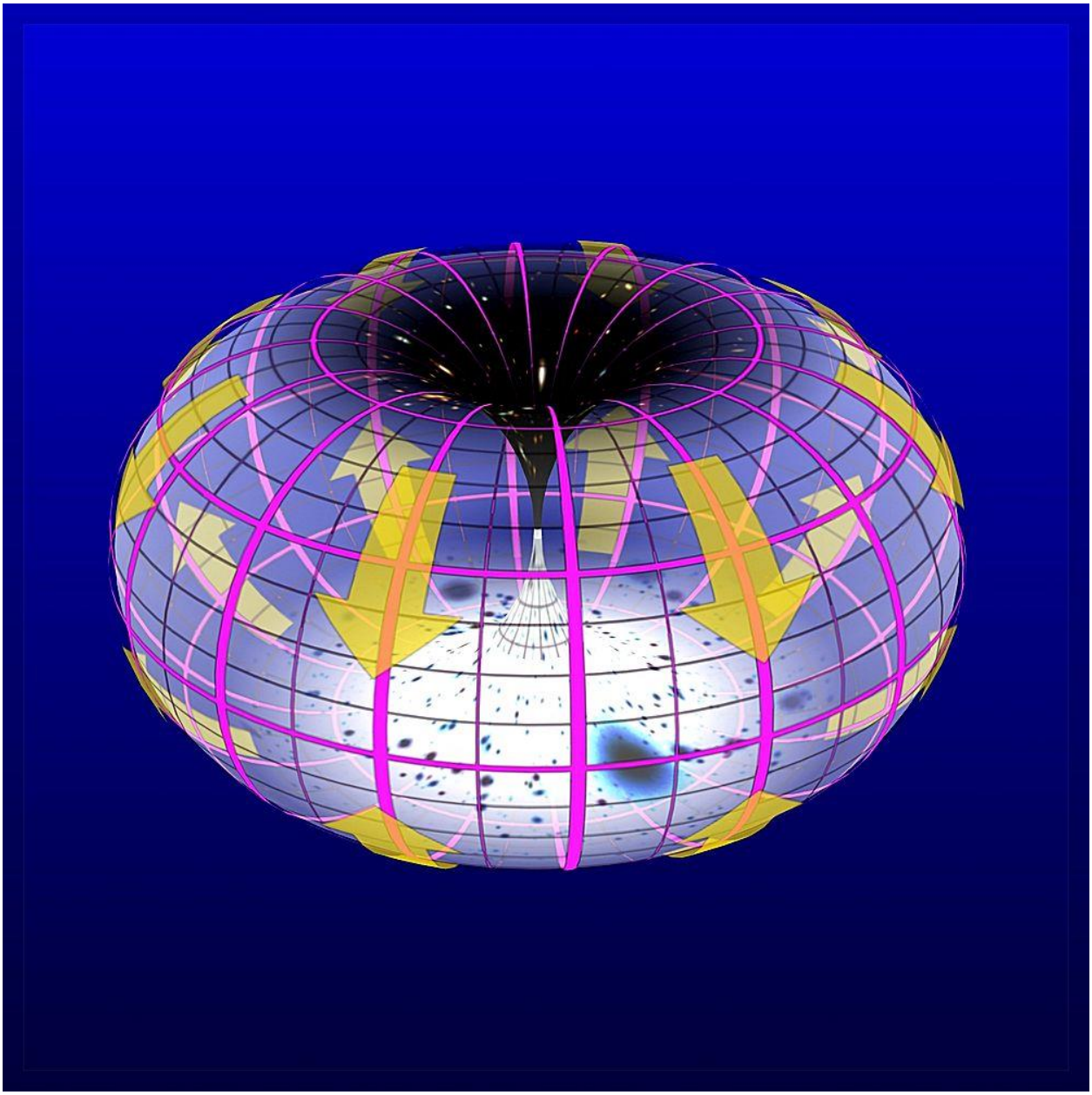
What is Dark Energy?
A Toroidal Model of the Cosmos
The Big Bagel

