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### Limited Realism: Cartwright on Natures and Laws

A leaf falls to the ground, wafting lazily on the afternoon breeze. Clouds move across the sky, and birds sing. Are these events governed by universal laws of nature, laws that apply everywhere without exception, subsuming events such as the falling of the leaf, the movement of the clouds and the singing of the birds? Are such laws part of a small set of fundamental laws, or descended from such a set, which govern everything there is in the world?

Yes, say most realist philosophers of science.

No, says Nancy Cartwright.<sup>1</sup> Laws of nature are not universal. Instead, reality is governed, when it is governed at all, by a patchwork of laws. "There is no universal cover of law" (6).

The view strikes many as bizarre or incomprehensible. What does it mean to say that laws of nature are not universal, that they only apply to small patches of the world? Even more puzzling is Cartwright's view that some parts of the world are not subsumed by any laws at all (e.g., 27-8, 31-2). How can such a thesis be acceptable to anyone but the more radical sort of antirealist? Cartwright should not be labeled a radical antirealist, but her answers to these questions depend on a rich, comprehensive view of how theories and models are used to characterize the world that will take some work to explicate.

The usual realist thesis about laws is that, whatever they are, they are exceptionless regularities that govern our universe by governing the interactions between all objects. Such laws might supervene on fundamental regularities that obtain necessarily, as opposed to accidentally, or they might be relations (of some special sort) between universals that lawful regularities instantiate.<sup>2</sup> The picture includes a measure of deductive elegance: there will be a small number of fundamental laws whose descriptions function like axioms, and a larger number of less fundamental laws whose descriptions follow from the axioms as theorems. Realists also hold that it is the principle task of the natural sciences (or perhaps the natural sciences along with other empirical disciplines) to discover such laws, and the concept of law is strongly related to the concepts of causation, natural property, necessity and probability, amongst others.

By denying that laws govern universally, Cartwright denies a central tenet of the realist picture. In essence, what Cartwright is denying is that there exist a small set of fundamental laws under which all phenomena are subsumed (23). How can this make sense? A law *just is* a thing that governs universally. It applies everywhere and always, even if there are no events or properties that instantiate it. So how can it make sense to think of only some parts of the world as law-governed while others are not? Our world doesn't *seem* to be random in some places and organized in others. By

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<sup>1</sup>In her (1999), *The Dappled World* (Cambridge Univ. Press). All page references are to this book unless otherwise specified.

<sup>2</sup>Defenders of such views include David Armstrong (1997), *A World of States of Affairs* (Cambridge Univ. Press), David Lewis (1973), *Counterfactuals* (Harvard Univ. Press), Fred Dretske (1977), "Laws of Nature", *Philosophy of Science* 44, 248-68, Michael Tooley (1987), *Causation: A Realist Approach* (Oxford Univ. Press) and C.G. Hempel (1965), *Aspects of Scientific Explanation* (The Free Press).

denying the universality of law, is Cartwright advocating the view that our theories about the world are merely reflections of our interests and limitations, fashioned so as to be consistent with the observable macro-phenomena we can measure in various ways? In other words, is she abandoning realism and advocating a strong version of antirealism?

According to Cartwright, her view occupies a middle ground between realists and antirealists (47). Realists take their views to be supported by current scientific practice and success. Cartwright, in reply, argues that her views are better supported by current scientific practice than are the realist views that take laws to be universal (11-12). Because of her emphasis on the way science is really done, as opposed to an emphasis on logical consequence and the abstract structure of scientific theory, she even claims to shoulder the empiricist mantle.

So how are we to make sense of such a view if it is not merely a variation on familiar themes of antirealism? What sense are we to make of a concept of law that does not involve the concept of governance, and how can this be consistent with contemporary scientific success, let alone contemporary scientific realism?

Many, including myself, have found Cartwright's writings on this topic difficult to understand. So what I'm going to try and do here is construct the metaphysical picture that seems to underlie Cartwright's account of the world, in the hopes of going some ways towards explaining her approach to those who find it difficult to make sense of. Let me be clear that I'm by no means sure that I've got her view right—in fact, I'm pretty sure that some of the details will be wrong, if only because sometimes Cartwright seems to say things that contradict bits of picture I'm going to sketch. But I think that the account will be consistent with the spirit, if not the letter, of Cartwright's view, and it may help realists to see the importance and the interest of the program she is advocating.

