The Metaphysics of Quantum Mechanics

By James Daniel Sinclair

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Abstract: Is the science of Quantum Mechanics the greatest threat to Christianity? Some years ago the journal Christianity Today suggested precisely that. It is true that QM is a daunting subject. This barrier is largely responsible for the fear. But when the veil is torn away, the study of QM builds a remarkably robust Christian apologetic. When pragmatic & logically invalid interpretations are removed, there remain four possibilities for the nature of reality (based on the work of philosopher Henry Stapp). Additional analysis shows two are exclusive to theism. The third can be formulated with or without God. The last is consistent only with atheism. By considering additional criteria, options that deny God can be shown to be false.

Quantum mechanics is the science of the small, typically describing phenomena that occur at the atomic level. Throughout the history of science, it has been interested in describing the nature of different areas of reality by appeal to waves, or by appeal to particles. These descriptions are mutually exclusive. Things that are waves interfere with each other, such as when one throws two rocks in a pond simultaneously at different locations. One will see rings lapping away from the impacts that can be counted either as the troughs (low points in the water) or peaks. When the rings from the two rocks collide, an interference takes place. Two peaks colliding will result in doubling the peak size of the wave (given that the two rocks were identical). Two troughs colliding will have a similar addition (actually subtraction).

By contrast, particles have no such interference. Their behavior, as when one fires a machine gun at a target, is simply additive. Firing two machine guns at targets near each other will simply result in two big piles of lead. By contrast, consider a water wave front approaching a barrier with two holes in it, beyond which is a solid barrier. The front will break up into two ring fronts (similar to the example of chucking rocks in a pond) which will interfere at the barrier. One will get regions of high water, and regions of extreme low water against the sea wall. A similar phenomena is seen when light waves, rather than water waves, are used. Light shining from a common source against a barrier with two holes in it (if the holes are small compared to the wavelength of the light) will show bright bands and dark bands on a screen behind the barrier. In this way Thomas Young showed that light must be a wave phenomenon in 1802. Since waves and particles are mutually exclusive phenomena, this should have settled the debate as to the nature of light for all time. But it didn't.

Up until 1905, physicists were puzzled at a phenomenon called the photoelectric effect. It had been discovered that shining light upon a metal would produce an electric current. If light is actually a wave, then shining a light with a higher intensity *should* increase the magnitude of the current. Yet it became obvious that this wasn't true. In fact, for light of some frequencies, no current at all was seen regardless of the intensity. Yet for light of higher frequencies, a current could be observed even for extremely low intensity. Albert Einstein realized that if light of a certain frequency had to exist as discrete packets of energy (a particle view), it could explain the photoelectric effect. Suppose that electrons in the metal could not be torn loose unless impacting particles had a minimum energy. This would explain why light of low frequency would not cause a current regardless of the intensity. Einstein's view of light as a particle was spectacularly confirmed by the experiments of Robert Millikan, who won a Nobel Prize for his efforts. So here we have Young proving that light is a wave, and Millikan proving that light is a particle. Yet waves and particles are mutually exclusive.

Then the Danish physicist Niels Bohr took the idea to explain how an electron can orbit an atomic nucleus without crashing into it. The problem he solved was this: electrons have electric charge, which when accelerated by a force will radiate energy. An electron in an orbit feels the electromagnetic attraction from an atomic nucleus. Hence it must radiate energy, which will cause it to spiral into the nucleus. But suppose that electrons can radiate only by giving up energy in discrete chunks. The effect of this is that only certain orbits will be allowed, including a minimum range orbit which prevents the electron from crashing into the nucleus. Chemistry (& chemists) are saved!

Bohr realized that somehow matter must have characteristics of waves & particles. This did not resolve the paradox, however. By 1929, Bohr and his associates had developed the first interpretation of what Quantum Mechanics means to reality as a whole: the "Copenhagen" interpretation. As Thomas Young's two slit experiment had shown with light, nature will give you whatever answer you are looking for. If you are looking for wave characteristics in light, you will find them. If, however, you seek to show that light is made of particles called 'photons', and a photon must go through one hole or another in Young's barrier to ultimately illuminate the screen behind it, then you will measure light as a particle phenomenon. Bohr asserted that the characteristics of matter – when an observer is not looking at it – are indeterminate. Erica Carlson's example of the spinning quarter in the RTB video *Quantum Apologetics* is a good example of this. While the quarter is spinning, it has no property of being 'heads' or 'tails'. Slapping it down to the table will produce this property in the quarter, however. In Bohr's case, he claims that quantum objects do not have properties such as 'location' or 'momentum' while they are unobserved. In fact, he believed that the question of what matter is doing while not observed is meaningless. The answer to this question arrived at by New Age advocates is the source of *Christianity Today's* lament that quantum mechanics is the modern Goliath.

To answer whether quantum mechanics really is a modern Goliath, we must consider this issue: what are the real metaphysical consequences of the Copenhagen interpretation and other (mutually exclusive) interpretations of quantum mechanics?

The Copenhagen Interpretation

The first question is the indeterminacy of matter while in an unobserved state[1]. This indeterminacy seems to agree very well with a Hindu worldview. Hindus believe the world observed through our senses is an illusion, and the actual reality (the universe) is itself God. One can argue that indeterminacy proves that nature is an illusion after all. It also seems to show that there can be no reality outside the universe, hence God is the universe or there is no God. This follows from a proof of Von Neumann in the 1930s

which demonstrated that 'Hidden Variables' cannot exist. 'Hidden Variables' is the reductionist view that there exists an underlying physical explanation for quantum mechanics, but it is hidden from view. New Agers (and certain reputable physicists such as John Wheeler) take this one step further, by claiming that observations themselves, hence observers, create reality.

