Celestial Observer

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CCAS Member Peter Bresler: Comet C19 Y4 - Celestron Edge HD 11 inch SCT with focal reducer on an Astrophysics Mach 1 Mount; ZWO 294 MC Pro camera

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Next Meeting: ONLINE!
Thursday, April 23th at 7pm with guest speaker Michael Fernandez on *Cal Poly Light Sail*. We are streaming this meeting straight to your computer at home! You can use an iPad, laptop, computer or cell phone.

Connect here:
www.CentralCoastAstronomy.org/meetings

Next Star Gazing: ONLINE!
Saturday, April 18th at 7pm with Kent Wallace and Aurora Lipper! You'll get a front-row seat in a planetarium-style star tour of the night sky right from your computer at home!

Connect here:
www.CentralCoastAstronomy.org/stargaze

ONLINE: Thursday, April 23rd at 7pm
Michael A. Fernandez (Cal Poly Light Sail II)

LightSail is a citizen-funded project from The Planetary Society to send a small spacecraft, propelled solely by sunlight, to Earth orbit.

It took 10 years to transform The Planetary Society's crowdfunded LightSail 2 mission from an idea on the drawing board into a space mission. Dozens of people worked on the project over the years, backed by funding from more than 50,000 Planetary Society members, private citizens, foundations, and corporate partners.

But out of all those people, only one person, known as the ground operator, can communicate with the spacecraft at a time. That role is often filled by Michael Fernandez, a fourth-year physics undergrad at Cal Poly San Luis Obispo. When he's on duty, you can find Fernandez in the Cal Poly CubeSat Laboratory, also known as PolySat, ready to punch commands into his laptop whenever LightSail 2 is in range of the spindly radio antennas on a nearby roof.

Due to the complexities of orbital mechanics, LightSail 2 is only in range of its ground stations at Cal Poly, Purdue, Georgia Tech, and Kauai Community College for a few minutes each day. During those intervals, it's Fernandez's job to complete any tasks requested by the mission team. He might command the spacecraft to send him some stored telemetry or upload new orbital data that helps LightSail 2 know where it is.

It's not all that different than using a command-line interface to transfer files between computers. Except the computer he's talking to is 700 kilometers overhead, flying at a speed of 7 kilometers per second.

Me & My Telescopes: Gustav Nelson

Astronomy has weaved its way through my life since taking a class at Poly in the late 60's. I haven't been without a scope for 50 years. The current collection includes a dozen scopes – all refractors except an 8SE (a "gift" that is still broken) and a Mak-Cass that I bought for the mount.

But it isn't the science that has drawn me – it's the people and places that are connected to the sky. Tracked Tycho and Kepler from Kepler's high school and Uraniborg to the castle in Prague. Saw Harrison's clocks and Halley's old scopes at Greenwich. Made a pilgrimage Down Under to see the Clouds and great globulars. Visited all the great scopes of the American West including the huge cathedral to science known as the VLA. Struggled to get to the Egyptian/Libyan border for a solar eclipse. I went to a secret private observatory in Syria where owning scopes is illegal. Went to Justinian's castle where his monk, Dennis the Little, presented his revised calendar. A cathedral in Rome has a built-in sundial to track Gregory's further calendar changes. Been there.

It is those connections to people and places that make astronomy exciting for me.

And to all these places, I have taken my favorite scope – a Borg Mini-50 with a straw spotter and a cheap Radio Shack tripod. It has been smuggled into the Islamic World on multiple trips. [Scopes (and binocs) are illegal in all but Turkey.] Nearly a thousand people have looked through that scope in scores of countries…and at BurningMan.

I guess that makes me sort of an astronomy evangelist.

Gustav Nelson, LtCol (Ret)

Other scopes: IOptron 108, old Tasco 75, TeleVue Ranger, Orion 100, Coronado 40 & 60

Next Stargazing: ONLINE! Invite friends!!

Saturday, April 18th at 7pm

CCAS Member Kent Wallace and president Aurora Lipper are hosting an online star gazing event that you don't want to miss! It'll be like going to a planetarium except it's from your computer screen at home. We will focus on how to find naked-eye and binocular objects in the April sky, and you'll be able to interact and ask questions as we go along. When we're done, go outside and look up, and you'll be able to not only find objects but also understand what you're looking at. Check our website for all the details:

www.CentralCoastAstronomy.org/stargaze

April's Lyrid Meteor Shower by CCAS Member Tom Frey

Meteor in the Milky Way, APOD, Image Credit & Copyright: Marko Korosec

Here's hoping that the April rain showers will dissipate so the Lyrid meteor shower can be observed. Although the range of this meteor event includes April 14-30, your best time to look will be April 19-23, and the peak will be on the 22nd, where about 18 meteors/hour are predicted.

