Kepler Debates Tycho: Does the Earth Orbit the Sun?

Dean Howarth and Jeffrey Jones
Natural Philosophers & Educators

Abstract: The story of the flamboyant Danish astronomer, Tycho Brahe, and the ingenious German mathematician, Johannes Kepler, is one of the most interesting episodes in the history of science.

Appearing in period attire and using an array of replica instruments and demos, Dean and Jeff capture the dynamic rivalry between the two men of science in a witty, yet scientifically accurate, narrative suitable for all ages and all levels of interest and experience.

Principles of astronomy and physics, and even arcane theories of the past are shared and debated with the audience who learns that the lessons of the past have much to do with the science of today!
Early Solar System Beliefs

Geocentric

The philosopher, Anaximander, used reason & observations to derive a model of the Universe. His model features Earth’s flat surface atop a cylindrical base (ca 5th century BCE). A solid sphere separates the fire region from the air, which contains Earth & stars. However, the sphere has holes in it that allow the light of the fire ring to shine through as additional stars. The philosopher also indicated that there were 3 continents on Earth: Asia, Europe & Libya.

Ptolemy’s model (2nd century CE) features fixed stars and a spherical Earth at the center. There were heliocentric models (e.g., Aristarchus of Samos) before Claudius Ptolemaeus proposed his geocentric model; but they didn’t gain ground. In addition, the geocentric view was accepted by the Roman Catholic Church in the Middle Ages and any open opposition to this view was heresy.

Tycho Brahe’s assistant, Johannes Kepler, was a Copernican. Among other things, he discovered that the planetary orbits in the Solar System were elliptical.

Kepler Debates Tycho – continued from page 1

Biographical Sketch:
Dean Howarth and Jeffrey Jones are veteran physics teachers in Fairfax County, VA. For over a decade, the two have collaborated on unique and innovative ways to bring science to life. Both men are firm believers that the history of science is a fruitful and compelling way to introduce the sometimes complex principles of science to their students and to the public.

Stories about the great scientists of the past show the human element and drama behind great advances in science. This drama remains intriguing throughout the ages and invites listeners to learn more about the science and technologies that affect modern life.
**System Beliefs – continued from page 2**

### Heliocentric

Nicolaus Copernicus (Mikolaj Kopernik), proposed that the Sun was the center of the planetary system. In 1514 CE, he released a manuscript, “Small Commentary,” in which he introduced his heliocentric system; and, “On the Revolutions of the Heavenly Spheres” was released in 1543, just before Copernicus died. The latter work was banned by the Church in 1616 (a few months after Galileo’s Inquisition trial). It remained a prohibited book until 1835.

Tycho Brahe (17th century CE) developed an integrated model of both geocentric & heliocentric components: all other planets orbit the Sun, which orbits Earth.

### Sky Watchers

**Winter Schedule**

**January**

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
</table>
| 12   | 6:43 am – **Full Moon**, Global.  
Other Moon Names: Full Wolf Moon, Moon After Yule, Old Moon. Snow Moon. |
| 17   | 8:00 pm - **Asteroids**, N. Hemisphere. Vesta (in opposition to the Sun). |
| 18   | 12:00 am – **Planets**, N. Hemisphere. Jupiter 3° south of Moon. |
| 21   | 7:14 pm – **Moon**, Global (apogee at 251,602 miles). |
| 24   | 5:00 am - **Planets**, N. Hemisphere. Saturn 4° south of Moon. |
| 31   | 8:00 pm – **Planets**, N. Hemisphere. Mars 2° north of Moon. |

*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](#)
Vera Rubin and the NCA

John Hornstein

You have probably seen the articles in the Washington Post and elsewhere on Vera Rubin's death. Vera Rubin made epochal contributions to astronomy, especially to our understanding of what material the Universe is comprised.

