Bruce Gordon on Idealism and Quantum Physics (Part II)

http://mindmatters.ai/podcast/ep130

Austin Egbert:

What does quantum mechanics say about the nature of our reality? Our guest host Dr. Michael Egnor discusses his favorite discovery of modern science today on Mind Matters News.

Announcer:

Welcome to Mind Matters News where artificial and natural intelligence meet head on.

Michael Egnor:

What is the most fascinating discovery of modern science? We each have our opinion and my opinion is a discovery that my guest Bruce Gordon can tell us quite a bit about. Dr. Gordon is a philosopher of science and an expert in the history of science. He is associate professor of history and philosophy of science at Houston Baptist University. He's a senior fellow at the Center for Science and Culture at the Discovery Institute. He's also one of the smartest men I know. Actually, I've been dying to ask Bruce this question for a very long time. When I was in college, I was a biochemistry major and I took some courses in quantum mechanics. It was noted in the course that when you look at the most fundamental properties of subatomic particles, matter seems to disappear. That is that the reality of the subatomic particles is that they're mathematical concepts. That utterly fascinated me that at its basic structure, reality is an idea which fits very nicely with idealism. So Dr. Gordon is an expert on idealism and on the philosophy of science. I wanted to ask him, what do you think about all this?

Bruce Gordon:

Well, certainly my own path to idealism was paved by my reflections on the metaphysics of quantum physics. So I'm deeply sympathetic to the questions that you're raising. Maybe we should do a little exploring of some of the phenomena of quantum physics that seem to point in this direction. So of course, quantum physics is a highly mathematical theory that describes the nature of a reality at the atomic and subatomic level. The mathematical descriptions of quantum physics have a variety of experimentally confirmed consequences, that I would say preclude the possibility of a world of mind independent material substances, that's governed by efficient material causation. That's not the way that the world is constituted, although that has been the way and is the way that we tend to think of it, because we still live in a reality that seems very much to be described by classical Newtonian kinds of mathematical descriptions.

Bruce Gordon:

However, at the most fundamental level that's not the case. So let's take a look at, or talk about maybe some interesting quantum experiments that point toward the mind dependent character of reality. Okay? So one of the standard ways of talking about quantum physics... And of course, quantum physics itself, and the interpretation of it particularly has been a cottage industry throughout the 20th century and on up to the present in the 21st century. There are a variety of different perspectives that have been offered. We have kind of standard Copenhagenism. We've got the many-worlds interpretation. We've got De Broglie–Bohm Variable theory. We've got quantum logic, we've got Ghirardi–Rimini–Weber spontaneous collapse theory, and on and on. But I would say that fundamentally in the background we've got, with all due respect to De Broglie-Bohm theorists and other hidden variable advocates, a situation in which reality at the quantum level does not exist until it is observed.

Bruce Gordon:

So what sort of indications do we have of that? I think one of the most fascinating ones is what's in the literature is referred to as the quantum eraser experiment, or a delayed choice quantum eraser experiment. What this experiment is set up to do is to measure... There's this inherent duality in quantum physics as well, wave particle duality. When you're not just not observing reality, it seems to behave in accordance with the Schrodinger wave equation, and various relativistic expressions of that and on into quantum field theory. But when you are observing it, it seems to take on a more particulate character.

Bruce Gordon:

So what is the delayed choice quantum eraser experiment do? Well, it tries to measure which path a particle would have taken after interference in the wave function itself has been created that is inconsistent with that particle behavior. So you've got a splitter of some sort, that's going to divide the quantum wave function and send it along two different paths. Then you're going to make a measurement along one of the paths to see what's happening. Okay? That interference can be turned off or on by choosing whether or not to look at which path the interference has taken, or which path the particle has taken after the interference already exists.

Bruce Gordon:

Now if you don't look, you get an interference phenomenon at the end. If you do look the wave function instantaneously collapses, and you detect the particle along that pathway. So choosing to look erases the wave function to interference that already exists and gives the system a particle history. Okay? This experiment has been performed under what would be called Einstein Locality Conditions. In other words, no signal could have passed subject to the limiting velocity of the speed of light between the components of the system to cause the effect that you're observing. Okay?

