The SAN MATEO COUNTY ASTRONOMICAL SOCIETY

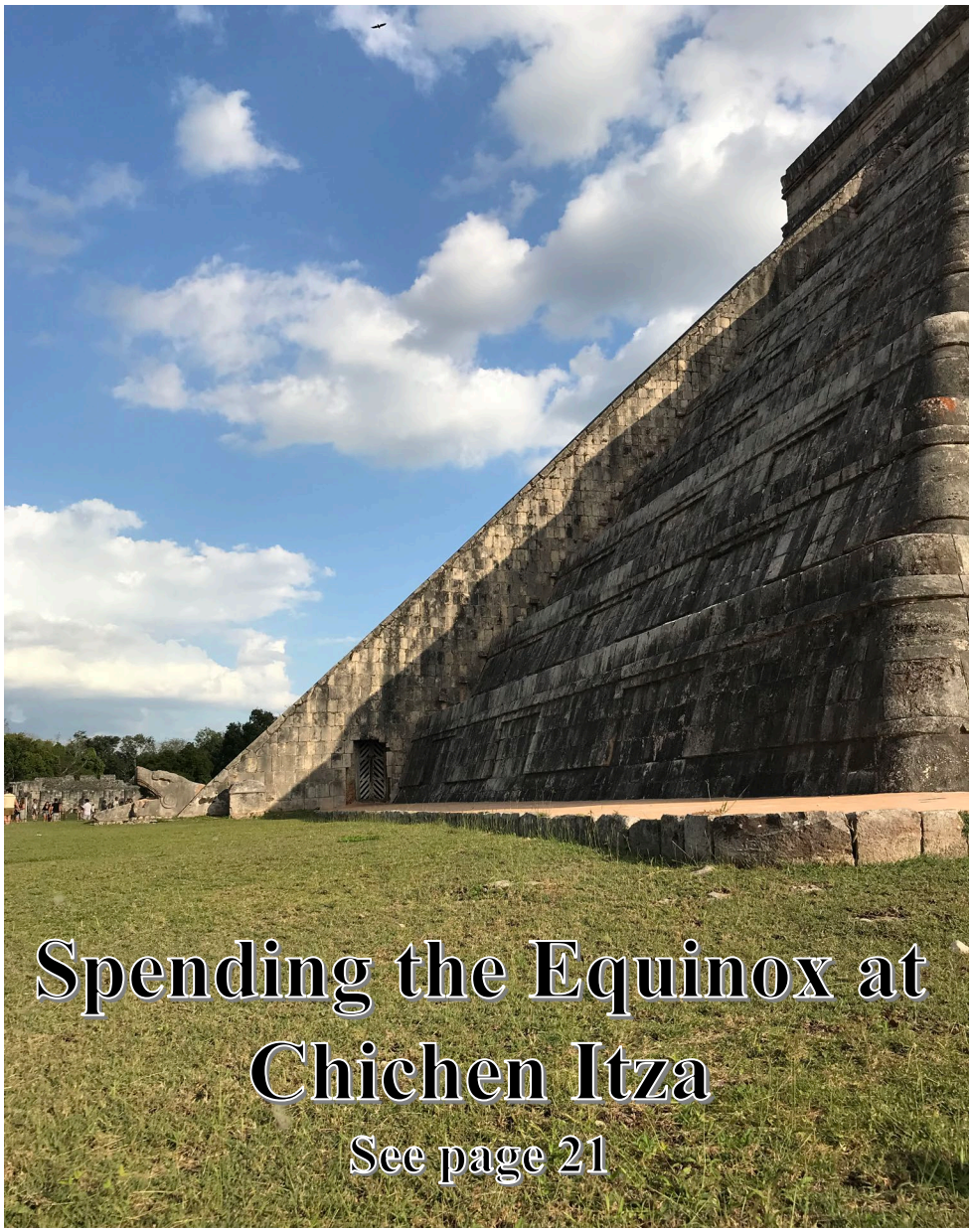
April – June • 2022 Issue

786th General Meeting: April 1
787th General Meeting: TBD
788th General Meeting: TBD

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. In nonpandemic times, 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, 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. The Membership Application form is on the back page.



Spending the Equinox at Chichen Itza

See page 21

Table of Contents

PLEASE NOTE: CSM is still closed due to the pandemic.

Cover: The beginning of the equinox and the beginning of shadow's serpent appearing at the Pyramid of Kukulcan at Chichen Itza. Photo by Michelle Morales Torres.

From the Prez

Hello All,

Well, it begins to appear as though the COVID scare may finally be subsiding. Let's all keep our fingers crossed that there isn't a resurgence or, heaven forbid, another variant on the horizon.

With the resumption of live Crestview Star Parties, we are currently holding them separately from our monthly general meetings. The College of San Mateo has still not said when on-campus hosting might resume so, for now, our general meetings will continue to take place over Zoom on Friday evenings, as they had been pre-Covid. We will normally try for the first Friday of each month, but will adjust the dates as necessary to accommodate our speakers. Our normal meeting start time will continue to be 8 pm.

Our April general meeting will feature Dr. Xinnan Du, a charming young astronomer who coordinates public outreach and presentation for KIPAC (the Kavli Institute for Particle Astrophysics and Cosmology). It's affiliated with Stanford University, and co-located with SLAC at the latter's campus on Sand Hill Road in Menlo Park.

Her topic is 'Extraterrestrial Life, and Where To Find It'. Since she speaks on April 1 (April Fool's Day!), readers may not see this issue of the Event Horizon soon enough to note the lecture though, if you attend all our meetings via Zoom, you won't miss it. But, if you do, her presentation will be recorded, edited and posted on our SMCAS YouTube channel, likely sometime in April, courtesy of our members, Lisa and Michael Cooke.

Xinnan has replaced our longtime friend and collaborative colleague, Mandeep Gill, who's relocated to the Chicago area. However, he's not completely out of our sphere. He has been kind enough to step in as a substitute astronomy instructor at CSM, during Darryl Stanford's medical recovery over the Spring term.

Xinnan came to Stanford from UC Riverside, and was involved with both UCR and the Riverside Astronomical Society doing livestreamed programs of public outreach. She has now approached us, SMCAS, with a proposal to set up a similar collaboration, featuring quarterly star parties in concert with the Stanford (student) Astronomical Society.

Our board is in process of discussing with her the details of how it might work. Xinnan has proposed April 28 for the first such event. It will be livestreamed over Zoom, likely with a narration, then later posted, perhaps to YouTube. We'll keep you informed.

Please note that board elections are coming up for the 2022-2023 year. We open nominations at the May general meeting, then conduct our election at the June Annual Meeting. This is a great opportunity for those of you who'd like to be more involved to stand for election as an officer, or to the board of directors. Most of us who've been shepherding the Society for years are quite senior, and presented with a willing alternative, may be glad to consider giving someone else a chance. We need to encourage a younger generation of members, say in their 30's-to-50's, to step up and carry the Club forward. If you'd like to serve in office, or even just find out what's involved, please contact me, Mike Ryan, at your earliest convenience. My email and phone number follow this article.

Don't be concerned that you won't know what to do (we'll teach you!), or that it'll be too much work. We have a by-laws provision that enables us to create a committee to share the tasking if desired. If you don't want to hold the office, you could assist the one who does. So, please, give it some serious thought.

(continued on page 4)

From the Prez (cont'd)

Next up on the calendar of social events; our Crestview Officer Installation potluck, likely in August.

Mohsen Janatpour at CSM has traditionally performed an annual public program called 'Art and Science'. It features his engaging lectures on a broad range of philosophical and historical topics, and his superb paintings, done in a style he titles 'Symvisio'. He had done nearly 30 such shows, which we in SMCAS have supported with telescope viewing afterward. Following the COVID hiatus, Mohsen would like to restart the series. He has set Friday, May 6 as his target date, all-else permitting. His usual start time has been about 7pm.

In my last 'From the Prez', our Board member, Bill Lockman, had revealed that his wife's cousin was in the IC, with a severe case of COVID-19. I asked for your prayers on his behalf. Well, our prayers were answered. Bill's relative came back from the brink, and I'm told, is on his way to a lengthy, but stable, recovery.

On the other hand, I regret to note that our Vice-President and Outreach Chairman, Ed Pieret, on February 9 lost his brother in Merced. Our condolences and best wishes to Ed and his family.

Since I've 'spilled the beans' regarding the health issues and status of some members and families, it's probably only fair to disclose my own. As some of you know, I've had severely degraded eyesight since 2018, losing color in my better eye, focus, glare tolerance, peripheral vision with blind spots, and night vision in both eyes. How about that; a blind astronomer! Well, I'm glad to say that as of two weeks ago, some of my vision has returned; principally the night vision and partial left eye focus. Last year, the left eye was rated 20/80. Now, it's 20/60. The right eye has improved from 20/60 to 20/30 (!), but is still heavily astigmatic.

