Understanding the Night Sky

Back to Basics

Flamsteed Astronomy Society

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Flamsteed Astronomy Society
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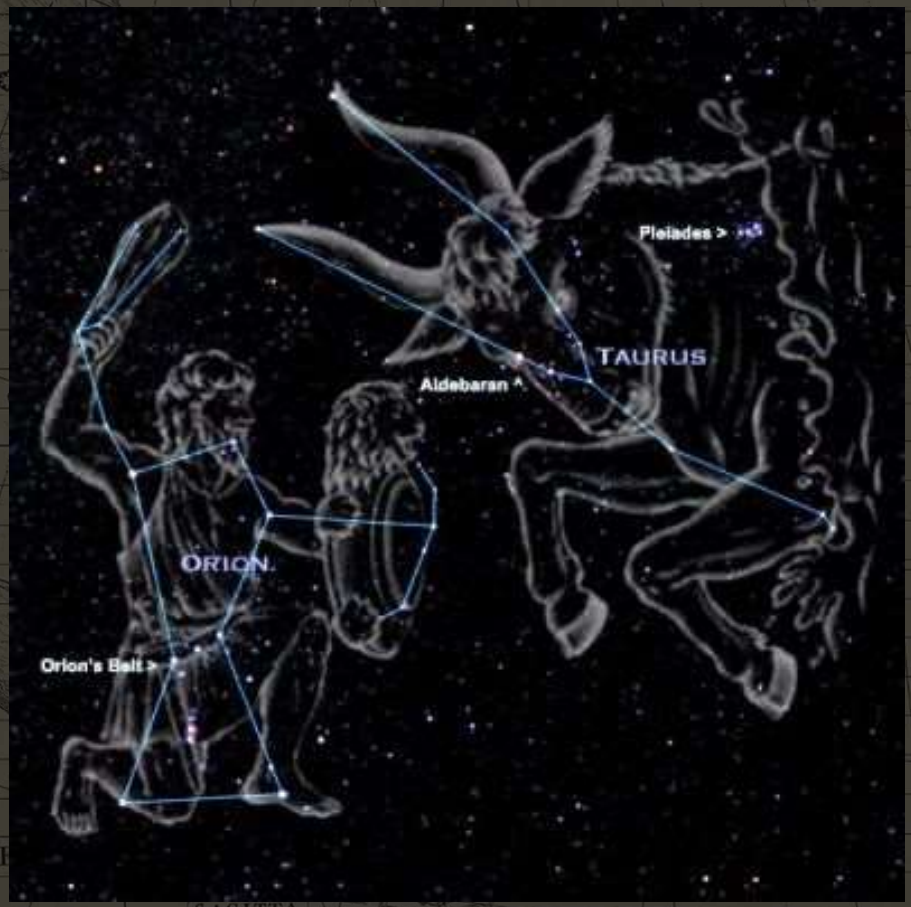


Distance Measurements

- 1 **Astronomical Unit (A.U.)** – average distance between the Sun and the Earth.
  - 1 A.U. = 93 million miles = 150 million kilometers
  - measure distances within our Solar System. Mercury is about 1/3 of an A.U. from the Sun, while Pluto, is about 40 A.U. from the Sun

- 1 **light-year (ly)** - the distance that light travels in 1 year in a vacuum.
  - 1 ly = 5,880,000 million miles = 9,460,000 million kilometers = 63,240 A.
  - Measure distances outside the Solar System. The nearest star to us is about 4.3 light-years away. Our galaxy, the Milky Way, is about 150,000 light-years across, and the nearest large galaxy, Andromeda, is 2.3 million light-years away.

- **Parsec (pc)** – distance of an object that has a **par**allax angle of 1 arc **sec**ond.
  - 1 pc = 3.26 light years (1 arcsecond is 1/3600th of a degree)
  - Used to measure large distances outside the Solar System.
  - In Star Wars: A New Hope, Han Solo, brags that his starship -- the Millennium Falcon -- is "the ship that made the Kessel Run in less than 12 parsecs."

