

Behind the Scenes at *Scientific American*

George Musser
6 April 2012



Colossal Galactic Explosions

Enormous outpourings of gas from the centers of nearby galaxies may ultimately help explain both star formation and the intergalactic medium

By Nicholas Meecham, Gabriel Corti and Jonathan Braine

Millions of galaxies exist in the universe, each with its own unique structure. Some are spiral, some are elliptical, some are irregular. The study of these galaxies is a key part of understanding the universe. In this article, we explore the phenomenon of galactic outflows, which are massive outpourings of gas from the centers of galaxies. These outflows can have a significant impact on the intergalactic medium and star formation in nearby galaxies.

Galactic outflows are a common phenomenon in the universe. They are caused by a variety of processes, including star formation, active galactic nuclei (AGN), and supernovae. These outflows can have a significant impact on the intergalactic medium and star formation in nearby galaxies. In this article, we explore the phenomenon of galactic outflows and their impact on the universe.



Illustration of a galaxy with a large outflow of gas and dust.

Black Holes and the Information Paradox

What happens to the information in matter destroyed by a black hole? Searching for that answer, physicists are groping toward a quantum theory of gravity

By Leonard Susskind

Some of the most profound questions in physics are about black holes. What happens to the information in matter that falls into a black hole? This is the information paradox, and it has been a major focus of research in quantum gravity.

The information paradox is a problem that arises from the combination of general relativity and quantum mechanics. It asks how information can be preserved when matter is destroyed by a black hole. This is a question that has puzzled physicists for decades.

Physicists are working to resolve the information paradox by developing a quantum theory of gravity. This theory would describe how gravity works at the smallest scales, where quantum effects are important.



Diagram illustrating the information paradox: information entering a black hole and the search for its recovery.



Artistic rendering of a galaxy with a complex structure and a bright core.



THE STRING THEORY LANDSCAPE

The theory of strings predicts that the universe might occupy one random "valley" out of a virtually infinite selection of valleys in a vast landscape of possibilities

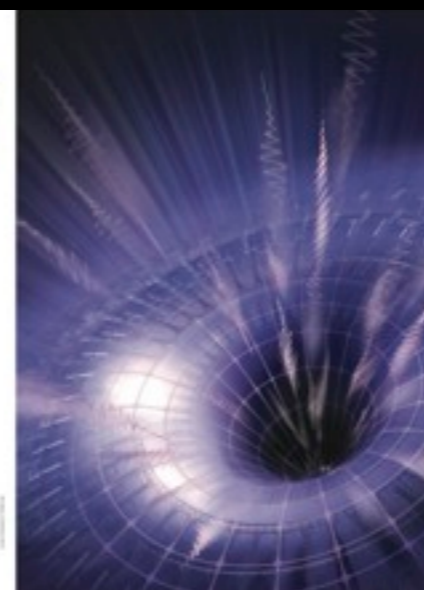
By Raphael Bousso and Joseph Polchinski

PHYSICISTS COULD SOON BE CREATING BLACK HOLES IN THE LABORATORY

QUANTUM BLACK HOLES

By Bernard J. Carr and Steven S. Giddings

Ever since physicists invented particle accelerators, nearly 80 years ago, they have used them for such exotic tasks as splitting atoms, measuring elements, producing antimatter and creating particles not previously observed in nature. Well, look, though, they could soon undertake a challenge that will make these achievements seem almost pedestrian. Accelerators may produce the most profound yet mysterious objects in the universe: black holes.



The Illusion of Gravity

The force of gravity and one of the dimensions of space might be generated out of the peculiar interactions of particles and fields existing in a lower-dimensional realm

By Juan Maldacena

An ECHO of Black Holes

Sound waves in a fluid behave uncannily like light waves in space. Black holes even have acoustic counterparts. Could spacetime itself be a kind of fluid, like the ether of pre-Einsteinian physics?

By Theodore A. Jacobson and Renaud Parentani

When Albert Einstein proposed his special theory of relativity in 1905, he showed that the speed of light was the same for all observers, no matter how fast they were moving. This led to the realization that space and time are intertwined in a way that we don't fully understand yet.

ASTRONOMER



What my friends think I do



What my mom thinks I do



What society thinks I do



What the university thinks I do



What I think I do



What I really do

<https://www.facebook.com/photo.php?fbid=638223742425&set=a.610601697225.2096038.8404414&type=1&theater>

THEORETICAL PHYSICIST



What my friends think I do



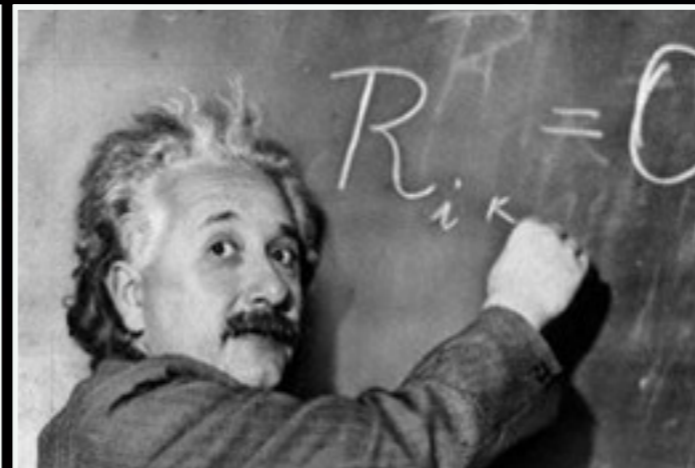
What my mom thinks I do



What society thinks I do



What the university thinks I do



What I think I do



What I really do

http://www.cbs.com/shows/big_bang_theory/photos/103797/the-hawking-excitation/103798, <http://access.aasd.k12.wi.us/wp/baslerdale/2009/10/30/why-care-about-e-mc2-on-colbert/>, <http://couragewolfmeme.com/courage-wolf-571>, <http://kevinspraggett.blogspot.com/2011/06/karpovs-chess-schools.html>, <http://www.law-guy.com/>



A coupled thermal-mechanical model for corona formation on Venus

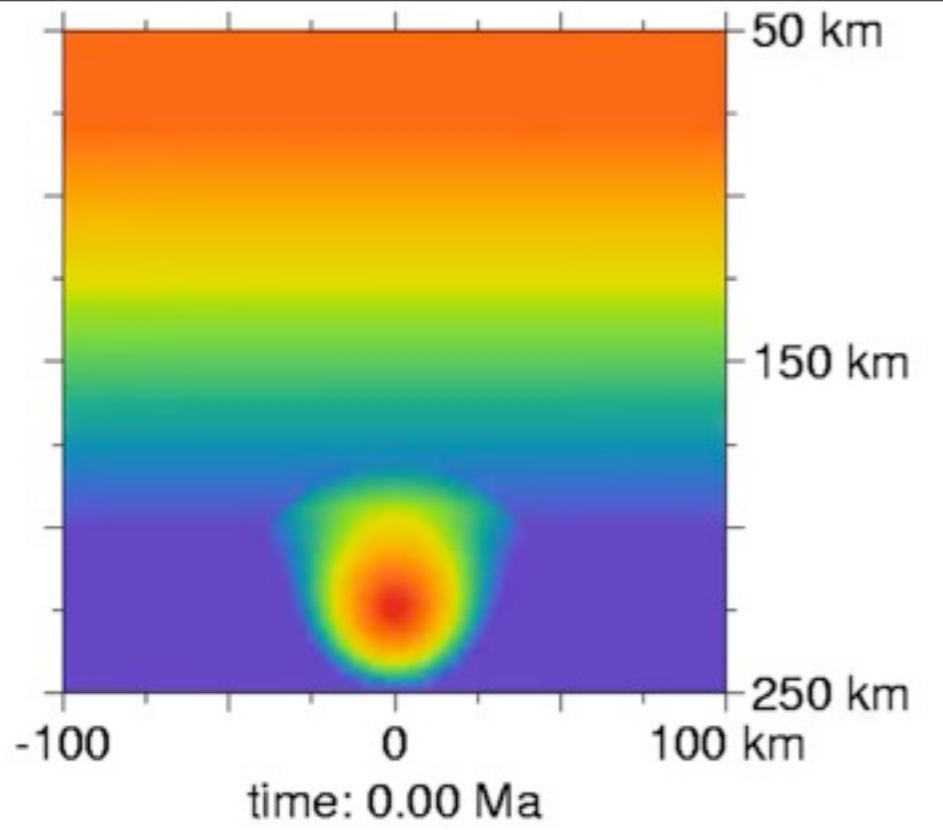
George S. Musser, Jr.
Astronomical Society of the Pacific, San Francisco, California

Steven W. Squyres
Center for Radiophysics and Space Research, Cornell University, Ithaca, New York

Abstract. We develop a model of the combined thermal and mechanical evolution



<http://solarsystem.nasa.gov/multimedia/gallery/Venus.jpg>; <http://nssdc.gsfc.nasa.gov/image/planetary/mars/>



JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 102, NO. E3, PAGES 6581-6595, MARCH 25, 1997

A coupled thermal-mechanical model for corona formation on Venus

George S. Musser, Jr.