My right knee went bone-on-bone just before COVID hit, relegating me to hobbling about with a cane, costing me my balance, and making me prone to falling. As sometimes happens when one can't exercise, my weight ballooned, and I'd never been able to lose any. However, finally, a combination of medication and diet change has enabled me to lose 30 pounds. My goal is to lose another 30, which will take me down to 180.

As I lose weight, the stress and pain on my knee is easing, improving my quality of life and usefulness. It's also mitigating the conditions that often afflict seniors, like diabetes, high blood pressure and cholesterol. I may choose later to have the knee replaced, but I'm told the procedure will go much better if I'm lighter and in better condition. I especially want to avoid susceptibility to stroke, which took both my parents. I know everyone has to die of something, but my own preference is to be shot in bed by a jealous husband! I have a couple of other issues too, but I don't want to share all the fun at once.

So, I invite any among you to contact me, or another Board member, if you have any questions, or if we can assist you in any way. Thanks again for supporting the San Mateo County Astronomical Society. All the best to you, your families and dear friends.

Mike Ryan

(650) 678-2762

jmrastro@yahoo.com

Upcoming Events

PLEASE NOTE: CSM is still closed due to the pandemic. SMCAS in-person Star Parties have resumed at Crestview Park. Click here to see the schedule.

Friday, April 1: Presentation: Extraterrestrial Life and Where to Find it by Dr. Xinnan Du (Stanford/KIPAC) via Zoom 8pm. Click here for the Zoom link.

Saturday, April 2: Star Party – at sunset (7:32pm) – Crestview Park, 1000 Crestview Drive, San Carlos, CA 94070. See page 25 for directions and guidelines.

Saturday, April 23: Star Party – at sunset (7:52pm) – Crestview Park

Saturday, April 30: Star Party – at sunset (7:58pm) – Crestview Park

Saturday, May 21: Star Party – at sunset (8:17pm) – Crestview Park

Saturday, May 28: Star Party – at sunset (8:22pm) – Crestview Park

Saturday, June 18: Star Party – at sunset (8:33pm) – Crestview Park

Saturday, June 25: Star Party – at sunset (8:35pm) – Crestview Park

April 1, 8pm Presentation: Extraterrestrial Life and Where to Find it by Dr. Xinnan Du (Stanford/KIPAC)

Via Zoom video conference. Click here to access the Zoom link.

What are we, and are we alone in the universe? For hundreds of years, philosophers and scientists have been trying to answer this question. Today, we explore this question in astrobiology, a multidisciplinary field that involves astronomy, geology, chemistry, biology, and engineering. In this presentation, Xinnan will be discussing our current understanding of life, habitable conditions for life, the possible places to search for extraterrestrial life, and also introduce the effort humankind has made to search for and get in contact with extraterrestrial intelligence, the "aliens."

Dr Xinnan Du is the Outreach and Engagement Manager at the Kavli Institute for Particle Astrophysics and Cosmology (KIPAC) at Stanford University. Xinnan got her PhD in astronomy in 2018 from UCLA, and her research focuses on the physical properties of the interstellar and circumgalactic gas in distant star- forming galaxies. Before moving to Northern California, Xinnan spent 3 years at UC Riverside as a postdoctoral scholar, outreach director, and program manager. She is very enthusiastic about public outreach. With a long- term career goal in informal science education, Xinnan hopes to inspire and engage everyone in learning astronomy through various outreach programs.

Recap of Dr. Kimberly Ennico-Smith's Feb. 11 SMCAS Zoom Presentation on Viper – A Next Great Leap in Mapping Water on the Moon

By Bill Lockman

Dr. Ennico-Smith provided the following summary of the VIPER mission to the Moon:

"NASA will be sending the Volatiles Investigating Polar Exploration Rover (VIPER) to the south pole of the Moon in late 2023. This mission will provide the first closeup view of the location and concentration of water ice whose presence was only discovered these last few decades. Data from VIPER will generate the first water resource map on any celestial body outside of Earth. Humans will also land there through NASA's Artemis program. Water is critical for deep space exploration. It can be drunk, turned into oxygen, serve as a fuel supply, thus allowing a long-term human presence on the Moon, Mars and beyond."

The remainder of her presentation described a series of lunar exploration leaps culminating in the VIPER mission.

The first leap in exploring the Moon began in 1609 when Galileo became the one of the first humans to observe the Moon magnified though a small telescope. He discovered that the Moon was not smooth, but contained mountains and craters. Seventeenth century astronomers mistakenly used the term "maria" (seas) to describe the flat, dark regions of the Moon.

The second leap in exploring the Moon began in 1959 when Luna 2, a space probe launched by the Soviet Union, made a hard impact on the surface of the Moon. Luna 9 (February 1966) made the first robotic lunar soft landing. Surveyor 1 (June 1966) made the first US soft robotic landing. During the Apollo program from 1969 to 1972, US Astronauts landed on the Moon and brought back samples of lunar soil and rocks which

(continued on page 8)

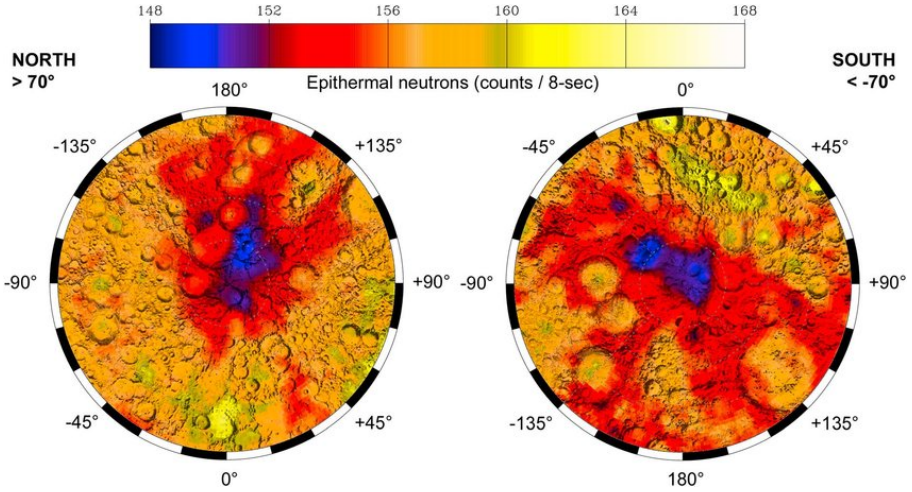


Figure 1 – Maps of epithermal neutrons for the north (left) and south (right) poles measured by the Lunar Prospector Neutron Spectrometer. From Review Article (10.1002/2016JE005167) Figure 4. Courtesy of Reviews in Mineralogy and Geochemistry.

Recap of Dr. Kimberly Ennico-Smith's Presentation (cont'd)

were subjected to careful analyses. The Moon got a dry reputation from these early Luna, Surveyor and Apollo explorers. The dry Moon reputation was further bolstered by the theory that the Moon was formed in a collision between the early Earth and a Mars-sized object, an impact so fiery and violent that scientists suspected that any water, whether it came from Earth or from the mystery object, would have boiled away for good.

The third leap in exploring the Moon (1999-2020) involved the first searches and subsequent hints for water on the Moon, especially near the poles. The Lunar Prospector (1999) measured spectra of neutrons, gamma rays, electrons, and alpha particles emitted from the Moon. Of particular relevance in the search for water was its ability to perform neutron spectroscopy. Neutron spectroscopy measures the quantity and energy of neutrons emanating from the lunar surface. Epithermal neutrons are strongly absorbed by hydrogen atoms. A low flux of neutrons implies the presence of excess hydrogen as shown by the maps in Figure 1. Note that neutron mapping only detects hydrogen—it does not tell us in what form the hydrogen occurs (atomic, molecular, or mineral-bound). A direct assay of the lunar surface is required to make that determination.

Enter the Lunar CRater Observation and Sensing Satellite (LCROSS), launched simultaneously with the Lunar Reconnaissance Orbiter (LRO) mission (2009) as the vanguard of NASA's Lunar Precursor Robotic program. LCROSS crashed the upper stage of its booster rocket into one of the permanently shadowed regions near the lunar south pole and spectroscopically analyzed the contents of the resulting plume. They found water ice grains in the plume, along with water vapor, carbon monoxide, ammonia, methane, organics, and other things. Thus, a strong Hydrogen signature in a permanently cold spot on the moon seems to correlate with the presence of water ice there.

