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THE PANAGIA KOSMOSOTEIRA AT PHERAI (VIRA):  
THE NATURAL LIGHTING OF THE KATHOLIKON

With eight plates

I. INTRODUCTION

The Monastery of the Panagia Kosmosoteira was founded in Byzantine Vira by the sebastokrator Isaac Komnenos, third son of the Emperor Alexios I, in 1151–52, according to the monastery's typikon, which Isaac himself drew up.<sup>1</sup>

All that survives of the monastery today is the katholikon, a splendid edifice, which reflects the art and culture of 12<sup>th</sup>-century Constantinople.

Typologically, it is a variant of the simple tetrastyle cross-in-square type of church with a dome (Figs. a–b), the east side of which rests on two long piers, which separate the sanctuary from the prothesis and the diakonikon, and the west side on two very slender pairs of columns.<sup>2</sup> The corner bays are covered by small domes.

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<sup>1</sup> L. PETIT, Typicon du monastère de la Kosmosotira près d'Aenos (1152). *IRAIK* 13 (1908); G.K. ΠΑΡΑΖΟΓΛΟΥ, Τυπικόν Ισαάκιου Κομνηνού της Μονής Θεοτόκου της Κομοσοότειρας. Komotini 1994; N. P. ŠEVČENKO, Kosmosoteira: Typicon of the Sebastokrator Isaac Komnenos for the Monastery of the Mother of God Kosmosoteira near Bera, in: Byzantine Monastic Foundation Documents. A Complete Translation of the Surviving Founders' Typika and Testaments, II. Ed. J. THOMAS – A. CONSTANTINIDES HERO (DOS 35). Washington, D.C. 2000, 782ff.

<sup>2</sup> A.K. ORLANDOS, Τὰ βυζαντινά μνημεία τῆς Βήρας. *Θρακικά* 4 (1933) 3–34; S. SINOS, Die Klosterkirche der Kosmosoteira in Bera (Vira) (*Byz. Archiv* 16). Munich 1985; Th. USPENSKIJ, Konstantinopol'skij Saraljskij Kodeks Vos'miknizija. *IRAIK* 12 (1907) 3–28; Ch. ΒΑΚΙΡΤΖΙΣ, Byzantine Thrace 330–1453, in: Thrace (ed. General Secretariat of the Region of East Macedonia-Thrace). Komotini 1994, 189–199; Ch. ΒΑΚΙΡΤΖΙΣ, Western Thrace in the Early Christian and Byzantine Periods: Results of Archaeological Research and the Prospects, 1973–1987, in: First International Symposium for Thracian Studies. Byzantine Thrace: Image and Character. *BF* XIV,1 (1989) 49–50; I. VOLONAKIS, Η Κομοσοότειρα των Φερόων. Alexandroupolis 1975, 7–12; Ch. ΒΟΥΡΑΣ, Βυζαντινή και Μεταβυζαντινή Αρχιτεκτονική. Athens 2001, 120; N. ΓΙΟΛΕΣ, Βυζαντινή Ναοδομία 600–1204. Athens 1987, 105–106.

