

## *Dispositions, Capacities, and Powers* A Christian Analysis

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*The real difficulty lies in the fact that physics is a kind of metaphysics; physics describes "reality." But we do not know what "reality" is; we know it only by means of the physical description."*

Albert Einstein (letter to Schrödinger, June 19, 1935)

*To find out the reasons of things in natural philosophy is only to find out the proportion of God's acting.*

Jonathan Edwards ("The Mind," 1723)

In philosophical, scientific,<sup>1</sup> and even ordinary discourse, it is not unusual for any of us to attribute dispositional properties to objects. When we assert, for example, that a certain vase is *fragile* we attribute the dispositional property, *fragility*, to the vase. Other examples are the *malleability* of copper, the *elasticity* of a rubber band, the *solubility* of sodium chloride, the *combustibility* of gasoline; the ability of aspirin to relieve pain, and the *toxicity* of arsenic. But dispositional terms are not reserved for reference to ordinary objects and substances, they apply at all scales from the *charge, mass, and spin* of electrons and the *decay* of a radium molecule to the *elliptical orbits* of the planets and, in between, to the traits of persons (such as *compassion* or *gullibility*) and capacities of persons (such as *agility* or *versatility*). Dispositional terms seem indispensable. We inevitably encounter things that appear to involve a "capacity," a "power," "inclination," "habit," "propensity,"

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ABSTRACT: Dispositional properties have been receiving an increasing amount of attention in the last decade from metaphysicians and philosophers of science. The proper semantics and ontology remains controversial. This paper offers an analysis and ontology of dispositional properties rooted in Christology and the biblical doctrine of creation. The analysis overcomes the standard problems faced by all such analyses and provides an account of "ungrounded dispositions." The analysis involves a version of a Leibnizian-Aristotelian notion of possible worlds and provides a novel notion of truth-makers for subjunctive conditionals.

1. E.g., in theoretical physics, chemistry, biological psychiatry, epistemology, educational theory, and social theory.

“proclivity,” “tendency,” “capability,” “ability,” “aptitude,” or some other such thing. Moreover, discovering and mathematically describing dispositional properties is what science primarily aims at.<sup>2</sup>

It is almost obvious that to attribute a dispositional property to an object is to indicate what events to expect under the right conditions.<sup>3</sup> If *x* is *fragile*, expect disintegration under the right conditions; if *x* is *poisonous*, expect sickness or death under the right conditions. However, the issue confronting attempts at analysis is whether those events are due to some real property (which the disposition term denotes) or whether those events are all there is to a dispositional property.<sup>4</sup> The demonstrated shortcomings of the *material conditional analyses* in first-order logic noted by Rudolph Carnap in 1936 has led many, including Gilbert Ryle and Nelson Goodman, to account for dispositional properties in terms of events alone by way of a *subjunctive conditional analysis*:

(SCA) “Object *x* has disposition *D*” means “Were *x* in circumstances *C*, then *x* would manifest *D*.”

The story has oft been told of the shortcomings of this analysis and its revisions.<sup>5</sup> The inadequacy of the Stalnaker-Lewis possible-worlds approach to subjunctive conditionals has also often been noted.<sup>6</sup> The primary problems for the latter are specifying what counts as “nearness” or “similarity” of worlds and how one comes to know such things. It is not my purpose to review the various proposals and their shortcomings. My aim in this paper is to offer a new analysis and a corresponding ontology.

2. See I. J. Thompson, “Real Dispositions in the Physical World,” *British Journal for the Philosophy of Science* 39 (1988): 67–79. James Ladyman and Don Ross claim that “science describes the objective modal structure of the world” (*Every Thing Must Go: Metaphysics Naturalized* (Oxford: Oxford University Press, 2007), 130).

3. Mauro Dorato discusses the predictive role disposition attributions serve in ordinary language in *The Software of the Universe: An Introduction to the History and Philosophy of Laws of Nature* (Aldershot: Ashgate, 2005).

4. The latter view owes much to Bacon, Descartes, and Boyle, but reached its zenith under the twentieth-century empiricist hegemony of Carnap and Quine. The former view was held by Aristotle, Aquinas, and Suarez and various dynamist natural philosophers (e.g., Gilbert, Kepler, Greene, and Boscovich) and enjoys a current revival among many philosophers of science, metaphysicians, and physicists.

5. See François Schmitz, “Dispositions and Counterfactuals: From Carnap to Goodman’s Children and Grandchildren,” in *Dispositions and Causal Powers*, ed. Max Kistler and Bruno Gnanassounou (Aldershot: Ashgate, 2007): 43–66.

6. See Wolfgang Malzkorn, “Defining Disposition Concepts: A Brief History of the Problem,” *Studies in History and Philosophy of Science* 32 (2001): 335–53; and Stathis Psillos, *Causation and Explanation* (Chesham: Acumen, 2002).

### *Some Observations toward a Generic Analysis*

What, then, is *meant* by such dispositional attributions in philosophical, scientific, and ordinary discourse? What are we asserting when we make such statements? If there are *real* dispositions, capacities, and powers, just exactly *what* are they? Observe, first of all, that a dispositional term seems to denote a thing's *state* of being. However, it is a special kind of state: it is a state of being poised either *to effect* a change or *to be* changed. Whereas electrons do not change essentially when manifesting *charge* by repelling other negatively charged particles, aspirin tablets do change when manifesting *solubility*. Secondly, it follows that, in both cases, dispositional properties appear to be directed toward some kind of event. Putting these two initial observations together, we may hold that a dispositional property seems to be a *directed potentiality* of some kind. On this initial synthesis, an aspirin tablet's *solubility*, for example, denotes its state of being-poised to *be* changed, which is its dissolving, so that to attribute solubility to an aspirin tablet is to refer to a specific kind of potentiality. Let us then observe these definitions:

(DEF) A *dispositional property* of an object, substance or system is its state of being poised to effect (or to be subject to) some type of causal process.<sup>8</sup>

(DEF) The type of terminating event in a type of causal process that a disposition is a state of being poised to effect (or to be subject to) is its *manifestation-type*.

*Shattering*, for example, is a token of the manifestation-type associated with *fragility*. *Dissolving* is a token of the manifestation-type associated with *solubility*. Some dispositions have only one type of manifestation and others have multiple manifestation-types.

