SIRIUS ASTRONOMER

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The Newsletter of the Orange County Astronomers

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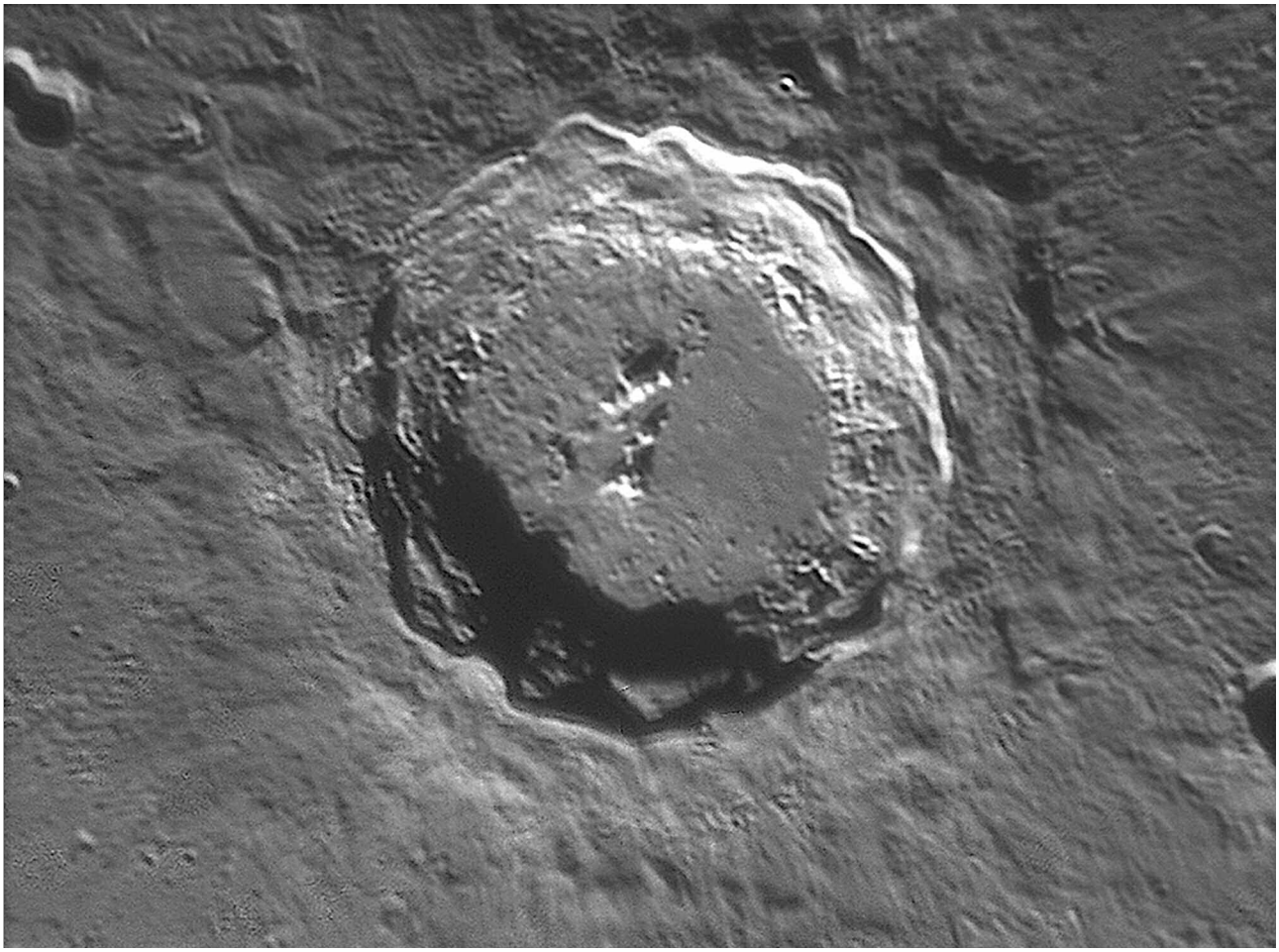


Lunar impact crater, Copernicus, captured here by member Bill Hall on 12/27/17 from his backyard in Yorba Linda, CA. He used a C8 tube assembly on a Super Polaris mount, 2x Celestron Barlow lens yielding F/20 through a Celestron NexImage 5 planetary camera. Best 2,100 (of total 3,000) frames were stacked using Registax 6.1.

OCA CLUB MEETING

The free and open club meeting will be held on January 12 at 7:30 PM in the Irvine Lecture Hall of the Hashinger Science Center at Chapman University in Orange.

This month, Tim Thompson from Mt. Wilson Observatory will speak about String Theory.

NEXT MEETINGS: February 9, March 9 (speakers TBA)

STAR PARTIES

The Anza site will be open on January 13. The Orange County site will open on January 20.
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 January 5 and February 2.

Youth SIG: contact Doug Millar

Astro-Imagers SIG: Jan 3, Feb 7

Astrophysics SIG: Jan 19, Feb 16

Dark Sky Group: contact Barbara Toy

President's Message

By Barbara Toy

Happy New Year, everyone!

After a lot of false starts, with unseasonable heat spells and an extended Santa Ana season, it looks like winter is finally upon us. I'm actually writing this at Anza on the day of the December star party (i.e. December 16, 2017), and we've had a smattering of rain, with the daytime temperatures in the low 50s – reasonable for the season but not something we've experienced much so far this year. Although the weather this year has been unusual (some say any weather in California that isn't perfect is "unusual," but this year has been unusual by any standard), I expect that the temperatures will have stabilized on the colder side by the time you see this in January.

