ASTRONOMY

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Etymology

- Greek word astron…means star
- Greek word nomos…means law

Law of the Stars

Astronomy is the study of objects and matter outside the Earth's atmosphere and of their physical and chemical properties.

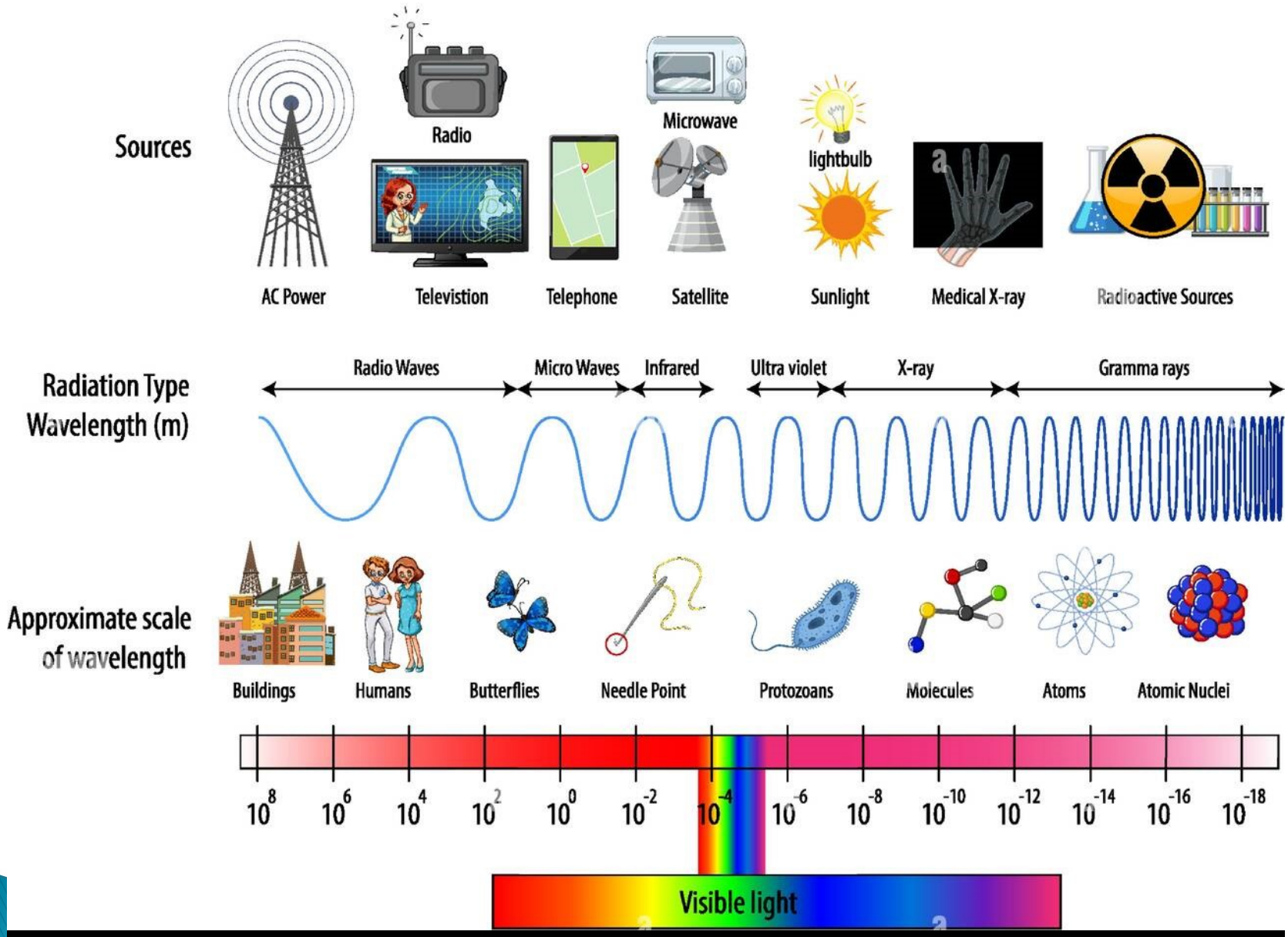
Branches

- **Optical Astronomy** is the study of visible celestial objects
- **Non-Optical Astronomy** uses instruments other than telescopes to create a picture of the universe that spans the entire electromagnetic spectrum

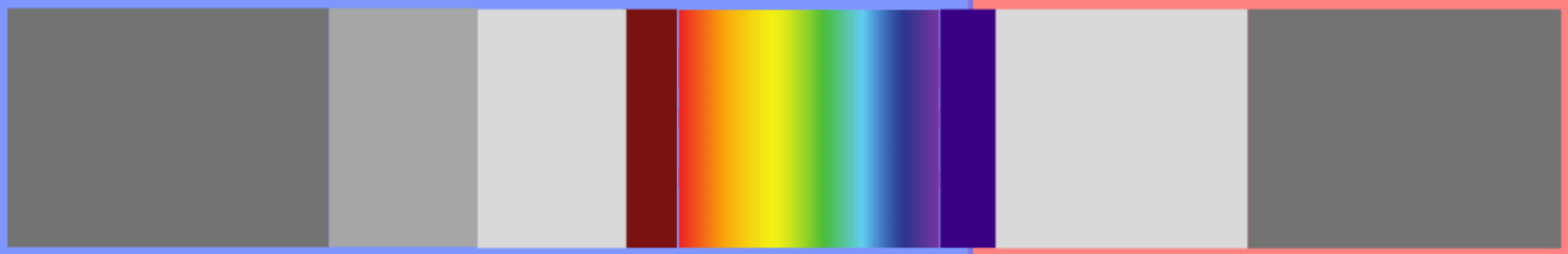
Subfields include:

- **Planetary astronomy**: focuses on planets within and outside our solar system.
- **Stellar astronomy**: study of the stars including their origin, evolution and death.
- **Galactic astronomy**: studies the complex system of stars, nebulae and dust that make up the Milky Way. It also studies the motion and evolution of the Milky Way and the formation of galaxies.
- **Extragalactic astronomy**: This is a study of galaxies in the universe outside of the Milky Way to learn how galaxies are grouped and interact on a large scale.
- **Cosmology:** Cosmologists study the structure of the universe to understand its origin. They attempt to model what the Universe would have looked like soon after the Big Bang occurred.

THE ELECTROMAGNETIC SPECTRUM



Non-Ionizing and Ionizing Radiation



extremely low frequency

radio

microwave

infrared

visible light

ultraviolet

x-rays

gamma rays

alpha particles
beta particles
neutrons

sciencenotes.org

What will we learn?

- The sun, earth, moon system
- Our solar system
- Stars
- Constellations
- Galaxies
- The Big Bang

The Earth

- What do you see?

By the numbers

- The diameter of the earth is 7,926 miles – 12,756 km at the equator. Same at poles?
- The circumference is 24,901 miles – 40,075 km
- The earth is 71% covered by water, 29% by land
- How long is a day?
- Who can tell me, based on what we have learned so far, how fast the earth is rotating?
- The earth is 92,960,000 miles – 149,600,000 km from the sun
- The earth is about 4.5 billion years old

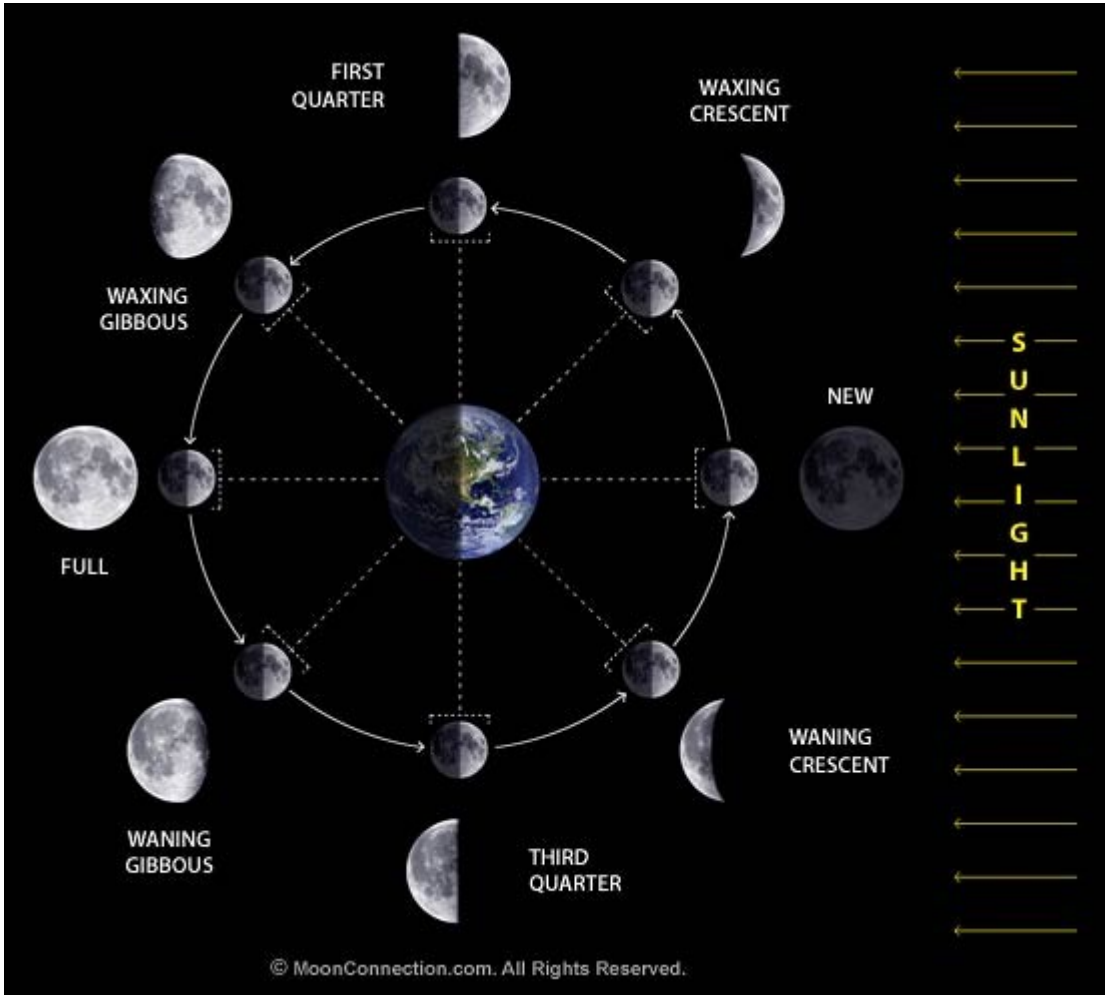
The earth has 1 moon

What do you see?

The moon

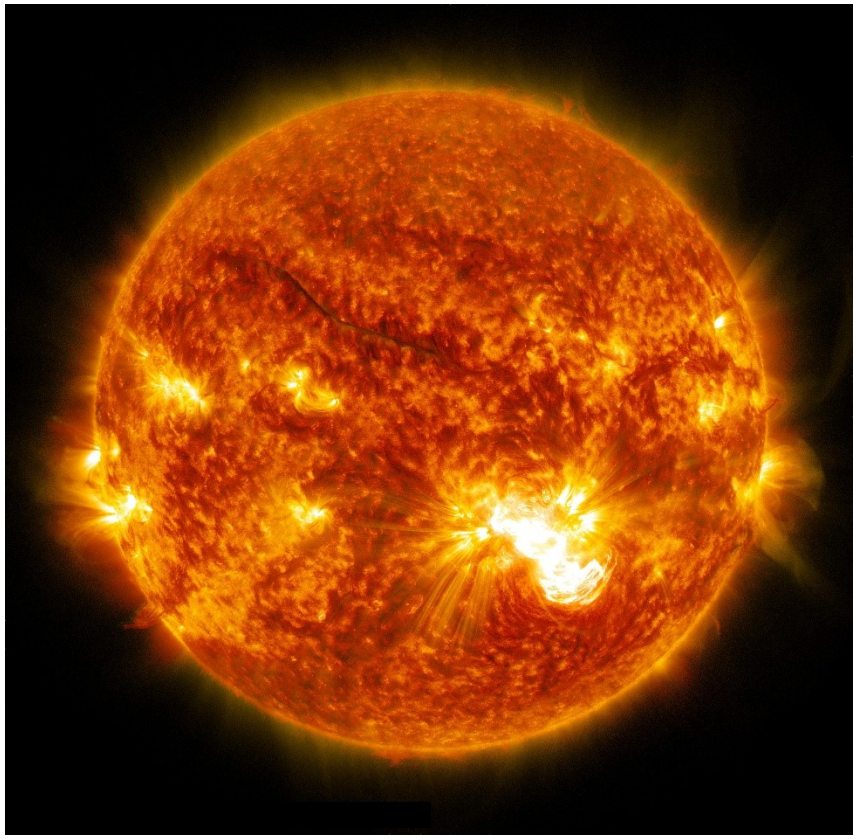
- Is 238,900 miles – 384,400 km from earth
  - It takes about 3 days to get there on a space ship
- The moon is about 4.4 billion years old
- It formed as the result of a collision of a mars sized object with earth.
- The moon is the main cause of tides on earth
- Life as we know it would not be possible without the moon.
- Man first landed on the moon 20 July 1969.
- Circumference is 6,784 miles – 10,917 km
- Our moon is the 5th largest in the solar system and the largest relative to the size of its primary.

Phases of the moon



The Sun

- What do you see?



What *is* the sun?

- The sun is a yellow dwarf star (white when viewed from space)
- Diameter is 865,374 mi – 1,392,684 km
- Ongoing thermonuclear reaction converts H into He and releases energy and light
- Sun formed just over 4.5 billion years ago
- Sun's light takes 8 minutes to reach earth
- The sun has an atmosphere called the corona
- The temperature at the core is about 27 million degrees F, 15 million C, and at the surface (photosphere) about 10,000 F, 5,500 C, but the corona is about 1.8 million degrees F, 1million C.

