

An Ancient Rule for Constructing Dodecagonal Quasi-Periodic Formations

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Abstract : The discovery of quasi-periodic structures in material science is revealing an exciting new class of symmetries, which has never been explored before. Due to their unique structural and visual properties, these symmetries are drawing interest from many scientific and design disciplines. Especially, in art and architecture, these symmetries can provide a rich source of geometry for exploring new patterns, forms, systems, and structures. However, the structural systems of these complicated symmetries are still posing a perplexing challenge. While much of their local order has been explored, the global governing system is still unresolved. Understanding their unique global long-range order is essential to their generation and application. The recent discovery of dodecagonal quasi-periodic patterns in historical Islamic architecture is generating a renewed interest into understanding the mathematical principles of traditional Islamic geometry. Astonishingly, many centuries before its description in the modern science, ancient artists, by using the most primitive tools (a compass and a straight edge), were able to construct patterns with quasi-periodic formations. These ancient patterns can be found all over the ancient Islamic world, many of which exhibit formations with 5, 8, 10 and 12 quasi-periodic symmetries. Based on the examination of these historical patterns and derived from the generating principles of Islamic geometry, a global multi-level structural model is presented that is able to describe the global long-range order of dodecagonal quasi-periodic formations in Islamic Architecture. Furthermore, this method is used to construct new quasi-periodic tiling systems as well as generating their deflation and inflation rules. This method can be used as a general guiding principle for constructing infinite patches of dodecagon-based quasi-periodic formations, without the need for local strategies (tiling, matching, grid, substitution, etc.) or complicated mathematics; providing an easy tool for scientists, mathematicians, teachers, designers and artists, to generate and study a wide range of dodecagonal quasi-periodic formations.

Keywords : dodecagonal, Islamic architecture, long-range order, quasi-periodic

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