LRO continues to map the lunar surface characteristics today. In addition, analysis of data from several other missions (2009-2020) also detected molecules containing hydrogen in other areas of the Moon. In particular, the SOFIA Airborne Observatory observed water in the daylight regions of the Moon. A reanalysis of the Apollo lunar rocks revealed water containing deuterium, an isotope of hydrogen, in those rocks. This type of water appears to be cometary in origin. See also the paper from Hui et al. Water in some form seems to be in many places on the Moon.

After nearly three decades of studies from orbiter and impactor missions, scientists now believe the Moon's soils could contain hundreds of millions of gallons of water. But at what concentrations? In what kinds of soils? And is the water in a form that's accessible? The lunar polar regions appear to be the best option for obtaining water for future human consumption, but the only way to know for sure is to go there and prospect.

The next leap in lunar exploration will begin in 2023 with VIPER. The primary mission goal for VIPER is to characterize the distribution of water and volatiles across a range of ther

(continued on page 9)

Recap of Dr. Kimberly Ennico-Smith's Presentation (cont'd)

mal environments, including some permanently shadowed regions (PSR). This characterization will assist in understanding the origin of lunar polar volatiles and also help evaluate the In-Situ Resource Utilization (ISRU) potential of the lunar poles [Reference 2].

The VIPER Rover is shown in Figure 2. The rover is designed to drive through various types of lunar regolith. It has an antenna on top to receive roving commands from Earth when the Earth is above the lunar horizon. (When Earth drops below the lunar horizon, roving stops.)

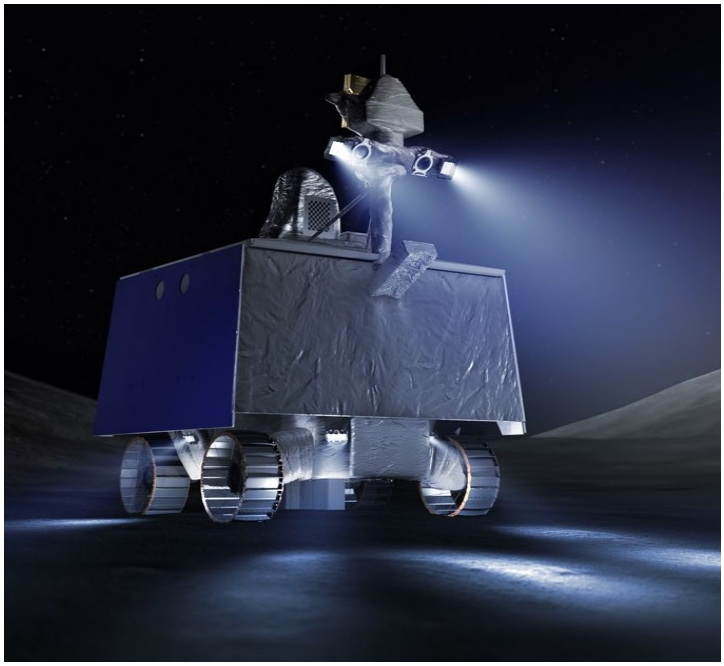


Figure 2 – The VIPER rover with cameras and lights in the front, back and near each wheel to allow for safe roving under all lighting conditions.

The rover is powered by solar panels when in sunlit regions and a 50-hour capacity battery when in darkness. The rover also includes internal heaters to deal with the large temperature swings between sunlit regions and PSRs. The rover's sustained average speed (1 cm/sec) is a tradeoff between going fast enough to get the mileage to do the mapping, yet slow enough to gather signal statistics along the way.

The rover-borne science instruments include a front-mounted Neutron Spectrometer System (NSS) to look for excess hydrogen by a suppressed epithermal neutron signal, and near-infrared and mass spectrometers mounted underneath. The Near InfraRed Volatiles Spectrometer System (NIRVSS) can determine water and other volatiles spectroscopically, and includes a thermal radiometer to measure surface temperatures under the rover as well as a color camera to image the soil. The Mass Spectrometer Observing Lunar Operations (MSolo) distinguishes different types of hydrogen molecules/isotopes based on their atomic weights. All the spectrometers operate continuously, whether the rover is driving or stationary.

In addition, a 1-meter drill called The Regolith and Ice Drill for Exploring New Terrains (TRIDENT) can bring material up from a depth of 1 m in 10 cm "bites" and put that material on the surface where it can be examined by NIRVSS and MSolo. TRIDENT is also instrumented to provide subsurface temperatures and thermal conduction.

The instruments have been designed and optimized to locate surface and sub-surface frozen volatiles in a variety of challenging Earth environments, including in laboratories where the lunar environment is simulated.

(continued on page 10)

Recap of Dr. Kimberly Ennico-Smith's Presentation (cont'd)

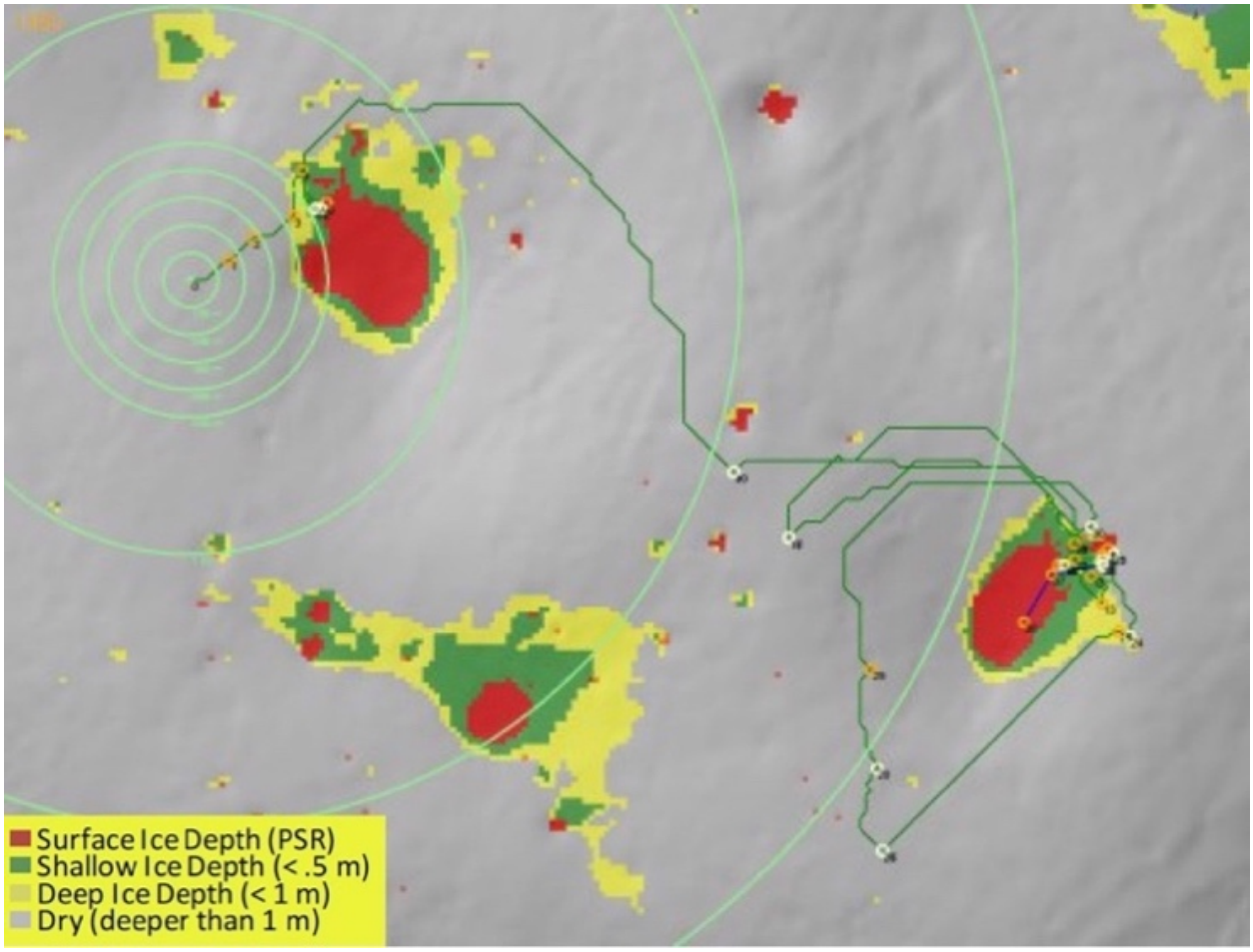


Figure 3 – An example of a traverse plan in an area north of the Nobile Crater. The colors indicate locations where the subsurface temperature is predicted to allow for water ice stability. From Reference 1.

