

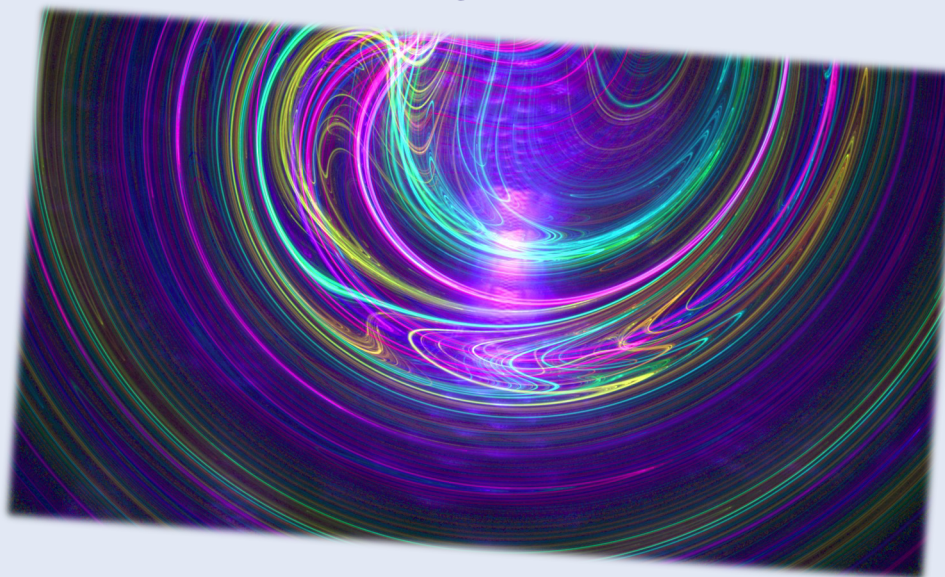


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The Beauty of Chaos

乱騰





What is the Common Denominator in All of These Phenomena?

- Ant Colonies
- Earthquakes
- Cellular Phone Antennas
- Facial Recognition
- Cancerous Tumors
- Weather
- Sand Piles
- Evolution
- Heart Arrhythmia
- Computer Animation



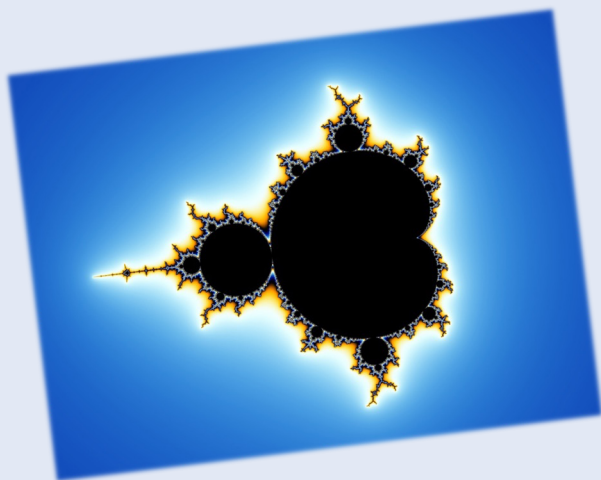
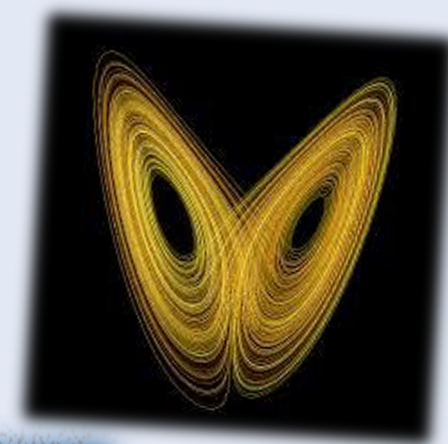


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The Exploding Field of Dynamical Systems Theory!

- Chaos Theory
- Fractal Geometry
- Self Organized Criticality





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Chaos Theory

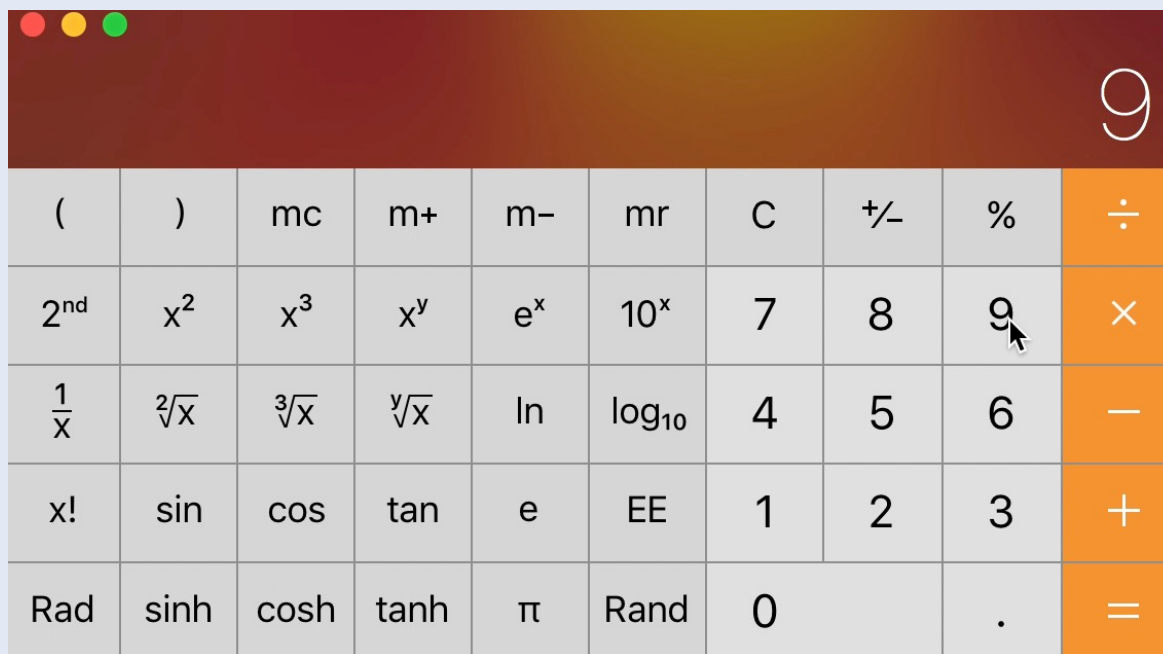
- Got a shout out in the first Jurassic Park Movie





Chaos Theory

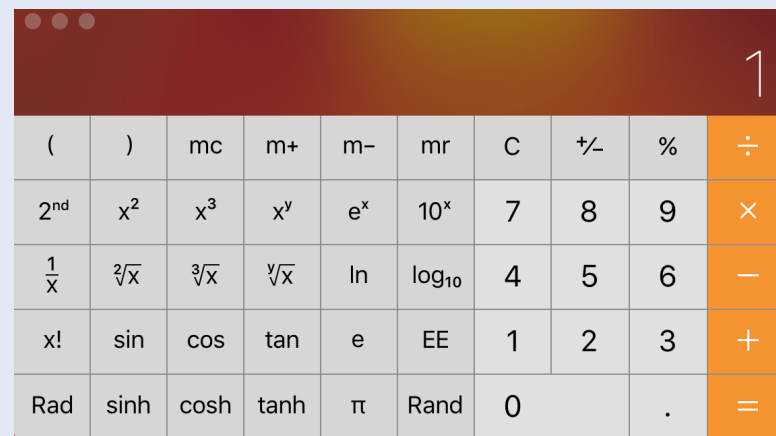
- Got a shout out in the First Jurassic Park Movie
- $\sqrt{x}$, iterated





Chaos Theory

- Got a shout out in the first Jurassic Park Movie
- $\sqrt{x}$, iterated
- We ALWAYS get to 1. Why?
- This is a Dynamical System – used to model any phenomenon that involves change.
- Does this ALWAYS happen, that we settle down to a fixed value?



