Introduction To Modern Astronomy I: Solar System

Introducing Astronomy
(chap. 1-6)

Planets and Moons
(chap. 7-15)

Chap. 16: Our Sun
Chap. 28: Search for
Extraterrestrial life

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

Highlights

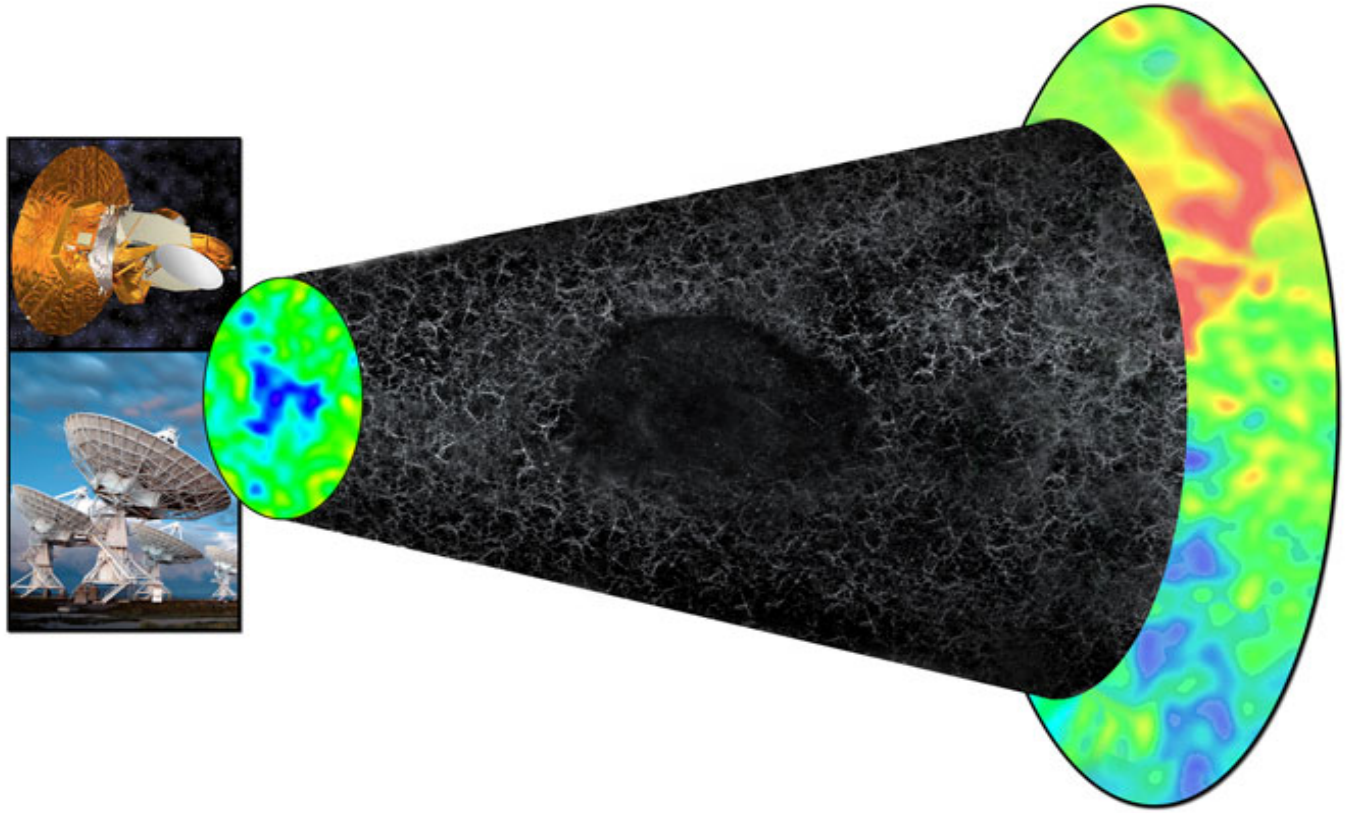
- A total lunar eclipse Tuesday morning, Aug. 28, 2007

