SIRIUS ASTRONOMER

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The Newsletter of the Orange County Astronomers

July 2017 *Free to members, subscriptions $12 for 12 issues* **Volume 44, Number 7**

Nebulosity from brilliant Antares shines on the lower right with rho OPH on the left. Two globular clusters are also apparent; large M4 above Antares, and NGC6144 at the 10:30 position. Image is a stack of 10 subframes, each 8 min in length, taken at the OCA Anza site on the nights of May 23rd and 24th, 2017. OCA member Rick Hull used an unmodified Canon 6D DSLR at ISO1600 through a Williams Optics 80mm FD semi-apo refractor operating at f/5.55.

OCA CLUB MEETING

The free and open club meeting will be held July 14 at 7:30 PM in the Irvine Lecture Hall of the Hashinger Science Center at Chapman University in Orange. This month, Randy Chung and Sean League of SpaceFab.US will speak about private space telescopes, asteroid mining and manufacturing.

NEXT MEETINGS: August 11, September 8 (speakers TBA)

STAR PARTIES

The Black Star Canyon site will open on July 15. The Anza site will be open on July 22. 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 July 7 and August 4.

Youth SIG: contact Doug Millar
Astro-Imagers SIG: July 1, Aug 8
Astrophysics SIG: July 21, Aug 18
Dark Sky Group: contact Barbara Toy

President's Message

By Barbara Toy

Congratulations on Pauline Acalin's First Issue as the New Editor of the Sirius Astronomer!

This issue of the Sirius Astronomer is the first for Pauline Acaline as our new editor – as I write this, in mid-June, I don't know if she had any particular problems pulling it all together and getting it to the publisher, but I hope all has gone smoothly! Please let her know you're glad she's come on board, and help her (and the club) with club-related/club-generated content – if you have an article on something astronomical or club-related that you've been thinking of writing, please do, and send it to Pauline for our newsletter. There may be some things she can't include, or has to postpone to a later issue, but we do like to have original content on topics of interest to our membership. I know there are a lot of you out there doing interesting astronomy-flavored things or with knowledge that gives interesting insights on topics of astronomical interest – do write them up so we can all benefit!

More Changes on the OCA Board:

Most unfortunately (for us), Amir Soheili has been transferred out of state and so has had to resign his position as OCA Trustee. He expects to be back in this area for weekends for a while, until his wife finds a new position and the whole family can move, so they both will be kept very busy during this transition period, but he may be able to make it to a few more club meetings or star parties before their move is complete. We will really miss his input and enthusiasm, as well as all the hard work he's been putting into designing a new website for the club using current technology. In spite of all of the hours he put into developing a new website that would meet the needs of our club, there's a lot more that needs to be done before it could go on line, so we do need a volunteer to take over on that project. Amir is willing to work with whoever takes that on to help get him or her (or them – this doesn't have to be a solo job) up to speed on what he's done, what's still needed, and the concerns that have to be dealt with to complete it. If you're interested in helping out with this, please contact me at btoy@cox.net, or contact Alan Smallbone (asmallbone@earthlink.net) or Charlie Oostdyk (Charlie@cccd.edu).

This also left a vacancy on the Board, and John Hoot, who volunteered at the time of our previous vacancy, presenting the Board with the very difficult choice between him and Doug Millar to fill it, has graciously agreed to fill it. So, though we are very sorry to lose Amir, we are looking forward to having John, with his many years of experience in equipment design and astronomical research, joining us on the Board.

Annual Starbecue – July Anza Star Party:

Our annual club potluck Starbecue will be the evening of the July Anza Star Party, on July 22. Sometimes we have it at the August Star Party, but that is not an option this year, as so many club members will be out of the area for the eclipse on August 21; I suspect that both of our August Star Parties (both Anza and Black Star Canyon are on August 19) will have lighter attendance than usual for summer star parties as people head out to wherever they plan to view the eclipse.

So, July is the better of the summer options this year, and I expect that one of the topics of conversation during both the Starbecue and star party itself will be the plans that people have for where and how they plan to view (and image) the eclipse.

Besides the food, Starbecue star parties are particularly fun because more family members tend to come than for regular star parties, and people who only make it out to Anza intermittently often make it a point to come, as well, so it's a chance to see people we haven't seen in a while and to get to know members we may not have run across before. Also, since people are generally busy imaging or viewing during star parties and often don't have time to roam around

the site much, and the Anza site is so big and with so many different areas where people set up, it gives a chance to visit with people who may be out there a lot but stay in different areas of the site. This is a potluck, and – speaking from experience with past Starbecues – we have a lot of really good cooks in the OCA! We'll have a barbecue going (gas, so we don't have to worry about briquettes), so feel free to bring something to grill. Salads, casseroles, vegetables, other side dishes, appetizers, fruit, deserts – all are welcome, but we don't have a formal sign-up for what people are bringing. If you bring something you think would serve around eight people, that generally works out well.

The club supplies plates, tableware, napkins and bottled water as well as the club barbecue. We have barbecue utensils, donated by Greg Schedcik several years ago, but please bring anything needed to serve or prepare what you bring (e.g. serving spoons, bowl or platter, knife, tongs). If you bring something that needs power (such as a slow cooker), please also bring an extension cord.

We plan to start setting up on the east/shady side of the club observatory around 5:00 p.m. on July 22, and eating will probably be in full swing around 6:00. We have some tables for setting out the food, but a limited number of chairs – it's a good idea to bring something comfortable to sit on even if you expect to spend a lot of time wandering around talking to people. We have limited parking by the observatory, so, if you need to drop things off, please plan to park on the levels below the observatory afterward.

