

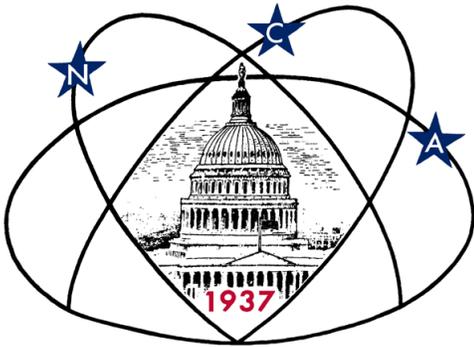
# Star Dust

Newsletter of National Capital Astronomers, Inc.

[capitlastronomers.org](http://capitlastronomers.org)

December 2014

Volume 73, Issue 4



## Next Meeting

**When:** Sat. Dec. 13th, 2014  
**Time:** 7:30 pm  
**Where:** UMD Observatory  
**Speaker:** Drake Deming

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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 "The Common," the restaurant in the UMD University College building located at 3501 University Blvd.

The meeting is held at the UMD Astronomy Observatory on Metzger Rd about halfway between Adelphi Rd and University Blvd.

## Need a Ride?

Please contact Jay Miller, 240-401-8693, if you need a ride from the metro to dinner or to the meeting @ observatory. Please try to let him know in advance by e-mail at [rigel1@starpower.net](mailto:rigel1@starpower.net).

## 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.

## Habitable Extrasolar Planets to be Discovered by the TESS Mission

*L. Drake Deming, University of Maryland-College Park*

**Abstract:** The first extrasolar planet found to orbit a solar-type star was discovered in 1995. This discovery was due to the motions toward and away from us that the planet produced orbiting its star. A few years later, another exoplanet, discovered by the same technique, was found to periodically pass across the face of its star (i.e., transit in front of the star), because its orbit was nearly edge on from our perspective. Transits help us learn more about an exoplanet by allowing scientists to calculate the radius, mass, average density and atmospheric composition of the distant world.



*Courtesy Drake Deming*

*Transiting Exoplanet Survey Satellite (TESS)*

Although the Kepler mission has discovered thousands of transiting exoplanets, including many "super-Earths," the planets observed are too distant to allow us to characterize their atmospheres. The Transiting

*continued on page 2*

## Reminder

After the meeting, everyone is invited to join us at Plato's Diner in College Park. Plato's is located at 7150 Baltimore Ave. (US Rt. 1 at Calvert Rd.), just south of the university's campus. What if it's clear and you want to stick around and observe? No problem -- just come over when you're through. This is very informal, and we fully expect people to wander in and out.

## Asteroid Irmgard

*David Dunham*

At 7:15 pm on Monday, November 10th, the asteroid (591) Irmgard was predicted to occult 11.5-magnitude TYC 2913-00946-1 in Auriga. The observation was difficult since the star was only  $15^\circ$  above the northeastern horizon. Steve Conard observed from the Westminster Astronomical Society's Blaine Roelke Observatory at Bear Branch



The predicted occultation path (between the blue lines), the predicted central line (green line), and the approximate location of the actual path (between the black lines, shifted about  $4/10$ ths of a path-width southeast of the predicted path). The large, green dots mark the two stations that had occultations and the red dots mark two locations where no occultation occurred (including the location not pictured but manned by John Brooks southwest of Hagerstown).

Nature Center north of Westminster where he had a low-enough horizon to successfully video record the occultation (the location was also

*continued on page 3*

*TESS Mission – continued from page 1*

Exoplanet Survey Satellite (TESS) mission, launching in 2017, will survey the entire sky for nearby transiting super-Earths. TESS will find super-Earths in the habitable zones of nearby stars; close enough to allow measurement of the molecular content of the planetary atmospheres using the James Webb Space Telescope.

## Biographical Sketch:



For more than 30 years, Dr. Drake Deming was a NASA research scientist in planetary & stellar astronomy at the Goddard Space Flight Center. In 1995, Drake began working on the problem of detecting light from extrasolar planets and characterizing their atmospheres. In 2005, he led one of two teams that made "first light" observations of exoplanets using the Spitzer Space Telescope and received the Beatrice Tinsley Prize from the American Astronomical Society for that achievement. In 2011, he joined

the faculty of the University of Maryland at College Park, where he is now Professor of Astronomy. Drake is a co-investigator for the Transiting Exoplanet Survey Satellite (TESS), to be launched in 2017.