	EDT	PDT
– Partial eclipse begins:	4:51 AM	1:51 AM
– Total eclipse begins:	5:52 AM	2:52 AM
– Total eclipse ends:	-----	4:23 AM
– Partial eclipse end:	-----	5:24 AM

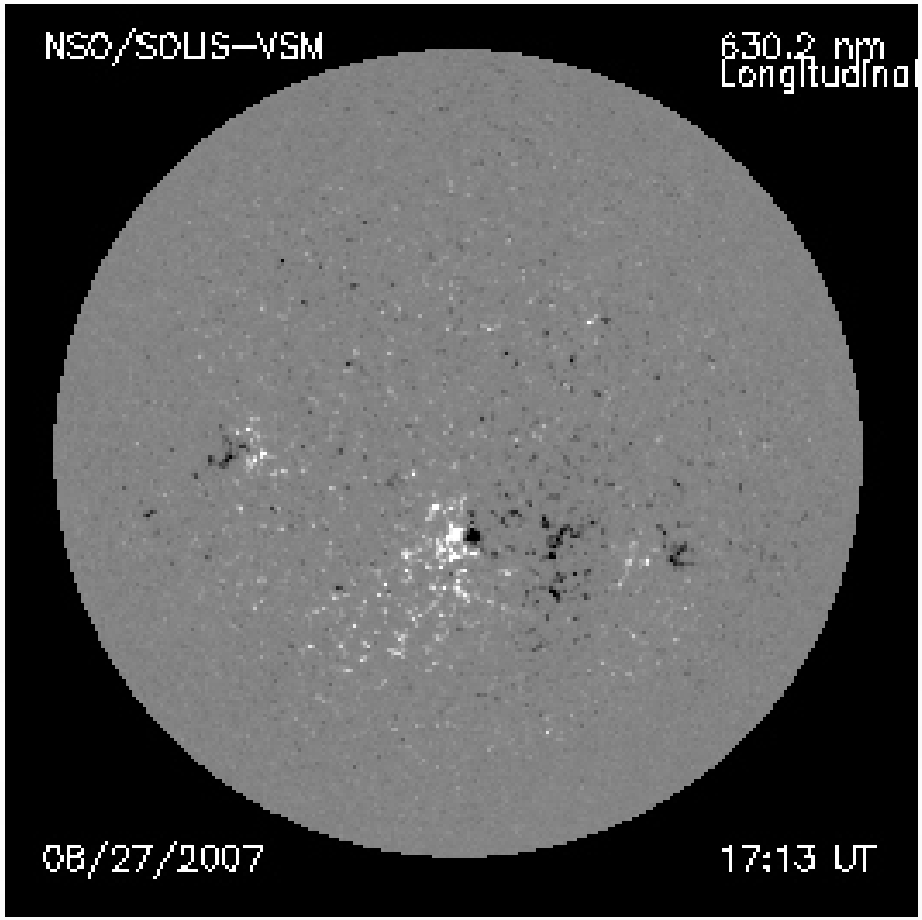
- Google Earth “searches” the sky.

