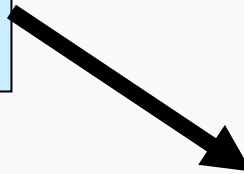# Introduction To Modern Astronomy II

Introducing Astronomy
(chap. 1-6)

Planets and Moons
(chap. 7-17)

Ch1: Astronomy and the Universe
Ch2: Knowing the Heavens
Ch3: Eclipses and
          the Motion of the Moon
Ch4: Gravitation and
           the Waltz of the Planets
Ch5: The Nature of Light
Ch6: Optics and Telescope

# Astronomy and the Universe

Chapter One

Guiding Questions

1. What methods do scientists use to expand our understanding of the universe?
2. What makes up our solar system?
3. What are the stars? Do they last forever?
4. What are galaxies? What do astronomers learn by studying them?
5. How does measuring angles help astronomers learn about objects in the sky?
6. What is powers-of-ten notation, and why is it useful in astronomy?
7. Why do astronomers measure distances in astronomical units, light-years, and parsecs?
8. How does studying the cosmos help us on Earth?

Scientific Methods

- **Scientific Method**
  - based on observation, logic, and skepticism
- **Hypothesis**
  - a collection of ideas that seems to explain a phenomenon
- **Model**
  - hypotheses that have withstood observational or experimental tests
- **Theory**
  - a body of related hypotheses can be pieced together into a self consistent description of nature
- **Laws of Physics**
  - theories that accurately describe the workings of physical reality, have stood the test of time and been shown to have great and general validity

Uncover the Formation of Solar System
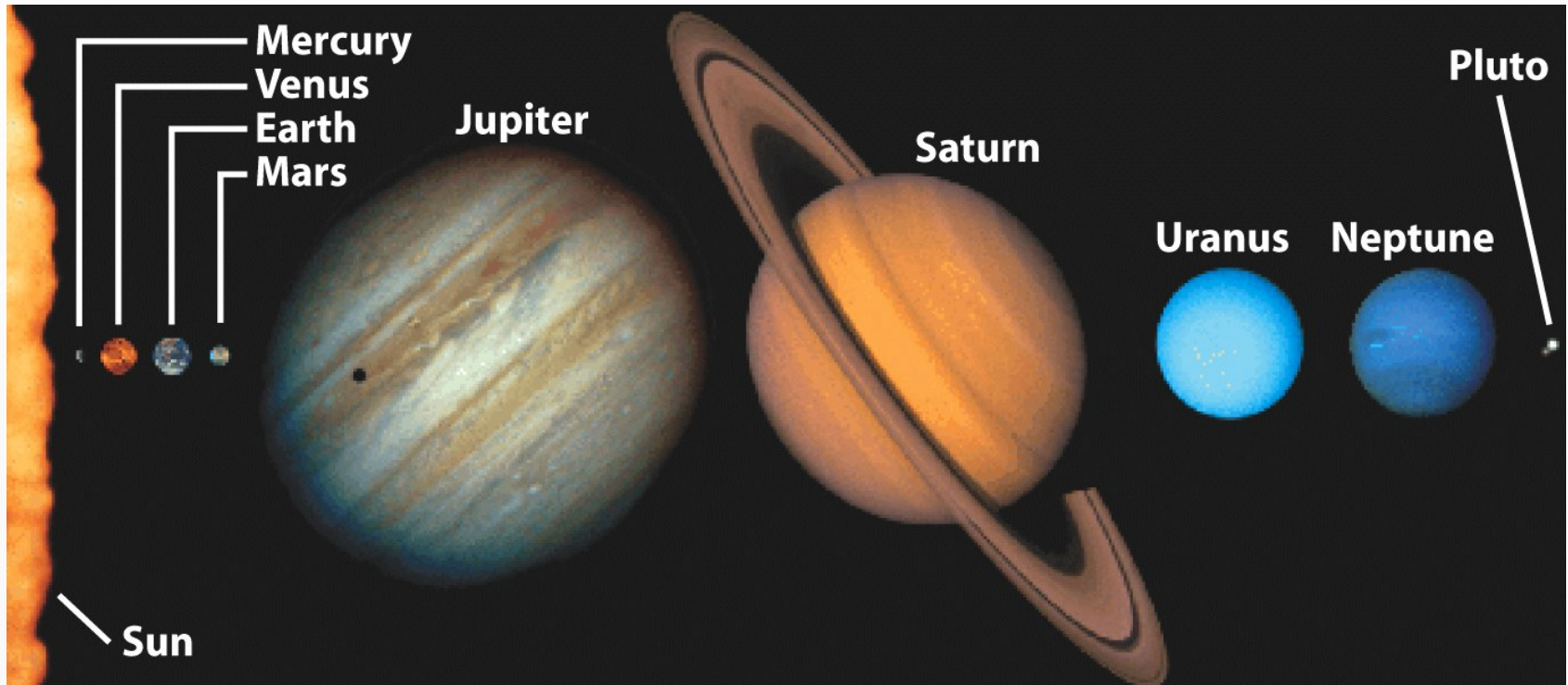
– The star we call the Sun and all the celestial bodies that orbit the Sun
- including Earth
- the other eight planets
- all their various moons
- smaller bodies such as asteroids and comets

