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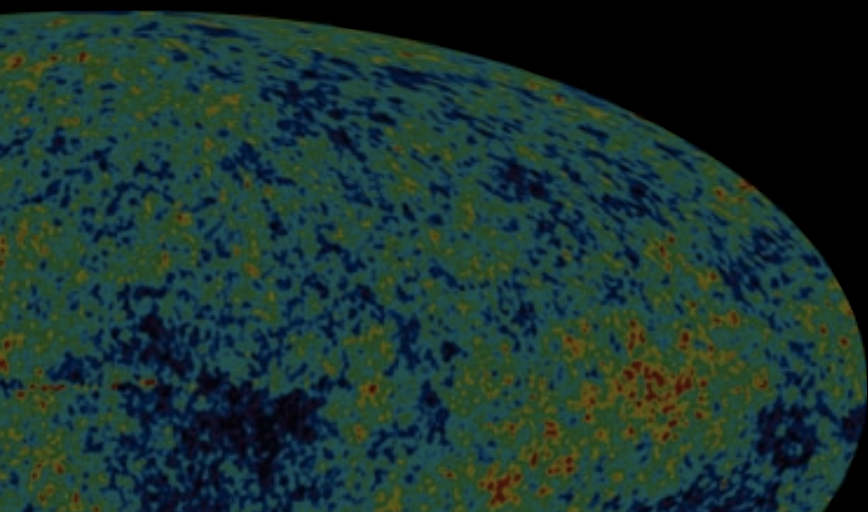
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image credits: Scientific American

scientific consensus and public perception of science



Trust, Expert Opinion, and Policy
Dublin
02/09/2017

- ▶ a case study: the inflationary paradigm
- ▶ another case study: the multiverse debate
- ▶ disagreement among peers
- ▶ public perception of science
- ▶ the scientific method
- ▶ general discussion
- ▶ conclusions

