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*Newton on Substance*

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Newton does not explicitly discuss the notion of substance much and certainly does not articulate his conception of substance in any detailed or systematic way. In the face of this fact about Newton's writings it might seem a misguided act of speculation to attempt to provide an account of Newton's conception of substance. Nevertheless, Newton's conception of substance plays an important role in his thought. Among other issues, Newton's conception of substance is intimately connected to his claim that action at a distance is absurd and inconceivable, that God is omnipresent, that minds are spatially located, that matter is passive, and that space and time are not substances. By getting clearer on Newton's conception of substance, we can hope to have a better understanding of these claims and Newton's reasons for asserting them. Moreover, as I will argue in this paper, Newton's conception of substance provides a particularly nice window into the empiricist underpinnings of Newton's thought through its affinities with the conception of substance Locke develops in his *Essay*.

The ultimate claim I will defend here is that on Newton's conception of substance a substance can have only one power. An immediate consequence, as we will see, is that gravity is not a power of bodies and so not a material force. In order to defend my central interpretive thesis, however, there is much groundwork that must be laid. I will begin by drawing out the connection between power and substance for Newton. In doing so, and to help clarify the relation between power and substance, I will draw a parallel between Newton's and Locke's conceptions of substance (Part I). Once we have the basics of

Newton's conception of substance on the table, a particular problem will arise: Newton appears to claim that bodies have multiple powers but given the conception of substance developed, it isn't clear how multiple powers can be powers of one substance (Part II). After considering the answer to this question offered by Stein (2002)—an interpretation of Newton's conception of substance which is broadly in agreement with the one I develop in the first part of this paper—I will argue that Stein's interpretation cannot be reconciled with Newton's claims about gravity and distant action. With Stein's solution off the table, I will argue for what I call a *minimalist* interpretation of Newton's conception of substance: given Newton's Lockean approach to substance, a substance can only have one power (Part III).

### I. Newton's Conception of Substance

In this section I will give and motivate my interpretation of substance in Newton's thought. The main aim is to establish the following points: substance is power, that is, what is intelligible concerning substances are powers; activity is best thought of as interactivity, contrasting not with passivity but instead with influence on change in motion or thought; and finally, that Newton rejects a substratum view of substance. The starting point for my interpretation is Newton's discussion of the difference between space and body in *De Gravitatione*. After announcing his main concern in *De Gravitatione* Newton begins by defining place, body, motion and rest. He then immediately notes that his definitions are at odds with their Cartesian counterparts and launches an extended attack to undermine the Cartesian status quo. After taking on Descartes' conceptions of motion and place, Newton targets what he sees as the rotten core of the Cartesian metaphysics of motion: the claim that

body is extension.<sup>1</sup> To defeat the Cartesian conception of body, then, Newton argues that space and body must be distinguished. In drawing this distinction between non-substantial space and substantial body, Newton reveals the central components of his conception of substance. As we proceed through the evidence of *De Gravitatione*, I will also draw on later works to show that this conception of substance survived into Newton's later thought.

*i. Substance as activity*

Newton's argument against the Cartesian identification of body and extension proceeds by giving an account of each such that their non-identity is evident. An overview of this argument will be helpful for structuring my interpretation. Newton begins with an account of space in which he argues against its substantiality. Obviously, given that body is a substance, if space isn't a substance, then body and space cannot be identical. Having considered space, Newton goes on to give an account of the nature of body. Newton argues that body includes more than extension from two different directions. In his (famous) hypothetical creation story, Newton speculates as to what God might have added to empty space in creating body. Less famously, Newton goes on to suggest that even following Descartes' method for determining the essence of body—stripping or abstracting the merely sensible from body—does not leave extension alone. We can now turn to the text of *De*

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<sup>1</sup> That Newton thinks the last refuge for Cartesian metaphysics of motion in the wake of his attacks on Descartes' definitions of motion and place is to be found in its account of body is evident in the following passage from *De Gravitatione*: "In addition, since Descartes...seems to have demonstrated that body does not differ at all from extension...and as this has been taken by many as proved, and is in my view the only reason for having confidence in this opinion, and less any doubt should remain about the nature of motion, I shall reply to this argument by saying what extension and body are, and how they differ from each other" (Newton, 21).

*Gravitatione* to highlight how each of these three anti-Cartesian arguments reveal the centrality of power in Newton's conception of substance.

We can begin with Newton's arguments against the substantiality of space. Of course, the precise status of space in Newton's thought is a thorny issue—if it is neither attribute nor substance, what could it be? Fortunately, given my limited aim of examining Newton's conception of substance, we can set that issue aside and instead focus on Newton's discussion of what counts against space's substantiality. Newton claims, “[Space] is not a substance: on the one hand, because it is not absolute in itself, but is as it were an emanative effect of God and an affection of every kind of being; on the other hand, because it is not among the proper affections that denote substance, namely actions, such as thoughts in the mind and motions in the body” (Newton, 21). Since the first clause in this passage focuses on a more positive characterization of space as an ‘as it were emanative effect’, I will focus on Newton's other hand. Newton immediately proceeds to draw out the connection between activity and substance:

“For although philosophers do not define substance as an entity that can act upon things, yet everyone tacitly understands this of substances, as follows from the fact that they would readily allow extension to be a substance in the manner of body if only it were capable of motion and of sharing in the actions of body. And on the contrary, they would hardly allow that body is substance if it could not move, nor excite any sensation or perception in any mind whatsoever” (Newton, 21-22).

Newton here clearly ties the insubstantiality of space to its inability to act. With respect to bodies this inaction is irrelevant in determining the motions of bodies. With respect to minds, it is a matter of having no influence in determining the thoughts of minds by exciting sensations or perceptions in them. In his subsequent exposition of space, Newton again highlights its irrelevance to determining the motions of bodies: “in space there is no force of any kind that might impede, assist, or in any way change the motions of bodies” (Newton

26). So, Newton's arguments against the substantiality of space suggest that substantiality requires activity, which, with respect to body, is influence on motion.

The connection between substance and activity is also exhibited in the second phase of his anti-Cartesian argument, his account of body. Newton begins his account by framing it in terms of a hypothetical creation story, "we can define bodies as *determined quantities of extension which omnipresent God endows with certain conditions*" (Newton, 28 original emphasis). In spelling out the endowed 'conditions' it becomes evident that such conditions are powers:

"(1) that they be mobile, and therefore I did not say that they are numerical parts of space which are absolutely immobile, but only definite quantities which may be transferred from space to space; (2) that two kinds of this kind cannot coincide anywhere, that is, that they may be impenetrable, and hence that oppositions obstruct their mutual motions and they are reflected in accord with certain laws; (3) that they can excite various perceptions of the senses and the imagination in created minds and conversely be moved by them, which is not surprising since the description of their origin is founded on this" (Newton, 28-29).<sup>2</sup>

God creates bodies by endowing regions of space with certain powers: the power to move, the power of impenetrability, and the powers of interacting with minds (exciting sensations and being moveable by acts of will). Thus, in creating substantial bodies, God creates certain powers. Again, then, the connection between substance and activity or power is evident.

