A physicalist interpretation of the relation between Physics and Mathematics

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1. Introduction:

Observations give us some ideas regarding the nature of the world we live in. We find certain regularities in the motions of stars and planets. Using mathematical equations, we are able to predict when and where these could be seen. This has created an impression that mathematical-logic (reasoning based on mathematical relations) can lead us to the ultimate truth of this physical world. In this context, I would like to ask two basic questions: (i). What actually is the role of mathematics in the physical world? (ii). Can the physical world be explained based on physical-logic (reasoning based on physical properties)? These, I think, are subjects that have not been debated seriously.

The ultimate aim of all physicists is to explain the physical world completely (or at least as far as possible). Whether we should base our explanations on physical-logic or mathematical-logic is a philosophical question. '*Physicalism*' and '*mathematicalism*' are thus two distinct philosophies that we can choose. We can choose any, and only on completion of the explanation can we be sure that our philosophical approach was correct; till that time, it is just tentative. In this essay, I propose physicalism as the right approach.

At present, nearly all physicists subscribe to mathematicalism; they just ignore physicalism. The result is that the connection between physics and mathematics appears to be mysterious. Based on physicalism, I argue that the connection is very simple, and the role of mathematics in the domain of physics can be unambiguously defined.

2. Mathematics and physics:

Mathematics is the most fundamental branch of knowledge. A creator or a follower is not a prerequisite for mathematical laws to exist; it is totally *background-free*. Even an omnipotent creator has to obey the mathematical rules. He can, however, interfere at any point and make it appear as if the law is being violated; but, that is just a trick and not a violation. Mathematics has a role in all domains of knowledge, including physics.

Physics explains the physical world. The existence of a physical world is a must for physics, or physics can never be background-free. Any explanation of the physical world should start from the description of the background, which can be stated as follows: Space is three dimensional; time moves forward; bodies have mass and volume; a body cannot remain at two positions at any given instant (position and time are absolute); a body cannot remain in two forms at any given instant. The background description is based entirely on direct observation, and we can call these 'the only conditions' for *physical reality* (or physical meaning). Physicalism implies that any explanation of the physical world should be in agreement with *physical reality*, and the role of mathematics should be unambiguously defined.

3. **Physical world – properties and laws:**
Direct observation reveals the nature of the background. These and any other such information based on experiments, indirect observations and logical conclusions can be regarded as the *properties* of the physical world. Physicalism requires that these properties are defined unambiguously in meaningful physical terms, and not in mathematical terms, and that the properties should be in agreement with *physical reality.*

Observations reveal that the physical world changes with time. Why is it so? Consider a body that does not and cannot have any kind of motion, either external or internal. It will remain at its position, without any change, forever. If any change is to happen, either the body or its constituents will have to physically move from their respective places. Thus changes can happen by way of motion only. So the fact that the physical world changes with time indicates that motion is a property of the physical world.

Motion is a space- time relation that follows mathematical rules. Since changes can happen only by way of motion, all changes follow mathematical rules. A world that does not change have no laws. The laws are required solely for explaining the changes, and so the laws are invariably mathematical. That is, the physical world has no laws of its own; the laws applicable to it are mathematical.

Thus, in explaining the physical world, there should be a clear distinction between properties and laws: properties should be physical and laws should be mathematical. So the role of mathematics can be stated as follows: '*Mathematics governs the changes in the physical world*'. That is the only role of mathematics in the domain of physics. Thus the connection between physics and mathematics is very clear, not at all mysterious.

4. **Mathematicalism** *vs* **Physicalism – Trick** *vs* **Truth:**
As the changes in the world follow mathematical laws, we can arrive at the mathematical relation involved in a particular change. Mathematicalism implies that from this relation, we can arrive at a logical conclusion regarding the physical properties of the bodies involved. This is the accepted method followed by mathematicalists. However, this can be tricky as given below.

Consider a simple case of A and B drifting away from each other at a certain speed. We can obtain a simple mathematical relation for this. But based on this relation, there can be five different interpretations regarding properties: (i) A alone is moving (ii) B alone is moving (iii) both A and B are moving (iv) the space is expanding, A and B remaining at rest (v) motion and rest are just relative, not absolute. Thus, a unique mathematical equation can lead to different interpretations regarding properties. This is a trick played by mathematics, or the magic of mathematics.

Out of the various interpretations possible, only some may have physical meanings. Mathematicalists do not care for any physical meaning; they rather prefer a mathematical meaning. Even then, for each mathematical relation, they will have a set of 'preferred interpretations' from which they can select. From many such sets covering different areas, a network of matching interpretations is taken as the real fact. They expect that ultimately it will be possible to include everything in a single network.

