Transcript of “Aquinas and Quantum Theory”
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For some people, the title “Aquinas and Quantum Theory” might sound like a rather strange title for a talk. If you know anything about St. Thomas Aquinas at all, you probably know he lived in the 13th Century, whereas people have only been studying quantum theory from the 20th Century onward. Indeed, the year of Aquinas’ birth, 1225 is almost 700 years before the German physicist Max Born coined the term Quantum Mechanics in a 1924 paper. If you know a little bit more about Aquinas, you’ll also know that he believed in a geocentric cosmos with the earth at the center, which was itself contained by a number of celestial spheres, each of whose motions was governed by an angel. Aquinas also believed that there were only 4 elements in the sublunar realm, namely earth, air, fire, and water, and that the celestial angels were able to fashion the vast array of living things in the world out of these four elements via so called seminal powers. Needless to say, this is not how scientists understand the world today. So, we might therefore wonder what possible relevance Aquinas’s understanding of the cosmos could have to quantum theory.[click]

Well, I think that the very fact that Aquinas was interested in the contemporary physics of his day should give us pause for thought. Aquinas was one of the greatest if not the greatest Catholic theologian in the history of the Church, and so we should be asking ourselves “why would a Catholic theologian be interested in physics?”

Now with regard to this question, two answers come to mind. Firstly, [click] there are some people out there who think that physics contradicts the Catholic Faith. Now since it is impossible for two truths to contradict one another, Catholic theologians (or at least some of them) should be trying to offer interpretations of physics that are compatible with the Catholic Faith. Thus, Aquinas writes in the opening question of his Summa Theologiae "Since faith rests upon infallible truth, and since the contrary of a truth can never be demonstrated, it is clear that the arguments brought against faith cannot be demonstrations, but are difficulties that can be answered." Therefore, following the example of Aquinas, there should be at least some theologians who are willing to listen to the difficulties a contemporary physicist might have with the doctrines of the Catholic faith, and once these difficulties have been properly understood, the theologian should strive to find ways in which they might be resolved.

But even if there weren't physicists raising difficulties that needed addressing, I think there is still a reason for Catholic theologians to be interested in physics. [click]

And this is because of the Incarnation. The fact that God became incarnate taking on our physical nature should have consequences for how theologians thing about physical reality. Our faith is a faith not solely concerned with the life to come, but it is also concerned with our life on earth here and now. So, in the light of the Incarnation, I think we can hope to bear some spiritual fruits through our contemplation of physical reality. For instance, both theologians and physicists say a lot about light. Now although theologians speak of light in different ways, these ways aren't entirely unrelated to the way in which physicists speak of light. From a personal point of view, I've found that studying the physics of light has made me much more attentive to how often light is mentioned in scripture and in the prayers of the Divine office.

Now the purpose of my talk is really just to present an interpretation of quantum theory that is inspired by the thoughts of Aquinas, but before I do that, I'll just say a little bit more about the first answer to my question as to why a Catholic theologian would be interested in physics, that is, the desire to resolve difficulties with the Catholic faith. [click]

So, here is a picture of the physicist and Nobel Laureate, Steven Weinberg who is famous for his theory that unified electromagnetism with the weak interaction force. He is also a fervent atheist who said among other things "the more the universe seems comprehensible, the more it also seems pointless." I've also listed on this slide some of the views a physicist might have that could lead to difficulties in accepting the Catholic faith. [Click]

The first view that I think can lead to difficulties is the view that atomism gives a complete account of physical reality. Atomism is a very attractive view to physicists. For instance, the physicist Richard Feynman writes in the first lecture of his lecture series in physics "If, in some cataclysm, all of scientific knowledge were to be destroyed, and only one sentence passed on to the next generations of creatures, what statement would contain the most information in the fewest words? I believe it is the atomic hypothesis that all things are made of atoms – little particles that move around in perpetual motion, attracting each other when they are a little distance apart, but repelling upon being squeezed into one another. In that one sentence, there is an enormous amount of information about the world, if just a little imagination and thinking are applied.” Now as Feynman says, the atomic hypothesis does indeed have a great amount of explanatory power, but if we take this hypothesis too literally and suppose that it gives us a complete account of physical reality, then it raises the question of where we as human beings fit into this account. According to the Catechism of the Catholic Church, “Man, though made of body and soul, is a unity. Through his very bodily condition he sums up in himself the elements of the material world.” But if atomism really were a complete account of physical reality, then it would follow that atomism could account for the behavior of the physical reality of the human body, and so there wouldn’t then seem to be any role for the soul to play in governing the behavior of the human body. Atomism can therefore make the soul seem redundant, and so people who embrace this view may conclude that they don’t have souls. Such people may therefore find it very difficult to accept the Catholic Faith given that the central mission of the Catholic Faith is the preaching of the Gospel for the Salvation of Souls.[Click]