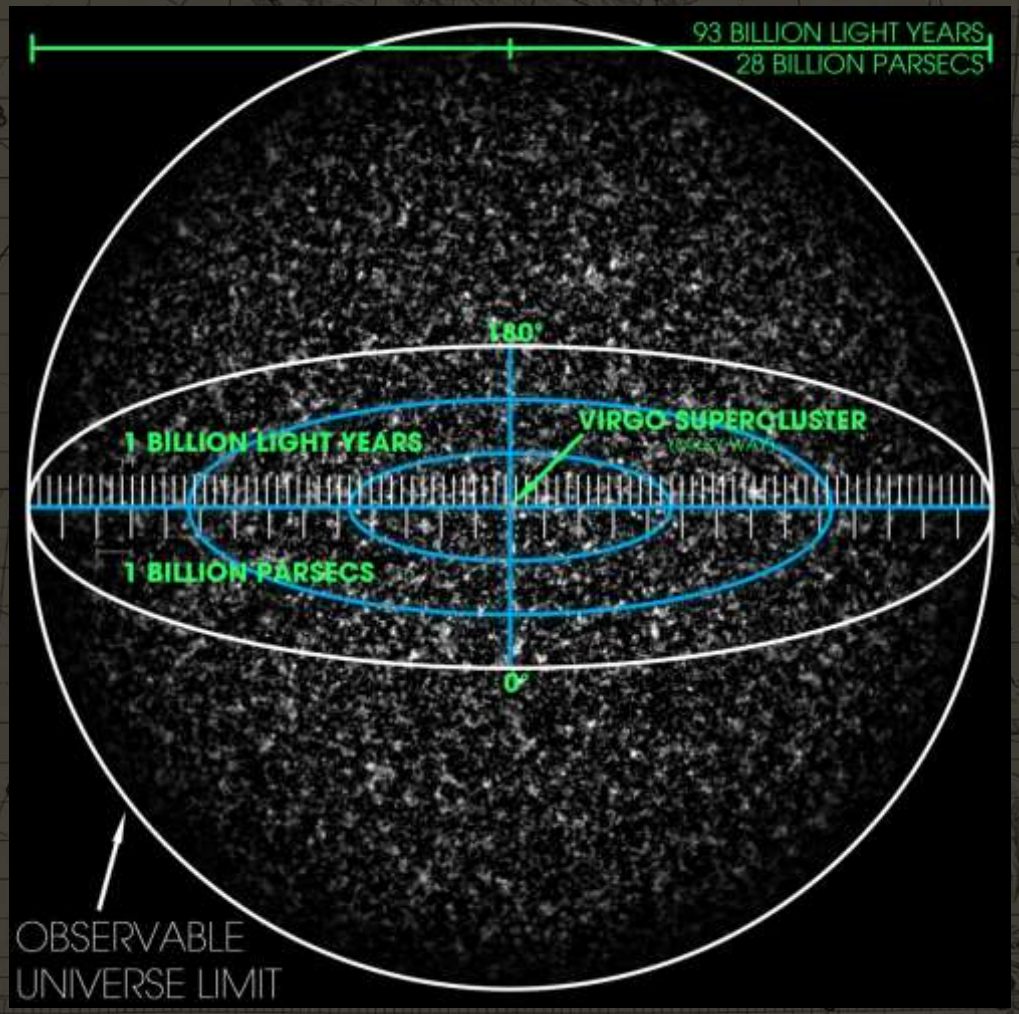
The Observable Universe

- The Observable Universe is all we know:
  - Astronomers do not know for sure how big our actual universe is or where the boundaries are. So for now, we can only refer to our '*observable universe*' as what we can currently see/detect in all directions.
  - It is a **sphere** which is around **93 billion light years in diameter**.
  - The rate of expansion of the universe is currently estimated to be around 73 kilometers per second per megaparsec
    - $H_0 = 73.24 \pm 1.74$ (km/s)/Mpc
  - The age of the Universe is put at around **13.7 billion years old.**
  - *Question: Is the Earth the centre of the Actual Universe or the centre of the Observable Universe or none?*

Investigate how we know the diameter is 93 billion years

Investigate how the age of the universe can be derived.

The Observable Universe

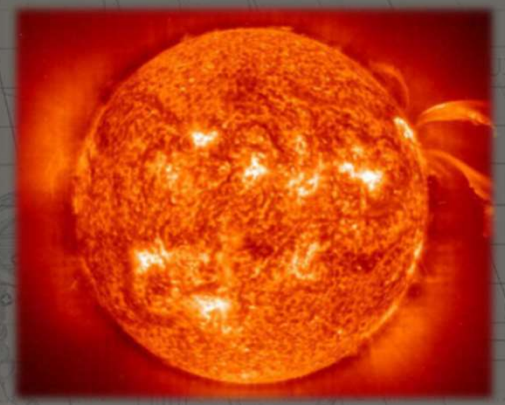


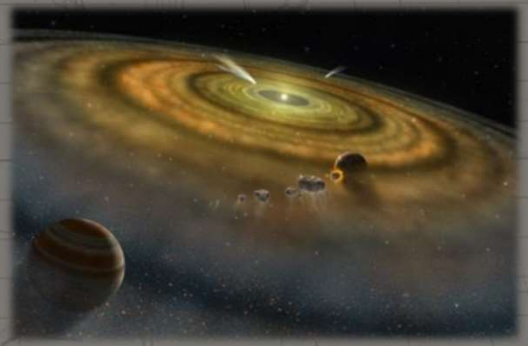
The Big Bang

- Best model to explain the origin and age of the Universe
- The Universe began from a single point called a **Singularity** which then exploded violently.
  - It was an explosion of space itself which then created time. The universe grew from a point smaller than an atom to larger than a galaxy in the fraction of a second.
  - According to the **Inflation Theory**, there was a sudden burst of energy where and 4 fundamental forces were created which now governs the universe:
    - *Gravitational force,*
    - *Electromagnetic force,*
    - *Strong Nuclear Force,*
    - *Weak Nuclear Force*.
  - Primordial elements of Hydrogen & Helium were randomly scattered.

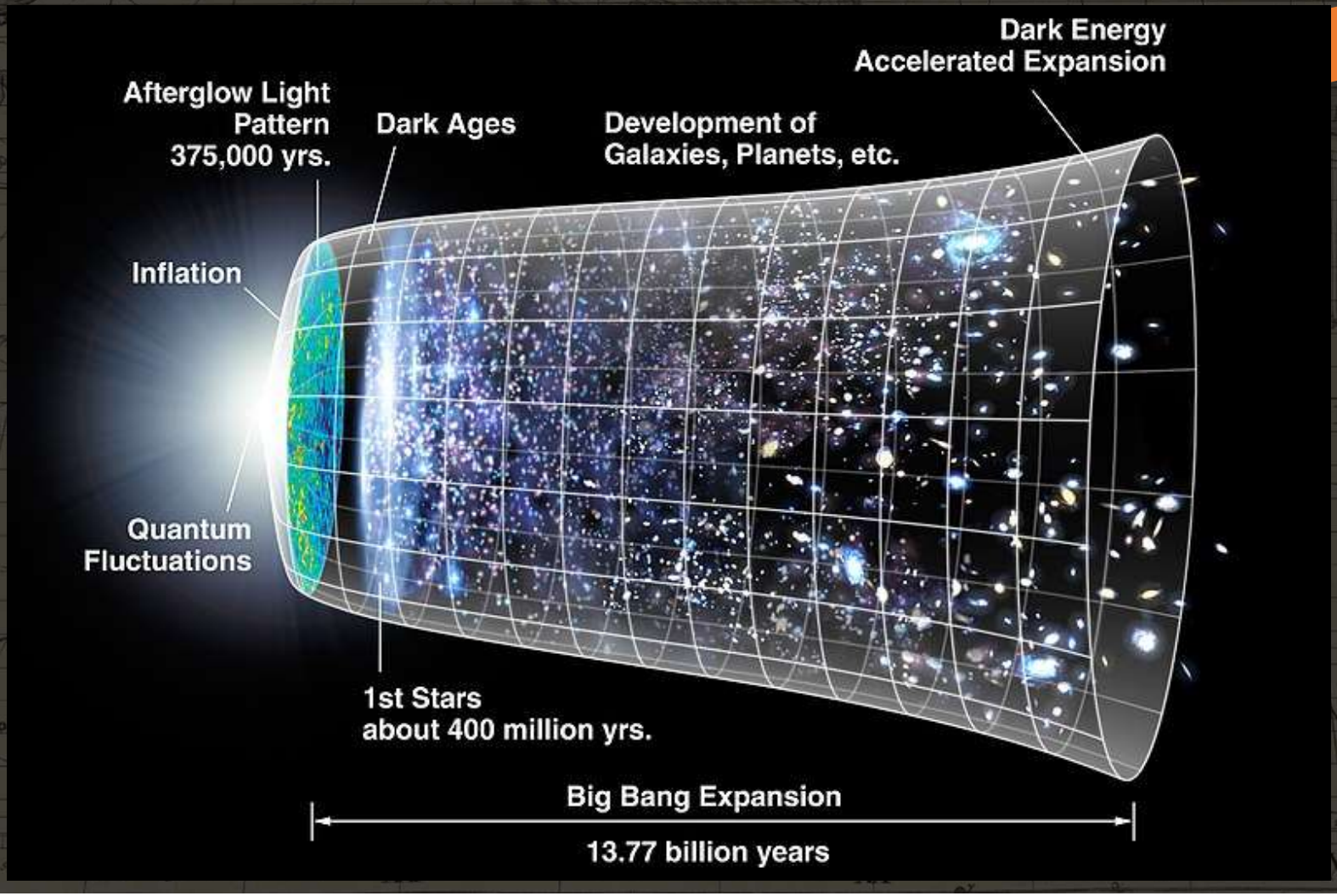
After the Bang !!!

