Meridian Service in Rome at S. Maria degli Angeli with Bianchini and at Collegio Romano with Secchi. Summer solstice decorations on the meridian line of S. Maria degli Angeli in Rome are obliquity meters.

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Abstract The decorations on the floor of the Basilica on the path of the Sun at the Summer solstice have been identified for the first time as half of the solsticial solar image, used to evaluate rapidly the secular obliquity variation. The red marble which limit the area of the great secular ellipses of the Polaris is located on the exact path of the center of the Sun at 1702 Summer solstice; the comparison with the Winter's one is done.
Sommario Le decorazioni presenti sulla meridiana di S. Maria degli Angeli sul percorso del Sole al solstizio d'Estate sono state identificate per la prima volta come metà immagine solare solstiziale, usati per valutare rapidamente la variazione secolare dell'obliquità eclittica I marmi rossi che circondano l'area rettangolare che include le grandi ellissi secolari della Stella Polare terminano esattamente dove il centro del Sole passava al Solstizio estivo. Al solstizio invernale l'immagine del Sole del 1702 lambiva il Capricorno.

Introduction

Measuring inside a dark chamber (as Toscanelli in Florence's Dome since 1475) is better than outside with obelisks,[1] because of the penumbra and low image's contrast. Measuring the solstice instant is possibile with one hour accuracy near the Winter solstice at the meridian line of S. Maria degli Angeli (Sigismondi, 2018). The meridian line of S. Maria degli Angeli was made to measure the obliquity variation, and nowadays this is possible at both Winter and Summer solstices.

Two Summer decorations were not explained, nor considered until to now (e.g. in Catamo & Lucarini 2011, Sigismondi 2009) Here I show that there are two *Obliquity meters*.

Obsveration of the 2018 Summer solstice

As usual the image appears short before the meridian transit, which is the topical event to be measured at the meridian line.

1 also Navona square is a sundial, with timing sectors... “piazze assolate con giganteschi obelischi che fungono da gnomoni”, cfr. Museo di Roma.

The altitude's variation in ±20 minutes from the transit is ±33'. Through the pinhole the Sun's path projected from 20.344 m of height and 71° is a hyperbola tangent to the line in red marble. This hyperbola is 21 mm closer to that line at the second decoration, as calculated extrapolating the first superposition 4 minutes before the second one at 13:01:20 on June 20, 2018.

Timing Jun 20 2018	First half Sun (calc)	Second half Sun (obs)
180° - azimut	13°	7⅓°
Sun's altitude	71°09'	71°24.5'.
Distance from zero	7.313 m	7.205 m
Projection to meridian	7.125 m	7.146 m

The difference is 21 mm, the position at azimut 180° and h=71°33' is 7.153 m. The projections help to understand how the hyperbola is approximated by the line.The two decorations

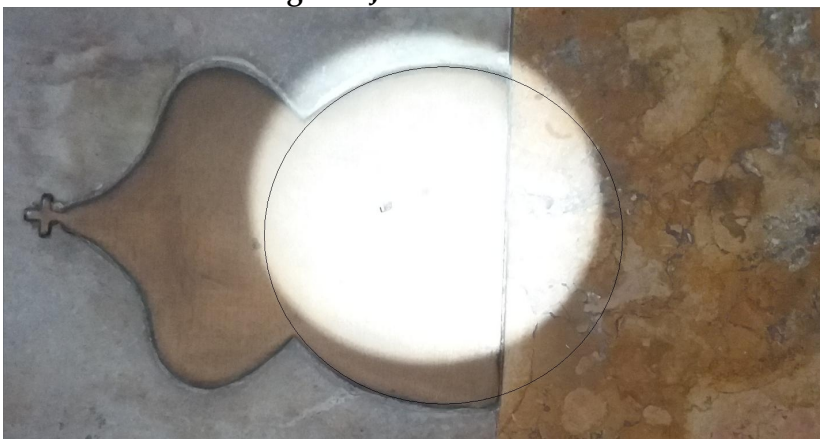
show two phases of the “Sun rising” over the red marble line. The left brass semi-ellipse is less than half, the second one is nearly half. The solar image is not complete because of the Vanvitelli arch, interrupting the sunlight from the pinhole.
Even though the solar image is not complete is evident that the

complete one is more distant from the lower red marble than the 1702 one, materialized by the two brassed semi -ellipses.
They are therefore an Obliquity meter and a pathfinder for the Summer lowest hyperbola.

Difference between 1702 and 2018 solstices

Being the obliquity of Earth's orbit diminished from 23°28' to 23°26' in 3 centuries it corresponds to a shift of 12.4 mm at the level of Summer solstice in S. Maria degli Angeli meridian line, at 21,42 m from the pinhole. For the Winter solstice the shift is 28.6 mm, at 49.6 m from the pinhole.
Both dimensions are measurable and verificable at this meridian line. For the Summer solstice the location error of the present pinhole (different from the original one, Sigismondi 2012) can be comparable.
The uncertainty about the limit of the solar image is ≈1 mm, at maximum we have 2 mm when there is a lot of turbulence.
The distance between the two solstices on this meridian line then shortened by 41 mm in 3 centuries.

