FIRST LIGHT

Journal of the South Bay Astronomical Society – April 2024
on line at http://sbastro.net/
On Facebook at facebook.com/SBAstroSociety
On Yahoo Groups at: https://groups.yahoo.com/neo/groups/SBASTRO/info

Monthly General Meeting: Friday April 5th 7:30 PM

NO MEETING THIS MONTH

Thank you very much for coming to our York School STAR Party! Our families and students really enjoyed it. -John Burke

Thank you for providing such an amazing night for my tk students Angela Camodeca

Thank you so much! It was amazing and the students and families loved it! V. Kusz Gal

Thank You for all you do. We ♡ the Solar System Theresa.

South Bay Astronomical society,

Thank you so much for bringing such an amazing & unique experience to the York community! We really appreciate the time, wisdom, & love of science that you shared with us! Thank you!

Best,
Principal Cacdillo

Thank you for letting our students and their families experience the night skies! Our families raved about the telescopes (first time for many) and the students enjoyed learning fun facts about Jupiter and the moon. We are so grateful for your time and love of outer space! Thank you for making our Star Party a hit!

- Jenny Tanaka

Thank you for the telescopes.

I Liked seeing the moon! Matthew
5th grado

Thank you for taking the time to come to york and let us see the moon! From Marlon

Thank you for letting me learn about Jupiter's gases!
by: Julian 4th. grade

Dear South Bay Astronomical Society,
Thank you for bringing telescopes and showing me Jupiter from 45 ow min. ago! From Julia 3rd grade

I like seeing the moon really big. It was pretty! Valeria 2 grade

My favorite part was when I saw Jupiter.
from Daniel first grade

The March 1 Meeting

President Steve Pedersen called the meeting to order at 7:40, and asked for observing reports. Ken Munson reported on three outreach events hosted by the SBAS in Torrance; the first was a struggle against the clouds, but the other two had decent weather. President Petersen pointed out that the solar eclipse coming up on Monday, April 8 will be partial in Los Angeles, starting at 10:06 am and ending at 12:22 pm, with at maximum coverage of 58% at mid-eclipse at 11:12 am.

Steven Morris said that he would be observing totality near Niagara Falls, Ontario, but not at the Falls, which will be overwhelmed by visitors trying to get some stunning photographs. He speculated that a photograph of a rainbow at the Falls might show an emission-line spectrum if a prominence is particularly bright. President Petersen pointed out that there will also be a penumbral lunar eclipse two weeks earlier. Ken Munson then spent some time describing the use of smartphones for astrophotography.

After a ten-minute social break, Ken Munson delivered the evening's lecture, "Interplanetary Navigation for Dummies". To navigate among the planets, the controllers need three things. First, radio communication to track the spacecraft's position and velocity, and receive optical data about the spacecraft's orientation so the rockets can be fired in the correct direction to change the path. Second, a determination of the best statistically-determined orbital path based on the radio measurements. Third, a computer to determine which trajectory-correcting maneuvers would be optimal.

The navigation requirements vary depending on the nature of the mission. A flyby gets close to the target object, but is moving too fast to linger. An orbital survey requires a precise firing of retro-rockets to place the spacecraft in a suitable orbit. A landing requires extremely precise navigation, especially as the time delay due to the finite speed of light places the spacecraft beyond immediate control.

Walter Hohmann determined the most efficient means to transfer a spacecraft from one planet to another. A fourth

type of maneuver is a gravitational assist, as a spacecraft passes close to a planet and fires its rockets to get a boost of speed, flinging it much farther than it could otherwise go. This was studied by Hermann Oberth, who found that if a rocket is fired deep in a planet's gravity well, the spacecraft could gain a great deal of kinetic energy while the planet lost kinetic energy, changing the planet's motion by an infinitesimal amount.

The five people in the audience applauded Ken Munson's efforts, and the meeting was adjourned at 8:53.

