



The Dome of Santa Maria del Fiore (the Duomo) Florence, designed by Filippo Brunelleschi and built 1420-36 (photo by Valerie Shrimplin).

# Domed architecture as image of the Universe

Abstract

Domed architecture significantly brings together architecture, astronomy and geometry, but its origins are untraceable to a single point of origin, in time or place. More than a functional type of vaulting, the cosmic symbolism of the dome is basically imitative of natural eye observation of the flat earth surmounted by the 'dome of Heaven'. Of ancient origin, this underlying spiritual and symbolic meaning is fundamental to its usage in ancient classical-pagan, Judaeo-Christian and Islamic architecture. Revived during the Italian Renaissance, it remains significant up to the present day.

Le strutture architettoniche sormontate da cupole combinano armoniosamente architettura, astronomia e geometria, ma le loro origini non possono essere ricondotte a un unico luogo o momento storico. Oltre alla sua funzione strutturale, la cupola possiede un forte simbolismo cosmico, ispirato alla percezione naturale dell'occhio umano, che vede la terra piatta sovrastata dalla "volta celeste". Questo significato spirituale e simbolico, di antichissima origine, è stato centrale nell'architettura classica-pagana, giudeo-cristiana e islamica. Riscoperta durante il Rinascimento italiano, la cupola continua a mantenere la sua rilevanza fino ai giorni nostri.

Key-words

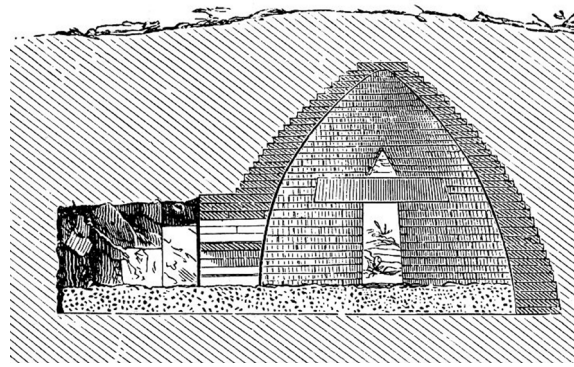
Domes  
Heavens  
Cosmology  
Architecture  
Geometry

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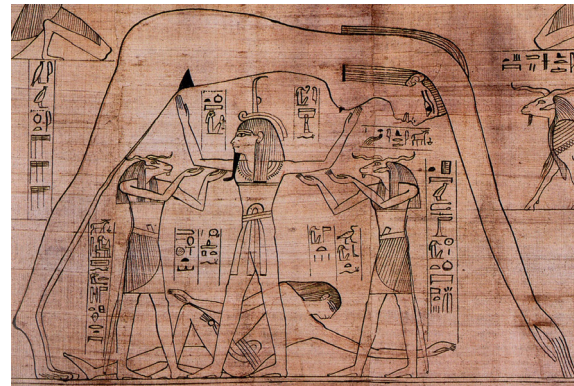
## Introduction

The origins of domed architecture are untraceable to a single point of origin, in time or place. Primitive constructions or shelters, based on the use of flexible materials tied at the top, have been found in early civilisations and are still in use in some primitive societies today. Underlying symbolic meaning cannot be argued for these simple structures, although they provided the basis for the eventual spiritual tradition and symbolic importance of the dome. More than a functional type of vaulting, the cosmic symbolism of the dome relates to humanity's relationship with the Earth beneath and Sky above. The model is basically imitative of natural eye observation of the flat Earth surmounted by the 'dome of Heaven' which is of ancient origin and fundamental to its usage in ancient classical-pagan, Judaeo-Christian and Islamic architecture. Indeed, the Roman architect Vitruvius, in his *Ten Books of Architecture*, specified that it is essential for all architects to "be acquainted with Astronomy and the theory of the Heavens". He refers to ancient astronomers and defines the Universe as "the general assemblage of all nature, and it also means the Heaven that is made up of the constellations and the courses of the stars" (Vitruvius 1960 ed., pp. 6, 249-277). Cosmic symbolism of the dome had its roots in classical architecture in Egypt, Greece and Rome; was of prime importance in Christian architecture; revived during the Renaissance; and remains significant up to the present day.

The point at which architectural domes, irrespective of the material used, assumed special symbolic significance is hard to determine. Discussion of domes tends to emphasise construction and development, as well as the variety of forms, ranging from shallow to hemispherical to 'beehive' or 'onion' domes that may be placed on or over cylindrical, square or more complex buildings (Osborne ed. 1993, pp. 320-322; Bannister Fletcher 1975 ed., pp. 269f., 378f., 823, 842). Materials were significant as early wooden domes came to be replaced by structures of brick and masonry, not simply for utilitarian reasons (such as fireproofing) but due to some inherent or symbolic or spiritual meaning. Constructional developments appear to have been sought as the result (not the cause) of the spiritual associations. The opposite scenario whereby having achieved the construction of masonry dome, the architects and their secular or ecclesiastical patrons then hunted around for some form of symbolic attribute for it, seems far less likely. Cultural reasons, relating to the symbolic shape of the dome, must have provided the impetus, whether divine, celestial or royal. The ideology seems to pre-date the domical vault as the earliest structures gradually took on a ceremonial function as an ancestral or lordly home, a place of audience, or the eternal memorial or dwelling house for the dead. The ear-



