

PRIMEFOCUS

Tri-Valley Stargazers



April 2021



Meeting Info: Lick Observatory Back On Sky: 2020 Wildfire Recovery

Who:
Dr. Jon Rees

When:
April 16, 2021
Meeting at 7:30 p.m.
Lecture at 8:00 p.m.

Where:
Virtual Meeting using: Zoom*
See the April or May 2020 issue of PrimeFocus for info on getting connected using Zoom.

Inside

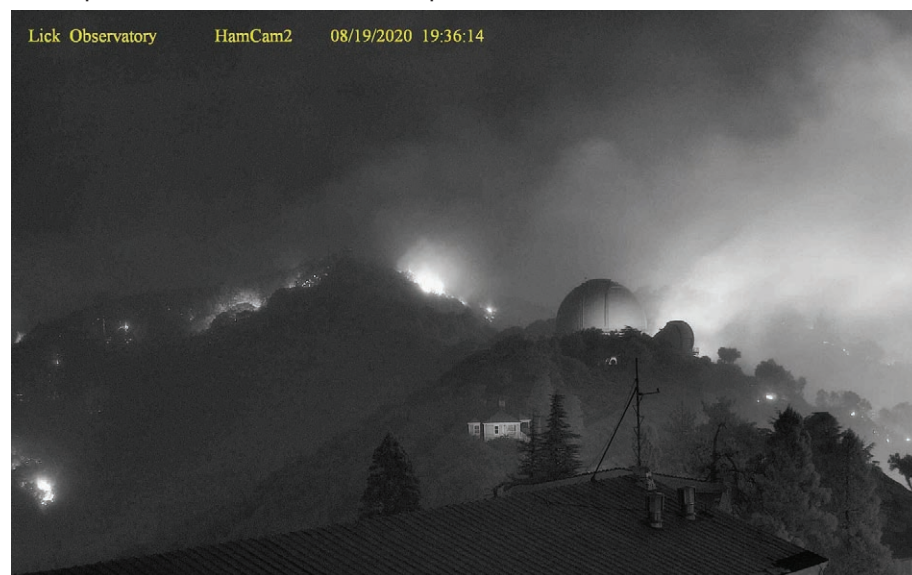
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April Virtual Meeting Using "Zoom"

Lick Observatory Back On Sky: 2020 Wildfire Recovery Dr. Jon Rees, Lick Observatory

The 2020 wildfire season saw an unprecedented series of lightning strikes sparking fires across the Bay Area. Located on Mount Hamilton, outside of San Jose, Lick Observatory was directly threatened by these fires and, for the first time in its history, was forced to evacuate.

In this talk I'll discuss the events leading up to the SCU Lightning Complex fire reaching Lick Observatory, the damage it caused to our site, and the resulting cleanup efforts before our return to operations.



Caption: The SCU fire burned across the site of Lick Observatory on 19th August 2020, as seen in this image from one of the Mount Hamilton webcams. (Credit: UCO/Lick Observatory). Also see: <https://news.ucsc.edu/2020/08/mt-hamilton-fire.html>

Jon Rees obtained his undergraduate degree from Cardiff University, using the 0.4m telescope to observe transiting extra-solar planets. He received a Ph.D. in Physics from the University of Exeter in 2016, focussed on observations of young star clusters with the Isaac Newton Telescope and CTIO 4-m. After a research position at the University of Arizona and UC San Diego, during which he added experience with the Lick and Keck Observatories, Jon switched to more hands-on, telescope-oriented positions. He was the Observatory Manager at New Mexico State University, maintaining their campus observatory along with the 24-inch and 1-m robotic telescopes. Since 2020, Jon Rees has been a support astronomer at Lick Observatory.

News & Notes

2021 TVS Meeting Dates

Below are the TVS meeting dates. The lecture meetings are on the third Friday of the month, with the Board meetings on the Monday following the lecture meeting.