As we shall see, although a kind of antirealism comes into the picture, much of Cartwright's view is consistent with a robust metaphysical realism about necessity, causation and truth. Cartwright's view is not only original and exciting but parts of it—the parts that don't involve antirealism—can provide the groundwork for a new metaphysics for a realist account of laws. Moreover, I think she can be located within a small but growing group of realists about the metaphysics of science who have recently argued for related or similar theses.<sup>3</sup> In any case, whether I've got the intended interpretation right or not, Cartwright's arguments can be used to suggest a quite metaphysically robust story about the world, one which is worth the telling—so I'm going to take advantage of the opportunity to do so.

#### The picture:

Cartwright recognizes a role for our interests to play in constructing theories, and, most importantly, she gives pride of place to the fact that descriptions of laws of nature, taken as general claims about the world, are *ceteris paribus* claims. Start with the thesis that the law statements scientists take to describe the fundamental laws of nature are not true in every situation. Instead, at best, they are true *ceteris paribus*, and hence when taken to be universal claims they are strictly speaking false.

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<sup>3</sup> For example, Alan Chalmers (1990), *Science and Its Fabrication* (Univ. of Minnesota Press), Brian David Ellis (2001), *Scientific Essentialism* (Cambridge Univ. Press), C. B. Martin (1994), "Dispositions and Conditionals", *Philosophical Quarterly* 44, 1-8. Alan Chalmers (1988) has argued for connections between Cartwright and Roy Bhaskar's work in "Is Bhaskar's Realism Realistic?", *Radical Philosophy* 49, 18-23.

Now, if law statements are merely true *ceteris paribus*, but laws are exceptionless generalizations that govern reality, how can we take them to describe laws at all? Many realists address this problem by holding that the descriptions of laws that science gives us are at best *approximate characterizations* of what the real laws are. The laws themselves are universal, but we've only got the characterization of them approximately right.

Cartwright rejects this realist position, arguing instead that some parts of the world are governed by laws, and others are not. But how can this be consistent with any brand of realism? Worse, how can it make sense? To see how Cartwright draws her conclusions about the nature and application of laws we need more information about her metaphysics. First of all, in Cartwright's picture, we reject the picture where we have objects plus something extra, the laws which govern the actions of the phenomena. Instead of thinking that we have the laws of nature plus the objects that they govern, we have objects in which certain causal powers or "capacities" inhere, and the world consists of these objects arranged in different ways.

Cartwright takes objects to be collections of properties or "structures" (81). I understand this to mean that objects are bundles of properties (collections of properties) or perhaps substrates with attributes attached (structures). Presumably, for an object to have a property is either for a property to be included in the bundle that is the object or for the property to be ascribable to the bundle that is the object, or for the property to be among the attributes attached to the substrate or to be ascribable to the substrate-attribute complex. The point here is that the conception of objects Cartwright endorses is *not* (neo)Aristotelian: objects are not substances identified by falling under sorts or by having certain forms.

Leaving the account of what a property is aside for now (is it a collection of tropes? or something else? Surely Cartwright would reject transcendent and immanent universals), properties had by objects include those such as charge, momentum and the like. Objects, by having certain properties, are able to behave in certain ways. A particle, in virtue of being excited to a higher energy state, can emit light. A particle, in virtue of having a particular momentum, can impart a force on impact. Cartwright calls such abilities to behave *capacities*, and I think it is fair to identify them with causal powers. So an object has certain capacities in virtue of having certain properties. Cartwright holds that the capacities an object has are part of the object's *nature*.

Objects can interact in different ways; in so acting they express certain capacities to behave in such and such a way, given the circumstances they are in. So objects' capacities to behave are indexed to particular circumstances, since they will express different capacities depending on the interactions they have with other objects, i.e., depending on the circumstance they are in. When an object acts according to its nature it expresses a capacity in a situation (72).

