

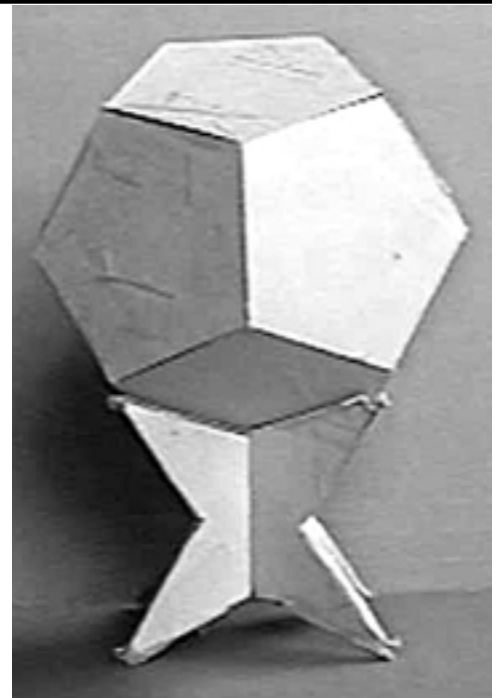
The Journey

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REGULAR PENTAGONAL DODECAHEDRON OVERVIEW:

A rather shop worn dodecahedron resting on a tired concave dodecahedron.

The dodecahedron has twelve regular pentagonal faces that traditionally have been considered unlikely candidates for any kind of close packing, space filling arrangement. Three decades ago regular pentagonal crystals were found in nature. This means that there is some arrangement that allows dodecahedrons to pack in a uniform space filling manner. Crystallographic areas related to the study of 5-fold forms include quasicrystal and approximant research.



The regular pentagonal dodecahedron and the concave (pentagonal) dodecahedron together fill space. I first saw this documented at George Hart's polyhedra website.

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This is the work of Zvi Hecker, polish born architect and his housing complex in Jerusalem.

I became aware of Hecker's work via Marion Walter, a retired University of Oregon geometry professor. When Marion saw my model of dodecahedra packed around a nuclear center, she was reminded of Hecker's work and dug out this reference from the publication Leonardo, Vol. 13, pp.272-275 "THE CUBE AND THE DODECAHEDRON IN MY POLYHEDRIC ARCHITECTURE", Pergamon Press, 1980. Photos are from this publication. Hecker "noodled" this packing over a period of several years, then carried his ideas to the building complex shown.

The drawing shows his awareness of how cubes are formed in the centers of the regular pentagonal dodecahedrons, and how the dodecahedrons close pack in alignment, as if the cubes were stacked flat on a table. The awareness of the cube in the center of the dodecahedron was first described by Euclid, so the internal cube isn't especially news.

No mention is made of the space filling concave dodecahedron so I assume Hecker was not aware of it.

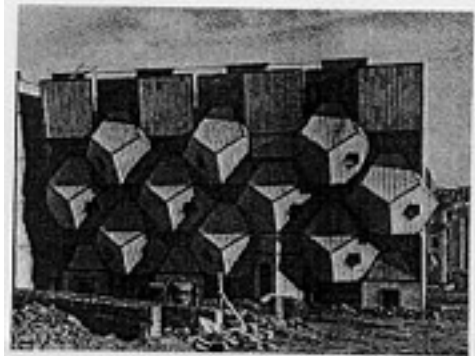


Fig. 6. View of façade overlooking courtyard, Ramat Housing Complex, Jerusalem. (Photo: H. Hunter, Tel-Aviv, Israel)

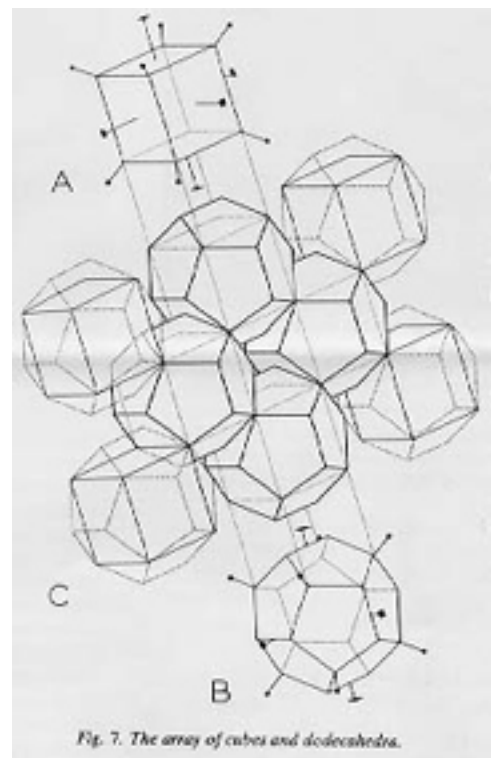


Fig. 7. The array of cubes and dodecahedra.

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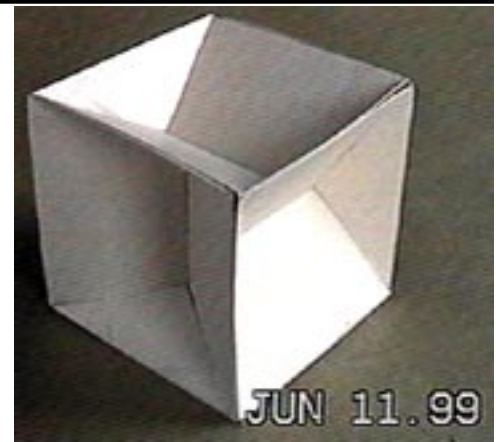
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The key to my understanding the close packing of regular pentagonal dodecahedrons was when I cut the tents off the faces of the cube that lies inside the dodecahedron and turned the tents over, then reassembled the dodecahedron with all of its vertices facing inward. There was an immediate awareness of this form being a dodecahedron “socket” that would allow dodecahedrons to pack together in a uniform way. If the model shown was inflated from inside, the tents would pop up and a dodecahedron would form. Later I found with the help of George Hart that I had “invented” the concave dodecahedron, albeit with “invisible membranes”. As it turns out, it was those membranes that made it easy to visualize how the dodecahedrons would stack together like cubes.

The grouping with the red dodecahedron center is the middle layer of a close pack of twelve dodecahedrons around a nuclear (red) core. The concave dodecahedron “sockets” seat four dodecahedrons and the bottom layer seats four dodecahedrons.

When all twelve dodecahedrons are in position the cluster to the right shows the close pack around a thirteenth nuclear dodecahedron. The triangular opening in front is where the spire of a concave dodecahedron fits.

The cube “sockets” in the center surround a nuclear (red) dodecahedron (not visible). The twelve dodecahedrons plug into the “sockets” to form the close pack grouping. These clusters are replicating and fill space.



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Summary

My interest in a close packing arrangement was underlined when I realized that the dodecahedrons would pack like spheres, twelve around a nuclear dodecahedron. This arrangement produces the vector equilibrium pattern, when the centers of each dodecahedron are connected. With this in mind I set out to see if the close packing in these two arrangements would provide clues to embedding 4-fold and 5-fold symmetry. This paper looks at the grouping of dodecahedrons that form a close pack. A separate paper will more closely look at the differences in the two close pack arrangements, while exhibiting the same vector equilibrium pattern.