Absolutism vs Comparativism About Quantity

Shamik Dasgupta

Draft of July 2010, comments welcome

We naturally think that material bodies have *weights*, *sizes*, *masses*, *densities*, *volumes*, and *charges*; that there are *spatial distances* between them *temporal durations* between events involving them. These are all features of material bodies that fall under the category of *quantity*.

In this paper I discuss a question that arises for all quantities but which is most perspicuously illustrated by the case of mass. The property of having mass is a determinable, but it appears to have two kinds of determinates. On the one hand, we naturally think that something with mass has a determinate *intrinsic* property, a property it has independently of its relationships with other material bodies. But we also think that things with mass stand in various determinate *mass relationships* with one another. Some of these relations are ratios, such as the relation of x being twice as massive as y; others are merely ordinal, such as that of x being more massive than y. My question is: of the intrinsic masses and the mass relationships, which are metaphysically prior? According to a view I call *absolutism*, the intrinsic masses are prior to the mass relationships. The absolutist does not deny that things with mass stand in determinate mass relationships, she just insists that those relationships, along with all facts about the masses of material bodies, hold in virtue of the particular intrinsic mass possessed by each body. In contrast, *comparativism* is the opposite view that the fundamental facts about mass concern how material bodies are related in mass to one another, and all other facts about mass hold in virtue of them.

That, in brief, is the issue in the case of mass, but as I will soon explain an analogous issue arises for any quantity whatsoever. Given the central role that quantities play in our understanding of the natural world, it is surprising that neither the physics nor the philosophy literature contain much discussion of this issue. In this paper I will motivate and defend comparativism, but I am less interested in convincing you of that particu-

lar view as I am of outlining how I think the issue should be approached and convincing you of its interest and importance. I will focus almost entirely on the case of mass, but most of the considerations I discuss generalize to other quantities.

My argument for comparativism is developed in Section 3. In outline, the idea is that if material bodies really possessed the kind of intrinsic mass posited by the absolutist, those intrinsic masses would be undetectable in a very strong sense: not only would they be imperceptible by the naked eye, it would also be in principle impossible to build a measuring instrument that could reveal them to us. But a reasonable Occamist principle states that positing undetectable structure is a vice, in the sense that if two theories of the material world differ in that the former posits undetectable structure that the latter does not, then all else being equal (or at least near enough equal) we should prefer the latter. All else being near enough equal, then, we should prefer comparativism. Indeed, this is the reason that modern physicists and metaphysicians dispense with absolute velocity and absolute simultaneity: both features are undetectable, and that is a mark against theories which claim that they are part of reality. Now our Occamist principle only recommends that we dispense with the undetectable structure if all else is near enough equal, and whether this is so depends on whether there are stronger considerations absolutism's favor. I will argue in Section 2, the bulk of this paper, that there are not. But before that, I start in Section 1 by clarifying the distinction between absolutism and comparativism.

Although I intend much of the discussion to generalize to all quantities, I will not discuss how the category of quantity itself is to be defined (I take us to be good at recognizing paradigm instances of quantities, and that is enough for current purposes). I will also bracket the largely empirical question of which particular quantities are instantiated around us. Relativistic physics teaches us that at rock bottom there are no temporal or spatial distances but rather a unified space-time interval, and other physical theories might talk of even more weird and wonderful quantities. But I focus on the case of mass for simplicity.

1 More on Absolutism and Comparativism

The absolutism/comparativism issue *per se* has not received much discussion in the literature. To be sure, views that count as absolutist have been defended by Armstrong [1] and [2], Mundy [16], and Lewis (see the introduction of his [15]); and views that count as comparativist have been defended by Ellis [9], Bigelow and Pargetter [3] and [4], and Field [10] and

[11]. But those discussions are often intertwined with other issues about quantites, so let us clarify the issue I have in mind before considering arguments either way.

Above I stated both views in terms of one kind of fact "holding in virtue of" another. To say that a fact holds in virtue of another is to say that the latter explains the former in a distinctively metaphysical way. To illustrate, imagine asking what explains Europe's being at war in 1939. A causal answer might describe events during the preceding 50 years that led, say, Chamberlain to declare war on Germany. But there is another kind of answer that would try to say *what it is* for Europe to have been at war in the first place. Regardless of what caused Chamberlain to declare war in 1939, someone in search of this second answer wants to know what it was about the continent that *constituted* its being in a state of war. As I use the phrase, an answer of this second kind is a statement of that *in virtue of which* Europe was at war in 1939. I take this sort of explanatory relation to be reasonably intuitive: regardless of the truth of this claim about what Europe's being at war held in virtue of, we have a strong pre-theoretic grasp of what the claim means.

Now, there is a live question concerning whether the relata of the *in virtue of* relation are facts, states of affairs, propositions, or some other kind of entity. For our purposes it does not matter, but for ease of prose I will suppose that they are facts. Put like this, absolutism becomes the view that all facts about the masses of material bodies, including facts of the form

(C1) *X is more massive than Y*

(C2) *X is 2 times as massive as Y*

are either identical to or else hold in virtue of facts about which particular intrinsic mass those bodies have, i.e. facts of the form

(A) *X has the intrinsic mass M*

Facts like (A), says the absolutist, are the fundamental facts about how the world is massed. Some absolutists will add that in addition to facts like (A), facts about how the intrinsic masses themselves are related to one another are among the facts in virtue of which (C1) and (C2) hold, but this in-house issue will not concern us here.[1] In contrast, comparativism becomes the claim that all facts about the masses of material bodies—including facts of the form (A), if there are any such things—are either identical to or else hold in virtue of facts of the form (C1) and (C2). Note

[1]See Armstrong [2], Bigelow and Pargetter [3] and Mundy [16] for more on this issue.

that this leaves open the relation between facts of the form (C1) and those of the form (C2): some comparativists will claim that the latter hold in virtue of the former, while others will deny that link. But again, this in-house dispute will not matter for our purposes.[2]

Note that I have not yet mentioned facts about mass in a particular scale, such as my laptop's being 2 kgs. One might consider this omission strange since it is this sort of fact that we most often express when talking about mass. But it is not immediately obvious whether this is ultimately a fact that holds in virtue of my laptop's intrinsic nature or in virtue of its mass relationships, so to avoid begging questions it is best to state the absolutist/comparativist issue without mentioning facts about mass in kilograms and leave it as a further question what they hold in virtue of (I discuss this further question in Section 2).

As I define them, absolutism and comparativism are just claims about how things actually are: neither should be thought of as being a claim about how things must necessarily be. One is of course welcome to consider the idea that either is a necessary truth, but I will not do so here.