(	)	mc	m+	m-	mr	C	+/-	%	÷
2 nd	x ²	x ³	x ^y	e ^x	10 ^x	7	8	9	×
$\frac{1}{x}$	$\sqrt[2]{x}$	$\sqrt[3]{x}$	$\sqrt[y]{x}$	ln	log ₁₀	4	5	6	-
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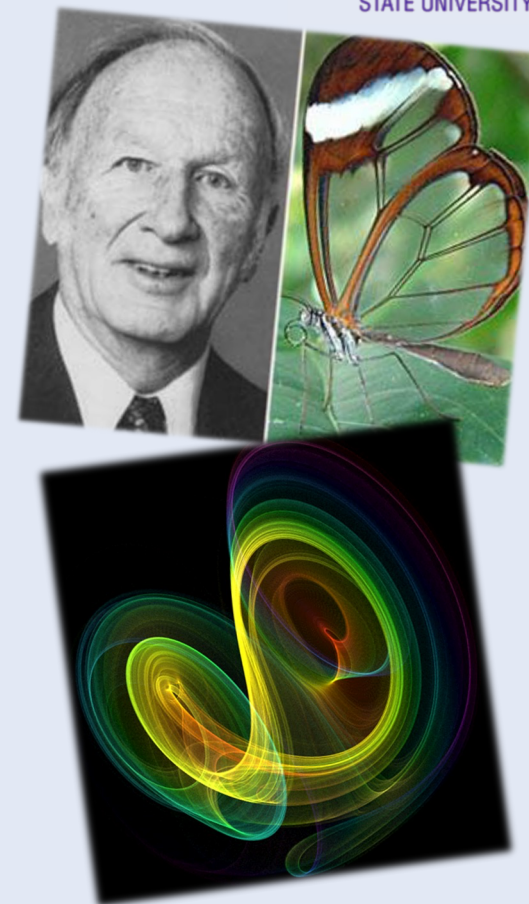
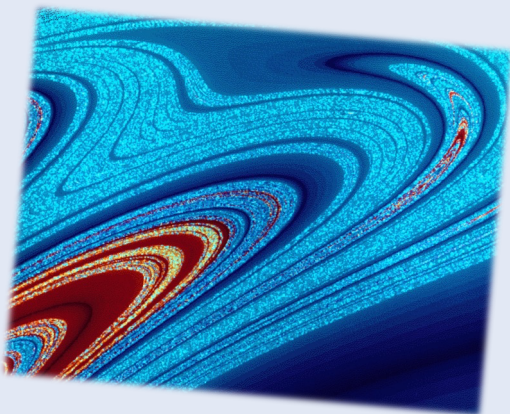


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Chaos Theory

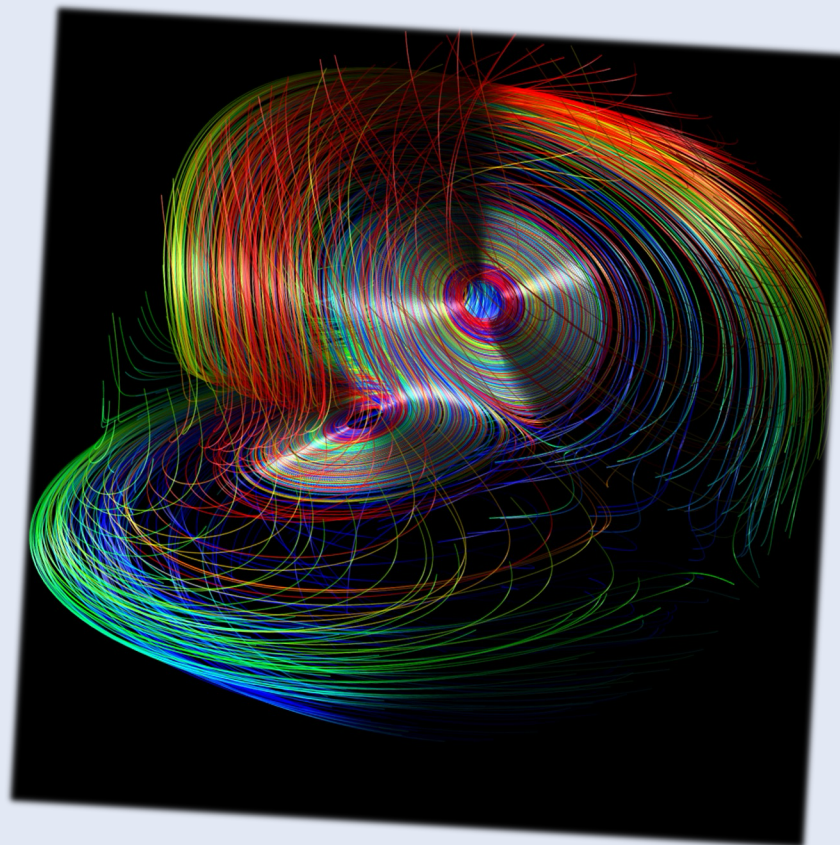
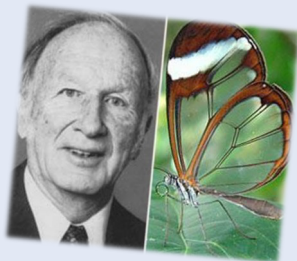
- Does this ALWAYS happen, that we settle down to a fixed value?
- This is, essentially, the *central question* of Chaos Theory.
- Edward Lorenz, 1963, Meteorologist.
- James Yorke, 1975, Coined the Term “Chaos.”





Chaos Theory

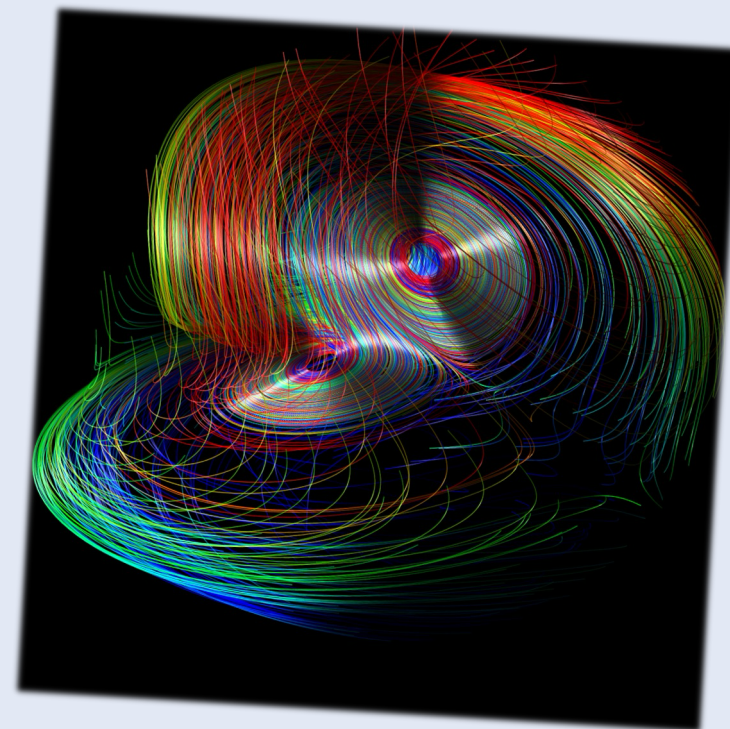
- **Edward Lorenz (1963, MIT):** discovered the Lorenz Attractor.
 - Weather is complicated because so many factors are interacting?
 - NO! Three factors is all that Lorenz built into his system, yet his system is AS COMPLICATED as the weather itself.





Chaos Theory

- The essence of chaotic behavior is ***SENSITIVITY TO INITIAL CONDITIONS***.
- No matter how close together the initial state is, the behavior after a very short time can be completely different!
- This leads to a system whose behavior is practically impossible to predict.





Chaos Theory

- This means that unpredictability is ***not necessarily*** the result of MANY factors interacting.
- Chaotic, unpredictability is ***built into the universe at a very basic level.***
- That is why we ***STILL*** cannot predict the weather very far in advance...but more on this a bit later.





