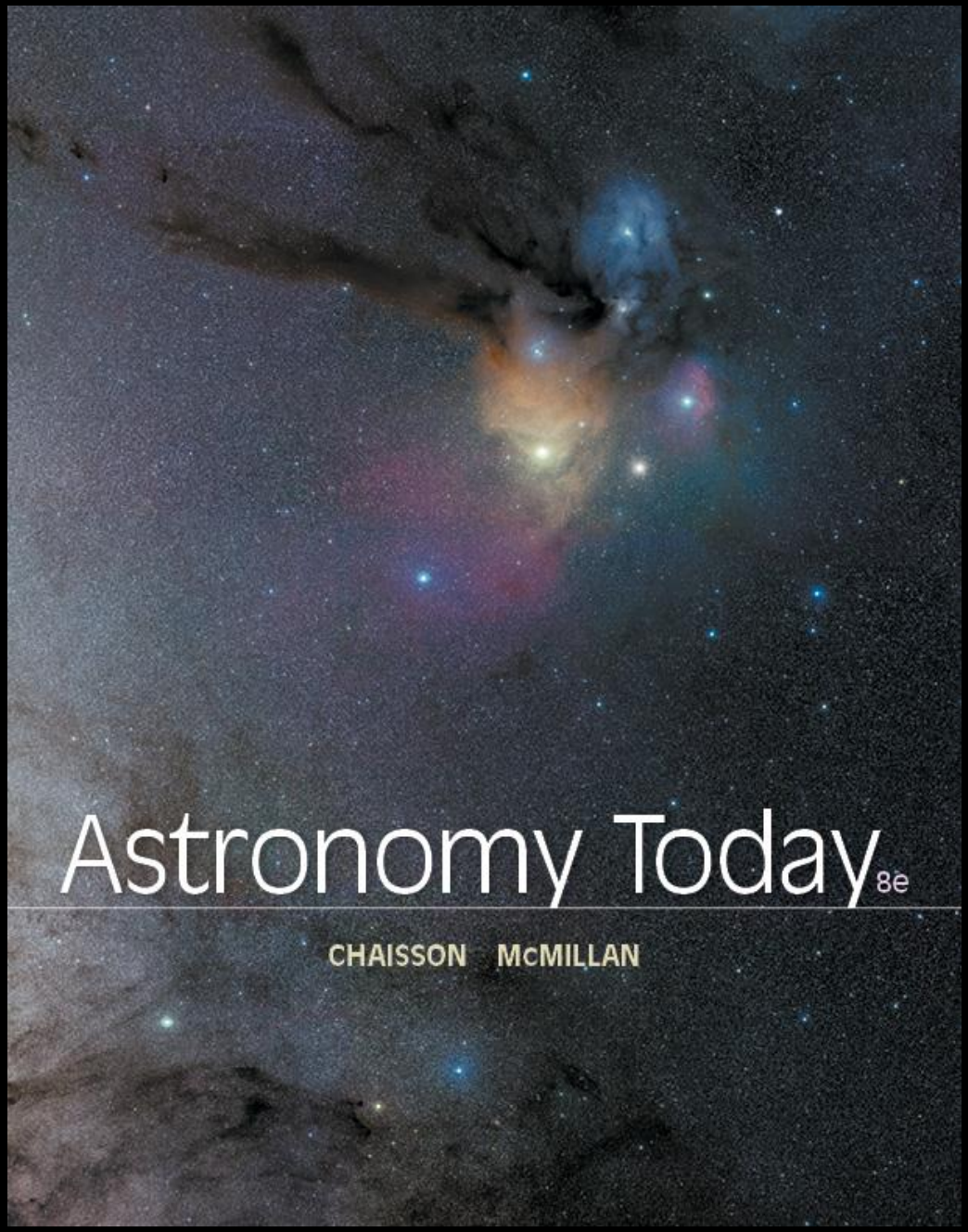


Lecture Outlines

Chapter 1

Astronomy Today

8th Edition

Chaisson/McMillan

Chapter 1

Charting the Heavens

Units of Chapter 1

1.1 Our Place in Space

- **Earth** is average—we don't occupy any special place in the universe

- **Universe**: totality of all space, time, matter, and energy

1.1 Our Place in Space

- **Astronomy**: study of the universe

- **Scales** are very large: measure in light-years, the distance light travels in a year—about 10 trillion miles

1.1 Our Place in Space

- **This galaxy is about 100,000 light-years across.**

1.2 Scientific Theory and the Scientific Method

Scientific theories:

- **Must be testable**
- **Must be continually tested**
- **Should be simple**
- **Should be elegant**

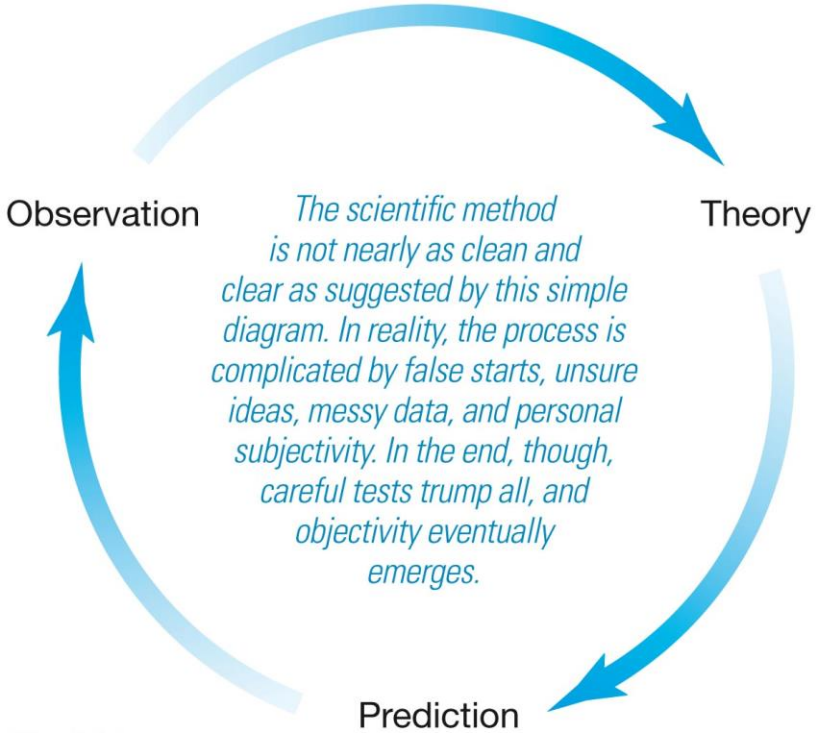
Scientific theories can be proven wrong, but they can never be proven right with 100 percent certainty.

1.2 Scientific Theory and the Scientific Method

- **Observation** leads to theory explaining it.

- **Theory** leads to predictions consistent with previous observations.

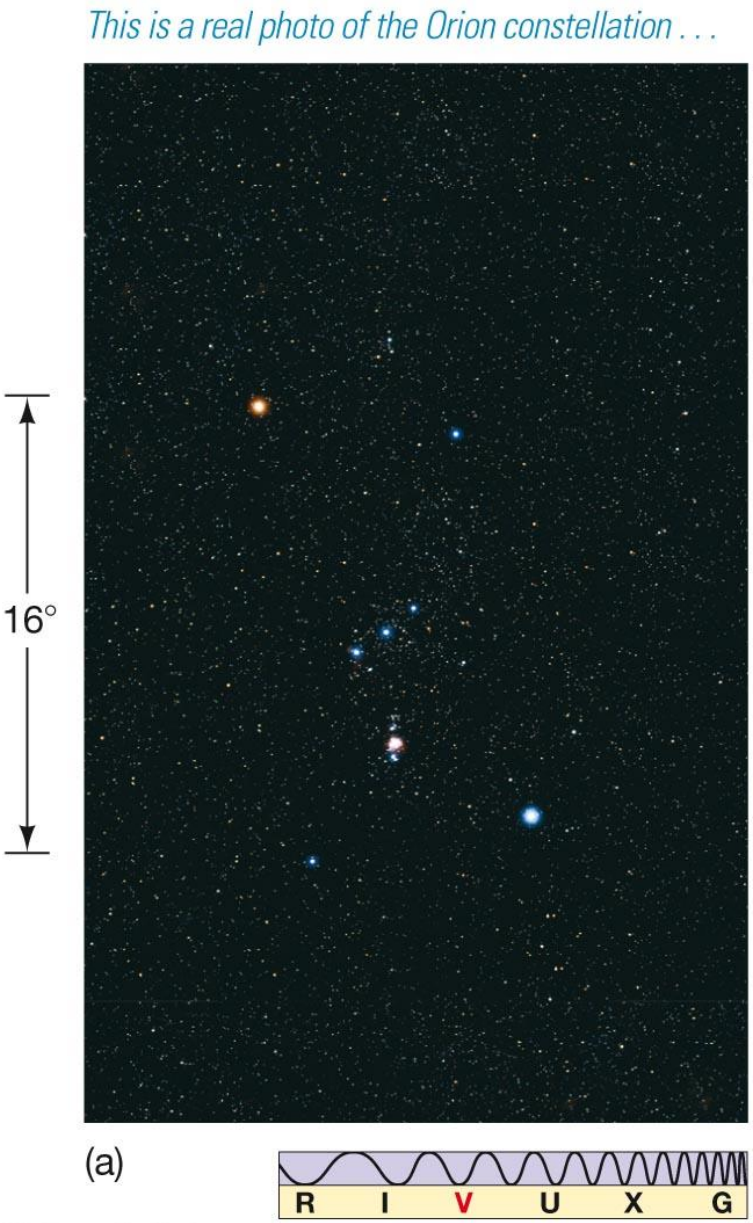
- **Predictions** of new phenomena are observed. If the observations agree with the prediction, more predictions can be made. If not, a new theory should be made.



