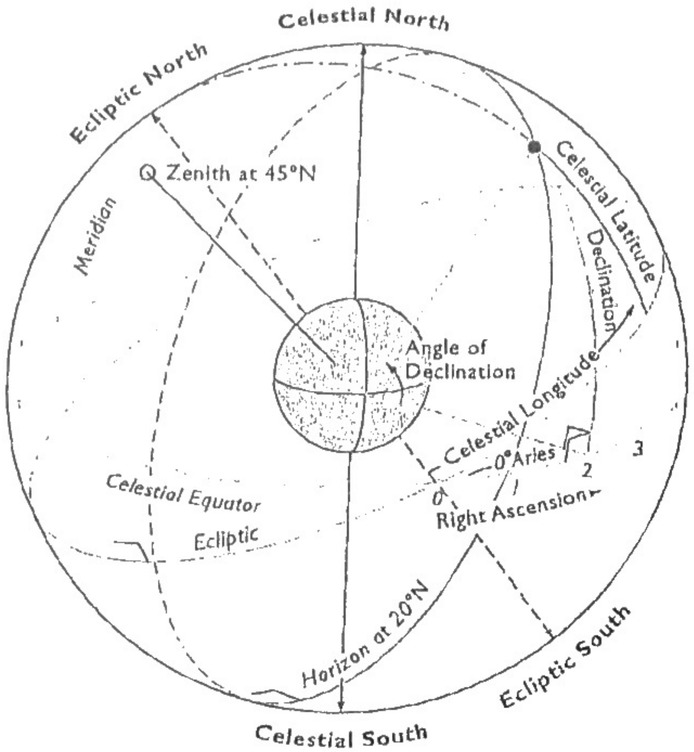
THE MOTION OF THE STARS

The *Celestial Sphere*, a projection of the Earth's surface into the sky with the Earth at its centre, is a fundamental concept in astronomy. Lines of sight are projected onto it, and measurements of arc between celestial objects are made on the inside surface of this imaginary globe.

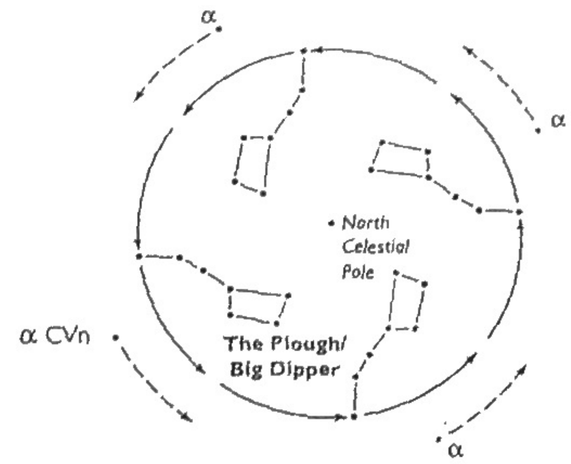
At any position on the Earth a horizon circle cuts the Sphere into upper (visible) and lower (invisible) sections. The *astronomical horizon* is any horizon circle whose plane cuts through the centre of the Sphere. We see a close approximation to the notional astronomical horizon at sea and in flat deserts. The point on the Celestial Sphere directly overhead is the *zenith*. At the zenith's opposite point on the Celestial Sphere lies the *nadir*. A measure above the horizon is termed *elevation*; and the zenith is by definition at the maximum elevation of 90°, a quarter circle, above the horizon.

All the stars and planets lying on the Sphere appear to rotate around the Earth once every 24 hours. From modern science we know that it is the Earth's turn on its own polar axis that makes the sky "turn". If this polar axis is projected onto the Celestial Sphere, it pierces it at the *Celestial Poles*: the North Celestial Pole is the zenith for an observer at the Earth's North Pole; the South Celestial Pole is the zenith at the Earth's South Pole. Midway between the Celestial Poles is the *celestial equator*. During the night, the stars cross the sky above the horizon in circles parallel to the celestial equator.

The Celestial Sphere The projection of the Earth's Poles onto the Sphere gives Celestial North and South, with the celestial equator midway. The ecliptic (tilted at 23½° to the equator) marks the Earth–Sun orbital plane. Equator and ecliptic intersect at the March equinox point (0° Aries, the starting point for celestial measurement), and at the opposite point on the Sphere (the September equinox). Celestial objects are measured against the equator (Right Ascension and declination) or the ecliptic (celestial longitude and latitude).



Circumpolar motion As we approach the pole, more stars become visible and never set; that is, they are circumpolar. At 50°N the Plough or Big Dipper is circumpolar, its stars having declinations greater than 50°N. The star Cor Caroli (α CVn) is at declination 38°N, and so at 50°N on Earth it passes below the horizon. At the poles the whole hemisphere sky is circumpolar.



The location of any celestial object, including the stars and planets, can be pinpointed on the Celestial Sphere in two ways. The system of Right Ascension (RA) and declination is equatorial. RA is measured in 24-hourly sections along the equator; declination is measured in degrees above or below the equator (0° to +90° in the North; 0° to –90° in the South). The system of the ecliptic (the circle made by the apparent path of the Sun) measures the positions of stars in celestial longitude (0° to 360° along the ecliptic) and celestial latitude (0° to 90°) north (+) or south (–) of the circle. Both systems begin at 0° Aries (see p.14).

The observer's location on the Earth changes the way in which the Sun, Moon and stars appear to rise and set. At the equator the Sphere appears to turn so that stars rise at right angles to the horizon; north or south of the equator the angle of rising and setting becomes increasingly slanted. Hence the short twilight and dawn on and near the equator, and the long, slantwise rising and setting of the Sun at latitudes toward the poles.

The line that joins the North and South Poles and runs through the observer's zenith is termed the *meridian*. This cuts the horizon at right angles to the cardinal points north and south. The meridian is a key to astronomical observation and to time-keeping. As a rising star crosses the upper meridian (that part of the meridian above our heads), it is said to *culminate*. The culmination of the Sun – sundial noon – is the basis of the ancient measurement of time.