SIRIUS ASTRONOMER

www.ocastronomers.org

The Newsletter of the Orange County Astronomers

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The Trifid Nebula, M20, is shown in this recent image created by John Castillo from the Anza site. This image is the product of over eight hours of imaging with 7-minute RGB subs through a 12.5-inch telescope. Located 5,000 light-years from Earth in the prominent summer constellation Sagittarius, M20 is unusual in that it is composed of three separate objects: an open cluster; an emission nebula; and a dark nebula giving the object its trifid-like appearance. At magnitude 6.3, it is an easy object for beginners with modest equipment.

OCA CLUB MEETING

The free and open club meeting will be held July 12 at 7:30 PM in the Irvine Lecture Hall of the Hashinger Science Center at Chapman University in Orange. This month, Dr. Joshua Smith from CSUF will present 'Gravitational Wave Astronomy with LIGO: Opening a New Window on the Universe.'

NEXT MEETINGS: August 9, September 13

STAR PARTIES

The Black Star Canyon site will open on July 13. The Anza site will be open on July 6. 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: July 16, Aug. 20
Remote Telescopes: TBA
Astrophysics SIG: July 19, Aug. 16
Dark Sky Group: TBA

President's Message

July 2013

By Greg Schedcik

Hello OCA members,

As I'm sure you know, this is the first President's message in a long time. It is also my first, for which I apologize. My job has kept me so busy these last few months; I haven't been able to write to you all. But, let's get started…

I've had the pleasure of being an OCA member for several years. I was a trustee, then Vice President last year and President this year. For those of you that know me, I'm not a very talkative person, especially when it comes to written correspondence. I'm usually brief and to the point. So, if this letter seems short, have a good laugh because it's probably twice as long as my usual letters.

OCA is one of the, if not the, largest member amateur astronomy clubs in the USA, if not the world. That is quite an accomplishment that we all should feel proud of being a part of. I know I am. We have many great events happening every week and month. We have a great reputation as well. I heard a few comments lately about how we don't have as many events as we used to.

Now I know it was before my time, but I would like your input on events that you might like to see again. Email me please and let me know. I would also like to ask for your help. Some of the events you might like to see started again will need to be organized-your help will be needed. So, let me know your ideas and how you can help. We could use some help with our website – any volunteers? And think about joining the board as a trustee. Our great club is run by volunteers – please let me know what you can bring to this great organization and let's enrich our club and your membership.

A lot of the events we have are organized and held by many of the same people. We need more help with our Outreach events organized by Jim Benet. Come out to our star parties and lend a hand.

Speaking of star parties, we have ANZA on July 6th and Black Star Canyon on July 13th. Of course, we have our general meeting on July 12th – come on by and introduce yourself. Also on July 13th we have a booth at SCAE at OPT in Oceanside. OCA will have a booth there so come by if you can and say" hi" – and talk to possible members. It starts at 10 am. Hope to see you there.

I wanted to give you a heads up for August, too. We have our annual Starbeque and Kids Star Party at ANZA on August 3rd. Please try to come.

We will also have our beginner's astronomy class on August 2nd. (July is dark). Our general meeting is on the 9th and Black Star Canyon is on the 31st. Please see our on line calendar at www.ocastronomers.org

I will close for now and do my best to get more info for you on a monthly basis – until then:

Clear Skies.

Greg

Western Amateur Astronomers Newsletter Update

by Tim Hogle

WAA Vice President and OCA Representative

As I mentioned in my last update (Sirius Astronomer March 2013), WAA has finally launched our newsletter, the New Pacific Stargazer, after a nearly 20-year hiatus from publication of the original Pacific Stargazer. The inaugural issue is published in electronic form, and is available at https://drive.google.com/folderview?id=0B5I869rZBwb5cm1jUV9Mc2dZMnc&usp=sharing.

I encourage everyone to have a look at it; we have gotten very favorable reviews of the look and content of the publication. Although only four pages, we on the WAA Board believe the present edition represents a very good start to a greatly improved means for inter-club communication.

For those of you who have only joined OCA since March, welcome to this discussion. WAA is what is termed an umbrella organization of astronomy clubs, with emphasis on those in the western USA. That means members are clubs, not individuals, though the benefits are intended to flow to individual members of each member club. Founded in 1949, WAA's purpose is to promote communication between astronomy clubs for their mutual benefit, to give awards for recognition of outstanding achievement in the world of amateur astronomy and to promote astronomy in general. Members in addition to OCA are mentioned in the newsletter on the WAA web site, http://www.waa.av.org..