According to Cartwright, properties can also have capacities and natures (e.g., 82). Moreover, properties are individuated by their capacities, so that what a property is, in an important sense, is defined by its capacities. Cartwright suggests that it may even be the case that a property is just a conglomeration of capacities (70).<sup>4</sup> In light of this, I'm not sure whether objects are collections or structures of properties,

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<sup>4</sup> I find some of Cartwright's remarks on essentialism puzzling. On 82-3 she argues that the "nature of charge" as expressed in certain interactions does not reveal the essence of charge. Yet earlier (70) she argues that "what a property empowers an object to do is part of what it is to be that property". This sounds like essentialism to me, so I'm not sure what Cartwright is rejecting in the later passage.

collections or structures of capacities, or collections or structures of properties and capacities.

I think capacities for Cartwright are taken as primitive entities, and properties are also taken as primitive entities—perhaps, as she suggests (70), properties are just "conglomerates" of capacities. But now a puzzle arises: if objects are just bundles of properties and properties are conglomerates of capacities then objects themselves are just bundles or "conglomerates" of capacities.

I find it hard to think of objects as just bundles of capacities or causal powers—objects seem to be, speaking metaphorically, more substantial than this. There are alternative theories of objects, but I'm not sure which one Cartwright would prefer. Perhaps she would prefer to hold that objects are substrate-attribute complexes, and so an object is a substrate with a bunch of powers. For those who find substrates metaphysically acceptable, this might make the best sense of the way objects include their causal powers. If we took properties as primitive but distinct from capacities, we could hold that objects are bundles of some properties that somehow endow objects with powers, but then it would be nice to know why the having of certain properties implies the having of certain capacities. (Another necessary connection we take as primitive?) Talk of natures, while evocative, is no help here: according to Cartwright, natures are also just conglomerates of capacities that and (somehow) allow objects to express different capacities in different settings in virtue of the properties the objects have.

In any case, it should be clear that there are some robust metaphysical assumptions here about objects, properties and powers that I think Cartwright should flesh out. The view has many virtues, but until the details are worked out it is hard to assess the overall attractiveness of the thesis. Metaphysicians interested in a realist account of laws will have many questions about this ontology, especially about the nature of the capacities or causal powers that are being relied on so heavily.<sup>5</sup>

Leaving worries about defining objects, properties, natures and capacities aside, we now have the basic machinery needed to construct Cartwright's picture of the world. We build from the bottom up, so that when we have a world of objects, we have a world that includes the powers that inhere in those objects. For Cartwright, a description of a law is a description of the capacities objects express in particular situations. Once we have the world of objects we have all their capacities too, expressed in various ways according to their natures. This means that we already have everything that we need to have laws—we don't need to impose anything extra—on top of the objects.

Thinking of laws as about objects' natures or causal powers gives us a nice way to capture the sense of necessity we need when making nomic claims. Since we build the metaphysics in from the start, we don't need to impose any extra ontological layers on top of the particulars in the world in order to get an explanation of why objects behave the way they do. We don't have to go as far as stipulating that there exist universals and nomic connections between universals, yet we have a—much needed—stronger kind of necessity than traditional regularity theories, where laws are just (selected) regularities of events, can bestow.

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<sup>5</sup> What is the structure of a causal power? By taking powers as primitive, isn't Cartwright just shifting much of the ontological structure the defender of universals uses to characterize laws from outside the object to inside the object, and then refusing to explicate the ontological structure by making it primitive? Worse, the move seems to add more problems than it helps, e.g., laws become necessary (see the discussion below).

According to Cartwright, when we consider a particular experimental setup, what we are considering is a collection of objects that are behaving in accordance with their natures in virtue of expressing the capacities they have relative to the particular circumstances of that experiment. When we repeat experiments in order to confirm results, we are conducting experiments in order to confirm the claim we want to make about the natures of the objects, or more precisely, the claim we want to make about the capacities the objects express in that setup. To ensure repeatability the environment of the experiment must be constructed in just the right way, i.e., so as to exclude factors that could cause some other interaction and hence interfere with the production of the result. This makes sense in terms of natures if we say that the objective is to confirm that an object has a particular capacity: if we change too much about the experiment the object(s) may behave differently—there may be interactions with other objects that cause a different aspect of the object's nature to be expressed—and we cannot then confirm the original hypothesis.

