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# Sacred Alignments of Early Christian Churches, Baptisteries and Mausoleums in Ravenna: The Intuition of Giuseppe Gerola, 1936

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*Abstract*: In this transdisciplinary archaeoastronomical project, the researcher examined the hypothesis put forward by the historian Giuseppe Gerola (1877-1938) who postulated at the beginning of the 20th century that the early Christian sacred buildings in Ravenna, Italy, were oriented towards the sunrise on a specific day. His methodology, however, did not allow him to determine the orientation with accuracy so his hypothesis had to remain speculation. The researcher analysed the early Christian sacred buildings in Ravenna (mentioned by Gerola) and that are still extant today in their (partial) original form (18 buildings), by conducting georeferenced surveys with astronomical, trigonometric calculations combined with the study of primary and secondary sources. The author's methodology allowed her to obtain with high precision azimuths and declinations of these sacred architectures and in combination with written evidence realistic hypothesis can be expressed. She aimed to verify or falsify Gerola's hypothesis concerning the existence of an ancient building tradition regarding the alignments of early sacred buildings toward sunrise on a specific day. Her study confirms Gerola's early theory: some sacred architectures in Ravenna were indeed aligned toward the sunrise on a significant day, but some also with the sunset and one of them with the moon.

*Keywords:* Sacred Alignments, Early Christian Buildings, GPS Surveys, Giuseppe Gerola.

## 1. Introduction

We are in the early years of the twentieth century. The studies conducted by astronomers and archaeologists to understand the disposition of sacred buildings in space (archaeoastronomy) had focused mainly on megalithic structures and sites, with the aim of understanding through measurements and calculations why blocks of stones had been positioned according to a specific pattern (rows, circles, etc.). On the other hand, theologians and historians had concentrated on written sources and studied the tradition of aligning sacred buildings, investigating the rites of different cultures; two fundamental texts, Nissen's *Orientation* (1906) and Dölger's *Sol Salutis* (1925) are worth remembering. However, these two areas of study remained separate (Spinazzè, 2010; 2015). At that time, the historian Giuseppe Gerola, Superintendent of the Monuments of Romagna, Italy, carried out archaeological excavations at the early Christian sacred buildings in Ravenna. On that occasion, with the collaboration of Giorgio Rosi, director of the Royal Office of Antiquities and Art of Ravenna, he determined the azimuths of the axes of those buildings using a precision compass taking into account the magnetic declination (Gerola, 1936, p. 244). Gerola wondered why the axes of the sacred buildings diverged so greatly from the astronomical points such as the equinoxes and solstices and argued that there must be a reason. He intuited that these Christian buildings were not randomly oriented in space but towards a precise point on the horizon. On this basis, he developed orientation criteria, but his methodology did not allow him to make sufficiently certain deductions, as he stated, and therefore he was unable to establish a plausible connection between the

building and the criterion. Because of this gap in the data, he stated that "new research and new studies are necessary to reach more definitive results and more certain deductions" (Gerola, 1936, p. 261).

The following orientation criteria, developed by Gerola, may have been chosen by the builders to orientate Christian sacred buildings when tracing their foundations: orientation to the astronomical east; to the winter solstice (Christmas) and summer solstice; to the birth of the sun on the feast day of the patron saint of the church; to the birth of the sun on the day of particular importance for the founder; to the birth of the sun on the day of the foundation of the church; to Jerusalem; to the magnetic north; random orientation (Gerola, 1936, pp. 251-252).

## 2. Methodology

The good preservation state of the sacred buildings of the early Christian Age (churches, baptisteries, mausoleums) and their remains (foundations) in Ravenna and Classe have enabled the author to undertake detailed measurements. These sacred buildings were not bound by pre-existing buildings or other topographical obstacles, "and one can believe that they arose on a site well chosen by the founders" (Gerola, 1936, p. 242). To verify whether or not Gerola's intuition could be confirmed, the author studied primary sources (patristic and liturgical writings to confirm the existence of a tradition to orientate sacred buildings, archaeological excavation reports to understand the evolution of sacred buildings, martyrology to know when a feast entered the calendar, etc.) as well as secondary sources. She carried out a georeferenced topographic survey (GPS survey) of all the sacred buildings of the early Christian Age in Ravenna and Classe that had been studied by Gerola, using a combination of theodolite and GPS, and made trigonometric and astronomical calculations to determine the alignment of each ancient sacred building, taking into account the mountain profile in the direction of the apse and the façade (the local horizon to the east - Adriatic Sea - is free, while to the west it appears distant and does not affect the calculations), the refraction, the latitude and, in the case of a lunar alignment, also the parallax of the moon. In addition to the azimuth at the rising, the author determines the azimuth at the setting of the celestial object, the declinations on the astronomical and local horizon, the days on which the sun, the moon or another celestial object was in line with the axis of the sacred building, then she draws up concrete hypotheses on the orientation linked to the individual historical events of each sacred building (Tab. 1). This method provides a higher precision than results obtained using a compass, aerial photographs (rarely zenithal), or cadastral maps (schematic profile), from which it is not possible to precisely recognize the axis or the inclinations of the walls, the oldest parts of the building and their possible overlaps. The days obtained by using the ephemeris refer to the Julian calendar and to the century in which the sacred building was founded. For the 5th and 6th centuries, the Julian calendar was 1-2 days behind the astronomical cycle. The author's methodology leads to highly accurate and reliable data, which allows one to express plausible hypotheses and to find an answer to Gerola's intuition. The difficulties in the GPS survey were due to the irregularities of the ancient walls, which required a more complex examination of all the existing walls. In the case of Ravenna, some texts speak of a shift with a rotation of about 5° that has occurred over the centuries due to the movement of tectonic plates, without however specifying how this value was calculated. The example discussed refers to the Mausoleum of Theodoric to make its axis coincide with the equinoctial line (Piazza, 2020, pp. 205-215). If this were the case, all the buildings in Ravenna and the surrounding area would have been rotated at indefinable angles. However, the results for all the sacred buildings analyzed show proper alignments pointing mostly to the sunrise or sunset on an important Christian day related to the history of the single sacred building (Tab. 1). This is exactly the case in the Mausoleum of Theodoric, which incorporates an orientation linked to the Incarnation of the Lord (25 March). The author also carried out a comparative analysis, comparing and contrasting the data obtained