My characterization of the two positions made free reference to properties and relations, but this is dispensable. To be sure, a realist about properties who adopts absolutism will claim that there really is a domain of entities, the intrinsic masses, and that all facts about how the world is massed concern which of those intrinsic masses are instantiated by which material bodies. More fully, when the realist about properties says that facts about mass relationships hold in virtue of facts of the form

(A) *X has the intrinsic mass M*

she will take the expression '*M*' to refer to a property and she will take the expression '*has the intrinsic mass*' to be a relational predicate holding of the material body *X* and the property *M*. But a nominalist about properties may also be an absolutist: when she says that all facts about how the world is massed hold in virtue of facts the form (A), she will take the expression '*has the intrinsic mass M*' to be a primitive monadic predicate containing no referential devices at all. Analogous remarks apply to the comparativist. I will continue to refer to properties and relations, but nominalists may paraphrase such talk into their own preferred way of speaking.[3]

[2]Note that both views are entirely neutral as to the status of facts about the nomic relation between mass and other quantities. Instead, the issue just concerns the status of "catergorical" facts concerning the masses of things: the absolutist claims that they hold in virtue of facts of the form (A) while the comparativist claims that they hold in virtue of facts of the form (C1) or (C2).

[3]This is not to say that the absolutism/comparativism issue is entirely independent of the issue of realism about properties. One might argue, for example, that the nominalist

The absolutism/comparativism distinction applies to other quantities too. For example, consider the case of spatial distance. In this case, when material bodies X and Y stand in the determinable relation of being spatially related, there appear (as in the case of mass) to be two kinds of determinate relations that they enter into. On the one hand, it is natural to think that X stands in a determinate distance relation to Y. But it is also natural to think they stand in various comparative spatial relations to other bodies, for example the relation of X being twice as far from Y as Z is from W, or even just of X being further from Y than Z is from W. But of the former distance relations and the latter comparative relations, which are prior? The absolutist will claim, and the comparativist will deny, that the former are prior. More fully, the absolutist will claim that all facts about distance, including the comparative facts like

X is further from Y than Z is from W

and

X is twice as far from Y as Z is from W

are either identical to or else hold in virtue of facts about the distances between things, i.e. of the form

X is a certain distance D from Y

In contrast, the the comparativist will say that that all facts about spatial distance hold in virtue of the comparative facts.[4] It should now be clear why I use the terminology 'absolutism' and 'comparativism' when discussing the case of mass rather than 'intrinsicalism' and 'relationalism': when we generalize to other quantities such as spatial distance, the facts that the absolutist takes to be metaphysically prior are themselves facts about relationships between material bodies.

---

has a hard time being an absolutist since her vocabulary would then be required to include an infinite number of primitive predicates, one for each determinate mass. Still, logically speaking the issues are orthogonal and in what follows I will not be concerned with considerations that depend on a resolution to the question of realism about properties.

[4]It might help to note that the absolutism-comparativism issue about distance is independent of the substantivalism/relationalism debate. The latter debate is whether, fundamentally speaking, the relata of spatial relations are material bodies or regions of space. Whichever way that dispute is resolved, we may then raise the absolutism/comparativism debate by asking whether the fundamental facts about spatial relations concern 2-place absolute distance relations or 4-place comparative relations. This question makes sense whether those relations should ultimately be thought of as holding between material bodies (as the relationalist thinks) or regions of space (as the substantivalist thinks).

2 Arguments for Absolutism

As I said, my reason for rejecting absolutism (developed in Section 3) is that the intrinsic masses posited by the absolutist would be undetectable in a very strong sense. The Occamist principle described earlier deems this to be a significant mark against absolutism, but whether it is a decisive mark depends on whether there are stronger considerations in absolutism's favor. In this section I consider five kinds of argument for absolutism: arguments from *intuition*, from *modality*, from *semantics*, from *perception*, and from *the lack of relational grounds*. I will argue that none outweigh the Occamist consideration in favor of comparativism.

2.1 Arguments from Intuition

When first introduced to the issue, absolutism strikes many as being the more intuitive and plausible view. If I am more massive than my laptop, it initially seems that this is *because of* my intrinsic mass and that of my laptop. One might then argue that absolutism's intuitive plausibility is reason to think that it is true.

The last paragraph conflates a number of arguments. One unconvincing argument is that just as we are endowed with a faculty of perception that reliably produces true beliefs, we are also endowed with a reliable faculty of intuition which delivers the verdict that absolutism is true. But to this argument we might well object that we have good reason to doubt that we have a reliable faculty of this sort (for one thing, anatomists and neurologists have yet to find anything corresponding to it). Note that our objection need not deny that we have a faculty of intuition that is a reliable guide to math, logic, and perhaps the structure of our concepts; all it needs to insist is that we do not have one that delivers reliable verdicts as to which kinds of physical properties and relations are instantiated around us, for it is only with regards to this latter topic that absolutists and comparativists disagree. The denial of such a faculty should therefore be reasonably uncontroversial.

A better argument does not appeal to a dubious faculty of intuition and instead argues on other grounds that the initial plausibility of absolutism carries epistemic weight. For example, one might try to say that absolutism is a "Moorean truth", a proposition in whose truth we are more certain then in any premise used in an argument to the contrary. Or one might point out that absolutism is our starting point in the inquiry and then argue for a principle of epistemic conservatism according to which our starting point is (defeasibly) justified merely by virtue of being our starting point. Either way, the upshot would be that our initial absolutist

inclinations are epistemically significant.

In response, I do not wish to object to the principle of epistemic conservativism or to Moorean approaches to philosophy. In particular, let me concede that absolutism's initial plausibility is at least *some* reason to believe it. But any such reason is defeated by my Occamist argument. To see this, consider the case of absolute simultaneity. While it is initially extremely plausible that there is such a thing as simultaneity, almost everyone would agree that considerations from special relativity are enough to defeat any consideration from Mooreanism or epistemic conservativeness in simultaneity's favor. This shows that our belief in simulteneity is not, after all, more certain than the premises of any argument against it; and it also shows that while our belief in simultaneity may have been epistemically privileged by virtue of being our starting point, its privilege was not enough to ward off stronger arguments to the contrary. Now, I take the initial plausibility of simultaneity to be at least as strong as the initial plausibility of absolutism. Therefore, since my reason to reject absolutism is the same as our reason to dispense with simultaneity (I leave it till Section 3 to make good on this claim), it will be be strong enough to defeat considerations from Mooreanism or epistemic conservativeness in absolutism's favor.

2.2 Arguments from Modality

Another class of arguments for absolutism appeal to modal considerations. My sense is that theorists with absolutist inclinations are often moved by them, so I will consider three such arguments in some detail. The first is that while it is possible for everything's mass to double tonight at midnight, the comparativist cannot make sense of this kind of change since the mass relationships between things would be exactly the same tomorrow as they were today. But in response, the comparativist may consider some of the fundamental facts about mass to include how something's mass at one time relates to its mass at another. If so, she can perfectly well make sense of the possibility of everything's mass doubling at midnight.

A second, more compelling argument along these lines would appeal to doublings of mass across worlds rather than times. Here is Hawthorne:

> It seems, for example, that there could be a pair of worlds w_1 and w_2 such that the same pattern of [comparative mass-relations] obtains between the objects in w_1 and their counterparts in w_2, yet the mass of each particle in w_1 is double that of its counterpart in w_2. From a [comparativist] point of view, it

seems difficult to make sense of such possibilities.[5]

Now, I defined absolutism and comparativism to be views about the nature of *our* world, so for our purposes we should take w_1 to be actual. The argument, then, is that while it is possible for everything's mass to have been double what it actually is, comparativism cannot make sense of this.