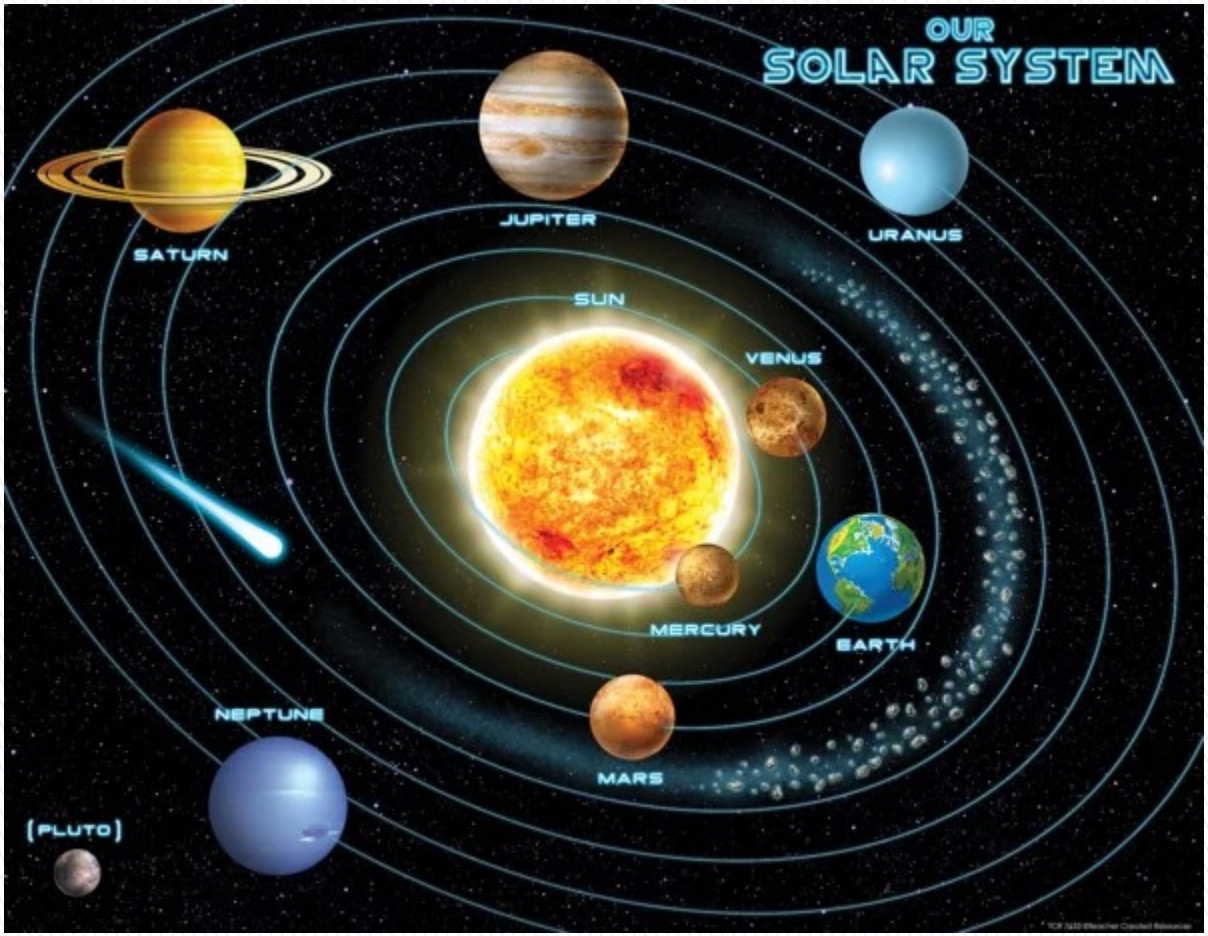
The Sun Is An Ordinary Star

- The other stars are suns that are very far away
- Spectroscopic analysis allowed us to see that the other stars have the same chemical make up as the sun. They are all the same.

Our Solar System

Who else is in the neighborhood?

- Not to scale…



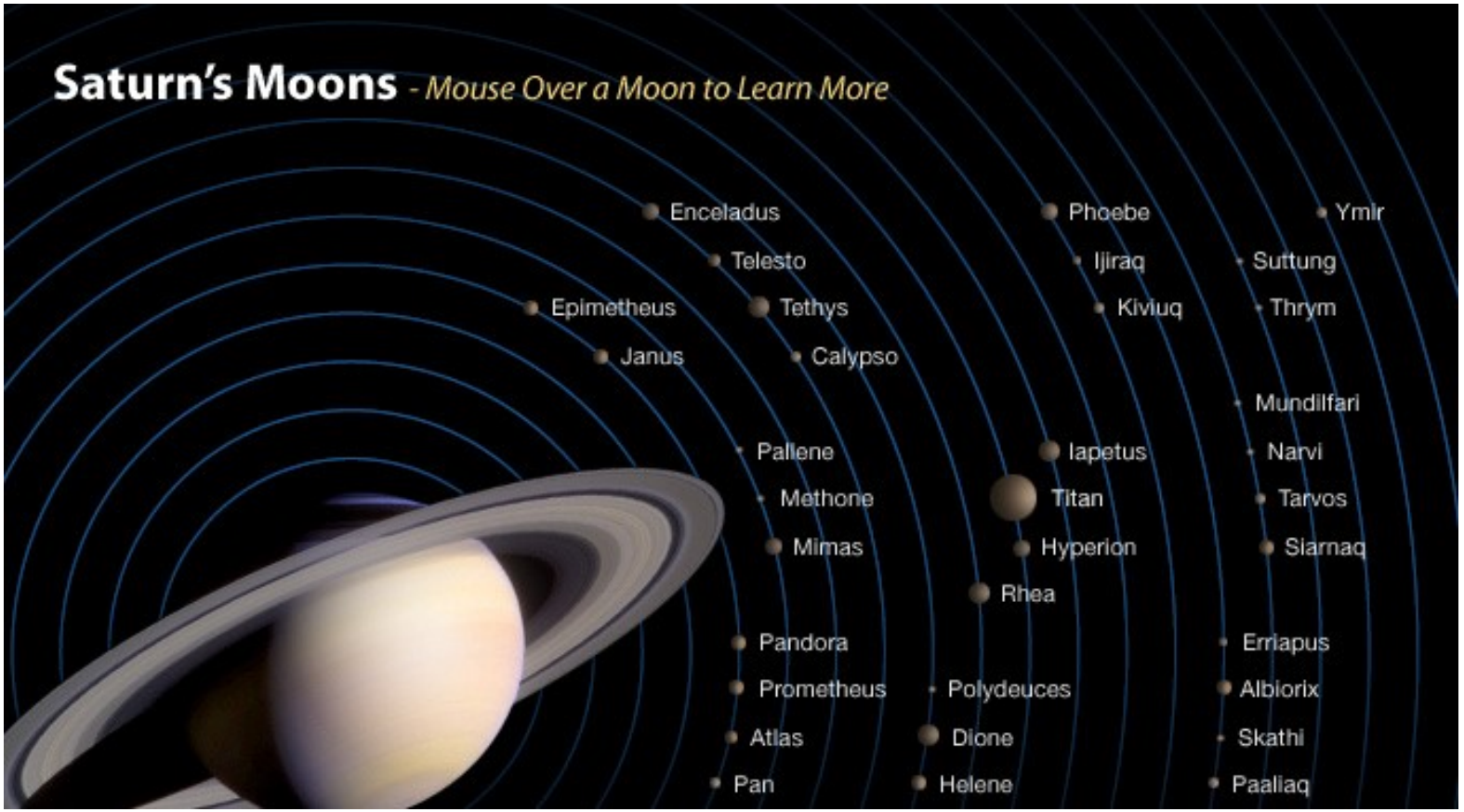
MVEMJSUN

M(r) Vem J Sun

3rd Rock from the Sun

- Mercury, Venus, Earth and Mars are the inner, rocky planets.
- The asteroid belt (Mars – Jupiter) is probably comprised of leftovers from the sun's accretion disk
- Jupiter, Saturn, Uranus and Neptune are the outer gas giants

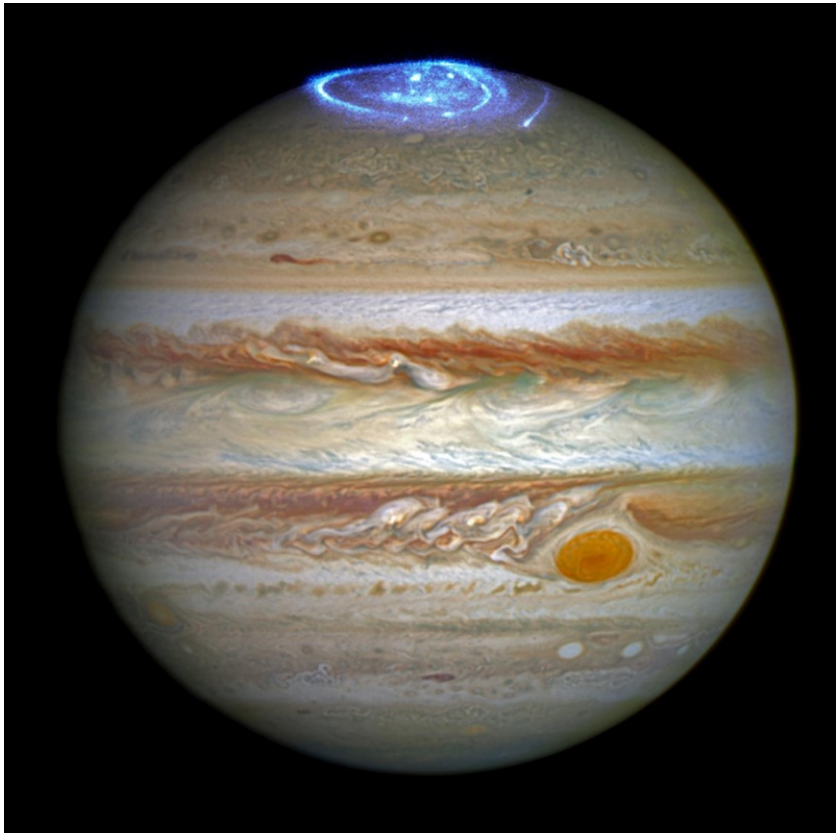
Saturn



Saturn's magnificent rings are mostly water ice chunks under 30'

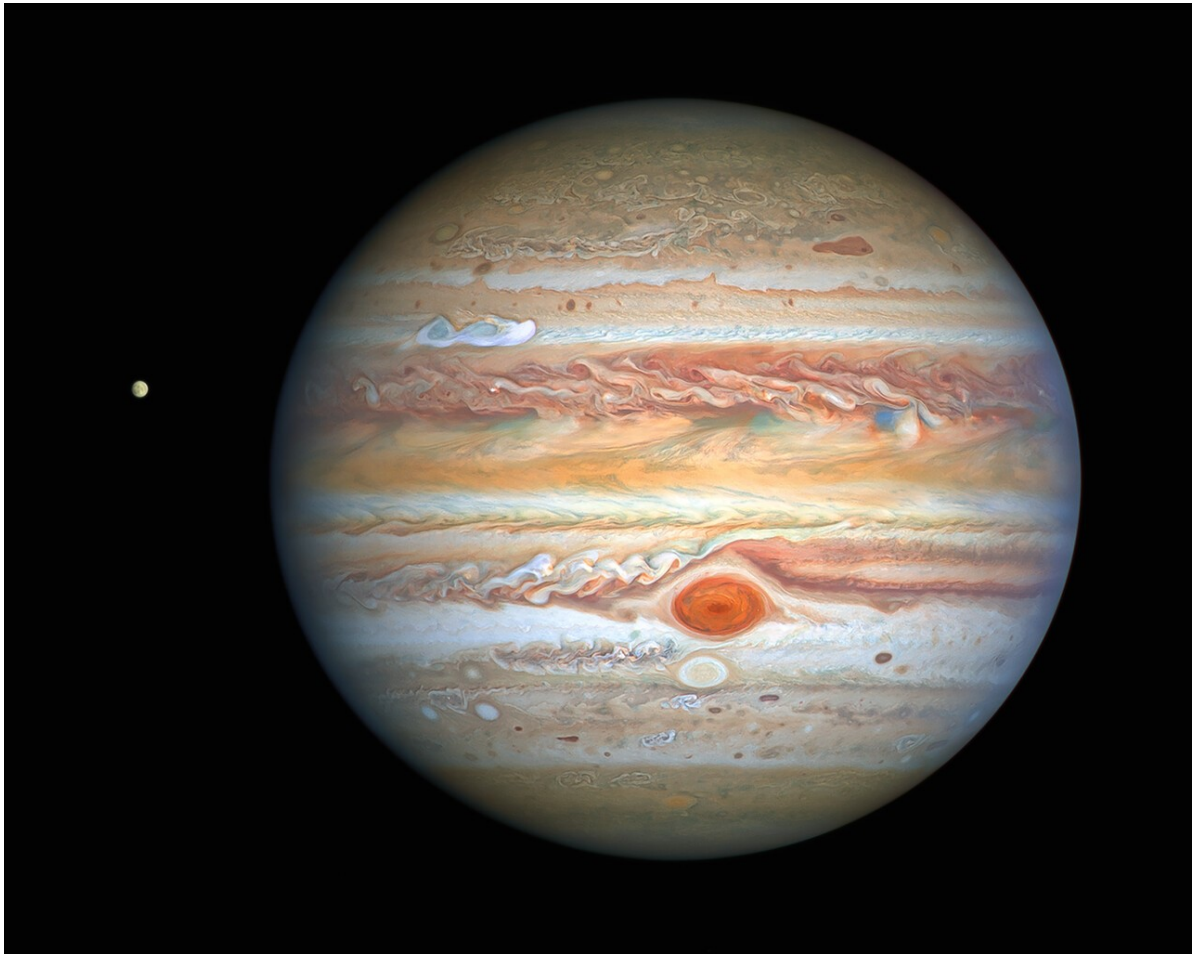
All of the outer planets have rings.

