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Aristotelian powers at work: reciprocity without symmetry in causation¹

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Introduction

This paper puts powers to work by developing a broadly Aristotelian account of causation,² built around the fundamental idea that causation is the exercise of causal powers.³ What is distinctive about the ontology underpinning this account of causation is that it takes the manifestation of a power to be the activated state of the very same power, and not the occurrence of a new power.⁴ Furthermore on this account, there are no lonely powers; all powers have partner-powers.⁵ Each partner-power serves as a necessary condition for the existence and manifestation of the other.⁶ Thus another distinctive feature of the account is that each power is individuated, jointly, by the type of activity its manifestation is and the type of partner-powers it can have.⁷

What does this view commit one to, when it comes to explaining causation in terms of causal powers? First, it offers a realist theory of causation that, as we shall see, does not reify the mutual activation of the causal partner-powers into a relation. Second, from the fact that powers depend for their activation and their

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² The paper develops, in an original way, Aristotelian insights on causation and causal powers, but does not discuss these exegetically.

³ The view that causation is the mutual activation of causal powers is gaining consensus in contemporary power metaphysics. In fact, activation of causal powers is *all there is* to alternative power-based accounts of causation in contemporary metaphysics. See e.g. Heil, this volume; Mumford, this volume; and Martin 2008. My account adds that the activation of causal powers is their activity, i.e. a process in time.

⁴ E.g. Mumford and Anjun (2011) and Bird (2007) hold this view.

⁵ The view that powers have manifestation partners is gaining consensus among contemporary power metaphysicians; see e.g. Martin 1992, 2008, and Martin's contribution to Crane 1996; Mumford and Anjun (2011); Heil 2003 and this volume. I argue in my book manuscript *Power Structuralism in Ancient Ontologies*, in progress, that this is a view that in fact stems from Heraclitus, on to Plato, and develops into a theory of active and passive mutual partners in Aristotle.

⁶ A power can have two or more partner-powers. The account can become more complex by entertaining powers whose partners are in some possible worlds but not in every possible world in which the powers exist.

⁷ The type of activity and the partner-power(s) are not two independent individuation principles.

exercise on the activation and exercise of their mutual partner-powers, it follows that there is reciprocity in causation. The reciprocity may be illustrated for example with a causal scenario where A causes B to become hotter. A's power to heat is activated; it manifests by heating B up. But A's heating up B can take place only if B's power to be heated is activated too, and manifests itself in B's getting hotter. A's heating and B's being heated are mutually dependent in a variety of ways, and each activity lasts as long as the other lasts.

If causation is mutual activation of causal powers, one might think that there is an important feature to causation that is left out in this account, namely that causation has a direction and is thus asymmetric. My analysis of the mutually manifesting causal powers is different from others advanced in the contemporary debate, in that it explains the intuition that there is direction in causation; and this direction is metaphysically underpinned by a distinction of roles between causal agent and patient. Hence, the view that causation is the mutual activation of causal powers does not commit one to giving up causal agency. Yet, is it the powers, or the substances that possess them, that are causally efficacious? At the most fundamental level, it is powers that are causally activated; derivatively, at the macro-level, we can say that the substances, constituted by the powers, are the agents of causal action.

1. Powers and manifestations

I shall begin with a very brief account of the nature of causal powers.⁸ On my account, a power is the potentiality to bring about a change, or the activity of bringing about that change. Nothing inert, or impotent is needed in the power's nature to anchor the power to reality.⁹ To put the point concisely, one may say that all there is to a power is its powerfulness, that is, what it can do or is doing.

In this connection, it is somewhat unclear to say that a power is potentially its actuality (which is an expression Aristotle introduced), because this can be read in two ways: that the potentiality is for the power's *activation*; or that the potentiality is for the power's *activity* when it is being exercised. It is the second meaning that I intend. The point may be clarified by way of contrast with a widely shared view in contemporary metaphysics. On my account the powerfulness of a power is its capacity to actively engage in an activity (whether this activity is a doing or a suffering, as we shall see below). By contrast, many contemporary power ontologists take the powerfulness of a power to be its readiness to get activated, that is, to instantaneously 'jump' into another power, which is the causal effect.¹⁰

⁸ Although I am concerned in this paper with the fundamental powers in the ontology, I will sometimes speak of powers generally, when I believe that my corresponding claims apply to all powers. (I assume that a defense of my generalizations will be needed only if counterexamples are supplied.)

⁹ E.g. Bird (2007), Holton (1999), Shoemaker (1984), Mellor (1974). Contrast with views on which a power has a categorical basis (e.g. Ellis 2010; Armstrong, 2004: 138-139; 2000: 13-14; 1997, 80; Crane 1996).

¹⁰ E.g. Mumford and Anjun (2011) and Bird (2007) hold this view.

How does a power get to do what it can do? What does the exercise of its powerfulness consist in? On my account when a power is activated, it engages in the activity it is for, or it suffers the activity of its power-partner. Take for example a pile of books on a table with a glass table top, and imagine that we keep adding books to the pile: as they pile of books exercises increasing pressure on the glass table top, the glass ‘suffers’ the pressure (where pressuring is the activity of the heavy pile) and gradually breaks (where breaking is the activity of the fragile glass).

A power that is engaged in the activity it is for (e.g. the magnetic power of a magnet attracting some metal) is in a different state than when it is in potentiality (not attracting any metal). On my view, the activation of a power is an *internal* ‘transition’ from one state to another of the very same power: its manifestation is not the occurrence of a new power; rather it is simply a different state of the original power: an activated state.¹¹ This view of the activation of powers sets my account apart from other power ontologies that do share the commitment that all there is to a power is its powerfulness.¹²

There are two issues on which I hereby take a position. First, there is the question of whether ‘pure’ power ontologies of the kind I endorse (where there is nothing categorical anchoring the powers to reality) are committed to a *world of mere potentiality*. I argue they need not be so committed. Second, there is the question of whether powers have an *essentially relational nature*. I argue that they do not; powers are monadic properties ontologically dependent on various types of circumstances.