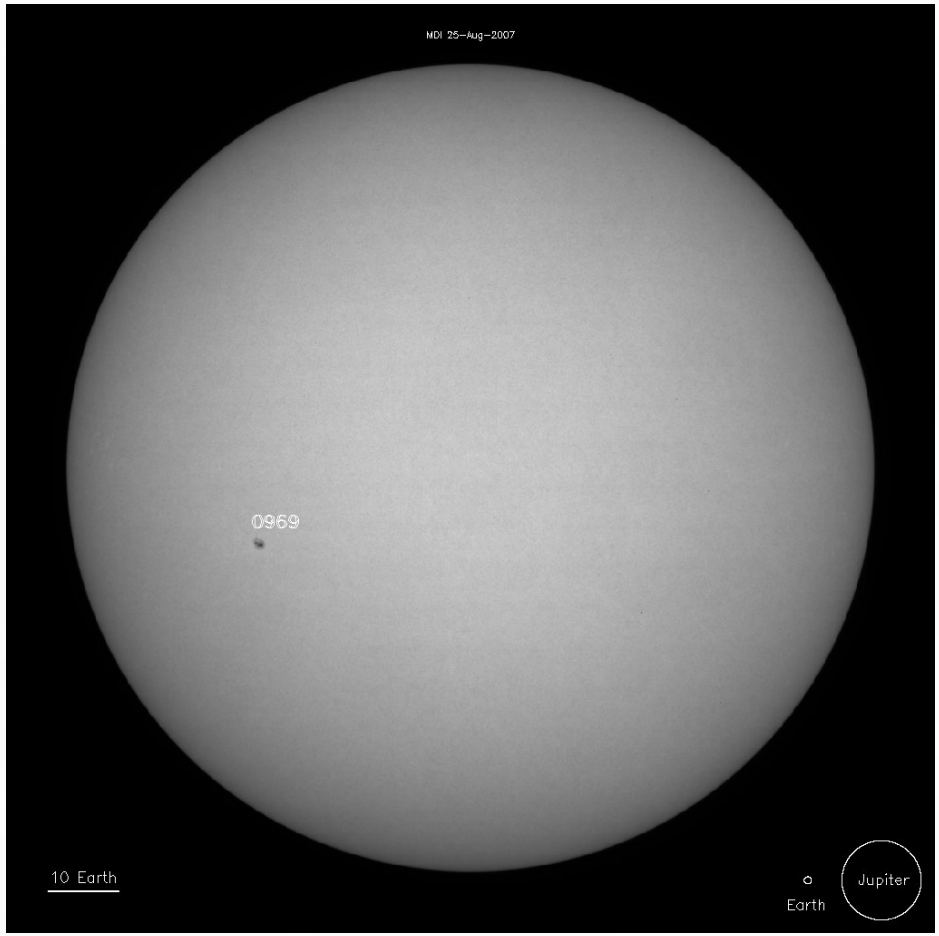
Astronomy Picture of the Day (2007/08/27)

Huge Void in Distant Universe



Today's Sun (2007/08/27)





