The Journey

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The Journey is a personal exploration of pattern, shape and form that started in 1961. The approach and methodology from the start has been based on hands-on geometric modeling with after-the-fact follow-up mathematical confirmation of findings. This series of PDF files is a sketchbook that strings together some of the thinking and results that have occurred to date. Each PDF file is considered a draft and the file name is followed by a number. For example: ve.pattern.1.PDF is draft one from the original file: ve.pattern.PDF. Since the approach is more that of a sketchbook than a book, the order is undetermined at this stage. The advantage of this approach is a growth that is somewhat organic in nature, moving in directions motivated by the questions and interests of others as well as the ongoing observations and questioning that has been a part of this journey from the start. There is an unfolding of events and observations. It seems likely that there will be a gathering of related material at some stage where a glossary, beginning, middle and end can be assigned. Until then I plan to fill the pages of the sketchbook with my observations from the trail and occasionally off trail and in darkness.

Jim Lehman, Vancouver, Washington, USA

VECTOR EQUILIBRIUM PATTERN OVERVIEW:

This paper explores the pattern of the vector equilibrium as it appears in several different close packed arrangements.

There are several features of the vector equilibrium (VE) in this study that have special significance. The VE formed by a close packing of cubes is clearly one of these. The cubes define the boundaries of positive and negative space and contain these in equivalent volumetric “boxes”. In turn this defines two same size VE patterns that are required by a “virtual pattern law” to coexist. These cubes, positive space and negative space (colored white and red) are enveloped by regular pentagonal dodecahedrons that penetrate one another. These merged dodecahedrons are space filling with no negative space between them. Their internal cubes are stacked face to face, filling space, and replicating in all directions. Every white cube (which is enveloped by a pentagonal dodecahedron) has a centered white sphere, concave dodecahedron, octahedron, icosahedron, rhombic dodecahedron, and stella octangula (duo-tet cube). Every red cube (which is enveloped by a pentagonal dodecahedron) has a centered red sphere, concave dodecahedron, octahedron, rhombic dodecahedron, and stella octangula.

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When twelve close packed spheres surround a nuclear sphere and their centers are connected with a line, the resulting pattern is the vector equilibrium (VE). As long as the spheres stay in their same relative positions, they may be reduced or enlarged and the VE pattern remains unchanged.

Forms other than a sphere may surround the vertices of the VE, but in so doing, the distance from center to center may change as the VE pattern remains unchanged.

In this study there is a hierarchy of form and a decimal unit of measure is used throughout to provide an “at-a glance” sense of physical size and scale of one form in relation to another. Exact notation for the algorithm follows in parenthesis. This gives hands-on model making a front seat for design and observation and positions math as a refinement and verification tool.

The cube is used as a common bridge to relate forms one to another. The cube has an edge length of 1.618 (phi). The sphere fits inside this cube and has a diameter of 1.618 (phi). In the red drawing above, the edge length of the VE is 1.618 (phi).

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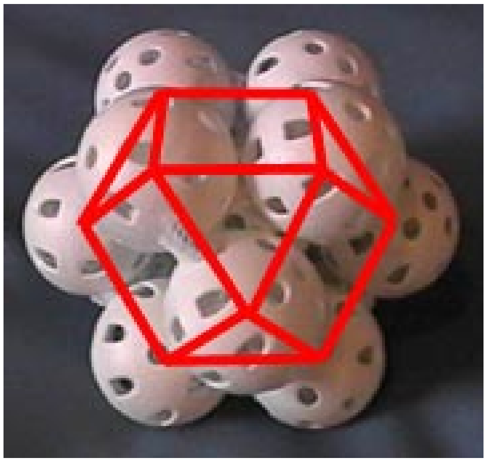
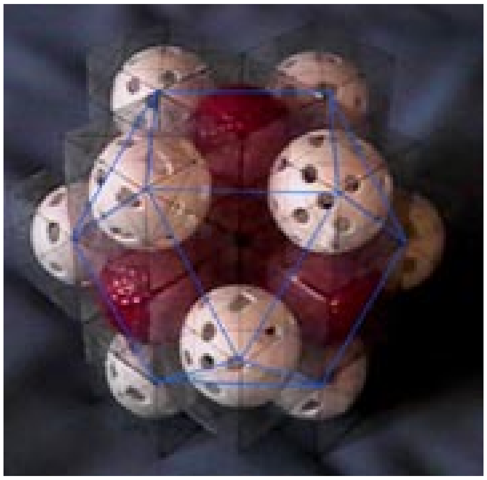
The grouping on the left is a close packing of spheres, twelve around a nuclear thirteenth sphere.

