Celebrating 80 Years of Astronomy
1937-2017

Star Dust
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September 2017 Volume 76, Issue 1

The Lives and Deaths of Extremely Massive Stars
Michael F. Corcoran
(Catholic University of America, Goddard Space Flight Center)

Abstract: Extremely massive stars are extremely rare, but their cosmic importance far exceeds their numbers. These stars are associated with some of the most energetic phenomena in the Universe, and are key sources of chemical elements needed for planets and life. In this talk I'll discuss the current understanding of how massive a star can be, describe how extremely massive stars form, live and die, and show how these stars can become sources of extreme gamma-ray explosions and perhaps even sources of detectable gravitational radiation. In particular, this talk will emphasize the unusual properties of some of the most massive stars directly identified in our local Galactic neighborhood, and the various pathologies these stars exhibit.

continued on page 2
Recent Astronomy Highlights

While the National Capital Astronomers has been on summer break, astronomy research has continued unabated. Below are but a few research highlights from recent months.

Diamond Rain Inside Neptune?
Scientists at SLAC National Accelerator Laboratory simulated the conditions deep inside icy gas giants, showing that there may be diamonds raining down within Uranus and Neptune.

- Citation: D. Kraus et al., *Nature Astronomy*, 21 August 2017 (10.1038/s41550-017-0219)

Nearby System with Four Super-Earths
By spectral analysis of its light, scientists have found evidence that Tau Ceti, a Sun-like star 12 light years away, has a system of four Super-Earths.

- [www.sciencedaily.com/releases/20170817095549.htm](http://www.sciencedaily.com/releases/20170817095549.htm)
- Citation: Fabo Feng et al, *Astronomical Journal*, 2017

The Mystery of Ultra-Diffuse Galaxies
Did these extremely faint galaxies start out small, then inflate by tidal interactions? Or did they begin like other galaxies, but fail to initiate the star formation rates of their brighter cousins? Recent research suggests the latter.

- [aasnova.org/2017/07/21/globular-clusters-for-faint-galaxies/](http://aasnova.org/2017/07/21/globular-clusters-for-faint-galaxies/)
- Citation: Pieter van Dokkum et al 2017 *ApJL* 844 L11

The Cosmic Velocity Web
A research team has measured the velocities of 8,000 galaxies in a billion-light-year region centered on Earth in order to determine the flow of those galaxies and their clusters through the cosmos. A video of the results is available at the following link:

- Citation: doi.org/10.3847/1538-4357/aa7f78

Biographical Sketch: Mike Corcoran received his PhD from the University of Pennsylvania in 1988. At Penn, Mike began a life-long career studying the unusual properties of very massive single and binary star systems, helping to unlock the secrets by which these stars form and transition into supernovae and black holes. Mike has been working as an astrophysicist at the NASA’s Goddard Space Flight Center in one form or another since he received his PhD, and now works as a Senior Research Scientist at the Catholic University as part of NASA’s Center for Research and Exploration in Space Science and Technology. In addition to studying high-energy emission from massive stars (notably Eta Carinae, the most massive star within 10,000 light years), he works at NASA's High Energy Astrophysics Science Archive Research Center at Goddard, where he serves as archive scientist for a number of high-energy missions, and where he writes the High Energy Astrophysics Picture of the Week ([heasarc.gsfc.nasa.gov/docs/objects/heapow](http://heasarc.gsfc.nasa.gov/docs/objects/heapow)), which highlights new developments in x-ray and gamma-ray astrophysics.

NCA 2017-2018

Schedule of Speakers

Sep 09 Michael Corcoran (Catholic University), *The Lives and Deaths of Extremely Massive Stars*

Oct 14 Erika Nesvold (Carnegie DTM), *Debris Disks and New Planets*

Nov 11 Alexander van der Horst (George Washington U), *Transient Relativistic Jets*

Dec 09 Mario Gliozzi (George Mason U), *What X-rays Tell Us About Black Holes*

Jan 13 Dean Howarth & Jeff Jones, *Newton and Halley*

Feb 10 Brett Denevi (JHU/APL), *The New Moon* (Date may change.)

