"Gina Says"

Adventures in the Blogosphere's

String War

Selected and edited by: Gil Kalai

Debates portrayed in books, are the worst sort of readings, Jonathan Swift.

Preface

In the summer of 2006 two books attacking string theory, a prominent theory in physics, appeared. One by Peter Woit called "**Not even wrong**" and the other by Lee Smolin called "**The trouble with Physics**." A fierce public debate, much of it on weblogs, ensued.

Gina is very curious about science blogs. Can they be useful for learning about, or discussing science? What happens in these blogs and who participates in them? Gina is eager to learn the issues and to form her own opinion about the string theory controversy. She is equipped with some academic background, even in mathematics, and has some familiarity with academic life. Her knowledge of physics is derived mainly from popular accounts. Gina likes to debate and to argue and to be carried by her associations. She is fascinated by questions about rationality and philosophy, and was exposed to various other scientific controversies in the past.

This book uses the blog string theory debate to tell about blogs, science, and mathematics. Meandering over various topics from children's dyscalculia to Chomskian linguistics, the reader may get some sense of the chaotic and often confused scientific experience. The book tries to show the immense difficulty involved in getting the factual matters right and interpreting fragmented and partial information.

Gina's writings on the blogosphere were selected and edited by Gil Kalai, Professor of Mathematics and member of the Center for the Study of Rationality at the Hebrew University of Jerusalem and Professor of Computer Science and Mathematics at Yale University. (The original blog postings were often shortened.) Small academic pieces associated with the blog discussions, were added with the help of some colleagues (and Wikipedia). Let me mention especially the help of Professors Avishai Margalit, Itamar Pitowski, Oded

Schramm, and Edna Ullmann-Margalit. Anat Lotan edited the English and contributed two chapters, and Mike Borns assisted with scientific editing.

This is a draft; remarks are welcomed!

Links can be followed by pushing the Ctrl key and clicking on them.

Content:

Prologue: String theory and the debate surrounding it

What is string theory? String theory is a very ambitious (yet incomplete) answer to the problem, prevalent on the minds of physicists for almost a century, of bringing together quantum theory and Einstein's theory of gravitation. String theory is delicate enough to include (at least in principle) the successful twentieth-century physics theories of elementary particles. (The "standard model" refers to the description given by these successful theories for the three out of four fundamental forces in nature, and for the particles associated to these forces.) Although string theory is far from complete, some of its insights are surprisingly detailed and robust.

Is it possible that string theory a major physics theory, described as a crowning intellectual human achievement, is simply false, and the efforts of thousands of brilliant researchers for more than two decades have been misguided? Even worse, is it the case that string theory fails even lead to any predictions and cannot be regarded as a scientific theory? Has this failure been covered up by prominent scientists who simply ignore the evidence in front of them, use their stature to promote failed ideas, and artificially hype them while basically refusing to admit failure? Are these scientists ready to modify the definition of science, scientific standards, and the ethics of science, just to have it their way? And could it be that they not only failed, but even led to the fall of science as a whole? Such claims against string theory have been heard on occasion in the last two decades. The books by Peter Woit and Lee Smolin that appeared in the summer of 2006 put together various strong arguments against string theory as well as against the social aspects of academic life and universities, and ignited a fierce public debate.

This book is not about string theory. String theory and the debate around it are the envelope for the events and issues described in this book. It may be useful, however, to describe at this point some of the major insights of string theory. The reader who wish to proceed directly to the debate, even knowing as little as Gina knew when she got into it, may proceed directly to Chapter 1 and consult when needed this chapter and the little dictionary following it for additional background.

Some of the major insights of string theory can be described as follows:

1) Point particles are replaced by strings, one-dimensional geometric objects. In later variants of the theory, more general geometric objects called branes also play a role.

2) These strings exist in a high-dimensional space. In other words, in addition to the familiar three dimensions of our world and the one dimension needed to describe time, there are additional six (or more) tiny dimensions.

3) String theory is based on "supersymmetry," a new form of symmetry for the laws of physics.

While these three basic insights of string theory are already quite confusing and may look rather strange, the next four insights use jargon which we ask the reader to take for granted. Detailed popular explanations appeared in various books and article, like Briane Green's best seller "the elegant universe." (We will return to "high dimensions" and some of the other technical notions later in the book.)

4) The additional six dimensions are described by mathematical objects called "Calabi-Yau manifolds."

5) String theory also offers "dualities," which is a name for deep connections between different string theories. Dualities discovered by string theorists revolutionized some areas of mathematics.

6) Another important insight of string theory is that of a mysterious "M-theory," which unifies various models for string theory into a single entity

7) Finally, there is an extended (huge) family of different universes described by string theory. This phenomenon is referred to as the "landscape of vacua of string theory." This discovery has led to various foundational questions regarding string theory as a scientific theory, both among string theorists and among its critics

All these insights are, to some extent, "negotiable." There are variations of string theory, where a few of these ingredients are omitted and replaced by others.

The technical study of string theory is, of course, not based on these verbal descriptions (nor even on the far more detailed descriptions that can be found in several popular books), but on complicated mathematical formulations of these and related ideas. Some of the critique on string theory is very technical, but much of it, and certainly the points that appeal to a wider audience, is nontechnical and refers to general issues regarding the philosophy of science, and especially the need for empirical validations of scientific theories, the relations between physics and mathematics, and the sociology of scientific life.

Following is a small dictionary of terms about physics and string theory.

A small dictionary

With the kind help of Wikipedia, I have compiled a short dictionary of some recurring "buzz words" in the string theory discussion. (Alas, sometimes the definition of a term sounds as cryptic as the term itself.) *To the reader: skip this part and return to it only if needed.*

Quantum electrodynamic (QED) – The classical theory of electricity and magnetism is among the crowning achievements of nineteenth-century physics and associated mainly with the work of Maxwell. Quantum electrodynamics describes electricity and magnetism in the framework of quantum mechanics and, in particular, the mathematical rules according to which electrons, positrons, and photons interact. The theory was developed over the first half of the twentieth-century, and is considered the "jewel of physics" for its extremely accurate predictions.

Quantum chromodynamics (QCD) – The theory of the strong interaction, a fundamental force describing the interactions of "quarks," which are the building blocks for particles like the proton and the neutron.

The Standard Model – A theory that describes three of the four known fundamental interactions between the elementary particles that make up all matter. (QED and QCD are parts of the standard model.) The missing force not described by the standard model is gravitation.

Quantum gravity – A theory that unifies quantum physics and the theory of gravitation.

String theory – A prominent theory for quantum gravity that includes the standard model. The main idea of string theory is to replace point-particles by one-dimensional geometric objects called "strings." A bold consequence of string theory is that the universe has extra dimensions. The first version of the theory studied a 26-dimensional universe and more recent versions (based on "supersymmetry") assert that the universe has 10 or 11 dimensions.

Supersymmetry (SUSY) – A new kind of symmetry studied in theoretical physics and mathematics, and yet to be confirmed empirically as a rule of physics. Supersymmetry suggests that every known elementary particle has a yet to be discovered "super partner," and offers a possible explanation of "dark matter," which accounts for most of the mass in the universe. Supersymmetry also plays an important role in string theory.

Loop quantum gravity (LQG) – An approach to unifying gravitation and quantum mechanics that differs from that of string theory.

The landscape – String theory seems to allow an astronomical number of different possible universes. (The number is taken to be 10^{500}, that is, one followed by 500 zeroes.)

The anthropic principle – A controversial approach to studying the rules of physics according to which humans should take into account the constraint on the rules of physics that human existence imposes. The anthropic principle is offered as a way of dealing with the landscape.

Particle physics phenomenology – The part of theoretical particle physics that deals with the application of the theory to high-energy particle physics experiments. Within the Standard Model, phenomenology is the calculation of detailed predictions for experiments, usually at high precision. Beyond the Standard Model, phenomenology addresses the experimental consequences of new models.

The Large Hadron Collider (LHC) – A particle accelerator and collider located near (or underneath) the Frenco-Swiss border. After many years of constructions the LHC began operation in September 2008. The LHC is the world's largest and highest-energy particle accelerator. It is hoped that the LHC will confirm some predictions of the Standard Model and will allow for the testing of further insights of theoretical physics, like supersymmetry.

Part I NOT EVEN WRONG: The Blog of Peter Woit

1 Extraordinary claims

Virtually all of string theorists are nice people who never argue with anyone else, they're not chauvinists, and most of them are feminists, Lubos Motl, August 30, 2006

Gina Says:
August 30th, 2006 at 7:39 am

Peter, is it possible to state the main points for the "case against string theory" with 4-5 sentences on each? This will be very helpful. Please consider doing it. It will be useful to

a) Separate the strictly scientific points from more sociological and philosophical points

b) Separate points that say that (*)"string theory is not (yet) successful" from those saying that (**) "this and that aspects of the theory are fishy" from those saying that (***) "string theory is not the right direction for dealing with 'final theory/grand unification' ", from those saying that (****) "the whole endeavor of final theory/grand unification is misguided".

c) Hint whether physics requires more back-tracking or whether it is just string theory that is problematic.

Thanks!

Gina's first comments have generated several answers: 'a' said that string theory's main scientific problems are two-fold: "first, since we cannot directly probe quantum gravity, a useful theory of quantum gravity must predict something at the lower energies where we can conduct experiments, and second, that string theory allows something like 10^{500} different possible theories and that this seems practically equivalent to allowing everything and predicting nothing."

Peter Woit Says:
August 30th, 2006 at 1:36 pm

Gina,

At this point, I'm way too busy, and writing another explanation of what the problems are with string theory isn't at all something I want to spend time on. The article I wrote back in 2001 is still a good short version of the argument; all it is missing is a discussion of how things have gotten much, much worse for string theory since then, because of the landscape.

The issues involved here are pretty complicated, and I don't think short sound-bites, or me countering people's "10 quick reasons why string theory is great" with "10 quick reasons why string theory doesn't work" is going to be very enlightening. Partisans of one point of view or the other aren't going to be convinced by this, and people who want to seriously understand the issues and make up their own minds should read both the pro-string theory point of view put forward in several books, and the other side of the story, as explained in my book and in Lee's. I do believe that the problem is not just string theory, but more generally the idea of supersymmetric grand unification; these issues are discussed extensively in the book.

Gina was happy with Peter's answer. Especially interesting was his skeptical point of view, not just toward string theory, but also toward the idea of "supersymmetry". Another answer came from Nigel.

Nigel Says:
August 30th, 2006 at 8:38 am

Gina,

Your idea would, I fear, produce a list of string theory claims with the same boring label 'uncheckable speculation' beside each.

'Extraordinary claims require extraordinary evidence.' - Carl Sagan.

Gina fondly remembered what her great uncle Lena used to say about extraordinary claims:

"Why should I be surprised if I can simply disbelieve."

As for Sagan's line on extraordinary claims, Gina later discovered that quoting it is quite popular on both sides of this debate, and other debates as well. Gina found Sagan's statement rather confusing. She felt that, just like ordinary claims, extraordinary claims must be based on good evidence, and that the problem with the many extraordinary claims that Sagan talked about (flying saucers, astrology), was that the evidence was simply lacking. Sagan's statement led to endless discussions about which side of the debate is extraordinary to begin with, and it was not clear what 'extraordinary evidence' really means.

Nigel continued:

You can see plenty of extraordinary claims in string theory (it solves almost all the big problems of unification, quantum gravity, the nature of particles, black holes). You don't see any stringy evidence, let alone extraordinary evidence, and nobody expects to find much.

The string theory failure has some weak precedents in science: the "Vortex Atom" and "Aether" (both the subjects of intricate mathematical speculation and wild claims of ad hoc success from mathematical physicists including Kelvin and Maxwell, who both died firmly believing flawed theories).

However, string theory is more dangerous. At least Kelvin and Maxwell's ideas could later be checked by experiment. String theory deliberately speculates about practically uncheckable phenomena (Planck scale unification, etc) thus remaining safe from experimental refutation, and consequently string theory is becoming a religion:

'Whatever ceases to ascend, fails to preserve itself and enters upon its inevitable path of decay. It decays … by reason of the failure of the new forms to fertilize the perceptive achievements which constitute its past history.' – Alfred North Whitehead, F.R.S., Sc.D., Religion in the Making, Cambridge University Press, 1927, p. 144.

Gina was happy with the responses. She was unclear about why dying with a firm belief in a flawed theory was worse than simply dying, and how string theory could possibly be dangerous, but found it completely convincing and yet too general to be relevant, that what stops to ascend may enter a path of decay. So she asked:

Gina Says:

August 30th, 2006 at 2:10 pm

Is the critique of string theory similar to the critique on the biologists for not understanding/finding a cure for cancer? Or is it stronger?

I think the main reason for me to be suspicious about "string-theory bashing" is that it does not lead to interesting science: namely to scientific papers (not popular reviews and books). Why is that?

Peter Woit once more gave a thoughtful answer: He regarded the situation as far worse than cancer research and added: "an analog would be if current cancer treatments not only didn't help at all with the disease, but made it much worse." He explained that "string-theory bashing" does not lead by itself to new science, but encourages people to leave "failed ideas" behind and look for something else. And he pointed out that there are alternatives to string theory and that he has his own ideas regarding alternatives.

Another key figure in the debate on Woit's blog and on his own blog, was Lubos Motl, a Harvard physicist. Expressing himself quite bluntly, Lubos referred to Woit and Smolin as crackpots, and as the enemies of science. Some of his opinions came across as chauvinistic and racist. When Gina conjectured that Lubos' attitude was highly uncharacteristic of string theorists, it was Lubos himself who quickly supported her conjecture.

Lubos Motl Says:
August 30th, 2006 at 6:47 pm

Virtually all of string theorists are nice people who never argue with anyone else, they're not chauvinists, and most of them are feminists. Most of them also think that string/M-theory are robust twin towers that are not threatened by any social effect or passionate proponents of alternative theories or proponents of no theories, and they almost always try to avoid interactions that could lead to tension, which also gives them more time for serious work. Almost no string theorists drive SUVs and they produce a minimum amount of carbon dioxide.

Gina was happy to partake in the conversation and felt she got it going. She was fascinated with the other bloggers and she was curious as to who they were. Some of them had strange names and she could not understand the reason for picking such names.

The discussion got an interesting twist when a blogger mentioned logic and the famous work of Gödel's theorem as an analogy to the case at hand. We will come to this in the next chapter, but first here is a brief description of some of the participants in the "blogosphere string war."

Who are the bloggers?

