Star Dust

Newsletter of National Capital Astronomers, Inc.

capitalastronomers.org

November 2018 ***Volume 77, Issue 3***

Celebrating 81 Years of Astronomy

Next Meeting

When: Sat. Nov. 10th, 2018

Time: 7:30 pm

Where: UMD Observatory

Speakers: Dr. Erika Kohler

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Directions to Dinner/Meeting

Our time and location for dinner with the speaker before this meeting is 5:30 pm at "Hunan Treasure" at 7537 Greenbelt Road, Greenbelt, MD 20770 in Greenway Center just east of where Greenbelt Road crosses over the Baltimore-Washington Parkway.

The National Capital Astronomers meeting is held at the UMD Astronomy Observatory on Metzerott Rd about halfway between Adelphi Rd and University Blvd.

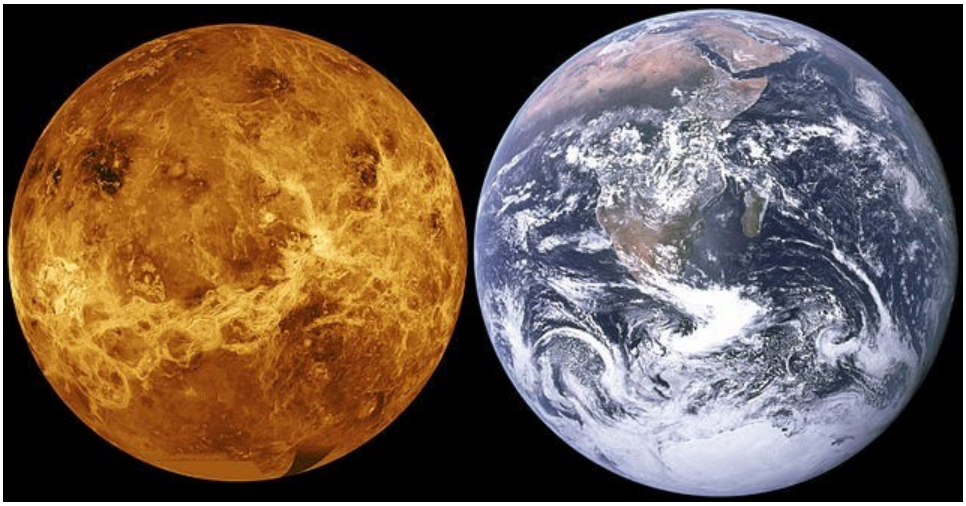
Observing after the Meeting

Following the meeting, members and guests are welcome to tour through the Observatory. Weather-permitting, several of the telescopes will also be set up for viewing.

The Surface of Venus

Erika Kohler
Universities Space Research Association at
Goddard Space Flight Center

Abstract: Some regions on the surface of Venus are unexpectedly radar bright. For quite a few years we have been trying to explain this mystery. The strongly reflective regions are at altitudes which are cooler than the average Venus' surface, so that there might be metallic frosts on the surface, or low-lying metal-rich clouds or fog. We use a simulation chamber at the Goddard Space Flight Center to simulate conditions on Venus, allowing us to measure how candidate reflecting compounds behave under the very un-Earthlike conditions on Venus. What we have found will help guide what kind of mission to Venus would be most effective for solving the mystery of the anomalously radar-reflective regions on Venus.



Radar image of Venus (left) taken by the Magellan probe during the early 1990s. The image of Earth taken by astronauts on Apollo 17 is included to show the relative sizes of the two planets. Image Credit: NASA

Biography: Dr. Erika Kohler earned her PhD in Space and Planetary Sciences from the University of Arkansas at Fayetteville. While working on her PhD research, as a Harriet G. Jenkins Research Fellow, she researched the interactions between Venus' surface and its lower atmosphere, by using a Venus simulation

