PHYSICALISM, SUBSTANCE, AND THE SHIFTING LOCUS OF FUNDAMENTALITY

by

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Abstract

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Advisor: Barbara Montero

I demonstrate two main theses. First, the physicalist and Aristotelian worldviews are deeply incompatible, particularly in regards to the locus of fundamentality: where the fundamental level of reality is taken to be, which entities, processes, and facts are understood as fundamental, and, as a corollary, which are taken to be derivative or unreal. Second, the physicalist is committed to eliminativism about what the Aristotelian thinks is the fundamental basis of reality. And as these Aristotelian theses largely comport with a common-sense ontology, I thereby show that physicalism is far more revisionary than many have suspected.

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Preface

Metaphysics is often said to be the study of ultimate reality. Though 'ultimate' etymologically connotes 'last' or 'final', and Aristotle thought of metaphysics as "first philosophy", it is easy to see why these conceptions do not truly differ, or why such characterizations of metaphysics persist: metaphysics concerns the basis, grounds, or bedrock of reality, i.e. where reality starts and investigations must end. Synthesized in a word, metaphysics concerns what is fundamental.

It is increasingly popular to describe the goal of metaphysics in these terms, as many contemporary metaphysicians see their task as discovering the relations between the fundamental and nonfundamental; discerning "what grounds what", in Jonathan Schaffer's (2009a) phrase, or limning "metaphysical structure", in Theodore Sider's (forthcoming 2012), is now perhaps the predominant conception of metaphysical inquiry. And though this language is (somewhat) new, the idea, it seems to me, is deeply traditional.

For the most part, though, the burgeoning literature on fundamentality and related topics is ahistorical.[1] Moreover, these tasks are often pursued without considering how an overarching worldview can inform what is taken to be fundamental, or, conversely, how what is taken to be fundamental can itself define a worldview. In this dissertation, however, I aim to demonstrate the value of considering questions concerning fundamentality historically, and in relation to a comprehensive worldview. In particular, I will focus on two worldviews- Aristotelianism and physicalism. I will show that these

[1] Though Schaffer is a notable exception, insofar as he incorporates the wisdom of the ages into his work, so to speak; he often quotes figures such as F.H. Bradley or Spinoza in support of his arguments (see esp. his 2009a, 2010). Nonetheless, he tends to use these philosophers to buttress his arguments for what is fundamental, rather than using the notion of fundamentality to shed light on these figures.

two pictures are deeply incompatible, as they differ profoundly on what I call the locus of fundamentality: where the fundamental level of reality is taken to be, which facts and entities are understood as fundamental, basic, or ungrounded, and, as a corollary, which are taken to derivative, secondary, and even unreal.

The result, however, is not only that these two worldviews differ. For I will not only argue that the physicalist takes to be secondary what the Aristotelian takes to be primary, but that, more strongly, the physicalist is committed to eliminativism about many of the entities and processes that the Aristotelian thinks are the fundamental basis of reality. And as these Aristotelian entities and theses largely comport with a common-sense ontology, I thereby show that physicalism is far more revisionary than many have suspected.

The structure of this dissertation is as follows. In chapter 1, I set out and defend a particular conception of physicalism as the predominant and representative one: physicalism is the view that everything is determined by the fundamental posits of physics. I then show that this implies a constraint on the physicalist ontology: if something is not determined – or underdetermined – by the fundamental physical entities, the physicalist is committed to its nonexistence. In chapter 2, I establish several respects in which the Aristotelian and physicalist differ on the locus of fundamentality: according to the Aristotelian, I argue, the macroscopic level of reality is the fundamental level, the identity of a substance as an instance of a natural kind is a fundamental fact, and a substance's most basic properties, including its persistence conditions, are determined only by the substance itself (via formal causation), and are thereby intrinsic. I then show that the physicalist rejects all of these tenets, thereby establishing a wholly distinct and

incompatible notion of what is fundamental. In chapter 3, I further develop my account of the fundamental entities of the physicalist worldview, and how this profoundly differs from the Aristotelian view: I show that contrary to the Aristotelian world of separate and independent enduring substances, the basic entities in the physicalist worldview are essentially interconnected and interdependent properties, which is say, extrinsic properties. And in chapter 4, I draw out the revisionary nature of the physicalist ontology. There, I argue that the identity of substances as instances of substantial natural kinds, as well as the possession of intrinsic persistence conditions, is underdetermined by the fundamental physical entities. So what is fundamental for the Aristotelian, I conclude, must be entirely jettisoned from the physicalist ontology. The moral, then, is that substances with intrinsic properties are either fundamental, or they are nothing; once these are removed from the metaphysical ground floor, they have nothing to stand on, as it were.

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Chapter 1. Physicalism: Fundamentality and Determination

1.0: Introduction

Though physicalism is the view that everything is physical, it also contains a fundamentality thesis: according to the physicalist, everything that exists depends on, and is determined by, the fundamental physical entities. In this chapter, I flesh out and defend this characterization of physicalism as historically salient and philosophically viable.

1.1 A brief history of physicalism

To say that everything is material or physical obviously implies that nonmaterial or nonphysical beings do not exist. Thus, materialism necessarily has eliminativist commitments. And what has typically been eliminated are mental or spiritual substances, as well as divine or supernatural entities- on the grounds that these are not made of matter, or are physical. Materialists have also typically rejected vital forces, entelechies, or otherwise teleological entities, for similar reasons.

Yet the idea of what it is to be material, and what qualities something must have in order to count as material, have changed considerably over the years, going all the way back to the pre-Socratics.[2] Nonetheless, the revival of materialism concurrent with the Scientific Revolution was marked by broad agreement, and should be familiar to any philosopher: to be material is to be extended, solid, inert, and impenetrable, as well as deterministically interactive. And this conception held more or less constant through the late 19th and early 20th centuries.

But a problem emerged. First, and despite the presumed affinity between materialism and the natural sciences, physics has shown that not everything has those features. Over the last century and a half, physics has posited extensionless point particles, penetrable (or

[2] See Toulmin and Goodfield (1962) for an extensive history of the notion of matter.

superimposable) fields, and spontaneously (i.e. indeterministically) decaying atomic nuclei.[3] According to modern physics, then, traditional materialism is false.

Now, this may not appear to be a serious problem, for one might think the spirit of materialism can live on (however ironic that phrase): for one may claim that the materialist may simply update her list of characteristic material properties. But this move is not unproblematic. For suppose that one does compile an updated list of definitive physical properties. If physics were to discover some years hence that matter did not possess *those* very properties, then one would again be in the scenario in which physics disproves materialism or physicalism. And so on, if not literally *ad infinitum*, then for all intents and purposes. Moreover, as Montero (1999) convincingly argues, even as of this moment there does not appear to be a set of properties that all and only physical objects have that mark them as physical, and which draws the proper contrast with paradigmatically nonphysical things.

And this may be even more problematic. For physicalism is supposed to be an ontological thesis[4] according to which everything that exists shares some common characteristic(s) that marks them as physical,[5] and which thereby provides a contrast with those

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[3] Cf. Crane and Mellor (1990), Wilson (2005), Brown and Ladyman (2009).

[4] Physicalism was not an ontological thesis for the positivists such as Carnap, Neurath, and Schlick, of course: although logical positivists championed science as an epistemology, they rejected traditional materialism as metaphysical (in the pejorative sense), and so as meaningless (on a verificationist theory of language). For the positivists, who introduced the term 'physicalism', physicalism was a thesis about the unity of science, rather than an ontological characterization of the nature of the world (for an overview, see Uebel 2006). Upon the demise of positivism (largely due to the rejection of verificationism), and the subsequent return of metaphysics, philosophers of a naturalistic bent returned to a broadly materialistic metaphysics of nature. So, rather than the difference between physicalist and phenomenalist language-schemes being a Carnapian convention, by the late 1950's physicalism-as-realism was prevalent. For example, Smart (1959) wrote "there does seem to be, so far as science is concerned, nothing in the world but increasingly complex arrangements of physical constituents" (p. 169). Smart cites Oppenheim and Putnam 1958 as allies in this regard. See also Nagel (1961), Armstrong (1968), and Hellman and Thomson (1975) for characteristic views of the time. However, the use of the term 'physicalism' was not necessarily ubiquitous; Smart (1959) still refers to his "materialistic metaphysics" (p. 173).

[5] Or, if that common characteristic is 'being physical', further fleshing out is still required to give content to a dispute over whether the mind, for example, has this characteristic as well.

entities thought to be nonphysical (whether existent or not); hence the eliminativist commitment mentioned above. But without knowing what these features are, it may seem that physicalism is unhelpfully vague, for it might be unclear in any given case whether an entity is to count as physical or nonphysical.

For better or worse, though, physicalists did not seem to worry very much about this – at least until recently – but rather have treated physicalism as something of a cipher: for many, what it is to be physical is to be posited by physics, where this can be fleshed out as physics sees fit. So, for example, Hellman and Thomson (1975: 553) characterized physicalism as the claim that "everything is exhausted.. by mathematical-physical entities," where to be a mathematical-physical entity is to satisfy "any predicate in a list of basic positive physical predicates" of the (object) language of physics.[6] And Lewis (1983: 219) argued that physicalism[7] is the claim that "the world is as physics says it is, and there's no more to say. World history written in physical language is all of world history."

Notwithstanding the reference to predicates (and hence language) in each of these passages, physicalism was understood as an ontological or metaphysical view that characterized the nature of entities, but where this characterization was to come from physics (and not metaphysics)- even if that characterization was not yet known. By 1990, Crane and Mellor (1990: 185) called this conception of physicalism "orthodox".[8,9]

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[6] Examples Hellman and Thomson give include 'is a neutrino', 'is an electromagnetic field', and 'is a four-dimensional manifold'.

[7] Lewis actually used the word 'materialism' here, not physicalism. But he is clearly referring to the contemporary version, not the 17th century variety.

[8] This is somewhat fudged; more accurately, they called the belief in the *truth* of physicalism "almost orthodox". What makes it slightly less than orthodox, though, is that some believe physicalism is false. But even those dissenters at the time of the writing would agree, presumably, that this is what physicalism is. Hence, I infer they consider the formulation of physicalism "orthodox".

[9] Other notable proponents include Meehl and Sellars (1956), Oppenheim and Putnam (1958), Davidson (1970), Hellman and Thompson (1975), Smart (1978), Lewis (1983), Hellman (1985); Post (1987).

1.2: Should physicalism be defined by physics?

Nonetheless, Crane and Mellor's (1990) paper challenged this "orthodox" conception of physicalism. Their paper, entitled "There is No Question of Physicalism", argued that "Physicalism lacks a clear and credible definition, and that in no non-vacuous interpretation is it true" (p. 185). Their argument works as follows. In order for physicalists to meaningfully – and truthfully – assert that the world "contains just what a true complete physics would say it contains", physics must be demarcated from the other sciences. But Crane and Mellor argue that this generates a dilemma. Either physics cannot be so demarcated, in which case psychology – and the mental properties with which it deals – are trivially physical, i.e. by definition a part of physics, or else physics is narrowly demarcated as being approximately what physics textbooks present physics as- in which case physicalism is (obviously) false, as these textbooks do not deal with psychological or economic facts. Though something similar to this dilemma had been argued before (e.g. Smart 1978, Hempel 1969, 1980) Crane and Mellor's paper spawned a literature concerned not just with the truth of physicalism *per se*, but with the proper formulation of it. Papers such as Pettit's (1993), entitled "A Definition of Physicalism", became the norm.

This dilemma (or something akin to it), suggested by Hempel, Smart, and Crane and Mellor, came to be known as "Hempel's dilemma". Thinking the dilemma not able to be resolved, many agreed that Hempel's dilemma undermines the substantivity of a physicalism defined in terms of physics (e.g. Papineau 1993, Daly 1995, Van Fraassen 1996).[10]

The effect was that conceptions of physicalism splintered. Of those ceding victory to Hempel's dilemma, some argued that physicalism – at least the version defined by physics – is a trivial rather than substantive thesis. Others claimed that physicalism is not a metaphysical doctrine at all, but an attitude or stance concerning the authority of physics (Van Fraassen 1996,

[10] More recent defenders include Montero, Poland (2003), Ney (2008), Howell (2009)

Ney 2008). Some philosophers instead contended that 'physical' is defined by paradigmatic physical objects, independently of physical theory (Stoljar 2001b, Strawson 2006). Still others that there is no positive characterization to be had, and that characterizing the physical as the "non-mental" is sufficient for philosophical purposes (Montero 1999, Spurrett and Papineau 1999, Levine 2001, Montero and Papineau 2005, Montero 2006). Still, no one alternate conception has overtaken the physicalism-as-physics version. Moreover, philosophers continue to defend the traditional version; since the Crane and Mellor paper, defenders of Physicalism as a doctrine defined by physics include Armstrong (1991), Pettit (1993, 1995), Kirk (1994), Lewis (1994), Kirk (1996), Brandon-Mitchell and Jackson (1996), Chalmers (1996), Armstrong (1997), Melynk (1997), Ravenscroft (1997), Papineau (2001), Loewer (2001), Witmer (2001), Dowell (2006), and Wilson (2006).

In short, there is ample evidence that many prominent philosophers take physicalism to be the view that 'physical' is defined by reference to physics, despite the problems raised for that view. As indicated, although there are alternate conceptions, no consensus has emerged to rival the traditional defined-by-physics version. So simply as a matter of historical and contemporary belief, it is appropriate to treat physicalism as being defined by the posits of physics (and so appropriate to treat that version of physicalism as the subject of this dissertation).

But that a view is more popular does not, of course, make it true, nor shield it from criticism. And if there are good philosophical reasons to view physicalism as defined by something other than physics, as many already cited maintain, popularity is no match. There being a more preferable formulation than the one I present only diminishes the generality of my project. But, if Hempel's Dilemma is successful, physicalism has no content capable of being compatible or incompatible with anything. And so my project, according to which physicalism

is incompatible with Aristotelianism, cannot get off the ground. So, I will defend the substantivity of physicalism against Hempel's dilemma.

As indicated, Hempel's dilemma has evolved to become something slightly different than the dilemma posed by Crane and Mellor. The problem is no longer typically understood as how to demarcate physics from the other (physical) sciences. Instead, the problem has to do with *which* physics is the physics in terms of which physicalism is defined. Because, presumably, an ideal, completed physics will posit entities different than those posited by current physics, a physicalism defined in terms of the former will have different ontological commitments than a physics defined in terms of the latter. Consequently, what entities count as physical will differ depending on which incarnation of physics is definitive of physicalism. In this light, the dilemma has come to be understood as follows. The first horn: if physicalism is defined by the posits of current physics, then physicalism is almost certainly false, given the overwhelming likelihood that current physics will be superseded by an improved version in the future.[11] Call this problem *obvious falsity*. The second horn concerns defining physicalism in terms of an ideal, completed physics, and presents two distinct problems. The first problem of the second horn: If physicalism is defined by ideal physics, physicalism is too vague to be evaluated, assuming the content of ideal physics cannot be currently known. Call this problem *vacuity*. The second problem: if physicalism is defined in terms of ideal physics, then it is trivially true. For if physics is ideal and complete just in case it accounts for everything that exists, then by definition everything that exists is physical. Call this problem *triviality*.

Most concede *obvious falsity*, thereby admitting that physicalism cannot be defined by current physics. Melnyk (1997), however, argues that physicalism ought to be defined by current

[11] It has been pointed out that because General Relativity and Quantum Mechanics are inconsistent, and because no inconsistent theory can be true, current physics is (certainly) false. See Wilson (2006: 65) and Ney (2008: 2) for discussion of this point.

physics, and even though that makes physicalism (obviously) false, it is nonetheless rational to believe it.[12] But as one need not accept this implication (as I will argue subsequently), there is little reason to accept this doctrine.

What would count as defeating *triviality*? To be nontrivial, a final physics-based physicalism must be possibly false. To be possibly false, there needs to be at least one possible entity that even if actual would be beyond the scope of final physics to posit. But in order for there to be an entity beyond the scope of physics to posit, physics must have boundaries or limits. So for a final physics-based physicalism to be nontrivial, such that its truth does not follow from its definition, there must be a *constraint* on physics that prevents future physics from expanding so as to posit anything that could possibly exist.[13]

Precisely because many contend that no such constraint exists, they conclude that *triviality* – and so Hempel's dilemma – cannot be solved. Some argue, in a deferential and naturalistic spirit, that it would inappropriate for philosophy to place (external) constraints on the progress of physics (Montero 2001, Poland 2003).[14] But even granting this, it does not follow that there are no internal constraints on physics. Now, others do argue that there are no internal constraints on physics, and that therefore there is no solution to *triviality* (Ney 2008, van

[12] For discussion and criticism, see Wilson (2006: 63-67).

[13] Of course, the nonfundamental entities of the special sciences are beyond the scope of fundamental physics, but are not (necessarily) candidates for falsifying physicalism. This is because such nonfundamental entities are believed to be connected to fundamental physics by some dependence relation. So, while one way for physicalism to be false is for there to be a nonfundamental entity that is not suitably connected to the fundamental posits of physics, another way is for an entity at the fundamental level to nonetheless be beyond the scope of fundamental physics. It is the latter sort which is of interest here, as it is this sort of entity that physics would ostensibly expand to incorporate.

[14] For Montero, "placing *a priori* restrictions on science [from the armchair], on what it is and how it is allowed to progress seems blatantly anti-naturalistic" (2001: 69). And Poland approvingly describes Chomsky's view of science as an endeavor "not substantively constrained by *a prioristic* forms of speculative or analytic philosophy" (2003: 5).

Fraassen 1996).[15] However, the fact that the word 'physics' has a (lexical) definition, and that the activity *physics* has a corresponding real definition, suffices to put a constraint on physics, and hence counters this argument for triviality.

To see this, suppose for argument's sake the definition of the word 'physics' is "the science of the composition, dynamics, and interactions of all occupants of spacetime."[16] Now consider a professional physicist who posits Cartesian minds existing outside of spacetime. Is this physics evolving? Did this card-carrying physicist extend the scope of physics to include Cartesian minds, or is this person no longer doing physics? Using the stipulated definition as the criterion for what counts as physics, this activity no longer counts. It follows that a definition of 'physics' is sufficient to constrain the word 'physics' from applying to an activity that posits Cartesian minds. And if this definition can be taken to represent the real definition of physics, i.e. what physics *is*, then any activity that posited Cartesian minds would not *be* physics. So, to maintain that physics has no constraints whatsoever, one would have to deny that 'physics' has any (lexical) definition, and that physics itself has no "real definition" corresponding to this lexical definition. But there is no obvious reason to think this. So, just as the nominal definition of the word 'physics' constrains its application, so too does the real definition of *physics* constrains its evolution. As such, there are constraints on the evolution of physics *qua* physics, and this argument for the triviality of physicalism fails.

This suggested definition does not suffice to solve Hempel's dilemma, however,[17] and so it is not the constraint I suggest in my account. Moreover, the constraint I suggest (based on

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[15] For Van Fraassen, there can be no "science stoppers" (1996: 158), i.e. nothing that constrains or stops the progress of science. And Ney declares it a "fact that physics itself does not have any *a priori* limitations in what it may posit" (2008: 8).

[16] This is the definition Poland (1994: 124) suggests.

[17] Despite suggesting this definition (see note 16) in order to solve Hempel's dilemma, Poland, in later work, admits that it fails to do so. See his (2003).

arguments in chapter 3) that is able to solve the dilemma is not strictly definitional, but is, I contend, included in the concept of *physics*, insofar as that can be discerned via the paradigmatic goals of physics. But in order for that account to get off the ground, the very idea of a constraint on physics must be made palatable. I hope to have done that here.

1.2.1: Wilson's and Dowell's Final Physics-Based Solution to Hempel's Dilemma

Both Dowell (2006) and Wilson (2006) attempt to solve Hempel's dilemma via a definitional account of the sort mentioned above. For Wilson, because being a science at all, and being "the science of the fundamental" in particular are "characteristic features" (p. 68) of any physics, *a fortiori* final physics will be the science of the fundamental. This, according to Wilson, bestows determinate content on final physics, thereby solving *vacuity* (the first reading of the second horn). Moreover, Wilson argues that because being the science of the fundamental implies that final physics will not posit the nonfundamental, falsifiability conditions for a final physics-based physicalism are established: if nonfundamental entities "over and above" the fundamental exist, then a final physics-based physicalism is false. In just one move – defining physics as the science of the fundamental – a constraint on physics is established that solves *vacuity*, and also provides falsifiability conditions for physicalism. (Dowell makes the same moves, though she spells out the content of and criteria for being a scientific theory in more detail.)

Wilson's and Dowell's accounts, then, work via an innocuous physics-derived constraint on the possible evolution of physics. This constraint links current with future physics, and provides determinate content and falsifiability conditions for physicalism. Though I defended this strategy above, there remains a problem with the particulars of this account. This particular

constraint on the evolution of physics – being the science of fundamental entities – does not rule out physics from positing fundamental mentality, and as such, this constraint on the posits of physics does not suffice to distinguish physicalism from dualism.[18] Consequently, on this formulation of physicalism, mental properties could be considered trivially physical.

Dowell accepts this implication of her account and essentially bites the bullet, though she tries to explain away the intuition that physicalism should not be compatible with dualism. She concedes, though, that some may consider (her) physicalism's ultimate compatibility with the existence of fundamental mentality a *reductio* of her account (p. 27). Clearly, an account which did not leave this open would be preferable.

Wilson attempts to tackle the problem head on. Conceding that the constraint on physics that it is the science of the fundamental does not rule out physics' positing fundamental mentality, Wilson argues that a final physics-based account of physicalism needs to be supplemented by a "No Fundamental Mentality" proviso. For Wilson, in order to ensure the desired incompatibility of physicalism and dualism, one should simply stipulate that the physical is whatever final physics posits, provided that it not posit fundamental mentality. Wilson contends that the so-called "NFM constraint" both "preserves the historical associations of physicalism as the descendent of materialism" (p. 91) and "suffices to preserve materialism's traditional incompatibility with its dualist rivals" (p. 85).

Even if Wilson can rebut both Judisch's (2008: 307) criticism that the NFM strategy does neither, and Dowell's criticism that the NFM constraint is inappropriately *a priori*, and even granting that the NFM move accomplishes what Wilson thinks it accomplishes, it still suffers from another, more serious flaw. Wilson's need for a distinctly metaphysical supplement amounts to the fatal concession that an *entirely* physics-based physicalism is unable to solve

[18] Ney, Wilson, and Dowell each recognize this point.

triviality. Wilson happens to not be particularly troubled by this, writing "the guiding idea [of her account] is to allow that some appeal to future (ideal) physics is needed… while recognizing that physicalists need not and should not hand over *all* authority to physics to determine what is physical" (p. 69, original emphasis). But this concession is more serious then Wilson lets on, as it is susceptible to Ney's criticism that the philosopher who makes such a move no longer subscribes to "Physicalism as the thesis that *the world in its totality is the way physics says it is"* (2008: 8), despite this being precisely what is supposed to be constitutive of physicalism. According to Ney, Wilson's move instead commits her to the school that proclaims that "we believe what physicists say exist exists, just so long as they don't say *that* is what exists" (original emphases). Ney argues convincingly this is not physicalism at all. For Ney, the failure to formulate an entirely physics-based physicalism incompatible with dualism is one of the most persuasive reasons to concede to Hempel's dilemma and reject a final physics-based physicalism as a substantive ontological doctrine. That Wilson is glib about the failure is no counter to Ney. In short, Wilson's *ad hoc* stipulation, whatever its other merits, betrays the version of a final physics-based physicalism that is supposed to be defended from Hempel's dilemma.

So Dowell's and Wilson's accounts are unable to provide an entirely physics-based account that rules out fundamentally mental properties from being trivially physical. And as this is one of – if not *the* – central point of Hempel's dilemma, these accounts can be considered partial successes at best, though they are also plausibly seen as failing to solve the dilemma.

1.2.2: Physics and no fundamental mentality

But it need not be the case that an entirely physics based account falls short. Consider two briefly sketched ways that a physics-based account could solve the problem.

First, I contend that my account of the fundamental physical properties in chapter 3 provides such a solution. There, I argue that physical properties are extrinsic. But this argument is not based on a perhaps ephemeral or replaceable physical theory. Rather, I argue it is a consequence of something essential to physics as such: namely, how physics defines its fundamental predicates (and corresponding properties). For, I argue, as long as the fundamental physical predicates are defined by their place in mathematical-physical law, then the corresponding properties count as extrinsic. This, then, is a structural feature of physicalism, akin to Wilson's and Dowell's claim that physics is the science of the fundamental. And this solves the dilemma. For it follows that if mental properties are intrinsic (as many are typically taken to be), then the existence of fundamentally mental intrinsic properties falsifies physicalism. And as the arguments for physical properties being extrinsic and mental properties being intrinsic are motivated independently of considerations from Hempel's dilemma, this provides a non *ad hoc* way of precluding fundamental mental properties from the purview of physics, thereby solving the dilemma.

Second, it is plausible to suppose that any fundamental physical property is amenable to measurement or quantitative rendering more generally, and that being so amenable is necessary for the inclusion in the sorts of laws physics is in the business of positing. That is, it seems that being able to be included as an element or relatum in a quantitative law is necessary for a property being amongst the fundamental posits of physics. So, if this condition were built into the criteria for counting as a fundamental physical property, then it seems that mental properties are not eligible to be fundamental physical properties. For it is not clear that there could be units of intentionality or qualia, or different quantifiable degrees of them that would allow them to be

incorporated into fundamental quantitative laws.[19] Though preliminary and sketchy, such an account could rule out mental properties from being among the fundamental *physical* properties, even if they turned out to exist.

In short, Hempel's dilemma need not be insurmountable. This is not to say that as a result, physicalism *should* be defined in terms of physics. Instead, given the predominance of the belief that physicalism *is* defined in terms of physics, it is sufficient for my purposes to show that the view is tenable, and is not ruled out from serving as the subject matter of my dissertation, as the conception that underlies the physicalist worldview.

1.3. The nonfundamental physical: supervenience and determination

If what it is to be physical is to be posited by physics, however, what makes those entities not literally posited by physics physical? Similarly, if the entities posited by physics are the fundamental entities, what relation(s) between the nonfundamental entities and the fundamental entities must hold in order for the nonfundamental entities to also count as physical?

Among the many candidates for an answer to this second question are realization, constitution, identity, reduction, and explanation. But by and large, it is (or had been) most frequently supposed that the suitable connection is supervenience. Though there is a large variety

[19] Of course, degrees of belief may be treated quantitatively in e.g. game theory or decision theory. Nonetheless, it is hard to see how such mental predicates could be included in a fundamental physical theory, as any such theory- when expressed via an equation- requires the transformation or conversion of units. For example, mass, while traditionally expressed in grams or kilograms, can also be expressed in joules, or in micro electron volts (MeV), i.e. in units of energy, because there are equations lawfully linking mass and energy. More generally, as any quantity expressed on one side of an equals sign can be converted – or can be treated as equivalent to – a quantity on the other side, this suggests that if 'belief units' were employed in a fundamental law, such units would be able to be converted to – or substituted for –an equivalent non-mental unit, such as joules per coulomb, if such quantities also appeared in the fundamental laws. And it is hard to recognize the notion of belief being represented in such units without the accusation of a category mistake, for instance. Again, this account is sketchy and needs fleshing out. Its purpose here, though, is simply to suggest that it is more difficult to incorporate mental predicates into fundamental physical theory than simply saying that they can be added.

of supervenience relations differing in subtle ways (see McLaughlin and Bennett 2005 for an overview), the basic idea behind supervenience is easily expressed: a set of properties B supervene on a set of properties A iff there cannot be a change in B-properties without a change in A-properties. So, for example, if mental properties cannot change without a change in physical properties, they supervene. If supervenience is sufficient for the physicalist's suitable connection between the fundamental and nonfundamental, then the supervenience of the mental on the physical shows that the mental can be included in a physicalist ontology, rather than falsifying physicalism.

Although supervenience may be necessary for physicalism, that supervenience is sufficient has been widely criticized (Schiffer 1987, Kim 1990, Heil 1992, Horgan 1993, Wilson 2005). (For a recent defense, though, see Howell 2009.) The basic idea uniting these criticisms is that intuitively nonphysical properties may supervene on physical properties. Put another way, views traditionally opposed to physicalism – such as emergentism and dualism – can accept that emergent or mental properties supervene on physical properties without impugning their doctrines. If the supervenience of the mental on the physical is compatible with emergentism or dualism, then supervenience does not suffice to make supervening properties physical.

To illustrate this point, consider Leibniz' parallelism.[20] According to Leibniz, God has created the universe in such a way as to guarantee a (pre-established) harmony between the mental and physical, despite their never interacting. In such a Leibniz-world, the mental supervenes on the physical (both globally and locally). But clearly such a world is not a physicalist one. Hence supervenience does not suffice to capture the physicalist relation between the fundamental physical and the nonfundamental.

[20] Ney (2007: 45) uses this example.

Supervenience-based formulations of physicalism also face "the necessary beings problem" (Jackson 1998). Obviously, God's existence is incompatible with physicalism. But if God is a necessary being, and no two things can differ in regards to necessary properties, then God's existence supervenes on anything (and everything), including the fundamental physical properties.[21]

There are other problems associated with a supervenience formulation of physicalism (see Stoljar 2001/9, and McLaughlin and Bennett 2005 for an overview). But these two mentioned here are the most pressing, and reveal the heart of the problem better than others. To see this, consider some of the properties of supervenience. First, supervenience is non-symmetric, not asymmetric (Daly 1995). Second, supervenience does not entail that one supervening entity obtains in virtue of another (McLaughlin 1995). And, thirdly, supervenience does not necessarily indicate ontological priority. On this basis, McLaughlin and Bennett conclude that "at heart, all a supervenience claim says is that a-properties *co-vary with* b-properties" (2005: 9). Yet, an intuition behind physicalism is that everything that exists does not merely happen to co-vary with the fundamental physical. Instead, the fundamental physical should asymmetrically determine the nonfundamental, be that in virtue of which the nonfundamental obtains, and be ontologically prior to the nonfundamental; as Loewer (2001) puts it, "Physicalism claims that all facts obtain *in virtue of* the distribution of the fundamental entities and properties.. of completed fundamental physics" (p. 39, my emphasis). Supervenience only reveals covariance, it does not reveal priority or what holds in virtue of what. In a Leibniz world, for instance, mental properties co-vary with physical properties; they supervene. But the physical is not prior to the mental in that scenario, nor does the mental obtain in virtue of the

[21] Jackson (1998: 22-3) tries to avoid the necessary beings objection. It is unclear if successful.

physical. And even if a necessary divine entity supervenes on the physical, the physical is not ontologically prior to that entity, nor that in virtue of which the divine entity is as it is.

What this reveals is that the physicalist requires an asymmetric relation that renders the fundamental physical ontologically prior to the nonfundamental, and can be that in virtue of which the nonfundamental facts obtain. In their classic 1975 paper on physicalism, Hellman and Thomson contend that the core idea of physicalism is of "one realm of facts determining another" (p. 557), in particular that the fundamental physical facts determine all others. As such, 'determination' seems to satisfy the job description: to say that the physical facts determine all the facts is to say that the physical facts make the other facts what they are, such that the physical facts are ontologically prior, and that they are that in virtue of which the other facts obtain.

So consider the Leibniz-world again. In a Leibniz-world, the physical does not determine the mental. Instead, in a Leibniz-world, God determines the nature and distribution of mental properties. Even though the mental supervenes, it is not determined by the physical. In fact, it is this failure of physical determination, I contend, that accounts for the intuition that a Leibniz-world is not a physicalist one despite supervenience obtaining.

It appears, then, that the basic idea embedded in physicalism is that the fundamental physical entities determine everything else. In which case, physicalism should be formulated both as a fundamentality thesis, and in terms of a determination relation obtaining between the fundamental and nonfundamental. Here, then, is how I understand physicalism.

Physicalism $=_{df}$ Everything that exists is posited by fundamental physics or is determined by the posits of fundamental physics.

The word 'determination' is not idiosyncratic; following Hellman and Thomson (1975), Kim (1982), Crane (1991) and Wilson (1999) use the term to characterize physicalism. And Montero

(2006), despite her opposition to the conception, notes that physicalism is often described as being precisely this claim.

Now, I do not suggest that this settles the debate about how to formulate physicalism. 'Determination' may be vague, and there may be different varieties of determination relations (Ladyman, Ross et al. 2007: 38-9). It is even possible that on some understandings, supervenience is a determination relation.[22,23] Nonetheless, 'determination' is good enough to work with as is. For it explains why supervenience as typically understood is insufficient for physicalism, it captures the intuition that all else depends on the fundamental physical, and is the way it is in virtue of the fundamental physical. And it captures the intended asymmetry between the fundamental and nonfundamental.[24]

'Determination' works well as the suitable connection between the posits of fundamental physics and everything else for another reason: it nicely contrasts with 'underdetermination'. If, for example, the mental is determined by the physical, it too counts as physical. But if the mental were not determined by the physical – that is, if the nature or distribution of mental properties is underdetermined by the nature and distribution of physical properties – then physicalism is false. For if the mental is underdetermined by the physical, then the mental is determined by something

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[22] It is interesting that supervenience has become detached from determination. Wilson (2005: 434) notes that after his 1970 in which he introduced the concept, Davidson later (1973: 716–7) explicitly "advocated supervenience as a psychophysical determination relation". It is not clear whether Davidson was wrong about his version of supervenience being a determination relation, or whether subsequent developments lost sight of this constraint, and so included non-determination relations under the rubric of 'supervenience'.