The second view that I think can lead to difficulties with the Catholic Faith is the view that the whole of physical reality is deterministic. This view might not seem so widespread with the advent of quantum theory, but there are still interpretations of quantum theory such as the many worlds interpretation and the Bohmian interpretation that are deterministic. Now determinism leads to difficulties with the Catholic faith because of the importance the Catholic faith gives to human freedom, and because of the difficulty in reconciling human freedom with physical determinism. For instance, the catechism of the Catholic Church says that “Man cannot live fully according to truth unless he freely acknowledges God's love and entrusts himself to his creator." The physicist who embraces determinism might well ask "in what sense can we freely acknowledge God's love if the whole of physical reality is predetermined so that we are not free to do anything apart from what we actually do?" Now there are some people who argue that determinism and freedom are in fact compatible after all, but personally I think this is a rather difficult position to maintain, and so I think that by adopting compatibilism we'd just be relocating the difficulty that determinism presents to the Catholic Faith.[Click]

The third view that can lead to difficulties (and is really contrary to the second view I've just presented) is that all of physical reality is fundamentally random. This view does not deny that there are regular patterns in nature, but rather that these regular patterns can be explained in terms of randomness. For instance, the fact that heat typically flows from hot bodies to cold bodies can be explained in terms of the random motion of particles. Now randomness itself does not present a challenge to the Catholic faith. For instance, Aquinas himself was perfectly willing to acknowledge that things could happen by chance. However, randomness does present a challenge to the Catholic faith if we try to reduce all physical explanations to randomness. For as Catholics, we believe that we can order our human actions to certain ends, and that through the grace of God we can order all the human actions of our lives towards eternal beatitude. But if the whole of physical reality is fundamentally random, then it seems that it would just be a convenient fiction to suppose that people are really capable of acting in a purposeful manner towards ends. [Click]

And the fourth view that can lead to difficulties is the idea that physical reality is fundamentally weird. Now the fact that some aspects of physics might seem rather weird doesn't necessarily pose a challenge to the Catholic faith. For instance, time dilation in special relativity and wave particle duality in quantum theory may at first appear rather weird to us, but this is only because we don't have that much experience of travelling close to the speed of light or observing phenomena at the quantum scale. However, there are some kinds of weird hypotheses that I think would present a challenge to the Catholic faith. For instance, many people think that the Schrodinger's cat thought experiment implies that a cat could be in a state in which it is both actually alive and actually dead. Now the conclusion which people draw from this thought experiment is not saying something about extreme situations, but rather it is saying something about our current situation, that the principle of non-contradiction can be violated. Originally this thought experiment was invoked to highlight the problems inherent in quantum theory, but it has since become increasingly common for popularizers of quantum physics to proclaim this weird conclusion as an established fact. Another related view which is not quite so radical as to reject the principle of non-contradiction, but is still pretty radical all the same, is the view that there are no local matters of fact such as the fact that a particular cat is dead or alive. Instead, there is just one universal matter of fact, that is, there is just one subject of predication, namely, the universal wave function. Now the mathematics behind this view is indeed very elegant, and this elegance might explain why some physicists might subscribe to this view despite it undermining the very possibility of doing physics as a science. But in any case, this view is obviously incompatible with the Catholic Faith. For instance, according to this view, it would strictly speaking be incorrect to say that at a particular point in time, and at a particular location on earth, Jesus Christ rose from the dead. Now, in this talk, I'm not particularly interested in trying to convince the stubborn skeptic. If people really don't want to believe in the revealed truths of the Catholic faith, then they will always find some reason or other not to believe. Rather, I'm much more interested in helping people who want to believe the revealed truths of the Catholic faith and are trying to make sense of them in our modern world. To this end, I'm interested in considering interpretations of quantum physics that do appear to be compatible with what we believe as Catholics, and one of the interpretations I'm investigating and expanding upon in my doctoral thesis is a very recent interpretation by the physicist Adrian Kent.[Click]

Now Kent's interests are entirely different from my own. [Click]