by GPS surveys with those of Gerola (1936) and with the study by the astronomer Giuliano Romano (1995), who in the 1990s analyzed a part of the sacred buildings in Ravenna that Gerola had examined in 1936, perhaps not knowing the important study by the Superintendent. Romano determined the azimuths for most of the sacred buildings from the cadastral map at 2000 scale, while for a few he used a theodolite (without georeferencing). Subsequently, he calculated the declinations solely in relation to sunrise. In his text, Romano essentially speaks of two possible alignments: equinoctial or solstitial, although he did not find any alignment exactly on the equinox or solstice. Even though the values he found deviated up to 10° from the astronomical directions, Romano still considers them to be equinoctial or solstitial alignments, stating that these deviations are the result of construction errors and the impossibility for the builder to see the sun rising on the horizon inside the city (Romano, 1995, p. 108). This hypothesis appears to be implausible, especially in the case of very large angular deviations, such as ten degrees. Imagining the tracing operations that took place on the ground, ten degrees corresponds to approximately twenty consecutive solar disks seen on the horizon. But even at two degrees, it is highly unlikely to think in terms of error. Furthermore, the city of Ravenna at that time was not structured in such a way (Manzelli, 2000, p. 238) that it was impossible to choose the place where to build and the master builder appointed by the bishop and/or the ruler of the city was the most qualified. As an astronomer and historian of astronomy, Romano's work mainly focused on megalithic structures from an astronomical point of view. It is perhaps for this reason that he considered almost exclusively only equinoctial or solstitial alignments of early Christian sacred buildings. These alignments are mainly present in prehistoric structures, but not in early Christian buildings, as the author's studies have subsequently shown. In contrast to the pagan structures, over the centuries Christians had developed other religious rites, and feasts, which then entered the calendars and martyrologies as early as the 4th century after the Milan Act (313), such as the Nativity of Christ in the mid of the 4th century, the main Marian feasts (Annunciation, 25 March; Assumption, 15 August; Purification, 2 February; Nativity, 8 September), the *Cathedra* of Saint Peter, feasts of the first martyrs, which were mentioned in the *Martyrologium Hieronymianum* dating back to the 4th-5th century. Some of these days are actually reflected several times in the directions of the axes of these sacred buildings in Ravenna.

## 3. Geography and Christianity in Ravenna in the Early Christian Age

Situated in a strategic position, surrounded by dunes and protected by a vast lagoon, Ravenna was built between waterways on lagoon land. The topographical layout of the town was built with Iulius Caesar, and then with Octavianus Augustus the port of Classe was established. Various cults from the East arrived there through legionaries, artisans, and travellers, but very few traces of pagan religious buildings remain (Deichmann, 1965, p. 613). The arrival of Christianity has been attributed to Apollinaris, who according to legend, came from the East with the Apostle Peter, on his way from Antioch to Rome, and then on to Ravenna (Agnellus, 1708, vol. I, p. 124). However, this story has been questioned by modern historiography, which places the episcopate of Apollinaris at the beginning of the 3rd century. In 7th century Ravenna, a legend placed Saint Apollinaris in the 1st century; he was considered a disciple of the Apostle Peter and this claim was used to express Ravenna's supremacy over Rome at the time (Lanzoni, 1927, pp. 738-741).

