

# Quantum Randomness, Hylomorphism, and Classical Theism

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**Abstract:** According to certain interpretations of quantum mechanics, the behavior of some physical systems is random—that is, certain current states of physical systems are related to other current states and the set of possible future states in a probabilistic, rather than a deterministic, fashion. This account of physical systems seems to conflict with the claim that there is an omnipotent God—that is, a God Who can efficaciously bring about any logically possible creaturely state, and Who can cause efficacious secondary causes—and so raises problems for classical theism. After explaining these problems, I provide a solution to them based upon a version of hylomorphism, which I call Theistic Hylomorphism with Randomness. On this view, it can be affirmed that the physical world is both random and in determinate states, and divine omnipotence can be upheld in a random world. After presenting this version of hylomorphism and showing how it defeats the problems for classical theism raised by quantum mechanics, I defend it against three objections.

Some contemporary scientists have theorized that some of the behavior of all physical systems is random. By this, they mean that certain current states of physical systems are related to other current states and to the set of possible future states in a probabilistic, rather than a deterministic, fashion. Given a value of one of certain states, there is a probability less than 100% that that state will later have some other given value, and a probability less than 100% that other states have some given value. Examples of such probabilistic relations are discussed, for example, in the study of radioactive atoms, in quantum mechanics (QM), and in neurology. In this paper, I use ‘random’ for any such probabilistic relation; no state is random considered in itself, but only as related to some other state. An objection to this use of ‘random’ may immediately arise: if one state is related to another state such that if the first obtains, there is a very high probability that the second will obtain, then we would not normally say that the two events are related “randomly.” I admit that my use of ‘random’ here is perhaps unusual, but, nevertheless, I retain this use of ‘random’, because my interest in this paper is to consider God’s acts regarding events and states related to one another in any sort of probabilistic manner. Furthermore, my use of ‘random’ is appropriate because the probabilities involved in QM are rarely very high.

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But if any reader thinks that this misuses the word, then he or she should substitute some other appropriate word, such as ‘probabilistic’.<sup>1</sup> Similar considerations must be kept in mind for my use of ‘determinate’, which I use for any relation among states where given one definite state, some definite value for another state follows from the former.

On many interpretations of QM, its claim that current physical states are related to other current states and to the set of possible future states randomly is not just understood to mean that we must treat the world as random given the current state of science or the limitations of human cognition. Rather, this claim is understood to mean either that any observer will find this randomness (that is, despite what might be the case ontologically, no knower can know the world otherwise than as having random relations among physical states) or that randomness is an intrinsic property of things (that is, that randomness is a real property of these relations among states, though not of the states considered in themselves). For the classical theist, these claims pose some potential problems. On classical theism, there is a being, God, Who is causally responsible for the existence of the universe, maximally perfect, free (that is, could have done otherwise than He does), omnipotent, and omniscient. In this paper, I consider whether traditional versions of classical theism, such as that held by Thomas Aquinas, is defeated by the claims of QM. On the versions of classical theism in question in this paper, God is omnipotent just in case God can efficaciously bring about anything not logically contradictory or any possible creaturely state exactly as He wills, God can bring about any possible creaturely state immediately or without the cooperation of creaturely causes, and God can bring about efficacious creaturely causes distinct from Himself. To efficaciously bring something about is to bring into existence some being, state, or property instance, such that between the agent’s act of bringing this thing about and the actual coming about of the thing there is a determinate, not a random, relation.<sup>2</sup>

If the physical world is random in the sense defined above, then it would seem, as I shall argue below, that even God could not act efficaciously upon the world. Rather, His acting upon some physical system would reduce it to a state related only randomly and not determinately to His actions, and so God would not be able to bring about a world exactly as He wills. This problem is formalized below in an argument that I call The Problem. In this paper, I present a theory on which The Problem can be defeated, which draws on scholastic hylomorphism, and which I call Theistic

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<sup>1</sup> For other senses of random see (Eagle 2014). I do not intend calling something random to entail that that thing is purposeless or unplanned, in contrast to (van Inwagen 1995, 50).

<sup>2</sup> For this account of omnipotence see (Aquinas 1889, q25). It is also the view of omnipotence taken, on my reading, by other major Christian thinkers of the past e.g., Augustine, in his *City of God* book 5, chapter 10 (Augustine 1993, 156-8) and book 22, chapter 2 (Augustine 1993, 811-2); John Duns Scotus, in his *Ordinatio* book 1 d42, q.un., n8 (Scotus 1963, 342-3); John Calvin, in his *Institutes of the Christian Religion* book 1 chapter 16 (Calvin 1845, 169-78). It is also the view of omnipotence taken, on my reading, by classical statements of various Christian denominations e.g. the Catholic *Catechism of the Council of Trent* part 1, article 1 (Pius V 1829, 27-8), and the Reformed *Westminster Confession* chapter 5 (Schaff 1877, 612-4). This account of omnipotence is meant to ground a strong view of divine providence, on which all creaturely events and states are willed either directly or permissively by God, though not in such a way as to eliminate creaturely causality. There may be other versions of classical theism for which The Problem does not arise, but they are not my concern here.

Hylomorphism with Randomness (THR). First, I present some support for The Problem from QM. Although I refer in this section to key scientific claims, I do not defend those claims, nor do I present them mathematically, because all I need is motivation for the claim that there is randomness in physical systems. Next, I present the basic ideas of THR, and I argue that THR entails the denial of at least two premises of The Problem. Finally, I respond to three objections.

## I. The Problem

Assuming the foregoing account of omnipotence, I first present and then defend The Problem:

[1] If all states of physical systems are randomly related to other simultaneous and prior states, or can only be so understood, then no agent (including God) can efficaciously perform any freely chosen non-random act upon a physical system.

[2] If no agent (including God) can efficaciously perform any freely chosen non-random act upon a physical system, then classical theism is false.

[3] So, if all states of physical systems are randomly related to other simultaneous and prior states, or can only be so understood, then classical theism is false.

The Problem can be motivated by considering some interpretations of QM on which the antecedent of [1] is true. There are some interpretations on which randomness in physical systems is merely apparent, and all physical states are actually determinately related (as on the “pilot wave,” “many worlds,” and “modal” interpretations). These interpretations deny the antecedent of [1]. In this paper I am interested to show that The Problem can be defeated even if physical systems are intrinsically random (as on “objective reduction” interpretations, such as the Girardi-Rimini-Weber or Penrose interpretations), or even if they must be understood as random (as on many versions of the “Copenhagen” interpretation).<sup>3</sup> Accordingly, I restrict my attention to interpretations of QM on which the antecedent of [1] is true. Other problems for classical theism can be raised on other interpretations of QM, but they are not my concern here.

