Finding Our Way Around The Sky

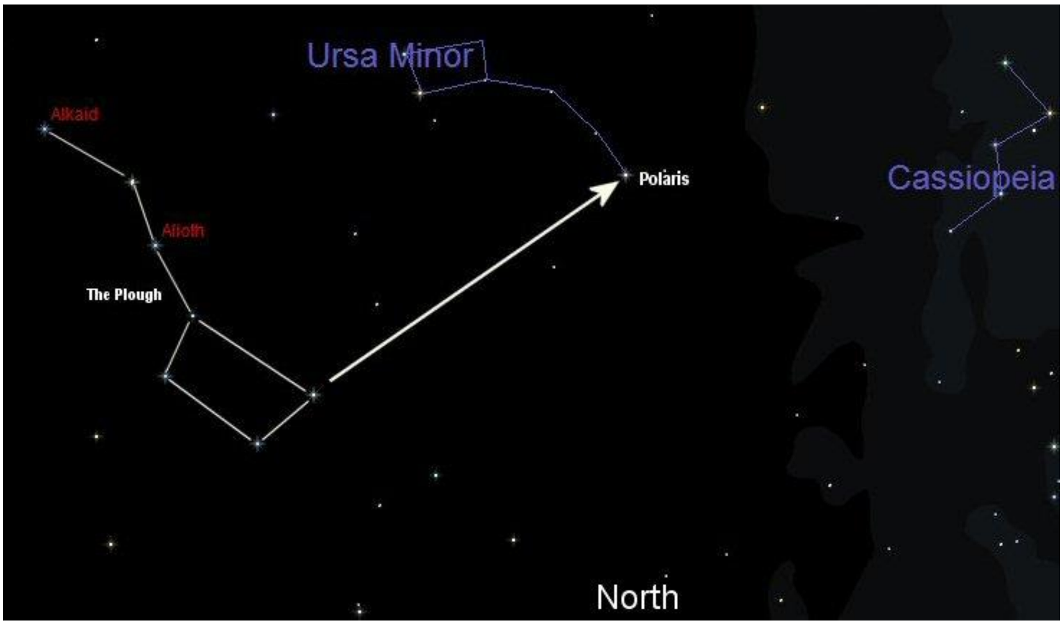
The **Celestial Sphere** can be envisaged as an immense globe with all the celestial objects such as stars, galaxies and nebulae appearing to be projected or "painted on the inside surface of it [1] and with the **Earth** at its centre.

As the Earth rotates around its own axis each day from *west to east* relative to the sun, objects on the celestial sphere appear to move in our sky from *east to west* at the same rate of 15 degrees per hour (15° x 24 hrs =360°).

The Earth's North Pole points to the **North Celestial Pole** very close to which lies the star we call **Polaris (**Alpha Ursae Minoris - sometimes "*The Pole Star*"). This is jolly useful if you're lost in the countryside on a clear night [2] but we astronomers often use Polaris as an initial reference point when setting up our telescopes.