## 4. Geometry, common architectural features

Ravenna is home to sacred buildings dating from the early Christian Age whose plans display various shapes: basilica (Sant'Apollinare in Classe, Sant'Apollinare Nuovo, San Francesco, Sant'Agata, San Giovanni Evangelista, the Basilica Ursiana, and the Arian Basilica dedicated to Anastasis and later

known as the Church of the Holy Spirit), cross (Church of Santa Croce, Mausoleum of Galla Placidia, Chapel of Saint Andrea), central shape (Mausoleum of Theodoric, the Neonian Baptistery and the Arian Baptistery, the Church of San Vitale). The plans of the basilicas in Ravenna are similar to each other, both in shape and proportions (except for the Church of the Holy Spirit which is shorter), reminiscent of the first early Christian basilicas such as those built in Milan in the 4th century (Basilica of Sant'Ambrogio, Santa Tecla, Sant'Eustorgio). The apses also share common characteristics, with an outer polygonal shape and an inner semicircular shape, a composition deriving from the Constantinopolitan influence, as well as in the use of materials, mainly walls built with Roman bricks (6-9 cm high and later in the 6th century 3-4 cm high) (Deichmann, 1965, p. 619) bound with a large bed of lime mortar with gravel. Instead, the Mausoleum of Theodoric was built with square blocks of Aurisina marble from Istria, which provides great luminosity to the monument. The use of pilaster strips (*lesene*) is another architectural feature of Ravenna and northern Italy, used above all on the outside of the basilicas to mark the long walls and the façade, as is the case in the Mausoleum of Theodoric, where the upper level is punctuated by pilasters carved into the stone; similarly, large round arches were common, as dictated by ancient Roman theories. Another common feature of the early Christian sacred buildings in Ravenna and Classe is undoubtedly their orientation: numerous alignments have been found with the rising or setting of the sun on 25 March (Annunciation to Mary, Incarnation of the Lord), with a probable Easter, on the *Cathedra*of Saint Peter (22 February), with a liturgically and historically important feast for the Christian Church such as the Transfiguration (Sant'Apollinare in Classe) and others (Tab. 1).

Three early Christian sacred buildings are discussed in this paper in depth (the Basilica of Sant'Apollinare in Classe, the Mausoleum of Galla Placidia with the Church of Santa Croce, and the Arian Baptistery with its Cathedral). In a forthcoming publication, the complete work will be published with the drawings of the GPS surveys, the results, and the interpretations.

## 5. Basilica of Sant'Apollinare in Classe

Romano reports an exception to the equinoctial and solstitial alignments: the case of Sant'Apollinare in Classe, a basilica built at the beginning of the 6th century. The azimuth detected by the astronomer is 66.4° and the days to the sunrise are 8 August and 6 May (Romano, 1995). With this data, he hypothesizes that the church was oriented to the sunrise on 23 July, the feast of Saint Apollinaris. But this hypothesis is unlikely because, between 23 July (real azimuth 60.5°) and 8 August (real azimuth 65.2°), there are 16 days corresponding to an angular difference of about 5°, an angle that is equal to about ten solar disks seen on the horizon. This would mean that the church's alignment was traced by moving ten solar disks. Furthermore, the angular error of 5° translated into linear measurement corresponds to 5 meters for this sacred building, which is 57 meters long: it is unrealistic to think that a builder would have made a mistake of such a magnitude. It should be noted that the Basilica is located in the open countryside to the south of Ravenna and at that time the building setting in Classe was of a modest standard, a reflection of the conditions of its inhabitants (Manzelli, 2000, p. 238); there was no visual obstacle on the horizon in the direction of the apse and the mountains are distant in the direction of the façade, therefore the builder was free to choose the place where to trace the foundations. Instead, from the georeferenced topographic survey of the Basilica, an azimuth of 65°14' in the direction of the façade-apse is obtained with a declination of 16°59' on the local horizon which for the 6th century, according to the Julian calendar, corresponds to the days of 7 May and 5 August, approximately the same as those obtained by Romano (Fig. 1a). Even if some days of tolerance are acceptable, the difference lies in the interpretation. With this data and the information on the history of the Basilica, the author can put forward a plausible theory: 6 August corresponds to the ancient feast of the Transfiguration (*Transfiguratio Domini*), a concept

emphasized in the apse by the majestic mosaic representing the Transfiguration of Christ (Bendazzi & Ricci, 1992, p. 213). The apse was already covered with mosaics at the time of the solemn consecration of the Basilica by Bishop Maximian (546-556) which took place on 9 May 549 with the translation of the body of the saint and martyr Apollinaris (Mazzotti, 2017, pp. 46-47, 78, 176, 273). 9 May was likely chosen for the translation, as on that day the rising sun, returned to the same place on the horizon, and was aligned with the church.

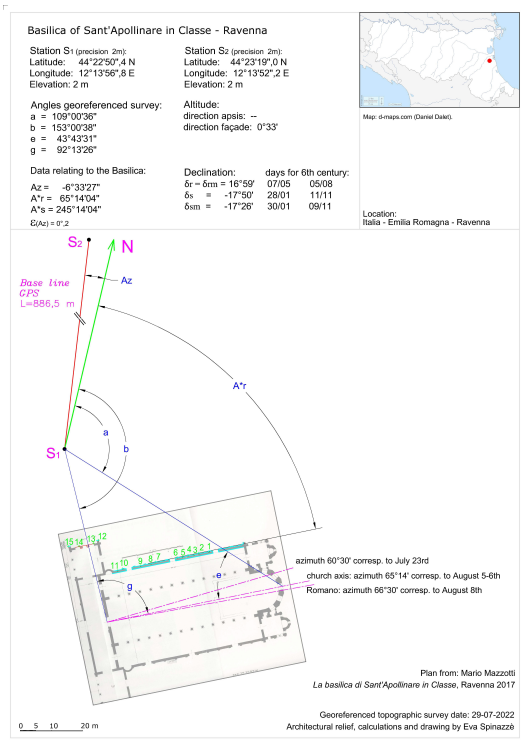
The Basilica mentioned in Agnellus' *Liber Pontificalis* was promoted by Bishop Ursicinus (533-536), financed and built by Giulianus Argentarius (Agnellus, 1708, vol. II, pp. 5, 68, 89, 94-95; Mazzotti, 2017, pp. 46-47) who dedicated it to Saint Apollinaris (Bendazzi & Ricci, 1992, p. 208).