As one of the papers which describes his interpretation suggests, Kent is interested in finding a solution to the Lorentzian Quantum Reality Problem. You don't need to know exactly what this problem is, but only that if Kent's solution really worked, it would be a big deal. [Click]

Indeed, the philosopher of physics Jeremy Butterfield is so excited about Kent's proposal, he wrote a survey paper titled "Peaceful Coexistence: Examining Kent's

Relativistic Solution to the Quantum Measurement Problem." I mention Butterfield since he offers one of the most accessible accounts of Kent's interpretation if you want to learn more about it. So why do I think Kent's interpretation of quantum physics might have anything to do with St. Thomas Aquinas. [Click]

Well, the reason I think this is because back in 2018, I presented at a poster session at a philosophy of physics summer school in Chicago, and my presentation was titled "Hylomorphism and the Superposition of Cat States." Now hylomorphism is an Aristotelian theory that St. Thomas Aquinas subscribed to, and it is about the composition of physical things. Hylomorphism posits that all physical things are a composite of two principles, namely, matter and form, matter being the thing's principle of potency and form being the thing's principle of actuality. And in my Chicago presentation, I tried to make the case that the superposition of cat states is not as weird as it sounds, so long as you make the distinction between potency and actuality. And I went on to give some details on what this distinction would mean in the context of quantum physics. Now when one of the other participants at this philosophy physics workshop found out what I was working on, he recommended that I read about Adrian Kent's interpretation of physics, and he pointed me in the direction of Jeremy Butterfield's paper. Now although there are a number of differences between Kent's interpretation and my own, when I learnt about it, I saw that it was something I could clearly build upon. I was particularly impressed by the role that light played in Kent's interpretation in determining the unfolding of a one world history. I don't know what Kent's religious beliefs are, and I suspect he has little knowledge of Aristotle or Aquinas, but whatever Kent believes, I'm only trying to show that his interpretation of physics is consistent with a Thomistic philosophy of nature rather than it entailing a Thomistic philosophy of nature. But today, I'm not simply going to repeat the presentation I made in Chicago, mainly because I want to say something a little bit more theological. So, I want to share with you some of the pious speculation that was at the back of my mind when I was putting my Chicago presentation together.[Click]

So, let's think about the Divine nature. Aquinas famously said that we cannot know what God is, but rather only what God is not, so we need to be aware of our inability to grasp God's nature when we are doing theology. That is, when we speak about God, we don't really know what we are talking about. Nevertheless, this doesn't stop us from speculating about the nature of created reality in the light of what we think about God. [Click]

So here are some beliefs that Aquinas held about God. Firstly, [Click]

God is the first cause, that is, God is the cause of all creation, but nothing is the cause of Him. [Click]

From this it follows that God is simple. In other words, any kind of composition you can think of does not apply to God, since every composition depends on its parts, but God does not depend on anything. Thus, God is not a body, He is not a composite of matter and form, and He is not any other kind of composite you can think of. [Click]

God also creates freely. He doesn't have to create, for He is perfect in Himself. The only reason He needs for creating things is that created things are good, that is, created things reflect the goodness of God.[Click]

God is also eternal. Aquinas following Boethius defines eternity to be the simultaneously-whole and perfect possession of interminable life. So, in God, there is no process in which He thinks about one thing and then thinks about another. That is, there is [click]

no succession of before and after. Rather, there is just one single act of knowing in God. And this single act of knowing is interminable insofar as it [Click]

doesn't have a beginning and that it won't have an end. [Click]

And in this single eternal act of God, God perfectly knows everything there is to know. So, He eternally knows His own being perfectly, and He eternally and necessarily knows every way in which His being can be imitated. For instance, for all eternity, God has known about human nature, for beings such as ourselves imitate the being of God, but God didn't need to create human beings to find this out. [Click]

