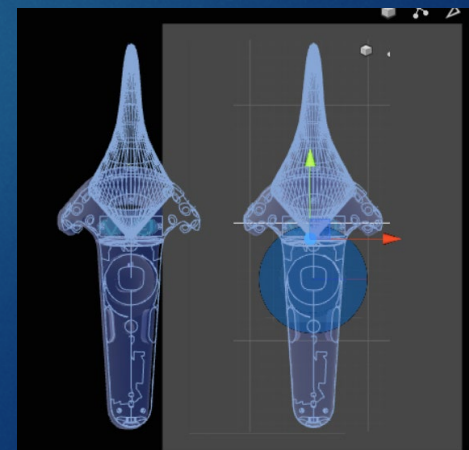


VR Applied to Scott's Model of Birkeland Currents

DAVID JOHNSON, LUKAS WOMACK,
JIM WENINGER, JUAN CALSIANO

What is the VU?

- ▶ Organic Development
- ▶ GPU Video Card – 1920 CUDA Cores (NV GTX 1070) – 1080 - 3840
- ▶ General Purpose High Speed Parallel Vector Processing
- ▶ The VU is a Field Effect Explorer – Highly configurable interactive field simulator. New type of Chemistry Set for Home and Lab – Started as toy.
- ▶ Convergent Technologies
 - ▶ Positional Tracking – Motion Capture
 - ▶ Parallel Processing – Video Card Display Technology
 - ▶ Rapid Software Development – Unity c# Multi-Platform



Compute Shader

GPU Parallel Processing

- ▶ Every Frame (90 fps) each point determines the field effect of the active attractors (a through g in this case) on their vector velocity at it's current position P_0 . These changes to the particle's velocity vector are summed then the result is added to it's current velocity.

$$V_1 = V_0 + dV_a + dV_b + dV_c + dV_d + dV_e + dV_f + dV_g$$

- ▶ The point's new position for the new frame after the time dt becomes:

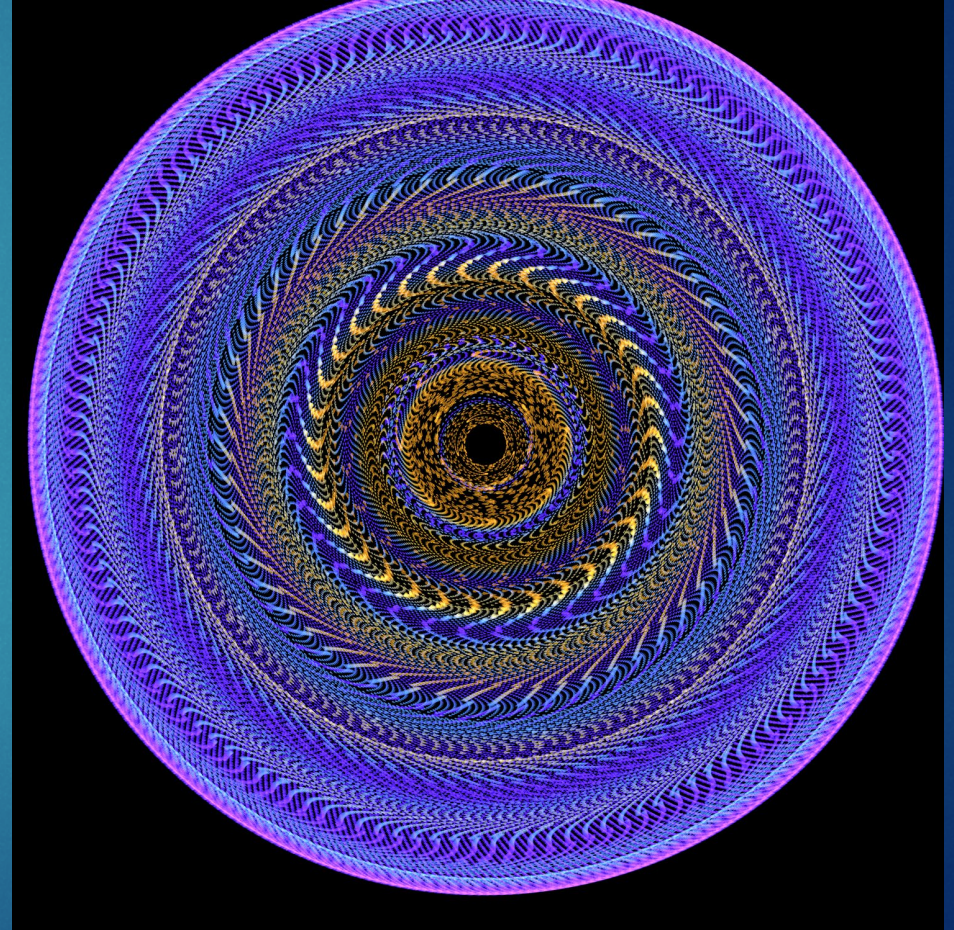
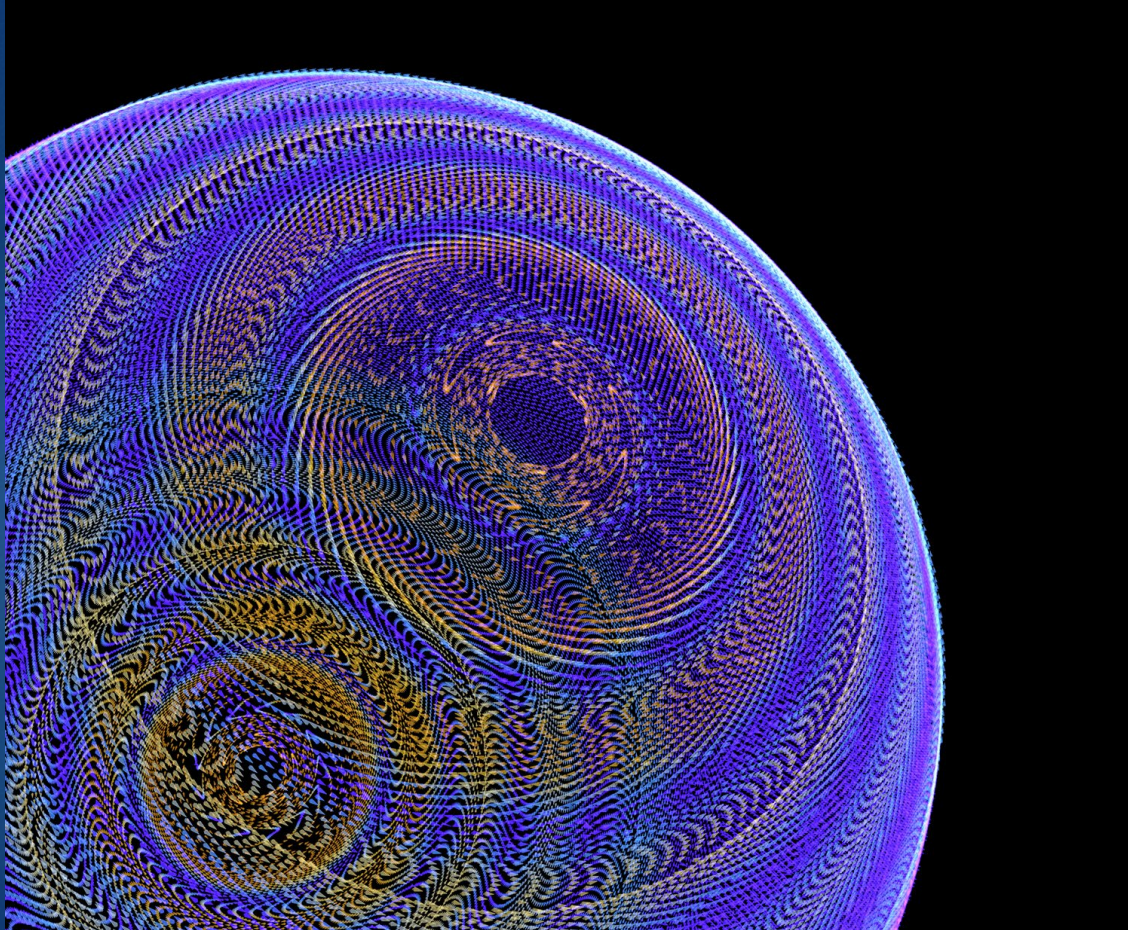
$$P_1 = P_0 + V_1 * dt$$

- ▶ We run a maximum of 144,000 points/frame through our compute shader at this time.

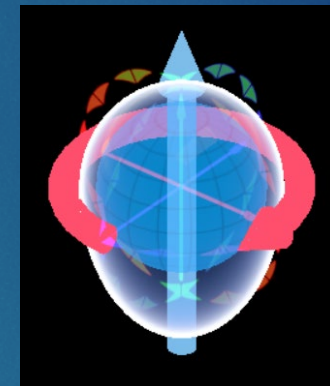


Birkeland Currents

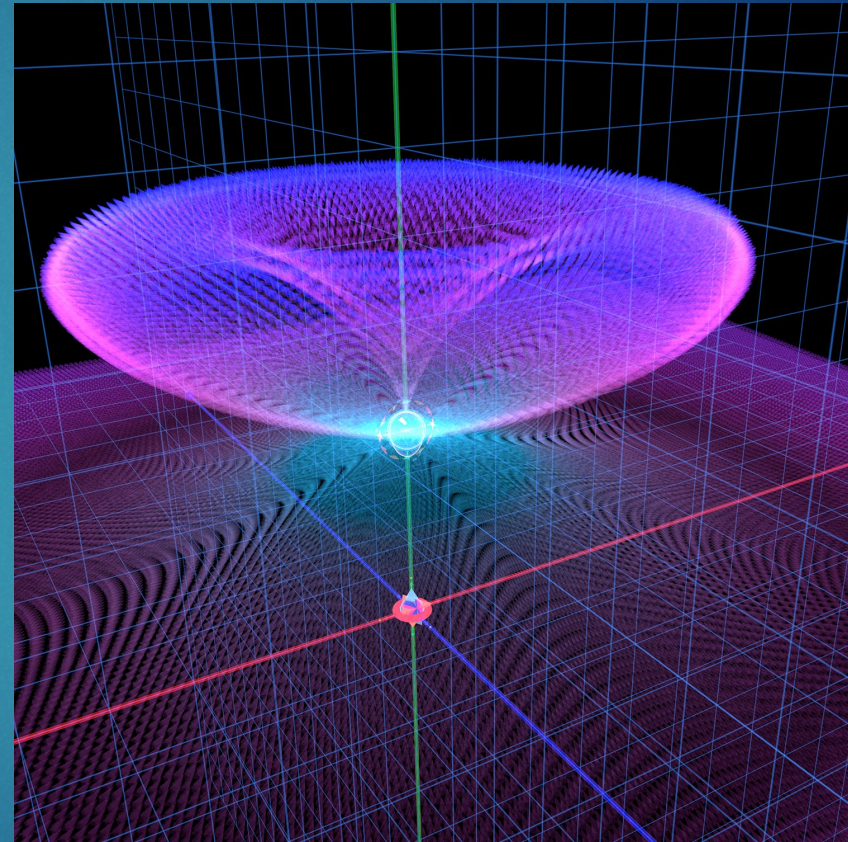
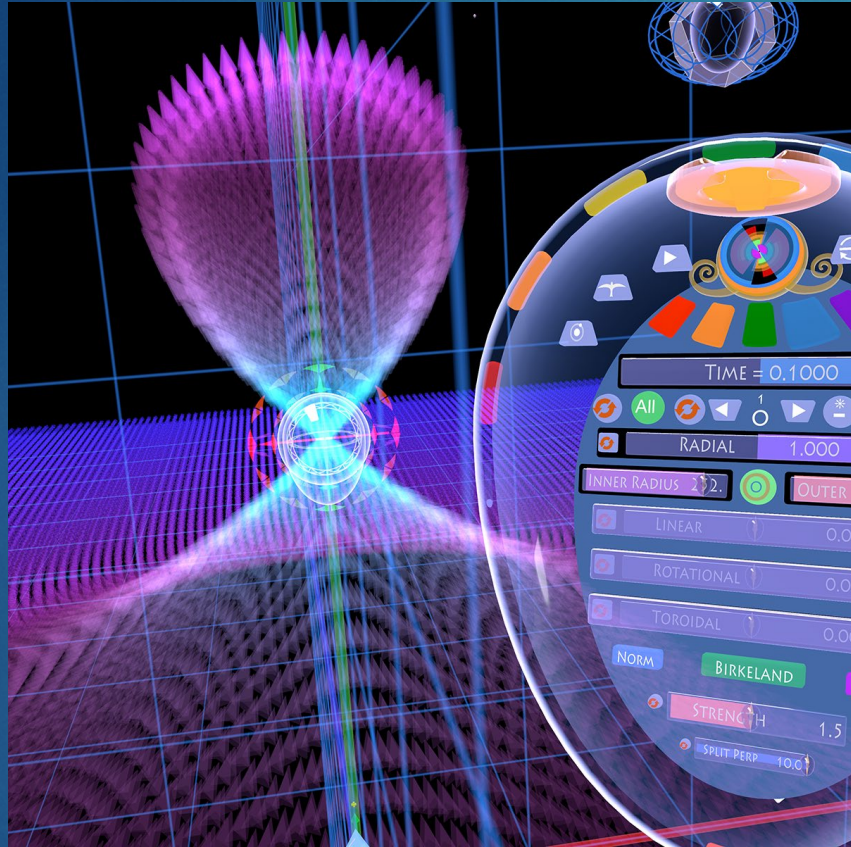
Spherical Point Cloud with Birkeland attractor



Attractors and Vector Fields



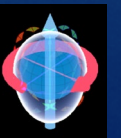
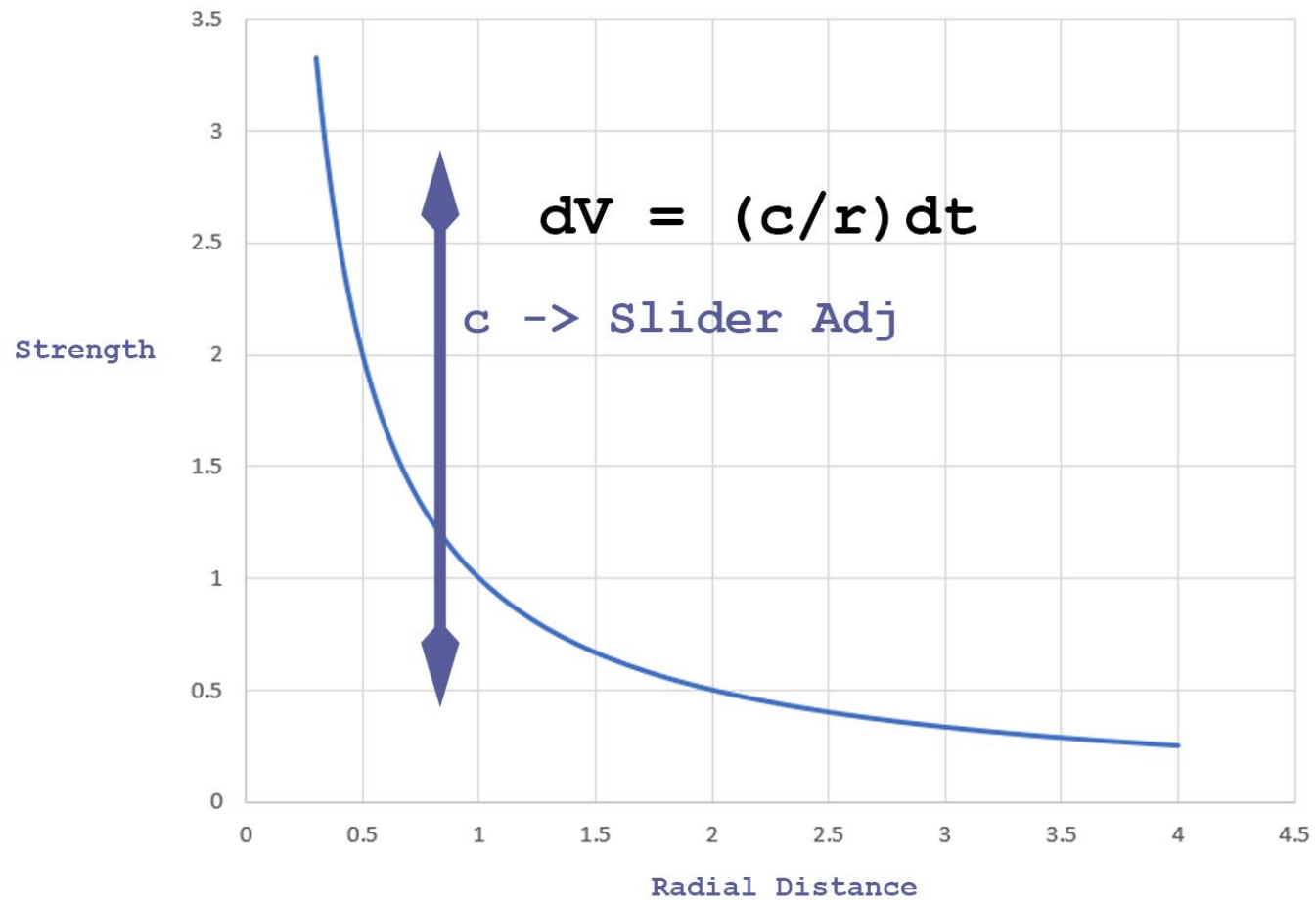
Radial – Examples