By Howard Bloom



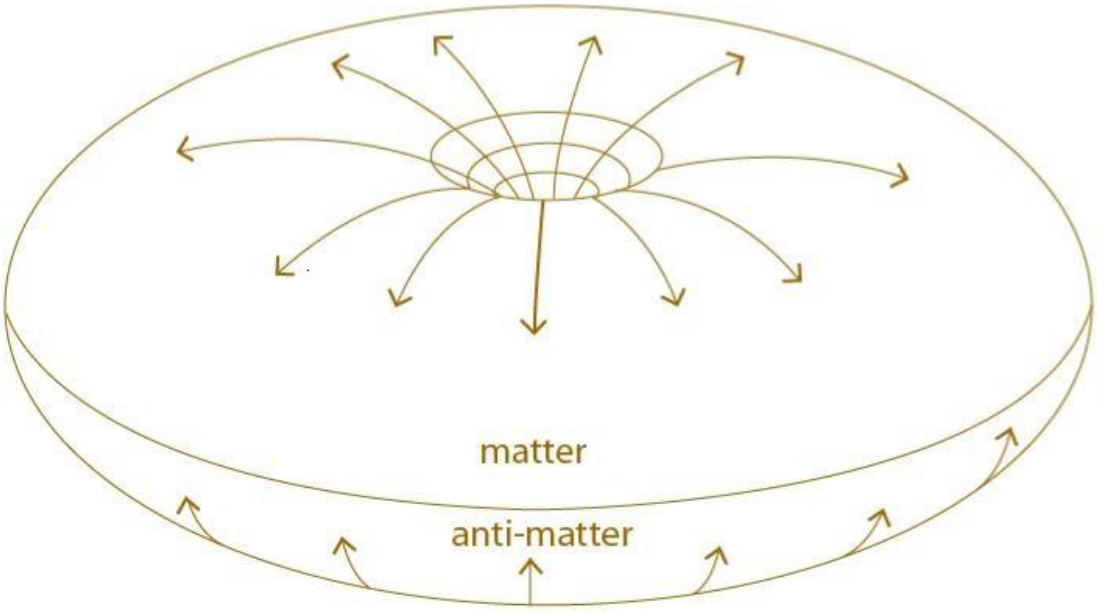
(Illustration: Bryan Brandenburg)

Big Bagel Theory, the Bloom Toroidal Model of the cosmos, is a theory of the beginning, middle, and end of the cosmos. A theory that explains Dark Energy.

Among the many brain-teasers in current science are these:

1) If matter and anti-matter are created simultaneously in equal amounts, why is there so much matter in this universe and so little anti-matter (the parity problem)? And
2) What the heck is dark energy?

The Bloom Toroidal Model of the Universe, aka The Big Bagel, answers both of these questions. And it makes an ominous prediction. According to standard cosmological models, the end of the universe is roughly 100 trillion years away. But according to the Bloom Toroidal Model, the end may be a mere 1.68 billion years down the road.



(Illustration: Sabine Allaeys)

Big Bagel Theory was conceived in 1959, while I was a 16-year-old working at the world's then-largest cancer research facility, the Roswell Park Memorial Institute in Buffalo, NY. I was brainstorming with other Roswell Parkers daily during lunch breaks in the cafeteria on the implications of CPT (charge, parity, and time) symmetry. At the end of the summer, I put the finishing touches on a toroidal theory of the cosmos, Big Bagel Theory, then threw it away, convinced that it was comic-book science. But the theory contained two implicit predictions. And those predictions proved to be accurate.

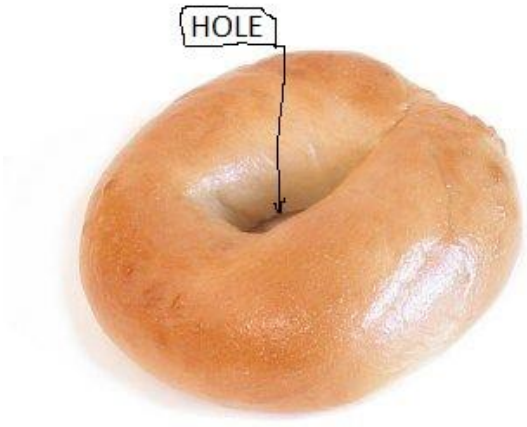
Big Bagel Theory implied an extremely rapid expansion of the universe immediately after the Big Bang, then a slowdown to a more leisurely pace.

In 1980, 21 years after the Big Bagel was conceived, Alan Guth's theory of inflation agreed with prediction number one… an extremely rapid expansion followed by less haste.

Big Bagel Theory also implied that at a certain point, the universe would begin to accelerate away from itself. It implied that the pace of cosmic expansion would pick up and keep adding more speed. That prediction proved accurate in September 1998, 38 years after Big Bagel was conceived, when Reiss et al. found that the cosmos was increasing in its rate of expansion. It was speeding up, accelerating.[1]

