SIRIUS ASTRONOMER

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The Newsletter of the Orange County Astronomers

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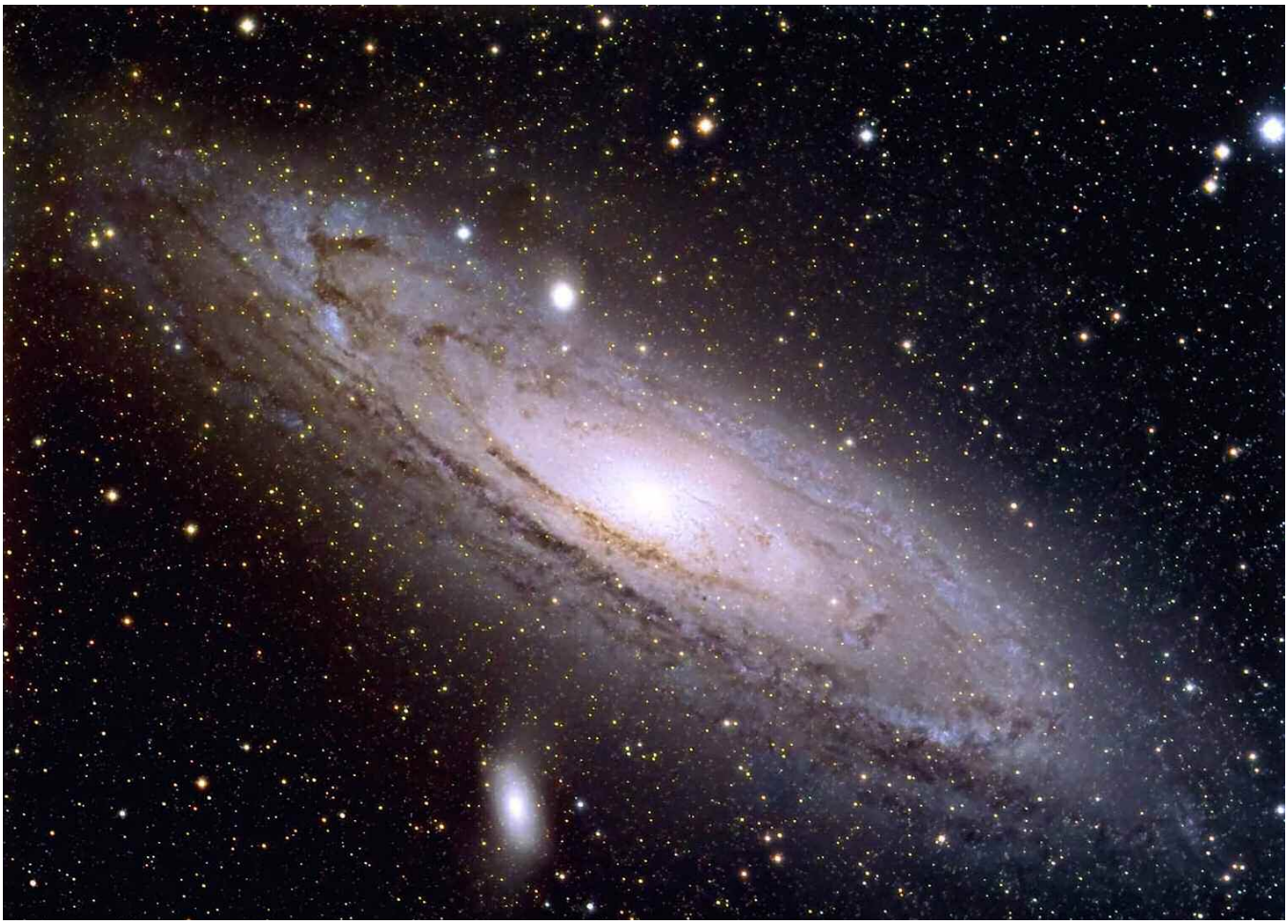


Steve Borgens captured this image of the Andromeda Galaxy (M31) with a QSI 683WSG8 CCD camera attached to an Astro Tech EDQ 65 telescope mounted on an Ioptron iOptron CEM60.

OCA CLUB MEETING

The free and open club meeting will be held on April 6 at 7:30 PM in the Irvine Lecture Hall of the Hashinger Science Center at Chapman University in Orange.

This month, Joseph Masiero on Searching for our Nearest Neighbors, the Near-Earth Asteroids: Hazard, Resource, and Destination.

NEXT MEETINGS:
May 11 – Daniel Limonadi
June 8 – (speaker TBA)

STAR PARTIES

The Anza and Orange County site will be open on April 14. Members are encouraged to check the website calendar for the latest updates on star parties and other events.

Please check the website calendar for the outreach events this month! Volunteers are always welcome!

You are also reminded to check the web site frequently for updates to the calendar of events and other club news.

COMING UP

The next sessions of the Beginners Class will be held at the Heritage Museum of Orange County at 3101 West Harvard Street in Santa Ana on April 6 and May 4.

Youth SIG: contact Doug Millar

Astro-Imagers SIG: April 4, May 2

Astrophysics SIG: April 20, May 18

Dark Sky Group: contact Barbara Toy

OWENS VALLEY RADIO OBSERVATORY TRIP
SCIENCE BEYOND THE BOOK

June 15th -17th, 2018
With Dr. Doug Millar and Ms. Cecilia Caballero

Please join with us on the above date for an extraordinary adventure in science education at the Owens Valley Radio Observatory outside of Big Pine, CA. Included are science activities at the 40m antenna and a tour, walking a scale model of the distances of the planets, solar astronomy and night time astronomy. All the above is free and courtesy of Dr. Mark Hodges, OVRO and Cal Tech. This trip is open to teachers and their families, members of local astronomy clubs and radio hams. You must RSVP to go on the trip to Dr. Millar so that we know how many to expect. Please also forward your cell phone number.

