

Reading

PRIMARY SOURCES - Required Reading

The calendars themselves as well as astrolabes provide your primary sources for this week. Additionally the classical texts of Hesiod, Ptolemy and Ovid are also primary sources.

Visit the Online Exhibition 'The Astrolabe East and West' <http://www.mhs.ox.ac.uk/astrolabe/exhibition/>

This exhibition from the Museum of the History of Science is quite extensive and uses particular instruments to reveal the issues of cosmos, destiny and faith all entangled with the astrolabe.

Hesiod's *Works and Days* <http://www.sacred-texts.com/cla/hesiod/works.htm>

Ovid's *Fasti* - <http://www.poetryintranslation.com/PITBR/Latin/Fastihome.htm>

Fox, M. (2004). 'Stars in the 'Fasti': Ideler (1825) and Ovid's Astronomy Revisited'. *The American Journal of Philology*, 125, 91-133.

Hesiod's *Shield of Hercules* http://ancienthistory.about.com/library/bl/bl_text_hesiod_shield.htm

The Greek world – the flow of war, life and death, the agricultural cycles – this can be compared with the Shield of Achilles from Homer's *Illiad*.

Reading

SECONDARY SOURCES - Required Reading

eBook - Stern, Sacha. *Calendars in Antiquity: Empires, States, and Societies*. Oxford ; New York: Oxford University Press, 2012.

Read - Chapter 6 - Dissidence and Subversion: Gallic, Jewish, and Other Lunar Calendars in the Roman Empire.

Finding this chapter : Log in to your library account and either go through the TSD library to the eBook section OR select from the list of available resources OXFORD SCHOLARSHIP ON LINE . Once at that site in the search engine type the author's name – Sacha Stern. Two of her works will appear, select *Calendars in Antiquity*.

Module Textbook: HARRIS, Alexandra, Weatherland; *Writers and Artists under English Skies* (London Thames & Hudson, 2015). chapter 2, 51-81, '**All things have their season.**'

JSTOR Papers

Lehoux, Daryn Rosario. "Parapegmata, Astrology, Weather, and Calendars in the Ancient World ", University of Toronto, 2000.

Jones, Alexander. "On the Reconstructed Macedonian and Egyptian Lunar Calendars." *Zeitschrift für Papyrologie und Epigraphik* 119, no. (1997): 157-166.

Melville, Charles. "The Chinese-Uighur Animal Calendar in Persian Historiography of the Mongol Period." *Iran* 32, British Institute of Persian Studies (1994): 83-98.

Heavenly Discourses

Time and Calendars

Dr Bernadette Brady
University of Wales
Trinity Saint David
May 2018



Sky is the Primary Sources of all Time Keeping

Plato *Timaeus* 37c-39e

Wherefore he resolved to have a moving image of eternity, and when he set in order the heaven, he made this image eternal but moving according to number, while eternity itself rests in unity; and this image we call time. ... They (the heavens) are all parts of time, and the past and future are created species of time.

Genesis 1:14 RSV

And God said, "Let there be lights in firmament of the heavens to separate the day from the night; and let them be for signs and for seasons, and for days and years, and let them be lights in the firmament of the heavens to give light upon the earth."

The Calendar – time organised - as a Cultural Device.

Calendars are used to control and organise a population.

In speaking of ancient calendars Sacha Stern comments,
 'All ancient calendars we have studied so far were set and controlled by political rulers.... Control of the temporal organisation of society was regarded, it seems, as an inherent right of political rulers; this is why reckoning of the calendar was understood in the ancient world as a political function.'

Today - Most of the world functions on a solar calendar (agricultural calendar tied to the seasons) however individual countries will shape the calendar by national holidays, school terms, academic terms. Added to this different religions will seek to impose their control over the national calendar – ritual days, feast days. Some countries will prefer to function using a lunar calendar (festival or religious calendar).

