

SURFER

a real-time raytracer for algebraic surfaces

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Klaus Tschira Stiftung
gemeinnützige GmbH



MOTIVATION

$$\begin{aligned} & ((3x^2 + (y - 1.9)^2 + 4z^2 - 1)^2 + 0.2z) \cdot (((((0.8z + 1.2)^3 + 5y - 6)^2 + 16x^2 - 0.5) \\ & \cdot (x^2 + (y + 6)^2 + (z - 2.8)^2 - 0.3) \cdot (x^2 + (y - 1)^2 + (z + 3.3)^2 - 0.03) + 290) \\ & \cdot (9x^2 + (y - 0.1 \cdot z + 2.5)^2 + (4z - 5 + y)^2 - 1) - 400) - 99 = 0 \end{aligned}$$

MOTIVATION



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SURFER

IMAGINARY

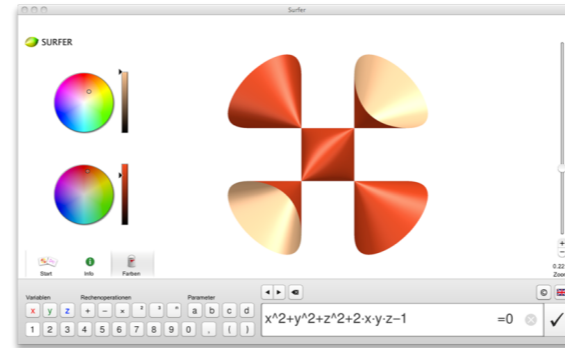
open mathematics

SURFER

The image shows the SURFER software interface. At the top, the window title is "Surfer". In the top-left corner, there is a logo and the text "SURFER". The main area displays a 3D plot of a surface with four lobes, colored in a gradient from red to yellow. To the left of the plot are two color selection tools, each consisting of a circular color wheel and a vertical slider. Below these are three buttons: "Start", "Info", and "Farben". On the right side, there is a vertical zoom slider with a current value of "0.22 x Zoom". At the bottom, there is a keyboard interface with sections for "Variablen" (x, y, z), "Rechenoperationen" (+, -, x, ^2, ^3, ^n), and "Parameter" (a, b, c, d). A central input field contains the equation $x^2+y^2+z^2+2\cdot x\cdot y\cdot z-1$. To the right of the input field are buttons for "=0", a close button (X), and a checkmark button (✓). Navigation arrows and a copyright symbol are also visible in the bottom right corner.

user interface

JavaFX; scalable, nice look, intuitive



SURFER

components

galleries & explanations

LaTeX \rightarrow PDF; get users started, teach some math
<https://github.com/IMAGINARY/SURFER-Galleries>

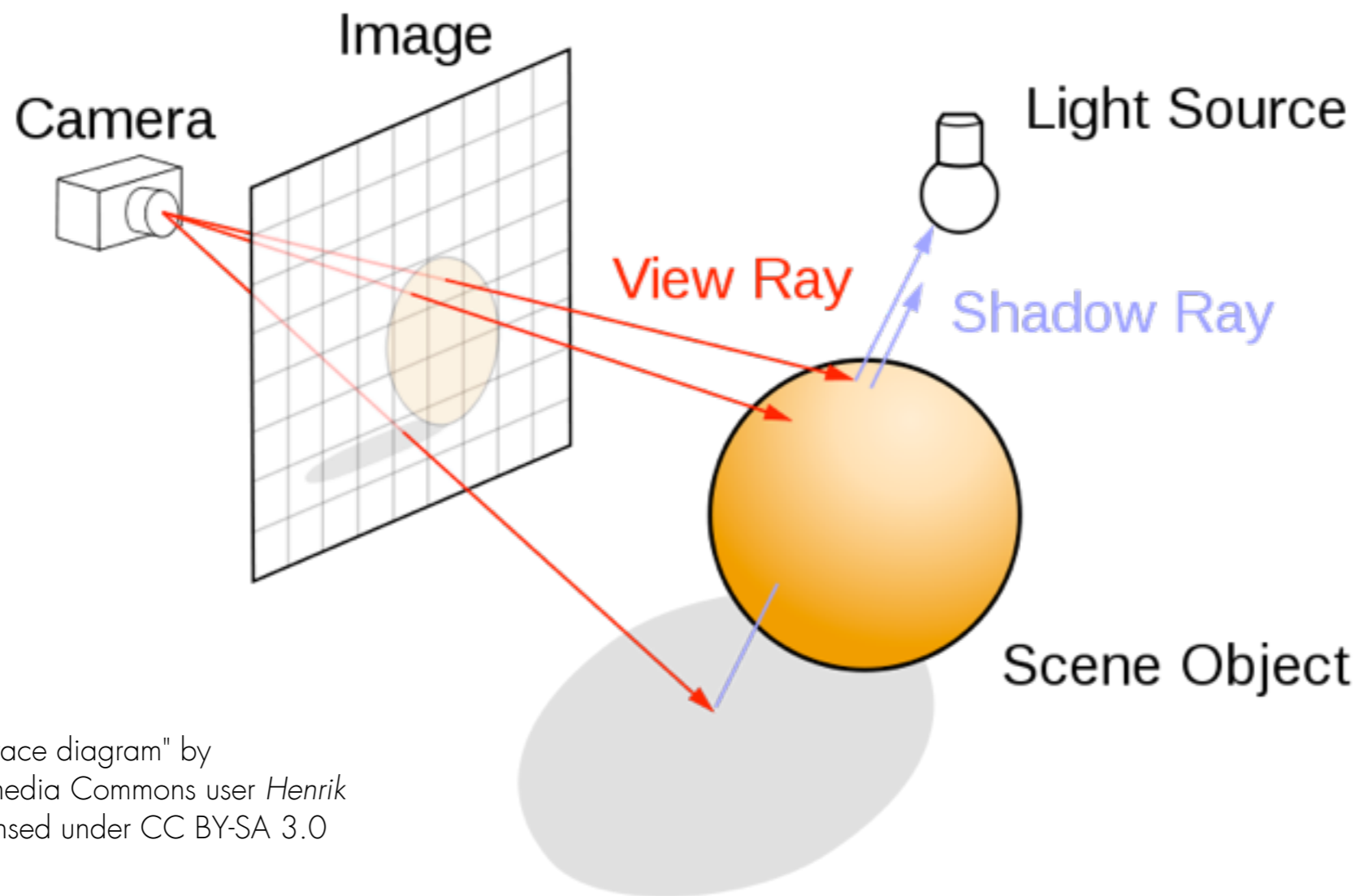


rendering core

Java; does all the hard work
computer algebra, numerical methods, parallelization
<https://github.com/IMAGINARY/jsurf>