## The Great North American Eclipse of 2017

*Joan Dunham*

Get ready! On August 21, 2017 a solar eclipse will be visible coast-to-coast from the 48 contiguous states. The path of totality will cross Oregon, Idaho, Wyoming, Nebraska, Missouri, Kentucky, Tennessee, Georgia, North Carolina, and South Carolina. Many cities, towns, schools, parks and recreation centers will be in its path. This will be one of the defining events of our lifetime.



*Courtesy NASA*

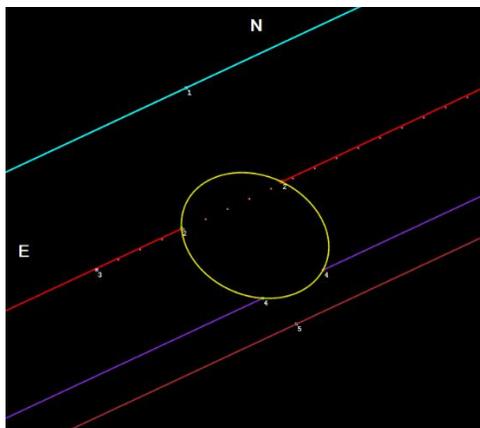
David and I recently attended two very interesting conferences which brought together eclipse observers and solar astronomers, both amateur and professional. The first conference, the *Eclipse Workshop* (held in Missouri), was to prepare for the Great North American Eclipse of 2017. The second, *SEC2014* (held in New Mexico), brought together eclipse observers to discuss past eclipse work and future plans. Following are some summaries from the two events:

**Eclipse Workshop** - Amateur, professional, and commercial representatives gathered to plan how to share observing information with every resident of the USA. August 21, 2017 is going to be a Monday and

*continued on page 4*

*Asteroid Irmgard – continued from page 2*

near the predicted central line). The relatively short dark time and delays allowed me time to run two "mighty maxi" 120 mm refractor stations, one looking over a field in northwestern Beltsville (remote station set up behind a trash bin in the back of a church parking lot) and the other in a residential neighborhood northwest of Highland, MD, where I could observe low enough from a street corner. Replaying the tapes later showed that I probably had a short occultation at Highland, and none at Beltsville. Both sites were a little outside the predicted path. Clever analysis of my recordings by Scotty Degenhardt determined the times of the occultation events at Highland.



The Sky Plane plot shows an ellipse with dimensions 56 by 44 km fit to the two occultation chords.

**Astro Rock**



A lot like "Schoolhouse Rock," this song explains "The Secret of Stars" using the equation  $E = MC^2$ .

<http://youtu.be/BuxFXHircal>

**Sky Watchers**

**Winter Schedule**

**December**

14	Pre-dawn – <b>Meteors</b> , N. & S. Hemisphere. <i>Geminids</i> (radiant point near Castor in Gemini Constellation)
19	4:00 pm – <b>Planets</b> , N. Hemisphere. Moon 1.5° north of Saturn
21	6:03 pm – <b>Winter Solstice</b> , N. Hemisphere. 8:36 pm – <b>New Moon</b> , Global 
25	3:00 am – <b>Planets</b> , N. Hemisphere. Moon 6° north of Mars
28	12:00 am – <b>Planets</b> , N. Hemisphere. Moon 1° north of Uranus

**January**

3	Pre-dawn – <b>Meteors</b> , N. Hemisphere. <i>Quadrantids</i> (radiant point near Arcturus in the Boötes Constellation near Ursa Major)
11	1:00 am – <b>Asteroids</b> , N. Hemisphere. <i>Vesta</i> (in conjunction with Sun)

Times EST

**Winter Constellations and Bears**



Courtesy University of Cambridge Spaceflight

Ursae Major & Minor (the Big & Little Bears) aren't the only sky bears. There's "Terrible Teddy" riding in Santa's sleigh (not to mention these stylish bears to the left)! Come learn about the winter constellations and provide a holiday gift for other children. It's easy: just bring a donated teddy bear to the *Terrible Teddy* planetarium show at 7:30 pm on December 12<sup>th</sup> at the Owens Science Center (you'll get half-price admission). Come early (7 pm) to explore teddy bear history. See this newsletter's calendar (page 7) for more information on the event.

