The Venerable Astrolabe

Galen of Ockham, OP

Litell Lowys my sone, I haue perceiued well by certeyne euidences thine abilite to lerne sciencez touchinge noumbres & proporciouns; & as wel considere I thy bisi preyere in special to lerne the tretis of the astrelabie. than, for as mechel as a philosofre seith, he wrappeth him in his frend, þat condescendith to the rihtful preiers of his frend.
Ther-for haue I geuen the a suffisaunt astralabie as for owre orizonte, compowned after the latitude of Oxenford vp-on which, by mediacion of this litel tretis, I purpose to teche the a certein nombre of conclusions apertenyng to the same instrument.

(*Chaucer 1391,1*)

Our modern era has become disconnected with the wonders of the cosmos. We no longer look at shadows to tell us the time, or the position of the Sun against the background of stars to foretell the changes in the seasons. Our medieval cousins didn't have convenient watches, microprocessors, or the internet to determine the positions of the heavenly bodies, but they did have access to a computer to determine celestial happenings day or night, rain or shine.

Chaucer's late 14th century *Treatise on the Astrolabe* later became subtitled "Bread and Milk for Children". While this is probably a tongue-in-cheek editorial addition, it is also true that the average person would have been more familiar with the sky than most gentles are in these current Middle Ages. The low level of outdoor lighting meant the splendor of the sky was available to all who would look up. Even those living in large cities could marvel at the vast celestial stage. The stars provided a grand almanac as well as the forms of characters from the classic tales of ancient mythology. Every season brought its own tales of heroes, royalty, monsters, and magical creatures stretched across the sky as eternal nocturnal companions.

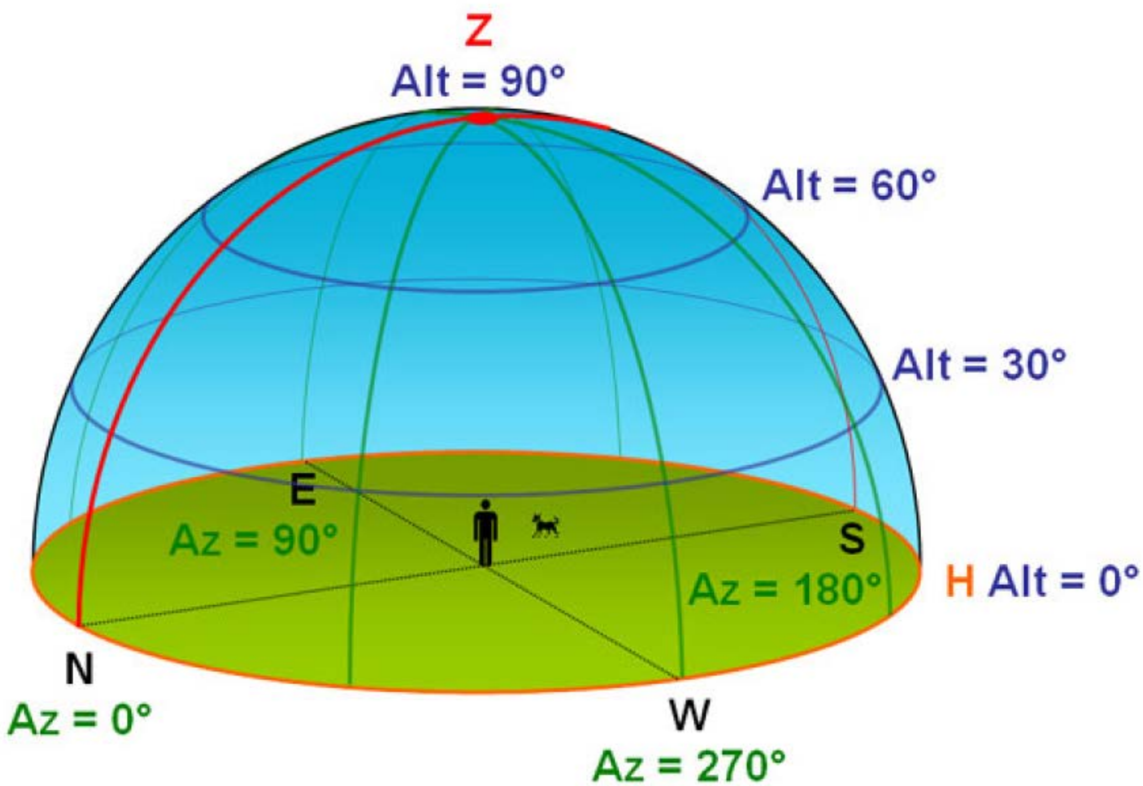
History

- The mathematical basis for the astrolabe was known to the Greeks at least as far back as 470 BC when Agartharchus applied the method of stereographic projection to a theory of perspective (Morrison 2007, 32).
- There is evidence of true astrolabes existing as early as the 4th century (Morrison 2007, 31). The earliest known, dated, Arabic astrolabe is from 927/28 AD (van Cleempoel 2005, 42).
- Philoponus wrote of the astrolabe in the 6th century describing the instrument and its use (van Cleempoel 2005, 23).
- Brass was the preferred material for the construction of astrolabes, though they were also made of copper, bornze, wood, steel, and pasteboard (van Cleempoel 2005, 15).

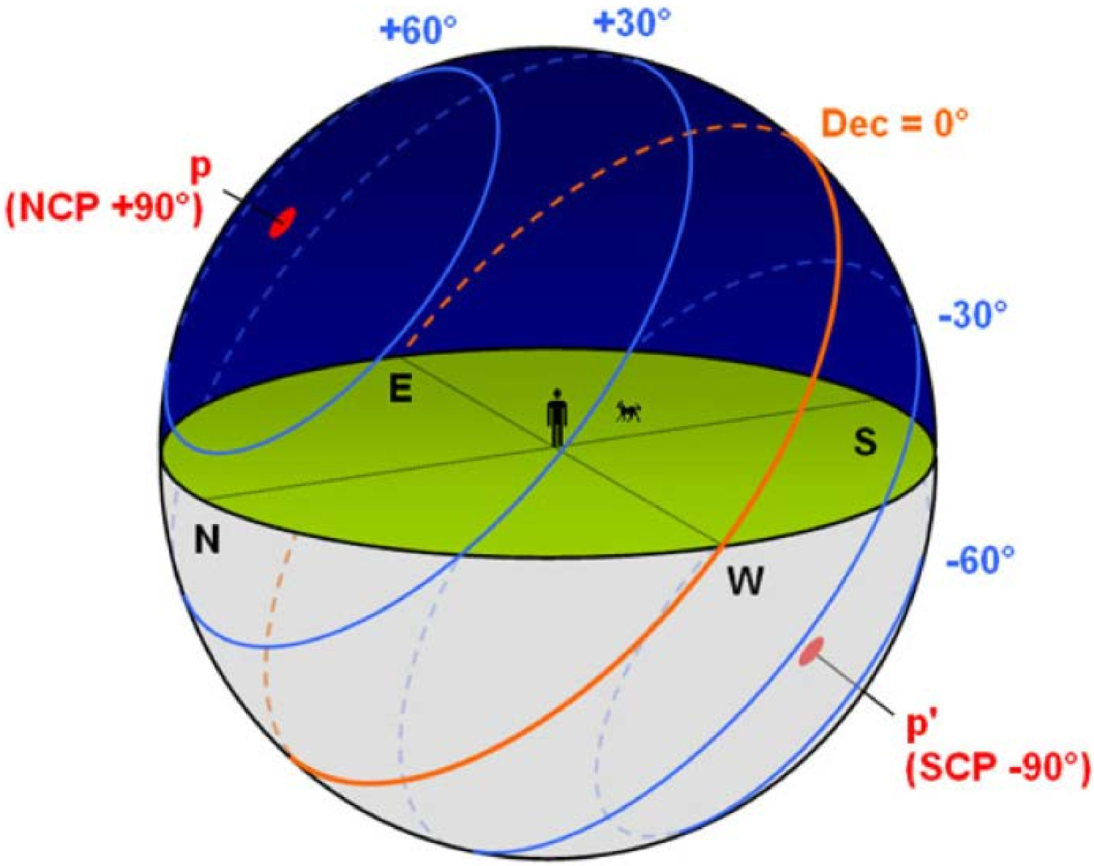
Parts is Parts

The purpose of the astrolabe is to give you a model of the universe for solving astronomical problems without having to wrap you head around spherical trigonometry.

To describe the position of an object in the sky, the most straightforward method is to tell someone which direction and how high above the horizon to look. This is called the 'Alt/Az' coordinate system (short for Altitude and Azimuth).

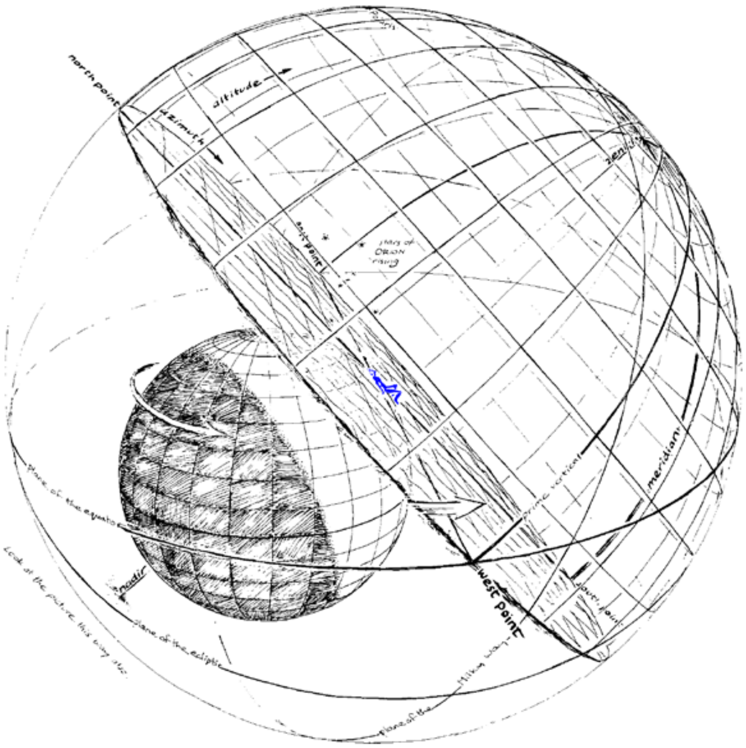


The stars, however, don't follow this simple scheme. For the most part, objects rise in the east, hit their highest point somewhere south of their rising point, and then set in the west. Ancient observers realized that the paths of celestial objects were following fixed circles around an axis of the daily rotation of the sky. You can use this as a reference for measurements, called the equatorial system.



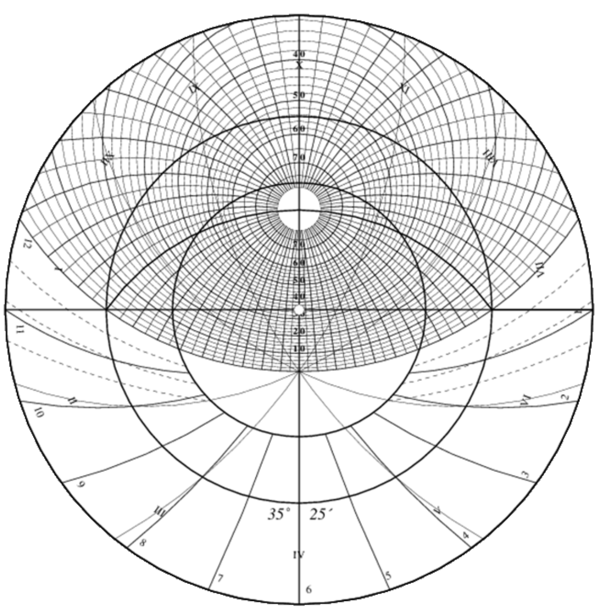
These two systems are just different ways of looking at the same thing. At every point on Earth, an observer will have a local horizon and can point out an elevation and azimuth for any object, but an observer in a different location at a different time will see the same object at a different altitude and azimuth. Equatorial coordinates can be defined independent of the observer's location, but translatable into local coordinates.

The stereographic projection allows you to essentially squish the three dimensional view of the world onto a two dimensional plate.



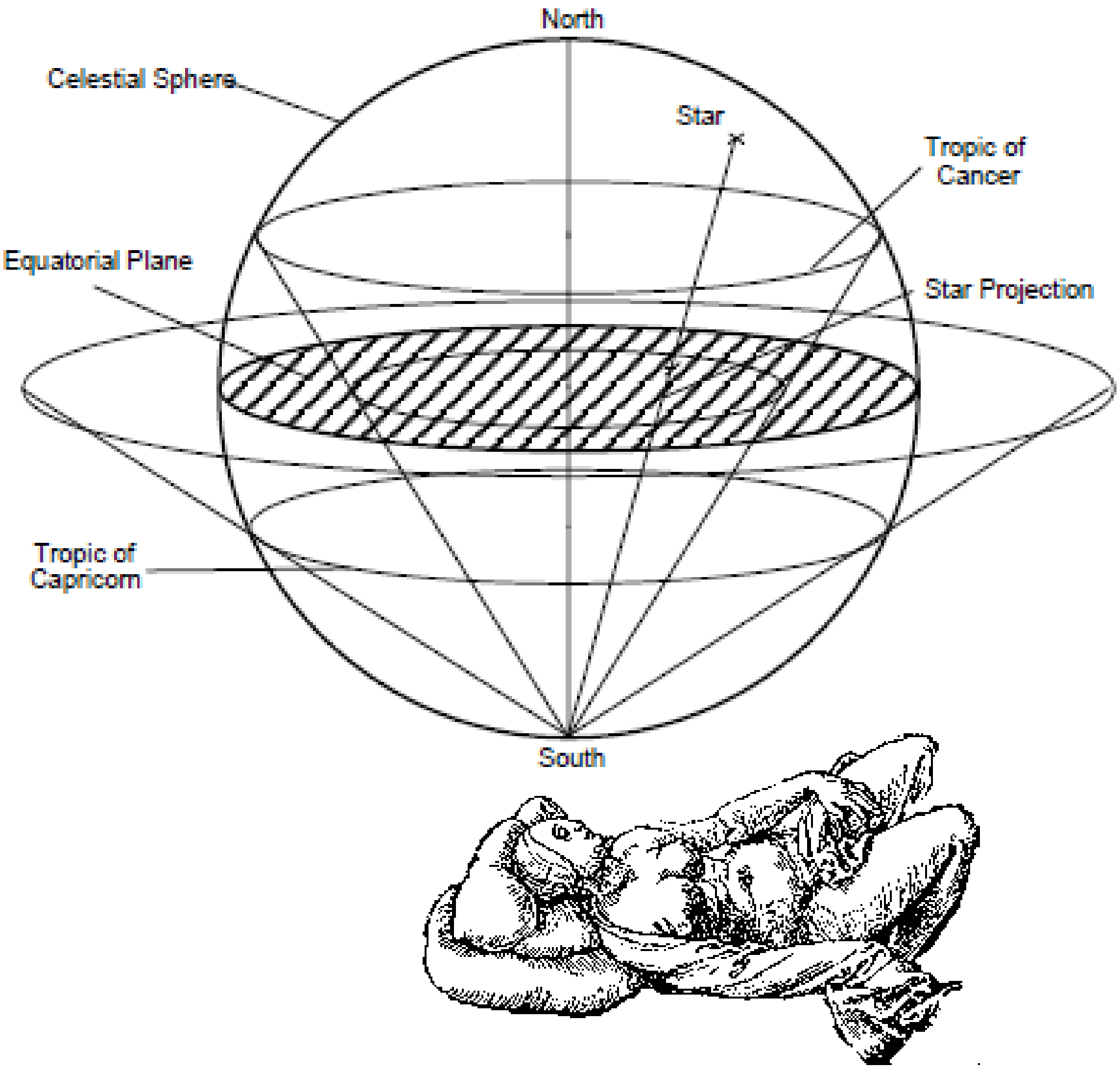
So if you take your local view superimposed on the big-picture equatorial view...

