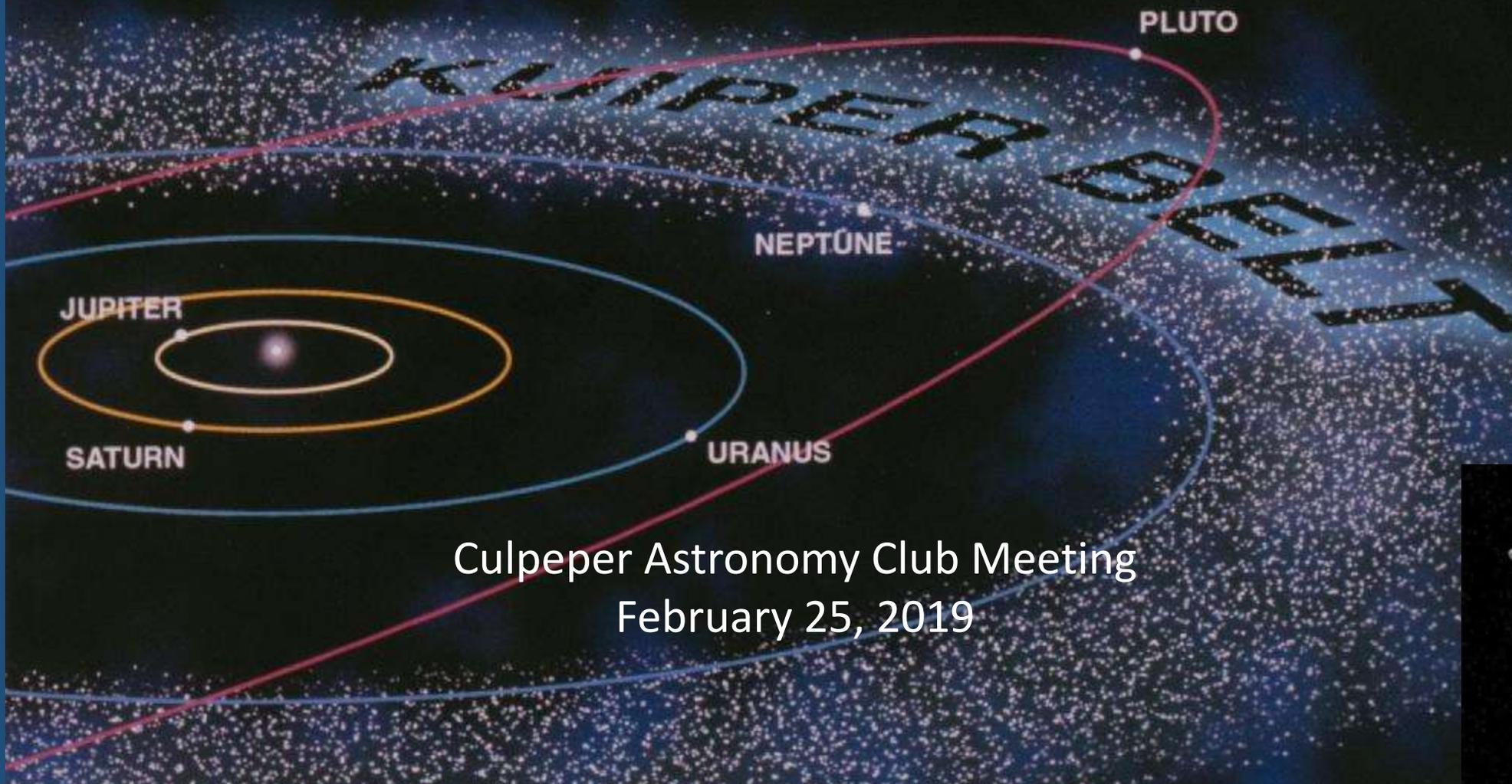


# The Kuiper Belt and Dwarf Planets



Culpeper Astronomy Club Meeting  
February 25, 2019



# Overview

- Introductions
- Galileo
- Kuiper Belt Objects
- Constellations: Monoceros, Canis Major, Puppis
- Observing Session (Tentative)

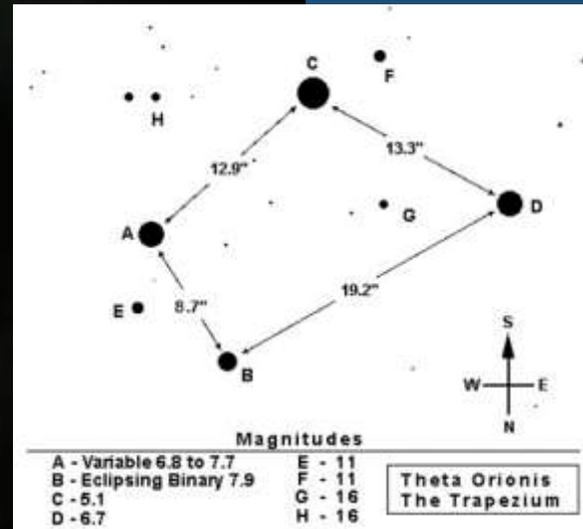
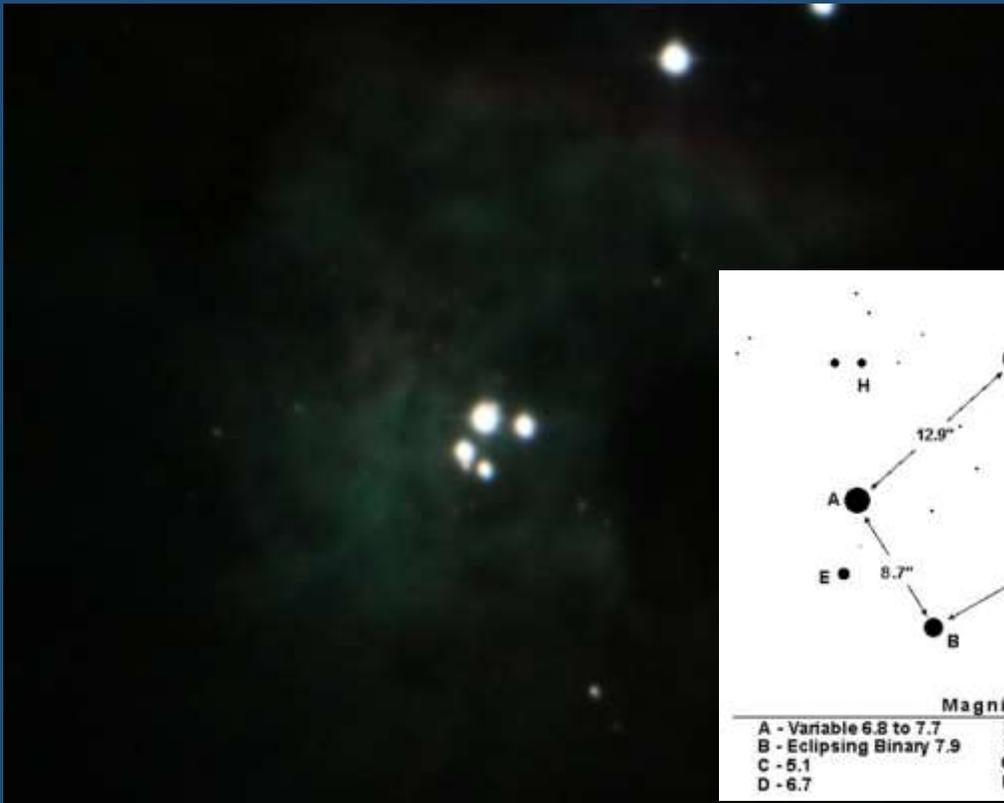
# Observing Sessions