RADIAL

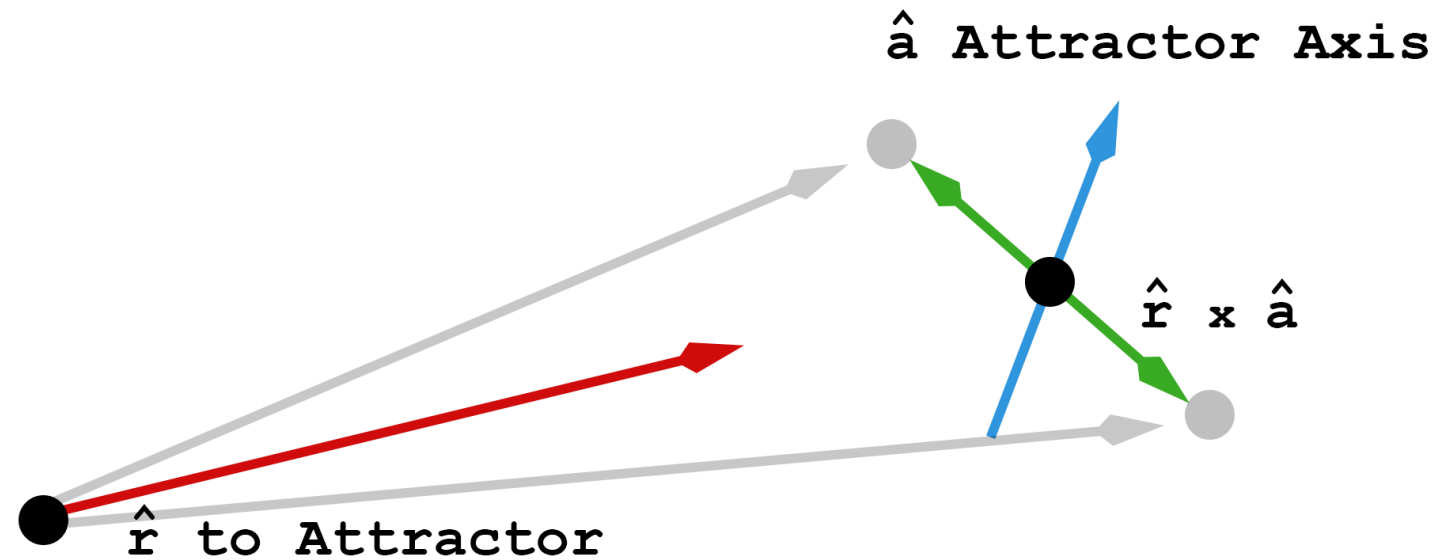
1.000



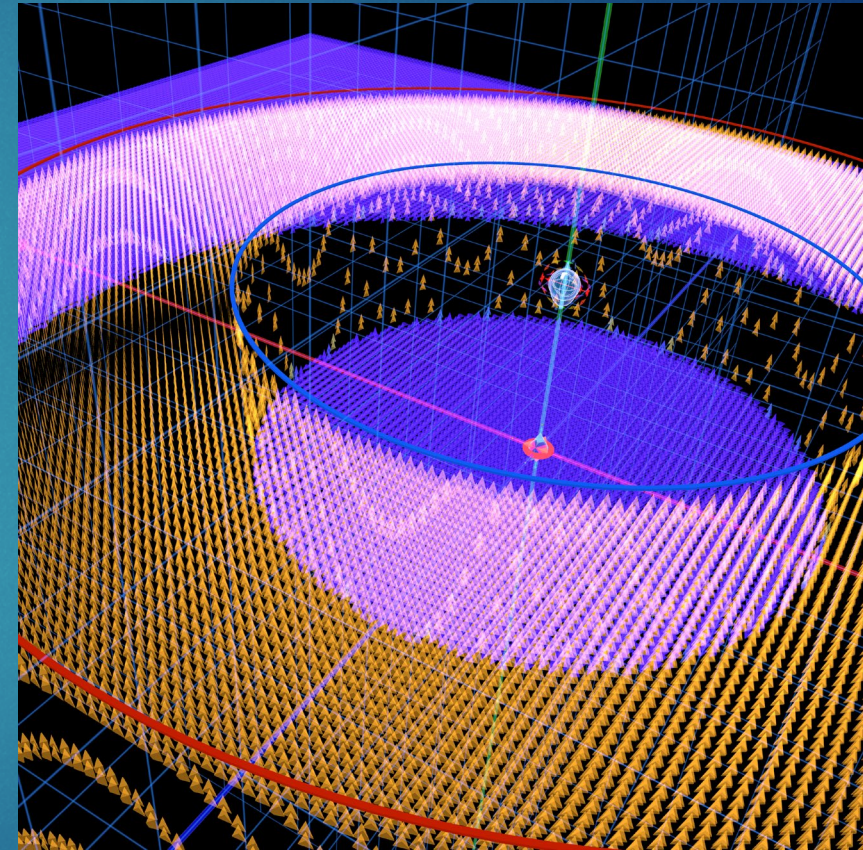
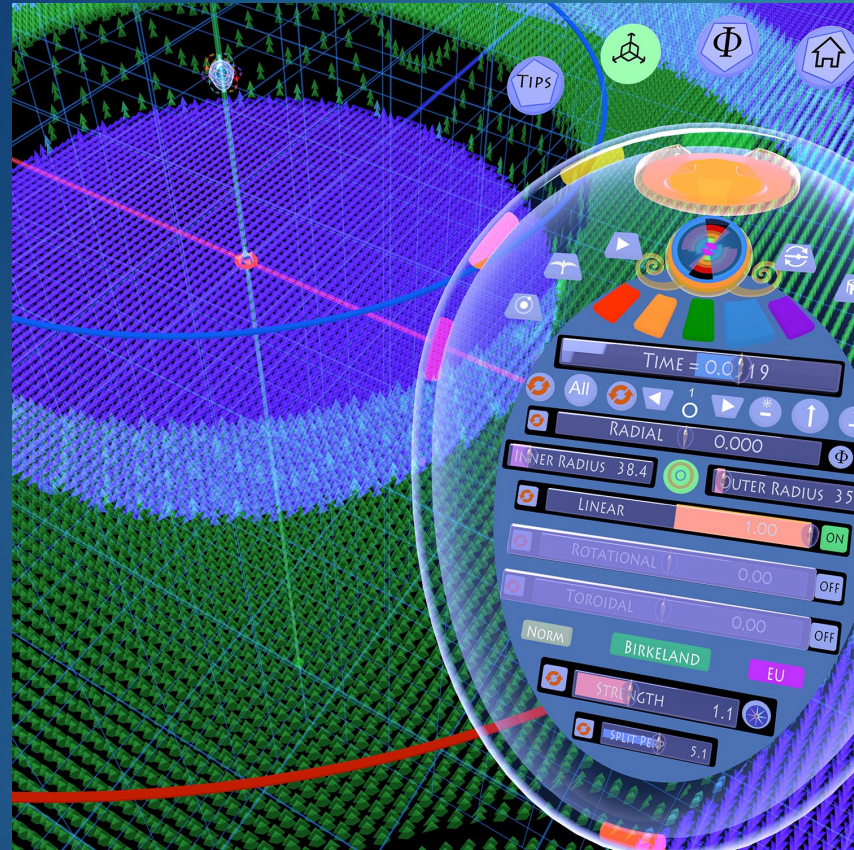
Approaching Zero


Split Perp – Radial




Split Perp allows points to pass within small distances of the attractor without the float 16 errors caused when the distance r approaches zero on the $1/r$ radial setting.

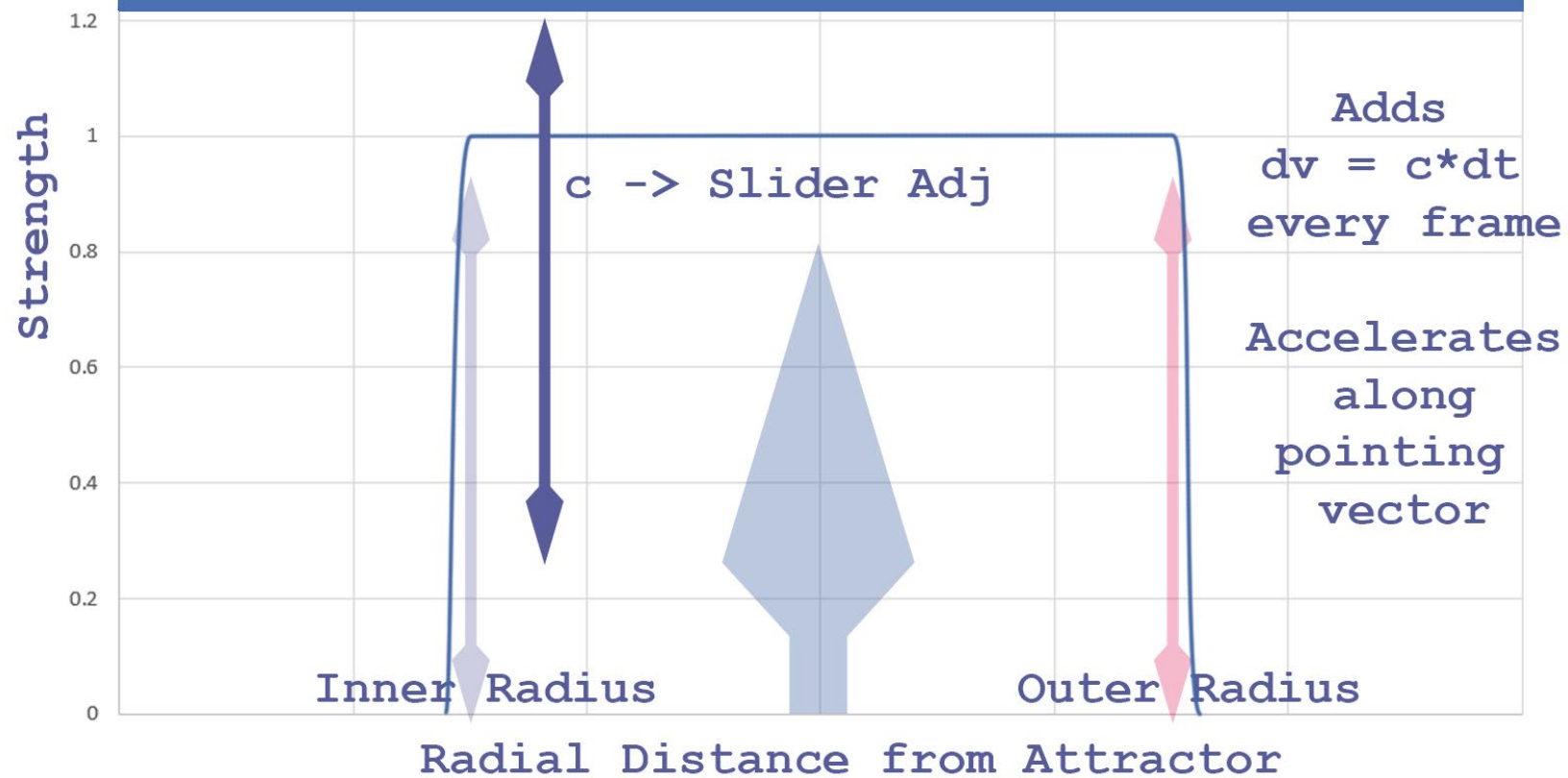


Linear - Examples

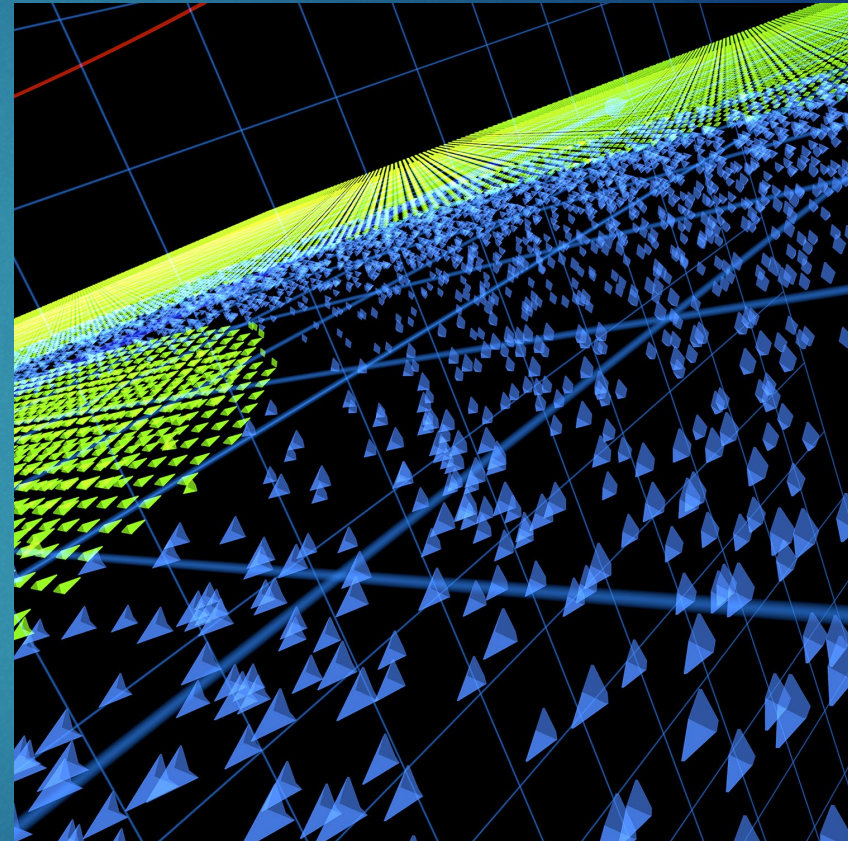
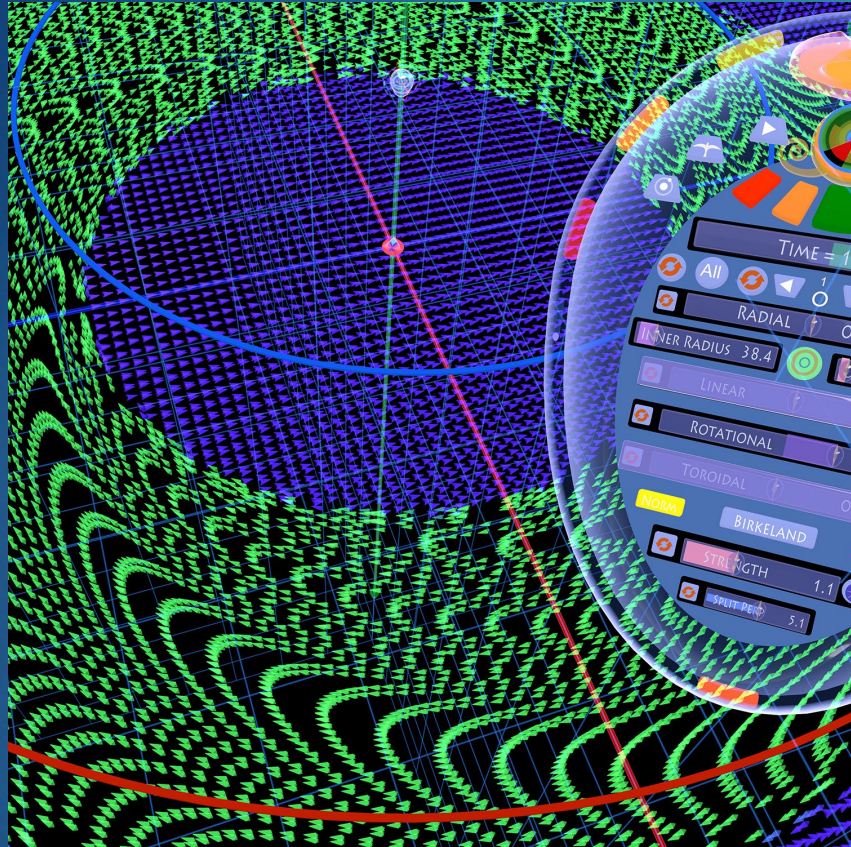


INNER RADIUS 0.00  OUTER RADIUS 300.

 LINEAR  0.26 



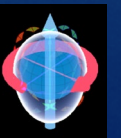
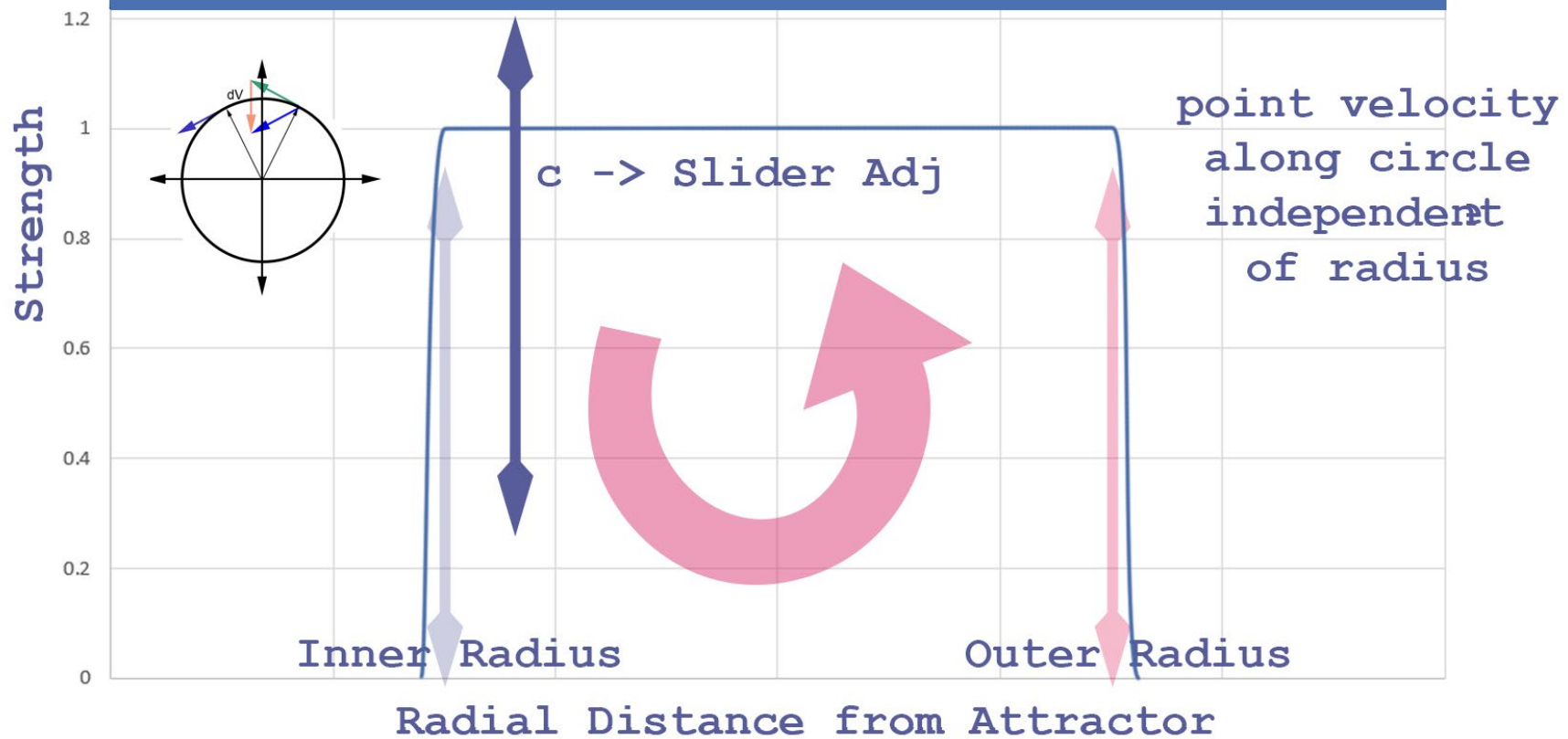
Rotational - Examples