...And then squish it down to a two dimensional picture...

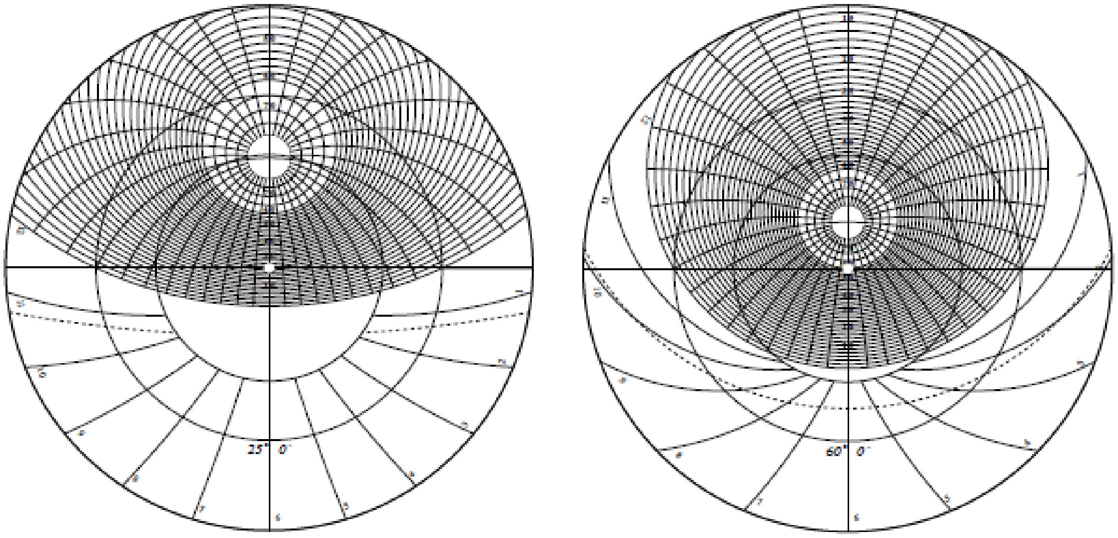


...You wind up with an astrolabe plate

The stereographic projection allows complex spherical trigonometry problems to be solved graphically. For a planispheric astrolabe, the projection plane is the equator with the observer at the south pole. Circles on the celestial sphere are projected as circles on the projection plane. Angles between objects on the projection plane are the same as angles on the sphere.

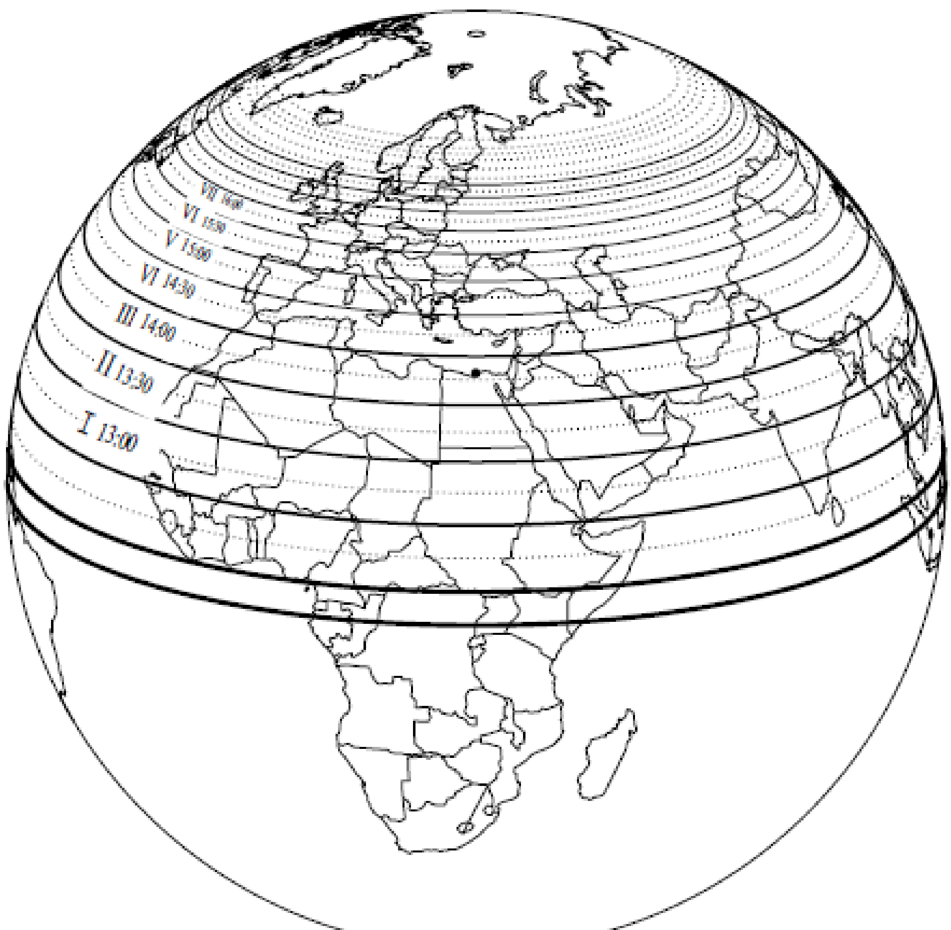


The resulting *plate* is specific for its given latitude. All the other parts of the astrolabe are universal. A world traveler would have to have a series of plates available to accommodate various latitudes. Fortunately, many traditional instrument manufacturers did exactly that. By making an astrolabe that has storage for 4 double-sided plates, you could cover the world with acceptable accuracy.



25 degree north plate vs 60 degree north plate

The plates were typically based on the seven standard climates of the known world. A *climate* was defined as a latitude that differed from its adjacent climates by having one half hour difference in the length of the longest day in the year.



		Latitude	Longest Day
I	Meroe	16° 27′	13 h
II	Soene[52]	23° 51′	13 ½ h
III	Lower Egypt	30° 22′	14 h
IV	Rhodes	36° 0′	14 ½ h
V	Hellespont	40° 56′	15 h
VI	Mid-Pontus	45° 1′	15 ½ h
VII	Mouth of Borysthinia	48° 32′	16 h

The zodiac was used to show position in celestial longitude. Any mention of the zodiac in modern times brings skoffs, but it can and was used in a very scientific fashion when used as a position marker.

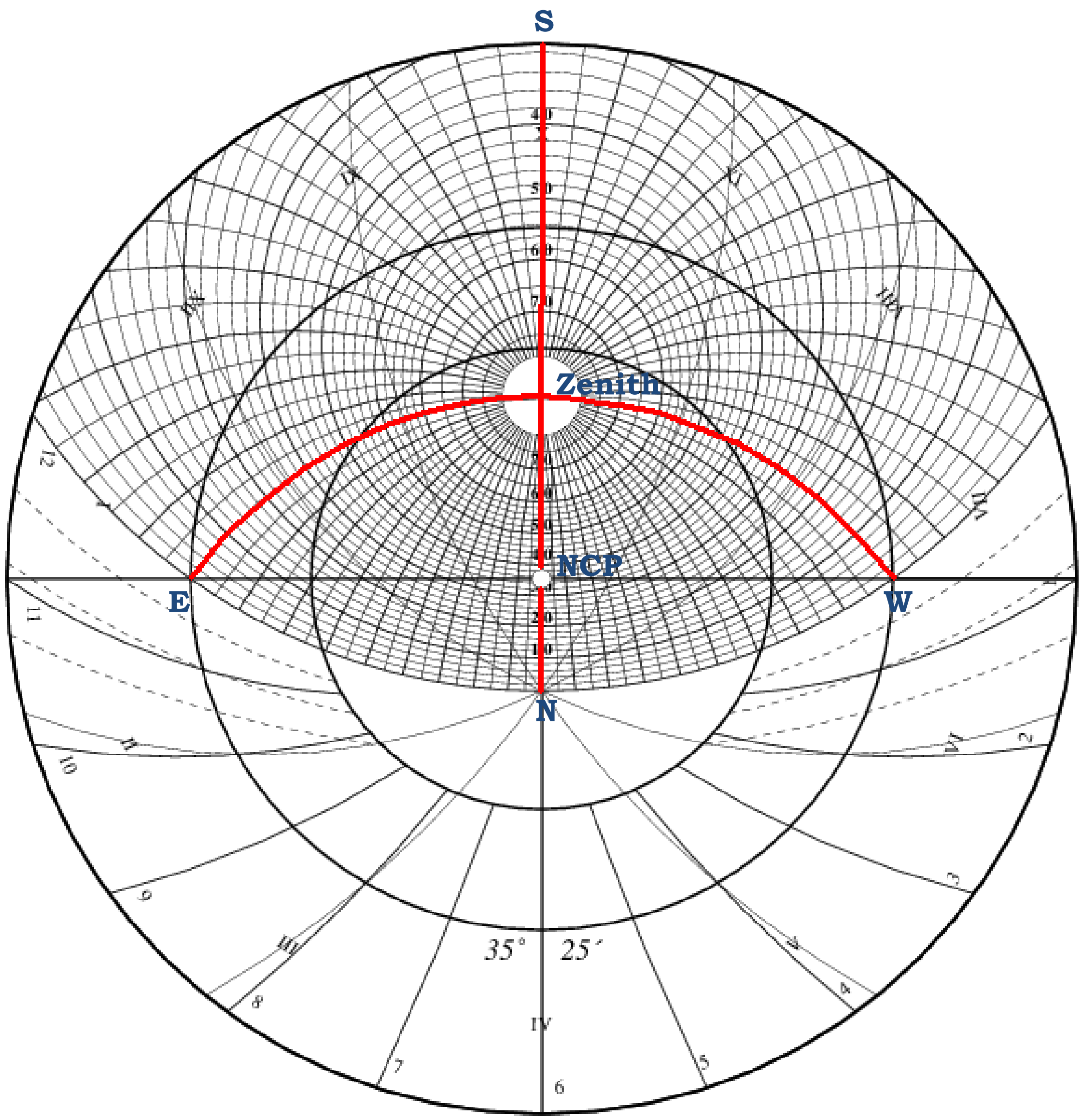
Solar Longitude	Name	Symbol
0°	Aries	♈
30°	Taurus	♉
60°	Gemini	♊
90°	Cancer	♋
120°	Leo	♌
150°	Virgo	♍
180°	Libra	♎
210°	Scorpio	♏
240°	Sagittarius	♐
270°	Capricorn	♑
300°	Aquarius	♒
330°	Pisces	♓

Figure 5. The Zodiac

When you see the news reports that pop up regularly saying "astrology is wrong as the signs have all shifted" you know they don't understand the history of astrology/astronomy. The signs of the zodiac have nothing to do with constellations (except sharing names). They are simply a system of measuring the longitude of celestial objects.

Let's look in detail at the various lines on a planespheric astrolabe plate.

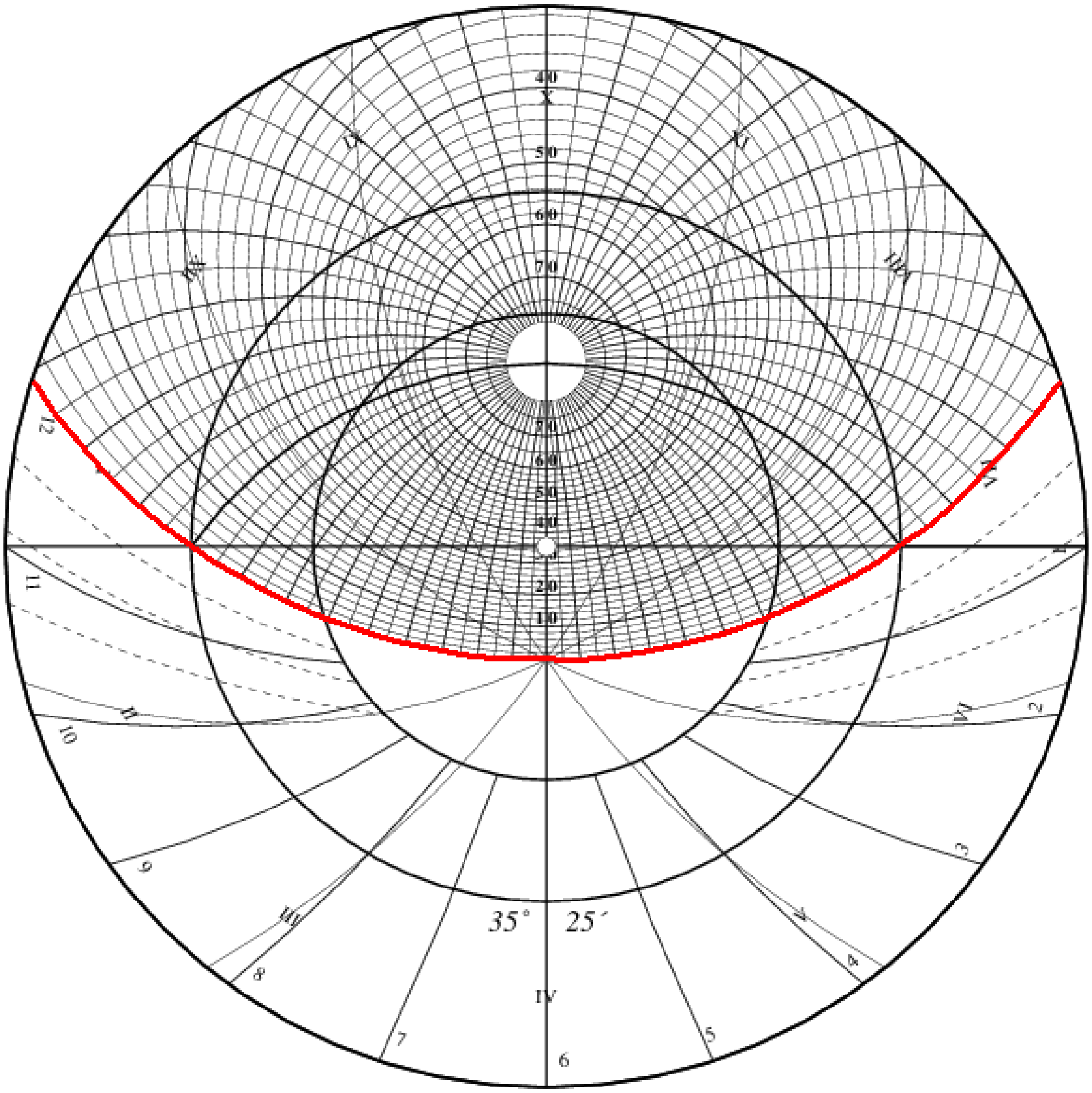
Meridians



The Astrolabe is designed to be held low in front of you while you're facing south, not over your head like a modern planisphere.

