Galactic coordinate system

- The equatorial coordinate system, which pinpoints objects in the celestial sphere with earth at its centre, is not followed for locating objects within the Galaxy because the celestial equator is tipped from the mid-plane of the Galactic Disk by an angle of approx. 62.5^o. Rather, the Galactic Coordinate system has the sun at its centre.

- The two coordinates of a celestial body are Galactic latitude and Galactic longitude.

  1. The Galactic latitude (b) is the angular distance above or below the mid-plane. Thus, objects with b equal to 0^o will be located in the plane of the disk. Those with a positive b will be above the plane in the northern galactic hemisphere and those with negative b will be below the disk. Hence, it ranges from $-90^o \leq$ b $\leq 90^o$. The point where b = $+90^o$ is called the North Galactic Pole (NGP) analogous to the North Celestial Pole (NCP) in equatorial coordinates.
  2. The Galactic longitude (l) is defined within the Galactic plane but measured eastward from the line joining the sun and the centre of the galaxy. Its value lies between $0^o \leq l \leq 360^o$.

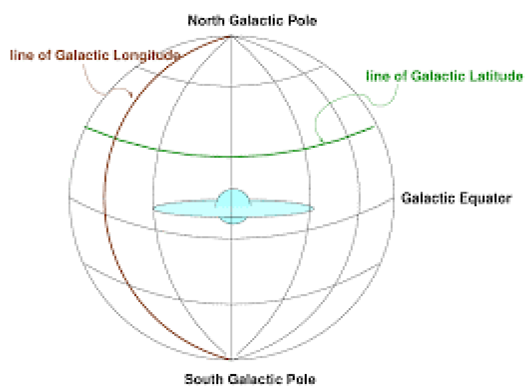

Figure 1: Galactic coordinate system

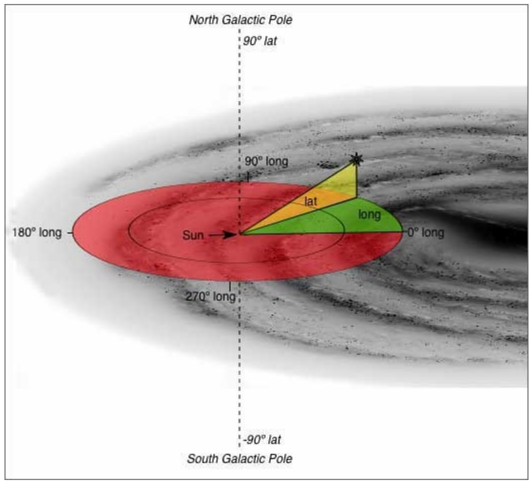

Figure 2: The galactic equator (i.e., 0^o galactic latitude) is coincident with the plane of the Milky Way Galaxy and is shown as the red circle in the image above.

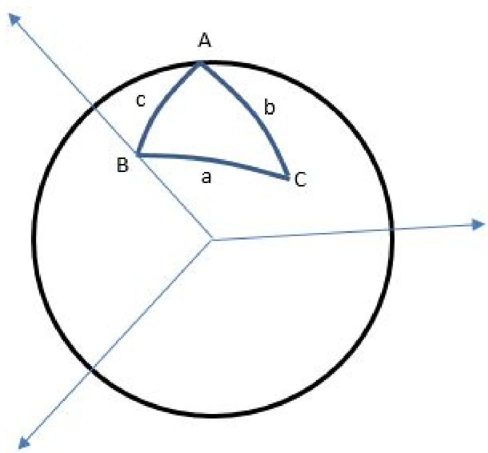

Figure 3: An example for the application of Spherical Trigonometry to triangles.Consider a triangle ABC on the surface of a sphere with radius = 1 as shown in the above figure

- To find the position of any star within the Galaxy, spherical trigonometry is made use of, in converting the equatorial coordinates to Galactic coordinates. The known values of (b,l) of the NCP and (α, δ) of the NGP is useful in constructing a triangle on the surface of the sphere with NCP, NGP and the star at the vertices as shown in Figure 3.
- Law of sines :

$$\frac{\sin A}{\sin a} = \frac{\sin B}{\sin b} = \frac{\sin C}{\sin c} \tag{1}$$

- Law of cosines :

$$\cos a = \cos b \cos c + \sin b \sin c \cos A \tag{2}$$

$$\cos b = \cos a \cos c + \sin a \sin c \cos B \tag{3}$$

$$\cos b = \cos a \cos c + \sin a \sin c \cos B \tag{4}$$

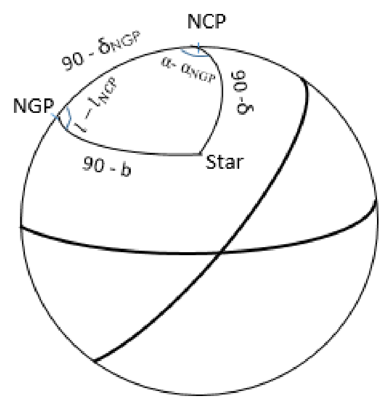

Figure 4: The galactic Coordinates can be obtained by constructing a triangle as shown and applying trigonometric identities

- According to the Figure 4, applying A = $\alpha - \alpha_{NGP}$, B = l - l_{NCP} , a = b and b = δ to equation (1),

$$\sin l - l_{NCP} = \frac{\cos\delta \sin\alpha - \alpha_{NGP}}{\cos b} \tag{5}$$

- Similarly, equation (2) becomes,

$$\sin b = \sin\delta \sin\delta_{NGP} + \cos\delta \cos\delta_{NGP} \cos\alpha - \alpha_{NGP} \tag{6}$$

- Given that (α_{NGP}, δ_{NGP}) = (12 h 51 m, 27 7.7') = (192.85948^o, 27.12825^o),(α_{GC}, δ_{GC}) = (17 h 45.6 m, -28^o 56.2') and l_{NCP} = 122.93^o the Galactic corordinates l and b of any celestial object can be obtained.