Most dispositions have *initiating conditions* that, under normal conditions, seem sufficient to initiate a causal process that ends in a manifestation event.<sup>9</sup> Striking a vase is an initiating condition of fragility that ends in shattering; seeing a person in pain or in need is an initiating condition for compassion. Some dispositional properties have more than one set of sufficient initiating conditions. In many cases, these may be fulfilled in degrees or blocked all together. Sometimes dispositional properties are not manifested

7. I deny that they are properties of *kinds* of things. My view overcomes Alice Drewery's objections in that it treats *objects*, *substances*, and *systems* to be nothing more than structures of dispositional properties, "Dispositions and *Ceteris Paribus* Laws," *British Journal for the Philosophy of Science* (2001): 723–33.

8. In my view, there are several "types of causal processes." Brian Ellis refers to dispositional properties by the term, "dynamic universal" in *The Philosophy of Nature: A Guide to the New Essentialism* (Montreal: McGill-Queens University Press, 2002), 68.

9. This seems to be what underlies a disposition's being a relation describable isomorphically by mathematical models. See Dorato, *The Software of the Universe*.

because of interference of some kind or because their initiating conditions are not met in the first place. A museum, for example, takes great pains to ensure that one of its ancient Chinese vases never manifests its fragility. A complete analysis should represent and explain these three alternatives: (1) normal manifestation, (2) nonmanifestation because no event occurs that meets the initiating conditions, and (3) nonmanifestation because some other causal process interferes. We have this definition:

(DEF) A dispositional property's *initiating conditions* are those conditions that are sufficient to begin a causal process that terminates in a manifestation event.

With few exceptions, objects retain their dispositional properties throughout the duration of their nonmanifestation. In other words, dispositional properties usually seem to be present in their subjects even when such dispositional properties are not manifested or even if they are never manifested. This is part of what I had in mind when I first said that dispositional terms denote *states* of being poised to effect a change or to be changed. Thus, dispositional terms appear to denote *properties* of some kind that are responsible for these possibilities. In other words, something *x* has a potentiality, *because* of its having some other property *y*. The *toxicity* of arsenic, for example, points to its potential for causing sickness or death *because* of something essential to it as arsenic and because of something essential to the physiology of mammals. An electron repels, *because* it is negatively charged. There are also second-order dispositions, which are dispositions to acquire, modify or lose first-order dispositions.

Whatever accounts for an object's being in a particular state-of-being-poised to *effect* or to *being subject* to some causal process involving initiating conditions and a manifestation is that property's *grounds* (sometimes called *categorical base* or *causal base*). In other words, the *grounds* of a dispositional property seems to be what it is about an object that involves it in causal processes. Let us then observe this definition:

(DEF) The *grounds* of a dispositional property of a material object or substance is an intrinsic, intentional, causally-efficacious, feature.

With few exceptions, the grounds or causal base of a dispositional property is a "lower-level" physical feature of the object possessing the property. However, such physical features are usually *structures* of other lower-level dispositional properties that, in turn, may be structures of even other lower-level dispositional properties, and so "all the way down" to an apparently ungrounded disposition. These ungrounded or irreducible dispositional properties seem to have no lower-level components that could be the cause of its manifestation.<sup>10</sup> In sum, since a dispositional property *D* of some object

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10. I am indebted to the physical account given by I. J. Thompson in his unpublished manuscript "Pragmatic Ontology I: Identifying Propensity as Substance."

or substance  $x$  seems to be a state of being poised *to effect* a change (be a causal agent) or *to be* changed (be a causal subject), it involves  $x$ —by virtue of some further property of  $x$ , called *grounds*—in a type of causal process  $C$ , which has *initiating conditions* and *manifestations*.

Eventually, there are three kinds of natural dispositional properties that I want to account for: *dispositions per se*, *capacities*, and *powers*. Space precludes giving a detailed account of all of them in this paper, but let us initially say that for an object, substance or system to *have a disposition* is to be constituted in such a manner so as to be potentially *subject to* a token of a type of causal process and to *have a capacity* is to be constituted in such a manner so as to be potentially *an agent of* a token of a type of causal process. (I am using the term, “agent,” figuratively. Let us understand the term, “causal process” to denote a sequence of states that may be either deterministic or stochastic.) Each dispositional property involves an intrinsic feature called *grounds*. *Capacities* are complex dispositional properties that have at least one *power* as a component. Charge and mass are examples of basic *powers*.

There is one more crucial point that I must add to this general conception. Whether or not the causal processes associated with dispositional properties are realized depends on what the actual world plan includes. The “actual world plan,” as I use the term is a representation *for* the physical universe. It is a consistent, infinite, strict linear-order of discrete total world states or situations according to which the physical world is realized. If the mass-energy distribution depends on something else, then the actual world plan represents what that something else *realizes*. I will propose this in more detail in the section devoted to ontological explanation.

### An Analysis

We may convert these observations in the following analysis. Let

- (1)  $x$  represent an object, substance or system, and
- (2)  $\sigma_x$  represent a situation involving  $x$ , and
- (3)  $D$  represent a dispositional property, and
- (4) both  $C_x$  and  $[[\sigma_x \vDash \{i\}]^\delta \xrightarrow{\alpha} [\sigma'_x \in \{m\}]^{\delta' > \delta}]$  represent types of causal processes involving object  $x$  ( $C_x$  is an abbreviated form of the latter), where
  - (i) “ $\xrightarrow{\alpha}$ ” represents the grounds of  $D$ , and
  - (ii)  $[\sigma_x \vDash \{i\}]^\delta$  means *situation  $\sigma_x$  satisfies a set  $\{i\}$  of  $D$ 's initiating conditions within duration  $\delta$* , and
  - (iii)  $[\sigma'_x \in \{m\}]^{\delta' > \delta}$  means, *situation  $\sigma'_x$  is a token of one of  $D$ 's manifestation types occurring over duration  $\delta'$  later than  $\delta$* , and
- (5)  $C_x^* > C_x$  indicates that  $C_x^*$  is causally stronger than  $C_x$ , and
- (6)  $\alpha$  represents the actual world plan.

