



# Castle San Romualdo's Sundial.



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## Sundial and origine

Sundials are control instruments of the movements of the earth and sun. In them converge science, culture and art, and they have been during a long time the only help, the only point of reference to the mechanic evolution after all types of sundials.

During the hundreds of thousands of years of human evolution, man behaves like a simple predator. He ate which he found: fruits, seeds, roots or what they hunted or fished, and socially he was organized in hordes few in number that moved when food was rare. These men were very well observatory of nature and sky phenomena had to call them attention. Maybe, at first it was just a distraction, they looked the stars and they imagined figures and histories. Nevertheless, they found soon an utility for some of these phenomena in the sky: the place of the horizon where the sun set, the phases of the moon or the constellations visible at night, coincided with other phenomena necessary for their survival: collecting the fruits, migration of animals or the rainy season or drought. In this way, the movement of celestial bodies(Sun, moon, stars) offered the possibility to these men to be located on time. They know few details of how they did it, however archaeological remains are preserved, as some sticks and bones, dating from the Ice Age that occurred 20,000 years ago in Europe, in which a man pierced holes marked lines and counting the days between phases of the moon.

Later, about twelve thousand years ago, occurred that archaeologists have called "Neolithic Revolution" or "agricultural revolution. How some men lived changed radically, roving collectors came to settle in territories where they grew their food. They needed to measure the time, too. The observation of sun and his various positions in the sky during a year were possible to establish the most appropriate time for the various agricultural practices.

*The alignments of megalithic constructions around 4700 years ago at Stonehenge (England) shows that their purpose apparently included the prediction of the seasons and astronomical ephemeris determined: lunar eclipses, solstices ...*

*The stone "heel" marked the place of sunrise at the summer solstice.*

Primitive minds of these humans associated the agricultural cycle, which their subsistence depended, with the celestial bodies and they gave them an extraordinary power. So, sun, nature regulator and symbol life, was an object to pray. We can find remains in the oldest popular traditions:

- Christmas, in the winter solstice, was celebrated with fire and sacrifices to feed the newborn sun.
- St. John's fires, which coincide with the summer solstice, celebrated the victory and mature of sun.

More than a practical application to agriculture, that due to the weather fluctuations is more irregular in their activities, these festivities and religious ceremonies, that accompanied the agricultural activities, were prompted the invention of calendars and the study of astronomy. That knowledge was resigned to priest who enjoyed a big social power.

To organize their religious and bureaucratic duties, every time more complex, in some civilizations in Middle East and North Africa, for 4000 or 5000 years ago, the day was divided in pieces. First, Sumerians did it and later Egyptians.

Egyptians, around 3500 B.C., reached obelisks whose shadows indicated noon, and the longest day and shortest of the year. Later they added more marks on the obelisk's base to divide the day in more pieces. It was around VIII B.C. century, when they thought the first sundial capable of measuring the passage of the hours. This instrument divided the period of the day with the sun in ten pieces, which they added another two corresponding to sunrise and sunset. It consisted in a dipstick which acted as a base and another one perpendicular and horizontal on one of the extremes, that projected her shadow on timestamps of the base. In the morning, it was oriented to east, turning in afternoon to west, to indicate the hours of the afternoon.

## Types of sundials

- *Vertical*: we can find these types of sundial on walls of churches and other buildings. It can be direct austral sundial if they are facing south. On this occasion, gnomon will form an angle of value equal to the site colatitude (complementary angle of the latitude, that is, the difference between  $90^\circ$  latitude), and time line, if it is outlined by the local hour, will be symmetric respect the vertical noon line. If it isn't facing directly to south, we define it like declining sundials, and in this case, the gnomon will do an angle less than the colatitude, and the time line generally will be grouped more closely in the morning hours declining of the southeast. By contrast, in this sundials will be grouped more closely the afternoon hours.
- *Horizontal*: sundials that we can find usually on pedestals in gardens. The plane of the sundial is horizontal. Gnomon(which project shadow) does an angles equal to the latitude where it's located. There are sundials which are not vertical and horizontal, and whose name is *inclined*, although they are not very common.
- *Equatorial*: we can describe it like a sundial whose plane is fixed on the plane of equator, and whose gnomon is perpendicular to his plane. Lines what represent hours are spacing equally  $15^\circ$ . The armillary sphere is a development of this idea, and consists of a series of rings located at the meridian and equatorial plane. In addition, a dipstick is located parallel to axis of the earth that goes through center of the rings.

### Variables to create a sundial

- **Latitude**: It indicates our position respect the equatorial line. It can be north or south and it's expressed in angular measures which goes from  $0^\circ$  to  $90^\circ\text{N}$  or  $90^\circ\text{S}$ (seconds we are in the north or south pole). Latitude is measured in sexagesimal degrees, and expressed with  $^\circ$ .

If we refer to the influence of the time to build a sundial, we can say that is not the same stand at Ecuador in Russia.

- **Declination of the wall about the polar axis**: it will affect the angle of the

gnomon. If declination of the wall about the polar axis is wrong expressed, hour will be wrong expressed, too.