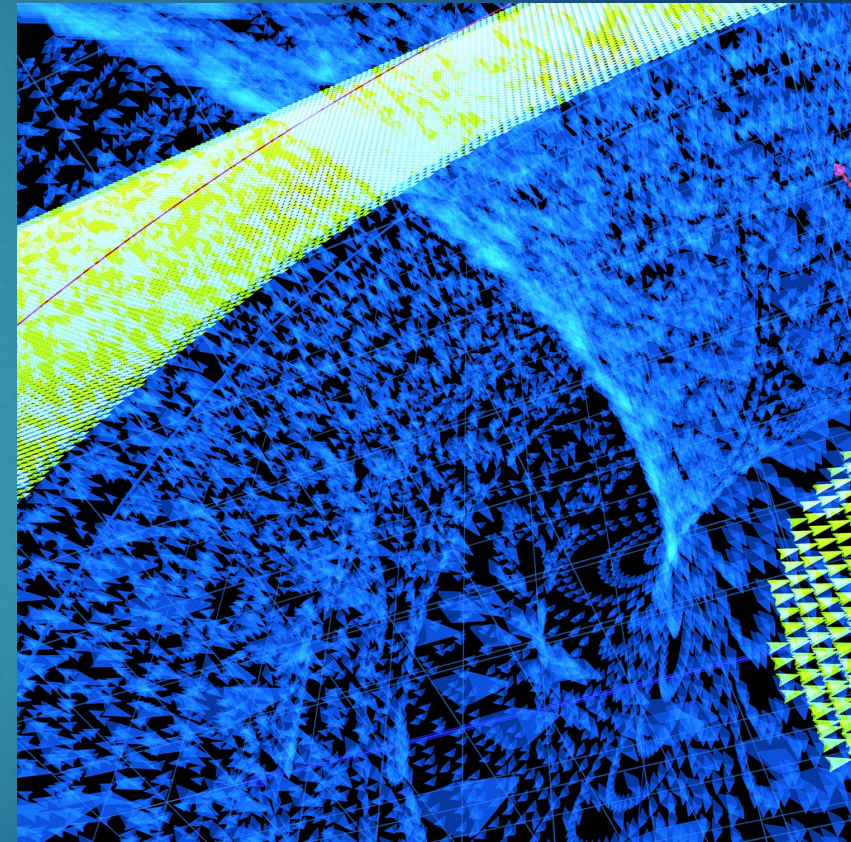
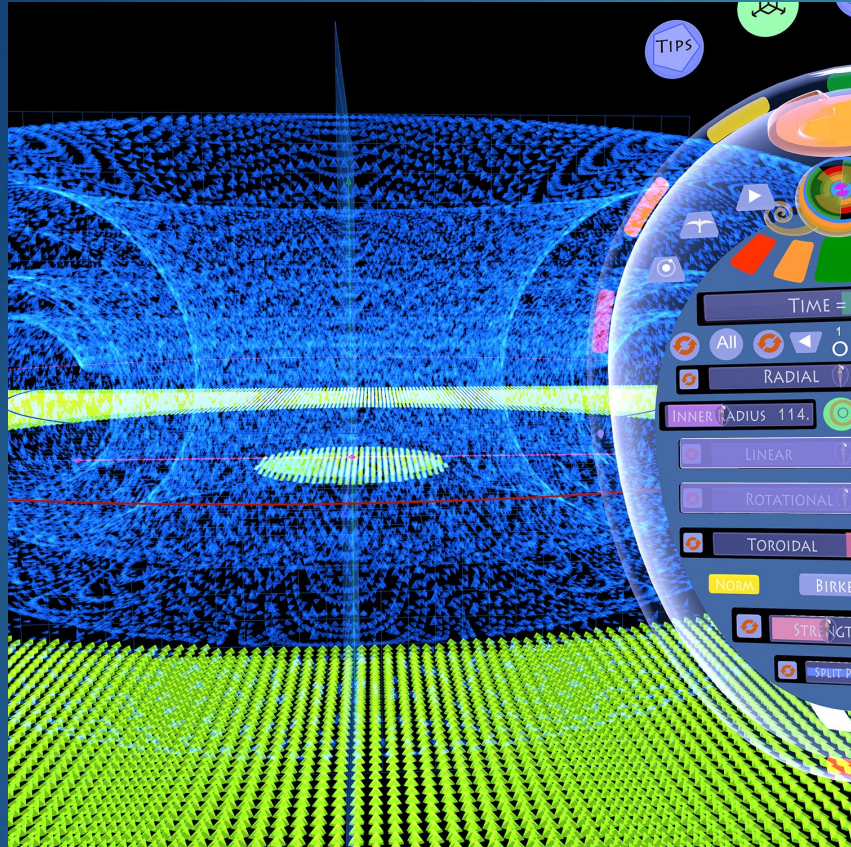
INNER RADIUS 0.00

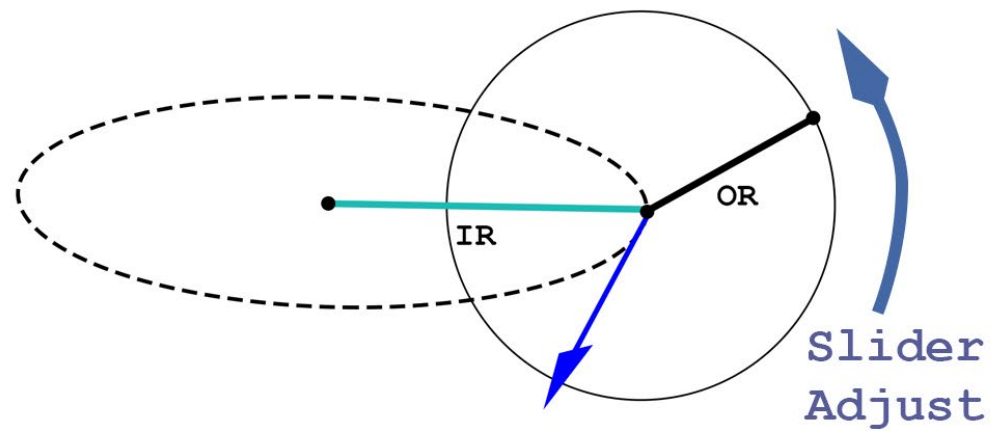
OUTER RADIUS 300.

ROTATIONAL -0.8 ON



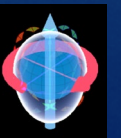
Toroidal - Examples





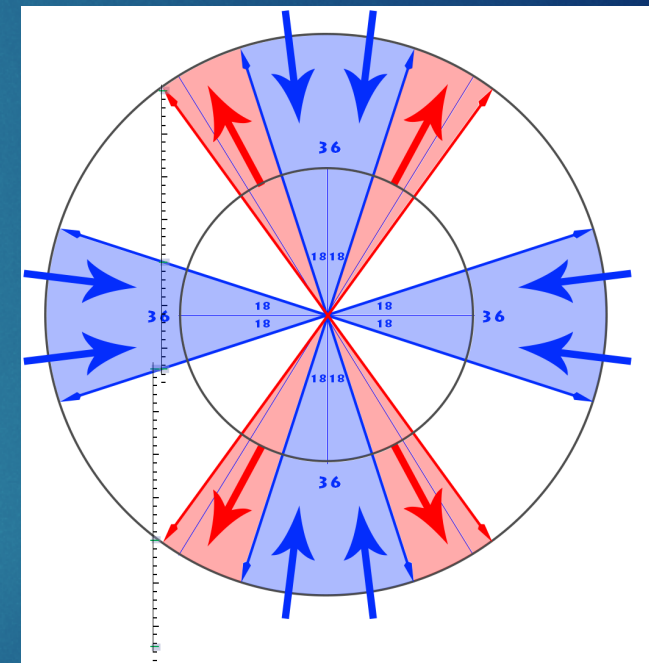
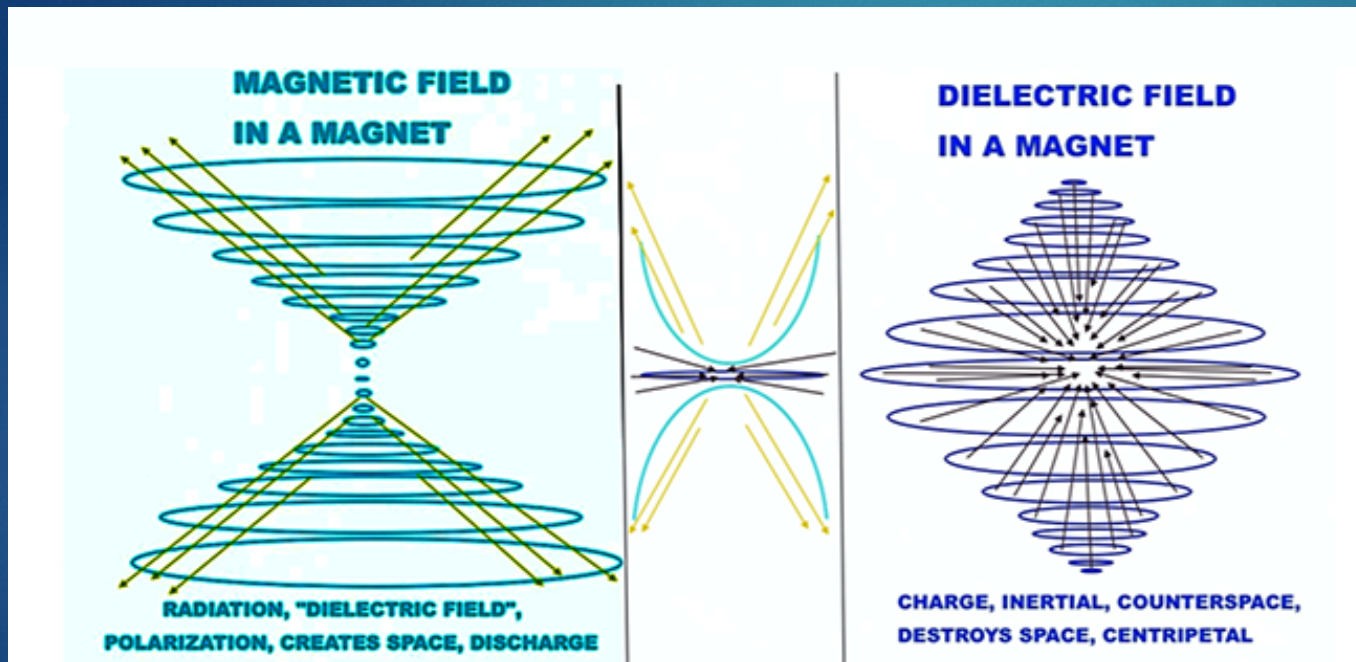
IR = Inner Radius

OR = Outer Radius

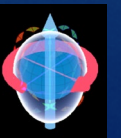
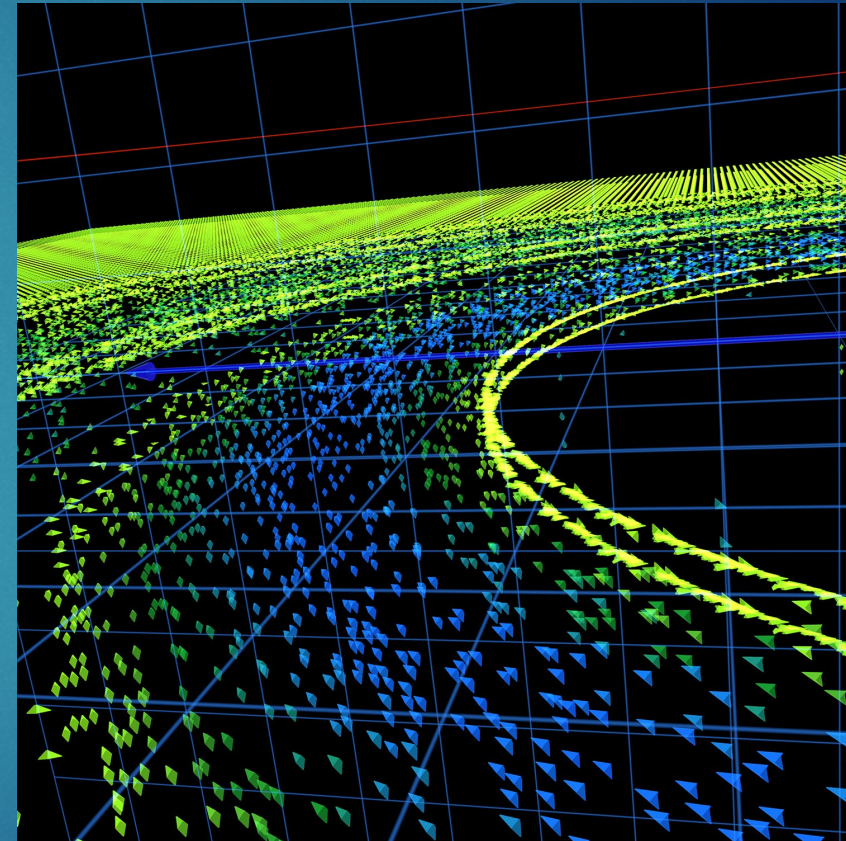
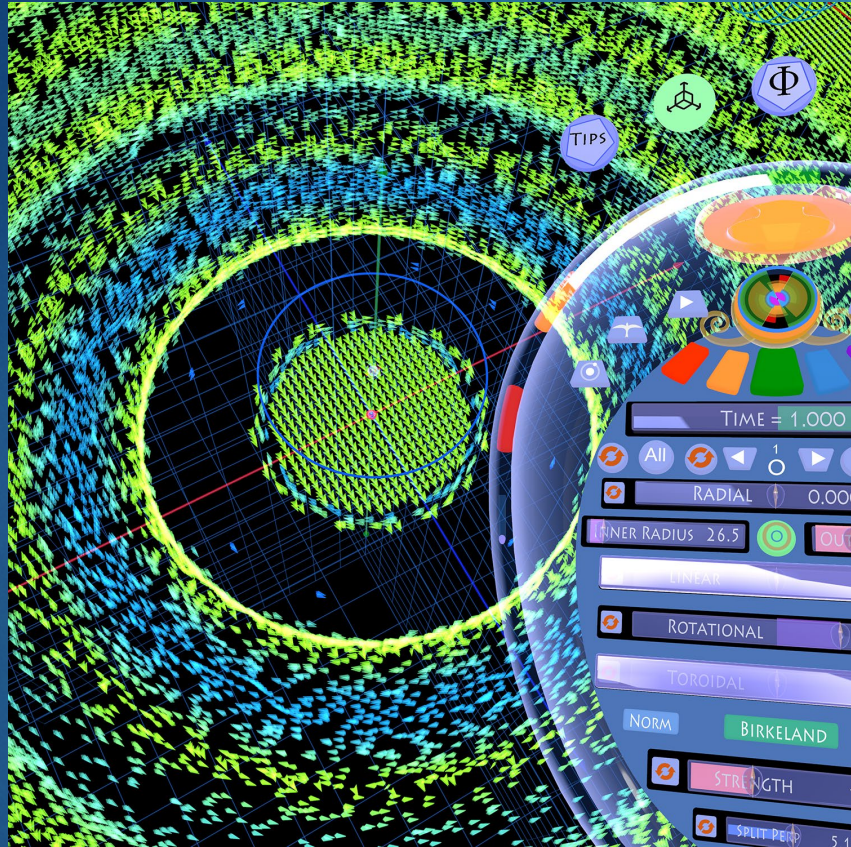


Toroidal – Field

Phi Relationship



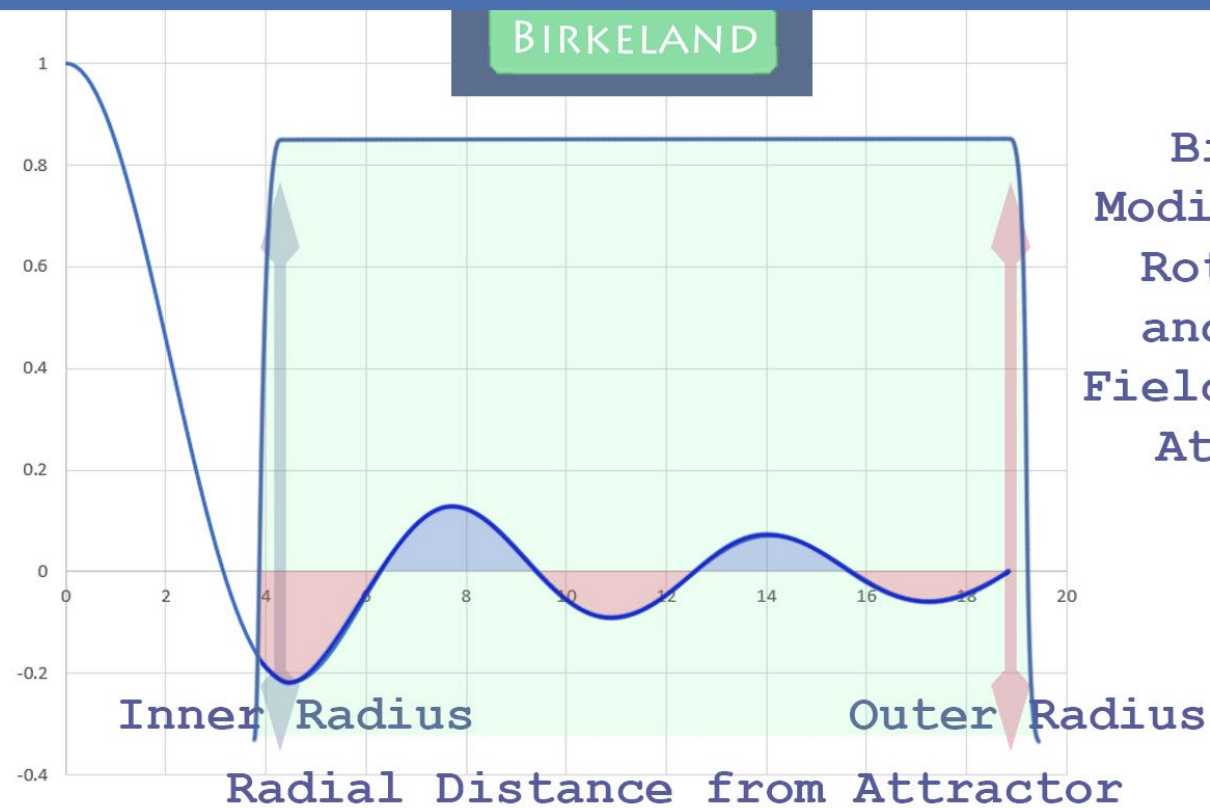
Birkeland Modifier - Examples



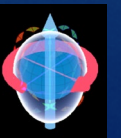
INNER RADIUS 0.00

OUTER RADIUS 300.