Stern, S. (2012). *Calendars in antiquity : empires, states, and societies*, Oxford ; New York, Oxford University Press. p1



Algeria



Libya



Mauritania



Malaysia

The Practice of Astrology is a Personal Calendar generator

Anthony Giddens argued that a requirement of any life-style, which contains any form of planning required a personal calendar,

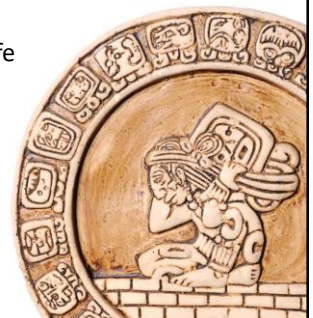
... the reflexively organised trajectory of the self. [The self is located in time and space and] Life-planning is a means of preparing a course of future actions mobilised in terms of the self's biography. We may also speak here of the existence of personal calendars or *life-plan calendars*, in relation to which the personal time of the lifespan is handled.

In my PhD field work I found that many astrologers use their horoscope to plan their life through the timing of future events.

Calendar therefore is at the very fabric of culture – national, family and personal.

Anthony Giddens, *Modernity and self-identity. Self and society in the late modern age* (Cambridge Polity Press, 1991), p.85.

The multiple cycle Mayan Calendar



Calendars – the basic forms

- **Solar cycles** – based on the four ‘anchors’ in the year of two solstices and two equinox. This is agricultural as it provides the seasons.
- **Lunar cycles** – based on the 12 to 13 lunar phases of the year. This calendar posed a serious problem as it tended to contain the religious days, or feast days but its mismatched to the solar calendar thus the religious festivals are not aligned to the agricultural year. **The floating date of Easter is an example of this mismatch.**
- **Star cycles Calendars** – (rare) bases on the return of a star to visibility , the most famous case is the Egyptian use of Sirius. They had a stellar-lunar calendar.
- **A mixture of any three of the above** – the sun (solar) Moon (lunar) the stars (stellar).

• Continuous count calendar - Julian Date

This is taken as counting solar days – the length of time it takes the sun to reach the same place in the sky from one day to the next. Generally this is taken as the sun’s zenith as it is the easiest to observe. The Egyptian and Roman day was measured from sunrise to sunrise, while the Hebrew and Babylonian was measured from sunset to sunset. Today astronomers measure their days from noon, while the civil practice is to measure from midnight. This is reflected in the way that astronomers record the date - Julian date - 4pm BST on 9 May 2018 = JD 2,458,248.166667 (from noon 1 January 4713 BC).



A Solar Calendar in the landscape
The sun is consistent and produces the seasons which drive life on earth – harvest and hunting.

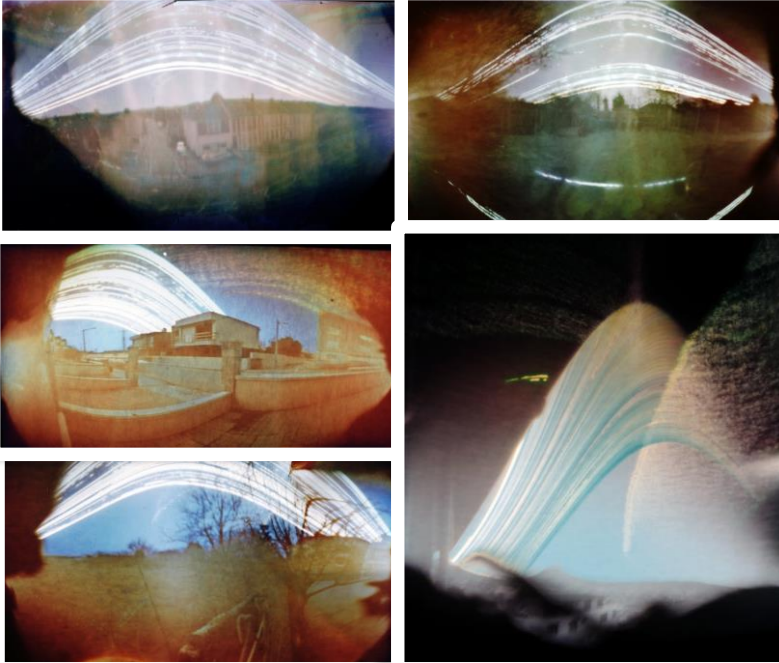
Sunrise summer solstice
 The longest day