So, let's now reflect on God's single act of knowing in a little bit more detail. Now I have to caveat what I'm about to say as being somewhat controversial. This is my own interpretation of Aquinas, so there are likely to be many Thomists who disagree with some of the things I say. That said, concerning God's knowledge, there are some things He knows necessarily and some things He knows contingently. Aquinas referred to the principle of God's knowledge of things as they existed in God's mind as [Click] divine ideas. By divine simplicity, since everything that is in God is God, the divine ideas are [Click]

identical to the one divine essence. Also, because there are many things that God knows, Aquinas argued that there are [Click]

many divine ideas in the mind of God. With our limited minds we can't comprehend how God can both be simple and how there can be many divine ideas in God's mind. All we can say in this regard is that God's having many ideas doesn't entail that there is any composition in God, and so, as I said, the many divine ideas in God must be identical with the one divine essence. And we can also say that God [Click]

necessarily has divine ideas, because God necessarily knows what He can do. So, we can say that divine ideas necessarily "flow" so to speak from God's own self-understanding. Now the word "flow" might be a bit misleading, since God is entirely immutable and non-changing. Nevertheless, by using the word "flow" I'm trying to capture the sense that there is an eternal and unchanging dynamism within the mind of God. Now God can do more than just think about ways in which His being can be imitated. God can also think about [Click]

particular individual things that imitate His being. God does [Click]

not have to think about individual things, for He knows everything intelligible there is to know about individual things prior to their creation. As an analogy for the contingent aspect of God's thinking, we could consider our knowledge of [Click]

right-angle triangles. In our own case of understanding, before we come to understand Pythagoras' theorem, we need to consider many [Click]

individual triangles. [Click]

However, once we understand what a right-angle triangle is and how to apply Pythagoras' theorem to it, we don't learn anything more about Pythagoras' theorem after seeing many more right-angle triangles. Now God, in His perfect act of knowledge, eternally understands Pythagoras' theorem, and so He is like us in having this understanding, and He doesn't gain any further insight into Pythagoras' theorem by considering individual triangles. But unlike us, He doesn't need to consider any individual triangles to gain this understanding in the first place, for God's single act of knowing is perfect and eternal.[Click]

Now when God thinks of individual things, He does not act without reason, for to do so would be irrational, and God is not irrational. But God does have a reason for thinking about individual things, namely, because it's good to think about individual things. So, we can say of the things that God knows in His single act of knowing, that some of these things He knows necessarily, and that some of these things He knows contingently. The things God knows necessarily through His divine ideas belong to His divine essence, whereas the things God knows contingently are the individual things that imitate His essence and [Click]

do not belong to His essence. So, when God thinks of individual things other than Himself, it is not as though He is thinking of them as possible individuals and then deliberating on whether or not to create them. Rather, creation just is God thinking about individual things other than Himself. [Click]

So, in God's single act of knowing, God freely creates the things He does, and we can go on to suppose that the things He creates are free to act as they will insofar as they are expressions of God's freedom to create. In other words, the freedom of individual things is identical to the freedom of God to contingently think them into existence. [Click]

So how does all this theological speculation connect with quantum physics? Well, I'll first have to tell you a little bit about quantum physics itself. So, let's start with a very basic interpretation of quantum physics, namely the Copenhagen interpretation. Probably the most famous experiment that demonstrates quantum effects is the double slit experiment. [Click]

In this experiment, one fires electrons through a double slit. Now electrons are particles, so when they hit the detection screen, they are detected at point-like locations. However, somewhat remarkably, these point-like locations are not uniformly spread out but rather they occur in fringes, **[click]**

which suggest that two waves emerge from the double slits which interfere with one another, and one can calculate a wavefunction to accurately specify the likelihood that electrons will be measured at a particular location. To model this, quantum physicists suppose there is an initial quantum state psi. [Click]

What this state means is that if you took a possible location x [Click]

at which the particle might be detected, you can form a quantity, [Click]

namely the bracket of x and psi. This quantity is also written as[Click]

psi of x, and if you [Click]

square it, it gives you [Click]

the probability that the particle in state psi will be detected at location x. This is called[Click]

the Born Rule. Furthermore, it is supposed that if you know what the state psi is at a given time, then you can work out what the state will be after a length of time t later. For instance, if you know the state[Click]

of the particle near the beam gun at [Click]

time t0 say, then by solving the [Click]

Schrodinger equation you can calculate[Click] the state Ut of psi for a time [Click]

t later when you would expect the particle to have reached the screen. To see how this formalism helps you to predict the probability distribution of measurements at the screen location, what you do is consider the simpler case in which you close off one slit, say the second one and then calculate the state [Click]

psi one of the particle just as it emerges from the first slit. And if you know how to calculate the state psi one of the particle, then you will also know how to calculate [Click]

the state psi two of the particle that would emerge from slit two if slit one was closed off. Then to find out what the state for the particle would be as it emerges from the double-slit situation with both slits uncovered, you will just [Click]

add these two states together and [Click]