The 2018 solstice image: 20 June 13h01m20s



IMCCE ephemerides of Paris give 21 June 2018 at 10h07m UT, 12:07 local. This image is 25.1 hours before the solstice.

Difference with 21 June: from h=71.423° to h=71.426° only 10.8" say 1.1 mm. A few seconds before this image the figure of the Sun was below in the photo, superimposed on the decoration, aligned to the black ellipse, which represents the Solstice of 1702. The horizontal diameter (vertical in the photo Dh) of the solar image is 19.58 cm + 1cm of pinhole=20.58 cm; the ratio 1067:1013 in pixel of the original photo is equal to 20.58:21.67 the meridian Dm (projected) diameter. $Dm=Dh*[1+1/\tan^2(h°)]^{0.5}$. The calculated ratio is 1.055 q.e.d.
Same ratio is obtained with the black ellipse fitting the "half sun". The photo is zenithal, without significant deformations.

Two decorations: a missed visit or a solstice's chronometer?

They are made before the 1750 renovation under Benedict XIV, because now the Sun appears only after the first decoration.
The facture is similar to the decorations of Jan Sobiesky and Maria Casimira of Poland, made in 1702, september 11, 19 years after the battle of Wien.[2] The dimension of the half solar image is coherent with the solsticial one, up to a millimiter.
The vertical and horizontal dimension are in ratio 3:√10, as obtained from the tangent of the height of the meridian solstice Sun 1:3 for Rome. On the photo, in black, is reported the whole solar image fitted to the decoration. It is closer to the pinhole base, than the 2018 one, as it is expected.
Two other images are dedicated to the visit of Pope Clement XI on 20 august 1702, and their dimensions are the ones of the Sun. Is it possible that the images were prepared for an important visit on the Summer solstice? Or was this a device prepared by Bianchini to measure with accuracy the Solstice's instant? The double image recalls the "equinoxes'

2 Same date of the attacks on 11 september 2001, interpreted as 9-11 the emergency call in USA. The battle of Wien was the safety of Europe from Turks in 1683.

chronometer" that Bianchini put before and after the meridian line at the crossing of the celestial equator. That device is explained with the opportunity to have two more occasions for evaluating how many hours +/- from the equinox are. Was this device something to evaluate the time +/-from the solstice?

The Capricorn and the Cancer

The two solstitial signs are realized in different ways on the meridian line: The southern edge of the solar image approaches the dark borders of the Capricorn on December 21, it touched it in 1702. The red border of the Northern meridian line with the Polaris' ellipses is the path of the center of the solar image on June 21 in 1702. Once again the disposition of the marbles has astrometric purposes. The eye could check immediately the difference from the solstice in 1702 and the current one at any time within 20 minuted from the transit.

The passage on the second *arabesque dome with cross* decoration, at the superposition's instant, gives immediately the evaluation of the difference. It is done with the southern limb of the Sun again, which is much easier than calculating the position of the solar center.

Angelo Secchi, geodesy and the signal of mean noon

The father of Italian geodesy is Francesco Bianchini (1662-1729) who built the meridian line in the Basilica of S. Maria degli Angeli in Rome with the purpose of measuring accurately the variation of the obliquity of Earth's orbit and the tropical year duration. He compared the observations of eclipses made in Rome and in Bononia, at the meridian line (1655) made by Giandomenico Cassini and found that the meridian of the Pontifical State was from Rome to Rimini.

While Bianchini published many details of the meridian line in 1703, the presence of two decorations near the Summer solstice position has remained unexplained until 2018. Only

one of them receives the image of the Sun nowadays and allows immediately to evaluate the secular shift of the solstice's position. The position of the red marble strip under this decoration is the materialization of the solstitial center of the solar image in 1702.

For 1.5 centuries the signal was given by that meridian line, Secchi was able to automatize the procedure of the ball-drop, as in Greenwhich observatory. A signal was spread to the city, through the fall of a sphere visible from far on top of the Flamsteed house, to give the instant of the local meridian transit. This was established in 1833 and automated in 1852 by Airy. Secchi upgraded a similar device (set up by Father De Vico S. J. after 1840) upon the roof of St. Ignatius, where his Observatory was located. This ball-drop gave the signal to the cannon on Gianicolo hill. Nowadays the tradition of the cannon continues, without the intervention of astronomers.

Secchi measured carefully the meridian of Rome, and paved the way to the modern geodesy and the fundamental meridian of Italy at 12° 27' 08" from Greenwich.

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