A Brief History of Nothing

by Anthony Rizzi

Introduction

Physicist Stephen Hawking has recently said in his book "The Grand Design" and in interviews related to that book that the universe could come from nothing so there is no need for God. He says in his book, "…the Universe can and will create itself from nothing. Spontaneous creation is the reason there is something rather than nothing, why the Universe exists, why we exist."[1] Given the nature of the statement that the whole universe could come from nothing, one would have expected a violent response asserting the insanity of this statement. Nothing is no-thing. It cannot cause anything because it is not anything. That is what the word means. The response from physicists was effectively nil. That should be revealing to a general public who generally know very little of physicists and their physics. It should make us realize that physicists have little concern about this issue. Indeed, this is made even clearer when we recognize that some physicists strongly supported Hawking's idea. Furthermore, apparently the problem has spread widely upward from the base science of physics, since most other members of academia were either silent or supportive of the idea. Those in academia who did argue against him tended to be those with already held strong religious beliefs. Every single one of these that I heard said, effectively, that Hawking had no right to talk about where the universe came from because that subject belongs to metaphysics, not physics. This is fundamentally wrong, but to understand why and in what sense, seldom understood distinctions need to be made.

Why do top physicists so easily and comfortably fall into saying that something, let alone the whole universe, comes from nothing? The answer is that it is a confused way of speaking that reveals a fundamentally confused thinking that is common to the discipline. To understand why it is common, we have to understand that we physicists speak from equations, because they are at the heart of our thinking. And, due to this focus on logical systems centered on equations, key aspects of our thinking are left confused, leading, as we will see, to crazy thinking and statements when we try to speak without our equations, i.e. in ordinary language.

The Difference between Modern and Pre-modern Science

This touches the unique nature of the modern scientific method that is not really clearly known. Namely, the difference between modern science and earlier science is not what people think. The key difference is not that modern science is empirical or, even less, that it uses reason, expecting nature to act in a consistent way cleared of magical thinking. "Ancient" science properly so called was both rational and empirical.

The real difference, and there is a radical difference, is most visible in physics, which is the base of all science. Modern physics uses logical systems that are centered around

[1] Page 180 of Grand Design

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an equation or system of equations. The powerful method of capturing physical reality in systems of symbols that one can mechanically manipulate according to rules is the reason mathematics and physics make such huge leaps in the modern period. Now, the equation-centered system thinking is what is new; ancients would never dream of having a merely mental reality like an equation take the place of the thing to be understood. To be fair, this is not simply what we modern physicists do either, but this is what effectively happens. We physicists understand at a certain level that the equation only describes nature (indeed this is what we will say if asked), but when push comes to shove we really do not have anything more to say about nature than our equations. There is more to say, but we do not know what it is in any real way. This is why so much of what we say is hard for laymen to grasp, and in fact, if truth be told, we do not really know what we are saying, except in so far as it relates back to the equations.

This, of course, does not alter the fact that physicists have discovered an immense number of very important things and, therefore, know them better than anyone else. In fact, these discoveries, and those of the other hard modern sciences building on them, are fundamentally what makes the modern world modern. Now, if there were a guy in town who alone had the ability to discover treasure of all kinds, but was not able to understand and articulate where and even what the nature of his great discoveries really were, one would still have to depend on him to get access to those treasures. It is like this with modern science; only the scientist knows them but the way he knows them is tied up with equations.

The Problem with Something Coming from Nothing

Hawking, for example, has discovered wonderful things, including, potentially, some of the equational findings he was attempting to explain in his "Grand Design." However, one of those discoveries, as you well know, is ***not*** that something can come from nothing. Now, there is no crazier idea than "something can come from nothing," for this means that the nothing has some kind of power and hence some kind of reality. In other words, something and nothing are the same thing! In thinking this, one rejects the root principle of all thinking: something is what it is. This principle is so immediately given in ordinary sense experience that when we say it, it seems trivial.