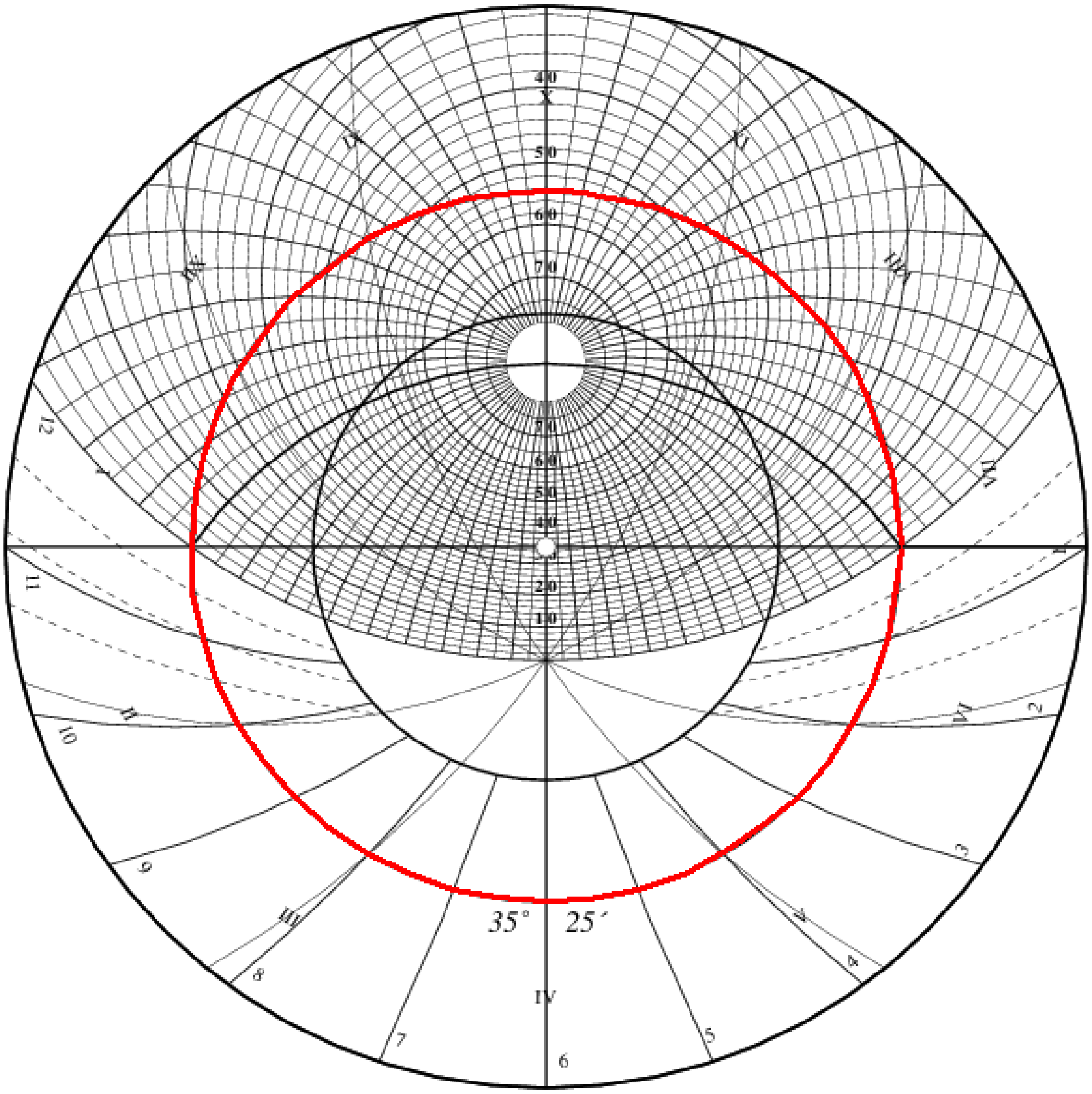
The line from due north to do south is your meridian. The Zenith is the point directly above your head. The North Celestial Pole (NCP) is the pivot point for the sky - everything revolves around it. In reality, it's the extension of the north pole of the Earth.

Horizon

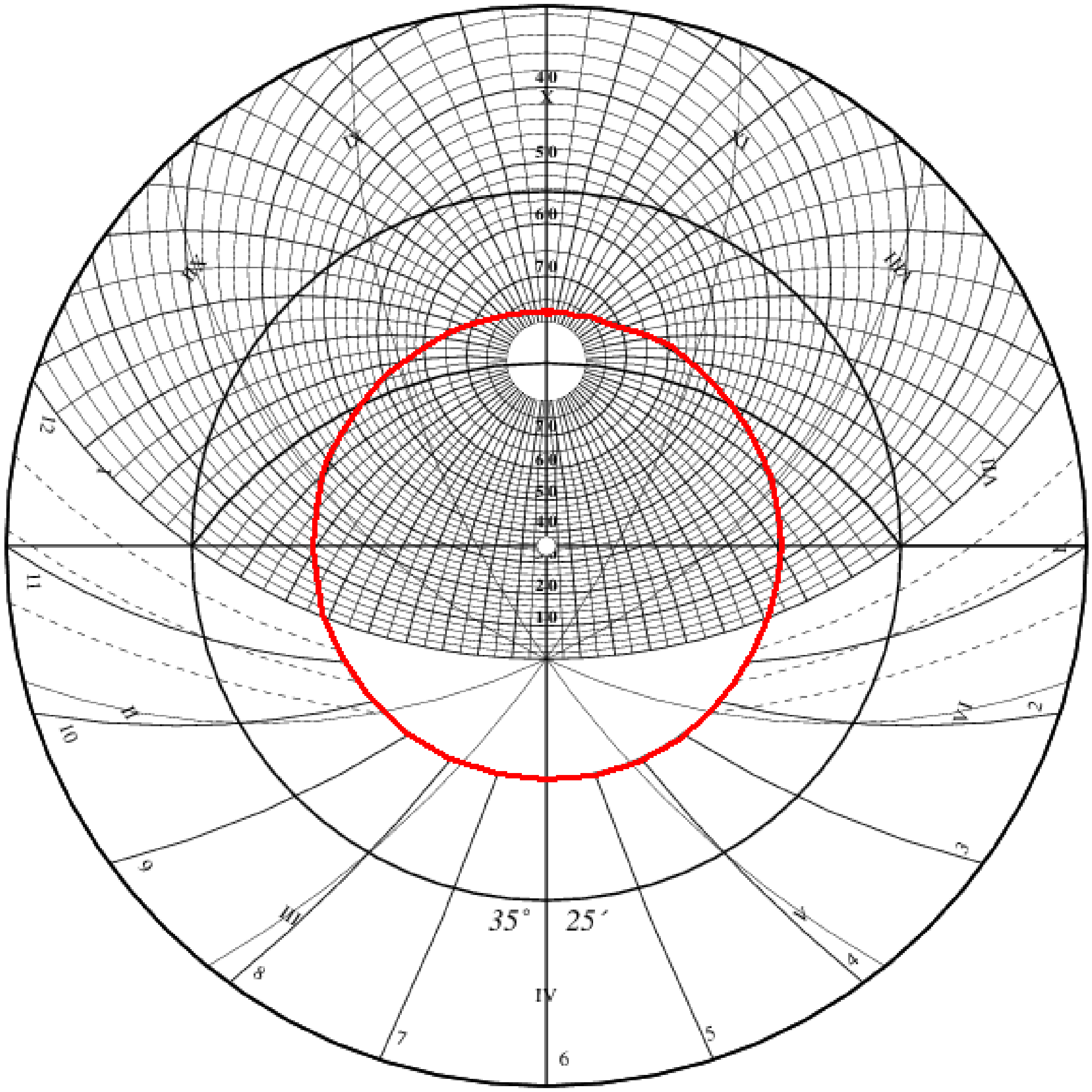


The southern horizon is cut off and does not appear on the instrument.

Equator

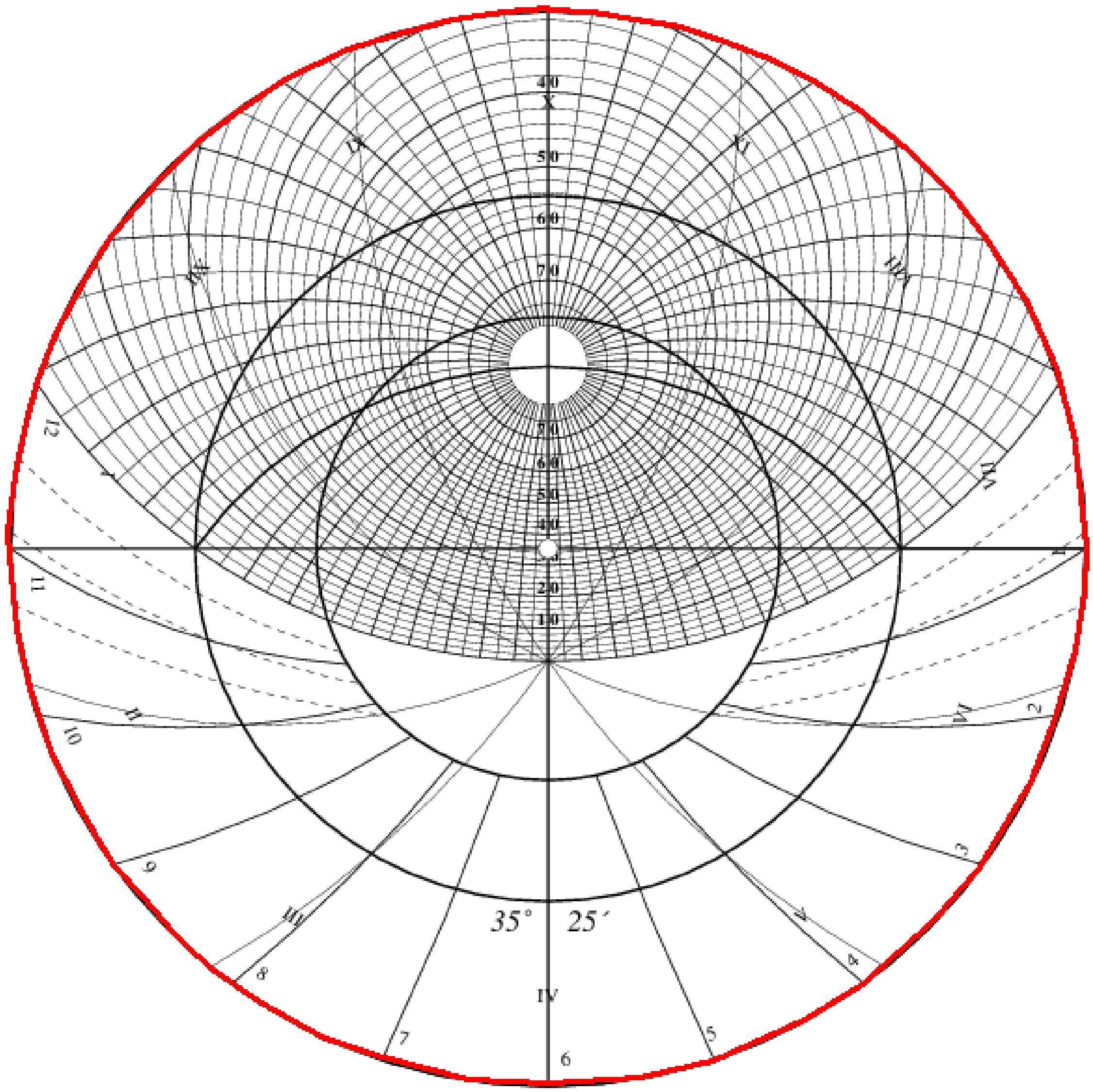


Tropic of Cancer



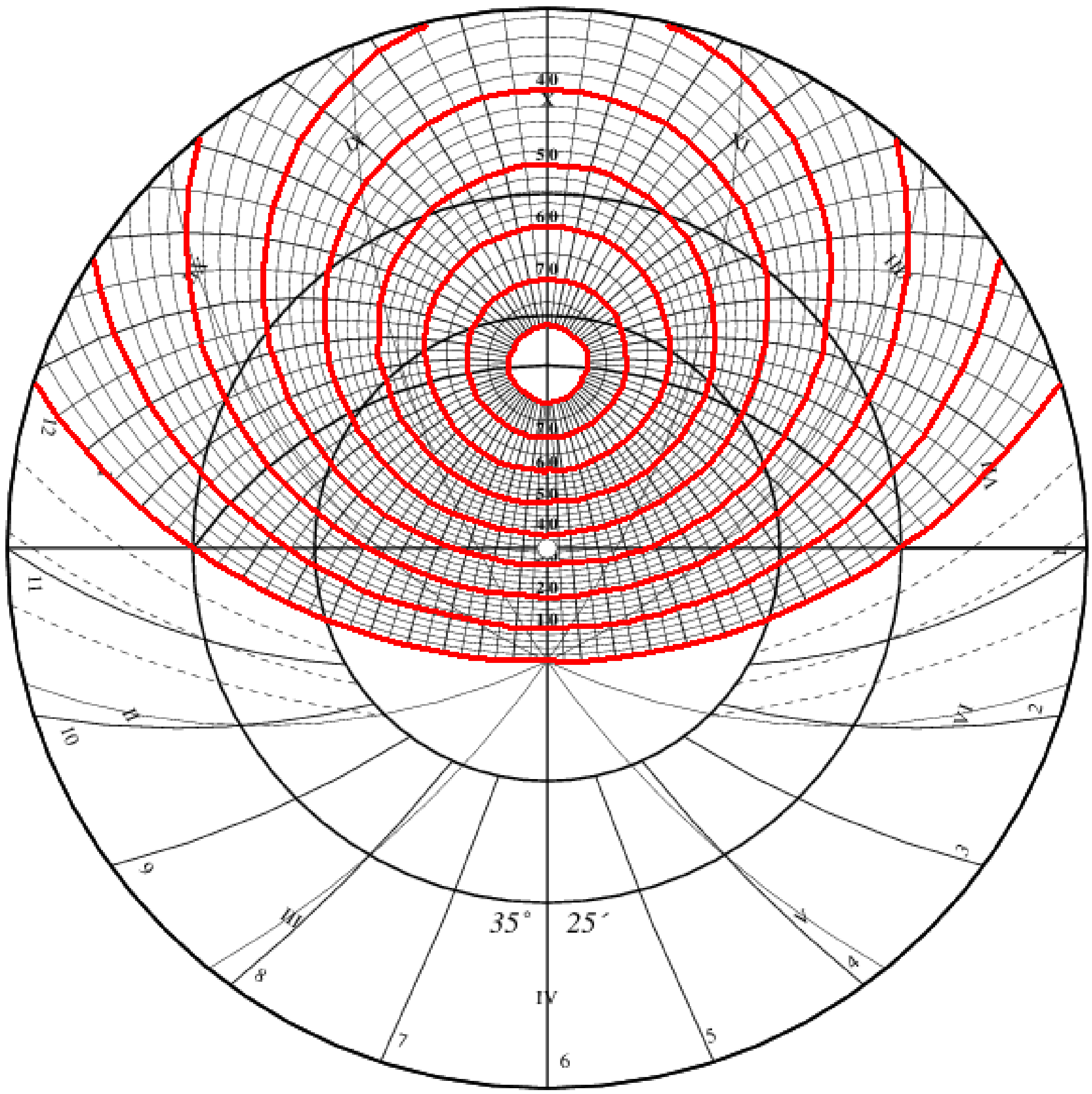
The Tropic of Cancer represents the farthest point north on the travel of the Sun. On the Summer Solstice, the Sun would be directly over 23.5 degrees north latitude.