This will happen during New Moon so the skies will be very dark. On April 22nd, the radiant, the point in the sky where the meteors appear to originate, will be in Lyra, the Harp, near the bright star Vega. Although meteors can appear anywhere in the sky, try looking 40-50 degrees away from Vega, to catch the trails. The best time to view the shower is in the few hours before dawn, when the radiant is high in the sky.

This shower occurs as the Earth's orbital path crosses the orbital path of the long-period Comet Thatcher (C/1861 G1). The ice and small grains of rock and dust left behind in the comet's tail contact the atmosphere at speeds of 25,000 to

100,000 mph and burn up, causing the light trace we see. Comets are now named by the year of discovery followed by a letter indicating the half-month of discovery (so G would be the first half of April), and a number indicating the order of discovery (so, 1, being the first in April) in 1861. The period of the comet has been estimated at 415 years, so no photo has ever been made.

Although the best time to catch the maximum number is before dawn, also look earlier for Earthgrazers. These are slower moving, longer lasting meteor traces where the meteoroid is traveling horizontally as the enter the Earth's atmosphere high up and leaves again. The very bright ones are referred to as bolides.

The best way to observe meteor showers is to relax on a lawn chair in a sleeping bag and have a hot beverage by your side and watch, naked eye. It is best to view these at a dark sky site away from city lights and possible marine layer. Enjoy the rain of comet dust!

Meteor Over Crater Lake, APOD, Image Credit & Copyright: Brad Goldpaint

Venus and Pleiades Cluster Conjunction

Astronomers get really excited when one (or more) objects appears close to another, and it's happening on April 3rd – this is one that's easy to see with your naked eyes.

This happens once every 8 years so this will be a unique experience. You don't even need binoculars - just look for the brightest star in the sky (Venus is the one that is west and doesn't twinkle) and you'll see a small star cluster (open cluster) around it!

Image taken on April 2nd by CCAS Member Larry Vickman

New Comet! C/2017 T2

In May 2017, the Panoramic Survey Telescope and Rapid Response System (PanSTARRS), located atop Haleakala on the island of Maui, discovered a faint comet beyond the orbit of Saturn. Designated C/2017 T2, it will finally reach perihelion on May 4 when 1.6 a.u. from the Sun. It is predicted to increase from 14th magnitude, from a year ago, to at least 8th magnitude through May and into June. In a dark, moonless sky, it should be visible in binoculars as a fuzzy, pale blob.

In late April and early May, the comet should appear about 10 degrees to the right, or east, of Polaris. Throughout the rest of May, the comet moves down toward the bowl of the Big Dipper (Ursa Major). For those with a telescope, it will appear very close to the two galaxies M81 and M82 on May 22-24. On June 5, the comet will appear about 1 degree east of Dubhe (the northernmost pointer star in the dipper) and close to the galaxy M109 on June 15-16. Look for it within the bowl of the dipper from June 6 through June15 but best between June 11-15 or later when the Moon won't present a problem.