Chaos Theory

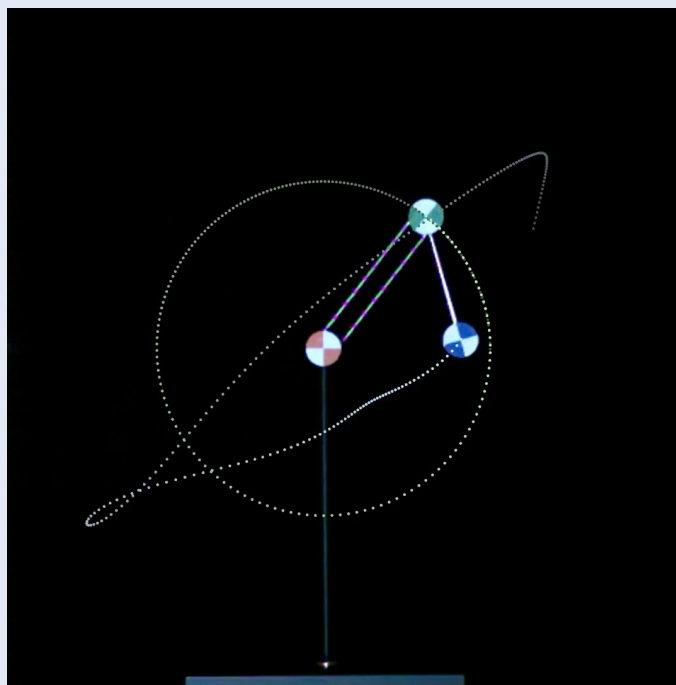
- We can't even predict far in advance the behavior of a double pendulum!





Chaos Theory

- We can't even predict far in advance the behavior of a double pendulum!

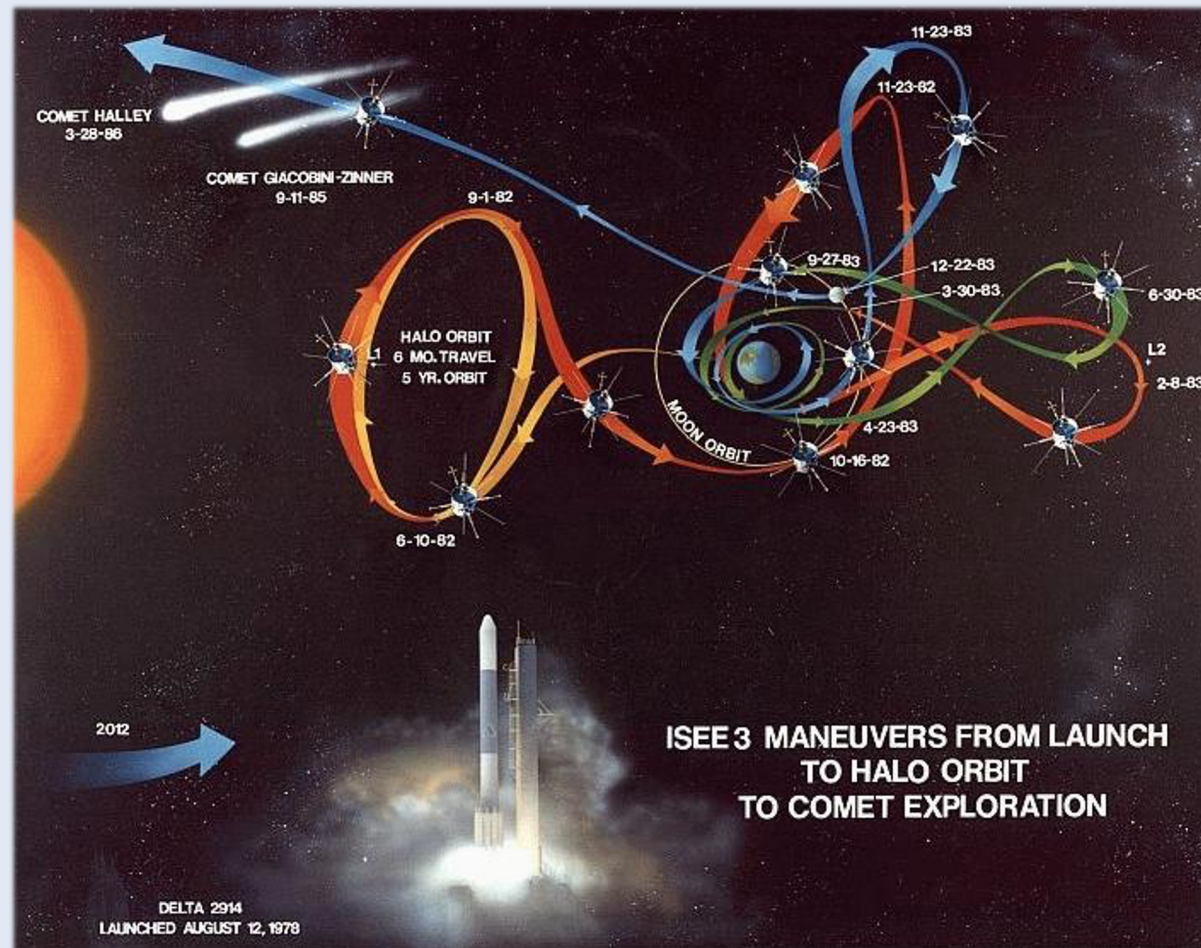




Chaos Theory

- Should we despair, since our dreams or predicting behavior have been dashed?
- **Yorke (1975, University of Maryland):** this also means that we can
 - model complicated systems with very simple formulas, and
 - control chaotic systems with minimal energy input.

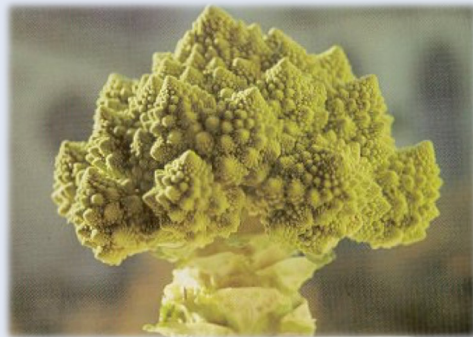






Fractal Geometry

- **Benoit Mandelbrot (1980, IBM):** Euclidean geometry does not capture richness of nature, which is “musical.”
 - Abundant variation precludes boredom → richness & variety
 - Regular repetition precludes “noise” → regularity & order



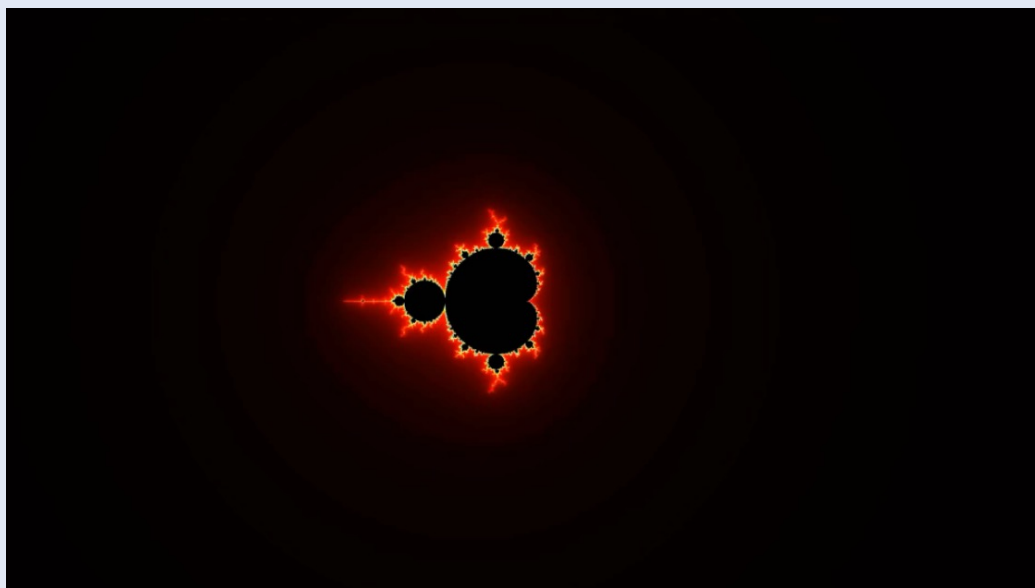
© 2001 Mandelbrot, Gemini W. Images, © Dr. Vahneema Lubiano



