SIRIUS ASTRONOMER

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The Newsletter of the Orange County Astronomers

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GOT MEAT? ANNUAL STARBECUE AT ANZA AUGUST 3RD!

Left: Great Nebula in Andromeda, the first-ever photograph of another galaxy. Image credit: Isaac Roberts, taken December 29, 1888, published in *A Selection of Photographs of Stars, Star-clusters and Nebulae*, Volume II, The Universal Press, London, 1899. For more information on the history of deep-sky astro-photography, turn to the NASA Space Place article on page 2.

Right: What a difference 114 years makes! Bill Patterson took this image of M31 from Sunglow Ranch, Arizona on December 28, 2002 using a Takahashi FSQ106 with a ST10X-ME imager. To learn how modern amateur equipment can contribute to the story, read Bob Buchheim's article on astrophotometry on page 3.

OCA CLUB MEETING

The free and open club meeting will be held August 9 at 7:30 PM in the Irvine Lecture Hall of the Hashinger Science Center at Chapman University in Orange. This month, Dr. Ed Krupp of Griffith Observatory will present "Star Trek: The Search for the First Alleged Crab Supernova Rock Art"

NEXT MEETINGS: September 13, October 11

STAR PARTIES

The Black Star Canyon site will open on August 31. The Anza site will be open on August 3. 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 August 2. The following class will be held September 6.

GOTO SIG: TBA
Astro-Imagers SIG: Aug. 20, Sep. 17
Remote Telescopes: TBA
Astrophysics SIG: Aug. 16, Sep. 20
Dark Sky Group: TBA

Inventing Astrophotography: Capturing Light Over Time

By Dr. Ethan Siegel

We know that it's a vast Universe out there, with our Milky Way representing just one drop in a cosmic ocean filled with hundreds of billions of galaxies. Yet if you've ever looked through a telescope with your own eyes, unless that telescope was many feet in diameter, you've probably never seen a galaxy's spiral structure for yourself. In fact, the very closest large galaxy to us—Andromeda, M31—wasn't discovered to be a spiral until 1888, despite being clearly visible to the naked eye! This crucial discovery wasn't made at one of the world's great observatories, with a world-class telescope, or even by a professional astronomer; it was made by a humble amateur to whom we all owe a great scientific debt.

Beginning in 1845, with the unveiling of Lord Rosse's 6-foot (1.8 m) aperture telescope, several of the nebulae catalogued by Messier, Herschel and others were discovered to contain an internal spiral structure. The extreme light-gathering power afforded by this new telescope allowed us, for the first time, to see these hitherto undiscovered cosmic constructions. But there was another possible path to such a discovery: rather than collecting vast amounts of light through a giant aperture, you could collect it *over time*, through the newly developed technology of photography. During the latter half of the 19th Century, the application of photography to astronomy allowed us to better understand the Sun's corona, the spectra of stars, and to discover stellar and nebulous features too faint to be seen with the human eye.

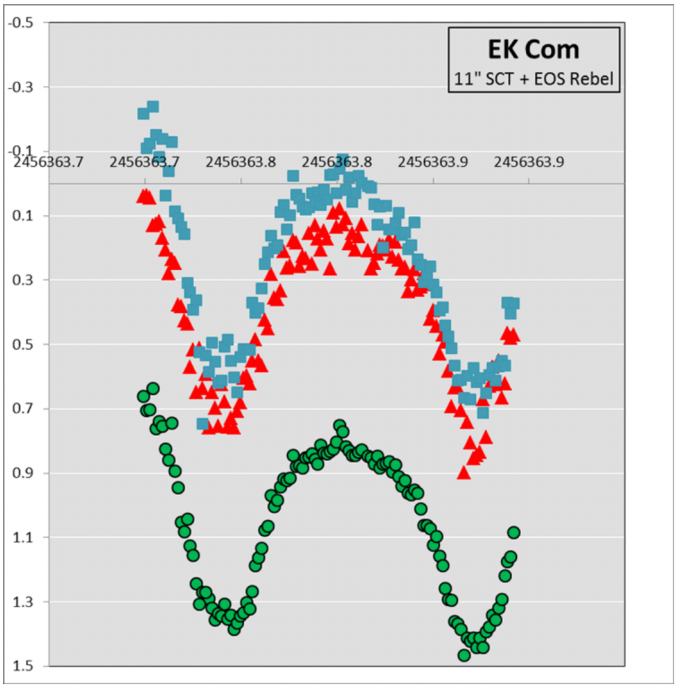
Working initially with a 7-inch refractor that was later upgraded to a 20-inch reflector, amateur astronomer Isaac Roberts pioneered a number of astrophotography techniques in the early 1880s, including "piggybacking," where his camera/lens system was attached to a larger, equatorially-mounted guide scope, allowing for longer exposure times than ever before. By mounting photographic plates directly at the reflector's prime focus, he was able to completely avoid the light-loss inherent with secondary mirrors. His first photographs were displayed in 1886, showing vast extensions to the known reaches of nebulosity in the Pleiades star cluster and the Orion Nebula.