1.3 The "Obvious" View

Simplest observation:
Look at the night sky

About 3000 stars visible at any one time; distributed randomly but human brain tends to find patterns



1.3 The "Obvious" View

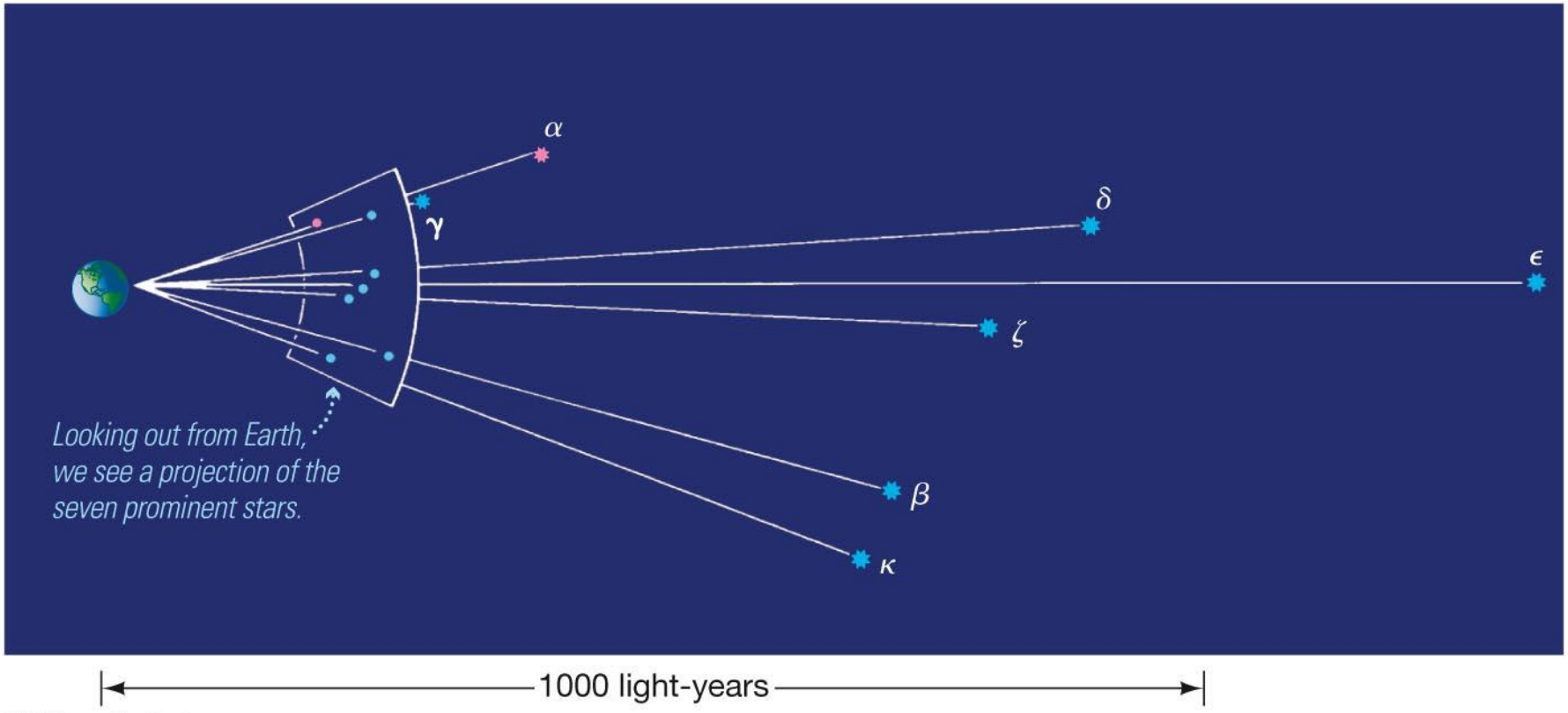
Group stars into constellations: Figures having meaning to those doing the grouping

Useful: Polaris, which is almost due north

Useless: Astrology, which makes predictions about individuals based on the star patterns at their birth

1.3 The "Obvious" View

Stars that appear close in the sky may not actually be close in space

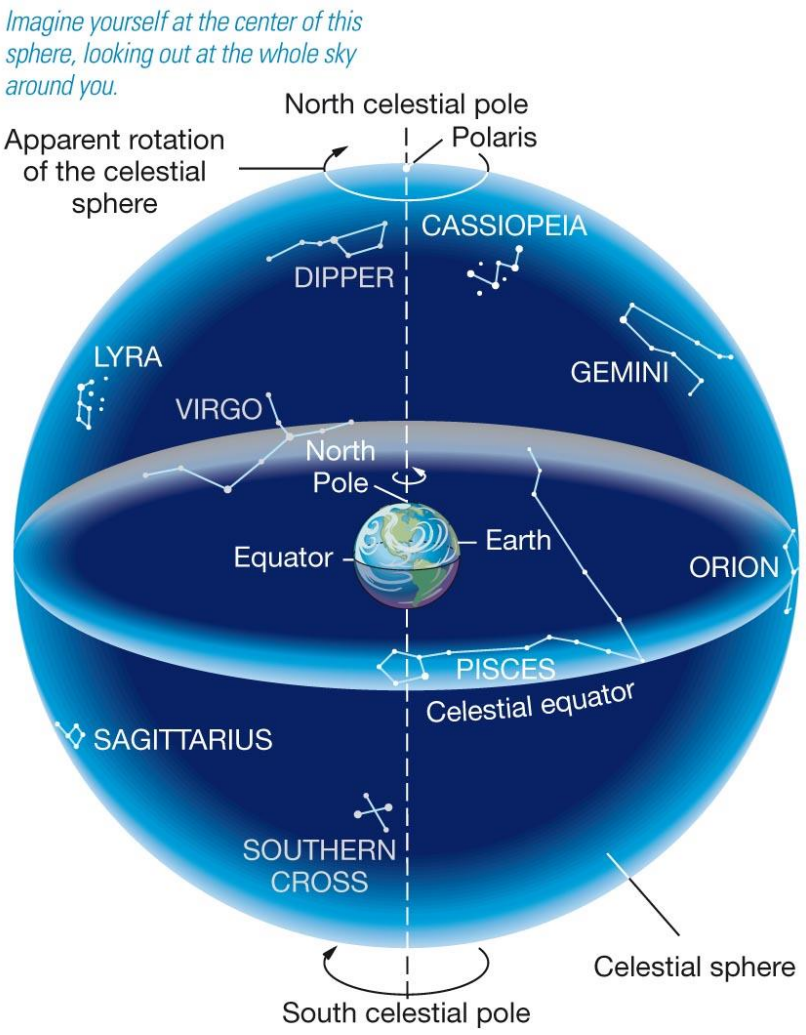


1.3 The "Obvious" View

The celestial sphere:

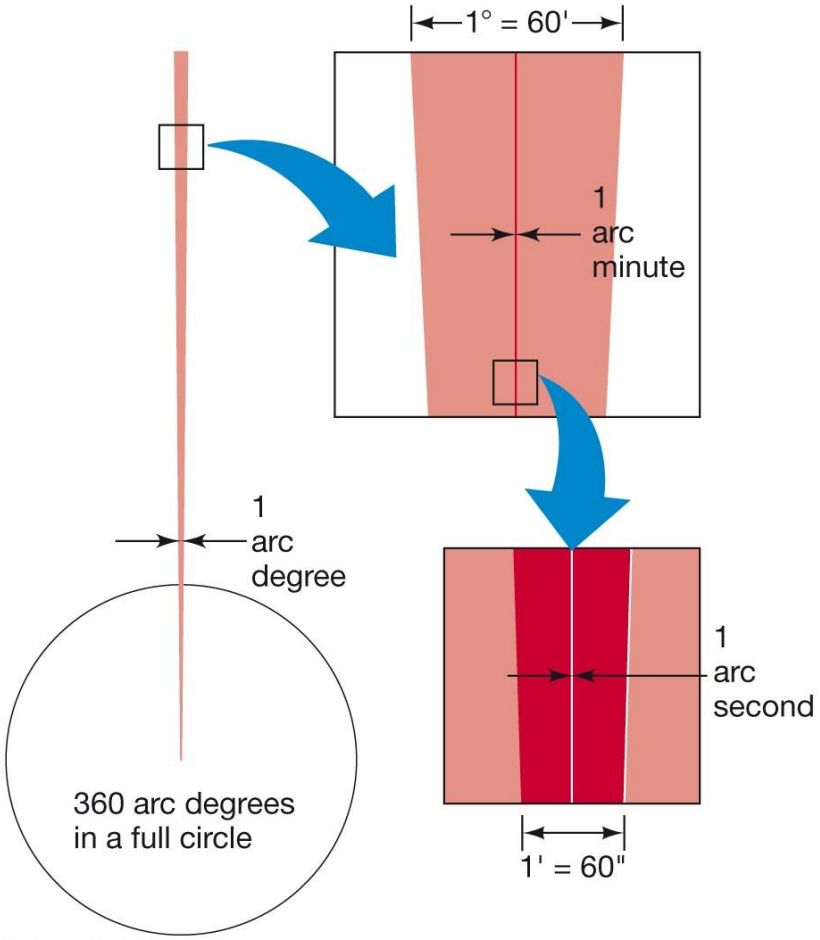
Stars *seem* to be on the inner surface of a sphere surrounding the Earth