- CAC Group Session - February 2 (Morning Calm Observatory)
  - Planets (Mars and Uranus)
  - Open Star Clusters (Taurus, Perseus, Puppis)
  - Nebula: Orion, Flame, Horsehead (Orion)
  - Double Stars
- US Naval Academy – February 8
  - Class of '41 Observatory – 7.75 inch Clark Refractor
  - Support for STEM program
  - NOVAC Supported
  - Lunar, Mars, Orion Nebula, Trapezium, Castor, Mizar/Alcor
- Personal Sessions: February 9, 13 and 16 (Culpeper)
  - 4 inch refractors on G-11 mount
  - Lunar, Mars, Uranus, various bright open star clusters



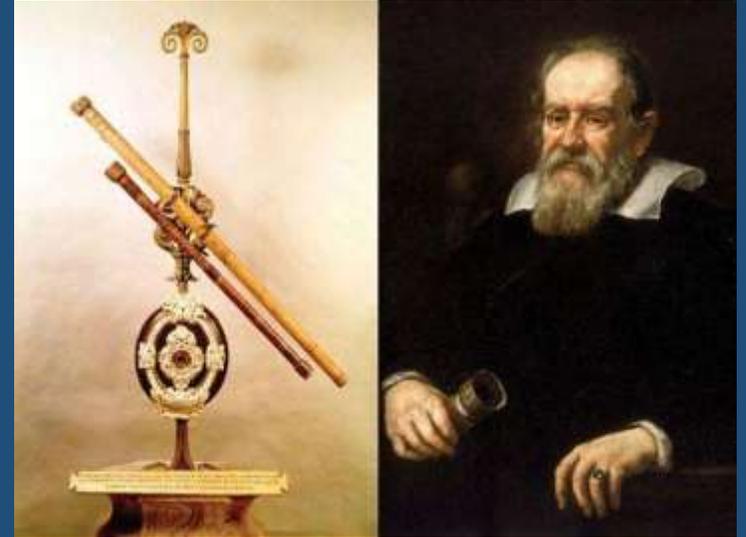
# Observing Sessions

- MCO (Don and Chris): February 9
  - Astrophotography



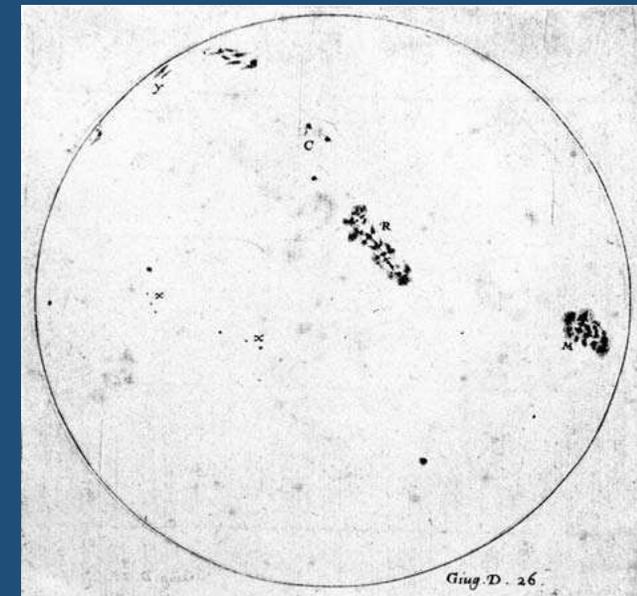
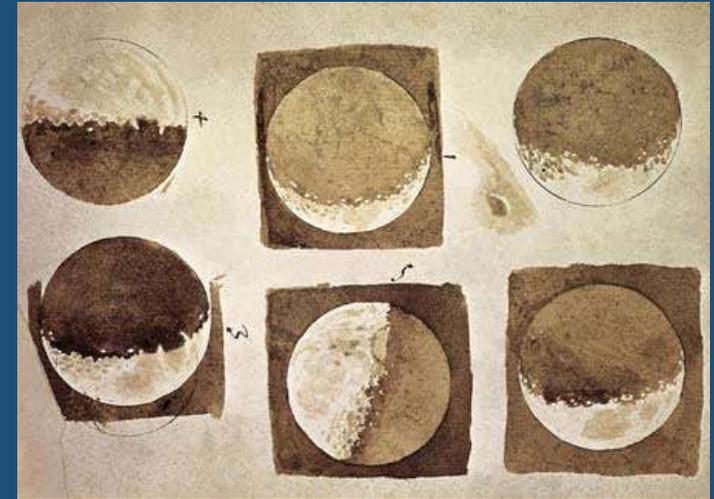
# Galileo Galilei

- Italian astronomer (1564-1642) who provided a number of scientific insights that laid the foundation for future scientists
- In the Spring of 1609 he heard that in the Netherlands an instrument had been invented that showed distant things as though they were nearby
- By trial and error, he quickly figured out the secret of the invention and made his own 3X spyglass from lenses for sale in spectacle makers' shops
- Others had done the same; what set Galileo apart was that he quickly figured out how to improve the instrument, taught himself the art of lens grinding, and produced increasingly powerful telescopes
- In August of that year he presented an eight-powered instrument to the Venetian Senate and was rewarded with life tenure and a doubling of his salary
- In the fall of 1609 Galileo began observing the heavens with instruments that magnified up to 20X



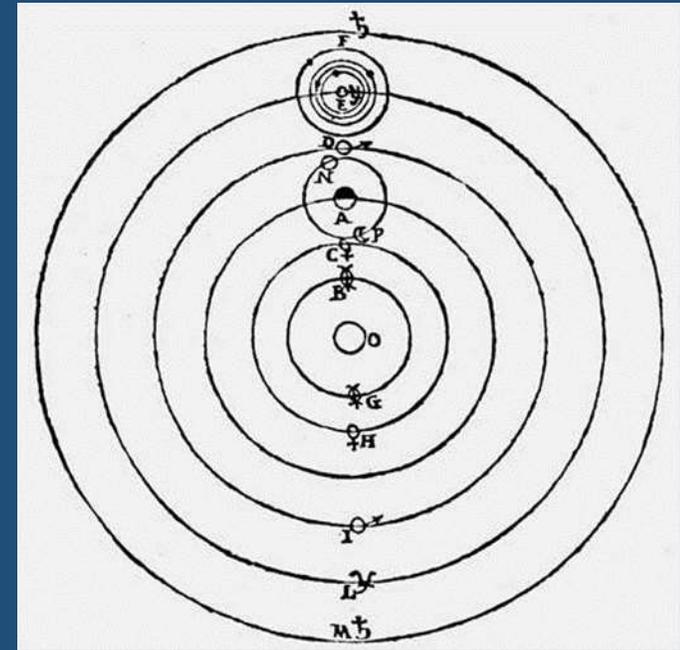
# Galileo Galilei

- Was the first to see craters on the moon, discover sunspots, and track the phases of Venus
- Observed the rings of Saturn which puzzled him
  - Appearing sometimes as lobes and then vanishing when they were edge-on
- Recent research provides some evidence that he discovered Neptune two centuries before it was officially known
- Best known for his discovery of the four most massive moons of Jupiter
  - Io, Ganymede, Europa, and Callisto
  - Now called the Galilean moons



