Galaxy Leggings, Truth Serum, & the Visibility Cloak

$$5 \times 6 = ?$$

$$128 \div 8 = ?$$

$(\nu_x)_{x \in \mathbb{R}}$ is a family of prob. measures with on $\mathbb{R}$

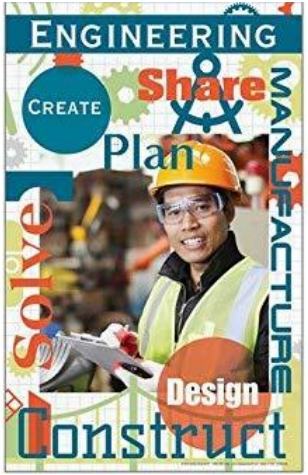
$\operatorname{supp} \nu_x \subset K$ compact, a.e. x, and

$$x \longmapsto \int \varphi(z)\, d\nu_x(z) \quad \text{measurable for every } \varphi \in C_c(\mathbb{R}).$$

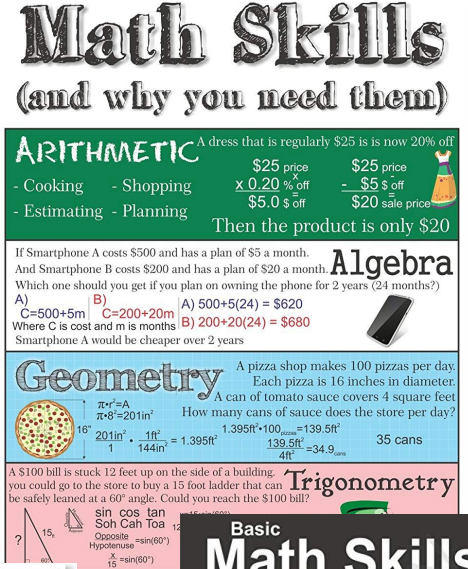
<u>Question</u>: $\exists\, (u_k) \subset L^\infty$ bounded and that $\forall \varphi\ \forall \psi$

$$\int \varphi(u_k(x))\, \psi(x)\, dx \longrightarrow \iint \varphi(z)\, d\nu_x(z)\, \psi(x)\, dx$$

Peter Scholze's Notes • Nyani Quarmyne for Quanta Magazine



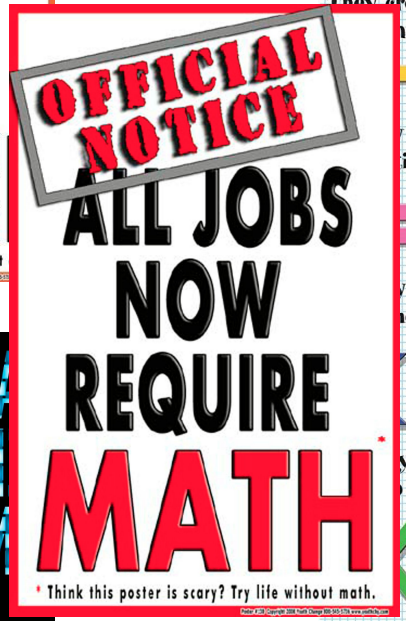
Really Good Stuff



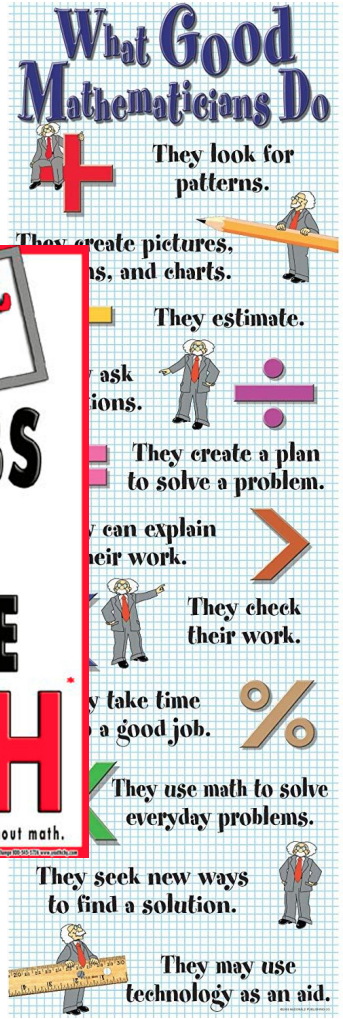
PosterEnvy

PosterEnvy

PosterEnvy



Youth Change Inc



McDonald Publishing Company

Jon Fox for Quanta Magazine

ARTIFICIAL INTELLIGENCE

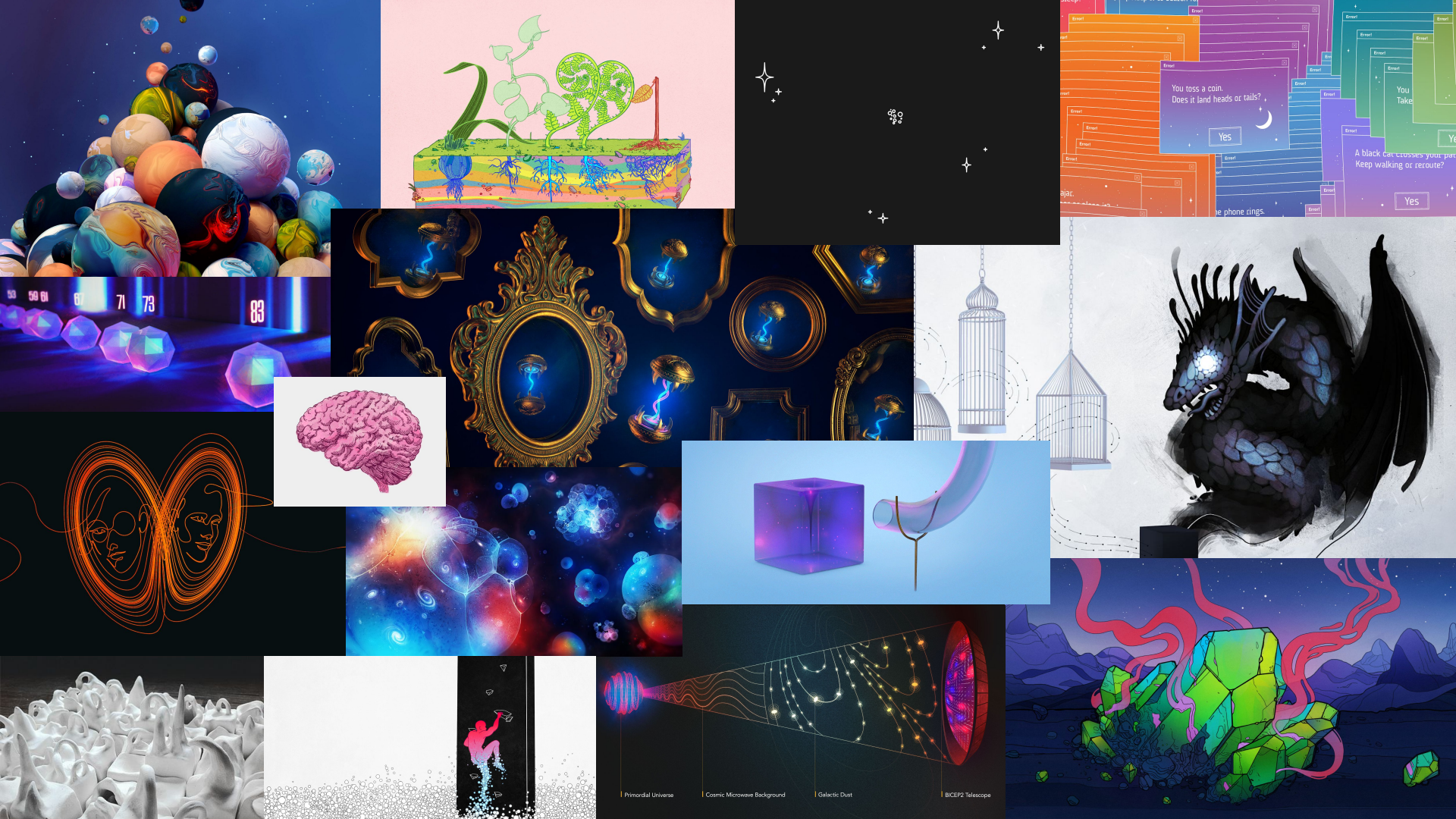
Machines Beat Humans on a Reading Test. But Do They Understand?

A tool known as BERT can now beat humans on advanced reading-comprehension tests. But it's also revealed how far AI has to go.

> Read article

— By JOHN PAVLUS

QuantaMagazine.org • October 2019

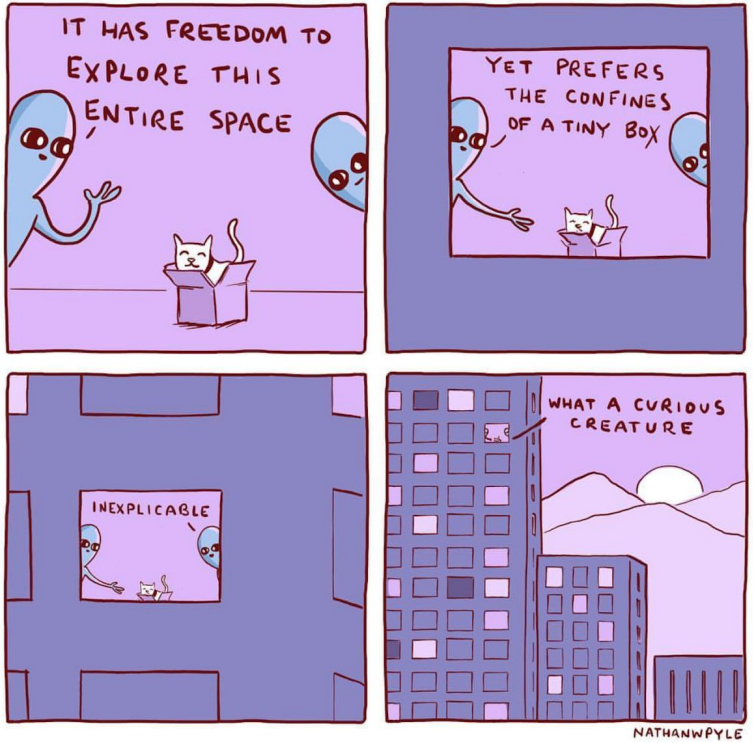

You toss a coin.
Does it land heads or tails?
Yes
Keep walking or reroute?
Yes
Primordial Universe
Cosmic Microwave Background
Galactic Dust
BICEP2 Telescope

Truth Serum

sarahandersencomics

justadamnmess

nathanwpylestrangeplanet



What makes something funny?

What makes something funny?