All of that is a roundabout way of reminding everyone to be sure to plan for lower temperatures when you're going to be out observing under winter skies, and dress accordingly, with lots of warm layers and backup plans for keeping warm. Nothing cuts into the pleasure of a clear, dark, steady night sky like getting too cold, and observing through a telescope is not vigorous exercise calculated to keep you warm by generating body heat (even if you do get warmed up while setting up your equipment). Imagers often have the luxury of hanging out in warmer quarters while their equipment is doing its thing out in the cold, but us observers have to be out there in the cold with our equipment the whole time we're observing – and after so many months of reasonably warm nights, it can be hard to remember just how cold it gets in January and February. Fortunately, at least at Anza, we have places we can retreat to for some warmth – Anza House and the warming room at the club observatory are often refuges for the overly-chilled.

The winds this year have been a reminder that they can cause as many problems for good viewing as clouds – beyond the annoyance of trying to get a telescope focused on an object when the wind is bouncing it around, the bad seeing from all that turbulence makes getting a sharp image in the eyepiece or camera pretty much impossible. I know of several people who had high hopes for viewing and imaging before the December star party who gave it up due to the wind – hopefully by the time you see this the Santa Anas will be a fading memory, though there may still be winds from winter storms to contend with.

California Fires

The wind-driven fires in California over the last few months, from the firestorms in the Napa Valley area to the fires in Anaheim Hills, the ongoing inferno in Ventura and Santa Barbara Counties that's still burning as I write this, and so many others, are all painful reminders of what a dangerous combination fire and wind can be. I don't know of any club members who have lost property or been injured themselves due to the fires this year – if any of you have been victims of the fires, please accept my heartfelt condolences.

It's likely that there are many of us who have family or friends who were affected even if we weren't directly affected by the fires ourselves. One I know of, Andy Lowry, our current Outreach Coordinator, has family and friends in the Napa area, and she's mentioned that, even where homes didn't burn, there was damage from smoke and other effects of the fires. Many of us know of people who had to evacuate because of different fires – never a fun process – or who lost power or suffered other indirect damage from the fires. Anyone downwind of them has had to deal with smoke and ash, both of them pretty caustic, and smoke that wound up higher in the atmosphere has certainly affected viewing conditions. Fire may be part of our natural environment, but it's no fun to deal with when it's acting as a force of nature.

Despite the challenges of this fire season, I hope all of you and your families and friends have come out of it safely, with your health and everything else intact! And, for those who have not been so fortunate, I hope things are improving and that, if there's anything we might be able to do to help, you'll let us know.

Black Star Canyon/Orange County Star Party Changes

Our in-county star party for the last several years has been at a location in Black Star Canyon that we've had access to through the various successors to the Irvine Company, which originally owned the area and dedicated it for restoration as a green belt/wilderness area. Because of the concerns about restoring the habitat in the area where our Black Star Canyon star parties were held, there were limits on where we could set up and how may vehicles and people could be accommodated there. By the time Steve Mizera took over as the Coordinator for these star parties early in 2017, the number of people who wanted to attend these star parties was regularly more than the limits that were imposed on the site – in other words, we had outgrown it.

Steve has been working with the various entities in charge of possible alternative star party locations to find a location that would accommodate more people and vehicles, and would also allow people to set up near their vehicles (which often wasn't possible at the Black Star Canyon site after various modifications were made to it over the years that limited the parking and viewing areas more than when we started there). One site that is promising is near Irvine Lake, but there is a different group that has the primary right to use it now, so our use is somewhat provisional.

Because we expect that there may be more changes in the location of the in-county star party as conditions and options change, we've decided that it would be better just to call it the "Orange County Star Party" rather than designating it by a specific location, and we don't have specific information on the location of the current viewing site on the website because there are still a lot of details that Steve is working out. The best way to make sure you have the most accurate information on the location of these star parties is to get on Steve Mizera's email list – contact him at ***mizeras@cox.net*** to be put on his list. He also sends out information on when he plans to open the gate before each star party, and any other information that might be helpful for the star party, including cancellations due to local emergencies, so there are a number of reasons it's good to be on it and to make sure you read the emails before heading out to any of the star parties.

Steve has been doing a great job with these parties, and we really appreciate all the time and effort he's been putting into them – and to finding them a new home!

New Combination at Anza

If you're planning to go out to our Anza site, be sure to check with Charlie Oostdyk, Alan Smallbone or me for the current combination. We periodically change the combination for security reasons, and Don Lynn, who still manages to do quite a bit as Anza Site Custodian even though he is splitting his time between his new home in Colorado and his long-time home in Orange County, was able to make the change on his last trip out to Anza in early December before heading back to Colorado to enjoy the winter snowstorms.

If you have the new combination, please be sure you only share it with others you know are current club members. One reason we have to change it periodically is there have been a certain number of people over the years (fortunately, not many), who have continued to use the Anza site even though they are no longer members of the club and no longer have the right to use it. Our membership fees are a major source of income for the club, and having people who aren't contributing use the club's facilities is a drain on our resources as well as posing a security issue, since we would not have the information on them that we do for current members. So, please protect yourselves as well as your fellow members by not sharing that information outside of the club.

In Closing…

New Years is often a time when people make resolutions for what they hope to achieve in the coming year. I hope that whatever resolutions you've made for your astronomical activities for 2018 bring you tremendous joy and satisfaction! And may all of our star parties this year feature clear, dark, steady skies!