QM purports to describe every physical system at the most fundamental level (van Inwagen 1983, 191-2), but even if it only correctly describes some systems, The Problem, *mutatis mutandis*, remains. According to QM, the states of a system evolve over time deterministically. This deterministic, non-random evolution of a system’s states are described by an equation known as the Schrödinger equation. This equation relates the changes in a system’s “wavefunction” (a description of the

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<sup>3</sup> On interpretations of QM, see (Acín 2013, 8; Penrose 2005, 782-91; van Fraassen 1993, 274). I concur with Koons (2015, 13), who holds that any hylomorphic ontology for QM (like the one I present in this paper) should be understood as incorporating aspects of the objective reduction and Copenhagen interpretations of QM.

system as a function of time and the system's position or momentum states) to the energy of the system. Any quantum system is (or is best treated as) a combination of many position or momentum states, spread out like a wave.<sup>4</sup> But when the system is observed or measured, it is always observed in just one of these states. The apparently instantaneous "process" whereby the system takes just one of its possible states is known as "state reduction" or "wavefunction collapse." Which state the system reduces to cannot be predicted with certainty on the basis of prior or simultaneous states. Wavefunctions do not predict that physical systems will take on one defined state. Rather, as already mentioned, wavefunctions describe a physical system as a wave or spread of multiple position or momentum states, with a probability for the system being found in each state upon measurement. The wave that is each quantum system is a spread of probabilistically-weighted states, and given prior facts about a quantum system, one cannot predict with certainty what value it will take on when observed in the future. For any physical system, there will be some future states of physical systems to which it is randomly related. The probability that a system will be found in each of various states upon observation is mathematically determinable, and these probabilities are empirically verifiable.<sup>5</sup> When measuring a state of some observable property of a physical system (such as its position state) one cannot at that moment determine with certainty the precise measurement that other states of that system would have at that moment (such as its momentum state). Given one state of what are called pairs of "non-commuting properties" (such as position and momentum), the other property in the pair will be (or will be best treated as) a wave or spread of probabilistically-weighted states (Ismael 2014; Maudlin 2007, 53-61; Penrose 2005, 423-524).<sup>6</sup> For any physical system, there will be some states of physical systems simultaneous with it to which it is randomly related. Furthermore, given the inherently random way in which physical systems collapse, and given the fact that, prior to collapse, physical systems just are probability-spreads of states, one cannot predict what measurement a physical system will have when one acts upon it on the basis of the properties of one's own act (Penrose 2005, 585-591).

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<sup>4</sup> The wavefunction for each property is not a function over observable, three-dimensional spacetime. Rather, it is a function over an infinite-dimensional, complex configuration space, where each point of that space corresponds to a possible position or momentum state of the physical system, and which is related to our ordinary spacetime as a fiber bundle. Any quantum system is (or is best treated as) a spread of such states, and so as a wave spread out in and moving through configuration space (Penrose 2005, 217-221, 325-331, 534-535, 962-978).

<sup>5</sup> The probability that a system will be found in or collapse to a given value is determined mathematically by the "Born Rule," a formula derived by physicist Max Born, on the basis of the work of Erwin Schrödinger. What the real grounds for this formula are—that is, what the basis for the probability-weightings of quantum systems is—are contested by the various interpretations of QM (D'Espagnat 2006, 91, 94, 110; Landsman 2009).

<sup>6</sup> The degree of certainty that can be had about each state given knowledge of the other is given by the Heisenberg Uncertainty Relation. On some interpretations, the Uncertainty Relation is ontological: a precise state of one property is in fact a wavelike spread or probability distribution of the state of the other property. Furthermore, these properties can each only be considered in a different reference frame, e.g., position requires a fixed reference frame, but momentum requires a non-fixed frame; see (Bohr 1961, 39-40; Maudlin 2011, 128-130).

If the foregoing (or any theory on which there is randomness with respect to both current and future states of physical systems) is correct, then any interaction with a physical system, whether to know the state of the system<sup>7</sup> or to influence the system causally, will result in the system randomly taking on some state. Given this state of affairs, then, as [1] says, no agent could interact with a physical system with complete efficacy, and without reducing the system to some state that followed only randomly from the previous physical states of the system and from the agent's own act. Even if the agent intended some definite effect, and knew all previous states of the system, the agent could not produce that effect with absolute efficacy. Furthermore, on many interpretations of QM, there are probabilities not only for what states a system can take on, given prior states of the system, but also for whether physical systems will arise at all, given background conditions such as the quantum state of the vacuum from which those systems arise (Penrose 2005, 656-683).<sup>8</sup> If this is right, and if any agent freely acts upon or attempts to cause a physical system, then there is a probability less than one that that agent's intended action will come to pass. This is due to the probabilities inherent in the nature of physical things as to whether the physical system that is willed will arise, and to the fact that, as we can observe, when agents act upon physical systems, those systems are randomly reduced to some state according to antecedently fixed probabilities. If all this is correct, then, as [1] holds, no agent could produce a planned effect in a physical system with complete efficacy (Esfeld 2000; Suarez 2013, 65). There is no reason, given the observed probabilistic behavior of physical systems, to think that there could be an exception to these conclusions for some agent, such as God. The way in which states of physical systems relate randomly to one another and to acts upon them seems to be incompatible with efficacious action upon those systems by any agent.

On this basis, [2] can be defended, given the account of divine omnipotence and classical theism in the introduction above: physical randomness and divine omnipotence are incompatible, and so physical randomness and classical theism are incompatible. If any action upon a physical system (including, perhaps, the initial vacuum state of the universe) randomly reduces that system to some state, then God could not produce any creaturely state exactly as He wills. Furthermore, God could

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<sup>7</sup> God can still know the actual state of a physical system, whether in a definite state or as a probability spread, at all times on this view, by "intuitive cognition" (Spencer 2016; John of St. Thomas 1711, 117-129; Francisco Marin-Sola 2013, 90-94), which is a kind of cognition whereby a knower knows all things that are present to him or her, just because they are present, so long as the knower already has an idea corresponding to that kind of thing in his or her mind, rather than by interacting with the system. God has ideas of all things by nature, and is present to all things necessarily, and so can "intuit" all actual states. But God could not know all things "practically"—that is, He could not know what His acts would produce just by knowing those acts. The views of this paper are meant to be compatible with either a temporal or timeless God. For an account of how a timeless God causes temporal creatures see (Osborne 2006; Pruss 2008; Pruss 2014; Grant 2012; Spencer 2016). For an account of a temporal God see (Rhoda 2011).