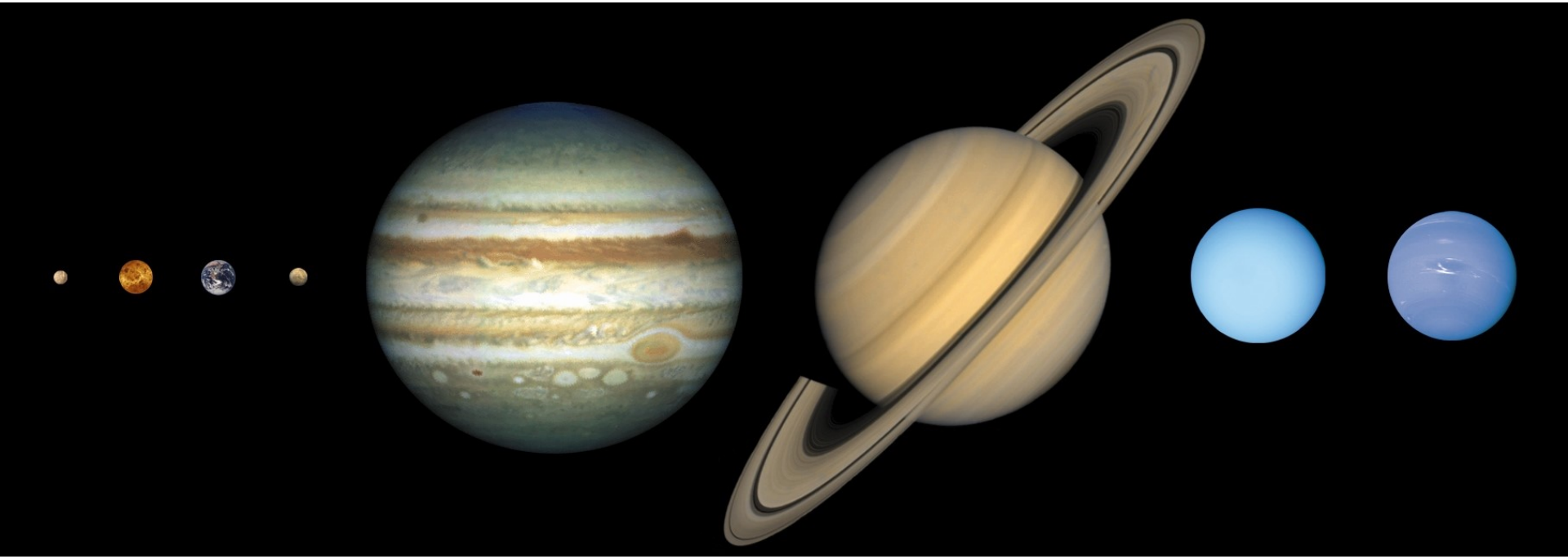
Jupiter



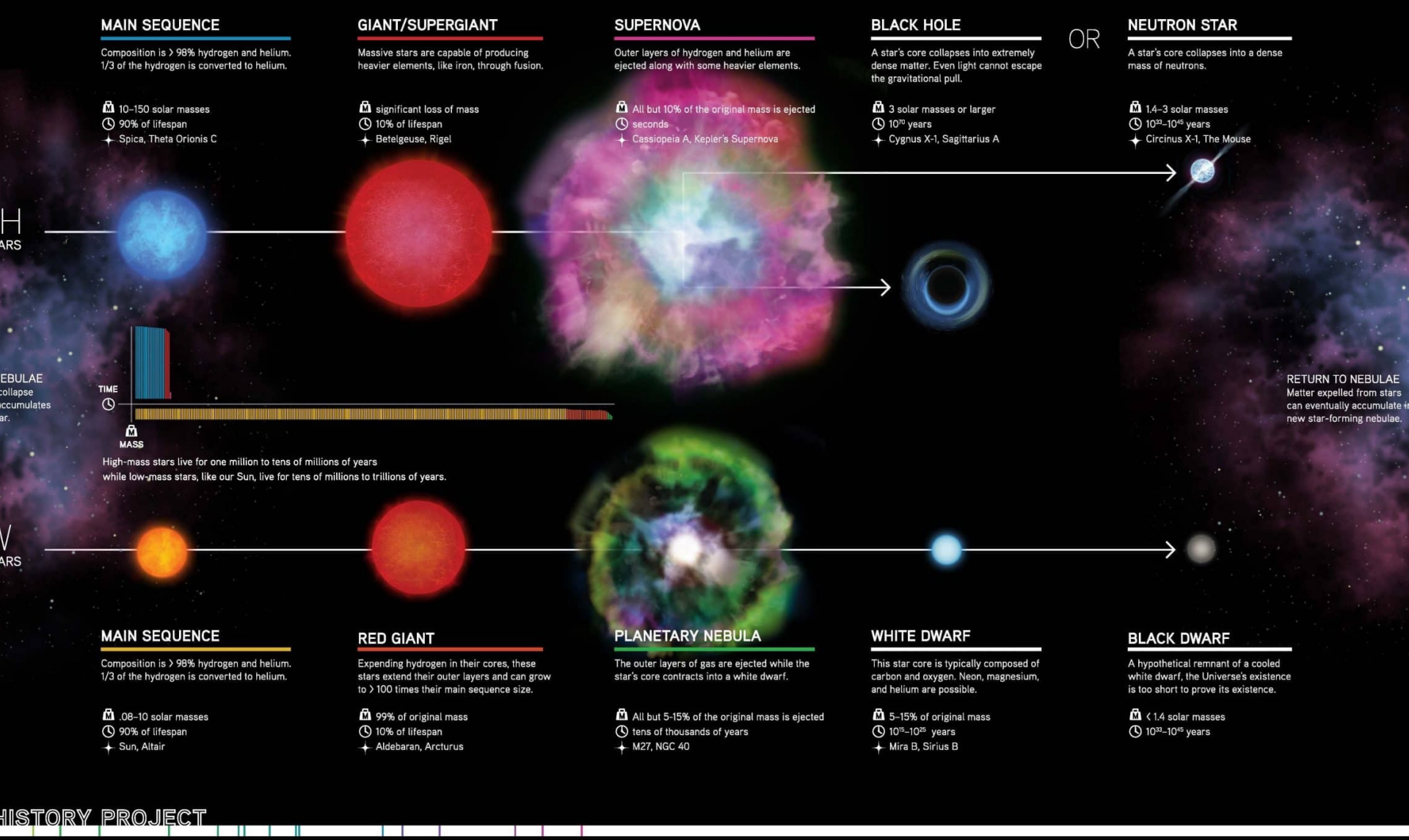
Jupiter's composition is similar to a star. If it were a little bigger, it would have become a star. It is the largest planet in our solar system. Life as we know it on earth would not be possible without Jupiter.

Hubble's View of Jupiter and Europa in August 2020



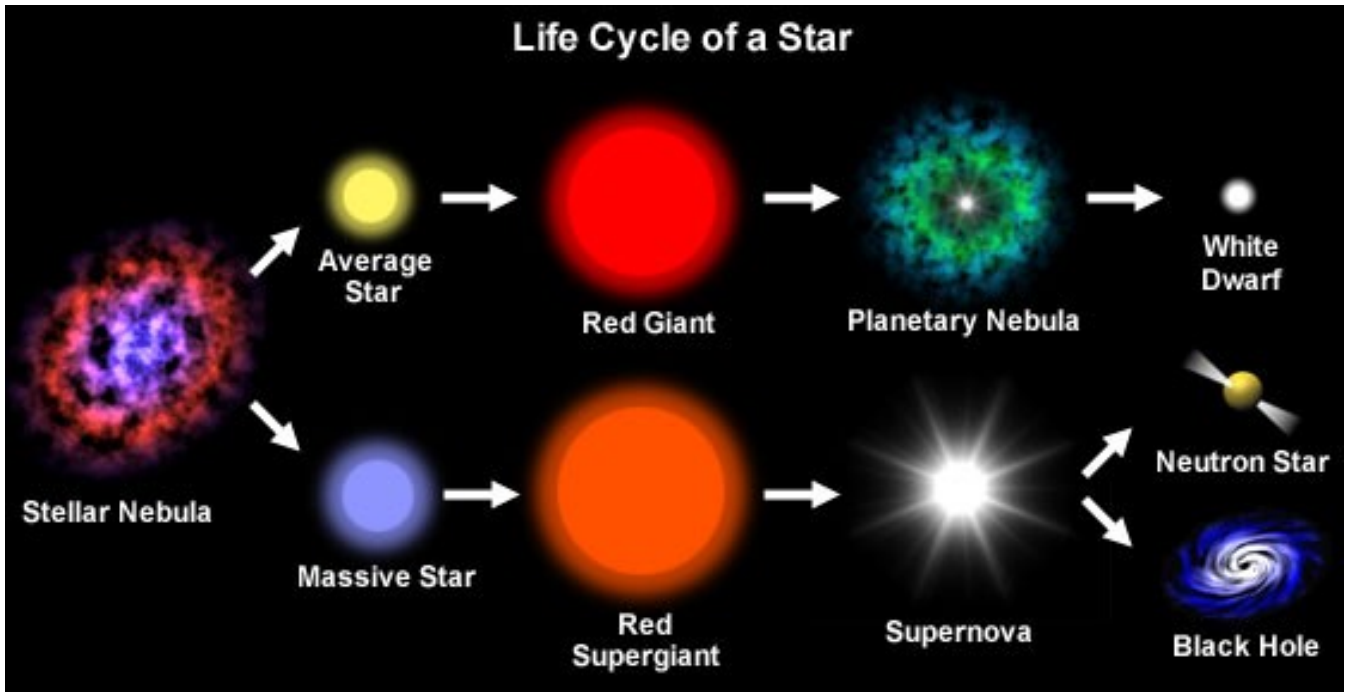


HE LIFE CYCLES OF STARS



HISTORY PROJECT

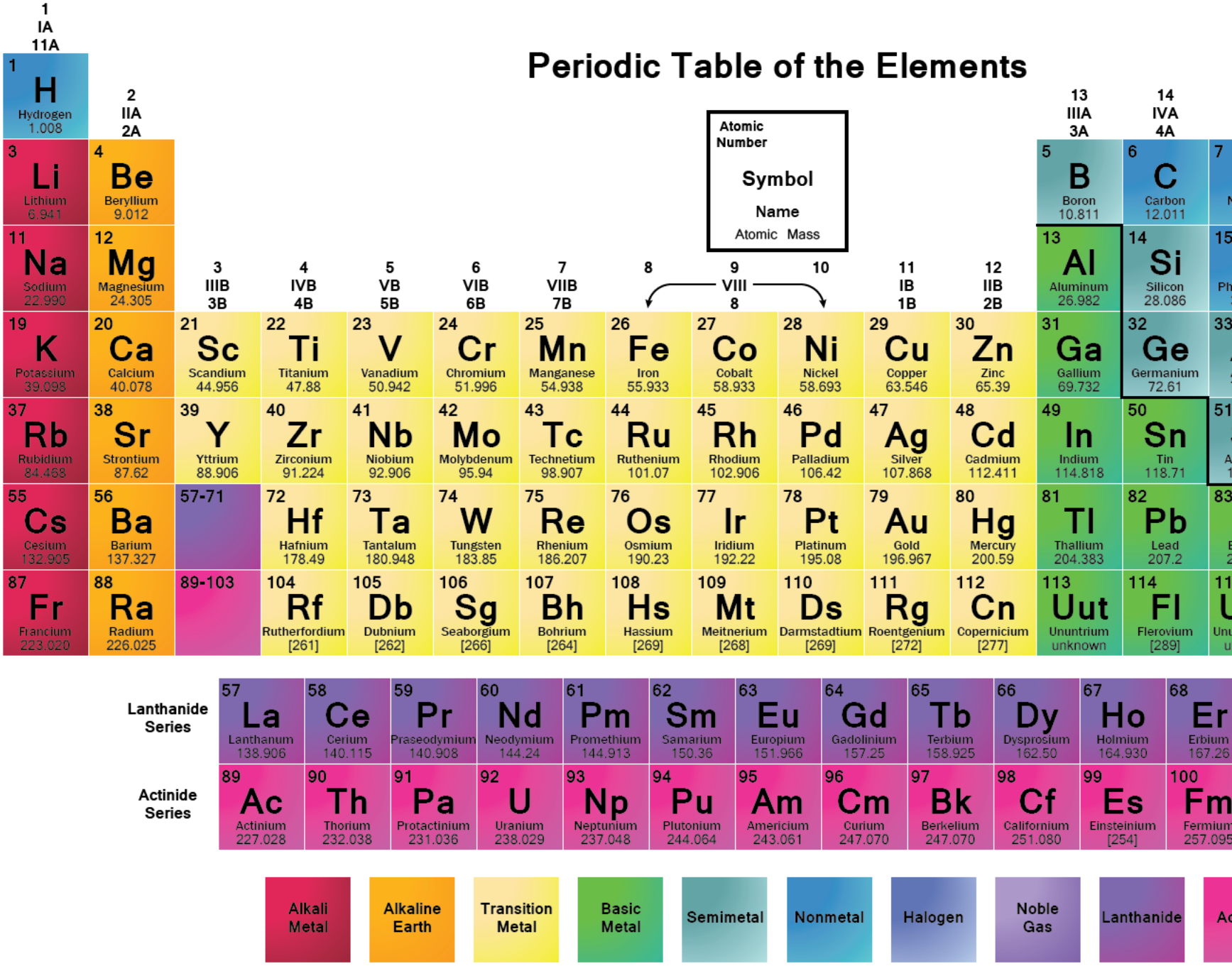
A Star's Mass Determines Its Life Cycle



Main Sequence Stars

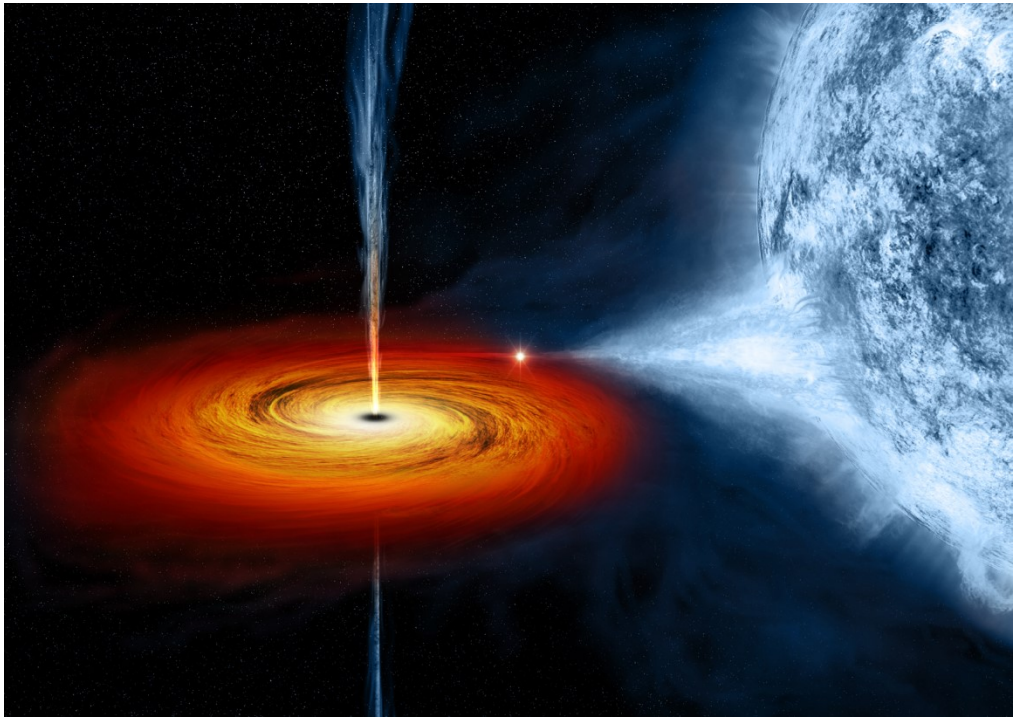
- 90% of stars, including our sun, are MS stars, also called dwarf stars. They fuse Hydrogen (H) into Helium (HE).
- When the helium is gone, the next step depends on the star's mass.
- All elements up to Iron (FE) are formed in MS stars.
- More massive stars become super novae. Almost all elements heavier than FE are formed inside supernovae (gold AU)