But his greatest achievement was this 1888 photograph of the Great Nebula in Andromeda, which we now know to be the first-ever photograph of another galaxy, and the first spiral ever discovered that was oriented closer to edge-on (as opposed to face-on) with respect to us. Over a century later, Andromeda looks practically identical, a testament to the tremendous scales involved when considering galaxies. If you can photograph it, you'll see for yourself!

Astrophotography has come a long way, as apparent in the Space Place collection of NASA stars and galaxies posters at http://spaceplace.nasa.gov/posters /#stars.

Digital Cameras Can Be Used as Astronomical Photometers

Bob Buchheim



Photometry is a fundamental technique in astronomy that addresses the accurate measurement of the light from a celestial object: how bright it is, what color it is, and whether its luminosity is constant or changing. A wide variety of stellar and planetary properties are investigated by photometry. Examples include the orbital period of eclipsing binary stars, the rotation periods of asteroids, the characteristics of pulsating variable stars (period, color/temperature and the stability – or not – of the pulsations), an even exoplanet transits. Remarkably, all of these can be observed with backyard-scale telescopes. Astronomical photometry can provide enlightening and educational activities suitable for high school science fairs and college-level research projects.

Two things that have impeded amateur astronomers from trying photometric projects have been the expense and the trouble: CCD cameras and photometric filters aren't cheap, and learning to use the specialized software for photometric analysis has required a significant investment of time.

But times have changed! Modern digital cameras (DSLR's and even some "point-and-shoot" versions), which are both inexpensive and ubiquitous, turn out to be quite effective astronomical photometers. Several software packages that are widely used by astro-imagers have routines for both differential photometry and time-series photometry (e.g. Maxim-DL and CCD-Soft); and Meade's "Envisage" package (which can be downloaded from their website for free) provides all of the image-processing and data analysis that is needed for excellent astronomical photometry.

If you'd like to learn how, and try your hand at some astronomical photometry with a digital camera, visit the OCA Library. John Hoot and Bob Buchheim presented a "Digital photometry" class at the 2013 SAS Symposium, and the complete class is available on a DVD in our Library. Check it out!

You may also want to take a look at some of the resources available on the website of the Society for Astronomical Sciences (SAS), including videos of many of the recent technical presentations, and the SAS Newsletter. Go to www.SocAstroSci.org.

REMEMBERING ART LEBRUN (October 22, 1943-May 15, 2013)

Art was born in the Panama Canal Zone, at the time administered by the United States. He was employed for many years with Meade Instruments. Astronomy was his forte, and in 1967 with his uncle Charles they got the idea to form a club in Orange County and made it happen. Thus, OCA was born in October 1967.

At his passing, Art was in possession of numerous articles of interest to OCA members, including many back issues of the Sirius Astronomer and issues of Sky and Telescope dating back to 1967 (the October 1967 issue announced the club's first meeting!) Art is survived by several family members, including Charles.

AstroSpace Update

August 2013

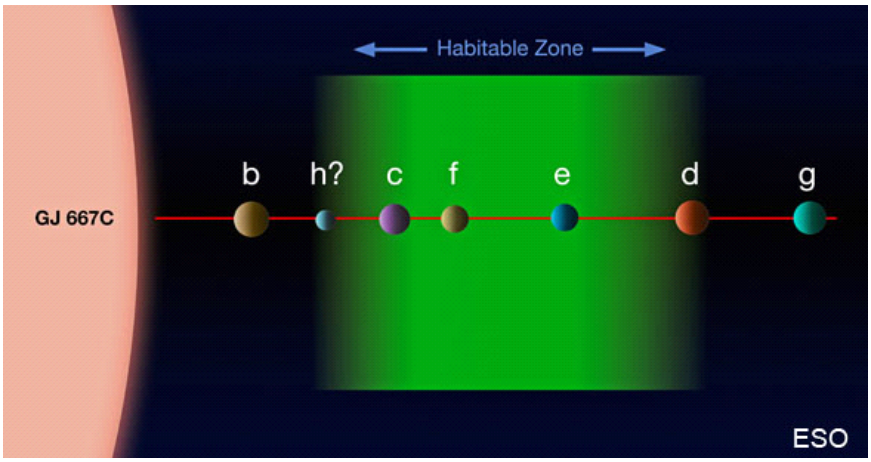
Gathered by Don Lynn from NASA and other sources

Radio burst – Only one of these had ever been observed, lasting a few milliseconds and thought to have come from outside our Milky Way. A new study of data from the Parkes radiotelescope has found 4 more such bursts, and they have been shown to come from billions of light-years away. The distances were determined by the effects on the radio waves of charged particles encountered on the way here. The cause is unknown, but it must be some extremely energetic process, such as neutron stars, magnetars, black holes, or supernovas, though the data do not fit well what is expected from any of these. From the tiny part of the sky seen by the radiotelescope, and the fact that 4 were seen, it was calculated that detectable radio bursts are going off every 10 seconds somewhere in the sky, but no one knows where to look. None of the bursts has been seen in any other wavelength of light.