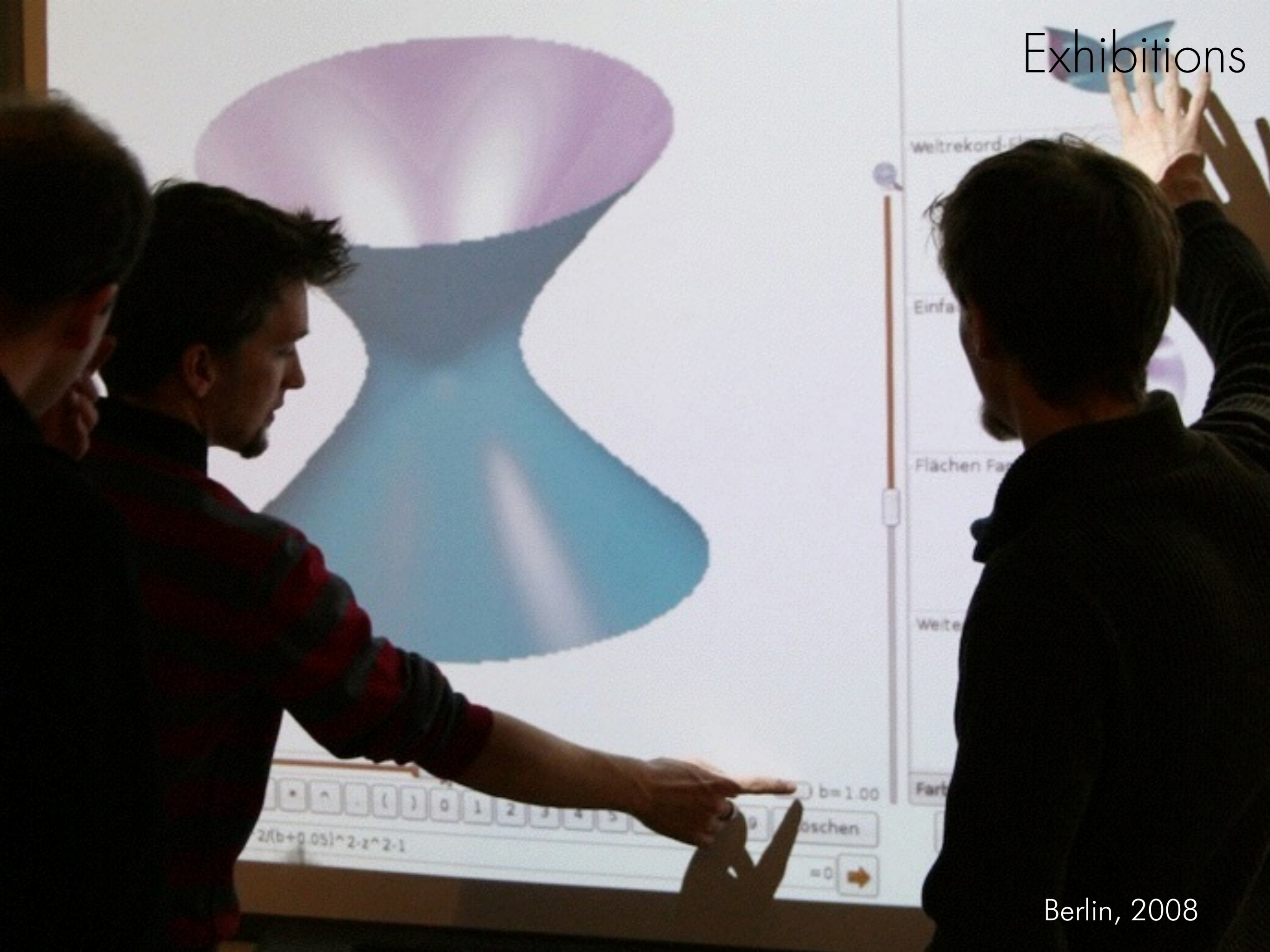
Ray tracing

- non-linear objects (algebraic)
- real time



"Ray trace diagram" by
Wikimedia Commons user *Henrik*
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Exhibitions



Berlin, 2008

Exhibitions



Belgrade, 2011

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 ITBA-IMAGINARY - PLANETARIO, BUENOS AIRES
www.imaginary-exhibition.com/surfer

$x \cdot 694 + x^2 \cdot z^2 \cdot y \cdot 3 \cdot 5^2 \cdot 7$

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 Galicia

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$x \cdot (z - fi + z^x) \cdot z \cdot fi \cdot g$

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Del mismo modo que las representaciones gráficas (tablas y gráficos) nos ayudan a pensar de manera más clara, las ecuaciones también están formadas por miles de puntos. De hecho, una ecuación puede ser una imagen de una ecuación.

Una manera de pensar en el infinito es imaginar a contar una, dos, tres... Siempre hay un número mayor y un número menor de números entre los números naturales.

