Chapter 11
Derivative Dispositions and Multiple Generative Levels

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11.1 Introduction

Recently, much philosophical work has emphasized the importance of *dispositions* for realistic analyses of causal processes in both physics and psychology. This is partly because of the attractiveness of the thesis of *dispositional essentialism*, which holds that all existing things have irreducible causal powers, and such views are advocated in (Bird, 2004; Cartwright, 1983; Chakravartty, 2003; Elder, 1994; Ellis, 2000, 2001; Ellis and Lierse, 1994; Fetzer, 1977; Harré and Madden, 1975; McKitrick, 2003; Molnar, 2004; Mumford, 1995, 1998; Shoemaker, 1984; Swoyer, 1982 and Thompson, 1988). The thesis opposes the views of (Ryle, 1949: ch. 5) who sees dispositions as merely 'inference tickets' or 'promises', and (Armstrong, 1969) who sees them as derived from universal laws combined with non-dispositional properties. (Mumford, 2005) articulates a common aspect of dispositional essentialism, to imagine how the concept of universal laws could be rather *replaced* by talk of specific objects and their dispositions.

Recent critics of dispositional essentialism have pointed, for example, at Least Action Principles (Katzav, 2004), and Gauge Invariance Principles (Psillos, 2006), both of which principles appear to be independent laws that do not follow the pattern of aggregations with dispositions of the constituents. It might therefore appear that we have to move our understanding beyond that of simple dispositions. Related complexities are described in the works of (Krause, 2005) and (Stachel, 2005); who consider the difficulties arising from the identity of indistinguishable particles in quantum mechanics.

Certainly in physics and elsewhere, there are a great number of dispositional ideas such as *force*, *potential*, *propensity* that we should try to understand more systematically. There are other ideas of *energy*, *probability* and *virtual fields* that could well be linked with concepts of dispositions. Maybe a more sophisticated theory of dispositions will allow us to make headway in understanding least action principles

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and gauge invariance within the framework of dispositional essentialism. I therefore continue the analysis of *kinds* of dispositions using suggestions from physics, to consider the possibility of what I will call *derivative dispositions*, and later consider whether these together may form a structure of what may be called *multiple generative levels*. This paper therefore consists of proposals for what those concepts might mean, and analyses of examples in physics and psychology that appear to need such concepts for their understanding. We will need to distinguish cases whereby new dispositions come about from rearrangement of parts, from possible cases where they are 'derived' or 'generated' in some more original way.

11.2 Beyond Simple Dispositions

11.2.1 Changing Dispositions

Most examples of dispositions in philosophical discussions are those, like fragility, solubility, radioactive instability, whose effects (if manifested) are *events*. If a glass exercises its fragility, it breaks. If salt shows its solubility, it dissolves, and the manifestation of radioactive instability would be a decay event detected say with a geiger counter. However, physicists want to know not merely *that* these *events* occur, but also *how the dispositions themselves may change* after the manifestation event. In the cases here, the fragility of the parts or the stability of the nuclei may change as a result of the manifestation events, and it is an important part of physics to describe the new (changed) dispositions as accurately as possible. Such descriptions are part of more comprehensive dynamical theories, as distinct from descriptive accounts of events.

Sometimes, *new* dispositions may be ascribable after an event that could not have been ascribed before the event. The fragments of a broken glass may be able to refract light in a way that the intact glass could not, for example. The dissolved salt may be to pass through a membrane, in contrast to the dispositions of the initial salt crystals. The fragments arising from a nuclear decay may possibly decay by emitting electrons in a way the parent nucleus could not.

In general, it often appears that new dispositions may be truthfully ascribed as the result of a prior disposition's operation. When this happens, as in the above examples, it at least appears that new dispositions come into existence as the manifestation of previous dispositions. Since now one disposition leads to another, some philosophical analysis is called for.

11.2.2 Rearrangement Dispositions

The existence of some of these new dispositions may perhaps be successfully explained as the rearrangement of the internal structures of the objects under discussion, when these are composite objects. The refraction by pieces of broken glass, in contrast to the original smooth glass, has obvious explanations in terms of the shapes of the new fragments. Salt's diffusion through a membrane, once dissolved, is presumably because of the greater mobility of salt ions in solution compared with the crystal form.