This statement is based on the rotation movement. The earth takes 24 hours to spin 360°. Therefore, the earth rotates 15° every hour. If declination of the wall about the polar axis is bad built our sundial won't indicate what has passed one hour when shadow project 15°.

- **Altitude:** altitude is a fundamental variable that we have to know when we want to build a sundial. Sunny hours are different as we raise our position in the field.
- **Sunny hours:** Probably, it's the most important variable to correct operation of a sundial. If sun doesn't shine, sundial doesn't work. Therefore the best sundial is located in a place with many sunny hours.
- **Angle of the gnomon:** gnomon is defined as the elongated object which casts shadow. The horizontal plane will be inclined at an angle equal to the latitude of where you place your sundial, and vary for different types of clocks (equatorial, declining, etc.). In the northern hemisphere, the simplest case, the edge that casts the shadow is oriented to the north, running parallel to the axis of rotation of the Earth.

## **HISTORY OF SUNDIAL (CASTLE SAN ROMUALDO).** As

we are from San Fernando, a town near Cadiz, we will discuss one of the most important watch our city and, specifically, the oldest. This is the sundial located in the Castle of San Romualdo. This sundial was restored earlier because of their poor condition and currently can be seen perfectly.



Our sundial is uncertain origin that is closely linked to the castle. The truth is that no documentation is very faithful to its origin, both as the castle sundial, because the truth is that several sources attribute the second Arab origin, while many others attribute a Christian origin in the period of the Reconquest. However, several sources name him as ribat (old fort with defensive functions), so that the relevant hypothesis is that they were a stronghold of Muslim origin who was Christianized during the Reconquest in a period of time between the XII and XIV.

Due to its architecture, it follows that the castle was heavily rebuilt. He attributes the existence of a church dedicated to Santa Maria (whose possible existence dates from 1338). Known as the Castle of Logar de la Puente (name of the current San Fernando), the first historical references to our castle dating from the 1370s, when King Henry II made the donation of the castle and a house gentleman Alfonso Garcia Jerez Vera. Later, at the decline of the area, the castle and the island became part of the manor of Rodrigo Ponce de Leon in 1492. During his lordship declaring the existence of the church of San Pedro in a document that dictates the following: "... and gave vn memorial estauan escriptas synple that certain weapons and

ornaments and jewelry strength from the Church of Saint Peter della and a esclauo  
... "

The military importance of the castle has its greatest exponent in the defense of the island during the assault of the English earl Essex to Cadiz in 1596. The defensive position near the bridge Zuazo (single point of access by land to the small island) ensured victory. In addition, serve to repel other Anglo-Dutch attack until mid-seventeenth century.

However the mid-eighteenth century, begins to lose its importance both militarily, the loss of military importance due to the construction of the arsenal of the ratchet, and cultural, as it made the construction of the Church of San Pedro and San Pablo in 1769.

The term "Castillo de San Romualdo" first appears in the Gazetteer, Statistics, History of Spain and its overseas possessions Pascual Madoz.

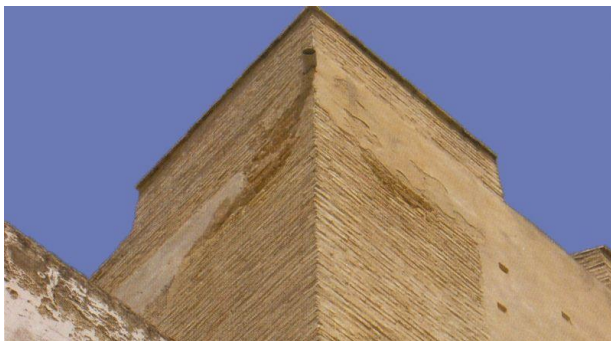
On June 3, 1931 is declared Artistic Monument Architectural and later, in 1968, the castle is reflected in the Inventory of European Cultural Heritage.

### **URBAN ENVIRONMENT**

Around the castle, after the Christian reconquest and expulsion of Muslims in the Cadiz area, established a village to repopulate the area. There are no data on the population of the time, or as structured urban architecture of the population accurately. But we know some of their characteristics. The castle was the center due to the ability to protect the villagers in case of attack and because they built a church, which would be the first of the term. This population pawn the position of controller for those who want to get to Cadiz by land to enter the harbor and ship goods. So, despite the lack of data, we can say that this was a population around the castle and aimed at controlling step of the bridge and then to the salt mines.

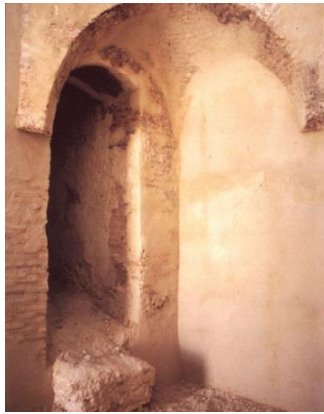
### **ARCHITECTURE OF THE CASTLE**

With regard to architectural study of the castle, there a theoretical basis for its origin established by the historian Leopoldo Torres Balbas (year 1950) in which possibly were a Muslim ribat built in the time of Alfonso XI by builders under Moorish architecture Islam. Obviously, the observable features of the castle today are the result of the Christianization produced after the reconquest of the island of San Fernando by Christians.