The analysis is this:

(AWP)  $\forall x, \forall \sigma_x, \forall D, \forall \delta, Dx\delta \leftrightarrow$

- (1)  $\alpha \sqsupset [[\sigma_x \models \{i\}]^{\delta'} \Rightarrow [\sigma'_x \in \{m\}]^{\delta'' > \delta'}]]^\delta = C_x$ , and exactly one of the following:
- (2)  $\alpha \not\sqsupset [\sigma_x \models \{i\}]^{\delta'}$ , or
- (3)  $\alpha \sqsupset [\sigma_x \models \{i\}]^{\delta'}$  and  $\alpha \sqsupset [\sigma'_x \in \{m\}]^{\delta'' > \delta'}$  and  $\forall C_x^* > C_x \alpha \not\sqsupset C_x^*$ , or
- (4)  $\alpha \sqsupset [\sigma_x \models \{i\}]^{\delta'}$  and  $\alpha \not\sqsupset [\sigma'_x \in \{m\}]^{\delta'' > \delta'}$  because  $\exists C_x^* > C_x \alpha \sqsupset C_x^*$ .

Informally, the analysis is this:

For any object  $x$ , situation  $\sigma_x$ , dispositional property  $D$  and duration  $\delta$ , *Object x has a dispositional property D* if and only if

- (1) the actual world plan includes a type of causal process (call it  $C_x$ ) grounded in a feature of  $x$  such that situation  $\sigma_x$  satisfies a set  $\{i\}$  of initiating conditions over some duration and situation  $\sigma'_x$  is a token of one of  $C_x$ 's manifestation types occurring over duration  $\delta''$  later than  $\delta'$ , and exactly one of the following, either
- (2) the actual world plan *does not* include a situation  $\sigma_x$  that satisfies a set  $\{i\}$  of  $C_x$ 's initiating conditions at  $\delta'$  or,
- (3) the actual world plan *does* include a situation  $\sigma_x$  that satisfies a set  $\{i\}$  of initiating conditions over some duration and the actual world plan *does* include a situation  $\sigma'_x$ , a token of one of  $C_x$ 's manifestation types occurring over duration  $\delta''$  later than  $\delta'$ , and the actual world plan *does not* include any causal process  $C_x^*$  that is stronger than  $C_x$  over duration  $\delta$  or,
- (4) the actual world plan includes a type of causal process  $C_x$  grounded in a feature of  $x$ , but a different causal process  $C_x^*$  interferes over duration  $\delta$ .<sup>11</sup>

Therefore, object  $x$  has a dispositional property  $D$  just in case

- (a) (1) and (2) hold, so that  $D$  is not manifested at  $\delta'$ , or
- (b) (1) and (3) hold, so that  $D$  is manifested at  $\delta'$ ,<sup>12</sup> or
- (c) (1) and (4) hold, so that  $D$  is not manifested because of some interference.<sup>13</sup>

This is the structure of the meaning of subjunctive conditional sentences, so that with some exceptions perhaps, the truth of a counterfactual conditional proposition regarding some object  $x$  depends on the dispositional structure

11. In some cases, object  $x$  becomes a part of another object  $y$ . In other cases, the fields of propensity characterizing the space within which a manifestation can occur overlap with other objects so that occurrence is a manifestation of several different objects. These cases and others have been "accounted for" in other analyses by adding *ceteris paribus* clauses.

12. For the sake of simplicity, I omit mention of cases of *degrees* of manifestation. These, of course, are presupposed by the use of differential equations to describe behavior under change.

13. This is the structure of the meaning of subjunctive conditional sentences, so that (with some exceptions, perhaps) the truth of a counterfactual conditional proposition regarding some object  $x$  depends on the dispositional structure constituting  $x$  and, thus, what the actual world plan includes. This is consistent with many who have recently claimed that, if there are causal powers (dispositions), then those powers are the truth-makers of counterfactual propositions that involve them.

constituting  $x$ . In other words, whether or not an object has a dispositional property is matter of what the actual world plan includes. However, the actual world plan's inclusion or not of some situation is not sufficient for that situation to be a "test case" to serve empiricist purposes, for we have no access to the contents of the actual world plan.

### *A Disposition: Fragility*

We are claiming that to have a *disposition* is to be constituted in such a manner so as to be *subject to* a token of a type of causal process. Let us take *fragility* as an example. Typically, the sentence "Vase  $v$  is fragile" entails " $v$  is liable to disintegration under relatively low-level stress." I now represent this in a semiformal manner. Letting " $Sv$ " represent " $v$  is stressed," " $Dv$ " represent " $v$  disintegrates," and " $Fv$ " represent " $v$  is fragile," then

$Fv\delta$  iff  $\exists\delta, \delta', \delta''$ , where  $\delta$  includes the present moment subjectively considered,  $\delta'$  and  $\delta''$ , and  $\delta'$  earlier than  $\delta''$ ,

- (1)  $\alpha \supset [[Sv]^{\delta'} \Rightarrow [Dv]^{\delta''}]^{\delta} = C_x$ , and exactly one of the following:
- (2)  $\alpha \not\supset [Sv]^{\delta'}$ , or
- (3)  $\alpha \supset [Sv]^{\delta'}$  and  $\alpha \supset [Dv]^{\delta'' > \delta'}$  and  $\forall C_x^* > C_x \alpha \not\supset C_x^{*\delta}$ , or
- (4)  $\alpha \supset [Sv]^{\delta'}$  and  $\alpha \not\supset [Dv]^{\delta'' > \delta'}$  and  $\exists C_x^* > C_x \alpha \supset C_x^{*\delta}$ .

In other words, vase  $v$  is *fragile* just in case,

- (a) (1) and (2) hold, so that *fragility* is not manifested at  $\delta'$ , or
- (b) (1) and (3) hold, so that *fragility* is manifested at  $\delta'$ , or
- (c) (1) and (4) hold, so that *fragility* is not manifested because of some interference.

What, then, accounts for the vase's breaking under case (b) where *fragility* is manifested? *Why* does the vase break? The answer has to be found in the grounds of *fragility*,  $\Rightarrow$ , which is an intrinsic, intentional, causally-efficient, feature of the vase  $v$ . This feature is complex. It involves, among other things, the relative strength of the molecular bonds of the glass. However, the so-called categorical bases (of which molecular bonding is an example) are themselves structures of dispositional properties. Therefore, *fragility* is a complex dispositional property whose grounds are the dispositional properties of its parts and its structure.