- Stars
  - Clouds of primordial elements coalesce or clump together, to create pockets of intense heat, energy and dust - then collapse under their own gravitational pull and ignite under intense heat to form stars. At a very basic level, stars are formed in this way, including our very own Sun.
- Planetary Systems
  - The new star, with its strong gravitational strength, attracts the elements and space dust around it. The dusts then coalesce to form planets, moons and other space bodies which continue to orbit the star under the influence of gravity. This forms a planetary system just like our **Solar System** with the star in the middle and planets orbiting around it.
- Galaxies
  - An environment for planetary systems and all other space bodies to born, live and die. They are considered to be the primary units in the structure of the Universe. Our Galaxy is called **The Milky Way.**



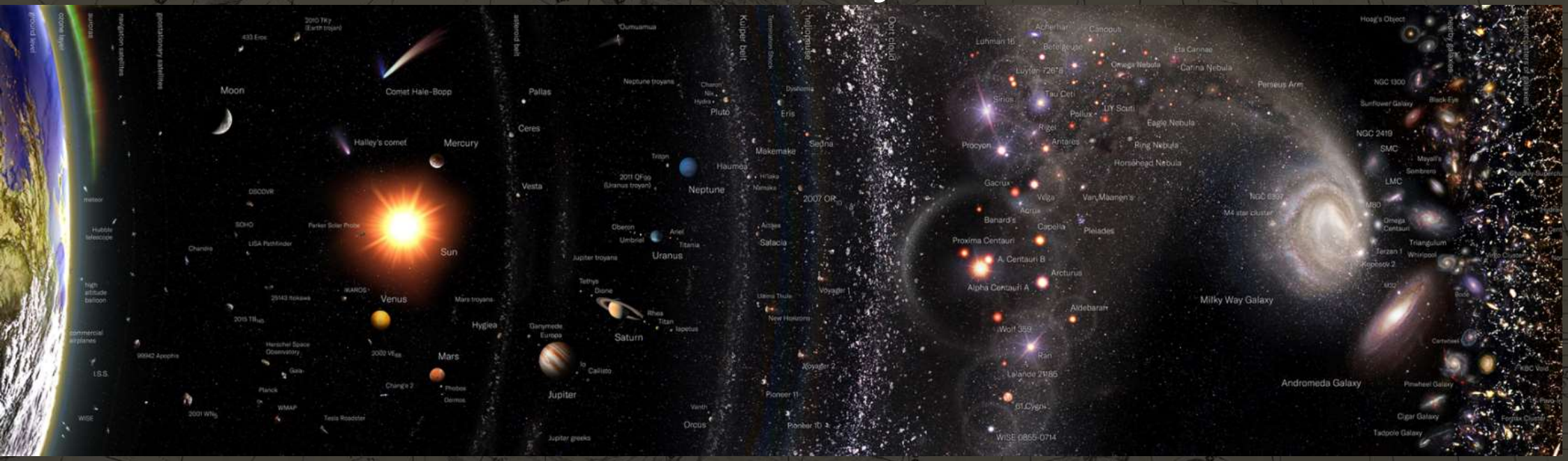


Big Bang Expansion



Occurs in all directions

What do we see in the sky



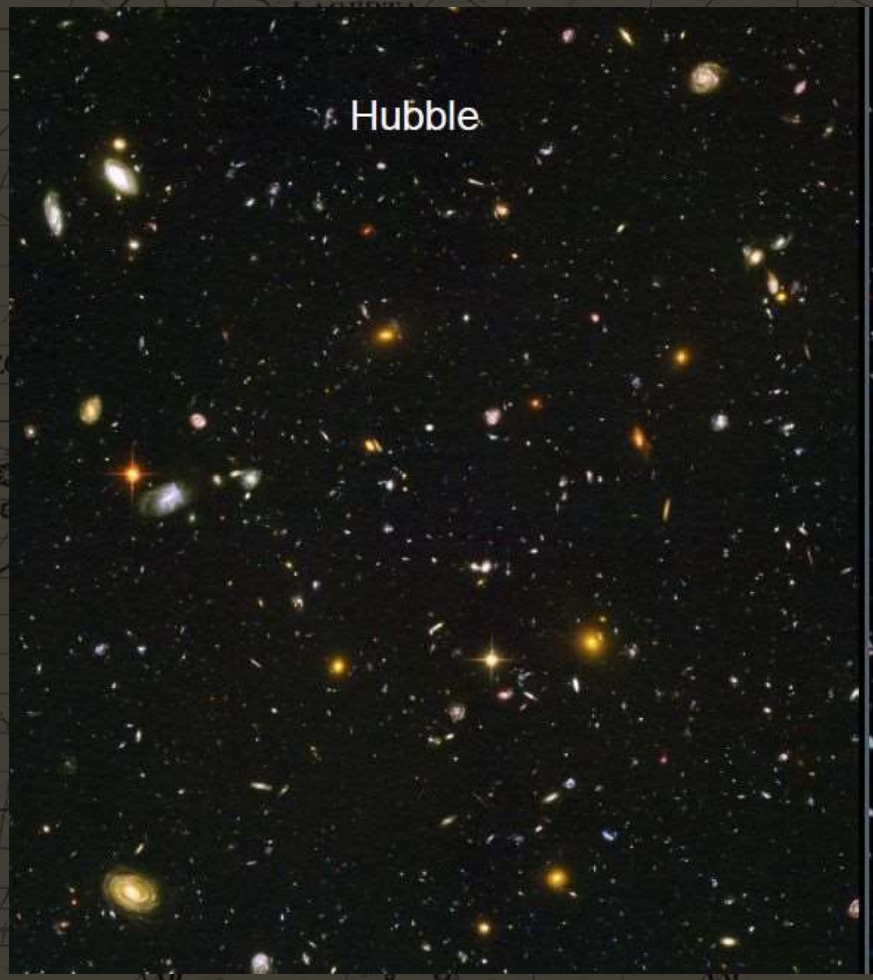
Representation of what we see in the sky based on the order in which they appear from Earth.