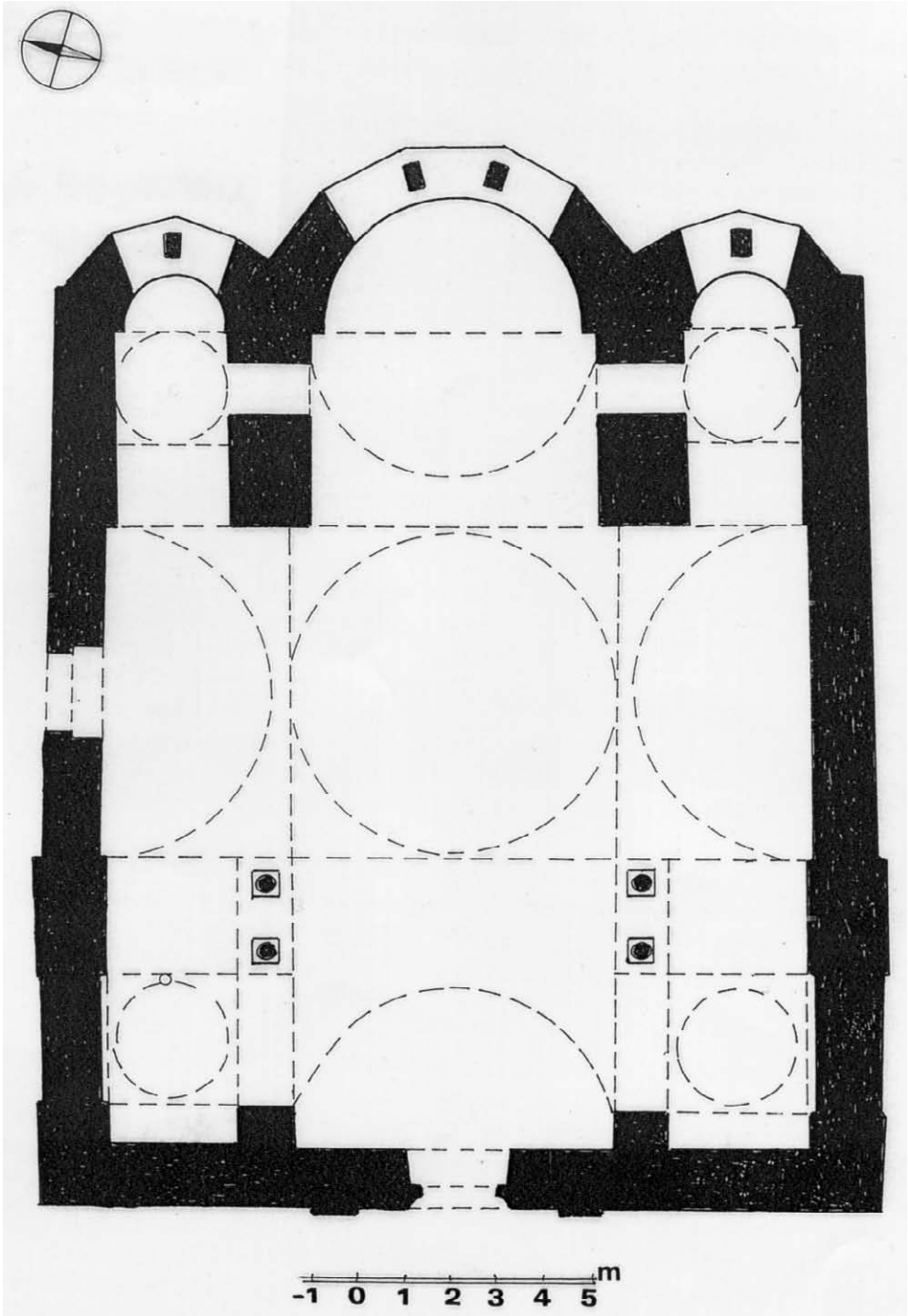


Fig. a: Panagia Kosmosoteira. Plan (A. Orlandos)

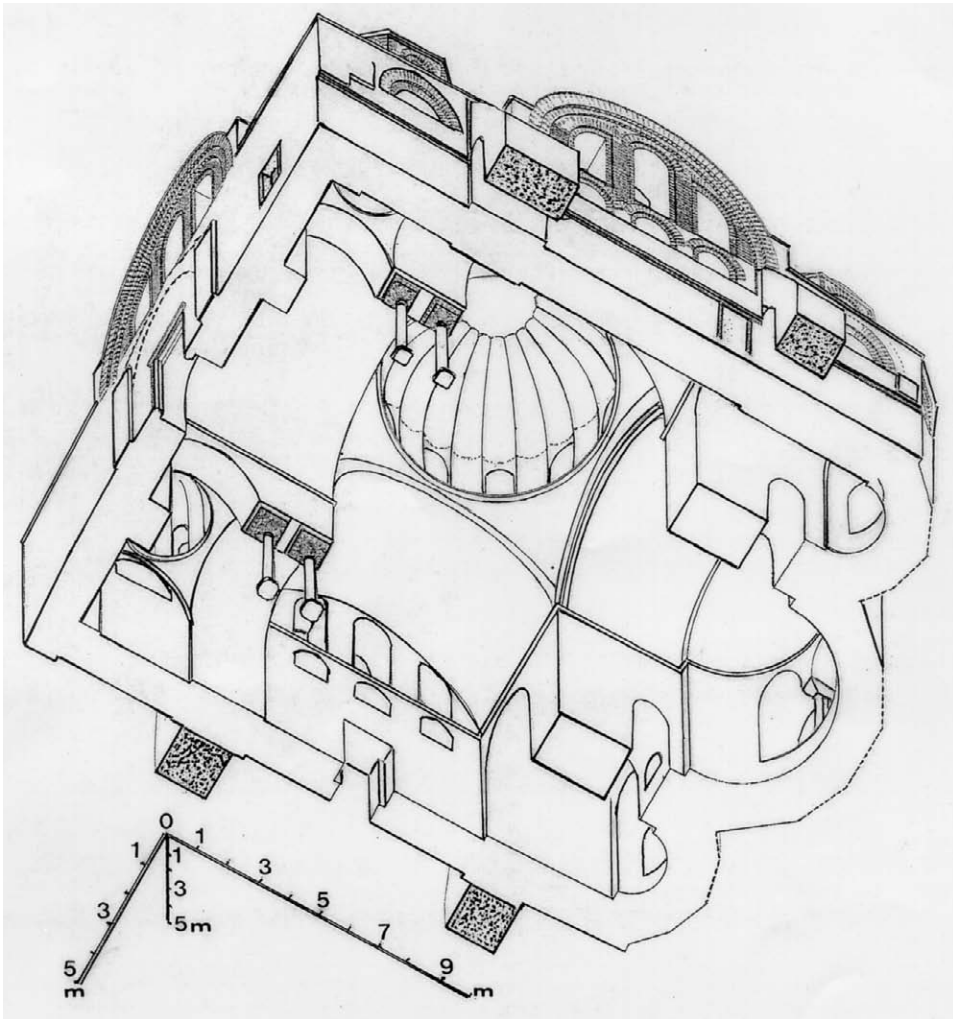


Fig. b: Panagia Kosmosoteira. Axonometric view (12th Ephoreia of Byzantine Antiquities.  
 Drawn by Manolis Korres)

This solution, which is original in both conception and execution, creates a spacious interior which provides the viewer, wherever he or she stands, with a clear view of the arches and the dome above.

These features lead one to assume that the Constantinopolitan architect of the Kosmosoteira may have been instructed by the founder to base the design on the interior of the Hagia Sophia.

The interior of the Kosmosoteira was adorned with frescoes<sup>3</sup> by a team of painters which the founder very probably brought from Constantinople.

The tomb of the Byzantine prince is believed to lie inside the church, beneath the north-west dome.<sup>4</sup>

The originality of the architectural solution applied in the Panagia Kosmosoteira has been discussed by numerous researchers. Of particular interest, however, is Ch. Bakirtzis' observation<sup>5</sup> that: 'In his endeavours to endow the building with mystical meaning and transmute it into a spiritual concept, the master builder of the Kosmosoteira sought to eliminate optically these four bearing static elements, so that the whole overlying curvature of the vault appears to be inexplicably suspended...'