We hope to continue publishing the New Pacific Stargazer on a quarterly basis. Content will be material of interest to member clubs and hopefully to members of each club. A means of distribution has yet to be worked out, but I will keep you informed. In the meantime, if you have an interest in writing an article of interest to members of the amateur community or have suggestions for content, please let me know. My contact information is always on the back of the Sirius Astronomer.

NOTE FROM THE EDITOR: Prior to this issue going to print, I was informed of the passing of Art LeBrun, a cofounder of Orange County Astronomers, last month due to a heart attack. More details are forthcoming. I spoke with Charles LeBrun briefly; he will be providing a more extensive obituary at a future date but currently the family is occupied disposing of Art's estate. OCA wishes to express its sincerest condolences to his family and all who knew and loved Art, and its profound thanks to Art for his early contributions to the club.

AstroSpace Update

July 2013

Gathered by Don Lynn from NASA and other sources

Dark matter? – A detector system designed to see the rare interactions of the proposed WIMP particle (a candidate to explain dark matter) with ordinary atoms, has seen the expected signal with a calculated 99.8% certainty. This is based on only 3 events seen. This is not enough certainty to claim the particle has been discovered, but the scientists are continuing to take data, and in fact are upgrading the detectors. The project is called the Super Cryogenic Dark Matter Search and its detectors are located ½ mile underground in a Minnesota mine and are cooled nearly to absolute zero to protect them from non-WIMP factors that would register on the detectors.

Migrating planets – Hot Jupiters, those planets roughly Jupiter's size that orbit quite close to their stars and so are hot, are known to form farther from their stars and migrate in. Researchers using data from the Kepler planet-finding space telescope have shown that such migrating planets stop their inward journey before reaching their star and being swallowed. Instead they remain in fairly stable orbits close to their stars for billions of years. Tidal forces from the star stabilize and circularize the planet's orbit, and when it becomes nearly circular, its migration stops. There has been much debate about what processes could stop planet migration. To test which theory is correct, scientists looked at 126 confirmed planets and 2300 suspected planets, and saw how the planets' distances from their stars varied in relation to the mass of the star. The theory that the stars' tidal forces on the planets stopped the migration correlated exactly with the new study's findings. That is, more massive stars generated tidal forces farther out, stopping the planet migrations farther out.

Very hot Jupiters – A new theory proposes that many hot Jupiters are connected to their stars by magnetic fields and huge electric currents (billions of amps). Calculations show that such current could heat planets even hotter than their stars' light alone does, which would puff them up larger than expected. Observations have indeed shown many hot Jupiters are too large to be explained previously.

Hot Jupiter weather – Rudimentary maps have been made of the temperatures of nearly a dozen hot Jupiters by measuring the changes in infrared given off as they rotate. Day temperatures typically exceed night by 1000°.This should drive winds to blow at thousands of mph (kph). Computer simulations of these conditions show that Jupiter-like belts become super sized, with only a 2 or 3 fitting on the planet. Storms like the Great Red Spot would swell to ¼ the size of the planet. It would be too hot for water or methane clouds, but clouds of silicate vapor (vaporized rock) would form.

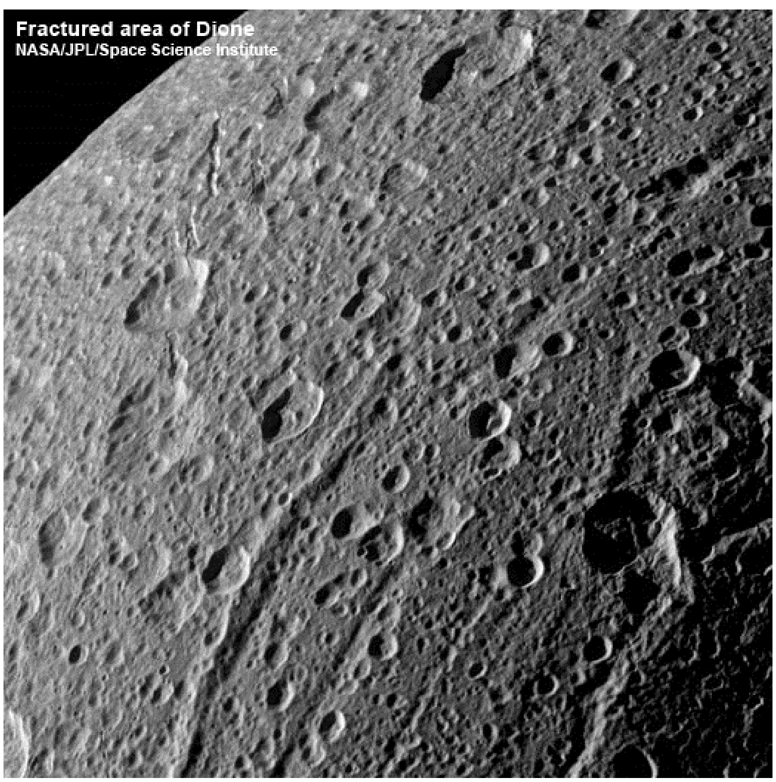
Exoplanet seen – A team of astronomers using adaptive optics on the Very Large Telescope in Chile has imaged a faint object near a bright star that appears to be the least massive exoplanet directly observed. Although nearly 1000 exoplanets have been discovered, only about a dozen have been directly imaged. The mass was estimated from its brightness, and appears to be 4-5 times that of Jupiter. The object was imaged in infrared light, and used differential imaging, which helps overcome the contrast between the dazzling star and the dim planet. The star involved is a young one (probably 10-17 million years old) designated HD 95086, is a little more massive than the Sun, is surrounded by a debris disk, and lies about 300 light-years away. The planet does not orbit where theorists expect such a planet to form, so they are trying to figure out why it migrated. It is distant from its star, about twice as far as Neptune is from our Sun.