I) a case study: inflationary cosmology

COSMOLOGY

POP

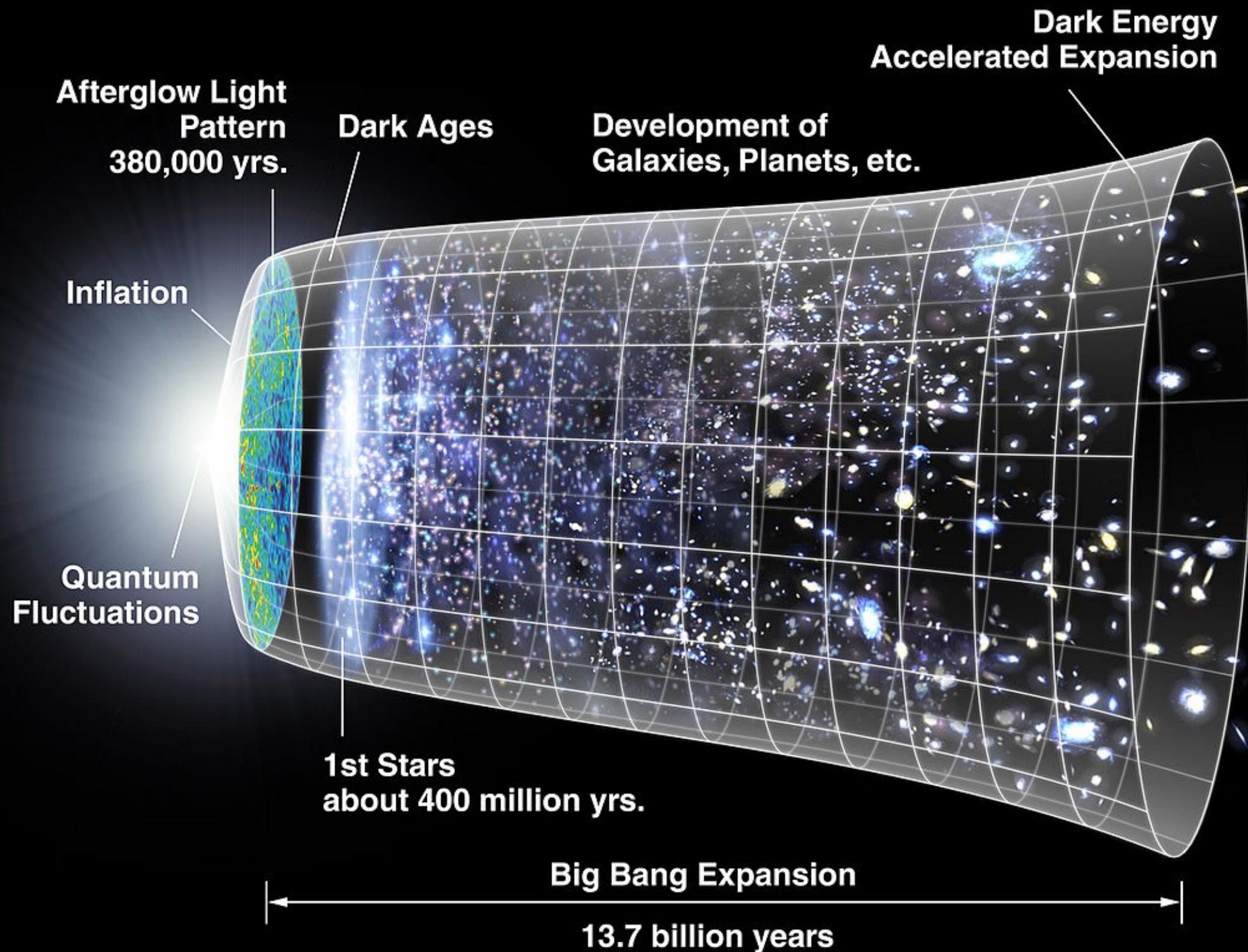
*goes the
universe*

THE LATEST ASTROPHYSICAL MEASUREMENTS,
COMBINED WITH THEORETICAL PROBLEMS, CAST DOUBT
ON THE LONG-CHERISHED INFLATIONARY THEORY
OF THE EARLY COSMOS AND SUGGEST WE NEED NEW IDEAS