1. Treasury of Atreus, Mycenae, 1325 BCE (Wikimedia Comms; public domain).



2. The Sky-goddess Nut in the Greenfield papyrus of Nestanebetisheru, *Book of the Dead*, c. 950 BCE (Wikimedia Comms; public domain).

liest stone, domed structures for which evidence survives seem to be those in the Neolithic settlement of Choirokoitia in southern Cyprus, dating from the sixth millennium BC. (Phylactopoulos 1974, pp. 85-87). Comparisons may be made with modern primitive constructions, still built according to ancient tradition but of less durable materials.

## The Ancient, Classical Vision

In the architecture of ancient Greece, the dome is clearly more than a functional vaulting device and its symbolic meaning dates back to early Greek tholos (*θόλος*), tombs signifying the dome or cupola of a circular building, hence the building itself (Phylactopoulos 1974 ed., p. 315). One of the best-known early examples is the *Tomb of Agamemnon* ('*Treasury of Atreus*') of the second millennium BCE at Mycenae in the Peloponnese [fig. 1].

The form of the tomb might well derive from an ancient association between the dead and the symbolism of the circle which generates the dome and signifies eternity. The metal 'rosettes' that studded the vault suggest stars, and the emphasis on circular cosmology and associations with the dead are reinforced by contemporary references in Homer and Hesiod (Homer *Iliad*, XVIII, 483-489; Homer *Odyssey*, V, 270-74; Hesiod, *Theogony* 1964 ed., pp. 85-95). As Baldwin Smith demonstrates, most early civilisations had domical schemes that originated



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in the use of pliable materials but came to be imitated in masonry for ideological reasons (Baldwin Smith 1950, p. 6f). While much classical Greek architecture based on the post and lintel system did not lend itself to domed structures, circular buildings were popular in classical Greek times, exemplified by the *Tholos* at Delphi (c 400 BCE). Little is known about the roofing of these structures, although records of destruction by fire suggests wooden roofing. The cosmological significance becomes clear since Delphi was considered to be the centre of the Universe - 'the omphalos' (navel of the Earth). Greek writers speculated on the shape of the Earth from the sixth century BCE onwards, and presocratic philosophers like Thales of Miletus and Anaximander considered the Universe to be circular (either a disc or sphere), while Pythagoras maintained that the world must be in the most perfect form of a sphere (Guthrie 1962, vol. I, pp. 89-100, 132-37, 282-300). The writings of Plato (especially the *Timaeus*) and Aristotle (*De Caelo*) provided the foundation for later Greek cosmology and were of enormous influence throughout medieval and Renaissance Europe.

In ancient Egypt, the perception of the Universe was indicated by images based on the flat Earth concept as the sky goddess *Nut* represents the celestial vault stretching from horizon to horizon with the stars above her [fig. 2] (Frazer 1996, p. 217; cf.

Hesiod, *Theogony*, 176-78). The identification of the arch form with the curve of Heaven also relates to the ceremonial importance of the King's dwelling or meeting place.

### Roman Domes

The Romans based their architecture on arcuated structures and were able to span enormous spaces with the use of concrete and arches (Baldwin Smith 1956, pp. 12-13). The height of the *Pantheon* in Rome (AD 126) [fig. 3] is the same as the radius of the dome which is placed on a cylindrical building, supported by immense walls. There is no doubt about the cosmic overtones since the contemporary Dio Cassius records that the very name of the *Pantheon* was related to the twelve classical gods of ancient mythology. He also comments that "because of its vaulted roof, it resembles the heavens" (Dio Cassius 1917, p. 27). Meaning, rather than solutions to constructional problems, seems to have inspired such monuments. In Greece, the *Rotunda* in Thessaloniki (built in 300 CE and converted to the Christian Church of St. George, c 400) relates in design to the *Pantheon* in Rome, with its hemispherical dome. In Rome itself, a cupola decoration in the *Golden House of Nero* (*Domus Aurea*) had an eight cornered canopy surrounding a central circle with Jupiter depicted on clouds and cosmic overtones are

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*Pantheon*, Rome,  
126 CE  
(photo by V.  
Shrimplin)

clear in other vaults from the same building with astronomically decorated cupolas. Nero was aware of the astronomical implications of the dome and had a banqueting hall with a domical Heaven that "went round day and night like the world" (Baldwin Smith 1956, pp. 6-11, 123). The Roman domed celestial baldachin over the great *Altar of Zeus* at Pergamon, depicted on a coin of Septimus Severus, shows the altar of the supreme sky god and clearly has celestial meaning (Baldwin Smith 1950, p. 106; Kleinbauer 1971, pp. 227-70).