Finding Polaris

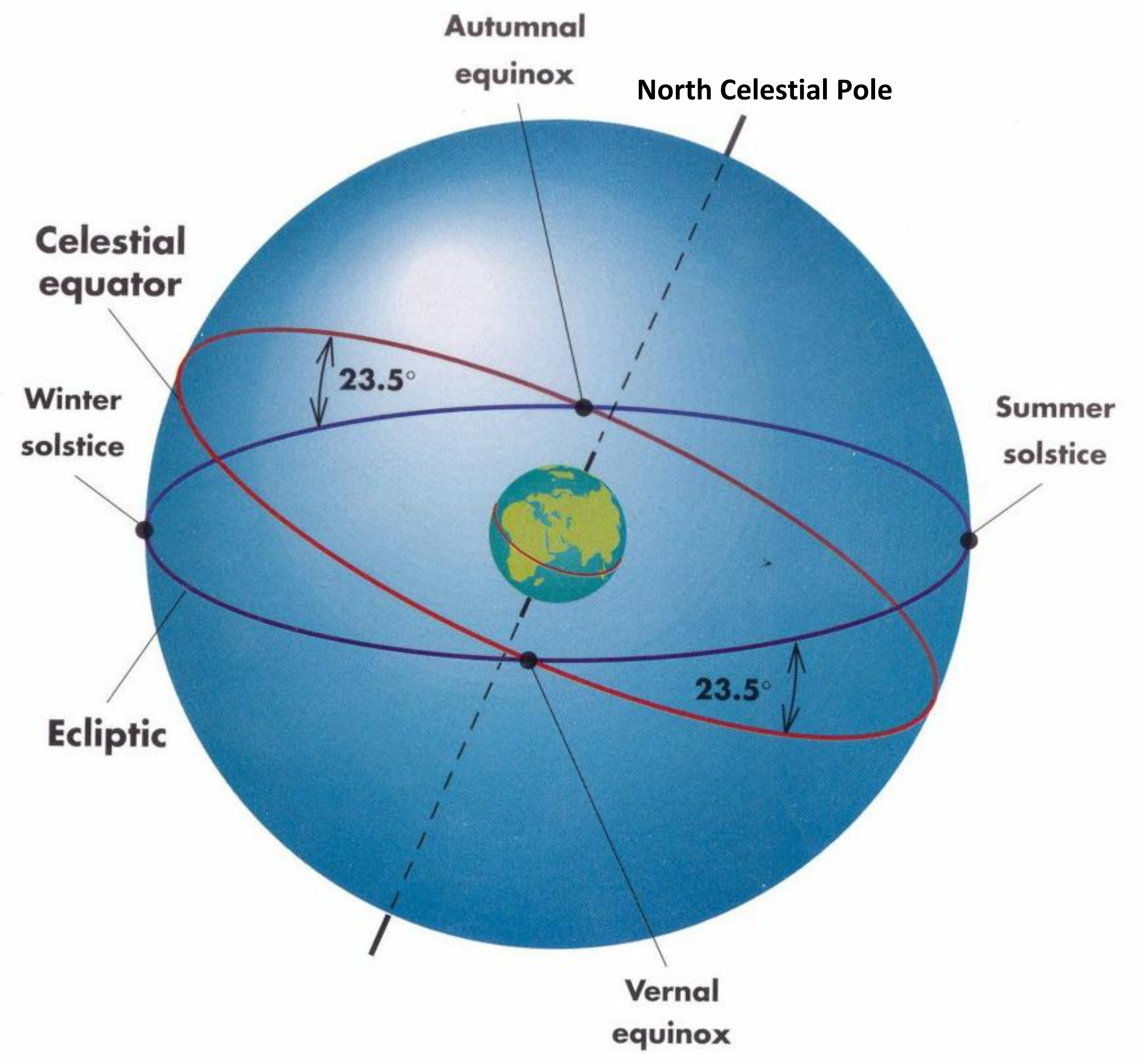
Polaris is the brightest star in the asterism we call **Ursa Minor** (The Little Bear) and, to the naked eye or in a telescope at low magnification, it stands reasonably isolated from its neighbours. It can be found most easily by imagining a line joining the two brightest stars at the front of The Plough (Merak and Dubhe) and extending it towards Ursa Minor - as shown below.



1 At these truly astronomical distances it doesn't matter that some celestial objects are very much further away than others.

2 In the Northern hemisphere, if you find "**The Plough**" and Polaris, then follow a vertical line from Polaris to the horizon you'll be looking North.

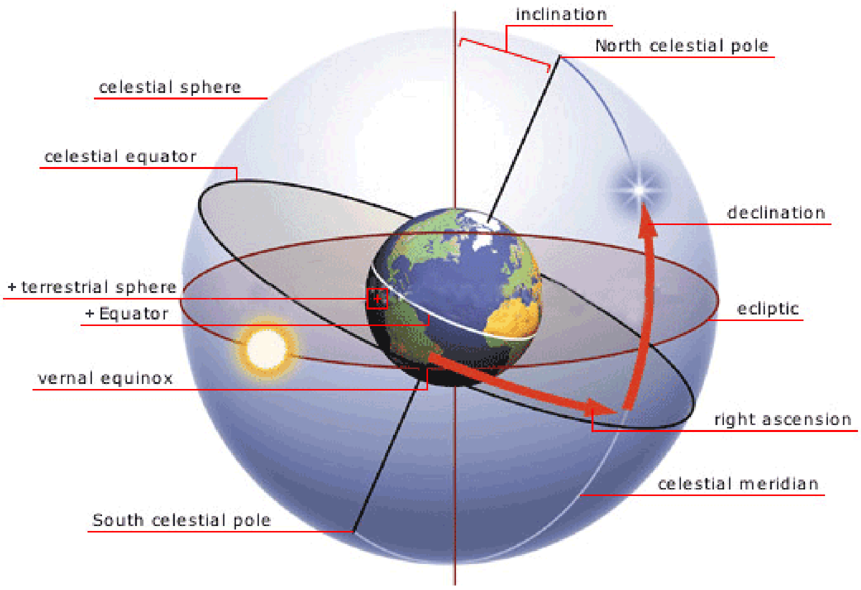
The imaginary plane of the Earth's orbit around the Sun is called the **ecliptic** [3]. The Sun's apparent path across the Earth's sky throughout the year therefore also lies in this plane. The Earth's axis is tilted at 23.5° to the ecliptic - which is how we come to experience summer when our northern hemisphere leans towards the Sun and winter when it leans away from it. The ecliptic is therefore angled at 23.5° relative to the celestial equator.