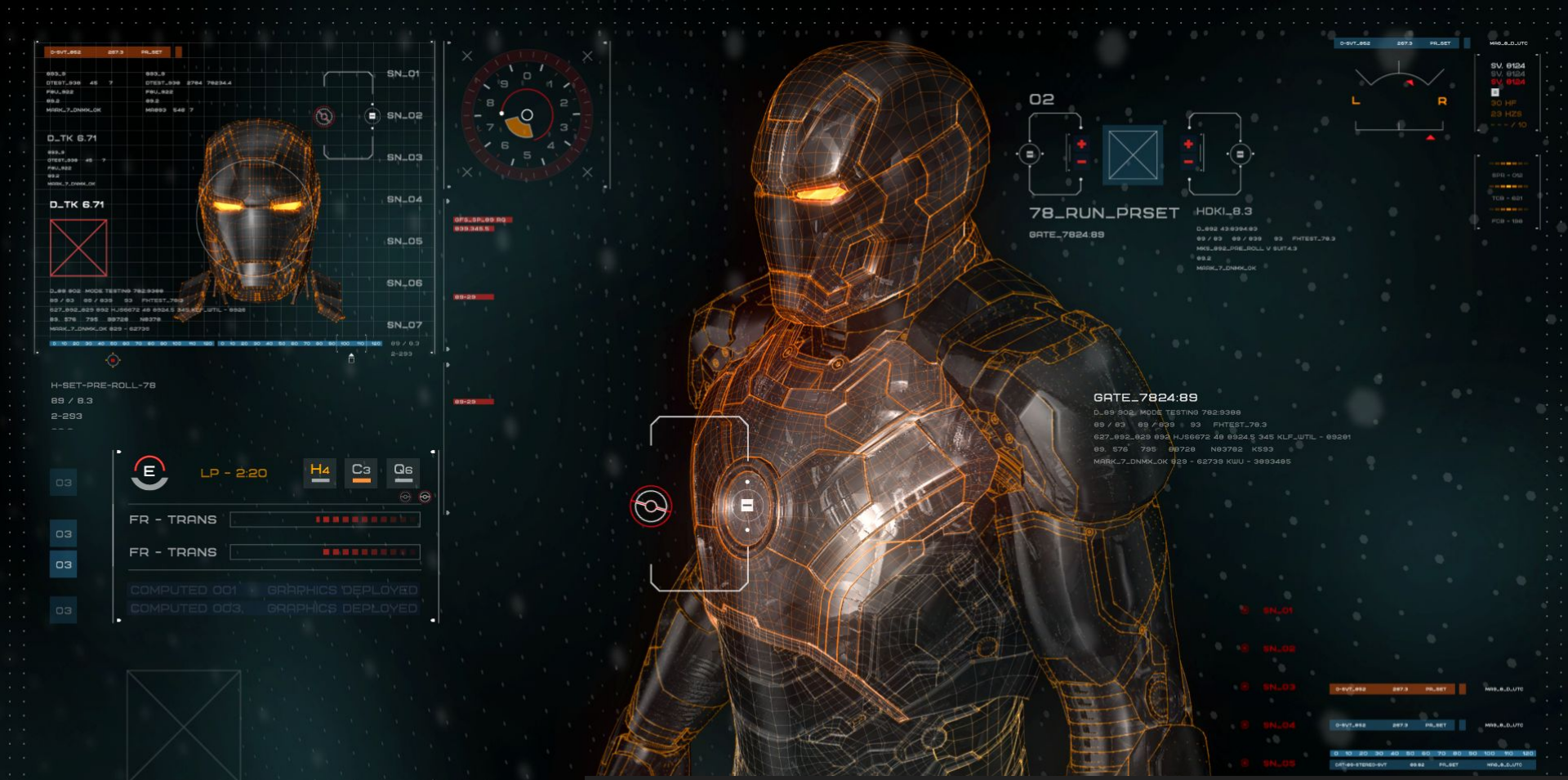
Just telling the truth — in a surprising way.

IN THE PARTICULAR IS CONTAINED THE UNIVERSAL.

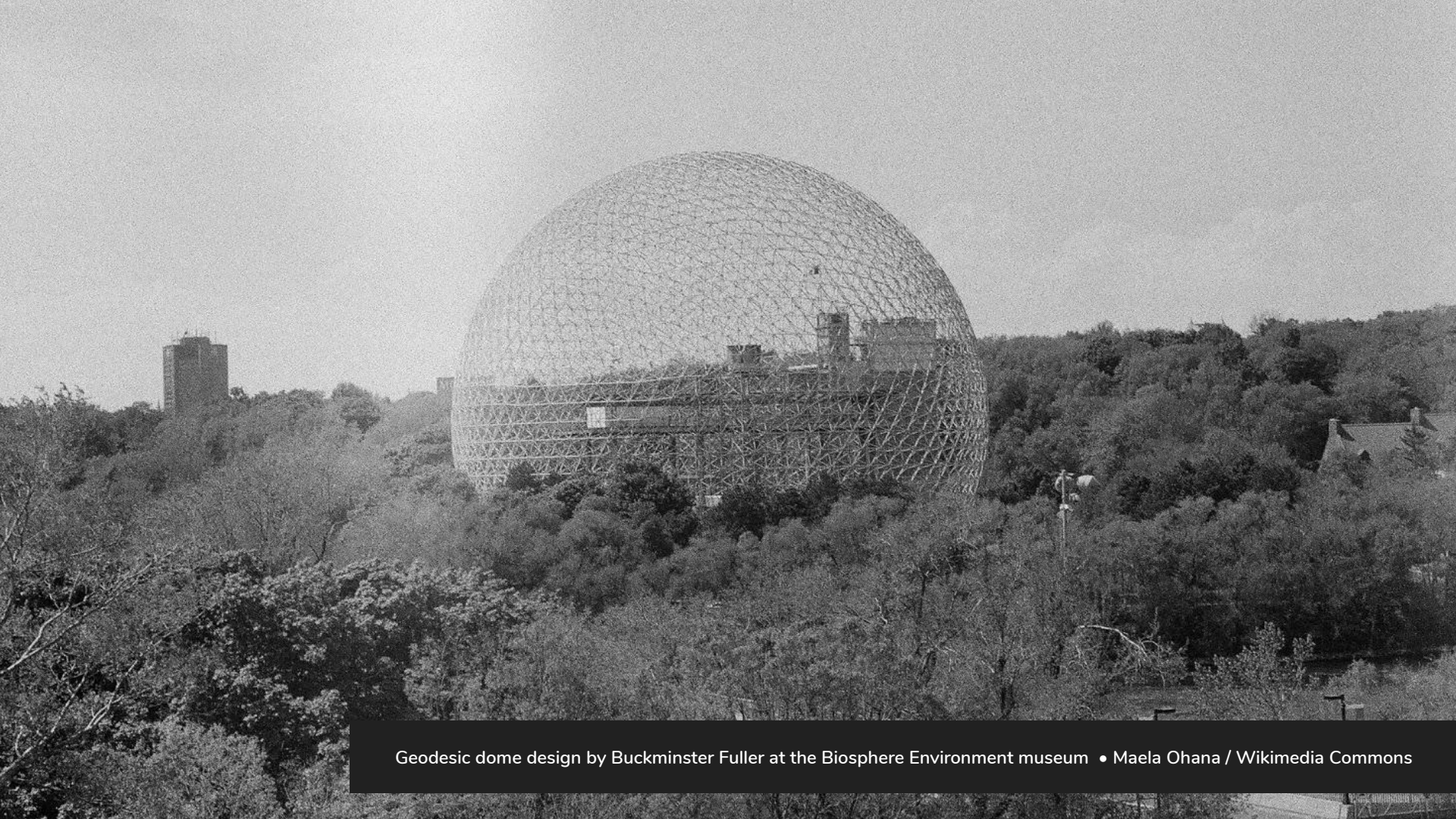
James Joyce

Science provides an understanding of a universal experience... arts provide a universal understanding of a personal experience.

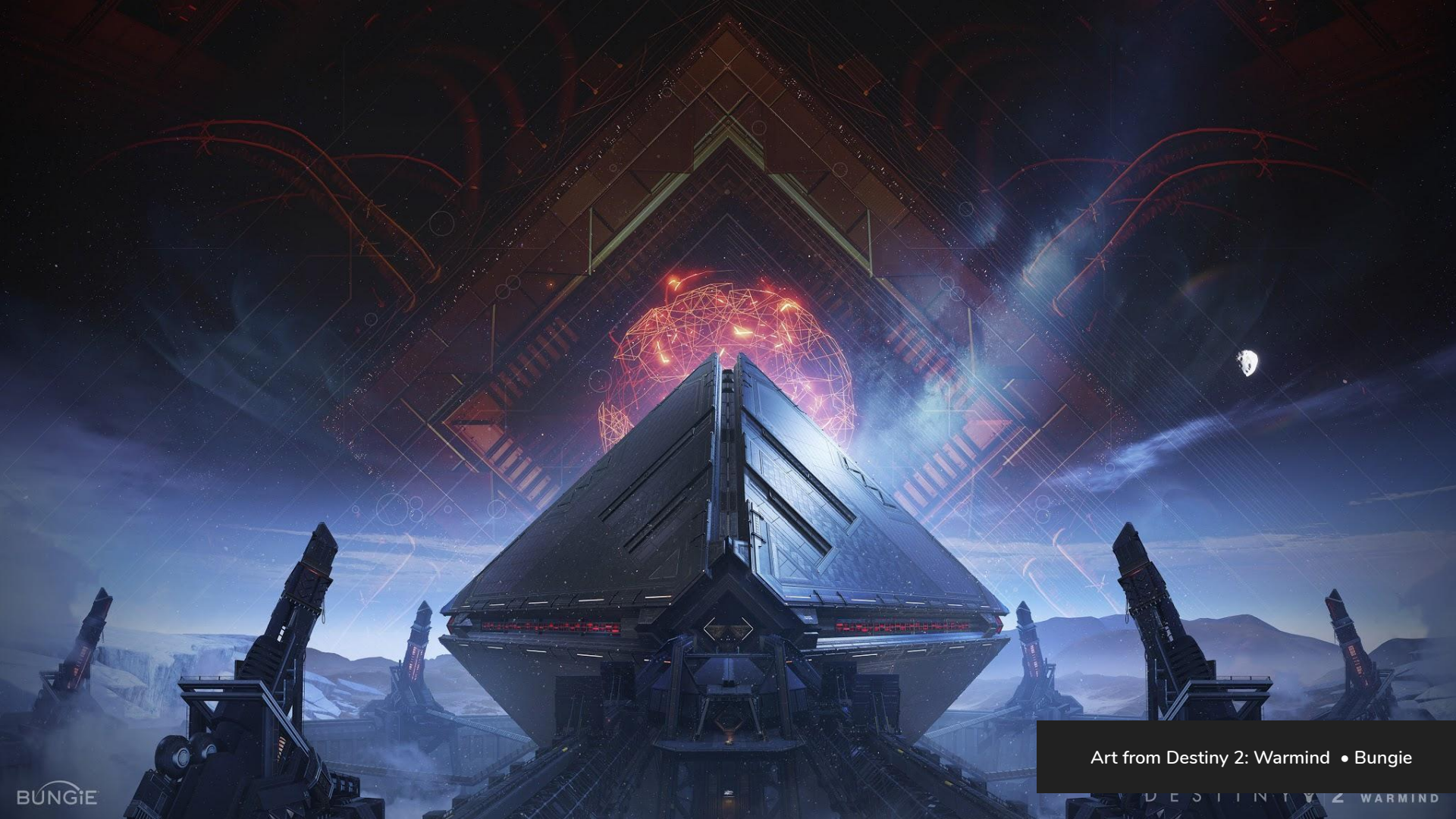
Mae C. Jemison, Astronaut



Iron Man UI by Martí Romances • © 2015 Marvel Avengers: Age of Ultron / Territory Studio / Disney

