The SAN MATEO COUNTY ASTRONOMICAL SOCIETY

April-May, 2019 Issue: 660th General Meeting Notice: June 21, 2019

659th General Meeting Notice: May 03, 2019

EVENT HORIZON

Founded in 1960, the San Mateo County Astronomical Society is a 501(c)(3) non-profit organization for amateur astronomers and interested members of the public. Visitors may attend Society meetings and lectures on the first Friday of each month, September to June, and star parties two Saturdays a month. All events are free for visitors and guests. Family memberships are offered at a nominal annual cost. Detailed membership information is found at ***http://www.smcasastro.com/membership.html*** *where those who want can join via PayPal. Membership also includes access to our Event Horizon newsletter, discounted costs and subscriptions to calendars and magazines, monthly star parties of the Society and the College of San Mateo, use of loaner telescopes, field trips, social occasions and general meetings presenting guest speakers and programs. For additional information, please email us at* ***SMCAS@live.com****, or call* ***(650) 678-2762****.*

Membership forms are available near the end of this newsletter beginning on page 23.

Figure 1: Mary Ann McKay and Bill Lockman recap the Spring 2019 Equinox Party on page 14. Photo by Bill Lockman.

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Tuesday, June 18, 2019, 7 pm –9 pm: SMCAS Board Meeting, CSM ISC Room 110
Friday, June 21, 2019, 7 pm –10 pm: General meeting, Pizza and Presentation, Page 18
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May, 2019 Solar System Rise and Set Times:

By Ron Cardinale, SMCAS Member

SMCAS 2019 (PDT)	May 4 Rise	May 4 Set	May 11 Rise	May 11 Set	May 25 Rise	May 25 Set
Sun	6:09 AM	8:02 PM	6:02 AM	8:08 PM	5:52 AM	8:19 PM
Moon	6:23 AM	7:58 PM	12:18 PM	1:53 AM	1:25 AM	11:56 AM
Mercury	5:33 AM	6:30 PM	5:37 AM	7:10 PM	6:08 AM	8:49 PM
Venus	5:07 AM	5:45 PM	5:01 AM	5:59 PM	4:51 AM	6:28 PM
Mars	8:23 AM	11:11 PM	8:15 AM	11:04 PM	7:59 AM Northeast	10:49 PM
Jupiter	11:01 PM	8:40 AM	10:31 PM	8:10 AM	9:29 PM	7:09 AM
Jupiter's moons	g iJe c		c g iJe		g cJie	
11:3 PM, East on left	J=Jupiter, c=Callisto, e=Europa, g=Ganymede, i=Io					
Saturn	12:57 AM	10:41 AM	12:29 AM	10:13 AM	11:29 PM	9:16 AM
Uranus	5:44 AM	7:04 PM	5:18 AM	6:38 PM	4:25 AM	5:47 PM
Neptune	3:53 AM	3:22 PM	3:26 AM	2:56 PM	2:32 AM	2:02 PM
Pluto	1:09 AM	10:52 AM	12:42 AM	10:24 AM	11:42 PM	9:28 AM
- Star parties are at Crestview on the 4th and 25th.						
- Jazz Under the Stars is at CSM on the 11th.						

President's Corner

Welcome to the April edition of Event Horizon…. The summer ahead of us is going to have a lot of activities for club members. These are the following events to attend as a club or individually:

- The Splashdown 50th Anniversary at the USS Hornet Museum. The USS Hornet recovered the Apollo 11 astronauts from the Pacific after their splashdown on July 24th, 1969. The museum will hold an 8-day long event starting on August 16th with the main event on August 24th onboard the Hornet. More information is available at www.uss-hornet.org.
- For those looking for dark skies, the Golden State Star Party will be June 29th – July 3rd at the Frosty Acres Ranch near Adin, CA. and the Oregon Star Party will be July 30th – August 4th in central Oregon. Both are excellent events and offer views of the Milky Way from horizon to horizon with the naked eye. While not official club trips this year, some members will be attending. Please send a note to the membership email smcas@groups.io if you are looking to coordinate your trip with others attending.
- SMCAS will be hosting a Yosemite Glacier Point star party for the National Park Service the nights of July 19th and 20th. This will be an organized club trip. We are working on details for transportation and camping logistics. We are limited to 30 attendees and have a sign up list already started. Please contact Frank Seminaro if you wish to attend. The trip is limited to club members or those accompanied by a club member. Our goal is to support the event with a presentation and at least 15 telescopes for viewing.
- Our Crestview Park star parties/outreach should get busy in the next few months. Summer viewing will have Jupiter, Saturn, Mars, a partial lunar eclipse and a solar eclipse (if you want to travel to South America). Hopefully we will have crystal clear skies at Crestview for a change! For more information about the Crestview star parties, see Page 22.



Clear Skies!

Frank Seminaro
President, San Mateo County Astronomical Society
Frank_Seminaro@yahoo.com

Editor's Report: First Direct Image of a Black Hole's Shadow

By Bill Lockman, SMCAS Board member

Einstein's Theory of General Relativity (GR) predicts the existence of black holes, regions of space-time where the pull of gravity is so strong that nothing, not even light, can escape from inside a bounding surface known as the event horizon (not coincidentally, the name of our newsletter). There is plenty of indirect observational evidence for the existence of black holes, but prior to April 10, 2019, nobody had ever directly observed the shadow of a black hole. The primary reason is that black holes and their surrounding accretion disks are extremely compact objects and thus, difficult to resolve. The event horizon of the supermassive 6.5 billion solar-mass black hole M87* located near the center of the elliptical galaxy M87 some 55 million light years away in the Virgo Cluster has a Schwarzschild diameter of 1.5 light-days. The bright radio emission ring seen in Figure 2 subtends an angle of ~42 micro arc seconds (μas). To resolve substructure within this angular cone using 1.3 mm wavelength radio waves requires a radio telescope mirror with a diffraction-limited resolution of ~25 μas[1]. Such a mirror would have a diameter approximately that of the Earth's!

To achieve this resolution, the ~200-member Event Horizon Telescope (EHT) Collaboration linked together an array of eight radio telescope stations distributed over six geographic locations around the world, forming an Earth-sized virtual mirror using very long baseline interferometry (VLBI). The data used to image M87* were acquired over several days in April, 2017, then analyzed and validated over the next two years, during which time the collaboration cloaked their work in complete secrecy.