Astronomical Society of the Pacific, San Francisco, California

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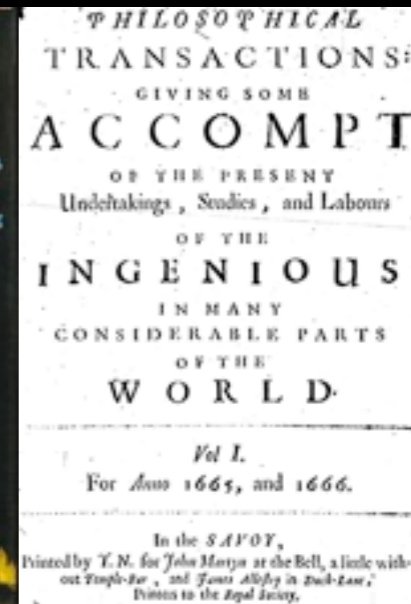
Center for Radiophysics and Space Research, Cornell University, Ithaca, New York

Abstract. We develop a model of the combined thermal and mechanical evolution



<http://solarsystem.nasa.gov/multimedia/gallery/Venus.jpg>; <http://nssdc.gsfc.nasa.gov/image/planetary/mars/>

Early History



http://upload.wikimedia.org/wikipedia/commons/f/fe/Scientific_american_2808184.png, <http://>

Chronicle of the Industrial



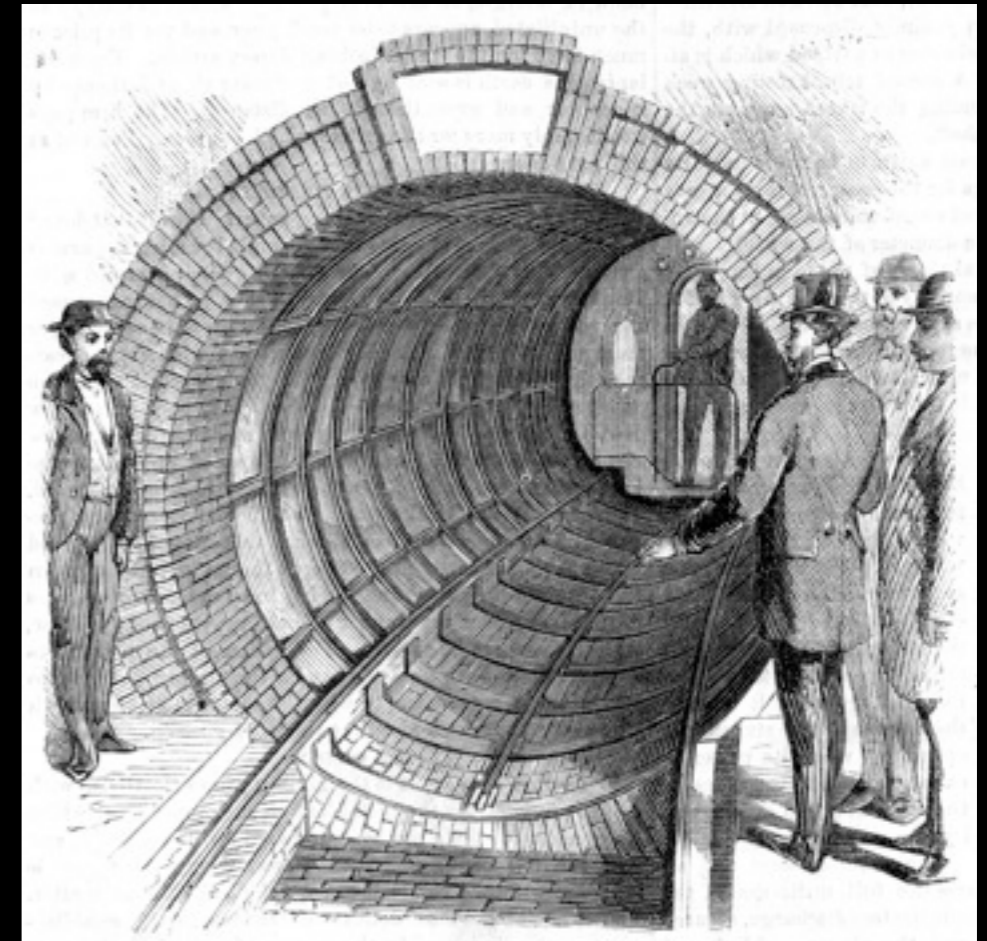
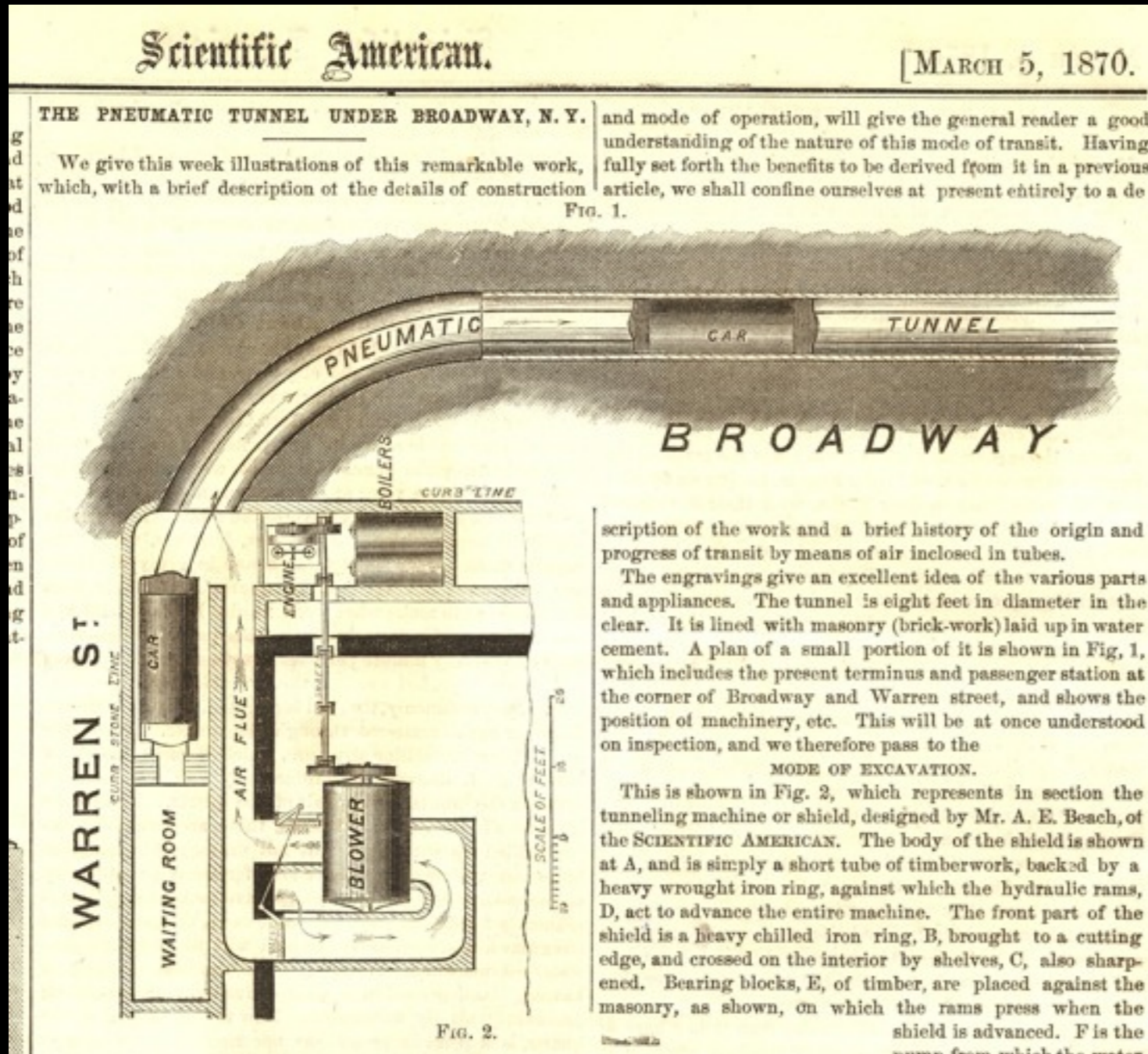
- Rufus Porter
 - Schoolmaster, painter, musician, editor, inventor of the revolver (sold to Colt)
 - After 10 months, bored, he sold *Scientific American* for \$800 to...

