Ch. 1 Charting The Heavens

Goals:
1. Understand celestial spheres and angular measure
   - to locate objects in the sky
2. Describe how Sun, Moon & stars appear to move in the sky
   - night to night and month to month
3. Account for their apparent motion in terms of their
   - actual motion
4. Understand eclipses
5. Explain how geometry allows distance/sizes measurement

I. Our Place in Space

- We live on a rocky planet orbiting a star in the Milky Way galaxy. Our galaxy is one of billions of galaxies (For Exp. 1-1a).
- Most of the chemical elements in our bodies were made billions of years ago in the stars that died in giant explosions.
- Universe - totality of all space, time, matter, and energy
- Astronomy - study of the universe

Fig. 1. NGC 4449 (New General Catalogue object 1444) is about 70,000 light-years (sky) across. A day is distance light travels in one year.

- 365 days x 24 hours x 60 minutes x 60 seconds = 10 trillion km = 10^13 km
- 1 trillion miles

- The vocabulary of the scientific revolution include: metric
  and scientific notation
- We write very small and very large numbers in a more compact
  format using scientific notation

Size of a proton: 0.000000000000000005 m = 5 x 10^-19 m
Diameter of Sun: 1.392 x 10^6 km
Declination - measured in degrees N or S of celestial equator. Celestial equator is 0° North. Celestial pole is +90°N, South celestial pole is -90°S.

Right Ascension measured in hours, minutes, and seconds. (Remember Earth rotates 360° in 24 hrs or 24 × 60 = 1,440 or 15°) One hour = 15° of angle.

Choice of zero RA is arbitrary - fixed to sky at position of the vernal equinox. Analogous to long. being fixed at 0° at Greenwich, England.

Actually because of Earth's precession this point moves over time, precession cycle is 26,000 yrs. This causes a shift of 0.1° or a right-to-right basis.

- Usually use values for some standard epoch (1950, 2000).

Examples:
- Betelgeuse (in Orion) RA: 5h 52m 0s (east of vernal equinox)
  Dec(δ): 7° 24' N
- Rigel (in Orion) RA: 5h 13m 31s
  Dec(δ): -8° 13'
The Obvious View (See Plate - Fig 1.3)

Constellations in the Sky
- About 3000 stars visible to naked eye in a dark sky at night
- Sky divided into regions, some stars visible
- Stars grouped together into constellations
- Historically, cultures across the globe (Greek, Babylonian, Chinese) have identified constellations
- Stars actually not near each other
- Practical reasons for study in the sky: navigation, calendars
- Astrology, astronomy, religion tied together
- Some constellations considered pseudo-science

The Celestial Sphere
- During course of night, constellations appear to cross the sky from East to West. Ancient thought they were attached to a sphere that revolved about the Earth (Fig 1.8)
- Celestial poles, where Earth's rotation axis intersects the celestial sphere
- Celestial equator, intersection of Earth's equator extended to the celestial sphere
- Position of stars on celestial sphere is determined by latitude and longitude
- Celestial equator, declination (degs) and Right Ascension (RA)

Angles: 360° in circle, 60° in 1°, 60′ in 1′

Declination ≈ 0° ± 30° from Earth
1.3 Earth's Orbital Motion

- Days to day changes
  - We measure time by the Sun. The 24 hour Solar day.
  - The daily progress of the Sun and other stars across the sky is known as helioaur motion (consequence of Earth's rotation).

- Short position in sky: does not repeat exactly night to night.
  - Days of position differ in length from a solar day (Fig. 1.2).

- Causes for Earth's revolution about Sun
  - Solar day about 4 min longer than sidereal day.

Seasonal Changes

- Each season is about a 90° revolution of Earth about the Sun. Different constellations will appear overhead in spring, summer, fall or winter. (Fig. 1.1)
  - Sun traces out a path on celestial sphere known as the ecliptic.

The constellations along the ecliptic are the zodiac constellations. (Fig. 1.12)

- The ecliptic plane and celestial equator are tilted to one another by 23.5° (2i of Earth).

- Summer solstice: highest point of Sun above celestial equator (near June 21) - longest day

- Winter solstice: lowest point of Sun above celestial equator (Dec. 21) - shortest day

- Equinox: crossing point of ecliptic and celestial equator
  - March 21: Vernal equinox (near near March 21)
  - September 21: Autumnal equinox (Sept. 21)

Long Term Changes

- Precession of the equinoxes of Earth's rotational axis. (Ps: 26,000 years)
  - North pole changes because of this. 12,000 yrs. from now it will be Vega. In 3000 BC it was Thuban.

- Sideral year: 365.251 days.