“Now there is one outstandingly important fact regarding Spaceship Earth,

and that is that no instruction book came with it”

- R. Buckminster Fuller
First Bonus Assignment

• Bring me a picture of the Moon during the eclipse tomorrow morning!
  – You must take the picture yourself
  – Can be during partial or total eclipse (extra points for both!)
  – Submit with a brief description of your experience (one paragraph)
• Window of opportunity: 5:30 am – 6:30 am
  – Moon sets at 7:13 am
• Due by Friday, August 31st

Total Eclipse of The Moon
August 28, 2007
Mid-Eclipse - 06:37am
Eastern Daylight Time

Courtesy of F. Espenak
NASA's GSFC
suneart.gsfc.nasa.gov/eclipse
What We Will Learn Today

• In how many ways are you moving right now?
• How have patterns in our sky impacted our history?
• What can we learn from them?
• How did astronomy help us define day, month, and year?
How Many Ways Are You Moving?

At least *eight* ways!

Don’t believe me? Well let’s see…
Motion # 1: The Earth Rotates

- The reason for our days & nights!
- About ½ km per second at the equator
  - A thousand miles per hour!
• Approximately when (time of day) was this picture taken?
• What do we see here?
• How long was the exposure?  $12^\circ/360^\circ \times 24 = 0.8 \text{ hours} = 48 \text{ minutes}$
Motion # 2: The Earth Revolves

- Earth’s revolution takes it on a billion kilometer journey around the Sun.
- Completes one orbit per year at a speed of over 65,000 miles per hour!
- The orbital plane is called the *ecliptic*.
- Earth’s rotational axis is tilted 23.5° with respect to this plane.
Motion # 3: Sun Moves Thru Galaxy

- Sun’s random motion in local neighborhood
  - 44,000 mph!
- Sun’s revolution around Galactic center
  - 500,000 mph!
Motion # 4: The Galaxy’s Motion

• Local motion
  – We are approaching the Andromeda galaxy at 190,000 mph

• Expansion of the Universe
  – Farther you look, faster it’s moving away

Fig 1.16
Motion # 5: Precession of the Axis

- Similar to a spinning top
- Occurs due to tugs on Earth’s equatorial bulge from Sun and Moon
- 26,000 year period
- Polaris will not always be the pole star!
Other Slower Motions

6. Earth-Moon center of mass
7. Perturbation of Earth’s orbit due to other planets (primarily Jupiter)
8. Plate tectonics
   - Few cm per year
   - Atlantic grows
   - Pacific shrinks
   - Himalayas taller

Fig 9.35
The Night Sky: Constellations

- Patterns seen in the sky
- 88 constellations
  - See Appendix I
- 12 Zodiacs
  - Lie along the ecliptic
- Stars in a constellation need not be close together
  - Remember, there is a third dimension!

Betelgeuse = Alpha Orionis
Brightest star in constellation Orion
Rigel = Beta Orionis
2nd brightest star in Orion
The Zodiac

- Constellations that lie along the ecliptic
- Mnemonic
  - Ram-Ble Twins Crab Li-Ver(ish);
  - Scaly Scorpions Are Good Water-Fish
The Celestial Sphere

• Geocentric view of the universe
  – Corresponds to our perspective from Earth
Celestial Coordinates

• Right Ascension
  – Like longitudes on Earth
  – RA = 0 Position of Sun at Spring Equinox
  – Specified in hours, minutes, seconds

• Declination
  – Like latitudes on Earth
  – Specified in degrees, minutes, seconds
  – 0° at Celestial Equator,
  – +90° at Celestial North Pole
A Few Terms

- **Horizon**: Sky meets Earth
- **Zenith**: Directly overhead
- **Meridian**: Circle connecting Zenith with North & South on horizon

- **Stellar location**:
  - **Azimuth** (angle along the horizon – from N towards E)
  - **Elevation** (angle above horizon)

- **Angles in the sky**:
  - Size of moon on sky is ½ degree
  - 30 arcmin or 1800 arcsec

Fig 2.6
Yes, Stars Rise & Set Too

- Actually, our rotation makes them appear to, just like the Sun
  - Remember the star-trails picture?
- Circumpolar stars
  - Always in our sky
Planets in the Sky

- Planets = came from Greek word for “wanderer” (*planetes*)
- Retrograde motion

Fig 2.32 b
Stellar Parallax

- Ancient Greeks could not measure parallax and hence favored Geocentric view
- RECONS group at GSU uses stellar parallax to measure accurate distances to nearby stars
- Parallax is an angle
  - degrees
  - arcmin = 1/60 degree
  - arcsec = 1/60 arcmin
- Stellar parallaxes are typically measured in arcsec
Another Distance Unit: parsec

- 1 parsec = distance at which a star would have a parallax of 1 arcsec

\[
\text{Distance (in parsec)} = \frac{1}{\text{parallax (in arcsec)}}
\]

- 1 parsec = 3.26 light years
Timekeeping: Day

- **Sidereal Day**: One rotation 23h 56m – “Stellar” day
- **Solar Day**: Noon to noon (24 hours)
Timekeeping: Month

- **Sidereal Month**: Moon's orbital period (27.3 days)
- **Synodic Month**: New moon to New moon (29.5 days)

Fig S1.3
Timekeeping: Year

- **Sidereal Year:** Earth’s orbital period
- **Tropical Year:** Cycle of seasons
  - 365 days 5 hours 49 minutes * reason for leap years
  - 20 minutes shorter than sidereal year due to precession
Timekeeping: Weeks

• Chosen to represent observable Solar System Objects
  – Sunday = Sun
  – Monday = Moon
  – Tuesday = Mars (Twisday, after Tyr)
  – Wednesday = Mercury
  – Thursday = Jupiter (Thor’s day)
  – Friday = Venus
  – Saturday = Saturn
Astronomers use UT or Universal Time
- Observations across many time zones
- UT = Time at longitude 0, Greenwich Mean Time
- UT = EST + 5 hours or EDT + 4 hours