SIRIUS ASTRONOMER

www.ocastronomers.org

The Newsletter of the Orange County Astronomers

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A HERO RETURNS HOME: Jorge Rubino took this picture of Space Shuttle *Endeavour* atop its 747 carrier landing at LAX on September 22. The shuttle is destined for permanent display at the California Science Center. The greater Los Angeles area figures prominently in the history of the Space Shuttle program. All five spaceworthy Shuttles (as well as the glide-test model *Enterprise*) underwent final assembly at the Rockwell (now Boeing) facility in Palmdale, California with most major components built in Downey. Completed in 1991, *Endeavour* was the last of the shuttles built, being the replacement for *Challenger* which was lost with no survivors in 1986. It flew 25 missions between 1992 and 2011, carrying a total of 154 crewmembers into space over a cumulative 296 days in space. The carrier aircraft, originally built for American Airlines in 1974 but purchased by NASA, will be repurposed by NASA for use in the SOFIA program.

OCA CLUB MEETING

The free and open club meeting will be held October 12 at 7:30 PM in the Irvine Lecture Hall of the Hashinger Science Center at Chapman University in Orange. This month, our own Chris Butler will present ASTRO_IMAGINING!

NEXT MEETINGS: November 9, December 14

STAR PARTIES

The Black Star Canyon site will be open on October 20. The Anza site will be open on October 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 on Friday, October 5th at the Heritage Museum of Orange County at 3101 West Harvard Street in Santa Ana. The next two sessions will be on November 2nd and December 7th.

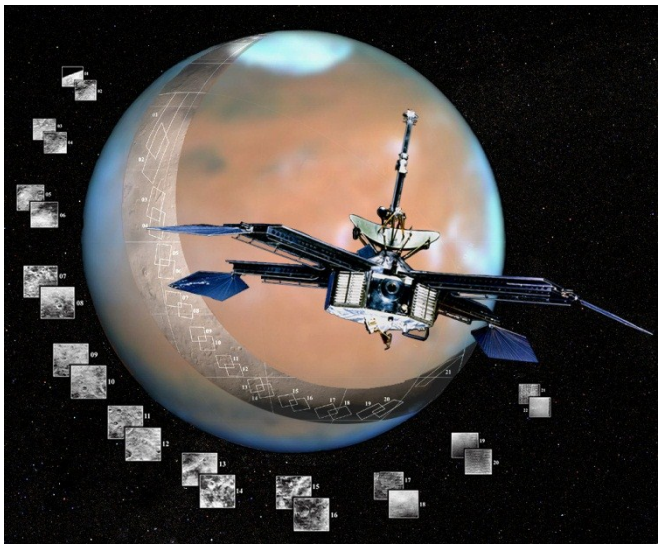
GOTO SIG: TBA
Astro-Imagers SIG: Oct. 16, Nov. 20
Remote Telescopes: TBA
Astrophysics SIG: Oct. 19, Nov. 16
Dark Sky Group: TBA

Doing Science with a Spacecraft's Signal

By David Doody

Mariner 2 to Venus, the first interplanetary flight, was launched August 27 fifty years ago. This was a time when scientists were first learning that Venus might not harbor jungles under its thick atmosphere after all. A Russian scientist had discovered that atmosphere during the rare Venus transit of 1761, because of the effects of sunlight from behind.

Mariner 2 proved interplanetary flight was possible, and our ability to take close-up images of other planets would be richly rewarding in scientific return. But it also meant we could use the spacecraft itself as a "light" source, planting it behind an object of our choosing and making direct measurements.



In this poster art of Mariner 4, you can see the parabolic reflector atop the spacecraft bus. Like the reflector inside a flashlight, it sends a beam of electromagnetic energy in a particular direction. Credit: NASA/JPL/Corby Waste.

Mariner 4 did the first occultation experiment of this sort when it passed behind Mars as seen from Earth in July 1965. But, instead of visible light from the Sun, this occultation experiment used the spacecraft's approximately 2-GHz radio signal.

The Mariner 4 experiment revealed Mars' thin atmosphere. Since then, successful radio science occultation experiments have been conducted at every planet and many large moons. And another one is on schedule to investigate Pluto and its companion Charon, when the New Horizons spacecraft flies by in July 2015. Also, during that flyby, a different kind of radio science experiment will investigate the gravitational field.

The most recent radio science occultation experiment took place September 2, 2012, when the Cassini spacecraft carried its three transmitters behind Saturn. These three different frequencies are all kept precisely "in tune" with one another, based on a reference frequency sent from Earth. Compared to observations of the free space for calibration just before ingress to occultation, the experiment makes it possible to tease out a wide variety of components in Saturn's ionosphere and atmosphere.

Occultation experiments comprise only one of many categories of radio science experiments. Others include tests of General Relativity, studying the solar corona, mapping gravity fields, determining mass, and more. They all rely on NASA's Deep Space Network to capture the signals, which are then archived and studied.