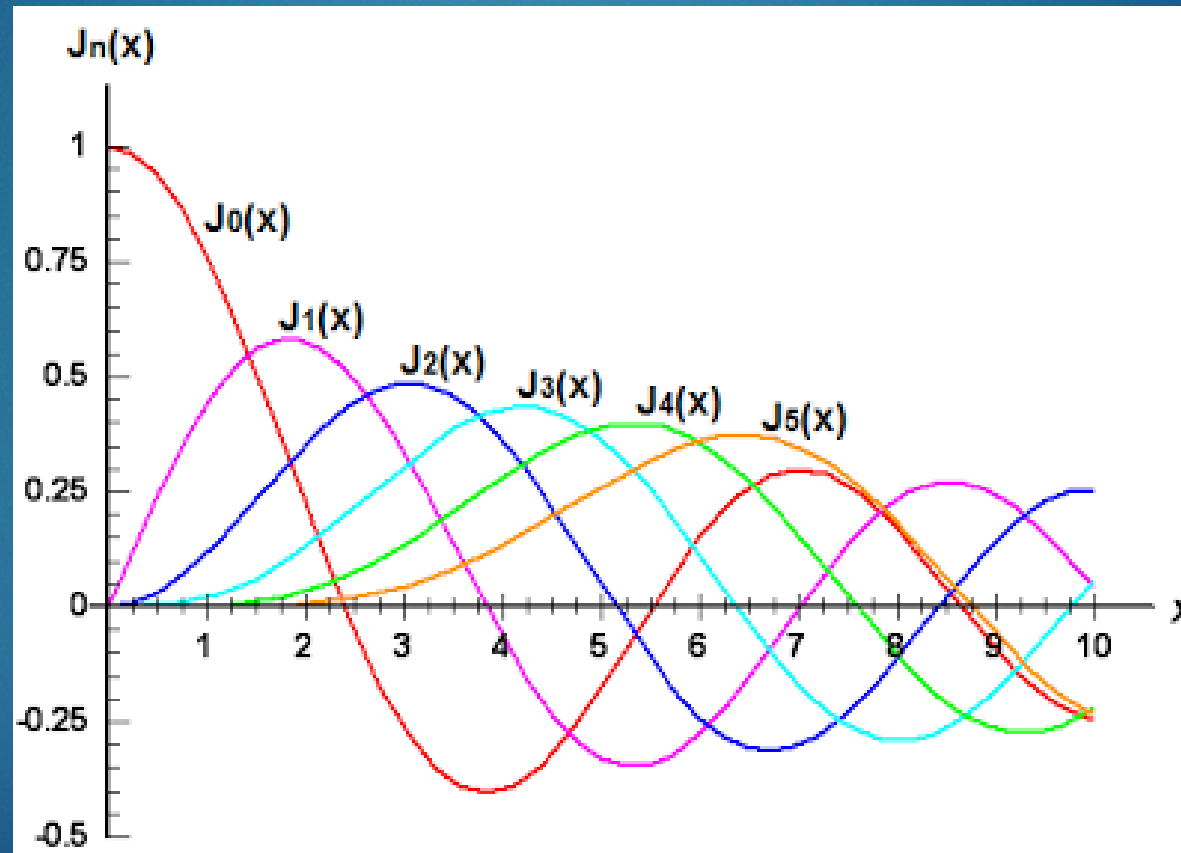
ROTATIONAL -0.8 ON



Birkeland
Modifies both
Rotational
and Linear
Fields of the
Attractor

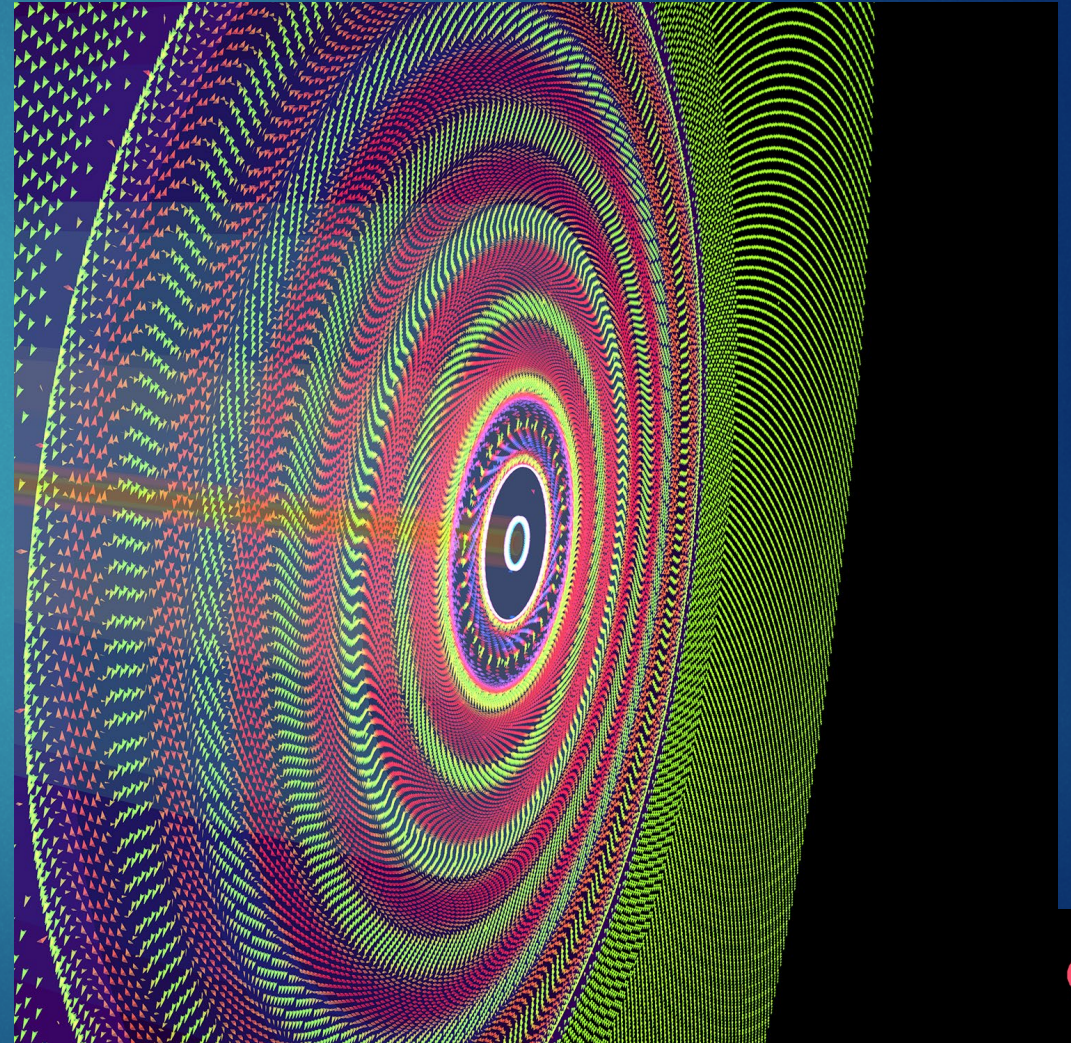
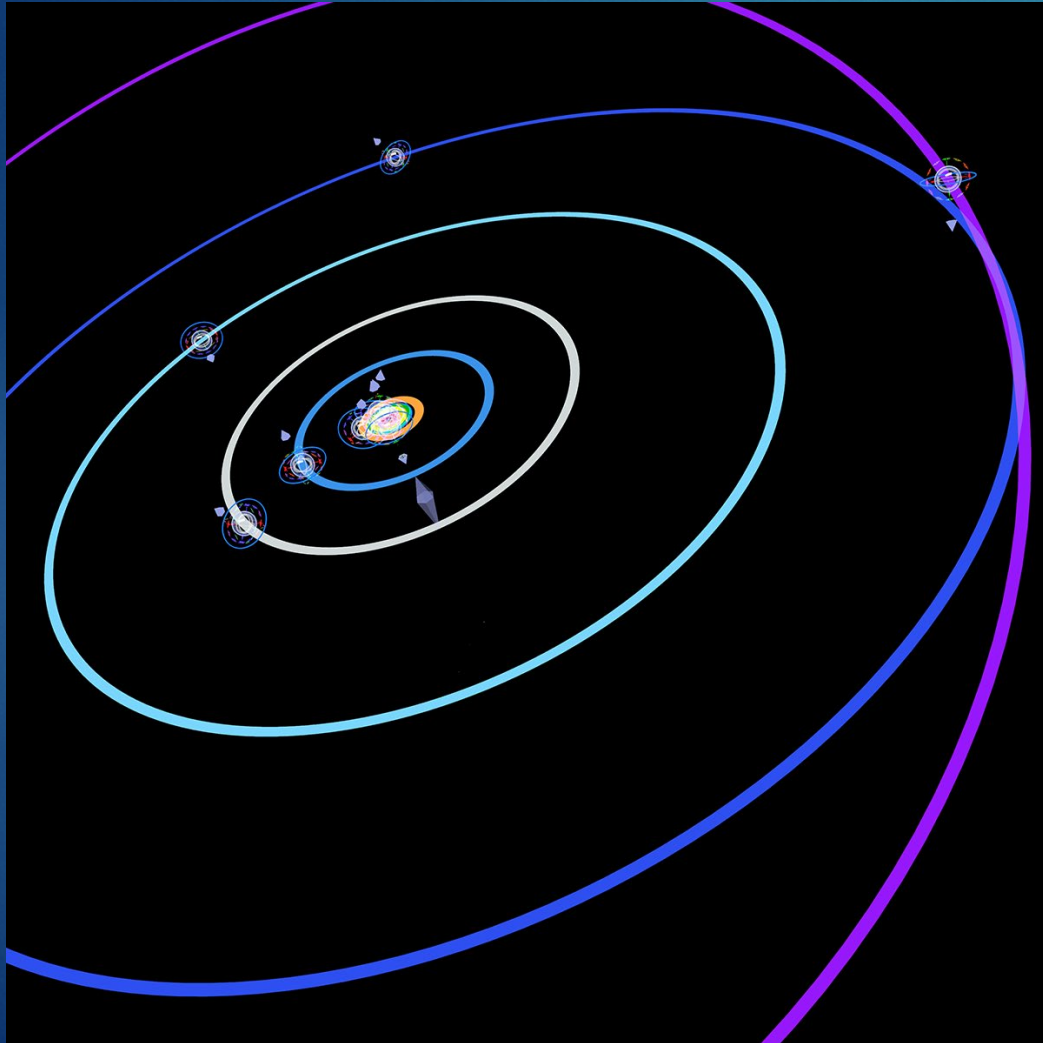


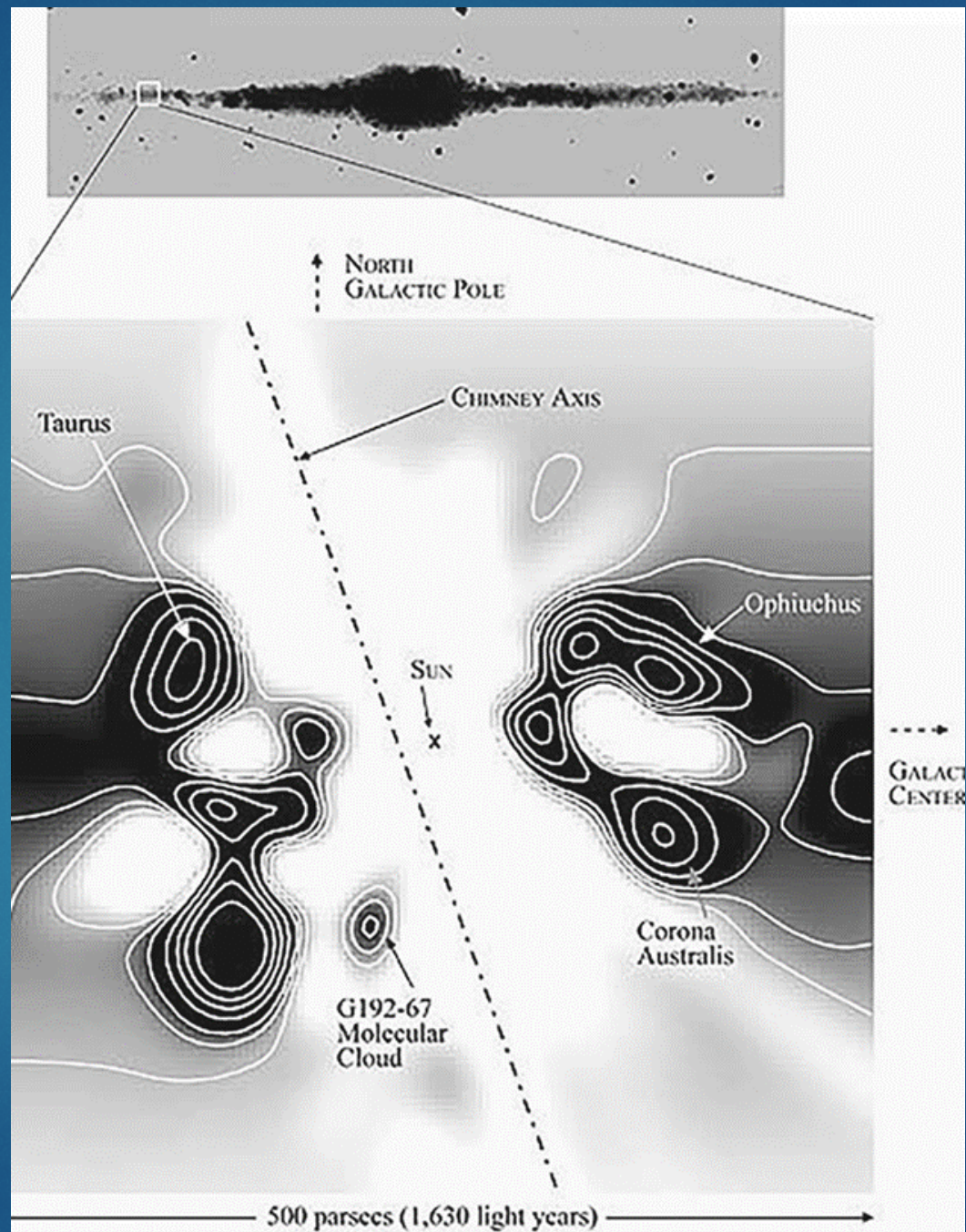
Birkeland Modifier – Bessel Function

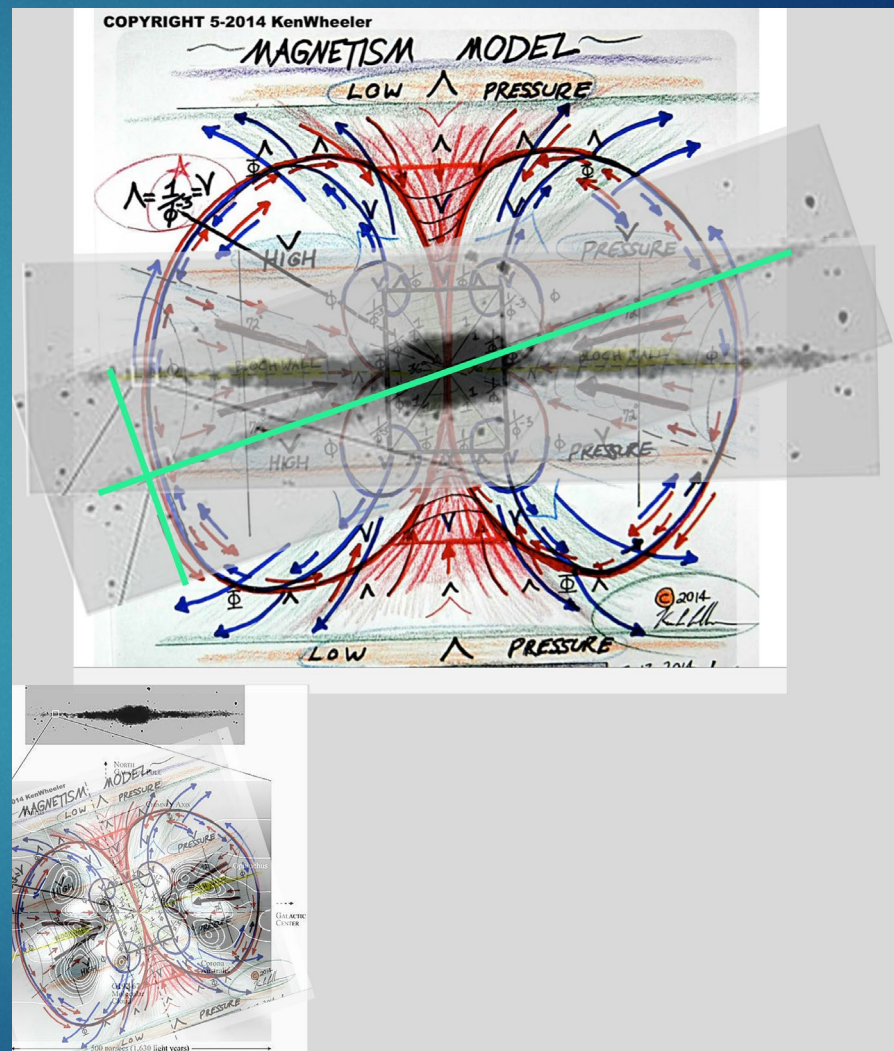
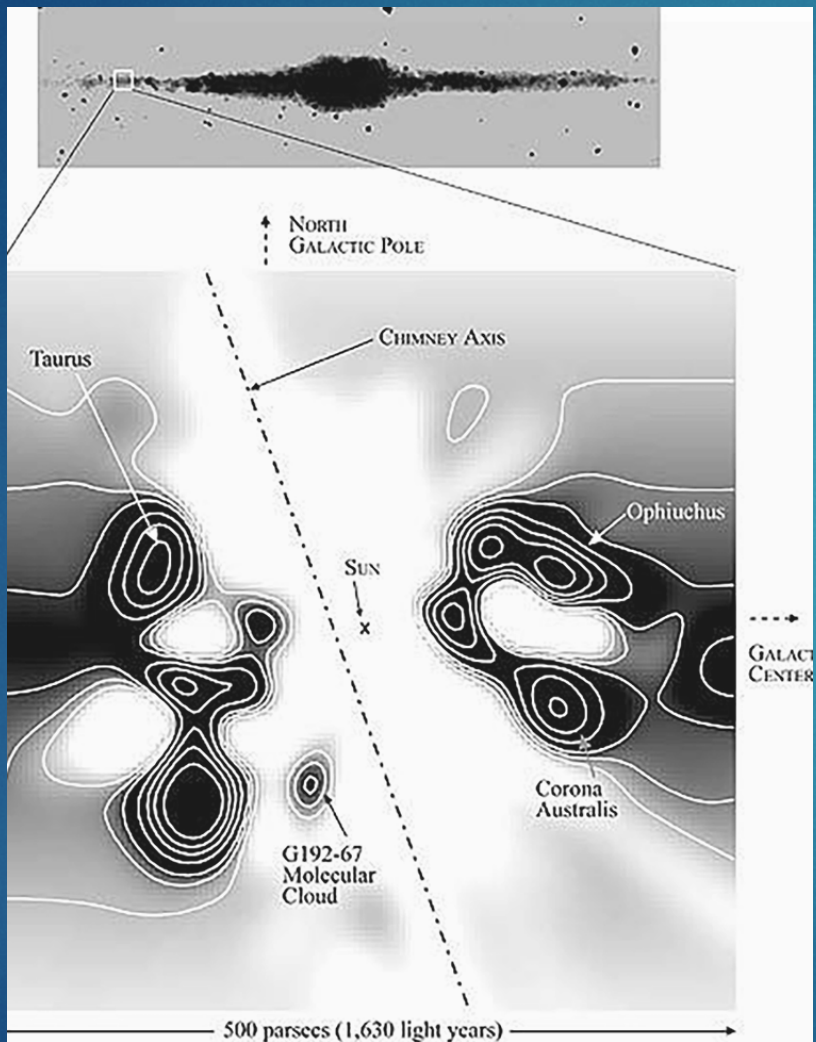