Astronomy and the Universe

Chapter One

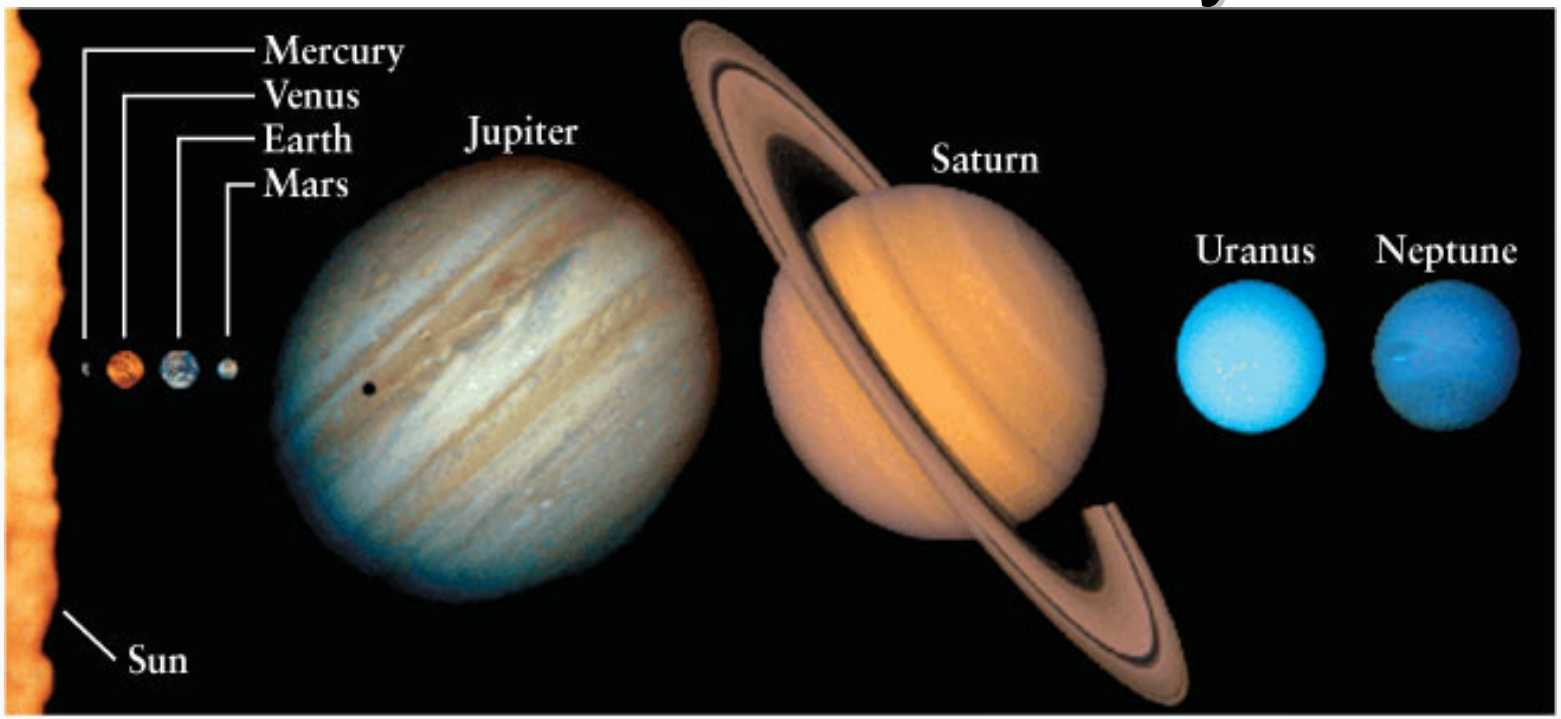
Scientific Methods

- **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

Example

Theory: Earth and planets orbit the Sun due to the Sun's gravitational attraction

Formation of Solar System

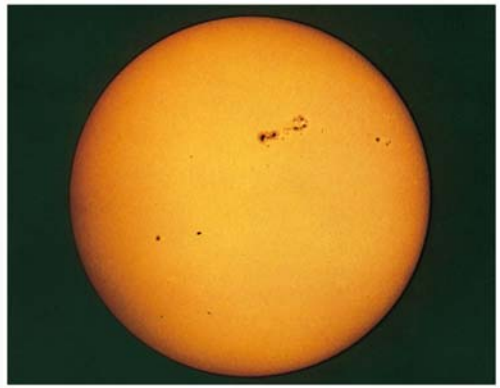


The Sun and Planets to Scale

- By exploring the planets, astronomers uncover clues about the formation of the solar system
  - Terrestrial and Jovian Planets
  - Meteorites. 4.56 billion years
  - Solar nebula

Evolution of Stars

Orion Nebula



Our Sun

Crab Nebula

Thermonuclear reaction; H-bomb

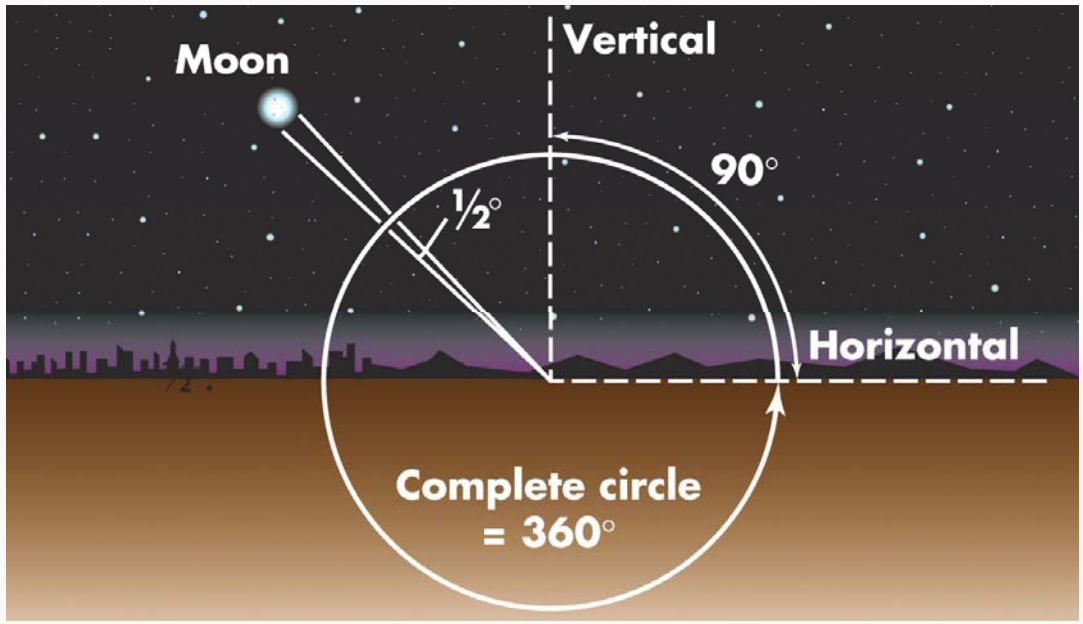
- A star has a full life cycle: be born, evolve, and die

