FERMI SOCIETY OF PHILOSOPHY

biweekly meetings and talks

mailing list:
philosophysociety@fnal.gov (through the listserv)

Genesis of a Pythagorean Universe Pt. I

Alexey and Lev Burov — Apr 7th

The laws of nature are discovered as specific mathematical structures. Why these structures and not other? Why are they mathematically beautiful? The talk reviews an original approach to these questions by the eponymous award-winning article; recently, it was published by Springer, together with all the winners of the 2015 contest of the Foundational Questions Institute.

Genesis of a Pythagorean Universe Pt. II

Alexey and Lev Burov — Apr 21st

Open discussion on Genesis of a Pythagorean Universe

Open — May 5th

MEETINGS ARE SCHEDULED EVERY OTHER THURSDAY,
12:00-1:00, REQ ROOM (WH4NW)

discussion: **fermisocietyofphilosophy.wordpress.com**

GENESIS OF A PYTHAGOREAN UNIVERSE

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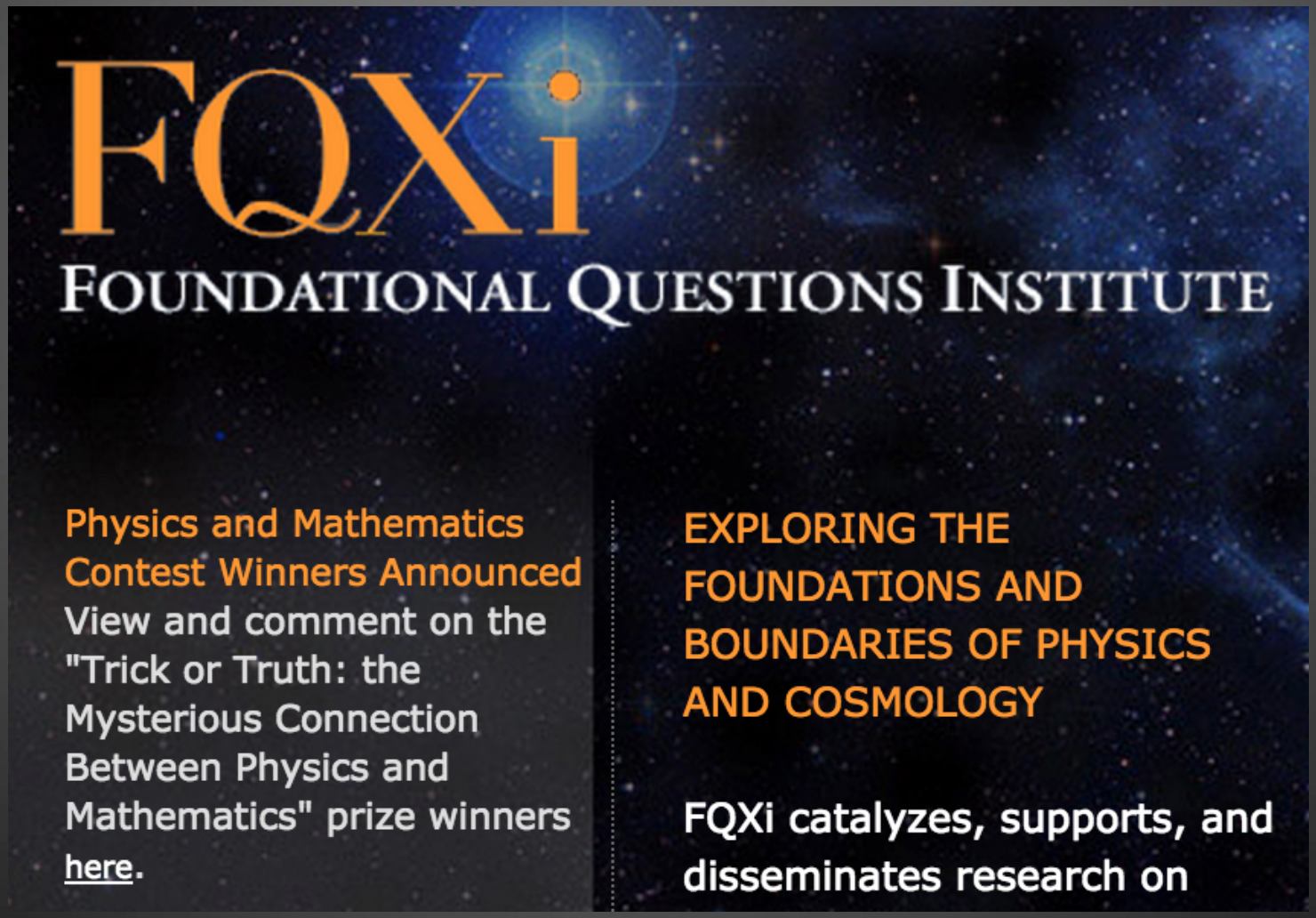
http://arxiv.org/abs/1411.7304



Disclaimer

The following was motivated by our
love of reason.

I will try my best to make our arguments clear
for the joy of sharing
with those who dare to think about ultimate questions.