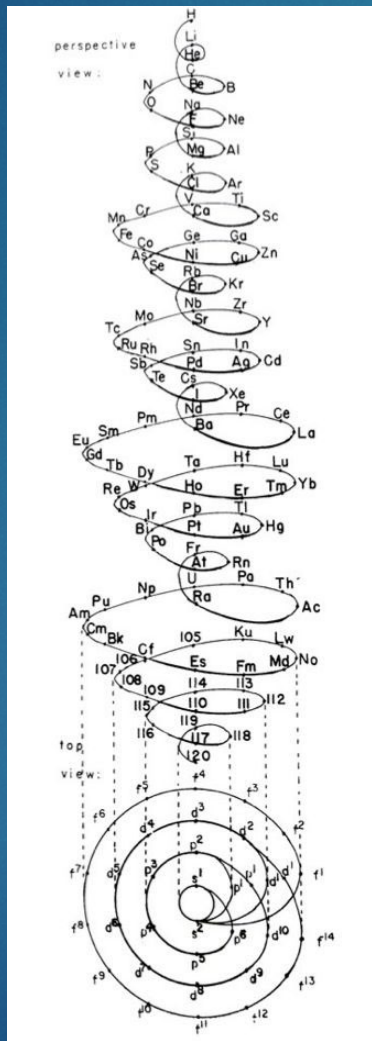
The Solar System

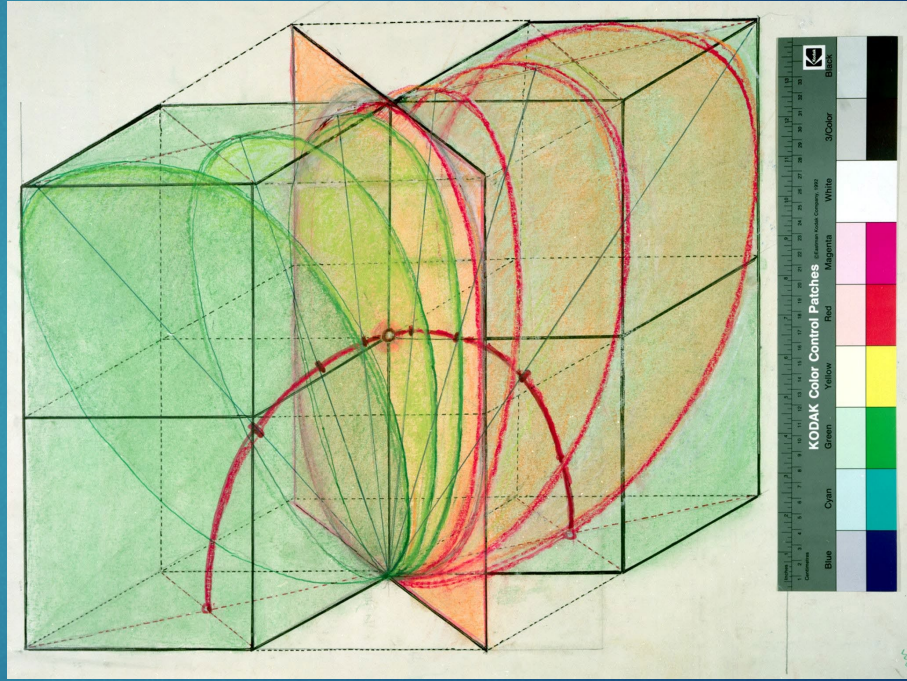
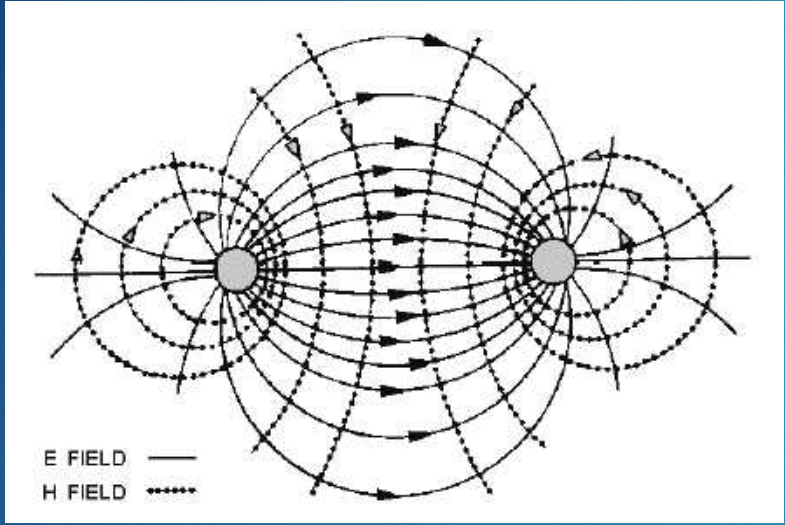
and Birkeland Currents





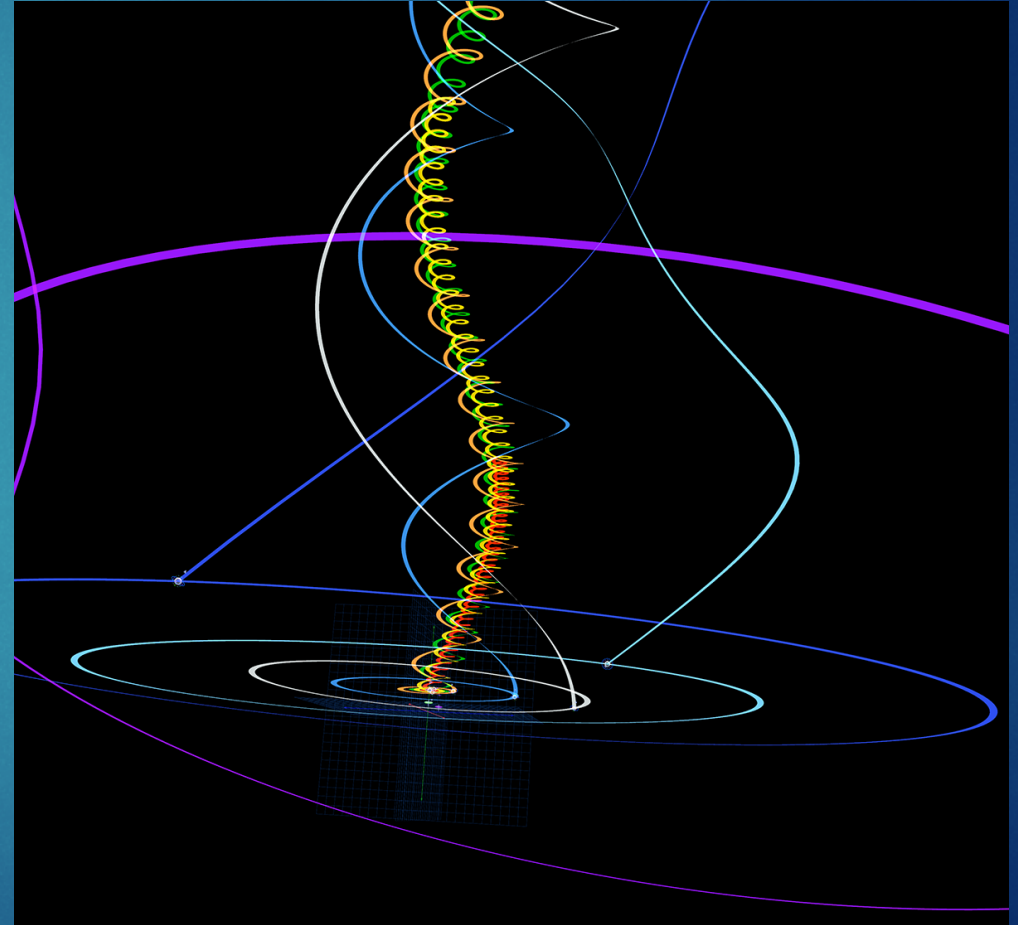
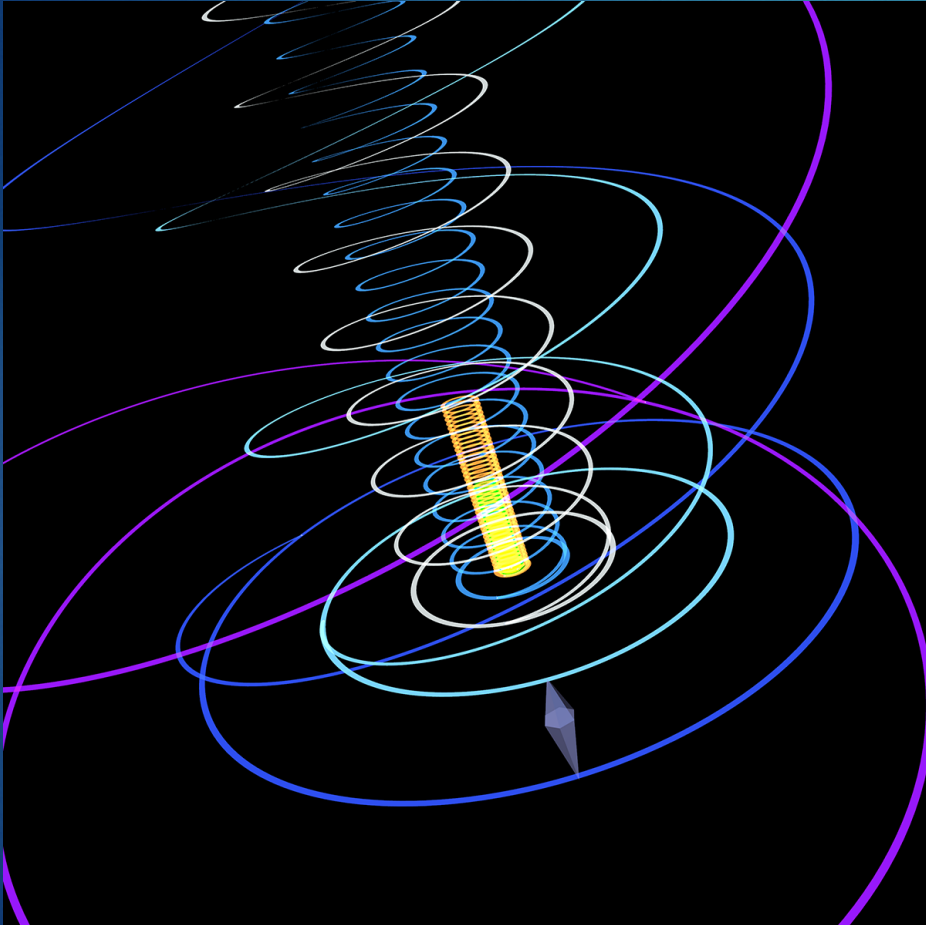




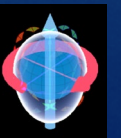
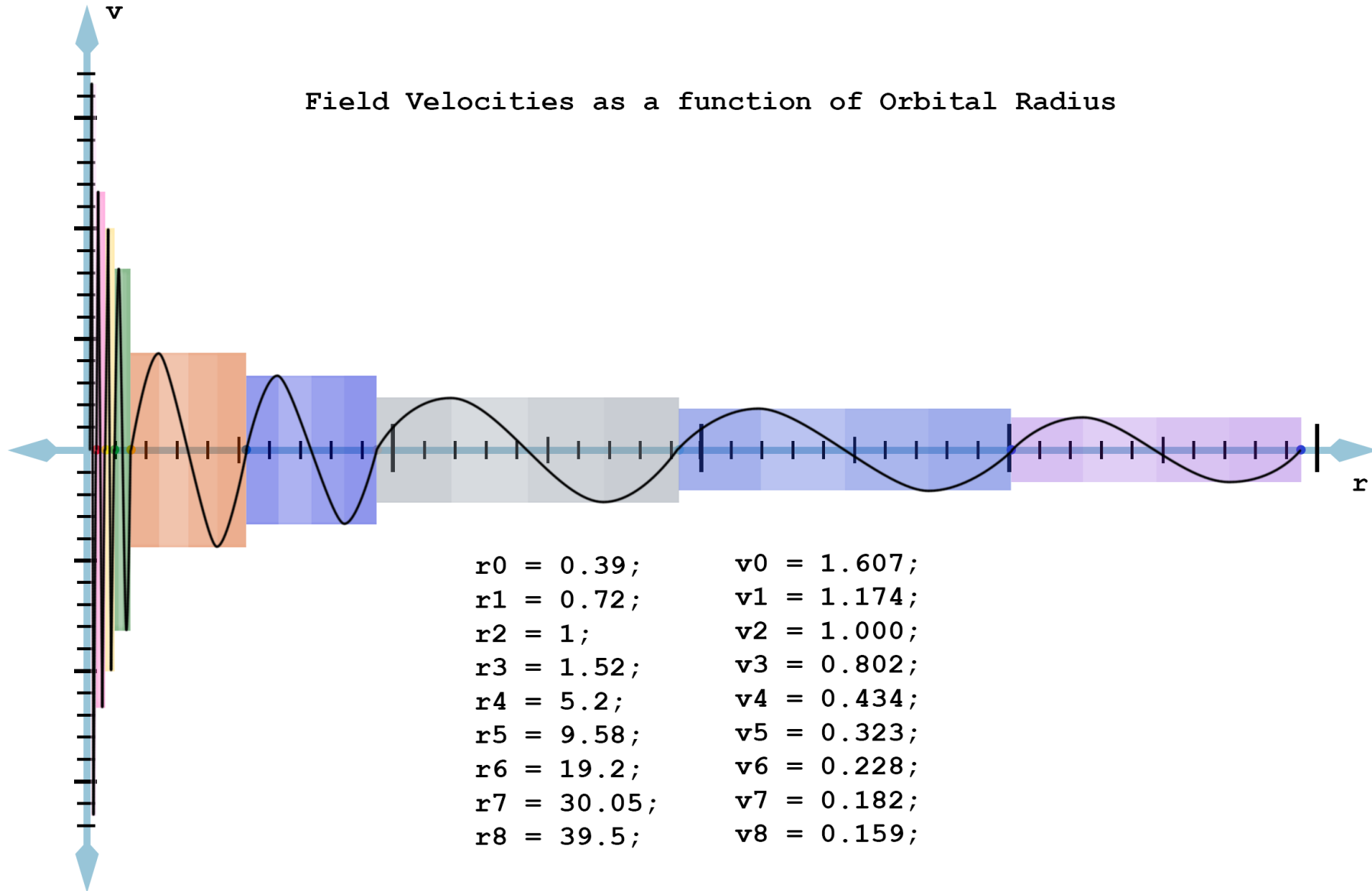


Birkeland Currents

Applied to Solar System Model

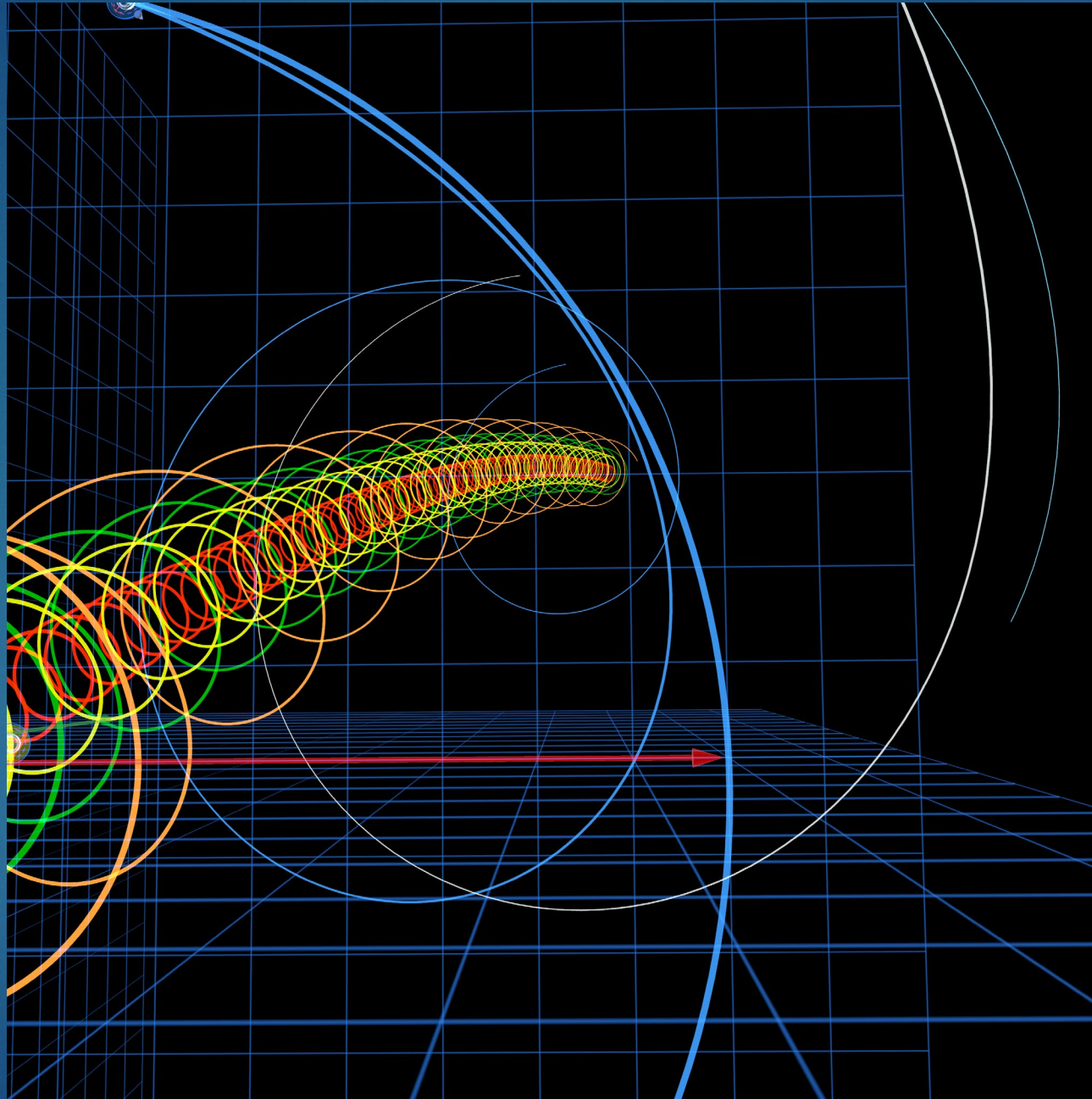


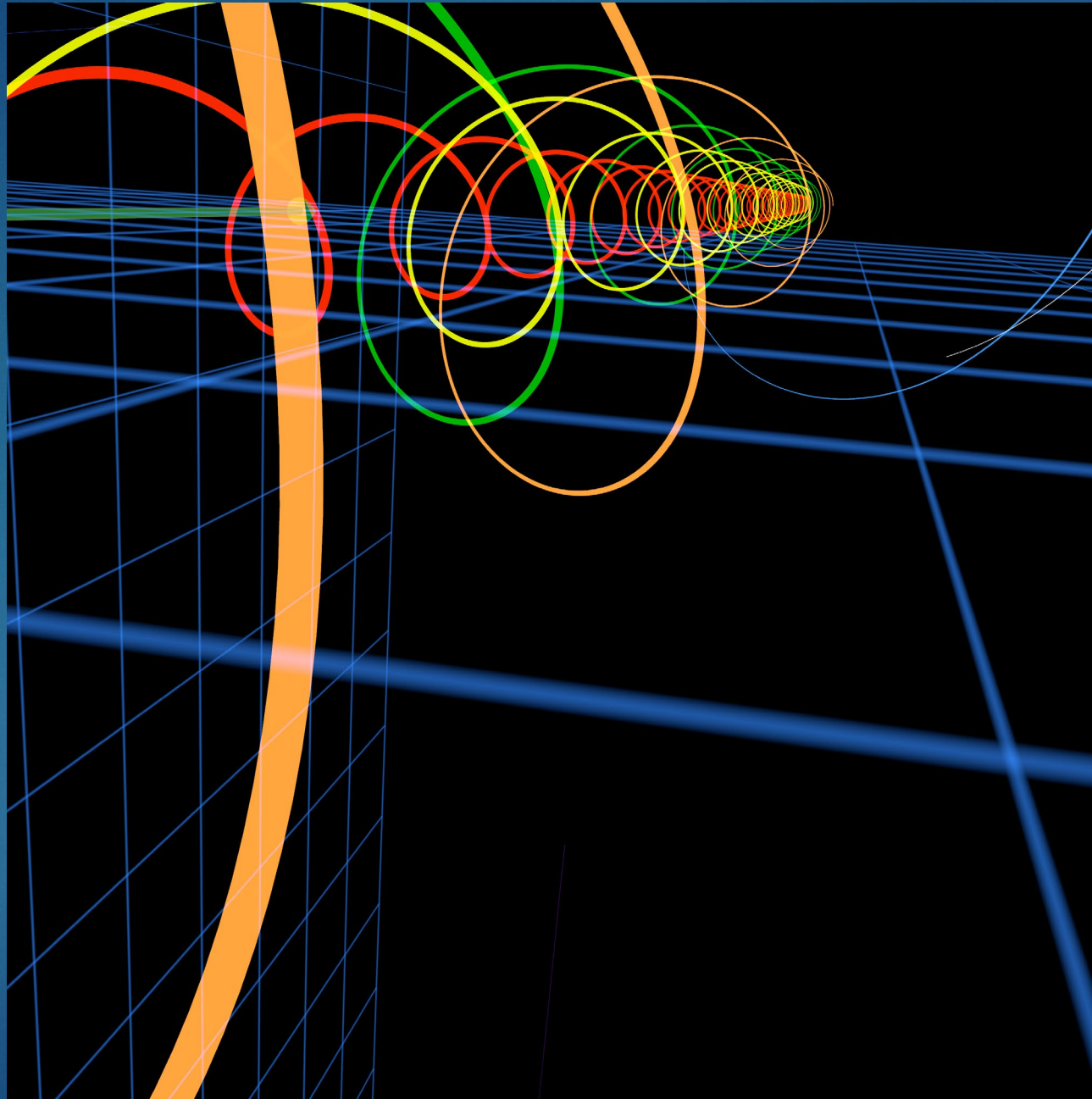
Field Velocities as a function of Orbital Radius

