Star Dust

Newsletter of National Capital Astronomers, Inc.

capitalastronomers.org

March 2022 ***Volume 80, Issue 7***

Celebrating 85 Years of Astronomy

Next Meeting

When: Sat. Mar. 12th, 2022

Time: 7:30 pm

Where: Online (Zoom)

See instructions for joining the meeting on Page 8.

Speaker: Dr. James Ira Thorpe

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Artist Illustration of Pioneer 10 Flyby of Jupiter. Image Credit – NASA

Fifty years ago this month, Pioneer 10 began its mission of discovery through the Solar System and beyond. The first article in a planned series on the spacecraft's mission can be found on Page 3.

Bringing the Gravitational-Wave Revolution to Space

James Ira Thorpe

NASA's Goddard Space Flight Center

After decades of effort, an international team of scientists and engineers have succeeded in developing a new kind of astronomical observatory – the gravitational wave detector. These exquisitely-sensitive instruments

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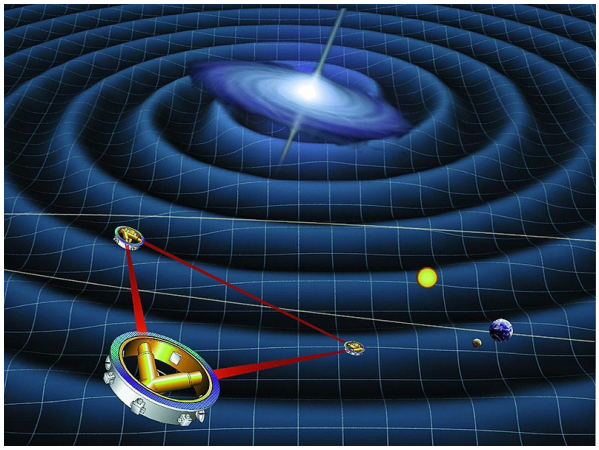

The three LISA spacecraft will be placed in orbits that form a triangular formation with center 20° behind the Earth and side length 5 million km. (The figure showing the formation is not to scale.)

Each spacecraft will begin an individual Earth-like orbit around the Sun. The orbits are chosen to minimize changes in the lengths of the sides of the triangle. The orbits of the three spacecraft have a relationship between inclination and eccentricity that inclines the plane of the formation by 60° with respect to the ecliptic. The nodal longitudes of the three orbits are shifted by 120° to create the triangle. The heliocentric orbit offers a particularly quiet environment, critical for the control of disturbances on the test masses defining the interferometer arms. The test masses are free-falling and shielded by the enclosing spacecraft from disturbances of the solar wind and photon pressure. The orientation of the spacecraft with respect to the Sun changes very slowly. The Sun appears to move along a cone with a 30° half angle aligned with the spacecraft's cylindrical axis once per year, giving constant illumination. The major source of disturbance in the measurement band is the variation in the solar constant caused by the Sun's normal modes of oscillation, amounting to less than 10 ppm in intensity.

The orbital motion of the antenna sweeps its sensitivity lobes across the sky, giving an amplitude modulation dependent on a source's angular coordinates. Similarly, the Doppler effect gives a phase modulation dependent on a source's angular coordinates. The two effects combine to give directional information about every source. Most of the sources observable by LISA are periodic or quasi-periodic and can be observed for at least a year. The angular position accuracy depends on the signal-to-noise ratio. For the strongest sources, the direction to the source can be determined to about 1 arc minute. Image and cation credit – NASA

Recent Astronomy Highlights

Supermassive Black-Hole Pair Spiraling Toward Merger

It probably won't take place for another quarter billion years, but a pair of supermassive black holes has been discovered orbiting around each other in NGC 7727, which lies approximately 89 million light years away. That distance makes it the closest such pair that astronomers have found so far. Approximately 1600 light years from each other, the supermassive black holes are estimated to have masses of 154 million and 6.3 million times the mass of the Sun. The smaller of the pair of black holes appears to have been part of a galaxy that was consumed by the larger galaxy hosting the more massive black hole. More information on the discovery is available at www.space.com/merging-black-hole-pair-close-to-Earth. And a preprint of the paper announcing the discovery is at arxiv.org/pdf/2111.14854.pdf.