On April 10, 2019, the EHT researchers revealed that they had finally succeeded in capturing the first-ever visual image of the shadow of a black hole[2], that of M87*, as

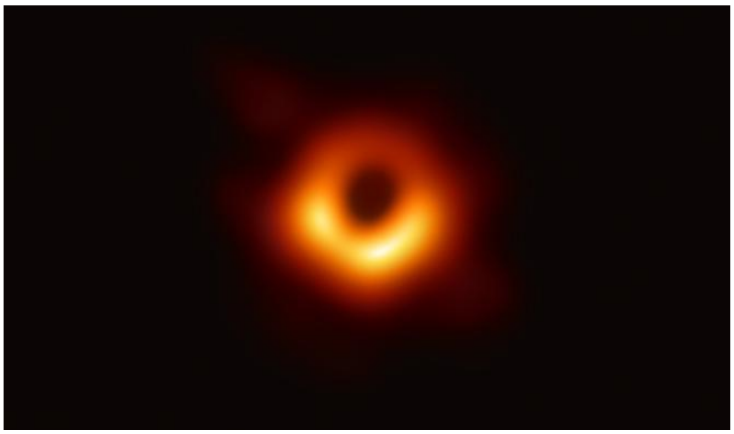

Figure 2. Scientists have obtained the first image of a black hole, using Event Horizon Telescope observations of the center of the elliptical galaxy M87. The image shows a bright radio emission ring formed as light bends in the intense gravity around a black hole that is 6.5 billion times more massive than the Sun. This long-sought image provides the strongest evidence to date for the existence of supermassive black holes and opens a new window onto the study of black holes, their event horizons, and gravity. Credit: Event Horizon Telescope Collaboration

[1] 25 μas is the angle subtended by a 5 cm-diameter disc on the moon as viewed from Earth.

[2] The shadow of a black hole is the closest we can come to an image of the black hole itself, a completely dark object from which light cannot escape. The black hole's boundary — the event horizon from which the

shown in Figure 2. This breakthrough was announced in a series of six papers [I, II, III, IV, V, VI] published in a special issue of The Astrophysical Journal Letters, along with a focus issue that summarizes the published results.

A YouTube video posted before its release describes the features that might be seen in the EHT image of M87*, including its shadow. The edge of the shadow is the so-called "photon capture ring" having a radius 2.6 times that of the black hole's event horizon. Inside the shadow, photons traversing the curved space-time surrounding the black hole are eventually captured. Therefore, this region appears black. As explained in a follow-up video, the clockwise-rotating plasma forming the accretion disk contains bright and darker areas where the plasma is coming toward us and going away from us, respectively. This variation is due to relativistic beaming.

These image features persisted over many independent EHT observations, and also matched the predictions of computer simulations that include the physics of warped space, superheated matter and strong magnetic fields, according to Paul T.P. Ho, EHT Board member and Director of the East Asian Observatory. The features seen in the EHT image of M87* indicate that its shadow exists, its slightly oblong shape is consistent with that of a spinning (Kerr) black hole as predicted by GR, and the inferred mass derived from its shadow size is [VI]:

$$\mathrm{M} = \left[6.5 \pm 0.2_{\mathrm{stat}} \pm 0.7_{\mathrm{syst}}\right] \times 10^9 M_{\mathrm{sol}}.$$

More details on lessons learned are listed here.

In April 2017, the EHT collaboration also acquired data on Sagittarius A*, the much smaller 4-million solar-mass black hole located at the center of the Milky Way galaxy, 25,640 light years away. Sagittarius A* is more challenging to image because it exhibits greater variability in radio flux density over short time periods than M87* does, according to EHT director Shep Doeleman of Harvard University and Harvard-Smithsonian Center for Astrophysics. Consequently, these data are still being analyzed.

Addressing future improvements, Doeleman states that it should be possible to sharpen existing images using improved algorithms. In newer 2018 data, the EHT team added one additional dish, in Greenland, and also plans to add yet another, one at Arizona's Kitt Peak, to increase the imaging fidelity of the Earth-sized virtual mirror further. The project also plans to image at shorter wavelengths, 0.87 mm, which increases the angular resolution by 30%. Over the longer haul, the collaboration would like to enhance the virtual mirror by

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EHT takes its name — is around 2.6 times smaller than the shadow M87* casts and measures just under 40 billion km across.

adding a space-based radio telescope in orbit around the Earth. "*It would sweep out even more of that virtual mirror and do it much more quickly,*" says Doeleman.

References to the First M87 Event Horizon Telescope Results:

I. The Shadow of the Supermassive Black Hole
II. Array and Instrumentation
III. Data processing and Calibration
IV. Imaging the Central Supermassive Black Hole
V. Physical Origin of the Asymmetric Ring
VI. The Shadow and Mass of the Central Black Hole

Near Earth Asteroid Hazards, Research and Space Missions

By Ken Lum, SMCAS Board Member

Asteroids are one of the classes of small body remnants left over from the formation of the Solar System that did not form any main planets. The others include comets, Kuiper Belt objects, the Oort cloud, interplanetary dust responsible for the Zodiacal Light, etc. Dr. Michael Busch of the SETI Institute came in March to describe asteroids and the projects and missions that are being conducted to study them (Figure 3).

Figure 3: Ken Lum (left) and Dr. Michael Busch (right) examining some asteroid samples.

The first asteroid to be discovered is Ceres which was discovered in 1801 by Giuseppe Piazzi and recently visited by NASA's Dawn spacecraft from 2015 to 2018. Since then well over 300,000 have been discovered and catalogued that are at least 3 km diameter and larger. But millions of even smaller objects are estimated to exist and remain to be found.

Asteroids are broadly divided into 3 groups depending on where they are. Most are in an orbital region between Mars and Jupiter. These are known as ***Main Belt Asteroids***. There may be as many as 1-2 million asteroids in this region. A second group are called the ***Trojan Asteroids*** which are located at the Lagrange Points in front of and behind Jupiter along its

orbital path. Finally, there are the ***Near-Earth Asteroids*** ***(NEAs)*** whose members come close to the Earth and may pose collision hazards with Earth.

Dr. Busch mostly described efforts to find, characterize and track ***NEAs.*** The proposal by **Dr. Walter Alvarez** of UC Berkeley in the 1990s that an asteroid impact caused the extinction of the dinosaurs (see accompanying article beginning on Page 11) along with the actual observed impact of **Comet Shoemaker-Levy 9** into Jupiter in 1994 greatly motivated the development of this search with an eye towards impact hazard mitigation. Other recent collision events on Earth such as the 1908 **Tunguska Event** in Russia and the 2013 explosion of an asteroid over **Chelyabinsk** – again in Russia, added to the urgency.