### *A Justification of the Analysis*

This account treats dispositions as *properties of objects* and as involving *types* of causal processes. As states of some object's being *subject to* or *agents of* such causal processes, dispositional properties are characterized by (1) at least one *set of initiating conditions* met by situations, (2) a *set of manifestation types* of which a manifesting event is a member, and (3) *grounds*



(an intrinsic causally-relevant structure) that accounts for both the existence of the dispositional property even when not manifested and connects events in the sequence. The condition that the actual world plan includes a disposition as a type of process differentiates this analysis from a *simple subjunctive conditional analysis* and prevents it from holding vacuously.<sup>14</sup>

However, the extensive critical attention that has been given to analyses of dispositional properties has revealed several conditions that any proposed analysis must meet. In what follows I will briefly describe five such conditions of adequacy showing how our analysis meets each of them in turn.

First of all, an adequate analysis represents a dispositional property's *being* a property of an object (essentially or accidentally). By the symbol " $\overset{\rightarrow}{x}$ " I represent that feature of an object  $x$  in virtue of which  $x$  is associated with some type of causal process and being so associated is what it means for an object  $x$  to have a disposition or a capacity.

Second, an adequate analysis represents the relevant causality of dispositional properties. In our analysis, the symbol " $\overset{\rightarrow}{x}$ " represents the *grounds* of a dispositional property of  $x$ . It also represents both the *intentionality* (that is, directedness towards a manifestation) and the *causal necessity* of a dispositional property associated with object  $x$ . It represents, that is, what it is *about*  $x$  that renders it the agent of or subject to tokens of types of causal processes.

Third, an adequate conceptual analysis represents a dispositional property's existence even when not manifesting. To show that our analysis meets this condition, it is crucial to first recognize that by " $Dx\delta$ " we represent an object  $x$ 's having a property  $D$  over some duration  $\delta$ . We want also to represent those conditions when it does not manifest. We observed earlier that to *have a disposition* is to be constituted in such a manner so as to be *subject to* a token of a type of causal process and to *have a capacity* is to be constituted in such a manner so as to be *an agent of* a token of a type of causal process. Thus, object  $x$ 's *having* property  $D$  over some duration  $\delta$  just is the actual world plan's including a type of causal process over some duration involving  $x$ 's essential nature. We represent nonmanifestation by the semiformal sentence,

$$\begin{aligned} & \text{"}\alpha \sqsubset [ [\sigma_x \models \{i\}]^{\delta'} \overset{\rightarrow}{x} [\sigma'_x \in \{m\}]^{\delta' > \delta'} ]^{\delta} = C_x, \text{ and either} \\ & \alpha \not\sqsubset [\sigma_x \models \{i\}]^{\delta'} \text{ or} \\ & \alpha \sqsubset [\sigma_x \models \{i\}]^{\delta'} \text{ and } \alpha \not\sqsubset [\sigma'_x \in \{m\}]^{\delta' > \delta'} \text{ and } \exists C_x^* > C_x \alpha \sqsubset C_x^{*\delta}. \text{"} \end{aligned}$$

This representation is an extension of the more familiar way of representing (in the language of first-order logic) an object's having a property. For example, the sentence, "Socrates is feline," may be represented in first-

14. It differs also from the *reformed conditional analysis*, from a *possible worlds analysis*, and from the *habituals analysis*. See David Lewis, "Finkish Dispositions," *Philosophical Quarterly* 47 (1997): 143–58; Elizabeth Prior, R. Partridge, and F. Jackson, "Three Theses about Dispositions," *American Philosophical Quarterly* 19 (1982): 251–7; and Michael Fara, "Dispositions and Habituals," *Noûs* 39 (2005): 43–82.



order logic as “ $F_s$ .” We say that the sentence, “ $F_s$ ,” (or the proposition it expresses) is true if, in fact, Socrates is feline. To put it another way, we might say, “The proposition, *Socrates is feline*, is true just in case the actual world plan includes the state of affairs, *Socrates’ being feline*.” In more formal terms, ““ $F_s$ ” is true just in case  $\alpha \sqsupset [F_s]^\delta$ .” By the same pattern, then, *vase v is fragile* is true if and only if the actual world plan includes a type of causal process over some duration involving  $v$ ’s essential nature. In other words, “ $F_v$ ” is true just in case  $\alpha \sqsupset [F_v]^\delta$ . But

“ $\alpha \sqsupset [F_v]^\delta$ ”

is identical to

“ $\alpha \sqsupset \llbracket [Sv]^\delta \Rightarrow [Dv]^\delta \rrbracket^\delta$  (and exactly one of three mentioned conditions hold).”<sup>15</sup>

Fourth, an adequate analysis represents the condition under which object  $x$  has disposition  $D$  while not being subject to refutation by examples of overriding processes. Recall that thinking of dispositional attributions in terms of activating and manifesting events has led many to attempt to account for dispositional properties in terms of a *simple (subjunctive) conditional analysis* of disposition attributions. C. B. Martin refuted the simple conditional analysis by giving an example of a mechanism that prevents the manifestation of the disposition because its initiating conditions trigger an overriding process.<sup>16</sup> These types of counterexamples are prevented in (AWP) by the combination of (1) and (4):

(AWA)  $\forall x, \forall \sigma_x, \forall D, \forall \delta, Dx\delta \leftrightarrow$

(1)  $\alpha \sqsupset \llbracket [\sigma_x \models \{i\}]^\delta \Rightarrow [\sigma'_x \in \{m\}]^{\delta' > \delta} \rrbracket^\delta = C_x$ , and

(4)  $\alpha \sqsupset [\sigma_x \models \{i\}]^\delta$  and  $\alpha \not\sqsupset [\sigma'_x \in \{m\}]^{\delta' > \delta}$  and  $\exists C_x^* > C_x \alpha \sqsupset C_x^{* \delta}$ ,

**where includes**  $\delta', \delta''$ , and the present moment.

In other words, such interferences occur in cases where (1) the actual world plan includes a type of causal process (call it  $C_x$ ) grounded in a feature of  $x$ , and the actual world plan includes a situation  $\sigma_x$  that satisfies a set  $\{i\}$  of  $C_x$ ’s initiating conditions at  $\delta'$ , but the actual world plan does not include another situation  $\sigma_x$ , which is a token of one of  $C_x$ ’s manifestation types occurring at duration  $\delta''$  later than  $\delta'$ , because the actual world plan does include a stronger causal process  $C_x^*$ . Clearly this does not mean that when the causal process is overridden, it is *false* that object  $x$  has disposition  $D$ . We have described in general terms conditions when dispositions are not manifested.

