SIRIUS ASTRONOMER

www.ocastronomers.org

The Newsletter of the Orange County Astronomers

June 2018 *Free to members, subscriptions $12 for 12 issues* **Volume 45, Number 6**

John Castillo creating this stunning image of the Geminids Meteor Shower from the OCA's Anza site on 12/7/17. He used a Canon 6D with 14mm Sigma lens. (Image is rotated 90 degrees counterclockwise)

OCA CLUB MEETING

The free and open club meeting will be held on June 8 at 7:30 PM in the Irvine Lecture Hall of the Hashinger Science Center at Chapman University in Orange.

This month, Jonathan Feng on The Search for Particle Dark Matter and Dark Sectors.

NEXT MEETINGS:
July 13 – Kate Rubin
August 10 – (speaker TBA)

STAR PARTIES

The Anza and Orange County site will be open on June 9. 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 sessions of the Beginners Class will be held at the Heritage Museum of Orange County at 3101 West Harvard Street in Santa Ana on June 1 and July 6.

Youth SIG: contact Doug Millar

Astro-Imagers SIG: June 6, July 11

Astrophysics SIG: June 15, July 20

Dark Sky Group: contact Barbara Toy

President's Message

By Barbara Toy

We're moving along briskly now toward the Summer Solstice – it's still almost a month off as I write this, but the sun is visibly nearing the northern end of its annual migration, the days are long and the nights too short, at least for those of us who enjoy viewing the night skies. Of course, at this time of year the night sky is often obscured by what I recently read is called "May Gray," at least during the month of May; I thought the phenomenon was generally referred to as "June Gloom" regardless of when in spring or summer it occurred, but apparently it is acquiring some refinements I wasn't aware of. Regardless of the name, it can be a real irritant, particularly when it occurs (as it too often does) right around the new moon. Sadly, the May Anza star party fell victim to the condition, though I'm told there was at least one night in the week before the star party when conditions were excellent, so it wasn't a complete loss for those who could make it out there in mid-week.

Aside from the Summer Solstice, we have at least one other event coming up that may be of interest...

Annual Starbecue Potluck at Anza

Our annual potluck party at Anza this year will be the evening of the July star party, July 14. Conveniently, the Orange County star party is the weekend before, so, for you Orange County regulars, you can make it to the Starbecue without missing the Orange County star party. These parties give us all a chance to socialize with other members and their families and friends while enjoying an array of good food before we start on our usual dark sky activities.

The potluck festivities usually are in full swing by 6:00 p.m., with set-up starting around 5:00 (volunteers to help out with this are welcome!). This all occurs in the area behind (i.e. east of) the club observatory, as the building gives us a big patch of shade, which is very welcome on a summer day at Anza. We generally set up a couple of large tables for the food, along with the picnic table that's by the observatory (which has benches), and people bring their own chairs along with food to share. The club provides paper plates, napkins and tableware, along with chilled bottled water (which has consistently proven much more popular than any of the other drinks we've tried over the years).

We'll fire up the club's barbecue, so you can bring something to grill. If you're bringing something that needs to be served hot but wouldn't be grilled, it's best to heat it before coming out – we have a microwave in the observatory warming room, but that's the limit of our ability to warm things there and it's not particularly efficient. If you do need to warm something up out at the site, it would be better to do that at Anza House and then bring it up to the observatory hot. If what you bring needs to be chilled, we have only a small office-style refrigerator at the observatory, though we have a full-sized one in Anza House. I think most people use ice chests, which give more flexibility. Generally, ice cream or other frozen items should be avoided as it's almost impossible to keep them cold enough for the party.

We don't have much parking up at the observatory, so if you need your vehicle to transport things to the party, please plan to drop them off and park elsewhere

Please also remember to take any leftovers with you after the party is over – we don't want to encourage the rats, mice and other critters by leaving food around! Also, if you can take one of the trash bags to dispose of after the party, that would be very helpful.

We usually get a good turnout for these parties, so they're a great chance to catch up with folks you haven't seen in a while, and to meet members you may not have crossed paths with before – and to put daylight faces to voices you may be familiar with from nights under the stars. More families tend to come to Starbecue star parties than other star parties, so it's also a chance to meet families of fellow members and to introduce your own family to the pleasures of viewing on a nice warm night following the Starbecue itself. If all goes as planned, the club observatory should be open during the star party for viewing through the Kuhn telescope.

So, bring something to serve about 6 people, a chair if you want to be sure of seating, maybe a drink if you want something other than water, a good appetite, and come on out for a fun time at the Starbecue!

Another Sad Loss for the Club

A bit over fifty years ago, a group of astronomy enthusiasts decided that Orange County needed an astronomy club, so they started setting up meetings and other astronomy-related events. Fortunately for us, enough of them maintained their interest through this formative period to pull together into a formal organization, resulting in the club we know and love. I'm not sure how many charter and early members we had in those first few years in the late 1960s, but they provided the core for what has developed into an active club of around 800 members. Inevitably some of those early members dropped out for various reasons, some moved out of the area, but a core group of folks from the early days of the club has remained. Unfortunately, time has taken its toll as well – it shouldn't be a surprise that after 50 years many of our members from the early days of the club would have passed away, but it's always sad to lose any of them (or any member) that way.

