Star Dust

Newsletter of National Capital Astronomers, Inc.
capitalastronomers.org

December 2016 ***Volume 75, Issue 4***

Next Meeting

When: Sat. Dec. 10th, 2016

Time: 7:30 pm

Where: UMD Observatory

Speaker: John G. Baker

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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 Metzerott 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.

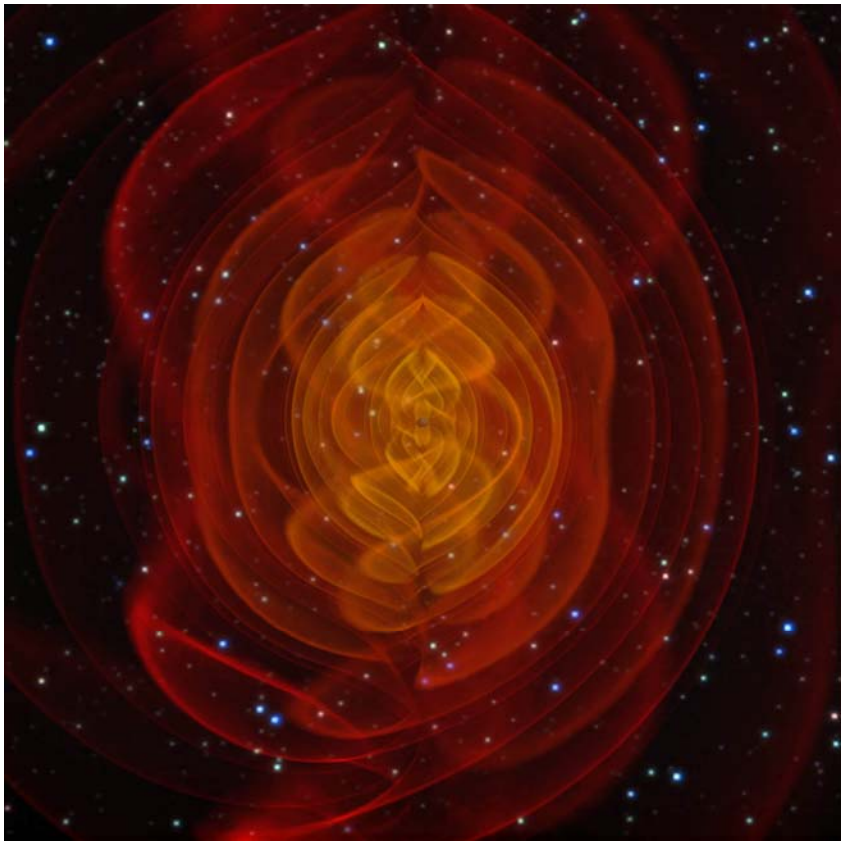
Observing after the Meeting

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.

Rumbling Sky: The New Astronomy of Gravitational Waves

John G. Baker
NASA's Goddard Space Flight Center

Abstract: Earlier this year, the Laser Interferometer Gravitational-Wave Observatory (LIGO) team announced the first *direct* observation of gravitational waves, providing long-awaited direct confirmation of a century-old prediction of Einstein's General Relativity. At the same time, these new astronomers revealed and precisely measured a previously unobserved population of black holes having masses tens of times that of the Sun. This is the first major discovery enabled by a new tool,



Courtesy Chris Henze/NASA Goddard Numerical Relativistic Astrophysics Group
Computer-generated image of a gravitational wave field during the merger of two stellar-mass black holes.

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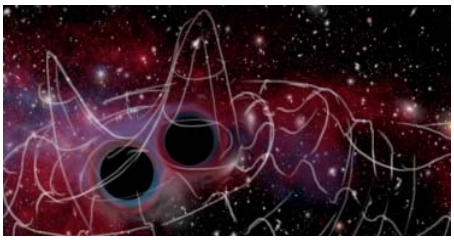
Gravitational Waves: a 10-Second History

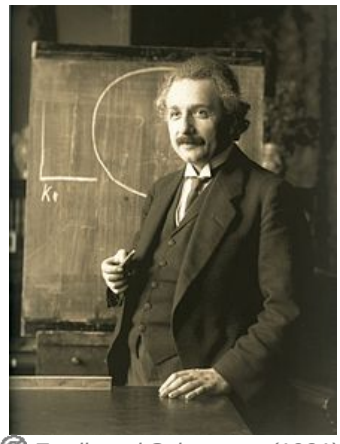
1.3 Billion Years ago…



© Nutsinee Kijbunchoo (2016). Used with permission.