### Biblical sources and Christian architecture

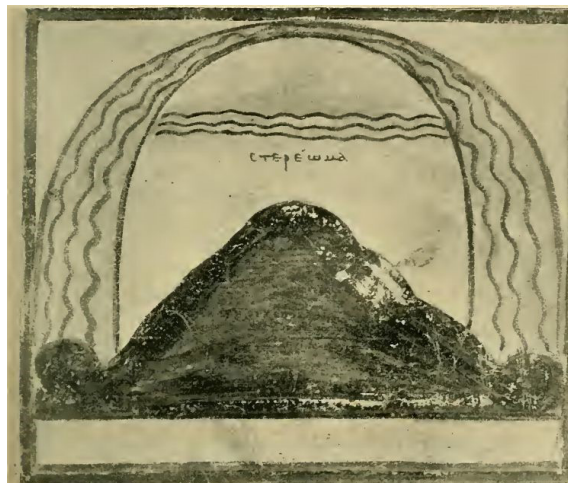
Roman building techniques were imitated and the dome was frequently used in pagan design, such as the dome covering the temple of the sky god, *Marnneion* at Gaza, 130 CE (Baldwin Smith 1950, p. 14ff). However, the concept of the dome of heaven and its transference to ecclesiastical architecture was crucial. In the Judaeo-Christian tradition, the links between cosmology and theology are clear from *Genesis I*. In the *Old Testament*, God is viewed as the architect or creator of the physical Universe who "sitteth upon the circle of the Earth" and "stretcheth out the heavens as a curtain and spreadeth them out as a tent to dwell in" (Isaiah 40:22, Psalm 104, Jeremiah 10:12). This clearly provides the basis for the view of the flat Earth covered by Heaven's dome, and Jerusalem was regarded as the centre of this flat-Earth system (Ezekiel 5:5)<sup>1</sup>.

The concept of the Universe with heaven above and hell beneath the Earth's surface is reinforced throughout the *Scriptures*. Cosmological concepts were reflected in art and architecture and ideas carried over into church construction and decoration, underpinning much of the architecture of the eastern Mediterranean during the Early Christian and Byzantine periods. The shape of the *Holy Tabernacle* (Exodus 25-27) was rectangular with a curved roof, twice as long as it was wide. The Earth was held to be the same shape (Koestler 1984, pp. 92-93). The proportions of the *Temple of Solomon* were founded on the same concept (I Kings 6) and the *Sistine Chapel* in Rome was built to the same proportions in imitation (Shrimplin 2000, pp.13-14).

Early examples are found in mausolea and martyria rather than in large churches where the Roman basilican type was often adopted. The circular plan, with its connotations of perfection, symmetry and eternity, was more commonly used for edifices relating to death or commemoration. Precise shapes varied from hemispheric, shallow, onion, pine-cone, cosmic egg or 'heavenly bowl'. The actual word for dome derives from *domus* used in Greek and Latin to signify a house or dwelling and, later, with the precise meaning of roof or cupola. From this, in time, was derived the word dome which in Chri-



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4. Mausoleum of Galla Placidia, Ravenna, 425

(Wikimedia Comms/unknown author, licensed under the Creative Commons attribution share-alike international licence (4.0)).

5. The Universe in the *Christian Topography* of Cosmas Indicopleustes, sixth century (Wikimedia Comms/Kmorozov 2012; Public Domain).

stian terms came to signify the ceremonial meeting place or cathedral (*duomo* in Italian; *dom* in German). Little remains of very early Christian domed structures, although evidence suggests wooden domes, painted in blue and gold to signify the heavens. The type is shown on an early ivory at the *John Rylands Library* Manchester that demonstrates the celestial overtones (Baldwin Smith 1950, p. 114). Increasingly durable construction, influenced by Roman vaulting, led to more churches being built with official approval. Domes had been used in Syria and there was a very solid tradition of domed churches in the *Holy Land*. Further impetus was gained as Christianity became the official religion of the Roman empire (313) and the Emperor Constantine created his new capital at Byzantium (renamed Constantinople, 330). At the same time, the *Holy Sepulchre* at Jerusalem (326-335) was first built as a circular commemorative type erected by Constantine as memorial tomb of Christ. It was

likely to have possessed a starred wooden dome rather than masonry due to lack of evidence of buttressing. Other examples of wooden domes include Antioch (327 and 526-88); *The martyrrium of Gregory of Nazianzus* (374), and *The martyrrium at Nyssa* in Cappadocia (379) (Baldwin Smith 1950, pp. 29ff, 218-227).