15. This account is the key to a metaphysics of modality and a modal logic that will fulfill the hope and desiderata outlined by Alexander Pruss: “There is hope, however, that the theistic account, *once elaborated sufficiently* [emphasis added] would end up combining the strengths of the Platonic, Aristotelian and Leibnizian accounts while avoiding most of their weaknesses” (Alexander Pruss, “The Actual and the Possible,” in *The Blackwell Guide to Metaphysics*, ed. Richard M. Gale (Oxford: Blackwell, 2002): 317–33).

16. See C. B. Martin, “Dispositions and Conditionals,” *Philosophical Quarterly* 44 (1994):1–8; and Alexander Bird, “Dispositions and Antidotes,” *Philosophical Quarterly* 48 (1998): 227–34.

Wrapping a fragile vase in bubble wrap does not remove fragility, it merely prevents its manifestation.

Fifth, an adequate analysis *represents* apparent ungroundedness of the dispositional properties of elementary particles. To reiterate what was said earlier, the grounds or causal base of a dispositional property is a “lower-level” physical feature of the object. However, such features turn out—on closer examination—to be structures of *other* lower-level dispositional properties, which, in turn, may be structures of even other lower-level dispositional properties, and so “all the way down” to apparently ungrounded disposition, that is, a dispositional property that seems to have no lower-level components that could be the cause of its manifestation. The issue of *apparently* ungrounded dispositional properties has attracted an increasing amount of attention in recent years not only from the standpoint of theoretical physics, but more so from contemporary analytic metaphysics and philosophy of science.<sup>17</sup> Electrons are the most frequently given example. As Jennifer McKittrick puts it, “a bare disposition . . . has no *distinct* causal base. . . . While fragility does not look like a good candidate for a bare disposition, perhaps some of the dispositions of fundamental particles are. Consider the property of being negatively charged, and the dispositions of negatively charged things, such as being disposed to repel other negatively charged things.”<sup>18</sup> Mauro Dorato writes, “dispositions in [quantum mechanics] are irreducible simply because there are no categorical, non-dispositional properties to which they can be reduced.”<sup>19</sup>

Given my proposed analysis, since a disposition is a state of being poised *to effect* a change or *to be* changed, a dispositional property involves a type of causal process that (usually) has activating conditions, manifestations and grounds. We must conceptualize ungrounded dispositions accordingly. The “ungroundedness” of the electron’s *charge* should not be understood as a disposition without grounds *per se*—that is, lacking a real underlying basis—but rather as dispositional property whose grounds are not a structure of *other* dispositional properties. Let us consider this same idea from another angle. Electrons are currently taken to be fundamental particles. But it is a mistake to treat them as the “smallest bits of matter” in a Democritean sense. The particle physicist, Gordon Kane calls electrons and quarks “impenetrable pointlike objects, with no apparent substructure” of other more

17. Stephen Mumford has arguably done the most to focus the issue. See Stephen Mumford, “The Ungrounded Argument,” *Synthese* 149 (2006):471–89; “Filled In Space,” in *Dispositions and Causal Powers*, 67–80; and *Dispositions* (New York: Oxford University Press, 1998). See also Rom Harré, “Is There a Basic Ontology for the Physical Sciences?” *Dialectica* 51 (1997): 17–34; George Molnar, “Are Dispositions Reducible?” *Philosophical Quarterly* 49 (1999): 1–17.

18. Jennifer McKittrick, “The Bare Metaphysical Possibility of Bare Dispositions,” *Philosophy and Phenomenological Research* 66 (2003): 349–69.

19. Mauro Dorato, “Dispositions, Relational Properties and the Quantum World,” in *Dispositions and Causal Powers*, 249–69.

basic components.<sup>20</sup> Electrons are not composites of deeper particles. Still, these “impenetrable pointlike objects, with no apparent substructure” have dispositional properties based on their charge, mass, and spin. Rom Harré says that “If charges are the sources of fields and fields are regions through which the power of the charge can be exercised, there are no attributes left with which to characterize the charge bearer, yet to answer ‘A mere point’ to the question seems to beg an important question.”<sup>21</sup> I. J. Thompson says these “pointlike” objects—these “particles”—are *nothing but* “fields of propensity.” ( This seems to make quantum entanglement conceptualizable.<sup>22</sup>) If these elementary particles—these fundamental constituents of all physical things—have no substructure of other components, on what do they depend? To reiterate, the problem of accounting for ungroundedness is *how* to account for something that appears genuinely basic. But this problem has two dimensions. The first is this:

How can ungroundedness be *represented*?

The second dimension is both a metaphysical and a physical question:

What then *is* an ungrounded disposition?

Consider first the representational problem. The grounds of a complex dispositional property is a *structure* of underlying, more basic, dispositional properties. For example, the grounds of the *fragility* of a glass vase involve the relatively weak molecular bonds in the crystalline structure of the glass. In terms of our formal analysis, electron *e*'s *charge* is grounded in an intrinsic, intentional, causally-efficacious, feature of *e* itself. But  $\Rightarrow$  is nothing more than *e*'s being negatively charged. There is no *other* entity or complex structural feature of *e* that contributes to *e*'s *being charged*. What then, *is*, an electron? More to the point, What then *is* an ungrounded disposition? That is our second question. In sum, it appears that our analysis has met the fifth condition of adequacy: even though it does not say *what* an elementary particle is, it *represents* apparent ungroundedness. Meeting these conditions coupled with the fact that our analysis does not require *ceteris paribus* clauses, recommends its acceptance.

### *An Ontology for the Analysis*

We now face the second dimension of the problem of accounting for ungroundedness: What then *is* an ungrounded or irreducible disposition? There

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20. See Gordon Kane, *Supersymmetry: Squarks, Photinos, and the Unveiling of the Ultimate Laws of Nature* (Cambridge, MA: Perseus, 2000), 16–39, and *The Particle Garden: Our Universe as Understood by Particle Physicists* (Reading, MA: Addison Wesley, 2000).