...two supermassive black holes (each about 30 times the Sun's mass) merge & create space-altering gravitational waves.

1915 CE…



Ferdinand Schmutzer (1921).

…Albert Einstein predicts in his *General Theory of Relativity* that accelerating masses emit gravitational waves.

2015 CE…

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}.$$

Einstein field equation from the General Theory of Relativity (1915)

…Einstein's *General Theory of Relativity* celebrates its 100th anniversary and CID-42 (in Constellation Sextans), believed to be a remnant of a merged, supermassive black hole, exhibits behavior that supports relativity theory.

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continued on page 3

Rumbling Sky – continued from page 1

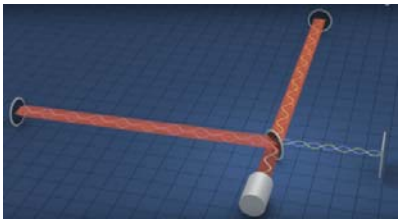
namely, the ability to measure, or "hear," the vibrations of space-time from distant cataclysms. This tool is now available to aid astronomers in their enduring quest to understand the Universe through careful and ever more precise observations.

In this talk, basic principles of gravitational-wave astronomy will be reviewed; the results of these first gravitational-wave observations will be discussed; and some of the questions the aforementioned have raised for astronomers and astrophysicists will also be discussed. This talk will conclude with the prospects for further observations in the years and decades ahead, and an outline of what we expect to learn as we continue to advance our ability to listen to the rumbling sky.

Biographical Sketch:

John Baker is an astrophysicist in the Gravitational Astrophysics Laboratory at NASA's Goddard Space Flight Center in Greenbelt, MD. John has worked as a NASA civil servant astrophysicist since 2004. During 2005-6, his team developed computational techniques that finally enabled effective numerical simulations of black hole mergers. They then computed the first predictions for the gravitational-wave signals from those events that were confirmed by the observation of GW150914 last year. John continues to explore black hole merger phenomenology through numerical simulations and develop time-domain astrophysical data analysis techniques. He also develops aspects of gravitational-wave mission design in support of a future space-based gravitational-wave instrument. Currently, John serves on NASA's L3 Study Team, helping to explore a role for NASA in the European Space Agency's future L3 gravitational-wave mission.

The Chirp Heard Across the Universe



LIGO's interferometer measures space distortions so small that it can discern changes that are only a fraction of the size of a proton. How does it work? Learn how in 3 minutes and hear the wave that passed over the Earth:

youtu.be/FlDtXIBrAYE

EM-What?

White et al (2016) Cone of the EM Drive

The EM Drive's full title is the "Electromagnetic Propulsion Drive." The idea has been around for about 20 years; and, scientists of NASA-Eagleworks' EM Drive project have a study published in a recent issue of the peer-reviewed *Journal of Propulsion and Power* to address some of the concerns of previous studies. The engine is reported to produce thrust while violating Newton's 3rd Law of Motion (for

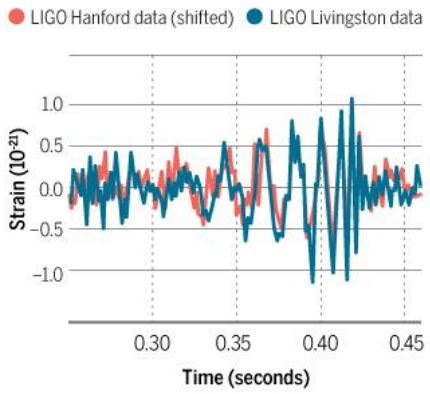
continued on page 7

GW in 10 Seconds – continued from page 2

2015 CE…

… on September 14th at 09:50:45 UTC, during the same year as the relativity theory centenary, LIGO directly detects gravitational waves generated 1.3 billion years ago.