IBEX (particle imaging spacecraft) has mapped for the 1st time the tail of the solar system. The tail is caused by interstellar wind pushing the Sun's magnetic field off to the downwind side. It is not a simple tapered round tail. The cross section is more 4-leaf clover shaped than round. This is caused by different speeds of solar wind emitted by the Sun's poles (faster) as compared to equatorial regions. Further, the clover shape twists somewhat as it recedes from the Sun. This is caused by interstellar magnetic fields. The length of the tail (depth into the sky from our point of view) has not been measured, so we are seeing only a 2-dimensional picture. Tails have been spotted around a few other stars. Voyager 1, the only spacecraft that is near leaving the solar system, as defined by its particles and magnetic field, is aimed in almost the opposite direction to the tail, so we have no direct measurements of the tail region.

Exoplanet color – Hubble Space Telescope has deduced the color of an exoplanet, known as HD 189733b. The planet is 63 light-years away, making it one of the closest exoplanets among those that transit their stars. Spectral observations of the planet and its star were made before, during, and after the planet went behind its star, and the difference was the light from the planet, which was quite blue. Since the planet orbits very close to its star, it is nearly 2000°F (1100°C), so the blue is not an ocean, but is likely blue clouds of molten glass droplets. As if raining glass isn't bad enough, the winds there are estimated at 4500 mph (7200 kph), making for really ugly rainstorms.

Exoplanet water – A team of astronomers using the Very Large Telescope (VLT) in Chile have detected water vapor in the atmosphere of an exoplanet (the same blue planet as above) by using a new technique. The planet and its star cannot be resolved separately, but the spectral lines from the planet can be separated from those of the star because they periodically shift slightly from Doppler Effect as the planet orbits the star. Carbon monoxide was also found in the planet's atmosphere by the same technique. It is believed that the technique will work on lots of other planets and some other molecules.



Habitable zone exoplanets – A study using more data has expanded the known planets orbiting the star Gliese 667C from 3 to probably 7, though 1 of those is just barely detectable. 3 of the 7 lie in the habitable zone, the region where temperatures may allow liquid water to exist. Whether water does exist will depend on their atmospheres and other factors. All 3 are super-Earths, that is, more massive than Earth, but less than Neptune. Of the other 4 planets, 2 orbit closer to their star and are therefore too hot, and 2 farther and therefore colder than the habitable zone. No more planets could be awaiting discovery in that star's habitable zone, since a 4th would be too close to the others and therefore unstable in its or-

bit. The inner 5 planets are expected to have tidally locked their rotation to their orbiting, so that 1 side always faces their star, and the other side is in perpetual darkness. Gliese 667C is 22 light-years away in Scorpius. Gliese 667 is a triple star, "C" being the smallest. The other 2 stars would be so bright as to be visible in daytime and provide more light in night than our Moon. It would make for interesting sunrises and sunsets, even for the 5 planets where the nearest of the triple star never sets. It would be tough to schedule star parties, when and where all 3 stars are not visible.

Cluster exoplanets – 2 exoplanets have been found in Kepler (planet-finding space telescope) data that are located in a star cluster, NGC 6811. Only 4 other planets are known in star clusters, and it had been surmised that the conditions in clusters, at least dense ones, would be too violent to allow planet formation. This discovery probably shows that is not true. The cluster is about 3000 light-years away, is about 1 billion years old, and has remained intact. Many star clusters scatter their stars before this age.

Galaxy evolution – Astronomers using the VLT have spotted a distant galaxy hungrily snacking on nearby gas. Though astronomers have long suspected that galaxies grow by pulling in material from their surrounding, this process has proved very difficult to observe directly. This time the gas was seen by its effect on light passing through it from a distant quasar, and it was definitely moving inward toward the galaxy. Galaxies quickly deplete their reservoirs of gas as they create new stars, and so must somehow be continuously replenished with fresh gas. The composition of the gas was identified from its spectral lines added to the quasar spectrum. The galaxy lies so far that its light left there when the Universe was only 2 billion years old, and the quasar is even farther.

More galaxy evolution – 2 teams of astronomers have used the Australia Telescope Compact Array (radiotelescopes) to detect clouds of carbon monoxide around early forming galaxies. The goal is to detect hydrogen clouds that will fuel star formation, but hydrogen does not emit radio waves, while carbon monoxide almost always accompanies hydrogen, and does emit radio. One team chose galaxies that lie exactly behind foreground galaxies whose gravity caused magnification through gravitational lensing. These observations complement the above observations by the VLT.

More gas clouds – A new study using the Herschel infrared space telescope looked for clouds of gas feeding our Milky Way galaxy. But instead of looking for hydrogen or its often accompanying carbon monoxide, the study looked for ionized carbon, which also is thought to accompany hydrogen. Ionized carbon is easily detected in far infrared, Herschel's specialty. Previous searches for carbon monoxide around our galaxy had sometimes come up empty because ultraviolet light had destroyed the carbon monoxide in many places. The new study shows that previous searches had missed as much as 1/3 of the gas and had underestimated how far the gas extended.

Galaxy halos – A new study using the Hubble space telescope indicates spiral galaxies are surrounded by halos of gas that can extend over 1 million light-years in diameter, larger than previous studies had found. The material found was ejected from the galaxies by supernova explosions. Theoretical studies showed that spiral galaxies should possess about 5 times the gas in their halos that previous studies had found. The new observations are more in line with theories. The observations were made by tracking ultraviolet light from distant quasars which passed through foreground galaxy halos.