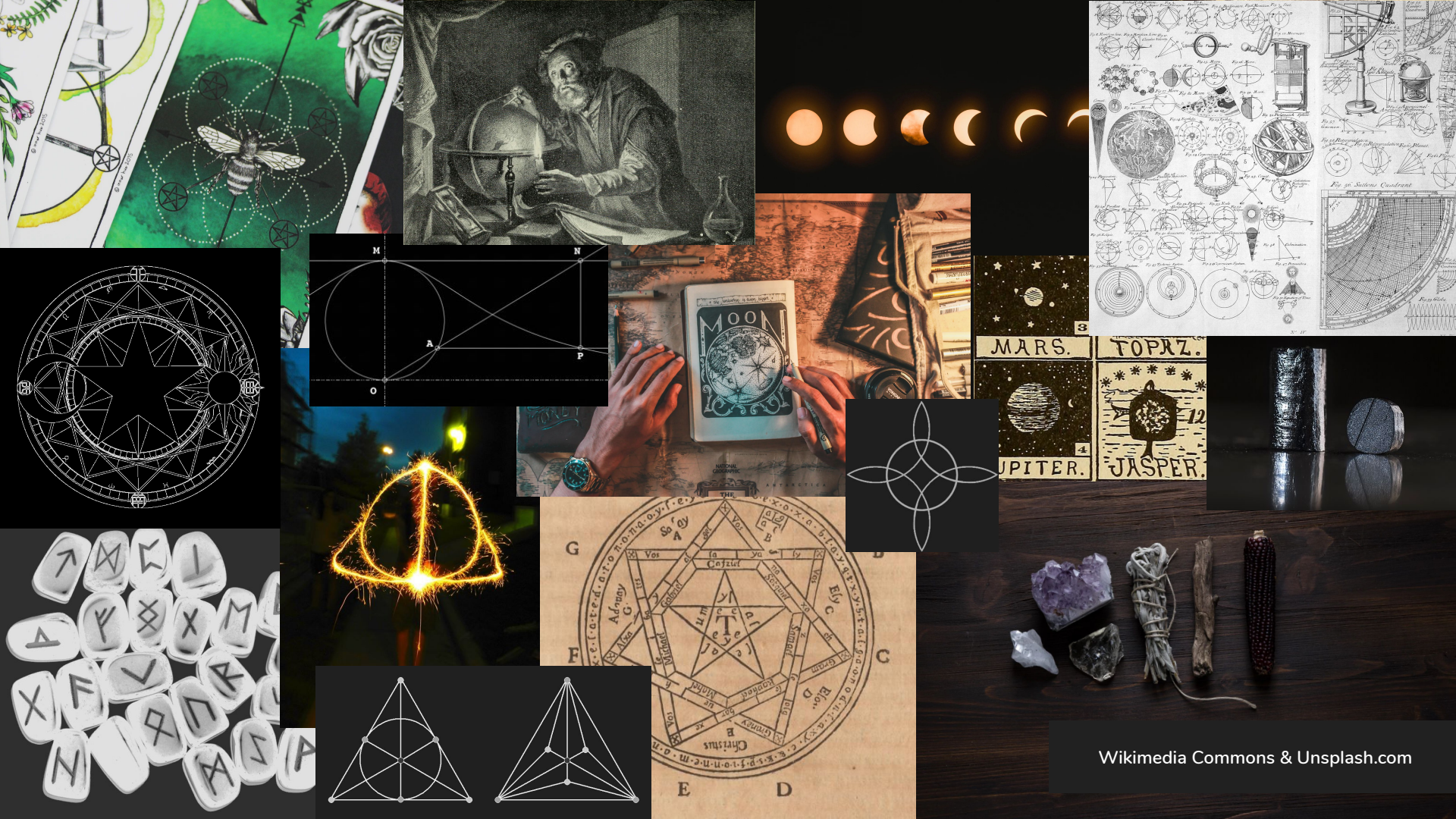


Geodesic dome design by Buckminster Fuller at the Biosphere Environment museum • Maela Ohana / Wikimedia Commons



Art from Destiny 2: Warmind • Bungie

Carl Sagan • Cosmos: A Personal Voyage • PBS



Wikimedia Commons & Unsplash.com

Sufficiently Advanced Technology

Adventure. Fantasy. Sci-fi.

Why should we care about all of this?

For the same reason that has driven artists, scientists, and everyone in between for millenia: to find out what makes it tick.

In this case, what makes something interesting? Why? What makes people respond? And can we employ those things to inspire interest in intimidating topics (like those found in higher mathematics)?

But rather than just copying what's popular, let's learn to fish: what makes those kinds of stories genuinely appealing? What traits do they share?

Galaxy Leggings

Andromeda galaxy, AKA Messier 31 • Tony and Daphne Hallas • 1999

Across the Universe

In the late 1990s - early 2000s, NASA began dropping an unprecedented collection of colorful, stunning images of space.

Stars, galaxies, nebulae, and worlds far, far away, all uploaded online for earthly display.

The Original Hubble Deep Field • R. Williams (STScI), the Hubble Deep Field Team and NASA/ESA • 1995

Sombrero Galaxy • NASA/JPL-Caltech and The Hubble Heritage Team (STScI/AURA) • 2003

Dwarf Galaxy NGC 1569 • European Space Agency, NASA & Peter Anders (Göttingen University Galaxy Evolution Group, Germany) • 2004

A Deeper Field

"The next breakthrough came after the 2009 servicing mission in which astronauts installed a new instrument capable of making greatly improved infrared observations."

Hubble Ultra Deep Field - Infrared (2009)

Creative Freedom

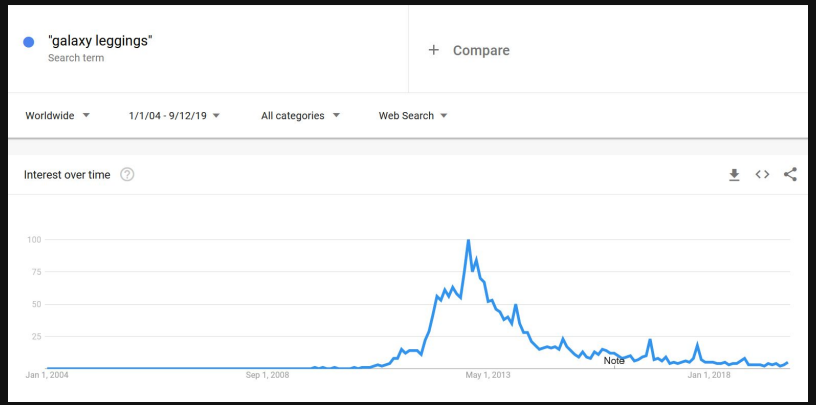
More of these incredible images surfaced over the years, in increasingly high res.

Best of all: they were Creative Commons.

So, not only was the general public inspired by these glittering photos from light-years away — anybody with a creative idea could put them to use, as long as credit was given.

And so they did…

One of the first brands to make “galaxy leggings” launched in 2009. Google Search Trends shows that interest in that search term started to rise around 2010.



Fashion has always reflected the culture of an era in one way or another, but this! In no other time in history could this have occurred: people were so taken with these images of the universe, created by light traveling from unfathomably far/long ago, that we wore them on our legs.

© BlackMilk Clothing

What a Time to be Alive.

Invisible Things

We're not all as fortunate as NASA: although the work that goes into making them is impressive, those glittering images of the cosmos are charismatic and easily digestible.

The rest of us plebs have to deal with the likes of dark energy, genes, AI, algorithms, monster groups, infinities, randomness, quantum stuff, etc.

A zoo of degenerates.

The Visibility Cloak

How to train your dragon

make great work with artists

~~Far over the Misty Mountains cold~~
~~To dungeons deep and caverns old~~

Step 1: Find ~~a willing sacrifice~~ an artist.
But where?!

We are online, just like everybody else (or at least, we should be).
It's dangerous to go alone; take these:

bit.ly/2PbsvMz

P.S. If you always have a lot of tabs open, get this browser extension:

One-Tab.com

Some of these websites force you to log in just to view. If you don't want to make a real account, you can Google a fake email generator OR use:

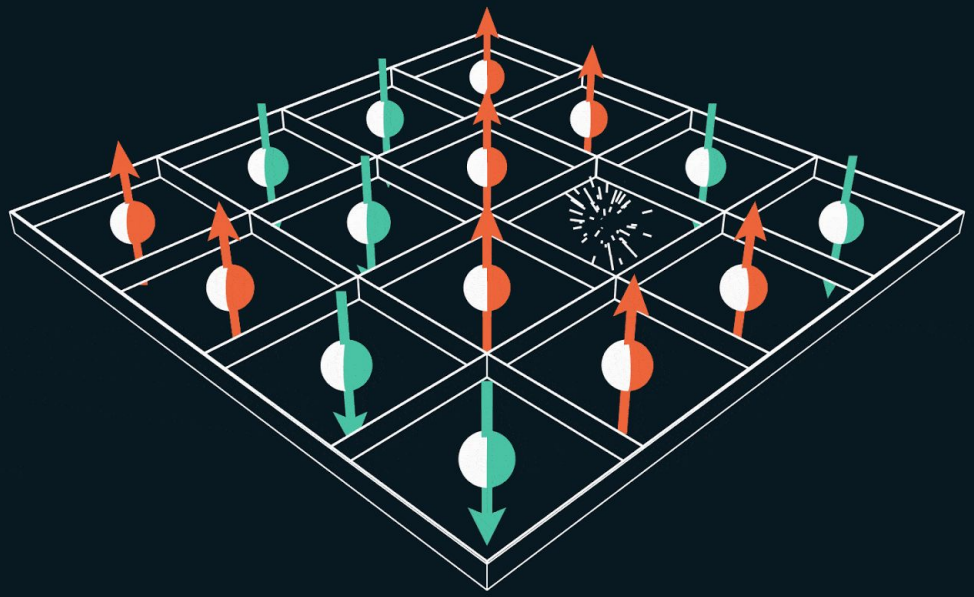
BugMeNot.com

~~It must be magic~~

Some tools that digital artists use.

In many of these programs, it's possible to input equations and/or code, or even install or create plugins to make mathematical or math-inspired visuals:

bit.ly/2P6Zamp

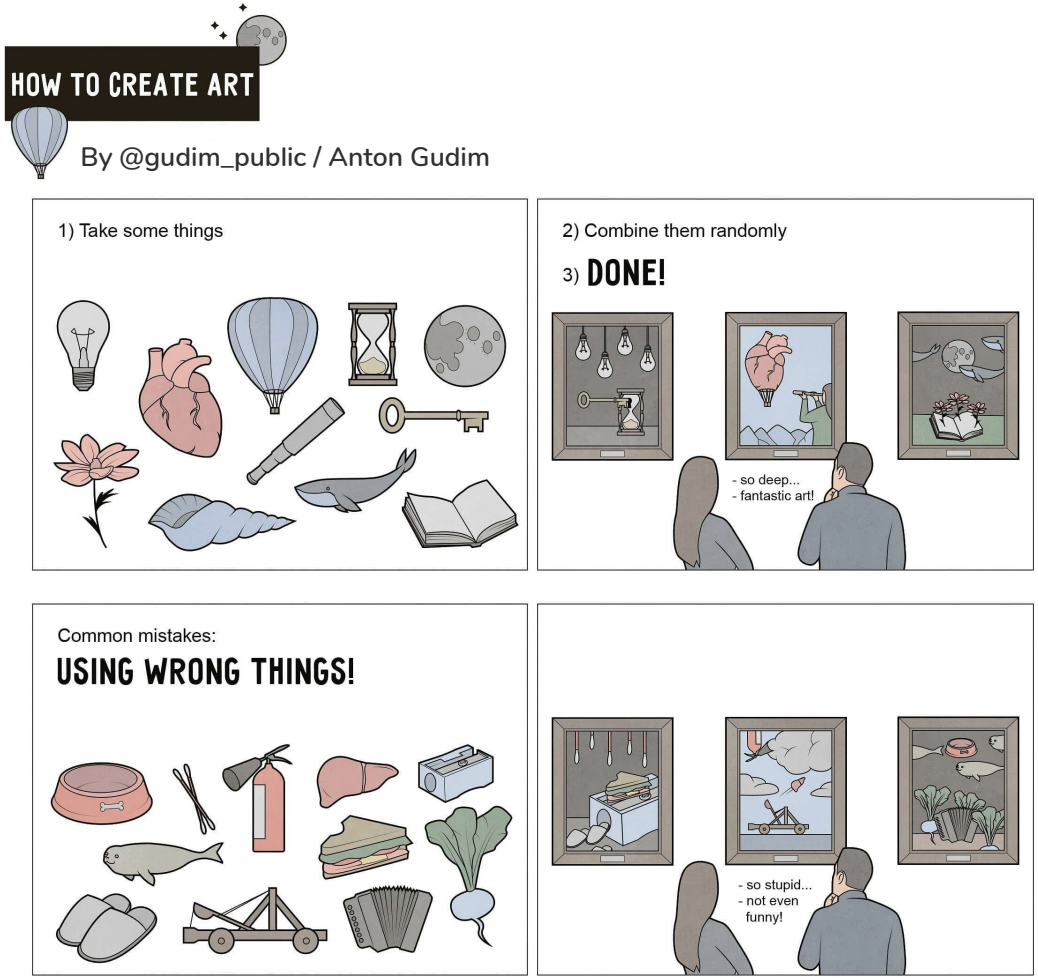


A Thing of Beauty

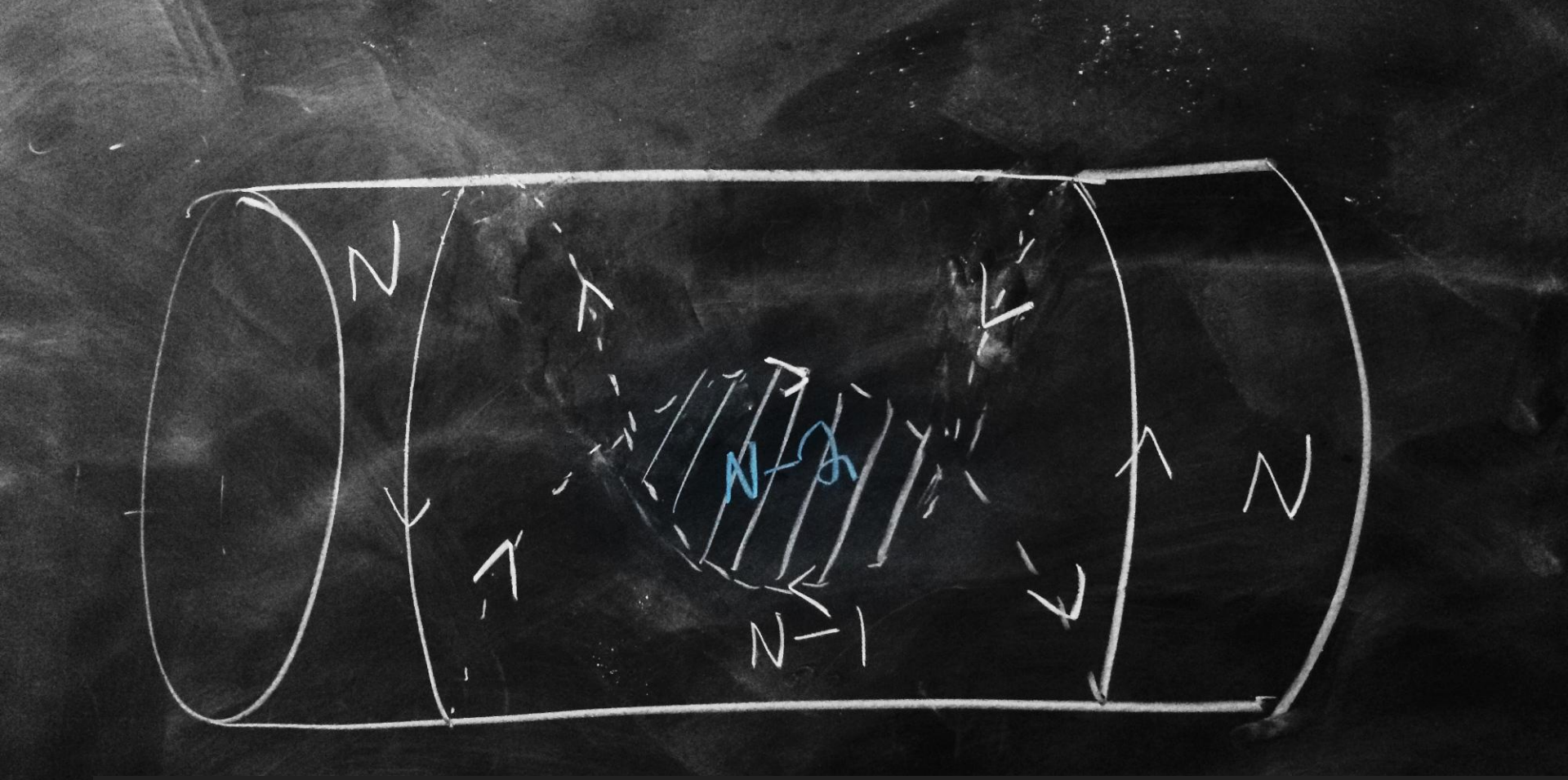
A good artist (or designer) is not a decorator. Pretty isn't the goal.

The art world left the notion of ***Beauty*** behind nearly two centuries ago, for better or worse. It's even become something of a faux-pas.

Via knowledge of visual principles and reasoning informed by a variety of subjects (psychology, history, and yes, even science & mathematics, among others), a good artist will know how to weave information into a narrative that can inspire, evoke emotion, provoke a response, or "simply" clarify an idea.



Olympia: the beginning of modernism • Manet (Wiki Commons) • 1863



Sketch by string theorist and cosmologist Matthew Kleban of his Big Bang model known as unwinding inflation • Photo: Olena Shmahalo/Quanta Magazine

By @gudim_public / Anton Gudim

~~A PAIR OF HANDS~~

A good artist will have experience in a myriad of arenas and subjects — they're not just a "pair of hands" meant to execute someone else's ideas verbatim.

The artist can help you think about ideas in transformative ways. They can help a concept evolve. But to do so, they must be well-informed.

~~All you need to know~~

Don’t be stingy with information: give the artist as much factual detail as you can.

Deciding “all they need to know” for them can lead to a situation like a so-called “game of telephone”: missing intel leads to filling-in blanks and assumptions, which results in inaccuracies… or just an impoverished narrative.

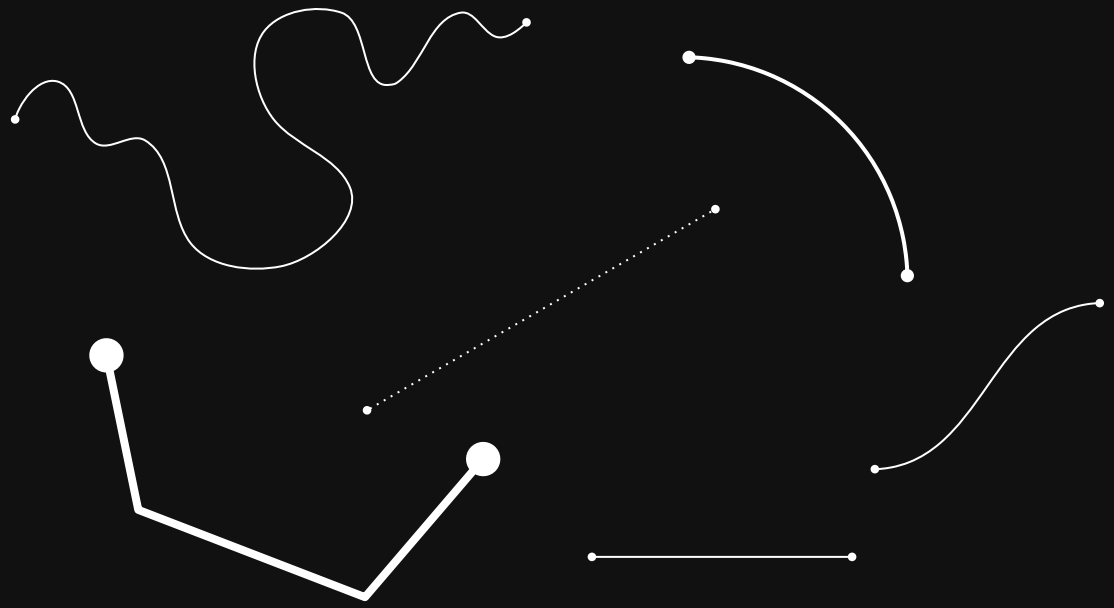
~~Information Subtracts~~

“...knowledge of science ... only adds to the excitement and mystery and awe of a flower. It only adds. I don't understand how it subtracts.”

Richard Feynman

Breadth of knowledge — essentially, better data — allows us to create a picture that more closely mirrors the complexity of nature.

~~Imagine a line between two dots~~



~~You should know this by now~~

Help where you can: don't "dumb down" but **clarify, decode, and demystify.**

Don't just truncate, customize: **tailor your explanation.**

Explain esoteric terms. (jargon)

Include images; do sketches. Doesn't matter if they're "bad", just get the idea across. (The way an equation transforms into a picture or graph may be obvious to you, but understand that it may as well be a foreign language to others.)

~~How about that peduncle?~~

HABIT : evergreen climbing herbs, producing flagellae. LEAVES : several to many, distichous. PETIOLE : geniculate apically, sheath long, marcescent to deciduous, often decomposing to conspicuous net-fibrous mass. BLADE : entire, often oblique, lanceolate, elliptic, elliptic- oblong, or pinnatipartite to pinnatisect, rarely minutely perforate (E. pinnatum); primary lateral veins pinnate, running into marginal vein, secondary and often tertiaries parallel-pinnate, tertiary and higher order venation often reticulate. INFLORESCENCE : 1(-2) in each floral sympodium. PEDUNCLE : relatively short. SPATHE : boat-shaped, withering after anthesis, usually deciduous. SPADIX : subcylindric, conic, often quite thick, sessile or stipitate, shorter than spathe. FLOWERS : bisexual, or lowermost ones female, perigone absent. STAMENS : 4, filaments linear, somewhat broad, anthers much shorter than filaments, connective slender, thecae oblong-ellipsoid, dehiscing by longitudinal slit. POLLEN : fully zonate, **hamburger-shaped**, medium-sized (mean 40 µm., range 36-44 µm.), exine foveolate-fossulate, psilate at periphery, apertural exine coarsely verrucate. GYNOECIUM : ovary subtetragonal-prismatic, truncate, 1-locular, ovules usually 2, more rarely 4 or 6-8 (E. amplissimum), anatropous, funicle short, placenta parietal or near base of parietal partial septa, stylar region prismatic, as broad or broader than ovary, stigma umbonate to oblong-linear in axial plane of spadix. BERRY : 1-8-seeded, throwing off apical tissue. SEED : reniform, testa thickish, brittle, smooth, embryo curved, endosperm copious.

~~How about that peduncle?~~

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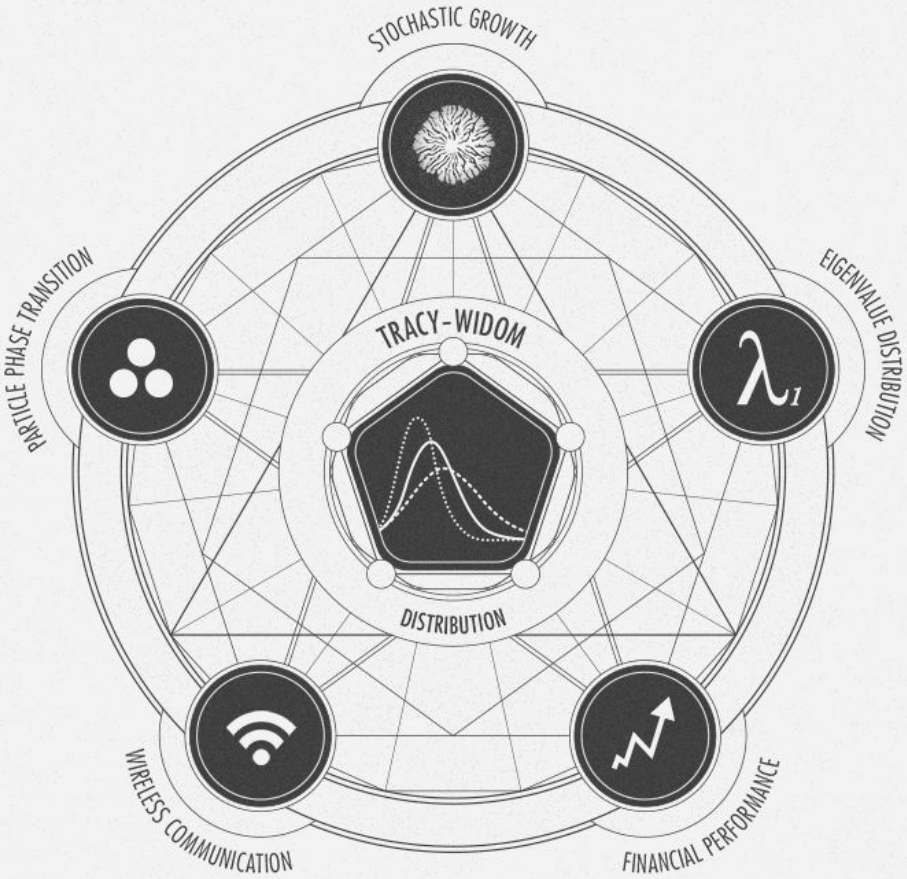
L' Illustration horticole, vol. 27: t. 381 (1871)