One of our early members, Bob Beck, has told us that his brother, Ed Beck, passed away on March 19, 2018. They were actively into astronomy since 1956, and joined the club together in its early days, attending meetings and star parties, viewing together, building telescopes – in general, enjoying a wide array of astronomical activities and remaining active members of the club as it evolved over the years. Bob plans to continue enjoying astronomical activities as long as he can (though probably not the telescope making part), but, as he said, it won't be the same without Ed, particularly when hunting galaxies, Ed's favorite deep sky objects (per Bob, Leo was his favorite hunting ground, and he apparently had a particularly good eye for picking out the dim ones that Bob had trouble seeing).

It must be really nice to share an interest like that with a sibling – so often it seems that only one person in a family develops the passion and everyone else tolerates it or ignores it. Shared nights viewing under good skies are particularly good for enjoying the company of others, for sharing and conversation, even with comparative strangers, and I think sharing those nights with someone who shares so many other parts of one's life and history must be an extraordinary pleasure. I'm sorry Bob won't be able to share viewing nights with his brother anymore, but hope he finds other companions to help cheer his viewing sessions, and that his own health will allow him to continue with the activities he and Ed enjoyed for a long time to come.

In Appreciation of Those Who Have Gone Before…

There's a lot about the early years of the club that I don't know, though I've had some of the high points filled in over the years since I joined by some of those who participated. I know there was a period when our meetings were at the Santa Ana Library, and I think other locations were tried before we obtained our current meeting location thanks to the generosity of Chapman University. We had other dark sky viewing locations before finding and buying the Anza site, which was selected largely because it was within the Palomar Protected Zone and so more protected from light pollution than other locations.

Earlier members put in a lot of ingenuity and sweat equity developing the Anza site, including installing the plumbing and electrical wiring, and designing and building the club observatory as well as the Kuhn telescope (the latter we owe to the creativity and persistence of Bill Kuhn and those who helped him). We have some photos of some of that on our website, particularly those from John Sanford in the Misc Club Photos\OCA Historical section. One of my favorites shows Charlie Oostdyk and Don Lynn in what is now the observing area of the club observatory as it neared completion in 1982 (http://www.ocastronomers.org/astroimages/album.asp?ID=790). The magnitude of what the participating members at the time had to do is hinted at in another photo from the year before, showing an overview of the work site and the walls going up after the foundation was laid (http://www.ocastronomers.org/astroimages/album.asp?ID=789). There are also some photos of early phases of building of the Kuhn telescope (e.g. one of Bill Kuhn and the early telescope in 1976, http://www.ocastronomers.org/astroimages/album.asp?ID=4403).

Installation of Anza House came later, and we have it primarily due to Gary Schones, who was able to get us the second-hand trailers for a very reasonable price and to do the basic installation (Gary also does most of the ongoing maintenance of the roads on the site, has prepared areas of the site for building, and has built several of the member observatories out there, among many other helpful activities). The replacement of the moving roof on

the club observatory, which has made it a lot more usable, was largely due to the efforts of Dave Radosevich, Jim Hannum, John Kerns, Don Lynn and their crew of helpers (I'm sorry to say that I never got a complete list – but as the Observatory Custodian, I really love that new roof!). The Kuhn itself has had a number of changes to its control system over the years, including separate upgrades made by John Hoot and Dave Radosevich, so it's much easier to use now and, thanks to our maintenance consultant, Pat Knoll, it's in great collimation and a pleasure to view through.

Of the names I've mentioned, which are only a few of those who've contributed over the years, a number of you may recognize Don Lynn as the author of one of our most popular columns in the Sirius Astronomer as well as our Anza Site Custodian and the person who regularly brings copies of recent photos of astronomical interest to the meetings (and is quite happy to explain in understandable terms why they're significant – I highly recommend discussing them with him). Unfortunately, it's harder for him to participate at the levels he has in the past, as he's living a good part of the time in Colorado. Charlie Oostdyk, of course, is our current treasurer and the person who deals with the membership records, gets the Sirius Astronomer addressed and in the mail, and innumerable other activities that help keep us going and keep us operating in the black. John Sanford was a long-time member of the club who unfortunately had retired by the time I joined in early 20000, but I did manage to strike up a friendship with him even though he was living in the Sierra foothills by then, due to the convenience of emails – he was president of the club a number of times and held other offices, was editor of and did a lot of the writing for the Sirius Astronomer for years, and in general was involved in so many aspects of the club that it would have been quite different without him.

We've had a lot of changes over the years in our Orange County activities, too. When I joined, our in-county viewing site was in Silverado Canyon by agreement with the Irvine Co., and we were able to build some pad areas (though without power), installed a portapotty, and some members were able to get access even on non-star party nights. Bob Buchheim was the coordinator when I joined, and passed that on to Steve Short, I believe just before the Irvine Co. transferred all of that land to the Conservancy, which designated our Silverado site as an area that needed a lot of restoration work and ultimately transferred our viewing area to Black Star Canyon. That site, unfortunately, became too small for all the people who wanted to use it and their cars, and our current coordinator, Steve Mizera, worked with Orange County Parks and the other powers that be to come up with the site we are currently using near Irvine Lake, which is much roomier.