And If You Can't Wait A Quarter Billion Years To See A Supermassive Black Hole Merger…

How about a mere 10,000 years? Based on data collected over a period of decades, astronomers speculate that such a supermassive-black-hole merger might very well be in the offing. Approximately nine billion light years away, PKS 2131-021 is a galaxy known as a blazar, a galaxy with an active galactic nucleus, or AGN, which has a supermassive black hole emitting relativistic jets, one of which is pointed at Earth. Records of the intensity of radio signals collected from that galaxy over the past forty-five years have shown a cyclic change in brightness, each cycle lasting approximately two years. One of the most likely explanations for the cyclic nature of the light is that two supermassive black holes, each hundreds of millions of times the mass of the Sun, are orbiting approximately 2000 Astronomical Units (the average distance between the Sun and Earth) away from each other with each orbit taking approximately two years. The paper describing the SMBH candidate can be found at arxiv.org/pdf/2111.02436.pdf.

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Abstract and Biography – continued from page 1

measure ripples in the fabric of spacetime produced by astrophysical cataclysms in the distant universe. In the few years that these instruments have been operating, they have already helped to answer important questions such as what powers gamma ray bursts and what are the origins of heavy elements? Equally important, they have posed new questions as well, such as how large or small can "stellar origin" black holes be? Are all of them even remnants of massive stars? This combination of answering old questions and posing new ones is precisely the motivation for investing the tremendous effort it took to add this new technique to the astronomers' toolkit.

While efforts such as LIGO and Virgo have launched the field of Gravitational Wave astronomy, there are many directions for it to expand. One of the most promising directions is to develop space-based detectors, which allow for much larger facilities in significantly quieter environments. Space-based observatories are particularly suited to observing low-frequency gravitational waves with periods of minutes to hours. These are produced by a wide variety of astrophysical systems including binary systems in our own Milky Way and mergers of massive black holes in the very distant universe. In parallel with the development of the ground-based detectors, scientists in Europe and the US have spent several decades developing the Laser Interferometer Space Antenna (LISA) concept: a triangular constellation of spacecraft linked with laser beams spanning millions of kilometers which will be sensitive to gravitational waves in the milliHertz band. The European Space Agency and NASA are currently pursuing LISA as a joint mission, with launch expected in the 2030s. I will provide an overview of LISA's science objectives, the mission concept, and some of the key technologies that are under development.

Image Credit - NASA

Biography: Dr. (James) Ira Thorpe is an Astrophysicist in the Gravitational Astrophysics Lab at NASA's Goddard Space Flight Center in Greenbelt, MD. His main research interests are development of space-based gravitational wave missions, in particular the Laser Interferometer Space Antenna (LISA) concept, for which he serves as the NASA lead scientist. In his 15 years at Goddard, Ira has worked on various aspects of the LISA mission including laboratory prototypes of instrumentation, simulations of science measurement and data analysis, and development

continued on page 3

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 April's issue of Star Dust, is March 21st.

Clear Skies!

Biography – continued from page 2

of mission concepts. From 2015-2017, he participated as the NASA liaison to ESA's LISA Pathfinder mission, a technology demonstration flight that validated key aspects of the LISA measurement. Prior to arriving at Goddard, Ira completed a Ph.D. in physics from the University of Florida in 2006, an M.S. in physics from the University of Maryland in 2002, and a Bachelor of Arts in Physics and Bachelor of Science in Mechanical Engineering from Bucknell University in 2001. Ira was born and raised in Santa Fe, New Mexico and currently lives in Rockville, MD with his wife and three sons.