Chronicle of the Industrial



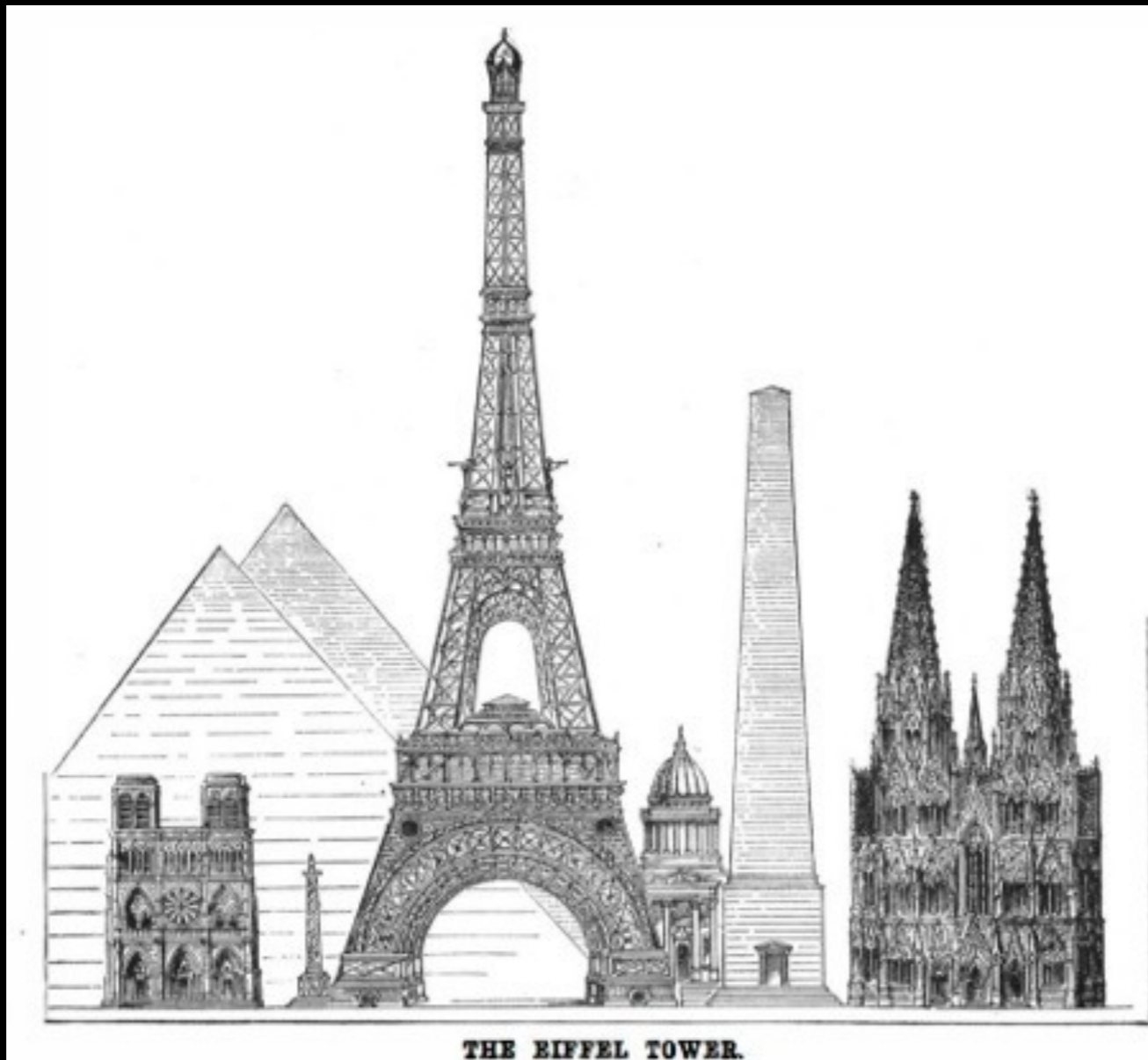
- Orson Desaix Munn, 22
- Alfred Ely Beach, 19
 - Beach was son of *New York Sun* publisher and inventor of first subway (pneumatic tube)
 - Magazine processed one-third of patents issued in U.S.

Chronicle of the Industrial



http://upload.wikimedia.org/wikipedia/en/9/90/Beach_Pneumatic_plan.jpg, <http://upload.wikimedia.org/>

Chronicle of the Industrial



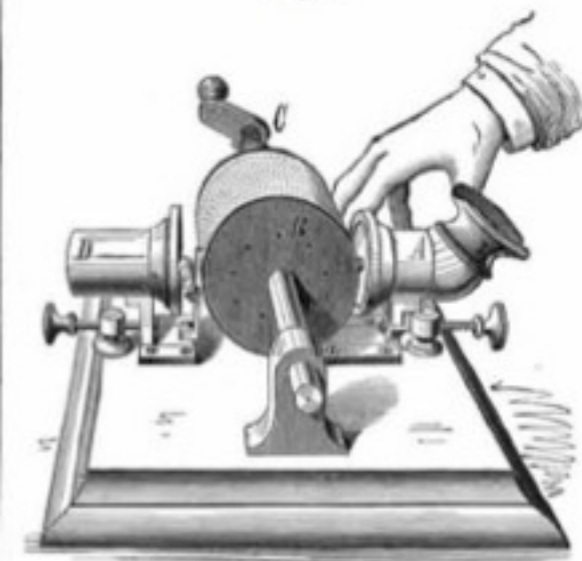
[DECEMBER 22, 1877.]

THE TALKING PHONOGRAPH.

Mr. Thomas A. Edison recently came into this office, placed a little machine on our desk, turned a crank, and the machine inquired as to our health, asked how we liked the phonograph, informed us that it was very well, and bid us a cordial good night. These remarks were not only perfectly audible to ourselves, but to a dozen or more persons gathered around, and they were produced by the aid of no other mechanism than the simple little contrivance explained and illustrated below.

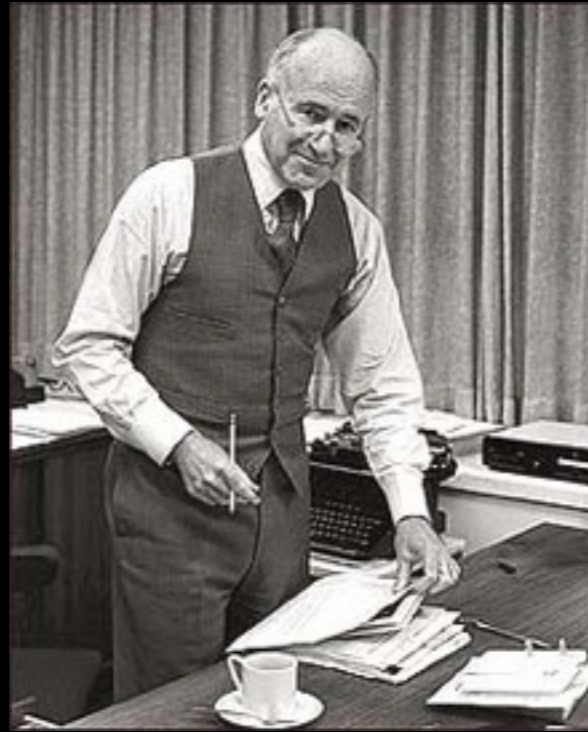
The principle on which the machine operates we recently explained quite fully in announcing the discovery. There is, first, a mouth piece, A, Fig. 1, across the inner orifice of which is a metal diaphragm, and to the center of this diaphragm is attached a point, also of metal. B is a brass cylinder supported on a shaft which is screw-threaded and turns in a nut for a bearing, so that when the cylinder is caused to revolve by the crank, C, it also has a horizontal travel in front of the mouthpiece, A. It will be clear that the point

Fig. 1.