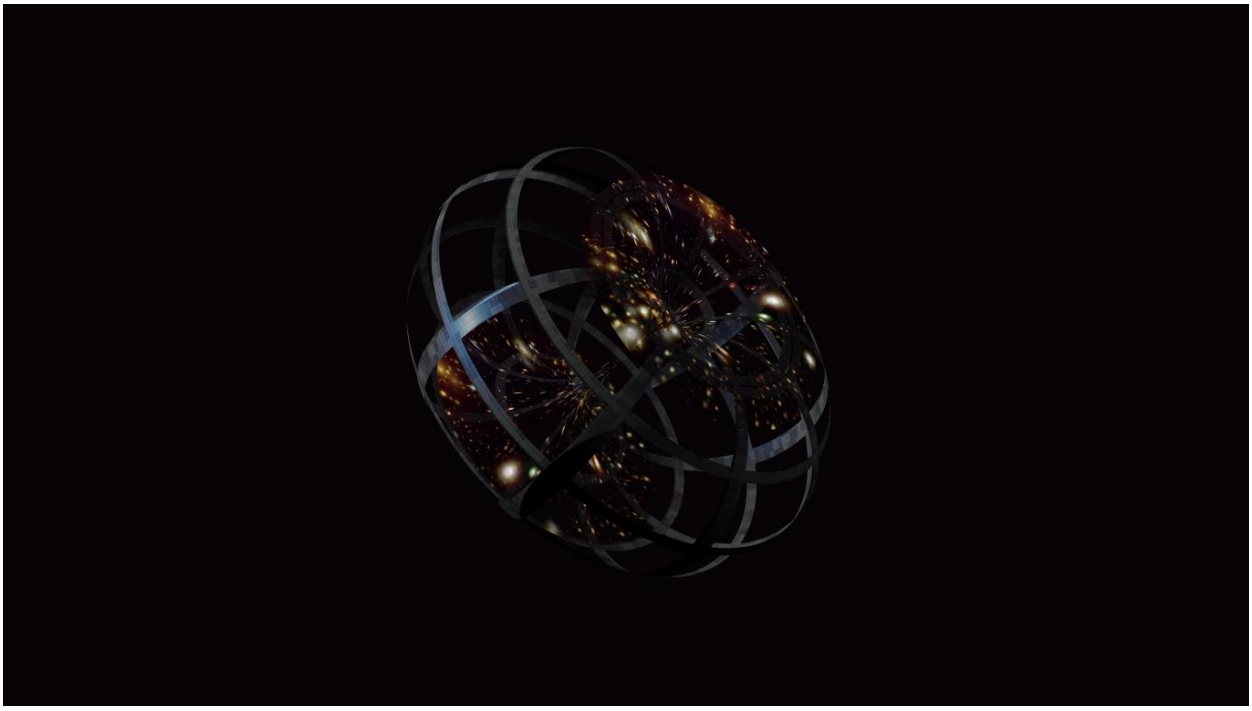
And the Big Bagel gained even more credence a few months after the Reiss discovery when the astronomical community came up with yet another finding. The acceleration started roughly 7.7 billion years into the cosmos's existence, 7.7 billion years ABB, seven billion seven-hundred million years after the big bang.[2]

These discoveries left a question. A huge one. Acceleration takes energy. Where does the energy hastening the cosmos's flight away from itself come from? To answer that question, the physics community resurrected the Cosmological Constant and invented the concept of Dark Energy. But neither of those moves explained where the energy jack-rabbiting the cosmos comes from. Big Bagel theory does.

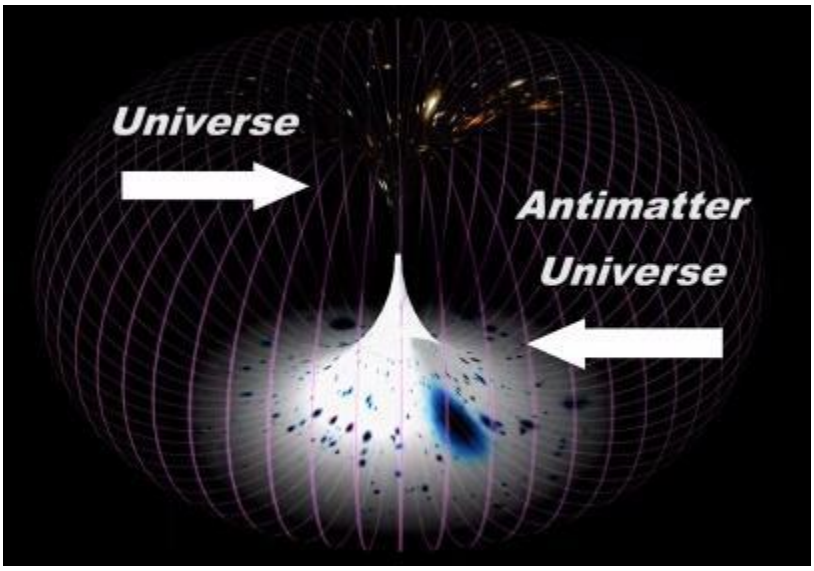


How does Big Bagel Theory work? Imagine a bagel with one of those anally retentive, infinitesimally tiny holes. Your bagel is an Einsteinian manifold, a sheet of time, space, and gravity. It is 13.72 billion years ago. An explosion spurts abruptly from the bagel's hole. Rocketing up the bagel's topside is a big bang of matter. Normal matter. But gushing from the hole on the bottom is an equal and opposite, a big bang of anti-matter. That is where all the anti-matter goes.