The red vector equilibrium (VE) drawing shows the pattern formed when sphere centers are connected.

When alternating white and red spheres are placed inside cubes, the white spheres form a VE and the red spheres form an octahedron.





In the red line drawing of the VE the length of the lines is 1.618 (phi). In the blue line drawing of the VE the length of the lines is 2.288 ( ). None of the white spheres are touching.

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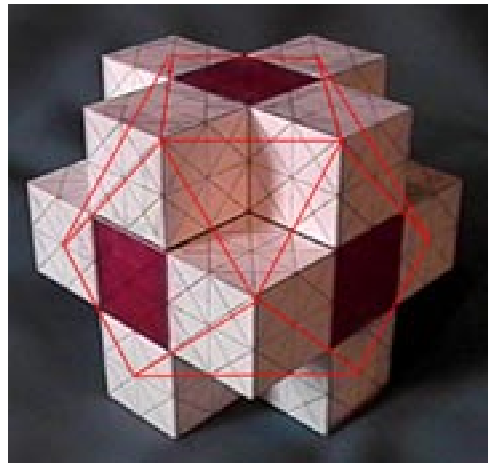
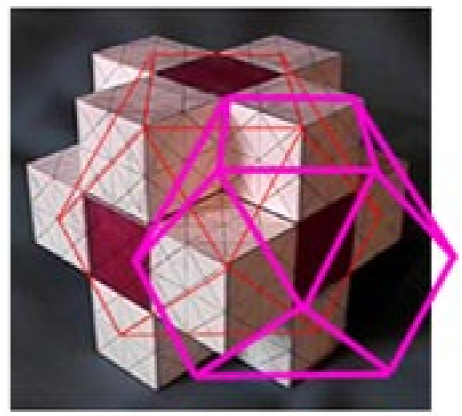


When the white cubes close pack their centers can be connected to form a vector equilibrium (VE). The edge length of the red VE drawing is 2.288 ( ).

The white and red cubes have an edge length of 1.618 (phi).

When the centers of red cubes (not all are shown) are connected, the magenta VE results. This offset between the white cube VE and the red cube VE is 1.618 (phi).



If we call white cubes "positive space" and red cubes "negative space", then the red drawing of the VE would represent a positive space VE and the magenta drawing would represent a negative space VE. These two coexist as a basic pattern integrity when cubes of alternating identity (white & red) are placed in a space filling arrangement.

Buckminster Fuller's isotropic vector matrix (IVM) is a space filling extension of the red VE drawing and is a pattern relationship of close packed sphere centers filling space in all directions. In the example of close packed cubes, the emergence of a second equal volume VE as a negative space representation is of critical importance in laying the foundations for a separate paper involving curvature of the tetrahedron.

These basic pattern conditions of positive and negative are inseparable and form a fundamental dualism in a similar way to the concepts of figure/ field, and in/out. Important to note however, is that the vector equilibrium shape is a virtual outer "shell" pattern that represents core conditions lying, in this case, at the absolute virtual "nothingness" centers of the cubes. the vector equilibrium based on an arrangement of tetrahedrons forms as its center, an absolute virtual "nothingness" as a core. So while these relationships of the vector equilibrium can be physically modeled, they exist as virtual patternings following a virtual pattern law.

