The Sirius Enigmas Mathematical Tops

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Overview

The physics, mathematics and sheer beauty of spinning objects - tops, dreidels, gyroscopes, rattlebacks, planets, stars, black holes, galaxies - intrigues and delights everyone.

Having already introduced two new spinning tops to the world at previous G4G gatherings - the ϕTOP® at G4G12 - and the πTOP® at G4G13 - today I will introduce two new mathematical tops: the eTop and the iTOP.

Constants ϕ, π, e and i
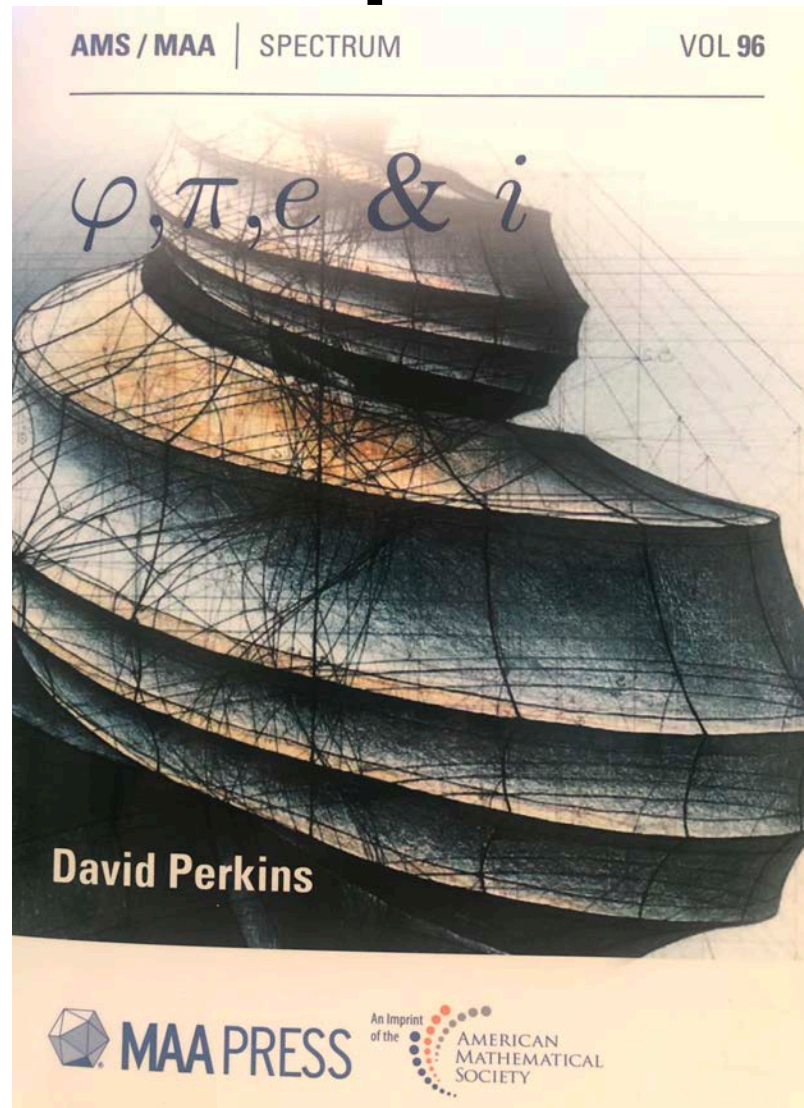
D. Perkins, "ϕ, π, e and i", Mathematical Association of America, 2018.

