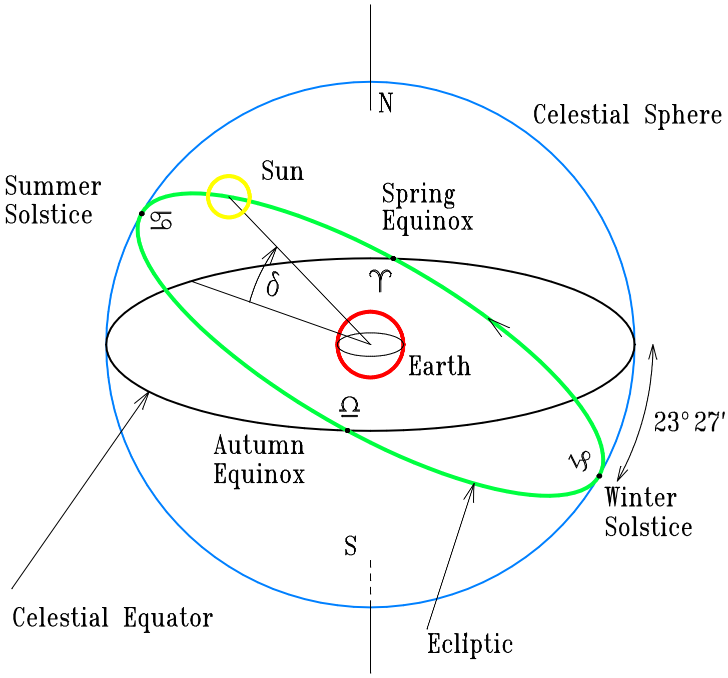
THE HELIOSKIAMETER

Short description of the solar motion

If we take the distant stars as a reference frame, the Sun describes in it an annual flat trajectory, called the Ecliptic, which forms an angle of 23° 27′ with respect to the celestial equator, as shown in the picture.



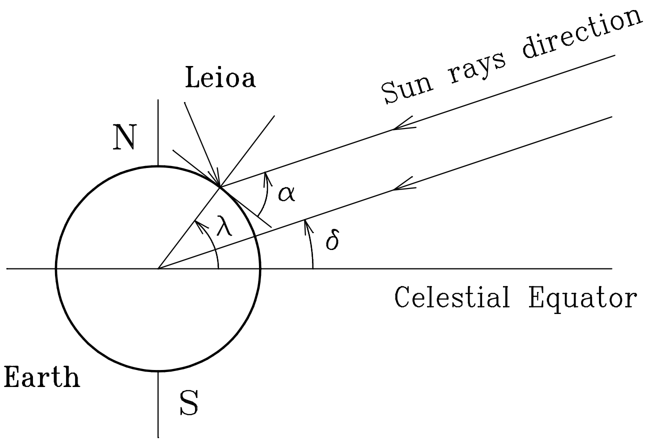
The Zodiac is a ±8.5° strip centred about the ecliptic where the motions of the Sun, the Moon and the Planets take place, as seen from the Earth. Babylonian astronomers divided the Zodiac into twelve sectors, three for each season. Each sector bears the well known Latin name of a characteristic constellation which is located on it. In northern hemisphere during spring time, the Sun travelled through the Aries, Taurus and Gemini sectors, reaching the summer solstice (21st or 22nd of June) where, it is said, it entered Cancer, beginning the summer.

Four important points on the ecliptic can be noticed, i.e. the two points of intersection with the equator (equinoxes) and the other two farthest from it (solstices).

These points divide the ecliptic into four periods called seasons. In the northern hemisphere, spring begins at the vernal point of Aries or spring equinox, and ends at the summer solstice. In the southern hemisphere it begins at the autumnal equinox or Libra point.

Today, because of the Earth axis precession, the vernal point of Aries is located at the constellation of Pisces. However, by historical reasons, Astronomy still retains the old names. When spring begins, it is said that the Sun enters the Aries sign, although the Sun is in the Pisces sector. Even a new constellation Ophiucus is also included in today's Zodiac and the Sun spends there between November 30 till December 17. This implies, for instance, that in the constellation of Scorpius the sun only spends a week, 23-29 of November.

