**Newton’s “Law-First” Epistemology and “Matter-First” Metaphysics**

**1. Introduction**

Much has been written on Newton’s concept of matter, as well as Newton’s laws. Meanwhile, the metaphysical and epistemological relationships *between* these two principal features of Newtonian philosophy are relatively unexplored. Among the existing accounts of the relationship between bodies and laws, two are especially compelling: the “law-constitutive” approach from Katherine Brading and the “formal-cause” approach from Zvi Biener and Eric Schliesser. Both accounts argue that Newton’s bodies are (at least partially) metaphysically dependent on the laws. That is, according to Brading, Biener, and Schliesser, Newtonian laws are ontologically prior to the bodies they govern.

Relying on drafts and published passages from *De Gravitatione* (*De Grav*, hereafter), *Philosophiae Naturalis Principia Mathematica* (the *Principia*, hereafter) and the *Opticks*, I reply to Brading, Biener, and Schliesser.[[1]](#footnote-1) In Section 2, I reconstruct and reject the law-constitutive approach. In Section 3, I reconstruct an alternative: the formal-cause approach. In Section 4, I develop a negative argument against the formal-cause approach by closely examining three features of Newton’s ontology—forms, particles, and active principles—and their relationship to the laws. In Section 5, I offer an explanation as to why “law-first” approaches have (understandably) dominated recent Newtonian exegesis. Finally, I present a positive argument for what I believe to be a superior alternative: Newton’s law-first approach is purely pragmatic. It is a feature of his experimental philosophy that we should begin our inquiry into the metaphysical constituents of the universe with the laws that arise from them. This does not entail, however, that Newton views laws as *constituting* or *forming* physical bodies. Newton’s metaphysics should be interpreted as “matter-first,” with bodies giving rise to laws, whereas his epistemology should be interpreted as “law-first,” with knowledge of laws giving rise to knowledge of bodies.

**2. The “Law-Constitutive” Approach**

Brading argues that Newton adopts a “law-constitutive” approach to the relationship between bodies and laws, seen both in *De Grav* and drafts of the *Principia.*[[2]](#footnote-2)The slogan form of her argument is this: “a necessary condition for something to be a body is that it satisfy certain laws” (Brading 2012, p. 23).[[3]](#footnote-3) There is a strong interpretation of this approach and a weak interpretation. On the strong interpretation, that something satisfy certain laws is a necessary *and sufficient* condition for being a body. On the weak interpretation, it is merely a necessary condition; some other properties may also be required. In either case, she says, “the definition of physical bodies is *incomplete* prior to the specification of the laws of nature, and *completed by* those laws of nature” (Brading 2012, p. 20).

We see evidence of the weak interpretation in *De Grav*. For example, in a thought experiment, Newton describes “a certain kind of being similar in every way to bodies, and whose creation we cannot deny to be within the power of God, so that we can hardly say that it is not body” (Newton 2004, p. 27). Brading cites the following passage from Newton’s thought experiment, arguing that “Newton is explicit that a necessary condition for something to be a body is that it move in accordance with the laws” (Brading 2012, p. 24):

If we should suppose that that impenetrability is not always maintained in the same part of space but can be transferred here and there according to certain laws, yet so that the quantity and shape of that impenetrable space are not changed, there will be no property of body which it does not possess. (Newton 2004, p. 28)

Thus, we can say the following of the relationship between bodies and laws in *De Grav*: Newton has not articulated an account of bodies that stands independently of the laws that govern the motions of those bodies. In other words, Newton’s bodies are not ontologically prior to the laws. On the contrary, if we wish to determine whether entity *x* is a body, then *x* must conform to the relevant laws.

Additionally, Brading argues that Newton’s law-constitutive approach persists in the *Principia.* She cites three drafts written “in preparation for the third edition of the *Principia*,” intended to appear after Newton’s Rules of Reasoning (Brading 2012, p. 26). In two of these drafts, Newton defines body “in the sense that the common people always accept the word,” which includes the condition that they, “in their motions observe the laws of bodies” (as cited in Brading 2012, p. 27). This means the relationship between bodies and laws is such that bodies partially *depend* on the laws for their existence.

But what are we to make of the passages where Newton turns the arrow of metaphysical dependence the other way round, apparently claiming that bodies and their properties are ontologically prior to the laws? For example, in Definition 3, Newton explicitly identifies the inertial property of a body as the cause of its resistance to a change of state: “*Because of the inertia of matter*, every body is only with difficulty put out of its state either of resting or of moving” (1999, p. 79, my emphasis). A body’s resistance to its change of state is expressed by the laws, yes, but it is caused by the inertial property (namely, the *inertia massae*). This echoes Alan Gabbey, who writes, “it would be correct to make the general point that all three laws are essentially passive laws, taking their origin in the inertial property of the body” (1971, p. 53).[[4]](#footnote-4)

We see further evidence for Gabbey’s claim in the *Opticks*, wherein Newton describes the *vis inertiae* as a “passive Principle by which Bodies persist in their Motion or Rest, receive Motion in proportion to the Force impressing it, and resist as much as they are resisted” (1952, p. 397). From this quotation, Howard Stein observes that “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 [i.e., the first law of motion],’ but the *conjunction of all three laws of motion*” (Stein 2016, p. 360). Stein says this characterization is “quite in accord” with the commentary to Definition 3 of the *Principia*, wherein Newton “describes the twofold manifestation or ‘exercise’ of the force of inertia: in reducing the acceleration of the body acted upon by an impressed force (Law 2), and in the reciprocal ‘endeavor to change the state’ of the body responsible for that impressed force (Law 3)” (2016, p. 360).[[5]](#footnote-5)

Newton is even clearer in the *Opticks* when he writes that bodies have “a Vis inertiæ, accompanied with such passive Laws of Motion as naturally result from that Force” (1952, p. 401). Moreover, were God to alter this force, he would thereby “vary the Laws of Nature” (1952, p. 404). Therefore, the Newton of the *Principia* and the *Opticks* appears committed to the view that the inertial property of bodies, by whichthey act in accordance with the three laws of motion, is ontologically prior to those laws. This tension in Newtonian philosophy—namely, that bodies are sometimes prior to laws and at other times depend on laws—is addressed by Biener and Schliesser. In their reply to Brading, they argue that this tension is accommodated by their “formal-cause” approach, to which I now turn.

