

AN INTRODUCTION TO ASTRONOMY



Peterborough Astronomical Association
Novice Astronomy Class #1
February 4, 2022
Brett Hardy

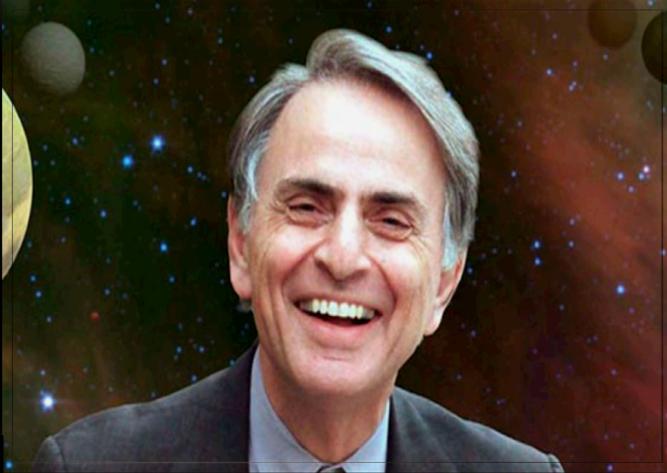
WHAT IS ASTRONOMY ?

Astronomy is a scientific discipline that seeks to answer the big questions.

- How did the Universe begin ?
- How big is our Universe ?
- How old is our Universe ?
- How will our Universe end ?
- What is the nature and composition of objects in the night sky ?
- Is there life elsewhere in the Universe ?
- Is there more than one Universe ?

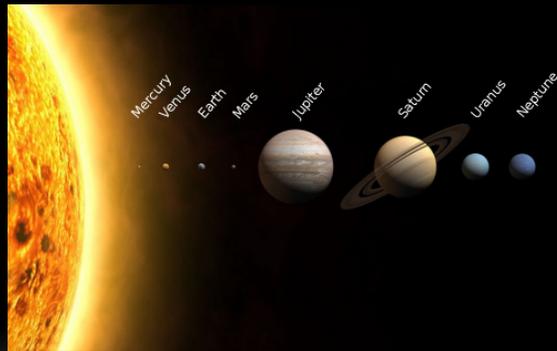
OUR COSMIC ADDRESS

- Our first step starts here



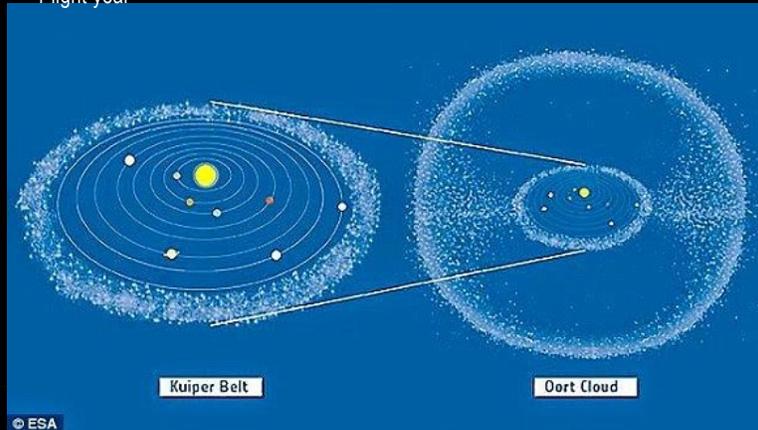
OUR COSMIC ADDRESS

- Our solar system is vast
 - Our Sun
 - Mercury
 - Venus
 - Earth
 - Asteroids
 - Jupiter
 - Saturn
 - Uranus
 - Neptune
 - Comets



