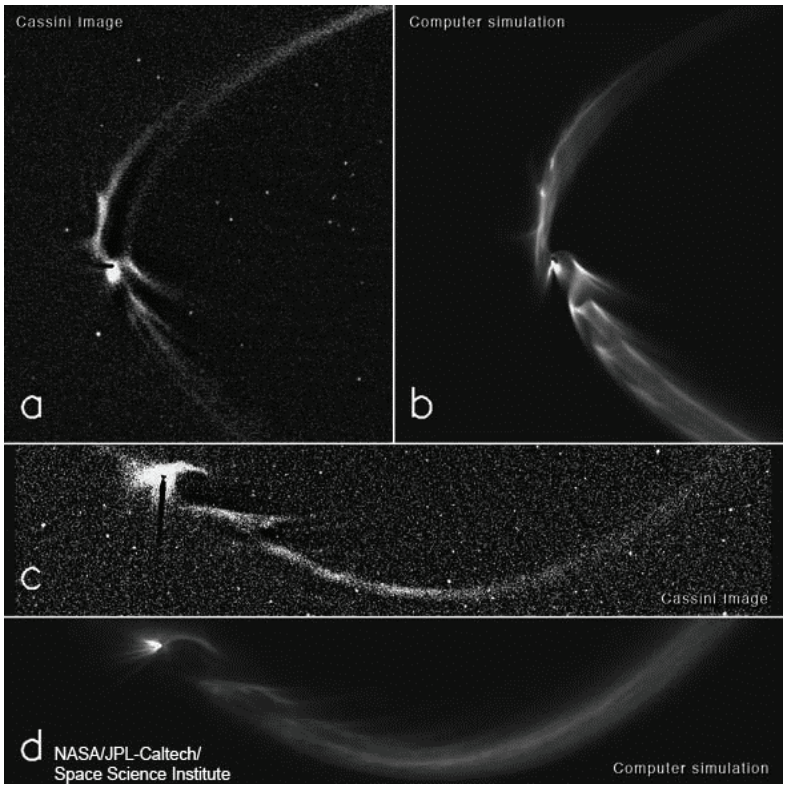
Image credit: National Oceanic and Atmospheric Administration, of the first image ever obtained from a GOES satellite. This image was taken from over 22,000 miles (35,000 km) above the Earth's surface on October 25, 1975.

AstroSpace Update

June 2015

Gathered by Don Lynn from NASA and other sources

Saturn storms – The long-standing mystery of why Saturn seethes with enormous storms every 30 years may have been solved by scientists working with data from the Cassini mission. The storms can grow into bright bands that encircle the entire planet, and were found to be on a natural timer. In 140 years of telescope observations, great storms have erupted on Saturn 6 times. The timer theory is that water vapor is heavier than the hydrogen and helium that make up the bulk of Saturn's atmosphere, so once each giant storm dumps its huge mass of rain, the air within the clouds is left lighter than the atmosphere below. For a time, this situation shuts off convection, in which warm air rises and cool air sinks, that creates new clouds and storms. The air above has to cool off before convection can continue, and this cooling process takes about 30 years. Saturn probably contains more water than Jupiter, and that is why this 30-year storm cycle happens on Saturn but not its neighbor planet.



Cassini (Saturn mission) – Computer simulations of particle movement from the geysers on Saturn's moon Enceladus have reproduced tendrils observed by Cassini reaching from that moon to the E-ring, tens of thousands of miles (km) away. The size of particles and source on Enceladus can be determined by what simulation best matches the observations. The tendrils are composed of particles no smaller than about 1/100,000 inch (1/4000 mm), which is consistent with other measurements made of the particle size in the E-ring. The details in the tendrils change with time, probably in sync with the tidal forces acting on the fractures from which the geysers emanate. More observations are planned of tendrils, geyser plumes, and the surface of the moon at the geyser locations.

More geysers – New research using data from Cassini suggests most of the eruptions from Saturn's moon Enceladus might be long curtains rather than geyser-like jets. Many features that appear to be individual jets of material might be phantoms created by looking through folds in the curtains. The researchers modeled eruptions on Enceladus us uniform curtains along the tiger stripe fractures. They found that phantom brightness enhancements appear where looking through a fold. The folds exist because the fractures are more wavy than perfectly straight. The researchers think this illusion is responsible for most of what appear to be individual jets. Phantoms in simulated images produced by the scientists line up nicely with some of the features in real Cassini images that appear to be discrete jets. Curtain eruptions occur on Earth where molten rock gushes out of a deep fracture. These are seen in places like Hawaii, Iceland and the Galapagos Islands.