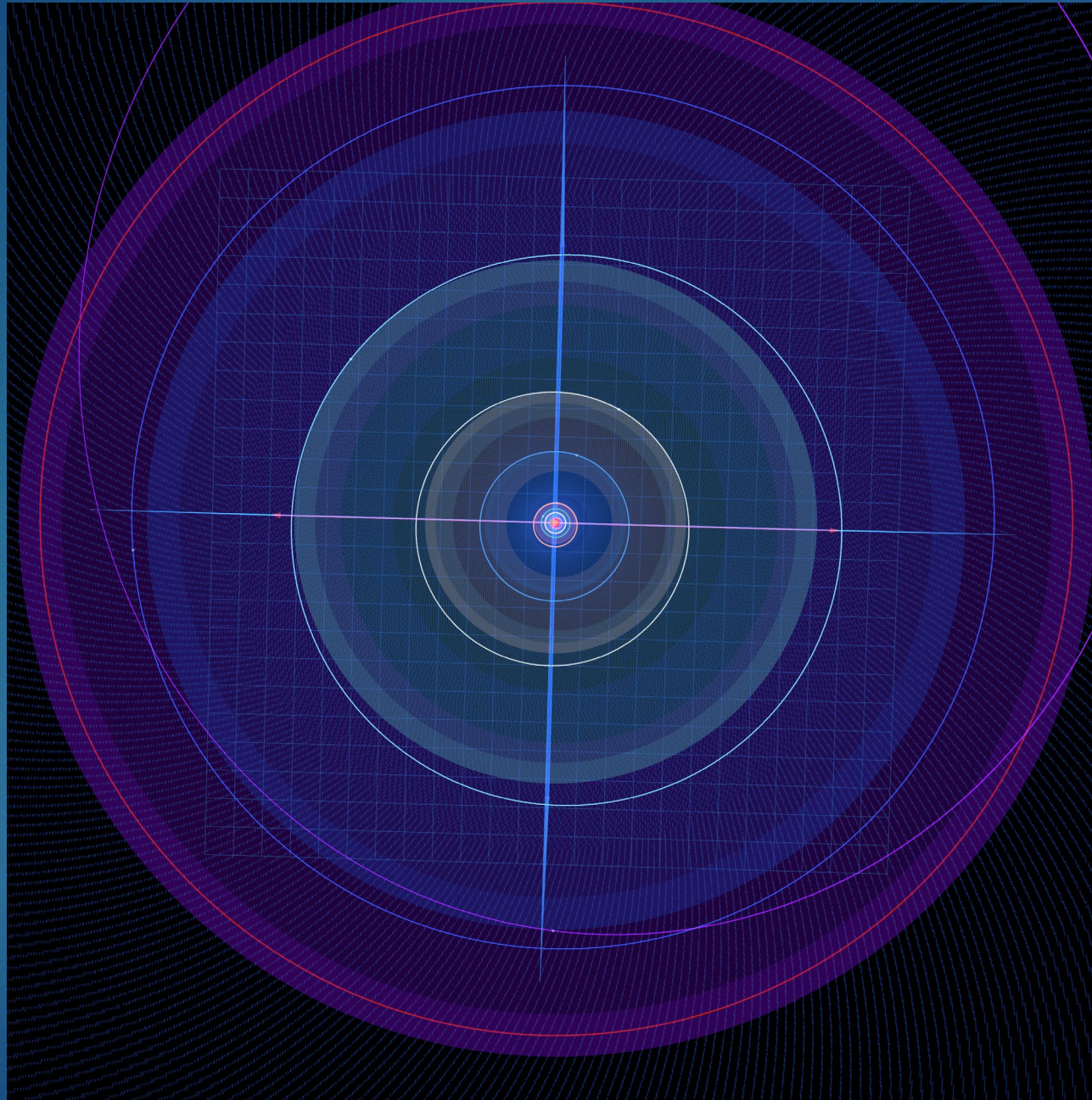


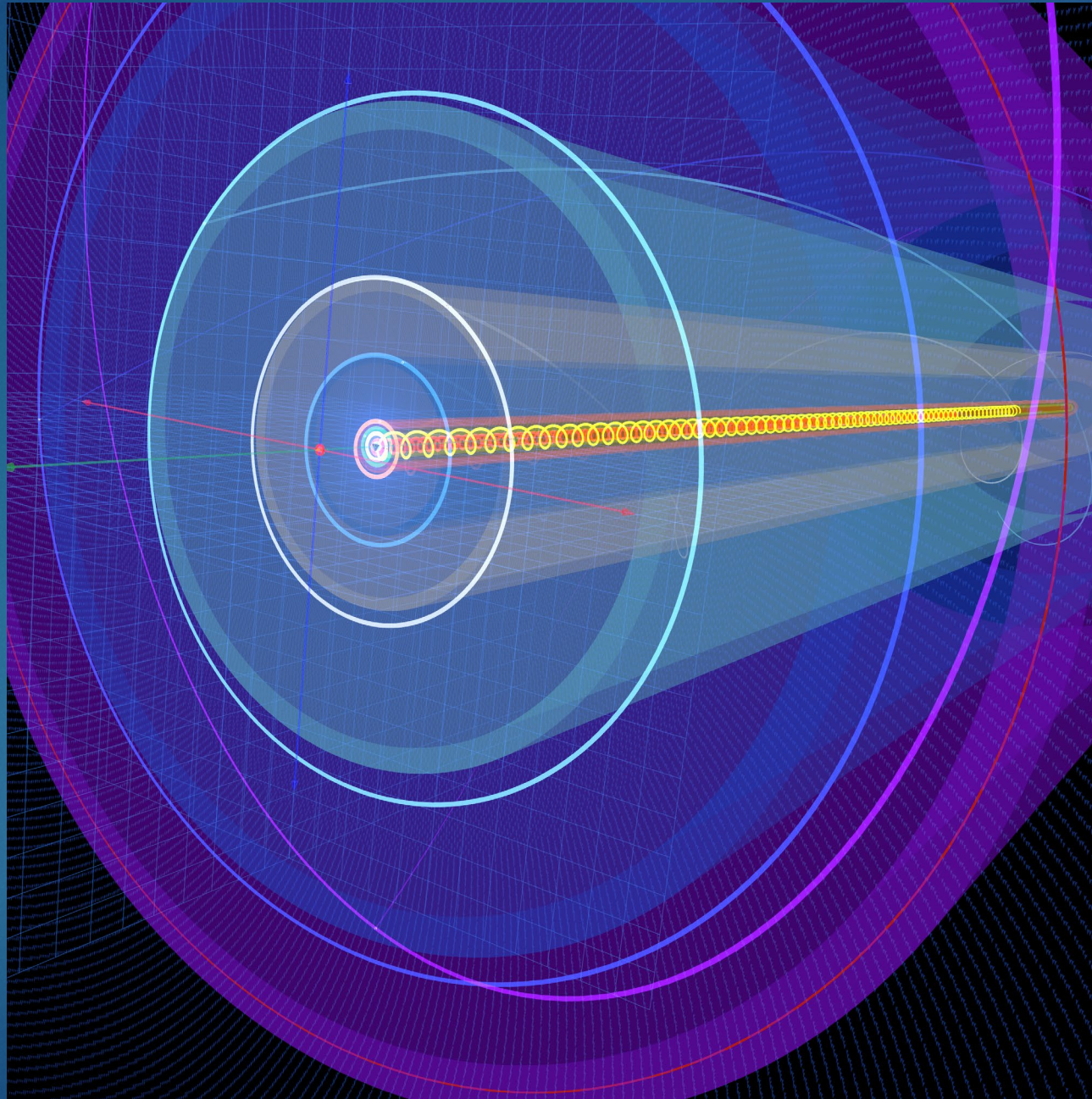
Panels Solar System

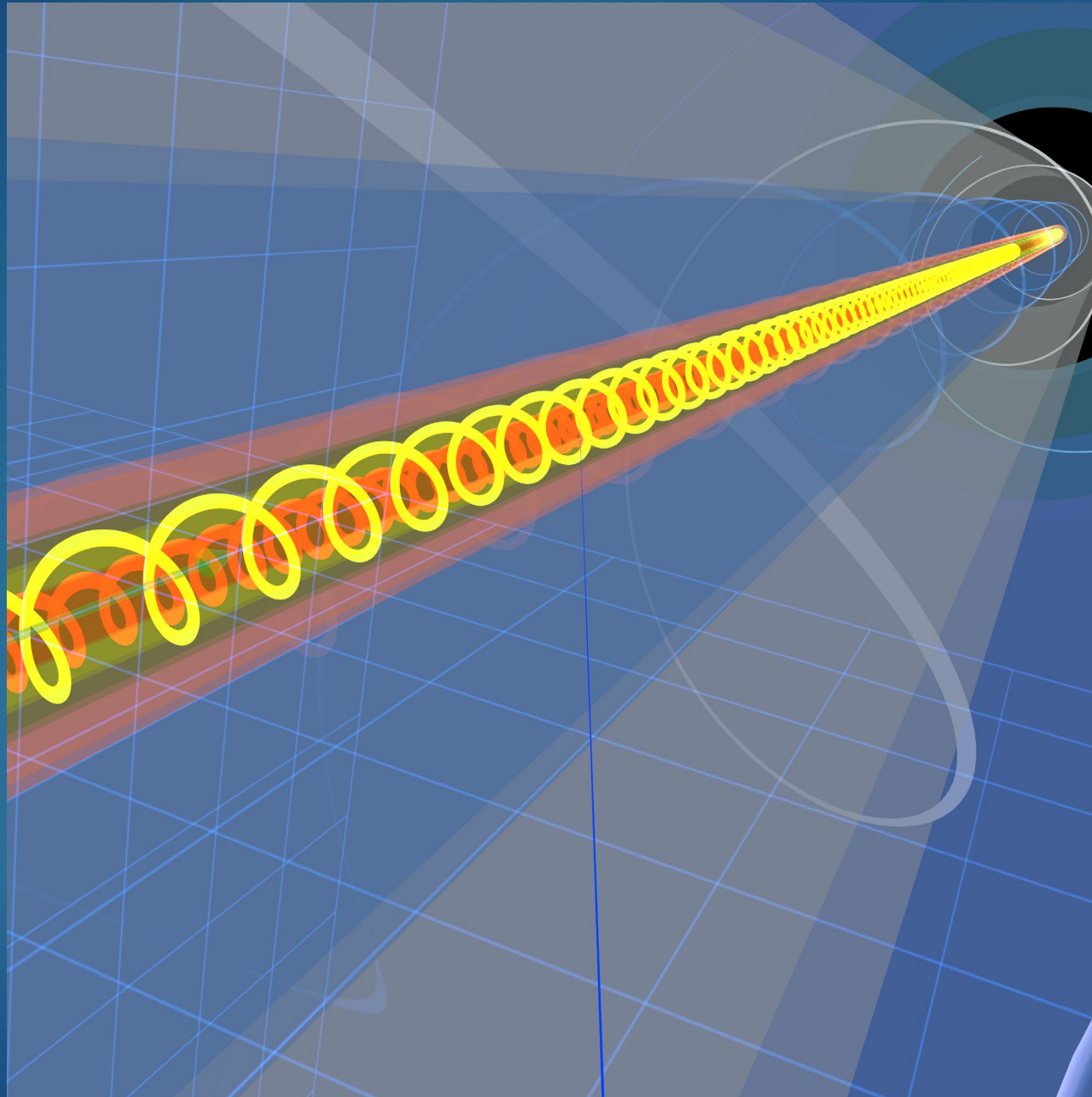


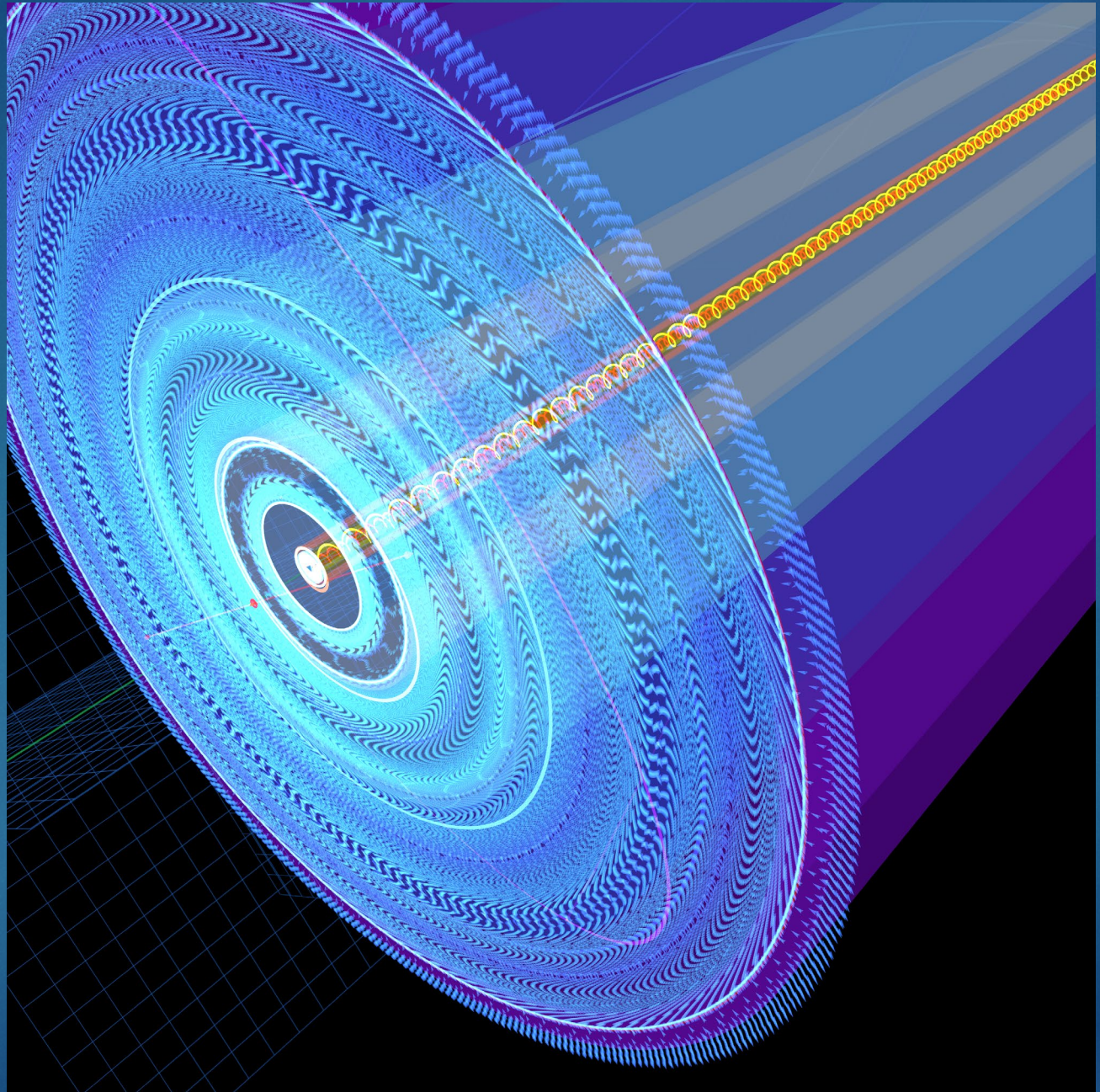


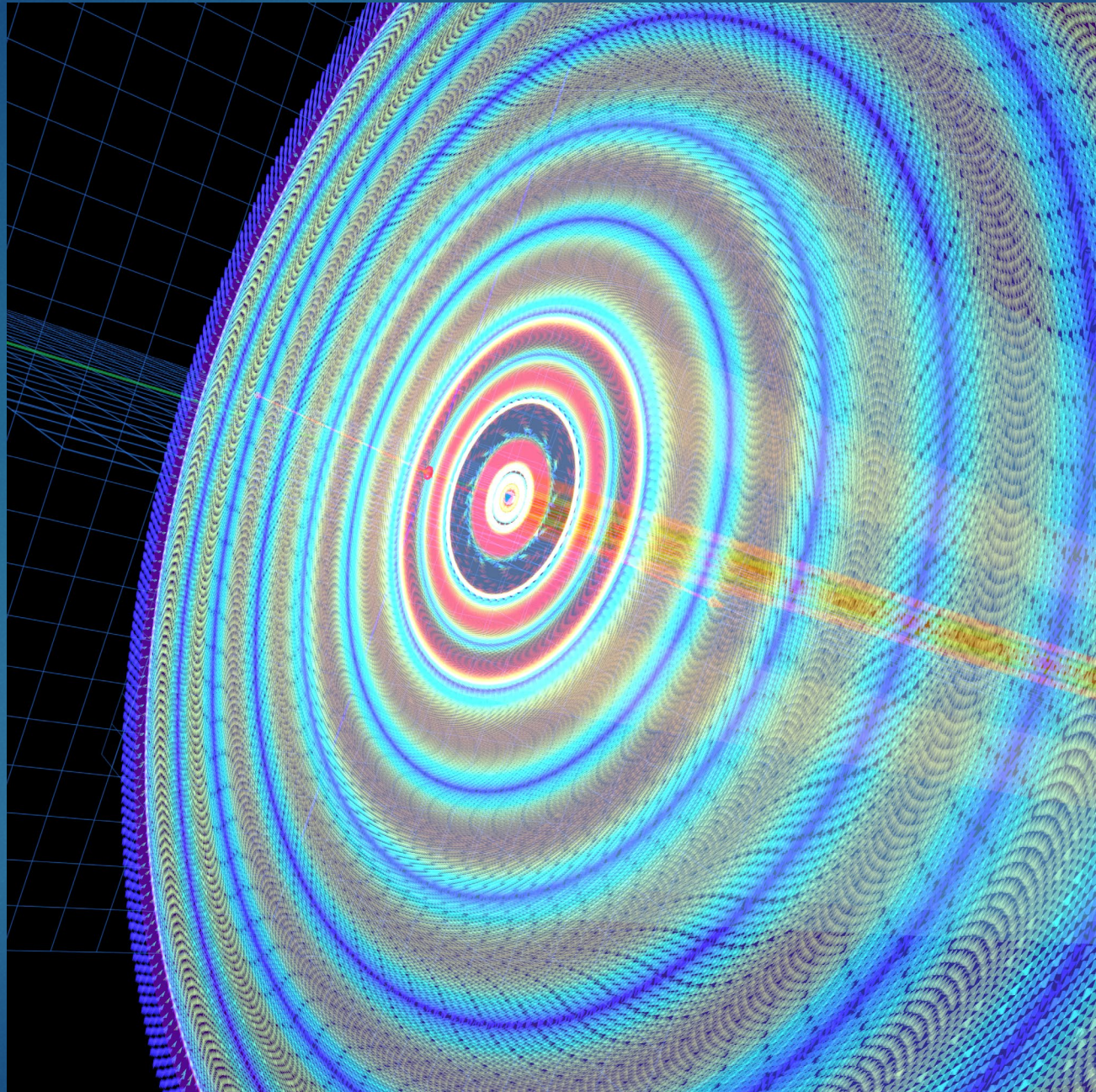


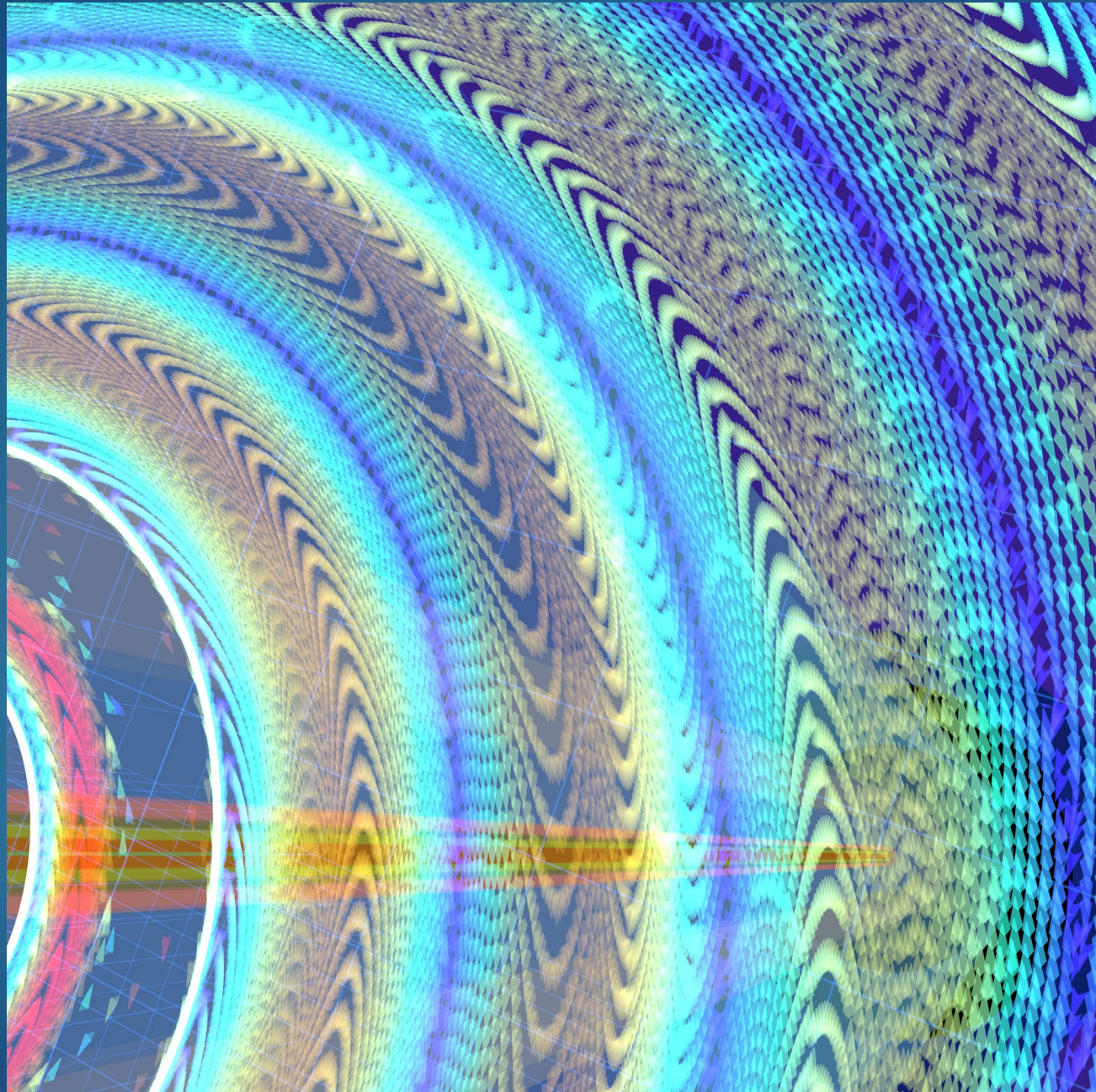


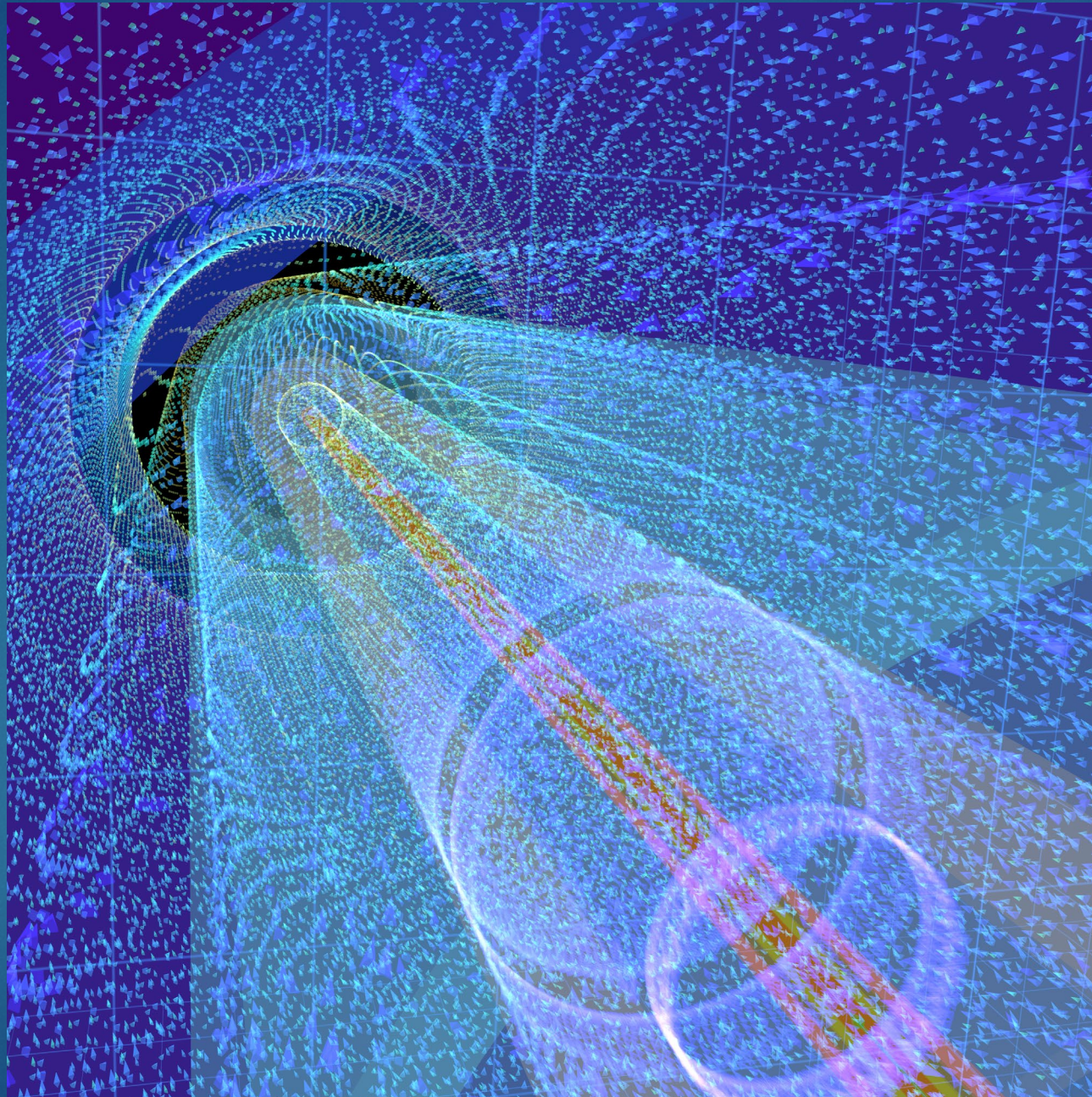












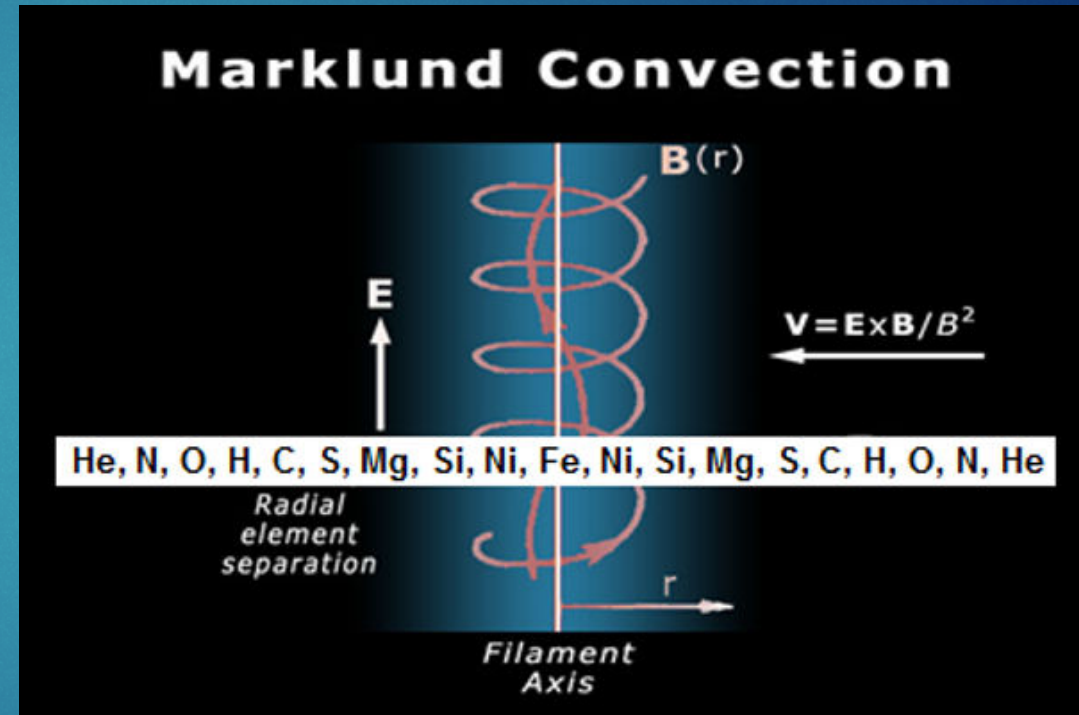
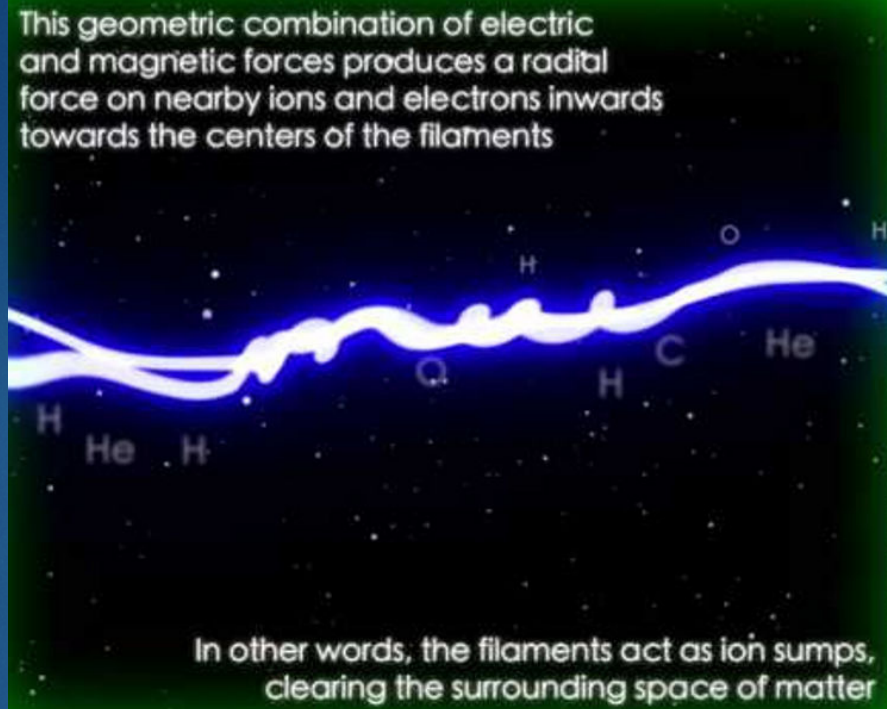
Enhancements/Extensions

- ▶ Ionic Charge/Mass Distributions
- ▶ Semiconductor Charge Carriers
- ▶ Fluid Dynamic Models

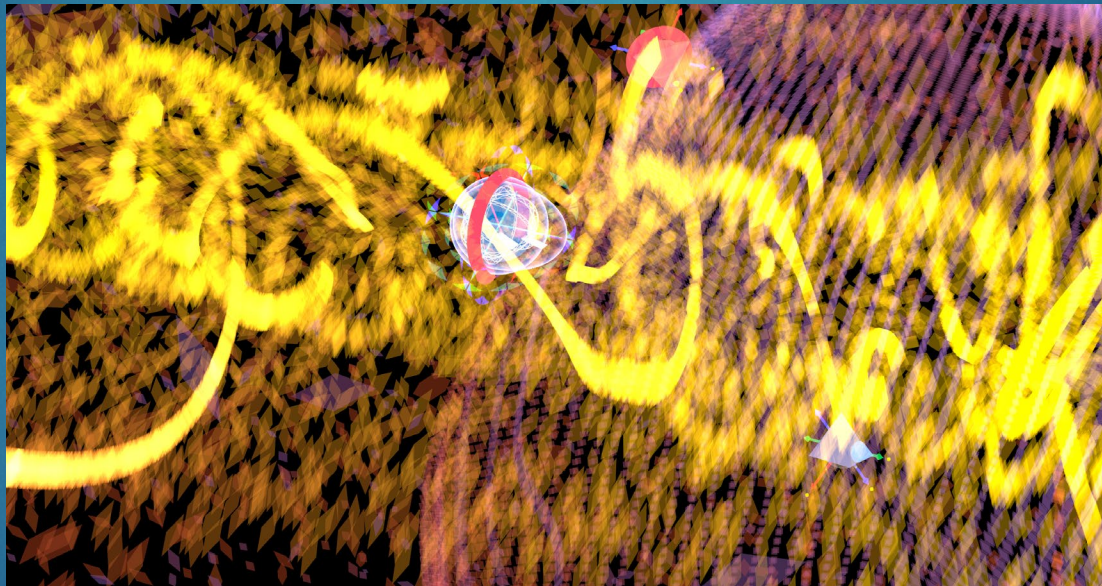