The astro-bears in the photo were an experiment by a Cambridge University student organization, a science club and a community college in 2008. Each of the bears wore a different space suit designed by 11-13 year-olds. The bears flew to 30,085 meters above sea level to determine which materials provided the best insulation against the -53 ° C temperatures experienced during the journey.

*Great Eclipse 2017 – continued from page 2*

is currently planned to be the first day of the 2017 school year at the University of Missouri (in the path of totality) as well as many other public and private schools across the country. This eclipse will be one of the most accessible of modern times. And 7 years later, April 8, 2024, there will be another total eclipse that also will be visible from a large swath of the USA. The paths cross in Illinois, so areas around Cedar Lake, Carbondale, Route 127 between Murphysboro and Anna will be in the path of totality in both 2017 and 2024.

The workshop was in support of the American Astronomical Society's Solar Eclipse Task Force, formed to support safe observing of the partial or total eclipse by approximately half a billion citizens and visitors. Some of the logistics are mind boggling – just the time and effort involved in manufacturing and distributing solar viewers to every person is amazing. There are many individuals and organizations preparing for this eclipse, but there are still many areas where others can contribute. If you are interested in participating in the planning or preparation efforts, let me know at [joanbdunham@gmail.com](mailto:joanbdunham@gmail.com) and I will see that you are connected with one of the groups.

**SEC2014** - The first day of the pre-conference was highlighted by observations of the partial eclipse and the amazing sunspot visible that day. Eclipse-viewing shades were provided to attendees, and many brought their own equipment. Particularly impressive were setups designed to share telescopic views with displays on screens of the filtered Sun. We observed the sunspot from Sunspot, NM!

Following are brief summaries of a few of the presentations directed at general observers:

**Jay Anderson**, author of the [Eclipser web site](#), gave a thorough presentation of weather prospects for the 4 solar eclipses from 2015 to 2017. Two of the relevant points he made addressed cloud cover and terrain issues. A “clear” sky to an instrument called a ceilometer means clear below its range. Older ceilometers range to 12,500 feet, which means that skies covered with cirrus can be “clear” to a ceilometer. Jay presented a graph showing the average cloud amount along the center line from the Pacific to the Atlantic. As would be expected, the cloud cover average increases from west to east. This does not mean, however, that east coast observers have no chance for viewing, as there are clear as well as cloudy days in August across the country. Jay also presented maps of where mountains around Svalbard will block the Sun during totality for the March, 2015 eclipse. There were stories told of past eclipses where not considering the terrain led to heartbreak at totality. There are also other viewing considerations as in Madras, OR which had obscuring forest fire smoke last August. Jay's [website](#) has maps and cloud cover information.

**Kris Delcourte** spoke on getting dramatic photos of the eclipsed Sun

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**Thank you!**

### Orion Launch

• On December 4<sup>th</sup>, the Orion spacecraft will  
 • be launched into Earth orbit on top of a Delta  
 • IV rocket. Both this and the 2<sup>nd</sup> test flight in  
 • 2018 are scheduled to be unmanned. The 1<sup>st</sup>  
 • manned mission is scheduled for 2021 in  
 • preparation for the trip to Mars in the 2030s.



Courtesy NASA

## 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 Watts angle (WA) is given; it is aligned with the Moon's rotation axis and can be used to estimate where a star will reappear relative to lunar features. The selenographic latitude is WA -270. For example, WA 305 - 310 is near Mare Crisium.