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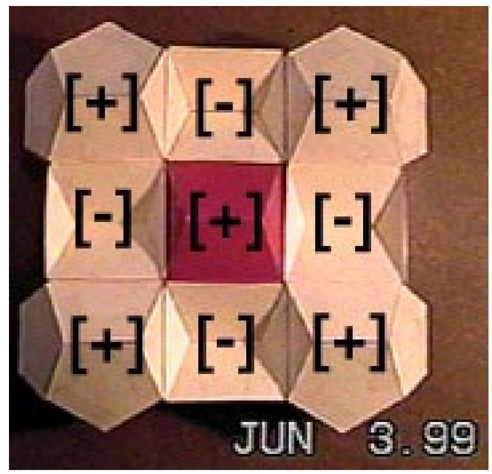
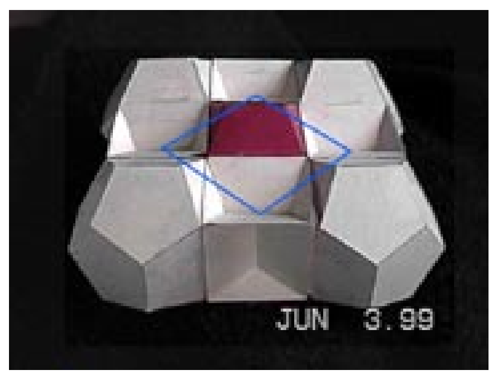
Dodecahedrons are coded [+] and concave dodecahedron “cube sockets” are coded [-] to more easily identify their positions. The arrangement shown is the mid-layer of a close pack grouping. When four dodecahedrons are added on top of the [-] sockets a top-layer is added. When four more dodecahedrons are added directly below the [-] sockets and in the same position, the close pack of twelve dodecahedrons around a core dodecahedron is completed.



The centers of the upper and lower dodecahedrons are rotated 45 degrees from the centers of the mid-layer, shown by the blue lines.



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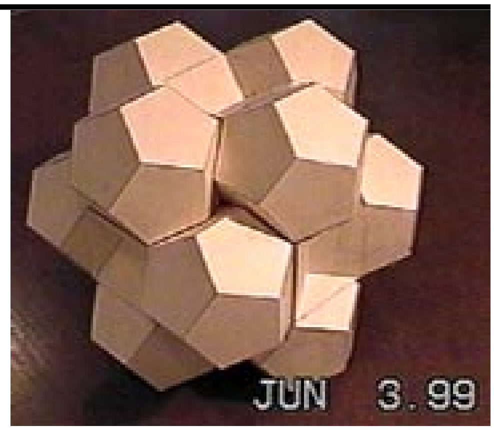
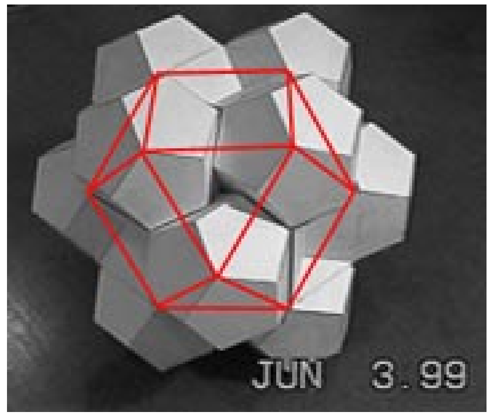


The centers of this close pack of pentagonal dodecahedrons are in the same position and have the same distance as a close pack of cubes.



When pentagonal dodecahedrons close pack their centers can be connected to form a VE. The edge length of this VE is 2.288 ( ).

The vector equilibrium drawing shows the position of the VE vertices in relation to dodecahedra centers.