Periodic Table of the Elements

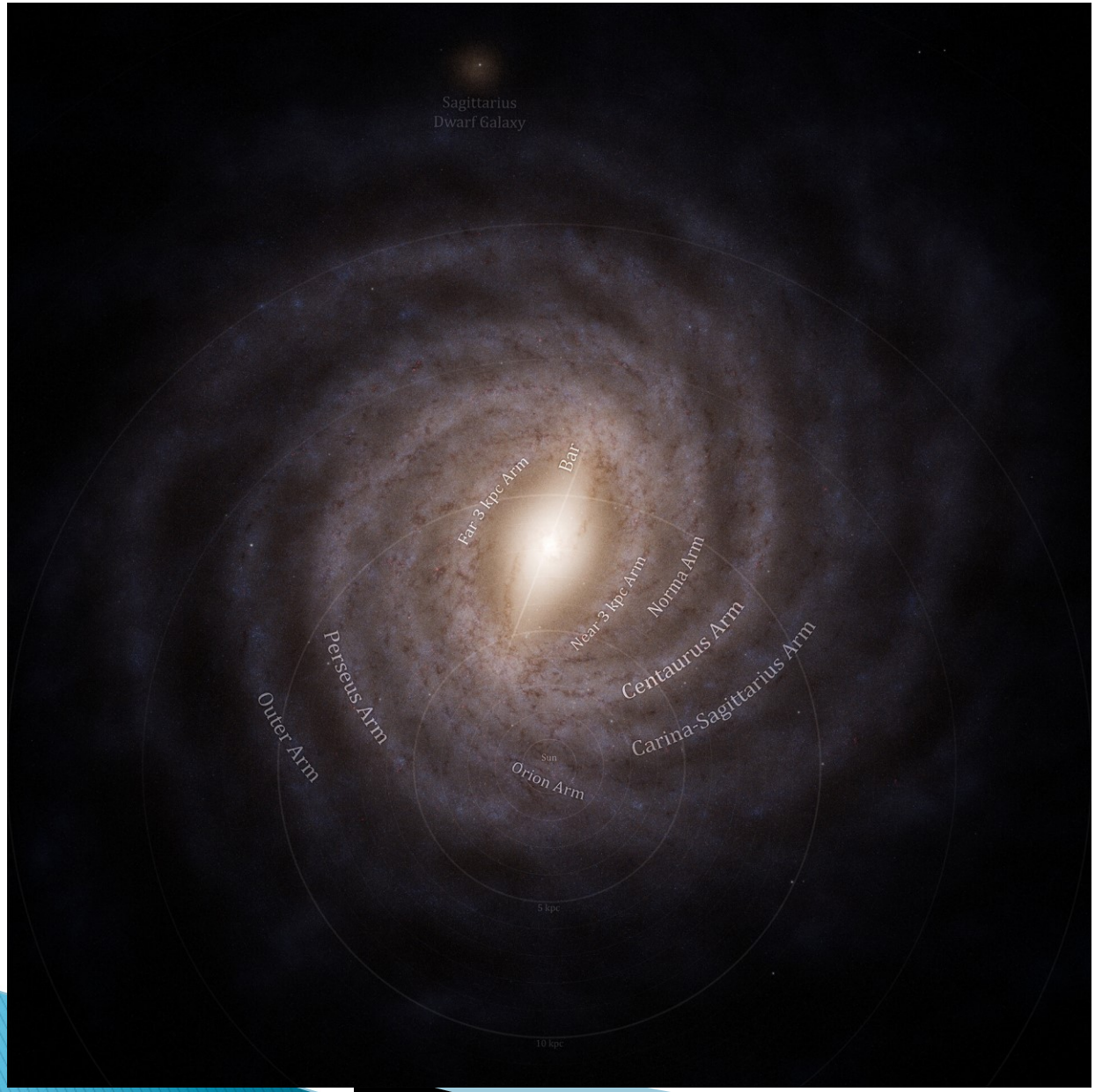


Black Holes

- More massive stars eventually collapse into neutron stars and the most massive stars become black holes.



Milky Way Galaxy



The Milky Way contains between 100 Billion and 400 Billion stars (other galaxies contain between 10 billion and 100 trillion stars)

There are as many planets in the Milky Way as stars

All the stars you see on a dark night are in the Milky Way

The Milky Way has absorbed several smaller galaxies

It is 13.2 billion years old

The Milky Way has a Super Massive Black Hole at its Center (Sagittarius A*)

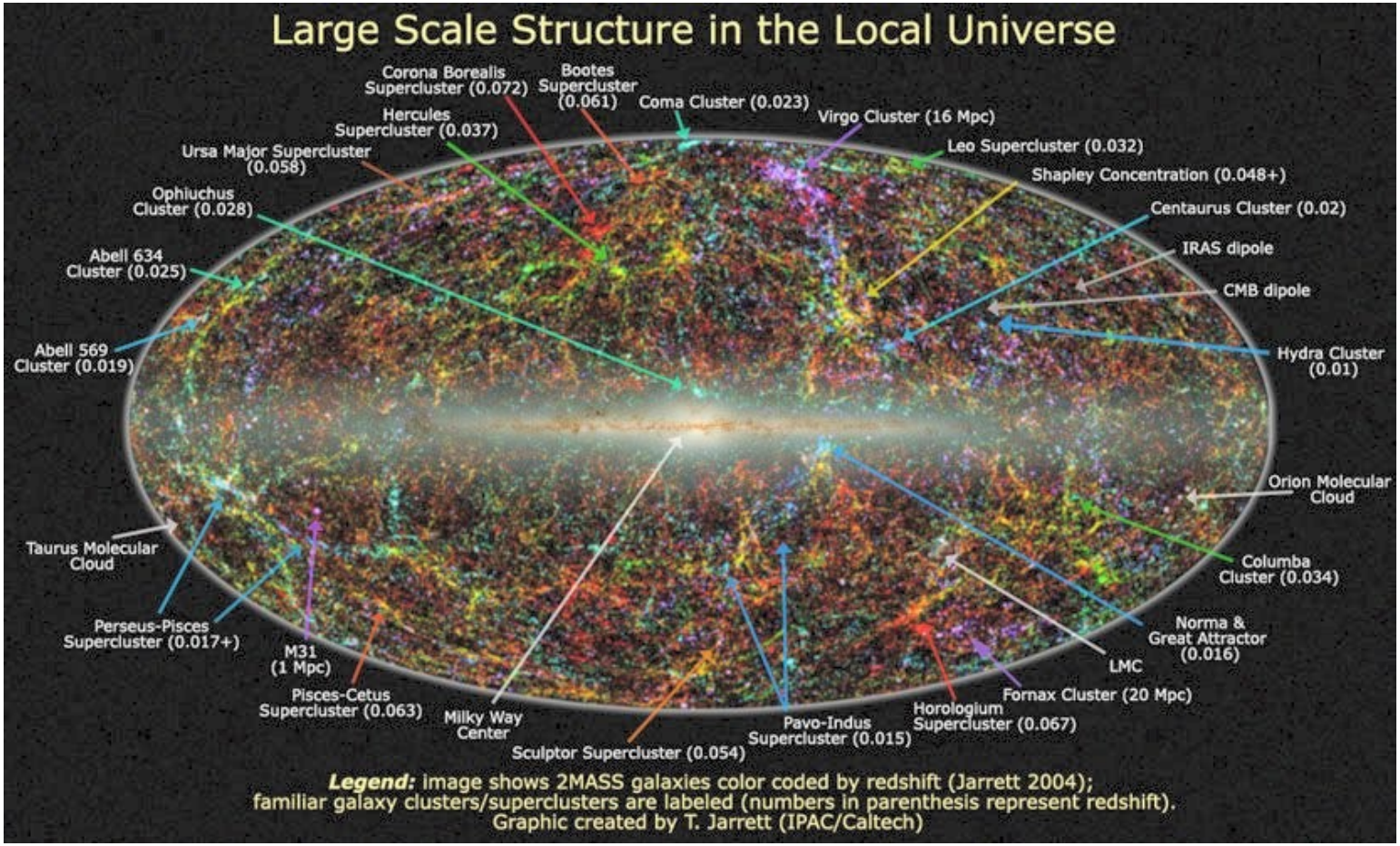
The Milky Way moves at about 1.3 million mph. Our solar system moves within the galaxy at about 500,000 mph

How Many Galaxies Are There?

- It wasn't until the late 1920s that Edwin Hubble proved that there are many Galaxies outside the Milky Way.
- The aptly named Hubble Telescope has allowed us to view a vast array of galaxies all across the universe. The estimate is that there are 200 Billion to 2 Trillion Galaxies. The most recent observations by Hubble and other telescopes put the number at 2 trillion or more.

Hubble Deep UV – August 2018

Distribution of Galaxies



What are Constellations?

- Latin – “Set of stars”
- In 1930 The International Astronomical Union recognized 88 constellations covering the northern and southern sky
- The 12 constellations of the zodiac are no more important to astronomers than the other 76 constellations
- The significance of the zodiac stems from the fact that the ecliptic -- the narrow path on the sky that the Sun, Moon, and planets appear to follow -- runs directly through these star groupings. They "wander" through the background stars of the zodiac. It was reasoned that these zodiacal constellations must be special to make up this path

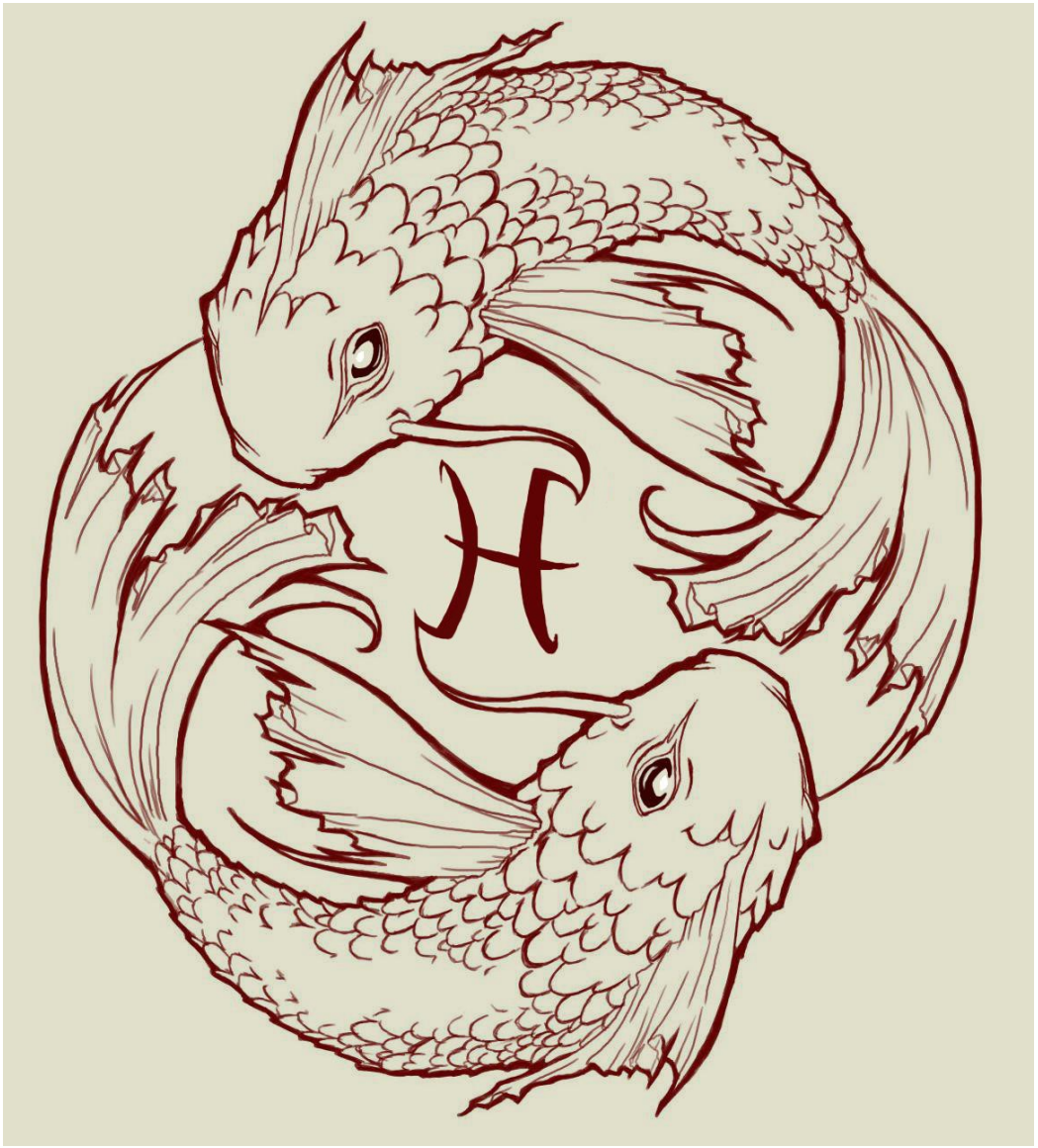
Where Did The Names Come From?

- Most constellation names are Latin in origin, dating from the Roman empire, but their meanings often originated in the distant past. Scorpius, for instance, was given its name from the Latin word for scorpion, but ancient Egyptian hieroglyphs from before 3000 BCE refer to the star group the scorpion king. Orion the hunter bears a Greek name, but had been seen as a hunter/hero figure since the times of ancient Babylon (2300 BCE)

What does it look like to you?

Who Says Pisces Looks Like A Fish?

- The horrible earthborn giant Typhoeus suddenly appeared one day, startling all the gods into taking on different forms to flee. Jupiter transformed himself into a ram; Mercury became an ibis; Apollo took on the shape of a crow; Diana hid herself as a cat; and Bacchus disguised himself as a goat. Venus and her son Cupid were bathing on the banks of the Euphrates River that day, and took on the shapes of a pair of fish to escape danger. Minerva later immortalized the event by placing the figures of two fish amongst the stars.



Short Version Is Someone Made It All Up Based On A Vivid Imagination

- Astronomers use patterns of stars called asterisms to find their way around the sky. An example is the big dipper (not a constellation)
- Astronomers look for lines, shapes, characteristics and patterns to find objects in the sky.
- Arcturus is an easy star to find and can lead you to many other objects.