By Anna Ijjas, Paul J. Steinhardt and Abraham Loeb

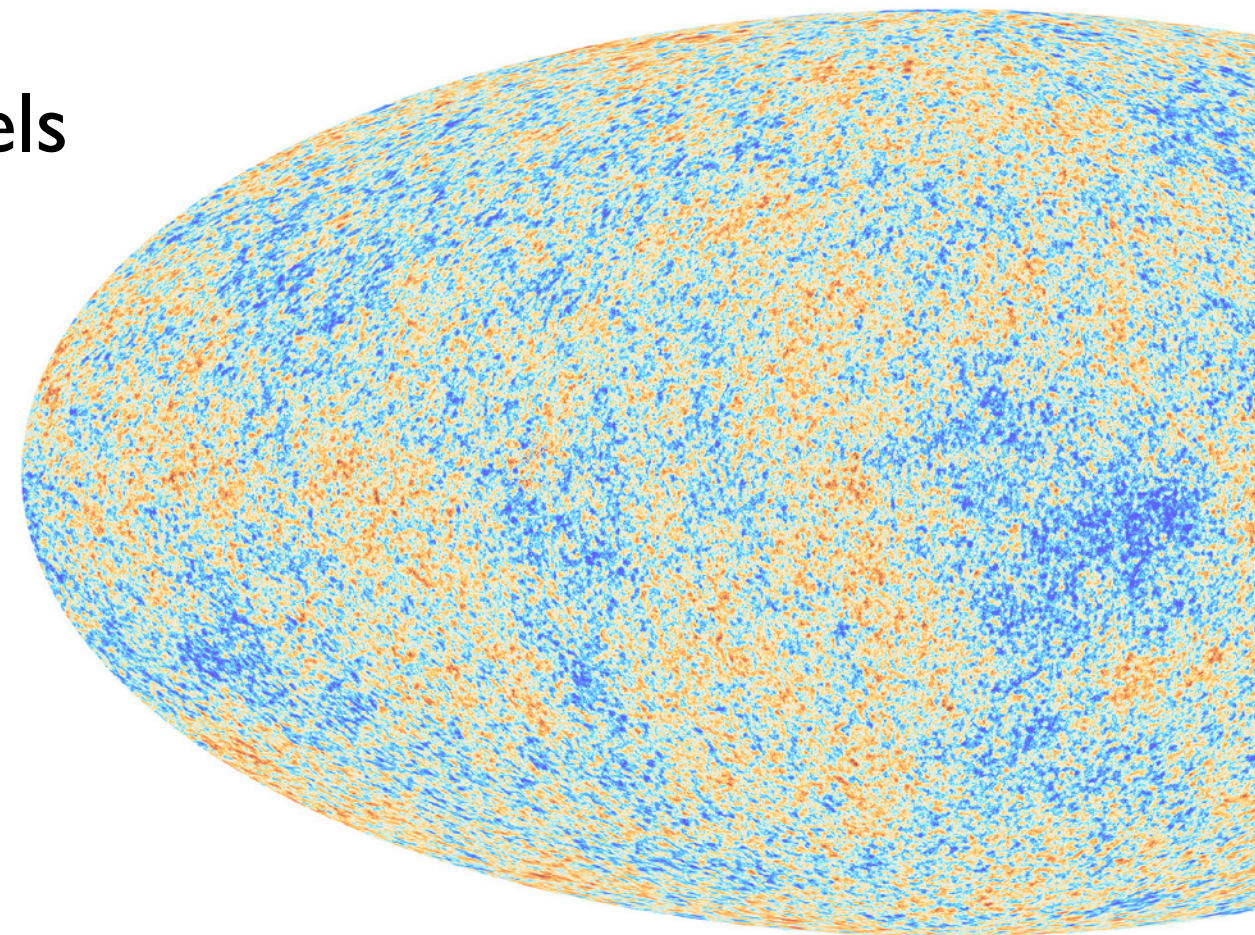


I) a brief history of the universe



I) stating the "problem"

- ▶ motivation: horizon & flatness problems
- ▶ scale invariance
- ▶ fine-tuning of initial conditions
- ▶ many inflation models predict a multiverse
- ▶ alternatives to inflation: bouncing models



I) source of disagreement

"Yet even now the cosmology community has not taken a cold, honest look at the big bang inflationary theory or paid significant attention to critics who question whether inflation happened. Rather cosmologists appear to accept at face value the proponents' assertion that we must believe the inflationary theory because it offers the only simple explanation of the observed features of the universe. But, as we will explain, the Planck data, added to theoretical problems, have shaken the foundations of this assertion."

"Some scientists accept that inflation is untestable but refuse to abandon it. They have proposed that, instead, science must change by discarding one of its defining properties: empirical testability. This notion has triggered a roller coaster of discussions about the nature of science and its possible redefinition, promoting the idea of some kind of nonempirical science."

Ijjas, Steinhardt, and Loeb; "Cosmic Inflation Faces Challenges"; Scientific American
<https://www.scientificamerican.com/article/cosmic-inflation-theory-faces-challenges/>

A Cosmic Controversy

A *Scientific American* article about the theory of inflation prompted a reply from a group of 33 physicists, along with a response from the article's authors



Credit: *Scientific American*, February 2017

LATEST NEWS



"What the Health"
Documentary: A Review



Amazon Hit with Lawsuit
over Eclipse Glasses



Skeleton Plundered from
Mexican Cave Was One of the
Americas' oldest

Guth, Kaiser, Linde, and Nomura; "A Cosmic Controversy"; *Scientific American*
<https://blogs.scientificamerican.com/observations/a-cosmic-controversy/>

I) the rebuttal

Alan H. Guth

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http://web.mit.edu/physics/people/faculty/guth_alan.html

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29 people signed in support

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<https://web2.ph.utexas.edu/~weintech/weinberg.html>

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appeal to authority

I) the rebuttal

"Moreover, as the work of several major, international collaborations has made clear, inflation is not only testable, but it has been subjected to a significant number of tests and so far has passed every one."

false statement

"Inflation is not a unique theory but rather a class of models based on similar principles. Of course, nobody believes that all these models are correct, so the relevant question is whether there exists at least one model of inflation that seems well motivated, in terms of the underlying particle physics assumptions, and that correctly describes the measurable properties of our universe."