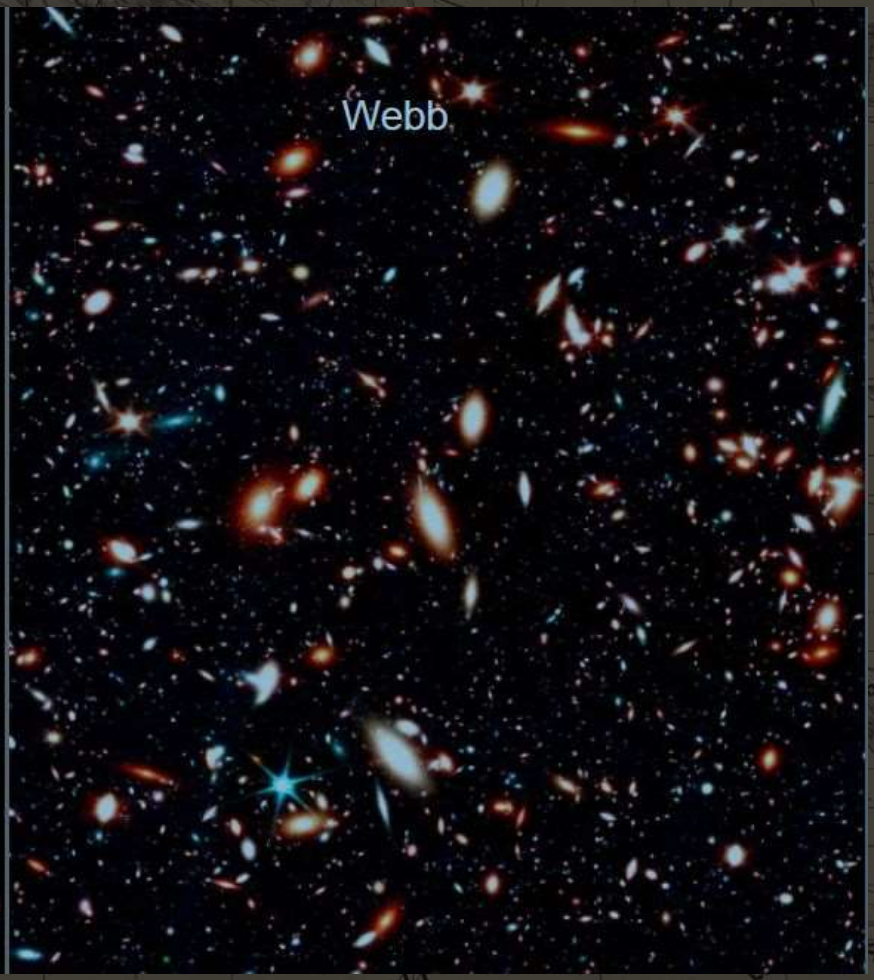
Moon, Sun, Planets, Edge of Solar System, Stars in our Galaxy, then all other Galaxies in the observable universe.

The 'general public' sometimes call everything in the night sky a 'star'… but not everything is a star. Some are planets, galaxies or other space bodies.

Ultra Deep Field Images

Hubble (2004) vs JWSP (2022).



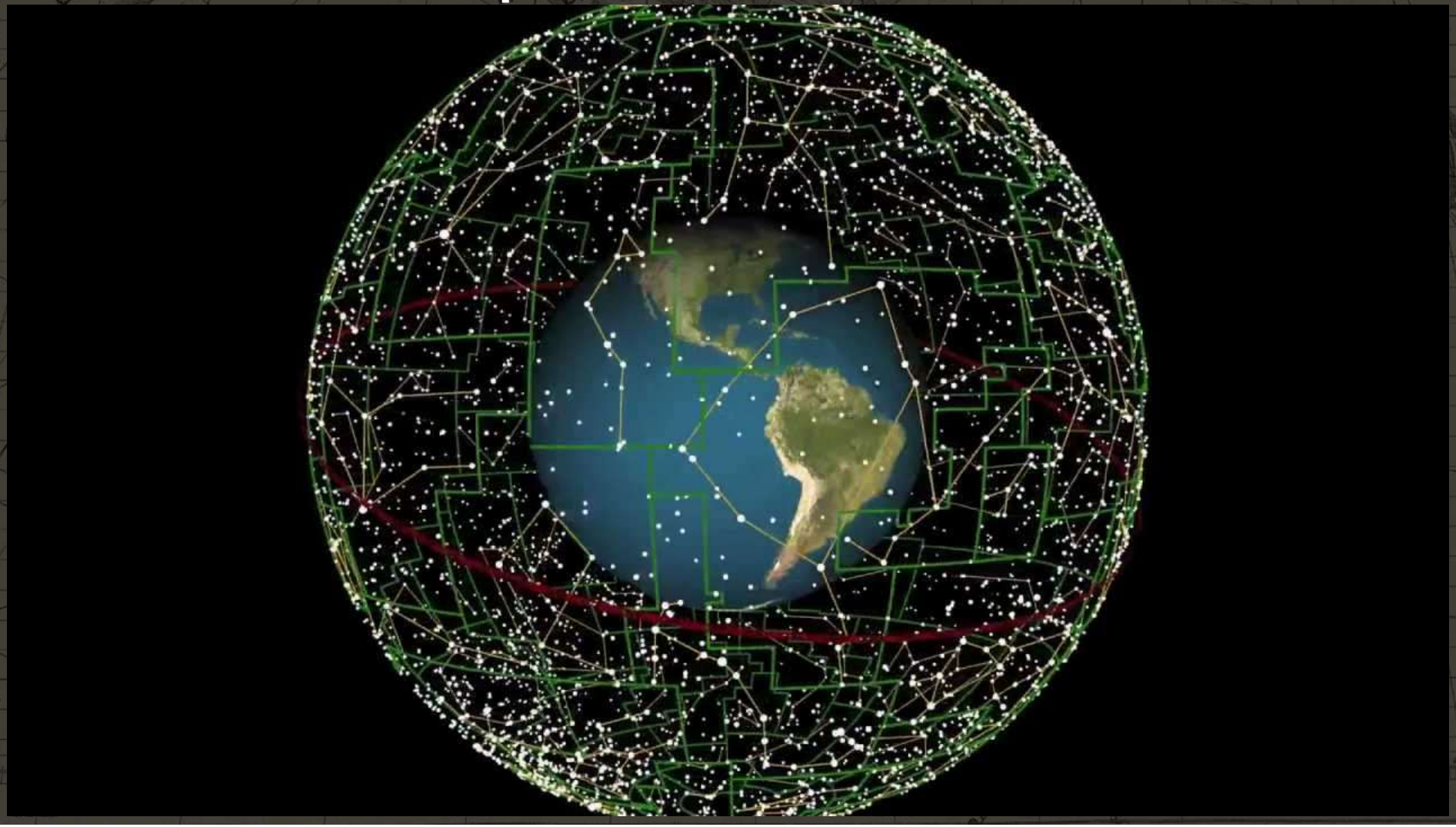


As late as the 1920s, astronomers thought all of the stars were contained inside of the Milky Way.

It wasn't until Edwin Hubble's research that astronomers realized that the fuzzy patches once classified as nebula were actually separate galaxies.

