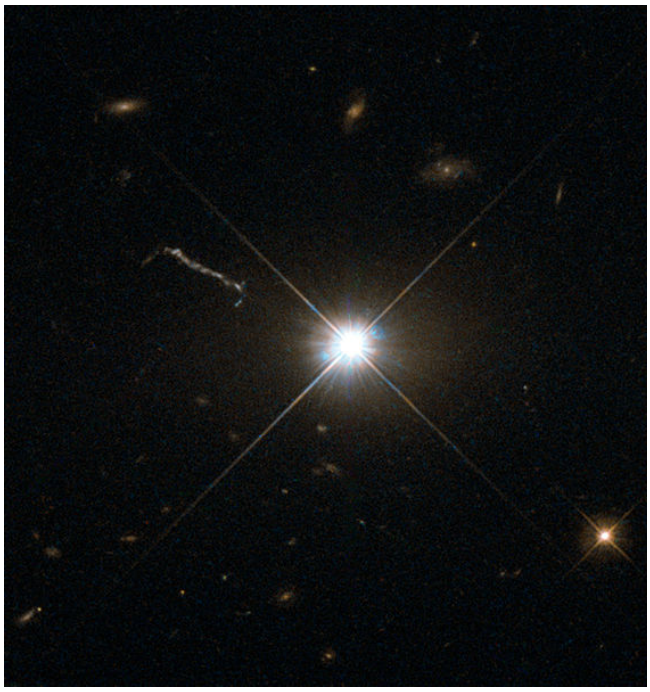
Temecula Valley Astronomer

The monthly newsletter of the Temecula Valley Astronomers July 2018

Events:

General Meeting : No general meeting this month. Check your TVA email for details about the Star-B-Que in Anza.

Please consider helping out at one of the many Star Parties coming up over the next few months. For the latest schedule, check the Calendar on the web page.



Quasar 3C 273 - 2.4 Gly - mag 12.9 – with large scale visible jet ~200,000 ly long. Source: Wikipedia.

WHAT'S INSIDE THIS MONTH:

Send newsletter submissions to Mark DiVecchio <markd@silogic.com> by the 20th of the month for the next month's issue.

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General information:
Subscription to the TVA is included in the annual $25 membership (regular members) donation ($9 student; $35 family).

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Cosmic Comments
by President Mark Baker

STAR-B-Q…!!! What a great ring to it!!! Over the years, this has become a personal favorite event and I am truly thankful for Terry and Frances Ostahowski for “growing” it to where it is now. I don’t ever remember a bad sky, and the people, food, music, and frolic add to a great night of observing the celestial orb through a plethora of different scopes.

Terry had told me last year that it might be the last, so I’m doubly grateful for “just one more time” this year. If you haven’t been to one yet, make this the one…but don’t forget to RSVP, either by email or via the FaceBook page. And feel free to contribute a side dish or dessert, and your favorite beverage…the fine Italian cuisine main course (pizza) will be awaiting your consumption!!!

Thanks again to all members, like the O’s, that make our TVA such a great group. Keep encouraging those around you to look up and enjoy the wonders and beauty of our Universe. It is to be shared!!!

Clear, Dark Skies my Friends…

Looking Up Redux

compiled by Clark Williams

from sources:
Sky and Telescope
Wikipedia
in-the-sky.org
The American Meteor Society, Ltd.
NASA.gov

ALL TIMES ARE LOCAL PST WILDOMAR

Times are given in 24-hour time either as hh:mm:ss or hhmmss. A time given as hhmm+ indicates that it is the hour of the next day. Similarly a time hhmm− indicates a time in a previous day.

Moon Phases for the month by date: (all times are PDT)

Friday the 6th @ 00:50 LAST QTR
Thursday the 12th @ 19:47 NEW
Thursday the 19th @ 03:50 FIRST QTR
Friday the 27th @ 13:20 FULL

Perigee comes on 2018-07-12 @ 01:30 – 357,431 km (222, 098 mi)
Apogee comes on 2018-07-26 @ 23:45 – 406,222 km (252, 415 mi)

2018 has: (12) new moons, (12) 1st Qtr moons, (14) Full moons, (13) 3rd Qtr moons
(2) Blue moons and (1) Black moon

Luna:

Luna can be found rising in Capricornus at the beginning of the month about 22:37:41 PDT. By mid month Luna is rising in Leo and transiting in the afternoon about 15:38 PDT. By the end of the month Luna is rising in Pisces at 22:19 PDT.

Highlights: (from Sky & Telescope)

06 July: Earth is at aphelion (farthest from the sun) at a distance of 152,095,566 km (94, 508, 038 mi).

09 July: Early evening: Venus accompanies Regulus at a separation of less than 1° as Leo, the Lion, sinks in the west.

10 July: Dawn: The thin sliver of the waning crescent Moon is in the Hyades, a mere ½° from Aldebaran, as they rise together in the east.