<sup>8</sup> Smith (1997) holds that QM gives unconditional probabilities that certain physical systems will arise—that is, probabilities that those systems will arise not based on prior conditions. For arguments against Smith see (Craig 1997; Deltete and Guy 1997). If Smith's interpretation is wrong, even probabilities for the arising of physical systems based on background vacuum conditions pose a problem for classical theism.

not immediately and efficaciously bring about some creaturely effects—namely, any definite state of a physical system that could arise through the creaturely process of state reduction. On my account of omnipotence, God should be able to efficaciously bring about this effect, since it is a possible creaturely state, and since it is in fact brought about through the creaturely process of state reduction. But God cannot do so if any action upon physical systems just randomly reduces the system to some state. Finally, if the above account of QM randomness is correct, then God cannot produce creaturely causes that can efficaciously act, contrary to the definition of omnipotence; creaturely agents too, like any agent, would only be able to randomly reduce physical systems to some state, regardless of their intentions, rather than efficaciously cause some intended state. If all of this is correct, then my account of classical theism is false.

In order to motivate [2] more definitively, I consider two views on which it appears that one can affirm both QM randomness in physical systems and divine omnipotence, and so deny [2]. I argue that neither of these views is actually able to deny [2]. The first of these views is Molinism,<sup>9</sup> on which God, prior to creating the world, knows counterfactuals of freedom—that is, He knows what any free creaturely agent would freely do were he or she placed in each possible circumstance. The agent is not causally determined by the circumstance (or by anything other than his or her free choice) to perform that action, but it is just the case that the agent would do some definite action in that circumstance. By guiding the course of circumstances, God can have providence over all events, while allowing for created freedom: the creaturely agent alone brings about his or her free acts, but, in each circumstance, does what God knew he or she would do. The Molinist can claim that just as there are counterfactuals of freedom, so there are counterfactuals of state reduction: for each circumstance, there is some definite state that a physical system would reduce to when an agent interacts with the system in that circumstance. The state is not caused by the circumstance, by any agent, or by the previous states of the system, but just is what the system would reduce to in that circumstance. God can efficaciously bring about any state by placing physical systems in the circumstances such that they will reduce to the state that He desires. This view still affirms [1]: God does not efficaciously perform acts upon physical systems, but rather just guides circumstances such that the systems, on their own, reduce to the states that He desires. God does so in such a way that the actual state reductions occur with the frequencies predicted by the quantum probabilities; He does so perhaps because a world in which these probabilities are followed is more valuable or desirable than any other world. In this way, God efficaciously brings about whatever states He wills.

This response to [2] will not work for several reasons. First, it is subject to a version of the grounding objection to Molinism. The classic version of this objection is that there are no true counterfactuals of freedom, because nothing, prior to the actual free choice, could serve as the truthmaker or ground for those counterfactuals. I give a further version of this objection in Spencer (2016): there are no true counterfactuals of freedom because they are contrary to the nature of freedom. To be free is to be the sole determiner of whether one acts and what one does, and of what is the case about one's choice. If there were a fact of the matter as to what one would

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<sup>9</sup> For a fine account of current arguments and literature regarding Molinism see (Perszyk 2013).

do, prior to one's making of the choice, then one would not be the sole determiner of what is the case about one's choice. Regardless of where one stands on my version of the grounding objection regarding creaturely freedom, an even stronger grounding objection seems available regarding counterfactuals of state reduction. It seems to be part of what QM says that prior to an actual reduction there is no fact of the matter as to which state the system will reduce; rather, there are only probabilities for each possible state. It is contrary to the very nature of reducible quantum systems that there be a fact of the matter as to which state they would reduce to in a given circumstance. If this is right, then God could not bring about His will by guiding circumstances. Second, if QM as explained above is right, then there are no circumstances that God could efficaciously guide, because all circumstances in which physical systems are found just are themselves probabilistically-weighted quantum systems. Even the vacuum and the spacetime in which physical systems are placed have their states randomly. Third, this version of Molinism does not allow for the view of omnipotence being defended in this paper to be met. On that view, God can bring about any creaturely state immediately, without any creaturely cause. But that is false on Molinism: rather, God can only bring about the state reductions that He wills by setting physical systems in the right circumstances, and allowing creaturely processes to bring about the state reductions. Furthermore, on this paper's view of omnipotence, God can bring about efficacious creaturely causes. But it is not clear that God can do this on this version of Molinism; rather, it seems that He can only bring about creaturely causes that bring about their effects randomly. A response to the Problem should be able to show how God can bring into existence creaturely causes that we common-sensically take to be efficacious, such as human free will.

The second view that seems to be able to deny [2] is that of Peter van Inwagen (1995, 54-60). He argues that in a world that includes quantum indeterminism, God does not cause the particular position, momentum, or other states of particles, but just endows particles with existence and certain causal powers at every moment, and then lets them take on their actual states randomly, through quantum processes. God can endow physical systems miraculously with new causal powers, such that novel effects come about. God does not cause the particular states to which physical systems reduce, and most of the outcomes of those reductions are not part of God's plan—that is, not among the states of affairs that God has decreed will come about. Some of the things that God has decreed—such as that there be creatures made in His image and likeness—only come about through random physical processes. By decreeing the initial probabilities in such a way that they will conduce to the evolution of the persons that He wants to evolve, God still efficaciously guides the course of the world. On this view, everything that God wills efficaciously comes about, and so God is still omnipotent, and classical theism still true, contrary to [2]. It is just that very few states of the world are positively willed by God, though all are sustained by God, since God has set up a world that largely evolves through random processes. God could have created a world in which He brought about every state, but He, in His omnipotence by which He can decree whatever He wills, did not do so.

This response to [2] will not work in the context of the version of omnipotence that I am defending in this paper. On van Inwagen's view (1995, 55-6), if some state comes about through random physical processes, then it is not willed efficaciously by

God. For it to be willed efficaciously by God, it would need, on van Inwagen's view, to be the result of a miraculous intervention by God in which He endowed the physical system with new causal powers so that it brought about the effect He willed. While the system develops randomly, its states cannot be efficaciously willed by God. But this is contrary to my account of omnipotence, on which every created state must be able to be efficaciously willed by God. Furthermore, God cannot, on van Inwagen's view, bring about any created state immediately: some created states can only come about through random processes. Finally, for the same reasons given in response to Molinism, God cannot create efficacious creaturely causes on van Inwagen's view.

There seem to be good reasons to accept [1] and [2] and so to conclude to [3]. Since there also seems to be good reason, at least on some interpretations of QM, to affirm the antecedent of [3], the proponent of The Problem seems to have good reason to reject classical theism. I now turn to a response, which will show how the classical account of omnipotence given above, and QM randomness, are compatible.

