Class notes for 31 August - Review of Concepts, Sections 3.1, 3.2

**Trig parallax**

\[ d = 1 \text{ AU} / \tan \theta = 1/\theta \text{ AU} \]

\[ d = 2.063 \times 10^5/\theta'' \text{ AU} \]

\[ d = 1/\theta \text{ (d in parsecs)} \]

**Example** - in 1838 after 4 years of observing 61 Cygni, Bessel announced his measurement of a parallax angle of 0.316" for that star. This corresponds to a distance of

\[ d = 1/\theta = 1/0.316 \text{ pc} = 3.16 \text{ pc} = 10.3 \text{ ly} \text{ (within 10\% of the modern value of 1.1 ly)} \]

**Magnitude Scale**

**Apparent magnitude** - logarithmic scale of relative brightness of objects in the sky. A difference of 5 magnitudes corresponds to a factor of 100 in brightness.

**Photometer** - instrument used to measure apparent magnitude of stars

**Radiant flux** - total amount of light energy at all wavelengths crossing a unit area oriented perpendicular to the direction of the light's travel in a unit time. (ergs per sec per square cm)

**Luminosity** - total energy emitted per second from a star

\[ F = L/(4\pi r^2) \]

**Example** - The solar luminosity is \( L = 3.826 \times 10^{33} \text{ erg per sec} \). At a distance of 1 AU = 1.496 \( \times 10^{13} \text{ cm} \), earth receives a radiant flux above the atmosphere of

\[ F = L/(4\pi r^2) = 1.36 \times 10^{6} \text{ erg / sec / cm}^2 \]

This value of the solar flux is known as the **solar constant**. At a distance of 10 pc = 2.063 \( \times 10^{16} \text{ AU} \), an observer would measure the radiant flux to be only \((1/2.063\times10^{6})^2\) as large. That is, the radiant flux from the sun would be \(3.196\times10^{-7} \text{ erg /sec/cm}^2\) at a distance of 10 pc.

**Absolute magnitude**

\[ F_2/F_1 = 100^{(m_1-m_2)/5} \]

Take the log…

\[ m_1-m_2 = -2.5 \log(F_1/F_2) \]
Combine flux and mag definitions

\[ 100^{(m-M)/5} = \frac{F_{10}}{F} = \left(\frac{2}{10\text{pc}}\right)^2 \]

or \( d = 10^{(m-M+5)/5} \) pc

\( m-M \) is called the **distance modulus**

\( m-M = 5 \log(d) - 5 = 5 \log \left(\frac{d}{10}\right) \)

**Example**: The apparent magnitude of the Sun is \( m_{\text{Sun}} = -26.81 \), and its distance is 1 AU = \( 4.848 \times 10^{-6} \) pc. The absolute magnitude of the Sun is

\[ M_{\text{Sun}} = m_{\text{Sun}} - 5 \log(d) + 5 = 4.76 \]

For two stars at the same distance, the ratio of their radiant fluxes is equal to the ratio of their luminosities

\[ 100^{(M_1 - M_2)/5} = \frac{L_2}{L_1} \]

Let one star be the Sun

\[ M = M_{\text{Sun}} - 2.5 \log(L/L_{\text{Sun}}) \]

Where \( M_{\text{Sun}} = 4.76 \) and \( L_{\text{Sun}} = 3.826 \times 10^{33} \) erg per sec

So… \( m = M_{\text{Sun}} - 2.5\log(F/F_{10,\text{Sun}}) \)

(where \( F_{10,\text{sun}} \) is the radiant flux received from the sun at a distance of 10 pc.)