Three factors combine to produce this impression: space, time and light. The first of these three factors has already been studied. It remains, therefore, to investigate the role played by natural light, in connection with time, in the conception and application of this specific architectural solution.<sup>6</sup>

This investigation is the purpose of the present study, which is based on a series of observations and measurements of the distribution of light in the interior of the church.

## 2. THE ORIENTATION OF THE CHURCH – VISUAL ORGANIZATION OF SPACE

In the first phase of the investigation, the following were determined:

- a) the orientation of the church, with the aid of a compass;
- b) the azimuth of the sun at sunrise for Pherai's latitude (40° 54' N).

<sup>3</sup> ORLANDOS 22–26; SINOS 174–205; BAKIRTZIS, Byz. Thrace 192–199; Ch. KONSTANDINIDI, Παρατηρήσεις σε παραστάσεις ιεραρχών στο καθολικό της μονής Παναγίας Κοσμοσωτείας στη Βήρα, in: First International Symposium for Thracian Studies. Byzantine Thrace: Image and Character. *BF* XIV,1 (1989) 305–317; M. PANAYOTIDI, The wall-paintings in the Church of the Virgin Kosmosoteira at Feraï (Vira) and stylistic trends in 12<sup>th</sup> century painting, *ibid.* 459–472.

<sup>4</sup> N. ŠEVČENKO, The Tomb of Isaak Komnenos at Pherrai, *Greek Orth. Theol. Rev.* 29 (1984) 135–139; ORLANDOS 27–28; BAKIRTZIS 189; SINOS 57; R. OUSTERHOUT, Where was the Tomb of Isaak Komnenos?, in: Eleventh Annual Byzantine Studies Conference. Toronto 1985, 34; R. OUSTERHOUT, review of Stefan Sinos, *Speculum* 63 (1988) 229–231.

<sup>5</sup> BAKIRTZIS, Byz. Thrace 189.

<sup>6</sup> M. KALLIGAS, Η αισθητική του χώρου στις Έλληνικές Εκκλησίες. Ή Αθήνα στο Μεσαίωνα. Athens 1946; P.A. MICHELIS, Η αισθητική προσέγγιση της βυζαντινής τέχνης. Athens 1990, 121–126; G. TRIANTAFILIDIS, Στοιχεία φυσικού φωτισμού τών βυζαντινών εκκλησιών. *AD* 3 (1964); J. POTAMIANOS, Το φως στη βυζαντινή εκκλησία. Thessaloniki 2000.

The measurements revealed that the sanctuary has a  $15^\circ$  deviation to the north-east (NE) and is slanted towards Constantinople ( $41^\circ$  N).<sup>7</sup>

As for the azimuth, it was found that a) in spring and autumn sunrise coincides with the church's central axis, with a small deviation from month to month; b) in winter it coincides with the axis of the southern sanctuary windows, while in summer it coincides with that of the northern ones.

This particular choice of orientation determines the alignment of the whole building in relation to the path of the sun. Thus the church's windows – those in the dome and the tympana – possess a specific orientation and the light is directed at certain points of the interior, creating effects which might be described today as chance phenomena.

Apart from anything else, the lighting enables the visitor, on entering the church, to view the interior. Thus when he stands in the main entrance he can see the whole of the sanctuary from the prothesis to the diakonikon, in an angle of view of  $42^\circ$  (Fig. c), and if he looks to the left or to the right, his gaze will pass through the pairs of columns and extend as far as the middle of the sanctuary apse. Furthermore, if he stands beneath the north-west or south-west dome he may observe, through the nearest pair of columns, the width of the cross-arm, with an angle of view of  $21^\circ$  (i.e. half of the angle of  $42^\circ$ ) and the height of the tympanum with an angle of view of  $30^\circ$ . On the vertical plane, his vision also extends from the centre of the dome to the highest point of the semi-dome of the sanctuary apse – also an angle of view of  $42^\circ$  – and from the base of the dome to the floor (Fig. d).

From the foregoing it may be concluded that the angle of view depends on the dimensions of the building.<sup>8</sup> It may also be concluded that there is a relationship between the dimensions of the various architectural elements of the church<sup>9</sup>, namely:

- the height of the columns is equal to the height of the three-light window in the sanctuary apse and to  $\frac{1}{2}$  of the internal height of the central dome;

<sup>7</sup> ORLANDOS 30, Fig. 20. The plan shows the monastery's fortifications together with the katholikon, where the orientation is indicated. According to this, the sanctuary apse lies at an angle of  $90^\circ$  to north. Our recent measurements, however, have shown that the sanctuary does not face due east but lies at an angle of  $15^\circ$  to the north-east of it, in the direction of Constantinople. Furthermore, the orientations of the openings are directly connected with the angle of the sun's azimuth at different times of the year.

<sup>8</sup> The human eye, if it remains still, has a conical angle of vision of between  $30^\circ$  and  $45^\circ$ : the angle of  $42^\circ$ , therefore, lies within these limits.

<sup>9</sup> Sinos 157–176; H. BUCHWALD, Lascarid Architecture. *JÖB* 28 (1979) 262–296, and *JÖB* 42 (1992) 293–321; R. OUSTERHOUT, *The Architecture of the Kariye Camii in Istanbul*. Washington D.C. 1987, Fig. 49.