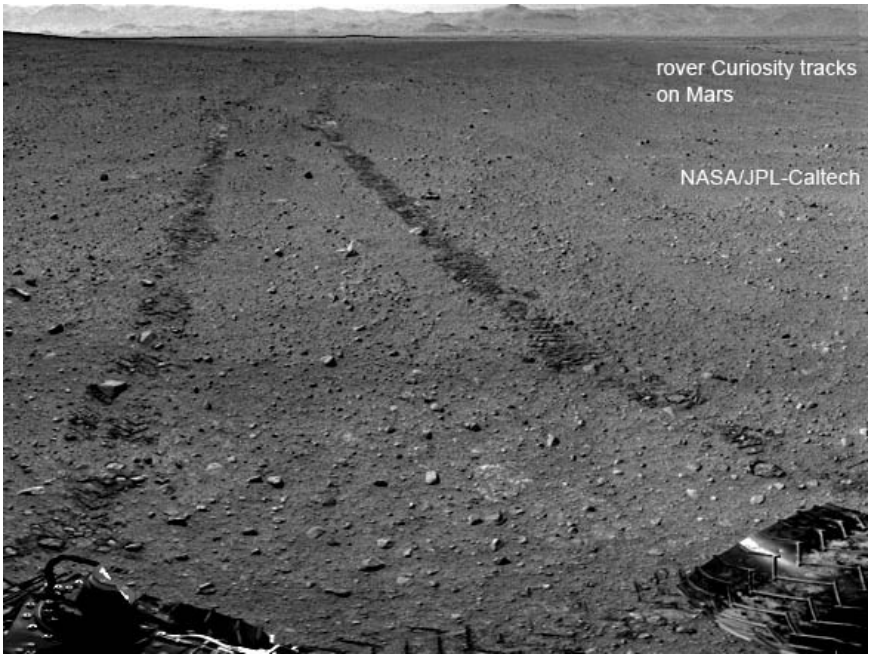
Find out more about spacecraft science experiments in "Basics of Space Flight," a website and book by this author, http://www2.jpl.nasa.gov/basics. Kids can learn all about NASA's Deep Space Network by playing the "Uplink-Downlink" game at http://spaceplace.nasa.gov/dsn-game.

This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

AstroSpace Update

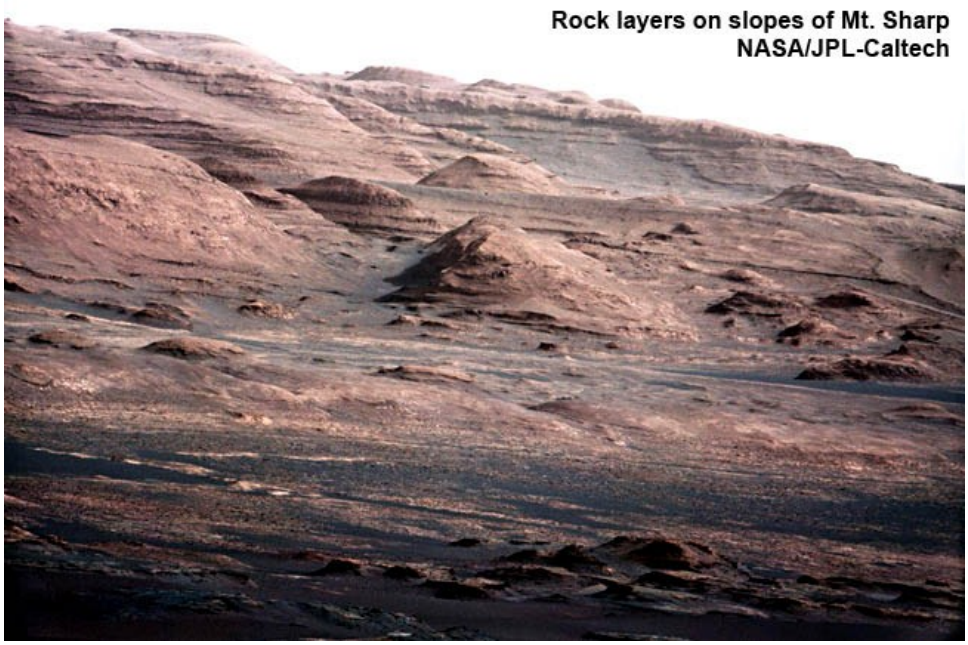
October 2012

Gathered by Don Lynn from NASA and other sources



Mars rover Curiosity has begun roving, after spending a few weeks checking out all instruments. The laser has been fired hundreds of times on rocks near the landing point. It vaporizes rock, and the spectrometers image the vapor and tell what the rock is made of. The spectrometers record ultraviolet, visible, and infrared light at a total of 6144 wavelengths. Among the targets is the bedrock exposed by the landing rockets. It is basalt. The laser is fired dozens of times over a few seconds, and analyzed each time. If it changes, you know the composition of both the surface dust or coating and the interior. The panoramic pictures taken during camera tests are spectacular. The 7-foot-long (2 m) robotic arm was flexed and calibrated (it moves differently with Martian gravity and temperatures than on Earth). On the end of the arm are a camera/microscope, a drill, a spectrometer, a brush, a scoop, and a sample portioning device.

