

A Surface-Stacking Structural Model for Icosahedral Quasicrystals

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A new theoretical framework for describing the long-range order of icosahedral quasi-periodic structure, without appealing to higher dimensions or matching/deflation rules is proposed. This model is based on a surface-stacking image of icosahedral quasicrystals and is in concert with the step-terrace morphology observed in many experimental investigations of real icosahedral surfaces. According to the new geometrical model, constructing the infinite three-dimensional icosahedral quasi-periodic structure is achieved by stacking quasi-periodic surfaces oriented perpendicular to all 5-fold axes of the icosahedral symmetry; resulting in a network of intersected surfaces that allows for a perfect icosahedral quasi-periodic infinite order to emerge effortlessly (Fig 1), without the need for abstract or complicated mathematics (i.e. inflation, deflation, substitution, matching overlapping, projecting, etc.). This new approach suggests that the position of geometric units locally and globally is orchestrated by one governing framework and not based on local rules. The proposed model, which operates within the real physical (Euclidean) space, provides a direct three-dimensional visual representation which can be instrumental for conducting different modes of analyses and fabrication strategies; eliminating a major roadblock for researchers especially in the non-technical fields. More importantly, understanding the long-range structural logic of quasi-periodic symmetries will hopefully provide a deeper understanding of the structure of quasicrystals at an atomic scale and help achieve improved control over material compositions and structure.

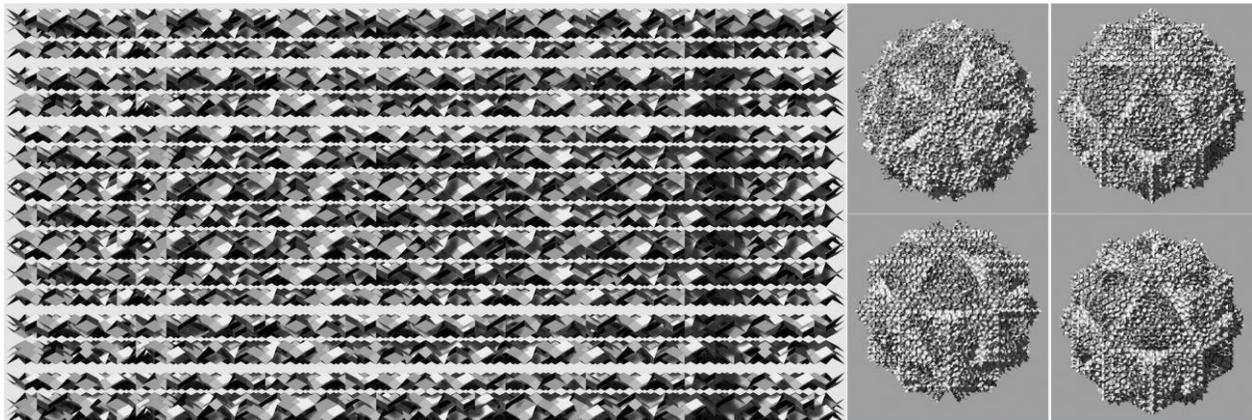


Figure 1. Left: A stacking order of quasi-periodic surfaces arranged perpendicular to one 5-fold axis of the icosahedral symmetry. Right: views of icosahedral quasi-periodic superstructure generated using the surface stacking model. Top Left: view along 5-fold axis. Top Right: view perpendicular to 5-fold axis. Bottom Left: view along 2-fold axis. Bottom Right: view along 3-fold axis.