Different people in our club have always been involved in Outreach work, but Jim Benet really developed the program when he took over as the Outreach Coordinator in the late 1990s. Our current coordinator, Andy Lowry, is continuing to develop the program and can always use more volunteers – if you haven't tried doing Outreach events, you should, for a real feel-good experience and one of the best antidotes to a bit of depression I've found.

A lot of our other programs started when someone had an idea and put the effort in to get it going, which includes our Beginners Astronomy Class, our Telescope Loaner program and our Special Interest Groups, and they have developed in new ways as different people took them over. Our club is wonderfully dynamic, and there undoubtedly will be more changes as time passes to meet the changing needs and interests of our members, changes in technology, and other challenges that lie ahead. It's easy to be part of all this – find an aspect of the club that interests you and volunteer to help out with it.

Well, thank you for indulging me with my excursion down Memory Lane, and if those who were actually there for some of those past events saw it all differently, or know of interesting bits of information I missed, I hope they'll write them up to benefit all of us!

AstroSpace Update

June 2018
Gathered by Don Lynn from NASA and other sources

TESS – On April 18, a SpaceX Falcon 9 rocket launched NASA's next exoplanet-finding space telescope, named TESS (stands for Transiting Exoplanet Survey Satellite), to begin a planned 2-year mission. It will perform a gravity slingshot maneuver by the Moon in order to reach its unusually elongated science orbit. Like its predecessor Kepler (which is nearing its end of life), it watches hundreds of thousands of stars continually to detect the slight dimming when a planet passes in front (this is the transit method of planet search). But there the resemblance ends. TESS is designed for different classes of stars and planets than Kepler, so has these feature differences:

- TESS has a field of view over 5% of the sky, while Kepler's is ¼ of 1%.
- TESS stares at a part of the sky for a lunar month, then moves to a new area, while Kepler stared at just one area for years.
- TESS sees quite a ways into the infrared (in addition to some visible light), while Kepler is sensitive mostly to visible light.
- TESS has a very elliptical orbit about Earth, while Kepler is in solar orbit.

These differences mean the TESS will cover most (85%) of the sky, looking for somewhat brighter stars (and therefore closer to Earth on average). Closer and brighter means more chance to follow up by taking spectra with other telescopes to learn more about the composition of planets and their atmospheres, as well as measuring planetary masses. TESS is more sensitive to red dwarf stars (which give off much of their light in infrared), which are the most common star type. TESS is looking for short period exoplanets (it does not watch an area long enough to find the long period planets), at the sacrifice of missing longer period ones. However, the pattern that will be used for moving the field of view each month will overlap completely near the poles of the sky, so TESS will cover these areas for a full year, and so will find some long period planets. TESS will be able to transmit much more data to Earth, which it does during the close approaches of its elliptical orbit. The far portion of its orbit is necessary to keep that big glowing ball of our planet from degrading TESS's images. The period of TESS's orbit about Earth is exactly half a lunar month, designed to keep the Moon out of its way also. TESS has 4 telescopes and 16 CCDs to achieve its huge field of view. Kepler found a few thousand planets (and thousands more planet candidates are still being checked out by other telescopes for confirmation), yet with all these differences, TESS is expected to find roughly the same number (best estimate about 4500 exoplanets). Look for a lot of amazing discoveries from TESS over the next 2 years, or longer if its mission gets extended.

InSight – On May 5, an Atlas V rocket launched the next Mars lander, named InSight (for INterior exploration using Seismic Investigations, Geodesy and Heat Transport), to begin a mission of about one Martian year (687 Earth days) probing the interior of the Red Planet. Its 2 main instruments are a seismometer and a burrowing heat probe to measure how much heat is escaping from the interior. Both these instruments will be placed on the surface near the lander using a robotic arm. The seismometer is actually triplicated to measure motion in 3 dimensions, and again duplicated to measure different frequencies of motion, resulting in 6 instruments. The arm will place a dome over the instrument to protect it from Martian weather. In addition, there are 2 weather stations on the lander, not only to track weather, but also to determine if the weather is inducing any spurious indications in the seismometers. The only other time seismic measurements have been made on Mars was by the Viking landers in the 1970s, but little data was obtained due to a hardware failure and interference by Martian weather. Seismometers were planned for 4 missions since Viking, but all those missions failed, were cancelled, or postponed. The InSight seismic instruments should allow measurement of Marsquakes, interior structure of the planet, and rate of meteorite impact.

The heat probe will hammer itself (interior hammer) as much as 5 yards into the soil (limited by its tether wires). It will measure temperatures and heat conductivities through surrounding soil at various points along its burrow. Heat flow is helpful in interpreting seismic data and in building computer models of the planet's interior. Our understanding of the interior of the Moon was greatly advanced when Apollo 15 drilled into the surface and took heat measurements.

Further science will be done by radio tracking of the lander, so precise that wobbles of inches in the axis of the planet's rotation will be measured. These wobbles can reveal the distribution of mass within the planet. Also aboard is the first magnetometer to land on Mars. A retroreflector will also be placed on the surface for future use by laser altimeters on Mars orbiters.