The water resource mapping uses a geostatistical approach developed by USGS. It is based on using temperature as a proxy. Cold temperature (< 100 degrees Kelvin) is a good indication that volatiles such as water will stick around rather than evaporate. Ice Stability Regions (ISR), areas in which it is expected that between the surface and one-meter depth the thermal environment would support water ice being stable for geologic periods of time, are shown in Figure 3, along with an example traverse route. See Reference 2 for a description of the traverse planning process.

Stated the speaker: "As the rover is traversing, the instruments are on and scientists back on Earth will obtain near real-time data of the amount of hydrogen, the presence or absence of surface water ice and surface temperature. The mission will get immediate indication of where reality matches predictions and where it does not. Then the team can react and replan where the rover should go next."

(continued on page 11)

Recap of Dr. Kimberly Ennico-Smith's Presentation (cont'd)

The speaker then gave a concrete example of the readout data as the rover passed over an area of surface ice and a hidden ice bearing layer below. To quantitatively assay the subsurface, the rover must halt, then drill into the subsurface. The incremental drilling and assay analysis provides depth information to the water resource maps. Because the drilling is expensive time-wise, the VIPER science team will plan the drilling using geostatistical analysis methods to determine the optimal hole placements.

After its launch aboard a SpaceX Falcon Heavy rocket in November or December, 2023, VIPER will land west of the Nobile Crater aboard the Commercial Lunar Payload Services (CLPS) Griffin Lunar Lander, a generic cargo lander built by Astrobotic. The "study area" within the Nobile region is situated on a high plateau and was chosen for its reasonable terrain for landing and roving, nearness to several ISRs, a direct line of sight to Earth, and sunlight for power. The reference traverse plan in the study area will bring the rover close to two large, accessible PSRs with potential surface ice. The rover will travel between 10 and 15 miles over a period of about 100 Earth days. After that time, the lunar south pole will stay in shadow for more than 50 hours, and VIPER's batteries will drain, ending the mission.

Further information about VIPER can be found at https://www.nasa.gov/viper.

The YouTube recording of the VIPER presentation is at http://www.smcasastro.com/water-on-the-moon.html. ◆

References:

1. The Volatiles Investigating Polar Exploration Rover (VIPER) Mission – Measurements and Constraints, A. Colaprete et al., 52nd Lunar and Planetary Science Conference (2021).
2. VIPER Traverse Planning, M. Shirley et al., 53rd Lunar and Planetary Science Conference (2022).

Moon shot taken in January by member Nonong Norman.

An Astro-Imaging Session

By Frank Seminaro

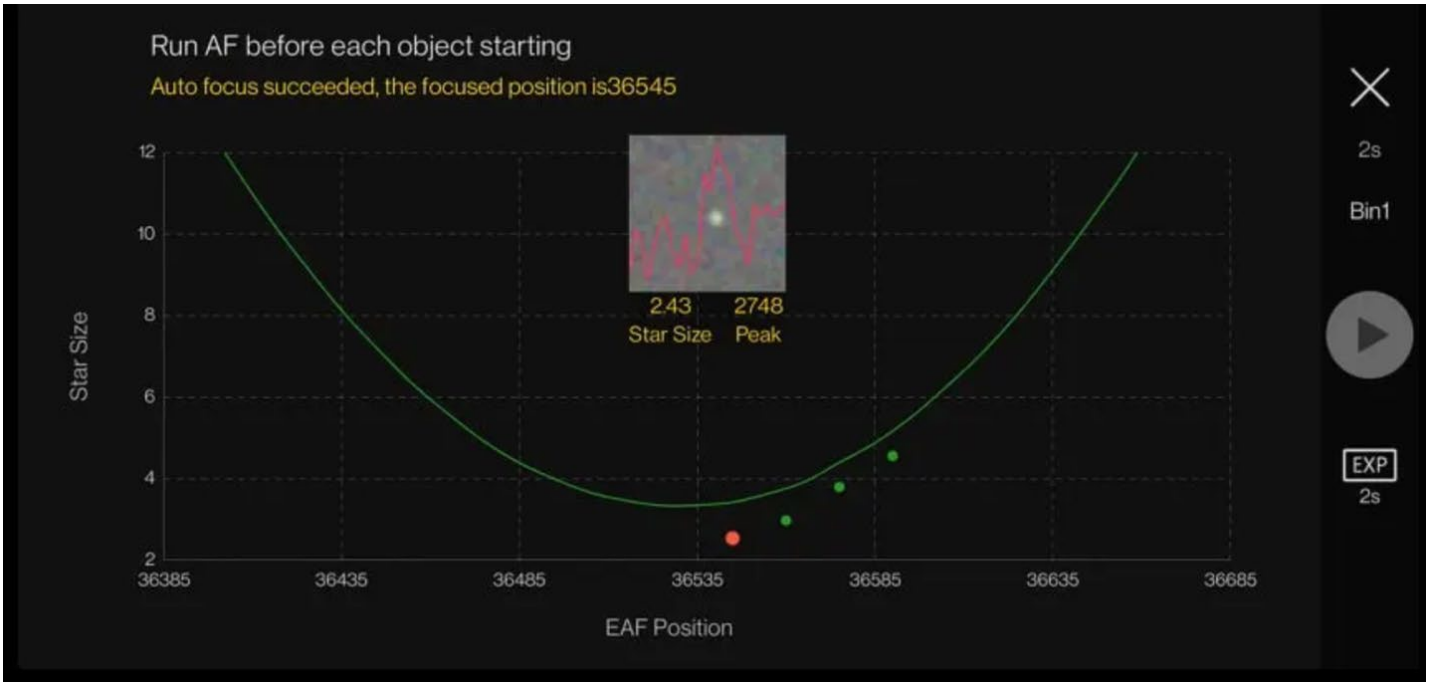


Figure 1 - Focusing screen

In the last issue I introduced the ASIAir Pro by ZWO. I use this minicomputer on my astrophotography setup to control everything needed for Astrophotography. I already covered how to polar align. Now I am going to describe preparing for and taking photos. For my equipment set-up, the first order of business after polar alignment is to one star align my AP1200 mount. I use the main camera in the "live" view to center an alignment star using the mount controller within the crosshairs shown on my iPad. Once aligned, I am done with the mount controller and can move back to only using the ASIAir Pro software on my iPad. The iPad connects to the ASIAir Pro wirelessly and it will sync date, time, and location data to the AP1200 mount automatically since the ASIAir Pro has a USB connection to the mount. The software also detects which main camera, guide camera, electronic focuser motor and storage device I have wired to the ASIAir Pro. I also have to enter the focal length of the main and guide telescope to enable plate-solving (more on that later). I also turn on the main camera cooling feature to give it time for cooling the main camera sensor. While still on the alignment star, I next activate the autofocus feature. The software will automatically select a star in the field of view of the main camera. In my case, this is the ASI2600MC color camera connected to a Hyperstar on a C14. The camera then starts taking pictures of the same star and calculates the selected star's size. Simply put, it describes how much a point of light spreads out on the camera sensor. The ASIAir now starts to talk with the ZWO Electronic Automatic Focuser (EAF). The EAF is an electronic motor attached to the focusing knob on the C14. It is connected to the ASIAir Pro via USB cable which also powers the motor.

(continued on page 13)

An Astro-Imaging Session (cont'd)