Proxima Centauri, the nearest star to our Sun, is predicted to cross in front of 2 distant stars, one in October 2014 and the other in February 2016. Gravitational micro lensing of the background stars will allow the mass of Proxima to be calculated. It should also be possible to determine if any planets orbit Proxima by those planets' effects on the lensing. Previous searches for Proxima's possible planets have been unsuccessful, but the methods were less sensitive than gravitational lensing should be. A team of astronomers searched 5000 stars that have large motions across the sky to find any alignments that would produce gravitational lensing, and Proxima's passages in front of these 2 stars appear to be the most interesting alignments found.

Exoplanet sizes – The 4-meter Mayall Telescope in Arizona was used to study a large sample of stars that the Kepler planet-finding space telescope had reported as having probable planets. The study revealed that many of the stars are actually somewhat larger than originally estimated. Most were slightly larger, and ¼ of the stars were at least 35% larger. Since the sizes of the planets found are calculated by the % of starlight blocked, the planets are also somewhat larger than previously estimated. By implication, the number of Earth-size planets is somewhat smaller (many graduate to the next larger size planet). The previous estimates of star sizes were made from the color and brightness of the stars, but the new measurements were made with spectra, which is a more accurate method. The new study also confirmed a previous assertion that planets larger than Neptune are more likely to be found orbiting stars that contain more heavy elements than the Sun does, and that small planets were independent of this effect. This implies that early generations of stars (which have less concentrations heavy elements) are not capable of producing large planets, but only small ones.

WISE (infrared space telescope) data has been analyzed to find new families of asteroids and to classify or reclassify thousands of asteroids. An asteroid family is formed when a collision breaks apart a large parent body into fragments of various sizes. Members of a family can be identified by their similar orbits and constituent material. The WISE work examined 120,000 asteroids, found 28 new families (48 other families were already known), and classified 38,000 asteroids as family members.

Cassini (Saturn mission) has confirmed the presence of complex hydrocarbons in the upper atmosphere of Saturn's moon Titan, that are chemicals that evolve into the orange-brown haze that dominates that moon's lower atmosphere. The hydrocarbons found are known as PAHs (polycyclic aromatic hydrocarbons), and shed light on how the haze formed. The spectral detection of the PAHs was made difficult by methane spectral lines at nearly the same place. The spectral lines for the PAHs were found to build up during day-time, so the chemicals are apparently produced by reactions triggered by sunlight.



Cassini has found evidence that the moon Dione was likely active in the past, and possibly still is. The magnetometer has detected a faint particle stream coming from Dione, and images showed a mountain that caused the crust to pucker as if there was a liquid or slushy layer underneath when the mountain formed. Also there are fractures on Dione similar to those on Enceladus that are home to the geysers, though no geyser activity was seen in Dione's. It is believed that Dione suffers from flexing from tidal forces, and therefore could be internally heated. Scientists are trying to figure out why Enceladus is so much more active than Dione, though they were subjected to similar tidal forces and radioactive heating.

Solar eruptions – About 70 years ago Hannes Alfvén developed the flux-freezing theorem, which explained the behavior of most particles erupting from the Sun. He later won a Nobel Prize in physics for closely related work. A big problem in astrophysics is that no one could explain why flux-freezing fails occasionally. A new computer simulation shows that turbulence, the same effect that jostles jets, causes flux-freezing to fail. When turbulence hits magnetic field lines from the Sun, they spread out like a plume of smoke, and the particles that were following the magnetic field lines stop behaving.

