

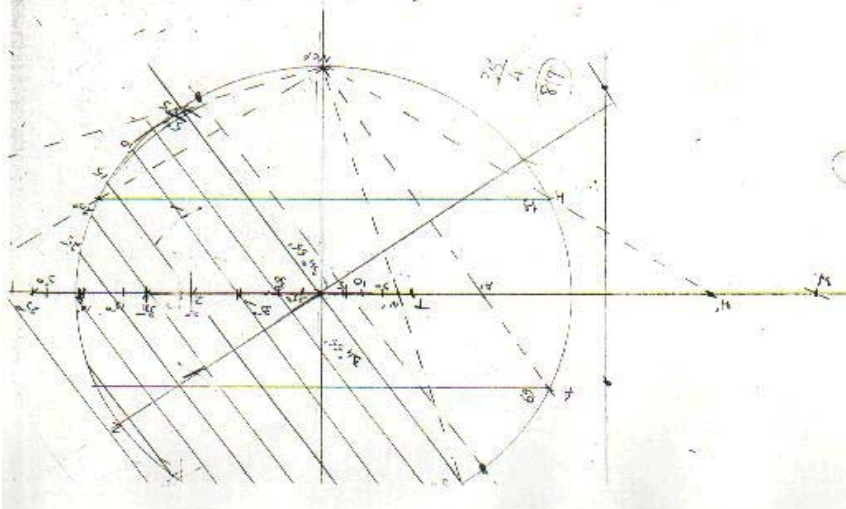
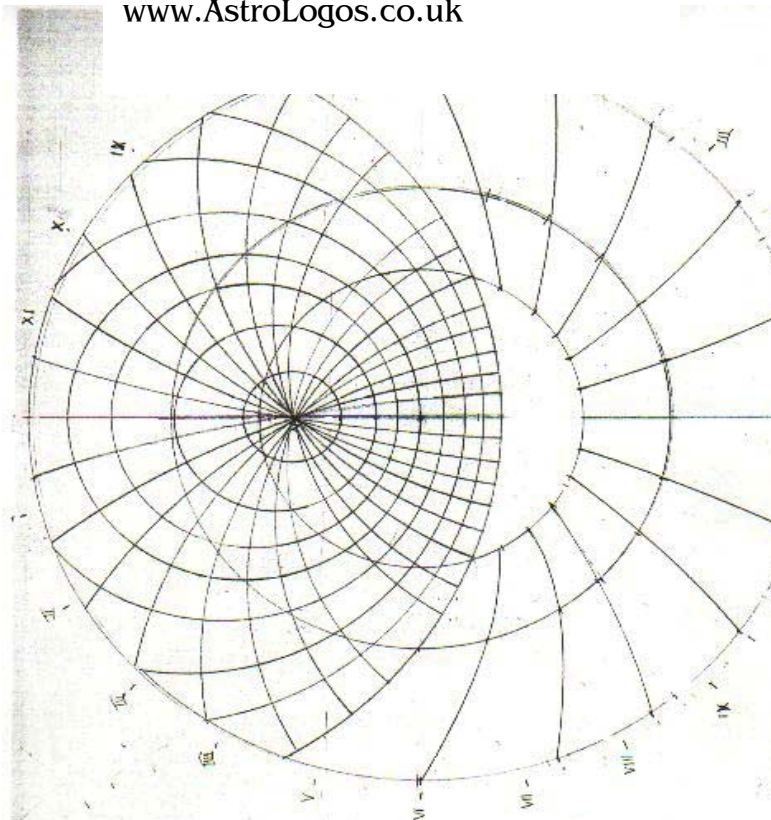
The Northern Hemisphere Astrolabe



