SIRIUS ASTRONOMER

www.ocastronomers.org

The Newsletter of the Orange County Astronomers

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NGC 5128, also known as Centaurus A, is the one of the closest radio galaxies in the night sky and the fifth-brightest optical galaxy. The galaxy's odd shape and dark central band is generally accepted as evidence that it is actually two galaxies that have undergone a collision. It is a good object for most instruments low on the southern horizon in the summer sky. Bill Hall obtained this image from our Anza site on April 3rd using an 8-inch f/4 Newtonian with a coma corrector on an Atlas EQ-G mount. Bill used an ST-8300 imager, compositing 7 5-minute exposures.

OCA CLUB MEETING

The free and open club meeting will be held May 13 at 7:30 PM in the Irvine Lecture Hall of the Hashinger Science Center at Chapman University in Orange. This month's speaker is Omar Blaes of UC Santa Barbara discussing The Bizarre Variability Patterns of Black Hole Accretion Flows

NEXT MEETINGS: June 10, July 8

STAR PARTIES

The Black Star Canyon site will open on May 28 and June 25. The Anza site will be open on May 7 and June 4. Members are encouraged to check the website calendar for the latest updates on star parties and other events.

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

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

COMING UP

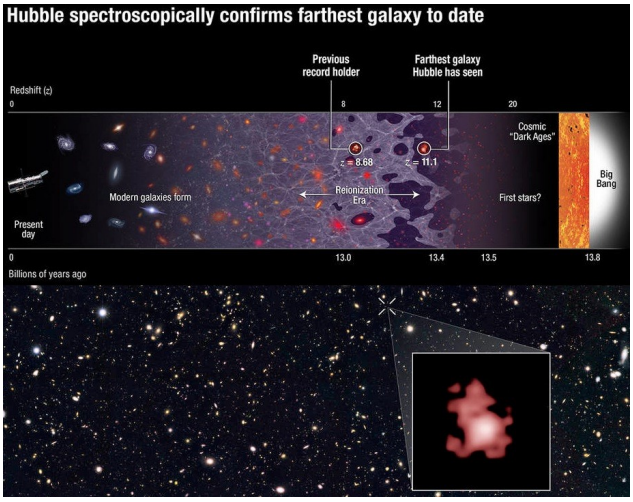
The next session of the Beginners Class will be held at the Heritage Museum of Orange County at 3101 West Harvard Street in Santa Ana on May 6. The following class will be held June 3.

GOTO SIG: contact Mike Bertin
Astro-Imagers SIG: May 10, June 14
Remote Telescopes: contact Delmar Christiansen
Astrophysics SIG: May 20, June 17
Dark Sky Group: contact Barbara Toy

Hubble Shatters The Cosmic Record For Most Distant Galaxy

By Ethan Siegel

The farther away you look in the distant universe, the harder it is to see what's out there. This isn't simply because more distant objects appear fainter, although that's true. It isn't because the universe is expanding, and so the light has farther to go before it reaches you, although that's true, too. The reality is that if you built the largest optical telescope you could imagine -- even one that was the size of an entire planet -- you still wouldn't see the new cosmic record-holder that Hubble just discovered: galaxy GN-z11, whose light traveled for 13.4 billion years, or 97% the age of the universe, before finally reaching our eyes.



Images credit: (top); NASA, ESA, P. Oesch (Yale University), G. Brammer (STScI), P. van Dokkum (Yale University), and G. Illingworth (University of California, Santa Cruz) (bottom), of the galaxy GN-z11, the most distant and highest-redshifted galaxy ever discovered and spectroscopically confirmed thus far.

There were two special coincidences that had to line up for Hubble to find this: one was a remarkable technical achievement, while the other was pure luck. By extending Hubble's vision away from the ultraviolet and optical and into the infrared, past 800 nanometers all the way out to 1.6 microns, Hubble became sensitive to light that was severely stretched and redshifted by the expansion of the universe. The most energetic light that hot, young, newly forming stars produce is the Lyman-α line, which is produced at an ultraviolet wavelength of just 121.567 nanometers. But at high redshifts, that line passed not just into the visible but all the way through to the infrared, and for the newly discovered galaxy, GN-z11, its whopping redshift of **11.1** pushed that line all the way out to 1471 nanometers, more than double the limit of visible light!

Hubble itself did the follow-up spectroscopic observations to confirm the existence of this galaxy, but it also got lucky: the only reason this light was visible is because the region of space between this galaxy and our eyes is mostly ionized, which *isn't true* of most locations in the universe at this early time! A redshift of 11.1 corresponds to just 400 million years after the Big Bang, and the hot radiation from young stars doesn't ionize the majority of the universe until 550 million years have passed. In most directions, this galaxy would be invisible, as the neutral gas would block this light, the same way the light from the center of our galaxy is blocked by the dust lanes in the galactic plane. To see farther back, to the universe's first true galaxies, it will take the James Webb Space Telescope. Webb's infrared eyes are much less sensitive to the light-extinction caused by neutral gas than instruments like Hubble. Webb may reach back to a redshift of 15 or even 20 or more, and discover the true answer to one of the universe's greatest mysteries: when the first galaxies came into existence!