Curiosity (Mars rover) – Perchlorate was previously identified in Martian soil by Curiosity and the Phoenix lander. It has properties of absorbing water vapor from the atmosphere and lowering the freezing temperature of water. This has bee proposed for years as a mechanism for possible existence of transient liquid brines at higher latitudes on Mars, despite that planet's cold dry conditions. New calculations were made based on more than a Mars year of temperature and humidity measurements from Curiosity. They indicate that conditions at the rover's near-equatorial location were favorable for small quantities of brine to form during some nights throughout the year, drying out again after sunrise. Conditions should be even more favorable at higher latitudes, where colder temperatures and more water vapor can result in higher relative humidity more often. Researchers using the high resolution camera on the Mars Reconnaissance Orbiter have in recent years documented numerous sites on Mars where dark flows appear and extend on slopes during warm seasons. The features are called recurring slope lineae, or RSL. A leading hypothesis is that they involve brines forming.

MAVEN (Mars orbiter) detected evidence of widespread auroras in Mars's northern hemisphere. The lights circled the globe and descended so close to the Martian equator that, if they had occurred on Earth, they would have been over places like Florida. This isn't the 1st time a spacecraft has detected auroras on Mars. But it is the most extensive seen. Unlike Earth, Mars does not have a global magnetic field that envelops the entire planet. Instead, Mars has umbrella-shaped magnetic fields that sprout out of the ground here and there, but mainly in the southern hemisphere. According to MAVEN data, solar particles that caused the lights penetrated deeply into the Martian atmosphere, sparking auroras less than 60 miles (100 km) from the surface. That's lower than auroras on Earth, which range from 60-300 miles (100-500 km). A diffuse green glow seems quite possible in the Mars sky.

Salt – For more than a decade, scientists have wondered about the nature of the dark material that coat long fractures and other relatively young geological features on the surface of Jupiter's moon Europa. Its association with young terrains suggests the material has erupted from within Europa, but with limited data available, the material's chemical composition has remained elusive. A new study has placed various materials into a chamber duplicating conditions on Europa, except with the radiation applied more quickly, and plain old salt has become a good candidate. It ages with radiation into stuff the color (yellowish brown) and spectrum matching observations. Previous studies showed that sulfur and magnesium compounds matched the data reasonably well. The longer salt samples were exposed to radiation, the darker the resulting color. So it might be possible to determine the ages of various patches on Europa by how dark they are. To settle definitively what the material is, we need another spacecraft with higher resolution spectrographs to visit Europa.

Dawn (asteroid mission) – A new color map of dwarf planet Ceres made from Dawn data reveals differences in features and color across the surface, suggesting Ceres was once an active body. Ceres' surface is heavily cratered, as expected from meteoroid impacts since the surface formed long ago. The map shows fewer large craters than expected and some very bright spots in the northern hemisphere. The infrared mapping spectrometer has been examining the relative temperatures of features. One pair of bright spots (brightest on Ceres) shares the temperature of their surroundings, while other bright spots are cooler than their surroundings.

Formation of the Moon – Within the 1st 150 million years after our Solar System formed, a body about the size of Mars struck and merged with Earth, blasting a huge cloud of debris into space that eventually coalesced to form the Moon. However, the isotopes of some elements found on the Moon and Earth implied the story was not that simple. The isotopes are too much alike. The Moon should show differences because it would contain more of the impacting body, and it is extremely unlikely that the impacting body had the same isotopes as the pre-impact Earth. A new study of the isotopes of tungsten may have solved the mystery. If the impact was violent enough, new simulations show that the material from Earth and the impactor would thoroughly mix before settling down and forming the Moon. Evidence suggests that both Earth and Moon gathered additional material after the main impact, and that Earth collected more of this material. The new material contained a lot of tungsten, but relatively little of this was of the lighter isotope 182. So one would expect that Earth would have less tungsten-182 than the Moon. The new study found exactly this. The small, but significant, difference in tungsten-182 corresponds to the difference in material gathered after impact by the Earth and Moon. So immediately after impact, the Earth and Moon had the same abundance of tungsten isotopes, implying that impact material thoroughly mixed.

Spitzer (infrared space telescope) has teamed up with a telescope on the ground to find a remote gas planet about 13,000 light-years away, making it one of the most distant planets known. The OGLE telescope in Chile scans the sky for microlensing events. These occur when a foreground object (star or planet) passes in front of a more distant star, and the gravity of the foreground object focuses the light of the distant one, making it appear brighter for a period of days. The technique has yielded about 30 planet discoveries so far, with the farthest residing about 25,000 light-years away. From just the microlensing event, the distance to the object cannot be determined. But in the latest example, simultaneous observation with Spitzer yielded timing differences between the 2 views of the event, from which distance can be calculated. Scientists were also able to calculate the mass of the planet, which is about half that of Jupiter.