Among the most active ground-based searches mentioned by Dr. Busch include **Pan-STARRS** **(Panoramic Survey Telescope and Rapid Response)** in Hawaii, and the **Catalina Sky Survey** **(CSS)** in Arizona. Included in these is the **Siding Spring Survey** **(SSS)** in Australia to provide southern hemisphere monitoring. The **Lincoln Near-Earth Asteroid Research** (**LINEAR**) project in White Sands, New Mexico, surveyed for asteroids between 1998 to 2005 until **CSS** assumed those responsibilities.

In space, the **Wide Field Infrared Survey Explorer** **(WISE)** telescope was launched by NASA in 2009 and has continued to search for **NEAs** to this day. Finally, the **Large Synoptic Survey Telescope** **(LSST)** in Cerro Pachón, Chile (discussed in last month's Event Horizon newsletter) is due to start its science run around 2022 and will search for NEAs as part of its mission. Collectively, these and other projects have catalogued approximately 2000 NEA objects per year since their inception and accumulated a total catalogue of over 19,000 NEAs.

Aside from cataloguing NEAs, these projects have been characterizing their orbits to help estimate their collision risk, determining their sizes, compositions, and masses, and, in some cases obtaining images to assess their shapes. This has been done by directly visiting the asteroids with imaging spacecraft as in the case of NASA's ***Dawn*** and Japan's ***Hayabusa 1 and Hayabusa 2,*** among others. In the case of Hayabusa 1, a small sample was even brought back. Or they have been imaged from ground-based radar using NASA's Deep Space Network and the Arecibo radio telescope in Puerto Rico.

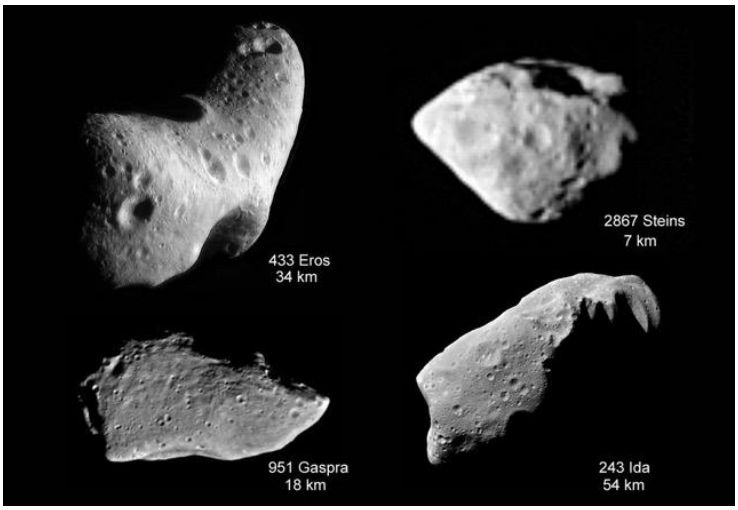


Figure 4: Examples of some small irregularly shaped asteroids. Photo courtesy of NASA.

Because they are generally not massive enough to have formed by default as spheres, asteroids have been found to come in many and varied shapes and sizes as seen in Figure 4. The formation processes have been influenced by weak gravitational attraction, electrostatic attraction (or repulsion) induced by the solar wind, collisions of varying force, and radiation pressure. Several asteroids have even formed moons orbiting the parent body. How these processes have interacted to form the bodies that we observe has been a source of considerable scrutiny.

Dr. Busch touched on some current and future missions such as the ongoing Japanese **Hayabusa 2** which arrived at asteroid **Ryugu** in June, 2018 whereupon it deployed 2 landers and fired an impactor to produce a plume of dust from which a sample was taken to be brought back to Earth in 2020. NASA also has the **Osiris REx mission** which has been orbiting asteroid **101955 Bennu** with the intent of picking up a surface sample and bringing it back to Earth in 2023.

Mining missions have also been proposed, but none have gone past the proposal stage.

Finally, should a potentially damaging asteroid be detected, what should we do? As described by Dr. Busch, methods of asteroid mitigation that have been thought of so far include a **gravity tractor** wherein the gravity of a spacecraft flying alongside an asteroid is used to slowly divert its path to avoid the Earth. This would work only if there were years of advanced notice, a highly accurate orbit determination, and the target object is less than 500 meters in diameter.

Another method of path diversion would involve slamming a spacecraft into a target asteroid without involving explosives. Such a mission is the ***Double Asteroid Redirection Test*** (**DART**) mission that has been proposed for a test impact in 2022 on asteroid **Didymos B,** the smaller component of a double asteroid.

Yet another method is laser ablation of the surface in an attempt to start an outgassing geyser to push the asteroid in a desired direction. Then a last-ditch method would be to explode a nuclear device on the asteroid. This has the disadvantage of potentially producing some highly unpredictable outcomes.

A private space foundation, the **B612 Foundation,** was founded by former astronauts, Ed Lu and Rusty Schweickart and several others to develop a privately funded space observatory called the **Sentinel Space Telescope** to search for NEAs and develop diversion methods. But it has had difficulty with fund raising and a key component of the mission has been cancelled by NASA for now.

Day of Reckoning for the Dinosaurs?

Death Record in the Tanis, North Dakota Sedimentary Layer of the Hell Creek Formation Following the Chicxulub Asteroid Impact[3]

By Ed Ching, SMCAS Board Member

In the 1980s, two faculty members at University of California at Berkeley proposed that the geologic iridium layer, which dated approximately to the extinction of the dinosaurs, came from the impact of a large object onto the Earth. The element iridium is rare on earth, mostly derived from extraterrestrial sources. This research developed into the identification of the Chicxulub site in the Yucatan, which has been recently confirmed as the location of an impact. The presence of fused quartz was generated by the enormous pressure of the asteroid impact. The size of the crater at Chicxulub suggests that the resulting debris would have caused extreme weather effects likely to have lasted a decade, and these events corresponded in date to a dramatic increase of species extinctions including the dinosaurs.

Recently, it has been proposed that the extinction of the dinosaurs came about from the "geologically" simultaneous combination of volcanism and the impact, though the impact conceivably could have been large enough to induce the volcanism. See: https://www.sciencemag.org/news/2019/02/did-volcanic-eruptions-help-kill-dinosaurs

As *The Economist* describes:

> The [Tanis] layer is loaded with the bodies of marine and freshwater fish. This alone struck [the author] as odd since Hell Creek is not known for the preservation of brackish ecosystems where such animals could mingle. But what proved truly unnerving was the fact that all of the bodies were intact, faced the same direction and were scattered among felled tree trunks. That hinted at a sudden surge of water: the streamlined shape of fish means they automatically orient themselves with their heads pointing into a current of fast-moving water. That the bodies were all intact suggests that they were rapidly buried. Moreover, only the most powerful of currents can knock trees down, so the assemblage must have formed during a single devastating event.
>
> Wedged between a 66M-year-old layer of Cretaceous sediment, and another dating from the subsequent Tertiary period, when mammals came to dominate Earth, the Hell Creek fossils are in the perfect position to record the moments that immediately followed the asteroid impact.