¹¹ Depending on the ontological assumptions in play, one may think that for powers that suffer change their activation is either the qualitative change of the same power or the generation of a new power. Whether the power that suffers the partner-power’s activity is considered, when manifesting, numerically the same power or not as before manifesting, depends on how finely or coarsely a power is individuated. If the individuation of powers is fine-grained, the power is numerically different (for example one may think that the rising heat of the pot on the stove involves the generation of distinct powers in it). If the individuation of powers is coarse-grained, the power remains numerically the same, and it only gets altered (the heat simply increases).

¹² C. B. Martin (2008) takes the directedness of a power toward its manifestation to be intrinsic to the power; but his position differs from mine in that he does not make the manifestation of a power a different state of the power itself; see for example his Two-Triangles Model:

You should not think of disposition partners jointly *causing* the manifestation. Instead, the coming together of the disposition partner *is* the mutual manifestation: the partnering and the manifestation are identical. This partnering-manifestation identity is seen most clearly with cases such as the following. You have two triangle-shaped slips of paper that, when placed together appropriately, form a square. It is not that the partnering of the triangles *causes* the manifestation of the square, but rather that the partnering *is* the manifestation. (2008: 51, emphasis in the original)

This is an important difference between the view that I am proposing and Martin’s, in that for him, although the directedness is intrinsic to what has it (the powers), what it is directed toward (the manifestation) is not intrinsic to what has it (the power itself). With reference to the example in the quote above, the square is not intrinsic to either of the triangles that constitute it. By contrast, on my view the power that is directed towards heating is activated when it is in fact heating something. Heating is the exercise of the powerfulness of the power to heat, which is a state attained by the power to heat.

Is there only potentiality in a world of 'pure' powers?

Is the account of powers I am proposing prey to the criticism that if all fundamental properties are powers, as described above, all there is or can be at the bedrock of reality is potential, and that change is simply a transition from one potential state of the world to another such state? The concern has been raised for many contemporary power ontologies; one expression of it is the Always Packing Argument.¹³ David Armstrong (1997: 80), following C. B. Martin (1993: 68), formulates it thus:

Given purely dispositionalist accounts of properties, particulars would seem to be always re-packing their bags as they change properties, yet never taking a journey from potency to act.

The Always Packing Argument raised difficulties for the position held by contemporary power ontologists whereby the activation of a power in potentiality is merely an instantaneous 'jump' to its manifestation, which is another power in potentiality. A theory of powers that did not allow powers when activated to exercise their powerfulness would be rather odd indeed – yet, this seems the position that some power ontologists are committed to, when claiming that the manifestation of a power is merely a new power in potentiality.¹⁴ It is this conception of the power's manifestation that commits one to a network of powers in potentiality, where nothing ever is actual. This is the complaint that Armstrong's argument voices: that there is no actuality in the ontology. There is no journey from potency to act, not because nothing happens in a world of 'pure' powers; powers do in fact manifest; but the manifestation is an instantaneous transition to another power in potentiality. The exercise of powers on other powers is not reified, i.e. it is not part of the ontology. In other words in such ontology change is not defined in terms of potency and act, but only in terms of potency to potency. My account avoids a commitment to worlds of mere potentiality: the manifestation of a power, that is, its transition from potentiality to actuality, is a transition the power makes to its own activated state. A power in potentiality is numerically same power when manifesting. (The activated power may cause further powers to come about, but this is not what the manifestation of the original power consists in.)

John Heil raised additional objections against an ontology of 'pure' powers only, with his Domino Argument, which is similar and yet different from Armstrong's Always Packing Argument. Heil writes,

Despite its appeal in some quarters, many philosophers have been struck by the thought that a properties-as-powers view leads to a debilitating regress. Suppose *As* are nothing more than powers to produce *Bs*, *Bs* are nothing more than powers to produce *Cs*, *Cs* are nothing more than powers to produce *Ds* . . . and so on for every concrete spatio-temporal thing. How is this supposed to work? Imagine a row of dominos arranged so that, when

¹³ The expression "always packing, never travelling" is first used by Molnar (2003: 173).

¹⁴ Contrast with e.g. Mumford and Anjun: 'The manifestation of a power will ... be itself a *further* power or cluster of powers' (2011: 5, my emphasis).

the first domino topples, it topples the second, which topples the third, and so on. Now imagine that *all there is* to the first domino is a power to topple the second domino, and *all there is* to the second domino is a power to be toppled and a power to topple the third domino, and so on. If all there is to a domino is a power to topple or be toppled by an adjacent domino, *nothing happens: no domino topples because there is nothing—no thing—to topple.* (2003:98, my emphasis)

We saw that the Always Packing Argument assumes that the world is a sequence of powers in potentiality getting constantly replaced, upon being manifested, by other powers in potentiality; there is nothing but powers in potentiality in the world. But the Domino Argument does not question how a power will take the journey from potency to act, if all there is to a thing or to the ontology is potency. Rather, it questions how a power can take the journey from potency to act *if all there is to the thing a power will act on is potentiality.* This is a concern, not about the fact that powers never take a journey from potentiality to actuality, but about their journey having no destination as it were. In other words, the question is whether there is an object *at all* when all there is to its constitution are pure powers in potentiality.