21. Rom Harré “Is There a Basic Ontology for the Physical Sciences?”

22. I. J. Thompson, “Pragmatic Ontology I.”

is currently no physical way to answer the question. Thomas Greenlee, in personal correspondence, writes,

It seems to me that you could say that properties like “mass” or “charge” have grounds, but we just don’t know those grounds yet. The apparent ungroundedness of the electron’s charge is a reflection of our state of knowledge, not of the real world. For example, the mass of a particle may be due to its interaction with the Higgs field, which would be another dispositional property. That interaction could either be a grounds or could be due to some “deeper” dispositional property.”

Other than admitting current lack of knowledge, one could consider several competing hypotheses rooted in, on the one hand physicalist (or metaphysically naturalist) assumptions and, on the other hand, theistic metaphysical assumptions. Physicalist hypotheses include the infinity of levels view, Humean supervenience, ultra-grounding, and dispositional essentialism. It is fair to say that the dominant hypothesis is dispositional essentialism.<sup>23</sup> This view, however, treats elementary particles as fields of propensity and, in turn, their ungrounded dispositional properties as brute (or ultimately inexplicable) facts. Alternatively, Ladyman and Ross: “Ontic Structural Realism (OSR) is the view that the world has objective modal structure that is ontologically fundamental.”<sup>24</sup> None of these views seems subject to empirical confirmation or falsification. So, if there are irreducible (ungrounded) dispositions, then nature is constituted (at least in part) by irreducible modal properties and most, if not all physicalist accounts run out of explanatory resources.

There are, in addition to these physicalist views, at least two theistic views. The first theistic view, which may be called *theistic impositivism*, holds that dispositional properties result from God’s imposition of regularities. John Foster, for example, thinks it crucial to distinguish between God’s creation of matter initially and God’s management of that matter subsequently. God’s manages matter by prescribing the laws matter must “obey.” He writes,

We must conclude that God creates the universe by directly creating its initial state, and by making provision for its subsequent history by prescribing the systematic ways in which its state at any given time is to give rise to its states at subsequent times. This will ensure that God imposes certain regularities on the universe as regularities, thereby

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23. More recent versions of dispositional essentialism are held by George Molnar, *Powers: A Study of Metaphysics*, ed. Stephen Mumford (Oxford: Oxford University Press, 2003); Brian Ellis, *Scientific Essentialism* (Cambridge: Cambridge University Press, 2001); Anjan Chakravartty, “The Dispositional Essentialist View of Properties and Law,” *International Journal of Philosophical Studies* 11 (2003): 393–413; and Alexander Bird, *Nature’s Metaphysics: Laws and Properties* (Oxford: Oxford University Press, 2007).

24. Ladyman and Ross, *Every Thing Must Go*, 130. Theories of quantum gravity such as *string theory*, *loop quantum gravity*, or *causal sets* seem to be the current alternatives.

creating laws; and the creation of laws will, in the standard way, furnish material objects with their dispositions.<sup>25</sup>

Foster's view exhibits the defects common to impositional (or normative rather than descriptive) metaphors of "laws of nature." It is not the metaphor of God's government of nature that I find wanting. In fact I affirm its reality. It is a fundamental belief held by all Christians that the existence, nature, and dynamics of the physical world is *ultimately due to* God's acting. I am offering a metaphysical view that treats such things *as* God's acting.

Before I introduce it, though, an important point must be recognized here. Accounting for apparently ungrounded dispositions seems not to be a purely empirical issue—at least not yet. Rather, it looks to be an issue in which metaphysical and physical theorizing may compete for or blend into the best explanation. As Albert Einstein wrote in his letter to Schrödinger (June 19, 1935), "The real difficulty lies in the fact that physics is a kind of metaphysics; physics describes 'reality.' But we do not know what 'reality' is; we know it only by means of the physical description."

On our analysis, whether or not the causal processes associated with dispositional properties are realized depends on what the actual world plan includes. But what is the actual world plan? The "actual world plan," as I use the term, is a *representation for* space-time. The "actual world plan" is composed, not of *propositions* or *states of affairs* as standardly understood in the metaphysics of modality and philosophy of science.<sup>26</sup> Rather, the "actual world plan," as I use the term, is a complete and composite *plan*. Plans (generically considered) are imagined situations that an agent intends to achieve by acting. Plans involve both actions to be taken and situations to be achieved; situations achieved once for all (such as earning a bachelors degree) or situations achieved and sustained over time (such as cultivating a good marriage). Plans (generically considered) make sense implicitly within a pre-existing causal framework of objects. On the other hand, God's plans (that is, *plans* considered in relation to God's creating/sustaining actions) were made prior to and are descriptive of space-time itself. Only one agent could fulfill the role of agent having a plan *for* space-time such that this agent's acting accordingly *constitutes* physical reality. Let us consider this more carefully.

Hebrew-Christian scripture and tradition indicate that God creates and sustains the world *ex nihilo* through and for Christ for His glory. If what scripture affirms is true, the "logic" of everything must lie in the logic of God's action. Thus, at some point, ontology must give way to divine action.

25. John Foster, *The Divine Lawmaker: Lectures on Induction, Laws of Nature, and the Existence of God* (Oxford: Oxford University Press, 2004): 165, 86–8, 114–15, 162–5, 177.

26. See Robert Adams, "Theories of Actuality," *Noûs* 8 (1974): 211–31; and Alvin Plantinga, "Two Concepts of Modality," in *Metaphysics*, Philosophical Perspectives 1, ed. James E. Tomberlin (Atascadero, CA: Ridgeview, 1987), 189–231.

This clue leads me to conjecture that the abstract objects of mathematics and logic and the ontological presuppositions of science should find an integrating ground in God's purposeful *actions* in Christ. While there are several historical and contemporary Hebrew-Christian theistic views of God and creation, the view I am urging holds that God's acting according to plan is what makes the situations comprising space-time real.<sup>27</sup> This idea is consistent with fundamental physics. Fundamental physics holds space-time to be a function of the mass-energy distribution. Robert DiSalle writes,

Almost from the beginning of general relativity, mathematicians and physicists [saw it] as a theory of the geometrical structure of the world. . . . it represents the geometry of space-time as a function of the mass-energy distribution. . . . a dynamical structure whose states depend on the states of the matter and energy within it.<sup>28</sup>

A realized aspect of space-time is a physical phenomenon that should be explained in terms of God's acting. On our view, the mass-energy distribution is the direct manifestation of God's creating/sustaining action. God's acting sequentially according to plan gives it its dynamical nature<sup>29</sup> and accounts for our perception of the passage of time. That is, while the actual world plan is God's plan in Christ, the *spatiotemporal world* is, from our perspective, God's plan as it has been partially realized, is now being realized piece by piece and will be realized in full by God. Thus, every space-time situation is a state of God's creative relation to creation.