The feast of the Transfiguration of Christ dates back for the East to the 4th century, when Empress Helena, mother of Constantine, built a church dedicated to the Transfiguration on Mount Tabor in Galilee in the same place (Bugeja, 1875, p. 48). For the West, the origin of the feast remains uncertain, but it is already celebrated in a hymn by Saint Ambrosius (4th century) named *In Transfiguratione Domini*: "O nata lux de lumine, Iesu, redemptor saeculi... Prae sole vultu flammeus, ut nix amictu candidus, in monte dignis testibus tu paruisti conditor". An ancient custom of the early Christians was to accompany sacred ceremonies with the singing of hymns, and this is how the Feast of the Transfiguration came into liturgical use. Furthermore, in Ravenna the oriental element was predominant, first with the merchants and then with the exarchal government (Mazzotti, 2017, p. 74), a good example of which are the apses with a polygonal external profile, as well as in the relationship with Milan, the previous capital of the Roman Empire. This leads us to believe that the feast of the Transfiguration of Christ (Mark 9:2-9; Matthew 17:1-9; Luke 9:28-36; Peter 1:16-17) arrived early in Ravenna and that the alignment of the Basilica with the sunrise on 6 August was deliberately chosen and underlined by the light and by the message depicted in the apse.

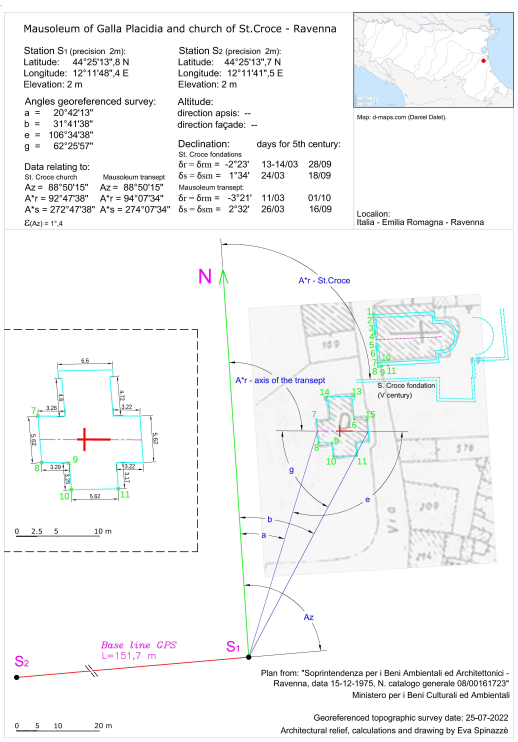
## 6. Mausoleum of Galla Placidia with the Church of Santa Croce

This Mausoleum is the burial place intended for Galla Placidia, sister of Emperor Honorius, built in the second quarter of the 5th century, shortly after the construction of the nearby Church of Santa Croce, erected between 417 and 421 (Gerola, 1936, p. 246; Cirelli, 2008, p. 254). Built in brick with an irregular cross plan, the lantern tower rises at the intersection of the two arms, enclosing the dome which is not visible from the outside. The interior is entirely in mosaic. Upon entering the mausoleum, the believer or visitor is struck by the starry mosaic vault: in the centre, there is a golden cross on a blue background surrounded by hundreds of stars, also golden. This large Latin cross is illuminated when the entrance door is opened and by the light that passes through the narrow openings. The cross, symbol of the Redeemer, underlines the alignment of the axis of the transept: Christ, with his head to the West, looks to the East, towards the Resurrection.

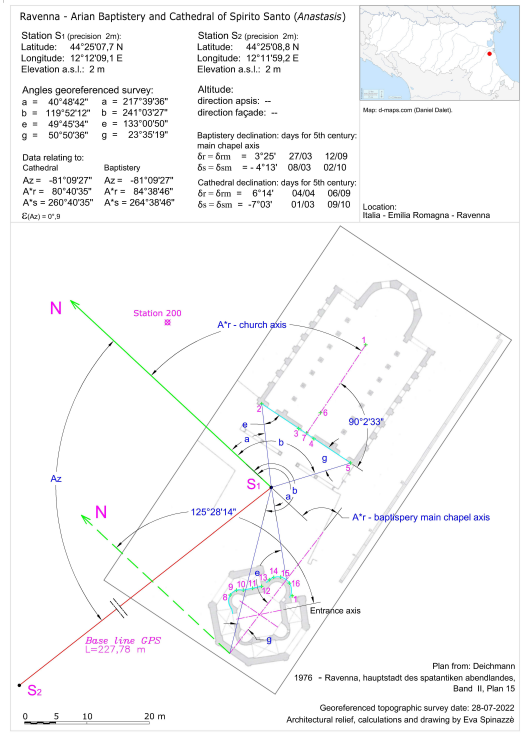
Some assume that the chapel was first dedicated to Saints Nazaro and Celso and that it was later dedicated to San Lorenzo, although the lunette at the back of the short arm of the building is splendidly decorated with mosaics, probably depicting the latter saint (Deichmann, 1974, p. 63). The hypothesis that the first building was dedicated to the Saints Nazaro and Celso is strengthened by Galla Placidia's inspiration also considering the Church of San Nazaro in Milan (*Basilica Apostolorum*, 4$^{th}$ century) with its cross-plan built by Saint Ambrosius; but also, the Church of San Simpliciano in Milan (*Basilica Virginum*, 4th century), which has a Latin cross-plan, influenced Galla Placidia's choice of this type of plan. It was Saint Ambrosius who promoted the cruciform plan in the second half of the 4th century. His poem, which can be seen in an inscription (now restored) near the apse of the *Basilica Apostolorum,*