Are mere collections of powers in potentiality *no thing* at all? I submit that there is no metaphysical impediment to the existence of things constituted of pure powers in potentiality.¹⁵ On the other hand, such a circumstance could not arise in our world. To explain why I do not find the Domino Argument to be an objection to pandispositionalism, and why I do not think that it describes what our world would be like if things are indeed constituted of pure powers only, I need to briefly address the question of the constitution of things in an ontology of only pure powers *in potentiality.*

First let me say that I agree with Heil that there are no objects that are constituted of the power to topple something else and the power to be toppled. After all, powers cannot be toppled! But these are not the powers that dominos consist of. The power to topple is a complex power, consisting of simpler powers, and ultimately, of fundamental powers; nor is the power to topple a power that exists on its own, but rather it belongs to objects that have many other powers in addition to the power to topple. For contemporary physics, the fundamental powers are mass, spin and charge. Elementary particles are combinations of these powers. Thus, an electron consists of 0.5 mass, -1 charge, and $\frac{1}{2}$ spin. That an electron repels another electron is a result of the powers that comprise them. The powers electrons have to light up the night result from powers that they acquire when they function within larger structures, possibly including many types of entities. Now, if one was to ask the core question Heil asks, namely whether such a thing as an electron exists as a thing composed of these three powers (mass, charge, spin), if they happen to be in potentiality only, my answer is 'yes'. Even if the electron is not interacting with anything else, and the three powers that constitute it are only in potentiality, there is no obstacle to

¹⁵ I argue for this claim in my book manuscript *Power Structuralism in Ancient Ontologies*, unpublished.

understanding its existence, and the readiness of its powers to be activated by its environment. Similarly, consider photons, which make the case even clearer: they consist of 0 mass, 0 charge, and 1 spin. They are, to adapt a term from biology, monopotent, i.e., one power only constitutes them. And yet, even photons are entities.

On the other hand, as a matter of fact, things in our world are not combinations of powers in potentiality only. Fundamental powers of elementary particles are continuously manifesting in their environment, given the presence of the ambient gravitational force in the universe, but also of the other fundamental forces. In complex objects, powers are continuously manifesting in the presence of other powers in the same object; for instance, the gravitational and electromagnetic powers of physical parts of a domino manifest in the presence of such powers of the other parts of the domino, etc.¹⁶ In the case of powers such as the power to topple, they presuppose structural constitutional complexity of the object that possesses them – size, shape, weight, hardness, etc. Many of these powers of a domino will be constantly activated, manifesting in the presence of the other powers of the domino, even if the power to topple is not. In short, there is a domino there to be toppled.

To recapitulate, the commitment I make with the claim that all there is to a power is its powerfulness (which is shared by a number of contemporary power metaphysicians) is not uncontroversial; it has brought about in some quarters the worry that is expressed in the Always Packing Argument by David Armstrong, and in the Domino Argument by John Heil. I address these concerns, on the one hand, by reifying in my ontology the state of activation of powers; and on the other hand, by showing that there are always powers in the state of activation in the world.

Are powers monadic or relational properties?

Although it is a common (Aristotelian) assumption that powers are defined in terms of their manifestation, power ontologies that make the manifestation of a power be a further power thereby establish a network of polyadic relations; each power is defined in terms of its relation to something different from itself, namely other powers. Many hold this view; for example Alexander Bird:

The essence of a potency involves a relation to something else; if inertial mass is a potency then its essence involves a relation to a stimulus property

¹⁶ The four fundamental *forces*, the weak, strong, electromagnetism, and gravitation, are not additional powers for physicists. Rather, they are considered four fundamental *interactions*, explained as the emission and absorption of elementary particles. So, following my description above, the four fundamental interactions are emissions and absorptions of combinations of fundamental powers constituting elementary particles.

(impressed force) and a manifestation property (acceleration). (2007: 107)¹⁷

I too follow the Aristotelian conception of a power as defined in terms of its manifestation, but on the view I am proposing this does not result in an account of powers as polyadic relations. On my account the manifestation of a power is not another power the original power is related to, but another state of the same power. (E.g. the power to heat manifests by heating up something, not by becoming a different power of heat – there is more to say below about causal reciprocity.) Furthermore, a manifesting power is described in terms of what it does, and this description makes reference to the type of effect the power brings about, namely to the activity that is suffered by the partner-power (e.g. heating). This indicates the type of dependence partner-powers have on each other. Yet, ontological dependence is not a polyadic relation, and powers are not relational properties. Rather, fundamental powers are *monadic* properties that are outwardly directed. This is a core Aristotelian intuition with I develop in section 3. But before examining the non-relational nature of powers, I will say more about which dependencies hold in my view among fundamental powers.

2. The interdependencies among fundamental powers

In this section I address the issue of which dependencies there are among fundamental powers, arguing that powers depend on other powers for their existence and activity.

Do powers depend on other powers for their existence?

Powers are defined in terms of what they do, when activated. We have in fact no other way of knowing a power than its operation on its partner-power. This is to say that there is *epistemological dependence* of the potential state of a power on its activated state. A consequence that follows is that powers are defined in terms of the type of partner-powers they can have, since this determines what they do.

Whether *lonely* powers (that is, powers without partner-powers) exist or not is ultimately a question of ontological parsimony. I favor parsimony, so I assume that powers with no partners do not exist even in potentiality. An argument could be made to allow for powers that have no partners in the actual world (so they cannot be manifested in it), but do in other possible worlds (so they can manifest in them). The position can become more complex if one distinguishes between degrees of similarity between the actual and the possible worlds, especially in relation to the physical laws of nature. Thus one could allow for lonely powers in the actual world which have partners in very similar worlds to the actual one, but not allow for lonely powers in the actual world if the only

¹⁷ See e.g. Bird (2007) chapters 5 and 6; Psillos (2006), and my discussion of his paper in Marmodoro (2009).

partners they have are in remotely different worlds. It is the latter possibility that threatens to overpopulate one's ontology, and thus one needs to guard against it. Instead of entering the slippery slope of possible world similarity, I assume as a rule of thumb for my ontology that the only lonely fundamental powers there are in the world are the ones that have partners in possible worlds with the same (relevant) physical laws as the actual world. So, suppose that there is a fundamental power that cannot manifest if the universe freezes over; on my view such a power is not to be banished from the ontology. Thus, my stance is that fundamental powers are *existentially dependent* on their partners in the actual world; or, if lonely, on their partners in physically similar possible worlds.

Do powers depend on other powers for their activation?