Fractal Geometry

- **Benoit Mandelbrot:** made two discoveries.
 - Simple formulas can give infinitely rich geometric objects.

$$z^2 + c$$

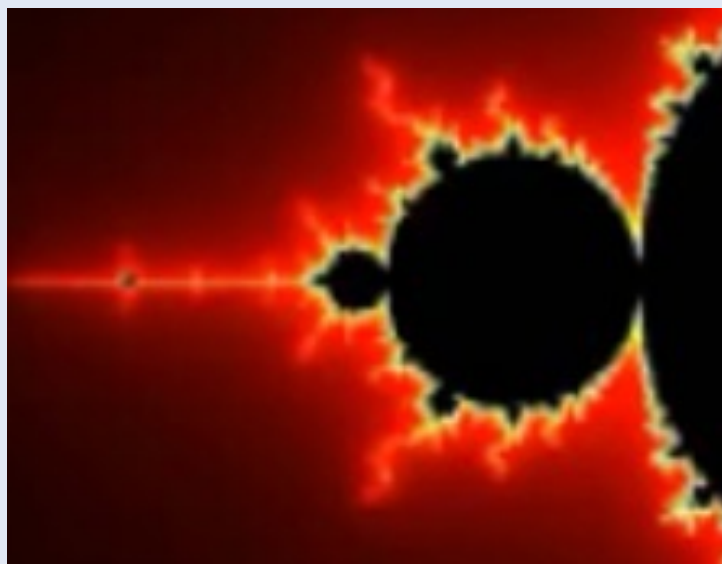




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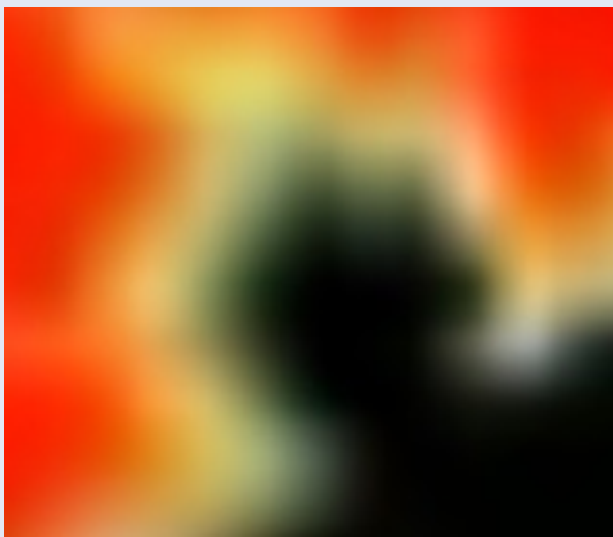




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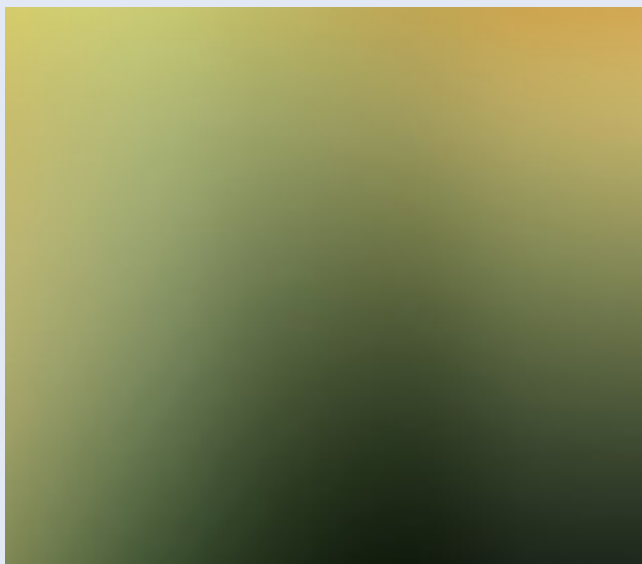