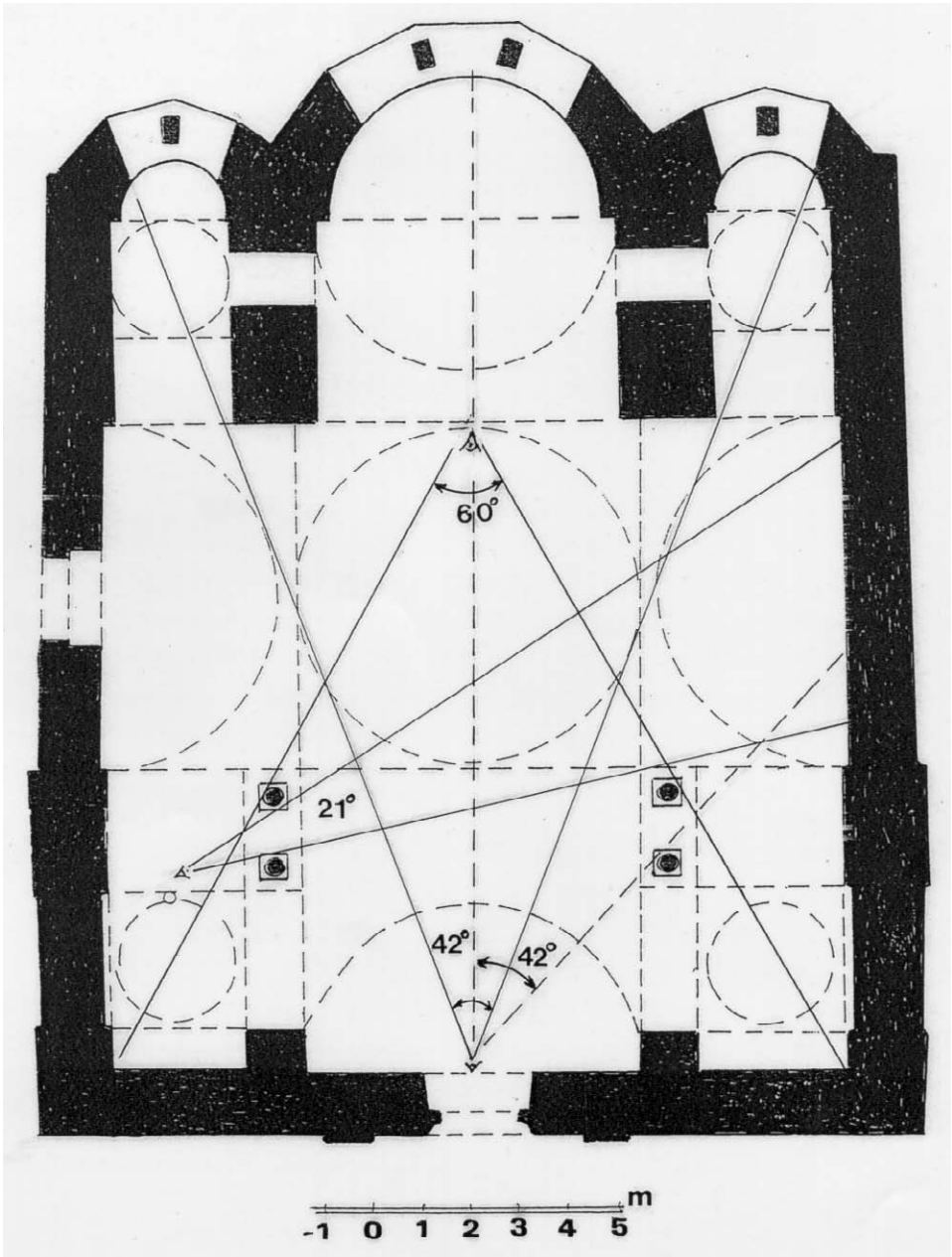


Fig. c: Panagia Kosmosoteira. Horizontal angle of view

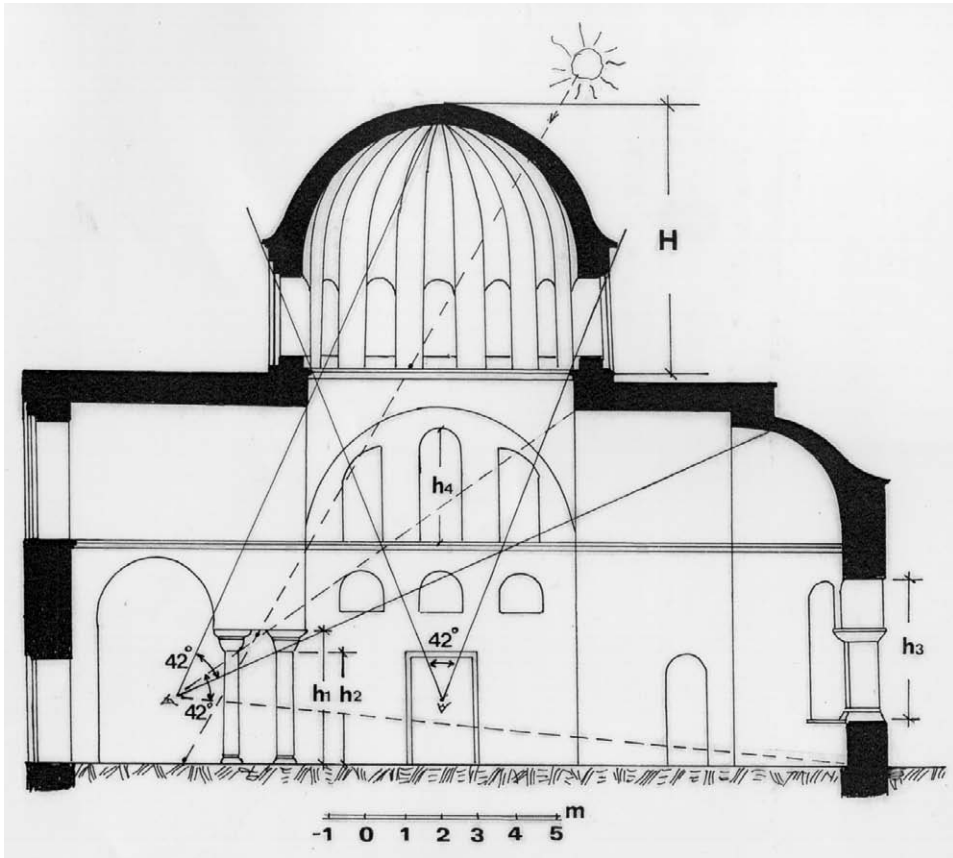


Fig. d: Panagia Kosmosoteira. Vertical angle of view

- the columns and the central arched window in each arm of the cross are equal in height;
- the distance between the two columns in each pair equals the width of the lateral windows in the tympana.

