

Roger Freedman • Robert Geller • William Kaufmann III

Universe

Tenth Edition

Chapter 2

Knowing the Heavens

2-1: Naked-eye astronomy had an important place in civilizations of the past



Figure 2-1
Universe, Tenth Edition
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The Sun Dagger at Chaco Canyon

By reading this chapter, you will learn

- 2-1 The importance of astronomy in ancient civilizations around the world
- 2-2 That regions of the sky are divided around groups of stars called constellations
- 2-3 How the sky changes from night to night
- 2-4 How astronomers locate objects in the sky
- 2-5 What causes the seasons
- 2-6 The effect of changes in the direction of Earth's axis of rotation
- 2-7 The role of astronomy in measuring time
- 2-8 How the modern calendar developed

The Ancients

- The realms of big numbers, deep time, and vast space were unknown to ancient peoples.
- Therefore, their interpretation of the heavens, though thoughtful and picturesque, is fatally flawed.
- Nonetheless, it is they with whom we will start our discovery.

Center of the Universe

- The ancient model of the Cosmos, all the way up until the 17th Century, was a *Geocentric* model.
- There were other models, but geocentricity [sp] was the norm.
 - Perhaps you've known someone like this ☺?

Sensible

- Earth at the center of the Universe makes sense:
 - Everything in the sky seems to move overhead;
 - You don't *feel* any motion;
 - The gods would naturally place their subject realm at the center.

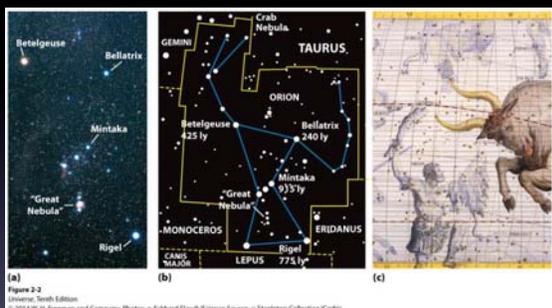
Before we get all impressed with our modern selves...

- What happens every morning in the East?
- Actually, the Earth turns on its axis so that each part of it in turn faces the Sun.
 - How could you *prove* that to someone who thought otherwise?

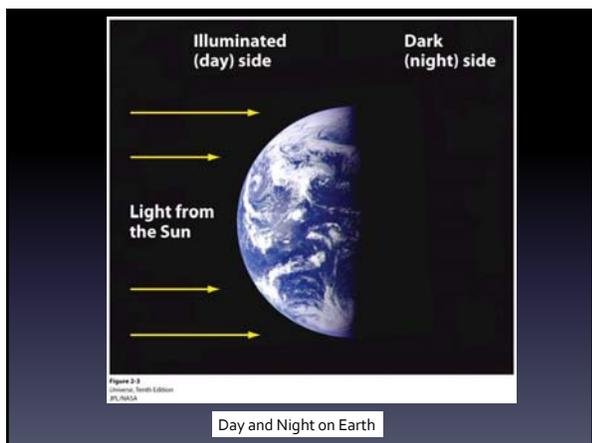
To be fair...

- We know the distances involved whereas ancient people didn't;
- We have instruments to measure all sorts of physical and astronomical quantities whereas they didn't;
- They weren't stupid, and we aren't necessarily smarter: we just have better information.

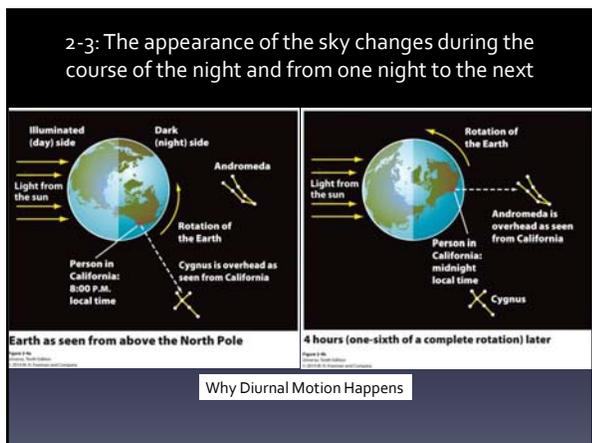
2-2: Eighty-eight constellations cover the entire sky