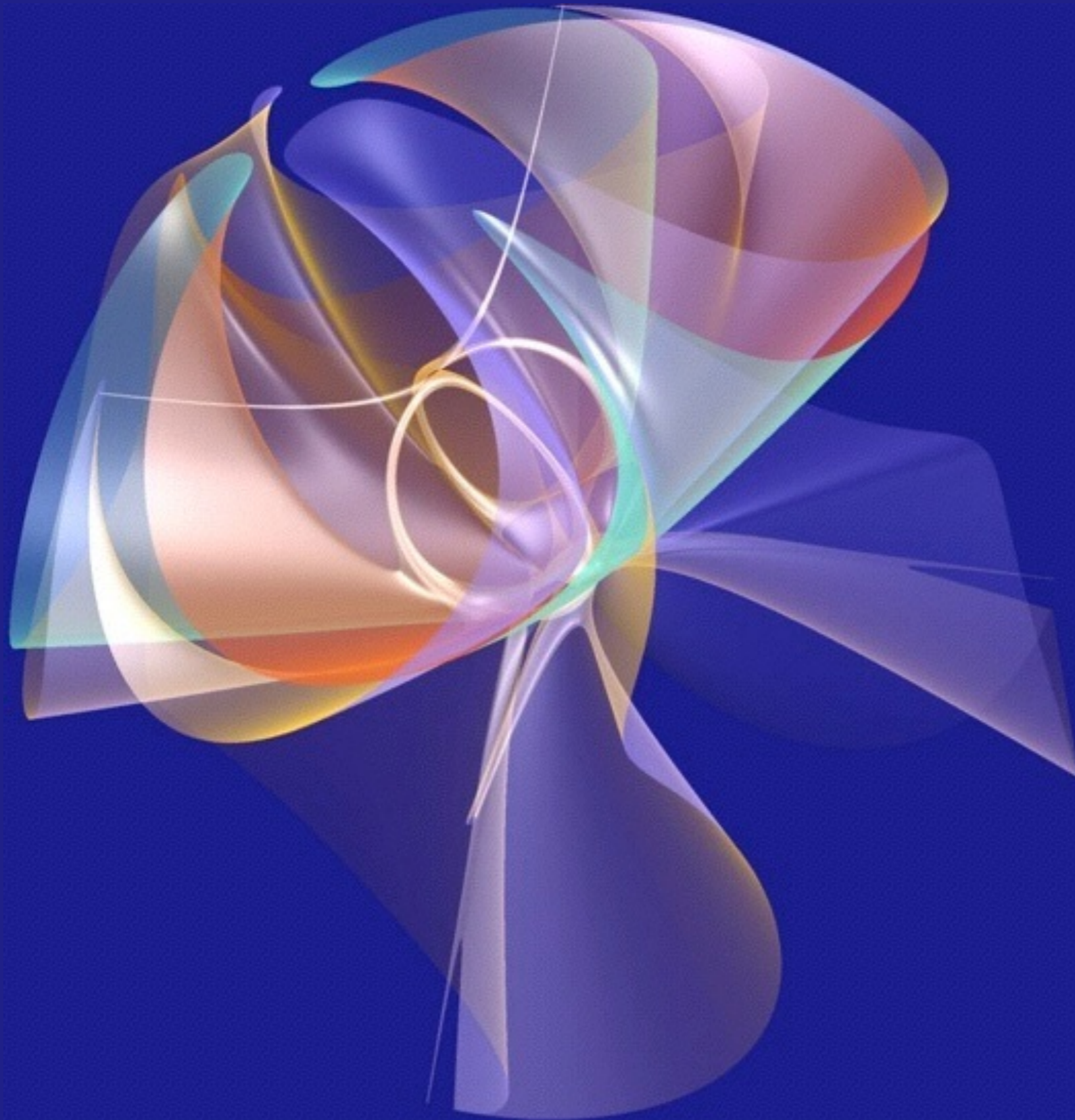
Figura en la ecuación del Conicoides el factor de multiplicación de la ecuación. Por eso, cuando se aplica de los planos $z=0$ (horizontal) y $z=1$ (vertical) siempre sale de sí. Pero no solamente figura como el Conicoides, que contiene dos planos, están formados por una infinidad de puntos. Se construye en un solo día, también.

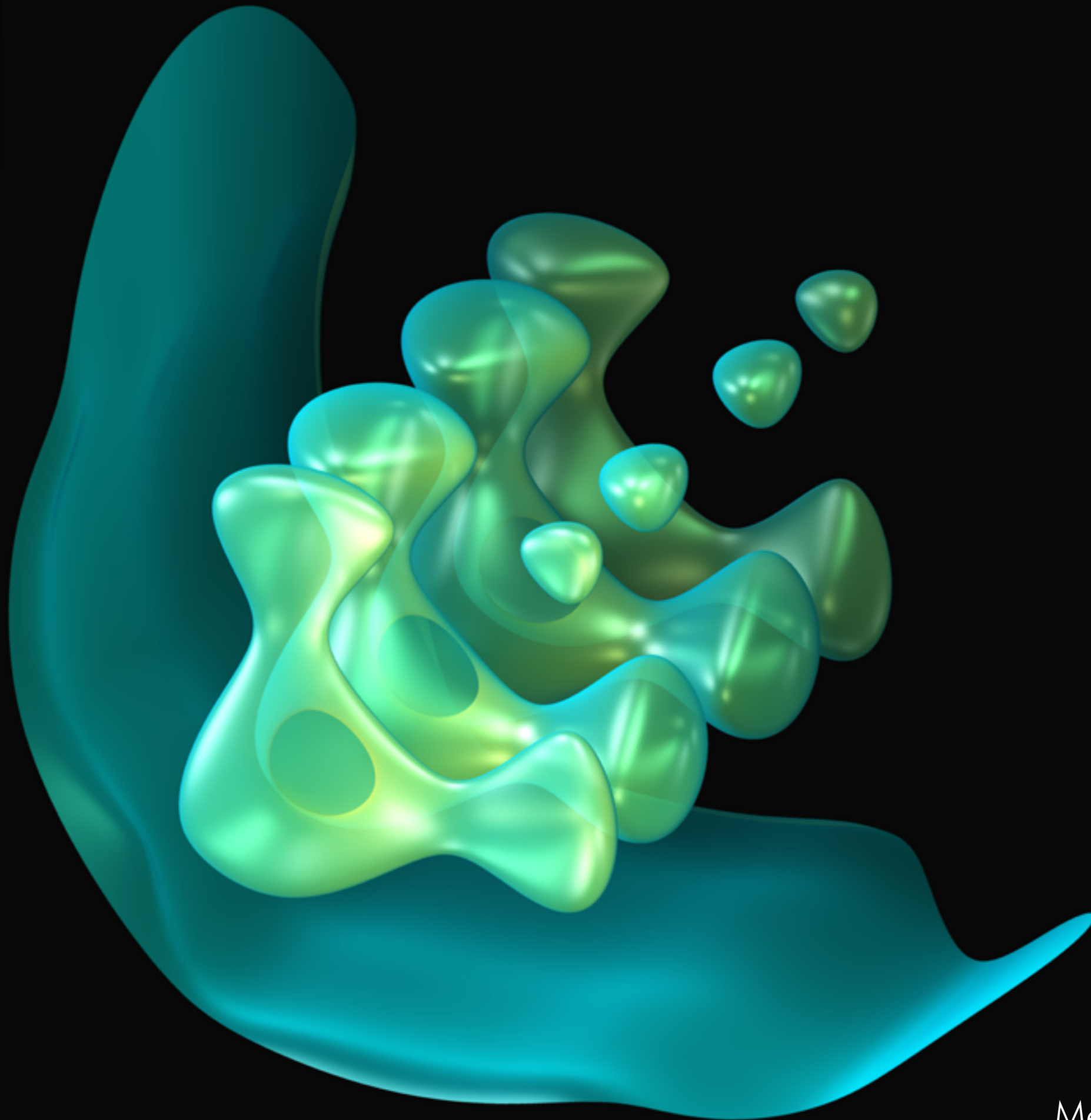
¿Puedes imaginar que algunos puntos pueden ser un resultado, que se sea una parte finita, ¿verdad? Pasa que los puntos son tan pequeños que se los necesita en dimensiones, y el resultado llega realmente a ser una percepción al que tú mismo.