The ϕTOP®

The PhiTOP® is a prolate ellipsoid with ratio of major to minor axes equal to ϕ ~ 1.618…
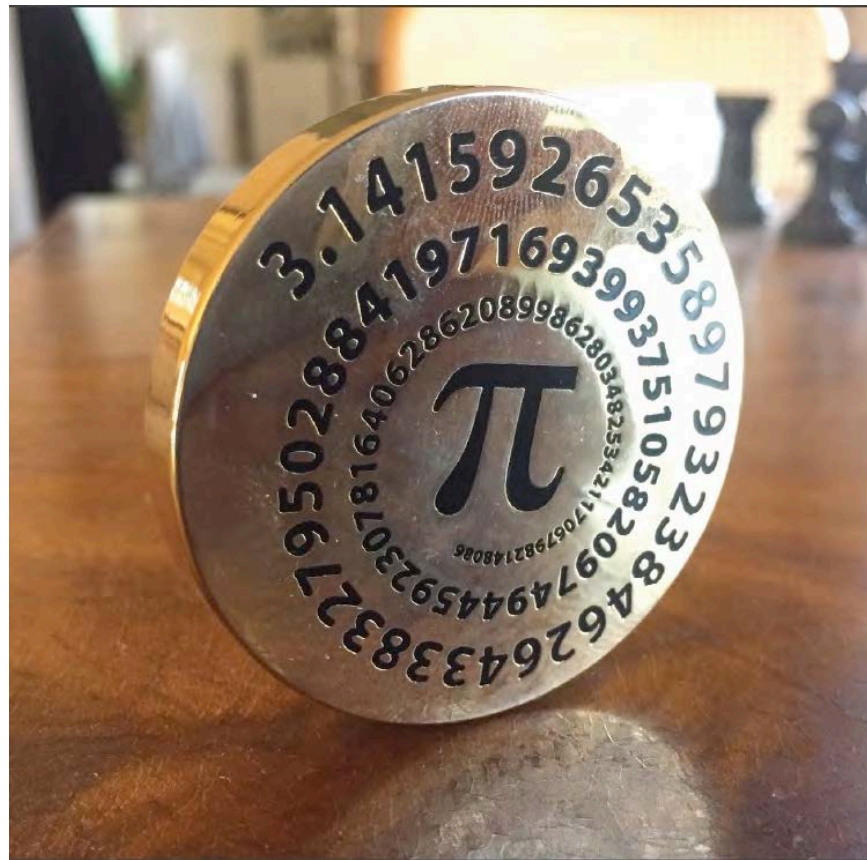
φTOP® Dynamics

Spin the PhiTOP® starting from its stable static equilibrium position and it will stand up and spin stably for several minutes.

**Cf. "Physics of the PhiTOP", K. Brecher and R. Cross, <u>The Physics Teacher</u>, 57, 74, 2019.**

The πTOP®

The PiTOP® is a right circular cylinder with ratio of radius r to thickness t, r/t = π ~ 3.14…