Tropic of Capricorn



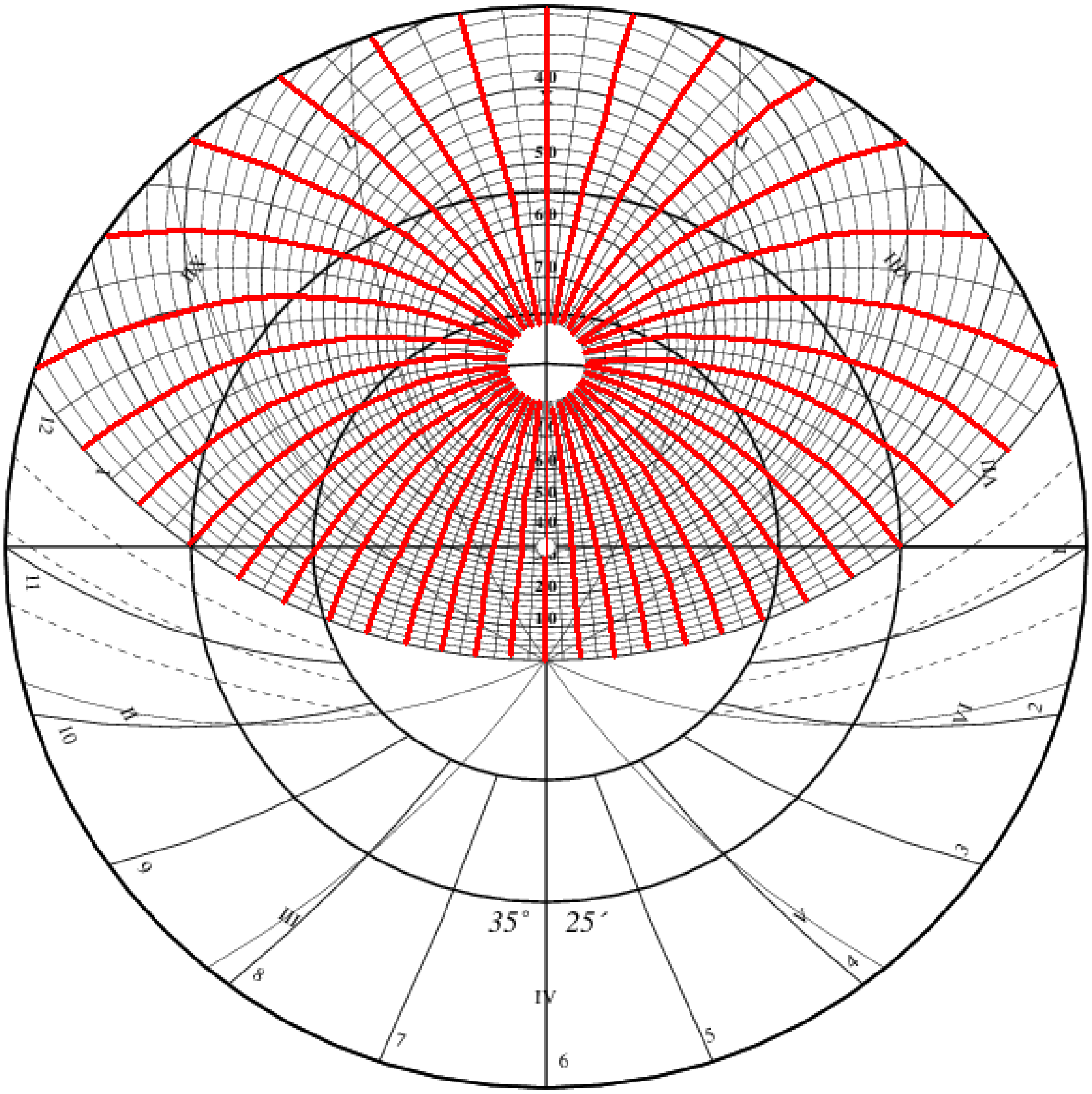
Likewise, the Tropic of Cancer is the farthest south travel of the Sun. It is the limb of the astrolabe plate.

Almucanters



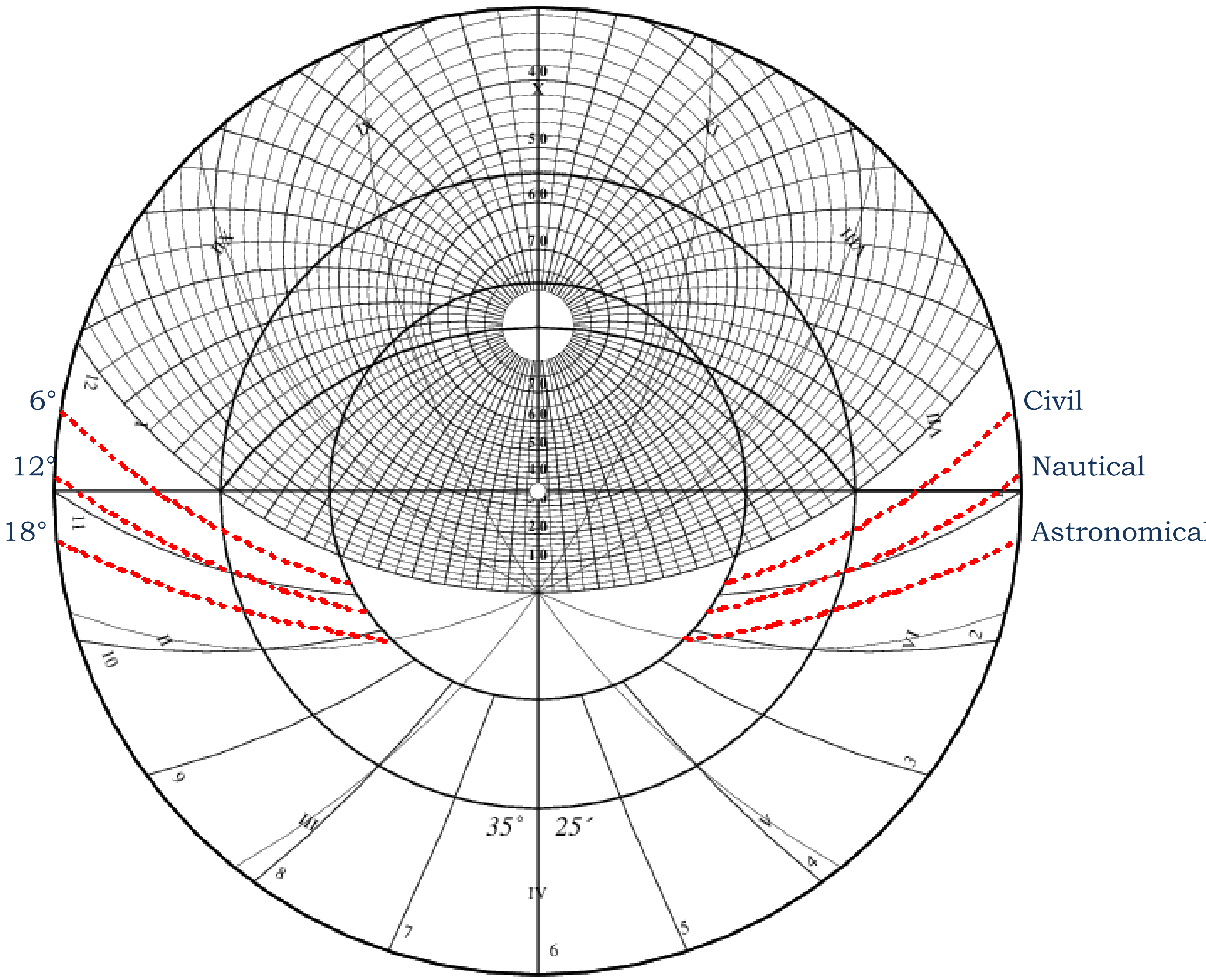
The lines that form circles around the Zenith are called Almucanters, or lines of elevation. They represent how far an object is above the horizon. The labels for these lines are along the meridian line. This is one of the most important sets of lines on the plate.

Azimuth



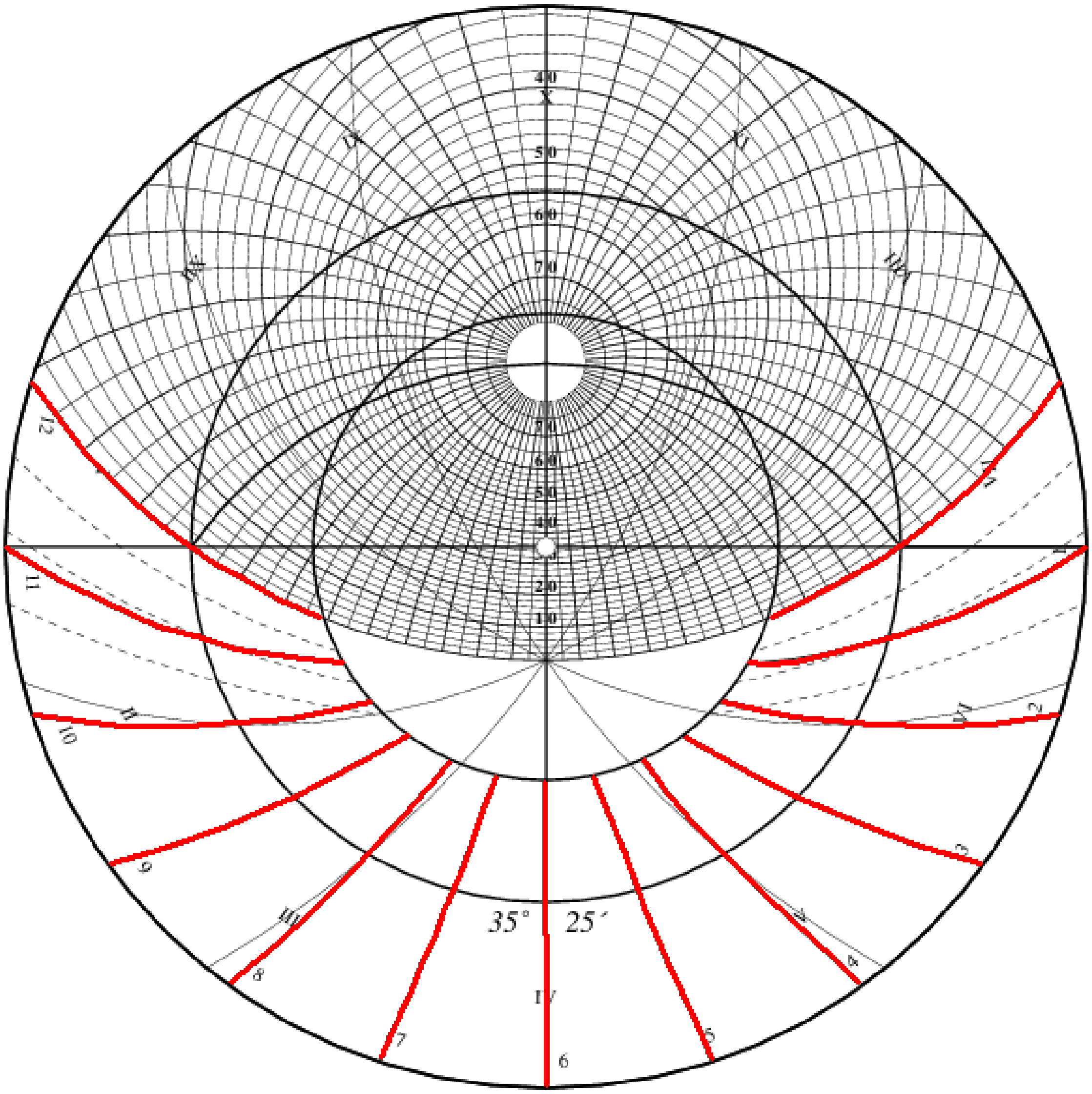
The lines of azimuth are surprisingly unimportant on the astrolabe. The main thing you need to keep straight is whether the object is east or west of the meridian. The lines are not labeled, but you can figure out the direction since you know N, S, E, and W.

Twilight Arcs



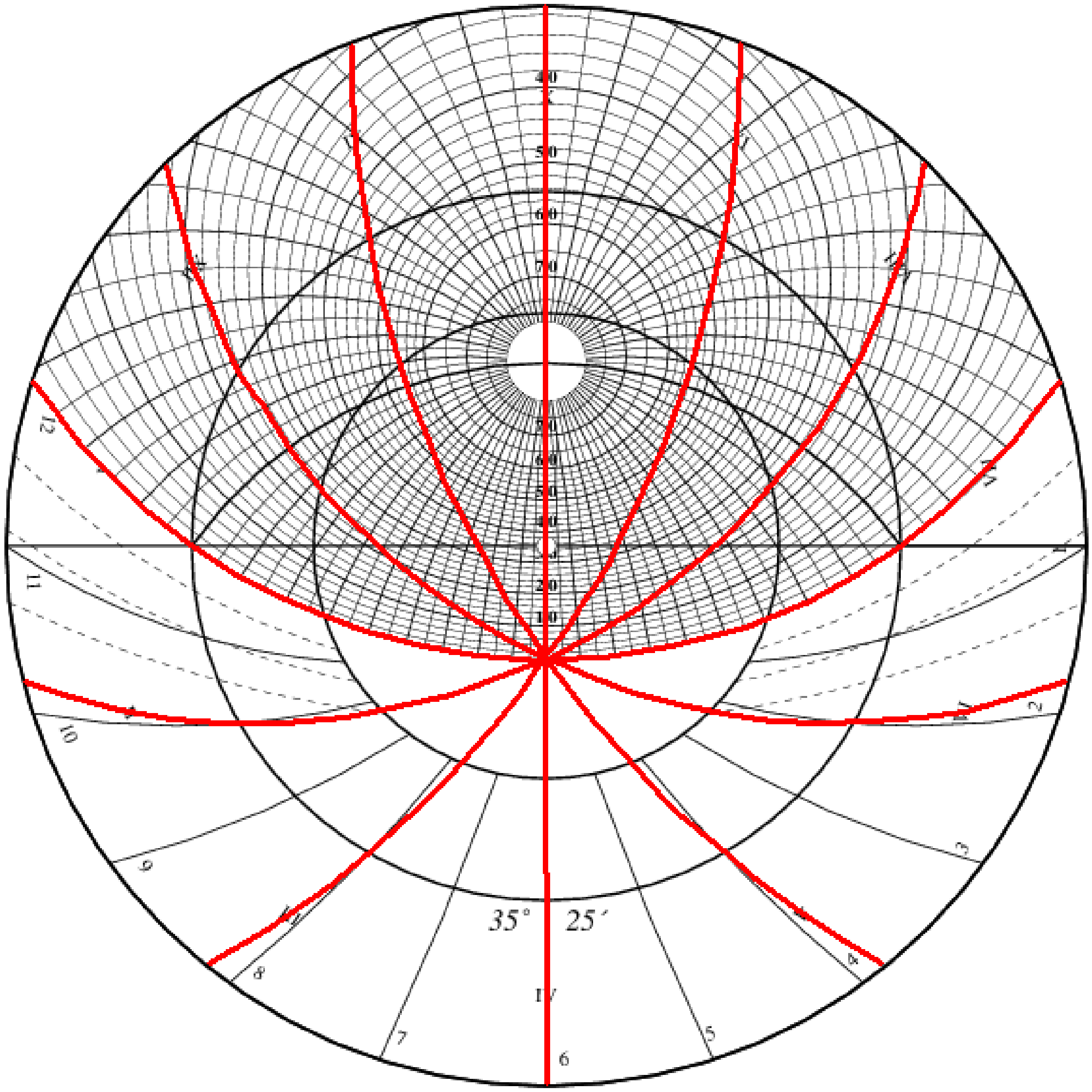
The dashed lines below the horizon are place at 6, 12, and 18 degrees. When the Sun is 6° below the horizon it marks the end of Civil Twilight - the time you need to start using artificial light. 12° below the horizon is when it is too dark to see the horizon to take accurate readings at sea and thus is called Astronomical Twilight. None of the light of the Sun is visible when it is more than 18°, Astronomical Twilight.