Although it is not my concern as to
how convincing our arguments are,
I would be grateful for any responses
of those who made the effort to understand me.

ToE as the goal of physics

- Physics is looking for the laws of nature, the logical structure of the Universe.

- When the axioms of nature are all discovered, being logically unified into a single theory of everything (ToE), the task of fundamental science would be over.

- Although humanity does not have the ToE now, and may possibly never have it, many of its limit cases are already known.

Independently of incompleteness
of our knowledge of the ToE,

We may ask:

Why the laws are what they are?

ToE as a problem of metaphysics

- Why is the world defined by any mathematical structure at all? Why is this structure so *simple* that it is **discoverable**?

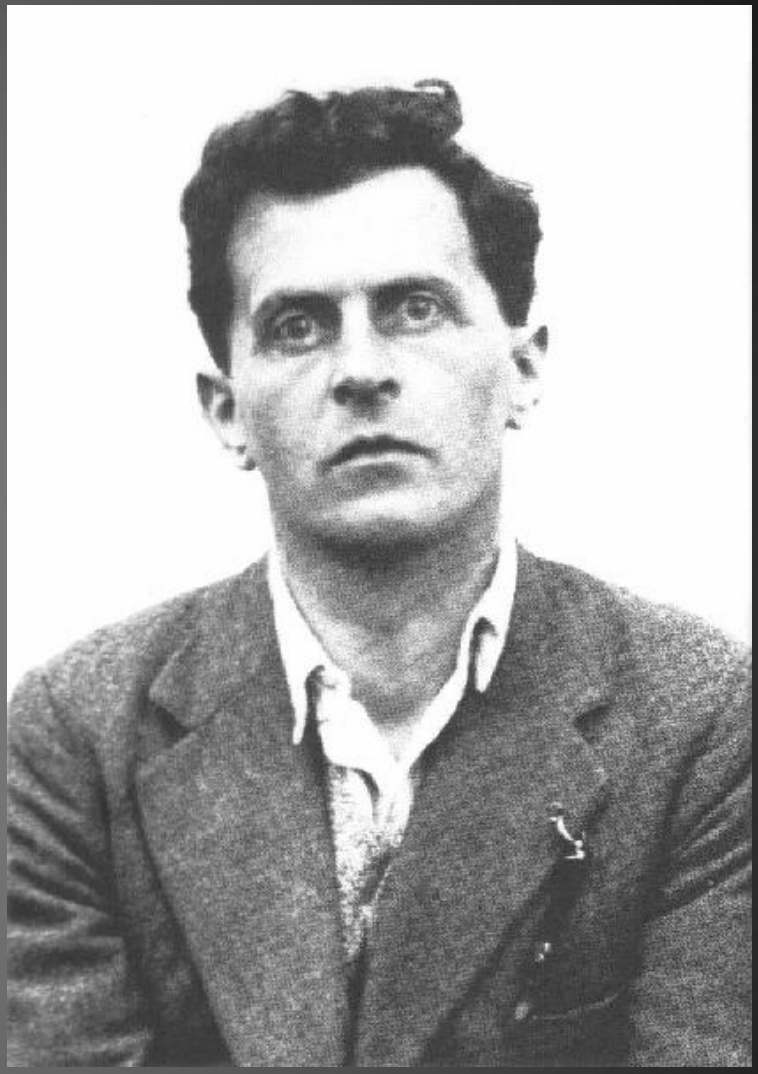
- While it is thinkable for a universe to be structured by any logically consistent system, out of this infinite set of structures only one determines our universe. Why *this* structure and not another? Who or what singled it out and on what ground?

- In this way the laws of nature become a problem, though not in the usual physical context of searching them out, but as something that requires its own explanation. For that, we have to think about physics, looking at physics from outside of it; thus, we have to think meta-physically.

What can be the Terminus?

- The illusory nature of an explanation that does not go beyond natural laws was pointed out by Ludwig Wittgenstein (1889-1951) (“Tractatus”, 1922):

- “The whole modern conception of the world is founded on the illusion that the so-called laws of nature are the explanations of natural phenomena. Thus people today stop at the laws of nature, treating them as something inviolable, just as God and Fate were treated in past ages. And in fact both are right and both wrong: though the view of the ancients is clearer in so far as they have a clear and acknowledged terminus, while the modern system tries to make it look as if everything were explained.”



Ludwig Wittgenstein

1889-1951

Physics normally thinks bottom-up,
looking for more and more general theories.

Let's think top-down:
What, in principle, can be thought as the Terminus?
And what cannot?

Absurd as a Ground of Reason?

- One of the reactions to the problem of terminus is to deny the reasonableness of this questioning.

- Paul Davies: "If that is so [if it is unreasonable to ask], then the unified theory—the very basis for all physical reality—itself exists for no reason at all. Anything that exists reasonlessly is by definition absurd. So we are asked to accept that the mighty edifice of scientific rationality—indeed, the very mathematical order of the universe—is ultimately rooted in absurdity!"