[23] As I understand it, the failure of supervenience to be determination is what motivates the notion of "superdupervenience" (Horgan 1993, Wilson 1999). That is, it seems to me that superdupervenience is just the variety of supervenience where the subvenient properties determine the supervenient properties.

[24] However, Huttemann and Papineau (2005: 133) note that because "determination simpliciter may be mutual", determination must be noted as asymmetrical. They contend that in an equation where the sum of three masses equals a fourth, there's an asymmetry of determination, for "any three values of the above variables determine the fourth. The law (M) that governs the relations of parts and wholes thus seems to imply no asymmetric determination of the macromass, but simply a mutual dependence of parts and wholes" (p. 37-8).

else. Perhaps, as Leibniz, or Dualists contend, it is determined by God, or by nothing at all, in which case the mental cannot be included in a physicalist ontology, and, presumably, physicalism would be false if such mental entities or facts exist. More generally, if something is underdetermined by the fundamental physical facts, then either that something exists and falsifies physicalism, or else physicalism is true and there is no such something.

In general, then, we see that physicalism has built into it a constraint on its ontology. For by providing a criterion for what counts as physical, one thereby provides a criterion for what counts as nonphysical. Consequently, whether something is determined by the fundamental physical entities provides a litmus test for inclusion in a physicalist ontology: if something is determined by the fundamental physical entities, it counts as physical and may be included in a physicalist ontology, but if something is underdetermined by the fundamental physical, the physicalist is committed to eliminativism in regards to it.

1.4: Objection: Physicalism need not be foundationalist

I have argued that physicalism has built into it a fundamentality thesis. Montero (2006) argues, however, that because it is not true *a priori* that there is a fundamental level to reality, it is best that physicalism not be defined in terms of a fundamental level. She criticizes Schaffer (2003), who contends that physicalism is an "irreparably fundamentalist doctrine". Instead, Montero offers a formulation of physicalism that could account for the possibility of there being infinite levels, rather than a fundamental one.

But even assuming that it is not true *a priori* that there is a fundamental level, one could argue that because physicalism has historically been a fundamentalist doctrine, it should continue to be understood as one. If so, there being no fundamental level could be taken as falsifying

physicalism, rather than a possibility that a definition of physicalism should be amended to fit. After all, the definition of physicalism is not amended to accommodate the possibility of God existing; rather, if God exists, physicalism is false. On the other hand, though, it is possible, as Montero contends, that much of what the physicalist wishes to say – particularly in drawing a contrast with dualism – can be stated by amending the definition of physicalism to account for the possibility of infinite descent (i.e. no bottom level). But, Montero contends, doing so requires abandoning the notion of physicalism as defined in terms of physics. Though she considers this a virtue (because it avoids Hempel's Dilemma), it is not an option here, where I am working with the defined-by-physics version.

How, then, can a physics-based physicalism accommodate the possibility of infinite descent? Physicalism, as I've described it, is the doctrine that everything is determined by the posits of physics. Even if there are infinite levels, there need not be – nor can there be, of course – infinite disciplines each studying a different, lower level. If it turns out there are more levels than physicists can reach, this need not impugn physicalism.[25] For whatever is *relatively* fundamental is what physics studies. The live question for physicalism, then, is whether the stuff *less* fundamental than that studied by physics is determined by the posits of physics. This question would remain regardless if the physicist's explanations bottom out before reality does.[26]

Moreover, this scenario would still preserve the contrast with the Aristotelian worldview. For the Aristotelian, as I will discuss in the next chapter, it is the macroscopic level of everyday perception that is the fundamental level. The physicalist, by claiming that the macro is

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[25] Quarks and electrons appear to be indivisible, and exist at the range of 10^{-18} meters. Should there being entities even smaller falsify physicalism?

[26] Now, Montero would not accept this solution, for if there is a level of mentality below whatever level the physicists study, this is tantamount to physicalism being false. But, as alluded to earlier, I have another account of physical properties that maintains the incompatibility of physics and mental properties, wherein (relatively) fundamental intrinsic mental properties are excluded from counting as physical.

determined by lower levels, rejects this picture- even if the lower level does not ultimately bottom out. For even in this scenario, the physicalist is at least approaching the more fundamental level, even if she does so asymptotically, by investigating the increasingly small. This in itself, I will show, constitutes a rejection of the Aristotelian worldview, and so suffices for my purposes. As such, the problem of infinite descent will not affect those central arguments.[27]

[27] A reminder: I am not attempting to salvage this definition of physicalism from such an eventuality. For I have chosen the physics-based formulation not for its philosophic merits but simply because it is what philosophers take physicalism to be. My attempts to justify it have stopped at the point where the doctrine seems not to collapse.

Chapter 2: Aristotle, Physicalism, and the Shifting Locus of Fundamentality

2.0: Introduction

As argued in chapter 1, physicalism is the descendant of materialism, in particular the materialism that emerged with the rise of mathematical physics during the scientific revolution. As is well-known, that materialism was largely adopted in opposition to the hitherto dominant Aristotelian worldview, and especially in opposition to Aristotelian physics (broadly construed). Yet many of the *meta*physical implications of rejecting Aristotelianism are not sufficiently understood. In this chapter, I draw out and clarify several of these implications. In particular, I draw out and clarify the implications that concern the (shifting) locus of fundamentality: I argue that the Aristotelian holds several theses regarding what is fundamental, all of which the materialist rejects. I then argue that contemporary physicalism inherits from its materialist ancestor the rejection of these several Aristotelian fundamentality theses.

2.1: Aristotle's Locus of Fundamentality

2.1.1: Fundamentality and size

Aristotle's use of the Greek word 'ousia' is typically translated in English as 'substance', though it may be more literally translated as 'being'. In such contexts, Aristotle often qualifies 'ousia' with 'prote', meaning 'primary'. In brief, when Aristotle is speaking of substances, he is speaking more literally of "primary beings" (Robinson 2009).

A primary being is by definition a fundamental being. For being primary obviously entails not being secondary or derivative, and not being secondary or derivative is what it is to be fundamental (cf. Schaffer 2009, *inter alia*). And if what is fundamental is the ground of being, as is often taken to be the case, then even the English word 'substance' contains this notion; a

substance, etymologically speaking, is that which stands under, i.e. that which is the ground of being.

In his *Categories*, Aristotle declares that the primary beings – that is, the fundamental objects – are individual instances of biological kinds, such as individual humans and horses (1a20, 2a11). Aristotle is explicit that these are fundamental, in that he claims everything that exists ontologically depends on these objects, and that these objects do not depend on anything else (2a34-2b6). And even when Aristotle in later work develops his hylemorphic theory of substances – that substances are composites of matter and form – Aristotle nonetheless holds that the whole substance is prior to these components, such that it is the whole unified substance that is fundamental (see e.g. *Metaphysics* 1041b12).

For my purposes, what is especially striking about this view is that these fundamental entities are macroscopic entities, which implies that the fundamental level of reality is the macroscopic level. Of course, it is now common to think that the microscopic level is fundamental, and that ultimately, material atoms, as the smallest entities that exist, are the most fundamental. But given Aristotle's belief that macroscopic entities are fundamental or primary, it should not be surprising that he rejects atomism.[28] For simply put, according to the Aristotelian, fundamentality has little if anything to do with smallness; zooming in on objects with ever increasing magnifications is not to get closer to the fundamental level.[29,30] Instead, for the Aristotle, the locus of fundamentality is found at the macroscopic level of everyday observation.

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[28] But in rejecting atomism (and the void), Aristotle did not replace it with a Cartesian plenum, or some other variety of corpuscularianism, or even "gunk" (the contemporary term for infinitely subdivisible matter). For on all these, smallness remains proportional to fundamentality.

[29] There may be many reasons for this. Two are relevant here. First, the four elements– earth, air, fire, water- were familiar macroscopic substances. Second, because these elements were believed to be homogenous all the way down, so to speak, investigating ever smaller samples would not reveal anything that a larger sample wouldn't show.

This is one of many respects in which the medieval and renaissance Scholastics follow Aristotle. Which is why the (re)introduction of atomism during the Scientific Revolution of the 17th century was tantamount to the rejection of this important facet of the Aristotelian worldview. For atomism is not simply the claim that atoms exist. It is also naturally understood as having a fundamentality claim built into it: atomism holds that the smallest entities are the most fundamental entities, such that aggregates or sums of material particles – such as macroscopic objects- are derivate or secondary entities. On such an atomist view, the existence and nature of macroscopic objects is taken to be derived from and determined by the properties of their (insensible) atomic parts. Insofar as early modern materialism is linked to an atomistic view according to which what is fundamental is what is smallest, the shift to atomism constitutes a shift in the locus of fundamentality.

2.1.2: The fundamentality of Aristotelian substantial identity

For Aristotle, individual substances have built into them an identity as an instance of a natural kind. Put another way, an Aristotelian particular is not a 'bare this', in itself bereft of features, but instead is a 'this-such' (*Metaphysics* 1029a28), such as 'this horse' or 'this man'.

The distinction is crucial for (at least) four reasons. First, it explains why Aristotle thinks predications of the form 'x is a K', where K picks out a kind of substance, are crucially different than predications of the form 'x is F', where F picks out a quality such as redness or roundness (cf. Sellars 1957). For Aristotle holds that the connection between a particular man, say, and his possessing the (supposed) definitive or essential features of manhood (i.e. rationality and animality) is even closer than the connection between a particular man and his having the

[30] Compare the contemporary Aristotelian David Oderberg (2007: 159): "a lower level of constitutive explanation does not by that very fact get you closer to the essence of a thing, which is why hidden structure essentialism is confused."

particular shape he has (as an accidental quality).[31] For insofar as objects are logically isolable from their qualities, one can imagine stripping these away until one reaches the bare particular, as Locke famously suggested. But this is not possible on the Aristotelian conception of substance, for being an instance of a kind is simply not isolable from the thing itself. (And this is reflected in the abovementioned view of predication: rather than being predicated of an object as logically separable qualities are, as in the form 'x is F', an individual substance (necessarily) instantiates the kind to which it belongs, as expressed in the form 'x is a K', where K-ness is not separable from x). Second, this package of ideas fleshes out Aristotle's claim that substantial-kinds such as *horse* and *man* belong in the ontological category of substance (as "secondary substance"), whereas quality-kinds such as *redness* or *roundness* do not.[32] Third, these notions make sense of Aristotle's tendency to think of the components of the essence of something as more like *parts* of a substance than like *qualities* of the substance.[33] For Aristotle, something's

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[31] Primary substances are the subjects of predicates, but cannot be predicated of anything else. The reason the kind 'man' is not a primary substance is because it can predicated of a primary substance, namely a man, as in 'Socrates is a man'. But being a predicate does not mean that the substantial kind 'man' is a quality; not being predicated of anything is a criterion for being primary substance, not secondary substance. Instead, the function of substance-category predications is to *classify*, rather than to *qualify*. So, Aristotle claims that "*White* signifies nothing but a qualification, whereas species and genus mark off the kind of substance- they signify what sort of substance" (*Cat*. 3b17-21) (cf. Wiggins 2001: 21, Ayers 1991: 71). In the *Categories*, Aristotle develops a theory that distinguishes these different forms of predication: Aristotle distinguishes predicates that are "said-of" a substance from predicates that "inhere in" a substance (*Cat*. 1b10). The difference in these forms of predication can be cashed out in terms of ontological category: that which inheres in a substance are qualities that are not themselves substances, whereas those predicates that are 'said-of' a substance apply to instances in the same ontological category (Cohen 2008: 4). So, for instance, Aristotle claims that 'man' is 'said of' a man, (e.g. Socrates is a man), and that 'animal' is said of the kind 'man' (e.g. 'men are animals'), where a man, the kind *man*, and *animal* are in the category of substance, but at different levels of generality.

[32] Compare Oderberg (2007: 47), according to whom essences "are not mere bundles of essential features" because essence is in the category of substance, not property. Accordingly, he argues that "since *mammal* is a genus, being a mammal is *not* a property of any mammals", and that "being a mammal and having mammalian properties are not the same thing" (p. 160). This is so because 'mammal', as a genus, is in the category of substance, and so is a component of a substantial essence, and is not a property (as described in the previous section).

[33] Aristotle writes "the essence of a thing is what it is said to be in respect of itself" (*Met*. 1029b14), And in *Posterior Analytics*, he writes "what belongs to a thing in respect of itself belongs to it in its essence

essence is the "the-what-it-was-to-be-that-thing", which is the more literal translation of Aristotle's Greek phrase that is typically translated as 'essence'.[34] So, in the case of a man, what it is to be a particular man is to have the features definitive of the kind *man*, i.e. rationality and animality. As these are the constituents of the essence (or the constituents of what it is to be the thing that something is), these constituents are more like parts (in the category of substance) than qualities (in a non-substantial category).[35] And fourth, given this intimate connection between the particular and its definitive features, there is nothing other than the substance itself that can explain why a particular instance of a substantial kind has the features that it is. That is, because it is simply built into the very nature of man to be a rational animal, there is no explaining why man is a rational animal, or how man comes to be a rational animal, other than the fact that it is of the nature of man to be rational.

Putting these together, the resulting view is this: the identity of a substance as an instance of a substantial kind is itself a fundamental fact, not explicable by anything ontologically prior. Moreover, that a substance has the features definitive of a kind is itself a fundamental fact: either because it is not at all explicable in independent terms, or because the means by which a man is rational is itself a fundamental and irreducible causal process (as I will discuss in the next section).

Before fleshing out this last point, a brief argument is worth mentioning here. While supposing with Aristotle that the essence of man is to be a rational animal, consider the following question: in virtue of what is something a man? It may be tempting to say 'in virtue of

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(*en tôi ti esti*)" for we refer to it "in the account that states the essence" (*Post. Analytics*, 73a34-5) See Cohen 2008.

[34] The phrase is: "to ti ên einai, to ti esti" (see Cohen 2008).

[35] And this in turn even better explains the impossibility of the bare particular on the Aristotelian conception: imaginatively stripping away all of something's qualities won't result in a bare particular if something's essential features (such as rationality and animality) are not conceivably separable qualities to begin with, but are instead more like (nonseparable) parts of the substance.

being a rational animal'. The problem, though, is that if there is an *in virtue of* relationship in this direction, then the features of rationality and animality would be ontologically prior to being a man. And if this were so, then rationality and animality would be the primary or fundamental beings, and being a man would be secondary. But Aristotle, of course, denies this is the case. Consequently, for Aristotle, there is nothing in virtue of which something is a man, nor is there anything in virtue of which something is a horse. Instead, these facts are fundamental. Why this is so, and what this view amounts to, will be further spelled out in the next section.

2.1.3: Aristotle and the priority of substantial whole over part

In the *Metaphysics*, Aristotle asks: "Why is man a unity and not a plurality of, as it may be, animal and biped?" (*Met*. E6, 1045a). That is, if the essence of man is to be a bipedal (or rational) animal, the question is what makes a man one unified entity, and not a plurality or sum of the apparently distinct features of being an animal and being a biped (or being rational)?

In brief, Aristotle's answer has two basic features. First, and as above, *animal* and *biped* (or *rational*) are better understand as parts of a substance rather than as qualities of the substance. Second, Aristotle considers the unified whole is to be ontologically prior to its multiplicity of parts.

Consider the second point first. For Aristotle, only truly unified things are genuine (or *per se*) substances. So for Aristotle, heaps do not count as genuine substances, as heaps are mere aggregates rather than genuine unities.[36] And what marks the difference is the priority or posteriority of the whole in relation to its the parts (see *Met*. 1041b12). Aggregates such as heaps are posterior to their parts because their parts jointly compose them. But when the whole is prior to parts, as it is for Aristotle in the case of genuine substances, the parts do not exist and then

[36] Leibniz echoed this point when he argued that if something is not *a* unified being, it is not a *being*.

compose a whole. Rather, the unified whole is prior, and can subsequently be *decomposed* into parts.[37] (In this scenario, it is said that the parts exist "virtually" within the whole).

Aristotle believes it follows from this that genuine wholes – substances – are not identical to their parts, but are something "over and above" them. As Aristotle puts it, things "which have several parts and in which the totality is not, as it were, a mere heap, but the whole is something besides the parts" (*Met*. 1045a8-10).[38] So substances that are unities are not only prior to their parts, but they are not identical to their parts.

Putting these together, the view amounts to the following: true substances are genuine unities, i.e. single things, and the multiplicity of their parts is posterior to their unity. Contrapositively, if the multiplicity of the parts were ontologically prior, then there would be no true unity at all, for all that would exist in such a scenario is a mere aggregation or plurality such as a heap. In brief, unity, according to Aristotle, cannot arise out of multiplicity as something posterior. Instead, unity must be prior – and so (more) fundamental – and multiplicity (somehow) emerges from it, as something secondary.

With that in mind, consider the other feature of Aristotle's solution to the problem of the unity. Because Aristotle rejects (Democritean) atomism (as well as the priority of part over whole), his notion of parts is not of pre-existing mereological simples that come together to compose (ontologically posterior) wholes. Instead, Aristotle maintains that a substance has non-

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[37] According to Scaltsas (1994: 109): "For Aristotle, a substance is complex, not because it is a conglomeration of distinct abstract components like matter, form, or properties; a substance is complex because such items can be separated out by abstraction, which is a kind of division of the unified substance". For a similar distinction, see Schaffer (2009).

[38] His argument goes something like this: because the parts can come apart and still exist, such as the letters in the syllable, yet the whole (syllable) does not exist, this shows that the whole is something other than the parts.

mereological parts, such as form and matter, or animality and rationality (or bipedality).[39] Moreover, Aristotle holds, there is "an isomorphism between the relation of the account to the entity that it concerns and the relation of a part of the account to a part of the entity" (*Met*. Z10, 1034b). In other words, the account or definition of *man* has parts, namely rationality and animality, and, analogously (or isomorphically), *man* itself has the same parts, namely rationality and animality. Now, in both cases, the whole that composes these – the individual man composed of form and matter, and the substantial kind *man* composed of the parts of the definition – are prior to the composing elements. In addition, and as above, the whole is something in addition to the parts; the parts are not identical to the whole. Now, it may sound odd that on the hylemorphic conception, that the man is not identical to the two parts of matter and form.[40] But if man were identical to these two, then a man would be two, and not one, and hence, not a unity. Instead, the unified (and prior whole) *man* may be decomposed into two parts, form and matter. And the same goes for the definition: if the substantial kind man were identical to the conjunction of rationality and animality, then man would be a plurality of the two, and not a unity. So, in brief, a unified whole is prior to its parts, and the parts of the substance that are posterior to the unified substance are components of the definition, i.e. animality and rationality.

2.1.4: The fundamentality of formal causation

Because a substantial whole has *priority* over its parts, where these parts are the definitive features of a natural kind, it follows for Aristotle that a substance has the characteristic

[39] This may come to the same thing: Aristotle identifies matter with the genus, e.g. animal, and form with the differentia, e.g. rationality. But this can be put aside here.

[40] Pasnau (2004) argues "According to *Metaphysics* Zeta 17, the unity of a substance is a product not just of its elements, but of some further unifying principle, the form, that is not itself an element. This argument suggests that the formal cause occupies a different conceptual space from that of material or efficient causes" (p. 40).

features of a kind *in virtue of* being the whole that it is. That is, because being a substantial unity of a specific kind *entails* having the components characteristic of that kind, it follows from x's being a man that x is rational (or bipedal) and an animal. Consequently, for Aristotle, a man is rational *because* he is a man, and being a man *explains* being rational and an animal.[41,42]

But how does being a man explain being rational? How is it that a man acquires rationality and animality in virtue of being a man? The answer, for the Aristotelian, is via formal causation. The sense in which a substance is that in virtue of which, and so thereby explains, a substance possessing the definitive features of a kind is via formal causation, or formal explanation.

It should be stressed that for the Aristotelian, formal causation and explanation are themselves fundamental forms of causation and explanation, in that they are irreducible to any other kind of causation or explanation, and have their own distinctive (or *sui generis*) work to do. Consequently, the fact that this formal relation holds between the substance and its definitive features (or parts) is itself a fundamental fact, as it is not explicable in any other way. Moreover, insofar as the physicalist rejects formal causation and formal explanation, as I will discuss summarily, the possession of the distinctive features, having no other way of being explained on the Aristotelian model, appear as inexplicable and brute. But precisely because the physicalist claims that these facts are not fundamental, but are rather explicable in a physically tractable way, the physicalist rejects this kind of Aristotelian explanation.

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[41] I assume Aristotle would accept this deduction as explanatory: Socrates is a man/ All men are rational// Socrates is rational. See *Prior Analytics* I.2, 24b18-20, and *Posterior Analytics* II.3-10

[42] Now, this may be a considerable simplification of Aristotle's account. Aristotle thinks he must a) introduce the actuality/potentiality distinction, b) identify actuality and potentiality with form and matter, respectively, and c), identify the differentia with form (and hence with actuality), and identify genus with matter (and so potentiality), in order to make sense of the basic idea I've outlined above (see esp. *Met*. H.6 1045a-b). But what I have showed suffices for my purposes.

But before considering the physicalist response, though, I will first spell out the idea of formal causation. Rather than consider Aristotle directly as I have done thus far, however, the issue is thrown into clearer relief by considering how these Aristotelian ideas were taken up by Aristotle's Scholastic followers (against whom the early modern materialists were more directly responding).

Robert Pasnau (2004: 34) argues that "for scholastic philosophers of all persuasions, the substantial form is the explanatory basis for the entire substance". *A fortiori*, this implies that the substantial form – say, the form of *man* in men – explains its characteristic features. But it must be emphasized that this is not only explanation in the epistemic or pragmatic sense. Rather, it is a metaphysical notion of explanation. Aristotle's Greek word 'aitai' is often translated both as 'cause' and 'explanation', and with good reason: it is meant both ways. On the Scholastic view, following this tradition, a substance or substantial form both causes and explains it having the features it has: consequently, it is often said that the features of a substance "flow" from its essence or substantial form, and as such, that a substance has its features in virtue of being the sort of substance it is.[43] As Pasnau (2009) elsewhere puts it, "a substance's intrinsic individual properties are often staid to stem from the distinctive features of an individual's substantial form" (p. 10).[44] An example provided by Michael Ayers (1981: 251) is particularly instructive: Ayers argues that notions such as that expressed in a Scholastic text from 1628 (Spencer's *Art of Logic*) were typical, wherein it is claimed that rationality, as well as other features, flows from

[43] Although this view of properties "flowing" is an indisputably Aristotelian idea, according to Pasnau there appears to be no one particular source in Aristotle where this idea comes from (personal communication). However, Aquinas seems to develop this idea on his *Commentaries on Aristotle's Metaphysics* (Book V, Lesson 9, Section 890).

[44] In supporting this notion, Pasnau (2004: 36) quotes Aquinas (p. 38), who wrote that "substance… must be the cause of its accidents" (*de Ente*, 6.54-57)[44], and also Suarez, who argued that "a form is required that, as it were, rules over all those faculties and accidents, and is the source of all actions and natural motions of such a being, and in which the whole variety of accidents and powers has its root and unity." (*DM* 15.10.61)

the form of man "as a natural emanation". Moreover, contemporary Aristotelian-Thomist David Oderberg (2001: 41) explicitly follows in this tradition. Writing of a particular man (named Fred), Oderberg argues that "the essence of Fred is the entire unity of his being the kind of thing he is, namely human: from it flow immediately the parts, namely animality and rationality."

So, to reiterate, formal cause (and related notions such as *flow* and *emanation*) are taken to be metaphysically real forms of causation, not only modes of explanation. And that the parts or features of a substance are to be explained in this manner is a canonical part of the Aristotelian-Scholastic worldview. As Denis Sullivan (1982: 490) puts it: "In the Thomistic interpretation of Aristotle, formal causes are seen as somehow dynamic, as somehow productive of the characteristics and behaviors of substances."[45]

Of course, one might be hesitant to count formal causation as a genuine kind of causation, and instead one might think of the Scholastic notions of flow and emanation as vague or metaphorical. But, as I will discuss summarily, this criticism is part of the materialist heritage, according to which causal processes must be in some sense mechanistic or otherwise physically tractable to count as genuine. For the Aristotelian, by contrast, formal causality is as real as efficient causality, and irreducible to it, despite the fact, as we will see, that formal causation is not a recognizably physical process (as efficient causation is taken to be). So again, it is worth repeating that even if there is a sense in which the identity of something is explained (via a formal cause) on the Aristotelian account, and which may thereby make substantial identity appear nonfundamental, that formal causation is itself fundamental implies that this relation between a substance and its definitive features is itself a fundamental fact, irreducible to something like efficient causality.

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[45] quoted in Hill (2007: 9).

In the previous section, I argued that for Aristotle, a substance or substantial form is something in addition, and prior, to its parts or features. It is this that allows a substantial form to be the source and explanation of a substance's characteristic or definitive features (which are nonetheless in the category of substance). The Scholastics adopted these ideas, and even took them further. Again, I turn to Pasnau (2009):

"A substantial form is more than just a cluster of necessary properties, and more even than just those properties that give a thing its essential nature as a thing of some kind (horse, gold, etc.). To be sure, the substantial form is closely associated and sometimes identified with the essence of a thing. But an essence is more than just a certain sort of defining property- an essence defines a thing because it plays a critical functional role within a substance, *explaining* the various characteristic properties of a thing, both necessary and accidental" (p. 9, my emphasis).

As Pasnau indicates in the last sentence, the Scholastic also invoked substantial form as being responsible for, or explaining, not only the essential features of a substance, but the necessary but nonessential features entailed by the essence (known as 'propria'), and also, in many cases, accidental (though intrinsic) properties. The paradigmatic example of a proprium is the capacity for humor. As Oderberg (2007: 49) illustrates,

"having a capacity for humor is an essential property- a *proprium*, to use the traditional terminology- of human beings, and in this sense we can say it flows *from the essence* of human beings to have a capacity for humor. But the *essence* of being human is to be a *rational animal*, and humans have a capacity for humor *only because* they are rational animals."

For Oderberg, being human (formally) causes being rational, which (formally) causes having the capacity for laugher. It must be stressed that this is the standard or traditional view. Benjamin Hill (2007: 9) sums this up nicely.

"Substantial form is commonly recognized as a thing's "internal principle of activity". Thus it has often been assimilated to the soul quickening the body, the soul resulting in and *determining* its internal activities. But I'm not thinking about the internal behaviors and activities of substance here; rather I'm thinking about the *determination* of properties more broadly speaking. The form determines the various internal properties of a thing. By internal properties, I mean firstly the set of essential properties, secondly propria or Properties with a capital P (propria are necessary consequences of essential properties, like being shaped a proprium of the essential property of being extended), and thirdly certain accidental properties and potentialities that result

entirely from the thing's internal operations, e.g. my distinctive whiteness even when I appear bright red from having fallen asleep in the sun" (my emphasis).

I emphasize 'determining' in order to (later) throw physicalism into relief: the scholastic, but not the physicalist, appeals to the substance itself as that which determines something's properties.

For now, though, notice, that Hill also includes "potentialities" amongst the facts that are determined by the substantial form, and that in addition, Hill uses an example of persisting though change (of color). Because the sorts of changes something can and cannot survive are (taken to be) determined by something's essence, the essence is also responsible for, and so the grounds of, something's persistence conditions. To foreshadow the discussion in chapter 4, consider a statue and a lump of clay. A statue cannot survive being squashed, whereas a lump of clay can. These differences in persistence conditions are plausibly seen as determined by their differing essences, in the sense that it is built into the nature of a statue that it is highly sensitive to change, whereas it is built into the nature a lump of clay that it can take many shapes, squashed and otherwise. More generally, then, for the Aristotelian-Scholastic, a substance has its persistence conditions in virtue of being the sort of substance it is, via formal causation.

So, to conclude, consider these three questions: Why is a man rational? Why is a man capable of laughter? Why does a man have the persistence conditions he has? The Aristotelian-Scholastic answers these in the same way: because a man has the substantial form of man.

2.2: Materialism Shifts the Locus of Fundamentality

2.2.1: Materialism and the rejection of formal causation

As is well known, the materialists and mechanists of the scientific revolution (and modern period more generally) rejected substantial forms and formal causation. For these materialists, formal explanations and formal causes are not genuine explanations or causes: for

the materialist, it is vacuous to say that a man is rational because he is a man, or man is capable of laughter because he is rational.

Why reject formal cause, though? Why should it be thought vacuous? The reason is simple: there is no mechanism or physically tractable process by which formal causation occurs. Saying that properties flow or emanate from something does not explain the mechanics of *how* such properties actually come about. So insofar as there is no mechanical or physical process by which a man's nature causes his rationality, which in turn causes his capacity for laughter, then there is no genuinely explanatory or causal process by which this happens, judged by mechanistic or materialistic standards. And the same goes, I should add, for the persistence conditions, a crucial point which will be developed later (in chapter 4). For it also appears there is no mechanical or physical process by which a man is caused to have the ability to persist through certain changes and not others.

So, the materialist rejects the idea that the substantial form of man explains why man is rational, and, consequently, that man's rationality is inexplicable in any terms other than it being of the nature of man to be rational. Instead, on the materialist ontology, according to which the macroscopic is determined by the microscopic, man's rationality is explained, ultimately, as a function of the primary qualities of the microscopic atoms that compose macroscopic objects (where the promise of such a breakthrough in explanation was perhaps one of the chief attractions of the atomist picture in the 17th and 18th centuries). Contemporary physicalism obviously inherits this idea: man's rationality is determined by his instantiating various neurological properties,[46] the possession of which are in turn determined by various biochemical

[46] Though of course a physicalist may tie rationality to external or normative factors outside an individual's brain, such that rationality does not supervene exclusively on the neurological properties of an individual, but on external or social factors as well. If so, though, presumably the physicalist would adopt a global supervenience thesis, and suggest the physical properties of the entire world, or, if more

properties, all the way down to the properties of fundamental physics. Like all macroscopic properties according to the physicalist, rationality is explained as a complex property determined by the possession of more fundamental physical properties, and in independent terms that need not refer to anything specific to *man* as such. So, there is no need to claim that fundamental macroscopic substantial forms explain or cause these features via formal causation, because the materialist can explain (or promises to explain) these features as the effects of the underlying primary qualities of the fundamental material atoms.

2.2.2: Materialism and the rejection of fundamental substantial identity

For similar reasons, the identity of a macroscopic object as instance of a kind is not a fundamental fact for the physicalist. For if the fundamental entities are the smallest entities, and the properties of macroscopic entities are determined by properties of micro entities, then obviously *being a man* is not primitive or fundamental, but is rather determined by the arrangement and properties of the underlying physical objects. More generally, something's being an instance of macroscopic kind depends on the underlying pattern of property instantiations; i.e. a quantity of atoms or simples being arranged or structured in certain characteristic ways.

Consequently, being a man or being gold is not itself explanatory for the materialist. For the properties of men and pieces of gold do not flow from these substantial identities, as they do for the Aristotelian, and so a man is not rational in virtue of being a man so much as in virtue of instantiating properties at a mereological level lower than that of the whole organism, such as the neurological or biochemical level. It is these more fundamental, lower level properties that do the

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restricted, all the relevant external facts, determine that man is rational. In either case, the basic picture remains the same.

explanatory work for the materialist when it comes to macroscopic properties, not a substantial identity.

So, in brief, the crucial contrast is this: whereas for the Aristotelian, a man is rational because he is a man, for the materialist, something is a man because he is rational (among other things).

2.2.1.1: Objection: Devitt on the explanatory value of substantial identity

So, insofar as the mode of explanation by which being an instance of a substantial kind is explanatory – namely, formal causation – is rejected by the materialist, this seems to commit the materialist to rejecting the claim that being an instance of a macroscopic kind is explanatory. But one might object, and claim that the physicalist and Aristotelian models are not so distinct after all. Michael Devitt (2008) seems to take this position. In attempting to "resurrect biological essentialism" – a doctrine with Aristotelian tendencies – Devitt argues that "being an F – for example, being a lion or being a tiger – is an explanatory property" (p. 362). He reiterates the point, claiming that "being a member of a certain taxon is more than informative, it is *explanatory*. Matthen points out that 'many biologists seem committed to the idea that something is striped *because* it is a tiger' (1998: 115)" (p. 352). And insofar as Devitt is a physicalist or materialist, one might claim there is nothing untoward about a physicalist accepting such a mode of explanation.