Lecture Meeting	Board Meeting	Prime Focus Deadline
Apr. 16	Apr. 19	
May 21	May 24	May 07
Jun. 18	Jun. 21	Jun. 04
Jul. 16	Jul. 19	Jul. 02
Aug. 20	Aug. 23	Aug. 06
Sep. 17	Sep. 20	Sep. 03
Oct. 15	Oct. 18	Oct. 01
Nov. 19	Nov. 22	Nov. 05
Dec. 17	Dec. 20	Dec. 03

Money Matters

As of the last Treasurer's Report on 3/22/21, our club's account balance is \$65,179.88. This includes contributions of \$44,580.27 to the H2O Rebuild fund.

TVS Welcomes New Member

TVS welcomes new member Scott Maher. Please say hello and chat with him during our Zoom meetings.

H2O and Del Valle Observing Sites Reopened

The club is happy to announce that the Del Valle and Hidden Hill Observatory sites have reopened for observing by those who have paid their 2021 TVS Membership dues and are approved key holders.

Due to the ongoing COVID-19 emergency, the following restrictions must be followed:

- *The sites are open for individual use only by club members and immediate family; no guests or group events allowed
- *You use each observing site at your own risk and agree to hold the club and the landowners free of all liability
- *Do not use either observing site if you are not feeling well or suspect you were recently exposed to the virus
- *Announce your intention to use either site on our groups.io group
- *While at either site maintain social distancing of at least 15 feet (about a car's length)
- *Bring hand sanitizer and use it before and after touching any locks or facilities
- *Club members should not touch or look through each other's equipment. Focuser knobs and eyepieces can potentially spread the virus.
- *H2O keyholders who wish to use the Quick Dome

should first contact Ross Gaunt (secretary at trivalleystargazers.org) to reserve it for individual use for the day

*Note that these restrictions do not replace or negate any Alameda or Santa Clara County health orders in place at this time.

Ross Gaunt, our club secretary, emailed the updated lock combinations and usage instructions for each site to all H2O key holders and all Del Valle registered users. If you are a H2O key holder or Del Valle registered user and didn't get Ross's email, please let Ron (president at trivalleystargazers.org) or Ross know and we'll straighten it out.

H2O orientations will be scheduled as soon as reasonably possible for those who have paid the annual access fee but have not received their key.

Outreach Star Party Schedule

Cancelled through April.

Contact Eric Duetgen if you are interested in participating in future events (outreach at trivalleystargazers.org).

H2O Rebuild

Progress is being made in the rebuild of H2O. On April 10, TVS will use a drone to perform a site survey with ground control GPS marked reference points. This will facilitate exacting plans for the best locations for the new observatories.

Several purchases have been approved by the TVS Board, including the purchase of a controller for the donated Mathis mount, a shed for storage of site work tools and materials, and necessary cables. The purchase of a new picnic table for H2O will be forthcoming as soon as the board reviews the available options.

As a safety concern, in case of future fire, the large pine tree at H2O will be felled on or about April 11.

Calendar of Events

April 17, 7:30pm

What: Black Hole Portrait: How We Got Our First Picture
Who: Prof. Eliot Quataert (Princeton University)
Sponsor: Mt. Tam Astronomy Program
Online: <https://us02web.zoom.us/j/89697734661#success>

Black holes are among the most remarkable predictions of Einstein's theory of gravity: so much material is compressed into such a small volume that nothing, not even light, can escape. Black holes have also captured the public imagination, and are commonly featured in popular culture, from Star Trek to Hollywood movies. In Spring 2019, the multinational Event Horizon Telescope (EHT) released the first real (non-Hollywood!) picture of gas around a black hole and the "shadow"

Header Image: If after reading the Journal Club article on p.5 you are interested in learning more about Supernovae, the NASA Night Sky Network has a toolkit just for you. It has many resources, and is well-suited to those who are teaching at home. See: https://nightsky.jpl.nasa.gov/download-view.cfm?Doc_ID=275

Calendar of Events (continued)

cast as that gas swirls in. How did the EHT do it, and what have its combined observations taught us about black holes?

For more information see: <https://www.mttamastronomy.org/calendar> and <https://youtube.com/MtTamAstronomy>

April 17, 24; May 1, 8, 9:00pm-10:30pm

What: Virtual Telescope Viewing

Who: Chabot Staff

Sponsor: Chabot Space and Science Center

Online: https://www.youtube.com/channel/UCarFXs-04xmdHW_PVc7LWRg

Each week, our astronomers will guide us through spectacular night sky viewing through Nellie, Chabot's most powerful telescope. Weather permitting we will be able to view objects live through the telescopes and our astronomers will be available to answer your pressing astronomy questions.