Changing exoplanet – For the 1st time, researchers have detected atmospheric variability on a rocky planet outside the Solar System. They observed a nearly 3-fold change in temperature over a 2-year period. Although the researchers are quick to point out that the cause of the variability is still under investigation, they believe the readings could be due to massive amounts of volcanic activity.

Using the Spitzer Space Telescope, the researchers observed thermal emission coming from the planet, called 55 Cancri e, located 40 light-years away, and for the 1st time found rapidly changing conditions, with temperatures swinging between 1800 and 4900°F (1000 -2700°C). If caused by volcanic activity, it would be higher than what has been observed on Io, the most geologically active body in the Solar System. The researchers believe that volcanic activity is spewing gas and dust that sometimes block our view of the thermal emission. 55 Cancri e is a super-Earth, that is, a rocky exoplanet about twice the diameter of Earth. It is one of 5 planets orbiting a Sun-like star so closely that a year lasts just 18 hours. The planet is tidally locked, keeping ones side permanently toward its star. Since it is the nearest super-Earth whose atmosphere can be studied, 55 Cancri e is among the best candidates for detailed observations of surface and atmospheric conditions on rocky exoplanets. In recent years, astronomers have been able to map the conditions on many gas giants, but it is much more difficult to do so for super-Earths. Earlier observations of 55 Cancri e pointed to an abundance of carbon, suggesting that the planet was composed of diamond. But the observations supporting this are changing, so the carbon-rich properties may not be there.

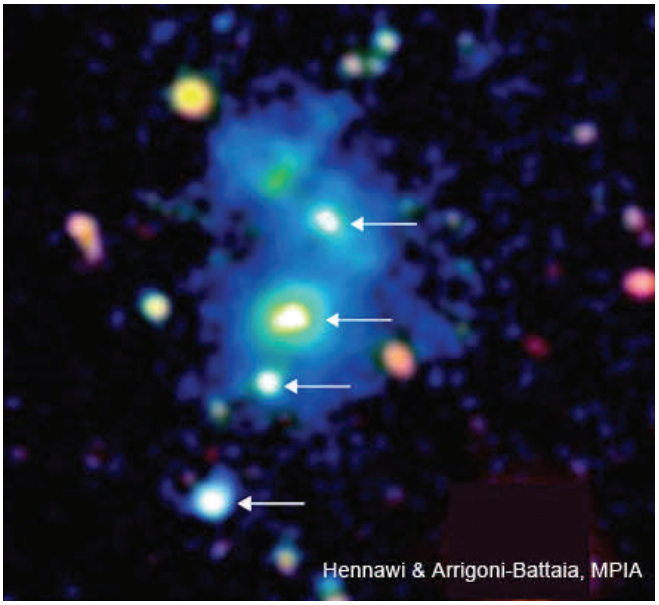
ALMA (radiotelescope array in Chile) – For the 1st time, astronomers have detected the presence of complex organic molecules in a protoplanetary disk surrounding a young star. This discovery, made with ALMA, reveals that the protoplanetary disk surrounding the million-year-old star MWC 480 is brimming with methyl cyanide, a complex carbon-based molecule. Both this molecule and its simpler cousin hydrogen cyanide were found in the cold outer reaches of the star's newly formed disk. The molecules found in MWC 480 are also found in similar concentrations in our own Solar System's comets. Studies have yet to detect any obvious signs of planet formation in the disk, so it is in the very early stages of development. It had been known that such organic chemicals could form in cold dark interstellar clouds, but until these observations, it was not clear that they could survive the forming of a star and its disk.

Black hole magnetic field – ALMA has detected an extremely powerful magnetic field, stronger than anything previously detected in the core of a galaxy, very close to the event horizon of a supermassive black hole. Supermassive black holes are located at the heart of almost all galaxies. These black holes can accrete huge amounts of matter in the form of a surrounding disk. While most of this matter is fed into the black hole, some can escape moments before capture and be flung out into space at close to the speed of light as a jet. How this happens is not well understood, although it is thought that strong magnetic fields play a role. Up to now, only weak magnetic fields far from black holes (several light-years away) had been found. In this study, however, astronomers have detected signals directly related to a strong magnetic field close to the event horizon of the supermassive black hole in a distant galaxy known as PKS 1830-211. This magnetic field is located at the place were matter is suddenly boosted away from the black hole in a jet. The team measured the strength of the magnetic field by studying the way in which light was polarized as it moved away from the black hole. The polarization indicated an extremely strong magnetic field only a few light-days from the event horizon.