Most power ontologists recognize that powers can be either in potentiality or can be activated. Leaving aside for now the discussion of whether there are spontaneous manifestations of powers (to which I return below), the activation of a power in potentiality needs to be somehow explained; there must be some trigger, stimulus or obtaining condition that explains why a moment before the power was in potentiality and now it is activated. The Stimulus Model for powers' activation, which might *prima facie* seem intuitively appealing; Heil for example (this volume) describes the model thus:

Philosophers who have been attracted to an ontology of dispositions or powers, sometimes characterize powers as features of objects that manifest themselves in a particular way given a particular kind of 'trigger' or 'stimulus'. Alexander Bird (2007), for instance, takes a disposition, **D**, to be characterizable by reference to a manifestation, **M**, resulting from **D**'s being stimulated by **S**.

Yet this model has attracted much critical discussion in recent literature. Heil (this volume) develops an epistemological argument against the validity of the Stimulus Model: there are cases in which it seems impossible to tell (in a non arbitrary way) which is which:

Note, first, how poorly this way of thinking about dispositions fits with our examples, with, for instance, salt's dissolving in water. We have salt, water, and the salt's dissolving. Where do we locate **D**? In the salt? In the water? And where is **S**? Is **S** the salt, the water, or something else?"

Mumford and Anjun offer two additional arguments. The first is that the Stimulus Model does not allow for spontaneous manifestations, of which they think there are plenty of examples in nature; the second,

is based more on a rejection of what can be called passivist accounts of nature (see Ellis 2001: 7). A passivist metaphysics is one in which there is no internal principle of change within things. They do not contain potentialities within them, for instance. Rather, they move or change only when they are pushed to do so from outside ... This general concern about

passivism can be found in the specific instance of the stimulus-manifestation pair. The power itself is depicted as being on its own passive. It will produce no change unless it is stimulated to do so by the appropriate stimulus. But then this makes the stimulus look like the power: it is the element that has the power to produce change, while the power itself has, on this account, been rendered impotent. Something seems to have gone wrong with the account, therefore, as it disempowers the very powers it is supposed to explain. *The activation of the exercise of a power is 'explained' only by allotting responsibility entirely to this stimulus that is itself left unexplained* and, furthermore, it is hard to see how it could be explained if the elements in the world are all said to be passive. (2011: this volume, my emphasis).

Additionally, others have pointed out against the Stimulus Model that there is the danger of a regress ensuing if the stimuli have to be stimulated to stimulate the powers. I do not examine the aforementioned arguments in detail here, because I agree with the general stance taken, that we do not need to introduce a stimulus in order to explain the manifestation of a power. Rather, powers have other powers as their *manifestation partners*. Contrary to Bird, and with Heil, Mumford and Anjun among others, I hold that it is the 'coming together' in appropriate conditions of the partner-powers that accounts for their mutual activation. For example, the solubility of salt requires that salt be placed in solvent in order for it to dissolve.

It is of course difficult to draw a line between what in the environment is to count as the partner power and what as enabling conditions. This difficulty has been explored extensively in the causality literature in recent decades, and so I will not engage here with it. I will only acknowledge here that there is a degree of contextual selectivity, whether pragmatic, given social circumstances, or scientific, given theoretical pursuits, which enters into the determination of partner powers. For fundamental powers it is only the theoretical considerations that would enter into the distinction between partner powers and enabling conditions.

3. Causal powers are relatives

Reality at the fundamental level is not a web of relations. Powers are not (polyadically) relational properties. Furthermore, there is no polyadic relation connecting a power in potentiality to its manifestation, since the manifestation is numerically the same power in a different state.¹⁸ Nor is the essential nature of a power P a different power Q, to which P in potentiality is related; P *is one* with its essential nature.¹⁹ The essence of power tells us what type of entity the power is,

¹⁸ I am on this point in disagreement with Bird (2007); and in agreement with Martin (2008: 12): "A disposition cannot be a relation to a manifestation". But Martin's justification for the view that dispositions or powers are not relations differs from mine: he thinks that dispositions cannot be relations because 'a disposition can exist although its manifestation or even its reciprocal disposition partners, do not' (2008: 6).

¹⁹ See Marmodoro (2009) and forthcoming.

namely, of the sort that can do such and such type of activity to this or that type of thing. Finally, there is no polyadic relation connecting a power to its power-partners. Powers are ontologically dependent on their partners, but as we have seen, ontological dependence is not a polyadic relation.

Powers are monadic properties, but monadic properties of a special kind, which Aristotle called *pros ti*, literally, 'toward something'; such properties are 'pointing toward something'. This 'pointing' is what we call nowadays the *directedness* of powers. The current translation in English of '*pros ti*' is 'relative'. Aristotle says,

All relatives are spoken of in relation to correlatives that reciprocate. For example the slave is called slave of a master and the master is called master of a slave. (*Categories* 6b28-30)

He explains the directedness of relative properties thus,

We call *relatives* all such things as are said to be just what they are, *of or than* other things, or in some other way *in relation to* something else. For example, what is larger is called what it is *than* something else (it is called larger than something); and what is double is called what it is *of* something else (it is called double of something); similarly with all other such cases. (*Categories* 6a36-b3)

The relation between relatives is not a linguistic or a semantic relation. It is an *ontological* relation, as he states clearly,

If there is no master, there is no slave either ... When there is a slave there is a master; and similarly with the others [*sc.* other relatives] ... Also, each carries the other to destruction; for if there is not a double there is not a half, and if there is not a half if there is not a double. So too with other such cases. (*Categories* 7b6-22)

This is what 'binds' monadic properties into reciprocal pairs, e.g. being a master and being a slave: that they are ontologically interdependent. The 'pointing' nature of relatives is Aristotle's way of depicting ontological dependence. Aristotle explains (reductively) the ontological dependence between relatives as a counterfactual dependence; e.g. if there is no master there is no slave. If we apply this understanding of ontological dependence to the case of causal relata, it follows that taking causal relata as ontologically interdependent amounts to the view that there is no cause of activation or change if there is no patient of the activation or change.