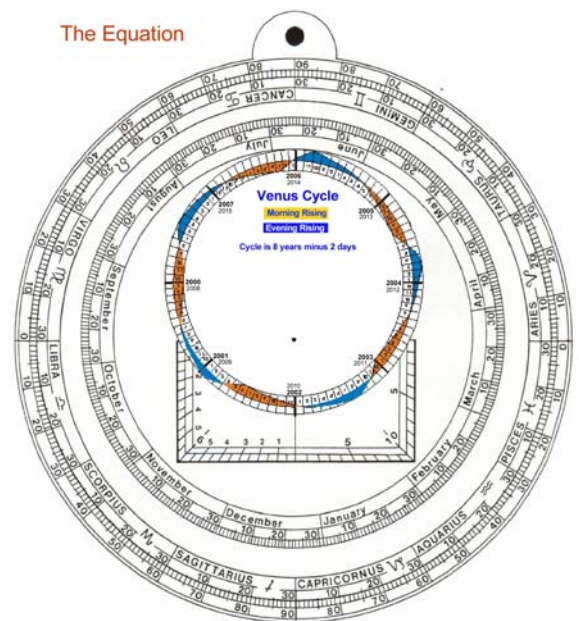
Chaucer wrote the first scientific text in English – which was on the Astrolabe.....

By Bernadette Brady

bnbrady@AstroLogos.co.uk
www.AstroLogos.co.uk

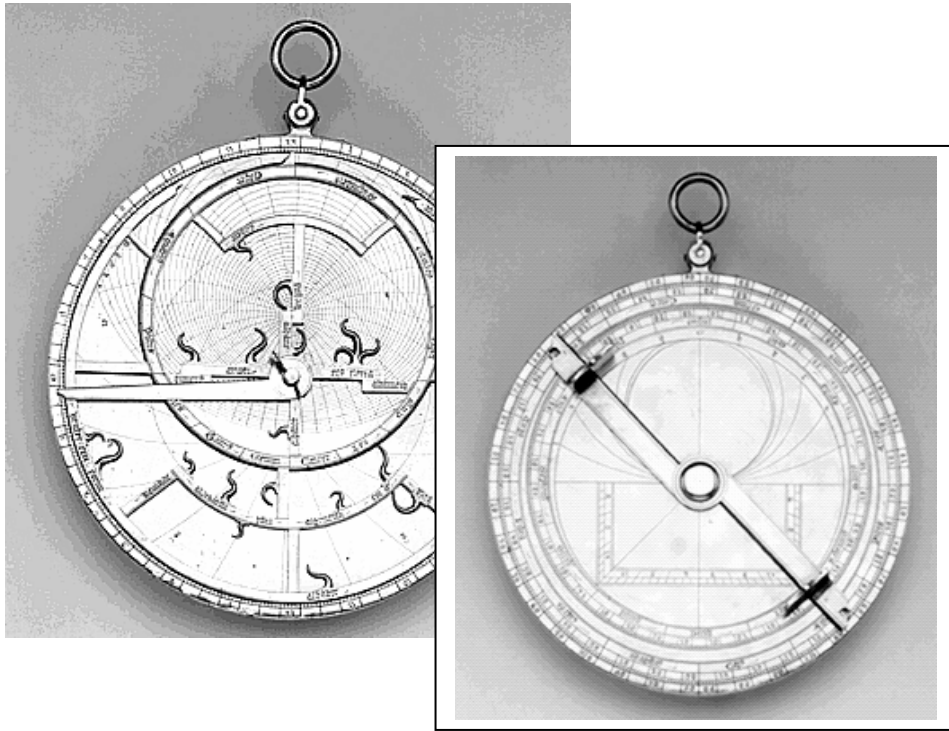


The Equation



THE ASTROLABE

"I know that I am mortal and the creature of a day; but when I search out the massed wheeling circles of the stars, my feet no longer touch the Earth but, side by side with Zeus himself, I take my fill of ambrosia." Claudius Ptolemy



Astrolabe by Jean Fusoris, ca 1400 (courtesy Adler Planetarium and Astronomy Museum)

ORIGINS OF ASTROLABE

No one knows exactly when the stereographic projection was actually turned into the instrument we know today as the astrolabe. Theon of Alexandria (ca. 390) wrote a treatise on the astrolabe that does not survive except for the table of contents which was preserved by Ya'qubi in his "History of the World" (ca. 880). This treatise was evidently the basis for much that was written on the subject in the Middle Ages. Synesius of Cyrene (378-430) apparently had an instrument constructed that was arguably a form of astrolabe. This is plausible since Synesius was a student of Hypatia, Theon's daughter.