Smallest galaxy – Scientists using the Keck Telescope in Hawaii have measured the least massive known galaxy, named Segue 2, composed of just about 1000 stars and enough dark matter to hold it together. Galaxy formation theorists have been claiming for a long time that there ought to be many more dwarf galaxies around the Milky Way, and maybe astronomers have just not looked for small enough galaxies.

Black hole – The Very Large Telescope Interferometer (hooking together 2 VLTs as 1 instrument) has gathered the most detailed observations ever of the dust around the supermassive black hole at the center of an active galaxy (NGC 3783). These observations show that dust is being pushed away from the black hole as a cool wind, not just as a hot donut (torus) orbiting the black hole. Intense radiation from the hot torus seems to drive the wind.

More black holes – A new study confirms long-held suspicions about how stellar-mass black holes produce their highest-energy light. The study traced the complex motions, particle interactions, and turbulent magnetic fields in billion-degree gas on the threshold of a black hole. A supercomputer simulation of gas flowing into a black hole reproduced a range of important X-ray features long observed in active black holes. Gas falling toward a black hole initially orbits around it and then accumulates into a flattened disk. The gas stored in this disk gradually spirals inward and becomes greatly compressed and heated as it nears the center. Ultimately reaching temperatures up to 20 million °F (12 million °C), the gas shines brightly in low-energy, or soft, X-rays. The new study showed that both soft and hard X-rays arise from gas spiraling in. Soft X-ray photons sometimes collide with a particle moving at appreciable fractions of the speed of light. The collision increases the photon's energy to a hard X-ray. The study simulated a non-rotating black hole. Future work will accommodate rotation.

Black hole napping – NuSTAR (X-ray space telescope) observed the mildly active black hole in the galaxy NGC 253, which had been observed in lower energy X-rays by the Chandra spacecraft nearly a decade ago, and found it dormant. Astronomers were not expecting it could run out of gas to suck into the black hole so quickly. The galaxy has quite a bit of star formation going on, and theorists had predicted that black hole activity and star formation should go hand in hand, since both are fed by gas falling in. Chandra was pointed at 253, repeating its previous observations, and also found no black hole activity. Observations will continue.

Yet more black holes – A study of many years of X-ray observations by Chandra of the Andromeda Galaxy (M31) has produced 26 X-ray sources that are probably stellar-mass black holes (they must still be confirmed). 9 were known previously. The total is the most black holes known in any galaxy outside our own Milky Way. The astronomers involved say it is only the tip of the iceberg, since most black holes do not have a closely orbiting companion star, which is required to produce X-rays. The companion donates the material falling into the black hole, and the material falling in heats until it produces X-rays. 8 of the probable black holes are in M31's globular clusters. No similar black holes are known in the Milky Way's globulars. 7 of M31's black holes are found near the galaxy center, more than known near the Milky Way's center, but this is to be expected, since M31's central bulge contains far more stars.

Dark matter – A team of astronomers has used the Subaru Telescope in Hawaii to measure the distribution of dark matter in 50 galaxy clusters and found that its density gradually decreases from the centers to their diffuse outskirts. The distribution matches that predicted by Cold Dark Matter (CDM) theory, which posits that dark matter is composed of a relatively slow-moving particle that almost never interacts with dark matter, normal matter, or light, except by its gravity. The dark matter was mapped for the 50 clusters by how it bent light, due to gravitational lensing. Previous attempts at this using only a few galaxy clusters had found more concentration of dark matter at centers, not agreeing well with the CDM prediction.

Stellar magnetic fields – For the 1st time astronomers have watched the complete magnetic cycle of a star (Tau Boötis) other than the Sun. While our star takes 22 years to reverse its magnetic field twice (a complete cycle), Tau Boo does it in less than 2 Earth years. The star is 51 light-years distant, and hosts a giant exoplanet about 6 times the mass of Jupiter, which orbits every 3.3 days. The reasons for Tau Boo's fast magnetic cycle are unclear, but the star's fast spin or the proximity of its giant planet may affect it. The discovery was made during a study to measure the magnetic fields of 10 stars with known closely orbiting planets. Only 7 stellar magnetic fields were measurable, and only Tau Boo's field was found to reverse so fast.

New type of variable star – A team of astronomers has observed a red giant star that had expanded until it collided with its companion star, and this collision stripped away much of the giant's mass. The surprise was that the stripped star is pulsating in a manner unlike any other type of variable star. Only a few other recently stripped red giants have ever been found. The newly found star turned up in a survey looking for planets. Further observations are planned to work out how long it will be before the star stars to cool and eventually become a white dwarf (with very low mass due to the stripping).

And another – A study of the Pearl Cluster (NGC 3766), an open cluster about 5800 light-years away, has found 36 variable stars that do not fit the pattern of any known type of variable. Their periods are between 2 and 20 hours. The stars are somewhat hotter and brighter than the Sun, but otherwise apparently unremarkable. They vary by only about 0.1%. Theory predicts this type of star would not vary periodically at all. Some astronomers have theorized that the stars' spins have something to do with their variability.