Curiosity has begun returning Martian weather reports from its weather instruments, which measure air and ground temperatures, wind, atmospheric pressure, humidity and ultraviolet light. Every Martian lander (there have been 7 successful ones) has carried weather instruments, but Curiosity's are the most comprehensive and accurate. Air temperature has swung from 28° F (-2° C) on a balmy afternoon to overnight lows of minus 103° F (-75 C°). The ground temperature varies even more than the air temperature. Pressure readings have averaged about 7 millibars, less than 1% of Earth's sea-level pressure. Winds have been light and variable. Relative humidity averages less than 10%. The weather station takes readings every hour, even if the rest of the rover is asleep. Spain built the weather instruments. One of the 2 wind sensors was damaged during landing, probably by debris thrown by the landing rockets. It is the only malfunction seen so far on the rover. It is expected to degrade, but not prohibit, wind measurements. The landing site is just south of the equator, and the southern hemisphere is transitioning from winter to spring.



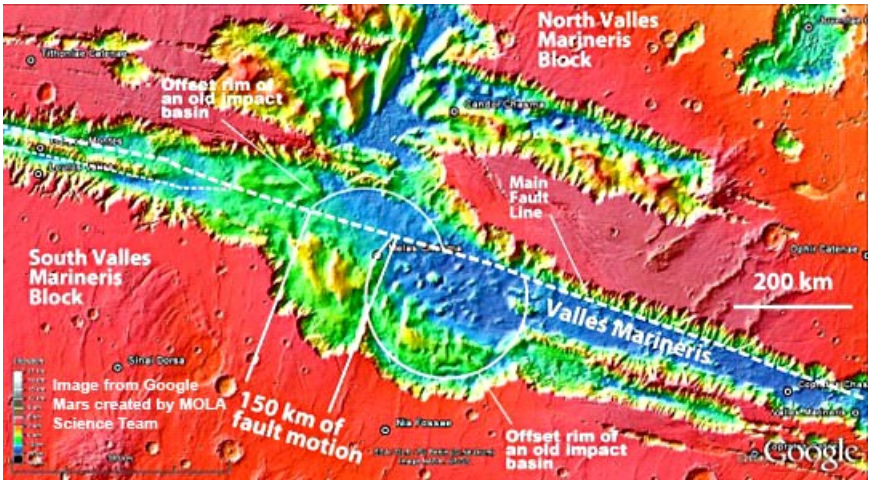
Curiosity's landing point has been named (by NASA) Bradbury Landing in honor of the late author Ray Bradbury. The 1st major target has been chosen about 400 yards (meters) away, dubbed Glenelg, which is where 3 different types of surface meet, including layered bedrock and alluvial. It will probably take a few weeks to get there, since stops are expected at interesting rocks on the way. A few months will be spent on the 3 types of terrain there, using the drill, laser, spectrographs and other instruments. Then the rover will head for a break in the nearby sand dunes, which will

afford safe travel to Mount Sharp. Rovers tend to sink into dunes, hence heading for the break between them. Mount Sharp shows hundreds of layers of apparently sedimentary rock that should keep geologists busy for years.

Russia built an instrument for **Curiosity** that shoots neutrons at the ground to determine the types of minerals in the top yard (meter) of the soil. This technology is used in oil prospecting on Earth, but this is its 1st use on another planet. The device is sensitive to hydrogen, which usually is contained in water. In this area of Mars it is expected that most hydrogen in the soil would be in the form of water hydrated within minerals. Such hydrated water can withstand billions of years of dry conditions like we see on Mars today.

Martian methane has long been known to be a trace element in the red planet's atmosphere. Methane is broken down in at most a few hundred years under Martian conditions, so it must be continually replaced somehow. The best guesses are that geological processes or bacterial life produce it. The concentration of methane varies over time and location, and these variations have not been firmly linked to any geological process or possible bacterial life. A new study has found a 3rd (and a 4th) possible source. Laboratory experiments found that electrical discharges (lightning) in Mars-like atmosphere when ice is present produced methane. The discharge breaks up carbon dioxide and ice into their elements, and some of the results combine to make methane. Dust devils and dust storms on Mars are known to cause electrical discharges. The study also experimented with ultraviolet radiation to produce methane from Martian atmosphere, and found that it does indeed, but at about 1/3 the efficiency of the electrical discharges. The study did not rule out that methane may come from other sources as well.

Martian tectonics – It has long been believed that only Earth, among observed planets, has plate tectonics, that is, where large sections of the surface move slowly relative to each other. A new study of Valles Marineris, the Grand Canyon of Mars (but much larger than Earth's Grand Canyon), shows that the opposite sides of the canyon have moved relative to each other in the manner of tectonics. It is said to resemble movement at Earth's Dead Sea. The linear volcanic zone on Mars may also be indicative of tectonic movement. This study result will probably be controversial.



Mars Reconnaissance Orbiter (MRO) has used its Climate Sounder instrument to detect clouds of frozen carbon dioxide (dry ice) over the south pole during winter. The clouds were observed as low as ground level, and persisted long enough for the particles to fall to the ground. The south polar cap is known to contain a great deal of dry ice, which grows and contracts with seasons, but it has been disputed whether that falls as snow or freezes out as frost. The new observations show that a great deal of it falls as (dry ice) snow. One cloud was observed that was 300 miles (500 km) across over the pole, and smaller clouds at latitudes from 70 to 80° south. Dry ice requires temperatures of about minus 193° F (-125° C). This is the 1st observation of dry ice snow falling, not only on Mars, but anywhere. Water-ice snow was observed falling on Mars in 2008 by the Phoenix lander near the north pole.

