What Is Mathematics? Clues from Quantum Physics

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Abstract

The philosophy unconsciously held by atheists working in science is that of “materialistic reductionism.” This states that everything that exists is merely the sum total of its constituent particles. Therefore, nothing has particular significance. However, such a philosophy is now struggling to come to terms with the recent discoveries of science, particularly in quantum physics where scientists are speaking of consciousness being the ultimate reality. Similarly, the philosophy of materialistic reductionism has not proved helpful in unravelling the mystery of what mathematics actually is.

A breakthrough understanding of mathematics (solving the impasse over whether maths is simply a language we invent, or whether it is a strange new land with discoveries waiting to surprise us) is obtained when maths is overlaid with the principles of quantum physics. This allows for the unknown surprises of maths to exist, and then to collapse into a mathematical language when observed.

The thinking that underpins the philosophy of most atheists is “materialistic reductionism.” While most atheists wouldn’t be able to put this name to their thinking they would nonetheless hold to its basic tenets. Materialist reductionism came into vogue in the seventeenth century as Europe was going through a metaphysical revolution, giving up Aristotelian flavoured Christianity in favour of “liberal” flavoured Christianity and atheism.

Materialistic reductionism is “reductionist” because it reduces the significance of existence, saying that nothing has significance, for everything is simply a composite of meaningless particles of matter. Most reductionists would also claim to be “empiricists” as they would not claim anything to be true unless they had first proved it to be so through empirical evidence.

Christians should rightfully rejoice in the empirical truth of science. After all, science uncovers the order, creativity and rational mind of God. This thought was put well by the seventeenth-century German astronomer Johannes Kepler who is reputed to have described science as “thinking God’s thoughts after him.” There is therefore nothing wrong with empiricism and most Christians are empiricists to a degree; they love the mathematical beauty of the universe and the outrageously unlikely fine-tuning of the physical forces that have allowed life to develop. Christians see this as pointing to the rationality of God.

Francis Collins, who directed the international team that mapped the human genome, said: “I have found there is a wonderful harmony in the complementary truths of science and faith. The God of the Bible is also the God of the genome. God can be found in the cathedral or in the laboratory. By investigating God's majestic and awesome creation, science can actually be a means of worship” (Collins 2007).

Materialistic reductionism does, however, have a problem when it comes to seeking out truth. Its particular weak point is that it suppresses questions on anything but mechanism. In other words, it can describe the technical specifications of a car very well, but can’t tell you why the car exists. It can give a right answer, but it hasn’t got the capacity to answer the really significant questions.

One of the reasons for the limited field of vision of materialistic reductionism is that its only centre of reference for knowing is “self.” This enthronement of self as the centre for all things was well expressed by Fredrich Nietzsche who said: “If there is a God, how can one tolerate not being God oneself?” (Nietzsche, quoted in Camus, 1951).

Materialistic reductionism therefore makes Christian theologians nervous. They understand full well the propensity of humankind for grabbing at God’s crown so they can wear it for themselves. The human desire to be like God in having the authority to determine what was right and wrong was actually the very first sin mentioned in the Bible (Genesis 3:1–5). This, of course, does not mean that God (or theology) should be allowed to impose theological dogma on science. However, it does mean that scientists who are Christians understand that truth comes in the wider context of God’s character, purpose and meaning. In other words, they understand that a bigger game is being played.

The appropriateness of materialistic reductionism as the underpinning philosophy of science is increasingly being called into question. This is because materialistic reductionism is poorly placed to underpin a world of science where mystery, complementarity, and consciousness are emerging as significant entities. A foray into the world of mathematics will help explain this further.

The mystery of mathematics and quantum physics

Mathematical philosophers have wearied themselves for many centuries trying to determine what maths actually is. A materialistic reductionist approach to this question cannot help but be human-centric. It suggests that maths is simply a language humans have invented to help them quantify things such as the number of eggs in an egg carton.