However, since each interpretation is selected from a 'preferred set' of interpretations, and not from 'all possible' interpretations, the net result will be (unless they are very lucky) they will end up with a disjointed network, or they will reach a dead-end. That is, mathematics will trick them into believing that they are approaching the truth, but the truth will evade them.

If physicalism is also considered, the selection will be from 'all possible' interpretations, and not from the 'preferred set' of interpretations, and so the probability that finally everything is included in a single network is more. From a physicalist point of view, if that becomes possible, then the interpretation selected at each step will invariably be the one that agrees with *physical reality.* That is, only physically meaningful interpretations need be considered for getting a complete picture.

5. **Newton opened the Pandora's box:**
Now, let us examine how and when mathematicalism crept into physics. Before Newton, mathematics had not much role in physics. However, there was a feeling that some thing remains hidden in that box (in mathematics). It was newton who opened it. Out came the laws of motion and gravity. These are indeed laws, in the sense that these are mathematical and are expressed in the form of equations. From these, he arrived at the following interpretations regarding the properties of bodies: (i). A body left to itself will either remain at rest or move along a straight line. (ii) Every body attracts every other body.

Now, analyzing these in retrospect, the following questions arise. How did he assume that bodies move along straight lines and remain at rest? Based on observations? No, all heavenly bodies move in closed paths, and none remains at rest. Why did he not consider a closed path? Why did he not consider the possibility that motion also may be a property like attraction? Why did he overlook the fact that his law implies that using a small force, velocity can be increased to infinity? Or why did he not put a limit to the force that can be exerted by a body?

The reason is that Newton was a mathematician; it was as if he discovered the mathematical reality behind this physical world; naturally, he ignored all the physicalist interpretations possible. Thus it was Newton who introduced mathematicalism in physics. However, he did not bring out any physically meaningless concepts. He in his wildest dreams would not have expected that those who follow will adopt the strategy that 'anything logical in mathematics is logical in physics'.

6. **QM and G R – the mysterious creatures:**
From a physicalist point of view, Quantum Mechanics and General Relativity are mysterious concepts. Space-time, expanding-space, Big-bang singularity, gravity curving the space, wave-particle duality, independent fields, mass-less particles, mass-giving particles, force-particles, antiparticles, etc. have no physical meanings; that is, their properties are mysterious and do not conform to *physical reality.* The equations of QM and GR, like Newton's laws, are correct within limited areas; that is, in that areas, changes follow the respective equations. But, the interpretations regarding the properties of the physical world, based on these laws, are incorrect.

QM and GR are considered to be mutually incompatible. However, this has nothing to do with the equations. The incompatibility comes only when the properties based on these equations are considered. That is, the properties based on QM do not agree with the properties based on GR. As the properties were arrived at using mathematicalist interpretations, the problem may be entirely due to the mathematicalist approach.

Then, why do physicists subscribe to mathematicalism? One reason is that it is the *accepted philosophy* from the time of Newton, and a paradigm shift is not so easy. The other reason is the *magic of mathematics*. Magic is a combination of beauty and trick. Equations are beautiful, and at the same time tricky; with each new equation, their belief in mathematicalism increases; they are being tricked by mathematics.

Now, let us verify whether there can be any physicalist interpretation that agrees with the equations of QM and GR. Consider the following possibilities and their consequences:

- Motion may be a fundamental property of matter.
- Gravity may be reaction to motion, so gravity of a body curves its path.
- Light may be fundamental particles of matter moving along a helical (curved) path.

The helical path of light (fundamental particles) gives wave nature to matter and so it follows QM equations. The particles of light have gravity, and so aether dragging can be replaced by gravitational dragging, and Lorentz transformations (the basic equations of GR) become valid. Thus, the above mentioned physicalist interpretations agree with the equations of both QM and GR. I am not arguing that these interpretations are the right ones (maybe, these are right). It only shows that physicalist interpretations can make QM and GR compatible.

Newtonian physics, Quantum mechanics and General relativity become distinct theories just because these are regarded as representing the mathematical reality behind this physical world; however, each tends to predict a different reality. If these are unified using physicalist interpretations, these will no more be 'distinct theories', these will become just 'equations'. From a physicalist point of view, the underlying reality is physical, and so unification based on physicalist interpretations is possible.

7. **The present deadlock**:
The Standard Model of particles is a set of interpretations based on QM. Similarly, the λCDM model of the universe is a set of interpretations based on GR. These models are still incomplete, and require further refining. These are classic examples of disjointed-networks, a consequence of mathematicalism, mentioned earlier. As these models are based on QM and GR, these are mutually incompatible. To bring these already disjointed networks together in a single network that includes everything is a herculean task.