### Early Christian and Byzantine

During the Early Christian and Byzantine period, architecture was used to heighten theological concepts, particularly at a time when many were poorly educated or unable to think abstractly and spiritually. Ecclesiastical authorities used architecture to produce the vision of heaven on Earth in richly decorated churches. A leading example with obvious celestial overtones, is the *Mausoleum of Galla Placidia* at Ravenna (425) [fig. 4] (Incerti 2018, pp. 181-189; Incerti 2019, pp. 492-505). Here the heavenly dome is signified by stars, showing a heavenly starred vault over a tomb as visible proof of the heavenly home of the departed soul. The idea of an other-worldly cosmic paradise is also emphasised by the surrounding images of the sylvan paradise with animals and the fountain of life. Domed vaults in the catacombs in Rome contained images of Christ in paradisaic settings linked to pagan Roman traditions as in Virgil's *Eclogues*. The dome mosaic of the fifth century martyrrium at Casaranello also has celestial overtones (Baldwin Smith 1950, fig. 71; Hautecoeur 1954, pp. 205-210). The difficulty of placing a circular dome on the square crossing of a cruciform church shows the determination of the architects, aiming to 'square the circle'. At *San Vitale* in Ravenna, the constructional problem of surmounting the octagonal church with a dome was solved by using lightweight hollow pots to alleviate the immense stress. Christ is shown seated on the sphere of the Universe in the semi-dome of the apse. By the sixth century, the order of the Universe had been codified in hierarchical ascending and descending order, linking the celestial and terrestrial systems. The church was a microcosmos of the macrocosmos, a mystical replica of the Universe, as explained by Pseudo-Dionysius, the Areopagite, whose *On the Celestial Hierarchy* and *On the Ecclesiastical Hierarchy* related the ordering of the Universe to the order of the Church on Earth (Lovejoy 1936). The influence of the cosmological view of the Universe on art and architecture is demonstrated by the *Christian Topography* of the monk Cosmas Indicopleustes, active in the sixth century. He provided an account of the Universe, summarising the cosmology of the scriptures and early church fathers. The *Christian Topography* is particularly significant since it is illustrated with diagrams, and that of the Universe [fig. 5] clearly demonstrates

the idea of the heavens as a dome, echoing other drawings of the Universe in the same manuscript (Cosmas Indicopleustes 1968; Ainalov 1961, p. 33f). Cosmas' views were not official doctrine but held by many (Koestler 1984, pp. 92-94; Kuhn 1957, p. 108). Based on the fundamental concept of an 'up for heaven' and 'down for hell' approach, curved and domed vaults (often star-covered) recur frequently in Early Christian and Byzantine architecture from Ravenna to Constantinople.

The sacred and celestial aspects of the dome were increasingly refined in Byzantine cross-in-square Churches. For example, the sheer size of the massive dome of *Sta. Sophia* in Constantinople, built 532-37, (32.6 metres across and 54.8 metres high) adds to its dramatic and spiritual effect. A contemporary, Procopius, described its dome: "overlaid with pure gold and rests with apparently little support, seeming to 'float on the air'; it appeared as if suspended by a chain from Heaven" (Procopius 1971 ed., pp. 46-47, 21f). As with most Byzantine church architecture, the exterior decoration of *Sta. Sophia*, in continuous use until 1453, is rather less impressive than the interior, the prime aim being to create an other-worldly effect for those entering the building.

Byzantine mosaic schemes of decoration reflect the religious, political and social ordering of the Church on Earth. The use of a cupola or dome is invariably part of any formal Byzantine scheme and, as Demus expresses it, represents "the image of the changeless and celestial world set over the earthly sphere of the ground plan" (Demus 1948, p.12). The cross-in-square church represents an image of the Universe and "[...] the dome represented Heaven" (Krautheimer 1965, pp. 201-213, 344). It is essentially based on a hanging architecture as vaults appear to depend from above, with the dome symbolising heaven and other areas representing a descending hierarchical order down to the earthly zone of the lower walls. Figures of saints and angels are placed according to 'rank', with the Virgin Mary occupying the conch of the apse as the bridge between heaven and earth. The schemes also closely correspond to the liturgy and the calendar of the Christian year with the recurring flow of events circling around the centre - an eternal motion related to that of the heavens (Demus 1948, pp. 14 -17). In the mid-Byzantine period (9th-12th century) the dome was reserved for subjects with cosmic overtones such as the *Ascension*, *Pentecost* or *Pantocrator*, often with a rich gold mosaic background, symbolising infinity. At Hosios Loukas (begun 1020) and Daphne (1080) in mainland Greece, such schemes are strictly followed as proof of the existence of the heavenly realm above. From the depiction of the *Pantocrator* in the dome to the rich gold mosaic



6. St. Mark's, Venice, Creation Dome, mosaic, 12th century (Wikimedia Comms/ Derbrauni; licensed under the Creative Commons attribution international licence (4.0)).

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backgrounds, the cosmic allusions are clear (Demus 1948, pp. 56-61).