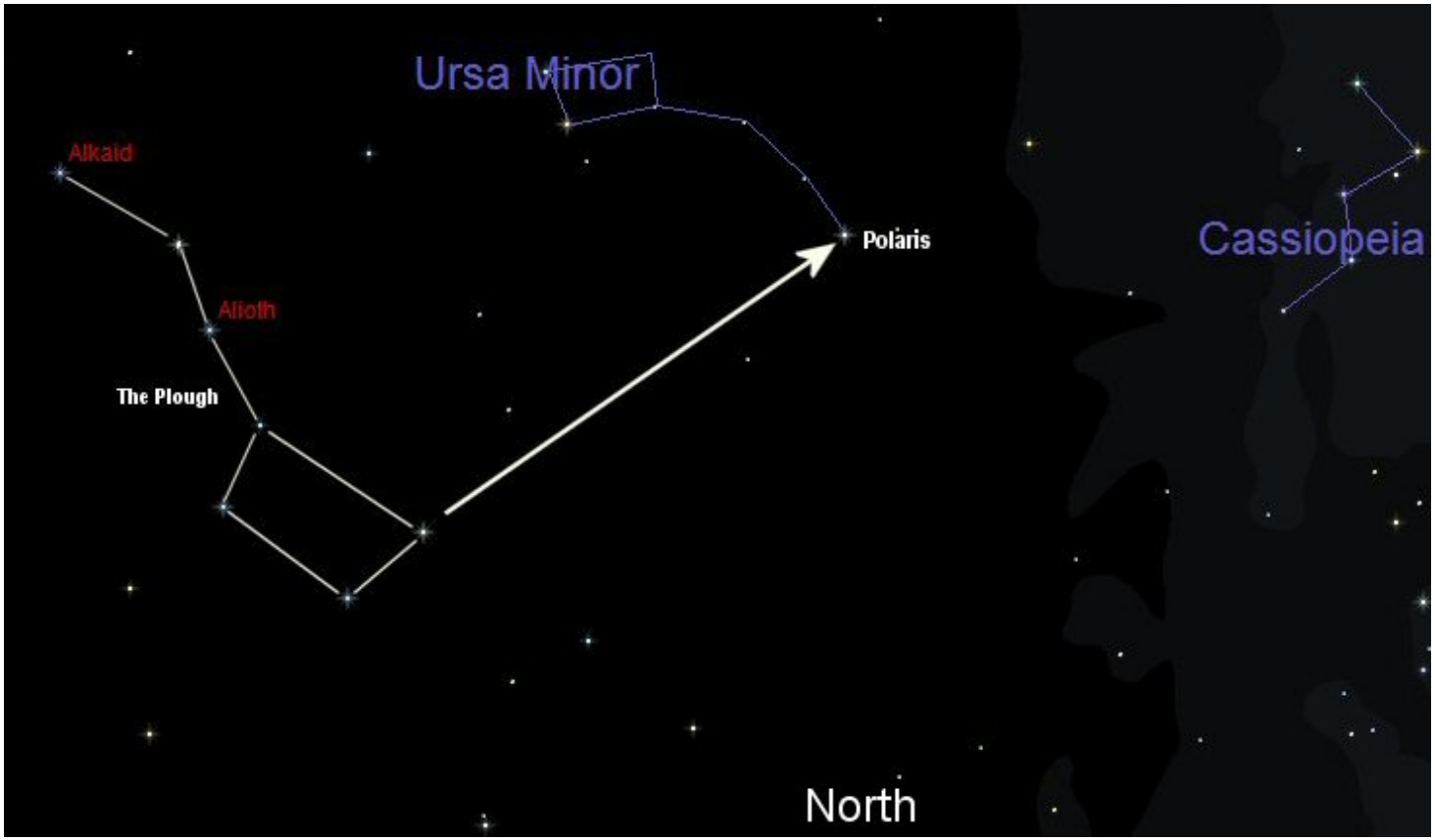
The Big Bang

- The Big Bang theory is the prevailing cosmological model for the universe from the earliest known periods through its large scale evolution. It states that the universe was in a very high density state and then rapidly expanded.

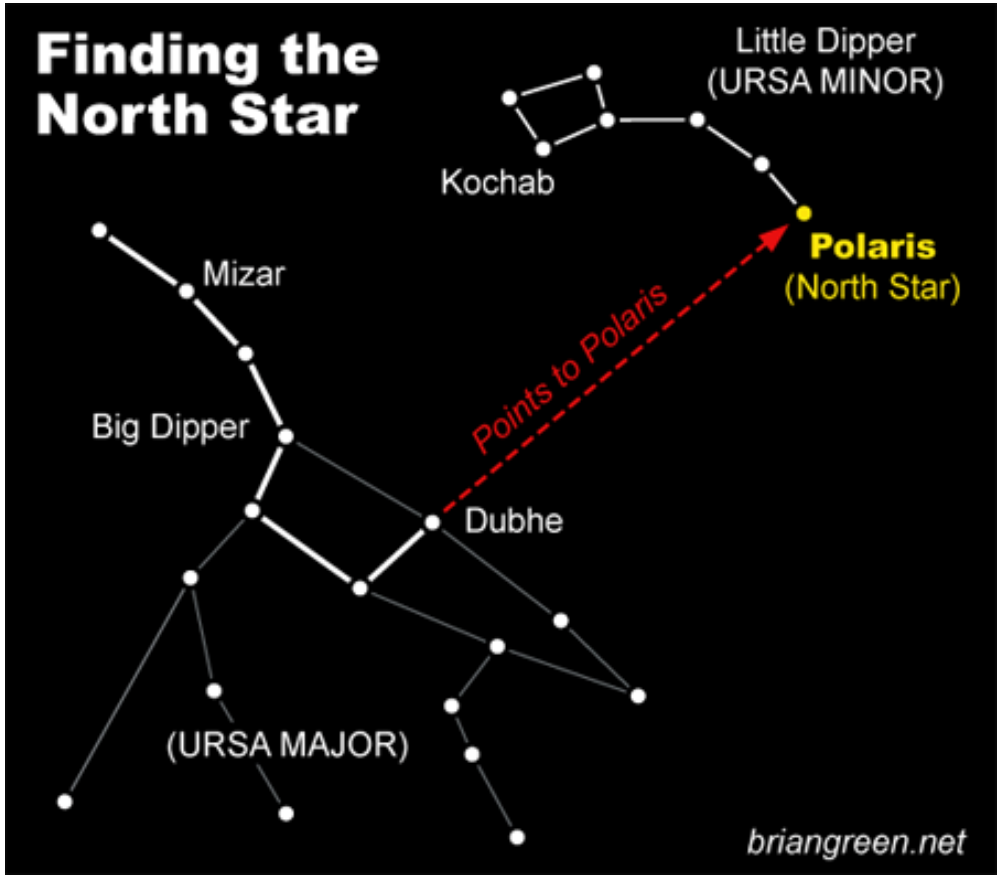
Observing Tips

- Stars twinkle, planets do not
- Use known objects to find objects new to you
- Binoculars are fine, you do not need a telescope
- Check out space.com for information
- Get used to finding Polaris
- Find the darkest place you can (light pollution makes dimmer objects impossible to see)
- Read about the objects you find (Polaris, Arcturus, Spica, Vega, Sirius, Betelgeuse, etc.)

Finding Polaris

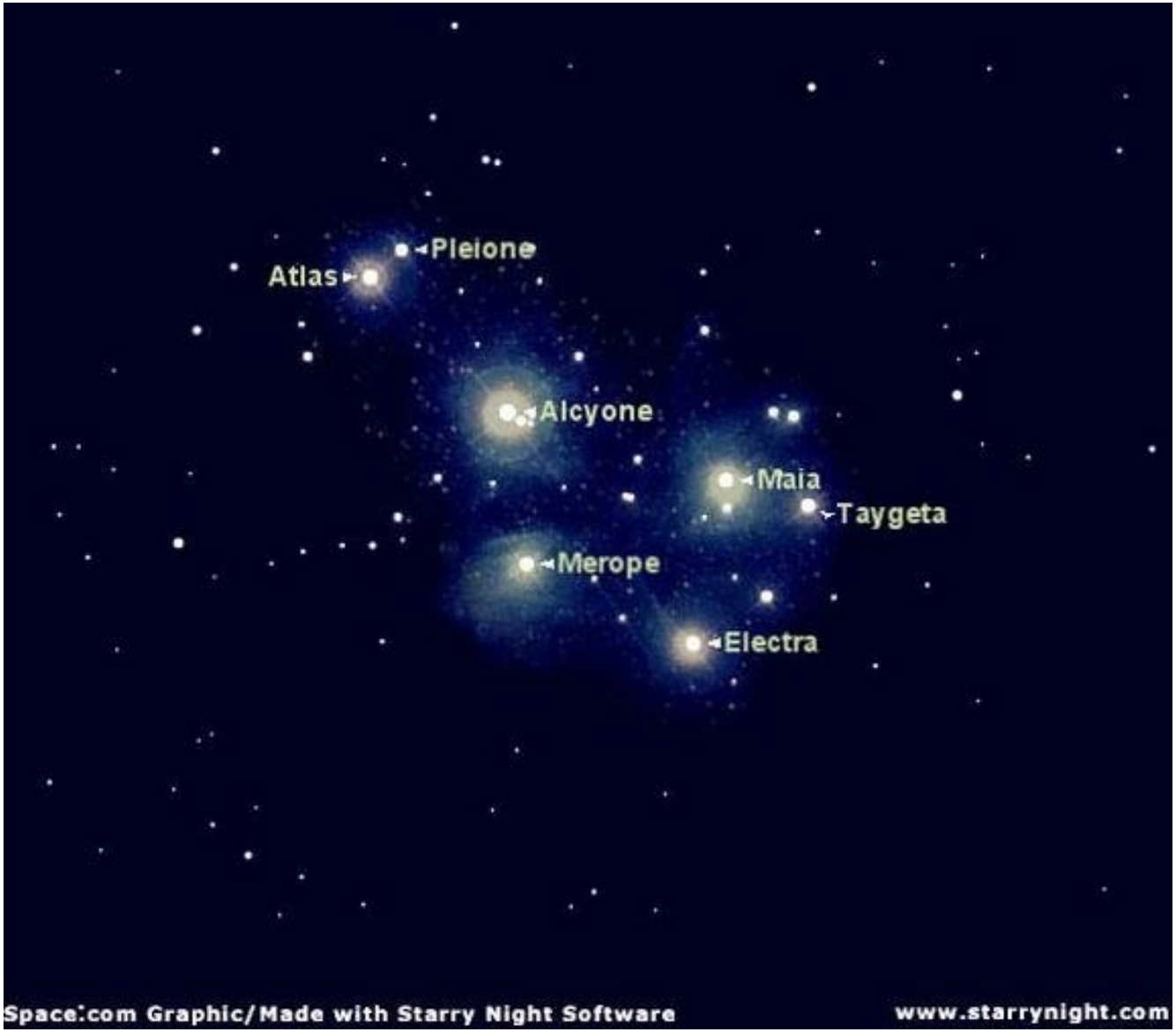


Big Dipper is an asterism in Ursa Major



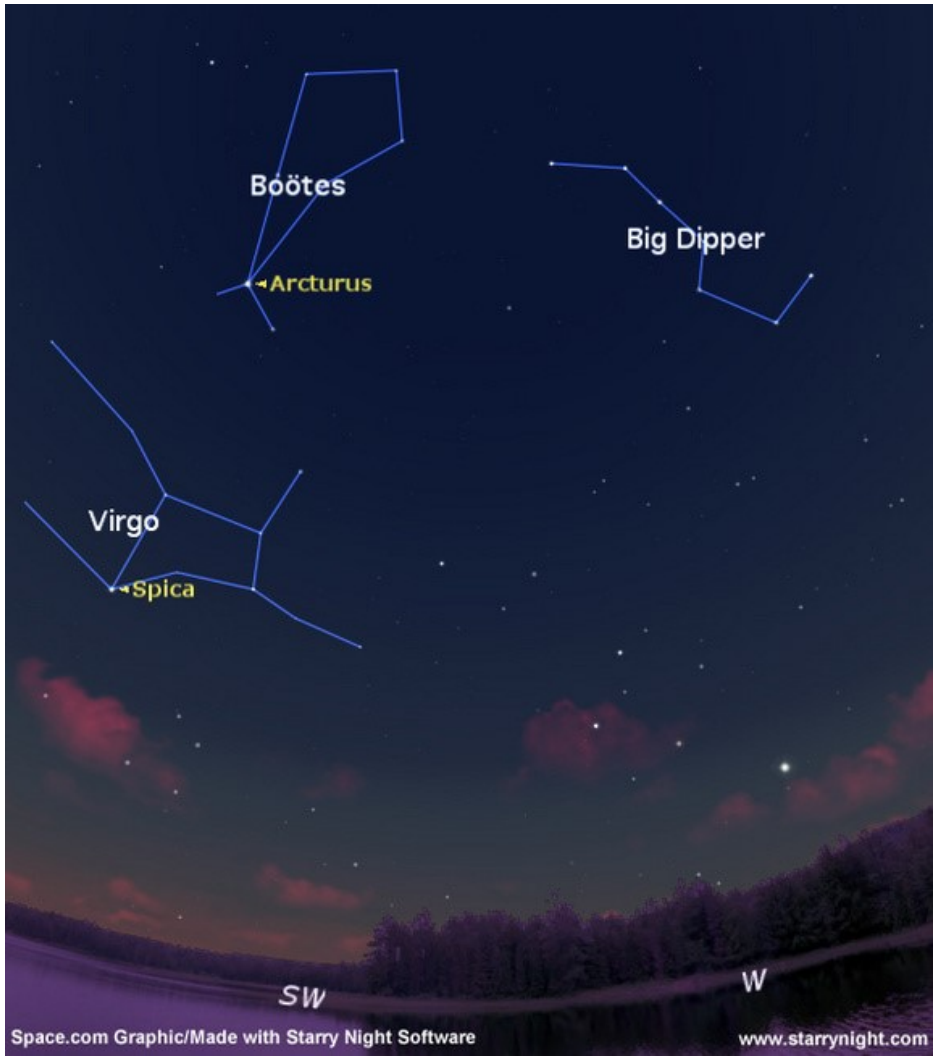
Finding Sirius (the brightest star)