Origin and Fate of the universe

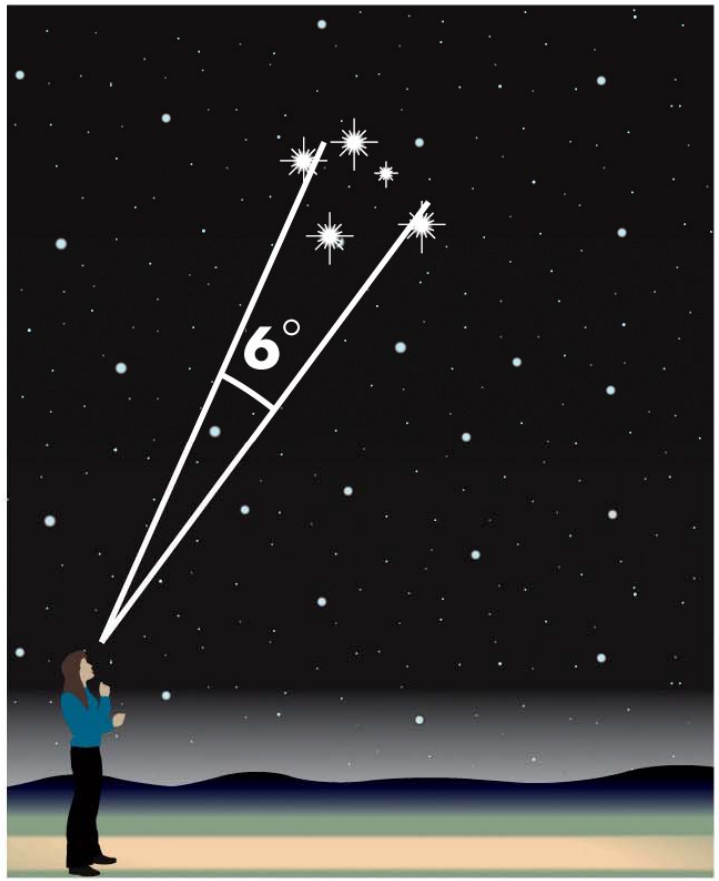
- Galaxies are flying away from each other
- Expanding universe
- Big bang theory

Angular Measure

- Denote position and size of astronomical object
- **degree (°)**: the basic unit of angular measure
  - One entire cycle is 360°
- **Angular diameter,** or **angular size**
  - The Moon is ½°, and also the angular size of the Sun



