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# *Futurama* π*k*
## Mathematics in the year 3000

**Tom Georgoulias**
Austin, TX
**Sarah J. Greenwald**
Appalachian State University
**Marc Wichterich**
RWTH Aachen University, Germany

*Futurama* is a rare exception in broadcast television—a satirical science fiction cartoon that aims its jokes squarely at the top of the brow, yet allows those brainy zingers to thrive among gags that fall further below. Developed by a writing crew of ex-scientists and assorted bright folks, *Futurama* follows the exploits of Fry, a young, unmotivated pizza delivery boy whose boredom with his life ends when he accidentally falls into a cryogenic chamber. Fry is awakened 1000 years later, in the year 3000, and realizes that he now has a chance to change his life and pursue whatever he wants to. Or so he thinks. Fry quickly learns that all "defrostees" are greeted with permanent career implant chips, and the future really isn't as limitless as he expected. He makes his escape with Leela, a beautiful one-eyed mutant whose original job was to implant career chips, and Bender, an easily corrupted robot who drinks Olde Fortran 800 Malt Liquor and walked off his job as a steel bending unit. The three take jobs with Fry's great-great-…-great nephew Professor Farnsworth, a senile scientist with a soft spot for wacky inventions and the owner of the Planet Express Delivery Company, and journey between the far reaches of the universe and the well-worn couch in the employee lounge.

*Futurama* is especially fun to watch because math, science, or programming references seem to appear in almost every episode. Here we examine the motivation for these references as we present some of our favorites.

One math reference takes advantage of Fry's 1000 years of cryogenic sleep. In the episode *A Fishful of Dollars*, Fry wonders if his bank account is still open.

**Bank teller:** Ok... You had a balance of 93 cents.

**Fry:** All right!

**Bank teller:** And at an average of two and a quarter percent interest over a period of 1000 years, that comes to... 4.3 billion dollars.

[Fry hyperventilates, drools and then faints.]


(Left) Bender 1729, Volume 2 DVD, *Xmas Story*. (Right) So Many Movie Choices, Volume 2 DVD, *Raging Bender*.

In the DVD audio commentary for this episode, executive producer and head writer David X. Cohen discusses the validity of the 4.3 billion dollar figure. The writers performed the calculation three different times on a palm pilot in order to make sure that it was correct (when rounded). Perhaps this reference is a nod to Benjamin Franklin, who left 1000 pounds each to Philadelphia and Boston, although this possible connection is not mentioned in the commentary. Franklin's plan was that the fund would gather interest over a period of 200 years by loans made to apprentices. While there were problems with this scheme, each city did end up with a lot of money. In the DVD commentary, Cohen also mentions that two *Futurama* staff members have degrees in mathematics.

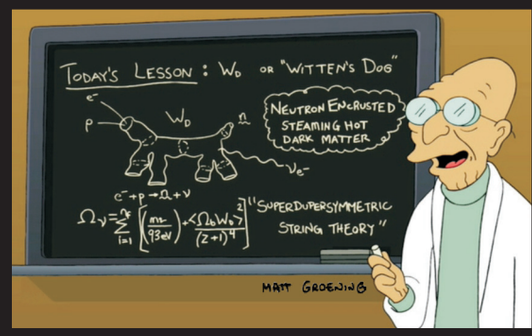
One of these mathematicians is executive producer and writer Ken Keeler, who has a PhD in applied mathematics from Harvard University. Ken Keeler recently won the 55th Annual Writers Guild Award in the animated program category for the episode *Godfellas*. He discusses his transition from mathematics to comedy writing in an interview with fan website Can't Get Enough *Futurama*.

**Can't Get Enough *Futurama*:** Executive Producer David X. Cohen said in an interview that you have a PhD in Applied Math and a Masters in Electrical Engineering. How does one go from there to writing for TV shows?