But Devitt's language is misleading, and the physicalist is indeed committed to rejecting the explanatory value of substantial identity. First, note that Devitt is aware that this sort of explanation does not appear especially robust. Devitt writes:

"At first sight, the explanation of the animal's stripes [because it is a tiger] may seem rather superficial, but it is not really. For, when biologists group organisms together under some name on the basis of observed similarities, they do so partly *on the assumption that those similarities are to be explained by some intrinsic underlying nature of the group*.. So the apparently superficial explanation points to the deep fact that there is something intrinsic, probably unknown, partly in virtue of which the animal is a tiger and which causes it to be striped. That something is an essential intrinsic property. The sum of those properties, together perhaps with some historical ones, constitute the essence of a tiger. Sober rightly insists that the essence of a species must explain why its members are the way they are. It must be a 'causal mechanism that acts on each member of the species, making it the kind of thing that it is' [1980] 1992, 250). That is exactly what this (partly) intrinsic essence is." (p. 352-3, original emphasis)

For an Aristotelian, as we've seen, that something is a tiger does explain its having stripes, insofar as stripes can be thought of as properties flowing from the essence via formal causation. But, as we've also seen, for an Aristotelian that essence is macroscopic, and there is no more fundamental "underlying nature" (in the sense of microstructure) that explains the possession of these macroscopic properties. So from the physicalist perspective, saying that a tiger (formally) explains its stripes not only sounds superficial, as Devitt suggests, but entirely vacuous or even mysterious, for not only does it fail to go beyond the surface to the underlying microstructure, but because it amounts to admitting non-mechanistic or nonphysical formal causation. Now, Devitt avoids the charge that he is reintroducing substantial form by claiming that the essential properties that are doing the genuine or deeper explanatory work are the underlying microscopic properties (probably but not necessarily, the genetic structure).[47] But what this shows is that any explanatory power that *being a tiger* has on the physicalist model is derived from the explanatory work that the microstructure in virtue of which something is a tiger has. For on Devitt's account, following Sober, being a tiger does not explain having stripes unless *being a tiger* is identical to the cluster of underlying causal properties in virtue of which the tiger has stripes.[48] And this is a

[47] Devitt writes "explanations in biology demand that there be essential intrinsic underlying properties." (p. 349) And see also p. 352

[48] Devitt contends that "the intrinsic essence is identified by its causal work.. the essence of the Indian rhino is the underlying property that does, as a matter of fact, explain its single horn and other

far cry from the Aristotelian position, according to which it is the substantial identity itself that is fundamental, and not the underlying physical properties. (Moreover, on the Aristotelian view, the substance is something in addition to its parts or features, and not identical to them.) So while Devitt's view may sound Aristotelian, it is not genuinely so (at least in this regard), and for that reason the Aristotelian language is misleading. More importantly here, though, is that by appealing to underlying properties, Devitt's view provides no reason to think that the physicalist may accept that macroscopic substantial identities are explanatory, or prior to the properties characteristic of instances of a kind.

2.2.3: Physicalism and fundamental substantial kinds

This point creates a nice segue to the case of substantial kinds which the physicalist seems to consider fundamental. For if electrons and quarks are fundamental, for instance, then there are no more fundamental underlying properties that can explain the properties of electrons and quarks, on the model of Devitt's suggestion above. The question then is whether *being an electron* is explanatory for the physicalist, or whether something has the properties characteristic of an electron in virtue of being an election.

So consider the question: are substantial identities explanatory in the case of putatively fundamental substantial kinds? Suppose that electrons and muons (each a kind of lepton) are fundamental – or at least the smallest – kinds of objects. Electrons and muons have the same negative charge, but muons are slightly more massive. If being a muon or being an electron is explanatory, then it seems to follow that an electron has its mass in virtue of being an electron, and muon has its slightly greater mass in virtue of being a muon. Put another way, if being a

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phonotypical features" (p. 371). And responding to Okasha's (2002) remark that "species taxa are distinguished by clusters of covarying chromosomal and genetic traits, not by shared essences" (2002, 197), Devitt writes "Great! The clusters [of covarying chromosomal and genetic traits] *are* the essences!"

muon or electron is explanatory, then the differences in mass between an electron and a muon is explained by the fact that one is an electron and one is a muon, just as the difference in stripes between a tiger and elephant may be thought to be explained by one being a tiger and one being an elephant. But as one cannot appeal to any underlying properties in the case of the leptons (supposing they are indeed fundamental), this appeal is clearly vacuous (by physicalist standards). For again, there is no physical process by which a muon imbues itself with its mass, and the electron imbues itself with its slightly less mass. From this physicalist perspective, it does not seem any more explanatory to say that an electron has its mass in virtue of being an electron than to simply say that an electron's mass is a brute, fundamental fact, obtaining in virtue of nothing at all.

As this claim is central to my thesis, it is worth pushing this point. Suppose one did claim that a physicalist can hold that being an electron is metaphysically explanatory, and that an electron has its mass in virtue of being an electron. If so, one who advocates this claim must answer the following sorts of questions. First, *how*, or by what process or mechanism, does the electron imbue itself with its mass? In addition, what it is that grounds the 'in virtue of' claim in 'the electron has its mass in virtue of being an electron'? What sort of entailment or determination relation is this 'in virtue of' relation? As we saw, the Aristotelian's answer is 'formal causation': the 'in virtue of' claim is cashed out in terms flowing, emanation, and the like. But I just don't see how the physicalist can help herself to any of these notions, for these are not mechanical or physical processes, or otherwise physically tractable or explainable in any familiar way. So either the physicalist posits a *sui generis* relation suspiciously similar to formal cause at the fundamental level, and which bears no resemblance to any other physical process ever posited, or else the physicalist rejects the explanatory value of being an electron. Given the

oddity of the first option, and, moreover, the blatant inconsistency with the history and spirit of materialism, I claim that the physicalist is not entitled to reintroduce substantial forms and formal causation at the fundamental level.

Moreover, if the physicalist may reintroduce substantial forms at the microscopic level, then there seems to be no principled reason for not reintroducing them at the macroscopic level: if the essential properties of an electron flow from its substantial form, then it seems there is no principled reason for rejecting the claim that a man is rational in virtue of being a man, and that a man's neurological properties, say, flow from his rationality. But if this is so, then it appears that any scientific explanation which explains rationality in terms of neurological properties is itself ontologically misguided, as it explains what is prior (apparently) in terms of what is posterior. For after all, if it is the form and not the microstructure that is responsible for man's rationality on this picture, a metaphysically perspicuous explanation must run in that direction. But again, based on the history of what materialism is, this seems as incompatible with physicalism as introducing a Cartesian mind in order to explain man's ability to reason.

So, if one rejects formal causation, then it is not clear how else one could cash out the 'in virtue of' that is embedded in the claim that an electron has its mass in virtue of being an electron. While it is true that one might appeal to some sort of "metaphysical entailment", it's hard to see why this isn't simply formal causation by another name. For it would remain the case that this metaphysical entailment is not something specifiable in terms other than it simply following from the nature of electronhood to have that mass, or something to that effect. Lacking any mechanistic or otherwise paradigmatic physical process or means by which the properties of an electron could be explained, the physicalist must reject the explanatory value – and thereby the priority – of substantial identity.

What is the alternative, then, for the physicalist? The physicalist ought to simply declare the possession of an electron's mass and charge to be fundamental or brute, i.e. not explainable (assuming that an electron is fundamental). This move, then, inverts the traditional Aristotelian order of explanation. It is to say that the instantiations of an electron's or muon's mass and charge are themselves fundamental or inexplicable facts, and that consequently, something is an electron or muon in virtue of the possession of these properties.

2.3: Substantial identity and priority: A Euthyphro question

Priority and fundamentality are usefully illuminated by Euthyphro questions. In Plato's *Euthyphro*, Socrates asks "Is the pious loved by the gods because it is pious, or is it pious because it is loved by the gods?" (*Euthyphro* 10a). In posing this question, Socrates seeks to discover which is prior- piety or the gods' love. Rather than answering this question, for my purposes all that matters is that one understands the difference between one or the other being prior. For if so, then by posing a Euthyphro question, one can at the very least pump intuitions about what is prior to what, and what is more fundamental than what.

Philosophers more recent than Plato continue to use this method: Jonathan Schaffer (2009), Theodore Sider (2006), and David Armstrong (2004) have each used Euthyphro-type questions to argue for various instances of ontological priority, and so for (relative) fundamentality. In fact, Armstrong claims that the Euthyphro dilemma "is in many ways the most useful dilemma in metaphysics," and that he "rel[ies] on it at a number of points" (p. 40).[49]

[49] Armstrong somewhat misspeaks here: It is not the Euthyphro *dilemma* that is useful per se, but the Euthyphro *question*. That is, posing a Euthyphro question can serve to pump intuitions about priority, and this is what concerns Armstrong (and myself.) Whether that leads to a dilemma for any particular view is a further issue- one perhaps unique to Socrates' intention to show that a divine command theory of ethics is arbitrary or false- is not at issue here.

I will follow them in this respect, and pose a Euthyphro question in order to cement the arguments of this chapter.

So, consider the following: "Is something an electron because it has negative charge, or does something have negative charge because it is an electron?"[50] (The 'because' here connotes ontological priority, as it did for Socrates). My arguments thus far should make it clear that an essential difference between the Aristotelian and physicalist worldview is how these answer this Euthyphro question. For, as I've argued, substantial identity is fundamental for the Aristotelian. So, anachronistically of course, for the Aristotelian, an electron's charge follows from its electronhood, which is to say an electron has its charge in virtue of being an electron (where this 'in virtue of' claim is understood as adverting to formal causation). By contrast, I have argued, it is the instantiation of charge that is fundamental for the physicalist, and being an electron (or being a man) that is derivative.

Of course, this question is an instance of a more general schema:

Euthyphro$_{si}$: Is something an instance of substantial kind K because it has properties $P_1 \ldots P_n$, or does something have properties $P_1 \ldots P_n$ because it is an instance of substantial kind K?

So, in general, this question is the litmus that distinguishes the Aristotelian from the physicalist: whereas the Aristotelian argues for the priority of substantial identity, from which a substance's characteristic properties flow, the physicalist takes substantial identity to be derived from the instantiation of the fundamental physical properties.[51]

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[50] Of course, things other than electrons have negative charge. Other leptons- muons and taus- for instance. And electrons have properties other than charge as well. For rhetorical simplicity, though, I restrict myself to asking the question of one property and one substance. I do not believe this affects the main thrust of the argument.

[51] Again, consider the contemporary Aristotelian-Thomist David Oderberg. In his (2001), he writes "In order to explain why whales give live birth, we use the truth that whales are mammals" (p. 37). For

2.3.1: Objection: priority, identity and the bundle theory

One may object, though, to this discussion of the putative priority relations between substance and properties. For according to the bundle theory of substance, a substance is, of course, just a bundle of properties. And if one holds this kind of view, one might deny that there is any priority relation at all between a substance and the properties to which it is identical, such that not only is my Euthyphro question ill-formed, but that there is no real point of contention between the Aristotelian and physicalist.

Firstly, the Aristotelian obviously rejects the bundle theory. So insofar as I am simply attributing a view to the Aristotelian concerning the priority relation between a substance and its properties, whether there are any such substances is moot. Nonetheless, however, and even granting the bundle theory for the sake of argument, the objection does not succeed. For not only does it not affect my characterization of the Aristotelian view, but even if the physicalist adopts the bundle theory, the physicalist is still committed to answering the Euthyphro question in the manner I attribute to her.

To see why, I will (perhaps ironically) borrow a strategy that David Robb (2005) uses to defend the bundle theory. Robb supposes that an objector to the bundle theory would say the following: if the bundle theorist contends

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Oderberg, being a mammal explains (at least partially) why whales give live birth. This is possible only if whales being mammals is prior to whales giving live birth, and so constitutes a response to my Euthyphro question; whales give live birth because they are mammals. They are not mammals because they give live birth. If this last claim sounds odd to physicalist ears, it should. Though he does not say so in so many words, Oderberg both recognizes that his reasoning generates an answer to my Euthyphro question, and, moreover, that this order of explanation might sound backwards to his contemporaries. He writes: "There are mammalian properties- having fur, lactating, and so on- but being a mammal and having mammalian properties are not the same thing. A mammal has mammalian properties because it is a mammal; these properties point to its essence. But isn't it a mammal because it has these properties? Isn't the real essentialist's [Oderberg's name for his Aristotelian-Thomistic doctrine] order of explanation upside down? To reverse the order of explanation, however, is ultimately to do away with essence, not to explain it. More accurately, it does away with real essence and replaces it with a surrogate bundle theory for essence as a collection of properties." (p. 160)

(i) an object is a property,

where ‘is’ denotes identity, then this is equivalent to saying

(ii) a property is an object.

The objector, says Robb, claims that because there is no priority of properties over objects in (ii), there is no priority of properties over objects in (i). And this undermines the substantivity (no pun intended) of the bundle theory. In reply, though, Robb asks the reader to consider Spinoza's theological views as two different claims:

(i*) God is the physical universe.

(ii*) The physical universe is God.

Assuming ‘is’ denotes identity, these claims also appear equivalent. However, Robb argues that there is a difference between i* and ii*. He contends that

“One might use (i*) to *demote* God to the status of the physical universe. God, according to (i*), isn't as interesting as we thought: he's not a mind, he's not omnipotent, etc. By contrast, one might use (ii*) to *promote* the physical universe to the status of God. The universe is more interesting than we thought: it is a mind, it is omnipotent, etc. (i) and (ii) work the same way. By asserting (i), I am not asserting (ii). In (i), 'property' takes **priority**, so that the features traditionally associated with properties--being a nature, a way of being--are ascribed to objects” (2005: 488, original italics, my boldface).

Robb makes two interesting claims here: first, that there can be priority between terms even in (putative) identity claims because there are distinct clusters of concepts associated with the different ways of picking out the (putatively) one entity in question. That is, ‘god’ and ‘physical universe’ pick out different concepts, and are associated with different stereotypical properties. To say that the entities referred to by the distinct terms are identical is to say one or the other set of concepts actually applies, but not both. Secondly, and relatedly, identity claims may often involve the promotion or demotion of an entity (or concept) by conceptualizing it as prior or posterior, as the case may be. Both points apply to my Euthyphro approach, and the

question of substantial identity more generally. As Robb indicates, the identification of an electron with a bundle of properties is to demote the substance-kind *electron* to a bundle of properties, which amounts to denying that there is a unified and persisting entity in addition to there being a set of compresent nonsubstantial properties, say. And this is not to preclude asking the Euthyphro question, it is to answer it in a certain way: it is to say something is an electron in virtue of being a particular bundle of properties, and that as such, properties such as negative charge and spin are prior to being an electron. So, regardless of whether the physicalist adopts the bundle theory or not, she is committed to the priority of property instances over substantial identity.

2.3.2: Structural properties, conjunctive properties, and substantial identity

The nonfundamentality of substantial identity on the physicalist model manifests itself in a strong tendency amongst physicalists to think of substance-kinds as conjunctive or structural properties. Insofar as this is emblematic, it is further evidence for my position.

So, consider what I take to be a representative discussion of this issue. Armstrong (1997) considers the question of whether one ought to posit the substantial kind electron(hood) in addition to positing (quality) kinds such as mass, charge and spin. He argues that one should not, because it appears there is "a reductive account.. of electronhood." Noting that the quantity of mass, charge, and spin are identical in all electrons, Armstrong asks "why, then, should not electronhood be identified with the property that is the conjunction of these three properties?" (1997: 67). Even if there are reasons not to do this, it is easy to see why the physicalist might be inclined follow Armstrong here. For if the substantial kind is not prior to or more fundamental than these properties, as I have argued the physicalist maintains, then electronhood suggests

itself as posterior, or derivative. And as a conjunction of properties is less fundamental than its conjuncts, of course, taking electronhood to be a conjunctive property allows one to transparently display its nonfundamental or derivative status. Hence the appeal.

Similarly, consider structural properties, of which Robb (2005: 477) cites methane as a paradigmatic instance (for methane exists when certain atomic and subatomic entities are structured appropriately). As Robb then puts it: "Because structural properties are composed of properties of and relations among objects at a lower mereological level, structural properties are *dependent* properties." Obviously, then, structural properties are not fundamental, from which it follows that the substantial identity of a nonfundamental entity such as an instance of methane is itself not fundamental.

But, as I've indicated, similar reasoning applies even to the ostensibly fundamental kinds. For even *being an electron*, I've argued, is a structural or at least conjunctive property for the physicalist, insofar as it (appears to be) determined by the arrangement (or coinstantiation) of the more fundamental physical property instances such as mass, charge, and spin.

Armstrong offers another argument (in his 1997) along these lines that I take to be emblematic of the physicalist position, and that in particular draws the contrast with Aristotelianism. There, Armstrong considers whether there is a substantive-kind universal *humanity* of which each human is an instance. (More specifically, Armstrong considers whether there is an "abstract description" of the "structure" of human DNA that is necessary and sufficient for being human, and would thereby count as the universal *humanity*). In so doing, Armstrong argues that "the only reason I can think of for postulating such a universal is that things answering to this description play some unique and irreducible causal or nomic role in the workings of the world." And though he concedes this is conceivable, "the causal work in

producing and maintaining a human being is surely done by constituent molecules, and more complex structures, that act in virtue of their determinate properties" (p. 66).

In brief, Armstrong's argument is that the substantial kind universal *humanity* does no work, as it is the underlying constituents that determine the existence and nature of humans. But is there another conception of this universal according to which it does do work? Armstrong (p. 66) writes:

> "But if the universal of humanity is not a determinable biological structure, what is it? In the Aristotelian tradition one has the impression that this universal broods over the whole and somehow, a 'somehow' perhaps linked with final causes, keeps the individual human being within its biological limits. But how can the contemporary scientific realist who wishes to combine scientific realism with a recognition of universals conceive of this universal if not as a determinable biological structure? From the substance-universals, as we may call it, the ordinary properties of human beings must somehow flow. But what have we here but vague gesture?"

To fill out this picture, Armstrong, contrasting "substance-universals" with structures, writes that "[substantial] kinds, as I understand them, are conceived of as universals that are both other than mere properties and in some way govern properties" (p. 67). In these remarks, Armstrong suggests that the Aristotelian tradition differs from the "scientific realist" – read physicalist – in conceiving of *humanity* as a substance-universal, in contrast to a "structure" (which, as above, is nonfundamental). He suggests that in thinking of humanity as a substantial kind, the Aristotelian thinks of it as something other than as properties, and, moreover, that it has explanatory priority over the properties, insofar as "the ordinary properties of human beings must somehow flow" from these substances. (Moreover, he even adds that the substantial-universal has causal priority over these properties for the Aristotelian, insofar as the substance-kind "governs" them). As a physicalist (who rejects formal causation), Armstrong accuses the Aristotelian of mystery-mongering; he says that on the Aristotelian model, properties are thought to "somehow flow" from the substance, that this is "vague gesture", and that kinds "in some way govern properties".

Though dismissive, his depiction of the Aristotelian view, I contend, is sufficiently accurate from the point of view of a physicalist ontology. As I've argued, for the Aristotelian, a substantial form is not identical to properties, and it is the source of, and has priority over, the characteristic properties of a substance. And, I claim, Armstrong is right in thinking this picture incompatible with the physicalist one ("scientific realist", as he puts it here).

2.4: Objections and Replies

Still, one might object. For one might insist that nothing commits the physicalist to thinking of substance-kinds as conjunctive properties, or to rejecting substantial kinds as part of fundamental ontology. Firstly, one might argue that the traditional physicalist commitment to atomism is itself a commitment to basic or fundamental substances. Second, Brian Ellis (2001, 2002, 2005), for instance, explicitly defends a view of physicalism as committed to fundamental substance-kinds. And E.J. Lowe argues for the fundamentality of substantial kinds more generally. So, in the remainder of this chapter, I will defend my description of physicalism against these positions.

2.4.1: Objection: Physicalism is committed to atomism, i.e. fundamental substances

The belief that there is a fundamental level- the level that fundamental physics describes- is often conjoined with a belief in Democritean atoms, i.e. indivisible entities that are the mereological basis for all composite entities. Kim (1998) describes this thought as follows: "The bottom level is usually thought to consist of elementary particles, or whatever our best physics is going to tell us are the basic bits of matter out of which all material things are composed."

The idea that there are fundamental particles that compose all else is of course atomism. And if atoms are fundamental, and count as substances, then perhaps the physicalist-cum-atomist picture does not differ so greatly from the Aristotelian, other than on whether smallness is directly proportional to fundamentality.

So, does physicalism require a commitment to atomism? Will "our best physics" in fact tell us that there are basic bits of matter out of which all else is composed or constructed? Why should it be "usually thought", as Kim says, that final physics will tell us that there are fundamental particles, the materials out of which things are constructed or composed?[52] More strongly, is it part of the concept of physics that it posit fundamental things or substances, i.e. atoms?[53]

Not only do Ladyman, Ross et al. (2007) answer 'no', they are particularly scathing and polemical on the point. They contend that *contemporary* physics is non-atomistic. They contend that quantum mechanics, in particular the phenomenon of entanglement, undermines the notion

[52] Contemporary physicalism often supposes an atomist base; see e.g. Oppenheim and Putnam (1958), van Inwagen (1990), Merricks (2001), Pettit (1993), Lewis, Kim, Markesan (2005)

[53] Atomism is perhaps the earliest form of materialism (Lange 1873), originating with Pre-Socratics such as Democritus, and so quite obviously predates physics. Early atomism was speculative, not empirical. It was motivated largely by *a priori* arguments concerning the (im)possibility of change (including coming into and out of existence), motion and divisibility, as these related to the arguments of Parmenides and Zeno (see e.g. Berryman 2005). The renaissance of atomism in the scientific revolution was not accompanied by any empirical evidence for atoms, either (Chalmers 2005). As late as the early 20th century, even physicists and philosophers of science such as Ernst Mach denied the (empirical) existence of atoms, as the evidence for their existence was not overwhelming. It is widely thought that only upon Einstein's explanation of Brownian motion in terms of the motions of discrete particles in 1905 was atomism empirically vindicated. Yet despite the historically tenuous connection with empirical findings, materialism and atomism have always been closely associated. The reason, I suspect, is not so much in the commitment to tiny indivisible objects swirling in a void as it is to the commitment of the fundamentality of the small. But one can make do with micro property instances, I contend, regardless of whether such objects (or the void) exists.

of "self-individuated atoms", or independent mereological simples.[54] Ladyman and Ross contend that the

"Democritean image of the world mereologically composed of simple atoms corresponds to [reality] even less; this image has no more in common with reality as physics describes it than does the ancient cosmology of four elements and perfect celestial spheres" (p. 20).

Ladyman and Ross go on to argue that the persisting belief in atomism or mereological simples – despite the findings of 20th and 21st century science – is the result of imposing the manifest image on the scientific image. They refer to this process as "domesticating"; an attempt to fit the strange and wild world of contemporary physics into a familiar and safe category. They write

"the domesticating metaphysics finds no basis in contemporary science. The attempt to domesticate 21st century science by reference to homely images of little particles that have much in common with 17th and 18th century mechanistic and materialist metaphysics is forlorn. There are, we will argue, no little things and no microbangings" (p.4).

Even if Ladyman and Ross are wrong in their interpretation of present physics, or, even if they are right about current physics but future physics reverts (or progresses) back to an atomistic conception, the live possibility they and others (such as Huttemann and Papineau 2005 and Papineau 2007) raise shows that it is not *a priori*, nor a conceptual truth that physics is atomistic. So even if physicalism necessarily concerns the fundamental, as I contend it does, atomism is not a necessary component of physicalism.

Moreover, given that there remains an outstanding metaphysical debate independently of contemporary physics over whether the fundamental level is discrete or atomist, as opposed to continuous (i.e. "gunky" or a plenum), atomism shouldn't be built into the formulation of physicalism. For a gunky (i.e. infinitely divisible) world, or a world containing a plenum and lacking a void, would not *ipso facto* be an anti-physicalist world. The reason this is so, I contend, is that the small would still be the (relatively) fundamental. Whether there are indivisible entities

[54] See also Maudlin (2007), Ladyman (2007/2009), Papineau (2007), Brown and Ladyman (2009), French (2000/2006)

or empty space is not as important for the physicalist view as is the fundamentality of the microscopic, I maintain.

Moreover, there are many outstanding philosophical questions about the status of putative substances in physics. Are the up and down quarks that compose protons and neutrons metaphysically separable even if not physically separable? Are fields or particles ultimately real (substances)? Does quantum entanglement undermine the individuality of entangled particles? Regardless of the answers to these sorts of questions regarding the status of putative substances, it is obvious that physics posits properties (at least concrete instances thereof), such as mass, charge, and spin.[55] For these are determinables with a range of quantitative determinates, and there is no physical law which does not invoke such quantifiable properties. So it is these (concrete) entities, I claim, that are physically fundamental, for it is these property-instances that serve as the building blocks of physical entities, and are that in virtue of which macroscopic entities have the features that they have. So, in brief, it is the physical properties that are prior or basic entities, as revealed in the Euthyphro question, not kinds of objects or substances.

2.4.2: Ellis on physicalism and fundamental substances

Ellis refers to his brand of scientific realism as "physical realism" (see esp. Ellis 2005). And Ellis is a physicalist: "Physical realism is the thesis that the world is more or less as present-day physical theory says it is" (2005: 371). For Ellis, the task of the physical realist is to answer this question: "how is the sophisticated, relatively stable, scientific image of the world that is the result of the last two or three centuries of scientific work to be explained?" (p. 381). And among

[55] The issues of nominalism vs. the reality of universals is an orthogonal issue. Assuming any sort of minimal realism, physics is positing something, and it seems to me uncontroversial that among them are property instances. Whether tropes as opposed to universals, for instance, is the better ontological characterization is a further, but not germane, issue.

the aspects of this scientific image to be explained is a commitment, he contends, to natural kinds of substances. In fact, he argues "the most salient general feature of reality I seek to explain is its natural kinds structure" (2001: 67).[56] In short, Ellis conceives of his own physical realism as "a modern form of physicalism that takes due account of the natural kinds structure of the world" (2005: 371).

Ellis's doctrine has implications for many topics in metaphysics and philosophy of science. What is particularly relevant here, though, is that for Ellis, the physicalist is committed to substantive natural kinds – in addition to property-universals – in order to explain the scientific image. And if so, it would be open to the physicalist to see substantial identity as playing an irreducible or fundamental role in ontology.

Consider an argument that Ellis levies against the idea of an electron being a structural or conjunctive property, as I have suggested the physicalist is inclined to do. For Ellis:

"Certainly, the property of being an electron (if, indeed, there were such a property) *could not be an ontologically fundamental* one, and the same must be true of all properties (assuming that they exist) whose names are generated from natural kind names. The property of being an electron would not be ontologically fundamental because its having instances is *ontologically dependent* on there being things that have unit charge, unit mass, spin ½, and so on. The property of being an electron would therefore have to be ontologically dependent on these other properties" (my emphasis).

But Ellis did not conclude (as did Robb), that such substance-kinds are thereby nonfundamental properties. Instead, Ellis argues that "property names that are derived from natural kind names do not name properties". This is so, Ellis explains, because

"electrons, protons and the like, might well be ontologically *fundamental kinds* of objects. Therefore, to insist that there is a property of being an electron or one of being a proton is to turn what might well be a *fundamental* existent in the category of substances into a neutral thing (which, inexplicably, could not be anything other than an electron or a proton, as the case may

[56] For Ellis, this also includes two other categories of natural kinds- in addition to natural kinds of substances, Ellis posits dynamic natural kinds, whose instances are events and processes, and property natural kinds, whose instances are tropes and relations.

be) with a property that is ontologically dependent on all of these other properties" (my emphasis).[57]

Of course, this is just what I've argued is the physicalist response to the Euthyphro question. Rather than accept that this shows substantial identities to be nonfundamental, however, Ellis seem to take the fundamentality of *electron* as a unfalsifiable datum, which then motives him to construe the above argument as a *reductio* against treating predicate names built from natural kind terms as derivate properties rather than fundamental substances. And Ellis seemed content to leave it at that. However, Ellis was forced to add the following:

"While I find this argument quite convincing, there are many who do not. A reader of the manuscript for this book, for example, has argued that electrons are nothing more than bundles of causal powers. There is no bare particular or neutral object in which these various causal powers are coinstantiated. Their tropes are simply compresent in an entity that is an electron. Given this perspective, it follows that the property of being an electron is instantiated not in, but by, an electron. An electron is a freestanding trope of the conjunctive property universal- that of being an electron" (ibid).

As I've indicated, the argument offered by Ellis' reader is the typical physicalist view. Rather than take a strong stand for his distinctive brand of physicalism, though, Ellis is in fact mostly willing to concede the point to his reader, as long as the distinction between freestanding tropes and tropes or properties that are not freestanding is made. He writes: "For if the property of being an electron exists, then it is at least a very special kind of property- one that can be instantiated without being instantiated in anything." But the bundle theorist, or one who otherwise believes that an electron is "nothing more than a bundle of causal powers" need not concede that tropes need be instantiated in anything, or that the substance/attribute theorist's refrain that properties must be properties of something, is warranted. Moreover, Ellis' argument for this aspect of 'being an electron' in contrast to other "not freestanding tropes" is specious, and question-begging. First, Ellis contends that the property of being negatively charged differs from the

[57] It should be noted that on the Standard Model, while electrons are fundamental, protons are not, as they- like neutrons- are composed of up and down quarks. I will ignore this, though.

"alleged property of being an electron" in that "many different kinds of things, including electrons, can have the property of being negatively charged. But clearly nothing other than an electron can have the supposed property of being an electron." But this argument simply presupposes that *electron* is substantial, in contrast to negative charge. For if *negatively charged* were itself a kind of *thing*, then the only kinds of things that could be negatively charged would be negatively charged things. And if this kind had a substance *name*, in the form of a count noun such a 'negcharge', rather than an adjectival one such as 'negatively charged thing', then it would follow that "clearly nothing other than a negcharge can have the supposed property of being a negcharge." It is only if 'negative charge' is presumed to be nonsubstantial or adjectival that it can apply to different sorts of substances. Contrapositively, it is only if a term is presumed substantival that it cannot apply to different kinds of substances. So if electron is supposed a substantive kind, it of course follows that an electron is the only kind of substance that can be an electron. But this distinction between electron and negative charge begs the question. Secondly, and more importantly, if an electron was identical not just to negative charge, as it is not, but instead to the conjunction of negative charge, a mass of 9.1×10^{-31} kg, ½ spin etc., then it would not be the case that many different kinds of things could have those three properties in conjunction- only an electron could have those. So the substance as conjunctive property idea even survives Ellis' claim that only a something of that sort can be of that sort.

So, Ellis has certainly not demonstrated that the physicalist must recognize a substantial kind *electron* as distinct from, and not determined by, fundamental properties such as charge, spin, and mass. In fact, Ellis even writes he is "happy to accept" that "substantive universals are a species of property universals" in the case of ostensibly fundamental objects such as electrons,

"which are very plausibly just bundles of causal powers".[58] So, not only do Ellis' arguments for substantial kinds not succeed in committing the physicalist to them, he seems willing to concede to his opponents on the crucial issue here. Moreover, given that I am arguing that accepting the fundamentality of substantial identity commits to the physicalist to formal causation, Ellis' arguments give no reason to think that the physicalist may answer the Euthyphro$_{si}$ question differently than I claim she does.

2.4.3: Lowe on fundamental substantial kinds

But Ellis is not the only philosopher of science to argue for there being fundamental substantial kinds. E.J. Lowe (2006a) has also argued for fundamental substantial kinds in addition to properties, his account of which is part of a theory of natural law (as is Ellis'), and to that extent appears as a physicalist conception of fundamental substantial identity. But Lowe is not a physicalist: for instance, he advocates (non-Cartesian) substance dualism in his (2006b), and he is not concerned with physicalist priority as such. In fact, he contends that the scientists' ontology "presupposes" a "categorization" of posited entities, and that "the task of category-construction is ultimately one for metaphysics, not for empirical science" (1998: 206). Consequently, his arguments for the existence of substances and substantial kinds need not apply to, nor characterize, the physicalist's conception.[59]

Lowe offers three arguments for substance and substantial kinds as being among the fundamental categories of existence, as against, for example, the arguments of Armstrong

[58] Though Ellis adds the proviso that "we should at least demand a sparse theory of conjunctive property universals- one that would include that of being an electron, but exclude that of being a positively charged cube".

[59] Moreover, elsewhere I (will) argue that his belief in fundamental substantial kinds, and its implications for his view of laws and for his (non-Cartesian) substance dualism are in fact part of a package, and so are inherently anti-physicalist. But, as I cannot rely on these arguments as yet, I put them aside.

discussed earlier. If Lowe's arguments are valid, and can be thought to apply to physicalism, then he might have a case for the fundamentality of substantial kind identity, even on a physicalist scheme.