Science is largely successful in explaining such dynamical evolutions of empirical dispositions of natural objects. It bases the explanations in terms of changes in their structural shapes and arrangements of their parts, along with the fixed underlying dispositions or propensities of these parts. It is from the dispositions of these parts that, according the structure, all their observed dispositions and causal properties may be explained.

The existence of new dispositions by rearrangement of the parts of an object may be taken as non-controversial within existing philosophical frameworks. It appears that typical philosophical analyses can readily accommodate the way the derivative dispositions of an *aggregate* are explained in terms of recombinations of the dispositions of its parts.

11.2.3 Derivative Dispositions

However, it appears that not all dynamical changes of dispositions occur by rearrangements of parts, and those that are *not* rearrangements are what in this paper I want to call *derivative dispositions*. There are some cases, to be listed below, where new dispositions come into existence, without there being any known parts whose rearrangement could explain the changes. The next section gives some examples from physics and psychology of what appear to be such derivative dispositions, and this is followed by a more general analysis of how these might work.

11.3 Examples of Derivative Dispositions

11.3.1 Energy and Force

If we look at physics, and at what physics regards as part of its central understanding, one extremely important idea is *energy*. Physics talks about kinetic energy as energy to do with motion, and potential energy as to do with what *would happen* if the circumstances were right. More specifically, if we look at definitions of force and energy which are commonly used to introduce these concepts, we find definitions like

- *force:* the tendency F to accelerate a mass m with acceleration F/m.
- *energy:* the capacity E to do work, which is the action of a force F over a distance d,
- *potential energy field:* the field potential $V(x)$ to exert a force $F = -dV/dx$ if a test particle is present.

Furthermore, we may see a pattern here:

- *potential energy field:* the *disposition* to generate a *force*, and
- *force:* the *disposition* to accelerate a mass, and
- *acceleration:* the final result.

We cannot simply identify for example 'force' and 'acceleration', because, as (Cartwright, 1983 points out, force is not *identical* to the product *ma*: it is only the *net force* at a point which can have that effect. An individual force is only by itself a tendency which may or may not be manifested. It is a disposition, as is energy generically, as well as potential energy. It is generally acknowledged that 'force' is a disposition: my new point is that it cannot be reduced either to 'acceleration' or 'energy'.

I therefore take these as an example of two successive *derivative dispositions*, where the effect of one disposition operating is the generation of another. An electrostatic field potential is a disposition, for example, the manifestation of which – when a charge is present – is not itself motion, but which is the presence now of a derivative disposition, namely a force. The manifestation of a force – when acting on a mass – may or may not occur as motion, as that depends on what other forces are also operating on the mass. The production of a force by a field potential does not appear to be something that occurs by means of the rearrangements of microscopic parts, but appears to be more fundamental, and almost sui generis. It appears that *field potentials*, *force* and *action* form a set of multiple generative levels, and this situation is clearly in need of philosophical inspection.

Admittedly, many physicists and philosophers often manifest here a tendency to say that *only* potential energy is 'real', or conversely perhaps that 'only forces are real', or even that 'only motion is real', and that in each case the other physical quantities are only 'calculational devices' for predicting whichever is declared to be real. Please for a while apply a contrary tendency to resist this conclusion, at least to the end of the paper. In Section 11.5 I will be explicitly evaluating such reductionist strategies, along with a discussion of the comparative roles of mathematical laws and dispositional properties within a possible dispositional essentialism.

11.3.2 Sequences, or Levels?

We normally *think* of energy, force and acceleration as the sequential stages of a process. However, in nature, there is still energy even after a force has been produced, and forces continue to play their roles both during and after accelerations. This means energy does not finish when force begins, and force does not finish when acceleration begins, but, in a more complicated structure, all three continue to exist even while producing their respective derivative dispositions. The best way I can find to think better of this more complicated structure is that of a set of 'multiple generative levels'. In this way we can think of a 'level of energy' which persists even while it produces forces, and is 'level of forces' even as they produce accelerations.

Admittedly the idea of a 'level' is a spatial metaphor for what is not itself spatial, but the metaphor still serves to illustrate my argument.