**3. The “Formal-Cause” Approach**

One of the first appearances of the formal-cause approach in Newtonian exegesis may be found in (Schliesser 2013).[[6]](#footnote-6) In this earlier work on Newtonian emanation, Schliesser argues that the laws of nature for Newton may be reasonably thought of as a species of formal causation. Schliesser finds inspiration for this view in Bacon’s *Novum Organum*, and suggests that Newton may have operated within a similar framework when theorizing about the relationship between laws of nature and physical bodies. Schliesser further argues that Newton’s language in *De Grav* provides “overlooked evidence for Thomas Kuhn’s old speculative claim that formal causes are replaced by laws of nature during the scientific revolution” (cited in Schliesser 2013, p. 451).

The approach is further developed by Biener and Schliesser, who agree with Brading that the laws of motion, in part, are constitutive of Newton’s bodies (2017). However, they argue that Brading’s law-constitutive approach is incomplete. For Brading, the arrow of metaphysical dependence goes in only one direction: the laws constitute the bodies. According to Biener and Schliesser, this one-way relationship from laws to bodies undermines their metaphysical interdependence. In other words, “accounts that stress the constitutive character of Newton’s laws do not do full justice to the fact that Newton explicitly claims that laws are grounded in (contingent) bodies and forces” (Biener and Schliesser 2017, p. 320). The authors cite two passages in the *Opticks* as evidence:

And since Space is divisible in infinitum, and Matter is not necessarily in all places, it may be also allow'd that God is able to create Particles of Matter of several Sizes and Figures, and in several Proportions to Space, and perhaps of different Densities and Forces, and thereby to vary the Laws of Nature, and make Worlds of several sorts in several Parts of the Universe. At least, I see nothing of Contradiction in all this. (Newton 1952, pp. 403-404)

The upshot of this passage is that “for Newton laws are clearly contingent” (2017, p. 316). The nature of matter and forces *gives rise to* the laws of nature. If you vary the properties of matter or vary the relevant force, you thereby vary the laws of nature. Thus, the arrow of metaphysical dependence simultaneously points in both directions—from bodies to laws and from laws to bodies. Again, note that Biener and Schliesser do not disagree with Brading’s conclusion that, for Newton, the laws of nature are constitutive of bodies. Their criticism is that the law-constitutive approach does not go far enough. Biener and Schliesser cite a second passage from the *Opticks* that is intended to demonstrate the interdependence between bodies and laws:

It seems to me farther, that these Particles have not only a Vis inertiæ, accompanied with such passive Laws of Motion as naturally result from that Force, but also that they are moved by certain active Principles, such as is that of Gravity, and that which causes Fermentation, and the Cohesion of Bodies. These Principles I consider, not as occult Qualities, supposed to result from the specifick Forms of Things, but as general Laws of Nature, by which the Things themselves are form'd… (Newton 1952, p. 401)

In this passage, we see that the laws of motion “naturally result” from particles and their forces, yet we also see that bodies are themselves formed by laws of nature. Biener and Schliesser cite these passages so that they may bring to light “an inherent tension in Newton’s account,” one that arises from the metaphysical interdependence of bodies and laws (2017, p. 318). What are we to make of this interdependence? Biener and Schliesser propose a neo-Aristotelian framework: for Newton, “laws are akin to *formal* causes in a traditional, Scholastic sense” (2017, p. 319).[[7]](#footnote-7) Their analogy is worth reproducing here:

In one sense, a formal cause constitutes (and is thus prior) to the substance in which it inheres. Without a formal cause, a substance would not be what it is or do what it does. In another sense, a substance is prior to its form. Substance is the genuine existent and subject of predication, and form’s existence is grounded in the existence of substance. It is thus possible to speak both of forms as forming substances and [of] substances as grounding forms. This tension—which is built directly into the notion of formal causation—mirrors the tension in Newton’s account of laws. In one sense, bodies and forces are prior to the laws of nature, since from different forces and bodies arise different laws of nature. In another sense, laws of nature are prior to bodies and forces, since they are the principles by which the “things themselves” are formed. (ibid.)

Let us recall the question at hand: what is Newton’s account of the relationship between bodies and laws? Notice that the account offered by Biener and Schliesser does not differ from the account offered by Brading in an important respect*.* They say explicitly that “Brading’s account dovetails nicely with the conception of laws as formal causes: they (at least partially) define what bodies are and how they behave” (319). However, “the issue is that Newton’s accounts of body and the laws are embedded in a set of broader ontological commitments” that the law-constitutive approach does not capture (319-320). In sum, Biener and Schliesser argue that their formal-cause approach is superior (qua exegesis), given that it situates Newton’s account of the relationship between bodies and laws within his broader (neo-Aristotelian) metaphysical commitments.