πTOP® Dynamics

Spin the PiTOP® as you would a coin. It will spin but also precess. As the PiTOP® loses kinetic energy to friction, the angle α it makes with the surface will decrease and the precession frequency Ω increases.
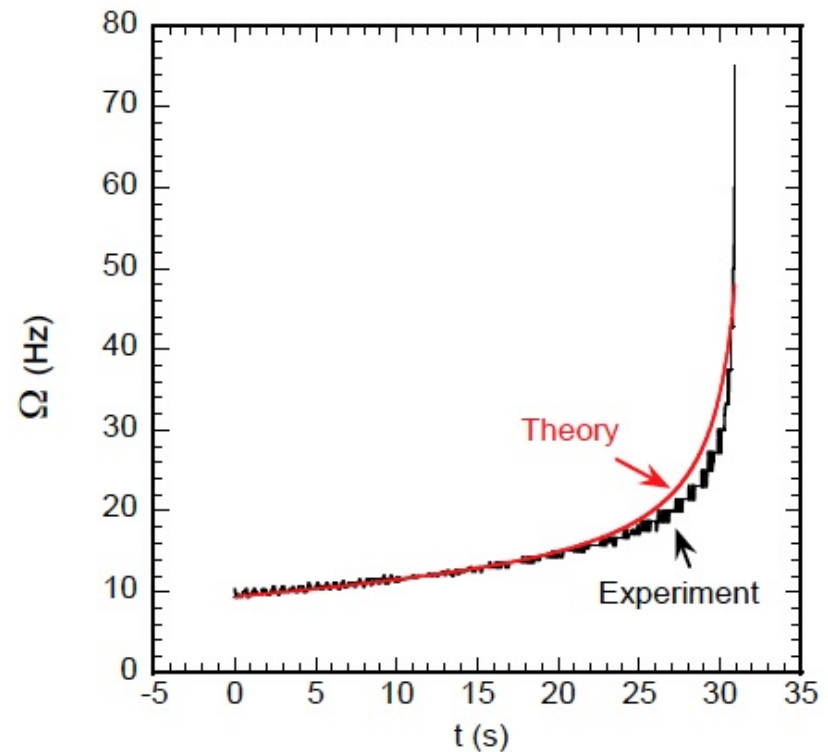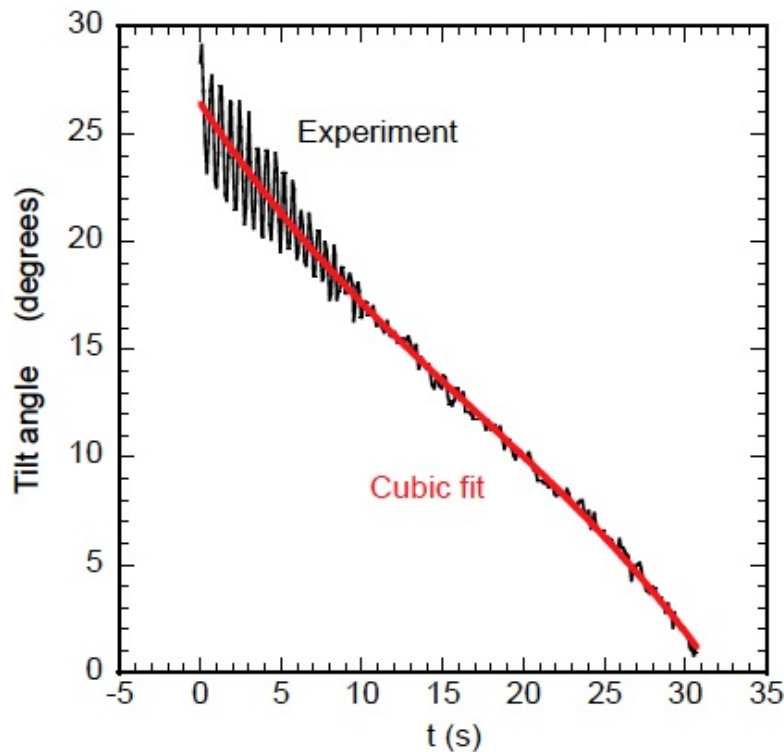
Data based on the dynamics of the PiTOP® from Rod Cross, "Effects of Rolling Friction on a Spinning Coin", <u>European Journal of Physics</u>, 39, #3, 2018.