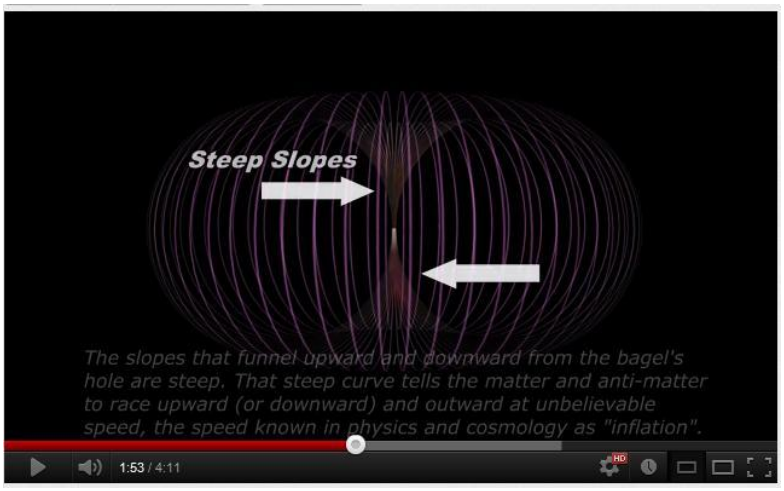
[1] Adam G. Reiss et al., "Observational Evidence from Supernovae for an Accelerating Universe and a Cosmological Constant," *Astronomical Journal* 116, no. 3 (September 1998): 1009-38.
[2] Adam G. Riess and Michael S. Turner, "The Expanding Universe: From Slowdown to Speed Up," *Scientific American*, September 23, 2008, www.scientificamerican.com/article.cfm?id=expanding-universe-slows-then-speeds (accessed September 10, 2011).



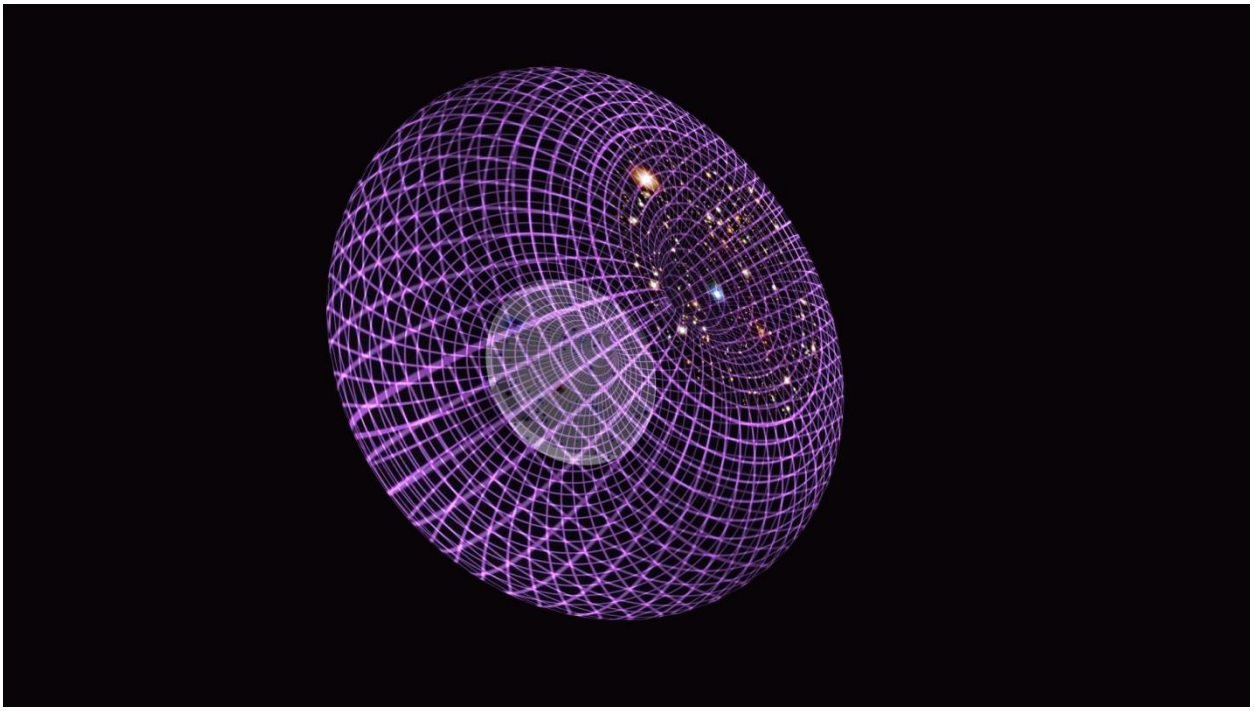
(Illustrations above and below: Bryan Brandenburg)



In Einsteinian manifolds, the shape of space tells matter how to move. A steep slope says move fast. Rush. Race. Speed. The slopes that funnel upward and downward from the bagel's hole are steep. That steep curve tells the matter and anti-matter universes to race upward (or downward) and outward at unbelievable speed, the speed known in cosmology as inflation.



