SIRIUS ASTRONOMER

www.ocastronomers.org

The Newsletter of the Orange County Astronomers

February 2015 *Free to members, subscriptions $12 for 12 issues* **Volume 42, Number 2**

Comet Lovejoy (C2014/Q2) is seen in this spectacular image by Kaz Fuseya taken from Julian, California (north of San Diego) on January 20, 2015. Lovejoy may still be seen in the evening sky this month.

OCA CLUB MEETING

The free and open club meeting will be held February 13 at 7:30 PM in the Irvine Lecture Hall of the Hashinger Science Center at Chapman University in Orange. This month's speaker is Dr. Andrew Benson from UC Irvine. The topic for this month's presentation is "To The Ends of Galaxies: How Do The Smallest Galaxies Form?"

NEXT MEETINGS: March 13, April 10

STAR PARTIES

The Black Star Canyon site will open on February 14. The Anza site will be open on February 14. 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

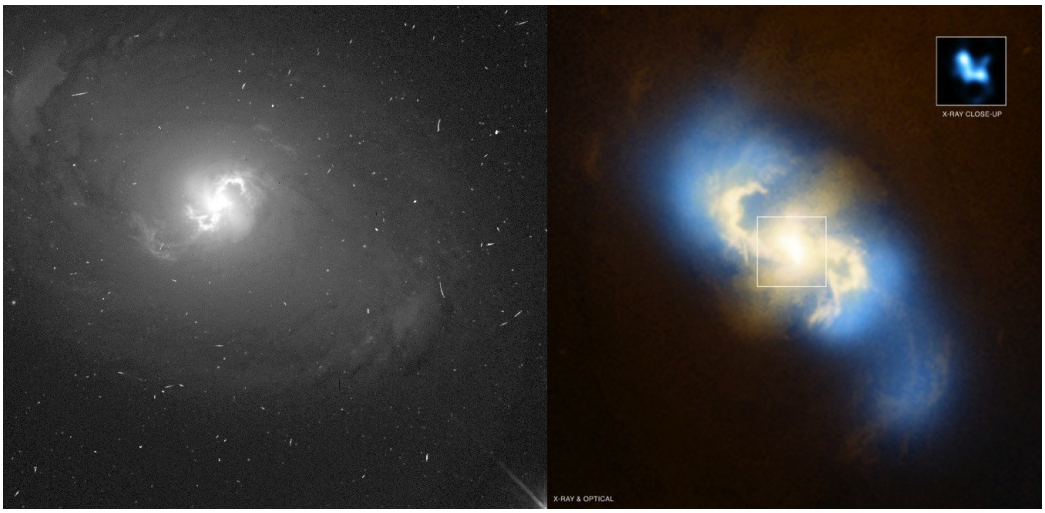
The next session of the Beginners Class will be held at the Heritage Museum of Orange County at 3101 West Harvard Street in Santa Ana on February 6. The following class will be held March 6.

GOTO SIG: TBA
Astro-Imagers SIG: Feb. 10, Mar. 10
Remote Telescopes: TBA
Astrophysics SIG: Feb. 20, Mar. 20
Dark Sky Group: TBA

Minor mergers have massive consequences for black holes

By Dr. Ethan Siegel

When you think of our sun, the nearest star to our world, you think of an isolated entity, with more than four light years separating it from its next nearest neighbor. But it wasn't always so: billions of years ago, when our sun was first created, it very likely formed in concert with thousands of other stars, when a giant molecular cloud containing perhaps a million times the mass of our solar system collapsed. While the vast majority of stars that the universe forms—some ninety-five percent—are the mass of our sun or smaller, a rare but significant fraction are ultra-massive, containing tens or even hundreds of times the mass our star contains. When these stars run out of fuel in their cores, they explode in a fantastic Type II supernova, where the star's core collapses. In the most massive cases, this forms a black hole.



Images credit: NGC 3393 in the optical (L) by M. Malkan (UCLA), HST, NASA (L); NGC 3393 in the X-ray and optical (R), composite by NASA / CXC / SAO / G. Fabbiano et al. (X-ray) and NASA/STScI (optical).

Over time, many generations of stars—and hence, many black holes—form, with the majority eventually migrating towards the centers of their host galaxies and merging together. Our own galaxy, the Milky Way, houses a supermassive black hole that weighs in at about four million solar masses, while our big sister, Andromeda, has one nearly twenty times as massive. But even relatively isolated galaxies didn't simply form from the monolithic collapse of an isolated clump of matter, but by hierarchical mergers of smaller galaxies over tremendous timescales. If galaxies with large amounts of stars all have black holes at their centers, then we should be able to see some fraction of Milky Way-sized galaxies with not just one, but *multiple* supermassive black holes at their center!

It was only in the early 2000s that NASA's Chandra X-ray Observatory was able to find the first binary supermassive black hole in a galaxy, and that was in an ultra-luminous galaxy with a double core. Many other examples were discovered since, but for a decade they were all in ultra-massive, active galaxies. That all changed in 2011, with the discovery of two active, massive black holes at the center of the regular spiral galaxy NGC 3393, a galaxy that must have undergone only minor mergers no less than a billion years ago, where the black hole pair is separated by only 490 light years! It's only in the cores of active, X-ray emitting galaxies that we can detect binary black holes like this. Examples like NGC 3393 and IC 4970 are not only confirming our picture of galaxy growth and formation, but are teaching us that supermassive relics from ancient, minor mergers might persist as standalone entities for longer than we ever thought!