Technically, this is a regular plan fortification consisting of a small courtyard surrounded by four aisles. Each of these bays is divided into small sections or rooms most with arches, opening to the outside by a door which receive input light. Its height is reduced, including seven towers divided by the contour of the castle.

Of these towers can highlight the Tower of Homage. The perfect preservation of its merlons and battlements (each of the prisms that crown the walls of the ancient fortresses to shield defenders on them) has shown the inner dome structure and is one of the most remarkable architectural peculiarities of the castle.



However, some research indicates the possible location of a tower that would stand in the middle of the canvas northeast and disappear because of the construction of the first parish church of the emerging city of the Isle of Leon (San Fernando), which as stated in the previous section, was addressed to the cult of Saint Mary. In turn, this would place on chapel former places of Islamic worship.

Returning to the ships interior architectural features are of great interest, since in this castle there is the association of barrel vaults, groin, esquifadas and vaults, answering them stays bounded by the usual type of cell characteristic of Islamic ribats. Furthermore, the castle walls are tough because they have more than one meter thick.



Regarding the use of the castle, despite the above sources who claim the existence of a chapel, only the military can be secured firmly. The documented uses of the castle as a church dating from the seventeenth and eighteenth centuries.

Other architectural highlight of the castle would be the dust located around the courtyard. It also features a small cross in relief on the outside of the canvas south of the sundial also located in the south main tower of the canvas (which will be explained later).

## SUNDIAL

The sundial feature of San Romualdo Castillo has dimensions (including decoration) of 3 meters wide and 2.10 meters high. In addition, we define the lateral dimensions of watches, with the eastern side clock 1.30 meters high and 1.20 meters wide, while the western side has a sundial levels of 1.30 and 1.18 meters meters wide.

The watches were in a very deteriorated state in which hardly appreciated and equinoctial hour lines. However, to mark the bicentenary of the Courts, 1810 meeting in San Fernando, the castle and in particular the clock were restored, allowing the present study.

$$\text{Colatitud} = 90^\circ - \text{Latitud}$$

$$\text{Colatitud} = 90^\circ - 36^\circ 27'$$

$$\text{Colatitud} = 53^\circ 33'$$

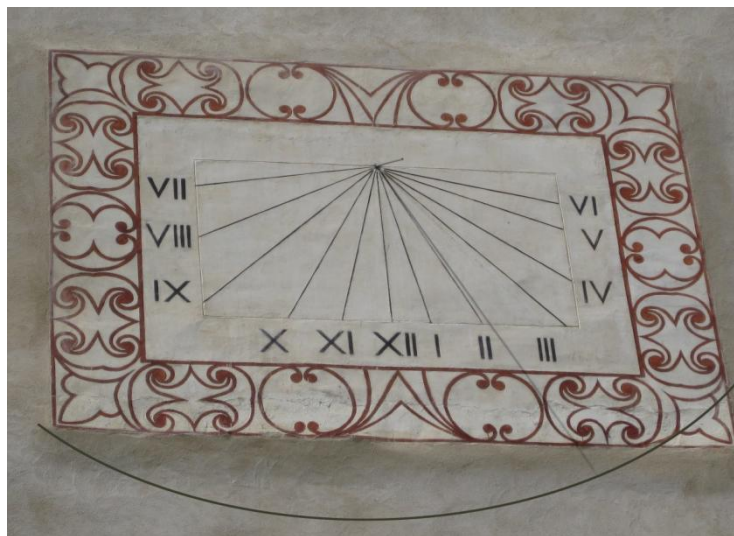


The master sundial, which is a clock located in the southern upright southern stretch of the wall, but with a decline to the west of  $15^\circ$ . However during the restoration and as calculated by the restorer, D. Antonio J. Sanchez Fernandez, these measures were erroneous due to the failure of the geometric calculations which provided that the original decline should be  $8^\circ$  to the west. D. Antonio believes that such failure data can come from a decline in the tectonic deformation of the wall over time.

Therefore we cannot say that the time is accurate, although it is true that the possible error is minimal and not noticeable, because the clock as generic feature, only measures the hours, not including half and quarter of an hour .

Note that the actual latitude of the position of the clock is  $36^\circ 27'$  North. The restored clock, gnomon has a length of which is unknown. However, knowing that the angle described between the gnomon and the wall is the colatitude (difference between  $90^\circ$  and latitude) we conclude that:

Thus the co-latitude of our clock is  $53^\circ 33'$  and that theoretically matches the Earth's axis. In the images posted below this text, we can see the line that describes the shadow of the gnomon along the clock (marked in black) on the solstice (in this case) summer, produced on 21 June 2011. We take pictures throughout the day to observe the way. However, because the line described sundial protruding from the frame, we can not say you are prepared to undertake calculations at different times of seasonal change.



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### **Entrevista con:**

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- D. Antonio J. Sánchez Fernández
- D. Antonio Salazar (Real Observatorio de la Armada)

Members´ s of the group pictures.