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<sup>2</sup> Newton's final claim—"which is not surprising since the description of their origin is founded on this"—seems to be a reference to his preface to the creation story in which he says we can understand God's endowing regions of space as similar to our ability to move our bodies merely by acts of mind: "Since each man is conscious that he can move his body at will, and believes further that other men enjoy the same power of similarly moving their bodies by thought alone, the free power of moving bodies at will can by no means be denied to God, whose faculty of thought is infinitely greater and more swift. And for the same reason it must be agreed that God, by the sole action of thinking and willing, can prevent a body from penetrating any space defined by certain limits" (Newton, 27).

The connection between substance and activity or power continues in the third of Newton's arguments, his self-described 'concise response' to Descartes.<sup>3</sup> Instead of considering what God could have added to extension to create body, Newton considers what remains when we strip all sensible qualities from body and end up with what Descartes would consider body's essential qualities: "let us abstract from body...all sensible qualities so that nothing remains except what pertains to its essence. Will extension alone then remain? By no means" (Newton 33-4). Stripping body of its sensible qualities, leaving its essence we are not left with extension but (i) the powers of interacting with minds and (ii) the power of resistance. Newton thinks the latter is evident in the motions of bodies in fluids. After noting that different fluids provide different resistances to bodies passing through them, Newton claims, "if the subtle matter were deprived of all forces of resistance to the motion of globules, I should no longer believe it to be subtle matter but a scattered vacuum. And so if there were any aerial or aetherial space of such a kind that it yielded without any resistance to the motions of comets or any projectiles, I should believe that it is utterly empty" (Newton 33). Again, the connection between substance—body in this case—and activity or power—"resistance to the motion of globules"—is at the root of Newton's distinction between non-substantial space and substantial body. The absence of a power to alter the motions of bodies is the absence of substance.

*ii. Activity as interactivity*

The preceding discussion not only reveals an important connection between substance and activity or power for Newton. It also provides insight into how 'activity' or 'power' should be understood in the context of substance for Newton. Perhaps most

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<sup>3</sup> "Moreover, so that I may respond more concisely to Descartes' argument..." (Newton 33).

important, the texts reveal that ‘activity’ and ‘power’ are *not* to be contrasted with passivity. Consider the last power examined above, the power of resistance Newton believes to remain after we abstract from body’s sensible qualities. This power of resistance appears to be passive in the sense that a body must be acted upon before this power is manifest. In similar fashion, one might worry that impenetrability is similarly passive—only when another body attempts to occupy another’s place will the impenetrability of each be manifest in the subsequent alteration of each body’s motion. If we understand ‘power’ and ‘activity’ in this broad way, however, one might worry that even space may have some substance-making powers; the power, for example, to be filled or occupied.

Fortunately, the texts we have already examined provide sufficient evidence to thread this needle. Substance-making powers are powers relevant to determining the motions of bodies and perceptions of minds. This point is most evident in Newton’s argument against the substantiality of space (the first argument considered above) and his claim that a power of resistance remains in body even once we have abstracted away from its sensible qualities (the third, so-called ‘concise’, argument). Taking the former first, recall that space exhibits no activity, is impotent, according to Newton because it has no bearing on determining the motions of bodies or perceptions of minds. Similarly, in defending his claim that a power of resisting motion remains in our conception of body even if we strip away from its sensible qualities, Newton insists that to strip away the power to resist the motion of other bodies is to finally eliminate body and leave only empty space.

On the one hand, then, substance-making activity is not to be contrasted with passivity. Since ‘power’ seems to me to more readily cover both ‘active’ and ‘passive’ powers, going forward I will only use that term. On the other hand, however, substance-

making powers are robust enough such that that space does not qualify as a substance on the grounds that it has the capacity to be filled. In short, then, Newton's conception of substance places *interactive* powers are at the heart of substantiality: at least in the non-divine cases, substance-making powers are powers of interaction, powers to change motions of bodies and thoughts of minds.

As I noted above, two of the three sets of texts previously considered neatly support the claim that substance-constituting powers are powers of interaction. One might worry, however, that not all of the powers given in the other text, Newton's hypothetical creation story, offer such support. In particular, one might worry about whether one of the powers added to space to get body is a power of *interaction* at all: namely, the power of mobility.

At first glance the condition of mobility does not look like an interactive power since we can understand it as an ability to change place. Of course, by moving, one thing may effect the movement of something else, but it isn't clear how mobility is itself an interactive power. If mobility is not itself a power of interaction, then it cannot on my interpretation constitute a substance. But in laying out how God might have created body, Newton seems to suggest that mobility is a substance-making power of body. If correct, this would seriously undermine my interpretation. Fortunately, however, that there is a difficulty in understanding what it is to endow a region of space with mobility and so this *prima facie* understanding of mobility must go and its proper replacement is more obviously an interactive power.

The issue is this: the creation story is a story of what God might do to a region of space to create body. In this context, 'space' refers to the conception of absolute space that



Newton has developed in the immediately preceding pages of *De Gravitatione*.<sup>4</sup> Of course, if the parts or regions of space are not themselves moveable as Newton states in his account of space (Newton, 25), then it isn't clear in what sense a part of space can be endowed with mobility. Indeed, it is difficult to understand how a region of absolute space could move at all since, by Newton's own lights, for it to move would be for it to become a different region of space (Newton, 25).<sup>5</sup> Thus, a straightforward understanding of the power of mobility as a power to change place endowed to a region of space is not acceptable because parts of space cannot change place without loss of identity. We need a different approach to the power of mobility.

The following seems a promising candidate: the mobility of body is the mobility of body's other substance-making powers, such as impenetrability. The important lesson for addressing the interactivity of mobility is that mobility is not a fundamental power of bodies in the same way that impenetrability and mind-interactivity are since mobility is not something that can be added to a region of space itself. Thus, the substance of body is not, at root, constituted by a power of mobility. However plausible this account may be, it raises the question of how to understand the mobility of bodies, fundamental or not. I suggest that the answer to this question is that there is no discrete power of mobility for Newton. Rather there are particular power(s) of motion, that is, powers of moving in certain ways. The power of mobility is nothing but the exercise of these powers.

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<sup>4</sup> That Newton is concerned with absolute space in his account of the nature of space seems to be evident in his claims about it: it is infinite (Newton, 23), its parts are motionless (25), "the positions, distances, and local motions of bodies are to be referred to the parts of space" (26), and finally, space is "eternal in duration and immutable in nature because it is the emanative effect of an eternal and immutable being" (26).

<sup>5</sup> Newton makes this point himself in the definitions at the beginning of the *Principia* (add citation).