A few examples

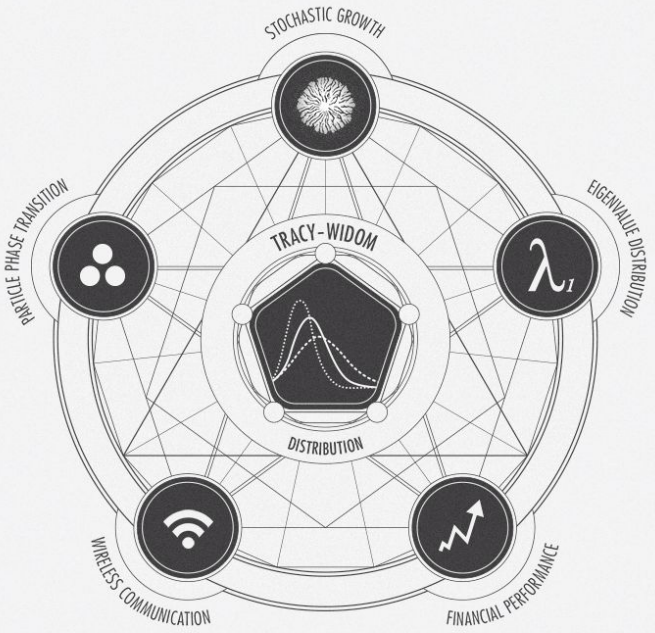

STOCHASTIC GROWTH
EIGENVALUE DISTRIBUTION
FINANCIAL PERFORMANCE
WIRELESS COMMUNICATION
PARTICLE PHASE TRANSITION
TRACY-WIDOM
DISTRIBUTION

At the Far Ends of a New Universal Law

A potent theory has emerged explaining a mysterious statistical law that arises throughout physics and mathematics.

Artist: Olena Shmahalo
Author: Natalie Wolchover
Editor: Thomas Lin

Notes: A “magic circle” connecting various outcomes or applications of the Tracy-Widom distribution.

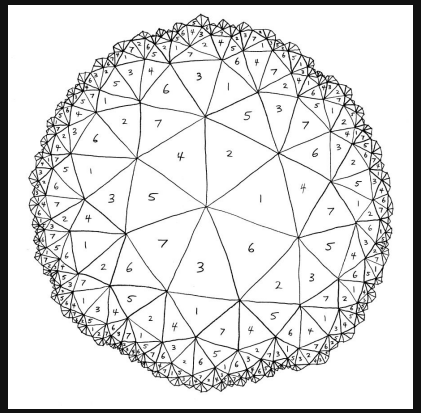


Mathematicians Chase Moonshine's Shadow

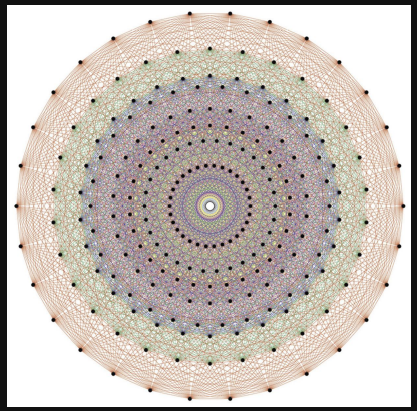
Researchers are on the trail of a mysterious connection between number theory, algebra and string theory.

Artist: Peter Diamond
Author: Erica Klarreich
Editor: Thomas Lin

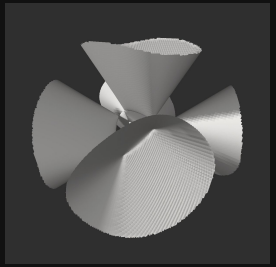
Notes: A dreamy or surreal scene featuring monster groups reflected as moonshine, Srinivasa Ramanujan, hyperbolic tiling, and researchers Miranda Cheng, John Duncan, and Jeffrey Harvey.

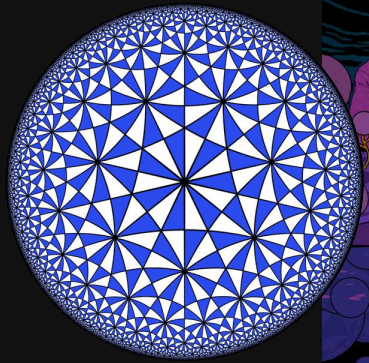


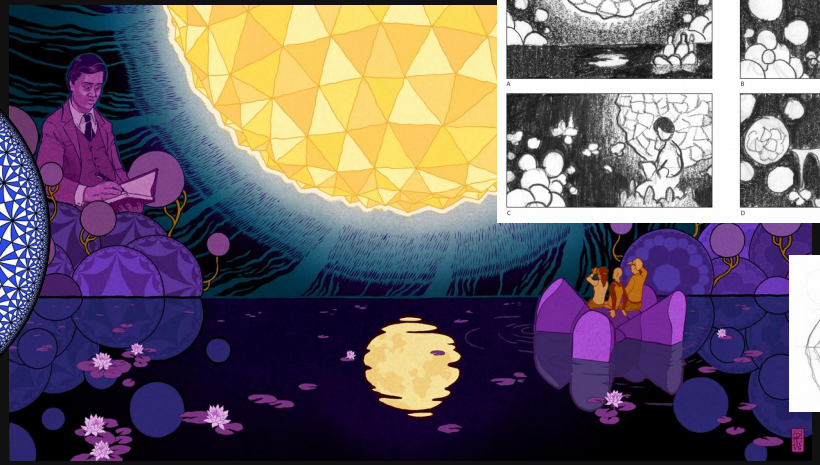
http://homepages.wmich.edu/~drichter/mathieu.htm

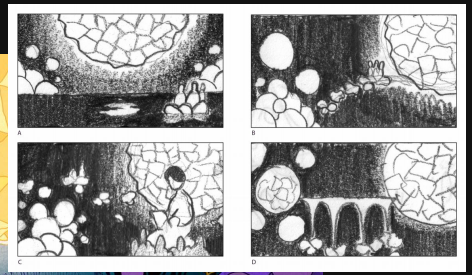


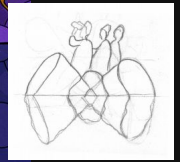
http://www.cabinetmagazine.org/issues/34/wertheim.php











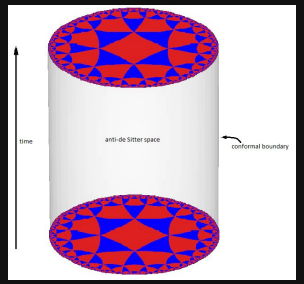

ANTI-DE SITTER SPACE
NAKED
SINGULARITY

Where Gravity Is Weak and Naked Singularities Are Verboten

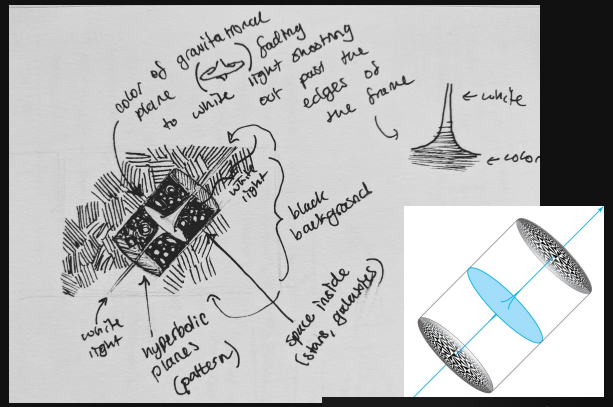
Recent calculations tie together two conjectures about gravity, potentially revealing new truths about its elusive quantum nature.

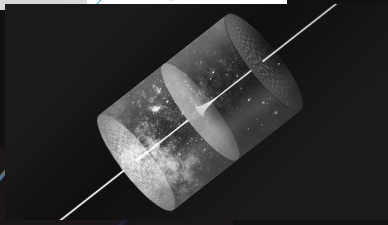
Artist: Mike/XiaoLin Zeng | 曾潇霖 | Zaoeyo
Author: Natalie Wolchover
Editor: Thomas Lin

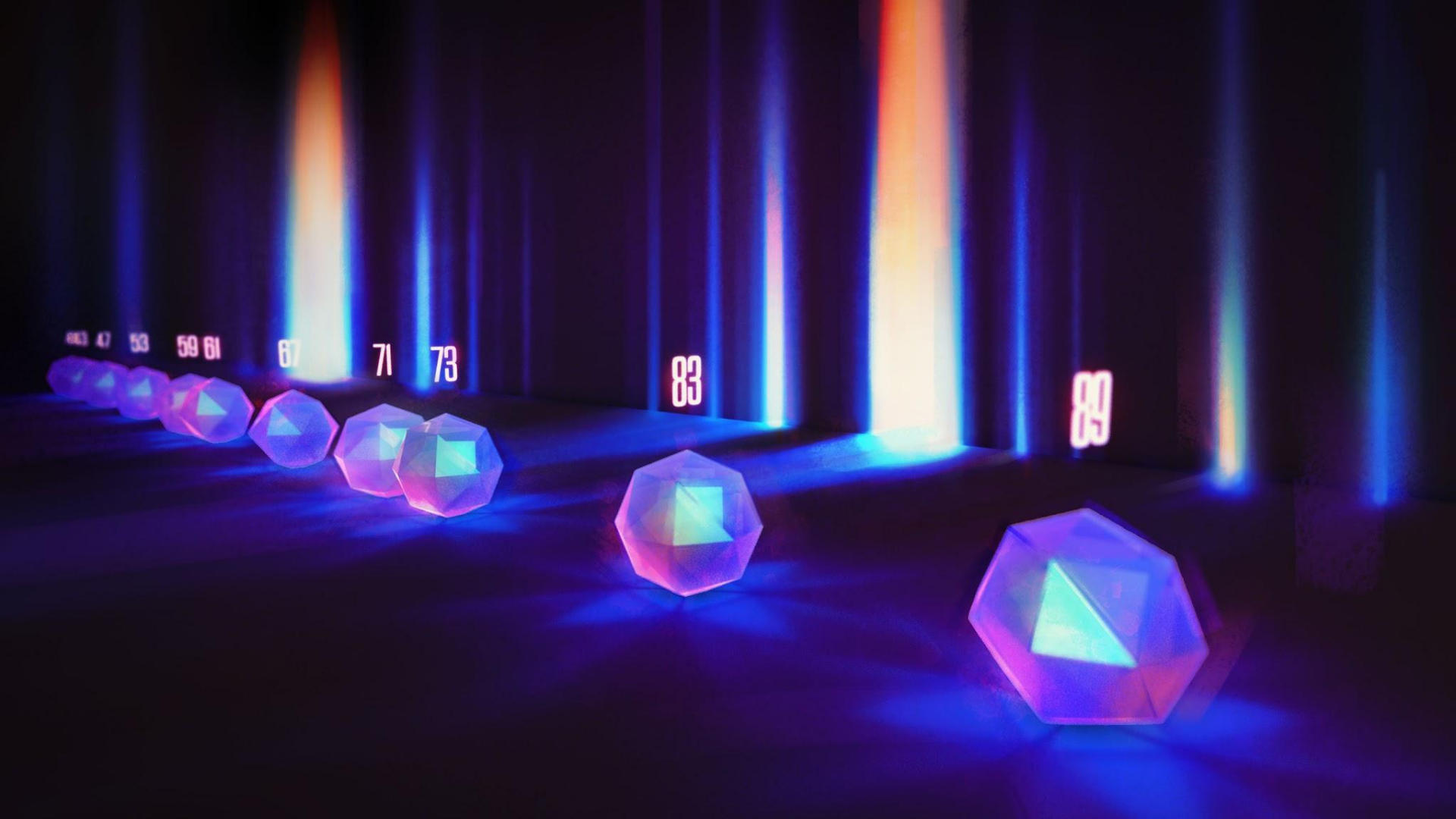
Notes: What would a naked singularity look like, placed into ADS Space?



