SIRIUS ASTRONOMER

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The Newsletter of the Orange County Astronomers

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This spectacular picture of the Venus-Jupiter conjunction was taken by Vittal Badithe on June 30, 2015 from Irvine, California. Vittal used a Meade ETX-125 with a Canon 10D imager to create the image. In addition to Venus and Jupiter, all four Galilean satellites are visible.

OCA CLUB MEETING

The free and open club meeting will be held July 10 at 7:30 PM in the Irvine Lecture Hall of the Hashinger Science Center at Chapman University in Orange. This month's speaker is Dr. David Stephenson of Caltech, who will speak on the Origins of the Moon.

NEXT MEETINGS: August 14, Sept. 18

STAR PARTIES

The Black Star Canyon site will open on July 11. The Anza site will be open on July 11 and July 18. 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 March 6. The following class will be held April 3.

GOTO SIG: TBA
Astro-Imagers SIG: Aug. 11, Aug. 14,
Remote Telescopes: TBA
Astrophysics SIG: Aug. 21, Sept. 11
Dark Sky Group: TBA

No Surprise! Earth's Strongest Gravity Lies Atop The Highest Mountains

By Ethan Siegel

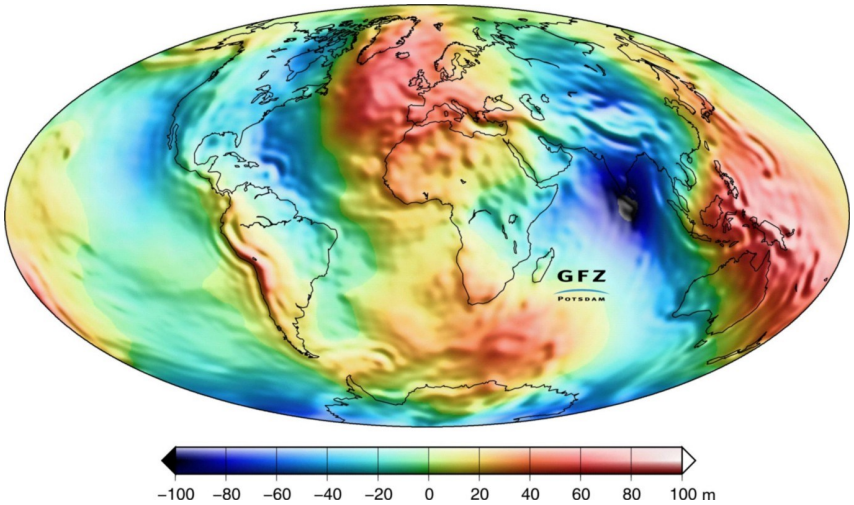


Image credit: NASA / GRACE mission / Christoph Reigber, et al. (2005): An Earth gravity field model complete to degree and order 150 from GRACE: EIGEN-GRACE02S, Journal of Geodynamics 39(1),1–10. Reds indicate greater gravitational anomalies; blues are smaller ones.

Put more mass beneath your feet and feel the downward acceleration due to gravity increase. Newton's law of universal gravitation may have been superseded by Einstein's, but it still describes the gravitational force and acceleration here on Earth to remarkable precision. The acceleration you experience is directly proportional to the amount of mass you "see," but inversely proportional to the distance from you to that mass squared.

The denser the mass beneath your feet, the stronger the gravitational force, and when you are closer to such a mass, the force is even greater. At higher elevations or even higher altitudes, you'd expect your gravitational force to drop as you move farther from Earth's center. You'd probably also expect that downward acceleration to be greater if you stood atop a large mountain than if you flew tens of thousands of feet above a flat ocean, with nothing but ultra-light air and liquid water beneath you for all those miles. In fact this is true, but not just due to the mountain's extra mass!

Earth is built like a layer-cake, with the less dense atmosphere, ocean, and crust floating atop the denser mantle, which in turn floats atop the outer and inner cores of our planet. An iceberg's buoyancy is enough to lift only about one tenth of it above the sea, with the other nine tenths below the surface. Similarly, each and every mountain range has a corresponding "invisible mountain" that dips deep into the mantle. Beneath the ocean floor, Earth's crust might be only three to six miles thick, but it can exceed 40 miles in thickness around major mountain ranges like the Himalayas and the Andes. It's where one of Earth's tectonic plates subducts beneath another that we see the largest gravitational anomalies: another confirmation of the theory of continental drift.

A combination of instruments aboard NASA's Gravity Recovery and Climate Experiment (GRACE) satellites, including the SuperSTAR accelerometer, the K-band ranging system and the onboard GPS receiver, have enabled the construction of the most accurate map of Earth's gravitational field ever: to accelerations of nanometers per second squared. While the mountaintops may be farther from Earth's center than any other point, the extra mass of the mountains and their roots – minus the mass of the displaced mantle – accounts for the true gravitational accelerations we actually see. It's only by the grace of these satellites that we can measure this to such accuracy and confirm what was first conjectured in the 1800s: that the full layer-cake structure of Earth must be accounted for to explain the gravity we experience on our world!