Check out some cool images and artist reconstructions of black holes from Chandra: http://chandra.harvard.edu/photo/category/blackholes.html

Kids can learn all about Black Holes from this cool animation at NASA's Space Place: http://spaceplace.nasa.gov/black-holes.

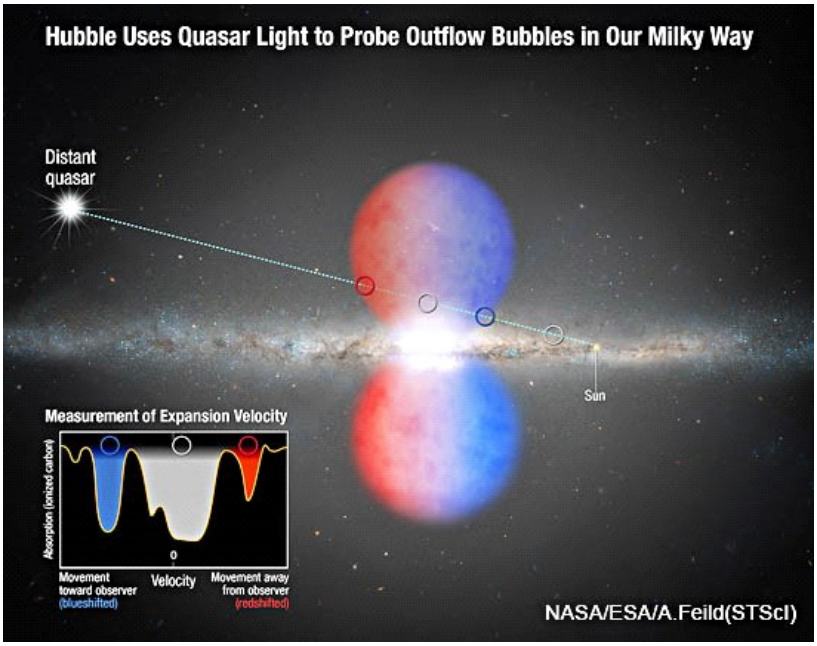
AstroSpace Update

February 2015

Gathered by Don Lynn from NASA and other sources

ALMA (radiotelescope array) was used to make detailed observations of the protoplanetary disk surrounding the star known as HD 107146, and found an unexpected increase in the concentration of millimeter-size dust grains in the disk's outer reaches. This increase, which begins remarkably far about 8 billion miles (13 billion km) from the host star, may be the result of Pluto-size planetesimals stirring up the region, causing smaller objects to collide and blast themselves apart. Dust in debris disks typically comes from material left over from the formation of planets. Very early in the life of the disk, this dust is continuously replenished by collisions of larger bodies, such as comets and asteroids. In mature systems with fully formed planets, comparatively little dust remains. In between these 2 ages, certain models predict that the concentration of dust would be much denser in the most distant regions of the disk. This is precisely what ALMA has found. This is the opposite of what is seen in younger primordial disks where the dust is denser near the star. According to current computer simulations, the density of dust higher in the outer regions of the disk can only be explained by the presence of recently formed Pluto-size bodies. Their gravity would disturb smaller planetesimals, causing more frequent collisions that generate the dust. The data also show a possible dip in the dust about ¾ billion miles wide (1.2 billion km), beginning about 2.5 times the distance of Neptune from our Sun. This dip could be a gap in the disk, which would indicate a planet sweeping the area clear of debris. The star is of particular interest to astronomers because it is in many ways a younger version of our Sun. It represents a period of transition from a solar system's early life to more mature stages where planets have finished forming. The star is about 90 light-years away in Coma Berenices. It is about 100 million years old.

ALMA was also used to observe binary protostars (stars still forming), and found spiral arms of molecular gas and dust around them. Compared to single star formation, our understanding of binary star formation has been limited. However, more than half of stars with a mass similar to our Sun are known to be binaries. Some recent observations have been made of binary protostars, but not with the resolution and sensitivity of ALMA. The new observations showed a gas component associated with each binary star and a disk surrounding both stars, with a radius of 300 AU (1 AU is the Sun-Earth distance). This is about 10 times the size of Neptune's orbit. To understand these features, the research team constructed a computer simulation of binary formation using a supercomputer. The results show that the baby twin stars shake the surrounding disk and induce the falling gas motion to feed the materials to the baby twins.