Guth, Kaiser, Linde, and Nomura; "A Cosmic Controversy"; Scientific American
<https://blogs.scientificamerican.com/observations/a-cosmic-controversy/>

I) a reply to the rebuttal

"We have great respect for the scientists who signed the rebuttal to our article, but we are disappointed by their response, which misses our key point: the differences between the inflationary theory once thought to be possible and the theory as understood today. The claim that inflation has been confirmed refers to the outdated theory before we understood its fundamental problems. We firmly believe that in a healthy scientific community, respectful disagreement is possible and hence reject the suggestion that by pointing out problems, we are discarding the work of all of those who developed the theory of inflation and enabled precise measurements of the universe."

"We are three independent thinkers representing different generations of scientists. Our article was not intended to revisit old debates but to discuss the implications of recent observations and to point out unresolved issues that present opportunities for a new generation of young cosmologists to make a lasting impact. We hope readers will go back and review our article's concluding paragraphs. We advocated against invoking authority and for open recognition of the shortcomings of current concepts, a reinvigorated effort to resolve these problems and an open-minded exploration of diverse ideas that avoid them altogether. We stand by these principles."

I) repercussion amongst peers

One is told that eternal inflation implies a multiverse with different physics in different universes, but in a single inflaton model this physics should just depend on a single parameter, and such a theory should be highly predictive (once you know one mass, all others are determined). What's really going on is that there is no connection at all between the simple single field models that GKL&N and IS&L are arguing about, and the widely promoted completely unproductive string theory landscape models (involving large numbers of inflaton-type fields with dynamics that is not understood).

I think IS&L made a mistake by not pointing this out, and that Guth, Linde, Nomura and some of the signers of their letter (e.g. Carroll, Hawking, Susskind, Vilenkin) have long been guilty of promoting the defeatist pseudo-scientific idea that “evidence for inflation is evidence for a multiverse with different physics in each universe, explaining why we can't ever calculate SM parameters”. By defending the predictivity of “inflation” while ignoring the “different physics in different parts of the multiverse” question, I think many signers of the GKL&N letter were missing a good opportunity to make common cause with IS&L on defending their science against an ongoing attack from some of their fellow signatories.

Peter Woit; "A Cosmic Controversy"; Not Even Wrong
<http://www.math.columbia.edu/~woit/wordpress/?p=9289>

I) media repercussion

“They really made the accusation that the inflationary community understands that the theory is not testable,” Guth, one of the idea’s founding fathers, says. “Those words angered me.” In response, Guth and his colleagues have taken the unusual step of replying with their own letter in Scientific American that insists they are doing science. They even went to the trouble of circulating their response, in order to collect signatures from many of the world’s most prominent cosmologists. “What’s the point of just making it look like it’s three people disagreeing with three people?” says David Kaiser, another author of the letter.”

“Our point is that this kind of reasoning is inconsistent with normal science and cannot be resolved by invoking authority,” Ijjas, Steinhardt, and Loeb wrote to The Atlantic. They argue their intention is to direct a new generation of cosmologists to look for opportunities away from the established orthodoxy.”

Joshua Sokol; "A Cold War Among Physicists Turns Hot"; The Atlantic
<https://www.theatlantic.com/science/archive/2017/05/a-cold-war-among-cosmologists-turns-hot/526329/>

I) media repercussion: trust and disagreement

Time Magazine

PHYSICS

Stephen Hawking and Fellow Scientists Dismiss 'Big Bounce' Theory in Letter

Aric Jenkins

May 13, 2017



Stephen Hawking and 32 fellow scientists have written a critical letter in response to an article published in *Scientific American* that details an alternative theory on how the universe began.