Pioneer 10 Remembered @ Fifty (1972-2022 & Beyond), Part 1

Daniel J. Costanzo – NCA Past President (1991-1992)

Left: Pioneer 10 in the final stages of construction. Image Credit – UCLA
Right: Pioneer 10's 1972 launch. Image Credit – NASA

Humanity's longing to sail off to the stars shifted from dream to reality fifty years ago this month when, on March 3, 1972, our NASA launched from Cape Canaveral (then called Cape Kennedy) the now all too easily forgotten spacecraft Pioneer 10.

Pioneer 10, and sister-craft Pioneer 11 (launched successfully a little over a year later), were utterly primitive by today's high technology standards. And they were a little primitive even by circa-1972 standards. For they were built using space technology proven on previously successful Pioneer missions, but packed into two relatively small, lightweight craft, each weighing 259-kilograms (571-pounds), with electricity provided by plutonium-238 radioisotope thermal generators (RTGs).

Both Pioneers were designed to operate a little less than two years (twenty-one months), i.e., just long enough to reach Jupiter and study that planet in order to "pioneer" the paths to be followed several years later by NASA's then planned outer Solar System "Grand Tour" flyby missions.

Pioneer 10 was boosted away from Earth at 51,682-kilometers/hour (32,114-miles/hour), as the fastest spacecraft ever launched up to that time, eating up the same distance from Earth to the Moon's orbit that took Apollo astronauts three days in only eleven hours. (Apollo 15 was launched several months earlier, and Apollo 16 would be launched a little over a month later.) Pioneer 10's scientific firsts in Cosmic Discovery are too long to list here. The most important was accomplishing humanity's

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Sky Watchers

March/April

The morning sky is where you will find all of the naked-eye visible planets, although Jupiter will rise so close to dawn that it will probably not be visible until April. Saturn and Mars will have a very close conjunction on April 4 (see below).	
3/18	Full Moon at 3:17 EDT
3/20	Venus reaches Greatest Western Elongation – Our sister planet will be at its farthest from the Sun in the morning sky and approximately 24° above the horizon at dawn.
3/20	Vernal Equinox – The Sun will be directly overhead at the equator at 11:27 a.m. ushering in Spring in the Northern Hemisphere.
4/4	Conjunction of Saturn and Mars - Low in the morning sky, Saturn and Mars will appear to be within 19' (approximately 1/3 of a degree) from each other.

All times are in EDT (Eastern Daylight Savings Time)

JWST Update - From Eighteen Images to One

HD 84406 is a Sun-like star approximately 250 light years away. The star is too faint to be seen by the naked eye and, therefore, not well known. But it suddenly became famous as the initial target of the James Web Space Telescope, used to align the eighteen mirror segments that initially gave eighteen separate images of the star, one from each of the mirror segments.

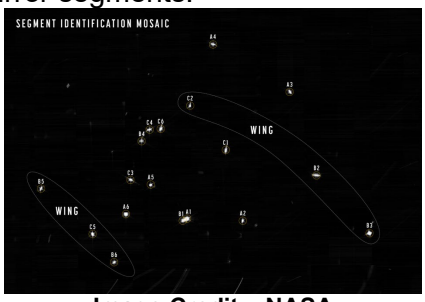

Image Credit – NASA

Since then, the JWST team has made small adjustments to the mirrors in order to sharpen the star images. They also aligned the images so they are stacked on top of each other.

Image Credit – NASA

Finally, the team will make additional vertical adjustments to the mirrors so that the wavelengths of all eighteen images are synchronized as well, further sharpening future images. Soon after that the telescope's exploration of the Universe begins. Stay tuned.

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Thank you!