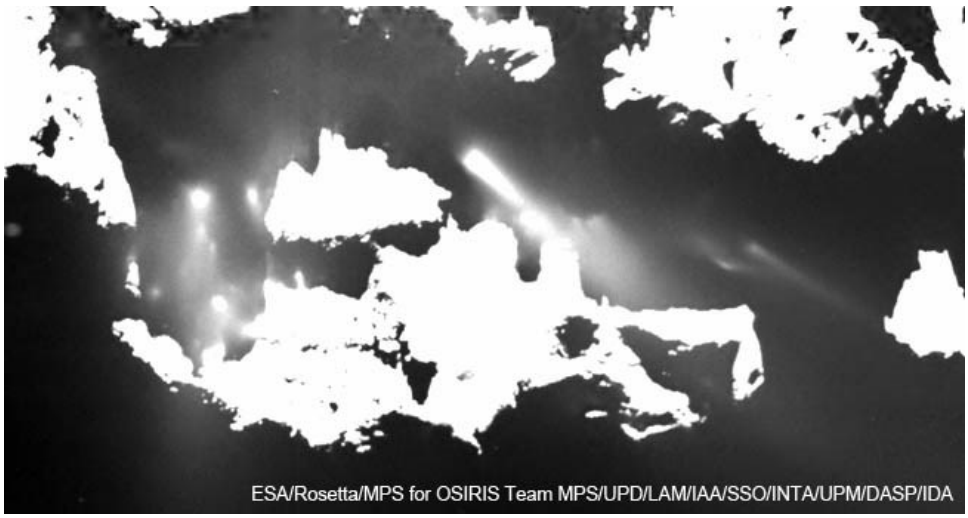
AstroSpace Update

July 2015

Gathered by Don Lynn from NASA and other sources

Philae (comet lander) has awakened. As part of the Rosetta mission, Philae landed on Comet 67P/Churyomov-Gerasimenko last November. Unfortunately its harpoons failed to fire and instead of anchoring in place, it bounced for hours. Eventually it landed in a shadowed area, and managed to run all of its instruments for about 60 hours until its battery ran down, unable to recharge by solar cells. Scientists had hoped that as the comet's orbit approached the Sun, the shadows would move off Philae, the solar cells would recharge its battery, and it would come back to life. Apparently this finally happened, and after a few days it radioed Earth on June 13. The initial message, less than 1.5 minutes long, said that the probe is fine and there is enough sunlight to continue communicating. This is predicted to last until October, when sunlight should again be insufficient. Closest approach to the Sun occurs August 13. Previous imaging by the orbiting Rosetta has found 5 tiny spots that might be Philae, and study of these made one the prime candidate to be where the lander finally landed. It is expected that this can be confirmed now that Philae is awake.

Rosetta (comet mission) discovered an unexpected process at its comet nucleus that causes the rapid breakup of water and carbon dioxide molecules. It has long been known that water and carbon dioxide break up into hydrogen, oxygen and carbon rather quickly after they are emitted from a comet. However, it had been thought that ultraviolet sunlight did the job. The new data shows that electrons hitting the molecules cause the breakup. The sunlight is involved, however, in that it creates the electrons by knocking them off molecules. The process was caught in action by the ultraviolet spectrometer on Rosetta, and was confirmed by other spacecraft instruments. It occurs within 0.6 mi (1 km) of the comet nucleus. The molecular breakup is similar to that previously found at Jupiter's moon Europa, though the source of electrons is different.



More Rosetta – The comet (67P/Churyumov-Gerasimenko) is still becoming more active, as it is still coming closer to the Sun in its orbit. Closest point (perihelion) is August 13. Until recently, the comet's activity originated from illuminated areas on the day side. As soon as the Sun set, jets subsided and did not re-awaken until after the next sunrise. But now dust jets have persisted even after sunset. The Rosetta camera team thinks that the comet can store the incoming heat for some time beneath its surface, resulting in sustained activity even after nightfall. Previous comet missions, such as Stardust and Deep Impact, also found evidence of jets sustained on the night side.

Pluto's moons – Analysis of data from the Hubble Space Telescope shows that 2 of Pluto's moons, Nix and Hydra, wobble unpredictably. If you lived on one of these, every sunrise would come at a chaotically different time and different direction. They wobble because they are embedded in a gravitational field, created by Pluto and its large moon Charon, that constantly shifts in relation to the small moons. The effect is strengthened by the football-like (rather than spherical) shape of the small moons. Scientists believe that it is likely Pluto's other 2 moons, Kerberos and Styx, are in a similar tumbling situation, but sufficient data to prove this has not yet been

gathered. A few other tumbling bodies are known, such as Saturn's moon Hyperion. The Hubble data also showed that Kerberos is as dark as charcoal, while the other moons are as bright as sand.