12 Dec 1877, 18 May 1889

Birth of the Modern *Sci Am*



- Gerard Piel, 33
- Dennis Flanagan, 28
 - *Life* magazine reporters
 - “Joint effort” between scientists and journalists

<http://www.janusmuseum.org/panabasis/jan05.htm>

Golden Years

MATHEMATICAL GAMES

The fantastic combinations of John Conway's new solitaire game "life"

by Martin Gardner

Most of the work of John Horton Conway, a mathematician at Cambridge and Caltech, has been in pure mathematics. For instance, in 1967 he discovered a new group-theoretic "Conway's construction"—that includes all but two of the three known sporadic groups. (They are called "sporadic" because they fall to fit any classification scheme.) It is a breakthrough that has had exciting repercussions in both group theory and number theory. It fits in

with an earlier discovery by John Leech of an extremely dense packing of unit spheres in a space of 24 dimensions where each sphere touches 240,000 others. As Conway has remarked, "There is a lot of room up there."

In addition to such serious work Conway also enjoys recreational mathematics. Although he is highly productive in this field, he seldom publishes his discoveries. One exception was his paper on "Mrs. Perkins's Quilt," a division problem discussed in "Mathematical Games" for September, 1968. My topic for July, 1985, was, of course, a topological pencil-and-paper game invented by Conway and M. S. Paterson. Conway has been mentioned here several other times.

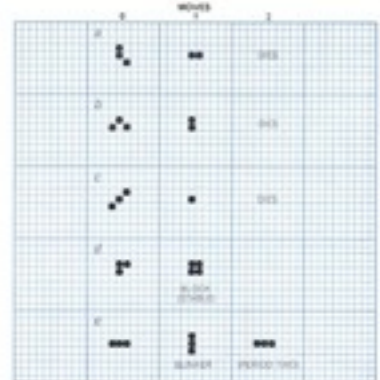
1. There should be no initial pattern for which there is a single point that the population can grow without limit.
2. There should be initial patterns that eventually die out without limit.
3. There should be single initial patterns that grow and change to a considerable period of time before coming to an end in three possible ways: falling away completely from according to time increasing too rapidly, settling into a stable configuration that remains unchanged thereafter, or entering a self-keeping phase in which they repeat an infinite cycle of two or more periods.

In brief, the rules should be such as to make the behavior of the population unpredictable.

Conway's genetic laws are delightful. For one, that each cell of the checkerboard (assumed to be an infinite plane) has eight neighboring cells, four adjacent orthogonally, four adjacent diagonally. The rules are:

1. Survival. Every creature with two or three neighboring creatures survives for the next generation.
2. Death. Each creature with four or more neighbors dies (is removed) from overpopulation. Every creature with one neighbor or none dies from isolation.
3. Birth. Each empty cell adjacent to exactly three neighbors can come, or become, a birth cell. A creature is placed next to the next move.

It is important to understand that all births and deaths occur simultaneously. Together they constitute a single genera-



The Human Population

The articles presented in this issue point out, among other things, that rapid population growth cannot last long. The question is: Will population level off because of high death rates or low birth rates?

by Ronald Freedman and Bevard Denton

The rate of growth that normally characterizes the human population as a whole is a temporary deviation from the normal growth rate that prevailed during most of man's history and most of the earth's history. Today's situation is unique in mankind's experience: the highest growth rate in human history (about 2 percent per year) from the highest base in absolute numbers (nearly 4 billion). The world is currently adding nearly 90 million people per year, about as many as the population of the eighth-largest country (Bangladesh).

Over the millennium until very recent times the human population increased at a very low rate. From the time of the agricultural and urban revolutions about 5,000 years ago the population increase probably never reached as much as 1 percent a year for any long period until the late 19th century. As Audrey J. Cole shows elsewhere in this issue (see "The History of the Human Population," page 85), the acceleration of world population growth was particularly pronounced in countries that are among the most highly developed today: the European countries and the North American continent. That growth was the product of the decline in their death rates, prolonged over three centuries and more, reached from about 1800 on, and the lag in the parallel decline in their birth rates. Now the population is engaged in what can truly be called a vital revolution. We happen to live in the crucial transitional generations. Earlier the high fertility of mankind was balanced by high mortality. Currently, however, death rates have been falling almost everywhere. The birth rate has also been falling in many nations and communities, but this trend has come along later and more slowly. The population has therefore been increasing, and up to now at an increasing rate. In the 1970s the rate of increase has slightly exceeded 2 percent per year. That means a doubling time of less than 30 years, and the number currently being doubled is a very large one. Population of such growth for very long into the future produces a world population larger than the most optimistic estimates of the planet's carrying capacity. In the long run, zero-rate growth will have to be achieved—either by lower birth rates or by higher death rates.

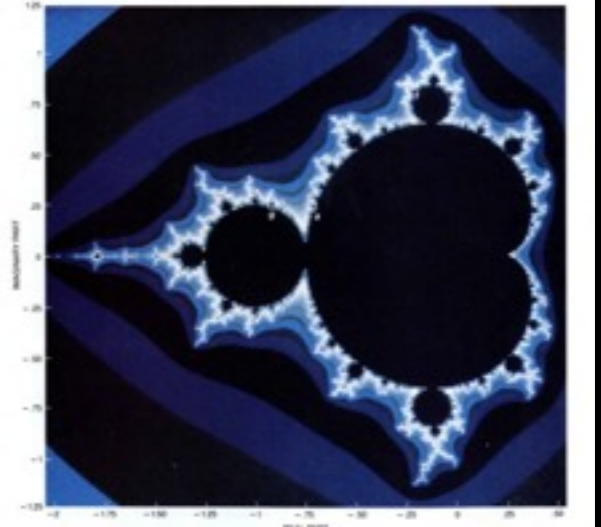
Moreover, the world is demographically divided. The developed countries are now close to replacement levels of reproduction (although there is no certainty that they will remain there). The underdeveloped countries are growing very fast; mortality is falling more or less rapidly, but fertility is changing very little, except in a few small countries. The differing age structures of the two levels of population contribute their own problems.

The possibility that growth may be halted and the population stabilized by the control of fertility is illustrated by the recent demographic history of the developed countries since 19th century, as illustrated by the appropriate agencies of the United Nations, that show in the material abundance of industrialization. The close to the death rates of these countries has grown their population life expectancy that approach or exceed 70 years. The age structure of these populations, reaching toward roughly equal numbers in every age cohort up to the sixth decade (see the illustration on pages 28 and 29), constitutes a biological stability and new balance in human populations. Fertility rates in many developed countries have declined close enough to their

Fortunately I can guess all the complex numbers z that are screening off to infinity. The Mandelbrot set is the set of all complex numbers c for which the size of $z^{n+1} + c$ does not exceed an arbitrarily large number of iterations. The program I am about to describe searches for such numbers. I am indebted in all of this to John H. Hubbard, a mathematician at Cornell University. Hubbard is an authority on the Mandelbrot set, and he was one of the first people to make computer-generated images of it. Most of the images in this article were made by Henri-Olivier Peitgen and his colleagues at the University of Bremen. Peitgen learned the art from Hubbard.

Hubbard's program has inspired a program of mine called *pic*, which is needed for writing pictures. The series of *pic* are separate picture elements called *pixels*, which are arranged in a grid pattern. Hubbard's *pic* has 400 columns and 400 rows, and Peitgen's is even larger. Readers who want to adapt my program for personal use must change an array named in their equipment and temperature. Larger arrays require a longer wait for the pictures, but they improve the resolution.