11.3.3 Hamiltonians, Wave Functions and Measurements

In quantum physics, energy (the total of the kinetic and potential energies) is represented by the Hamiltonian operator $\hat{H}$. This operator enters into the Schrödinger wave equation $\hat{H}\ \Psi(x,t) = i\hbar\partial\Psi(x,t)/\partial t$, which governs all quantum wave forms $\Psi(x,t)$. It thus generates all time evolution, and hence all fields of probabilities $|\Psi(x,t)|^2$ for measurement outcomes. The principal dynamics in quantum physics are specified by knowing what the initial state is, and what the Hamiltonian operator is. These remarks apply to quantum mechanics as it is practised, by using Born's statistical interpretation and then naively saying that the quantum state changes after a measurement to one of the eigenstates of the measurement operator. (This is the much discussed 'reduction of the wave packet', which we may agree at least appears to occur.)

We may therefore consider quantum physics in the following 'realistic' way. We have the Hamiltonian which is to do with total energy, which is somehow 'active' since it is an *operator* which operates on the wave function and changes it. The Schrödinger equation is the rule for how the Hamiltonian operator produces the wave function, which is a probabilistic disposition (a propensity) for action. This wave function (in fact its squared modulus) gives a probability for different of macroscopic outcomes of experiments, and the wave function changes according to the specific outcome.

Such is the structure of quantum physics as it is practised, and we may observe a sequence of derivative dispositions in operation:

- *Hamiltonian operator:* the fixed disposition to generate the wave function by evolving it in time,
- *wave function:* the probabilistic disposition (a 'propensity wave') for selecting measurement outcomes, and
- *measurement outcome:* the final result.

It appears again that we have multiple generative levels, with the set of *Hamiltonian*, *wave function* and *selection event*. Note here also that the final result is the weakest kind of 'minimal' disposition, which influences merely by selection, because it *is* a selection. It appears as the last of a sequence of derivative dispositions, as a kind of 'bottom line' if we want to include it within the framework of multiple generative levels.

Admittedly again, reductionist tendencies may be applied. Most commonly, it may be denied that there are distinct measurement outcomes in any ontological sense, and that they may only be approximately defined within a coarse-grained 'decoherent history'. Advocates of the Many Worlds Interpretation, or of Decoherence theories, take this view. Others such as Bohr take the opposite view:

he holds that only the measurement outcome is real, and that the Hamiltonian and wave function are calculational devices and nothing real. These views in tension will be discussed in Section 11.5.

11.3.4 Virtual and Actual Processes

Taking a broader view of contemporary physics and its frontiers, we may further say that the 'Hamiltonians, wave functions and measurements' of above describe just the dispositions for a class of 'actual processes'. The Hamiltonian is the operator for the total energy, containing both kinetic and potential energy terms. However, we know from Quantum Field Theory (QFT) that, for example, the Coulomb potential is composed 'in some way' by the exchange of virtual photons. Similarly, we also know from QFT that the mass in the kinetic energy part is not a 'bare mass', but is a 'dressed mass' arising (in some way) also from many virtual processes. This again suggests the theme of my paper: that the Hamiltonian is not a 'simple disposition', but in fact is *itself derivative* from some prior 'generative level'. In this case the needed generative level could be called that of 'virtual processes', in contrast to that of 'actual processes'.

The class of virtual processes, as described by QFT, have many properties that are opposite to those of *actual* processes of measurement outcomes. Virtual events are at points (not selections between macroscopic alternatives), are interactions (not selections), are continuous (not discrete), are deterministic (not probabilistic), and have intrinsic group structures (e.g. gauge invariance, renormalisation) as distinct from the branching tree structure of actual outcomes. All these contrasts (which I do not have the space to expound here) suggest that virtual processes should be distinguished from actual events. The guiding principles have different forms: virtual processes are most commonly described by a Lagrangian subject to a variational principle in a Fock space of variable particle numbers, whereas actual processes, as discussed above, deal with the energies of specific observable objects leading to definite measurement outcomes.

It is more certain that virtual processes form a simultaneous 'level' in addition to the 'level' of Hamiltonians, propensities and measurements. This is because virtual processes are clearly occurring perpetually and simultaneously with Hamiltonian evolution, as they are necessary to continually 'prepare and form' the 'dressed' masses and potentials in the Hamiltonian. Dressed masses and potentials persist during Hamiltonian evolution. In atoms and molecules, virtual processes such as photon exchanges to generate the Coulomb potentials exist continuously as a kind of background for observable processes.