-Dr. Steven Morris

Outreach Event

Bert Lynn Middle School – On Friday, March 8th, club members Ken Lehmer, Larry Kinney and Ken Munson set up their scopes for a star party at Bert Lynn Middle School in Torrance. The sky was beautifully clear for a change. We were able to set up the scopes well ahead and got a chance to give a number of students and teachers who were around a view of the Sun and, eventually, Jupiter.

The star party really got underway at 6 PM and we were pretty busy for the next hour and a half. Jupiter was the big attraction for the evening but we did show off some good star clusters and double stars. Although this was a middle school event, most families brought their younger children along as well. There was a lot of interest from quite a number of students as well as parents.

- Ken Munson

SBAS Executive Board

President	Steve Pedersen	310-378-6479	epsonstylusc82@earthlink.net
Vice-President			
Secretary	Steve Pedersen	310-378-6479	epsonstlyusc82@earthlink.net
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SBAS Committees

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Outreach Committee	Ken Munson	310-345-4796	kenmunson333@gmail.com
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Publications Committee:			
SBAS Website Webmaster			
***First Light* Editor**	Ken Munson	310-345-4796	kenmunson333@gmail.com
Observing Committee			

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Monthly General Meetings

We normally meet on the first Friday of each month at 7:30 p.m. in the Planetarium at El Camino College (16007 Crenshaw Bl. In Torrance). If the first Friday is on or close to a holiday, we usually defer the meeting until the second Friday of the month. The Planetarium is on the south side of Manhattan Beach Blvd., one block west of Crenshaw Blvd. (near the center of the map at left).

The planetarium is the only round, domed building on campus. There is on-street parking, and we can often use campus parking: check inside to see if you need a FREE parking permit for your car.

We enjoy the planetarium facilities through the courtesy of the El Camino College Administration and have several faculty members of the Astronomy Department as members of our Club. Our meetings always include an informal opening, when new attendees are invited to introduce themselves and let us know about their interests in astronomy. Members share their latest news and observations at this time. The rest of the evening is devoted to guest speakers, who range from amateur astronomers to professional astronomers to representatives from local aerospace companies to college professors. We are fortunate to have all these talented people in our area, willing to come and talk to us.

Monthly Planning Meeting

Committee members (and anyone else with an interest in Society activities) meet each month, usually on the Monday following the general meeting. Meetings are sometimes rescheduled due to travel and other circumstances. Exact date and time of each month's meeting will be announced in the monthly meeting. The February planning meeting will be held at the home of TBA.

SBAS Dues

Month Join/Due	Member (Family)	Student	Expires
January	$40.00	$25.00	Dec
February	$36.67	$22.92	Dec
March	$33.33	$18.75	Dec
April	$30.00	$20.83	Dec
May	$26.67	$18.75	Dec
June	$23.33	$16.67	Dec
July	$20.00	$14.58	Dec
August	$16.67	$12.50	Dec
September	$13.33	$10.42	Dec
October	$10.00	$8.33	Dec
November	$6.67	$6.25	Dec

To simplify the dues, we suggest that all membership expire in December. Dues are $40.00/year ($25.00/year for students) and expire on December 31, of the current year. The First Light is now only available via email notification and on our web site. Make checks payable to the South Bay Astronomical Society. Dues may be paid at the general meeting or mailed to:

South Bay Astronomical Society
Attn: Gary Inouye
P.O. Box 1244
Redondo Beach, CA 90278

SBAS Membership Benefits

Contact TBD for magazine subscriptions at club rates: "Sky & Telescope" $32.95 and "Astronomy" $34.00/1 year or $60.00/2 years!
Note: S&T subscribers at the club rate renew their subscriptions by mailing their renewal notice and check or calling the 800# on the renewal notice.
Only new subscribers or subscribers converting their subscription to the club rate need to contact Arnie or send a check to the PO Box. Astronomy subscriptions and renewals still go via the PO Box.

Astronomy Technology Today has become a digital only magazine. They have stated that current print subscribers will continue to be able to access digital issues without any cost. New subscribers should check their website for ordering details and subscription costs (www.astronomytechnologytoday.com).