There may be well over 500 billion Galaxies in the Observable Universe

The Celestial Sphere



The Celestial Sphere

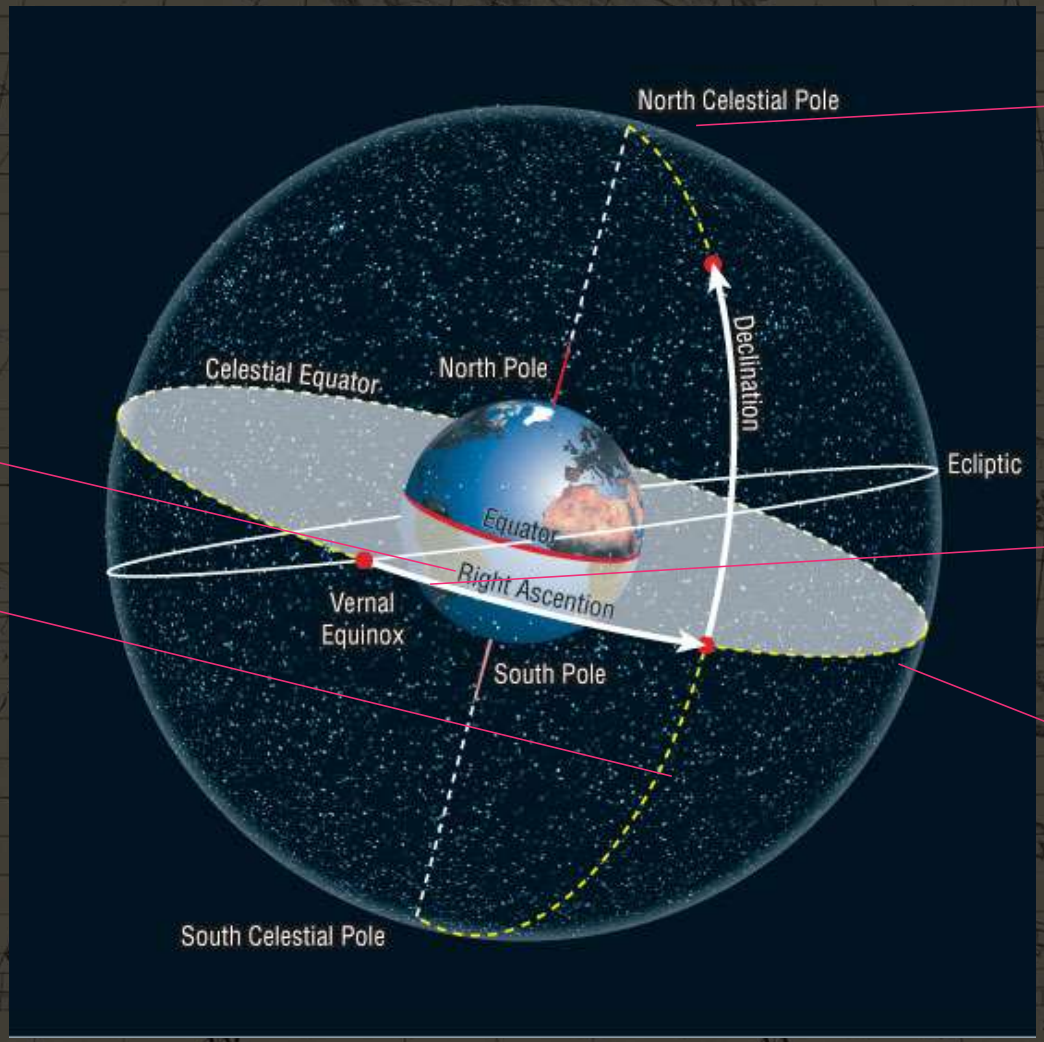
Need to understand this in more details and all the terminology!

Right Ascension

Right Ascension is analogous to longitude on Earth. Measured along the celestial equator, as the angular distance to the vernal equinox. Expressed in units of time.

Declination

Declination is analogous to the latitude on Earth. Measured northward or southward from the plane containing the equator. The declination of the equator is 0 degrees, the North Celestial Pole, +90 degrees, the South Celestial Pole, -90 degrees.



North and South Celestial Pole

Earth's north and south poles extended into space to meet the Celestial Sphere. Polaris -NCP and the southern cross for SCP.

Ecliptic

The apparent path of the Sun on the Celestial Sphere

Vernal Equinox

March/Spring Equinox. Point where sun appears to leave southern hemisphere and cross Celestial Equator

Celestial Equator

Extension of the earth's equator, but at a much greater radius.

The Celestial Sphere

- The celestial sphere is an imaginary sphere with the earth at its center. We use it to keep references of celestial bodies in the sky.
  - ***North Celestial Pole (NCP)*** *and the* ***South Celestial Pole (SCP)*** - these are just the north and south poles extended into space.
  - ***Celestial Equator*** - The earth's equator, but at a much greater radius. If the earth's equator was a rubber band, then the celestial equator is the same rubber band just stretched away from the earth.
  - The **Ecliptic** is the apparent path of the Sun on the CS.
  - ***Horizon*** - The horizon changes depending on your position on earth.
  - ***Zenith-*** The point on the celestial sphere directly overhead.
  - ***Meridian-*** The line that extends from the north point on the horizon upwards through the zenith and then downward to the south point on the horizon.

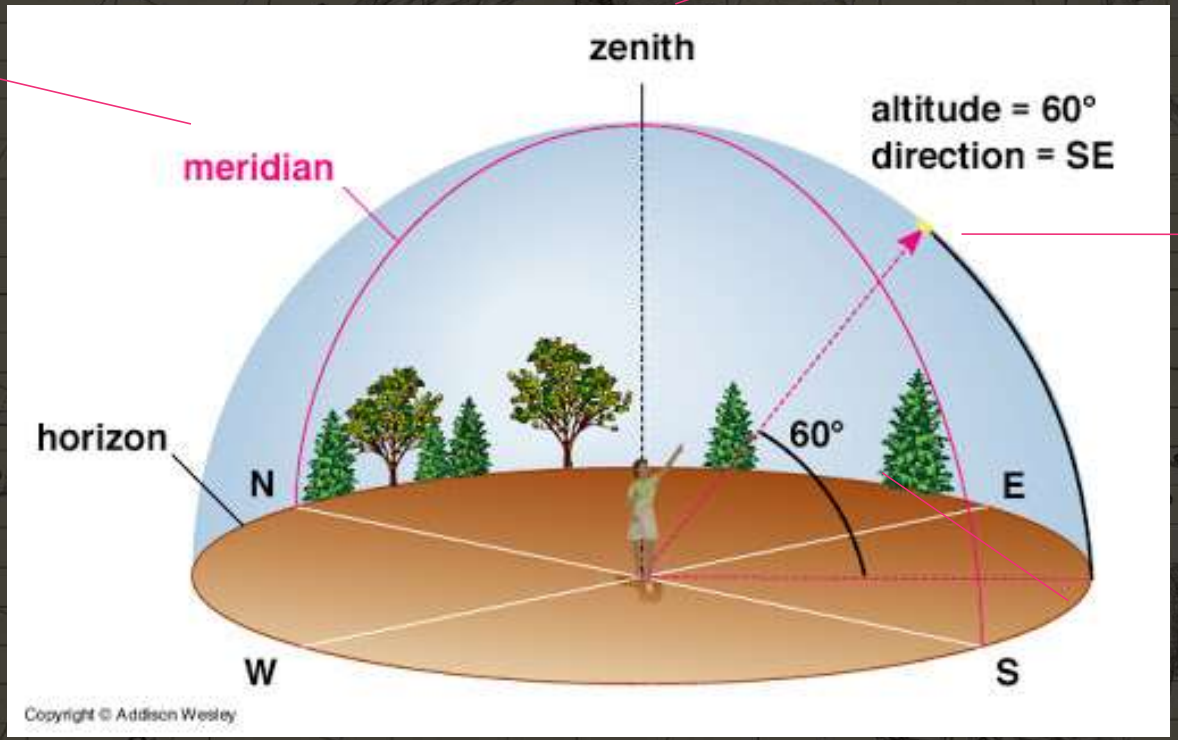
- We can locate any object by giving it two coordinates, the Right Ascension and the Declination.
  - **Right Ascension** is analogous to longitude on Earth. Measured along the celestial equator, as the angular distance to the vernal equinox. Expressed in units of time.
  - **Declination** is analogous to the latitude on Earth. Measured northward or southward from the plane containing the equator. The declination of the equator is 0 degrees, the North Celestial Pole, +90 degrees, the South Celestial Pole, -90 degrees.