# Galileo Galilei

- In Galileo's lifetime, all celestial bodies were thought to orbit the Earth
  - Teaching opposite this system was declared heresy in 1615
- His discoveries led him to question the Geocentric Theory and support Copernican's Heliocentric Theory
  - Observations of the phases of Venus
  - Jupiter had moons that didn't orbit
- In 1616, was summoned to Rome and warned not to teach or write about this controversial theory
- In 1632, believing that he could write on the subject if he treated it as a mathematical proposition, he published work on the Copernican system
  - He was found guilty of heresy, and was placed under house arrest for the remaining nine years of his life

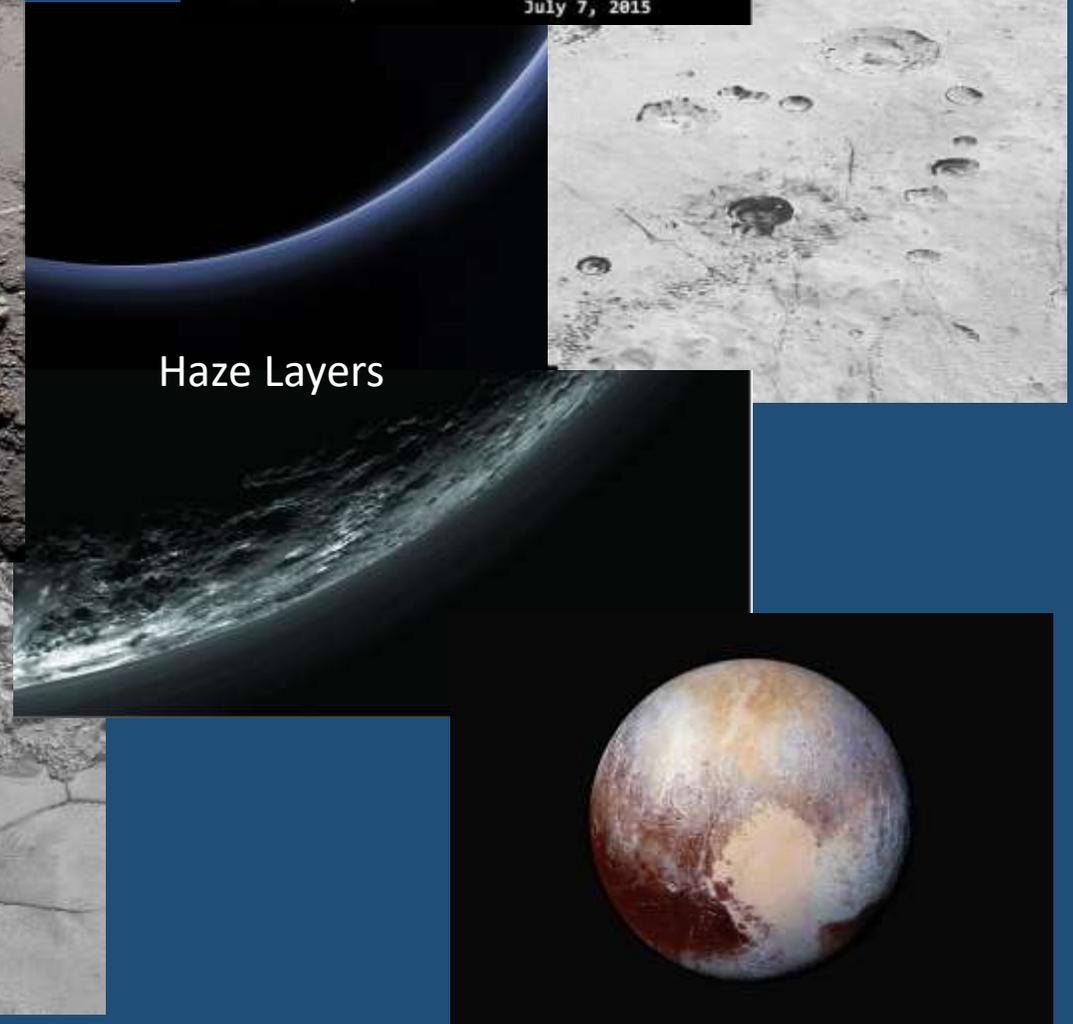
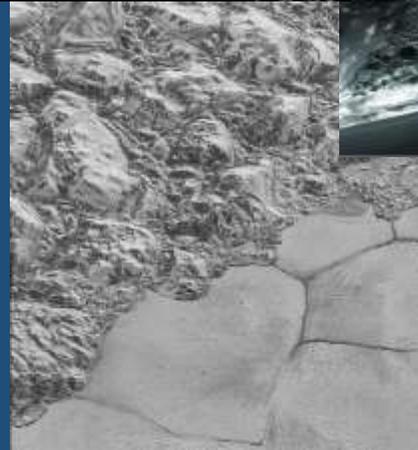


# The Kuiper Belt

- In 1951, Dutch-American astronomer Gerard P. Kuiper first proposed the idea of the Kuiper Belt
- He believed there was an elliptic shape region that was filled with a swarm of icy, rocky objects
  - A disk shaped region past the orbit of Neptune
  - Extends from 30 to 50 AU (2.5 to 4.5 billion miles) from the Sun
  - Short- period comets originate in the Kuiper belt
- Found the first KBO in 1992 using photography
  - Have since discovered thousands
- Wide range in size; many, especially the large ones have moons
- Existence of these objects (Dwarf Planets) brought about the demise of Pluto