AstroSpace Update

May 2016

Gathered by Don Lynn from NASA and other sources

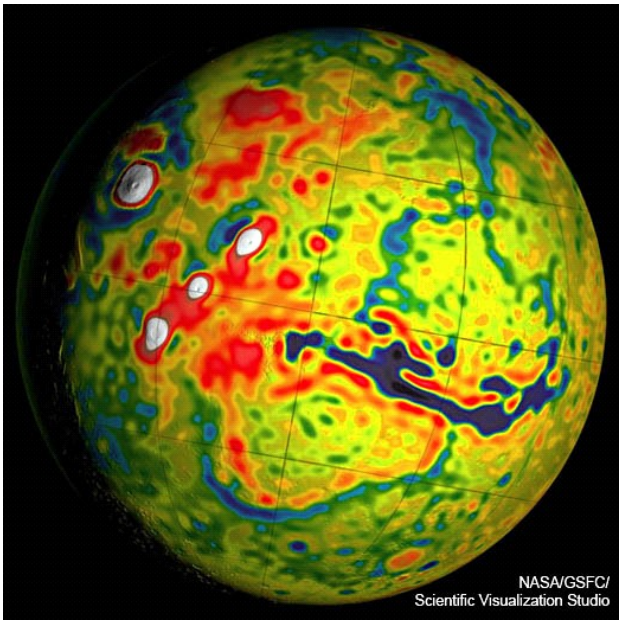
Fast radio burst (FRB) – Remember how we reported here last month that an afterglow had been seen at the location of an FRB? Further study of the "afterglow" showed that it was caused by a distant galaxy active nucleus, which continues to intermittently flare, and coincidentally happened to appear near the FRB. So we still don't know the source of any FRB. Observations triggered by future FRBs will continue.

3 suns – Scientists have found for only the 4th time a planet with 3 suns. It is 685 light-years away, which is closer than the other 3-sun planets, and has been dubbed KELT-4Ab. KELT refers to the system that found the planet, 2 small wide-field telescopes that look for planet transits, and the "A" means that the planet orbits the brightest of the 3 stars. The B & C stars orbit each other every 30 years, but as a pair, orbit the A star every 4000 years. The planet is quite close to A, and orbits it every 3 Earth days. It is thought that gravitational disturbance from the B and C stars may have driven the planet so close to A. From the planet, the B and C stars would appear about as bright as our Moon appears to us.

Exoplanet heat map – Spitzer infrared space telescope has mapped the temperature around a super-Earth exoplanet, by observing complete rotations of the planet. It is 55 Cancri e, about 40 light-years away, one of several planets orbiting the 6th magnitude star 55 Cancri. It is about 2 times the diameter of Earth and about 8 times the mass, so is definitely a rocky planet, not a gas giant. It is quite close to its sun, making it quite hot, and completes a revolution in just 18 hours. It is tidally locked so that one side always faces its sun. The hottest point is nearly 4400°F (2420°C) and the coolest is 2060°F (1120°C). Previous predictions were that the planet should have high winds that would distribute the heat more evenly than this. The new data imply that the planet does not have much atmosphere. The hottest spot is shifted somewhat from the point directly under the sun. This could be explained by limited atmospheric circulation or lava hot spots. The dayside temperature is definitely high enough to melt rock and cause lava on the surface.

Eccentric exoplanet – Researchers have found an exoplanet with a highly eccentric orbit, and used the Spitzer infrared space telescope to study how the planet's temperature changes with its distance from its sun. The planet is about the diameter of Jupiter, though 4 times the mass, and orbits the star HD 80606, 190 light-years away in Ursa Major. Every 111 Earth days the planet swoops quite close to its sun for several hours. During the close pass, the star-facing side reaches 2000°F (1100°C), but cools so much within 10 hours that it becomes invisible in infrared. The best theory on how many Jupiter-sized planets end up quite close to their sun is that another planet disturbs their orbit into a highly elliptical one, and then tidal forces near the sun cause the orbit to circularize close in. Because we have seen few exoplanets with highly elliptical orbits, the circularization process is thought to occur quickly (on astronomical time scales, which is to say far under a billion years). But study of this exoplanet shows that circularization is proceeding far slower than expected. So is this an exception, or is a new theory needed?

Free-floating exoplanet – A team of astronomers has found one of the youngest and brightest planet-like objects free of any star to orbit. The object is designated 2MASS J1119-1137, is between 4 & 8 times Jupiter's mass and is only 10 million years old. First they had to determine that the object is nearby. Then they determined its age by the fact that its 3-dimensional motion matched that of the youngest group of stars in the solar neighborhood (the TW Hydrae association), and that group is known to be only 10 million years old. The temperature and age allowed estimating the mass, which showed it to be too small for a brown dwarf or star. Not being next to a star, whose light would overwhelm it, will make it easier to study this object. Some astronomers estimate that there should be as many such free-floating planets as those orbiting stars (based on theories of how they form), but they are very hard to find, so only a few are known.