To clarify this point and see some of its textual basis, we can consider some reasons why impenetrability might not seem like a fundamentally interactive power. As in the case of motion, it seems clear that if a body is impenetrable that impenetrability will effect the movement of other bodies. However, as also in the case of motion, we seem to have a grasp on impenetrability that is independent of the motions of other bodies: bodies are impenetrable in that no two bodies can occupy the same place. In Newton's hands, however, this characterization of impenetrability yields to an explicitly interactive conception: "that two of this kind cannot coincide anywhere, that is, that they may be impenetrable, and hence that oppositions obstruct their mutual motions and they are reflected in accord with certain laws" (Newton, 28). This suggests that substance-making power of impenetrability be understood as that power which determines how bodies move when 'attempting' to occupy the place of another body. I propose to understand the 'conclusion' of the above passage ('and hence...') as articulating the non-coincidence of bodies rather than describing the effect of impenetrability. The impenetrability of bodies consists in the motion that results from their attempting to occupy each other's space, as characterized by the laws governing these motions.<sup>6,7</sup> Further support of this interpretive point will come shortly as I defend the

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<sup>6</sup> One might worry that impenetrability can be understood through a variety of different laws of reflection. On one possible scenario, two things brought into contact may simply stop and stay in contact. On another, they move away from each other. In each case, however, there is impenetrability. Thus impenetrability is more than the laws relevant to the reflection of bodies. The appropriate reply, I believe, is similar to the move I made above with respect to the relation between the power of mobility in general and the powers of moving in particular ways: we can form a general understanding of impenetrability as a generalization from the varieties of reflection. This move, however, is admittedly far removed from any of Newton's own writings.

<sup>7</sup> Schliesser (MS) also contains the suggestion the power or force of impenetrability be understood as a power or force of moving in certain ways and so characterized by certain laws. Schliesser's interpretation of the conditions of Newton's creation story, emphasis added: "That is to say, the 'nature-engendering nature' of bodies is not God's will, but

claim that substance-making powers are made intelligible to us through laws of motion. For now, however, we can return to the issue of how to understand the power of mobility as an interactive power.

According to the suggestion above, the power of impenetrability just is a power of moving in certain ways upon impact with another body. Thus, if impenetrability were the only power of motion, impenetrability would exhaust body's power of mobility and the two could be identified. That is, the power of mobility would be nothing more than the power of impenetrability; or, the exercise of the power of mobility would be understood as nothing more than the exercise of the power of impenetrability.<sup>8</sup> At metaphysical root, then, would be the power of impenetrability (or other particular powers of motion), an interactive power of bodies by which their motions are determined.

*iii. Newton, Locke and the intelligibility of substance and power*

At this point it will be helpful to turn to Locke's treatment of substance to help clarify the connection between powers and substance in Newton. So far we have seen that interactive powers are at the heart of Newton's conception of substance. In this respect there is a strong, and, I believe, illuminating parallel between Newton and Locke on substance. By turning to Locke on substance I hope to flesh out the relation between power and substance in Newton that I have so far sketched. Specifically, the point I want to make is that on Newton's conception of substance, what is intelligible to us concerning substance are interactive powers; our knowledge of substance is knowledge of powers.

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(presumably) the essential qualities of body, e.g., i) mobility; ii) *impenetrability, which Newton articulates in terms of law-like behavior in collision*; and iii)..." (Schliesser, 8).

<sup>8</sup> As we will see in sections II and III below, when gravity comes prominently on the scene in *Principia*, this story gets more complicated since one might worry that if gravitational attraction is a principle of the mobility of bodies, bodies will act distantly.

Working within the framework of a theory of ideas, Locke approaches substance through our idea of substance. According to Locke, our ideas of substance are complex ideas formed by the mind from the simple ideas it receives in sensation and reflection. We form ideas of substances when we notice certain ideas constantly going together (cite 2.23.x). Complex ideas of substance are unique among complex ideas in that their construction involves combining the constantly conjoined ideas with the idea of some kind of support. Most important for my purpose here, however, is that, according to Locke, the ideas which go into our ideas of substances are for the most part ideas of powers and so our ideas of substances are almost entirely composed of ideas of powers (2.23.8-10, 37). In the first place these powers are sensible qualities, powers to produce ideas in us (these includes both primary and secondary qualities) (cite 2.21.x). In the second and no less important place, the powers of substances are powers to produce and undergo changes in sensible qualities through interacting with other substances (cite 2.21.x). And as in Newton the powers of a substance are both passive and active powers (2.21.2). Moreover, the ideas of the powers which make up the majority of our ideas of substance are also complex ideas, strictly speaking; they are, presumably, ideas of modes or perhaps relations (2.21.3, 2.23.7). These complex ideas of powers have as an essential ingredient the simple idea of power, which is the topic of *Essay* 2.21. Since ideas of substances are complex ideas mostly composed of ideas of powers, and such ideas of powers all have as an essential component the simple idea of power, it is no surprise that Locke claims that the idea of power is ‘a principal Ingredient’ in our ideas of substances (2.21.3/234).

As noted, however, Locke also claims that there is more to our ideas of substances than ideas of powers; namely, an obscure, relative idea of support for the substance’s powers. Similarly, the texts for Locke may also suggest that some of the simple ideas that go

into our complex ideas of substances are ideas of primary qualities. Insofar as primary qualities are something more than powers to produce ideas in us, our ideas of substances consist in more than ideas of mere powers. These two aspects of Locke's thought on substance—what to make of 'support' or substratum, and what to make of the distinction between primary and secondary qualities—are notoriously difficult. For my purpose of drawing a parallel between Locke and Newton, however, we can set aside these thorny issues. I want to draw attention to the following point: in addressing substance through the theory of ideas, we can understand Locke's claims about substance in the following way. His account of substance vis-à-vis our complex idea of substance is an account of what is intelligible to us when it comes to substance. And for the most part—perhaps for the whole part, depending on interpretation—what is intelligible to us in substance are powers. Our grasp on substances (even our own substance, our own mind) does not penetrate beyond the powers of substance to affect us (our own mind appears to itself through ideas of reflection) or other substances.

I suggest that Newton's conception of substance should be understood in similar vein. That is, the connection between substance and power I have developed thus far concerns what is intelligible to us concerning substances. For Newton, what we grasp concerning substances are their powers; namely, powers relevant to determining the motions of bodies and perceptions of minds. One of the final passages in *De Gravitatione's* argument against Cartesian body contains an important passage supporting this suggestion. Ending the 'concise' anti-Cartesian argument, Newton concludes: "thus, you see how fallacious and unsound this Cartesian argumentation is, for when the accidents of bodies have been rejected, there remains not extension alone, as he supposed, but also the capacities by which

they can stimulate perceptions in the mind by the means of various bodies” (Newton, 35).<sup>9</sup> The phrase of interest in this passage is ‘stimulate perceptions in the mind by the means of various bodies’. Given the interpretation of substance developed thus far, the following interpretation of the phrase suggests itself: the phrase is a reference to the alterations in motions bodies create in one another through their interaction. This interaction, the alteration in motions of bodies, is our access to substance-making powers as the manifestation or exercise of such powers. This epistemology also appears in Newton’s preface to the first edition of the *Principia*: “For the basic problem of philosophy seems to be to discover the forces of nature from the phenomena of motions and then to demonstrate the other phenomena from these forces” (Newton, 41). And in the General Scholium Newton says the following concerning substance: “We see only the shapes and colors of bodies, hear only their sounds, we touch only their external surfaces, we smell only their odors, and we taste their flavors. But there is no direct sense and there are no indirect reflected actions by which we know innermost substances.” (Newton, 89). In this last passage, Newton expresses the thoroughly empiricist position that our only access to the

