



## From Disorder to Hidden Order; Fractal Cosmology from Isfahan to Shah Mosque

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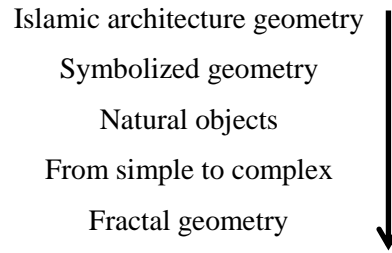
### Abstract

In Islamic art, geometry has a significant role that is used as pattern with the purpose of ornamentation and spatial organizations. Through complexity theories occurred as new paradigms, in a dynamic space and a living system of traditional inheritance, hidden orders- not only physically but also mentally- could be analyzed and recognized. The aim of the study is to investigate the relationship between complexity theories and cosmologic thoughts of Islamic worldview through traditional architectural spaces in Iran. It examines the fractal continuity visually from the urban scale of Isfahan, then the plans, elevations and finally decorative patterns of Shah Mosque.

## 1. INTRODUCTION

In Muslim art and architecture, geometry has an important role, which is used as pattern with the purpose of ornamentation and spatial organizations. Especially Iranian traditional art is stated as inherently a geometry-oriented nature [8]. By examining Iranian art and architecture, dynamism and complexity could draw the attention in traditional cities in different eras. This organized complex geometry has a continuous language starts from urban scale to even the ornaments of a building in a micro scale. Akkach, in his article: *'In the Image of the Cosmos Order and Symbolism in Traditional Islamic Architecture'*, tries to prove that Islamic architecture is far from being just a functionally versatile form and it has a rich symbolism associated with its underlying geometry [2]. Further, this study tries to prove that this sacred architecture includes hidden meanings and this hidden architecture can only be analyzed by a deeper view and knowledge of geometry.

Previous studies have shown that Islamic architecture was analyzed with Euclidean geometry in terms of only construction and ratios. But, through a new paradigm of research, which was occurred in the middle of the twentieth century, the ways of seeing universe by scholars have changed. As Dickau states that the utility of the central concepts of *fractal theory* defining the things that are rough and varied rather than smooth and regular, have been the invitation to cosmologists [7]. The theory has a great potential for understanding the processes of the universe. The metaphorizing of cosmos can obviously be traced by sacred/spiritual architecture. With this new way of looking, it is now possible that from the simplest pure forms to more complex ones, Islamic architecture can be investigated to figure out the hidden/ invisible symbolic meanings. In other words, as seen in the diagram below, by using fractals, we can trace the cosmological thoughts behind the bifurcation processes of relation between complexity and geometry in Islamic architecture.



**Diagram 1.** Bifurcation process of complexity and geometry in Islamic architecture

In this context, this paper aims to contribute to the field in terms of the relation between complexity theories as new paradigms and cosmologic thoughts of Islamic worldview behind a traditional architectural space. Thus, through this new paradigm, in a chaotic/dynamic space and living system of traditional inheritance, hidden orders- not only physically but also mentally- could be analyzed and recognized.

The focused architectural product to be studied in the scope of the paper is considered as Shah Abbas Mosque. To understand the knowledge of Islamic cosmology with the theory, it is thought that the mosque should be considered together with the context, Isfahan City that is considered as the environment of it. Such a review carried out on similar geometric and proliferating patterns will reveal the existence of '*continuity*' in macro (urban) and micro (building) scales. Hence, it seems possible to analyze the patterns in the frame of the basic feature of theory, which is *self-similarity*, in the organization of the region Isfahan and its continuous geometrical/ symbolical relation with the Shah Abbas Mosque.

## 2. FRACTAL GEOMETRY AS A TOOL OF INVESTIGATING ARCHITECTURE

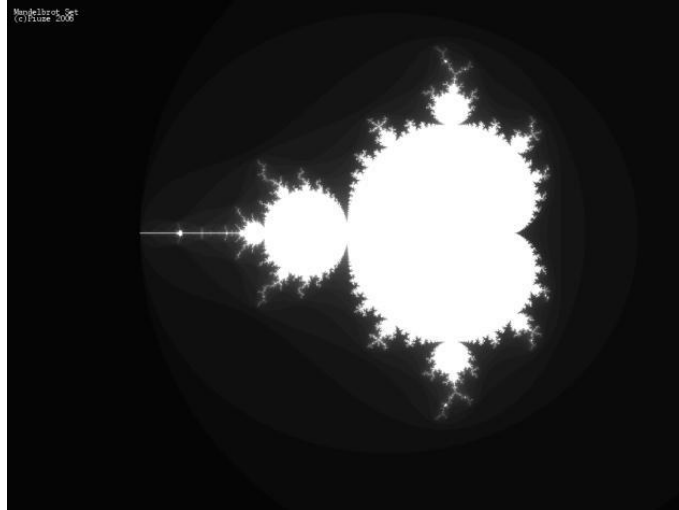
*“Euclidean geometry cannot analyze natural forms. No mountain, no cloud or no walnut is triangle, oval or spherical, respectively. However, in nature, harmony, coordination and surprise attraction exist between the components of natural landscapes that are attractive in the human eyes contrary to Euclidean geometry”* [9]