The Hindu and New Age view crumbles, however, due to three considerations. The first is John Stuart Bell's refutation of Von Neumann's proof. It turns out Von Neumann made a math error. Hidden Variable interpretations *are* allowed (see Bell's *Speakable and Unspeakable in Quantum Mechanics*). On a personal note, I was still being taught that Von Neumann's proof was valid in my quantum mechanics courses at Carnegie-Mellon University in the mid-80s, despite the fact that Bell's refutation was published in the 60s. This had a tremendous impact on my own views of Christianity until I independently discovered that the teaching was wrong.

The second is the Copenhagen Interpretation's fundamental measurement problem. Quantum indeterminacy is only resolved through observation (called 'collapsing the wave function'). Hence an outside measurement apparatus must always exist. But cosmologists started to run into a problem when they began to consider the whole universe as a quantum object. What or who, outside the universe, collapses its wave function? An infinite regress problem develops that can only be resolved by recourse to a necessary being!

The third is the fallacious nature of the claim that the observer 'creates' reality by collapsing a wave function. In fact, the only control the observer asserts is to increase the accuracy of measurement of a particle attribute at the expense of decreasing accuracy in a partner attribute. These pairs of variables appear in the famous Heisenberg uncertainty relation, and multiplied together have the units of 'action'. Thus pairs such as energy x time or position x momentum multiplied together have a minimum uncertainty equal to Planck's constant divided by 4p. Properly understood, this is a limitation on human knowledge compared to the previous classical view, as opposed to a promotion in human importance.

Proponents of observer created reality must take their argument one step further, however, since clearly human observers did not appear on the scene until recently. They must claim that a human observation in the *present* created the *past*. Wheeler uses the 'delayed-choice' experiment to seemingly demonstrate this ability. In his ultimate thought experiment, Wheeler proposes setting up a Young-like apparatus that uses the light from a gravitational lens as input. The idea behind a gravitational lens is that a distant galaxy emits light which is bent toward us by an intervening galaxy. This light arrives by very different paths ostensibly decided billions of years ago. Our apparatus can take light from these different paths and cause it to interfere, or not, after the fact. Hence it appears that we can, in the present, force photons in the past to pick a specific path to travel around the intervening galaxy. The subtle fallacy in Wheeler's argument is that it presumes that light is real particles following definite paths, hence we can reach into the past and force the photon to pick one real path over another. However, real particles following real paths are part of a hidden variables interpretation, in which the observer has no special role. But if the observer doesn't matter, then Wheeler's view falls apart.

One more crucial aspect to the Copenhagen Interpretation is that random events appear *intrinsically* random. When a radioactive atom decides to decay *right now*, there is no apparent reason why it made that choice. All other interpretations of quantum mechanics are *purely deterministic*. Think about how important this is. If Stephen Gould is right, for example, in that human evolution (really happened and) is an extremely improbable outcome based on numerous contingent events, then he is entitled to that view only if Copenhagen is true. But if Copenhagen is right, then a necessary being must exist! I am positive he is unaware of this. I am also positive that it would be very difficult to explain it to him, as it would have to result in a worldview shift worthy of dropping one's transmission! The same problem applies to any atheist cosmologist trying to build a model of an uncaused universe by appeal to quantum fluctuation. This is an apologetic that very few, if any, Christians have caught on to.

But is it inconsistent with Christianity, given its high regard for God's sovereignty? Surprisingly the answer is no. There is a specific example within my own work that demonstrates this. I do air-to-air combat analysis for the United States Navy. In my work we use a sophisticated simulation called BRAWLER. In a model run of, for example, an 8 versus 8 combat, numerous probabilistic events occur: radar detections, kills resulting from missile impacts, etc. A theoretical observer within the simulation would have no way of determining that these events were anything but intrinsically random. Yet each model run is deterministically reproducible. Each model run uses a string of probabilities generated by an algorithm which is unique, based on an initial random number seed. If I know the seed, I know, deterministically, the string of random numbers that will be produced, hence I know the outcome of any simulation run. If I don't know the seed, there is no way, *even in principle*, for an observer examining the number sequence to prove that it is not intrinsically random. Essentially, the Copenhagen Interpretation represents a *compressed information* method of running the universe. A ‘random’ number represents the outcome of a missing cause-effect chain.

You see where I’m going with this? Perhaps I’m guilty of the same mistake that Isaac Newton made, seeing reality as clockwork precision, with God as clock-maker. I’m seeing reality as a grand simulation of apparently random events, but God knows the outcome because he made the generator and knows the random number seed. But it looks to me that a very good case could be made that God must exist, upholds reality (the doctrine of creatio continuans) through observation, and imposes complete sovereignty without appeal to a vitalistic force, if Copenhagen is true.

The Hidden Variables Interpretation

The Hidden Variables interpretation has had many weighty champions throughout its history, among them Louis DeBroglie, David Bohm, and John Stuart Bell. Hidden variables is a reductionist view that there *really is* a mechanism behind quantum mechanics which produces the madness. It is hidden, however, by the nasty influence of the Heisenberg principle. HV takes the equations of quantum mechanics and imposes a realist interpretation upon them. Matter is real particles following real trajectories at all times, acting in normal cause and effect relationships with forces. The difference between it and the classical view is the idea of the pilot wave. The reader may be aware from quantum theory of Schrodinger’s equation, which describes the probability of a particle (or system of particles) being in each possible state that it could be in. In Penrose’s example, the equation would be simple in that it would include just two probabilities: one giving the chance of finding the electron spinning ‘up’, and the other giving the probability of the electron spinning ‘down’. To HV advocates, this equation is not just an abstract mathematical trick that gives us the right answer on the blackboard. They believe the equation, now called the pilot wave, is a real part of nature. The answer to the paradox of Young’s two slit experiment is that part of the pilot wave traverses each hole in the barrier. The particle really can take both paths at the same time.