multiply it by an appropriate normalization factor which is one over the square root of two in this case. Then when you evolve this state over time via the Schrodinger equation to find out what the state will be like when the particle reaches the detection screen, [Click]

these two components of the state will interfere with each other leading to the interference pattern. And if you want to calculate the probability distribution for the particle to end up at position x, you first calculate this[Click]

quantity, where I’ve assumed you’ve already evolved the state via the Schrodinger equation to the time at which you want to make the measurement. And then you would square it to find the probability via the Born Rule. But I ought to reiterate, [Click]

in this situation, psi is just the state of a single particle state, but because it can be thought of as the sum of the two state psi one and psi two, physicists describe the state psi as being a superposition of these two states. Now in the Copenhagen interpretation, it is assumed that the state psi is a [Click]

complete description of the particle. In particular, this means that there is no fact of the matter about where the particle actually is. That is to say, the wavefunction is not a measure of our ignorance of the particle’s exact position, for in the Copenhagen interpretation, it is assumed that a particle is not the kind of thing that has an exact position. And so, when the position of the particle is[Click]

measured its state psi collapses to a much more localized state which is the new complete description of the particle. But again, the particle’s position still isn’t localized to an exact position. The localized state to which it collapses is entirely random, except that it collapses to a location with probability specified by the Born Rule. So in this example, when the wave function looks like this, on measurement, the wavefunction is moderately likely to collapse to [Click] these positions, and not very likely to collapse to [Click]

these positions, whereas for this highly localized wave function, on measurement, the wavefunction is very likely to collapse to this position[Click]

and not very like to collapse to any of [Click]

these positions. Still, although the collapse location is [Click]

random, the evolution Ut of psi before the collapse is completely deterministic, since this evolution is determined by the Schrodinger equation. [Click]

Now so far, we've only been considering one-particle systems. That is, although we've been considering the double slit experiment in which we fire many many electrons through the double slit with the result that we get a distribution of measurement outcomes, for each individual measurement we make, we have only been considering the physics of a single particle. If this was all quantum physics could do, then its applicability to our world would be very restricted. Quantum theory therefore has to be able to deal with multiparticle systems. So, for instance, to model a two-particle state one of whose particles is in the[Click]

state psi one, with the other particle being in the [Click]
state psi two, we can write the corresponding two-particle state like so.[Click]

And this two particle state gives rise to a wavefunction that is now a function of two locations[Click]

and via the Born Rule, the square of this wave function will tell you the probability that the two particles will be detected at locations x1 and x2. And as before, one can use the Schrodinger equation to find out how this state evolves over time. Now quantum theorists generally presume that if you had a huge[Click]

number of[Click]
particles, say around [Click]

10 to the 26 of them, one might be able to construct the [Click]

multiparticle state for something like a [Click]

cat. However, in the Copenhagen interpretation, we do not want to suppose there is any additional law of physics that comes into play when one has cat-wise configurations of particles, since if there were, then quantum theory would only be an approximation. Thus, it is supposed that although the cat state will continually collapse according to the Born rule as it is observed, it's just statistically very likely that the sequence of collapses will look to us like the behavior of a living cat. Now the problem with the Copenhagen interpretation is the question of what happens when macroscopic states like cats[Click]

are coupled to [Click]

microscopic states such as the states of radioactive nuclei. Schrodinger noted that in theory if a cat were placed in a sealed box with a radioactive nucleus which if decayed would release a deadly poison, then before the sealed box was opened, the cat-wise configuration of particles would enter into a superposition of particles configured in an arrangement that behaved like a [Click]

living cat, and of particles configured in an arrangement that behaved like a [Click]

dead cat. So statistically, according to the Born rule, the cat-wise configuration of particles doesn't behave like at cat after all. [Click]

Another issue that troubled the pioneers of quantum theory was the localized wavefunction behavior of particles. Although in quantum theory, a particle such as an electron would not have an exact position, it was still hoped that the wavefunction for the particle would still be fairly localized. However, if one considers a [Click]

wavepacket that describes a particle with the mass of an electron and suppose that the initial width of the wave packet is about the width of a hydrogen atom, then if one solves the Schrodinger equation for this particle, one would find that in the space of a [Click] second, the wave packet would have spread to the width of a thousand kilometers. [Click]