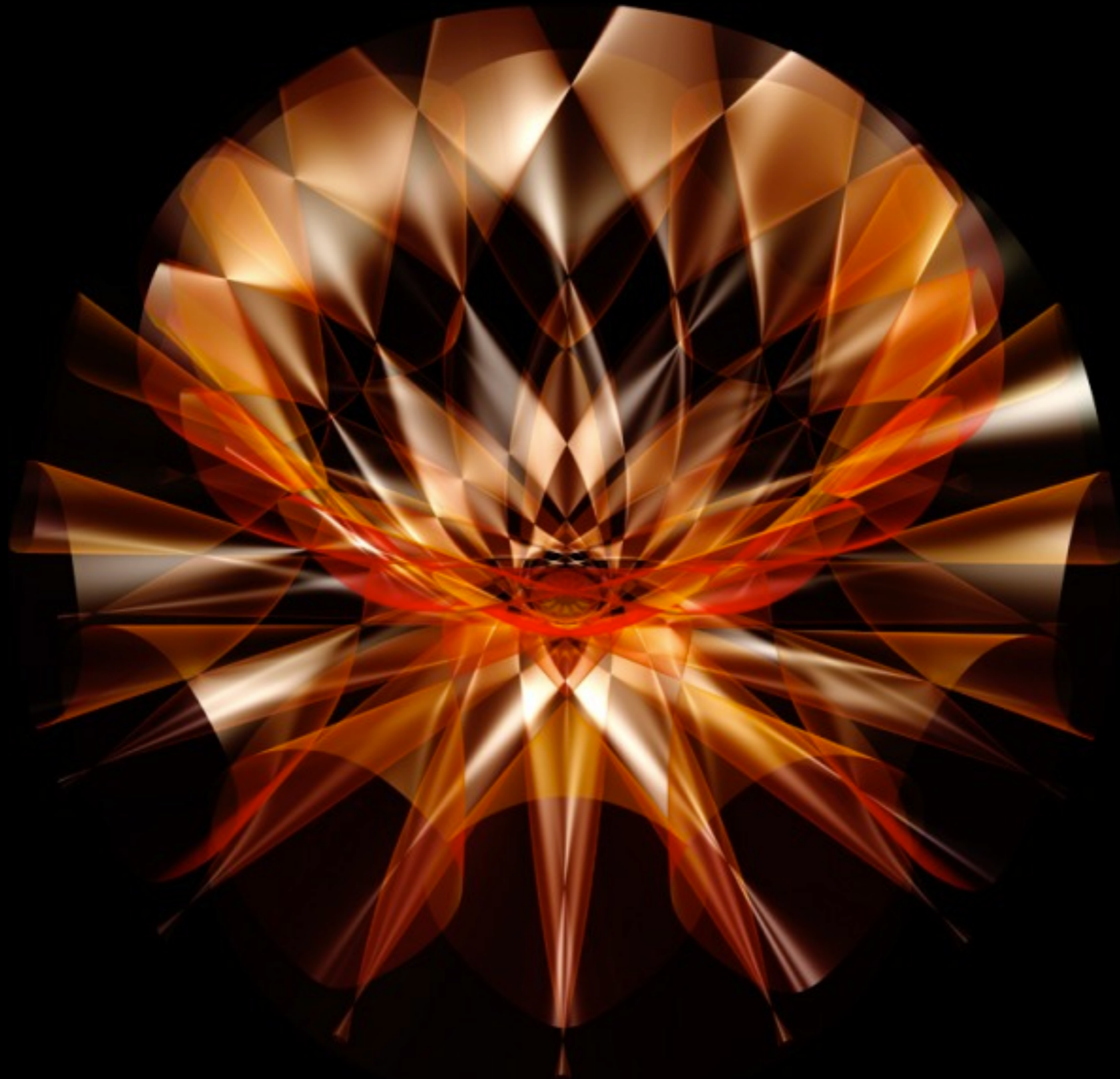
Inicio Info Cálculos

Operadores aritméticos Parametros

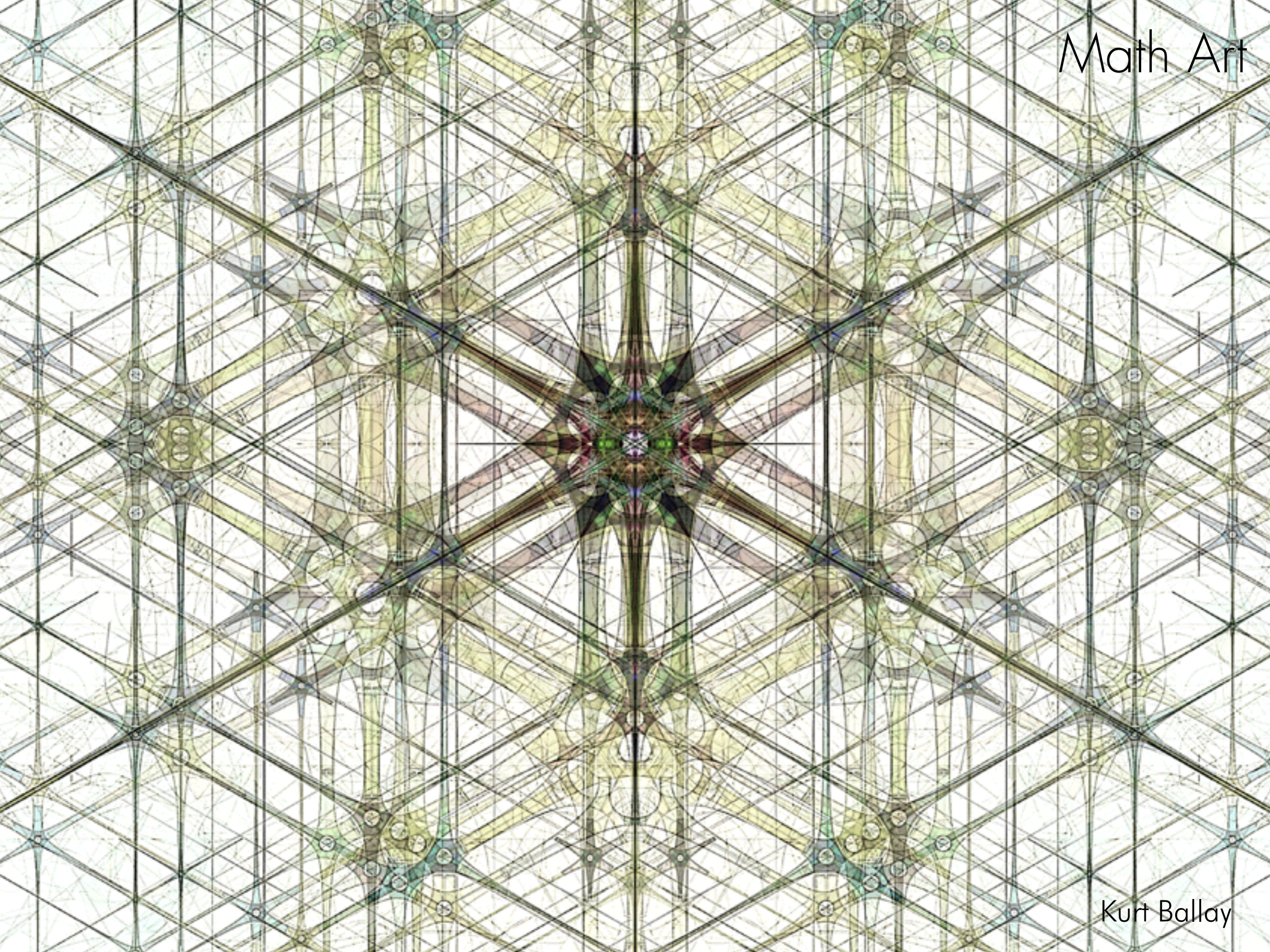
$y \cdot z \cdot (x^2 + y - z)$



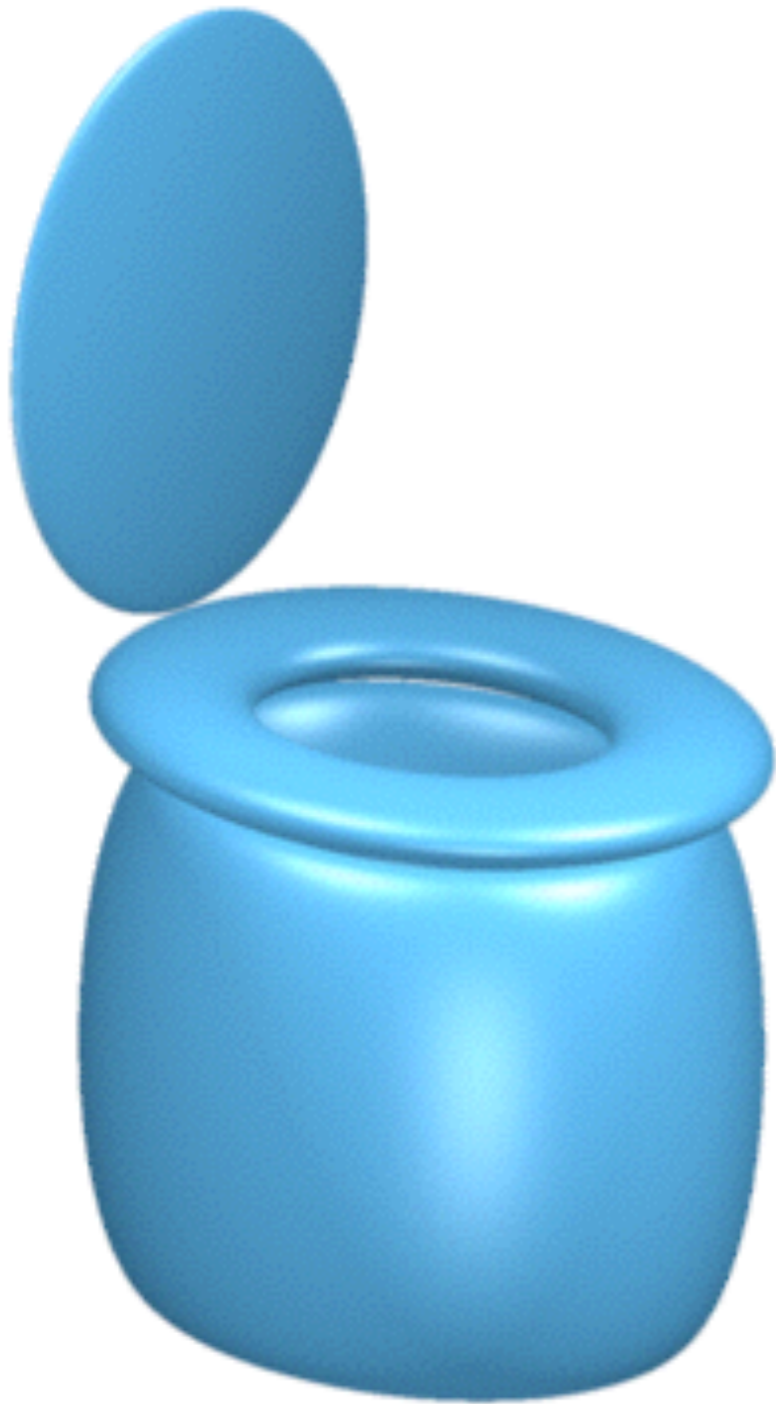




Math Art



Kurt Ballay



$$\begin{aligned} &((0.7*x^2+y^2+0.07*(z-2)^2+0.9)^2-4*(0.7*x^2+y^2)) \\ &*((0.7*x^2+y^2+4*(z-0.58)^2+0.9)^2-4*(0.7*x^2+y^2)) *(100*(x \\ &+1.52)^2+0.9*y^2+0.55*(z+0.86)^2-1)=0 \end{aligned}$$