[3] Largely based on The Economist (Science & Technology), April 6, 2019 article: https://www.economist.com/science-and-technology/2019/04/06/stony-evidence-of-the-hellfire-that-drove-dinosaurs-to-extinction

> Supporting this, spheres of what was once molten glass and fragments of quartz generated under exceptionally high pressure and blasted into the air are scattered throughout the site. Some of it was lodged inside the gills of fossilized fish. Presumably, they sucked it in with their last desperate gulps. The bottom layer of the site contains burrows that appear to have been dug by mammals and are filled with coarse sand brought in over land at great speed, the signs of which are seen in the ripples left in the sand. Dusting the top of the formation is an ominous layer of iridium.
>
> Other fossil finds, yet to be confirmed, include fish impaled on the spines of one another, wasp nests, flooded ant hills, ancient primates, and the leaves of plants probably related to the modern banana tree. [The initial publication is in PNAS, see below, and other observations have yet to be peer reviewed. However, much has peculiarly been published in the unreviewed popular press in the New Yorker article, see below, which leads to some criticism as described in the Science commentary.]
>
> What is clear already from the confirmed evidence is the sequence of events that unfolded in the minutes and hours after the asteroid hit. It struck the Mexican coast, sending enormous volumes of gas and molten material into the atmosphere, and igniting a firestorm that would have engulfed much of the planet. Its impact crater, located beneath the Yucatan peninsula and the southern Gulf of Mexico, has been a focus of scientific interest for many years. Undoubtedly, this would have created an enormous tsunami, but [the author] suspects that the Tanis fossils, located thousands of kilometers [about 1800 miles] to the north, were killed by a different phenomenon, triggered by the impact: a seiche wave.
>
> Also known as standing waves, seiche waves form in large bodies of water that are either steadily blown by strong winds or shaken by tremors. [The author of the article] and his colleagues propose that the asteroid impact shook Earth so forcefully that seiche waves as tall as 100 meters rose up in every large body of water across the planet, including the shallow sea near Tanis.

At the time of the Chicxulub impact, the Tanis, North Dakota site was submerged under an inland sea. (This sea was not believed to be contiguous with the Gulf of Mexico.) As such, it is thought unlikely that a direct route would have existed for a tsunami to reach the Tanis site from the impact site, so a different mechanism for the water inundation was conceived, thus the seiche wave.

Amazingly, the glass beads formed by the impact would have been able to travel the 1800 miles in an estimated 30-45 minutes, or 2400-3600 mph across the atmosphere, and have started to settle on this and other sites. These fish, a large concentration of whose bodies accumulated by these events, would have been killed immediately by the enormous water

surge with the accompanying fallen trees and sand debris, presumably within an hour by the seiche inundation. Although not included in the peer reviewed publication, the New Yorker article mentions that a triceratops bone was found in the site. It remains to be determined whether the dinosaur was alive at the moment of the water inundation, or whether it may have died earlier from other causes. The supposition is the former, that this inundation event led to the immediate death of that particular unlucky dinosaur, and subsequently of "virtually all" of the dinosaurs. Similar effects occur from volcanic eruptions on a smaller scale, which can affect worldwide climate and food production.

Further Reading:

Primary source article in Proceedings of the National Academy of Sciences (PNAS): https://www.pnas.org/content/early/2019/03/27/1817407116

Berkeley News article: https://news.berkeley.edu/2019/03/29/66-million-year-old-deathbed-linked-to-dinosaur-killing-meteor/

New Yorker article: https://www.newyorker.com/magazine/2019/04/08/the-day-the-dinosaurs-died

Science Magazine article: http://www.sciencemag.org/news/2019/04/astonishment-skepticism-greet-fossils-claimed-record-dinosaur-killing-asteroid-impact

National Geographic article: https://www.nationalgeographic.com/science/2019/03/fossils-found-from-day-dinosaurs-died-chicxulub-tanis-cretaceous-extinction/

Amazon's Involvement in Chilean Astronomy Data Storage

By Tom McDonough, SMCAS Treasurer

Amazon Web Services has agreed to store massive amounts of data and telescope images from Chile, with a goal of granting access to researchers worldwide. The company said its cloud computing services would help Chilean astronomers crunch massive troves of data, including images of the night sky taken from telescopes in Chile's Atacama Desert. Chile's telescopes cannot keep 83 percent of the data they glean because of limited storage capacity, according to Jeffrey Kratz, General Manager for Public Sector AWS in Latin American, Caribbean, and Canada. Amazon is a founding member of the project, dubbed the Chilean Data Observatory, as it seeks to expand its services in Latin America (Reuters).

Spring, 2019 Equinox Party

By Mary Ann McKay and Bill Lockman, SMCAS Board Members

In celebration of the return of longer days (and warmer but shorter nights for outdoor astronomy activities!) we held our annual Spring SMCAS Spring Equinox Party at the Crystal Springs Methodist Church on Saturday, March 23, 2019.

Everyone seemed to enjoy the entrees brought by the board and the sides brought by the other members (see Figure 5 for an example).

Figure 5. Delicious Salmon and cream cheese appetizers made for the Spring, 2019 Equinox party by Karen Lockman. Photo by Bill Lockman.

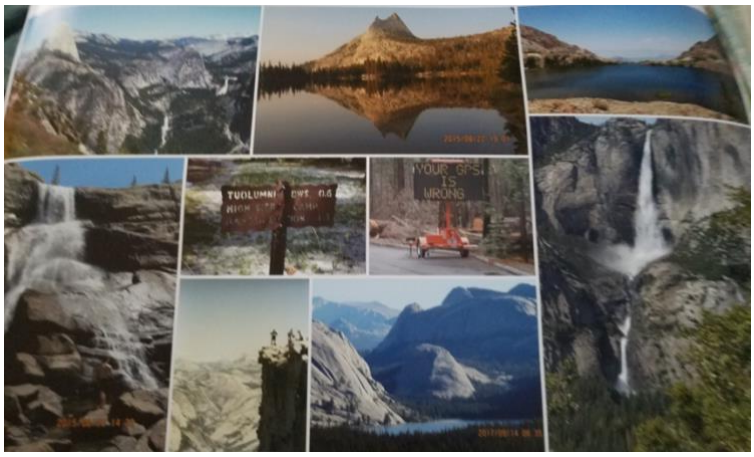


Figure 6: Yosemite montage from Ed Pease.