This is not a school sponsored field trip. Each participant is on their own to arrive at the observatory. Please try to arrive at OVRO about 2:00pm on Saturday. There are several motels in Big Pine to stay at. Please make your own reservations. We usually eat at the Country Kitchen in Big Pine or the Pizza Factory pizza in Bishop. You can also camp out both at the dish or in Big Pine in either tents or campers.

The weather will be warm and dry.

The event is from Friday PM to Sunday AM

You can choose to come for visual astronomy only on Friday evening. We will set up by the main buildings and rail road tracks. 110vac will be available as will restrooms and a kitchen (for coffee, water and tea).

For the main program, you should arrive at the site in the early afternoon on Saturday, you may want to stay over and go back on Sunday afternoon. Some of us will arrive on Friday and enjoy some nighttime astronomy at the OVRO site. Anyone is welcome to join us on Friday night. Let me know if you would like to come then as well. Please call Dr. Millar on the day of the trip and let him know when you are starting out and where you are about 1pm.

Schedule

Friday

- Setup outside the main office building for astronomy by sunset. 110vac available.

Saturday

- 2:30pm arrive at OVRO 30m dish
- 5pm check in at your Motel and go to dinner in Bishop.
- Evening – Astronomy at the site

Sunday

- Breakfast 8:30am at Country Kitchen
- Leave whenever you like. Check web sites about the area and the Highway 395 for sightseeing opportunities.

The directions from the LA area are: Drive North on the 5/14 through Palmdale and Mojave. Continue through Inyokern and join 395. Continue on North through Little Lake and Lone Pine. Continue up to Big Pine. Just as you get to the end of town turn right towards the Westgard Pass. Go out about 2 miles and after Zurich, turn left onto the observatory road. You should be able to see the dish in the distance, but it is 4 miles away! Continue onto the property and go to the large dish. We will be at the base or inside of it. On the right is a more detailed map.

If you would like to bring your own telescope or radio along, please do.
Owens Valley Radio Observatory:
http://www.ovro.caltech.edu/

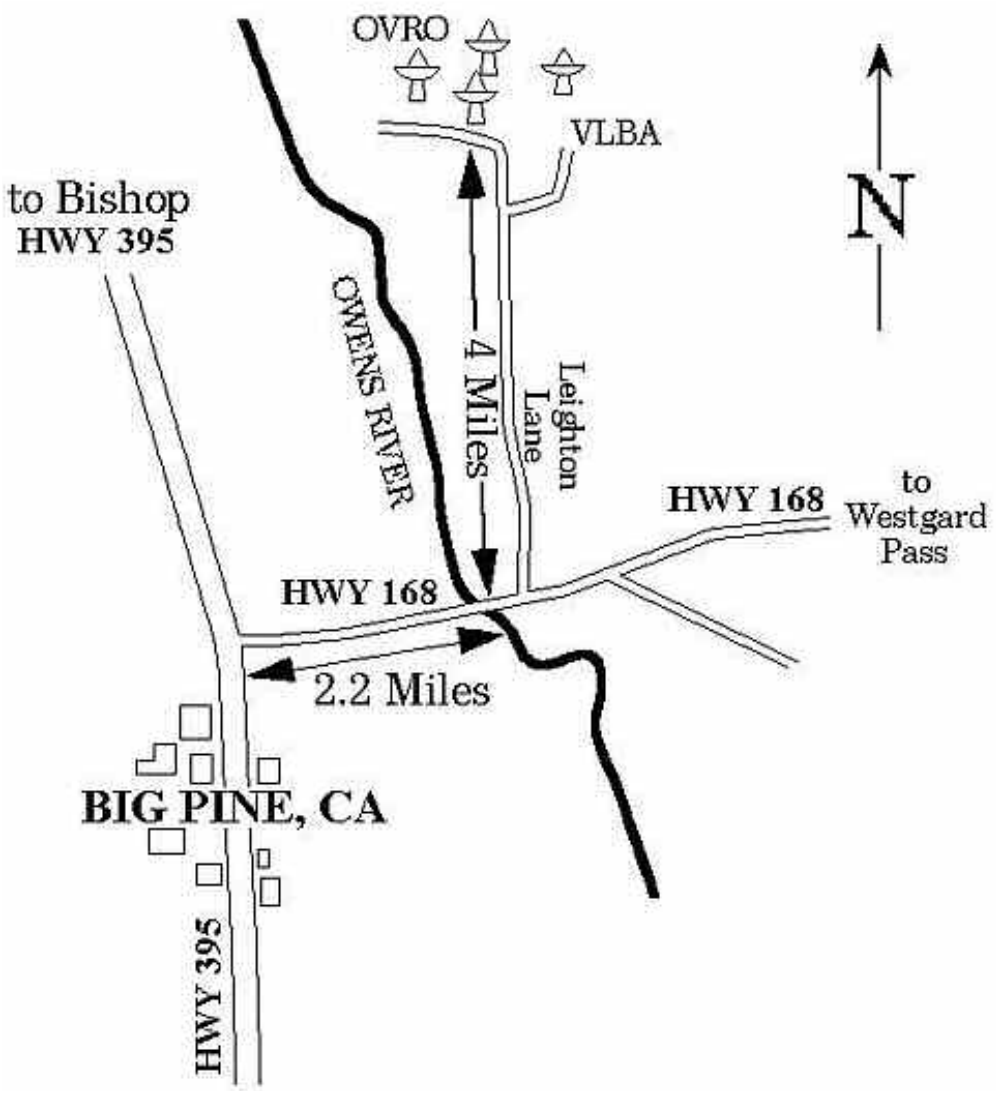
For any questions and RSVPs, my contact information is:

Dr. Doug Millar
Cell: (562) 810-3989
Email: drzarkof56@yahoo.com

Thank you and I hope to see you on the trip!
~Dr. Millar

Local Directions to the dish

Although just 14 miles south of Bishop, the Owens Valley Radio Observatory is located closest to the town of Big Pine. At the northern tip of Big Pine, by a large pine tree, starts Highway 168. The only public access road to OVRO is via Highway 168. From Big Pine, turn onto Highway 168 and follow the road east. After approximately 2 miles you will cross the Owens River. Once across the river, turn down the first paved road to the left, Leighton Lane.