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<sup>9</sup> Indeed, Schliesser (MS) gives a similarly epistemic interpretation of this passage. Schliesser suggests that according to Newton we come to know bodies, indeed any substance whatsoever, by measurement. He writes:

“Newton insists against Descartes that bodies must also have ‘the capacities’ to ‘stimulate perceptions in the mind by means of various bodies’. For a body to be a body in the mechanical substances it must be susceptible to measurement...What is true of body is true of all entities: they must have the ability to be perceived by minds by means of other bodies, that is, by rods...and by timekeepers.” (12)

On Schliesser’s interpretation we come to know individual substances by measuring them in space and time. Measuring devices are the ‘other bodies’ perceived in conjunction with the to-be-known-bodies. While this interpretation is not obviously incompatible with Newton’s claims, it does seem something of a stretch as an interpretation of ‘by means of’. At the very least, I believe that the interpretation I offer fits better and perhaps comprehends Schliesser’s.

world around us is through appearance. As a result, our grasp of the world is limited to what we can make of it through appearances. Combining these passages with the interpretation of Newtonian substance so far developed, the following picture presents itself. Our grasp of substances beyond<sup>10</sup> our sensory interactions is limited to the motions of bodies and so consists in nothing more than such powers of motion.

For Locke, what is intelligible in substance are powers to produce ideas in us, whether immediately by producing ideas in us or mediately by altering the sensible qualities of other substances. Our knowledge of these powers, however, does not penetrate any further than an apprehension of them as powers to produce ideas. Though he is not working within a theory of ideas, I hope to have shown that a similar point holds for Newton. We know substance-making powers through the motions that we observe. Our grasp of substances consists in our access to the powers of altering motion manifest in the motions of bodies and goes no further. As in Locke in which our ideas of substance consists in powers to produce ideas, for Newton our grasp of substance consists in nothing other than powers to affect motion. Thus, substances are intelligible to us insofar as powers of motion are rendered intelligible. This raises the question: how are powers rendered intelligible? Given that motion is our window into substance-making powers, it seems fair to conclude that it is through the formulation of laws of motion that such powers are themselves apprehended.

Stein (2002) has argued for a similar position on the relation between Newtonian substance and laws in great detail. He points out that Newton, in Query 31 of the *Opticks*, “makes the explicit distinction, among natural powers or forces of nature, between the *vis*

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<sup>10</sup> Such grasp goes ‘beyond’ sensory appearances only in that it is more general, applying to body whether perceivable or not, and abstract, independent of any particular sensory appearance.

*inertiae*, as a ‘passive principle,’ and the other forces, which are ‘active principles’; but in both cases, he makes clear, what characterizes or identifies a particular such force is a *law* of nature” (Stein, 289).<sup>11</sup> Putting this point together with the *De Gravitatione* creation story, Stein proposes that Newton has made a dramatic departure from past metaphysics by replacing substantial forms with laws of nature such that things are constituted by laws of nature:

“We have, then...the indication that these principles, forces, or laws, are taken not to *result from* something like Aristotelian ‘substantial forms,’ which are ‘occult Qualities,’ but to *replace* them: it is *by* these ‘general Laws of Nature’ that ‘*the Things themselves are form’d*—just as, in ‘De gravitatione,’ the *clear* attributes of impenetrability through the parts of space *replaced* the obscure notions of substance and substantial forms” (Stein, 290).

As should be evident, I am in broad agreement with Stein’s interpretation in taking the powers characterized by various laws to be substantial bedrock for Newton. In the next section of the paper, I will further consider Stein’s view with an eye towards developing important differences between our interpretations.

#### *iv. Space and inherence*

Before moving on to examine Stein’s interpretation, however, we need to have one more piece of Newton’s conception of substance on the table. Treating substance-making powers as substantial bedrock brings us to an important point concerning substance on which Newton is very explicit: the notion of a subject of inherence is unintelligible. That is, substance-making powers are not powers that inhere in anything or that are in need of any existential support, for Newton. The following passage from *De Gravitatione* is decisive: “And so substantial reality is to be ascribed to these kinds of attributes, which are real and

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<sup>11</sup> Stein is careful to note that in the case of inertia, what “Newton regards as *the law or principle* characterizing the intrinsic force of matter as a natural power, not what *we* call the ‘law of inertia,’ but the *conjunction of all three Laws of Motion*” (Stein, 289).



intelligible things in themselves and do not need to be inherent in a subject, rather [ascribed] than to the subject which we cannot conceive as dependent, much less form any idea of it” (Newton, 32). So, the fundamental constituent of substance just is its power(s), there is no need for the powers to inhere in anything. Attributes in space and time are all there is to substance for Newton. Newton goes on to develop this point in his numbered exposition of body (Newton, 29-30). For example, the creation story shows that, “for the existence of [bodies] it is not necessary that we suppose some unintelligible substance to exist in which as subject there were an inherent substantial form; extension and an act of the divine will are enough” (Newton, 29). The metaphysical picture Newton develops here is one that banishes the notion of subject or substantial support. Instead all that there is to substance are powers in space and time.

While it is clear that Newton rejects the necessity or intelligibility of a subject of inherence when it comes to substance, the ramifications of this rejection must be carefully considered to understand Newton’s conception of substance. For example, one way to make sense of one substance having multiple qualities is through common inherence: the qualities all inhere in the same subject or substratum. Indeed, as we saw above with Locke, though he allows only an obscure and relative idea of substratum or substance in general, he does insist that our ideas of substance in part consist in such an idea of support. The passage from Stein quoted above suggests that space is supposed to take over the role of subject of inherence for Newton just as powers or laws of motion take over the role of substantial form in traditional metaphysics. In the remainder of this paper I will further develop the form this question takes in light of what we have already seen of Newton’s conception of substance and then consider Stein’s interpretation of Newton’s answer to that

question. After arguing that Stein's interpretation falls short in certain important respects, I will propose my own solution.

To close this section, however, we can summarize Newton's conception of substance as so far interpreted. First, substance and power are tightly linked: taking our lead from Locke and the parallels between Locke and Newton on substance and power, what is intelligible concerning substance are powers. Second, these powers are 'interactive', that is substance-making powers can be both active and passive; what makes a power a substance-making power is that it determines the motions of bodies (and/or perceptions of minds). Third, these powers are themselves rendered intelligible through the formulation of laws of motion. Finally, these powers need not inhere in a metaphysically deeper subject which offers the powers existential support. Powers need only exist in space and time

## II. Putting substance together again and distant action

### *i. One thing many powers*

To begin, we can translate the problem raised at the end of the previous section into the context of the interpretation of Newtonian substance I have so far developed. Having rejected any notion of substratum in which distinct qualities inhere in a single subject, it isn't clear how a Newtonian substance could possess multiple qualities. In this specific context, however, in which we have seen the centrality of power to Newtonian substance, this question becomes: how are different powers tied together into one substance given that he rejects the intelligibility of substratum? The seeds for this problem can be seen in *De Gravitatione* but they come to full bloom in the *Principia*. Consider two of the powers attributed to body in *De Gravitatione*: the power of impenetrability, listed in Newton's creation story, and the power of resistance, which Newton attributes to body in his 'concise'

anti-Cartesian argument. It appears that we have here two powers, of resistance and of impenetrability. Suppose that these are distinct powers.<sup>12</sup> If the substance of body is its powers, and there is no unifying subject of inherence, we can wonder: by virtue of what are these powers the powers of one substance, namely, body? More generally, by virtue of what are some powers unified into a single substance? Call this the power unification problem.