President Frank Seminaro discussed the need for the Club to begin planning the upcoming Glacier Point Star Party in Yosemite this coming July 19-21, 2019. Member Ed Pease showed the poster he created illustrating various views of Yosemite (Figure 6). For more information, please see President's Corner article on Page 4.

Other than this item of business, the interactions among the 25 party attendees were light-hearted, enjoyable, and full of star-talk (Figure 7). Former President and current Secretary Marion Weiler was back in town and shared his travel experiences to New York and Central America with some of us.

Figure 7: Enjoying each other's company at the Spring 2019 Equinox party. Photo by Ed Ching.

In summary, we all enjoyed the food and drink and each other's company and are looking forward to our next Equinox party scheduled for this coming Fall.

NASA Night Sky Notes:

April, 2019: Mars the Wanderer

By David Prosper

April's skies find Mars traveling between star clusters after sunset, and a great gathering of planets just before sunrise.

Mars shows stargazers exactly what the term "planet" originally meant with its rapid movement across the evening sky this month. The ancient Greeks used the term *planete,* meaning *wanderer*, to label the bright star-like objects that travelled between the constellations of the zodiac year after year.

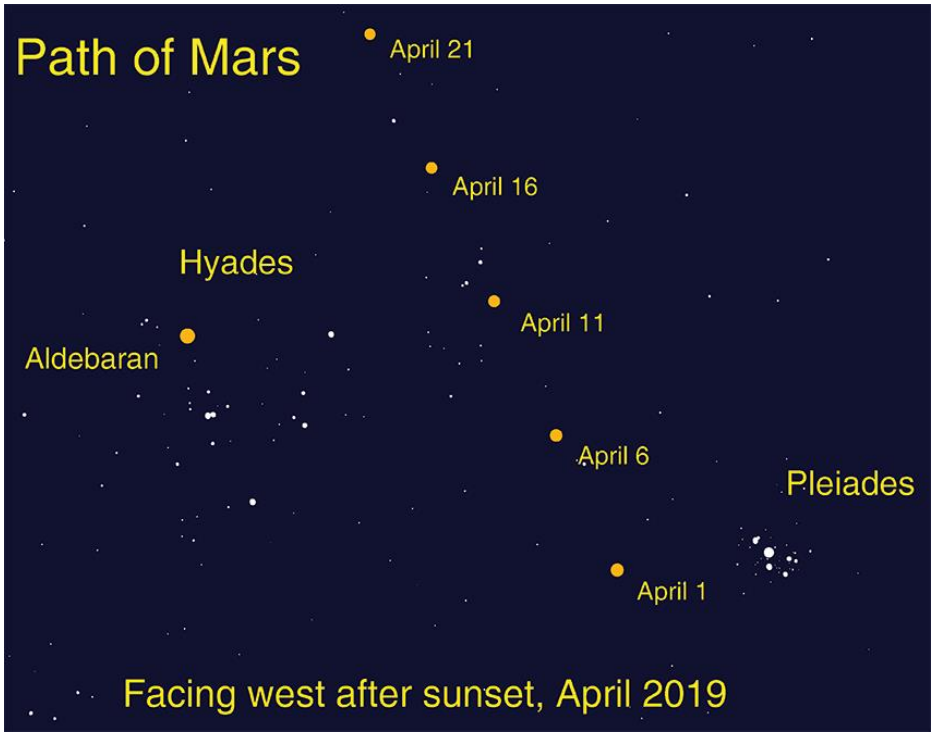


Figure 8. The path of Mars between the Pleiades and Hyades in April.

You can watch Mars as it wanders through the sky throughout April, visible in the west for several hours after sunset. Mars travels past two of the most famous star clusters in our night sky: the Pleiades and Hyades. Look for the red planet next to the tiny but bright Pleiades on April 1st. By the second week in April, it has moved eastward in Taurus towards the larger V-shaped Hyades. Red Mars appears to the right of the slightly brighter red-orange star Aldebaran on April 11th. We see only the brightest stars in these clusters with our unaided eyes; how many additional stars can you observe through binoculars?

Open clusters are made up of young stars born from the same "star nursery" of gas and dust. These two open clusters are roughly similar in size. The Pleiades appears much smaller as they are 444 light years away, roughly 3 times the distance of the Hyades, at 151 light years distant. Aldebaran is in the same line of sight as the Hyades, but is actually not a member of the cluster; it actually shines just 65 light years away! By comparison, Mars is practically next door to us, this month just a mere 18 light minutes from Earth - that's about almost 200 million miles. Think of the difference between how long it takes the light to travel from these bodies: 18 minutes vs. 65 years!

The rest of the bright planets rise before dawn, in a loose lineup starting from just above the eastern horizon to high above the south: Mercury, Venus, Saturn, and Jupiter. Watch this month as the apparent gap widens considerably between the gas giants and terrestrial planets. Mercury hugs the horizon all month, with Venus racing down morning after morning to join its dimmer inner solar system companion right before sunrise. In contrast, the giants Jupiter and Saturn move away from the horizon and rise earlier all month long, with Jupiter rising before midnight by the end of April.

The Lyrids meteor shower peaks on April 22nd, but sadly all but the brightest meteors will be washed out by the light of a bright gibbous Moon.

May, 2019: Watching the Late Spring Skies

Late spring brings warmer nights, making it more comfortable to observe a good showing of the **Eta Aquarids** meteor shower. Skywatchers can also look for the delicate **Coma Star Cluster**, and spot the **Moon** on the anniversary of **Apollo 10**'s "test run" prior to the Moon landing in 1969.

The **Eta Aquarids** meteor shower should make a good showing this year, peaking the morning of May 6. This meteor shower has an unusual "soft peak," meaning that many meteors can be spotted several days before and after the 6th; many may find it convenient to schedule meteor watching for the weekend, a night or two before the peak. You may be able to spot a couple dozen meteors an hour from areas with clear dark skies. Meteors can appear in any part of the sky and you don't need any special equipment to view them; just find an area away from lights, lie down on a comfy lawn chair or blanket, relax, and patiently look up. These brief bright streaks are caused by Earth moving through the stream of fine dust particles left by the passage of Comet Halley. While we have to wait another 43 years for the famous comet grace our skies once more, we are treated to this beautiful cosmic postcard every year.