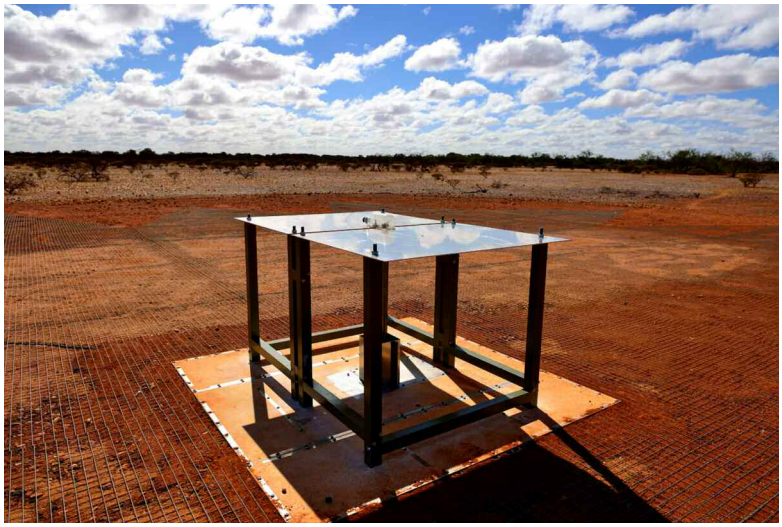


AstroSpace Update

April 2018
Gathered by Don Lynn from NASA and other sources

Stephen Hawking – has died at age 76. He had become perhaps the most recognizable figure in physics and cosmology. For many years he held the same professorship at Cambridge that was once held by Isaac Newton. Hawking's scientific work included much theory on singularities and black holes. His most famous result is that quantum physics implies that radiation should slowly leak out of black holes, a process dubbed Hawking Radiation. It is generally considered that this would earn for him a Nobel Prize when Hawking Radiation is detected, but such detection remains unachieved as yet. 54 years ago, Hawking was diagnosed with ALS, a crippling disease that is usually fatal within a few years. It confined him to a wheelchair for much of his life. When he lost the ability to speak, a computer system was developed that allowed him to write and speak. For years he was able to control it with one hand, but the system had to be adapted later to respond to facial movements. Hawking has been quoted as saying that his sense of humor helped him work through his disability. That humor showed up in guest appearances on shows that included The Simpsons and The Big Bang Theory. In 1988 he published a book A Brief History of Time, which explained cosmology in terms the public could understand, and it became a record-setting best seller. He said he wrote it to be able to pay for his daughter's schooling. The book was followed over the years by many more, some coauthored with various scientists, authors, and his daughter. The world has lost a great scientist and icon of courage in the face of disability.

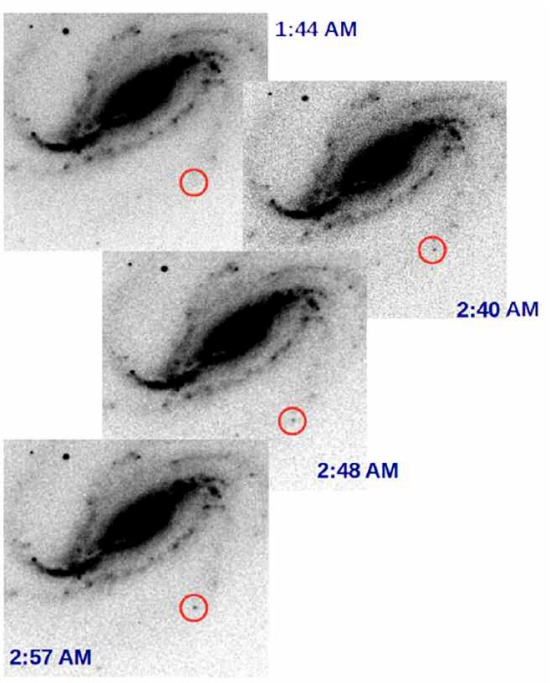
First stars – Scientists using a new small radiotelescope in Australia have for the first time detected evidence of the first stars in the Universe. The observations, made in lower frequency radio than previous attempts, showed spectral lines of hydrogen indicating that it had been ionized by the ultraviolet light of stars. The distance, and therefore look-back time, indicated this was earlier after the Big Bang (only 180 million years after it) than any other detection of gas so ionized. The expansion of the Universe since the observed light was emitted stretched it out to 78 megahertz radio waves. The radio signal was stronger than expected, which means that the hydrogen was cooler than theory predicts, in fact about half the expected temperature. One possible explanation for this is that dark matter interacted with the hydrogen somewhat more strongly than theory predicts, which would cool the gas. More observations and experiments are needed to determine why the radio signal was so strong.