AstroSpace Update

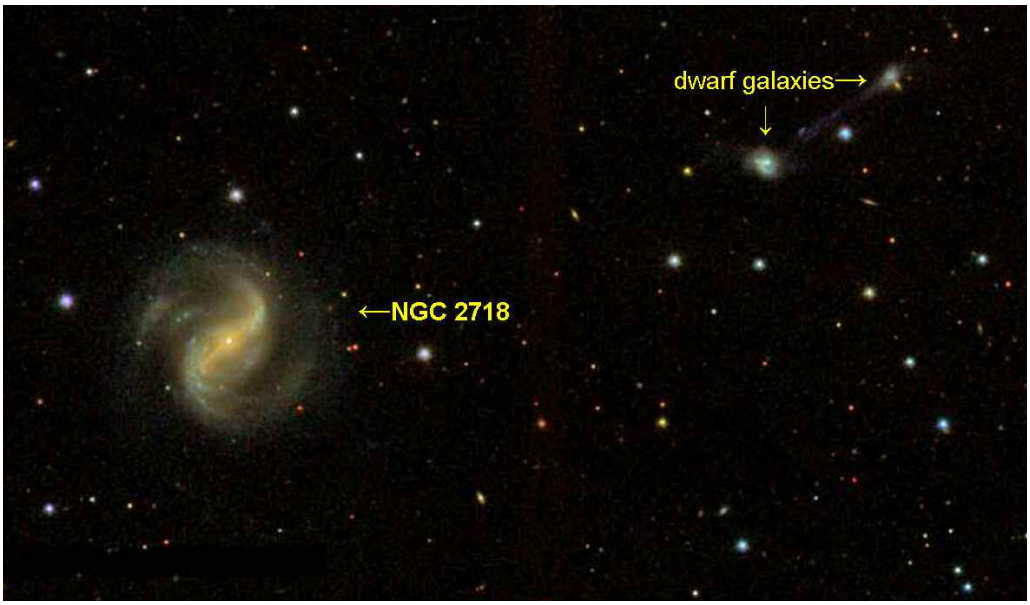
January 2017
Gathered by Don Lynn from NASA and other sources

New star names – The International Astronomical Union (IAU) has added 86 new star names to its list. While the previous 227 official star names have been mostly traditional Greek, Latin and Arabic names, the new additions are mostly from other cultures. They include Australian Aboriginal, Chinese, Coptic, Hindu, Mayan, Polynesian, and South African names. Examples are Xamidimura (means "eyes of the lion" in the language of the Khoikhoi people of South Africa) for Mu1 Scorpii, and Pipirima (twins who became stars in Tahitian legend) for Mu2 Scorpii. Mu is the 3rd bright star below Antares, and is perceptible to the naked eye as binary. 11 of the new names are Chinese, including 3 that derive from the names of Chinese lunar mansions (areas of the stars through which the Moon passes). Also in the new star names is Barnard's Star, a nearby red dwarf discovered by E. E. Barnard in 1916.

Exoplanet atmosphere – Previous observations of the exoplanet 55 Cancri e have been ambiguous as to whether it has an atmosphere. The planet is known to be tidally locked to its star, that is, it keeps the same side of the planet toward the star. It is quite close to its star, so is quite hot. The difference between previous measurements of the daytime and nighttime side temperatures seemed to imply there could be no atmosphere, because atmosphere would distribute more of the day heat to the night side. A new study using observations from the Spitzer infrared space telescope showed that the temperature difference was not as extreme as previous work, and that the hottest spot was not the point directly under its sun. These imply the planet DOES have an atmosphere. The new observations are consistent with an atmosphere of either nitrogen or carbon monoxide, but ruled out water or carbon dioxide atmospheres. The new temperature measurements appear to rule out a theory based on previous work, that the planet (at least the dayside) is covered with lava. The planet is a super-Earth, since it is about twice the diameter of Earth and about 8 times the mass.

Exostratosphere – Another planet has been found to have a stratosphere, that is, a portion of its upper atmosphere where temperature increases, rather than decreases, with increased height from the surface. The planet is WASP-18b, found about 325 light-years away. The observations that found this stratosphere (and others) were in fact looking for stratospheres, but what made this one interesting is that it is the only stratosphere known to be caused by carbon monoxide (which is absorbing heat from its star that causes the temperature rise). It apparently has little or no water vapor in the upper atmosphere.

Magellanic Cloud parallel – A search to find interacting dwarf galaxies has found a pair that highly resembles the Magellanic Clouds, which are nearby to our Milky Way galaxy. The newly found pair are similar to the Clouds in masses, interaction with each other, star forming, distance from each other, and distance from a nearby Milky-Way-like large spiral galaxy (in this case, NGC 2718). Such pairs near a spiral galaxy are rare. That may be because continued gravitational disturbance by a large spiral would tend to strip or disrupt any such dwarf galaxy pairs. Further study of this discovery may help explain the conditions that resulted in our Magellanic Clouds.



Credit: Sloan Digital Sky Survey

Spectra of very distant galaxies – The Very Large Telescope in Chile has obtained spectra for 1600 very faint galaxies that are in the area covered by the Hubble Ultra Deep Field (HUDF), which was the result of the Hubble Space Telescope staring at a small portion of sky in Fornax for over 260 hours. Since that picture was taken in 2003-4, the same area has been studied extensively by many other telescopes in wavelengths from radio through X-rays. The new spectra allowed accurate red shifts, and therefore distances, for the first time for most of these galaxies. Motions and chemical makeup for most of these galaxies was also first established by these spectra. 72 galaxies that were too dim to be seen in the wavelengths covered by the HUDF showed up in the new spectra. Hydrogen halos were commonly found surrounding the subject galaxies.

How to find more planets – A computer program that learns was fed 15,000 Kepler (planet-finding space telescope) signals of known planets transiting their stars to train the program. Then it examined all the Kepler signals from 670 stars known to have multiple planets, and it found quite a few previously overlooked planets. Weak signals are sometimes missed by the methods previously used to find planets in the Kepler data. In the case of star Kepler-90, a star over 2500 light-years away, which was already known to have 7 planets, it found an 8th planet. This ties the record (held by the Solar System) for the most known planets orbiting any star.

