The Black Hole at the Centre of this Orb is a Rhombic Dodecahedron

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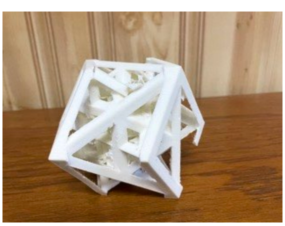
Abstract

I am exploring the symmetry of the rhombic dodecahedron in a way that produces a steady stream of visual extravaganzas. In my video with the same title as this paper (link below) I dynamically remove & replace colour on a stationary rhombic dodecahedral '*Orb*'.

At GA 2022 XXV I am presenting a further eight clips of the rhombic dodecahedron as a *void,* a void constrained by the symmetric 'cuts' that separate the rhombic dodecahedron from its circumsphere.



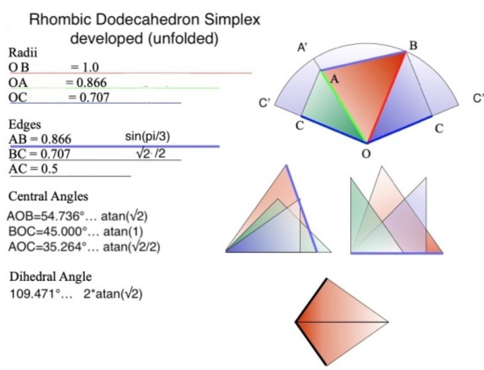
Mamma mia! I just broke my rhombic dodecahedron!

Just to be perfectly clear the rhombic dodecahedron in question is the Catalan solid that is the dual of the Archimedian cuboctahedron. It is an all space filler.[3]

1. Making the Cuts

A rhombic dodecahedron has four axes of symmetry. The three it shares with the octahedron provide the cuts that produce the simplexes that make an orb that I describe below. The fourth axis is a 2 fold symmetry aligned to opposite mid-edges.

Before I do any shading in my virtual world I construct a collection of surfaces by slicing the rhombic dodecahedron with octahedral symmetry planes into 48 pieces of equal volume; 2 sets of 24 irregular tetrahedra with mirror symmetry (enantiomorph simplexes) with surfaces labeled from the net drawing below: Face ABC, cross sections: Hypotenuse AOB,



Altitude AOC, Base BOC.

The rhombic dodecahedron's circumsphere can also be cut by these same planes producing 48 '*spherical*' irregular tetrahedra, (*spherical enantiomorph simplexes*): spherical S-Face A'BC', cross sections: S-Hypotenuse A'OB, S-Altitude A'OC', S-Base BOC'.

These 48 spherical simplexes are common to polyhedra with octahedral symmetries.

A spherical simplex minus a polyhedral simplex produces a *lens* unique to the polyhedron under examination.

In the octahedral family of polyhedra 48 lenses construct an O-orb. 24 lenses construct a T-orb for tetrahedral polyhedra and 120 lenses make an I-orb for icosahedral solids.

The rhombic dodecahedral lens contains five surfaces. Imagine, while referring to the diagram above, folding a cut out of the diagram along its radial lines to create surfaces in 3D: a triangular segment of a unit sphere (A'BC'), a triangle (ABC) that is 1/4 of a rhombic dodecahedral face and three chords (C'A'AC, A'BA, BC'C).

In composite assemblies left & right chords are shared by adjacent lenses. They are identical except for the direction of their surface normal vector. For these animations with the same display parameters as in 'The Black Hole…', experiments shading pairs of chords produced a slight brightening. Therefor in these animations I have reduced chord surface sets from 48 to 24 each.

The animation "The Black Hole…" with YouTube link below, is a shading of all 240 surfaces of the rhombic dodecahedral orb (5x48 surfaces). It was the first animation in this series that asks the question, "How is it possible that these observations, which seem so different, are actually shadings of a singularity, the rhombic dodecahedron?"

The animations I am presenting at GA 2022 XXV do not shade surface ABC or the redundant chords. This 'no-face' version reduces surface count and speeds shading. It simplifies the scene and to my eye there is less visual noise.

In the animation "The Black Hole …" the camera angle is aligned with the rhombic dodecahedron's 3-fold axis corresponding to the octahedron's mid-face axis of symmetry.

These new recordings are seen along the 4 axes of symmetry of the rhombic dodecahedron both from within and from without: concave and convex.

2. In Practise

These animations use my algorithm, the Rotating Transparency Transform, or RTT, for evoking a sense of *motion*. Motion that resembles that of a kaleidoscope.

I suspect the resemblance arises because this rhombic dodecahedron is constructed from a set of simplexes that are themselves kaleidoscopes; i.e. dihedral kaleidoscopes. [1]

Instead of looking into a kaleidoscope I am looking **into and through** a *set of 48 kaleidoscopes* from each of the 4 convex viewpoints.

For the concave shadings I am looking through 24 kaleidoscopes from inside at viewpoint (0,0,0) with single digit camera lens length, looking outward along the 4 symmetry axes.