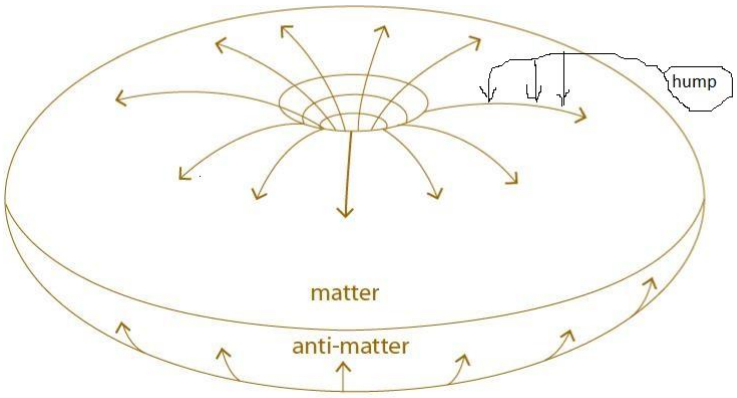
A still from the Bryan Brandenburg animation of Big Bagel Theory on YouTube: www.youtube.com/watch?v=wdJyafSBCb0



(Illustration: Bryan Brandenburg)

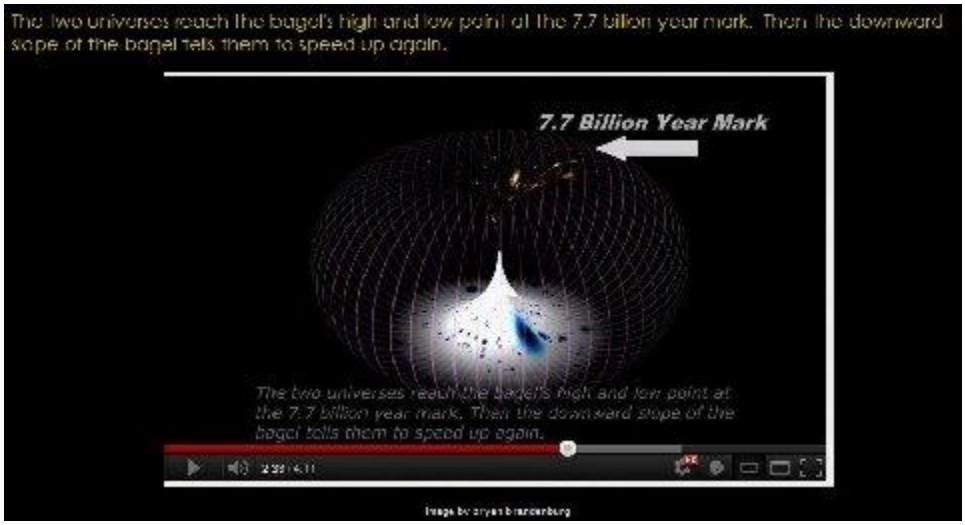
Note the sparkle of the normal matter universe on top. And keep your eye peeled for that white gush on the bottom—the anti-matter universe.

But the traveling orders that space gives to matter change as the two universes approach the flatness of the bagel's upper and under hump. The leveling, horizontal curve of space dictates a more leisurely pace. Like a cannonball reaching the high point of its curve, the universe and anti-matter universe begin to run out of the energy that has shot them apart from each other.



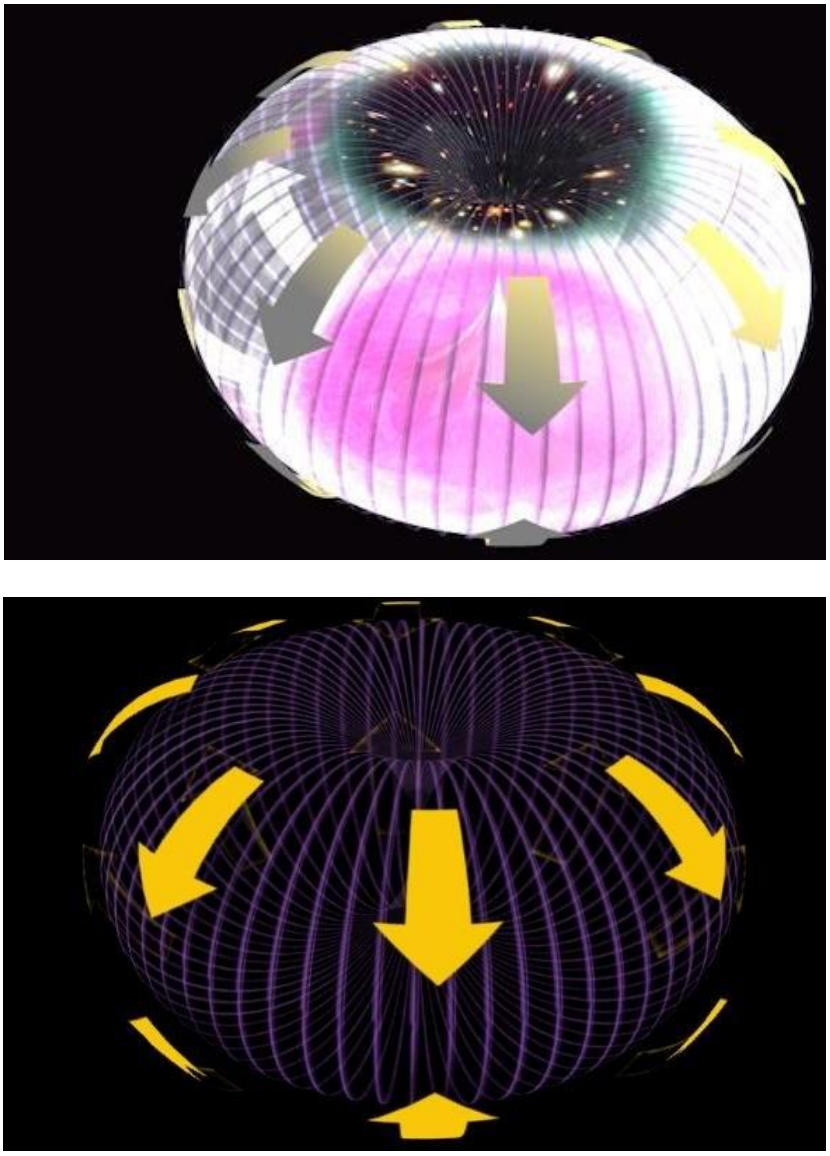
(Illustration: Sabine Allaeys)