Lowe argues that substantial universals such as gold are neither identical nor reducible to non-substantial universals "typically exemplified" by such kinds, such as a certain melting point, density, color, malleability, and the like. According to Lowe, "we plainly cannot say that an individual substance necessarily instantiates the kind 'gold' if and only if it exemplifies all of these typical properties, for any substantial universal like this may have untypical individual exemplars" (2006a: 26). For Lowe, that an instance of gold may be atypical – lacking the characteristic properties of gold – yet still *be* gold shows that being gold is not identical to having those properties, and so therefore must be something more than those properties. But this raises a question: in virtue of what would that atypical entity be gold at all? If Lowe were relying on an essence/accident distinction, then he could claim that although gold commonly has a number of properties that are strictly accidental, something lacking typical yet accidental properties would still have the essential or definitive properties. But this argument would not show that the substantial kind gold cannot be reduced to or thought identical with the essential properties, as opposed to the accidental ones. And, of course, if these are essential, then an aberrant gold that lacked such properties wouldn't be gold at all- it would be something else. So suppose Lowe is not relying on such a distinction. There can, of course, be some variation in the determinate values of the determinable properties instantiated by any particular instance of gold. So, if something is an atypical sample of gold, but is still gold and not something else, it will still instantiate the same determinable properties that all gold instantiates, even if the exact value of the determinate properties are slightly different. But as long as the range of these determinate

values fall under the same determinable property-universal that is itself characteristic of the kind, then the atypicality is irrelevant. For if the instance still counts as gold, however atypical, there must be something it shares in common with every other instance. For the physicalist, in the case of a nonfundamental kind such as gold, these are the properties that determine the chemical properties of gold. So there must be a property universal- just of a broader range, or perhaps at slightly higher taxonomic level, such that it admits of more determinate variation, that characterizes the kind 'gold.' And at that determinable level, there can be no atypical samples. For anything that fell outside *that* range, the thing in question would not be gold at all. Put another way, to think of something as atypical yet still as gold is simply to hone in on a subspecies of gold (even if it is not officially recognized as a subspecies). But if the kind has boundaries, that is, if there are features that are necessary and sufficient for being gold, there cannot be something that is a sample yet lacks those features. Hence, Lowe's atypicality argument fails.

Lowe's second argument works as follows.

"it may also be that gold has a 'scientific essence', consisting in its being constituted by atoms possessing an atomic number of 79, in which case the predicates 'is gold' and 'is constituted by atoms possessing an atomic number of 79' would appear to be, of metaphysical necessity, coextensive. However, 'is gold', in this context, means 'is made of gold' and 'gold' as a substantival general term must be distinguished from the predicative expression 'made of gold', or 'golden'."

Put aside that Lowe's view seems to imply that "Gold is made of gold', and 'Gold is golden' are perfectly coherent and even substantive metaphysical claims, insofar as the substance *gold* is to be distinguished from the properties *is made of gold* and *is golden*. Here Lowe's argument seems to depend on the linguistic distinction between subject and predicate, or between substantival and adjectival terms. But whether this reflects reality – and more specifically, the commitments of

fundamental physics – is just the point at issue.[60] That is, one may fairly ask why the substantival term 'gold' "must" be distinguished from the predicative expression 'is made of gold'. Perhaps apparent substances such as gold can be recategorized as structures of simples, i.e. as simples arranged goldwise. That aside, though, there is little reason to suppose that *a priori* arguments for preserving the substance/property distinction – especially if metaphysics is taken to be prior to physics, as Lowe does – are a part of the physicalist picture.

Lowe does seem to think, though, that something more than the *a priori* principle 'there must be a substance in which properties inhere' is at stake here. Lowe argues that

> "The substantival general term [gold] refers to a kind of stuff, which as a matter of natural law is characterized by many non-substantial universals, such as [a certain melting point, density, color, malleability, etc]. But there is, in principle, no finite limit to the number of such characteristics nomically tied to the nature of gold: 'gold', used as a substantival general term, is not a way of denominating the totality of such characteristics, but rather a way of referring to what it is- a kind of substance- that *bears* those characteristics, as a matter of natural necessity" (2006: 26, original emphasis).

Again, to the extent Lowe's argument that the substantival general term 'gold' "is not a way of denominating the totality" of properties relies on the structure of language, or on *a priori* arguments independent of physicalist commitments, it does not apply here to my characterization of physicalist ontology. Moreover, the rest of Lowe's argument is unclear. In citing that potential infinity of properties that are nomically tied to gold as a reason to believe the substance is distinct from the properties, Lowe seems to suggest that in order for the substance gold to be identical to the characteristic properties of gold, there would have to be a finite list of such properties. But it is not clear why an identity statement between a substance-term and a list of

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[60] Philip Bricker (2009), in reviewing Lowe's book, offers a similar complaint. Bricker writes that Lowe's "four category ontology" is inspired by Aristotle's system, in that "Substantial universals are needed in addition to property universals to ground the distinction between sortals and adjectives, and to provide a simple and natural account of natural necessity". Bricker's first comment is that "A reader steeped in modern physics might well doubt whether this ontology has application to current, as opposed to Aristotelian, science. The little that Lowe has to say about this [19, 75] will do nothing to assuage the worry" (p. 676)

properties would have to be a finite conjunction rather than infinite one, especially because it does not follow from there being an infinite list of properties that there isn't a smaller, finite, list of basic or essential features from which the other nomic properties could be derived, which would serve as the restricted property cluster to which the substance-kind is reduced. But no matter, for this contrast of Lowe's between infinite and finite is a red herring. For Lowe then states that 'gold', used as a substantival general term, is not a way of denominating the *totality*" (my emphasis) of the nomic characteristics of gold, "but [is] rather a way of referring to what it is – a kind of substance – that *bears* those characteristics, as a matter of natural necessity" (2006a: 26, original emphasis). So, for Lowe, even if there were a *totality* of nomic properties that could be denominated, rather than an infinite list, this would still not suffice for Lowe reducing the substance-kind gold to its characteristics. And, again, it appears Lowe's arguments here are not physicalist ones.

Lastly, Lowe defends his account of nonreducible, fundamental substantial kinds against arguments such as Armstrong's (discussed above) and C.B. Martin's in the following way. Lowe asks "Why is it that of all the possible combinations of powers in fundamental particles, only some combinations are found in nature?" Lowe thinks that only a view such as his, committed to substantial universals, can explain this phenomenon. His answer – and explanation – is "because there are no substantial kinds, governed by appropriate laws, for any such particles to instantiate" (2006a: 135).

But this hardly seems an explanation at all. Lowe thinks that what he is explaining is why a unit negative charge and a certain rest mass characteristic of an electron co-occur. His explanation is that they are both properties of the same substance, namely an electron. But this does not explain why those two properties co-occur, it just asserts that they do. Relatedly, why is

the same unit charge not found with an entire range of masses?[61] Lowe's answer, quoted above, is that "individual fundamental particles exhibiting other possible combinations of powers are not found simply because there are no substantial kinds, governed by appropriate laws, for any such particles to instantiate" (p. 135). But Lowe has no answer to this question: why is it, of all the possible substantial kinds, only some kinds are found in nature? Of course, there is an end to accounting for why the particular properties found in nature are there; obviously, some will have to be primitive. But simply saying there exists no substance which has those two specific properties does not explain why those two properties do not co-occur any more than simply saying they do not co-occur. Moreover, an explanation of why they don't occur could be demonstrated if they were shown to be incompatible with other laws of nature, say. But these laws need not advert to the co-occurrence of properties within the boundaries of a substance, rather than to the co-occurrence of properties in a bundle, or to the global distribution of all properties, regardless of substantial boundaries.

In short, none of Lowe's arguments for fundamental substantial kinds pass muster, or give any reason for the physicalist (as such) to adopt a view of fundamental kinds that might allow substantial identity on the ontological ground floor.

2.5: Conclusion

The materialist-cum-physicalist rejection of the Aristotelian worldview shifts the locus of fundamentality along (at least) three dimensions. For the Aristotelian, the macroscopic is the fundamental level of reality, the identity of a substance as an instance of a kind is a fundamental fact, as is a substance being that in virtue of which it has the features definitive of its kind.

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[61] The same unit charge is found with at least some other masses: the muon and tau share the charge but have slightly greater masses than the electron. These elements are highly unstable, however.

Moreover, the Aristotelian posits formal causation as the means by which a substance imbues itself with its characteristic intrinsic properties, including its persistence conditions. But, I have shown, the physicalist rejects these claims. The micro, not the macro level, is fundamental, substantial identities are derivative, and there is no formal causation to account for something having the features it has.

In chapter 1, I argued that physicalism is not only a fundamentality thesis, but that it has built into it a constraint on its ontological commitments: the physicalist can only accept in her ontology what is determined by the fundamental physical entities. Upon shifting the locus of fundamentality, then, the physicalist must show that what are now conceived of as nonfundamental entities are determined by the fundamental physical entities. I will show, however, that this cannot be done, and that the physicalist is committed to rejecting the existence of substances with intrinsic persistence conditions, among other entities.

Chapter 3: Fundamental Physical Properties are Extrinsic Properties

3.0: Introduction

The Aristotelian world is a world of separate substances. Each substance, insofar as it is an independent being, does not rely on other entities for its nature or existence. Substances, for Aristotle, are defined in terms of the kinds to which they belong (i.e. by genus and differentia), and not in relation to each other. The properties which flow from the nature of the substance are thereby intrinsic properties, had only in virtue of themselves. Their temporal development is guided by an entelechy, an internal principle of teleological development. They have natural motions- heavy objects move towards the earth, light objects move towards the sky- as determined by their internal and intrinsic properties. When interfered with or thwarted by external objects, the properties thereby acquired are accidental, and the motions thereby imbued are violent or unnatural. Put together, the fundamental facts are of internally driven separate substances, each, in a sense, a universe unto itself, insofar as each may exist and behave in logical – and metaphysical – isolation from all else.

Building on the results of the last chapter, in this chapter I show how thoroughly the physicalist picture differs from the Aristotelian. In the previous chapter, I showed that substantial identity is not fundamental for the physicalist, but that properties (or property instances) such as mass, charge, and spin are fundamental. In this chapter, I show how this conception differs from the Aristotelian notion of fundamental substances along a further dimension: whereas the Aristotelian posits separate and independent substances, the physicalist, I argue, posits interconnected and interdependent properties. Rather than being defined by genus and species as an instance of a kind, physical properties, I argue, are defined in relation to each other. Rather than evolving according to an internal principle or entelechy, independently of all else, the

evolution of physical property instantiations is governed by laws which relate them of physical – and perhaps metaphysical – necessity. These properties, insofar as they are defined in terms of their relations and interdependencies, are thereby extrinsic properties, and not intrinsic. In brief, and putting these together, the physicalist world is a world of interconnection and interdependence, of externally and extrinsically defined properties, and so ultimately a unified universe, not one of separate substances, each of which are universes unto themselves.

The structure of this chapter is as follow. In §3.1, I describe two previous paths to the conclusion that the fundamental physical properties are relational or extrinsic. In §3.2, I argue for an epistemology of intrinsic and extrinsic properties: specifically, I argue that one knows whether a property is intrinsic by its definition, conjoined with knowledge of the ambient conditions of the property's instantiation. On that basis, I argue in §3.3 for the main thesis: that the fundamental physical properties are extrinsic. In §3.4, I respond to a wide variety of objections.

3.1: Historical Preamble: Two Paths to Relationalism

My claim that the fundamental physical properties are extrinsic is not new. A similar view can be traced back to Leibniz and Kant, and has been advocated by philosophers of science ever since, as I will discuss summarily. Though versions of this view differ in detail and emphasis, Seager (2006: 138) provides a helpful label for what these views have in common: he calls 'Relationalism' the view that "*all* there is to matter is the set of inter-relationships which science reveals" (original emphasis). In this section, I give a brief history of Relationalism, before making the notion- and my claims specifically- more precise in the subsequent sections.

Broadly speaking, there have been two paths to Relationalism. The first, which I call 'the a priori path', proceeds via reflection on the general nature of physical properties and the general concepts employed in the physical sciences, but is not based on any particular physical theory. The second- 'the a posteriori path'- is motivated by a specific (empirical) physical theory, namely Quantum Mechanics. I will discuss each in turn.

3.1.1: The A Priori Path

David Lewis declared that "it is part of our conception of fundamental properties that they are intrinsic" (Lewis 1983b). I'm not sure who Lewis intends to include in "our conception", but, as mentioned above, Leibniz and Kant believed that the fundamental *physical* properties, at least, are relational,[62] and not intrinsic.[63]

Leibniz' and Kant's arguments for Relationalism were part of their attacks on the Cartesian notion of matter. For Descartes, extension is the fundamental intrinsic property of matter. Leibniz and Kant, though, argued that extension was not fundamental at all.[64] They argued that although extension (and therefore shape) appeared as intrinsic properties of objects, nonetheless these spatial properties are in fact determined by the extrinsic spatial relations of the parts of those objects.[65] But the parts of those objects were not physical atoms with less but finite and intrinsic extension: for Leibniz and Kant, the more fundamental physical property out of

[62] Historically, nonintrinsic properties have often been called 'relational'. More recently, philosophers have urged applying 'relational' only to concepts, and contrasting intrinsic properties with extrinsic properties (see Weatherson 2006). For historical accuracy, though, I will often use 'relational' to refer to nonintrinsic properties.
[63] For extended argument, see Langton (1998) and Pereboom (2011).
[64] For instance, Leibniz wrote: "Nor do I think that extension can be conceived in itself, but I consider it an analyzable and relative concept, for it can be resolved into plurality, continuity, and coexistence or the existence of parts at one and the same time" (Quoted in Pereboom 2011: 163).
[65] As such, Leibniz and Kant considered extension or shape to be 'comparatively' or 'relatively' intrinsic, but not 'absolutely intrinsic'.

which extrinsic spatial relations are built are (unextended) pointlike instances of forces of attraction and repulsion.[66] And for Leibniz and Kant, these fundamental physical forces are relational; they are relations which of necessity concern how objects interact, e.g. by attracting or repelling.[67]

Of course, Leibniz' and Kant's notion of force as the fundamental physical property was not entirely independent of their knowledge of the specific physical theories of their day. However, the considerations leading them to these conclusions, as is apparent from this argument, are largely a priori in nature. They derive- apparently- from the very idea of extension, shape, and space, and the very idea of a force. For Leibniz and Kant, Relationalism is a general conclusion about the nature of the material world.

But for Leibniz and Kant, Relationalism could not be the whole story about the world. Because, they argued, the truly fundamental properties must be intrinsic, the fundamental physical properties could not be not the fundamental properties *simpliciter*. (Perhaps, then, I was quick to criticize Lewis' reference to "our conception" of fundamental properties, for Leibniz and Kant do after all share it). And because they took it to be necessary that substances have intrinsic properties, they inferred that substances cannot be exhausted by extrinsic properties, and that therefore there must also exist fundamental but nonphysical intrinsic properties. As such, Leibniz and Kant were not physicalists.[68]

But what are these fundamental, nonphysical intrinsic properties, if not physical properties such as forces? Leibniz argued that the true (intrinsic) fundamental properties were

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[66] Kant: "We are acquainted with substance in space only through forces which are active in this and that space, either bringing objects to it (attraction), or preventing them penetrating into it (repulsion and impenetrability)" (*Critique of Pure Reason*, A265/B321).
[67] On Pereboom's reading, "In Kant's view, force is ultimately an extrinsic property because it is a relation among material items or, more abstractly, spatial points" (p. 173).
[68] Though not physicalists, it is arguable that Kant and Leibniz were nonetheless scientific realists. See Langton (1998), McDonough (2007), Watkins (2007).

mental, not material; Leibniz' (unextended) monads had their mental- nonphysical- properties intrinsically. Kant disputed this conclusion, or at least the epistemology of it;[69] instead, Kant argued that we are irredeemably ignorant of the fundamental intrinsic properties of things- how things are in themselves.[70] So, despite this epistemic disagreement – Leibniz argued we could know that the fundamental properties were mental in nature, whereas Kant argued that we were ignorant of what the fundamental properties are – both agreed that the world could not bottom out in the purely relational properties that are the physical properties.[71]

Despite the anti-physicalist association, philosophers of science have often adopted either of these positions; this Leibnizian and Kantian dialectic continues to this day, in fact. Amongst philosophers of science in the late 19th and early 20th centuries, it was common to hold that the laws of physics, as expressed by mathematical equations, described only relations and not intrinsic properties. From this thesis, some adopted the Leibnizian view- that the intrinsic properties were mental, others the Kantian view that we are ignorant of the intrinsic properties. The Kantians of that era included Ernst Mach, Poincare, Duhem, Cassirer, and Carnap.[72] The Leibnizians included Russell (1927) and Eddington (1928),[73] (and perhaps Dewey 1925; see

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[69] See the *Critique*, A266/B322.

[70] For arguments that Kant's "things in themselves" should be understood as the intrinsic properties of things, see Langton (1998).

[71] Langton (1998) characterizes the Leibnizian view as epistemic optimism, insofar as we can know the fundamental nature of the world, and Kant's view as humility, as we must humbly accept limits on our knowledge. They key disagreement underlying these different conclusions, Langton argues, is the thesis of receptivity – that our knowledge is sensory and thus receptive to the external world – conjoined with a thesis regarding the reducibility of relations. But we need not get into that here.

[72] For instance, Mach wrote "*physicists* have nothing to seek 'beyond the appearances'. Whether *philosophers* will always find it necessary to affirm something real… whose *relations may only be recognized in the wholly abstract form of equations*, may be left entirely for the philosophers to decide." (quoted in Van Fraassen 2006: 278, my emphasis). Poincare (1905/1952, xxiv) wrote "The aim of science is not things themselves, as the dogmatists in their simplicity imagine, but the relations between things; outside those relations there is no reality knowable."

[73] Russell (1927) argued that the only knowledge that physics provides is of abstract mathematical relational properties, such that the "intrinsic character" of nonexperiential reality was unknown. However, Russell did think we had knowledge by acquaintance of the intrinsic character of our own experience,

Godfrey-Smith 2002). More recently, Foster (1982) and Chalmers (1996) have adopted this Leibnizian view that physical properties are extrinsic, but the fundamental intrinsic properties are mental. And although it is arguable whether these variants of Kantian view are compatible with physicalism, the Leibnizian view is clearly incompatible with it.[74] Russell argued for neutral monism- that the fundamental stuff is neither mental nor physical- on this basis, Eddington and Foster for idealism, and Chalmers for (naturalistic) property dualism.

But the association of Relationalism with anti-physicalism has been challenged recently. Assuming that the properties of physics are relational, that there are also intrinsic properties is not something that itself derives from physics. Many contemporary Relationalist views reject this further premise; conjoining the thesis that physics posits relational properties with the thesis that physics can discover all the fundamental properties (i.e. physicalism), one is left with (a variant of) the view dubbed "Structural Realism".[75] In short, whereas Kant and Leibniz argue as follows:

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and, as such, that physicalism was not the whole story (this was his neutral monism). Eddington (1928, esp. Ch. 12) went further. He argued that physics exclusively deals with "pointer readings", or quantitative measurements, and that these readings are only defined in terms of their relations to other pointer readings and measurements, and that consequently, the "intrinsic nature" of reality is unknown to physics. However, our knowledge of the intrinsic nature of mentality suggests idealism; that the fundamental nature of the world is mental in character, not physical, nor neutral, as Russell maintained.

[74] But perhaps this is not so clear-cut; G. Strawson (2003) argues that physicalism entails panpsychism, and that this is a- if not the- legitimate form of physicalism. Montero (2010) also defends "Russelian physicalism" against the view of Chalmers referred to here. However, neither Strawson nor Montero accept the conception of physicalism as defined by physics. If physicalism is understood this way, then clearly this Leibnizian view is anti-physicalist. See also Ney (2007).

[75] There are many varieties of SR, and many critics of it. Unfortunately, the advocates of SR are not always entirely clear on just what structure is, and what is to be contrasted with structure, such that it is not clear what is or isn't included in a physical-cum-structuralist ontology. In addition to the denial of intrinsic properties, objects, haeccities, the identity and individuality of objects, and the fundamentality of events, objects and properties have also been denied under the SR banner. Moreover, both proponents and critics of SR often focus not on the opposition between relations and intrinsic properties, but on several other oppositions. Among them include: structure vs. nature (Worralll 1989, Gower 2000), structure vs. content (Van Fraassen 2006), structure vs. intrinsic quality (Russell 1927), form vs. content (Gower 2000), form vs. matter (Poincare 1905), structure vs. intrinsic nature, structure vs. objects (Ladyman 1998, Chakravartty 2003), relations vs. relata (Poincare, Esfeld 2003), abstract vs. concrete (Van Fraassen 2006, Psillos (1999, 200x), structure and relations vs. objects and properties (Ladyman 1998), and 2nd

1. Physical properties are relational
2. Substances must have intrinsic properties
3. Therefore, physics is incomplete,

Structural Realism (on one reading) argues, instead, as follows:

A. Physical properties are relational
B. Physics is complete
C. Therefore, there are no substances with intrinsic properties.

So Relationalism need not be an anti-physicalist doctrine; the thesis that matter is exhausted by extrinsic properties does not of itself entail anything about the completeness of physics, or the status of substances and intrinsic properties.

In this chapter at least, though, I am not concerned with this further question about substances and intrinsic properties. Instead, what matters here is the idea of the *a priori* path to Relationalism: that there is a long history in the philosophy of science of *a priori* reasoning about the differences between intrinsic and extrinsic (relational) properties, and that these categories are closely related to the notion of fundamentality in the material world.

3.1.2: The A Posteriori Path

The *a posteriori* path to Relationalism is more recent, as it is based specifically on Quantum Mechanics (QM), and not on general considerations about physics. (As such, this argument can succeed only if QM is appropriately interpreted and not replaced by a future theory or ontology). In its most general and bare outline, the QM-based argument for Relationalism runs like this:

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order properties vs. 1st order properties (Busch 2003). For an survey, including criticisms, see Ladyman (2007)

1) In contrast to past theories, QM implies that objects cannot be individuated independently of the relations in which they stand.

2) Therefore, quantum objects do not have properties intrinsically.

Whatever its merits, this argument is clearly a very different argument than the sort advocated by the Kantian and Leibnizian tradition. I will say no more of this argument now, deferring discussion until §3.4.5, in the context of defending Relationalism against objections.

3.2: The Epistemology of Intrinsic Properties

As we've seen, Leibniz and Kant contend that the fundamental physical properties are relational. Structural realists see the fundamental physical properties as relational-cum-structural. But David Lewis thinks they are intrinsic categorical properties, and Alexander Bird (2007) and Brian Ellis (2001, 2002) argue they are intrinsic dispositional properties. Lacking, though, in these approaches is a systematic response to the general question: How does one know if a property is intrinsic or extrinsic (relational)?

In this section, I argue for an epistemology of intrinsic properties. Specifically, I contend that what indicates whether a property is intrinsic is the definition of the predicate corresponding to the property (or the 'real definition' of the property), conjoined with the physical conditions of instantiation for that property. In §3.3, I show that these criteria – motivated independently of any concern with Relationalism – show the fundamental physical properties to be extrinsic.

3.2.1: What Is An Intrinsic Property?

First, of course, one must know what an intrinsic property is. There is widespread agreement on the intuitive notion of what it is for a property to be intrinsic, as reflected both by

the platitudes used to convey the intuition and the propensity of philosophers to quote those platitudes approvingly. Following that tradition, consider the following: Lewis (1983a) writes that "a thing has its intrinsic properties in virtue of the way that thing itself, and nothing else, is." Dunn (1990) asserts that an intrinsic property "is a property that the object has by virtue of itself, depending on no other thing". Humberstone (1996: 229) claims that intuitively, intrinsic properties are properties a thing has in and of itself. Vallentyne (1997) considers a property intrinsic iff a thing's having it depends only on the thing itself and not on any wholly distinct thing. Yablo (1999: 479) asserts: "*You* know what an intrinsic property is: it's a property a thing has (or lacks) regardless of what may be going on outside of itself."

These intuitions clearly have something in common- they distinguish between a) an object and its environment, and b) properties that are independent of or dependent on an object's environment. As a result, it is widely agreed that being compatible with "loneliness" is a necessary condition for being an intrinsic property: if an intrinsic property is one which only depends on a given object and on nothing else, including the object's environment, then it follows that even were that object alone in the universe – *sans* any environment at all – the object could still possess that property.[76] An extrinsic property, by contrast, is one that is incompatible with loneliness, i.e. a property whose instantiation requires the existence of a distinct object or environment.

It may be that there are other necessary or sufficient conditions for being intrinsic, and despite agreement on the 'compatibility with loneliness' criterion, accounts differ as to how to

[76] The term 'loneliness' in this context originates with Kim (1982) (though the idea surely predates this; Van Cleve (1999: 151-2) calls this intuition "Kant's test" for intrinsicality.) For various reasons, including the fact that the property of being lonely is itself an extrinsic property, various emendations have been made to the formulations of intrinsicality whilst preserving this intuition. The details of these various proposals do not matter here, though.

formalize or analyze the intuitive account of intrinsicality.[77] Langton and Lewis' (1998), for example, argue that a property is intrinsic iff it is compatible with loneliness and lawlessness, i.e. the absence of laws of nature.[78] Though this account is currently more popular than any rival, the lawlessness criterion is controversial. (Notice that none of the platitudes cited above refer to laws of nature. The inclusion of the lawlessness criterion, rather than relying on the intuitive notion of intrinsicality, relies instead on a controversial metaphysics of laws and properties, namely that the laws of nature are contingent, and that properties are only contingently related to their powers.[79]) But as compatibility with loneliness is a necessary condition for intrinsicality, and I will be concerned with putative incompatibilities with loneliness, the conception of intrinsicality as compatibility with loneliness is sufficient for my purposes. So, going forward, I will consider a property to be intrinsic only if its instantiation is compatible with loneliness.

3.2.2: How Does One Know If a Property Is Intrinsic?

How one knows whether a property is intrinsic is discussed far less often – if at all – than what it is to be intrinsic. Yet this epistemic issue is no less important. As far as I can tell, here are the most plausible candidates for an epistemology of intrinsic properties; that is, a list of methods or indicators by which one could conclude that a given property is intrinsic or extrinsic.

1) Intuition

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[77] In the decade or two since these platitudes were expressed, disagreements have proliferated. For a recent overview, see Weatherson (2006).

[78] Though this view was itself refined by Lewis (2001). For criticisms, some of which motivated the amendment, see Yablo (1999), Dan Marshall and Josh Parsons (2001), Sider (2001).

[79] What motivates this criterion is the idea that an object's powers (dispositions, potencies, etc.) are contingent, such that they depend on what the (contingent) laws of nature happen to be. So, if an object has the property of being able to cause certain effects it may only have this power in virtue of the laws (and circumstances) instantiated in that world- even if that property appears intrinsic. But if the power depends on the contingent laws and circumstances, then that property (of having that power) is not intrinsic. But some argue that the laws of nature are necessary, not contingent, and that properties are not contingently connected to their causal powers (Shoemaker 1980, Ellis 2001, 2002, Bird 2007).

2) Natural language predicate definition
3) Grammar/ predicate -adicity
4) Predicate definition as posited by physics
5) Conditions of instantiation/sensitivity to environment

Consider first the appeal to intuition. Assuming that philosophers agree on which properties are intuitively intrinsic and which intuitively extrinsic, intuitions obviously reveal a psychological distinction between properties believed to be intrinsic, and properties believed to be extrinsic. But are these intuitions truth-tracking? Should one assume that human intuitions are infallible indicators of metaphysical reality? Suppose intuitions were regarded as infallible. If so, whenever a theory – scientific or otherwise – conflicted with them, the theory would be discarded on the basis of having counter-intuitive implications (cf. Dennett 2005: 34). Progress in science – especially in the physics of motion, as developed during the scientific revolution – would have been impossible. Should one disallow a philosophical theory with counter-intuitive implications precisely on that basis? Surely the burden of proof is on the philosopher who claims intuition to be infallible in this regard. But, one may respond, perhaps intuitions are defeasible evidence for intrinsicality. Perhaps, but in which cases are they unreliable, and for what reasons? Presumably, whatever trumps intuition in those cases would be the more reliable epistemic indicator generally. In either event, 1) is unsatisfactory.

So consider 2). Here, what indicates whether or not a property is intrinsic is whether the definition of its corresponding predicate invokes distinct existences. If the definition of ‘shape’, for example, is something like ‘the external outline of a figure’, such that this definition makes no reference to a distinct existent, then the property shape is intrinsic. By contrast, if the definition of ‘brother’ is something like ‘male sibling (of another person)’, then this definition

does refer to at least one distinct existent. It follows that the property *being a brother* cannot be instantiated in the absence of distinct existences, such that this property is incompatible with loneliness and so is therefore extrinsic.

Underlying this approach to discerning intrinsicality is an assumption of word/world correspondence. Specifically, this approach presumes an isomorphism between the -adicity of the predicate and the intrinsicality or extrinsicality of the property it picks out, such that there is a one-one mapping between argument places and objects in the world.[80] (Above, I listed predicate -adicity as the third method by which one could recognize intrinsicality, but consider this method in conjunction with 2) for the moment.) Put another way, the underlying assumption here is that a monadic predicate, such as 'is round', corresponds to an intrinsic property, and a polyadic predicate, such as 'is to the left of', or 'is the brother of', corresponds to an extrinsic property. On this model, if a predicate is polyadic, its instantiation places logical constraints on what else exists. For if it is true that x is to the left of y, then both x and y must exist; a lonely x cannot instantiate the property *is to the left of*. On the other hand, since a monadic predicate can be satisfied by only one object, the instantiation of the corresponding property places no logical constraints on what else exists. More generally, if the -adicity of the predicate reveals intrinsicality or extrinsicality, there is a presumed isomorphism between predicate and property, or word and world.

Despite its obvious affiliation, 3) (determining intrinsicality via –adicity) may be distinct from 2) (determining intrinsicality by definition) if a predicate does not have a definition. It is possible that spatiotemporal relations are primitive; it may not be possible to define e.g. 'being to the left of.' However, such a predicate would still have an –adicity. Therefore, 2) and 3) are not

[80] Of course, the depth grammar might diverge from the surface grammar of a term. Or, different –adicities may be attached to different forms of the predicate. For instance, 'is an uncle' gives the superficial appearance of being intrinsic, insofar as it is monadic. I ignore this sort of worry here, though.

identical, though they are obviously closely linked.

Be that as it may, each of these approaches share a potential problem, which is that it appears there is no role for empirical investigation. It is (probably) *a priori* that the definition of 'brother' is 'male sibling', or that 'shape' is 'the external outline of a figure.' Above I ruled out intuition as a legitimate means by which to discern intrinsicality due to the inability to revise intuitions in the face of discovery. Might similar considerations apply here? Is it possible for an empirical discovery to alter the definition or –adicity of a predicate, thereby changing one's belief in the intrinsicality of the corresponding property? That is, is it possible for it to be empirically discovered that a property thought to be intrinsic on the basis of intuition, grammar, or definition, is in fact extrinsic?

Consider 'weight' and the likely English synonym 'heaviness'. These are monadic predicates – 'something has weight', or 'something is heavy' or 'something has heft' –and so the surface grammar gives the impression of a single quality (i.e. weight, heaviness, or heft) inhering in something. Hence, intuitions read off the surface grammar suggest that *weight* and *heaviness* are intrinsic properties. But there may also be some theory behind this. Consider Aristotelian physics. For Aristotle, material bodies were composed of the simple elements- earth, air, water, and fire. These elements each had one of two opposing pairs of simple qualities: each element was either hot or cold, and wet or dry. These combinations of simple qualities determined the possession of another quality pair- heaviness or lightness (which in turn determined natural motion). So, for example, fire is hot and dry, and therefore light (and as such naturally moves in a straight line away from center of universe). Earth is dry and cold and therefore heavy, (and as such naturally moves toward the center of the universe). For Aristotle, the properties of hot, cold, wet, dry, heavy and light were distinct qualities possessed by a body, and could be picked out by

monadic predicates. So, Aristotelian physics suggests that heaviness (or weight) and lightness are intrinsic properties.

In contemporary English, though, 'heavy' and 'light' are often treated as relative terms, insofar as something is only heavy or light relative to a comparison class. If so, the monadic 'is heavy' is elliptical, presumably, for the dyadic 'is heavy for a(n)'. Does this suggest *heavy* is not intrinsic?[81] If so, does simple and presumably *a priori* reflection on language justify reclassifying the property as extrinsic? Or does it take more substantive metaphysics to provide an alternative to Aristotle's conception? Or, perhaps, is there a straightforwardly empirical investigation to be made?

Locke and Berkeley, in arguing for the primary and secondary quality distinction, treated the discovery of the relativity of qualities as a profound philosophical one, as it was supposed to show that Aristotle was wrong to think of qualities such as heavy, light, hot, and cold as qualities inhering in a body. Insofar as this was an important discovery, it appears not to simply be a function of grammar or ordinary language use (though this is debatable).