Why can comparativism make no sense of the possibility of uniformly doubled mass? Because of the plausible principle that if the fact X holds in virtue of the fact Y, then every world in which Y obtains is also a world in which X obtains. Along with this principle, comparativism implies that worlds agreeing on mass relationships agree on all facts about mass. But the "doubled" world agrees with the actual world on all mass relationships; hence it is not a world that differs regarding facts about mass and is therefore not a world in which everything's mass is doubled.

Now, one response is to become a modal realist in Lewis' sense and say that the fundamental facts of the world are really facts concerning a plurality of worlds. The comparativist may then think that the fundamental facts concerning mass relationships include how objects in different worlds relate to one another in mass. A comparativist of this sort will consider the argument in the last paragraph unsound, since on her view the actual world and the doubled world disagree on their inter-world mass relations. But this is an unhappy response. Put aside the worry that modal realism is an unpopular doctrine, the more important concern is that the response will not generalize to the case of spatial distance: the generalization would be that comparative spatial relations hold between bodies in different possible worlds, yet this conflicts with Lewis' account of a possible world as the mereological sum of spatio-temporally related things.

So let us restrict attention to the comparativist who concedes that there are no inter-world mass relationships. Still, there are two responses available to her: one is to argue that her failure to make sense of the possibility of uniform doubling is no real vice, the other is to argue that she can make sense of the possibility without inter-world mass relations after all. I think both responses are reasonable.

Start with the first. The argument under consideration rests on the idea that a uniform doubling of mass really is possible, but is this right? I find that my inclinations here depend on my current theoretical convictions: when absolutism strikes me as attractive it seems to me that it is possible, but when I am in the grip of comparativism it seems to me that the possibility is just a silly philosophical mistake. This should not be surprising, since the absolutist and the comparativist are both likely to agree that *if*

[5]Hawthorne [12], pp. 230–231, though he doesn't explicitly endorse this argument. A similar argument is given by Eddon, [8].

absolutism is true *then* uniform doubling in mass is possible. Now, if our intuition that doubled worlds are possible rested on a prior belief that absolutism is true, it would beg the question in the current dialectic. So the question is whether we have an inclination to think that uniform doubling is possible that is independent of any prior belief in absolutism, and if so how strong that inclination is. I am not sure how one might go about answering this question, but an answer is crucial to the current argument. For now, then, it is reasonable to take the issue of uniform doubling to be a case of "spoils to the victor".

The second response is that the comparativist can account for the possibility of uniformly doubled mass without using inter-world mass relations. But before seeing how, let us turn to the third and last modal argument against comparativism since our response to it will introduce the necessary materials. The third argument is that while it is surely possible for my laptop to have been twice as massive as it actually is, the comparativist can make no sense of this possibility. To be sure, she can perfectly well make sense of a world W that is just like ours with the one exception that the mass-ratio between my laptop and all other things is double what it actually is. But without inter-world mass relationships, there is no fact of the matter as to whether W is a world in which my laptop is twice as massive as it actually is, or one in which my laptop is the same mass and everything else is half as massive as they actually are! The worry does not arise for the absolutist, for on her view each material body possesses a particular intrinsic mass and so the relation between my laptop's actual intrinsic mass and its intrinsic mass at W will fix whether W is a world in which my laptop is more massive than it actually is. But without inter-world mass relationships, the comparativist has no resources to make a similar inter-world comparison. And note that the situation is not improved by noting that comparativism is a contingent claim and allowing the material bodies in W to have absolute masses. For so long as the *actual* material bodies lack intrinsic masses, as the comparativist insists, there remains no fact of the matter as to whether W really is a world in which my laptop is twice as massive as it actually is.

This argument is far more compelling than the last, for while we might reasonably deny that it is possible for everything's mass to have been doubled we surely must concede that my laptop could have been twice as massive: if the comparativist cannot even make sense of this, that is a vice indeed. I am therefore surprised not to have seen or heard this argument expressed by those with absolutist inclinations.

How might the comparativist respond? I believe she should accuse the argument of using an incorrect model of how a possible world represents

my laptop's mass, and introduce a better model that allows her to make sense of the possibility in question. To start, let us be clear on how a possible world represents something *de re* of my laptop in the first place. Lewis famously said that it does so not by containing my laptop itself but by containing one of its counterparts instead. It does not matter for our purposes whether he was right about this, but let us assume that he was so that we have a working model of *de re* representation in play. Given this assumption, the world W introduced above can be re-described as a world containing counterparts of every actual material body such that if my laptop is r times as massive as another body x, my laptop's counterpart in W is $2r$ times as massive as x's counterpart in W. Note that with respect to the mass ratios they enter into, my laptop differs systematically from its counterpart in W by a factor of 2. But other objects differ from their counterparts in W only with respect to *one* mass relationship: for example, my printer's mass relationship to all bodies other than my laptop is exactly the same as its counterpart's mass relationships to theirs. So my printer's mass role is very similar to the mass role of its counterpart in W, but my laptop's mass role is systematically different from that of its counterpart. The comparativist might therefore say that it is in virtue of this asymmetry that W represents my laptop as being more massive than it actually is and everything else as being the same mass as they actually are.

In effect, the comparativist just introduced a "mass-counterpart" relation in addition to the ordinary, Lewisian counterpart relation. Since my printer and its counterpart in W resemble one another with respect to their mass role, we call them mass-counterparts. And, the idea is, because my printer's counterpart is also its own mass-counterpart, W represents my printer as being the same mass as it actually is. Here the mass-counterpart relation is doing somewhat analogous work to Lewis' counterpart relation: just as the latter is not identity but instead stands in for it when determining what a world represents *de re*, the mass-counterpart relation is not the same-mass-as relation but instead stands in for it when determining what a world represents about mass.

More generally, we can think of the comparativist as actually having introduced a whole slew of mass-counterpart relations, one for each real number. My printer's mass role resembles its counterpart's mass role, so we call them mass_1-counterparts. My laptop's mass role does not resemble its counterpart's in the same way, but since the mass ratios my laptop stands in are *uniformly* half those of its counterpart, their mass roles resemble each other perfectly *modulo* a factor of 2. As a result, we call them mass_2-counterparts. We may then propose the general principle that, relative to a counterpart relation and a set of mass-counterpart relations, W

represents an actual object x as being r times as massive as it actually is just in case x has a counterpart in W that is also x's mass$_r$-counterpart. Relative to the mass-counterpart relations just described, this delivers the desired result that W represents my laptop as being twice as massive as it actually is.

