Modeling Reality with Mathematics

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In 1965, I found myself sitting in classroom with about 50 other students waiting for the professor. The classroom was typical with a huge chalkboard in front. A lone lectern stood before the chalkboard. The class was theoretical mechanics. The professor entered the room that day and did not walk up to the chalkboard and begin drawing pictures with little arrows. Instead, he stood behind the lectern with a somber expression on his face. He announced, "Today you must change the way you think of physics. Up until now, you drew pictures of objects with arrows representing speed and direction. You have drawn springs and things that show the direction of forces. You have used pictures of balls and disks to represent the mental experiments you run. If you wish to move into the real world of physics, you must avoid these crutches and become accustomed to using mathematics to describe the world around you."

The professor continued by saying that those that could not make this transition would not become real physicists. After working in a variety of industries for about 40 years, I have concluded that those that made the transition created a barrier for themselves that has prevented them from viewing the reality around them. To me, this has created the understanding that, "No one understands quantum mechanics."

There are Two Tasks

The thrust of the argument in this paper is two fold. Mathematics is a language, like English, that is used to describe. Mathematics, like English, can describe things that do not match reality. The first thrust is to convince you that this is true. The second task is to convince you that we must describe some feature of the universe with mathematics, form some kind of model that is used in conjunction with mathematics to describe the behavior, and perform tests to see that the math and the model correspond to reality.

This paper will present two mental experiments to demonstrate the value of this philosophy.

First, we examine where this "math only" concept may have originated. Then we discuss some examples that demonstrate that math is not reality.

Who Said Math Rules?

In 1948, the world's greatest physicists gathered in a hotel meeting room in Pennsylvania at an event called the Shelten Island Conference. Several of these men took turns standing at the blackboard in the front of the room and discussed a subject called QED. Eventually a young man named Richard Feynman took the chalk and drew a simple picture on the chalkboard. Neils Bohr leaped out of his seat screaming indignation. In fact, the entire audience including Dirac rebuked Feynman for using pictures to explain anything. Words were uttered claiming Feynman an idiot and knew nothing about quantum physics. This bit of information is from *The Illusion of Reality. BBC Atom Part 3 of 3* (Southern Star Entertainment UK Pic, 2007, 27:00).

The question here is the effect Neils Bohr had on the use of math in physics. He strongly believed that any description of quantum level behavior must use mathematics only. He ran the Institute for Theoretical Physics at the University of Copenhagen. It was founded in 1921 and was the source of work for many noted physicists of the time. Could it be that he exerted his will on the entire community then and that controlled what my professor presented to my class in 1965? Was that appropriate?

Is Math Real?

Let's cut to another scene. Five men sit on a stage, each with a microphone clipped to their collar. There is nothing on the stage other than a curtain behind them and the chairs they are sitting on. The theater is filled with people that are listening to a discussion about Indian philosophy and science. One of the men on the left is making a logical point about woo-woo pseudo science and religion. A man on the right, Deepak Chopra, shoves his hand out toward the speaker and blurts, "Do you believe in infinity?"

While watching this I felt that Chopra had no idea what infinity is. I wished I were on stage and could ask the question, "How many 'infinities' are in your hand?" I suspect he could not answer that question. The answer of course is an infinite number. Locate two points on anyone's hand, draw a line between and calculate how many points are on that line. Then, how many points are on a person's hand that allows one to draw a line between them.

The point is that, to Deepak Chopra, infinity is a real physical thing or that is what he purports to his followers. While contemplating the content of this paper, Chopra's action triggers more thoughts about several numbers or mathematical objects, if you will, that are not about something real. They are zero, infinity, "i" the imaginary number, and dx the calculus infinitesimal. There is nothing in the real world that matches these concepts.

Zero does not exist in reality. Does an empty basket contain zero apples or zero peaches? Do zero pears, grapes, kumquats, or even elephants exist. Is zero equal to nothing? We have seen sticks twelve inches long. We have never seen a stick zero inches long. We will never see something of infinite size. Zero and infinity have similar properties. Take an infinite number of zero length sticks and put them together to make one stick, that stick is still zero inches in length. The point here is that, mathematically, these comments make sense but cannot appear in the real world.

The imaginary number, the square root of minus one, has similar problems. Interestingly the people that named this understood it had no sense in the real world other than to name some condition in mathematics.