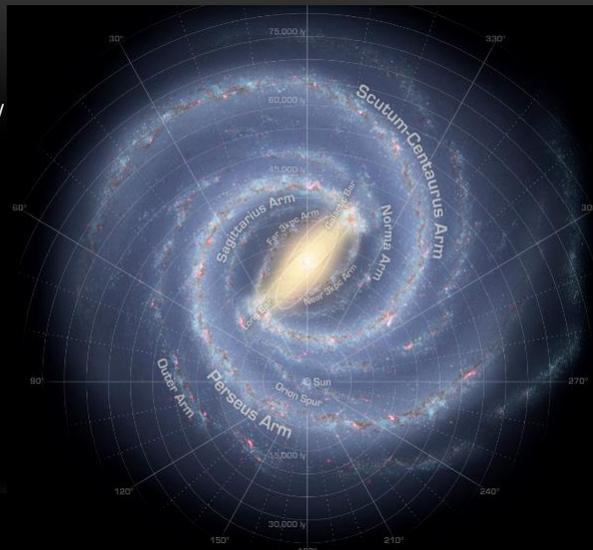
OUR COSMIC ADDRESS

- Kuiper Belt
- Oort Cloud
- ~ 1 light year



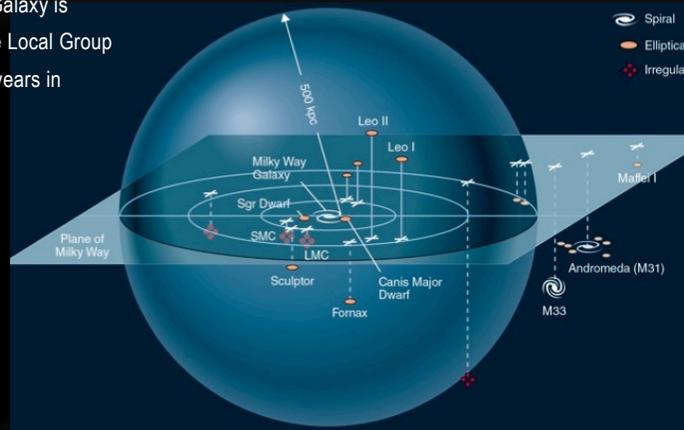
OUR COSMIC ADDRESS

- Our solar system is a tiny part of the Milky Way Galaxy
- Barred spiral
- ~ 100,000 light years across
- ~ 1,000 light years thick
- 13.4 billion years old
- 200 - 400 billion stars
- Sun ~ 28,000 light years from galaxy centre



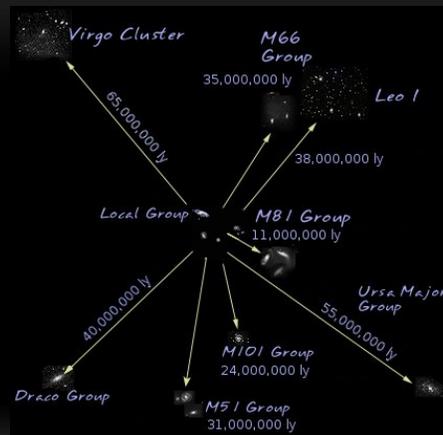
OUR COSMIC ADDRESS

- Our Milky Way Galaxy is a member of the Local Group
- ~ 4 million light years in diameter



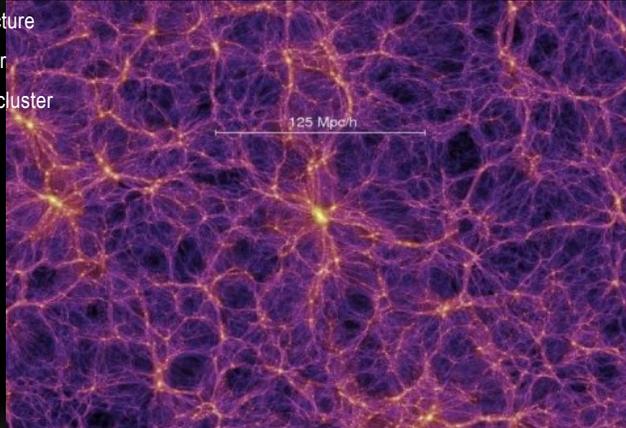
OUR COSMIC ADDRESS

- Our Local Group is gravitationally bound to the Virgo Supercluster
- ~ 150 million light years in diameter