Roughly two thirds of the comments on the weblogs that Gina participates in were made by anonymous bloggers. Some of these anonymous entities have been taking part in blog discussions for years. A few prominent anonymous participants are 'Nigel' (Chapter 1) (perhaps identical to 'nc' in Chapter 42), 'Ebgert' (Chapter 2) who draws the analogy between string theory and Gödel's theorem, and 'The Graduate' (Chapter 3) who takes part in many discussions and who seems open minded and genuinely interested in learning. Here are a few more: The 'geometer' (Chapter 7) is apparently a mathematician based in geometry, and he often has interesting comments to make about geometry and other geometers. 'Renormalized' (Chapters 4 and 12) holds rather strong anti string theory views and is, at times, quite hostile to Gina. 'Yatima' (Chapter 6) seems to have broad academic interests and knowledge, which are perhaps not rooted in the exact sciences. CapitalistImperialistPig (CIP, for short, Chapter 11) is quite an active participant and has a blog of his own. He is also rather negative towards string theory. Some extreme supporters of Peter Woit's view adopted insulting nicknames like 'lubos makes me puke' (referring to Lubos Motl, a string theorist who aggressively attacked Woit and Smolin). There are many more participants - in one heated debate (Chapter 11), there is one 'Anon' who sides with Gina, while yet another 'anon' takes the other side. Among the regular anonymous participants on the string theory side we can find 'moveon' (Chapter 40), 'amused' and 'aha'. One participant who contributes thoughtful remarks from time to time calls himself 'garbage .'

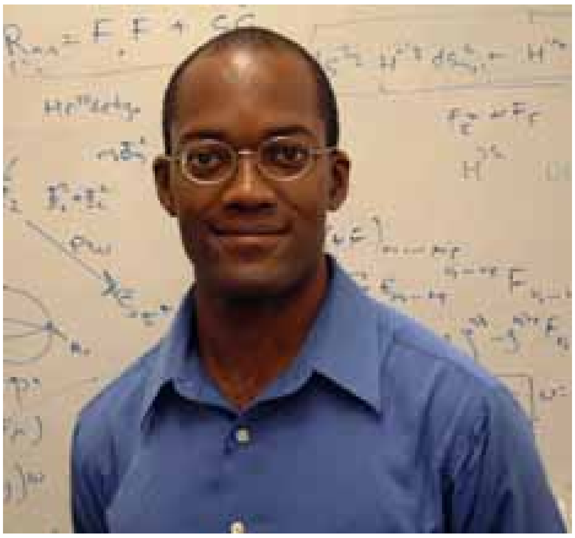
Among the bloggers who sign their full name, you can see, shoulder to shoulder, well known scientists, people outside academia with alternative physics theories of their own, and a wide spectrum of people in between. Quite a few of these participants also have blogs. For example, string theorist Jacques Distler (Chapters 18 and 36) has a blog called 'Musing,' 'bee' is the nickname of physicist Sabine Hossenfelder, who, along with her partner Stefan Scherer, runs a blog called Backreaction, and 'Christine' (Chapter 39) is physicist Christine Dantas who ran a blog "Christine's Background Independence".

Mark Srednicki's (Chapter 44) participation in blog discussions regarding string theory is of special interest. Mark Srednicki is the chairman of the department of physics at the University of California at Santa Barbara. Srednicki works mainly in high energy physics. While making some contributions to string theory he is not a string theorist. He is very negative towards the recent anti string theory campaign. Using his full name and academic credentials, Srednicki tried at a very early stage to shoot down Peter Woit's anti string theory campaign and claims, by commenting in Peter's blog. Later, he took part in various discussions. In one comment, Srednicki told interesting personal stories about the early stages of string theory and about his reactions to Witten's earlier discoveries. In many other comments, he gave his point of view on various scientific issues that came up in the discussion. While patiently arguing with Lee Smolin and Peter Woit, it seems that his recent approach towards the blog discussion and the entire debate is playful and relaxed, and he makes a sincere effort to explain to laymen physics, in general, and his own views on matters at hand, in particular.

Srednicki recently wrote a paper together with physicist James Hartle, entitled "Are we typical," where, using Bayesian probability theory (see Chapter 4), he examines the assumption that humans are typical observers in the universe.

Mark Srednicki

Peter Woit (left) and Lee Smolin (right)



Clifford Johnson – the last part of the book takes place on his blog

Christine Dantas

2 Gödel's Theorem and logic

"...we conclude because A resembles B in one or more properties, that it does so in a certain other property." John Stuart Mill, "*System of Logic Ratiocinative and Inductive* [1843]", Chapter XX on analogies.

A few days later, a blogger named 'Ebgert' attacked string theory, citing as an example Gödel's famous theorem about the incompleteness of mathematics. He drew the analogy between the landscape in string theory and Gödel's theorem in mathematics. Gina liked analogies and was curious about the value of analogies and about the way they were used in debates.

Gina Says:
September 3rd, 2006 at 5:51 am

Ebgert,

Your Gödel's theorem example goes the opposite way. There was a "foundational crisis" in mathematics based on the fear that its foundations were not provably sound. Gödel's theorem confirmed this fear, but strangely this was the end of the "crisis" and mathematics continued as before. There were people like Brouwer that thought and taught that mathematics should be done completely differently in view of these problems, but his views did not prevail. So if "landscape" to "string theory" is like "Gödel's theorem" to "mathematics", you can expect a bright future for string theory.

Ebgert Says
September 3rd, 2006 at 6:43 am

Gina,

I agree with most of your points. In fact, Brouwer was correct, and mathematicians didn't pay as much attention to him as they should have.

Instead, they said "What's that weirdo talking about? Never mind, who cares? Let's ignore him and call him a crackpot."

Ebgert continued:

"The physicists, string theorists in particular, will continue to insist that they are talking about the ultimate truth?"

Gina was puzzled by Ebgert's last statement:

"My statement stands. Humans have *not* evolved significantly since the McCarthy era; if you think otherwise you are wrong."

Gina Says:

September 3rd, 2006 at 7:29 am

Ebgert,

Hmmm, I am glad that you agree with most of my points. You come across as being rather hostile towards physicists and mathematicians. This seems unfortunate to me. Overall, it is not difficult to create public hostility against intellectuals, scientists and various other minority and/or "elite" groups. But I do not think this is a very good path to follow and I doubt this is what Peter or Lee intend to do in their critiques. Brouwer, right or wrong, was also a mathematician and he probably also had an "ego" (a term coined by yet another intellectual).

Gina continued to mingle with the other bloggers. She got a feel for things and she even read Peter Woit's 2001 article. To her surprise she could understand it. The concern that string theory cannot be tested was prominent in this paper. Parts of the paper dealt with matters of public relations, hype and funding, which Gina found interesting while not at the center of things. All in all, Gina was quite impressed by the many participants and by their knowledge. She was ready to look closer and critically at some of Peter Woit's claims.

Gödel, Hilbert and Brouwer

Is mathematics a consistent theory? Or, rather, is there a danger of finding a correct mathematical proof for a false statement like "0 = 1"? These questions became quite relevant at the end of the nineteenth century, when some mathematical truths dating back many centuries were shattered and mathematicians started to feel the need for completely rigorous and solid foundations for their discipline.

Gödel's incompleteness theorem is a famous result in mathematics that shows the limitation of mathematics itself. At the end of the nineteenth century and the beginning of the twentieth, mathematicians tried to find a complete and consistent set of axioms for mathematics. This goal is often referred to as Hilbert's program, after the mathematician David Hilbert who posed it as the second problem in his famous list of open problems in mathematics. In 1931 Kurt Gödel proved that this goal is impossible to achieve. Gödel proved that for any system of axioms for mathematics there are true results that cannot be proved! This is referred to as Gödel's first incompleteness result. One startling consequence is that it is impossible to precisely formulate the consistency of mathematics and therefore impossible to prove the consistency of mathematics. This is the content of Gödel's second incompleteness theorem.

Gödel's theorem is one of the few results of mathematics that capture the imagination of people well beyond mathematics. The well-known book *Gödel, Escher, Bach* by Douglas Hofstadter discusses common themes in the works of mathematician Gödel, artist M. C. Escher, and composer Johann Sebastian Bach.

Gödel's theorem is the climax (and, paradoxically, the end) of the "foundational crisis" in mathematics. Gottlob Frege made an important attempt to reduce all mathematics to a logical formulation. However, Bertrand Russell found a simple paradox that demonstrated a flaw in Frege's approach. The Dutch mathematician Luitzen E. J. Brouwer proposed an approach to mathematics, called intuitionism, which does not accept the law of excluded middle. This approach does not accept "Reductio ad absurdum," or, in other words, mathematical proofs "by contradiction." Most works in mathematics, including Brouwer's own famous earlier work, do not live up to the intuitionistic standards of mathematical proofs. Brouwer's ideas were regarded as revolutionary and, while on his lecture tours, he was received with an enthusiasm not usually associated with mathematics.

Hilbert and Brouwer were the main players in a famous controversy in the editorial board of *Mathematische Annalen*, the most famous mathematical journal of the time. Hilbert, the editor-in-chief, eventually fired Brouwer from the editorial board. There are different accounts regarding the nature of the disagreement. Some scholars have claimed that Brouwer wanted to impose his intuitionistic proof standards. Other scholars strongly reject this story and claim that Hilbert wanted to remove Brouwer in an inappropriate way simply because he felt that Brouwer was becoming too powerful.

Brouwer

Gödel

Hilbert

3 Obviously I disagree

" There's no success like failure, and failure's no success at all." Bob Dylan, "Love Minus Zero/No Limit"

The title of Peter Woit's September 15th post was "Reviews in The Economist, Slate and the Times." Peter Woit discussed several reviews of his and Smolin's books, and Gina thought this would be a good opportunity to share her thoughts on Peter's book. A week earlier, Gina submitted a review, or as she called it a "pre-review," which was based on her initial impression of Woit's approach and book. She felt that Peter did not really have "a case" against string theory. However, it was posted in the wrong place and was deleted.

Gina Says:
September 16th, 2006 at 9:53 am

Let me remark how, in my opinion, the overall nice book by Peter (after all it is just a book, not a "case"), can be made nicer.

Most of the chapters of the book are quite good. I think this is a very good popularization of particle physics all the way to the "standard model". Popularization of science is a tricky business and deserves a whole separate discussion. There is no way to avoid some "cheating," but one should still try to be honest, useful and non-manipulative and Peter does a good job. The description of the connections with mathematics is especially interesting and the story about the Seiberg-Witten discovery is told very vividly.

With the exception of too strong rhetoric, most chapters on string theory are also well-written. I am learning a lot reading the book. Thank you, Peter!

What could make this book nicer? The story about the Bogdanov brothers and the reference to (the overplayed) Sokal's hoax do not contribute to the book. The same applies to the story about the string theory guy who became a Maharishi scientist, as well as to the description of the

Cambridge University Press refereeing process. I have quite a few scientist friends, and complaining about referee reports is one of the few drawbacks in their sweet lives. Besides, they are the referees themselves! (And they also complain about the burden of refereeing.) The rhetoric against string theory, and string theorists, as Peter himself noted (p.225, l. -5) is indeed too strong. This does not add to, but rather reduces the value of the book.

The concluding chapter starts with a beautiful quote from Bob Dylan's song "Absolutely sweet Marie" –

"But to live outside the law, you must be honest".

When I first saw this quote I thought that this is a self-reference and that Peter set a standard for himself: If, coming from the outside, you want to single-handedly claim that one of the hottest scientific areas of our time failed, and that the efforts of thousands of string theorists are worthless, you'd better be honest about the details, presentation and even about your own motives. Apparently, Peter referred not to himself but rather to string theorists, for whom, in the absence of empirical support to their theory, honesty is paramount.

And Dylan's cryptic line from "Love Minus Zero/No Limit" also comes to mind:

" There's no success like failure, and failure's no success at all."

Bob Dylan (right) with Joan Baez (Washington D.C. 1963)

Debating string theory by quotations from Bob Dylan looked like the way to go!

Peter Woit Says:
September 16th, 2006 at 11:39 am

Gina,

Obviously I disagree with you about the relevance of some chapters in the book to my argument. In particular, the refereeing story at Cambridge was a very unusual one, involving two referees who strongly backed publication, and two string theory partisans trying (successfully) to stop Cambridge from publishing the book, while lacking any arguments against its content.

I should perhaps have made more explicit what I meant to convey with the Dylan quote. It's not specifically about me or about string theorists, but about the situation particle physics finds itself in. Lacking the discipline enforced by experiment, theorists now need to be a lot more self-critical and honest in evaluating the results of the speculative work they are engaged in.

Looking back later on her debate experience, Gina found it hard to think of a better phrase to describe the nature of blog debates than: "**obviously I disagree with you**." People hardly ever reversed or modified, or even reconsidered their opinions, not only on the big matters, but on the little points, as well.

Gina Says:
September 16th, 2006 at 4:29 pm

Peter: My main (mild) critique was not about irrelevancy, but that the items I mentioned (and a few others), reduce the quality of your book. Of course, a book may have many qualities and I am mainly referring to the quality of the book as a serious discussion and debate of science. For example, if you refer to the string theory community as a "mafia", this statement is, of course, highly relevant, but making such a statement reduces the value of the book, at least in my opinion. I think you are wrong to consider your experience with Cambridge University Press as very unusual. Many authors had similar experiences, even with much less controversial (and more important) books and papers.

"The Graduate," another contributor expressed some similar thoughts on the need for some "framing" in what Peter was writing. ("Who is 'the Graduate'?" thought Gina, remembering the movie and the famous Mrs. Robinson.)

woit Says:
September 16th, 2006 at 8:12 pm

Gina and the Graduate,

I did not refer to string theorists in the book as a “mafia”, I said that some of the people who wrote to me did so. It is a fact that many people in the physics community feel this way and I was reporting this. It’s not a word I would use to describe my own perception of string theorists' behavior. All the things that Gina objects to are things that I was reporting that are factually accurate.

Gina Says:
September 17th, 2006 at 1:49 pm

Peter,

The choices you have made make the book perfectly appealing for a commercial publisher but indeed not appropriate for a university press publication. Part of it is the rhetoric and selection of issues for discussion, and part of it is the clarity and strength of your overall argument.

Concerning the small issue of using the word "mafia": Indeed it is a quote from somebody else, but the discussion in the sentences which follow it gives the impression that you endorse what is behind this term, if not the term itself. This I find unfortunate.

In an extensive discussion in which there was much for Gina to learn, a discussion characterized by many misunderstandings, uncertainties and confusions - and, of course, fierce debate, it was comforting to be certain about something. And Gina was certain that Peter Woit's reference to string theorists as "mafia," was wrong.