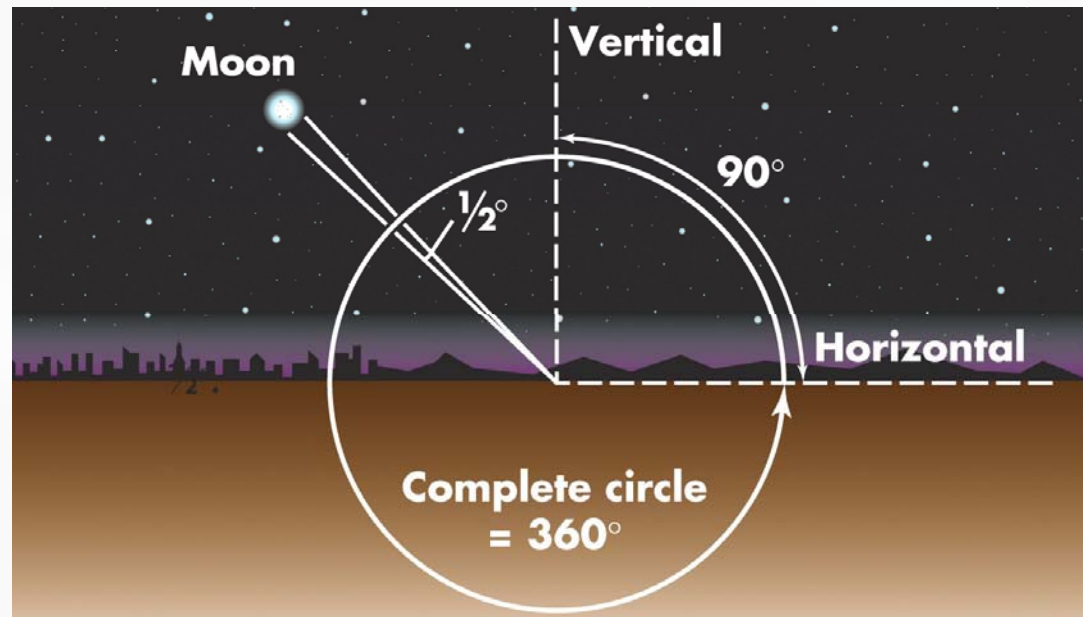# Discover Stars Born, Grow and Die
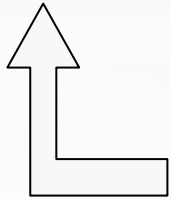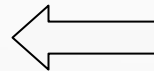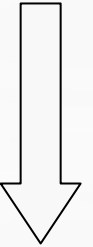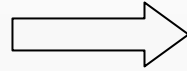
Learn origin and fate of the universe

