On Force in Cartesian Physics*

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There does not seem to be a consistent way to ground the concept of "force" in Cartesian first principles. In this article, I first review the literature on the subject. Then, I offer an alternative interpretation of force—one that seems to be coherent and consistent with Descartes' project. Not only does the new position avoid the problems of previous interpretations, but it does so in such a way as to support and justify those previous interpretations.

1. Introduction. Before one can understand the particulars of Descartes' physics, one must be familiar with his more general project.[1] He held that when one begins "to tackle true philosophy in earnest" one discovers that "the whole of philosophy is like a tree. The roots are metaphysics, the trunk is physics, and the branches emerging from the trunk are all the other sciences" (AT 9b, 14; CSM 1, 186).[2]

Cartesian metaphysics concerns what he terms the "principles of knowledge." Though various lists consisting of these principles may be disputed, any catalog must, at least, include the ideas of God, self, and extension (Nelson 1997, 166). These principles can be clearly and distinctly perceived and it is upon these "first truths" that other principles rest (AT 6, 40; Garber 1992, 51). Thus, it must be possible to ground the concepts of physics in one or more of these first principles.[3] This connecting back of

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1. For a thorough discussion, see Garber 1992, 30–62.

2. Citations in the text make use of these abbreviations. AT: Adam and Tannery 1982–91. CSM: Cottingham, Stoothoff, and Murdock 1985. CSMK: Cottingham, Stoothoff, Murdock, and Kenney 1991.

3. In Descartes' epistemology, clear and distinct perceptions are guaranteed to track ontology. So, if we can clearly and distinctly perceive that, for example, the idea of force is contained in the idea of extension or God, then we know that force ontologically depends on those principles and is, therefore, grounded in them.

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all knowledge to metaphysical principles is the general project of Descartes and that which has been criticized for its inconsistency even in the most sympathetic literature (see Nelson 1997, 163).

The notion of "force" in Cartesian physics proves to be especially problematic. Force (of motion or rest) is identified as "the power which all bodies have to act on, or resist, other bodies" (AT 8a, 66; CSM 1, 243). But Descartes is also committed to the position that bodies are simply the objects of geometry made real (see Garber 1992, 63–64). In other words, bodies (and thus force, it seems) must be connected back to the principal idea of extension. However, it is unclear how the notion of force (and its associated tendencies) fits into Descartes' limited geometrical ontology.

In this article, I will briefly outline the previous proposals to understand Cartesian force along with the virtues associated with them. However, it will be clear that none of the theories qualify as a "satisfactory view of the ontology of force in Descartes, one that is coherent and sensible, and is consistent with what he says about force in all of his writings and what he commits himself to in other contexts" (Garber 1992, 297). Then, I will offer an alternative interpretation of force—one that seems to be coherent and consistent with Descartes' project. I hope to show that not only does the new interpretation avoid the problems faced by the previous commentators, but that it also explains why they viewed Cartesian force as they did.

2. Previous Interpretations. Before considering each of the previous interpretations, let us first examine in more detail the problems associated with a naive attempt to ground force in extension. A comparison of two articles of Descartes' *Principles of Philosophy* reveals the apparent contradiction. The first relates the position that all of physics can be described geometrically.

> The only principles which I accept, or require, in physics are those of geometry and pure mathematics; these principles explain all natural phenomena, and enable us to provide quite certain demonstrations regarding them. (AT 8a, 78; CSM 1, 247)

The next bit of text consists in Descartes' third law of nature. While outlining the conservation of quantity of motion, there is explicit mention of the motion which one body "imparts to the other body" (AT 8a, 65; CSM 1, 242).

Taken together, the two texts seem to be at odds because the imparting of motion, made possible by the "force" or "power" within the body, is not a geometrical notion (AT 8a, 66; CSM 1, 243). One may argue that while the *effects* of the imparted motion may be geometrically described

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(by taking measurements of positions at different times, for example), the imparting of motion itself is not the sort of thing one can explain in terms of "matter (extended substance) in motion (where this motion is described kinematically)" (Hatfield 1979, 113). Thus, an alternate account of force is required.

2.1. God as the Locus of Force. It was Gary Hatfield's (1979) view that by carefully attending to Descartes' metaphysics, one must conclude that the source of any motion of matter (force) must be attributed to God. This view was adopted in response to inconsistencies found in Richard Westfall's (1971) attempt to ground force in the first principle of extension.