Unequal Hour Lines



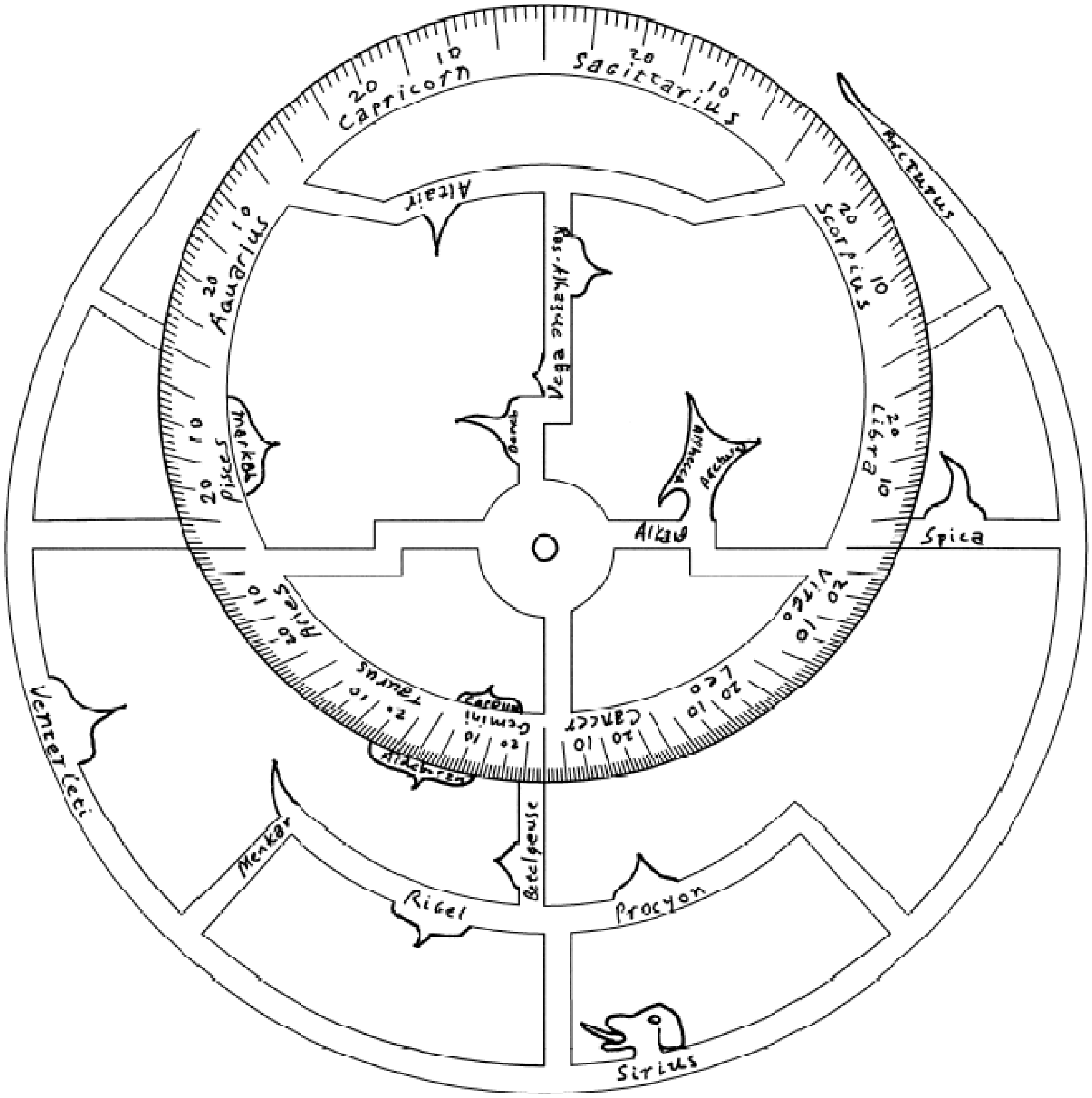
You're used to an hour always having 60 minutes. That hasn't always been true. The time system we use currently is called 'equal' or 'equinoctial' hours. In the days prior to mechanical clocks, it was more common to divide the time from sunrise to sunset into 12 parts, and then the night from sunset to sunrise into 12 hours. Since the day is much longer than the night during the summer, it follows that a summer day hour is much longer than a summer night hour. These are called 'unequal' or 'seasonal' hours.

Astrological Houses



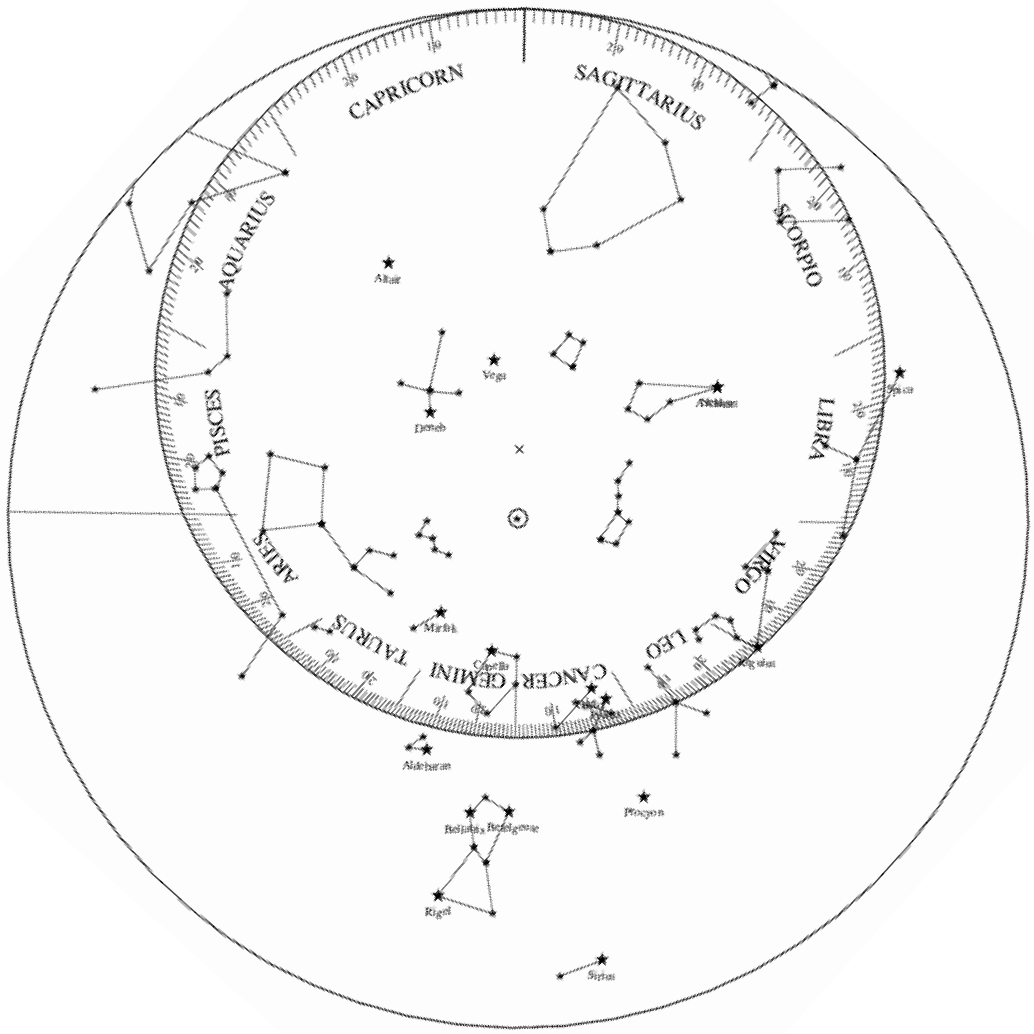
Some instruments had markings for astrological houses. This plate has the divisions according to Regiomontanus (late period).

Rete

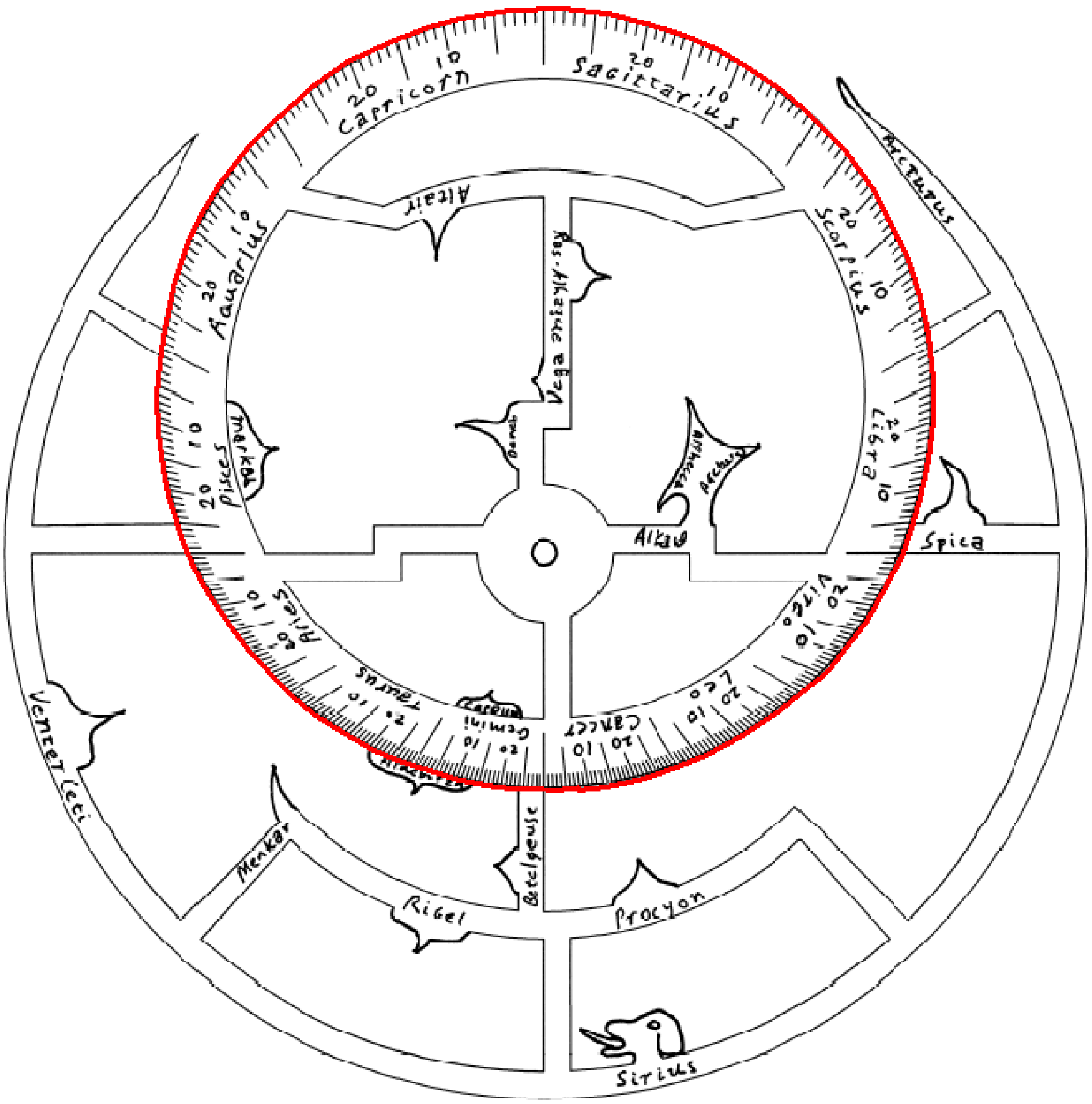


The Rete is a star map. It turns with the sky and allows you to position celestial objects as they appear in the sky.

Here's a modern version of the rete showing the sky map a little better. Notice how it's a mirror image of the way you'd typically see a map. That's just a side-effect of the stereographic projection.