However, other mathematicians disagree with this human-centric view and point out that mathematics is not so much a language but a mysterious unexplored land that sits waiting for us to explore and make great discoveries. They point out that maths delivers surprises that mathematicians never asked of it, for example, the Mandelbrot set. The

Mandelbrot set is based on a fairly simple equation that was expected to draw a fuzzy white dot. Instead, it drew intricate, organic-looking pictures that were infinitely magnifiable. Its capacity to be magnified is limited only by the computing power of the computer doing the calculations. Materialistic reductionism doesn't cope well with this sort of mystery.

One of the most fertile fields of science for mystery is quantum physics. Again, materialistic reductionism struggles to cope with the findings of Nobel prize-winning physicists such as Eugene Wigner and John von Neumann who speak of physical matter being composed of "contents of consciousness" (Wigner, 1967, 171; von Neumann, 2011, 21).

Materialistic reductionism reigned supreme in the modernist era when humankind looked as if it was conquering all ignorance with knowledge. It was a time when, to misquote an old aphorism concerning the health benefits of apples: "a scientific breakthrough a day, kept the need for God away." But now scientists are discovering more mystery. For example, the strange force that is causing the universe to pull against gravity causing it to expand at an ever-increasing rate, is unknown. Scientists have simply labelled this force "dark energy." And, as we said earlier, a great deal more mystery is seen in the quantum world where subatomic particles collapse from being a cloud of potential into being a tiny particle of matter only when they are observed (Hawkes, 2019).

The assertion being made in this paper is that an underpinning worldview of theism may be more fruitful when it comes to uncovering truth. Theism makes sense of the primacy of "observation" in quantum physics, and it also explains why the universe is rationally transparent to our inquiry. Theism as a philosophic position makes sense of mystery as well as order.

According to Judeo-Christian thinking, there are two things of significance concerning the universe. The first is that the universe is meant to showcase God's creative genius, and do it on a grand scale. This means that whenever a scientist with a theistic worldview examines the cosmos, he or she is not surprised by its wonder. In fact, they fully expect to be amazed. King David wrote about the wonders of the cosmos showcasing the glory of God in a 3,000 year-old song, Psalm 119:1–4. The Apostle Paul also spoke about the order of creation pointing to the likely existence of God. He suggested that to be indifferent to its wonder was culpable folly (Romans 1:20). Similarly, when Paul spoke to the citizens of Athens during one of his missionary journeys, he gave the reason why God ordered the world as he did. It was so that people would seek him and perhaps reach out for him and find him (Acts 17:27 NIV). In other words, there was a relational reason for the universe being so amazing.

This brings us to the second biblical feature of the universe as understood by theologians. It is the fact that humankind has exactly the right amount of intellect to unlock the secrets of the universe. One of the great mysteries of science is that the cosmos is so rationally open to our inquiry—and that mathematics can unlock its secrets.

This feature of the universe sits very comfortably with Christian thinking. Christians know that God is relational, and that the wonders of creation are designed to be comprehended so that we would be encouraged to reach out to the one who designed it. It must be said, however, that whilst God wants to be found, he doesn't force himself on us with overwhelming evidence for his existence. Rather, he gives us enough evidence (through the wonders that exists) to prompt us to reach out and freely choose to relate to him without coercion.

This mindset has implications for what Christians expect to see in science. Christians fully expect the workings of the universe to be understandable. Why? Because their worldview persuades them that God is inviting people into a relationship through it. One of the most powerful tools available to scientists to help them unlock the secrets of the universe is mathematics.

A brilliant quantum physicist from the Institute for Photonics and Advanced Sensing at Adelaide University recently voiced a question during a conversation with me. He was telling me that there was no way of knowing what was going on in quantum physics except through mathematics. This led him to wonder how long mathematics would be able to do this as scientists continued to drill down into the strange world of subatomic particles. Because of my Christian worldview, I felt emboldened to suggest that mathematics would always be able to explain the fundamentals of matter—because we are meant to understand it. My comment was an example of theology looking over the shoulders of science and saying, "What you see is of no surprise to us. We have had that understanding for many centuries." It was then my turn to ask my scientist friend a question. I asked if he saw a link between mathematics and quantum physics. He said that he'd never really thought about it. So, let's dare to do so.

What is mathematics?

