Star Dust

Newsletter of National Capital Astronomers, Inc.

capitalastronomers.org

February 2022 ***Volume 80, Issue 6***

Celebrating 85 Years of Astronomy

Next Meeting

When: Sat. Feb. 12th, 2022

Time: 7:30 pm

Where: Online (Zoom)

See instructions for joining the meeting on Page 8.

Speaker: Dr. Joe Pesce

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Looking a little like the Starship Enterprise, the upper right formation is actually two gravitationally interacting galaxies. More details can be found at www.sci-news.com/astronomy/hubble-trio-galaxies-10486.html. Image Credit - NASA / ESA / Hubble / J. Dalcanton, Dark Energy Survey / DOE / FNAL, DECam / CTIO / NOIRLab / NSF / AURA / ESO / Judy Schmidt, www.geckzilla.com.

Monsters in the Universe: New Insight into Black Holes

Joe Pesce

NSF and George Mason University

Black holes are among the most enigmatic objects in the universe, and come in a variety of sizes, from several times the mass of the Sun to monsters with many billions of times the mass of the Sun (and maybe even atomic-sized ones). New advances in astrophysical instruments - with traditional electromagnetic observations as well as new ones using particles and gravitational waves - make this a golden age of black hole research. Recent findings from the electromagnetic spectrum, particles, gravitational waves, and the early universe are challenging traditional views.

This artist's concept illustrates a supermassive black hole with millions to billions of times the mass of our sun. Supermassive black holes are enormously dense objects buried at the hearts of galaxies. (Smaller black holes also exist throughout galaxies.) In this illustration, the supermassive black hole at the center is surrounded by matter in an accretion disk flowing toward the black hole. This disk forms as the dust and gas in the galaxy falls onto the hole, attracted by its gravity. Also shown is one of the two oppositely-directs jets of ultra-relativistic charged particles, believed to be powered by the black hole's spin. The regions near black holes are compact sources of high energy X-ray radiation thought, in some scenarios, to originate from the base of these jets. This high energy X-radiation lights up the disk, which reflects the X-rays, making the disk a source of X-rays. The reflected light enables astronomers to see how fast matter is swirling in the inner region of the disk, and ultimately to measure the black hole's spin rate.

There also exist stellar-mass black holes whose masses are about 5 to tens of solar masses, and intermediate-mass black holes, whose masses are hundreds or thousands of solar masses. Image Credit - NASA/JPL-Caltech (2013-02-21), www.nasa.gov/mission_pages/nustar/multimedia/pia16695.html. Caption Authors - NASA/JPL-Caltech (2013-02-21). This file is in the public domain in the United States because it was created solely by NASA.

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Recent Astronomy Highlights

Small Supermassive Black Hole Discovered In A Dwarf Galaxy

Using the Chandra X-ray Telescope, astronomers have discovered a black hole about 200,000 times the mass of the Sun in a dwarf galaxy known as Mrk 462 which lies approximately 110 million light years away. The discovery holds the potential to help in understanding how black holes grow to be supermassive, either from stellar-mass black holes, or via direct collapse of a cloud of gas into such a black hole. If there are a large number of such supermassive black holes in dwarf galaxies, this would seem to favor stellar-seed growth process. The large ratio of high-energy X-rays vs. low-energy X-rays seen by Chandra indicates that the black hole is obscured by dust and gas, a clue that perhaps many other such small supermassive black holes might lie in the hearts of other dwarf galaxies. More information on the discovery can be found at chandra.si.edu/press/22_releases/press_011022.html.