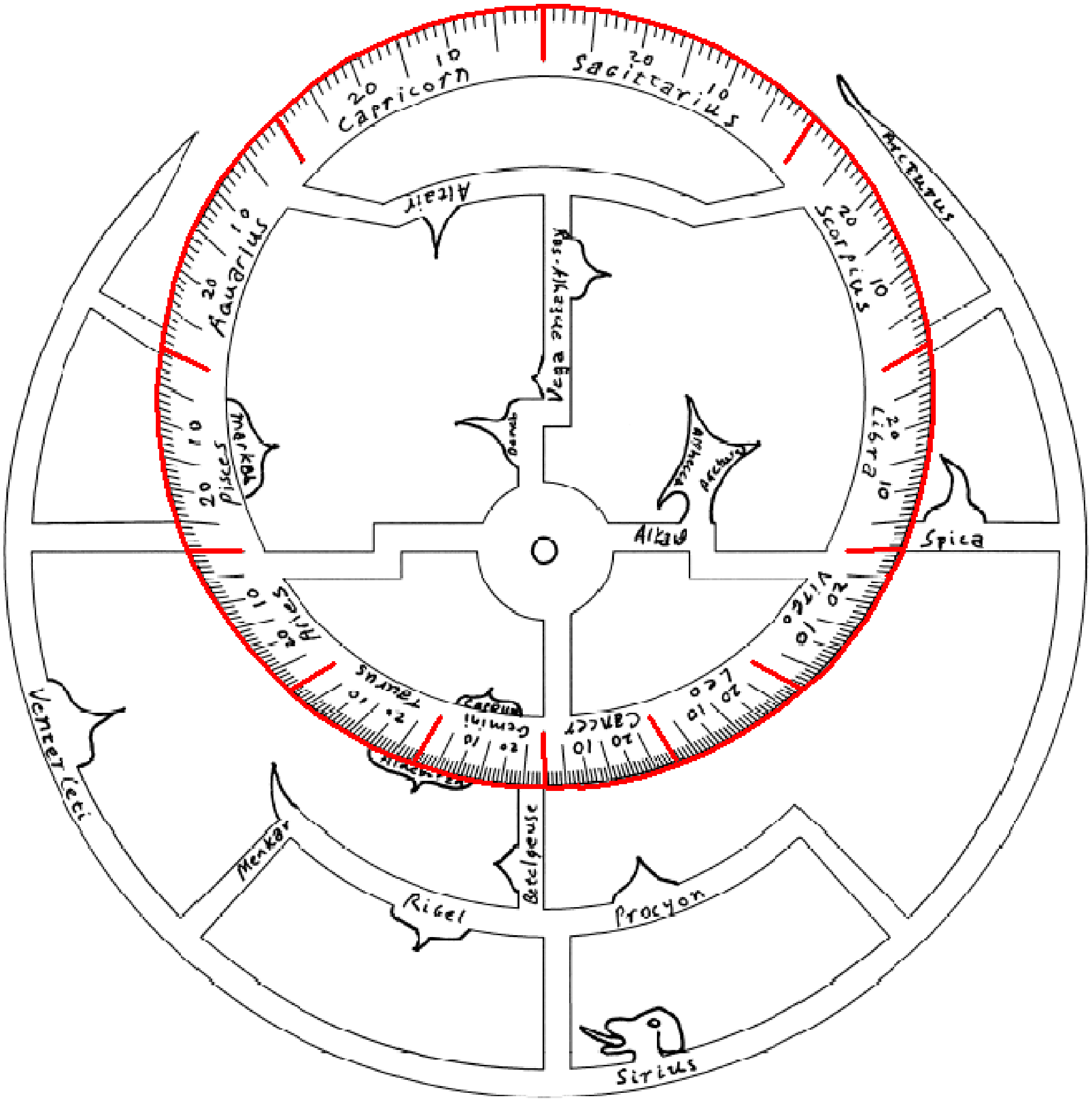


The Ecliptic



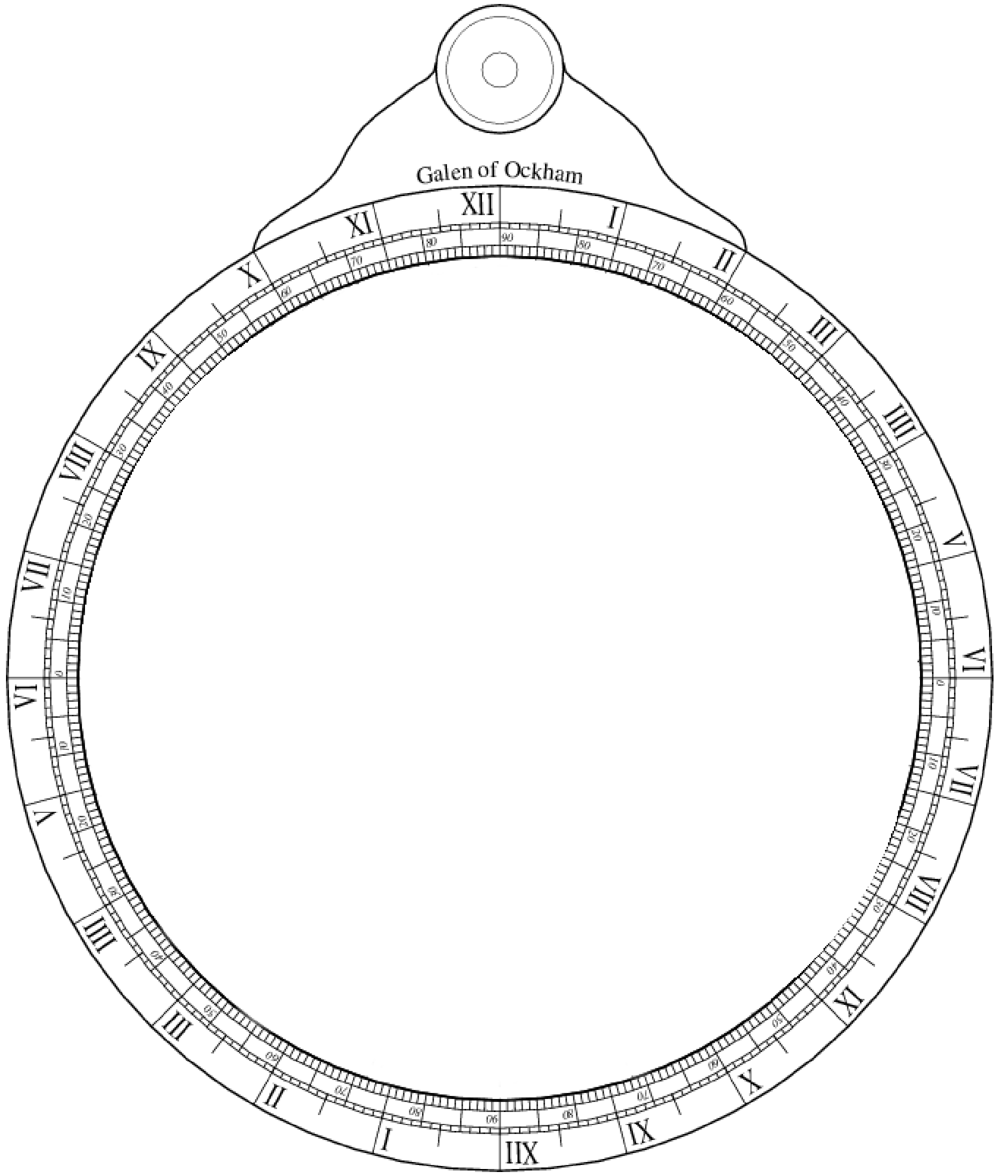
The Ecliptic is the path of the Sun through the sky. It's represented by the outer edge of the small circle in the rete.

The Zodiac



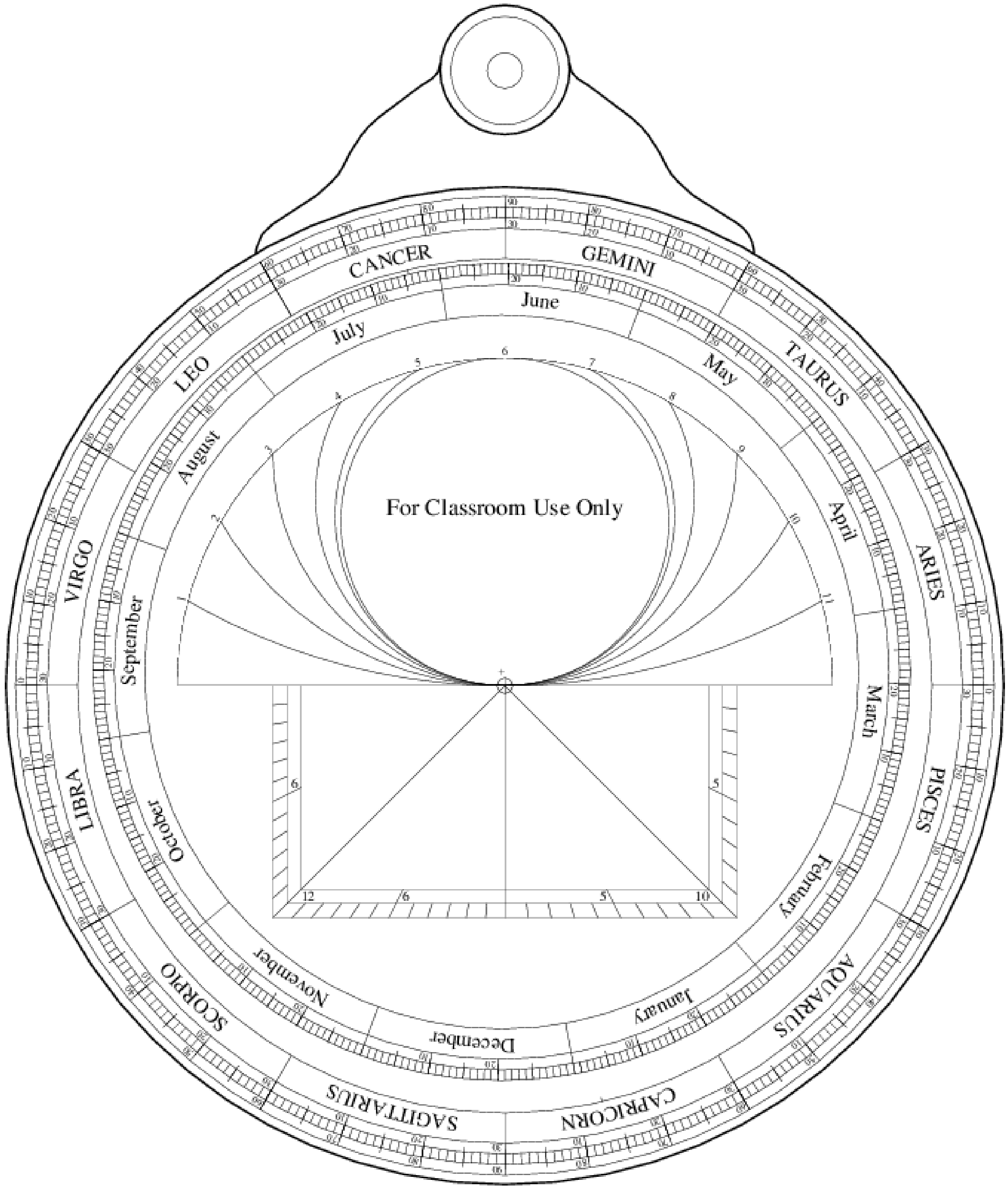
The Zodiac is marked on the inner part of the ecliptic circle.

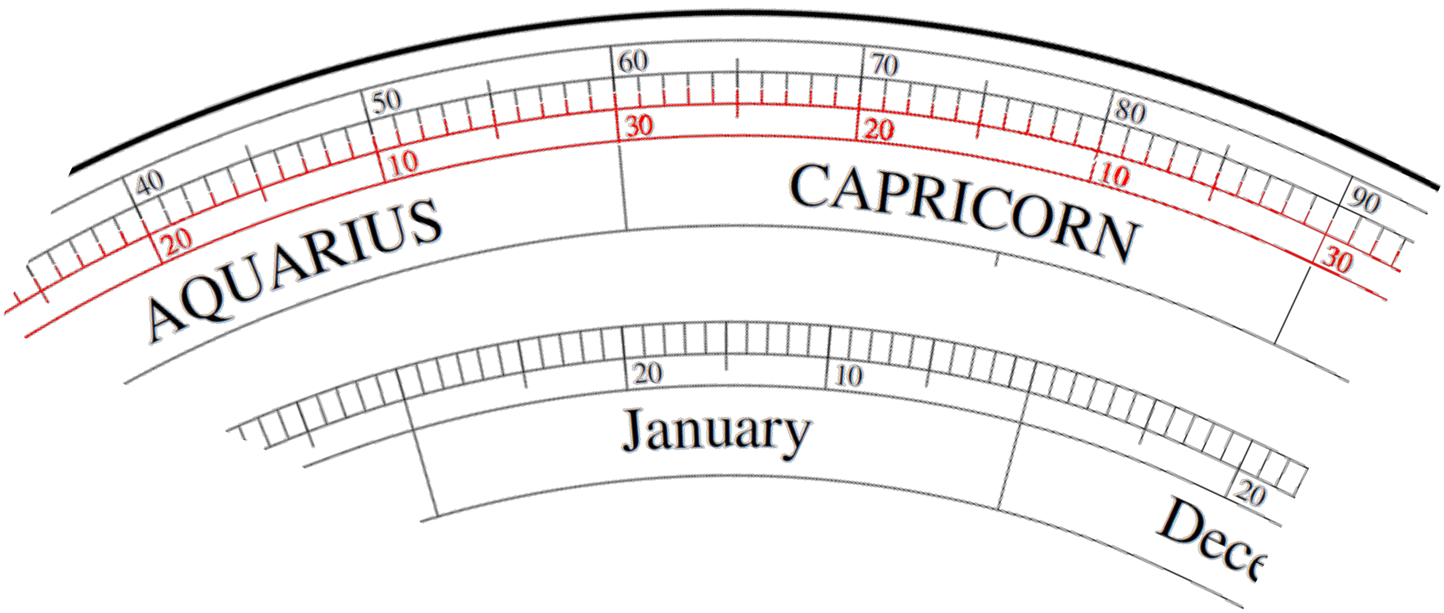
The Mater

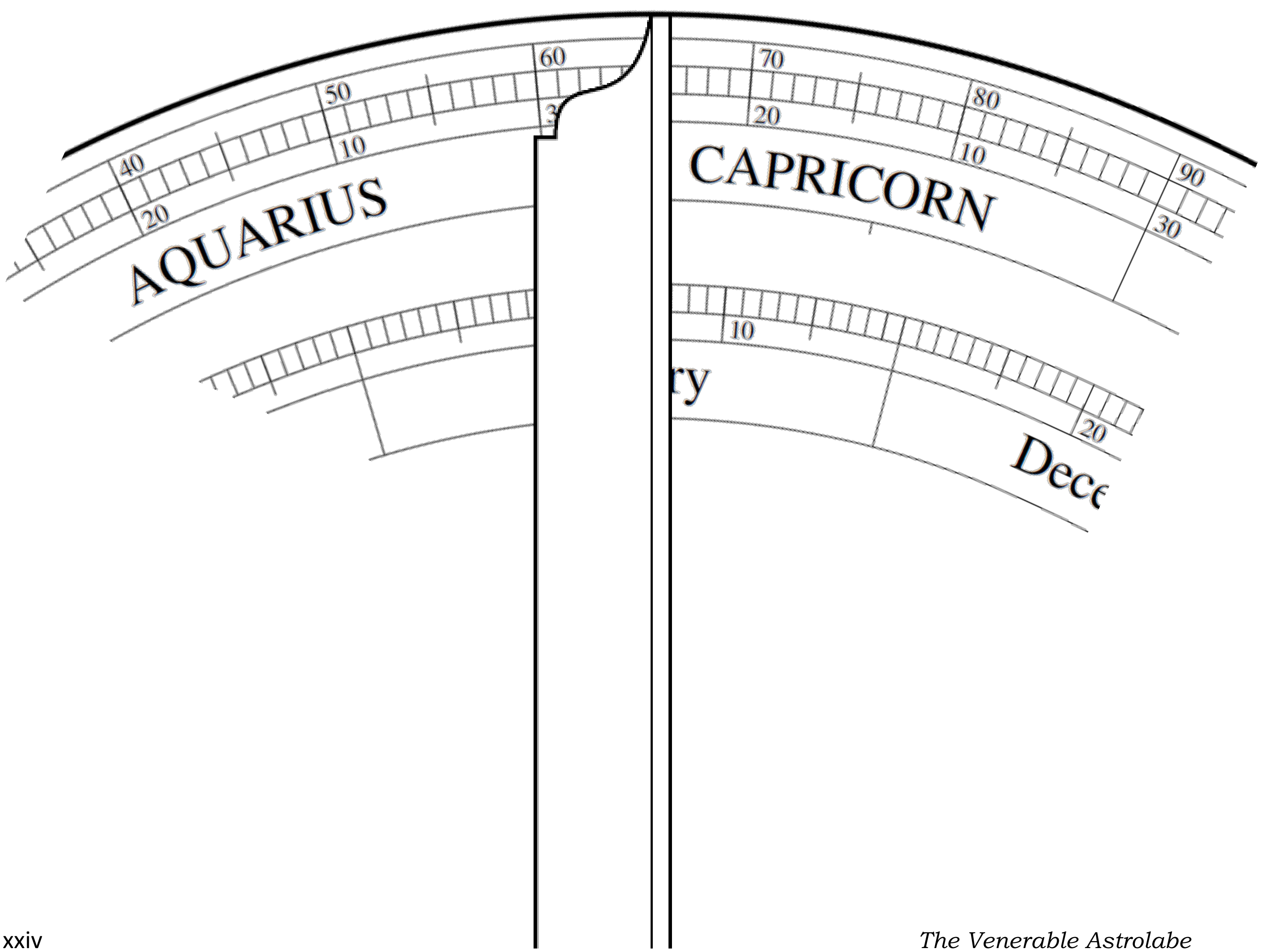


'Mater' is Latin for 'Mother'. It's the main body of the astrolabe and holds and secures the remainder of the instrument.