The *e*TOP

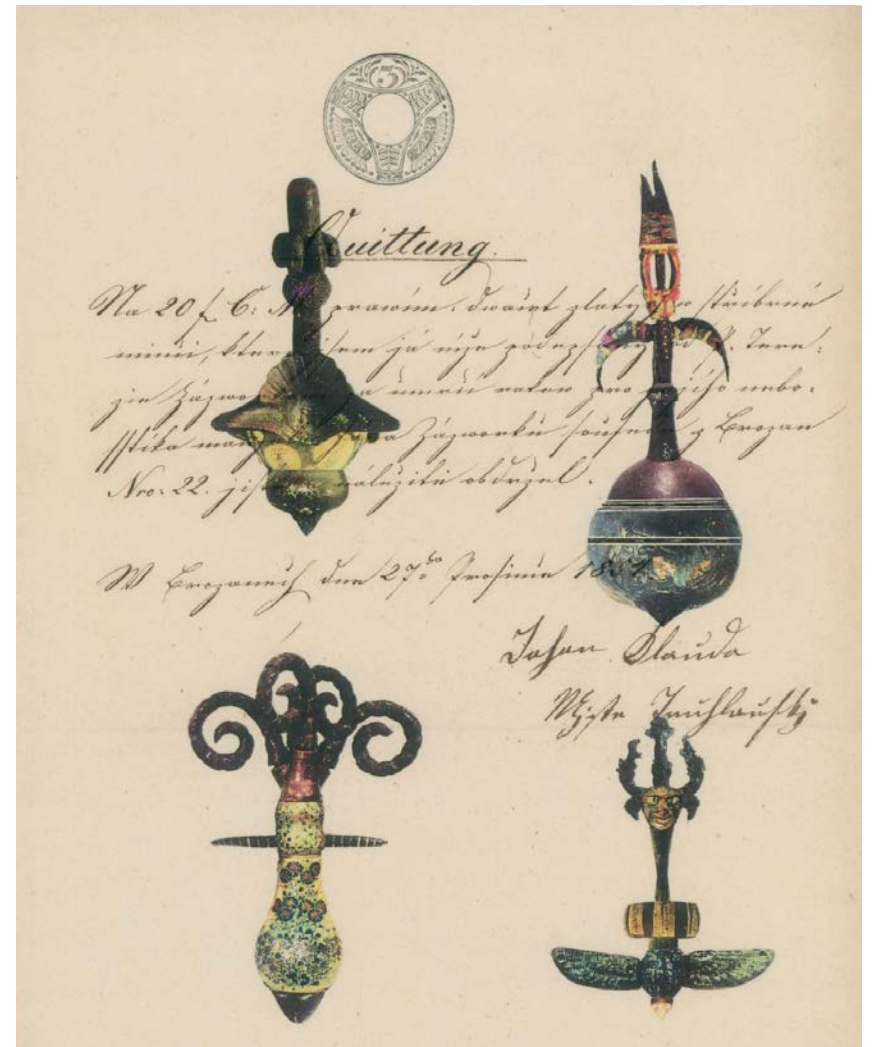**The *e*TOP is an oblate ellipsoid with ratio of major/minor axes = *e* ~ 2.718…**
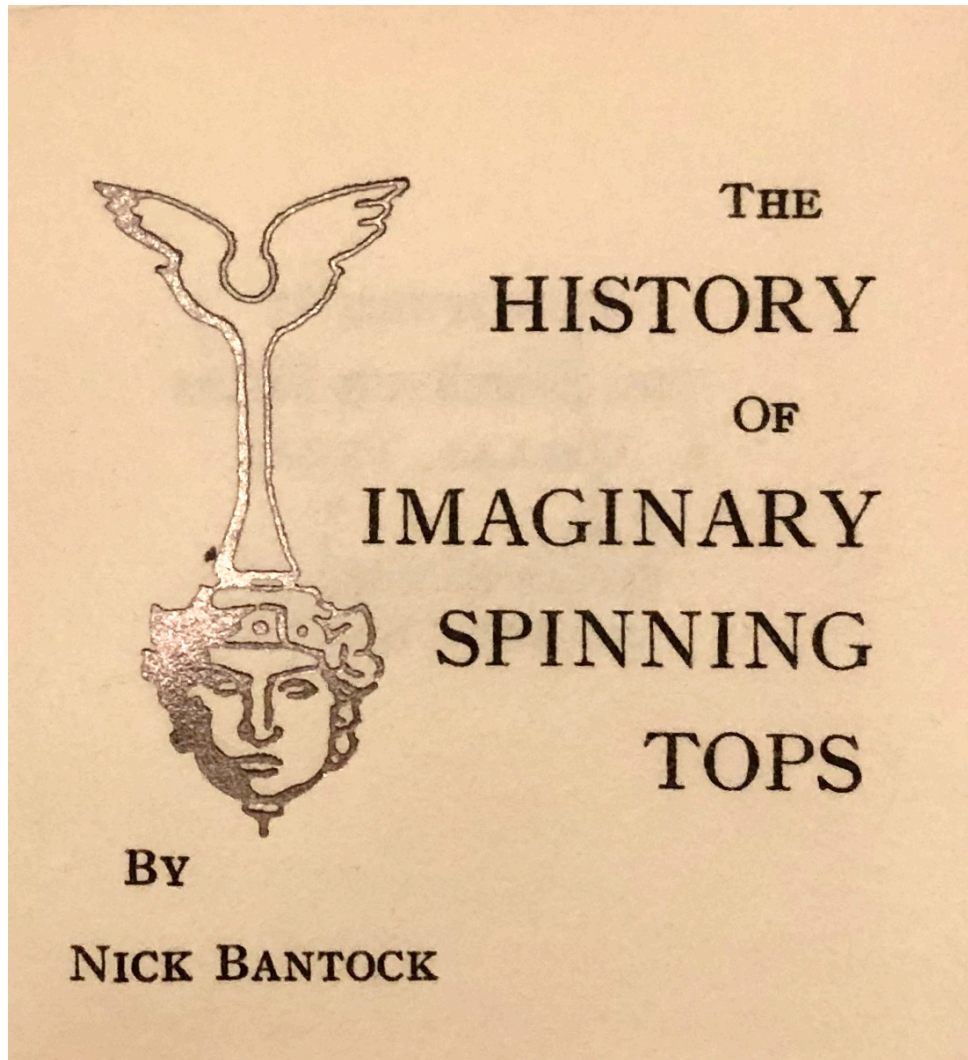
*e*TOP Dynamics