Night: Jupiter arrives at its stationary point — look for it 2° right of the double star Alpha (α) Librae; henceforth, the giant planet slowly starts moving eastward against the backdrop of stars.

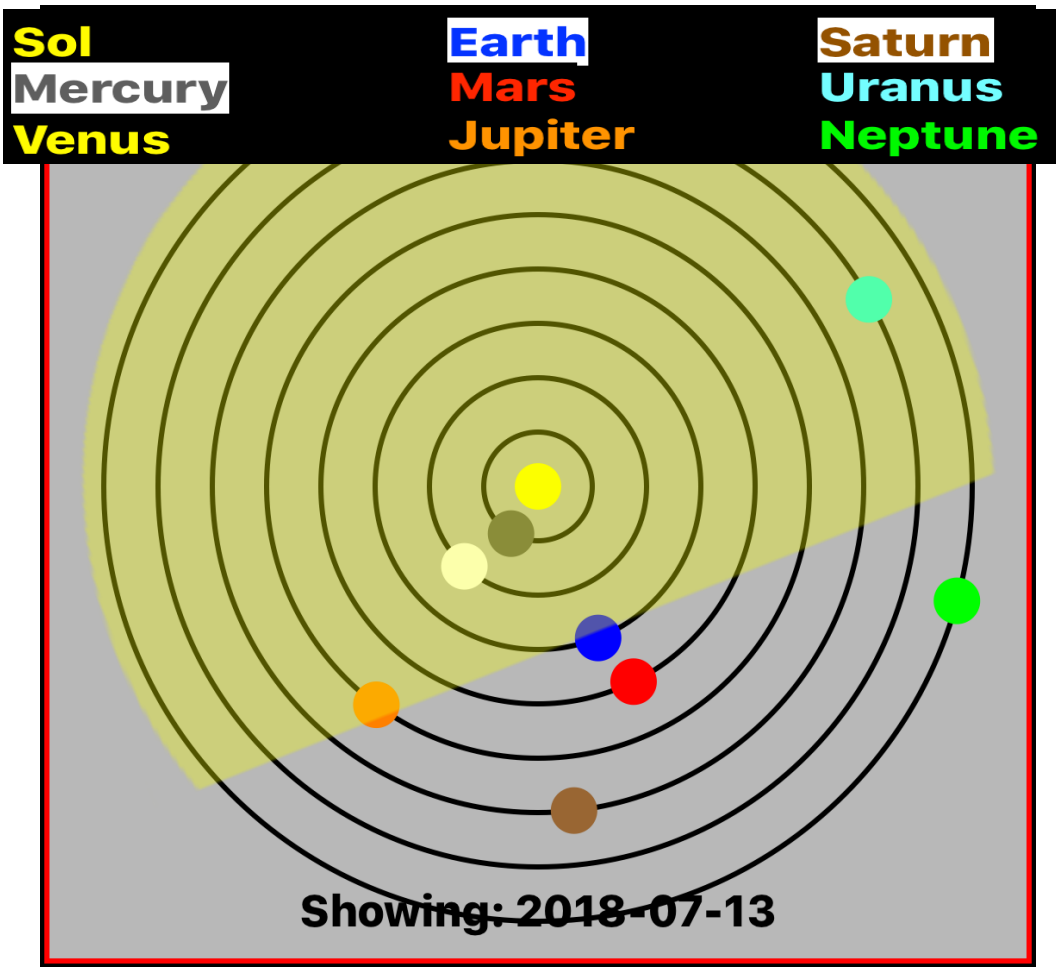
11-12 July: Night: Mercury achieves a greatest eastern elongation of 26°; it then fades from view until re-emerging at dawn in late August.

26-27 July: All Night: Mars arrives at opposition.

30-31 July: All Night: Mars comes closer to Earth than it has since 2003. Look in southwest Capricornus to see the Red Planet blazing at magnitude –2.8 and flaunting a disk some 24.3″ wide.

Planets:

Planetary Positions July 2018: (from TVA App iOS version)



Astronomy retains several hold over definitions from Latin and astrology – yes THAT astrology. The reason for this is that at one time all astronomers were astrologers. One of these words is “dichotomy” and is referred to when a planet or moon is at “dichotomy”. The definition is: the appearance of the moon or of a planet when half of the surface facing the earth is illuminated.

- **Mercury:** Although difficult to see at only 11° above the horizon Mercury will be at dichotomy on Saturday 07 July at 07:56 PDT (14:56 UTC) and shining at mag 0.2. It will then sink towards the horizon, setting 1 hour and 33 minutes after the Sun at 21:37. Mercury will be at greatest eastern elongation on 11 Jul 2018 at 21:00 PDT.