Online Subscribe/Renew Instructions Astronomy Magazine

US Subscription Rate: 1 year/12 Issues…..$34.00
2 years/24 issues….$60.00
3 years/36 Issues….$85.95

This year, there is an additional option for club member to order or renew. If you prefer, you can complete your individual transaction online with a credit card. Please follow the instructions below:

1) Go to www.astronomy.com/promo
2) When prompted for the promotion code, type in your club's unique offer code "RCLUB165" and click the "Get Offer" button.
3) Select the order term (1 year, 2 years, or 3 years).
4) Enter your name, address and credit card information. Please note: you do not need to enter the promotion code a second time on this order page. That entry field can be disregarded.
5) Click on the "Submit" button. You will receive a confirmation page immediately. Please print this page for your records.

If you have any questions, call one of our Customer Service Representatives at 1-800-533-6644, Monday – Friday 8:30 AM – 4:30 PM CT. Outside the US and Canada, please call 262-796-8776.

Astronomical League Observing Clubs

All SBAS members in good standing are also members of the Astronomical League and are eligible to participate in the League's Observing Clubs. The Astronomical League provides many different observing programs (clubs). These programs are designed to provide a direction for your observations and to provide a goal. The programs have certificates and pins to recognize the observers' accomplishments and for demonstrating their observing skills with a variety of instruments and objects. For more information, go to:
http://www.astroleague.org/observing.html.

New Free Astronomy Technology Today Subscription Offer

Astronomy Technology Today offers a free 12-month online subscription for members. Go to the following URL for instructions on how to subscribe: http://www.cnyo.org/2016/02/01/12-free-months-of-astronomy-technology-today-tellem-cnyo-or-your-own-club-sent-you/

Useful and Interesting Astronomy Websites

Website	Description
http://www.calsky.com/	A useful site for planning an evening's star gazing if you don't have your own planetarium software.
https://www.aavso.org/	Information for observers with an interest in tracking variable stars.
http://www.cleardarksky.com/csk/prov/California_clocks.html	Good site to check to know what the weather will be like where you might be planning on going.
http://ssd.jpl.nasa.gov/horizons.cgi	Great site to use when you want to find a new comet or asteroid that isn't already in your planetarium software's list. See the Ephemeris Generator file on the SBAS Yahoo group site for instructions.
https://ssd.jpl.nasa.gov/horizons.cgi	NASA website for generating an ephemeris for any solar system object from any point on the Earth's surface.
http://heavens-above.com	Check this site to find out what satellites are visible in your sky.
http://www.lunar-occultations.com/iota/iotandx.htm	Website for the International Occultation Timing Association. Good place to find information on asteroid occultations of background stars.
http://pictures.ed-morana.com/ISSTransits/predictions/	Find out when the ISS will transit in front of the Sun or Moon as seen from your location.
http://www.aerith.net/comet/weekly/current.html	Weekly information on bright comets. Good place to learn where there are bright comets to be seen. Refer to the Horizons website above to generate ephemerides.
http://sohowww.nascom.nasa.gov/	See the sun in ways you might never have imagined! You can even create your own movies of the sun in different the different frequencies imaged by the SOHO spacecraft.

Dr. Robert D. Furber, PhD March 9, 1935 – January 19, 2024

Dr. Robert D. Furber, PhD, passed away at the age of 88 in his cherished home in Manha an Beach, CA. Born to Margaret E. and George D. Furber, he spent his forma ve years in Plainville, CT, alongside his mother and two older sisters, Janice Ann, and Patricia Jean.

Robert's brilliance in science emerged early, flourishing during his me at Plainville High School, where he was awarded the prestigious Raycroft-Walsh Scholarship. This scholarship, covering four years of tui on and expenses, enabled him to pursue his passion for science at Wesleyan University, where he earned a BA in Physics and Astronomy in 1958. He furthered his studies at Indiana University and the University of Southern California, culminating in a Ph.D. in Physics from the University of Minnesota in 1976, with a groundbreaking thesis on stellar atmospheres.