Deriving a position

Need to understand this in more details and all the terminology!

Meridian-
The line that extends from the north point on the horizon upwards through the zenith and then downward to the south point on the horizon.

Zenith-
The point which is directly overhead from your position.

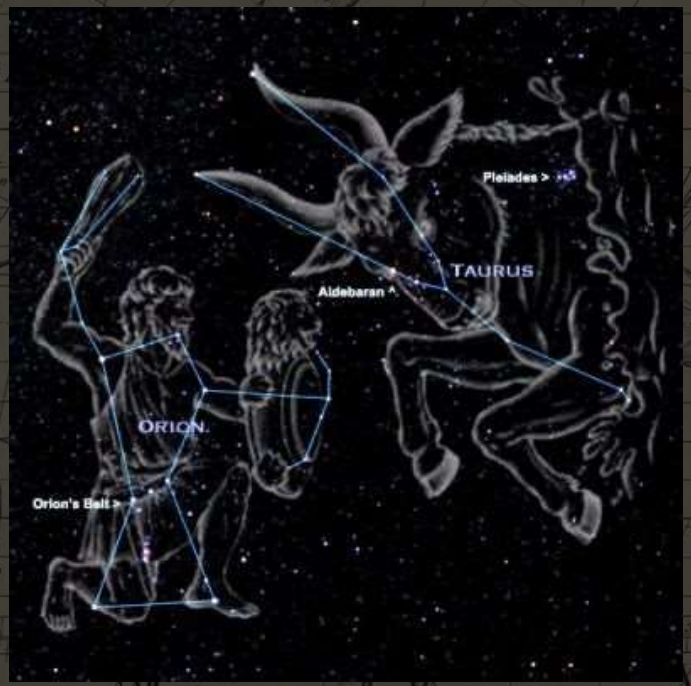


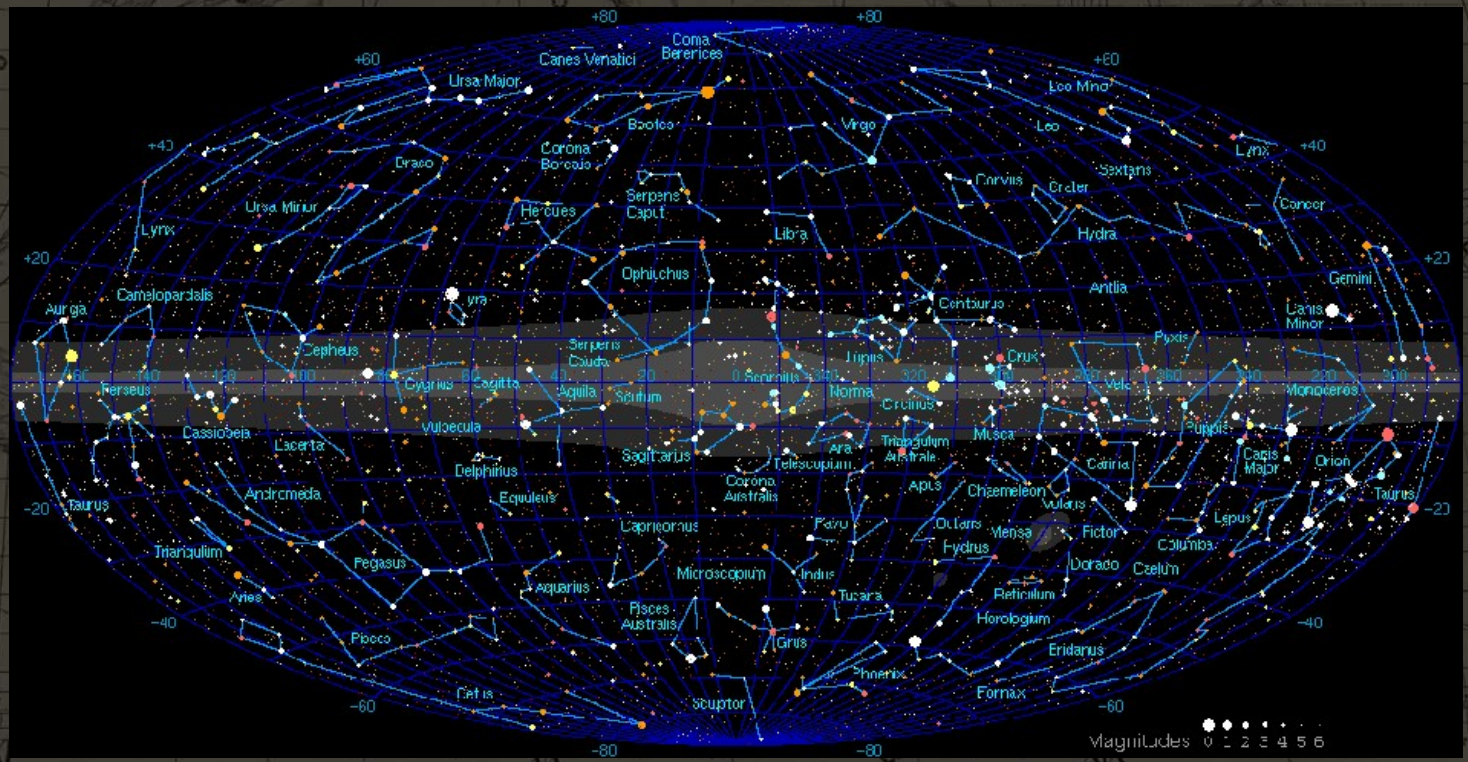
Altitude
The angle of an object from the horizon.

Horizon
the apparent line that separates earth from sky. Changes depending on your position on earth.