The *e*TOP, like the πTOP, can be spun by hand starting from a standing position. It can also be spun up with a magnetic stirrer.

Imaginary Tops

THE
HISTORY
OF
IMAGINARY
SPINNING
TOPS

BY

NICK BANTOCK

Nick Bantock is the author "The Museum at Purgatory", among many other books.

*i*TOP – Inverting Top

A "real" imaginary top is, well, hard to imagine. In its place, I have designed a quasi two-dimensional inverting top – the "*i*TOP".

*i*TOP Dynamics

Spin the iTOP starting from a standing position, heavy side down, and it almost instantly inverts to spin in the opposite direction! Imagine that! Almost an imaginary top!
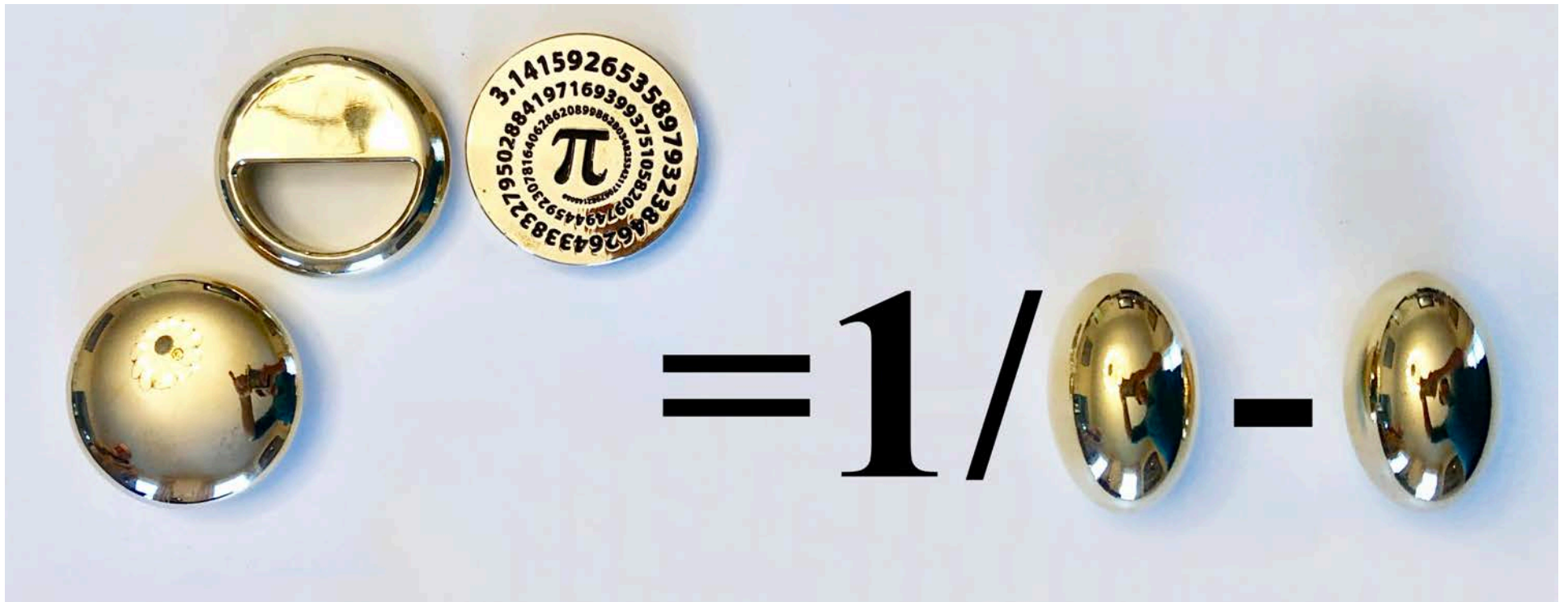
The Sirius Enigmas Mathematical Tops