– By observing the galaxies

Angular Measure

- Astronomers use **angular measure** to
  - describe the apparent size of a celestial object
- **degree (°)**: the basic unit of angular measure
  - One entire cycle is 360°
- **Angular diameter,** or **angular size**
  - The Moon is ½° or the Moon **subtends** an angle of ½°.
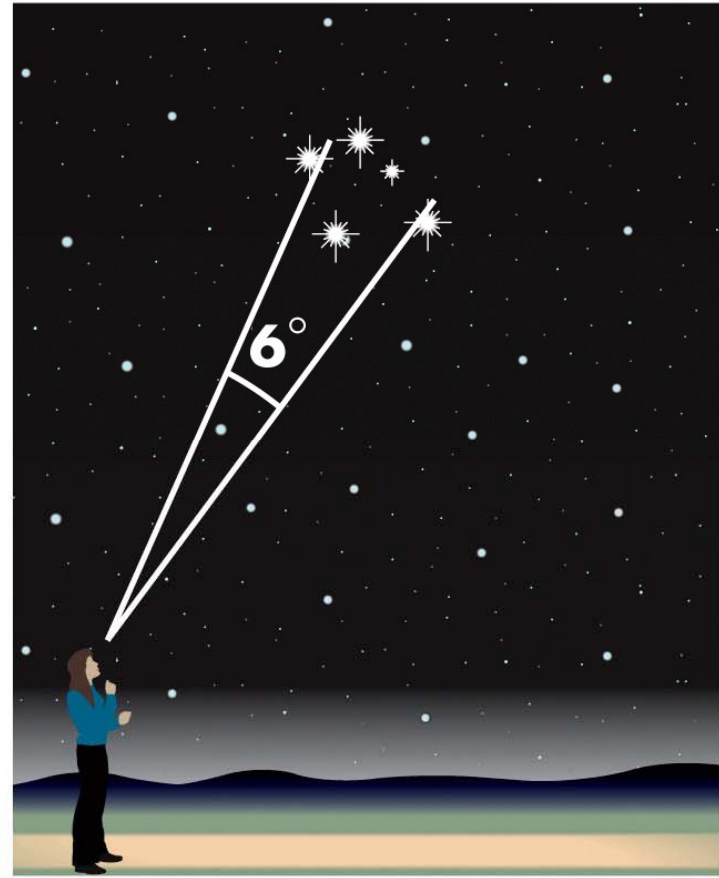
Angular Measure

Angular distance: If you draw lines from your eye to each of two stars, the angle between these lines is the **angular distance.**

Angular Measure

- The adult human hand held at arm's length provides a means of estimating angles
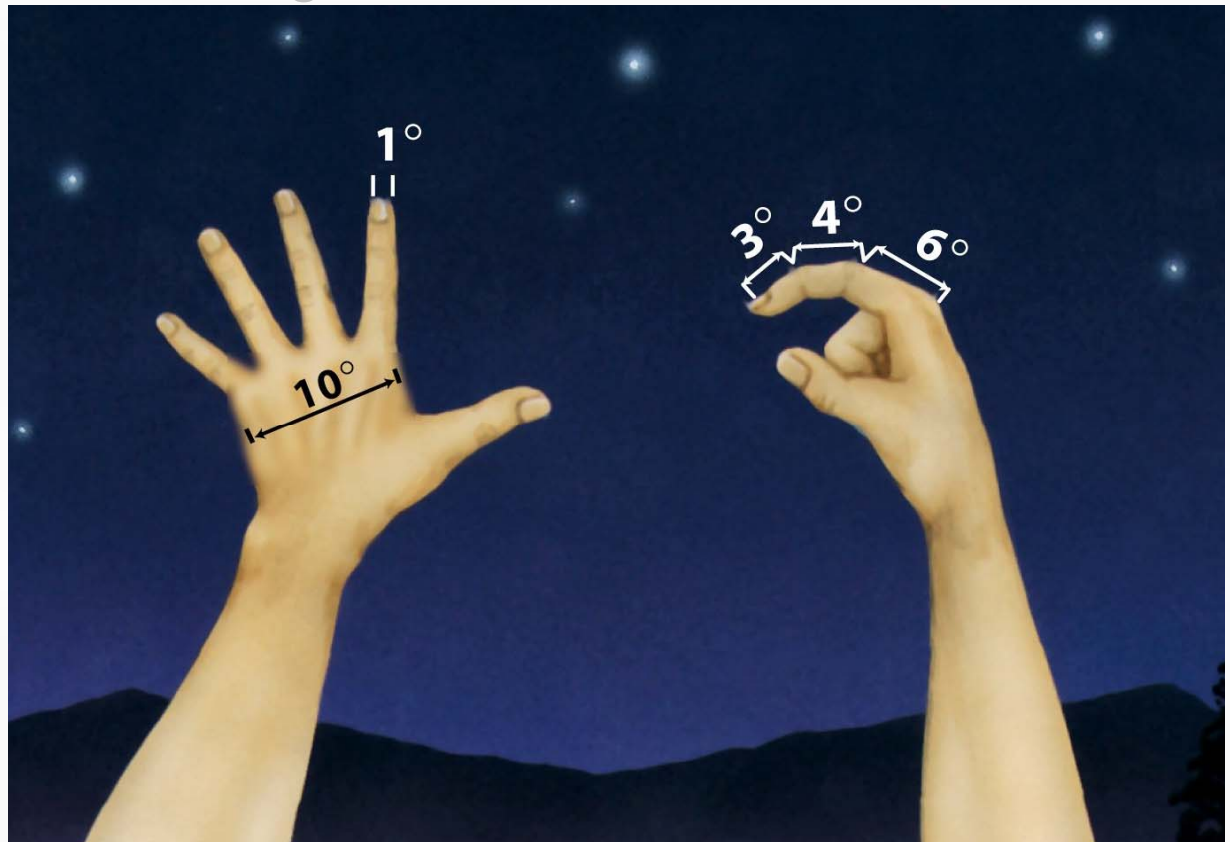 - About 10° for the fist
  - About 1° for the finger