- In other words, such superstition destroys the meaning and value of fundamental science by undermining the importance of reason, subjected by this belief to the absurd.

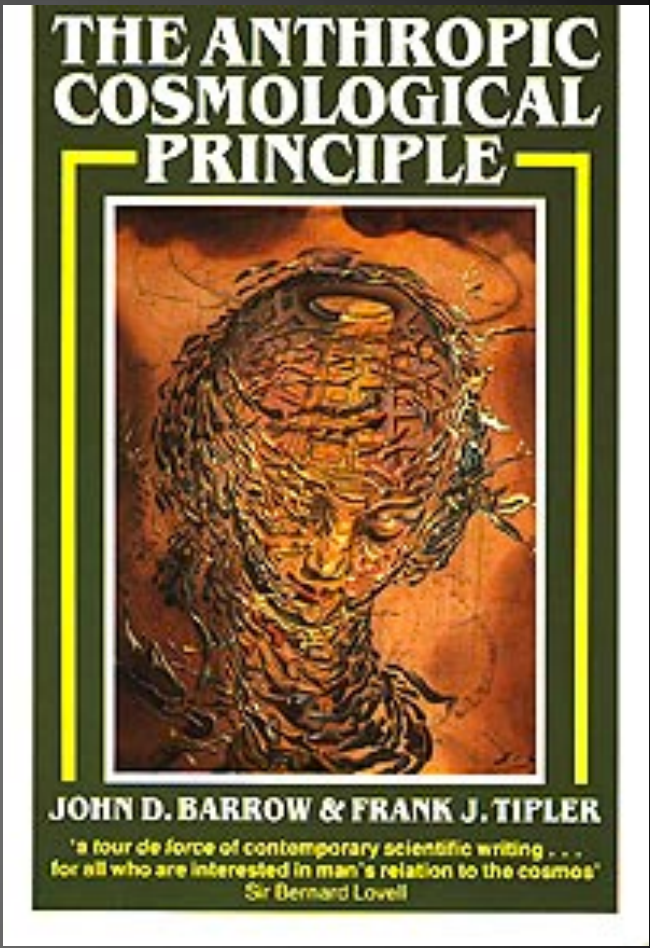
- What reasonable answers can there be concerning the source of the laws of nature? Is there any way of *choosing* or rejecting one or another?

Before any attempt to explain the laws of nature, let's first ponder on what they are.

Are they specific in any respect?

The Fine Tuning

- “The laws of science, as we know them at present, contain many fundamental numbers, like the size of the electric charge of the electron [fine structure constant] and the ratio of the masses of the proton and the electron. ... The remarkable fact is that the values of these numbers seem to have been very finely adjusted to make possible the development of life.” (S. Hawking)



- “There is now broad agreement among physicists and cosmologists that the universe is in several respects ‘fine-tuned' for life.” (P. Davies)

The Structural Tuning

- The laws of nature are very special mathematically: they are expressed by reasonable and simple mathematical forms, at the same time allowing rich life-friendly family of solutions, i.e. they are *beautiful.*

- These forms cover a huge range of parameters with extraordinary precision, which excludes them being a mere fitting or an artifact.

- *E. Wigner*: "...the mathematical formulation of the physicist's often crude experience leads in an uncanny number of cases to an amazingly accurate description of a large class of phenomena. This shows that the mathematical language has more to commend it than being the only language which *we* can speak; it shows that it is, in a very real sense, the correct language…", *The Unreasonable Effectiveness of Mathematics in the Natural Sciences*,1960.

Eugene Wigner
(1902-1995)

Dual Tuning

- For today, our scale of scientific cognition is described by an enormous dimensionless parameter **~10^45;** that big is the ratio of the sizes of the largest object of physics, the universe, **~10^26m**, to the smallest ones, the top quark and the Higgs boson, corresponding to **~10^-19m**.

- It is important that the same laws precisely work for the entire range of these 45 orders, both for the Universe en grand and for its tiny elements, fundamental particles.

- Thus, the **laws of nature are tuned in *two* senses**: they are both elegant and anthropic. The tuning is *both* structural and fine.

- Now we are coming back to the question of the *terminus*.

A pure scientistic approach

- Who or what tuned the universe so specially?
- A pure scientistic approach requires finding an objective answer: not "somebody" but "something" as the cause of tuning.
- This "something" can only be a pure accident, the totality of Chaos, Nothingness.
- This leads to an idea of all thinkable universes to exist (Nozik, Lewis), or each mathematical structure is realized as the theory of everything of some universe in the multiverse (Tegmark).
- So cosmogenesis is suggested to be considered as *chaosogenesis* (CG).

Max Tegmark suggested his own solution to the "embarrassing" question: **"mathematical democracy"**

"If the ToE [theory of everything] exists and is one day discovered, then an embarrassing question remains, as emphasized by John Archibald Wheeler: Why these particular equations, not others? Could there really be a fundamental, unexplained ontological asymmetry built into the very heart of reality, splitting mathematical structures into two classes, those with and without physical existence? After all, a mathematical structure is not "created" and doesn't exist "somewhere". It just exists. As a way out of this philosophical conundrum, I have suggested that complete **mathematical democracy** *holds*: that mathematical existence and physical existence are equivalent, so that all mathematical structures have the same ontological status." ("The Mathematical Universe", Foundations of Physics, 2007)

Is it possible though that laws
so specific are purely accidental?