So for Cartwright, when laws apply they cover relations between capacities, what experiments measure is the expression of capacities, and what scientists want to know is which capacities objects will express in which circumstances. Now return to the questions about the application of laws discussed at the start. Cartwright claims that scientific practice and success suggests that laws are piecemeal and that governance, if it occurs at all, is patchy. How can her views about natures help with this?

Recall that Cartwright defines what there is in the universe from the bottom up. Thus far, what we have are a lot of objects behaving in certain well-specified ways, in other words, behaving strictly in accordance with their natures. Objects can behave different ways in different circumstances, but if we have correctly identified a capacity of an object, i.e., some fact about its nature, its behavior will be *repeatable*. In the very same circumstances, the object will express the very same capacity. Now reconsider the usual realist notion of law: it has two parts, the part about governing the universe and the part about being an exceptionless regularity that is necessarily true.

To understand Cartwright's position on laws we need to remember that Cartwright thinks the lawlike claims of science are only true *ceteris paribus* and that she is reading the results of scientific practice literally: she takes scientific experiments that give results which fail to conform to the letter of the very general lawlike characterizations of science to be giving us evidence about laws *themselves* (9). If an experiment gives us a repeated regularity, it gives us evidence of a law. If a somewhat different experiment gives us a somewhat different regularity, it gives us a *different* law, even if the laws are similar and we could come up with some sort of lawlike generalization that approximately describes both. On this approach, laws really are exceptionless generalizations, but the lawlike claims of science aren't describing these laws. Instead, the lawlike claims of science should be seen as rough generalizations that are, strictly speaking, false in most situations. (They might be strictly true when relativized to certain well-defined contexts.)

If we accept this view, then how should we think of laws applying to the world? One thing we could think is that there are many different, albeit roughly similar, laws governing different parts of the world, and the law statements we use are generalizations capturing only some of the content of these many similar laws. Another thing we could think is that some parts of the world are governed by laws, and others are not. Yet another interpretation is that laws don't really govern anything

at all—this seems to collapse into the claim that there are no laws, merely false generalizations that we must use in order to make sense of a disorderly world.

Cartwright does not see how we can infer that we have universally true laws given that descriptions of laws are only true *ceteris paribus*. But she does see how laws could be regularities that involve necessitation of some sort, i.e., regularities involving the expression of capacities. So what she does, in effect, is restrict the notion of law to regularities involving (causal) necessity while jettisoning the part about governance (37). "It is a different question to ask, 'Do Newton's laws govern all of matter?' from 'Are Newton's laws true?'" (48) So laws are *exceptionless regularities* of a certain type, regularities of objects expressing capacities. If we accept this restricted notion of law, then we can see how we can have many different laws for many different parts of the universe. We can have a law that obtains for each situation where we have repeated expression of capacities and precise results. If the expression of capacities is even a little bit different, the law that obtains is just that much different.

A situation that generates a repeated series of events in a well-defined region of spacetime is part of what Cartwright calls a *nomological machine*. A nomological machine is either an experimental setup designed to identify and isolate a capacity or set of capacities, or created by a fortuitous event of nature (such as the regular motion of the planets). Cartwright emphasizes that for a situation to be a nomological machine, it must be an environment that is shielded or not affected by outside disturbances or influences so the events that occur in it are controlled or regular. The controlled environment allows the capacities of the objects to be expressed in a stable (i.e., repeatable) way. If the environment is not shielded there can be interference that prevents repeatability (50, 87-90).

In this picture, laws are just regularities of the expression of capacities of objects: laws are regularities generated by the capacities that different objects express when combined in certain ways (49). We can now see how to make sense of the idea that the universe could be characterized in terms of a patchwork of laws. What we should do when we make claims about laws is make strictly true claims about the relations between capacities of objects that arise given particular circumstances. In this sense, a few fundamental laws do not govern the whole; rather, a bunch of different laws apply to a bunch of different parts of the whole, since the capacities expressed by objects changes depending upon the details of the situation. This gives us enough to understand the view that "we have a patchwork of laws".