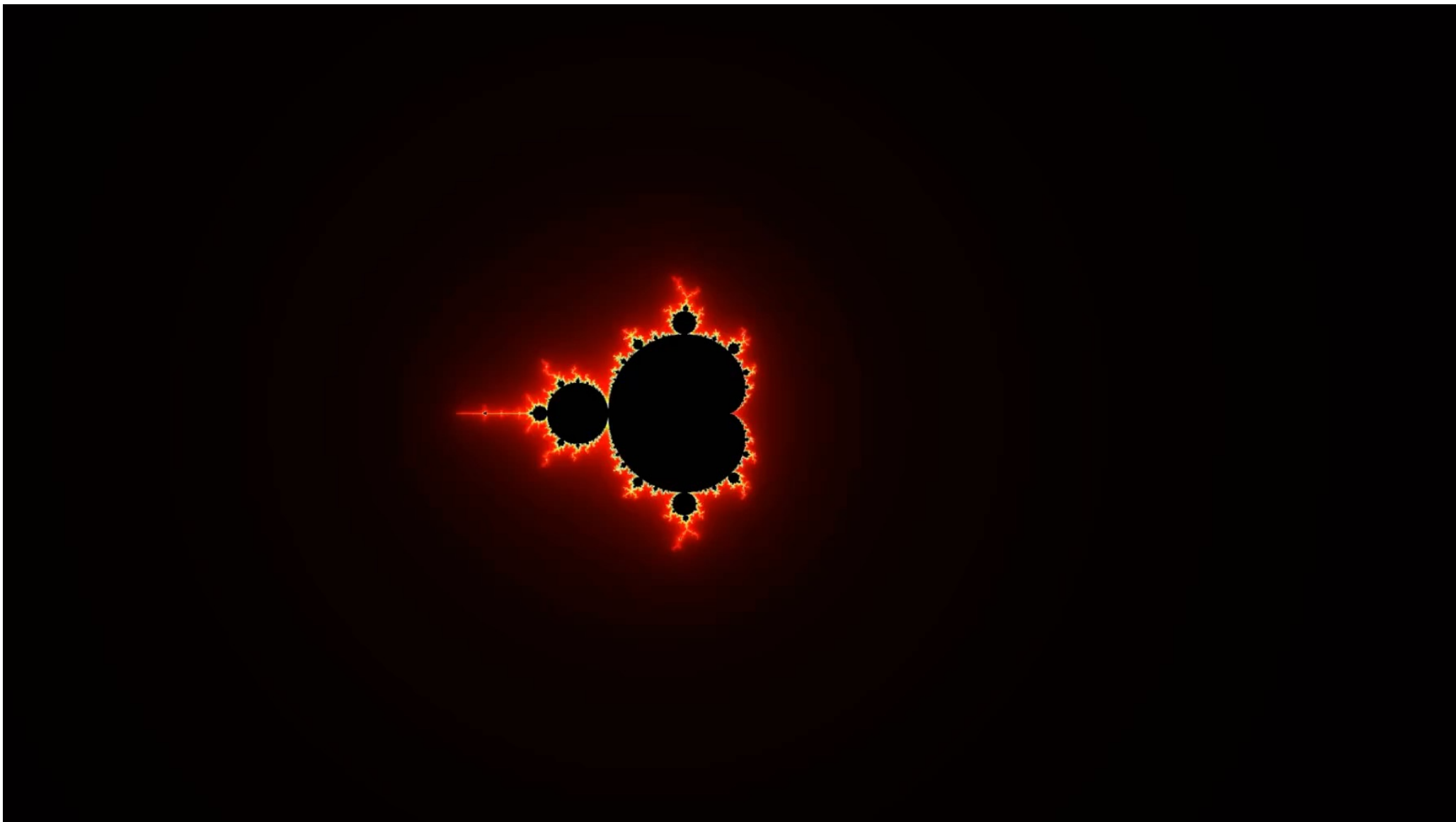


Fractal Geometry

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$$z^2 + C$$





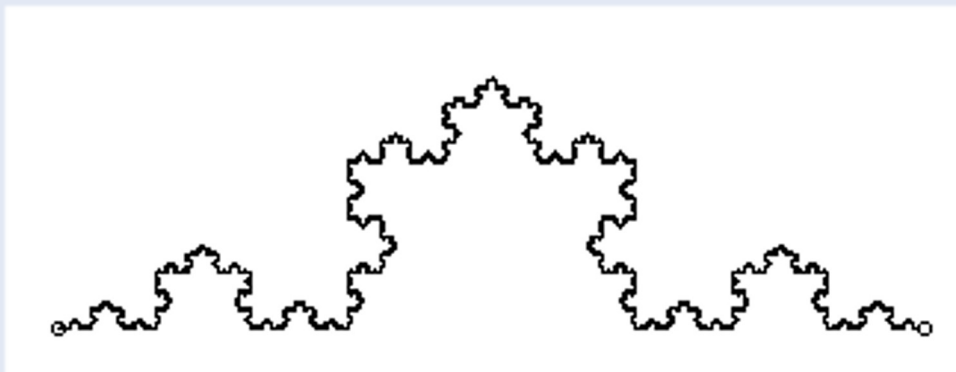


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Fractal Geometry

- **Benoit Mandelbrot:** made two discoveries.
 - Simple formulas can give infinitely rich geometric objects.
 - Geometrically rich objects have a dimension that is not an integer – a Fractal Dimension.





Fractal Geometry

- **Applications: *Fractal Antennas***
 - To be effective, an antenna has to work at several different scales.
 - A line, which is self-similar in a trivial way, will do, but it does not have much surface area.
 - Fractals have the advantage of being self-similar and having more surface area.





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Fractal Geometry

- **Applications: Fractal Antennas**
 - To be effective, an antenna has to work at several different scales.
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 - Fractals have the advantage of being self-similar and having more surface area.





Fractal Geometry

- **Applications: Cancer Detection**
 - Biopsies are invasive and to be avoided if possible.
 - Cancerous cells have an irregular boundary, which can be precisely characterized by its fractal dimension.
 - Statistical analysis reveals the breakpoint.



ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC

News: Cancer,Biomedicine

Fractals can catch cancer

Analyzing shapes of cell borders may prove useful in diagnosis

By Sam Lemonick 11:02am, October 7, 2013

The geometric patterns known as fractals make for pretty pictures; one day they might help doctors diagnose cancers faster and more accurately.

Looking for a better alternative to the staining methods traditionally used on biopsied cells, Joachim Spatz and colleagues at the University of Heidelberg in Germany focused on patterns at the edges of pancreatic cancer cells. [The group reported](#) September 30 in *Nano Letters* that quantifying "fractalness" along individual cell borders allowed the researchers to distinguish between two types of cancer 97 percent of the time. Even in combination, the best staining techniques are right only about 85 times out of 100.

► [Apf](#)

Fractal dimension analysis as an easy computational approach to improve breast cancer histopathological diagnosis

[Lucas Glaucio da Silva](#)¹, [Waleska Rayanne Sizinia da Silva Monteiro](#)¹, [Tiago Medeiros de Aguiar Moreira](#)², [Maria Aparecida Esteves Rabelo](#)¹, [Emílio Augusto Campos Pereira de Assis](#)^{1,3}, [Gustavo Torres de Souza](#)^{2,4,✉}

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PMCID: PMC8087740 PMID: [33929635](#)



Fractal Geometry

- Applications: CGI





Fractal Geometry

- Applications: CGI
- Applications: Image Compression



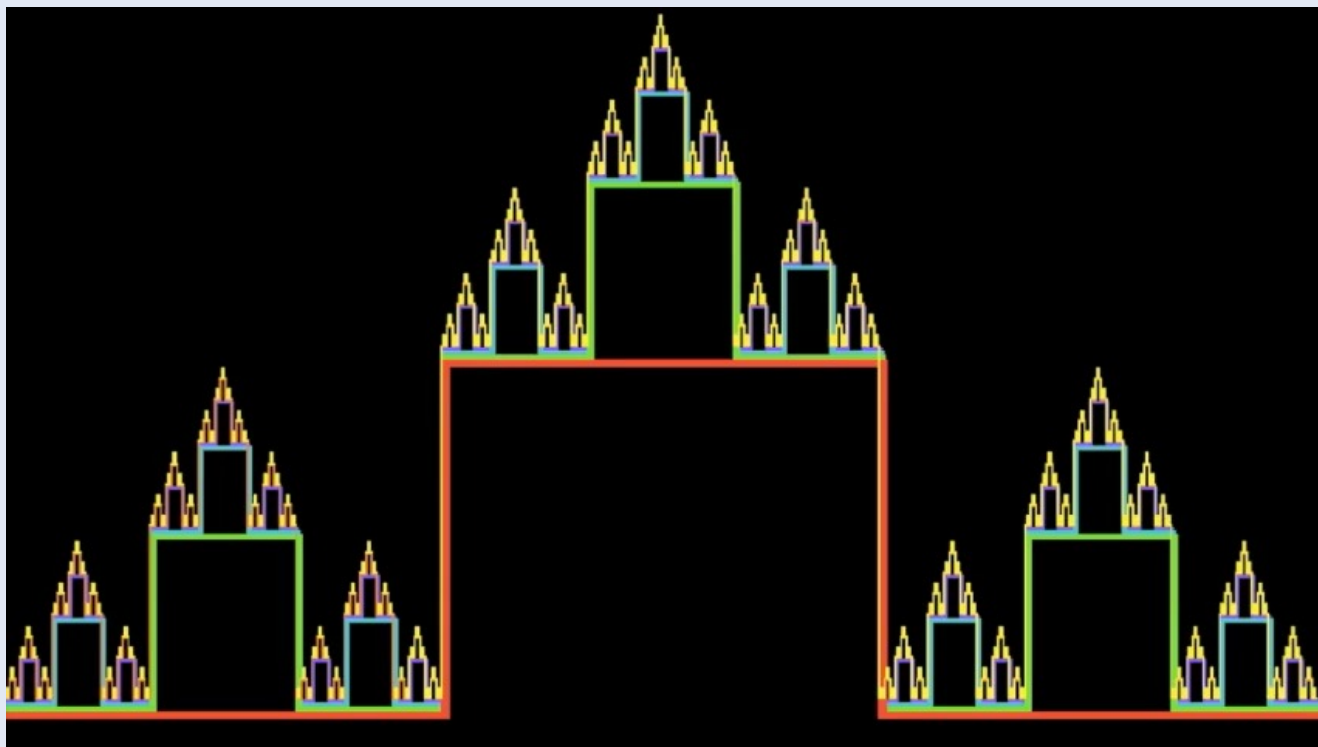
Guardians of the Galaxy, Volume 2 (2017), Planet Ego





Fractal Geometry

- **Applications:** *CGI*
- **Applications:** *Image Compression*
- **Music:** overlapping, scaled replications





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Fractal Geometry

- **Applications:** *CGI*
- **Applications:** *Image Compression*
- **Music:** *Bach's use of transposition, inversion, and retrograde inversion when composing fugues*





Self-Organized Criticality (Emergencing Order)

- **Canonical Example #1:** Sand Pile
 - Each grain of sand arranges its position based only on the few grains touching it.
 - Always, a cone EMERGES, with base angle in a predictable range.
 - Avalanches





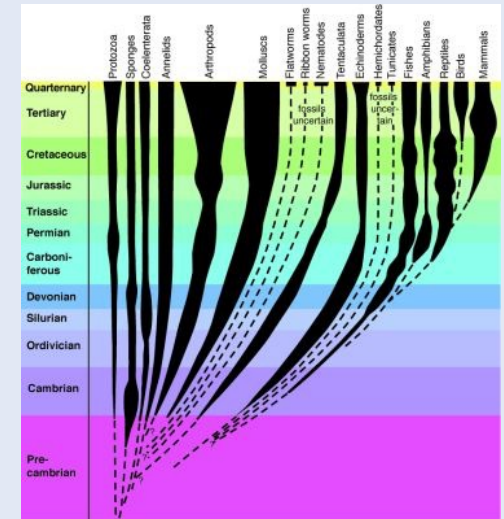
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Self-Organized Criticality

- **Avalanches:**
 - Earthquakes
 - Stock Market Crashes
 - “Going Viral”
 - Evolution



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Self-Organized Criticality

- **Canonical Example #2: Ant Colony**

- At Individual Level – Mind-Numbingly Stupid
- Put 100,000 Together – Intelligence, Adaptability & Sophistication Emerge
- The intelligence belongs to no one individual, nor to the group, but rather emerges from the relatively simple interaction among them.