Recent Astronomy Highlights – continued from page 2

First Known Quadruple Asteroid System

Astronomers recently discovered that 130 Elecktra, an asteroid orbiting between Mars and Jupiter, has a third asteroid, or moon, orbiting it. 130 Elecktra was discovered in 1873. It is 260 kilometers in diameter. The first of its moons, which is six kilometers in diameter, was discovered in 2003 and the second, which is two kilometers in diameter, was discovered in 2014. The third moon was actually discovered using archived data, not because of any new observations. Improved processing of the data allowed for that third moon, which orbits much closer to 130 Elecktra to finally be seen. More information is at www.sciencealert.com/this-is-the-first-asteroid-ever-discovered-to-have-three-moons.

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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
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 15 Tue	20:45	TYC97511210	12.1	Arequipa	2.6	6	5	cVA,eMD,sePA;DC?
Mar 15 Tue	21:15	4UC60641289	12.0	Leto	0.9	32	5	cMD,DC,eVA;nVA?
Mar 19 Sat	4:06	4UC44952005	13.8	Schumann	2.6	2	10	se-nVA,swMD,DC?
Mar 20 Sun	4:54	4UC33187596	12.8	Nicole	2.8	2	8	w-swMD,n-eVA;DC?
Mar 26 Sat	21:56	TYC18180363	10.4	Polymele	9.0	0.7	4	nKS,eTN,w+sNC
Mar 28 Mon	21:38	4UC45224522	13.3	Malabar	1.6	5	9	w&nVA,DC,cMD,NJ
Mar 30 Wed	21:20	4UC56238652	13.3	S2000-762-1	.8	1.4	9	nOH,nWV,nVA,sMD*
Apr 6 Wed	23:48	4UC49150379	12.9	Kashirina	3.9	3	9	c+nVA,sDC,ecMD
Apr 9 Sat	3:54	4UC60646723	12.3	DavidBender	3.5	5	5	seNY,nNJ,nPA,nOH
Apr 11 Mon	22:56	4UC32765639	12.4	Gunila	1.6	7	6	sNJ,neMD,se-ncPA
Apr 12 Tue	23:14	4UC51344730	14.5	Prokne	0.4	12	11	sAZ,c+nVA,DC,MD

Lunar Grazing Occultations

2022 Day	EDT	Star	Mag	% alt	CA	Location, Notes
Mar 19 Sat	1:20	Porrima	2.8	99- 53	31S	nEln,nSHil,VA;Halifx,Ocrck,NC
Apr 7 Thu	21:37	X 8757	9.8	38+ 47	6N	nRckvil,Wheaton,sGreenbelt,MD
Apr 7 Thu	23:36	SAO 78284	8.9	39+ 24	7N	Olney, s.Kontera, s.Bowie, MD
Apr 7 Thu	23:36	ZC 974	8.8	39+ 24	7N	Chmbrsbg,PA;Wstmnstr,sTosn,MD
Apr 8 Fri	21:40	SAO 79164	7.4	48+ 55	7N	RndTp,PA;DpRn,Sprks,Brdshw,MD