Weak Anthropic Principle (WAP)

- WAP: In the infinite multiverse, only those universes can be observed where observers can appear, which selects a narrow class of fine-tuned universes.

- The fine tuning apparently receives a scientific explanation: Although in the infinite megaverse only a tiny portion of universes is fine-tuned for life and consciousness, the probability for any observer to see the universe as fine-tuned is 100%.

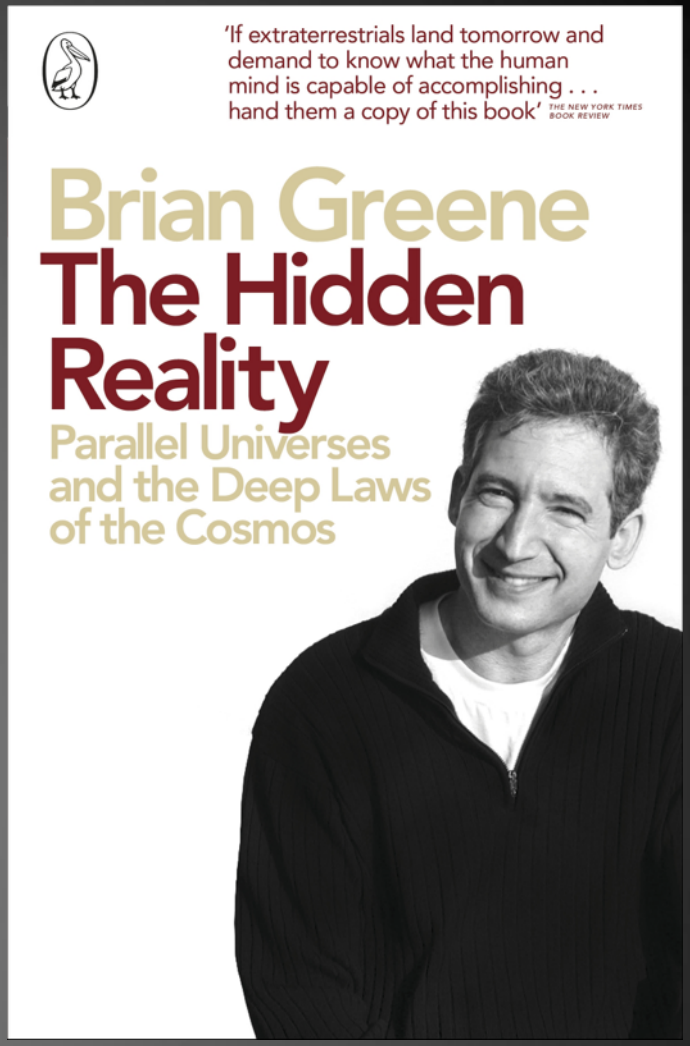
- Nothing seemingly contradicts the assumption that our universe is a random representative of WAP-selected subset of the full-blown multiverse, but is that really so? Does the universe indeed have no clear signature excluding any possibility of it having been **randomly** selected from this totality of all possible mathematical structures? Is the concept of CG irrefutable by any thinkable observation?

- Apparently, it is considered as irrefutable by some leading experts.

Is Tegmark's Hypothesis Irrefutable?

For instance, Brian Greene clearly says that:

"I draw the line at ideas that have no possibility of being confronted meaningfully by experiment or observation, not because of human frailty or technological hurdles, but because of the proposals' inherent nature. Of the multiverses we've considered, only the full-blown version of the Ultimate Multiverse falls into this netherland. If absolutely every possible universe is included, then no matter what we measure or observe, the Ultimate Multiverse [i.e. Tegmark's] will nod and embrace our result." ("The Hidden Reality: Parallel Universes and the Deep Laws of the Cosmos", 2011)



Contrary to B. Greene, we are showing that Tegmark's hypothesis runs counter to certain observations, so it fails, and fails as a scientific theory.

Refutation of CG

- Can we make any testable prediction with CG?

- In Tegmark's unlimited "democratic" library of laws there is an infinite number of those able to generate a however fast deadly event at any given moment. The fact that they were sleeping so far does not provide a ground to exclude their immediate awakening. Since there is no ground for that exclusion, the correct consequence is to conclude that the world must end immediately. Contrary to that, the world continues to be.

- Thus, world duration refutes CG (of *Lewis/ Nozik/ Tegmark*).

Since CG is refuted,
Laws compatible with the world duration cannot be totally accidental.

What can be their terminus then?

What cannot be the Terminus?

Laws cannot be: all the laws are to be explained.

Accident cannot be (just shown).

Nothing specific can be.

It can only be a totality, one that is able to generate meaningful specificities.