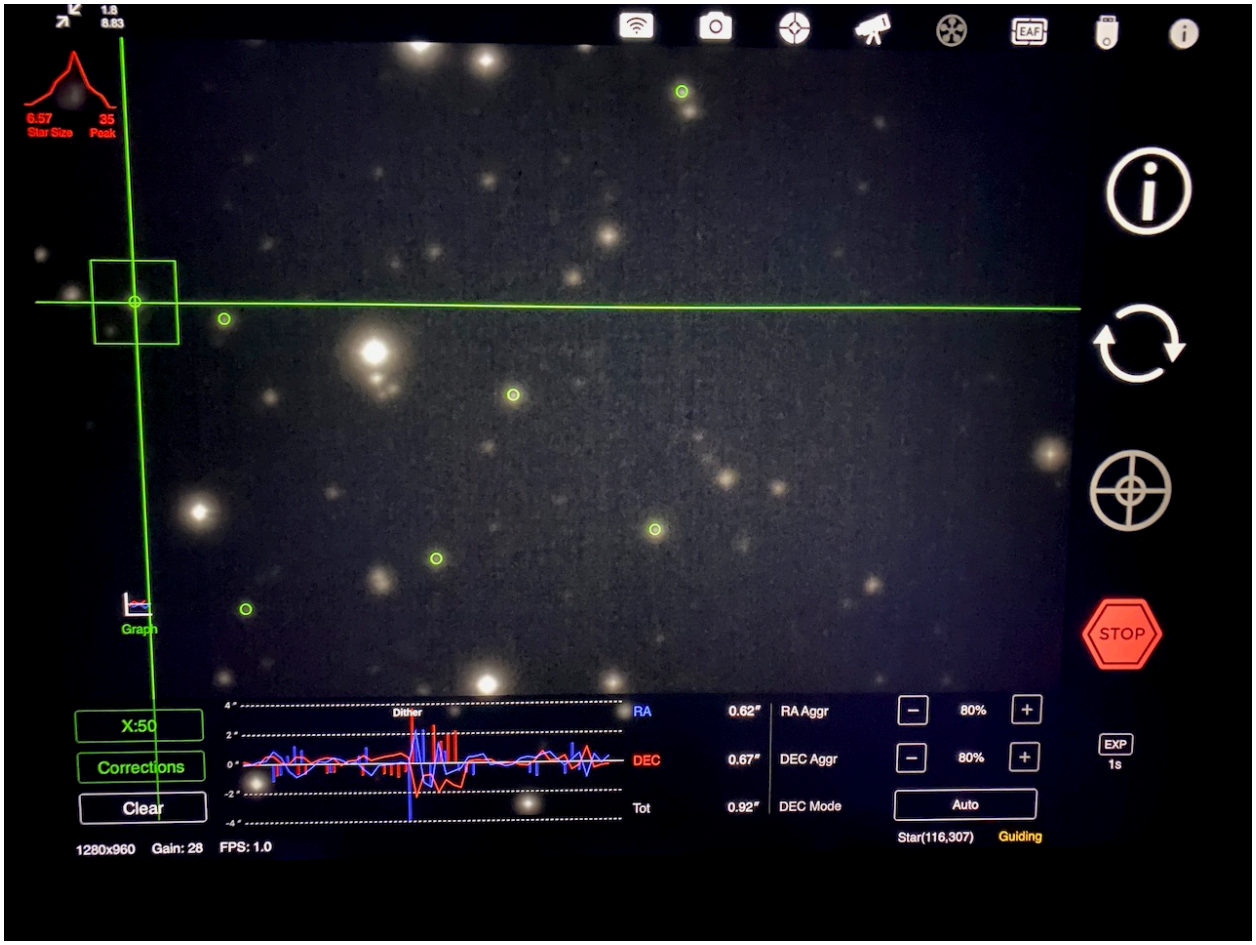


Figure 2 – Guiding screen

It will begin to move the focuser incrementally while the camera keeps taking pictures.

The star size for each shot is plotted on a curve. (See Figure 1 on page 12.) It will keep plotting until it knows the smallest star size obtainable for the target star and the related focuser position. The process takes about a minute and you are now in perfect focus. I repeat this process after I move to a new object to photograph just in case the shifting of the mount has slightly changed the position of the optics.

Now that I am in focus, I can slew the mount through the ASIAir Pro app to the target object. The software has an extensive list of objects built in to choose from. This is where plate solving comes in. When the mount completes its slew to the target, the main camera will take an exposure and plate solve it. Contained within the ASIAir Pro memory is a database of star positions. It will compare the image with the database and automatically adjust the RA and DEC of the mount to perfectly center the object. Another neat option is the Annotate function. This feature will identify all the star and object names in your image on the iPad.

The next step is to commence guiding. The ASIAir Pro requires a separate guide scope and camera to connected to your main telescope.

(continued on page 14)

An Astro-Imaging Session (cont'd)

Figure 3 – Imaging camera control screen

I use a William Optics 50mm guide scope with the ASI120MM mono guide camera. The guide scope is mounted on the C14. The ASI120MM camera is connected to the ASIAir Pro via USB and a separate power cable.

The guide camera is also connected to the AP1200 mount via an RJ-11 (telephone wire) connection. Figure 2 on page 13 shows the ASIAir Pro Guiding screen.

At the start of guiding, the software will automatically select a star. The guide camera will continuously take more pictures tracking the position of the guide star on the camera sensor. If the star moves, it will send a pulse to the mount and move the RA or DEC axis to place the star back into the original position. It will also graph the RA and DEC movements which are shown in Arc Seconds. Good guiding is essential for crisp astrophotography images. It corrects for any error in your polar alignment. A measure of less than 2 arc seconds per pixel makes for a great imaging session. Note the session in the picture is less than 1!

We are now ready to start taking pictures. At this point, I am usually 10 to 15 minutes into setting up an imaging session. There are many features in the imaging portion of the

(continued on page 15)

An Astro-Imaging Session (cont'd)

software. The range of features will satisfy most advanced imagers and imaging types (Color, Mono and Planetary). I will cover the basics I use 99% of the time.

Here is an iPad screen shot of the main camera control screen while imaging M42 (Orion Nebula). To start imaging with the main camera, I need to enter how many pictures I want to take, camera gain (sensitivity), sensor cooling temperature, what type of exposure, and how long of an exposure for each image. In Figure 3 on page 14, the camera is on image 2 of 5 and has 73 seconds left in the current 120 second exposure. Each exposure is saved to a removable USB memory stick in the ASIAir Pro. In addition to taking individual exposures, there is a live video option. The guiding status is also visible in the screen shot to keep you aware of mount tracking. Finally, there is an adjustable color histogram. This allows you to adjust the white and black point of the image on the iPad screen. This is very helpful for live shots or to confirm dim objects. This does not change the data being collected and ultimately saved on the memory stick for post processing.

Since my setup utilizes the Hyperstar, I am imaging at F2. This allows for the fast collection of light thus low exposure times. I usually use 30 seconds of exposure for each image. The number of images to capture varies depending on the object. In the previous picture of the Orion Nebula (M42), the 2 minute exposure setting was too long. M42 is a fairly bright object to image (Mag 4). The core of M42 was over-exposed. There are four stars in the center of the nebula called the Trapezium Cluster. The goal is to resolve these stars in addition to the surrounding nebula. Some imagers stack different length exposures to combine the different levels of details captures. In comparison to M42, a dim object such as Thor's Helmet (NGC 2359, Mag 11.45) will require the longer exposure times and more images for stacking.

The combination of the Hyperstar and the ASIAir Pro takes a bit of experimentation to dial in. The shorter exposure times allow me to image several objects in a single evening. It also minimizes any polar alignment or tracking errors. Finally, to complete an imaging session, I also collect several image types used in post processing. They are Flats, Darks, and Bias. These reference images help remove noise from the object images. I will discuss post processing in the next issue. ◆

Summary of Dr. Wei-Chun Jao's SMCAS November 19, 2021 Presentation "From Astrometry to Discovery"

By Ed Ching

Dr. Jao began his talk [Reference 1] with a brief introduction to how astrometry is a basis of observational study of stars, stellar motion, and stellar evolution. The big existential questions of astronomy first require understanding of the universe, which requires that locations be unambiguously and reproducibly defined. The combination of distance with a coordinate system (which uses time as one defining parameter) are the basis of astrometry. He generally described how global navigation needs were approached by mathematicians and scientist/engineers to change navigation from a two-dimensional plane to a spherical surface of the Earth [Reference 2]. Mathematicians, who were often also astronomer/natural scientists, developed a two-dimensional coordinate system into a polar coordinate/time dimension system used in current star atlases. They added a third distance dimension to provide a three-dimensional coordinate system for defining all points in 3D space.

Figure 1 – The GAIA satellite, which measured precise coordinates, precise distance, brightness, and precise radial velocity. Note that GAIA satellite is located at L2 Lagrange point (same as James Webb Space Telescope), a different point from earth, so "double stars" which are optically aligned from earth will not be optically aligned from L2 and resolution of certain "optical pairs" will be resolved and separated.

The third distance dimension was developed using the standard parallax system which biology adopted in visual systems, having two eyes with angular separation. With processing within the brain, the distance to an object can be "computed". Not only is this the standard distance measurement method for human eyesight, but also for animals, including cuttlefish, as he described. Explaining how parallax works astronomically, the principle for determining distance was presented.

Having explained the coordinate system and distance, individual stellar objects can be defined and reproducibly tracked and characterized, and repeatedly observed over time with observations linked to a specified object.