This paper suggests that there are not just analogous similarities between mathematics and quantum physics, but that there may be a connection in reality. Furthermore, if the connection between the two disciplines is rightly understood, it will resolve the ancient conundrum that has puzzled philosophers for centuries, namely, trying to understand what mathematics actually is.

Theology has been conducive to mathematics for a very long time. It is significant that almost all philosophers up until Nietzsche were theists; certainly, the classical ones were (for example, Plato, Aristotle, Descartes, Spinoza, Leibniz, Kant, and Hegel). This means that

philosophy and mathematics have often walked hand in hand. Pythagoras, Plato, Galileo, Descartes, Pascal, Spinoza, Newton, Leibniz, and Laplace were all philosopher-mathematicians. It is alleged that Plato had the phrase “Let no one ignorant of geometry enter” engraved above the door of the Academy he founded in Athens. It seems that for much of human history, the one discipline has invited comment from the other. This has resulted in a host of different theories about what mathematics actually is.

Philosophers wonder whether maths is simply a language we have formulated to describe the order around us. Partly, it is, but not entirely. Maths can lead us to discoveries mathematicians didn’t expect to make, for example, the Mandelbrot set mentioned above. Does this therefore mean that mathematics exists independently of humanity? Does it sit there waiting for humanity to discover it, like some hitherto unexplored land? Partly, but not entirely.

Maths doesn’t really exist until we give it a voice (learn to notate it) and so the debate continues even today. This has resulted in a plethora of mathematical philosophy “isms” such as Platonism, Empiricism, Logicism, Formalism, Conventionalism, Psychologism, Intuitionism, Structuralism, Fictionalism, and Nominalism, to name but a few. Tweaking these “isms” has been particularly fertile ground for students seeking a PhD.

Most mathematical philosophers are realists. “Mathematical realism” holds that mathematical entities exist independently of the human mind. Humans don’t invent mathematics; rather, they discover it. Triangles, for example, are real entities, not just creations of the human mind. However, they are perceived by the mind. Although it is widely embraced by mathematical philosophers, there is a problem with mathematical realism, and it is this: Where and how do the mathematical entities exist, and how do we know about them? Is there a world occupied by mathematical entities that is completely separate from our physical world? On the one hand, mathematical truths seem to have a compelling inevitability, but on the other hand, the source of their truthfulness remains elusive.

How do we unify these different aspects of mathematics? How do we allow for the order of mathematics—its surprises, its mysteries, its comprehensibility, and its capacity to be codified into a language that is beautiful? There is help from a surprising quarter: quantum physics. I suggest that a breakthrough in understanding the essence of mathematics, can be derived from quantum physics.

Quantum physics examines the world of tiny, subatomic particles (smaller than an atom). It explores how these particles behave and what their relationship is to energy. In the quantum world, a particle can act as a wave or as a particle. The world of quantum physics is really quite bizarre. It is a world in which particles can appear and disappear or change their form depending on whether or not they are observed.

The discovery of these phenomena in the last century has caused a seismic shift in how we think about physics. Quantum physics has required scientists to move beyond having a purely mechanistic view of the material world and to consider matter in a completely different way. As a result, scientists no longer talk about electrons orbiting the nucleus of an atom. They talk about a "probability wave," which denotes where an electron *probably* is at any one time. Similarly, elementary particles are no longer *things*. Elementary particles live in worlds of probabilities, not actualities.

One of the scientists who pioneered the work of quantum physics was Werner Heisenberg. He became well known for the "uncertainty principle" which he developed in 1925. The Heisenberg uncertainly principle states that you can either know the velocity of an electron, or you can know its position, but you can't know both. This is just one of many paradoxes in the quantum world that physicists have learned to live with.

Heisenberg's work was developed further by the English physicist, Paul Dirac, and the German physicist, Erwin Schrödinger. As a result of their research, physicists have discovered that subatomic particles only appear when we actually observe them. It is the process of observation that results in them collapsing into physical reality. Let me stress: this is not a lunatic, crackpot idea. This is serious science.

Some leading scientists working in the field of quantum physics are even beginning to speak of matter itself being a "content of consciousness." As we said earlier, one of the scientists making this claim is the Nobel prize-winning physicist, Eugene Wigner. He says: "Study of the external world leads to the conclusion that the contents of consciousness are the ultimate reality" (1967, 171). His view is shared by John von Neumann (also a Nobel prize-winning physicist) who says: "All real things are contents of consciousness" (2011, 21).