Lithium – Scientists using the Keck 10-meter Telescope in Hawaii have made the best measurement yet of the amounts of Lithium-6 and Lithium-7 (two isotopes of that element) in old stars and found that they agree with what is predicted to have been produced by the Big Bang. Previous measurements had differed markedly from prediction, and this had been worrying cosmologists for a couple of decades. Taking accurate measurements of lithium in old stars is extremely challenging, in particular for lithium-6 because its spectral signature is very weak. A very large telescope with a high resolution spectrograph was needed, and the Keck Telescope fit this need. Even so, several hours of observation for each star was needed to gather enough light. It also required a supercomputer simulation of stellar atmospheres to predict what would be observed for given concentrations of lithium.

Starburst area – Many distant galaxies are known to be undergoing starburst, where new stars are produced at rates hundreds or more times normal. Now a starburst area has been found nearby, in fact in our part of the Milky Way, only about 5500 light-years away, which may shed light on how starbursts occur. The region lies in NGC 6334, known as the Cat's Paw Nebula. The new work used infrared from the Spitzer Space Telescope as well as ground-based observations to probe far deeper into the nebula than seen before. Huge numbers of newly-formed stars were found.

SOFIA (airborne 100-inch [2.5 m] telescope) has captured the most detailed mid-infrared images yet of a massive star condensing within a dense cocoon of dust and gas. The star is known as G35.20-0.74, is one of the most massive known protostars (20 times the Sun's mass), and is located about 8000 light-years away. Until now, scientists expected the formation process of massive stars to differ from smaller ones in that they should be more turbulent and chaotic. But these observations show it is forming by the same orderly process as do stars with the Sun's mass. The protostar is too embedded in dust for visible-light telescopes to observe it, and is too bright in infrared for the infrared space telescopes, but SOFIA is perfect for the job.

Star formation – Studies of the star TW Hydrae suggest that the Sun grew in fits and starts and emitted bursts of X-rays when it was young. TW probably looks like the Sun did when it was only 10 million years old. It is an orange step K star with 80% the mass of our Sun, and is still accreting gas from a surrounding disk. That disk may contain forming planets. TW is accreting material in clumps and episodes rather than uniformly. The accretion process is seen to change from night to night. Young stars are more magnetically active than the Sun is now, and magnetic effects may contribute to this rapidly changing behavior.

Planet formation – Astronomers using the ALMA radiotelescope array in Chile have imaged a region around a young star where dust particles can grow by clumping together. This is the first time that such a dust trap has been clearly observed and computer modeled. It solves a long-standing mystery about how dust particles in disks grow to larger sizes so that they can eventually form comets, planets and asteroids. Computer simulations usually show that larger dust grains break up more often than clump together when they collide in a dust disk. But the newly found dust trap has gentler collisions so that dust can clump through this size range. The trap is cashew shaped, not ring shaped. Computer simulation showed that this shape would live for hundred of thousands of years and its dust would later disperse over millions of years, giving time for larger bodies to form.

Galaxy formation – A new supercomputer simulation of galaxy formation shows that, contrary to previous simulations, the material feeding star formation swirls along narrow paths into the core rather than flowing from all directions. This results in more material reaching the core faster and cooler, and stars therefore form faster than in previous simulations. The material is also spinning faster than expected. These results are more in line with what is observed.

Galaxy merging – Two young galaxies that collided 11 billion years ago (but so distant that we are just seeing them now) are seen to be rapidly forming a massive galaxy about 10 times the size of our Milky Way. The new mega galaxy is the brightest most gas-rich galaxy merger ever seen in submillimeter radio light. The galaxies are in a feeding frenzy that will quickly exhaust the supply of material to form stars, and in hundreds of millions of years should result in a galaxy that slowly starves for material to form stars for the rest of its life. The collision was found as an amazingly bright blob in images from the Herschel space telescope, which uses infrared to see where previous telescopes could see only dust. Follow up observations from many telescopes at a variety of wavelengths revealed the nature of the collision, and showed that their velocities will result in them merging rather than flying apart.

Galaxy distances – New measurements have been made of the distances to M31 and M33, our nearest neighbor full-sized galaxies. These were done in infrared because it is believed that is less sensitive to sources of error (such as dust) than visible light distance measurements. Cepheid variables, whose brightness is related to their periods of variation, were used for the determinations. The new result for M33 is 2.74 million light-years. Two teams measured M31, and got 2.45 and 2.54 million light-years. The latter measurement used only one globular cluster at M31, so could be consistent, since the globulars are at slightly different distances than the galaxy center.