*ii. Avoiding the problem through power maximalism*

As we saw above, in claiming that space takes the place of substratum and that powers characterized by laws take the place of form in Newton's conception of substance, Stein's interpretation offers a solution. Given that Newton replaces substratum with space, it seems that common inherence of qualities in a substratum is replaced by the co-location of powers in space. So, for two powers to be powers of the same substance is for them to be located at the same place. One prima facie difficulty for such an interpretation is that Newton famously allows that minds and God are located in space.<sup>13</sup> Newton also insists that minds, bodies and God are distinct substances. So, given that minds and bodies can be co-located but really distinct, the unification of powers into powers of a single body must be understood in some other fashion than mere co-location. One way this might be achieved is if powers of mind and body are sorted on an a priori basis. If we have that a priori division, we can then allow that all powers grasped through laws of motion are powers of body, and such powers are thought to be powers of the same body by virtue of their co-location.

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<sup>12</sup> Ultimately I will argue that these are the same power in Newton's eyes by the *Principia*, but the problem can be raised using gravity and inertia.

<sup>13</sup> From *De Gravitatione*: "God is everywhere, created minds are somewhere, and body is in the space that it occupies; and whatever is neither everywhere nor anywhere does not exist" (Newton 25).

The grounds for such an interpretation might be found in *De Gravitatione* as Newton, despite challenging the Cartesian notion of body, seems to accept Cartesian dualism. Before beginning his argument against Descartes' identification of body and extension Newton makes the following remark: "Since the distinction of substances into thinking and extended...is the principal foundation of Cartesian philosophy...I consider it most important to overthrow [that philosophy] *as regards extension*, in order to lay truer foundations of the mechanical sciences" (Newton, 21, emphasis added). Newton's claim here is not that Descartes is wrong to divide the world into mental and material, but rather that he is wrong to take the material to be nothing but extension and so take extension as the exclusive province of one half of the mind-body divide. Thus, Newton seems to allow that powers can be sorted, a priori, into mental and material powers. The same general principle described above about substance consisting in activity would hold, we just now recognize that all non-mental (and non-divine) activity is material activity. If this is the case then any laws of motion deliver us powers body. Call this a maximalist approach to the powers of body as it assigns to body all those powers grasped through laws of motion.

Stein's maximalism is evident in his treatment of the change in Newton's thought motivated by the discoveries of the *Principia*. According to Stein, the change was profound: it "led Newton to a quite new conception of the nature of what Descartes had called 'a natural power in general'; that is, to a new conception of how it *may be fruitful*...to conceive of the 'actions' that characterize nature" (Stein, 282). Newton re-conceives the actions that characterize nature by thinking of them in terms of "*principles governing forces of attraction and repulsion*—themselves to be discovered by reasoning from the phenomena" (Stein, 283). After examining how this shift manifests itself in Newton's definitions of force and their commentary, especially concerning centripetal force and its quantities, Stein concludes that

the shift results in the addition of fields of force to Newton's metaphysics of body (Stein, 287). Putting this development in terms of the *De Gravitatione* creation story, Stein concludes that Newton's mature metaphysics of body holds that, "in creating a body, God...must impose, not only the field of impenetrability and the laws of motion appropriate thereto, but other fields as well, with their laws, characterizing forces of interaction of the kind that have been described" (Stein, 289). Substance-making powers are understood as fields, grasped through their respective laws, which determine the motion of bodies. Stein's maximalism is evident in the phrase 'in creating a body'. Body is created by creating these distinct fields; that is, the substantiality of body consists in these existence of certain fields (or to use my, perhaps more neutral terminology, powers).

Stein's maximalism is also manifest in his interpretation of Newton's denial that gravity is essential to body (perhaps most famously in a letter to Bentley). According to Stein, Newton denies that he is committed to the essentiality of gravity because for Newton discovering laws of nature is discovering *candidate* fundamental powers of body. We can never be sure whether the motions attributed to a power, such as gravity, will be shown to be nothing over and above the operation of some other power, or whether any two (or three, etc.) powers will be shown to be the operation of another: "it will be a question for the future whether (yet deeper) *causes* of these principles may remain to be found out" (Stein, 291). The important presumption underlying this interpretation is that gravitational attraction is certainly a power of body. The only open question is whether it is fundamental.

So, Stein's maximalist approach is evident in two ways. On the one hand, Stein's interpretation holds that any power characterized by laws of motion is a power of body. On the other hand, Stein understands Newton's denial that gravity is an inherent power of body

as a manifestation of epistemic modesty concerning the *fundamentality* of gravity. What is not open on Stein's interpretation is that laws derived from the motions of bodies characterize powers that aren't powers of bodies.

Having seen that Stein is a maximalist about the powers of body, we can now examine how this maximalism blocks the power unification problem. The predominant theme of Stein's interpretation is that Newton's metaphysics transforms traditional metaphysics of matter and form into an intelligible metaphysics of fields in space. According to the tradition of substance against which Newton is reacting, we are faced with two questions in our thought about substance: "(1) *In what* do the qualities we attribute to a substance *exist together*? (2) What is the *cause* of their existing thus together?" (Stein, 278). We can understand Newton's answers to (1) and (2), according to Stein, by returning to the creation story of body (Stein, 278): the answer to (1) is that the attributes exist in space, but that is not to say that space offers some mysterious substantial support to the attributes; the answer to (2) is explicit in the creation story—attributes exist together simply in the sense that they coexist in the same place. So, there need not be some further substantial form from which those powers flow, nor prime matter in which they all exist and are bundled into a body; existence in the same place accounts for the unity of powers into one substance.

As noted above, however, all substances occupy some (or all space), and so substances can be in the same place. Thus, it seems that a spatial criterion cannot be Newton's solution to the power unification problem because distinct substances can exist in the same place. It is exactly at this point, however, that Stein's maximalism helps since it allows for an a priori division of the world into mind and body according to which powers

of the latter are known by the laws formulated in studying of motions of bodies.<sup>14</sup> The powers grasped through the motions of bodies are, and can only be, powers of body and so the power unification problem is deflated. Though an appealing solution, I will next argue that maximalism runs into important interpretive difficulties. If maximalism is off the table, then so is its simple spatial unification principle and the power unification problem returns.

*iii. Distant action and essential gravity*

In a letter to Bentley, Newton makes perhaps his most famous denial concerning gravity and action at a distance:

“It is inconceivable that inanimate brute matter should, without the mediation of something else, which is not material, operate upon and affect other matter without mutual contact, as it must be, if gravitation in the sense of Epicurus, be essential and inherent in it. *And this is one reason why I desired you would not ascribe innate gravity to me.* That gravity should be innate, inherent, and essential to matter, so that one body may act upon another at a distance through a vacuum without the mediation of anything else, and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking can ever fall into it.” (Newton 102-3, emphasis added).