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Recent Astronomy Highlights

New Findings Concerning the Chemical Complexity of Saturn's Rings and Their Effects on the Planet
During the Cassini probe's last orbits, a mass spectrometer on board detected more than simply water in Saturn's D ring, the innermost one. Additional chemicals detected included ammonia, carbon dioxide, methane and molecular nitrogen. And while diving from the ring into Saturn's atmosphere, Cassini's spectrometer found that the amount of these gases feeding into that atmosphere was much higher than expected. The high feed rate seems to indicate that gas and dust from the rings may be making significant changes to Saturn's atmosphere. That rate also may mean that the planet's rings are shorter lived than previously believed. More information can be found at: www.sciencedaily.com/releases/2018/10/181004143937.htm

First Possible Exomoon Detection
An additional dip in the light curve during the transit of an exoplanet in front of its star, along with a delay in the expected start of one such transit, seems to indicate that a gas-giant planet several times as massive as Jupiter, designated Kepler-1625b, has a Neptune-sized moon. If confirmed, this would be the first exomoon, a moon around a planet in another solar system, detected. For more information, go to: arxiv.org/pdf/1810.02362.pdf

Another Neutron-Star Neutron-Star Collision?
A gamma-ray burst, officially named GRB150101B, which was detected in 2015, seems to bear a lot of similarities to the neutron-star neutron-star collision, designated GW170817, which was detected by LIGO in 2017. Like the event detected by LIGO, GRB150101B gave off a brief gamma-ray burst and emitted x-rays for a much longer period. GRB150101B took place before LIGO's advanced detectors came on line so gravitational-wave detection was not possible. For more information go to: cmns.umd.edu/news-events/features/4253

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chamber at NASA's Goddard Space Flight Center. She now works at Goddard for the Universities Space Research Association, a nonprofit corporation under the auspices of the National Academy of Sciences, continuing her research on the composition of the surface of Venus, and also on metallic and silicate components in the atmospheres of extrasolar planets.

A Cubesat Odyssey

Cubesats are small satellites weighing no more than a few pounds. With their low mass, and their construction often using off-the-shelf parts, cubesats are much cheaper to build, launch and operate than traditional satellites. Unfortunately, this relatively new approach to exploring space has come with a high rate of failure – up to 50% of the cubesats launched haven't ended up being functional.

Dellingr, named after the Norse god of dawn, is one of the success stories, albeit one with many challenges on the way to that success. Designed to study the Earth's magnetic field and the ions and neutral particles in the ionosphere, it was sent to the International Space Station on a Falcon 9 rocket. Dellingr was subsequently launched from the ISS in November of 2017, and almost immediately developed problems involving early deployment of its magnetometers. Later problems included software and sensor malfunctions as well as issues with the satellite resetting its systems so often at one point that it effectively didn't have enough time to communicate with facilities down on Earth. A fascinating article about the travails of Dellingr, and the ingenuity of the NASA team that overcame them, can be found at: www.nasa.gov/feature/goddard/2018/dellingr-the-little-cubesat-that-could

Exploring the Sky

*"**Exploring the Sky**"* is an informal program that, for 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

Final 2018 Exploring the Sky Session
17 Nov 7:00 pm – Saturn, Mars, Uranus, Moon

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

Have an astronomy related experience to share with your fellow NCA members? The submission deadline for December's Star Dust, is November 21st.

Clear Skies!

Sky Watchers

November/December

Venus remains in the morning sky getting brighter through the end of November. Mercury and Jupiter transit from the early evening sky to the morning sky in late November. Saturn remains in the evening sky while Mars will remain visible until near midnight.	
11/17-18	The Leonids Meteor Shower peaks from the night of 11/17 into the morning of 11/18 with approximately 15 meteors/hour. Best viewing conditions will be after midnight when the Moon has set.
11/23	The Full Moon takes place at 12:40 a.m. EST.
12/1 - 2	Even though Venus will have moved past its closest approach to Earth, these are the mornings when it will appear brightest. Viewed through a telescope, it will appear as a bright, thin crescent. An article explaining why Venus will be its brightest on these dates can be found just below.

Times in EST

The Brightness of Venus

Two factors go into determining the brightness of Venus as seen from Earth. The first, of course, is how close the planet is to us. When it is on the far side of the Sun from Earth, Venus is approximately 162 million miles away, while when it is at its closest, it is only around 24 million miles away. With such a variation in distance, it would seem like the planet would be brightest when it is closest to Earth.