Angular Measurements

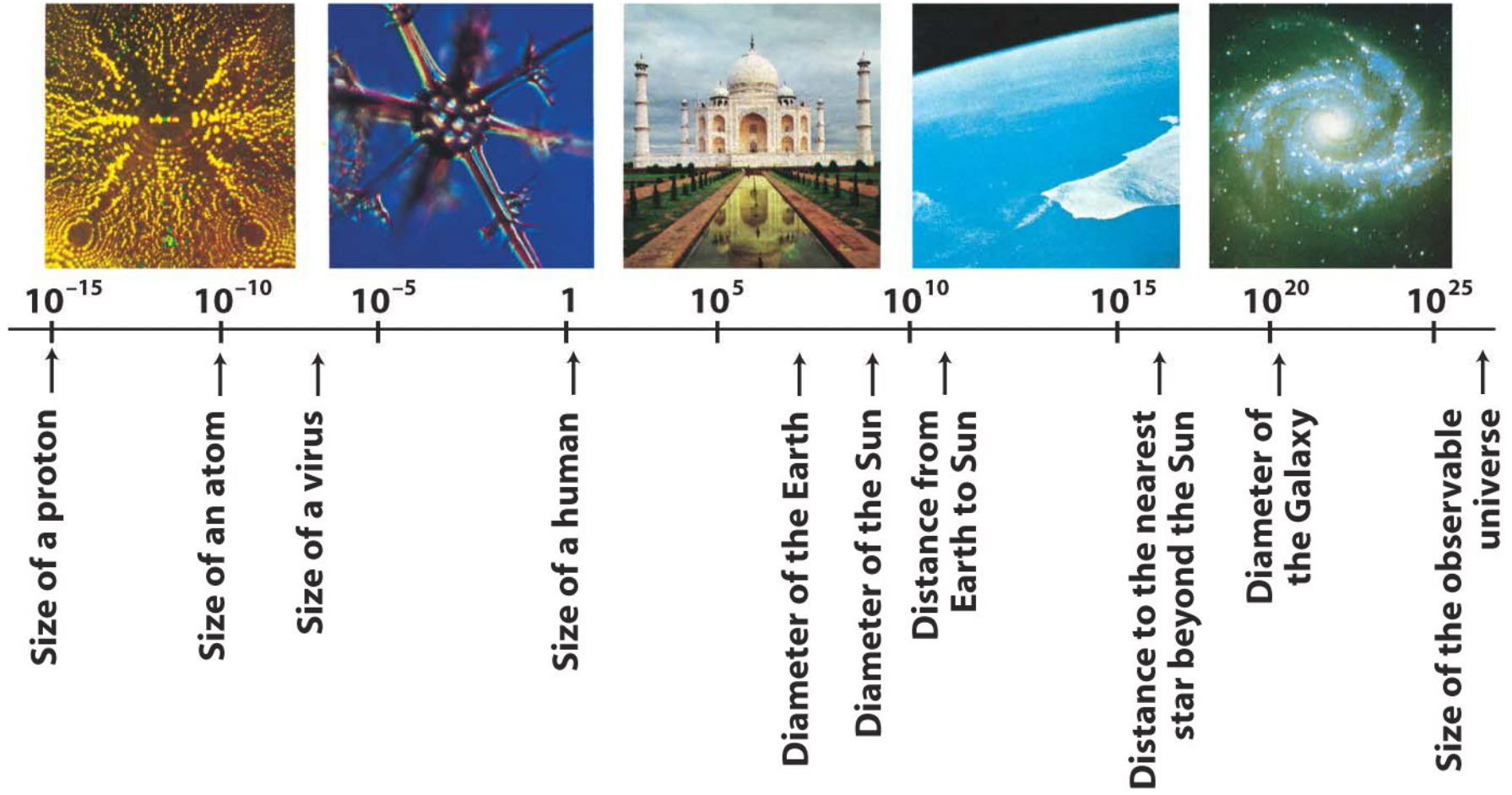- **Subdivide one degree into 60 arcminutes**
  - minutes of arc
  - abbreviated as 60 arcmin or 60´
- **Subdivide one arcminute into 60 arcseconds**
  - seconds of arc
  - abbreviated as 60 arcsec or 60"