Which leads to the second physics question of the day. What is dark energy? The two universes reach the bagel's high and low point at the 7.7 billion year mark. Then the downward slope of the bagel tells them to speed up again. Why do they accelerate? Where does the extra energy that rushes galaxies apart from each other come from? The answer? Gravity.



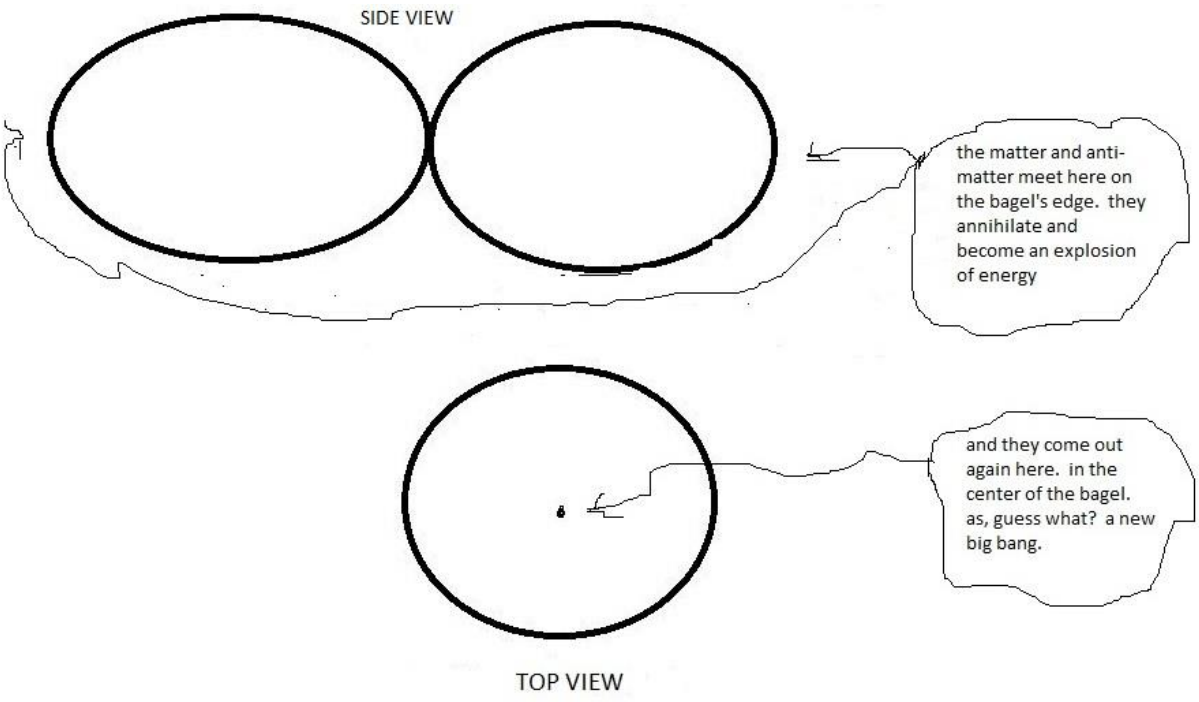
Screenshot from Big Bagel video at www.youtube.com/watch?v=wdJyafSBCb0
(Video: Bryan Brandenburg)

As it slips down the bagel's outer slope, the normal universe falls under the seductive sway of the anti-matter universe's gravity and speeds up. And the anti-matter universe is caught by the come-hither power of the matter universe's gravity. It, too, speeds up.



(Illustrations: Bryan Brandenburg)

How will the universe end? At the bagel's outer edge, the two equal but opposite universes will meet and do what matter and anti-matter always do. They will annihilate. But here is the trick. They will annihilate in a burst of energy. And thanks to a topological trick, the bagel's outer rim is also its center. So the explosion of annihilation will be, guess what? The next big bang.



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Where are we on the bagel in 2012? We passed the bagel's hump 6.02 billion years ago, which puts us perilously close to the big smash at the bagel's outer edge. Roughly 1.68 billion years from that smash.

That is it: the Big Bagel. A Bagel that explains dark energy. A Bagel whose shape hints that the end of the cosmos may be nigh.