11.3.5 Pregeometry and the Generation of Spacetime

Field theories such as QFT still use a geometric background of spacetime, and there is currently much speculative work in quantum gravity research to determine how this spacetime might arise. Wheeler started interest in ‘pregeometry’: the attempt to formulate theories of causal processes which do not presuppose a differentiable manifold for spacetime. Rather, his aim was to encourage speculation as to how spacetime might *arise*. Most commonly, the task has been taken as showing how spacetime may turn out to be a ‘statistical approximation’ in some limit of large numbers of hypothetical pregeometric processes. Proposals have involved spinors by (Penrose, 1987); ‘loop quantum gravity’ as described for example in (Rovelli, 1998); and ‘causal sets’ according to (Brightwell et al., 2003).

If some pregeometry could be identified, I would speculate that a good way of seeing this would be as a distinct pregeometric level within a structure of derivative dispositions. That is, instead of spacetime being a statistical approximation (in the way thermodynamics is a statistical approximation to molecular gas theories), it could be better imagined that spacetime is an aspect of derivative dispositions that have been generated by ‘prior’ pregeometric dispositions. This is admittedly speculative, but it does follow the pattern of some current research, so I use it as an example of how the philosophical analysis of dispositions may yet interact fruitfully with modern physics. This appears to be useful particularly since the very aim of ‘deriving spacetime’ has itself been called into question by (Meschini et al., 2005).

11.3.6 Psychology

There are many examples of apparent derivative dispositions in everyday life, in psychology, in particular in cognitive processes. Such dispositions are involved whenever the accomplishment of a given disposition requires the operation of successive steps of kinds different from the overall step. The original disposition on its operation therefore generates the ‘derived dispositions’ for the intermediate steps, which are means to the original end. An original ‘disposition to learn’, for example, can generate the derived ‘disposition to read books’, which can generate further ‘dispositions to search for books’. These dispositions would then generate dispositions to move one’s body, which in turn lead ultimately to one’s limbs having (physical) dispositions to move. These successively generated dispositions are all *derived* from the original disposition to learn, according to the specific situations.

Another example of sequential and derivative dispositions is the ability to learn. To say that someone is easy to teach, or that they are musical, for example, does not mean that there is any specific action that they are capable of doing. Rather, it means that they well disposed to learn new skills (whether of a musical or of a general kind), and that it is these new skills which are the dispositions that lead to specific actions.

In this I follow (Broad, 1925): that there are ‘levels’ of causal influence. We might allow that particular dispositions or intentions are best regarded not as the most fundamental causes, but as ‘intermediate stages’ in the operation of more persistent ‘desires’ and ‘motivations’. The intention to find a book, for example, could be the product or derivative of some more persistent ‘desire for reading’, and need only be produced in the appropriate circumstances. Broad would say that the derived dispositions were the *realisation* of the underlying dispositions. These are called 'levels' rather than simply 'sequences' because the underlying motivation still exists during the production of later levels: it operates simultaneously with the derivative dispositions. It is not the case that 'desire for reading' ceases during the act of reading, for it is rather then at its strongest and in fulfilment.

11.4 Analytical Scheme

11.4.1 Generative Sequences

The first general idea is that 'multiple generative levels' are a sequence $\{A \rightarrow B \rightarrow C \rightarrow ..\}$ in which A 'generates' or 'produces' new forms of B using the present form of B as a precondition. We say that B derives from A as its manifestation. Then B generates C in the same way. This sequence may perhaps continue until an end Z, say, where the only activity is the 'selection' described below.

This rough scheme does not tell us, however, how A, B, etc might be *changed* as a result of their operation. Presumably this occurs often, as for example in naive quantum theory, when a wave function is changed after it generates a particular measurement outcome. We want to consider the philosophy for a general scheme which might explain the (apparently mysterious) logic of the 'reduction of the wave packet'. In order to formulate such a general scheme, let us extract some guidelines from our example derivative dispositions listed previously. To do this, we will need to first distinguish the concepts of principal from instrumental and occasional causes.

11.4.2 Principal, Instrumental and Occasional Causes

(Davidson, 1967) argues that causality is a two-place relation between individual events. Thus causal relations are certainly not just implications from the description of the first event to that of the second event, but are something more real. The reality of causality, however, does not thereby automatically include such components as dispositions and propensities, although (Steiner, 1986) wants to extend Davidson's ideas in this direction. In the present paper, I want to allow *both* dispositions *and* previous events to be causes, although in different senses.