So the ontological interdependencies of causal powers (as described in Section 2) are not polyadic relations holding between them;²⁰ rather, they are mutual *conditions* that enable their respective existence and activity. A power *p* is

²⁰ Typically when we provide an ontology for xRy , we take *R* to be an entity that exists between *x* and *y*. Either such an entity would belong to *x* and to *y*, or to neither but be somehow self standing. With Aristotle, I hold that there is no entity that belongs to both *x* and *y*, when they are related, nor that exists between them.

manifesting when such and such a power p' (where $p \neq p'$) is satisfying such and such conditions (i.e. it exists, it is appropriately located, nothing impedes etc.).²¹ For example A's power (p) to heat requires B's capacity (p') to get hotter, where B is in sufficient proximity to A with nothing in the way, in order for A to be able to achieve its manifestation, that is, heating.²²

From the ongoing discussion, three core conclusions follow. Powers are the metaphysical bedrock of reality. Powers are ontologically dependent other powers. Powers are monadic properties; not a network of polyadic relations.²³

4. The modality of powers

In this section I turn to the modality of powers. I take fundamental powers to be physical powers. Such powers are subject to a physical modality, which I do not associate with natural laws, but with the nature of things. In this I follow Aristotle's account of the essence of substances, especially as the thesis has been interpreted and developed by Kit Fine.²⁴ But my concern is not the nature of substances, but the nature of what there is in elemental ontology. Aristotle allows his account of 'nature' to extend to fundamental constituents of nature. As is well known, he thought that the primary elements in the world are earth, fire, air, and water. In explaining natural phenomena, he discusses the upward movement of fire in the cosmos and explains that the movement does not have its own source of normativity; rather, nature is the origin of the movement's normativity:

The term 'according to nature' is applied to all these things and also to the attributes which belong to them *in virtue of what they are* [that is, in virtue of their natures], for instance the upwards transference of fire – which [transference] is not a 'nature' nor 'has a nature' but is 'by nature' or 'according to nature' [namely, the nature of fire or the universe]. (*Physics* 192b35-193a2; my emphasis)

Accordingly, the normativity I attribute to physical powers has its source, on my account too, in the natures of the entities in the ontology.

I will start from the distinction Aristotle makes between three types of normativity, namely necessity, physical necessity, and chance,²⁵ and show that

²¹ This point is developed below p. ***

²² Because of this mutual dependence, partner-powers manifest themselves in activities that are *co-determined, co-varying, and co-extensive in time*. See Marmodoro 2006. It follows that if causation is explained in terms of causal powers, there is reciprocity in it in the sense that both causal partners powers get activated, each 'facilitating' the activation and the activity of the other. This point is discussed below p. ***

²³ Bird (2007) for example holds this view.

²⁴ Aristotle's grounding of necessity on the nature of things has been analysed and explicated by Kit Fine (Fine 1994).

²⁵ 'First then, we observe that some things always come to pass in the same way, and others for the most part. ... But as there is a third class of events besides these two – events which all say are 'by chance' – it is plain that there is such a thing as chance and spontaneity'. (*Physics* 196b10-15)

their explanation does not require three distinct primitive normative notions, but two. What distinguishes necessity from physical necessity is that unqualified necessity is not impeded; what is necessary is. By contrast, it is not the case that what is physically necessary is. Rather, it may, or may not be. By this I do not mean that somehow physical necessity fails to 'fire' some times, namely that it is somehow a 'faulty mechanism' of necessity. Rather, I mean that physical necessity does not determine what will come to be under any circumstances, come what may; it determines what will come to be *under specific circumstances*, only if and when such circumstances obtain. So, for instance, fire makes wood burn, unless the wood is wet. What is characteristic of the modality of things that happen according to nature is that it is a *defeasible* modality.

We could describe this type of physical modality as *conditional necessity*, in order to indicate that it is governed by obtaining circumstances. Thus, in the case of powers, the circumstances pertaining to their activation consist in the presence of their partner-powers, as well as of further conditions, including the absence of conditions which might impede the activation of the power (e.g. the wetness of the water). These are all empirically determinable coefficients for each power, which give the profile of the conditions that must obtain for the activation of each power. Aristotle too stresses the need for the obtaining of external circumstances for the activation of a potentiality:

[a thing] has the potentiality in question when the *passive object is present* and is *in a certain state*; if not it will not be able to act. To add the qualification 'if nothing external prevents it' is not further necessary; for it has the potentiality ... on certain conditions, among which will be the exclusion of external hindrances; for these are barred by some of the positive qualifications [for the potentiality in question]. (*Metaphysics* IX.5, 1048a15-20, my emphasis)

On the other hand, although physical necessity is governed by obtaining circumstances, if these circumstances are satisfied, the power *cannot fail* to get activated. The satisfaction of the external conditions, including the presence of the partner power, necessitates the activation of the power.²⁶

Stephen Mumford and Rani Anjun describe the modality of disposition as follows, questioning whether we can use the notion of necessity to explicate the modality of powers, as I did above:

²⁶ The account of physical modality I just offered, namely, conditional necessity, is to be distinguished from an Aristotelian notion that plays a different role in his metaphysical system, namely, hypothetical necessity. *Hypothetical necessity* is a requirement set by the form (or essence) of a thing, on account of what matter there is. Aristotle's example is a saw, which necessarily has to be made of iron, or something hard, if it is to serve the function of a saw (*Physics*, II.9). Hypothetical necessity is an expression of a requirement, a necessary condition for a function to be served. It is not expressive of the normativity of a natural power. When conditions are satisfied, the function can be served. By contrast, conditional necessity describes the way that powers behave in nature – when conditions are satisfied, the powers manifest.