BeSSeL – Determining the structure of our own Milky Way galaxy has been a longstanding problem because we are inside it. A new survey designated BeSSeL, using the Very Long Baseline Array (VLBA) of radiotelescopes, has found that it can locate gas clouds that show the galaxy structure, and determine their distances by parallax, allowing creation of a 3-dimensional map. In fact the motions can also be measured. The result shows that there is more structure than thought to the Local Arm, the piece of the Milky Way in which we live. It had been thought that the Local Arm is a tiny spur off a larger arm of the galaxy, but the new mapping shows it may be a significant branch of a galaxy arm or possibly a separate arm. BeSSeL stands for Bar and Spiral StructurE Legacy. Don't try to find the 1st "e". They added it in honor of Friedrich Bessel, who made the 1st accurate measurement of a star's parallax, and therefore distance, in 1838.

VLBA has also measured the distance to the variable double star SS Cygni at 370 light-years. This is a dwarf nova, consisting of a white dwarf star with an accretion disk and a red dwarf star in close orbit, which outbursts, in this case, every 49 days. A previous measurement of its distance, made by the Hubble Space Telescope, was 520 light-years. At that distance, SS Cygni would be the brightest dwarf nova known, and theoretically the accretion disk should not become unstable as material was added and thus it would not outburst. But at the new distance, SS Cygni behaves just like the other dwarf novas. Astronomers are already making up excuses why the Hubble measurement was so far off, such as that the objects that the Hubble parallax was measured against were actually moving.

EBL – Most of the light of all wavelengths from radio to gamma rays that was ever emitted by all the galaxies in the Universe is still speeding through space. This light is known as the extragalactic background light (EBL). Directly measuring the EBL poses huge technical challenges. Astrophysicists have developed a method of measuring the EBL indirectly. Blazars are supermassive black holes in the centers of galaxies with brilliant jets that happen to be directed toward us. They give off gamma rays that over cosmic distances occasionally collide with lower energy forms of light. Different energies of gamma rays dissipate from this effect at different rates. So measuring the loss of gamma rays at different energies over different distances tells us how much EBL intervenes between us and the blazars. A new study using this method has measured the EBL over the time period from 5 billion years ago until today. The result confirms that the EBL over this 5 billion year period was mostly emitted by galaxies like those seen today.

Black holes – There is an unresolved glow of infrared throughout the Universe that is known as the cosmic infrared background (CIB), which is thought to have been produced mostly from clusters of massive stars in the Universe's first generations of stars and by black holes also in the early history of the Universe. The black holes also produced X-rays. And there is also seen a cosmic background of X-rays (CXB). So observations of the X-ray and infrared background were made over the same regions of sky (a well observed strip in Boötes) in order to pin down how much of the infrared background was from the black holes. The answer is about 20% of the CIB is from black holes.

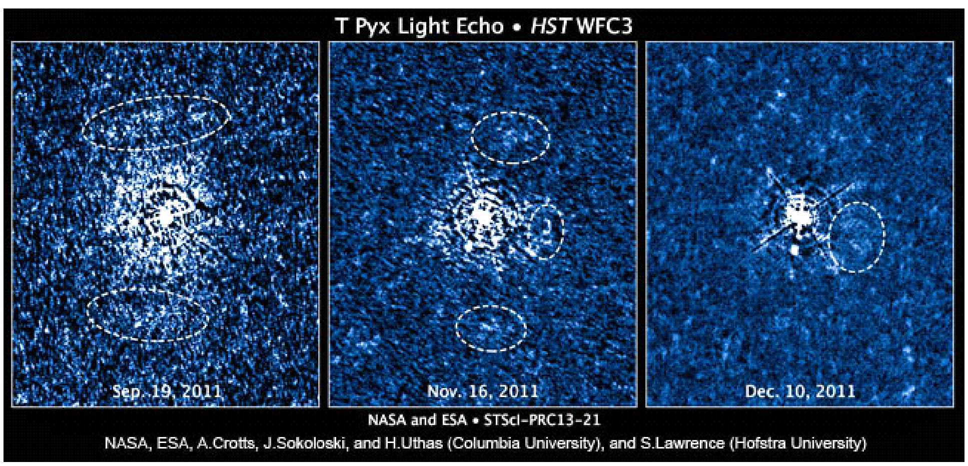
Swift (Gamma-ray and ultraviolet space telescope) has made the most detailed ultraviolet (UV) surveys ever of the Large and Small Magellanic Clouds (LMC and SMC respectively), neighboring galaxies to our Milky Way. Thousands of images were assembled into 2 seamless mosaics of the galaxies. They show about 1 million UV objects in the LMC and ¼ that in the SMC. Hot young stars are seen best in UV. Most UV is blocked by the Earth's atmosphere, so this work had to be done by a space telescope. Over a week of total exposure was made for this survey.