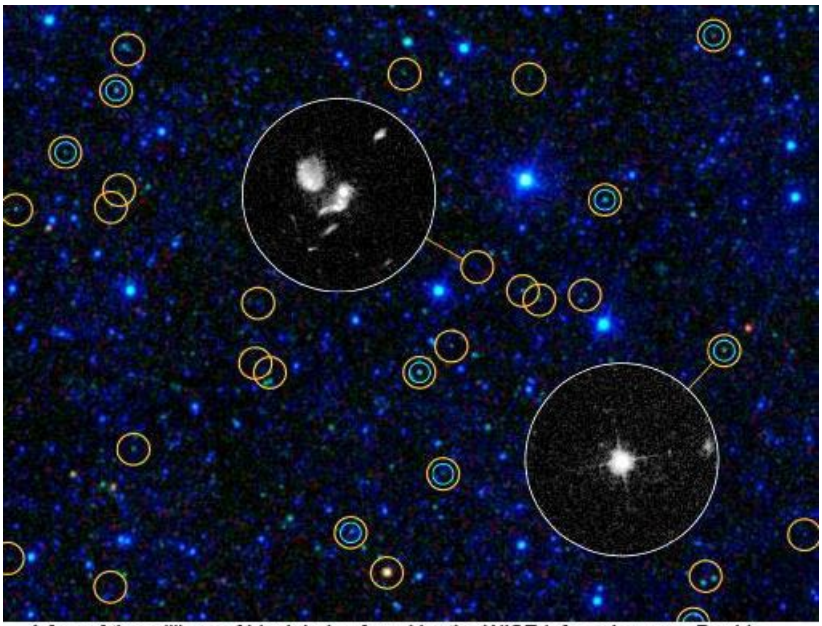
InSight is the name of the next Mars lander, just selected by NASA to be built for launch in March 2016. It will remain stationary, not rove, and will reuse the design of the Phoenix lander. However its instruments will concentrate on probing the interior of the red planet. It will carry a seismograph to record marsquakes, a hammer-drill with thermometer to measure heat seeping from the interior, and will use its radio to precisely track the planet's rotation. These should tell scientists what kind of core Mars has. The craft will also have a robotic arm and 2 cameras. It is a joint project with the German and French space agencies. The mission is planned to last a Martian year, which is about 2 Earth years. InSight is a low-cost mission in NASA's Discovery series. Until InSight was announced, the only US mission to Mars still being funded was MAVEN, an orbiter for launch in 2013. All other US Mars missions had been canceled in earlier budget cuts. For example, NASA withdrew from participation in the joint ExoMars mission during those cuts.

Kepler (exoplanet-discovering space telescope) has found the 1st known multiple planet system orbiting (both parts of) a binary star. Only a few examples of a single planet orbiting a binary are known. The new system is known as the Kepler-47 system, and is 4900 light-years away. The stars eclipse each other every 7.5 days. 1 star is similar to the Sun in size, but a bit dimmer (84% as bright), and the other is tiny: 1/3 the size and 1% as bright as the Sun. The inner planet, known as Kepler-47b, orbits the pair in less than 50 Earth days. Astronomers calculate that it must be a very hot world, perhaps with a hazy atmosphere. The outer planet orbits the pair in 303 days. It is larger than Neptune, so is probably a gas giant. Its temperature would allow liquid water to exist, but as a gas giant, there is no surface for that water to form oceans on. From its temperature, it likely has water vapor clouds. Theorists are going to go back to the drawing board to explain how planets can form around such an unstable system as a binary star.

Planets in clusters – Astronomers have discovered 2 gas giant planets orbiting stars in the Beehive open star cluster. These are the 1st exoplanets found orbiting sun-like stars in any crowded cluster. Until these were found, it was feared that crowding in clusters disrupted the planet-forming process. The newly found planets are hot Jupiters, that is, gas giants orbiting so close to their stars that they are kept very hot by their stars. It is believed that gas giants form far from their stars, so that hot Jupiters must have migrated toward their stars after forming. The relatively young age of the Beehive stars sets limits on how long it can take for planets to migrate in close to their stars. Stars in the Beehive have more heavy elements than does the Sun. More planets have been found orbiting stars with more heavy elements, so the new discovery is consistent with this.

Planets in galaxy center – It was recently announced that a cloud of gas was found falling toward the center of our Milky Way galaxy. One explanation for the source of this cloud was that it resulted from gas streaming from stars. A new study of the cloud suggested that the cloud was the result of a planet-forming disk being gravitationally deflected toward the galactic center. This would imply that planets can form even in the chaotic environment near the galactic center.

South Pole Telescope has produced new data that show that the era of Reionization of intergalactic hydrogen started 250 million years after the Big Bang and lasted 500 million years. The previous best estimate was that it lasted 750 million years, and the start date was unknown. The South Pole Telescope is a 10-meter dish operating at millimeter wavelengths (very high frequency radio), and has been observing the strength and polarization of the Cosmic Microwave Background (CMB). The first large galaxies to form after the Big Bang radiated enough light to knock the electrons off most of the hydrogen in the Universe, causing the Reionization. The CMB interacts with the electrons in ionized gas, which is what the new observations detected. Upgrading of the South Pole Telescope and comparison of its data with the Herschel orbiting telescope should over the next few years improve the precision of the dates of the Reionization.