More important here than philosophical debates and their relation to depth grammar and *a priori* reflection, though, is the (potential) contribution of physics. Consider again 'weight', or 'weighs 10 pounds'. Again, as a monadic predicate, 'weight' appears to pick out an intrinsic property. And perhaps unlike 'heavy', *a priori* reflection on the grammar of 'weighs 10 pounds'

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[81] Aristotle recognized that something was relatively heavy or light, though he seems to have taken this to mean that different things possess the intrinsic quality in different degrees. In *On the Heavens*, Aristotle wrote: "Let us then apply the term 'heavy' to that which naturally moves towards the centre, and 'light' to that which moves naturally away from the centre. The heaviest thing will be that which sinks to the bottom of all things that move downward, and the lightest that which rises to the surface of everything that moves upward. Now, necessarily, everything which moves either up or down possesses lightness or heaviness or both-but not both relatively to the same thing: for things are heavy and light relatively to one another; air, for instance, is light relatively to water, and water light relatively to earth. The body, then, which moves in a circle cannot possibly possess either heaviness or lightness. For neither naturally nor unnaturally can it move either towards or away from the centre."

does not reveal this to be elliptical for something dyadic, such as 'weighs 10 pounds on Earth', or 'weighs 10 pounds at sea level'. Yet Newtonian physics defines weight as (partly) a function of the local gravitational forces acting on a body, the strength of which (in part) depends on a body's distance from other masses. On this non-Aristotelian definition of weight, a given body does indeed have a different weight on different planets or at different elevations on the same planet. Whereas for Aristotle, weight is intrinsic, for Newton it is extrinsic. For on this definition, weight is incompatible with loneliness; the instantiation of weight requires an environment containing gravitational forces.

Should one accept the Newtonian revision of the Aristotelian concept? Recall option 4) for discerning intrinsicality- the definition according to physics. Is the physical definition a better indicator of intrinsicality than the vernacular or Aristotelian definition?
Many suppose so.[82] But making this move has implications: for, if *weight* is extrinsic, then the intuition, -adicity, or definition of 'weighs 10 pounds' prior to physical theory, or as defined by a falsified or superseded theory, is irrelevant for indicating the intrinsicality or extrinsicality of *weighs 10 pounds*. That is, if the definition of a physical predicate as it appears in an accepted physical theory is that which indicates intrinsicality or extrinsicality, then the previous three methods – intuition, natural language definition or –adicity – play no epistemic role in figuring out whether the property in question is intrinsic.

Now, there are a number of thorny issues here as regards 'weight'. Did Aristotle and Newton refer to the same property, but offered different accounts of its nature, or is the term simply homonymic? Is the contemporary English word 'weight' a variant of the Aristotelian or

[82] For instance, the second sentence of Weatherson's (2006) *Stanford Encyclopedia of Philosophy* entry on "Intrinsic vs. Extrinsic Properties" cites weight as the exemplar of an extrinsic property.

Newtonian definition, or, perhaps, is the word 'weight' used in (at least) both ways?[83] I do not need to settle these issues here because I am ultimately concerned with the fundamental physical predicates- predicates which physics unambiguously has the sole prerogative to define. When it comes to discerning the intrinsicality of mass, charge, or spin, for instance, we should look at the physical definition, and not to common sense or intuitions. That is, clearly option 4) – the definition according to physics – is the best indicator of a physical property's intrinsicality.

Thus far, this talk of definition has left out talk of 5)- the empirical conditions of a property's instantiation or its sensitivity to environment. Consider *weight* again. The weight of a body is sensitive to its environment; the same body subjected to a different gravitational field will have a different weight. A body instantiates a particular weight due to the specific conditions of its environment; only under the conditions of a net force or nonuniform motion, for instance, does it have a weight. As such, weight requires distinct existences for instantiation, and so is extrinsic. This may suggest that a property's sensitivity to its environment is an indicator of extrinsicality.

Along these lines, though, Nerlich (1979) argues that something's shape depends on the curvature of the space in which it is embedded. Consequently, a body would have a different shape in a differently curved region of space. That is, Nerlich argues that a body's shape is sensitive to its environment, and as a result, shape is not intrinsic. In this respect, shape appears analogous to weight: just as a body would have a different weight in a different gravitational field, a body would have a different shape in a differently curved spatial region. Moreover, just as weight, which may have at first seemed intrinsic, is discovered to depend on the environment, so too is shape, on Nerlich's suggestion. It appears that in both cases what is treated initially as a monadic predicate or an inherent quality by common sense or ancient metaphysics is shown by

[83] For a discussion of the often ambiguous and changing definition of 'weight', see Gat (1988)

physics to be extrinsic after all.

Yet not everyone sees the analogy. Consider this passage from Skow (2007), who asks the reader to imagine someone cupping a pile of sand in her hands. Skow contends that the argument that shape is not intrinsic because the shape of cupped sand depends on being held by distinct existents (i.e. the hands) is a "bad argument". Skow continues.

> "This argument is not good. We should distinguish between physical dependence and metaphysical dependence. The sand's shape physically depends on the existence of my hands: it is the physical forces my hands exert on the sand (and the sand grains on each other) that gives the sand its shape. But it is fine for an intrinsic property to physically depend in this way on the existence of other things. Intrinsic properties merely need to be metaphysically independent of the existence of other things. And the sand's shape is metaphysically independent, it seems: we can conceive of a world (a world with different laws of nature to be sure) where the sand has the shape it actually does even though my hands do not hold it in the shape" (p. 6).

Considering the cupped hands as a stand-in for curved spacetime, Skow's argument obviously rejects the implication from the sensitivity of an object's shape to its environment to the extrinsicality of shape. But if this criticism is legitimate, does Skow's argument also apply to *weight*? Should one distinguish between the physical dependence of weight on gravitational forces from the putative metaphysical independence of weight from gravitational forces? Can we conceive of another world (with different laws of nature) wherein something has the same weight yet that world does not contain the gravitational forces that give it weight in this world?

How to answer such questions is not straightforward. Let's assume though, as Skow seems to, that conceivability entails logical possibility. That is, assume that if a state of affairs is conceivable, it is at least logically possible. Before getting to metaphysical as opposed to logical possibility, the important question here is: does anything govern or limit what is conceivable?

Worries about the analyticity notwithstanding, surely definitions play a role in governing what is conceivable and hence taken to be logically possible. If 'bachelor' is defined as 'unmarried man', then surely a married bachelor is neither conceivable nor logically possible.

And assuming that what is not logically possible is also not metaphysically possible, it follows that a married bachelor is not metaphysically possible either. And, as argued before, definitions play a role in indicating the intrinsicality of properties. So, if the definition of 'uncle' is 'male sibling of a person's parent', then it is logically impossible – and therefore inconceivable – for the property *uncle* to be instantiated in a world without siblings or the children of siblings. That is, the definition of 'uncle' shows it is not logically possible – and therefore not metaphysically possible – for there to be a lonely uncle (in the metaphysical rather than psychological sense, of course). This shows that not only do definitions play a significant role in limiting what is logically possible, but also with what we can conceive to be metaphysically possible.

Suppose that the *definition* of 'weight' contains as a part 'the external gravitational force applied to an object'. If so, then it is not even *logically* possible that an object have weight in a world where there are no external gravitational forces. That is, just as the definition of 'uncle' shows that it is logically impossible for there to be an uncle absent siblings and parents, so too does this (Newtonian) definition of weight show that it's logically impossible for there to be weight absent external gravitational forces. And if it is not logically possible for weight to exist apart from gravitational forces, then it is not metaphysically possible either. Putting this together, not only is it physically impossible for there to be weight in the absence of gravitational forces, but it is logically impossible and therefore metaphysically impossible too- all because the property in question is *defined* by physics (as extrinsic). More generally, if definitions govern logical possibility, and definitions are given by physics, then physical possibility exhausts logical possibility and metaphysical possibility (at least for that which is defined by physics). These various forms of impossibility become co-extensive, rather than nested.

If the relevant property definitions being given by physics collapses the distinction between physical, metaphysical, and logical impossibility, then what these arguments also show is that distinguishing these forms of (im)possibility presupposes that the relevant definitions are not given by physics. If one had an Aristotelian definition of weight, then one would think it is logically or metaphysically possible that weight could exist in the absence of gravitational forces- just as Aristotle did in fact think.

So what of shape, and Skow's argument? If it is logically possible (or conceivable, as Skow puts it) that the sand could have its shape even were it not held, such that the shape is metaphysically independent despite being physically dependent, then, presumably, this is because the definition of shape – something along the lines of 'the external figure of something' – does not refer to any distinct object exerting forces or pressures that determine the thing's shape. As such, one can conceive of something's shape independently of such forces. Suppose, though, for argument's sake, that after the discovery of the curvature of spacetime, the predicate 'shape' comes to be *defined* as a relation between an object and the curvature of space, i.e. 'the external outline of a figure as determined by the curvature of the space in which it is embedded, and the external forces applied to the figure'. If something like this is the definition of 'shape', then it is not even logically possible for an object to satisfy this predicate independently of the distinct existent known as space. On this definition, then, *shape* is indeed extrinsic, contra Skow.

Now, I am not arguing that this definition of shape is or should be the one suggested by physics. What is important here is the following idea: whether it is conceivable that shape is metaphysically independent despite being physically dependent itself depends on what the definition of 'shape' is, and, specifically, whether that definition comes from physics or from somewhere else. And clearly Skow assumes it comes from somewhere else.

And what this shows, among other things, is that the conditions of a property's instantiation or its sensitivity to the environment – thesis 5) above – does not suffice for indicating intrinsicality. For it may be that every actual shape that is had by every actual object is determined by the environment in which that shape exists. But as long as 'shape' is defined independently of those conditions, one may insist that physical dependence (i.e. sensitivity to physical context) does not suffice to make a property (logically) extrinsic. Weight, as opposed to shape, is thought to be extrinsic because the definition of weight, unlike shape, suggests it is, despite the fact that the actual physical instantiation of both properties may entirely depend on the conditions of a body's environment.

One may worry that this reliance on physical definitions makes the whole business of physics too *a priori*, or perhaps conventional or simulative. But this worry is misguided. First of all, one may construe physics as searching for the "real definition" of a property, i.e. its true nature. Secondly, even if restricting definitions to predicates rather than properties, a property's sensitivity to its environment, or its conditions of instantiation clearly influence how a predicate is defined, but are obviously discovered empirically; definitions in physics are not merely stipulative nor tautological. In the case of weight, the empirical discovery that a certain measure (associated with scales and qualitative heaviness) is influenced by gravitational forces is incorporated into the definition. Generally speaking, there is an interplay between the empirical conditions of instantiation and the "legislative" definition of the property.[84] For empirical considerations often suggest how a predicate *should* be defined – say, 'has weight' in a Newtonian rather than Aristotelian fashion – and this is neither arbitrary, stipulative, nor *a priori*.

[84] See Robinson (1950) for more on legislative definitions

As such, I conclude this section with the following: the definition of physical predicates conjoined with the physical conditions of the corresponding property's instantiation jointly determine the intrinsicality or extrinsicality of a physical property.

3.3: Arguments for Relationalism

In the previous section, I argued that what indicates the intrinsicality or extrinsicality of a physical property is the definition of the corresponding predicate, and the ambient conditions of the property's instantiation. In this section, I present two main arguments for a restricted version of Relationalism, i.e. that the fundamental physical properties, rather than all physical properties, are extrinsic, reflecting this bipartite division. In §3.3.1, I argue that the definitions of physical predicates show the properties to be extrinsic. In §3.3.2, I argue that the conditions of instantiation for physical properties are determined by ambient conditions and, as such, are incompatible with loneliness. To bolster these two arguments, I then present a "meta-argument" in §3.3.3 that attempts to block a revisionary approach to rebutting the first two arguments.

3.3.1: The Argument from Definition

The argument from definition has a linguistic and ontological reading, between which the term 'definition' may be ambiguous. If taken linguistically, this argument might better be phrased 'the argument from predicate definition'. If taken ontologically, this argument might be better phrased 'the argument from real definition.' I'll consider these in turn.

3.3.1.1: The Argument from Predicate Definition

The argument runs as follows.

A. Physical predicates are defined via equations.[85]

B. Equations only express relations.

C. Therefore, physical predicates are defined by their relations.

An important class of equations, of course, are the equations that express laws. Which equations are to count as laws, and which count as definitive of a given predicate is not an issue here; what is important here is only that at least one does. As such, an adjunct to this argument goes as follows:

a) Physical law-statements are expressed by equations.

b) Law-statements express relations between physical predicates.

c) Physical predicates are defined by the law-statements in which they appear.

d) Therefore physical predicates are defined by their lawful relations.[86]

These arguments conclude that physical predicates are defined relationally. According to the arguments in the previous section, a predicate being defined in terms of relations to other entities is indicative of the corresponding property being extrinsic.

Consider again 'weight' as an example. Suppose weight = mass times the gravitational force, i.e.

$w = mg$.

If the predicate 'weight' is defined by this relation, such that

$w =_{Df.} mg$,

then the instantiation of weight requires the instantiation of these other properties, just as it is the case that if 'brother' is defined by its relation to another person of the same parentage, the instantiation of the property *brother* requires the instantiation of the other properties to which it

[85] See e.g. Russell (1919: 59); Psillos (1995), Esfeld and Lam (2005: 2-3), McArthur (2006: 209).
[86] See e.g. Carnap, G. Maxwell (1970), Hellman and Thompson (1975).

is related. Therefore, it is logically impossible for *brother* to instantiated by a lonely object. Analogously, and assuming that these other properties by which weight is defined are themselves properties of distinct existences,[87] then, as argued above, it is impossible (by definition) for weight to be instantiated independently of these distinct existences, i.e. it is impossible for weight to be instantiated by a lonely object.

But the key move here is that weight is not special in this regard. Instead, the argument generalizes: any physical predicate defined via an equation relating the predicate to distinct existences thereby corresponds to an extrinsic property.[88]

3.3.1.2: The Argument from Real Definition, or The Argument from Causal Essentialism

The ontological version of this argument is analogous, of course; it amounts to simply replacing 'predicate' with 'property'.

The view here is that what a property is – its identity – is its relations to other physical properties. Privileged among these relations, presumably, are those lawful relations, such that properties are defined (in the sense of "real definition") by their place in laws (cf. Psillos 1995, Esfeld 2003, Esfeld and Lam 2005). For example, as Seager concisely notes, this is the idea that "a mass of m is just that property such that something with it will obey the relation that m=F/a for a force F and acceleration a, and so on" (2006: 135). Because such properties have no

[87] For one might counter that the relata of an equation need not be properties of distinct existences. For example, suppose density $=_{Df.}$ mass/volume. Firstly as I will argue, mass is itself extrinsic. Second, density is not a fundamental property. Third, such a definition may allow anti-realism about the property; are there three properties here- mass, volume, and density- or two- mass and volume, together dubbed 'density'? Fourth, precisely because this equation looks intrinsic, i.e. does not appear to invoke distinct existences, it does not describe interactions, and so this definition is not lawful or lawlike.

[88] For example, one might take Coulomb's law as defining the magnitude of electric force to be equivalent to the constant K x $q_1.q_2/d^2$, or that Kinetic Energy = ½ (mass x velocity^2).

identity apart from their relations, their instantiation requires the instantiation of these other properties. Therefore, such properties are extrinsic.

Put in terms of causal essentialism, the idea is that a property's essence is to have the causal profile it has; it wouldn't be that property unless it displayed those causal powers. So, on this argument, that a property's essence is its causal relations entails that the property is extrinsic, requiring for its instantiation the distinct entities that constitute its definitive relations.

3.3.1.3: The Argument from Doing

As Frank Jackson (1998) writes, "When physicists tell us about the properties they take to be fundamental, they tell us about what these properties *do*" (p. 23, original emphasis). Jackson describes such properties as appearing to be "causal-cum-relational" properties.[89] Armstrong (1991) makes a similar observation. He notes that "if we look at the properties of physical objects that physicists are prepared to allow them such as mass, electric charge, or momentum, these show a distressing tendency to dissolve into relations that one object has to another."[90] Ney (2007) approvingly quotes these remarks of Armstrong's, and elaborates: "physicists think of mass in terms of attractive effects on particles. They think of electrical charge in terms of a field produced and effects on the movement of surrounding particles" (p. 44).

As these sorts of passages indicate, some philosophers have come to perceive physics as describing what objects do in terms of their relations, and then treating those relations themselves as fundamental. Dipert (1997) is explicit. He argues:

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[89] Other have adopted this rhetorical usage of "doing": for instance, Whittle (2006, p. 485) writes "we cannot divorce a property from what it does", as does Howell (2009).
[90] Quoted in Ney (2007, 44).

"We come to attribute these 'properties' [microphysical properties such as charge, mass, and spin] to these 'things' only through what we might call their *interactivity*… Our regarding a particular to *have* the 'property' of a certain mass is our explanation of why it interacts in certain ways with other similarly interactive entities. We should perhaps instead express ourselves in terms of the root phenomenon, rather than its convenient monadistic shorthand, and say that certain entities interact with other entities in certain ways: this relational interactivity… *is* the underlying phenomenon." (p. 340)

For Dipert, it is interaction – i.e. how entities *relate* through what they *do* – that is the fundamental phenomenon, and the attribution of intrinsic properties to each separately – the "monadistic shorthand" – is secondary, or derivative.

Putting these remarks together, the "argument from doing" is that fundamental physics characterizes what a property does, what a property does is how it interacts, and interactions are causal relations, not intrinsic properties.[91]

Implicitly underlying these remarks, I contend, is the argument from definition. The reason that physics appears to say what an object does, as Jackson observes, and the reason that physical properties tend to dissolve into relations, as Armstrong observes, is because physics defines a property in terms of its relations and interactions with other properties. Physics does not describe how a property is in itself, or what it is for an object to have that property independently of how it interacts.

It should be noted, though, that neither Jackson nor Armstrong consider the fundamental physical properties to be extrinsic. I will discuss their reasons in the next section, when responding to objections. For now, though, it is worth noting in response that Armstrong and Jackson divorce the appearance – i.e. physics appears to posit relational properties – from what

[91] Before moving on, it must be noted that in both arguments given so far- the arguments from doing and lawfully defined properties- several of the philosophers cited in support of these doctrines do not actually do not consider the properties in question to be extrinsic. Jackson and Armstrong, for instance, deny that physical properties are actually relational despite appearing so. And Ellis and Bird, for instance, despite arguing that properties have their causal relations essentially, deny that such properties are extrinsic. I will deal with objections along these lines in §3.4.

they think is reality –i.e. that physics actually posits intrinsic properties – because of insufficient attention to the arguments from definition. But more on this in the next section.

3.3.2: The Argument from Ambience

In §3.2, I argued that there are two components that serve to indicate intrinsicality: the definition, and the ambient conditions of property instantiation. The previous argument concerned definition, and the following concerns the second.

Harris (2010) argues for the "causal dependency thesis". He describes it as follows.

> "For natural science tells us that *all* the general physical properties of actual concrete objects and events depend in one way or another on the way the rest of the world is, because, without exception, their possession or loss is *conditional* upon causally relevant circumstances, like temperature, pressure, illumination, magnetic, electrical or gravitational field strength, etc." (p. 3)

According to Harris, no property is instantiated in a vacuum, so to speak;[92] the instantiation of every property is conditional, or dependent on, ambient conditions. In general, then, this argument has it that all physical properties are instantiated not in virtue of an object itself, but in virtue of the environment conditions in which an object exists. As such, no physical properties are instantiated by virtue of the object itself, and therefore all such properties are extrinsic. (And, as I will discuss in §3.4.3, this holds both of what are sometimes called state-dependent and state-independent properties.)

3.3.3: The Meta-Argument from Descriptive (Meta)physics

I call this last argument a 'meta-argument' because it concerns an approach to assessing the previous arguments.

[92] Even the presence of an actual vacuum would itself count as ambient conditions, as it would change whatever properties something might otherwise have.

The previous arguments have something in common: they appeal to the appearances of physics. The argument from definition holds that physics appears to define properties (and predicates) relationally, via their causal or nomological roles and relations, as these are expressed via equations. Similarly, the argument from doing holds that physics appears to tell us what properties "do", i.e. how things interact with each other, not how they are intrinsically or independently of any interaction. And the argument from ambience holds that physics appears to show that each property instantiation depends on ambient conditions. The question, then, is: why should such appearances be taken seriously?

Suppose one granted my arguments to some extent, agreeing that the properties of physics *look* extrinsic. One might go on to say, however, that although they appear extrinsic, they *really* are intrinsic. Such a counter-argument asserts an appearance/reality distinction when it comes to the posits of physics. My 'meta-argument' is intended to support the identification of appearance and reality (at least as far as the posits of physics are concerned), and thereby prevent this schism from emerging. To justify this, though, I will take a step back, and employ an analogy.

Much of the history of metaphysics could not have occurred as it did (or perhaps at all) if the ontological category under which a given entity falls was transparent, such that it could be read off from appearances. Consider an example: the appearance of an apple. And consider the various and incompatible ontological categorizations of it that have been advocated throughout history- here are my top ten.

1) The apple is a substance in which its apparent properties inhere
2) The apple is not a substance, but an attribute of a mode of the one substance, called alternatively 'nature' or 'God'

3) The apple is an idea in the mind of God
4) The apple is merely an imperfect representation of an Ideal Apple
5) The apple is identical to a bundle of properties
6) The apple is identical to a bundle of sense-impressions
7) The apple is a logical construction out of sense-data
8) The apple is a logical construction out of (physical) events
9) The apple is merely atoms arranged apple-wise
10) What appears as an entire apple is only a single time-slice of a four dimensional object that is not wholly present at any given moment

If which (or any) of these ontological categorizations were obviously correct, or easily apprehended on the basis of appearances, or could be 'read off' the perception of an apple, there could have been no metaphysics as we know it.

Yet this ontological ambiguity has not prevented there being a common sense or default position; I don't suspect it would be much disputed that thinking of the apple as an enduring substance with inherent properties is the default pre-philosophical position, for lack of a better term.[93] Philosophers, though, reflecting on the default position, may find something problematic. For example, if the default substance with inherent quality model implies the absurd possibility of a bare particular, or warrants skepticism about the external world, or conflicts with an empiricist epistemology, then philosophers may be motivated to recategorize or reinterpret the apple as a bundle of properties or sense-impressions, for example. That is, realizing a problem or inadequacy implied by the default view may motivate recategorization in terms of something more philosophically satisfying.

[93] Nothing rides on whether this is in fact the default position; I am interested here in the idea of default position. This example is not intended as sociology, but to illustrate a larger point.

If this briefest sketch is right, a number of important distinctions arise. First, there is a distinction between domains or discourses- in this case between pre-philosophical common sense and metaphysics proper. Second, one can distinguish between a descriptive and a revisionary account of ontological posits, in P.F. Strawson's (1959) famous sense of the terms. For Strawson, the difference is that revisionary metaphysics desires to "produce a better structure" than the descriptive variety (p. 9). In my example, describing common sense would commit it to substances and inherent properties. But if this model were found wanting, revisionary metaphysics, seeking to produce a better structure, might revise those commitments, thereby recategorizing in a way that is more philosophically satisfying. Third, these imply that in some sense, the default position would be the "literal" or "natural" way of ontologically categorizing, whereas metaphysics would have the revisionary job of *reinterpreting* the ontological categorizations of the default position. Fourth, these imply that the non-descriptive revisionary discourse attempts to pull rank on the default, or descriptive discourse. Put another way, revisionary metaphysics takes itself to be the ontological authority, i.e. authorized to show that the default position is incorrect. Of course, there may be philosophically sophisticated ways of defending the common-sense view, aimed at showing the folk got it right after all, but it remains the case that the revisionary metaphysics attempts to trump or pull rank on the common sense view. Whether it succeeds is immaterial in this respect. Fifth, the attempt to pull rank implies that the two domains are in competition, and are therefore rivals, rather than standing in a relation of supplicant, assistant, or helper. Sixth, this implies that the domains are not continuous, i.e. that one shades smoothly into the other (as Quine thought philosophy and science were continuous). After all, rivals have sharp boundaries; two teams opposed in sport do not blur into each other. Seventh, and lastly, the distinction between discourses implies a demarcation

between sources of material. That is, a distinction emerges between what comes from inside the discourse, and what comes from outside of it. The materials or resources of the revisionary metaphysical arguments cannot be entirely drawn from or derived from the common sense perspective. For if one claimed that those materials were derived from the common sense discourse as something latently present, then one is committed to the claim that the common sense view was in error about what its own view is. But as a description of what common sense does, there is no possibility of error- it does what it does, as they say. The idea that common sense commits radical error cannot come from within common sense, but only from a revisionary discourse reflecting on it from the outside. Perhaps, even, the assertion that common sense is in error establishes a distinct, revisionary discourse.

Now, suppose there were a metaphysical view called common-sense-ism. According to this view, everything is determined by the posits of common sense. In light of the distinctions just described, consider the following question. Are the posits of common-sense-ism the posits recognized by a descriptive or revisionary discourse? Clearly the former: it would be odd to say that common sense is committed to time slices, for instance, or objects being ideas in the mind of God. Whatever their merits, a philosopher who held one of these latter views could not properly be described as a common-sense-ist. Common-sense-ism must include only its posits understood descriptively, not in a revisionary sense.

Having established this, now reconsider physics, and physicalism. Physicalism has it that everything is determined by the posits of physics. But what are those posits? Are they the posits of physics understood descriptively, or by a revisionary method? As is the case with common-sense-ism, one must understand the posits of physics *qua* physics, that is, as a description rather than a revision. In the case of physics, though, rather than an apple being the analysandum, the

appearances include entities such as mass and charge. The question is then: under what ontological category does a descriptive (meta)physics subsume these entities? Assuming these are properties (rather than substances, events, etc.), my question is whether a descriptive account of physics considers them intrinsic or extrinsic. Thus far, my arguments show that fundamental physical properties *appear* extrinsic, and not intrinsic, and therefore the default, "natural", or literal way of understanding these posits of physics is as extrinsic properties, not as intrinsic properties. By contrast, it is a reinterpretation to think that the properties of physics are intrinsic. Therefore, considering the posits of physics as intrinsic properties is revisionary.

The schism between revisionary and descriptive metaphysics arises due to the perceived inadequacy in the common sense ontology. Analogously, philosophers may perceive an ontological inadequacy if all physical properties are extrinsic, for many contend that a 'pure' system of relations fails to characterize the intrinsic nature of the world, or is otherwise unintelligible. As a result, they may be motivated to reinterpret the fundamental physical properties as intrinsic. But this is illegitimate. Return to the apple example. It may be that common sense has it wrong; perhaps apples really are bundles of sense-impressions, not independent, enduring material substances. Even so, it would not legitimate to argue along the following lines:

a) according to our best philosophical arguments, we know that material objects are really bundles of sense-impressions

b) Therefore, common sense posits bundles of sense-impressions.

Nothing about the best philosophical arguments has implications for what common sense posits. Analogously, I contend, it is illegitimate to argue along the following lines:

c) according to our best philosophical arguments, we know there are intrinsic properties.

d) Therefore physics posits intrinsic properties.

What the best philosophical arguments say does not entail anything about what common sense says, neither do they not entail anything about what physics says.

So why revise at all, rather than simply say the two domains have different (possibly competing) ontologies? For example, why not simply posit time-slices or Spinozistic modes, and leave common sense aside? In short, because some philosophers wish to save the original discourse (for whatever reasons), and so are motivated to impute the revisionary ontology onto the original discourse. So, if one wished to both assert, for example, that there are no material objects but only bundles of sense-impressions in the mind of God, but also that common sense got it right, one may attempt to characterize common sense as positing such an ontology. Analogously, those who wish to include intrinsic properties in one's ontology but also to preserve physicalism may be motivated to impose such an ontology on physics. Ironically, though, such a philosopher establishes herself as a revisionary rival of physics. As above, revisionary metaphysics vis-à-vis physics involves metaphysics pulling rank on physics, thereby putting itself in competition for ontological authority. Revision cannot save an ontology, it displaces it. Otherwise, revision is false consciousness.

Be that as it may, this competition is misplaced, at least here. For the goal here is simply to discern the posits of physics, not to consider whether such an ontology is otherwise philosophically satisfying.[94] In sum, the goal of this "meta-argument" is not to rule out

[94] Consider the way this distinction might play out in another context: For example, consider philosophers of physics who debate over whether fields are real or "convenient fictions". As a descriptive matter, this is straightforward: Measurable field-values appear in equations, so therefore physics appears to be committed to them. A descriptive account, then, includes them amongst the posts of physics. The

metaphysical inquiry, nor to imply that there are or are not fundamental intrinsic properties, but to rule out a revisionary interpretation of physics motivated by philosophical dissatisfaction with a world of fundamental extrinsic properties.

3.4: Objections and Responses

In this section, I respond to the wide variety of objections that may be levied against my positions and arguments thus far. The structure of this section is as follows. Each subsection (e.g. §3.4.1, §3.4.2) has as part of its title a condensed version of an objection to my view. After some elaboration, I respond to the objection. The objections are loosely organized as follows, with some overlap. §3.4.1- §3.4.4 are largely concerned with objections to my description of physics as such. It is here that my arguments from definition provide the bulk of the defense. In §3.4.5- §3.4.8, the objections mostly derive from the (putatively) unpalatable implications of physics positing only extrinsic fundamental properties. And in the rest of §3.4 (through §3.4.12), the objections concern alternate philosophical interpretations of physics. It is here that the meta-argument from descriptive (meta)physics does much of the work.

3.4.1: Surely mass and spin – intrinsic angular momentum – are fundamental intrinsic properties

Surely, one might argue, mass is a paradigmatic intrinsic physical property. Moreover, one may contend that physics rather than common sense suggests this, for it defines mass (and spin) differently than claimed by my arguments in §3.3.1. For example, according to Definition I

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philosophical question is whether this descriptive ontology- containing fields- is adequate, and should be revised. It should be noted, though, that the question I am addressing here is not quite analogous to this example, because it does not concern whether a certain physical entity exists. Instead, it concerns the categorization of entities assumed to exist. Assuming mass and charge are real properties, in whatever sense one wishes to take that, the question is then whether these real entities are intrinsic or extrinsic properties, not whether mass and charge exist at all.

of Newton's *Principia*, 'mass' is the "quantity of matter."[95] Here, mass is not defined by an equation, nomological relations, or by what mass does, contra my arguments above. And this form of definition is not restricted to mass. More generally, physical definitions of any physical predicate F, rather than being defined by lawlike equations, may be of the following form:

F $=_{Df.}$ the quantity of G,

where such instances may include

Mass $=_{Df.}$ the quantity of matter,

Momentum $=_{Df.}$ the quantity of motion[96],

Spin (angular momentum) $=_{Df.}$ the quantity of rotary motion.

Because such definitions make no appeal to distinct existences, these definitions imply that the defined properties are intrinsic.[97] That is, if a body's mass is the quantity of matter of that body, it seems that a lonely material object could have mass. Analogously, if spin is defined as the quantity of rotary motion of a body, this definition does not refer to distinct existences, 'has spin' is a monadic predicate, so spin too is an intrinsic property. And so forth for any property defined in this manner.

Response:

Definitions of the form 'F $=_{Df.}$ the quantity of G' face two severe problems in this context. First, such definitions are only plausibly legitimate when the property in question is visualizable or imaginable, and, as such, this form of definition is inapplicable to the properties posited by contemporary physics. Second, and even restricting attention to those cases where

[95] Newton then adds: "which arises from its density and bulk conjointly"
[96] This is Newton's Definition II in the *Principia.*
[97] Or, one might claim, if Newton did define mass by an equation such as being equivalent to density over volume, because these properties are properties of a single object, rather than consisting in a relation between wholly distinct objects, mass is still an intrinsic property.

such definition is plausibly legitimate, it turns out it is the visualizability, rather than the definition *per se*, that is responsible for the sense that the properties in question are intrinsic. By my previous arguments (in §3.2.2), however, this is not a legitimate criterion for discerning the intrinsicality of a physical property. I will develop these claims in turn.

Of course it is difficult to say in general what forms of definition are or are not legitimate (for the *locus classicus* on definition, see Robinson 1950). But a survey is not needed, for it is sufficient to note that one necessary criterion of a good or legitimate definition of some x – one that has any hope of counting as a "real definition" of x – gives something resembling a useful answer to the question 'what is x?'.[98] I argued previously that physical properties are defined by their nomological role. Such a (real) definition captures how the instances of that property behave and interact, which are the basic facts of scientific interest. So such definitions are very useful. Moreover, and more importantly for 'real definition', such a definition robustly answers the 'what is x?' question because, on this model, such properties just *are* what they *do* (§3.3.1). This law-based model of definition, then, not only captures what the property is, but also can be used to generate predictions and provide explanations, insofar as what the property is is just how it interacts and relates to other entities.