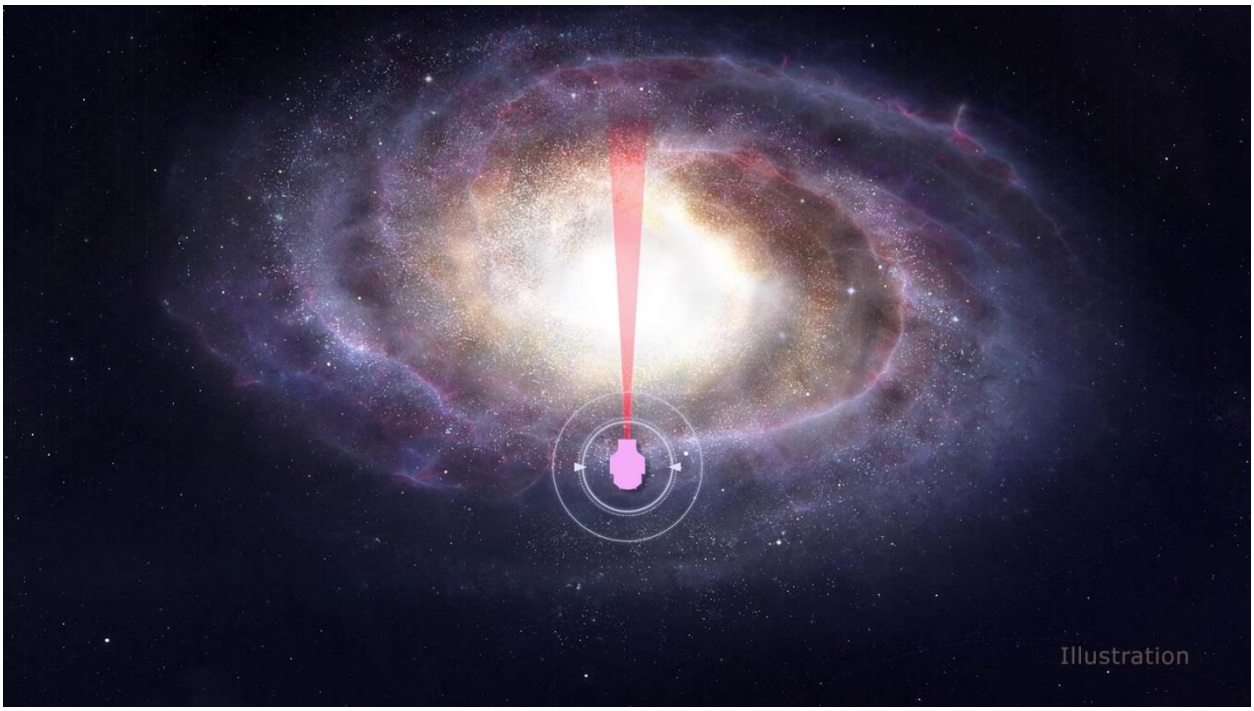
Being a new comet, C/2017 T2, or PanSTARRS, may present some surprises as this is its first encounter with our solar system. Check it out throughout late April and May as its brightness and tail could dramatically change over this period of time. Wishing you all good observing!

~CCAS Member L:ee Coombs

Image source: Sky & Telescope

WFIRST Will Use Warped Space-time to Help Find Exoplanets Credit: NASA JPL

The NASA mission will identify planets with large orbits, similar to our solar system's far-flung giants, Uranus and Neptune.



NASA's Wide Field Infrared Survey Telescope (WFIRST) will search for planets outside our solar system toward the center of our Milky Way galaxy, where most stars are. Studying the properties of exoplanet worlds will help us understand what planetary systems throughout the galaxy are like and how planets form and evolve.

Combining WFIRST's findings with results from NASA's Kepler and Transiting Exoplanet Survey Satellite (TESS) missions will complete the first planet census that is sensitive to a wide range of planet masses and orbits, bringing us a step closer to discovering habitable Earth-like worlds beyond our own.

To date, astronomers have found most planets when they pass in front of their host star in events called transits, which temporarily dim the star's light. WFIRST data can spot transits, too, but the mission will primarily watch for the opposite effect - little surges of radiance produced by a light-

bending phenomenon called microlensing. These events are much less common than transits because they rely on the chance alignment of two widely separated and unrelated stars drifting through space.

"Microlensing signals from small planets are rare and brief, but they're stronger than the signals from other methods," said David Bennett, who leads the gravitational microlensing group at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "Since it's a one-in-a-million event, the key to WFIRST finding low-mass planets is to search hundreds of millions of stars."

In addition, microlensing is better at finding planets in and beyond the habitable zone - the orbital distances where planets might have liquid water on their surfaces.

Microlensing 101

This effect occurs when light passes near a massive object. Anything with mass warps the fabric of space-time, sort of like the dent a bowling ball makes when set on a trampoline. Light travels in a straight line, but if space-time is bent - which happens near something massive, like a star - light follows the curve.

Any time two stars align closely from our vantage point, light from the more distant star curves as it travels through the warped space-time of the nearer star. This phenomenon, one of the predictions of Einstein's general theory of relativity, was famously confirmed by British physicist Sir Arthur Eddington during a total solar eclipse in 1919. If the alignment is especially close, the nearer star acts like a natural cosmic lens, focusing and intensifying light from the background star.

Planets orbiting the foreground star may also modify the lensed light, acting as their own tiny lenses. The distortion they create allows astronomers to measure the planet's mass and distance from its host star. This is how WFIRST will use microlensing to discover new worlds.

Familiar and Exotic Worlds

"Trying to interpret planet populations today is like trying to interpret a picture with half of it covered," said Matthew Penny, an assistant professor

of physics and astronomy at Louisiana State University in Baton Rouge who led a study to predict WFIRST's microlensing survey capabilities. "To fully understand how planetary systems form we need to find planets of all masses at all distances. No one technique can do this, but WFIRST's microlensing survey, combined with the results from Kepler and TESS, will reveal far more of the picture."