Only one essence remains:
Mind per se.

To be consistent with the duration of life,

We have to assume that Mind at least excluded laws that are too volatile from the multiverse.

After that, apparently WAP could be an explanation of our existence (laws anthropness)

Why are the laws discoverable then?

Could it be a byproduct of their anthropness?

Can Discoverability be a Coincidence?

- Can the discoverability of the laws of nature be a coincidental byproduct to their anthropness?

What if our discoverable laws are the only anthropic ones?

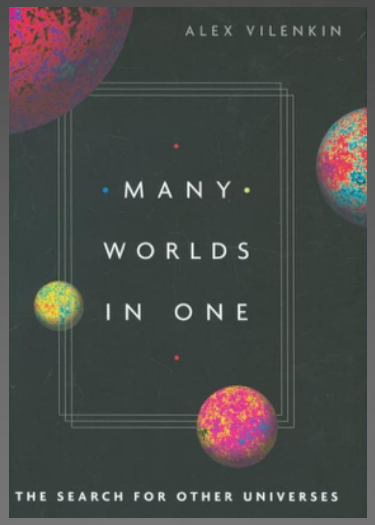
- The anthropness selects the entire infinite family of laws within the relative width of ~0.001 (like Mp/Mn), or wider.

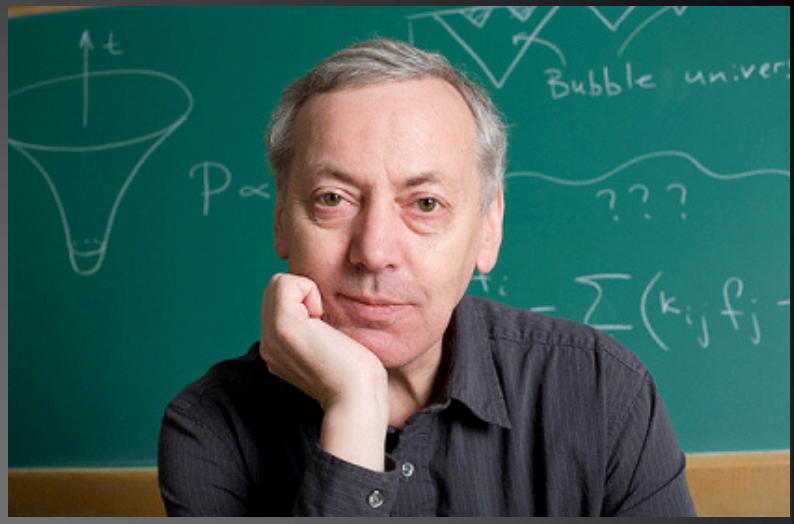
- Within this width, presumably, there is no selection; thus, with an exception of a few elegant laws, within this width they have to be dominated by ugly undiscoverable forms. So, *were* the laws selected anthropically *only*, they would not be discoverable with accuracy better than the anthropic width.

- However, currently the confirmed accuracies of QED and General Relativity are 12 and 14 digits—far outside of the 3 digits of the anthropic width.

- By that, the coincidental discoverability is refuted, and we have to conclude, that the laws are mindfully selected to be simple.

Vilenkin: Primacy of Mind?





- Contradiction of Tegmark's "mathematical democracy" with the aristocratic reality of simple laws was noted by Alex Vilenkin: "Tegmark's proposal, however, faces a formidable problem. The number of mathematical structures increases with increasing complexity, suggesting that "typical" structures should be horrendously large and cumbersome. This seems to be in conflict with the simplicity and beauty of the theories describing our world." ("Many Worlds in One: The Search for Other Universes", 2006)

- "… the laws should be "there" even *prior* to the universe itself. Does this mean that the laws are *not* mere descriptions of reality and can *have* an independent existence of their own? In the absence of space, time, and matter, what *tablets* could they be written upon? The laws are expressed in the form of mathematical equations. *If* the medium of mathematics is the mind, does this mean that *mind* should predate the universe? " (ibid)

Value of Fundamental Science

- So far, it cannot be excluded that life and consciousness are coincidental byproducts of simplicity of the laws. What if the Creator, preferring elegant laws, picked the anthropic ones coincidentally?

- To exclude this option, elegance and anthropness of the laws are not sufficient. This exclusion cannot be done without the value of the fundamental science taken into account.

- If the Creator presumably did *not* care about humans, why *would* his deeply hidden laws be so important for us? Why not *forget* about them, saving time and money for something more important?

- If he cares though, than it gives a powerful motivation for us to care about his laws too.

Pythagorean Universe

- Since the laws of our universe are not picked randomly, they can only be purposefully chosen.

Our universe is special not only because it is populated by living and conscious beings but also because it is theoretizable by means of elegant mathematical forms, both rather simple in presentation and extremely rich in consequences. To allow life and consciousness, the mathematical structure of laws has to be complex enough so as to be able to generate rich families of material structures. From the other side, the laws have to be simple enough to be discoverable by the appearing conscious beings. To satisfy these opposing requirements, the laws must be just right.