## II. Theistic Hylomorphism with Randomness

A response to The Problem needs to show both how God can efficaciously and immediately cause any creaturely state, and how God can create both efficacious created causes and physical randomness. It should show that even if there is randomness in physical systems, it is not the case that no agent can efficaciously act upon physical systems. Such a response is not possible on a view of physical systems on which they are purely physical; if physical systems were purely physical, in the manner described in the last section, then any act upon them really would just randomly produce some state, and the conclusion of The Problem would follow. What is needed is a view on which physical systems are both genuinely random in some respects, but determinate in other respects. THR is such a view: it is able to accomplish these tasks because, on THR, physical systems are not purely physical but have a non-physical part called "form." My goal here is to present THR; there is not space to fully defend it or hylomorphism in general. First, I present a traditional version of hylomorphism. Next, I review some attempts by contemporary hylomorphists to include physical randomness in hylomorphism; THR can only be understood in the context of this hylomorphic tradition, since I work out THR's claims by building on the work of previous hylomorphists and correcting what I take to be their deficiencies. Finally, I present THR itself, and an argument as to how this theory entails that [1] is false.

According to hylomorphism, physical substances<sup>10</sup> are composed of two fundamental parts, matter and form. These parts are posited to account for how substances come into and go out of existence. In each such event, form changes, while

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<sup>10</sup> While I have heretofore been using 'system', I now use 'substance'. Below, I clarify that, on THR, any quantum system is a hylomorphic substance.



matter stays the same.<sup>11</sup> Matter, the stuff out of which substances are made, is potentially many things, but form makes that matter to actually constitute a substance that is a unified instance of a certain kind. When a substance comes to be, a form is introduced by an agent into matter, which is actualized by the form—that is, made to actually constitute some substance—while retaining its potency to be actualized in other ways. Agents introduce forms into matter through the powers that they have because of their own forms.<sup>12</sup> Form is immaterial and irreducible to matter; it causes matter to be a certain actual way, and matter provides the potential on which form performs its actualizing work, though it also limits that work to the range of the potentials that it provides. Form and matter together compose one substance, and matter never exists in an uninformed state. While a substance persists, its form remains the same, while its matter may change.

THR builds on the view of those hylomorphists, such as Francisco Suárez (2004, 13.1.14-15, 13.8.5&10, 13.14.15-16, 18.4.3), who distinguish multiple kinds of matter. Most fundamentally, there is prime matter, which is pure potency to any substantial form, and has no actual characteristics in itself. But matter always exists with quantitative or mathematically measurable accidents, which persist through substantial changes, and belong to prime matter ontologically prior to its being informed and actualized by substantial form; quantified matter never exists unactualized by substantial form.<sup>13</sup> Substantial form both causes a substance to be a unified instance of a certain kind, and gives the resulting substance an end and powers to act in ways typical of that kind, where these acts are new accidental forms over and above the quantitative accidents of matter. For example, the forms of living substances give them the ability to move themselves efficaciously, and the forms of free substances give them the ability to move themselves as a result of choices not determined by any substance other than themselves. Substantial form and quantified matter can be examined separately from each other, but, to be understood fully, must be understood in the context of some substance in which they are unified.

Some hylomorphists have incorporated QM randomness into hylomorphism.<sup>14</sup> Some of these hylomorphists hold that physical randomness allows for the efficacy of free will in the physical world, while determinism would not (Herzfeld 1961, 62; Smith 2005, 103). However, they tend not to note the challenges to the efficacy of free will (and of agency in general) that can be raised on the basis of physical randomness. Those who argue for the compatibility of hylomorphism with randomness often draw on physicist Werner Heisenberg's view that the wavefunction describes a sort of potentiality. A wavefunction does not present a physical system as being in a definite state, but rather as being potentially in various states, with probabilistic weights for finding the system in each state (Heisenberg

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<sup>11</sup> This view of hylomorphism is largely drawn from: (Aquinas 1889, q75-77; Aquinas 1933; Aquinas 1953a, a1-2; Aquinas 1953b, a2-4, 11; Aquinas 1954, bk1 lect13, bk3 lect5; Aquinas 1959, bk2 lect1-5; Aquinas 1961, bk2 c56-72; Aquinas 1972). See also (Pasnau 2001; Wippel 2000).

<sup>12</sup> On many hylomorphists' views, God is a form, though not one that informs matter.

<sup>13</sup> Suárez's view of quantified matter is controversial among hylomorphists, but I think that it is the hylomorphic view of matter that best makes sense of modern mathematical physics.

<sup>14</sup> I do not consider versions of hylomorphism that favor a deterministic interpretation of QM, e.g., (Jaki 1989).

1962, 41; Smith 2005, 73; Wallace 1979, 195).<sup>15</sup> Some see this as providing a basis for a version of hylomorphism that includes randomness: QM describes the structure of matter as potentiality, which is in itself random, but also actualized by forms, yielding the substances that actually exist and have defined states. Stanley Grove (2008, 283) notes that the matter that Heisenberg describes is already structured, and so cannot be prime matter, but Grove (2008, 265) argues that the quantum probabilities of matter must be based in prime matter. This cannot be right: prime matter is without any mathematical characteristics, and so these probabilities cannot be founded in prime matter. It is more plausible to hold, building on Suárez's account of quantified matter, that they are quantitative accidents that inform prime matter.

One hylomorphist who builds on Heisenberg's remarks is Wolfgang Smith (2005, 26-51, 118), who argues that the world has at least two parts: the physical world, which is observed through the instruments of physics and expressed mathematically, and the corporeal world, which is the world observed through sense perception and which includes qualitative properties and classically-described entities. My body considered as an aggregate of measurable particles belongs to the physical world, while my body as it appears to my senses belongs to the corporeal world. The physical world only exists in a state in which it is actualized into corporeal substances, which are presentations of physical objects, which of themselves cannot be sensibly displayed at all.<sup>16</sup> William Wallace (1979, 193-5; 1996, 45-47, 55; 1997) builds on this view in claiming that physical things are related to higher-order substances as potentiality to actuality. On Wallace's view, QM gives us the best account of matter, but not of actualized substances.

These actualizations are explained, on Smith's account (2005, 99-117), by state reduction, an instantaneous event that reduces the potentiality described by a wavefunction to actuality. Considered in terms of QM, our best theory of the physical world as such, these events are random and uncaused. But considered metaphysically, as the event appears in the corporeal world, it must have a cause, which must be an agent that introduces a form into the potentialities of the physical world, reducing the latter to an actual defined state. The agent must be outside the corporeal and physical worlds, so as to be independent from random physical influence. On Smith's view, the agents that bring about reduction are free beings, that is, human persons and God. When I observe reductions, I observe events caused by God. When I make a free decision, my immaterial will reduces the potentialities of my matter to definite states. This is not to say that I consciously choose the definite states that each of my particles take on. Rather, I consciously choose to perform some act, and the immaterial power of my will unconsciously "selects" definite states for all of my particles, such that my consciously chosen act efficaciously comes about. The physical world provides parameters within which persons freely act, since the "selection" must abide by the probability weightings given by physical systems; this must be held because we have empirical evidence that these probability weightings are never violated. Smith (2005, 78-94) also responds to the argument that even if God could act upon physical systems, He could not simultaneously reduce both of a pair of non-commuting

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<sup>15</sup> See (van Fraassen 1980, 158-9).