The point I want to draw from this passage is that (one reason) Newton denies gravity to be innate, inherent, or essential to matter is because such a status implies that matter acts distantly. Given the obvious absurdity of action at a distance, ‘innate’ gravity is likewise absurd.<sup>15</sup> Newton’s worry seems to be that if gravity is innate (etc.) in body then the *bodies themselves* will be doing the gravitating, they will themselves be responsible for the

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<sup>14</sup> To further appreciate how Stein’s maximalism allows for a metaphysically deflationary answer to this (same place), consider that even answering (2) with ‘God’s will’ does not shed much light on the issue without an account of what the unification of powers amounts to. Even if we read ‘cause’ in (2) as formal cause, what is God willing when God wills some powers be together?

<sup>15</sup> One may wonder why Newton takes action at a distance to be so absurd. Does he take it as a primitive metaphysical principle? Is it derived from something else? If I am right about substance it seems to fall out of his conception of substance.

gravitational attraction between them. The problem for maximalism, it seems to me, is that it is not able to explain how denying the innateness of gravity will allow Newton to avoid the charge of action at a distance. To see this, we can begin by sorting out different senses of innate, whether gravity being innate in that sense entails distant action, and finally to which of these senses of ‘innate’ maximalism may appeal.

One way to understand the innateness of gravity is to emphasize Newton’s use of ‘essential’ and so to take it to mean that without gravitational attraction body would not exist. The *De Gravitatione* creation story again provides interpretive help: if God did not create the power of gravitational attraction God would not have created something indistinguishable from matter, just as if had God created mind-interactivity but not solidity, what was created would be distinguishable from matter. Though a relatively straightforward sense of innate, it isn’t quite clear (to me, anyhow) whether gravity’s being innate in this sense would entail action at a distance. And so denying the innateness of gravity in this sense seems to have no bearing on whether Newton is rightly charged with positing distant action.

Another way to understand Newton’s denial of gravity’s innateness is as suggested by Stein—gravity is not a fundamental power of bodies. What is important in this context, however, is that the non-fundamentality of gravity allow Newton to escape a commitment to distant action. On this front, however, I believe that maximalism fails on account of running into the following trilemma.

In the first place, gravity could be non-fundamental in the sense that the movements associated with gravitational attraction could be understood as the operation of another power of body, say, its impenetrability. A vortical account of gravity would be an example



of the non-fundamentality of gravity in this sense. Newton, however, strongly and consistently denies that any vortical (or other impact-based) theory is up to this task.<sup>16</sup>

A second way in which gravity could be non-fundamental is that it is perhaps super-added (in a Lockean sense) to bodies. Under this scenario God could create something indistinguishable from matter without creating gravitational attraction and so in creating body would not therein create gravitational attraction. The problem for this approach, however, is that even if gravity is not innate in this sense, such non-innate gravity still implicates distant action. The superadded attractive powers are still acting distantly.<sup>17</sup>

A third way in which gravity might be non-fundamental to body is that while the attraction is sensitive to features of bodies (their mass and distance), the attractive force is communicated by a medium distinct from the bodies themselves. Gravity would be non-fundamental to body in the sense that the attraction can change without the bodies themselves changing since the operation of the medium could be leaned on to explain the difference in attraction. Of course, for reasons similar to those at the heart of Newton's resistance to a vortical account, this medium cannot operate through impact. But then it isn't clear that the medium could be material in the sense of being constituted, at least in part, by the power of impenetrability. If, for example, atomic particles are massy, as Newton suggests, then they exert gravitational attraction on other bodies. But given their atomic nature they cannot be permeated by a material medium, and so no material medium can account for the gravitational attraction (among atomic bodies at least). A non-material

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<sup>16</sup> Janiak (2007) contains a thorough discussion of this point under the heading of addressing the 'reality' of the gravitational force for Newton. See as well the General Scholium to Book III for Newton's rejection of vortical accounts of gravitational attraction.

<sup>17</sup> Either that or this option collapses into the vortical option likewise fails Newton's texts.

medium, however, is not open to the maximalist, since such a medium is a non-mental, non-material entity (that is neither space nor time) in a world that the maximalist must divide a priori into mind and matter if she is to defend the spatial criterion of co-existence.

Thus, none of the three options for understanding the non-fundamentality of gravity is compatible with maximalism. Moreover, it seems that the ‘non-fundamental’ reading is the *only* option available to the maximalist for making sense of Newton’s denial in the letter to Bentley. What, if not something like ‘not fundamental’, could the non-innateness of gravity amount to if all powers grasped through laws of motion are powers of body? Thus, Stein’s interpretation, and maximalism more generally, cannot properly account for Newton’s thought on innateness and distant action. If maximalism and its spatial criterion of power unification are not tenable, however, the power unification problem presses again. Finally, given the interpretation of substance developed so far, it should be evident that the maximalist cannot lightly dismiss Newton’s denial of distant action. As I have shown, the link between action and substance is at the core of Newton’s thought on substance; not even God acts distantly according Newton.<sup>18</sup>

In the end, then, recourse to an a priori dualism cannot save the maximalist interpretation of the power unification problem. Maximalism cannot make proper sense of Newton’s denial of distant action because it cannot make sense of the relation between gravity and body such that gravitational attraction does not imply the distant action of bodies on one another. At best the maximalist can offer that gravity is a non-fundamental power of bodies, but I have argued that the senses of non-fundamental acceptable to Newton and

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<sup>18</sup> God is not merely virtually omni-present, but substantially omni-present: “[God] is omnipresent not only *virtually* but also *substantially*; for action requires substance.” (Newton, 91).

open to the maximalist (given its required a priori dualism) still imply that bodies act distantly.

### III. Power minimalism

The possibility of making out a coherent conception of substance in Newton's thought looks dim. The most straightforward answer to the power unification problem—maximalism—does not seem to respect Newton's thought in importantly substance-related area of distant action. While the situation is bleak, it is not without hope. An important assumption behind both maximalism and pessimism about solving the power unification problem, indeed an assumption behind the power unification problem itself, is that distinct powers need to be unified; that substances have distinct powers. I propose what I will call power minimalism. Minimalism falls neatly out of the conception of substance described in part I: if substance is activity in space and time, then a power just is a substance, a unit. According to minimalism there is no need for an account of the unity of powers into a substance and so Newton's claim that minds are located in space does not threaten to conflict with his a priori dualism by positing a spatial criterion of co-existence. Nor, of course need we follow maximalism in taking such dualism as prior to a spatial criterion of power unification. Minimalism therefore fits comfortably with Newton's claim that different substances can be present in the same place.

While the upside of minimalism is clear, the roadblock to minimalism, and so to a coherent picture of substance in Newton's thought, is equally clear: bodies seem to have multiple powers even once we've abstracted away from their sensory appearances. In the next section I will attempt to show how this apparent diversity can be rendered merely

apparent (or at least, that minimalism and hence coherent Newtonian metaphysics depend on this).

