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8 Newton's metaphysics

When one speaks of Newton's "metaphysics," it should be noted that the word itself was rarely used by Newton; further, that in point of general philosophical usage, that word has not had in our own time a fixed and well-established acceptation. For the purposes of the present study, a rather broad view will be adopted – suggested on the one hand by Newton's most influential near predecessor, the previous author of a book called *Principia Philosophiae*,[1] Descartes, according to whom metaphysics treats of *the principles of* [all] *knowledge*, and serves as *the root* of the "tree of philosophy" (whose "trunk" is physics, and whose "branches" are what we should call the "applied sciences");[2] and on the other by the author of the article "Metaphysics" in the eleventh edition of the *Encyclopaedia Britannica*, Thomas Case, who summarizes the concern of this discipline in the two questions: "1. What is the world of things we know? 2. How do we know it?"[3] Thus metaphysics will here be understood to be the discussion of the most general features, *both* of the constitution of the world, *and* of the principles of human inquiry into the nature of the world.

It will be useful for our discussion to put Newton's position in comparison with that of Descartes; for the work of the latter was both enormously influential in general – in the seventeenth century, and also, so far as metaphysics (in contrast to natural philosophy) is concerned, right down to the present day – and of great moment for Newton in particular.

On the methodological side, Descartes's program for a reformation of knowledge – for the establishment of a science that should be both secure in its theoretical attainments and of unexampled power in its aid to the control of the natural conditions of human life[4] – was

based upon the demand that every item of knowledge be either *immediately clear and certain beyond a doubt*, or be *connected* to such clear and certain foundations by clear and certain links. Both the guarantee of the truth of what the mind perceives clearly and with no possible doubt,[5] and the identification of the fundamental principles so perceived, come, according to Descartes, from metaphysics or "first philosophy"; therefore this science is indeed "first" in the order of investigation: as already remarked, metaphysics is the "root" of that tree of which physics – natural philosophy – is the "trunk."

It is important to emphasize that this radical position does *not* mean, as it has sometimes been taken to, that Descartes thinks all of physics can be *deduced* from principles known through "pure reason." In his program for the investigation of the natural world, *experiment* plays a central role. But to characterize that role, something must be said about the deliverances of Cartesian metaphysics on what one might call its "ontological" side. The chief points that are relevant here are these:

Descartes, like Aristotle and the scholastic tradition, takes "substance" to be the primary category of "being" in the world: the "things that are" are "substances." A central *innovation* by Descartes is his principle that there are two fundamentally distinct sorts of substance, each distinguished by its characteristic essential "attribute": "thinking things" (*res cogitantes*) or minds, and "extended things" (*res extensae*) or bodies. Bodies form the subject of natural philosophy. Since it is of the essence of these simply *to be extended*, the notion of empty space – extension void of body – is just contradictory; so the world is a plenum: body is everywhere. The only distinctions or diversities that are conceivable among bodies *as* extended things are diverse *motions.* Therefore, the processes of nature consist solely in the motions of bodies and the changes of those motions; and the foundations of physics consist in the principles that govern those motions and changes of motions. The task of natural philosophy, therefore, is to account for all natural phenomena by describing the motions and changes of motion in which they consist, and exhibiting those processes of motion and change of motion as consequences of such fundamental principles.

Now, at the very base of this conception lies a serious difficulty: namely, how to characterize "motion" *at all*, when it has been declared that there is nothing more to body than its attribute of

extension. In his earliest treatise on physics, *The World*, Descartes takes for granted what one may call the "naive" conception of motion: it is "that by which bodies pass from one place to another and successively occupy all the spaces between"; and what *place* is, is a question not even raised. If, however, bodies are essentially just "what is extended," there is no real distinction between "bodies" and "spaces"; so one is baffled what to make of the notion of *the same body* successively occupying *different spaces.* It is in fact clear that in *The World* Descartes is taking it for granted that we possess – presumably as clear and innate ideas – two distinct notions of *identity* (over time) for "the extended": (1) identity of place, and (2) identity of body. On the other hand, since Descartes himself does not explicitly signalize this twofold notion of identity – which, as we shall see presently, Descartes drastically revises in his decisive work, the *Principles of Philosophy* – it seems impossible to acquit him of a *lack* of "clarity and distinctness" on this point.

The World was not published during Descartes's lifetime. In a letter to Mersenne of 22 July 1633, Descartes says that the treatise is nearly finished. In late November, he wrote again. This time he says that he had intended to give Mersenne a copy of the completed work as a New Year's present. But he has just learned that Galileo's *World System*[6] has been condemned in Rome; and the only reason he can think of for such a condemnation is the fact of its having "tried to establish that the earth moves" – on which issue, he continues: "I must admit that if the view is false, so too are the entire foundations of my philosophy, for it can be demonstrated from them quite clearly. And it is so closely interwoven in every part of my treatise that I could not remove it without rendering the whole work defective." Consequently, Descartes set the work aside, and – after a considerable lapse of time – proceeded to revise its foundations so far as the nature of motion is concerned.