Calendar Scale




AQUARIUS
CAPRICORN
January


AQUARIUS
CAPRICORN

Parts

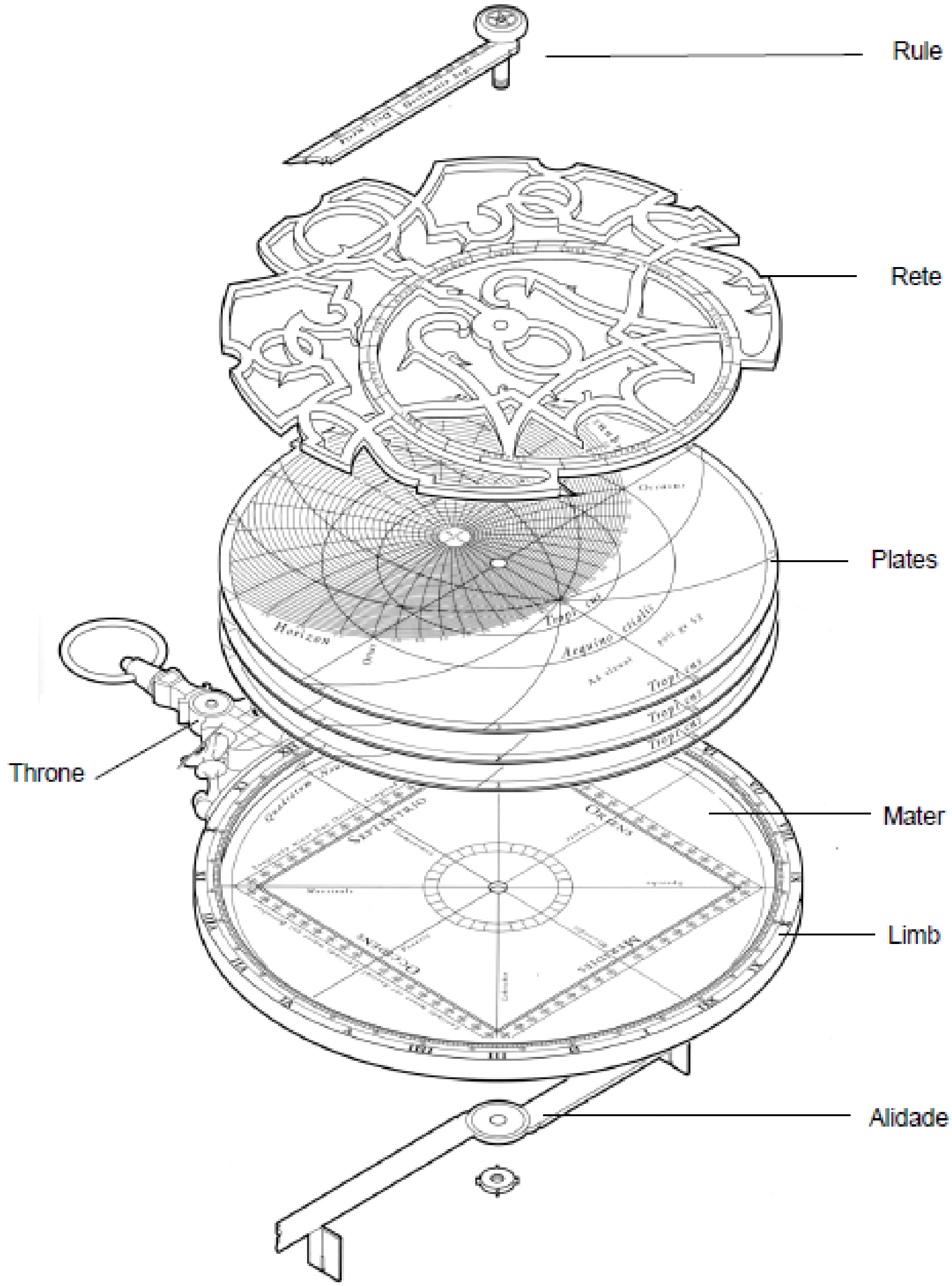


Figure 6. The Parts of the Astrolabe

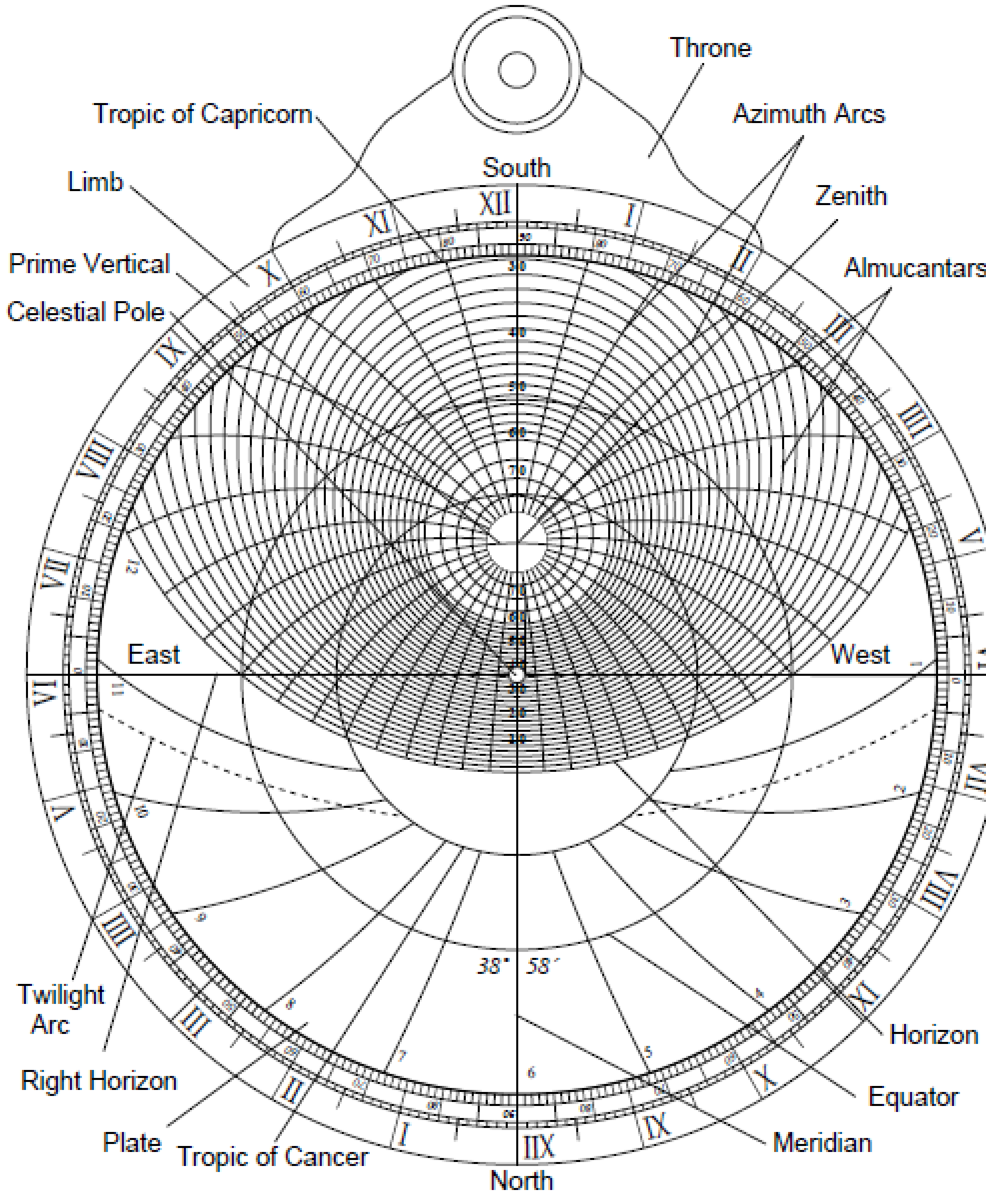


Figure 7. Typical Astrolabe Front

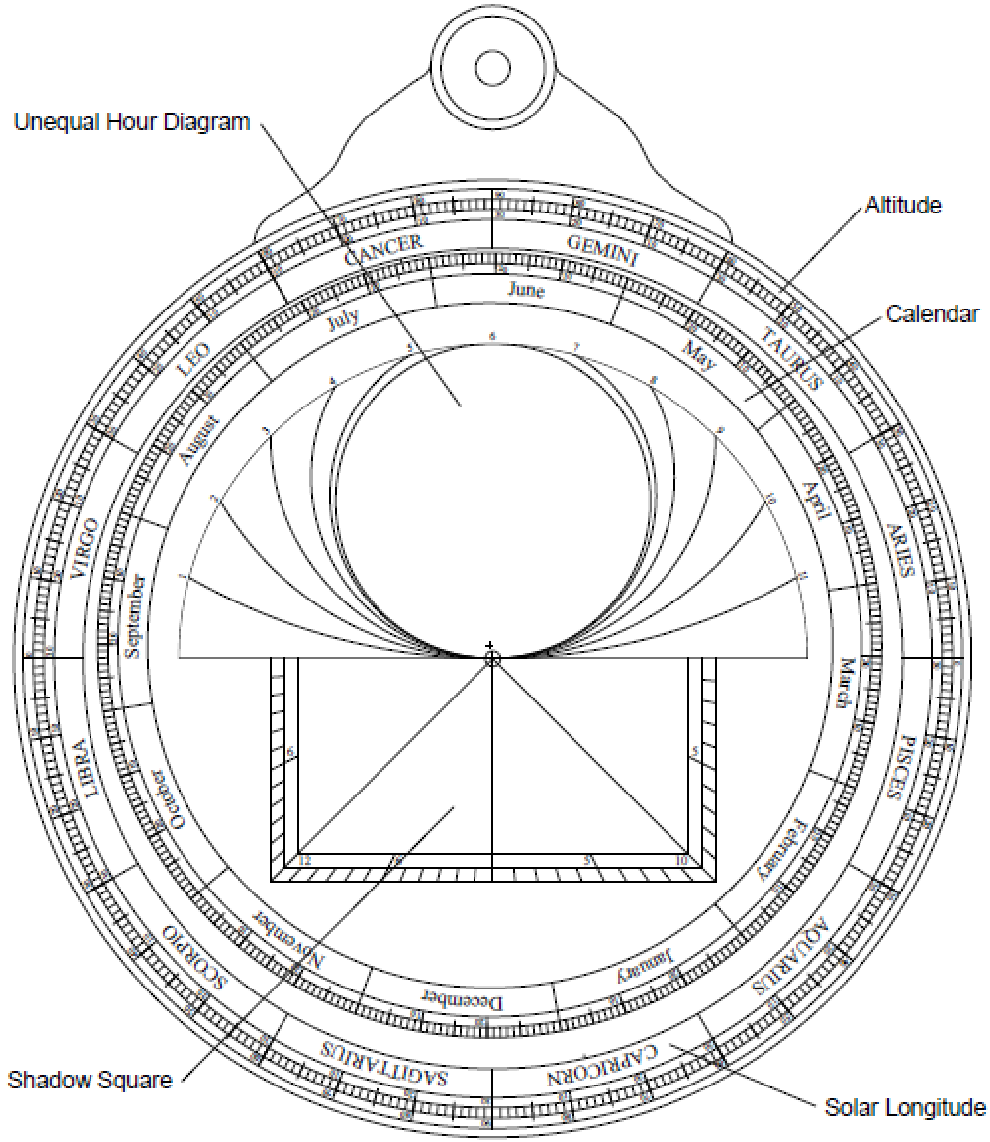


Figure 8. Typical Astrolabe Rear

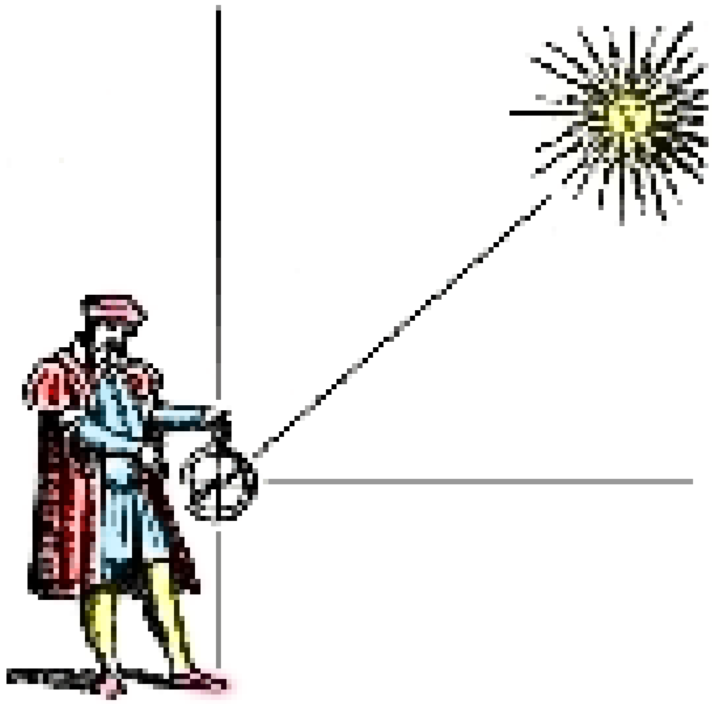


Figure 9. Safely Sighting the Sun

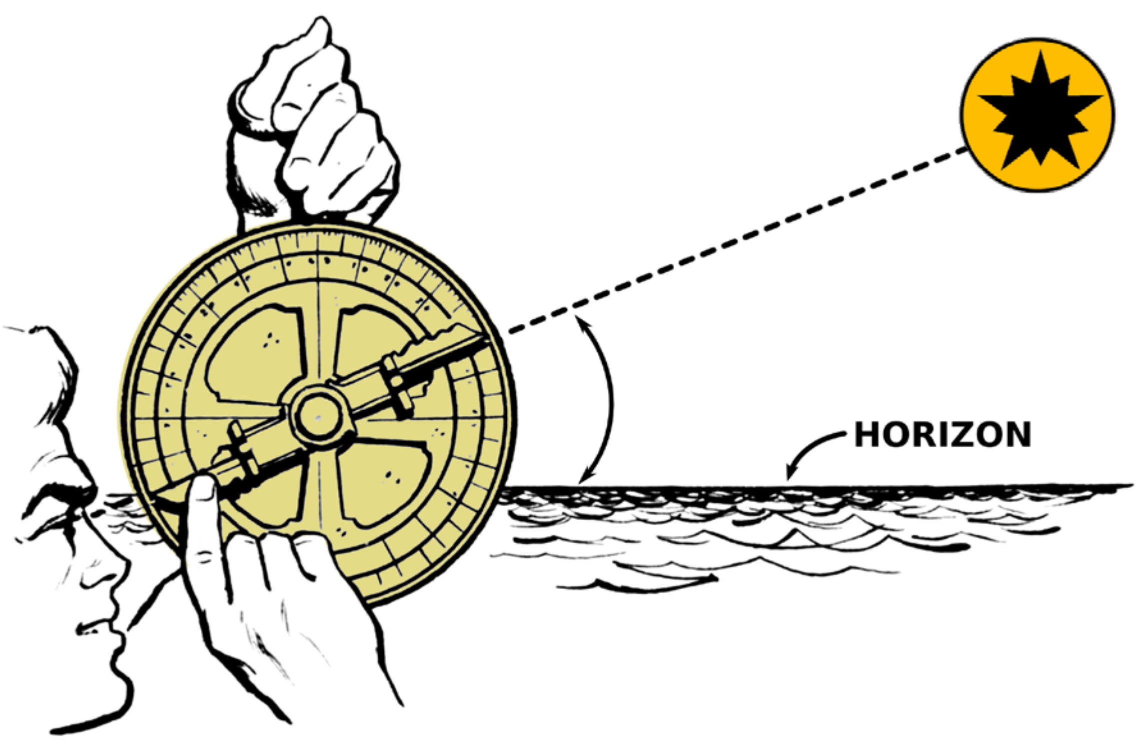


Figure 10. Sighting a Star

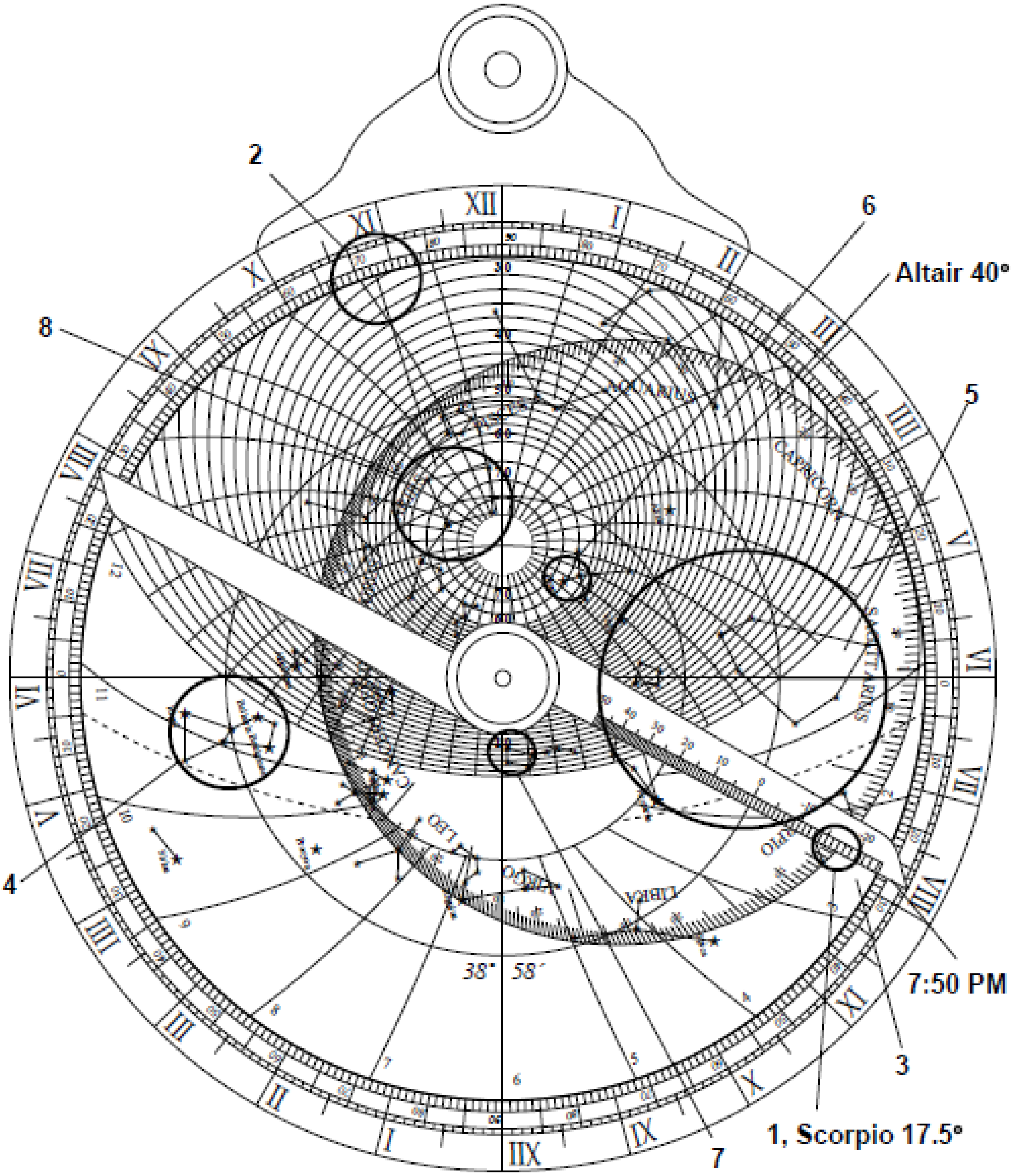


Figure 11. A Plethora of Information!

Example: You are observing on November 9th early in the evening. You measure Altair at 40° above the western horizon. What information can you obtain from the astrolabe?

1. The Sun's declination is -17°
2. Sidereal Time is 22:50
3. It is the third hour of the night
4. Orion an Gemini will rise soon
5. Ophiuchus and Boötes are setting
6. Deneb is high 65° above the horizon
7. The pointer stars of the big dipper are at lower culmination
8. Andromeda and Pegasus are nearing zenith
9. The local solar time is 7:50 pm

Astrolabes to Purchase

Norman Greene - puzzlering.net/astrolabe.html

Various sizes and metals
Expensive (3” or 4”, $130 - $525)
Shops at several large Renaissance Festivals

Jim Morrison - astrolabes.org

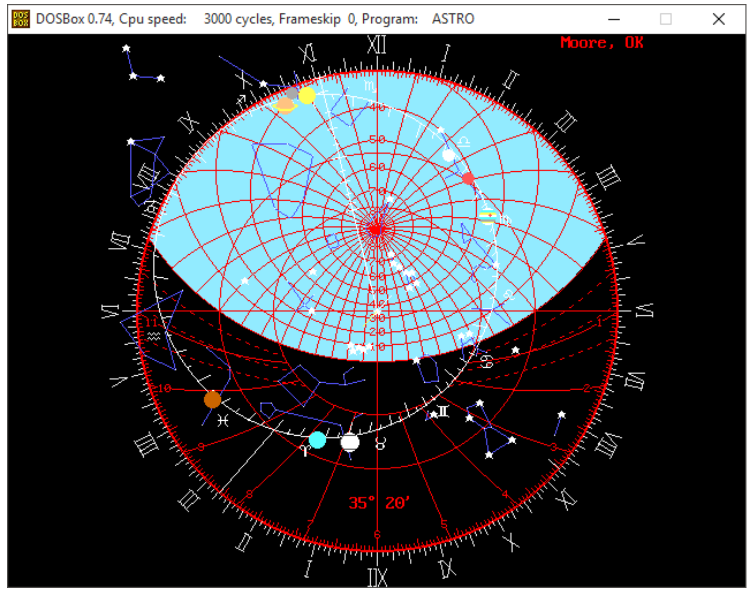
Paper Personal Astrolabe $29

Shadows Pro - shadowspro.com

Software that allows you to create and print an astrolabe
Must have full paid version for astrolabe creator - 50 €

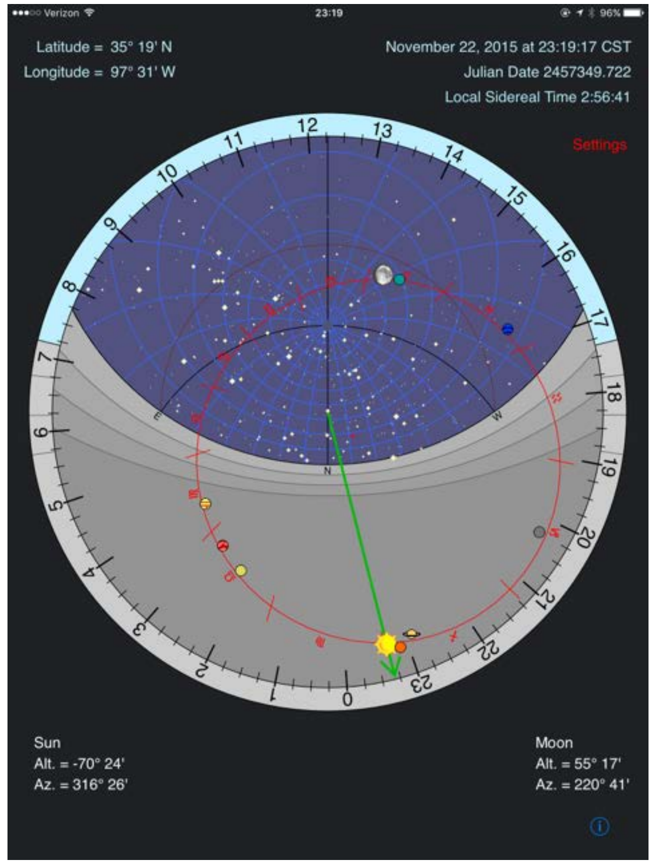
Astrolabes Apps

Jim Morrison - astrolabes.org
Older DOS machine language program
Can run on Win/Mac/Linux using