They aren't, but can use two-dimensional spherical coordinates (similar to latitude and longitude) to locate sky objects



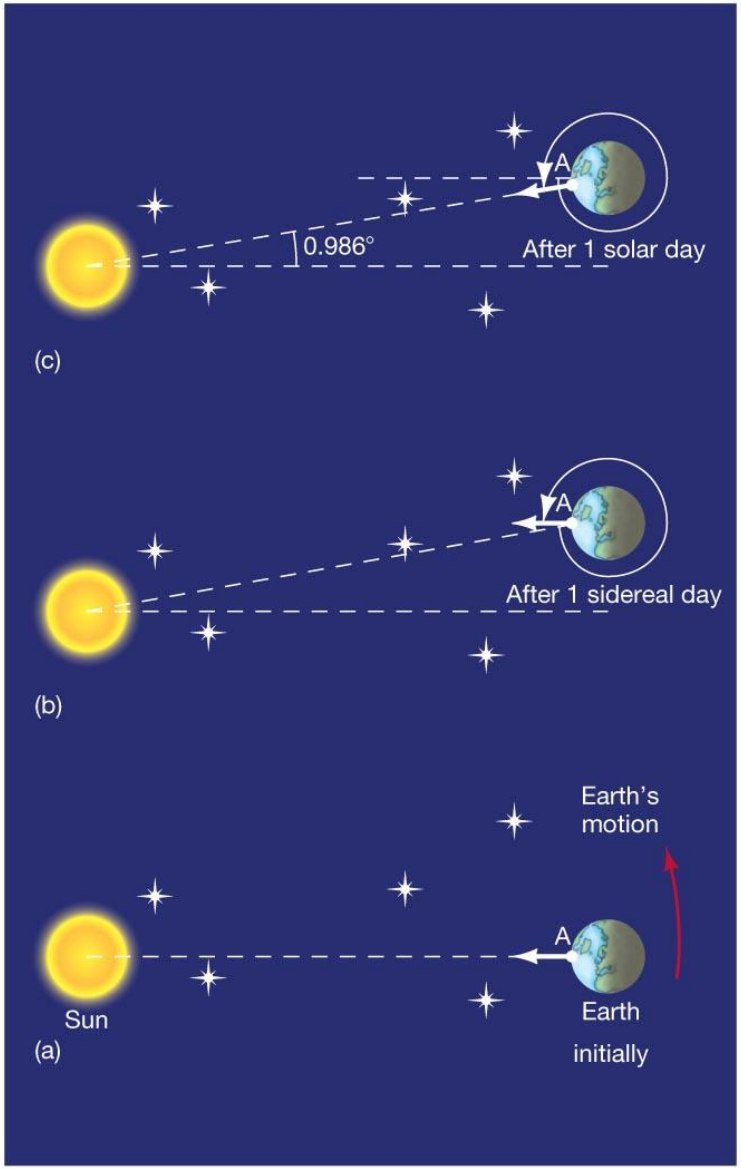
More Precisely 1-1: Angular Measure

- Full circle contains 360° (degrees)
- Each degree contains 60′ (arc-minutes)
- Each arc-minute contains 60″ (arc-seconds)
- Angular size of an object depends on its actual size and distance from viewer



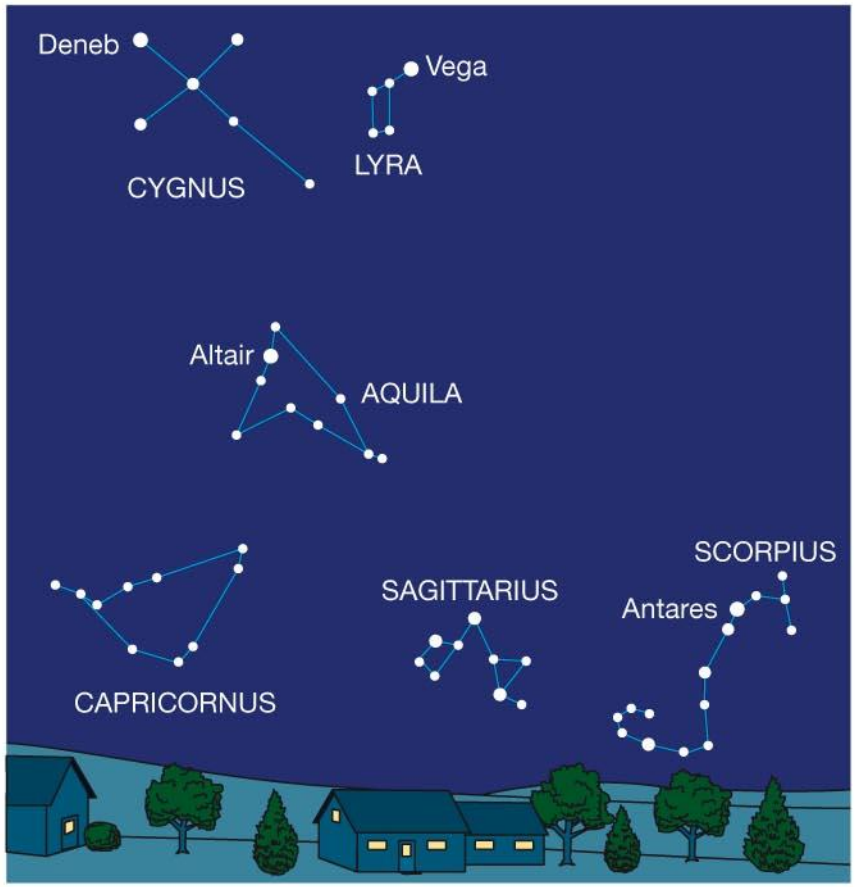
1.4 Earth's Orbital Motion

- Daily cycle, noon to noon, is **diurnal motion** — solar day
- Stars aren't in quite the same place 24 hours later, though, due to Earth's rotation around Sun; when they are once again in the same place, one **sidereal day** has passed