The earliest descriptions of actual instruments were written by John Philoponos of Alexandria (a.k.a. Joannes Grammaticus) in the sixth century and a century later Severus Sebokht, Bishop of Kenneserin, Syria, although it is likely that Sebokht's work was derivative of Theon. It is certain that true astrolabes existed by the seventh century.

By the eighth century the Islamic world was using astrolabes to aid in worship. Using astrolabes, they could determine the time of day and the direction of Mecca for their prayers. The astrolabe was also used for astrology, an essential part of early Islamic culture.

Following the Muslim conquest of Spain the astrolabe entered Europe. One of the medieval sources was the XIth century manuscript *Mensura Astrolabi*, by Hermanus Contractus, abbot of Reichman Abbey, which described the use and construction of the astrolabe. This work was based on a manuscript by Llobet of Barcelona (Xth century).

Since the 13th century the astrolabe spread throughout Europe from the Iberian peninsula and Sicily into the great university cities of Europe. The astrolabe has remained one of the most important tools of astronomers until the end of the 18th century.

A Star-Taker or a Star-Finder¹

Even though the astrolabe is among the world's most ancient scientific instruments, it has never been equalled for providing a clear, concise picture of the heavens. A glance at a properly set astrolabe gives a complete snapshot of the sky at a particular time and place. The astrolabe is also an inherently beautiful device and a device of wonder to those who do not understand its simple elegance and a source of admiration to those who do. The unique properties of the astrolabe continue to excite interest after more than two millennia.

The astrolabe was a widely used astronomical instrument for over 1000 years without significant change in its basic form. Despite embellishments to improve its utility in different cultures and epochs, a 10th century astrolabe would be instantly recognized as an astrolabe by a modern user. The success of the instrument is due to the uniquely concise, complete and useful view of the heavens that the astrolabe provides.

The astrolabe is an astronomical instrument that shows the user the positions of the Sun and stars for a specific time and place. It can be used to solve a great many astronomy problems that would require mathematical calculations if you didn't have such a device.

The name comes from the Greek "aster", meaning star, and "lambanein" (imperf. labein) meaning take, seize, catch, grasp and, derivatively, apprehend, determine, estimate. Combined as the word *astrolabe*, the name means that an astrolabe can be used as either a star finder or a star taker. As a star finder the astrolabe can be used to find stars and other objects in the sky. As a star taker, the astrolabe can be used to find the time by taking a reading of the Sun or a known star's position. The astrolabe

¹ Source: James E Morrison's manual for the *Electric Astrolabe*, see references

is both a map of the heavens and a portable computer for solving astronomical problems.

Why the Astrolabe Works

The purpose of the astrolabe is to represent the sky on the face of the instrument as it appears at a specific location at a given local time. That is, astrolabes are used to position stars and the Sun by determining their altitude above the horizon and position relative to south (northern hemisphere instruments). This is done by projecting the sky onto a plane and marking the projected image so celestial positions are easy to find. The principle of the astrolabe is easier to understand if you know a little about the projection technique used.

Much astronomical thought is based on the idea that celestial objects are so far away that they can be considered to be on the surface of a very large sphere known as the celestial sphere, with the Earth at the centre. Technically, the astrolabe is a projection of the celestial sphere onto a plane with moveable components to locate celestial objects for any time and date. The celestial sphere is projected onto the plane of the equator on the most common type of astrolabe.

The projection used in the astrolabe is the stereographic projection (Figure 1). The sphere in the figure is the celestial sphere of arbitrary but very large diameter with the Earth at the centre. The equator and tropics are shown on the celestial sphere, as they would be seen from the Earth. In the stereographic projection, which is among the oldest and simplest of all projection techniques, the eye is assumed to be at one of the poles of the sphere being projected (the south pole for astrolabes designed to be used in the northern hemisphere). A ray is projected from the pole to the point on the sphere to be projected. The projected point is where the ray crosses the projection plane. The projection plane for a planispheric astrolabe is the plane of the equator.