**(a)** Basilica of Sant'Apollinare in Classe, Ravenna, first half of the 6th century.




**(b)** Mausoleum of Galla Placidia with the Church of Santa Croce, Ravenna, beginning of the 5th century.




**(c)** Arian Baptistery with its Cathedral erected by King Theodoric, Ravenna, end of the 5th century/beginning of the 6th century.

**Fig. 1:** Drawings of the georeferenced topographic surveys carried out in July 2022 with the results of the calculations. Theodolite Geodimeter, System 500. Garmin GPSmap 62 (in 2022). Architectural relieves, calculations, and drawings made by the author.

relates the plan of the building to the shape of the Cross of Christ: “Forma crucis templum est, templum victoria Christi, sacra triumphalis signat imago locum”.

The Mausoleum, with an azimuth of 94°07’ – 274°07’ along the transept axis, is oriented towards the setting of the sun on the day of the Annunciation to Mary, the Incarnation of the Lord, celebrated as early as the 4th century on 25 March (Fig. 1b). In ancient times, the 25 March symbolically represented not only the Resurrection, the rebirth but also the Passion of Christ. These are two moments in a life that come one after the other: To be reborn, one must die as the sun sets. At the beginning of Christianity, the planimetric form was evolving, and the Latin cross appeared with the transept slightly inclined according to the axis of the apse which could symbolically represent the crucifixion of Christ with his head inclined on the cross. This iconography was resumed in later centuries with the planimetric solution of the inclination of the apse in relation to the central nave. This shape, which the author has found several times in Christian sacred buildings, incorporates an orientation to the day of Easter, symbolizing the Passion of Christ with the setting sun and the rebirth with the rising sun. It is precisely this concept that is conveyed in the Mausoleum, with the alignment of the axis of the transept and the golden Latin cross mosaic inside the dome, which had an orientation with the setting of the sun around the day of the Incarnation of Christ, 25 March; also in the nearby Church of Santa Croce, built by Galla Placidia when the Empress resided in Ravenna (Cirelli, 2008, p. 204), the shape of the cross is emphasized, both, through the name of the church itself and its plan.

In the *Life* of Bishop Johannis the XX of Ravenna, the protohistorian Andreas Agnellus presents a tradition according to which the Empress Galla Placidia constructed the Church of Santa Croce and adorned it with precious stones and sculpted stucco (Agnellus, 1708, vol. I, pp. 284-286; Deichmann, 1974, p. 51-59). The original part of the church can still be seen today in the north and south walls of the sacred building. The church had a narthex that connected it to the Mausoleum. Then, in the Romanesque period, the apse was transformed from rectangular to semicircular (Gerola, 1912, pp. 211-213). In the late 14th century, some major modifications were made: demolition of the transept (the north and south arms) and shortening of the presbytery area and the apse. In the late 16th century, the narthex was demolished and the church was shortened on the west side of the façade to create a small street that still runs between the church and the Mausoleum.

The cross is a sign of victory, and a church with a cruciform plan serves to emphasize the triumph of Christ. In ancient times, the 25 of March was considered the Death and Incarnation of Jesus Christ. According to an ancient tradition, "it is believed that (Christ) was conceived on 25 March, the day on which he also suffered the Passion" (*Octavo enim Kalendas Apriles conceptus creditur quo et passus*), as St. Augustine states in his work *Trinity*, IV.5.9. The cross is a prominent symbol of the triumph over death. The ancient foundations on the south side of the church were topographically surveyed and the GPS survey gave an azimuth of 92°02’ in the direction of the façade-apse and 272°02’ in the direction of the apse-façade. The declination for sunset is 1°03’ which corresponds to the sunset around the vigil of 25 March and when the sun returned to the same point on the horizon on 20 September. Despite an alignment on the day of the *Incarnatione Domini* the church and the mausoleum display an “Easter orientation”: around the presumed years of construction of the church, the sunset on Easter Eve, aligned with the axis of the church in the year 414 (22 March, Easter); and for the Mausoleum the sunset on Easter Eve aligned with its transept in the year 422 (26 March, Easter). The alignments lead to these dates and, when considered in conjunction with the two sacred buildings, a plausible theory can be formulated, according to which this orientation conveys the meaning of the Passion and Resurrection of Christ. The moment of sunset can be seen as a commemoration of the Passion of Christ, as Saint Augustine points out in his work *Trinity*, IV.6.10: Christ was buried when it was already evening, that is, at the end of the day. Saint

Ambrosius also wrote a hymn in honour of *De sancta Cruce*, which extols the wonderful sign of the cross and Christ, the focal point of this sacred emblem: “Tu, Christe, rex piissime, huius crucis signaculo”.