- **Venus:** Will start the month as an “evening star” setting around 2230 and heading for elongation in August. By mid-month it is setting 12 minutes earlier at 2218 PDT. Near the end of the month Venus is setting as early as 2157 PDT. Venus has two conjunctions this month: July 9th, Regulus is about 1° to the lower left of brighter Venus. July 15th, the waxing lunar crescent stands less than 2° lower to the right of Venus.
- **Mars:** July is all about Mars. Mars begins the month rising about two hours after sunset and already glaring at magnitude –2.2, just a little dimmer than Jupiter. But the warrior planet reaches opposition on the night of July 26–27, rising less than a half-hour after sunset and peaking at –2.8 for the final week of July and beginning of August. Mars makes its closest approach to Earth on the night of July 30–31 and reaches a diameter of 24.3″. Mars is more than 24″ wide from July 24th through August 8th and wider than 18.6″ (its maximum 2016 diameter) almost all summer. Mars follows a little bit more than 30° behind ringed Saturn throughout July. Mars is in retrograde just above faint ψ Capricorni around mid-month.
- **Jupiter:** Jupiter is near the meridian in the south soon after sunset in early July. The planet this month fades from magnitude –2.3 to –2.1 and in telescopes shrinks in diameter from 41″ to 38″. Jupiter shines 2° to the upper right of the wide double star α Librae as the planet’s apparent motion slows to a halt during the night of July 10–11. Then the planet resumes direct motion, creeping eastward against the back- ground of the stars.
- **Saturn:** Saturn was at opposition on June 27th and starts July visible from dusk to dawn. Its magnitude fades from +0.0 to +0.2, but the ringed planet continues to glow in the midst of the Sagittarius, slowly retrograding west to within a few degrees of the Lagoon Nebula and the Trifid Nebula. The globe of Saturn has an apparent equatorial diameter of about 18″. The rings of Saturn gloriously remain open to 26°, nearly their maximum tilt. Saturn is highest around midnight or late evening this month.
- **Uranus:** Uranus is a few hours behind Neptune in the sky during July.
- **Neptune:** Neptune is almost at its highest in the south during July dawns.
- **Pluto:** Pluto is dim this month at about mag 14.8. It is also in a very crowded region of the night sky. So it is a real challenge to find and for some it is unrewarding being small in a high magnification eyepiece. On July 11–12, the night of opposition, Pluto is just 12′ from this K-class star, making 50 Sagittarii an obvious jumping of us. The hunt is easier under dark, transparent skies. You need a 10- or 12-inch scope. Draw a sketch so you can return to the eyepiece on the next clear evening to confirm your observation. Pluto dims about a tenth of a magnitude each year as it moves away from perihelion. It won’t stop fading until it reaches magnitude 16 at aphelion in 2114. It continues to move southward each year as well, at least until 2030 when it nears declination –24°. The point of all of this is that your best bet for viewing Pluto is now.

Asteroids:

- From the Asteroids feed – Asteroid 88 Thisbe at opposition: THU, 19 JUL 2018 21:48 PDT

Meteors:

- The Perseid meteor shower, one of the brighter meteor showers of the year, occurs every year between July 17 and August 24. The shower tends to peak around August 9-13. You'll need dark skies in July especially.

Comets:

- Comets come in various classifications:
  - 1) Short Period comets – further broken down into:
    - Halley Type: The Halley Types are believe to come from the Kuiper Belt and have periods in excess of 20-years.
    - Jupiter Type: The Jupiter types have a period less than or equal to 20-years.
    - Short period comets may have a near circular orbit or an elliptical orbit. The latter being far more common.
  - 2) Long Period comets – thought to originate from the Oort cloud these comets have periods of over 200 years and have random inclinations around the celestial sphere.
- 37P/Forbes reaches its brightest on Thursday, 2018 July 05
- P/2013 CU129 (PANSTARRS) reaches its brightest on Monday 2018 July 09
- C/2016 M1 (PANSTARRS) at perihelion on Monday 2018 July 18
- C/2016 N6 (PANSTARRS) at perihelion on Wednesday 2018 July 18

Deep Sky:

In each case you should look for the following on or about the 15th Day of July 2018 at 2100 PDT and you will have about 20 minutes of viewing time total.