A few of the millions of black holes found by the WISE infrared survey. Double circles indicate previously known from visible-light images. Two show expanded Hubble images. Those seen also in visible light tend to be point-like, others not. NASA/JPL-Caltech/UCLA/STScI

WISE (infrared space telescope) – Analysis of the WISE survey of the entire sky has discovered about 2.5 million black holes, most of which were too obscured by dust to be seen in other wavelengths of light. The light from friction as material is heated falling into the black holes is still obscured from WISE, but that light heats the obscuring dust, which in turn gives off infrared that WISE can see. These black holes range as far away as 10 billion light-years. WISE data analysis also found thousands of extremely bright galaxies that are too dust enshrouded to have been seen without using infrared. Some of these galaxies are pouring out 100 trillion times the light of the Sun. Typical galaxies merely produce hundreds of billions of times the Sun's light. The huge amount of light comes from both activity around the central black hole and birth of new stars. These newly discovered galaxies are being called DOGs (Dust-Obscured Galaxies). Of course the brightest ones are being called hot DOGs.

Galactic winds – New observations show that fierce galactic winds powered by an intense burst of star formation may blow gas right out of massive galaxies, shutting down further star formation. Most galactic winds throw material out like a fountain, falling back eventually. But these newly observed ones are so powerful that the material escapes, never returning. 29 of these galaxies were found in a study, and they had outflowing winds of 300 to 1600 miles per second (500 – 2500 kps). The winds originate throughout the galaxies, showing that they were not the result of central black hole outflow, so had to be from star formation. Probably a huge number of massive stars formed nearly simultaneously, then quickly went through their lives and exploded as supernovas in a short time period, blasting material outward as a galactic wind. Galaxies with such high winds are rare – a huge number were examined to find the 29. The question now to be answered is whether such winds happen to only a few galaxies, or happen often but last a very short time so that we now see few of them.

Record-breaking galaxy cluster – Astronomers have found that the Phoenix galaxy cluster is breaking several cosmic records. Observations were made with the Chandra X-ray space telescope, the South Pole Telescope (where the cluster was discovered), and a number of other ground-based telescopes. The cluster is about 5.7 billion light-years away, of course in the constellation Phoenix. Stars are forming in the cluster at the highest rate ever observed in the middle of a galaxy cluster. The few that exceed this star formation rate do so only in the edges of the galaxy cluster. Usually galaxies at the center of clusters are old and dormant. The Phoenix cluster is the most powerful producer of X-rays, and is among the most massive galaxy clusters known. The rate of hot gas cooling in the central regions of the cluster appears to be the largest ever observed.

Gravity waves – Another pair of white dwarfs has been discovered that are orbiting each other so close and so fast that they should produce gravity waves. They are about 3000 light-years away, and orbit every 12.75 minutes. Since the discovery last year, because of their eclipsing each other, astronomers have been timing the orbits to see if they speed up as predicted by gravity-wave theory (a part of General Relativity). 1st results are that they indeed are speeding up the correct amount. The measured amount is ¼ millisecond speedup per orbit per year. The accumulation of these sub-milliseconds for all the orbits since discovery is now about 6 seconds. Gravitational waves have never directly been detected, but in a few cases like these, the waves can be indirectly measured by their effect on the orbits. A 3-spacecraft mission to directly detect gravitational waves, called LISA, was canceled during budget cuts last fiscal year. The European Space Agency, which had been partnered in LISA, is now pursuing its own gravitational wave mission.

Supernovas and novas – Observational evidence has been mounting over recent years that some Type Ia supernovas occur when a companion star dumps material onto a white dwarf and its mass exceeds that which is stable, but other Type Ia supernovas occur when 2 white dwarfs spiral into each other, again exceeding the mass limit. Now we have a 3rd scenario for Type Ias. It is really the 1st scenario above, but differs in that the white dwarf goes through a series of recurrent novas before the big explosion. Observations of the recently discovered supernova PTF 11kx brought this possibility to light. The supernova is surrounded by shells of gas that have to have been given off by previous novas. A handful of previous supernovas had been suspected of having shells of gas about them, but this new observation is quite certain about the shells, since astronomers are watching the supernova ejecta colliding with them. The speed of the shells has been measured as being too slow for supernova gas and too fast for stellar wind gas. That only leaves recurrent nova as the cause. The new supernova resembles the nearby recurrent nova RS Ophiuchi. With only one good example, it is difficult to say what fraction of Type Ias are previous recurrent novas, but the astronomers involved believe that it is less than 20%, perhaps much less. Finding more similar supernovas may pin down this fraction.