(continued on page 17)

Summary of Dr. Wei-Chun Jao's Presentation (cont'd)

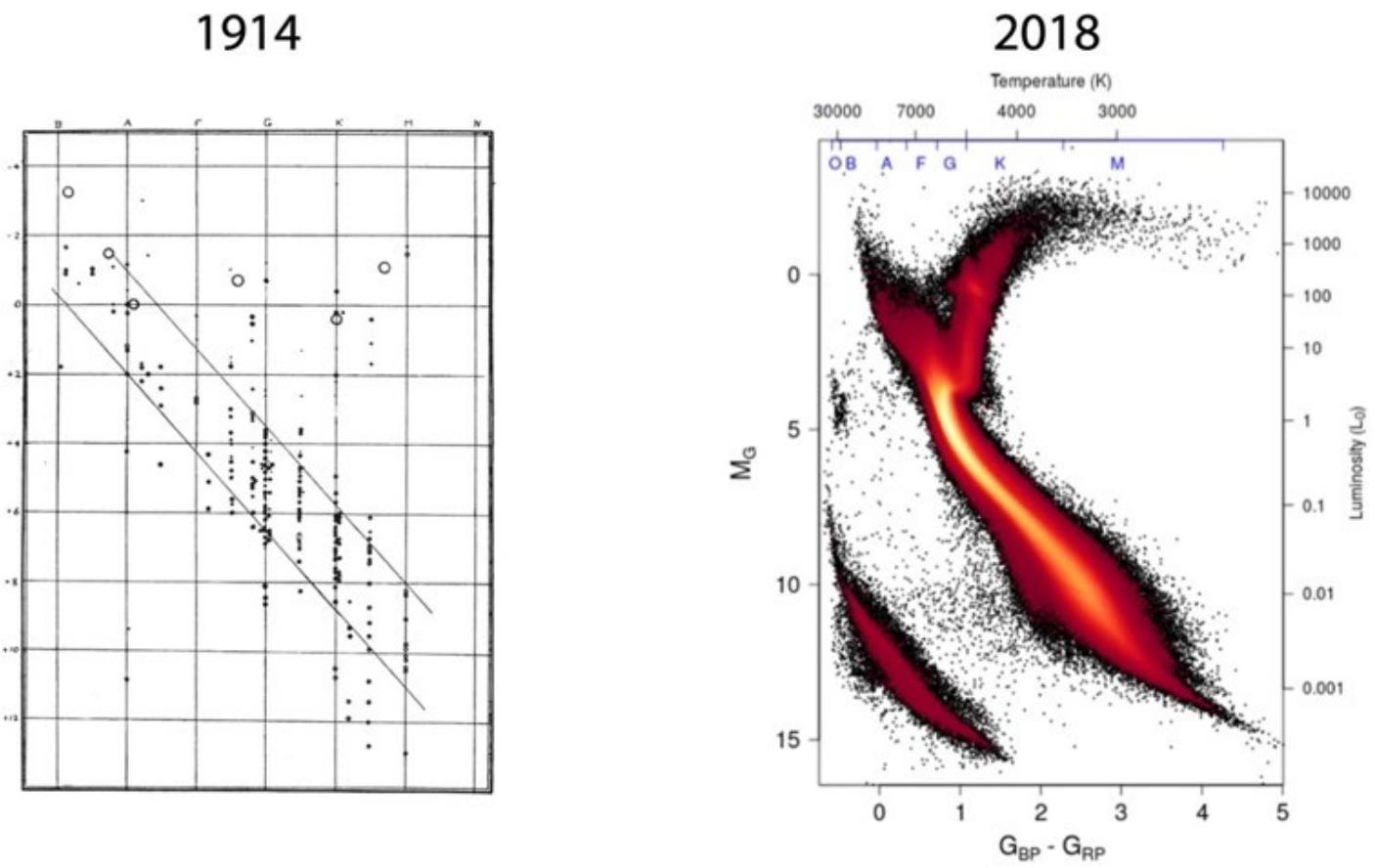


Figure 2 – Comparison of Luminosity vs Temperature plots by Henry Norris Russell (Nature 1914; <100 stars) and GAIA data release 2 (2018, over 4 million stars). However, the 1914 plot labels one axis (left, vertical) as "apparent magnitude" while the GAIA plot labels the corresponding vertical axis (left) as M_G (Absolute Magnitude; but right as Luminosity), and horizontal (bottom) axis as G_{BP}-G_{RP} (but top axis as Temperature). It would seem that the Luminosity measure from GAIA is the direct measurements from brightness and precise distance, and Absolute Magnitude derived therefrom.

Next, Dr. Jao changed gears and focused on specific stellar characterization methods. He explained how the concepts of the HR diagram developed over time. The "first" such plot is usually identified as the Henry Norris Russell (Nature, 1914) figure plotting Absolute stellar Magnitude vs. Temperature for maybe a few hundred stars, with an "indicated region" of most stars. But on more thorough search an earlier plot was published by Ejnar Hertzsprung in 1911. And even before that in 1910, Hans Rosenberg published a plot of Apparent magnitude vs Temperature for maybe 100 stars. Today, the diagram is referred to as the HR diagram, with most referring to Hertzsprung-Russell. But historically, Hans Rosenberg predated that, and why is Hertzsprung listed before Russell? Quite possibly because it should be Hans Rosenberg diagram, but substituting Hertzsprung for Hans, and Russel for Rosenberg? Perhaps some USA vs European "political" thing?

(continued on page 18)

Summary of Dr. Wei-Chun Jao's Presentation (cont'd)

In any case, the whole process of astrometry was revolutionized when the GAIA mission (ESA) was conceived and executed with a launch date of December 2013. See Figure 1. GAIA adopted a highly parallel high throughput measure of millions of star targets simultaneously and repeatedly. See https://www.esa.int/Science_Exploration/Space_Science/Gaia_overview.

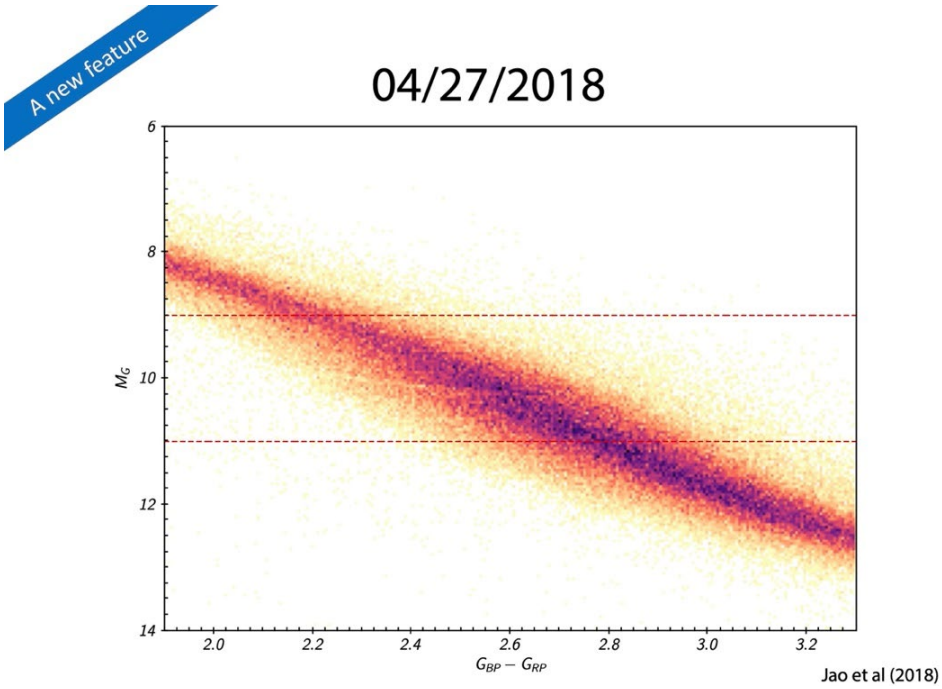


Figure 3 – Replot of selected region of Absolute Magnitude vs Temperature plot by Dr. Jao 2 days after Gaia data release 2, showing a "gap", or region where particular L,T pairings are "unstable", i.e., are not observed. The sample contains 70,700 sources, each source selected to be within 100 parsecs. In the corresponding region of the whole GAIA dataset, no gap is apparent, but the gap is hidden in the data. An analogous "Hertzsprung Gap" of the HR diagram is an "absence of stars" (or relative gap); stars do exist in the gap region, but because they move through/from this section "quickly", that portion of the diagram is less densely populated. While Jao says that the "depletion" reaches only 25-30%, some of his plots seem to show a gap of virtually no underlying stars within the gap.

The second GAIA data release, DR2, occurred April 25, 2018. This included precise position and brightness measures of 1.7B stars, precise surface temperature measurements of 160M stars, parallax and proper motion measures on 1.3B stars, blue and red photometer measurements of 1.4B stars, and other measurements on tens or hundreds of millions of stars. GAIA expanded astrometry data over 1000 times in terms of targets covered, and increased precision dramatically. Figure 2 shows the progress in HR diagram from 1914 to 2018.

Within two days of the DR2 release, Dr. Jao's manipulation of the data by cleaning up extraneous points, e.g., selecting nearby stars within 100 parsecs (for which the parallax data is especially

(continued on page 19)

Summary of Dr. Wei-Chun Jao's Presentation (cont'd)

precise), and removing double stars, some of which are gravitationally bound partners and others which are optical partners on the same line of sight from the vantage point, generated a selected plotting shown in Figure 3. This focuses in on a select region of M_G between 6-14 and G_{BP}-G_{RP} from 1.8-3.3.