## 7. Arian Baptistery with its Cathedral erected by Theodoric

The Basilica of the Holy Spirit was built by King Theodoric (493-526) at the end of the 5th or beginning of the 6th century, to give his people a sacred building of the Arian faith, dedicating it to the Resurrection: *Anastasis Gothorum* (Deichmann, 1974, p. 245). *Anastasis* emphasizes the celebration of the Easter Resurrection, from which both the Arian Cathedral and the Catholic Ursiana Cathedral derive their names (Deichmann, 1974, p. 245; Gerola, 1936, p. 246; Agnellus, 1708, vol. II, pp. 122-124, 131, app. p. 35). The georeferenced topographic survey carried out on the church gives an azimuth of 80°40’ for its axis, corresponding to a declination of 6°14’ for the sunrise on the local horizon on 4 April and 6 September. The church incorporates a probable Easter orientation with the sunrise (around 4 April) and the feast of the Nativity of Mary on 8 September. Sources suggest that it was built in the early years of King Theodoric’s reign in Ravenna (Deichmann, 1974, p. 245): at that time, the probable years in which Easter fell around 4 April were 497 (6 April) and 500 (2 April). A stone’s throw from the church is the Arian Baptistery dedicated to Saint John the Baptist, built together with the church and mentioned by Agnellus in the *Life* of Bishop Agnellus (556-570) (Agnellus, 1708, vol. II, pp. 122-123). The Arian Baptistery has a central, octagonal plan with four protruding niches, including a larger one facing northeast, built entirely in bricks. Inside, the dome is covered with mosaics depicting John the Baptist baptizing Christ