Observation of a Dying Star's End

In the Fall of 2020, a supergiant star in the galaxy NGC 5731, which lies approximately 120 million light years away, was observed to end its life in a Type 2 Supernova. Fortunately, the Pan-STARRS telescope in Hawaii detected an unusual amount of light coming from the doomed star in Summer 2020 allowing a team of astronomers running the Young Supernova Experiment (YSE) transient survey to watch the star, which was approximately ten times the mass of the Sun, over the period of its final 130 days. Such pre-supernova activity has never been observed and recorded before, with previous supergiants having been relatively quiescent up until the time that they went supernova. The observations will no doubt lead to advances in the understanding of the final stages of such supergiant stars lives. More information about the discovery can be found at phys.org/news/2022-01-astronomers-witness-dying-star-explosive.html

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Abstract and Biography – continued from page 1

Biography: Joe Pesce is an astrophysicist whose primary area of interest is supermassive black holes. He has held research positions at the Space Telescope Science Institute and the Pennsylvania State University. He is currently a Program Officer at the US National Science Foundation, responsible for most of the US Government's ground-based radio astronomy facilities (the National Radio Astronomy Observatory - NRAO - including the Atacama Large Millimeter/submillimeter Array (ALMA, in Chile), the Very Large Array (VLA, in New Mexico), and the US component of the Very Long Baseline Array (VLBA, spread across Earth). In addition to his day job, he is a Part-time Professor at George Mason University (Fairfax, Virginia) and a Visiting Professor at the University of Colorado (Boulder, Colorado). Previously, he founded, and served as CEO, of several firms specializing in high-level science and technology, critical thinking and problem-solving, consulting and education.

An important aspect of Joe's work involves public outreach, as an ambassador for science in general and astrophysics specifically. Among other activities, he has made numerous television and podcast appearances, and has served as science advisor to several science fiction series (television and online) and science fiction authors.

He is a Fellow of the Royal Astronomical Society and the Cambridge Philosophical Society; serves on the Board of Directors of The Presidents Leadership Class (University of Colorado, Boulder); is a proud alumnus of Peterhouse; is a member of the American Astronomical Society; the American Association for the Advancement of Science; Sigma Pi Sigma; the American Institute of Physics; and the Cosmos Club (Washington DC).

Joe received a B.A. degree in physics from the University of Colorado in Boulder, and M.Sc., M.Phil., and Ph.D. degrees in astrophysics from Cambridge University (Peterhouse) and the International School for Advanced Studies in Trieste, Italy.

Joe's other interests include science policy, space, leadership, interspecies communication, non-human intelligence, psychology, science fiction, and all things British. He conducts art-history research and collects art, antiquarian books, and antique furniture.

Exploring the Sky

*"**Exploring the Sky**"* is an informal program that, for over 70 years, has offered monthly opportunities for anyone in the Washington area to see the stars and planets through telescopes from a location within the District of Columbia. Presented by the National Park Service and National Capital Astronomers, sessions are held in Rock Creek Park once each month on a Saturday night from April through November, Beginners (including children) and experienced stargazers are all welcome—and it's free!

Hosted by: National Capital Astronomers, Inc and Rock Creek Park

Due to the ongoing Coronavirus Pandemic, Exploring the Sky sessions are canceled. When the situation changes, sessions will once again be scheduled.

More information can be found at NCA's web site, www.capitalastronomers.org or the Rock Creek Park web site, www.nps.gov/rocr/planyourvisit/expsky.htm. You can also call the Nature Center at (202) 895-6070. For general information on local astronomical events visit www.astronomyindc.org

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The article-submission deadline for March's issue of Star Dust, is February 21st.

Clear Skies!

Fully Deployed James Webb Space Telescope Reaches Its Final Destination – A Halo Orbit of L2