Mar 10 Ludmilla Kolokolova (UMd), *What We Can Learn from Dust in the Solar System* (Date may change.)

Apr 14 Jonathan Gagné (Carnegie DTM), *Planets without Stars*

May 12 Brian Morsony (UMd), *Relativistic Jets Stir Things Up*

Jun 09 Science Fair Winners, Election, Astro Photos
"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!

### 2017 Observation Dates

- **16 September (8:00 pm)** – Saturn, Antares & Vega
- **21 October (7:30 pm)** – Summer Triangle
- **18 November (7:00 pm)** – Pleiades & Winter Constellations

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

**NCA Member Interview**


Guy’s log of his eclipse experience can also be found at: [guysmathastro.wordpress.com/2017/08/27/an-eclipse-seen-in-wyoming/](http://guysmathastro.wordpress.com/2017/08/27/an-eclipse-seen-in-wyoming/)

**Joseph Chandler Morris (1943 – 2017)**

A long-time member of the NCA, Joe Morris died at home on August 8th of natural causes.

Joe grew up in New Orleans where his father was the head of the Physics Department at Tulane University. Receiving his BS and MS in Engineering from the University of Tennessee, Joe entered the work force when large main-frame computers were first coming into wide use. Fascinated by them, Joe made computers and information technology his career. He taught at the University of Tennessee from 1967 to 1984, then became the Department Chief Engineer for Information Technology at the Northern Virginia location of the MITRE Corporation.

Joe perceived early on how crucial it was for the public to understand science. He volunteered an enormous amount of energy, time and thought to advancing that understanding. For many years he served as President of the National Capital Astronomers (NCA). He often began meetings by welcoming new people and, with his usual humor, offering to bankrupt them in becoming members for the outrageous amount of ten dollars a year - five dollars if they were students.

Joe also spearheaded the popular monthly "Exploring the Sky" sessions, which are sponsored jointly by the National Park Service and the NCA, where the public can come to Rock Creek Park to view the sky through telescopes. Joe was particularly pleased that "Exploring the Sky" offered youngsters an opportunity to experience the fascination of science. The sessions would often go late, until everyone had a chance to look through the telescopes. However sometimes things could get overwhelming. At NCA meetings, in soliciting volunteers to help with Exploring the Sky, Joe would often tell of the time when there was an extremely long line of potential star gazers and only one telescope, ending the story with, “Thank God it was cloudy!”

Joe was also a very active volunteer at the Steven F. Udvar-Hazy Center, a branch of the Smithsonian Air & Space Museum, which houses many historically important aircraft. Indeed, flying was a passion of Joe’s. He was a licensed amateur pilot. In addition, Joe was also an avid motorcyclist, and took pride in riding his motorcycle at the head of the Fourth of July parades in Oakton, Virginia.

Joe will be missed. The members of the National Capital Astronomers are grateful for his many years of service. Clear Skies Forever, Joe! Unless, of course, the line is long and there’s only one telescope.
Sky Watchers

September

Saturn is visible in the evening sky throughout the month (and into October), setting around 11:30 p.m. mid-month and around 10:30 p.m. at the end of the month.

Jupiter is visible in the early evening sky, setting around 8:30 p.m. mid-month.