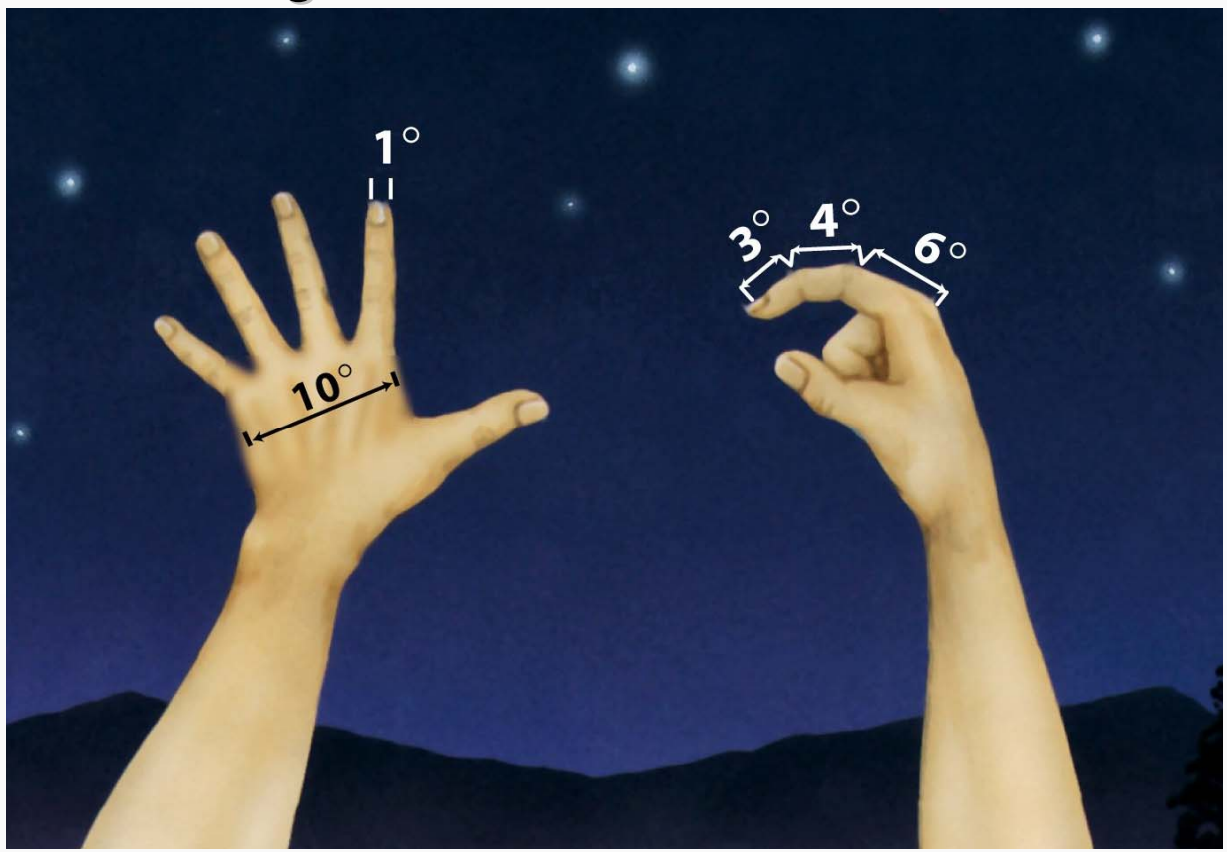
Angular Measure



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 Measure

- 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 arcmin = 60´

1´ = 60 arcsec = 60”

- For example
  - Moon: 0.5°, 30 arcmin, or 1800 arcsec
  - Saturn: 20 arcsec
  - A star: much less than 1 arcsec, can not be resolved by any telescopes