Now in recent decades, physicists have come up with a theory which is meant to save the appearances. This is called decoherence theory. Decoherence theory is very ingenious, though when one first learns about it, it also seems very weird. Advocates of decoherence theory realized you couldn't just treat electrons as isolated systems from the rest of the universe, and this is even more so the case with cats enclosed in boxes. Photons will continually interact with the system, and significant numbers of these photons will be flying off into outer-space. [Click]

As the system wavepacket spreads, the photons that interact with it will go into [Click]

a superposition of states depending on where each of the photons interacts with the system. This is called [Click]

entanglement. [Click]

but if you were now able to measure these photons, [Click]

their location would determine the location at which they interacted with the system, and so the system would become localized again.[Click]

Let's now consider the Schrodinger's cat experiment in the light of decoherence theory. That is, we now extend our model to include not only the radioactive nucleus,[Click]

the poison and [Click]

the cat, but we also include [Click]

Schrodinger conducting the experiment and [Click]

his laboratory and [Click]

all the photons interacting with the laboratory, though in order that things don't become too cluttered, I'll [Click]

suppress some of these elements. Now in this scenario, although the wave function of the atom will[Click]

spread fairly quickly (which I depict by the subscripts one and two), the photons will interact with the expanding wavefunction of the atom and so the photons will become [Click]

entangled with the atom in accordance with where the photons interact with the atom's wavefunction, but if one were to measure enough of these photons, one would be able to work out from where they had scattered, and hence work out a localized position for the atom. [Click]

But also, in the case of a radioactive atom, as the light interacts with it, the photons will also become entangle with [Click]

the decayed and a non-decayed state of the atom. So we can depict this entanglement process as a branching [Click]
process, [Click]

but this is just another way of how the states evolve, so that this branching here just says that the combined state of the photons and the atom have evolved from this to this. If we now consider including the cat [Click]

to this model, then the photons will also interact with the cat and so become entangled with the cat regardless of whether or not the poison has been released, and there's a high probability that some of these photons will also fly off into space, and if we measured enough of these photons, we could work out the mass configuration and location of the cat. And photons will also interact with [Click]

Professor Schrodinger. And the same story applies. But given enough time, the superposition state of the radioactive atom will lead to the [Click]

following entangled state where the happy face indicates that Schrodinger has opened the box and is delighted to see that the cat is alive, and the frowny face indicates the Schrodinger has opened the box and is disappointed to find that the cat has died. And again, if we wish, we could [Click]

depict this process in our branching diagram, and if we so wished we could also include [Click]

the lab state in this depiction, though obviously here, I haven't completed this depiction on all the branches. And perhaps we can speculate that there will be further branches after this. For instance, if the cat is alive, to celebrate, Schrodinger might either give the cat some [Click]

creamy salmon flavor cat licks or [Click]

some moist seafood medley flavor cat treats. On the other hand, if the cat has died, Schrodinger might [Click]

either make arrangements for burial at the local pet cemetery, or [Click]

he made decide to purchase an urn in which to place the ashes of his deceased cat. And all the while, we remember that photons are interacting with these four different components of the wavefunction, so that if one were to measure enough of the light that is flying off from the lab, one would be able to determine which of these scenarios occurred. Now one might suppose that this story of [Click]
branching goes [Click]
on and on forever [Click]

without any measurement ever actually being made. This is the so called many worlds interpretation of quantum mechanics, and although it has a mathematical elegance to it, I still think it's rather ridiculous. So, what about Adrian Kent's interpretation? Well he buys into all this decoherence theory and the role that light plays in it, but rather than embracing the many worlds interpretation, he supposes that as the universal wavefunction and the universe expands, it will become less and less likely for the light to interact with any other matter. So infinitely far in the future, [Click]

all branching will cease. And so he supposes that at some notional time in the future the location of all the light in the universe will be [click]

determined in a notional measurement. And then from this end of time determination, Kent argues that one would be able to [Click] [Click][Click]

determine a one world history corresponding to the location of all the light. One of the nice things about light is that since it is massless, it doesn't spread out like particles which have mass do. This nice property of light suggests that after a certain point in the evolution of the universe, if you determine the location of all the light, it is not going to noticeably change the corresponding one world history. [Click]