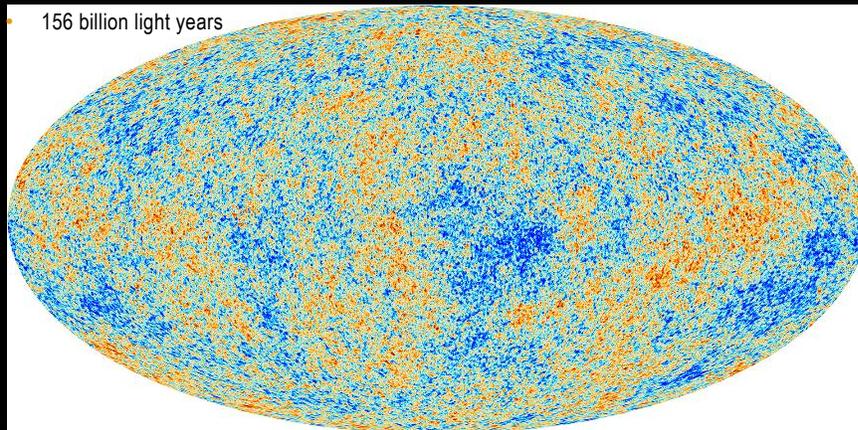
OUR COSMIC ADDRESS

- Large filamentary structure
- Laniakea Super Cluster
- Pisces – Cetus Supercluster Complex



OUR COSMIC ADDRESS

- Observable Universe
- Our baby picture
- 156 billion light years



OUR MOON

- Earth has one natural satellite, Luna – our Moon
- ~ 27 days to orbit Earth
- Only see near side
- 400,000 km average distance ~ 1.3 light seconds
- Twelve people have stepped upon its surface



Chuck Smith

Peter Curley

OUR MOON

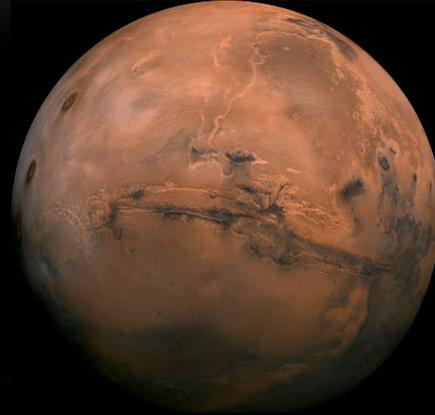
- 8 major phases



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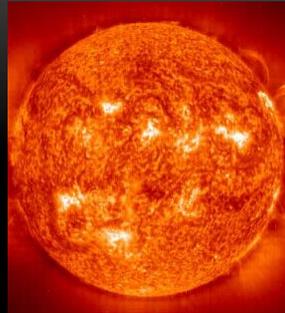
PLANETS

- My Very Educated Mother Just Served Us Nachos



STARS

- Stars are giant spheres of hydrogen gas
- Our Sun is a star
- Nuclear fusion
- Creates helium, heat and light
- Life cycle: born, evolve, die
- Size matters: life span, colour, fate
- Most stars are binary or multiple star systems
- Stars come with their own solar system



Alireo

CONSTELLATIONS

- Constellations are groupings of stars that form patterns in the night sky
- Asterisms are portions of constellations
- Proper motion of stars
- Pointers in the night sky