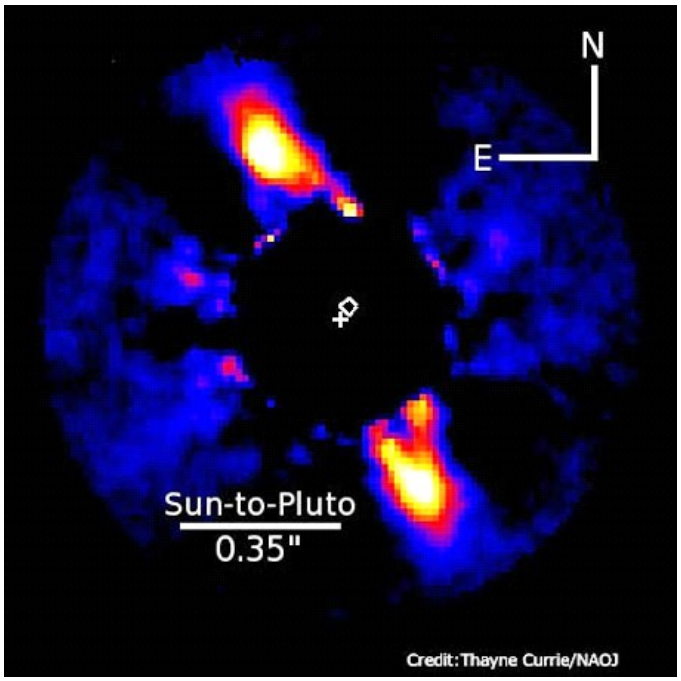
Curiosity (Mars rover) can measure the composition of nearby rocks by zapping them with a powerful laser, which vaporizes the rock, and taking images of the vapor with a spectrograph. This instrument is known as the ChemCam. It has a 2nd, less powerful, laser that is used just to focus the spectrograph on the rock before vaporizing it. Unfortunately the 2nd laser broke. So ChemCam team members reprogrammed the spectrograph to run through various focus positions, taking images, and find the sharpest one, without needing the focus laser. The new technique was tested and found to focus even better than the original method. For some time before the reprogramming, basically the same work-around method was used, but the test images had to be sent back to Earth, analyzed, and then the spectrograph commanded to move to the best focus point. The new technique runs nearly instantly instead of taking days. So ChemCam is firing full speed again.

Mars Reconnaissance Orbiter (MRO) has detected deposits of glass within several ancient, yet well-preserved, impact craters on Mars. The glass is formed by the heat of the violent impact. A study last year of impact glass on Earth found organic molecules and plant matter entombed in glass formed by an impact that occurred millions of years ago in Argentina. Similar processes might preserve signs of life on Mars, if life were present at the time of an impact. Picking out the glassy deposits was no easy task. To identify minerals and rock types remotely, scientists measured the spectra of light reflected off the planet's surface. But impact glass doesn't have a particularly strong spectral signal. A new computer program was written to separate the weak glass signal from the mixture of other stronger spectral signals. One crater, named Hargraves, that contains impact glass and is in an area thought to date back to when Mars was a much wetter planet, is a contender to be the landing location for the Mars 2020 rover.

MESSENGER (former Mercury orbiter) data reveal that Mercury's magnetic field is almost 4 billion years old. Researchers used data obtained when the spacecraft flew quite close to the planet's surface, at altitudes as low as 9 miles (15 km). Scientists have known for some time that Mercury has a magnetic field similar to Earth's, but much weaker. The motion of liquid iron deep inside the planet's core generated the field. When MESSENGER flew close to the planet, its magnetometer detected magnetism frozen into the rocks in the planet's surface when that surface formed. Magnetic fields were found in rocks that formed 3.7-3.9 billion years ago.

Water delivery via asteroids of comets is likely taking place in many other planetary systems, just as it happened on the early Earth, new research strongly suggests. The research finds evidence for numerous planetary bodies outside our Solar System, including asteroid and comets, containing large amounts of water. Earth is believed to have formed dry, due to the heat of formation, so later asteroid or comet collisions must have supplied our water, including the oceans. Observations by the Herschel Telescope in the Canary Islands detected a large quantity of hydrogen and oxygen in the atmosphere of a white dwarf. The quantities found provide evidence that a water-rich exoasteroid was disrupted and delivered its water onto the star. The asteroid had to be of size comparable to Ceres, the largest asteroid in our Solar System. Oxygen, a relatively heavy element, will sink deep into a star over time, leaving only the excess hydrogen visible from water colliding with a star. But many white dwarfs have excess hydrogen in their atmospheres, which suggests that water-rich asteroids or comets are common around other stars.