Radio spectrometer at Murchison, Australia. Credit: CSIRO Australia

Hubble Constant – Astronomers using the Hubble Space Telescope have completed a study to add more precision to the measure of the Hubble Constant, the rate at which the Universe is expanding. They did this by expanding the number and distance of observed Cepheid variables, which allow rather precise distance measurements to galaxies that are close enough for Hubble to see individual stars. The result for the Constant is 73, and it is estimated to have no more than 2.3% error. That does not agree well with the calculation of the Constant made from Planck Space Telescope data, which came up with 67, and is believed to be within 3% of correct. The new result also does not agree with last month's determination of the Hubble Constant by the Dark Energy Survey team. However, the new measurement agrees quite well with the latest result from studying Type Ia supernovas. The Planck result depends on properties of the Cosmic Microwave Background (CMB), which is light that was emitted 370,000 years after the Big Bang. The Planck calculation takes into account all known effects since the CMB was emitted of expansion of the Universe, ordinary matter, dark matter and dark energy. The supernova result depends more heavily on current conditions of the Universe. Now that the latest result agrees so well with the supernova result, theorists are desperately looking for something that was overlooked in the Planck calculation. The first guesses at this are that there is another (undiscovered) kind of neutrino or that dark matter interacts with ordinary matter or with light somewhat differently than theory has it.

Supernova imaged early – An amateur astronomer in Argentina did something no one else has ever done: he took a series of images of a supernova during the first hour of its exploding. He was testing a new camera on his 16-inch telescope aimed at the galaxy NGC 613 and noticed a star not visible on the first images he took, but brightening on succeeding images. Professional astronomers are using the images to learn more about the early behavior of supernovas. Further study and theory showed that the star had an initial mass about 20 times that of the Sun, and had lost ¾ of its mass, probably to a companion star, before collapsing in a Type IIb supernova.



Credit: V. BUSO, M. BERSTEN, ET AL.

Active galactic nucleus imaged – The clearest image of a rotating torus (donut shape) about an active supermassive black hole has been made using ALMA (radiotelescope array in Chile). The object is in the center of galaxy M77. Not only was rotational motion detected, but also quite a bit of random motion. This could indicate that a past merger with a small galaxy stirred up the motion. This galaxy is one of the closest with an active nucleus, that is, with much material falling into its black hole.

Halo stars – Our Milky Way galaxy is surrounded by a huge but sparsely populated halo of stars. It has long been thought that most of the stars in that halo are ones that were captured from small galaxies that collided with the Milky Way. A new spectroscopic study of 15 halo stars show that they originated in the disk of the Milky Way, not in other galaxies. This was determined from detailed chemical abundances of the stars. However, computer simulations show that collisions of small galaxies were involved. Those collisions appear to have set up waves in the disk of the Milky Way, and those waves threw stars from our galaxy's disk out into the halo. Further work planned is to measure more halo stars, including ones farther away from the disk, and to determine ages and masses of halo stars.

Proxima flare – ALMA was observing our nearest neighbor star, Proxima Centauri, when it emitted the largest flare yet seen from that star. It was 10 times more powerful in radio waves than the Sun's largest flares. Such flares make the planet orbiting Proxima an unsafe place for life to have possibly developed.

ULX – When ultraluminous X-ray sources (ULX) were discovered roughly 30 years ago, they were generally attributed to active black holes. But there have always been problems explaining the observations with black hole theory. New studies using multiple X-ray space telescopes have determined that at least some ULXs have neutron stars at their hearts. The spectrum of a ULX in the galaxy M51 showed evidence of cyclotron resonance scattering, a phenomenon that occurs in neutron stars, but not black holes. Exactly how neutron stars can produce such bright X-rays is still not settled. Depending on what type of particles is emitting the X-rays, it might require incredibly strong magnetic fields. More observation of ULXs is planned.

Unusual binary star comes to life – Integral (X-ray space telescope) has observed a particular binary star occasionally for 15 years and just saw for the first time an X-ray burst from the neutron star in that binary. It is believed that the other star of the binary, a red giant, has dumped material onto the neutron star, and it finally burst out in X-rays. The binary is a strange one, in that the neutron star seems to be much younger than the red giant, and yet binary stars should form at the same time. One possible explanation is that the neutron star did not form the usual way by collapse of a played-out massive star, but instead built up to a neutron star mass from a smaller star having material dumped onto it by its companion red giant. This would take longer than the usual formation of a neutron star, and so lengthen its life. The length of time since the star transitioned into a neutron star is also a puzzle, since its magnetic field says it is young and its spin rate says it is old. The dumping of material by the red giant may have changed the spin rate. More study is needed. There are only 10 known binary stars that are composed of a red giant and a neutron star.

Binary neutron stars – A binary star consisting of 2 neutron stars has been discovered using the Arecibo radiotelescope. The stars are so close that they orbit in just 1.88 hours, the shortest period of any known binary neutron stars. One of the pair is spinning every .017 seconds, fairly fast for a neutron star. Such closely orbiting pairs emit gravitational waves, which cause their orbit to shrink, eventually forcing them to collide. This is predicted to happen in 46 million years.

When it does, the fast spin of one of the stars will amplify the gravitational waves, making the strongest such waves of any known neutron star pair. The total mass of the pair is only about 2.5 solar masses, among the least massive of any such pair. Because of the extremes in this binary, it can serve as a gravitational laboratory, testing various effects of General Relativity.