On the basis of the above observations, an investigation of the lighting conditions in the interior of the church acquires particular significance.

### 3. NATURAL LIGHT IN THE INTERIOR OF THE CHURCH

During the course of the investigation a series of observations were made of the path of the sun and the directions of its rays within the interior of the church, as well as a series of measurements (in Lux) of the

vertical and horizontal illuminance at certain points in the church. The instrument's sensor was fixed at a distance of 1.60 m. from the floor<sup>10</sup>.

The measurements were taken in conditions of sunlight, for only then can strong variations in the light be observed. In cloudy weather<sup>11</sup>, on the other hand, the lighting is even and lacks any distinctive features.

Next, a note was made of the modern interventions that currently affect the distribution of light in the interior of the church. It was found that the following have been bricked up: a) the two lateral lights of the window in the sanctuary apse and a considerable section of the central light of the same window; as well as a window in the prothesis and a window in the diakonikon; b) the five windows facing the cross-arms of the eight in each of the corner domes. In addition, the sills of the windows in the central dome and the corner domes have been raised by 0.40 m.

The windows of the church used to contain panels of circular glass panes, fragments of which have been found in the east and south windows of the south-east dome.<sup>12</sup>

During the two-and-a-half-year period over which the investigation was conducted, a considerable amount of data was gathered which it is impossible to present in a short publication of this type. For this reason only the results of the observations will be presented here. These fall into two categories: the first consists of observations on the general lighting conditions for each season of the year, while the second consists of observations on the lighting conditions during the different months of the year in the north-west and south-west corner bays, i.e. the area of the church where the two pairs of columns are located and in which researchers are currently most interested.

This 'arbitrary' presentation of the natural lighting conditions should assist the reader to understand the relationship between light and architectural form in this particular monument.

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<sup>10</sup> The Panagia Kosmosoteira is a parish church in which the Divine Liturgy and all the sacraments are celebrated. For this reason the church contains moveable furniture and furnishings (pews, icon-stands, candelabra, seats, rugs, etc.). In these conditions it was not possible to carry out readings on the floor. I therefore chose the height of 1.60 m. partly because this is the height of an average person and partly because the readings would not be affected by the furniture.

<sup>11</sup> Observations and readings in cloudy conditions were made throughout the course of the investigation. The results, however, revealed that in these conditions the lighting of the church is uniform. This means that the light is diffuse in all parts of the church; sometimes it is very bright and at others dim, even gloomy. This is the time when artificial lighting should be used. In these conditions, therefore, it is difficult to draw conclusions.

<sup>12</sup> Ch. ΒΑΚΙΡΤΖΙΣ, Φέρες – Κοσμοσώτειρα. *AD* 47 (1997) 506–507.



The dates which are mentioned in this study follow the Gregorian calendar which is in use today. For greater accuracy, however, these should be converted to the Julian calendar by subtracting thirteen days in each case.

### 3.1 *General lighting conditions*

#### 3.1.1 Winter<sup>13</sup>

During the winter three measurements were taken, one for each month: 11 December (sunrise 7.30 a.m., sunset 5.06 p.m.); 23 January (sunrise 7.36 a.m., sunset 5.39 p.m.); and 28 February (sunrise 7.00 a.m., sunset 6.15 p.m.).

During this period, between 7.30 and 8.30 a.m., the first rays of sunlight become visible in the vicinity of the north-west pendentive of the central dome (Pl. 1a). At this moment the dome is the brightest point in the church. In contrast, today the sanctuary is much dimmer than it used to be owing to the alterations in the original form of the windows.

If, however, the sanctuary was recreated in its original form, it would be much brighter. Consequently, in the morning, after sunrise, the church would be illuminated on both its horizontal and vertical axes at the same time.

Gradually the light beams move from the dome towards the north arm of the cross, i.e. the N-S axis (11.30 a.m.). Light beams now become visible on the frescoes in the north tympanum (Pl. 1b); at the same time images of the windows in the south cross-arm are formed on the floor, with the result that the area is flooded with light.

If the windows were covered with screens, then the amount of incoming light and, therefore, glare would be reduced. The visitor would then be able to observe the frescoes more easily than is possible today.

At noon, between 12.00 and 1.00 p.m., the sun's rays are directed by the windows in the south cross-arm onto the icon-screen, while the light

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<sup>13</sup> According to my calculations, the orientation of the south windows in the sanctuary apse, the prothesis and the diakonikon coincides with the azimuth of the sun at sunrise (60°) and the maximum height of the sun during the winter does not exceed the angle of 30°. In addition, the highest point of the windows in the south tympanum (9.0 m. from the floor) is visible from the base of the opposite, north side at an angle of 30°.

On the basis of the above symmetry, therefore, it would be possible to explain some of the lighting phenomena that are visible during the winter. For example, at noon the images of the three windows in the south tympanum are formed at the base of the north wall. At this particular moment the sun lies on the axis between the north and south cross-arms.