A brief description of Peter Woit's book:

After a popular description of modern particle physics in Chapters 1-9, (which is easier for a mathematically inclined reader,) Chapter 11 goes on to describe string theory. Chapter 10 is devoted to a description of some startling insights from string theory to mathematics. The "case" against string theory is made in Chapters 12-18. Chapter 12 is somewhat technical and describes certain advantages offered by the notions of supersymmetry and string theory for settling fundamental problems in physics, as well as some difficulties associated with these notions which Woit regards as problematic. One such problem is the "hierarchy problem" which is a central puzzle in theoretical physics.

The "landscape" is described and discussed in Chapter 17. The difficulty, perhaps even impossibility, of finding empirical evidence is emphasized in all chapters. In chapter 13 on beauty and difficulty, Woit asserts that despite spending a lot of time learning string theory, he does not find it beautiful. He also regards the complexity of the theory as a negative indication. Chapter 14 raises the claim that string theory is not a science. A story about a string theorist who switched to studying transcendental meditation serves as a central example. Chapter 15 tells the story of two brothers, Igor and Grishka Bogdanov, who managed to publish several papers of no value in respectable physics journals. A famous hoax by Sokal, who intentionally submitted and published a worthless physics paper with a postmodernist flavor, is mentioned as an analogy. Chapter 16 tries to explain the dominance of string theory in spite of its alleged failure and the existence of some alternative approaches. Woit quotes an unnamed physicist referring to string theorists as "mafia," and further claims that a physicist criticizing string theory might need to worry about his or her professional safety! This chapter also describes Cambridge University Press's rejection of Woit's book.

4 "It is not in the cards"

The discussion went on. Usually, Gina's comments were premeditated, but from time to time she could not resist making a quick reply "on the fly." This time 'Dan' asked Peter for his prediction on the future of string theory.

woit Says:
September 17th, 2006 at 2:15 pm

My best guess is that string theorists will keep doing string theory no matter what, unless another bandwagon starts up for them to join. This might come about because of an exciting unexpected LHC result, because Witten comes up with a promising non-string theory idea, or some other reason. If the LHC doesn't find evidence for supersymmetry or extra dimensions (which I think is very likely), string theorists will concentrate more on black holes and cosmology (this has already been happening). While they do this, they'll slowly lose the support of their colleagues in other physics subfields, their funding will get cut, and, to a large extent, they'll take the whole field of theoretical particle physics slowly down with them.

Gina Says:
September 17th, 2006 at 4:07 pm

What you wrote, Peter, is an excellent generic guess for any prominent theory:

My best guess is that X-theorists will keep doing X-theory no matter what, unless another bandwagon starts up for them to join. This might come about because of an exciting unexpected EMPIRICAL result, because some prominent X-theorists come up with a promising non X-theory idea, or some other reason.

If no EMPIRICAL support will be found (which I think is very likely), X-theorists will concentrate more on possible application to theory Y (this has already been happening). As they do this, they'll slowly lose the support of their colleagues in other fields of their science, their funding will get cut, and, to a large extent, they'll take a large area of research slowly down with them.

woit Says:
September 17th, 2006 at 4:15 pm

Gina,

Yes, but in the generic case, a real possibility is that "X-theory will achieve one or more of its major goals, making it a solid and permanent part of science, opening up new areas to work on that build on this success". That's not at all in the cards in this case…

Gina Says:
September 17th, 2006 at 10:19 pm

"That's not at all in the cards in this case…"

Wow, so you have those magic cards, Peter! Boy, we have a lot of questions to ask you…

Renormalized Says:
September 17th, 2006 at 5:03 pm

Gina- Do you always just regurgitate what others have written? I can't see you are adding anything to any discussion you have been involved with. Your responses are more in line with a common online troll.

This is uncalled for, thought Gina, it is legitimate to try to understand whether some of the critique against string theory actually has nothing to do specifically with string theory. Anyway, Gina's appeasing mood had changed. It was time to come back to her old review of Woit's book.

Thomas Bayes and probabilities

"It is not in the cards" said Peter Woit. Later on, physicist Peter Orland referred to certain possible uses of probability reasoning in a discussion about an ambitious project, the string vacuum project. To quote Orland: "This probably won't happen, and isn't a proper application of probability anyway." Orland perhaps did not notice that the first part of his sentence also talks about probabilities in an improper way.

How can we assign probabilities in cases of uncertainty? And what is the nature of probabilities, to start with? And what is the rational mechanism for making a choice under uncertainty?

Thomas Bayes lived in the eighteenth century. Bayes' famous formula shows how to update probabilities given some new evidence. Following is an example for an application of Bayes' rule:

Suppose that ninety percent of pedestrians cross a certain crosswalk when the light is green, and ten percent cross it when the light is red. Suppose also that the probability of being hit by a car is 0.1% for a pedestrian who crosses on a green light, but the probability of being hit by a car is 2% for a pedestrian who crosses on a red light. A pedestrian is hit by a car at this particular crossing and brought to the hospital. How likely is it that he crossed on a red light?

Well, to start with (or *a priori*), only ten percent of the people who cross the crosswalk cross it on a red light, but now that we are told that this person was hit by a car it makes the probability that he crossed illegally higher. But by how much? Bayes' rule allows us to compute this (*a posteriori*) probability. I will not describe the mathematical formula, but I will tell you the outcome: the probability that this person crossed on a red light is 2/3.

The Bayesian approach can be described as follows. We start by assigning probabilities to certain events of interest and, as more evidence is gathered, we update these probabilities. This approach is applied to mundane decision-making and also to the evaluation of scientific claims and theories in philosophy of science.

Bayes' rule tells us how to update probabilities but we are left with the question of how to assign probabilities in cases of uncertainty to begin with. What is the probability of success in a medical operation? What is the chance of your team winning the next baseball game? How likely is it that war will break out in the Middle East in the next decade? What is the meaning of Orland's statement "this probably won't happen?" And what is the probability that string theory will prevail as the theory of quantum gravity?

One very early approach to probabilities, the principle of indifference (a.k.a. the principal of insufficient reason), asserts that given a certain number of mutually exclusive events, their probabilities are the same. The formulation of this principle goes back to Jakob Bernoulli and Pierre-Simon Laplace. This principle is an important very early appearance of the notion of **symmetry**. Of course, there are many cases where the principle of indifference fails miserably. Various other approaches to "subjective probabilities" and to the foundation of probability theory were developed in the twentieth century.

Decisions under uncertainty depend not only on the probabilities but also on the "stakes." Crossing a crosswalk on a red light will get you to your destination more quickly ninety-eight percent of the time, and two percent of the time you will be hit by a car. To make a rational decision between crossing on a red light or not, you have to take into account how good it is for you to get to your destination earlier and how bad it is for you to get hit by a car. A theory of decisions under uncertainty, based on the notion of utility, was developed by John von Neumann and Oskar Morgenstern, the founders of "game theory." In this theory, to each possible outcome we assign a numerical quantity called a "utility." Rational decisions are based on combining the probabilities for various outcomes and the utility gained from each of these outcomes. The theory of von Neumann and Morgenstern has been the subject of intense debate in recent decades.

Thomas Bayes

Perhaps the major difficulty with the Bayesian point of view, whether relating to decisions under uncertainty or to the Bayesian philosophy of science, is that quite often, no one has a clue how to assign probabilities in cases of uncertainty.

The addition of probability thinking remarkably extends our understanding of reality. At the same time, we face the impossibility of understanding various phenomena, perhaps those about which we are most curious, even with the language and tools of probability at our disposal. Introducing the language of probability allowed us to ask many new questions that we cannot answer even using the tools of probability.

Lena, Gina’s beloved great-uncle, once told her: "The only thing I learned between the age of thirty and the age of fifty was how to deal with uncertainty." And then he sighed and added: "And the only thing I ever wished to learn after the age of fifty was how to deal with certainty."

5 Pre review and riskless risks

"My own heart goes to Chemistry," Gina, Sept. 17, 2006

Gina Says:
September 17th, 2006 at 11:05 pm

And here is my review of last week.

"NOT EVEN WRONG", by Peter Woit; A review

(Replies and comments are very much welcomed, and this also means you, ReNorm)

Peter Woit is wrong claiming that "string theory" is "not even wrong". It is questionable if the distinction between "right", "wrong" and "not even wrong" coined by Wolfgang Pauli should be taken as a serious way of classifying scientific theories. It is a nice gimmick, though, and a great name for the book. In any case, the insights and truths offered by string theory, one of the most daring intellectual endeavors of our time, may well be wrong. They may also very well prevail as an important and unique part of physics. We cannot tell which way string theory will go.

"Landscape", the possibility of a huge number of theories that we may never be able to choose between, may be an artifact of string theory itself, or just of string theory in its present form. But it can also be an "impossibility result" which reveals a genuine problem with our ability to describe physical reality at some scales, whether we like it or not.

Whether string theory will prevail or not, it is already a well established fact that it has contributed important insights and technical infrastructure to mathematics and to physics

Even if "string theory" is the "theory of everything", string theory is not "everything". In mathematics we see many examples of such a distinction. Mathematical logic is a "mathematical theory of everything" that was developed in order to understand the foundations of mathematics. But while mathematical logic formally includes all other mathematics, in reality it is a beautiful field which is but one of many fields of mathematics and, as a matter of fact, a rather separate field. It took many decades before important links between mathematical logic and other mathematical disciplines were found.

While a theory which studies the most fundamental and general rules is appealing, in my mind, relevance is of key importance, which is why, of all sciences, my own heart goes to Chemistry.

Modern science and academic life do not give sufficient incentives for true scholarship. But Peter Woit is a scholar and large parts of the book exhibit both genuine scholarship as well as Woit's gifted ability to present and discuss in non-technical terms complicated mathematics and physics. Another advantage of the book is that Woit does not offer alternatives of his own to string theory. Woit does present a few nice ideas and observations that deserve to be pursued.

When it comes to string theory, Woit has concerns (some shared by string theorists), complaints (a few justified), suspicions, and unrealistic expectations (like everybody else); but Woit does not have a case.

Recommendation: For a layman wanting to read about string theory I would recommend Brian Greene's "The Elegant Universe" over Woit's new book. An intelligent reader should use grains of salt regarding any new scientific theory and any popular book describing it.

As I explained elsewhere, some of Woit's choices of content and rhetoric are disappointing.

I also do not like Woit's analysis of sociology, politics and funding of science. For a scientist, trying to explore something completely new (e.g., a replacement for string theory,) is a very very risky business. Woit aims at a system which allows scientists to take riskless risks. As there is no such thing as a riskless risk, Woit's ideas on this front may deserve the title "not even wrong".

Gina

(And thank you Ebgert for the analogy with mathematical logic.)

The first reaction came from another Gina.

Gina Says:
September 17th, 2006 at 11:31 pm

Gina – do you have a background or degree in physics?

"Who is this Gina?" thought Gina and replied that she has some academic background but not a degree in physics. "The graduate" criticized Gina's review and said that it had to be more specific and support the points it made to a greater extent. Peter Woit himself was also negative and said: "I’m happy to debate people with a serious background in string theory who want to discuss the arguments in my book, but you’re just wasting my time."

The "Renormalized" (or "born again Norm" as Gina used to think of him) asserted that the last paragraph "shows a total lack of understanding or insight into what Peter has said from the beginning," and continued: "Peter is not asking for a riskless risk, I feel dumb even copying 'riskless risk', he is asking for strings to be tied to reality in even the smallest way." Gina liked her "riskless risk" notion, and thought that in many respects, people in western society look for all sorts of riskless risks.

The long thread of comments was not over, and, as we will see in the next chapter, Gina had a chance to look back and have second thoughts about one of her claims.

Who is Gina?

As seen by Anat Lotan

Perhaps it's time to say a few words about our fearless Master of Ceremonies in cyberspace - Gina.
35 years of age, Gina is of Greek and Polish descent.
Born in the quaint island of Crete, she currently resides in the USA, in quiet and somewhat uneventful Wichita, Kansas. Gina has a B.Sc in Mathematics (from the University of Athens, with Honors), and a Master's Degree in Psychology (from the University of Florence, with Honors).

Currently in-between jobs (her last job was working with underprivileged children), she has a lot of free time on her hands, which gives her ample opportunities to roam the blogosphere.
Forever the proud Grecian, Gina is the happy owner of Papa, her beloved pet tomcat, named after "that dear man", Christos Dimitriou Papakyriakopoulos, whom she has been an ardent fan of ever since she first learned about him in high school. (See Chapter 7.)

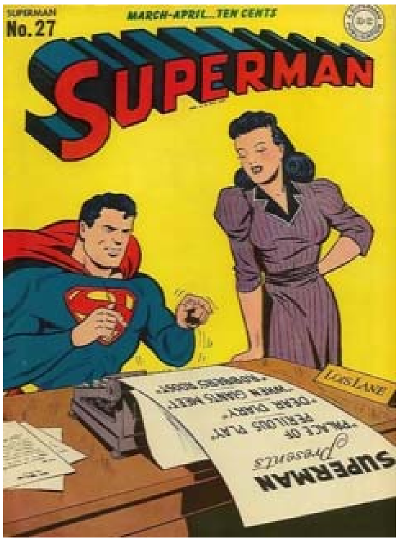
Leaving behind Greece and Europe was not an easy decision to make. Still, Gina was certain that moving to the US would be a life changing experience, which, if nothing else, would certainly do wonders for her less than perfect English.

Possessing an insatiable thirst for knowledge, Gina is a voracious reader and reads everything from scientific textbooks to People Magazine. She also enjoys writing, and keeps a daily journal. Since moving to the US, she has attended various journalism courses, eager to pursue her life long dream of becoming a professional writer. Until this dream is realized, however, she finds pleasure in expressing her musings in the blogosphere.
Gina is fascinated by both people and phenomena – the more complicated and controversial the better. An avid participant in the blogosphere, she has

a genuine desire to understand the topics at hand, but, at the same time, being a fan of psychology, she would also like to investigate the character of the people who write blogs. She is even contemplating starting a blog of her own, but there's simply so much she'd like to say, she fears she wouldn't know where to begin, let alone end. Writing a blog, however, would certainly help her improve her English, which Gina knows is still not quite up to standard.

She is very inquisitive – a bit too inquisitive, according to some people. At times, her obvious tendency not to let go of a question or issue until she is absolutely satisfied can be quite exasperating. Gina is not oblivious to this annoying feature; it was actually one of the main reasons she decided not to pursue a career as a psychologist.