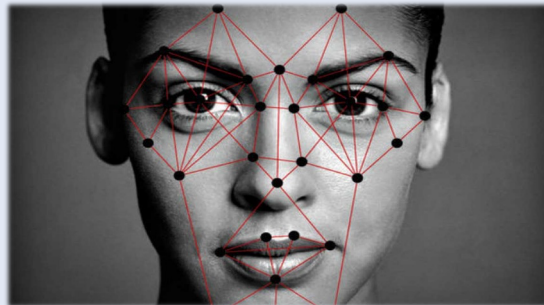
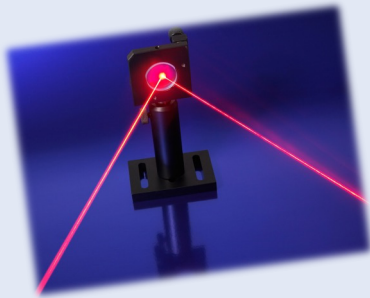


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Self-Organized Criticality

- **Emerging Order:**
 - Neural Networks & Machine Learning
 - Facial Recognition
 - Flocking or Swarming, Drones
 - Lasers
 - Predicting Weather





Self-Organized Criticality

- *Canonical Example #2: Ant Colony*
 - The intelligence belongs to no one individual but rather emerges from the relatively simple interaction among them.
 - The importance of **free speech** in academia and society.





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College Encourages Lively Exchange Of Idea

Students, Faculty Invited To Freely Express Single Viewpoint



The Onion
NEWS IN BRIEF
April 27, 2015
VOL 51 ISSUE 17
News • College



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BOSTON—Saying that such a dialogue was essential to the college’s academic mission, Treseott University president Kevin Abrams confirmed Monday that the school encourages a lively exchange of one idea. “As an institution of higher learning, we recognize that it’s inevitable that certain contentious topics will come up from time to time, and when they do, we want to create an atmosphere where both students and faculty feel comfortable voicing a single homogeneous opinion,” said Abrams, adding that no matter the subject, anyone on campus is always welcome to add their support to the accepted consensus. “Whether it’s a discussion of a national political issue or a concern here on campus, an open forum in which one argument is uniformly reinforced is crucial for maintaining the exceptional learning environment we have cultivated here.” Abrams told reporters that counseling resources were available for any student made uncomfortable by the viewpoint.



Self-Organized Criticality

- The Importance of **Free Speech** in academia and society.
 - Amala Ekpunobi, a former black activist turned conservative activist, was invited to speak at WSU during the fall semester of 2022.
 - Faculty Senate wrote a letter to the editor of the Winonan opposing her appearance and encouraging professors to let students stay home from campus that day because they may not be “safe.”



Self-Organized Criticality

- The Importance of **Free Speech** in academia and society.

Letter to the editor: statement on Ekpunobi event

Winona Faculty Association
October 16, 2022

...“When the speech of political provocateurs like Ekpunobi is elevated on our campus, it creates a climate that is not inclusive and is not safe for our most marginalized faculty. To this end, we want to assure every single faculty member on this campus that you have your union’s full support if you decide to stay away from Winona State’s campus on the day of Ekpunobi’s next presentation.

“We also ask that you stand in solidarity with any students or staff who express a desire not to be on campus that day.”...



Amala Ekpunobi, a speaker from PragerU. She returns again to Winona State University on Oct. 14 after speaking at the campus last year.



Self-Organized Criticality

- The Importance of **Free Speech** in academia and society.

Letter to the editor: Barry Peratt response to WSUFA statement

Barry Peratt

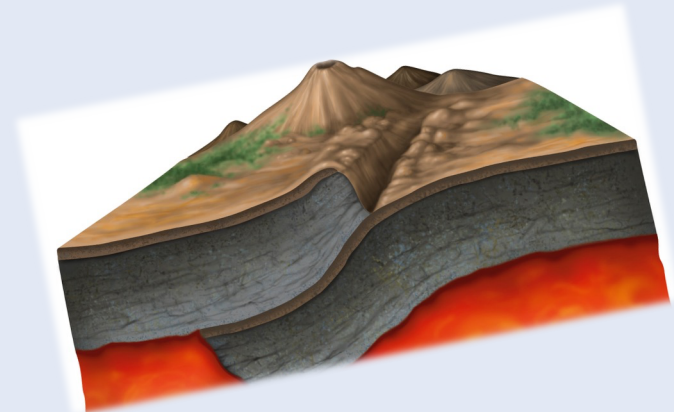
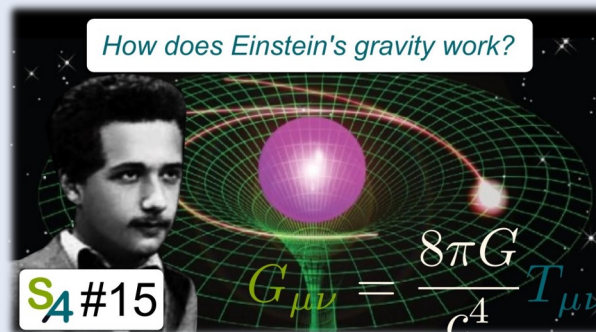
October 11, 2022

This is a response to the Faculty Association letter to the editor regarding the Amala Ekpunobi event. The letter claims that there are faculty, and perhaps students, who will not feel safe on campus the day that Amala speaks, because she has expressed, in the past, points of view that challenge their assumptions and beliefs (specifically regarding systemic racism and gender discrimination). I can personally testify that the times I have encountered ideas on campus with which I disagree were horrifying. I barely survived.



Self-Organized Criticality

- The importance of **Free Speech** in academia and society (and avalanches).
 - Alfred Wegener proposed "Continental Drift" in 1912 but was ridiculed by fellow scientists.
 - Einstein's Theories of Relativity
 - Big Bang (Catholic priest Georges Lemaître)
 - Any revolution in thought.





Self-Organized Criticality

- The Importance of **Free Speech** in academia and society.
 - Many scientists, many in the field of epidemiology and virology, and some Nobel Prize winners, disputed the lockdown approach to COVID. Sweden was most famous for flaunting the conventional wisdom on lockdowns and masks.



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Self-Organized Criticality

- The Importance of **Free Speech** in academia
- Many scientists, many in the field, have disputed the lockdown approach as a conventional wisdom



≡ TIME

PRESENTED BY
SIEMENS

IDEAS • COVID-19

The Swedish COVID-19 Response Is a Disaster. It Shouldn't Be a Model for the Rest of the World

BY **KELLY BJORKLUND** AND **ANDREW EWING** OCTOBER 14, 2020 5:00 AM EDT

Kelly Bjorklund is a writer and human rights activist who has worked on public policy and advocacy with elected officials, civil society and media for two decades.

Andrew Ewing is a professor of molecular biology and chemistry at the University of Gothenburg and a member of the Swedish Academy of Sciences.

IDEAS



Self-Organized Criticality

- The Importance of **Free Speech** in academia
- Many scientists, many in the field of epidemiology, have disputed the lockdown approach to COVID. Sweden was a conventional wisdom on lockdowns.

CORONAVIRUS

No-Lockdown Sweden Seemingly Tied for Lowest All-Causes Mortality in OECD Since COVID Arrived

Focusing on all-causes mortality, and not just on COVID mortality, helps account for various potential indirect effects of lockdowns.

EUGENE VOLOKH | 1.10.2023 12:30 PM

Sydney Today 14 ° / 29 °



news.com.au

National World Lifestyle Travel Entertainment Technology Finance Sport Shopping

Technology > Science

Sweden has the lowest excess mortality rate after the pandemic, despite refusing to lock down

Telling new data has shown an incredible fact about one nation that completely rejected lockdowns throughout the pandemic.