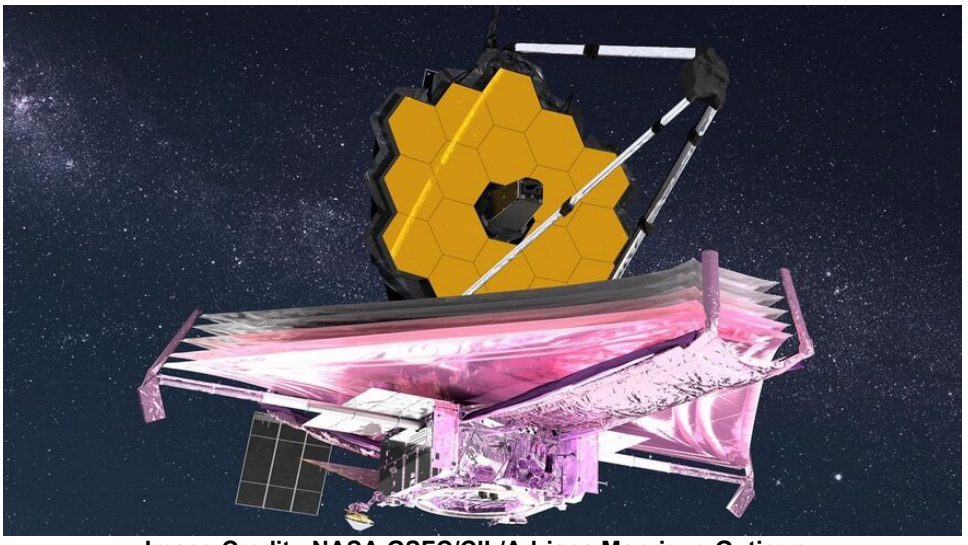

Image Credit - NASA GSFC/CIL/Adriana Manrique Gutierrez

At the September 2021 NCA meeting, Dr. Heidi Hammel gave a fascinating talk about what the James Webb Space Telescope (JWST) would explore in the Solar System and the types of discoveries it was expected to make. (A recording of that talk is available at capitalastronomers.org/recordings/20210911_HHammel_What-the-JamesWebbSpaceTelescope-Will-Tell-Us-About-the-Solar-System.mp4.) But, no doubt on the minds of many who watched that talk were thoughts about all of the ways that the enormous space telescope might fail to deploy properly. Well, a little over four months after that talk, and a month after launch, at the end of what NASA dubbed the '29 Days of Terror', the almost completely deployed JWST fired its thrusters for about five minutes to change its velocity by about 1 ½ meters/second in order to enter what is known as a halo orbit around the Sun-Earth Langrange point known as L2. A number of other space probes, including the Wilkinson Microwave Anisotropy Probe, W-MAP, Planck and the Global Astrometric Interferometer for Astrophysics, Gaia, have also been sent to halo orbits of L2 for the advantages of being far away from the Earth and Moon, and their heat and fields, even while staying with Earth in orbiting the Sun, allowing for continuous communications with the spacecraft.

NCA member David Dunham has a long history with the concept of sending spacecraft to halo orbits of Lagrange points. He spent decades working with Robert Farquhar, known as the Father of Halo Orbits, who would jokingly describe their relationship: "Dave does all the work, and I take all the credit." In 1989 at a Goddard conference, Farquhar and Dunham gave a presentation first describing how a space observatory in a Sun-Earth L2 orbit had the advantage of access to at least half the sky, with the bright Sun, Earth, and Moon behind it. In 2021, David and four coauthors wrote a paper, "The Birth of Halo Orbits, a Fiftieth Anniversary", to memorialize the history of halo orbits and their use in space science and exploration. That paper can be found at iota.jhuapl.edu/AAS21-766paper.pdf. In addition, the pdf and audio file of a longer presentation David gave at a Future in-Space Operations (FISO) telecon are available at fiso.spiritastro.net/telecon/Dunham_11-3-21/.

Sky Watchers

February/March

Now in the morning sky, Mercury will reach Greatest Western Elongation in mid-February (see below). Venus also shines bright in the predawn sky. Mars will be in the morning sky. Jupiter is the only planet remaining in the night sky, low on the horizon at sunset until it begins to transition to the morning sky in early March, where it will join the other planets, including Saturn.	
2/16	Mercury at Greatest Western Elongation – The planet will be 26.3 degrees from the Sun in the morning sky.
2/16	Full Moon at 12:38 EST

All times are in EST (Eastern Standard Time)

Occultation by the Trojan Asteroid (3548) Eurybates in the s.w. USA, 2021 Oct. 20

David W. and Joan B. Dunham

Eurybates is one of the Trojan asteroid targets of NASA's Lucy mission that launched only 4 days before this occultation. The Lucy mission is described in a good article, "Rock On", about it and other NASA missions to asteroids on pages 12-19 of the February 2022 issue of Sky and Telescope. On p. 17 is a box called "Get Involved", where the Southwest Research Institute (SwRI) asks interested amateurs to contact them, to possibly join their campaigns to observe occultations by the Lucy asteroids, and gives an example of one by (11351) Leucus that occurred in Arizona in late December 2019; Joan and I successfully ran four stations for that event, obtaining the southernmost chord and one other, as well as the constraining miss line on the south side.