The Italo-Byzantine church of *St. Mark's*, built in Venice 1063-85, owes to both eastern and western traditions. The mosaic decoration (twelfth-century) emphasises the cosmic significance of its multiple domes, and subjects with cosmological and astronomical significance were included. The *Pantocrator* in the main dome has clear astronomical references with concentric rings of stars; the north dome includes references to the points of the compass that would have had special significance for the Venetians as a seafaring nation reliant on stars for navigation (Demus 1988, p. 93). Even more spectacular are the domes with the creation cycle, based on *Genesis I* [fig. 6] cosmology. The creation story, from the separation of light and dark, to the formation of the Sun, Moon and Stars, transports the worshipper from earthly reality to the heavenly realm above, reflecting the relationship between humanity and the Heavens – as above, so below. Other domes in the atrium depict abstract symbolic 'orbits'. The celestial symbolism of the dome was somewhat lost in the medieval west, but one area where the domical tradition continued was in the great curved tympana of the medieval cathedrals, often used to depict the end of the Universe in the form of a *Last Judgment*. Heaven, Earth and Hell (the three parts of the 'known Universe') were depicted together on western façades as a disciplinary reminder to the congregation on exit. The curvature of the domed universe was shown above Christ in many examples of cathedral sculpture that focus on the perception

of the layered, domed universe, often with astronomical symbols (Hautecoeur 1954, pp. 264-270). However, it was not until the fifteenth century that the centralised domed plan was again popularised in western Europe. The acceptance of the domed church as an ideal design was linked to the Renaissance revival of Greek thought, precipitated by the influx of Greek writers, architects and thinkers following the fall of Constantinople in 1453.

### The Renaissance Revival of Domed Architecture

While the Classical and Byzantine traditions secured a role for domed architecture, it was not until the Renaissance revival of classical thought that the dome again became a truly dominant style in western Europe (Murray 1986; Heniger, 197 *passim*.). The revival of the dome was very much based on its derivation from the circle as the most perfect form, according to Neoplatonic thought. In his *De Re Aedificatoria* (c.1450) Alberti elaborates on sacred architecture and the building and decoration of the ideal church. Discussion begins with a eulogy on the perfection of the circular form and an emphasis is laid on the dome and its relation with the sky. Alberti cites ancient authors regarding 'the vast vault of the Heavens', and describes the construction of arched vaults and domes (Book 3, chapter 14). He seems to have been aware that a cosmic interpretation of the dome had been common in antiquity and kept alive in the eastern Church (Alberti 1988, Book 7, pp. 81-87, 222, 278f; Wittkower 1973, pp. 3, 9ff.). The choice of a domed octagon for Florence Cathedral, begun in 1294, proved impossible

to construct and the task of spanning the 42.7m opening was not solved until Filippo Brunelleschi, inspired by his visit to Rome to study ancient building design and construction, enabled him to address the problems and complete the dome in 1420-34. Based on a pointed arch rotated around a central point, Alberti described the *Duomo* as "so great a structure rising above the heavens [...] broad enough to cover with its shade all the people of Tuscany" (Dedication to Brunelleschi, *De Pittura*, m/s II, IV, 38, Bibl. Naz. Firenze). The interior was decorated with the suitably cosmic scene of the *Giudizio Universale*, imagining the end of the Universe, by Vasari.

The revival of Platonic philosophy by Neoplatonists such as Marsilio Ficino (1433-99) should not be underestimated in its influence on the perfect circular form. As Wittkower states, "the full renaissance conception of the perfect church was rooted in Plato's cosmology" (Wittkower 1972, p. 23). The shape of the cosmos is described in *Timaeus* as the perfect circular form and Renaissance Church building continued to imitate this, as exemplified by the domed *Pazzi Chapel* (1429-46) built in classical and harmonious proportions. The astronomical implications of the dome are also evident in Brunel-

leschi's *Old Sacristy of S. Lorenzo* (Florence), where the cosmic allusions are heightened by depictions in one dome of the constellations at a given time [fig. 7]. They are shown on a blue background while the meridians, equator, ecliptic, stars, Sun and Moon are in gold. Almost like a planetarium, the dome painting portrays the northern celestial hemisphere as it would have appeared on 4/5th July 1422. The painting in the dome of the *Old Sacristy* can be compared with the slightly later, but damaged, painting of the constellations in the dome of the *Pazzi Chapel* at *Santa Croce*, Florence (from 1443), whilst in the *New Sacristy* (also known as the *Medici Chapel*) 1521-34, another large dome is complemented by sculptures by Michelangelo that have clear cosmological allusions. The whole chapel was intended to be a representation of the ordering of the Universe, according to neoplatonic schemes. The earthly world on the lower registers below contrasts with the luminous other-world above as souls ascends towards the brightness above, in the dome (Tolnay 1943-60, pp. 3-83; Murray 1984).

#### Michelangelo in Rome

The project to rebuild *St. Peter's Basilica* in Rome had been ongoing for some time (lasting from

7.  
Giuliano d'Arrigo,  
Brunelleschi,  
*San Lorenzo, Old  
Sacristy*, 1421-28.  
Choir dome fresco,  
1422 or 1439  
(photo by V.  
Shrimplin).