Please remember to take any leftovers with you when you leave – and if you can help with the cleanup, that would be great! We need volunteers to take trash bags away for disposal, too, as we don't have trash service out there. I look forward to seeing you at Anza for another fun Starbecue!

About that Eclipse...

Several people have contacted me in recent weeks about whether the club is organizing an expedition to see the August 21, 2017 solar eclipse, which is definitely a Big Deal for those of us in North America who are interested in astronomical events, and which is even attracting the attention now of people beyond astronomy enthusiasts as the media catches eclipse fever. Our club doesn't have the resources to organize something like that – any of you who have been to talks that Joel Harris, a club member who became a professional eclipse tour organizer many years ago, has given on some of his past trips and on factors to consider in choosing a viewing location, has some idea of just how complex that can be. Most of those who regularly organize eclipse tours were reserving accommodations and making other arrangements well over a year ago, and the most popular locations have been sold out for months.

What the club has done over the last year or more is provide various presentations with information to help people decide where they want to go for the eclipse and how they want to view or image it. Among these have been talks by Joel Harris at one of our general meetings and at the club banquet (the latter was specifically on the upcoming eclipse), and there have been a number of presentations at meetings of the AstroImagers group on different topics related to the eclipse. Those that I happened to see included presentations by Dave Kodama on his observations from traveling around some of the areas he was considering as eclipse-viewing sites over the last two Augusts, and he also gave a talk on imaging tips for the eclipse based on his past experience, and Alan Smallbone and others at different meetings talked about the pros and cons of different equipment that could be used to image the eclipse. Of course, people have also been sharing their particular plans and information they have gathered in informal discussions at various club events, and there has also been a lot of sharing of information through the club's email groups, though more on Astroimagers@yahoogroups.com than on the more general email group, OCAstronomers@yahoogroups.com (if you want to check the archives).

If you want to see the eclipse and haven't made specific plans, you definitely need to move fast to get something in place as time is short and a lot of options are no longer available. For everyone who's going – best of luck with your viewing location, and I'm looking forward to hearing about your experiences and seeing your images! For those who can't go – I hope you have fun with the partial eclipse! As for me – I'm really looking forward to seeing my first total solar eclipse!

© Barbara Toy, June 2017

AstroSpace Update

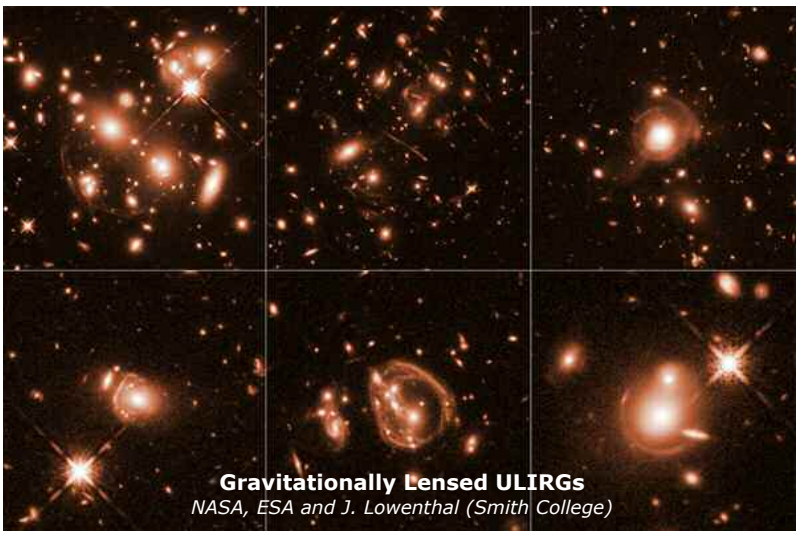
July 2017
Gathered by Don Lynn from NASA and other sources

Cold nebula explained – The Boomerang Nebula is called the coldest known object in the Universe. It is so cold that the Cosmic Microwave Background, at 2.7° above absolute zero, is warming the nebula. New observations with ALMA (radiotelescope array in Chile) show how it got that cold. It appears that a small star plunged through the red giant star at the heart of the nebula, and gravitational interaction from this is throwing a huge amount of gas and dust out of the red giant at very high speed. The gas cools as it expands, and cools very strongly because it is moving so fast. The red giant is also throwing out, at lower speed and higher temperature, a pre-planetary nebula, which is buried inside the gravitationally thrown gas. The Boomerang is about 5000 light-years away in Centaurus.

Universe explained (maybe partly) – Nearly all the reactions between subatomic particles are symmetric between matter and antimatter. This brings up the question of why the Universe exists containing essentially all matter and no antimatter. Both should have been created in nearly equal amounts shortly after the Big Bang, and should annihilate whenever those opposites touch, leaving no Universe. A few reactions are known with what is called CP violation, that is, favoring either matter or antimatter, but those are so rare that they can't explain our Universe. New experiments at the Japanese neutrino detector Super-Kamiokande have shown CP violation in neutrino oscillation. The experiments have not been run long enough to claim conclusive identification of CP violation; this may take 9 more years. And it's probably not enough violation to explain the Universe of matter, but it's a step in the right direction.

Hubble Constant explained (maybe) – The Universe is known to be structured as a "cosmic web" of gas and galaxy clusters, with large voids in between, which contain much fewer gas, stars, and galaxies. A new study shows we live in a void, in fact the largest known void, with a radius of about 1 billion light-years. As has been reported many places in recent months, the most authoritative methods of measuring the Hubble Constant, the speed with which the Universe is expanding, disagree by over 7%, a larger amount than can be explained. The new study finding that we live in a void states that the void should distort Hubble Constant measurements made using supernova, but should not affect measurements using the Cosmic Microwave Background. More work is needed, but maybe this void explains the Hubble Constant discrepancy.