While you're up meteor watching, try to find a delightful naked eye star cluster: the **Coma Star Cluster** (aka Melotte 111) in the small constellation of Coma Berenices (Figure 9). It can be spotted after sunset in the east and for almost the entire night during the month of May. Look for it inside the area of the sky roughly framed between the constellations of Leo, Boötes, and Ursa Major. The cluster's sparkly members are

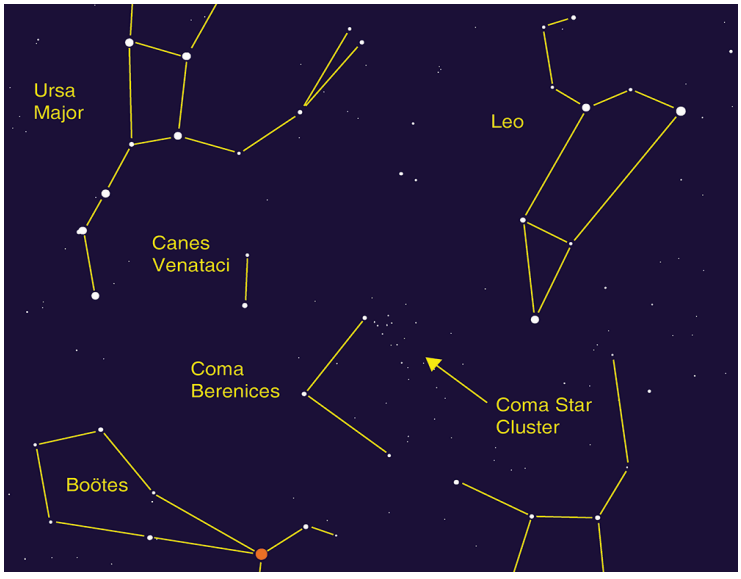


Figure 9. Guide to Coma Star Cluster.

also known as “Berenice’s Hair” in honor of Egyptian Queen Berenices II’s sacrifice of her lovely tresses. Binoculars will bring out even more stars in this large young cluster.

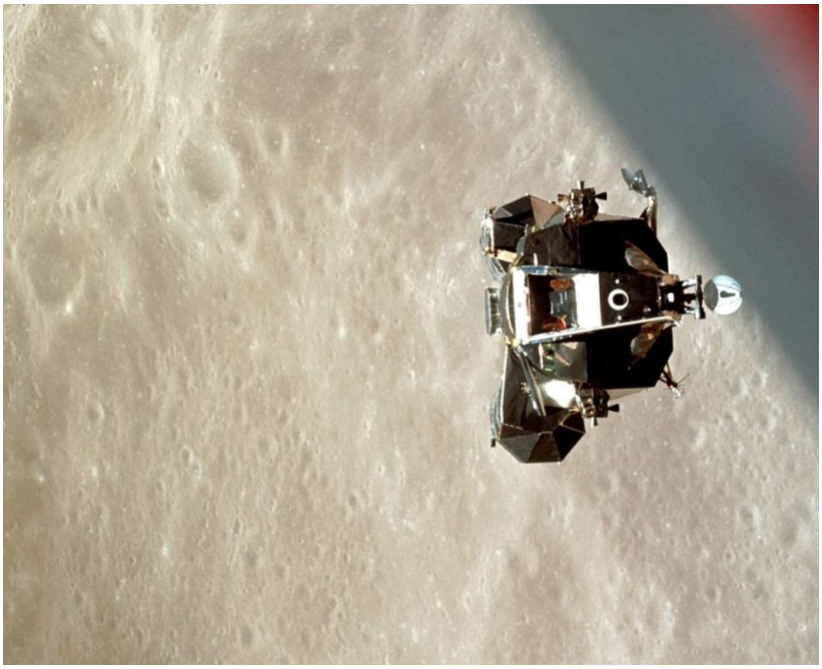


Figure 10. A view of Apollo 10’s Lunar Module from the Command Module as it returned from maneuvers above the lunar surface. Photo Credit: NASA. Source: http://bit.ly/apollo10view

May marks the 50th anniversary of the Lunar Module’s test run by the A**pollo 10** mission! On May 22, 1969, NASA astronauts Thomas Safford and Eugene Cernan piloted the Lunar Module - nicknamed “Snoopy” - on a test descent towards the lunar surface (Figure 10). Undocking from “Charlie Brown” - the Command Module, piloted by John Young – they descended to 47,400 feet above the surface of the Moon before returning safely to the orbiting Command Module. Their success paved the way for the first humans to land on the Moon later that year with Apollo 11. Look for the Moon on the morning of May 22, before or after dawn, and contemplate what it must have felt like to hover mere miles above the lunar surface. You’ll also see the bright giant planets Saturn and Jupiter on either side of the Moon before sunrise. When will humans travel to those distant worlds?

The Night Sky Network program supports astronomy clubs across the USA dedicated to astronomy outreach. Visit nightsky.jpl.nasa.org to find local clubs, events, and more!

You can catch up on all of NASA’s current and future missions at nasa.gov

SMCAS General Meeting Presentations:

Friday May 3, 2019:

Brian Day

NASA AMES Research Center

Journeys to the Moon with NASA

Friday, May 3, 2019, College of San Mateo, Building 36
SMCAS General meeting at 7:00 p.m., ISC Room 110
Presentation at 8:00 p.m., Planetarium
Free and open to the public, free parking (lots 5 or 6).

As NASA, the nation, and the world prepare to celebrate the 50th anniversary of the first human landing on the Moon, we will examine NASA's missions of lunar exploration. We will review the missions that led to Apollo as well as the six individual Apollo missions, explore missions that came after Apollo, and finally look ahead to what's in store for future lunar exploration. After the talk, you'll have a chance to touch an actual piece of the Moon!

Brian Day is the Lead for Lunar and Planetary Mapping and Modeling, as well as Lead for Citizen Science and Outreach at NASA's Solar System Exploration Research Virtual Institute (SSERVI). As program office project manager for Lunar and Planetary Mapping and Modeling, he oversees data visualization and analysis tools designed for mission planning, planetary science, education, and public outreach. In his citizen science role, he coordinates programs with internal and external partnering organizations, focusing on providing opportunities for students and the public to directly participate in NASA science and exploration.

Friday June 21, 2019:

Peter Shyvers

USS Hornet Museum

Keeping Moonwalkers Feet Dry:
USS Hornet in the Apollo Program

Friday, June 21, 2019, College of San Mateo, Building 36
SMCAS General meeting at 7:00 p.m., ISC Room 110
Presentation at 8:00 p.m., Planetarium
Free and open to the public, free parking (lots 5 or 6).