Anti-glitch – Neutron stars spin at extremely stable rates. Once in awhile, they suffer a glitch, in which the rotation rate suddenly jumps a tiny bit faster. The Swift space telescope caught a neutron star in the 1st ever observed anti-glitch, in which rotation jumped a tiny bit slower. Glitches are thought to occur when the neutron star quakes, possibly because of an adjustment between the core and crust. A week before the anti-glitch, the neutron star produced a brief, but intense X-ray burst seen by the Fermi gamma-ray space telescope. Theorists are trying to figure how these 2 events are connected, and how an anti-glitch could even occur. The star in question is a magnetar, which is a neutron star with an even stronger than usual magnetic field. It is designated 1E 2259+586 and is located about 10,000 light-years away in Cassiopeia.

Chandra (X-ray space telescope) has measured the surface magnetic field of a known magnetar and found it to be far lower than other magnetars previously measured. This magnetar, designated as SGR 0418, behaves otherwise like the other known magnetars in such properties as spin rate and occasional large blasts of X-rays. It is estimated to be 550,000 years old, which is older than most magnetars. It is theorized that with age magnetars lose their external magnetic field while retaining the internal extremely powerful magnetic fields. More research is needed to understand objects like this.

AGB – Astronomers expect that stars like the Sun will blow off much of their atmospheres into space near the ends of their lives, in a stage of their lives known as asymptotic giant branch (AGB). But new observations of a huge star cluster (NGC 6752) using the Very Large Telescope in Chile have shown that a majority of the stars studied did not get into this stage at all. The team also found that all of the stars that puffed off their atmospheres were low in sodium, and none of the stars high in sodium had lost their atmospheres. Low sodium is an indication of an early generation of star – sodium and other heavy elements are generated by stars and distributed into the later generations of stars. The team expects that similar results will be found for other star clusters, so further observations are planned.

Hubble Space Telescope is healthy. The last service mission of astronauts visiting the Hubble in 2009 was designed to allow at least 5 more years of operation of the telescope. Except for a minor amount of detector degradation, the telescope was found to be in perfect condition during a check on its health, except for the NICMOS camera. That camera is not being used because of cooling system problems, but could probably be restarted if needed. However other instruments overlap much of its capabilities. As a result of this health check, plans are now to try to operate Hubble until about 2020. One benefit of this would be to overlap operation of the James Webb Space Telescope, which is now scheduled to begin operation in 2018. Without the Space Shuttle to boost it, Hubble's orbit will decay, resulting in its falling to Earth somewhere in the 2030s. Hubble is demonstrably the most productive telescope ever, and is more productive today than ever. Over 11,000 papers based on Hubble data have been published in scientific journals, and a new PhD based on Hubble research is awarded on average every 10 days. Observing time with Hubble that is applied for exceeds time available by more than 5 to 1.



Nova – A flash of light given off by an erupting nova known as T Pyx is being watched by Hubble as the light moves out through debris thrown off earlier by the star. This is allowing a 3-dimensional map to be made of that debris. It formed a disk, contrary to expectations. A spherical shell of debris had been predicted. A nova erupts when sufficient hydrogen has fallen onto a white dwarf star from a closely orbiting companion star. The hydrogen detonates like a colossal bomb, resulting in the star brightening by about 10,000 times in little more than a day. In the case of T Pyx, these eruptions repeat at intervals of 12 – 50 years. This latest occurrence was seen in April 2011. Seeing how fast the light moves out, and knowing the speed of light, allow calculating the distance to the nova, which was found to be 15,600 light-years. Previous measurements by other methods ranged from about 6-16 thousand light-years. This is the 1st time that a nova outburst has been observed to light the debris and allow it to be mapped.