Dispositionality is a primitive, unanalyzable modality that is intermediate between pure possibility and necessity ... because of its special modal nature, no analysis that fails to invoke it can succeed. It will be subject to counterexamples because it will attempt to reduce dispositionality to something else, such as necessity, which thereby misses the subtlety and flexibility of dispositionality. In particular, it would miss the key element that dispositions can be subject to prevention and interference. This modal feature is essential to dispositionality: it is what makes it distinct from everything else (2011: 193)

I have argued that we can explain the modality of dispositionality using the notion of necessity, without sacrifice of the flexibility of dispositionality. On my account, necessity is qualified by the external circumstances required for the activation of a power. The account explains both, the nature of the flexibility in the activation of a power, as determined by the obtaining or not of the external conditions, as well as the modal 'imperative' of the power's activation, when the external conditions do obtain. It shows that there is a normative pattern to the behavior of powers – what one might call 'physical laws governing the powers' – that derives from the nature of the powers (and their bearers) and ensues in the necessity of the activation of a power, in the appropriate circumstances.²⁷

Mumford made (in personal correspondence) the following reply to my proposed account of the modality of powers:

Though I like explanations that are 'for the most part', I'm not sure that it captures the dispositional modality. I think there can be quite significant dispositions that are a long way short of 'for the most part'. Consider the disposition of the contraceptive pill to cause thrombosis. This is medically significant and there is a clear tendency towards that outcome rather than all the other logical possibilities. But only 1 in 1,000 women taking the pill get thrombosis so it falls well short of for the most part.

I do not think that this is an objection to the conception of conditional necessity that I developed above, in order to explain physical normativity. Rather the opposite, since my account can well explain this phenomenon. To begin with, the example that Mumford gives can be described in a way that shows its compatibility with my explication. Although it is only 1 out of 1000 women taking the pill that gets thrombosis, and although this is a medically significant percentage, it is *not* a percentage that reflects the frequency of activation of the pill's power to cause thrombosis in women. The reason is that the pill is taken by selected women to activate the pill's power for contraceptive protection, rather than to activate the power to cause thrombosis. *These* women's bodily systems provide the appropriate external conditions for the contraceptive powers of the pill to be activated (in contrast to the conditions that would be provided by the, non-selected for the pill's use, prepubescent girls, post-menopause women, or

²⁷ Heil too (this volume) finds a firm normative imperative in the activation of powers, when the circumstances are right, while allowing that circumstances might not facilitate the activation of a power: 'Whether various reciprocal powers are on hand at a given time can be probabilistic, but, given the powers at *t*, causings at *t* are thoroughly deterministic'.

men). But the adult women selected for the pill's use are not selected in order to activate the pill's power to cause thrombosis. The reason why the pill causes thrombosis in 1 out of 1000 women is that the physical state of the type of organism which that one woman has is the (only) type that satisfies the requisite conditions for the pill to cause thrombosis. If the pill was given selectively to women of this type, the statistics of the activation of the pill's disposition to cause thrombosis would be very different.

5. Causation is the mutual activation of two (or more) causal powers

In thinking about the mutual activation of causal powers, it seems natural or intuitive to think of it as a *transmission* of powerfulness between them. But transmission of power – if we want to use this expression – shouldn't be thought of quantitatively in the account of what takes place in causation. Rather, powers are powerful because they can bring about qualitative change in other powers.

The idea that causation happens because of the passing around or transmission between properties can be traced back to an ancient Greek conception known in the literature as the Contagion Model of causation.²⁸ But this should not be read quantitatively.²⁹ Rather, their conception was that what was passed around was a qualitative state originating from the state of the source. Aristotle too talked of transmission between powers, when he talked of the 'form' of the active power being transmitted onto the passive power.³⁰ But, even for Aristotle, this is a figurative way of describing the mutual activation of powers, not quantitative.³¹

On the view I am proposing, the causal partner-powers are mutually activated from potentiality to activity. All there is to their causal 'interaction' is their *mutual and simultaneous manifestation* (e.g. heating and being heated). The power fulfilling the active causal role is activated, while the power fulfilling the passive causal role is activated, and, often, changes as well. There is no exchange between them, no transmission of anything, and no relation bridging the two.

The account I am proposing is thus to be contrasted with the Passing Around Model put forward by Mumford and Anjun (2011). They develop this model as an answer to the Always Packing Argument discussed above (p. ***); and introduce the model thus:

On reflection, the idea of causation as a passing around of powers, especially for a pandispositionalist, starts to look extremely attractive (Mumford 2009). Some examples will illustrate this. You come in from the cold and sit by the fire. You sit by the fire because it is hot, which for the

²⁸ For an account of the model in ancient thought with particular reference to Aristotle, see e.g. Scaltsas (1989). The contagion model was also revived in early modern philosophy; see for reference e.g. O'Neill in Nadler (1993: 44).

²⁹ The ancients experimented with quantitative readings of transmission too, but they were not successful or prevalent.

³⁰ See *Physics* 202a9-11.

³¹ Marmodoro forthcoming.

pandispositionalist means that it has the power to warm your body. Causation occurs when the fire warms your body, changing it from cold to hot. Armstrong retorts that such causation, for pandispositionalism, consists in the mere passing around of powers. In the present case, that would mean that the heat of the fire, which consisted in it having the power to warm some other object, has been passed on to you. But that sounds quite right. (2011: 5-6)

The position proposed by Mumford and Anjun is intuitively attractive, but raises a number of questions. How does 'passing on powers' take place, metaphysically? What is the mechanism of the transfer of powers such as, e.g., the power to warm another object? It is also not clear, crucially, whether the first object loses the power that is passed on to the second object, or the power is duplicated. Related to the last question, what individuation criteria are in play for the token powers that are passed on? Finally, how does this account explain what happens, in the case of a vase that breaks, in terms of a power that was passed on to the vase?

More generally, Mumford's and Anjun's proposed model raises the question of whether causation can be adequately accounted for in *quantitative* terms only, as their Passing Around model appears to suggest. One might think that contemporary physics stirs our intuitions in that direction, offering a *particulate* account of causation in terms of the transfer of particles. To explain how elementary particles 'act' on one another, contemporary physics posits the existence of virtual particles whose role is to be force-carriers. (For our discussion I propose to think of virtual particles as pure quanta of powers, which are passed around from object to object). Thus, elementary particles, e.g. protons, exert forces on each other by exchanging such virtual particles – e.g. gauge bosons. One might think that, thereby, contemporary physics does away with qualitative change in causation; that by introducing virtual particles to carry forces from particle to particle, e.g. to carry the electromagnetic force, or the weak, or the gravitational forces, contemporary physics has reduced causation to the addition or subtraction of force in the constitution of the particles, thereby eliminating the need to talk of qualitative effects of one particle on another. But this is not the case. Virtual particles of various types interact with one another *qualitatively*, too, and this cannot be accounted for in terms of force-carriers only. For instance, vector mesons can be produced by quark-antiquark annihilation in different *structural* arrangements.³² In such cases, I contend, the constitutional additions or subtractions of particles, through force-carriers or collisions, is not sufficient to account for structural variation. As I understand it, the force-carriers achieve two things. They transfer token quantities of energy from one entity to another; and they bring (through their presence) the first entity in contact with the second. But this is not sufficient to explain qualitative change.