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Is there support for the big bagel model? In 1984 at the Landau Institute in Moscow, Dr. Alexei Starobinski studied the data available at that point on the cosmic microwave background radiation and concluded, in the words of the *New York Times*, "that the universe could have been born as a doughnut."[3]

In 2003, Max Tegmark, then a cosmologist at the University of Pennsylvania, now at MIT, used far more sophisticated data on the fluctuations in the cosmic background radiation, data from NASA's Wilkinson Microwave Anisotropy Probe, to consider toroidal models in articles in *Science*[4] and in one of the top journals in physics, the American

[3] Dennis Overbye, "Universe as Doughnut: New Data, New Debate," *New York Times*, March 11, 2003, www.nytimes.com/2003/03/11/science/universe-as-doughnut-new-data-new-debate.html (accessed April 16, 2011).
[4] M. Tegmark, "Measuring Spacetime: From the Big Bang to Black Holes," *Science*, May 24, 2002, 1427-33.

Physical Society's *Physical Review D*.[5] Tegmark's work and that of many others hit the *New York Times* in a March 11, 2003 story headlined "Universe as a Doughnut: New Data, New Debate." But in the end, Tegmark "ruled out" what even he called the "bagel" model.[6]

Then the cosmic doughnut hit the headlines again in 2008, this time on the prestige British science journal *Nature*'s news site. A German team led by Frank Steiner had run the data from the Wilkinson Microwave Anisotropy Probe through four different forms of analysis[7] and had concluded that "the doughnut gave the best match to the Wilkinson Microwave Anisotropy Probe data."[8]

So the toroidal shape, the bagel shape, was being kicked around. Not in the form I proposed it. Not with two universe separating, then crunching together again. But nonetheless the bagel was in play.

Then there is another aspect of the big bagel theory, the idea of two universes on two separate surfaces saying goodbye to each other and eventually getting back together again: the idea of the matter universe climbing from the bagel's hole up its topside and the antimatter universe sliding down from the hole on the bagel's bottom side.

Several concepts arose that support the notion of two universes on different but adjacent surfaces. Surfaces like the bagel's bottom and the bagel's top. One is the idea of a Saran Wrappish sort of surface that comes from string theory. It's called a brane—named for a membrane. A brane is thin, like plastic wrap. And an entire universe rides on each brane, on each Saran Wrappish sheet.

Princeton's Paul Steinhardt and the director of the Perimeter Institute, Neil Turok, have one brane-based theory that is very reminiscent of the big bagel.[9] In Steinhardt and Turok's model, there are two of these plastic-wrap thin branes. There are two universes a hair's breadth apart. They are separate universes, blithely unaware of each other's existence. Unaware except for one small fact. Dark Energy is a force that pulls them together. Periodically they bump into each other. Yes, every once in a while they collide. And each time they collide, they set off a big bang whose energy sends them rushing away from each other again. So they alternate between big bangs and big crashes. As it says in my 2012 book *The God Problem: How a Godless Cosmos Creates*, "Does this sound big bagelish?"[10]

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[5] A. de Oliveira-Costa, M. Tegmark, M. Zaldarriaga, and Andrew Hamilton, "Significance of the largest scale CMB fluctuations in WMAP," *Physical Review D* 69, 063516 (2004).
[6] Ibid.
[7] Ralf Aurich et al., "Do We Live in a 'Small Universe'?" *Classical Quantum Gravity*, June 21, 2008.
[8] Zeeya Merali, "Doughnut-Shaped Universe Bites Back: Astronomers Say Universe is Small and Finite," *Nature*, May 23, 2008.
[9] Paul L. McFadden, Neil Turok, and Paul J. Steinhardt, "Solution of a Braneworld Big Crunch/Big Bang Cosmology," *Physical Review D* 76, 104038 (2007); Ron Cowen, "Pre-Bang Branes and Bubbles: What Happened Before the Big Bang?" *Science News*, April 23rd, 2011, 22.
[10] Op. cit., 550.

What's more, there are existing cyclic models of the cosmos.[11] Models in which the cosmos annihilates, then is reborn in a new big bang. Martin Bojowald's cosmos[12] is one of these. The University of Pennsylvania loop quantum gravity cosmologist proposes a model in which "branes approach collision and bounce back without actual collision."[13] That near head-on crash ends one universe and starts another one.

In another line of thought that supports the Bloom Toroidal Model, New York University's Georgi Dvali[14] suggests that gravity may leak from branes, an idea that goes one more small step toward the idea that separate universes on separate branes may be able to communicate with each other. One small step toward a universe on the top of a bagel beckoning to a universe on the underside with gravity.

Then there is Alexander Kashlinsky, a senior staff scientist at NASA's Goddard Space Center, who has measured the motion of nearly eight hundred galaxy clusters against the backdrop of the cosmic background radiation and has spotted what he calls "dark flow"—a speed-rush of galaxies that seems to defy the assumptions of what is called the "conventional model" of the cosmos. This rush of galaxies seems to be hurrying toward a goal, and, to Kashlinsky, it seems to hint at something "tugging" on them.