Nellie is a 36-inch reflector telescope, housed in a rolling roof observatory that allows access to 180 degrees of sky. This modern, research-quality telescope offers breathtaking views of the cosmos.

For more information, see: <https://chabot.space.org/events/events-listing/>

April 21, 11:00am

What: Going Dark: The Mystery of Vanishing Stars

Who: Dr. Michael Busch (SETI Institute)

Sponsor: SETI Institute

Online: REGISTRATION REQUIRED: <https://www.eventbrite.com/e/going-dark-the-mystery-of-vanishing-stars-tickets-149797962739>

Comparing a 70-year-old survey with recent images of the

night sky, astronomers have discovered that 100 stars may have gone dark. Those vanishing light sources could be short-lived flashes in the night or possibly, the disappearance of a long-lasting star. These preliminary findings almost certainly represent natural and well-understood events, but there is the hope that they could indicate technological civilizations elsewhere.

We invited two astronomers to discuss this extraordinary finding and the future of this research.

Beatriz Villaroel is the principal investigator of the Vanishing & Appearing Sources during a Century of Observations (VASCO) project. She led the effort to compare a series of sky images taken by the U.S. Naval Observatory (USNO), starting in 1949, with recent observations by the Panoramic Survey Telescope and Rapid Response System (Pan-STARRS) between 2010 and 2014. While searching for vanishing stars, the VASCO project found ~100 red transients; objects found in the old Palomar plates that did not appear in the new ones.

James Davenport is a Research Assistant Professor of Astronomy at the University of Washington and the Associate Director of the DiRAC Institute. He advocates using big data techniques to search for intelligent life in the universe and leads multiple data-driven technosignature projects, including at the Vera Rubin Observatory. This 8m telescope will start scanning the sky once every few nights in late 2022 and speed the hunt for such transient objects.

These astronomers will give us an update on the search for vanishing stars two years after their discovery. They'll discuss the possibility that we are seeing unknown phenomena or that the vanished "stars" could be relics of technologically advanced civilizations, particularly the theoretical mega-en-

continued on p.4

Officers	Volunteer Positions	Night Sky Network Rep.:	Refreshment Coordinator:
President: Ron Kane president@trivalleystargazers.org	Astronomical League Rep.: Dennis Beckley alrep@trivalleystargazers.org	Ross Gaunt nnsn@trivalleystargazers.org	Laurie Grefsheim
Vice-President: Eric Dueltgen vice_president@trivalleystargazers.org	Club Star Party Coordinator: Eric Dueltgen coordinator@trivalleystargazers.org	Observatory Director/Rebuild Chairman: Chuck Grant observatory@trivalleystargazers.org	Webmaster: Hilary Jones webmaster@trivalleystargazers.org
Treasurer: John Forrest treasurer@trivalleystargazers.org	Del Valle Coordinator: David Wright delvalle@trivalleystargazers.org	Observing Program Coordinator: Ron Kane awards@trivalleystargazers.org	Web & E-mail www.trivalleystargazers.org info@trivalleystargazers.org
Secretary: Ross Gaunt secretary@trivalleystargazers.org	Historian: Hilary Jones historian@trivalleystargazers.org	Outreach Coordinator: Eric Dueltgen outreach@trivalleystargazers.org	TVS E-Group To join the TVS e-group just send an e-mail message to the TVS e-mail address (info@trivalleystargazers.org) asking to join the group. Make sure you specify the e-mail address you want to use to read and post to the group.
Past President: Roland Albers past_president@trivalleystargazers.org	Librarian: Ron Kane librarian@trivalleystargazers.org	Potluck Coordinator: OPEN potluck@trivalleystargazers.org	
	Loaner Scope Manager: Ron Kane telescopes@trivalleystargazers.org	Program Coordinator: Dan Helmer programs@trivalleystargazers.org	
	Newsletter Editor: Ken Sperber newsletter@trivalleystargazers.org	Publicity and Fundraising: Brian Blau publicity@trivalleystargazers.org	

Calendar of Events (continued)

gineering projects known as Dyson spheres. Either way, this discovery has turned up something that may become very important for both astrophysical and SETI investigations.