Mercury, Venus and Mars are visible in the morning sky throughout the month.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>12th</td>
<td>Mercury is at its greatest elongation (angular separation from the Sun) of 18 degrees and will be the high in the predawn sky.</td>
</tr>
<tr>
<td>13th</td>
<td>Moon at perigee – 229,820 miles from Earth – 12:06 p.m.</td>
</tr>
<tr>
<td>16th</td>
<td>Conjunction of Mercury and Mars – 3’ separation - 2:23 p.m.</td>
</tr>
<tr>
<td>17th</td>
<td>Waning crescent Moon passes by Venus.</td>
</tr>
<tr>
<td>18th</td>
<td>Waning crescent Moon passes by both Mercury and Mars.</td>
</tr>
<tr>
<td>26th</td>
<td>Waxing crescent Moon passes 4 degrees north of Saturn.</td>
</tr>
<tr>
<td>27th</td>
<td>Moon at apogee – 251,250 miles from Earth – 2:50 a.m.</td>
</tr>
</tbody>
</table>

October

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>5th</td>
<td>Full Moon – Known as the Full Hunter's Moon and Dying Grass Moon. 2:40 p.m.</td>
</tr>
<tr>
<td>5th</td>
<td>Conjunction of Mars and Venus – 13’ separation – 9:26 a.m.</td>
</tr>
<tr>
<td>9th</td>
<td>Moon at perigee – 227,953 miles from Earth – 1:54 a.m.</td>
</tr>
</tbody>
</table>

**Star Dust** is published ten times yearly September through June, by the National Capital Astronomers, Inc. (NCA).

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Thank you!

The submission deadline for October’s Star Dust, including Eclipse pictures and stories, is September 26th. Please send material to NCAStardust@gmail.com.

Clear Skies!

**NCA Telescope For Sale**

The NCA has an **Orange Tube Celestron 14” Schmidt-Cassegrain** - $1400 or best offer. Details about the telescope’s condition are at: www.astromart.com/auctions/details.asp?auction_id=20017. Pictures are available at: www.walkerandhenry.com/NCA%2014%20Sale/album/index.html

If interested, contact Guy Brandenburg, gbrandenburg@yahoo.com or Henry Bofinger, hbofinger@earthlink.net.
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 gibbous if it is more than 50.
- Cusp Angle is described more fully at www.iota.jhuapl.edu/exped.htm.
- 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

#### Asteroidal Occultations

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>EDT</th>
<th>Star</th>
<th>mag.</th>
<th>Asteroid</th>
<th>dur. Ap.</th>
<th>dmag</th>
<th>s</th>
<th>Location, Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep 12</td>
<td>2</td>
<td>09</td>
<td>SAO 146133</td>
<td>9.0</td>
<td>Germany</td>
<td>2.5</td>
<td>18</td>
<td>4</td>
<td>SLC, Reno, SFO</td>
</tr>
<tr>
<td>Oct 1</td>
<td>2</td>
<td>36</td>
<td>4UC3422955</td>
<td>12.8</td>
<td>Undina</td>
<td>0.6</td>
<td>11</td>
<td>9</td>
<td>WA, NM4, SP; NVA?</td>
</tr>
<tr>
<td>Oct 3</td>
<td>3</td>
<td>54</td>
<td>4UC342-2109</td>
<td>13.8</td>
<td>Dione</td>
<td>0.7</td>
<td>13</td>
<td>6</td>
<td>DE, SMO, DC, NVA</td>
</tr>
<tr>
<td>Oct 5</td>
<td>4</td>
<td>54</td>
<td>4U10143659</td>
<td>12.7</td>
<td>Triton</td>
<td>1.2</td>
<td>16</td>
<td>9</td>
<td>e. N. America</td>
</tr>
<tr>
<td>Oct 8</td>
<td>4</td>
<td>49</td>
<td>TYC01061212</td>
<td>10.9</td>
<td>Traversa</td>
<td>4.7</td>
<td>4</td>
<td>6</td>
<td>ePA, De; NJ, eMD?</td>
</tr>
<tr>
<td>Oct 9</td>
<td>0</td>
<td>05</td>
<td>TYC06440064</td>
<td>9.4</td>
<td>Nysa</td>
<td>1.1</td>
<td>11</td>
<td>4</td>
<td>wNY, nWPA, n&amp;swOH</td>
</tr>
<tr>
<td>Oct 14</td>
<td>4</td>
<td>08</td>
<td>SAO 128801</td>
<td>9.6</td>
<td>Zeissia</td>
<td>4.9</td>
<td>1</td>
<td>4</td>
<td>nNJ, e-swPA, SOH</td>
</tr>
</tbody>
</table>