Dark matter explained (maybe) – The AMS-02 cosmic ray detector has been installed and observing on the International Space Station for about 6 years. The latest analysis of its data on 100 billion particles shows a slight excess of antiprotons in a certain energy range that matches what is predicted for WIMPs (Weakly Interacting Massive Particles). WIMPs are theoretical constructs that have never been detected, but might constitute the dark matter of the Universe. Such particles that react only through the Weak Nuclear Force should in theory, on rare occasions, collide with each other and break down into a pair: proton and antiproton. The particles would have to be roughly 85 times the mass of a proton in order to best match the AMS-02 data. Two teams analyzed the data, using different methods, and came to similar conclusions regarding WIMPs. A lot more work is needed before anything is said to be discovered, but maybe we are on the trail of dark matter. It would be nice to find a WIMP like this in particle accelerator experiments.



Gravitationally Lensed ULIRGs
NASA, ESA and J. Lowenthal (Smith College)

Ultra bright galaxies explained – There is a class of galaxies that is very bright in infrared, known as ULIRGs (Ultra Luminous InfraRed Galaxies). A new study of the brightest of these, ones up to 100 times brighter than your everyday ULIRG, found that the first 12 of them observed were each lensed by the gravity of a galaxy cluster that happened to lie in front. Gravitational lensing is caused by the bending of light rays, as predicted by General Relativity. Such lensing makes the further object appear much brighter than normal. It is thought that generally ULIRGs are not gravitationally lensed, but are bright because they are undergoing massive star formation. Now it seems that essentially all of the brightest ULIRGs are also lensed. The study will continue observing more very bright ULIRGs. Astronomers also hope to find the cause of ULIRGs' massive star formation.

Rarity of Venusian volcanoes explained – A new study of Venus data shows that the intense heat at the surface is sufficient to soften the planet's crust into the consistency of Play-Doh. This would prevent tectonic plates from forming and reduces the chances of formation of cracks in the crust. These greatly reduce the frequency of volcanoes forming. This explains why very few volcanoes have been identified in the radar images of Venus.

Flashes explained – In 1993 the Galileo spacecraft did a flyby of Earth and spotted bright flashes on Earth. At the time they were attributed to reflections of the Sun off water. Now the DSCOVER spacecraft is monitoring the Earth (as well as solar ejections) and has seen the same kind of flashes, but not always over water. Measuring angles proved they were indeed reflections of the Sun, but they had to be reflecting off ice crystals, at least in those occurring over dry land. The scientists who published this result noted that we might try to look for such flashes from exoplanets.

Bad image explained – Analysis of a wobbly picture taken in October 2014 by the Lunar Reconnaissance Orbiter shows that the radiator on the left-hand Narrow Angle Camera was struck by a meteoroid. The spacecraft suffered no permanent damage, and recovered stability before that same image was entirely scanned. The particle was probably just under a millimeter in size, but hit at 4 miles/sec (7 km/s).

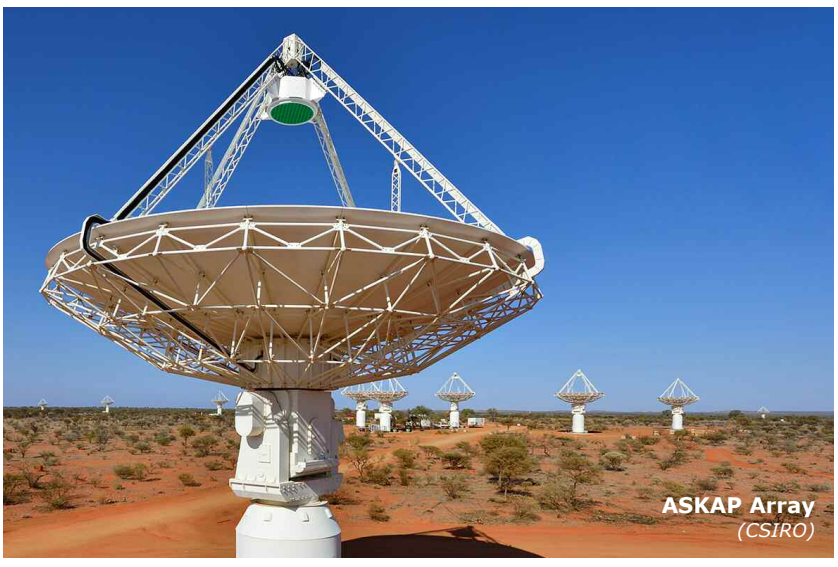
Gravitational wave – LIGO scientists have announced the detection of the 3rd ever gravitational wave. Like the first two, it was the result of two black holes merging. This one came from more than twice as far away (3 billion light-years) as the previous gravitational waves. The black holes were of more unequal masses than previously, and the resulting single merged black hole was 49 times the Sun's mass, in between the masses of the previous resulting black holes. For the 3rd time, the black holes involved were over 20 times the Sun's mass, larger than theorists and telescope observations say the masses should be of black holes produced by collapsing stars.

White dwarf properties confirmed – The Hubble Space Telescope observed a white dwarf star as it passed in front of a more distant star, and was able to measure the gravitational lensing caused by the white dwarf's mass. From this, astronomers were able to calculate the mass of the white dwarf at 68% the Sun's mass. This agrees well with theoretical predictions of such a star's mass. They were also able to measure the diameter of the white dwarf, and this too agreed with theory.