**4. Against the “Formal-Cause” Approach**

We may be tempted to conclude that the formal-cause approach has won out. After all, the metaphysical interdependence inherent in formal causation can accommodate the passages where the properties of bodies seem to give rise to the laws, while simultaneously accommodating the passages where the laws are constitutive of bodies. However, we may have several reasons to doubt that Newton really adopted such an approach. To see why, we must carefully inspect three features of Newton’s ontology, all of which appear in the relevant passages from the *Opticks* invoked by Biener and Schliesser: (1) forms, (2) particles, and (3) active principles.

*4.1. Forms*

As we analyze the formal-cause approach, an obvious first strategy is to consult the places where Newton explicitly discusses formal causation.[[8]](#footnote-8) This will hopefully enable us to catch a glimpse into how he understands formal causes. Consider the following passage from *De Grav*, which comes soon after Newton’s thought experiment (mentioned in Section 2):

That for the existence of these beings it is not necessary that we suppose some unintelligible substance to exist in which as subject there may be an inherent substantial form; extension and an act of the divine will are enough. Extension takes the place of the substantial subject in which the form of the body is conserved by the divine will; and *that product of the divine will is the form or formal reason of the body denoting every dimension of space in which the body is to be produced*. (2004, p. 29, my emphasis)

In a subsequent paragraph, he likens “extension and its impressed form” to the “prime matter and substantial forms” of the Aristotelians (2004, p. 29). The impressed form, or “formal reason of the body,” denotes the dimensions of the body, conserved by the act of divine will. Newton’s language in this passage is strongly spatial: the formal causes of bodies seem to impose form (i.e., shape, size, etc.) on a region of extended space. This is made even clearer in the next sentence, when Newton posits that “any form may be transferred through any space, and everywhere denote the same body” (2004, p. 29). Thus, Newton is invoking formal causation, yet his use of the concept is seemingly restricted to the *geometrical* or *spatial* forms of bodies preserved by divine will. It is akin to saying that the form of the brass ball is a sphere. Moreover, note the parallels to Newton’s language one page before: “Thus we may suppose that there are empty spaces scattered through the world, one of which, defined by certain limits, happens by divine power to be impervious to bodies” (2004, p. 28). Empty spaces take the place of prime matter, and demarcation by certain boundaries (which happen by divine will to be impervious to bodies) takes the place of substantial form.

Hylarie Kochiras and I converge on this interpretation of formal causation in *De Grav.* In a discussion of the structural similarities between Newton’s form and the Aristotelians’, she writes:

…we must ask what he could mean by ‘form’ in connection with his own account. I think he means ‘form’ to refer to the extent and shape of the configured set of powers. For in a limited class of cases, the Aristotelians take form to be little more than shape, and that is a use of the term that Newton can accept, even as he rejects the notion of substantial form more generally. Thus, when he writes that the form of the body is conserved by the divine will, he means that the spatial configuration of the set of powers is maintained by God’s action… (2013, p. 334).

A similar view is defended by Ori Belkind in (2021):

Aristotle’s notions of matter and essential form are replaced in Newton’s formulation by Space itself and the bounded areas of Space. Thus, for Newton the criterion for the individuality of a material substance consists of the spatial forms of the smallest corpuscles from which bodies are made. Newton’s notion of a boundary of impenetrable regions of Space thus replaces Aristotle’s notion of essential form. We identify a region as a particular body by designating the boundary separating the impenetrable region from the areas outside it. This requires that the boundaries of a body become essential to its definition – a body retains its identity over time by retaining the same shape of a boundary.

Biener and Schliesser are therefore correct in saying that Newton operates within a formal-cause framework. They are, however, incorrect in identifying laws as his formal causes. Instead, his formal causes are the physical boundaries of the body. In fact, I think we can take their (albeit misplaced) neo-Aristotelian characterization of Newton one step further: Newton’s account of body in *De Grav* is hylomorphic. To clarify: Newton is of course explicit in his rejection of prime matter and substantial form. The substantial form, which was said by the Scholastics to inhere in the body, is a fiction on Newton’s view. But something else plays the role of this substantial form: the impenetrable spatial dimensions of the body impressed by the divine will. Similarly, something else plays the role of prime matter: extension. This is certainly a modified matter-form-ism. This view is shared by Benjamin Hill, who writes, “Newton retained the metaphysical structures of the Scholastics’ hylomorphism but substituted into those structures extension for prime matter and impenetrability + mobility for substantial form” (2003, p. 317). For Hill, Newton’s remarks clearly indicate that, “rather than supplanting the Scholastic frame- work, Newton preferred to tinker within it” (ibid., but cf. Kochiras 2013, p. 351). A salient consequence of this reading is that it conflicts with the Baconian view Schliesser attributes to Newton, namely, that his formal causes have nothing to do with hylomorphism (2013, p. 458).

One final remark on Newton’s understanding of forms. One may object that the passages I have considered in this section are from *De Grav*, an early work, while the passages that Biener and Schliesser invoke are from the *Opticks*, a later work. It is therefore possible that Newton’s formal causes are simply shapes and spatial boundaries in *De Grav* but develop into laws of nature by the time he writes the *Opticks*.[[9]](#footnote-9) To forestall this objection, I quote a draft Query—meant for the *Opticks*—which J. E. McGuire dates at around 1705:

And it may be further argued from the great capacity of (one & the same matter) by corruption & generation to put off & put on all manner of forms, & be changed into all sorts of shapes … the forms & uses of matter are innumerable & therefore we are not to consider it as composed of irregular particles casually laid together like stones in a heap, but as formed wisely for all those uses. (Add. 3970, 234r-v, as cited in McGuire 1995, p. 192).

