„Dlaczego istnieje raczej coś niż nic?”

G.W. Leibniz, *Zasady natury i łaski oparte na rozumie*

„Dotychczas mówiliśmy li-tylko jako fizycy, teraz należy wznieść się do metafizyki, posługując się tą nie dość wykorzystywaną wielką zasadą, która głosi, że **nic nie pozostaje bez racji dostatecznej**”.

Tu pojawia się pytanie:

„Dlaczego istnieje raczej coś niż nic?

„Nic nie jest prostsze i łatwiejsze niż **coś**”.

COŚ JEST RACJONALNE

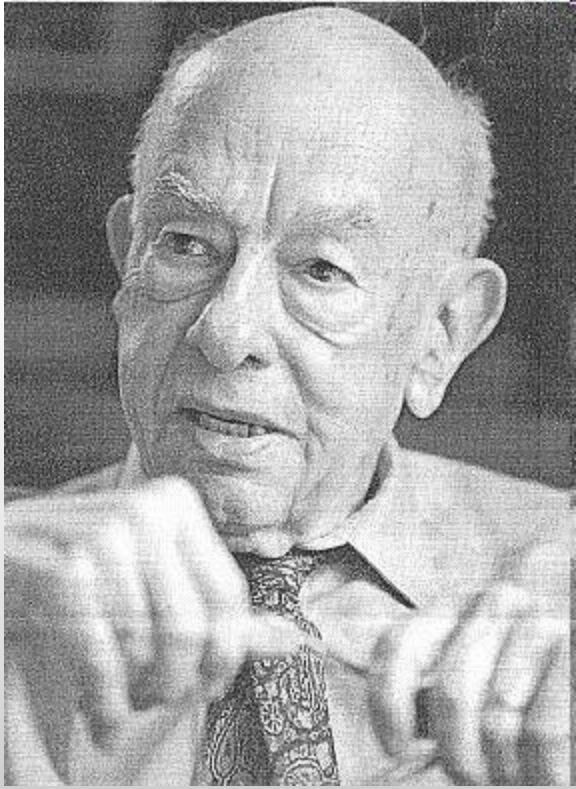
Co to znaczy „istnieć?

$$\sum_x f(x)$$

„Istnieć to znaczy być wartością zmiennej”

W. Quine

“To be is to be the value of a variable”



„The theory is committed to those and only those entities to which the bound variables of the theory must be capable of referring in order that the affirmations made in the theory be true”.

We look to bound variables in connection with ontology not in order to know what there is, but in order to know what a given remark or doctrine, ours or someone else’s, *says* there is; and this much is quite properly a problem involving language.

W. Van Orman Quine,”On What Is”, in: *From a Logical Point of View*, Harvard University Press, Cambridge Mass., 1964, pp. 1-19; quotation from p. 15.

Analysis *à la Quine*

Three types of interpretations of physical theories:

1. An interpretation that is inconsistent or even contradictory with the mathematical structure of the theory; for instance, Bergson's interpretation of special relativity.

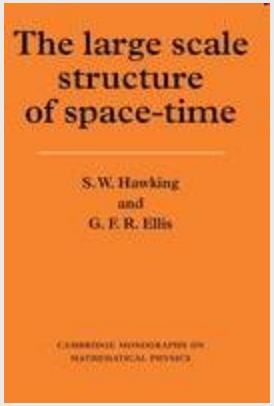
E.g., H. Bergson, *Duré et simultanéité (à propos de la théorie d'Einstein)*, Alcan, Paris, 1922.

2. An interpretation that is neutral with respect to the mathematical structure of a given physical theory. For instance, the space-time of special relativity can be interpreted as a "block universe", i.e., as a totality existing "all at once", or as "now" flowing in time.

3. An interpretation could so closely follow the structure of the physical theory that any its "perturbation" would result into inconsistencies or contradictions with the theory's formalism. This I call ***exegesis of the structure of this theory***.

E.g., interpretation of theorems on the geodesic incompleteness of space-time as space-time singularities; see, S.W. Hawking, G.F.R. Ellis, *The Large Scale Structure of Space-Time*, University Press, Cambridge, 1973.

W to angażuje się teoria.



Such an exegesis is a practical way (and often unconsciously done by physicists) of disclosing what a given theory "says there is".

Beyond Quine

And to which ontology we commit ourselves *when we are doing physics*? How to identify "ontological commitments" of the method? We are not asking about the "absolute ontology of reality", we are only looking for the ontology of the *univers de discourse* of physics.

In answering these questions we should look for such elements without which doing physics would be impossible.