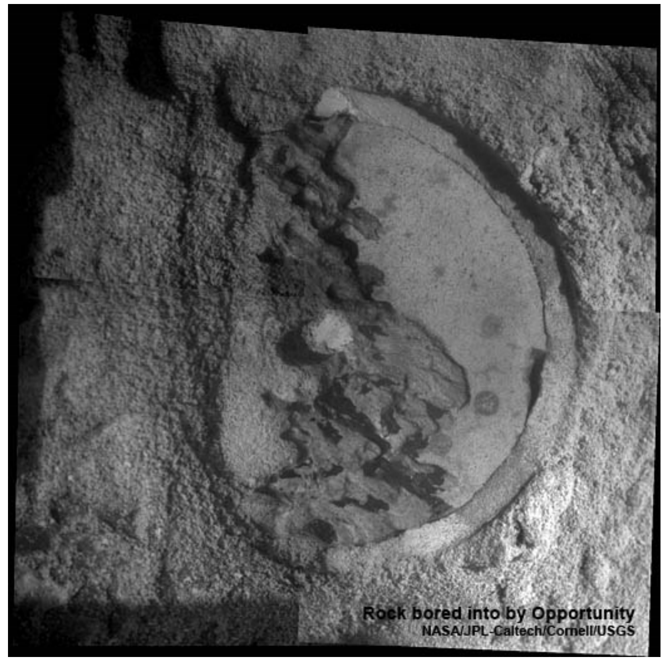
Ring Nebula – Hubble and some ground-based telescopes have managed to map the Ring Nebula in 3 dimensions, and there are some surprises about its shape. It is being compared to a jelly doughnut rather than a ring or bagel shape, because its center is filled with material. The ring wraps around a blue, football-shaped structure (the jelly in the doughnut). Each end of the football protrudes out of an end of the ring. The nebula is tilted toward Earth such that the ring is seen face-on. The blue structure is glowing helium. Radiation from the central star, a white dwarf, excites the helium to glow. Hubble views show dark irregular knots of dense gas embedded along the inner rim of the ring, which look like spokes in bicycle wheel. These spokes formed when expanding hot gas pushed into cool gas ejected previously by the star. The knots are more resistant to erosion by the wave of ultraviolet light unleashed by the star. Astronomers have found similar knots in other planetary nebulas. All of this gas was expelled by the central star about 4000 years ago. The original star was several times more massive than out Sun. During its red giant phase, the star shed its outer gaseous layers into space and began to collapse. A gush of ultraviolet light from the dying star energized the gas. The outer rings were formed when faster-moving gas slammed into slower-moving material. The nebula is expanding at more than 43,000 mph (69,000 kph), but the center is expanding faster. The nebula's expansion was measured by comparing new Hubble images to 1998 ones. The Ring will continue to expand for another 10,000 years, a short phase in the lifetime of a star. The nebula will fade until it merges with interstellar stuff. The Ring Nebula is about 2000 light-years away and roughly 1 light-year across.

Lunar meteoroids – For the past 8 years astronomers have monitored the Moon for the flashes of light given off when meteoroids strike the surface. Of the hundreds spotted, one seen in March was by far the brightest, indicating the largest meteoroid. It was calculated to be about 90 lbs (40 kg) and at least a foot (0.3 m) across. Its speed of about 56,000 mph (90,000 kph) would cause it to dissipate as much energy at the collision as 5 tons of TNT exploding. For about 1 second, the glow was as bright as a 4th magnitude star, and so could have been seen with the naked eye from Earth. The Lunar Reconnaissance Orbiter will look for a new crater at the location of the flash. The crater could be as large as 22 yards (20 m) across. Cameras that search for meteors in Earth's sky picked up more than usual numbers the same night, so apparently the Earth and Moon hit a pocket of meteoroids. In the 8 years, more than ½ of the lunar flashes came from known meteoroid streams, such as the Perseids and Leonids.

Mars rover Curiosity is finishing up its investigations in the area where it has been working for 6 months, and will soon start driving long distances toward the base of Mount Sharp, the huge mountain exposing miles of geological layers. Rover controllers expect to stop on the way to Mt. Sharp at 2 areas that look like a mudstone/sandstone boundary and a river deposit. However, any other geological interesting objects spotted may occasion more stops. The 2 drillings made so far indicate that relatively neutral water (not salty) flowed through the rocks in the distant past, perhaps billions of years ago. Further analysis of pebble-containing slabs seen by Curiosity confirmed that they were, as previously theorized, conglomerate rocks formed by flowing water over long periods of time. The water had to have flowed at a walking speed and was as much as hip deep. The pebbles had to have been carried by the water a few miles (km) to have attained their rounded shape.

Rover record – The farthest that any NASA rover traveled off the Earth was the 22.210 miles (35.744 km) that astronauts Cernan and Schmitt drove their Apollo 17 rover on the Moon in 1972, that is, until Mars rover Opportunity reached that distance on May 15. The all-countries record is still held by the Soviet Union (before Russia) Lunokhod 2, which traveled about (it did not have a precision odometer) 23 miles (37 km) on the Moon by remote control in 1973. Opportunity is expected to take the record in the next few months on its way to Solander.