2016 CE…



Source: BP Abbot et al (2016).

…Detection of gravitational waves officially announced to the world.

The Great North American Eclipse

Aug 21st 2017

www.greatamericaneclipse.com/

Sky Watchers — *Early Winter Schedule*

December

10	5:15 pm - **Planets**, N. Hemisphere, Southwest Sky. Mercury at greatest eastern elongation (21º east of Sun).
13	7:06 pm – **Full Super Moon**, Global (3rd and final one of the year at 222,737 miles). Other Moon Names: *Full Cold Moon, Long Nights Moon (because of the proximity to Winter Solstice), Moon-before-Yule.*
13-14 (peak)	Overnight - **Meteors**, N. Hemisphere. *Geminids* (debris from Asteroid 3200 Phaethon, radiant point is Constellation Gemini).
20-30	Evening – **Globe at Night**, Global. Features: *Constellation Perseus* (N. Hemisphere) & *Orion* (S. Hemisphere).
21	5:44 am **– Winter Solstice**, N. Hemisphere. Sun at maximum southern sky position, directly above the Tropic of Capricorn (23.44º S).
27	4:00 pm - **Planets**, N. Hemisphere. Saturn 4º south of Moon.
29	1:53 am – **New Moon**, Global.

Times EST

Exploring the Sky

*"**Exploring the Sky**"* is an informal program that, for over 60 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!

The Program will return in April 2017!

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

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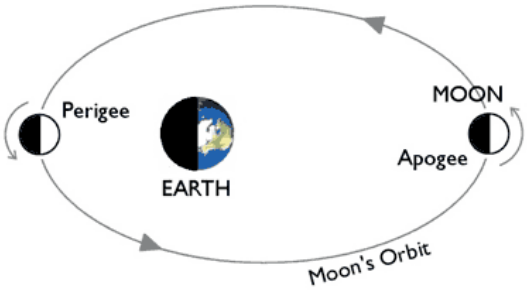
Perigee-Syzygy and Super Moons

According to NASA, syzygy [*siz*-i-gee] is the scientific term for the alignment of the celestial bodies of the Earth-Moon-Sun system as the Moon orbits Earth. When "perigee-syzygy" of the system occurs in which the Moon is on the opposite side of the Earth from the Sun, the result is a full moon that is closer to the Earth (perigee). This is commonly referred to as a Super Moon (the Moon's average distance from Earth is 238,000 miles). A Moon at perigee can look as much as 14% larger and 30% brighter than at apogee.



As it turns out, Super Moon is more of an astrological term than astronomical. It was first created and used in 1979 by astrologer Richard Nolle for his article in Dell Publishing's *Horoscope* magazine. He used the term to describe a full Moon that "is at or near 90%" of its closest orbital pass of Earth. Nolle states that he learned about perigee-syzygy the year before by reading *The Strategic Role of Perigean Spring Tides*: *In Nautical History and North American Coastal Flooding, 1635-1976* (Fergus Wood). Some have issued Nolle mathematical challenges regarding his Super Moon definition. Others have embraced it and clarified (e.g., TimeandDate.com defines a Super Moon as "a full or new Moon that occurs when the center of the Moon is less than 223,694 miles [360,000 km] from the center of Earth"). Also, in 2011, Nolle addressed some "media crisis-mongering" that ensued regarding Super Moons, citing Rush Limbaugh, in particular, as misquoting him on disasters.

The dates of the 3 Full Super Moons of 2016 are: October 16, November 14 and December 14 UTC (December 13, EST). A Super Moon becomes full the day of perigee. November's Moon became full within 2 hours of perigee and was the closest Moon of the century (so, NASA refers to that as an "*extra*-Super Moon"). The next time that the Moon will be as close to Earth as it was in November 2016 (221,524 miles) will be November 25, 2034 (221,485 miles).

Images: Courtesy MetaHistory.org, AskIdeas.com and NASA/JPL-Caltech

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Thank you!