To flesh out how crazy it really is to say "something comes from nothing," consider that accepting this principle would allow someone to say that he is Napoleon or Marie Antoinette. This is because the differences between him and them are actually something, which he can take to be nothing; therefore, he is either or both of them. This leads us back to the question of how physicists fall into this kind of, well, truly crazy thinking.

The problem starts with the scientific revolution when this new equation-centered logical system way of thinking was born.[2] The

[2] Jacques Maritain calls this the empiriological, because it looks at the empirical world as a logical system. In my work, I have clarified and deepened the use of this word. This is a word people should learn how to use, because it succinctly describes the new and unique nature of the modern scientific method. I coined the word *quantiological* to describe the parallel process that first happened in mathematics where the quantitative is captured in a logical system. The process of knowing becomes: first, guessing some axioms, then if deductions from

first success of this method was Newton's theory of motion of the bodies on Earth and in the sky. The next is James Clerk Maxwell's discovery of the equations of *electricity and magnetism*; those equations cover, for example, at the "classical" level, how and why all your electronics and communication systems work and they also apply to light. After that comes the great 20th century discovery of special relativity. Much more can and should be said, but for our brief history this is more than enough. In this history, I focus on the most fundamental kind of change, change of place. There are other avenues by which the crazy ideas (including the idea that something comes from nothing) enter into our thinking but my aim is to give you insight into the general way that they enter, not a complete account.

Note we are also not here attempting a detailed historical account of what people like Newton and Maxwell thought. Instead, we are focusing on the thinking that was implicit[3] in the equations that govern the given subfield which, because it was implicit, gradually took hold of the subfield until it became *explicitly* accepted. Indeed, it is better to think of the history that I am about to give as a history of the education of a modern physicist, which, in its own way, recapitulates the history of physics.

How Nothing Enters Newtonian Physics (mechanics)

In any modern introductory mechanics textbook, one can find the equation- centered description that results from the primal equation of mechanics $\vec{F} = m\vec{a}$. It is taught that uniform motion does not need a cause; it is on a par with rest. Indeed, in the so-called Galilean view (called Galilean relativity), rest and uniform motion are taught to be equivalent because one can make an apparent motion go away by viewing it from a reference "frame" moving along with it. In either case, one has introduced the idea that something is nothing. How so?

Take the first case, the idea that motion does not need a cause. To understand it, we need to understand motion.[4] Take the case of a baseball moving from the pitcher to home plate; it goes through a continuum of places as it moves from its place in the pitcher's hand to its place in the catcher's glove. This means there are many new places that come about in the motion of the ball, whether it is uniform motion, i.e. at a constant speed and direction, or not. If we say motion does not need a cause then all those new places of the ball come from nothing, hence are identical with nothing. Voila, something is nothing. That something (all those places except where the ball is at some particular moment), which has been equated with nothing, in this case, is the ball's relationship with the air as it moves through it.

Take now the claim that rest and motion are the same thing. If we say that the ball at rest, say in the catcher's mitt, is the same as the ball moving from pitcher to catcher, we have obviously made the "something" of all the places between the pitcher and catcher into

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them are useful, finally you accept the tentative axiomatic system as what you know.

[3] Much more can be said here, see *Science Before Science: A Guide to Thinking in the 21st Century* and "The Science before Science – Reintegration of the Modern Mind and its Science" in *Reading the Cosmos: Nature, Science, and Wisdom*, edited by G. Butera (p 60-79, 2011, Washington D.C.: American Maritain Association).

[4] See my *Kid's introduction to Physics (and Beyond)* for the background principles and context and see my *Physics for Realists-Mechanics* (PFR-M) for more depth on these and other issues related to the mechanics discussed here.

"nothing." The "something" (all those places except where the ball is at some particular moment) which has been equated with "nothing" is, in this case, effectively the air through which it moves.