Throughout his illustrious career, Robert made significant contributions to aerospace engineering and space defense. From his early days at United Aircraft Corporation to his tenure at Hughes Aircraft Company, he played pivotal roles in projects ranging from inertial guidance systems to space-based IR sensing. Robert's expertise in orbital mechanics and advanced electromagnetic theory was invaluable, earning him recognition and respect within the industry.

An ac ve member of the scientific community, Robert was a published author and a member of the American Physical Society. His passion for knowledge extended beyond his professional pursuits, as he immersed himself in genealogy and remained a voracious reader of scientific literature. He also enjoyed traveling and followed the eclipse to many destinations around the world.

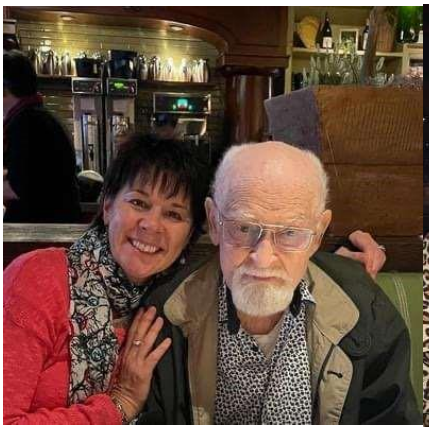
Beyond his professional achievements, Robert was a compassionate soul who cherished his family, friends, and feline companions. Fondly known as "Uncle Bob," he leaves behind a legacy of warmth, intellect, and generosity. He will be dearly missed by his nieces, nephews: Michele Ann (Lange) Lentini, Scott R. Lange, William D. Beyer and Laurel J. Beyer as well as five grandnieces and nephews; Michael Len ni, Ma hew Len ni, Trey Sibert, Cameron Sibert and Lilly Lange.

In retirement, Robert found solace by the ocean, where he spent his days biking, walking, and embracing the beauty of nature. His contributions to science and space defense have left an indelible mark on the aerospace industry, shaping its future for generations to come.

Education and Career

- Plainville High School 1954 - Won first Raycroft -Walsh Scholarship (4-years, full tui on plus expenses) Wesleyan University 1958 - BA in Physics and Astronomy.
- Indiana University, 1962-1964 - Graduate study with an emphasis upon stellar atmospheres (radiative transfer), hydromagnetic and advanced electromagnetic theory.
- University of Southern California, 1966 - MA in Physics.

- University of Minnesota, 1976 – PhD Physics. Thesis Title: A Single Channel Resonating Group Study of the Seven Nucleon System using a Noncentral Two-Nucleon Potential.
- United Aircraft Corporation, 1960-1962 (R&D Engineer), 1955-1959 (Intern) - Performed analysis for the first successful strap-down inertial guidance system as an R&D engineer.
- North American Avia on, 1962-1964 (Research Engineer) - Proved under-designed features of the Apollo Space Sextant.
- Lockhead Spacecraft Organization, 1962-1964 (Senior Research Engineer) - Determined inertial guidance and interface subsystem requirements in major proposed aerospace vehicles.
- TRW Systems Group 1964-1966 (Technical Staff) - Modeled gravitation advanced Minuteman Targe ng.
- The Aerospace Corpora on 1973-1975 (Technical Staff), Summers 1966-969 – Worked on Orbital system design and trajectory analysis for DoD space programs.
- Rockwell International, B-1 Division 1977 (Lead Engineer) - Led the B1 so ware development & test.
- Singer Company, Link Division 1977-1979 (Sec on Chief) – Developed so ware for Payload Accommodation System of Space Shu le Mission Simulator.
- Hughes Aircraft Company (Hughes Space and Communications Company/Boeing 2000), 1979 – 2000 (Senior Staff Engineer, Senior Scientist) - Specialized in space-based IR sensing, orbital mechanics, ground-based laser system simulation for SDI and the analysis of manned bomber and cruise missile missions.
- 1982: Published Resonating Group Study of the 3HE(3H)+ alpha Systems: bound States to 113 Mev., Physical Review C, January 1982, vol. 25.
- Re red in 2000 from Boeing.