So, would this interpretation of quantum physics be acceptable to a Thomist? Well, I think it could be. For let's consider what I said earlier about the divine nature and God's perfect act of knowledge. God, in His single act of knowing, as well as necessarily thinking all the ways His being can be imitated, can also contingently think of [Click]

a particular beginning and a particular end. As I mentioned earlier, this contingent thinking of God is His act of creation. Now the particular beginning is somewhat akin to the quantum state. In quantum physics, it is always supposed that there is an initial state, and from this state, one can work out [Click]

all the future possibilities via Schrodinger's equation. Now God being God would of course instantly know all the possibilities that flowed from the particular beginning He conceived. And moreover, there would be a genuine ontology to the possibilities, that is to say, they are [Click]

real possibilities, that could happen at [Click]

possible times. But in order to avoid the absurdity of the many worlds interpretation, we have to make the distinction between real possibilities and real actualities. So, if God in His creative act only conceived this particular beginning without conceiving a particular end, creation would be completely devoid of form, so for instance, there would be no cats or human beings, and the particles of physics would have no individuality. Of course, God would never conceive of a particular beginning without conceiving a particular end, because without a particular end, the particular beginning would be devoid of any real intelligibility. In Aristotelian language, God would only have conceived of a pure potency principle in conceiving a particular beginning. But nevertheless, given this particular beginning, if one could see into the mind of God, one would be able to see how probable it would be for the matter and light to be distributed in a certain way at possible times if one were to measure it. And this probability distribution would be consistent with the Born rule. As for the particular end that God contingently thinks, this is like an actualization of the light so that the potentiality of [Click]

all the light in the beginning state and the possibilities that flow from the beginning state is determined to determinate locations. Moreover, since once the location of light is determined, one can determine[Click]

the location of the matter which the light was entangled with, one can determine the configuration of all the matter throughout history. Among such configurations, there will be cat-wise and human-wise configurations of matter. And since God determines the location of all the light in such a way that this choice is consistent with the Born rule, what God determines is consistent with what we understand to be quantum physics. But we need to say more than this. For there is likely to be many many possible matter and light configurations that are consistent with the Born rule. So God chooses a particular mass configuration because this mass configuration is intelligible and hence reflects His own intelligible being. And this intelligible account or reality can be parsed in such a way that the matter of the universe is parsed into individual beings like cats and human beings. So speaking both metaphorically and literally, it's only in the light of its intelligibility that matter can truly said to be actualized. God lights up His creation in an intelligible way. Moreover, there is an order to this intelligibility. By this I mean that when God lights up His creation, He sees a huge amount of information which has an order to it. So, if He sees a configuration A, then it will follow that He will also have to see configuration B, but if He sees configuration B, it doesn't follow that He will have to see configuration A. For instance, if God sees me giving a Talk at Texas A&M, he will also see me receiving an invitation to give a talk at Texas A&M, but if He sees me receiving an invitation to talk at Texas A&M, it doesn't follow that God will see me giving a talk at Texas A&M. But although God immediately sees all He sees in His single act of knowing, from our perspective, in this ordering of information, we see the ordering of [Click]

actual time. [Click] [click] [Click]

As another example, one could consider the situation of Schrodinger and his cat experiment. In the previous diagram I drew, I considered a rather limited number of different responses Schrodinger might have made depending on whether the cat was found to be alive or found to be dead. However, I very much doubt it would violate quantum physics if on discovering the cat to be [Click]

alive, Schrodinger contacted the [Click]

local pet cemetery to enquire about burying his deceased cat, or alternatively if the cat was [Click]

dead, Schrodinger then [Click]

opened a packet of cat treats for his cat. But although these possibilities wouldn't necessarily be ruled out by quantum physics, these possibilities by themselves would not be intelligible. Now perhaps God would still choose to actualize one of these seemingly strange possibilities, but in order to discern the intelligibility of God's choice, we would need to consider a wider context. So, for instance, if Schrodinger had finally gone insane, as trying to feed his dead cat would suggest, then maybe his insanity will provide the opportunity for a mental health nurse to shine with virtue as the nurse patiently takes care of Schrodinger. But whatever way God chooses to configure the matter and light of the universe, there is an intelligible account of His choice, of the manner in which His choice imitates His intelligible being. [Click]

So in conclusion, I'll raise this final question "if we could transport Aquinas from his own time to our time and explained to him all the discoveries of modern physics, how might Aquinas suggest we should interpret quantum theory? Well, maybe, he would just tell us to take our interpretation from the first few lines of the book of Genesis: [Click]

In the beginning [click]

God created the [click]

heavens and the earth. The earth was without form and void, and darkness was upon the face of the deep; and the Spirit of God was moving over the face of the waters. And God said, [click]

"Let there be light"; [click]

and there was light. And God saw that the light was good. [click]

[click]