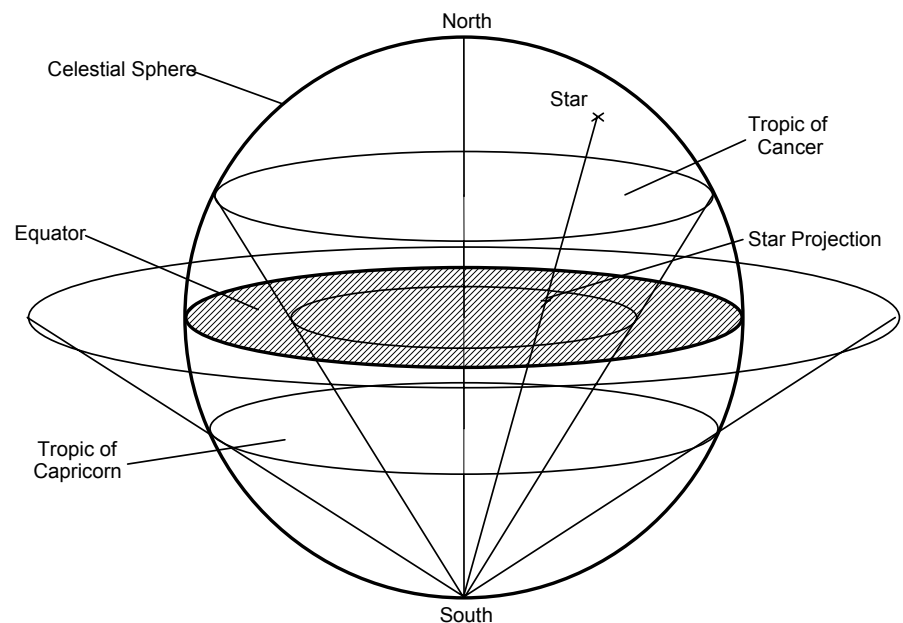


Figure 1. Principle of the Stereographic Projection.

Modern terrestrial maps and stars charts use the stereographic projection with a projection plane tangent to the sphere and centered at the place of interest, usually the zenith for a particular latitude. The projection principles are identical.

The stereographic projection has two properties that make it ideal for an instrument intended to solve astronomical problems:

- In the stereographic projection, circles on the celestial sphere are projected as circles on the projection plane (the equator for the planispheric astrolabe). This means that the circles such as the equator and ecliptic are projected as circles and that altitude and azimuth arcs are preserved. This property is particularly easy to demonstrate for the tropics that, since they share a common centre with the axis of the Earth, are clearly projected as circles.
- Angles between arcs on the sphere are preserved in the projection thus allowing direct measurements to be made on the projected plane.

These properties are ideal for astronomical purposes since most celestial positions are measured as angles along circles. Note, however, that this form of projection introduces significant distortions in relative size for objects that are very close to the axis or very far away from it. In theory it is possible to project the entire celestial sphere but astrolabes constructed for use in the northern hemisphere show the celestial sphere only as far south as the Tropic of Capricorn. This range includes almost all of the sky visible from northern temperate latitudes and avoids the severe distortion of scale that would result from including extreme southern declinations.

Using the stereographic projection, it would be possible to project the positions of the stars and planets at any time onto a piece of paper and then take measurements of relative positions. It would, however, be impractical to attempt to project the sky at every instant for every location onto paper. The real genius of the astrolabe is how it makes use of the projection to allow the instrument to be used at any time and to be flexible enough to be used at many locations.

Astrolabes, people and notable facts

When Prince Henry the Navigator established his seafaring fleet, he began using the astrolabe to navigate the ships. For many years, this gave the Portuguese the exclusive ability to navigate open waters, which the other countries could not do. When Sir Francis Drake raided ports along the South American coast he was forced to flee from the Spanish ships. Drake attacked a Portuguese ship and took its navigator hostage to guide him on his round the world voyage, thus avoiding the Spanish Fleet. Most of the great voyagers in the age of exploration navigated with the aid of the astrolabe, including Columbus, Magellan, and Drake.

In 1391, Chaucer wrote his *Treatise on the Astrolabe* for his son. All scientific texts were written in Latin, but Chaucer's son was too young to read Latin, so Chaucer's instructions to his son on how to use an astrolabe became the first scientific text written in English.