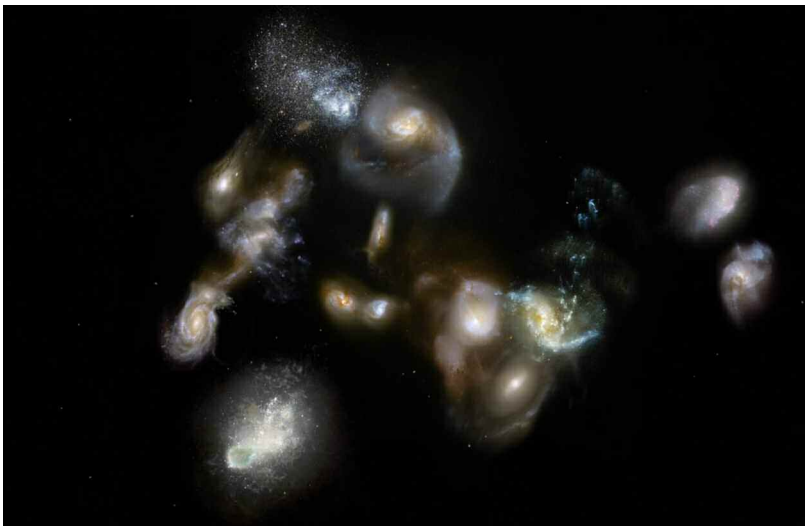
The lander is built largely on the plan of the highly successful Phoenix polar lander, though InSight will land near the equator. The landing location (Elysium Planitia) was chosen for safety in landing and sufficient sunlight for its solar panels, since nearly anywhere on the planet is equally good for seismic and heat measurements. It will land similarly to Phoenix, using a heat shield, a parachute, and finally retrorockets. Its nearest neighbor will be the rover Curiosity, over 300 miles away.

InSight was the first launch of a planetary mission from Vandenberg, California, and the first sent into polar Earth orbit before proceeding to deep space. Launch from Florida or Guiana is considerably more efficient in attaining Earth orbit, due to those locations using the Earth's rotation to boost launch speed. However, the rocket used had sufficient energy to launch polarly (the only direction of launch from California for safety reasons), and the launch schedule from Florida was quite crowded this year. InSight will land on Mars November 26. It will land on the side away from Earth at the time. So the radio contact during landing will be through relay spacecraft. Two tiny (smaller than a breadbox) relay spacecraft were launched piggyback on InSight, and will perform this task.

Neutron star size – Two independent studies made of the gravitational waves (detected last August) produced by colliding neutron stars calculated that the radii of those stars were up to 8.6 miles. Some of the previous theoretical work had claimed neutron stars should be no more than 6.8 miles, but this assumed that the cores of neutron stars would compress the neutrons into quark plasma. These new studies imply the quark plasma does not occur. Scientists hope that more neutron star collisions will be seen in gravitational waves (only one has ever been seen) to confirm the sizes and theories.

Clear exoplanet atmosphere – Astronomers have found an exoplanet that is free of clouds. The planet, dubbed WASP-96b, is a hot Saturn, that is, about the mass of Saturn, but hot due to orbiting close to its star. A spectrum was obtained with the Very Large Telescope in Chile, both with and without the planet, and the results subtracted to separate just the spectrum of the planet's atmosphere. Sodium appeared in the spectrum, and that should only be visible theoretically if you can see to the bottom of the atmosphere, which implies no clouds. WASP-96b is 980 light-years away in the constellation Phoenix. Further work with this spectrum is expected to yield abundances of water and oxides of carbon. The team had taken spectra of 20 planets before finding a cloud-free one.

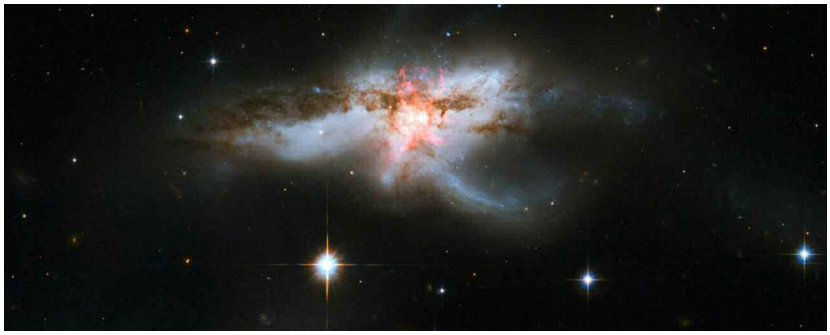
Bright protocluster of galaxies – A team of astronomers investigating a smudge in an image taken by the South Pole Telescope found using ALMA (radiotelescope array) data that it was a protocluster (cluster still forming) of 14 galaxies, so distant that we are seeing them as they were only 1.4 billion years after the Big Bang. The galaxies are forming stars at rates 50-1000 times that of our Milky Way galaxy. The astronomers calculated that the galaxies were close enough to each other that they should have remained to this day gravitationally bound in a galaxy cluster (many protoclusters dissipate if their mass is not concentrated enough). Some of the 14 galaxies have probably merged by now. The galaxies are much brighter than other similar protoclusters and computer simulations of protoclusters. More observation and study of early protoclusters is needed to understand them.



This artist's impression of SPT2349-56 shows a group of interacting and merging galaxies in the early Universe. Credit: Credit: ESO/M. Kornmesser

Supernova survivor – In 2001 a supernova was observed in galaxy NGC 7424. Since the afterglow of that explosion has now faded, the Hubble Space Telescope was able to find the companion star that orbited the one that exploded. This is the first image ever made of a companion star that survived a supernova. The explosion was Type IIb stripped-envelope. This means that the finally-imaged companion star likely gravitationally pulled the outside off the other star before the explosion. Some theoreticians claim that this type of supernova occurs because huge stellar winds strip the outer parts, but this observation supports the theory of stripping by companion star, at least in this case. Observations of more Type IIb supernovas are needed to support one or both of these stripping theories.