How is this done? For motion in a straight line, the equation is: $F = ma$; it says that if the force, *F,* is zero, then the acceleration, *a*, is zero; that is, the speed is not changing. This could mean that the body is at rest or in uniform motion (i.e. moving at some constant speed). Thus, from the point of view of the equation, these effects belong together. Then we notice something very powerful that Galileo, and before him Buridan, noticed. If someone is, for example, on a windowless train that is moving at a constant speed in a constant direction, he cannot tell whether he is moving or not. This powerful fact that the effects appear to be the same whether one is moving or not make it natural, at that level, to lump rest with uniform motion. In fact, it becomes natural in a certain way to make the analogical[5] abstraction that rest and motion are the same thing, just viewed from different reference frames.[6] This step is not made with the careful distinctions I have just made but as a sort of practical step that is useful for working with the equation and the experiments that it describes. Hopefully, you begin to see how the fog of confusion will form as these jumps over the distinction between something and nothing are left unnoticed.

But we are not done yet. We need numbers to use in our equations. This is the connection with experiment that is essential. It is through measurement that we get numbers that we can put in our equations. In our baseball example, we are talking about local motion, change of place, and the crucial measurement related to length. Length of itself, of course, is not a number but an extended set of parts one next to the other. For example, your son has a certain height because he has a foot connected to his ankle connected to his leg connected to his knee and you know how it goes up to his head. Now, your son's height is not itself a number. We need to measure his height to get a number. A measurement is a comparison; in this case, a comparison between two lengths (though, again, neither of these is said clearly in physics texts). To measure his height, we effectively determine how many 1 foot rulers have the same length as he is high. If it is 4, we say he is 4 feet tall. Similarly, if we do the same for the extension, length, between the pitcher and the catcher, we get a number.

Now, once we turn the places between the catcher and pitcher into a number, it becomes very easy to forget that this number actually is a comparison and represents many places for the ball. We can then easily reduce that extension to nothing, which is what we do explicitly when we say that rest and motion are the same thing. Indeed, it becomes easy to identify outer-space and/or the region between the electrons and the nucleus within an atom as

[5] Not a real abstraction, which never leaves out something that properly belongs to the thing that you abstract. For example, we abstract brown from the brown squirrel, but we do not abstract the brown from the fact that it is on a surface. "Brown" on a dimensionless point would destroy the meaning "brown" that we wished to abstract.

[6] Two principles that are clearly left out in such an analogical abstraction (in a precise language given in my *Kid's Introduction to Physics*) are the intrinsically related categories of action and reception. For, in reality, if there is a motion, the body and its environment are in action and reception in a specific way not in all possible ways or in no way. See my *PFR-Mechanics*.

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"empty space."[7] And, from there it is easy to let the number represent only a distance from which we (analogically) abstract the actual extension between the two bodies of interest, say the baseball and the catcher. Notice again the odd nature of this "abstraction;" we talk about two objects separated by nothing. If two objects really had nothing between them, they would be touching each other.

So the system of Newtonian physics finds it convenient (when gravity is left out) to just talk about the rate of change of this number distance and not worry about the nothing in-between things. In this way, we make a system of thinking that is very helpful, but it is full of things that cannot exist anywhere but in one's mind.

Let's recap and explain in a little more depth. In so far as Newtonian physics seems to claim that uniform motion does not need a cause, it denies the principle of causality, i.e. "nothing changes itself,"[8] and with that implicitly identifies something with nothing. But, one can just ignore the cause of the motion and not notice this violation and make a kind of confused escape in this way. However, that escape is blocked by the next move. That is, as soon as one uses the fact[9] that *one cannot tell whether the ball is moving at you or you're moving at the ball* to say "rest and motion are the same thing," one has said "something is nothing." But at this point, one is saved from the embarrassment that would come in noticing this because, having converted the distance between the ball and the catcher into a number and its speed as a changing number, we already think of the extension as "nothing." And, we no longer even have the idea of motion in front of us but have only the idea of number and whether or not it changes. But what about the *change in the number?* Never fear-- that will not easily bring the embarrassing situation to light because we will make that too into a number, the uniform speed, v, at which it moves. If that changes we can do the same with the rate of change of speed!