Why the particles do what they do, as opposed to being influenced by an observer, differs depending on the modeler. Bohm believed, for example, that particles in our reality (what he called the explicate order) are a lot like Plato’s example of shadows on the wall by a flickering campfire. Shadows can do some amazing things, even travel faster than light, but they are merely reflections of a ‘real’ three dimensional reality (the implicate order). Before a Christian panics, however, he might want to read Bohm’s punch line (the Super-Implicate order) at http://www.satyana.org/html/bohm4.html#Superimplicate. Bohm explains the relationship of our explicate order, several intervening implicate orders, and an ultimate Super-Implicate order by appeal to a video game. The characters in the video game live in the explicate order. The computer program that describes the actions and world of the characters is the implicate order. The game player, with joystick in hand, manipulates the computer-generated world as the Super-Implicate order. How would you assess the identity of the Cosmic game player? What is surprising is that Bohm was a dedicated Hindu, yet he could espouse this view without seeing the implication of the Super-Impli-cate.

Another view is that of John Cramer, of the University of Washington. You can read about him in http://mist.npl.washington.edu/npl/int_rep/tiqm/, or Gribbin's *Schrodinger's Kittens*. Cramer's 'transactional interpretation' takes advantage of a result from electromagnetic field theory. It predicts that, in addition to 'retarded waves' that travel from the present to the future, the models generate a solution called an 'advanced wave' that seems to imply electromagnetic waves can travel from the future to the present! Sometimes in physics, when a model makes multiple predictions based on a square root function, they can all be true. Dirac found this out when he took Schrodinger's equation and applied Einstein's special relativity to it. In addition to the usual electron, the equations predicted that an antiparticle, the 'positron' must exist! Sure enough, antimatter exists.[2] Sometimes, however, these extra predictions are just mathematical garbage. For example, when I calculate when a cannon shell will hit the ground, I generally get two solutions: one with a positive time, and one with a negative time. Obviously the negative time solution is meaningless. So the mere existence of the advanced wave in equations tells us nothing about its reality.

In Cramer's world, every transaction that takes place involves a 'handshake' between the past and future. The metaphysical implications are that these handshakes would instantly create a perfectly deterministic universe. Of course this is a feature of all HV models. In a Cramer world, an outside observer not confined to our timeline could see the end from the beginning. A possible drawback to the Cramer model is that it requires a closed universe geometry. It's beginning to look like the universe is flat instead.

For another model, see John Bell's *Speakable and Unspeakable in Quantum Mechanics*. Bell seems very comfortable with a 'One-World' model that has a holistic character. In other words, the reason a radioactive atom chooses to decay at this particular moment comes from its interaction with every other particle in the universe. To us, who don't have access to this universal wave function, the decay seems random. In fact its behavior is not arbitrary. Its unpredictability is solely due to our lack of knowledge.

For any HV model to work it must be *non-local* in character. This has been experimentally verified. In some sense, the universe behaves as a holistic reality despite the limitations imposed by Einstein's speed-of-light limit to information transfer. The proof was done by applying a mathematical construct called Bell's inequality to the results of an experiment named after Einstein and two other physicists, Podolsky & Rosen. These physicists wrote the EPR paper in 1935 as a challenge to the validity of quantum mechanics. In effect it pitted the 'immovable object' of special relativity against the 'irresistible force' of quantum mechanics. Both theories enjoyed overwhelming experimental support. Yet they seemed to disagree on a specific point. Suppose that a motionless particle with no angular momentum (not spinning) decays into two particles which it flings to the left and right. If one is spinning 'up', the other must be spinning 'down' so the total angular momentum remains zero. So if, after letting the particles separate by a great distance, we measure particle 'A' to be spinning 'up', we know that particle ‘B’ must be spin ‘down’. So what. This is trivial, right? The problem is that angular momentum is one of those quantities that can appear in Heisenberg’s uncertainty relation. So here is the problem that can develop. Suppose I set up my apparatus so that instead of measuring ‘up-ness and down-ness’, I measure ‘left-ness and right-ness’. One might think that the particle could still be spinning ‘up’, hence I would measure zero ‘left-ness or right-ness’. But that is not what happens. The Heisenberg principle has the effect of obliterating whatever knowledge I might have of an ‘up or down’ spin if I choose to measure ‘right-ness or left-ness’. When I try to measure ‘left-ness or right-ness’, I am always going to find the particle spinning *fully* left or *fully* right. So here’s where life gets interesting. If experimenter Bob measures the ‘left-ness or right-ness’ of particle ‘A’, and experimenter Sue measures the ‘up-ness or down-ness’ of particle ‘B’, then it appears I can obtain knowledge of the angular momentum of the system in two different spin axis. This is a violation of the Heisenberg principle. Hence, if true, quantum mechanics must be false (on this point). This experiment was actually done by the French physicist Alain Aspect in 1982. It was done in such a way that Bob and Sue measured the effect on their relative particles within a time interval where no communication signal could be sent from one to the other unless it exceeded the speed of light. The result was that *somehow* the two particles were able to conspire in an apparent superluminal fashion without sending explicit communication signals between them. If Sue, measuring first, chose to measure ‘up-ness’, and Bob measuring second also chose to measure ‘up-ness’, 100% of the time when one measured the particle to be up, the other was down. It was the same if both chose to measure ‘rightness or leftness’. If Sue, again measuring first, chose to measure ‘up-ness’, and Bob chose to measure ‘left-ness and right-ness’, then half the time Bob would get a left spin and half the time a right spin, with no relation to whether Sue saw an up spin or a down spin. In other words, there was zero correlation between Bob and Sue’s results in the second case. The experiment can be repeated with Bob and Sue randomly putting their measuring apparatus in any orientation. Bell’s contribution was to calculate what the correlation results would look like in the case where zero communication was allowed (Einstein’s restriction of *locality*). Aspect’s experiment showed that the zero communication assumption was false. The interesting fact is that it is still impossible to use this effect to send a superluminal message between Bob and Sue. Although Sue’s actions can predetermine what Bob sees, it turns out he has no way to determine the difference between his result and pure randomness, unless Sue can send a message telling him what orientation her machine was in. This can only be done through conventional means! So Einstein’s light-speed limit holds after all! Does this have a metaphysical implication? Perhaps. Someone with full knowledge of the total wavefunction of the universe could non-locally impact any part of the universe meaningfully without detection. Does this sound like anyone you know?