- The laws of nature are not only fine-tuned with respect to the *anthropic principle* but structurally simple to be *discoverable* as well. It could be even that they are at their *simplest* within our sort of life. Would it be possible to take *any* part away from our existing theories *without* compromising the forms of life as we know them?

- Such a special universe deserves a proper term, and we do not see a better choice than to call it Pythagorean, in honor of the originator of theoretical cognition, who coined such important words as cosmos (order), philosophy (love of wisdom), theory (contemplation), and who made an extremely bizarre and extremely fruitful assertion: "all things are numbers"…

Dual confirmation of the Pythagoreanism

- Starting with Pythagoras, it was a matter of faith for sparse groups of few people and lonely individuals that "things are numbers", "the book of nature is written in the language of mathematics", "laws of nature are described by beautiful equations." Theoretical science was conceived and nurtured by this very faith with its "cosmic religious feeling", which inspired scientific cognition for twenty-five centuries. Without any exaggeration, all great theories, from Copernicus, Kepler and Newton to Einstein, Dirac and Feynman happened as guesses on the grounds of some fundamentally simple and productive ideas like symmetry, conservation, or equivalence. The noted forty-five orders of magnitude of scientific cognition, with more than ten digits of precision reached in some experimental verifications, allow us to conclude about a scientific confirmation of what was considered a matter of faith for two and a half millennia: now it is a matter of fact that the universe is indeed Pythagorean. For such very special laws, the Absolute Mind is the only candidate for **terminus**.

- After two and a half millennia since its birth, fundamental science reached a grade of maturity allowing for a dual confirmation of its faith: the Pythagorean faith is confirmed both as a prophecy coming true and as a good tree that brings forth good fruit.

Faith of Galileo

"I know perfectly well that the Pythagoreans had the highest esteem for the science of number and that Plato himself admired the human intellect and believed that it participates in divinity solely because it is able to understand the nature of numbers. And I myself am well inclined to make the same judgment."[65]

[65] *Dialogo*, 35.

(1632)

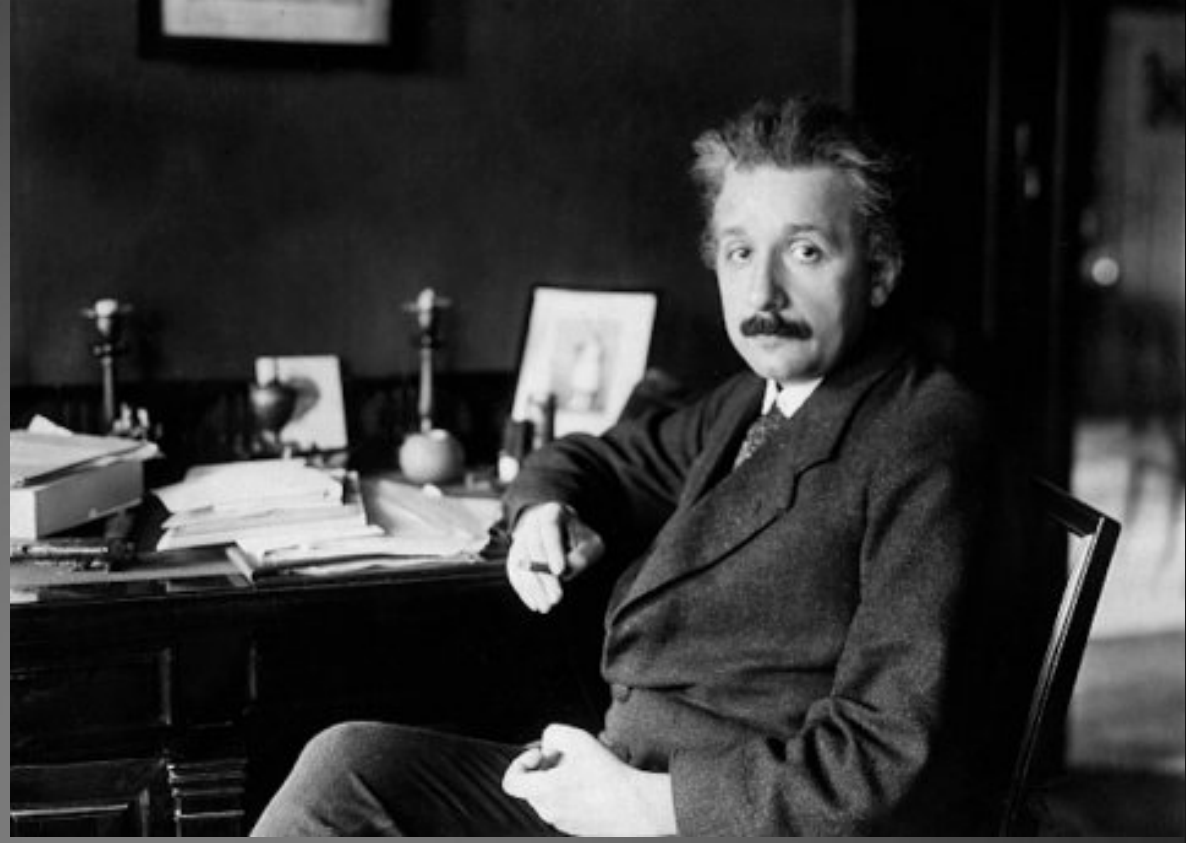
Universe is a great book written in the mathematical language. (1623)