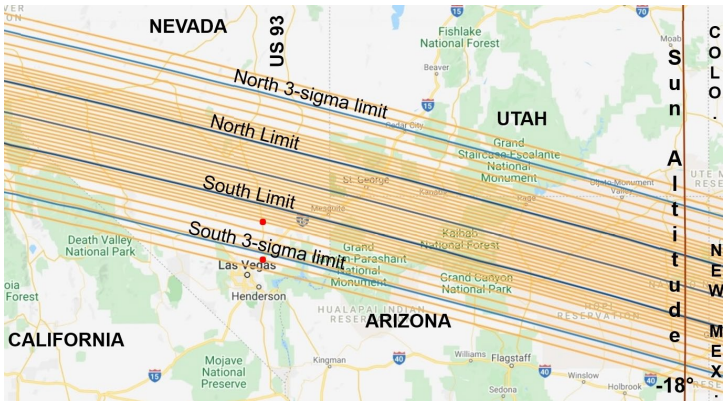

Fig. 1. This map shows the observations planned by SwRI for the occultation of a 13.5-mag. star near 5th-mag. 32 Tauri by Eurybates last October 20th. Credit: SwRI and Google Maps. Observers set up telescopes with video and CCD cameras at each of the 37 orange lines shown on the map, near where they crossed highways. Most participants, including teams from SwRI, many of the volunteer observers of the 50 observatories of the Research and Education Collaborative Occultation Network (RECON), and IOTA, converged on Las Vegas for practice sessions, helped by local amateur astronomers and high school students. On event night, they travelled to their assigned line, many near US 93 north of Las Vegas. Two red dots show the locations of the two stations run by the authors, with a pre-pointed stationary 10-in. Dobsonian on line 2 (numbered from south to north) and an 8-in. SCT on line 6. Results are shown below.

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Thank you!

Recent Astronomy Highlights – continued from page 2

Strange Radio Transient Discovered

Using the Murchison Widefield Array (MWA) in Australia, radio astronomers have discovered an unusual source of radio waves. Sources that give off radio waves on a noncontinuous basis are called transients. Some examples of this phenomenon are objects such as pulsars, fast-spinning neutron stars from which radio telescopes receive signal in periods around that of milliseconds, and supernovae which can radiate brightly in the radio part of the spectrum for many days. But the source seen by MWA was extremely bright for about a minute out of twenty. It may be an ultra-long period magnetar, a slow spinning neutron star with a very strong magnetic field. More details can be found at www.eurekalert.org/news-releases/941140.

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Occultation Notes

- D following the time denotes a disappearance, while R indicates that the event is a reappearance.
- The times are for Greenbelt, MD, and will be good to within +/-1 min. for other locations in the Washington-Baltimore metropolitan areas unless the cusp angle (CA) is less than 30 deg., in which case, it might be as much as 5 minutes different for other locations across the region.
- Some stars in Flamsteed's catalog are in the wrong constellation, according to the official IAU constellation boundaries that were established well after Flamsteed's catalog was published. In these cases, Flamsteed's constellation is in parentheses and the actual constellation is given in the notes following a /.
- Mag is the star's magnitude.
- % is the percent of the Moon's visible disk that is sunlit, followed by a + indicating that the Moon is waxing and - showing that it is waning. So 0 is new moon, 50+ is first quarter, 100+ or - is full moon, and 50- is last quarter. The Moon is crescent if % is less than 50 and is gibbous if it is more than 50.
- Cusp Angle is described more fully at the main IOTA Web site.
- Sp. is the star's spectral type (color), O,B,blue; A,F,white; G,yellow; K,orange; M,N,S,C red.
- Also in the notes, information about double stars is often given. "Close double" with no other information usually means nearly equal components with a separation less than 0.2". "mg2" or "m2" means the magnitude of the secondary component, followed by its separation in arc seconds ("), and sometimes its PA from the primary. If there is a 3rd component (for a triple star), it might be indicated with "mg3" or "m3". Double is sometime abbreviated "dbl". Often, rather than the separation, I give “dTime” or “dT”, the time difference of the secondary star occultation relative to the primary star’s occultation.
- Sometimes the Axis angle (AA) is given. It is the angle measured around the Moon's disk, from the Moon's axis of rotation. It can be used with a lunar map to tell where a star will reappear relative to lunar features.