Regardless of the details of the HV model, the key metaphysical impact is that St. Augustine’s classical philosophical argument that ‘the effect of the universe’s existence requires a suitable cause’ is unambiguously applicable here. If HV is true, uncaused beginnings are not. Like David Bohm’s Super-Implicate Order, this leads you straight to a necessary being. The alternative is the logical contradictions exposed by the Kalam argument (the fact that the present exists is proof that the time cannot reach eternally into the past – see William Lane Craig *Reasonable Faith* or J.P. Moreland's *Scaling the Secular City*.)

The Many Worlds Interpretation

It would seem that if chance is real (Copenhagen), God must exist as the Cosmic Observer. If determinism is real, God exists as the Hidden Variable that stops the infinite regress of causes. Doesn't chance plus determinism cover the full array of possibilities? Have we proved God exists? Not exactly. If reality disappoints, you can deconstruct it. And that is precisely what some have done in construction of the many-worlds & superdeterminism models of reality.

As is explained well in Zukav's *The Dancing Wu-Li Masters* (the Chinese designation for physicists), one can question a key assumption of rationality called contrafactual definiteness. When one questions 'definiteness' one constructs many worlds. Definiteness is a simple idea. It is as follows: if I choose option 'A', then option 'B' does not happen. But what if there is not a definite outcome to choice? What if 'A' and 'B' both still happen, but in different universes (the person in universe 'B' would have picked 'B'). In effect, choice has no consequences. Again we are back to determinism. Perhaps you can see why this might be attractive to the atheist. This idea has the potential of removing the observer from a position of importance. It does not, however, solve the problem of why this multiverse exists in the first place. In fact, those such as Hawking that try to eliminate the need for a beginning to the universe and account for fine-tuning (the Anthropic principles) by proposing a multiverse model still try to appeal to the intrinsic randomness of an uncaused beginning (quantum fluctuation) to get the whole thing started. Yet intrinsic randomness applies only to Copenhagen, and Copenhagen and Many-Worlds are mutually exclusive. Hence Hawking is in the midst of a logical contradiction.

There are three competing schools within MW. The idea started out in 1957 with the thesis of Hugh Everett. His idea was that reality started out as one universe, which branched out as necessary every time a quantum event, such as a radioactive decay, occurred. By this appeal, the measurement problem of the Copenhagen Interpretation is done away with. Collapse of the wave function never really happens.

The second school, started by Bryce Dewitt in the 60's, argues that all of the many worlds always exist. This school is more metaphysically challenging to theism because it claims to account for fine-tuning as well as eliminating the need for a beginning. They don't do this by denying that a beginning exists. They claim that *time itself* does not really exist (the ultimate deconstruction). If time doesn't really exist, perhaps the idea of a beginning is incoherent. Reality is a lot like the collection of still shots that make up a movie. Each still photo, in the DeWitt view, eternally exists. Time appears (as an illusion) when the stills are collected together in a linear sequence. The 'glue' that holds the sequence together and determines the order is the laws of physics (see David Deutsch *The Fabric of Reality*). What the model has going for it is a calculation done by DeWitt in the 60s that seems to show that quantum mechanics & gravity are reconciled in a particular mathematical framework in which time itself drops out of the equations. Another advocate, Julian Barbour, explains in *The End of Time* that Paul Dirac discovered in the 50's that general relativity has no natural time dimension, yet quantum mechanics requires a near-Newtonian version of outside time. Attempts to put these together produce a natural paradox, when one attempts to keep time as a real phenomenon. It is a lot like the equation 2T = T (this is not the DeWitt equation), which is only solvable if T = 0. Barbour suggests that reality is only logically consistent if reality is static. Perhaps the DeWitt equation is an illusion, however. Suppose the Dewitt equation has a similar quality to 2T=T. One can apparently prove that 2=1 in the above equation by dividing out the T (not allowed since one cannot divide by zero). Perhaps this is what DeWitt is doing to remove time. In a similar sense, the majority of physicists deeply suspect the Dewitt solution, believing there to be a deeply hidden error. This is not impossible in science. An error of precisely this sort (dividing by zero) is exactly how Alexander Friedman disproved Einstein's model of the static universe. Most feel that more is needed to falsify a phenomenon of nature so apparently obvious as time.

The third school is Hawking's. Hawking makes a realist interpretation of a mathematical method for calculating quantum outcomes developed by Richard Feynman. Interested readers can find Feynman's own description of his path integral approach in *The Strange Theory of Light and Matter*. In Feynman's approach, a photon on its way to illuminate a barrier in a Young apparatus simultaneously really does traverse every possible path on its way there. These paths, however, interfere in the same way that waves do. Blocking some paths (like putting up barriers) changes the way these paths interfere. The probability of finding the photon in a particular location changes accordingly.

In Hawking's model, every possible universe that can exist is one of these Feynman paths. Hawking's description of time is also important to understanding his model. Hawking does away with the need for a temporal beginning by proposing that reality is in a closed time loop. For times beyond the Planck time, the universe expands out of a Big Bang till gravity halts the expansion, then contracts into a Big Crunch. For times near the Planck time, time begins to act as a true spatial dimension. To make this happen, Hawking must make a realist interpretation of another useful mathematical device: imaginary numbers. If time has both a real and an imaginary component, then time can act as a spatial dimension near the Planck time while behaving normally beyond it. What Hawking's model has going for it is the success of Feynman's method in the field of quantum electrodynamics.