PhiTOP   PiTOP   iTOP   eTOP
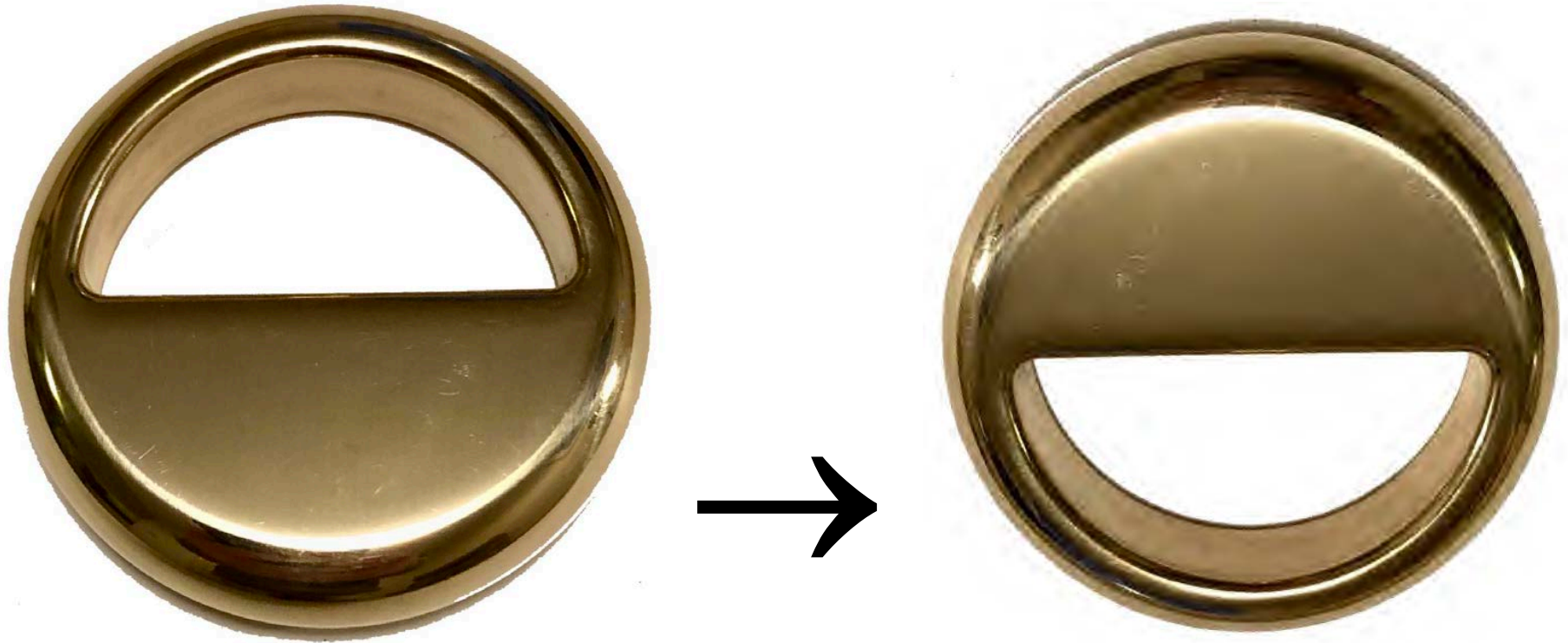
Euler's Identity