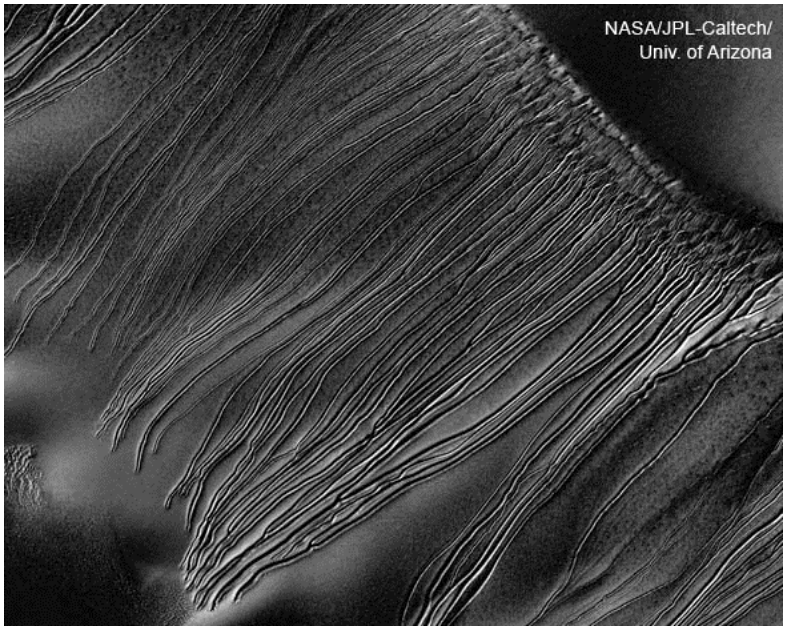
Rare pulsating star – Astronomers have used the Struve Telescope in Texas to discover pulsations from a white dwarf star, designated GD 518, which is roughly 170 light-years away in Draco. It is unusually massive for a white dwarf, at 1.2 times the Sun's mass, and is the most massive white dwarf found to pulsate. Observations will continue to be able to perform asteroseismology on the star, which tells the internal structure of the star that must exist to produce the pulsations observed.

Blue stragglers are hot blue stars that appear to be young, even though they must have formed the same time as all the old stars in their star cluster. 2 theories have been proposed: 1) that 2 stars collide, and the new more massive star supports faster nuclear burning, which turns it hot and blue, 2) 1 star of a binary pair dumps material onto its companion, making it hotter and bluer. A binary star system in the globular M55 that was studied recently has been found to be performing the 2nd scenario. Matter was detected moving from 1 star to the other. The star gaining mass is already bluer than would be expected. It is the 2nd star ever seen in the process of becoming a blue straggler. The binary was found accidentally during a study to find ages and distances of nearby clusters.

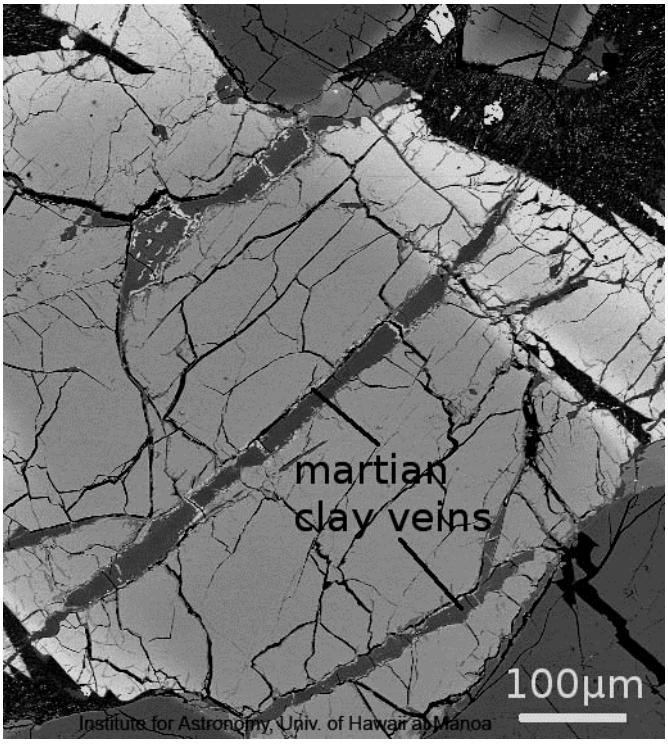
Mercury – A new study of images from Messenger (Mercury orbiter) shows that the planet's oldest terrains are 4-4.1 billion years old, matching the date of the Late Heavy Bombardment which left crater records on the Moon, Mars, and other bodies. Older Mercury terrain was apparently destroyed or covered up. The ages of the youngest areas were determined to be 3.6-3.8 billion years, and were apparently formed by being flooded by volcanic activity. The ages were determined by crater counts, using relations between craters and ages that were established with lunar studies.