With a series of imaginative solutions, atheists have constructed (or de-constructed) answers to the problem of the observer, the problem of fine-tuning, and the problem of the beginning. When considering the level to which this is a 'Modern Goliath', one must start with the fact that MW is still just a *consistent* explanation (with atheism) of the world rather than an *exclusive* one. Some of the above MW models are consistent with theism as well. In fact it commends itself quite well as a solution to certain paradoxes in theism in much the same way that extra dimensionality does. On a personal note, it was precisely this characteristic of MW that helped bring me back to theism (at the time I favored MW as the best interpretation), although I now am more inclined toward Copenhagen or HV.

For example, one might make a literal interpretation of Jesus's statement that we could move mountains with prayer if we just had the faith, or the statement that all we need do is knock, and the door will be opened to us. Might God have constructed the universe that it will respond appropriately if we but ask, kicking us into the right branch of the quantum tree? Hence God answers prayer without invoking a vitalistic force. I'm not advocating this. I'm merely pointing out the congeniality of an Everett interpretation with a feature of Christianity.

Another example is the sovereignty versus free-will problem. There is a minority of Christians that call themselves 'Christmas Calvinists': no-L. This is a reference to the five points of Calvinism (acronym TULIP), where the 'L' stands for limited atonement. Limited atonement is unpopular[3] because it implies that God plays favorites. Some he has (arbitrarily it seems) favored to be saved, others condemned from the beginning. Recall the verse that says 'Jacob I loved, Esau I hated' before either was even born.

But suppose there are many worlds. Suppose a person who is not among the elect from this world, has copies of himself living in these other universes. Perhaps, there, he might be saved. What if the ratio of copies of oneself that ends up saved is the same for all persons? This would certainly answer the question of fairness. Then a person saved in this universe has a choice: what is more objectionable: me being granted grace while others are (apparently) condemned arbitrarily by God, or other copies of yourself in other universes condemned to eternal damnation? One could imagine that free will and God's sovereignty are reconciled in general through a MW approach. Imagine reality as a cavern with many passages. God knows 'the end from the beginning' for every path. Yet imagine that humans still have free will to choose which path through the maze they will follow. Again, I am not advocating this view. I am merely showing how paradoxes are resolved in a MW view.

Problems with Everett's Interpretation

Everett's model does not solve the problem of the beginning or the problem of fine-tuning. This is why it is out of favor with contemporary atheist cosmologists. If it turned out to be true, therefore, it should be regarded as much more congenial with theism, rather than atheism, although not necessarily a separate proof.

Problems with DeWitt's Interpretation

DeWitt's model has no natural way of explaining the illusion of cause & effect as well as why nature has an apparent beginning, or for that matter, consciousness (plus memories) itself. Most laws of physics (such as the 2^{nd} law of thermodynamics) are ad-hoc in their model. In one sense, if time doesn't exist, then why does it so overwhelmingly appear that it does? This is not qualitatively different from the Appearance of Age argument. In a DeWitt universe, the past is an illusion. DeWitt's problem is worse. Why should I have memories at all if the past is an illusion? If they don't postulate infinite world-sheets, then there is no particular reason why a past instant that appears to be cause-and-effect linked to your instant need exist. If they do postulate infinite world sheets, then there is no reason that that world sheet need be connected in any way with your instant. If atheists feel the need to beat up on young earth advocates for this, then they should be consistent in their treatment of MW. I'll give them the benefit of the doubt. They are inconsistent because they don't know the facts about MW. (As a day-age advocate, I have the luxury of disagreeing with them both).

For that matter, there is no such thing as consequences of current decisions (or decisions themselves or consciousness itself). At one point Barbour repeats a joke attributed to J.S. Bell as to whether MW advocates (or solipsists) feel the need to have children or buy insurance. Barbour says that yes, he has insurance and children, and this is just an example of an ad-hominem attack. He never actually explains why he has children and insurance, however. (To be fair, this section of his book demonstrated that Bell had toyed with MW ideas at one point.) If Barbour's view is correct, it should be overwhelmingly likely that the universe should end in the next instant, since chaos is so much more likely than order and cause & effect is not real. In technical terms, there is either no world sheet that appears to be a follow-on in time from mine, or even if there is, there is no particular reason why it should in any way be connected with mine. Of course, Deutsch would say that the mere similarity is somehow sufficient to connect them. This effect is ad-hoc to their model.

Barbour's answer seems to be that time is just one of those illusions that appears here and there as a tiny subset of a much larger uninteresting chaos. Our existence, our illusion of rational existence is only permitted if there is an apparently orderly timeline, so we see time (a restatement of the Weak Anthropic Principle). This is an example of Boltzman's Blunder. Recall that Boltzman (the father of the 2^{nd} law of thermodynamics) attempted to explain the existence of our universe's low entropy state as a rare fluctuation that happens from time to time. As others soon pointed out, a fluctuation that would produce a single human as an observer, or a single solar system, is *far* more likely than the fluctuation of an entire life-giving universe. Why should I as an observer in a Barbour world-sheet expect to see the rest of my world-sheet appear rational (given that a fluctuation of order that just includes me is so much more likely)? Why should a set of these world-sheets happen to appear together in a meaningful sequence?

Whatever the merits of the above debate, it would seem that the rug has been pulled out from under the DeWitt model. Strominger, in 1996, reconciled quantum mechanics and general relativity without making time a victim. From an Occam's razor point of view, Strominger's view would seem to be the better one. It was done within the rubric of superstring theory, which seems the most promising line of unifying the laws of physics.