In an HR diagram, the data from star sources is replotted, and the point plots do not retain any relationship to spatial direction or location in 3D space. Thus, the "gap" or depletion of points in that region of the diagram are not related to any depletion of physical localization of points. As the legend of Figure 3 describes, the depletion results from the selection against combinations of M_G and G_{BP}-G_{RP}. On a line of continuous M_G, the G_{BP}-G_{RP} seemingly adjusts discontinuously (or vice versa).

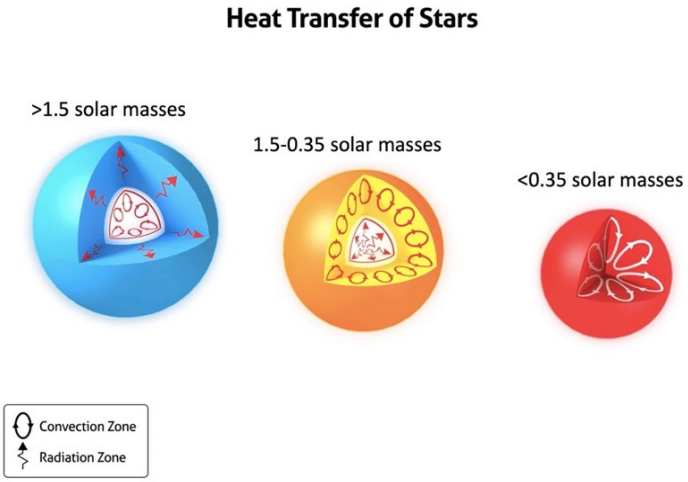


Figure 4 – Theoretical cartoon of how energy transfer from star core to surface occurs, based upon existing models, with thresholds for different "fully convective" vs "partially convective (radiative plus convective)" transfers. The transition point for the "fully convective" vs "partially convective" star sizes is "close" to the location of the gap, but different theoretical models for that transition occur at different solar mass thresholds. Thus, the theoretical models are being developed to fit the observed gap feature. Perhaps different metallicity contents of stars might affect the transition point, or other variable not captured from the Absolute Magnitude or Temperature parameters.

The location of the gap corresponds nearly to, but not exactly at, the theoretical transition point for temperature transfer from core to surface of stars in that size range. See Figure 4. The accuracy of the models for where the transition between partially convective and fully convective transfer vary with an error which ranges over this area. Thus, the theoretical models have empirical observations to match to refine the accuracy of the models. The observation of the gap is reported in Jao, et al. 2018 [Reference 3].

In his publication, Jao states that "the gap is not unique to the Gaia photometry, and is not caused by specific stellar spectroscopic features in the optical or near-infrared bands alone." The GAIA data team saw the same features but did not assign any significance to them until later questioned. The gap is not an artifact of the instrumentation or data processing. A similar gap was observed in a 100-130 parsec target selection set, with the gap corresponding to the exact same location. The GAIA dataset was needed to observe this gap because prior data was not of sufficient numbers of targets or precision. Jao states "This is the location on the main sequence where interior structure models

(continued on page 20)

Summary of Dr. Wei-Chun Jao's Presentation (cont'd)

show a transition from partially to fully convective stars, i.e., for thermal transfer from core to surface." And that "[t]he narrow gap implies a 'sudden' transition from one state to another, which happens to fall near the mass where stars are modelled to become fully convective." He says "it is probable that the gap and the transition to fully convective stars are linked … The result implies that stars above the gap may prove to be mostly convective with a thin radiative layer and are more massive, while those below are fully convective, less massive and smaller."

Figure 5 is a cartoon of an interior structure dynamics model within the gap.

Dr. Jao suggested future studies will investigate, among others, can we reproduce the main-sequence from models; what kind of dynamo model is for these gap stars; what is the exact mass range of this transition; do stars in the gap show additional activities at the surface? ◆

References:

1. YouTube link to Dr. Jao's talk: https://www.youtube.com/watch?v=xNItcduBh4A
2. Dava Sobel (1995) Longitude: "The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time", Penguin Books, ISBN 0-8027-1312-2.
3. Jao, et al. "A Gap in the Lower Main Sequence Revealed by Gaia Data Release 2" Astrophysical Journal Letters (2018) arxiv.org/pdf/1806.07792.pdf

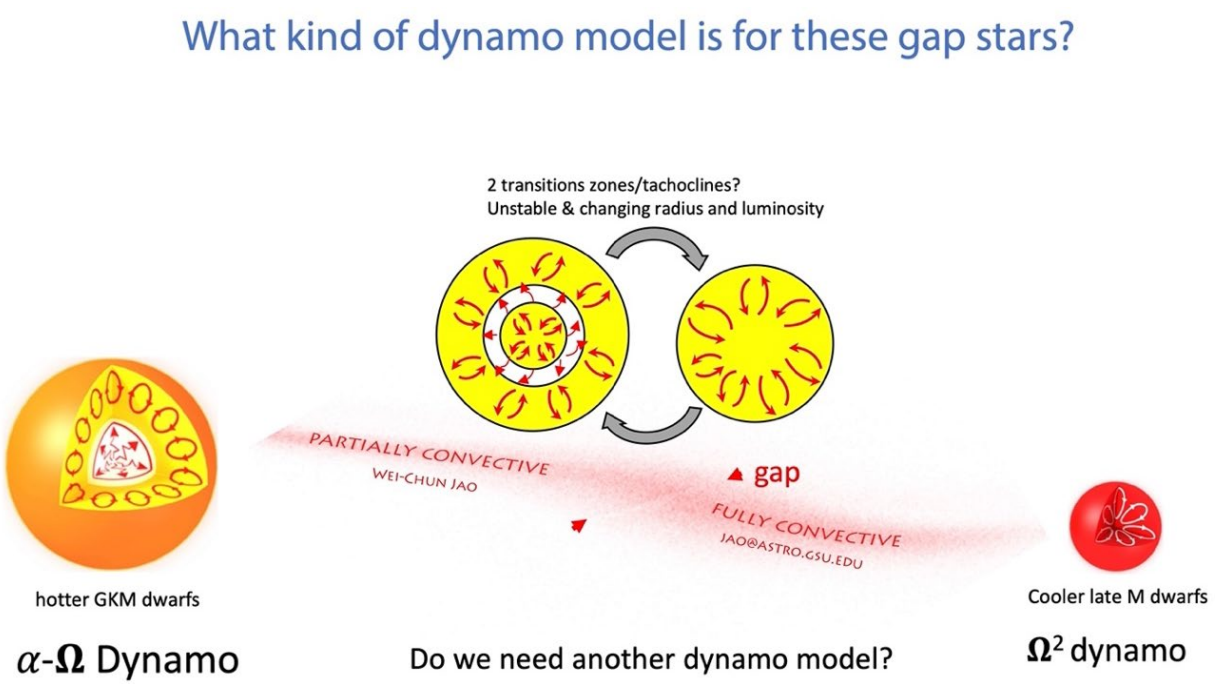


Figure 5 – New dynamo model for gap stars, attempts to explain why certain Surface Temperatures either fluctuate or are unstable, causing certain Luminosity, Temperature combinations to be "depleted" or observed in lower density.

The Equinox at Chichen Itza & the Pyramid of Kukulcan

By Michelle Morales Torres

The front of the Pyramid of Kukulcan at Chichen Itza. This side has been restored by archeologists to how they think it once looked. Note the steps on the left side, they are what cause the shadow's serpent to appear on the other side of the pyramid. *Photos by Michelle Morales Torres.*

As an amateur astronomer, I had always wanted to see, what is considered to be one of the wonders of the world, Chichen Itza. Chichen Itza is the largest pyramid in the Yucatan of Mexico. It was built by the Mayans. They still exist but at the time they built the pyramids, they were an ancient civilization that was very advanced. They were known for being great astronomers (they knew when solar eclipses would happen!), engineers, writers and for doing both human and animal sacrifices. There's a phenomenon that happens at each of the equinoxes at the pyramid – the shadow of the snake appears on one of the sides of the pyramid. This happens because of the way it was built. I have often read the description of how the construction of the of the side of the pyramid made the phenomenon possible and even watched videos on YouTube to see this incredible marvel but it didn't click until I sat in front of the edge of the pyramid that caused the shadow of the snake. I think it was because the videos and pictures I saw, didn't include the wall that caused the shadow. The shadow lines up perfectly with the head of the snake at the bottom of the pyramid.