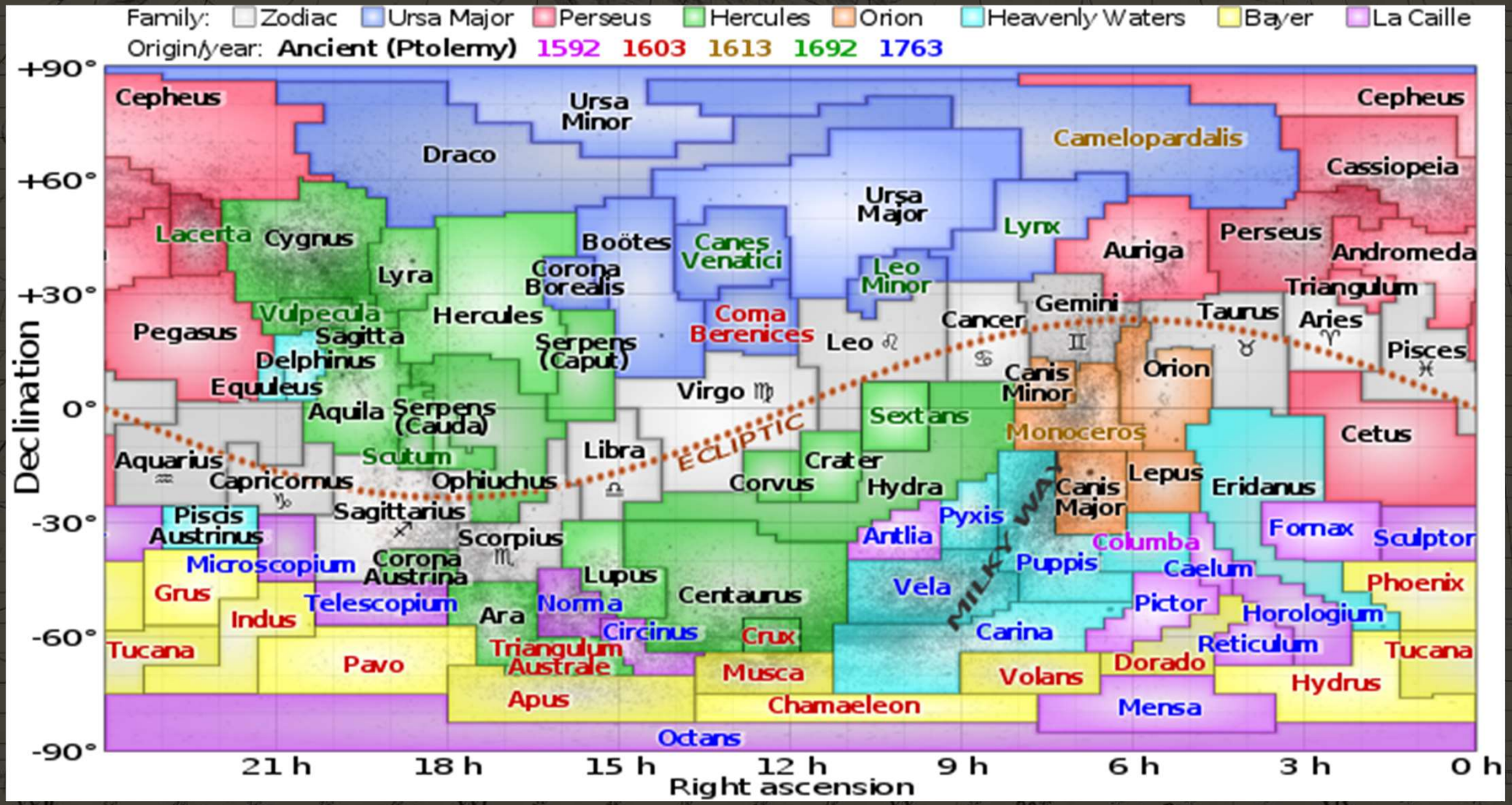
Constellations

- A constellation is an area on the celestial sphere in which a group of visible stars forms a perceived outline or pattern, typically representing an animal, mythological person or creature, or an inanimate object.





Constellations-Defined areas of the sky based on imaginary patterns



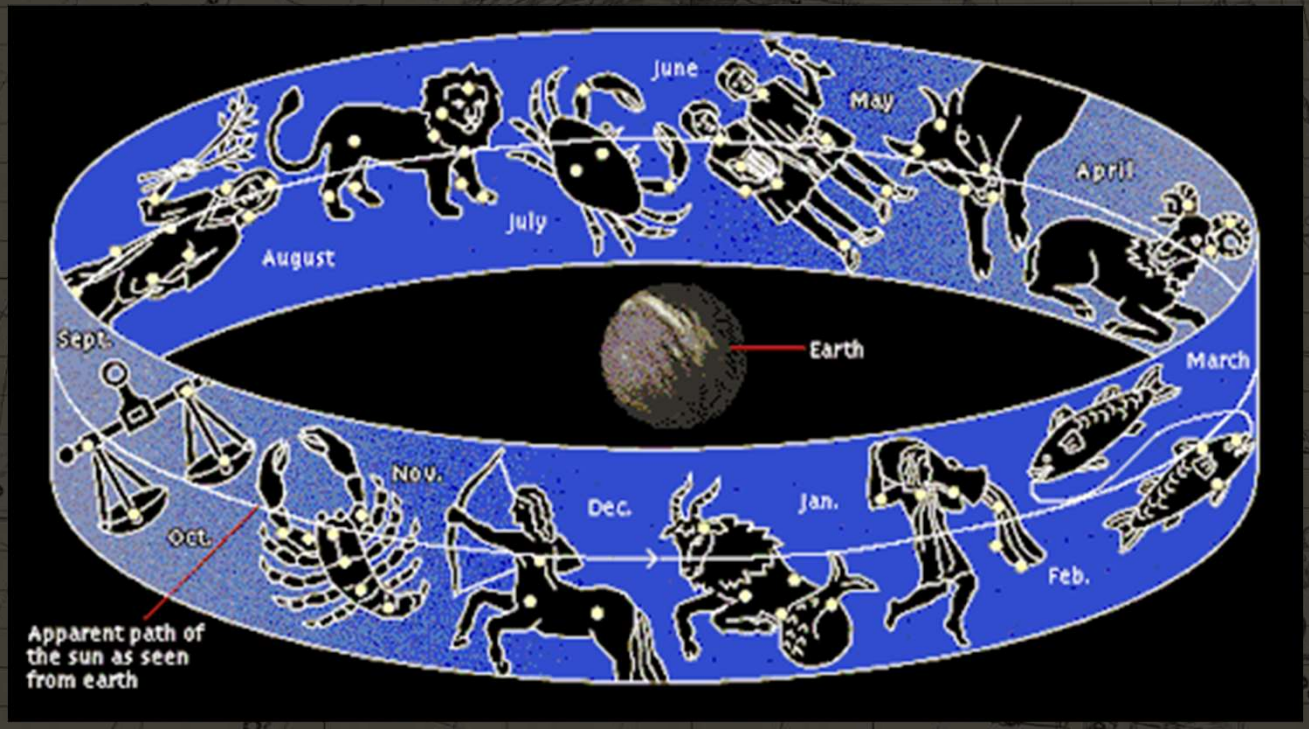
88 Constellations

Start with some of the key constellations from your location and then move from there. E.g Orion, Ursa Major, Ursa Minor, Cassiopeia