With the development of chaos and complexity theories, fractal geometry had occurred in the 70s<sup>1</sup>. The theory of fractal was produced first by B.B. Mandelbrot who was French-American mathematician. With a mathematical perspective, he tried to put forward the basic principles of the geometry [9]. The universe, which Mandelbrot describes as fractional geometry, is a rough, indented, bent and heterogeneous universe. In fractal geometry, parts or components that make up a body resemble the entire body. Irregular details repeat the pattern on scales that shrink even further. Fractal geometry has more characteristics than certain characteristic sizes exist in Euclidean geometry (E.g. radius of circle). We can give many fractal examples by looking at the formations in nature. Systems such as snowflakes, trees, sprawling rivers and neural networks display a fractal structure.

When looked closely at a fractuated object, in other words, when the scale becomes smaller, the degree of irregularity usually remains the same. Therefore, they are independent of the scale. Fractals are indented protruding objects with increased detail as they grow. So they have infinite details. The most important features of them are repetitions, self-similarity, unpredictability, self-organizing and non-linearity.

Fractals are very complex and have unlimited details. Even when you zoom in to a section of the fractal, you can see as much detail in the whole fractal. They are described as repetitive and the same small sections are the same. As can be understood from here, this process can be repeated forever, open-ended. There is a repetition of a continuous main shape, which is also called self-similarity.

<sup>1</sup> The term ‘fractal’ was named by Mandelbrot to define the geometry in 1975 and it was derived from ‘fractus’, which means irregularly fractured and broken [5].



*Figure 1. Mandelbrot set [9]*

Although the discovery of fractals in the scientific sense dates back to the 20th century, from the past to the present, when the architectural examples are examined, fractal fictions can be found. The nature, the social structure and the social-cultural structures have always been used as a guide in the design process, and thus, the fractal fictions that exist in nature have influenced architectural designs. The 'self similarity' existing in nature, the repetition of similar elements, is also observed in architecture. A visual analysis of the architectural monument is observation of the buildings to identify their self-similar elements, which, in fact, are the fractal patterns or identification of mathematical fractal forms [13]. Repeated elements can be found in any architectural components.

### **3. EXPLAINING FRACTAL COSMOLOGY FROM ISFAHAN CITY TO SHAH MOSQUE**

A mosque is a symbolic structure that includes fundamental concepts of Islamic philosophy about cosmos. To comprehend the significance of self-similarity as an organizing system in Muslim architecture, the relation of it with the understanding of cosmological basis on Islamic architecture is necessary.

#### **3.1. Urban Scale-Linearity (Macro Scale)**

In the Islamic period, various palaces, bridges, streets and gardens were built in various towns in Iran, especially in Isfahan. The city, beyond its evolution as a living organism, has a whole structure whose continuity can be observed with its integral structure. The fractal geometry of traditional cities has been deliberately ignored due to the application of arbitrary stylistic rules. However, fractal geometry can clearly be traced in Iranian traditional cities, particularly Isfahan. The change of urban morphology and the analysis of fractal structure in different periods bring a different approach to the evaluation of urban space. When viewed from the upper scale, it is seen that the urban development of Isfahan is continuous and the initial conditions affect the development of the city.

For Akkach, while understanding the spatial order of Islamic buildings which focuses on individual spaces rather than complex and entire spaces, we encounter that confined spaces reveal some common spatial features:

- spaces laid out around a center,
- clearly identified a cross of directions,
- spaces symmetrically organized around a central vertical axis [12].

