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Trick or Truth: the Mysterious Connection between Physics and Mathematics

[Date]

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Note: I am just a freshman at a Science and Engineering school so I do not know much about Physics or Mathematics beyond the introductory undergraduate level.

A Mathematician is a mystic. He uses Mathematics as a way of communicating with God (by God, I mean Spinoza’s God, not the God described in Abrahamic religions). In this perspective, not only is God a Mathematician, but he is a Mathematician of the highest order. As the enigmatic and ingenious Indian Mathematician SrinivasaRamanujan said, “Sir, an equation has no meaning for me unless it expresses a thought of GOD.”(Subramanian, 2003).

For a Pure Mathematician, this communication is enough. He is content with his continuous perseverance to create increasingly beautiful, profound and interconnected Mathematical structures and systems. He finds spiritual satisfaction and yes, a sense of euphoria, from understanding and deriving equations of great elegance. But what is an elegant mathematical equation? What are elegance and beauty, in Mathematical terminology?

From my understanding, the beauty found in Mathematics is the same as the beauty that is found in Poetry. In my opinion, Mathematics is Poetry. It is a version of Poetry that is deeper in content and insight than the works of Wordsworth or Tennyson. Therefore, asking what Mathematical beauty is, is analogous to asking what Poetic beauty is. The answer to both
questions is currently not known. We, as humans, have this ability to perceive a property which we call ‘beauty’ in Mathematics and Poetry but we currently lack the knowledge which can enable us to understand what the nature of this property we seem to perceive actually is.

Theoretical Physics is an attempt at using Mathematics as a tool to understand Nature. This attempt has proved to be unexpectedly successful at increasing our understanding of the Universe and our place in it, over the past couple of centuries. With the methods of Theoretical Physics, we humans, using nothing but mathematical reasoning backed up or confirmed by experimental evidence, have been able to transcend the barriers of space and time and peer back to the Big Bang (the birth of our Universe), make estimations and predictions for the end of the Universe and even contemplate the existence of a Multi-verse, filled with other universes each with its own set of Physical laws and probabilistic event sequences.

The connection between Mathematics and Physics is indeed mysterious, but it isn’t unique. In spite of its marriage to Physics, Mathematics also has another mistress: Economics. Economics is perhaps the most mathematical of all Social Sciences. In fact, there is something so similar in the links between Theoretical Physics and Mathematics and those between Economics and Mathematics that there are real-life Theoretical Physicists who research in Finance and Economics (Manzoor, 2013). This similarity is perhaps what led Paul Dirac, one of the pioneers of Quantum Mechanics, to state:

“...There is in my opinion a great similarity between the problems provided by the mysterious behavior of the atom and those provided by the present economic paradoxes confronting the world. In both cases one is given a great many facts which are expressible with numbers, and one has to find the underlying principles. The methods of theoretical
physics should be applicable to all those branches of thought in which the essential features are expressible with numbers.” (Dirac, 1933)

There is, however, one thing special between the relation of Mathematics with Physics, compared to its relation with other fields. Physics is the most mathematical of all Natural and Social Sciences. In fact, Physics sometimes requires Mathematics so advanced that it hasn’t even been invented (or discovered, depending on one’s philosophy) by contemporary Mathematicians. Therefore one often sees Physicists inventing entirely new Mathematics for use in their theories and models. This trend isn’t recent. It has been present long before the birth of string theories. Sir Isaac Newton invented his own branch of Mathematics: Calculus, to describe the laws that govern motion.

The biggest question that arises in the mind of the observer of this strange connection between Mathematics and Physics is: “Why?” To use the words of Eugene Wigner (Wigner, 1960), why is Mathematics so unreasonably effective in the Natural Sciences? In my opinion, the answer lies in pattern recognition. The thing Mathematics is “unreasonably effective” at is describing patterns and highlighting connections between similar patterns. Hence, Mathematics can be useful in any field that relies on patterns, be they the laws of Nature in Physics, or the financial models in Economics or even linguistic patterns in the arts and humanities.

This hypothesis, in turn, raises two more questions. Firstly, why is Mathematics so good at describing patterns? Patterns are something that can be quantified and follow a logical sequence. Quantification and logic are the very things Mathematics is designed to address. Therefore it isn’t really surprising that Mathematics handles patterns well. The second and far
more opportune question is: Why does Nature follow patterns? That, sadly, is a question which cannot be satisfactorily addressed even with contemporary human understanding.

One explanation might, of course, be what in Cosmology is called the Anthropic principle. The reason we exist in a universe that follows logical patterns and definitive laws is because that is the only kind of universe suitable for life. A second, strongly propagated, hypothesis is that the universe follows laws and patterns because it was designed by an “Intelligent Designer”. This is a version of what is called the watchmaker analogy.

However, if the universe was formed by a Creator… who created the Creator? The standard reply to that is that the existence of the Creator of the Creator is irrelevant. However, if the existence of the Creator of the Creator is irrelevant, why not just employ Occam’s razor and state that the existence of a Creator is irrelevant? Which, of course, leads one back to the Anthropic principle or in search of a more satisfactory explanation.

Ultimately, we must realize that the reason behind the effectiveness of Mathematics in Physics, which is a derivative of the reason behind the (probabilistic) predictability and regularity of the laws of Nature, cannot be answered without further research in Science and further collection of evidence. For now, to paraphrase Richard P. Feynman (Feynman, 1981-1982), it is far better to accept that we do not have an answer than to believe in an answer that lacks evidence and might be incorrect.
Works Cited