Merging galaxies – NGC 6240 is a butterfly-shaped galaxy with 2 supermassive black holes, so for some time has been believed to be 2 galaxies merging. A new study using data from 3 telescopes has been able to measure the location and velocity of various types of gas, and so determine their origins. Stellar winds and ejected material from the black holes explain the various "wings" of the butterfly. Some extend 30,000 light-years out from the galaxy core. These causes combined are throwing outward every year the mass equivalent of 100 Suns. There are hints that this outflow is shutting down the formation of new stars, though it is apparent that star formation has been occurring at huge rates in the recent past, as a result of the galaxy merging.



NGC 6240 as seen by the Hubble Space Telescope. Credit: NASA, ESA, the Hubble Heritage (STScI/AURA)-ESA/Hubble Collaboration, and A. Evans (University of Virginia, Charlottesville/NRAO/Stony Brook University)

Instant AstroSpace Updates

NASA announced that a **helicopter** has been added to the next Mars rover (so far named only Mars 2020), so aerial views near the rover can be obtained. It weighs less than 4 pounds and has twin rotors that spin 10 times as fast as ordinary earthly craft, in order to fly in the thin Martian atmosphere.

Scientists analyzing data from NICER (an X-ray timing telescope mounted on the International Space Station) have found a pulsar (spinning neutron star) orbiting a companion star with the **fastest orbital period** (38 minutes) of any such system, meaning they are orbiting extremely close together. The companion star is likely a hydrogen-stripped white dwarf, as any larger type of star would have been torn apart.

It has been calculated that the Earth's orbit, due to gravitational perturbations of the other planets, should go through several cycles of **changing eccentricity**, affecting Earth's climate, the longest being 405,000 years. A rock core of ancient sediments was recently drilled that shows the 405,000 year cycle has persisted for at least 50 million years.

The IAU has accepted a dozen names for features on Pluto's moon **Charon** that were suggested by the New Horizons spacecraft team. The names are from literature and mythology of exploration, and include Dorothy (of Oz), Clarke (author Arthur C. Clarke), Nemo (of 20,000 Leagues) and Kubrick (director of 2001).

FAST, the new 500-meter dish radio antenna (world's largest) in China, is still undergoing commissioning, but has already discovered more than 20 new pulsars, including a radio millisecond pulsar that spins 193 times per second.

Pad License For Sale

Be permanently polar aligned! Have a secure place to store equipment between star parties. An observing pad makes it a breeze to set up for observation. This pad is located in the prestigious Upper Pad Area, so comes with a graveled parking area and the use of warming and storage sheds, with microwave and refrigerator. The pad is carpeted, for comfort and dropped eyepiece protection. Has a sturdy steel pier with built-in wedge, drilled to fit all major fork-mounted telescopes. Includes a tray that fits on the pier to hold eyepieces and star maps. I'm letting it go because I graduated to an observatory. The pad fee is paid up for this year. Asking $1200, but negotiable.

Contact Don Lynn at 714-882-9648 or dlynn@ieee.org

The Library Needs Your Help

You may have noticed that the doors to the cabinets of the OCA library where our meetings are held are in dire need of replacement. I have a couple of ideas, but really need the help of a professional contractor or carpenter. If anyone is willing to take a look at the job and give me some pointers, direction, and/or an estimate, I would appreciate it. The cabinets themselves are in good shape, but the doors need to be changed.

Please contact Karen Schnabel at Karen@schnabel.net or 949-887-9517 if you are able to assist.

Greetings from Palmia Observatory

By George Robinson

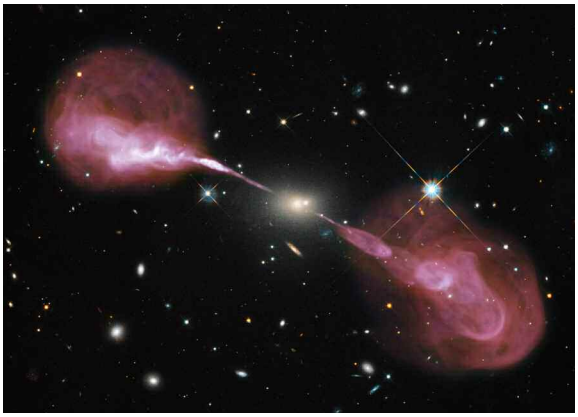
You all have probably seen some image similar to the one on the right showing some configuration of the dish antennas that make up the array. The VLA is located in a remote and mostly radio quiet location about an hour drive west of Socorro, NM. It was built in the 1970's and has just been recently upgraded with newer electronics and after the upgrade is often called the Jansky Very Large Array, after one of the early radio astronomers. With these upgrades the VLA can observe over the 1-50 GHz frequency. Since radio waves at these frequencies are not impacted much by the atmosphere and dust in the universe the array can provide details about galactic structure that optical observations cannot see through.