Questions/Discussion



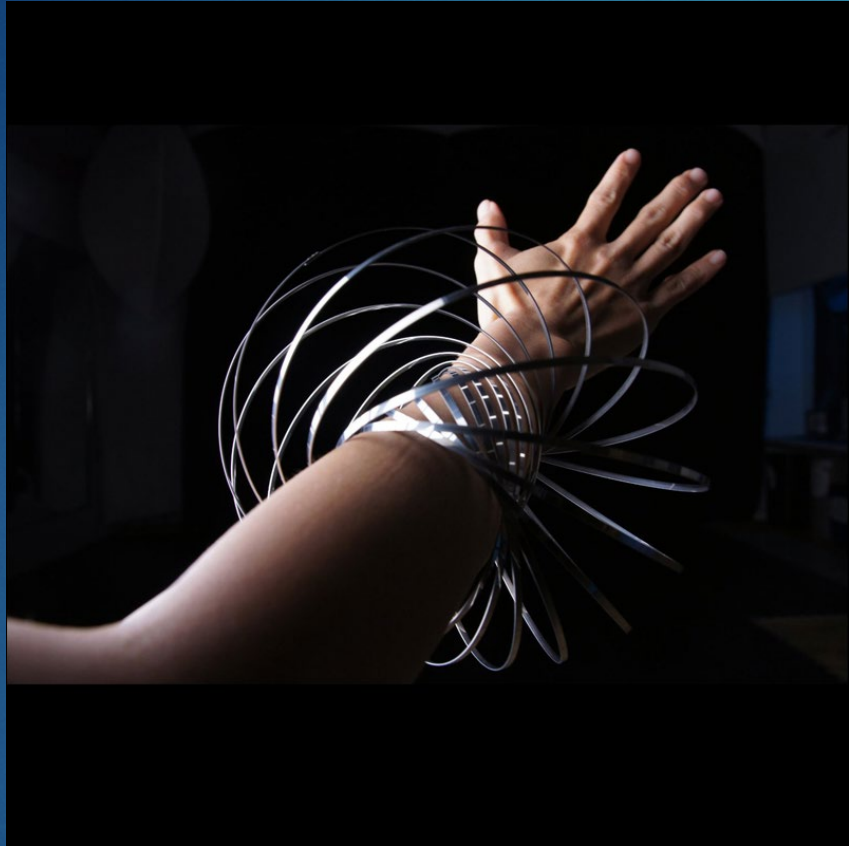
Marklund Convection



Experiment:



Toro Flex and Ferro Cell

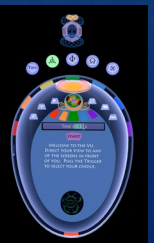
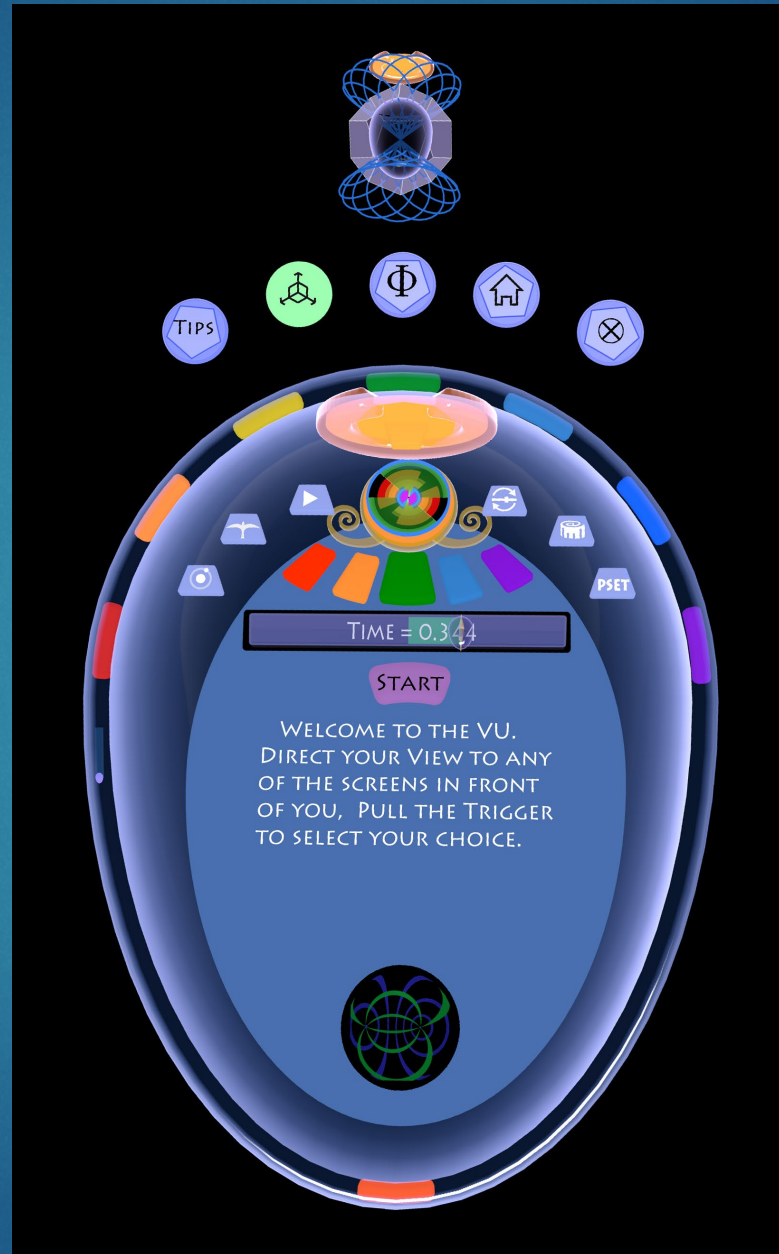


Platonics

- ▶ Harmonic Resonances
- ▶ Minimum Energy Configuration
- ▶ Coherency



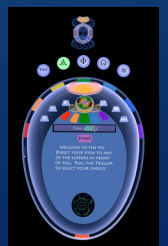
Panels



Panels Spawner



Panels
Platonics



Panels

Color Blender



Panels
Color
Picker



Panels

Geometry

Shader



Panels Settings



Panels

Attractor

Settings

TIME = 0.344

RADIAL 1.000 Φ

INNER RADIUS 0.00 OUTER RADIUS 300.