## Mid-Atlantic Occultations

David Dunham

### Asteroidal and Planetary Occultations

Date	Day	EST	Star	Mag	Asteroid	dmag	dur. s	Ap. "	Location, Notes
2014									
Dec 13	Sat	4:34	2UC31819546	12.0	Genua	0.4	7	8	DE, SMD, DC, nVA, WV
Dec 13	Sat	5:17	SAO 59412	9.3	Leukothea	3.9	9	4	cTX, cNM, cNV, nCA
Dec 20	Sat	19:55	2UC39280579	12.3	Volga	2.1	5	8	DE, SMD, eVA, wNC
Dec 22	Mon	3:36	2UC37691066	12.0	Dubia	3.2	5	8	NJ, MD, PA; nVA, DC?
Dec 27	Sat	21:05	TYC13861334	11.6	Nephele	2.6	6	7	SMD, c&wVA; DC, DE?
2015									
Jan 1	Thu	6:26	2UC27854538	12.5	Camilla	1.4	8	9	PA, MD, DC, NJ, DE
Jan 2	Fri	1:51	TYC47981572	10.9	Seppina	2.8	6	6	s, c, &wNC, nTN
Jan 8	Thu	1:55	theta Cancr	5.4	2001 SW63	13.4	0.9	1	nNC, sVA, nKY, slN
Jan 10	Sat	6:17	TYC19650338	10.9	Bredichina	2.7	10	6	cNC, cVA, eWV, wPA
Jan 11	Sun	3:05	TYC14080096	9.9	Cevenola	4.8	2	4	neGA, swSC, wNC, TN

### Lunar Grazing Occultations

Date	Day	EST	Star	Mag	% alt	CA	Location & Remarks
2014							
Dec 14	Sun	0:23	75 Leoni s	5.2	52-	7	4N nRi chmond, Sal uda, nPai nter, VA
Dec 16	Tue	6:42	SAO 139067	8.4	31-	43	5S Hymrkt&Wdbrg, VA; LPI ta, MD; Sn-7
Dec 19	Fri	7:20	zeta Lib	5.5	8-	25	1S Frostburg, MD; Reston&Vi enna, VA
Dec 23	Tue	18:16	X 47044	9.1	5+	7	-3S sFai rfava; DC; Lanham&Bowi e, MD
Dec 27	Sat	20:35	SAO 146860	8.2	41+	31	ON *nFredrk, sWstmnstrMD; Medi a, PA
2015							
Jan 2	Fri	3:07	del ta2 Tau	4.8	91+	18	16N Hol l i ns&Ski pper, VA; Ki tyHk, NC
Jan 6	Tue	20:28	SAO 97952	7.4	96-	18	18N sStafrd, VA; Bel AI tn, sTrappe, MD
Jan 9	Fri	23:04	58 Leoni s	4.8	78-	16	5N Brookv, Watsntwn, EStroudsb, PA

Interactive detailed maps at <http://www.timerson.net/IOTA/>, no expedition planned from DC area