Possible binary black hole – As 2 galaxies enter the final stages of merging, scientists have theorized that the galaxies' supermassive black holes will form a binary: 2 black holes in close orbit. A new study has found a quasar that pulses, which may be caused by such a binary supermassive black hole. Theoretically such a pair should absorb matter cyclically in sync with their orbit, causing their light to pulsate. The researchers were conducting a systematic search for variable quasars using the Pan-STARRS1 telescope on Maui. They found that quasar PSO J334.2028+01.4075, which has a very large black hole of almost 10 billion solar masses, emits a signal that pulses every 542 days. Continued observations may show the period shortening as the black holes lose energy and they move toward merging. The researchers are continuing to search for more variable quasars.

More black hole – There is lots of evidence that black holes exist, but a group of scientists is trying to actually see the features that should exist about the event horizon of a black hole. They call themselves the Event Horizon Telescope project, and they are using a wide-spread radiotelescope array to do the job. Peering at the heart of the giant galaxy M87, using just 3 of the radiotelescopes that will eventually be used, the team has looked for splash of the material falling in. An event horizon has no splash (the material just falls in and disappears), while other compact objects do have splash when material falls in. The result: too dark for splash. When all of the radiotelescope array is assembled, the team hopes to image the silhouette of an event horizon.

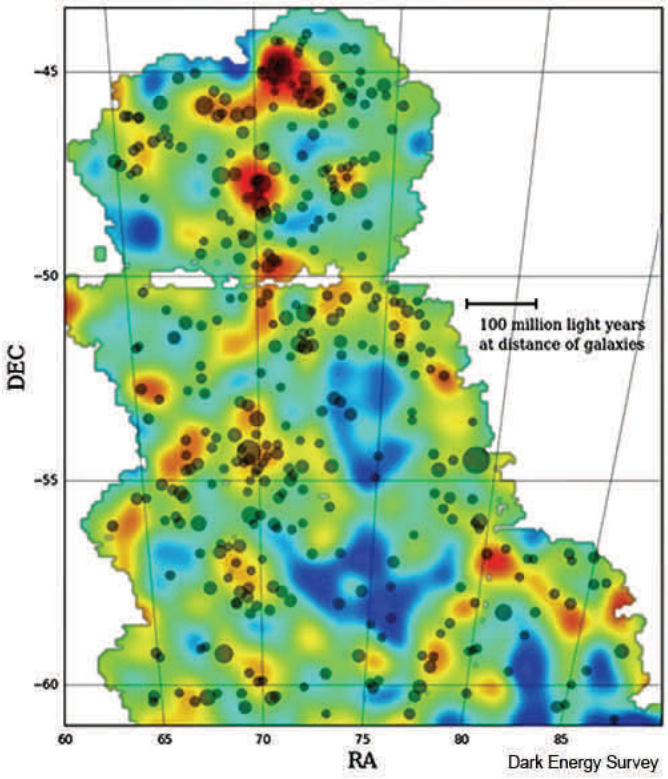
Quadruple quasar – Using the Keck Observatory in Hawaii, astronomers have discovered the 1st quadruple quasar: 4 active black holes situated in close proximity to one another. The quartet resides in one of the most massive structures ever discovered in the distant Universe, and is surrounded by a giant nebula of cool dense gas. Quasars are a brief phase of galaxy evolution, powered by the in-fall of matter onto supermassive black hole at the center of a galaxy. But these very bright episodes last only a tiny fraction of a galaxy's lifetime, making them rare in the sky, typically separated by hundreds of millions of light-years from one another. The 4 quasars are surrounded by a giant nebula of cool dense hydrogen gas, which emits light because it is irradiated by the quasars. In addition, the area has a surprisingly large amount of matter. There are hundreds of times more galaxies in this region than expected at that distance. The researchers speculated that some physical process might make quasar activity much more common in this unusual environment. One possibility is that quasar episodes are triggered when galaxies collide, because these violent interactions funnel gas onto the central black hole. Such encounters are much more likely where galaxies are found more densely. Supermassive black holes can shine as quasars only if there is gas for them to swallow, and an environment that is gas rich could promote this. How the environment observed happened is somewhat of a mystery; current simulations predict more rarefied gas that is hotter than what is seen.