An analogy may be useful here. Tim Maudlin advocates a physicalist metaphysics, taking laws of nature as ontologically primitive. In addressing the question of how the passing of time should be represented mathematically, he considers "some intrinsically time-directed representational medium" such as music.<sup>30</sup> I think it an apt analogy. This mass-energy distribution constituting physical space-time is nothing other than God's acting accord-

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27. The actual world plan's being God's plan for creation is what makes propositions about the world true. However, the actual world plan's inclusion or not of some situation is not sufficient for that situation to be a "test case" to serve empiricist purposes, for we have no access to the contents of the actual world plan.

28. Robert DiSalle, *Understanding Space-time: The Philosophical Development of Physics from Newton to Einstein* (Cambridge: Cambridge University Press, 2006): 15, 16. Mauro Dorato writes, "within an ontological option in which there are irreducible dispositions of the GRW [acronym for the Ghirardi, Rimini, Weber interpretation of quantum mechanics] type, it is reasonable to follow Bell . . . and assume that *physical Spacetime*, regarded as the set of localized physical occurrences, is just *constituted by or identical with* the set of all 'flashes,' or localizations, occurring at a precise location at a certain time. . . . the collection of such localization events that constitute both physical Spacetime and the world around us. . . ." ("Properties and Dispositions: Some Metaphysical Remarks on Quantum Ontology," in *Quantum Mechanics*, ed. A. Bassi, D. Dürr, T. Weber, N. Zanghi, *American Institute of Physics Conference Proceedings* 844 (2006): 139–57.

29. This is a form of the traditional view called "continuous creationism."

30. Tim Maudlin, *The Metaphysics within Physics* (Oxford: Oxford University Press, 2007): 135–42.

ing to plan and perceived as manifested dispositions and described by laws of nature. The world states comprising the actual world plan are intentional objects in God's mind as God's plans.

This provides a way to synthesize two views of time referred to as the "A-theory" and the "B-theory." The A-theory (sometimes called the *presentist*, *dynamic*, or *tensed* view of time) holds that the apparent distinction between the past, the present, and the future is objectively real, though only the present moment is real.<sup>31</sup> The B-theory (sometimes called the *eternalist*, *static*, or *tenseless* view of time) holds that all times and their contents are equally real and stand in a *earlier-than* relation to each other. Like sheet music to a musician: on the page, the music is B-theoretical; as performed the music is A-theoretical. Like a play to its director: the script is B-theoretical; as performed: A-theoretical. Like a recording to a music lover: on the recording B-theoretical; as played, A-theoretical. Physical time is God's sequential acting and is A-theoretical. However, though God's being seems to constitute metaphysical time, God's plan is B-theoretical. Therefore, times and durations are real as segments of God's plan.

Thus, the actual world plan is a consistent, infinite, strict linear-order of discrete total plans (that is, special "world states") according to which God acts, thereby achieving his purposes. How does the actual world plan conceived this way relate to dispositions, powers and capacities? How does this view close the explanatory gap left open in purely impositional views? The length of this paper permits little more than a précis in lieu of a detailed proposal. Scripture frequently mentions God's *ways*. God's ways are different types of God's "actings" in realizing his chosen plans. I am conjecturing that among God's ways may be his *commitments to acting on condition*, his *constant actings*, and his *patterns of unifying* these two. If the conjecture is plausible, then dispositions (ontologically considered) may be construed as God's constant, invariable commitments to act on condition. In other words, what we perceive as dispositional properties are actually *God's constant, invariable commitments to act in a determinate way A, upon the complete (or proportionate) satisfaction of some condition C*. *Mass* (or something "behind" it such as interaction with the Higgs field) and *charge* are two causal powers that (ontologically considered) are *God's constant actings*.<sup>32</sup> Such powers seem to be the sources of the *forces* of gravity and electromagnetism. This reverses the Humean mechanistic view that such forces are the sources of powers. Furthermore, when a class of elementary particles exhibits just

31. Some presentists hold that both the past and present are real.

32. If the power for libertarian-free choice is the (contingently) causally-immune and (contingently) causally-impotent power of proximal intention formation, it could be included among the category of causal powers as a *bestowal* and this would address the problem of evil. See Walter Schultz, "No-Risk' Libertarian Freedom: A Refutation of the Free Will Defense," *Philosophia Christi* 10 (2008): 183–200. Also, what appear to be *stochastic processes* or *propensities* can, with sufficient refinement, be subsumed under this category of *constant actings*.



three dispositional properties, *spin*, *charge*, and *mass*, then there must be *something else* that accounts for these three properties being “held together,” as it were. There must be some kind of *structural* component over and above the dispositional properties. Given the ontology we are urging, these *structures* are *patterns* of God’s unifying; they are patterns of God’s acting simultaneously in various ways. Some of God’s unifying constitute the strong nuclear force. Therefore, every object is *nothing* but a structured unity of dispositions, capacities and powers,<sup>33</sup> which are God’s ways of acting according to plan. Here we have continual, discrete creation *ex nihilo*. Lee Smolin, who repeatedly rules out the legitimacy of using theistic explanatory factors, nevertheless writes that “We cannot understand the world we see around us as something static. We must see it as something created, and under continual recreation, by an enormous number of processes acting together. The world we see around us is the collective result of all those processes.”<sup>34</sup> The theist need not oppose Smolin on this point.