| **Early Christian building church (c); baptistery (b); Place: Ravenna, Italy Date of construction** | **Geogr. coord. Station 1 Lat. N. Long. E.** | **Geogr. coord. Station 2 Lat. N. Long. E.** | **Azimuth true rising setting** | **Decl. on a.h. rising setting** | **Uncer. of az <** | **Days corresp. to foundation age rising setting** | **Horizon Altitude rising setting** | **Decl. on l.h. rising setting** | **Days corresp. to foundation age rising setting** | **Link with the history of the sacred building of the centuriation interpretation** |
|---|---|---|---|---|---|---|---|---|---|---|
| Cathedra Ursiana | 44°24'53",4 | 44°24'59",2 | 126°03'04" | -25°18' | | --- | --- | -25°18' | --- | |
| the end 4th, beginning 5th century | 12°11'49",8 | 12°11'55",7 | 306°03'04" | 24°24' | 0°,9 | summer solstice | --- | 24°24' | summer solstice | summer solstice |
| Baptistery of Neon | 44°24'53",4 | 44°24'59",2 | 76°25'42" | 9°14' | | 13 April, 29 August | --- | 9°14' | 13 April, 29 August | Probable Easter |
| beginning 5th century | 12°11'49",8 | 12°11'55",7 | 256°25'42" | -10°03' | 0°,9 | 21 Feb., 19 October | 0°21' | -9°48' | 22 Feb., 18 October | *Cathedra Petri*, 22 February |
| Chapel of St. Andrew | 44°24'53",4 | 44°24'59",2 | 37°51'54" | 33°50' | | *Crux Maior* | --- | 33°50' | *Crux Maior* | *Crux Maior* of the constellation Cygnus |
| 5th century | 12°11'49",8 | 12°11'55",7 | 217°51'54" | -34°49' | 0°,9 | --- | 0°41' | -34°14' | --- | |
| Church of St. Andrew | 44°24'55",6 | 44°24'59",5 | 37°49'34" | 33°51' | | *Crux Maior* | --- | 33°51' | *Crux Maior* | *Crux Maior* of the constellation Cygnus |
| 5th century - foundation south wall | 12°11'38",1 | 12°11'31",4 | 217°49'34" | -34°50' | 1°,2 | --- | 0°41' | -34°15' | --- | |
| Church of St. Crux | 44°25'14",2 | 44°25'15",7 | 92°02'15" | -1°51' | | 16 March, 27 Sep. | --- | -1°51' | 16 March, 27 Sep. | |
| 5th century | 12°11'49",9 | 12°11'49",9 | 272°02'15" | 1°02' | 1°,2 | 23 March, 20 Sep. | --- | 1°02' | 23 March, 20 Sep. | *Incarnatione Domini*, 25 March |
| Mausoleum of Galla Placidia | 44°25'13",8 | 44°25'13",7 | 92°47'38" | -2°23' | | 14 March, 28 Sep. | --- | -2°23' | 14 March, 28 Sep. | |
| apsis wall - 5th century | 12°11'48",4 | 12°11'41",5 | 272°47'38" | 1°34' | 1°,2 | 24 March, 18 Sep. | --- | 1°34' | 24 March, 18 Sep. | *Incarnatione Domini*, 25 March |
| Mausoleum of Galla Placidia | 44°25'13",8 | 44°25'13",7 | 94°07'34" | -3°21' | | 11 March, 1 Oct. | --- | -3°21' | 11 March, 1 Oct. | |
| transept axis -5th century | 12°11'48",4 | 12°11'41",5 | 274°07'34" | 2°32' | 1°,2 | 26 March, 16 Sep. | --- | 2°32' | 26 March, 16 Sep. | *Incarnatione Domini*, 25 March |
| Church of St. Giovanni Evangelista | 44°25'07",1 | 44°25'14",6 | 86°09'01" | 2°20' | | 25 March, 17 Sep. | --- | 2°20' | 25 March, 17 Sep. | *Incarnatione Domini*, 25 March |
| 5th century | 12°12'22",5 | 12°12'22",0 | 266°09'01" | -3°09' | 0°,9 | 12 March, 30 Sep. | --- | -3°09' | 12 March, 30 Sep. | |
| Basilica of St. Francesco (Pietro) | 44°24'56",7 | 44°25'03",9 | 75°08'41" | 10°08' | | 16 April, 27 August | --- | 10°08' | 16 April, 27 August | Probable Easter |
| 5th century | 12°12'00",4 | 12°11'56",7 | 255°08'41" | -10°57' | 0°,9 | 19 Feb., 21 October | 0°20' | -10°43' | 20 Feb., 20 October | *Cathedra Petri*, 22 February |
| Church of Spirito Santo | 44°25'07",7 | 44°25'08",8 | 80°40'35" | 6°14' | | 4 April, 6 Sep. | --- | 6°14' | 4 April, 6 Sep. | Probable Easter: 6/4/497, 2/4/500 |
| 5th century | 12°12'09",1 | 12°11'59",2 | 260°40'35" | -7°03' | 0°,9 | 1 March, 9 October | --- | -7°03' | 1 March, 9 October | *Nativitate Mariae Virginis*, 8 September |
| Arian Baptistery | 44°25'07",7 | 44°25'08",8 | 125°28'14" | -25°55' | | --- | --- | -25°55' | --- | |
| nord east wall - 5th century | 12°12'09",1 | 12°11'59",2 | 305°28'14" | 24°02' | 0°,9 | summer solstice | --- | 24°02' | summer solstice | summer solstice |
| Arian Baptistery | 44°25'07",7 | 44°25'08",8 | 84°38'46" | 3°25' | | 27 March, 12 Sep. | --- | 3°25' | 27 March, 12 Sep. | *Incarnatione Domini*, 25 March |
| chapel axis - 5th century | 12°12'09",1 | 12°11'59",2 | 264°38'46" | -4°13' | 0°,9 | 8 March, 2 October | --- | -4°13' | 8 March, 2 October | |
| Mausoleum of Theodoric | 44°25'29",2 | 44°25'41",6 | 84°26'58" | 3°36' | | 28 March, 12 Sep. | --- | 3°36' | 28 March, 12 Sep. | *Incarnatione Domini*, 25 March |
| 5th century | 12°12'32",6 | 12°12'26",3 | 264°26'58" | -4°25' | 0°,5 | 8 March, 2 October | --- | -4°25' | 8 March, 2 October | |
| Basilica of St. Apollinare Nuovo | 44°24'59",9 | 44°24'44",8 | 76°29'19" | 9°11' | | 12 April, 29 August | --- | 9°11' | 12 April, 29 August | Probable Easter |
| Domini Nostri Jesu Christi, 6th century | 12°12'15",5 | 12°12'22",6 | 256°29'19" | -10°01' | 0°,4 | 21 Feb., 19 October | 0°21' | -9°48' | 22 Feb., 18 October | *Cathedra Petri*, 22 February |
| Basilica of St. Apollinare in Classe | 44°22'50",4 | 44°23'19",0 | 65°14'04" | 16°59' | | 7 May, 5 August | --- | 16°59' | 7 May, 5 August | *Transfiguratio Domini*, 6 August |
| 6th century | 12°13'56",8 | 12°13'52",2 | 245°14'04" | -17°50' | 0°,2 | 28 Jan., 11 Nov. | 0°33' | -17°26' | 30 Jan., 9 Nov. | *Purificatio Mariae Virginis*, 2 February |
| Basilica of St. Vitale | 44°25'13",8 | 44°25'13",7 | 132°45'34" | -28°42' | | Midsummer lunistice | --- | -28°42' | Midsummer lunistice | M. Midsummer L.: 19/6/536, 20/6/555 |
| 6th century | 12°11'48",4 | 12°11'41",5 | 312°45'34" | 29°18' | 1°,4 | Midwinter lunistice | --- | 29°18' | Midwinter lunistice | M. Midwinter L.: 25/12/535, 24/12/554 |
| Church of St. Maria Maggiore | 44°25'13",8 | 44°25'13",7 | 116°38'08" | -19°06' | | 23 Jan., 15 Nov. | --- | -19°06' | 23 Jan., 15 Nov. | *Sancta Maria ad Martyres*, 13 May |
| 6th century | 12°11'48",4 | 12°11'41",5 | 296°38'08" | 18°14' | 1°,4 | 1 August, 11 May | --- | 18°14' | 1 August, 11 May | *Sancta Maria ad Nives*, 5 August |
| Church of St. Agata Maggiore | 44°24'50",1 | 44°24'43",5 | 81°20'17" | 5°46' | | 3 April, 7 Sep. | --- | 5°46' | 3 April, 7 Sep. | Probable Easter |
| ancient north wall - 5th century | 12°12'03",8 | 12°12'05",3 | 261°20'17" | -6°35' | 0°,9 | 2 March, 8 October | --- | -6°35' | 2 March, 8 October | *Nativitate Mariae Virginis*, 8 September |
| Church of St. Giovanni Battista | 44°25'14",4 | 44°25'18",1 | 88°01'20" | 1°01' | | 22 March, 19 Sep. | --- | 1°01' | 23 March, 19 Sep. | *Incarnatione Domini*, 25 March |
| 5th-6th century | 12°12'02",5 | 12°12'02",2 | 268°01'20" | -1°49' | 1°,8 | 14 March, 26 Sep. | --- | -1°49' | 15 March, 26 Sep. | *Conceptio Sci Iohannis baptiste*, 24 Sep. |
| Church of St. Salvatore a Calchi | 44°24'58",1 | 44°24'47",7 | 74°42'19" | 10°26' | | 15 April, 25 August | --- | 10°26' | 15 April, 25 August | Probable Easter |
| foundation - 6th century | 12°12'15",9 | 12°12'22",1 | 254°42'19" | -11°16' | 0°,6 | 18 Feb., 21 October | 0°47' | -10°42' | 20 Feb., 19 October | *Cathedra Petri*, 22 February |
| Church of St. Giovanni e Paolo | 44°25'06",3 | 44°24'58",4 | 125°22'21" | -24°52' | | --- | --- | -24°52' | --- | feast martyrs John and Paul, 26 June |
| 6th century | 12°11'37",8 | 12°11'53",1 | 305°22'21" | 23°58' | 0°,5 | summer solstice | --- | 23°58' | summer solstice | summer solstice |
| Roman *centuriation* - approx. *cardo* | 44°24'49"7 | 44°25'08"0 | 36°07' | | | | | | | |
| 36°07' (cardo) + 90° = *decumanus* | 12°11'33"1 | 12°11'51"8 | 126°07' | -25°20' | | | --- | -25°20' | | |
| *decumanus* | | | 306°07' | 24°27' | | approx. summer sol. | --- | 24°27' | approx. summer sol. | summer solstice |
| 1st century BC - 1st century AC | Porta Aurea | Ponte Augusto | few evidence of the ancient Roman *centuriation* | | | | | | | |

