CHAPTER 00: EXPLORING THE HEAVENS

0.1: THE OBVIOUS VIEW

Our Place in Space
✦ Astronomy: study of the universe
✦ Earth does not occupy a central or special place

Constellations In The Sky
✦ About 3000 stars visible to naked eye from any random location on earth
✦ Constellation: pattern identified, "picture" formed by group of stars
✦ No astronomical significance because stars in specific constellation have no relationship to each other
✦ Cultural significance: important way for non-literate societies to preserve and pass on important information

The Celestial Sphere
✦ Method for locating objects in the sky
✦ Ignores the fact that objects are at different distances from the earth
✦ Project an invisible sphere out from the earth
✦ NCP: North Celestial Pole = projection of earth's North pole into the sky
✦ SCP: South Celestial Pole = projection of Earth's South pole into sky
✦ CE: Celestial Equator = projection of Earth's equator into the sky
✦ Stars appear fixed with respect to each other, but entire celestial sphere "spins" as Earth turns on its axis

Celestial Coordinates
✦ To precisely locate an object, two coordinates required
✦ On Earth: latitude measures degrees of angle from 0° to 90° north or south of equator
✦ In space: declination measured in degrees from 0° to 90° north (+) or south (–) of celestial equator
✦ On Earth: longitude measured in degrees around the equator
✦ Zero chosen arbitrarily: 0° longitude = Royal Observatory, Greenwich, England
✦ Measure from 0° to 180° East (towards Asia) or 0° to 180° West (towards N America)
✦ In space: right ascension measured in hours, minutes, seconds around the celestial equator
✦ Zero chosen arbitrarily: 0h RA = where sun crosses the celestial equator on vernal equinox (HUH??!!!)
✦ Measure from 0h to 24h RA around CE in the same direction as the earth spins

0.2: EARTH’S ORBITAL MOTION

Day-to-Day Changes
✦ Solar day: Earth completes one rotation with respect to the sun = 24 hours
✦ Start timing when sun crosses S meridian (noon), stop timing when sun crosses meridian again tomorrow
✦ Sidereal day: Earth completes one rotation with respect to distant star = 23h56m
✦ Start timing when star crosses S meridian, stop timing when same star crosses meridian again tomorrow
Seasonal Changes
✦ Earth's axis is tilted
✦ Draw an enormous flat plane through the equator of the sun, and extend it all the way through the solar system
✦ This plane does not cut the Earth in half at its equator
✦ Axis tilt = 23.5°

Ecliptic
✦ Apparent path of the sun across the sky (really the Earth in motion, not the sun)
✦ Ecliptic is tilted b/c Earth's axis is tilted

Seasons
✦ Tilt of axis creates changing seasons
✦ Distance from sun does not create seasonal changes
✦ Earth is marginally closer to sun in Dec than Jun, but Dec is not the hottest month in the N hemisphere!

Summer Solstice
✦ Usually 06/21 (may fall ± a calendar day)
✦ Longest day of the year [N hemisphere] because sun has maximum declination (+23.5°)
✦ N hemisphere is tipped toward sun, more direct daylight makes the season summer

Winter Solstice
✦ Usually 12/21 (may fall ± a calendar day)
✦ Shortest day of the year [N hemisphere] because sun has minimum declination (−23.5°)
✦ N hemisphere is tipped away from sun, less direct daylight makes season winter

Equinoxes
✦ Vernal (Spring) Equinox: 03/21 (may fall ± a calendar day)
✦ Autumnal Equinox: 09/21 (may fall ± a calendar day)
✦ Equal length day & night because sun crosses CE (dec = 0°)

Long-Term Changes
✦ Earth's axis wobbles slightly as it spins
✦ Today, NCP points almost perfectly at Polaris
✦ Wobble means that Polaris was not always the Pole Star, and will not be forever

0.3: The Motion of the Moon

Lunar Phases
✦ Understanding the phases helps us really start to get to grips with the layout of the solar system
✦ New moon: moon located in between Earth and sun (angle is 0°)
✦ 1st quarter: moon makes a 90° angle (If you are the Earth, stick your right arm straight out and make a fist; your fist is the sun. Stick your left arm straight out to your side, so your arms make a 90° angle. Your left fist is the moon.)
✦ Full moon: moon is 180° away from sun in sky (If you are the Earth, the sun is directly in front of you, then the moon would be directly behind you.)
✦ 3rd quarter: moon makes 90° angle (switch hands, and let your left fist be the sun sticking straight out in front. Make a 90° with your right arm, and your right fist is the moon)
Lunar Month
✦ Sidereal Month: 27.3 days for the moon to complete one full rotation with respect to distant star
✦ Synodic Month: 29.5 days for moon to complete one full cycle of phases, or a complete rotation with respect to the sun (as seen from the earth)

Solar Eclipse
✦ Sun is eclipsed by the moon: moon passes in between Earth and sun
✦ Can only happen when phase of moon is new
✦ Does not happen every month because moon's orbit is tilted with respect to ecliptic
✦ Annular eclipse: moon is farthest from Earth, making it appear slightly smaller (so it does not completely cover solar disk)

Lunar Eclipse
✦ Shadow of the Earth eclipses the moon: Earth passes in between sun and moon
✦ Can only happen when moon is full
✦ More frequent occurrence than solar eclipse
✦ Partial eclipses not uncommon

0.4: THE MEASUREMENT OF DISTANCE

Triangulation
✦ Measure distance to objects that are too far or inconvenient to be measured directly
✦ Requires some geometry and trigonometry
✦ Observe the same object from two different vantage points, compare
✦ This works for stationary objects on Earth, but can also be used to locate planets

Parallax
✦ Apparent shift in the position of an object in the foreground with respect to the background
✦ Result of changing point of observation, not the motion of the actual object
✦ For close object, large parallax observed with relatively small baseline shift
✦ The farther an object, smaller the parallax: increase baseline to increase parallax

0.5: SCIENTIFIC THEORY AND SCIENTIFIC METHOD

It's Only a Theory...
✦ A scientific theory has been repeatedly tested, and never found to be false (not once, not even a little bit)
✦ If something is referred to by scientists as a theory, it is widely accepted as the best framework for explaining something
✦ A theory must be able to explain what has been observed and predict what should happen as a consequence
✦ Scientists accept that, if new facts or experiments reveal a flaw, the theory must be modified or discarded

Scientific Method
✦ Process by which science gets done
✦ The whole point is, it's never actually done

Sizing Up Planet Earth
✦ Eratosthenes accurately measured Earth's circumference and diameter in about 200BC
✦ All you need are two sticks and scratch paper
✦ More to the point: He apparently took it for granted that the Earth was a sphere...in 200BC