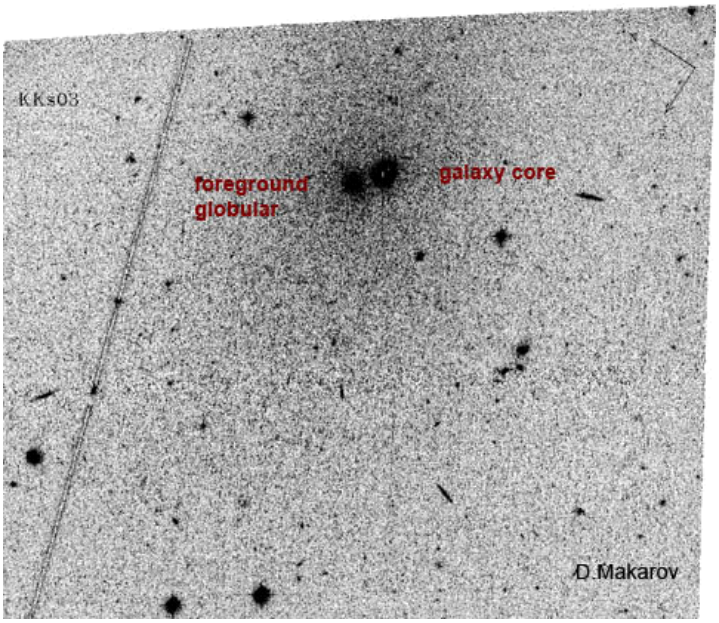


Hubble Space Telescope has measured the velocity, composition and temperature of the expanding gas inside the galactic outflows from the Milky Way known as the Fermi bubbles. Hubble probed the light from a distant quasar to analyze the Fermi bubbles as the quasar light passed through. The outflow was produced by some violent event that happened about 2 million years ago in the Milky Way core. Gasses and other material were driven outward at 2 million mph (3 million km/h). The gas on the near side of the bubble is moving toward us and the gas on the far side is traveling away. The Hubble spectrograph detected silicon, carbon, and aluminum, indicating that the gas is enriched in the heavy elements that are produced inside stars. The temperature of the gas is about 17,500°F (9700°C), which is much cooler than most of the super-hot gas in the outflow, thought to be about 18 million °F (10 million °C), from X-ray data. Now we are witnessing the result: billowing clouds of gas towering about 30,000 light-years above and below the plane of our galaxy. The enormous structure was discovered 5 years ago as a gamma-ray glow. The features have since been observed in X-rays and radio waves. The Hubble observations were the 1st to measure the velocity and composition. Astronomers have

proposed 2 possible origins for the lobes: a firestorm of star birth at the Milky Way's center, or the eruption of its supermassive black hole. This is the 1st result in a survey of 20 quasars whose light passes through gas inside or just outside the Fermi bubbles. An analysis of the full sample will yield the amount of mass being ejected, which will allow calculating the amount of energy that drove the outburst, and possibly reveal the origin of the event.

Galaxy mergers – A detailed study of the motions of different populations of stars in Andromeda galaxy by scientists using Keck Observatory (in Hawaii) and Hubble Space Telescope data has found striking differences from our Milky Way galaxy, suggesting a more violent history of mergers with smaller galaxies in Andromeda's recent past. Youngest stars in Andromeda showed relatively ordered rotational motion around the galaxy center, while older stars displayed much more disordered motion. The well-ordered stars are confined to a thin plane, whereas the disordered stars form a much puffier layer. The researchers considered different scenarios of galactic disk formation and evolution to account for the observations. One scenario involves the gradual disturbance of a well-ordered disk as a result of mergers with small satellite galaxies. Previous studies have found evidence of such mergers in tidal streams of stars in the extended halo of Andromeda, which appear to be remnants of cannibalized dwarf galaxies. Stars from those galaxies can also accrete onto the disk, but accretion alone cannot account for the observed increase in disorder with stellar age. An alternate scenario involves the formation of the stellar disk from an initially thick, clumpy disk of gas that gradually settled. The oldest stars would then have formed while the gas disk was still puffed up. Over time the gas disk would have settled into a thinner configuration, and the youngest stars would then have formed in that configuration. Or a combination of these scenarios could have occurred. Statistically galaxies the size of Andromeda or the Milky Way should have a 70% chance of interacting with at least one sizable satellite in the last 10,000 years. But the Milky Way's disk is much too orderly for that to have happened, while for Andromeda it appears it did happen.

Neighbor galaxy – A team of astronomers has found a tiny and isolated dwarf galaxy almost 7 million light-years away, which is a member of our Local Group of galaxies. It was found using the Hubble Space Telescope, and was named KKs3. It is located in the southern sky in Hydrus. Its stars have only 1/10000 the mass of our Milky Way. Such dwarf Spheroidal galaxies lack spiral arms and have an absence of gas and dust needed to form new generations of stars, leaving behind older and fainter relics. In almost every case, this raw material seems to have been stripped out by nearby massive galaxies. But KKs3 and only 1 other local galaxy are isolated, so were never near enough to a massive galaxy for this stripping to have happened.



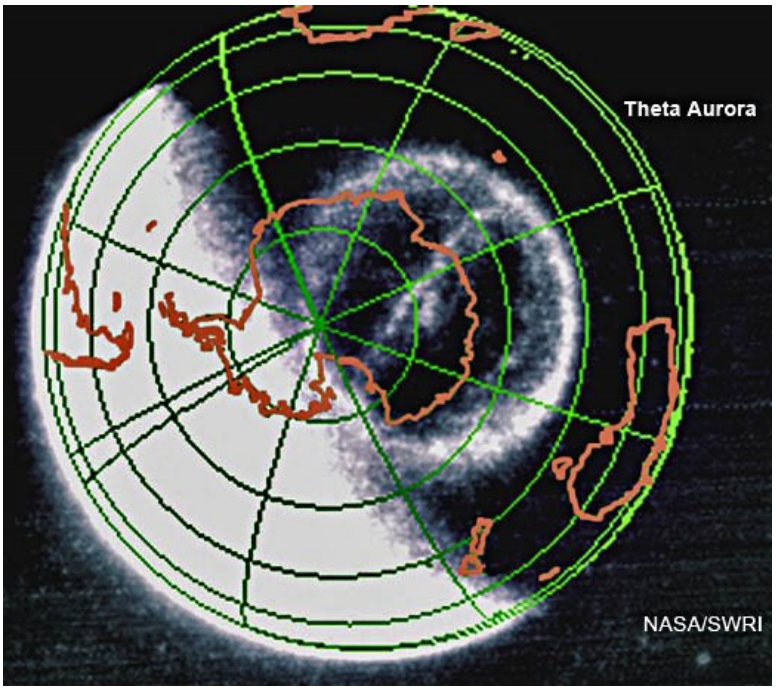
X-ray flare – Astronomers observed in September the largest X-ray flare ever detected from the supermassive black hole at the center of the Milky Way galaxy. The discovery was made using Chandra X-ray space telescope to observe how the black hole, known as Sgr A*, would react to a cloud of gas, known as G2, making a flyby near the black hole. It appears that G2 had little impact on the black hole, and the X-ray flare was unrelated to G2. The flare was 400 times the usual low level of X-rays there, and 3 times brighter than the previous record holder, which occurred in early 2012. Another large flare, half as bright, occurred a month later, in October. There are 2 leading theories on the cause of the huge flares: an asteroid came too close to the black hole and was torn apart by gravity; or magnetic field lines within gas flowing towards Sgr A* became tangled, and reconfigured themselves to produce X-rays. The asteroid theory fits the data a little better, in that the flare lasted about as long as it should take an asteroid to disintegrate and fall in. An object as big as a planet falling in would have released more energy; hence it must have been an asteroid.