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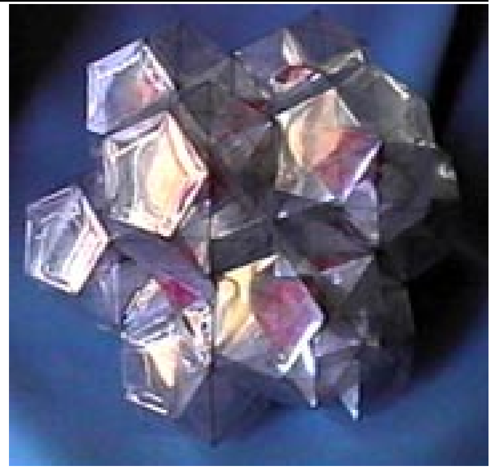
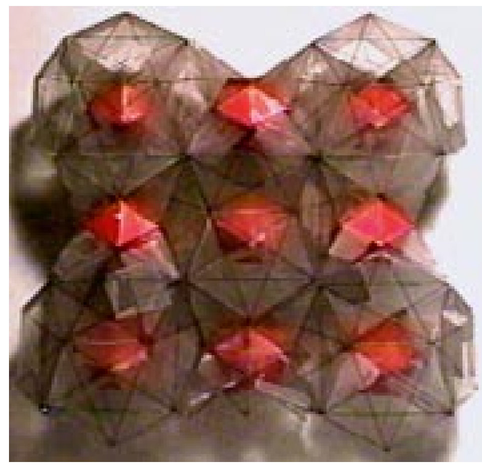
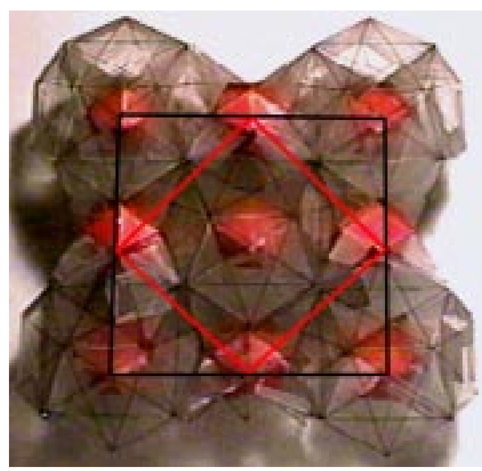


A close pack of twelve pentagonal dodecahedrons around a nuclear dodecahedron with concave dodecahedrons filling the “empty” spaces. Inside each dodecahedron is a concave dodecahedron with an octahedron core and inside the octahedron is an icosahedron. Inside each concave dodecahedron is an icosahedron inside an octahedron.





The black lines connect the centers of four icosahedrons that form the core of dodecahedrons on the same plane. Red lines connect the centers of four icosahedrons that form the core of concave dodecahedrons that are on two different planes. The black lines are parallel to the observer but the red lines drop into the next layer. Note that in the physical model the black lines are the same length as the red lines.

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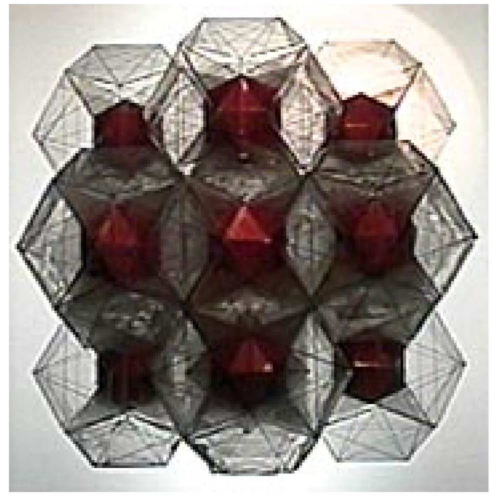
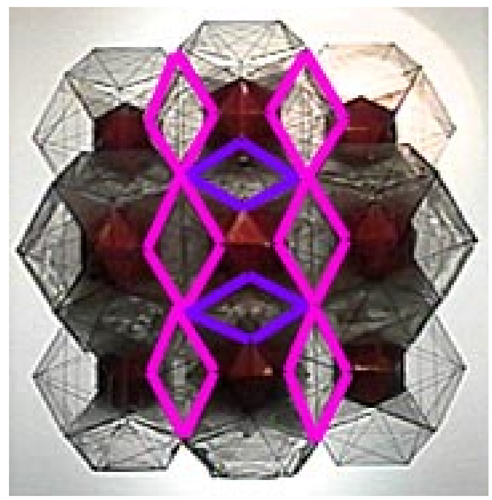
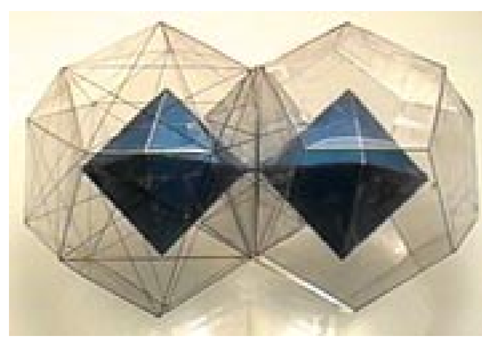
A dodecahedron close pack showing how one dodecahedron merges into another.