The Seven Sisters

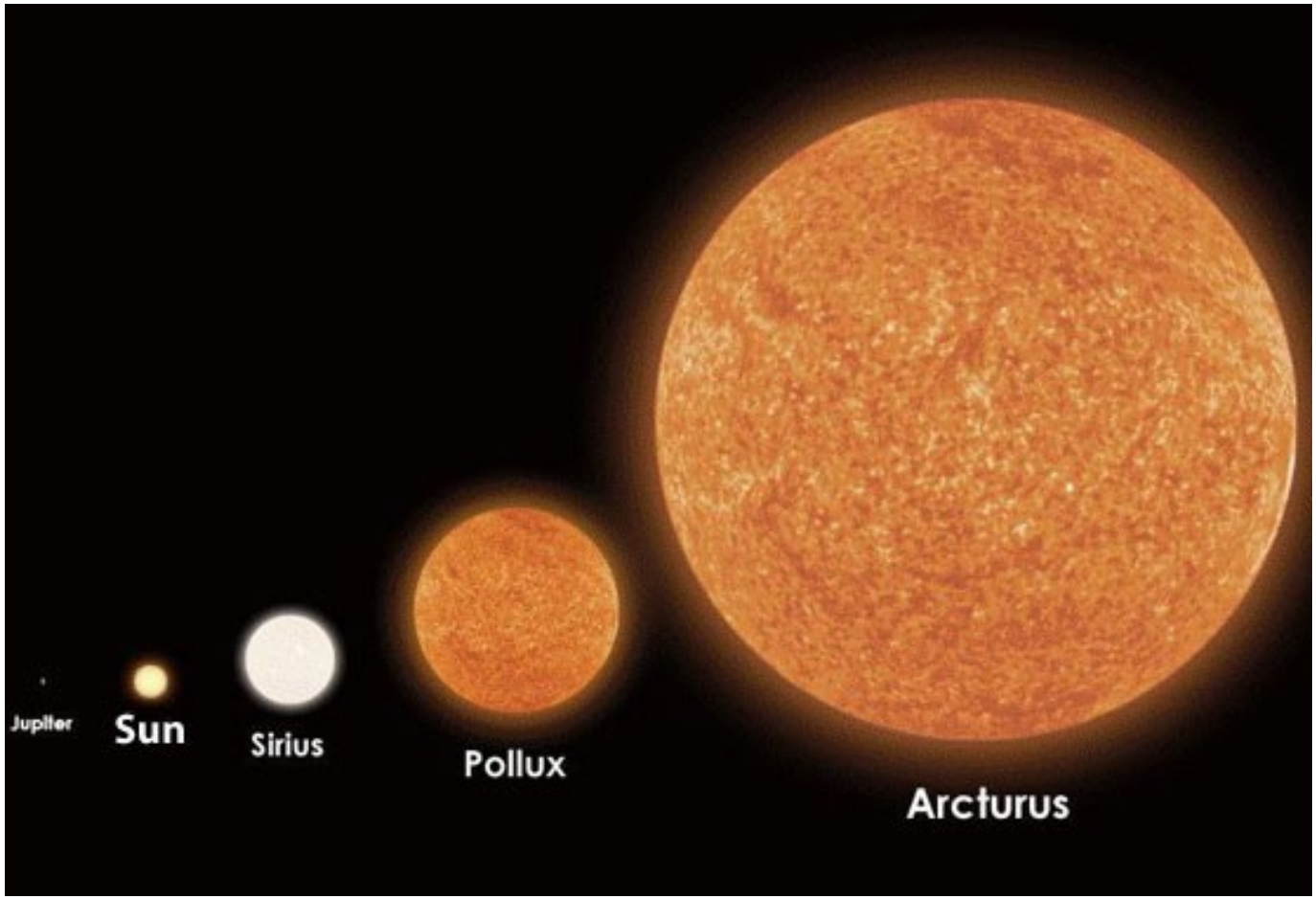

Pleione
Atlas
Alcyone
Maia
Taygeta
Merope
Electra
Space.com Graphic/Made with Starry Night Software
www.starrynight.com

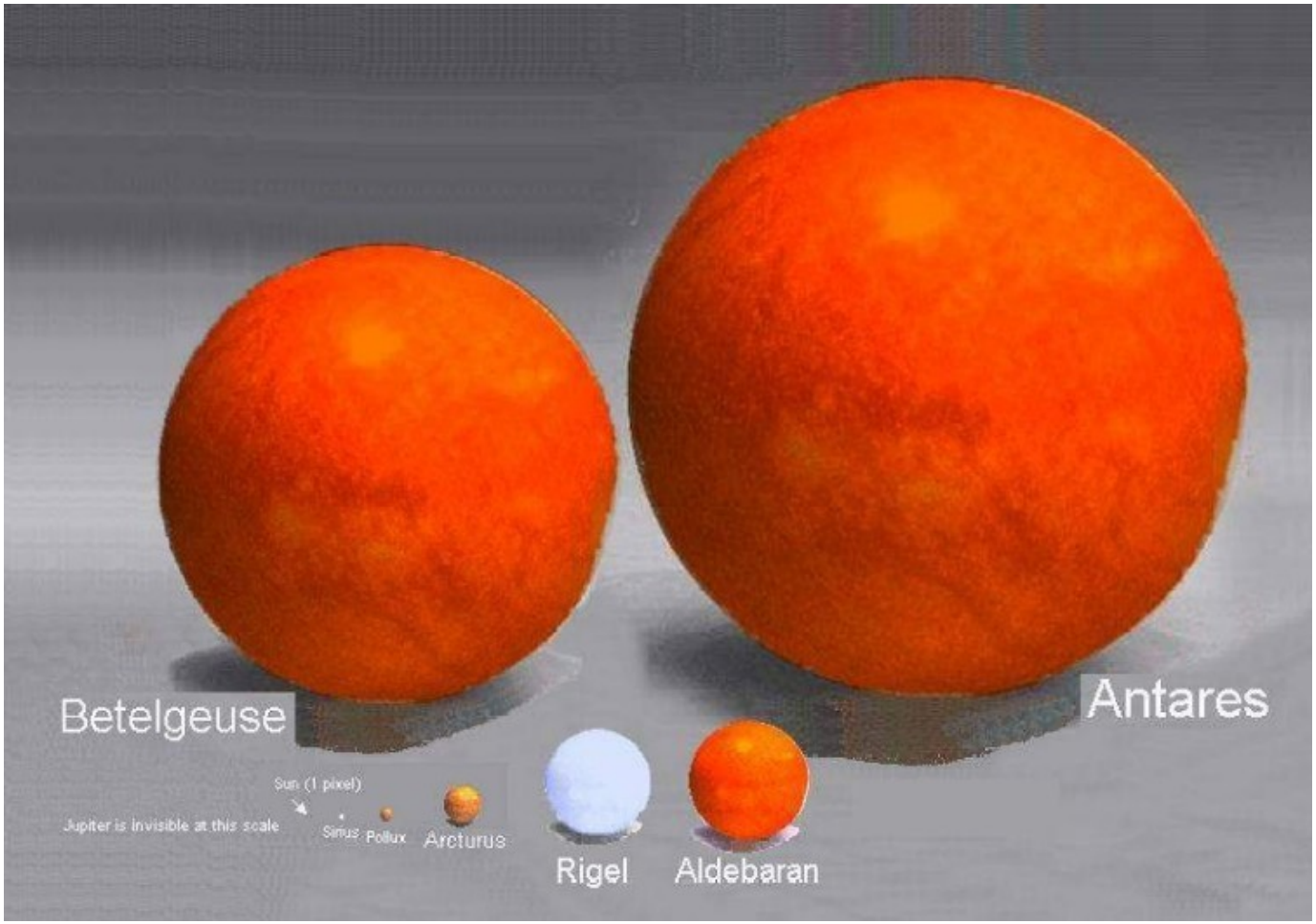
SUBARU

Back to the Big Dipper…



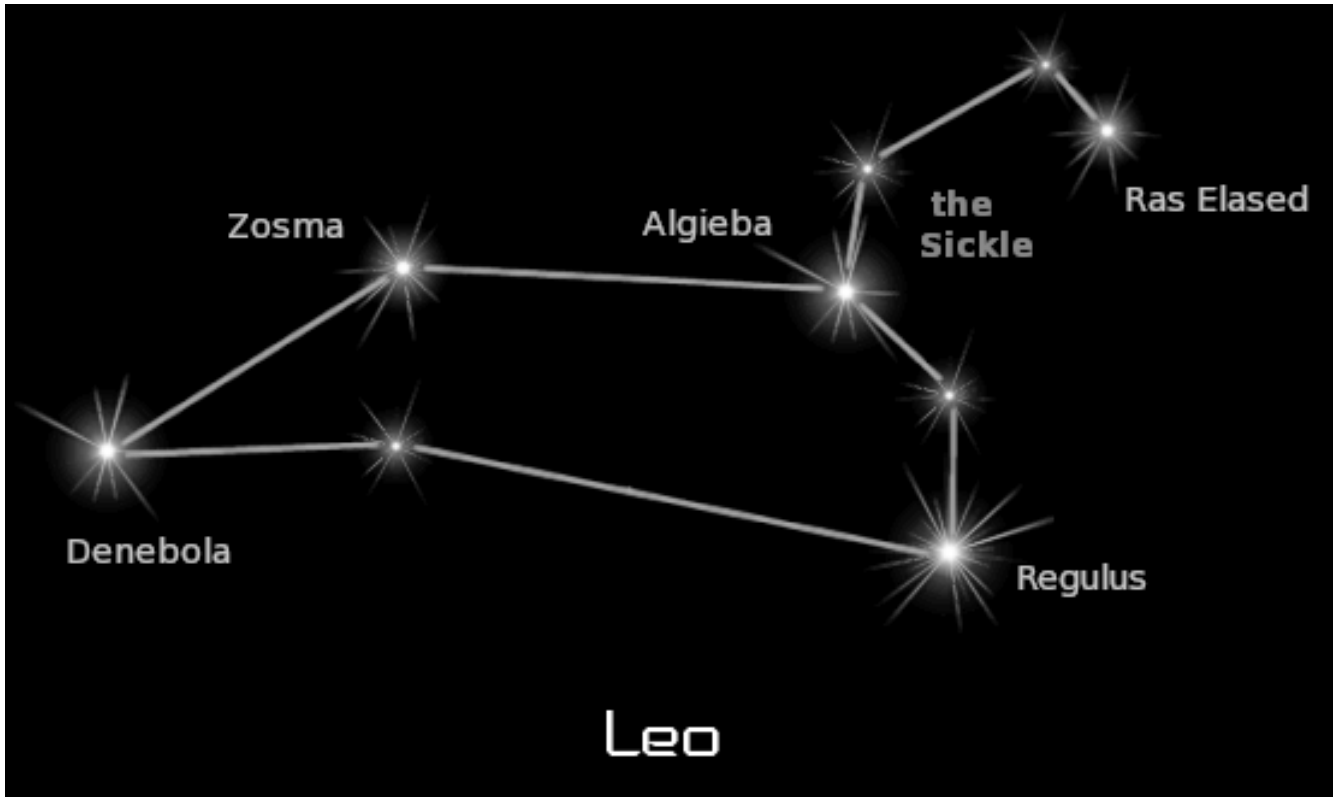
Arcturus

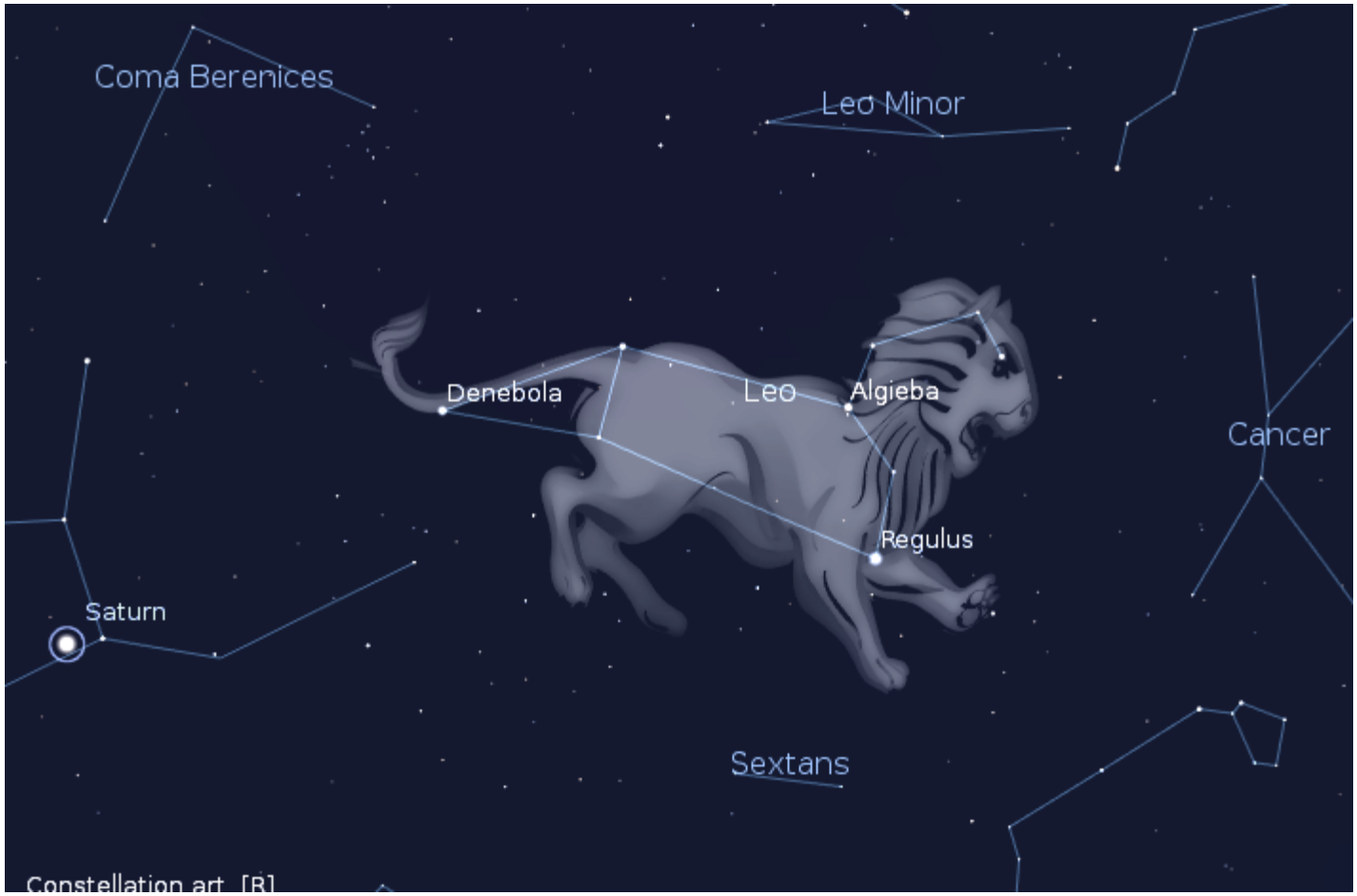



Betelgeuse
Antares
Sun (1 pixel)
Jupiter is invisible at this scale
Sirius
Pollux
Arcturus
Rigel
Aldebaran