Milky Way arm – Astronomers have discovered a new spiral arm at the outer reaches of the Milky Way. But it might be an extension of a distant arm discovered back in 2011, in which case that arm may encircle the entire galaxy. Our understanding of what the Milky Way looks like is inhibited by living directly inside it; nearer material obscures more distant stars, making direct observations challenging. Back in 2011, astronomers discovered an extension to the Scutum-Centaurus galaxy arm. The newly discovered arm starts about 40,000 light-years from this and continues to about a point outside the beginning of the Scutum-Centaurus Arm, so may constitute a

360-degree arm. Astronomers are expected to look for molecular clouds in the gap to see if the new arm is indeed connected. The new discovery was made by using radio waves to detect sizable clouds of carbon monoxide gas, which is abundant in galaxy arms. The new segment is located at a radius of between 50 and 62 thousand light-years. Across most of its length the arm is about 1300-2000 light-years thick.

Dark matter – Researchers have found a signal in X-ray light that has no known cause, so may be evidence of dark matter annihilating. An excess of X-ray light at a particular wavelength was observed coming from both the Andromeda galaxy and the Perseus star cluster, with energy around 3.5keV. It is consistent with theoretical predictions for the proposed sterile neutrino, which many scientists believe is a prime candidate for dark matter. The signal is absent from observations of deep empty space, implying that it is real and not just instrumental artifact. However, many theories of dark matter point to a particle with over 3 times this energy, so it will take a lot more evidence before anyone claims this is dark matter.

Terrestrial gamma rays – Every day, thunderstorms around the world produce about 1000 quick bursts of gamma rays, called terrestrial gamma-ray flashes (TGFs). A new study compared data from the Fermi Gamma-ray Space Telescope with data from ground-based weather radar and lightning detectors. They found that any thunderstorm, even very weak ones, can produce TGFs. In 2012, Fermi scientists reprogrammed that space telescope, making it 10 times as sensitive to TGFs. The flashes occur unpredictably and fleetingly, with durations less than a millisecond, and remain poorly understood. The new study found that most TGFs generate strong bursts of radio waves. Fermi can only very roughly determine the location of a TGF; hence this new study used ground-based lightning detectors that use radio waves, which pinned down the locations. Scientists suspect that TGFs arise from strong electric fields near the tops of thunderstorms. Under the right conditions, the upper part of an intracloud lightning bolt disrupts the storm's electric field in such a way that an avalanche of electrons surges upward t high speed. When these fast-moving electrons are deflected by air molecules, they emit gamma rays. About 2000 intracloud discharges occur for each TGF that is being detected. The new study confirmed previous findings indicating the TGFs tend to occur near the highest parts of a thunderstorm, between about 7 and 9 miles (11-14 km) high. It is suspected that TGFs may be occurring at lower altitudes, but traveling through more air weakens the gamma rays such that they are not being detected.



Aurora – A new published work has explained how one type or aurora, the Theta Aurora, is created from the interaction of the charged particles, electric and magnetic fields surrounding the Earth. Theta aurora is so named because its shape resembles the Greek letter theta (Θ). Their conclusions required the coordination of simultaneous observations of 2 missions: Cluster and Image. Thetas were discovered from space, as they cannot be recognized from the ground. Thetas are uncommon and do not persist long. Early on in studying this phenomenon, researchers became aware that they occur when the Sun's magnetic field turns northward, rather than its usual southward. When the Sun's magnetic field flips northward locally, a convolution takes place that will, at time, but not always, produce a Theta aurora. A group of researchers identified how the particles and fields interact to produce Thetas. A specific event in September 2005 was studied. The southern lobe of the Earth's magnetotail was acting as a bottle and particles were bouncing between 2 magnetic mirrors. The consequences are that highly energetic particles flooded down the field lines from the lobes and impacted the upper atmosphere transferring their energy and causing the light show of the Theta Auroral Oval. This supports the theory that Theta aurora is produced by energized particles from within the closed magnetic field lines and not by particles directly from the solar wind.

Martian water – A team of scientists has found evidence in meteorites that fell to Earth that indicates Mars has a distinct reservoir of water or ice near its surface. This may help resolve the question of where the "missing Marian water" may have gone. Much evidence shows that Mars was much wetter a few billion years ago, but most of that water went missing. The meteorites studied were knocked off Mars, from somewhere relatively close to the surface, by meteorite impacts, then eventually fell to Earth. The ratio of hydrogen isotopes in the studied meteorites was found to not match either that of the current Martian atmosphere nor the current Martian mantle. This ratio changes in the atmosphere over time as hydrogen is lost to space. So the water trapped in the meteorite represents a reservoir of water that was isolated, at least partially, from the atmosphere in the distant past.