#### Lunar Grazing Occultations

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>EDT</th>
<th>Star</th>
<th>mag.</th>
<th>% alt</th>
<th>CA Location &amp; Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep 9</td>
<td>6</td>
<td>12</td>
<td>nu Piscium</td>
<td>4.5</td>
<td>89-</td>
<td>2 Richmond, Delmarva, VA</td>
</tr>
<tr>
<td>Sep 17</td>
<td>7</td>
<td>31</td>
<td>SAO 98571</td>
<td>7.8</td>
<td>9- 17</td>
<td>Hagerstown, MD; Logansville, PA</td>
</tr>
<tr>
<td>Oct 11</td>
<td>6</td>
<td>31</td>
<td>SAO 95410</td>
<td>8.3</td>
<td>63- 9</td>
<td>Winchstr, VA; Comus, Baltimore, MD</td>
</tr>
<tr>
<td>Oct 12</td>
<td>2</td>
<td>40</td>
<td>SAO 96571</td>
<td>8.5</td>
<td>52- 32</td>
<td>Catlett, VA; Woodmore, BW, MD</td>
</tr>
<tr>
<td>Oct 15</td>
<td>5</td>
<td>05</td>
<td>Regulus</td>
<td>1.4</td>
<td>20- 24</td>
<td>7 N. Baker, MT; Bismarck, ND; Bemidji, MN</td>
</tr>
</tbody>
</table>