Exoplanet weather – A team of astronomers examined 4.5 years of Kepler (planet-finding space telescope) data to find 14 exoplanets that show clear brightness changes during their orbits. The data collected show a relation that could predict the weather on certain exoplanets based on their temperatures. Kepler detects planets by the drop in light of stars when a planet passes in front. But the light of the planet is mixed in with the star's light, and in some cases it can be separated out. 14 of these were found in which variations in the planet's light occurred. Most were hot Jupiters (gas giants close to their stars). Hot Jupiters are tidally locked to their stars so that one side always faces their star. This creates a hot spot on the planet, where the star is perpetually overhead. The new study found that planets around 2000°K (3100°F) have the hot spot offset later in the orbit, while those around 3000°K (4900°F) are offset earlier. The study found that clouds should produce the earlier offset, while heat internal to the planet would offset later when clouds are negligible. So the hotter planets are probably cloud-free. However, some planets examined showed no offset in the hot spot, so it is not clear what that implies.



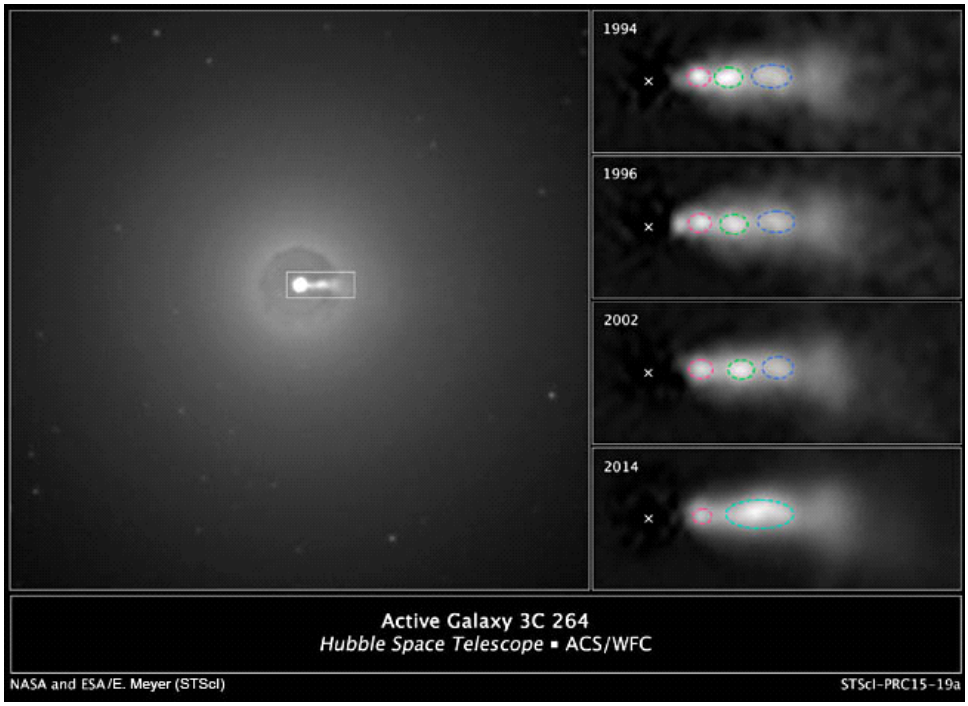
Planetary system – A team using the Gemini South Telescope in Chile has discovered a young planetary system that shares similarities to our early Solar System. The images reveal a disk of debris surrounding a Sun-like star in a birth environment similar to the Sun's. The disk appears to be sculpted by at least one unseen solar-system-like planet, is roughly the same size as our Solar System's Kuiper Belt, and may contain dust and icy particles. Its birth cloud is similar to the nebula in which the Sun formed some 4.5 billion years ago. By using computer simulation, the team calculated what kind of planet might be distorting this disk. They found that a planet like our gas giants, but with a more eccentric (less circular) orbit would work. This study is valuable in understanding the early formation of the Sun and its planets.

Unplanet? – I reported here a year ago the discovery of 2 planets orbiting Kapteyn's Star, one of the Sun's very near neighbors, 13 light-years away. A new study disputes this finding, claiming that the radial velocity measurements interpreted as tugging by the planet Kapteyn b could better be explained by starspots. Other astronomers are disagreeing, standing by the planet explanation. Further observations are needed.

Helium planet – Kepler (planet-finding space telescope) has found hundreds of warm Neptunes, that is, planets of roughly Neptune's mass, but far closer to their Sun, closer in fact than Mercury is to its star in our Solar System. A new theory proposes that many of these have helium atmospheres. The explanation is that heat from their close star would boil away the hydrogen, leaving mostly helium, since those 2 gasses make up much of gas giant planets. The theory was prompted by observations of a warm Neptune known as GJ 436b, which found carbon (in the form of carbon monoxide), but no methane, but methane should be common in any hydrogen atmosphere that also contains carbon. The conclusion was that the planet must have lost its hydrogen. The next step is to look for more warm Neptunes with carbon monoxide and no methane, to see if this is as common as the theory predicts. The hydrogen loss could take billions of years, so old planets should be observed.