Like the ordinary counterpart relation, we can let the mass-counterpart relations be context sensitive: which aspects of an item's mass-relational profile are important to determining its mass$_r$-counterparts will depend on the conversational context. With a bit of conversational coaxing, we might engineer a lax enough context in which my laptop's counterpart in W is also my laptop's mass$_1$-counterpart; and relative to this set of mass-counterpart relations, W represents my laptop as being the same mass as it actually is and everything else as being half as massive as they actually are!

Although the preceding discussion presupposes Lewis' own theory of *de re* modality, the mass-counterpart theory just introduced is consistent with many other theories, including ersatz views. There is of course much more to about it, but most will resemble the literature on ordinary counterpart theory. Instead, let me return to the second modal argument we left earlier and explain how the comparativist can use this mass-counterpart theory to make sense of the possibility of uniform doubling. The problem, remember, was that a "uniformly doubled" world would agree with ours on all mass relationships and so, by the comparativist's own lights, on all facts about mass whatsoever and would therefore not be a doubled world after all. But with mass-counterpart theory in hand, I believe the comparativist can accuse the objection of ignoring the distinction between *worlds* with *possibilities*: she can concede that she can make no sense of a uniformly doubled world, but insist that she can make perfectly good sense of the possibility of uniform doubling.

It is a familiar fact that worlds and possibilities come apart in ordinary counterpart theory. To use Lewis' example, I might have been either one of a pair of twins: I might have been the first born, and I might have been the second born.[6] Here we have one possible world containing twins but two possibilities, one in which my counterpart is the first born and the other in which my counterpart is the second born. Similarly, we have already seen a distinction between worlds and possibilities induced by mass-counterpart relations: the world W discussed above represented two possibilities depending on which mass-counterpart relation we focused on, one in which my laptop is twice as massive as it is and one in which everything else is half as massive as they are. In his discussion of the

[6]See Lewis [14], p. 231.

distinction between worlds and possibilities, Lewis' also points out that our counterparts need not always be in other worlds. When I consider the unhappy possibility of being my neighbor Fred, Fred himself (my world-mate) is acting as my counterpart and represents me as having all his properties.[7] In this case the actual world, along with a certain counterpart relation, is representing a non-actual possibility for me.

Mass-counterpart theory allows the comparativist to model the possibility of uniform doubling in the same way that Lewis models the possibility of being Fred, namely by using the actual world along with a suitable mass-counterpart relation. For suppose we let each material body be its own counterpart and its own mass_2-counterpart. Then relative to these counterpart relations, the actual world represents the non-actual possibility of everything being twice as massive as they actually are! In this way, mass-counterpart theory allows the comparativist to make sense of the possibility of uniform doubling after all.

That is the basic idea, but it needs refining. I just supposed that I am my own mass_2-counterpart, but one might reasonably object to this supposition: we said above that x is y's mass_2-counterpart just in case x's mass role resembles y's *modulo* a factor of 2, but my mass role resembles my mass role *modulo* a factor of 1, not 2. One might think, therefore, that even a very generous conversational context will not count me as my own mass_2-counterpart. But the comparativist can concede all this, for we should never have been thinking about *my* mass-counterparts at all. When we consider the possibility of uniform doubling, we are considering a possibility for *every* material body at once; and according to Lewisian counterpart theory, we should model possibilities concerning many objects by considering counterpart relations defined on ordered sets of those objects. So, if we let S be an ordered set containing every material body, we are really thinking about a possibility for S. But now, S's mass role—the pattern of mass-relations displayed by the members of S—does indeed resemble its mass role *modulo* a factor of 2: the pattern of mass-relations are exactly as they would be were everything doubled in mass! Therefore, it is perfectly reasonable to hold that S can be S's own mass_2-counterpart as well as its own counterpart, in which case our mass-counterpart theory—suitably generalized to apply to ordered sets—implies that the actual world can represent the possibility of uniform doubling.

This might be surprising. In every discussion of this issue I have encountered, comparativists and absolutists alike have assumed that the former cannot account for the possibility of uniform doublings; the disagreement has only been whether this is a vice. But if I am right the shared

[7] See Lewis [14], p. 232.

assumption is wrong and the comparativist can make sense of the possibility after all.

2.3 An Argument from Semantics

Some absolutists might argue on semantic grounds. To see how, recall Kripke's famous claim that we use the term 'meter' with the reference-fixing stipulation that if it refers to anything, it refers to the length of standard meter in Paris.[8] The analogous view in the case of mass is that we use 'kilograms' with the reference-fixing stipulation that if it refers to anything, it refers to the mass of that lump of platinum-iridium alloy in Paris that serves as our standard of measurement, known as the International Prototype Kilogram (IPK). But the entity that the Kripkean theory takes the referent of 'kilogram' to be, namely *the mass* of IPK, sounds suspiciously like an intrinsic property of IPK. After all, if the fundamental facts about mass were just facts about mass relationships, it is difficult to see what "the mass" of IPK could possibly be. So, the argument would go, it follows from this Kripkean view that comparativism must be false.

I sometimes get the sense that those attracted to absolutism have this sort of argument in the back of their minds, so it is worth pointing out three ways in which it fails.

First, the Kripkean theory of reference-fixing it presupposes is false. To see this, imagine reading in the Times that the French have been misleading us into thinking that IPK is twice as massive as it actually is in some perverse attempt at a joke. Imagine that the article explains that the illusion has been systematic, so that whenever we used IPK to calibrate our measuring instruments, the calibration succeeded even though we were misled about the properties of the lump. Thus, the article says, if we were to put IPK on one of the many calibrated measuring instruments located around the world, it would read '500 grams', not '1 kilgoram' as we would have expected.

If we believed this article, how would we report the discovery? Intuitively, by saying that we have discovered the surprising fact that the IPK is actually 500 grams! The alternative—to insist that it is 1 kg even in the face of this evidence—would require us to revise our beliefs about the mass in kilograms of *all* other material bodies: if I used to believe that I was 80 kgs, I would have to revise and believe that I am 40 kgs intstead. And this, I claim, we would not do. Therefore, I take the article in the Times to constitute empirical evidence that IPK is not 1 kg. But according to the Kripkean theory of reference-fixing there can be no such evidence,

[8] See Kripke [13].

for it holds that the term 'kilograms' is stipulated to refer to the mass of IPK whatever that turns out to be. Indeed, the Kripkean theory predicts that that we would insist that IPK is 1 kg even after reading the article, contrary to fact. Therefore, the Kripkean theory is false.[9]

A second response to the semantic argument is to grant the Kripkean theory of reference-fixing but point out that the argument only goes through on the assumption that the term 'kilograms' refers. After all, the Kripkean theory only says that *if* 'kilograms' refers to anything it refers to the mass of IPK, but the comparativist may deny the antecedent. The absolutist may respond that it must refer since sentences such as 'My laptop is 2 kilograms' are true, which they could not be if 'kilograms' failed to refer. But the comparativist may simply adopt an error theory about those sentences and deny that they are true after all.

