



The Universe

Introduction

- This presentation will introduce the universe to students, as well as different measurements that astronomers use when dealing with the large numbers and distances associated with the study of the universe.
- The **highlighted** portions of the slides are **important concepts** and should be written down in students notes.
- **Underlined words** are **vocabulary** and should also be **written down along with their definitions!**

Tools of Astronomers

- The Universe is defined as everything that exists (including all matter and energy)
 - This includes our solar system, our galaxy, other galaxies, etc
 - It's big!!!
- Large numbers are used when talking about distances in the universe
 - Ex. The closest star (other than our sun) is 42,000,000,000,000 Kilometers away
That's 42 Trillion km!

Scientific Notation

- Because of these large numbers Astronomers use Scientific Notation
- Scientific Notation is a mathematical abbreviation for writing very large numbers or very small numbers. Numbers in Scientific Notation are written as a value between 1 and 10 multiplied by a power of 10
 - Ex... 42 trillion kilometers written in scientific notation is 4.2×10^{13} km

Scientific Notation step by step

- 1. Move the decimal until you get a value that is between 1 and 10. Count the number of times you move the decimal
- 2. Write down the new number without all of the zeros
- 3. Write down $\times 10$ after the number

Scientific Notation step by step

- 4. Write down the number of times you moved the decimal as a power of 10 (the exponent).
 - If you moved the decimal to the left the exponent will be positive
 - If you moved the decimal to the right, the exponent will be negative

Practice

- Use the steps to write the distance of the Earth to the Sun
 - Average distance of the earth from the sun is 150,000,000 kilometers

Answer

- A: 1.5×10^8 Km
- Scientific notation practice sheet

Astronomical Distances

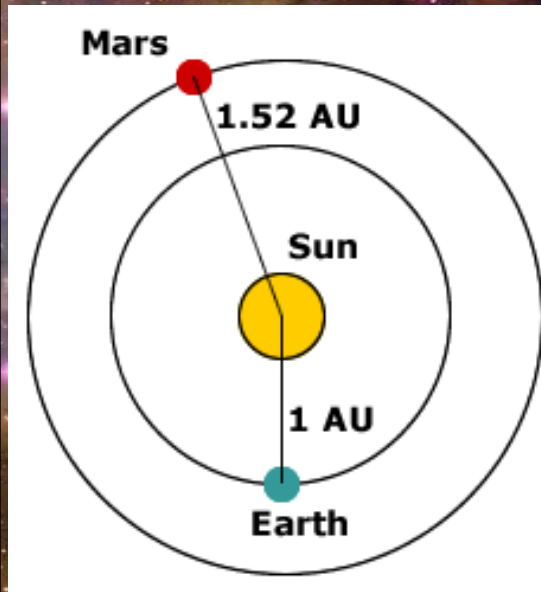
- Astronomers use units other than kilometers and meters to measure the vast distances in space... one of these is the Light year
- A Light Year (ly) – measures the distance that light travels through space in one year
 - Light travels at a speed of 300,000 km/s (186,411 miles per second)
- There are 31,536,000 seconds in one year
- 1 Light year = Speed of light X time
- 1 Light year = 300,000 Km/s X 31,536,000 Seconds
- 1 Light year = 9.46×10^{12} km
 - Whats easier to use?
 - 9,460,000,000,000 km or 1 ly

Astronomical Distances

- A **Parsec** (pc) – is another unit of length used by astronomers and is equal to about 3.26 light years
 - $1 \text{ pc} = 3.26 \text{ ly}$
- Parsec is units used to describe position and distance of objects in space relative to Earth

Measuring Distance in our solar system

- Light Years are too big of a unit to use in measuring distance in our Solar system, so astronomers have another smaller unit
- **The Astronomical Unit (AU)** – the unit of measurement that is equal to the distance of the Earth from the Sun
 - Approximately 150,000,000 km or 93,000,000 miles