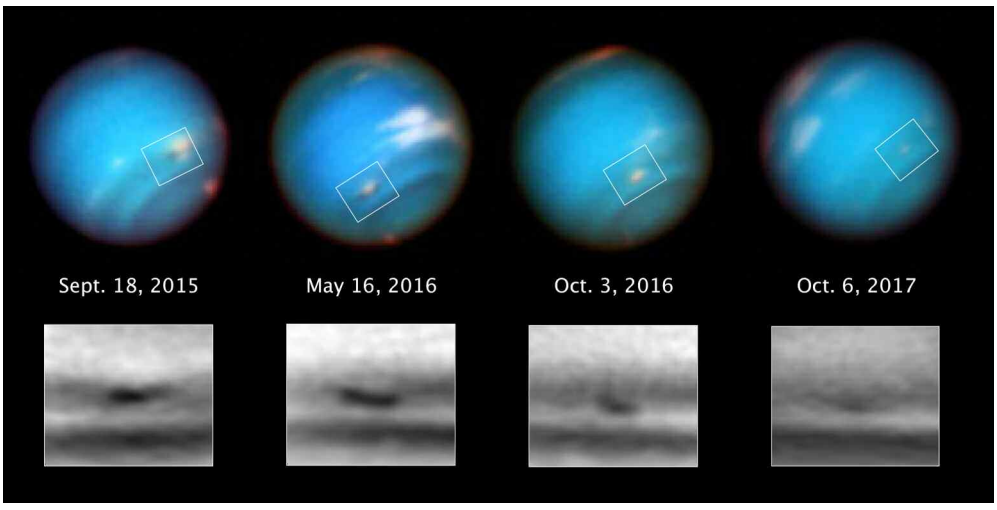
Eccentric exoplanet – There are 116 confirmed exoplanets that orbit giant stars. The latest-discovered of these, dubbed HD 76920b, has the most eccentric (elongated) orbit. The planet has around 4 Jupiter masses and orbits its star in 415 Earth days. Usually eccentric planet orbits are caused by a companion star disturbing the orbit. But no companion star has been found in this case, so the next best explanation is that close encounters with other planets, probably early in the life of the planetary system, disturbed the planet into its eccentric orbit. The eccentricity is so extreme that the planet comes within 4 star radii of its host at the low orbital point. Tidal forces and star expansion will engulf the planet within its star within about 100 million years.

Exoplanet atmosphere – A new study of the exoplanet WASP-39b using the Hubble Space Telescope and other telescopes has resulted in the most complete study of any exoplanet's atmosphere. The planet and its star cannot be resolved separately, so the spectrum of just the planet is obtained by subtracting the spectrum taken when the planet is behind its star from that when the planet is in front. The planet has a puffy atmosphere and has no high-altitude clouds. The puffiness is caused by the heat of its star, about which it orbits quite closely. The atmosphere contains quite a bit of water, which is surprising, since the high temperature there could have caused all the water vapor to escape the planet. This implies that the planet obtained a very large supply of water during or just after its formation. This could not have happened this close to its star, implying that it formed farther away and then migrated in toward its star. The planet is tidally locked, that is, presents the same side toward its star as it orbits about it. From atmospheric temperature measurements, the planet must have strong winds that distribute much of the heat from the starward side to the night side.

Curiosity drill working – Mars rover Curiosity used its drill 15 times to pulverize and collect rock samples for analysis in its laboratory instruments since landing in 2012. But over a year ago the stabilizer probes that keep the drill running straight failed. A new technique that in order to stabilize the drill uses a sensor in the arm that holds the drill was developed here on Earth. The technique has just been tested on Mars, and it works. Further tests will be done, including a new way to dump the drilled material into the analyzer instruments (the failed stabilizer probes get in the way of the old method), and then drilling and analyzing will begin again.

Instant AstroSpace Updates

Continued imaging of Neptune using the Hubble Space Telescope shows that the **Great Dark Spot**, a storm on that planet discovered by the Voyager spacecraft about 1989, is drifting toward the south pole while slowly shrinking, and may dissipate entirely. Theory had said it should drift away toward the equator and then dissipate suddenly, so scientists need to revise their theories.



Credit: NASA, ESA, and M.H. Wong and A.I. Hsu (UC Berkeley)

New computer simulations of galaxy formation show that the **Andromeda Galaxy** could attain its current shape, including the concentrations of stars of different ages and different abundances of elements, only if it is the product of 2 galaxies colliding, one about 4 times the mass of the other, between 1.8 and 3 billion years ago.

SOHO (solar space telescope) celebrated 22 years of operation, so it has now seen complete 11-year cycles of sunspot activity in both hemispheres of the Sun. The original plan was to operate for just 3 years, but it continued turning out valuable data, so its mission was extended multiple times.