Lunar Total Occultations

2022 Date	Day	EDT	Ph	Star	Mag	%	alt	CA	Sp.	Notes
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	
Mar 15	Tue	2:02	D	ZC 1393	6.5	90+	47	56S	G7	
Mar 15	Tue	19:46	D	eta Leonis	3.5	94+	34	80N	A0	Sun-7,ZC1484,close dbl?
Mar 16	Wed	5:31	D	42 Leonis	6.2	96+	14	29N	A1	Azimuth 278, ZC 1514
Mar 19	Sat	0:56	D	Porrima	2.8	99-	47	0S	F0	ZC1821,mg2 3.5 dT -15s
Mar 19	Sat	1:36	R	=gamma Vir	2.8	99-	49	60S	F0	AA 228,mg2 3.5 dT +14s
Mar 19	Sat	3:03	R	ZC 1825	5.9	99-	47	65N	G8	AA 284, Term. Dist. 19"
Mar 20	Sun	2:30	R	77 Vir*	7.0	95-	43	57N	F0	Axis Angle 300, ZC 1947
Mar 21	Mon	1:53	R	ZC 2065	6.5	89-	32	27N	K2	mg2 11, sep 42",dT -74s
Mar 22	Tue	6:36	R	ZC 2207*	7.0	80-	25	49S	A4	Sun altitude -7 degrees
Mar 23	Wed	2:21	R	SAO 184305	7.5	71-	15	85S	B9	Azimuth 137 degrees
Mar 23	Wed	3:54	R	SAO 184337	7.0	71-	24	56S	B6	
Mar 24	Thu	3:31	R	ZC 2501	8.1	60-	13	64N	K0	Azimuth 141 degrees
Mar 24	Thu	5:30	R	SAO185404*	7.5	59-	23	15N	B8	mg2 10 sec5",dT-25s
Mar 26	Sat	5:43	R	SAO 188292	8.3	36-	14	43S	K1	Azimuth 143 deg.
Mar 27	Sun	5:49	R	SAO 189469	7.7	26-	9	41N	K0	Azimuth 132 deg.
Mar 27	Sun	6:53	R	ZC 3012	6.9	26-	17	23N	A7	Sun alt. -2 deg.
Apr 4	Mon	20:37	D	13 Tauri*	5.7	13+	28	31S	B9	ZC 531, spec. binary
Apr 4	Mon	20:57	D	SAO 93560*	8.4	13+	24	31N	A2	close double??
Apr 5	Tue	19:45	D	SAO 76636	7.1	20+	48	55N	K2	Sun altitude -3 deg.
Apr 5	Tue	22:30	D	ZC 693*	6.0	21+	18	88S	F5	
Apr 6	Wed	23:39	D	SAO 77217	8.3	30+	15	49S	A3	Azimuth 291 deg.
Apr 7	Thu	19:52	D	SAO 78172	8.3	38+	67	66S	K0	Sun sltitude -4 deg.
Apr 7	Thu	20:45	D	SAO 78195	8.0	38+	57	56S	K2	close double??
Apr 7	Thu	22:07	D	SAO 78245	8.3	38+	42	77N	A0	
Apr 8	Fri	20:26	D	ZC 1089	6.7	47+	70	87N	K0	Sun altitude -10 deg.
Apr 8	Fri	21:31	D	SAO 79164	7.4	48+	59	22N	G8	close dbl?; PA,MD graze
Apr 9	Sat	0:46	D	SAO 79277	8.1	49+	22	84S	F0	mg2 11 sep .6" dT -1s
Apr 9	Sat	1:59	D	SAO 79319	7.9	49+	9	80N	K2	Azimuth 296 deg.
Apr 11	Mon	0:27	D	ZC 1348	8.1	68+	41	64S	G5	

*in Kepler2 program so occultation light curves are sought.

More information is at http://iota.jhuapl.edu/exped.htm; sometime soon, the URL will change to https://iota.jhuapl.edu/exped.htm.
David Dunham, dunham@starpower.net

2021-2022 Officers

Pioneer 10 Remembered @ Fifty (1972-2022 & Beyond), Part 1 – continued from page 3

first space exploration beyond Mars' orbit, particularly, of the asteroid belt and Jupiter.

The first ever Jupiter flyby was achieved on December 3, 1973 by the craft's whisking only 132,252-kilometers (82,178-miles) above that gas giant's outer atmosphere at an amazing 132,000-kilometers/hour (82,000-miles/hour), while gathering the first ever close-encounter data (including images) about Jupiter, Jupiter's moons, and surrounding space environment.

Pioneer 10 then became the first spacecraft to ever use a planet's gravity as a gravitational slingshot, with mighty Jupiter slinging the craft out towards the stars.

In 1983, still operating normally and returning valuable data about the Outer Solar System's interplanetary space well beyond Jupiter, the craft passed Neptune's orbit, then the outermost ninth "planet" recognized by the International Astronomical Union (IAU). (That was before the IAU's controversial 2006 vote dethroning Pluto as the ninth "planet.") Thus, Pioneer 10 became the first human-made object to officially leave the Solar System.