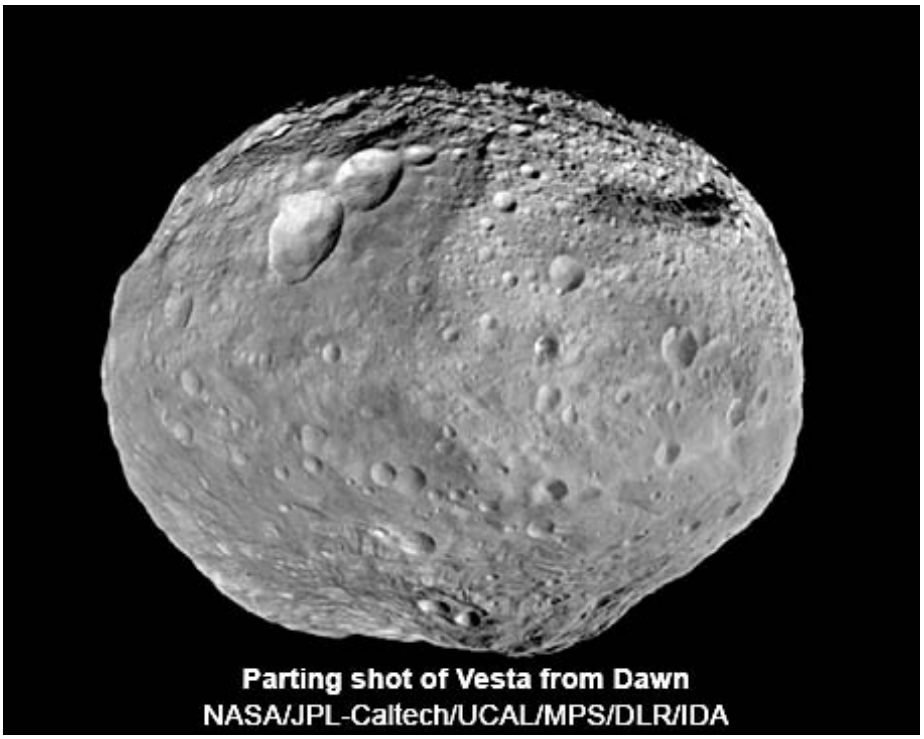
Hubble Space Telescope has been used to study the R136 open star cluster in the Tarantula Nebula in the Large Magellanic Cloud and it has been found to be actually 2 clusters. They differ in age by about 1 million years. One is distorted in shape, and so the 2 clusters may be in the early stage of colliding and merging. The Tarantula Nebula, aka 30 Doradus complex, has been actively forming stars for 25 million years, and it is not known how much longer this region can continue creating new stars. The study was actually looking for runaway stars, fast-moving stars that have been kicked out of their stellar nurseries by gravitational

interactions. But observing star ages and velocities resulted in the new discovery. Follow-up studies will look for more interacting clusters in the area.

Lunar Reconnaissance Orbiter (LRO) has employed its radar on Shackleton Crater, and the results are consistent with small patches of ice embedded in the lunar soil on the inner walls of the crater. The radar penetrates the surface to a depth of a yard (meter) or 2. Glacial ice under the soil is ruled out by the observations. The ice content was calculated from the observations to be as high as 5-10%. Shackleton Crater lies near the pole of the Moon, and much of its interior never gets sunlight, making it a cold trap where ice can remain near the surface. The finding is consistent with the results from LCROSS, which crashed into a nearby crater and kicked up measurable ice in the lunar soil.

LRO, using its ultraviolet spectrometer, has detected helium in the extremely thin atmosphere of the Moon. The spectrometer was designed to analyze the surface of the Moon, but was used this time to look for the atmosphere. Helium had previously been detected by the LACE instruments set on the Moon by astronauts during the Apollo 17 mission. Sophisticated analysis was done on the LRO data to distinguish helium about the Moon from interplanetary helium. Further LRO observations will be made to try to determine the source of the helium. The LACE measurements also detected Argon, so LRO will try to detect that also.

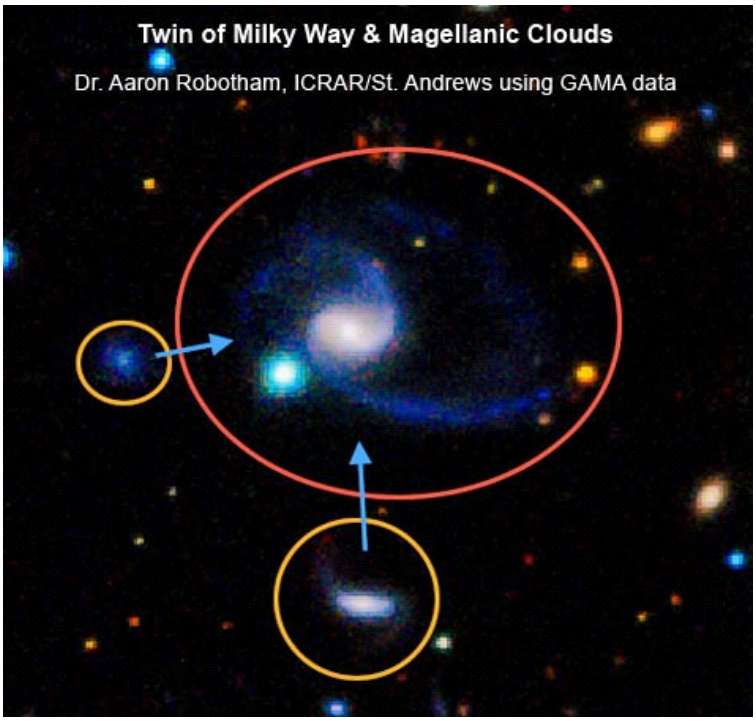
Dawn (asteroid mission) left its orbit about Vesta on September 4, under the power of its ion engines, to start a 2.5-year journey to Ceres. Dawn will become the 1st spacecraft to orbit and study 2 distant destinations. This is made possible by the fact that ion engines operate for years before they run out of fuel. The power for the engines is supplied by electricity from solar panels. The data from Vesta will continue to be analyzed for years.