Even then, efforts are being made in that direction. String theories, Loop quantum gravity, etc are proposed as possible theories that can bring QM and GR together. But, these are again mathematicalist interpretations, and the result is that more and more mysterious concepts come up, unification still remaining a dream. Thus it seems that physics steered by mathematicalism has reached a dead-end. So it is time for a paradigm shift.

Thus the question whether the connection between physics and mathematics is a trick or truth is very relevant at present. From a physicalist point of view, the answer to the above question is clear: the present connection is a trick played by mathematics. Such a question being discussed indicates that there is some rethinking at certain quarters, or physicalist philosophy may be slowly emerging.

8. **The Theory of Everything:**
The influence of mathematicalism is so strong that physicists even doubt whether there can be Theory of Everything. Indirectly, they are admitting that the present mathematicalist philosophy will not lead to a unified theory. Let the box opened by Newton remain open, and we will see what else can come from inside. As in the case case of Pandora, the last one will be the winged fairy, that will put everything in its own place. It may be that for realizing the actual role of mathematics, we have to explore all possibilities.

Godel's incompleteness theorem in mathematics, it is claimed by many, suggests that a Theory of Everything is impossible in physics. If we are searching for a mathematical

theory as the Theory of Everything, then Godel's theorem gives the right answer: “It is impossible”. Thus, the solution for the problem created by mathematics comes from mathematics itself.

From a physicalist point of view, a theory of everything is a reality. My own theoretical research has emboldened me to make such a statement. *The Finiteness Theory*[1], which I have developed and is now being refined, is a Theory of Everything; but it need not be the right theory. As more more physicists from the mainstream resort to physicalism, more theories will come up, and ultimately, the right Theory of Everything will emerge.

A Theory of Everything will indeed be a *physical theory,* explaining the physical world in physical terms. Everything will be explainable on the basis of fundamental properties that are stated in unambiguous terms having physical meanings. The emergent properties and the emergent structures at different levels will also be in agreement with *physical reality.* But as the physical world has no laws of its own, there will be no fundamental laws.

Given the basic properties, mathematics decides the emergent structures, and these structures decide the emergent properties. Given these emergent properties, mathematics again decides the next-level structures, and so on. This may seem an infinite process, but if we start with a finite number of properties, and discard the physically meaningless structures, the possibility is that we may end up with a finite number of distinct (hierarchical) levels, the last level being such that it cannot lead to any emergent structures. In such a case, there may be both *bottom-up* and *top-down* causality at the middle levels.

Observations suggest the possibility that physical world has only three hierarchical levels: particle, atomic and cosmic levels. At the cosmic level, there are only bodies; bodies are invariably made up of atoms, and atoms are invariably made up of particles. The equations used at any level depend upon the number of variables involved in the structures. Using mathematics suitable for that structures, we can arrive at the required equations.

At the most basic level, there need be just four variables to represent mass, volume, energy and force. So the laws may be simple, and the outcome, easily predictable. At the cosmic level, the number of variables is again the minimum. Leaving out the mathematical constructs like, entropy, dark mass, dark energy, etc. there are only two real variables, gravity and speed. So further emergence may be impossible, and the law may be very simple, and the past and future of the universe may be easily predictable from the present.

But at the level of atoms, the number of variables is the maximum. The particles come in nearly 120 distinct packs (or atoms); the energy remains divided between these; the force remains divided as gravity and electromagnetism; electromagnetism is further divided into electrostatic and magnetic forces, and each comes in attractive and repulsive modes; and lastly, there are the bottom-up causality from particle level and top-down causality from cosmic level. Thus it is no wonder it offers maximum diversity and complexity, and prediction becomes very difficult.

The human brain may be the limit of complexity offered by matter: 'A complexity' which can interpret its own complexity can be regarded as the *ultimate complexity.* This power to interpret the complex behavior of a system is our best tool. The interpretations become correct just because we are observing a real world, the reality of which is independent of our observations. Thus, in spite of the difficulty in predicting, in many cases, we can effectively eliminate many variables, and get a predicted result. All our technologies become possible just because of this.

9. Conclusion:

The point raised in this essay is this: The physical world should be explained primarily on the basis of physical-logic. Mathematics has only a specific role of deciding how the world changes with time. But today, mathematics has transgressed that limit. This has created confusion among many, and they are forced to ask the question, “Is this 'mysterious' relation between physics and mathematics a trick or truth?”. The answer is, “It is a trick played by mathematics”. *Mathematicalism* can never lead to a complete theory. A search based on *physicalism* may ultimately lead us to a complete *physical theory,* the Theory of Everything.

The physical reality

“*The physical world is real, as real as we see it;*
But strange, it has no laws of its own;
Tricky mathematics decides it all”

Reference:

[1]. The Finiteness Theory: Basic concepts and overall model available at http://finitenesstheory.com/