[3] Most of the other planets in our solar system together with our own Moon also orbit approximately in this plane because they were each formed from the same spinning proto-planetary disk.

For terrestrial navigation, if we want to locate a point on the Earth's surface we use values of **latitude** - North or South referenced to the Earth's equator- and of **longitude** - East or West referenced to the **Prime** (**Greenwich) Meridian**.

To locate a celestial object however we need to refer to a set of coordinates which are related to the celestial sphere. To do this we define **Right Ascension** [4] as the angular distance from the **Vernal Equinox** to the meridian of the object in question (measured eastward along the celestial equator in hours, minutes and seconds where 1 hour is the equivalent of 15°) and **Declination** as the angle of the object above the celestial equator (measured in degrees). The vernal (spring) equinox occurs at the date and time when the ecliptic intersects the celestial equator in spring; at this point day-time and night-time are of approximately equal duration all over our planet.



An "**Equatorial**" telescope mount is set up with one of its two rotational axes accurately aligned to the Celestial Pole. Once the mount is "polar aligned" and the object of interest has been found by carefully adjusting the R.A. and Dec. controls, the object can in principle be kept in view simply by driving the R.A. axis at a rate to match the Earth's rotation. This is one reason why defining or recording the position of an object using R.A. & Dec. is so powerful and why equatorial mounts are so popular and have been for centuries [5].

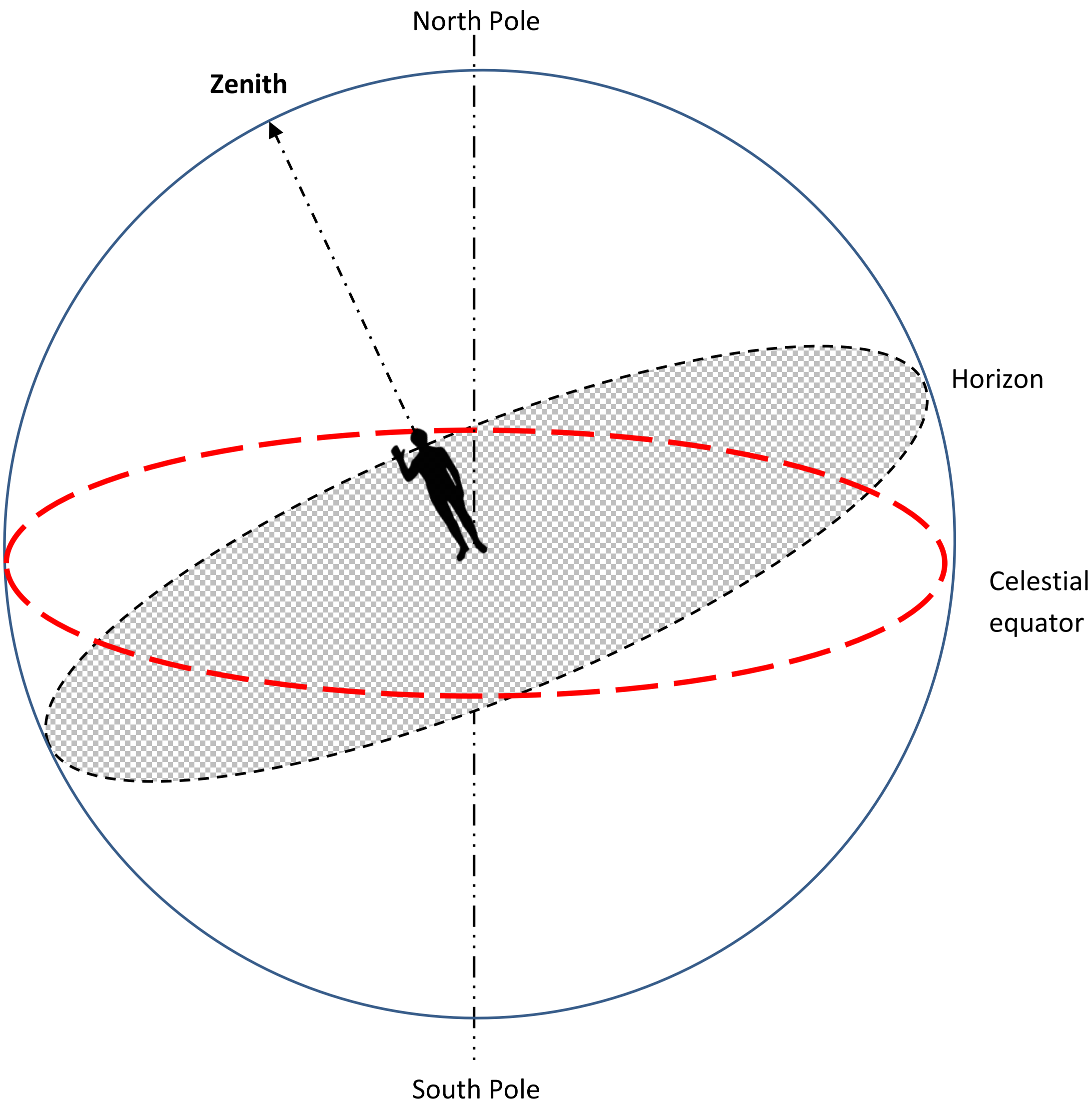
"**Altazimuth**" mounts on the other hand rotate about vertical and horizontal axes. They are simpler to make but do require computer control to automatically keep an object in view in the eyepiece. The image also rotates in the viewfinder as the earth rotates which makes astrophotography considerably more complex and fiddly. A **Dobsonian** telescope is a typical example of an altazimuth mount.