**Tab. 1:** GPS survey Data, results and interpretations of the analyzed early Christian sacred buildings in Ravenna. (Abbreviations: ah/lh=astronomical/local horizon; Decl=declination; M Midsummer/Midwinter L=Major Midsummer/Midwinter Lunistice; Uncer=Uncertainty of the azimuth).

in the Jordan. The Arian Baptistery has many architectural and decorative similarities with the Orthodox Baptistery, which was built a century earlier. It is smaller and currently less decorated than the Orthodox one with an orientation of the axis passing through the large apse at sunrise on 25 March, with an azimuth of 84°38' and a declination of 2°25' on the local horizon (Fig. 1c). This apse (azimuth 84°38) has the same orientation as the axis of the Mausoleum of Theodoric (azimuth 84°27'), with only a difference of a few minutes between the two horizontal angles and on a free horizon, which does not affect the calculations. Both sacred buildings built at the behest of the Ostrogoth king are oriented to the day of the Incarnation of the Divine Word.

## 8. Conclusion

Scholars of the last century have tried to explain the divergences in the orientation of early Christian and medieval churches by considering them anomalies and construction errors. This is because they have tried to find the orientations of pagan structures, mainly aligned with the equinoxes and solstices. An exception is represented by Giuseppe Gerola who, a century ago, examined all the Christian sacred buildings of the early Christian Age in Ravenna and the surrounding area to understand their orientation. He used the compass to determine the azimuth. The azimuth data alone did not allow him to obtain satisfactory results and to connect the measured azimuth with any of his orientation criteria.

In the present research, the author has examined the sacred buildings in Ravenna studied by Gerola, carrying out for each one an accurate georeferenced topographic survey in July and August 2022 (Tab. 1). The author's results have established a relationship between the building and the orientation criterion that is reflected in some of the considerations formulated by Giuseppe Gerola (orientation to the sunrise on the day of the feast of the titular saint; to the sunrise on a day of particular importance for the founder; to the sunrise on the foundation of the church), and she was able to confirm the validity of the Superintendent's intuition, expressed a century ago in his fundamental work *L'orientazione delle chiese di Ravenna antica* (1936). This research has consolidated the hypothesis on the orientation of Christian sacred buildings by going back to the origins of Christianity and has succeeded in confirming Gerola's relevant intuition with a scientific approach.

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