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1506-1626). Artists and architects including Leonardo da Vinci and Bramante had become involved and its massive dome was finally constructed according to Michelangelo's design. Leonardo had shown a particular fascination for domed architecture as evidenced by his numerous drawings and schemes for ideal, centralised domed churches. He also, significantly, observed that "il sole no si muove" further demonstrating his interest in Astronomy and possibly heliocentricity (Leonardo da Vinci 1970 ed., pp. 135-172). Bramante had also devised schemes based on ancient Roman and antique Christian sources, which were however, unbuilt. This interest in the significance of the dome with its celestial symbolism is evidenced by his small Renaissance circular domed church known as the *Tempietto in S. Pietro in Montorio* (1502-10) [fig. 8] (Wittkower 1973, p. 24; Murray 1986, pp. 118-120). By the time of Michelangelo's death in 1564, the drum of *St. Peter's* had been completed to his design up to the springing of the dome, and the original plans for a hemisphere had been raised slightly (for constructional reasons to reduce thrust)<sup>2</sup>. It was finally completed during the period of the Counter Reformation when the Catholic Church was at its most powerful. The dome, surmounted by a globe symbolising the Church's global authority, represents the height of the power of the Catholic Church and the Counter Reformation [fig. 9].



8. Bramante, *The Tempietto of S. Pietro in Montorio*, 1502 (Wikimedia Comms/Herbert Weber, licensed under the Creative Commons attribution share-alike international licence (4.0)).

9. *Dome of St Peter's, Rome*, completed 1590 (photo by V. Shrimplin).

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### Borromini and Kepler

Architecturally, the seventeenth century saw remarkable developments in domed architecture. In particular, if the spherical dome is reflective of the view of the Universe, could it be coincidence that the dramatic introduction of elliptical domes occurs at the same time as Kepler revolutionised the idea of the Universe and its mechanics as based on the ellipse? Might the radical changes in domed architecture in the Baroque period have any relation to Kepler's elliptical orbits? (Shrimplin 2005, pp. 413-422; Shrimplin 2021, pp. 107-123).

The use of the elliptical dome is a key feature of Baroque architecture, yet the preference of architects like Borromini for elliptical rather than perfectly circular/hemispherical domes is curious. The inspiration of developments in Astronomy in the seventeenth century challenged classical precepts such as the perfection of the circular form, and the predilection for the ellipse by Borromini could be related to Kepler's views. In his scheme for *S. Carlo alle Quattro Fontane* (1638-41) [fig. 10] Borromini was accused of overthrowing the classical rules of architecture - an artistic anarchist who replaced accepted ideas with innovation and disorder (Blunt 1979, p. 22f, 47, 68). Yet mathematical precision underlies his apparently extravagant



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schemes and scientific developments, especially the enormous changes in world view, Cosmology and Astronomy, could have had an effect on his work. While types of oval domes were not unknown in the sixteenth century (*S. Andrea* in Via Flaminia, 1554; *S. Anna dei Palafrenieri*, 1572; *S. Giacomo*, 1590) these were often simply based on the domed type with a circular dome elongated along one axis, or rectangles with rounded corners (Murray 1986, p. 198; Blunt 1979, p. 68). By contrast, the use by Borromini of the elliptical dome in churches like *S. Carlo alle Quattro Fontane* and by Bernini at *S. Andrea al Quirinale* (1658-70) are striking in their geometry. Kepler considered the ellipse as the basis of Astronomy and the view of the Universe, rather than circular orbits. He realised that the Universe did not work on perfect circular motion but that the orbits of the planets were elliptical instead, with the Sun at one of the foci<sup>3</sup>. These views might well have influenced the cosmological symbolism of religious architecture, especially in the work of Borromini. The prevalence of elliptical domes at this time seems to suggest a link, and the idea that elliptical domes could be related to contemporary astronomical theory is reinforced by evidence of astronomical symbolism appearing elsewhere in Borromini's work. Borromini's patron in Rome was Cardinal Barberini, later Pope Urban VIII (1623), who was a known patron of Galileo (Koestler 1984, pp. 362, 437, 448; Blunt 1979, pp. 22f., 47). The drawings for the *Oratory of S. Filippo Neri*, *S. Giovanni in Laterano* and the *Collegio di Propagande Fide* also include numerous star motifs and at *S. Ivo della Sapienza* (Rome, 1542) the six-point starred decoration completely dominates. Borromini's inclusion of the motif of the icosahedron on the Filomarino altar in *SS. Apostoli*, Naples (1635), relates directly to Kepler's theory of the solids as expressed in his *Mysterium Cosmographica*, 1596. Yet it is difficult conclusively to prove a direct link between Keplerian theory and the elliptical domes of Baroque architecture.

#### Sir Christopher Wren as architect-astronomer

At the same time as Bernini and Borromini were changing the face of Rome, the rebuilding of London was taking place. Sir Christopher Wren had already been consulted about work on *St. Paul's* which was in danger of collapsing when the process was interrupted by the Great Fire of London (5 September 1666), that made total rebuilding necessary. Instead of improving the medieval cathedral with a tower and spire, Wren opted for the completely new domed structure that now dominates the London skyline. Wren's knowledge of Palladian architecture and his meeting with Bernini in Paris in 1665-66 suggest an emulation of *St. Peter's*, but

10. Borromini, *San Carlo alle Quattro Fontane*, 1638-41 (Wikimedia Comms/Nicholas Hartmann; licensed under the Creative Commons attribution share-alike international licence (4.0)).