Hot planet – An exoplanet named KELT-9b has been found to be the hottest gas giant planet known, with a dayside temperature of more than 7800°F (4300°C). That is hotter than most stars. It orbits extremely close to its star, orbiting in only 2 Earth days, which explains the heat. It is 2.8 times the mass of Jupiter, but only ½ as dense, since the heat swells up the planet. It is tidally locked, so one side always faces its star. It is only 300 million years old. It is probably shedding matter as a result of the close-by strong stellar radiation, forming a comet-like tail, which will be looked for in future observations. It is possible that eventually the star may evaporate and blow away the whole planet.

FRB update – New observations with radiotelescope interferometry show that the source of the repeating Fast Radio Burst (FRB) is offset slightly (12/1000 arcsecond) from the source of faint steady radio emission. It is in a star-forming region off center in a dim dwarf galaxy. None of the other 2 dozen or so FRBs have been found to repeat, even though their locations have been monitored now for some time. The best guess for the source of the repeating FRB is that it is a recently formed neutron star. However, neutron stars often emit X-rays, and searches for X-rays at the location of the FRB have not turned up anything. There isn't even a good guess for the sources of the non-repeating FRBs.

We may be learning more about FRBs soon, because a new radiotelescope array has joined the study of them: the Australian Square Kilometre Array Pathfinder (ASKAP). It has a very wide field of view, and so is more likely to catch an FRB, which lasts only milliseconds. In its first few days of observation, ASKAP already found an FRB. ASKAP pinned down the location of this FRB to an 8 arcminute area, but observations of the area turned up no galaxies there.

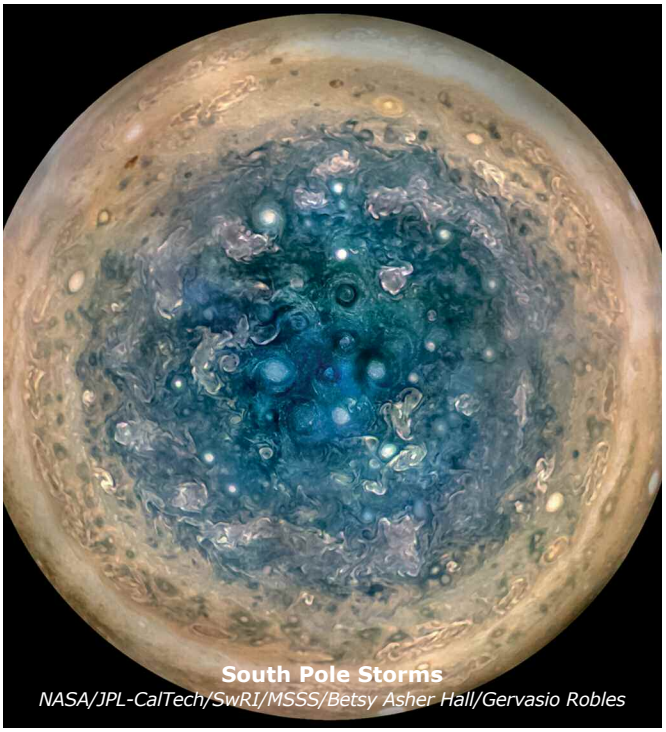


ASKAP Array
(CSIRO)

Speeding black hole – Astronomers have spotted a supermassive black hole somewhat off center and speeding away from a galaxy 3.9 billion light-years away. It is likely recoiling gravitationally from a galaxy merger. Further observations will be made to eliminate other causes of speeding black holes, such as orbiting another as yet unseen black hole. This is the 2nd speeding black hole found in recent months.

Magnetic field – Astronomers using a radiotelescope array in Australia have detected a magnetic field in the space between the Magellanic Clouds, two of our neighboring dwarf galaxies. It was already known that there is a bridge of gas there, apparently formed by gravitational pulls during a past close encounter between the Clouds. The gas apparently has a magnetic field. The evidence for the magnetic field was that it polarized light from more distant objects shining through the region. This is the first magnetic field detected outside of any galaxy. It is about 1 million times weaker than the Earth's magnetic field.

Jovian moons found – A checkup on the bunches of Jupiter moons found back around 2003 has found yet two more moons, for a total of 69. They have been designated S/2016 J 1 and S/2017 J 1. They are about magnitude 24 (extremely faint) and are probably 1/2–1 mile (1–2km) across. Like most outer moons there, they revolve retrograde in fairly large and fairly elliptical orbits. Based on this, they were probably captured by Jupiter somewhat after the planets formed.



South Pole Storms
NASA/JPL-CalTech/SwRI/MSSS/Betsy Asher Hall/Gervasio Robles

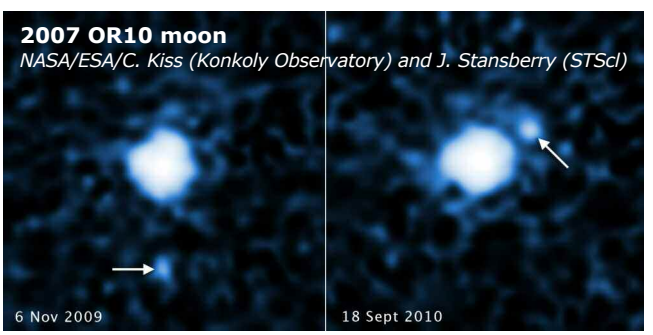
Juno (Jupiter orbiter) discoveries announced – Both of Jupiter's poles were found to be heavily covered in Earth-sized storms. The microwave radiometer, which observes as far as a few hundred miles (km) below the opaque cloud tops, finds that the belt near the equator penetrates as far as can be detected, but the other belts and zones (dark and light stripes about the planet) change into other structures somewhat below the visible light surface. Ammonia concentration is variable, but increases with depth. The planet's magnetic field close to the visible surface is even stronger than expected, and lumpier in shape. The uneven field distribution suggests that it may be generated closer to the visible surface rather than in the core. Auroras were observed near both poles, and the initial observations imply they form differently than auroras on Earth.