Karl G. Jansky Very Large Array (VLA) in New Mexico (USA). Credit: NRAO/AUI

The VLA can be arranged in four different configurations, A through D, in which the 27 identical dishes can be grouped together in a tight Y formation of about 0.6 mile diameter or spread out in a very wide Y formation of about 22 diameter. Most of the time all dishes are directed toward the same target but in some instances the array can be split up and different observations of different objects can go on at the same time.

One of the best examples I've seen for why all four configurations get used in the study of one object is this study of the Hercules A galaxy. The very wide A configuration can get very high angular resolution of objects and the other configurations can achieve more and better degrees of sensitivity. Check out how these four different perspectives on Hercules A show different levels of detail.

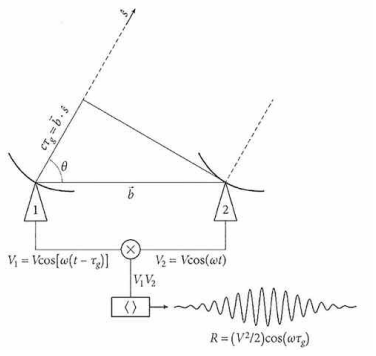
Finally, when the results of the four configurations are brought together in one image and overlaid with optical images you get a very impressive view of Hercules A. Without radio astronomy the jets emerging from the galaxy would not be visible.



Radio-optical view of the galaxy Hercules A. Credit: NASA, ESA, S. Baum and C. O'Dea (RIT), R. Perley and W. Cotton (NRAO/ AUI/NSF), and the Hubble Heritage Team (STScI/AURA)

We can't show these great images made with the help of the VLA without talking a little bit, at least, about how the array works as an interferometer and how all of the 27 antennas are interconnected to collect radio light from distant objects. Hmmm, this could get a bit technical and mathematical, but we can't just ignore it so let me try just one diagram that I have been studying in my radio astronomy textbook. The interferometry and correlation science is much more detailed, but I think this one diagram will start to show what is involved.

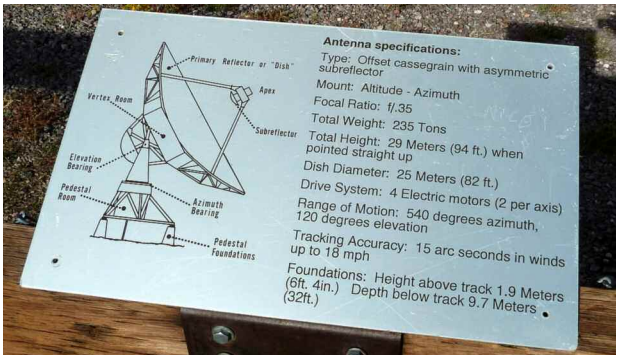
This diagram just shows two dishes but the key thing about correlation of radio signals from all the antennas can be compared and correlated in the same way. The distance between any antennas sets the baseline distance and this distance results in incoming signals from some object to arrive at slightly different times at each antenna. The correlation of these signals, done with a supercomputer correlator at the VLA, is essentially a multiplication and filtering of the two signals, which shows up as the squiggly signal that rises and falls in amplitude as the two antenna signals move in and out of phase and alternatively result in constructive or destructive interference. As the antennas track the object across the sky, the time delay between the two objects naturally changes as the angle of elevation changes. This correlation of widely separated antennas allows the VLA to achieve very high angular resolution, down in the milli-arcsecond range. Whew, ok, enough of that and if you want more check out the referenced textbook!



Block diagram showing correlation between just two antennas. Source: "Essential Radio Astronomy"

So, to find out more about the VLA, I met up with Science Nerds and Theatre Impresarios, Scott and Sandy, and we made our way from OC to Albuquerque to Socorro and finally to the VLA. Here we all are trying to make our way over to one of the closest dishes near the visitor center. The visitor center has a gift shop and is the starting point of guided or self guided tours. They also show a great introductory video of the VLA and how it all works. Of course, they chose Jodie Foster of "Contact" to be the narrator.

As we approached this big dish, it obediently slewed around to face us, not because of our specialness and a desire to pose for us, but it just happened to be direction to its next target. When near the dish, you can hear he drive motors and gearing and also the air conditioning and cryogenic cooling systems doing their thing. Even after it got to its commanded position, it still had to keep tracking to compensate for the Earth's rotation.



There is a plaque (left) near the dish that lists some of he significant antenna specifications.

We also had a guided tour of the VLA control center and correlator. You can see one of the dishes outside the control room window. During our visit the array operator had to interrupt his description of the facility in order to launch a calibration command. The VLA is highly automated but the operator still has to verify that the right sequence of scripts is being implemented and the correct number of antennas are online and ready to go. For calibration, all 27 dishes are pointed to the same deep space object, like a quasar, and if they are all pointing at the same object then their output readings should all agree and/or be tuned to agree.

Resident Astronomer and two other OCA members, Scott and Sandy, tour the VLA. (Source: Palmia Observatory)

Our VLA tour includes an inside look at the VLA control room. (Photo: Palmia Observatory)

The VLA observing schedule is such that each of four configurations has a four month term after which the next configuration is chosen for the next four months. This offset in the calendar year means that each configuration rotates through the calendar and all parts of the sky will be eventually covered. Of course, the VLA can operate 24 hours per day and does not have to wait for dark to begin observing. Sometimes heavy winds will interfere with observation and the dishes have to be placed in a wind safe mode, which is essentially just pointing straight up.