Sunrise at equinox
 Equal day and night –
 this will be due east

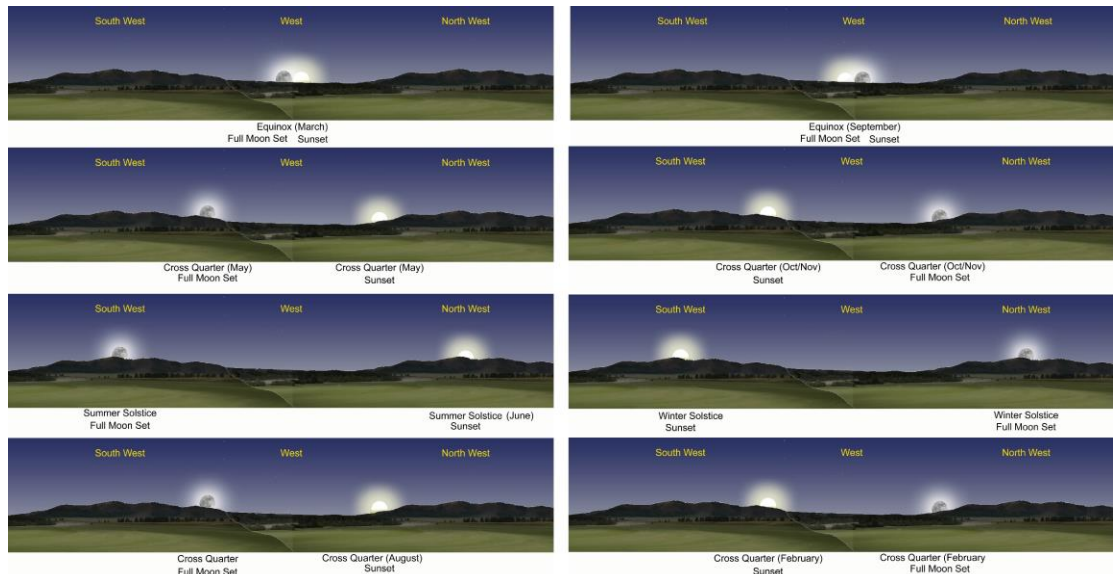
Sunrise at Winter solstice
 Shortest day.

54 North

Thus the landscape can be used as calendar.

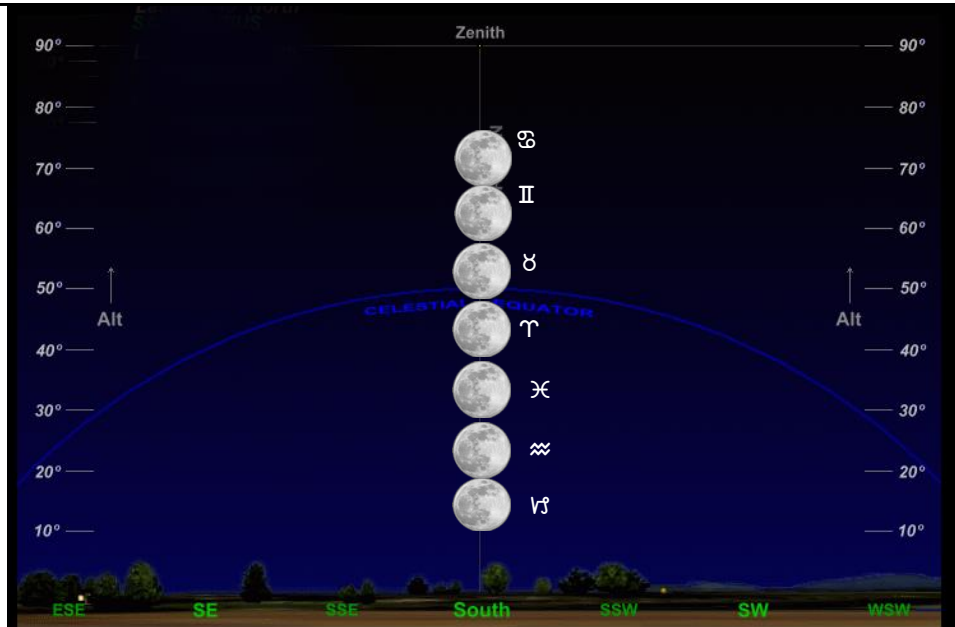


Solargraphy - using a pinhole camera to show the path of the sun through the sky from December solstice to March Equinox, northern and southern hemisphere.