Discovery Tests Theory on Cooling of White Dwarf Stars

Science Daily – 8 March 2024 - Open any astronomy textbook to the section on white dwarf stars and you'll likely learn that they are "dead stars" that continuously cool down over time. New research published in *Nature* is challenging this theory, with the University of Victoria (UVic) and its partners using data from the European Space Agency's *Gaia* satellite to reveal why a population of white dwarf stars stopped cooling for more than eight billion years.

"We discovered the classical picture of all white dwarfs being dead stars is incomplete," says Simon Blouin, co-principal investigator and Canadian Institute of Theoretical Astrophysics National Fellow at UVic.

"For these white dwarfs to stop cooling, they must have some way of generating extra energy. We weren't sure how this was happening, but now we have an explanation for the phenomenon."

Understanding the age and other aspects of white dwarf stars helps scientists reconstruct the formation of the Milky Way Galaxy.

Using 2019 *Gaia* data, Blouin collaborated with Antoine Bédard of the University of Warwick and Institute for Advanced Study researcher Sihao Cheng to make the discovery.

Over 97 per cent of stars in the Milky Way will eventually become white dwarfs.

Scientists have long considered these stars to be at the end of their lives.

Having depleted their nuclear energy source, they stop producing heat and cool down until the dense plasma in their interiors freezes into a solid state, and the star solidifies from the inside out.

This cooling process can take billions of years.

According to the new paper, in some white dwarfs, the dense plasma in the interior does not simply freeze from the inside out.

Instead, the solid crystals that are formed upon freezing are less dense than the liquid, and therefore want to float.

As the crystals float upwards, they displace the heavier liquid downward.

The transport of heavier material toward the centre of the star releases gravitational energy, and this energy is enough to interrupt the star's cooling process for billions of years.

"This is the first time this transport mechanism has been observed in any type of star, which is exciting, as it is not every day we uncover a whole new astrophysical phenomenon," says Bédard, Research Fellow at the University of Warwick.

Why this happens in some stars and not others is uncertain, but Blouin thinks it is likely due to the composition of the star.

"Some white dwarf stars are formed by the merger of two different stars. When these stars collide to form the white dwarf, it changes the composition of the star in a way that can allow the formation of floating crystals," says Blouin.

White dwarfs are routinely used as age indicators: the cooler a white dwarf is, the older it is assumed to be. However, due to the extra delay in cooling found in some white dwarfs, some stars of a given temperature may be billions of years older than previously thought.

"This new discovery will not only require that astronomy textbooks be revised but will also require that astronomers revisit the process they use to determine the age of stellar populations," adds Blouin.

The research is supported by the National Sciences and Engineering Research Council of Canada (NSERC), the Banting Postdoctoral Fellowship program, the European Research Council, and the Canadian Institute for Theoretical Astrophysics (CITA).

Peering Into the Tendrils of NGC 604 With NASA's Webb

Science Daily – 11 March 2024 - The formation of stars and the chaotic environments they inhabit is one of the most well-studied, but also mystery-shrouded, areas of cosmic investigation. The intricacies of these processes are now being unveiled like never before by NASA's James Webb Space Telescope.

Two new images from Webb's NIRCam (Near-Infrared Camera) and MIRI (Mid-Infrared Instrument) showcase star-forming region NGC 604, located in the Triangulum galaxy (M33), 2.73 million light-years away from Earth.

In these images, cavernous bubbles and stretched-out filaments of gas etch a more detailed and complete tapestry of star birth than seen in the past.

Sheltered among NGC 604's dusty envelopes of gas are more than 200 of the hottest, most massive kinds of stars, all in the early stages of their lives.

These types of stars are B-types and O-types, the latter of which can be more than 100 times the mass of our own Sun.

It's quite rare to find this concentration of them in the nearby universe.

In fact, there's no similar region within our own Milky Way galaxy.