Hatfield begins with a discussion of matter and motion. The essence of matter (substance) is to be found in the first principle of extension (AT 8a, 25; CSM 1, 210). Motion, on the other hand, "is a mode of the mobile thing" and therefore "not a substance" (AT 8a, 25; Hatfield 1979, 121). In other words, motion carries with it no reality outside the thing that it is moving. Thus, "as long as the discussion is limited to matter and motion, it need be concerned only with things that are definable geometrically" (Hatfield 1979, 121).

For Hatfield, it seems natural to next try to understand the cause of the motion in matter. Descartes identifies the general cause and preserver of motion in bodies as God. But how is this idea of God as creator and preserver of motion or rest in extended bodies connected back to the concept of force? It is in Descartes' third law that the transfer of motion between bodies (governed by force) is discussed. The proof which Descartes gives for the part of the third law that deals with transfers of motion rests on the immutability of God (AT 8a, 66; CSM 1, 243).

Hatfield argues that because force is grounded upon the immutability of God, God must must be responsible for the force that governs the transfer of motion between bodies (i.e., it is God that actually transfers the motion between the bodies; 1979, 126–127). And so God's continual imparting of motion (or rest) to matter is the "reality, the force or power, behind that mode of body which is called motion" (131). In other words, force is not a property of the bodies, but instead "depends entirely upon God" (129).

Certainly, this interpretation is superior to the naive approach of grounding force in extension. If force (and the associated tendencies of bodies) are grounded in God instead, the problem of finding some sort of geometrical interpretation for them dissolves: forces are not in bodies and are therefore in need of no such geometrical interpretation.

However, the Hatfield interpretation is not free of difficulties. Garber (1992) argues that the reading fails to square well with texts that attribute forces to bodies. In particular, in his discussion of the impact contest

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model, Descartes speaks of the "force each body has" (AT 8a, 66; Garber 1992, 293). Elsewhere Descartes writes, that a body "has in itself the force to continue to move" (AT 3, 213; Garber 1992, 294). Given these and other passages, Garber thinks it "absurd to say that it is God himself who *has* the force for proceeding or force of resisting that appear as parameters in a particular case of collision" (1992, 294).

2.2. Force in Both God and Matter. It was Martial Gueroult's view that Cartesian physics (and therefore force as well) rested on both extension (as matter and motion geometrically defined as a mode) *and* on God (as the cause of the existence of the matter and its modes; 1980, 200–201). In arguing for his position, Gueroult notes first that Descartes' physics deals not only with the "true and real beings" one finds in mathematics but also with physical bodies that are "actual and existent" (AT 5, 160; Gueroult 1980, 196). The principle of actuality and existence is, of course, God. The creative force of God is what distinguishes extension as possibly existing from extension as actually existing. Thus, it seems that any discussion of force must be necessarily be tied back to the first principle of God.

For Gueroult, motion and rest (defined geometrically) are modes of extension but the force (of motion or of rest) is the "power that makes a thing with such a mode exist" (1980, 198). So, force and the attributes of duration and existence are all identified as one and the same thing and immutably express God's creative action (197).

However, Gueroult does not (like Hatfield) only locate force in God. Characteristic of forces is that they are "immanent in 'nature' or extension and . . . can be calculated at each instant for each body" (Gueroult 1980, 198). How can forces, which are immanent in extension, also be referred to God? Gueroult distinguishes between force as a cause and the effects of the forces (motion or rest as modes of extension). It is the effects of the forces (not the forces themselves) that are found in bodies and can be calculated. He explains.

> Consequently, we can see that physics must rest on two quite different foundations: on extended substance and motion geometrically defined as a mode . . . and on God as the sole power capable of creating matter, in short as the cause of extended substance and its modes. (Gueroult 1980, 198)

Gueroult's position is very appealing and certainly "quite ingenious" (Garber 1992, 295). In many ways, it seems to be an extension of Hatfield's interpretation without the undesirable result of God being in bodies. Force can be understood as being grounded in God (as the creative force al-

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lowing the existence and duration of motion or rest) and yet the calculable effects of force can be immanent in extended substance.

The interpretation carries with it its own problems, however. Garber (1992, 296) argues that there is no explanation of how, if force really is identified with the attributes of existence and duration in a body (stemming from the invariable nature of God), the calculable forces in a body can vary—having one value at one time and another value at another.

Alan Gabbey, who represents his position as an extension of Gueroult's, also recognizes this problem. He holds (with Gueroult) that the ontological status of force is complex and is grounded both in extension *and* God: forces "are in created substances as the effects of God's creative and conserving activity" (1980, 234).

To circumvent the difficulty, Gabbey suggests that there is a sense in which force can be considered a mode of extension (and therefore variable in nature). He explains: "Forces as causae secundum fieri are clearly in body diverso modo, so they are modes of body, rather than attributes" (1980, 237).