Gina, in fact, likes to think of herself as a modern day Lois Lane, who has yet to find her superman…any candidates???



6 Scientists are paid to be gullible

"My guess is that should individual scientists ever become 'objective and rational' in the sense of 'impartial and detached', then we should indeed find the revolutionary progress of science barred by an impenetrable obstacle"
Carl Popper, "The rationality of scientific revolutions"

Gina Says:
September 20th, 2006 at 6:34 pm

One frustrating thing about this science business is the necessity to keep double checking not only those matters of disagreement, but also matters of complete agreement. There was a single item in the discussion I certainly agreed with Peter about, the need for an honest and self-critical approach, and even this item, on closer examination, is not that simple.

We do not pay scientists to be just honest, we pay them to be gullible, as well. They have to be gullible in their beliefs regarding the foundation of the current theory they are working on, the prospects for its success, the relevance of its methods, and its overall importance. And mostly they have to be gullible about their own abilities. They have to be somewhat blind to the frustrating nature of their profession, and to the overwhelming probability that, somewhere down the road, they may realize that they have been missing out on their lives.

Yatima Says:
September 20th, 2006 at 9:17 pm

Gina, this pertains to your interests, I think.

Just now I'm burrowing through Lee Smolin's book (in the middle of the night…hmm double special relativity? tasty!) but I will stop for now and quote from a novel by Arkadi and Boris Strugatsky (not to be confused with the Bogdanoffs) called 'Far Rainbow' which, on the face of it, is about a physical experiment going horribly wrong.

Towards the end, Camille, the greatest physicist of Rainbow, is heard to say (he has worked too hard, not to mention died, a few times):

"The Great Logician. Logical methods demand absolute concentration. To do anything in science, day and night you have to think about one and the same thing, read about one and the same thing, talk about one and the same thing... And where can you go from your psychic prism? Away from the inborn capacity to love... You've got to love, read about love, you've got to have green hills, music, pictures, dissatisfaction, fear, envy... You try to limit yourself - and you lose an enormous part of your happiness. And you know very well you're losing it. So then to blot out that consciousness and put an end to the torture of ambivalence, you castrate yourself. You tear away from yourself the whole emotional half of your humanity and you leave yourself with only one reaction to the world around you - doubt. Then loneliness lies in wait for you."

Hopefully most physicists are not so bitter. But still, one gets what he means.

"Who is Yatima?" thought Gina. Reversing the letters, one gets "Amitay". Perhaps Yatima stands for Amitay?

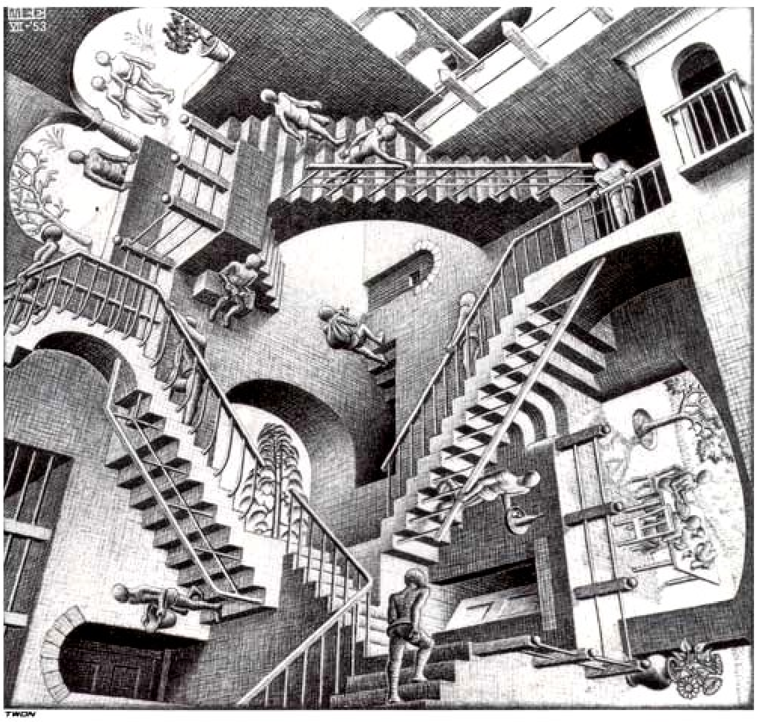
Drachmas

"The fixed price to JFK is 28 dollars" said the taxi driver; "toll and tips not included, and I want the two dollars and seventy five cents for the toll upfront." I reached to my wallet, dug eleven quarters and handed them to him. He carefully checked the quarters and said: "If you're wondering why I want the toll money here, it is all because of the Drachmas." "The Drachmas?" I asked. "Yes" said the driver. "They want to take me to trial for putting drachmas instead of quarters in the toll machine." Apparently, using 100 Greek Drachma coins, which are almost of no value, instead of US quarters became quite a problem. "No matter how much I tell them that I put whatever the clients give me in the machine they still do not believe me, and want to bring me to trial. Therefore I now check the quarters the clients give me here in New York, in the light." "I see" I said.

I felt sorry for him. He was getting into serious trouble because of greedy, heartless passengers.

We started talking. Najim told me about his old country back in Asia and how he came to the United States to start a new life. He is working hard driving the taxi, and makes a good living. And he has some plans and dreams. I told him about my country. We talked about family far away and about friends from the old country here in the States. His Drachmas story and the injustice done to him instantaneously connected us.

By the time we reached the toll machines we felt like old friends. "Look what I am doing" my new friend told me. He took my eleven quarters and put them in his right pocket, then pulled eleven drachma coins from his left pocket, showed them to me, and threw them to the basket. The gates opened and shortly afterwards we arrived at JFK.



7 The Poincare conjecture and Christos Dimitriou Papakyriakopoulos

"The perfidious lemma of Dehn
Was every topologist's bane
'Til Christos Papa-
kyriakopou-
los proved it without any strain.", John Milnor, around 1956.

Christos Dimitriou Papakyriakopoulos (picture: Jay Goldman)

This chapter is about something quite different. Jumping from one topic to another, which is so characteristic of blog discussions, suited Gina quite well.

In 2002 Gregory Perelman, a Russian mathematician, presented a proof of the Poincaré conjecture concerning "three dimensional manifolds." Poincaré's conjecture was one of the most important problems in mathematics. Perelman's proof was an amazing scientific victory. His proof was rather concise, and filling up the details was itself an extremely important and difficult mathematical task, which several groups of mathematicians took upon themselves to carry.

Woit's Sept 19 post was not about the Poincaré problem itself, but rather about the controversy surrounding Perelman's proof of the Poincaré conjecture, and certain remarks concerning it made by the famous mathematician Shing-Tung Yau.

This was the only time Gina really wanted to divert the discussion to a different direction, as she felt that the controversy regarding the solution of the conjecture was quite artificial, while the story of the Poincaré conjecture itself was so wonderful.

Is the story of the Poincaré conjecture related in any way to string theory? Not directly, but there are various indirect connections. The notions that Poincaré developed and, in particular, the notion of a manifold, became central in mathematics and in physics; the techniques used in the solution of the Poincaré Conjecture are closely related to physics. There is another connection related to the work of the mathematician S. T. Yau. String theory itself relies on the idea that in addition to the four dimensions we are familiar with (one dimension representing time), there are six additional dimensions related to a geometric object called "a Calabi-Yau" manifold.

- *Gina* Says:

September 21st, 2006 at 7:08 pm

Wouldn't it be a better use of both time and space to talk about these exciting three dimensional manifolds themselves and how they are now understood, and what perhaps remains to be understood, rather than about lawyers and credits and newspaper articles and prizes and slanders and power struggles etc??

- *geometer* Says:

September 21st, 2006 at 8:23 pm

Gina said: "Wouldn't it be a better use of both time and space to talk about these exciting three dimensional manifolds themselves..."

Well, the proof of Poincaré's Conjecture means precisely that there are no exciting (simply-connected closed) 3-manifolds: all of them are copies of the 3-sphere. It'd be much more exciting if the Poincaré Conjecture were false; unfortunately this is not the case.

- *Gina* Says:

September 21st, 2006 at 8:39 pm

Actually, I have a specific question that maybe you guys can help me with. I vaguely remembered the wonderful story of this humble mathematician whose nickname was "Papa" who worked on some things related to manifolds in dimension three, and who after years of effort managed to prove something really big. Thanks to Google and Wikipedia I found his full name - Christos Dimitriou Papakyriakopoulos, and apparently he proved the "Dehn's lemma". I am curious if the new proof of Poincaré's conjecture still relies on "Papa's" work.

- *geometer* Says:

September 21st, 2006 at 9:18 pm

Gina,

I am not a 3d-topologist, but as far as I know Perelman's proof does not imply Dehn's lemma. I suspect that Dehn's lemma is used at the very last stage of Perelman's proof, when he obtains a collapsed 3-manifold and concludes that this must be a graph manifold.

- *Gina* Says:

September 21st, 2006 at 10:35 pm

Dear Geometer,

Many thanks for the interesting information. I do not know what a graph manifold is precisely (never mind that), but I am very happy to hear that the proof of the Poincaré conjecture still relies on the work of that dear man "Papa", Christos Dimitriou Papakyriakopoulos. From what I heard he was a very special person.

You said, "It'd be much more exciting if the Poincaré Conjecture were false; unfortunately this is not the case."

I beg to disagree with you on this point. The way I see it, it is exciting that the Poincaré conjecture was proven true and it would have been exciting had it been proven false and, perhaps, the most exciting thing is that we could not have known in advance: not what the answer would be and not even if people would be able to crack this problem at all.

By the way, before going to dimension four, is everything known about manifolds in dimension two?

- *geometer* Says:

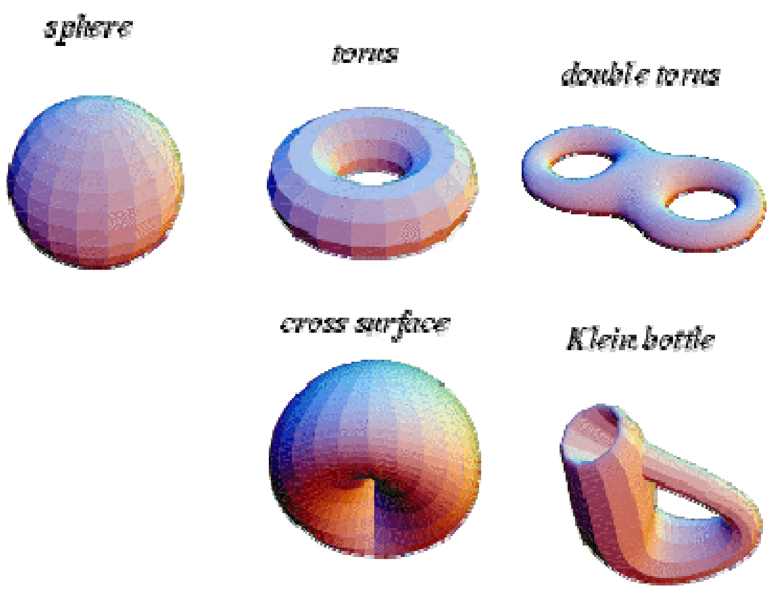
September 21st, 2006 at 11:58 pm

Gina asked: "is everything known about manifolds in dimension two?"

Their classification is classical (pretzels with many holes and all that), but there are still some mysteries about surfaces, e.g. studying the mapping class group (i.e. the group of self-homotopy equivalences of a surface) is a very active area of research involving several branches of mathematics on which there is extensive literature.

Three-dimensional manifolds and the Poincare Conjecture.

Here are some "two-dimensional manifolds without boundary" (drawings taken from *MathWorld*):



Every point on these geometric objects gives the “feel” of existing in a two-dimensional plane—just as every one of us gets the feeling that the earth is flat. The sphere has another interesting property: every circle that you draw on it can gradually be shrunk to a point. However, this is not the case for the torus: a circle drawn around a "hole" cannot be shrunk to a point.

Three-dimensional manifolds are spaces with the property that around every point it "feels" like our three-dimensional space. In 1904 Henri Poincaré formulated a conjecture that suggested a characterization of the three-dimensional sphere as the only three-dimensional manifold "without boundary" in which every circle can be gradually shrunk to a point. (In 1900 Poincaré had made a stronger statement that he himself came to refute by constructing a space based on a platonic solid dodecahedron. This space is now called the Poincaré dodecahedral sphere.) People even formulated analogs to the Poincaré conjecture in dimensions higher than three. (The idea of dimensions greater than three is confusing. Bear with us and we shall return to these spaces in Chapter 12.) Quite surprisingly, the high-dimensional problems are easier to solve. Steve Smale proved the conjecture above dimension 4 and Michael Freedman proved it at dimension 4. The original Poincaré conjecture remains unsolved.

In 1982 William Thurston offered a much more general conjecture, called "the geometrization conjecture," that proposed a very daring geometric picture of all three dimensional manifolds. In the 1980s Richard Hamilton proposed a program for proving the geometrization conjecture and, in particular, the Poincaré conjecture. It was based on tools and ideas from analysis. Proofs of the Poincaré conjecture and of the entire geometrization conjecture, based on Hamilton’s program, were described by Gregory Perelman in 2003.

The results of Christos Dimitriou Papakyriakopoulos still constitute a crucial part of the proof of the Poincaré conjecture. In 1956 "Papa" proved a result known as "Dehn's lemma," whose original 1910 proof by Dehn had a gap. (A few words of explanation may be of help. Main mathematical results are called "theorems." Smaller results needed in the course of proving theorems are called "lemmas." In some cases proofs contain mistakes and often the mistakes are in those places where the authors feel that something is easy or obvious. In this case, proving the lemma that Dehn thought he proved had been a major challenge for decades.) Besides Dehn's lemma, "Papa" proved two other fundamental related results called the loop theorem and the sphere theorem. For the rest of his life, "Papa" tried to settle Poincaré's conjecture, but did not succeed.

The next two chapters will describe Gina's efforts to understand some specific ingredients of string theory. What is the reason for the appearance of high dimensions? And why is it that so much effort is devoted to the study of two-dimensional models? What is the meaning of the infinite sums that are so useful in physics and in string theory?

8 Useful divergence

Gina felt ready to ask a few questions about string theory, the magical high dimensions of our universe and the mysterious "infinite sums" - they were all so fascinating and cryptic.

Gina Says:
September 25th, 2006 at 10:24 pm

Here are a couple of questions I had while reading NEW ("Not Even Wrong").