Greetings from Palmia Observatory

By George Robinson

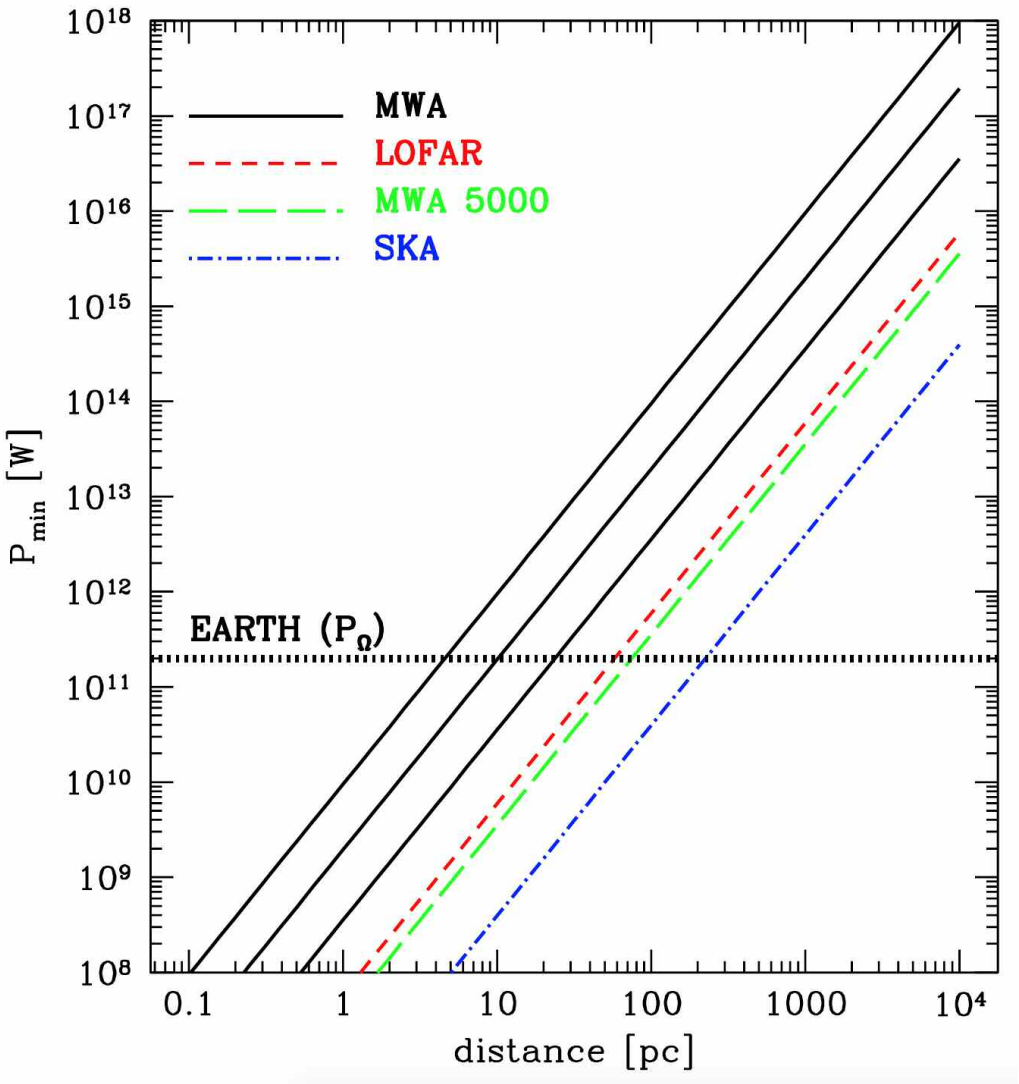
Well the clouds are out in full force this week and it rains every now and then so nighttime astronomical observing is pretty much not going to happen. So, get out your meteorology study books or just stay inside or in this case I can refer to some comments received by readers regarding the detection of leakage radio emissions as part of the SETI program. In addition, it was time for the OC Science Fair and a new judge on the circuit, and finally remembering Stephen Hawking.

First up, we received some feedback from Science Squad and Gravity Guy, Ken, who found, after reading my back of the envelope calculations, in the March 11 post, regarding alien detection of radio leakage signals from Earth, a published paper going into those details. Recall that in that post, my estimate that leakage from everyday radio and TV broadcast stations were expected to be detectable by alien civilizations if their radio telescopes had sufficient sensitivity and sufficient time for the radio leakage, now less than say 100 years old, had reached their receivers.

That paper described several additional factors that I had not specifically included in my calculations. First these authors note that it is more appropriate to use the total radio broadcast power, not just the power rating of one particular transmitter and secondly, that the use of longer integration times, from hours to days, could be used to increase the receiver sensitivity. Nonetheless, the estimate range of reception was listed as about 100 pc, which is equivalent to about 326 light years. Ok, so the ball park estimate was right in this neighborhood too! By the way, if you like these sort of radio astronomy issues, you should check into attending the monthly OCA Astrophysics SIG, which is currently showing some radio astronomy lecture DVDs.

If you want to follow up on this original reference paper, check out the freely available listing on the archive reference as shown in the figure caption. Thanks for that info, Ken!

This week has been the time for the Orange County Science and Engineering Fair at the OC Fairgrounds, March 12-14, 2018. Hundreds of middle school and high school students presented their science fair projects to the public.



The minimum detectable radio power Pmin for various high-redshift 21 cm surveys and observing times as a function of the distance to the source. We assume for simplicity that the source emits isotropically and steadily. For the MWA we adopt a bandwidth of Δv = 8 kHz and observing times of 1 hour, 1 day and one month (solid lines from top to bottom). We assumed the same bandwidth for LOFAR, for a future extension of MWA with ten times its collecting area (called MWA 5000) and for the SKA. In those cases we only plot the sensitivity for a one month integration. The dashed line delineates the power per solid angle, PΩ, along the beam of military radars [Ballistic Missile Early Warning Systems (BMEWS)] from our civilization.

Big Oil Chemist, Dr. Arnold, who I worked with more than twenty years ago, and who we keep bumping into at various ongoing scientific meetings, had been urging me to sign up and volunteer as a judge at the science fair. Having sufficient judges who can review the students projects and provide feedback and encouragement is a key part of the whole science fair event. Well, I finally agreed to be a judge, after a couple of years of urging and nudging by Dr. Arnold. I just had a hard time, not because I didn't have the time or unable to make the time available, but because I couldn't see me as being a judge. It turns out that the whole scene was really enjoyable and I really liked hearing the students describe their projects and hear of their enthusiasm. I especially enjoyed meeting one young woman who had built a cloud chamber and had collected cosmic ray arrival statistics. Wow, this was really neat, especially because I had tried to build my own cloud chamber as a young high school student and never quite got the thing to work. I just hope that I could offer the right amount of feedback, questioning, and encouragement to these young student scientists. Thank you, Arnold for your own volunteer work on the OCEF Board of Directors, and for continuing your encouragement for me and others to participate!

Inside, just a small section of the Orange County Science and Engineering Fair, March 12-14, 2018.