In particular, her measurements of the orbital rotation speeds in spiral galaxies as a function of the distance from the galactic center eventually forced astronomers to take Fritz Zwicky's earlier assertion seriously - based on his measurements of clusters of galaxies - that there was an enormous amount of matter in the Universe that doesn't produce or absorb light. Vera's contribution led to the realization that most of the matter (as distinguished from the Dark Energy) in the Universe was Dark Matter. This has since been confirmed in ways that are quite independent of both Vera's and Zwicky's types of measurements. It has been confirmed by gravitational lensing (the gravity produced by Dark Matter deflects light) and by cosmological measurements on the fluctuations in the cosmic microwave background radiation.

You might not know that Vera also had a long-lasting connection to the NCA.

She joined the NCA while still a teenager, and resumed her association with the NCA when her career trajectory brought her continued on page 6
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.
back to the Washington area, when she earned her PhD under George
Gamow, and later, when she joined the staff of the Carnegie Institution of
Washington.
Vera continued to attend NCA meetings until late in 2007. There are
several fascinating online articles about her life, her personality, and
her struggles with gender bigotry.

**Learn More About Vera**

- *Personal recollections by people who knew Vera*
  - docs.google.com/document/d/1H5zUk4CKxbu6pJTSIEPJsdJG2mG0hvGqpiPr5j7TI/edit

  The 13th item is an amusing brief recollection by Nancy Grace Roman,
  and the next-to-last item is by Wayne Warren. It cites a phenomenon
  that every one of us has noticed, and that might well have been what first
  triggered Vera’s interest in astronomy.

- **The American Institute of Physics**
  - www.aip.org/remembering-vera-rubin

  AIP is providing access to audio and video interviews with Vera, and with
  prominent astronomers talking to Vera about her life

- **Astrobites**
  - astrobites.org/2016/12/30/the-unsung-contributions-of-vera-rubin-
    her-mission-in-retrospect/

  There is also a very informative Astrobites post by Zephyr Penoyre:
  - astrobites.org/2016/12/27/how-one-person-discovered-the-
    majority-of-the-universe-the-work-of-vera-rubin/

- **The Washington Post**
  - www.washingtonpost.com/national/vera-rubin-astronomer-who-verified-
    existence-of-dark-matter-dies-at-88/2016/12/26/545e617c-cb9d-11e6-
    a747-d03044780a02_story.html?utm_term=.4c152a0b0180

  o Shortcut: wpo.st/6cVQ2

    science/?tid=ptv_rellink&utm_term=.83a64e2bd4e4

  o Shortcut: wpo.st/PcVQ2

  - www.washingtonpost.com/local/from-lab-to-olympic-podium-to-white-
    house-accomplished-women-still-get-dismissed/2016/12/29/cc109552-
    cdd0-11e6-a747-d03044780a02_story.html?utm_term=.0e341f29cf42

  o Shortcut: wpo.st/ecVQ2
**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 gbrandenburg@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)

- **Lockheed Martin IMAX Theater** in DC: “Rogue One: A Star Wars Story” (PG-13), Dates through Wed. Jan. 19, $15 (adults) and $13.50 (youth), shows start at 11:40 am. [http://www.si.edu/Imax/](http://www.si.edu/Imax/)

- **Steven F. Udvar-Hazy Center** in Chantilly, VA: Making STEM Magic January Challenge: “Astro-Bots: Astronomy,” Sat. Jan. 14, FREE (parking $15), 10 am - 3 pm. [https://airandspace.si.edu/events/robotics](https://airandspace.si.edu/events/robotics)

- **Mid-Atlantic Senior Physicists Group**: “Probing Physics & Astrophysics with Gravitational Wave Observations” with Peter Shawhan (UMD), Wed. Jan. 18, at 1 pm at the American Center for Physics (1st floor conference room). [http://www.aps.org/units/maspg/](http://www.aps.org/units/maspg/)

- **New Telescope Owners Nights**: Wednesday, Jan. 25 or Saturday, Jan. 28, 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:

---

**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 January 14th
7:30 pm
@ UMD Observatory
Dean Howard and
Jeffery Jones

Inside This Issue
Preview of Jan 2017 Talk..................1
Sky Watchers......................................3
Vera Rubin and the NCA...............4
Occultations..................................5
Calendar........................................7