The Lunar/Solar Rhythm

Full Moon and the Sun in the west

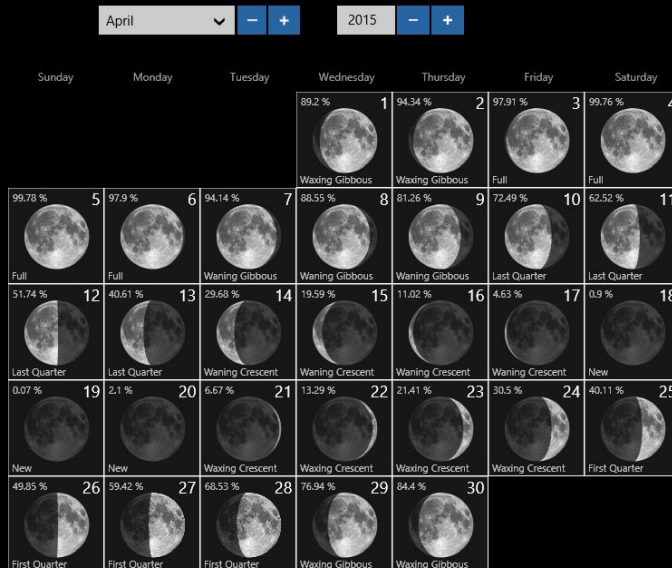


When the Full Moon is high the Sun is low and vice-versa.

Thus the two heavenly Lights are balanced and equal.

Many social functions would be planned at the time of the full moon so that people could return to their homes in the light of the full moon.

Watching the Full Moons (ignoring the possible celestial latitude of the Moon) - Bath, UK



The Lunar month is based on the lunar phase and is close to 29 ½ days in length.

The 1st day of the month will be on the new moon and thus the 14/15th day of each month is always a full moon.

The Lunar Calendar



Different ways of beginning a lunar month. The dominant method which Islam adopts is the **first day of the month being counted from the first appearance of the crescent moon in the west at sunset.**

Sunset and the first visible crescent of the new moon.

Note for the northern hemisphere the horns of the crescent moon point south -you are looking west in this picture – and they are not forming the letter 'C'.

This is the beginning of the Islamic lunar month.



The Ancient Egyptian Lunar Month

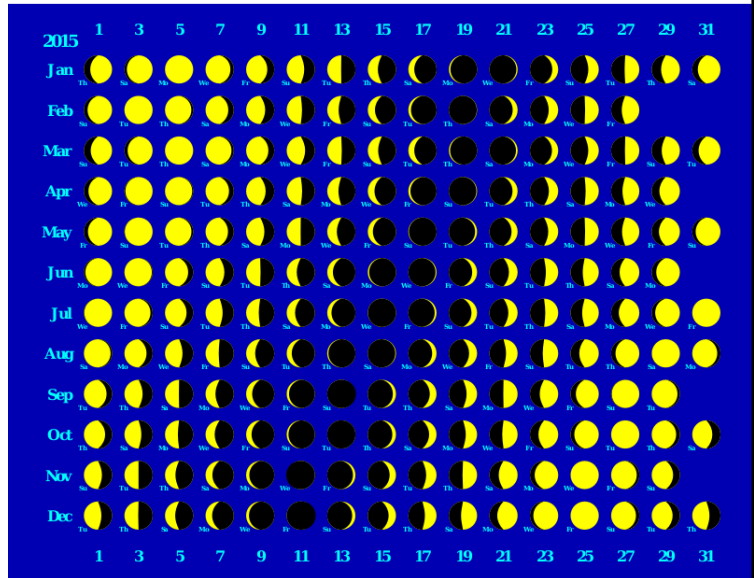
Sunrise, last visibility of the balsamic moon – the next day at sunrise you will **not see the moon**. That is the first day of the Egyptian lunar month.

Note, for the northern hemisphere, the horns of the balsamic moon are a 'C'.

You are looking east in this picture, thus the horns of the moon are still pointing south.

The Lunar Calendar and the seasons

The lunar year, twelve new or full moons, is on average **11 days short of the solar year of 365 ¼ days**. This means that every second to third year a **thirteenth month** needed to be included in the calendar otherwise the seasons would drift through the year. However, this leap month approach, taken over five years, produces an excess of 7-8 days.