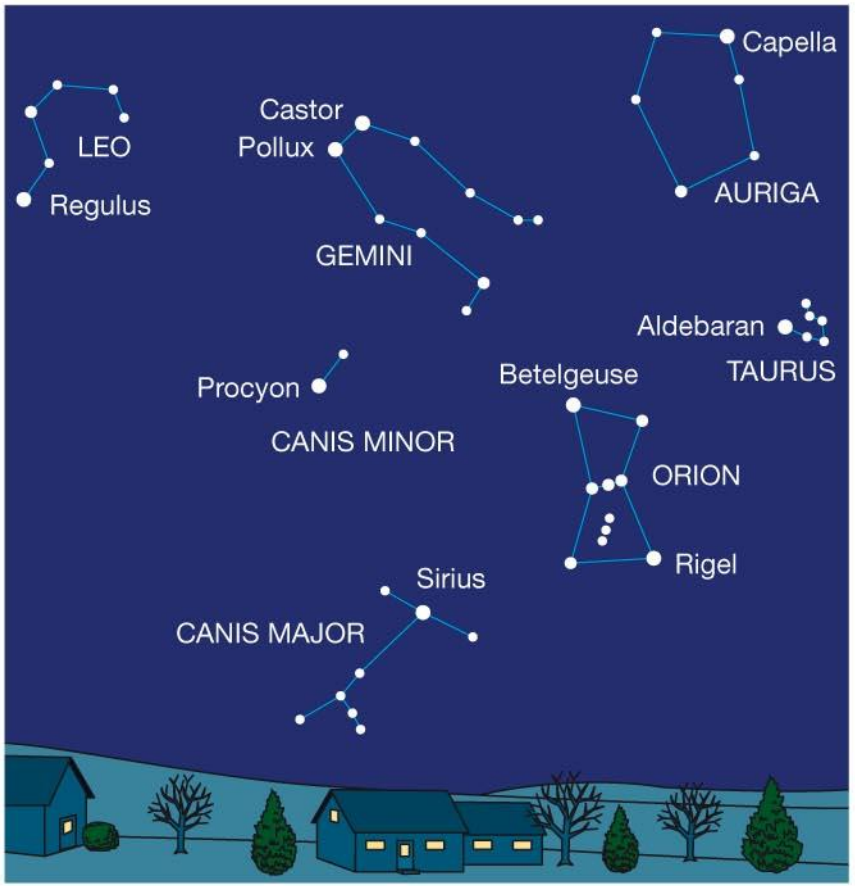


1.4 Earth's Orbital Motion

Seasonal changes to night sky are due to Earth's motion around Sun



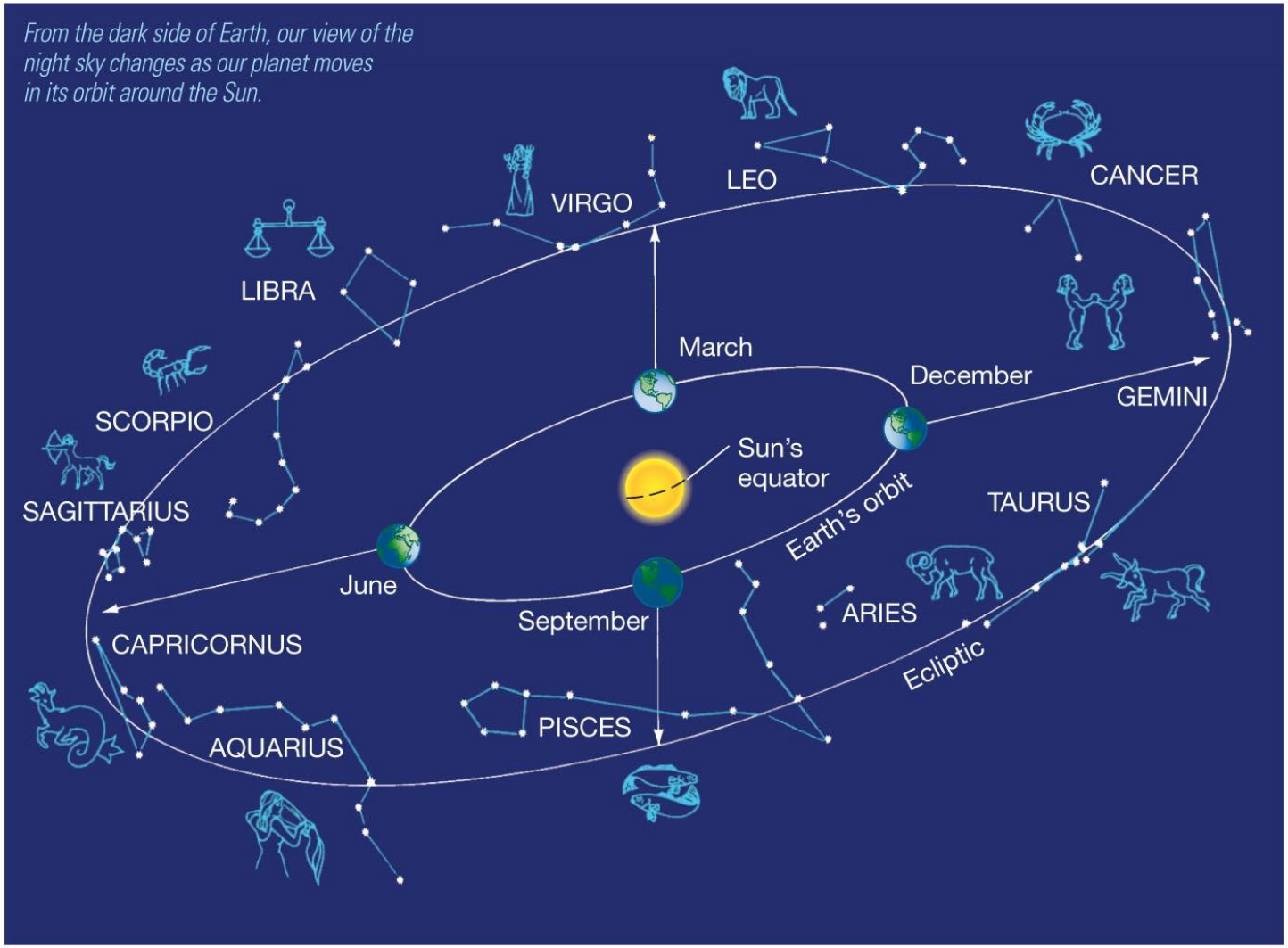
(a) Southern horizon, summer



(b) Southern horizon, winter

1.4 Earth's Orbital Motion

Twelve constellations Sun moves through during the year are called the zodiac; path is ecliptic



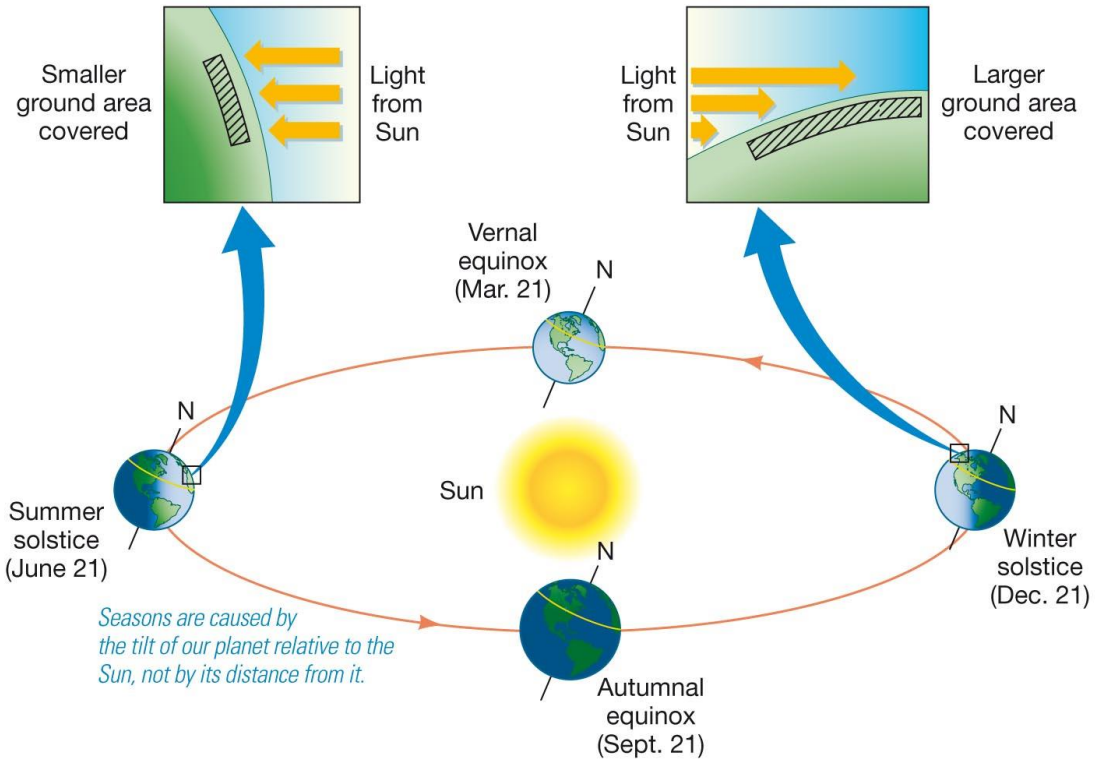
1.4 Earth's Orbital Motion

- **Ecliptic** is plane of Earth's path around Sun; at 23.5° to celestial equator

- Northernmost point of path (above celestial equator) is **summer solstice**; southernmost is **winter solstice**; points where path crosses celestial equator are **vernal** and **autumnal equinoxes**

- Combination of day length and sunlight angle gives seasons

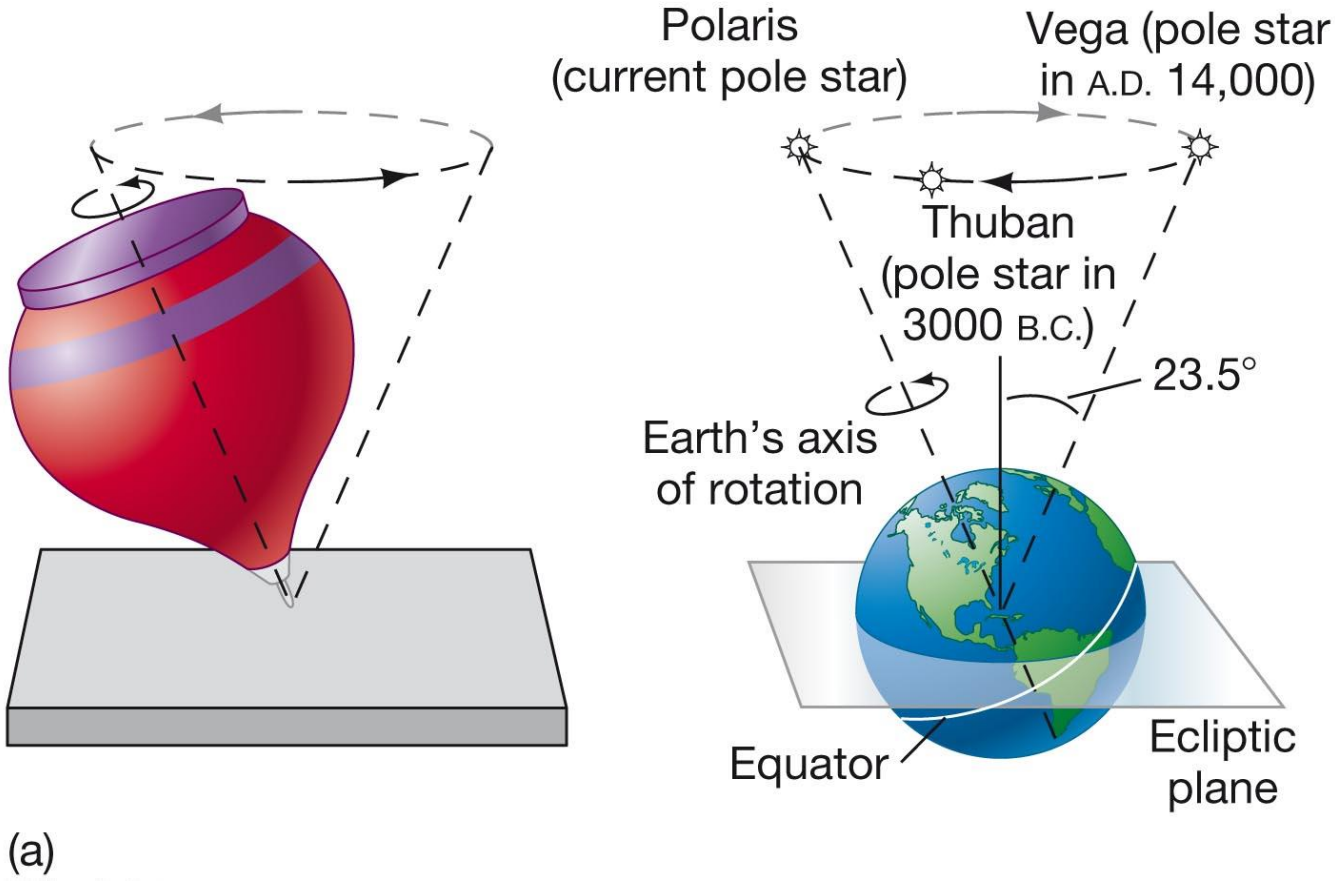
- Time from one vernal equinox to next is **tropical year**



1.4 Earth's Orbital Motion

Precession: rotation of Earth's axis itself; makes one complete circle in about 26,000 years

Earth precesses like a top, but very, very slowly.