April 23, 7:00pm

What: Saving the Dark: Movie and Panel Discussion
Who: Sriram Mulali (File Producer), Astronomers Gerald McKeegan and Richard Ozer
Sponsor: Chabot Space and Science Center
Online: <https://www.youtube.com/watch?v=cTDBlaCsWwc>

Join us for a special screening of *Saving The Dark*, a documentary movie on astronomy and light pollution. Learn more about the significance of astronomy and the night skies, effects of light pollution on astronomy, human health, wildlife and beyond, what we can do to fight it.

Panelists will include *Saving the Dark* film producer Sriram Murali, joined by astronomers Richard Ozer and Gerald McKeegan. We will discuss the costs of light pollution, including its' affects on our health, wildlife and our environment.

For more information, see: <https://chabot.space.org/calendar/saving-the-dark-movie-and-panel-discussion/>

April 27, 7:00pm-8:00pm

What: Space Science for Families: Near-Earth Asteroids, The Impact Hazard, and Space Missions
Who: Dr. Michael Busch (SETI Institute)
Sponsor: SETI Institute and Chabot Observatory
Online: <https://www.youtube.com/watch?v=Yi63lG4nIC8>

Near-Earth asteroids (NEAs) are small solar system bodies in orbits that come near or cross the orbit of Earth. I will review NEAs as unique physical worlds, as potential impact hazards to Earth, and as accessible destinations for spacecraft.

Michael W. Busch, PhD, is a planetary astronomer and research scientist at the SETI Institute. His research focuses primarily on studying individual asteroids with radar and radio technique; to understand their histories, rule out future Earth impacts, and support space missions.

For more information, see: <https://www.seti.org/event/space-science-families-near-earth-asteroids-impact-hazard-and-space-missions>

April 28, 7:00pm

What: Black Hole Survival Guide
Who: Prof. Janna Levin, Barnard College
Sponsor: Silicon Valley Astronomy Lecture Series
Online: <https://www.youtube.com/watch?v=wQl7pfU9EBA>

In this talk, Prof. Levin will help us understand, and find delight in, black holes – perhaps the most opaque theoretical construct ever imagined by physicists. She will take us on an

exploratory tour of the neighborhood of a black hole, and help us feel the visceral experience of encountering it (for example, warning us about the danger of being “spaghettified” by its enormous tidal forces.) She’ll also discuss the influence of black holes on the universe at large, including their mergers and the way their presence can sculpt entire galaxies.

Dr. Janna Levin is Claire Tow Professor of physics and astronomy at Columbia University’s Barnard College. Her scientific work deals with the nature and extent of space and time, black holes and neutron stars, the background radiation from the early universe, and gravitational waves. She is also Director of Sciences at Pioneer Works, an interdisciplinary cultural center in Brooklyn, that encourages cooperation between the arts and the sciences. She is the author of *How the Universe got its Spots*, and *Black Hole Blues and Other Songs from Outer Space*. Her first book of fiction, *A Madman Dreams of Turing Machines*, won the PEN Prize. Her latest popular book, *Black Hole Survival Guide*, is published by Knopf and available in many formats.

The lecture is co-sponsored by The Foothill College Science, Tech, Engineering & Math Division, The SETI Institute, The Astronomical Society of the Pacific, and The University of California Observatories (including Lick Observatory).

Past lectures in the series can be found on YouTube at <http://www.youtube.com/SVAstronomyLectures>

Type 1a Supernovae Simulations

Understanding the mechanism(s) of the family of Type 1a Supernova explosions, and that of supernovae in general, has been a tough battle. In modelling such explosions, the degree of complexity in terms of the variety of nuclear reactions that need to be considered, the role of neutrinos in determining whether an explosion fizzles or proceeds promptly, and the geometry of the explosion (e.g., 2-dimensional or 3-dimensional) requires intensive computations. Only recently have such resources become available to move into the 3-dimensional computational regime where prior assumptions about the symmetry of the explosions can now be superseded.