According to this response, the term 'kilogram' is similar to 'phlogiston': both were used with the reference-fixing stipulation that if they refer to anything they refer to whatever entity satisfies some description, but since nothing in the world answers to the description they both fail to refer. The main difference between the two cases is that there is a pragmatic reason to continue using the term 'kilogram' that is lacking in case of 'phlogiston', namely that the former allows us to conveniently store and communicate information about mass relationships. The idea is that if we allow our use of 'kilograms' to be governed by the inference rule

a is r kilograms

b is s kilograms

Therefore, a is r/s times as massive as b

then 'kilogram' can be used as a convenient way of storing and communicating information about mass ratios even if it does not actually succeed in referring to anything and even if the sentences containing it are not strictly speaking true.[10] There is of course a lot to say about an error theory of this sort, but much of it will resemble the discussion about error theories in the case of mathematics, morality, color etc, and I have nothing to add here to the contours of such a debate.

[9] I discuss this sort of case in more detail in Dasgupta [7]. Personally, I find it surprising that the Kripkean theory of 'meters' and 'kilograms' is so often taken for granted in the literature on the contingent apriori, since to my mind the sort of case described in the text clearly shows that it is mistaken. I also argue there that thinking about our use of 'kilograms' actually supports the comparativist view that we use it to express facts that hold in virtue of mass relationships.

[10] I discuss the role of this form of inference in more detail in Dasgupta [7].

The third response to the semantic argument is perhaps the least controversial. The argument, remember, says that the entity to which 'kilogram' is stipulated to refer, namely the mass of IPK, does not seem to be identical to any of IPK's mass relationships, and it concludes that the comparativist must say that there is no such thing. But this last step is a non-sequiter. All the comparativist claims is that all the *fundamental* facts about mass are facts about mass relationships; it is perfectly consistent with this that there is such a thing as the mass of IPK which is not itself identical to any mass relationships, so long as any fact of the matter concerning the mass of IPK holds in virtue of facts about IPK's mass relationships. So the comparativist is free to agree that there is such a thing as the mass of IPK to which the term 'kilogram' refers after all.

The non-sequiter exhibited by the semantic argument is perhaps more evident in the following example. Consider a physicalist who claims that all facts hold in virtue of facts concerning physical entities, and imagine an objector who says 'The term 'stock market' refers to the stock market, but the stock market is not a physical entity; therefore your physicalism is false.' In response, our physicalist will surely point out that her view was never that everything is a physical entity but rather that all facts about the world hold in virtue of facts concerning physical entities, so the argument misses its mark entirely. The comparativist should say exactly the same about the semantic argument.

2.4 An Argument from Perception

One might think that we have direct perceptual evidence for absolutism. This might not be plausible in the case of mass since mass is arguably a theoretical quantity that is not directly perceived at all. So consider the case of spatial distance instead. Right now I am enjoying a visual experience of a computer screen, a mouse and a keyboard layed out on the table in front of me. Directing my attention to the screen and the keyboard, my experience represents them as being a certain distance from one another. Moreover, my experience does not appear to represent this as being a matter of their standing in more complex comparative distance relationships: if I move the mouse, for example, the distance between the screen and keyboard represented by my visual experience is unchanged. But if our visual experiences represent things as standing in absolute distances, one might think that this gives us reason to think that they do indeed stand in absolute distances and that comparativism about distance is therefore false.

But the argument does not convince, for it is guilty of the same non-sequiter as the semantic argument just discussed. The comparativist may

grant that my visual experience does indeed represent my screen as being a certain distance from my mouse and that this is not itself a comparative state of affairs, so long as she insists that facts concerning the distance between the screen and the mouse hold in virtue of comparative facts about distance.

The absolutist might change tack and argue that even if we lack direct perceptual evidence for absolutism, we nonetheless have indirect perceptual evidence. The idea here would be that the intrinsic masses posited by the absolutist are indispensible to our best scientific theories, and that is good empirical reason to think that they are real. But I will argue in Section 3 that absolute quantities are in fact dispensable from our best scientific theories, so let me leave a discussion of this argument until then.

2.5 An Argument from the Lack of Relational Grounds

Perhaps the most direct way to argue against comparativism is to find some facts about mass that do not hold in virtue of mass relationships. For example, consider my laptop's being 2 kgs. The absolutist has no problem making sense of this fact: she can say that it is either identical to, or else holds in virtue of, the fact that my laptop has a certain intrinsic mass. But how is the comparativist to make sense of it? If one can argue that there are no mass relationships fit to do the job, one will have argued that there are facts about the masses of things that do not hold in virtue of mass relationships and hence that comparativism is false.

Why think that there are no mass relationships in virtue of which my laptop is 2 kgs? Primarily because the obvious suggestions do not work. After all, one obvious suggestion is that my laptop's being 2 kgs holds in virtue of its being twice as massive as IPK. But, the argument goes, it is surely possible for my laptop and IPK to both be twice as massive as they actually are, in which case my laptop would be twice as massive as IPK and yet would be 4 kgs, not 2 kgs. But it is a general principle that if the fact that p holds in virtue of the fact that q, then necessarily if q then p. Therefore, my laptop's being 2 kgs does not hold in virtue of its being twice as massive as IPK.

In response, the comparativist might try to find fault in the last paragraph. I believe that there are indeed ways of resisting the argument, but ultimately I believe that its conclusion is correct. So let me concede for the sake of argument that my laptop's being 2 kgs does not hold in virtue of its being twice as massive as IPK, and instead ask how else the comparativist might respond.[11]

[11]For a more detailed discussion of why my laptop's being 2 kgs does not hold in virtue

One option is to adopt the error theory described earlier, according to which there are no facts about mass-in-kilograms. For those not attracted to error theories, though, the other strategy is to find some other body of mass relationships in virtue of which my laptop is 2 kgs. There are a number of possible suggestions. One view is that my laptop's being 2 kgs holds in virtue of my laptop's being twice as massive as IPK *actually* is, for the above argument is no objection to this tweaked view. But one might reasonable worry that this view's use of the actuality operator is somehow illegitimate, so let me outline my own preferred alternative. The key is to recognize that the *in virtue of* relation is irreducibly plural, in the sense that a plurality of facts X can sometimes hold in virtue of another plurality of facts Y even though no X when taken on its own holds in virtue of any of the Y, or indeed in virtue of anything. Given this "pluralistic" conception of the *in virtue of* relation, the comparativist may take the set K of all facts about the masses of things in kilograms, and the set R of all facts about their mass relationships, and propose that the members of K (plurally) hold in virtue of the members of R even though no member of K taken on its own holds in virtue of anything. By adopting this position, the comparativist neatly avoids the burden of having to find some mass relationships in virtue of which my laptop is 2 kgs, for according to her there is nothing in virtue of which it, when considered on its own, obtains. But this does not mean that the view has collapsed into absolutism: since the plurality of all facts about mass in kilograms taken together hold in virtue of the mass relationships between things, it remains the case that the fundamental facts about mass are comparative.

I believe this last response is correct, though I will not defend it here.[12] For current purposes, I hope to have put enough responses on the table so that a would-be comparativist finds one of them convincing.