1.4 Earth's Orbital Motion

Time for Earth to orbit once around Sun, relative to fixed stars, is sidereal year

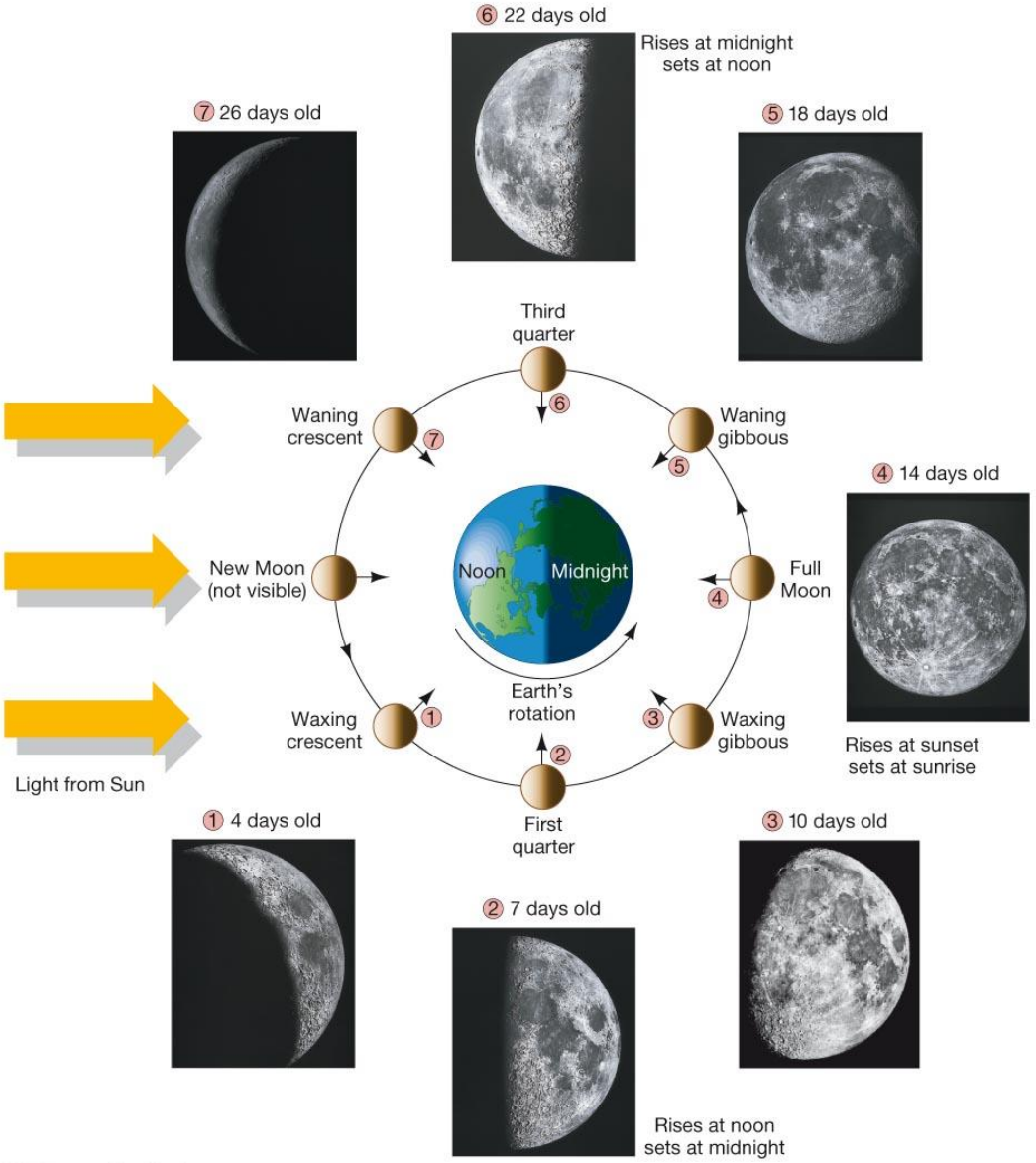
Tropical year follows seasons; sidereal year follows constellations—in 13,000 years July and August will still be summer, but Orion will be a summer constellation

1.5 Motion of the Moon

Moon takes about 29.5 days to go through whole cycle of phases—synodic month

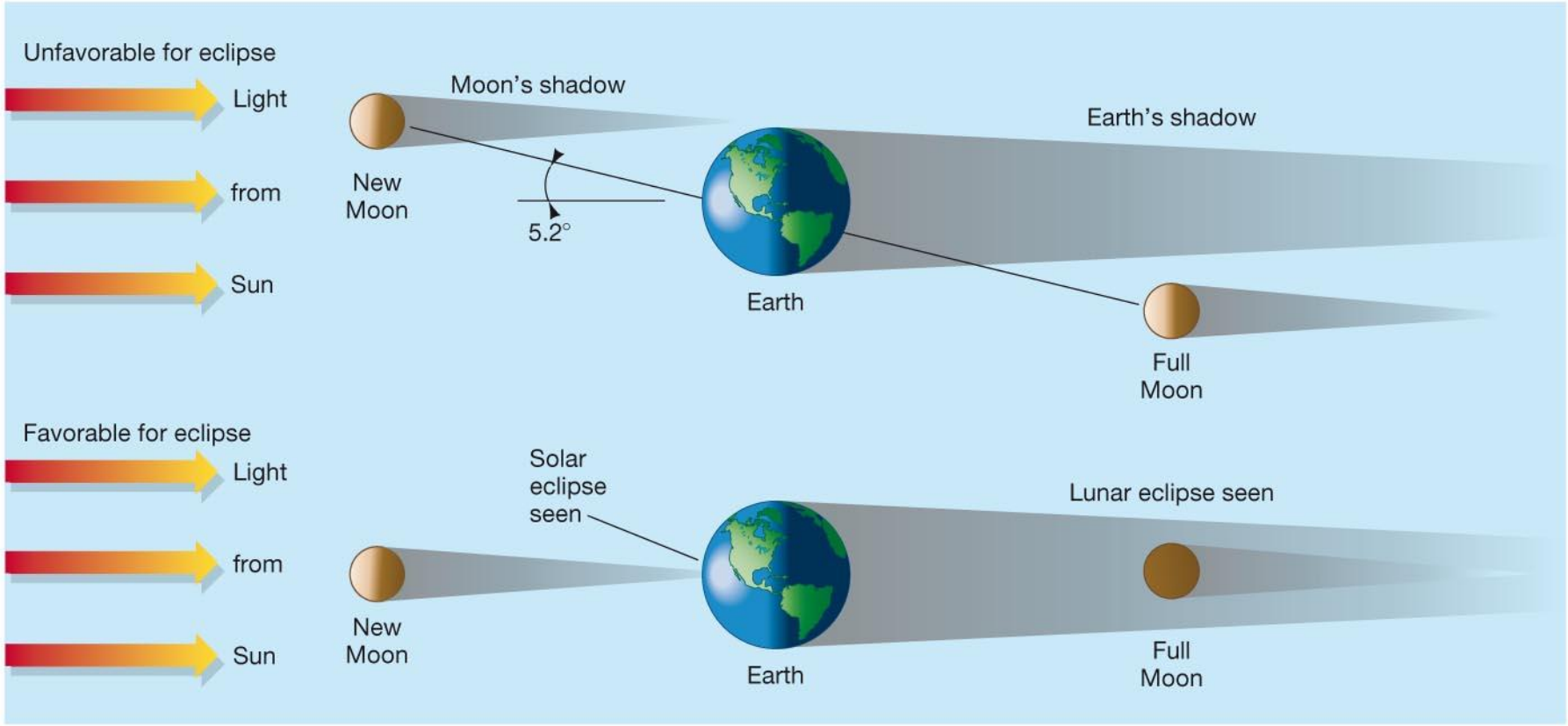
Phases are due to different amounts of sunlit portion being visible from Earth

Time to make full 360° rotation around Earth, sidereal month, is about 2 days shorter