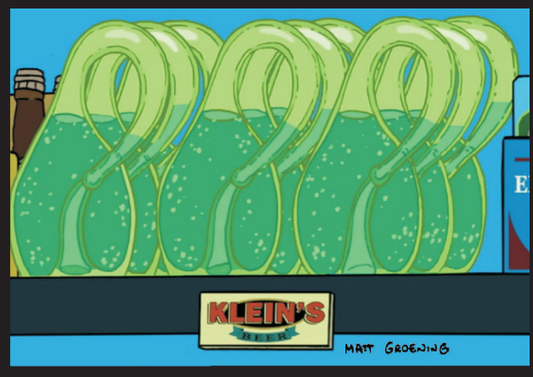
**Ken Keeler:** Short version: when I was finishing my doctoral dissertation, there were many, many new PhD's applying for very few research and academic jobs; meanwhile, people I knew from my college comedy-writing days were getting great TV jobs. So as a crazy form of bet-hedging, I applied to the old David Letterman show (in those days you didn't need an agent at Letterman). Before hearing from them, I got a great research job at Bell Labs—and then got contacted by the Letterman people with an offer. I felt like if I didn't try writing now, I'd regret it the rest of my life. So after a year at Bell Labs, I went to Letterman. I've regretted it the rest of my life.

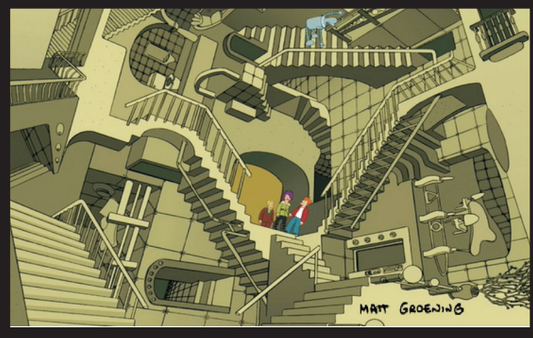
**Can't Get Enough *Futurama*:** Did it ever pay off to go through all these years of education?

**Ken Keeler:** Well, sure. For example, Bender's serial number is 1729, a historically significant integer to mathematicians everywhere; that "joke" alone is worth six years of grad school, I'd say.








(Top) Superdupersymmetric String Theory, Volume 1 DVD, *Mars University*. (Second) The resolution of $P = NP$, Volume 2 DVD *Put your Head on my Shoulder*. (Third) "Klein's beer" in a 3-D Klein Bottle, Volume 3 DVD *The Route of all Evil*. (Bottom) Fry considers an apartment that resembles Escher's 1953 "Relativity." Fry: "I'm not sure we wanna pay for a dimension we're not gonna use." [Bender falls down the staircase and continues to fall "down" the other staircases in many different directions.] Volume 1 DVD *I, Roommate*.

Keeler refers to the episode *Xmas Story*, written by Cohen, in which Bender receives a card from the machine that built him wishing "SON #1729" a Merry Christmas.

The number 1729 is sometimes referred to as the "Ramanujan-Hardy" number. British mathematician G.H. Hardy, impressed by his correspondences with the untrained Indian mathematician Srinivasa Ramanujan, invited Ramanujan to Cambridge for collaboration. One day, Hardy took a cab to visit Ramanujan and commented that his taxicab number, 1729, was rather dull. Ramanujan quickly replied that 1729 was in fact a very interesting number since it was the smallest number that could be written as the sum of two cubes in two different ways:

$$1729 = 9^3 + 10^3 \text{ and } 1729 = 1^3 + 12^3.$$

The number 1729 also appears in many episodes of *Futurama* on the hull of the space ship called the Nimbus, and as the reference number of the universe populated by "bobble head" characters in the episode *The Farnsworth Parabox*.

The sum of two cubes also comes up in the episode *Lesser of Two Evils*, when Bender and fellow robot Flexo compare their identification numbers and laugh about how both of them, 2716057 and 3370318, are expressible as the sum of two cubes.

Another numerical reference occurs as the name of a movie theatre called Loew's $\aleph_0$-plex in the episodes *Raging Bender* and *I Dated a Robot*.