3 In Favor of Comparativism

Having surveyed a number of arguments against comparativism, I find none of them convincing. But is there any positive reason to be a comparativist? I believe there is. As I outlined in the introduction, I think we should dispense with the intrinsic masses posited by the absolutist for the same reason that modern physicists and most modern metaphysicians dispense with absolute velocity and absolute simultaneity: these features would all be undetectable if real, and our Occamist principle says that this is a mark against any theory that posits them.

of its relationship to IPK, see Dasgupta [7].

[12] See Dasgupta [7] for an extended defense of this view.

Much depends on what I mean by 'undetectable'. If I used the term to include anything that we cannot see with the naked eye, our Occamist principle would recommend that we become radical scientific anti-realists and dispense with so-called "theoretical" entities such as electrons. But as I use the term, electrons are detectable because there are physically possible processes such as those that occur in particle accelerators that reveal their presence and their properties to us. The Occamist principle I wield is therefore reasonably weak, since it only recommends dispensing with features that are physically impossible for us to access. Nonetheless, it is strong enough to recommend our dispensing with absolute velocity and simultaneity, as well as intrinsic mass.

Nor does our Occamist principle say that we should *always* dispense with undetectable structure. It just says that undetectable features undesirable, so that all else being near enough equal we should prefer theories like comparativism that dispense with them. But the last section suggests that for our purposes all is indeed near enough equal, for it showed that there are no overwhelming reasons to reject comparativism.

Our crucial premise, then, is that if material bodies really possessed the kind of intrinsic mass posited by the absolutist, those intrinsic masses would be undetectable in our strong sense of the term. The bulk of this section will argue for this. I will then finish by discussing the extent to which our argument generalizes to other quantities.

3.1 Perceptions and Devices

How should we argue for the claim that the intrinsic masses posited by the absolutist would be undetectable if real? There is a reasonably well known argument for the analogous claim in the case of absolute velocity, so let us rehearse it before applying it to the case of intrinsic mass.[13]

First, what is *absolute* velocity? We often talk of a material body's velocity relative to another material body: a car cruising down the highway might have a velocity of 55 mph in a particular direction relative to the highway and 10 mph in the same direction relative to the train traveling alongside it. Its absolute velocity, if there is any such thing, is neither of these things but instead a velocity independent of its relations to other material bodies.

Now why, if there were such a thing as absolute velocity, would it be

[13]This sort of argument has received perhaps its clearest written expression in Roberts [17]. I heard similar arguments orally in seminars given by Tim Maudlin at Rutgers and David Albert at Columbia. However, all these theorists run the argument in importantly different ways. My presentation here is similar to my presentation in Dasgupta [5]. A more thorough analysis of the style of argument is presented in Dasgupta [6].

undetectable? It is a familiar fact that sitting in a train in smooth motion looks and feels just like it does when the train is at rest in the station (so long as one does not look out the window!). This motivates the thought that we cannot distinguish between different absolute velocities with the naked eye. But it does not yet follow that absolute velocity is undetectable in our sense, since it remains open that we could build some sort of device that could measure it. But what would such a device be like? At a minimum, it would need to be sensitive to whether it was in a state of absolute rest or not. What this means is that it would need to have two properties: first, it would need to be built in such a way that if it were switched on at some initial time t_0 while at rest, it would register this fact by, say, displaying 'At Rest' on a computer screen at some later time t_1; and second, if it were switched on at t_0 while moving it would then register this differently, say by displaying 'Moving' on the screen at t_1 instead.

But according to most of our best confirmed physical theories, it is physically impossible for a device to have both properties. To show this, we suppose that I succeed in building a device with the first property and then show that it lacks the second. To this end, suppose I take a device with the first property and switch it on at t_0 while at rest, and it therefore registers 'At Rest' on its screen at t_1. Now consider a world W just like ours with the one exception that at any given time the absolute velocity of each material body is five mph greater in a certain specified direction. Note that W is a world in which the device is switched on at t_0 while moving, and yet—since the relative positions of all material bodies at all times are (by construction) the same in W as they actually are—it is a world in which the words 'At rest' appears on the device's screen. Now, let us assume that the laws of motion governing W are the same as those governing ours. If so, it follows that the behavior of the device in W represents *how it would behave, given the physical laws governing it, were it turned on while in a state of motion*. Therefore, it follows that if the device were turned on while moving it would display 'At rest' on its screen, not 'Moving'; hence it does not have the second property listed above.[14]

[14]This sketch of the argument leaves out many details. For one thing, someone might object that being at rest is part of the device's "ready state", and therefore that how it would behave when switched on while moving is of no relevance when asking whether it counts as an absolute velocity measuring device. One short reply to this objection is that it must ultimately be directly perceivable (without the use of machines) whether a device is in its ready state, on pain of our never being able to recognize whether it is in that state, and we have already argued that absolute velocity is not directly perceivable (though this is not the reply I would endorse). Another issue is that the argument only considers two outcome states, namely a display of 'At rest' and 'Moving', so how do we know that the argument generalizes the outcome states of all possible devices? I discuss these questions in Dasgupta [6].

That is the reasonably well-known argument for the claim that absolute velocity would be undetectable if real. Note that we had to assume that the laws of W are the same as the actual laws, for if this were not the case then W would teach us nothing about how the device would behave in the counterfactual scenario that it is turned on while moving. And the assumption is reasonable, since it follows from most of our best confirmed physical theories. But what is seldom noticed—and this will be important in what follows—is that a similar argument can be run with a weaker assumption. Suppose that the laws of W are different from the actual laws but that an empirically indiscernible set of laws obtain in W instead. By saying that they are empirically indiscernible, I mean not only that they are empirically equivalent to the actual laws, but moreover that they score equally well on the other theoretical virtues that we use to choose between competing theories, such as being explanatory, unifying, simple, and so on. Then even if a device with the two properties listed above were physically possible, we would nonetheless be in no position to use it because we would not know what is indicated by an outcome in which the phrase 'At rest' appears on the display at t_1. Conditional on the laws of the actual world holding it indicates that the device was at rest at t_0, while conditional on the laws of W holding it indicates that the device was moving at t_0; but since the two sets of laws are empirically indiscernible we are not in a position to know which set of laws to conditionalise on!

So for a device to enable us to measure our absolute velocity, it must have a third property in addition to the two listed above: it must be possible for us to know what absolute velocity a given outcome of the measurement indicates. As long as the laws of W are empirically indiscernible from our own, no device could have this property while having the two listed above. Therefore, the assumption we need to make about W is not that W's laws are our actual laws, but rather that *either* they are our actual ones *or* they are empirically indiscernible from them.

Returning to the case of intrinsic mass, let us suppose for reductio that the material bodies around us have the intrinsic masses posited by the absolutist; our task is to argue that those intrinsic masses would be undetectable. As in the case of velocity, we start by motivating the idea that we cannot perceive them with the naked eye, and then argue that it would be physically impossible to build a device that could help.