1. String theory in its first simplest version implies that the universe has 26 dimensions. Is it possible to explain why in a few sentences, or a couple of paragraphs?

2. In the book there is a distinction (for very successful theories from physics) between "convergent sums", "useful divergent sums", and "useless divergent sums". Is there any formal distinction between the last two types? Does it make sense in math?

3. The era before QCD and the standard model is described as being at least as confused and chaotic as the situation in string theory today, if not more so. Yet people who promoted these unsuccessful but very dominant theories were not asked to admit failure; moreover, they did not fail: conceptual and technical ideas from these unsuccessful theories turned out to be useful later, and students of these scientists had a crucial role in developing more successful and completely different theories. This looks like a good model to proceed with, doesn't it?

Gina was very thankful for Peter's answer.

- *woit* Says:

September 25th, 2006 at 11:12 pm

Gina,

1. Away from d=26, quantization introduces an "anomaly" in the symmetry of conformal transformations of the string worldsheet. Basically this

means that the quantum string theory is more complicated and the metric on the world sheet becomes a dynamical variable you have to deal with. People study these “non-critical” string theories also. There are various different calculations that give you the 26, I don’t know of any simple physical explanation for it.

2. Some divergent sums are “asymptotic” approximations to some function, which means that, at a fixed order, the truncated series is a better and better approximation to the function as the expansion parameter gets small (even though, at a fixed small parameter, as you go to a higher order, the sums sooner or later diverge). The perturbation series for QED is supposed to be such an asymptotic expansion. This kind of divergent sums can be quite useful, giving very good approximations.

3. Actually, the "bootstrap program", which was a dominant research program before QCD did fail as a theory of the strong interactions, and was pretty much killed off by QCD. Many of the people who worked on it certainly admitted that it failed; other die-hards never did admit this, but were no longer taken seriously by most theorists. Certainly some things learned from this were ultimately useful, but the program failed to do what it was intended to, and sensible people admitted this.

Gina learned about the "bootstrap program" from Woit's book. It was a dominant research program in high energy physics in the 1960's and overall it failed to achieve its ambitious goals. But she could not share Peter's interpretation of this story. This line of research did contribute some useful insights as Peter said, but much more than that, the students of those researchers who promoted the ideas that had failed, were among those who developed the theories that ultimately prevailed.

Convergent and Divergent Infinite Sums

The fact that the sum of infinitely many numbers can still have meaning is one of the most important insights of mathematics. A famous example is

1 + 1/2 + 1/4 + 1/8 + 1/16 + 1/32 + 1/64 + ... = 2.

The three dots mean that we continue forever. A sum like this one is referred to as an *infinite sum*, and when we can attribute a number to an infinite sum, the sum is called "convergent."

Convergent infinite sums are related to the old question of Achilles and the Tortoise. In this paradox Achilles is racing a turtle that has been given a 100-meter head start by Achilles. It takes Achilles some time (10 seconds, say) to reach the turtle's starting point, but during this time the turtle has advanced further, say by another 50 meters. (This is a quick turtle especially trained to demonstrate the infinite sum above.) It takes Achilles 5 seconds to reach the turtle's new position, but by then the turtle has advanced further still. Thus, whenever Achilles reaches a point where the turtle has been, the turtle advances further and Achilles can never reach him. This is the paradox. The insight that an infinite sum can express a finite number is rather important in understanding this paradox. (Some philosophers disagree, claiming that the infinite sum description merely gives us a way to state the paradox, but not to solve it!)

Sometimes, convergent infinite sums are useful for computations. There are famous infinite sums that converge to the number pi, thereby providing a very good approximation for pi by computing just the first terms. In other cases, obtaining good approximations may require too many terms.

There are also infinite sums that are not convergent and they are called "divergent."

The sum

1 + 1 + 1 + 1 + 1+...

is divergent. A more subtle example is the sum

1 + 1/2 + 1/3 + 1/4 +...

This sum is also divergent. How can we see that this is the case? One way is to note that the first term is larger than 1/2. And the sum of the next two terms (1/2+1/3) is larger than 1/2. And the sum of the next four terms (1/4+1/5+1/6+1/7) is larger than 1/2. And so on.

One of the surprising facts of modern physics is that certain divergent sums are still useful for computations and for theory. In "quantum electrodynamics (QED)," which is often referred to as the most successful physics theory ever (in terms of its precise predictions), the sums are described by gadgets called Feynman diagrams. Computational methods that are yet to be understood by mathematicians are common in most areas of physics.

Giving meaning to divergent Sums (A bit Harder)

The sum

1 + 1 + 1 + 1 + 1+ ...

is divergent. Can we still give this sum a meaning? And what about

1 + 1/2 + 1/3 + 1/4 + ...?

It turns out that there is a context where we can associate numbers to these divergent infinite sums. The context is related to one of the most famous problems in mathematics, the Riemann hypothesis. The Riemann zeta function is a function which is described at any number using an infinite sum. It turns out that the function can be defined using a different approach even for values where the sum diverges! The bottom line is rather counterintuitive:

1+1+1+... = -1/2

and

1 +1/2 +1/3 + ... = -1/12

Unlike values of convergent infinite sums, we have to be quite careful in using values of divergent infinite sums. Nevertheless, they are important both in mathematics and in physics.

Another surprising fact is that in physics computing the first few terms of a "useful divergent sum" can, as the name implies, yield extremely good calculations, even though the entire sum is divergent. There is no clear mathematical understanding of this remarkable phenomenon.

9 Why just two-dimensional models?

Gina, you and quite a few others seem confused about the meaning of higher dimensions. Thomas Love, September 28th, 2006 at 2:16 pm

From very high dimensions Gina moved to think about just two dimensions. Peter Woit mentioned the great successes of physics in two dimensions; "we should be trying to understand four dimensions" he wrote. Gina asked around about it.

Gina Says:

September 27th, 2006 at 8:18 pm

WHY THE EMPHASIS ON TWO DIMENSIONAL MODELS?

Peter wrote (in the book): " It is the precise expression of the mathematical relationship of representation theory and QFT that has been worked out in recent decades in two dimensions, exactly the thing that I would argue we should be trying to understand in the physical case of four dimensions."

Indeed one very nice point raised in Peter's book is the fact that many of the successes of physics and mathematics related to string theory and earlier physics are coming from two dimensional models. I asked around among my friends:

" Why can't you do anything as impressive for D>2, after all nobody, not even strings theorists claim that our universe has two dimensions?"

It seems that for D>2 scientists are simply stuck and things look very gloomy. "Aren't there any ideas around," I asked. Well, there are a few.

One guy told me with a spark in his eyes about an idea to move directly from D=2 to D=4 and to base models on “homological” notions which will extend important “duality” properties for planar models. He talked about things like “Poincaré duality” and “signature”, and was quite excited but then admitted that these were all just ideas. (I guess this is the same old Poincaré.) Another guy had much hope for extensions to higher dimensions of "conformal analysis", which is prominent for two dimensional models using "representation theory". But this is also in a very premature state. A third guy praised the “Heisenberg Lie group” as a place to “be in high dimensions and to feel in two dimensions”.

There are ideas, but overall there is also some feeling that studying higher dimensional models is a waste of time. Some of these guys actually spent a lot of time on it and got nowhere.

I tried to be tough on them and I asked if sticking to the cozy D=2 and looking for the coin under the lamp is all about the summer salary.

“No, Gina” they said “this is not the reason”. They said they simply do not know what to do. They need something to start with, perhaps a tip of a string to hold to, but often it turns out they just try to pull themselves up holding their own shoe laces. They have nothing, they said. They are quite savvy in failures but doing D>2 leads to “not even a failure”. They did sound convincing but you never know with these wise guys.

Thomas Love Says:
September 28th, 2006 at 2:16 pm

Gina Says:

WHY THE EMPHASIS ON TWO DIMENSIONAL MODELS?

As a PhD mathematician, I know the answer: because the math is easier there.

Gina, you and quite a few others seem confused about the meaning of higher dimensions. Think of a dimension as an entry in an inventory form; how many numbers are required to describe the situation? (The standard reporter questions). Clearly, we need to know where and when (x,y,z,y), but we also need to know the field strengths, electric, magnetic, gravity, etc. Each of those requires another entry in the form, i.e. a dimension.

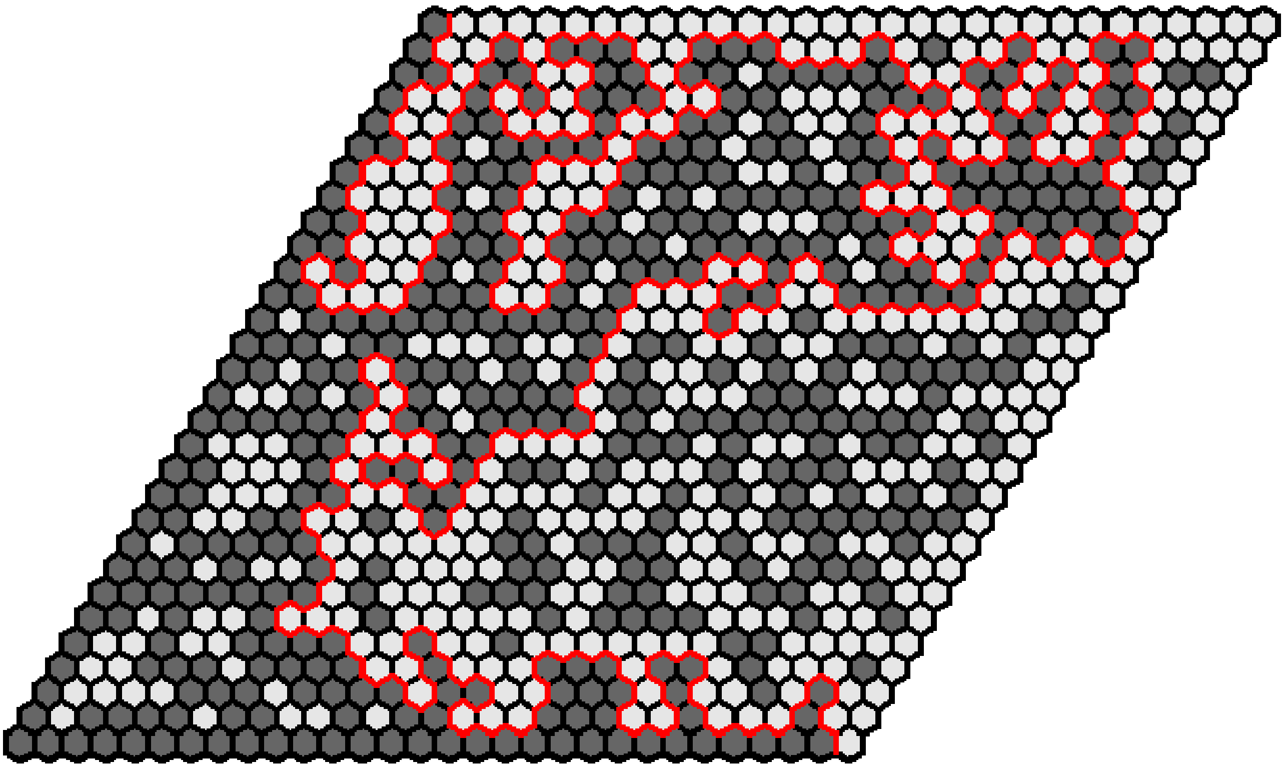
- *Gina* Says:
September 28th, 2006 at 3:25 pm

" Gina, you and quite a few others seem confused about the meaning of higher dimensions."

You bet! I am very confused!!!

After two chapters devoted to mathematics, in the next chapter we will discuss the central element in the popular claims against string theory relating to basic questions about science, scientific theories and the teachings of philosophy of science.

HEX and Percolation



Here is a 30 by 30 board of the game HEX. In the original game one player, the BLACK player, fills an empty hexagon with black and the other player, the WHITE player, fills an empty hexagon with white. The WHITE player wins if there is a continuous all-white path from left to right. The BLACK player wins if there is a continuous all-black path from top to bottom. If we fill the hexagons at random with the colors black and white we obtain the two-dimensional statistical physics model of *percolation*. In the above picture all hexagons outside the boundary are colored randomly. The lowest black-white "border" (marked in the picture) is an important example of a stochastic curve in the plane.

Returning to the original game of HEX, John Nash proved a theorem that the first player has a winning strategy. His proof is not constructive and so nobody knows what this strategy might be.

10 Can Philosophy of Science help doing science?

Enough with technical mathematics thought Gina. As the title of Woit's October 4 post was "Controversy, Controversy..." it was a good time for Gina to look at the philosophical arguments against string theory. These philosophical claims were at the core of the arguments against string theory, and they were not difficult to understand.

- *Gina* Says:

October 5th, 2006 at 10:07 pm

Some remarks on the controversy:

DO WE REALLY HAVE A CONTROVERSY (YET)?

A striking fact about the debate concerning string theory is that there is almost a complete agreement on factual matters, between what string theorists say and what people who attack string theory say. The interpretation of the facts is sharply different, but many of the issues concerning the interpretation are not specific to string theory, and are of a very general nature.

CAN PHILOSOPHY OF SCIENCE HELP DOING SCIENCE?

This is a fascinating aspect of the discussion here and in Peter's and Lee's books. Philosophers will probably be the most skeptical about such "practical" applications of philosophy, for example, about Popper's point of view. It is hard to consider the various theories in philosophy of science as normative, and it is hard to consider them as descriptive. (They also are in conflict, of course.) These theories can be regarded as a way towards understanding and discussing what science is in a scientific way.

IS STRING THEORY FALSIFIABLE?

Well, I am not sure it is clear what string theory IS. But from the rough description of what it is, it seems very clear that string theory is falsifiable. For example, as Peter explained in his book, the 26-dimensional model without super-symmetry was rejected because it has consequences to physics that are regarded as unreasonable. This, in principle, can happen to the supersymmetric string theories.

DESTROY STRING THEORY AND SAVE PARTICLE PHYSICS?

Peter Woit's noble reason for his attack on string theory is the desire to save particle physics. Well, in general, as in this particular case, one has to be very skeptical about claims of the form "Destroy X to save Y". (But appropriate efforts to falsify or criticize a theory are as noble as efforts to prove or support it.)