Bruce Gordon:

So it's a non-local collapse of the wave function that instantaneously gives a particle position to the measurement after phenomena that is inconsistent with that, has already been created. So the very fact that we can make a causally disconnected choice of whether wave or particle phenomena are manifested in a quantum system, essentially shows that there is no measurement, independent and causally connected, substantial material reality at the micro physical level that's there. It is created by the measurement itself.

Michael Egnor:

What counts as a measurement?

Bruce Gordon:

Oh, now that is a deep question. So what can count as a measurement is any sort of interaction that would localize the wave function and yield a determinant local result. That could involve a conscious observer, or it might not involve a conscious observer.

Michael Egnor:

What sort of measurement wouldn't involve a conscious observer? Does it matter how much you pay attention? If I'm a little preoccupied, do I not get much interference, but maybe a little? Because it really implies that there's number one, there is an actual something that is observation and it's an on or off thing, it's yes or no. There's no in between. What is that?

Bruce Gordon:

Well, so this is going to take us into certain metaphysical interpretations of what's going on. Now on a standard Copenhagen view, you would have a collapse of the wave function to a localized result. On say a many-worlds interpretation, which I'm not that sympathetic with ontologically, but I do see a role for in terms of deriving idealistic conclusions and embedding them in a context in which the universal wave function becomes a manifestation of divine omniscience. But that could take us a little bit farther afield than we probably want to go immediately, at least. So another thing that happens, another way of describing what's going on is to think of it in terms of wave interference. And a whole bunch of different quantum systems in their way of functions interacting. Okay?

Bruce Gordon:

Now, if you think about waves in water, you have phenomena of constructive or destructive interference. So if you think about a typical transverse wave in the water, moving through the medium of the water, it has a crest and a trough. If it meets another wave, say of the same size coming from the other direction, then where the crests meet the amplitude of the wave, the height of the wave if you like, is doubled if the waves are initially the same size. But where a crest meets a trough, they cancel out and you observe calm water. Even though that calmness is an artifact of the waves passing through each other in a crest meeting a trough.

Bruce Gordon:

Now when quantum systems decohere, as they call it in this way, when the wave functions cancel each other out, in terms of destructive interference effects, you get the perception of a calm reality. Even though it's really just quantum waves moving through each other that generate that appearance. So the substantiality then that you observe, or the calmness that you observe around you in quantum description can be regarded as a deep phenomenon of decoherence. It's really the cancellation due to destructive interference of all of these quantum systems interacting with each other. Such that reality appears calm, but underneath there's nothing substantial. It's just the wave functions interfering with each other.

Michael Egnor:

The metaphysical implications of this of course are fascinating and profound. But there's also a kind of just an empiric reality that we have to take into account. Say, for example, that I'm a physicist who is looking at a quantum system, and I'm actually looking at the oscilloscope, or whatever our modern instrument is, when it's happening. Everybody would say, "Well, that's an observation for sure." Let's say that I'm not in the room and I'm just taping it but I plan to look at it later. Is that an observation? If I change my mind and decide not to look at it, does that change the system? So I'm fascinated by what we mean by an observation, because in reality, an observation is a continuum. I mean, I could be watching something then my mind wanders, I'm thinking about lunch. Does that kind of make the system go back into indeterminacy? Then it becomes determined again, when I focus on it?

Bruce Gordon:

Not necessarily. If you've got decoherence happening in the quantum metaphysics of the world around you. So how do we bring this into relationship with idealism... In fact, I was going to talk about some other experiments to kind of further massage people's intuitions with respect to the nature of the reality that undergirds these sorts of phenomenon. Let me talk about at least a couple more.

Michael Egnor:

Sure.

Bruce Gordon:

Then we'll come back to the question of, "What's going on when we're not looking?"

Michael Egnor:

Right. Right, right. Is the moon there if no one's looking at it?

Bruce Gordon:

Yeah. David Mermin, physicist at Cornell, phrased things that way.

Michael Egnor:

Sure.