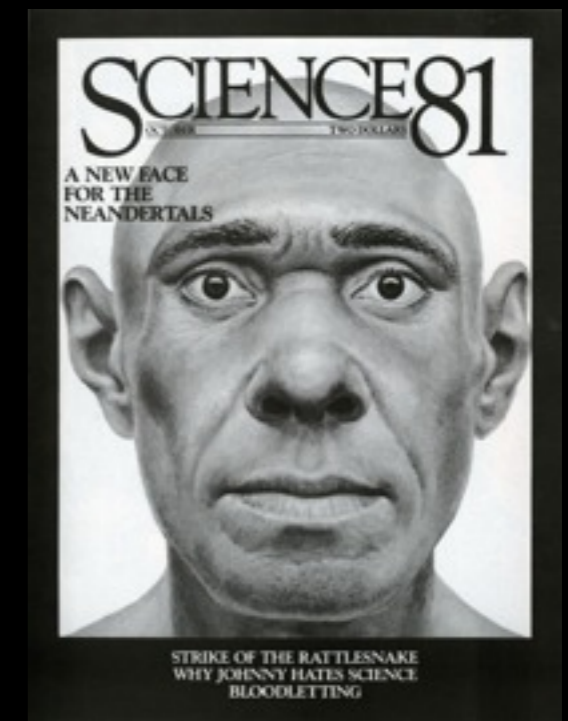
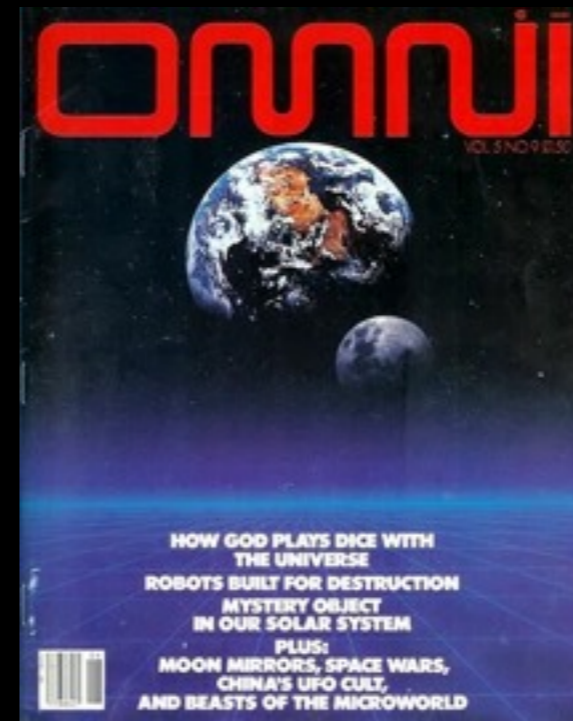
In the first part of my series, even as they select one square region of the complex plane to be examined. Specifically the northwest corner of the square with the complex number to which it corresponds. Two variables in the program, *ax* and *ay*, are used to enter the real part and the imaginary part of the number respectively. Specify the length of each side of the



The Mandelbrot set and its coordinate in the complex plane. The detail shown on the cover and on the next two pages are outlined.

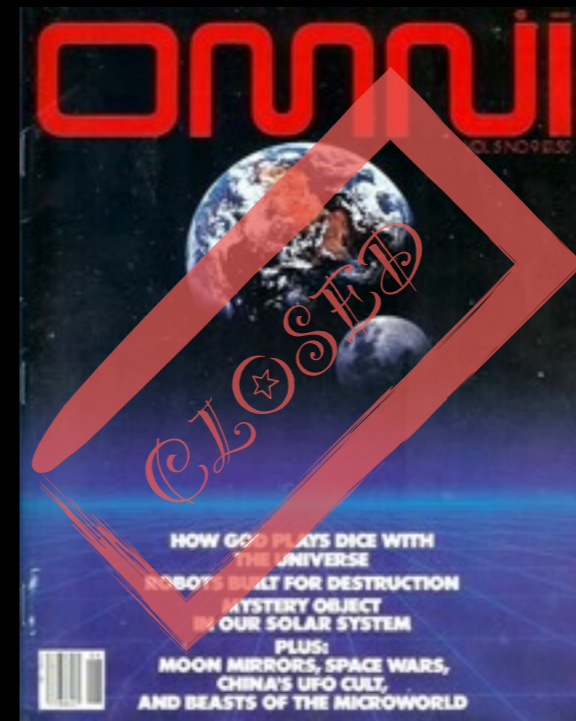
October 1970, September 1974, August 1985,

Boom ... and Bust



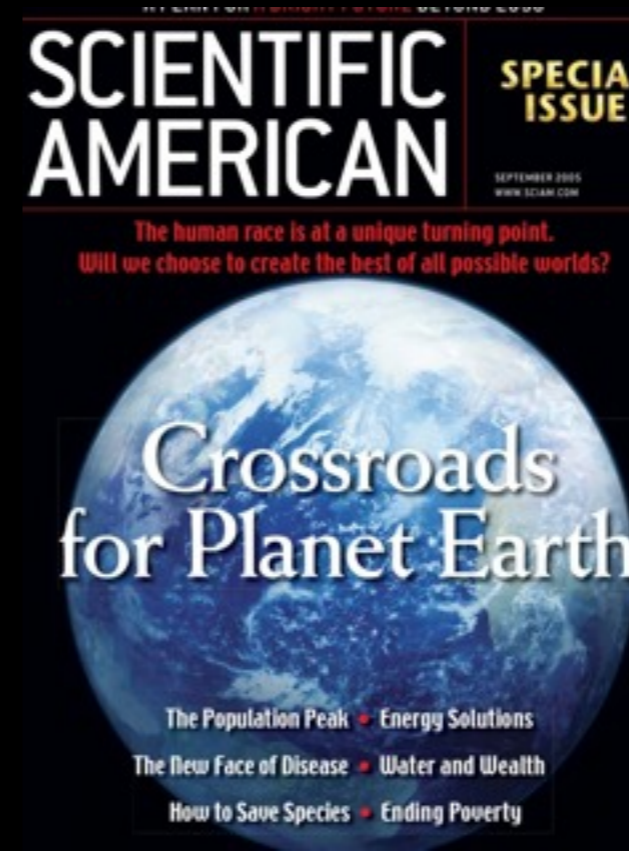
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Boom ... and Bust



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Recent Years



Today: Print Readers

- 450,000 circulation in U.S.
 - 3.3 million readers worldwide
 - Record subscriber renewal rates
- U.S. newsstand sales average: 70,000
 - In top 100 of U.S. titles
 - BUT newsstand for SA & all magazines sliding: –15% to –20% in 2011 from 2010
 - Factors: Borders bookstores close, airline traffic down, POS changes, inherent display flaws (“Men’s”)

What's Going On?

- Print (MRI)
 - 47 median age
 - 70% male/30% female
- Online (Nielsen)
 - 37 median age—YES, 10 years younger
 - 56.5% male/43.5% female
- Print/online readers respond differently
 - On different devices, the audience shifts
 - And on different services, they change, too

Who Are the Readers?

scientists (3–4%)

engineers (6–15%)

doctors (4–8%)

teachers (10–15%)

students (4–8%)

managers (25%)



by Avonelle Wing, 26 Mar 12

What Makes a *Sci Am* Story?