The one thing July brings us is the potential for marvelous viewing and imaging:

- **Eagle Nebula** – AKA M-16 or NGC 6611 and also known as the Star Queen Nebula and The Spire is a young open cluster of stars in the constellation Serpens, discovered by Jean-Philippe Loys de Chéseaux in 1745–46. Both the "Eagle" and the "Star Queen" refer to visual impressions of the dark silhouette near the center of the nebula, an area made famous as the "Pillars of Creation" photographed by the Hubble Space Telescope. The nebula contains several active star-forming gas and dust regions, including the Pillars of Creation. The Eagle Nebula is part of a diffuse emission nebula, or H II region, which is cataloged as IC 4703. This region of active current star formation is about 7000 light-years distant. A spire of gas that can be seen coming off the nebula in the northeastern part is approximately 9.5 light-years or about 90 trillion kilometers long. The cluster associated with the nebula has approximately 8100 stars, which are mostly concentrated in a gap in the molecular cloud to the north-west of the Pillars.[5] The brightest star (HD 168076) has an apparent magnitude of +8.24, easily visible with good binoculars. It is actually a binary star formed of an O3.5V star plus an O7.5V companion.[6] This star has a mass of roughly 80 solar masses, and a luminosity up to 1 million times that of the Sun. The cluster's age has been estimated to be 1–2 million years. The descriptive names reflect impressions of the shape of the central pillar rising from the southeast into the central luminous area. The name "Star Queen Nebula" was introduced by Robert Burnham, Jr., reflecting his characterization of the central pillar as the Star Queen shown in silhouette. Do try to image this one. It is beautiful.
- **Elephant Trunk** – a term used to describe certain formations of interstellar matter found in space. Scientists refer to these as cold molecular pillars, referring to their existence in molecular clouds. They are located in the neighborhood of massive O type and B type stars, which, through their intense radiation, can create expanding regions of ionized gas known as H II regions. Elephant trunks resemble massive pillars or columns of gas and

dust, but they come in various shapes, lengths, and colors. Astronomers study elephant trunks because of their unique formation process and use 2-D and 3-D simulations to try to understand how this phenomenon occurs. Besides the apparent image of a lovely little doggie (probably a terrier or a tera-poo [terrier poodle mix]) shape makes this a warm and cuddly image. I've seen many lovely 12-inch, 14-inch and 16-inch scope images of this area. Some rival HST's image of ;this area. You really should give it a shot if you have an imager.

- **The Omega Nebula** – AKA the Swan Nebula, Checkmark Nebula, and the Horseshoe Nebula, cataloged as M17 or NGC 6618, is an H II region in the constellation Sagittarius. It was discovered by Philippe Loys de Chéseaux in 1745. Charles Messier cataloged it in 1764. It is located in the rich star-fields of the Sagittarius area of the Milky Way. The Omega Nebula is between 5,000 and 6,000 light-years from Earth and it spans some 15 light-years in diameter. The cloud of interstellar matter of which this nebula is a part is roughly 40 light-years in diameter and has a mass of 30,000 solar masses. The total mass of the Omega Nebula is an estimated 800 solar masses. It is considered one of the brightest and most massive star-forming regions of our galaxy. Its local geometry is similar to the Orion Nebula except that it is viewed edge-on rather than face-on. The open cluster NGC 6618 lies embedded in the nebulosity and causes the gases of the nebula to shine due to radiation from these hot, young stars; however, the actual number of stars in the nebula is much higher - up to 800, 100 of spectral type earlier than B9, and 9 of spectral type O, plus over a thousand stars in formation on its outer regions. It is also one of the youngest clusters known, with an age of just 1 million years. The luminous blue variable HD 168607, located in the south-east part of the Omega nebula, is generally assumed to be associated with it; its close neighbor, the blue hypergiant HD 168625, may be too. The Swan portion of M17, the Omega Nebula in the Sagittarius nebulosity, is said to resemble a barber's pole.

July is great for both planetary and deep sky viewing and imaging. Spend some time outside with your scope. Summer is here.

For now – Keep looking up.

Random Thoughts
by Chuck Dyson

I Miss That L.A. Smog

In 1980 Mt. St. Helens erupted and a few days later the ash cloud made its way to Red Wash, Utah. Red Wash was the site of my father's pilot plant for testing new methods for extracting oil from shale rock. The ongoing project, at that time, was a fireflood project where large diesel engines would pump air and natural gas unto the oil formation and then the mixture would be ignited and the oil would be heated and thus flow easier to the well heads. As the volcanic ash represented a significant increased particle load for the filters on the engines, the maintenance schedule was changed from weekly service for oil change to every eight hours and filter changes, air and oil filters, every twenty-four hours. Ninety days later the engines were shut down completely as they would not run and the engineer on site told my father that the inside of the engines looked like a hall of mirrors because the little bits of volcanic dust that had gotten into the engines had polished the cylinder walls until they were oversized and the pistons until they were undersized and it was the same story with the crankshaft and the connecting rods. This was my introduction to volcanic ash.