4 Right Ascension is abbreviated to **R.A.** whilst Declination is usually abbreviated to **Dec.**. In most sources of astronomical reference information, the coordinates of celestial objects are given in terms of R.A. and Dec..

5 The first star catalogue to use R.A. and Dec. was John Flamsteed's *Historia Coelestis Britannica* (1712, 1725).

The point in the heavens vertically above your head is called the **Zenith**.

As we can only see things above the horizon, what we can see in the heavens depends on our terrestrial latitude [6]. In the northern hemisphere, the higher our latitude the closer the zenith is to the celestial north pole and the less we'll be able to see of objects in the southern celestial hemisphere.



Those stars, galaxies and nebulae whose declination is greater than (**90° minus your latitude**) never drop below the horizon and so are always above it [7]. Such objects are called **circumpolar**. Thus if our latitude is 50°, objects with a declination of 40° or more will always be visible in the sky (subject to hills, trees, buildings, weather etc.). At either terrestrial pole all objects in that celestial hemisphere are circumpolar, whilst if we happen to be on the terrestrial equator (latitude 0°) no objects are circumpolar [8].

6 Inevitably your view may also be restricted by hill, trees and buildings; lucky is the astronomer who lives in the Fens or in Holland - apart from problems with rising damp and mists.

7 Although we won't usually be able to see them during the day.

8 If we were at the Earth's equator objects exactly above us would move in a straight line (from east to west) as the Earth rotates. Objects above or below the equator would move in shallow hyperbolic paths.

Acknowledgements

Diagrams courtesy of Anthony Ward, Nick Tanton & Matthew Cook

Useful references

Stellarium

Stellarium is an open-source free-software planetarium program available for Linux, Windows and macOS.

Home page	http://stellarium.org/
Win64 download	https://sourceforge.net/projects/stellarium/

SkyView

SkyView is an app. that allows you to point your phone or iPad at the sky and identify stars, constellations and planets etc..

iOS	https://www.terminaleleven.com/skyview/iphone/
Android	https://skyview-free.en.uptodown.com/android]

There is a free version of SkyView (SkyView Lite) and a more sophisticated version without adverts for which you pay a modest once-off fee.

Guildford Astronomical Society

Home	https://www.guildfordas.org/
Ask an Astronomer	https://www.guildfordas.org/ask-an-astronomer/
Constellation Viewer	https://www.guildfordas.org/astronomy-applets/

Weather

BBC	https://www.bbc.co.uk/weather/
Met Office	https://www.metoffice.gov.uk/public/weather/forecast
First Light Optics	https://clearoutside.com/forecast/51.23/-0.33
Scope Nights	http://scopenights.com

Moon Phase

https://www.timeanddate.com/moon/phases/

Polar Alignment

About	https://en.wikipedia.org/wiki/Polar_alignment
	https://themcdonalds.net/richard/wp/polar-alignment-of-your-equatorial-mount/
	http://www.skyatnightmagazine.com/feature/how-guide/how-toalign-telescope-mount
iOS App	https://itunes.apple.com/gb/app/polar-scope-align/id970157965?mt=8

There is a free version of PS Align and a version without adverts for which you pay a modest once-off fee.

Magazines

Sky at Night	https://www.skyatnightmagazine.com/
Astronomy Now	https://astronomynow.com/

Books

Turn Left at Orion — Guy Consolmagno & Dan M. Davis

Collins Stargazing: Beginners guide to astronomy

2018 Guide to the Night Sky : A month-by-month guide to exploring the skies above Britain and Ireland.

Note that this is a small selection of websites, apps and books that have been found to work and are used by us . There are also many videos on YouTube which offer explanations or “how-to” demonstrations at various levels of competence and interest.