present a problem/paradox/tension/mystery

provide some resolution

needn't be—shouldn't be—linear

represent not just author's work, but a community's

thematic rather than mission- or instrument-based

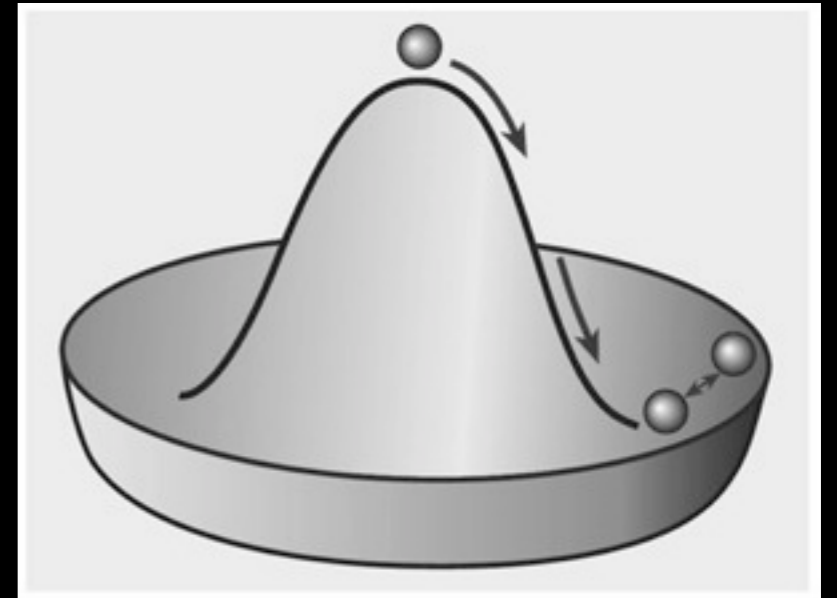
timely: why now?

how you know what you know

make a point (spouse test)

Words to the Wise

underestimating the reader
worrying what colleagues will say
journalese: “insights,” “implications”
received-wisdom syndrome
metaphors that don’t travel well
obsessing over length
readers can stop anytime




Words to the Wise


*underestimating the reader
worrying what colleagues will say
journalese: “insights,” “implications”
received-wisdom syndrome
metaphors that don’t travel well
obsessing over length
readers can stop anytime*

[WHY THE HIGGS?]
BREAKING SYMMETRY



A central question of the Standard Model is why the electroweak forces are asymmetrical: electromagnetism is long-ranged, whereas the weak nuclear force is short-ranged. Physicists think these forces are actually symmetrical, but their symmetry is hidden, or “broken.”

MAGNETIC SPATIAL SYMMETRY
A simple analogy is an infinite grid of magnetic filings. The symmetry in this case is the equivalence of all directions in space.

The symmetry is evident at high temperatures. Heat jostles the filings every which way.  Symmetry



When the temperature drops, the filings lock one another in place. Although their alignment may seem more orderly, it is less symmetrical, because it singles out one randomly chosen direction over the others.  Broken symmetry

ELECTROWEAK SYMMETRY
This symmetry is more abstract. It means the freedom to decide which leptons are electrons and which are neutrinos or how to label up and down quarks.

In the symmetrical case, the lepton-naming convention (represented by an arrow) is set independently at each point in space. What one person calls an electron, another might call some mixture of electron and neutrino, and it would make no difference to their predictions.

In the broken symmetry, the convention is fixed everywhere. What one person calls an electron, all do. The Higgs field brings about this symmetry breaking.

Electroweak symmetry makes all the electroweak force particles massless.

Broken symmetry gives masses to the W and Z bosons, thereby restricting their range.

Life Cycle of a Print Article I



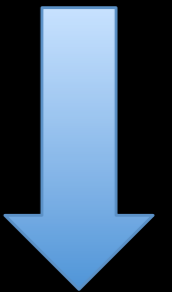
Article



Editorial



Invitation



Waiting



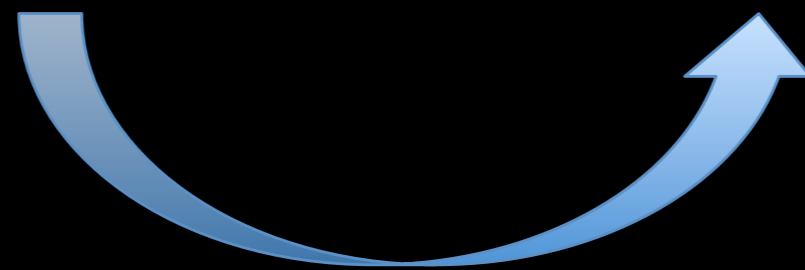
Submission



Drafts



Writing



Life Cycle of a Print Article II

line-editing; summary for art and web team	(e.g., December)
author review of line-edit	(early January)
copy-editing and first proofs	(late January)
full proofs	(early February)
article goes to press	(mid-February)
goes up on newsstands and website	(mid-March)
it ain't over: readers' responses	(April, May)



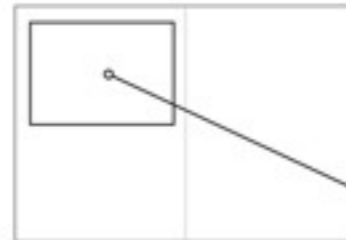
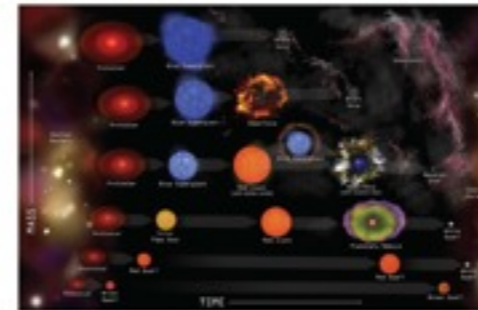
by Jen Christiansen, 29 Mar 12

INFOGRAPHICS



Box 1: Birth, life, and death of stars

How stars are born and die (stars of different masses die in different ways). Era of intense star formation is over, but the universe is, and will be, far from static. Something like this:



Box 2: Collision of Milky Way and Andromeda

Our star and planet system is due for a collision. Interactions like this will reinvigorate star formation temporarily, producing starbursts.



Box 3: chart: the effects of higher levels of heavy elements in future stars

1) increased opacity of star's outer layers --> lowers nuclear fuel consumption and nudges towards longer life
2) but, the heavy elements do not participate in nuclear fusion, therefore reducing nuclear fuel available, and limiting the star's life
These 2 effects operate on different timescales: could be interesting to plot them over time, showing prospects for a long life, then crossing over into the zone of limited life when heavy elements reach a certain level.

Also-- heavy elements should favor birth of planets.

Evolution of an Infographic



http://chandra.harvard.edu/edu/formal/stellar_ev/poster_horiz_med2.jpg

<http://blogs.scientificamerican.com/at-scientific-american/2012/02/21/the-evolution-of-a-scientific-american->

The Emperor, Darth Vader and the Ultimate Ultimate Theory of Physics

blogs.scientificamerican.com/observations/2012/03/30/the-emperor-darth-vader-and-the-ultimate-ultimate-theory-of-p...