Therefore, the height of the tympana was determined by the maximum height of the sun above the horizon.

from the windows in the dome is directed onto the north-east pendentive of the central dome.

Before sunset the brightness of the E-W axis decreases, while, in contrast, the brightness of the vertical axis increases.

Specific lighting conditions in the NW and SW bays of the church

#### December

A beam of light from the windows in the semicircular south tympanum is directed onto the surface above the fresco of the Virgin , while another is directed onto the west wall of the north-west corner bay and a third onto the west pillar of the northern pair of columns (8.30 a.m.).

The above lighting conditions are particularly pronounced between 9.00 and 10.00 a.m. To be precise, the features which are illuminated are the fresco of the Virgin (Pl. 2a), the northern pair of columns and the south-facing surface above them , as well as part of the fresco of the Archangel (Pl. 2b). At this particular moment the north-west bay is flooded with light.

At midday (12.30 p.m.) a light beam enters the south window of the south-west dome and is directed towards the north-west corner bay through the northern pair of columns.

In the afternoon light travels diagonally from the windows in the west tympanum towards the north-west corner bay.

#### January

The first rays of the sun (8.00 a.m.) pass through the arched window in the outer south wall of the diakonikon and are directed towards the north-west corner bay, via the northern pair of columns (Pl. 3a). At the same time lighting phenomena may be observed which are similar to those occurring in December.

As the sun rises, the light changes direction in the interior of the church. A large section of the northern pair of columns is now brightly illuminated (9.30 a.m.) (Pl. 3b). The north-west corner bay is 'bathed' in light. These phenomena last until 10.30 a.m.

After midday, at 2.30 p.m., light passes through the windows in the west tympanum and is directed onto the northern surface of the west cross-arm, i.e. above the northern pair of columns. Light also passes through the west window in the north-west dome and is directed towards the north-west corner bay.

#### February

In February the lighting conditions are similar to those in January. It is noteworthy, however, that during the winter a light beam becomes visible

for the first time on the upper section of the fresco of the Archangel (Pl. 4a) – a beam which enters through the south-east window in the dome.

In the afternoon (3 p.m.) the north-west corner bay is also brightly lit (Pl. 4b). Also, the light travels diagonally from the windows in the west tympanum towards the north-west corner bay.

#### Comments

It is known that the founder's birthday was on 16 January and that the church is dedicated to the Theotokos, the Mother of God.

During this period a bright beam of light may be observed illuminating the fresco of the Theotokos, as well as beams of light passing between the northern pair of columns towards the NW corner bay.

The following conclusion emerges: If a solid pillar stood where the two columns are situated, and if the church had a different orientation, then it would not be possible to observe the above phenomena.

#### 3.1.2 Spring

##### General lighting conditions

The investigation was continued during the months of March, April and May – to be precise, on 27 March (sunrise 6.19 a.m., sunset 6.43 p.m.), 23 April (sunrise 5.40 a.m., sunset 7.08 p.m.) and 24 May (sunrise 5.09 a.m., sunset 7.36 p.m.).

A few minutes after sunrise, sunlight enters from the north-east windows of the dome (Pl. 5a), which are formed on the north-west pendentive. After sunrise, it is principally the E-W axis of the church that is highlighted and, to a lesser extent, the vertical axis.

If the sanctuary was recreated in its original form, then the light entering the window of the prothesis would be directed onto the northern pair of columns, and that entering the window of the diakonikon would be directed onto the fresco of the Concelebrating Hierarchs on the south side.

At 8.00 a.m. the fresco of the Concelebrating Hierarchs in the north cross-arm is brightly illuminated by the light entering through the windows in the north-east dome. At the same time light from the windows in the south-east dome is directed towards the space between the southern pair of columns and the icon-screen. In both cases the light beams pass marginally below the western arched openings in the prothesis and diakonikon, respectively.

Between 8.00 and 10.00 a.m. the north-west corner bay and the northern pair of columns are brightly illuminated as a result of the light entering through the windows in the dome.

Between 10.00 a.m. and 1.00 p.m. the light is evenly distributed. Between 1.00 p.m. and sunset light enters through the windows in the west tympanum, illuminating the central part of the church at first and then towards sunset the north side of the south pier (Pl. 5b).

Specific lighting conditions in the NW and SW bays of the church

#### March

In March (9a.m) beams of light from the windows in the south tympanum and in the dome are directed simultaneously onto the frescoes of the Virgin and the Archangel, respectively (Pls. 6 a–b). The north-west corner bay is brightly lit. In the afternoon the north-west and south-west corner bay are brightly lit, respectively.

#### April

During this month the sun is already higher above the horizon than in March. Now the fresco of the Archangel is brightly lit (from 8.00 to 10.30 a.m.). The north-west corner bay and the adjacent pair of columns are flooded with light (Pls. 7 a–b).

It is noteworthy, however, that a beam of light from the south-east window in the dome passes between the northern pair of columns and is directed towards the north-west corner bay, forming a pool of bright light.

Gradually, as the afternoon wears on, the above phenomena fade. Subsequently the intensity of the light increases in the north-west and south-west corner bays until the approach of sunset.<sup>14</sup>

#### May

After sunrise, bright sunlight enters the central light of the window in the sanctuary apse and is directed along the central axis of the church and illuminates the southern pair of columns (Pl. 8a).