Unusual supernova – Astronomers using the Very Large Array radiotelescope have found a long-sought missing link between supernova explosions that generate gamma-ray bursts and those that don't. The scientists found that a stellar explosion seen in 2012 has many of the characteristics of one that generates a gamma-ray burst, but did not produce such a burst. Supernova 2012ap is a core-collapse supernova. This type occurs when the nuclear fusion at the core of a massive star no longer can provide the energy needed to hold up the core against the weight of the outer parts of the star. The core then collapses into a super-dense neutron star or black hole. The rest of the star's material is blasted into space in a supernova explosion. The most common type of such blasts the star's material outward in a nearly spherical bubble at speeds far less than that of light. These explosions produce no burst of gamma rays. In a small percentage of cases, the infalling material is drawn into a short-lived swirling disk surrounding the new neutron star or black hole. This accretion disk generates jets of material that move outward from the disk's poles at speed approaching that of light. This combination produces gamma-ray bursts. 2012ap had the jets, but produced no gamma-ray burst. So it is a link between the gamma-ray bursts and ordinary core collapse supernovas.

NuSTAR (X-ray space telescope) has spotted an unexpected glow of high-energy X-rays while peering into the heart of the Milky Way. 4 theories have been proposed as the source of these: pulsars, white dwarfs, or black holes could be devouring material from companions, or cosmic rays could be striking dense gas. None of these fits particularly well, since most of them should produce low-energy X-rays also, which are not seen. No objects are seen there in radio either. White dwarfs are not expected to be very common in that area, and would have to be more massive than expected to produce high enough energy X-rays. In the 3 devouring cases, a swarm of objects would be needed, not just a single instance. A swarm of neutron stars might do the job if they are spun-up ones, so -called millisecond pulsars, though they would have to be quiet in low-energy X-rays. Theoretically there should be many of these millisecond pulsars near the galactic center, but none has ever been seen. Dust and gas found in the area could be masking them. More observations are planned to better understand the X-ray source.

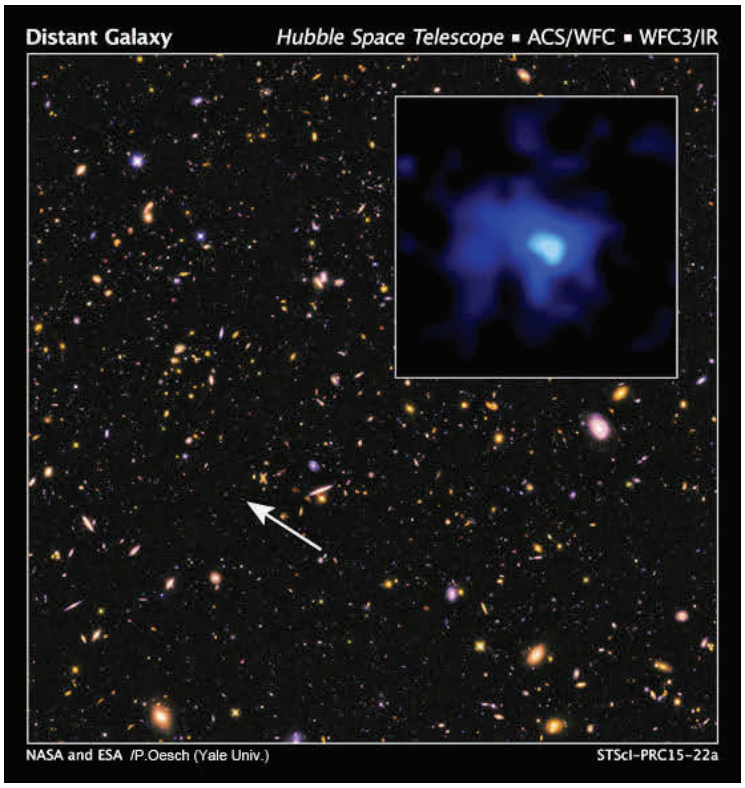
Wide binary pulsar – A team of determined high school students discovered a pulsar by analyzing data from the Byrd Green Bank radiotelescope. Further observations by astronomers revealed that this pulsar has the widest orbit of any binary neutron star. The orbit spans about 32 million miles (52 million km), roughly this distance of Mercury from our Sun, and it orbits its companion once every 45 days. About 10% of known pulsars are in binary systems, though most of those are orbiting white dwarfs, not another neutron star.



Dark matter – The 1st release has been made by the Dark Energy Survey (DES) team of detailed maps showing the distribution of dark matter calculated from its gravitational effects, covering 139 square degrees of sky. The maps confirm theories that galaxies form where large concentrations of dark matter are. The maps show how dark matter envelops galaxies of different types and how they evolve over cosmic time. The observations for DES are made with the 570-megapixel Dark Energy Camera on the 4-meter Blanco Telescope in Chile. 30 times the area of these maps will be mapped over the next few years by DES.