Mars gravity map – Using 16 years of tracking data from 3 Mars orbiters, scientists constructed a map of the strength of gravity over the surface of Mars. It took 2 years of analysis to remove non-gravitational forces acting on the spacecraft, such as sunlight pressure and atmospheric drag. Tidal stretching of the solid surface of Mars was detected, both from the Sun and from the closer larger moon Phobos. The amount of stretching corresponded to that expected if the outermost part of the core is molten. The freezing out of about 15% of the atmosphere, alternately at the north then south poles, was also detected. A gravity trough was found around the

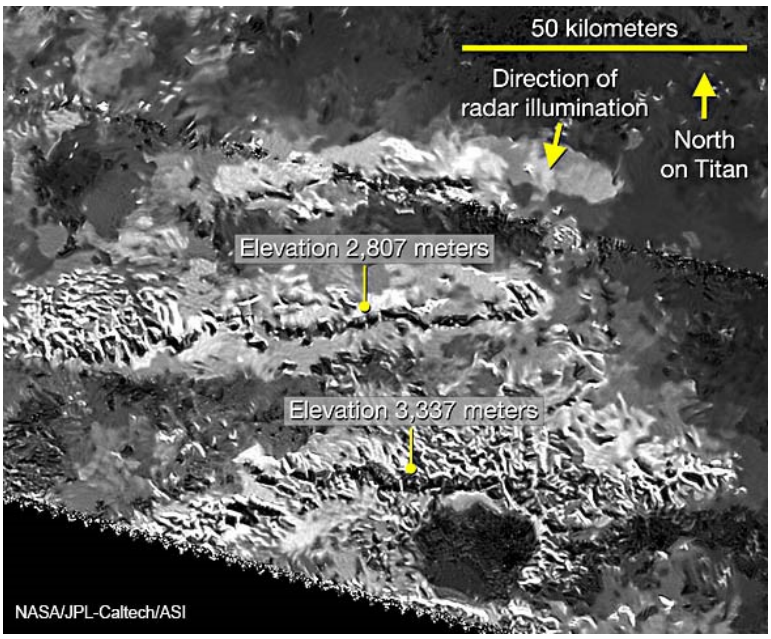
northern lowlands. At first it was thought this might be a buried water channel system, but it is in places in the wrong direction for ancient water flow. The new theory is that the trough is an effect of the weight of the Tharsis volcanic region. The new data allowed calculating the thickness of the Martian crust.

Mars-comet encounter – Analysis has been released of data taken by Mars orbiters during the close approach (about 87,000 mi = 140,000 km) of comet Siding Spring (C/2013 A1) to the red planet in October 2014. The planet was flooded with charged particles from the comet's coma. The dense inner coma of the comet reached the planet's surface, or nearly so. The comet's magnetic field temporarily merged with and overwhelmed the planet's weak field. The encounter probably blew away some of the planet's upper atmosphere, similarly to a strong solar storm. As Mars's magnetosphere started to react to the comet's approach, some regions began to realign to point in different directions. The comet's advance almost made the planet's magnetic field flap. At closest approach, Mars's magnetic field was in complete chaos.

Opportunity Mars rover has climbed the steepest slope (32 degrees) attempted in its 13 years on the Red Planet. When the wheels spun fruitlessly, it was still a few inches short of being able to place its instruments on an interesting science target. So the rover backed off and proceeded to another target. The area being investigated has quite a bit of smectite clay, which must have formed in water. The smectite was found some time ago by the Mars Reconnaissance Orbiter, and immediately became an area of interest for the rover. A recent Opportunity panoramic image showed a dust devil rolling along nearby.

Enceladus geysers – New computer simulations of Saturn's moon Enceladus have finally explained how the observed geyser eruptions can be sustained. Water from the subsurface ocean is being pumped in and out of deep fractures by tides. The 5-hour delay in the peak of eruptions past the peak time of tidal force tells us how much the narrow fractures impede the flow of water. Turbulence in the water flow heats the water and surrounding ice. The computer model predicts certain temperatures in the shell of the moon near the fractures, so future measurements of those temperatures should be able to verify this computer simulation.

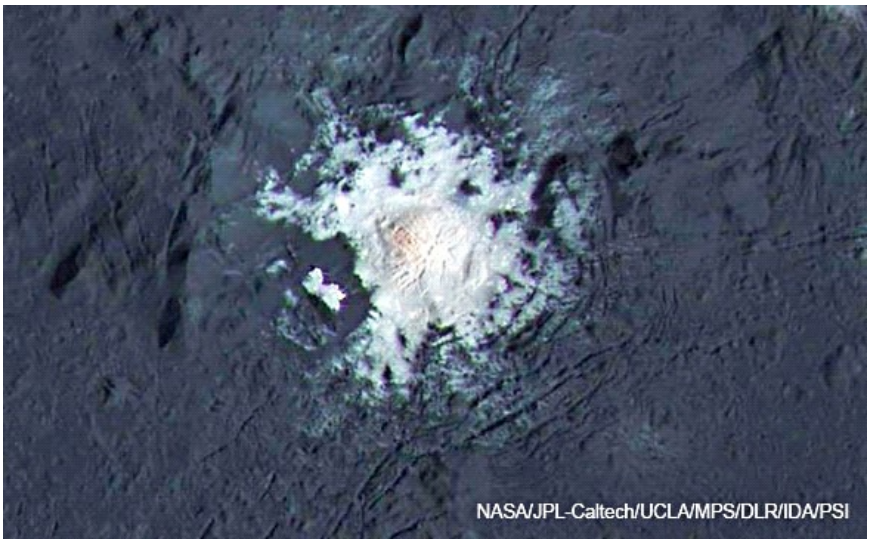
Cassini (Saturn mission) has measured with radar the height of the tallest known peaks on Titan. The highest is 10,948 feet (3337 m). Most of Titan's tall mountains have been found close to the equator. This area has been observed well, so likely no taller peaks are still to be found. It is surprising that such tall mountains exist on Titan. It has an icy crust resting on a liquid water ocean, and this structure cannot permanently support such tall mountains. That is, once tectonic forces create such a mountain, it slowly sinks. Thus the tectonic mountain-building forces are likely going on still. Scientists are still not sure what forces act on Titan to create tall mountains, so more research is needed.