You see the very strength of the method that makes it such a powerful aid to human thinking can also be a complicated maze in which we can lose our basic common sense. Moreover, this will eventually happen if one does not step back and think about what it is one is doing and why. Indeed, because we have not, we are lost in the maze.

However, although the above idea of relative motion is useful and thus such a trap does exist, there is a two-fold block to this trap that rest and motion are the same in Newtonian physics, namely light and gravity. Because of these, Newtonian (empiriological[2]) physics never gives up on motion all the way; in particular, it still doesn't reduce the stuff in-between things to nothing. It provides the keystone steps and builds some of the hand

[7] Note the first meaning of space is simply what one gets when we leave behind all categories of properties but quantity (extension) (see kid's book or *Science Before Science* book referenced in footnote 3 and 4). This is not a purely mental reality, because things really do have extension. However, we usually go one step further and think of the property of having extension as existing as a substance as if it could exist without being the extension of someTHING. This is the usual idea of space that is taught to people. This concept is purely mental because properties are not substances. This jump however facilitates certain ways of thinking including making it easier to treat space as nothing, especially once we have turned it into a number by comparing it with a standard unit of length.

[8] See kid's book and *Science Before Science* book referenced in footnotes 3 and 4.

[9] This comes with certain conditions at this point, but nonetheless is true at a real level.

railing, but more steps are needed. It is only with special relativity, which deals with light, that the relativity of motion can take its full status.

Before we trace those steps let me emphasize a key point about what we have said above. Namely, keep in mind that I have untangled the mess for you. Physicists (with the exception of the Institute for Advanced Physics[10] and those learning from its members and materials) do not know these things and avoid saying crazy things only by always speaking within the equation-centered system. As soon as a physicist must speak to someone who does not understand that equation-centered structure, his years of training and thinking that ignores fundamental physical distinctions and principles, such as "nothing changes itself," make it virtually impossible to avoid implying crazy things. In fact, physicists are aware that there is something fundamental lost when one transitions to ordinary speech; this is one of the reasons few physicists attempt to convey much depth to the public. It's not that we physicists realize that we have deeply lost certain fundamental principles, or that we think the general public is intrinsically unable to understand. Most physicists simply realize that there is a huge barrier to explaining the equation-centered things we know to those who do not understand those equations. If we knew that this barrier arises, at the generic level, because we are missing proper grounding and distinctions, we could demolish the barrier at that level. But, again, we don't know this. This is the power of the trap. It is confused, trained into us and lived, rather than thought out and deliberately chosen.

[10] The Institute for Advanced Physics is a non-profit (501c(3)) that has existed for 10 years.

How Electricity and Magnetism and Special Relativity together save Nothing

The next step in the history of nothing is of course found in the next crucial step in the advancement of modern physics. This is the development of Maxwell's equations of electricity and magnetism. These equations describe, among other important things, light. Now these equations, especially as given in the form of solutions which correspond to light, have a lot of similarities to those of wave motion in an ordinary medium, for example, the waves of water along an ocean shore. However, if we are stuck literally with this way of thinking, the medium must be a solid to sustain the transverse, high speed light waves; yet, it must also have an extremely low density so that we and the planets can move through it easily as clearly we do! Getting stuck in this way does happen, as perhaps you can imagine after our explanations above, when one tries to couple physical explanations with equational explanations without an awareness of the proper distinctions and principles.[11] By the way, the infinitely stiff stuff that is low density was named the luminiferous ether. One can see how the stuff between the planets and within the atom (which is also called "vacuum" or "empty space") is becoming a real pain in the neck for equational physics. We would really like by now to get rid of it, make it nothing. It seems helpful that we can think of it as pure extension. After all, pure extension is already a purely mental thing, not a real thing, for extension is a property of a thing, not a thing itself; something

[11] Bringing back the things discussed in the *Kid's Introduction to Physics (and Beyond)*, including definition of a physical thing and the nine categories of accidents that we all see and cannot deny without committing intellectual suicide, would, again, allow us to avoid such problems.