Flare star findings – Kepler was designed to capture the tiny dimmings of stars caused by planets moving in front of them. But the Kepler data show lots of other events. A new study used Kepler data to study flare stars. It has been believed that a flare on a star is caused by a magnetic reconnection event, and the magnetic fields (that are occasionally reconnecting) are generated by dynamos in the star's convective zone (zone where hot material rises). Surprises found in the new study include: Some A stars (spectral type A) have flares, though A stars are thought not to have convective zones; some giant stars have flares, though they are thought to have too weak of magnetic fields to cause flares; fast rotating stars tend to have flares more often and stronger flares; small percentages of every type of star flare frequently.

Juno (Jupiter orbiter) – During a close pass of Juno over The Great Red Spot last June, the spacecraft's microwave radiometer was able to show what activity was happening up to 200 miles interior to the visible surface. The structure of the Spot goes deeper even than this instrument can probe. It found winds up to 3 times hurricane speeds, and that the lower levels are warmer than the top.

Positron mystery – An unexpected surplus of positrons (anti electrons) was found in Earth orbit in 2008. Two theories were proposed to explain the source of these positrons: 1) nearby pulsars spewed them, 2) dark matter processes generated them. New observations by the High-Altitude Water Cherenkov Gamma-Ray Observatory (HAWC), located in Mexico, have been made of 2 nearby pulsars, and they were found to not be releasing positrons fast enough to explain the excess in Earth orbit. More work needs to be done to entirely rule out theory 1, but it is becoming more unlikely.

Space Debris Sensor – is an instrument that was just launched to the International Space Station to be mounted on the outside to monitor impacts of small (typically under a millimeter) space debris. It measures size, speed, direction, time, energy, mass, and density of impacting particles. Data on small space debris in low Earth orbit is sparse, so this will fill a gap in our knowledge. Design of future spacecraft protection from debris depends on such knowledge.

Instant AstroSpace Updates

On January 24 Mars rover **Opportunity** celebrates 14 years of operation on the red planet, more than 50 times its planned life. It survived its 8th Martian winter.

Observations made during a stellar occultation by **2014 MU69**, the next target of the New Horizons spacecraft, appear to show a moon orbiting it, or I should say "orbiting them", since this object was already known to be a double Kuiper Belt object.

Some, but not all, close spacecraft flybys of planets have resulted in small (but measurable) deviations from the paths predicted, and this has become known as the "**flyby anomaly**". It showed up again in recent approaches near Jupiter by the Juno spacecraft.

Galaxy motions mapped – The motions of about 1400 galaxies within 100 million light-years of us have been mapped back as far as 13 billion years ago by a team of astronomers. The Virgo Cluster is the main gravitational attractor in the mapped volume, having pulled into itself more than 1000 galaxies.

Greetings from Palmia Observatory

By George Robinson

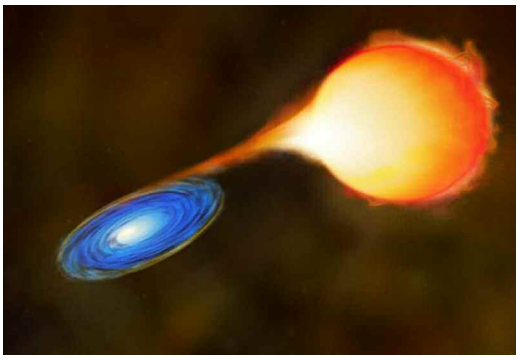
Many astronomer hate when the clouds come in and interfere with our observations, but just looking up at the sky during the daytime can yield some interesting observations. We will talk about that in a minute and then we will discuss the wonderful star Mira and this lazy astronomers new approach to making quick observations of impossible to see in city lights and hard to find objects.

Even on cloudy days astronomers look up and ask "Why do aircraft contrails form globules?" (Source: Palmia Observatory)

While out and about, escorting Astronomer Assistants Danny and Ruby, I noticed this view and image of some visible aircraft contrails. I wondered why the contrails didn't just evaporate away and instead developed these individual globs or lobes along the length of the contrail. What was going on?

What causes these lobes? See, you can also find curious things up in the day time sky! Make a guess and then check out this pretty good discussion regarding what is probably going on:
http://onlinelibrary.wiley.com/doi/10.1002/wea.2765/full

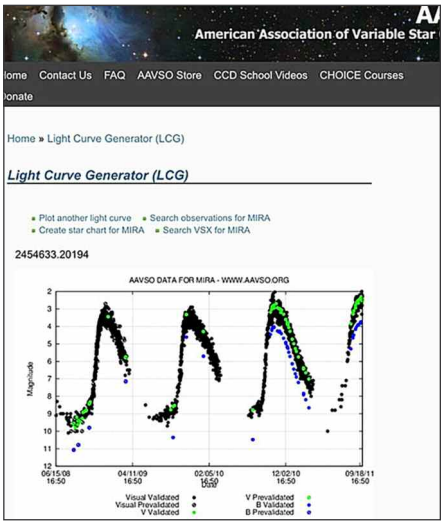
At the monthly OCA meeting, the What's up Speaker, OCA and Griffiths Observatory Astronomer, Chris Butler, mentioned the wonderful star system, Mira. Mira is located in the constellation, Cetus, The Whale. Following astronomical star naming convention, Mira is identified as o Cet, for Omacron Cetus. I was so excited about Mira also, that I planned to make one of my own observations of the star. Thanks for generating the excitement, Chris!



Artists conception of binary red giant/ white dwarf with accretion disk. (Source: www.aavso.org, Illustration: CXC/M.Weiss)

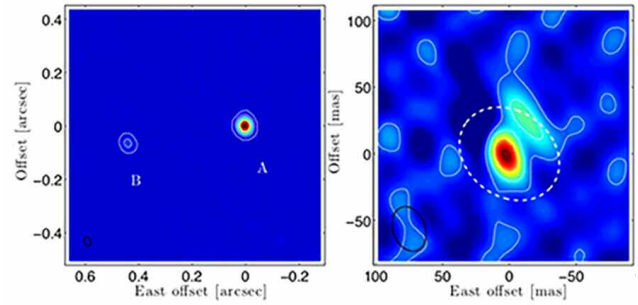
Mira is currently understood to consist of a large red giant, designated Mira A, and a white dwarf, designated Mira B. Gas is being stripped from the red giant and flowing to the white dwarf and creating an enhanced accretion disk there. See the artist's concept image (left).