<sup>16</sup> See (Caldin 1940).

properties. He responds by positing a third part to the world, “Nature,” which is never examinable, but that determines and is manifest in the physical world, and can be acted on by God. It can be in definite states for both of a pair of non-commuting properties simultaneously, though it can only physically manifest one of these at a time.<sup>17</sup>

While Smith provides what I think is a good explanation for state reduction, which allows for randomness in the physical world, he eliminates this randomness through his deterministic “Nature” to which apparent randomness in the physical world reduces. His view does not allow for the complete response to The Problem that I am seeking, which will affirm both irreducible physical randomness and classical theism.<sup>18</sup> Furthermore, his view entails all actualization occurs only as a result of free agency; contrary to traditional hylomorphism and to the way the world seems to be based on observation, no non-human physical thing would be an agent. Finally, as Grove (2008, 293-8) argues, Smith goes too far in separating the physical and corporeal worlds, allowing them to be linked only in acts of measurement. It is implausible to think that the physical manifests itself corporeally only when some conscious observer is present; surely events in distant, uninhabited galaxies had a corporeal manifestation even prior to the existence of any observers, and surely it would be more plausible to hold that these manifestations can be explained without requiring that God immediately causes all of them.<sup>19</sup> Robert Koons (2015, 10, 25) argues that there are many chemical and physical causal interactions (such as colliding, fastening, molecular interaction in cells and gravitational interactions) that require that physical systems have definite positions and momenta, and that this suggests that they are actualized naturally, apart from conscious acts of measurement, into definite states.<sup>20</sup>

Smith’s account can in part be corrected by turning to the work of an earlier hylomorphist, Philippus Soccorsi (1956, 116-121, 262-273), though he also problematically holds that all actual states of physical systems are produced by immaterial agents. Like Smith, Soccorsi holds that QM just considers the physical

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<sup>17</sup> Compare to D’Espagnat (2006, 236-45), who holds that QM reveals that the empirical world partially manifests but also hides an underlying “veiled reality” to which we have no direct access. D’Espagnat (2006, 458-9) likens his account to Aristotelian hylomorphism.

<sup>18</sup> Smith’s view of “Nature” is deterministic in a similar way to the pilot wave interpretation of QM: apparent randomness is explained away by an underlying determinism. The randomness on which The Problem is based requires that randomness be unfounded on anything deterministic.

<sup>19</sup> Grove does not go far enough in developing his hylomorphism. On his view, QM quantities, like position as a spread of probabilities, co-exist alongside sensible quantities, like definite position; the former does not become the latter when actualized. On THR, by contrast, QM quantities *are* actualized into sensible quantities, while also retaining their own nature—just as on traditional hylomorphism, matter is actualized by form, and thereby becomes some substance, but also its own nature of pure potentiality.

<sup>20</sup> Koons (2015, 13) argues that a hylomorphic interpretation of QM rightly takes from the Copenhagen interpretation the view that there are genuine classical, macro-level realities, but opposes that interpretation’s view that the quantum and classical levels of reality are entirely separate, as Smith holds. These levels of reality are distinguishable but united as matter and form. In general, hylomorphism opposes any view that would separate the world into two separate realms (e.g. the scientific and manifest images, or the spaces of causes and reasons), instead arguing for their unity, often in terms of matter and form, potentiality and actuality.

aspect of things, not substances in their entirety. On this view, there is randomness, as defined in the introduction of this paper: the state of one of a pair of non-commuting properties has, considered in itself, no determinate, physically-meaningful connection to the states of other properties at the same time, or to any possible future states. But, unlike Smith, Soccorsi shows how the hylomorphist can retain irreducible physical randomness, while holding that substances as wholes can be in a defined state for both of a pair of non-commuting properties simultaneously. When we consider a system physically, we are considering it just insofar as it can be known through the measuring methods of physics, which interact just with the quantified matter of a substance. Through such methods the value of only one of a pair of non-commuting properties can be known at a time, and the other is really randomly related to the known property. But the substance as a whole form-matter composite can be in a defined state with respect to both properties when an immaterial agent makes it so, though Soccorsi does not explain how this happens.<sup>21</sup>

THR<sup>22</sup> builds on this account and makes sense of Soccorsi's proposal that non-commuting properties can both be randomly related to one another and each in a defined state. On THR, prime matter is actualized by quantitative accidents, which give matter its mathematical accidents as described by QM, in virtue of which it develops over time in accord with the Schrödinger equation, and has probabilities for being found in various states.<sup>23</sup> When we examine the world with the measuring instruments of physics, which are designed to interact not with whole substances (unlike intellectual acts) but just with the material part of substances, we can only consider one of a pair of non-commuting properties at a time, and the other property will be randomly related to the one we examine. Considered just in terms of the quantitative structure of matter, given one property, the other can only be a spread of probabilistically-weighted states; on THR, these probability weightings are a real

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<sup>21</sup> See (Hoenen 1945, 209-210, 373, 387). There are two proposals for how a non-material thing could influence a random physical system which I do not advocate. The first is from Schrödinger (1947, 87-90), who reconciles the claims that all physical systems proceed according to quantum laws, and that I also know by introspection that I freely direct my actions, by arguing that I am the one who first set up the laws of nature—by which he means that I am God. But this does not solve The Problem, since it is contrary to the definition of omnipotence: it does not allow for genuine causes distinct from God, nor for intervention in the evolution of the universe after setting up the laws of nature. The second is from Eccles (1994, 148-160) on which immaterial minds can change the probability of neurological events, such as exocytosis of neurotransmitters. On this view, agents could change the probability of an act occurring, but could not ensure that it happens, and so this does not defeat The Problem.

<sup>22</sup> THR is similar to accounts of God's action upon the physical world through selecting states in reducing quantum systems in Plantinga (2011, 115-116) and Russell (2008, 151-211), but it provides a metaphysics explaining how this is possible.