I do not feel obliged to believe that the same God who has endowed us with senses, reason, and intellect has intended us to forgo their use and by some other means to give us knowledge which we can attain by them. (1615)

1564-1642

Faith of Einstein

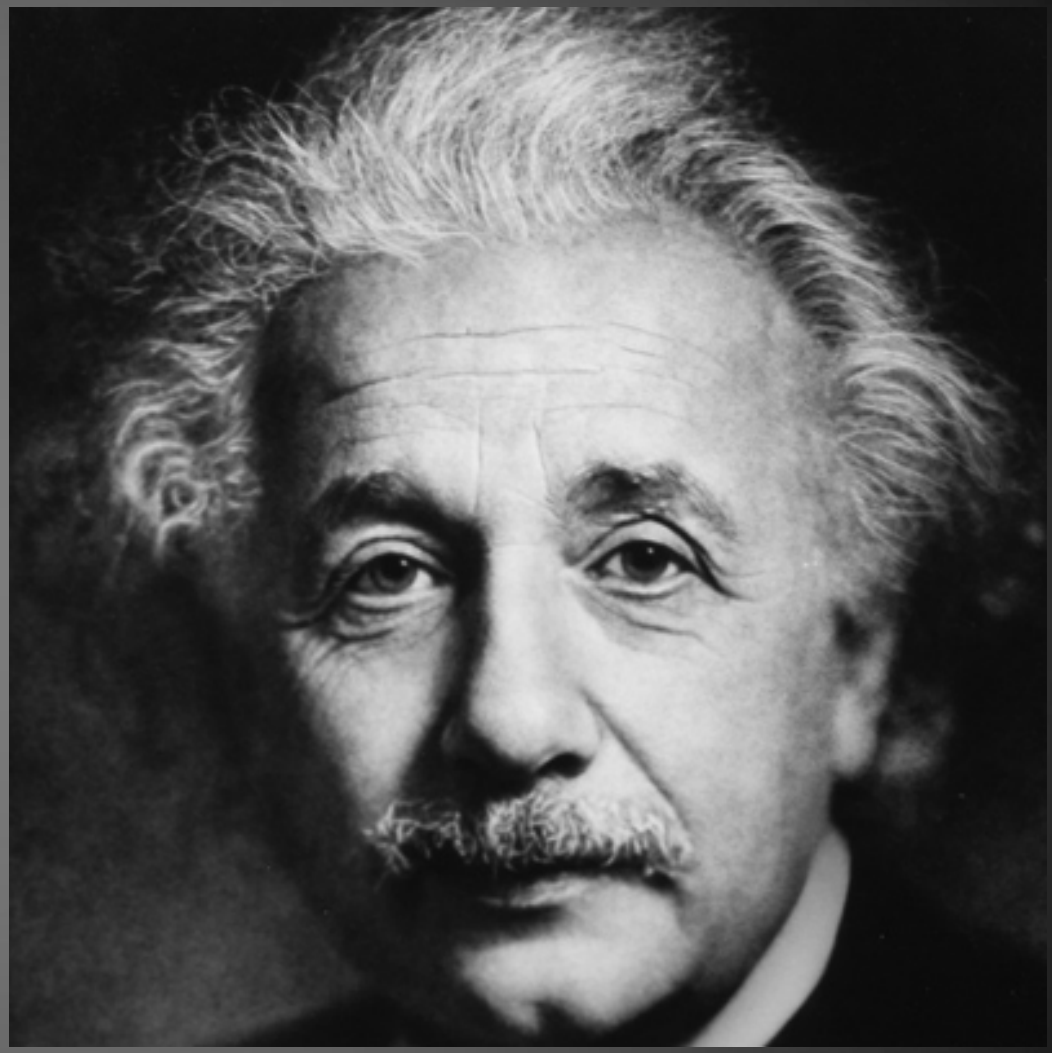
1879-1955



I maintain that the cosmic religious feeling is the strongest and noblest motive for scientific research. Only those who realize the immense efforts and, above all, the devotion without which pioneer work in theoretical science cannot be achieved, are able to grasp the strength of the emotion out of which alone such work, remote as it is from the immediate realities of life, can issue. What a deep conviction of the rationality of the universe and what a yearning to understand, were it but a feeble reflection of the mind revealed in this world, Kepler and Newton must have had to enable them to spend years of solitary labor in disentangling the principles of celestial mechanics! (=>)