This concentration of massive stars, combined with its relatively close distance, means NGC 604 gives astronomers an opportunity to study these objects at a fascinating time early in their life.

In Webb's near-infrared NIRCam image, the most noticeable features are tendrils and clumps of emission that appear bright red, extending out from areas that look like clearings, or large bubbles in the nebula.

Stellar winds from the brightest and hottest young stars have carved out these cavities, while ultraviolet radiation ionizes the surrounding gas.

This ionized hydrogen appears as a white and blue ghostly glow.

The bright orange-colored streaks in the Webb near-infrared image signify the presence of carbon-based molecules known as polycyclic aromatic hydrocarbons, or PAHs.

This material plays an important role in the interstellar medium and the formation of stars and planets, but its origin is a mystery.

As you travel farther from the immediate clearings of dust, the deeper red signifies molecular hydrogen.

This cooler gas is a prime environment for star formation.

Webb's exquisite resolution also provides insights into features that previously appeared unrelated to the main cloud.

For example, in Webb's image, there are two bright, young stars carving out holes in dust above the central nebula, connected through diffuse red gas.

In visible-light imaging from NASA's Hubble Space Telescope, these appeared as separate splotches.

Webb's view in mid-infrared wavelengths also illustrates a new perspective into the diverse and dynamic activity of this region.

In the MIRI view of NGC 604, there are noticeably fewer stars.

This is because hot stars emit much less light at these wavelengths, while the larger clouds of cooler gas and dust glow.

Some of the stars seen in this image, belonging to the surrounding galaxy, are red supergiants -- stars that are cool but very large, hundreds of times the diameter of our Sun.

Additionally, some of the background galaxies that appeared in the NIRCam image also fade.

In the MIRI image, the blue tendrils of material signify the presence of PAHs.

NGC 604 is estimated to be around 3.5 million years old. The cloud of glowing gases extends to some 1,300 light-years across.

New Research Suggests That Our Universe Has No Dark Matter

Science Daily – 15 March 2024 - The current theoretical model for the composition of the universe is that it's made of 'normal matter,' 'dark energy' and 'dark matter.' A new uOttawa study challenges this.

A University of Ottawa study published today challenges the current model of the universe by showing that, in fact, it has no room for dark matter.

In cosmology, the term "dark matter" describes all that appears not to interact with light or the electromagnetic field, or that can only be explained through gravitational force.

We can't see it, nor do we know what it's made of, but it helps us understand how galaxies, planets and stars behave.

Rajendra Gupta, a physics professor at the Faculty of Science, used a combination of the covarying coupling constants (CCC) and "tired light" (TL) theories (the CCC+TL model) to reach this conclusion.

This model combines two ideas -- about how the forces of nature decrease over cosmic time and about light losing energy when it travels a long distance.

It's been tested and has been shown to match up with several observations, such as about how galaxies are spread out and how light from the early universe has evolved.

This discovery challenges the prevailing understanding of the universe, which suggests that roughly 27% of it is composed of dark matter and less than 5% of ordinary matter, remaining being the dark energy.

Challenging the need for dark matter in the universe

"The study's findings confirm that our previous work ("JWST early Universe observations and ΛCDM cosmology") about the age of the universe being 26.7billionyears has allowed us to discover that the universe does not require dark matter to exist," explains Gupta.

"In standard cosmology, the accelerated expansion of the universe is said to be caused by dark energy but is in fact due to the weakening forces of nature as it expands, not due to dark energy."

"Redshifts" refer to when light is shifted toward the red part of the spectrum.

The researcher analyzed data from recent papers on the distribution of galaxies at low redshifts and the angular size of the sound horizon in the literature at high redshift.

"There are several papers that question the existence of dark matter, but mine is the first one, to my knowledge, that eliminates its cosmological existence while being consistent with key cosmological observations that we have had time to confirm," says Gupta.

By challenging the need for dark matter in the universe and providing evidence for a new cosmological model, this study opens up new avenues for exploring the fundamental properties of the universe.