<sup>23</sup> One way to make sense of this is to hold that quantified matter exists not in ordinary spacetime, but in infinite-dimensional configuration space, and is then actualized by substantial form into substances in ordinary spacetime. The configuration space is genuinely part of the structure of reality, and non-commuting properties in that space are related randomly. But, through the actualizing work of form and the new accidents bestowed on a substance by form over and above its material properties, both of a pair of non-commuting properties can have definite, classical values in actualized, ordinary spacetime. On THR, the probability-weightings given by the Born Rule are grounded in the intrinsic properties of quantified matter.

feature of the world, grounded in the properties of matter. But all such matter only really exists as part of a complete substance, actualized by an immaterial form.<sup>24</sup> Form first actualizes quantified matter, making it actually to be a substance of some kind with certain powers, including the power to efficiently cause itself, by state reduction, to be in those definite states for some property necessary for being and acting as the kind of substance that it is. Second, the substance through its form actualizes its quantified matter into some defined state. The matter in itself is potentially in many definite states, for each of which there is some probability. Through the power of the form, the substance causes its matter actually to be in some definite state through an act of state reduction; on THR, unlike on Smith and Soccorsi's views, every substance, and not just free agents, can reduce their matter to defined states through their forms.<sup>25</sup>

In state reduction, the form adds to the substance a new quantitative accident, actualizing the probabilistic quantitative accidents described by QM. Through these new accidents, the substance has, for example, some definite position and momentum. This definite quantity actualizes the potentialities of quantified matter, but does not thereby eliminate the probabilistic quantitative accidents of that matter, nor the random relation among the quantitative accidents that fundamentally belong to quantified matter. This parallels how in traditional hylomorphism, form actualizes the potentialities of prime matter, but does not thereby eliminate prime matter's potentiality to be any kind of substance. Quantified matter here corresponds to the notion of the physical world in Smith's view, but unlike Smith's physical world, quantified matter is not just presented in the corporeal world, but the latter really is the actuality of the former. Furthermore, this matter is not identical to fundamental particles; rather, fundamental particles too are substances, with forms and quantified matter. A substance can have a definite position and momentum through determination by its form—but nothing about either property, considered as quantitative accidents of matter, will entail anything definite about the other, or about any future states of the system. Position and momentum involve two separate kinds of quantitative accidents; as quantitative accidents informing matter, they are randomly related and in probabilistically-weighted potential to being in definite states, but as actualized by form, they can be in definite, sensible states. Quantified matter, considered in itself (as QM considers it) cannot be in definite states for both of a pair of non-commuting properties, but when actualized by form, it can be so actualized. On THR, according to the definition of 'random' given in the introduction

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<sup>24</sup> One might object that there are instances of material things that seem to exist just in the manner described by QM, e.g. free electrons. THR insists that even those material things have a form that accounts for their actions and states, where this form actualizes quantified matter. Grove (2008, 278-9) holds that fundamental particles have the properties of incompletely-defined potentialities, which are actualized, and so reduced to some actual state, when they are measured by a measuring device in the corporeal world. But I contend that even fundamental particles should be understood as form-matter composites, and so as capable in themselves of having defined states (as can be seen when they are measured), rather than being understood as just having properties of having incompletely-defined potentialities.

<sup>25</sup> This is an objective reduction theory, but state reduction is not explained by some special physical force, but by the act of immaterial form upon matter.

of this paper and by Soccorsi, the states of the properties are randomly related to one another, but each is also in a definite state.

When a substance in virtue of its form reduces its own states, it follows the probabilities set by the matter. Form selects from among the probability-weighted states presented by quantified matter, in accord with that probability weighting, such that the probabilities manifest themselves over multiple reductions. As already pointed out, the probability-weightings themselves are based in the quantitative accidents of matter, but the actual selection of states is carried out by form; the empirical observation that state reductions over time follow the probability-weightings is explained both by the quantitative accidents of matter, and by form's act of selection of states from among those probabilistically-weighted accidents. In any given selection act or state reduction event, a form can select any state, so long as over time the probability weightings are manifested—that is, so long as form follows the constraints set by the quantitative accidents of matter. Earlier states do not constrain the form as to which state it will select in a given event of state reduction; each region of a wavefunction is equally fit to be actualized by form—again so long over time as form selects states in a pattern that matches the probabilistic-weightings given by the quantitative accidents of matter.

Form can carry out this work of selection because it is immaterial, and so in itself is independent of material randomness. Just as on traditional hylomorphism, formal causality is constrained by the properties of the matter from which a substance is made, so on THR, a substance can only be reduced through its form to states allowed by its matter's probabilistic quantitative accidents. When selecting among these states, the form actualizes only energy and momentum already present within the system as the probabilistically-weighted quantitative accidents of matter, and so on THR conservation of energy and momentum is preserved.<sup>26</sup> State reduction does not violate conservation of energy or momentum, and forms do not introduce any new energy or momentum into a physical system. Rather, they causally explain why the substance takes on the definite states that it takes on; absent such an explanation, there is no sufficient casual reason, but only a probabilistic non-causal reason, why matter is found in the states in which it is found.<sup>27</sup>

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<sup>26</sup> For worries that determination of state would violate the laws of conservation of energy or momentum, and for answers to those worries, see (Eccles 1994; Barrett 2000).

<sup>27</sup> Koons (2015, 26-7) is right to see physical substances taking on definite states as a kind of spontaneous symmetry-breaking, but only from the physical, QM point of view; viewed metaphysically, the taking on of definite states and the breaking of symmetry occurs through the determination of form. On THR, while, as already said, the quantitative accidents of matter ground the probability-weightings given by the Born Rule, actual events of state reduction are causally explained by determination of form. Furthermore, a scholastic might object at this point: On traditional hylomorphism, all powers of material things except human intellect and will are exercised in matter, not by form alone; that intellectual powers are not exercised in matter (even though in close conjunction with matter) is evidence for the immortality of the intellectual form. But on THR, all forms have a power to reduce physical states, which they exercise upon but not in matter. It would seem to follow that on THR all forms are "immortal." I accept this conclusion, and deny that it is problematic.

Forms can allow their substances to evolve in a wave-like fashion<sup>28</sup> with respect to some properties, allowing for the wave-like properties that material things sometimes exhibit; for example, some material things, like single photons, sometimes interfere with themselves as waves interfere with themselves, indicating that the thing is in multiple states simultaneously for the same property (Penrose 2005, 504-5). THR bears some resemblance to “hidden variables” interpretations of QM, on which there are unobservable or hidden properties of quantum systems, represented by hidden variables in the equations that describe the behavior of quantum systems, and that account deterministically for those systems’ odd behavior. But the “hidden variables” on this view are not deterministic principles in matter, but rather the immaterial forms that put substances into their actual states. But these actual states need not always be definite states, such that a substance moves in particle-like fashion. Rather, since this is within the capacities of matter, a form can actualize its matter such that it is in multiple states at a given time for the same property, and moves in a wave-like fashion. Being spread out in a wave-like fashion is a way for a substance to be actual; the wave-likeness of physical systems is not always just potential on THR. There is no need to hold that physical substances follow “surreal trajectories”<sup>29</sup> in which they would jump, as particles, from place to place, in order to account for the apparent wave-like movement of some physical systems. Rather, a form can make a substance have a definite, particle-like position at one time, then allow it to radiate across space in a wave-like fashion and then take on another definite position at a later time, selected from among the range of possible definite positions allowed by that wave.

