Review of: "Mathematics Is Physical"

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The discussion proposed by the author on the relationship between mathematics and physics is an interesting one that definitely requires further attention. The author focuses on certain threads of historical progress on this question such as Landauer's “Information is Physical” paper, Gödel's incompleteness theorem, and Church-Turing thesis. The author brings the topic of quantum mechanics and moreover quantum computing into the discussion. Below are my comments:

1) To be honest, I was relatively disappointed to see that the paper misses the entire history of whether quantum states are "real" or not. There is a strong and rich history of this line of discussion being put forward back in the 1930s by Einstein, Schrödinger, Bohr, and others, continued by Bohm and later by Bell in the 50s and 60s, and more recently in the 90s being picked up by figures such as Mermin and Hardy. There is no consensus on whether quantum states (not particles, but states) can be accepted as ‘real’ or not. I think the author's dismissal of this entire literature hints at the implicit assumption they make, which is “quantum states are physical objects.”

2) I think the author also completely missed out on the literature on different schools of philosophy of mathematics (such as mathematical empiricism, realism, constructivism, etc.). The references to Galileo and statements like “Notwithstanding the exertions of mathematicians such as Hilbert, Whitehead, and Russell to establish pure mathematics through axiomatization, Gödel's incompleteness theorem proved in 1931 declared such endeavors futile” hints that the author has a chosen ‘camp’ in these discussions, but presents their discussions as consensus beliefs, which is definitely not the case.

3) “The influence of underlying physics on mathematics may be subtle, but it can be very powerful.” This is true but also a rather incomplete statement, in the sense that physical rules which govern our universe are not the ‘only’ physics that we can formulate in a formal (or abstract) space. Therefore, if the author claims that every formulation of physics is ‘physical’ (i.e. even if certain models are ruled out by experimental data, the ‘potentiality’ of their existence in a formal statement makes those ‘physical’), the title becomes a tautology. If the author actually claims that all math we can do is bounded by the physics of our universe, I don't understand how this paper actually argues that.

In summary, if this was a peer-review process, I'd recommend the author to have a more modest title, make their assumptions and philosophical stance on certain questions (such as mathematical realism vs. empiricism) explicit, and elaborate more on what they actually argue. If you define the bounds of mathematics as what is physically possible, assume that all potential physical systems and laws that can be represented via mathematical formulation by physics are by definition ‘physical’, and disregard the question of “whether physical objects have to be real or not”, then the author's paper has some merit. However, they need to provide strong arguments for each of these to justify such a bold title and claim.