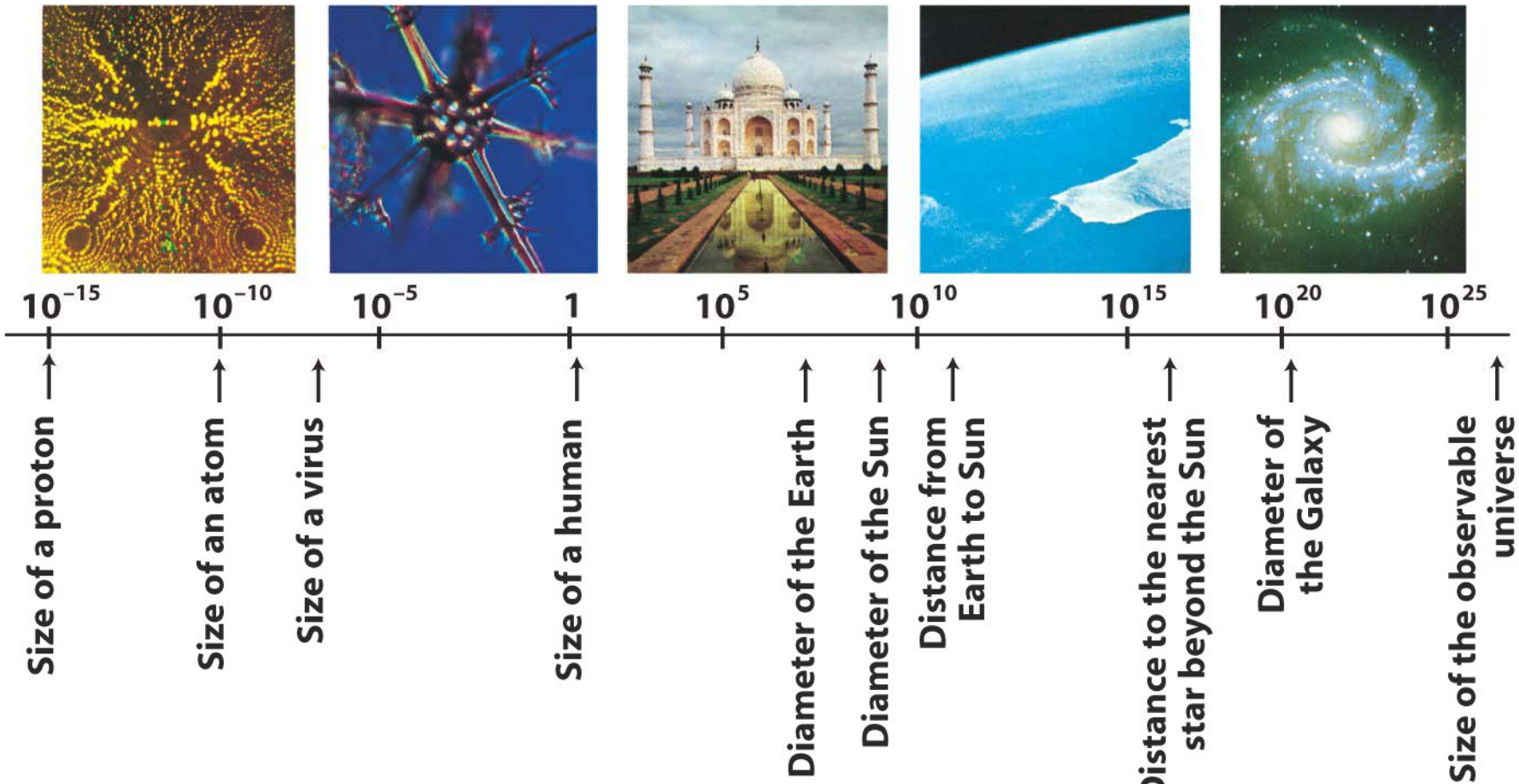
Angular Measure

- **Small angle formula**
  - D: linear size of an object
  - d: distance to the object
  - α: angular size of the object, **in arcsec**

$$D = \alpha\, d\, /206265$$

- If same linear size, the more distant the object, the smaller the angular size
- If same angular size, the more distant the object, the greater its actual (linear) size