THR can also explain the entanglement exhibited by spatially-separated physical systems that have previously interacted (Penrose 2005, 582-94; D’Espagnat 2006, 63, 465-476). It seems common-sensical to assume that physical systems only interact locally, that is, when they are in contact with one another, present together in the same place. If this were in fact the case, then there would be certain limits, the Bell inequalities, to how well we could predict the states of one system on the basis of observing the other system. But these inequalities are violated by the behavior of quantum systems, as in Einstein-Podolsky-Rosen cases. In these cases, when two quantum systems, which have previously interacted locally and then are spatially separated, are measured, then the state of one system is correlated with that of the other, such that the systems seem to interact instantaneously, even at great distances. Even when experimenters in these cases freely choose which properties to measure after the systems are separated from one another, these unexpected correlations and apparently non-local interactions are still observed. Some have tried to explain this entanglement by positing hidden variables, which would explain away the apparent interaction at a distance. But the experimental and theoretical data of QM shows that no physical theory that includes hidden variables, where these variables only act locally and without instantaneous action at a distance, can explain these observations. As already noted, THR is a sort of hidden variables view, but the hidden variables are forms. Because of their unified activity, it is plausible for the hylomorphist to treat an

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<sup>28</sup> This wave-like behavior is manifested in actual spacetime, not just in configuration space.

<sup>29</sup> See (Barrett 2000).

entangled quantum system as a single substance.<sup>30</sup> Forms are immaterial and wholly located in every piece of matter that they inform, including in a substance that has spatially-scattered parts. As such, the form could simultaneously determine the states of each spatially-scattered part. The form could bring about non-local interaction at a distance of the parts of an entangled quantum system, since the form is at no distance from any of the matter it informs, and, as immaterial, is not in itself localizable.<sup>31</sup>

On THR, all substances in virtue of their form, in a sense “choose” or “move themselves to” their own definite states at the moment of state reduction, for the sake of their own form-given ends, since substances need to be able to direct themselves efficaciously to their ends in order to reach them. Their matter gives them a range of probability-weighted states among which to “choose” to reduce themselves. As already seen in discussing Smith’s view, it is not the case that all substances are properly speaking “free” or “alive”, or that any substance reduces its matter’s states consciously, but rather that all substances have a power analogous to life and freedom.<sup>32</sup> The claim here is that each substance, in virtue of its form, unconsciously “selects” the states of all of their myriad physical properties.<sup>33</sup> States are not determined by the nature of the matter or of the form, but by acts of a substance in virtue of its immaterial form. If states were determined by the matter, then the matter would not be random; if they were determined by the nature of the form, then all instances of a certain kind would always reduce their states in the same way, which is not so.<sup>34</sup> Genuine life requires the power to engage in other kinds of self-motion, such as locomotion, and genuine freedom involves the power to choose acts on the

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<sup>30</sup> One might object to this part of THR: some of my matter is entangled with matter outside of me, but my matter is informed by my form, and that matter is informed by some other form. I respond: matter can be informed by more than one form at a time e.g. by my substantial form, and by the form of an entangled quantum system. Tim Pawl and I have given an empirically-based defense of the claim that a given batch of matter can be informed by more than one form at once in (Pawl and Spencer 2016). On this view, some law of nature will govern which form determines the states of a multiply-informed batch of matter in a given situation.

<sup>31</sup> In addition to this non-locality of form, there is also the non-local structure of the configuration space in which quantified matter exists; see (Penrose 2005, 990-992; Suarez 2013, 66). THR denies that the values that physical systems take on are had apart from something like a measurement, e.g., formal or divine causality. In this way, THR is in accord with the “Kochen-Specker Theorem” (Held 2013).

<sup>32</sup> THR is not a version of panexperientialism, panpsychism, or panzoism, but it does follow the traditional hylomorphic view that lower-order substances have analogous versions of the powers of higher-order substances; see (Aquinas 1961, bk. 4 ch. 11; Pickstock 2013, 31-38).

<sup>33</sup> One might object that sometimes substances do not put themselves in a state with perfect efficacy with respect to their “intended” acts or with respect to their teleological orientation—for example, when a body is deteriorating. In reply, THR can affirm that every physical event occurs under the direction of some form. But there could be more than one form acting upon a given batch of matter at a time, or when one substance acts on another, it could “compel” the latter to take on some reduced states. The key point for THR is that every actual state of every substance is ultimately explained by a form’s act of determining the state of the matter.

<sup>34</sup> THR is in accord with the “strong free will thesis” that responses of particles to experiments is not determined by earlier properties of the universe, given by (Conway and Kochen 2009). This reasoning here underlies the rejection of Molinism earlier in the paper: on THR, there is no particular state that a given substance would select in some situation.



basis of reasons. But the efficacious exercise of these powers relies upon the power of substances to reduce their matter to definite states through forms.

We can now turn to the question of how THR helps solve The Problem. If THR is correct, then [1] can be denied. On THR, agents can, in virtue of their forms, efficaciously act upon physical systems. When I choose to perform some free act, my substance, in virtue of my form, unconsciously puts each piece of matter used to carry out that act into definite states, such that my freely chosen act comes about. These acts still contain an element of randomness, since they are implemented in matter in accord with matter's randomness or probability-weighting, and they are randomly related to other physical states. But this randomness is only on the level of quantified matter; the act itself is implemented exactly as the agent chooses, since the agent substance, through its form, "selects" precisely which material states to actualize, so as to bring about the agent's intended act. Given the distinction between a physical system considered just at the level of quantified matter and apart from form, and a physical system considered as actually informed by substantial form, and the fact that only the former, not the latter, are random, [1] is ambiguous. On THR, and leaving the antecedent true, [1] can be disambiguated in two ways:

[1'] If all states of physical systems qua states of quantified matter are randomly related to other simultaneous and prior states, or can only be so understood, then no agent (including God) can efficaciously perform any freely chosen non-random act upon a physical system considered just at the level of quantified matter.

[1''] If all states of physical systems qua states of quantified matter are randomly related to other simultaneous and prior states, or can only be so understood, then no agent (including God) can efficaciously perform any freely chosen non-random act upon a physical system considered as actually informed by substantial form.