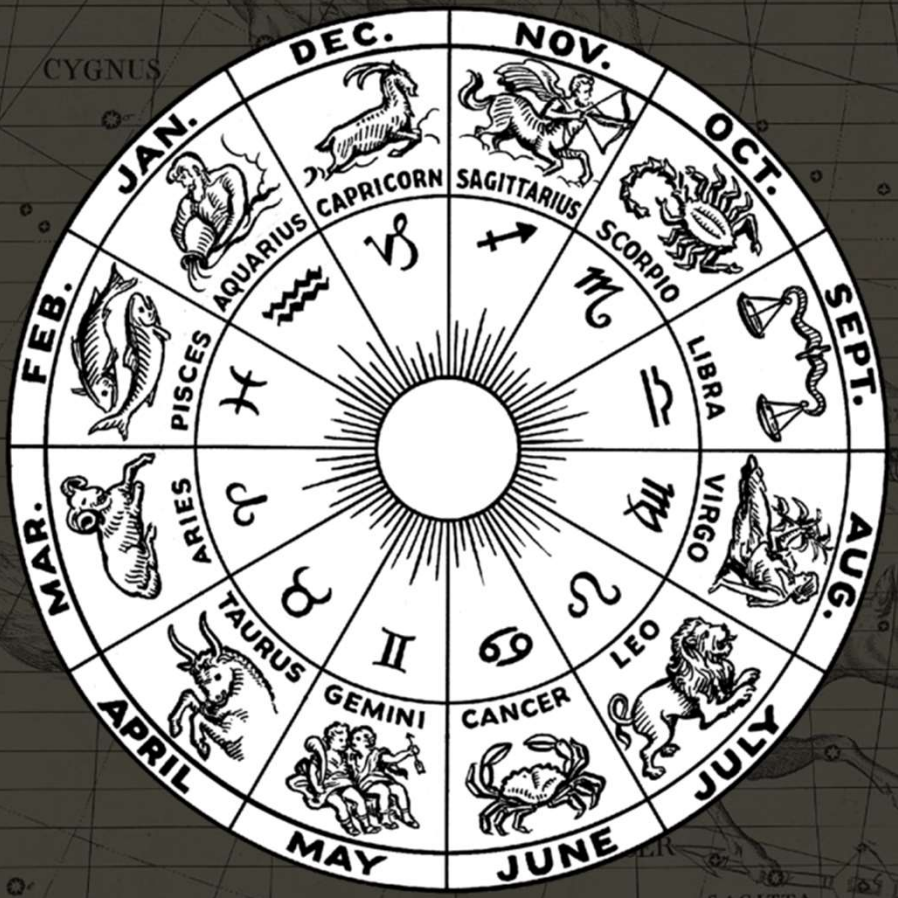
And	Andromeda	CVn	Canes Venatici	Ori	Orion
Ant	Antlia	Cyg	Cygnus	Pav	Pavo
Aps	Apus	Del	Delphinus	Peg	Pegasus
Aql	Aquila	Dor	Dorado	Per	Perseus
Aqr	Aquarius	Dra	Draco	Phe	Phœnix
Ara	Ara	Equ	Equuleus	Pic	Pictor
Arg	Argo	Eri	Eridanus	PsA	Piscis Austrinus
Ari	Aries	For	Fornax	Psc	Pisces
Aur	Auriga	Gem	Gemini	Pup	Puppis
Boo	Bootes	Gru	Grus	Pyx	Pyxis
Cae	Cælum	Her	Hercules	Ret	Reticulum
Cam	Camelopardalis	Hor	Horologium	Scl	Sculptor
Cap	Capricornus	Hya	Hydra	Sco	Scorpius
Car	Carina	Hyi	Hydrus	Sct	Scutum
Cas	Cassiopeia	Ind	Indus	Ser	Serpens
Cen	Centaurus	Lac	Lacerta	Sex	Sextans
Cep	Cepheus	Leo	Leo	Sge	Sagitta
Cet	Cetus	Lep	Lepus	Sgr	Sagittarius
Cha	Chamaeleon	Lib	Libra	Tau	Taurus
Cir	Circinus	LMi	Leo Minor	Tel	Telescopium
CMa	Canis Major	Lup	Lupus	TrA	Triangulum Australe
CMi	Canis Minor	Lyn	Lynx	Tri	Triangulum
Cnc	Cancer	Lyr	Lyra	Tuc	Tucana
Col	Columba	Men	Mensa	UMa	Ursa Major
Com	Coma	Mic	Microscopium	UMi	Ursa Minor
CrA	Corona Australis	Mon	Monoceros	Vel	Vela
CrB	Corono Borealis	Mus	Musca	Vir	Virgo
Crt	Crater	Nor	Norma	Vol	Volans
Cru	Crux	Oct	Octans	Vul	Vulpecula
Crv	Corvus	Oph	Ophiuchus		

The Zodiac – 12 constellations

- Ecliptic - Area of the sky where the Sun crosses along the Celestial Sphere. (8 deg N/S)
- The Zodiac are the 12 (or 13) Constellations which are along the Ecliptic on the Celestial Sphere.

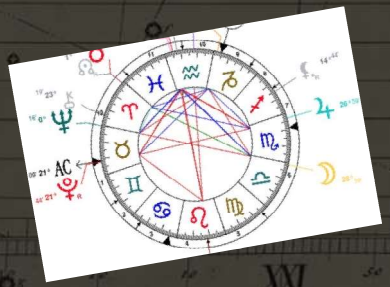


Signs of the Zodiac



A bit about Astrology …

- The signs of the Zodiac are not the same as the Constellations of the Zodiac.
- The Constellations have shifted a bit since the Babylonians/Greeks came up with it so the duration of the apparent motion of the Sun in each Constellation has changed.
- Plus there is one more .. Ophiuchus, that makes 13 Constellations in the Zodiac.



2016	Sun is in sign	Sun is in constellation
Jan	Capricorn	Sagittarius
	Aquarius	Capricornus
Feb		
	Pisces	Aquarius
Mar		Pisces
	Aries	
Apr		
	Taurus	Aries
May		
	Gemini	Taurus
Jun		
	Cancer	Gemini
Jul		
	Leo	Cancer
Aug		Leo
	Virgo	
Sep		
	Libra	Virgo
Oct		
	Scorpio	Libra
Nov		Scorpius
	Sagittarius	Ophiuchus
Dec		
	Capricorn	Sagittarius

Recap and Questions

- Observable Universe
  - Understand the size and age of the Observable Universe
  - Research the expansion rate of the universe
- How it started
  - Big Bang and Inflation theory
  - Life cycle of stars
  - Planetary formation
  - Galaxies and Black Holes
- Celestial Sphere
  - Celestial coordinate systems (RA and Dec)
  - Get familiar with some of the major constellations

Thank you for watching!

Flamsteed Astronomy Society