<http://time.com/4778304/stephen-hawking-scientific-american-letter-big-bounce/>

Newsweek

TECH & SCIENCE

BIG BANG OR BIG BOUNCE? STEPHEN HAWKING AND OTHERS PEN ANGRY LETTER ABOUT HOW THE UNIVERSE BEGAN

BY HANNAH OSBORNE ON 5/12/17 AT 7:32 AM

<http://www.newsweek.com/big-bang-stephen-hawking-origin-universe-608104>

2) another case study: strings and the multiverse




Defend the integrity of physics

Attempts to exempt speculative theories of the Universe from experimental verification undermine science, argue **George Ellis** and **Joe Silk**.


Ellis & Silk; "Defend the integrity of physics"; Nature

<http://www.nature.com/news/scientific-method-defend-the-integrity-of-physics-1.16535>

2) the case of the multiverse



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ARNOLD SOMMERFELD CENTER FOR THEORETICAL PHYSICS
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Why Trust a Theory? Reconsidering Scientific Methodology in Light of Modern Physics

7-9 December, 2015

Idea and Motivation

Fundamental physics today faces increasing difficulties to find conclusive empirical confirmation of its theories. Some empirically unconfirmed or inconclusively confirmed theories in the field have nevertheless attained a high degree of trust among their exponents and are de facto treated as well established theories. This situation raises a number of questions that are of substantial importance for the future development of fundamental physics. Can a high degree of trust in an empirically unconfirmed or inconclusively confirmed theory be scientifically justified? Does the extent to which empirically unconfirmed theories are trusted today constitute a substantial change of the character of scientific reasoning? Might some important theories of contemporary fundamental physics be empirically untestable in principle?

The workshop will be centred around an in-depth discussion of these and other related questions, with a particular focus on the methodological and philosophical aspects. As such, it will be an interdisciplinary event, involving physicists and philosophers of science. It will bring together main exponents of important theories in fundamental physics, physicists who have expressed criticism of the current strategies of theory assessment in fundamental physics and philosophers who have thought about those issues.

2) the debate

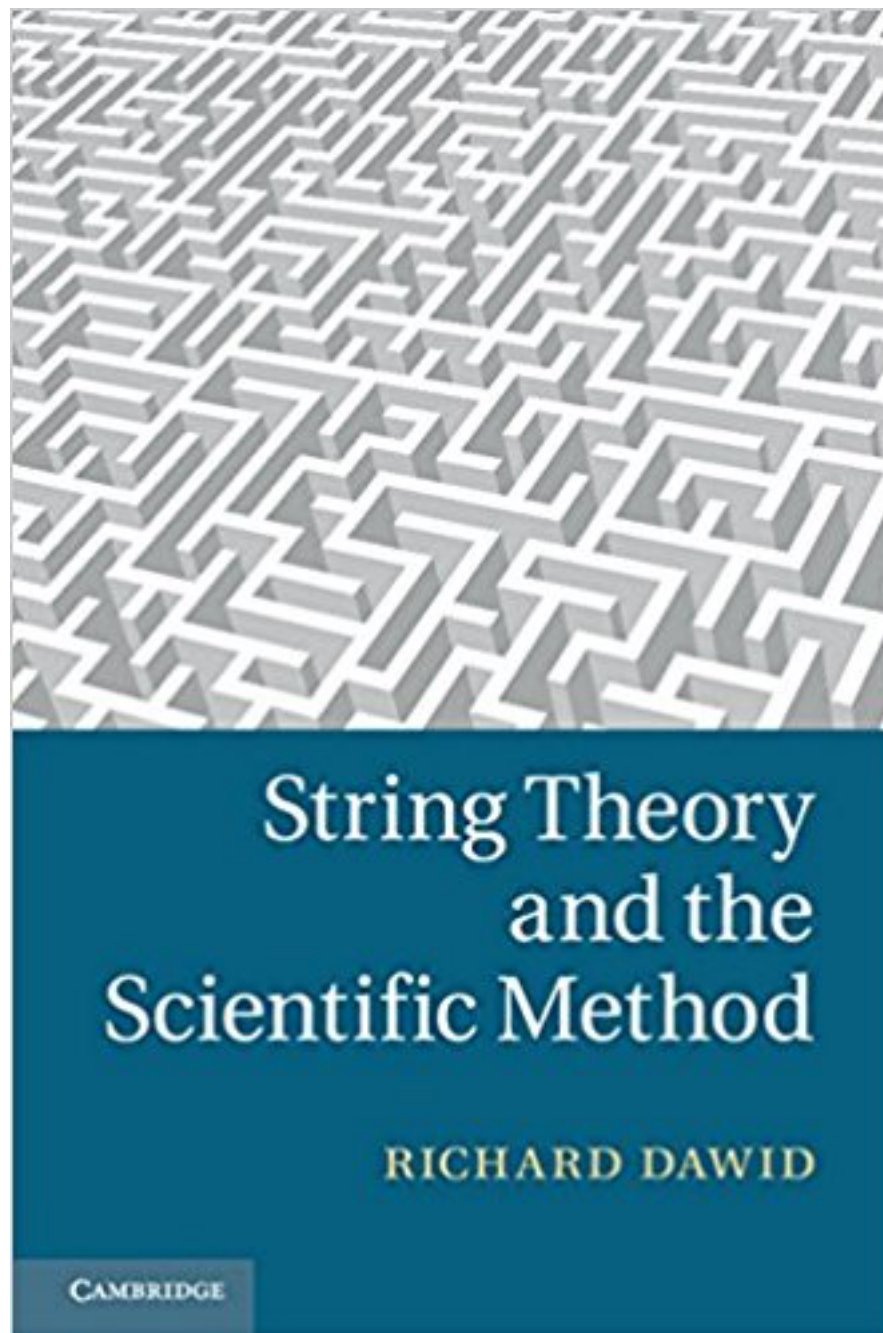
"Faced with difficulties in applying fundamental theories to the observed Universe, some researchers called for a change in how theoretical physics is done. They began to argue — explicitly — that if a theory is sufficiently elegant and explanatory, it need not be tested experimentally, breaking with centuries of philosophical tradition of defining scientific knowledge as empirical. We disagree. As the philosopher of science Karl Popper argued: a theory must be falsifiable to be scientific."