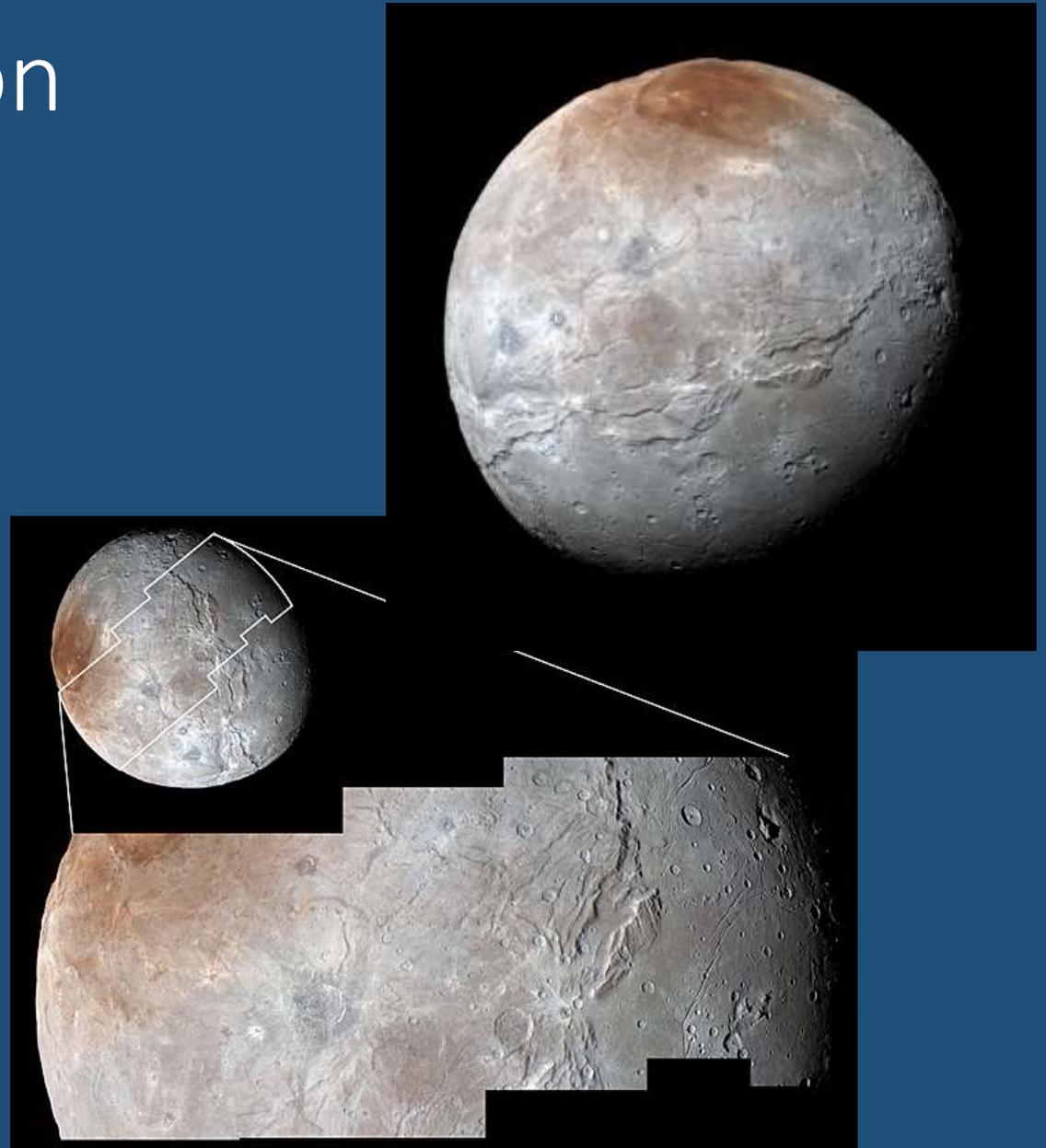
# Pluto – Per *New Horizons*

- The complexity of Pluto and its satellites is far beyond what we expected
- The degree of current activity on Pluto's surface and the youth of some surfaces on Pluto surprising
- Pluto's atmospheric hazes and lower-than-predicted atmospheric escape rate upended all of the pre-flyby models
  - Pluto's atmosphere is blue!
- Pluto shows evidence of vast changes in atmospheric pressure and, possibly, past presence of running or standing liquid volatiles on its surface
- Pluto's vast 1K-kilometer-wide heart-shaped nitrogen glacier is the largest known glacier in the solar system.



# Charon

- Charon's enormous equatorial extensional tectonic belt hints at the freezing of a former water ice ocean inside Charon in the distant past
- Charon's dark, red polar cap is unprecedented in the solar system and may be the result of atmospheric gases that escaped Pluto and then slowly accumulated on Charon's surface
- All of Pluto's moons that can be age-dated by surface craters have the same, ancient age
  - Adds to the theory that they were formed together in a single collision between Pluto and another planet in the Kuiper Belt



# Pluto and its Moons

- The Pluto system consists of four tiny satellites — Nix, Hydra, Kerberos and Styx
  - orbiting a "binary planet" comprised of Pluto and its largest moon Charon, which, at 750 miles (1,207 kilometers) in diameter, is nearly half as wide as the dwarf planet itself
- This binary setup has profoundly influenced the orbits of the four small moons, injecting chaos into their movements
- Hydra is around 28.2 miles (45.4 km) across, while Nix has a diameter of 24.6 miles (39.6 km) or so
- Kerberos and Styx are about 15.4 miles (24.8 km) and 4.2 miles (6.8 km) wide