Mars rover Opportunity has found that a new rock target is composed of clay that has been intensely altered by relatively neutral water neither acidic nor salty). The rover used its still functioning (after 9+ years) Rock Abrasion Tool to expose the interior of the rock analyzed. The rock was higher in aluminum and silica and lower in calcium and iron than other rocks the rover has examined. Most, but not all, of the rocks previously inspected by Opportunity were formed in highly acidic or salty water. Next Opportunity will drive to Solander Point, where many layers of rock are exposed. Solander also offers north-facing slopes where the rover can tilt itself toward the coming low winter Sun, increasing the solar panel output enough to continue performing science observations throughout the winter. It will be the rover's 6th Martian winter.



Instant AstroSpace Updates

Further analysis of data from the twin **GRAIL** spacecraft that measured the gravity of the Moon showed that the mascons (areas of more mass) on the Moon had to have been formed by impacts melting denser material from deep in the Moon. The origin of the mascons had long been debated.

Computer simulations of the atmospheres of **Uranus and Neptune** matched against observations from Voyager's flyby showed that the swirling clouds and violent winds do not extend deeply into the atmosphere, penetrating no more than 680 miles (1090 km) deep. Deeper winds would have been noticeable in Voyager gravity data. The Juno spacecraft will similarly measure the depth of weather on Jupiter.

The Cassini flyby of Saturn's moon **Titan** in late May was programmed to look for waves (which have been predicted theoretically) on a sea named Ligeia Mare using the altimeter, and to make stereo views of northern lakes to measure the height of walls around them.

NASA has awarded a contract to a company to develop a 3-D printer that will **print pizza**, with flavors to order; eventual use would be on long space flights. The company has already built chocolate and other food printers.

The **asteroid 1998 QE2**, which passed only a few million miles (km) from Earth in late May, was found in radar images to have a moon nearly 5 times smaller across orbiting it. Radar also showed dark features and concavities in the asteroid that may be craters.

South Africa's new **KAT-7 radiotelescope** has observed a neutron star known as Circinus X-1 in great detail during multiple cycles of flares. The 1st paper based on KAT-7's observations has been accepted by a major journal.

High-energy Spy

By Dr. Martin C. Weisskopf

The idea for the Chandra X-Ray Observatory was born only one year after Riccardo Giacconi discovered the first celestial X-ray source other than the Sun. In 1962, he used a sounding rocket to place the experiment above the atmosphere for a few minutes. The sounding rocket was necessary because the atmosphere blocks X-rays. If you want to look at X-ray emissions from objects like stars, galaxies, and clusters of galaxies, your instrument must get above the atmosphere.

Giacconi's idea was to launch a large diameter (about 1 meter) telescope to bring X-rays to a focus. He wanted to investigate the hazy glow of X-rays that could be seen from all directions throughout the sounding rocket flight. He wanted to find out whether this glow was, in fact, made up of many point-like objects. That is, was the glow actually from millions of X-ray sources in the Universe. Except for the brightest sources from nearby neighbors, the rocket instrument could not distinguish objects within the glow.

Composite image of DEM L50, a so-called superbubble found in the Large Magellanic Cloud. X-ray data from Chandra is pink, while optical data is red, green, and blue. Superbubbles are created by winds from massive stars and the shock waves produced when the stars explode as supernovas.

Giacconi's vision and the promise and importance of X-ray astronomy was borne out by many sounding rocket flights and, later satellite experiments, all of which provided years-, as opposed to minutes-, worth of data.

By 1980, we knew that X-ray sources exist within all classes of astronomical objects. In many cases, this discovery was completely unexpected. For example, that first source turned out to be a very small star in a binary system with a more normal star. The vast amount of energy needed to produce the X-rays was provided by gravity, which, because of the small star's mass (about equal to the Sun's) and compactness (about 10 km in diameter) would accelerate particles transferred from the normal star to X-ray emitting energies. In 1962, who knew such compact stars (in this case a neutron star) even existed, much less this energy transfer mechanism?

X-ray astronomy grew in importance to the fields of astronomy and astrophysics. The National Academy of Sciences, as part of its "Decadal Survey" released in 1981, recommended as its number one priority for large missions an X-ray observatory along the lines that Giacconi outlined in 1963. This observatory was eventually realized as the Chandra X-Ray Observatory, which launched in 1999.

The Chandra Project is built around a high-resolution X-ray telescope capable of sharply focusing X-rays onto two different X-ray-sensitive cameras. The focusing ability is of the caliber such that one could resolve an X-ray emitting dime at a distance of about 5 kilometers! The building of this major scientific observatory has many stories.

Learn more about Chandra at www.science.nasa.gov/missions/chandra . Take kids on a "Trip to the Land of the Magic Windows" and see the universe in X-rays and other invisible wavelengths of light at spaceplace.nasa.gov/magic-windows.

Dr. Weisskopf is project scientist for NASA's Chandra X-ray Observatory. This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

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