Of course, this takes care of the problem of the variable nature of calculable force, but in turn, it recreates the complications of the naive approach to grounding force in extension. If there is a sense in which forces are in bodies as modes, "what becomes of Descartes' commitment to the position that everything in body must be conceived [only] as a mode of extended substance?" (Garber 1992, 297). Certainly Gabbey's position that force be ultimately grounded in God does not square well with this commitment.

2.3. Force as Explanatory Construct. The difficulties associated with the foregoing positions led Daniel Garber (1992) to an altogether different type of interpretation. Instead of trying to ground the concept of force in first principles, Garber argues that force has no ontological status and is simply a "way of talking" about God's creative and preserving activities (298). On this interpretation, God is the cause and preserver of motion in extended substance. There is "no need to attribute some new kind of property to bodies" (298). And so, when force enters the discussion, it is only as a "shorthand" description of the lawlike way in which God governs the interactions between bodies (see Slowik 2002, 58).

Garber's interpretation certainly takes care of the ontological status of force. If force is merely a shorthand for God's creative and preserving activities, many of the worries of Hatfield and Gueroult simply vanish. On this interpretation, there are no difficulties with Descartes' force because there is no force!

But, this is not to say the theory is without its own problems. Garber, himself, notes that one drawback to this approach is that the view is "not

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found in Descartes in any explicit way" (1992, 298). But this is not the extent of difficulties. It seems to be quite a task to explain why, if there is "no need" to attribute the property of force to a body (as Garber holds), Descartes did so. Why insist that Descartes' discussion of force means something other than "force"? Why not take Descartes at his word?

3. Alternative Interpretation. Given the problems of each interpretation, it may seem as though there isn't a consistent and coherent way to understand force in Cartesian physics. I believe that there is and that the key to constructing such a theory lies in considering force within a much more comprehensive interpretation of Cartesian ontology. This interpretation of Descartes' ontology has been nicely developed by Lawrence Nolan (1997) and Alice Sowaal (2004, 2005). In the next section, I will briefly outline their positions. Then, I will specify how the concept of force fits within this framework. Finally, I will show how such an understanding of force resolves the difficulties recounted in the previous interpretations.

3.1. Theory of Attributes. For Sowaal, there are three categories of things answering to the label "substance" within Cartesian ontology (2004, 222–227). Descartes defines substance in terms of independence and therefore God (the first or primary substance) and extended substance make up two categories (AT 8a, 24; Sowaal 2004, 223). But Sowaal further divides the category of extended substance. For her, there is the secondary substance *res extensa*, that is, extension as a single, whole substance. Then there are tertiary substances which are individual bodies (what I have been calling "extended substances").[4] Sowaal provides textual evidence for her interpretation by noting that in some places, Descartes speaks of extended substance "taken in the general sense" while elsewhere he refers simply to "bodies" (AT 7, 14; CSM 2, 10).

Of the three substances, the degree of reality is greatest for God and least for bodies. Because the degree of reality of bodies is so low, full Cartesian metaphysical rigor can be achieved only when considering primary and secondary substances. Tertiary substances are understood only as individuated by sensation, which is ultimately confused rather than clear and distinct (Sowaal 2005, 259).

We can regard tertiary substances as modes of the secondary substance *res extensa*. Thus, bodies can be understood in two ways: they "have an ontological status at both the secondary and tertiary levels—in addition

4. For more on secondary and tertiary extension, see Smith and Nelson 2009.

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to being [tertiary] substances, bodies are also [secondary] modes" (Sowaal 2004, 231).

There are attributes and modes associated with each of the three types of substances. Thus, it is appropriate to speak of primary, secondary, and tertiary attributes and secondary and tertiary modes (there are no primary modes because of God's invariable nature). Sowaal argues that tertiary attributes mirror particular secondary attributes—a tertiary attribute can be considered a delimitation of the secondary attribute. She elucidates the point.

> For example, as *res extensa* has indefinite size as one of its secondary attributes, bodies have some finite size or other as one of their tertiary attributes; further, as *res extensa* has its quantity of motion as one of its secondary attributes, bodies have some local motion or other as one of their tertiary attributes. (Sowaal 2005, 259)

It is Nolan who fully develops Descartes' theory of attributes. He interprets a crucial text as implying that an attribute has the same status as a mode of thought—that a mode is, literally, a way of thinking about something (1997, 136).