As discussed in Ferrand et al. (2021, *Astrophysical Journal*, 906:93) for Type 1a supernovae, four explosion scenarios are typically considered: (1) a White Dwarf (WD) accretes matter from a companion star until it reaches the Chandrasekhar limit-sufficient mass for thermonuclear runaway in the core, (2) in a sub-Chandrasekhar mass WD double detonation occurs in which accretion causes a surface thermonuclear reaction that triggers core detonation, (3) the merger of two WD's, and (4) a combination of (2) and (3) known as dynamically driven double degenerate double detonation. Over and above these scenarios, there is uncertainty regarding how the thermonuclear flame front propagates through the star, either by subsonic deflagration or supersonic detonation.

Ferrand et al. (2021) consider explosion scenario (1) in which a WD accretes matter from a companion star, thus reaching the Chandrasekhar limit, and they evaluated cases in which the thermonuclear flame front propagates via (a) deflagration (DEF) and (b) deflagration to detonation transition (DDT). The authors indicate that "to reproduce a normal SN Ia the explosion has to start as a deflagration to pre-expand parts of the high-density material, thus enabling the synthesis of intermediate mass elements." They also state that "pure (supersonic) detonation of Chandrasekhar-mass WD are not good models for normal SN T1a because they produce too much of Fe-group elements, mostly ^{56}Ni , as almost the whole star goes through Si-burning."

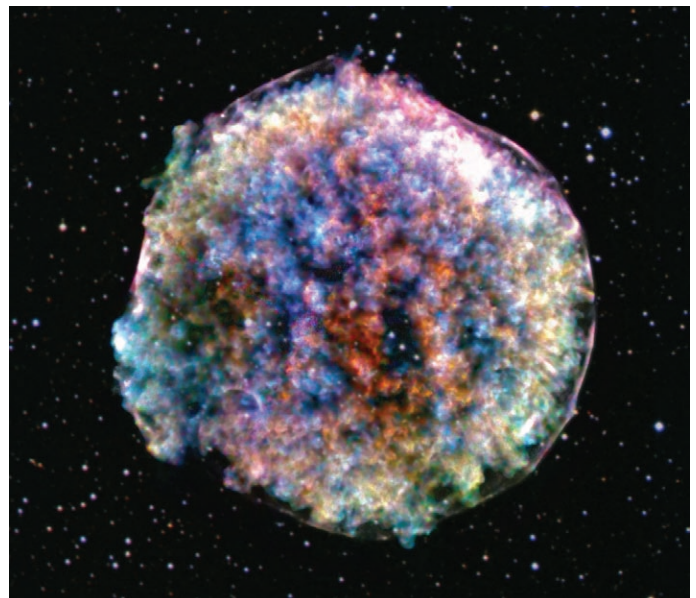
In total, the authors consider four models of SN T1a explosions, DEF only and DDT, each with 5 flame fronts (number of locations where thermonuclear ignition occurs) and 100 flame fronts. In all cases the explosion is modelled as a 1.4 solar mass Chandrasekhar mass WD of radius $1.96 \times 10^6\text{m}$, composed of equal parts ^{12}C and ^{16}O by mass, and using a low interstellar medium density for dynamics similar to that of Tycho's Supernova Remnant (SNR), which exploded in 1572. Previous results by Seitenzahl et al. (2013b) and Sim et al. (2013) indicate that the N100DDT model produces normal brightness and spectral characteristics of SN T1a in which ~ 0.6 of a solar mass of ^{56}Ni is synthesized. Output from each of these four types of explosions is fed into a model of supernova rem-

nants (SNR), and integrated for 500 model years to evaluate differences in the SNR geometry as each of the four types of explosions interact with the interstellar medium.

The results of their study indicate that in the DDT models the initial WD is completely unbound in the thermonuclear explosion, while the DEF models result in partial explosions in which a remnant of the WD remains (typically a significant fraction of a solar mass). At 500 years all simulations of the SNR are essentially spherical, though in detail the simulations differ. Notably, the N100 DDT and DEF simulations tend to produce symmetric explosions, while the N5 models produce asymmetric explosions. Specifically, N5DDT produces a two-sided remnant in which one side of the shell (defined as the distance between the forward and reverse shocks) is thicker than the other. In N5DEF the shell thickness is uniform, but it is offset from the center.

