

## THE CELESTIAL GLOBE

Familiarize yourself with the celestial globe by noting the positions of the following:

horizon, zenith, nadir, north, south, east and west points, vertical circles;  
celestial equator, north and south celestial poles, hour circles, hour angle;  
ecliptic, Vernal and autumnal equinoxes, summer and winter solstices, north ecliptic pole;  
observer's meridian,  $\Sigma$  point, observer's latitude;  
Milky Way plane, galactic centre, north pole of the Milky Way

Set the globe to show the sky as seen from the terrestrial north pole and study the nature of diurnal motion. Then do the same for a point on the equator. Keep in mind the following relationship when setting the globe:

altitude of the pole =  $\phi$ , the latitude of the observer = zenith distance of the  $\Sigma$  point

Set the globe for latitude  $45^\circ$  north and study the diurnal motion.

## SPHERICAL CO-ORDINATE SYSTEMS

The establishment of a co-ordinate system on a sphere is analagous to establishing a 2-dimensional system on a plane.

A review of the basic steps

1. Define an x-axis.
2. Define a y-axis perpendicular to the x-axis. The 2 axes intersect at the origin.
3. Drop a perpendicular from point P to the x-axis (the ordinate).
4. The first co-ordinate of P is the distance on the x-axis between the y-axis and the ordinate.
5. The second co-ordinate is the length of the ordinate between the x-axis and point P.

The co-ordinate system on a sphere is set up in the same fashion, but great circles replace straight lines.

Basic steps for spherical co-ordinates

1. Define the first fundamental circle (FFC) as a great circle on the sphere by specifying its plane or its poles.
2. Define the second fundamental circle (SFC) as a great circle passing through the poles of the FFC and some other arbitrarily chosen point.
3. Define the secondary circle as a great circle passing through the poles of the first fundamental circle and the point P whose co-ordinates are required.
4. The first spherical co-ordinate of P is the length of the arc of the FFC between the SFC and the secondary circle of P.
5. The second spherical co-ordinate of P is the length of the arc of the secondary circle between the FFC and P.

## SPHERICAL CO-ORDINATE SYSTEMS IN ASTRONOMY

### 1. Horizon system (azimuth, Az; altitude, h)

FFC - horizon

SFC - meridian

secondary circle - vertical circle

origin - north point

azimuth:  $0^\circ$  to  $360^\circ$  - measured from north through east

altitude:  $0^\circ$  to  $90^\circ$ , zenith distance  $z = 90^\circ - h$

### 2. Equator system #1 (local hour angle, declination)

FFC - celestial equator

SFC - meridian

origin -  $\Sigma$  point

secondary circle - hour circle

LHA - hour angle: 0 to  $24^h$  - measured westward

$\delta$  - declination: 0 to  $\pm 90^\circ$

### 3. Equator System #2 (right ascension, declination)

FFC - equator

SFC - hour circle through the Vernal Equinox

origin - Vernal Equinox

secondary circle - hour circle

$\alpha$  right ascension (RA): 0 to  $24^h$  - measured eastward

$\delta$  (dec) - declination: 0 to  $\pm 90^\circ$

### 4. Ecliptic system (celestial longitude, celestial latitude)

FFC - ecliptic

SFC - great circle passing through ecliptic poles and Vernal Equinox

origin - Vernal Equinox

celestial longitude  $\lambda$ : 0 to  $360^\circ$  - measured eastward

celestial latitude  $\beta$ : 0 to  $\pm 90^\circ$

### 5. Galactic system (galactic longitude, galactic latitude)

FFC - plane of the Milky Way galaxy. (North galactic pole has  $\alpha = 12^h 49^m$ ,  $\delta = 27^\circ 24'$ , Epoch 1950)

SFC - great circle passing through galactic poles and galactic centre. (Galactic centre has  $\alpha = 17^h 42^m .4$ ,  $\delta = -28^\circ 55'$ , Epoch 1950)

origin - galactic centre

galactic longitude  $l$  - measured in direction of increasing right ascension: 0 to  $360^\circ$

galactic latitude  $b$ : 0 to  $\pm 90^\circ$



## EXERCISE

In setting the celestial globe, one must take both the time and the latitude of the observer into account. Star time is sidereal time (LST). It is measured in hours and minutes.

LST = LHA of the Vernal Equinox

LST = the right ascension of an object on the observer's meridian

LST = LHA + RA of any object

Thus, for a particular LST, one sets the globe so that the right ascension of the observer's meridian is the same as the LST.

The latitude of the observer is the same as the altitude of the celestial pole (north pole in the northern hemisphere and south pole in the southern hemisphere).

1. Set the globe for the position of Toronto (latitude  $43^{\circ} 40'$  north) at LST  $20^{\text{h}}$ . Locate the stars Deneb and Altair. Using the globe determine the right ascension, declination, hour angle, azimuth and altitude of the two stars. For each star, calculate the sum of the LHA and RA. Is it the same as the LST?
2. Set the globe for LST  $22^{\text{h}}$ . Use the table of bright stars in the Observer's Handbook to find two stars of spectral class A that are well positioned for observing, i.e. have altitude greater  $45^{\circ}$ . Then use the table of star clusters to find a cluster that is more than  $45^{\circ}$  above the horizon.