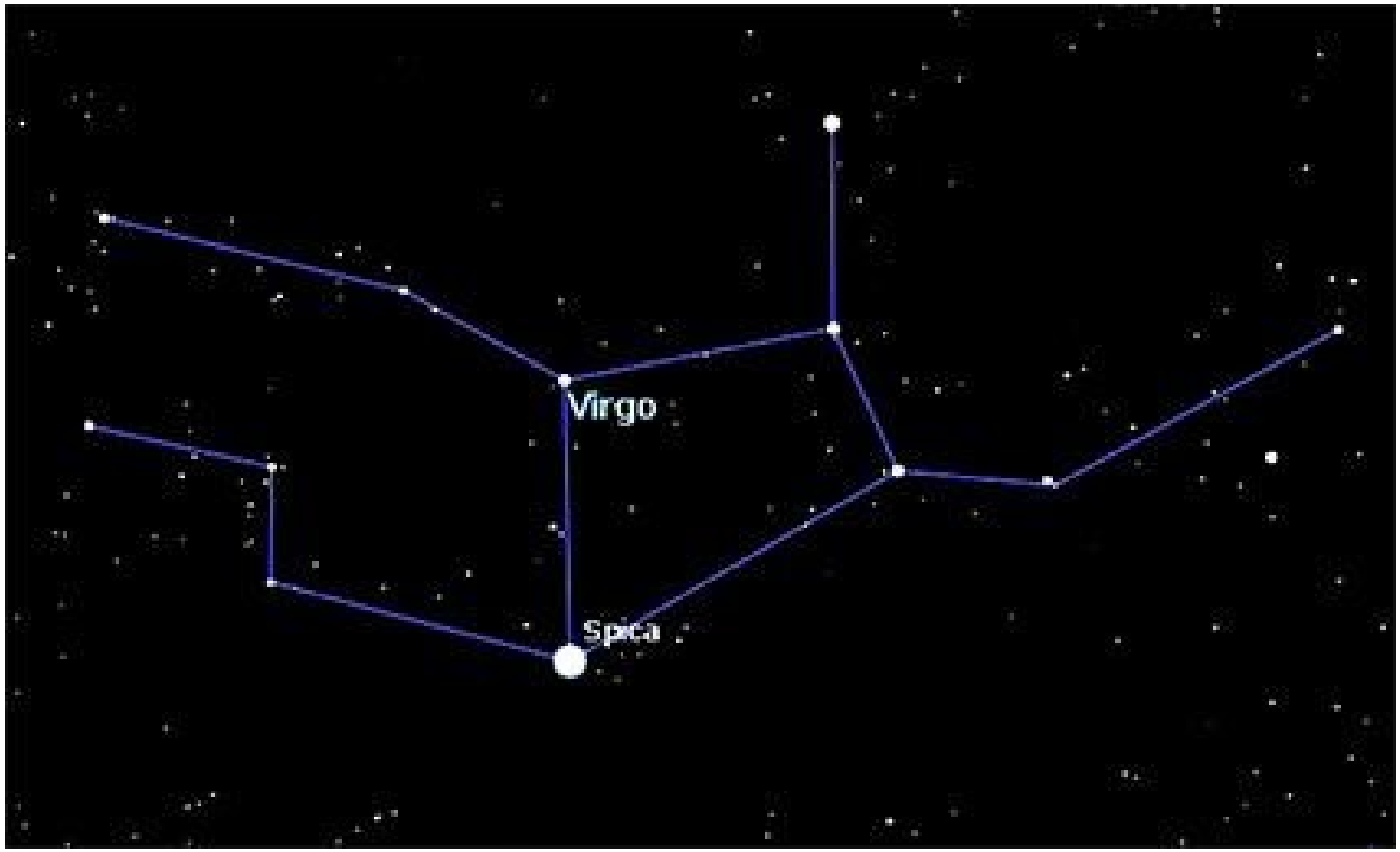
In The Sky Now

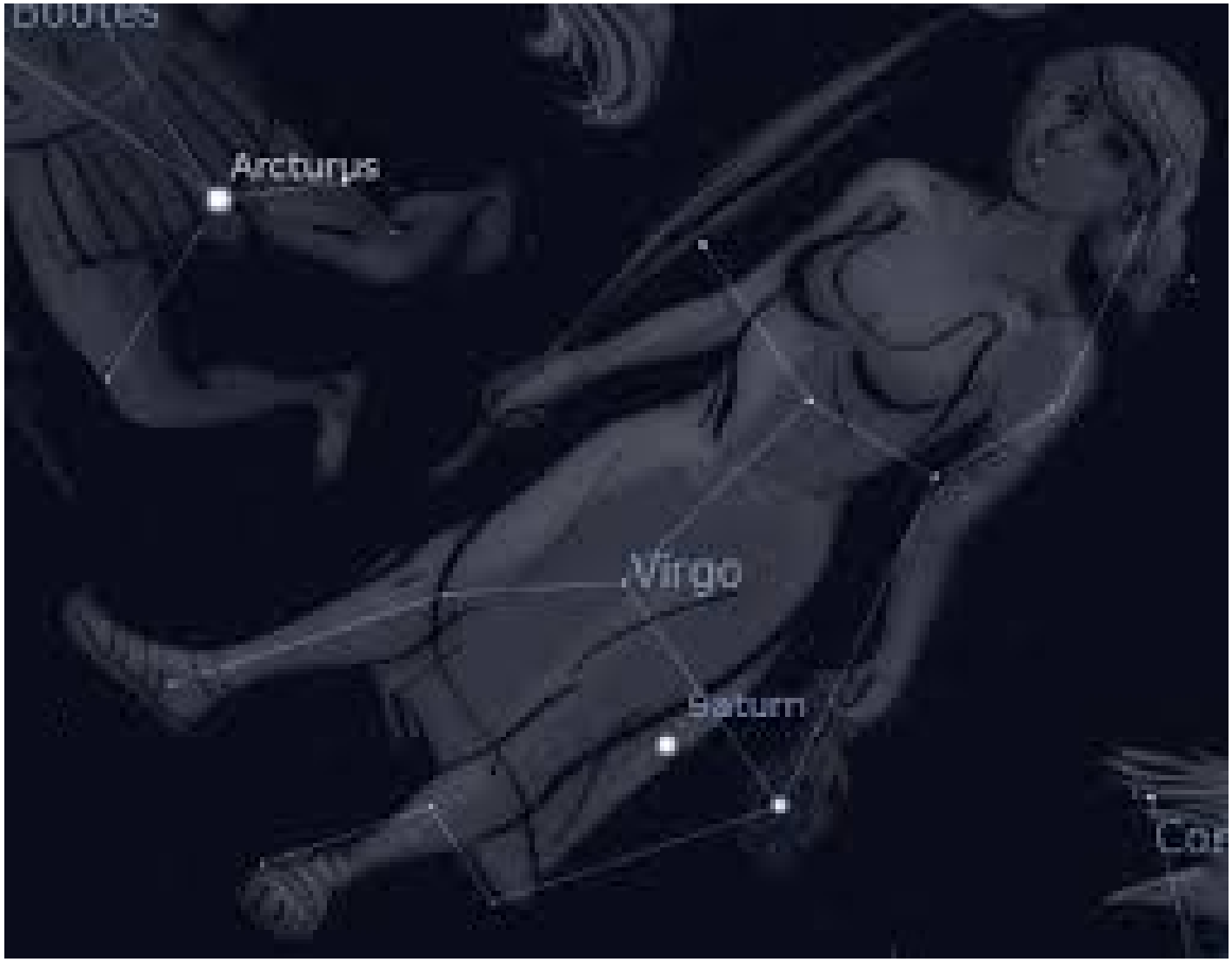
- Of the zodiacal constellations one of the best known is Leo, the Lion, which stands high above the southern horizon as darkness falls. Pretend that the bowl of the Dipper has a hole in it; the water streaming out of the bowl would fall directly on Leo. A backward question-mark-pattern of stars, known as the Sickle, forms the Lion's head and mane, while a triangle of stars to the left of the Sickle forms the Lion's hindquarters.


Zosma
Algieba
the Sickle
Ras Elased
Denebola
Regulus
Leo

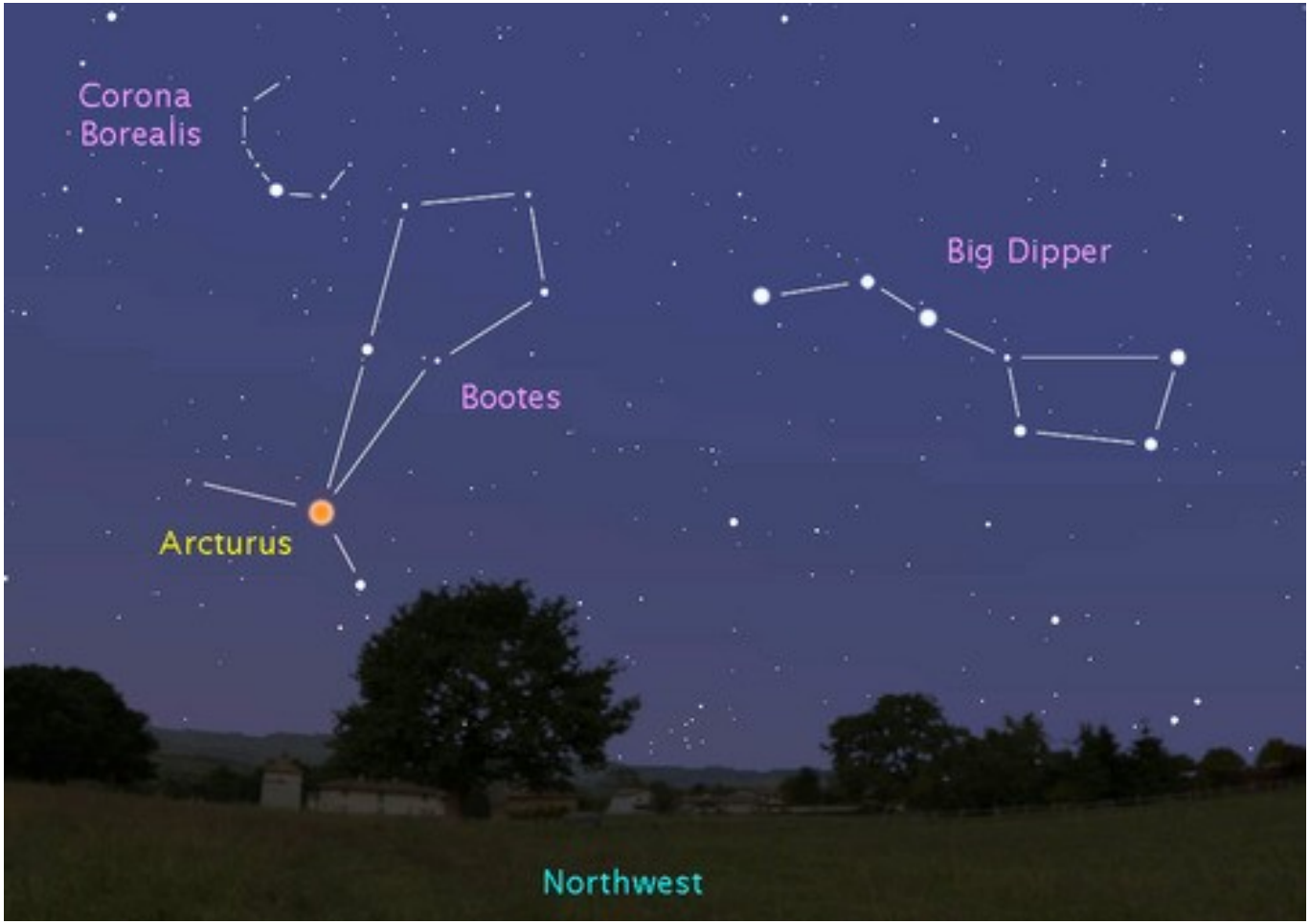

Coma Berenices
Leo Minor
Denebola
Leo
Algieba
Cancer
Regulus
Saturn
Sextans

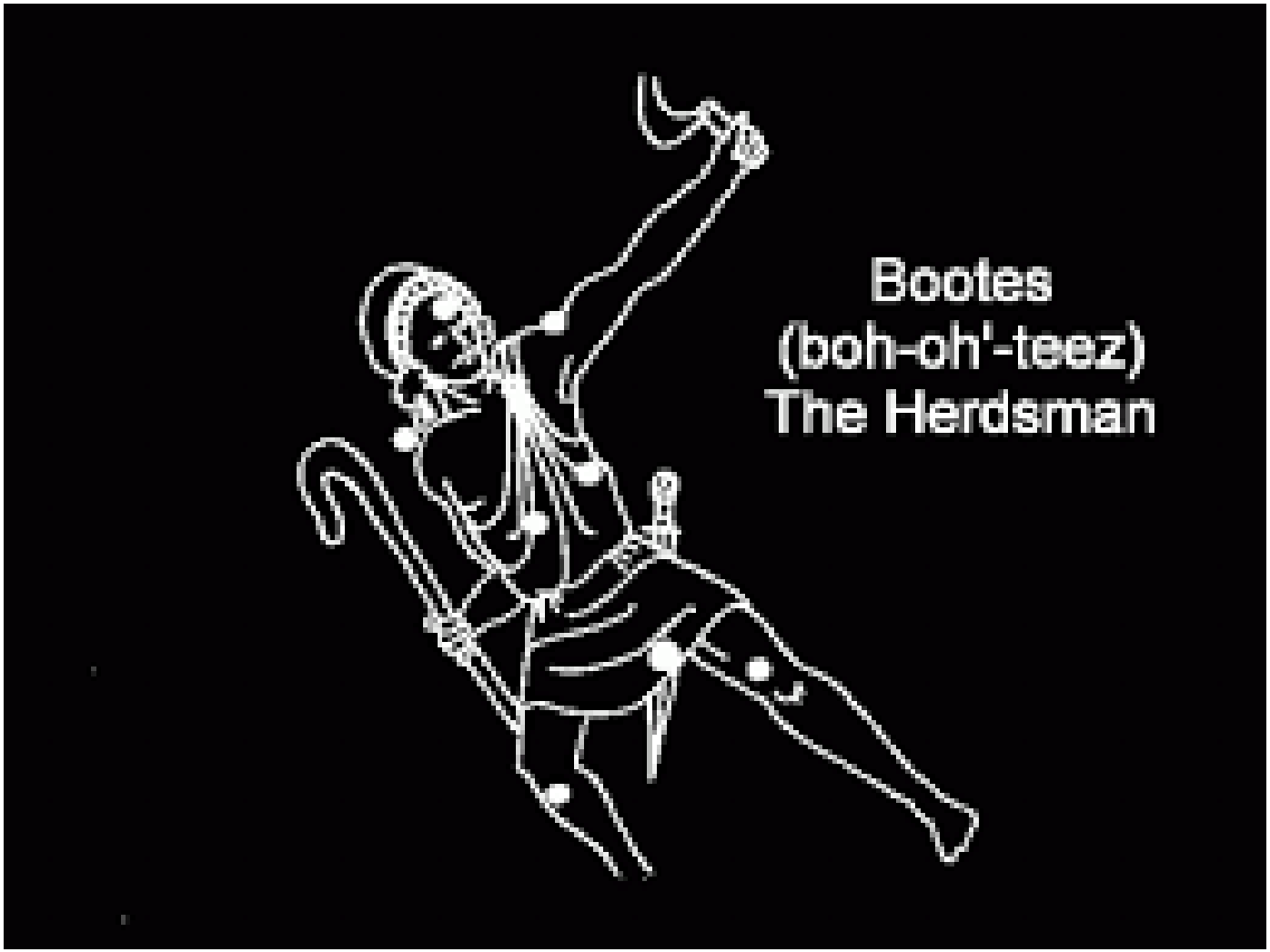
Another zodiacal constellation, situated to the lower left of Leo, is Virgo, the Young Maiden. Her brightest star is Spica, a blue-white first-magnitude star that is 250 light-years away. If you follow the curve of the Dipper's handle through Arcturus, you can "speed to Spica, or Spike to Spica."