Most of us are not going to be able to resolve the binary system, but we all can make a photometric measurement of the light curve for Mira. A search of the AAVSO variable star database shows this plot of some previous measurements of the light from Mira (right).



Light curve measurements for Mira (Source: www.aavso.org)

Light curve observation of Mira shows its wide magnitude change with a period of around one year. The observed magnitude varies between something like between dim 10 and quite bright 2. While it is harder to get high resolution optical images the use of long baseline radio astronomy can get resolved images down to the milli-arcsecond range. The ALMA images (below) show the relative distances between Mira A and Mira B and also a bright glob of gas around the red giant.



High resolution images of Mira A and B with ALMA (Source: Vlemmings, et al, arXiv:1503.07647v2)

So, wow, Mira is quite wonderful and is the first of many prototypical star systems that exhibit much the same behavior.

I scheduled a quick observation of Mira and again used the lazy astronomer approach. Rather than wheel out the scope and rolling tripod, which by the way was put together to make it easy to do quick observations, I felt even lazier and elected to just take out the camera tripod. The issue here then is how to find Mira when there are not a lot of visible stars nearby. Of course, if I wheeled out my tracking goto mount and did all the setup and alignment, I would be good to go, but that takes more work than I wanted to assign to this one simple light curve measurement data point.

So here is the lazy astronomer approach to this problem:

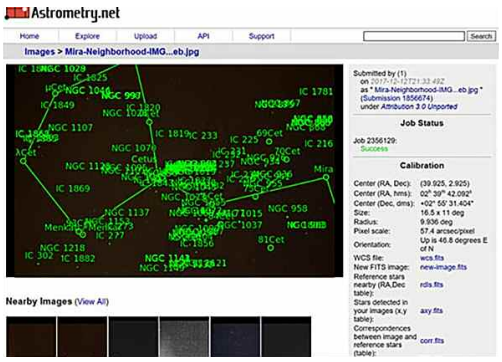
1. Select a bright star, in this case Fomalhaut, near the target star, in this case, Mira
2. Use planetarium software to calculate predicted Azimuth and Altitude of Fomalhaut at convenient observation time
3. Use planetarium software to calculate predicted Azimuth and Altitude of Mira, say 5 minutes later
4. Calculate the differences between the two values of Azimuth and Altitude
5. Setup and level tripod and track reference star, Fomalhaut, up to the observation time
6. Change tripod Azimuth and Altitude settings according to the calculated differences
7. Wait until the chosen observation time for Mira
8. Take the image and hope for the best

Use three-axis camera tripod head to point to target sky position (Source: Palmia Observatory)

The observation time for Fomalhaut was selected for 6:00 PM and predicted locations were Az = 189 and Alt = 26. The observation time for Mira was selected to be 5 minutes later when Az = 126 and Alt = 38. The difference between these two pointing locations is -63 degrees in Azimuth and +12 degrees in Altitude.

We are now ready to make the observation when the sun goes down. The image below shows the various setting circles on the camera tripod head. A key thing to remember to do when using this method is to level the tripod, using the installed bubble levels, when the tripod has been setup in the selected observing location, which is chosen so that both reference star and target star are visible. Al I have to do is note what the azimuth and altitude indicators show for the starting location, here to be Fomalhaut, and then turn the knobs to adjust for the relative differential change in position for where Mira will be in 5 minutes.

The 15-second exposure had several visible stars, even though hardly any were naked eye visible so in order to tell if Mira was in the camera frame of view, the image was uploaded to Astrometry.net and hey, luckily, Mira was just barely inside. I guess my change to the azimuth and altitude settings was off a bit but still just enough to capture the target star.



Astrometry screenshot shows location of Mira and 81 Cet (Source: Palmia Observatory)

Below is the DSLR image, 15 second exposure, 75 mm lens, with annotated locations of Mira and a known star, 81 Cet, that will serve as the photometric reference star. We can now use measurements of the total light received from the reference star and Mira in order to calculate our estimate of the visual magnitude of variable Mira at this observation time.

Mira and selected comparison star 81 Cet, 15 seconds, 75 mm, IMG3382 (Source: Palmia Observatory)

Ok, the preliminary photometry on this photo, using AIP4WIN, measured the total light from Mira and compared it to the light from the reference star, 81 Cet. The total pixel ADU sum for Mira was found to be 357,170 and 81 Cet was measured to be 192,643.
With 15 second exposures we must always be alert to suturing the camera with bright objects, but in this case these two stars only had maximum pixel ADU values of 6401 ADU, so the exposure time was just right. Now the reference magnitude for 81 Cet is m = 5.65 is adjusted by the scaling factor for the difference in received light by 2.5 * log (357,170 / 192,643) = 0.67.
So the estimated magnitude of Mira is 5.65 - 0.67 = 4.98.

We should not interpret the two significant digits in the estimate to actually be significant to two decimal places because of all the other correction factors that need to be applied to magnitude measurements. For instance this estimate does not include corrections for light extinction due to altitude, even though in this case the altitudes of the two stars are both within a couple of degrees, and the vignetting effects, but luckily in this case, both stars are located near the edges of the image.

So, this has been a wonderful review and first attempt at imaging the wonderful binary star, Mira, which has been observed by other astronomers for over 400 years now. It is known now that the two stars in the binary system are about 70 AU apart, which from our perspective is about 0.6 arc seconds and the pair is located about 92 pc or about 302 light years away from us. It is so neat to see that with new radio observatories, like ALMA, we can resolve these two stars down to the milli-arc second and begin to see the workings of the binary star accretion disk and bright spots and hot gas blobs around the red giant.