Note the striking claim that matter has the capacity of putting off and putting on “all manner of forms” and of being “changed into all sorts of shapes.” It is unlikely that he refers to laws when he speaks of putting on and putting off forms. It is far more likely that, as the next clause suggests, he is referring to the *shapes* of bodies. Furthermore, in the second edition of the *Principia* (Book III, Proposition 6, Corollary 2), Newton lumps “Aristotelians and Cartesians together, implicitly identifying ‘form’ with shape, when rejecting the view that ‘form’ could of itself affect the weight of a body” (McMullin 1978, p. 7).[[10]](#footnote-10)

These passages demonstrate that Newton regarded “forms” as spatial configurations even as late as 1713. Newton is diachronically consistent in his language, and there is no dearth of examples throughout his oeuvre. It is therefore a fair exegetical question to ask why Newton, who spent a considerable amount of time and ink in pursuit of a satisfactory ontology, would not have more perspicuously articulated the view of formal causes attributed to him by Biener and Schliesser.

*4.2. Particles*

A second worry about the formal-cause approach emerges upon a close reading of Query 31. In the final Query, Newton explicitly distinguishes between particles and the bodies composed of them (e.g., “All Bodies seem to be composed of hard Particles,” 1952, p. 389). In other words, throughout the Queries, Newton uses “particles” to refer to the parts of bodies. Bodies, then, are composite structures that result from the cohesion of particles. So, when we ask the question of whether Newton’s bodies ground his laws or the laws constitute his bodies, we must first specify what we mean by “bodies.” Bodies and particles cannot be used interchangeably—at least not in the Queries. Particles are primitive, whereas bodies are not.[[11]](#footnote-11)

Once we distinguish between particles and bodies, we must also specify *which laws* are supposed to be their formal causes. We know that primitive particles give rise to the passive laws of the *Principia*, as demonstrated by Gabbey and Stein in Section 2 (see footnotes 4 and 5)*.* The same can be said of bodies, given the additivity of passive quantities of matter (Parker 2020). However, the “general Laws of Nature” to which Newton refers in Query 31 (e.g., gravity, fermentation, and cohesion) donotform particles. They form bodies *from* particles. Moreover, the laws of Query 31 are the widely discussed “active principles” of the *Opticks—*arguably one of the most opaque and contentious features of Newton’s ontology. I will discuss active principles in greater detail in the next subsection. For now, the salient claim is that we ride roughshod over many important distinctions in Newton’s ontological system when we say things such as “bodies and forces are prior to the laws of nature” or “laws of nature are prior to bodies and forces.” Newton posits different relationships between different sets of laws and different sets of particles. We should therefore distinguish the laws of nature in Query 31 from the laws of motion in the *Principia* as activelaws and passivelaws, respectively.

In sum, particles, given their inertial mass, give rise to passive laws of motion, and particles compose bodies. Passive laws of motion, however, do not form particles (and I know of no quotations to suggest otherwise). Active laws—the “general Laws of Nature” of Query 31—do not form particles either. The primitive particles are prior to bodies, the things formed. Therefore, if the active laws *are* to be identified as formal causes, then they cannot be formal causes of particles—beyond the initial act of divine will, there is no forming of particles to be done (Newton 1952, p. 400). Schliesser is aware of this constraint: he quotes Brading, who says that the formal-cause approach makes better sense within the context of force laws, since “they make matter clump together into the kinds of bodies that there are” (2013, p. 460).

It follows, then, that the only remaining candidate for a formal-cause approach as proposed by Biener and Schliesser is the relationship between *composite* *bodies* and *active* *laws*. Perhaps it may be said that the active laws which govern these inter-particle cohesions are formal causes of composite bodies, “by which the Things [bodies] themselves are form'd.” I admit that this interpretation is viable, but it is unlikely. Why? Because the interpretation only works if we are justified in equating “certain active Principles, such as is that of Gravity, and that which causes Fermentation, and the Cohesion of Bodies” with the active laws of nature, as Biener and Schliesser do. In the next subsection, I argue that such a move is unwarranted.

*4.3. Active Principles*

To what does Newton refer when he speaks of “active principles?” This question has been tackled by many of Newton’s expositors. Among the *loci classici* are (McMullin 1978; McGuire 1995), and recent illuminating discussions include (Kochiras 2009, 2011; Schliesser 2010, 2011; Ducheyne 2011, 2014; Parker 2020; Henry 2020). I leave it to these authors to guide us through the vast literature on Newton’s active principles—a role for which they are much better equipped than I am. But for our present purposes, a few points are especially important.

The presence of active principles in Newton’s metaphysical landscape is most likely due to his experiences with alchemy, as well as his familiarity with Cambridge Platonists such as Henry More and Ralph Cudworth (McGuire and Rattansi 1966). These experiences informed Newton’s belief that new motion is introduced into the world via the active principles (such as gravity, fermentation, and cohesion) cited in Query 31. The ontological status—and even the physical source—of those active principles is widely debated. Some such as Kochiras and Ducheyne argue that, for Newton, matter is *always* passive, and therefore the “seat” of active principles—their physical origin—is outside of matter (Kochiras 2009, 2011; Ducheyne 2011, 2014). Others are not so certain. For example, Schliesser argues that while a body itself cannot (*pace* Stein 2016) produce a gravitational force, each body has a *disposition* to gravitate (Schliesser 2010; see also Miller 2009). That disposition is realizedwhen two bodies come within a certain proximity to one another. A lone particle in the universe will not produce a gravitational force on Schliesser’s view. However, that lone particle does have the disposition to gravitate, and counterfactually it *would* gravitate were it placed sufficiently near another particle. Schliesser is compelled by the fact that “Newton never claims in his own voice that matter must always be passive” (2010, p. 92).