Can we perceive intrinsic mass with the naked eye? It is not entirely clear. I can arguably tell that my laptop is more massive than my cup just by picking them up, but this is just to perceive something about how they are related in mass. Now, we convinced ourselves that we cannot perceive absolute velocity with the naked eye by noticing that the familiar

situations of being in a train in smooth motion and one rest in the station look and feel the same. The analogous test is to ask whether situations that differ in a uniform doubling of mass would look and feel the same. But unfortunately these situations are not familiar to us at all!

Nonetheless, some considerations suggest they would look the same. For example, notice that the two situations would agree on all facts about particle positions, both in your brain and in the local environment. If we assume that the character of one's mental life depends only on the positions of the particles composing one's brain and local environment, it follows that the two situations would look exactly the same. And the assumption is surely plausible: to the extent that one's mental life depends on one's brain-state at all, the empirical evidence suggests that it depends on neural activity which itself consists in changes in the positions of various particles.

A full discussion of this issue would take us too far into the philosophy of mind. For now, let us press on by assuming that the two situations would look exactly alike and flag the assumption for further work. The next question is: if our bare senses cannot do the job, is there a physically possible device that could reveal the intrinsic masses to us? To argue that there is not, we can copy our argument in the case of velocity and ask what such a device must be like. For convenience, let us suppose that terms such as '1 kg' and '2 kgs' label intrinsic masses. Then, at a minimum, our device would need to have three properties: first, if presented with a 1 kg object at t_0 it would need to be built in such a way that it would display '1 kg' on its screen at t_1; second, if it were presented with a 2 kg object at t_0 it would need to display '2 kg' on its screen at t_2; and third, it must be possible for us to know which mass is indicated by each outcome.

But the same argument that we just rehearsed shows that such a device is physically impossible. For suppose I succeed in building a device with the first property, and suppose I present it with a 1 kg object at t_0 and it registers '1 kg'. Now consider a possible world W just like ours with the one exception that everything's mass is double what it actually is, and let us assume that the laws of W are either the same as the actual laws or else empirically indiscernible (I will defend this assumption in a moment). If the laws of W are our own, it follows that if the device were presented with a 2 kg object at t_0 it would (according to our laws) display '1 kg' on its screen at t_1 since that is what appears on the display in W, where the device is presented with a 2 kg object; hence it would not have the second property listed above. And if the laws of W are distinct but empirically indiscernible from our own, then whether an outcome of '1 kg' at t_1 indicates that the object presented to it at t_0 was 1 kg or 2 kgs

depends on which of two sets of empirically indiscernible laws obtain, which is something we cannot know; hence the device would not have the third property listed above. Either way, it is physically impossible for the device to have all three properties listed above.

For this reason, I believe that if material bodies really did possess the kind of intrinsic mass posited by the absolutist, those intrinsic masses would be undetectable in our strong sense of the term. Therefore, our Occamist principle recommends that (all else being roughly equal) we reject absolutism.

3.2 Sameness of Laws?

I just assumed that the laws of W would either be the same as ours or else empirically indiscriminable. But is this right?

To answer this question, let us just consider one simple law governing mass: $f{=}ma$. Ignoring any other laws specifying the force acting on each particle, let us simply ask whether this law, or at least an empirically indscriminable cousin, is a law in W if it is in the actual world (as we will see, the following discussion naturally generalizes to any set of laws and quantities).[15] Now, $f{=}ma$ is a law in W just in case (i) it is true in W that $f{=}ma$, and (ii) that truth is also a law in W. But it is tempting to think that condition (i) is not satisfied, since if the equation is actually true then doubling everything's mass while leaving their forces and accelerations unchanged would break the equality. Put otherwise, if $f{=}ma$ was true in a world in which all masses were doubled it is tempting to think that everything would accelerate slower since they would be more massive, which is not the case in W. But in fact, that depends on how we interpret the content of the equation $f{=}ma$. I will argue that on one reading it is true in W after all, while on another reading it is not true but something empirically indiscriminable is instead. After that, I will argue in either case, the relevant truth in W (either $f{=}ma$ or the empirically indiscernible cousin) is also a law in W; hence condition (ii) is satisfied too.

So, what is the physical content of the equation $f{=}ma$? Taken at face-value, it appears to state a mathematical relationship between the numbers

[15] By focusing just on $f{=}ma$ we sidestep the complication that mass plays a unique role in classical mechanics: not only is it a "brake" on acceleration as described in $f{=}ma$, it is also a determiner of the gravitational force between things as described in the inverse-square gravitational force law. The fact that it plays this dual role might tempt one to think that doubling everything's mass would preserve the truth of the classical mechanical laws, since the increase in gravitational forces would be counter-balanced by the increased "brake" effect experienced by each body. But even if this line of reasoning were valid, it would not generalize to other quantities. Since we are looking for general considerations, I shall consider $f{=}ma$ in isolation from whatever force laws it might couple with.

and vectors that represent the quantities of force, mass and acceleration given a particular choice of scale. But it also states something about the quantities themselves, rather than the numbers and vectors that represent them. There are two readings of what it might say about those quantities, one on which it says something about absolute quantities and another on which it says something about comparative quantities. The first reading interprets it as saying that the absolute quantities of mass, acceleration and force all line up in a specific way. On this reading, part of its content is that anything with the particular mass M and the particular acceleration A has a certain force F acting on it (where 'M', 'A' and 'F' all refer to a particular absolute determinate mass, acceleration and force respectively). Of course, the law generalizes over other determinate absolute quantities too, so the complete interpretation will be something like this:

(L1) For any material thing x,

(a) For any reals r_1 and r_2, if x has mass r_1M and acceleration r_2A, then x has force r_1r_2F acting on it.

(b) For any real r_3, if x has force r_3F acting on it, then there are reals r_4 and r_5 who's product is r_3, such that x has mass r_4M and acceleration r_5A.

By contrast, a second interpretation of the equation has it stating a relationship between the ratios of mass, acceleration and force, for example that if a particle x has twice as much force exerted on it than y and they are of the same mass, then x will accelerate at twice the rate as y. Specifically:

(L2) For any material things x and y,

(a) For any reals r_1 and r_2, if x is r_1 times as massive as y and is accelerating r_2 times the rate of y, then x has r_1r_2 times as much force acting on it than y.

(b) For any real r_3, if x has r_3 times as much force acting on it than y, then there are reals r_4 and r_5 such that $r_4r_5 = r_3$, and such that x is r_4 times as massive as y and is accelerating r_5 times the rate of y.

Now when we write $f{=}ma$, we could mean (L1) or (L2). So when we ask whether W is a world in which $f{=}ma$ is true, we need to consider each interpretation in turn.

Clearly, (L2) is true in W if it is true in the actual world, for (L2) only talks of comparative relations and those are the same in W as they are in the actual world. Equally clearly, this point generalizes to other laws and

quantities: if the laws themselves only state relations between determinate *comparative* states, then a world that differs only in the determinate states posited by the absolutist while preserving the comparative states will be a world in which those same laws hold.