The magenta and blue lines show the edges where two dodecahedrons penetrate one another. These lens shaped overlaps form enclosures that are shaped like a pillow.



The pillow is a meeting place for the vertices of two octahedrons. Each octahedron vertex makes contact exactly in the center of the pillow.



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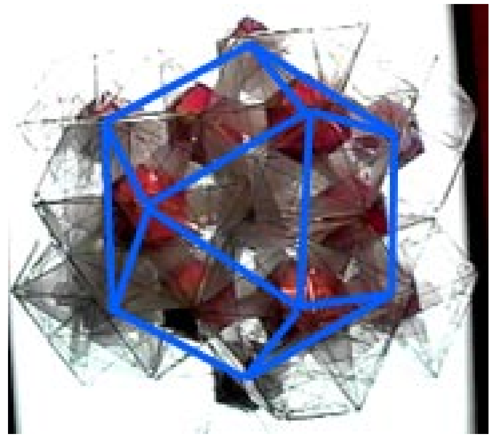
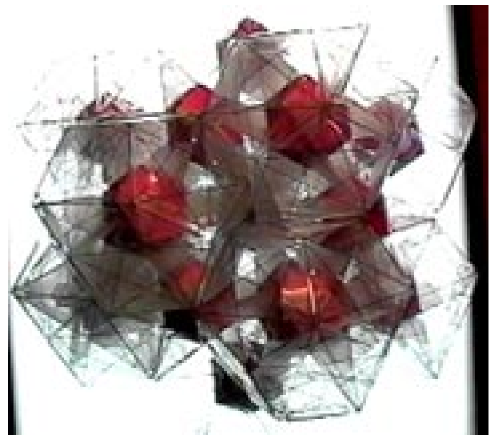
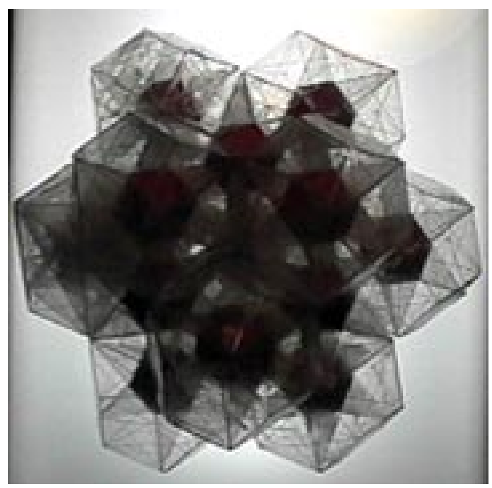
Icosahedra as cores of the pentagonal dodecahedron close pack to form the vector equilibrium pattern.



A hexagonal ring of icosahedrons is formed around the center of a vector equilibrium. The VE is formed by the tips of spires from the concave dodecahedron.





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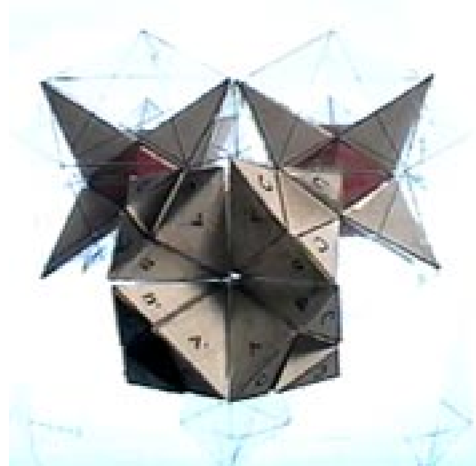
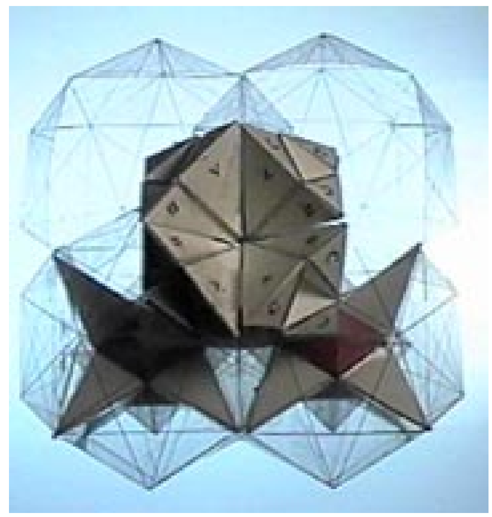
The spire tips of concave dodecahedrons form the center "point" of this vector equilibrium made from fragments created by the planes of regular pentagonal dodecahedra.