One lesson learned during this trial observation was to always plan for known rotation of the stars during your site selection. The location I picked was initially fine, but since I had got setup about 15 minutes before the first observation of Fomalhaut, by the time the final observation and centering of the star at 6:00 PM came around, the star was just dipping into a nearby palm tree and would have been obscured if I had to wait another 5 minutes. I also fooled myself into believing that everything was going to be ok because I could see the star from my eyelevel, but when I dropped down to camera optical axis level, there was hardly any margin left.

Crib sheet socks for your next physics test?
(Source: Palmia Observatory)

Finally, I received an anniversary gift from Resident Astronomer Peggy, who I assume was in cahoots with OCA and Hughes Lab Manager, Becky, both of which were shopping in Julian, and found some socks that could be useful to the budding physicist wannabe, especially as a crib sheet for the dreaded physics class quiz or exam.

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***

February Guest Speaker: Dr. Anthony Piro

Seeing and Hearing the Universe at the Same Time

Dr. Anthony Piro is a Staff Member at the Carnegie Observatories in Pasadena. His research is focused on theoretical astrophysics with a broad interest in topics involving compact objects, astrophysical explosions, accretion flows, and stellar dynamics. His recent awards include being named a Scialog Fellow by the Research Corporation for Science Advancement, and he is the Principle Investigator of the Swope Supernova Survey, which was awarded over 200 nights a year to use the 1 meter Swope Telescope to follow supernovae, gravitational wave counterparts, and other explosive transients.

Earlier this year, the Laser Interferometer Gravitational-Wave Observatory (LIGO) was awarded the Nobel Prize in Physics for the detection of merging black holes by gravitational waves. Although this was an amazing triumph, black hole mergers do not emit light and are therefore invisible to telescopes. Neutron star mergers, however, have long been expected to produce both light and gravitational waves, so the detection of these events has been eagerly anticipated. Following the first ever detected gravitational waves from neutron stars on August 17, 2017, our team at the Carnegie Observatories, in collaboration with UC Santa Cruz, were the first to discover the optical counterpart. I will describe this incredible discovery, the data that was taken over the following weeks, and the implication for the origin of gold and other heavy elements in our Universe.

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).

VOLUNTEER OPPORTUNITY

Website Designer for the OCA Website

The OCA website is a major resource for our members as well as where people most often get their first impression of us. Our current website has served us very well for over a decade, but it is based on old technology and urgently needs to be updated to meet our current needs, including an ability to work across multiple platforms (including smartphones and tablets). Amir Soheili, past OCA Trustee, was working on this project when he was transferred out of state earlier this year and had to give up his OCA activities.

If you are interested in getting involved in the redesign of the website, either as a solo project or as part of a group, please contact Alan Smallbone (asmallbone@earthlink.net) or Barbara Toy (btoy@cox.net).

Sale:

Meade LX-200 10-inch Telescope & Accessories
Basice Set: Telescope with Bob's Knobs, updated Meade Audio-Star controller, Meade field tripod, Meade 26mm Plossl eyepiece, Meade diagonal, Meade spotting scope (mounted), custom wood case with Meade foam. This should be the factory box set when purchasing this telescope. Priced at $1600.00.

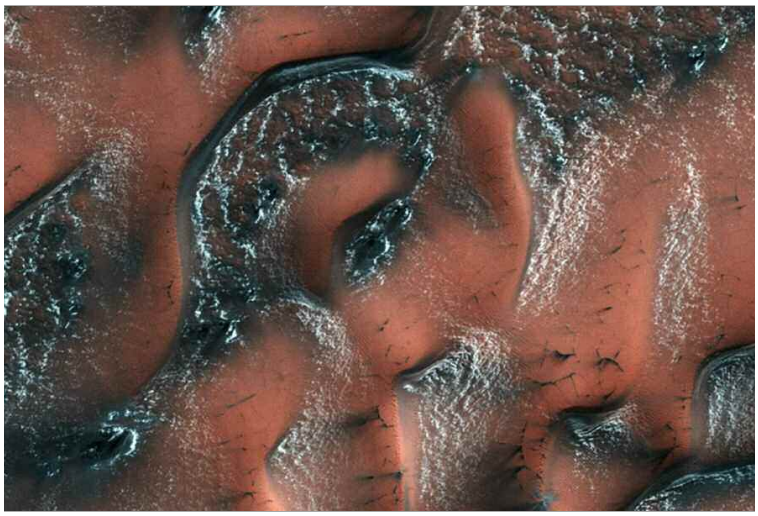
Accessories: • Meade heavy duty Super Wedge with precision gear upgrade • Meade #644 Flip Mirror system • William Optics 2-inch dielectric diagonal • 2X 0.96 Barlow • Televue 9mm Nagler eyepiece • Televue 32mm PLOSSL eyepiece • Televue 24mm wide field eyepiece • Meade illuminated 9mm PLOSSL reticle eyepiece • Various 0.96 inch filters • Meade Series 4000 PLOSSL lens kit, includes 40mm, 32mm, 20mm, 15mm, 12.4 mm, 9.7mm, 9.7mm, 9mm, 6.4mm, 6.4mm eyepieces in individual lens case, held in a metal case • Meade 2X Telenegative air spaced Barlow #140 • Meade variable projection tele-extender tube • Orion 2-inch diagonal • Meade camera adapter 0.96 • Meade T-adapter • Meade extension tube set • Laser culmination eyepiece • Meade f3.3 CCD Focal reducer with adapter • After market focus plate • Telerad with multiple mounting plates • JMI NGF-S motorized focus system • Bag of various t-rings, extension tubes, and ??? • Meade counterweight system (3 weights & rail) • Kendric dew remover system with 2 heater coils • Set of after-market tripod levelers • BAADER film 10-inch solar filter