Persistent Hiccups in a Far-Off Galaxy Draw Astronomers to New Black Hole Behavior

Science Daily – 27 March 2024 - At the heart of a far-off galaxy, a supermassive black hole appears to have had a case of the hiccups.

Astronomers from MIT, Italy, the Czech Republic, and elsewhere have found that a previously quiet black hole, which sits at the center of a galaxy about 800 million light years away, has suddenly erupted, giving off plumes of gas every 8.5 days before settling back to its normal, quiet state.

The periodic hiccups are a new behavior that has not been observed in black holes until now. The scientists believe the most likely explanation for the outbursts stems from a second, smaller black hole that is zinging around the central, supermassive black hole and slinging material out from the larger black hole's disk of gas every 8.5 days.

The team's findings, which will be published in the journal *Science Advances*, challenge the conventional picture of black hole accretion disks, which scientists had assumed are relatively uniform disks of gas that rotate around a central black hole. The new results suggest that accretion disks may be more varied in their contents, possibly containing other black holes, and even entire stars.

"We thought we knew a lot about black holes, but this is telling us there are a lot more things they can do," says study author Dheeraj "DJ" Pasham, a research scientist in MIT's Kavli Institute for Astrophysics and Space Research. "We think there will be many more systems like this, and we just need to take more data to find them."

The study's MIT co-authors include postdoc Peter Kosec, graduate student Megan Masterson, Associate Professor Erin Kara, Principal Research Scientist Ronald Remillard, and former research scientist Michael Fausnaugh, along with collaborators from multiple institutions, including the Tor Vergata University of Rome, the Astronomical Institute of the Czech Academy of Sciences, and Masaryk University in the Czech Republic.

"Use it or lose it"

The team's findings grew out of an automated detection by ASAS-SN (the All-Sky Automated Survey for SuperNovae), a network of 20 robotic telescopes situated in various locations across the northern and southern hemispheres. The telescopes automatically survey the entire sky once a day for signs of supernovae and other transient phenomena.

In December of 2020, the survey spotted a burst of light in a galaxy about 800 million light years away. That particular part of the sky had been relatively quiet and dark until the telescopes' detection, when the galaxy suddenly brightened by a factor of 1,000. Pasham, who happened to see the detection reported in a community alert, chose to focus in on the flare with NASA's NICER (the Neutron star Interior Composition Explorer), an X-ray telescope aboard the International Space Station that continuously monitors the sky for X-ray bursts that could signal activity from neutron stars, black holes, and other extreme gravitational phenomena. The timing was fortuitous, as it was getting toward the end of Pasham's year-long period during which he had permission to point, or "trigger" the telescope.

"It was either use it or lose it, and it turned out to be my luckiest break," he says.

He trained NICER to observe the far-off galaxy as it continued to flare. The outburst lasted for about four months before petering out. During that time, NICER took measurements of the galaxy's X-ray emissions on a daily, high-cadence basis. When Pasham looked closely at the data, he noticed a curious pattern within the four-month flare: subtle dips, in a very narrow band of X-rays, that seemed to reappear every 8.5 days.

It seemed that the galaxy's burst of energy periodically dipped every 8.5 days. The signal is similar to what astronomers see when an orbiting planet crosses in front of its host star, briefly blocking the star's light. But no star would be able to block a flare from an entire galaxy.

"I was scratching my head as to what this means because this pattern doesn't fit anything that we know about these systems," Pasham recalls.

Punch it

As he was looking for an explanation to the periodic dips, Pasham came across a recent paper by theoretical physicists in the Czech Republic. The theorists had separately worked out that it would be possible, in theory, for a galaxy's central supermassive black hole to host a second, much smaller black hole. That smaller black hole could orbit at an angle from its larger companion's accretion disk.

As the theorists proposed, the secondary would periodically punch through the primary black hole's disk as it orbits. In the process, it would release a plume of gas, like a bee flying through a cloud of pollen. Powerful magnetic fields, to the north and south of the black hole, could then slingshot the plume up and out of the disk. Each time the smaller black hole punches through the disk, it would eject another plume, in a regular, periodic pattern. If that plume happened to point in the direction of an observing telescope, it might observe the plume as a dip in the galaxy's overall energy, briefly blocking the disk's light every so often.