Venus wind – The most detailed record of cloud motion on Venus has been collected by Venus Express, and it revealed that the planet's winds have steadily grown faster over the last 6 years. Venus is famous for its curious super-rotating atmosphere, which whips around the planet once very 4 Earth days, in contrast to the planet's rotation of 243 Earth days. In 2006 winds within 50° latitude of the equator were found to be about 190 mph (300 kph), but they have increased to about 250 mph (400 kph). Over 45,000 cloud features were tracked by hand in images, and over 350,000 features by computer program in 2 studies. The studies also showed regular variations in wind speed related to local time of day and other factors. One regular oscillation occurs roughly every 4.8 Earth days and may be connected to atmospheric waves at lower altitudes. Dramatic variations in wind speeds were sometimes seen between consecutive orbits of the spacecraft around the planet. These remain unexplained, as does the general increase over 6 years.

Mars gullies – New research indicates that hunks of frozen carbon dioxide (dry ice) may slide down some Martian sand dunes cushioned by gas, plowing furrows as they go. A number of different types of gullies are actively forming on slopes on Mars, as seen in Mars Reconnaissance Orbiter images over time. One type of gully shows relatively constant width with raised banks along the sides and has no apron of debris at the bottom, though sometimes they have pits. Experiments performed by sliding dry ice blocks (bought at the ice store) down dunes on Earth have produced similar looking gullies. That type of gully is found on Mars on dunes that are covered by dry ice in winter, and the new gullies always appear in spring. The pits are probably caused by the dry ice hunk landing there and subliming (evaporating) into gas as the weather warms.



Mars temperature – The Mars Reconnaissance Orbiter has measured the atmospheric temperature and found that it peaks twice a day rather than once, and the 2nd peak is a little after midnight. Temperatures swing as much as 58 °F (32 °C). This pattern is global and year-round. Previous spacecraft have found the double peak in temperature, but only during dusty times. The explanation was found in water-ice clouds. They absorb infrared in the daytime and heat the atmosphere at night.



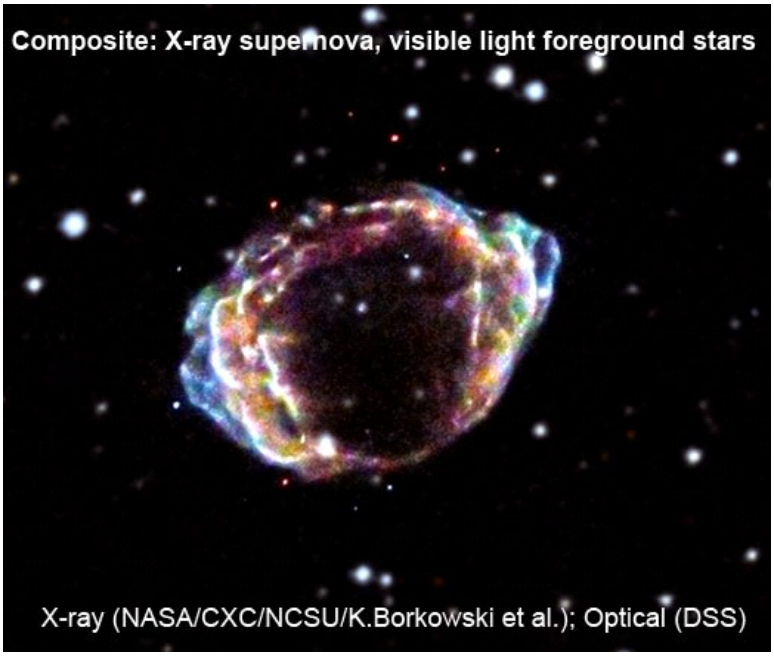
Martian boron – Researchers have discovered high concentrations of boron in a meteorite known to have come from Mars. On Earth it is thought that borate, oxidized boron, was key to the chemical formation of RNA before life began. Using an ion microprobe, the team analyzed veins of clay in the meteorite. After ruling out contamination from Earth, they determined boron abundances in these clays are over 10 times higher than in any previously measured meteorite. The Martian clay is through to be up to 700 million years old.

Uranus asteroids – Astrophysicists have found 3 asteroids that are locked with Uranus in their orbital periods, 1 of them at the leading Lagrange point, so it qualifies as a Uranus Trojan. The other 2 will probably be disturbed from their lock by Saturn's gravity, but may stick around for a few million years. They both have occasional close approaches to Uranus. Another candidate asteroid was found to not quite be locked to Uranus.

Faint young Sun paradox is that 2.8 billion years ago the Sun should have been 20% fainter (stars evolve that way), and yet it does not appear that the Earth froze back then (it would have killed off much of the simple life forms that existed then, which didn't happen according to the fossil record). A new more sophisticated computer simulation of Earth's climate back then may have solved that paradox. For several reasons our atmosphere should have had about 2% carbon dioxide, and may have had a bit of methane. This composition produced in the simulation a climate nearly like today's or perhaps slightly cooler, but not cold enough to freeze tropical oceans. Simpler climate simulations, even with the carbon dioxide and methane, had produced frozen oceans.

