Variable Stars and Telescopes

Culpeper Astronomy Club Meeting November 26, 2018



Overview

- Introductions
- Variable Stars (Mike Klosterman)
- Telescope Types
- Constellations: Auriga, Gemini, Taurus
- Observing Session

Observing Sessions

- Leonid Meteor Shower 17/18 November
 - Midnight 3 a.m. (sky conditions deteriorated)
 - Observed 12 meteors
 - Very bright Leonid (-4 mag) at about 1 a.m.

Variable Stars Our flickering Candles in the Sky

Mike Klosterman MSRO Staff Astronomer

November 26, 2018

Variable Stars

- What are they?
- Historical Context
- Why Observe them?
- Light Curves
- How to Observe them?

What are Variable Stars?

- Variable Star: Stars which show variations in their brightness over time
- Two main types
 - Intrinsic stars variable due to internal changes within the star
 - Pulsating Stars
 - Eruptive Stars (Cataclysmic, Novae, Supernova)
 - Extrinsic stars variable due to external factors
 - Eclipsing
 - Rotating

What are Variable Stars?

- Magnitude: brightness can change from as little as thousandths of magnitudes to as much as 20 magnitudes
- Time: brightness change can happen in matter of fraction of a second to years
- Nearly 40,000 variables in our galaxy (and approx. 10,000 suspected)

Pulsating Variable Stars

Cepheid Variables

Delta Cepheus (Prototype





Historically important due to its clock-like pulsations used as a "Standard Candle" for measuring distances

Eruptive Variable Stars

Cataclysmic Variable

Occasional violent outbursts due to thermonuclear changes at the surface or interior of the star

Supernova

Eclipsing Variable

Algol (Beta Persei) "The Demon Star" is a famous example

Algol "The Demon Star"



Oldest record of a variable star
Included in 3200 year old ancient Egyptian calendar of lucky and unlucky days

Historical Context

- Variable stars were particularly important in early 20th century
 - 1912 Henrietta Swan Leavitt Discovered "Period Luminosity" relationship while reviewing photographic plates of cepheid variables in Small Magellanic Cloud
 - - Pulsation period of a cepheid is directly related to its median luminosity
 - The brighter the magnitude, the longer the period
 - Hence, by measuring period (and knowing the zero point) know a cepheid's absolute luminosity and hence its DISTANCE = "The Standard Candle"
 - 1923 Edwin Hubble used the "Period Luminosity" Relationship to determine the distance and scale of the

Why Observe Variable Stars?

- Provide a wealth of information about the internal structure of stars, models of stellar evolution and distance determination
- Systematic observations over a longer period helps:
 - To determine the short-term and long-term behavior of the stars
 To construct theoretical models
- Research on variables stars is important for
 - deriving stellar properties, e.g., mass, radius, luminosity, temperature, internal and external structure, chemical composition and their evolution
- Professional Observatories do not have time to dedicate to long term observing campaigns

Light Curves – variation over time

Brightness in magnitude on Y axis
Time (Julian Date) on X Axis



• Omicron Ceti (Mira)



80 – 1000 days, 2.5 – 5.0 mag

How to Observe Variable Stars

- Visually- There are a number of brighter variable stars that can be observed and tracked
 - Requirements: Curiosity!, Dark (away from city) moonless night, finder charts with comparison stars, Perseverance!







Comparison star charts: https://www.aavso.org/apps/vsj

Delta Cephei • Delta Cephei is an excellent visual variable to observe in autumn months



1. Estimate your magnitude to the nearest tenth by using the nearby comparison stars. Look quickly back and forth and ask yourself: Is it dimmer or brighter than this comparison star? Is it dimmer or brighter than the second comparison star? If it is brighter, by how many tenths? Make a note of it. Repeat two more times and average results

2. Write down your time and convert to Julian Day time (See AAVSO website for JD converter)

3. Observe delta Cep on every night possible for the next month. If you wish to have a more complete light curve, observe it twice a night with 3 hours between each observation. You may decide to plot your data on a graph and calculate the neriod of delta Cen

How to Observe Variable Stars

- Small Telescope: thousands of variable stars can be accurately measured
 - Requires: Telescope 3" or larger on a driven mount, a detector, computer with software to reduce data and log/submit results
 - Types of detectors:





Advantages to Small scope Observing

1. Convenient access to a telescope

2. For sufficiently bright stars, small telescopes achieve same photometric accuracy as that of large telescopes

3. With advanced increasing sophistications in optics and electronics it is possible for smaller telescopes to do what larger telescopes could do in the past

4. Photometry of variable stars using small telescopes is very convenient and easy. Long term projects are specially good for small telescopes

5. The geographical location of an observing place can make it critically important, independent of telescope aperture.

Questions?