More dark matter – For the 1st time, dark matter may have been observed interacting with other dark matter in a way other than through gravity. Observations of colliding galaxies have picked up the 1st intriguing hints about this. A team of astronomers studied the simultaneous collision of 4 galaxies in the galaxy cluster Abell 3827. The team could trace out where the mass lies within the system and compare the distribution of dark matter with the positions of the luminous galaxies. The location of the dark matter was deduced using gravitational lensing. The collision happened to take place directly in front of a much more distant light source. The mass of dark matter around the colliding galaxies distorted space-time, distorting its image. In this study, the researchers found that one dark matter clump appeared to be lagging behind the galaxy it surrounds. The dark matter is currently 5000 light-years behind the galaxy. A log between dark matter and its associated galaxy is predicted during collisions if dark matter interacts with itself, even very slightly, through forces other than gravity. Cark matter has never before been observed interacting in any way other than through gravity. The researchers note that more investigation will be needed in order to rule out other effects that might produce the lag. Similar observations of more galaxies and computer simulations of galaxy collisions will need to be made.

Most distant galaxy – The farthest spectroscopically confirmed galaxy observed to date was found, having a redshift of 7.7. It appears to also be one of the brightest and most massive sources at that time. Due to the time light takes to reach us, we are seeing it as it appeared more than 13 billion years ago. The galaxy was about 100 million years old then. It was already more than 15% of the mass of our Milky Way today. The galaxy was still forming stars rapidly, about 80 times faster than the Milky Way today.



Dying galaxies – The most massive galaxies in the current Universe are ellipticals, typically characterized as "red and dead". That is, no new star formation is taking place, and the stars remaining are small long-lived red ones. But 10 billion years ago, these same galaxies were still producing new stars. A new study of galaxies so distant that we are seeing them as they were 10 billion years ago has found that the transition of massive galaxies to dead status occurs from the inside out. That is, star formation stops first at the core, then the stoppage spreads toward the outside. The finding does not apply to compact core galaxies, which apparently take a different evolutionary path to become some of today's giant ellipticals. The study

team has not determined why this inside-out pattern of dying occurred. Theories include effects of the central black hole and critical densities of stars shutting down star formation.

Compact ellipticals – Only about 30 compact elliptical galaxies were known until a recent study that found 195 more of them. M32, the small companion to the Andromeda galaxy, is one of the 30. Most of them lie in galaxy clusters, and debris had been found around some, leading to the theory that they were formed from a larger galaxy by having their outer edges ripped off by encounters with other galaxies. A few didn't fit this well, as they were distant from any other galaxies. Of the newly found 195, 184 of them are found in clusters or groups. The other 11 are isolated. The authors of the new study suggest that the 11 could have been flung far from the place where they were stripped, and showed how an encounter with 2 other galaxies could have done the flinging. More work needs to be done to rule out other possible scenarios for formation of compact ellipticals, but at least the newly found ones give astronomers a lot more to work with.

Instant AstroSpace Updates

The latest rocket sent with supplies to the **International Space Station**, a Russian Progress, failed to reach the proper orbit, and fell back to Earth, burning up, a few days later. The station has enough supplies to last until fall, and more supply rockets, of different types, are scheduled before then.

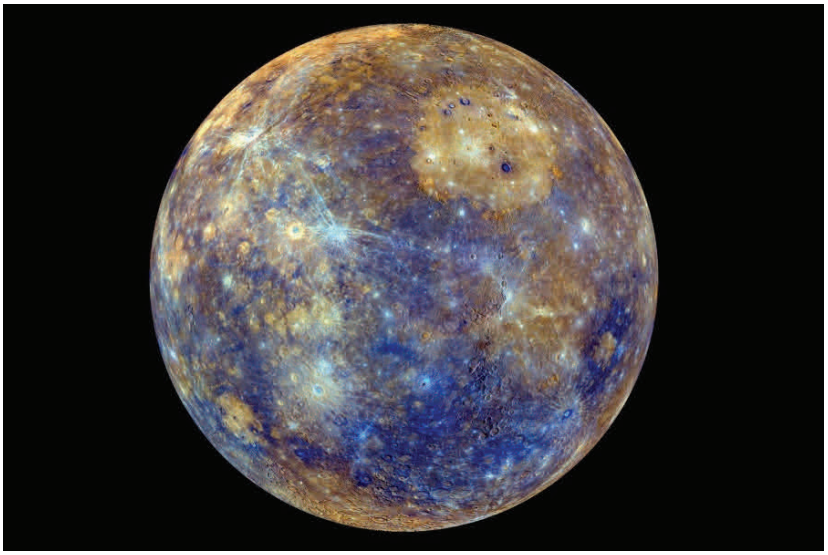
After its primary and 2 extended missions, comprised of more than 4000 orbits over more than 4 years, **MESSENGER** has run out of fuel and plunged into the planet Mercury at about 8750 mph (14,000 km/hr), probably creating a crater about 50 ft (15 m) wide. It happened on the side away from Earth, so was not observed.