But what about Cartwright's further claim that there might be parts of the world where laws don't apply? Cartwright doesn't just opt for the view that different laws apply to different parts of the world—she thinks there are some parts where no law at all applies. "Laws need nomological machines to generate them, and hold only on condition that the machines run properly" (59). Does this mean that there are situations in which things happen but capacities are not expressed? There are many naturally occurring situations that would not count as nomological machines because of the lack of shielding and general chaotic nature of the events involved. According to Cartwright, laws don't apply to these situations. But this seems wrong—if a leaf falls from a tree or clouds move across the sky, surely capacities are being expressed. But if capacities are expressed then why doesn't a law apply?

I've argued above that once we see how the metaphysics of law is supposed to work for Cartwright that the idea of a patchwork of laws is understandable and interesting. But nothing I've said thus far will help the realist understand the further claim that there are patches of the world where laws do not apply. To make sense of

this further suggestion, perhaps we can interpret Cartwright's position like this: since laws are regularities, we need a situation in which a capacity is expressed by an object *repeatedly* in order for there to be a law about it. In other words, to have a law, we need a regularity to obtain. Not all situations are those to which laws apply, because situation to which a law applies *must* involve a controlled series of repeated events. But many would find this unconvincing: why aren't capacities expressed all the time, even in unrepeatable instances? And if capacities are expressed all the time, why aren't there laws that apply to them, whether or not the expression of the capacity is repeated? The problem is one faced by regularity theorists in general: requiring that there is an actual regularity of some sort seems to be too strong a constraint on laws.

Perhaps Cartwright simply bites the bullet: we need a regularity to give rise to a law, because what laws *are* are claims about capacities or relations between capacities that *are* repeatedly expressed. In unrepeated, uncontrolled instances, there is no repeated series of events, hence no regularity, and so no law, even if some capacities are expressed. We can distinguish between patches of the world that are governed by law and patches that are ungoverned by law by pointing to differences in structure: patches governed by laws must involve repetition.

But Cartwright doesn't bite this bullet.<sup>6</sup> Instead, she devotes a reasonable amount of space to exploring how nomological machines that generate some events that are never actually repeated can still give rise to laws (87-90). What is required to have a nomological machine is not that a series of repeated events is actually instantiated, but rather that the events that are the expressions of capacities are *in principle* repeatable in a particular way. "Most situations do not give rise to regular behavior. But we can make ones that do. To do so, we deploy facts about the stable natures of the processes we manipulate and about the circumstances that will allow these natures either to act unimpeded or to suffer only impediments that can have a stable and predictable effect. When we have such a situation, we are entitled to generalize from even a single case" (89). But what counts as in principle repeatable? Surely *any* event or expression of capacities that occurs anywhere in the world is *in principle* repeatable, no matter how complex, and no matter how unlikely it would be that a repetition would actually occur. Cartwright's requirement seems to bring in an objectionable kind of constructivism: in cases where there is no natural repetition, what makes something a nomological machine, hence a situation where a law applies, is whether it is controlled by *us*, whether it operates in an environment shielded *by us* (73).

I think that here is the place where Cartwright departs from the ranks of the realists and moves some way towards antirealism. My interpretation of what is going here is that by "law" Cartwright means to pick out something that in many cases is at least partly constructed by humans. Laws are things that apply to certain types of situations, situations where we actually have repetition, or ones which in principle repeatability of a certain sort is possible. In principle repeatability is (usually) human-driven: because the situation is appropriately shielded and controlled, it can be reconstructed so as to generate a repetition of the expression of capacities even if we never actually do reconstruct it because the experiment is too time-consuming or expensive, etc. When we set up a nomological machine, we recognize that it is the

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<sup>6</sup> Or perhaps she does, since she says "[I]t is capacities that are basic, and laws of nature obtain—to the extent that they do obtain—on account of the capacities; or more explicitly, on account of the repeated operation of a system of components with stable capacities in particularly fortunate circumstances"(49). There are similar quotes scattered throughout the book, e.g., on page 4 and on page 49.

kind of thing that in principle allows repeatability, and so we can use it to infer that a law "covers" the situation of the machine. In this sense, then, we generate laws by constructing nomological machines, since such machine allow us to make true claims about the capacities expressed there. "Our most wide-ranging scientific knowledge... allows us to build new nomological machines never before seen giving rise to new laws never before dreamt of" (4).