$$1° = 60 \text{ arcmin} = 60´$$
$$1´ = 60 \text{ arcsec} = 60"$$

- For example
  - Moon: 1800 arcsec
  - Saturn: 20 arcsec
  - A star: much less than 1 arcsec, can not be resolved by any telescope

Powers-of-ten notation

10^{-15} 10^{-10} 10^{-5} 1 10^{5} 10^{10} 10^{15} 10^{20} 10^{25}

Size of a proton

Size of an atom

Size of a virus

Size of a human

Diameter of the Earth

Diameter of the Sun

Distance from Earth to Sun

Distance to the nearest star beyond the Sun

Diameter of the Galaxy

Size of the observable universe

Notation:Common Prefixes

Factor	Name	Symbol
(billion) 10^9	Giga-	G (1,000,000,000)
(million) 10^6	Mega-	M (1,000.000)
(thousand) 10^3	kilo-	K (1,000)
(hundredth) 10^{-2}	centi-	c (0.01)
(thousandth) 10^{-3}	milli-	m (0.001)
(millionth) 10^{-6}	micro-	μ (0.000001)
(billionth) 10^{-9}	nano-	n (0.000000001)

Powers-of-ten notation

- 149,600,000 km, the average distance between the Sun and the Earth

- 149.6 million km

- 1.496×10^8 km in scientific notation