The symbol $\aleph_0$ refers to the transfinite cardinal number that is assigned to the countably infinite set of positive integers {1, 2, 3, … n, …}. Since the theatre complex is an $\aleph_0$-plex, the movie titles can be put into an ordered list that goes on forever. If we assume that each screen shows a different movie, then even if Fry somehow manages to see 10,000 movies, he would never run out of movie choices since there would still be infinitely many movies left to see.

David X. Cohen discusses the inclusion of science within *Futurama* episodes in an interview with website `frontwheeldrive.com`.

**frontwheeldrive:** What influences do you draw upon in creating both the stories and science and technology for each episode?

**David X. Cohen:** One of the first rules that Matt Groening and I agreed upon for writing Futurama was, "Science shall not outweigh comedy." Still, we wanted to get in as much science as possible where it didn't clog up the gears of the story…

Now and then, we throw in some pretty obscure science references when and where we think they won't distract the casual viewer. For example, my friend David Schiminovich, an astrophysicist at Caltech, has provided comedy particle physics diagrams for a chalkboard seen in the background of one episode. We've also referred to the *P = NP* question and the Heisenberg uncertainty principle.

Our hope is that, although such material will fly by most people unnoticed, it might make die-hard fans of the people who do appreciate it.

I should also mention that we have several genuine ex-scientists on our writing staff: Ken Keeler has a PhD in Applied Math and a Masters in Electrical Engineering; Bill Odenkirk has a PhD in Inorganic Chemistry; and Jeff Westbrook has a PhD in Computer Science.

I'm actually somewhere in the middle of the pack, educationally! It's really a privilege working with such knowledgeable and interesting people. I think it helps me keep my sanity, since outside of our writing room there isn't such a high concentration of scientists in the TV industry. And I do still consider myself a scientist by nature.

Cohen has a bachelor's degree in physics from Harvard University and a master's degree in computer science from UC Berkeley. Cohen mentions a chalkboard containing comedy particle physics diagrams. The chalkboard can be found in the episode *Mars University*, which was written by producer and writer J. Stewart Burns. Burns has a bachelor's degree in mathematics from Harvard University and a master's degree in mathematics from U.C. Berkeley. Burns also wrote *Roswell that Ends Well*, an episode that won an Emmy in 2002, and he is the other mathematician on staff referred to by Cohen. While the Harvard connection to comedy writing is well known, the presence of comedy writers in Hollywood with mathematics in their background may seem surprising to some people. However, this confirms what we already knew, that people with mathematics degrees have many options after graduation.

In this episode written by Burns, Fry is confronted with the fact that even though he briefly attended college in the 20th century, this is the equivalent of being a high school dropout by 30th century academic standards. In the hopes of becoming a Mars University dropout, he begins enrolling in some courses.

**Fry:** Hey Professor, what are you teaching this semester?

**Prof. Farnsworth:** Same thing I teach every semester, the mathematics of quantum neutrino fields. I made up the title so that no student would dare take it.

**Fry:** [writing] Mathematics of wonton burrito meals. I'll be there!

**Prof. Farnsworth:** Please Fry, I don't know how to teach—I'm a professor.

**Fry:** See you in class.

**Prof. Farnsworth:** [groaning] Oh...

Later on, Professor Farnsworth is seen teaching to an empty room as Fry arrives late to class.

Supersymmetric string theory (see top image on page 13) is an actual branch of mathematical physics, but the "duper" is

listed for comic effect. Ed Witten is famous for his discoveries in mathematics using observations from physics. He even won mathematics' highest award, the Fields medal, for his work. Witten and other physicists collaborate with mathematicians on problems in string theory. The diagram of the dog is similar to a string scattering diagram, a string theory analogue of a Feynman diagram, representing particles combining or decaying. However, instead of the dog-shaped diagram in the picture, string theorists typically look at diagrams that resemble a pair of pants, or two pairs of pants sewn together at the waist. "Witten's Dog" is a parody of "Schroedinger's cat," a famous paradox in quantum physics. The equation on the bottom left-hand side of the board appears to resemble an astrophysics equation that constrains the mass density of neutrinos in the universe.