1.5 Motion of the Moon

Eclipses occur when Earth, Moon, and Sun form a straight line

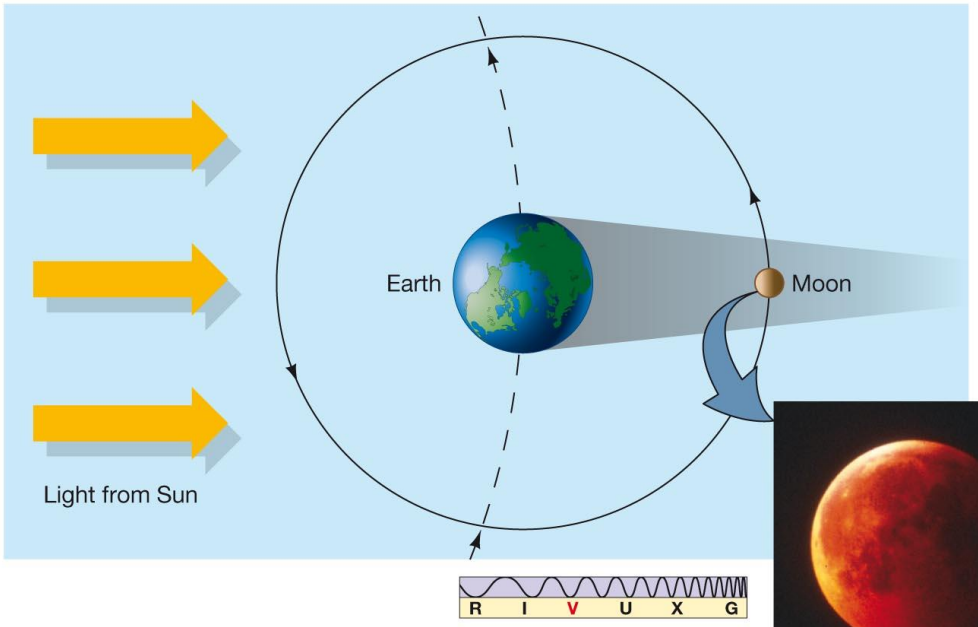


(a)

1.5 Motion of the Moon

Lunar eclipse:

- **Earth is between Moon and Sun**
- **Partial when only part of Moon is in shadow**
- **Total when it all is in shadow**

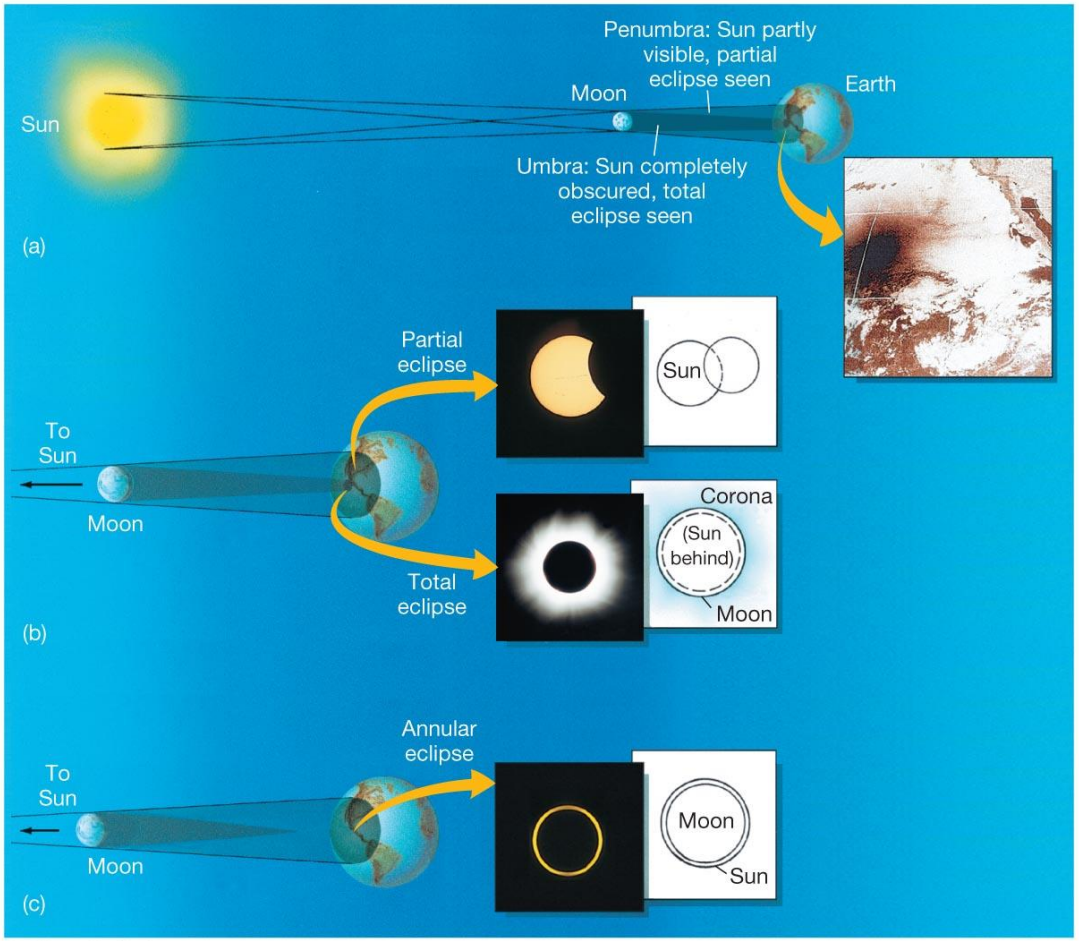


This is an actual photo of the eclipsed Moon, one of the great light shows visible to the naked eye.

1.5 Motion of the Moon

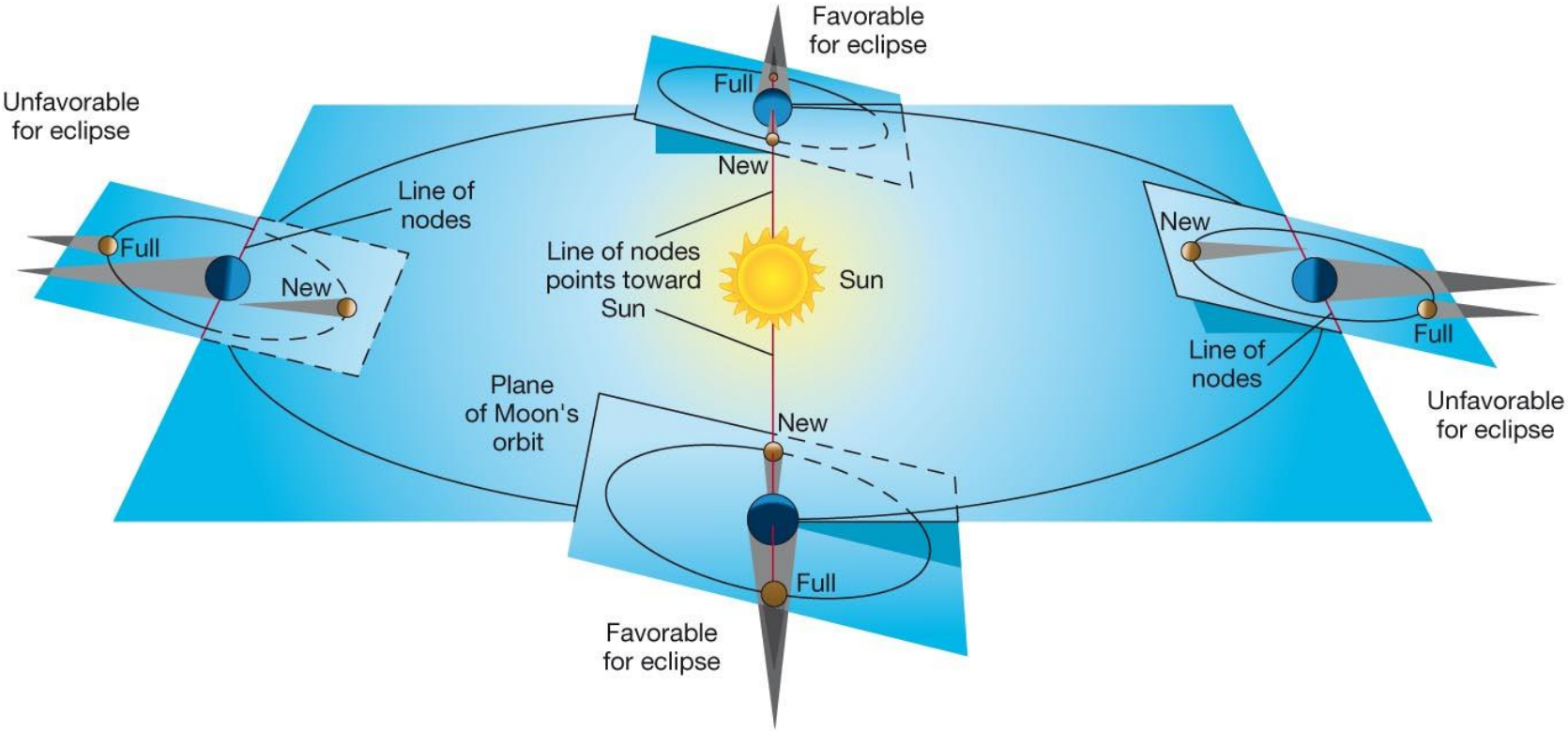
Solar eclipse:
Moon is between Earth and Sun

- **Partial when only part of Sun is blocked**
- **Total when it all is blocked**
- **Annular when Moon is too far from Earth for total**