Mid-Atlantic Occultations

David Dunham

Asteroidal Occultations

2022 Day	EST/ EST	Star	Mag.	Asteroid	dmag	dur. s	Ap. "	Location
Feb 10 Thu	3:12	4UC51652583	13.0	Eucharis	0.3	9	8	se-nVA,wMD;DC?
Feb 11 Fri	4:56	4UC34789304	13.4	Arenda	3.8	1.2	9	cOhio,nWV,nscVA
Feb 14 Mon	22:36	TYC06300079	10.3	Walkure	5.2	1.3	5	cAZ,nAL,nGA,cSC
Feb 15 Tue	0:22	4UC55941483	13.7	Erato	0.7	15	10	MD,DC,nVA,nOhio
Feb 17 Thu	5:39	4U368130322	13.1	Radek	3.1	0.9	9	cOH,nWV,nVA,sMD
Feb 18 Fri	2:33	4UC52347997	13.6	Gunlod	1.4	4	10	sNJ,c&nMD;nVA?
Feb 19 Sat	22:54	TYC07572115	9.7	Amalia	5.3	8	3	e-nVA,wMD,swPA
Feb 21 Mon	23:17	4UC51446027	13.6	Davewilliams	3.5	2	9	sNJ,MD,nVA;DC?
Feb 27 Sun	3:26	4UC51940502	14.0	Bronislawa	1.8	12	11	MD,sNJ,sc-nwPA
Mar 2 Tue	5:59	4UC66150990	12.1	WilliamsBay	5.1	4	5	sNJ,nMD;DC,nVA?
Mar 7 Mon	0:01	SAO 57301	8.8	Celuta	5.3	2.6	3	neTN,swNC,swSC
Mar 12 Sat	1:02	4UC52318483	11.9	Zhongolovich	5	2	6	cOH,nVA,sDC,sMD
*** Dates and times above are EST, those below are EDT ***								
Mar 13 Sun	22:59	4UC51210550	14.4	Gyptis	0.4	9	11	NJ,PA,nOH;nMD?

Lunar Grazing Occultations

2022 Day	EST	Star	Mag	% alt	CA	Location, Notes
Feb 22 Tue	7:38	alpha Lib	2.8	66- 22	-9N	IAD,Vienna,VA;sDC;TH&Owngs,MD
Mar 7 Mon	18:53	SAO 93315	7.7	27+ 48	8S	YorkHavn,Lititz,s.Lansdale,PA

