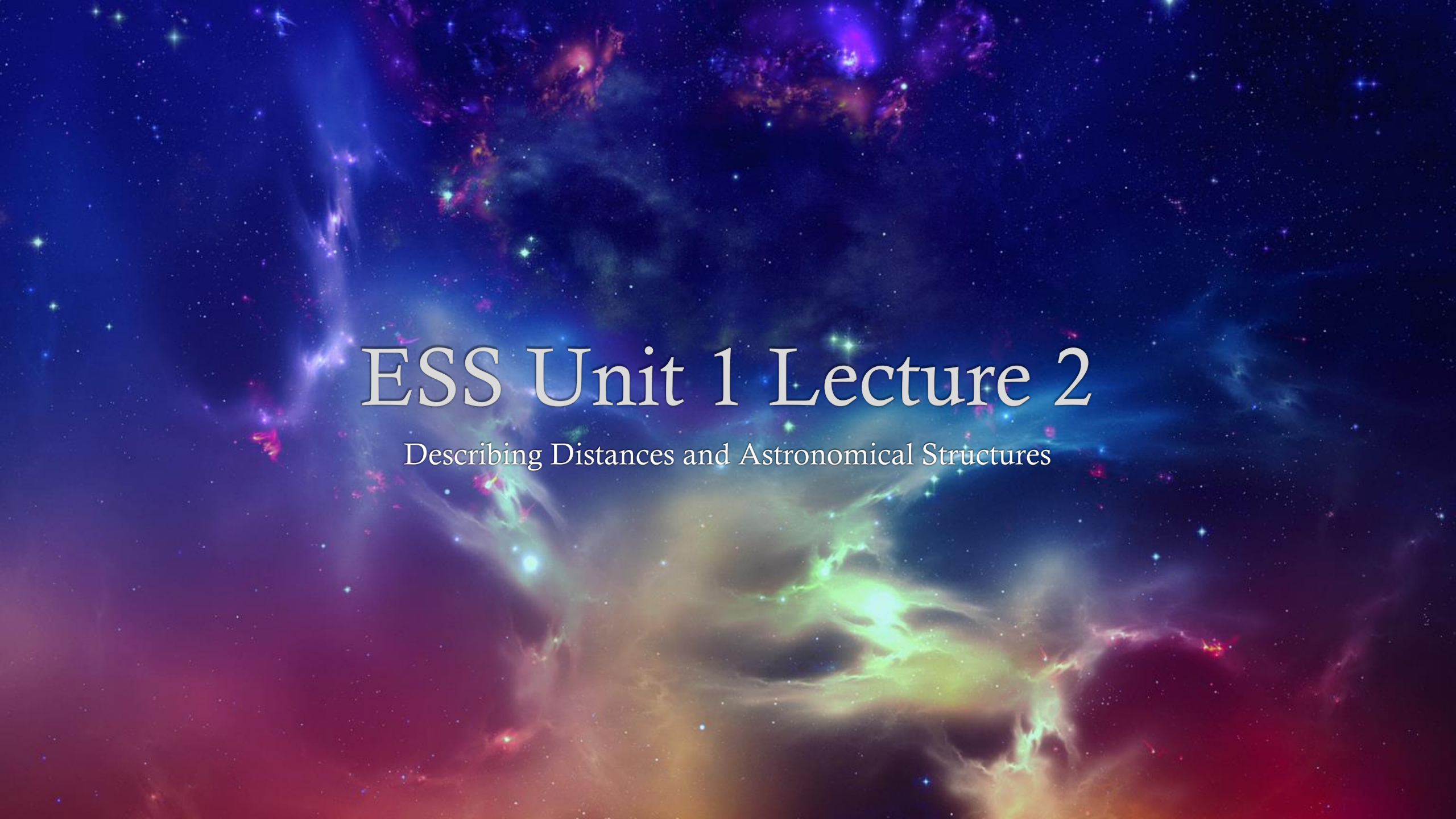

ESS Unit 1 Lecture 2

Describing Distances and Astronomical Structures


How big is the Universe?
Distances on a galactic scale

How big is a Light-Year?

- The light-year is a measure of distance not time
- It is the total distance that a beam of light, moving in a straight line, travels in one year.
- Ex. Take the circumference of the Earth (24,900 miles), lay it out in a straight line, multiply the length of the line by 7.5 (the corresponding distance is one light-second), then place 31.6 million similar line end to end. The resulting distance is almost 6 trillion (6,000,000,000,000) miles! [9.4 trillion km]

What is a Parsec?

- The merging of two different words, parallax and arc-second.
- Simply put a parsec is 3.26 light-years. [30.8 trillion km]
- This is just another large measurement to help simplify distances.

How big is and Astronomical Unit? (AU)

- An Astronomical Unit (AU) is the mean distance between the Earth and the Sun.
- In 2012 the International Astronomical Union defined the distance to be 149,597,870,700 meters.
- Tycho Brahe estimated the distance to the Sun as 8 million kilometers (5 million miles)
- Johannes Kepler estimated the distance as 24 million kilometers (15 million miles)
- Giovanni Cassini (with the help of Jean Richer), made a much better prediction by determining the parallax of Mars. Cassini calculated the AU to be 140 million kilometers (87 million miles), which is lower, but very close to the modern day number.

What is a Galaxy?

Size and Structure

What is a Galaxy?

- A galaxy is an enormous collection of gas, dust and billions of stars held together by gravity.
- One galaxy can have hundreds of billions of stars and be as large as 200,000 light-years across.

Types of Galaxies

Spiral Galaxy

Similar to our Milky Way Galaxy

Large central bulge with arms connect to the bulge, has both old and young stars, disk contains gas and dust, stars form largely in spiral arms, gas and stars rotate around central bulge

Elliptical Galaxy

The Sombrero Galaxy

Has no arms, stars are distributed evenly, contains mostly old stars, little or no gas, little or no new star formation, stars move around randomly like a swarm of bees.

Irregular Galaxy

Contains both new and old stars, has lots of gas and dust, stars and gas have irregular orbits

How Big is Our Galaxy?

- The disk of the Milky Way is about 100,000 light-years in diameter, but only about 1000 light-years thick
- Think about that, the Milky Way is so big that light would take 100,000 years to travel from one end to the other!


How Far Are Things?
Looking at Distances to Stars and How They are Meassured

How Far is the Nearest Stars?

- Proxima Centauri 4.2 light-years
- Regil 4.3 light-years
- Kentaurus 4.3 light-years
- Barnard's Star 6.0 light-years
- Wolf 359 7.7 light-years

How Do Scientists Measure these Distances?

- Radar:
  - For measuring distances in our solar system
  - Bounce radio waves off of objects and measure the time it takes for the wave to leave and come back (light travels at 3.0×10^8 m/s)
- Parallax:
  - For measuring distance to nearby stars
  - The use of geometry and taking measurements of the angle of the star in the night sky at the opposite times of the year (opposite points on the Earth's orbit)

How Do Scientists Measure these Distances?

- Cepheids:
  - For measuring distances in our galaxy and to nearby galaxies
  - This uses a star that pulses at a regular interval to be used as a cosmic “yardstick”, but only out to distances a few tens of millions of light-years
- Supernovae
  - For measuring distances to other galaxies
  - When a main sequence star enters into the last phases of life, they die in a bright explosion
  - A certain type gives off a standard and can be used in calculation of distances up to 1 billion light-years

How Do Scientists Measure these Distances?

- Redshift and Hubble's Law
  - For measuring distances to objects far, far away
  - Using Hubble's receding constant and the measurement of the Doppler shift of light, one can calculate the distance of objects further than 1 billion light-years