I am reminded of a joke that Ken Samples tells about an editor of a religious magazine that continually gets letters from a solipsist insisting that his metaphysics is true, at the expense of Christianity. Finally the editor responds, saying that the solipsist has convinced him that solipsism is true. So therefore the editor no longer believes in the existence of the solipsist, hence he would no longer correspond with him. If MW advocates of the DeWitt stripe keep insisting that their metaphysics is true, and therefore they as thinking, conscious beings do not really exist, perhaps we should take them up on it.

Problems with Hawking's Interpretation

In Hawking's model, time is real; it merely goes in a circle. It also assumes characteristics of space near the Big Bang, hence there is not 'truly' a beginning. Hence its problems are different from the DeWitt interpretation.

Hawking's first failure is the entropy problem. His goal was to remove the beginning as a creation event, as well as do away with the need for 'initial conditions' that such a beginning would entail. The problem of initial conditions is related to the fine-tuning of the universe. This is one reason why, to an atheist, they have to go. Initial conditions are also, by their very nature 'arbitrary', hence beyond explanation by a theory of everything, hence objectionable to Hawking. Nonetheless, it turns out that even if there was no initial point of time, the problem of initial conditions doesn't go away. This has been shown by Penrose (*The Emperor's New Mind*) and Guth (paper: *The Impossibility of a Bouncing Universe*). Penrose has shown that the maximum entropy of the observable universe is 10^{123}. The number of ways of fitting together (like legos) all the pieces of the observable universe is the exponential of this: EXP(10^{123}). This number is so big it's hard to come up with examples that would permit one to fathom it. Only the tiniest fraction of these states are ones that would permit life. Penrose also shows that the entropy at the start of our universe appears zero (his WEYL=0 condition). Now, Hawking's model is cyclical in time, hence the Big Bang must eventually become a Big Crunch. That means that the condition of the singularity at the Big Bang must be identical to the Big Crunch. This means one of two things, both unpalatable to a Hawking view: either the entropy at the singularity is zero, in which case Hawking must find an entropy reversing process in nature, or the entropy at the singularity is some big number, in which case Hawking must explain how an unintelligent process somehow hit the bulls-eye in producing a life-giving universe (the initial conditions problem). Either solution commits Boltzman's Blunder. The second answer turns out to be impossible, as shown by Guth. One must find an entropy reversing process, or give up the game. But cosmologists seem to agree this is impossible.

Or Hawking must admit he has a theory with a quantum singularity (an infinite collection of 4-spaces each with zero volume). This would permit his outgoing and incoming world lines to meet at the singularity without being continuous in entropy. In this case, Hawking has admitted the existence of a boundary to his universe which is uncaused and has created things with lower ontology (God by any other name . .)

Hawking's second problem is the problem of needing contingency. As I have stated (and has been testified to by MW advocates such as David Deutsch): MW is purely deterministic. Yet Hawking requires quantum contingency at two points in his model: a quantum fluctuation beginning out of a Feynman singularity, as well as fluctuations that convert time into space as one moves backwards toward the Bang. He is not entitled to intrinsic chance. MW and Copenhagen are mutually exclusive interpretations.

Hawking's third problem is the need for a closed universe geometry. As our latest measurements of the cosmic background radiation show, the universe appears to be flat.

If a closed universe were true, Hawking would have another problem (4^{th}) with his quantum fluctuation beginning. For a fluctuation to work, it must survive for indefinite time. For this to be true, the universe must have zero total energy. But if the universe has zero energy, the equations of general relativity predict a flat universe. So either:

Fluctuation is true = zero energy = flat universe = no boundary proposal is false.

Closed universe is true = some energy = no fluctuation = no boundary proposal is false

Hawking's fifth problem also relates to the fluctuation. The probability of a fluctuation drops to zero as the time interval allowed drops to zero. But time doesn't exist yet, hence how could there be a fluctuation?

Hawking's sixth problem, as pointed out well by William Lane Craig in his essay "*What Place, Then, for a Creator?": Hawking on God and Creation*, is his realist interpretations of the Feynman process and imaginary time. As Craig points out, Hawking does this arbitrarily. If time really has an imaginary component, doesn't Hawking have to prove it (similar to the onus place on DeWitt to show that time doesn't exist at all)?

<u>Hawkings seventh problem</u>: Feynman's sum over histories approach to quantum mechanics seems to me to be much more amenable to a hidden-variables interpretation as opposed to many-worlds. It is clear from Feynman's exposition that particles traverse the 'many worlds' in a virtual state; the waves interfering and producing a higher or lower probability at each position which is realized once a measurement is made *by an outside observer*. One does not live within one of the virtual paths! For example, in *The Strange Theory of Light & Matter*, Feynman explains his theory in reference to a diffraction grating (a generalization of the famous two slit problem). *The whole point of the two-slit problem is to demonstrate that the observer cannot observe what is going on with the photons without destroying their behavior*. It is clear that there are two distinct 'worlds' being referenced: the outer world in which the observer and his measuring device live, and the inner virtual world in which the light appears to travel multiple paths. Which one do we live in? If one attempts to interfere with the virtual particles, one collapses the quantum behavior and gets a classical scattering. Later on, Feynman describes his calculation of the magnetic moment of the electron using *virtual particle* diagrams. That's what his theory is for!

In Hawking's universe, a single worldline out of a quantum singularity is one of the Feynman virtual paths. Except he places us *within* the virtual worldline (otherwise privileged observers are collapsing wave functions). Feynman never does this. I don't believe this is even coherent (in a Feynman approach). Feynman's approach is a *hidden-variables* interpretation similar to Debroglie-Bohm. Hidden means hidden from us.