"Three-dimensional anti-de Sitter space is like a stack of hyperbolic disks, each one representing the state of the universe at a given time. The resulting spacetime looks like a solid cylinder." - Wikipedia



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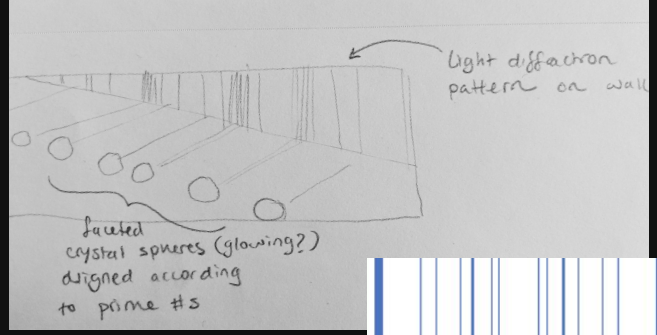
89

A Chemist Shines Light on a Surprising Prime Number Pattern

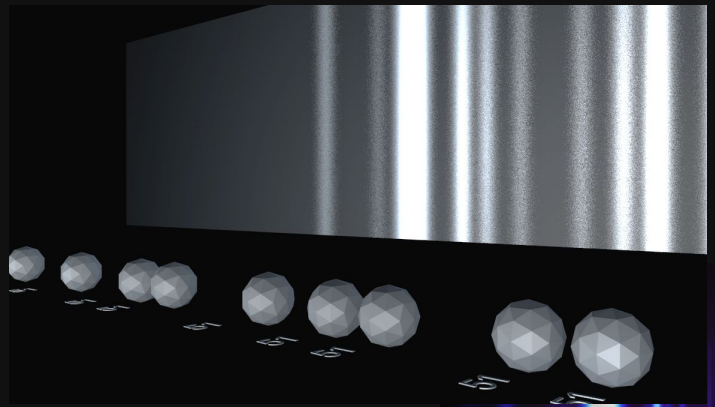
When a crystallographer treated prime numbers as a system of particles, the resulting diffraction pattern created a new view of existing conjectures in number theory.

Artist: Olena Shmahalo
Author: Natalie Wolchover
Editor: Thomas Lin

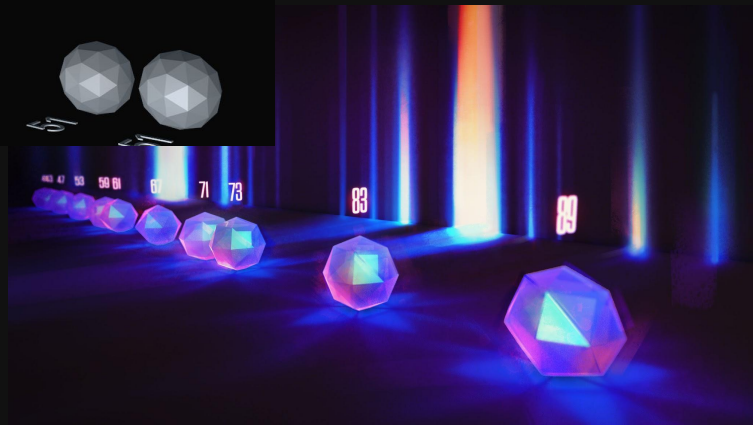
Notes: “Spherical crystals / faceted sphered (or, what most people would recognize as crystals) lined up like in a row … On a wall in the background, colored lines of light appear in the periodic pattern.

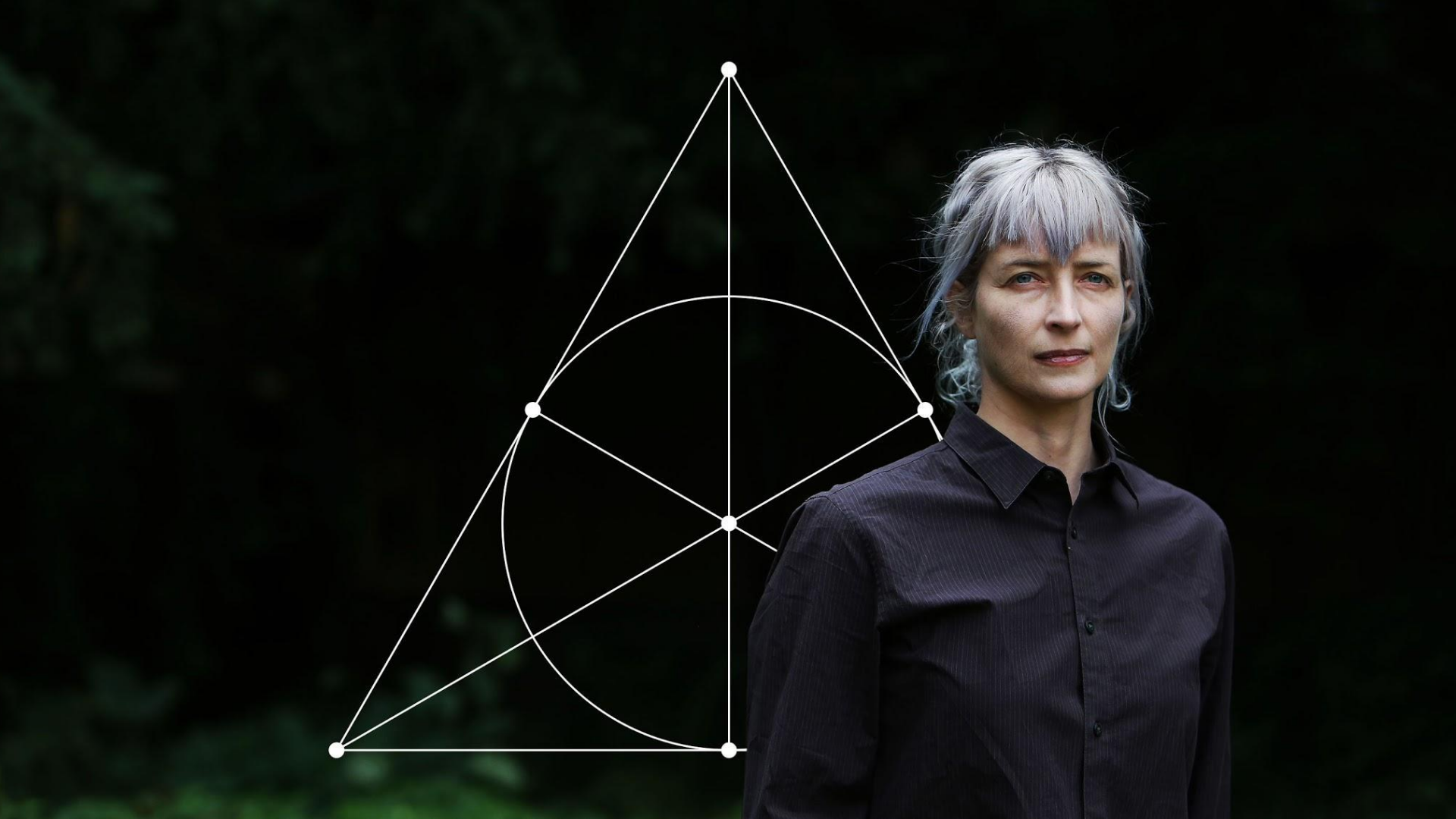


Actual diffraction pattern formed by the crystals.



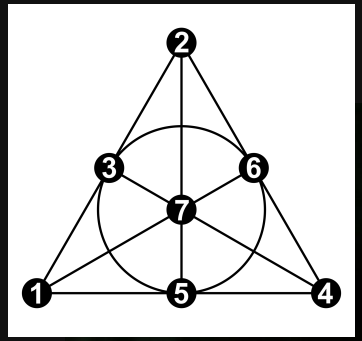
Early 3D scene / “smoke & mirrors”





The Peculiar Math That Could Underlie the Laws of Nature

New findings are fueling an old suspicion that fundamental particles and forces spring from strange eight-part numbers called “octonions.”



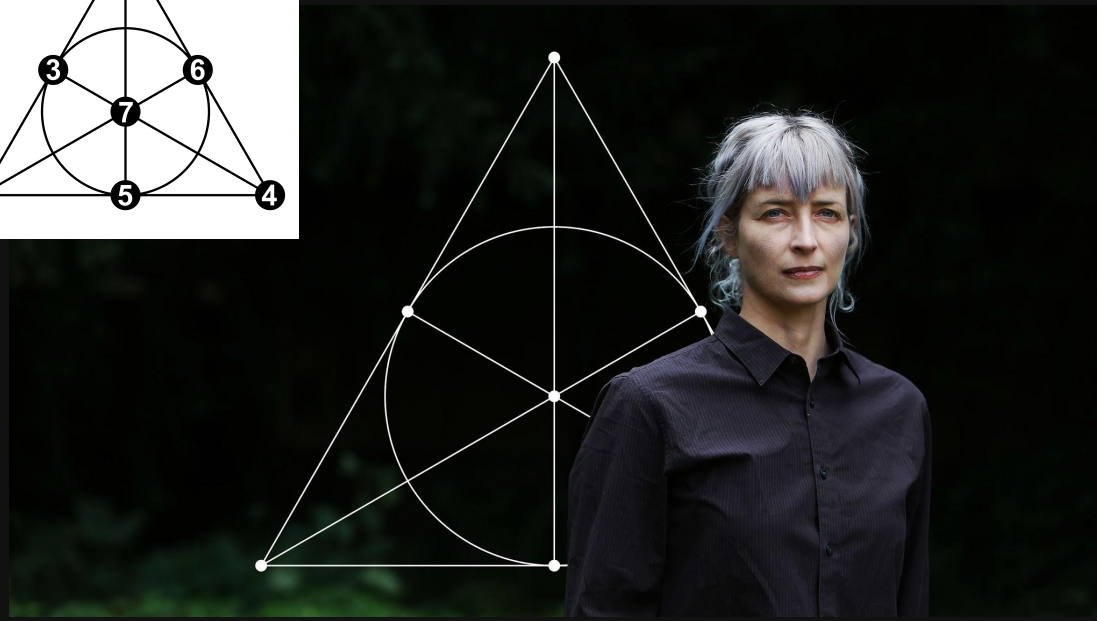


Image Caption: Cohl Furey, a mathematical physicist at the University of Cambridge, is finding links between the Standard Model of particle physics and the octonions, numbers whose multiplication rules are encoded in a triangular diagram called the Fano plane.