These characteristics are manifested in the organization of not only traditional Islamic buildings but also the settlements and landscapes. Akkach says that two prototypical orders reveals in embodying these:

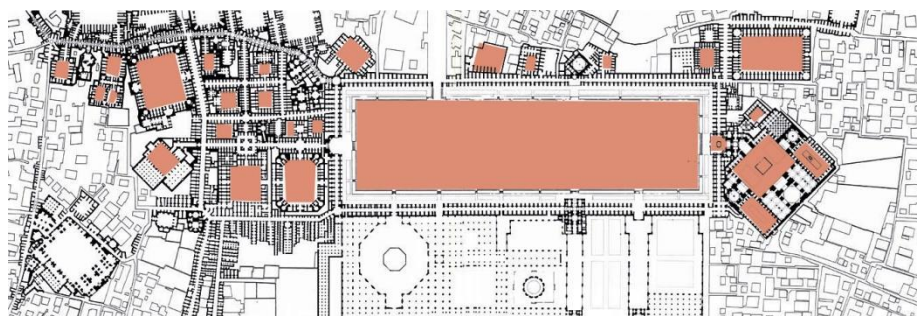
- The concentric order
- The linear order [2].

According to this approach, urban components of Iranian cities could be generalized as bazaar, mosque, citadel and residential quarters that are usually taking a linear shape together. Linear order relates to all spaces, which are focused by a moving center. It provides a principle unifying spatial order in dynamicity. We can see this characteristic in traditional Isfahan. We see a repetition of spatial unit with creating so many individual concentric spaces.

Naqsh-e-Jahan (world image), which is the great maydan of Isfahan, includes a cluster of gorgeous architectural products of Iran art. The square is identified as unique by historians for its architectural characteristics, ratios and magnificence. Traditionally, the guiding formative motif of Iranian architecture has been its cosmic symbolism by which man is brought into communication and participation with the powers of heaven [6].

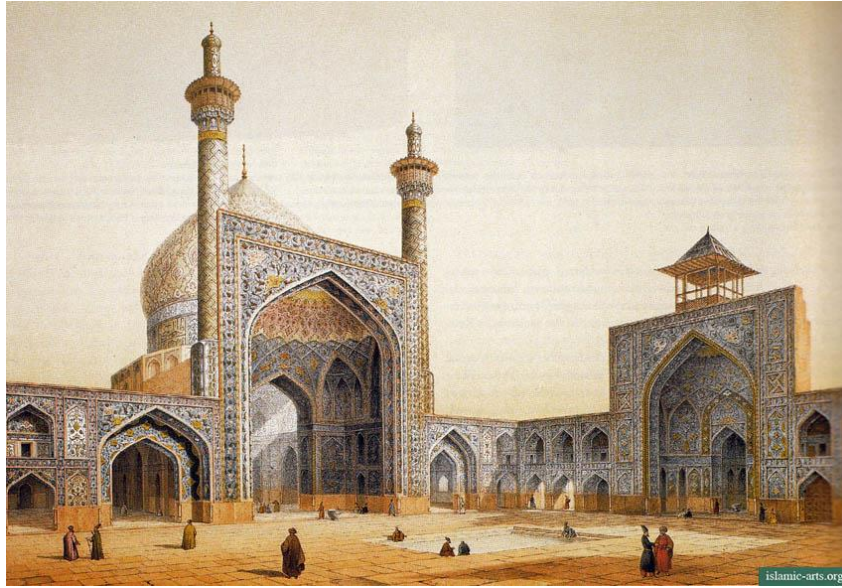
*“When you build a thing you cannot merely build that thing in isolation, but must also repair the world around it, and within it so that the larger world at one place becomes more coherent, and more whole; and the thing which you make takes its place in the web of nature, as you make it.”-Christopher Alexander [5]*

The small components of the city composition have the same look as the original whole organization (Figure 2). This layered unity has both the small parts and larger parts, which are similar to smaller ones of the city. Barrie defines Alexander’s words above with understanding architecture as a dynamic set of articulate relationships [5]. In terms of being a mediator, iwan plays a significant role in this context. The centralized open courtyards are mostly rectangular shaped and reveals a passage from unity to quadrature. The strong morphological pattern is here based on continuity of the vacuums that are functioned as rectangular shaped iwans. Iwan is considered a transition zone in Islamic cosmology. Peker believes that the emergence of the monumental iwan was determined by its invocation of an old image, 'the gate of heavens and earth' and that this symbolic function preceded its mundane, utilitarian, purposes [11]. This definition gives us that the continuity of the city is not organized in a random order. With the fractal fiction of the iwans, we can see a reflection of the transition from the city to the sanctuary.