The infinitesimal dx has similar problems. The value of dx does not exist in the real world. It is not zero in size but is close to zero. The value dx only works in the real world when expressed with a partner possibly dz. Then, working together, they may show a comparison in size of two sticks or represent the speed of a car in a freshman's math class.

However, the use of dx has some interesting descriptions of the real world. It could be used in the real world to describe the curve of a woman's hips. That is, dx could be part of an equation describing that beautiful curve. However, if we drop down to the molecular level, we encounter molecules and subatomic particles that are no longer some smooth curve. Yet the dx can be far smaller than a line of molecules and yet represent a line that is smooth and continuous midst a cloud of randomly moving particles. This all gets even weirder when dropping to the quantum level. The infinitesimal dx still may represent a smooth line when the thing it describes disappears, appears, and can even move backward in time.

The mathematics here is only accurate when observing the universe through squinted eyes and fuzzy glasses.

The King's Roses

Some time ago in a far away kingdom, the king of that land, loved roses. He had just torn down an old stable behind his castle. He had the royal gardener cover it with sod. The royal gardener ordered sod from the royal gardening company. He had the company deliver enough sod to cover the area that was the site of the old stable. In the end, the royal gardening company delivered 10,000 square yards of sod. The area was perfectly square and when the grass grew green, it was a royal place for the royal children to play. The king wanted the area surrounded with roses. He wanted one bush every yard around the perimeter of the new grass area.

Now the royal gardener was a smart person. Realizing that the square area was 10,000 square yards in size, he took the square root of 10,000 to get 100 roses per edge of the area. That was 400 rose bushes. However, the royal gardener was also a mathematician. He realized that there are two answers when taking the square root of a number. The other answer was -100. Thus, he ordered 400 rose bushes and -400 rose bushes.

The day came when the roses arrived. There were two trucks. The first truck driver asked the royal gardener where to put the 400 roses. The royal gardener pointed to a spot by the grassed area and the truck backed into that spot and placed 400 roses on the ground. The truck driver presented a bill to the royal gardener. It stated, "400 roses @ $10 per rose = $4000." Then the other truck driver asked where he should put the -400 roses. The royal gardener pointed to another spot by the grass area. The truck backed up to that spot. When the truck pulled away, there was a sign that said, "400 tachyon roses." The second truck driver presented a bill to the royal gardener. It stated, "400 tachyon roses @ $100 per tachyon rose = $40000." The gardener asked why so much for the tachyon roses. The driver replied without cracking a smile, "They are very difficult to grow." The drivers got into their trucks and drove away.

What is the issue here? In this obvious example of using a square root to determine something, we can see that -400 is a useless answer. That is because we see the reality of the situation.

In those situations in which there is no model that represents reality, we can make dreadful errors. In special relativity equations, the velocity is squared. This yields tachyons for one of the possibilities if v is negative. In every text about special relativity, there is a statement that there is no explanation or model for special relativity. Thus, we have no way of measuring the reality of the accuracy for a negative velocity.

The point is that without a model representing reality, we do not know how accurately math will describe that reality. Ergo, math does not represent reality.

The drive here is to suggest that real world study is a combination of reality, models, and mathematics.

The Next Mental Experiment

For our next mental experiment, we take up special relativity. It is certainly one of the more perplexing theories of physics and one of the most tested theories of physics. Most texts discussing the subject state that it is a purely mathematical theory. There is no model used to explain it. The claim is that understanding depends totally upon the math behind it.

This is a very good subject to demonstrate the use of models in understanding the world around us. This author has come up with a model to explain special relativity. It is presented here. Then consequences of the model are extrapolated. This will demonstrate the usefulness of the three ingredients that should be used when explaining phenomena: reality, a model of reality, and a mathematical description.

The Model

Einstein's explanation of special relativity begins with two postulates. The first, any phenomena appears the same in any frame of reference. The second is that the speed of light is constant in any frame of reference. The model presented is of the second postulate.

Consider a three space that contains points that all move in random directions with the same speed within that three space. Then, an observer in any location in that three space and within any frame of reference in that three space will see all the points moving with constant speed. Though simple, this is the model.

In the real world, we measure distance and time by comparing each to a known distance or time. That is, measurement consists of comparing one thing in our universe to another thing in our universe.

The only way to measure both time and distance in this model universe is to use something in that universe to measure or compare one thing to another. As the only thing one can use for such a measurement, is some other object moving at the same speed. The speed of any point measured, will be the same as any other object. Ergo, all points appear to move at the same velocity: the second postulate.