Contact Bob at rmbelljr@gmail.com or 714-815-4090

Snowy Worlds Beyond Earth
By Linda Hermans-Killiam

There are many places on Earth where it snows, but did you know it snows on other worlds, too? Here are just a few of the places where you might find snow beyond Earth:

Mars – The north pole and south pole of Mars have ice caps that grow and shrink with the seasons. These ice caps are made mainly of water ice—the same kind of ice you'd find on Earth. However, the snow that falls there is made of carbon dioxide—the same ingredient used to make dry ice here on Earth. Carbon dioxide is in the Martian atmosphere and it freezes and falls to the surface of the planet as snow. In 2017, NASA's Mars Reconnaissance Orbiter took photos of the sand dunes around Mars' north pole. The slopes of these dunes were covered with carbon dioxide snow and ice.

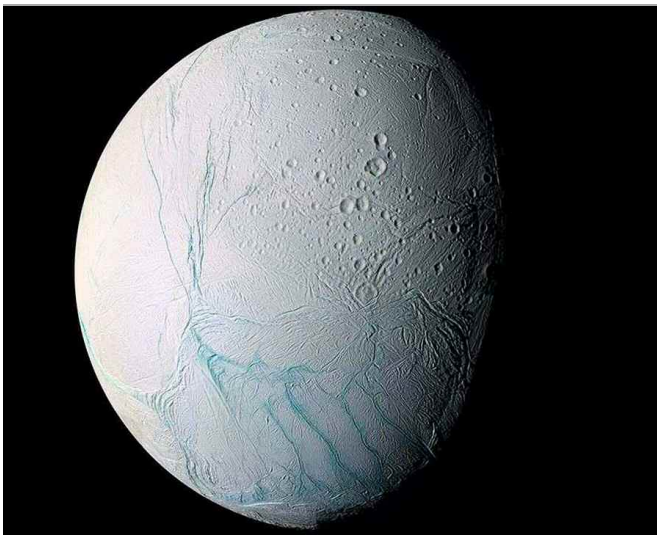


NASA's Mars Reconnaissance Orbiter captured this image of carbon dioxide snow covering dunes on Mars. Credit: NASA/JPL/University of Arizona

A volcano shooting molten sulfur out from the surface of Io. Credit: NASA/JPL-Caltech

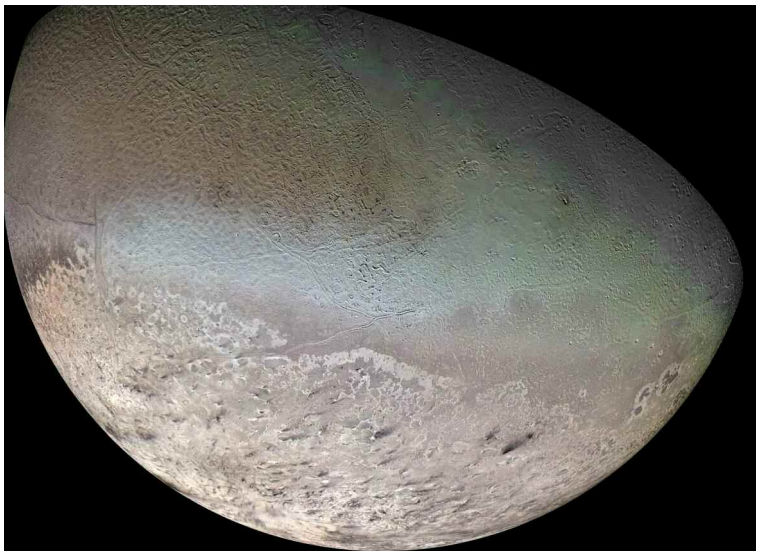
A Moon of Jupiter: Io – There are dozens of moons that orbit Jupiter and one of them, called Io, has snowflakes made out of sulfur. In 2001, NASA's Galileo spacecraft detected these sulfur snowflakes just above Io's south pole. The sulfur shoots into space from a volcano on Io's surface. In space, the sulfur quickly freezes to form snowflakes that fall back down to the surface.

A Moon of Saturn: Enceladus – Saturn's moon, Enceladus, has geysers that shoot water vapor out into space. There it freezes and falls back to the surface as snow. Some of the ice also escapes Enceladus to become part of Saturn's rings. The water vapor comes from a heated ocean which lies beneath the moon's icy surface. (Jupiter's moon Europa is also an icy world with a liquid ocean below the frozen surface.) All of this ice and snow make Enceladus one of the brightest objects in our solar system.