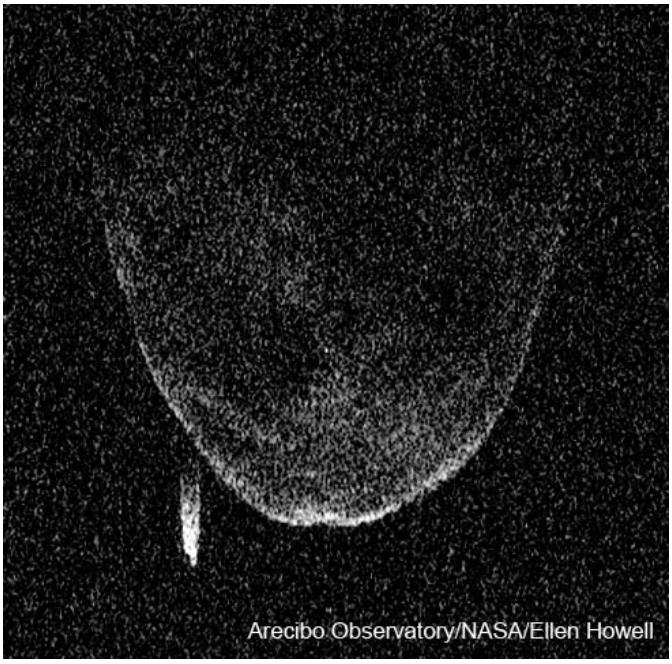
Supernovas – New observations of the remnant of supernova 1987A made with the Herschel infrared space telescope and the ALMA radiotelescope array found a vast reservoir of unexpectedly cold gas and dust, in the range minus 275-420°F (minus 170-250°C). It had been predicted that the gas and dust heated by the supernova would take far longer to cool. The cool solid material amounted to ¾ the mass of our Sun. This discovery should help us understand how supernovas can spread gas and solid material throughout galaxies, some of which may end up in another generation of stars and planets.

Chandra (X-ray space telescope) has observed a supernova remnant discovered in 2008, which proved to be from the most recent supernova in the Milky Way. It would have been seen a little more than 100 years ago if it had not been heavily obscured by dust and gas. It is likely about 28,000 light-years away near the center of our galaxy. The source was most likely a white dwarf star that underwent a Type Ia supernova. The Chandra data show that most of the X-ray emission is synchrotron radiation, produced by extremely energetic electrons accelerated in the rapidly expanding blast wave of the explosion. In addition, some of the X-ray emission comes from elements produced in the supernova. Most Type Ia remnants are symmetrical, with debris evenly distributed in all directions. However this one is extremely asymmetric. The strongest X-ray emission from elements like silicon, sulfur, and iron is found in the northern part of the remnant. Another exceptional feature is that iron, which is expected for form deep in the star's interior and move relatively slowly, is found far from the center and



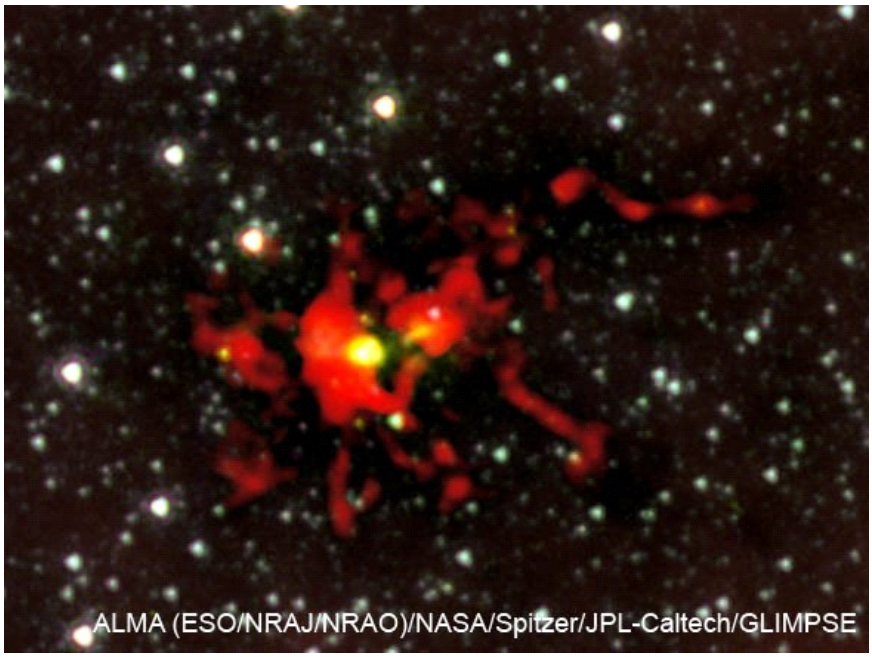
is moving at extremely high speeds. The iron is mixed with lighter elements expected to form further out in the star. By comparing the properties of this remnant with theoretical models, the researchers found that it was probably a delayed detonation, where the explosion occurs in 2 phases. First nuclear reactions occur in a slowly expanding wavefront, producing iron and similar elements. The energy from these reactions causes the star to expand, which allows a much faster-moving detonation front of nuclear reactions to occur. Future observations will be made of the expansion rates of various parts of the remnant to see if they also fit with the asymmetric explosion theory.