At 9.00 a.m., beams of light enter through the windows in the dome, pass between the northern pair of columns and form pools of light on the floor beneath the north-west dome. At the same time the northern pair of columns is illuminated. It is interesting to investigate the possible geometrical causes of this particular lighting phenomenon. It was found that at this particular moment the sun, the sill of the south-east window in the dome and a specific point on the floor of the north-west corner bay all lie on the same straight line (Pl. 8b). In addition, a study of the plans revealed

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<sup>14</sup> From the foregoing observations we may assume that in March light beams are projected both by the windows in the south tympanum onto the Virgin Mary and by the windows in the dome onto the Archangel.

that the columns and the windows in the dome may be observed from the same point in the north-west corner bay at an angle of  $42^\circ$ . If the window sills had not been raised by 0.40 m., these lighting phenomena would be even more pronounced.

Therefore, the appearance of the light beams in the north-west corner bay and on the columns is a result of the specific architectural solution that has been applied.

In the afternoon, at 5.00 p.m., a beam of light enters through the windows in the west tympanum and is directed towards the sanctuary and onto the fresco of the Hypapante.

Before sunset the central dome is flooded with light, thus accentuating only the vertical axis of the dome.

#### Comments

During this period, and particularly between the end of March and the tenth day of April, beams of light may be observed illuminating the frescoes of the Theotokos and the Archangel at the same time.

If one bears in mind that the Annunciation of the Virgin Mary is celebrated on 25 March, then the special lighting conditions that can be observed during this period acquire a particularly symbolic character.

#### 3.1.3 Summer

##### General lighting conditions

During the summer measurements were taken on 15 June (sunrise 5.02 a.m., sunset 7.48 p.m.), 20 July (sunrise 5.18 a.m., sunset 7.45 p.m.) and 31 August (sunrise 5.54 a.m., sunset 6.57 p.m.).

The axis of orientation of the northern lights of the sanctuary apse window lies at an angle of  $120^\circ$  to south. This angle coincides with the azimuth of the sun at sunrise and is the largest angle visible at any time of the year (in June).

Observing the path of the sun's rays between 5.10 and 6.00 a.m., it was found that if the northern lights of the sanctuary window had not been bricked up and if there were no external obstacles<sup>15</sup>, then the sun's rays would pass through the northern light of the window in the prothesis and be directed onto the northern pair of columns. In addition, the light from the windows in the sanctuary apse would be directed onto the southern pair of columns, and that from the windows in the diakonikon would be directed onto the fresco of the hierarchs on the outer south wall and the

<sup>15</sup> To the east of the church there are some trees which prevent the morning rays of the sun from entering the church.

fresco of the Concelebrating Hierarchs in the south cross-arm. Today light beams are visible only at the base of the northern pair of columns (9 a.m.) (Pl. 9a).

Between 10.00 a.m. and midday the light is evenly distributed, although it is brighter in the dome and the sanctuary. During June and July no rays of light are visible in the interior of the church at these times, whereas in August light enters through the central window of the south tympanum and forms a pool of light in front of the south pier.

After midday the sun begins to lose height, with the result that light now enters through the western windows of the dome and the west tympanum and is directed towards the central area of the church (3 p.m.). In addition, light entering through the windows in the north-west and south-west domes is directed towards the space between the two pairs of columns and the church's outer walls.

The above phenomena are visible every month, though on each occasion they occur 40 mins. later than in the previous month. To be precise, in June the phenomena are visible at 2.30 p.m., in July at 3.10 p.m. and in August at 3.50 p.m.

At 6.00 p.m. light beams from the windows in the west tympanum are directed onto the south pier and the fresco of the Hypapante (the Presentation of Christ in the Temple) (Pl. 9b), while light from the north-western windows of the dome is directed towards the sanctuary.

After 7 p.m. rays of light from the central window of the west tympanum are directed onto the fresco of the Concelebrating Hierarchs in the south cross-arm.

Before sunset the dome is more brightly lit than the other parts of the church.

### Specific lighting conditions in the NW and SW bays of the church

#### June

The angle of the azimuth at sunrise is larger at this time than at any other point in the year. Thus, in the morning the sun's rays pass diagonally through the central light of the sanctuary window – since the northern one has been bricked up – and are directed towards the fresco of the Virgin, the southern pair of columns and the south-west corner bay (Pl. 10a).

By 8.20 a.m. the sun has already risen quite high above the horizon. At this time beams of light enter through the windows in the dome and are directed towards the outer west wall. Gradually these beams move towards the north-west corner bay. Between 9.00 and 9.20 a.m. the phenomena in the vicinity of the northern pair of columns are pronounced.

In the afternoon, at 3.00 p.m., a beam of light is projected from the west window in the north-west dome onto the north-west corner bay and 5.0 p.m. onto the fresco of the angel in the soffit of the arch in the north-west corner bay (Pl. 10b).

### July

The observations made in July revealed that the lighting conditions during this month are very similar to those which occur in June.

### August<sup>16</sup>

Between 8.00 and 10.30 a.m. three beams of light are initially visible which enter through the east windows in the dome and are directed onto the outer west wall of the church and above of the Archangel. These gradually move towards the fresco of the Archangel (Pl. 11a) and, between the northern columns, onto the area beneath the north-west dome. At the same time the fresco of the Virgin is brightly lit by light from the windows in the south tympanum, while a beam of light covers the whole of the east pillar in the southern pair of columns (Pl. 11b).

After 1.00 p.m. numerous light beams are visible in the interior of the church. To be specific:

- light from the south-west dome is directed onto the southern pair of columns;
- light from the windows in the west tympanum is directed onto the northern pair of columns and the area beneath the north-west dome.

### Comments

The beam of light that may be observed illuminating the fresco of the angel (NW corner bay) in June acquires a particularly symbolic character because the angel is portrayed pointing towards the floor of the NW corner bay, where Isaac's tomb is supposed to be situated.

As a result of the special lighting conditions, it has been stated that towards the end of August the church is 'bathed' in light – an intensity of light that is not observed at any other time of the year.