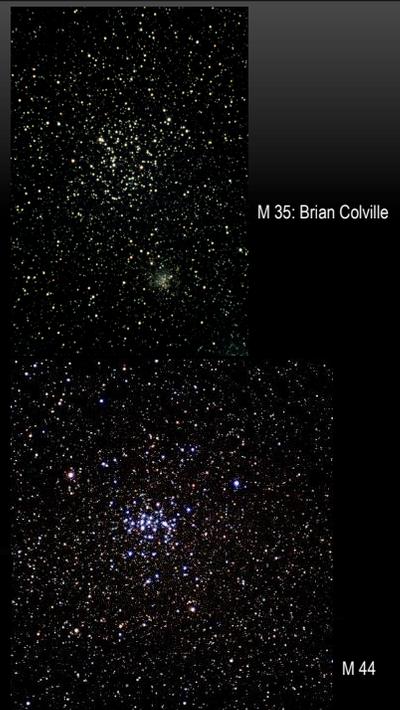


OPEN CLUSTERS

- Groupings of stars born at the same time from the same molecular cloud of gas and dust.
- Relatively young
- Hundreds to a few million years old
- 10's to thousands of stars
- Found in the disks of galaxies
- Dissipate over time due to gravitational interactions



M 37



M 44

GLOBULAR CLUSTERS

- Tightly bound spherical collections of stars
- Very old: 8 - 12 billion years
- Found in inner halo around central bulge
- Approximately 150 form a halo around the galactic core
- Contain hundreds of thousands to millions of stars



M 13: Jason Lichter

NEBULAE

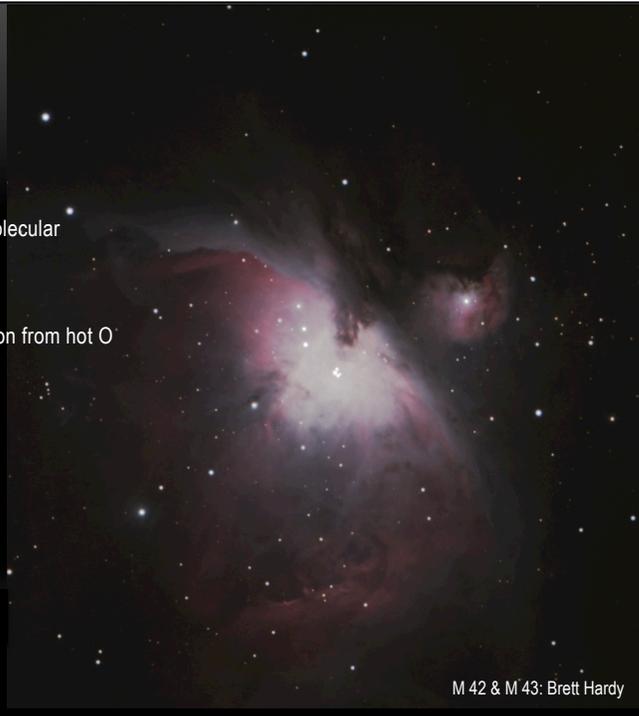
- Reflection Nebulae
- Visible due to reflected starlight
- M 45 the Pleiades



M 45: Jason Lichter

NEBULAE

- Emission Nebulae
- Enormous clouds of molecular hydrogen (HII)
- Stellar nurseries
- High energy UV radiation from hot O type stars
- M 42 the Orion Nebula



M 42 & M 43: Brett Hardy

NEBULAE

- Planetary Nebulae
- Medium size stars like our Sun
- White dwarf
- M 27 the Dumbbell Nebula



M 27 Dumbbell Nebula: Brett Hardy

NEBULAE

- Dark Nebulae
- Large clouds of gas & dust
- Barnard 33
- NGC 2023 is both a reflection and emission nebula



B33 & NGC 2023: Mike McCarthy

SUPERNOVAE

- Energetic explosions of stars
- Stars 8x and > than the mass of our Sun
 - Neutron Stars
 - Black Holes