Cosmology

- **Cosmology**- the study of the overall structure of the universe
- Not everything in the universe is visibly to us on Earth (dark matter, distant planets brown dwarf stars)
- There are parts of the universe whose light hasn't even reached us yet (so we can't possibly see them)
- Light travels at a set speed, so when we look into the cosmos (universe) we are really looking back in time (because the light we see has taken a long time to travel to us on Earth)

The Structure of the Universe

- Stars cluster (group together) to form galaxies
 - we reside in the Milky Way Galaxy
- Galaxies cluster together to form larger structures called Groups
 - Groups contain 10's of galaxies
 - Our galaxy is one of 30 galaxies in what is called the Local Group

Structure of the Universe - Clusters

- **Galaxies** also gather together in **groups of hundreds and thousands...** these are called **Clusters**
 - The average cluster contains hundreds of galaxies and spreads across 16 light years
- **Groups and Clusters cluster together to form Superclusters**
 - Our galaxy (in the Local Group) belongs to the Local Supercluster
 - **Superclusters** on average span **100 million light-years** of space

The Structure of the Universe

NGC 4881
Coma Cluster
HST · WFPC2



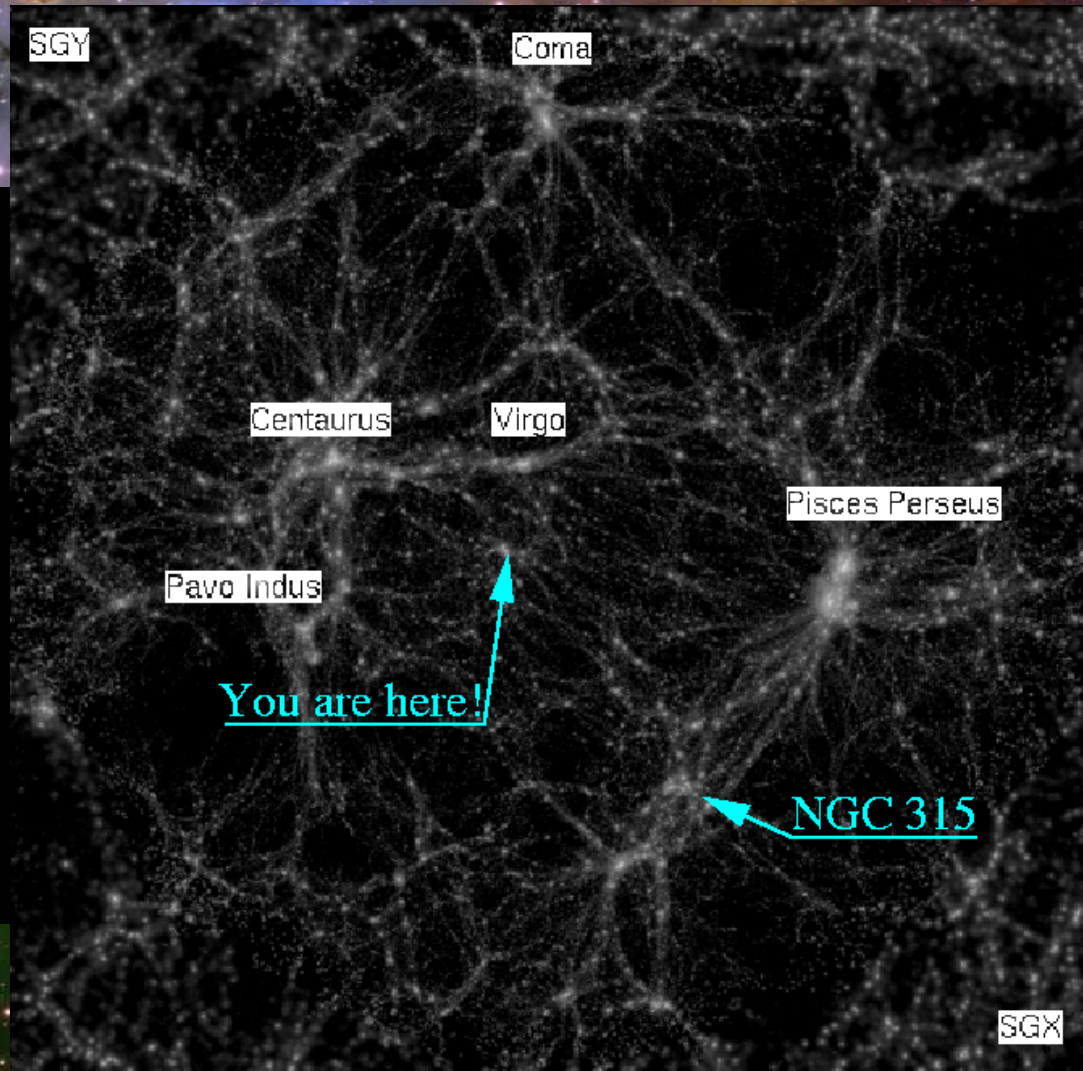
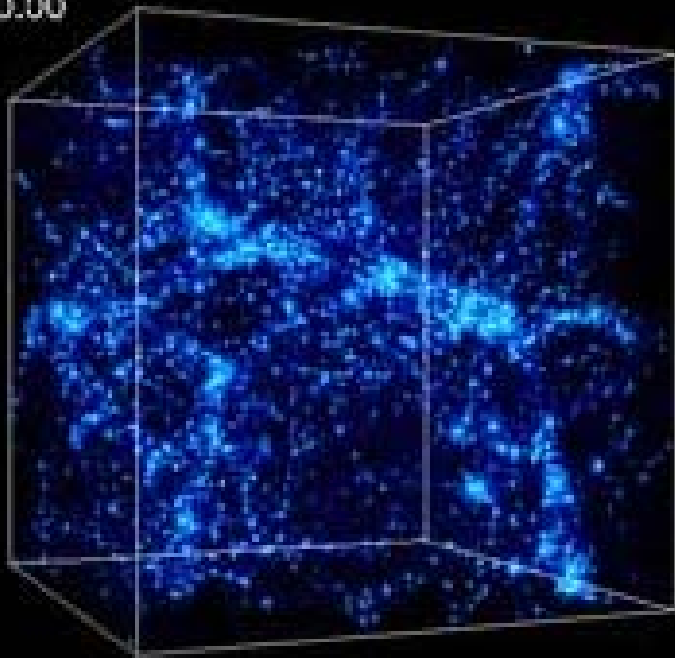
Superclusters and Voids