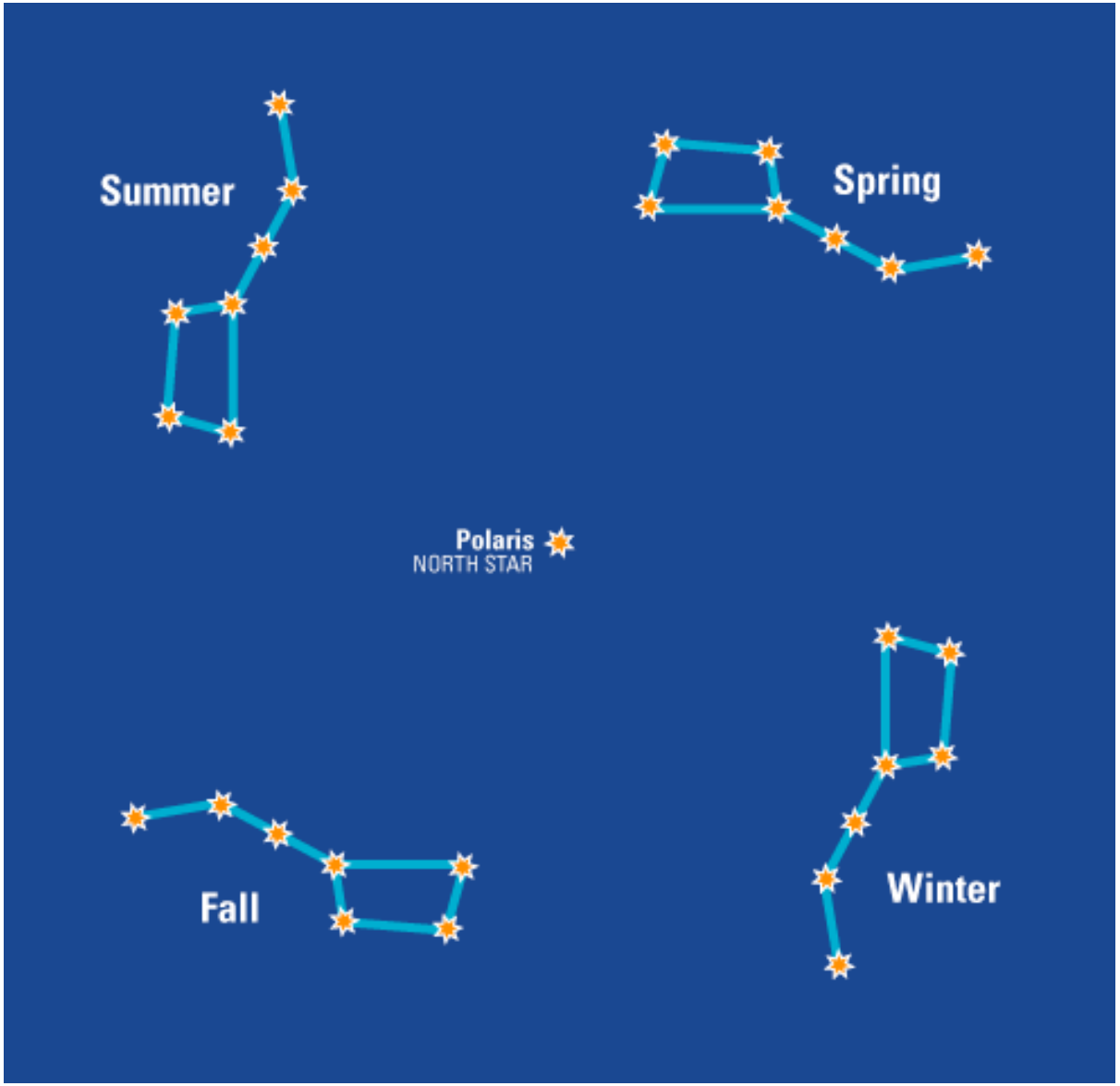

Virgo
Spica

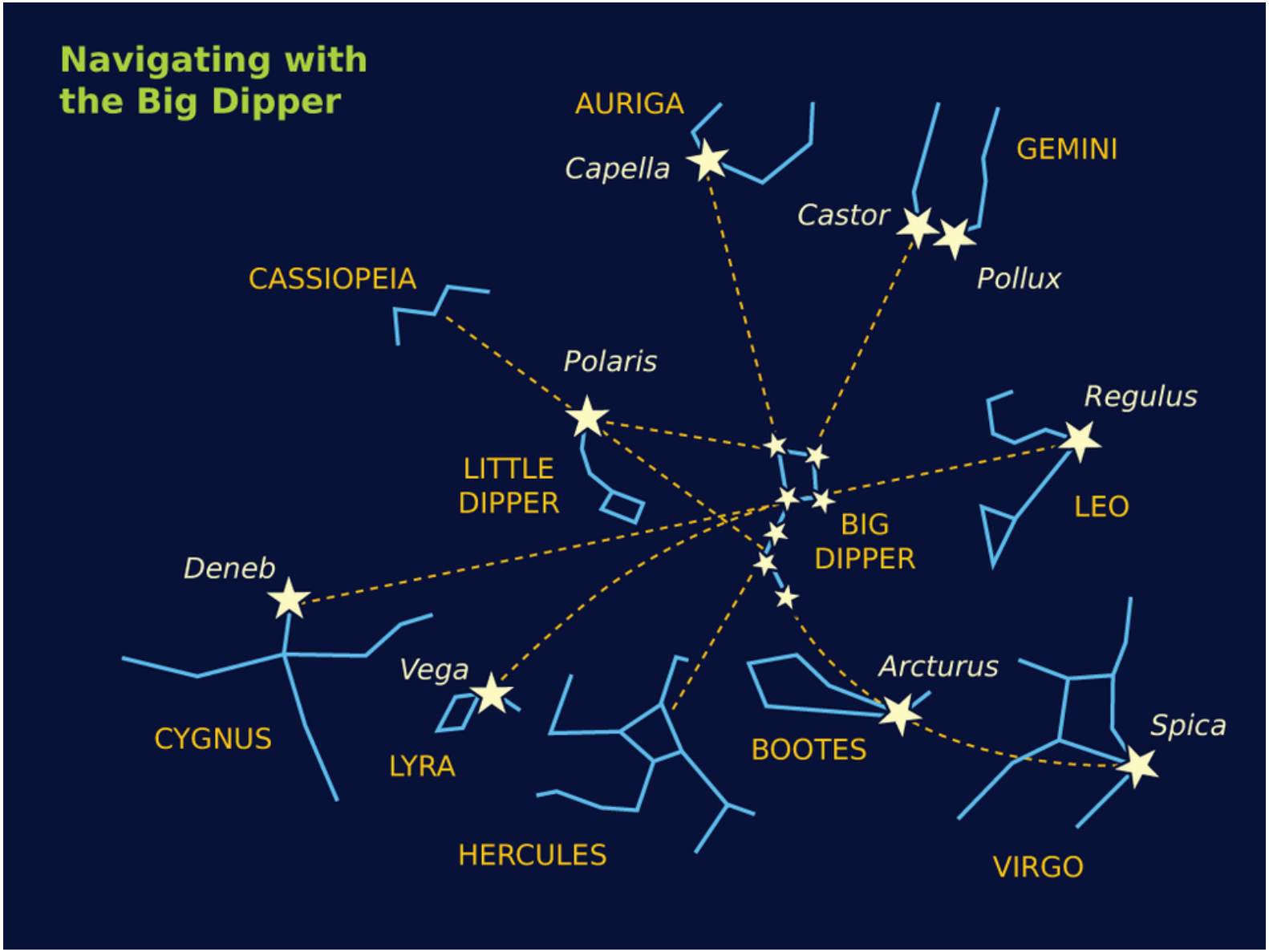

Arcturus
Virgo
Saturn

Bootes




Bootes
(boh-oh'-teez)
The Herdsman

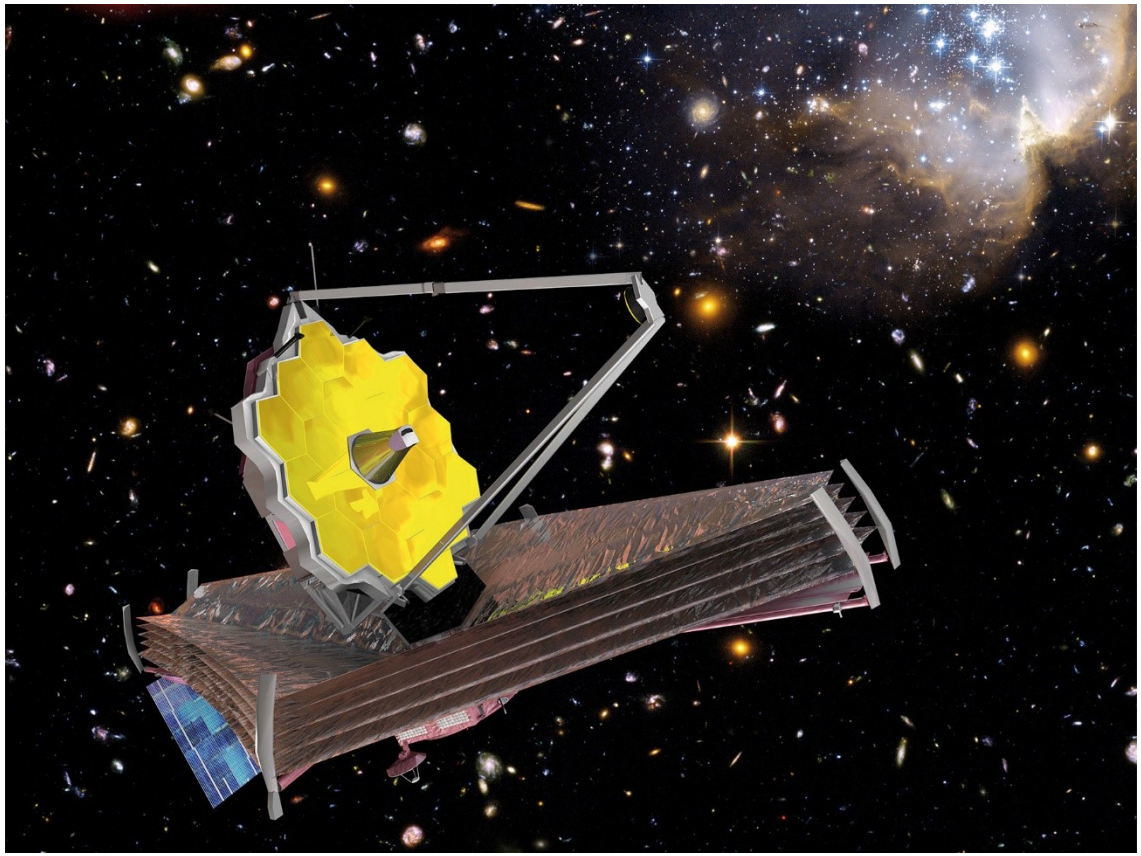

Summer
Spring
Polaris
NORTH STAR
Fall
Winter


Navigating with the Big Dipper
AURIGA
Capella
GEMINI
Castor
Pollux
CASSIOPEIA
Polaris
Regulus
LITTLE DIPPER
BIG DIPPER
LEO
Deneb
Vega
Arcturus
Spica
CYGNUS
LYRA
BOOTES
HERCULES
VIRGO


Visible - WFC3 - 2015
Infrared - WFC3 - 2015

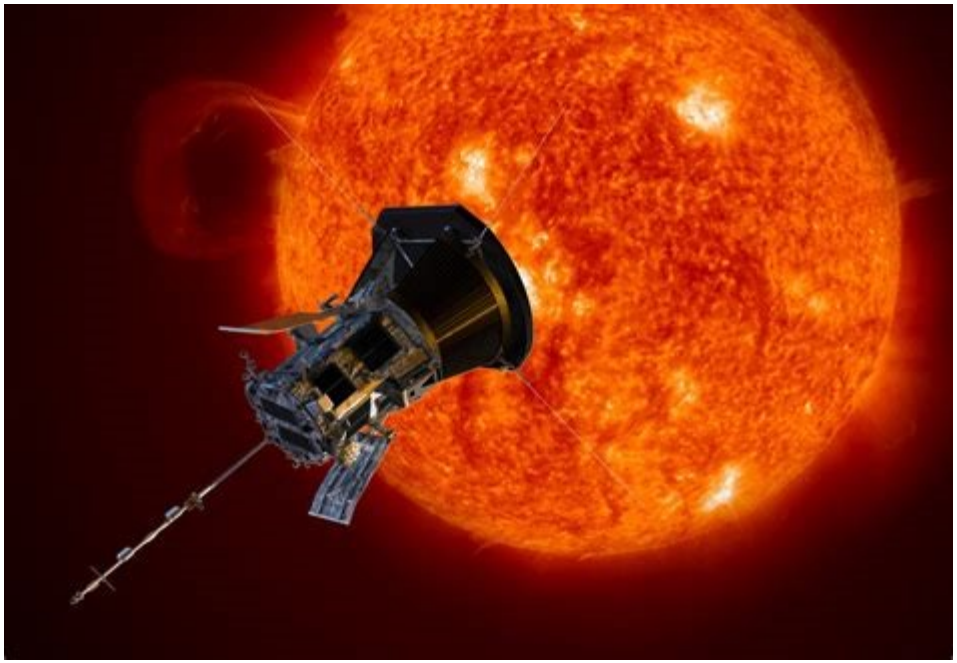
Hubble

JWST



Small Patch Of Sky

Parker Solar Probe



Vera C Rubin Telescope

Vera Rubin Image – 2025

WHAT'S NEXT?