Regular radio contact was maintained until 1997, and intermittent radio contact thereafter.

Finally, in 2003, nearly thirty-one years after launch, Pioneer 10 radioed a last signal Earthward, not due to malfunction, but because the RTGs couldn't generate enough electricity to keep the radio transmitter operating any more. With that final signal, the spacecraft was 12.2-billion-kilometers [7.6 billion miles, or 82 Astronomical Units (AU)] from Earth. Reaching Earth took that last signal, at the speed of light, 11 hours and 20 minutes.

Like all scientific inquiry, Pioneer 10 answered many questions about what lay beyond Mars, but raised many more. Those questions would be left for successor spacecraft to try to answer. Yet, we certainly got our money's worth from a spacecraft designed to last less than two years.

Since Pioneer 10's launch, our NASA has launched a veritable fleet of four other spacecraft escaping the Solar System, all on successful missions of Cosmic Discovery: sister-craft Pioneer 11 (launched in 1973 to both Jupiter and Saturn), Voyager 1 and sister-craft Voyager 2 (both launched in 1977 on the "Grand Tour"), and New Horizons (launched in 2006 to both Pluto and Kuiper Belt Objects, only months before the IAU's Pluto dethroning vote).

But it all began with Pioneer 10's launch a half-century ago this month. Now, a half-century later, Pioneer 10 is at a distance from the Sun of 19.5-billion-kilometers (12.1-billion-miles, or 130.5-AU), leaving the Sun behind at 42,876-kilometers/hour (26,642-miles/hour, or 2.51-AU/year).

In Washington, D.C., the Smithsonian Institution's National Air and Space Museum (SI-NASM) honors Pioneer 10 prominently by displaying a full-scale mockup in its Boeing Milestones of Flight Hall.

So, with the COVID-19 Pandemic apparently winding down, I encourage all to visit SI-NASM (after making sure it is open) and ponder the meaning of humanity's first starcraft from the Sun, now outward bound steadily in silence, towards the stars.

Recent Astronomy Highlights – continued from page 4

Evidence of a Third Planet Orbiting the Closest Star to the Sun
Astronomers have discovered another planet orbiting Proxima Centauri, which lies only four light years away from the Solar System. Designated Proxima d, the exoplanet has a mass of approximately 1/4 that of the Earth and orbits Proxima Centauri at less than 1/10 of Mercury's distance from the Sun. The discovery was made because of a slight 5-day-cyclic redshifting of light from the star, indicating that Proxima Centauri is moving toward and away from us in response to the orbiting of the exoplanet. While that orbit is too close to the star to be in its habitable zone, Proxima b, one of the other exoplanets does indeed reside in that habitable zone and has a mass approximately that of Earth, while Proxima c, the last exoplanet, orbits far out from the habitable zone. More information about Proxima d and its discovery is at www.sciencedaily.com/releases/2022/0

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: **9 April** 7:30 p.m. Johanna Teske, Carnegie Institute for Science's Earth and Planets Laboratory, **Compositions of Planets and Their Host Stars**

The APS Mid-Atlantic Senior Physicists Group: **(Zoom Meeting)** March 16th at 1:00 p.m., Garegin Papoian, University of Maryland, will give a talk entitled "Modeling Biomolecular Structure and Dynamics by Blending Ideas from Machine Learning and Physics". More information on the meeting will be made available at www.aps.org/units/maspg/meetings/meeting.cfm?name=SENIOR0322. If you're

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

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Alexandria, VA 22314

First Class
Dated Material

Celebrating 84 Years of Astronomy

Next NCA Meeting:

2022 March 12th
7:30 pm
(On Zoom)
Dr. James Ira Thorpe

To join the Zoom meeting, use the following link: umd.zoom.us/j/96856095178?pwd=cWhyNE92bGFYUkYxZnl6eWVIK0lKdz09

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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