Lunar Calendars

The Coligny Calendar considered to be a Celtic (Druidic calendar) from the third century BCE. It reveals the astronomical challenge of correctly aligning the solar year with the lunar calendar. **Thus ensuring the correct full moon fell in the correct season of the year.**

Garrett Olmsted, *The Gaulish calendar : a reconstruction from the bronze fragments from Coligny with an analysis of its function as a highly accurate lunar/solar predictor as well as an explanation of its terminology and development*, (Bonn: Habelt, 1992), pp. 73-75.

Adolfo Zavaroni, *On the structure and terminology of the Gaulish calendar*, (Oxford: Archaeopress, 2007), p. 18., 89.



The Coligny Calendar is a Celtic calendar found in bronze fragments at Coligny, France in 1897.

One of the earliest astronomical puzzles



How to align the lunar festivals (moon) into the seasons (sun)

- Adding a leap month every third year was not sufficient as the length of the lunar cycle cannot be evenly fitted into the length of a solar year.
- Using a **five solar year period is the best fit**, but this still gave a calendar that would be seven to eight days too long against the solar year. Hence leap days had to be removed!
- Added to this the moon does not move at a consistent rate and thus a five year block of lunar /solar years can be established by observation but it cannot be tabulated.
- This means that the **ONLY way to link the two calendars was by direct observation of the sky.**
- This can be done in two ways. Link a particular part of the lunar phase to a solar event or to a lunar event or to a solar/lunar/stellar event.

The Ancient Egyptian Solution Lunistellar Calendar



Egyptians solved the problem by using the rising of Sirius. If Sirius rose in the last 11 days of the **fourth month of the third season** then an extra month was added to the year to ensure that Sirius, in the following year, did not rise out of its month.

This tied the lunar calendar to the seasons and ensured that the beginning of the new year was always linked to the heliacal rising of Sirius and thus also the inundation.

The problem of Easter - Calendar conflicts - Computus

The Paschal Full Moon

The date of Easter used to be decided by the formula that Easter was to be celebrated on the Sunday following the first full moon after the vernal (spring) equinox. This statement was true prior to 325 A.D and is still, for the West, generally true.

The Council of Nicea 325 CE for the Western Church standardised it further to have it **based on tables rather than a lunar event** – that is it had to fall on a Sunday regardless of the phase of the moon. By 1583 A.D. the table for determining the **Ecclesiastical Full Moon** dates was permanently established and has been used ever since to determine the date of Easter for the Western Church.

Thus, according to the Ecclesiastical tables, the Paschal Full Moon is the first Ecclesiastical Full Moon date after March 20 (which happened to be the vernal equinox date in 325 A.D.). So, in Western Christianity, Easter is always celebrated on the Sunday immediately following the Paschal Full Moon.

The Eastern Orthodox Church adhered to the tradition that Easter must always fall after the Jewish Passover, since the resurrection of Christ happened after the celebration of Passover. Thus it is linked to the Jewish lunar calendar.

Calendars – Lunar and Solar

Lunisolar calendars – where the lunar calendar is readjusted through adding intercalary months to the solar year with or without the removal of leap days.

Hebrew
Buddhist
Hindu
Burmese
Bengali
Tibetan
Traditional – Chinese
Japanese
Vietnamese
Mongolian
Korean
Hellenic
Coligny
Babylonian

The **Islamic calendar is lunar**, but not a lunisolar calendar because its date is not related to the sun.

The **Egyptians used a lunar-solar +stellar** calendar where the solar year of only 365 days was linked to a larger correcting cycle of 1460 years known as the Sothis cycle

Star Calendars

Hesiod's Works and Days (c. 750 - 650 BCE) – a moral stellar calendar

Hesiod (2006). *Works and days, Theogony and the Shield of Heracles*, New York, Dover Publications Inc.

(Il. 383-404) When the Pleiades, daughters of Atlas, are rising (10), begin your harvest, and your ploughing when they are going to set (11). Forty nights and days they are hidden and appear again as the year moves round, when first you sharpen your sickle. This is the law of the plains, and of those who live near the sea, and who inhabit rich country, the glens and dingles far from the tossing sea, -- strip to sow and strip to plough and strip to reap, if you wish to get in all Demeter's fruits in due season, and that each kind may grow in its season. ... Work the work which the gods ordained for men, lest in bitter anguish of spirit you with your wife and children seek your livelihood amongst your neighbours, ... Nay, I bid you find a way to pay your debts and avoid hunger.