MAVEN (Mars orbiter) is beginning to make discoveries that are starting to reveal key features about the loss of the planet's atmosphere to space over time. The observations reveal a new process by which the solar wind can penetrate deep into a planetary atmosphere. They include the 1st comprehensive measurements of the composition of Mars's upper atmosphere and electrically charge ionosphere. MAVEN's solar wind analyzer has discovered a stream of solar-wind particles that are not deflected but penetrate deep into Mars's upper atmosphere and ionosphere. Interactions in the upper atmosphere appear to transform this stream of ions into a neutral form that can penetrate to surprisingly low altitudes. Deep in the ionosphere, the stream becomes ionized again.

Opportunity (Mars rover) climbed to the top of Cape Tribulation, which overlooks Endeavour Crater, 440 feet (135 m) higher than the surrounding plain. Very scenic views were taken from this high perch. Because the rover has been having trouble with part of its flash memory, controllers have been operating Opportunity without using the flash. This requires sending every day's data to Earth before turning off the control computer for the Martian night. A software remedy is being prepared to restore normal usability by avoiding use of problem areas in the flash. Opportunity celebrates it 11th anniversary on Mars January 24. But that's only 5.85 Martian years. Not bad for a mission designed to last 90 (Martian) days.

Europa – A new study of the ultraviolet data collected by Cassini as it flew by Jupiter's moon Europa in 2001 has failed to find evidence of any geyser plumes of water being thrown off by that moon. Also the tenuous atmosphere of Europa is about 100 times thinner than previous measurements had shown. If Europa does have any plume activity, it is likely intermittent. The observations show that most of the hot, excited gas, or plasma, around Europa originates not from the moon itself, but from volcanoes on the nearby moon Io. This new study was prompted by indications of possible plume activity on Europa in observations made by the Hubble Space Telescope in 2013.

Where is Saturn? – Researchers have analyzed radio tracking data of Cassini (Saturn orbiter) in combination with observations of Cassini's radio by the VLBA radiotelescope. The result is that we now know where Saturn and its moons are within about 2 miles (4 km). This is 50 times better precision than ground-based optical observations and 20 times better than Cassini tracking data alone. The improved information will help enhance navigation of interplanetary spacecraft, help refine measurements of the masses of solar system objects, improve predictions of Saturn occultations, and enable more stringent tests of General Relativity. Further VLBA observations of Cassini will be made until the end of its mission in late 2017, and similar observations will be made of the Juno spacecraft when it reaches Jupiter in mid-2016.

Asteroid breakup – Astronomers think that asteroids, like planets, formed in the early Solar System from the gradual agglomeration of smaller particles, but in the case of asteroids, their growth was interrupted by mutual collisions that caused them to fragment rather than to coalesce into planets. This hypothesis is being tested by gathering new data. Pressure of incident sunlight can cause asteroids to spin and, when the spinning is fast enough, to break up. The question was how often collisions broke up asteroids, as compared to spin breakups. A new set of calculations for breakups of main belt asteroids found that for asteroids about 100 yards (100 m) in diameter, collisions are not the primary cause – rapid spin is. Their results are in strong disagreement with previous simulations of asteroid breakup.

Kepler (planet finding space telescope) – After the reaction wheel failure that crippled Kepler, the K2 mission was designed to use sunlight pressure to stabilize Kepler in one dimension. The catch is that every 12 weeks, the pointing direction has to be moved. This new mission began last May, and is working on its 3rd target. The 1st confirmed exoplanet discovery made during K2 was announced. The planet is 2.5 times the diameter of Earth and orbits closely every 9 Earth days about the star HIP 116454, which is about 180

light-years away in Pisces. The planet is quite hot because it is so close to its star. K2 has observed 35,000 stars and collected data on star clusters, dense star-forming regions, and several planetary objects within the Solar System. Planned future targets include active galaxies and supernovas.

Data from the primary **Kepler** mission included monitoring gas-eating activity at the black hole in the center of a Seyfert galaxy known as KA1858+4850, which is about 100 million light-years away. This and ground-based observations of the same galaxy have been analyzed. Some of the light from feeding activity reaches us directly while other light reflects off clouds nearby. Measuring time delays between these 2 paths tells us the distances between where light is emitted and where reflected. Measuring the width of spectral lines tells us how fast the gas clouds are orbiting the black hole. From this the mass of the black hole can be calculated as 8 million times the Sun's mass.

Data from the **Kepler** primary mission are still being processed, and that has resulted in 554 more planet candidates being announced. Of those, 6 are near-Earth-size orbiting in the habitable zones (where temperatures allow liquid water) of their stars. The next release of data should complete processing of all observations made by Kepler during its primary mission. Meanwhile the backlog of 2 or 3 thousand candidates still to be verified is being worked on. Several newly verified planets have been announced, including 8 in habitable zones and 4 in multiple-star systems.

Star ages – Young stars generally rotate rapidly, and slow down as they age. Unfortunately old stars have few and small starspots, so it is difficult to observe their rotation. But certain classes of stars can have their ages fairly reliably determined by observing their rotation (called spin-dating or gyrochronology. A new study using data from Kepler has extended age dating by rotation to a larger class of stars, including the most common type of star. Kepler's sensitivity allows detection of the tiny brightness changes caused by relatively small star spots. The precision of age determination was found to be about 10%. The new study relied on observations of an old star cluster, NGC 6819. The new results support a previous theory that the rotational period of a star increases in proportion to the square of its age. The new study extends spin-dating down to stars of 85% the Sun's mass. This method can also be used to determine the ages of exoplanets, since they should be almost the same as the stars they orbit.