So, you might be wondering how these giant 235 ton dishes are moved around into the four configurations. Well, as we drove out to the VLA, some legs of which cross the highways, you could see that the antennas in the Y pattern are aligned with railroad tracks and the dishes can be moved along the tracks and then parked on the side. They have a specially built transport locomotive type machine that lifts up the 235 tons and moves it around on the tracks until it gets to the right location and then it rotates 90 degrees and moves off along perpendicular rail tracks to the final antenna parking position. If a given dish needs serious maintenance it can be brought back to the maintenance shed without interfering with the positions of any of the other dishes.

When I say the railroad tracks crossing the state highway, I said, hmmm, what they need here is a sign, sort of like "deer crossing" or maybe more appropriately for that New Mexico location, "antelope crossing" or similar sign? But no, there was no sign there, but the gift shop did have "Antenna crossing" signs there for sale (left).

So the array stretches across some of the state highways and we, at least as I recall, did not see any sign about turning off our cell phones until we arrived at the visitor center. Our tour guide told us that a cell phone on the moon would be seen to be brighter (and later I went back and calculated a rough order of magnitude of about 1 billion times brighter) than many of the deep sky objects that the VLA observes.

This got me thinking about a recent UCI Physics Colloquium and book signing where Brian Keating spoke about his new book on losing the Nobel prize and how the BICEP2 team had to withdraw their published finding of gravitational waves originating at the big bang. If they had to withdraw their paper due to not having the correct dust contamination model, what if some VLA discovery was being corrupted by cell phones? Maybe it was the long straight country road to the VLA or the sun glare in my eyes or something, but I couldn't help but imagining some VLA researcher cursing, "Darn, I could have won a Nobel prize except for all of these tourists and their cell phones." Well, maybe not, but check out the book if you want to hear more about trying to win the Nobel and about some advocates who think the rules of winning need to be updated to account for the thousands of scientists that now work as giant teams.

Until next time,

Resident Astronomer George

If you are interested in things astronomical or in astrophysics and cosmology, check out my blog at ***www.palmiaobservatory.com***

July Guest Speaker: Kate Rubin

The Enigmatic (but Not Empty) Space Between Galaxies.

Kate Rubin, Ph.D., is an astronomer specializing in galaxy formation and evolution, with a particular emphasis on the physics of large-scale flows of gas through distant galaxy environments. This research makes extensive use of large ground-based optical telescopes, including the Magellan and Very Large Telescopes in Chile and the Keck Telescopes in Hawaii, as well as the latest generation of the Sloan Digital Sky Survey (SDSS-IV). Rubin uses these tools to study how energy produced by supernovae drives material from star-forming regions into galaxies' surroundings, and to characterize the signatures of the accretion of gas onto galactic disks over the past eight billion years of cosmic time. Dr. Rubin earned a B.S. in Physics and Astronomy from Yale University in 2004, and obtained her Ph.D. in Astronomy and Astrophysics from the University of California, Santa Cruz in 2010. She has held postdoctoral fellowship appointments at the Max Planck Institute for Astronomy in Heidelberg, Germany, and at the Harvard-Smithsonian Center for Astrophysics in Cambridge, MA. She joined the faculty in the Department of Astronomy at San Diego State University in 2016.

Using powerful telescopes, we have now measured the distribution of galaxies from a time less than a billion years after the Big Bang. However, all of the stars in all of the galaxies account for a mere 6% of the "normal" (not dark) matter in the present-day universe. To search for the remaining normal matter, astronomers have designed experiments sensitive to an extremely diffuse phase of gas: using spectroscopy of bright background light sources (e.g., quasars), we identify foreground clouds of gas in absorption and count the number of atoms of various chemical elements they contain. I will present results from recent studies using this technique that reveal a massive reservoir of diffuse gas extending hundreds of kiloparsecs from galaxies like our Milky Way. I will then describe evidence demonstrating that the galaxies themselves play an important role in filling these reservoirs by driving large-scale flows of material away in so-called "galactic winds". These results imply that most bright galaxies are surrounded by a dynamic gaseous halo containing at least as much normal matter as all of the stars and nebulae in the galaxies' disks.

VOLUNTEER OPPORTUNITY

OCA Representative to WAA

Our club has been a member of Western Amateur Astronomers (WAA) for many years, and our representative for most of that time has been Tim Hogle, one of our Charter Members. He would like to retire from that position, and we are seeking a replacement.

WAA is an association of clubs in the western United States (different organizations serve other areas of the country), and its best known current activity is selecting the annual recipient of the G. Bruce Blair Award, which recognizes excellence in astronomy outreach activities. In the past, WAA organized conferences and provided resources for its members during times when there weren't many options available, and it is still available to provide support for its members, particularly smaller or newer clubs, though local needs have changed over the years.

The basic responsibilities of the WAA representative are to attend two Board meetings per year (one at RTMC and one elsewhere), report back to OCA on those meetings, solicit suggestions for OCA candidates for the G. Bruce Blair Award and formally deliver the nomination to WAA before the Winter Board meeting. Beyond that, our representative would potentially be able to influence the future course of WAA as it adapts to current conditions and determines how it can best serve the needs of its member clubs.