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$f * g = 0$

$f + g = a$

$f^2 + g^2 - a = 0$
0.001

$a * f + (1-a)g = 0$

AGREGAR

FUNDIR

INTERSECTAR

FADE

$\theta = \text{ángulo en radianes}$

$X = \cos(\theta) * x - \sin(\theta) * y$

$Y = \sin(\theta) * x + \cos(\theta) * y$

$f: x^2 + y^2 - 1 = 0$

$g: y^2 + z^2 - 1 = 0$

Science Communication



Polypaint



Pattern Pants



Formula Morph

The screen is divided into two main sections: **Croissant** and **Cayley Cubic**. Each section features a 3D visualization of the shape, a vertical slider on the left, and a formula. The **Formula Morph** section shows a combination of the two shapes.

Croissant

Formula for Croissant
Croissant = r
 $\frac{1}{2} \cdot r^2 \cdot \theta + \frac{1}{2} \cdot r^2 \cdot \theta + \frac{1}{2} \cdot r^2 \cdot \theta$

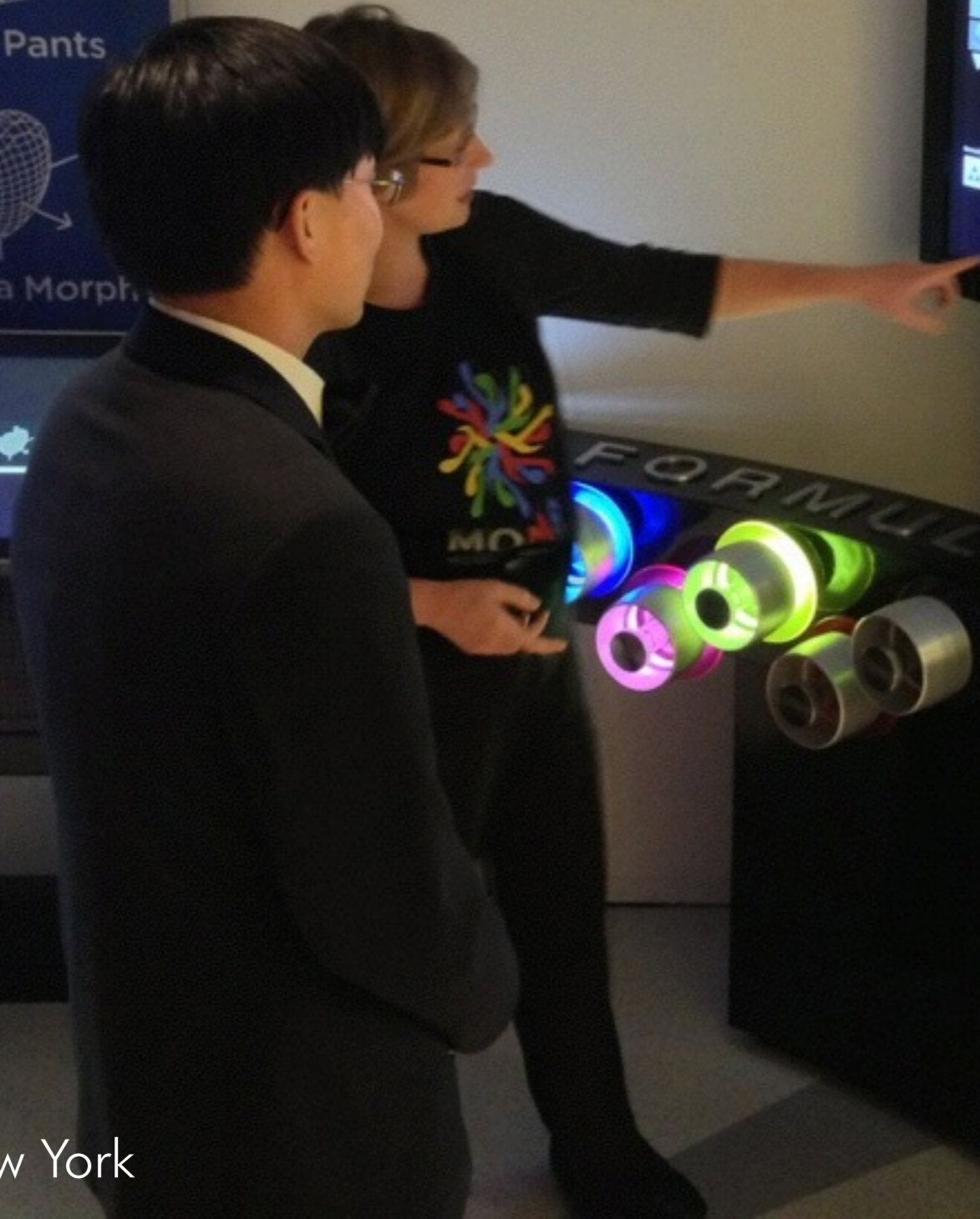
Cayley Cubic

Formula for Cayley Cubic
Cayley Cubic = $\frac{1}{2} \cdot r^2 \cdot \theta + \frac{1}{2} \cdot r^2 \cdot \theta + \frac{1}{2} \cdot r^2 \cdot \theta$