Moonrise (Pauline Acalin)

Fire anFire and Ice: A MESSENGER Recap

April 30, 2015: The planet closest to the Sun is, ironically, one of the coldest.

That's just one of many mind-bending discoveries about Mercury that NASA's MESSENGER spacecraft beamed back to Earth over the past 7 years. Earlier today, the mission ended with a crash as spectacular as some of its findings.



The colors of the solar system's innermost planet are enhanced in this tantalizing view, based on global image data from the Mercury -orbiting MESSENGER spacecraft.

Mission controllers at the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, have confirmed that MESSENGER slammed into the surface of Mercury on April 30th at 3:26 p.m. EDT. It had used the last of its propellant on April 24th and could no longer maintain a stable orbit. Traveling some 8,750 mph, the plummeting spacecraft made an unseen crater on the side of the planet facing away from Earth. "Going out with a bang as it impacts the surface of Mercury, we are celebrating MESSENGER as more than a successful mission," says John Grunsfeld, associate administrator for the Science

Mission Directorate at NASA Headquarters in Washington. "Now, we begin the next phase of this mission--analyzing the exciting data already in the archives, and unravelling the mysteries of Mercury."

Here are some of MESSENGER's most important findings so far:

The hidden face of Mercury: In the mid-1970s when Mariner 10 flew past Mercury three times, the probe imaged less than half the planet. Until MESSENGER arrived, the rest of Mercury was a land of mystery. MESSENGER was the first spacecraft to view the entirety of the mighty Caloris basin—one of the biggest and youngest impact features in the solar system. Moreover, MESSENGER spotted volcanic vents around the rim of the basin, proving that volcanism—and not only impacts—have shaped the surface of the innermost planet.

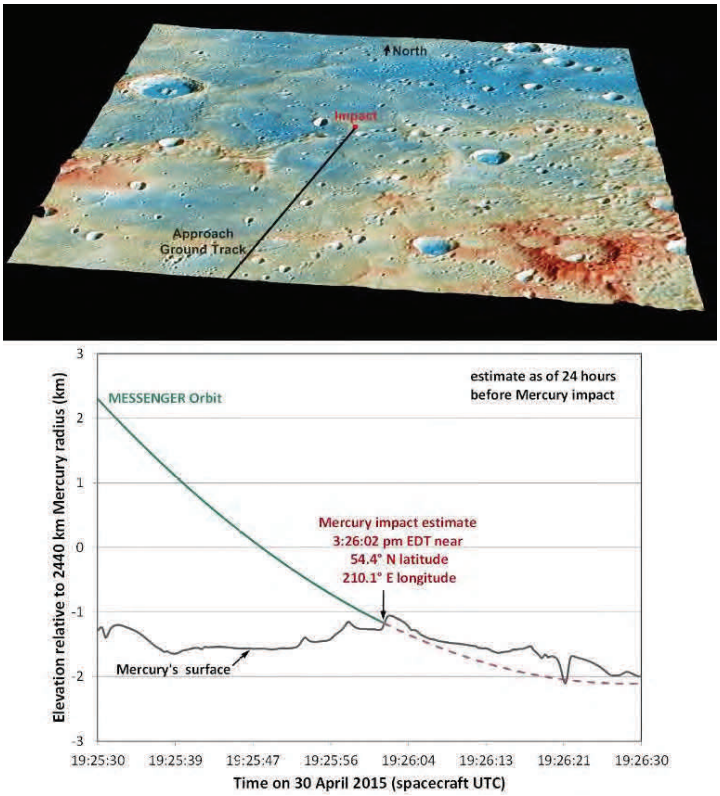
The irony of Mercury's poles: Mercury would seem to be an unlikely place to find ice. But the tilt of Mercury's rotational axis is almost zero - less than one degree - so the floors of craters at the planet's poles never see sunlight. Scientists suggested decades ago that there might be frozen water trapped there. The idea received a boost in 1991 when the Arecibo radio telescope in Puerto Rico and the Goldstone antenna in California detected unusually bright radar reflections from Mercury's poles—the kind of reflections that ice would make. From Mercury orbit, MESSENGER was able to look down on Mercury's poles like no other spacecraft or telescope, and it confirmed the unlikely: Permanently shadowed craters near Mercury's poles have temperatures less than -280F (-173C), and water ice is stable on their dark inner surfaces. Some of the polar ice is covered by a mysterious dark organic material that researchers still do not understand.