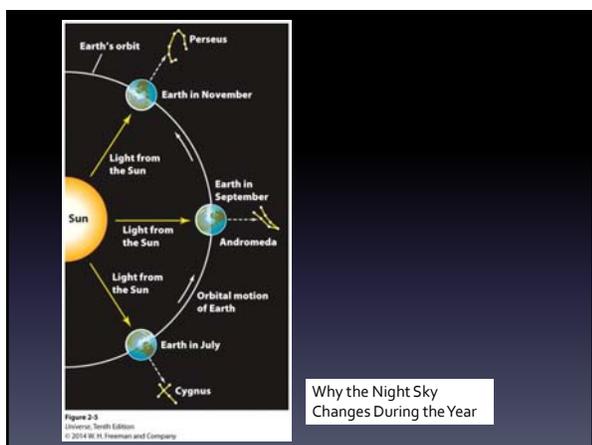
Three Views of Orion



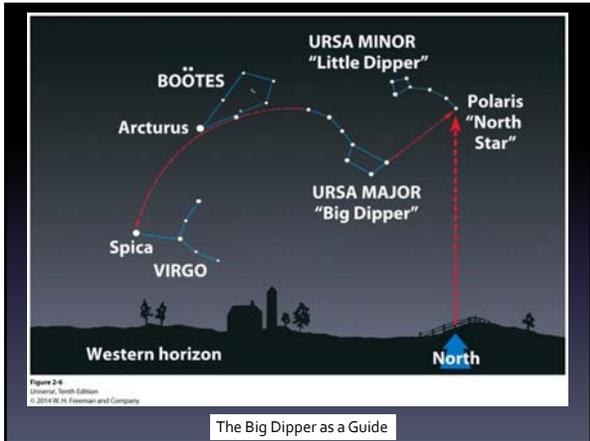
Day and Night on Earth



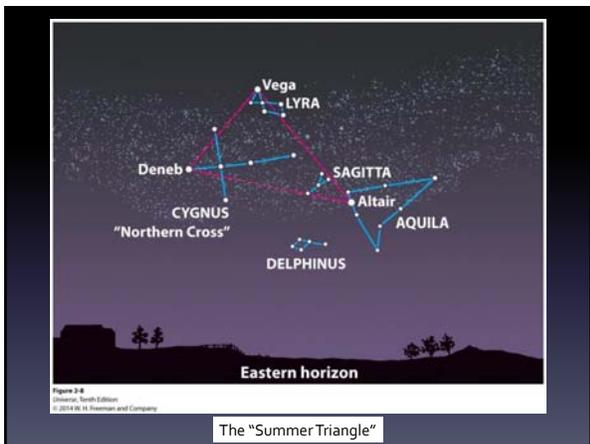
Why Diurnal Motion Happens



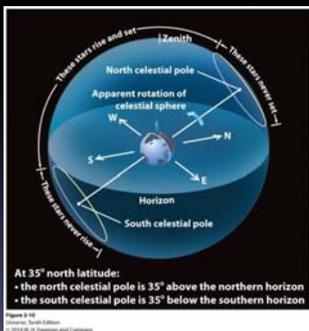
Why the Night Sky Changes During the Year







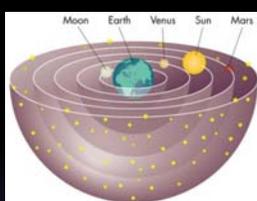
2-4: It is convenient to imagine that the stars are located on a celestial sphere



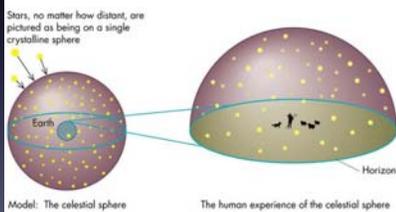
The View from 35° North Latitude

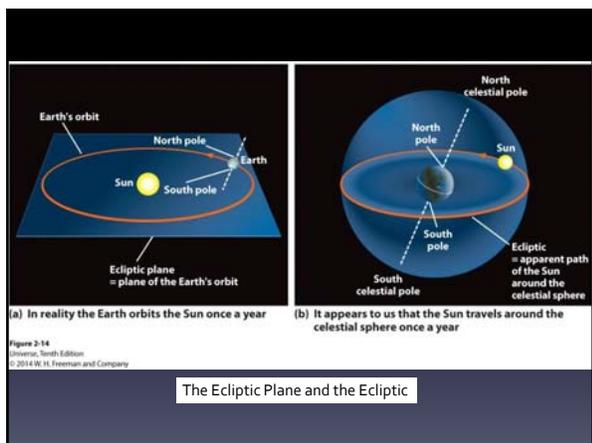
Geocentrism:

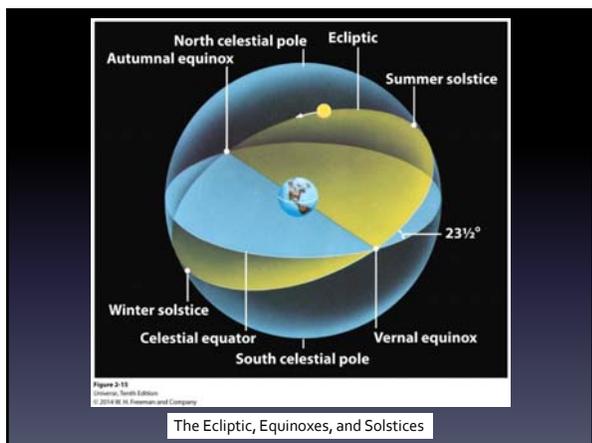
- ..Had the Earth at the center of the Universe,
- ..Had the Moon, Sun, and five planets circling the Earth on crystalline spheres,
- ..Had the stars fixed to a great canopy that also circled the world.

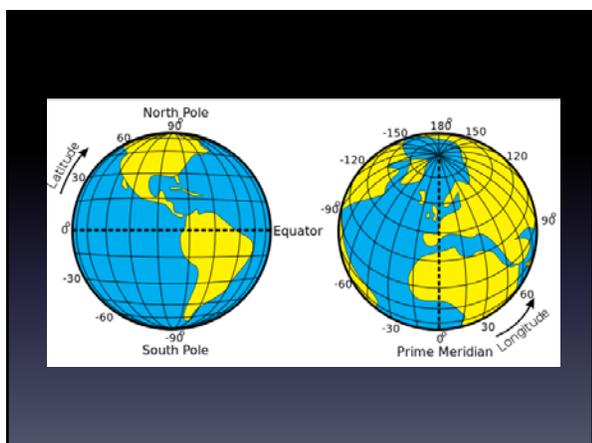


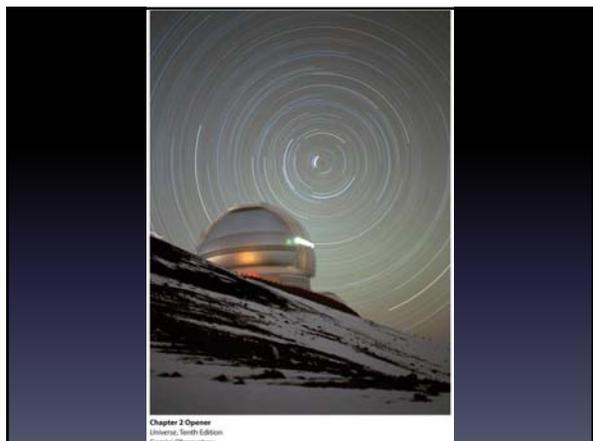
The different spheres for the Sun, Moon, planets, and stars clearly explained why some objects took longer than others to cross the sky.