Eight interpenetrating pentagonal dodecahedrons envelop the VE. Four dodecahedrons are shown here with a VE core.



The VE is not centered in any one dodecahedron. The VE occupies only a small portion of each of the eight cubes surrounding the VE. That portion consists of an internal 1/8 size cube in the corner of each dodecahedron. So the result is that 1/8 of each of the eight cubes that are internal to each of the eight dodecahedrons, allow space for this core VE.

Note that the stella octangula (not shown) is contained inside the internal cube in all interpenetrating dodecahedrons.

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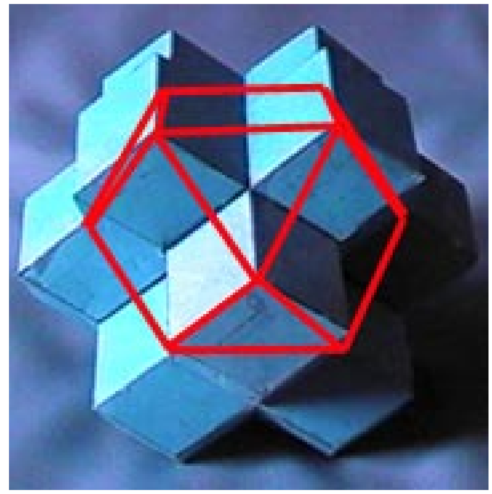

When rhombic dodecahedra close pack their centers can be connected to form a vector equilibrium (VE). The edge length of this VE is 1.144 ( ).

If 1.618 (phi) diameter spheres were formed around each vertex of this VE, the spheres would penetrate one another.

The VE formed by the centers of rhombic dodecahedra is singular, i.e., there is no negative space offset VE as in the packing of cubes and spheres. Both the positive and negative space in this form are “averaged” or “neutralized” to produce a unitary VE.

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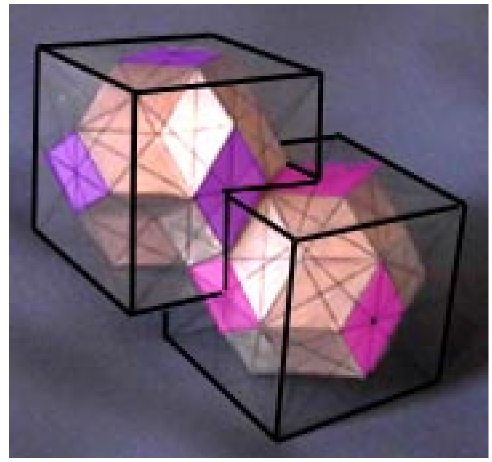

The rhombic triacontahedron shown on the right and the concave rhombic triacontahedron, on the left together form a close pack arrangement of twelve rhombic triacontahedrons around a nuclear core (not shown). These forms fit inside the cube with faces touching each face of the cube.

For the convex and concave forms to fit together when inside the cube, 1/8 cube section must be removed.

The rhombic triacontahedron is centered inside the cube as is the concave rhombic triacontahedron. The position of these two forms in a space filling matrix needs more study. One eighth cube must be removed to allow the convex form to seat in the concave form. This creates a penetration of cubes in such a way that the corners (vertex) of the white cubes lie exactly in the center or core of the cube containing the concave rhombic triacontahedron. This arrangement places the center or core of a vector equilibrium as the core of the concave rhombic triacontahedron. So it appears at this stage that the core of the rhombic triacontahedron and the concave rhombic triacontahedron is the vector equilibrium core “nothingness”, based on the observation that the vertex of a cube, housing either the convex or concave rhombic triacontahedron, lies in the center of these forms when they are seated one against the other.

So the implication is that when the VE is placed in a phi cube, the rhombic triacontahedron occupies this same cube. Keep in mind that this phi cube is not in the same position as the cube that lies inside the pentagonal dodecahedron.