Psyche (spacecraft) mission to Psyche (asteroid) – This spacecraft has been redesigned with a larger solar panel that will allow a more powerful electric propulsion system, which in turn allows it to skip one of its two planned flyby gravity slingshots (the one by Earth). So it will arrive at asteroid Psyche in 2026 instead of 2030. If you were planning to observe Psyche during the Earth gravity slingshot, cancel your plans, and make reservations to be on Mars in 2023. Unlike most asteroids, Psyche is made almost entirely of nickel and iron. It is thought to be the core of a protoplanet whose outer shell was entirely knocked off by collision. Proving this is one of the goals of the mission.

NASA budget – The President has proposed a national budget for next fiscal year that has a few changes in what NASA can spend money on. Typically the legislature changes the budget proposal, so this may all change. The proposal continues support for most NASA current and planned projects, but the following areas are proposed to be canceled: ARM, the manned mission to an asteroid; some Earth-observing satellites, including OCO-3, PACE, CLARREO PF, and the Radiation Budget Instrument (but continuing 18 other Earth-observing projects); and the NASA Office of Education.

Instant AstroSpace Updates

The largest object in the Solar System without a common name is the Kuiper Belt **dwarf planet** 2007 OR10. It has now been found to have a **moon**, also as yet unnamed, about 1/4 its diameter.



2007 OR10 moon
NASA/ESA/C. Kiss (Konkoly Observatory) and J. Stansberry (STScI)

A new study of Cassini (Saturn orbiter) data shows that the moon **Enceladus likely was struck** long in the past by another body, and the impact opened up the geyser area still seen there, and started wobbling that moved the rotational axis, so that geyser area is now near the south pole, while it started out near the equator.

Analysis of silica halos around fractures in bedrock, seen in **Curiosity** rover images, indicates that liquid water was present in Gale Crater for longer time periods than thought previously. When Mars dried up billions of years ago, and so the lake in Gale Crater dried up, possibly groundwater remained much longer, and formed the halos.

A Type II **supernova**, designated SN 2017eaw, has been discovered by an amateur astronomer in galaxy NGC 6946, known as the Fireworks Galaxy, because supernovas (10 in the past 100 years) keep exploding in it.

An **un-supernova** was discovered in the same galaxy, NGC 6946: A massive star that should have exploded as a supernova at the end of its life, instead faded away to undetectability some time in the last few years. It apparently formed a black hole without going through the explosion, surprising many theorists, but confirming others.

The first stone was laid on a Chilean mountaintop to build the **E-ELT** (European Extremely Large Telescope), a 39-meter (129 foot) telescope, to be completed in 2021. The 4.2 meter secondary mirror is already cast, and the contract signed to build the 798 segments of the primary mirror.

An observatory in Greece has begun observations with the **NELIOTA** project, which watches the dark part of our Moon for flashes caused by meteoroids striking it. The 1.2 meter telescope observes in 2 colors, so can estimate temperature of the flash, and therefore size of the impacting body.

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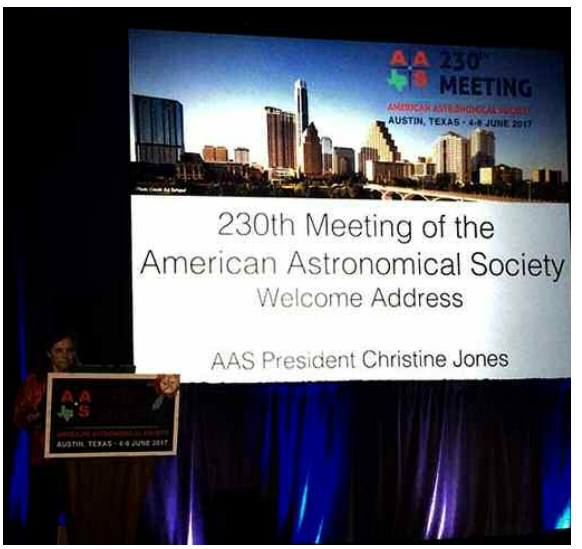
Greetings from Palmia Observatory

By George Robinson

Well I spent a better part of this week at the 230th meeting of the American Astronomical Society held in Austin, TX. The AAS is a professional astronomers society where the latest results and findings can be presented, discussed and critiqued. I have been attending this meeting for three years now and have always had a great time and learn a lot even if many of the more technical presentations are way over my head. My plan for this blog is to offer some brief takeaways from my perspective as an amateur astronomer, and physicist wannabe, of the key points that made it into my awareness. My comments are not meant to be a thorough review, but represent only those portions that resonated with me because of where I am on this journey through astronomy.



Waiting in the audience for President Christine Jones to welcome everyone to the 230th Meeting of the AAS.

We were welcomed to the meeting by current AAS president, Christine Jones, who is an accomplished PhD astrophysicist at SAO and lecturer at Harvard. The meeting had 3–4 plenary sessions per day, with the target audience being the general astronomers of diverse expertise, and shorter, more technical sessions designed for the experts in that particular field. These individual lectures could be something like 10–20 minutes long with time for questions. The topics covered the whole gamut of astronomy including astrophysics, laboratory verification of the physics and chemistry models used to explain observed astronomical findings, cosmology, star formation, formation and evolution of galaxies, solar physics, comets, asteroids, CMB, solar system dynamics and formation and evolution of planets and exo-planets, and probably a few other topics I have neglected to mention. I found most of the technical sessions mostly beyond my current interest or understanding, although I am getting the hang of it and am starting to understand what the main issues are, but the plenary sessions were very entertaining and educational.