The N5DEF model appears to account for weak T1a explosions, such as SN 2002cx and the specific class of supernovae known as SN T1ax. These explosions leave behind an ~ 1 solar mass WD remnant, which compared to the N5DDT model is characterized by an ejected mass that is 3.8x lower, kinetic energy that is 11.5x lower, and with the ejecta having one-half maximum velocity.

To see the images of the wonderful details of these simulations and learn more about the detailed intricacies of these results, a free preprint of the published article is available on the arxiv server: <https://arxiv.org/abs/2011.04769>



Caption: Composite image of Tycho's Supernova Remnant based on Chandra X-Ray data and Deep Sky Survey optical data. For more details, see: <https://chandra.harvard.edu/photo/2019/tycho/>

What's Up By Ken Sperber (adapted from S&T)

All times are Pacific Daylight Time

April

- 11 Sun **New Moon (7:31pm)**
- 15 Thu The crescent Moon is $\sim 5^\circ$ to the right of Aldebaran (Dusk)
- 16 Fri The crescent Moon is situated between the horns of Taurus, the Bull, with Mars $\sim 5^\circ$ above (Dusk)
- 17 Sat The Moon hovers $\sim 5^\circ$ above Mars (Dusk)
- 19 Mon The Moon, Pollux, and Castor are lined up in the west-southwest (Dusk)
- 19 Mon **First-Quarter Moon (11:59pm)**
- 20 Tue The Moon is in Cancer, $\sim 4^\circ$ from the Beehive Cluster, M44 (Dusk)
- 22 Thu The Lyrid Meteor shower is expected to peak in the early morning hours
- 26 Mon The Moon is $\sim 5^\circ$ from Spica in the west (Dawn)
- 26 Mon **Full Moon (8:32pm)**
- 29 Thu The Moon is $\sim 4^\circ$ from Antares in the south (Dawn)

May

- 3 Mon The Moon, and Saturn are $\sim 6^\circ$ apart, with Jupiter to their left above southeastern horizon (Dawn)
- 3 Mon **Last-Quarter Moon (12:50pm)**
- 4 Tue The Moon, Jupiter, and Saturn form a triangle above the southeastern horizon (Dawn)
- 6 Thu Though best in the Southern Hemisphere, a few Eta Aquariid meteors might be seen before moonrise at 4am
- 11 Tue **New Moon (12:00pm)**
- 12 Wed The 1.5 day old Moon is $\sim 1^\circ$ from Venus in the west-northwest. Binoculars helpful! (Dusk)
- 13 Thu The crescent Moon is $\sim 3^\circ$ from Mercury in the west-northwest. Binoculars helpful! (Dusk)
- 15 Sat The Moon in Gemini is $\sim 2^\circ$ from Mars (Dusk)
- 16 Sun The Moon in Gemini is $\sim 3^\circ$ from Pollux (Dusk)
- 17 Mon The Moon in Cancer is $\sim 2^\circ$ from M44, the Beehive Cluster (Dusk)
- 19 Wed **First-Quarter Moon (12:13pm)**
- 19 Wed The Moon in Leo is $\sim 5^\circ$ from Regulus (Dusk)
- 23 Sun The Moon in Virgo is $\sim 7^\circ$ from Spica (Dusk)
- 26 Wed **Full Moon (4:14am): Total Lunar Eclipse (4:11-4:25am)**
- 26 Wed The Moon is $\sim 6^\circ$ from Antares as they rise in the east (Dusk)
- 27 Thu Mars is $\sim 6^\circ$ from Pollux as they emerge in the west as twilight deepens (Dusk)



Watch the Lion: Celestial Wonders in Leo

By David Prosper

Leo is a prominent sight for stargazers in April. Its famous sickle, punctuated by the bright star Regulus, draws many a beginning stargazer's eyes, inviting deeper looks into some of Leo's celestial delights, including a great double star and a famous galactic trio.

Leo's distinctive forward sickle, or "reverse question mark," is easy to spot as it climbs the skies in the southeast after sunset. If you are having a difficult time spotting the sickle, look for bright Sirius and Procyon - featured in last month's article - and complete a triangle by drawing two lines to the east, joining at the bright star Regulus, the "period" in the reverse question mark. Trailing them is a trio of bright stars forming an isosceles triangle, the brightest star in that formation named Denebola. Connecting these two patterns together forms the constellation of Leo the Lion, with the forward-facing sickle being the lion's head and mane, and the rear triangle its hindquarters. Can you see this mighty feline? It might help to imagine Leo proudly sitting up and staring straight ahead, like a celestial Sphinx.