The question raised in this paper is whether or not there is a behavioural link between mathematics and quantum physics. It is suggested that there are at least five links:

- Quantum physics can only be understood by mathematics.
- Both mathematics and quantum physics are elemental, primal, features of the universe.
- Both can be rightly understood as being dualistic in form.
- Both collapse into physical reality only when they are observed.
- Both have a reliance on consciousness.

The thesis being proposed is an idea that was first mooted in the book *Who Ordered the Universe* (Hawkes, 2015, 108–114). Essentially, it is the idea that mathematics only exists in language form when it is observed. In other words, just as consciousness is foundational to quantum physics, so consciousness is foundational to mathematics. Although

mathematics may already exist, it only collapses into reality (into a language we understand) because of consciousness.

If this thesis is correct, it solves the interminable argument over what mathematics actually is. Is it a language, or an unexplored land? If we allow our understanding of mathematics to be informed by quantum physics, we can see that it is possible for mathematics to exist in complementarity, that is, in a dualistic form that manifests itself as language because of consciousness.

Consciousness at two levels

Nothing currently known can explain the existence of complex mathematical coding except for "consciousness." Similarly, nothing currently known can explain the existence of mathematics other than a consciousness. Both mathematics and quantum physics appear to rely on a consciousness that exists at two levels. The first is a "grand overall consciousness." This is responsible for two things: firstly, the existence of mathematics, specifically the mathematics used to build the universe, and secondly, "observing" the quantum "clouds of potential" of the cosmos so that they collapse into physical reality and build the universe (Hawkes, 2019).

The second level of consciousness operates at the human level. Human consciousness is required for two things. Firstly, it enables humankind to discover profound and unexpected things from mathematics that has hitherto been beyond them, waiting to be discovered. Secondly, human consciousness is required to enable scientists to observe subatomic particles into physical reality in scenarios such as quantum physics' famous double slit experiment. At first blush, it would seem that "human consciousness" has been invited to operate in partnership with a "grand overall consciousness." It is certainly hard to imagine how the two forms of consciousness could be irrelevant to each other.

A requiem for materialistic reductionism

The idea that everything can be explained from the bottom up, by our atoms, chemical composition, and neural pathways has been blown out of the water by quantum physics. This may not have percolated through to the biological world of Richard Dawkins, but perhaps some day it will.

Quantum physics has shown us that the old deterministic way of thinking about reality—that we are all just the product of a lot of tiny billiard balls that bump into each other to create sentient beings—now has very little credence. Science has journeyed a long way from Isaac Newton's mechanistic view of physics. Einstein can be blamed for heralding this new wave of thinking. His famous equation, $E=mc^2$, showed that matter was simply a state of energy. If that were not strange enough, quantum physics suggests that matter may be even

stranger—it may be a “content of consciousness.” The Danish physicist, Niels Bohr, says that those who are not shocked when they first come across quantum physics cannot possibly have understood it (1971, 206).

However, whilst this is so, it should be stressed that quantum physics is not just a speculative philosophy; it is a highly predictive discipline. Physicists may not intuitively understand it, but they have found that its mathematics works in fruitful ways that result in useful, practical outcomes.

Conclusion

So, what can we conclude?

There is good reason to believe that physics is fundamentally about consciousness. The old, deterministic idea that matter gives rise to mind has been turned on its head. It may now be that mind gives rise to matter! By equating matter to energy, Einstein began to dethrone matter as a fundamental reality. Quantum physics has now completed the job by suggesting that matter may be a “content of consciousness.” This reality is something that theologians have known for centuries: they have understood for a long time that fundamentally, we exist because of the mind of God.

The other gift that quantum physics has given us is a model that allows mathematical philosophers to finally resolve what mathematics actually is. Mathematics, like quantum physics, exists within the basic fabric of the universe and is waiting for us to observe it. When it is observed, mathematics collapses into being a language that describes physical things. This means that mathematics, like subatomic particles, exists in complementarity with itself.

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