Before saying anything more about ash let's take a look at what it will take to equip a space ship for long duration self-supporting flights between planets and possibly a beyond planets to the Kuiper belt missions. The first thing we will need is space and lots of it for our growing and food processing equipment. There will also need to be a waste treatment plant, as of 2009 the astronauts have had a recycling plant on the ISS and are recycling over 90% of the liquid waste, including urine. Solid waste, however, is still not recycled but is compacted and ejected into a downward trajectory and eventually becomes a "shooting star "in the earth's atmosphere. To be fair though I must say that NASA, through Pennsylvania State University, is working on a bacterial digester that will convert most of the solid waste into mineral salts and methane gas that will then be fed to a bacterium that will then convert the methane into a high protein goo, the researchers words not mine, that can be eaten.

If you are not up to eating green goo every day NASA and Russia have two different experiments designed to explore the possibility of growing garden plants in space, LADA for the Russians and VEGGIE for the U.S. Both of these experiments are first generation and are designed mainly to determine the following: what plants will grow, how to grow the plants optimally, are the plants equal in nutritional content to the plants grown on earth, all living things switch on and off different genes in space compared to the earth, and are the plants safe, bacterially, to eat. Although humans and plants struggle to adapt and survive in space the bacterium thrive in it and rapidly adapt and alter themselves to grow faster and become more pathogenic, super bugs; so, there is the well-founded worry that spaceships in general and plants in particular will become victims of a space plague from mutant bacteria.

Now that we have discussed the easy problems of long term space flight let's look at what it would take to start an off-Earth colony.

On the Northern Canadian island of Devon, there is an experiment going on to design a working greenhouse for a Mars colony. It would be hard to find a better place to test a Mars

greenhouse than Devon because it is 75 degrees north of the equator and in the summer the Sun never rises more than 35 degrees above the horizon producing a summer environment very similar to the Martian equator at the height of summer. In addition to being cold all year long, Devon is a desert island so the land conditions mimic Mars, dry and rocky. The Canadian team started in 2002 to design and build a greenhouse that would autonomously plant, water, adjust temperature, direct the maximum sunlight to the plants, and finally harvest the mature plants. Needless to say things did not go well for the first decade, but now the greenhouse is operating for eleven months out of the year with no human intervention.

The thought behind the autonomous operation was to be able to drop the greenhouse on the target body, the Moon or Mars, and have it set itself up and start growing food before the astronauts arrived. Cool!

Let's say the Devon green house is ready to go and we have acceptable plants, well then the ideal test area would be the Moon as it is just days away and not months away like Mars. Besides we have already been there in the 70's and now have much more space experience so setting up a Moon colony should be a snap. Not so fast cowboy. We may have space experience but it only in low Earth orbit and not completely in outer space. The average altitude of the ISS is 405 Km and the average altitude of the atmosphere is 500 Km so the ISS still gets a little radiation protection and in addition the altitude of the Earth's magneto sphere is, on the Sun side at 65,000 Km so the ISS is greatly protected from much of the space radiation that bombards us. On the Moon there is no protection from space radiation and its effects on human genes and brain. To get experience in space completely outside of the Earth's protective cocoon NASA plans to, before establishing a moon base, to establish a Lunar Orbiting Outpost, a sort of a 7/8 of the way house. Once the Lunar Orbiting Outpost is established in cislunar orbit, and that's a new word for your dictionary, and functional then the construction of a lunar base could start probably at the lunar North or South Pole as this will obviate the need to deal with the lunar 14 day long night, place the base in a temperature friendly area, as compared to the lunar equator, and possibly place the base near water sources. Once the astronauts are on the lunar surface the real fun begins and that is dealing with the lunar dust. First a reminder just like the destructive dust from Mt. St. Helens the lunar dust is actually rock glass with sharp edges, unlike Mt. St. Helens on Earth there is no atmosphere with rain to weather the dust on the moon so it stays sharp and nasty. To make thing even worse on the Moon UV radiation that is blocked by the Earth's atmosphere gets to bombard the dust particles on the Moon and in a vacuum this leads to metallic deposition on the dust particles, much like the way we coat the mirrors in our telescopes, and this deposition makes the particles magnetic and attracted to the astronauts' space suites. The astronauts were on the moon for a total of 12 days and in that time logged a total of 80 hours outside of the lunar lander. In the time that the astronauts were on the Moon the dust managed to do the following; make the gauges on the rovers unreadable by scratching up the gauges' cover glass, clogged up the rovers battery cooling system thus causing the batteries to overheat easily, wore through the three layers of Kevlar like covering of the astronauts boots in three days (you will need lots of pairs of shoes if you are going to live on the Moon), jammed the elbow joints on the space suits, interfered with the ability to create air tight seals in the crew cabin and the space suit oxygen connections, and finally caused pulmonary problems and ocular problems with the astronauts as they breathed the find dust and it got into their eyes. If

one plans to stay on the moon for even a year it becomes painfully obvious that dealing with the lunar dust is going to be a major issue and in all probability the engineers will be doing major redesigns of suites, habitats, rovers and green houses. After two or so years on the Moon and with space gear that actually works and has a reasonable life span, I do not think that a five day life span is reasonable; we could actually be ready to go to Mars.