Asteroid flyby – The Arecibo and Goldstone radiotelescopes imaged by radar asteroid 1998 QE2 as it made its close pass (3.7 million mi = 6 million km) by Earth in June. It was found to have a moon, as do about 1/6 of near-Earth asteroids. Analysis of the orbit of the moon about the asteroid will allow QE2's mass to be calculated. Visible light and infrared observations were made at other observatories, though the radar resolution is better. QE2 is dark, reddish and has never melted, making it different from any asteroid that spacecraft have visited. The designation QE2 was assigned alphabetically in the order discovered, so has no relation to the ocean liner Queen Elizabeth II (which is often abbreviated QE2), but comparisons were made anyway: the asteroid is 9 times the length of the ship.



China made its 5th space flight with crew, dubbed Shenzhou-10, taking 2 men and a woman to the single module space station Tiangong-1 for about 2 weeks in June. The mission included a lesson in zero gravity transmitted to students. Future plans include a larger station, to be called Tiangong-2, and a multi-module station about 2020. Chinese astronauts are known as Taikonauts.

Rover record – I reported here last month that the Mars rover Opportunity would soon surpass the all-time rover record set by the Soviet lunar rover Lunokhod 2, of about 23 miles (37 km) back in 1973. But since Lunokhod did not have an odometer, the 37 km was just an estimate. A new analysis of Lunokhod's path, aided by images of its tracks taken from orbit, shows that it may have made as much as 42 km, but the exact distance is still uncertain. So we probably won't know if Opportunity breaks the record unless it makes 42 km, which by averages in the past, would be 1-2 more years. As of this writing, Opportunity has traveled 37.09 km.



Instant AstroSpace Updates

A comparison of the **Eskimo Nebula** (NGC 2392) with other planetary nebulas in X-rays shows that it has an unusually high level of X-ray emission, which the researchers attributed to an unseen companion star.

New observations using the ALMA radiotelescope array have found the most **massive star-forming cloud** known in the Milky Way (with mass of 500 Suns) forming a new star that will probably top out at 100 times the Sun's mass. Previous observations, even in infrared, had not penetrated this cloud to show star formation in process.

A new study of hundreds of distant galaxies has found that **jets** from active galactic nuclei usually occur simultaneously with star formation, in contradiction to theoretical work that implies that jets should blast away material before it can form more stars. Further observation is needed to understand this result.

A new computer simulation of dust and gas **disks** about new stars shows that under certain conditions the disk can form rings and other patterns that now have generally been attributed to the gravitational disturbance of planets. This may mean that possible planets indicated by disk patterns may require more confirmation before being accepted as planets.

The 2 newest moons of Pluto, previously known as P4 and P5, are officially **Kerberos** and **Styx**, continuing the underworld mythology theme for the Pluto system.

Goals have been announced for the NASA **Mars rover** to be launched in 2020; based on the Curiosity rover design, its new instruments will look for signs of past microbe life on Mars, using analysis down to microscopic scales, gather samples for a future mission to return them to Earth, and test technology necessary for future human Mars missions.

OPALS, an experimental laser communications system, will be carried up to the International Space Station on a cargo rocket to undergo a 90 day test. It is hoped to increase data communication speeds by 10 to 100 times over radio.

IRIS was launched June 26 on a 2-year mission to help understand material and energy transfer from the Sun's surface to the much hotter corona.

NASA has selected 8 **new astronauts** from 6000 applicants to train in the 21st astronaut class, bringing the all-time total to 330 astronauts. 4 of the 8 are women.

NASA released a 1.3 billion pixel 360-degree panoramic image made by mosaicing together nearly 900 exposures from various cameras on the rover **Curiosity**.

Efforts to revive the transmitter on **Jason-1** (spacecraft measuring sea level, winds and wave height) were unsuccessful, so its mission has been declared over, though it will remain in its high orbit for 1000 years or so. It completed its planned mission and a follow-on gravity measurement mission years ago, and its replacement (Jason-2) has been orbiting for a few years.

Efforts to revive the instruments on **CoRoT** (spacecraft measuring stellar vibrations and finding planets) were unsuccessful, so its mission has ended, and it is being dropped from orbit. It had completed twice its originally planned mission and made many discoveries, including the 1st measurement of a brown dwarf diameter.

GALEX (ultraviolet space telescope) has been turned off after a decade of service, due to budget cuts, though it is functioning well and will not fall into Earth's atmosphere for over 65 years. The telescope has already received more than a year's reprieve due to Caltech's funding its operation after the project 1st ran out of money.

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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
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***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.**

Rho Ophiuchi is a cloud complex located one degree south of the star rho Ophiuchi in the constellation Ophiuchus, approximately 460 light-years from Earth. Covering an area about 30 square degrees, this extended object is best viewed with a wide field and an ideal photographic candidate. Vance Tyree created this image from the Anza site on July 10, 2013 using a Nikon 180mm telephoto lens. at f/2.8 with a Celestron Nightscape 8300 CCD camera.

FOR SALE

Celestron NexStar 5, barely used. $1400 o/b/o. Contact Carol at ccbopper@hotmail.com

Non-computerized C6 SGT including tube, mount (never used), Telrad finder, 25 mm eyepiece, focal reducer and case for the tube. Contact Michael Mirjahangir at 714-319-3103

Meade ETX-125C with accessories (tripod, carrying case, Autostar system, heat/dew cover, etc.) $500 o/b/o. Email SRFROGN@aol.com with copy to startraveler68@yahoo.com for details.

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