Now let us examine this more closely. By the symbolism,

$$\alpha \supset \llbracket [\sigma_x \vDash \{i\}]^{\delta'} \Rightarrow [\sigma_x' \in \{m\}]^{\delta'' > \delta'} \rrbracket^{\delta},$$

we represent the actual world plan’s including a type of causal process over time. The actual world plan’s including a type of causal process over time just *is* an aspect of God’s plan. It *is identical to* God’s being committed to acting on condition.<sup>35</sup> Consider the following analogy. Becoming a soldier involves *making a commitment* to take guard duty at some later time and *being on guard duty* during that later time is to be committed to acting on condition. Thus, the soldier makes an initial, yet enduring commitment (that is, he plans). That plan or commitment, in turn, involves him in later being committed over a defined duration to sounding an alarm when danger approaches. Likewise, the actual world plan’s including a type of causal process over a duration *is identical to* God’s commitment to later being committed to act on condition—and such a *later being committed* is an object *x*’s state of being subject to a type of causal process over some duration  $\delta$ . This

33. Note the similarity to what William Vallicella claims: “(PT) Necessarily, for any contingent individual *x*, *x* exists if (i) there is a necessary *y* such that *y* is the paradigm existent, and (ii) *y*, as the external unifier of *x*’s ontological constituents, directly produces the unity/existence of *x*” (William Vallicella, *A Paradigm Theory of Existence: Onto-Theology Vindicated* (Dordrecht: Kluwer Academic, 2002), 269). On our view there are not both objects and dispositional properties.

34. Lee Smolin, *Three Roads to Quantum Gravity* (New York: Basic Books, 2005), 64.

35. I. J. Thompson, in correspondence, has called into question my identifying God’s commitments to act and God’s acting with dispositions and powers, respectively. He recommends, instead, that I claim only a derivative relation. Failing to do so, in his opinion, risks confusing the spiritual with the natural and may oversimplify the relation between spiritual and physical realities. Perhaps he is correct, but maybe the relation *is* just that simple. If so, then although there is undeniable wisdom in hedging one’s claims by the use of a derivative relation, it would be mistaken. For the sake of pursuing a more detailed metaphysics, I will take the risk of commitment to the identity relation.

is what gives an object's dispositional property its apparent necessity and intentionality. It is nothing other than an omnipotent, faithful creator's commitment to act according to plan. Finally, since (1) the *realization* of some type of causal process *C* just is God's acting sequentially in accordance with that type and (2) an object *x*'s state of being subject to a type of causal process over some duration  $\delta$  is *identical* to one of God's current commitments to act on condition, then object *x*'s *undergoing* that causal process involves both God's commitment to act *and* his acting.

Putting all of this another way, Hebrew-Christian scripture indicates that God created the heavens and the earth and upholds them by the word of his power. The term, "heavens and the earth," is sometimes a synonym for "the universe," "the natural world," and "the causal nexus." Here then is a crucial point: God *cannot* sustain the causal nexus by means of the causal nexus. I claim that God's actions *constitute* the causal nexus; the causal nexus is *constituted by* God's ways of acting according to plan. This differentiates our theistic account from Foster's. It seems to be the type of theistic natural philosophy Newton was advocating. It fulfills William Lane Craig's admonition: "(God's) omnipresence should be explicated in terms of His being aware of *and causally active in* at every point in space."<sup>36</sup> Note that Jonathan Edwards urged something similar: "to find out the reasons of things in natural philosophy is only to find out the proportion of God's acting."<sup>37</sup>

Therefore, God's actions are related to the very existence (and internal dynamics) of the causal nexus by an entirely different kind of relation than is empirically ascertainable. The latter, God's actions, are apprehended or cognized by humans in two ways. The first is as objects having properties and standing in relations in space and time. But these things and human cognition of them are nothing more than structured unities of dispositions, capacities and powers. The second way God's actions are apprehended or cognized by humans is as "laws of nature." Ontologically considered, laws of nature (*as laws of succession*) are patterns or regularities in God's acting according to plan; *laws of coexistence* are the coordination of God's acting according to plan. As these regularities and co-ordinations of God's actions are perceived and conceived, "laws of nature" are descriptions of phenomenal regularities, where such phenomena are the manifestations of dispositions. Thus, laws as phenomena depend on dispositions instead of dispositions being determined by laws. This view differs from earlier theological views of laws of nature as *imposed* or as *governing* objects and events. As Roland Omnès puts it,

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36. William Lane Craig, *Time and the Metaphysics of Relativity* (Dordrecht: Kluwer Academic, 2001), 241 (emphasis added).

37. Jonathan Edwards, "The Mind" in *The Works of Jonathan Edwards*, vol. 6, *Scientific and Philosophical Writings*, ed. Wallace E. Anderson (New Haven: Yale University Press, 1980), 353.

. . . the fundamental laws of nature are pure mathematical forms accounting for the phenomena though providing no cause for them and showing no action . . . The laws expressing the regularities of reality are much more accessible to understanding than reality itself. . . They are prior to mathematics, however, just as reality is absolutely prior to anything.<sup>38</sup>

Now replace the word “reality” with “God’s actings” in the Omnès quotation, and it expresses the view I am proposing.<sup>39</sup>

There are only three kinds of fundamental things: God, God’s plans, and God’s ways of acting according to plan. Some may object that this is blatant occasionalism. I doubt that any rejoinder could improve on what Hugh McCann and Jonathan Kvanvig say:

the creative action of God is the only viable hypothesis, the only way of accounting for the being of anything that has a glimmer of a chance of being true. . . . We take this to be the positive import of occasionalism, and a legitimate accompaniment of the theories of divine sustenance and providence. The negative import often associated with occasionalism—that scientific laws have no legitimate standing, that there are no genuine interactions among the things God creates—we do not defend.<sup>40</sup>

I think what I have presented here is *positive* occasionalism, because it gives us a way to view not only scientific laws as legitimate descriptions of reality but also dispositions, powers, and the referents of other fundamental concepts or presuppositions of science.

Perhaps the most poignant way to conclude is to quote Mauro Dorato again:

It must be granted that introducing physical dispositions is implicitly admitting that there is something we don’t understand. Admitting an in-principle lack of any categorical basis to which dispositions could be reduced, in both the non-collapse views [of quantum mechanics] and Bohr’s seems a way to surrender to mystery.<sup>41</sup>

Mystery, yes. But maybe there is no complete mystery; maybe every thing’s nature and existence depends solely on God’s unmediated willing its nature and existence.<sup>42</sup>

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38. Roland Omnès, *Converging Realities: Toward a Common Philosophy of Physics and Mathematics* (Princeton: Princeton University Press, 2005).

39. This is consistent with I. J. Thompson, “The Consistency of Physical Law with Divine Immanence,” *Science and Christian Belief* 5 (1993): 19–36.

40. Hugh McCann and Jonathan Kvanvig, “The Occasionalist Proselytizer: A Modified Catechism,” *Philosophical Perspectives* 5 (1991): 587–615.

41. Mauro Dorato, “Properties and Dispositions,” 139–57.

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