#### Total Lunar Occultations

<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>EDT</th>
<th>Ph Star</th>
<th>mag.</th>
<th>% alt</th>
<th>CA</th>
<th>Sp. Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep 10</td>
<td>1</td>
<td>23</td>
<td>R x12 Ceti</td>
<td>4.3</td>
<td>82- 40</td>
<td>46S</td>
<td>B9 ZC 364</td>
</tr>
<tr>
<td>Sep 11</td>
<td>1</td>
<td>54</td>
<td>R ZC 491</td>
<td>6.0</td>
<td>72- 40</td>
<td>84N</td>
<td>K0 maybe close double</td>
</tr>
<tr>
<td>Sep 11</td>
<td>3</td>
<td>33</td>
<td>ZC 498</td>
<td>6.3</td>
<td>71- 56</td>
<td>53S</td>
<td>A0 spectroscopic binary</td>
</tr>
<tr>
<td>Sep 11</td>
<td>3</td>
<td>17</td>
<td>R Tauri</td>
<td>4.1</td>
<td>71- 64</td>
<td>5S</td>
<td>ZC 508, TermD 13”, db1?</td>
</tr>
<tr>
<td>Sep 12</td>
<td>1</td>
<td>05</td>
<td>R Gamma Tauri</td>
<td>3.7</td>
<td>61- 22</td>
<td>81N</td>
<td>G8 ZC 635, Hyadum I, db1?</td>
</tr>
<tr>
<td>Sep 12</td>
<td>4</td>
<td>02</td>
<td>R Zeta Tauri</td>
<td>6.6</td>
<td>60- 54</td>
<td>69S</td>
<td>F7 ZC 659, close = double</td>
</tr>
<tr>
<td>Sep 12</td>
<td>5</td>
<td>17</td>
<td>R Thetel Tauri</td>
<td>3.8</td>
<td>60- 60</td>
<td>14S</td>
<td>G7 ZC669, mg2 8.08” PA12</td>
</tr>
<tr>
<td>Sep 12</td>
<td>5</td>
<td>48</td>
<td>R Zeta Tauri</td>
<td>5.0</td>
<td>60- 67</td>
<td>68N</td>
<td>K2 Sun-12, ZC667, close?</td>
</tr>
<tr>
<td>Sep 12</td>
<td>6</td>
<td>02</td>
<td>ZC 672</td>
<td>6.7</td>
<td>60- 67</td>
<td>62S</td>
<td>F7 Sun-9, close double</td>
</tr>
<tr>
<td>Sep 12</td>
<td>8</td>
<td>15</td>
<td>Aldebaran</td>
<td>0.9</td>
<td>59- 36</td>
<td>71S</td>
<td>K3 Sun-37, ZC 692</td>
</tr>
<tr>
<td>Sep 13</td>
<td>4</td>
<td>57</td>
<td>R I115 Tauri</td>
<td>5.4</td>
<td>48- 55</td>
<td>32S</td>
<td>B5 ZC 814, close triple</td>
</tr>
<tr>
<td>Sep 13</td>
<td>4</td>
<td>14</td>
<td>R O1 Gem</td>
<td>6.8</td>
<td>37- 38</td>
<td>33S</td>
<td>K0 ZC 985</td>
</tr>
<tr>
<td>Sep 13</td>
<td>4</td>
<td>36</td>
<td>R SAO 96897</td>
<td>7.6</td>
<td>53- 36</td>
<td>71S</td>
<td>T2 8.1 “ sep 61” PA 97</td>
</tr>
<tr>
<td>Sep 16</td>
<td>3</td>
<td>54</td>
<td>R ZC 1260*</td>
<td>7.1</td>
<td>11- 17</td>
<td>57N</td>
<td>F5 Azimuth 77 degrees</td>
</tr>
<tr>
<td>Sep 16</td>
<td>4</td>
<td>28</td>
<td>R 25 Cancris</td>
<td>6.1</td>
<td>17- 17</td>
<td>86N</td>
<td>F6 ZC126, close db?</td>
</tr>
<tr>
<td>Sep 17</td>
<td>5</td>
<td>39</td>
<td>SAO 98571</td>
<td>7.8</td>
<td>9- 39</td>
<td>26N</td>
<td>A3 mag2 12 sep 13” PA 15</td>
</tr>
<tr>
<td>Sep 17</td>
<td>6</td>
<td>07</td>
<td>R ZC 3396</td>
<td>6.9</td>
<td>28- 45</td>
<td>82N</td>
<td>K2 close double</td>
</tr>
<tr>
<td>Sep 18</td>
<td>6</td>
<td>01</td>
<td>R Zc 1515</td>
<td>7.8</td>
<td>4- 11</td>
<td>72S</td>
<td>F8 Sun-10, Azimuth 85deg</td>
</tr>
<tr>
<td>Sep 27</td>
<td>2</td>
<td>21</td>
<td>D 16 Sgr</td>
<td>6.9</td>
<td>49- 28</td>
<td>43S</td>
<td>B0 ZC639, mag2 16”, 2.5” PA16</td>
</tr>
<tr>
<td>Sep 27</td>
<td>2</td>
<td>27</td>
<td>D 143603*</td>
<td>8.5</td>
<td>49- 27</td>
<td>85N</td>
<td>B9</td>
</tr>
<tr>
<td>Sep 28</td>
<td>2</td>
<td>59</td>
<td>ZC 2798*</td>
<td>6.1</td>
<td>9- 36</td>
<td>33N</td>
<td>K2 = db1, sep .08” PA 210</td>
</tr>
</tbody>
</table>

*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 iota.jhuapl.edu/exped.htm .

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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

- Upcoming NCA Meeting at the University of Maryland Observatory: Oct 14 Erika Nesvold (Carnegie DTM), Debris Disks and New Planets

2017 NCA Board Meeting Minutes (July 23, 2017)

Heinrich Bofinger

(Present - Heinrich Bofinger, Jack Gaffey Jr., John Hornstein, Jay Miller, Jeffrey Norman, Todd Supple and Harold Williams)

The first topic was the Treasurer’s report, which highlighted the continued intentional drawdown of the Capitol One bank balance, at the rate of about $350 a year, and about $4.50 per member. It was agreed that this was not alarming, and that currently membership fees are to remain as they are. The balance is still high at around $5,700. It was also noted that the Assistant Secretary-Treasurer is filing the required tax returns annually. The Secretary-Treasurer's report was voted as formally accepted.