Faith of Einstein

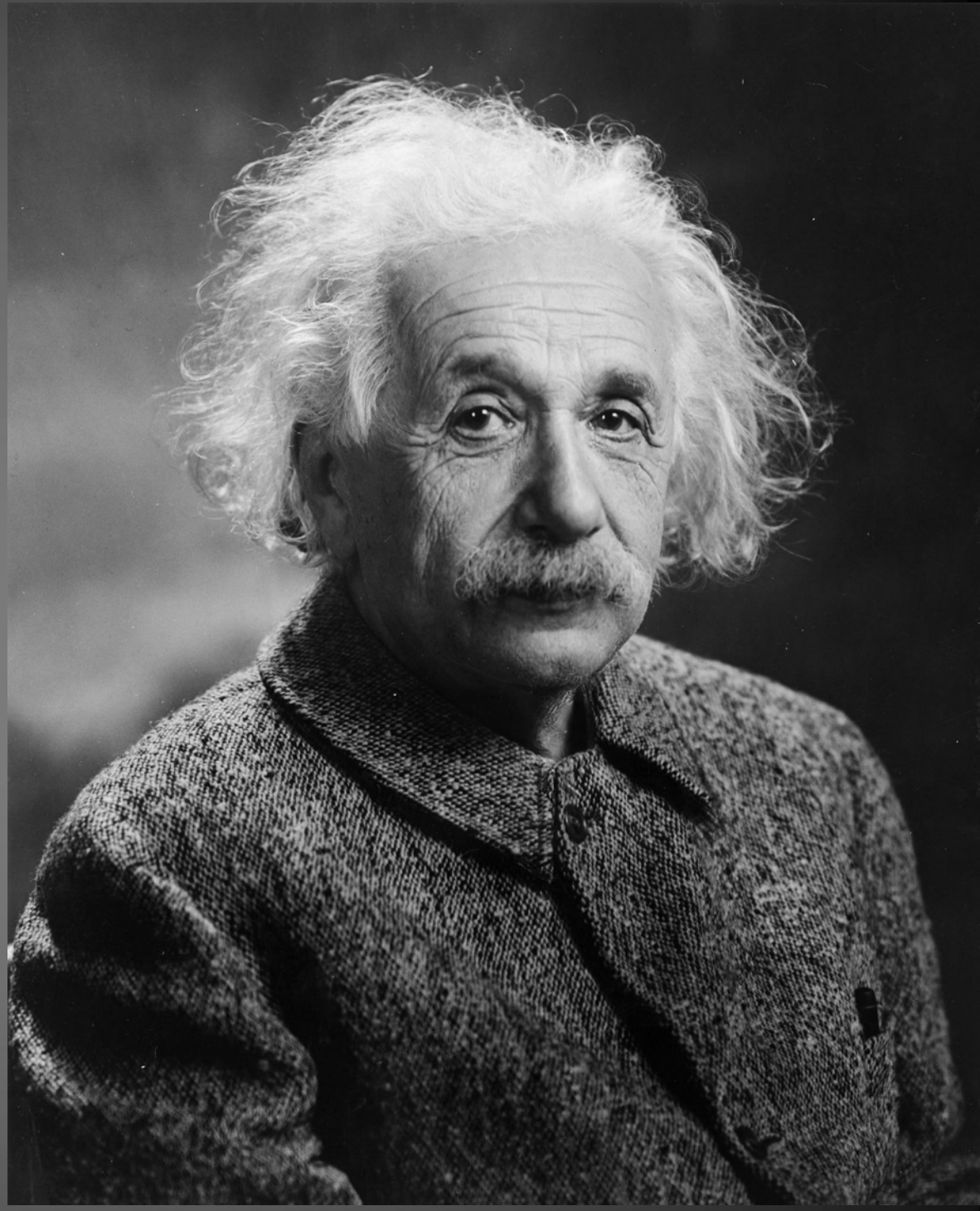
Those whose acquaintance with scientific research is derived chiefly from its practical results easily develop a completely false notion of the mentality of the men who, surrounded by a skeptical world, have shown the way to kindred spirits scattered wide through the world and through the centuries. Only one who has devoted his life to similar ends can have a vivid realization of what has inspired these men and given them the strength to remain true to their purpose in spite of countless failures. It is cosmic religious feeling that gives a man such strength. A contemporary has said, not unjustly, that in this materialistic age of ours the serious scientific workers are the only profoundly religious people. (1930)



1879-1955

Faith of Einstein

..every one who is seriously engaged in the pursuit of science becomes convinced that the laws of nature manifest the existence of a spirit vastly superior to that of men, and one in the face of which we with our modest powers must feel humble. (1936)



1879-1955

Key Terms and Ideas

- *Terminus* (Wittgenstein)
- *Chaosogenesis*
- *Anthropic width vs Discovery width*
- *Discoverability* (Gonzalez & Richards)
- *Simple and Cosmic Observers*
- *Cosmic Anthropic Principle*: The laws are purposefully chosen for the universe to be cosmically observed.
- *Pythagorean Universe*

Pythagoras, 570-495 BC

Woodcut showing Pythagoras with bells, a kind of glass harmonica, a monochord and (organ?) pipes in Pythagorean tuning. From *Theorica musicae* by Franchino Gaffurio, 1492 (1480?)

Thank You!