Alas, the source of these active principles in Newton’s ontology remains unsettled. Perhaps that is because there is no single answer. McGuire and Ernan McMullin have both shown that Newton’s position on this topic changed throughout his life. For example, McGuire notes that between the *Optice* of 1706 and the revised *Opticks* of 1717, Newton seriously considered an “electric spirit” as a candidate for this active principle which causes particles to cohere. In another draft (of Query 25) from this period, Newton writes, “Do not all bodies therefore abound with a very subtile, but active, potent, electric spirit by wch … the small particles of bodies cohere when contiguous” (Add. 3970, 235r). This, of course, seems to plainly suggest that the active principle—the electric spirit—is inherent in bodies. Interestingly, McGuire argues that this fascination with the electric spirit after the *Optice* was motivated by “the experiments of Francis Hauskbee in 1706-7 on electro-luminescence and on electrical attraction and repulsion” (McGuire 1995, p. 205; see also McMullin 1978, p. 94, and Hall 1993, p. 146). Prior to this period, it seems Newton considered the possibility that *light* is the source of active principles. As McMullin notes, Newton opens Query 22 of *Optice* as follows: “Do not bodies and light mutually change into one another? And may not bodies receive their active powers from the particles of light which enter into their composition?” (cited in McMullin 1978, p. 85).

Again, for our purposes, the resolution of this debate is peripheral. Perhaps bits of matter are endowed with active principles that give rise to electrical, magnetic, and gravitational forces. Or perhaps these active principles are superadded by God (*sensu* Henry 1999) or are impressed upon matter via light, electricity, or an aether (McMullin 1978, p. 96). Regardless of how Newton answers this question—and, as we have seen, his answer changes throughout his life—only one viable interpretation of the formal-cause approach remains: active laws of nature are formal causes of composite bodies and the forces that cause their constituent particles to cohere. In the last subsection I claimed that this admittedly viable interpretation only works if we are warranted in identifying active principles as laws of nature, as Biener and Schliesser do. This is understandably how they read Newton when he writes in Query 31 that, “These Principles I consider, not as occult Qualities, supposed to result from the specifick Forms of Things, but as general Laws of Nature.” [[12]](#footnote-12) But, just as Brading’s law-constitutive approach must confront the passages where Newton says that laws arise from bodies, Biener and Schliesser must also confront the passages where Newton says that laws arisefrom active principles. If the laws are contingent upon the active principles imposed on (or originating in) matter, then surely laws are not the same as active principles. For example, in a draft of Query 23, Newton posits that “Thinking is an active principle by wch we move or bodies according to or will, & thence arise other laws of motion unknown to us” (Add. 3970, 620v).[[13]](#footnote-13)

Several Newton scholars have also puzzled over his identification of active principles with laws of nature. For example, McMullin writes of this passage:

Here he identifies the ‘principles’ with the laws themselves, made manifest in the phenomena. They are thus fully known, though their ‘causes’ are not. More often, he takes the active principle to be itself the cause, the ontological constituent responsible for the motion. The term is thus for him a loose generic one, which could cover a wide variety of causes, such as will (whether human or divine) and the spirits responsible for fermentation and other chemical changes, as well as gravitational forces. (1978, 81-82)

McMullin takes Newton to be using “active principles” and “laws” loosely here. A worry, then, is that Biener and Schliesser have placed too much emphasis on one instance of this expression—an expression from the Queries of the *Opticks*, no less, where Newton was comfortable sketching conceptual possibilities and introducing metaphysical speculations. A recent analysis by John Henry further corroborates this worry:

It seems safest to assume, therefore, that Newton saw active principles as the causes of phenomena such as gravity, fermentation, cohesion, magnetism, electricity, and the other “attractive Powers” that he mentions in the course of this query … Almost immediately, however, he complicates the issue again by saying that he considers these active principles to be laws of nature … This is very problematic, and seems irresolvable. At first, an active principle is said to be the cause of gravity, and this principle is a law of nature; but then we are told that things are formed by the laws of nature, even though the causes of these things are not yet known … Newton seems to say that laws of nature (active principles) are the cause of things, and then to suggest that there are unknown causes operating in a regular way, which enable us to formulate laws. Newton is clearly unaware of his confusion—or, at least, unaware that he is writing in a way that readers can only find confusing. (2020, p. 345)

Of course, Biener and Schliesser would reply that this “problematic” and “irresolvable” confusion that Newton has introduced is the exact tension that motivates them to propose the formal-cause approach. Indeed, they argue that “this tension is not resolvable, but that it is inherent in a neo-Aristotelian conception of formal causation” (2017, p. 321). Henry, however, draws a different conclusion. He instead prefers to read Query 31 as a probing and, at times, imprecise exploration of active principles. Although he momentarily conflates laws and active principles, a more cautious Newton distinguishes between active principles as the *causes* of new motion, and laws as the physical regularities that result from those principles:

So, at this point everything seems clear. Newton believes that empirical phenomena lead us to the conclusion that there is an active principle which is the cause of gravity. This active principle acts in such a regular and predictable way that we can arrive, indeed we have arrived (thanks to Newton), at a law of gravity. The validity of the law then establishes that the starting premise—that gravity is caused by an active principle—is correct. (346)

Thus, McMullin and Henry provide us with a competing interpretation of the passage in Query 31: Newton was simply speaking casually. It has been noted by several scholars that Newton used the Queries to explore physical questions that had been excluded from the rigorous physico-mathematical method he pursued in the *Principia* (e.g., Ducheyne 2014, p. 698). We should therefore take Newton’s remarks about the “general Laws of Nature” with a grain of salt. It is true that Newton’s various remarks are in tension. But, *pace* Biener and Schliesser, it is a tension that is dissolved (if not resolved) once we embrace the exploratory and, at times, incautious prose of the Queries.