Rather, I submit that transfer of particles is a mechanism for attaining contact between objects, and even for transferring forms of energy from one object to another. But this only *sets up* the problem of causation, of how we get qualitative change from contact, plus more or less energy. Qualitative change is not

³² See e.g. Green (2003).

reducible to quantitative change, although quantitative change can be accounted for as a type of qualitative change.

6. Each instance of causation involves two (or more) manifestations

Following Aristotle, I take the view that when two causal partner powers are mutually activated, their two manifestations occur *simultaneously* in one event, but they are two *different types* of activity. C.B. Martin's account is aligned with the one I am proposing, in that it, too, is Aristotelian, explaining causation through partner-powers that manifest reciprocally and simultaneously. He writes:

There is a surprising identity in causing and affecting. One must take the reciprocity of a reciprocal readiness partnerings as their mutual manifesting seriously and not ask for the action of a single readiness factor because there is no such action. Instead, actions are the reciprocal partnerings of a web or net of readinesses. (2008: 22)

It is not a matter of two events, but of one and the same event – a reciprocal dispositional partnering as a mutual manifesting. (2008: 46)

But there is an important difference between my Aristotelian account and Martin's. Martin sees the mutual manifestation of two powers as their mutual identification into a single event, and emphasizes that we should not seek to find the activity of a single power in a causing. But is this realistic? Is it true that the two powers *do the same thing*, as Martin (and also among others, Heil, Mumford and Anjun) appear to think? Many counterexamples are available from our everyday experience: the stove *heats* while the pot *is heated*, the sense organ *hears* while the guitar *sounds*; etc.

7. Active and passive causal roles

That causation has a direction is a generally shared common-sense intuition.³³ The orthodox view on the direction of causation has been that it reduces to the direction of time: causes occur prior to their effects (see e.g. Hume 1975, Kant 1965, Beauchamp and Rosenberg 1981). But the temporal view of the direction of causation has fallen into disfavor of late,³⁴ again³⁵, and a number of alternatives have been suggested.³⁶ My account of causal agency is an alternative

³³ While there is general agreement that causation has a direction, people do disagree on what underpins metaphysically causal direction. See e.g. Shaffer (2007) for an excellent account of the spectrum of positions.

³⁴ Shaffer (2007) reckons six main arguments in the literature regarding the relation between the causal and temporal directions, and four conclude that they do not coincide.

³⁵ The first period of disfavor was brought about by Aristotle's theory.

³⁶ Other alternatives that Shaffer mentions are: "For instance, that the causal direction is the direction of *forking* (Reichenbach 1956, Horwich 1987, Papineau 1993, Dowe 2000), *overdetermination* (Lewis 1979), *independence* (Hausman 1998), and *manipulation* (von Wright 1975, Price 1991 and 1996, Woodward forthcoming). On these alternative views, the coincidence

way, to the temporal one, of underpinning causal direction metaphysically. Those accounts of causation that do not draw the distinction between (the roles of) causal agent and patient of change provide no argument in support of their claim that causation needs to be symmetric with respect to the activation of powers; some merely appeal to the frequency in nature of changes that appear to be symmetric, for example Heil in this volume:

The standard view of causation might lead you to think that the water and the salt are related as agent and patient: the water, or maybe the water's enveloping the salt, causes the salt to dissolve. Perhaps the water possesses an 'active power' to dissolve salt, and salt, a complementary 'passive power' to be dissolved by water. But look more closely at what happens when you stir salt into a glass of water. Certain chemical features of the salt interact with certain chemical features of the water (Ingthorsson 2002). This interaction is, or appears to be, continuous, not sequential; it is, or appears to be, symmetrical.

In the case above, water dissolves salt and salt dissolves in water. In disagreement with Heil and Ingthorsson, I don't think that positing a symmetrical interaction between salt and water provides an adequate metaphysical description of what occurs. It is not true that what the water does to the salt and what the salt does to the water are actions of the same type. In the causal interaction of water and salt, polarized water molecules break the bond between the negative chloride ions and the positive sodium ions; whereas salt does not break the water molecules. This is what makes the chemical reaction asymmetrical. Heil's and Ingthorsson's account fails to capture the directionality of the causal process, which is underpinned by the different 'actions' of salt on water and water on salt respectively. The fact that water dissolves salt, but not vice versa, is scientifically informative. It expresses a law of nature. The law is no less informative because it governs an interaction between macro-level entities, such as water and salt, which do not figure at the micro-level (where it is the interactions between the fundamental powers that are operative). Talking of water dissolving salt conveys genuine scientific knowledge. It is the explanatory value in science of such statements about the causal processes in the world that justifies the existence of sciences over and above elementary physics. Chemistry, botany, biology, etc. produce scientific knowledge by discovering and formulating such laws as that water dissolves salt.³⁷ But as will be seen below, I do not mean to, and should not be taken to be classifying causal asymmetry a macro-phenomenon.

of the causal and temporal orders is merely a contingent feature of the actual world, or at least a typical feature of our patch of it." (Shaffer 2007)

³⁷ One might at this point ask: does water have the power to dissolve salt, or is this only an epiphenomenon of the micro-level powers of water's constituents? My claim is that water does have the power to dissolve salt, *for the same reasons for which we claim that water exists*. There are substances at the macro-level of reality, and these substances have powers. A full defense of this claim cannot be made within the limits of this paper. But very briefly, consider the counter-intuitive consequence that if there were no substances, physics would be sufficient to explain the phenomena in the world. Can physics really offer adequate accounts for all macro-level phenomena? I do not believe it can, which is why I subscribe to an Aristotelian ontology of substances and their powers.