For centuries, the astrolabe helped in the construction of accurate time-measuring devices, such as sundials. The astrolabe itself never caught on as a popular timepiece, owing in part to the disapproval of Christian theologians who saw it as an instrument of the devil.

It is believed a woman invented the astrolabe. Hypatia (307-415), one of the ancient world's most accomplished women, is credited with inventing the astrolabe. The

Greek astronomer, philosopher and mathematician is said to have designed the instrument with one of her students, Synesius of Cyrene (378-430).

During his years in Vienna, Regiomontanus composed a tract on the construction and use of the astrolabe. Documentary evidence suggests that he later designed several of these instruments, including one presented to King Matthias of Hungary which is now lost.

Astrolabes were also a aid to casting a horoscope, and were most popular in the Latin West with medical doctors, since astrology played an important role in diagnosing illness and determining treatment.

The ecliptic, which is the apparent annual path of the Sun around the Earth, is a feature on all astrolabe retes. With the aid of astronomical tables, it can be used to locate the planets as they move through the Zodiac - a band extending five or six degrees on each side of the ecliptic. This made the astrolabe a useful aide in the casting of horoscopes. Those astrolabes which lack the star pointers of other instruments or carry astrological information were probably intended for astrological use.

Astrolabe URLs of interest as of May, 2003

<http://www.astrolabes.org/>

An overview of the history

<http://www.astrolabes.org/electric.htm>

On this site you can download a dos program known as the Electric Astrolabe. This is an excellent program for running an astrolabe on your computer. Also this is the source for the some of the historical notes in this handout.

<http://art-bin.com/art/oastro.html>

A Treatise on the Astrolabe by Geoffrey Chaucer, approximately 1391

Further Reading

Evans, James. (1998) The History and Practice of Ancient Astronomy. New York, USA: Oxford University Press.

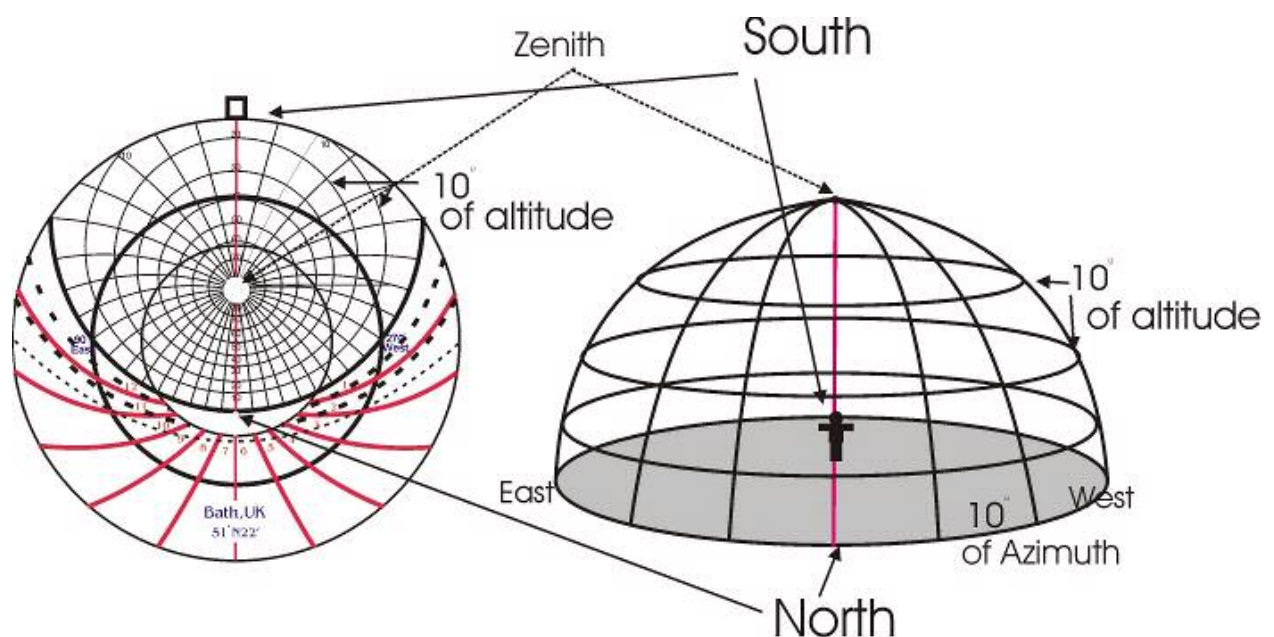
Orientation of a Northern Hemisphere Astrolabe

The view of the instrument is that it points south but you actually are seeing south and north at the same time.