"I was super excited by this theory, and I immediately emailed them to say, 'I think we're observing exactly what your theory predicted,'" Pasham says.

He and the Czech scientists teamed up to test the idea, with simulations that incorporated NICER's observations of the original outburst, and the regular, 8.5-day dips. What they found supports the theory: The observed outburst was likely a signal of a second, smaller black hole, orbiting a central supermassive black hole, and periodically puncturing its disk.

Specifically, the team found that the galaxy was relatively quiet prior to the December 2020 detection. The team estimates the galaxy's central supermassive black hole is as massive as 50 million suns. Prior to the outburst, the black hole may have had a faint, diffuse accretion disk rotating around it, as a second, smaller black hole, measuring 100 to 10,000 solar masses, was orbiting in relative obscurity.

The researchers suspect that, in December 2020, a third object -- likely a nearby star -- swung too close to the system and was shredded to pieces by the supermassive black hole's immense gravity -- an event that astronomers know as a "tidal disruption event." The sudden influx of stellar material momentarily brightened the black hole's accretion disk as the star's debris swirled into the black hole. Over four months, the black hole feasted on the stellar debris as the second black hole continued orbiting. As it punched through the disk, it ejected a much larger plume than it normally would, which happened to eject straight out toward NICER's scope.

The team carried out numerous simulations to test the periodic dips. The most likely explanation, they conclude, is a new kind of David-and-Goliath system -- a tiny, intermediate-mass black hole, zipping around a supermassive black hole.

"This is a different beast," Pasham says. "It doesn't fit anything that we know about these systems. We're seeing evidence of objects going in and through the disk, at different angles, which challenges the traditional picture of a simple gaseous disk around black holes. We think there is a huge population of these systems out there."

"This is a brilliant example of how to use the debris from a disrupted star to illuminate the interior of a galactic nucleus which would otherwise remain dark. It is akin to using fluorescent dye to find a leak in a pipe," says Richard Saxton, an X-ray astronomer from the European Space Astronomy Centre (ESAC) in Madrid, Spain, who was not involved in the study. "This result shows that very close super-massive black hole binaries could be common in galactic nuclei, which is a very exciting development for future gravitational wave detectors."

This research was supported in part NASA.

Schedule of Coming Events

Date	Event
1 April	**Third Quarter Moon**
5 April Friday Night 7:30 PM	**Monthly General Meeting** No meeting this month
6 April 10:08 PM	**Moon Near Mars** The moon will pass about 2^{o} from Mars
8 April	**New Moon**
8 April	**Solar Eclipse** Visible as a partial eclipse from the LA area.
	In-Town Observing Session at Christmas Tree Cove Located at the west end of Palos Verdes Peninsula at the intersection of Via Neve and Paseo Del Mar. Reached from PV West, turn on Via Anacapa then turn left on Via Sola and left again on Via Neve.
8 April Monday Night 7:30 PM	**Monthly Planning Meeting** See directions on Page 4.
10 February	**Out-of-Town Observing Session** Contact Ken Munson for a location.
15 April	**First Quarter Moon**
21 April	**Comet 12/Pons-Brooks at Greatest Magnitude** On April 21 Comet Pons-Brooks will be at perihelion. By this time, it is anticipated that it will be visible to the naked eye. Soon after, it will leave the northern hemisphere sky.
22 April	**Lyrids Meteor Shower Peak** The Lyrids is a popular meteor shower as it is known to produce bright fireballs. However, this year's shower occurs just before full Moon so it is likely that the bright Moon will outshine most meteors.
23 April	**Full Moon**
1 May	**Third Quarter Moon**

South Bay Astronomical Society

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Next General Meeting at El Camino College Planetarium

Friday, April 5th 7:30 PM

NO MEETING THIS MONTH

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South Bay Astronomical Society
P.O. Box 1244
Redondo Beach, CA 90278