Tim is hoping to be able to overlap with whoever will be taking that over from him as WAA representative, to ease the transition to the new representative, and he is available to answer questions about WAA and what is involved in representing OCA's interests with the WAA. If you are interested in this position, please contact Tim Hogle (TimHogle@aol.com) or Barbara Toy (btoy@cox.net).

What Is the Asteroid Belt?

By Linda Hermans-Killiam

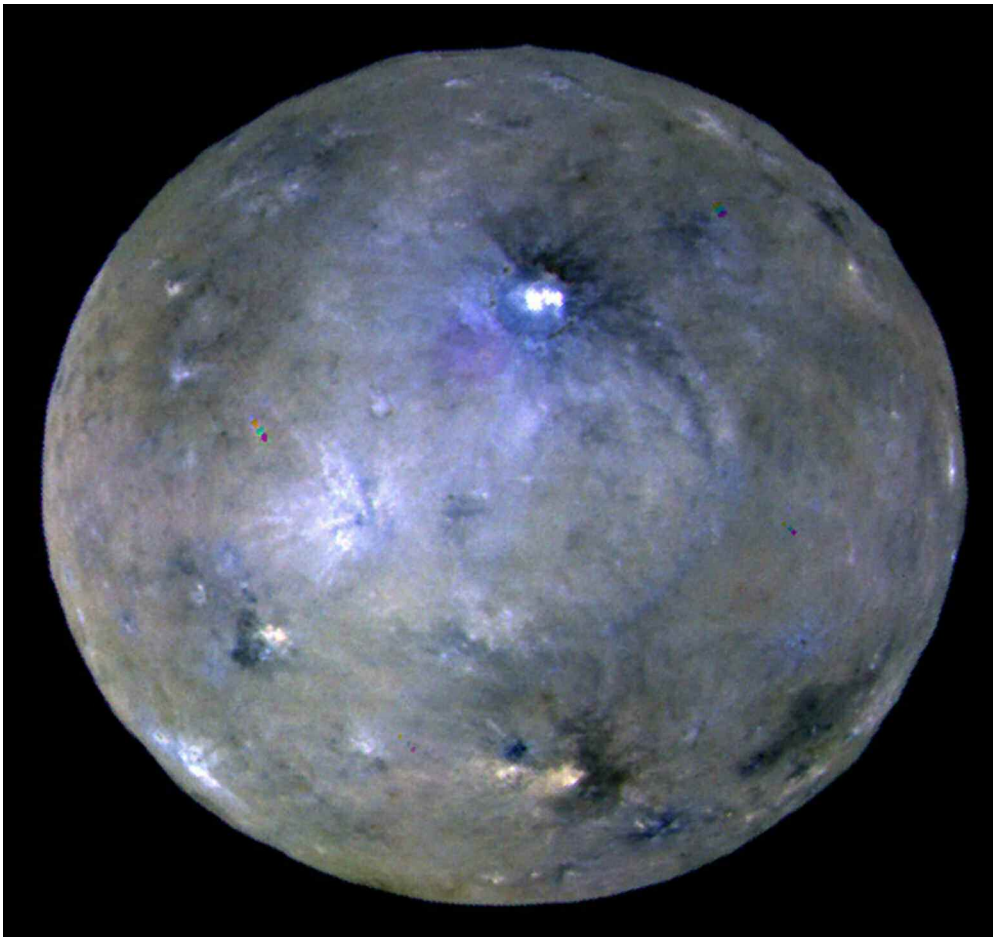
There are millions of pieces of rocky material left over from the formation of our solar system. These rocky chunks are called asteroids, and they can be found orbiting our Sun. Most asteroids are found between the orbits of Mars and Jupiter. They orbit the Sun in a doughnut-shaped region of space called the asteroid belt.

Asteroids come in many different sizes—from tiny rocks to giant boulders. Some can even be hundreds of miles across! Asteroids are mostly rocky, but some also have metals inside, such as iron and nickel. Almost all asteroids have irregular shapes. However, very large asteroids can have a rounder shape.

The asteroid belt is about as wide as the distance between Earth and the Sun. It's a big space, so the objects in the asteroid belt aren't very close together. That means there is plenty of room for spacecraft to safely pass through the belt. In fact, NASA has already sent several spacecraft through the asteroid belt!

The total mass of objects in the asteroid belt is only about 4 percent the mass of our Moon. Half of this mass is from the four largest objects in the belt. These objects are named Ceres, Vesta, Pallas and Hygiea.

The dwarf planet Ceres is the largest object in the asteroid belt. However, Ceres is still pretty small. It is only about 587 miles across—only a quarter the diameter of Earth's moon. In 2015, NASA's Dawn mission mapped the surface of Ceres. From Dawn, we learned that the outermost layer of Ceres—called the crust—is made up of a mixture of rock and ice.



This image captured by the Dawn spacecraft is an enhanced color view of Ceres, the largest object in the asteroid belt. Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA

The Dawn spacecraft also visited the asteroid Vesta. Vesta is the second largest object in the asteroid belt. It is 329 miles across, and it is the brightest asteroid in the sky. Vesta is covered with light and dark patches, and lava once flowed on its surface.

The asteroid belt is filled with objects from the dawn of our solar system. Asteroids represent the building blocks of planets and moons, and studying them helps us learn about the early solar system.

For more information about asteroids, visit: ***https://spaceplace.nasa.gov/asteroid***

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