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
Dec 10	Sat	3:56	2UC43417556	12.3	Loreley	0.9	14	8	NJ,PA,MD;DC,nVA?
Dec 13	Tue	3:35	TYC29381330	10.9	Zerbinetta	3.3	6	7	NJ,e&ncPA,swNY
Dec 13	Tue	20:59	SAO 165549	9.0	Genoveva	5.7	3	4	nwWV,sw&ncPA,cNY
Dec 13	Tue	23:01	TYC24660473	11.7	Aegle	1.0	19	8	sNJ,DE,eMD,DC,VA
Dec 18	Sun	4:59	4UC55246027	13.7	Pax	0.5	7	11	eNC,eVA,eMD,ePA
Dec 19	Mon	18:58	TYC24101374	11.6	Leto	0.4	9	7	seNY,PA,wMD,WV
Dec 24	Sat	5:16	TYC18681735	10.7	Garumna	2.3	3	6	sNJ,se-nwPA,sON
Dec 28	Wed	20:11	4UC53010952	13.3	Miriam	0.5	10	10	sNJ,DE,MD,DC,nVA
Dec 29	Thu	19:21	2UC41516680	12.0	Lucina	0.8	9	8	sNE,seNY,PA,sOH
Jan 5	Thu	18:20	4U395129710	12.4	Geraldina	3.4	2	8	w&nVA,DC,MD,sNJ
Jan 12	Thu	2:44	4UC58620000	12.5	Ruvuma	3.4	3	8	DE,MD,s&nwPA;DC?

Lunar Grazing Occultations

Date	Day	EST	Star	Mag	% alt	CA	Location & Remarks
Dec 25	Sun	5:57	ZC 2200	7.5	13- 20	3S	*Warntn&Triangl,VA;Newburg,MD
Dec 26	Mon	6:36	SAO 159794	8.7	7- 16	-1N	*nLoganvil,PA;nPortDeposit,MD
Jan 2	Mon	18:13	SAO165162	10.0	20+ 32	5S	GumSpg&Athens,VA;Hollywood,MD