Formula Morph

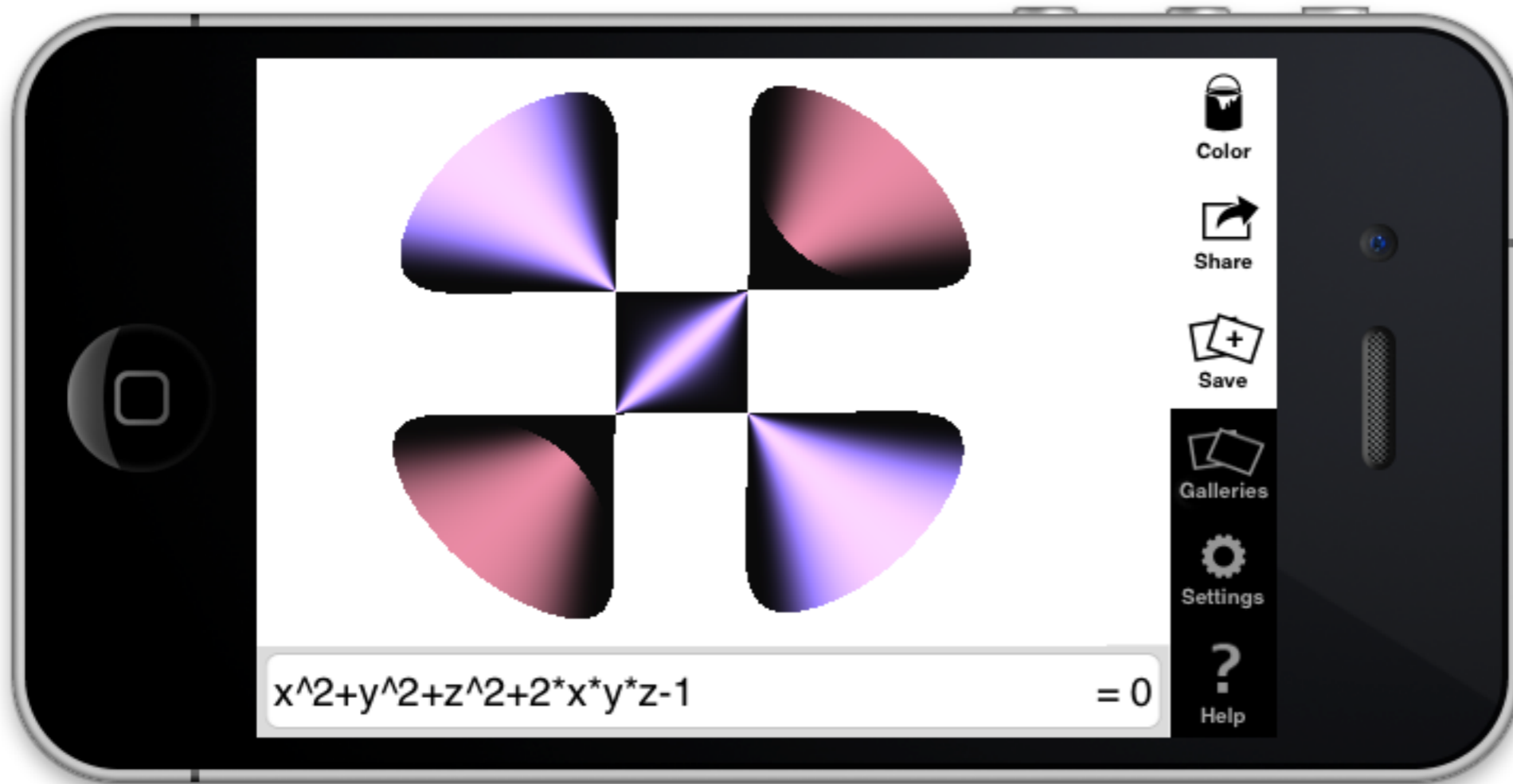
$\frac{1}{2} \cdot r^2 \cdot \theta + \frac{1}{2} \cdot r^2 \cdot \theta$

A small interactive screen on a stand, displaying icons for a paintbrush, pants, and a globe, corresponding to the Polypaint, Pattern Pants, and Formula Morph sections.