Hawking then speaks of 'quantum fluctuations' inside a virtual path. Virtual paths were (among other things) invented to explain fluctuations. What is the meaning of a fluctuation *within* a virtual path? There is no meaning. I believe Hawking is mixing his quantum interpretations (remember that if he is trying to reference some type of *intrinsic* chance, he is making an appeal to Copenhagen – many worlds is completely deterministic).

The Feynman path integral process, seems to me, to tie in better with a HV interpretation, rather than MW. In Feynman's examples of use of his process, the many paths resolve themselves into a single outcome at a measurement. One does not 'live' within one of the many paths.

Problems with all MW Interpretations

1) An outstanding problem with all models is the problem of existence. Why does something exist rather than nothing? This problem persists even if time, or a beginning, is done away with.

2) Perhaps the biggest problem that MW models suffer from is the rationality problem, expressed well by John Leslie in the book *Universes*. If all possible things routinely happen within the multiverse, then why do we live in a rational universe? Things of low probability, like the origin of life, can only be explained by appeal to MW. But this probability is less than that of the appearance of a perpetual motion machine (within a visible horizon of a universe). Once events that fall below the perpetual motion machine threshold are required, information itself disappears as a concept (this is Hubert Yockey's insight). As Leslie points out, suppose that every rock that a geologist split open had the message 'Made by Yahweh'. Being a good atheist, events like this don't bother him since he believes in low probability events like the origin of life anyway. If we attempt to reason this way, we get irrationality instead. Leslie goes on to explain that if we consider the sum total of all the different irrational events that must be allowed (like the appearance of pink bunny rabbits with bow ties, or Wickramasinghe & Hoyle's example of the 747 formed by a tornado in a junkyard), irrational happenings *must be the norm* within a multiverse. *So the existence of a rational universe is proof that MW is false.*

3) The atheist Anthony Flew is fond of saying that 'from necessary things, only necessary things come'. As some, to paraphrase Cosmologist Timothy Ferris, have said: 'This has been enough to impale Christian philosophers down through the ages.' Paul Davies mentions this in *The Mind of God*, as well as Tipler & Barrow in *The Anthropic Cosmological Principle*. This is apparently the crutch that holds up many an atheist view against contrary evidence. But consider the following. The atheists require MW to counter the problem of the observer, the problem of the beginning, and the problem of the fine-tuning. So they are stuck with MW. But if MW produces an infinite number of universes, this produces a *necessary*, rather than *contingent*, reality. If Anthony Flew is

right, then it *was* arguably something necessary that came from a necessary being. I am not sure that Flew's statement can be reversed to say 'if I find reality to be necessary, it implies a necessary creator.' But if it can, then atheists have a problem. Either they stick with MW, which produces a necessary being. Or they abandon MW, which pitches them back into the problem that chance (Copenhagen) & determinism (Hidden Variables) both require a necessary being. (In the second case, Flew's statement must ultimately be false.)

4) It is not clear that that even an infinite number of universes would produce our life-giving universe. If infinite matter ultimately exists, coming out of a quantum singularity, Penrose's entropy calculation goes to 1 in infinity. So even infinite universe generation doesn't reliably produce our universe (whose probability of existing is 1 divided by infinity). On a side note, even in the absence of a quantum-type of MW, the apparent flatness of our universe would produce a spatial extent equal to infinity. This reduces the probability of our particular universe configuration to 1 divided by infinity regardless of the quantum interpretation.

5) Lastly, the biggest problem MW suffers from is the falsifiability problem. MW acts for atheists exactly like God-of-the-Gaps works for theists. MW explains all the gaps. Leslie gives a good example of where this can trouble you in *Universes*. He mentions a scientist named George Stiegman who used a SAP (strong anthropic principle = MW + weak anthropic principle) explanation of why there is an abundance of matter over antimatter in the universe. We now know of two real physical processes that can account for it. The same thing applies to Hawking's original use of SAP to explain the nearness of the universe's expansion rate to the critical density. We have since found a physical explanation (inflation). What about all the other places where atheists currently invoke SAP? Is SAP true, in which case why prefer physical explanations to it, or is it false, in which case why ever apply it?

Superdeterminism

It is precisely MW's unfalsifiability that bothers some leading physicists such as Allen Guth (the inflationary universe theory), George Smoot (led the COBE effort: experimental verification of the inflationary universe) and Brian Greene (superstring theorist). Guth & Smoot have spoken up about the vagueness of the Strong Anthropic Principle (many-worlds stated as a solution to fine-tuning), as it appears to be the atheist equivalent of the God-of-the-Gaps. Whenever one can't explain something, MW 'explains' it. How can one prove that MW might be false?

Still, fine-tuning, the beginning and quantum events have to be accounted for. As many have noted, among them the philosopher Harry Stapp, and John Stuart Bell, one can account for the outcome of quantum experiments by questioning the 'contrafactual' nature of reality. This is a very simple idea. It is that choice does not exist (as opposed to MW, where choice exists but has no definite consequences). This is a very aggressive type of determinism. Here choice is not just denied to us in our universe. Choice is logically false. That means that God cannot exist.

Here is why:

Premise 1) If God exists[4], he is sovereign

Premise 2) Sovereignty is exercised by choice

Premise 3) Choice is logically false

Conclusion 1) Sovereignty is false

Conclusion 2) God is false

Superdeterminism can be stated as follows: "Reality is the way it is because it is impossible for it to be otherwise." Stated in this way, one might be able to find experimental proof for it, and disprove fine-tuning in one-felled swoop. The way to do this is to succeed at creating the Theory of Everything. Brian Greene, in *The Elegant Universe*, seems to state that superstring theory might ultimately explain many if not all features of physics which now appear arbitrary and fine-tuned. This still falls short of superdeterminism. To reach that state, one must show that the TOE is logically necessary. This means that **all laws, physical constants, properties of particles are really just reflections of abstract mathematical geometry: like p**. Even then, you must show that the TOE logically compels reality to exist. Or you must show that reality doesn't really exist. Even then, one encounters the information: matter distinction.