DOSBox (dosbox.com)
Free download

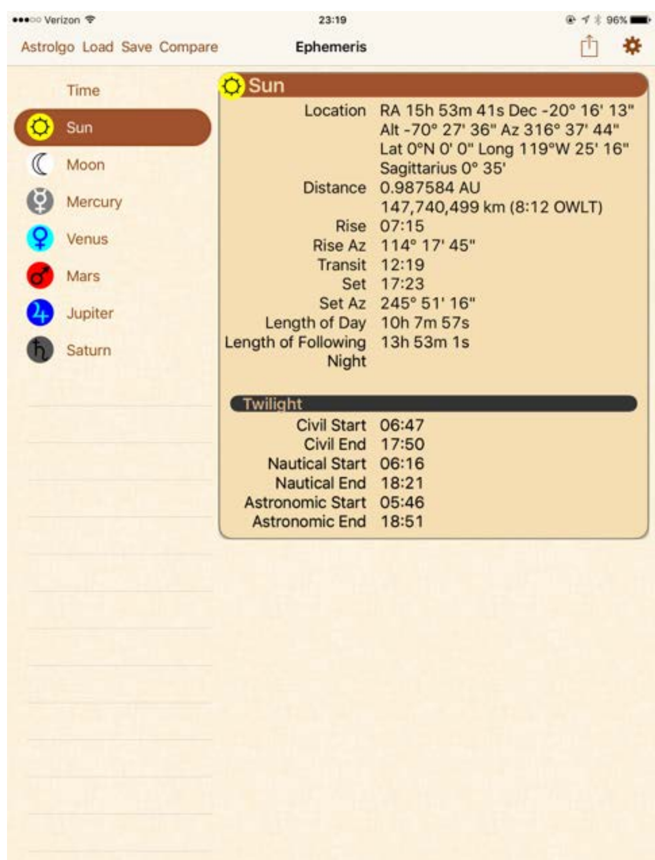


Phaeton
iOS
Free

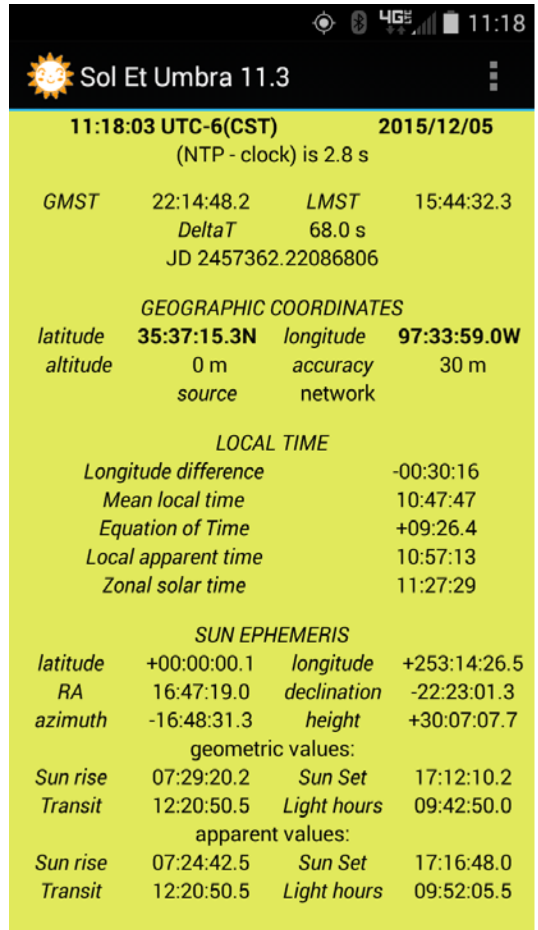
Astrolabe Clock
iOS
Free



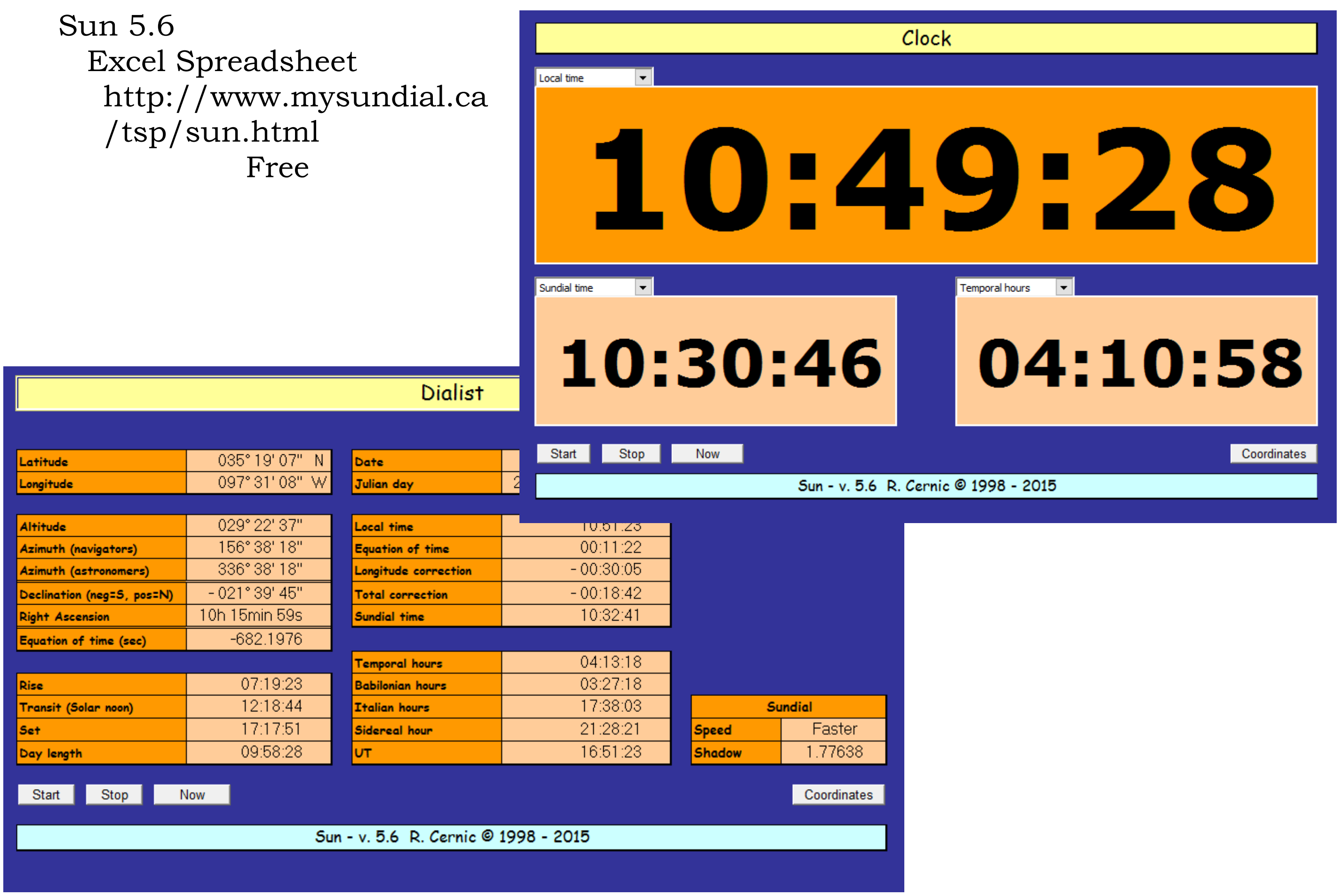
Astrologo
iOS
$9.99



Sol et Umbra
Android
Free



Sun 5.6
Excel Spreadsheet
http://www.mysundial.ca/tsp/sun.html
Free



Web References

The Astrolabe. http://astrolabes.org. ***The*** definitive starting place for astrolabe information on the web.

Chaucer's Treatise on the Astrolabe. Translation by Jim Morrison in parallel with Chaucer's Middle English text. http://medievalscience.org/treatise.html.

Stereographic Projection, Chaucer, and the Astrolabe. http://www.math.ubc.ca/~cass/courses/m309-01a/montero/math309project.html.

Galen's Medieval Science website with other astronomy and natural philosophy references. http://medievalscience.org.

Bibliography

Chauncer, Geoffrey. *A Treatise on the Astrolabe.* 1391. Edited by Walter M Skeat. London: N. Trubner and Company, 1872.

Evans, James. *The History and Practice of Ancient Astronomy.* Oxford: Oxford University Press, 1998.

Morrison, James E. *The Astrolabe.* Rehoboth Beach, DE: Janus, 2007.

North, John D. *Chaucer's Universe.* Oxford: Oxford University Press, 1988.

van Cleempoel, Koenraad. *Astrolabes at Greenwich.* Oxford: Oxford University Press, 2005.

Material in this pamphlet was compiled by Galen of Ockham, OP, MKA Keith E. Brandt, MD. Copies are available on the Medieval Science website, medievalscience.org or contact galen.of.ockham@gmail.com.

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Leo
Virgo
Libra
Aries