Alex Blair



@alexblair_1



3 min read

November 28, 2022 - 4:42PM

news.com.au



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Sweden's no-lockdown COVID strategy was broadly correct, commission suggests

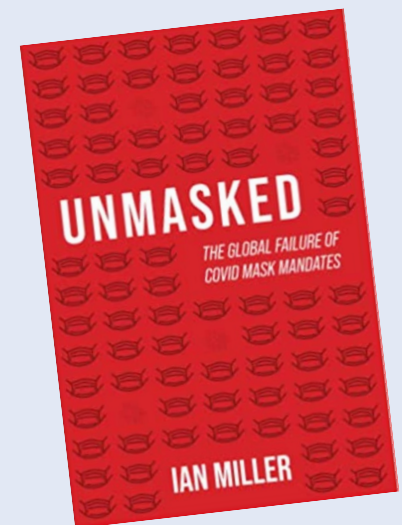
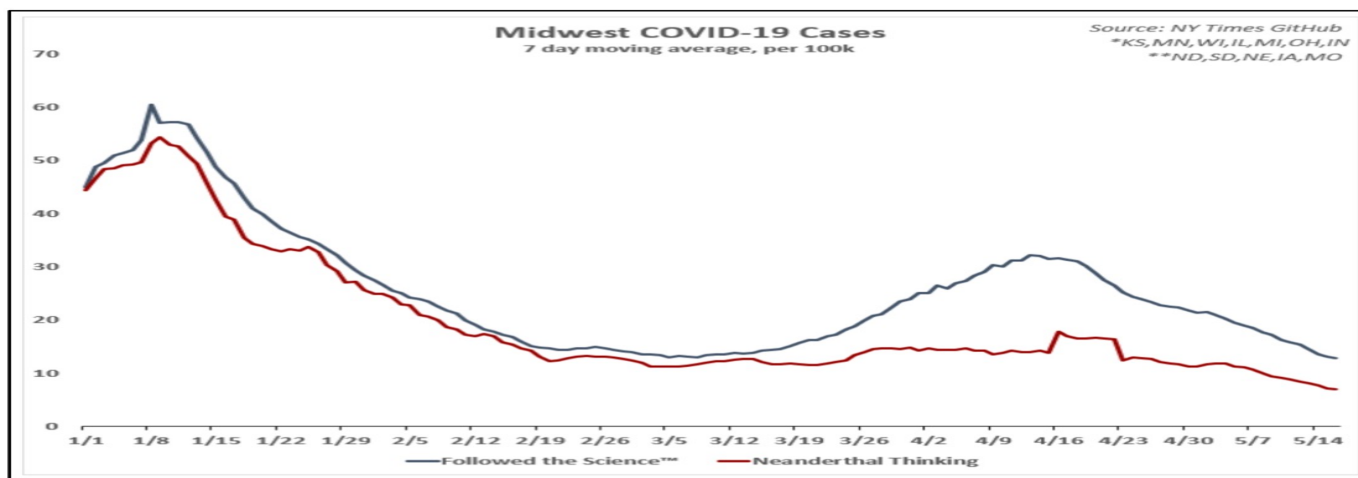
Thomson Reuters ·

Posted: Feb 25, 2022 10:14 AM CST | Last Updated: February 26, 2022



Self-Organized Criticality

- The importance of **Free Speech** in academia and society.
- Ian Miller was a consistent critic of COVID mask guidelines during the pandemic and was accused of spreading misinformation, even though he supported his claims with voluminous data from official sources.





Self-Organized Criticality

- The importance of **Free Speech** in academia and society.
 - Ian Miller was a consistent critic of COVID mask guidelines during the pandemic and was accused of spreading misinformation, even though he supported his claims with voluminous data from official sources. [cf. New York Times]



In U.S. cities where mask use has been more common, Covid has spread at a similar rate as in mask-resistant cities. Mask mandates in schools also seem to have done little to reduce the spread. Hong Kong, despite almost universal mask-wearing, recently endured one of the world's worst Covid outbreaks.



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Self-Organized Criticality

- The importance of **Free Speech** in academia and society.
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CONGRESS

Zuckerberg says he regrets caving to White House pressure on content

Meta's CEO tells the House Judiciary Committee that he wishes he had been more outspoken against Biden administration efforts during the pandemic.

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How Fauci and Collins Shut Down Covid Debate

They worked with the media to trash the Great Barrington Declaration.

By The Editorial Board
Dec. 21, 2021 6:47 pm ET

Share AA Resize 1574

Listen (2 min)

Journal Editorial Report: Paul Gigot interviews Dr. Marty Makary. Image: Spencer Platt/Getty Images

In public, Anthony Fauci and Francis Collins urge Americans to "follow the science." In private, the two sainted public-health officials schemed to quash dissenting views from top scientists. That's the troubling but fair conclusion from [emails](#) obtained recently via the Freedom of Information Act by the American Institute for Economic Research.

By LARA KORTE

08/26/2024 11:57 PM EDT

Updated: 08/27/2024 12:15 PM EDT



Mark Zuckerberg says he regrets that Meta bowed to Biden administration pressure to censor content, saying in a letter that the interference was "wrong" and he plans to push back if it happens again.



Self-Organized Criticality

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Scientists Join Lawsuit Against Biden Admin. for COVID Collusion w/ Big Tech

'The government may not work through private entities to accomplish censorship that the First Amendment forbids the government from doing directly...'

By Mark Pellin August 8, 2022

"Public statements, emails, and recent publicly released [documents](#) establish that the President of the United States and other senior officials in the Biden Administration violated the First Amendment by directing social-media companies to censor viewpoints that conflict with the government's messaging on Covid-19," the New Civil Liberties Alliance announced in a [statement](#) representing the group of scientists and doctors.

The group of high-profile medical experts joined the suit filed by the attorneys general of Missouri and Louisiana, which alleged that the Centers for Disease Control and Prevention and other administration agencies abetted social media companies like [Twitter](#), [Google](#) and [Facebook](#) to censor open discussion of the pandemic and the government's draconian response.

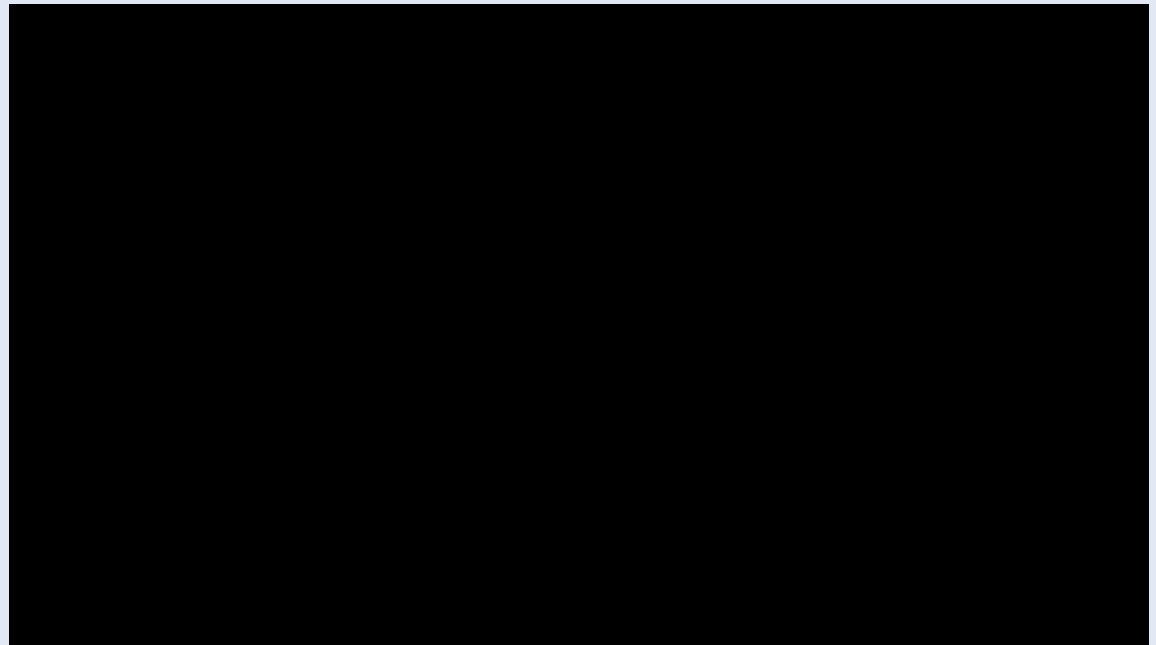
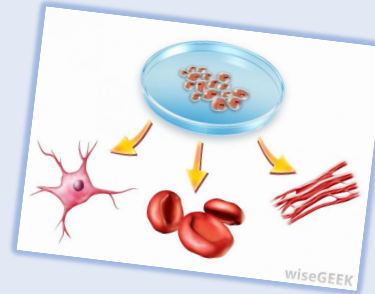