### Total Lunar Occultations

Date	Day	EST	Ph Star	Mag	% alt	CA	Sp.	Notes
2014								
Dec 14	Sun	2:05	R 76 Leoni s	5.9	52-	26	75N	K0 ZC 1637
Dec 16	Tue	2:50	R ZC 1847	8.0	32-	13	68N	A2 Azimuth 109 degrees
Dec 19	Fri	6:23	R 34 Librae	5.8	8-	17	42S	K0 Sun -11 deg., ZC 2213
Dec 19	Fri	7:27	R zeta Lib	5.5	8-	25	10S	B3 Sun0, ZC2218, wMD&VAgraze
Dec 20	Sat	6:17	R chi Oph	4.2	3-	6	50S	B2 Azimuth 120, ZC 2361
Dec 24	Wed	18:40	D ZC 3051	6.9	11+	15	47N	K4 Azimuth 239 deg.
Dec 25	Thu	19:31	D SAO 145718	7.2	20+	18	80S	F5
Dec 27	Sat	19:49	D SAO 146862	8.0	41+	39	29S	G5
Dec 27	Sat	20:27	D SAO 146860	8.2	41+	33	14N	A0 n MD, se PA graze
Dec 28	Sun	19:08	D SAO 109296	8.0	52+	53	26N	F5
Dec 28	Sun	22:06	D SAO 109365	8.0	53+	28	81N	G5
Dec 29	Mon	18:10	D ZC 214	6.2	63+	57	89N	K1 mag2 8.0 sep. 69", PA 99
Dec 29	Mon	18:13	D SAO 109908	8.0	63+	57	89S	F8 ZC 214 compani on
Dec 29	Mon	21:45	D ZC 226	6.5	64+	43	15S	K0 mg2 10.6 sep 4", PA 77
Dec 30	Tue	1:27	D ZC 247	6.3	66+	3	32S	F2 Az. 279, cl ose double?
Dec 30	Tue	20:33	D ZC 355	7.4	74+	62	87S	F5
Dec 30	Tue	22:53	D SAO 92971	8.0	75+	43	32S	F5
Dec 31	Wed	2:40	D 31 Ari eti s	5.6	76+	1	53S	F7 Az. 285, ZC384, cl ose dbl
2015								
Jan 1	Thu	18:29	D SAO 93805	7.0	90+	44	59S	B8
Jan 2	Fri	2:42	D SAO 93913	7.0	91+	23	58S	F6 mg2 10.6 separation .2"
Jan 2	Fri	3:54	D SAO 93938	6.9	91+	10	45S	K5 Azimuth 284 deg.
Jan 4	Sun	1:51	D ZC 934	6.4	99+	52	62S	K1 Termini ator Distance 16"
Jan 4	Sun	3:54	D ZC 944	5.9	99+	29	39S	A6 TmD 7", =dbl, sep .5" 141
Jan 7	Wed	5:55	R FX Cancr	6.7	95-	30	74S	M3 AxisAng 264 deg., ZC1320
Jan 9	Fri	4:13	R SAO 118241	7.4	84-	55	86N	F5 mg2 8.4, sep. 1", PA 306d
Jan 9	Fri	23:19	R 58 Leoni s	4.8	78-	19	34N	K1 ZC1599, dbl ?, PA&NJ graze
Jan 10	Sat	6:43	R SAO 118693	7.7	76-	38	52N	G5 Sun alti tude -8 degrees
Jan 10	Sat	23:22	R SAO 138388	7.3	70-	9	35S	K0 Azimuth 98 degrees
Jan 11	Sun	6:54	R SAO 138476	7.6	68-	39	80N	G5 Sun alti tude -6 degrees

Explanations & more information is at <http://iota.jhuapl.edu/exped.htm>. David Dunham, dunham@starpower.net, phone 301-526-5590

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• *Great Eclipse 2017 – continued from page 4*

• in the landscape. His emphasis was on searching for appropriate foreground landscapes to feature with the eclipsed Sun. Search for “Kris Delcourte eclipse” to find examples of his images.

• **Fred Espenak** reported news of new eclipse canons and his new eclipse web sites. A canon is a document listing elements and maps for eclipses over multiple years. In 1966, a canon covering the years 1898 to 2510 was published by Jean Meeus and others. In 2006, Fred and Jean published a 648-page canon covering the 50 centuries from 1999 to 3000. In 2009, they published another canon and catalogs for solar as well as lunar eclipses. Fred then retired from NASA, and decided to update both the solar and lunar canons and catalogs for the most frequently used time period of 1501 to 2500. Fred and Jay Anderson are also preparing an eclipse handbook for the August 21, 2017 solar eclipse, to be released early next year.

• The [NASA eclipse web site](#), started by Fred in 1996, is still in operation (and Fred is still the webmaster); but, Fred has found it increasingly difficult to manage as a retiree. He now has sites under his control, [MrEclipse](#) and [Eclipsewise](#), which have the most important information and features from the NASA site. He showed us examples of the information available from those sites.

• Fred’s sites include information on observing and photographing eclipses and post-processing the photos for composites. They also have galleries of total and lunar eclipse photographs, basic information for those just beginning to learn about eclipses and observation safety advice. The canons are available through those sites as well, and can be ordered in color or in black and white.

• **Dr. Glenn Schneider** of Seward Observatory presented a retrospective look at past-to-recent eclipses. He showed illustrations of the early photographic efforts, dedicating his talk to David P. Todd who lead 10 eclipse expeditions from 1878 to 1919. Todd invented the eclipse commutator, a system that controlled 12 to 30 telescopes and cameras. The pictures of these commutators were marvelous, with a version prepared for each expedition. The early ones were pneumatic systems controlled by player pump-organ and punched paper music rolls; later ones were electrically operated.