What the heck, let's go to Mars. First let's get a quick handle on what it means to go to Mars as opposed to the Moon. On average the Moon is 384,400 kilometers away from us, not exactly a walk in the park distance but close by in solar system standards. Mars, on the other hand, averages over 80 million kilometers at its closest and just over 400 million kilometers at its farthest. When you go to Mars you will be completely on your own for at least two years because with today's rockets it is just not possible to go to Mars except when it at its closest approach to us and that is every two years. One of the big questions that a Mars colony needs to answer is should the greenhouses be on the surface or underground each choice has its advantages and disadvantages. The above greenhouse will get some solar energy to help the plants grow and the underground one will not be subject to the extreme temperature swings of the Martian day and will be protected from the radiation that gets to the surface of Mars.

The next big question for living on Mars is how to handle the perchlorates. The basic perchlorate compound is one chlorine atom and four oxygen atoms and is soluble in water. The trouble comes when the perchlorate breaks down in water and releases its considerable binding energy suddenly as this has a tendency to tear apart organic protein compounds and as we are made of proteins, it has a tendency to tear apart us. Are there perchlorates on Earth? Yes. However, here is the problem, on earth the highest concentration of perchlorates is found in the Atacama Desert of Peru, as it is high and dry, but the concentration there is 1.2 parts per billion while on Mars the average concentration form several sample sites is 0.6% to 0.4% by weight and when you do the math to compare the two concentrations you find that the Mars concentration is 60,000 to 40,000 times that of the concentration found in the Atacama Desert. How toxic are concentrations of the various perchlorate compounds suspected to be on Mars? As we have nothing on Earth to compare it with we have no idea; however, we do know, from experiments on lab animals and the use of perchlorates as medicines, that they can and do cause lung failure, shutdown both temporarily and permanently the thyroid glands ability to take up iodine, and have caused some immune systems to stop functioning. How will the astronauts get exposed to the Martian perchlorates? That question, my children, brings us to the subject of the Martian dust. First the good news, Martian dust is different than lunar dust as it is composed of clay particles and is not as hard and abrasive as the lunar dust. Now the bad news, when simulated Martian dust was tested against Lunar simulated dust, and I must say simulated because we have never had any real Mars dust to use as a basis for our dust model whereas for the Lunar simulated dust it was modeled after the real dust samples brought back from the Moon, the Martian dust was much more toxic than the Lunar dust, oh joy. More bad news, even though the Mars dust is softer than the lunar dust because Mars has no active core it has no magnetosphere and those pesky high energy rays and particles hit the surface and create a magnetic charge on the surface of that dust and just like the lunar dust it loves to stick to space suites and that means that every time the astronauts/colonists go out their suits will become dust magnets and over the period of a year or so one can expect the

suits to bring into the habitat a considerable quantity of dust; and yes, one of NASA's major goals is figuring out how to strip dust off the suits on both the Moon and Mars missions.

Is there any really good news regarding Mars dust? Maybe. Microbiologists have identified around 40 types of bacterium that will use perchlorates as an energy source and in the process convert it into a salt and oxygen. I said that this maybe be good news because the

surface is bombarded with UV light and contains iron oxides and peroxides (H_2O_2) these compounds are definitely not friendly to life; so, the jury is still out as to whether or not our Earth bacteria can survive on Mars and actually make a meal out of the perchlorates. The really good news is that once the perchlorates are removed from the Martian regolith many plants will happily grow in it, unfortunately the same cannot be said about the lunar regolith (see figure above) and the best news of all is that some researchers threw some coffee grounds into one of the Martian regolith samples and the plants really took off. The answer to our Mars colony problem appears to be a simple one; just send a bunch of coffee drinkers and several tons of beans to Mars and in 100,000 cups of coffee or so, we will have an ecologically balanced colony.

Definitions

- Regolith: All of the broken up rock, big and small pieces, above bedrock.
- Soil: The part of the regolith that has organic material in it. As The Moon and Mars have no plant material they have no soil. NASA hopes to change that.
- Publicity stunt: Elon Musk's Mars plans.

Cheers,
Chuck

Swarms of Black Holes
by Clark Williams

There has been a lot of discussion regarding Supermassive Black Holes (SMBHs) at the center of galaxies recently. The intention of this article is to cover the background of what all this discussion is about.