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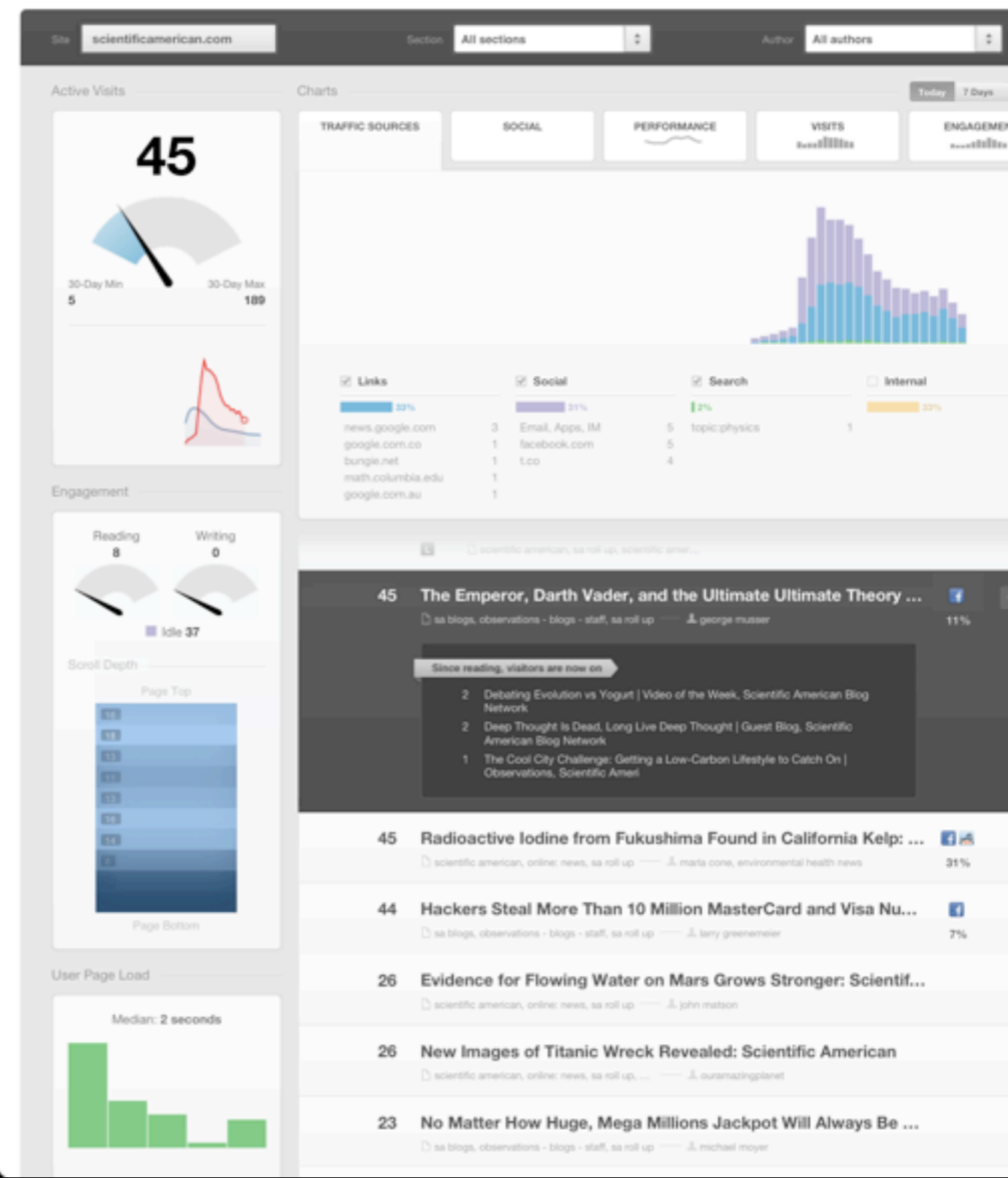
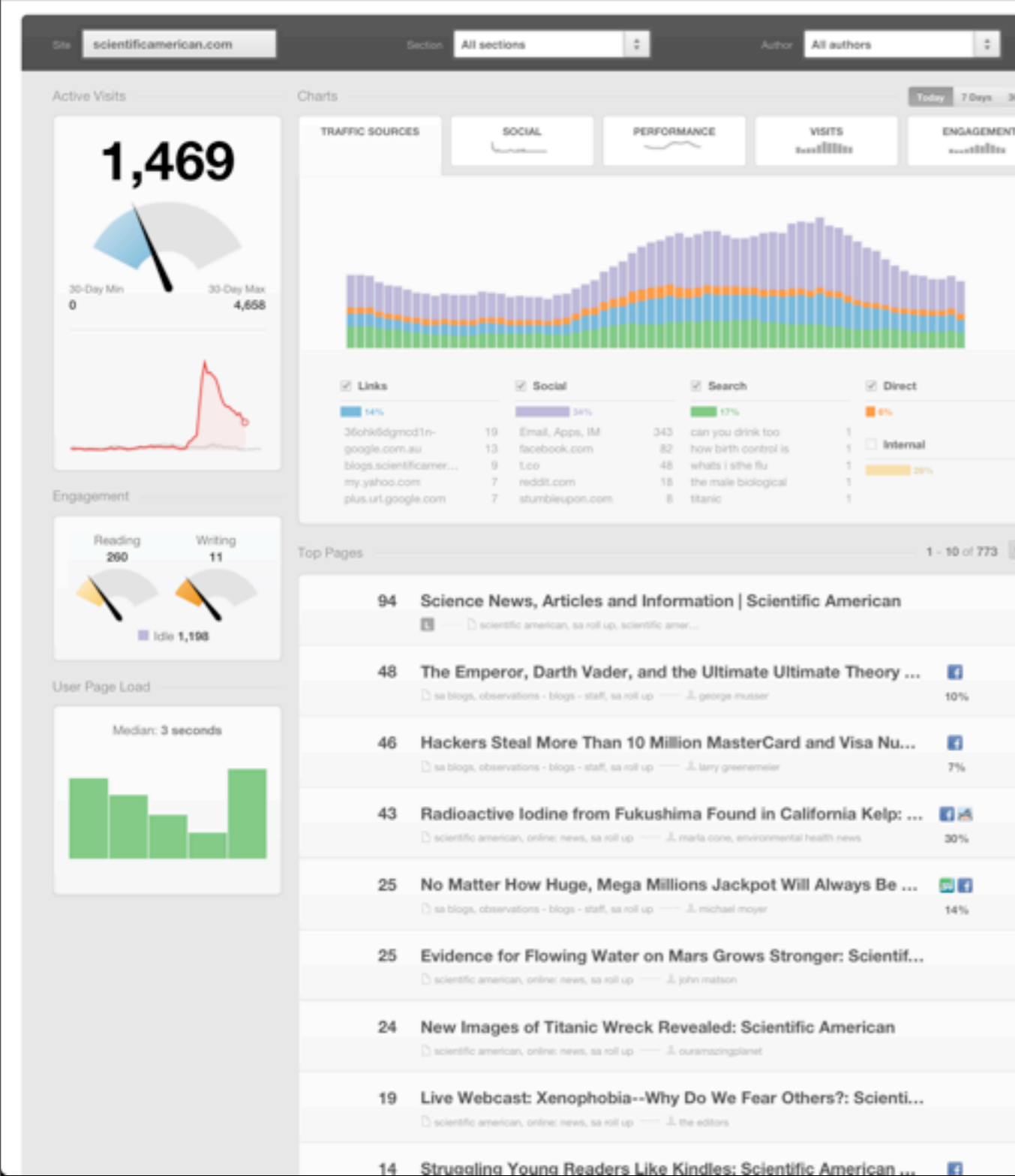
ENTER FOR A CHANCE TO WIN A TRIP FOR TWO

The Emperor, Darth Vader and the Ultimate Ultimate Theory of Physics

By George Musser | March 30, 2012 | 4

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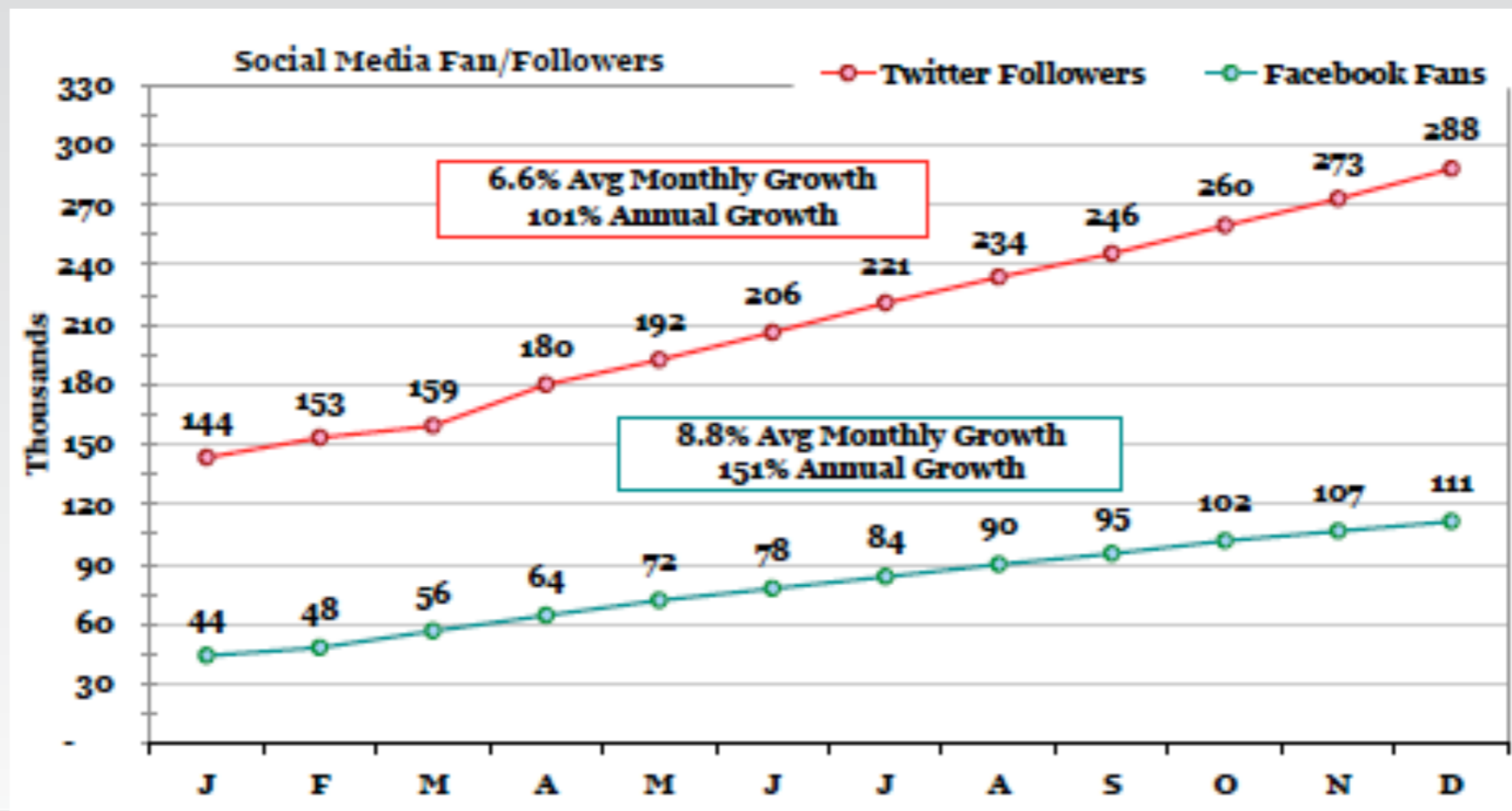
PASADENA—The theory is so obscure there's not a Wikipedia page about it yet. It might be impossible to formulate mathematically. One theoretical physicist calls it the Emperor Palpatine of theories, even more powerful and inscrutable than the Death Star.