By contrast, definitions of the form 'the quantity of G' do not describe how a property behaves, interacts with, or relates to anything else. So they are not equally useful in that respect. Now, one may contend that this is appropriate, for, one might claim, what a property does, i.e. how it interacts and behaves, should be separated from what it is, and consequently, 'what does x do?' should be considered a distinct question from 'what is x?'. This thought underlies the common worry that if a property is defined by its relations, one is left ignorant of what mass is

[98] Note that Newton's definition aspires to be a "real definition"; he is not simply saying that the sign 'mass' can be treated as equivalent to another sign 'quantity of matter'; Newton is saying what he thinks mass 'really' is.

"in itself", apart from its relations.[99] Keeping the questions separate seems to avoid this difficulty; Newton's definition of mass as 'quantity of matter', being independent of how things with mass behave, seems to capture, if anything does, what mass is in itself.

But does this definition actually serve that purpose? Before answering this question for mass, look at an analogous definition for electric charge. If mass is the quantity of matter or material stuff, then perhaps one can define charge analogously:

(electric) charge $=_{Df.}$ The quantity of electromagnetic matter/stuff.

But there is no such thing, and so charge cannot be defined this way. Suppose instead that one suggested the following:

(electric) Charge $=_{Df.}$ the quantity of electromagnetic force

But this isn't right either. Charge is not a measure of electromagnetic force. Charge and electromagnetic fields interact to produce electromagnetic force; whereas charge is measured in Coulombs, electromagnetic force is measured in Dynes per Coulomb, for example. But then what is charge – that which is measured in Coulombs – the quantity of? One might then suggest:

(electric) charge $=_{Df.}$ The quantity of (electrical) attraction and repulsion

Putting aside the worry of having a term ('electrical') on both sides, more important here is that this is to define charge in terms of what it does- how it relates to other charged bodies, not what it is in itself. For attraction and repulsion are relational- they refer to the effects something has on a distinct body. So this fails to answer what charge is 'in itself', apart from its effects. But –and this was the earlier point – it is not clear why one should think there is such a thing. It is not clear what, if anything, charge is, or could be, apart from its contributions to attractive and repulsive forces, or apart from its interaction with electromagnetic fields. There seems to be no plausible Newtonian-style definition of charge that does not refer to relations and interactions.

[99] See Lange (2002), Whittle (2006), Lewis (2009).

So why was that sort of definition at least plausible in the case of mass, spin (the quantity of rotary or angular motion), and momentum (the quantity of (linear) motion), as suggested above? Why do these properties seem to fit the Newtonian model, but charge does not? The answer, I contend, is 'visualizability'. One can (presumably) imagine or visualize a massy object, that is, some solid, impenetrable stuff. One can visualize momentum (linear or angular) insofar as one can visualize cohesive massy stuff moving through space or rotating in place. Moreover, one can visualize these phenomena prior to familiarity with theoretical physics. Prior to physics, then, one has some pre-theoretical understanding what these properties are. Not only that, but one (probably) has an entirely nonverbal or proprioceptive sense of impenetrable stuff and the motion of such stuff. Being given words such as 'mass', 'velocity', 'momentum', 'rotation', and 'spin' to name what we have a pre-theoretical, probably nonverbal acquaintance with creates the impression of gaining knowledge, or at least of understanding. So dubbing something perceptively familiar with a name and a description appears as a legitimate definition.

So, back to charge. Despite some familiarity with lightning and carpeting, people do not have a significant pre-theoretic notion of electric charge. And presumably, one cannot visualize a charged object as such. If one doubts this, try to visualize first a positively charged object, and then a negatively charged one, and then describe the difference. For what it's worth, I certainly cannot. It is not a coincidence, I contend, that lacking such experiences, charge fails to fit the Newtonian model of definition as the quantity of something familiar.

Notice that the same applies to quantum spin. Imagining a spinning top, or recalling the pre-theoretical bodily sensation of spinning, one might be satisfied with the Newtonian-type definition of spin as the quantity of rotary motion. But quantum spin is not really rotary motion; 'spin' is a misnomer. Torretti (1999) argues:

"the conception of the electron as a finite rotating sphere is fraught with difficulties, for not only is it hard to understand what keeps its charge together, but its equatorial velocity would have to exceed the speed of light to yield spin = +-hbar/2. After the image of the stationary atoms as a classical mechanical system was scuttled by Heisenberg, it was no longer necessary or even possible to understand the spin of the electron as a manifestation of rotation. Just as Pauli anticipated, spin is now conceived as an irreducible quantum property of matter, but the name 'spin' has stuck" (p. 320).

As physics moved away from the visualizable model of the atom, quantum spin could not legitimately be defined as 'quantity of rotary motion'. Simply put, quantum (and quantized) spin is not the quantity of rotary motion. And it is not the quantity of any other familiar phenomenon, nor of any one phenomenon in particular. Deprived of a pre-theoretic notion of quantized spin, and the image of a stable body spinning, the Newtonian 'quantity of G' form of definition fails. Instead, I contend charge and spin are defined by their lawful relations, i.e. by what they do, and how they interact- as described in §3.3.1.

It is important to see these points in historical context. Recall earlier the discussion of Aristotle and *weight* (§3.2.2); for Aristotle, because heaviness is a simple (or nearly simple) property, its (nonrelational) definition can only be something like "the inherent heaviness of something."[100] This definition is not terribly informative. And whatever informativeness it does have relies on a prior and probably nonverbal proprioceptive understanding of weight as the resistance to movement, or as the difficulty of hoisting something.[101] But absent such experience, Aristotle's definition is useless. And the same goes for Newton's of mass. Absent prior and possibly nonverbal experience with the bulk, inertia, or impenetrability of the stuff out there in the world, being told that mass is the 'quantity of matter' does not help one understand what mass is. As argued above, definitions of the form 'quantity of G' not only are helpful only if one

[100] Its relational definition may be "that which is responsible for moving towards the center of the universe."

[101] 'Heavy' is etymologically related to 'heave', which connotes the exertion of considerable force in order to launch something; both words derive from an Old German word for 'to lift up'.

can imagine or visualize the property in question, but only if one can imagine it prior to any definition. Such definitions can only help to describe what is already familiar, not what is novel. This was appropriate for the era; much of the new physics of the Scientific Revolution was devoted to making more rigorous and mathematical previously familiar concepts, such as weight, motion, rotation, and mass. Fitting with this spirit of "natural philosophy", the physicists of that era had no difficulty saying what mass is- for matter is essentially familiar (and in fact, Newton adopted the definition of mass as 'quantity of matter' from the 14th century cleric and philosopher Buridan).[102] But when it came to saying what gravity – a new theoretical posit – is, beyond what was expressed in his equations, Newton was famously mute.

And if one uses the 'quantity of G' form of definition, one must be mute on what electric charge and quantum spin are as well; the advance of physics beyond what was already familiar from everyday motion requires a different form of definition than 'the quantity of G'.[103] For when physics discovers novel properties, such as quantum spin or charge, for which there is no (or little) nonverbal, pre-theoretical visualizable content, 'quantity of G' types of definitions are useless. And what this shows is that in general they do not meaningfully answer the 'what is F?' question. Instead, for the more abstract properties of modern physics, where no intuitive or imaginary handle on the properties independently of laws can be had, 'What is F?' questions cannot be answered by citing something independent of the behavior, interactions, and relations of F. By contrast, questions such as 'how do charges interact?' and 'in what lawful relations does

[102] See McMullin (2010: 17, 20)

[103] This process was well on its way in the 19th century. J.C. Maxwell agreed that mass is "the quantitative aspect of matter" (1995: 811), but he denied that mass is the "quantity of matter in a body". Rather, for Maxwell, "the mass of a body is that factor by which we must multiply the velocity to get the momentum of the body, and by which we must multiply the half square of the velocity to get its energy." (1995: 396, see Harman 1985: 222-3, "Edinburgh philosophy and Cambridge physics"). In other words, Maxell accepted a lawfully defined notion of mass. And, assuming that velocity and momentum are defined via external forces and by reference frames, yet again we see the move to a lawful definition denies intrinsicality.

spin stand?' have answers as rigorous and informative as any questions do. And this throws the issue into sharp relief. It is this disconnect between the robustness of questions such as 'what does F do?', and the vacuity of questions such 'what is F, apart from what F does?', that motivates not treating them separately at all, at least in a scientific context. Put another way, it is the failure of there being no good answer to the 'what is x?' question apart from 'what does x do?' that motivates the claim that the property just is what it does. Putting it together, when physics confronts novel properties interacting in novel ways, it does not define them by reference to familiar, pre-theoretical and proprioceptively known properties. Instead, they are defined by lawful relations- by what they do, and how they interact.

This is not unrelated to the question of whether e.g. mass is intrinsic. If mass is just the quantity of matter or stuff of a body, it seems one can imagine a single lonely massy object, in which case one might think mass is intrinsic. And insofar as a spinning top is imaginable or visualizable independently of knowing the laws that define spin in relation to other quantities, one may be inclined to accept a definition of spin as the quantity of rotary motion, in which case one might think it is intrinsic. But what is doing the work here is not the definition per se, but the visualizability. The definition is a proxy; accepting a definition of the form 'the quantity of G' is an indicator that one has a pre-theoretical visualizable notion of the property in question, and so is an indicator of whether one may (take oneself to) imagine a lonely object manifesting that property. But it is this visualization, rather than the definition *per se*, that is the epistemic indicator of intrinsicality here, for it is the visualization that allows this form of definition at all. But my arguments in §3.2.2 ruled this out. It is not intuition, nor visualization, that is the proper indicator of intrinsicality: it is the definition. And in this case, without the visualization of the

abstract properties of fundamental physics, the 'quantity of G' definition is not legitimate. Instead, such properties can only be defined in a manner that implies they are extrinsic (§3.3.1).

The bigger picture here is as follows. As physics progressed from the era of natural philosophy and measuring easily imagined familiar properties, to modern mathematical physics and abstract properties, the definitions followed suit: they went from simple, intuitive and theoretically isolated, to complex, abstract, and holistically or relationally defined. And, as a result, properties moved from looking intrinsic, as being imagined instantiated independently of other objects and properties, to relying on relational systems for their instantiation.

And mass has not been left behind; the Newtonian definition no longer even suits mass as it is currently understood. According to Lange (2002: 205), for instance, "in Relativity theory, a body's mass cannot be interpreted as the amount of matter that the body is made of" because, Lange argues, in relativity mass is not additive;[104] that is, the mass of a body is not the sum of the mass of its parts.[105]

Second, the Standard Model of particle physics (including the Higgs field) seeks to explain or give an account of mass, something that Newton never did, of course. According to particle physicist Frank Close (2004: 124),

"what we recognize as mass is, in part, the effect of the interaction between particles and the Higgs field. Photons do not interact with the Higgs field and so are massless; the W and Z bosons do interact and thereby acquire their large masses. The building blocks of matter, the quarks and leptons, are also presumed to gain their masses by interacting with the Higgs field."

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[104] "A body's temperature, for example, does not measure the amount of some stuff it contains, since the temperature of my body is not equal to the temperature of its top half (98.6) plus the temperature of its bottom half (98.6), else I would be running an alarming fever (of 197.2). Likewise, a body's density does not measure the amount of some stuff the body contains, since its density is not the sum of the densities of its parts. The same goes for velocity. On the other hand, in classical physics, mass is 'additive' in this way, and so perhaps a body's mass can be interpreted as the amount of matter it is made of. But in relativity, mass is not additive." (Lange 2002: 229-30)

[105] Being additive, Lange argues, is necessary but not sufficient to measure a quantity of stuff, for energy, while is additive, is not invariant so is not a measure of stuff (and likewise for relativistic mass) (2002: 254). See also H. Cartwright (1975).

This is a long way from Newton's 'quantity of matter'. On this model, mass is not simply a primitive, intrinsic property, as 'quantity of matter' suggests, but instead something that arises via interactions, as a relation between a body and a field. Mass has come to be defined relationally, just the other fundamental quantities of physics are.

The Newtonian definition, as independent of the laws and equations, is appropriate for the birth of natural philosophy, as something not yet entirely mathematical and quantitative, and so reveals itself as not entirely discontinuous with the Aristotelian and medieval tradition. But, as physics matures, it abandons qualitative, intrinsic-looking definitions in favor of the lawfully defined and extrinsic. The fundamental properties of mathematical physics, as we know it today, posits extrinsic properties because it is mathematical physics.

3.4.2: But physicists use the word 'intrinsic', and posit single particle systems, so a descriptive account of physics must include intrinsic properties.

Response:

Physics uses words that advert to sensory experience, such as flavor, color, and spin. But that doesn't make the entities that possess these properties really flavored or colored, in the everyday sense of those terms, of course. So even if physicists use the word 'intrinsic' when speaking of 'intrinsic angular momentum', or call mass intrinsic, that doesn't necessarily make such properties really intrinsic, in the philosophical sense of the term. What physicists say is not *ipso facto* the truth. If physicists have ontological authority, it is because of their methodology, not because of their pronouncements independent of that method. Moreover, what determines intrinsicality is not what physicists say, or what they imagine, but how the properties in question

are (properly) defined (§3.3.1). That is the object of a descriptive (meta)physics, not an anthropological description of the verbal habits of physicists. After all, it may be that physicists have not thought about the philosophical question: how does one know a property is intrinsic? Absent that, simply calling a property 'intrinsic' – even if a physicist does it – does not entail that a property is intrinsic.

But even granting that argument, one may object that physicists do not so casually posit single particle systems, in which a single particle is treated as if it were a lonely object, thereby implying it has intrinsic properties. But to bolster my previous point, and to apply it to this case, I can help myself to Reichenbach's distinction between the "context of discovery" and the "context of justification". The context of discovery, loosely, is whatever it takes to come up with a theory, and can include Archimedes sitting in a bathtub.[106] But what justifies Archimedes' principle is not that he was in a bathtub when he thought of it; the context of justification may be entirely distinct from the context of discovery, and the physicists' ontology need not include bathtubs as a result. Speculation about single particle universes, I contend, is a part of the context of discovery, not justification. It is a way of thinking and talking, an idealization or a way of performing thought-experiments. It may be immensely fruitful, as when Einstein's imagined what it is like to ride alongside a photon and was led to special relativity. But such thought-experiments are not actually evidence for anything (at least in physics), and they do not carry ontological commitments. They have a valuable role of course: they may help to focus the mind, or lead to a moment of epiphany. But in lieu of evidence of actual single particle universes, such speculation, or thought-experiments, need not be indicative of genuine metaphysical possibilities, nor considered a genuine part of a physical theory. In short, the context of discovery

[106] I am somewhat taking liberties here; for a more subtle treatment of Reichenbach's distinction, see Glymour (2008)

is a part of the *practice* of science, but not a part of a *theory* per se, so talk of single particle systems need not carry ontological weight. Only the theory itself, and how properties are defined in the theory, matters for the epistemology of intrinsicality.

3.4.3: Physicists distinguish between state-independent and state-dependent properties, and this maps onto the intrinsic/extrinsic distinction

Consider Ellis (2001):

> "The properties that are of most concern in the physical sciences are those properties a thing has independently of the contingencies of its location, and its relations with other things, and would display if it existed as a closed and isolated system. For these are the properties it has intrinsically." (p. 26)

Response:

In general, Ellis rejects the "logical notion" of intrinsicality; rather than cashing out intrinsicality in terms of loneliness at another world, Ellis keeps the distinction this-worldly, in that the intrinsic properties are those that something would have "if it existed as a closed and isolated system". To illustrate, Ellis distinguishes between the shape of a hardened steel band, and the same shape had by a stretched rubber band. The rubber band shape's is extrinsic – or state-dependent – Ellis claims, for it relies on being stretched. Yet the shape of the steel band is independent of its state, and so is intrinsic, Ellis claims. As Harris (2010: 5) argues persuasively, though, that "Ellis' distinction between steel and rubber applies under our 'normal circumstances'- circumstances which are entirely parochial for physical science." He continues: "Ellis simply neglects the ambient conditions relevant to the shape of a steel band" (p. 4.) Harris then asks: what if the ambient conditions were a million degrees?" The steel band would lose its shape; therefore even the steel band's shape is dependent on ambient conditions.

But, one might claim, this only involves shape, which may be considered a state-dependent property no matter what object instantiates it. What of putatively state-independent properties such as mass and charge? Harris points out that the argument from ambience applies here too: "physicists are researching the conditions at the very start of the universe, which they are seeking to replicate in the CERN large Hadron collider, in which not even sub-atomic particles retain their properties" (p. 4). That is, the masses and charges of fundamental particles, then, are state-dependent too, in the sense that they can only be instantiated in certain conditions-conditions that may not have obtained in the first moments of the universe.[107]

This suggests that the state-dependent/state-dependent distinction is a relative one-whereas the intrinsic/extrinsic distinction is not. It follows that they are not identical. Harris continues: "Physical properties may be independent of where or when their bearers are, *all else being equal*, but if all else is not equal (i.e. their ambient conditions vary) then their properties will vary according to their bearers 'relations with other things'" (p. 6). And this is so regardless of whether the object is considered in a closed and isolated system. For

> "in science, a 'closed and isolated system' is an idealized scenario in which ambient conditions are under complete control. It is not a situation in which a thing is somehow removed from *any relation* to things outside itself. So 'isolated', as science understands this term, is entirely distinct from the philosophical term of art 'loneliness'. Experimental science seeks to 'isolate' causal factors, not by securing the absence of ambient conditions, but by controlling them (or for them: this why [sic] 'control' experiments, groups, etc. are so called). (p. 7)

Harris' arguments suggest that the state-independent/state-dependent distinction is a relative one. No property, Harris contends, is instantiated in complete isolation from the rest of the universe.

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[107] It may be objected that under these conditions, the particles in question did not yet exist, rather than existing but with different properties. Such an objection, though, relies on a prior conception of substantial identity that distinguishes changes something can undergo and continue to exist, as opposed to changes that amount to a coming into (or out of) existence. But if the state-independent/state-dependent distinction relies on this, such that state-independent properties are simply defined as those which do not change throughout something's existence, then a change of such properties constituting a cessation of that thing's existence is simply question-begging.

The obtaining of all physical properties depends, to varying degrees, on the state of the universe. There is no reason to think that such properties could be had by lonely objects, apart from ambient conditions. In slogan form, 'state-independent' does not mean 'universe–independent', i.e. compatible with loneliness.

3.4.4: Physical properties are too rich to be defined

According to Putnam (1975),

"Law-cluster concepts are constituted… by a cluster of laws which, as it were, determine the identity of the concept. The concept 'energy' is an excellent example of a law-cluster concept. It enters into a great many laws. It plays a great many roles, and… in general, any one law can be abandoned without destroying the identity of the law-cluster concept involved." (p. 52)

Putnam seems to suggest that a physical property is not defined by any one law. Lange (2002) takes this passage to suggest that physical properties do not have definitions at all. Because of the wide variety of connections involved in the cluster of concepts related to a given property – in Lange's example, temperature –

"there was no special class of connections holding purely in virtue of the meaning of 'temperature' In other words, there was no definition of 'temperature'. This is not to say that 'temperature' was meaningless (in the ordinary sense of the word) or that dictionaries could not come up with anything to say about it. Nor do I mean that a *host* of connections *collectively defined* 'temperature'. That would require me to say that whenever a single one of these connections was changed, the definition was changed, and so scientists were using a different temperature concept than before. Rather, once temperature acquired enough diverse important connects, the concept became too rich to have anything like a definition" (p. 83, original emphases).

Lange makes a similar argument using another example. According to Lange, Newton

"emphasized that being 5 kg in mass is not merely the disposition to exert and to feel certain gravitational forces, since mass is linked to gravity by *natural law* rather than *by definition*. According to Newton, mass is not 'specifick' to gravity, since besides the law of gravity, mass figures in other basic laws already known (such as Newton's second law of motion, linking a body's acceleration to its mass and the force on it), and mass was expected to figure in further basic laws as yet unknown, such as laws governing chemical reactions.. With the same few fundamental categorical properties expected to be ultimately responsible for all natural

phenomena, no single role played by any of these properties will be adequate to define it." (p. 86, original emphases)

Response:

These arguments rely on physics being a work in progress. But what about final physics: does final physics define properties? The metaphysical question concerning intrinsicality is not temporally indexed; it is fair to speculate about whether the properties of final physics will be intrinsic or not. None of these arguments even speak to that question, let alone pose an objection to the claim that final physics defines properties, and so they do not pose an objection to the claim that along the way, physics does (attempt to) discover the real definition of properties. Secondly, there is no reason why a definition has to capture all the relations in which a property stands; surely some are foundational, and hence definitive, and others derivable and so not definitive. Though Lange claims that some of the "various connections [between temperature and other concepts] differed in importance, there was no natural place to divide the connections into those that fixed temperature's meaning and those that did not" (ibid). But this is glib; though there may be no general rule as to how to divide those that are definitive from those that are derivative, there is little reason to dispute that in any given case, the line is fairly clear. Thirdly, these arguments assume a certain form of convergent realism (i.e. that science continuously improves by discovering new facts about the same old properties). Now, one need not accept convergent realism at all. But even assuming one does, this is not the only model of the success of science; science can make discoveries about a domain, or some phenomena such as motion, combustion, or acoustics, say, even if the properties by which such domains or phenomena are understood are replaced by successive ontologies. As a result, one could maintain that new connections do alter the identity of the property in question, yet remain consistent with what

might be called ‘domain-convergent realism’- that scientific discoveries are of new knowledge of some previously known domain rather than of previously known properties. If so, one need not reject that physical predicates have definitions, or that physical properties have real definitions.

3.4.5: Surely a Lonely Object is Possible

Seager (2006) argues that “If Relationalism is true then no entity can exist by itself” (p. 141). For if physical properties are extrinsic, and these exhaust all (concrete) properties, it follows (unless there may actually be bare particulars) that there can be no lonely substances. (And if there can be no lonely substances, then there can be no substances *simpliciter*, for a substance, insofar as it is that which is independent, is simply that which may exist alone at a world.) That a lonely substance with intrinsic properties is possible, however, implies that a view which rules out this scenario, such as Relationalism, is false.

First response:

Recall the historical preamble (§3.1): Leibniz and Kant argued that physical properties are relational, but also accepted the necessity of substances with intrinsic properties. As such, Relationalism does not of itself imply there can be no lonely substances- it implies only that there cannot be fundamental physical lonely substances. Because one may accept both Relationalism and the possibility of loneliness, this objection from loneliness is misguided.

Second response:

As argued previously, physicalists cannot go Leibnizian or Kantian. Desiring to retain physicalism and also their belief in the possibility of lonely substances with intrinsic properties,

they will be motivated to reject the thesis that the fundamental physical properties are extrinsic. But this route only leads to revisionary metaphysics, which is born of a perceived inadequacy with the descriptive account. But, as I've argued, revising appearances to solve the problem is illegitimate. Put another way, it is illegitimate to argue from physicalism's truth and the possibility of loneliness as premises to conclude that therefore fundamental physical properties must be intrinsic.

Third Response:

The physicalist should not be so quick to endorse the possibility of loneliness for another reason. Presumably, the defender of loneliness thinks that the conceivability of a lonely object entails the possibility of a lonely object, and, as a result, (the possibility of) intrinsic properties. But allowing this move may get the physicalist in trouble. Recall one of Descartes' arguments for dualism. Based on the conceivability of Descartes existing without his body, in contrast to the inconceivability of Descartes existing without his mind, Descartes concluded that his essence was mental, not physical, and that his mind could therefore exist separately from his body. In this vein, a Cartesian might respond to the claim that mind and body are identical with the "loner's refrain"- surely it is possible for a lonely mind to exist, independently of the body. And if a mind could exist independently of his body, then perhaps it could exist independently of all bodies; Descartes' argument for dualism is predicated on the conceivability- and hence possibility- of a lonely mind, i.e. a lonely mental substance.

Of course, the physicalist can block this argument by denying that conceivability entails possibility. One might argue that physics (and science more generally) discovers the interdependencies between things intuitively thought separate. One might initially suppose

weight is separate from gravity, or electricity from magnetism, or particles from other particles subsequent to entanglement. Yet it may turn out that the world may be such that despite pre-scientific concepts and intuitions, physics discovers that loneliness is not possible. So although it may seem that one can conceive of a mind without a body, a physicalist might argue that this is discovered to not be possible.

But it is not clear why or how a physicalist should reject Descartes' argument for lonely mental substances but accept the same sort of argument for the possibility of lonely physical substances and (physical) intrinsicality. For the difference between kinds of substances in question – i.e. physical or mental – does not seem relevant to whether conceivability entails possibility. Instead, the argument rejecting lonely minds should apply to lonely physical objects: despite intuitive notions of separateness between substances, physics reveals phenomena to be interrelated and so not independent.

Fourth response:

But even assuming that conceivability does entail possibility does not help the defender of physical loneliness here, because the relational definition of physical properties precludes one from even having a conception of them instantiated intrinsically. Recall the arguments for this conclusion in §3.2.2. There, I argued that if the definition of 'weight' indicates that *weight* is extrinsic, such that weight (necessarily) includes a relation between forces and a gravitational field, then in a world where there are no such forces or fields, there is no weight. By this definition of 'weight', it is no more conceivable for a lonely object to have weight than it is for a lonely object to be a brother or to the left of something, for by definition, the property's instantiation requires an environment. It follows that uttering the words 'lonely brother' does not

suffice for a conception of a lonely brother (any more than uttering the words ‘round square’ suffices for a conception of a round square). As argued, the definitions of the properties that physics gives in terms of relations and interactions with other entities reveal that the fundamental physical properties are extrinsic. Because they are defined by relations to other entities and properties, these properties cannot be had intrinsically. My argument is that all physical properties are like weight in this respect, such that one cannot have a genuine conception of them instantiated by a lonely object. Uttering ‘there is a lonely object with mass’ is not a conception of a lonely object with mass, even if it is an English sentence, just as “there is a brother existing alone in the universe” is not a genuine conception, despite being an English sentence.

Fifth response:

The *a priori* argument that the possibility of loneliness necessarily falsifies any theory that denies it is itself falsified by Quantum Mechanics (if it is possible to consider QM complete). Loneliness requires a “self-individuated object”, in that for an object to exist alone, it cannot rely on something else to individuate it, or to confer boundaries separating that object from every other (possible) object. Yet quantum entanglement (on many interpretations) suggests that quantum mechanics need not, and perhaps cannot, recognize self-individuated objects.

The arguments runs as follows. Quantum particles of the same kind are indistinguishable on the basis of their qualitative properties; each particular has the same mass, charge, etc. How, then, are such particles individuated? Traditionally (classically), qualitatively identical particles could be distinguished on the basis of their state-dependent properties such as position or momentum. (This classical assumption was undergirded by the principle of impenetrability; no two objects could exist in the same place at the same time.) This guaranteed that even

qualitatively identical particles would be numerically distinct, i.e. individuated, on the basis of having a distinct spatio-temporal position; each individual, in occupying a distinct spatio-temporal potion, was individuated prior to any relations in which the object engaged. Intuitively, such a particle could exist alone, then. But two problems emerge here on the quantum mechanical view. The first has to do with quantum statistics. If a particle is at any given moment unique in occupying the space it occupies, and is guaranteed to have definite state-dependent properties such as position and momentum, then swapping or permuting the positions of any two particles would constitute a change in state. This is reflected in the traditional (Maxwell-Boltzmann) statistics, where, as Chakravartty (2003: 869) puts it, "different permutations of objects are recognized as distinct arrangements." That is, given two boxes, with otherwise qualitatively indistinguishable particles in each, switching which particle is in which box counts as two distinct states. However, in quantum statistics, switching (permuting) the particles does not count as two distinct states, but as only one state. In the quantum arrangement, then, there is no fact about which particle has which state-dependent properties. And it was only on the basis of having nonidentical state-dependent properties that otherwise qualitatively indistinguishable particles could be counted as distinct from one another; consequently, these two particles are not intrinsically distinct, as far as quantum statistics is concerned.[108] This has suggested to many that if there is a principle of individuation that distinguishes the two particles, it transcends QM and any empirical observation (French 1989, 1998). But as far as quantum mechanics is concerned, there is no intrinsic individuality, and so no possibility of a lonely particle.

Secondly, but relatedly, quantum entanglement undermines the possibility of a lonely object. Esfeld (2003) asserts that "whatever entanglement may be, it is a relation among quantum

[108] As Ladyman and Ross (2007: 134) put it: "According to the formalism of QM, the permutation of indistinguishable particles in some state is not observable, and states which differ only with respect to the permutation of particles of the same kind are treated as the same state labeled differently."

systems. 'Being entangled with' is a property that is predicated of at least two quantum systems; it is thus a relational property" (p. 7). He continues "the question is whether it is possible within quantum theory to admit the existence of intrinsic properties that constitute a supervenience basis for the correlations [between entangled systems]" (ibid).

Because "entanglement concerns only the state-dependent properties of quantum systems, such as position, momentum, and spin angular momentum in any direction", (Esfeld 2003: 9) one might think that state-independent properties such as mass and charge might nonetheless be intrinsic properties. As Esfeld and Lam (2005) recognize, "state-independent fundamental features of quantum (field) systems, such as (rest) mass, charge, spin, etc. seem to be good candidates for intrinsic properties." But, "they are, however, of no help in individuating entangled quantum (field) systems" (p. 14). This is so because, as Ladyman and Ross (2007) argue, even

> "if the state-independent properties of QM are genuinely intrinsic rather than emergent from some further structure (and that seems unlikely), the fact that particles in entangled states may have all the same properties and relations as each other means that they cannot be individuated by such intrinsic properties" (p. 152, note 44).

So, entangled particles are not individuated prior to the entanglement relation, even if one is considering state-independent properties to be intrinsic. And if they are not self-individuated, they cannot be lonely. Hence there is no possibility of loneliness here that can undermine that the physical properties are extrinsic.

What of the claim, though, that state-independent properties might be intrinsic? As I argued in §3.4.3, this is not the case. But in this context, there is another argument for this conclusion (contra French and Krause 2006). That an object cannot be pulled apart from its relations implies that it cannot be lonely. If there can be no lonely objects, no properties can count as intrinsic. Or, put another way, the notion of intrinsicality presupposes a bounded, self-

subsistent individual. Asserting that x has F intrinsically iff F's instantiation is compatible with x's loneliness presupposes there's such a thing as x, with boundaries, such that the line separating x from everything else is real. If there is no such boundary, and x leaks into the rest of the universe, so to speak, x cannot exist as a lonely object. So, if individuation doesn't come via state-dependent properties, such that individuality is posterior to these relations, as the above argument maintains, then there are no self-subsistent individuals to have state-independent properties intrinsically to begin with.

3.4.6: Surely a relational world is incoherent

In defending structural realism – the view, mentioned earlier, that all that exists is relational structure – Ladyman (2007) notes it is common for philosophers to object on the basis of the view being incoherent, for, as it is often insisted, relations require relata, and, as such, structures must be structures *of* objects. Relationalism, then, which denies any intrinsic properties, either denies the existence of objects, or else denies the existence of objects with intrinsic properties. But, the objection goes, this is unintelligible or incoherent.

Response:

Firstly, SR comes in a variety of strengths, and not all deny objects. In response to objection that there must be objects, Esfeld proposes a Moderate (as opposed to radical) Structural Realism. On the moderate variety, objects exist – because relations require relata, Esfeld asserts – but these objects are exhausted by the relations in which they enter; they do not have intrinsic properties, and they have no identity independently of these relations. For some, this is as incoherent as the denial of objects, though Gareth Evans (1980: 102), for one, calls the

belief that the bearer of relational properties can't be exhausted by them merely a "deep conceptual prejudice".[109]

Secondly, there is again an implicit reliance on revisionary metaphysics here. In brief, the objection here looks like this:

i) There being only extrinsic properties is unintelligible

ii) Therefore, physics must not posit only extrinsic properties

But one might derive a different conclusion.

i) There being only extrinsic properties is unintelligible

ii') Therefore, there must be more properties than the extrinsic properties physics posits.

These arguments differ implicitly on physicalism, and on the (defeasible) status of intelligibility. If physicalism is true, then the fundamental physical properties exhaust the fundamental properties, whatever their ontological category. The physicalist, then, will be tempted to insist either that what physics posits is a coherent or intelligible ontology, or else intelligibility is either irrelevant to truth, or not an inviolable principle. If so, the physicalist response may look more like this:

I) Physics posits only extrinsic properties

II) Physics is the authority on matters of ontology

III) Therefore, *a priori* principles of intelligibility are irrelevant to evaluating the existence claims of physics.

Rather than try to resolve this impasse, I merely appeal to the contrast between a revisionary and descriptive account. Perceiving a lack in a system, in this case a failure to live up to traditional standards of intelligibility, and then revising what a descriptive account of physics warrants in order to "produce a better structure" is the essence of revisionary metaphysics. If intelligibility is

[109] Quoted in Langton (2004: 132)

a reason to reject Relationalism, it is not a reason to argue that physics does not support Relationalism. A revisionary account attempts to replace the descriptive ontology, not clarify it.