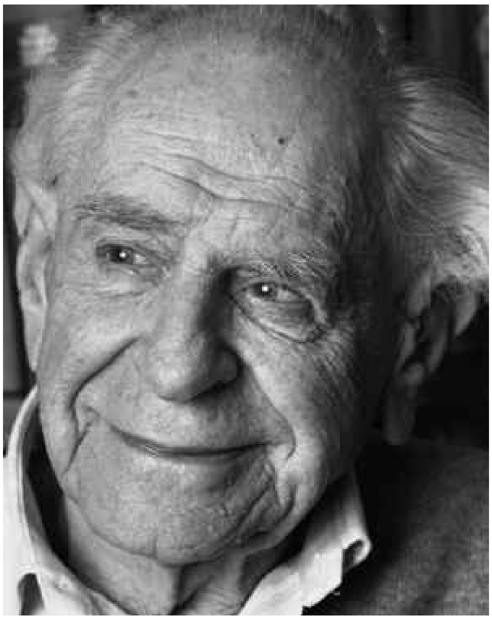
Some Philosophy of science

The Bayesian approach to the philosophy of science was developed in the first half of the twentieth century. Karl Popper and Thomas Kuhn are twentieth-century philosophers of science who later proposed alternative approaches.

It will be convenient to start with the Bayesian approach since we already talked about probability and Thomas Bayes in Chapter 4. The Bayesian approach (mainly associated with Ramsey and Savage) can be regarded as a verification-based philosophy of science; it is based on different scientists gradually updating, according to new empirical evidence, their (different) prior (subjective) probabilities of scientific explanations and theories, until the cumulative evidence is strong enough to reach a common conclusion.

One difficulty with the Bayesian approach is that in cases of disagreement, there are also disagreements on the interpretation of the evidence.

Bayesian view does not give a way to test a scientific theory but rather to update our beliefs in the theory given new evidence. In practice, scientific theories primarily explain existing observations. For example, the main motivation of Newtonian mechanics and the main support for its validity was the explanation of Kepler's laws. Kepler's laws concerning the elliptic orbits of planets around the sun were discovered seventy years before they were explained by Newtonian mechanics.



Karl Popper

Thomas Kuhn

Popper is famous for basing philosophy of science on the notion of falsification. According to Popper, the mark of a theory as scientific is falsifiability: the possibility to empirically refute the theory – in principle.

This is in contrast with other approaches that can be viewed as basing philosophy of science on confirmation or verification. Famously, two principal examples of non-scientific theories according to Popper are the Marxist theory of capital and Freudian psychoanalysis.

If the Bayesian approach, like approaches based on verification, suggests that the optimal way for a scientific theory to proceed is by making safe conjectures which may lead to small incremental progress, Popper's approach suggests making bold and risky conjectures. One concern about practical implication of the Popperian approach is the fact that bold conjectures and theories that pass the falsifiability test are of little value if they are absurd or simply false to begin with.

Critics assert that neither Popper's theory nor earlier approaches based on verification give a proper description of how science is practiced. Also, they have limited normative value regarding how science ought to be practiced. It is especially difficult to use the insights from philosophy of science for scientific theories under development.

Thomas Kuhn is famous for his notions of paradigm shifts and scientific revolutions. According to Kuhn, science is normally carried out inside a certain paradigm that is shared by a community of scientists, and it is furthermore characterized by "paradigm shifts," which occur when the current paradigm is no longer capable of explaining the new evidence. Kuhn referred to the process of switching from the common paradigm to a new one as a "scientific revolution." An important example of a scientific revolution analyzed by Kuhn is the shift from Newtonian mechanics to Einstein's theory of relativity. (We will come back to Kuhn in Chapter 44.)

It may be useful to put things described here in a larger context and give a few more details.

Verification approaches towards philosophy of science: Verification- (or confirmation-) based approaches to scientific theories were developed in the first half of the twentieth century and became quite dominant in the philosophy of science until today. An important role in their development was played by the Vienna circle, a group of philosophers, who shared common basic attitudes towards philosophy, and who gathered in Vienna mainly between the two world wars. According to most of these verification-based approaches, scientific theories are gradually examined and updated in view of new empirical evidence.

Philosophy and logic: The Vienna circle approach towards philosophy of science is part of their larger approach to philosophy centered on the rejection of metaphysics (and religion, in particular). This approach, called "logical positivism," is related to a greater move associated with Bertrand Russell and others to base mathematics, science and philosophy on logic. Logical positivism has led not only to distinctions of "what is scientific" and "what is unscientific", but also to an attempted classification of "what is meaningful" and "what is meaningless". As a result, for many decades the central interest in philosophy moved away from traditional issues like "justice," "ethics", and "beauty" which were labeled as unscientific and even meaningless. (At a later time, attempts to distinguish "meaningless" from "unscientific" were made, and eventually the main interest in philosophy moved back to where it was before "logical positivism".)

Critiques of early versions of confirmation approaches in the philosophy of science were made, at the beginning of the 20th century, by French philosopher Pierre Duhem and by Henri Poincare (whom we briefly met in Chapter 7). Duhem's approach asserts that the main test of a scientific theory is its internal coherence and consistency. Both Duhem and Poincare gave much weight to "intuition" and "insights." This dispute is related to a famous debate between Poincare and Russell on the role of logic in mathematics.

Probability: Probability plays an important role in some of the verification-based approaches to the philosophy of science. Often they rely on a logical (objective) notion of probability rather than "subjective probability" which is central to the Bayesian approach. Foundational questions regarding probability theory again come into play. Logical probability (also referred to as "partial deduction") is based on the idea that probability can describe a logical relation between two statements. This idea goes back to Wittgenstein, Caynes, and perhaps even to Leibniz. Rudolf Carnap, a central member of the Vienna circle, had a programme which he believed could lead to a whole logical calculus of probability starting with answer to the question: "What is the probability of a statement A given the validity of statement B?" and ending with an answer to "What is the probability that a theory X is correct?".

Popper deliberately diminished the role of probability in his approach to philosophy of science. A (familiar) critique of Popper was expressed by Oded Schramm (who read an early draft of this book.) Schramm wrote: "I remember when I read Popper, I was very disappointed with his treatment of probability. It was totally unsatisfactory. (This was much before I became seriously interested in probability.) Probability statements are never falsifiable."

It may be useful to put things described here in a larger context and give a few more details, and then to put them in even a larger context and give even a few more details, and then describe them in yet a larger context, and larger and larger ...

Science is not only about philosophy and mathematics; it is also about reviews and criticisms. How to accept rejection? How to deal with criticism? How to relate to anonymous reviews? We will come to these topics in the next Chapter

11 Referees and Ethics

"I don't really think it's unethical to speculate on who anonymous reviewers are - I've certainly heard a lot of reputable scientists do so." CapitalistImperialistPig October 10th, 2006 at 12:47 am

The title of Woit's new post was "**corrections...**" and one important item was a negative review of Peter Woit's and Lee Smolin's books by the science writer K. C. Cole. In trying to understand Cole's motives, Peter returned to the rejection of his book by Cambridge University Press and wrote: "As I said, I don't know Cole, so I don't know why she decided to write this kind of dishonest hit-job. Perhaps it has something to do with her professional association with string theorist Clifford Johnson at USC. I've long suspected that Clifford was the author of the referee report for Cambridge University Press. One is often wrong about such guesses, probably I'll never know..."

Shortly afterwards an update was added:

"**Update**: Amazing how quickly one finds out things one thinks one will never know. Over at Clifford Johnson's blog, Capitalist Imperialist Pig asked him if he was the referee who tried to stop Cambridge University Press from publishing my book. His answer: 'that's all just silly and irrelevant'. OK, now I know..."

Peter continued: "The funny thing about this is that Clifford has been bitterly complaining about the fact that the book is being marketed and publicized to a wide audience, but it appears that he was the one who stopped it from being published a couple of years ago in a form where it would have reached many fewer people. Priceless."

In the discussion following these discoveries Gina expressed the view that Peter chasing the identity of the referee was rather unethical. The issue was not only about ethics, but also about interpretation of all sort of partial evidence, and how easy it was to become more and more confident about a certain factual matter from accumulation of very weak evidence. Peter Woit was increasingly confident that Clifford Johnson was the referee of his book, as he was increasingly confident that string theory is nonsense. Did he really have solid evidence?

Gina Says:
October 9th, 2006 at 8:21 pm

Peter and Tim,
If you are talking about the referee report that Peter is attributing (with little evidence) to Johnson, I think, in this case, ethics is going the other way around. Trying to reveal the identity of an anonymous referee, certainly in public, is not so ethical.

anon Says:
October 9th, 2006 at 9:06 pm

Gina, this sentence is quite fuzzy.
"Trying to reveal the identity of an anonymous referee, certainly in public, is not so ethical."
Who is trying to reveal?
Peter didn't ask Clifford. It was CIP who asked him. Are you accusing CIP of being unethical, for asking Clifford, IN PUBLIC? Clifford didn't have to answer, but he did answer. Peter FIRST quoted Clifford exactly, and then reached his own conclusions about the meaning of the quote. I don't think that is unethical.
I think for a reporter to write an article, with so many errors, and so one-sided in favor of her friend Clifford - now that is unethical.

Gina Says:
October 9th, 2006 at 10:01 pm

Dear anon,

Hmmm, interesting comment. I certainly do not "accuse" anybody of anything. For a scientist, trying to speculate in public about the identity of a referee is somewhat unethical, or perhaps a better word is unconventional.

Actually, Clifford did **not** confirm that he was the referee at all and he reacted in the appropriate way when he was asked - whether he was the referee or not - not confirming and not denying. So for Peter to reach a conclusion that Clifford was the referee, and to continue the discussion based on this assumption is not very good logic and not very ethical.

This is just a small point. There is also the issue of ethics and conventions for weblog behavior. This looks like a truly fascinating subject but I do not have anything to contribute. What can be the ethical rules for a CapitalistImperialistPig? I suppose whatever he does he cannot really be kosher.

Another 'Anon' came on board, with a capital 'A', and he agreed with Gina.

Anon Says:
October 9th, 2006 at 10:41 pm

I agree with Gina. It is definitely unethical to publicly accuse (or state that one "suspects") someone of being the anonymous referee.

That puts the accusee in the untenable position of being unable to either confirm or deny the accusation, and it is highly corrosive of the anonymous refereeing process (on which we all depend).

Peter Woit Says:
October 9th, 2006 at 11:41 pm

I'm not the one who put Clifford on the spot about this, blame that on CIP.

I've suspected that Clifford was the referee for quite a while now (since one day after seeing his behavior in response to challenges to string theory, and looking up over my desk and seeing a copy of his book on my bookshelf. I realized it was published by Cambridge, and a light dawned…).

What an interesting description of the process of 'discovery', thought Gina.

… I finally decided to mention this publicly because I really had enough with the way he was going on about what a money-grubbing publicity hound I am, promoting my book to the general public who can not understand the subtler points of what I am saying. If it weren't for him, the book would have been published two years ago by Cambridge University Press, in a form aimed at, and marketed to, a small audience. He decided to stop that, and left me no choice but to find a trade publisher. He has no business at all complaining about how this book was published, and it was unethical of him to do so, knowing full well that he was responsible for this.

I'm pretty sure I know who the second string theorist referee was, but won't say anything publicly about that. Unless he gets a blog and starts complaining about how the book was published….

Anon Says:
October 9th, 2006 at 11:56 pm

"I'm not the one who put Clifford on the spot about this, blame that on CIP."

Why?

You are the one who publicly stated the accusation (excuse me, the "suspicion"). CIP merely brought it to Clifford's attention, which someone else would have done sooner or later, anyway.

And then you were the one who took Clifford's non-committal response (the only ethical one he could make) as a confirmation.

CapitalistImperialistPig Says:
October 10th, 2006 at 12:47 am

I don't really think it's unethical to speculate on who anonymous reviewers are - I've certainly heard a lot of reputable scientists do so. Is it unethical to ask? It's a bit hard for me to believe that it is, but if it is I apologize, abjectly but not profusely, to the gods of ethical physics, if such there be. Generally speaking, the baloney I serve on my blog *is* strictly Kosher.

In any case, Clifford had several options - to ignore my question, criticize my question for violating the sacred bond between a publisher and the authors it already publishes, or to say something noncommittal. He chose the last option, but in a rather strange fashion - one that I thought looked like a politician's non-denial non-denial.

Marty Tysanner Says:
October 10th, 2006 at 1:13 am

Peter,

Having occasionally "defended" you in the past, I would feel a little hypocritical in keeping silent on this. From what I have seen, I agree with Gina and Anon that you should not have publicly aired your hunches this way about Clifford's possible role as The Referee. It tends to create a suspicion of him without objective evidence. I also agree that you should not have publicly concluded that Clifford's non-answer to CIP showed that he really was that person.

woit Says:
October 10th, 2006 at 10:49 am

Marty,

Perhaps you're right. It's certainly true that I was highly annoyed by Clifford's recent behavior on his blog and because of that my judgment at the time may not have been the best. But still, I think mentioning my suspicions can be justified, even beyond the grounds I gave earlier that Clifford should not be criticizing how this book was published, unless he is willing to have his own role in that story examined.

On this front, Gina thought, Peter's argument looked increasingly unreasonable. (She even thought it is completely legitimate for Clifford to regard Peter's book as unsuitable **both** for a university press and for a commercial publisher.) In any case, she did not expect any breakthroughs pertaining to Clifford's role. It was time to wrap up the refereeing issue and move to another topic discussed in the post.

Peer Review

(From Wikipedia:) Peer review (known as refereeing in some academic fields) is a process of subjecting an author's scholarly work, research or ideas to the scrutiny of others who are experts in the same field. It is used primarily by editors to select and to screen submitted manuscripts, and by funding agencies, to decide the awarding of grants.

There are different conventions for submitting a manuscript for publication and for the review process. Usually, the identity of the referees is kept secret but there are exceptions. In some journals the identity of the authors of a manuscript is also kept secret from the referees, but this is usually not the case. The convention is that a manuscript can be submitted only to one journal at a time, but books can be submitted simultaneously to more than one publisher.

12 It is all a fantasy: Cole's Review

"Simply put, string theory does this by replacing point-like particles with tiny strings of some fundamental stuff vibrating in 10-dimensional space; their harmonies creating everything from quarks to galaxies. " K. C. Cole, LA times, October 2006.

"This is what you have never gotten in your head Gina. It is all a fantasy!" renormalized, October 11th, 2006 at 9:55 am.

Gina thought it was time to pay attention to K. C. Cole's review itself. The truth of the matter was that Gina liked the review and did not even consider it to be so negative towards Peter Woit and Lee Smolin. Cole's review was entitled "Strung Along" and Peter Woit regarded it as "basically a hit-job on me and Smolin."