"We applaud the fact that Dawid, Carroll and other physicists have brought the problem out into the open. But the drastic step that they are advocating needs careful debate. This battle for the heart and soul of physics is opening up at a time when scientific results — in topics from climate change to the theory of evolution — are being questioned by some politicians and religious fundamentalists. Potential damage to public confidence in science and to the nature of fundamental physics needs to be contained by deeper dialogue between scientists and philosophers."

Ellis & Silk; "Defend the integrity of physics"; Nature

<http://www.nature.com/news/scientific-method-defend-the-integrity-of-physics-1.16535>

2) the debate



"This brings me to the other shift that Dawid makes in his string (ha-ha-ha) of words, which is that he alters the meaning of "science" as he goes. To see what I mean we have to make a short linguistic excursion."

"In summary, there's no such thing as post-empirical physics. If it doesn't describe nature, if it has nothing to say about any observation, if it doesn't even aspire to this, it's not physics. This leaves us with a nomenclature problem. How do you call a theory that has only non-empirical facts speaking for it and one that the mathematical physicists apparently don't want either? How about mathematical philosophy, or philosophical mathematics? Or maybe we should call it Post-empirical Dawidism."

Sabine Hossenfelder. "Post-empirical science is an oxymoron". Backreaction Blog.
<http://backreaction.blogspot.ie/2014/07/post-empirical-science-is-oxymoron.html>

2) media repercussion

NATURE | NEWS

Nature

Feuding physicists turn to philosophy for help

String theory is at the heart of a debate over the integrity of the scientific method itself.

Daide Castelvechi

23 December 2015 | Corrected: 05 January 2016

The Atlantic

Physicists and Philosophers Hold Peace Talks

If only for three days

NATALIE WOLCHOVER | DEC 22, 2015 | SCIENCE

case 1: the inflationary paradigm	case 2: string theory & the multiverse
"consensus" in favour of inflation	community divided
"textbook physics" for the younger generation	"new" and not well-established
debate in Scientific American	debate in Nature
replies in Scientific American it became personal	"a conference should be convened"
"those words angered me"	"people from both sides of the testability debate must be involved."
headlines: "scientists can't agree on what science even means anymore"	headlines: "scientists debate the scientific method"

scientific responsibility and the appeal to "authority"