Pluto's atmosphere continues to confound scientists as observations of it are being returned by the New Horizons spacecraft. Pluto is so cold that ices of nitrogen, methane and carbon monoxide sublimate (evaporate from solid to gas) very slowly. Before New Horizons close-up observations of Pluto, astronomers had expected that much of the atmosphere would freeze during Pluto's passage far from the Sun in its eccentric orbit, then slowly sublimate during the period close to the Sun. Each warm period would also lose some of the atmosphere to space. But New Horizons data showed the upper atmosphere is far colder than thought, is less puffed up than thought, and is much less subject to being stripped away to space by solar wind. A little methane was seen escaping, but hardly any nitrogen. Scientists are now scrambling to explain how the upper atmosphere could lose so much heat. The freeze-out of the atmosphere expected to have started already (it has been over 26 years since Pluto was at its close point [perihelion] to the Sun)

was found not to be occurring. In fact the atmosphere is still increasing from sublimation. Scientists are blaming Pluto's extreme axial tilt for this. Apparently ices sublimate from the summer pole and freeze out at the winter pole in a cycle lasting Pluto's year (248 Earth years). According to new computer simulations, the atmosphere could get thousands of times denser than now at times during the million-year wobble of Pluto's poles. It could possibly get dense enough to support liquid nitrogen lakes and nitrogen rain. But this probably happened 900,000 years ago, if at all. One feature seen by New Horizons appears to be a small frozen nitrogen lake. The dark patches, which are ice-free, around much of Pluto's equatorial region were found to correspond fairly well with the zone that never gets polar continuous darkness any time. Astronomers expected a haze layer in Pluto's atmosphere, but New Horizons found 20 haze layers. The temperatures measured in the upper haze layers are warm enough to destroy the haze particles (which were found to be acetylene, ethylene and ethane). So something is continuously moving new haze into those temperature zones. The best guess is that waves of wind generated by mountain ranges are pushing the haze layers up, and those waves are what make the many separate layers of haze.

Lunar lava tubes – There has long been some evidence (sinuous rilles and "skylight" holes) that lava tubes formed on the Moon back when it was volcanically active. A new study looked at the gravity map of the Moon made by the twin GRAIL spacecraft for further evidence of lava tubes. A subsurface cavity, such as a lava tube, should leave a signature in the strength of gravity. Near the Marius Hole, thought to be a cave-in to a lava tube, the new study found a signature in the gravity map that appeared to be a lava tube. In other areas, at least 10 more were found. Some were more than 60 miles (100 km) long and miles (km) wide. The signatures were near the resolution of the gravity data, so confirmation will require a mission with finer resolution, such as a ground-penetrating radar lunar orbiter.



Dawn (asteroid mission) scientists released new high-resolution images of Ceres, including ones of Occator Crater, the location of the brightest of the strange bright spots. There is a dome in the center of the crater, on which bright spots are located. Linear fractures crisscross the dome, and other fractures cut across nearby plains. Occator Crater is 57 miles (92 km) across and 2.5 miles (4 km) deep. As reported here previously, the bright spots are magnesium sulfate, a relative of Epsom salts. The best theory on their origin is that water ice containing the salts was exposed to space, and the ice sublimated to leave the salt. The ice may have been exposed by asteroid impacts. Crater counts on the new images show that there are fewer large impact craters than predicted, but the expected number of smaller craters.

Infrared background explained – Astronomers have long known of a faint infrared glow across the entire sky, known as the cosmic infrared background (there are cosmic backgrounds in various wavelengths, not just infrared, which have different sources). ALMA (radiotelescope array in Chile) has the resolution and sensitivity to see individual sources in this glow for the 1st time. It operates at radio frequencies just below infrared. Examination of many small fields of view across the sky found 133 faint galaxies. Over half of these showed up in long exposure infrared or visible light images. The rest are probably hidden by dust. Such distant galaxies over the whole sky were calculated to emit enough infrared radiation to explain all of the cosmic infrared background.

The maximum mass of a neutron star before it collapses into a black hole has long been known, if the neutron star is not rotating. But if spinning, the centrifugal force will support the neutron star to somewhat larger mass. But there is a limit to how fast a neutron star can rotate without flying apart, but that limit is not well known because of different theories of how the interior of the neutron star may be structured. A new study shows that over the range of theories of the interior, the maximum mass of a maximally rotating neutron star is 1.20 times (±.02) the maximum nonrotating mass. Knowing this should help interpret gravitational waves produced by neutron stars.

Another runaway star, one moving so fast that it will escape the Milky Way, has been discovered. More than 20 runaway stars are known. What makes this one news? 1) It is the only known binary runaway star. It was thought that whatever hurls star at such high speeds would separate binaries from orbiting each other. 2) It did not originate near the Milky Way's central black hole, which was thought to fling such runaway stars to their high speed. 3) There are 2 other theories (besides black holes) of how runaway stars might be flung, and neither fits this pair. Gravitational interaction or collision with other stars does not fit because the odds are extremely against flinging both stars with the same velocity. Adjacent supernova explosion does not fit because a supernova should separate a binary pair. It has even been suggested that a pocket of dark matter might hold a binary pair together through a flinging event, but that seems really stretching for an explanation.