Independent Continual Count Cycles (separate to the sky) – the idea of a Week

A week is a independent cycle imposed on a calendar. It comes in many different forms:

- a) The Egyptian week was 10 days in length with three weeks to a 'month'.
- b) The French also used a 10 day week – decimal week – from 1793 to 1802.
- c) The modern 7 day week is considered to be of Jewish and Babylonian origin and is broadly based on the lunar phases.

Telling the Time at Night

The Star Snatcher



Week 2: Keeping time with the sky. Astrolabes and calendars, their construction, use and cultural influence

This week focuses on the sky used as a time finder and time keeper. As a time finder the astrolabe will be considered and as time keepers the development of calendars both lunar and solar will be discussed. This discussion will explore star calendars as portrayed in Hesiod's Works and Days, Ptolemy's star phases and Ovid's stellar calendar poem, Fasti. The week will also introduce calendars from Mesoamerica, India, Africa and China.

Resources

-  Weekly Description - Astrolabes and Calendars
-  Weekly Reading
-  Bernadette's notes on astrolabes

Links

-  Chaucer's Astrolabe - the Medieval GPS. BBC Radio program

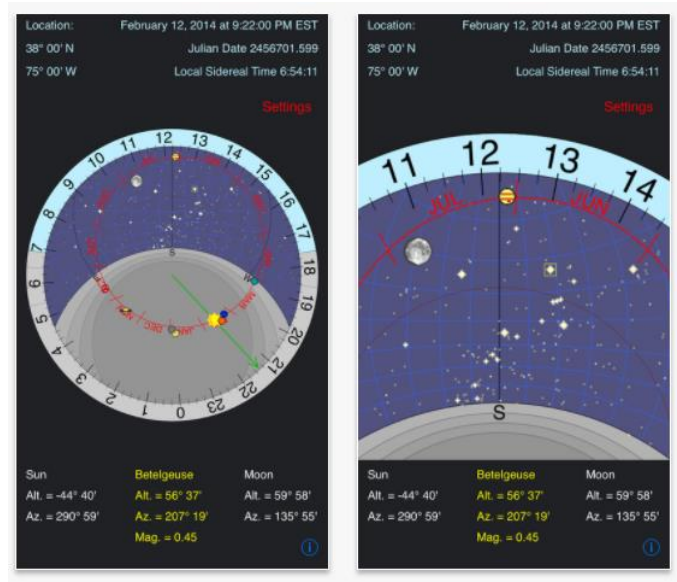
This is a 30 minutes radio program on the astrolabe and places it into a modern context and asks questions about 'Are people losing touch with the sky?' I hope people outside the UK can access this link. It is worth you listening to it over a cup of tea or coffee!

-  13th Century Astrolabe - Tom Wujec, TEDtalks
-  The Electric Astrolabe - an astrolabe for your computer
-  Making an astrolable - templates and instructions

-  Hesiod's 'Works and Days'.
-  Hesiod's 'Shield of Hercules'
-  Ovid's 'Fasti'.

-  Nick's PPT on Calendar Rituals

The Astrolabe App for smart phones



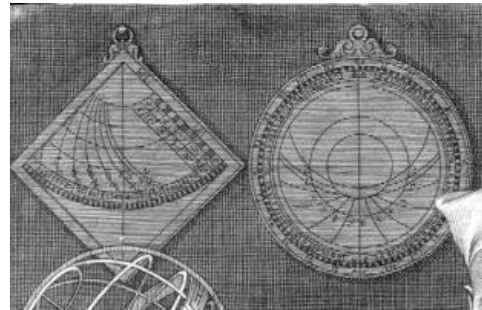
Saint Jerome in his study, by Jan van Eyck (1435).

The back of an astrolabe can be seen on the wall behind him. The alidade is visible and the shadow square can be identified.