Look at the zenith on the latitude plate. Your position when you use the instrument is directly underneath this zenith circle with you standing and facing south INSIDE the instrument.

As you face south you will notice that East is on your left and West is on your right, as marked on the astrolabe. The centre line of the latitude plate, which is the meridian, runs from north to south. The north point is the point where the meridian cuts the horizon line in the centre of the instrument, the south point is the point where the meridian cuts the Tropic of Capricorn which is the outer rim of the latitude plate.

So you are standing inside the astrolabe with the **Zenith** directly above your head, - the the centre zenith of the latitude plate as marking your position, thus **North** is behind you and **South** is in front of you.



You are standing INSIDE the astrolabe facing south

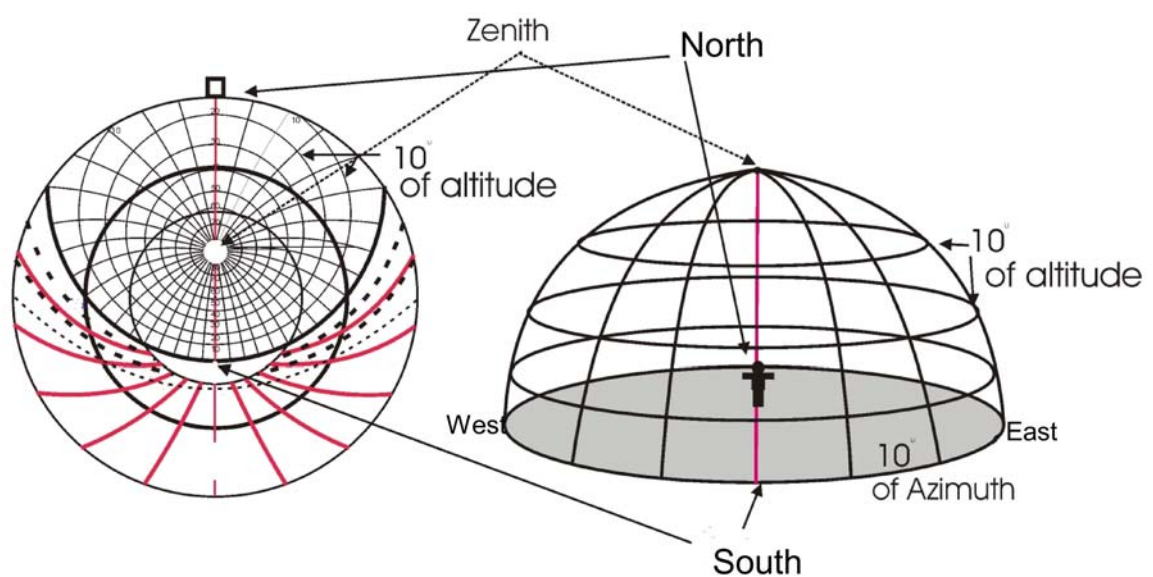
Orientation of a Southern Hemisphere Astrolabe

The view of the instrument is that it points north but you actually are seeing north and south at the same time.

Look at the zenith on the latitude plate. Your position when you use the instrument is directly underneath this zenith circle with you standing and facing north **INSIDE** the instrument.

As you face north you will notice that East is on your right and West is on your left, as marked on the astrolabe. The centre line of the latitude plate, which is the meridian, runs from north to south. The south point is the point where the meridian cuts the horizon line in the centre of the instrument, the north point is the point where the meridian cuts the Tropic of Cancer which is the outer rim of the latitude plate.

So you are standing inside the astrolabe with the **Zenith** directly above your head, **South** is behind you and **North** is in front of you.



You are standing **INSIDE**
the astrolabe facing **North**