Fry is clearly in over his head and is certainly on his way to achieving his goal of becoming a college dropout.

The question about whether $P = NP$ occurs in the episode *Put your Head on my Shoulder*, written by Keeler. After a serious car accident, Fry's life is saved when his head is grafted onto the body of his soon to become ex-girlfriend Amy. In the background, a book labeled as $P$ is seen sitting next to a book labeled as $NP$.

Stephen Cook and Leonid Levin formulated the $P$ versus $NP$ problem independently in 1971. The $P = NP$ question asks whether all problems solvable in polynomial time by a nondeterministic algorithm that can guess the right way at all decision points ($NP$ problems) can also be solved in polynomial time by a deterministic algorithm which lacks that oracle capability ($P$ problems). In other words, nondeterministic algorithms with oracle capabilities (which for now only exist in thought experiments) have a "magic" way of guessing the right computation path whenever there is a choice to be made from a finite set of possibilities. Meanwhile, deterministic algorithms lack a guessing mechanism and have to explore paths according to some strategy. So, if $P = NP$, then every problem that can be checked with a nondeterministic algorithm can also be solved through one we can actually implement. Scientists have been looking for either a problem that is in $NP$ but not in $P$ or a proof that there is no such problem. A $1,000,000 prize has been offered to anyone who can prove whether or not $P$ equals $NP$. If we had the books from *Futurama* that supposedly list the problems in each class, then we could compare them, see if the $NP$ book lists any extra ones, and collect our prize money.

A Heisenberg Uncertainty Principle joke appears in the episode *The Luck of the Fryish*, where the Planet Express Crew is betting on horse races at the track.

**Announcer:** And it's a dead heat. They're checking the electron microscope and the winner is… number three, in a quantum finish.

**Prof. Farnsworth:** No fair! You changed the outcome by measuring it!

The Heisenberg principle, formulated in 1927, says that uncertainties show up if one tries to measure the position and momentum of a particle at the same time. The more certain one is about the position, the less certain one can be about the momentum and vice versa.

Even differential equations provide comic relief in *Futurama*. In *Fear of a Bot Planet*, Fry and Leela, captain and friend, dress up as robots as they try to save Bender who has called for help from a planet inhabited by robots that hate humans.

**Leela:** OK. If we're gonna save Bender we've got to look and act exactly like robots.

**Fry:** [in a monotone voice] I am fully operational, Captain.

**Leela:** We'll have to walk like robots, talk like robots, and if necessary, solve complex differential equations like robots.

**Fry:** I can sort of dance like a robot, will that help?

If you think the fun is over and we've revealed all of the clever jokes that *Futurama* has up its sleeve, think again. The math and science references used in *Futurama* are too numerous to count, and the examples we have presented in this article have only scratched the surface. It is left as an exercise for the reader to tune into the show and find others, then share them with other fans on the internet (see Acknowledgments and Further Reading). Sadly, Fox has decided not to order any new episodes of *Futurama*. This leaves fans with the options of enjoying the show through the DVD boxed sets or watching re-runs on the Cartoon Network. Those viewers who do take the time to tune in will find their brains and funny bones richly rewarded. ■

## Acknowledgments and Further Reading

Thanks go to Amy Ksir for helpful conversations and to Shari Rosenblum and Twentieth Century Fox for permission to use their DVD images.

To learn more about *Futurama*, and order DVDs, visit `http://www2.foxhome.com/futurama`. Excerpts from this article came from `http://frontwheeldrive.com/david_x_cohen.html` and `http://www.gotfuturama.com/Information/Articles/Ken_Keeler_Interview.dhtml`. Also see `http://www.mathsci.appstate.edu/~sjg/simpsonsmath/futuramamath/`.