Bruce Gordon:

So another phenomenon that's really quite fascinating is a phenomenon of non-localizability of individual particles. So in quantum mechanical description, if you make some physically reasonable assumptions about individual particles. Most notably, I mean, there are a couple of other ones as well, but most notably that the particle and individual particle can't be two places at once. Furthermore, that it can't serve as an infinite source of energy. So that you can't run the power needs of New York City on a single electron from here to eternity, right? If you make those two physically very reasonable assumptions, then in the formalism, the quantum mechanical formulism, you can demonstrate that the particle in question has zero probability of existing in any bounded region of space, no matter how large. You can close various loopholes in that to make it kind of a rock solid result.

Bruce Gordon:

So what does that mean? It means that unobserved quanta don't exist anywhere in space, and thus have no existence apart from being observed. Interestingly enough, there have been experiments conducted that would support the quantum formalism. What does that mean then? It means that as far as microscopic material individuals are concerned, while particles may have pragmatic utility with respect to the measurement results that we observe, and with respect to say macroscopic appearances, it has no basis in unobserved mind independent reality. Okay. So that's just another example that would lead in the same direction as the quantum eraser experiment that I talked about.

Bruce Gordon:

Here's another one that's absolutely fascinating. It's been dubbed the quantum Cheshire cat phenomenon. You may recall from the story of Alice in Wonderland, that Alice observes this grinning Cheshire cat that then disappears leaving only its grin. Alice remarks that she's "Often seen a cat without a grin, but never a grin without a cat." In essence, that's what's going on here because certain experiments - in particular, one using a neutron interferometer - have separated the properties of neutrons from any sort of substrate. So micro physical properties don't necessarily require a substrate.

What did the experiment do? Well, it sent the position of neutrons along one path and their spins along a separate path.

Bruce Gordon:

So that'd be kind of like sending a top along one path, and the fact that it was spinning along a separate path. Or the redness of an object along one path and the location of that object along another path. Micro physical properties then can be separated from any idea of a substrate. They can be abstract properties moving through space. So what do you get then? It would seem that under appropriate experimental conditions, quantum systems are decomposable into disembodied properties. Kind of a collection of Cheshire cat grins, if you will. So how is it that an abstract property could exist without any sort of substrate? Well, it can't. Of course being a good kind of Neo-Aristotelian yourself, you would see properties as kind of mental abstractions from particulars.

Michael Egnor:

Right.

Bruce Gordon:

... Not existing in and of themselves, but only in the objects-

Michael Egnor:

But the property could exist in a mind.

Bruce Gordon:

Yes, that's exactly where I'm headed.

Michael Egnor:

Right. Okay, yes. Yes.

Bruce Gordon:

There is no physical substrate, but the property has to inhere in something, so it's inhering in the mind that perceives it. There is no, ultimately, there is no physical substrate that undergirds that property. Got it? So in a way you could look at the properties, the quantum mechanical properties as kind of abstract particular properties, tropes even. But the tropes have to inhere in something. What they inhere in is a mental substance, not a physical one.

Michael Egnor:

It's absolutely fascinating. What's particularly fascinating as you point out, is how a deep look at the peculiarities, at the counterintuitive aspects of the quantum world, suggests that only an idealistic or an idealist metaphysics could make sense of all this. That materialist, or perhaps even dualist metaphysical perspectives fail at the quantum level. But the idealist perspective doesn't. That's very interesting.

Bruce Gordon:

I would agree with that way of phrasing things. I'm not sure that you do entirely? I'm pretty sure you have some reservations about it, but yeah, that's pretty much where I'm at.

Michael Egnor:

Yeah. I must say yeah, I really do feel that way. What I'm fascinated with is particularly in neuroscience, there are aspects of the hylomorphic perspective of Aristotle and St. Thomas, that really do seem to make sense of empirical scientific results in very nice ways. I would love to see some kind of consilience between idealism and Aristotelian metaphysics. But idealism, as a theory of physics to me is the only one that seems to me to be viable.

