Review of: "Mathematics Is Physical"

Dongsheng Wang

Potential competing interests: No potential competing interests to declare.

This is a subject in metaphysics and philosophy. I am not an expert but I find this is interesting. The author presented an interesting claim that "math is physical", which sort of is not standard. Usually, we think math and physics are relatively independent, one dealing with logic, and one dealing with nature. Physics shall be mathematical so that a physical theory can be tested by experiment and make prediction. While math does not have to be physical since it only uses abstract symbols and rules on them.

So I suggest the author first to define what it means by "physics", and what it means by "physical". This two terms are not defined on the first hand. Is there a difference between "physics" and "nature"? Can we say "math is natural?"

For a basic setting, it is beneficial to think of the meaning of the number "infinity". Is it physical? Or is it a 'real' number? Does “physical” mean “finite”? This is like the question thought of by Pythagoras that whether irrational numbers, like square root of 2, are real numbers. Infinity is the central issue in Godel, Turing, Cantor. So it will be good to discuss it to set the stage.

About infinity, in physics a brunch of study is phase transition which relies on the notion of infinity. So, is the theory of phase transition a valid physical theory? It will be good if the author can study this example to further unveil his concept.

It is also necessary to briefly discuss the relationship between math and computation theory. Let me ask: is math computational? is computation physical? Shall all numbers be computable? We know that, according to Turing, not all numbers are computable, but all numbers are mathematical. This seems imply that, computation, as a process with a certain amount of spacetime cost, must be physical, but math does not. However, if the author does not agree with this, it is then necessary to explain more on this.

I can not see the relation between Gödel and Landauer. Did Landauer mentioned Gödel before in his paper?

The author stated “Mathematics is intrinsically connected to physics in two fundamental ways. First, it is performed by physical entities such as human mathematicians or machines, both of which have finite resources.” Sure, but I believe Plato would not agree with this logic. Platonists believe there are Ideas, and math is a study of Ideas, but physics is not.

Poisson brackets in Eq 5 can be explained in detail. For Eq 6, there is also a global constraint which is the normalization as we know.

For Eq 11, cf classical vs quantum, there is also a no-hiding theorem, Phys. Rev. Lett. 98, 080502, 2007, stating that quantum information cannot exist in the form of correlations. This might be relevant here.

Using the Hamilton form, or Geometric quantum mechanics, people has considered it for quantum computing. Say, in a paper https://arxiv.org/abs/1606.04998.

I do not have suggestion on the technical parts. My suggestions are mainly on the conceptual aspects of this thoughtful article. Hope my suggestion and confusion can help to improve the manuscript.