However, the second factor, how much of the daylight side of Venus we see, works against such a straightforward relationship. When Venus is on the far side of the Sun from Earth, it appears to us to be an almost wholly lit disk, but with its smallest apparent diameter. As it catches up with Earth from this far position, we see less of its daylight side, thus the planet is a waning gibbous, like the Moon in the days after a Full Moon. And as it approaches Earth, the diameter of Venus's gibbous grows in size. When Venus is at its point of maximum elongation, the point at which it appears to us to be the farthest from the Sun in the sky, its looks like a half circle. Then as it continues to catch up with Earth it goes into a waning-crescent phase. This process reverses itself at the time known as inferior conjunction, when Venus has its closest approach to Earth. Inferior conjunction is also the time when the planet transits from the evening sky to the morning sky or vice versa.

The combination of these two factors means that Venus appears brightest to us, an event known as the greatest illuminated extent, approximately 36 days prior to or after inferior conjunction. At that time, we see a quarter of Venus's daylight side.

In the days near to greatest illuminated extent, it is possible to see Venus even in the middle of the day. For historical buffs, one such daylight viewing took place at Abraham Lincoln's second inauguration in 1865. An article detailing what happened on that day can be found at: www.space.com/15036-venus-daylight-skywatching-tips.html

Venus – Helping Us in Understanding the Universe

Almost as if in compensation for the many mysteries it hides beneath a permanent curtain of clouds, our sister planet has proven valuable over the years in helping humanity to discover where Earth fits in our Solar System and to confirm the nature of the Universe. Three instances of such assistance are given below.

Earth's Place in the Solar System

While it is said to be possible for a person with the most acute vision, in ideal viewing conditions, to see Venus as a crescent when it is close to Earth, Galileo Galilei was the first person to witness the planet going through all of its phases. He did so by using a homemade telescope in 1610-1611. He wrote of his findings in several publications including *The Assayer*, published in 1623, in which he included a drawing of the Venusian phases and the relative sizes of the planet during those phases. A copy of that drawing can be accessed at - www.astronomy2009.org/resources/multimedia/images/detail/galileo_12/. The observed changes in the size of Venus, as well as its phases, were proofs to Galileo that Venus had to be orbiting the Sun and not the Earth, just as Nicolaus Copernicus had proposed.

The Size of the Solar System

In 2004 and then again in 2012, millions of people witnessed transits of Venus across the Sun. Such transits come in pairs separated by 8 years, as predicted by Jeremiah Horrocks of England in the early 1600's, and such transits proved key in finally measuring the size of the Solar System.

In the early 1600s, Johannes Kepler had calculated how far the other planets were from the Sun compared to the distance between the Earth and the Sun, now known as the Astronomical Unit (AU). But nobody at that time knew the actual distance of the AU. In 1691, Sir Edmund Halley proposed that taking measurements of the next pair of Venus transits, which would occur in 1761 and 1769, in various locations across the Earth, could allow for calculation of the Astronomical Unit, and from that the distances to other planets. Specifically, he proposed determining the amount of time it took for Venus to transit across the Sun at each observation site. At different sites, Venus would take different amounts of time to cross the disk of the Sun because it would appear to take different paths (higher or lower), the effect known as parallax. The extent of parallax could then be used to calculate the AU distance. (Apparently, Halley was inspired by James Gregory who had proposed the same method using measurements of the transit of Mercury across the Sun in 1677.) Halley died in 1742, long before the transit and also before the 1758 return of the comet which would subsequently bear his name.

But others took up the mission. Among them was Mikhail Lomonosov, who is credited with discovering that Venus had an atmosphere during

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Thank you!

Recent Astronomy Highlights – continued from page 2

Birth of a Neutron-Star Binary?