Lunar Total Occultations

2022 Date Day	EST/ EDT	Ph	Star	Mag	%	alt	CA	Sp.	Notes
Feb 12 Sat	20:51	D	39 Gem	6.2	88+	74	77S	F8	ZC1061, close double?
Feb 12 Sat	21:55	D	40 Gem	6.4	88+	76	19S	B8	ZC1062, close double??
Feb 13 Sun	3:19	D	ZC 1085	7.1	89+	20	82N	G8	mg2 7.8 sep 124" dT +4m
Feb 17 Thu	0:48	R	46 Leonis	5.4	100-	65	56N	M2	AA 269,ZC1544, TrmDst6"
Feb 18 Fri	21:27	R	ZC 1741*	7.1	93-	16	41S	K0	Axis Angle 214 degrees
Feb 19 Sat	4:07	R	ZC 1758	6.9	92-	47	67N	G5	
Feb 20 Sun	0:52	R	ZC 1864	6.7	86-	38	45N	K2	
Feb 20 Sun	2:32	R	46 Vir	6.2	86-	47	60N	K2	ZC1869,mg2 9,dTime+1.1s
Feb 22 Tue	4:48	R	5 Librae	6.3	67-	36	30N	K2	ZC2105,mg2 10,dTim+2.7s
Feb 23 Wed	2:52	R	ZC 2230*	6.7	56-	20	20N	F3	maybe close double?
Feb 24 Thu	5:46	R	SAO 184545	8.3	44-	26	70N	F5	
Feb 24 Thu	5:55	R	ZC 2398	6.1	44-	26	80N	A7	Sun altitude -11 deg.
Feb 25 Fri	4:40	R	ZC 2544	8.1	33-	13	54S	F0	Azimuth 142 degrees
Feb 26 Sat	4:24	R	ZC 2723	6.6	23-	2	47S	K0	Azimuth 129 degrees
Feb 26 Sat	5:06	R	SAO187290*	8.0	23-	9	15N	B8	Azimuth 135 degrees
Feb 26 Sat	5:54	R	SAO187318	7.7	22-	14	13N	A3	Sun alt. -10, Az. 144
Feb 27 Sun	7:01	R	omega Sgr	4.7	13-	16	59S	G3	Sun alt. +3, ZC2910
Mar 6 Sun	21:04	D	AG Arietis	8.2	19+	14	59N	B9	Az.275,ZC359,close dbl
Mar 7 Mon	18:35	D	SAO 93307	7.7	27+	53	29N	K2	Sun altitude -6 degrees
Mar 7 Mon	19:53	D	SAO 93333	8.4	27+	39	81N	A3	
Mar 7 Mon	22:36	D	SAO 93370	7.4	28+	8	83S	K5	Azimuth 286 degrees
Mar 8 Tue	19:32	D	SAO 76373*	7.6	36+	53	13N	K0	
Mar 8 Tue	21:40	D	SAO 76421	8.0	37+	29	34S	A2	
Mar 9 Wed	20:47	D	SAO 76810	7.6	46+	50	73N	F8	
Mar 9 Wed	21:19	D	SAO 76820*	7.5	46+	44	60S	F2	
Mar 9 Wed	21:42	D	SAO 76826*	7.9	46+	40	39S	A3	
Mar 9 Wed	22:27	D	SAO 76845*	8.2	47+	31	52S	B9	
Mar 9 Wed	23:29	D	99 Tauri*	5.8	47+	19	27S	G8	ZC 742,mg2 12,dTime-20s
Mar 10 Thu	0:28	D	SAO 76885*	7.8	47+	9	82S	F2	Azimuth 294 degrees
Mar 10 Thu	20:53	D	SAO 77523	7.3	56+	59	84N	B9	Mag2 8.3sep15"dTime -4s
Mar 10 Thu	21:20	D	SAO 77535	8.2	56+	54	42S	G5	maybe close double?
Mar 10 Thu	23:04	D	SAO 77593	7.3	56+	34	34S	K2	spectroscopic binary
Mar 11 Fri	0:03	D	SAO 77622	7.6	57+	23	22N	A3	
*** Dates and times above are EST, those below are EDT ***									
Mar 13 Sun	2:04	D	SAO 79610	7.2	75+	19	11S	F8	
Mar 13 Sun	20:27	D	SAO 80165	7.5	82+	64	81N	F2	

*in Kepler2 program so occultation light curves are sought.