SN 2020jfo

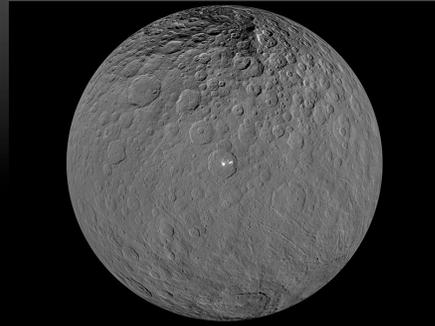
M 61 Supernova: Brett Hardy



M 1 Crab Nebula: Brett Hardy

ASTEROIDS

- Leftover remnants of the early solar system
- Three main types:
 - Chondrite (most common)
 - Stony
 - Metallic
- ~ 966,000 kilometers apart



(1) Ceres



Ida + Dactyl
Global
Mosaic



101955 Bennu

ASTEROIDS



COMETS

- Leftover remnants of the early solar system
- “Dirty Snowball”
- Composition: dust, rock, water ice and frozen gases
- Short period < 200 years
- Long period: as long as 30 million years

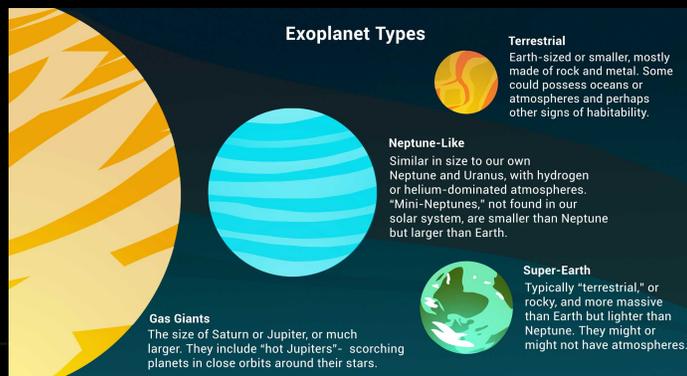


17P/Holmes: Phillip Chee

C/2021 A1 (Leonard): Jason Lichter

EXOPLANETS

- Planets around stars in other galaxies
 - Total: 4, 917 +
 - Planetary Systems: 3,636 +
 - Multiple Planet Systems: 810 +



NASA

GALAXIES

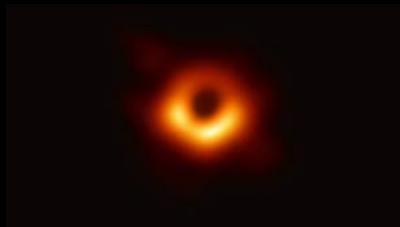
- ~ 2 trillion
- Systems of millions or billions of stars, gas and dust
- Spiral Galaxies
- M 31 The Andromeda Galaxy



M 31: Aria Bahraman

GALAXIES

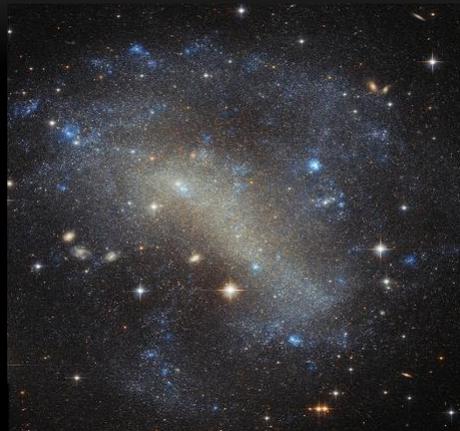
- Elliptical Galaxies
- Most common
- M 87



M 87

GALAXIES

- Irregular Galaxies
- IC 4710



IC 4710

DARK ENERGY & DARK MATTER – OH MY!

- Dark Energy 68%
- Dark Matter 27%



"The nitrogen in our DNA, the calcium in our teeth, the iron in our blood, the carbon in our apple pies was made in the interiors of collapsing stars. We are made of star stuff."

Carl Sagan



Novice Astronomy Class # 1
Stars
March 4, 2022