You might recall, the Mayans became very popular in 2012 because they had an ancient calendar that began August 11, 3114 BC and ended December 21, 2012. Many believed the world would end at that time. While touring ruins in Mexico, they arrange to have actual Mayans or mixed Mayans to lead the tours. One explained to us that the ending of the calendar didn't mean the end of time or the world, it was just the end and the beginning of one cycle or phase in time. What the

(continued on page 22)

The Equinox at Chichen Itza & the Pyramid of Kukulcan (cont'd)

Approximately the middle of the equinox and the shadow of the serpent appearing at Pyramid of Kukulcan a Chichen Itza. Note the head of the snake at the lower left.

next cycle or phase was supposed to be wasn't entirely clear but the Mayans believed that these cycles occur about every 5,000 years.

As you know, March 20 was the spring equinox. That is when the sun crosses the celestial equator going south to north. It's called "celestial" equator because it's an imaginary line in the sky above the Earth's equator. Equinox in Latin means "equal night," where aequus means equal and nox is night. On the equinox, the length of day and night is nearly equal in all parts of the world. Ancient civilizations lived by the equinoxes since they signified when it was time to start planting or harvesting.

Making the trek out to Chichen Itza means flying out to Cancun, Mexico (the direct flight from SFO took about 6 hours). Then driving for about 2 ½ hours from Cancun into the jungle. The entire site is called Chichen Itza, but the pyramid is actually called the Pyramid of Kukulcan or The Castillo. Kukulcan was a feathered serpent worshipped by the Mayans and others in the area, such as, the Aztecs and Toltecs but they called him Quetzalcoatl. They believed this god brought good things. Unfortunately, most of the Mayan myths and stories associated with this god no longer exist due to the Spanish Conquistadors burning most of the Mayans' books, in addition to crumbling stone where their version of hieroglyphics are no longer readable.

(continued on page 23)

The Equinox at Chichen Itza & the Pyramid of Kukulcan (cont'd)

The ending of the equinox just before the serpent's shadow disappears.

I really wanted to go the day of the equinox but the tour company didn't recommend it because it's gets so busy. They told us that there were times their buses didn't make it to the pyramid on the equinox because traffic was so bad. There's only one road that takes you there and that's the result when thousands, upon thousands try to take the same road somewhere. Fortunately, the phenomenon is visible a few days before and a few days after, so we opted for going the day after. If you're not able to make it out for the equinox, the shadow is now recreated at night with a laser light show.

It was a cloudy on March 21 and even poured rain for a few minutes in the early afternoon. Our tour finished about 3pm and the shadow was due to start showing at around 4:30pm. I was on a mission to get that corner spot of the pyramid where I watched videos and promptly planted myself at the corner of the pyramid at the edge that forms the shadow. For most of the afternoon, clouds covered the sun but once in a while it would break through. We weren't able to watch the phenomenon start due to the clouds, but it made its appearance in between. The crowd would "eeeew" with delight when the sun caused the shadow to appear or groan with disappointment when it disappeared. We all became really nervous when a big dark cloud appeared and stayed in front of the sun and it really looked like we wouldn't be able to see the shadow when all of the sudden, it disappeared! The equinox lasts for about 45 minutes. We were able to watch the last 20 minutes with no interruptions and until the shadow disappeared. Later we were told there was a crowd of about 10,000.

It was awe inspiring and mind blowing to witness the incredible planning that must've been completed in order for this building to have been constructed and without any modern day tools. We learned that the structure we see today was about 800 years old and that it was built over two other pyramids. It is believed that the first pyramid is 1,200 years old. It also shouldn't be too surprising to learn that the pyramid was also used as a calendar. Each side has 91 steps and then when you include the platform at the top, it totals 365, just as our own calendar year. There was a time when you could walk all over the ruins, but we were told that as it began to crumble and became damaged, it was decided it was best to keep people off of them. As it turns out, the stairs were actually closed after a woman fell to her death in 2006. ◆

Directions to SMCAS Public Star Parties (Weather Permitting)

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 small blue sign on the right, and the entry road on the left.

From Hastings and Club Drives: From Belmont, take Carlmont Drive to Hastings Drive. Follow Hastings about 1.5 miles, first uphill, then down, to San Carlos where it becomes Witheridge Road, then ends a block later at Club Drive. Turn right and climb Club Drive to Crestview Drive. Turn left and continue some 2 miles, first up, then down past Leslie Drive, to the small blue Crestview Park sign on the left. Turn right into the Crestview Park entry road.

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 flashlights 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.

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

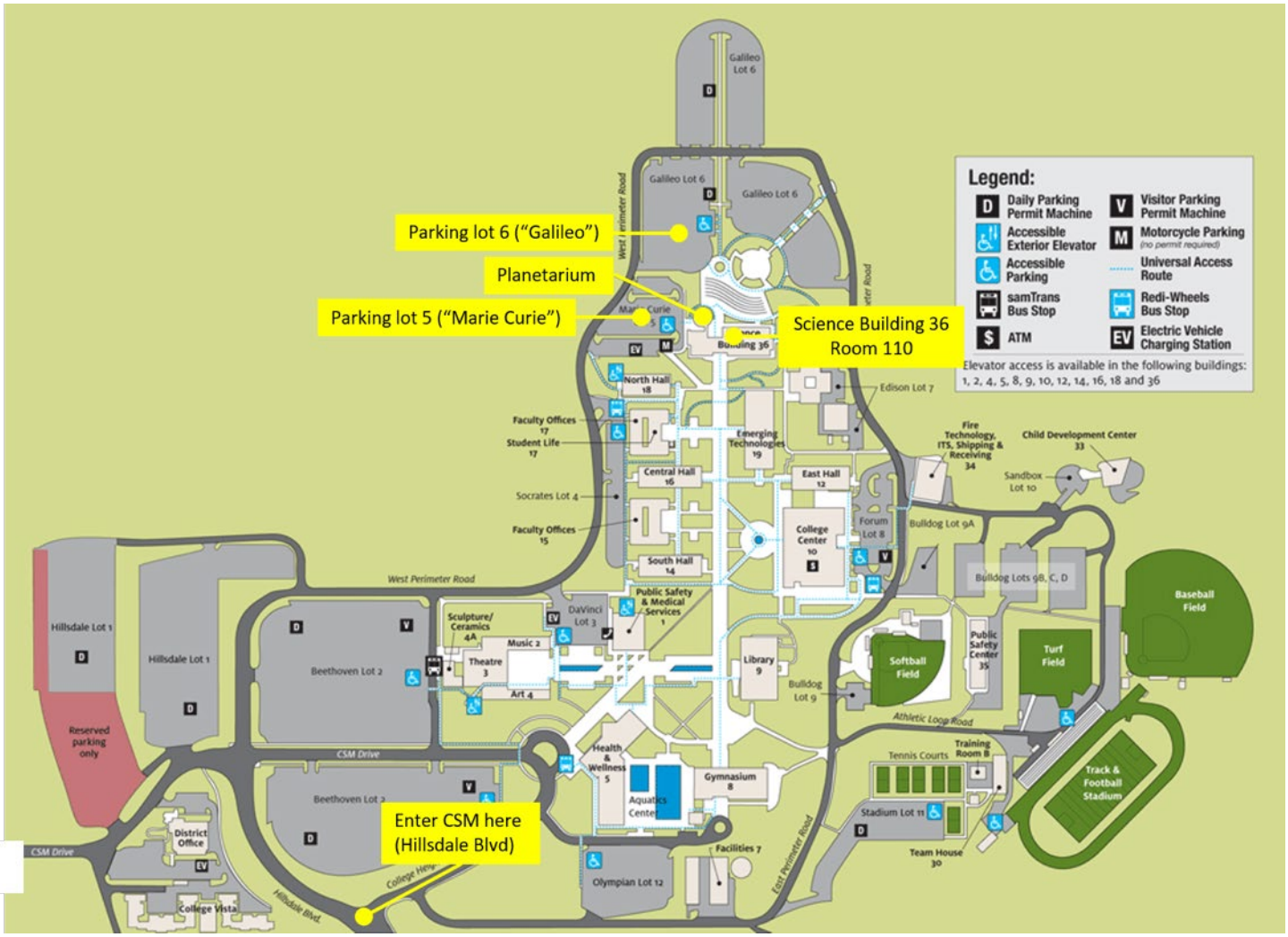
From San Carlos, take San Carlos Avenue to Club Drive, and climb to the 5-way intersection. Take the half-right to continue on Club Drive past Witheridge Road to Crestview Drive. Proceed as above to Crestview Park.

Directions to SMCAS Meetings at The College of San Mateo:

NOTE: CSM is closed due to the pandemic.

SMCAS events are online until further notice.

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 of Hillsdale Blvd. Continue straight onto West Perimeter Road and follow it until you reach 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.)



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 7pm 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' 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.

Membership Application on next page

San Mateo County Astronomical Society
Membership Application

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

rev 02272020

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' umbrella 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: _____