Bruce Gordon:

I'm inclined to agree with you. I mean, one of the things that we didn't talk about is the possibility of macroscopic superpositions as well. Having what would classically be impossible systems in superpositions of the position observable. Well, of course there are examples of this under special laboratory conditions. Large organic molecules have been put into superposition. But in the context of a superconductivity, you've got something called squids, and we're not talking about the cephalopods here. We're talking about superconducting quantum interference devices. In that context on a macroscopic level, occurrence have been put into superposition. So that you've got, for example, billions of electrons moving clockwise around a superconducting ring, superimposed on similarly billions of electrons moving anti-clockwise. So the two are put into super position that way.

Bruce Gordon:

So what's going on there, you can't have substantial objects in super position that way, if they're materially substantial. But they can be superimposed as a projection on our mental environment, without any difficulty. It's like a projection on the screen of our consciousness of two incompatible classical states, that cannot be substantial materially, but can be super-imposed mentally. We are standing as an observer outside that superposition observing it. We are not in superposition ourselves. Which I think in a way speaks towards something that can be said in response to the many-worlds interpretation. But nonetheless, that's just an added element of the peculiarity of the quantum world as it creeps up, or percolates up into our experiential reality. We can make it percolate up into our experiential reality under special laboratory conditions. Which is why we haven't noticed it in previous centuries. It's taken modern technology and the exploration of reality at its most fundamental level that modern technology has made possible, to reveal this aspect of the nature of the world, and of the nature of reality to us.

Michael Egnor:

Although I must say that Heisenberg, who is a philosophically rather sophisticated physicist, commented that "The phenomenon of quantum collapse was presaged in many ways by Aristotle's notion of the reduction of potency to act." That is that reality can exist in potential states, but actuality is a single state. Heisenberg was quite impressed with the notion that Aristotle had a deeper insight into these dynamics. That insight was sort of lost with the Newtonian physics. So maybe science is just rediscovering Aristotle.

Bruce Gordon:

Okay. I'm sympathetic to the idea of potentiality inhering in superposed states and then expressing itself through decoherence. Or if you like a wave function collapsed depending on how you're describing it, as actuality. So yes. But what's going on underneath the surface of the actuality if it's decoherence, it is essentially a destructive interference of potentiality.

Michael Egnor:

Right, right. One other thing I'll just quickly mention that absolutely fascinated me was that St. Thomas, kind of extending Aristotle's psychology, pointed out that in order to understand, or to perceive an object in the external environment, our intellect or our senses must grasp its form. That grasping of the form is the process of understanding. But St. Thomas pointed out that in order to grasp the form, it must be reduced from potency to act in order to grasp it. It must become actual, not merely a potential. Which to me sounds just like the observer effect in quantum mechanics - that is, to observe something our mind must make it actual to grasp its form.

Bruce Gordon:

Yes. One has to render it as a concrete particular for the purpose of grasping it and understanding it. I don't disagree and there is that kind of confluence of ideas that you're describing.

Michael Egnor:

Sure.

Bruce Gordon:

I'm sympathetic to looking at it that way.

Michael Egnor:

You can even ask how could an observer or a scientist understand the quantum system, if the quantum system were not reduced from potentiality to actuality? How can you understand something that's only potential if there is no actuality to it?

Bruce Gordon:

Right. It is the interaction if you like, of potentiality and actuality in that peculiarly quantum mechanical way that gave rise to the science.

Michael Egnor:

Sure, sure. So I want to thank Dr. Gordon for this absolutely fascinating discussion. We're actually, hopefully in our next podcast going to continue with this discussion more in the realm of neuroscience. But thank you, Dr. Gordon, it's been a privilege and fascinating. I hope we can talk more about this.

Bruce Gordon:

I am looking forward to it. Thank you, Mike.

Michael Egnor:

This is Mike Egnor from Mind Matters News, and please join us for our next podcast. Thank you.

Announcer:

This has been Mind Matters News. Explore more at mindmatters.ai. That's mindmatters.ai. Mind Matters News is directed and edited by Austin Egbert. The opinions expressed on this program are solely those of the speakers. Mind Matters News is produced and copyrighted by The Walter Bradley Center For Natural and Artificial Intelligence at Discovery Institute.