Observational Techniques In Astronomy

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Chapter 1

Introduction and Terms

1.1 RA/Dec co-ordinate system

We have two requirements for a co-ordinate system:

- The system needs to be well defined
- Everyone needs to use the same one to allow for collaboration

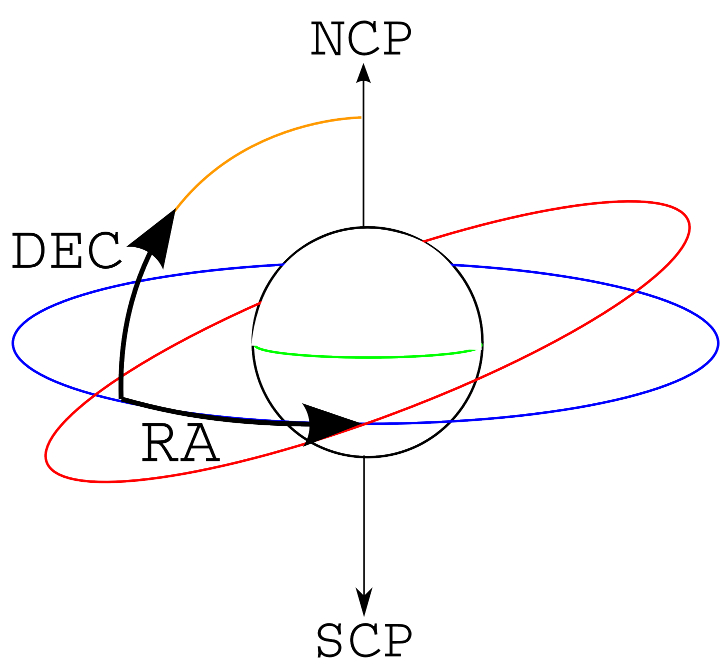

Figure 1.1: Red:Ecliptic, Blue:Celestial Equator, Green:Equator

A Siderial Day is the time between stars crossing the same line in the sky. This is an absolute earth day with respect to the stars - not the Sun! It is approx 23h56m long.

Example If a star with RA = 100° crosses a stationary telescope eyepiece at 11pm and another appears in the eyepiece an hour later, what is the RA of the second star?

Earth rotates once in 24h, so in 1h rotates 15°. Therefore the telescope now points at first star +15° = 115°!

Example Two stars seen in an image:

$$\alpha_1 = 117.397°, \ \ \delta_1 = 22.393°$$

$$\alpha_2 = 117.384°, \ \ \delta_2 = 22.390°$$

What is the separation in arcseconds?

Because the declination difference changes depending on the RA of each, we find that the distance is:

$$\Delta^2 = (\alpha_1 - \alpha_2)^2 \cos^2\left(\frac{\delta_1 + \delta_2}{2}\right) + (\delta_1 - \delta_2)^2$$

This gives us the distance $\Delta = 44.5$ as.

1.2 Fluxes and Magnitudes

Flux is luminosity corrected for distance:

$$F = \frac{1}{L}(4\pi r^2)$$

We define magnitude as a relative scale that is dependent on the fluxes of two objects. Normally, Vega is taken as the standard.

$$m_a - m_b = -2.5 \log\left(\frac{F_a}{F_b}\right)$$

With the naked eye, it is possible to see a maximum of 6th magnitude stars.

Example The star RR-Lyrae ranges in magnitude from 7.1 to 7.8 in 8 hours. What is the relative increase in brightess?

$$m_1 - m_2 = -2.5 \log\left(\frac{F_a}{F_b}\right)$$

$$10^{2.5(m_2 - m_1)} = \frac{F_1}{F_2} = 1.91$$

Example A binary star comprises two stars, a and b, with a brightness ratio of 2. We see them as unresolved, and the total magnitude is 5. What is the magnitude of each star?

Let's begin by pretending we have a reference star with flux F_0 and magnitude 0. We also know that the fluxes of the stars sum to make the flux of the binary system.

$$m_{a+b} - 0 = -2.5 \log\left(\frac{F_a + F_b}{F_0}\right)$$

Now, we can find F_0 in terms of the fluxes of the stars using $m_{a+b} = 5$:

$$100(F_a + F_b) = F_0$$

Again using the magnitude equation, we find m_a:

$$m_a - 0 = -2.5 \log \left(\frac{F_a}{F_0} \right)$$

Substituting in:

$$m_a = -2.5 \log \left(\frac{1}{100(1 + \frac{F_b}{F_a})} \right) = 5.44$$

We repeat for $m_b = 6.19$.

1.2.1 Absolute magnitude

Asbolute magnitude (M) is found by 'placing' the stars 10 pc away and 'measuring' it's magnitude. We do this mathematically with:

$$M = m + 5 \left(1 + \log \left(\frac{d}{10} \right) \right)$$