Photographer: Susannah Ireland
Author: Natalie Wolchover
Editor: Thomas Lin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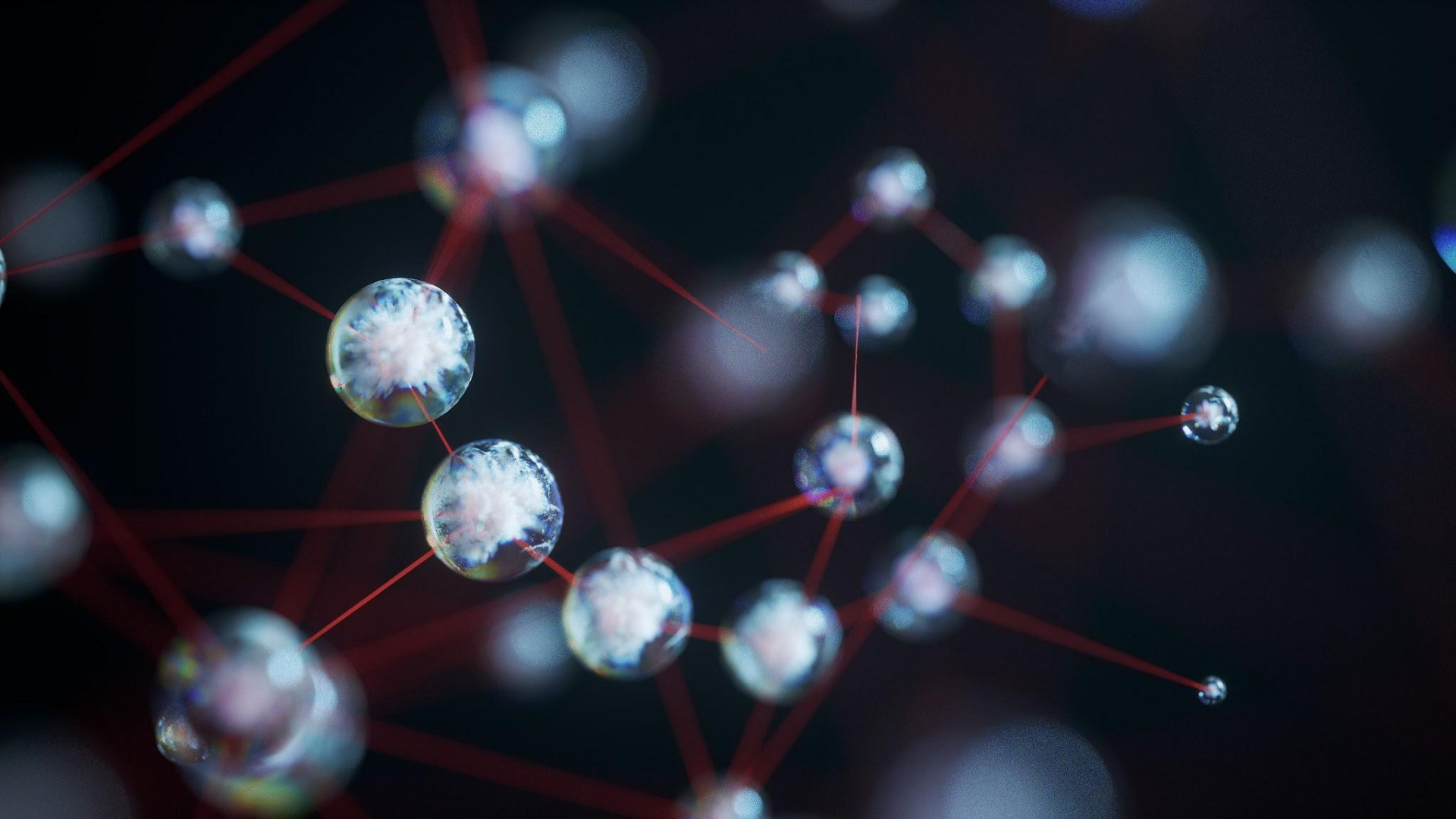
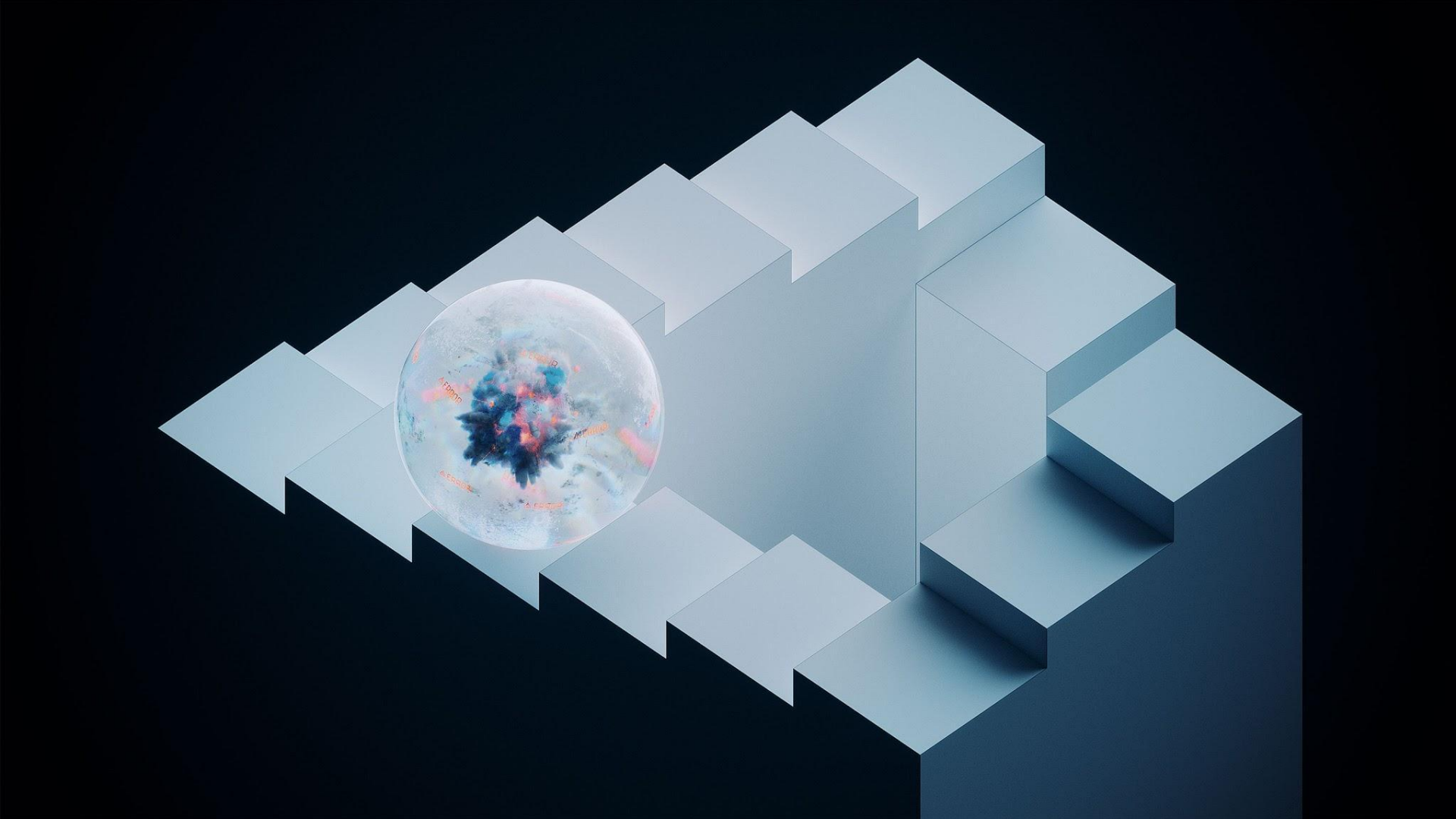




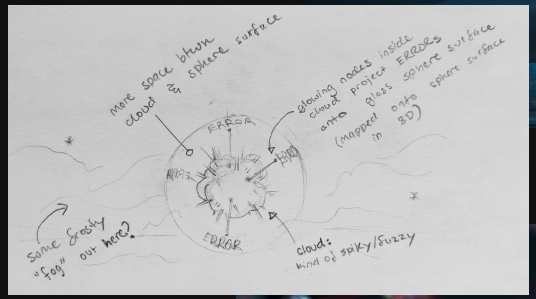
The Future of Quantum Computing

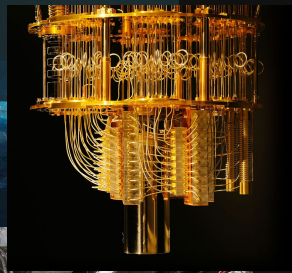
A 2018 series.

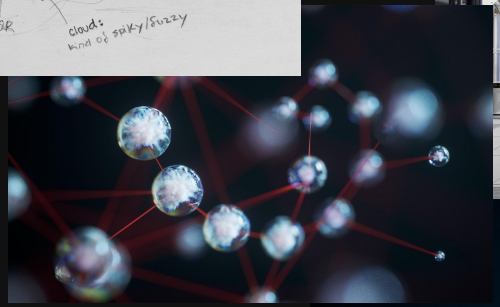
Caption (1st Image): Quantum computers have to deal with the problem of noise, which can quickly derail any calculation.

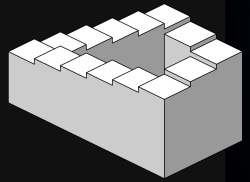
Artist: Josef Bsharah
Authors: Philip Ball, George Musser, Ariel Bleicher
Editors: Michael Moyer, Thomas Lin

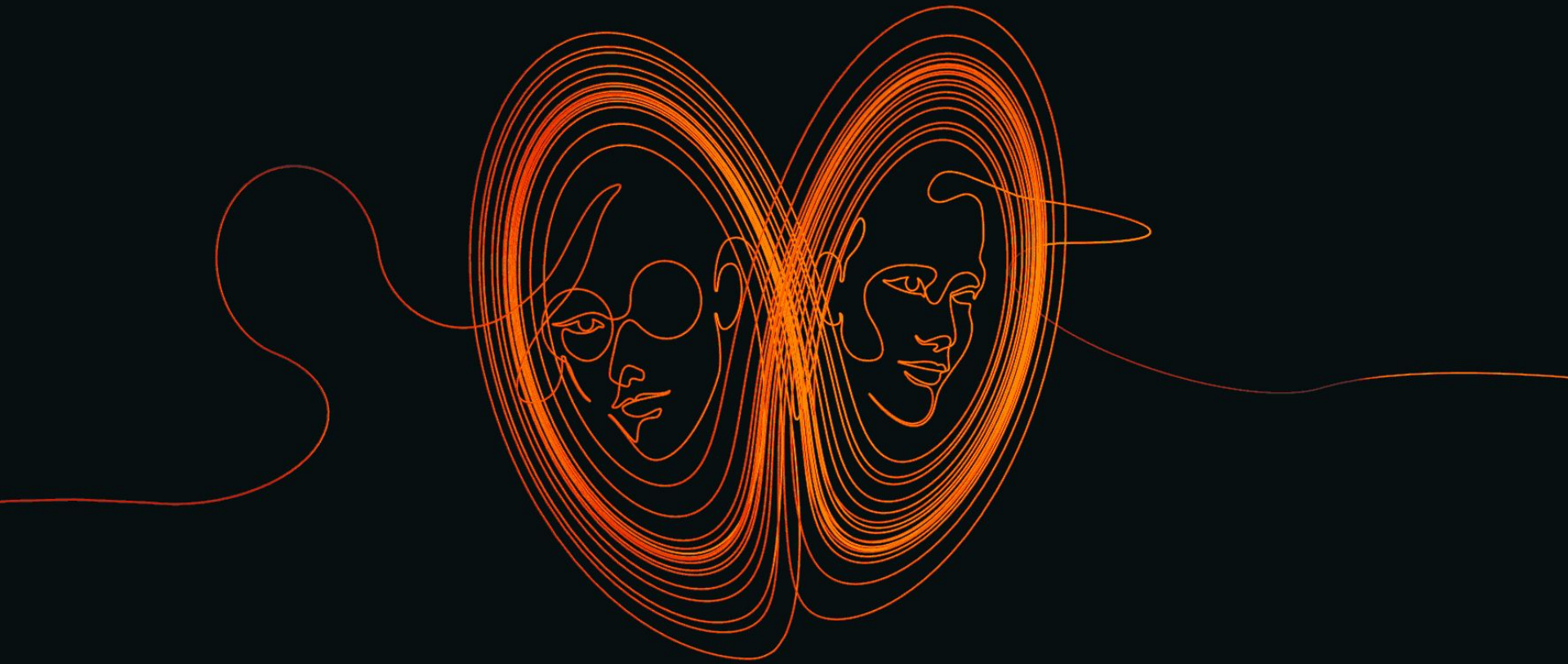
Notes: How can we represent a quantum computer, symbolically? (Full of errors, noisy/fuzzy, must be kept cold, fragile.) Part 2: Machine learning, neural networks. Part 3: The neverending race for supremacy. (Penrose stairs)











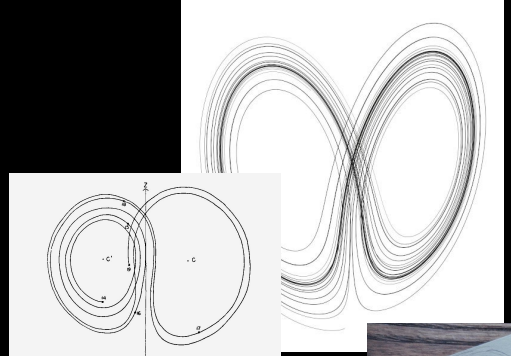
The Hidden Heroines of Chaos

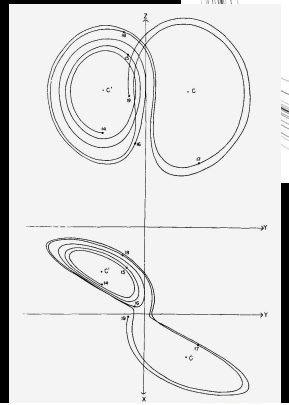
Two women programmers played a pivotal role in the birth of chaos theory. Their previously untold story illustrates the changing status of computation in science.