No expedition from DC planned

**** Interactive detailed maps at http://www.iota.timerson.net/ ****

Total Lunar Occultations

Date	Day	EST	Ph	Star	Mag	%	alt	CA	Sp.	Notes
Dec 10	Sat	21:01	D	ZC 368	6.2	87+	61	79S	K2	mg2 10 sep 1.5" PA 141
Dec 11	Sun	2:42	D	ZC 393	6.7	89+	15	31N	K0	Az. 272, close double?
Dec 12	Mon	2:22	D	ZC 526	6.7	95+	32	39S	G5	
Dec 12	Mon	18:00	D	70 Tauri	6.6	98+	20	77S	F7	ZC 659, close double
Dec 12	Mon	19:18	D	theta1 Tau	3.8	98+	35	39S	G7	ZC669,mag2 7 .2", PA355
Dec 12	Mon	19:29	D	ZC 672	6.7	98+	37	74S	F7	close double; Hyades
Dec 12	Mon	19:30	D	theta2 Tau	3.4	98+	37	8S	A7	ZC671,spec.bin,TmD 0.6"
Dec 12	Mon	19:34	D	75 Tauri	5.0	98+	38	51N	K2	ZC667,mg2 8 .02",TmD18"
Dec 12	Mon	20:13	D	ZC 677	4.8	98+	45	59S	A6	close double? Hyades
Dec 12	Mon	23:07	D	Aldebaran	0.9	99+	68	51S	K5	ZC 692, Term. Dist. 14"
Dec 13	Tue	0:21	R	=alpha Tau	0.9	99+	63	-87N	K5	Axis Angle 248 degrees
Dec 13	Tue	18:04	R	115 Tauri	5.4	100-	11	60S	B5	Az76,AA328,ZC814,TmD 3"
Dec 15	Thu	21:06	R	74 Gem	5.0	93-	22	79N	M0	AA 286,ZC 1158,double??
Dec 18	Sun	4:00	R	18 Leonis	5.7	76-	63	51S	K4	ZC 1439
Dec 19	Mon	1:36	R	49 Leonis	5.6	67-	37	74S	A2	ZC1550;spec.bin.;TX Leo
Dec 21	Wed	5:04	R	ZC 1766	7.9	46-	47	76N	K0	
Dec 22	Thu	1:33	R	ZC 1864	6.7	38-	4	29N	K2	Azimuth 97 degrees
Dec 22	Thu	3:15	R	46 Vir	6.2	37-	23	84S	K2	ZC1869,mag2 9 .6",PA182
Dec 22	Thu	5:32	R	48 Vir	6.7	37-	42	72N	F0	ZC1875,mag2 8 .5",PA192
Dec 23	Fri	5:38	R	SAO139579*	9.2	28-	34	21S	K0	
Dec 23	Fri	6:14	R	SAO139581	7.3	27-	39	90N	K0	
Dec 23	Fri	6:32	R	ZC 1985*	6.9	27-	40	58S	K0	Sun altitude -10 deg.
Dec 25	Sun	6:07	R	ZC 2200	7.5	13-	21	18S	K0	
Dec 26	Mon	6:13	R	X40639*	9.8	7-	13	48S	G2	Azimuth 125 degrees
Jan 1	Sun	20:05	D	ZC 3186	6.7	13+	4	37N	F5	Azimuth 251 degrees
Jan 2	Mon	18:03	D	SAO165162*	10.	20+	32	20S	F5	VA, MD graze
Jan 2	Mon	18:21	D	ZC 3313	6.5	21+	30	49N	K0	
Jan 2	Mon	20:21	D	SAO146213*	9.5	21+	12	84S	G0	Azimuth 248 degrees
Jan 3	Tue	20:05	D	SAO 146724	7.0	30+	26	88N	K2	
Jan 4	Wed	17:38	D	SAO 128677	8.4	40+	50	55S	G5	Sun -8,close double?
Jan 5	Thu	17:48	D	SAO109709*	9.5	51+	54	81N	F8	Sun -9,mg2 13 1" PA316
Jan 5	Thu	19:00	D	X 1633 *	9.5	52+	53	60N	K2	
Jan 5	Thu	21:11	D	SAO109752*	9.2	52+	38	54N	F8	
Jan 6	Fri	18:31	D	ZC 303	6.4	63+	58	36N	K0	close double??
Jan 8	Sun	22:20	D	ZC 608	6.0	84+	61	45S	F3	Mag2 9 sep. 4" PA 224 ??
Jan 9	Mon	2:28	D	48 Tauri *	6.3	86+	17	29S	F5	ZC 626
Jan 9	Mon	3:56	D	gamma Tau	3.7	86+	1	65S	G8	Az.289,ZC 635,double??

* *The star is in the Kepler 2 exoplanet search program so lightcurves of the occultation are desired to check for close stellar duplicity.*

Further explanations & more information is at http://iota.jhuapl.edu

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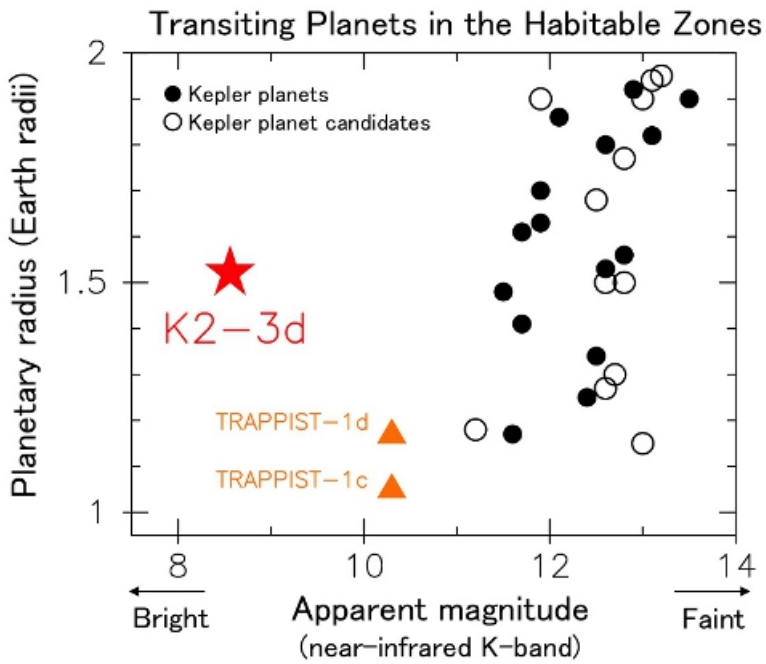
Planetary Destinations

On November 28th, an update on the search for extraterrestrial life was released. It was in regard to K2-3d, an extrasolar planet, which was actually discovered in 2015 by the Kepler Spacecraft (NASA) as part of the K2 Mission (Kepler's "Second Light"). K2-3d is 1.5 times Earth's size, orbits its star in 45 days and is 150 light years away.