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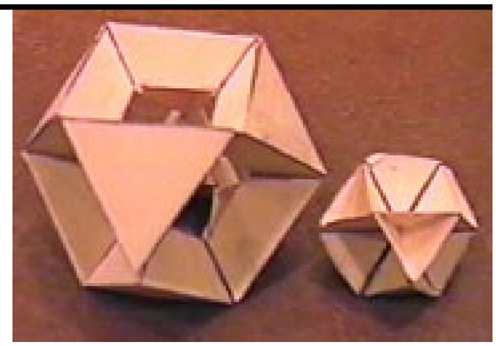

When the vector equilibrium is “cored” the center form is a smaller vector equilibrium. The coring can be continued until reaching the center volume “nothingness”. This is the “space” between all internal vertices. RE: Synergetics, 1013.42 “When the four planes of each of the eight tetrahedra move toward their four opposite vertexes, the momentum carries them through zero-volume nothingness of the vector equilibrium phase”.

The nature of this core is explored further in another paper concerned with curvature.

Conceivably if the tetrahedra planes are considered the positive space, or an artist might call this the figure, then the “zero-volume nothingness” that the planes are flying through would be called the field or negative space. The field in this instance has no properties whatsoever. In my estimation this territory is what John Brawley refers to in Tverse as a “piont”. I imagine this is open to debate and I look forward to a better understanding.

As construction proceeds with curved tetrahedra (not shown) I have become aware that this core VE, as shown above, is no longer a clone of the original form, but has a new set of features.

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Summary

I see two significant vector equilibrium sizes. One, the VE formed by the centers of pentagonal dodecahedra that are close packed but not penetrating one another. The other the VE formed by the vertices of eight tetrahedrons. The VE formed by dodecahedron centers has at its nuclear center a pentagonal dodecahedron. Each vertex of this VE is enveloped by a pentagonal dodecahedron. The other VE is formed by the vertices of tetrahedrons positioned to form the isotropic vector matrix. This second VE also corresponds to the pattern formed by connecting the centers of close packed spheres where all spheres are in contact with one another.

The tips or spires of the concave dodecahedron that is contained in the white cubes, and the tips of the spires extending from the red cubes form the centers of vector equilibriums formed by tetrahedrons. The tetrahedron is not centered inside the cube, but surrounds the spire of the concave dodecahedron. This always places the vertex of the tetrahedron that extends outward from the center of the cube in the center of the VE. This same VE center always corresponds to every vertex of the cube. So every cube vertex or corner is the core or center of a vector equilibrium that is based on a grouping of tetrahedrons.

It’s important to understand that the center of the cube and the center of the pentagonal dodecahedron is not the center of the vector equilibrium. The center of the VE is offset from the cube center and lies at the corner or vertex of every cube.

The tetrahedron, which is offset from the center of the cube, forms the vector equilibrium core or center inside a 4-frequency tetrahedron. This 4-frequency tetrahedron is formed by eight stella octangula (duo-tet cube) which are housed in eight cubes. The core of this eight cube complex is the vector equilibrium.

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Summary continued

All references to a cube, octahedron, tetrahedron, etc., are based on the hierarchical size for each used in this study. For example, the a cube has an edge length of 1.618 (phi) and the tetrahedron has an edge length of 1.114 (   ).

Every vertex of the cube lies at the center of a vector equilibrium composed of tetrahedrons and octahedrons with an edge length of 1.144 (   ).

Eight cubes stacked to form an enlarged cube will have one vector equilibrium at its center. This same cube will enclose a 4-frequency tetrahedron which will have as its center the same vector equilibrium.

When one cube is divided into eight smaller cubes and one tetrahedron with edges of 1.144 (   ), is placed in each of the smaller cubes, a vector equilibrium is formed within the large cube.

Each vertex of the stella octangula (duo tet cube) is the center of a vector equilibrium

Eight vertices of every regular pentagonal dodecahedron lie in the center of a vector equilibrium.

Every regular pentagonal dodecahedron will have eight of its twenty vertices involved in the center of eight different vector equilibriums where the tetrahedron has an edge length of 1.144 (   ).

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