Exostratosphere – Using the Hubble Space Telescope, scientists detected a stratosphere on the exoplanet WASP-33b. A stratosphere occurs when molecules in the atmosphere absorb ultraviolet and visible light from the star. This absorption warms the stratosphere and acts as a kind of sunscreen layer for the planet below. The Earth's stratosphere is caused by ozone absorbing ultraviolet. Other planets in our Solar System have stratospheres caused by hydrocarbons. But the newly found stratosphere is much too hot for either of these, so is likely caused by titanium oxide.

Black hole jets – An extensive survey using the Hubble Space Telescope (HST) of selected galaxies with extremely luminous centers (known as active galactic nuclei or AGNs) has determined that almost all AGNs with jets being emitted show signs of mergers with other galaxies now or in the recent past, but not all galaxies that had mergers are AGNs with jets. This implies that forming jets requires a merger and some other condition(s). The presence of jets in this survey was determined by radiotelescopes, since dust can hide jets in visible light. The survey team speculated that the other necessary condition is a fast spinning black hole at the galaxy center.



Jet collisions - A video of jet motion over a 20 year period was made from archived HST images of the elliptical galaxy NGC 3862 (= 3C 264), one of the few AGNs with jets seen in visible light. If the flow of infalling material toward the black hole is not smooth, blobs are ejected in the jets like a string of cannon balls rather than a steady flow. This is the case with this galaxy, and it was found that one of the blobs caught up to an earlier emitted blob, creating a shock that further accelerates particles and brightens the region of colliding material. It is believed that a blob launched later can have less drag from the interstellar medium being cleared out by a previous blob, and so catch up to the previous.

Star formation shutdown – New research found that when supermassive black holes launch jets of charged particles, that can stir up gas throughout the galaxy and interrupt star formation (previous evidence had shown this), but it only temporarily interrupts star formation. When the gas cools, star formation resumes. But the new research also found that sufficient supernovas occurring after the jet episode will permanently stop star formation, by blowing away the gas out of which stars form.

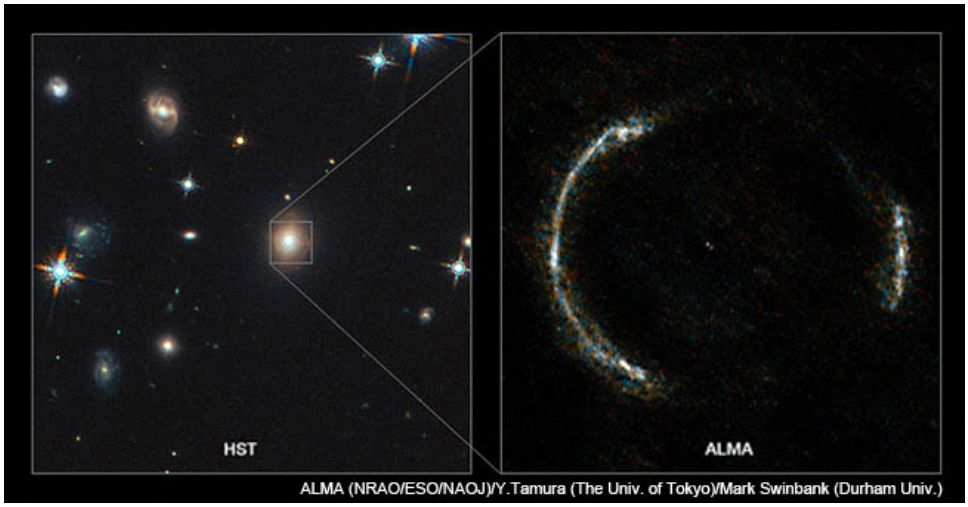
Surprising magnetar – A new study reveals that the amount of X-rays from magnetar SGR 1745-2900 is dropping more slowly than other previously observed magnetars, and its surface is hotter than expected. Astronomers discovered the magnetar in 2013 exceptionally close to the supermassive black hole at the center of the Milky Way. The new study team 1st considered whether starquakes are able to explain the unusual behavior observed. When neutron stars, including magnetars, form, they can develop a tough crust on the outside. Occasionally this crust will crack as a starquake. Although starquakes can explain the change in brightness and cooling seen in many magnetars, the team found that this mechanism by itself was unable to explain the slow drop in X-ray brightness and the hot crustal temperature. The starquake model resulted in cooling too quickly and was not as hot. The researchers suggest that bombardment of the surface of the magnetar by charged particles trapped in twisted bundles of magnetic fields above the surface may provide additional heating that slows the cooling. The researchers do not think that the magnetar's unusual behavior is caused by its proximity to the supermassive black hole, as the distance is still too great for strong enough gravitational or magnetic interactions with it.