Of all interpretations, superdeterminism has attracted the least adherents. But I predict that ultimately, more and more atheists will become dissatisfied with MW due to its many problems, and will end up here as a last resort.

Problems with superdeterminism

Anything that points to an 'arbitrary' nature to reality is an enemy of superdeterminism: a particular set of footprints in the snow, for example. Fully obeying the laws of physics, *this particular* set of footprints does not seem to possess the same level of necessity as the value of p. If Linde's eternal inflation were true, its 'random' jumbling of the physical constants at each inflation makes a superdeterminism explanation difficult. Virtual particle creation from the vacuum is hard to explain in a SD view (it is hard in an MW view as well). Why is the only reality possible one that permits life? One can't speculate on a 'beauty principle' so as to skate past Occam's razor. Life doesn't operate if so confined.

Being deconstructionist, it must counter the apparent reality of human free will. The burden of proof is on the superdeterminist to show why it is *logically necessary* that I eat at the Taco Bell today, rather than bag a lunch.

Why can we envision possible other values for physical constants (and other laws)? If superdeterminism were true, wouldn't it be easier to envision the logical formulation that would deny those other options? Does one then argue that it is logically necessary that it be difficult to envision them, and that it is logically necessary that it be difficult to imagine it being difficult to envision problems . . . and so on . . .

The origin of information cannot have a lawlike solution. Laws produce regular, ordered behavior. They are also information poor. Information is specified and complex. Any algorithm that could produce specified, complex information would have as much information as what it was trying to create (self-organization is false). Hence, even a logically necessary TOE which had the power of compelling reality to exist *still* wouldn't explain the information content of our universe.

The mathematician Kurt Godel, in his incompleteness theorem, proved that no self-contained system of logic (such as a theory of everything) is ultimately possible. There are truths that supercede brute logic.

Pragmatic models: Consistent Histories

No discussion of interpretations of quantum mechanics would be complete without discussion of the new Consistent Histories interpretation. CH is set aside because it is, self-admittedly, not a 'complete' theory of quantum mechanics. It is called, affectionately, by some as a 'FAPP' theory (for-all-practical-purposes). In other words, it works well in explaining laboratory phenomena but cannot be used to describe a universal wave function. Its very construction requires treating subsets of reality. (For a good explanation of this, see Penrose's *Shadows of the Mind*).

CH claims to be a fix to the Copenhagen Interpretation, to solve the problem of Schrodinger's cat (I almost completed an entire discussion of QM without mentioning the cat!) See Omnes *Understanding Quantum Mechanics* for a book-length description of CH. This would imply that it is a second interpretation which permits intrinsic chance. However, having read the means by which wave functions are collapsed – one part of reality acts to keep a second subset honest – one can see that this acts exactly like a Hidden Variables theory. Uncertainty in CH comes essentially from lack of human knowledge (like the insurance actuary setting rates) rather than intrinsically.

In any case, even if CH were an intrinsic chance interpretation, its inherent inability to describe a universal wave function leaves the metaphysical consequences of the Copenhagen Interpretation intact. If chance is true, then a Cosmic Observer is true. Of course, if CH is a HV treatment such as I believe, then it also requires the necessary being.

The upshot of this is that CH doesn't impact the metaphysical discussion of quantum mechanics.

Summary

In short, Copenhagen & Hidden Variables seem plausible and both *require* a necessary being. Many Worlds is at least *consistent* with theism, but seems highly problematic as a viable description of reality. Whatever the case, if Flew's statement about necessary beings turns out to be reversible (& true), then MW itself would require a necessary being. Superdeterminism would explicitly require atheism, but it doesn't seem possible that it could be true. Other interpretations (Consistent Histories) of quantum mechanics are purely pragmatic and hence have no metaphysical consequences. They don't supplant 'the big four', either (Copenhagen, HV, MW, SD).

Far from being a 'modern Goliath' that challenges Christianity, quantum mechanics seems to provide as good a proof of God's existence as there is. The subject is so complicated, however, and easy to obfuscate, that few if any theists or atheists know the truth about quantum mechanics. This provides great opportunity as an apologetics tool, given that the anti-intellectual bent in the Christian community over the last 100 years usually puts theists in a defensive position on apologetics issues (atheists often find these problems with their position 20-30 years before Christians catch up). If we took the offensive on this issue, for once we would be ahead of the game in our dialogue with atheists.

Notes

[1] Actually one should speak in a more accurate sense of a quantum superposition between multiple possible end states. Roger Penrose likes to use the simple example of a spinning electron. One can ask it the question: are you spinning up or down? The electron can only respond with one of two answers: 'yes' or 'no'. Before the question is asked, the electron is in superposition between these two states.

[2] Unfortunately Dirac fumbled the interpretation and failed to predict the positron's existence. He thought the equation described the proton. Remember Einstein & the cosmological constant? This was his 'greatest blunder'. Lesson: It takes unusual guts to defend a truly novel prediction. He is still one of the greatest physicists!

[3] It is actually a logical contradiction for a believer to question God on a question of morality. After all, to question God, one is using the moral awareness granted to oneself by God. Presumably this is the same as God's own moral code. If so, then when one questions God's morality on some question, he is also calling into question his own moral awareness. This automatically invalidates the questioner's argument.

[4] Theologian R.C. Sproul would have a heart attack if he saw the word 'exist' in the same statement with 'God'. In formal language, 'exist' is a word that applies only to created entities. The correct word to use for God's being, as opposed to non-being, is 'subsists'. But 'exist' has a popular meaning different from its formal one and 'subsists' is an unfamiliar term. Trying to explain this in the middle of an argument tends to clutter that argument. So I use 'exist' in its popular sense.