The deaths of neutron-star binaries have been much in the news since LIGO witnessed one in 2017. Now astronomers believe they have recorded the birth of such a system. 'Ultra-stripped supernovae' were theorized to take place in binary systems where one of the two stars becomes a white dwarf, neutron star or black hole that strips gas from the second star before that star goes supernovae. With this theory, astronomers searched the database from the intermediate Palomar Transient Factory, a wide-field survey, and found a possible match in iPTF14gqr, a faint supernova that took place in 2014. For more info go to: www.eurekalert.org/pub_releases/2018-10/nion-lsi101118.php

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Occultation Notes

- D following the time denotes a disappearance, while R indicates that the event is a reappearance.
- When a power (x; actually, zoom factor) is given in the notes, the event can probably be recorded directly with a camcorder of that power with no telescope needed.
- 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".
- 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 and TNO Occultations

2018 Date	Day	EST	Star	Mag.	Asteroid	dmag	dur. s	Ap. "	Location
Nov 11	Sun	3:44	2UC45786182	11.3	Amherstia	2.3	6	7	sNJ,se-nwPA,neOH
Nov 15	Thu	5:36	4UC533-6631	13.0	Brazilia	1.2	4	11	s&wMD,nVA,OH;DC?
Nov 18	Sun	4:18	TYC29111452	11.2	Klio	1.6	10	7	MD,DC,nVA,swPA
Nov 23	Fri	20:32	4UC537-7843	13.6	Prymno	0.3	4	12	sePA,nMD,nVA,WV
Nov 27	Tue	21:55	TYC51950448	10.4	Salonta	5.7	3	5	sPA,nMD;nVA,DC?
Dec 2	Sun	5:42	4UC53851863	12.8	Kreusa	0.8	8	10	NJ,PA,OH;nMD?
Dec 3	Mon	0:33	4UC425-9153	12.7	Strobel	1.9	5	10	DE,sMD,c&wVA;DC?
Dec 10	Mon	21:13	TYC58190972	11.5	Bellona	1.6	6	7	nVA,w&nMD,sePA

Event details at www.asteroidoccultation.com/

Lunar Grazing Occultations

2018 Date	Day	EST	Star	Mag	% alt	CA	Location, Notes
Nov 24	Sat	22:09	SAO 77654	8.2	95- 41	19N	Mineral, VA; Hughesville, MD

