SCI 238 Midterm Review (Chpt. 1–11)

The Sky

- **Celestial sphere**: coordinates and positions are relative to Earth's surface and rotation
  - **Celestial equator** = Earth's equator mapped to the sky
  - **Celestial poles** = Earth's poles
  - **Right ascension** = longitude lines, measured w.r.t. vernal equinox
  - **Declination** = latitude lines, measured w.r.t. celestial equator
- **Ecliptic** = plane of Earth's revolution around the sun
- **Vernal equinox** = point where the sun (ecliptic) crosses the celestial equator from south to north
- **Meridian** = latitudinal line directly above a given point on the surface of Earth
  - **Solar noon** = when the sun is along the meridian at the current location
    - a.k.a. 12:00 **apparent solar time**
- **Zenith** = directly overhead
  - Sun is at the zenith when observed at the equator, during equinoxes
  - Sun is at the zenith when observed at Tropic of Cancer/Capricorn, during solstices

Kepler's Laws

- First Law: if a = semi-major axis, e = eccentricity then
  - Perihelion distance = $a(1 - e)$
  - Aphelion distance = $a(1 + e)$
- Second Law: planets' revolution around the sun cover the same area in equal time
- Third Law: (orbital period)^2 = (semi-major axis)^3
  - $P^2[years] = a^3[AU]$
- Newton's version of the Third Law:

$$p^2 = \frac{4\pi^2}{G(M_1 + M_2)}a^3$$

  - Usually used to find <u>mass of main body</u>, given <u>orbital period</u> and <u>orbiting distance</u> of orbiting body
- Distances from 2 bodies to their common centre of mass (another Newton extension) = $m_1 a_1 = m_2 a_2$

Light

- When electrons transition between energy levels in atoms, specific fixed amounts of energy are absorbed/released
  - These amounts of energy correspond to specific fixed wavelengths of EM radiation
- A hot object emits thermal radiation, with a **continuous spectrum**
- A thin gas emits radiation at specific wavelengths depending on its composition & temperature
  - Creates an **emission line spectrum**
- A thin gas between a light source and observer absorbs radiation at specific wavelengths depending on its composition
  - Creates a **absorption line spectrum**
- First law of thermal radiation (**Stefan-Boltzmann Law**):
  - Hotter objects emits more radiation per unit surface area than cooler objects

$$F[\frac{W}{m^2}] = \sigma T^4$$

  - Or for total power over the surface area (e.g. of a star)

$$L[W] = 4\pi r^2 \sigma T^4$$

- Second law of thermal radiation (**Wien's Law**):
  - Hotter objects emits radiation with higher average energy (shorter average wavelength) than cooler objects

$$\lambda_{max}[nm] = \frac{2.9 \times 10^6}{T[K]}$$

- **Doppler broadening**: wider spectral lines indicate faster rotation of star, since light is red-/blue-shifted more by the rotation

Solar System

- **Thermal velocity** of gas particle = $v_{thermal} = \sqrt{\frac{2kT}{m}}$ where k = Boltzmann constant