SDSS – A new release of data, known as DR 12, was made by the SDSS III project. This is the 3rd project to survey huge parts of the sky with the Sloan 100-inch (2.5 m) telescope in New Mexico. It included information on 500 million stars and galaxies. SDSS III has several sub-projects. One is BOSS, which is measuring the clumping of galaxy clusters. This is known to reflect the waves seen in the Cosmic Microwave Background, but expanded over time until the galaxies formed. Measuring the size of galaxy clumping and comparing it to theory yields quite precise measures of distances (estimated by BOSS astronomers to be 1% accurate), independent of redshift or cosmological models. A 3-dimensional map of galaxies has been made that tracks the expansion of the Universe over 9 billion years (made possible because we are seeing the farther galaxies as they were when light left them billions of years ago). The BOSS data confirm dark energy's existence (that is, that some force is speeding up the expansion of the Universe) and that dark energy has remained constant per unit volume of space. 85% of the data for BOSS has been analyzed, and the final report is expected this spring. Another sub-project is APOGEE, which is studying 100,000 distant red giant stars in infrared in order to piece together the history of our Milky Way. Another is MARVELS, which is looking for the wobbles induced by the gravity of planets in the motions of stars. So far MARVELS has found 51 giant planet candidates and 38 brown dwarf candidates. Another is SEGUE, which is analyzing visible light from 250,000 stars in the outer reaches of our galaxy. SDSS IV began observations last year and will continue for 6 more years.

Planet density – A team of astronomers measured the masses, and calculated the densities, of several small exoplanets. They found that all planets smaller than 1.6 times Earth's diameter, and smaller than 6 times Earth's mass show the same relation between mass and size as do Venus and Earth. Therefore, below this limit, planets are probably made of the same stuff as Venus and Earth. Above this limit, the densities drop, indicating they have substantial oceans or atmospheres of hydrogen and helium, as do Neptune and Uranus, the planets in our Solar System that are next larger than Earth.

Oceans – It is believed that there exists several oceans worth of water trapped in the Earth's mantle. It got there by surface material being subducted under another plate by tectonics. Enough water to maintain oceans is returned to the surface by volcanic activity.

New computer simulations were run to see if this can happen on all rocky planets, including super-Earths. The findings: small Earth-like planets outgas their water quickly, while larger super-Earths form their oceans later on. The sweet spot seems to be for planets between 2 and 4 times the mass of Earth, which are even better at establishing and maintaining oceans than our Earth. Once started, these oceans could persist for at least 10 billion years. So looking for life should concentrate on older super-Earths.

Gemini Planet Imager (GPI) has completed a year of operation, with impressive results. GPI is an instrument for the Gemini South 8-meter telescope in Chile. It has an advanced optics system to obtain very high resolution, combined with a coronagraph (which blocks light from a planet's star to enable seeing dim planets and disks nearby), and a camera, polarimeter and spectrograph. Recently released were some of the most detailed images and spectra ever of the multiple planet system HR 8799, and images showing never-before-seen details in the dusty ring of the star HR 4796A. The newly obtained spectra of 2 planets orbiting HR 8799 present a challenge for astronomers to explain. The shapes of the spectra for the 2 planets differ more profoundly than expected, even though they have similar colors. The difference may be due to different cloud coverage and/or different composition. The ring about HR 4796A was found to be far denser and more tightly compressed than similar dust found in the outskirts of our Solar System. Other targets of GPI have ranged from asteroids in our Solar System to an old star near its death. GPI has not yet discovered a new planet, since initial observations concentrated on known planets or disks. However, a search for new planets has now begun. Since GPI operates in infrared, where young planets emit most of their light, the search for new planets is targeting young and nearby stars.

Venus Express (European Venus orbiter) – Knowing that the spacecraft was low on fuel, controllers attempted to raise its orbit to prolong its life a few more months. However, during the maneuver, it ran completely out of fuel. This meant Venus Express could no longer keep oriented correctly during science observations or during radio contact with Earth. So the mission was declared over. The spacecraft will soon burn up in the planet's atmosphere. During its 8 years orbiting Venus, it returned more science data than all previous missions to that planet combined.

Messenger (Mercury orbiter) – After more than 10 years in space, nearly 4 of those in orbit at Mercury, Messenger is nearly out of propellant, and the spacecraft's demise was predicted for March. But engineers have devised a way to use the pressurization gas in the fuel tanks, rather than the fuel itself, to orient Messenger for another month. Often something else breaks before a spacecraft runs out of propellant. But Messenger is otherwise performing fine, so any extension of its life gives that much extra science. The extra month finds Messenger in low orbit about Mercury, so higher resolution will be achieved in observations of the planet, due to being closer.

Voyager 1 has experienced 3 shock waves since leaving the influence of the solar wind. The most recent shock wave was 1st observed in February 2014, and still appears to be going on. It is the longest-lasting shock wave yet seen in interstellar space. These shock waves are more common than originally thought. A tsunami wave occurs when the Sun emits a coronal mass ejection, throwing out a magnetic cloud of plasma. When the wave runs into the interstellar plasma (the charged particles found between the stars) a shock wave results that perturbs the plasma.

Instant AstroSpace Updates

A **quasar** was observed in 2000 and again in 2010 and found to have stopped the emission of light from material falling into its black hole. Observations have pretty much ruled out that something is obscuring the quasar, so it must have shut down in only 10 years.