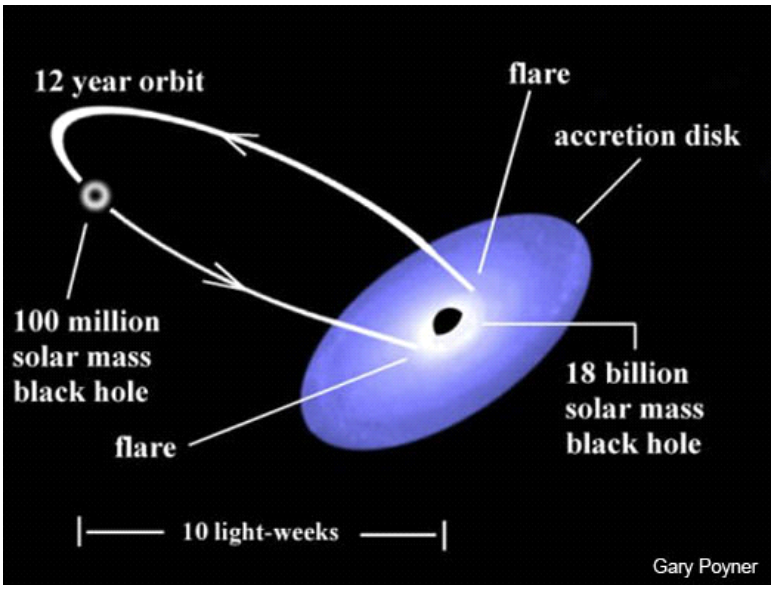
Local supernovas – A new study of layers of the isotope iron-60 in the deep-sea crusts shows that supernovas about 1.5 and 2.3 million years ago deposited these layers. A cluster of about 70 stars was found that should have been producing occasional supernovas over the last 13 million years, about 300 light-years from us. Computer simulations showed that those supernovas would carve out a region about the Sun similar to the known Local Bubble, a plasma-filled cavity, long thought to be a result of supernovas. The cluster is close enough to have produced the iron-60 layers.

Supernova cause – There are 2 theories for the cause of a Type Ia supernova: 1) 2 white dwarf stars collide and merge, or 2) a white dwarf star gravitationally steals material from a very close companion star. In either case, the mass exceeds what a white dwarf can support, and the core implodes while the outer part explodes. There is evidence for both theories. A new study supports that a particular supernova was a result of a merge. The supernova in question was the most recent one in the Milky Way, whose remnant is known as G1.9+0.3. It occurred about 110 years ago, but was so hidden by dust that it was not seen in visible light. The remnant was studied in X-ray and radio light. Theoretically a merger should produce increases in radio and X-ray brightness over time, while stealing material should not. The study showed such an increase in brightness of G1.9+0.3.

Kepler (planet-finding space telescope) – 2 Type II supernovas occurred in the field of view of Kepler. Because Kepler shoots another image every 30 minutes, the shock wave breaking out of the surface of the star during the supernova was captured for 1 of these 2. The shock wave breakout is predicted to be visible for only 20 minutes. The other supernova may have been surrounded by gas that blocked the view of the shock breakout. It is expected that Kepler will see dozens of supernovas as it continues observations.

More Kepler – The K2 mission of Kepler, which has been going on since 2 of the reaction wheels failed, must turn its broad side to face the Sun every 80 days, in order to maintain alignment during observations, replacing one wheel with sunlight pressure. The next 80-day segment has Kepler staring at the center of our Milky Way, not only to find planets transiting in front of stars, but also to detect microlensing caused by the gravity of stars and planets passing in front of stars. Statistically, they expect to see 5-10 microlensing events caused by rogue planets, that is, planets not orbiting any star. To verify microlensing events, they need simultaneous ground-based observations of the same stars. Such observations have been organized and are beginning.

Super spirals – A new study has found a new type of galaxy, dubbed super spirals. They are much larger than previously known spiral galaxies. They were discovered when some spirals' distances were measured and found to be much farther than previously estimated. Hence they are much larger than thought. They are as luminous and massive as the largest elliptical galaxies known. The study checked 800,000 galaxies within 3.5 billion light-years of us, and found 53 of the giant spirals. The closest one found is 1.2 billion light-years away. Super spirals have 8-14 times the brightness of our Milky Way, and about 10 times its mass. The largest one found is 440,000 light-years across. Super spirals give off copious ultraviolet and mid-infrared light, indicating they are making new stars at a high rate. Theory says that when spirals reach a certain size, they should suck in surrounding gas too fast and quench their star-making ability. 4 of the 53 were seen to have double nuclei, which probably means they are products of galaxy mergers. Such merging may push the super spirals past the quenching stage.



Black hole spin – A team of astronomers has developed a new way to measure the spin of a black hole, and applied it to one at the center of a distant galaxy known as OJ 287. It is rotating at about 1/3 the maximum rate allowed by general relativity. The equator of its event horizon is moving about 236 million mph (105,000 km/s). The galaxy has been observed to flare up about every 12 years since 1891. Astronomers finally figured out that the galaxy has 2 black holes at its center, the smaller orbiting the larger, and every 12 years the smaller crashes through the accretion disk about the larger. The orbit of the smaller black hole precesses, that is, wobbles, in a manner that depends on the spin rate of the larger black hole. Measurements made at the November 2015 flare-up allowed the precession of the orbit, and therefore the spin rate, to be calculated. Some astronomers have questioned whether the precession can be measured with sufficient accuracy, so astronomers would like to find more black hole pairs like this. Previous measurements of black hole spin, made by completely different means, have found several black holes with much larger spin, near the limit. This led to the belief that if a black hole is fed by material falling in from the same direction for long periods of time, it will spin up near the maximum. If the measurement of OJ 287 is accurate, that probably means that a past merger with another black hole slowed the spin down, or that the jets shooting out from the vicinity of

the black hole bleed off spin. The new observations also confirmed that the orbiting black holes are losing energy as they emit gravitational waves.