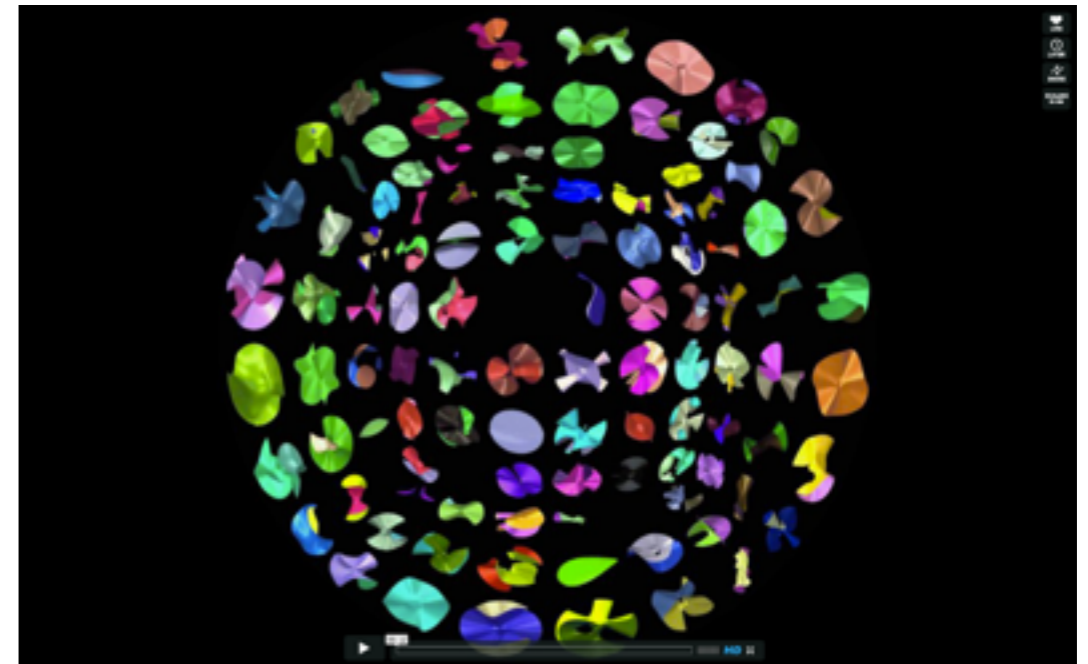
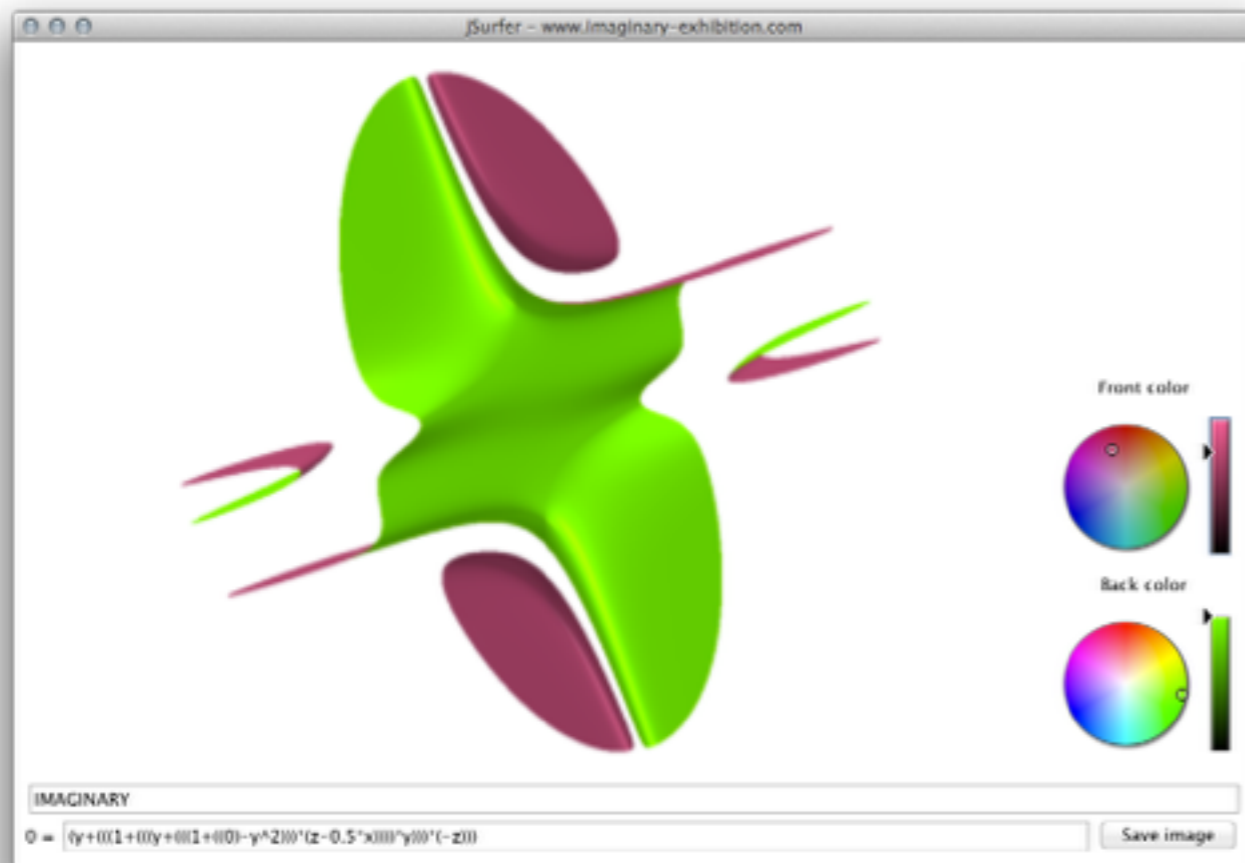


The **FORMULA MORPH** exhibit consists of a black base with several colorful rollers (green, purple, blue, red) that can be moved to create different mathematical shapes. The word "FORMULA MORPH" is written on the base.

SPIN-OFFS



- iSurfer
- NameSurfer
- Surfer Shuffle
- TimeSurfer
- JoySurfer
- SoundSurfer
- Surfer Dome
- Processing Surfer
- ...



SURFER spreading through IMAGINARY 2008-2013



IMAGINARY exhibitions/activities: 110 Cities and 23 countries

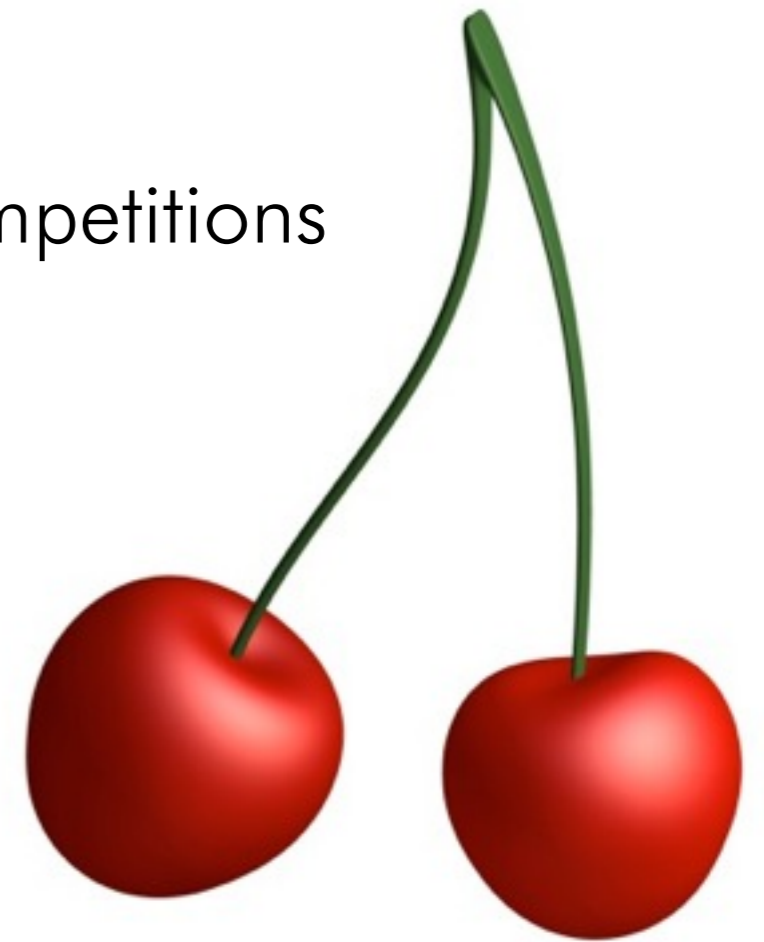
Visitors: > 1.000.000 visitors, among them 2.300 schools

Website: on average 800 unique daily visitors (on peak days up to 9,000 visitors)

Downloads: programs 700.000 times (programs), background material 500.000 times

START *SURFING*

- SURFER to create pictures
- SURFER in education
- SURFER for events, workshops, museums, competitions
- New ideas with algebraic surfaces
- join our team!



www.imaginary.org/program/surfer
surfer@imaginary.org