> I make a distinction between modes, strictly so called, and attributes, without which the things whose attributes they are cannot be; or between the modes of things themselves and the modes of thinking. (AT 4, 348–349; CSMK, 279–280)

Under Nolan's interpretation, things which are rationally distinct are identical external to the mind—in reality. He explains: "We generate a rational distinction in our thought by taking a substance which is singular, and not diverse in itself, and regarding it in diverse ways" (1997, 136).

In light of this approach, a substance and the attributes associated with it are identical in reality even if they are conceived differently. Indeed, the difference between a substance's attributes "does not arise in the substance itself but from our abstract ways of regarding it" (Nolan 1997, 136–137). So, for example, we may conceive a distinction between the bodies and the tertiary attributes of local motion and local rest but, in reality, either attribute is identical to the body in question and therefore unchanging in reality (so long as the body is unchanging).

Taken together, the interpretations of Sowaal and Nolan seem to constitute a coherent version of Cartesian ontology (one that is also consistent with Descartes' text). The true justification for the approach, however, comes when it is considered in relation to problematic topics such as

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force.[5] As we will see in the next section, it seems to dissolve some very hard interpretive problems.

3.2. Reinterpreting Force. When some body or another is discussed, Descartes explicitly speaks of the forces of that body (AT 8a, 66; CSM 1, 243). This seems to imply that, whatever else is the case, forces should be tied back to extension. The question is how exactly this is to be accomplished.

I believe that in Descartes' physics, "force" is, properly speaking, both a secondary attribute of *res extensa* and tertiary attribute of particular bodies. In accordance with Sowaal's account, the secondary attribute of force has a greater degree of reality than and is delimited by the calculable (Gueroult 1980, 198) tertiary attribute of force of motion or of rest. Here, one may object. If attributes are the general (i.e., unchanging) aspects of a substance, how is it that force (something regarded by previous commentators as a variable aspect of bodies) can be an attribute? The answer lies in the theory of attributes as presented by Nolan. We may conceive a distinction between the tertiary attributes of force of motion or force of rest but, in reality, the two attributes are identical (not only to each other but also to the body itself) and therefore unchanging in reality.

One may ask what exactly the relationship is between the tertiary attributes of force of motion and local motion itself. Because they are both attributes, in reality, they are identical in any given body. But what is the distinction between them in our thought? I believe that the attribute of force of motion demonstrates the cause of motion in a body whereas the attribute of local motion demonstrates the motion itself. To see why this might be, recall that Gueroult held that forces "directly express the creative action or will of God" (1980, 198) and that Hatfield felt force was grounded in God because it was God who is the "first or primary cause of motion" (1979, 121).

Finally, because force is the attribute demonstrating the cause of motion (God) in bodies, one may ask what the relationship is between God and the attribute of force. In my interpretation, God creates and maintains *res extensa* (which is, strictly speaking, identical to force at the secondary level) such that it *appears* to us when we make sensory observations that bodies interact in a regular fashion, in accordance with law three. This view differs from the usual interpretation that God "causes" the motion or rest (through forces) involved in impact collisions by directly varying the motions of bodies in a lawlike way (Sowaal 2004, 232–233). Notice, however, that this traditional view contradicts Descartes' position that

5. For an example of another problematic topic that this theory has helped to clarify, see the discussion of the consistency of collision laws in Sowaal 2004, 239.

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"in the case of God, any variation is unintelligible" (AT 8a, 26; CSM 1, 211). If, as explained, we view God as creating and maintaining *res extensa* in an invariable way (the variable aspects of motions imparted from body to body through force being just appearances to us), this traditional problem disappears.

3.3. Resolving Previous Difficulties. The interpretation presented in the last section seems to provide a coherent and consistent way of understanding Cartesian force but it still must be scrutinized to determine if this is really the case. My scrutiny will consist in considering to what extent the theory holds up against the (rather large) set of difficulties collected from each of the previous interpretations of force. I maintain that the force-as-extension interpretation resolves *all* of the difficulties in the set.

Naive Approach. The first of the problems encountered was that of the naive approach to ground force in extension. Recall that this came in two parts. On the one hand, all of physics must be understood in terms of extended substance and geometrically defined motion. On the other hand, it was unclear how the "imparting" of motion from one body to another in law three (through forces) was to be understood geometrically.

I believe that clarifying the relationship between God and force (as presented in the last section) eases this tension. God creates and maintains *res extensa* (strictly speaking, identical to force at the secondary level) such that it *appears* to us that bodies interact in a regular fashion, in accordance with law three. Motion and rest are distinguished only in thought and so the "imparting" of motion is only apparent. This interpretation is supported textually by a letter Descartes wrote to Henry More (1649).