3.4.7: Even a relational world requires individuation

Chakravartty (2003) argues that some account of individuation is required even in a relational world. After all, he points out, one must have an account of what it is for an individual instance of a relation or relational property to be an individual.

Response:

Esfeld and Lam's (2005) response to this sort of objection is successful. Esfeld and Lam compare Relationalism to semantic holism (inferential role semantics). In a web of belief, beliefs are "points in a web that are individuated by their position in the web, that is, by their relations to other beliefs… [such that] no two beliefs stand in exactly the same relations to all the other beliefs in the web" (p. 5). So, although no belief has intrinsic content, but instead derives its content from its place in the structure, that no two beliefs have all the same relations to the entire structure implies the possibility of individuation without intrinsic individuation. The very possibility of this applying to a relational physical world, which Esfeld and Lam argue is plausible, undermines the *a priori* objection that such a world is incoherent.

3.4.8: Causal dependence is not metaphysical dependence

Lowe (2003: 79) argues that although it is not 'causally possible' for an individual organism to be an isolated existent, it is nonetheless 'metaphysically possible'.[110] And Seager, in a similar vein, claims that "that fact that I need oxygen to survive will not prevent me from

[110] Quoted in Ladyman and Ross (2007, 13)

having intrinsic properties" (2006: 141), i.e. that fact that Seager is causally dependent on an atmosphere (ambient conditions) does not mean he could not exist alone, with intrinsic properties.

Response:

My arguments in §3.2.2 block this objection. There, I argued that what is logically impossible is *ipso facto* metaphysically impossible, and that the space of logical impossibility is governed by definitions. So, if a given property is defined by physics, then physical impossibility implies logical impossibility, which implies metaphysical impossibility. It follows that if the definition of physical predicates imply that that properties are extrinsic, and so logically dependent on distinct existences, then it is not metaphysically possible for a lonely object to instantiate such a property. Therefore, in order to make the distinction between physical and metaphysical independence, one must presuppose that properties are not defined by physics or by their causal role. This is highly implausible when it comes to the fundamental properties of physics. For the fundamental physical properties, then, no distinction between causal or physical independence and metaphysical independence can stand.

3.4.9: Relational concepts, intrinsic properties

Earlier I quoted Jackson (1998) in support of the Argument from Doing (§3.3.1.3). But, it turns out, Jackson doesn't actually support this argument. I left that part out. Here is that same passage, more fully.

"When physicists tell us about the properties they take to be fundamental, they tell us what these properties *do*. This is no accident. We know about what things are like essentially through the way they impinge on us and our measuring instruments. It does not follow from this that the fundamental properties of current physics, or of 'completed' physics, are causal cum relational

ones… [For the fundamental properties might have] relational names but intrinsic essences… [However], this leads to the uncomfortable idea that we may know next to nothing about the intrinsic nature of the world. We know only its causal-cum-relational nature" (1998: 23-24).

In other words, Jackson suggests that even though the *concepts* of physics are relational, the *properties* themselves may be intrinsic. But this revision of appearances is an imposition of revisionary metaphysics onto the posits of physics; to call these apparently extrinsic properties intrinsic properties with relational names is to reinterpret what is literally given by physics. The crucial question here is: What motivates the reinterpretation? What is it about the way physics appears to do things that is insufficient or unsatisfactory? Recall earlier when I quoted Jackson in support of the argument from doing, I also quoted Armstrong, who wrote that physical properties "show a distressing tendency to dissolve into relations that one object has to another." Well, it is only on the supposition that physics positing only relations is inadequate –or "distressing" – that one would be motivated to reinterpret the *prima facie* appearance of the fundamental properties being relational. That is, what motivates the belief that positing only relations is inadequate or "distressing" is the belief that there "must" be an intrinsic nature of the world, and, as such, it is the job of physics to posit intrinsic properties. But this strategy for discerning the posits of physics has been ruled out by my previous arguments. For even if there "must" be an intrinsic nature of the world, that simply does not entail that it is physics' job to posit such properties, nor that the properties physics does posit must therefore be interpreted as intrinsic. As we've seen, Kant and Leibniz reject physicalism due to their belief that there must be an intrinsic nature of the world, not revise what they think physics posits.

Because Jackson's argument is tempting, though, it is worth looking at a similar version to flesh out this response. Foster (1982: 67, 87) distinguishes between knowing a property "opaquely" and "transparently". He gives the following example. Describing the shape on a

paper (inside a sealed envelope) as a triangle is a transparent rendering of the shape. Saying that the shape on the paper inside the sealed envelope is the "type of figure whose properties are discussed in the 4th chapter of the only leather-bound book in Smith's library" is opaque. The first description reveals the property as intrinsic, the second does not. The first describes a thing in terms of its nature, apart from other things, the second describes it in terms of other things- yet, one may claim, these are same property.[111] Putting this to bear on Jackson's point, the idea is that the description physics gives are not transparent, but opaque. The properties would be intrinsic, this objection goes, but we would have no transparent or intrinsic description of it, only one where the intrinsic property was relationally, i.e. opaquely, specified or known.

But this move is plausible only on the assumption that an intrinsic specification is even possible. As discussed, the surface grammar of shape-predicates such as 'is a triangle' are monadic. But, as discussed, it is controversial whether shapes are themselves intrinsic properties. Further, for a property that is unarguably extrinsic, it is not clear what would even count as transparent description in terms of a(n intrinsic) nature: what would count as an transparent, intrinsic description of the *is the uncle of* relation? It may be that complex extrinsic property such as *is smart for a thing of type x* has an intrinsic component such as 'is able to perform certain computations', or *is a male human* in the case of *is the uncle of*. But the fundamental properties of physics are not complex; they are fundamental, and so simple properties. They do not have components. In short, there can be no intrinsic component, and there is no candidate for a transparent description. Therefore, despite being relational, the descriptions of physical properties in terms of what they do is nonetheless transparent, as that is all there is to such properties. Besides, as discussed above, pushing the line that the properties are intrinsic – despite appearances – is clearly motivated by revisionary metaphysics, and must be disqualified.

[111] Or so Allais (2006: 159) claims, though see Langton (2006) for an objection.

3.4.10: Fundamental physical properties are intrinsic dispositions

Several philosophers have used variations of the arguments from doing and lawfully defined properties to argue that the fundamental physical properties are intrinsic dispositional properties, rather than extrinsic properties. Though such philosophers may grant that dispositional properties look extrinsic, insofar as they are defined relationally,[112] nonetheless it is claimed that such dispositions are intrinsic properties.

Response:

In responding to this view, I will focus on the arguments of Bird (2007) and Ellis (2001, 2002), who have presented book-length arguments for a cluster of metaphysical notions centered on the thesis that the fundamental physical properties are dispositions, and intrinsic ones at that.[113] In these authors, the metaphysics of dispositions, as they relate to fundamental physical properties, is the most worked out.

Despite professing that the fundamental physical properties are intrinsic, however, I contend that Bird and Ellis are not entitled to consider such properties intrinsic. To the extent that they rely on versions of the argument from lawfully defined properties in particular, they are committed to the extrinsicality of the fundamental properties.

To see this, then, one must look at their metaphysical systems. Bird argues for what he calls "Dispositional Monism": the view that "all sparse, fundamental properties have dispositional essences" (p. 45). Ellis argues for a similar view, claiming that "with few, if any, exceptions, the fundamental properties of physical theory are all dispositional properties" (2002:

[112] For claims that the ascription of powers include references to distinct existences, see Ellis and Lierse (1994: 33); Martin (1994), Prior, Pargetter and Jackson (1982); Smith (1997: 445)

[113] Several other philosophers have argued that science can only discover dispositional properties, though. See Blackburn (1990) Robinson (1982: 109), Smart (1963: 72), Strawson (1980: 280), Jackson (1998: 23-4).

47). Each gives examples. According to Bird, for the property of negative charge, the "essence would be the disposition to repel other negative charges and attract positive ones" (p. 45). Similarly, "the inertial mass m just is the disposition to accelerate at rate F/m in response to impressed force F" (p. 100).

Notice, though, that this makes dispositions at least look extrinsic, as each property has an essence defined by distinct entities; negative charge is defined in relation to other negative and positive charges, and mass is defined in relation to an external force. Bird does not deny this. In fact, he claims he is following Shoemaker (1980), Swoyer (1982), and Ellis (2001, 2002) when he writes "The essential nature of a property is given by its *relations* with other properties. It wouldn't *be* that property unless it engaged in those relations" (p. 2, my emphasis), and that dispositions "involve properties other than themselves" (p. 6). Bird also claims that "if properties have a dispositional essence then certain *relations* will hold of necessity between the relevant universals" (p. 43, my emphasis). Ellis also uses the language of relations:

> "The world is not an agglomeration of logically independent states of affairs or self-contained atoms of any other kind. The world consists ultimately of things that have their causal powers essentially that determine what they can, must, or cannot do in *relation* to other things" (2001: 5, my emphasis).

In short, Ellis and Bird both argue that the essence of a disposition D is its relations and interactions with other properties $Q_1 \ldots Q_n$. Assuming a thing's essence is its real definition, such that a linguistic definition is a description of an entity's essential properties, it follows that for Bird and Ellis, a property's identity is defined by its relations. Bird clearly assents: "The essential nature of a property is given by *its relations with other properties*. It wouldn't be that property unless it engaged in those relations" (p. 2, my emphasis).

This, in so many words, is a variety of the argument from lawfully defined properties, which I contend shows that physical properties are extrinsic. For if a property is defined by its

relation to other properties (that are instantiated by distinct individuals or entities)[114], then it follows that such a property cannot be instantiated independently of the existence of distinct objects instantiating the distinct but essentially related property. Although Ellis and Bird insist that dispositions are intrinsic, then, it is not clear that they are entitled to this belief.

Their view on laws – which dispositional monism (or dispositional essentialism) is intended to support – makes the situation worse for the view that the dispositions are intrinsic. Ellis contends that "The laws of nature are explications of the essential properties of the natural kinds" (2002: 85), where these essential properties are dispositional properties. Bird contends that "the laws spring from within the properties themselves" (p. 2), (and in this he is following Shoemaker 1980, Swoyer 1982, and Ellis 2001, 2002).[115] This is so, Bird argues, because "if properties have a dispositional essence then certain relations will hold of necessity between the relevant universals; these relations we may identify with the laws of nature" (p. 43). In short, this is the basic argument for law necessitarianism; that in any world where a given property exists, the laws relating that property to other properties also obtains. On this basis, Ellis and Bird argue for

> **law necessitarianism**: The properties $Q_1 \ldots Q_n$ which are nomically related to property P at a world W_1 are necessarily related, such that any world W_n that contains property P also contains properties $Q_1 \ldots Q_n$ standing in the same (or similar) relations to P as they

[114] That there are necessary connections between, say, shape and size does not entail these properties are extrinsic, because both properties are instantiated by the same individual. What makes the property extrinsic is if the necessary relation is between (wholly) distinct relata, as I contend is the case with the physical properties in question.

[115] Although Bird sees himself as following Ellis, they do seem to differ on whether laws are linguistic or ontological items: Ellis contends that "laws of nature are not things in the world, but are general propositions descriptive of the kinds of natural necessities that exist in it" (Ellis 2006: 439). But this difference does not affect my argument here; for the shared view on properties that underlies the view on laws is what is relevant.

do at W_1, i.e. any world in which P is instantiated is a world in which the law relating P and $Q_1 \ldots Q_n$ obtains.

Hume's dictum is that "There is no object which implies the existence of any other if we consider these objects in themselves" (1739-40/ 1978: book I, part 3, section VI). This dictum expresses the belief in a lonely object: if no object implies the existence of any other object, then it is (logically) possible for any given object to exist alone at a world. But, according to law-necessitarianism, since any world that contains P also contains properties $Q_1 \ldots Q_n$, and assuming at least some of these are instantiated by individuals distinct from that which instantiates P, then it is not possible for a lonely object to have P, for another object instantiating $Q_1 \ldots Q_n$ is required for P to exist as well. Because instantiating P is incompatible with loneliness, it is extrinsic.[116]

Yet, as indicated, Bird and Ellis both insist that dispositions are intrinsic.[117] This claim rests in large part on the notion that a disposition has something to do with potentiality (and to capture this, Bird in fact calls dispositions 'potencies)'. More specifically, the claim is that the

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[116] Look at this another way. Law necessitarianism explicitly affirms necessary connections; Ellis and Bird are stridently anti-Humean, explicitly denying Hume's dictum that there are no necessary connections between distinct existences. Now, if there are no necessary connections, then it appears that an object could exist alone, as it is not necessarily connected to other objects. But if properties of distinct individuals are necessarily related to each other, then, it appears, such properties cannot be instantiated by lonely objects.

[117] A few caveats are required here. First, Ellis rejects the "logical notion" of intrinsicality based on loneliness. Instead, he proposes an entirely different standard of intrinsicality, based on causal independence. As I discuss in §3.4.3, though, this notion has its own problems, and, I contend, does not suffice for intrinsicality. Nonetheless, I am concerned here with the traditional conception of intrinsicality, regardless of Ellis' use for the notion. Second, and regarding Bird, I should note that Bird is rather glib about the subject of dispositions being intrinsic, and seems uninterested in it. So my arguments on his behalf are more reconstructed than directly taken from his text. Over the course of his entire book, Bird only briefly mentions the different competing analyses of intrinsicality, doesn't reject any in particular, and then suggests that the Langton and Lewis notion –even including the lawlessness criterion, apparently – is acceptable (p. 167). Elsewhere, briefly entertaining the subject, Bird concedes that "it is true that in special relativity, mass is extrinsic, but then the explanatory property is rest mass, which is intrinsic." He continues: "*No-one has suggested that charge, rest mass, and spin are not intrinsic* [my emphasis] such that he feels safe in concluding that "extrinsic dispositions are reducible to fundamental potencies that are intrinsic" (p. 125). But many have suggested that the fundamental properties are not intrinsic (see §3.1). And Bird gives no argument here; he simply dismisses the charge, and asserts that these properties are intrinsic.

necessary relation that a given property P bears to a distinct property Q is one of potentiality, rather than actuality. So, for a property P to have a dispositional essence including the property Q is for an object with P to have the potential to interact in a characteristic way with a distinct object with property Q. But, it is claimed, that distinct object with property Q need not *actually* exist for P to be instantiated. What it is to have P, it is claimed, is to have the disposition to interact with Q were an object with Q to exist. But, this distinct existent need not actually exist, it is claimed, for an object to have P. As such, an object with P could exist alone at a world, and therefore the dispositional property P is intrinsic. In sum, the move from the apparent relationality of physical properties to their intrinsicality relies on the potentiality, rather than actuality, of a given property's necessarily relations being instantiated.

But this move fails. For it confuses the *instantiation* of a dispositional property with the *manifestation* of a property. And in so doing, it confuses what the relata of the necessary relation is. To see this, consider the following. It is often said that a glass vase is fragile even when it is not breaking. If true, a glass vase instantiates the dispositional property *fragility* even when its fragility is not manifesting. More generally, objects don't have or instantiate dispositions *potentially*, they have or instantiate them *actually*. What is potential is manifesting the disposition, not having or instantiating it. That is, what is potential here is an event, i.e. an interaction, such as a ball shattering the glass vase. What is actual, despite such an interactive event being merely possible, is the instantiation of the dispositional property such as *being fragile*.

Now, one might want to claim that in this example, even the disposition *fragility* is not actual unless it manifested in an interactive event. If so, one would claim that what was actually instantiated was a categorical property (or some other occurrent property) which is taken to

underlie or ground the disposition which is said to only actually exist upon its manifestation, i.e. upon an interactive event. Regardless of the merits of this move in general, though, it is not available for Bird and Ellis, for whom the fundamental properties are ungrounded dispositions. So, for Bird and Ellis, because something in their ontology must be actual and not merely potential, and since there are no categorical properties, the only candidate for actuality is the disposition itself. So, for Bird and Ellis, an object must instantiate a fundamental disposition even if no interactive event in which the disposition is manifested ever occurs. That is, for a world of fundamental dispositions to be a world that does not suffer from "too little actuality", as Bird characterizes Armstrong's objection to his view, the dispositions must be actual, even when not manifesting.[118] To be clear: a) an object actually but not potentially *instantiates* the fundamental disposition, even if b) it only potentially but not actually *manifests* the disposition in an interactive event.

An interactive event, I assume, is localized in space and time; when the ball shatters the vase, it does so in a particular location (in space and time.) Presumably, such an interaction depends on the spatiotemporal position of the objects involved, and, presumably, state-dependent properties such as location are contingent, and not necessary. So, it follows, there is a contingent relation between the instantiation of a given dispositional property and the (spatiotemporal) occurrence of its manifestation. That is, there is a contingent relation between the instantiated disposition and the circumstances in which an interactive event occurs that manifests it.

This is not an argument, however, against law-necessitarianism. The law-necessitarian does not dispute that *this* relation is contingent; the law-necessitarian does not hold that a particular interactive event such as a ball shattering a glass is a necessary occurrence. What is

[118] Bird writes: "even if properties are what they do, a propertied entity does not have to be doing things at all times; it has merely to be capable of doing them. So the intimate link between laws and properties suggests that properties should be considered dispositions" (p. vii).

necessary on this view are the relations between the properties themselves- not the spatiotemporal conditions of their manifestation. That is, what is necessary is that a given property is constituted by, or has the essence of, standing in a (nomological) relation to other properties.[119] Put another way, what is necessary is that the property has the identity or essence it has, where its identity is not independent of these nomological relations. Instead, its essence is to stand in just those nomological relations. And again, this has nothing to do with the spatiotemporal or state-dependent properties in virtue of which a particular, localized manifestation or interaction-event occurs.

If the fundamental dispositional properties are intrinsic, as Bird claims, then such a property can be *instantiated* at a world in which its possessor is lonely. Assuming for the moment that such a world is possible, it is obvious that in such a world, the contingent spatiotemporal relations that are required for a particular interactive event in which the disposition is manifested do not obtain. So, one might think that this shows dispositions are intrinsic, i.e. that there is (or can be) a world in which a lonely object has this disposition. But that doesn't follow. What this example shows is only that the spatiotemporal or state-dependent properties in virtue of which a particular, localized manifestation or interaction-event occurs are contingently related to the disposition. That is, this example only shows that an object may exist in a world in which other objects don't exist in a place or time that will lead them to interact, thereby *manifesting* their dispositions. But this does not suffice to show a property to be intrinsic. For the property to be intrinsic, it is not enough that the property need never *manifest* at a world in which its possessor is (thought to be) lonely, the property has to be *instantiated* at a world in which its possessor is lonely. And that is a completely different issue.

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[119] As Bird put it- and quoted above- the relation is between the "relevant universals", not between particular spatiotemporal events.

The question, then, is can a property be *instantiated* by a lonely object? As I've argued, this is to be answered by appealing to the definition of the property. Given that Bird, Ellis, and myself agree with the argument from lawfully defined properties, the question turns on whether a given property is defined by its actual relations to other properties, such that it is extrinsic, or the potential relations to other properties, in which case the property appears intrinsic. But, as I've argued, the property cannot be potentially related to other properties. It can only be potentially related to manifestations. The contingent relationship here is not between properties, but between interaction-events or manifestations. Negative charge is necessarily related to positive charge, but only contingently related to the event of a particular charged particle interacting with another particular charged particle. The property is defined by that to which it stands in a necessary relation, not by that to which it stands in a contingent relation.

So, it follows that insofar as property P and property Q are necessarily related but cannot be instantiated by the same object, i.e. the same object can't both be negatively and positively charged, then it follows that for negative charge to be instantiated, positive charge must also be instantiated. This implies that an object instantiating negative charge cannot exist alone. Instead, there must be another object with positive charge (if indeed the law requires it). Therefore, properties with dispositional essences are extrinsic properties. So despite professions to the contrary, the world presented by Bird and Ellis – a world which bottoms out in dispositions – is a world with extrinsic fundamental properties.

3.4.11: Surely there are categorical properties

My arguments that dispositions are extrinsic relies on a property being defined by what it does, i.e. by its nomological role. This is the view adopted by Ellis and Bird in favor of law-

necessitarianism, as we've seen. They also deny that there are categorical properties underlying the dispositions- instead, the dispositions are taken as fundamental. But, perhaps, this view can be rejected, thereby saving the intrinsicality of the fundamental properties. That is, perhaps there are categorical properties that are intrinsic, rather than there being only dispositional or extrinsic properties.

There are two different objections underlying this line of thought. First, one might claim that the very properties that physics actually posits, such as mass and charge, are themselves categorical properties, and are therefore intrinsic. Second, one might concede that the actual properties that physics posits are dispositional or extrinsic properties, but physics ought to add distinct categorical properties to its ontology in order to underlie or ground the extrinsic or dispositional properties such as mass and charge.

3.4.11.1: The current fundamental properties are categorical

Response:

That the fundamental physical properties are themselves categorical has already been refuted. Consider Blackburn (1990)'s argument in a passage so oft-cited that it is often referred to as an oft-cited passage:

"When we think of categorical grounds, we are apt to think of a spatial configuration of things- hard, massy, shaped things resisting penetration and displacement by others of their kind. But the categorical credentials of any item in this list are poor. Resistance is par excellence dispositional; extension is only of use, as Leibniz insisted, if there is some other property who instancing defines the boundaries; hardness goes with resistance, and mass is knowable only by its dynamical effects… the magnitude of a field at a region is known only through its effect on other things in spatial relations to that region… Science finds only dispositional properties all the way down" (p. 62-3).

And, as indicated, Bird and Ellis argue at book-length for this thesis; that the fundamental properties are dispositional, in the Blackburn mode, and not categorical. I take these sorts of arguments as successful.

Despite this, though, there is also the sort of view offered by Chalmers (1996b), who argues that even though the physical concepts have their reference fixed by some dispositional role, they refer to an underlying categorical property. First, the Blackburn-style argument, as developed by Ellis and Bird, are about the properties themselves, not just their concepts. To the extent they are successful, the Chalmers-type view is blocked. But, that aside, the Chalmers view is also blocked by my previous arguments in §3.4.9; the claim that the properties are dispositionally or relationally described but are actually intrinsic properties, is revisionary, not descriptive. The only motivation for this revision, I contend, is the *a priori* assumption that intrinsic properties need to be saved. As I've already discussed this, I'll move on.

3.4.11.2: Physicists should add categorical properties to their current ontology [120]

First response:

The first thing to note about this objection is that it declares physics incomplete not on empirical grounds, but on *a priori* grounds. That is, it assumes that physics has the job of discerning the intrinsic categorical properties, and so reasons that insofar as physics has not done that, physics is incomplete. But it does not point to particular phenomena of which current physics gives an incomplete treatment.

One might object to this characterization, though, and consider the positing of categorical grounds not the result of *a priori* reasoning, but as a more empirically grounded inference to the best explanation. That is, one might contend that an inference to the best explanation is a

[120] Stoljar (2001a) suggests as much.

perfectly acceptable part of physics (rather than metaphysics), and that such an inference justifies positing categorical grounds.

But this move does not succeed. For what is the work that categorical grounds are supposed to do? Grounding is not a causal relation, presumably. Regardless, though, if my previous arguments are right, causal properties are "doing" properties, defined by their nomological role. This implies that categorical properties cannot have a causal role. Put another way, why is it that mass and charge fail to be categorical? If it is because they are defined by their causal role, then any property so defined fails to be categorical. Consequently, the categorical ground must not be a causal property. But how, then, does a categorical property explain, if not by being causally responsible for the explananda? And if positing them does not explain at all, then *a fortiori* such properties are hardly the best explanation of anything.

As Blackburn indicated, categorical properties are often identified with "the spatial configuration of things" such as shape or size or solidity. The traditional idea is that an object has its powers in virtue of the spatial configuration or structure of its parts (and the laws of nature). And this 'in virtue of' relation is not itself causal, yet, nonetheless explanatory. But is this model *a priori* true? Might not spatial properties emerge from more fundamental nonspatial properties? This is the case that Leibniz and Kant make (§3.1), and, more recently, Ellis makes (2002: 68-70); Ellis argues that the fundamental properties are dispositions, and that what appear as categorical properties (or spatial configuration properties) are emergent from them. Assuming this possibility coherent – and I believe Ellis has shown that, if not Leibniz before him – one cannot simply assert on an *a priori* basis that there must be categorical grounds, such that physics should keep looking.

Second response:

There might be another route to physics positing intrinsic grounds, however. Suppose one contended that because relations require intrinsic grounds (assuming for argument's sake this is so), there being relations entails that there be intrinsic grounds, and physics is thereby ontologically committed to anything entailed by that which it posits.[121]

This argument is more appealing in the abstract than in the concrete, however. On the assumption that the paradigmatic properties that physics posits (such as mass, charge, spin, etc.) are causal-relational properties, this implies that these particular properties are not the categorical grounds that physics is looking for. What, then, is an example of a fundamental noncausal categorical ground that physics does in fact posit? It does not appear there are any. And what is an example of an intrinsic property entailed by the existence of relational properties such as mass and charge? As Ney (2007: 54) points out in a response to a similar argument, no particular relational property entails the existence of any particular categorical property, except, perhaps, the cipher property 'that which grounds a particular relational property.' But, as a cipher, this property has no real physical content. And so there is no reason to think that physics is committed to such properties.

3.5: Conclusion and Historical Postscript

I started this chapter by discussing Leibniz and Kant in a historical preamble, and I will conclude it with a postscript inspired by Spinoza and Hume.

In his *Ethics*, Spinoza defines 'substance' as follows: "By substance I understand what is in itself and is conceived through itself, that is, that whose concept does not require the concept of another thing, from which it must be formed." The basic idea expressed in this chapter is that

[121] Ney (2007: 54) considers such an argument.

it is of the nature of physical properties to radically fail this criterion for substance. As I've argued by appealing to definition, the very concept of a physical property requires other properties; physical properties cannot be understood "through themselves", but instead "require the concept of another thing" in order to be understood. Unlike Spinozistic (and Aristotelian) substance, physical properties are not independent of each other. Their natures invoke other properties – their essences are "other-involving" – and so they cannot exist without those other properties. And this makes them extrinsic.

As quoted above, Hume's dictum is that "There is no object which implies the existence of any other if we consider these objects in themselves". This may be true for substances, but, I contend, this is precisely what fails for physical properties. For considering a fundamental physical property "in itself" *is* to consider other properties, as I hope to have demonstrated. In sum, the big picture as I see it, is that mathematical physics posits a relational system whereby each thing is understood not through itself but through other properties (and, in the last resort, perhaps, through *every* other fundamental physical property via a unified "theory of everything").

So, to conclude: the fundamental physical properties are extrinsic. As argued in chapter one, physicalism is the view that everything is determined by the posits of fundamental physics. As argued in chapter two, properties, not substance-kinds, are the posits of fundamental physics. Therefore, whatever is not determined by the fundamental extrinsic properties of physics is not compatible with a physicalist ontology.

Chapter 4: Physicalism, Substantial Identity, Underdetermination, and Elimination

4.0: Introduction

In chapter 1, I argued that a physicalist ontology may only include the fundamental posits of physics and what is determined by those posits. In chapter 2, I argued that substantial identities, including the intrinsic persistence conditions entailed by such identities, are not physically fundamental. It follows that in order for objects with intrinsic substantial identities to be included in a physicalist ontology, these identities, including the persistence conditions that follow from these, must be determined by the fundamental physical entities. In this chapter, however, I argue they are not: instead, I argue they are underdetermined. I thereby conclude that the existence of objects with intrinsic identities as instances of substantial kinds is incompatible with physicalism. The physicalist, therefore, must jettison these from her ontology.

First, though, a brief word on the terminology employed in this chapter is necessary. Analogously to the word 'general' being derived from 'genus', Locke derived the term 'sortal' from 'sort' (*Essay*, Bk.3, Ch.3, 15). Locke coined this term in the context of discussing the idea of an individual belonging to a substantial kind, in the Aristotelian or Scholastic sense. In this chapter, I will use the phrases 'sortal identity' and 'sortal properties' to mean (more or less) what I meant in chapter 2 by 'substantial identity' and 'features constitutive of a substantial identity', where the latter includes persistence conditions. This switch is motivated by the fact that the contemporary literature with which I am concerned in this chapter uses the term 'sortal', and not the terms I employed in chapter 2. So in one sense, this is merely a terminological convenience. However, that this also constitutes something philosophically significant is something I will address at the conclusion of the chapter.

4.1. Sortal terms and sortal properties

A *prima facie* difficulty presents itself: the thesis of this chapter may seem to conflict with another claim I made in Chapter 2. There, I posed a Euthyphro question regarding substantial (or sortal) identity. In light of that question, I argued that for the physicalist, something is an electron in virtue of possessing a certain mass, charge, and spin, rather than vice versa. I thereby inferred that substantial identities are not fundamental for the physicalist. Nonetheless, if something is an electron *in virtue of* such properties, then it appears that something's identity as an electron is *determined by* those properties.

But this is mere appearance. For even if properties such as mass, charge and spin determine the application of substantial or sortal *terms* such as 'electron', they do not determine genuinely sortal *identities* or *properties*, as it were. The difference between these, then, is integral for the claim I am defending.

Of course, one might be skeptical that there is any difference between these. For one might suppose that there is nothing more to being an electron than just possessing those very properties. But there is something more. For substantial identities do (metaphysical) work in addition to what the properties such as mass, charge and spin do, as we shall see summarily. And it is this additional work that creates the conceptual space to distinguish the conditions (taken to be) sufficient for the application of a sortal term from the conditions sufficient for the existence of genuinely sortal properties. But, I will argue, even if the existence of a certain mass, charge, and spin warrants applying the term 'electron', the existence of these properties is not sufficient for the existence of the further metaphysical properties constitutive of a sortal identity.

4.2: Sortals and nonsortal properties

So of course it is essential to see that sortal identities or properties have several features that distinguish them from non-sortal properties. As Grandy (2007) summarizes, a sortal

1. gives a criterion for counting the items of that kind
2. gives a criterion of identity and non-identity among items of that kind
3. gives a criterion for the continued existence of an item of that kind
4. answers the question "what is it?" for things of that kind
5. specifies the essence of things of that kind
6. does not apply to parts of things of that kind

Working from the bottom up (i.e. from point 6), if *tiger* and *electron* are sortals,[122] then parts of tigers are not tigers, and parts of electrons (if they have parts) are not electrons. By contrast, the parts of something with mass, charge, and spin may possess mass, charge, and spin.[123] Next, if *tiger* and *electron* are sortals, then the claim that something is a tiger or an electron specifies the essences of those things (point 5). By contrast, the claim that something has a certain mass, or a certain color, or is soluble, does not specify the essence of something. Now, one might object that such properties could be essential properties. However, if what counts as the essence of something is constrained by a criterion along the lines of point 4 (i.e. that a sortal answers the 'what is it?' question), then such properties are clearly nonsortal properties, even if they have some claim to being essential (on some conceptions of essence).[124] Put another way, *electron* and *tiger* are better candidates for an answer to the *what is it?* question than *charged thing* or *striped thing*, for instance.[125] Point 3 – giving a criterion of continued existence – is closely related to

[122] Whether 'sortal' refers to terms, concepts, or properties is often ambiguous. My default use of the term is to refer to ontological items, viz. properties. Otherwise, I use 'sortal term'.
[123] For some properties, of course, the parts may not have the same quantity as the whole. But this just points to further differences between physical magnitudes which may differ along a quantitative scale, and sortal properties, which are binary, i.e. either/or, or all or nothing.
[124] See Oderberg (2007) for differences between what he calls "hidden structure" essentialism, along the lines of Kripke and Putnam, and the more traditional Aristotelian conception. See also Fine (1995).
[125] The is some ambiguity about the how to go about answering the 'what is it?' question, and whether there is such a thing as the metaphysically best answer to it. But the usage is traditional, dating back to

this point regarding essence. For sortal properties are intimately related to something's persistence conditions, and hence mark the distinction between alterations and substantial changes, i.e. those changes that something may or may not survive. So, if a tiger may alter its color, size, shape, or mass, but still exist, then such changes are accidental, and such properties are not sortal properties, or constituents of a sortal identity. But if a tiger ceases to exist upon losing the property of being a tiger, then *being a tiger* is a sortal – and so essential – property. Lastly, and putting points 1 and 2 together, sortal properties provide criteria for counting and identity.[126] So, for instance, one can count the number of tigers or electrons. But one cannot count red things or striped things or massy things or charged things, as some or every part of a red, striped, massy, or charged thing may itself be red, striped, massy or charged, the result of which would be an indeterminate count. And though not explicitly mentioned on Grandy's list, closely related to these notions of counting and identity are the notions of wholeness or unity. So, although something may consist of several parts or properties, something is a unified whole, i.e. *one* tiger, or *one* electron, only relative to a sortal. The sortal's unifying feature is thus that which makes several properties or parts the properties or parts of one (countable) instance of a kind.[127]

Because a sortal identity has these features in addition to whatever features are possessed by nonsortal properties (however closely associated with a sortal identity they are), a sortal

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Aristotle and largely revived by Wiggins (2001/1980). For my purposes, the use is relatively unproblematic.