Finally, Newton makes an additional move in the *Opticks* manuscript that casts doubt on his identification of active principles with laws: he alsoidentifies *forces* as laws of motion:

I have hitherto been arguing from the effects to their causes & ~~fro~~ carried the argument ~~as high as~~ up to the power \certain forces/ by wch \little/ bodies act on one another at small distances. These forces may be recconed among the laws of motion, ~~& referred to an active principle \perhaps~~/ \but whether they depend on/ \~~For bodies alone~~/ Bodies \alone considered only a long broad & thick/ \bodies alone may be a question For/ are passive. ~~They~~ /By their vis inertiæ they\ continue in their state of moving or resting & receive motion proportional to ye force impressing it & \are/ resistes as much as they are \are/ resisted/ed\, but they cannot move themselves; & without some other principle \then the vis inertiæ/ there could be no motion in the world. ~~And what that Principle is & by \means or/ laws it acts on matter is a mystery & how it stands related to matter is a {illeg} difficult to explain~~ And if there be another Principle \of motion/ there must be other laws of motion de{g} depending on that Principle. [And the first thing to be done in Philosophy is to find out all the \general/ laws of motion ~~so far as they can be discover~~ on wch the frame of nature depends.] (Add. 3970, 620v)[[14]](#footnote-14)

Two important features of this passage stand out. First, Newton classifies the forces “by wch little bodies act on one another at small distances” as laws of motion.[[15]](#footnote-15) (He is, of course, including them among the active laws, not the passive laws of the *Principia*.) This is one more instance of Newton speaking loosely: surely his ontology is not actually such that forces *are* laws of motion—not in the sense of the *Principia*, anyway. Assuming, then, that Newton distinguishes between forces and force laws (both formulated and unformulated), I believe we should read him as identifying the former as active principles, as Henry suggests above. If I am correct, then an interesting consequence immediately arises: active principles are not formalcauses of bodies, but efficientcauses of bodies. This is yet another place where my account parts ways with Biener and Schliesser, who write that, “for Newton laws are genuine, so-called secondary causes. However, they are not efficient” (2017, p. 318). If they are referring to laws *sensu* the *Opticks* in this passage, then they are incorrect: the “general Laws of Nature” (forces and/or their causes) are efficient causes of bodies—the glue that binds bodies together.

The second notable feature of the above passage is that Newton asks whether these forces “depend on bodies alone.” He is entertaining the very question discussed earlier: is matter always necessarily passive? He is asking whether the forces of attraction, such as gravity, are seated in the bodies, or whether the attraction may be attributed to something extra-material (such as light or an immaterial aether). But note that, if Newton held that attractive forces *did* depend on the active laws—if the “general Laws of Nature” really *were* formal causes that constitute bodies and attractive forces—then it would not be a question whether these forces depend on bodies alone. Attractive forces would be metaphysically dependent on the laws that form them. Newton apparently does not answer the question this way. He poses the question due to his lingering commitment to the notion that attractive forces must originate in something besides matter. But it is, for him, a genuinely open question. If Newton held the formal-cause approach that Biener and Schliesser attribute to him, it would not be an open question. Attractive forces would depend on both the bodies *and* the laws that govern them.

Now, I certainly appreciate the fact that these passages come from a draft version of the Queries, and that we should perhaps weigh his published remarks more heavily than his drafted remarks. Even if that is the case, I include the above passages to highlight the fact that Newton is clearly using the Queries to play with new ideas. That he revises so drastically and, at times, seems to use forces, principles, and general laws of nature interchangeably demonstrates that Newton is unsure how to articulate these abstract ideas. A. Rupert Hall draws a similar conclusion in his analysis of the Queries when he asks, “What *is* a power, virtue, force, or active principle? The profusion of names itself suggests an uncertainty in Newton’s own mind” (1993, p. 149).

**5. An Alternative Account of Laws**

The question remains: why would Newton refer to active principles as general laws of nature in Query 31? This reference seems to be the source of tension between Biener and Schliesser’s interpretation and my own. To resolve this tension, I turn again to McGuire, who considers the relevant passage in (1995):

…what did Newton mean in the context of these passages by the term ‘principle’? … a principle could mean something formulated or asserted … [ranging] from primary truths and mathematical propositions, through normative expressions, to laws of nature … *Consequently, these principles are laws in the sense of being features of reality rather than confirmed assertions about it.* For unlike the laws of the *Principia* they were never fully formulated. (p. 219, my emphasis)

McGuire is proposing yet anotherterminological distinction: Newton uses “laws” in Query 31 in a different, more liberal sense than he uses “laws” in the *Principia.* Whereas the passive laws of motion of the *Principia* are mathematical formulations of nature’s regularities, the active laws of the *Opticks* simply refer to features of reality. If McGuire’s interpretation is correct, then even the referent of “laws” is not the same throughout Newton’s oeuvre. On this reading, the “general Laws of Nature” that form bodies from particles do not describephenomena in the way that the passive laws of motion do. Instead, they denote active principles: features of reality that give rise to new laws of motion awaiting axiomatization. This is how he can refer to forces and active principles as laws—they are real (i.e., not occult) features of the universe whose causes are yet unknown. In other words, the “general Laws of Nature” of the *Opticks* are placeholders for Newton. They outline features of his ontology that have yet to be filled out through his experimental philosophy.