Astronomers at a recent press conference gave this **recipe** for a rocky planet: 1 cup magnesium, 1 cup silicon, 2 cups iron, 2 cups oxygen, ½ teaspoon aluminum, ½ teaspoon nickel, ½ teaspoon calcium, ¼ teaspoon sulfur; bake this for a couple million years until you start to see a thin, light brown crust form on the surface; then season it with a dash of water. Check back in a couple billion years for intelligent life.

A SpaceX **Dragon** spacecraft on a Falcon 9 rocket launched to the International Space Station, loaded with more than 2 tons of supplies and science investigations, including replacements for experiments lost in the explosion of the Orbital Sciences Antares rocket in October. The attempt to land on a barge and recover and reuse the 1st stage of the Falcon 9 hit the target, but hit too fast and broke apart the spent stage.

DSCOVR is scheduled for January 29 to launch to the L1 point, 930,000 mi (1.5 million km) toward the Sun from Earth, to monitor approaching geomagnetic storms and provide advance warning for us on Earth before communications and power grids are disrupted. The aging ACE spacecraft is currently providing such warning.

The Great American Eclipse – Where Will You Be?

By Elaine Vander Linden

Preparing for THE GREAT AMERICAN ECLIPSE on August 21, 2017 might seem like something you don't have to worry about right now. But if you're an eclipse chaser, or want to be one, you should already be planning your trip, your equipment, and your goals.

I remember the total solar eclipse of 1991 in Baja. It was a big trip, and we brought what seemed like a lot of equipment to a very remote patch in Baja (small compared to what we have planned for 2017). And the events that occurred will stay with me the rest of my life. From the flowers closing (so quickly) because the sun "went down" to the cows lowing at the gate for the farmer to take them home, and especially that amazing three hundred and sixty degree sunset (coming down from the sun, mind you), with all the stars twinkling around the whole edge of the horizon. A total solar eclipse, seen from the center line, is an amazing sight that even non-astronomers will be astonished at. Wouldn't you want to take your family to see that?

The choices for where to go, unlike with most eclipses, will be endless…Oregon, Idaho, Wyoming, Nebraska, and more! For astronomers, though, there are some very important points to consider. Length of totality is of utmost importance to many. And that occurs at the center point of totality, along the center line of totality.

The path of the eclipse runs from Oregon to South Carolina, with the center line of totality running through quite a lot of decidedly decent viewing land throughout our great nation. The center point of totality will sit just outside Hopkinsville, Kentucky. What are those options?

Hopkinsville has an eclipse committee that is working to plan out the best way to handle the deluge of visitors. At present, the Hampton Inn in Hopkinsville is taking reservations. We have heard that the rooms are $599 a night, but since that hotel is the best rated by Google and Yelp (over four stars at last review), it might very well be quite worth it. Hopkinsville has a population in the thirty thousands, so there are very few restaurants, hotels, etc. The rest of the hotels in the area are awaiting that 365-day out booking plan, but the Hampton is booking NOW.

http://hamptoninn3.hilton.com/en/hotels/kentucky/hampton-inn-and-suites-hopkinsville-HOPKIHX/index.html
Hampton Inn & Suites Hopkinsville
General Manager: Mark Stevens
210 Richard Mills Drive
Hopkinsville, KY 42240
270-886-8800

Is that the best choice? That depends. You will see 2 minutes 40 seconds of totality there. But you may have heat over 100° and a relatively high level of humidity. However, you also have Nashville not too far away, which would make a great second destination for your vacation after the eclipse, should you so desire. There would be plenty of Southern Hospitality and wonderful BBQ places, as well as some good blues.

But what about clear skies? Well, there is a chance of storms, rain, and clouds in that part of the country at that time of year. What would be the next best choice?

There is the option of Casper, Wyoming. With notoriously clear skies, dry weather, and heat that might be in the upper nineties, but could be in the eighties, Casper is looking very good. Think about those dark, clear Wyoming skies at night. Now there's a nice second vacation for your trip!

With a population closer to sixty thousand, and being a location already accustomed to conventions and the population increase they bring, Casper has more accommodations, more restaurants, and more people to take care of the deluge. But what are you giving up?

This takes us to that question, the one that all eclipse-chasing astronomers have to ask themselves. What is more important? Those extra eighteen seconds of totality in Hopkinsville, or the better odds for a clear sky in Casper? No one can make that decision for you but, well, YOU.

Let me throw one more wrinkle into the mix, which is not meant to sway you either way, but just something to keep in mind. From August 14th to August 19th in Casper, Wyoming, ASTROCON 2017 will be happening. This is a convention of Montana, Wyoming, Colorado, and Utah astronomy clubs, and is open to all folks from all astronomy clubs, or even just the general public.

They have the following invitation to all astronomy clubs:

> *We would love to reach out to every single astronomy organization in the U.S. and Canada to not only attend ASTROCON, but seek out those that may want to present as a guest speaker or workshop presenter.*
>
> [See their website for the full agenda, which looks to be quite good] *On Saturday afternoon, there will be a new program called "Amateur Showcase" where over 600 clubs will be invited to bring information for display on how their club reaches out to the public, how they get young people involved in astronomy, and how they enhance their club members' involvement with astronomy.*
>
> *Star parties will be in the evenings south of Casper in the mountain at approximately 8,000 feet elevation. We are negotiating with a fellow that has a 70" portable scope. Wouldn't that be a scope to look through! The skies in Wyoming can be very dark and dry. You will love coming. We would love to have as many of your club members as possible to attend.*
>
> *Lowell Lyon, ASTROCON 2017 Chair*

http://astrocon2017.astroleague.org

Those interested can look at their website, and there you will also find a link to their Accommodations option, The Parkway Plaza Hotel and Convention Center. The Parkway is currently accepting reservations for the ASTROCON 2017 event from August 14th to August 19th, at $99/night, and those dates can be pushed over to include staying for the eclipse on the 21st. For example, if you can't get in until August 18th (just in time for Saturday's Star Party), they accept bookings from August 18th through some time after the eclipse, like August 22nd or 23rd, or whatever.