A second topic of discussion was the sale of the NCA’s Celestron C14, which had not proceeded as planned in the previous year. It has been determined that the efforts should be continued.

It has been decided that the NCA dinners would be moved. (The new location is still to be decided upon.)

It was voted that the compensation for the once-a-year appearance of Dean Howarth shall be continued at the current rate of $140.00.

John Hornstein presented his schedule of speakers.

Board meetings are to continue on an annual basis, with interim meetings called only when needed for specific issues.

NCA Financial Position 2016-2017

Heinrich Bofinger


Table 1: Membership history

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>2016-17</th>
<th>2015-16</th>
<th>2014-15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Members end of year</td>
<td>79</td>
<td>87</td>
<td>75</td>
</tr>
<tr>
<td>New</td>
<td>20</td>
<td>50 (some late renewals)</td>
<td>22</td>
</tr>
<tr>
<td>Attrition</td>
<td>27</td>
<td>23</td>
<td>50</td>
</tr>
<tr>
<td>Lifetime</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

continued on page 7
### Table 2: Net Income and Expenses - unadjusted

<table>
<thead>
<tr>
<th>Item</th>
<th>2016-17 Amount</th>
<th>Per member</th>
<th>2015-16 Amount</th>
<th>Per member</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>$1,100.45</td>
<td>$13.93</td>
<td>$940.00</td>
<td>$10.80</td>
</tr>
<tr>
<td>Expenses</td>
<td>$1,467.12</td>
<td>$18.57</td>
<td>$1,729.65</td>
<td>$19.88</td>
</tr>
<tr>
<td>Net</td>
<td>-$318.23</td>
<td>-$4.70</td>
<td>-$789.65</td>
<td>-$9.08</td>
</tr>
</tbody>
</table>

*Income includes US $45.00 still pending.*

### Table 3: Expense Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Yearly Amounts</th>
<th>Per Member</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of Members</td>
<td>2016-17</td>
<td>2015-16</td>
</tr>
<tr>
<td>Misc (incl. dinners)</td>
<td>$198.44</td>
<td>$170.56</td>
</tr>
<tr>
<td>Insurance &amp; Legal</td>
<td>$320.00</td>
<td>$400.00</td>
</tr>
<tr>
<td>Stardust</td>
<td>$436.68</td>
<td>$664.09</td>
</tr>
<tr>
<td>Astronomical League</td>
<td>$400.00</td>
<td>$395.00</td>
</tr>
<tr>
<td>Intl Dark Sky Association</td>
<td>$100.00</td>
<td>$100.00</td>
</tr>
<tr>
<td>Telescope Making Class</td>
<td>$903.98</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$1,467.12</strong></td>
<td><strong>$1,729.65</strong></td>
</tr>
</tbody>
</table>

### Table 4: Bank balances

<table>
<thead>
<tr>
<th>Amount</th>
<th>Date</th>
<th>Current Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening Balance</td>
<td>$6,085.91</td>
<td>$5,722.68</td>
</tr>
<tr>
<td>Closing Balance</td>
<td>$5,722.68</td>
<td></td>
</tr>
<tr>
<td>Net Change</td>
<td>$363.23</td>
<td>$5,722.68</td>
</tr>
<tr>
<td>All items included except for awards dinner ($48.44), and pending US $45.00 deposit</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**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
Next NCA Meeting:
2017 Sept. 9th
7:30 pm
@ UMD Observatory
Dr. Michael F. Corcoran

Inside This Issue
Preview of Sept. 2017 Talk..............1
NCA Speaker Schedule..................2
Remembrance of Joe Morris..........3
Sky Watchers...........................4
Occultations............................5
Calendar..................................6
2017 NCA Meeting Minutes.........6
NCA Financial Position...............6