Recently, while the planet was in transit across its sun, scientists from the National Astronomical Observatory of Japan, University of Tokyo and the Astrobiology Center studied it with Okayama Astrophysical Observatory's 188-cm telescope equipped with a MuSCAT instrument (Multi-color Simultaneous Camera for Studying Atmospheres of Transiting Planets). Via calculations, the scientists have concluded that the star's temperature and 3d's proximity make it warm enough to possibly support life and liquid water. In other words, 3d may support extraterrestrial life.

Because 3d is closer to Earth and its star is brighter than those of many potentially-habitable planets in the Kepler Mission, it has become a good candidate for follow-up missions (e.g., investigating atmospheric composition for oxygen) as the next generation of large telescopes become available.



Courtesy National Astronomical Observatory of Japan (NAOJ)

Transiting planets located in the habitable zone (the orbital region where a planet could hold liquid water on the surface), plotted in terms of planet radius vs. host star magnitude (brightness). Black circles represent confirmed planets discovered by the Kepler mission and white circles represent unconfirmed planet candidates. The orange triangles represent the Earth-sized planets TRAPPIST-1c and TRAPPIST-1d observed 40 light-years away by a ground-based telescope. TRAPPIST-1c and TRAPPIST-1d are thought to be just outside the habitable zone, but they are plotted for reference. The host star of K2-3d (red star) is the brightest in this figure.

EM-What? - continued from page 2

every action, there's an equal, opposite reaction). The drive is supposed to operate by bouncing microwaves around in a closed cone chamber, creating thrust without any device emissions (contrary to conventional propellants that push rockets forward by ejecting super-heated gas). Some scientists are skeptical; and, it has been said by critics that the EM Drive is like trying to move a car by getting inside and pushing on the windshield."

Peer-Reviewed Study:

Harold White, Paul March, James Lawrence, Jerry Vera, Andre Sylvester, David Brady, and Paul Bailey. (2016). "*Measurement of Impulsive Thrust from a Closed Radio-Frequency Cavity in Vacuum.*"

http://dx.doi.org/10.2514/1.B36120

The submission deadline for the January issue of Star Dust is December 30th.

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.

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

Lockheed Martin IMAX Theater in DC: "Arrival" (PG-13), Dates through Thurs. Dec. 15, $9 (adults) and $7.50 (youth), shows start at 3:15 pm. www.si.edu/Imax/

Steven F. Udvar-Hazy Center IMAX Theater in Chantilly, VA: "Fantastic Beasts and Where to Find Them" (PG-13), Dates through Wed. Dec. 14, $15 (adults) and $13.50 (youth), shows start at 3:30 pm. www.si.edu/Imax/

Owens Science Center Planetarium: "Winter Sky Festival," Fri. Dec. 9, 7:30 pm; $5/adult; $3/students/senior/teachers/military; children under 3 free. www1.pgcps.org/howardbowens

Mid-Atlantic Senior Physicists Group: "The Universe of Gravitational Waves" with M. Coleman Miller (UMD), Wed. Dec. 14*, at 1 pm at the American Center for Physics (1st floor conference room). www.aps.org/units/maspg/

** (this is the 2nd Wed. of the month).*

Upcoming NCA Meetings at the University of Maryland Observatory:
14 Jan: Dean Howarth & Jeff Jones,
"Kepler Debates Tycho: Does the Earth Orbit the Sun?"

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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First Class
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Next NCA Meeting:

2016 December 10th
7:30 pm
@ UMD Observatory

Dr. John G. Baker

Inside This Issue