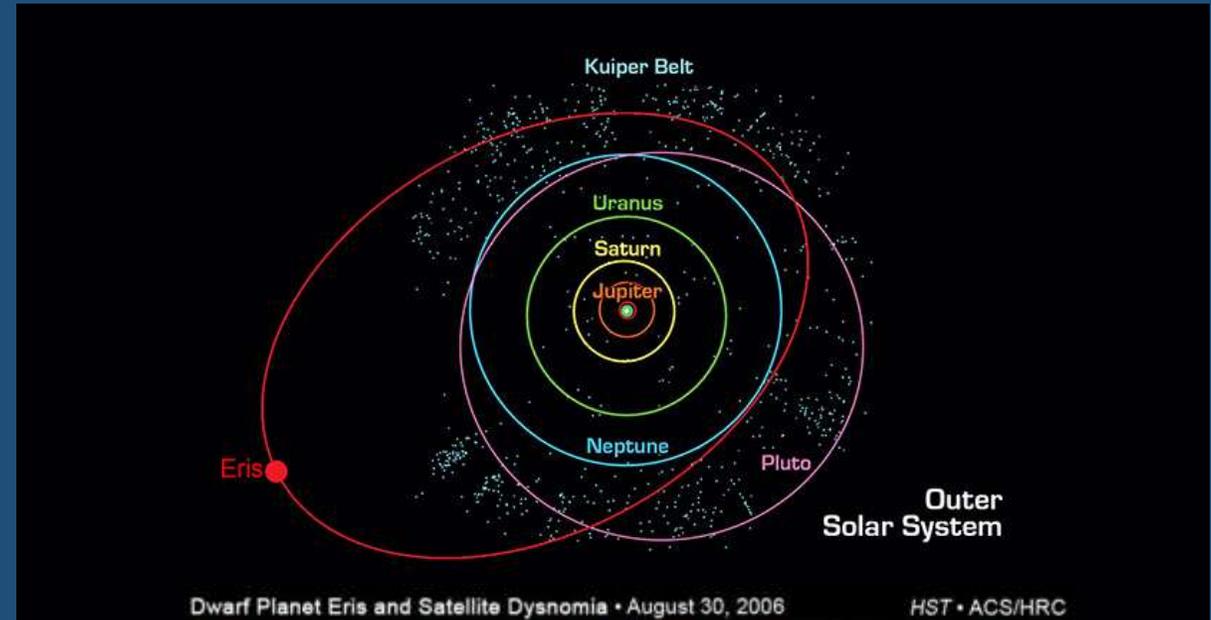


## Charon and the Small Moons of Pluto



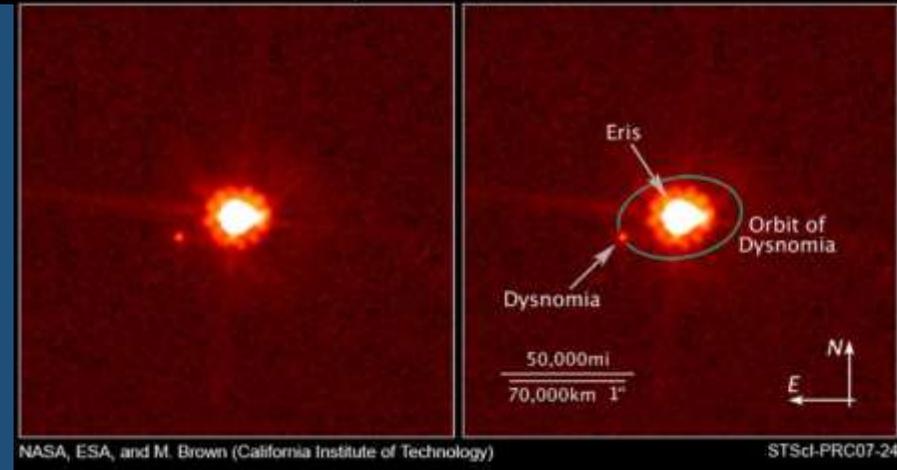
# The Other Dwarf Planets

- Eris' discovery was a big reason astronomers demoted Pluto to dwarf planet status in 2006
  - Discovered by Mike Brown's Team
  - Spotted in 2003; confirmed in 2005
- Estimated to be about same size as Pluto
  - Orbital period of 557 Earth years
  - Orbital plane extends beyond the Kuiper Belt
  - Has a single moon, Dysnomia
- There could be anywhere from 200 to 10,000 Dwarf Planets on the belt



Dwarf Planet Eris and Satellite Dysnomia • August 30, 2006

HST • ACS/HRC

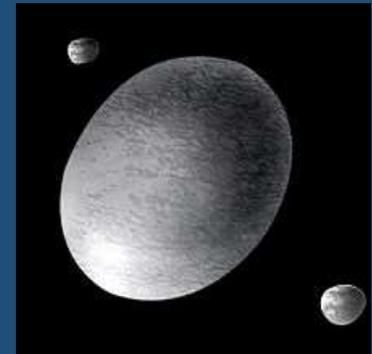


NASA, ESA, and M. Brown (California Institute of Technology)

STScI-PRC07-24

# Haumea

- Discovered in 2004 by Mike Brown's Team at Caltech
- On Sep 17, 2008, it was recognized as a dwarf planet
  - Named after Haumea, the Hawaiian goddess of childbirth
- Haumea's mass is about one-third that of Pluto
- It has an elongated shape, rapid rotation, high density, and high reflectivity (from a surface of crystalline water ice)
  - Thought to be the consequences of a giant collision
  - Left it the largest member of a family that includes several large trans-Neptunian objects (TNOs) and its two known moons, Hi'iaka and Namaka
- Haumea rotates every 3.9 hours



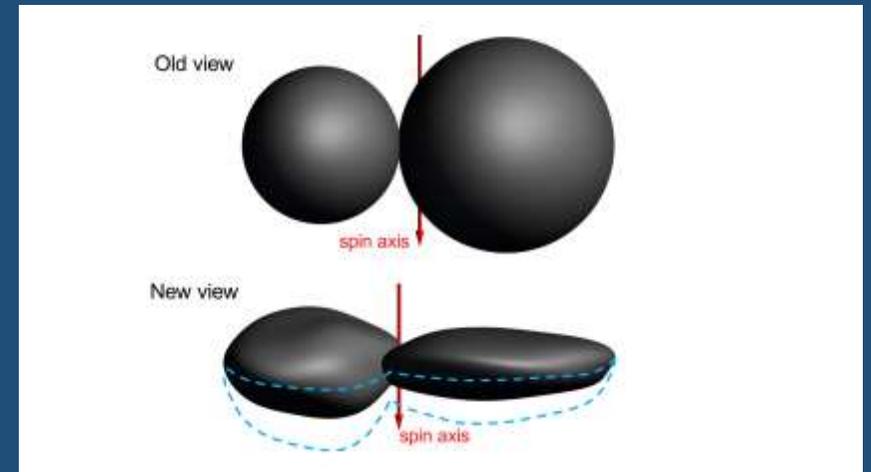
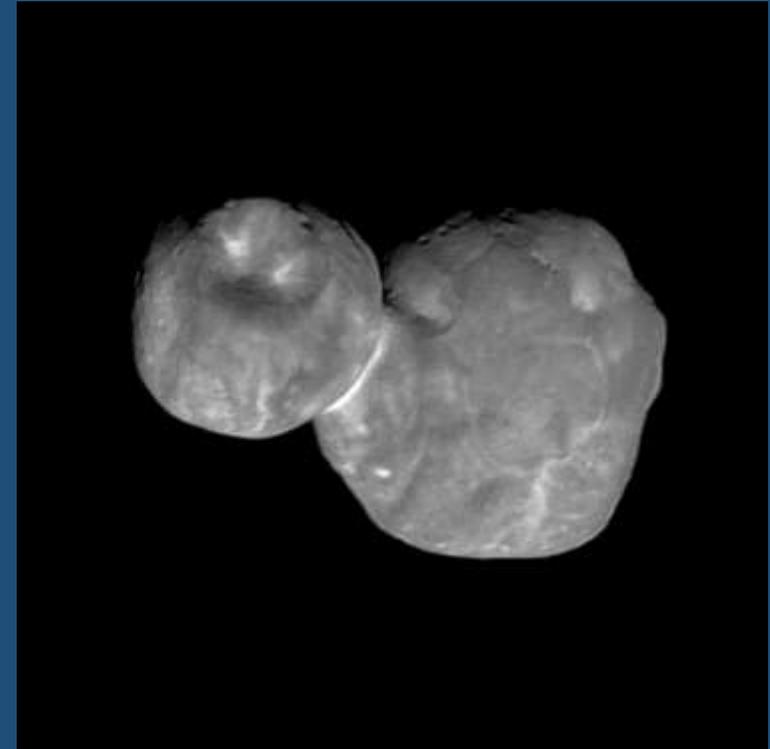
# Makemake

- Makemake was discovered in 2005
  - Named after the creator god from Easter Island mythology
- Estimate its size at 1,500 km diameter
  - No known moon
- Frozen nitrogen, frozen ethane and frozen methane have all been detected on the surface
- Along with Eris, its discovery was a major factor in making the IAU look at the definition of a planet