BEAM – An inflatable space station module, known as BEAM, built by Bigelow Aerospace was launched to the International Space Station for a 2-year test of the inflatable concept. It has multiple layers for protection against collisions with meteoroids and space junk. It holds only monitoring equipment, and will be visited by astronauts periodically for inspections and data retrieval. Results of this test will help refine the design of a larger inflatable habitat intended for use by space tourists.

ExoMars was launched in March on a 7-month flight to the red planet. It is a joint European and Russian mission. It consists of an orbiter to study gases in the atmosphere there and a lander called Schiaparelli to demonstrate landing techniques and do simple measurements on the surface. The orbiter will use about a year of aerobraking (dipping briefly into the top of the atmosphere to alter its orbit) to achieve its final low orbit. Of particular interest will be the orbiter's measurements of methane, which on Earth indicate either biological or geological processes. Finding either type of process on Mars would be amazing. Methane has been found to be both present and not present at various times and places on Mars in the past. So ExoMars's more sensitive instruments should help us unravel this puzzle. ExoMars part 2 will have a rover and a stationary science platform, to launch in 2018.

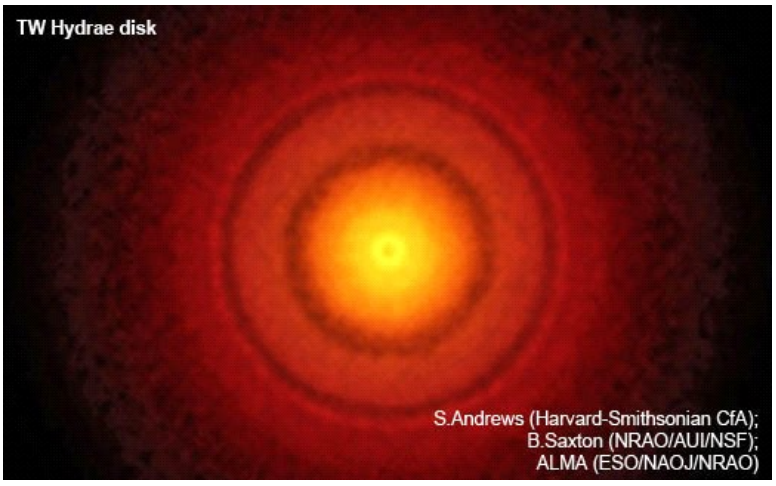
Astro-H/Hitomi (Japanese X-ray space telescope) – It was reported here last month that Hitomi was launched. It began operations, producing excellent data, but then communications with it were lost. Attempts to reestablish contact have not been successful. Observations from the ground seem to indicate that the spacecraft was tumbling fast and had broken into pieces. This is a great loss to X-ray astronomy.

LIGO (gravity wave detector) is not in operation while they upgrade its sensitivity. When it resumes operation in late summer it is estimated that with the upgrade it should see 10-100 gravity waves during the next observing run. They are expected to be from merging black holes or neutron stars. Then the scientists should be able to tell us which kind of merger is more common, an issue being argued by the theorists. Also, we will see if thirty-odd solar mass black holes, such as the first gravity wave detection, are the rule or the exception. Theorists were expecting less massive black holes. Most mergers producing gravity waves will not be detectable at current sensitivity. Estimates are that more often than every hour black holes merge somewhere in the visible Universe. It would be nice, but maybe overwhelming, to have the sensitivity in LIGO to see all those. But still, several per year will be amazing.

Instant AstroSpace Updates

SpaceX has successfully **landed** the 1st stage of their **Falcon 9** rocket on a barge at sea, after boosting a payload to space, opening up the possibility of reusing such rockets, and reducing the cost of orbiting satellites. Previous attempts had failed.

TW Hydrae is in the early stage of forming as a star and of forming planets, and new observations of it by ALMA clearly show the surrounding disk characteristic of stars in this stage, and gaps in the disk likely caused by forming planets.



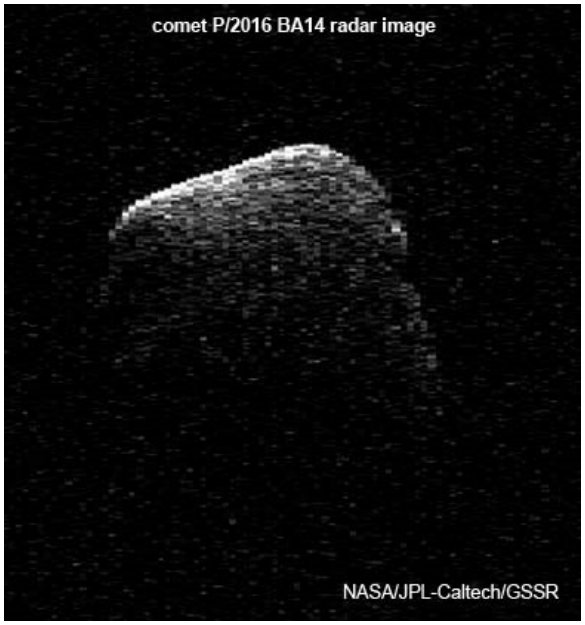
XMM-Newton (X-ray space telescope) has found the 1st known **pulsar** (spinning neutron star) in the **Andromeda** galaxy. Such stars are usually too difficult to see outside our Milky Way, though there should be millions of them in every galaxy.