In order to determine the position of the Sun on the ecliptic, and thus the day of the solar year, it is sufficient to measure the angle between the Sun rays and the equator. This angle



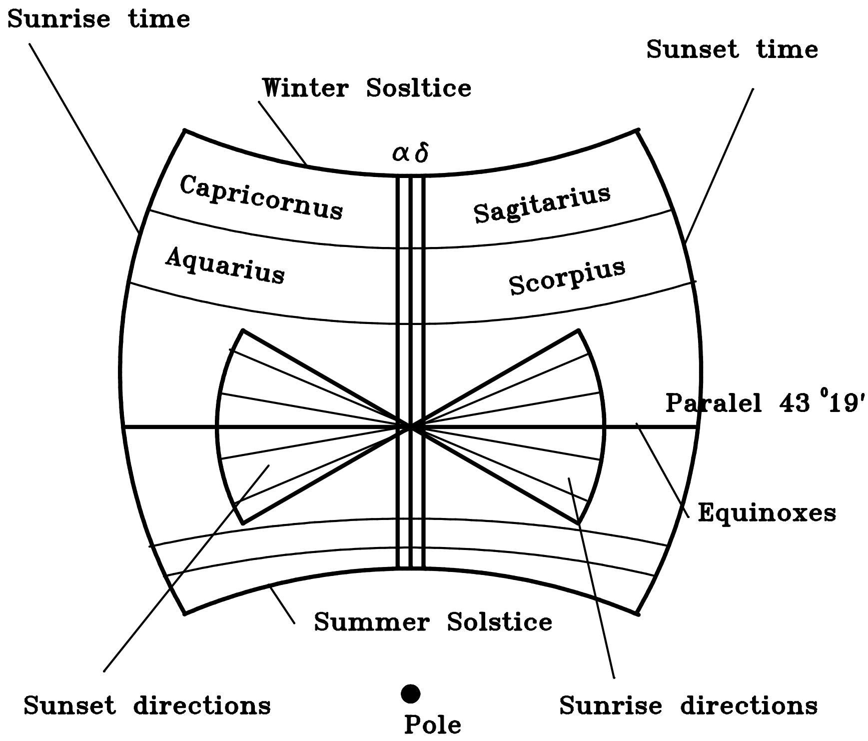
is called the solar declination δ. The angular direction of the rays with respect to the local horizon is the local altitude α. Both angles are related by $\alpha = 90^\circ + \delta - \lambda$, being λ the latitude. In the Campus of Leioa $\lambda = 43^\circ 19' 55"$ N.

To each value of the declination there correspond two days in different seasons, spring or summer and autumn or winter. In spring and summer, the Sun is above the Equator and the declination is taken positive, being negative during the other two seasons since the Sun is then below the Equator. The two days in which the Sun is on the Equator, are called equinoctial days, and then day time is approximately as long as night time.

Description of the Helioskiameter

We have named Helioskiameter, after the Greek helios (the Sun) and skias (image, shadow, projection), to this updated version of the primitive gnomon of the Egyptian and Babylonian cultures, perhaps the most ancient astronomic instrument known to us.

The helioskiameter we display below consists of a a pole with a lens which projects on the floor the Sun's image and allows us to measure several solar ephemerides, using the trajectory of this image.



This trajectory is, approximately, a branch of hyperbola with the concavity towards the pole in spring and summer and in the opposite direction in autumn and winter, being a straight line in the equinoctial days (20th or 21st of March and 22nd or 23rd of September).

The hyperbola closest to the pole corresponds to the image of the Sun trajectory in the summer solstice (21st or 22nd of June) and the farthest to the winter solstice (21st or 22nd of December) whereas, on the other days, the image trajectory lies in between.

The measurements the helioskiameter enables us to make are the following:

a) Sunrise and sunset times.

b) Position of the Sun in the zodiac.

c) Sunrise and sunset directions.

d) Solar declination with respect to the celestial equator and solar altitude with respect to the local horizon. Both are measured in degrees.

a) In the outer lateral edges of the helioskiameter field, the sunrise and sunset times are indicated. Their difference gives the hours of light during the day. The local time in the Campus corresponds to considering that the Sun goes through the meridian at exactly 12 o'clock, i.e. at noon. If it happens that the Sun crosses the meridian at 14 hours 15 minutes civil time, then we must add 2 hours and 15 minutes to the shown sunrise and sunset time in order to obtain the corresponding civil times.

b) The six coloured strips displayed, characterise the position of the Sun in the zodiac. For each colour, two possible zodiacal signs are allowed. In winter and spring the correct sign is represented on the left, while those on the right correspond to summer and autumn.

c) Once the strip colour of the current day is known, we can determine the local sunrise and sunset directions by standing at the crossing point of the meridian with the equinoctial line. We only have to look in the direction of the two sectors of the same day colour. In Stonehenge it is the sunrise direction in the summer sosltice which is marked by aligning the tip of central stone with the outer heel stone. In the recently discovered archeological site of Goseck (Germany) the sunrise and sunset directions at winter's solstice are marked by the two southmost gates of the wooden circle.

d) The symmetry axis of the helioskiameter is the local meridian of the Campus ($2°58'2"W$). The solar declination over the celestial equator is indicated on its left. On the right hand side we have the solar altitude above the local horizon when the Sun passes through the meridian. In autumn and winter, the declination is negative, since the Sun is below the Equator. The equinoctial line corresponds to the ($43°19'55"N$) local parallel.

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