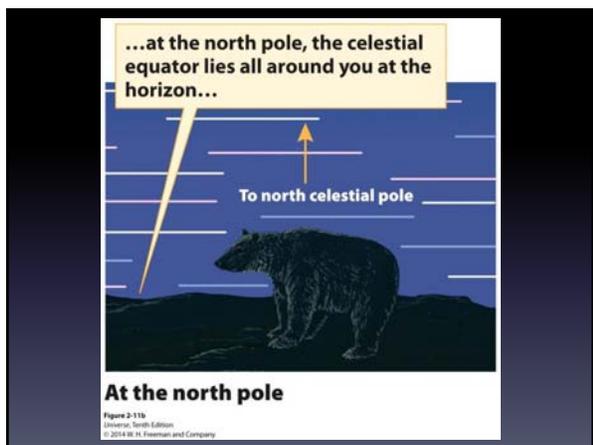


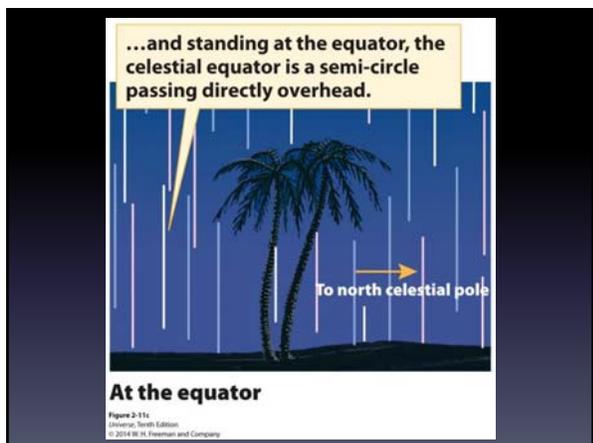


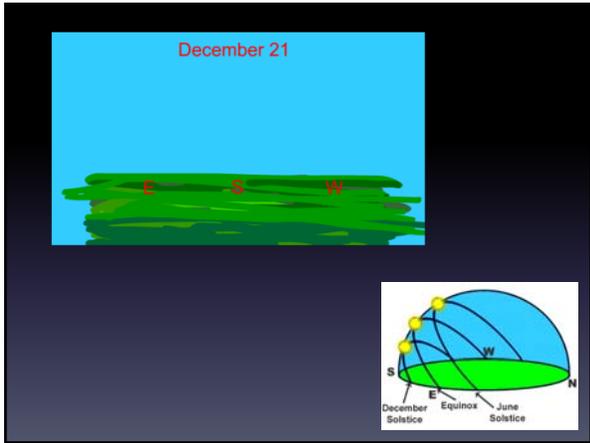




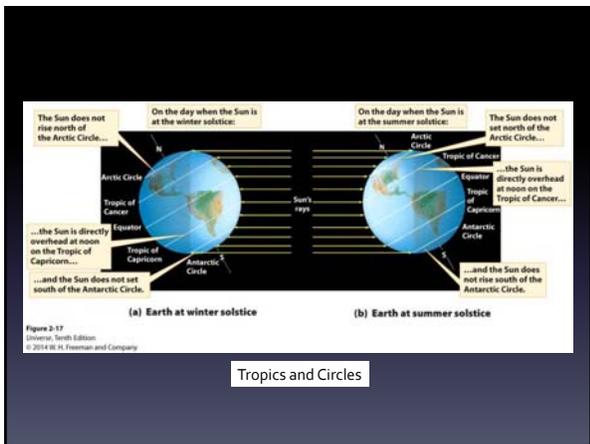
















Goseck Circle

- Oldest Solar Observatory
- Discovered in Germany 2002
- Bronze Age (7000 years ago)
- Reconstructions on upper, middle right
- Nebra disk (bottom) found nearby but not nearly so old

The top image shows the Goseck Circle in a landscape. The middle image is a 3D reconstruction of the circular stone structure. The bottom image is the Nebra Disk, a bronze disc with celestial symbols.

Stonehenge



Solstice Sunrise at Stonehenge



Carhenge (not so ancient)



Key Ideas

- **Constellations and the Celestial Sphere:** It is convenient to imagine the stars fixed to the celestial sphere with the Earth at its center.
- The surface of the celestial sphere is divided into 88 regions called constellations.
- **Diurnal (Daily) Motion of the Celestial Sphere:** The celestial sphere appears to rotate around the Earth once in each 24-hour period. In fact, it is actually the Earth that is rotating.
- The poles and equator of the celestial sphere are determined by extending the axis of rotation and the equatorial plane of the Earth out to the celestial sphere.
- The positions of objects on the celestial sphere are described by specifying their right ascension (in time units) and declination (in angular measure).

Key Ideas

- **Seasons and the Tilt of the Earth's Axis:** The Earth's axis of rotation is tilted at an angle of about $23\frac{1}{2}^\circ$ from the perpendicular to the plane of the Earth's orbit.
- The seasons are caused by the tilt of the Earth's axis.
- Over the course of a year, the Sun appears to move around the celestial sphere along a path called the ecliptic. The ecliptic is inclined to the celestial equator by about $23\frac{1}{2}^\circ$.
- The ecliptic crosses the celestial equator at two points in the sky, the vernal and autumnal equinoxes.
- The northernmost point that the Sun reaches on the celestial sphere is the summer solstice, and the southernmost point is the winter solstice.

Key Ideas

- **Timekeeping:** Astronomers use several different means of keeping time.
- Apparent solar time is based on the apparent motion of the Sun across the celestial sphere, which varies over the course of the year.
- **The Calendar:** The tropical year is the period between two passages of the Sun across the vernal equinox. Leap year corrections are needed because the tropical year is not exactly 365 days. The sidereal year is the actual orbital period of the Earth.