The consequent of [1'] is true but the consequent of [1''] is false. It is only if [1''] were true that divine efficacy and omnipotence would be threatened. Quantified matter, considered in abstraction from its actualization by substantial form, cannot be put into a definite state; it is only when quantified matter is actualized by substantial form that it is rendered capable of being determined to a definite state. But all quantified matter is informed by substantial form, and so all quantified matter as it actually exists (though not as QM studies it, in itself and in abstraction from substantial form), can be acted upon efficaciously. When God and creaturely forms reduce matter to some definite state, the quantified matter retains its random structure and quantitative accidents whereby it has the probability of reducing to some state.<sup>35</sup> God and creaturely forms reduce matter to some definite state subsequent to its actualization by some form, that is, they reduce matter as actually

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<sup>35</sup> THR is compatible with a version of traditional hylomorphism (Aquinas 1889, q22 a1 ad1) on which material chance is compatible with divine primary causality of all creatures and creaturely events.

existing in a substance. The states that God and creaturely forms bring about will only follow randomly from other physical states, but they will follow determinately from His choices (or the form's "selection"). As explained above, quantified matter has in itself accidents whereby it has the probability of taking on some state upon state reduction, but which state a physical system actually takes on upon state reduction is explained by an immaterial cause—such as a form or God. God and creaturely forms can give substances definite states only because, on THR, substances are not just quantified matter, but include immaterial forms as well. Were there no immaterial forms, there would be only quantified matter, and then no agent, even God, would be able to give definite states to physical systems, since quantified matter without substantial form is incapable of receiving definite states. But given that there are levels of actuality to substances over and above quantified matter, God and created substances can put those substances into definite states.<sup>36</sup>

This allows the definition of omnipotence given above to be met. God can efficaciously bring about any creaturely state in physical substances—but only because those substances are more than just quantified matter describable by QM, and so are capable of receiving definite states. God can (and does) also create efficacious creaturely causes—namely, each substance. But these causes are efficacious because they have an immaterial part, the form, which can actualize the potentialities of quantified matter; if creaturely causes were just quantified matter, then they could not efficaciously put themselves into any state. Since, on THR, God can bring about any state that He chooses, THR can deny [1] in the sense of [1''], from which a denial of classical theism would follow. The proponent of THR will also hold that God normally abides by matter's probability-weightings (which, *ex hypothesi*, He Himself originally set up) when putting physical systems into definite states. Quantified matter in itself does not require that God (or a form) choose any particular state in a given event of state reduction, but God respects (and forms must respect), as it were, the probability-weighting accidents of matter, such that these probability-weightings, which are really grounded in the actual properties of quantified matter, manifest themselves empirically over time. This accounts for the fact that we have never observed violations of these probabilities, and these probabilities seem to explain partially the states of the whole universe.

Since, on THR, [1] in the sense of [1''] can be denied, the Problem is defeated by THR.<sup>37</sup> I turn now to some objections to THR's solution of The Problem.

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<sup>36</sup> If the world were just quantified matter, it would be as van Inwagen (1995) describes it, which would entail the problems for omnipotence and efficacious created causality described above.

<sup>37</sup> There may be other views aside from THR on which The Problem can be defeated. But they would have to include something like form—that is, they would have to include levels of reality over and above QM-described quantified matter, and, in virtue of those levels of reality, creatures would have to be able to efficaciously affect themselves. Any such theory would look a lot like THR, though it might differ in particulars.

### III. Objections and Replies

It can first be objected that THR explains one obscure but observable phenomenon, state reduction, by an even more obscure and also unobservable phenomenon, formal causality. To say that substances cause themselves to be in a certain state in virtue of their forms seems to say little more than that there is some causal explanation for why substances are found in the states in which they are found—that is, no explanation has been given. Accordingly, no principled response to The Problem can be given on the basis of THR.<sup>38</sup>

But on QM alone, a description of state reduction can be given, but not a causal explanation; rather, when observed, a physical system is just found in some state, and there was a prior probability of finding it in that state. It is ambiguous to say that the reduction can be observed: what is observed is that the system takes on one state, and it is known that it could have taken on others. The actual reduction is instantaneous and so unobservable in itself. What is needed is a causal explanation for why the system is in one state rather than another, and no physical theory that includes randomness can provide that. Form and formal causality are well-defined ideas from hylomorphism, and while they cannot be directly observed, we can observe the effects that lead us to posit them, such as the unity and efficacious acts of substances. THR explains one well described, empirically founded, but directly unobservable physical phenomenon by means of a well described, empirically founded, but directly unobservable metaphysical phenomenon. This is genuine explanation: a principle, form, whose causal role—giving material substances their unity, kind, powers (including powers to be in definite states), and end—is worked out apart from considerations of randomness, explains a quantum phenomenon.

A second objection contends that, if certain interpretations of QM are right, then THR could be shown empirically to be false. On some interpretations of QM, random state reduction occurs when some physical force acts, such as the force of gravity acting on the various possible states combined in a physical system's wavefunction (Penrose 2005, 853-6). If this were right, then there would be no need for forms to explain state reduction, and so the motivation to hold THR would be lost.

But even if some physical cause explains when state reduction occurs, no physical cause can explain why the physical system takes on one possible state rather than another. The proponent of THR can hold that forms or God choose one state every time some physical force requires it to do so; the form still plays a key causal role here in explaining why the system takes on the definite state that it does, and so the motivation to hold THR remains. Indeed, many physical interactions, such as those involved in the processes leading to observations of physical systems, seem to occasion state reduction, but none of these interactions explain why the system takes on the exact state that it does, nor is there any evidence that state reduction occurs only when these physical interactions occur. For THR (and hylomorphism in general) to be disproved empirically, it would need to be shown that some purely physical

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<sup>38</sup> If this were meant to be an objection to hylomorphism in general, then that would be an objection whose reply would go beyond the scope of this paper.

description of a system entirely explains all that forms are meant to explain on the hylomorphic view, including teleological reasons why events occur.

A third objection is that THR in fact does not include randomness. Rather, randomness has been replaced with either a determinism founded upon the nature of forms, or a sort of “free” activity carried out by substances in virtue of their forms. The objector contends that THR has eliminated randomness through form just as Smith’s view did through “Nature”.

But the proponent of THR should maintain that all of the randomness included in QM as a theory of the physical world is included in THR. On the relevant interpretations of QM, physical systems are random inasmuch as their future physical states only result probabilistically from current states (considered purely as physical, that is, as they are in quantified matter), and given the current state of one property in a pair of non-commuting properties, the other property cannot be physically represented as in a defined state. On these views, there is no sufficient physical cause for a system being found in a certain state. THR affirms all of this. But all of this is entirely consistent with that state being determined by some non-physical cause giving to the system an actuality, such as a position or momentum state, over and above its probabilistically-weighted states.<sup>39</sup> On THR, no physical theory is a complete description of the world, but some physical theory on which there is randomness in physical systems is a true description of part of the world. Still, the proponent of THR should concede to the objector that if by randomness the objector means the arising of states with no determinate cause at all, then THR does not include randomness.

It can thus be seen that THR is capable of responding to The Problem in a principled way, and so laying the basis for incorporating the contemporary physics of intrinsic randomness into a theistic framework.<sup>40</sup>

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<sup>39</sup> Suarez and Adams (2013, 274), advocate replacing quantum indeterminacy with non-material agency. On THR, we have good reason to affirm both indeterminacy or randomness, and non-material or formal agency.

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