Three Basic Telescope Types

- Refractors have a lens at the front of the tube it's the type you're probably most familiar with
 - Generally low maintenance, get expensive as the aperture increases
 - An apochromat offers better optical quality (and is more expensive) than an achromat of the same size
- Reflectors gather light using a mirror at the rear of the main tube
 - For a given aperture, these are generally the least expensive type, but you'll need to adjust the optical alignment every now and then — more often if you bump it around a lot — but that adjustment (called collimation) is straightforward.
- Compound (or catadioptric) telescopes, use a combination of lenses and mirrors, offer compact tubes and relatively light weight
 - Most popular designs is called Schmidt-Cassegrain



Mounts – Most Important

- <u>Alt-Az</u>: On some mounts the scope swings left and right, up and down, these are known as altitude-azimuth (or simply alt-az) mounts
 - Many reflectors come on a simple wooden platform, known as a Dobsonian; a variation of the alt-az mount
- <u>Equatorial</u>: A more involved mechanism, designed to track the motion of the stars by turning on a single axis
 - Tend to be larger and heavier than alt-az designs
 - To use an equatorial mount properly you'll also need to align it to Polaris, the North Star





Refractors

- Typical amateur refractor ranges from 60mm to 6 inch
- Vary widely in focal length and optical quality
- Achromats cost \$100's; Apochromat's cost \$K's



Celestron AstroMaster 90EQ -90 mm (\$249)





Celestron Omni XLT 102 Refractor Equatorial (\$437)

Celestron AVX 6in Refractor Telescope (\$1439)

Reflectors

- Typical amateur ranges from 4.5 inch to 12 inch
- Basic Newtonian reflector can be mounted several ways



Sky-V Dobs

Apertura 8" Dobsonian Telescope with Accessories (\$449)

Sky-Watcher 10" Classic Dobsonian (\$499)



Schmidt-Cassegrains

• Typical amateur ranges from 4 inch to 11 inch



Celestron NexStar 5SE Schmidt-Cassegrain Computerized Telescope (\$599)



Meade 8" LX90 ACF (\$1574) Celestron CGX-L 1100 EdgeHD Computerized Telescope (\$6399)



Constellations

- The Winter Circle or Hexagon
- Orion can be used to locate several Winter constellations
- Will explore several starting this month:
 - Auriga
 - Gemini
 - Taurus



Auriga - "The Charioteer"

- Brightest star is Capella, the Goat Star
 - Sixth brightest star in the sky
- To its right, a small, narrow triangle of 3rd and 4th magnitude stars known as "the Kids" that form an asterism with Capella
- Deep Sky Objects:
 - Several Open Star Clusters; young Blue Dwarf Stars
 - M36, M37, M38
 - All about 4100 LY distant
 - Flaming Star Nebula (IC 405)
 - Emission Nebula about 1500 LY distant



Gemini - "The Twins"

- Gemini is associated with the Greek mythological characters Castor and Pollux; twin brothers born of the same mother but different fathers
- Significant objects:
 - Castor a six star system with three binary stars orbiting around each other
 - M35 Open Star Cluster
 - Eskimo Nebula, NGC 2392



Taurus - "The Bull"

- The red eye of Taurus (Aldebaran) glares at Orion as it guards the Seven Sisters (Pleiades) from Orion's advances
- Larger of two open star clusters is the Hyades
 - V-shaped consisting of over 100 bright and many faint stars
 - Measures about 5 degrees in diameter
- More famous open star cluster is the Pleiades (M45)
- Crab Nebula (M1) Result of Supernova that occurred in 1054



Meteor Showers

- Some of the best are listed below along with dates when the most meteors are visible
 - Quadrantids, January 3-4 (Comet 2003 EH1)
 - Lyrids, April 22-23 (Comet Thatcher)
 - Perseids, August 12-13 (Comet Swift-Tuttle)
 - Orionids, October 20-21 (Halley's Comet)
 - Leonids, November 17-18 (Comet Tempel-Tuttle)
 - Geminids, December 13-14 (Asteroid 3200 Phaethon)
 - Ursids, December 23-24 (Comet 8P/Tuttle)
- The name of each shower refers to the constellation to which the meteors trace their apparent paths



Comet 46P/Wirtanen

- Small short-period comet orbital period of 5.4 years
- Discovered on Jan 17, 1948, by the American astronomer Carl A. Wirtanen
- On 16 December 2018 the comet will pass within 7.2M miles of Earth
 - Estimated magnitude of 3 to 7.5
- Brightest predicted pass to date...and all future passes



Upcoming Events

- Next Meeting: January 28, 2019
 - Plan to focus on the historical contest of astronomy next year as well as continue constellation familiarization
 - Open for select topics and presenters
- Geminid Meteor Shower December 13/14
- Ursid Meteor Shower December 23/24