1.5 Motion of the Moon

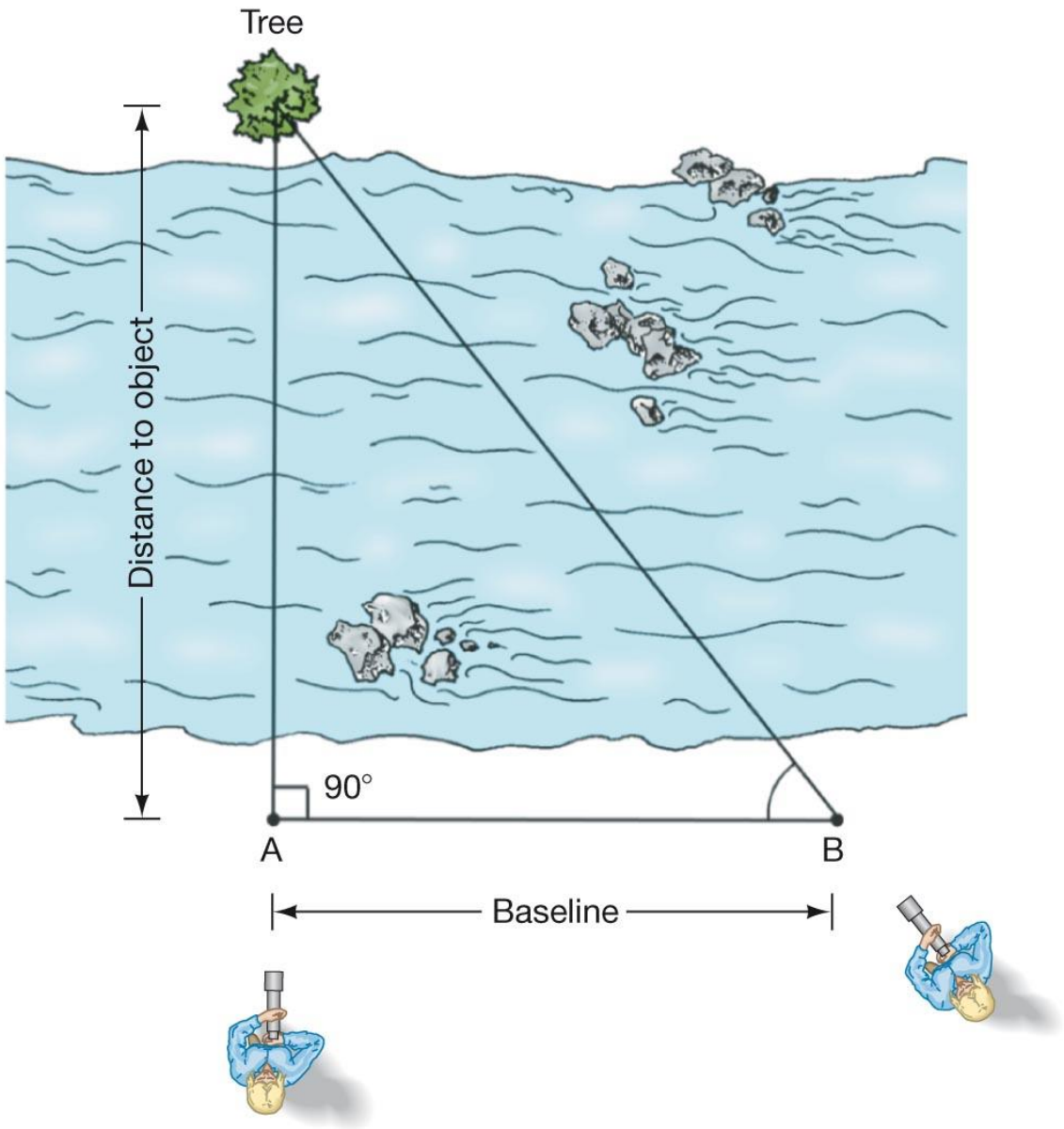
Eclipses don’t occur every month because Earth’s and Moon’s orbits are not in the same plane



(b)

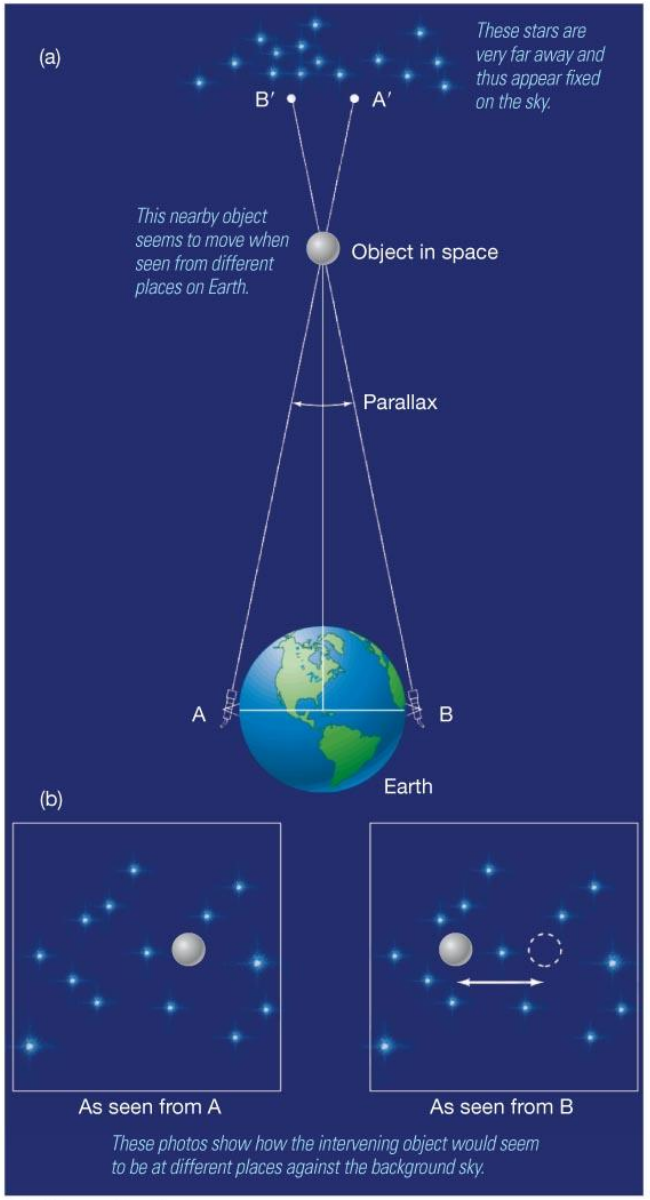
1.6 The Measurement of Distance

Triangulation:
Measure baseline and angles, can calculate distance



1.6 The Measurement of Distance

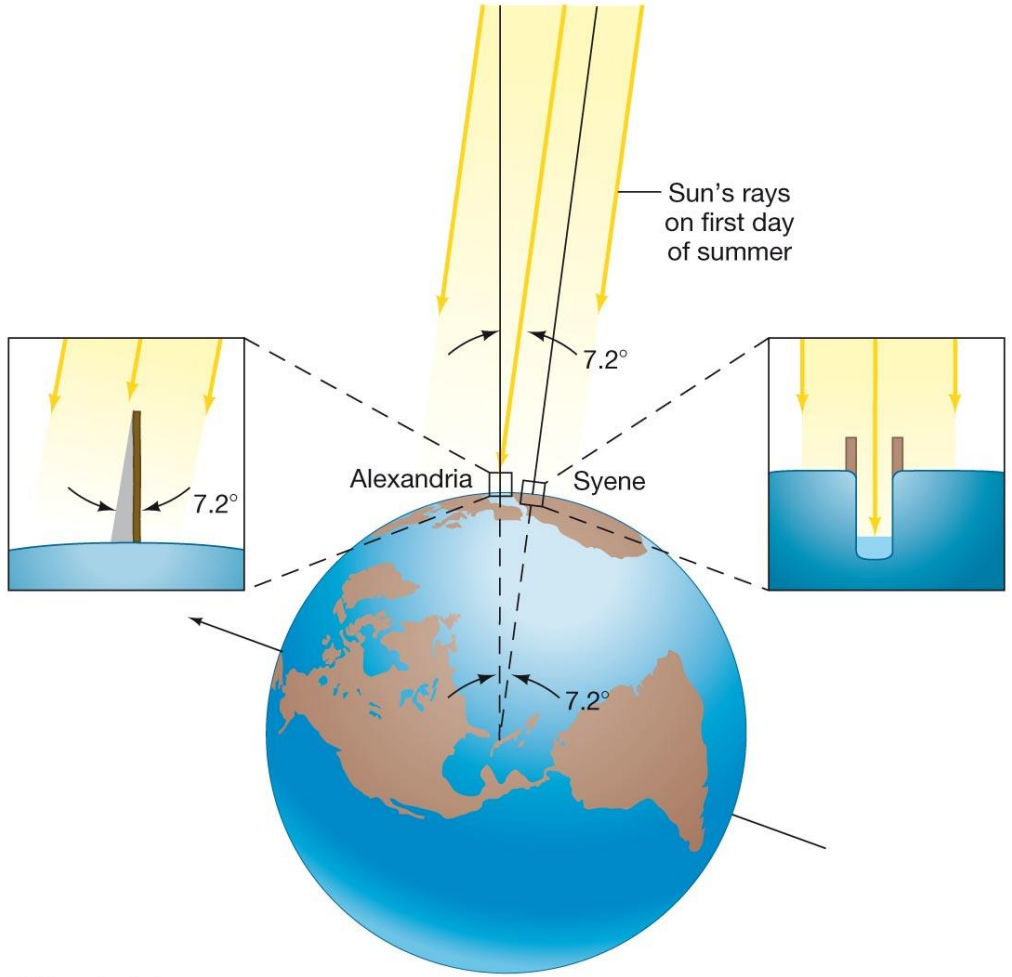
Parallax: Similar to triangulation, but look at apparent motion of object against distant background from two vantage points



1.6 The Measurement of Distance

Measuring Earth's radius:
Done by Eratosthenes about 2300 years ago; noticed that when Sun was directly overhead in one city, it was at an angle in another.