Nasty 1 – Astronomers using the HST have uncovered surprising new clues about a massive rapidly aging star, known as a Wolf-Rayet star, whose behavior is unlike anything yet seen in our galaxy. The catalog name of the star is NaSt1, since it is the 1st entry in the Nassau-Stephenson catalog. But since it does not behave like any other Wolf-Rayet star, astronomers have altered this to Nasty 1. The HST images were expected to show twin lobes of gas flowing from opposite sides of the star, like other Wolf-Rayets. Instead there is a pancake-shaped disk of gas encircling the star. The disk is nearly 2 trillion miles (3 trillion km) wide and may have formed from an unseen companion star that snacked on the outer envelope of the newly formed Wolf-Rayet. The disk is estimated to be just a few thousand years old. According to the team's scenario, a massive star evolves very quickly, and as it begins to run out of hydrogen, it swells up. Its outer hydrogen envelope becomes more loosely bound and vulnerable to gravitational stripping if it has a nearby companion star. In that process, the companion star winds up gaining mass, and the original massive star loses its hydrogen envelop, exposing its helium core to become a Wolf-Rayet. It is also thought that even without a companion star, the massive star will eventually lose its outer envelope by strong stellar winds. But there are too many Wolf-Rayet stars statistically for only stellar winds to have caused them, so it is believed that many were binary stars. Mass loss to a companion star is thought to occur quickly, so catching a pair in the process would be rare. It appears that Nasty 1 did a sloppy job of binary mass transfer, so gas escaped into a disk about the star. Viewing Nasty 1 hasn't been easy. The system is so heavily cloaked in gas and dust that it blocks even HST's view. Previous studies in infrared have shown a compact pocket of hot dust close to the stars. The presence of warm dust implies that it formed

recently as chemically enriched material from the 2 stellar winds collided. To measure the hypersonic winds from each star, the astronomers turned to the Chandra X-ray space telescope. The observations revealed scorching hot plasma, indicating that the winds from both stars are indeed colliding, creating shocks that glow in X-rays.

Hostless supernovas – Between 2008 and 2010, 3 supernovas were discovered that appeared to have no host galaxy. New more sensitive observations with the Hubble Space Telescope confirmed there are no galaxies there. It is believed that these stars were flung far from their home galaxies millions or billions of years before exploding as supernovas. All are within large clusters of several thousand galaxies, just between any of those galaxies. A recent study simulating massive clusters of galaxies showed that about 15% of the stars should be gravitationally thrown out of their home galaxies. These supernovas outside galaxies support this. A 4th apparently hostless supernova was found in the Hubble images to be in a faint object that may be a small galaxy or a globular cluster. No supernova is known to have occurred in a globular, so that would be interesting also.

Brightest galaxy – A remote galaxy shining with the light of more than 300 trillion Suns has been discovered using data from WISE (wide-field infrared space telescope). The galaxy is the most luminous galaxy found to date and belongs to a new class of objects recently discovered by WISE: extremely luminous infrared galaxies, or ELIRGs. The galaxy, known as WISE J224607.57-052635.0, may have a behemoth black hole at its center, gorging itself on gas. Supermassive black holes draw gas and matter into a disk around them, heating the disk to temperatures of millions of degrees and blasting out high-energy, visible, ultraviolet and X-ray light. The light is blocked by surrounding cocoons of dust. As the dust heats up, it radiates infrared light that was seen by WISE. Because light from the galaxy hosting the black hole has traveled 12.5 billion years to reach us, astronomers are seeing the object as it was in the distant past. The new study found 20 new ELIRGs, of which this was the brightest.



ALMA (radiotelescope array) has produced a spectacularly detailed image of a distant galaxy being gravitationally lensed by another galaxy that happens to be in front of it from Earth's point of view. The image has better resolution than the Hubble Space Telescope and reveals star forming clumps in the galaxy equivalent to giant versions of the Orion Nebula. The image shows the more distant galaxy distorted into a nearly perfect Einstein Ring. Using ALMA spectral information, astronomers also measured how the distant galaxy rotates and estimated its mass. Computer simulation of the lensing effect shows that the foreground galaxy has a supermassive black hole with more than 200 million solar masses.

Andromeda halo – Scientists using the Hubble Space Telescope have discovered that the immense halo of gas enveloping the Andromeda galaxy is about 6 times larger and 1000 times more massive than previously measured. The dark, nearly invisible halo stretches about a million light-years, halfway to our own Milky Way. The gargantuan halo is estimated to contain half the mass in dust as that of the stars in the galaxy itself. Because the gas in the halo is dark, the team looked using ultraviolet at bright background objects through the gas and observed how the light was changed by the gas. The background lights were 18 quasars that happen to lie in the right direction. The team also determined that it is enriched in elements much heavier than hydrogen and helium, and the

only way to get these heavy elements is from exploding supernovas. If the Milky Way possesses a similarly huge halo, the 2 galaxies' halos may be nearly touching.