More information is at http://iota.jhuapl.edu/exped.htm
David Dunham, dunham@starpower.net

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Occultation by the Trojan Asteroid (3548) Eurybates in the s.w. USA, 2021 Oct. 20 – *continued from page 4*

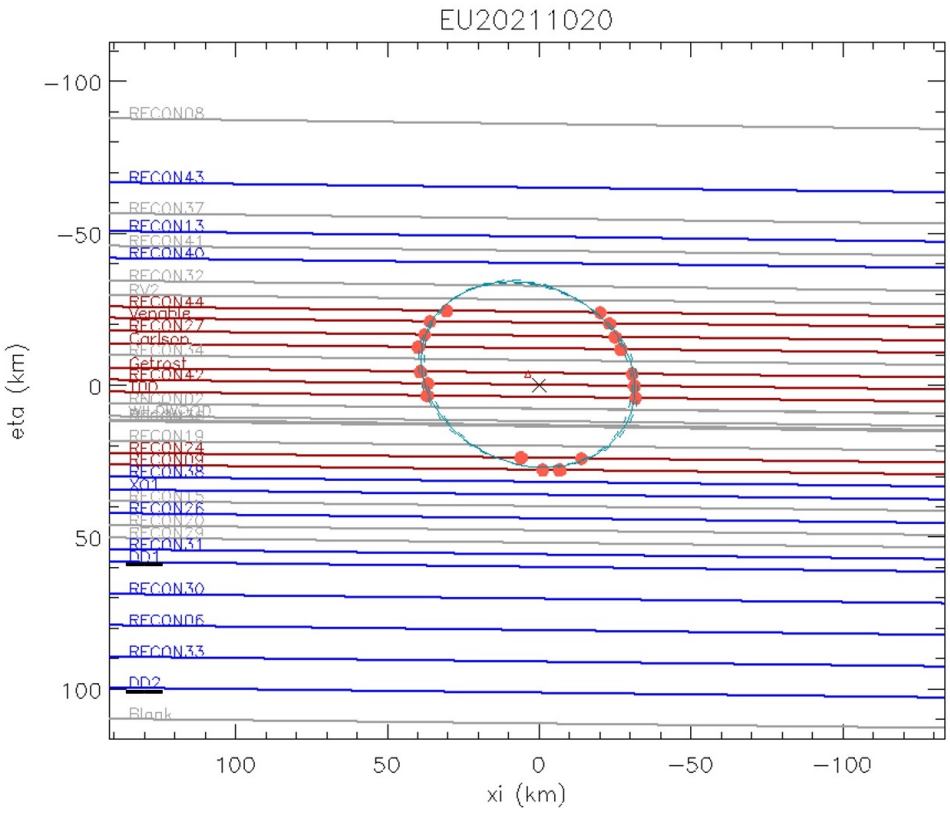

Fig. 2. Observations of the occultation projected onto the sky plane at Eurybates. Credit: Marc Buie, SwRI (presented at the AGU meeting in New Orleans in December 2021). Red lines show the paths of the stations that recorded the star and had an occultation, with dots marking the disappearances and reappearances of the star. Blue lines show stations where the star was recorded but no occultation occurred, including our two lines, DD1 and DD2, underlined. Gray lines are stations where observations were attempted, but the star was not recorded due to clouds or equipment problems. The best-fit ellipse is in green, with axis lengths 58 km and 73 km. The path was accurately predicted because a few observations had been made during an earlier occultation. But it was not known then if Eurybates might have a large relatively close moon that could shift the paths of future events, including this one; that's why observers were spread out so far. The October observations showed there was no such moon, which will allow tighter coverage of future events by Eurybates, to better improve our knowledge of the asteroid's size and shape.

Another occultation, of a 10.4-mag. star by another Lucy Trojan, (15094) Polymele, will occur on March 27 UT (evening of the 26th EST) in the Carolinas, but will also be visible as far west as Kansas. The observation area will be decided only a few days beforehand when weather forecasts stabilize.

You are invited to join SwRI's and IOTA's campaign to observe that event. Information about it and other 2022 Trojan occultations is available at occultations.org/publications/rasc/2022/nam22Trojanoccs.htm while SwRI's Google Map for the March 27th path is at lucy.swri.edu/occ/20220327Polymele.html.