Method of physics presupposes three things:

- (A) a certain mathematical structure;
- (B) a part or the aspect of the world which a given mathematical structure is supposed to model;

  (C) “bridge rules” interpreting (A) in terms of (B); owing to these rules (A) serves as a mathematical model of (B)

Ontological commitments of the method of physics

There exist: mathematical structures, a domain to which they refer, and rules establishing this reference.

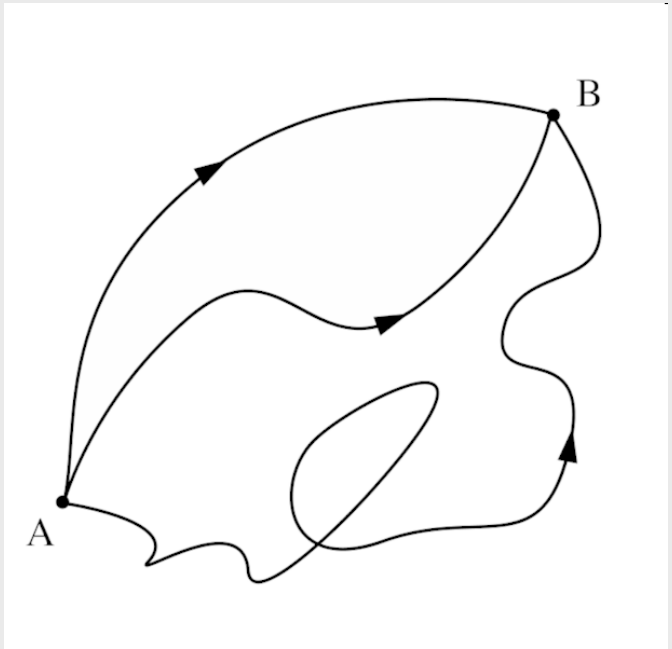
Without presupposing these three elements nothing can be done in physics; or even – *no physics could be possible*.

Hartle-Hawking quantum creation model. A case study

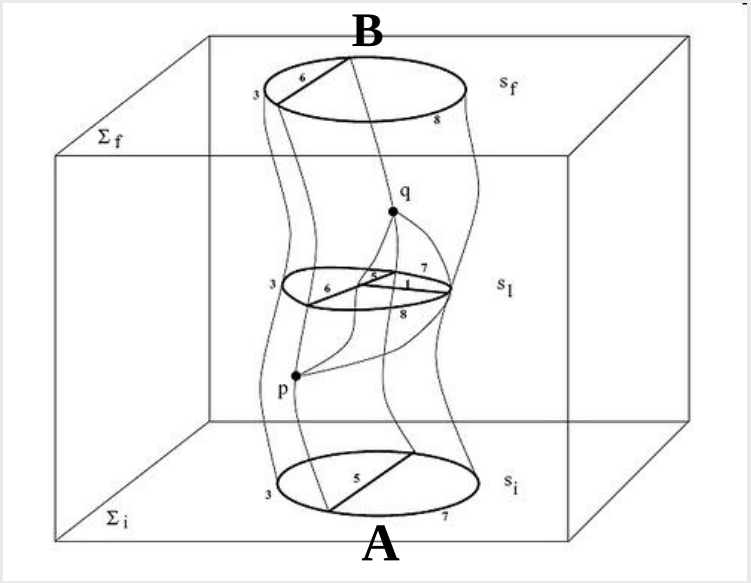
J.B. Hartle, S.W. Hawking, “The Wave Function of the Universe”, *Physical Review* D28, 1983, 2960-2975.

Feynman method:

In phase space of QFT



In space-time



Wave function serves to calculate probabilities

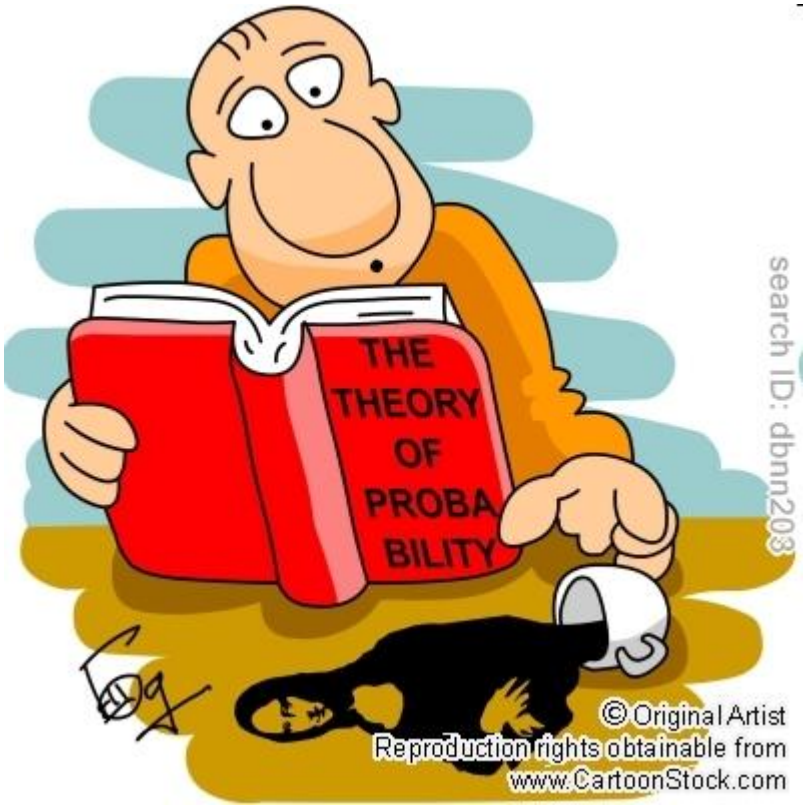
$$H(t)\,|\,\psi(t)\rangle = i\hbar\frac{d}{dt}\,|\,\psi(t)\rangle$$

In QM it satisfies Schroedinger equation

$$\left[\frac{-4h^2G}{3\pi\cdot c^4}\frac{\partial^2}{\partial R^2}+\frac{h^2}{4\pi^2R^2}\frac{\partial^2}{\partial\Phi^2}+\frac{3\pi\cdot c^4}{4G}kR^2-2\pi^2R^4V(\Phi)\right]\Psi(R,\Phi)=0$$

In H-H model it is supposed to satisfy DeWitt-Wheeler equation

QUESTION:
What is the probability of going from state A to state B if there is no state B?



$$|\psi|^2 = ?$$

"How do you want it—the crystal mumbo-jumbo or statistical probability?"

Why is there something rather than nothing?

How to change from equations to the existence („how to ignite equations with the existence”)?

$$\left[\frac{-4h^2G}{3\pi\cdot c^4}\frac{\partial^2}{\partial R^2}+\frac{h^2}{4\pi^2R^2}\frac{\partial^2}{\partial\Phi^2}+\frac{3\pi\cdot c^4}{4G}kR^2-2\pi^2R^4V(\right.$$

Analysis *à la Quine*

Which are ontological commitments of the Hartle-Hawking model?

Two levels of existence should be distinguished in it.
First, the level of a **potential existence**. The "potentialities' in the model are severely limited by many factors:
• The wave function of the universe must be a solution to the DeWitt-Wheeler equation.
• To overcome some technical difficulties Hartle and Hawking consider only a "small" subspace of the superspace, called mini-superspace.
Everything that goes beyond this limitations has no even potential existence in this model.

A second level of existence is an **actual existence**. Since the model is a quantum model, *probabilities* in it play the essential role.

• To states of the universe, before they are instantiated, only a certain probability of coming to existence can be ascribed. In this sense, the model's ontology admits a situation in *which there is (a different from zero) probability for some states of the universe to emerge from a no-state*.

• We should not forget that all the time we are speaking about the universe as an element of the model and about its existence as presupposed by the model (in the sense *à la Quine*).

• Whether this model corresponds to reality, i.e., to which degree is it verified experimentally – this is another story.