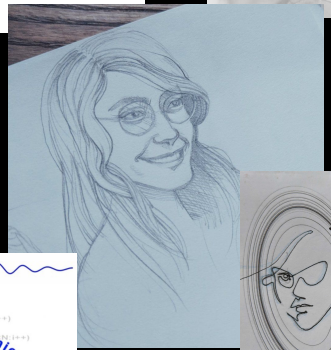
Image Caption: Ellen Fetter and Margaret Hamilton were responsible for programming the enormous 1960s-era computer that would uncover strange attractors and other hallmarks of chaos theory.

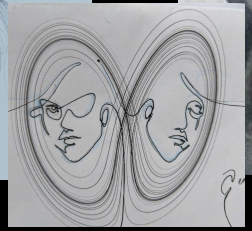
Artist: Olena Shmahalo
Authors: Joshua Sokol
Editor: Michael Moyer

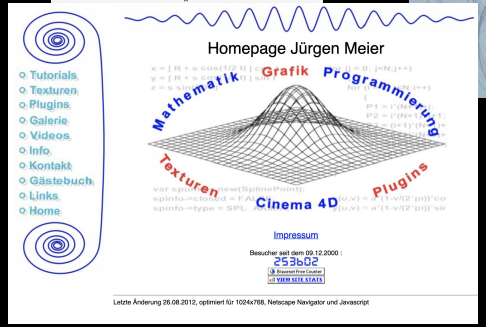
Notes: idea from Natalie Wolchover: embedding the faces of the two women within an attractor.











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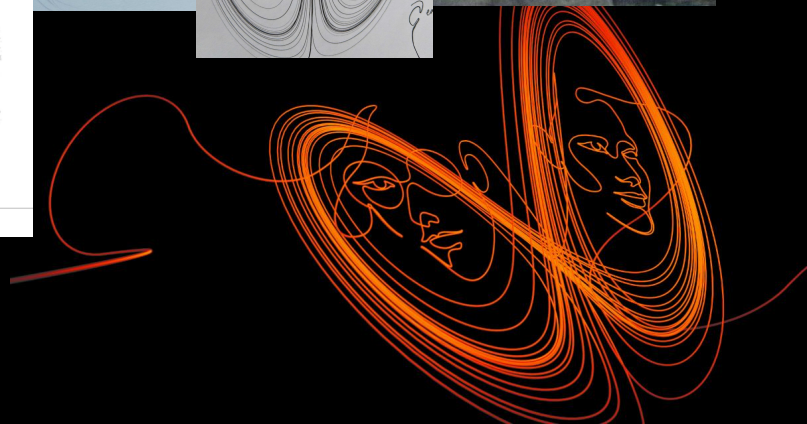
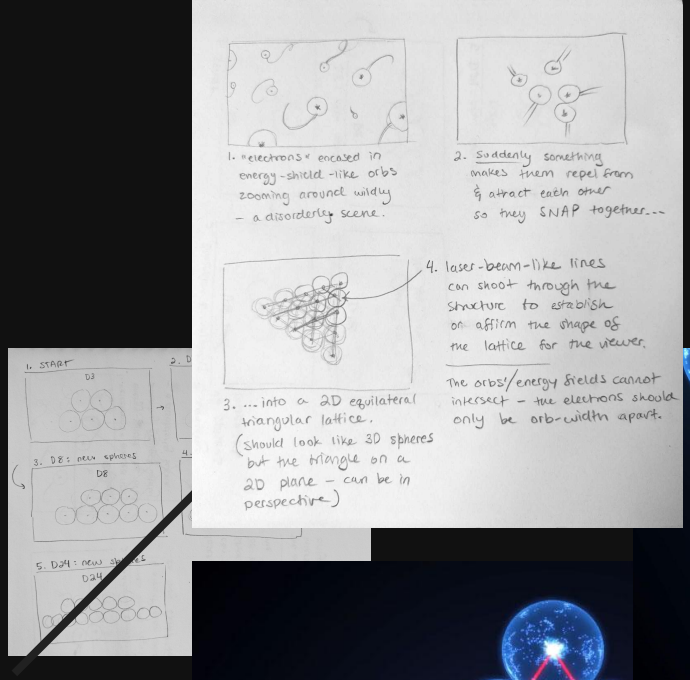


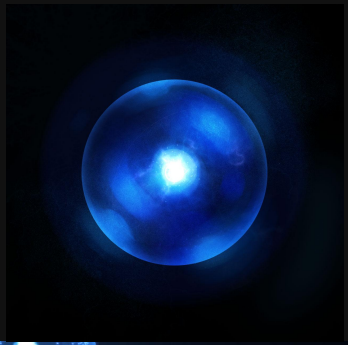
Out of a Magic Math Function, One Solution to Rule Them All

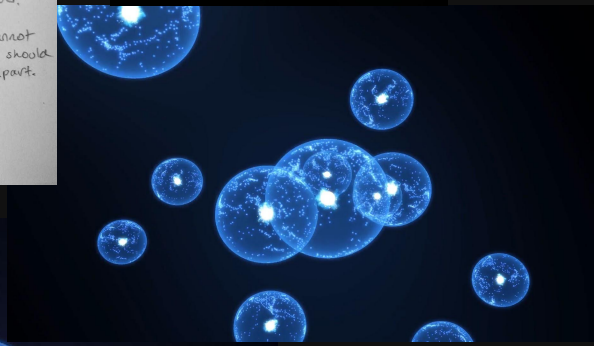
Mathematicians used “magic functions” to prove that two highly symmetric lattices solve a myriad of problems in eight- and 24-dimensional space.

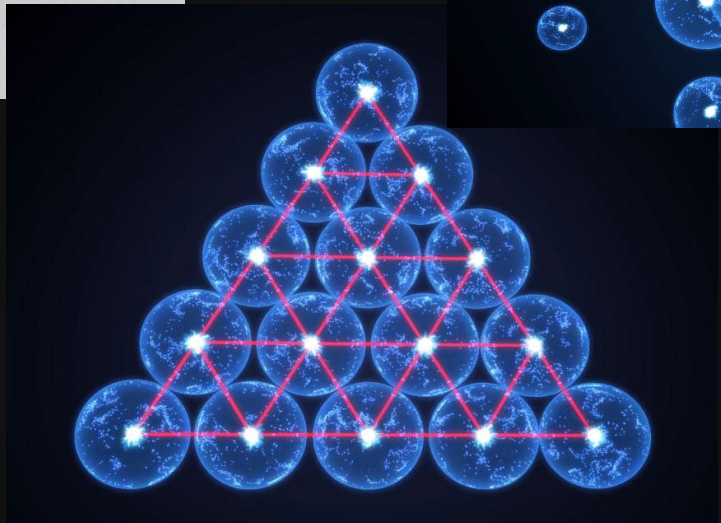
Artist: DVDP
Author: Erica Klarreich
Editor: Thomas Lin

Notes: How can we show multi-dimensional sphere-packing with the obvious problem of being limited, in reality, to three dimensions?







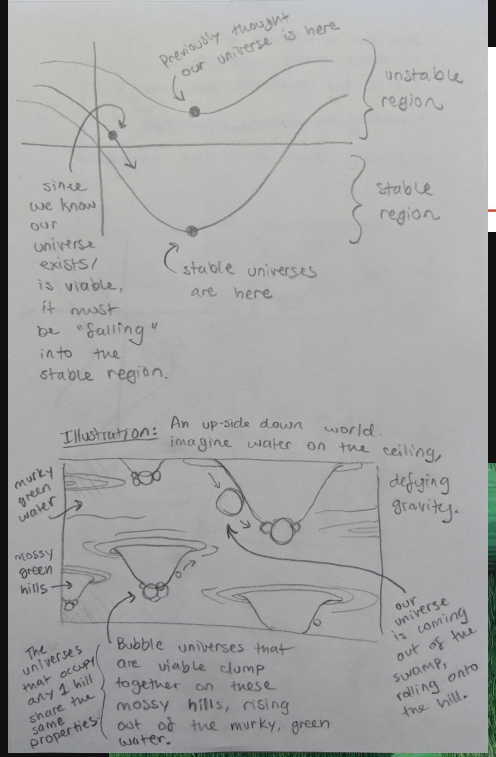


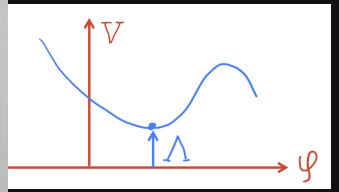
Dark Energy May Be Incompatible With String Theory

A controversial new paper argues that universes with dark energy profiles like ours do not exist in the “landscape” of universes allowed by string theory.

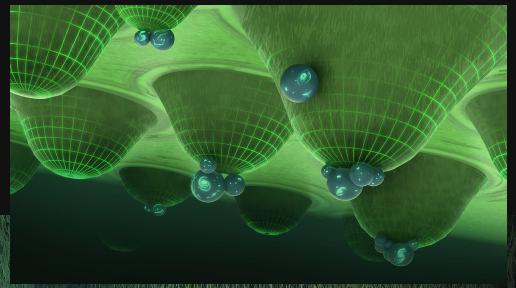
Caption: String theory permits a “landscape” of possible universes, surrounded by a “swampland” of logically inconsistent universes. In all of the simple, viable stringy universes physicists have studied, the density of dark energy is either diminishing or has a stable negative value, unlike our universe, which appears to have a stable positive value.

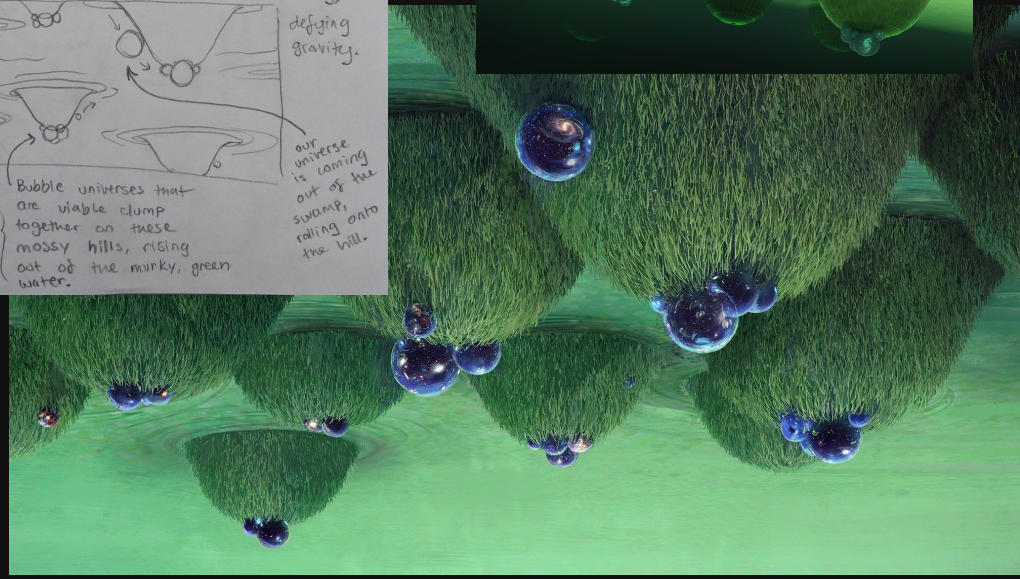
Artist: Maciej Rebisz
Author: Natalie Wolchover
Editor: Michael Moyer





Sketch from a talk by string theorist Cumrun Vafa





Thank You

Olena Shmahalo

Linktr.ee/NatureInTheory