Finally, it is sad news to hear of Stephen Hawking passing at age 76. I (we) always welcomed his insight into the mysteries of the cosmos, especially his insight into black hole evaporation, Hawking Radiation, and how understanding black hole physics is very much all tied up with some deep connection to all of spacetime, gravitation and physics.

Palmia Observatory Resident Astronomer shows up as one of OCSF volunteer judges. Source: Palmia Observatory

I have always enjoyed some of the Monty Python skits, in one classic example of which, Hawking is portrayed as running over fellow cosmologist, Brian Cox, with his wheelchair and then ascending into the heavens and soaring through the galaxy, all the time singing the Galaxy Song in his computer-generated voice. This skit in some sense displays what I see as Hawking's final journey through the cosmos. RIP! If you haven't seen the Galaxy Song skits, which are quite funny, check out this one reference, of several versions of the main theme, at:
https://www.youtube.com/watch?v=XfcC6FYyL4U&sns=em

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***

Conference Report (LogiCal-LA/Scientific Skepticism)

By Stephen Donovan

The second annual LogiCal LA conference devoted to scientific skepticism and critical thinking was held in the Renaissance airport hotel, Los Angeles February 9-12, 2018. There were a total of 15 speakers and panelists and about 85 attendees. A summary of a selection of the talks is given below and a biography of all the speakers can be found at http://logicalla.com/blog1/detailed-bios-and-presentation-titles/

During the three-day conference, there were two astronomy related talks, one by Dr. Lawrence Krauss, a professor at Arizona State University and an "internationally known theoretical physicist and cosmologist" who has a large number of general interest books and publications such as *The Greatest Story Ever Told – So Far: Why Are We Here?* (2017), Atria Books. His keynote lecture was a general, qualitative, cosmological overview of the universe loosely linking together concepts including the spiral structure of the Milky Way Galaxy and our projected collision with the Andromeda Galaxy, Doppler effect redshift evidence for an expanding Universe, Dark Matter, transiting method to finding exoplanets, the black hole at the center of the Milky Way, LIGO and gravitational wave detection, LISA (a much larger LIGO in space), and an idea for a LightSail spaceship with lasers trained on the sails so it can reach 4.3 light-year-distant Alpha Centauri and/or Proxima Centauri in 12-14 years (traveling at about 30% the speed of light). So lots of broad big-picture concepts supplemented with slides and several videos presented to a lay audience.

The other astronomy relevant lecture was by community college geology teacher Sian Proctor who discussed her experience in 2013 as a member of the six-person HI-SEAS simulated Mars habitat crew that spent four months on the side of a Hawaiian mountain in a 36-foot diameter dome. Her role was to broadcast from the habitat a weekly cooking show called "Meals for Mars" showing how food can be prepared over an open fire gas stove using freeze-dried and shelf-stable ingredients. She also ran a recipe contest, and as the crew outreach officer created videos of crew activities.

If the high point of the conference was the two astronomy related lectures, the low point was the talk by Yvette d'Entremont, a former analytical chemist. Her website is SciBabe.com which has the header "come for the science, stay for the dirty jokes," which should have been a warning of what was to come. Ms. D'Entremont was very profane, working every vulgar four letter word multiple times into her talk about a selection of food bloggers and health gurus who, in her view, make unsubstantiated and/or unscientific claims.

Another speaker was Brian Palermo, an actor and "improv trainer" who gave an animated talk about communicating science to non-scientists (Brian has a BA in communications). For example, he is currently working with JPL (in his words, "the A team") to help explain their work in grant applications to the Pentagon ("the C team").

John Wathey, a biologist and author of *The Illusion of God's Presence*, provided a thoughtful analysis which concluded that because of the brain's structure and early infant nurturing experiences, there are biological and societal reasons to conclude that a belief in God would persist even in a very secular society.

Also worthy of attention was the discussion by UC San Diego anthropology professor Pascal Gagneux who, based in part on his two years observing apes in West Africa, told us that humans are apes with culture and a social tolerance and that unlike apes humans teach each other. To illustrate ape-human contrast he noted, as a thought experiment, that if you put 300 male chimpanzees (that had not previously met or socialized with each other) on an 11-hour flight from Zurich to LAX, one would expect that they would "rip each others throats open and pull off the testicles of other males chimps in proximity," unlike the typical experience when human strangers travel together in a confined space.

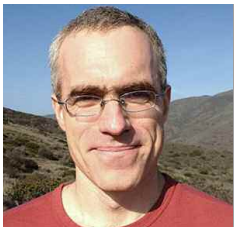
Among the remaining speakers, 18-year-old Alex O'Connor gave a rambling talk entitled *Why Smart People Believe Silly Things*, and magician/skeptic Jamy Swiss explained the three-card Monte game, and the tricks of psychics/other assorted con artists.

The common theme in all the talks, as set forth on the LogiCal LA website, was: "Scientific skeptics believe that empirical investigation of reality leads to the truth, and that the scientific method is best suited to this purpose. They attempt to evaluate claims based on verifiability and falsifiability and discourage accepting claims on faith or anecdotal evidence. Scientific skeptics often focus their criticism on claims they consider to be implausible, dubious or clearly contradictory to generally accepted science...LogiCal-LA is truly a project of devotion to the promotion of science and reason."

The parent organization of LogiCal-LA is the FreeThought Alliance, a 501(c)(3) entity and tax-exempt organization devoted to religious, charitable, scientific, literary or educational activities. The conference director was Bruce Gleason, founder of Backyard Skeptics and the OC Atheist Cable TV Show. Bruce attended Long Beach State University where he studied electrical engineering. He is producer/conference director of the FreeThought Alliance which has another conference specifically designed for atheists.