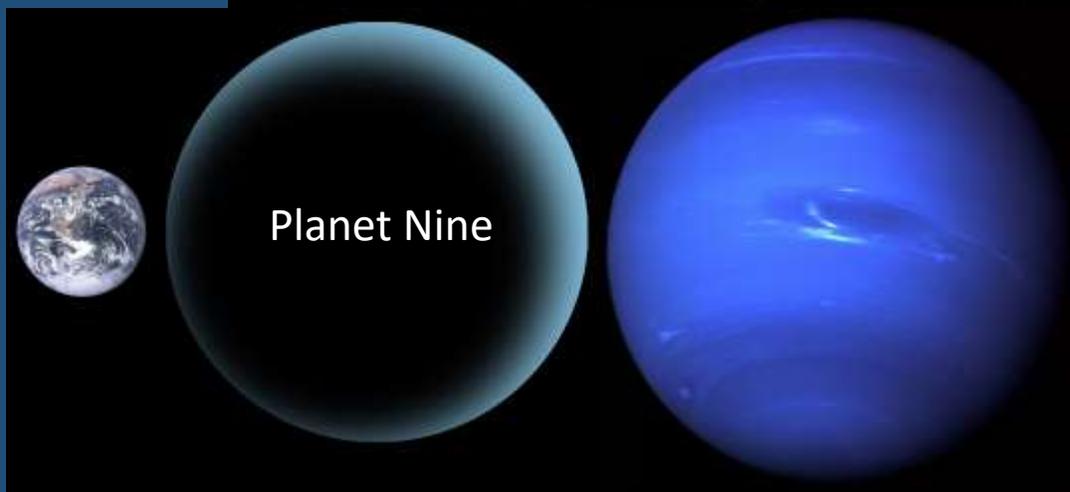
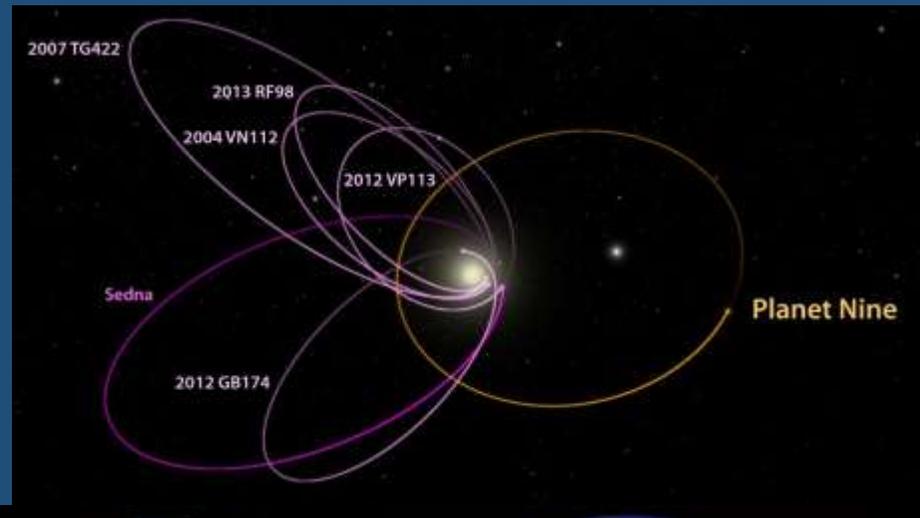
# Ultima Thule

- Using observations made with Hubble on June 26, 2014, the science team discovered an object that New Horizons could reach with its available fuel
- The object was subsequently designated 2014 MU69 and nicknamed "Ultima Thule" (which means "beyond the known world")
- Ultima Thule was 6.5 billion kilometers (4 billion miles) from the Sun, making this the most distant planetary flyby in history
- Is a "contact binary," consisting of two connected spheres. End to end, the world measures 19 miles (31 kilometers) in length
- Latest image reveals topographic details along the terminator, near the top. These details include numerous small pits up to about 0.4 miles (0.7 kilometers) in diameter