11. Sir Christopher Wren, *St Paul's Cathedral*, London, 1675-1710 (photo by V. Shrimplin).

his design was also partly the result of his astronomical knowledge and the celestial implications of domed structures. Wren was a Professor of Astronomy (in London and Oxford) long before he was famed as an architect. Although the concept of the flat Earth had clearly been superseded and was no longer accepted by educated persons (let alone professors of Astronomy), the celestial implications and the idea of the dome of Heaven persisted in church architecture. It appears to have acted as inspiration for the final design of the dome of *St. Paul's*, 1675 [fig. 11] (Shrimplin 2018, pp. 261-275; Downes 1971, pp. 36-37; Downes 1988). Bearing in mind that Wren was a mathematician and astronomer and also the architect for the *Greenwich Observatory*, the astronomical implications seem clear. Domed architecture continued to be reserved for schemes of special significance.

### Domed architecture in Russia and the Middle East

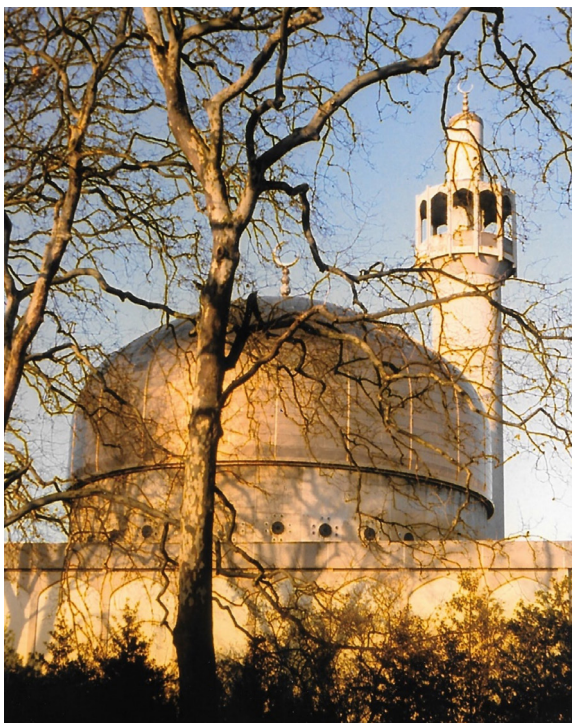
Space does not allow consideration of domed architecture in Eastern Europe and the Middle East but it is significant in the Russian Orthodox Church and also in relation to the rise of Islam and the development of the domed mosque. Together, these demonstrate the universality of the concept. The domed structure of the fourteenth-century *Church of St. Sergius Lavra* (in Sergiyev Posad, near Moscow), with its star-stud-

ded decoration, exemplifies the way that Byzantine architecture permeated the Russian Orthodox Church in its cosmic associations. The more recent *Church of the Resurrection of Christ* in St. Petersburg (1881) is another good example of the significance of the dome in Russian Orthodox Church architecture [fig. 12].

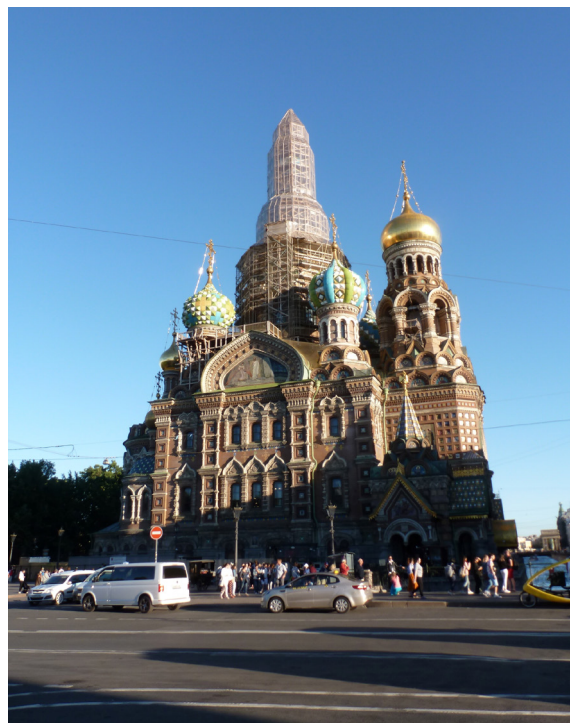
In the Islamic world, domed architecture was also a distinctive feature of Muslim architecture. The tradition may have derived from Byzantine architectural influence or from the heritage of the nomadic people who largely made up the Islamic world. The importance of the tent or canopy for nomadic peoples and the perception of the Heavens as such is provided by records of huge dome shaped tents. In the *Qur'an* itself, the word 'canopy' is frequently used as descriptive of the Sky or Heavens (XXX1 32; LII, 5; LXXIX, 28) and the firmament is clearly perceived as 'round' (LXXXVI, 11). Eternal, circular movement is reflected in the *qubba* or dome, as at the *Dome of the Rock* in Jerusalem, which has a central gilded dome (Ettinghausen, Grabar 1987, p. 18). Islamic mosques were built with imposing domes (often decorated and gilded) echoing a common and deep-rooted belief in the symbolism (Baldwin Smith 1950, p. 43f). The tradition became well-established and modern examples of domed mosques abound. The *Regent's Park Mosque* in London (c1970) [fig. 13] is a prime example. The interior of the dome is painted a rich deep blue with star shaped medallions of blue stained glass,

12.  
*Church of the Resurrection of Christ*, St. Petersburg, 1881, detail of domes (photo by V. Shrimplin).