- The largest structures in the universe that have been identified so far are **systems of clusters and voids** (empty space with no galaxies)
- At this scale the universe looks “foamy” with voids appearing as large spaces with galaxies along them in great filaments connecting superclusters Confused... see the next slide!!!

Superclusters and Voids



$Z = 0.00$



Structure of the Universe

Star



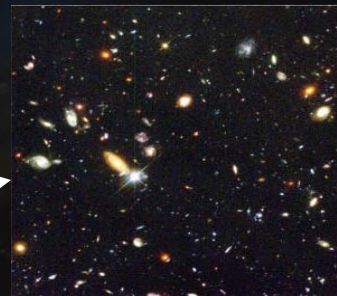
Galaxy



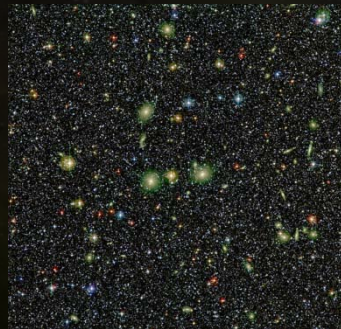
Group



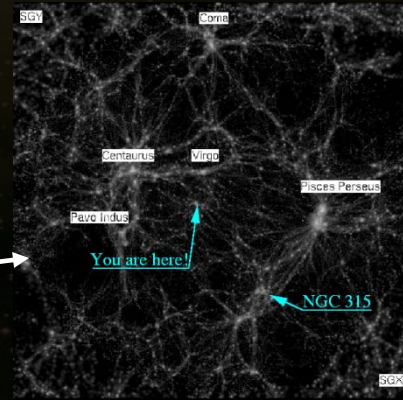
Cluster



Supercluster



Superclusters
and Voids



Smallest

Largest