This give us a human element in the natural and social sciences, an element reflected in what we designate as laws. But it is not entirely incompatible with realism, for laws in this sense aren't all that we have: we also have capacities or natures, and these are robustly ontological, i.e., they exist independently of anything pragmatic. Moreover, these natures are what give rise to what we characterize by our laws, and so the world has an independent character after all. Although situations to which laws apply can be constructed by us, not just anything goes, for what can be covered by a law is constrained by the natures of objects, and even if a law fails to apply in a situation, it doesn't mean that the interactions of the objects are random or arbitrary. If the way I've interpreted her view is correct, then Cartwright is indeed occupying a middle ground between realism and (at least a weak version of) antirealism, which is where she explicitly places herself (47).

If realists are prepared to argue that in principle repeatability can be defined in some way that is independent of human interests, they don't need to follow Cartwright towards the antirealist camp. If expressing a capacity, even once, is sufficient for a law to apply, then they can agree with Cartwright that the world is governed by a patchwork of laws but reject the idea that any part of the world is ungoverned: all the world is law-governed, even if no law governs all the world. Only when one goes further and adds pragmatic constraints restricting the situations to which laws apply is it the case that some expressions of capacities may well not count as laws, even if all the metaphysics we could need or want is there. So strong realists may be able to make good use of much of Cartwright's program.

Now that we have a characterization of Cartwright's view of laws, we can see why one potential problem for her might not be such a problem after all. Cartwright's account of the capacities had by properties of objects is strongly reminiscent of Sydney Shoemaker's thesis of properties as causal powers. (Cartwright notes the similarity (70).) But if Cartwright individuates properties by their capacities or powers, then, like Shoemaker (and like some types of regularity theorists), it would seem that she faces problems involving the modal status of laws. We tend to think that the laws of nature are contingent, and that there could be worlds with different laws but where the same properties or collections of properties occur.

But if the natures are determined by properties, then in worlds with the same properties we will have the same natures. And if natures are what ground laws, then in worlds with the same natures we will have the same laws. This makes the laws of nature necessary rather than contingent. Cartwright seems to confirm this when she says "So, 'How does the Hume world differ from ours?' It would not differ. Any world with the same properties as ours would *ipso facto* have capacities in it, since what a property empowers an object to do is part of what it is to be that property"(70).

Now, some have embraced the necessity of laws as it follows from the causal powers view, and there are different ways to make it reasonably palatable. But as the result of her sympathy with antirealist accounts of laws, Cartwright may be able to soften the blow. She'd have to grant that in a world where the distribution of properties across the spatiotemporal manifold was exactly the same, the laws would be the same. But worlds a little farther away, i.e., worlds that are very similar to ours,



could have different laws because they could include different nomological machines, even though the capacities of the objects in those worlds could not be different. I'm not sure that this way of handling our intuitions about the contingency of laws would be satisfactory to those who have them, but it's certainly a response that Cartwright is justified in giving, and it gives her some flexibility to address a worrying problem.

There are many other interesting aspects of Cartwright's view that I have not been able to address. *The Dappled World* contains discussions of the epistemology of laws for natural science as well as for social sciences like economics and sociology, addresses problems with causal modeling using the ideas of capacities and nomological machines, gives an account of how models are interpreted so as to apply to the world, and much more. It also ties together themes of Cartwright's previously published work and places her overall theory in the context of contemporary scientific and social scientific practice.

Over the past twenty years, Cartwright has been developing and refining an exciting and deep picture of the way we should understand the world through the lens of science and social science, and her work has had a significant impact on theoretical discussions in philosophy, economics and sociology. Metaphysicians and philosophers of science should read this book both for the in depth and interesting accounts of scientific and social scientific problems as well as for the new approach she takes towards laws, causation and the nature of world.

*L. A. Paul*  
*University of Arizona*  
*Australian National University, RSSH*