In the "Black Hole…" animation a virtual camera recorded a series of 2D images. Images of what at first glance are merely discs. Images that were recorded in *Parallel* view. There is no parallax; no software tricks to make you think you are seeing a solid object. 3D structure must be inferred over time. Inferred by observing dynamic 2D patterns of red and black that synchronize in the viewer's brain across time to hint at structure.

In the 3D modelling software Rhinoceros I select surfaces from a rhombic dodecahedron constructed of simplexes. I then iterate a rotation of a texture map in 0.1° increments. The texture consists of a single transparency derived from the Mandelbrot set. A *ViewCaptureToFile* command captures the rotational change for each of 3,600 frames. These combine to create an animation of length 2'30" at 24 fps.

In video post production clip duration can be adjusted. Titles, credits and audio can be added, as is the case in:

[The Black Hole at the Centre of this Orb is a Rhombic Dodecahedron]

3. Eight Orb recordings later.

I have recorded for GA 2022 XXV, for posterity, eight more visualizations in *parallel* view of the rhombic dodecahedron's domain. I have assigned the same rotating transparency [2] to select orb surfaces. Camera angles are selected from symmetry axes.

4. Viewers of the Orb

A new set of choices present themselves when I consider presentation. The raw footage was planned for a duration of 2'30" per clip at 24 fps. 8 clips makes for 20 minutes of viewing time. A lot to ask of an audience.

Each clip will loop seamlessly.

Adding titles disrupts the looping feature of the art. Linking clips together also disrupts the looping behaviour.

For presentation at the Generative Art Conference I have combined 2 sets of four clips, forgoing loops, at 2x & 4x speed.

Adding a sound track has become *de rigueur* for visualizations such as these. A score designed to loop with the visuals would perhaps deepen the experience. My efforts at guitar noodling are not sufficiently nuanced to burden an audience's ear for 20 minutes. What would surely feel like an eternity?

Perhaps readings by James Earl Jones, from an obscure tome, could accompany these pixel extravaganzas? A synergy of senses to hold a viewer entranced for the duration. May I suggest my poems, from my romantic youth? "Odes" voiced by *Prostetnic Vogon Jeltz!* [4].

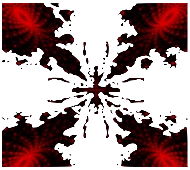
To collectivize my art, to reach more than one viewer at a time, I see a room with eight screens looping continuously. Audience members are encouraged to liaise with control surfaces to alter time, chroma and Ken Burns effects; to create a unique audience-engaged light show.

Of course, haute couture fashion houses attend the event ready to sign license agreements for use of selected patterns in their new spring line-ups. They provide complementary wine that flows! Relationships blossom.

I see a meta-verse installation of Horta Eggs [5] (fictional silicon based life forms) that when your avatar picks it up for examination, it begins to play an animation when a coded analog of: pitch, roll & yaw, is properly aligned to the optic nerves of one's avatar in the 'verse.

I see seniors' homes change the channel from *info-tainment news* to looping mandalas. Blood pressure medication use is reduced. (prediction not fact)

I see a glass bead game. A block chain.



5. Conclusion

Herein may we find beauty? Observe nature in a new way? Or just revel in the light!

For purposes of GA 2022 XXV I am providing links to 2 new composite animations.

The first animation is scaled in time to approximately four and a half minutes in length. This allows me to add my cover version of the classic John Cage [6] track, 4’33" to run as background audio. The clip runs at 216% speed; 68 seconds of observation per axis.

Rhombic Dodecahedra in a Rotating Transparency Field, Convex

The second animation is sped up in time by a factor of 4, providing approximately 30 seconds observation per axis. Caution! Speed may not be to your liking. A ‘*push me - pull you*’ or a ‘*point in every direction is the same as no point at all*’ effect is witnessed at high speed. Maybe your browser will let you slow it down.

Rhombic Dodecahedra in a Rotating Transparency Field, Concave

As a test audience of one, I actually prefer my slow 38 minute version of these clips. Yet for GA 2022 XXV I have *sacrificed my preference* for that of an audience that I imagine is *pressed for time*.

Each animation has its quirks.

For instance I can’t explain the variation in the apparent radial or concentric motion except that it has something to do with ‘*angle of incidence*’.

And why do these motions seem to be occurring simultaneously? "Oh. I get it! I am seeing the dark side of the moon, too!"

One quirk, did you see it? I confess is a periodic brightening, a slow strobe. Turns out my early programs’ initial conditions duplicated the first 2 frames in each of twelve, 300 frame recording sessions, required to capture the full cycle.

Do I fix it? or do I feature it?

5. References

1. "*27 Blue Dihedral Kaleidoscopes*", Curtis L Palmer. https://youtu.be/e7f2CqiTL4Q

2."*Mandelbrot Set-13-Julia Islands*" (Created by Wolfgang Beyer with the program *Ultra Fractal 3)*.

3."*Kepler and the Rhombic Dodecahedron", R. Cardil.* http://www.matematicasvisuales.com/english/index.html

4. "Hitchhiker’s Guide to the Galaxy" D. Adams 1978 BBC.

5. "The Devil in the Dark" Star Trek, 1967.

6. 4’33" John Cage. https://youtu.be/JTEFKFiXSx4