Thus I recommend that distinctions ought to be made between all of the following:

- the 'Principal Cause': that disposition which operates,
- the 'Occasional Cause': that circumstance that selects which dispositions operate,
- the 'Instrumental Cause': the origin of the occasional cause, so is another cause by means of which the Principal Cause operates.

The overall pattern is therefore that 'Principal causes operate according to occasional causes, which arise from instrumental causes'.

All three kinds of causes appear to be necessary for any event in nature, for example, when a stone is let fall: the principal cause is the earth's gravitational attraction, the occasional cause is our *act* of letting go, and instrumental cause is the muscle movements in our finger releasing the stone. Its hitting the ground is thus caused by our letting go, but only as an instrumental and then occasional cause. Many common uses of 'cause' (including that of (Davidson, 1967)) refer to occasional causes rather than principal causes, as it is only in this 'occasional' sense that *events* can be said to be causes. Previous events cannot be efficacious causes, (Emmet, 1984) points out, in the sense of 'producing' or 'giving rise to' their effects, since events per se are not themselves powers, but clearly they do make some difference whether they happen or not. This is because events are the changes in powers, but change itself is not a power but the property of powers. The instrumental cause *is* a genuine causal contributor, and may be said to 'set the stage', by making suitable conditions (namely, the occasional cause) for selecting the operation of the principal cause.

I acknowledge that using the phrase 'occasional cause' brings in perhaps an unnecessary amount of philosophical debate, but I see essentially the same questions occurring here as there. We need some generic concept to refer to the circumstances, conditions, or occasions that must obtain in order for a disposition to manifest itself.

11.4.3 Causal Sequences in Physics

Consider now a electron of fixed charge and mass moving in an electrostatic potential, according to classical electrostatics. At a given place x, the derivative of the potential $V(x)$ gives the force, and the force gives acceleration which in turn changes the velocity of electron, and it moves to a new place. In our framework of derivative dispositions, we see that the potential is a disposition which generates another, namely the force. It does so, moreover, according to the place of the electron. The electrostatic potential is therefore the principal cause of the force, and the place of the electron is the occasional cause. A place or any other spatiotemporal property *by itself* is never an efficacious cause, but it can be said to be the circumstance by means of which the potential generates the force. In general, when we include magnetism and radiation, such properties will include velocities and accelerations. Perhaps these properties will themselves require further dispositional analyses as in (Lange, 2005).

Note that we never have forces causing potentials to exist where they did not before, nor can places. Let us generalise by surmising a set of generative levels {Potential $\rightarrow$ Force $\rightarrow$ Places}, such that the principal causation is always in the direction of the arrow, and the only 'backward' causation is by selection with an occasional cause. The only feedback 'back up the sequence' is therefore with the conditional aspect of certain occasions. The specific operation of prior dispositions does not happen continually or indiscriminately, so needs to be selected, and thus there is an essential role for 'particular occasions' as preconditions.

Consider secondly the quantum mechanical evolution of a system from time t_0 that is subject to measurement selections at various later times t_1, t_2, etc. The quantum mechanical story is as follows. The initial quantum state $\Psi(t_0)$ is evolved according to the Schrödinger equation by the Hamiltonian $\hat{H}$ for $t < t_1$. Consider the measurement for operator $\hat{A}$ occurring at $t = t_1$, the operator having an eigen-expansion $\hat{A}u_\lambda = a_\lambda u_\lambda$. In practical quantum mechanics, the quantum state changes to $\Psi(t_1^+) = u_\lambda$ if the result of the measurement is the eigenvalue a_λ, which occurs with probability $p_\lambda = |< u_\lambda|\ \Psi(t_1) >|^2$. The new state $\Psi(t_1^+)$ is then evolved similarly for $t < t_2$, the time of the next measurement.

Seen in terms of derivative dispositions, the Hamiltonian is the disposition to evolve an initial state $\Psi(t_0)$ to new times t, generating $\Psi(t) = \exp(-i\hat{H}t/\hbar)\Psi(t_0)$. The new $\Psi(t)$ are themselves another disposition, namely a propensity to produce measurement outcomes with the various probabilities $p_\lambda = |\ < u_\lambda|\Psi(t) >\ |^2$. The final results are the discrete selection events at the times of measurement. These discrete events have themselves only the minimal causal powers as they influence the future evolutions of the wave function. In that sense, they are in our scheme just the 'occasional causes' according to which other dispositions may operate. The principal dispositions are first the Hamiltonian operator that starts the whole process, and then the wave functions considered as fields of propensity for different selection events.