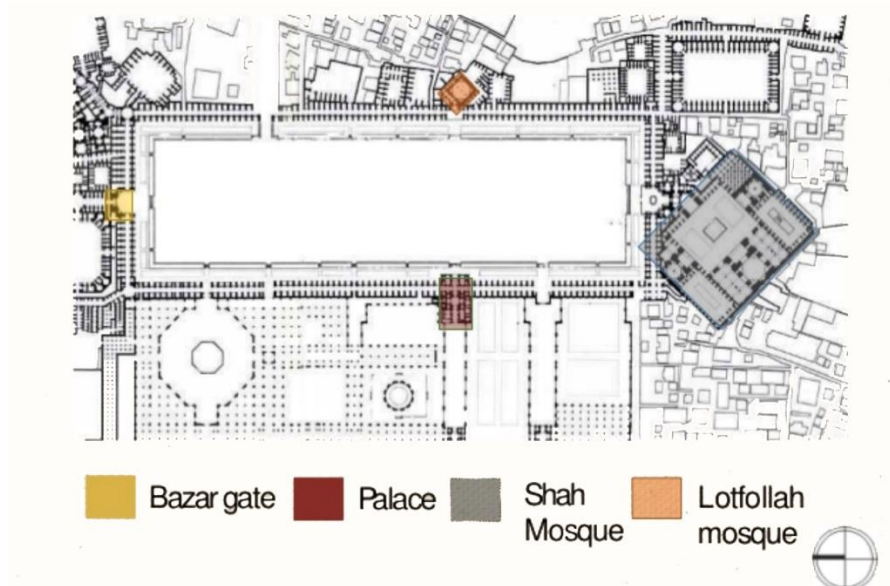


**Figure 2.** Isfahan city and organisation of vacuum spaces

### 3.2. Building Scale- Centrality (Micro Scale)

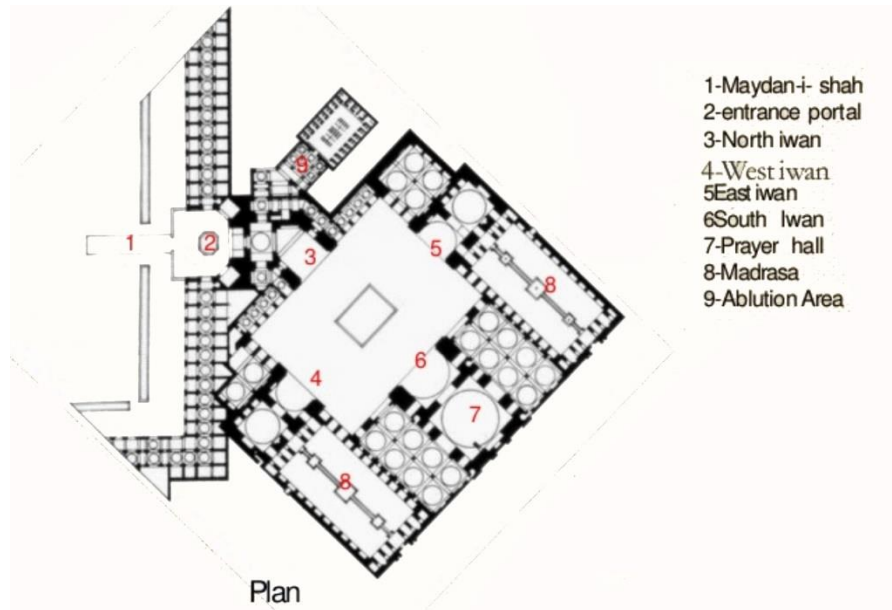


**Figure 3.** Shah Mosque ([www.islamic-arts.org/2012](http://www.islamic-arts.org/2012))



**Figure 4.** The place of Shah Mosque in Isfahan City (Created by the author)

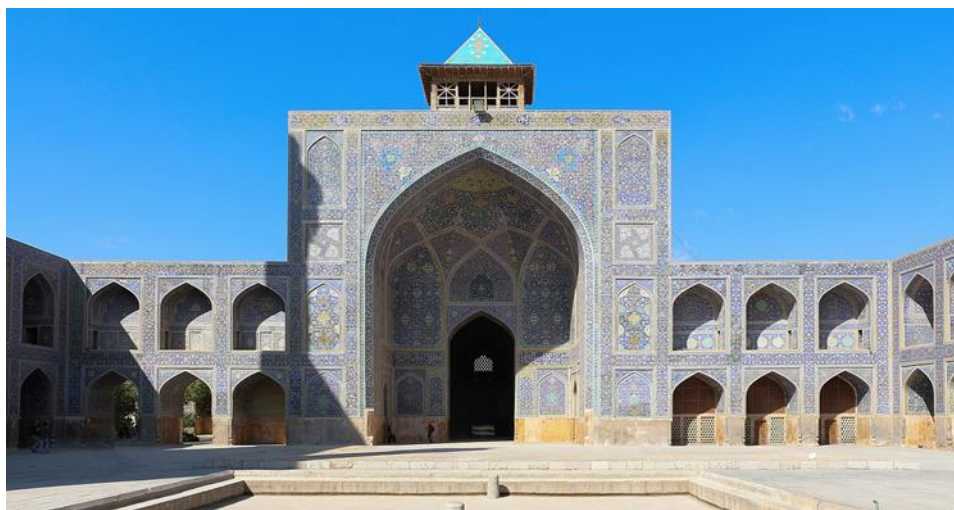
Shah Mosque, which is one of the most significant mosques of Isfahan, was built by Shah Abbas during the Safavid Era (Figure 3). The Masjid-i-Shah (Imam Mosque), which began in 1612, represents the culmination of thousand-year-old mosque architecture in Persia, which was under construction until 1638, despite the impatience of Shah Abbas. It is seen that Iranian architects used their highest level of artistry in designing and constructing the dome, iwan, mihrab and niches in the mosque. In the plan of mosque we see centralized forms (Figure 5). This concentrated composition contains not only the main linear axis reaching to the Divine, but also centralized open courtyards which are associated to the central axis in a fractured way.