To help celebrate the 50th anniversary of the first persons landing on the moon and their successful return to Earth, we are holding a special presentation at our annual meeting, election of officers, and summer solstice.

Off-camera and behind the scenes, as American astronauts commanded the world's attention, thousands of American servicemen prepared to assure their safe return. We'll review the USS Hornet's role in Splashdown, and her recovery of the first men returning from the Moon's surface.

Peter Shyvers has been a docent at the USS Hornet Museum for ten years, having studied avidly the US Navy, WWII, and carrier operations for over 55 years. A history buff (who got a good start on it growing-up in the Middle East), he has also been a docent at Santa Clara County Parks' Casa Grande Quicksilver Mining Museum at New Almaden for seven years. He is a Cal grad in economics and business with just shy of 40 years' experience in Silicon Valley in software development/support, infrastructure design/implementation, and customer systems management.

Jazz Under the Stars:

Astronomy

Jazz Under the Stars

CSM Science Building 36, Rooftop Observatory

Come peer through our telescopes and see craters on the Moon, the visible planets, star clusters, and more while we listen to CSM's very own **KCSM Jazz 91 FM.** Dress warmly. Free parking in Marie Curie Lot 5. Directions are available on the Maps, Directions & Parking page.

Spring 2019 Schedule

Date	Time
February 9	Canceled due to poor weather
March 16	8:00-10:00 pm
April 13	8:30-10:30 pm
May 11	8:30-10:30 pm

This event is weather dependent. Latest weather updates.

Jovian System - Chanan Greenberg, Greenhawk Observatory

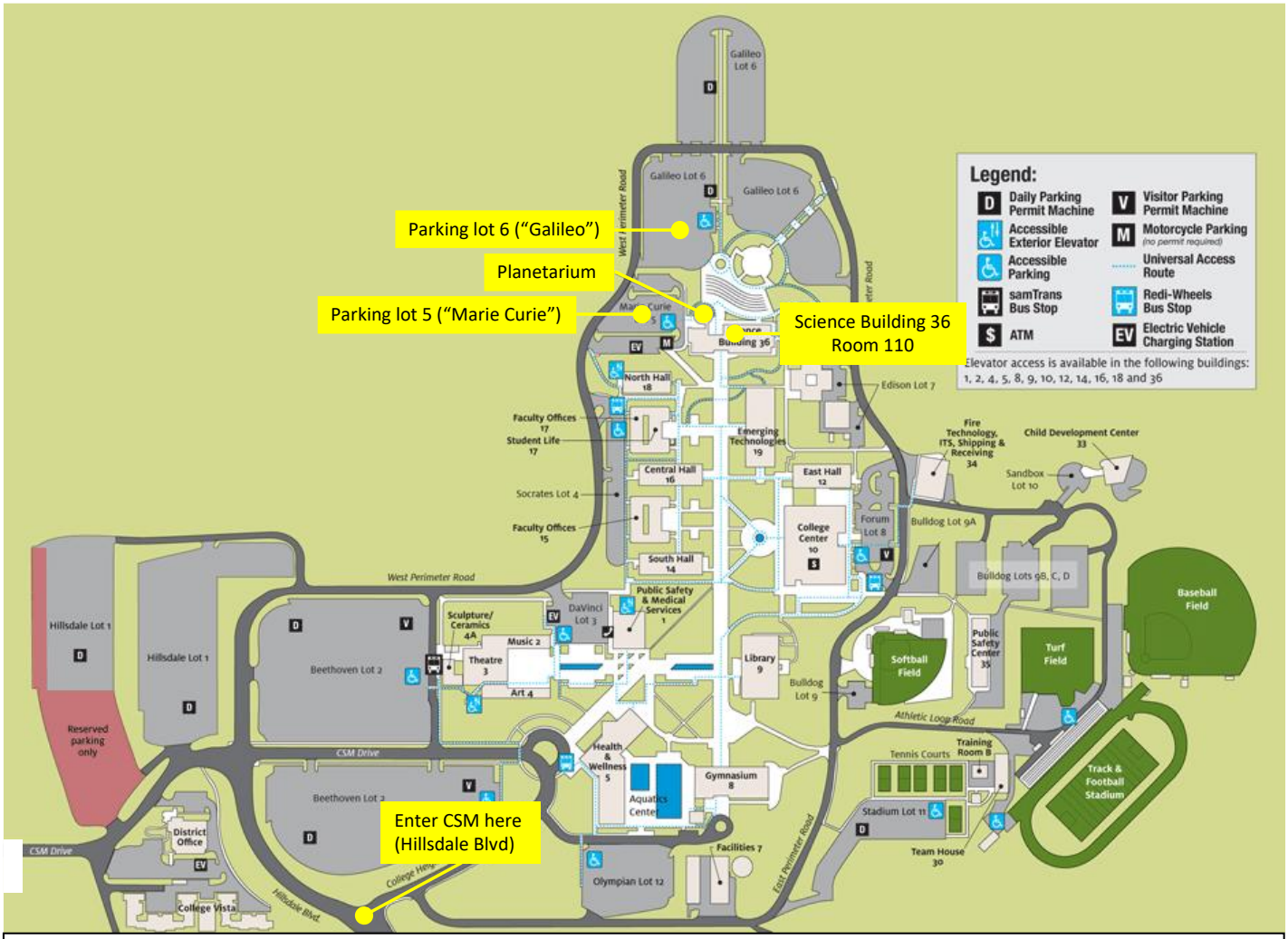
Email questions.
Listen to and support great jazz on KCSM.

No food or drinks in the observatory. Children are welcome and must be attended at all times.
Supported by San Mateo County Astronomical Society, KCSM Jazz 91.1FM, and CSM Astronomy.
Also see SMCAS star parties at Crestview Park.

For more information, visit the Jazz Under the Stars web page here:

http://collegeofsanmateo.edu/astronomy/jazz.asp

Directions to SMCAS Meetings at The College of San Mateo:



Directions to the CSM Planetarium for Meetings:
After exiting Hwy 92 at Hillsdale Blvd, climb the hill towards CSM, passing two traffic lights to the stop sign at the top. Continue straight, bear right then, after the 2nd stop sign, bear left over the rise. Enter the next parking lot on the right, called Lot 5, "Marie Curie", or Lot 6, "Galileo." Science (ISC) Bldg. (36) and the Planetarium lie straight ahead. Enter Bldg. 36 either through the door facing the lot, or walk around the dome to the courtyard entrance. We meet in ISC room 110 for pizza and soft drinks one hour prior to the talk in the Planetarium (pictured below).