There was a magic show, a comedy show, and a musical event on respectively the Friday, Saturday and Sunday nights of the February 9-12, 2018 LogiCal-LA conference and meals were provided on site.

An interesting post conference event was a behind the scenes tour of the La Brea Tar Pits Museum with a research director who provided a guided walk-through of the paleontology lab (where about 9,000 to 50,000-year-old fossils of extinct mammals and birds are stored) as well as entrance to closed tar pit areas.



April Guest Speaker: Daniel Limonadi

Robotic Exploration of Mars – Highlights and Future Directions.

Daniel Limonadi is a principle flight systems engineer at the Jet Propulsion Lab in Pasadena. Since 2014 he has been the lead Payload System Engineer on the Surface Water and Topography (SWOT) mission and also moonlights as a sea level rise science system engineer. Previously he was the "Phaselead" (also known as systems engineering team lead) for the Surface Sampling and Science aspects of the Curiosity rover. Prior to the Curiosity rover project Daniel worked on the Mars Exploration Rovers during development and operations, did a very short stint as surface systems engineer for the original Mars Smart Lander concept that eventually turned into Curiosity, and also worked at Hughes Space and Communications on Geosynchronous communications satellites.

NASA and other international space agencies have been exploring Mars since the late 1960s – what are some of the most exciting science, engineering, and management things we've learned? What are the most controversial? What lies in store in the near and more distant future exploration of Mars?

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).

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

Measuring the Movement of Water on Earth

By Teagan Wall

As far as we know, water is essential for every form of life. It's a simple molecule, and we know a lot about it. Water has two hydrogen atoms and one oxygen atom. It boils at 212° Fahrenheit (100° Celsius) and freezes at 32° Fahrenheit (0° Celsius). The Earth's surface is more than 70 percent covered in water.

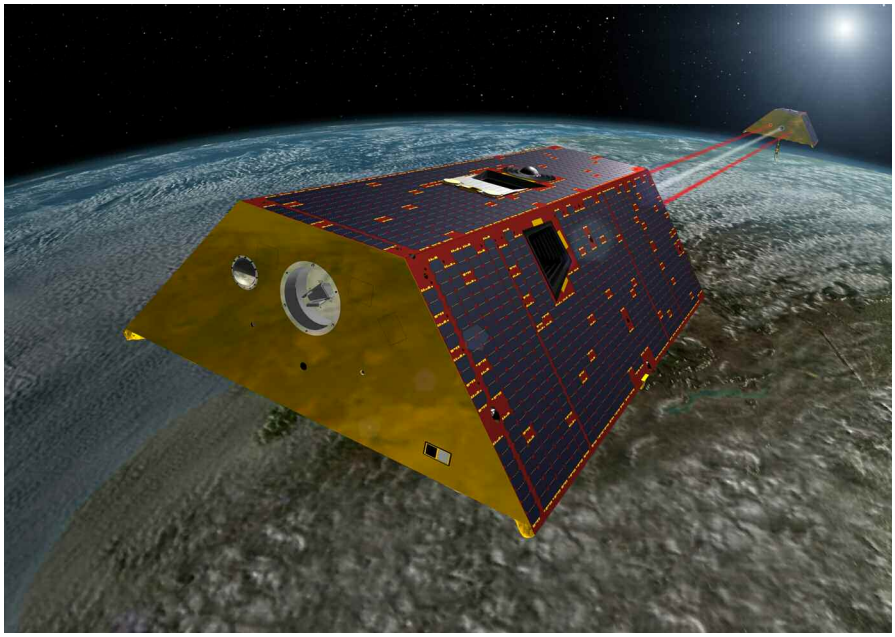
On our planet, we find water at every stage: liquid, solid (ice), and gas (steam and vapor). Our bodies are mostly water. We use it to drink, bathe, clean, grow crops, make energy and more. With everything it does, measuring where the water on Earth is, and how it moves, is no easy task.

The world's oceans, lakes, rivers and streams are water. However, there's also water frozen in the ice caps, glaciers, and icebergs. There's water held in the tiny spaces between rocks and soils deep underground. With so much water all over the planet – including some of it hidden where we can't see – NASA scientists have to get creative to study it all. One way that NASA will measure where all that water is and how it moves, is by launching a set of spacecraft this spring called GRACE-FO.

GRACE-FO stands for the "Gravity Recovery and Climate Experiment Follow-on." "Follow-on" means it's the second satellite mission like this – a follow-up to the original GRACE mission. GRACE-FO will use two satellites. One satellite will be about 137 miles (220 km) behind the other as they orbit the Earth. As the satellites move, the gravity of the Earth will pull on them.

Gravity isn't the same everywhere on Earth. Areas with more mass – like big mountains – have a stronger gravitational pull than areas with less mass. When the GRACE-FO satellites fly towards an area with stronger gravitational pull, the first satellite will be pulled a little faster. When the second GRACE-FO satellite reaches the stronger gravity area, it will be pulled faster, and catch up.

Scientists combine this distance between the two satellites with lots of other information to create a map of Earth's gravity field each month. The changes in that map will tell them how land and water move on our planet. For example, a melting glacier will have less water, and so less mass, as it melts. Less mass means less gravitational pull, so the GRACE-FO satellites will have less distance between them. That data can be used to help scientists figure out if the glacier is melting.



An artist's rendering of the twin GRACE-FO spacecraft in orbit around Earth. Credit: NASA

GRACE-FO will also be able to look at how Earth's overall weather changes from year to year. For example, the satellite can monitor certain regions to help us figure out how severe a drought is. These satellites will help us keep track of one of the most important things to all life on this planet: water.

You can learn more about our planet's most important molecule here: ***https://spaceplace.nasa.gov/water***

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