*i. The multiple qualities of body*

In several places Newton appears to straightforwardly claim that bodies have more than one power. *De Gravitatione* is one such place. In the creation story Newton claims that in creating body God must endow regions of space with *several* conditions. Later Newton appears to attribute another power to body not considered in the creation story: that of resistance to the motion of other bodies. Moreover, in later work, Newton twice gives lists that attribute multiple qualities to bodies. In the elaboration (justification?) of Rule 3 of the *Principia*'s Rules for doing Philosophy, Newton notes: "and thus we conclude that every one of the least parts of all bodies is extended, hard, impenetrable, moveable and endowed with a force of inertia" (Newton, 88). Another similar list appears in Query 31 to the *Opticks*: "it seems probable to me, that God in the beginning formed matter in solid, massy, hard impenetrable, moveable particles" (Newton, 136). In each of these lists Newton apparently holds that bodies have many qualities, and so minimalism apparently fails Newton's texts.

A first step in minimalism's defense is to recall my previous discussion of the distinctness of mobility and impenetrability. I argued that mobility should not be treated as a distinct power of bodies. Rather, the power of mobility is nothing over and above the power(s) of moving in certain ways. Since impenetrability is conceived by Newton as a power of moving in accord with laws of motion governing impact, the power of mobility is (in part, if body has other distinct powers) nothing over and above the power of impenetrability. Thus, mobility and impenetrability—at least in the context of *De Gravitatione*'s creation story—are not really distinct powers. We reduce two apparently

different powers to one power, characterized by the laws of motion pertaining to impact. Another quality on the lists above, the extension of bodies is straightforwardly accounted for under this interpretation: it is, the determination of space occupied by the power of impenetrability. So, extension, mobility and impenetrability can be understood, in the context of *De Gravitatione* creation story, as one power instantiated space.

*De Gravitatione* does not discuss two other qualities which appear on Newton's later lists. Firstly, while it mentions resistance to motion of other bodies this power isn't thoroughly discussed in the same context as the creation story. It is therefore harder to determine Newton's thoughts in *De Gravitatione* on how this power relates to the power of impenetrability. Secondly, hardness is not addressed at all in *De Gravitatione* as a power of body. Nevertheless, Newton makes clear in later works that hardness is a power in the sense I have developed: it is relevant to the motion of bodies. Here is how Newton takes the degree of hardness to be relevant to the motions of bodies in Query 31: "If they have so much elasticity as suffices to make them rebound with a quarter or half or three quarters of the force with which they come together, they will lose three quarters, or half, or a quarter of their motion" (Newton, 135). Even the extremes of elasticity are understood in terms of rebound motion: "For bodies which are either absolutely hard, or so soft to be void of elasticity, will not rebound from one another" (Newton, 135). Clearly then, the hardness and elasticity of a body are relevant to determining motions and so appear to be, by my account of substance-making powers, powers of bodies.

At the very least, then, it looks like body has three powers in Newton's later thought which are not (wholly) present in *De Gravitatione*: impenetrability, hardness, and inertia.<sup>19</sup> The plausibility of minimalism, however, depends on reducing these three powers to one since Newton clearly treats these as powers of body. In what follows I will suggest a way in which these three powers can be understood as one, just as impenetrability and mobility are only apparently two in *De Gravitatione*.

We can start with inertia to see how to re-integrate inertia and impenetrability. Impenetrability, I suggested, should be understood as determined by the laws governing the changes in motion bodies create in one another through contact. It seems fairly clear that by the *Principia* the inertial power is at the heart of explaining these motions. Of course, it explains more as well—for example, the orbits of objects acted on by centripetal forces—but it also clearly is central to how bodies affect each others' movements when they run into one another (given that no substances of the same kind can occupy the same place at the same time). The power of impenetrability, that is, the power characterized by laws governing impact, can be understood as the operation of inertial power, since the laws of reflection follow from the laws of motion given at the beginning of the *Principia* and characterize the power of inertia.<sup>20</sup>

The next power to be addressed is hardness. As noted above, Newton clearly thinks hardness is relevant to determining the motions of body and so a power in the sense relevant to substance. So, we must ask what sense we can make of hardness when it comes to the 'least parts of matter', the 'material particles' since the lists on which hardness appears

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<sup>19</sup> In the objections below, I will return to the power that plays a prominent role in *De Gravitatione* but which I have not addressed yet: interactivity with mind.

<sup>20</sup> The *Principia*'s three laws of motion and their discussion are relevant texts here.

among the qualities of body concern atomic bodies. It seems to me that the hardness of these particles should not be understood in contrast to softness or malleability but rather with elasticity.<sup>21</sup> Consider in full the passage above from Query 31 in which Newton discusses the relevance of hardness, softness and elasticity to motion: “For bodies which are either absolutely hard, or so soft as to be void of elasticity, will not rebound from one another. Impenetrability makes them only stop. If two equal bodies meet directly in a vacuum, they will by the laws of motion stop where they meet and lose all their motion, and remain in rest, unless they be elastic” (Newton, 135). In this discussion of body’s hardness it is clear that hardness is opposed to elasticity in the sense that absolutely hard bodies’ motions are determined fully by the laws of motion tied to inertia and impenetrability. What I suggest, then, is that we understand the hardness of material substances in contrast to elasticity. Other considerations count in favor of this view: the softness of non-atomic bodies is easy to understand in terms of their malleability, their shapes may be changed by a re-arrangement of their atomic components. When it comes to atomic material particles a change in shape seems more difficult, if not impossible, to grasp.<sup>22</sup>

If, as the texts suggest, we take the substance-making powers of body to be the powers possessed by atoms then the hardness of body must be understood in contrast with elasticity. If the hardness of a body is its perfect inelasticity however, we can straightforwardly assimilate hardness to the inertial power. As the passage cited above (‘If

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<sup>21</sup> Taken on its own, outside of the context of the discussion of elasticity the following passage from Query 31 Newton might seem problematic for my interpretation since it seems to treat hardness in terms of not being able to be broken or worn down: “these primitive particles being solids, are incomparably harder than any porous bodies compounded of them; even so very hard, as never to wear or break in pieces: no ordinary power being able to divide what God himself made one in the first creation” (Newton 136-7).

<sup>22</sup> As the previous footnote suggests, the text isn’t perfectly in line with my interpretation.

two equal bodies meet directly in a vacuum, they will by the laws of motion stop where they meet and lose all their motion, and remain in rest, unless they be elastic’) suggests, the elasticity of bodies is a matter of their impact-determined motion differing from what it would be if only inertial forces were at work (abstracting away from, eg, attractive forces like gravity). The hardness of body is its non-elasticity, which is no power in itself but instead determination of impact motions by inertial force. If anything, the hardness of body is best conceived not as a power at all but an absence, an absence of elasticity such that the powers characterized by the laws of reflection fully determine the impact motions of bodies.