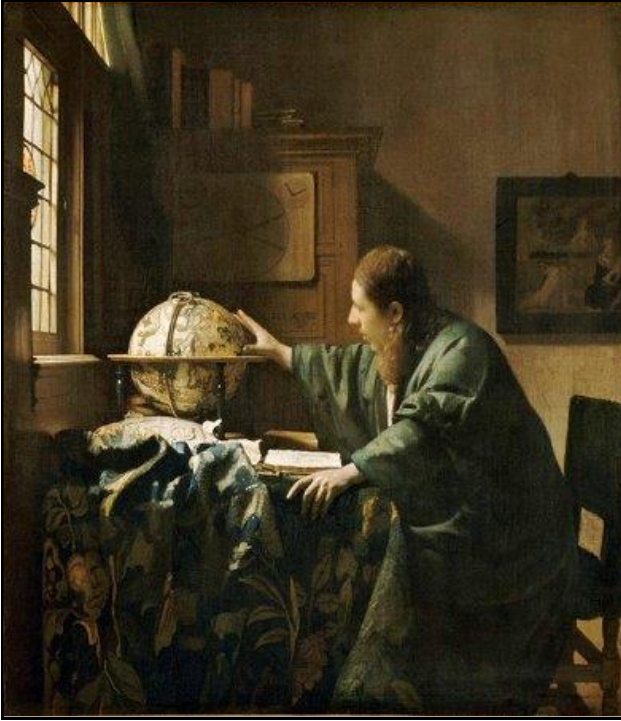


Engraving from 16th century E. de Boulonois fecit. [n.d., c.1680.]
 Engraving. 190 x 140mm. Mounted on card.
Mathematician & astronomer, opponent of the heliocentric model of Copernicus, and architect of the Gregorian Calendar, the astronomer Christophorus Clavius.

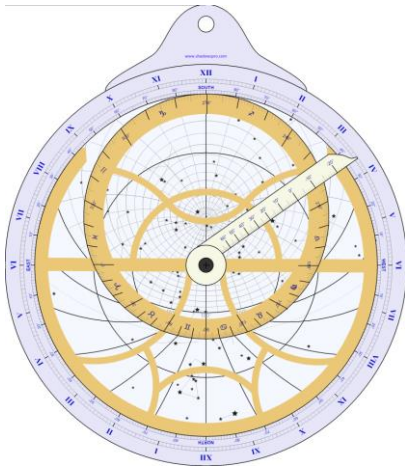
A quadrant astrolabe and an astrolabe latitude plate in its mater is seen in the back ground.



Flemish tapestry (Doornik?, c. 1500-1515) depicting the muse Astronomia with an astronomer (Claudius Ptolemy?), a scribe and shepherds gazing in awe at the heavens



THE ASTRONOMER
 (*De astronoom*)
 Johannes Vermeer 1668
 oil on canvas
 19 3/8 x 17 3/4 in. (50 x 45
 cm.) Musée du Louvre, Paris

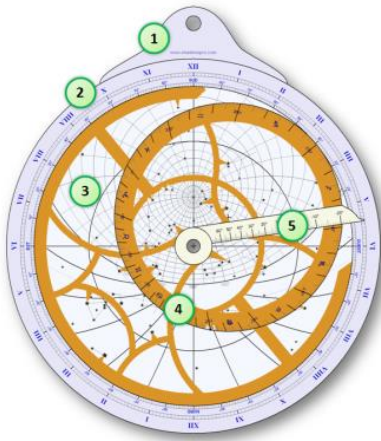


Astrolabes

Unique cultural instrument – the computer, the status symbol, the signifier of knowledge and wealth.



The oldest surviving astrolabe, made of brass by Nastulus (or Bastulus) in Iraq circa 927 AD; height 22.5 cm (8 13/16 in.), diameter 17.5 cm (6 7/8 in.)



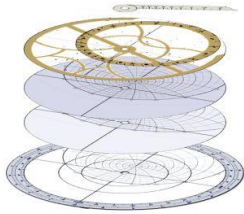
1 - the throne makes it possible to easily hold the astrolabe vertically when pointing a star or the Sun with the alidade. The throne on old astrolabes is usually nicely decorated and is equipped with a ring or a cord.

2 - the limb is scaled in hours and in degrees by quadrant. It gives a value when pointed with the ruler. The limb is inscribed on the **Mother**, the base that holds all the parts.