Lunar Total Occultations

2018 Date	Day	EST	Ph	Star	Mag	%	alt	CA	Sp.	Notes
Nov 11	Sun	19:02	D	SAO187096*	7.9	18+	19	49N	B8	
Nov 12	Mon	17:52	D	SAO 188233	8.2	26+	25	43N	K0	Sun alt. -11 deg.
Nov 12	Mon	17:56	D	SAO 188235	8.2	26+	25	46N	F0	Sun alt. -12 deg.
Nov 12	Mon	18:57	D	SAO 188252	7.2	26+	18	5N	A6	
Nov 13	Tue	18:17	D	SAO 189224	8.4	34+	28	78S	K5	
Nov 14	Wed	20:08	D	SAO 164241	8.4	44+	24	11N	F5	
Nov 14	Wed	21:40	D	HD 2026	5.4	45+	12	58S	B5	Az.235,ZC3113,double??
Nov 15	Thu	18:17	D	ZC 3225	7.2	53+	36	38S	G8	mg2 10.6 sep 9",PA271dg
Nov 15	Thu	20:16	D	SAO 164837	7.9	54+	31	35N	K0	
Nov 15	Thu	21:47	D	ZC 3236*	7.1	54+	20	80S	F3	
Nov 15	Thu	23:02	D	ZC 3240	6.7	54+	8	44N	A2	Azimuth 244 deg.
Nov 17	Sat	18:00	D	SAO146786*	7.4	72+	36	46N	K4	
Nov 18	Sun	17:28	D	ZC 44	7.4	80+	30	39N	F8	Sun altitude -8 deg.
Nov 18	Sun	19:01	D	SAO 128734	7.8	80+	42	60N	G5	
Nov 19	Mon	1:19	D	ZC 66	7.1	82+	16	35N	A0	
Nov 20	Tue	18:00	D	ZC 291	6.8	94+	26	82S	G5	
Nov 20	Tue	22:15	D	ZC 306	6.8	94+	58	63N	F0	
Nov 24	Sat	20:06	R	SAO 77547	7.1	95-	18	72N	K0	Axis Angle 294 deg.
Nov 24	Sat	22:53	R	ZC 892	6.7	95-	49	37S	B9	Axis Angle 222 deg.
Nov 24	Sat	23:13	R	chi1 Ori	4.4	95-	52	14S	G0	AA198,ZC894,TmD6",dbl?
Nov 25	Sun	4:21	R	SAO 77889	6.9	94-	54	37S	G5	Axis Angle 221 deg.
Nov 25	Sun	6:32	R	SAO 77983	7.1	94-	29	82N	K2	Sun -6, Axis Angle 282
Nov 25	Sun	22:18	R	ZC 1051	6.6	89-	31	71N	K1	mg2 9.9 sep 1.4" PA 194
Nov 25	Sun	23:26	R	SAO 78896	7.4	88-	44	53S	B8	mg2 10? sep 1.7" PA 202
Nov 26	Mon	6:21	R	ZC 1086	6.4	87-	43	34N	G9	Sun -8; very close dbl?
Nov 27	Tue	1:33	R	SAO 79899	7.0	79-	56	61N	G5	
Nov 27	Tue	3:34	R	ZC 1223	7.7	79-	71	18S	F8	
Nov 27	Tue	23:06	R	FZ Cancri	6.3	70-	16	67N	M4	ZC 1343
Nov 28	Wed	4:22	R	78 Cancri*	7.2	68-	68	61S	K3	ZC1362, close double?
Nov 29	Thu	1:29	R	SAO 98914	8.0	58-	30	64N	A1	
Nov 29	Thu	7:07	R	34 Leonis	6.5	56-	59	34S	F7	Sun 0,ZC1493,close dbl
Nov 30	Fri	2:33	R	ZC 1596*	7.2	46-	30	65S	A2	mag2 12 sep 1.6" PA 115
Dec 1	Sat	3:18	R	ZC 1719	7.8	35-	25	32S	K5	
Dec 1	Sat	5:40	R	SAO 119146	8.4	34-	48	23N	F5	close double??
Dec 1	Sat	6:09	R	SAO 119142	8.4	34-	51	37S	K2	Sun altitude -11 deg.
Dec 2	Sun	4:56	R	ZC 1840	8.0	24-	31	52S	F8	
Dec 3	Mon	5:49	R	SAO139480*	8.1	15-	28	72N	F5	
Dec 5	Wed	6:04	R	SAO159216*	8.7	3-	8	23N	G0	Azimuth 115 degrees
Dec 9	Sun	17:25	D	SAO187806	8.0	6+	13	30N	K0	Sun -8, Az. 227, dbl.
Dec 9	Sun	18:11	D	SAO187850*	8.7	6+	7	59N	A0	Azimuth 235 degrees
Dec 9	Sun	18:14	D	ZC 2806	7.0	6+	6	89N	A0	Azimuth 235 degrees
Dec 10	Mon	17:47	D	ZC 2929	7.1	12+	18	56S	G8	Sun-12, close double??

*in Kepler2 program so occultation light curves are sought.

More, esp. total lunar occultations, at iota.jhuapl.edu/exped.htm
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Comet 46P/Wirtanen Comes Close in December 2018

Discovered in 1948 by Carl A. Wirtanen, Comet 46P/Wirtanen is set for a close encounter, in astronomical terms, with Earth in coming months. Its closest approach to Earth, known as Minimum Orbit Intersection Distance or MOID, will bring the comet to within 7.26 million miles on December 16, 2018, or about 30 times the distance from the Earth to the Moon. This will make it the tenth closest approach by a known comet since 1950.

46P/Wirtanen is a short-period comet with an orbit of approximately 5½ years. The orbit brings the comet to within a little over 1 AU from the Sun at its closest, perihelion, which it will reach on December 12th, and out to over 5 AUs at aphelion, farthest distance from the Sun. Simulations show that in the last century, 46P/Wirtanen's orbit was perturbed by Jupiter on several occasions, causing its orbital period to shorten and decreasing its perihelion by nearly half an AU.