Caption: The stars of Leo: note that you may see more or less stars, depending on your sky quality. The brightness of the Leo Triplet has been exaggerated for the purposes of the illustration - you can't see them with your unaided eye.

If you peer deeper into Leo with a small telescope or binoculars, you'll find a notable double star! Look in the sickle of Leo for its second-brightest star, Algieba - also called Gamma Leonis. This star splits into two bright yellow stars with even a small magnification - you can make this "split" with binoculars, but it's more apparent with a telescope. Compare the color and intensity of these two stars - do you notice any differences? There are other multiple star systems in Leo - spend a few minutes scanning with your instrument

of choice, and see what you discover.

One of the most famous sights in Leo is the "Leo Triplet": three galaxies that appear to be close together. They are indeed gravitationally bound to one another, around 30 million light years away! You'll need a telescope to spot them, and use an eyepiece with a wide field of view to see all three galaxies at once! Look below the star Chertan to find these galaxies. Compare and contrast the appearance of each galaxy - while they are all spiral galaxies, each one is tilted at different angles to our point of view! Do they all look like spiral galaxies to you?

April is Citizen Science Month, and there are some fun Leo-related activities you can participate in! If you enjoy comparing the Triplets, the "Galaxy Zoo" project (galaxyzoo.org) could use your eyes to help classify different galaxies from sky survey data! Looking at Leo itself can even help measure light pollution: the Globe at Night project (globeatnight.org) uses Leo as their target constellation for sky quality observations from the Northern Hemisphere for their April campaign, running from April 3-12. Find and participate in many more NASA community science programs at science.nasa.gov/citizenscience. Happy observing!



Caption: Your view of the three galaxies in the Leo Triplet won't look as amazing as this image taken by the VLT Survey Telescope, unless you have a telescope with a mirror 8 feet or more in diameter! Still, even a small telescope will help your eyes pick up these three galaxies as "faint fuzzies": objects that seem blurry against a background of pinpoint stars. Let your eyes relax and experiment with observing these galaxies by looking slightly away from them, instead of looking directly at them; this is called averted vision, a handy technique that can help you see details in fainter, more nebulous objects. Image Credit: ESO, INAF-VST, OmegaCAM; Acknowledgement: OmegaCen, Astro-WISE, Kapteyn I.

This article is distributed by the NASA Night Sky Network, a coalition of hundreds of astronomy clubs across the US dedicated to astronomy outreach. Visit nightsky.jpl.nasa.gov to find local clubs, events, stargazing info and more.



Tri-Valley Stargazers
P.O. Box 2476
Livermore, CA 94551
www.trivalleystargazers.org

Tri-Valley Stargazers Membership Application

Contact information:

Name: _____ Phone: _____

Street Address: _____

City, State, Zip: _____

Email Address: _____

Status (select one): _____ New member _____ Renewing or returning member

Membership category (select one): Membership term is for one calendar year, January through December.

Note: NEW/Renewal memberships initiated after October 1, 2020 will be good through 2021!!!

_____ Student member (\$10). Must be a full-time high-school or college student.

_____ Regular member (\$30).

Hidden Hill Observatory Access (optional): Must be 18 or older.

_____ One-time key deposit (\$20). This is a refundable deposit for a key to H2O. New key holders must first hear an orientation lecture and sign a usage agreement form before using the observing site.

_____ Annual access fee (\$10). You must also be a key holder to access the site.

Donation (optional):

_____ Tax-deductible contribution to Tri-Valley Stargazers

Total enclosed: \$ _____

Member agrees to hold Tri-Valley Stargazers, and any cooperating organizations or landowners, harmless from all claims of liability for any injury or loss sustained at a TVS function. TVS will not share information with anyone except as detailed in our Privacy Policy (<http://www.trivalleystargazers.org/privacy.shtml>).

Mail this completed form along with a check to: Tri-Valley Stargazers, P.O. Box 2476, Livermore, CA 94551.