Analysis Beyond Quine

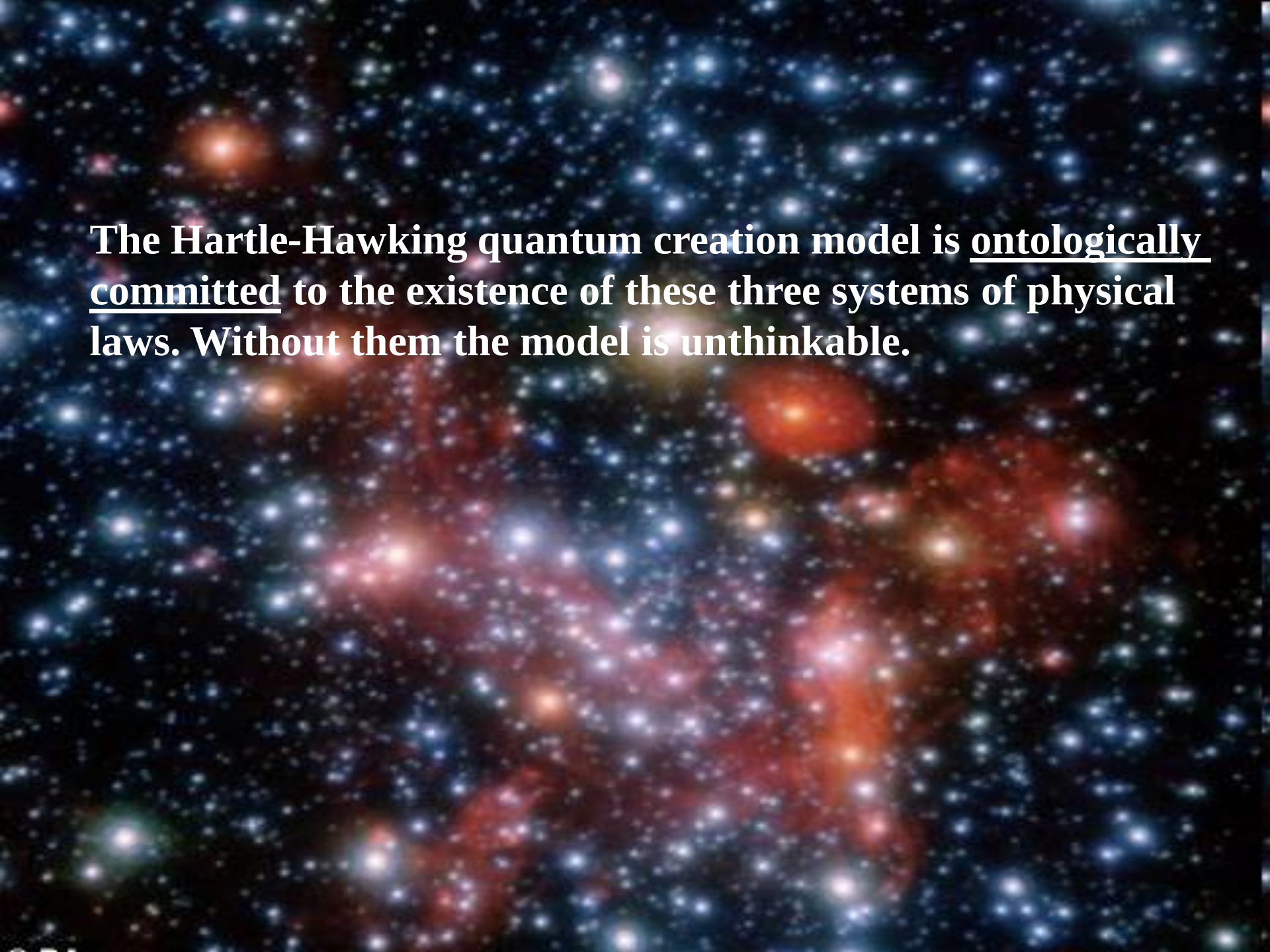
Ontological commitments of the method of physics on which the Hartle-Hawking model is based.

In the case of the Hartle-Hawking model three collections of physical laws (mathematical structures with suitable interpretations) are assumed:

• Laws taken from quantum field theory, such as Fenman's path integrals or the method of calculating probabilities with the help of wave function.

• Laws taken from general relativity, e.g., everything related to closed cosmological models, and some approaches to quantum gravity, e.g., DeWitt-Wheeler equation.

• Some new mathematical tools, suitably interpreted, e.g., imaginary time, that have turned out indispensable to make the above two kinds of laws work together.

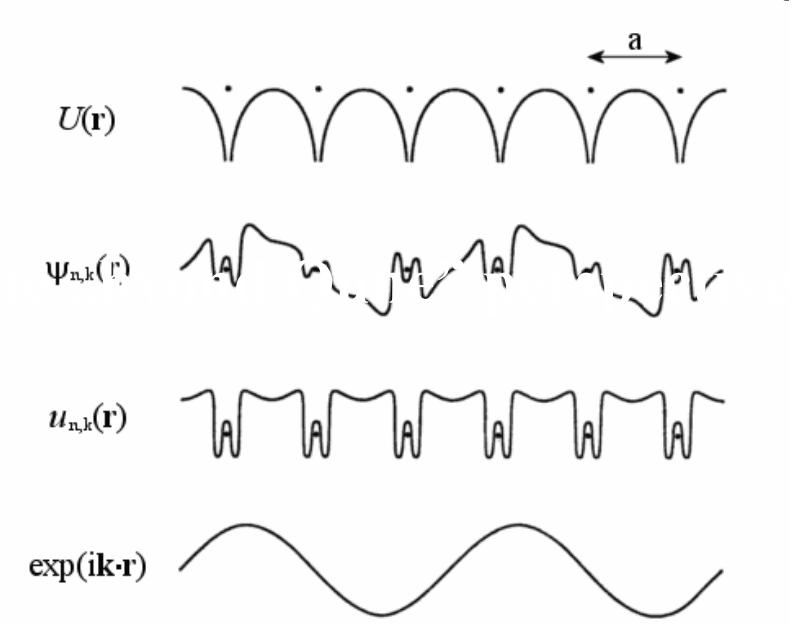

The Hartle-Hawking quantum creation model is ontologically committed to the existence of these three systems of physical laws. Without them the model is unthinkable.