When astronomers discovered supermassive black holes at the center of most galaxies the immediate question was “how did the SMBHs get there?” The problem is that the theory of cosmological evolution didn't account for supermassive black holes. So we came up with an augmentation to our theories. We weren't happy with the augmentations but it was a start. Still, like inflation theory, our augmentations allowed for things we just couldn't explain without the new theory but raised questions difficult to answer because of the new theory.

Then we discovered a quasar 13.1 billion light years from Earth (*Editor’s note: The first Quasar, 3C 273, was identified in 1963 by Maarten Schmidt using the 200 inch Hale Telescope at Palomar Observatory*). The quasar is a visible signature of a supermassive black hole near the quasar's center and emitting polarized particle jets shinning 400 trillion times brighter than our Sun. This new (to us) supermassive black hole weighs in at 800 million solar masses and that is over 175 times the mass of the SMBH at the center of our Milky Way Galaxy. This 800 million solar mass SMBH is now the oldest SMBH identified. The problem is that our current theories can't account for SMBHs forming so soon after the Big Bang.

So once again we are at the same question: How do the SMBHs form?

One hypothesis put forward by physicist Nassim Haramein is that black holes formed first, before Population III stars (the earliest stars) formed. These black holes then pulled in other stars when they formed and created galaxies. Thus SMBHs are a consequence of the physics of the Big Bang.

Recently a different hypothesis has gotten some backing from collected data. What if there were numerous smaller black holes and these merged over time to create SMBs? Since the physical mechanisms that would support the formation of SMBHs in this way takes a L-O-N-G time, there should still be perhaps dozens maybe even hundreds of black holes in the central core of galaxies.

This hypothesis is something that intrigued researchers for decades. Recently a paper published in *Nature* by Charles J. Hailey, Kaya Mori, Franz E. Bauer, Michael E. Berkowitz, Jaesub Hong & Benjamin J. Hord (https://www.nature.com/articles/nature25029), called: *A density cusp of quiescent X-ray binaries in the central parsec of the Galaxy*, described their results of looking at the Central Parsec Core in the direction of Sagittarius A. They conclude that there are dozens of black holes in the Central Core and the implication is that there are

many more. Statistically they theorize in their paper that there could be hundreds of "...binary systems in the central parsec of the Galaxy and many more isolated black holes."

So where did these black holes come from? One possibility is from globular star clusters.

Star clusters come generally in two types: globular clusters and open clusters. Open clusters are loosely bound and usually composed of young stars. Globular clusters are gravitationally bound and composed of hundreds or thousands of very old stars (see https://en.wikipedia.org/wiki/Star_cluster).

M13 and M92 are examples of globular clusters. M13 is a year round visible object. Both M13 and M92 are in Hercules. An example of an open cluster is the Pleiades.

So how does this all work? Differentiation is the current simple answer. "Denser" things "sink" to the center and lighter thing "float" at a layer above the denser ones. In reality, imagine a trampoline surface. Heavier (more massive) items would seek the center of the trampoline surface while lighter (less dense) objects would cluster around the more dense objects. By analogy the black holes would be the more dense objects and would 'gravitate' toward the central core.

So the mechanism works like this – a large enough star 5 to 15 solar masses goes supernova and blows off most of its atmosphere. Since it is large enough, it collapses into a black hole. Keep in mind that the atmosphere has been blown away but the remaining star is from 5 to 15 solar masses heavier than the "average" stars around it. So it begins to migrate toward the lowest point of the gravity well. As it moves other stars are gravitationally attracted toward the black hole and essentially they begin to "draft" the black hole just as car might draft an eighteen-wheeler on the highway. This steals momentum from the black hole and it begins to spiral toward a lower-energy orbit closer to the central core. The black hole may also sling a star into a higher orbit and loose momentum in that way as well. This also decreases the momentum and allows the black hole to seek an even lower-energy orbit closer to the Central Core. This mechanism of orbital decay is known as "dynamical friction".

Remember the globular clusters? Well they are old and have been around a long time. They also are assumed to have surrounded galaxies in an earlier time. There must have been a fair number of black holes in these globular clusters and over time dynamical friction helped some of them collect in the galactic center, bringing their black holes with them. Again this is assumed to take a very L-O-N-G time! The end result is some of the black holes merge creating a SMBH in the process. While others are continuing their journey slowly toward the Central Core.

For a more visual explanation see *PBS Space Time* on ***YouTube*** at: https://www.youtube.com/watch?v=UVhtKAnp3G4

A Close-Up View of Mars

By Jane Houston Jones and Jessica Stoller-Conrad

In July 2018, skywatchers can get an up close view of Mars—even without a telescope! In fact, on July 31, Mars will be closer to Earth than it has been in 15 years.

Why is that?

Like all the planets in our solar system, Earth and Mars orbit the Sun. Earth is closer to the Sun, and therefore it races along its orbit more quickly. Earth makes two trips around the Sun in about the same amount of time that Mars takes to make one trip.