Should amateur astronomers go to AAS meetings? Well, they are certainly welcome and the AAS just recently reduced the fee for non-members, from almost 150% above member rates to now the quite low 50% of what is charged for professional members. That now is a pretty good deal. But, all attendees should recognize that there will be a lot of discussion of data and statistics and error bars and significance and random and systematic error and biases, etc., so if this is not your thing, you are forewarned. After all, it is a scientific meeting. The poster sessions were filled with some of the latest research and many of the poster titles simply were not understandable to me. Sometimes, when no one else was stopping at a particular poster and especially if I didn't understand the title at all, I would ask the presenter what it was all about and they were always eager to explain what their work was all about and I could start to understand what the title of the work was all about. For me, as a budding physicist wannabe and practicing amateur astronomer interested in doing some science type observations, it's all great. Even if it is difficult to understand at times, I do finally start to understand what the issue is that they are talking about. So now, my plan is just to present some of the key ideas I heard without going into a lot of technical details.

Plenary speaker, Katherine Freese, U. of Michigan, author of *"The Cosmic Cocktail: Three Parts Dark Matter,"* and a Kavli Prize winner, spoke on "Looking for Dark Stars." Although she did not come out wearing her famous feather boa, her lecture was lively and full of interesting anecdotes of the personalities involved in her career. Her technical presentation covered the topic of dark stars, that is stars that are composed primarily of dark matter and shine, not due to nuclear fusion, but due to the decay and annihilation of dark matter itself. She outlined how to search for these strange objects and verify that they are more than just the result of a theorist's vivid imagination.

Rebekah Dawson, Penn State, and winner of the Annie Jump Canon Prize, made another of the plenary lectures. Recall that Annie Jump Canon was initially one of the "computers," working with the likes of Henrietta Leavit on the Draper Catalog at Harvard. Annie was eventually allowed to look through the telescope and in fact travelled to South America to observe the stars of the southern hemisphere. More of her and the other computers' stories are well told in Dava Sobel's new book, *"The Glass Universe."* Anyway, Dr. Dawson was recognized for her work on using the inner solar system as a window on the origin of planetary systems. In fact, her area of expertise was made a significant part of the AAS meeting with the studies of the inner solar system a major part of the number of presentations at the AAS meeting.

Catelin Casey, U. of Texas, Austin, made a plenary presentation of "The Universe's Most Extreme Star-Forming Galaxies." Dr. Casey described the key importance of dust in star-forming regions, even though dust is a minor component of the total mass of the galaxy. It seems that dust is a very effective absorber of radiation and the re-emitting and scattering of the radiation that the dust stays a relative cool 50 K. These star forming regions are known as DSFG's (Dusty Star Forming Galaxies).

Bonnie Buratti, NASA, presented a summary of the Rosetta mission, which was primarily a European mission to orbit Comet 67P and make a remote landing on it. Dr. Buratti described the dozen instruments on Rosetta and how the imaging and spectrometers were able to glean so much about structure and composition of the comet. Many organic molecules were detected on the surface and

the detection of molecular nitrogen, N2, is considered definitive evidence that the comet had to form way out in the solar system because that is the only location that nitrogen would be found cold enough (about 30 K at distances > 40 AU) to form N2. There was discussion about whether the source of water on the earth was from comets. The scientific method is to look for evidence and one of the key approaches is to examine the isotope chemistry of earth water and compare it with isotope chemistry of water found on comets. It turns out that the water on comets does not match the isotope ratios found on earth so more study is needed.

Macarena Garcia Marin, ESA (European Space Agency), made one of the several presentations concerning the effort going into planning the observations for James Webb Space Telescope (JWST), once it is launched. There are so many professional astronomers vying for time on the JWST that they hope to strengthen the hand of their proposed use of time by arguing that they have, through use of laboratory experiments or other techniques, concluded that they are using the minimum amount of observing time to establish their goals. For instance, they have done computer and laboratory experimentation and modeling to identify if they can meet their scientific goals with, say, just using two filters from the filter wheel rather than the other 6 or 8 filters from which to choose. A lot of work is ongoing how to plan for JWST observing so that the maximum amount of useful scientific data is gathered in each observing session. The principal investigators can't just say, "hey, point there and observe for thousands of seconds" without some well thought out observing plan based on evidence.

Swara Ravindranath, Space Telescope Science Institute (STSI), made another of the JWST observation planning lectures. Dr. Swara described how the spectrometers on JWST worked and how the spectrometer is tied together with the imaging camera so that the observed spectra can be accurately identified with each target astrometry. She mentioned how the Mid-Infrared Instrument (MIRI) spectrometer can operate as a slit defined spectrometer and as a slitless spectrometer, and the imaging camera in that mode can collect thousands of spectra per image. That is is pretty neat! As a budding amateur spectroscopy user, who is initially doing slit spectroscopy where I collect only one spectra at a time, it is really neat how JWST can be configured to collect many spectra, even of lower spectral resolution, at one time. Again, so much effort is being put into pre-planning the JWST observational plan so that the highly-valued resource is used most effectively. Included in this plan is taking many spectra at redshift z>7.

Chris Impey, U. of Arizona and author of *"Beyond Our Future in Space (2015),"* presented an historical view of our species' first efforts at getting into space and the exciting options just around the corner. He is a very dynamic speaker and I have attended many of his free courses on the internet (formats offered by Coursera and Edx). He talked about how there is now a commercial spaceport in New Mexico, commercial space missions being planned and somewhat funded by billionaires, the useful concept of the space elevator (not in space around the Earth, but in orbit around the moon) as a very cost effective way of getting into deep space, how the mining of asteroids could be a cost effective plan, and how terraforming of Mars is not a likely scenario anytime soon.