During this period are celebrated the feasts of the Dormition of the Virgin Mary (15 August) and the Deposit of the Virgin Mary's Girdle (31 August).

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<sup>16</sup> In August the church is brightly illuminated, both in the vicinity of the northern pair of columns and in the main part of the building. If we subtract thirteen days, which is the difference between the Gregorian and the Julian calendars, then the date on which the study was carried out coincides with the feast-day of the Theotokos. This issue, however, will be investigated in a future study.

It might be assumed, therefore, that the lighting lends emphasis to these important events.

### 3.1.4 Autumn

#### General lighting conditions

The investigation was continued on 18 September (sunrise 6.09 a.m., sunset 6.29 p.m.), 16 October (sunrise 6.34 a.m., sunset 5.47 p.m.) and 23 November (sunrise 7.14 a.m., sunset 5.09 p.m.). During this period the lighting phenomena are approximately the same as those which are visible in the spring.

#### Specific lighting conditions in the NW and SW bays of the church

##### September<sup>17</sup>

In September the same lighting phenomena may be observed as those in August, though at slightly later times. During this period (9.20 a.m.) light beams may be seen illuminating the frescoes of the Virgin and the Archangel at the same time (Pl. 12a).

It is noteworthy, however, that the light beams which illuminate the north-west corner bay and the fresco of the Archangel come from the south windows of the dome, while those which illuminate the fresco of the Virgin and the southern columns come from the windows in the south cross-arm.

Between 9.20 and 10.30 a.m. the lighting phenomena become more pronounced.

In the afternoon the northern pair of columns is brightly illuminated, while the southern pair is less well lit. Light enters mainly through the windows in the west tympanum and to a lesser extent through the west windows in the north-west and south-west domes.

If one observes the path of the sun's rays, it will be seen that the light gradually illuminates the entire height of the east pillar in the northern pair of columns (Pl. 12b). For this to occur, the east column and the window in the south cross-arm must be of the same height as these are vertical elements and lie between parallel straight lines (the sun's rays).

This example can be seen to justify the initial observation that a relationship exists between the church's architectural elements and the natural light.

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<sup>17</sup> In September observations were continued up until the end of the month. Once again, the lighting phenomena were pronounced, as in August.



### October

In October the same lighting phenomena may be observed as those in September. It is noteworthy, however, that light beams from the dome and the windows in the south tympanum are projected almost simultaneously onto the frescoes of the Virgin and the Archangel (Pls. 13 a–b). Of course, the light beam on the Archangel is now less bright than in September, whereas the light falling on the Virgin is brighter.

### November

In the morning, between 8.00 and 10.30 a.m., the north-west and south-west corner bays are brightly illuminated. Light passes through the windows in the south tympanum and is directed onto the northern pair of columns and into the north-west corner bay, while at the same time the fresco of the Virgin is illuminated (Pls. 14 a-b-c-d).

At 12.00 p.m. a light beam from the south-west dome is directed towards the northern pair of columns and at the same time passes between the southern pair of columns.

At 3.00 p.m. light beams from the windows in the west tympanum are directed onto the northern surface of the west cross-arm.

Before sunset these beams are directed onto the north pier of the sanctuary.

### Comments

According to the Byzantine church calendar, the Nativity of the Virgin Mary is celebrated on 8 September and the Presentation of the Virgin Mary in the Temple on 21 November.

The appearance of light beams on the frescoes of the Virgin Mary on these dates is the result of advanced architectural design, which aims to emphasise these great feasts of the Theotokos.

If of course one bears in mind that when the sun's rays entered the church at this time during the Byzantine era they would also have illuminated the clouds of smoke from the incense, then the atmosphere must have been even more mystical.

This study examines the symbolic character of the light only in the case of the frescoes of the Theotokos and the Archangel.

The investigation is being extended to cover the whole of the church's iconographic scheme.

## 4. CONCLUSIONS

a) The alignment of the central axis of the church at an angle of  $15^\circ$  NE determined the orientation of the windows with regard to the East and the path of the sun on the horizon.

b) Because of the later interventions, and particularly those in the openings of the sanctuary, the level of light in the sanctuary is reduced in the mornings. At the same time, light beams are obstructed by the walled-up lights of the windows and so the light does not reach frescoes in the nave, as was originally intended.

The minor interventions in the windows of the dome do not have a significant effect on its luminosity.

Furthermore, the nave did not use to be so bright as it is today. The existence of screens in the windows reduced the amount of light entering the nave, while also considerably reducing the amount of glare experienced by visitors.

Therefore, what attracted the visitor's gaze in the mornings was the sanctuary apse and the dome; that is to say, the horizontal and vertical axes of the church were accentuated.

The same conditions prevailed in the afternoons as well, until sunset. At midday, however, particularly in winter when the sun is low on the horizon, apart from the vertical axis, the N-S axis (i.e. the axis between the north and south cross-arms) is also highlighted.

c) The specific orientation of the building, together with the proportions that were given to the various architectural members and the conception and application of the two pairs of columns, determined both the visual organisation of the space and the direction of the sun's rays onto certain points in the church's interior and the frescoes.

In addition, we believe that the appearance of light beams on the frescoes of the Theotokos and the Archangel highlight the feasts of the Virgin Mary.

It is also noteworthy that lighting phenomena are observed more frequently in the vicinity of the north pair of columns than in other parts of the church. There thus appears to be an 'inexplicable' concern for the lighting of the NW corner bay.

We believe, therefore, that the solution – which is original in both conception and execution – of erecting two pairs of columns instead of solid piers is connected with the illumination of the site where the founder's tomb is supposed to be situated.