Summarising the quantum mechanical case, we see that here again, the principal causes act 'forwards' down a set of multiple generative levels, yet whose range of actions at any time is selected from all those presently possible, as constrained by past events. Those events thereby become occasional causes. Because the wave functions before a measurement event are the cause of that event, those wave functions are thereby the instrumental cause of the new wave functions after the measurement.

11.4.4 Conditional Forward Causation

From our examples, we may generalise that all the principal causation is 'down' the sequence of multiple generative levels $\{A \to B \to \ldots\}$, and that the only effect back up the sequence is the way principal causes depend on previous events or occasions to select their range of operation. Let us adopt as universal this asymmetric relationship between multiple generative levels: *that dispositions act forwards in a way conditional on certain things already existing at the later levels*. We regard this as a simple initial hypothesis, and will have to observe whether all dispositions taken as existing in nature can be interpreted as following this pattern.

We may therefore surmise that A, the first in the sequence, is the 'deepest underlying principle', 'source', or 'power' that is fixed through all the subsequent changes to B, C, etc. Conditional Forward Causation, the pattern we saw from physics, would imply that changes to B, for example, come from *subsequent* operations of A, and not from C, D,.. acting in 'reverse' up the chain. We would surmise, rather, that the *subsequent* operations of A are now conditioned on the results in B, C, D, etc. The operations of A are therefore the *principal causes*, whereas the dependence of those operations on the previous state of B is via *instrumental causation*, and the dependence on the results in C, D,... is via *occasional causation*. I would like to suggest that this is a universal pattern for the operation of a class of dispositions in nature, namely those that do not follow from the rearrangement of parts of an aggregate object.

11.5 Reductionism and Dispositional Essentialism

In all the apparent examples of multiple generative levels given here, many physicists and philosophers of physics will want to assert the particular ‘reality’ of one of the levels, and say that the prior levels are ‘merely calculational devices’ for the behaviour of their chosen real level.

For example, some assert in electromagnetic theory that only the field tensors (incorporating the electric and magnetic vector fields) are ‘real’, and that the vector potential (incorporating the electrostatic potential) is a calculational device with no reality. To this end, they note the gauge uncertainties in the vector potential, which for electrostatics is the arbitrariness in setting the level of zero potential energy. Against this, many have noticed that the scattering of electrons in the Bohm-Aharonov experiment is most succinctly explained in terms of the vector potential, not the field tensor. It turns out that, strictly speaking, it is loop integrals of the vector potential which carry physical significance. I conclude that there are non-trivial physical and philosophical questions about the relative ‘reality’ of potentials and forces which require not immediate preferences but considered responses.

We also saw how reductionist tendencies may be manifest in quantum theories. ‘Decoherent history’ accounts of quantum mechanics want to keep the wave function according to the Schrödinger equation, and deny that macroscopic outcomes occur in a reality, and only allow them to be approximate appearances. The founders of quantum theory such as Bohr and Wheeler, however, took the opposite view, that an electron is only ‘real’ when it is being observed – when it makes the flash of light at a particular place – not while it is travelling. In their opposite view, the Hamiltonian and wave function are calculational devices and nothing real, having only mathematical reality as portrayed by the mathematical name ‘wave function’.

The views which make prior or later levels into ‘mere’ calculational devices can be critiqued from the point of view of dispositional essentialism. This view encourages us in general to *not* invoke arbitrarily mathematical rules for the laws of nature, but, as (Mumford, 2005) suggests, *replace* the role of laws by that of the dispositional properties of particular objects. The question of simplicity, to be answered in order to apply Occam’s criterion, is therefore whether it is simpler to have multiple kinds of objects existing (even within multiple generative levels) each with simple dispositions, or simpler to have fewer kinds of existing objects, but with more complicated laws governing their operation. The discussion in the literature about interpreting the Bohm-Aharonov effect is trying to answer precisely this question, once it had been established that different approaches were both adequate in explaining the phenomenon.

In the present paper, I have shown many more apparent examples of multiple generative levels, each composed of derivative dispositions. The questions of simplicity, and adequacy, will have to be examined in all of these cases as well. Nevertheless, I believe that the concepts introduced here enable us to take a more comprehensive and universal view of physical dispositions (such as those of potentials and forces, or of Hamiltonians and wave functions) that otherwise appear to be *ad hoc* when taken individually.

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