It is still not known if Comet 46P/Wirtanen will be visible to the naked eye. Visibility predictions range from Magnitude 8 to Magnitude 3 at closest approach. However, the comet is certain to be a popular target for those with binoculars and telescopes through the late Autumn and Winter months. Fortunately, since the comet will be near to opposition (on the opposite side of the sky from the Sun) when it is closest, it will be visible for almost the entire night for those hardier souls willing to brave the cold in order to see it high in the sky.

Further information is available on **The Comet Wirtanen Observing Campaign** webpage at: wirtanen.astro.umd.edu/. Many thanks to this site for information in this article. Observations can also be shared at aop.astro.umd.edu/ .

Venus – Helping Us in Understanding the Universe – continued from page 4

the 1761 transit, when he noticed an arc of light around the planet just before and after it transited the Sun, a phenomenon now known as Lomonosov's Arc. The transit was measured by scientists from around the world, including the famous explorer Captain James Cook who, along with members of his crew, witnessed the transit of 1769 in Tahiti.

Despite difficulties in timing the transits, the results of all these observations allowed for determination of the Earth-Sun distance to within several percent of the currently accepted value of approximately 93 million miles. Subsequent observations of the transits of 1874 and 1882 led to a value that was even more accurate.

A Confirmation of General Relativity

Finally, Venus was used to test an effect of General Relativity known as the Shapiro Time Delay, an effect theorized by Irwin Shapiro. The effect has to do with a large mass, such as the Sun, warping the space around it such that light passing through that warped space will take longer to do so than if the mass were not present. In 1964, with Venus on the opposite side of the Sun, radar waves were transmitted from Earth, past the Sun to Venus. Some of those waves then bounced back from Venus. The time of the journey included a delay of 200 microseconds, a result within five percent of what was predicted by Einstein's theory, one more proof that General Relativity was correct.

Recent Astronomy Highlights – continued from page 4

Proto-supercluster Discovered

Astronomers have discovered a proto-supercluster of galaxies with a mass of over a million billion times that of the Sun. The supercluster, named Hyperion, had already formed by two billion years after the Big Bang. The structure is the largest found to have formed so early in the Universe, with its mass rivaling that of superclusters closer to Earth. Hyperion does differ from the superclusters in our region in that the matter in it is more diffusely distributed, instead of being concentrated in the associated galaxies. Likely such concentration of gas has taken place in the time since then. The discovery was a surprise to astronomers in that it was not believed that such a large structure could form in only two billion years. Study of Hyperion may help in refining theories about the growth of such structures. For more information, go to: www.sciencedaily.com/releases/2018/10/181017111036.htm

Calendar of Events

NCA Mirror- or Telescope-making Classes: Tuesdays AND Fridays, from 6:30 to 9:30 pm at the Chevy Chase Community Center (intersection of McKinley Street and Connecticut Avenue, N.W.) Contact instructor Guy Brandenburg at 202-635-1860 or at gfbrandenburg@yahoo.com. Additional information is at guysmathastro.wordpress.com/ and home.earthlink.net/~gfbranden/GFB_Home_Page.html

Open house talks and observing at the University of Maryland Observatory in College Park on the 5th and 20th of every month at 8:00 pm (Nov.-Apr.) or 9:00 pm (May-Oct.). Details: www.astro.umd.edu/openhouse

Mid-Atlantic Senior Physicists Group: (Please note that this lecture is on the **second Wednesday of the month, not the third.**) "Gravitational Waves and Light From Merging Neutron Stars" by Dr. Judith Racusin, NASA's Goddard Space Flight Center, Wed., October 17, at 1:00 p.m. at the American Center for Physics (1st floor conference room) with Q&A to follow. 1 Physics Ellipse, College Park, MD-- off River Rd., between Kenilworth Ave. and Paint Branch Parkway. www.aps.org/units/maspg/

Next NCA Meeting at the University of Maryland Observatory:
8 December: 7:30 p.m., Peter Shawhan (UMD), *New Astronomy with Gravitational Waves*

Montgomery College's Planetarium – "Astrolabes", Nov. 17th 7:00 p.m. For more information and directions, go to: www2.montgomerycollege.edu/departments/planet/

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 81 Years of Astronomy

Next NCA Meeting:

2018 November 10th
7:30 pm
@ UMD Observatory

Dr. Erika Kohler

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