Directions to SMCAS Public Star Parties (Weather Permitting):

Crestview Park - San Carlos

Come on out, and bring the kids, for a mind-blowing look at the Universe!

Bring your binoculars, telescopes, star guides, and lounge chairs for some informal star gazing at Crestview Park.

Dress warmly and wear a hat. Only visitors with telescopes should drive in. Others should park on the street and walk in, or arrive before dark so that car headlights don't affect the observers' dark adaptation. Bring small flash-lights only, covered with red cellophane or red balloon.

These measures avoid safety issues of maneuvering in the dark, as well as ruining the night vision of the viewers.

Please don't touch a telescope without permission. And, parents, please don't let children run around in the dark.

From Hwy 101 or El Camino: take Brittan Avenue in San Carlos, west (toward the hills). Follow Brittan 2.3 miles (from El Camino) to Crestview Drive. Turn right on Crestview. In half-a-block, you will see a small blue posted sign with an arrow, indicating the entry road into Crestview Park. It lies between houses with addresses #998 and #1000 Crestview Drive.

From Highway 280: take Edgewood Road exit. Go east (toward the Bay) about 0.8 miles. Turn left at Crestview Drive. Go 0.5 mile uphill to where Crestview meets Brittan. Again, drive the half-block, to the sign on the right, and the entry road on the left.

Note: If bringing a telescope and arriving after dark, please enter the Park with your headlamps and white interior lights off. If you aren't bringing a telescope, whether before or after dark, please park along Crestview Drive, and walk in.

Crestview Park is residential, adjacent to homes and backyards. Before inviting potentially noisy groups, please call Ed Pieret at (650) 595-3691 for advice and advisories. Call Ed also to check the weather and 'sky clock', and to see whether the star party is still scheduled.

Crestview Star Party schedule is here:

http://www.smcasastro.com/crestview-park.html

San Mateo County Astronomical Society
Membership Application

rev 04062019

SMCAS@live.com; P.O. Box 974, Station A, San Mateo CA 94403; (650) 678-2762

Become an SMCAS Member Today! Here's what you get:

- **Members Community**

Friendly advice and guidance from experienced recreational astronomers; access to SMCAS group emails which provide general orientation information, announcements of astronomy events, file access and exchange.

- **SMCAS Events**

General meetings are held the first Friday of most months, at 7 pm in the Integrated Science Center (ISC) Room and Planetarium in the Science Center (Bldg. 36) at the College of San Mateo (CSM), 1700 W. Hillsdale Blvd., San Mateo. Meetings include lectures and presentations on space science, an activity session, and refreshments (usually pizza).

We also offer stargazing two Saturdays a month, weather-permitting. Visitors and those without telescopes are welcome; members are glad to share! SMCAS also has sponsored dark-sky campouts at Fremont Peak State Park, field trips to SLAC, KIPAC and Lick Observatory, plus **member-only events, including Star-B-Ques and quarterly potlucks.**

- **Subscriptions** (free with your membership)

The Event Horizon, SMCAS' monthly newsletter, with SMCAS and member information, viewing tips and articles.

The *Reflector,* published quarterly by the Astronomical League, a national alliance of astronomy groups like SMCAS.

- **Significant Discounts on Equipment and Publications**

Discounts on purchases at Bay Area astronomical equipment retailer Orion Telescope Center, on sky calendars and ephemerides, and on such periodicals as *Sky & Telescope* and *Astronomy*.

- **Access to Loaner Equipment**

Use of SMCAS loaner telescopes and other astronomy equipment.

- **Sharing your Appreciation of Astronomy and Space Science with the General Public.**

Your SMCAS membership helps bring astronomy to interested lay people, especially students and children

Annual Dues: (SMCAS is a tax-exempt non-profit 501(c)(3). Dues may be tax deductible; consult your tax advisor):

$30 Regular Family Membership; $15 Student Membership

Every membership includes all members of your immediate family, (including your kids).

To join you can:

Send application (see reverse side), with payment, to: SMCAS, P.O. Box 974, Station A, San Mateo CA 94403.

- Bring the completed application and payment to a meeting or event and give it to any SMCAS officer.
- Go online at http://www.smcasastro.com/, click on the Membership tab and pay via PayPal.
- **Bring your completed application to your first meeting or mail it** to
  SMCAS, P.O. Box 974, Station A, San Mateo CA 94403

Application Form on reverse side

San Mateo County Astronomical Society
Membership Application

rev 04062019

SMCAS@live.com; P.O. Box 974, Station A, San Mateo CA 94403; (650) 678-2762

Date: _____ Please check one: [ ] New Member or [ ] Renewal

[ ] $30 Regular Family Membership; [ ] $15 Student Membership

All members, please indicate areas of interest below. New members, please complete entire form. Renewing members, please provide your name and any information that has changed in the last year.

We will list your name, address, email address, and phone number(s) in our membership roster unless you have checked the box preceding that information. The membership roster is distributed to active members only.

Each member's name and mailing address must be provided to the Astronomical League (AL), SMCAS' parent organization. If you don't want AL to have your phone number and email address, indicate below.

[ ] Name(s) _____ [ ] Email Address _____

[ ] Address _____

[ ] City & Zip Code _____

[ ] Phone Number(s): _____ [ ] Do not provide my phone number(s) to the AL.

[ ] Don't provide my email address to the AL. (Checking this means you can ONLY get ***The Reflector*** by regular mail)

Please check one: send ***The Reflector*** [ ] by mail, or [ ] by email.

Areas of Interest:

SMCAS encourages member involvement. We invite you to provide additional information about your interests, skills, occupation and prior experience. Please identify SMCAS projects and functions that you might like to help facilitate.

_____

Please indicate which of the following activities might be of interest to you:

_____Star Parties - Do you own a telescope you can bring: Yes ( ) No ( )

_____General Meetings - Finding (or being) a Speaker. Official greeter. Set up or take down ISC or refreshments.

_____ Family Science Day & Astronomy Festival (Usually at CSM the first Saturday in October).

_____Social Events - Equinoctial and Summer Solstice potlucks, Summer Star-B-Que, Holiday Potluck.

_____SMCAS Membership and Promotional Drives

_____Communications – 'Event Horizon' Newsletter, Website(s), Facebook page, group email, Publicity posting.

_____ Educational Programs – School, museum and library star parties, Bay Area Astro teacher assistants.

Other/Comments: _____