Konstantin Batygin, Caltech, presented the latest version of the ever popular "Planet 9 from Outer Space." This is probably the third version of this talk about Planet Nine that I have seen in the last year, but Konstantin is a dynamic speaker and this time he went into more of the technical details and it made a lot more sense why the idea of Planet Nine, a planet of approximately 10 earth masses in a highly elliptical orbit, could very well be a reality. For instance, this time he presented six major reasons why the theory of Planet Nine makes sense and some of reasons show that the theory does not just fit the existing facts of the solar system, but also predicted some things that were not part of the original data that now can be seen to be explained by the theory as well. This makes the theory very good and now all they must do is find the planet. Dynamic simulation, sometimes covering thousands of orbits, shows that on occasion planets find themselves close together and these alignments result in resonances that can eject objects, change the objects' eccentricities and inclinations to the solar system disk. I didn't quite write down all six reasons and can only remember that the first clue was the members of the Kuiper belt show unexpected clustering. The theory also predicts some high inclination objects which, subsequently it was learned that these objects had already been observed. In addition, the theory offers an explanation of why the sun's rotary axis is titled nine degrees from the plane of the solar system, and that Planet Nine could have tilted the whole solar system plane with respect to the sun. He says they have identified where to look for it and are busy trying to find it. It will be quite ironic if they do indeed find Planet Nine, given that Konstantin's other co-investigator is none other than Mike Brown, Caltech, who authored *"How I Killed Pluto and Why It Had It Coming."*

Manfred Schussler, Max Planck Institute, was the winner of the George Hale Prize and presented about our understanding of the solar magnetic field and how the theories, over time, went from complex to simple and now back to complex again. He talked about how the prizes' namesake was the first to discover sunspot magnetism and sunspot polarity rules. He described how it used to be that the sun's rotation was necessary for creating the magnetic field, but is now understand that rotation is not necessary and small scale magnetic fields are generated just by the turbulence of convective heat transfer cells. The sun's rotation does contribute to the dipole magnetic field and does distort the magnetic field lines created by turbulence. He said that magnetohydrodynamics modelling of the hot plasma has become so impressive and images of the simulated sun are so good that experts cannot tell which image is real observation and which is simulation. But, he also explained that even though the surface features look great, it is easily known that the modern computer codes do not have enough resolution to be able to completely explain what is going on just below the surface. More work is necessary.

Jay Pasachoff, Williams College, spoke about some of the scientific measurements made during eclipses and presented some anecdotal comments about his journey to Patagonia to capture images of the February 2017 annular eclipse. Remember, an annular eclipse is one where the moon is just at the right distance that it does not completely occlude the sun during an eclipse and a bright annulus is completely visible even when the moon lies directly in front of the sun. He mentioned a fantastic website sponsored by the International Astronomical Union (IAU) and hosted by Williams College. The web page as been installed on the blog list of useful websites.

Poster at AAS meeting for the screening of this documentary.

Also, speaking about the eclipse seekers, there was also a screening of *Black Suns,* a new one-hour documentary that follows the life of two astrophysicists and how they got into astronomy, with all the hurdles and successes along the way. It follows them as they teach their students the preparation for making solar eclipse measurements and, like the rest of us, hope for clear weather. If you follow any of the astronomy and astrophysics videos on the science channel you may already be familiar with one of the astrophysicists, Dr. Hakeem Oluseyi. He shared one anecdote about his first day attending college and that he had no idea what it entailed: the professor lecturing and writing on the blackboard and all the other students sitting quietly just writing in their notebooks. He grew up without any notion of college lecturing and his challenge was to overcome many obstacles and become an accomplished astrophysicist and now lecturer and professor. If you see this documentary in the news check it out!

Finally, I should mention that since the AAS meeting was held in downtown Austin, we were within easy walking distance of one of the Austin tourist attractions where bats have adapted to living under the Congress Avenue bridge and venture out in great flights of thousands as the sun goes down. Well, I wandered the couple of blocks down to the bride and stood several folks deep along the length of this major bridge through Austin and also noticed the large collection of boats, canoes, paddle boat, surfboards and even large tourist boats that collect and all barge together on the river in front of the bridge, all for the chance to observe the flight of these darn bats just after sundown. Well the first time I was there, it was actually kind of impressive to see these thousands of blood sucking mammals, just boil out from under the bridge and fly off as a great swarm to begin their nightly feeding ritual. When I returned to the hotel, I called Resident Astronomer Peggy about what I had seen and she wanted to see the photograph, since she was last in Austin she had planned to visit the bridge but for some reason could not fit it into her schedule. Oh, oh, Well, I had not thought to take a picture because I didn't think I could get the bats to show up on my little iPhone. So after hearing her disappointment I resolved to go down to the bridge the next night. Well, as luck would have it, the bats were either on strike or off their feed and only one little swarm came out from under the bridge. Oh, oh, I failed again to get an image of the bats. There are many folks that look forward to sundown so that they can capture a photo of the bats, much like I suppose many of us astronomers who wait for the sun to go down so that we can get photos of stars and galaxies. Anyway, luckily I was able to make a little restitution to Resident Astronomer Peggy because, by chance while at the airport, I was able to spy this little poster showing the bats swarming up into the air against the sky. Wow, that is a great photo and poster thanks to the Austin Convention and Visitors Bureau!

