**Chapter 0**

**Charting the Heavens**

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<th>Cosmic Structure</th>
<th>Biological Example</th>
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<td>• Planets</td>
<td>• Subcellular structures (Nucleus, Golgi apparatus, etc.)</td>
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<td>• Star Clusters</td>
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<td>• Galaxy clusters</td>
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**Chapter 0**

**Key Questions**

1. Is the North Star—Polaris—the brightest star in the night sky?
2. Do astronomers regard constellations as the familiar patterns of stars in the sky?
3. What causes the seasons?
4. When is the Earth closest to the Sun?
5. How many zodiac constellations are there?
6. Does the Moon have a dark side that we never see from Earth?
7. Is the Moon ever visible during the daytime?
8. What causes lunar and solar eclipses?

**Scientific Notation**

- writing large (or small) numbers in powers of 10
- used for simplicity

Examples:

\[ 1 = 10^0 \]
\[ 10 = 1 \times 10^1 = 10^1 \]
\[ 100 = 1 \times 10^2 = 10^2 = 10 \times 10 \]
\[ 0.1 = 1 \times 10^{-1} = 10^{-1} = 1/10 \]
\[ 4,200,000 = 4.2 \times 10^6 \]
Units of Distance

Astronomical Unit (A.U.) = The average distance Earth is from the sun
1 A.U. = 149,597,900,000 meters
≈ 1.5 \times 10^{11} \text{ m}

Light-year (ly) = the distance light travels in one year of time.
- Speed of light = 3.0 \times 10^8 \text{ meters per second}
1 \text{ ly} = 9.5 \times 10^{15} \text{ meters}
= 63,000 \text{ A.U.}

The view of the Sky

NW Sky
Summer Sky

Winter Sky
Constellations

Constellations – groups of stars named by ancient cultures to honor gods, animals, legends, etc.

- 88 total number
- 12 on the zodiac
- Patterns come from star positions ONLY

Orion Star Field

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Constellation boundaries

Constellations – groups of stars named by ancient cultures to honor gods, animals, legends, etc.

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Constellations

Constellations – groups of stars named by ancient cultures to honor gods, animals, legends, etc.

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- 12 on the zodiac
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The Celestial Sphere

- Equator
- North Pole
- South Pole

Measuring using Angles

- 360° in a circle
- 1° = 60 arcminutes = 60’
- 1’ = 60 arcseconds = 60”
The Celestial Sphere
- Equator
- North Pole
- South Pole
- Horizon
- Zenith
- Altitude
- Azimuth
- Latitude

The Horizon Coordinate System
Altitude: 0-90°
Azimuth: 0-359°

Earth’s Motion
- Is the Earth flat?
- Why do the stars move/change?
- What causes the seasons?
- What causes eclipses?
- Why does the Moon have phases?
The Round Earth
Observations
Disappearing ships
Stars disappear as you change position
Other celestial bodies
Eclipses

Motion of the stars
North Pole
Equator

Star Trails
Skyglobe
Motions of the Sun

Diurnal – Rotation, Earth spinning, length of a day
Annual – Revolution, Earth orbit, length of a year

Meridian – North-South line dividing the sky equally
Ecliptic – path of the Sun in the sky or Earth-Sun plane

The Horizon Coordinate System

The Ecliptic Plane

Ecliptic – path of the Sun in the sky or Earth-Sun plane
The Zodiac

**Question:** Why do we see Gemini at night in the Winter and Sagittarius at night in the Summer?

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Solar and Sidereal Days

**Solar day** – time measured by the Sun’s position 24 hours

**Sidereal day** – time measured by the position of the stars 23 hours 56 minutes

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Seasons

**Equinoxes** – Sun crosses the celestial equator (twice – Spring and Fall)

**Solstices** – Sun’s farthest northerly or southerly position (Summer or Winter)
The Seasons

Factors that cause the seasons?

The Seasons

Seasons - caused by
1) 23.5° tilt of Earth's axis of rotation with respect to the ecliptic (orbit) plane
2) Earth's orbit

Distance Effect? **No!**

Reasons for Warm Days
1. Sun is above the horizon longer in the summer
2. More direct light in the summer
The Seasons

Long Term Changes - Precession

Motions of the Moon

Phases of the Moon

Know:
1. Phase names
2. What time you can see them

Does the Moon Rotate?
Does the Moon Rotate?

Lunar Phases

Meridian – middle of the sky (a North-South line)

Lunar Phase Examples
1. When is a Third Quarter Moon on the meridian? 6 a.m.
2. Can you see a Full Moon at 9 p.m.? Yes
3. Can you see a Waxing Gibbous Moon at 9 a.m.? No
4. What time does a Full Moon rise? 6 p.m.
1. Lunar Eclipses
   a. Geometry
   b. Shadows
      i. Penumbra
      ii. Umbra
   c. Color
      Reddish – Bronze
   d. Partial and Total Eclipses
      Due to Moon’s orbit

Eclipse geometry

Types of eclipses
Solar Eclipses

a. Geometry: Sun – Moon – Earth
b. Shadows
   i. Penumbra: Partial Eclipse
   ii. Umbra: Total Eclipse
c. Angular Diameters: Moon ≈ 0.5°, Sun ≈ 0.5°
d. Annular Eclipses
   - Due to the non-circular orbit of the Moon
Solar Eclipses

Lunar Phases

What time does a 1st Quarter Moon rise?

What direction am I looking when the Moon is on the meridian?

If the Moon phase is Full in Tennessee, what’s the phase seen from Moscow, Russia?

If I see the Moon right after sunset in the western sky, what phase is it?
Misconception-Based Questions

- What phase of the Moon could not happen if the phases were caused by the Earth’s shadow?
- Which theory of the solar system [geocentric / heliocentric] is confirmed by the phases of Venus?

The Measurement of Distance
Angular Size, True Size, and Distance
Angular Size, True Size, and Distance

Angular size \( \propto \) True Size \( \propto \) Distance

\[ \text{True size} \propto \text{Angular Size} \]
\[ \text{Distance} \propto \text{Angular Size} \]

Angular size \( = 57.3 \) 3475 km

Moon's diameter 385,000 km

Angular size \( = 0.52 \)

Parallax

– the apparent change in position of an object due to the change in the location of the observer.
The Scientific Method

"Real" World

Initial Observations (Assumptions)

Model (hypothesis)

Compare to Predictions (Test)

Observe/Experiment

→ theorize

→ predict

→ test

→ modify

Revise model to Match observations Or experiments
Chapter 0
Summary

1. Makeup of the Universe
2. Scientific Notation (Appendix 1)
3. Units of Distance
   - Astronomical Unit (A.U.)
   - Light year (l.y.)
4. The Scientific Method
5. Constellations
6. Celestial Sphere
   - Angles
   - Celestial Poles, Equator
   - Zenith
   - Latitude
7. Motion of the Sun
8. Earth’s Motions
   - rotation
   - revolution
9. The Seasons
10. Lunar Phases
11. Eclipses

Review Questions
3, 5, 6, 7, 9, 10, 12, 14, 15

Self-Test
2, 4, 5 – 12

Problems
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