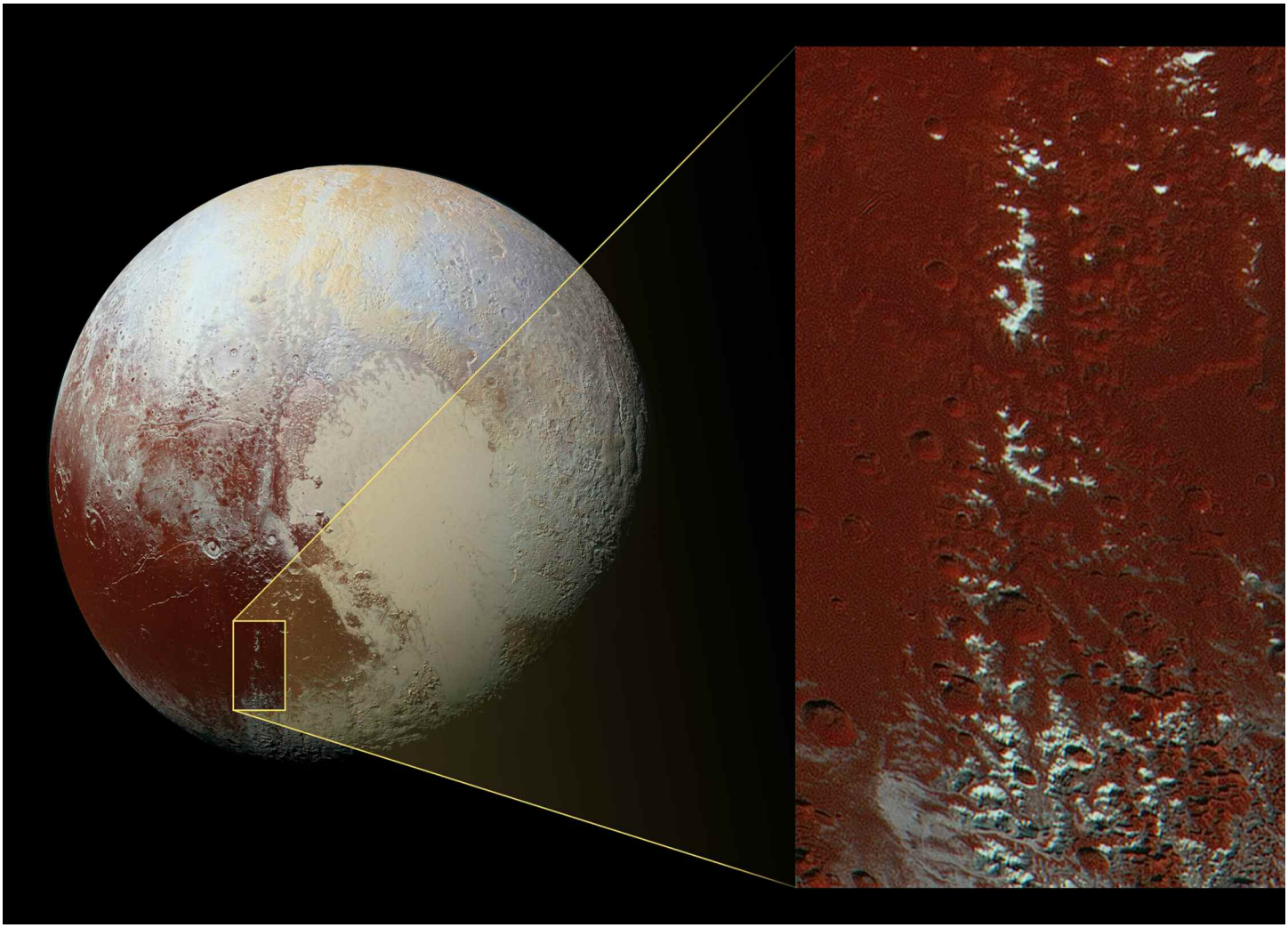


Enceladus as viewed from NASA's Cassini spacecraft. Credit: NASA

A Moon of Neptune: Triton – Neptune's largest moon is Triton. It has the coldest surface known in our solar system. Triton's atmosphere is made up mainly of nitrogen. This nitrogen freezes onto its surface covering Triton with ice made of frozen nitrogen. Triton also has geysers like Enceladus, though they are smaller and made of nitrogen rather than water.



The Voyager 2 mission captured this image of Triton. The black streaks are created by nitrogen geysers. Credit: NASA/JPL/USGS



The snowy Cthulhu (pronounced kuh-THU-lu) mountain range on Pluto. Credits: NASA/JHUAPL/SwRI

Pluto – Farther out in our solar system lies the dwarf planet Pluto. In 2016, scientists on the New Horizons mission discovered a mountain chain on Pluto where the mountains were capped with methane snow and ice.

Beyond Our Solar System – There might even be snow far outside our solar system! Kepler-13Ab is a hot, giant planet 1,730 light years from Earth. It's nine times more massive than Jupiter and it orbits very close to its star. The Hubble Space Telescope detected evidence of titanium oxide—the mineral used in sunscreen—in this planet's upper atmosphere. On the cooler side of Kepler-13Ab that faces away from its host star, the planet's strong gravity might cause the titanium oxide to fall down as "snow."

Want to learn more about weather on other planets? Check out NASA Space Place:
https://spaceplace.nasa.gov/planet-weather

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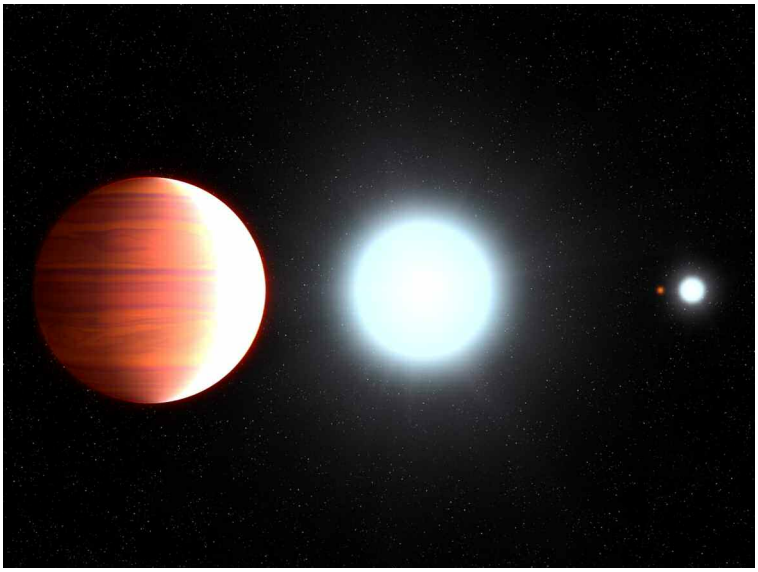

This is an artist's illustration of what Kepler-13Ab might look like. Credit: NASA/ESA/G. Bacon (STScI)

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