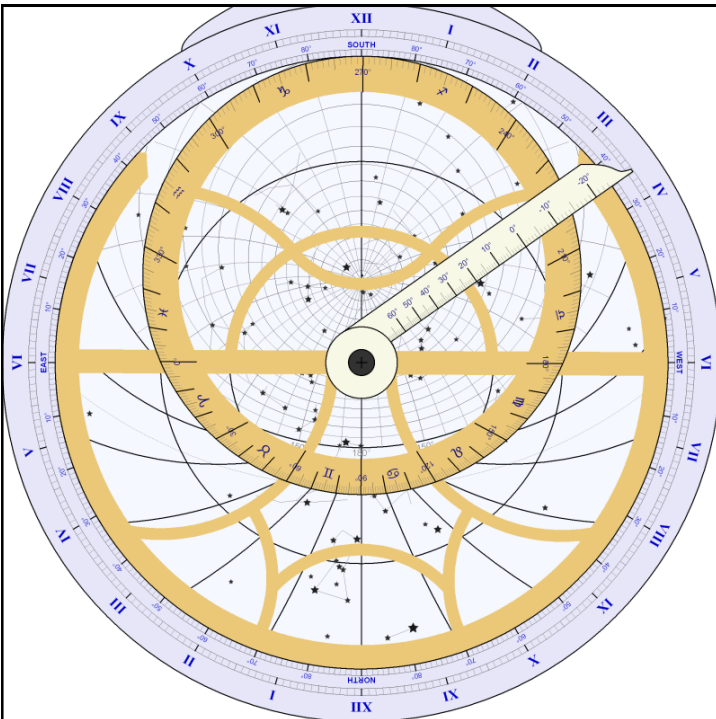
3 - the latitude plate is engraved with a coordinate system suitable for a given latitude. An astrolabe was usually provided with 2 or 3 plates engraved on both sides for different latitudes. The plate shows circles for tropics and for the equator, circles of altitude above the horizon and circles of azimuth, arcs of twilight and sometimes arcs of unequal hours.

4 - the rete can rotate around the axis and has pointers for the main stars. The ecliptic circle is scaled in ecliptic longitude and usually marked with Zodiac signs.

5 - the ruler makes it possible to point a value on the limb or a position on the plate.



- Use the back of the instrument to measure the angle of elevation of a star
- Rotate the rete so the star is at that degree of elevation
- Place the rule so that it points at the star
- Read the time on the Mater.
- You can also see what degree of the zodiac is rising, setting and culminating.





The earliest dated European astrolabe, often called “the Chaucer astrolabe” because it resembles the instrument described in his 1391 “Treatise on the Astrolabe,” is dated 1326 and is in the British Museum

The astrolabe however was being introduced into Europe by the 11th century (Islamic instruments).

Atomic Time vs. Universal Time



‘When the difference between UTC (Clock Time) and UT1 (Earth Time) approaches 0.9 seconds, a leap second is added to UTC and to clocks worldwide. By adding an additional second to the time count, our clocks are effectively stopped for that second to give Earth the opportunity to catch up.’ <https://www.timeanddate.com/time/leapseconds.html> May 2017

Conclusion

- The sky is the primary sources of all time keeping, it is a time finder as verses a time keeper.
- Calendars are built from the sky.
 - Solar calendars provided agricultural cycles, the seasons
 - The lunar months provided a religious or festival calendar
 - The two miss match – this cultural pressure to keep aligned with the right sky has been the fuel behind the development of astronomy and mathematics, can also be the seeds of many sky myths plus could well have been a central issue for the megalithic monument builders.
 - Star calendars (rare, Egyptian) but stars observations can help solve the calendar mismatches
 - Astrolabes are Time Finders – can capture the time directly from the sky, day or night.
 - The astrolabe became the instrument of astrology when it was introduced into Europe in the astrology was carried into the medieval world.

References

CLAGETT, Marshall, *Ancient Egyptian Science, a Source Book: Volume II, Calendars, Clocks and Astronomy* (Philadelphia: American Philosophical Society, 1995).

Giddens, Anthony, *Modernity and self-identity. Self and society in the late modern age* (Cambridge Polity Press, 1991), p.85.

Olmsted, Garrett *The Gaulish calendar : a reconstruction from the bronze fragments from Coligny with an analysis of its function as a highly accurate lunar/solar predictor as well as an explanation of its terminology and development*, (Bonn: Habelt, 1992), pp. 73-75.

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Zavaroni, Adolfo *On the structure and terminology of the Gaulish calendar*, (Oxford: Archaeopress, 2007), p. 18., 89.