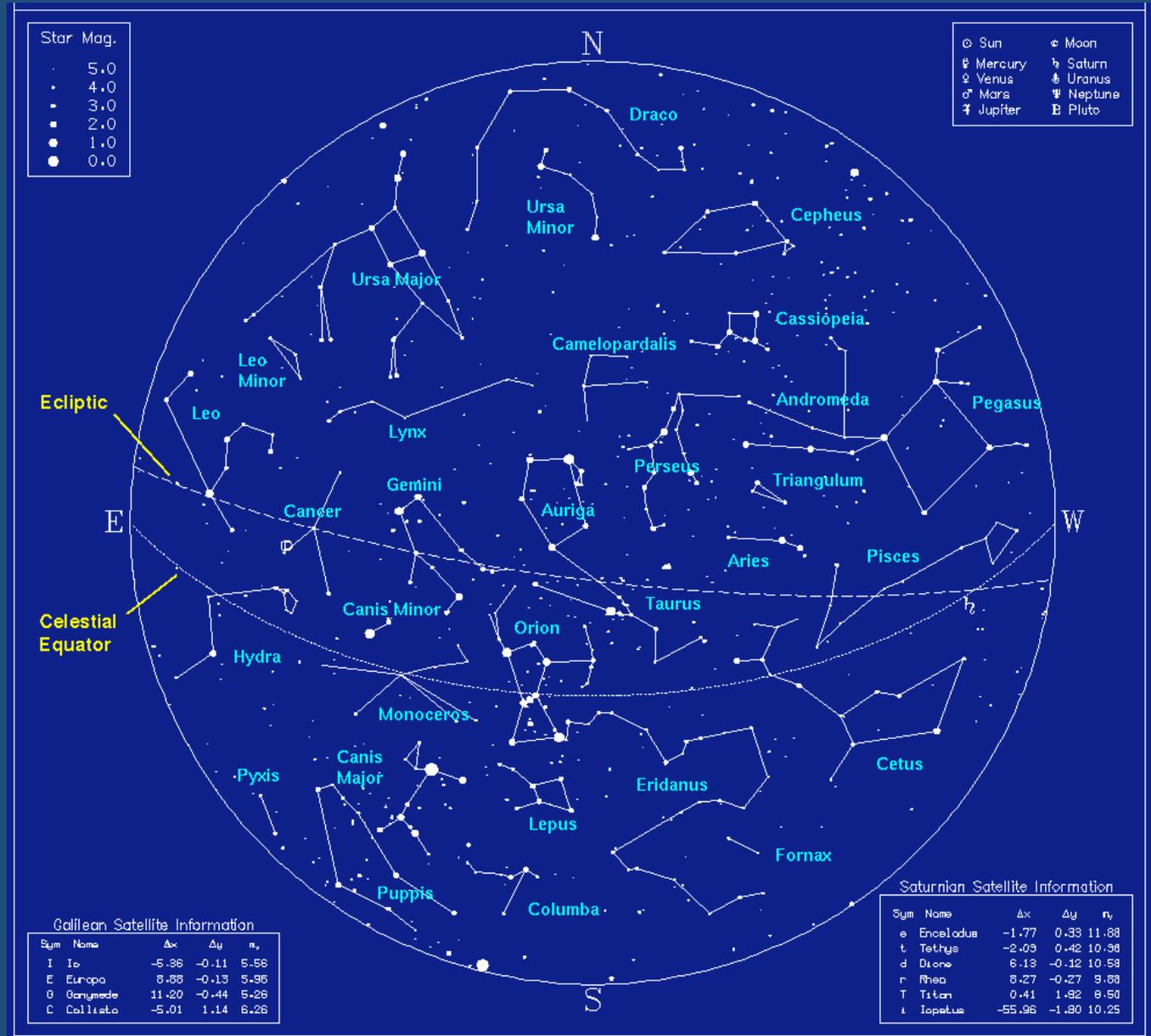
# Planet Nine

- Hypothetical large planet in the far outer Solar System posed by Mike Brown and Team
- Gravitational effects would explain improbable orbital configuration of trans-Neptunian objects (TNOs) that orbit mostly beyond the Kuiper belt
- Would follow a highly elliptical orbit around the Sun, with an orbital period of 10,000–20,000 years
- The planet is estimated to have 10 times the mass and two to four times the diameter of Earth
- Most likely an ejected ice giant, similar in composition to Uranus and Neptune
  - a mixture of rock and ice with a small envelope of gas



# Constellations

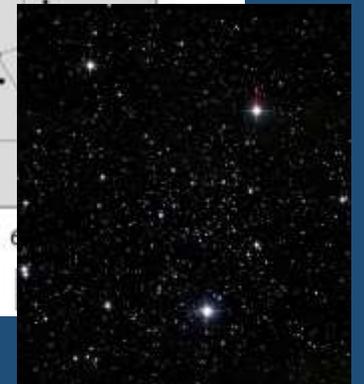
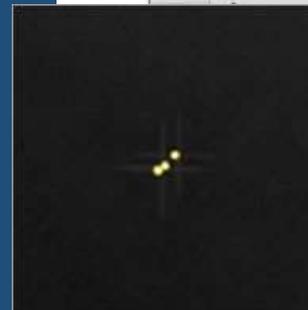
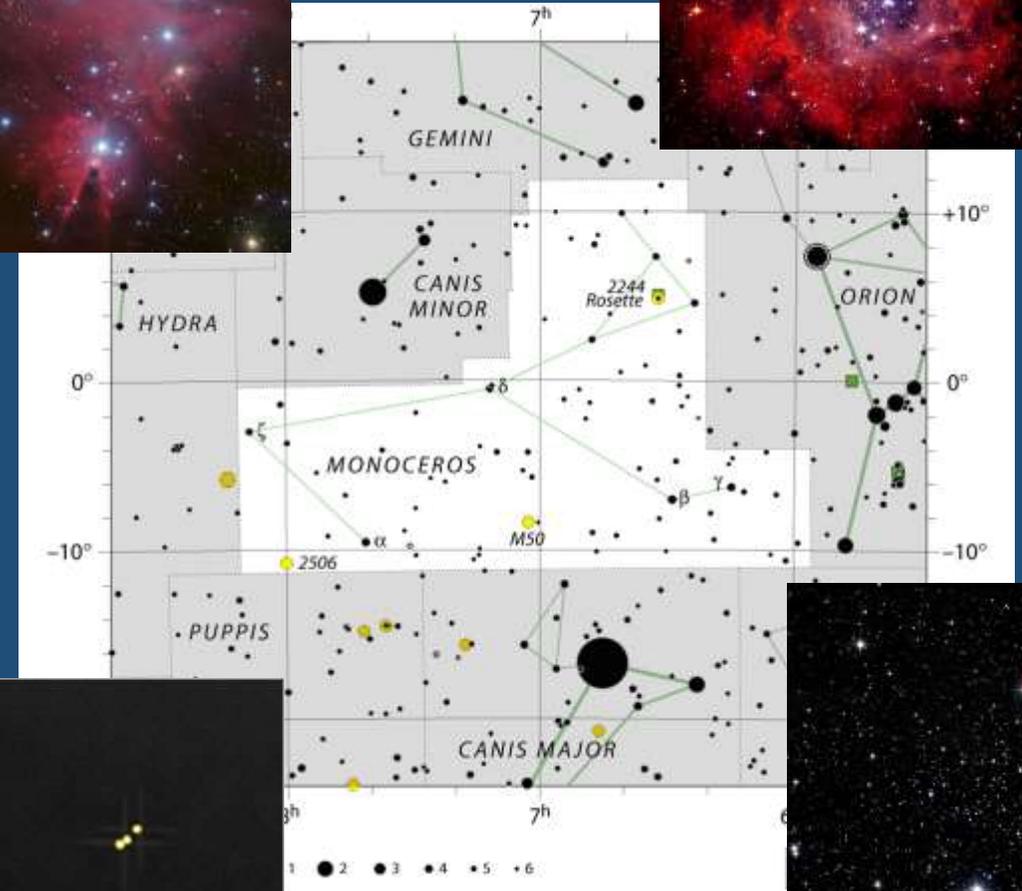
- Will explore three this evening
  - Monoceros, The Unicorn
  - Canis Major, The Big Dog
  - Puppis, The Stern