2 amateur astronomers videoed a brief flash on March 17 on the edge of **Jupiter**, caused by an asteroid or comet **impact**. The brightness indicated the object was tens of yards (m) across.

There are 2 theories for the **formation of Pluto's 4 small moons** (excluding Charon): 1) the collision that produced Charon also produced the small moons, 2) the small moons are Kuiper Belt objects that were captured. Measurements made by New Horizons spacecraft show the small moons have much brighter albedos (reflectivities) than Kuiper Belt objects, so theory 1 is supported.

A new analysis of pictures taken by Huygens from the surface of **Titan** in 2009 shows a (methane) **fog** bank nearby, confirming images from orbit that appeared to show fog. The fog likely formed after a methane rain shower.

High resolution radar images and infrared spectra were taken of **comet P/2016 BA14** in March, when it sped by Earth only 2.2 million miles (3.5 million km) away.



The 2nd year of data has been released from **NEOWISE**, an infrared space telescope looking for near-Earth asteroids or comets, and the data contained 72 new discoveries. NEOWISE took more than 5 million images last year.

A new study using computer simulation showed that asteroid and comet impacts on **Mars** a few billion years ago would produce enough heat to melt substantial subsurface ice, making the planet warm and wet, but only for a few million years per impact.

The **Cold Atom Laboratory** (CAL) is being tested, dropping temperatures to a millionth of a degree and producing strange quantum material known as Bose-Einstein condensate. CAL will be sent to the International Space Station next year to study this material in micro gravity, at even lower temperature.

On April 7 **Kepler** went into an emergency mode due to some failure onboard. Spacecraft controllers have regained control and are confident the spacecraft can resume science operations soon, but somewhat shortening the microlensing campaign (see "More Kepler" item above).

A couple of billionaires are sponsoring studies of how we could send a mission to the star nearest the Sun, which is the **Alpha Centauri** system. It would take at least 1000 times the speed of any existing spacecraft, so would be powered by an Earth-based laser pushing for 20-30 years against microsatellites with solar sails.

OWENS VALLEY RADIO OBSERVATORY TRIP

SCIENCE BEYOND THE BOOK

June 11th,2016

With Dr. Millar

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.

We should arrive 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 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 websites 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. Below 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 RSVP's my contact information is

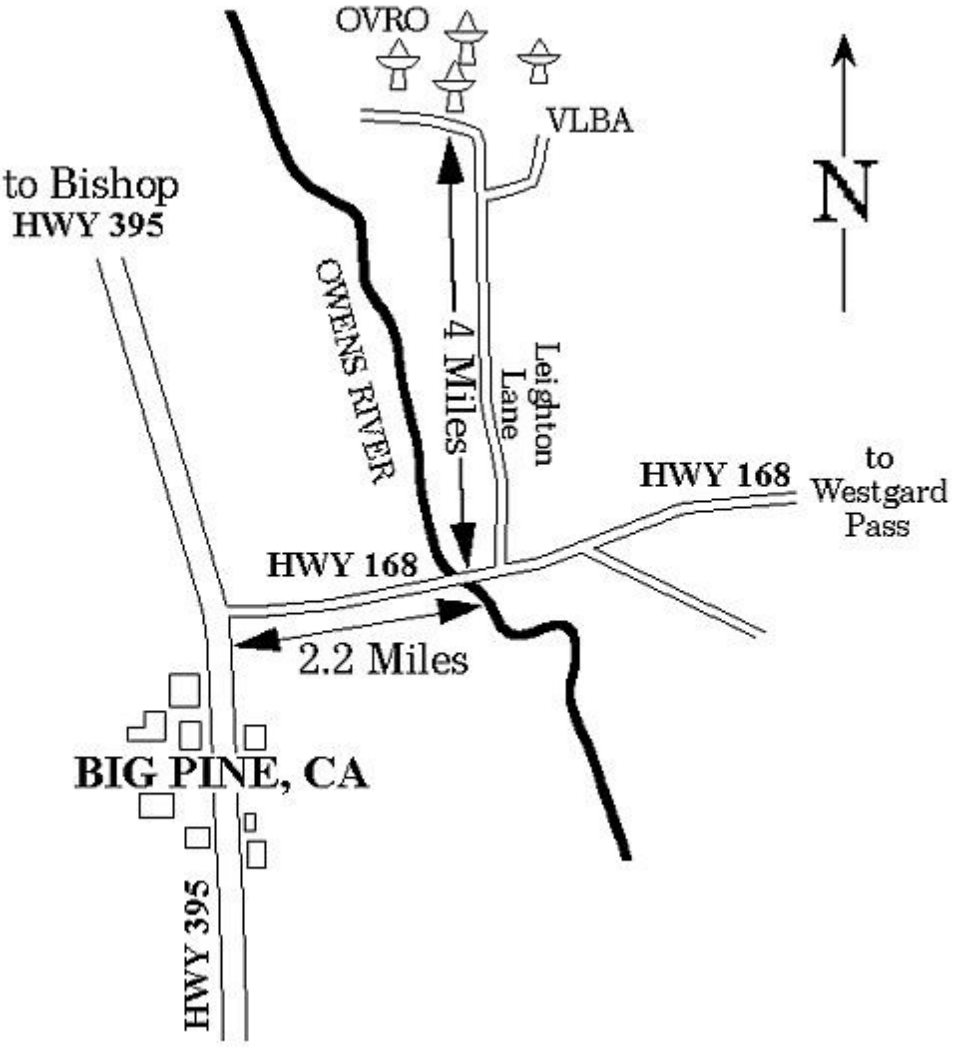
Dr. Doug Millar Cell- 562-810-3989 and email is drzarkof56@yahoo.com

Thank you and I hope to see you on the trip!