The incredible shrinking planet: The dominant tectonic landforms on Mercury are huge cliffs called "lobate scarps." Even before MESSENGER, researchers thought these scarps were signs of global shrinkage, like wrinkles on a raisin. Why would Mercury shrink? The planet's core makes up a whopping 60–70% of its mass. Cooling of this oversized core has led to a remarkable contraction of the planet. MESSENGER's images of lobate scarps show that the total contraction is two to seven times greater than researchers previously thought.

Magnetically speaking, Mercury is alive: Until Mariner 10 discovered Mercury's magnetic field in the 1970s, Earth was the only other terrestrial planet known to have a global magnetic field. Earth's magnetism is generated by the planet's churning hot, liquid-iron core via a mechanism called a magnetic dynamo. Researchers have

been puzzled by Mercury's field because its iron core was supposed to have finished cooling long ago and stopped generating magnetism. Some researchers thought that the field may have been a relic of the past, frozen in the outer crust. MESSENGER data show otherwise: Mercury's field appears to be generated by an active dynamo in the planet's core. It is not a relic.

A planet with a tail: Orbiting Mercury, MESSENGER made the first in situ observations of Mercury's unique exosphere. The exosphere is an ultrathin atmosphere where atoms and molecules are so far apart they are more likely to collide with the surface than with each other. This material is derived mainly from thesurface of Mercury itself, knocked aloft by solar radiation, solar wind bombardment and meteoroid vaporization. MESSENGER was able to determine the chemical composition of the exosphere (hydrogen, helium, sodium, potassium, and calcium) and monitor the material as it was stretched out into a comet- like tail as long as 2 million km by the action of the solar wind. This tail, as well as Mercury's magnetic field, was often buffeted by solar activity during MESSENGER's long mission, giving the spacecraft a point-blank view of the roughest space weather in the solar system.



These graphics show the predicted location and time of MESSENGER's impact on Mercury's surface.

In addition to science discoveries, the mission provided many technological firsts, including the development of a ceramic cloth sunshade that protected the spacecraft's instruments and electronics from fierce solar radiation.

"The front side of the sunshade routinely experienced temperatures in excess of 300° Celsius (570° Fahrenheit), whereas the majority of components in its shadow routinely operated near room temperature (20°C or 68° F)," said Helene Winters, mission project manager at the Johns Hopkins University Applied Physics Laboratory (APL). "This technology to protect the spacecraft's instruments was a key to mission success during its prime and extended operations."

Goodbye, MESSENGER, and thanks!

Credits:

Author: Dr. Tony Phillips| Production editor: Dr. Tony Phillips| Credit: Science@NASA

More information: The spacecraft was designed and built by APL. The lab manages and operates the mission for NASA's Science Mission Directorate. The mission is part of NASA's Discovery Program, managed for the directorate by the agency's Marshall Space Flight Center in Huntsville, Alabama.

For a complete listing of science findings and technological achievements of the mission visit:

http://www.nasa.gov/messenger

OWENS VALLEY RADIO OBSERVATORY TRIP

Doug Millar

I would like to announce our yearly trip to the Owens Valley Radio Observatory. It will be on June

19 and 20th. On Friday we will have night time astronomy by the main buildings. The next day we will have our tour of the 140ft dish and science experiments with Dr. Mark Hodges. That evening we will again have night time astronomy at the site.

The observatory is just outside of Big Pine, Ca on highway 395. You can find motel accommodations In Big Pine or Bishop. You can also camp at the site or at local camp grounds. We will go to Bishop on Saturday for pizza at the Pizza Factory.

It should be relatively warm, but plan on it being cold at night. Also plan on a few mosquitoes. The invitation is open to everyone and kids are especially welcome for both events. Please let your friends know. A map is below. If you have any questions, you can email me or call at 562 810 3989. Please RSVP so I know how many to plan on. Here is a link to the observatory for more information as well as a map. https://www.ovro.caltech.edu/

FOR SALE

Celestron Travel 70 Telescope $40; Celestron 114 'Cometron' telescope, $80

Vixen R130 f5 Newtonian OT, 6X30 finder; dovetail plate $100

Vixen mini Porta alt-azimuth mount $75

Celestron heavy duty alt-azimuth mount $50

Baader 'Q' turret (holds 4 eyepieces) $40

Orion 2" Crayford focuser for refractors with 10:1 fine adjustment $75

Call Val Akins (949) 583-9391

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Observatory Custodian/ Trainer/Member Liaison	Barbara Toy	btoy@cox.net	714-606-1825
OCA Outreach Coordinator	Jim Benet	jimbenet@pacbell.net	714-693-1639
Sirius Astronomer Editor	Steve Condrey	startraveler68@yahoo.com	714-699-1243
Telescope Loaner Program	Don Stoutenger	dstouten@yahoo.com	714-271-2646
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