At first glance, this is difficult to see. Taking an omniscient point of view, that is outside looking in; will not give the correct perspective. The point of view that works is taking the "in the observer's seat" point of view. By taking an observer's seat point of view, one does not see all the points all the time. The observer only sees points hitting his position. The observer must then use logic to compare one point that hits his point of view with another point that hits his point of view.

This is like the human eye. We measure our surroundings only by the photons entering our eye or a similar instrument. Then we use logic to analyze those events to build an omniscient idea of what surrounds us.

While going over this concept a realization was made that, the points in our model are like photons in our universe. We will continue with that realization.

From the perspective of the subject of this paper, the importance of reality, model, and math, is that we have real experiments of special relativity, a model being the universe of points or photons, and a bunch of math like Lorentz transforms. Then our knowledge of the world around us should grow if we examine the ramifications of these three factors.

Ramifications

So, let's look at ramifications of the model. The first to look at is that the model universe contains only photons moving about. This makes the statement that our real universe is made only of photons. What can we observe in the real universe to see this is true? First argument: in observing particles that decay and experiments in supercolliders: all particles decay into energy which consists of photons moving away from the site of decay. All except neutrinos. However, this author believes they will ultimately decay into photons as any other subatomic particle. Second argument, various experiments have been executed in which high-energy beams of light in special circumstances produce matter. The matter decays quickly but it is another demonstration that matter consists only of photons. Dirac presented an example of this. He observed that when a high-energy photon passes by a very heavy particle, there is a possibility a virtual electron will appear that will disappear sometime later in a burst of energy. This bit is from a college textbook, *Concepts of Modern Physics* (Arthur Beiser, 1963, McGraw Hill Book Company, Pg 326).

Here is another ramification. If the universe consists only of photons, particles then must consist of photon clusters. It suggests that certain numbers of photons can have a high probability of remaining in a cluster such as neutrinos, electrons, and protons. It suggests that other particles do not have a high probability to remain a cluster or hold the form of a particle.

Given that a particle in this photon universe is a cluster of photons, an observer in this universe could identify a particle as his frame of reference. Then, the observer could observe particles moving about him at a variety of speeds. This appears to be the case in the real world.

From this, we can draw some more conclusions. As a particle consists of photons moving at a constant velocity one can see that the maximum speed of any particle would be the speed of the photons or the speed of light. Therefore, we see a result of the theory of special relativity. Moving matter can only approach the speed of light but cannot exceed it.

Another consequence: the appearance of virtual particles now becomes clear. Photons can randomly come together to form a particle if the area of photons is dense enough. The small number of photons gathering would be such that the particle would not persist and decay into its component photons. This is observed in the real universe.

Now we can apply the second postulate, an object appears the same in all frames of reference. This means that the form of a particle would remain the same irrespective of the frame of reference. Consider how a particle might move. In a stationary particle, all constituent photons would move back and forth an equal distance. For such a particle to move, the constituent photons would be required to move a little more in a specific direction. That is, in a stationary particle, the sum of the distances traveled by the photons would be some specific value. As the particle must keep the same shape, postulate one, the photons must move some longer distance in a frame of reference the particle is moving within. Therefore, in the moving frame of reference, the photons are moving further and the total sum of photon motion is greater. This explains why time on a moving particle appears to slow down. As the speed of the constituent photons is constant, the particles use more time to travel in the moving frame of reference to keep their shape in the particles frame of reference.

This model also reveals the source of the Heisenberg Uncertainty principle. As a particle consists of a number of photons randomly moving around in space, the average center of the particle will be moving about. As contemporary physics considers the center of a particle to be where the particle is, the path of the particle through space displays Heisenberg Uncertainty properties.

The point here is that putting a model into the mix of the theory, understanding grows quickly.

Caveats

The astute scientist will be aware that there are some problems with the model proposed. One is that the model requires the constituent members be points. This would seem illogical. Another is that the points seem to collide a great deal for the model to support particles. Points of zero dimensions would not commonly collide with other points of zero dimensions. Then, present science today does not contain the concept of colliding photons.

There are two ways to handle this. One is to claim that these caveats are reason to discount the model. Another is to do more research to see if the problems discovered lead to more understanding.

The author of this paper has done this and the results are far beyond the purpose of this paper.

Conclusion

Math is a language that can describe reality. When used to describe reality there should be a model accompanying the math. The model and math should be compared to reality to test the validity of the math and model. If these three things are not in harmony, we do not understand the phenomena and need more research.