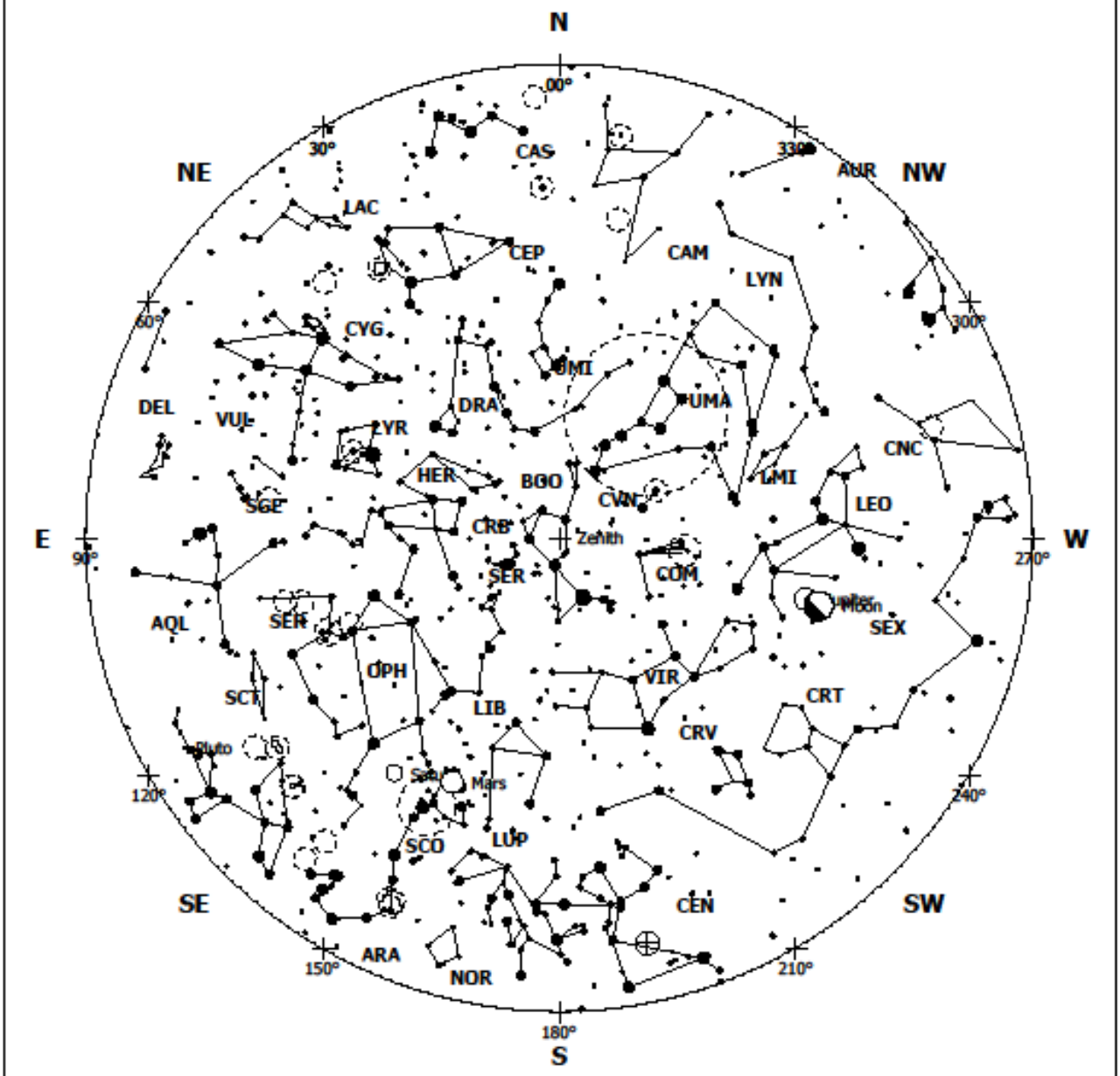
Dr. Millar

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.



May Whole Sky Chart



Symbols

Galaxy	Bright nebula	Antisolar point
Quasar	Dark nebula	Asteroid
Globular cluster	Planetary nebula	Comet
Open cluster	Supernova remnant	Meteor shower

Magnitudes

-6 -5 -4 -3 -2 -1 0 1 2 3 4 5

Location

United States, CA, Long Beach
Lon: 118° 11′ 18″ W, Lat: 33° 46′ 01″ N
Time zone: GMT-08:00
Elevation: 29 feet above sea level

Time

Local time: 2016-05-15 00:00:00
Universal time: 2016-05-15 07:00:00
Julian date: 2457523.79167
Sidereal time: 14h 41m 00s

View

Field of view: 200° 00′ 00″
RA: 14h 41m 00.34s, Dec: +33° 46′ 01.0″
Azi: 180° 00′ 00.0″, Alt: +90° 00′ 00.0″
Constellation: Bootes

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