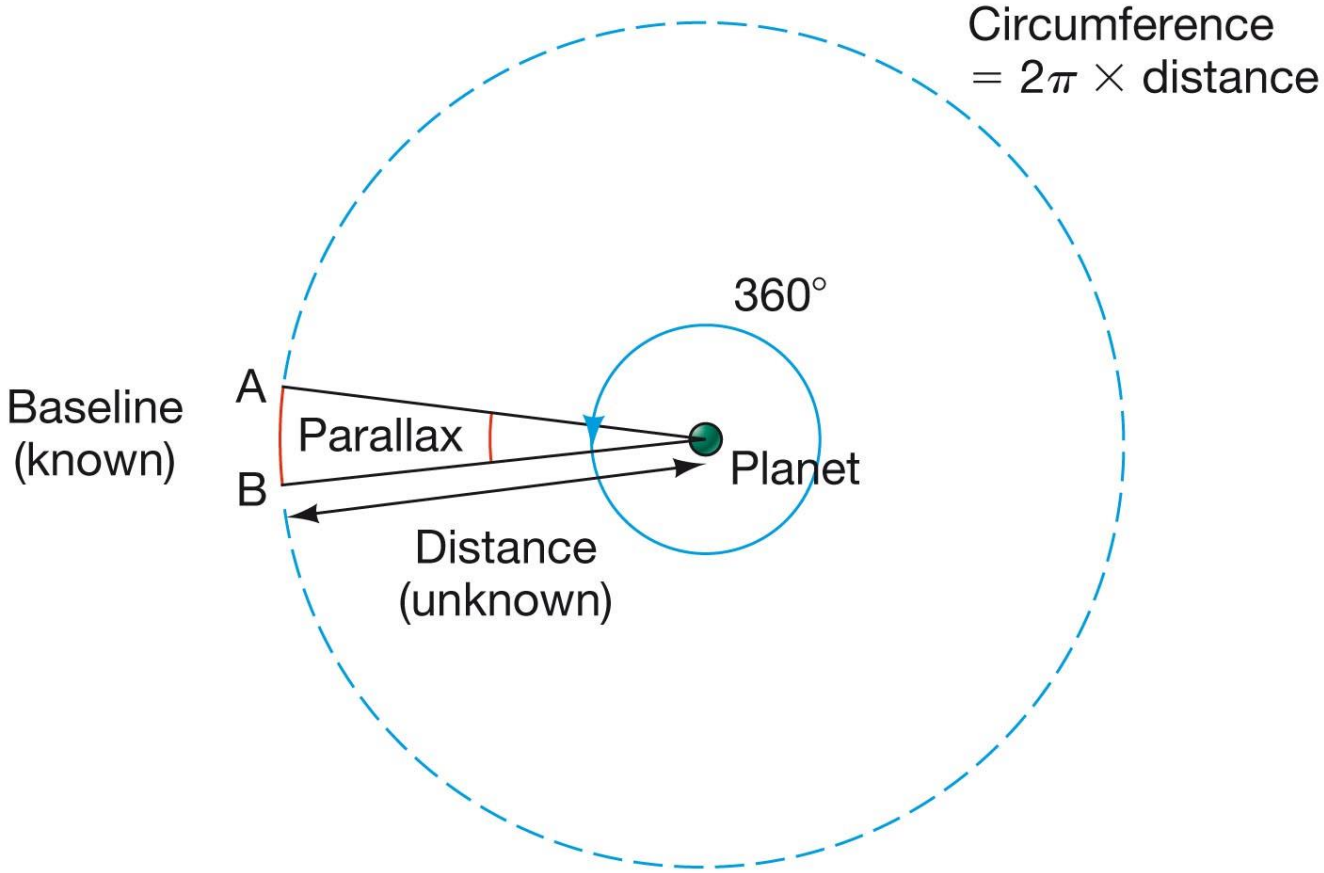
Measuring that angle and the distance between the cities gives the radius.



More Precisely 1-2:

Measuring Distances with Geometry

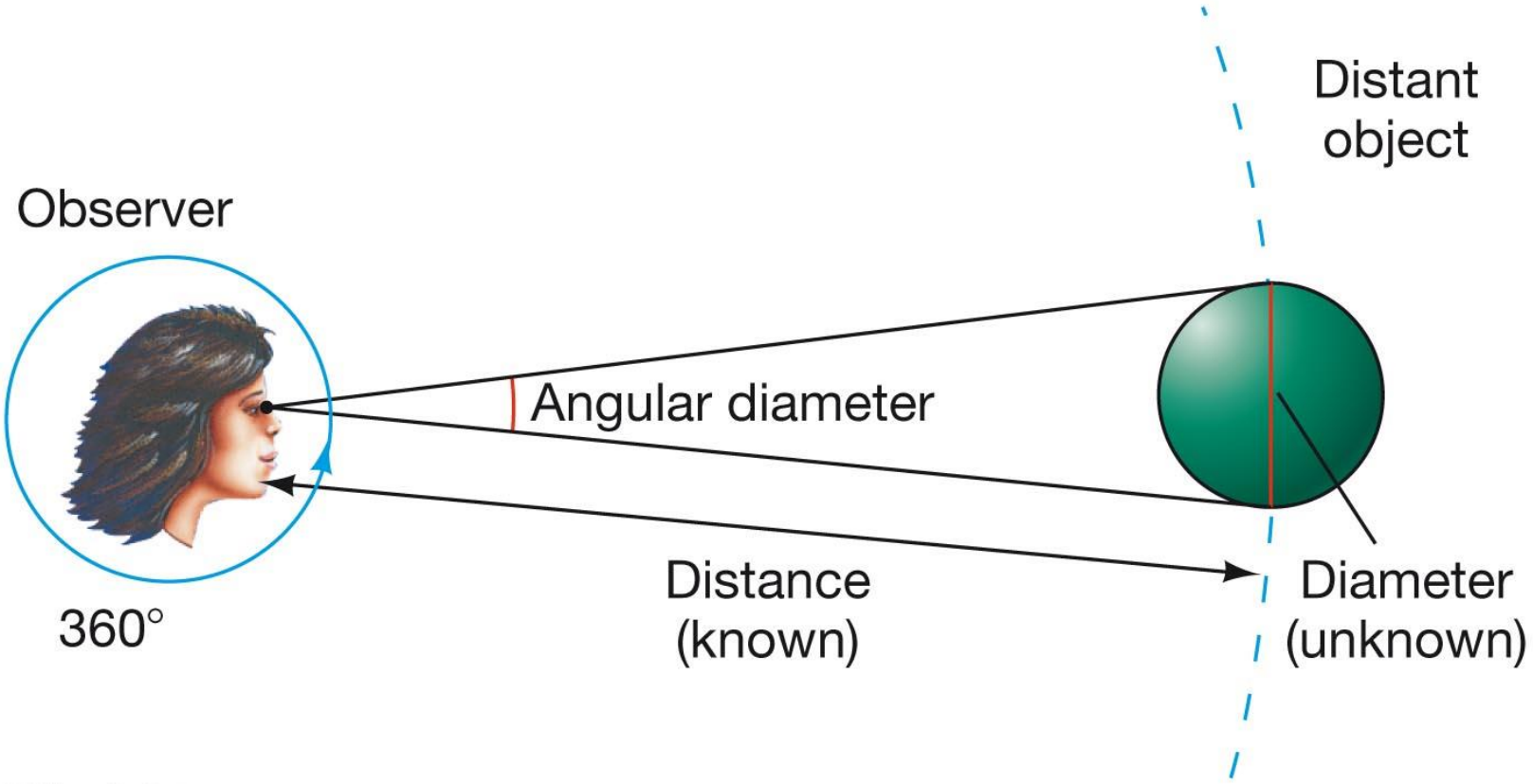
Converting baselines and parallaxes into distances



More Precisely 1-2:

Measuring Distances with Geometry

Converting angular diameter and distance into size



Summary of Chapter 1

- **Astronomy**: Study of the universe
- **Scientific method**: Observation, theory, prediction, observation, …
- Stars can be imagined to be on inside of **celestial sphere**; useful for describing location
- Plane of Earth's orbit around Sun is **ecliptic**; at 23.5° to celestial equator
- Angle of Earth's axis causes **seasons**
- Moon shines by reflected light, has **phases**

Summary of Chapter 1 (cont.)

- **Solar day ≠ sidereal day**, due to Earth's rotation around Sun
- **Synodic month ≠ sidereal month**, also due to Earth's rotation around Sun
- **Tropical year ≠ sidereal year**, due to precession of Earth's axis
- **Eclipses of Sun and Moon** occur due to alignment; only occur occasionally as orbits are not in same plane
- Distances can be measured through **triangulation** and **parallax**