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is extended not nothing. Still the extension itself is real, and it seems we need somehow to get rid of that too to solve our problem.

Now, this is where special relativity comes to the rescue (for the case of no gravity). If we employ the equations of special relativity, [12] Maxwell's equations apply[13] in the same form whether one is at rest or moving at constant speed in a certain direction. This means the problem with light that blocked Galilean relativity does not apply to special relativity. Hence, we can safely, *within our equation-centered system*, take rest and uniform motion to be interchangeable and thus the stuff in outer space and between atoms becomes *effectively* nothing. We have obliterated it, in the fashion described earlier, through a contradiction. However, remember we do not glory in the contradiction; we ignore it. We focus on the great simplification of understanding of what the equation does convey via experiment about the world. Remember, again, the equational system we use is not wrong; it is confused. It is the confusion that leads to the identification of the something with nothing. Once the equations are unpacked (see PFR-M and PFR-E&M), then the equational structure and its short hand way of thinking can be entered clear-eyed without danger of confusion. The equation can be seen with the proper distinctions and a real understanding of what I am doing and why, and most importantly what it says about the physical world and what it does not. Indeed, it is only by understanding what the equational physics says and what it does not that I can know what I am doing and why.

Quantum mechanics comes shortly after this as does general relativity and they have their parts to play, but this short history stops here to answer the question of why you must care about the history of nothing at all.

Why you must worry about Nothing

Physics, as we have said, is the base science. This is because physics is the study of the physical world and all we know is based in what comes to us of the physical world through the senses. Whatever we do in physics will thus be transmitted to all of the rest of our thinking. And, these are not esoteric things that tangentially affect us; these are things like whether something is nothing. You cannot just sit back and laugh at the physicist, for everything you think depends on him. If he is in trouble, you are in worse trouble.

As a simple example of how the nothing enters our primary educational system, consider the typical definition of matter common in textbooks. It is said that matter is:[14]

"Anything that takes up space and has mass."[15] This, of course, means that the "empty space" or the vacuum (which means a kind of "a nothing") that we have been discussing above is not matter. So, since we are talking about physical things, which we also call matter, the vacuum must be nothing. Also, note another severe problem in the definition; it says "takes

[12] One must adopt, among other things, an operational definition of simultaneity for time. See *Physics for Realists- Mechanics* Chapter 10 and *Physics for Realists: Electricity and Magnetism* Chapter 7.

[13] Within the conditions of their domain of applicability.

[14] I take this definition from a very well respected biology book: Campbell, 9th Edition, Pearson Benjamin Cummings, San Francisco, 2011, page 31.

[15] It also defines mass as the amount of matter in an object, which confirms that the vacuum is not matter, which appears to, in this context, leave it to be nothing.

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up space." Properly speaking, bodies do not take up space. They, in a way, by their existence, create space; that is, they are extended. What we mean by "take up space" is that it pushes space "out of the way." If I put a marble in a cup of water, it pushes the water out of the way, so it can have a place to sit. A body does not need to "take up space" to be there. Furthermore, to say something takes up space implies that space is a something, which is contradicted by the definition, which excludes anything without mass from being real. Now, a contradiction is nothing in the real world; it's purely mental. In this way, nothing is all over the place in this grade school definition of matter.

Modern physics is full of wonderful and undeniable discoveries, including Newtonian physics, electricity and magnetism, quantum mechanics, general and special relativity, cosmology, the standard model of particle physics and much more. But, its wonders need to be freed from its ability to inculcate a certain craziness and narrowness. And, because its equation-centered structure encapsulates so many real wonders about the world, they should be set free from that narrowness, so that they can be made available to everyone, not just technically inclined people.

I hope I have managed to make it clear that we had better set our minds, time, energy and finances to the task of uncovering the proper specific meaning of the full structure of modern physics in terms of proper first principles, *lest the nothing triumphs*.

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