> The force causing motion . . . is a mode in creature, but not in God; but because this was not easy for everyone to understand, I did not want to discuss it in my writings. . . . You observe correctly that a motion . . . cannot pass from one body to another. (AT 5, 403–404; Hatfield 1979, 130)

Thus, it seems that because the imparting of motion through force is something that occurs entirely "in creature," objectively speaking ("in God") there is no such transfer of motion. Thus, our attempt to geometrically understand the imparting of motion through force is misguided. It is our confused, sensory thought (as opposed to distinct, purely intellectual thought) that provides the impulse to view force as anything but *res extensa* itself.

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Hatfield. Hatfield argued that God was responsible for the force that governs the transfer of motion between bodies. This was well supported textually. However, he also argued that force depends *entirely* upon God. Indeed, Hatfield claimed that Descartes "banned force from inclusion among the properties of matter" (1979, 129). It is this latter position which seems to be ill supported with explicit text.

The force-as-extension view I have adopted seems to provide an understanding of force which is consistent with Hatfield's position that God is responsible for the forces that governs the interaction of bodies but which locates force not in God but in bodies. In this interpretation, God is the creator and preserver of *res extensa* that is identical to secondary force. But of course, force is also an attribute of the tertiary substance of bodies. Thus, ultimately, force is a property of matter.

Gueroult and Gabbey. Recall that one position Gueroult held was that force was identical with the (invariable) attributes of existence and duration in bodies. This position proved problematic when the varying nature of calculable forces was considered. How exactly could an invariable attribute be regarded, in some way, as varying? Note first that, strictly speaking, Gueroult's interpretation of force is fundamentally the same as the one I have presented. Because attributes are modes of thought, they are only rationally distinct. The tertiary attributes of existence and duration in a body are identical with that body and thus, identical with the tertiary attribute of force. The variation comes, as we have seen, from our experience of a rational distinction between the tertiary attributes of force of motion or force of rest.

Finally, consider the difficulty Gabbey encounters. He views force as both being grounded in God and also being in body as a mode. But Descartes is committed to the position that everything in body must be conceived as a mode of extended substance. How exactly is force a mode of extended substance? Gabbey does not say. In my theory, however, I *can* say exactly how it is possible for force to be in bodies and also be modes of extended substance. First, consider that the tertiary attribute of force in a body is identical to that body. But we also know that bodies are modes of *res extensa*. So, the tertiary attribute of force is a secondary mode of extended substance *res extensa*.

Garber. Garber held that "force" is not an ontological reality but a "way of talking" about God's creative and preserving activities. The difficulty was that the theory had no explicit textual support for this position. In fact, the text seems to strongly suggest otherwise. However, my proposed interpretation of force is such that it takes Descartes at his word in his various writings on force. The concept of force is not trivialized

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but taken seriously as having a real ontological status that fits consistently and rigorously within his larger system.

4. Conclusion. Clearly, the force-as-extension interpretation outlined here takes care of the difficulties encountered by the previous commentators. The success at resolving these long-standing problems justifies the theory in some sense. But, I want to highlight another positive aspect of this interpretation that has little to do with resolving difficulties. Instead, I propose that the theory provides proper perspective in that it shows *why* each of the previous commentators viewed force as they did and also just how close each of them came to the consistent theory they desired. In other words, I believe that the proposed interpretation of force does not show how everyone was "wrong" but how everyone was more or less "right" all along!

To see this, consider first the interpretation of Gueroult. His view under the new interpretation is exactly the same as the one I have proposed. Forces, for Gueroult, are the attributes of duration and existence. But these attributes are, strictly speaking, the same as what I have been calling the attribute of force since all attributes are distinct only in thought. We also showed how the position of Gabbey was, under the new interpretation, the same as mine. Force can be thought of as a mode if it is a mode of the secondary substance *res extensa*. The new interpretation also shows why Hatfield grounded force in God: force is an unchanging attribute that demonstrates the cause of motion or rest (God). Finally, we can see why even the Garber interpretation was, in a sense, correct. For Descartes, we use the term "attribute" (of a substance) when we are "simply thinking in a more general way of what is in a substance" (AT 8a, 26; CSM 1, 211). So an attribute is a "way of thinking" or (when verbalized) a "way of talking" about a substance. So, under this interpretation, force can be considered a "way of talking" about the objects of God's creative and preserving activities—just as Garber claimed it was.

So we see that not only does viewing force as an secondary and tertiary attribute of *res extensa* and bodies resolve all the difficulties of previous interpretations, it does so in such a way as to support and justify those interpretations. That all the major theories converge to one single position gives strong evidence that the proposed view is a satisfactory alternative to understanding force in Cartesian physics.

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