30 Mar 12

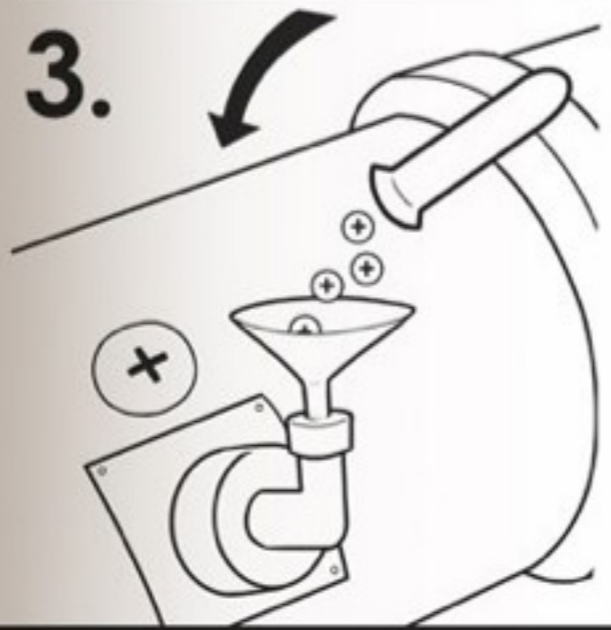
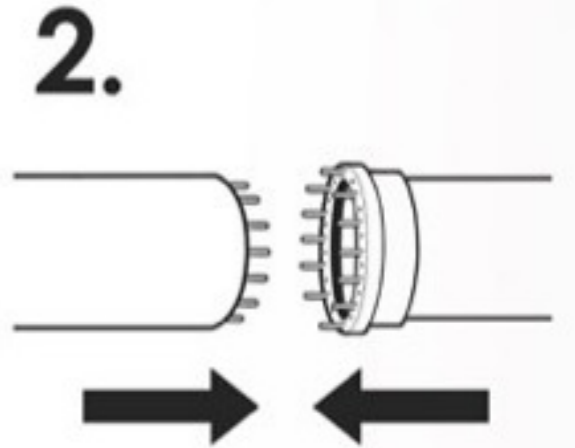
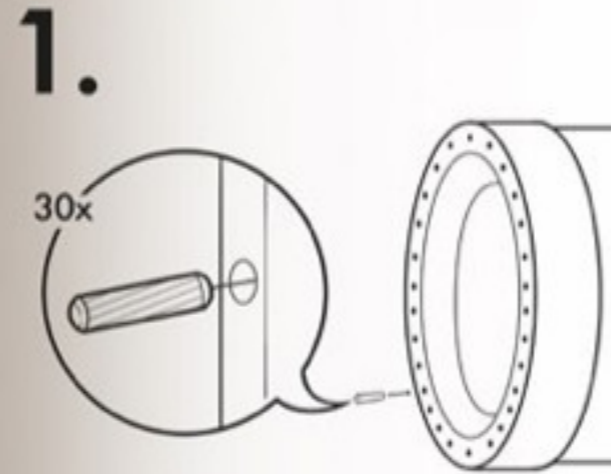
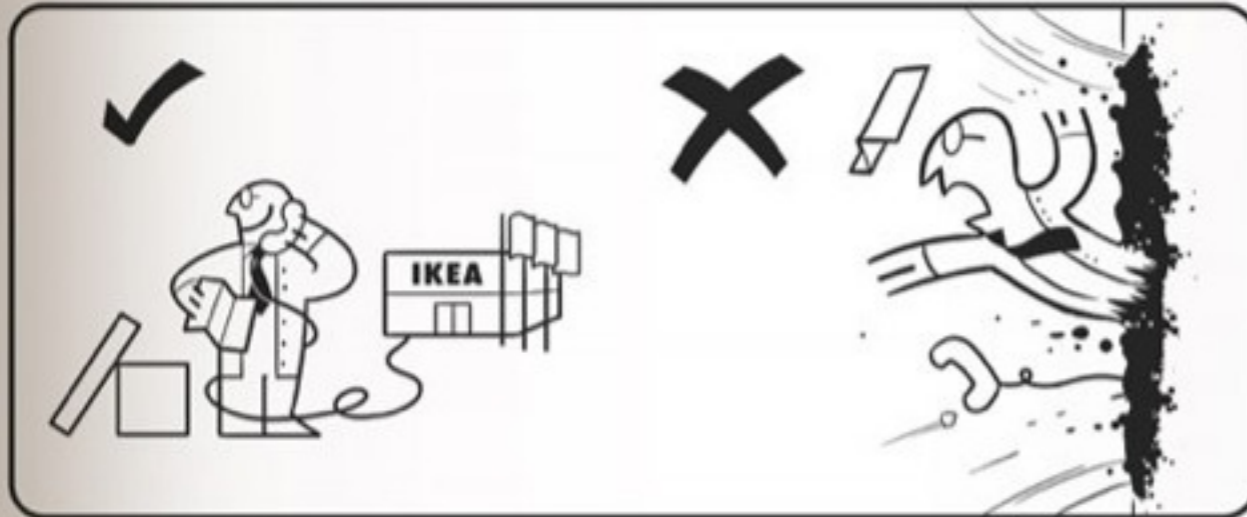
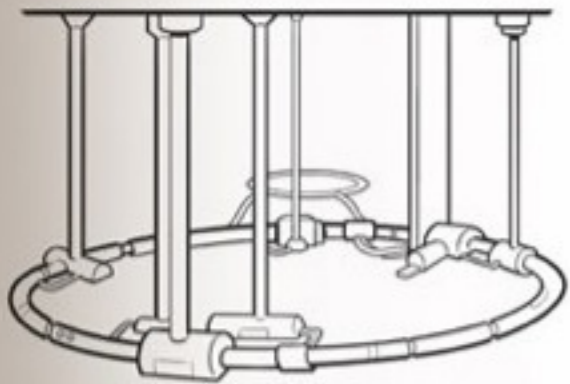
Why They Visit: Social Factor

- Social community referrals +172% (+2.1M)
 - Facebook+Twitter=96% social community traffic
- Social news referrals +82% (+2.8M)
 - StumbleUpon, Reddit, etc.



Thank You!

HÄDRÖNN CJÖLIDDER



<http://8.media.collegehumor.cvcdn.com/90/69/d772520dd7706bb5ed8211e77b187c6f.jpg>