From the asymmetry of causation follows the distinction between active and passive powers involved in a causal interaction.³⁸ There are various metaphysical differences between mutually manifesting partner powers that can ground classifying their mutual activation as asymmetric; such metaphysical differences can also ground distinguishing between active and passive roles of powers.

It follows that I hold that active and passive powers are not by nature such. Powers 'take on' an active or passive causal roles when engaged in causal interaction.³⁹ These causal roles are the roles of the 'doer' and the 'sufferer'. A power is a doer when it is described as doing something on something else; and a sufferer when it is described as suffering the causal activity of another power.⁴⁰ As 'doer' and 'sufferer' are roles that powers play, rather than features of their natures, in some cases each causal partner power can be *both active and passive*. Thus for example a power (or its bearer) may be heating while being cooled, and hence changed, at the same time.⁴¹

From a metaphysical point of view, an important feature that can ground classifying a power as active is if the power is bringing about *change* in another power (or its bearer). If the power's activity brings about change, e.g. in the direction of a particle's spin, then the effect of the power's activity is a new power that is generated in the process. The attribution of active and passive roles is less clear if a power's activity does not bring about change, but the effect is only the activation of another; for example, resting a playing card against another, which activates the resistance and weight of each without changing them. Again the attribution of active and passive roles is less clear if the powers temporarily alter

³⁸ Regarding the distinction between active and passive powers, as Heil notes, among contemporary metaphysicians e.g. Shoemaker (1980; 1998; 2007) draws a distinction along the same lines when talking of 'forward-' and 'backward-looking' 'conditional powers'. The distinction is rooted in a long-standing tradition: Plato (*Theaetetus*); Aristotle (*Physics*, *De Anima*); Locke (*Essay Concerning Human Understanding*); Leibniz (*Philosophical Essays*).

³⁹ I develop this view from an Aristotelian insight in *Physics* III 3. Although Aristotle's theory of causation might lead one to believe that there is a metaphysical distinction between active and passive powers, on my analysis of his theory, activity and passivity are roles that powers have in causal processes. In fact, I hold that Aristotle considers this the analysis of causation – namely, it is a *conceptual truth* that a power (or its bearer) that engages in a causal process is *doing* something which is *suffered* by another power (or its bearer).

⁴⁰ Can causal powers be activated neither as doers nor as sufferers? Do fundamental powers spontaneously become anything other than what they are? If they did, then this would not be an instance of doing or suffering. I submit that fundamental powers do not spontaneously become other than they are, but are governed by the conditions around them. For instance, alpha decay results from the counterbalancing of the electromagnetic and the nuclear forces; gamma decay results from a nucleus in an excited state, just as photon emission results from an electron that shifts to a lower energy level.

⁴¹ E.g. Heil, this volume, claims that: 'Examples of this kind [e.g. two playing cards propped against one another] ... arguably, they are by far the most common species of causal interaction' and from this concludes that 'The causing here is a reciprocal, symmetrical, continuous affair.' I argued above that there difficulties with Heil's stance, and I here offered an alternative metaphysics for such cases, preserving the important point that causation has directionality. I return to a discussion of Heil's views below, p. **.

and then recover, e.g. when the repelling powers of two electrons are mutually affected as they approach each other, but recover after they pass one another.

The distinction between active and passive causal roles has been discussed in the literature with such examples as the two playing cards holding each other up (Heil, this volume), or the one of an ice cube in a glass of lemonade (Mumford, 2006). On the back of such cases, Heil (this volume) claims:

Considered ontologically, causes and effects take a back seat to causings. Causing is where the action is.

For Heil, causing is the single manifestation mutual partners achieve in causation. (Recall Martin's 'surprising identity', discusses above, p. ***). Cases such as the two playing cards holding each other up are very common in nature and show that there is no ontological distinction between cause and effect, i.e. between the manifestation of the active power and the manifestation of the passive power. There is only one manifestation for both, and the fact that we call it 'dissolving' or 'being dissolved' (in the case of salt in water, as Heil sees it) is only a matter of 'perspectivalism'. He (this volume) concludes:

The mistake is to allow these epistemological concerns to call the shots ontologically ... My suggestion is that a dispassionate look at the ontology of causation takes us to causings, the mutual manifestings of reciprocal powers or dispositions.

I have argued above that although the differences between active and passive powers are functional roles powers are allotted in their mutual manifestations with their partners, the grounds for allotting these roles are not epistemological but metaphysical. For example, whether one only of the two powers changes, or changes more than the other, or alters temporarily, etc., can determine whether a power is classified as active or not. My position is that a variety of metaphysical differences between mutually manifesting partner powers can become the ground of allotting activity or passivity to them, or both.

Conclusions

This paper sketches the main tenets of a new account of the nature of fundamental properties. On the assumption that all properties at the fundamental level of reality are causal powers, the view this paper advances is this: Reality at the bedrock (that is, at the level of what is physically fundamental) is a network of causal powers which are dependent on each other for their existence and manifestation. The dependence of fundamental powers on partner-powers for their existence and activity does not tease out different levels of fundamentality. The dependencies are horizontal, and do not ground different ontological levels in nature. A power can be in a state of potentiality, or in a state of activation; in the latter state, it co-manifests with its partner power in activities of what they are potentially powers to do. As mentioned above, I take a manifesting power to be in activity, and thus to have temporal duration, rather

than be an instantaneous transition from one power in potentiality to another. On my account, activated powers (e.g. weight) can last in time, because the activation of a power does not require that the power change into a numerically different power. Thus the world consists of powers in potentiality; powers that are going in and out of activity; and powers that are constantly activated in the presence of their partner powers. The network of the interdependent fundamental powers in potentiality or in activation comprises a structure of powers, which is the ontological foundation of reality. The structure is not constituted of polyadic relations, but monadic relatives, which are the powers. I have derived this view from Aristotelian insights, and I call it *Power Structuralism*.

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