Units of Astronomical Distances

- **Astronomical Unit (AU)**
  - One AU is the average distance between Earth and the Sun
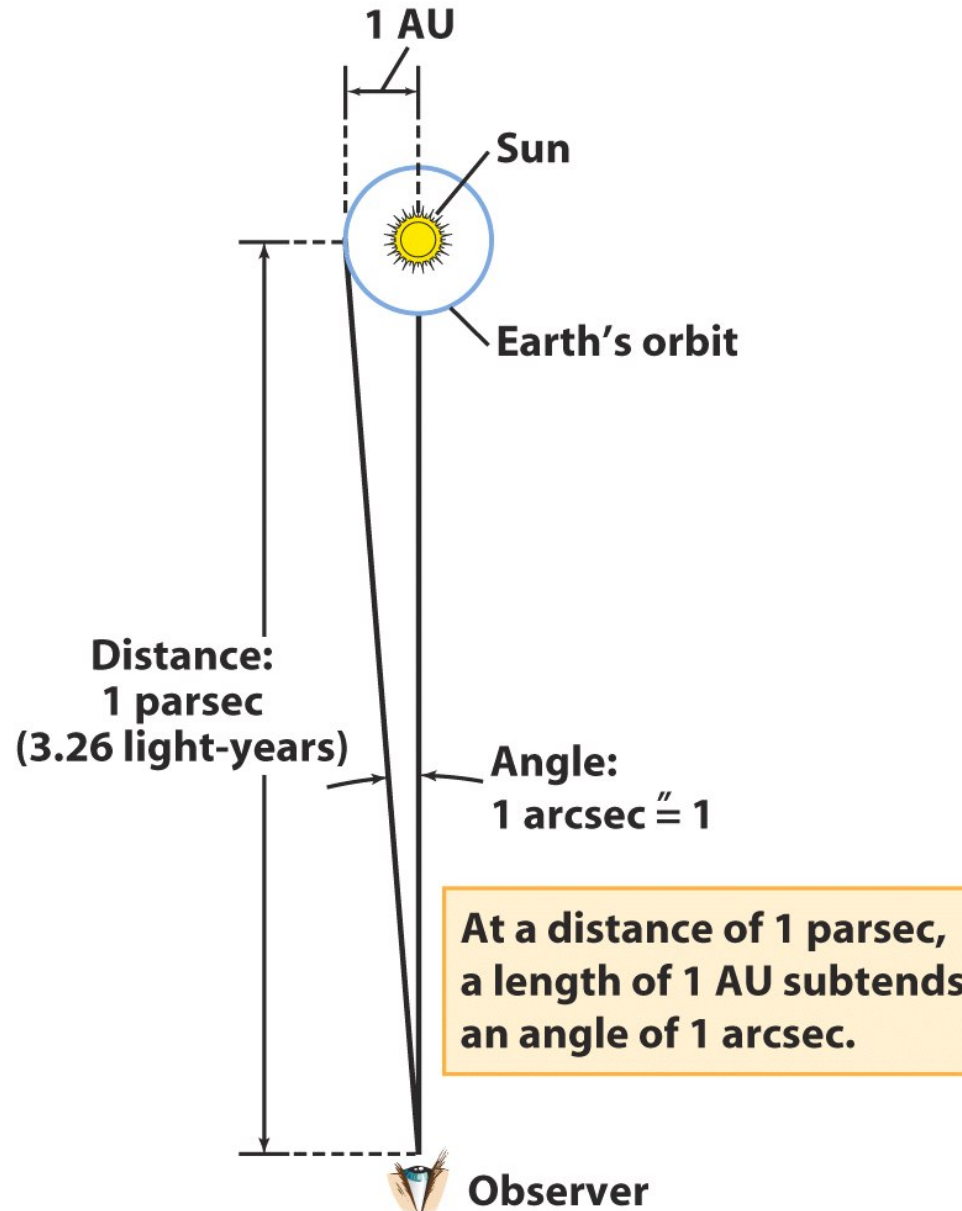 - 1.496×10^8 km or 92.96 million miles
  - Jupiter: 5.2 AU from the Sun
- **Light Year (ly)**
  - One ly is the distance light can travel in one year at a speed of about 3×10^5 km/s or 186,000 miles/s
  - 9.46×10^{12} km or 63,240 AU
  - Proxima Centauri, the nearest star: 4.2 ly
- **Parsec (pc)**
  - the distance at which 1 AU subtends an angle of 1 arcsec
  - 1 pc = 3.09×10^{13} km = 3.26 ly
  - Milky Way galaxy: 50 kpc

Units of Astronomical Distances

1 AU

Sun

Earth's orbit

Distance:
1 parsec
(3.26 light-years)

Angle:
1 arcsec $\overset{"}{=}$ 1

At a distance of 1 parsec, a length of 1 AU subtends an angle of 1 arcsec.

Observer

Final Notes on Chap. 1

- There are 8 sections. Section 1-1 to 1-7 are covered in the lecture

- There are 4 boxes. None of them is covered in the lecture. You are encouraged to study them on your own