• *~ More Information in the next Issue ~*

• The conclusion of the conference summaries and the full website list of additional resources will appear in the January 2015 issue of Star Dust. In the meantime, obtain additional information from: [www.eclipse2017.org](http://www.eclipse2017.org) and get your [solar viewing glasses](#) that meet the new standards: [www.eclipse2017.org/glasses\\_order.htm](http://www.eclipse2017.org/glasses_order.htm).



**Learn how to use your Telescope**



Courtesy CA Brooks

Sun-gazers taking turns at a NCA member's Dobsonian telescope in College Park, MD during the 2012 Venus Transit.

**Coming January 2015!**

**The submission deadline for the January issue of Star Dust is Dec. 28<sup>th</sup>.**

**Clear Skies!**

**Calendar of Events**

- **NCA Mirror- or Telescope-making Classes:** Tuesdays and Fridays, from 6:30 to 9:45 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 email him at [gfbrandenburg@yahoo.com](mailto:gfbrandenburg@yahoo.com).
- **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](http://www.astro.umd.edu/openhouse)
- **Phoebe Waterman Haas Public Observatory** at the National Air & Space Museum, Solar viewing, Wed. - Sun., 12 - 3 pm (weather permitting).
- **Owens Science Center Planetarium:** "Terrible Teddy," Fri. Dec. 12, at 7:30 pm; \$5/adult; \$3/students/senior/teachers/military; children under 3 free. Doors open 7:00 pm for pre-show activities. [www1.pgcps.org/howardbowens](http://www1.pgcps.org/howardbowens)
- **Mid-Atlantic Senior Physicists Group:** "Quantum Computer Programming" with Randolph Krutar (NRL, retired), Wed. Dec. 17, at 1 pm at the American Center for Physics (1<sup>st</sup> floor conference room). <http://www.aps.org/units/maspg/>
- **New Telescope Owners Nights:** Wednesday, Jan. 28 or Saturday, Jan. 31, from 6:00 pm to 9:00 pm (30-minute time slots). Registration required. [www.astro.umd.edu/openhouse/2programs/new-telescope-owners-nights.html](http://www.astro.umd.edu/openhouse/2programs/new-telescope-owners-nights.html)
- **Upcoming NCA Meetings** at the University of Maryland Observatory:
  - **10 Jan:** Gordon BJORACKER (GSFC), "Water Vapor and Hydrocarbons on the Outer Planets."

**National Capital Astronomers Membership Form**

**Name:** \_\_\_\_\_ **Date:** \_\_\_/\_\_\_/\_\_\_

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**Home Phone:** \_\_\_-\_\_\_-\_\_\_ **E-mail:** \_\_\_\_\_ **Print / E-mail Star Dust (circle one)**

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**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.?

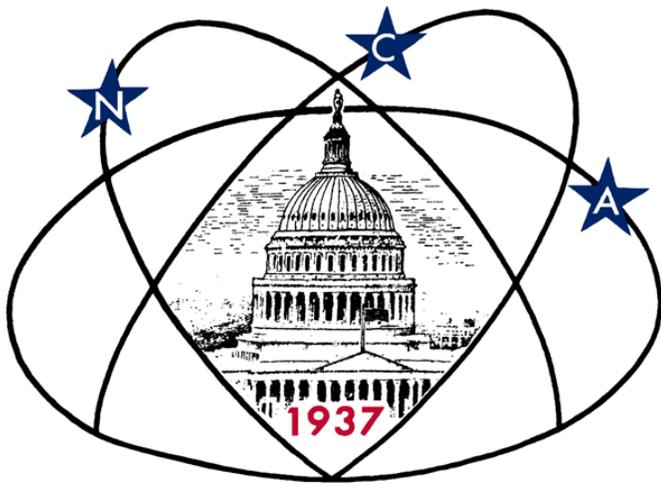
Are you interested in volunteering for: Telescope making, Exploring the Sky, Star Dust, NCA Officer, etc.?

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**



*Next NCA Meeting:*  
**2014 December 13<sup>th</sup>**  
**7:30 pm**  
**@ UMD Observatory**  
**Dr. Drake Deming**

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