- ▶ in the inflation debate, was the choice of Scientific American to publish the article irresponsible?
- ▶ did the editor of SciAm made a poor choice accepting the article, as this debate is not acknowledged as significant by the majority of the community?
- ▶ while it is important to bring to the public's attention current issues in science, the views presented by ISL are shared by very few people - for most, there is no debate
- ▶ the unreasonable outrage of the pro-inflation community contributed to drawing attention to the issue
- ▶ by invoking the authority and public appeal of Stephen Hawking, and a few nobel prize winners, the debate derailed - it was no longer about facts, but rather about names
- ▶ if they are all epistemic peers, then there is no authority - why the signatures? to sway the public's opinion?

"The main job of physics popularizers is the same as it is for any celebrity: get more famous. Most do this by finding increasingly mindblowing things to say that are just barely justifiable in modern physics, if you turn your head and squint hard enough. So you get sound bites from Brian Cox saying that when he moves some crystal around, all the electrons in the universe respond instantaneously and the whole universe is all one big connected web, or Lawrence Krauss telling us there's definitely no God because the whole universe popped out of nothing, or Hawking declaring that philosophy is dead, or Michio Kaku saying that cyborg hypercube superhumans will mindmeld with topological aliens made out of dark energy Calabi-Yau manifolds (or whatever he's talking about these days). Theoretician popularizers who refuse to go down this road (Steven Weinberg, Sean Carroll, Scott Aaronson, Kip Thorne) don't seem to reach the same level of popularity."

<https://www.forbes.com/sites/quora/2017/08/11/what-is-neil-degrasse-tysons-role-in-the-scientific-community/#2bb67c9c75a5>

Wired

NICK STOCKTON SCIENCE 05.16.17 7:00 AM

PHYSICISTS CAN'T AGREE ON WHAT SCIENCE EVEN MEANS ANYMORE

<https://www.wired.com/2017/05/physicists-cant-agree-science-even-means-anymore/>

The Telegraph

Stephen Hawking tells Google 'philosophy is dead'

Physicist Stephen Hawking has told Google's Zeitgeist conference that philosophers have not kept up with science and their art is dead

<http://www.telegraph.co.uk/technology/google/8520033/Stephen-Hawking-tells-Google-philosophy-is-dead.html>

trust and public perception of science

- ▶ the inflation debate can contribute to the distrust in science
- ▶ who should the public trust?
- ▶ when articles titled "Physicists can't agree on what science even means anymore", the scientists who triggered these headlines should acknowledge that they have failed the public
- ▶ ultimately, this contributes to decrease the public's trust in science and the trustworthiness of science itself
- ▶ the arrogance of some scientists ("philosophy is dead", Stephen Hawking) and disdain for other fields likely also contribute to the lack of trust in science

the *popperisation* of science



the *popperisation* of science

- ▶ some say science is becoming "popperised" and it is time to revisit the scientific method
- ▶ the scientific method is essentially common sense; when it is attacked, this may lead to a crisis in trust, where expert opinion loses its value, as claims cannot be proven
- ▶ when to recognise that something is not science and stop pursuing it?
- ▶ when to stop searching for evidences to support a theory? ("stopping problem")
- ▶ are we in the era of "post-empirical science"? should we even consider it?
- ▶ how do we recognise underdetermination? when to start looking for answers elsewhere?
- ▶ to abandon our positivist approach to science is to open the door to pseudosciences

- ▶ there are few arenas for actual debates - which ones should be used to discuss important issues that go against the consensus of the community?
 - academic journals may be biased (editors/reviewers' prejudices)
 - "accessible" outlets (magazines/newspapers/blogs) seem inadequate
 - discussion-oriented conferences, topical workshops, etc
- ▶ disagreement between peers: are all experts equal?
- ▶ is scientific consensus good, or does it prevent opposing paradigms to emerge?
- ▶ what is the value of invoking authority in a discussion amongst peers?
- ▶ science should be a collective epistemic enterprise; debates should not become personal, and interactions with the public should be ethical and responsible