*ii. Additional objections*

Accepting these suggestions for understanding the powers of impenetrability and hardness as identical with the power of inertia allows for the claim that there is ultimately one power constitutive of body and it is characterized and known by us through the laws of motion that characterize the inertial power. There are not really a multitude of powers to be tied together, but ultimately only one power which occupies a determined region of space and changes place in accord with the laws which characterize that power. Even if we go this far several questions may remain, the most pressing of which comes from remembering the mind-interactivity power that Newton put to so much anti-Cartesian work in *De Gravitatione*. How are we to understand how this power, which pretty clearly won’t be able to be identified with the *vis inertiae*, as part of the same thing as that power? Here I think it is best to bracket the issue under the general heading of difficulties surrounding the mind-body problem. We can gain worthwhile insight into Newton’s conception of substance by setting this particular issue aside.



A second objection may be made to my approach more generally and is rooted in what appears to be at least an epistemic modesty about and perhaps a full-blown skepticism about substance. Consider a fuller quotation of a passage we have already examined from the General Scholium. In the context of discussing our knowledge of God, Newton makes the following claim: “We see only the shapes and colors of bodies, we hear only their sounds, we touch only their external surfaces, we smell only their odors, and we taste their flavors. But there is no direct sense and there are no indirect reflected actions by which we know innermost substances; much less do we have an idea of the substance of God” (Newton, 91). This certainly echoes the claims prefatory to *De Gravitatione*'s creation story in which Newton offers the hedge that what he describes is something that would appear, as far as we could tell, to be body but actual body may have some other nature and be constituted by some other powers than those he names but which produce the same phenomena, that is, motions (Newton, 27). Furthermore, since I argued earlier that Stein's interpretation of Newton's epistemic modesty was incorrect, I might be expected to offer my own account rooted in my interpretation of Newton's conception of substance.

In response, note that on my interpretation our grasp of substance is only as good as the laws by which we characterize powers. Thus, insofar as there is any inadequacy of our laws to the phenomena from which they are derived and which they are supposed to explain, we have room to resist the claim to a complete grasp of the substance. Moreover, since our grasp of substance is by way of laws which characterize the substance-making powers, Newton's metaphysics remains as open as the natural philosophy that informs it. So, where there are powers that aren't understood as the operation of some others, we have reason to take there to be multiple substances on Newton's view. Thus, the epistemic modesty articulated by Newton with respect to gravity and substance more general, is that we do not

know whether further accounts of the activities characterized by these laws—and so differently characterized powers, and so different substances—will be forthcoming. As a result, though the conception of substances stays constant, what substances and how many substances there are is as open to empirical revision as the natural philosophy that informs our grasp of substance-making powers.

Finally, recalling the Lockean nature of the interpretation I have offered reveals a deeper response to this objection. For Locke our grasp of substance penetrates no further than their appearances. In Locke's case, this means that our grasp of substance cannot penetrate beyond the powers to produce certain ideas in us. I have argued above that the same general picture holds for Newton. The difference is that the appearances in question for Newton are the motions of bodies. Nevertheless, our grasp of substance is still limited to the powers to produce such motions. We have no knowledge of the power independent of its effect on the motions of bodies, and so our knowledge of substance does not ultimately penetrate beyond its appearances.

#### IV. Conclusion

To close I would like to compare the picture of Newtonian substance I have developed here with other recent work on Newton's conception of substance, Kochiras (forthcoming). Kochiras argues, on grounds similar to those seen here, that Newton has what she calls a substance counting problem. Newton has an insuperable difficulty, according to Kochiras, in explicating how we can come to infer substances from observed properties (or powers). Kochiras highlights three dimensions of Newton's thought on substance. First, as we have seen, Newton allows that different kinds of substances may occupy the same place. Second, as we have also seen to some degree, our knowledge of

substance is highly empirical for Newton in that our only access to substance is through the appearance of motions.<sup>23</sup> As a result, our knowledge of substances is as open and fluid as the natural philosophy that informs it. Finally, despite his empiricist commitments, Newton is also committed, on what look to be non-empirical grounds, to certain metaphysical principles; most notably, that nothing can act distantly. Given the empirical difficulties of isolating an immaterial substance, Kochiras argues, it doesn't seem that we could ever be in a position to empirically determine whether some property or power belonged to one substance or another. Or, indeed, whether a substance can be inferred at all from a property or power. She gives the following example: to determine whether or not air is responsible for the free fall of objects towards the earth, we can drop an object in a vacuum chamber. No such experiment, however, is possible when it comes to determining whether an immaterial substance may be responsible for the fall since there is nothing like a vacuum chamber when it comes to an immaterial substance; any material chamber would be permeable by the immaterial substance since different kinds of substances can occupy the same place.

Given these strains in Newton's thought about substance, Kochiras points out the following problem: there is no way to infer from properties or powers to substances for Newton and so no way to tell how many substances there are in any place at a time. Other powers besides gravity—exothermic reactions, electricity, magnetism—pose the same problems. Indeed, the epistemological problems of knowing what substances to infer from which powers and which powers to assign to which substances in such cases may be worse

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<sup>23</sup> Kochiras pushes this point further than I have here and argues that for Newton even God is only known through His appearance, 'phenomena', in creation (creation is the appearance of God).

because unlike gravity it isn't even clear what grounds Newton has to treat them as secondary powers rather than as God's own action (Kochiras, xx). Moreover, as I have argued here, a spatial criterion won't help for individuating substances even if we allow Newton an a priori division between mind and matter: individuation, or power unification, by co-location can't be reconciled with Newton's commitment to local action.

The chief difference between the conception of substance I have argued for here and that which Kochiras claims is at the heart of Newton's substance counting problem is that on my interpretation power exhausts substance. As a result, there is nothing in our thought over and above thought of powers on Newton's view. This Lockean approach to substance transforms Kochiras' substance counting problem into what I have called the power unification problem as the question of inferring substance from powers is ultimately a question of uniting powers. Stein argues that a consequence of Newton's Lockeanism is that Newton has open to him only a spatial criterion of unification: multiple powers are united into one thing by virtue of their co-location in space (supplemented by an a priori dualism about mind and body). I have argued, however, that a spatial criterion of individuation and unification cannot be reconciled with Newton's commitment to local action. Consequently, the only way in which powers are unified into a single substance is by being identified as a single power: the only criterion of substantial unity is the identity of powers. Since power exhausts our thought of substance, there is nothing but powers to account for the unity of powers into a single substance, not even space. That is, the unity of powers can only be understood as the identity of powers by showing that one power is nothing but the operation of some other. The challenge of inferring substances from powers is then a problem of determining the different distinctions that can be drawn between powers. To reconcile this claim with Newton's texts I have argued above that all of the powers of body

Newton lists in his later works can indeed be understood as identical with the power of inertia as characterized by the *Principia's* three laws of motion. In the end, then, a substance can have only one power for Newton. Thus, distinct powers such as gravity and inertia constitute distinct substances in Newton's metaphysics.<sup>24</sup>

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<sup>24</sup> Again, Newton takes these substances to be shown to be distinct in the *Principia* (See Janiak (2007) and the General Scholium). Presumably Newton thinks other powers of to Newton, electricity, magnetism, exothermic reactions, can also be distinguished from either of these, but none have been shown to be distinct as the *Principia* shows the gravitational and inertial forces to be distinct.

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