Parting shot of Vesta from Dawn
NASA/JPL-Caltech/UCAL/MPS/DLR/IDA

Radiation Belt Storm Probes (RBSP) are twin spacecraft launched in late August to explore Earth's Van Allen belts of charged particles. The belts were discovered by the 1st American Earth satellite, Explorer I, in 1958. The belts had been predicted by James Van Allen, but greatly underestimated. Most of the time Explorer I spent in the belts, its radiation detector was overloaded. The belts are full of charged particles that were ejected by the Sun. Yet when such ejections arrive at Earth, the Van Allen belts can increase in particles, decrease, or even stay unchanged. Finding why this happens is a goal of RBSP. They are scheduled to spend 2 years looping through all parts of the belts. It is important to understand how the belts work, since spacecraft (and people, during the Apollo missions) sometimes go through the belts, and can be damaged by them. RBSP have been built with protective plating and rugged electronics to survive the radiation.

X-51 (experimental unmanned aircraft) suffered a failure of a control fin during its latest test flight and broke apart. The plan was to reach about 6 times the speed of sound. This is difficult with an air-breathing jet engine, because fuel doesn't burn easily in air moving so fast. Because it does not have to carry oxidizer, a hypersonic jet could theoretically launch satellites far more efficiently than rockets. The test was conducted at about 50,000 ft (15 km) altitude, over the Pacific Ocean, after being launched from a B-52 aircraft. This is the 3rd test flight of the X-51, none of which have been completely successful.

Instant AstroSpace Updates



A survey called **GAMA** of much of the sky taken by Australian telescopes has so far found only 2 systems that look like the Milky Way (and a dozen more roughly similar): a large spiral with 2 close companions of size similar to the Magellanic Clouds. Spiral galaxies are common, but sizable close companions are rare.

New observations of the globular cluster M4 using the 2.2-meter telescope in Chile have shown that one of its stars has an unusual amount of **lithium**, which is normally consumed in stars. Further work is needed to determine if the star retained or enriched the lithium, and how that was accomplished.

Astronomers using ALMA (radiotelescope in Chile) have spotted a type of **sugar** (glycolaldehyde) falling inward toward a young binary star about 400 light-years away, the 1st sugar seen near a star, though such has been seen in deep space.

Voyager 2 became the longest-operating spacecraft in August, surpassing Pioneer 6, which lasted about a week short of 35 years. Voyager 1 launched 16 days after Voyager 2, so is the 2nd longest-operating spacecraft.

John Thomas obtained this image of the south polar region of the Moon using an off-the-shelf digital camera afocally with an 8-inch Celestron SCT. This image, taken from Fountain Valley, is an example of the work that can be done from an urban area with modest equipment.

Observation Report: Occultation of Venus (August 13, 2012)

