ASTRONOMICAL SURVEYING – I

Celestial Sphere.

The millions of stars that we see in the sky on a clear cloudless night are all at varying distances from us. Since we are concerned with their relative distance rather than their actual distance from the observer. It is exceedingly convenient to picture the stars as distributed over the surface of an imaginary spherical sky having its center at the position of the observer. This imaginary sphere on which the star appear to lie or to be studded is known as the celestial sphere. The radius of the celestial sphere may be of any value – from a few thousand metres to a few thousand kilometers. Since the stars are very distant from us, the center of the earth may be taken as the center of the celestial sphere.

Zenith, Nadir and Celestial Horizon.

The Zenith (Z) is the point on the upper portion of the celestial sphere marked by plumb line above the observer. It is thus the point on the celestial sphere immediately above the observer's station.

The Nadir (Z') is the point on the lower portion of the celestial sphere marked by the plum line below the observer. It is thus the point on the celestial sphere vertically below the observer's station.

Celestial Horizon. (True or Rational horizon or geocentric horizon): It is the great circle traced upon the celestial sphere by that plane which is perpendicular to the Zenith-Nadir line, and which passes through the center of the earth. (Great circle is a section of a sphere when the cutting plane passes through the center of the sphere).

Terrestrial Poles and Equator, Celestial Poles and Equator.

The terrestrial poles are the two points in which the earth's axis of rotation meets the earth's sphere. The terrestrial equator is the great circle of the earth, the plane of which is at right angles to the axis of rotation. The two poles are equidistant from it.

If the earth's axis of rotation is produced indefinitely, it will meet the celestial sphere in two points called the north and south celestial poles (P and P'). The celestial equator is the great circle of the celestial sphere in which it is intersected by the plane of terrestrial equator.

Sensible Horizon and Visible Horizon.

It is a circle in which a plane passing through the point of observation and tangential to the earth's surface (or perpendicular to the Zenith-Nadir line) intersects with celestial sphere. The line of sight of an accurately leveled telescope lies in this plane.

It is the circle of contract, with the earth, of the cone of visual rays passing through the point of observation. The circle of contact is a small circle of the earth and its radius depends on the altitude of the point of observation.

Vertical Circle, Observer's Meridian and Prime Vertical?

A vertical circle of the celestial sphere is great circle passing through the Zenith and Nadir. They all cut the celestial horizon at right angles.

The Meridian of any particular point is that circle which passes through the Zenith and Nadir of the point as well as through the poles. It is thus a vertical circle.

It is that particular vertical circle which is at right angles to the meridian, and which, therefore passes through the east and west points of the horizon.

Latitude (θ) and Co-latitude (c).

Latitude (θ): It is angular distance of any place on the earth's surface north or south of the equator, and is measured on the meridian of the place. It is marked + or – (or N or S) according as the place is north or south of the equator. The latitude may also be defined as the angle between the zenith and the celestial equator.

The Co-latitude of a place is the angular distance from the zenith to the pole. It is the complement of the latitude and equal to (90°-θ).

longitude (ϕ) and altitude (α).

The longitude of a place is the angle between a fixed reference meridian called the prime of first meridian and the meridian of the place. The prime meridian universally adopted is that of Greenwich. Te longitude of any place varies between 0° and 180°, and is reckoned as Φ° east or west of Greenwich.

The altitude of celestial or heavenly body (i.e, the sun or a star) is its angular distance above the horizon, measured on the vertical circle passing through the body.

Co-altitude or Zenith Distance (z) and azimuth (A).

It is the angular distance of heavenly body from the zenith. It is the complement or the altitude, i.e $z = (90° - α)$.

The azimuth of a heavenly body is the angle between the observer's meridian and the vertical circle passing through the body.

Declination (δ) and Co-declination or Polar Distance (p).

The declination of a celestial body is angular distance from the plane of the equator, measured along the star's meridian generally called the declination circle, (i.e., great circle passing through the heavenly body and the celestial pole). Declination varies from 0° to 90°, and is marked + or – according as the body is north or south of the equator.

It is the angular distance of the heavenly body from the near pole. It is the complement of the declination. i.e., $p = 90° - δ$.

Hour Circle, Hour Angle and Right ascension (R.A).

Hour circles are great circles passing though the north and south celestial poles. The declination circle of a heavenly body is thus its hour circle.

The hour angle of a heavenly body is the angle between the observer's meridian and the declination circle passing through the body. The hour angle is always measured westwards.