$$e^{i\pi} = -1$$

Combined with the definition of ϕ

$$1/\phi - \phi = -1$$

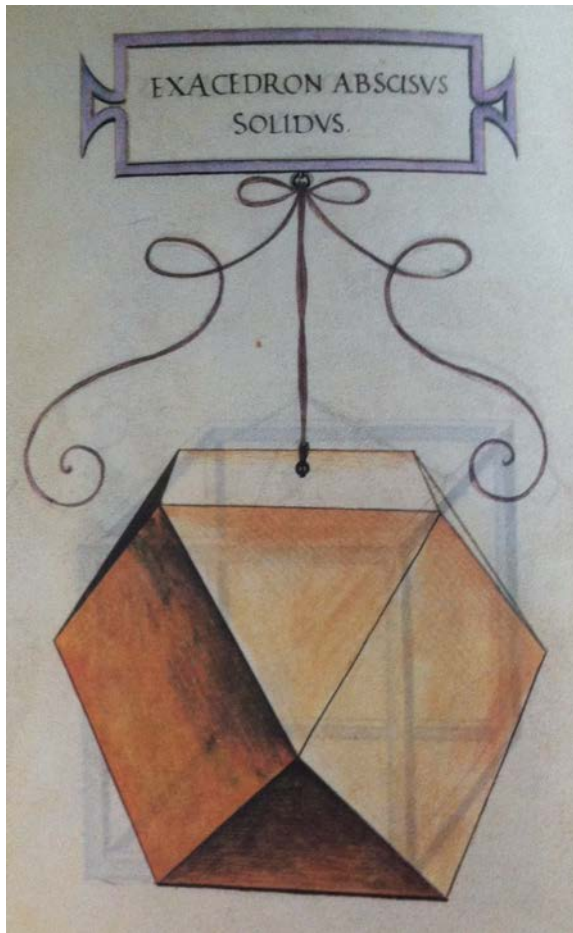**Results in the "e, i, π, ϕ" Identity:**

$$e^{i\pi} = 1/\phi - \phi$$

Sirius Enigmas Tops Physical Identity
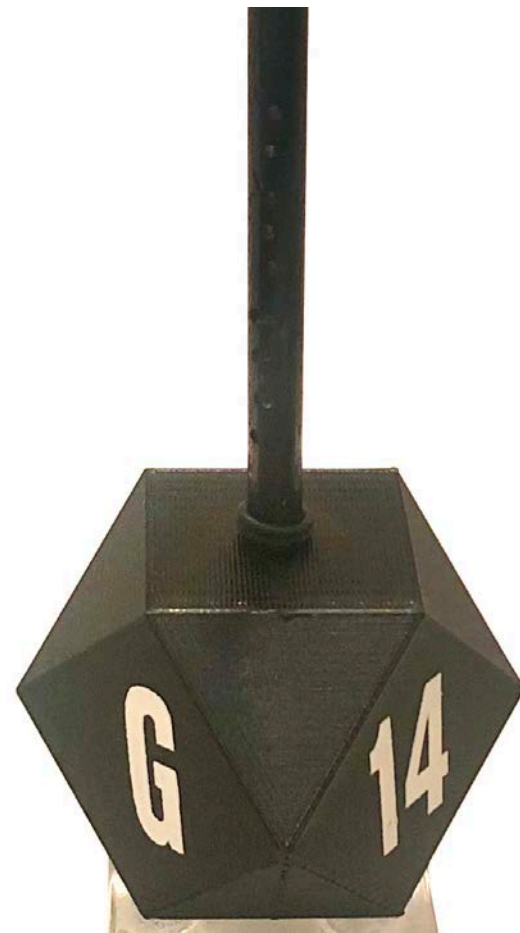
Postscript:
G4G14 Cuboctahedron Top

Leonardo da Vinci Cuboctahedron for Pacioli

Kenneth Brecher Cuboctahedron Top

Post Postscript

Introducing the DeltaCelt®

There is one more universal mathematical constant: $\delta \sim 4.669\ldots\ldots\ldots$ - the Feigenbaum constant. In 2019 I designed a new rattleback or celt based on δ. Like the other Sirius Enigmas spinning tops, it is quite elegant. Its motion is counterintuitive. It is also adjustable.