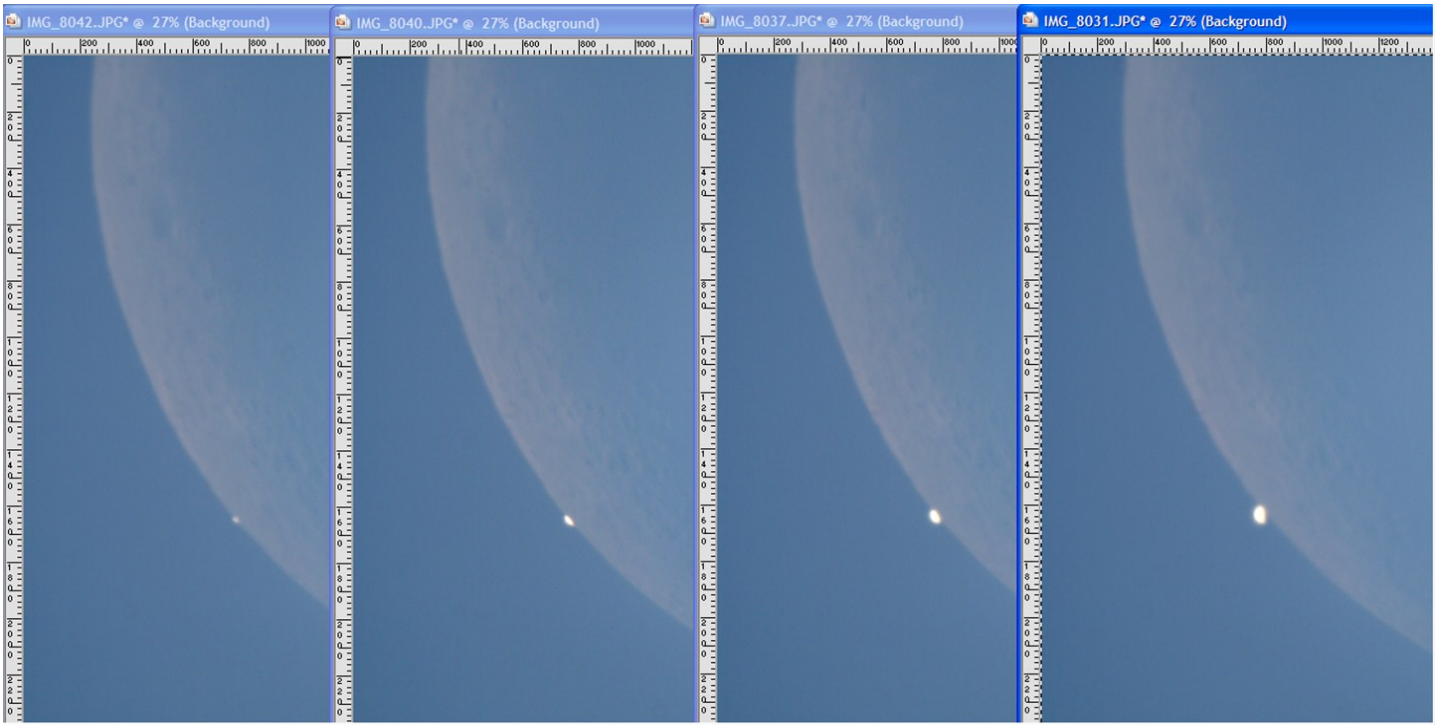
by Bob Buchheim

A month ago, we were treated to an interesting observing opportunity: the crescent Moon passed directly over the planet Venus (an event called an"occultation"). The timing was a challenge for those who have a "day job" – the Moon crept toward Venus, first touching the planet at about 1:40 PM (PDT). I managed to get some images of the approach and occultation using a Canon DSLR slipped into my 11-inch Celestron SCT, but the most amazing thing was the naked-eye view as the two came together. The crescent Moon showed low contrast against the full-daylight sky, but Venus was a startlingly bright white "star" adjacent to the Moon. You all know that Venus is easily visible in morning twilight, and that it can be followed as the sky brightens; but it's usually pretty tough to locate it in the daytime. With the Moon to guide you and help focus your eyes, that brilliant dot was the nearest thing to a UFO that I've seen in a long while.

I don't suppose that there is any new "science" to be had from such an observation, but it was educational, for a few of reasons. First, the naked-eye view was an opportunity to replicate an observation that may have been witnessed by Babylonians 3500 years ago. Babylonian star-gazers were careful observers of Venus back then. Having seen how the Moon gradually approached Venus over the few mornings preceding August 13, it is not difficult to imagine that any competent star-gazer would have been able to recognize that there was a good chance of a close pass coming up. And having seen how obvious both the Moon and Venus were in the daytime sky, makes it almost inconceivable that a similar event would have been missed, back then.

Second, there was no question that Venus went "behind" the Moon: if it had passed in front of the Moon, it would have been vastly brighter than the dim lunar crescent, and easily visible against it. So, this was plain observational evidence that Venus is more distant than the Moon.

Third, the "quarter phase" of Venus was obvious to everyone who saw it through my 4" 'scope – a nice replication of Galileo's seminal discovery of her phases. Fourth, remember that story that we always tell, about how Venus is swathed in highly-reflective white clouds, while the Moon rocks are



low-albedo, roughly like blacktop? The brightness contrast certainly made this story seem credible to even the most casual telescopic observer. Finally, not many people stare at the Moon long enough to "see" its motion across the celestial sphere, but this event fairly forced you to watch the scene evolve during the hour or so before first contact. During the Moon's approach to Venus, it was remarkable to see how rapidly it moved (roughly one lunar diameter per hour).

This is the second Venus occultation that I've seen, and it was a good reminder of how wonderfully sublime an event it is. Don't miss the next one! (From southern California, that will be at 8AM on December 7, 2015. Mark you calendars...)

The Big Dipper is seen over the open dome of the 100-inch Hooker telescope at Mt. Wilson Observatory. The telescope was built between 1908 and 1917 (with a delay due to World War I) and reigned for three decades as the world's largest telescope until the 200-inch Palomar telescope saw first light in 1948. This image is unusual in that the 100-inch dome is rarely opened these days. (credit: Bob Buchheim)

Magazine Subscriptions

Subscriptions to the Astronomy magazines are now due for renewal, if you subscribed for one year or would like to subscribe at the club rate. You may also extend an existing subscription that does not end in December for one year at the club rate. Bring your check made out to the OCA to the meeting or mail it to:
Charlie Oostdyk, Orange County Astronomers, PO Box 1762, Costa Mesa, CA 92628.
Checks made out to the magazine publishers cannot be processed and will be returned to you.
If you already subscribe, please provide the mailing label or the billing invoice with your check.
One-year rates are as follows:

	Club Rate	Regular Rate
Sky & Telescope*	**$33.00**	$37.95
ASTRONOMY	**$34.00**	$42.95

***Sky & Telescope subscribers please note: Due to a change by the publisher, renewals of current subscriptions should now be made directly through Sky and Telescope! New subscriptions at the club rate must still be made through Orange County Astronomers and then renewed through the publisher.**

The **DEADLINE** for subscribing at the club rates will be the **October monthly meeting, October 12th.** The publishers will send expiration notices to all current club subscribers about November 1st even if you renew through the club. It takes the publishers a few weeks to process renewals.

FOR SALE

Meade ETX-125C telescope with carrying case, tripod, autostar finder system and other accessories. $600 or best offer.

Contact Barbara Mays 562-439-7468

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