Still, one cannot help but wonder if Newton is aware of the confusion that arises from his equating active principles with laws. For instance, consider Newton’s instruction in the draft Query quoted earlier: “And the first thing to be done in Philosophy is to find out all the \general/ laws of motion ~~so far as they can be discover~~ on wch the frame of nature depends” (Add. 3970, 620v). Note that this is the *first* thing to be done. A revised remark makes it into the revised 1718 edition of the *Opticks*, but this time, “general laws” become “principles”:

But to derive two or three general Principles of Motion from Phænomena, and afterwards to tell us how the Properties and Actions of all corporeal Things follow from those manifest Principles, would be a very great step in Philosophy, though the Causes of those Principles were not yet discover'd: And therefore I scruple not to propose the Principles of Motion above mention'd, they being of very general Extent, and leave their Causes to be found out. (1952, pp. 401-402)

The “Principles of Motion” that Newton seeks to derive from phenomena are the same principles that, earlier in the same paragraph, he identifies as “general Laws of Nature.” This passage is especially helpful since it distinguishes “Principles” from the “Causes of those Principles.” We derive the principles, the general laws, from experience. We then demonstrate how the properties and actions of all matter *follow* from those principles. For example, we show how the properties and motions of particles follow from the active principle of cohesion (i.e., what properties the particles must have to manifest such principles). Here, Newton is using “follow” in the logical sense. That is, the properties of particles follow from the principle of cohesion in that we may (one day) *infer* the properties from our experience of the principle’s effects. This reading comports with Newton’s remarks at the beginning of Query 31:

For we must learn from the Phaenomena of Nature what Bodies attract one another, and what are the Laws and Properties of the Attraction, before we enquire the Cause by which the Attraction is perform'd. (1952, p. 376)

My claim is that Newton’s laws—active principles such as gravity, cohesion, fermentation, etc., as well as the axiomatized laws of the *Principia*—serve as epistemic points of access to a causal chain that begins with God. We learn of these principles, these laws, from experience of phenomena. We then proceed to investigate the series of secondary causes responsible for the phenomena (such as forces, the seats of those forces, the properties of bodies, primitive particles, etc.) until we arrive at the first cause, God’s divine will:

By this way of Analysis we may proceed from Compounds to Ingredients, and from Motions to the Forces producing them; and in general, from Effects to their Causes, and from particular Causes to more general ones, till the Argument end in the most general. (1952, pp. 404-405)

Therefore, Newton’s laws are the epistemic touchpoints—starting places from which we characterize phenomena and begin our investigations into their underlying ontology. We should not read Newton as saying that the properties and actions of corporeal things *depend on* the laws. It is only we who depend on the laws in order to investigate their causes. Simply put, Newton’s epistemic approach to physics is law-first (i.e., moving from laws to matter and forces) and his metaphysical approach is matter-first (i.e., matter, moved by various forces, gives rise to laws).[[16]](#footnote-16) In their new book, Brading and Marius Stan refer to Newton’s law-first strategy as a “principle approach” to philosophical mechanics (Brading and Stan, forthcoming). I agree that a principle approach is apparent in the *Principia*, as well as occasionally in *De Grav* and the *Opticks*. However, the argument of this paper is that Newton’s principle approach to epistemology does not entail a law-constitutive or formal-cause approach to ontology. As he “comes down” to physics via the laws of motion, Newton demonstrates the direction of empirical inquiry, not metaphysical dependence. A principle approach for Newton does not preclude the possibility that there is an independent and ontologically prior account of matter and force to be found. Rather, it implies that the only way of elucidating such an account is with the help of the laws.

**6. Conclusion**

The law-constitutive and formal-cause approaches are interesting and compelling. However, I believe they are unsuccessful when compared to the alternative—namely, the law-first epistemology and matter-first metaphysics that I have developed in this paper. While certain passages from *De Grav*, the *Principia*, and the *Opticks* lend themselves nicely to the positions of Brading, Biener, and Schliesser, I have argued that all of these passages are more easily reconciled with my position. The trickiest of these texts is the *Opticks*, wherein Newton mentions laws of nature actually forming physical bodies. Interpreted within a larger historical context, however, the *Opticks* reveals Newton’s belief that a rich physical ontology awaits discovery and formulation. This ontology is clearly scaffolded: it originates with the creator God and terminates with the perceptible, lawlike manifestations of his will. Newton is clearly eager to find out what happens in between these two extremes. Filling out this ontology is, after all, the “main Business of natural Philosophy” (1952, p. 369). But Newton is explicit in the order of his method: the causes of forces, the properties of bodies, and, ultimately, the role of the divine will can only be known after first formulating the laws.