Recent Astronomy Highlights – continued from page 4

A Black Hole's Outflow Causing Star Formation in Host Galaxy
Black holes have a well-earned reputation for destroying objects that come too near to them, such as stars. But in one dwarf galaxy, a recent discovery indicates that black holes can actually help in the creation of stars. That galaxy, Henize 2-10, lies approximately 30 million light years away. There an outflow has been observed coming from a supermassive black hole that weighs approximately one million times the mass of the Sun. That outflow gas, traveling at around a million miles per hour, has collided with a cloud of gas 230 light years from the black hole, causing collapse of the gas to form stars. This is in contrast to other supermassive black holes, with plasma jets leaving at nearly the speed of light, so fast that they would destroy any clouds of gas in their path. More information on the discovery is at www.sciencedaily.com/releases/2022/01/220119194144.htm.

Calendar of Events

NCA Telescope Making, Maintenance, and Modification Workshop (TM3W) (previously the NCA Mirror- or Telescope-making Classes): The Chevy Chase Community Center has reopened and classes have resumed. Classes will be Tuesdays and Fridays, from 5:00 to 8:30 pm at the Chevy Chase Community Center (intersection of McKinley Street and Connecticut Avenue, N.W.) Please contact instructor Guy Brandenburg at 202-262-4274 (leave message) or at gfbrandenburg@yahoo.com if you plan to attend. Note that masks are mandatory, as in all DC government buildings. More info is at guysmathastro.com.

Open house talks and observing at the University of Maryland Observatory in College Park are temporarily suspended. When they resume, they will be on the 5th and 20th of every month at 8:00 pm (Nov.-Apr.) or 9:00 pm (May-Oct.). Updates are posted at www.astro.umd.edu/openhouse.

Next NCA Meeting: **12 March** 7:30 p.m. Ira Thorpe (GSFC) **The LISA Pathfinder Mission: Gwaves and Micrometeoroids**

The APS Mid-Atlantic Senior Physicists Group: **(Zoom Meeting)** February 16th at 1:00 p.m., Jim Green, NASA, will give a talk entitled "The Exploration of the Moon and then onto Mars". More information on the meeting is available at www.aps.org/units/maspg/meetings/meeting.cfm?name=SENIOR0222.If you're interested in attending the meeting, please email units@aps.org.

National Capital Astronomers Membership Form

Name: _____ **Date:** ___/___/___

Address: _____ **ZIP Code:** _____

Home Phone: ____-____-_____ **E-mail:** _____ **Print / E-mail Star Dust (circle one)**

Membership (circle one): Student….. $ 5; Individual / Family…..$10; Optional Contribution…..$__

Please indicate which activities interest you:

- Attending monthly scientific lectures on some aspect of astronomy ____
- Making scientific astronomical observations ____
- Observing astronomical objects for personal pleasure at relatively dark sites ____
- Attending large regional star parties ____
- Doing outreach events to educate the public, such as Exploring the Sky ____
- Building or modifying telescopes ____
- Participating in travel/expeditions to view eclipses or occultations ____
- Combating light pollution ____

Do you have any special skills, such as videography, graphic arts, science education, electronics, machining, etc.?

Are you interested in volunteering for: Telescope making, Exploring the Sky, Star Dust, NCA Officer, etc.?

Please mail this form with check payable to ***National Capital Astronomers*** to:
Henry Bofinger, NCA Treasurer; 727 Massachusetts Ave. NE, Washington, DC 20002-6007

National Capital Astronomers, Inc.

If undeliverable, return to
NCA c/o Elizabeth Warner
400 Madison St #2208
Alexandria, VA 22314

First Class
Dated Material

Celebrating 84 Years of Astronomy

Next NCA Meeting:

2022 February 12th
7:30 pm
(On Zoom)
Dr. Joe Pesce

To join the Zoom meeting, use the following link: umd.zoom.us/j/96856095178?pwd=cWhyNE92bGFYUkYxZnI6eWVIK0lKdz09

Please download and import the following iCalendar (.ics) files to your calendar system: umd.zoom.us/meeting/tJIlcu-opz4rHdxfgBb8Lh5wRlgETFQ8lnI5/ics?icsToken=98tyKuCupj4sGt2QsR6PRowAGo_4M_TxmCVcgqdFmhjHAXh_albhBO5FF4ZZIYDc

Please note that NCA Zoom meetings are often recorded.

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