Parkway Plaza Hotel & Convention Centre
123 West E Street, Casper, WY 82601 | 307.235.1777 | 800.270.STAY

http://www.parkwayplaza.net/

Wherever you decide to go, be it Oregon or Nebraska, Kentucky or Wyoming, or South Carolina at the last tip of land before the eclipse moves out into the water, one thought to bear in mind is that you should find out how early you can put in vacation time requests at your work, and mark your calendar to do so as soon as you can. It may sound silly, but this is going to be a very big event for the whole country, and probably a lot of foreign visitors, as well. There's nothing wrong with planning ahead!

This also means that it may be time for you to review your equipment, and decide what improvements, repairs, adjustments, etc., are required for your trip. Will you try for a time-lapse? The Diamond Ring effect? One of those great shots of the Sun's Corona flowing out from the edges? All of the above (which is probably the answer for most astronomers)? Starting to plan now for all of the lofty and expensive solar filters, lenses, telescopes and cameras will make it that much easier to get everything in hand. Imagine, over the next two years or so, everyone is going to start to focus on solar photography.

Maybe you are unsure what you need, and need someone to assist? One good location for mylar filters, neutral density filters, etc., is Company 7, located in Maryland. They take phone orders and carry everything you might need, as well as having folks on hand that really know their product line. Maybe you are confused about what film (mylar) to buy and what filter (green? purple? neutral density?) to use? Give them a call and they can help you understand your needs, and your photo results, better.

http://www.company7.com/baader/options/asolar.html

If you already know what you need, and just want a website to order from, there are plenty out there. But now is a good time to start considering what you need, what you want, and what you have to do to get to the ready position.

SIRIUS ASTRONOMER
www.ocastronomers.org
The Newsletter of the Orange County Astronomers

Nonprofit Organization
U.S. Postage
PAID
Santa Ana, CA
Permit No. 1468

NEWSLETTER OF THE
ORANGE COUNTY ASTRONOMERS
P.O. BOX 1762
COSTA MESA, CA 92628

RETURN SERVICE REQUESTED

DATED MATERIAL
DELIVER PROMPTLY

HANDY CONTACT LIST

CLUB OFFICERS (to contact the entire board at once, send an email to board@ocastronomers.org)			
President	Steve Short	nightskytours@hotmail.com	714-771-2624
Vice-President	Reza AmirArjomand	reza@ocastronomers.org	646-494-9570
Treasurer	Charlie Oostdyk	charlie@cccd.edu	714-751-5381
Secretary	Bob Buchheim	Bob@RKBuchheim.org	949-459-7622
Trustee	Kyle Coker	kcoker@cox.net	949-643-9116
Trustee	Sam Saeed	sam@isismagna.com	714-310-5001
Trustee	Gary Schones	gary378@pacbell.net	951-687-7905
Trustee	Greg Schedcik	gregsched@verizon.net	714-322-5202
Trustee	Alan Smallbone	asmallbone@earthlink.net	818-237-6293
Trustee	Amir Soheili	amirsoheili@yahoo.com	714-276-7766
Trustee	Barbara Toy	btoy@cox.net	714-606-1825
COMMITTEES, SUBGROUPS, AND OTHER CLUB VOLUNTEERS			
Anza House Coordinator	Doug Acrea	dougcarola@att.net	949-770-2373
Anza Site Maintenance	Don Lynn	donald.lynn@alumni.usc.edu	714-775-7238
Beginner's Astronomy Class	David Pearson	p.davidw@yahoo.com	949-492-5342
Black Star Canyon Star Parties	Steve Short	nightskytours@hotmail.com	714-771-2624
Explore the Stars OCA Contact	Bob Nanz	bob@nanzscience.com	760-751-3992
Librarian	Karen Schnabel	karen@schnabel.net	949-887-9517
Membership, Pad Coordinator	Charlie Oostdyk	charlie@cccd.edu	714-751-5381
Observatory Custodian/ Trainer/Member Liaison	Barbara Toy	btoy@cox.net	714-606-1825
OCA Outreach Coordinator	Jim Benet	jimbenet@pacbell.net	714-693-1639
Sirius Astronomer Editor	Steve Condrey	startraveler68@yahoo.com	714-699-1243
Telescope Loaner Program	Don Stoutenger	dstouten@yahoo.com	714-271-2646
WAA Representative	Tim Hogle	TimHogle@aol.com	626-357-7770
Webmaster	Reza AmirArjomand	reza@ocastronomers.org	646-494-9570
SPECIAL INTEREST GROUPS (SIG's)			
AstroImagers SIG	Alan Smallbone	asmallbone@earthlink.net	818-237-6293
Astrophysics SIG	Bob Sharshan	RSharshan@aol.com	714-845-6573
Dark Sky SIG	Barbara Toy	btoy@cox.net	714-606-1825
Remote Telescopes	Del Christiansen	DelmarChris@earthlink.net	714-895-2215
GoTo SIG	Mike Bertin	MCB1@aol.com	949-786-9450