13.  
*Regent's Park Mosque*, 1970 (photo by V. Shrimplin).



12.



13.

as typical of Islamic works of this type (cf. Holod, Khan, 1998).

### Modern Times

Domed structures in modern times demonstrate continuing links between Architecture, Astronomy and the Sky. Cosmology and Astronomy increasingly became separated from theology and philosophy as, based on advanced physics and mathematics, Astronomy and Cosmology exerted less influence on religious architecture. The use of domes became less exclusively associated with religion. An increasing amount of secular and large scale domestic architecture showed how, by this time, the dome had become so ingrained as a symbol of power and authority that it continued to be used for key buildings, such as, in the UK, the *Radcliffe Camera*, Oxford (James Gibbs, 1737), the *Bank of England* (Sir John Soane, 1798), or the 'oriental' *Brighton Pavilion* (Nash, 1815-21) and so on. The dome was ingrained on the human consciousness as a powerful cosmic shape. Use of the dome in the construction of large grandiose schemes gradually increased with the use of new materials such as iron or steel frameworks. Steel frames and concrete shells made thick masonry walls redundant and increasingly wide spans could be built with no need for vaults and domes. Yet the significance of the dome remained and new methods and materials meant that huge domed spaces could be more easily achieved, such as the cast iron dome of the *United States Capitol*, Washington DC (1793-1867), or the *Jefferson Memorial* (1934-43). Celestial allusions in domed architecture demonstrate how its symbolism is embedded, in spite of scientific and astronomical developments. As a method of embracing large spaces and large numbers of participants, it can hardly be bettered, and has consequently become used for large gatherings of a different type, for example sports stadia, such as the massive scale of the *Olympic Stadium* in Rome (1960); the *Superdome New Orleans* (1971); or the *Auditorium* by Navarro in Salamanca (1992), where "the lightness of the roof accentuates rather than negates its primary historical role as the parallel of the sheltering sky vault" (Steele 1997, p. 59 and pp. 27, 28). In astronomical terms, the 'dome' is still used (and referred to) as a most

convenient structural method for the reproduction of the night sky. Observatories and planetaria continue to be domed in spite of current knowledge of the shape (or otherwise) of the Universe. There is no 'earthly' reason why a planetarium or observatory should be dome-shaped in terms of current knowledge of the structure of the Universe, yet the shape persists in spite of all that is known about the boundlessness of space (such as the re-modelled *London Planetarium*, 2004). It also comes as no surprise that a dome was selected to commemorate the new millennium (2000) in London. The spectacular *Millennium Dome* (significantly 365m in diameter, suspended from 12 cables) and completed 31 December 1999, is not a dome in the true sense, since it is not freestanding and self-supporting but held up by its system of cables. A dramatic sight when illuminated at night, it seems almost like a space craft, reflecting the avowed interest in Astronomy of its architect Michael Davies. It is remarkable that architects turned to the dome to find a fitting tribute for the cosmological event of the new millennium, concerned with time, space and eternity (Evans 1997, pp. 29-36).

### Conclusions

Consciousness of dome symbolism on the part of architects is not always easy to prove. Since the time of the Renaissance, different astronomical systems have come under consideration as the perception of the Universe developed from the flat Earth to geocentric, heliocentric, galacto-centric and finally a-centric. In matters of construction, materials and symbolism, the dome has provided an endless source of fascination. Tangible images and constructions were used to elucidate theoretical concepts as well as artistic interpretations of theological, philosophical or scientific theories. Without necessarily claiming that every dome is cosmic, and without overemphasising the aesthetic and symbolic functions of architecture at the expense of the structural and utilitarian, it may reasonably be argued that the body of evidence suggests that cosmological and astronomical concepts are a major source of interdisciplinary inspiration for the forms thus created.

### Note

1. Biblical references are taken from the English authorised version. The *Good News Bible*, 1966 translation refers to 'domes' in *Genesis* 1, 6-8: "so God made a dome [...] He named the dome Sky".
2. Raphael Peruzzi and the Sangallos (father and son) worked on the project after Bramante died. The dome was completed to Michelangelo's designs by Giacomo della
3. For a concise summary of Kepler's first two Laws (in his treatise on *Motion of Mars*, 1609) and third Law (in *Harmony of the World*, 1619) see Kuhn 1057, pp. 212-217.

Porta and Domenico Fontana (1585-90). Surprisingly, the dome of Florence is actually larger than that of *St. Peter's* in Rome, possibly indicating that Michelangelo, a Florentine, did not want the dome of the new *St. Peter's* in Rome to surpass the *Duomo* in his beloved Florence.

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