- *Gina* Says:

October 10th, 2006 at 5:03 pm

I agree that the issue of refereeing is not simple and sometimes loaded. In fact, almost every negative referee report is a little controversy. A completely open system may be an option; a "double blind" system is another option. But I do not see a simple solution except the universal advice: "take it easy".

I read Cole's review and it does not look to me like it's that negative. It is critical both to string theory and to the books by Lee and Peter, and this seems reasonable. There were 20-30 reviews on the book, most are positive, a few (like my own) are negative. I do not think it is right or wise, Peter, to regard negative reviews as "hit jobs" and to "go after" the people who write them. If you want people to listen to your criticism you should be ready to accept criticism.

- *Arun* Says:

October 10th, 2006 at 6:16 pm

[Quoting from Cole's review as quoted by Woit:] "Woit, and Smolin in 'The Trouble With Physics,' write mostly about how string theory has ruined their careers."

Whether or not a book is worth reading is a matter of opinion, and one can have any opinion. But what is in the book or not in the book should not be lied about.

- *Gina* Says:

October 10th, 2006 at 7:39 pm

Arun,

Indeed this quote struck me as unfair but I double checked, and it is not the full quote. Here it is:

"These issues are well worth addressing, which makes it all the more disappointing that Woit, and Smolin write mostly about how string theory has ruined their careers — and physics as well."

I think it is correct to characterize Peter's position as claiming that string theory ruined particle physics, and this is what Peter mostly writes about in the polemic part of the book. The part about string theory ruining Peter's career is an interpretation by Cole of what Peter tells about himself in the book. This is what Cole reads between the lines. It is a legitimate interpretation (for a journalist).

- *anon* Says:

October 10th, 2006 at 8:47 pm

Gina, I've never, ever heard Peter say that string theory ruined his career. In fact, Peter sounds to me as happy with his career as a pig in mud. Cole's sentence is groundless, a calumny, a character assassination; what she means is that Peter criticizes string theory because he is bitter; that his criticism has almost nothing to do with any shortcomings of string theory.

CapitalistImperialistPig Says:
October 10th, 2006 at 11:54 pm

Gina, your defense of KC Cole's review does not conform to a reasonable interpretation of the facts. Neither does her review. It wasn't merely biased, it was deeply dishonest. Writers (and actors, painters, and others) are totally justified in criticizing their critics, especially those who don't evaluate them honestly.

Since you have strongly insinuated yourself into this debate, including questioning my ethics, let me ask the following: what is your expertise? Are you a string theorist? A physicist?

Oh well, thought Gina. It was legitimate for Cole to speculate that Woit and Smolin are also driven by personal frustration. But even if this is the case it makes little difference. Personal motivations are often much overplayed. The main issue is the quality of Woit's and Smolin's arguments.

- *Gina* Says:

October 11th, 2006 at 8:42 am

Well guys, apart from the controversial sentence regarding Woit's and Smolin's careers, Cole's review is good.

Take this one sentence explanation of string theory:

"Simply put, string theory does this by replacing point-like particles with tiny strings of some fundamental stuff vibrating in 10-dimensional space — their harmonies creating everything from quarks to galaxies. The loops of string don't let anything get small enough to let quantum fidgeting rip space and time apart."

And the critique on string theory:

"String theory has its troubles, which the authors analyze in great and sometimes lucid detail: It appears to be untestable because the strings are too small to be seen, and recent research suggests that the theory may have an infinite number of solutions, so it can't make predictions. And string theory is so ill-defined that even ardent supporters admit they don't know what, exactly, it is."

And

"The authors are right to say that physicists can get cliquish; that some of them swagger; that they frequently fool themselves and that science has become too risk-averse."

- *Bert Schroer* Says:

[October 11th, 2006 at 8:48 am]

"Simply put, string theory does this by replacing point-like particles with tiny strings of some fundamental stuff…"

Well, this mantra with which string theorists used to start their talk is totally metaphoric.

- *Renormalized* Says:

[October 11th, 2006 at 9:55 am]

"Simply put, string theory does this by replacing point-like particles with tiny strings of some fundamental stuff vibrating in 10-dimensional space — their harmonies creating everything from quarks to galaxies. The loops of string don't let anything get small enough to let quantum fidgeting rip space and time apart."

This would be wonderful if it were true. The truth is we have never seen a string, never had an experiment which inferred there were strings, have never seen a dimension beyond the 3 dimensions for space and the one dimension for time. We have never seen this so called "fundamental stuff". We have never heard the so called "harmonies". We have never found a loop of string. This is what you have never gotten in your head, Gina. It is all a fantasy! This is what happens when you get one good idea about how the universe "might" work and then have many brilliant people working on it for many years, teaching brilliant students to work on the idea and then forgetting it was just an idea that "might" work.

Gina had her disagreements with "renormalized" in the past and was often puzzled by his language and attitude. But she felt that, right or wrong, string theory, as many other highlights of human activities, represents wonderful fantasies. Speaking of his own life, which was so full of events, and yet passed away so quickly, Gina's beloved great uncle Lena often told her: "It is all a dream, Gina; it is all a fantasy."

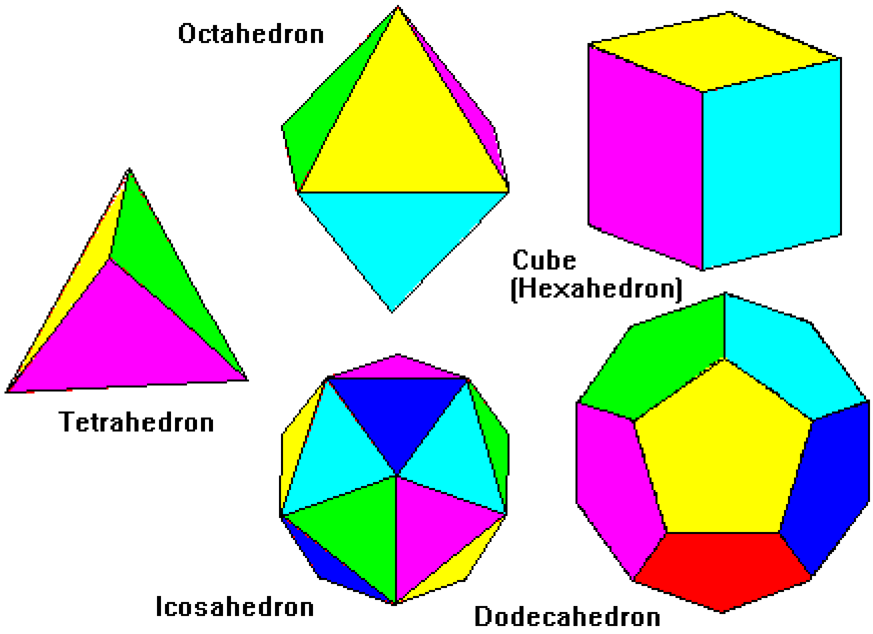
Many dimensions

Planar and spatial geometry were the flagship of ancient mathematics, while algebra was the central mathematical creation of the Middle Ages. René Descartes merged these two subjects via his analytic geometry. The idea was to present geometric objects like points and lines by means of variables and equations. A point on the plane can be represented by a pair of numbers (x,y), called coordinates, that uniquely describe its position. A point in space is similarly described by a triple of numbers.

An important notion in geometry is that of dimension. A point has dimension 0, a line has dimension 1, a plane has dimension 2, and space is three-dimensional. The universe we live in is usually described as a four-dimensional object, where the fourth dimension refers to time.

In the nineteenth century, mathematicians began studying various new notions of "geometry." Geometries that violate Euclid's "parallel postulates" were created; the most important of these is perhaps hyperbolic geometry. Finite geometries, namely geometries that contain only a finite number of points and lines (unlike the familiar Euclidean plane that contains infinitely many points and lines), were also created. Mathematicians also began studying geometries of dimensions higher than three. The basic idea is very simple: if we can represent every point in the plane with two numbers, and in our familiar three-dimensional space we need three numbers, in a geometry with N dimensions we can represent every point using N numbers. Here N can be any natural number 1,2,3,4,5,… (Mathematicians even considered geometries of infinite dimensions and geometric objects whose "dimension" is not a natural number.)

High-dimensional spaces carry many surprises. Ancient Greeks discovered the five regular polyhedra: the simplex, cube, octahedron, dodecahedron and isocahedron. These five geometric objects are also called the platonic solids. To the list of 5 platonic solids in dimension 3 we can add 6 hyper-platonic solids in dimension 4. Something magical occurs in dimension twenty four. A certain construction of a configuration of points in 24 dimensions discovered by John Leech in 1964 had an immense impact on several areas of mathematics.



The five regular polytopes (platonic solids). 19th century mathematicians discovered six regular polytopes in dimension four.

Replacing the 3 + 1-dimensional space used to model our physical world (one dimension describing time) with a higher-dimensional space allows for new opportunities in modeling our universe and resolving difficulties in traditional theories. In the 1920s Theodor Kaluza and Oskar Klein proposed that a fourth spatial dimension will allow to unify the theory of gravitation and electromagnetism. Moving to high dimensions has a central importance in string theory. The vibrating strings “live” in rather complicated ten-dimensional geometries. A further insight of string theory is that dimension itself need not be a firm characteristic of a physics theory: physics theories in different dimensions can lead to precisely the same rules.

13 Expelled

"Gina's comments are blocked on my blog because she was posting a large number of comments there, while most of the time clearly not understanding what she was writing about," P. Woit, "Backreaction" 5:59, December 27, 2006

Woit's next post titled "Rube Goldberg's Instruction Manual" again dealt with the "landscape" of the many different possible string theories. It was a high-level, quite technical, yet interesting discussion, and Gina offered a short summary. A few minutes later:

Peter Woit Says:
October 17th, 2006 at 9:06 am

Gina,

You're adding nothing to the discussion here, just repeating in garbled form what others who do understand the issues have written. In particular, Joe does not claim to have predictions common to all theories; he was discussing something that is a feature of one class of compactifications but not others. Please stop adding to the noise level here.

anonymous Says:
October 17th, 2006 at 9:58 am

I am just an intermediate grad student, but I agree with Gina.
As far as I can tell, the situation is: there are "old" string theorists who are stuck in 1985 and hope the whole thing [the landscape] will go away; more modern string theorists who realize this [the landscape] is a real issue with the whole theory (but the theory may well still be correct and one has to deal with the issue); and finally a bunch of people like Peter and Smolin who really dislike string theory, for reasons you can judge

yourself (they don't seem very sound to me). Anyway I need to read my next review now (about supersymmetry), so I'll sign off.

Then this delightful graduate student was confronted by some savvy participants. For example**, Jean-Paul** asked: "Before you run away, I am just curious why you want to enter a research field which is in a state of crisis...What do you expect to learn?" Gina found Jean-Paul's comment unfair, but when she posted a little note of encouragement she discovered that her messages were blocked. She checked the matter with Peter and realized that she would basically not be able to post further remarks. The next post by Peter titled **"The String Wars**" was an appropriate place for her farewell.

Gina Says:
October 18th, 2006 at 6:50 pm

Goodbye!

This is a little off-topic, but I hope Peter will allow it, just this time. Over the last eight-ten weeks I made occasional comments on several issues discussed here and in Peter Woit's book. I did put a lot of thought into my comments, although, I could not always be on par with the blog speed. My comments were mainly on issues regarding philosophy of science, and the practices and ethics of debating science. Following my attempt to summarize the recent landscape discussion, Peter informed me that since my contributions were drawing lot of criticism from other participants, criticism that he shares, I will not be able to post here without prior monitoring. This basically means that I will not be able to comment here anymore.

It was an interesting experience, even if unsuccessful. Best wishes everybody.

woit Says:
October 18th, 2006 at 7:37 pm

About Gina's comment: As the volume of comments has increased here, it has become more and more difficult to keep the noise level down…

especially difficult is the phenomenon of people who sometimes post something sensible and interesting, but all too often something that isn't.

ksh95 Says:
October 19th, 2006 at 10:59 am

Gina,

I have a Ph.D in physics, yet I would never be arrogant enough to go to n-category café [a name of a blog], start posting uninformed nonsense, jump in the middle of discussions I can't fully understand, and then sulk when my posts get deleted. **Instead**, I would read every day, try to learn as much as I could, and feel lucky that I was privy to such a high level discussion. Any post I would make would be to thank the blog owners for making such interesting discourse public, OR, to ask for simple laymen explanations.

Hal Says:
October 19th, 2006 at 6:34 pm

To add something missing from ksh95's comment I would like to wish Gina well since she did, after all, give her best wishes to everyone.

Ak had a different opinion.

ak Says:
October 20th, 2006 at 12:45 pm

…The more informal and liberal form of blogs makes it possible to share information flow between possibly poorly overlapping subjects and standpoints and people with very different knowledge backgrounds. This cannot be regarded as a pure 'noise phenomenon'.

The scientific blogosphere can serve the purpose of physics and mathematics, classically highly impenetrable subjects for non-experts, to communicate with the 'outer world'. Radically differing forms of reasoning expressed by philosophers, sociologists or even artists may be engaged in informal discussions with the mathematical or physical world.

Such an interaction could be of benefit to physicists or mathematicians themselves.

To be more concrete: as it seemed to me, Gina, for instance, does have a scientific background, and while it apparently does not quite overlap with particle physics (chemistry?), it does not quite exclude her from any form of rational reasoning, either.

Peter was, however, determined:

Peter Woit Says:
October 20th, 2006 at 2:11 pm

ak, sorry to be a bit obnoxious about this, but one of the whole points of the blog technology is to allow people to try and create an information source and discussion forum of whatever kind they want. One obvious thing to point out to people who don't like this is that the technology is free, you're welcome to create your own blog, and there you can do exactly what you want.

Noise

What is the correct picture of our world? Are noise and errors part of the essence of matters, and the beautiful perfect patterns we see around us, as well as the notions of information and computation, are just derived concepts in a noisy world? Or do noise and errors just express our imperfect perception of otherwise perfect laws of nature? Talking about an inherently noisy reality may well reflect a better understanding across various scales and areas.

14 H. S. M. Coxeter, polytopes and mirror symmetry

The next post on Woit's blog was about the mathematician H. S. M. Coxeter and his geometry, with little connections to string theory mentioned. D R Lunsford told about his memories from reading Coxeter's famous book on regular polytopes. Gina was tempted to submit one last comment, especially after she read DR Lunsford comment.