Sometimes the two planets are on opposite sides of the Sun and are very far apart. Other times, Earth catches up with its neighbor and passes relatively close to it. This is called Mars's closest approach to Earth, and it's happening this year on July 31. The Moon will be near Mars on that night, too!

Keep in mind that even during its closest approach, Mars is still more than 35 million miles away from Earth. That's really far. So, Mars won't appear as big as the Moon in the sky, but it will appear bigger than it usually does.

July and August will be a great time to check out Mars. Through a telescope, you should normally be able to make out some of the light and dark features of the Red Planet—and sometimes even polar ice. However, a huge Martian dust storm is obscuring these features right now, so less planetary detail is visible.

There is another important Mars date in July: Mars opposition. Mars opposition is when Mars, Earth and the Sun all line up, with Earth directly in the middle. This event is happening on July 27 this year.

Although you may see news focusing on one of these two dates, Mars will be visible for many months. For about three weeks before and three weeks after opposition and closest approach, the planet will appear the same size to a skywatcher.

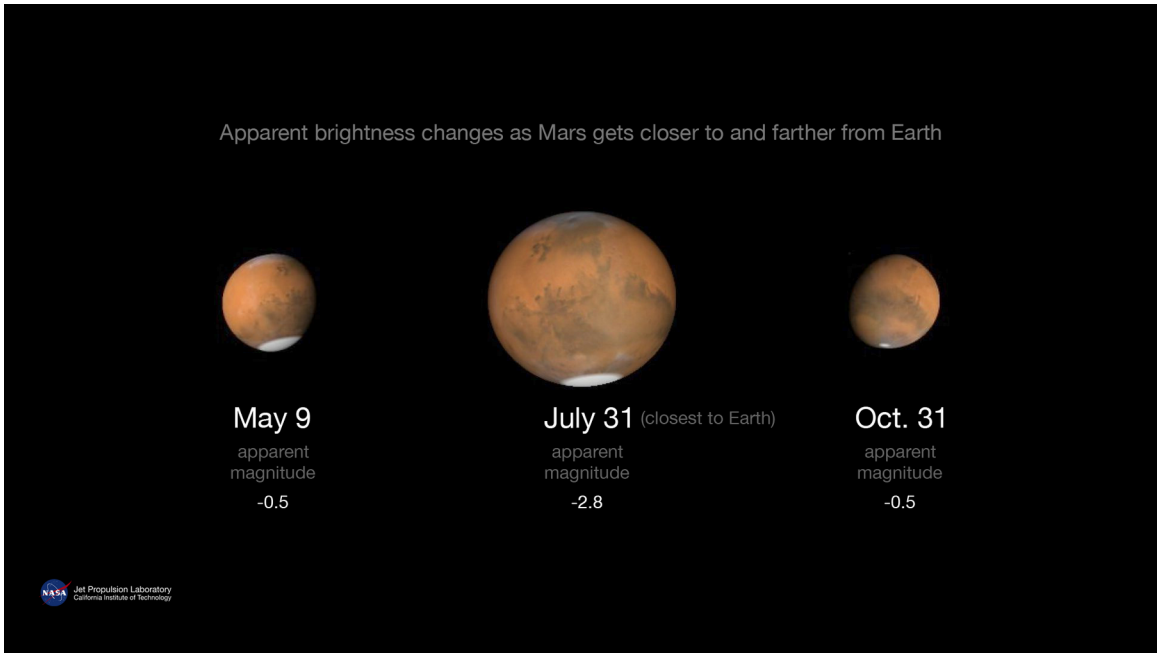
From July 7 through September 7 Mars will be the third brightest object in the sky (after the Moon and Venus), shining even brighter than Jupiter. The best time to view Mars during this time is several hours after sunset, when Mars will appear higher in the sky.

Mars will still be visible after July and August, but each month it will shrink in size as it travels farther from Earth in its orbit around the Sun.

In other sky news, there will be a partial solar eclipse on July 13, but it will only be visible from Northern Antarctica and southern Australia. On July 27 (beginning at 20:21 UTC), a total lunar eclipse will be visible in Australia, Asia, Africa, Europe and South America. For those viewers, Mars will be right next to the eclipsing Moon!

If you're wanting to look ahead to next month, prepare for August's summer Perseid meteor shower. It's not too early to plan a dark sky getaway for the most popular meteor shower of the year!

You can catch up on NASA's missions to Mars and all of NASA's missions at www.nasa.gov



Caption: In 2018, Mars will appear brightest from July 27 to July 30. Its closest approach to Earth is July 31. That is the point in Mars' orbit when it comes closest to Earth. Mars will be at a distance of 35.8 million miles (57.6 million kilometers). Credit: NASA/JPL-Caltech

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