What about (L1)? Well, if it is true in the actual world then it is not true in W, since in W the absolute quantities of mass, force and acceleration line up differently. However, something closely related is true in W, namely the result of replacing all occurrences of 'M' with '$2M$' (where this latter term refers to the mass that is double that of M). Call this (L3). The important thing to notice is that there is no experimental evidence we could possibly gather that would confirm which of (L1) or (L3) is true! After all, given any world in which (L1) is true, there is a corresponding world in which (L3) is true instead, namely the world that differs only in the fact that everything's mass is doubled. And since we are assuming that situations differing only by a uniform multiplication of mass would look and feel exactly the same, the two worlds would be indiscernible. And vice-versa: given any world in which (L3) is true, there is an indiscernible world in which (L1) is true instead. And since (L1) and (L3) have the same form, it is hard to see how any consideration of simplicity, elegance and so on could choose between them. Therefore, (L1) and (L3) are empirically indiscernible.

This suffices to show that in W, either $f{=}ma$ or an empirically indiscernible cousin is true. But are they *laws* in W? I think they would be, but how one should argue for this depends on one's opinion on the status of laws. Anti-Humeans believe that whether a truth is a law at a given world is itself a fundamental fact about the world that does not hold in virtue of the distribution of categorical properties and relations. Anti-Humeans can therefore stipulate that the relevant truth at W—either $f{=}ma$ or its empirically indiscernible cousin—is also a law at W. Other theorists, called Humeans, think that whether a truth counts as a law at a given world depends on the distribution of categorical properties and relations at W. For the Humean, whether $f{=}ma$ or its empirically indiscernible cousin is a law at W will depend on her exact account of what makes something a law. But I submit that on no plausible Humean view would count them as being laws in the actual world but not at W: a uniform doubling of mass simply does not seem to be the kind of change that could make the difference. And indeed, none of the Humean views on the market imply that they would be laws in the actual world but not at W.

If this is right, then W is indeed a world in which either our laws obtain or else empirically indiscernible laws obtain instead. Therefore, our argument for the impossibility of a device that detects different determinate intrinsic masses goes through.

3.3 Generalizing

This, then, is my reason for preferring comparativism. Since the intrinsic masses posited by the absolutist would be undetectable in our strong sense, it follows that given any physical theory of mass formulated in absolutist terms there is an empirically equivalent theory formulated in comparativist terms that dispenses with undetectable structure. Our Occamist principle then recommends that, all else being near enough equal, we should prefer the latter theory over the former, and Section 2 argued that all else is indeed near enough equal since there are no overwhelming reasons to reject comparativism.

To what extent does this argument generalize to other quantities? One issue is whether the features posited by the absolutist in the case of other quantities are undetectable in the same sense that intrinsic masses are. And even if they are, the second issue is whether there are overwhelming reasons to reject comparativist views of those quantities. As for this second issue, it seems to me that our discussion of the arguments against comparativism in Section 2—the arguments from intuition, from modality, from semantics, from perception and from the lack of relational grounds—all generalize unproblematically.

But the first issue is more pressing. To see this, consider the case of spatial distance. The absolutist, recall, claims that the fundamental facts about distance have the form

X is a certain distance D from Y

while the comparativist claims they take the form

X is further from Y than Z is from W

or perhaps

X is twice as far from Y as Z is from W

Now, would the absolute distances posited by the absolutist be undetectable if real? If we replicated our arguments in the case of mass, we would start by arguing that situations which differ only in a uniform doubling of distances from some origin would look and feel exactly the same, in just the same way that the interior of a train in smooth motion looks and feels exactly the same as one at rest in the station. And one might object that this is clearly not the case: surely everything would look more spread out!

But in fact, that is not clear. If I doubled all the distances from me to things in this room (doubling the size of the room) things would indeed look much more spread out, but that is not the relevant situation to

consider. Instead, we must imagine that all the particles composing me and my brain are similarly spread out from some origin. My eyes would therefore be larger and more spread apart, and this might result in things looking just as they actually do. More generally, recall that in the case of mass I floated the somewhat plausible idea that the character of one's mental life depends only on the positions of the particles composing one's brain and local environment. But the idea is ambiguous: are the relevant facts the absolute distances between particles or their comparative distance relationships? If the latter, then since they will be preserved by uniformly spreading out all the particles, it would follow that things would look and feel exactly the same in the spread out situation.

So it is certainly not *obvious* that things would look more spread out. As in the case of mass, a full discussion of this issue would take us too far into the philosophy of mind so I will not pursue it here. For our purposes, it suffices to say that this is probably where the absolutist's best line of defense lies.

4 Conclusion

The absolutism/comparativism issue has received very little discussion in the philosophy and physics literature. I consider this a significant lacuna in our understanding of what the natural world fundamentally consists in. In this paper I have clarified what the issue amounts to and described where I see the major battle lines as lying. My view is that comparativism is probably the correct view for theoretical quantities such as mass and perhaps even for quantities like spatial distance too. But even if I have not convinced you of that, I hope to have shown that the issue is important and that there is interesting further work to do in the area.

References

[1] Armstrong, D. 1978. *A Theory of Universals: Volume 2*. Cambridge: Cambridge University Press.

[2] Armstrong, D. 1988. Are Quantities Relations? A Reply to Bigelow and Pargetter. *Philosophical Studies* 54.

[3] Bigelow, J. and R. Pargetter 1988. Quantities. *Philosophical Studies* 54: 287–316.

[4] Bigelow, J. and R. Pargetter 1990. *Science and Necessity*. Cambridge: Cambridge University Press.

[5] Dasgupta, S. 2009. Individuals: An Essay in Revisionary Metaphysics. *Philosophical Studies* 145: 35–67.

[6] Dasgupta, S. Symmetries in Physical Reasoning. (Manuscript). Draft available at http://www.shamik.net/Research.html.

[7] Dasgupta, S. On the Plurality of Grounds. (Manuscript). Draft available at http://www.shamik.net/Research.html

[8] Eddon, M. Fundamental properties of fundamental properties. (Manuscript).

[9] Ellis, B. 1966. *Basic Concepts of Measurement*. Cambridge: Cambridge University Press.

[10] Field, H. 1980. *Science without Numbers* Princeton, NJ: Princeton University Press.

[11] Field, H. 1985. Can We Dispense With Space-time? *PSA* 2: 33–90.

[12] Hawthorne, J. 2006. Quantity in Lewisian Metaphysics. In *Metaphysical Essays*, pp. 229–238. Oxford: Clarendon.

[13] Kripke, S. 1972. *Naming and Necessity*. Oxford, UK: Blackwell.

[14] Lewis, D. 1986. *On the Plurality of Worlds*.

[15] Lewis, D. 1986. *Philosophical Papers: Volume 2*. Oxford: Oxford University Press.

[16] Mundy, B. The Metaphysics of Quantity. *Philosophical Studies* 51: 29–54.

[17] Roberts, J. 2008. A Puzzle About Laws, Symmetries and Measurable Quantities. *British Journal for the Philosophy of Science* 59: 143–68.