So that is about it for this week. Later this week we plan to meet up at the OCA general meeting and then next week, I will be going to the SAS symposium in Ontario, California. If you want to see what neat things real dedicated amateur astronomers are doing you should come and check it out. Other than that, since most of the university physics colloquia are entering summer break, I will probably just have a working lunch with the local physicist wannabes. The understanding of the fundamental physics problem that I have been struggling with this week, especially after hearing it mentioned several times at the ASS meeting, is the Hanbury Brown (&) Twiss effect. This effect, first mentioned in this blog in a post of June 11, 2016, was used to measure, in 1956, the diameter of the star Sirius by measuring the correlation between photons received here on Earth from opposite edges of the star Sirius. This measurement is part of a wider topic called intensity interferometry which applies to classical radio astronomy as well as quantum mechanics applications. Why should photons from such large distances on a star be correlated with each other? Strange, even if that is what the mathematics says should happen!

This poster sums up much better the experience of waiting for and seeing the bats.

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***

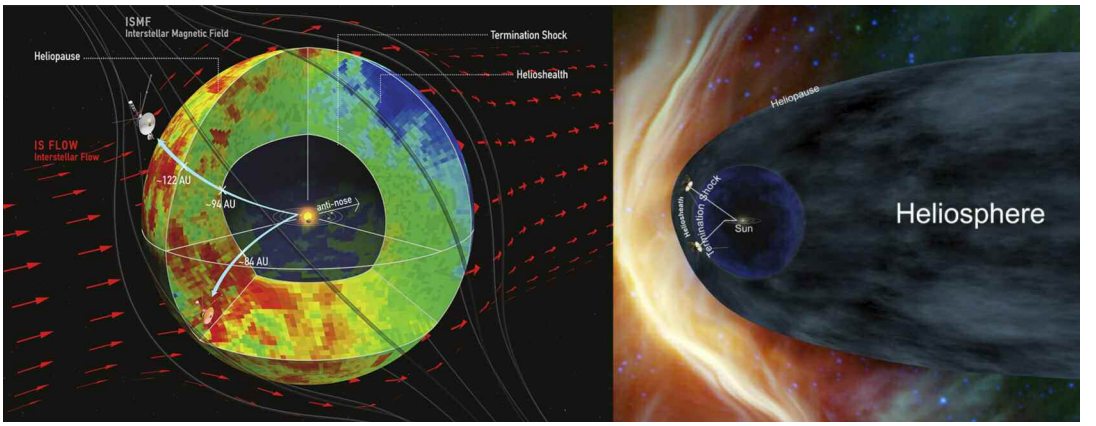
The Shape of the Solar System

By Marcus Woo

When Stamatios (Tom) Krimigis was selected for the Voyager mission in 1971, he became the team's youngest principal investigator of an instrument, responsible for the Low Energy Charged Particles (LECP) instrument. It would measure the ions coursing around and between the planets, as well as those beyond. Little did he know, though, that more than 40 years later, both Voyager 1 and 2 still would be speeding through space, continuing to literally reshape our view of the solar system.

The solar system is enclosed in a vast bubble, carved out by the solar wind blowing against the gas of the interstellar medium. For more than half a century, scientists thought that as the sun moved through the galaxy, the interstellar medium would push back on the heliosphere, elongating the bubble and giving it a pointy, comet-like tail similar to the magnetospheres—bubbles formed by magnetic fields—surrounding Earth and most of the other planet

"We in the heliophysics community have lived with this picture for 55 years," said Krimigis, of The Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland. "And we did that because we didn't have any data. It was all theory."



New data from NASA's Cassini and Voyager show that the heliosphere — the bubble of the sun's magnetic influence that surrounds the solar system — may be much more compact and rounded than previously thought. The image on the left shows a compact model of the heliosphere, supported by this latest data, while the image on the right shows an alternate model with an extended tail. The main difference is the new model's lack of a trailing, comet-like tail on one side of the heliosphere. This tail is shown in the old model in light blue. Image credits: Dialynas, et al. (left); NASA (right)

But now, he and his colleagues have the data. New measurements from Voyager and the Cassini spacecraft suggest that the bubble isn't pointy after all. It's spherical.

Their analysis relies on measuring high-speed particles from the heliosphere boundary. There, the heated ions from the solar wind can strike neutral atoms coming from the interstellar medium and snatch away an electron. Those ions become neutral atoms, and ricochet back toward the sun and the planets, uninhibited by the interplanetary magnetic field.

Voyager is now at the edge of the heliosphere, where its LECP instrument can detect those solar-wind ions. The researchers found that the number of measured ions rise and fall with increased and decreased solar activity, matching the 11-year solar cycle, showing that the particles are indeed originating from the sun.

Meanwhile, Cassini, which launched 20 years after Voyager in 1997, has been measuring those neutral atoms bouncing back, using another instrument led by Krimigis, the Magnetosphere Imaging Instrument (MIMI). Between 2003 and 2014, the number of measured atoms soared and dropped in the same way as the ions, revealing that the latter begat the former. The neutral atoms must therefore come from the edge of the heliosphere.

If the heliosphere were comet-shaped, atoms from the tail would take longer to arrive at MIMI than those from the head. But the measurements from MIMI, which can detect incoming atoms from all directions, were the same everywhere. This suggests the distance to the heliosphere is the same every which way. The heliosphere, then, must be round, upending most scientists' prior assumptions.

It's a discovery more than four decades in the making. As Cassini ends its mission this year, the Voyager spacecraft will continue blazing through interstellar space, their remarkable longevity having been essential for revealing the heliosphere's shape.

"Without them," Krimigis says, "we wouldn't be able to do any of this."

To teach kids about the Voyager mission, visit the NASA Space Place: ***https://spaceplace.nasa.gov/voyager-to-planets***

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