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Self-Organized Criticality

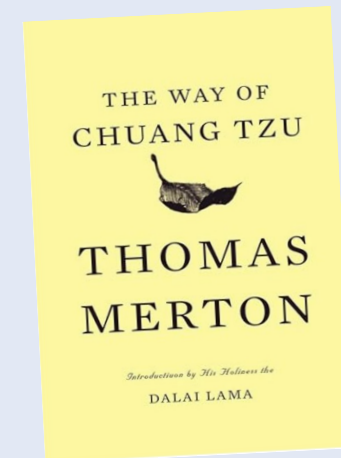
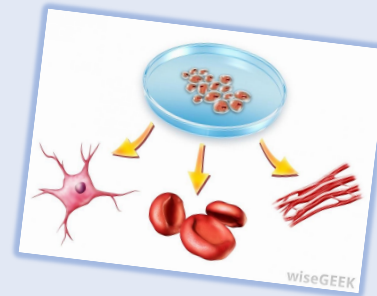
- **Emerging Order:**
 - Biological Systems (Cell Differentiation)
 - Octopuses? (*The Insane Biology of the Octopus*, Real Science, Youtube)





Self-Organized Criticality

- **Emerging Order:**
 - Biological Systems (Cell Differentiation)
 - Octopuses? (*The Insane Biology of the Octopus*, Real Science, Youtube)



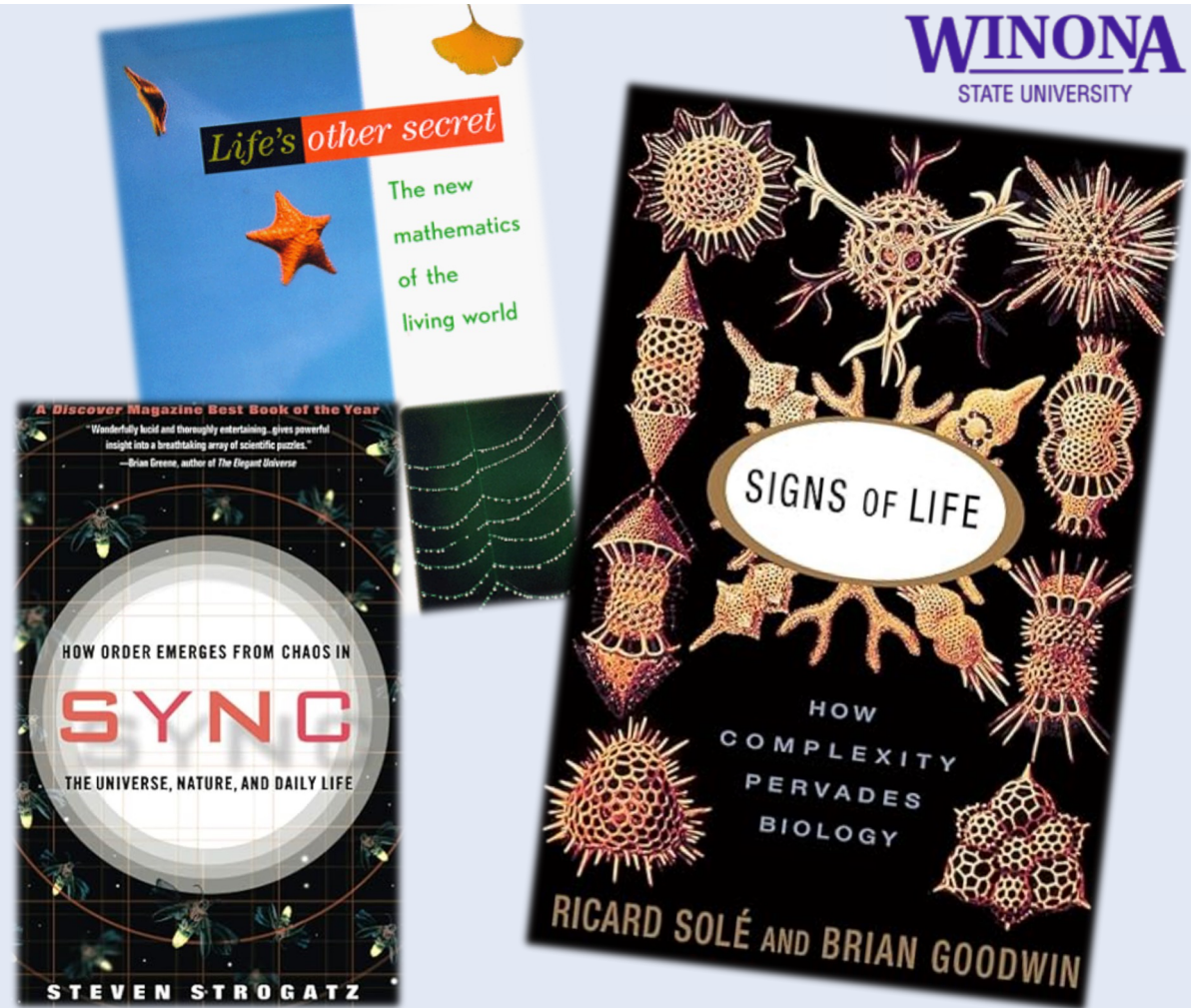
The grasshopper said to the centipede, “My, what a large number of legs you have! I don’t know how you do it. Why, I only have six legs and I can barely manage them sometimes!”
The centipede replied, “I don’t manage them.”



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Self-Organized Criticality

- **Emerging Order:**
 - Biological Systems (Cell Differentiation)
 - Octopuses? (*The Insane Biology of the Octopus*, Real Science, Youtube)





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Self-Organized Criticality

- **Emerging Order:**
 - Free Market Economics



“When I saw those shelves crammed with hundreds, thousands of cans, cartons and goods of every possible sort, for the first time I felt quite frankly sick with despair for the Soviet people.” (Boris Yeltsin, upon visiting Randalls supermarket near Houston, Texas, in September 1989)



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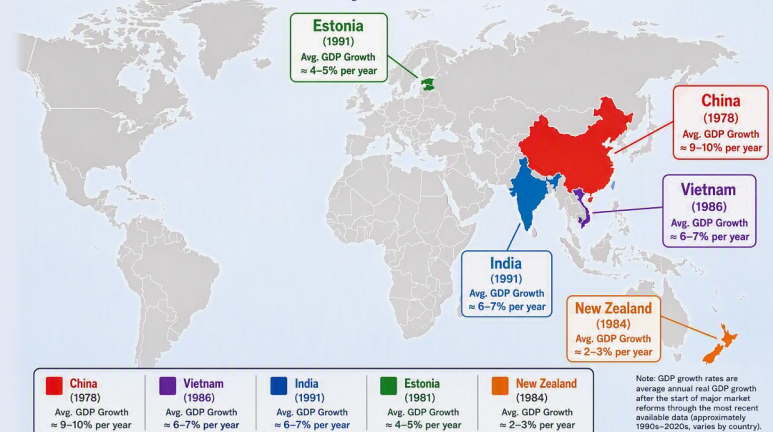
≡ DAILY NEWS

Soccer | World Cup tourists amazed by A/C, Costco, how...



World Cup tourists amazed by A/C, Costco, how much they now love U.S.

Countries That Moved Toward Free Markets and Subsequent GDP Growth





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