New kind of globular – Observations with the Very Large Telescope (VLT) in Chile have discovered a new class of "dark" globular star clusters around the giant galaxy Centaurus A (NGC 5128). These mysterious objects look similar to normal globulars, but contain much more mass as compared to the number of stars and may either harbor unexpected amounts of dark matter or contain massive black holes. This is the closest giant galaxy to us and is suspected to harbor as many as 2000 globulars in orbit about it. Many of these globulars are brighter and more massive than the 150 or so that orbit the Milky Way. The astronomers have made the most detailed studies yet of the globulars of Centaurus A, targeting 125 of them. The used these observations to deduce the mass of the clusters and compare this with how brightly each of the clusters shines. For most of the clusters in the new survey, the brighter ones had more mass in the way expected. But for some of the globulars, there was many times more mass than expected from the brightness of their stars. And even more strangely, the more massive these unusual clusters were, the greater the fraction of their material was dark (not stars). Possibilities include: black holes or other dark stellar remnants in their cores, or dark matter. The team is making a wider survey of other globular clusters in other galaxies, and there seem to be hints that such dark clusters may be found elsewhere.

Relaxation – Computer simulations have shown that in a globular star cluster gravitational interactions between stars will over time tend to push the more massive stars to the center and the less massive toward the edges. This process is called dynamical relaxation. When Sun-like stars reach the end of their lives, they throw off outer layers, becoming less massive and turning into white dwarf stars. So theoretically, new white dwarf stars in globulars should have lost mass and relaxation should be slowly pushing them outward. No one had caught this happening in actual observations until now. A new study using HST examined stars in the globular 47 Tucanae. The ages of white dwarfs were determined by their ultraviolet output, which drops as they age. 2 major populations of different ages were found among the white dwarfs. The younger ones gathered nearer the cluster center, while the older ones were nearer the outer edges. This confirms not only dynamical relaxation, but that the formation of white dwarfs involves considerable mass loss.

Instant AstroSpace Updates

For 17 years the Parkes Radiotelescope in Australia has been picking up mysterious pulses occasionally, termed "**perytons**", and newly installed radio noise monitors finally pinned down the source as being the microwave ovens in the astronomers' lunch room. Every electronic device near the telescopes had been tested for giving off perytons, and the microwaves were clean until someone opened the oven door while lunch was still being heated, which was found to be the cause.

In the wake of the late April failure of a supply rocket to the International Space Station (**ISS**), the investigation has resulted in rescheduling of most planned crew and cargo flights to and from ISS. One result is that Samantha Cristoforetti, Italian astronaut, along with her other 2 crew members stayed an extra month on ISS, and in doing so she set the record for longest flight by a female: 199 days.

Mars spent much of June behind the Sun as seen from Earth, which interrupts radio communications with spacecraft at the red planet, including 5 orbiters and 2 rovers. So no new Martian data for awhile.

Looking Up – July 2015

by Curtis Croulet, Temecula Valley Astronomers

Full Moon is July 1 at 7:20 pm; **Last Quarter Moon** is July 8 at 1:24 pm; **New Moon** is July 15 at 6:24 pm; **First Quarter Moon** is July 24 at 9:04 am; and a ***second*** **Full Moon** is July 31 at 3:43 am.

Mercury is in the morning sky as July begins. It rapidly dives toward the horizon, reaching superior conjunction on Jul 23.

Venus reached greatest elongation (angular distance from the Sun) on June 6. **Venus** and **Jupiter** are only 0.3 deg apart on June 30 and 0.60 deg apart on July 1. Both planets plunge toward the dusk horizon, with **Jupiter** sprinting ahead for a few days. But **Venus** actually catches up to **Jupiter** by July 31. **Venus** will reach inferior conjunction with the Sun on August 15. As high as **Venus** is after sunset as I write this in mid-June, it'll be gone from the evening sky within two months.

Mars is now low in the morning sky. It rises only a short time before sunrise.

Saturn is in northwestern Scorpius, ideally placed for evening viewing. The rings are nearly as wide open as they can be.

Uranus is a post-midnight object for most of July. It rises around 1 am on July 1 and as early as 11 pm on July 31. **Uranus** is in Pisces.

Neptune rises shortly after 11 pm at the beginning of July and shortly after 9 pm by the end of the month. **Neptune** is in Aquarius.

Pluto is in Sagittarius, which is up most of the civilized hours of the night. At mag 15, **Pluto** looks like a very dim star. It's beyond the reach of most amateur telescopes smaller than about 12-inch aperture. Maybe a 10 or 11-inch will show it. The July issue of *Sky & Telescope*, on pp.52-53, has a detailed chart of Pluto's positions throughout the coming months. More about **Pluto** below.