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1. Unless stated otherwise, all quotations from *De Grav* are in (Newton 2004); all quotations from the *Principia* are in (Newton 1999); and all quotations from the *Opticks* are in (Newton 1952). Passages from unpublished manuscripts, housed in the Cambridge University Library, are cited using the following convention: additional manuscript number, folio number (e.g., Add. 3970, 244r). [↑](#footnote-ref-1)
2. Howard Stein endorses a similar view in (2016), though his discussion is more cursory: “we have a perfectly clear conception of those attributes of bodies that the mechanical, corpuscular, philosophy has conceived as fundamental, including the laws governing the interactions of those bodies: the laws of impact.” (345). More plainly, “laws just are, on this view, the fundamental constitution of corporeal nature” (348). This is a curious position for him to take, given his remarks (quoted below) about the laws of motion arising from the vis inertiae. [↑](#footnote-ref-2)
3. An anonymous referee helpfully notes that the distinction between “body” and “account of body” is important here. Brading often writes in terms of an *account* of body, therefore suggesting agnosticism about Newton’s metaphysics. On this reading of Brading, to solve the problem of bodies, we seek an *account* of body that is serviceable to mechanical inquiry. But I read Brading to be asserting something stronger than this. For instance, in their new book, she and Marius Stan write that *any* satisfactory solution to the “problem of bodies,” as they call it, will have to “determine the nature of bodies” and “ascertain their essential properties, causal powers, and generic behaviors” (forthcoming). I therefore believe I am justified in attributing the following position to Brading: on Newton’s accountof bodies, they are constituted by laws, but that account is a realist one. A law-constitutive account identifies the true nature of body. See also, e.g., (Brading 2010, p. 146): “The laws give necessary conditions on *what it is* to be a body, on *what it is* to be a composite system of bodies, and on *what it is* to be a *part* of a body. Traditionally, these questions belong to matter theory, and to metaphysics, but with the development of Newtonian mechanics the two become entangled.” [↑](#footnote-ref-3)
4. An anonymous referee asks that I clarify Gabbey’s use of “passive laws” here. By “passive,” Gabbey means the laws of the *Principia* do not govern the introduction of new motions into the world. This is most easily grasped when distinguished from “active laws,” which I discuss at length in Section 4. [↑](#footnote-ref-4)
5. Stein is clearly suggesting that we can derive the three passive laws of motion from Definition 3 (Law 1) and the ensuing commentary (Laws 2 and 3). This is interesting, given that such a position instantly creates tension with his law-constitutive approach. [↑](#footnote-ref-5)
6. Schliesser is not, however, the first to argue that Newton endorses a species of formal causation. An earlier argument for this position is (Faulconer 1995). Faulconer even draws the analogy between Newton and Bacon’s remarks in *Novum Organum*, as Schliesser does. Another discussion of formal causation in Newtonian exegesis may be found in (Joy 2006). [↑](#footnote-ref-6)
7. I believe it is worth noting a possible tension in Schliesser’s own accounts of the Aristotelian influences on Newton’s metaphysics. In (2013), Schliesser writes: “Bacon’s forms are materialistic. In labeling his causes in this fashion, Bacon is even willing to risk confusion with the Scholastics. To be clear: a Baconian formal cause has nothing to do with hylomorphism.” In this paper, Schliesser argues that Newton’s is “a species of Baconian formal causation” (449). This seems to contradict Biener and Schliesser’s claim that Newton’s notion of formal cause is neo-Aristotelian. This is not, of course, to imply that an exegete should be diachronically consistent in their interpretations. I only raise the worry because Biener and Schliesser cite (Schliesser 2013): “we call laws the ‘formal’ causes of bodies and forces, thereby also picking out something resembling Baconian forms” (2017, p. 319). [↑](#footnote-ref-7)
8. Schliesser discusses these passages in (2013, p. 459). [↑](#footnote-ref-8)
9. See the fascinating discussion of Newton’s geometrical conception of body in (Biener and Smeenk 2009). Their discussion of these passages from *De Grav*, as well as their claim that Newton eventually adopts a law-constitutive approach in the *Principia*, are both quite salient for the present discussion. For example: “The conception of body as impenetrable extension takes precedence in *DG* [*De Grav*] over the nascent conception of body defined by laws of motion … Taken by itself, *DG* defines body primarily as a region of filled-in extension and only secondarily in terms of laws governing motion” (p. 112). [↑](#footnote-ref-9)
10. See also Proposition 6, Corollary 1: “Hinc pondera corporum non pendent ab eorum formis & texturis. Nam si cum formis variari possent, forent majora vel minora, pro varietate formarum, in æquali materia: omnino contra experientiam.” These corollaries provide a clear counterinstance to Schliesser’s claim that “one of Newton’s most important decisions in recasting the material for *Principia* was to drop the language of formal causation that was still present in DeGrav and replace it with the language of law” (2013, p. 451). [↑](#footnote-ref-10)
11. For example: “…and that these primitive Particles being Solids, are incomparably harder than any porous Bodies compounded of them” (Newton 1952, p. 400). [↑](#footnote-ref-11)
12. “We read the passage as asserting that in Newtonian philosophy, active principles— even universal ones like gravity—just *are* general laws of nature, and those laws *form* the things, which they govern” (Biener and Schliesser 2017, p. 318). [↑](#footnote-ref-12)
13. Several other examples of this language—viz., laws of motion arisingfrom active principles—are cited in (McGuire 1995). [↑](#footnote-ref-13)
14. NB: words written between slashes are inserted above the original line. [↑](#footnote-ref-14)
15. We find yet another example of this earlier on the same folio: “Gravity was recconed among the laws of motion & by the ancient Philosphers who attributed gravity to their Atoms in vacuo, & the same the forces by above mentioned by wch smal bodies act on one another ~~seem to~~ \at small distances may/ have a good a title \as gravity/ to be recconed among those laws.” See other passages from Add. 3970, such as 254r, for more examples of Newton conflating forces and “powers” such as gravity with laws of motion. [↑](#footnote-ref-15)
16. Lest the pithy label I’ve given my position be read too literally, allow me to clarify: at least in this paper, I remain agnostic on whether laws depend *entirely* on matter. As discussed in Section 4, it may be that active principles are imposed on matter from external sources. Nevertheless, in the relationship *between laws and matter*, Newton’s metaphysical stance is unidirectional: laws depend on matter, not vice versa. [↑](#footnote-ref-16)