And cosmologists like Anthony Aguirre of the University of California, Santa Cruz, believe that if dark flow is for real, it could be evidence for what Aguirre calls "other universes." Could Kashlinsky's tug come from the pull of just one other universe—an antimatter universe on the bottom of the bagel?[15] And could the antimatter cosmos on the underside of the bagel be responsible for the galaxies' unaccountable speed?

The bottom line? There are a lot of cyclic universe theories doing the rounds. But the big bagel appears to be alone in something crucial: explaining dark energy.

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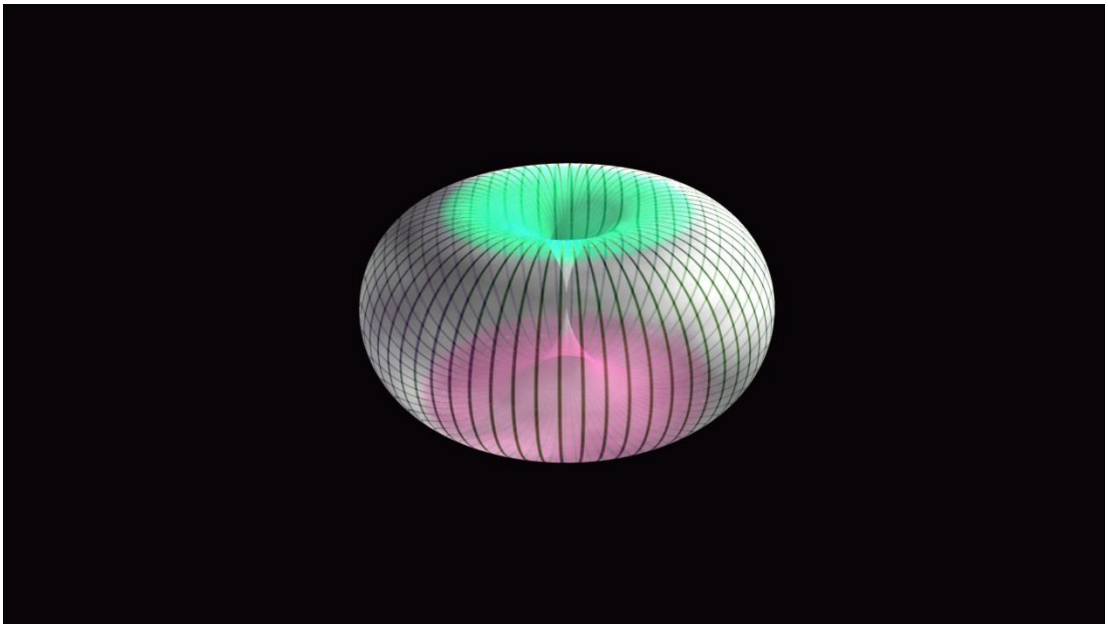
[11] Roger Penrose, *Cycles Of Time: An Extraordinary New View of the Universe* (New York: Random House, 2011); Theo Koupelis, *In Quest of the Universe* (Sudbury MA: Jones & Bartlett, 2011), 532.

[12] Martin Bojowald, *Once Before Time: A Whole Story of the Universe* (New York: Knopf, 2010, Kindle Edition).

[13] Martin Bojowald, Roy Maartens, and Parampreet Singh, "Loop Quantum Gravity and the Cyclic Universe," *Physical Review D* 70, 083517 (2004).

[14] Cédric Deffayet, Gia Dvali, and Gregory Gabadadze, "Accelerated Universe from Gravity Leaking to Extra Dimensions," *Physical Review D* 65, 044023 (2002); Ron Cowen, "Dark Doings Searching for Signs of a Force that May Be Everywhere… or Nowhere," *Science News Online*, May 22, 2004.

[15] Amanda Gefter, "Dark Flow: Proof of another Universe?" *New Scientist*, January 23, 2009, 50-53.



(Illustration: Bryan Brandenburg)

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About the Author: Howard K. Bloom is author of*: The Lucifer Principle: A Scientific Expedition into the Forces of History* ("mesmerizing": *The Washington Post*), *Global Brain: The Evolution of Mass Mind From The Big Bang to the 21st Century* ("reassuring and sobering": *The New Yorker*), *The Genius of the Beast: A Radical Re-Vision of Capitalism* ("Impressive, stimulating, and tremendously enjoyable": James Fallows, *The Atlantic*), and *The God Problem: How A Godless Cosmos Creates* ("Bloom's argument will rock your world": Barbara Ehrenreich).

Photos by Jondi Whitis (left) and Radic Smykowski (right)

Editor's Notes: Howard K. Bloom is a treasure to the Space Community. Author, Scientist, Founder of the Space Development Steering Committee, Publicist, Author on human evolution, Member of the Journal of Space Philosophy Board of Editors, and supporter of Kepler Space Institute and University since its founding. His bio is fascinating and part of it can be found at www.en.wikipedia.org/wiki/Howard_Bloom. *Bob Krone, PhD*.