LINEAR 0.26 ON

ROTATIONAL -0.8 ON

TOROIDAL 0.46 ON

NORM BIRKELAND EU

STRENGTH 1.0

LIT PERP 1.5



Panels

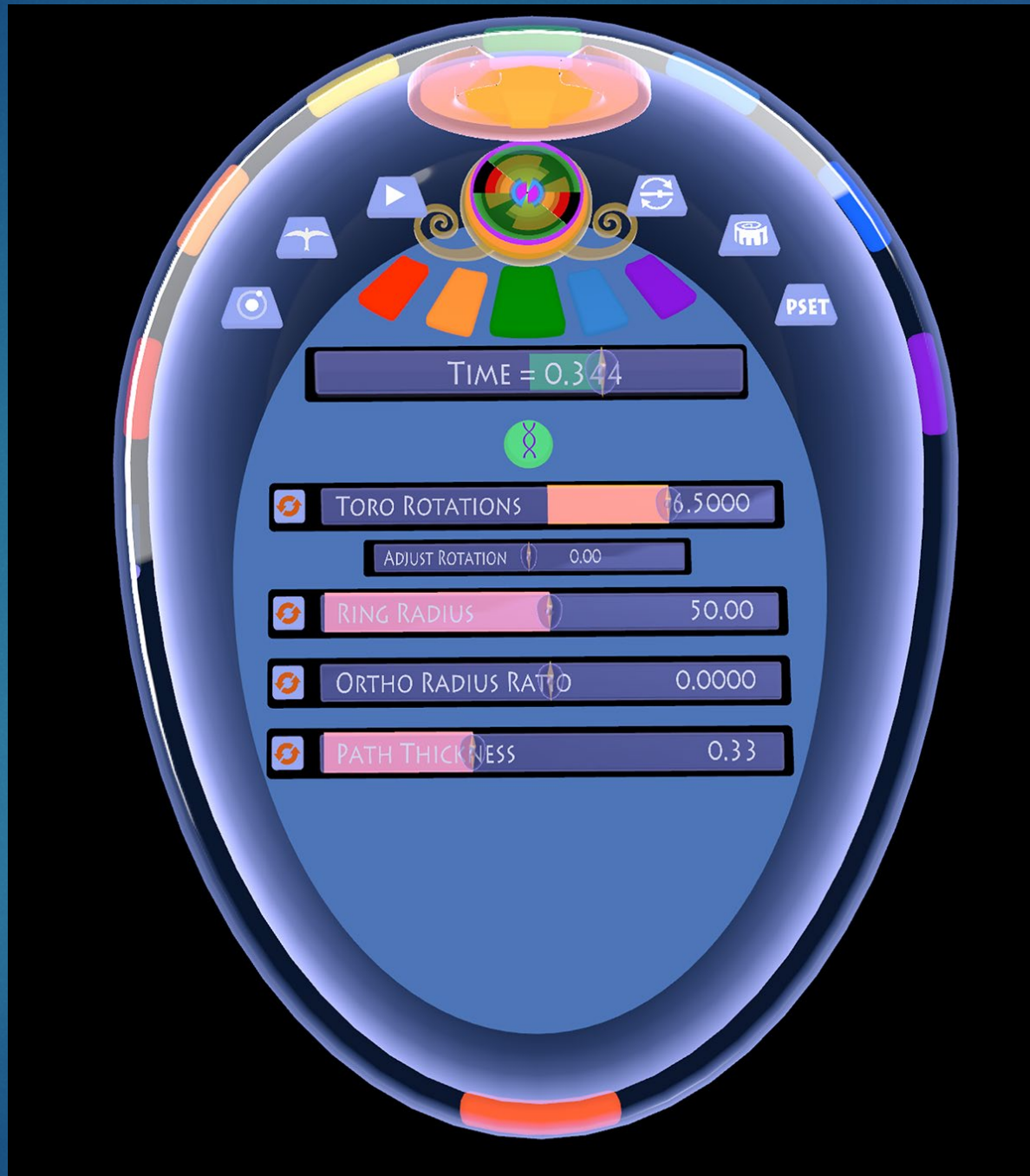
Birkeland Cylinders



Panels

Toro Flex

Resonance



Panels
Stylus
Settings



Panels

File

Save and Load



Panels

Presets

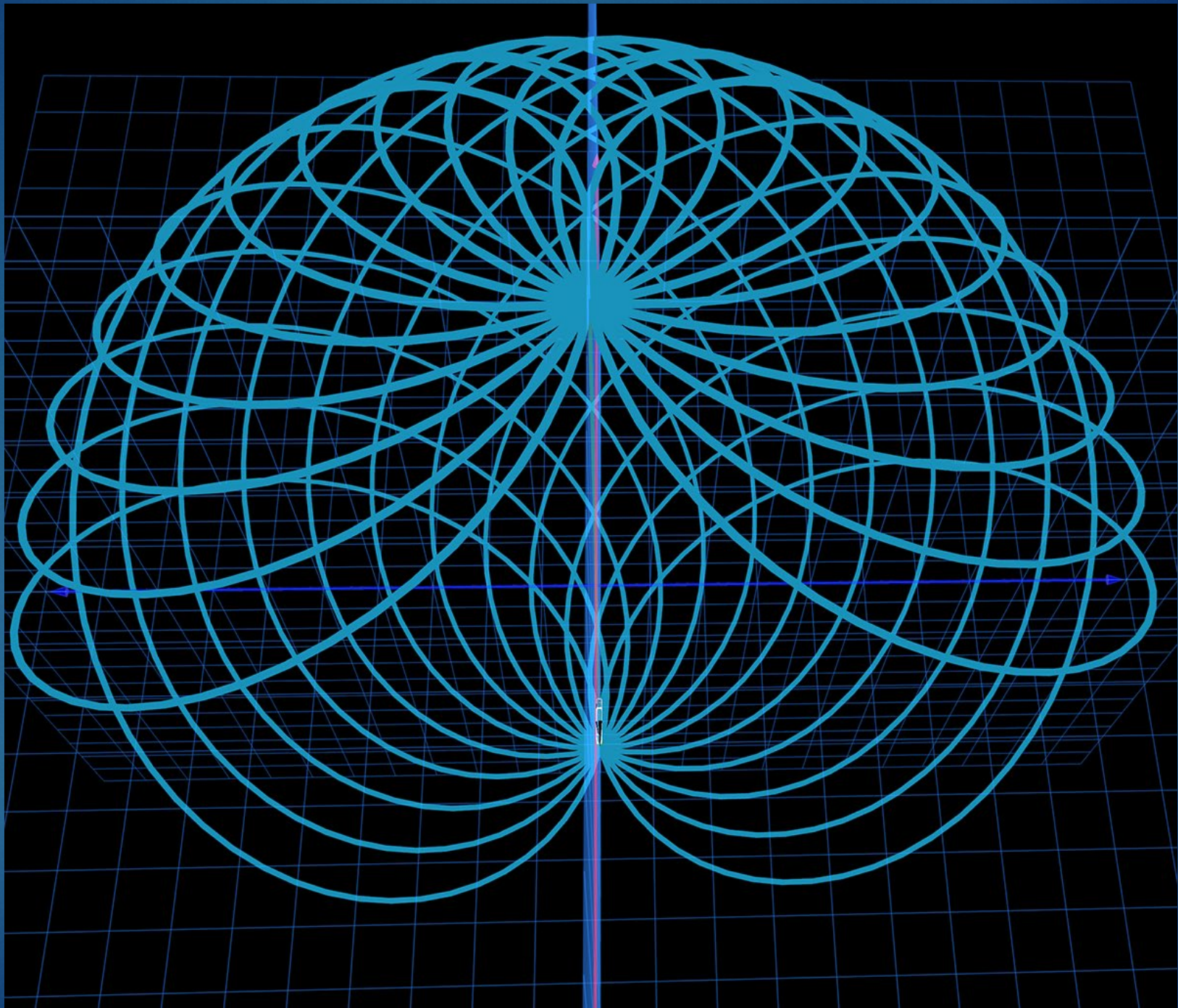
Load and Save

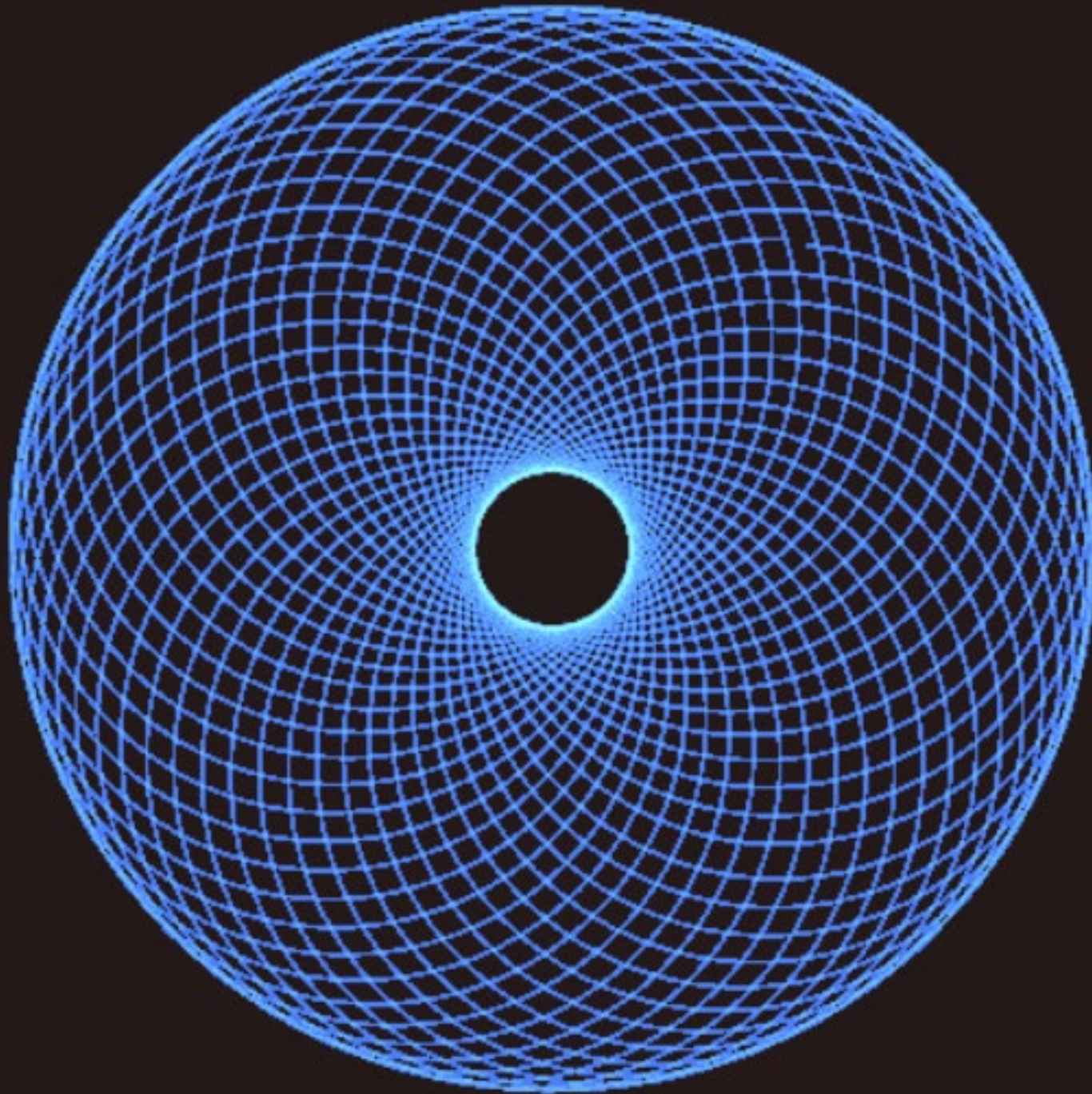


Panels

Pendulum Frisbee



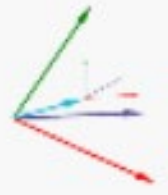




III

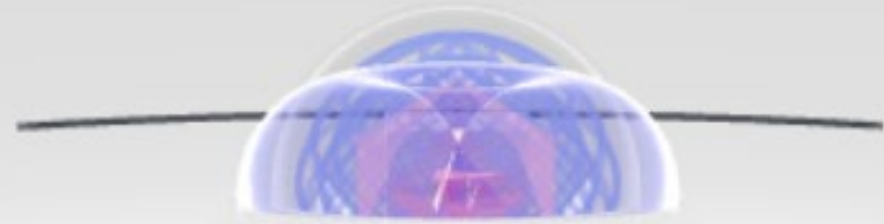


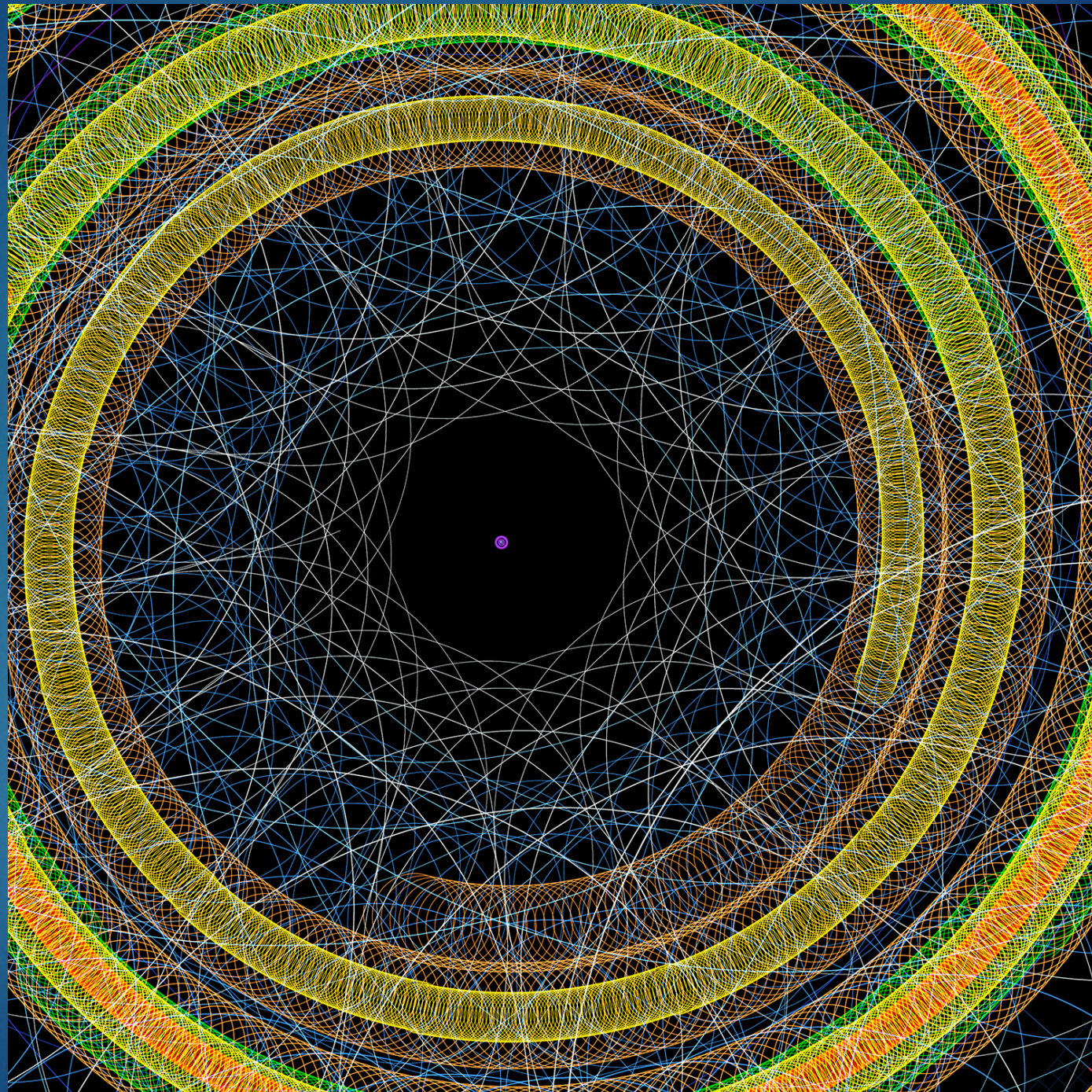
THE VU



FLY
USE YOUR CONTROLLER WEIGHTLESSLY FLY THROUGH YOUR CHARGED POINT CLOUD

EXPERIMENT
TEST NEW CONFIGURATIONS OF ATTRACTORS. ADJUST AND TEST THEIR BEHAVIOR







Meteors and star trails during the Perseid meteor shower