There are no bright and distinctive meteor showers in July. Looking ahead, the Perseids will peak on the morning of August 13, and they will have little interference from the Moon.

Let's look up.

July 2015 is Pluto's special month. The New Horizons spacecraft, launched January 19, 2006, from Cape Canaveral, will fly by Pluto on July 14, 2015. After 9-1/2 years, New Horizons' most important observations will be concentrated into a 48-hour period. New Horizons then will continue forever into the cosmos. We will get a good view of only one hemisphere each of Pluto and its moon, Charon.

As so often in science, the Pluto's discovery in 1930 resulted from a combination of perseverance and sheer luck. William Herschel discovered Uranus in 1781. In the following decades, Uranus was seen to deviate slightly from its predicted orbit, suggesting the existence of another planet. John Couch Adams and Urbain Jean-Jacques Le Verrier independently calculated the proposed planet's position. Adams was unable to interest Britain's Astronomer Royal,

George Airy, into searching for the predicted planet until it was too late. But Le Verrier was able to recruit Johann Galle at the Berlin Observatory. Galle quickly discovered the planet, soon named Neptune, in 1846. But Neptune didn't entirely account for the measured perturbations in Uranus's motions. In the following decades various astronomers predicted one or more additional planets. Percival Lowell, founder of Lowell Observatory in Flagstaff, AZ, calculated the position of a hypothesized Planet X.

Although Lowell died in 1916, his calculations were the basis of Clyde Tombaugh's successful search at Lowell Observatory in 1930. Tombaugh used a new 13-inch astrograph, a telescope specifically designed for widefield astrophotography. Within a few days of commencing his search, Tombaugh found the predicted planet. Astronomers quickly found the new planet on older photographs, including some taken previously at Lowell Observatory. Pluto was found to have a tilted orbit that sometimes came within Neptune's orbit. Milton Humason at Mt. Wilson Observatory, using the 60-inch reflector, came close to discovering Pluto in 1919. He used positions calculated by William H. Pickering. An unfortunate bit of fluff on one photographic plate and the proximity ofoverwhelmingly bright stars on another plate obscured Pluto and thus foiled Humason's attempted discovery.

Although the astronomical world hailed the discovery of the new planet, astronomers quickly calculated that the 15th magnitude dot found by Tombaugh couldn't possibly account for deviations in Uranus and Neptune orbits. Within a month of its discovery, the new planet was named Pluto. From then on, Pluto's estimated size and mass shrank every year. When I was discovering astronomy in the mid-1950s, one of my books pegged Pluto's diameter as somewhere between the diameters of Mercury and Venus. When Pluto's moon Charon was discovered in 1978, simple application of Newton's laws shrank Pluto's mass to less than 1% that of Earth. Pluto's diameter is about 1441 miles. What about the orbital deviations of Uranus and Neptune? Pluto was too small to affect them much. When Voyager 2 passed Neptune in 1989, Neptune was found to be 0.5% less massive than previously believed. When Neptune's corrected mass was entered into the equations, the deviations vanished. There are no additional massive planets beyond Neptune. There is no "Planet X."

We still have to answer the question of Pluto's status. Is Pluto a planet or not? In the early 2000s Caltech's Mike Brown discovered small objects in the outer reaches of the Solar System, well beyond Neptune's orbit. One of these objects turned out to be about the size of Pluto. The new object was eventually named Eris. When the International Astronomical Union met in Prague in 2006, they were presented with a proposal from a special committee that would have added three planets to the nine then recognized. The new planets were to be Ceres (the largest asteroid), Pluto's moon Charon (Pluto and Charon were treated as a double planet), and Eris. But a group of astronomers called "orbital dynamicists" objected. When the dust settled, the few remaining attendees at the Prague convention voted to create the new category of "dwarf planet." Ceres, Eris, and Pluto were dumped into the dwarf planets. Paradoxically, under the IAU's definition, dwarf planets aren't planets. Don't ask me to explain it or justify it.

Pluto's status has spilled into popular culture. In 2007 the New Mexico state legislature officially declared Pluto to be a planet. Clyde Tombaugh, Pluto's discoverer, just happened to be living in New Mexico. If you're driving between Animas and El Paso, don't call Pluto a "dwarf planet." If you visit Lowell Observatory in Flagstaff, AZ, you'll see abundant references to Lowell's role in the discovery of Pluto. You may even get to see the telescope Tombaugh used to discover Pluto. But absolutely nowhere will you find any reference to Pluto not being a planet. At Lowell Observatory, it's still 1930.

Clear skies!

Save the date! Our annual Star-Be-Cue will be at the Anza site on July 18, 2015! Come out to Anza for some observing fun and a good time with friends! This is a great occasion for family members to join us, and we promise the menu won't include this guy below!

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