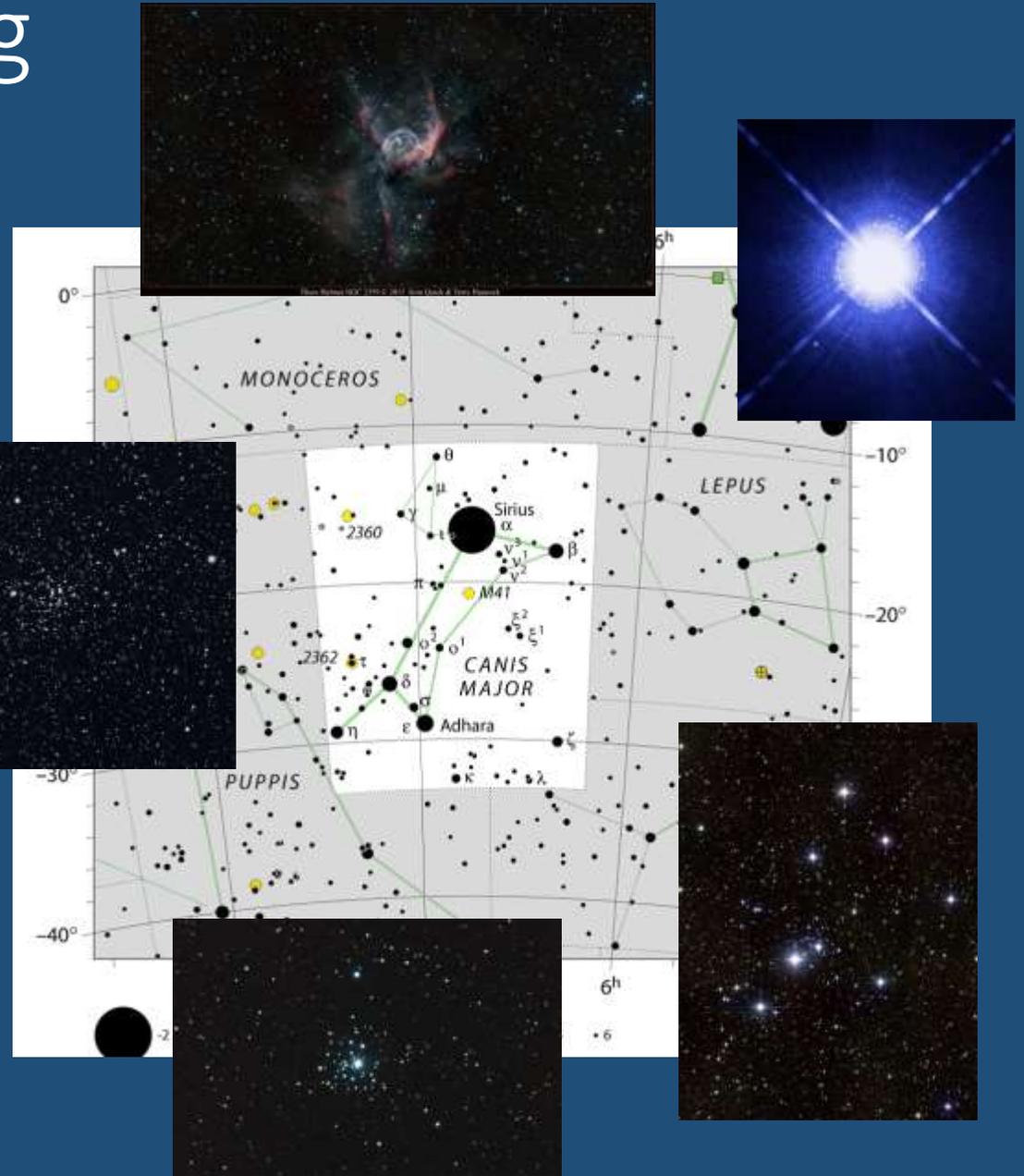
# Monoceros - The Unicorn

- The constellation was created to fill the area between Orion and Hydra, where there weren't any constellations introduced in Greek times
  - No particular myth associated with it
- Beta Mon is a triple star system
- Messier 50 is an open cluster
  - Distinct for its heart-shaped figure
- The Rosette Nebula is a large emission nebula
- NGC 2264 is a New General Catalogue designation for two deep sky objects
  - Christmas Tree Cluster
  - Cone Nebula



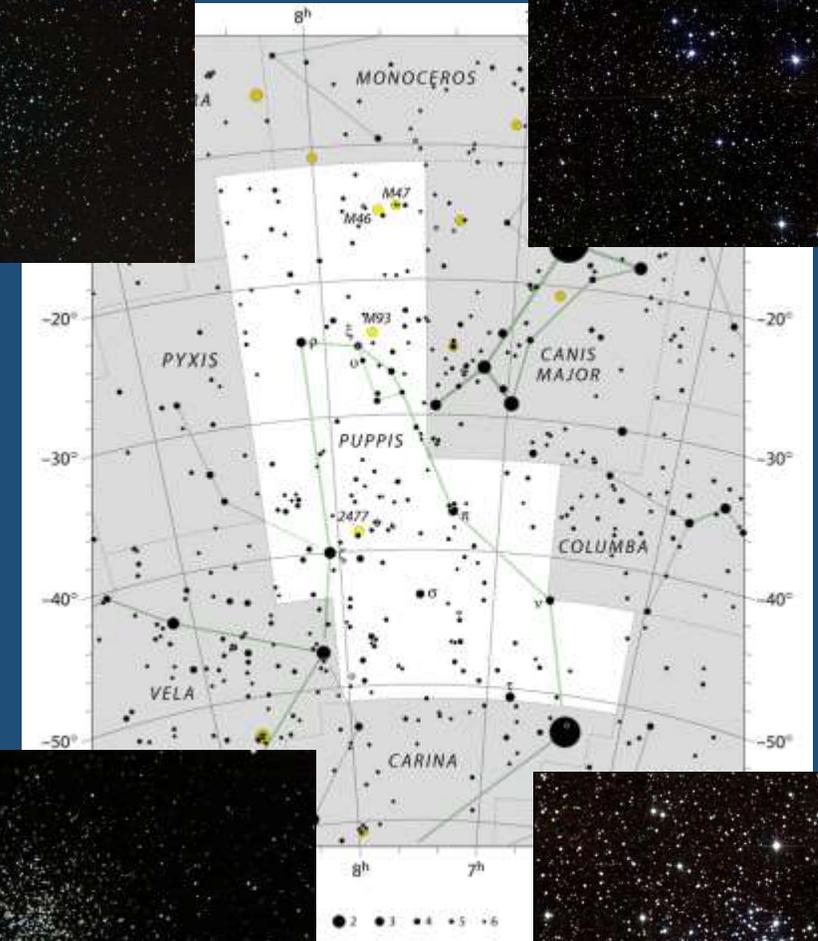
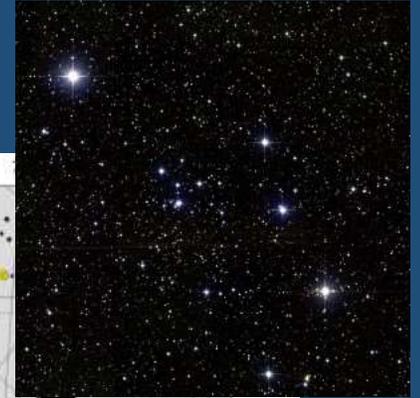
# Canis Major – The Big Dog

- Larger of the the two hunting dogs used by Orion; chasing the Hare
- Within the constellation can be found Sirius, the brightest star in the night sky
  - Known as the "Dog Star"
  - Derived from the Greek word seirios which means "scorcher"
  - Sirius – Difficult Binary (50 yr period)
- Open Star Clusters
  - M41, NGC's 2360, 2362
- Thor's Helmet (NGC 2359)
  - Emission Nebula - 30LY Wide; 15K LY Distant
  - Formed of ionized gases that emit light of various colors
  - Source of ionization is high-energy photons emitted from a Wolf-Rayet star named HD 56925



# Puppis – “The Stern”

- Represents the stern of a ship; used to be part of the much larger constellation which represented the ship on which Jason and the Argonauts sailed to get the Golden Fleece
- Deep Sky Objects:
  - Messier 46: Open Cluster with an apparent magnitude of 6.1; 5.5K LY distant; nice Planetary Nebulae in FOV
  - Messier 47: Open Cluster about a degree west of Messier 46; contains about 50 stars, the brightest of which is of magnitude 5.7
  - Messier 93: Open Cluster with apparent magnitude of 6.0; 3.6K LY distant
  - NGC 2477: Open Cluster with an apparent magnitude of 5.8; 3.6K LY distant; contains about 300 stars; about 700 million years old



# 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



# Upcoming Events

- Next Meeting: March 19, 2019
  - Primary Topic: TBD