Powers-of-ten notation



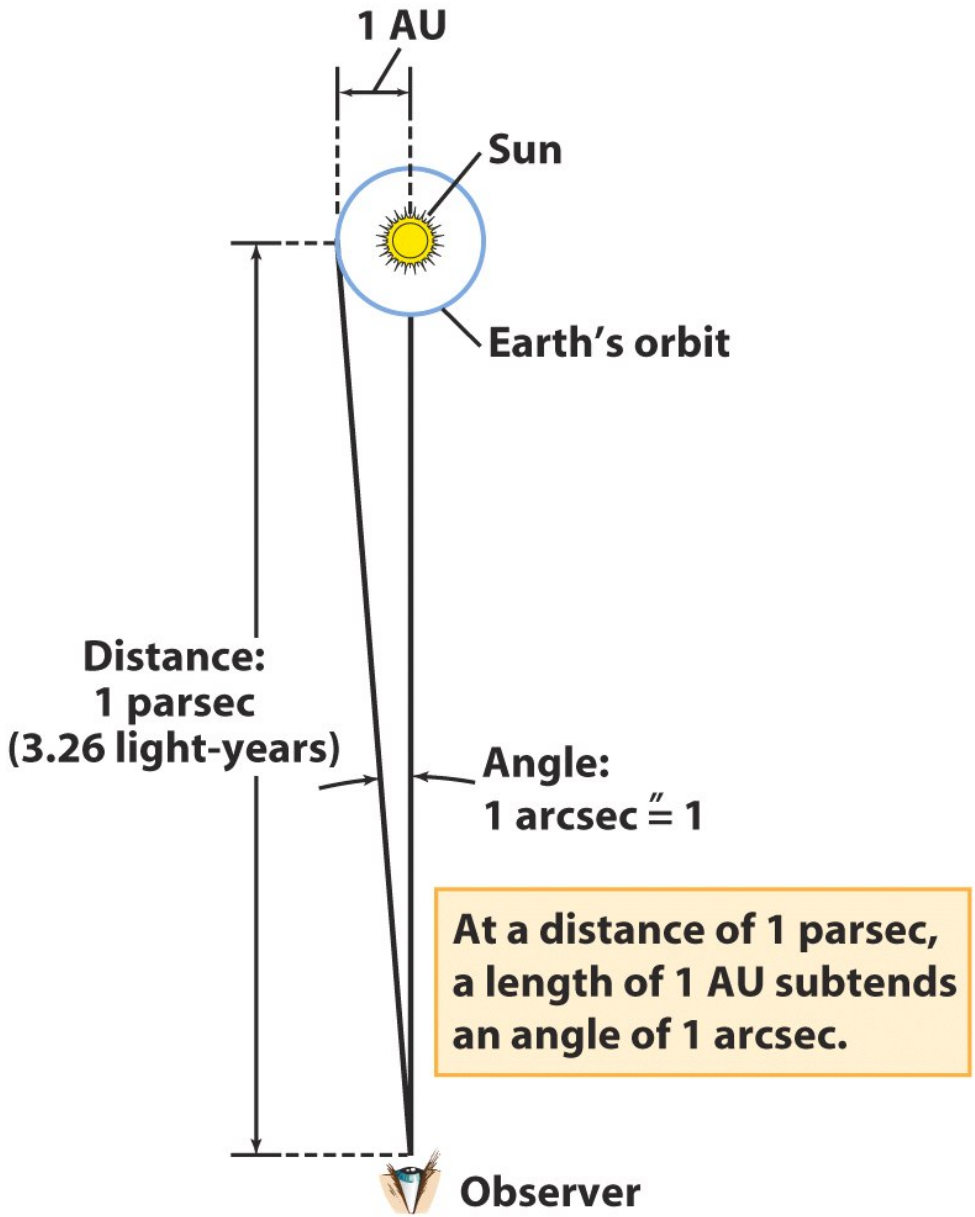
Powers-of-ten notation

- 10^n: Number 10 is multiplied n times
  - 10^5: 10X10X10X10X10
- 10^{-n}: number 10 is divided n times
  - 10^{-5}: 1/10 X 1/10 X 1/10 X 1/10 X 1/10
- Example
  - Earth diameter: 1.28 X 10^4 km
  - Sun's diameter: 1.39 X 10^6 km
  - Sun-Earth distance: 1.50 X 10^8 km
  - One light year: 9.46 X 10^{12} km
  - One year: 3.16 X 10^7 s
  - Mass of the Sun: 1.99 X 10^{30} kg
  - Mass of Proton: 1.67 X 10^{-27} kg

Units of Astronomical Distances

- **Astronomical Unit (AU)**
  - One AU is the average distance between Earth and 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
  - $1 \text{ pc} = 3.09 \times 10^{13}$ km = 3.26 ly
  - Milky Way galaxy: 50 kpc

Units of Astronomical Distances



Final Notes on Chap. 1

- There are 8 sections. Section 1 to 7 are studied
- There are 3 boxes. Box 1 and 2 are studied.

Advanced Question
Chap. 1, Q37 in P18

Suppose your telescope can give you a clear view of objects and features that subtend angles of at least 2 arcsec. What is the diameter in kilometers of the smallest craters you can see on the Moon?