**Figure 5.** The plan of Shah Mosque (Created by the author)

In order to define self-similarity it is necessary to mention about 'scaling'. Scale is used in architecture to subconsciously communicate with the users. The limit of the scale requires the definition of the 'boundary' (Figure 6). Sometimes a building itself, sometimes an ornament detail or sometimes a city's main arteries give us ideas about the limits and boundaries of fractal size. Because, every unit wants to have a boundary. As Salingaros states, units of different size can link with one another by having a similar shape, so the same pattern repeats at different magnifications [12]. While the linear order of the Isfahan city relates to all spaces which are focused by a moving center, it provides a principle unifying spatial order in dynamicity. Then, this characteristic relates with the mosque as well as the axis creates a repetition of spatial unit with creating so many individual concentric spaces.

As Akkach believes, the symbolism of Islamic architecture has a relation with basic geometrical forms which express the principles mentioned, (the concentric and linear orders) such as the circle and square and their three dimensional equivalent, the cube and the sphere. Architecture proposes us a diversity of three dimension expressions. The transition elements to the dome, openings in the facades, columns, dome elements and door gaps in the mosque are observed to be in a continuum [2].



**Figure 6.** Repeated elements of the facade



*Figure 7. Repeated dome transition elements*

For centuries, Islamic geometrical patterns have been used as decorative elements on walls, ceilings, doors, domes, and minarets [1]. Human consciousness communicates to architecture through even the smallest details. Aesthetics of Iranian art is based on ornament; ornament is not only a kind of imitation and inspiration from nature, but also includes some special thoughts insight from Islamic beliefs and thoughts [3]. The symbols, which are one of the important elements that attract attention in the decoration of the Safevi mosque, are also reflected in the decorations in this structure. The 'bundle of light' (nur demeti) in the heart of the dome consisting of repeating motifs represents 'the perfection' in mysticism. Here, we are witnessing a great harmony that geometry and the concept of eternity compose together. Through the deep theoretical background of ornaments in the mosque, it is valid to say that here ornament is not something added later, but it is the art and reality by itself via the complex fractal geometry. By comprehending the symbolic meanings of adornments in decorations, we can understand the mind of the architectures and finally can trace the culture and their views of the world.





**Figure 8,9,10.** Fractal ornaments of Shah Mosque

#### 4. CONCLUSION

*“Starting from the highest heaven, which is nearest to the Divine, the hierarchy of being descends through the heavenly spheres symbolizing the angels-and down to the world of the four elements, of which the heaviest, the earth, is the one farthest away from the pure light of heaven. The elements then are mixed to various degrees by the Soul which from them forms the three kingdoms. The process terminates with man, who is the final term of the effusion: ‘The unity and complexity of his soul and body respectively make him ‘the antipode of God.’” [10]*

From the words of Nasr, it can be clearly said that the perfection from human being to Divine can be followed by material and form which could be described as art and architecture in traditional Islamic architecture. Within the scope of the paper, it has been tried to prove that the connection between the user and cosmologic thoughts behind the architecture can be highlighted by the scaling hierarchy. In the study, this scaling is framed in the context of fractal geometry. With the vertical and horizontal axis’ that are clearly followed in Isfahan City connecting Shah Mosque can be clearly followed by the existing form of the architecture. Consequently, above all these analyzes and observations it can be said that fractality provides a strong continuity on both culture which embraces the great meanings of society and the symbolic unity of architectural characteristics of the environments.



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