[126] Though see Lowe (1998) for an arguments that these criteria might be best treated separately, in light of the problems of identity and individuation of quantum particles. See also Krause and French (2005) on quantum sortal predicates.

[127] There's an open question about priority vis-à-vis sortal and modal properties: are objects of a sort because they have certain modal properties, or do they have their modal properties because they are of the sort? I think sortal properties are prior. However, nothing really turns on it this claim, so I won't defend it. In discussing issues related to these, Bennett (2004) also wishes to avoid this question of priority, and simply uses the umbrella term 'sortalish' to indiscriminately refer to both sortal and modal properties. I won't use this somewhat uncouth phrase; I will stick to 'sortal', to encompass both. But this is for convenience; 'sortalish' could be used, as could 'modal', if one holds the opposite priority thesis.

identity cannot simply *be* the conjunction of those properties; the sortal identity is not identical to this conjunction. So even if one may call something an electron in virtue of there being compresent instantiations of mass, charge and spin, it does not necessarily follow that genuine sortal properties exist in virtue of these properties. Thus, there exists the conceptual space for distinguishing the conditions sufficient for an application of a sortal term, and the conditions sufficient for the existence of genuine sortal properties.

4.3. Physicalism and the Determination Requirement

But the question now is whether the sortal properties nonetheless do follow. That is, the question is whether the existence or instantiation of the (fundamental) physical properties is sufficient for the existence of sortal properties. For as argued in chapter 2, sortal identities are not fundamental for the physicalist. So, in order to be included in a physicalist ontology, sortal identities must be determined by the fundamental physical properties. But are they? Do physical properties determine sortal or modal properties?[128]

I intend this question to be of a kind with the questions of determination that physicalism has traditionally been faced with. Consider some of these. Do physical properties determine chemical properties? Do physical properties determine biological properties? Do physical properties determine mental properties? The answers to these questions have always been intimately related to what can be included in a physicalist ontology, and, relatedly, whether physicalism is (taken to be) true. So, if the fundamental physical properties do determine chemical, biological, and mental properties, then these properties may be included in a

[128] It is worth being a bit more precise in characterizing these nonsortal properties. In the same context, Paul (2006) writes that "material properties are roughly describable as nonmodal natural properties characterizing an object's matter, certain details concerning its matter (such as how the matter is arranged), and its location" (p. 625). Elsewhere, she calls such properties "the *material core*" (2010: 582). I follow her here, though I will use 'physical' in place of 'material'.

physicalist ontology. If physical properties do not determine these properties, however, then two outcomes are likely: either something like emergentism, vitalism, or dualism is true and physicalism false, or else physicalism is true but chemical, biological, or mental properties do not exist. More generally, if a given domain of properties is not determined by the fundamental physical properties, either physicalism is false or else that domain of properties does not really exist. So too, I claim, if physical properties do not determine sortal properties, then either physicalism is false, or else sortal properties do not exist. But in either case, such a failure of determination entails that sortal properties may not be included in the physicalist ontology.

Now, the historically familiar dialectic concerns the *demonstration* of determination. If it can be *shown* that physical properties determine a given domain of properties, then this suffices for counting that domain of properties as physical. So, for instance, if the physicalist can show *how* chemical properties are determined by subatomic properties and forces, say, then one has little if any reason to believe emergentism. And if the physicalist can show how physical and chemical properties and forces determine biological properties, then one has little if any reason to accept vitalism. Naturally, then, upon the demonstration of such claims by the mid-20th century, the emergentist and vitalist views of the previous century were mostly disregarded (cf. Papineau 2001). But what about mental properties? Presumably, whether mental properties are physical is a live debate today precisely because it is not been demonstrated (to everyone's satisfaction) just how – or whether – physical properties determine mental properties. As such, some form of anti-physicalism is not unreasonable (which isn't to say anti-physicalism is more reasonable than the alternative), for it is not outlandish to suppose that the failure to demonstrate determine thus far is an indication that determination will never be demonstrated. Physicalists, of

course, are more optimistic, and argue that if it has not been shown already, exactly how the physical determines the mental will be demonstrated in the not-too-distant future.

This particular debate is not the important issue here, however. What is important here, rather, is the presumably shared assumption underlying all these (current and former) debates: determination must be explicable, and, ultimately, demonstrated. So the case with sortal properties should be no different. If physical properties determine sortal properties, this should be demonstrable; the physicalist must be able to show *how* the fundamental physical properties determine sortal properties. Absent such a demonstration, however, or at least the basic outlines of one, one may conclude that sortal properties cannot be included in a physicalist ontology.

4.4: Sortal properties, underdetermination, and the grounding problem

My claim, however, is that that no such demonstration is forthcoming. For, I claim, physical properties do not determine sortal properties in any explicable way.

Many philosophers have come to endorse this very claim in the face of the prospect of material coincidence, and what has come to be known as the grounding problem (Bennett 2004), (though it does not appear the implications of this have been generally realized). So consider the puzzle that has led to this state of affairs. A clay statue – call it 'Statue' – cannot survive being squashed. The piece of clay constituting Statue – call it 'Clay' – can survive the squashing, however. As Clay and Statute have different properties, they are not identical, despite being co-located and sharing the same parts and physical properties. Assuming this argument valid, one is lead to the grounding problem: what grounds the difference between Clay and Statue? Given that they share the same location, parts, and physical properties, in virtue of what do Clay and Statue differ in their sortal properties and persistence conditions?

It has struck many as obvious that the answer cannot simply be their physical properties- for Clay and Statue share these (*ex hypothesi*). But note that this is tantamount to the claim that sortal properties are not determined by physical properties more generally. After all, if two objects can be exactly similar in their physical properties yet differ in their sortal properties, then this is a paradigm case of underdetermination. Put another way, if the physical properties possessed by Clay did determine the sortal properties of Clay, then Statue would also have those sortal properties. (And if the physical properties possessed by Statue did determine having the sortal properties possessed by Statue, then Clay would have those sortal properties). But as this is not the case, then physical properties simply do not determine – but rather underdetermine – the possession of sortal properties. So, given the coincidence of distinct entities, the underdetermination of sortal properties by physical properties is obvious.

Rather than accept underdetermination, though, others have denied that distinct entities may coincide, as I shall discuss shortly. But this does not really avoid the problem. For as Bennett (2004: 340) and Fine (2008: 109) have shown, the grounding problem is not specific to she who endorses coincidence. For there still remains the general question of what determines that statues have the sortal properties and persistence conditions they have, and what determines that pieces of clay have the sortal properties and persistence conditions they have. Moreover, it seems that even if statues and lumps of clay do not coincide, there can nonetheless be a lump of clay with certain physical properties in one place, and a statue with the same physical properties elsewhere. (That is, rather than thinking of the clay and the statue as sharing numerically identical physical property instances as would be the case of they coincided, instead suppose that two separate masses of clay exist, with exactly similar properties, but consider one to be a statue, and the other to be merely a lump). And in this sort of case where the statue and the clay are

spatially distant, there is no more reason to say that physical properties determine sortal properties as when they spatially coincide. So, regarding the question of the determination of sortal properties by physical properties, material coincidence turns out to be a red herring; though it serves to focus one's attention on the question of the relation between physical and sortal properties, whether coincidence occurs turns out not to even be relevant, let alone the crux.

As indicated, many are convinced by these considerations that sortal properties are not determined by physical properties. Despite these sorts of arguments (see esp. Bennett 2004), however, others have attempted to solve the grounding problem. Some, such as L.A. Paul (2006) and Fine (2008), accept the existence of coinciding entities, whereas others do not. In the next section, I consider a representative selection of these accounts. I argue, however, that these solutions either do not account for genuine sortal properties, or are not available to the physicalist. So, I conclude, accounting for sortal properties in physicalist terms fails.

4.5. Physicalism and coincidence-friendly solutions to the grounding problem

4.5.1: L.A. Paul

Paul (2006) accepts coincidence and attempts to account for the sortal and modal differences between Statue and Clay. In brief, Paul's' account works like this. The grounding problem, Paul points out, starts from the thought that Statue and Clay are composed entirely of the same stuff. Paul argues, though, that the classical mereological account underlying this thought is insufficient. For, she argues, objects are not merely fusions of smaller objects (ultimately mereological simples), but are, instead, "fusions of properties" (2006: 30).[129] So in addition to object-parts, objects have property-parts. Paul then argues that although Statue and

[129] She considers this a version of the bundle theory, but where the familiar mereological notion of fusion is used rather than the more traditional – and perhaps more obscure – notions of compresence or bundling.

Clay may share all their object-parts (and as such they materially overlap), they do not share all their property- parts (and so do not qualitatively overlap). Put another way, Statue and Clay each have property-parts that the other lacks: namely, the distinctive sortal properties and persistence conditions characteristic of each. These properties, Paul argues, are as much a part of the fusions that are Statue and Clay as their material object-parts. So, she claims, these objects only partially overlap, and their difference in sort is explained by each being a fusion of different properties.

But there's an unanswered question here: how do the sortal properties that Statue and Clay do not share come to exist? At one point, Paul notes that she is "assuming the distinctive properties [i.e. those sortal and modal properties that Statue and Clay do not share] exist when the material properties exist" (p. 636). But the physicalist can allow nothing in her ontology that is not determined by the fundamental physical properties, and so the physicalist cannot simply help herself to this assumption. Instead, the physicalist may assume this only if the existence of sortal properties (in general) can be accounted for in terms of the fundamental physical properties. And though at times Paul speaks of material properties "generating" sortal properties, this amounts to mere hand-waving if no account of *how* this generation occurs is on offer, or else it simply amounts to a question-begging assumption.[130] Absent such an account, then, Paul's' account is a non-starter for the physicalist.

Now, one could deny the need to account for the existence of sortal properties by claiming that sortal properties are primitive or fundamental (such that they are not determined by anything). Paul discusses this sort of primitivism (2006: 638, 2010: 582), but claims to reject it

[130] Paul suggests that spatiotemporal objects "generate" additional modal or sortal properties by "standing in relation to external objects" such as other-worldly counterparts or to the sort of which they are instances (2006: 651). But this presupposes that entities such as abstract substantial sorts exist, and there remains the question of whether a physicalist can accept such things. But even if the physicalist can accept modal realism (and so counterparts), there is still the problem that modal properties cashed out as similarity relations to counterparts do not determine having genuinely sortal properties. See §4.6.3.

(though it is not clear how she does explain the coming to be of sortal properties). Bennett (2004), however, argues that primitivism is the only way to save the non-identity of Statue and Clay, and material coincidence more generally. And though Bennett offers a way to make this view more plausible than it may seem at first glance,[131] this view remains incompatible with physicalism. For these putatively fundamental modal properties are macroscopic properties. And as I have made clear, the physicalist cannot accept any non-fundamental macroscopic property not determined by the fundamental physical properties, let alone a *fundamental* macroscopic property. So Bennett's suggestion also is a non-starter for the physicalist.

4.5.2: Fine

Fine (2008) attempts a solution based on what he calls "rigid embodiment". There is less need to discuss the details of Fine's proposal (such as they are),[132] for he seems to admit – though not in so many words – that his proposal is incompatible with physicalism. First, because there is no empirical difference between Statue and Clay, Fine suggests there is no discernible material (physical) difference between them. Consequently, Fine claims that science cannot explain the differences between coinciding entities; rather, the explanation of their modal and sortal differences will be on "the philosophical rather than the scientific" model of explanation (p. 104). For Fine, this means an account of the difference between Statue and Clay will be *a priori*.

But it would take considerable argument to twist this conception into a form admissible to the physicalist. For if sortal properties are determined by the fundamental physical properties, and the fundamental physical properties are known empirically, then sortal properties should be

[131] Bennett argues for a principle of modal plentitude, where every way of having a property essentially or accidentally exists wherever any physical property exists.
[132] Divers (2008) argues that Fine's account leaves many questions unanswered, and requires fleshing out.

knowable empirically, or through scientific means more generally. Similarly, it is far from clear that the physicalist can allow there to be differences in the properties of two objects that are not physical properties in some clearly defined sense. But if being determined by fundamental physical properties is the criterion used for counting nonfundamental properties as physical, then on Fine's account, sortal properties fail the test for counting as physical. Moreover, and like Paul, Fine simply helps himself to the sortal distinction in question; rather than account for how it could come about given only a physicalist base, he instead assumes (in light of *a priori* reflection) that the distinction does exist.

Furthermore, and also like Paul, Fine's attempt to distinguish Statue and Clay appeals to the idea that Statue and Clay differ in their constituents (cf. Divers 2008: 130-1). For Fine, though, this difference is explicitly non-material: although Statue and Clay share their *matter*, Fine argues, they differ in their *form* (where each is a form/matter composite). But if the *matter* that contrasts with *form* is equivalent to *physical stuff*, then clearly form – as contrasted with physical stuff – cannot be included in a physicalist ontology. But even if this is not the sense of *matter* in play, there is still the question, as there was for Paul, of how these forms – discerned, as above, via *a priori* rather than empirical means – come to be, given only a physical base. So, like Paul, Fine's account cannot be accepted by the physicalist.

4.6: Physicalism and coincidence-unfriendly solutions to the grounding problem

As indicated above, many philosophers deny that there exists more than one object where Statue and Clay appear to be. But also indicated above, this in itself does not solve the grounding problem. Nonetheless, one might suppose these anti-coincidence arguments might provide a solution, and, relatedly, provide an account of how sortal properties are determined by physical

properties. I argue, however, that this is not the case: no coincidence-unfriendly account saves the determination of sortal properties by physical properties.

First, though, consider the anti-coincidence accounts. The immediate question that the denial of coincidence raises is this: if it is not the case that both Statue and Clay exist, which one, if either, does exist? Answers differ (of course). Some argue that neither exist, others argue that one but not the other exists. Still others argue that although is only one object present, 'Statue' and 'Clay' are both names for that object, and so "both" exist, in that attenuated sense. I consider these views in turn.

4.6.1: Van Inwagen and eliminativism

Van Inwagen (1990) argues that no (nonliving) ordinary objects exist. He thereby avoids the grounding problem in one fell swoop, for if macroscopic objects such as Statue and Clay do not exist, there is no problem in accounting for how they acquire their different sortal profiles.

But this amounts to conceding my main thesis. For if there are no macroscopic objects with intrinsic sortal identities, then clearly the physicalist ontology cannot contain macroscopic objects with intrinsic sortal identities.[133] Moreover, what van Inwagen's ontology has instead of ordinary objects – namely, mereological simples in various arrangements – lack precisely those features associated with a sortal identity. For instance, rather than being *one* unified tiger, say, simples arranged tigerwise are merely *many* loosely assembled objects. Relatedly, these simples lack the persistence conditions associated with tigers. And so on for all Fwise arrangements (for any putative sortal F). So, clearly van Inwagen's elimination of objects with intrinsic sortal identity does not help the physicalist save an ontology of objects with intrinsic sortal identity.

[133] But are there fundamental objects with intrinsic sortal identity? No: in Chapter 2, I argued that the identity even of putatively fundamental objects such as electrons are not fundamental for the physicalist.

4.6.2 Burke and dominant kinds

Another option, then, for rejecting coincidence but avoiding van Inwagen's eliminativism is to eliminate only Statue or Clay, but not both. Of course, this immediately presents the problem of which one is to be considered non-existent, and, relatedly, how the physical properties determine the existence of one sortal profile but not the other.

Burke (1994) takes this approach, and attempts to solve the "which one?" problem. Although there is some physical stuff with both clay-properties and statue-properties, Burke argues, there is not something with the sortal properties – including the distinctive persistence conditions – characteristic of each kind. Instead, the physical stuff only has the sortal profile of its "dominant kind". According to Burke, the dominant kind is the kind that entails the "widest range of properties" (1994: 610). So, for example, the sort *statue* entails possession of both the physical properties of the stuff constituting the statue, but also the aesthetic and sortal properties of a statue. By contrast, the sort *clay* only entails the physical properties. So, Burke argues, the sort *statue* dominates the sort *clay*. So in cases of the apparent coincidence of Statue and Clay, Burke argues, there exists only an entity with the sortal profile of a statue (i.e. only Statue, but not Clay, exists).

Several problems have been raised for Burke's 'entails the widest range of properties' criterion for which kind is dominant (Rea 2000, Wasserman 2009). But one can put these aside, for regardless of the criterion, the dominant kind account does nothing to address the physicalism worry. Consider the following. On Burke's account (and any dominant kind account), one object, such as Clay, ceases to exists, and is replaced by another, such as Statue. This implies that the domination of the kind *clay* by the kind *statue* is an event in time. For at time t_1 Clay exists, and at time t_2, Clay ceases to exist and Statue comes to be. But this raises nearly endless questions.

But by what *physical* process does this occur? *How* does the one kind dominate the other? How much energy or work is required for this to occur? Is energy conserved in the process? Is this process efficient; does it produce considerable entropy? Do some kinds dominate other kinds with greater ease or less friction than others? Is the process reversible? I don't see how the dominant kind view can answer these questions. For it simply does not appear that the domination of one kind by another is a physical process or event. So even if there is theoretical utility in adopting Burke's view,[134] this does not mean that a physicalist can adopt it. Absent any account of how one sortal identity can come to dominate another in physicalistically acceptable terms, then, the dominant kinds account is of no help to the physicalist.

4.6.3. Lewis and context-dependent counterpart relations

More popular than the dominant kind view, though, is an account inspired by David Lewis (1986: 253). On the Lewisian view, there is no coincidence of distinct objects, but it is not the case that either Statue or Clay does not exist. Instead, according to Lewis, 'Statue' and 'Clay' are merely two names for the same object. But how can one object have two seemingly incompatible sortal and modal profiles? Lewis has an answer. For Lewis, modal properties (such as *can possibly survive being squashed*) are (sets of) similarity relations to possible individuals (i.e. individuals in other possible worlds). And any given object stands in (presumably) countless such relations to various individuals. For instance, the lump of clay (picked out by the names 'Statue' and 'Clay') is similar to other-worldly lumps of clay in some respects, and also similar to other-worldly statues in other respects; the lump therefore has both clay and statue counterparts. And according to Lewis, to talk of the properties of "Clay" is just to focus on the

[134] Burke argues that "what justifies accepting [his] criterion" for what counts as dominant kind is "its intrinsic reasonableness and, especially, the agreeableness of its rulings" (1994: 614).

Clay counterparts of the lump, whereas to talk of the properties of "Statue" is just to focus on its statue counterparts; hence, use of the different names evokes different counterpart relations. But these counterparts are nonetheless counterparts of the one (this-worldly) object. So, there is no genuine modal different between Statue and Clay, Lewis argues. Instead, the difference is merely context-dependent. As Divers (2008: 123) describes the Lewisian account of the putative modal difference between Statue and Clay: "it is difference in modal properties expressed, not difference in modal properties possessed."[135]

As indicated, the Lewisian account reduces apparently modal properties such as *can survive being squashed* to sets of individuals, where these individuals belong to different worlds. But there's a problem here. As we saw, on the Lewisian account there is a single object – call it 'O' – that has both statue and lump counterparts. But how does knowing this help one determine whether O could or could not survive any given change in *this* world? Suppose at time t_1 O is not squashed. But at time t_2 it is. Does O still exist at time t_3? If O is a statue (or has the sortal profile of statue), it does not. But if O is a lump of clay, it does. That O has counterparts that exist in another world's t_3 and different counterparts that do not exist in yet another world's t_3 does not tell us whether the visible object O in front of us, in this world, has in fact survived. In brief, if 'M' is the squashed object in this world at t_3, the question is this: is M identical to O or not? The Lewisian account does not appear to have an answer.[136]

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[135] This is of course a truncated version of the Lewisian view. For a fuller description of the Lewisian view in the context of the problem of coincidence, see Divers (2008).

[136] Lewis' mereological universalism is of no help here, it should be noted. According to this doctrine, the sum of any two simples exists no matter how those simples are arranged. It follows that no amount of scattering or dispersal can destroy a whole as long as the simples still exist. Consequently, mereological wholes exist for as long as mereological simples do. It then follows that if the squashing does not destroy the simples, the whole composed of these simples survives as well. But the problem is that this seems to collapse any distinction between the sense in which O even has some (statue) counterparts and some (lump) counterparts which *differ* as to whether they exist in a given world in which squashing has

This is closely related to a second problem. If modal properties are reduced to relations of similarity, as Lewis has it, then modal properties appear extrinsic (cf. Paul 2006: 644). But it seems that a sortal identity ought to be intrinsic; as Paul puts it, the Lewisian conception "violates the natural thought that objects include their natures, i.e. that they include their *de re* modal properties" (2006: 645). And it is precisely the extrinsicality of modal properties that generates the previous problem. For if something's sortal identity is intrinsic, and sortal identities determine persistence conditions, then it follows that whether a given entity is able to survive a certain change is itself an intrinsic property (as we saw on the Aristotelian account in chapter 2). But as these properties do not come out as intrinsic on the Lewisian account, the object O itself (i.e. how it is intrinsically) does not determine whether O survives the squashing. And this is why the problem of the previous paragraph arises: if O's sortal and modal properties consist in relations to other-worldly entities, such that there is no sort object O is intrinsically, then there is nothing about O itself that answers the question of whether *it* survives a particular this-worldly change.

Even if the Lewisian does not think this problem is serious, though, this does not affect my main point there: if sortal identities are not intrinsic on the Lewisian account, then of course the physicalist cannot adopt the Lewis an account in order to save intrinsic sortal identity.

4.6.4: Conceptualist solutions

Lastly, there are conceptualist solutions to the grounding problem (Sidelle 1989, 1998, 2010, Einheuser 2010). On these, the world in itself (intrinsically, one might say) contains no objects with sortal identities, and so, *a fortiori*, no coinciding objects with distinct sortal

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occurred. Instead, it amounts to the view that wholes survive all changes (other than the annihilation of the simples that compose them).

identities. Instead, sortal identities are in some sense projected onto the world in virtue of our having the various concepts (and projection powers) we do.

But clearly this view is of no help in saving an ontology of objects with intrinsic sortal identity. For if objects have their sortal profiles in virtue of our concepts, they only have them relative to us, which is to say extrinsically. Moreover, in being determined by concept-users, sortal identities are not determined by the fundamental physical properties, as the physicalist must have it.

So, to conclude this section, even the coincidence-unfriendly solutions to the grounding problem fail to save intrinsic sortal identities from underdetermination.

4.7. Objection from supervenience

I have argued that physical facts do not determine sortal facts. But this view might seem to have a puzzling consequence. On a distinct though related topic, consider this line of thought suggested by Loewer (2001).

> "Notice that it would be bizarre to suppose that a property like being a rock, or a cloud, etc. is linked by a special vertical law (over and above the laws of physics) to the physical state. If that were so there would be a possible world physically identical to the actual world, but where in the actual world there is a rock and at a certain location in the other world there is a cloud" (p. 22).

Here, Loewer is discussing emergentism and whether there are laws that link higher level (or emergent) phenomena to more fundamental phenomena. Loewer argues against such laws: for if sortal properties exist because there is a law linking these to fundamental physical properties, and if such laws are contingent, then in another physical identically world lacking those laws, sortal properties could be associated with altogether different physical properties. But, Loewer suggests, this would be "bizarre". Put in this context, the worry is this: if physical properties do not determine sortal properties, then there seems to be no reason that sortal properties must be

associated with the physical properties they are associated with, and so no reason that physical objects might not swap sortal profiles. But, one might argue, this is absurd. Put another way, if physical properties do not determine sortal properties, one might reasonably wonder why entities with the physical properties of a cloud don't have the sortal properties of a rock, and vice versa.

There are two ways to deal with the potential absurdity here. The first is to explain it away. To do this, recall the distinction between the application conditions for sortal terms and the existence of genuinely sortal properties (§4.1). If one thinks of nonsortal physical properties as sufficient (and necessary) for the application of sortal terms, then of course there is no conceptual space for the claim that the physical properties of a rock obtain yet 'cloud' should be applied instead (given the meaning of 'cloud'). So the idea that sortal terms could be inverted in this way will obviously appear absurd- or bizarre, as Loewer puts it. But as before, this approach fails to capture the additional sortal properties – such as persistence and unity – that are associated with belonging to a (substantial) sort. So to the extent that the absurdity of the no-determination claim is due to the background assumption regarding sortal terms, this concern is irrelevant here.

But what if the question concerns genuine sortal properties? Even if sortal profile swapping is not possible, I need not concede my main point. For to say that there may not be such swapping is just to say sortal properties supervene on physical properties. But as many have shown (and as I discussed in Chapter One), supervenience is not sufficient for determination. (Moreover, and as Bennett has convincingly argued specifically in this context, even if there are coincidence-friendly forms of supervenience, this does not suffice for showing determination or for solving the grounding problem (2004: 343).) For (as discussed earlier) supervenience is merely covariance. And simply noting that supervenience – covariance – obtains does not suffice

to show that one relatum of the supervenience relation is prior to or determines another. For instance, and as we saw in Chapter One, mental and physical properties co-vary in a Leibniz world, but, in such a world, the mental properties do not obtain *in virtue of* the physical; rather, each obtains in virtue of God's prearranging their harmony. So supervenience insufficient for determination, and insufficient for guaranteeing a physicalistically acceptable scenario.

Moreover, and as the Leibniz case shows, the priority relation that explains the covariance may be incompatible with physicalism. And this is also an option in the sortal case: for one putative explanation of the covariance of sortal and physical properties (if indeed they co-vary) is the claim that it is the physical properties that obtain in virtue of the sortal properties. That is, one might claim that the reason the physical properties of rocks are only found with the sortal properties of rocks (and not clouds) is that something has the physical properties characteristic of a rock *in virtue of* having the sortal properties of a rock. But as I argued in Chapter Two, this claim is itself incompatible with physicalism, and is, rather, constitutive of the Aristotelian picture. So although the Aristotelian may adopt this view, the physicalist may not.

So in conclusion, even if sortal and physical properties do co-vary (i.e. there is a supervenience relation between them), this does not suffice to show that physical properties determine sortal properties. Instead, like any determination claim, this must be demonstrated. And as argued above, no demonstration is forthcoming. So, absent any such demonstration, I conclude that physical properties do not determine sortal properties.

4.8. Relations, extrinsic properties, and sortal identity

There is a second path to the conclusion of this chapter, which is based on the conclusion of Chapter Three. There, I argued that the fundamental physical properties are extrinsic. If this is

so, then physical objects have no fundamental intrinsic properties. This implies that there is nothing such an object is fundamentally in itself, which in turn suggests that objects are simply bundles of relations (as discussed in chapter 3). That such an object would nonetheless have an intrinsic sortal identity, thereby being a unified persisting whole only in virtue of itself, seems incompatible on its face.

Nonetheless, one might object. For, as Esfeld and Lam (2005: 4) put it, "it is trivial that any relations among the parts of a whole can be represented as intrinsic properties of the whole". Others have made similar points (see Pereboom 2011: 197 for discussion). But if this is true, then one might object that there is no reason that fundamental extrinsic properties (or relations between parts) cannot entail – or, perhaps, determine – intrinsic properties of the whole. If so, then the extrinsicality of the fundamental physical properties is no barrier to an object having an intrinsic sortal identity.

But the objection does not succeed. I will grant the first point, though: if x and y are parts of z, then z has the intrinsic property of having x and y as parts. But even if x and y determine this property of z, this property – as Esfeld and Lam point out – is trivial. Not unrelated, this trivially determined property is not a genuinely sortal property, in the sense defined above. More generally, no intrinsic properties that simply fall out of extrinsic properties in this way are genuinely sortal properties. There are two main reasons for thinking this is so. First, there is no work that the trivial intrinsic property does that the extrinsic properties don't already do. Yet, as argued above, sortal identities do further work beyond their associated physical properties. The second reason is revealed by the grounding problem. For both Statue and Clay share whatever intrinsic properties are determined by their parts: so if Statue and Clay both have x and y have parts, they share the intrinsic property of having x and y have parts. But the issue is how the

acquire their distinctive properties, i.e. how they have the properties the other lacks. And it is precisely these properties that are not straightforwardly determined by the underlying extrinsic properties, as are the trivial intrinsic properties cited above. But even if one denies coincidence, as we saw above, this is no solution. For granting such trivial intrinsic properties to say, the Lewisian account, still does not allow Lewis to answer whether the lump survives the squashing or not, as discussed previously. Nor does this objection solve Burke's problem, nor inject sortal identities into van Inwagen's nihilist ontology.

So, I conclude, the thesis of chapter three provides yet another path to the central thesis: fundamental physical properties do not determine sortal identities.

4.9: Epilogue: substantial forms, formal causation, and the shifting locus of fundamentality

Recall that is commonly thought that an object has its persistence conditions *in virtue of* its sortal identity; this determination claim suggests the sortal identity in some sense *produces* or *generates* these persistence conditions. But *how* does this happen?

Generally speaking, and as discussed above, on the physicalist model determination claims must be explicable. But there appears to be no mechanism or process by which persistence conditions are determined by a sortal identity, or by nonsortal physical properties such as mass and charge. This is not simply because this generation is synchronic rather than diachronic, however (assuming, for the moment, that one can make sense of non-temporal generation or production). For supposing that the determination of the properties of water by the properties of hydrogen and oxygen is synchronic, there is still an explicable way in which this 'in virtue of' claim may be cashed out; just ask a chemist. But as argued, there is no such explication available for sortal properties. And calling the alleged process by which this occurs

'metaphysical determination' or 'metaphysical entailment' does not avoid the issue, for this does not reveal *how* metaphysical determination or entailment *works*. As I've argued, with the materials that the physicalist has at her disposal – namely, the fundamental physical properties – there simply doesn't seem to be any tractable way that this sort of thing could happen.

Here is my hypothesis that explains this state of affairs. Recall from chapter 2 that the way by which something has its persistence conditions in virtue of its sortal identity was given a name by Aristotle: he called it *formal causation*. As discussed in Chapter 2, for Aristotle, formal causation is the type of causation that occurs between a (substantial) form and the properties *metaphysically entailed* by the form; it is via formal causation that something has the properties entailed by its sortal identity. This hypothesis suggests a corollary: formal causation is applicable here because sortals just are substantial forms. In a sense, this should not be surprising: it is often recognized that sortals are closely related to Aristotle's notion of secondary substance (and it was in the context of discussing – and rejecting – such things that Locke coined the term 'sortal', as mentioned at the outset of the chapter). But these secondary substances are just what substantial forms are. Moreover, the job description of a sortal – answering the 'what is it?' question, being the ground of unity and identity, etc. – is just what Scholastics have always argued substantial forms do (cf. Oderberg 2007, Pasnau 2004, Hill 2007, Banach 2007). So, putting these together, sortals are substantial forms, and they entail persistence conditions and other sortal properties via formal causation.

And if this sounds mysterious to the physicalist, it should. As discussed in chapter 2, it is precisely because there is no mechanism or process by which a substantial form generates persistence conditions that substantial forms and formal causation were rejected by the *mechanistic* philosophers of the scientific revolution as pre-scientific and occult entities. For the

mechanist and materialist – read physicalist – of this period, properties were either determined by the primary qualities of Galileo and Locke, such as solidity, bulk, extension, or else they were not real. Precisely because there is no way to explain in physicalist terms *how* formal causation works, it was rejected as occult.

But in the years since, and for whatever reason, physicalists seem to have unlearned this lesson. Despite their official commitment to only positing what can be determined – in a physically tractable way – by the fundamental physical properties, they have often included sortals (i.e. substantial forms) in their ontologies, and with it, the various sortal properties (metaphysically) entailed by them. But as I've argued here, this is a mistake: substantial forms and formal causation were unacceptable to the physicalist the first time around, and, now known as sortals and metaphysical entailment or determination, respectively, they still are. It is this that I have attempted to show in this dissertation.

Another way to put the scenario is this: as argued in Chapter Two, sortal identity is fundamental for the Aristotelian, and, in addition, formal causation is itself a fundamental (i.e. irreducible) form of causation.[137] Conjoined, these tenets allow the Aristotelian to include sortal identity and the metaphysically entailed sortal properties in her ontology. But when the locus of fundamentality is shifted, as it did when the fundamentality of (macroscopic) sortal identity was rejected (and with it the kind of causation by which sortal identities produce persistence conditions), there was no way to recover it. The physicalist cannot simply deny that sortals are not fundamental and maintain an ontology with sortal identity and persistence conditions, for there is no physically acceptable means by which such entities could be generated as nonfundamental entities. Once sortals or substantial forms are rejected as fundamental entities,

[137] If any one Aristotle's four causes were reducible to any other, then, presumably, Aristotle would not have counted four kinds of causation. Hence, all four are considered fundamental.

then, they must be rejected *tout court*. Upon shifting the locus of fundamentality, then, the physicalist's ontology is impoverished of substances with intrinsic sortal identities and persistence conditions. And insofar as these entities are a part of the common-sense worldview, physicalism is thus more revisionary than many have suspected.

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