More than 4,000 confirmed exoplanets have been discovered so far, but only 86 were found via microlensing. The techniques commonly used to find other worlds are biased toward planets that tend to be very different from those in our solar system. The transit method, for example, is best at finding sub-Neptune-like planets that have orbits much smaller than Mercury's. For a solar system like our own, transit studies could miss every planet.

WFIRST's microlensing survey will help us find analogs to every planet in our solar system except Mercury, whose small orbit and low mass combine to put it beyond the mission's reach. WFIRST will find planets that are the mass of Earth and even smaller - perhaps even large moons, like Jupiter's moon Ganymede.

WFIRST will find planets in other poorly studied categories, too. Microlensing is best suited to finding worlds from the habitable zone of their star and farther out. This includes ice giants, like Uranus and Neptune in our solar system, and even rogue planets - worlds freely roaming the galaxy unbound to any stars.

While ice giants are a minority in our solar system, a 2016 study indicated that they may be the most common kind of planet throughout the galaxy. WFIRST will put that theory to the test and help us get a better understanding of which planetary characteristics are most prevalent.

Hidden Gems in the Galactic Core

WFIRST will explore regions of the galaxy that haven't yet been systematically scoured for exoplanets due to the different goals of previous missions. Kepler, for example, searched a modest-sized region of about 100 square degrees with 100,000 stars at typical distances of around a thousand light-years. TESS scans the entire sky and tracks 200,000 stars; however their typical distances are around 100 light-years. WFIRST will

search roughly 3 square degrees, but will follow 200 million stars at distances of around 10,000 light-years.

Since WFIRST is an infrared telescope, it will see right through the clouds of dust that block other telescopes from studying planets in the crowded central region of our galaxy. Most ground-based microlensing observations to date have been in visible light, making the center of the galaxy largely uncharted exoplanet territory. A microlensing survey conducted since 2015 using the United Kingdom Infrared Telescope (UKIRT) in Hawaii is smoothing the way for WFIRST's exoplanet census by mapping the region.

The UKIRT survey is providing the first measurements of the rate of microlensing events toward the galaxy's core, where stars are most densely concentrated. The results will help astronomers select the final observing strategy for WFIRST's microlensing effort.

The UKIRT team's most recent goal is detecting microlensing events using machine learning, which will be vital for WFIRST. The mission will produce such a vast amount of data that combing through it solely by eye will be impractical. Streamlining the search will require automated processes.

Additional UKIRT results point to an observing strategy that will reveal the most microlensing events possible while avoiding the thickest dust clouds that can block even infrared light.

"Our current survey with UKIRT is laying the groundwork so that WFIRST can implement the first space-based dedicated microlensing survey," said Savannah Jacklin, an astronomer at Vanderbilt University in Nashville, Tennessee, who has led several UKIRT studies. "Previous exoplanet missions expanded our knowledge of planetary systems, and WFIRST will move us a giant step closer to truly understanding how planets - particularly those within the habitable zones of their host stars - form and evolve."

From Brown Dwarfs to Black Holes

The same microlensing survey that will reveal thousands of planets will also detect hundreds of other bizarre and interesting cosmic objects. Scientists will be able to study free-floating bodies with masses ranging from that of Mars to 100 times the Sun's.

The low end of the mass range includes planets that were ejected from their host stars and now roam the galaxy as rogue planets. Next are brown dwarfs, which are too massive to be characterized as planets but not quite massive enough to ignite as stars. Brown dwarfs don't shine visibly like stars, but WFIRST will be able to study them in infrared light through the heat left over from their formation.

Objects at the higher end include stellar corpses - neutron stars and black holes - left behind when massive stars exhaust their fuel. Studying them and measuring their masses will help scientists understand more about stars' death throes while providing a census of stellar-mass black holes.

"WFIRST's microlensing survey will not only advance our understanding of planetary systems," said Penny, "it will also enable a whole host of other studies of the variability of 200 million stars, the structure and formation of the inner Milky Way, and the population of black holes and other dark, compact objects that are hard or impossible to study in any other way."

The FY2020 Consolidated Appropriations Act funds the WFIRST program through September 2020. The FY2021 budget request proposes to terminate funding for the WFIRST mission and focus on the completion of the James Webb Space Telescope, now planned for launch in March 2021. The Administration is not ready to proceed with another multi-billion-dollar telescope until Webb has been successfully launched and deployed.

WFIRST is managed at Goddard, with participation by NASA's Jet Propulsion Laboratory and Caltech/IPAC in Pasadena, the Space Telescope Science Institute in Baltimore, and a science team comprising scientists from research institutions across the United States.

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CCAS Information

Founded in 1979, the Central Coast Astronomical Society (CCAS) is an association of people who share a common interest in astronomy and related sciences.

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