Is the claim of Hartle and Hawking justified that they have succeeded in constructing a model of quantum creation of the universe from nothing?

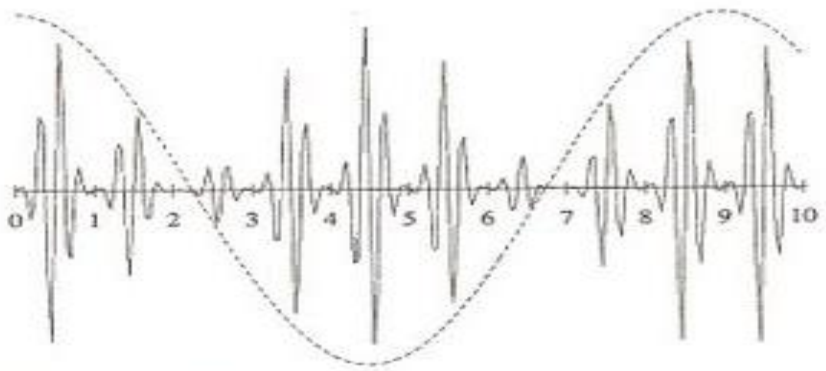
Assuming that their model is both mathematically and physically correct and taking into account our *à la Quine* analysis, we are entitled to say that, in their model, there is indeed a (different from zero) probability for the process of an emergence of the universe from nothingness to occur.

But *what does it mean "nothingness"* in this context? Let us notice that in the mathematical structure of the model there is nothing (and rightly so) that could be interpreted as "nothingness".

"Nothingness" is outside of the model. In this sense, nothingness is what model says nothing about.



The model is based on a rich mathematical structure equipped with a rich physical interpretation. The model itself, with all its structural elements (quantum creation included), is made out of this physically interpreted mathematical structure which is far from being nothing



If we attempted to construct a physical model from absolute nothing, the zero of existence, no mathematical structure, nothing to interpret, we would not be able to move one step forward.

This is why the Leibniz question:
“Why is there something rather than nothing?”
is so persistent.

Leibniz’s short comment”: “For nothing is simpler and easier than something”.
Why then is there something that is neither easy, nor simple?

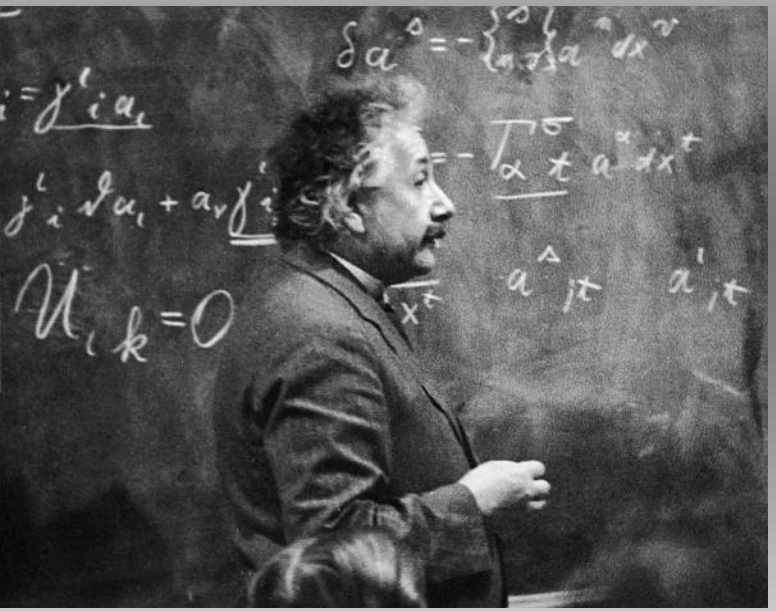
Cum Deus calculat
et cogitationem exercet,
mundus fit.

Leibniz

When God calculates and thinks things through,
the world is made.

Odręczna nota na
marginesie *Dialogus*

Two in one:



- Existence of the Universe
- Its comprehensibility