"I remember reading “Regular Polytopes” as a kid and discovering empirically a fact about the Platonic solids. I was eating a lot of Dannon Yogurt at the time - the container was environment-friendly wax paper which was nonetheless rather weak. To strengthen the top, a circular cardboard disk was inserted. I pried out a bunch of these identical disks and used them to make the five solids by inscribing regular polygons in them etc. In the end, each face of each solid could thus be inscribed in the same circle. When I set them on my desk, I noticed that they paired up in altitudes, the cube and octahedron having the same altitude, likewise the icosahedron and the dodecahedron, while the tetrahedron was paired with itself, being self-dual! "

D R Lunsford , October 19th, 2006 at 3:54 pm

Gina wanted to say:

"(Just one more remark for the road…) It is hard to avoid connections with string theory. The dual pairs of polytopes that DR Lunsford talks about (but in high dimensions) are undoubtedly connected to string theory mirror symmetry. And the string vacuum project offers to study all sorts of polytopes, objects that Coxeter apparently loved. (Another reason for NSF to support the project!)

The comment was waiting for moderation for a long while, and then Gina, for the first time, e-mailed Peter and asked him about it.

Gina,

you are wasting far too much of my time that I can't spare. This comment was uninformed and I'm really tired of having to spend time here or on the blog discussing this. For one thing, the reason algebraic geometers have been so excited about mirror symmetry is that it's a far more subtle and unexpected phenomenon than just the kind of geometric duality of polytopes that you write about.

Peter

Gina did not fully agree, but felt that Peter may have had a point and that her comment was too brief and cryptic. She submitted a more detailed comment which she thought was a nice contribution to Peter's blog, and she also wanted to impress Peter a little.

Gina wanted to say:

I did not plan on making more remarks on this weblog, but then Coxeter came along, and, you see, not only have I always had great admiration for him, I even once met him and his wife. So here is one more remark, for the road.

I would like to tell you a story that involves polytopes that Coxeter studied, and love, and string theory.

Gina continued to talk about polytopes, and about duality of polytopes which is connected to string theory mirror symmetry. She then spoke about other beautiful mathematical objects called "partitions" and about another nice and surprising chapter in the understanding of mirror symmetry discovered by the recent Fields medalist Andrei Okounkov, and several partners.

A partition is just a way to write a number as a sum of other numbers. Like 9=4+2+1+1+1. You can represent the partition by a picture (diagram) like this:

XXXX

XX

X

X

X

(This is a diagram representing 4+2+1+1+1.)

Partitions have attracted mathematicians for centuries. Among others, the famous Indian mathematician Ramanujan was well known for his identities regarding partitions. And now enters another idea, baring the names of Ulam, Vershik, Kerov, Shepp and others who studied partitions as stochastic objects. In particular, it was discovered that "most" partitions, say of a number n, come in a "typical shape".

The emergent picture drawn by Okounkov and his coauthors goes very roughly like this: an "algebraic variety" (a manifold of some sort) that takes part in a certain string theory is related to a class of partitions, and when we consider the typical shape of a partition in the class this gives us another algebraic variety, and - lo and behold - the typical shape IS the mirror image of the original one. The mirror relations translate to asymptotic results on the number of partitions, somewhat in the spirit of the famous asymptotic formulas of the mathematicians Hardy and Ramanujan for p(n)- the total number of partitions for the number n.

Peter remained unimpressed, and the remark was not accepted for publication.

And **apropos** Larry Shepp, one of the heroes in the story above, Gina recalled the following amusing story. Shepp gave a talk at Columbia University and presented a new statistical model. Transparency 3 of his lectures ended with the claim:

"This model is as profound and as interesting as any model in statistical physics..."

This claim was regarded as an insult, caused some discomfort in the audience that soon turned into a heated debate. The lecture was interrupted for 10 minutes and the situation nearly escalated to a fist fight. When things calmed down and the lecture resumed, Shepp put the next transparency, which began with the phrase:

" .... well, perhaps not quite."

15 The Future of String theory

"Utopia - 10%, Triumph and isolation - 40%, perpetuum mobile - 10% decay - 20% failure - 15% alternativa - 15%," Gil Kalai [trying to add up to 100%], Nov. 16, 2006.

Like with any separation, Gina felt that she was certainly also to blame. She was at times, rather annoying. She was a little shocked to be expelled but did not have hard feelings. For one, she did learn a lot from Peter's book and blog, and looking at the world mainly with curious eyes was also a means for avoiding hard feelings. Being a cyber entity she found thoughts about her *feelings* quite confusing. Overall, Gina liked Peter. When he did not discuss string theory he could be very interesting. Peter also had an endearing feature of fighting fiercely when he was not appreciated, and at the same time, becoming embarrassed and overly humble when he was. Gina thought it could have been better for Peter to receive compliments more willingly, and to accept criticism more lightly.

Indeed, Gina was very critical of Peter Woit's skeptical approach towards string theory and referred to it once as "skeptical harassment". She wondered what the role of skepticism in science is, and what a correct way to pursue a skeptical point of view should be. This is a fascinating question, she thought.

Gina had a few comments left in her drawer. One was about debating beauty. Is it at all possible? Another was about the ``future of string theory''. She was pleased to see that somewhat similar ideas were expressed by another participant.

Gil Kalai Says:
November 16th, 2006 at 6:37 pm

When brilliant and hilarious Scott Aaronson came to town last month, he was much more eager to tell us about the recent physics controversies, the new books about string theory, and the related blog excitements, than to discuss quantum computer's skepticism. Scott surely got us interested!

What might happen to physics in the next 50 years? Good question! And what does the future have in store for string theory? Below are six alternatives:

This (light) piece is inspired by the (deep and serious) classic paper by Russell Impaglliazzo on the five possible universes of computation and cryptography.

Apart from the illustrative details (which are meant to be amusing), I regard each of the six alternatives below as realistic. The second alternative can be regarded as the current default cautiously-optimistic main-stream approach of the scientific community which, perhaps, makes it the most plausible option.

Six Alternatives for String Theory's Future

1. UTOPIA

String theory continues to progress and converges in a few decades to become a solid part of our scientific understanding with plenty of empirical direct and indirect confirmations and many applications to all other areas of physics. Some of the landmarks after the "Maldacena conjectures" (1997) were the "Johnson Postulate" (2009), the "Motl Ansatz" (2014), the "Distler Paradigm" (2017) followed by the powerful "E-F-W Calculus" (2022). String theory becomes the "language of physics", perhaps even "the language of nature". Every graduate student in physics is able to make string theory computations, and this is what most physicists do. String theory represents a sound mathematical theory, in fact, mathematics is now considered as just "the special case of string theory for Plank constant 0". A few exciting problems remain.

Peter Woit's book "TRUE!" tops the NYT best sellers lists for 24 weeks. (In his book Woit advises caution when applying string theory to the area of finance.)

2. TRIUMPH and ISOLATION

String theory continues to progress and converges in a few decades to a solid part of our scientific understanding with convincing empirical direct and indirect confirmations, but with little applications and relevance to other areas of physics. Computations with string theory are extremely hard. (Computations based on the E-F-W calculus are computationally infeasible even on the newly built "quantum computers".) Mathematical foundations of string theory, much like those of earlier high-energy physics, remain shaky.

Peter Woit's book "NOT WRONG!" hits the market.

3. PERPETUUM MOBILE

String theory continues to progress but it does not converge. String theory thus remains a "useful divergent theory", whatever this means. More and more exciting connections to mathematics are found. More and more conceptual revolutions in the theory itself are taking place. (The latest is the "13th superstring revolution".) String theory leads to an entirely new way of looking at physics and, even more so, it is a scientific experience not seen before. As always, the best, most brilliant minds are attracted to this theory.

The 17th edition of Woit's "Not Even Wrong" appears.

4. DECAY

String theory continues to progress but the progress is slower; the attractiveness of the theory seems to diminish. String theory still looks promising, but while the success appears to be just around the corner, string theory is not sufficiently promising to attract the best people. Interest in physics is shifted to other directions.

5. GLORIOUS FAILURE

A brilliant string theorist from Vanderbilt University discovers a potential feature of supersymmetric string theory which contradicts basic physics insights. Massive computations in the "String Vacuum Project" confirm her discovery. After several years of extensive research (with beautiful new connections to mathematics found) it is now commonly accepted that string theory was falsified, and is no longer an option for a theory of everything. No alternative is in sight. 20 prominent string theorists declare string theory as part of "mathematical physics", rather than a viable physics theory, and within 72 hours, 18 of them get lucrative offers from top mathematics departments.

Woit's biography of Ed Witten "WRONG!!" is the basis for a successful Hollywood movie featuring Will Smith as Witten in the main role.

6. ALTERNATIVA

The alternative theory was discovered by sheer coincidence and, like string theory itself, is based on a technical rather than conceptual idea. The initial step was made by an elderly mathematician from Bristol University who, seeking a mathematical explanation for QED, suggested a small correction to the Feynman diagram expansion. Strangely, this has led to some consistent theory and made quantum gravity easier. The next step came when a researcher from the University of Tehran (provoked, in parts, by some rather general suggestions of P. Woit, and the mathematical notion of "noise sensitivity",) connected dark matter and dark energy with representations of unbounded weights and dimensions. Such representations are prominent in the new theory. (This new type of mass/energy is called "the mess".) The theory subsequently developed and was brought to completion by New-Jersey based physicists N. Seiberg and E. Witten.

An extremely surprising feature of the new alternative theory is that the universe is 3+1 dimensional.

The translation of the new edition of Woit's "Not Even Wrong" to Czech has just appeared.

(My subjective probabilities for the future of string theory, Utopia - 10%, Triumph and isolation - 40%, perpetuum mobile - 10%, decay - 20%, failure - 15%, alternativa - 15%. Of course, some combination or entirely different scenarios that I missed are also possible.)

Reading this, Gina recalled the story about Ulam and the future of mathematics:

Ulam and the "future of mathematics"

Ulam was scheduled to give a talk at the University of Chicago titled "The future of mathematics." Stanislaw Ulam was a rather famous mathematician and a major player in building the H-bomb, so a large audience gathered.

Ulam had trousers with two suspenders ending at a single front button. At some point in the talk, when Ulam became excited, this single button collapsed, the suspenders got untied and the trousers came down slowly, revealing colorful boxer underwear. Ulam did not notice it for a couple of minutes and then when he did, he raised the trousers and just supported them with his hand, which was fine, except that when he got over-excited and waved both hands, the trousers went down again.

Besides the colorful boxer under-pants, Ulam's lecture was a completely mundane mathematical talk: problems, lemmas, theorems, conjectures, little proofs, nothing unusual, and not a word about the future of mathematics.

When it was time to ask questions, a person from the audience asked Ulam about the future of mathematics. Ulam looked at him rather surprised, and replied very slowly.

"Young man" Ulam said, "you must understand: we are now in the present, and the future only comes *later*, so it is not possible to know what the future of mathematics will be, simply because it has not happened *yet*."

Then other people asked similar questions and reminded Ulam that the title of the talk was "The Future of Mathematics", but Ulam insisted that these questions were misguided since the future would only come at a later time.

16 Silly string wars in Jerusalem

"And, finally, of course, 'string wars' is mine. All mine!" Aaron Joseph Sturmthal Bergman [Claiming ownership of the term 'string war'] 11:37 AM, December 24, 2006

"Silly string wars are a common way of celebrating the day in Israel as seen on Ben Yehuda Street in Jerusalem on the holiday in 2006", Yom Ha'atzmaut - Wikipedia, the free encyclopedia

http://en.wikipedia.org/wiki/Image:IsraelShaving.jpg

Since the mid eighties, silly string wars have become a popular way to celebrate Israeli Independence Day (Yom Haatzmaut). Initially rooted in the competition between two prominent Jerusalem high schools, the "Leyada" and the "Gymnasia", silly string wars are nowadays conducted all over Israel. Every year, on Independence Day, festive young men and women split into groups of string opponents and string proponents and engage in the fun.

Among the silly things opponents do, is silently approach a group of proponents and surprise them with a loud shout "**t' Hooft** !!".

Silly proponents, on the other hand, follow their leader, who in turn asks: "What are we doing?" "Add" "and what is the answer" "Ten" "and what do you get?" "Add-we-ten" "Add-we-ten", the ecstatic proponents cry cheerfully. They also take out small mirrors, place them next to bystanders' faces and shout: "mirror symmetry!"

You can hear head to head clashes between proponent and opponents who, referring to finiteness of string theory, incessantly shout at each other: "Finite" "infinite" "finite" "infinite..." In recent years these roles have occasionally been reversed when proponent and opponents, referring to finiteness of N=8 supergravity, shout endlessly: "infinite" "finite" "infinite" "finite" "infinite..."

When the festivities end, people go back to their homes. They are ready for yet another year of serious productive activities in the boring city of Jerusalem, where nothing ever happens.

Fundamental impossibilities:

Understanding our fundamental limitations is among the most important contributions of science and of mathematics. There are quite a few cases where things that seemed possible and had been pursued for centuries in fact turned out to be fundamentally impossible. Ancient geometers thought that any two geometric lengths are commensurable, namely, measurable by the same common unit. However, for a right triangle with equal legs, the leg and the hypotenuse are incommensurable. In modern language (based on the Pythagorean theorem), this is the statement that asserts that the square root of two is not a rational number. This was a big surprise in 600 BCE in ancient Greece (the story is that this discovery, attributed to a Pythagorean named Hippasus, perplexed Pythagoras to such an extent that he let Hippasus drown). Two centuries later, Euclid devoted the tenth book of his work the *Elements* to irrational quantities. The irrationality of the square root of 2 is an important landmark in mathematics. Similarly, the starting point of modern algebra can be traced back to another impossibility result. Algebraists found formulas for solving equations of degrees two, three, and four. Abel and Galois proved that no such formula is possible for general equations of degree five and above. This theory also led to a solution of a problem that remained unsolved from the Ancient Greek era: finding a method of trisecting a general angle with a compass and a ruler. Galois' theory demonstrated that no such method exists.

There are other important impossibility results. We have already mentioned Gödel's impossibility result, asserting that it is not possible to prove (nor even to state) the consistency of mathematics from within mathematics. It is believed that there are inherent impossibilities for computers (and for any computational devices). This is the famous conjecture that P is different from NP. An impossibility theorem of Gibbard and Satterthwaite asserts that for an election with more than two candidates and at least two voters, there does not exist a voting method; that is, there is no method for choosing a winner, based on the voters' preferences, which is immune to manipulation. Impossibility insights outside mathematics, like the impossibility of building a perpetuum mobile, of turning iron into gold, and (most likely) of traveling in time, are related to profound scientific understanding. And, of course, the impossibility of traveling quicker than the speed of light is one of the famous and mind-boggling insights of science.