The *Principles of Philosophy*, published in 1644, is repeatedly referred to by Descartes in his correspondence as a new version of "my *World*." In it he presents, in place of what has above been called the "naive" conception of motion, a new and sophisticated one. Motion "in the ordinary sense of the term" is still "the action by which a body travels from one place to another";[7] but *place* is now said to be an ambiguous, or relative, notion[8] and, "rightly taken," to be defined by *the surface of the surrounding body*.[9] Accordingly, "motion

in the strict sense of the term" is defined as "the transfer of one piece of matter, or one body, from the vicinity of the other bodies which are in immediate contact with it, and which are regarded as being at rest, to the vicinity of other bodies." (This "sophisticated" – and semi-relativist[10] – conception raises new problems of its own, as Newton's critique will make plain.)

In any case, having posited the realm of "extended things" and its character as a plenum, Descartes appeals to the testimony of the senses (itself warranted as reliable on such an issue by God's necessarily non-deceptive character) to establish both that this realm *actually exists*,[11] and that *it is in continual and very diversified motion*.

The principles that govern such motion are on the other hand *not*, according to Descartes, to be ascertained by means of, or with any help from, empirical observation: these principles or rules he claims to infer directly from God's immutability – from the *constancy of his action* in preserving the world from moment to moment, which implies (a) the conservation of all states which are not necessarily altered through the postulated fact of motion, and (b) the conservation of the total "quantity of motion" itself (of all bodies together – not, of course, of each individually), from moment to moment. The actual rules stated by Descartes need not concern us (although it should be remarked that they – and the arguments he gives for them – are really bizarre); what is important is that these principles of motion constitute, in Descartes's system, the analogue of what the physicists of our own time call the "fundamental forces" of nature. Thus Descartes's position is (1) that a sound physics presupposes a (certain, indubitable) knowledge of the fundamental forces; (2) that such knowledge – prior to the rest of physics – is indeed possible; and (3) that this knowledge is possible through, and *only* through, unaided thought. In *this* sense, Descartes demands, and claims to have achieved, a "purely rational" physics – more accurately, a purely rational *foundation* for physics. In his *Rules for the Direction of the Mind*, this demand is expressed, in connection with the particular example of a problem in optics, as the stipulation that for a satisfactory solution of the problem it must be traced back to a knowledge of *what a natural power in general is* – "this last being the most absolute term in [the] whole series" (of conditions upon which the solution depends).[12]

The role of experiment in Cartesian method can now be briefly characterized as follows: by experiment we learn the existence of features of our natural environment, which pose *problems* for science. The *solution* of such problems, the very task of physics, consists in the tracing back of these observed natural phenomena to their *fundamental causes* – that is, the demonstration that the phenomena do (or would) result from the fundamental principles of physics, themselves derived as we have seen from first philosophy, when we have correctly attributed the phenomena we observe to underlying structures of Cartesian matter-in-motion: that is, when we have constructed (to use a later terminology) the appropriate *mechanical model* for each phenomenon. How *this* is to be done is certainly the most vexing problem in the interpretation of Descartes's scientific method; but what is most important in respect of Descartes's historical influence on later seventeenth-century investigators is the fact that the early attempts of Descartes to proceed *systematically and with certainty* from observed phenomena to their causes (that is, to mechanical models that represent the *true* nature of the processes underlying the observed phenomena) were abandoned – perhaps even in some degree by Descartes himself – in favor of a far more tentative procedure of seeking for *likely* models, that might "save" or "satisfy" the phenomena, and whose correctness could be rendered at least *highly probable* by their success in doing so.[13] In short, the method of investigation of nature that eventually came to complement Cartesian metaphysics – a method that grew out of the *failure* of his more stringent original prescription – was that of attempting to *invent mechanical hypotheses* that would explain, with the help of "rational" deduction from the fundamental principles of motion, whatever was discovered by experiment.

One other feature of the intellectual environment in which Newton developed should be mentioned: namely, that many adherents to some variety of the "new philosophy" came to reject Descartes's identification of matter with whatever is extended, in favor of the classical view of *atomism*: that (a) there is void space as well as occupied space – the world is not a plenum; and (b) the ultimate parts of matter are "corpuscles" or "atoms": *rigid* and *indivisible* bodies.[14] Within this "revisionist" conception – also known as the "corpuscular philosophy" – it was still maintained as a fundamental tenet that all the processes of nature consist in the

motions of bodies, and that all natural *changes* of motion are occasioned by direct actions of one body *pushing* on another.[15] The features common to this position and Descartes's constituted the framework of the celebrated "mechanical philosophy." It is *from* the mechanical philosophy that the metaphysics, as well as the natural philosophy, of Newton *departed*: that philosophy was Newton's point of departure; and he indeed departed from it, in profound ways.

Taking Descartes as the first point of comparison, a radical difference between his view of metaphysics and Newton's lies in the fact that for Newton metaphysics is *not* the "root" or foundation of natural philosophy – the "beginning of wisdom." His position may rather be said to agree with that of Aristotle – a conception symbolized by the fact that the followers of Aristotle placed his treatises on first philosophy "after the physical ones."[16] Aristotle, distinguishing between what is "first and better known to nature" and what is "first and better known to us," regards the most basic principles – "prior," *in nature*, to those of the special sciences – as *to be known* only *after* the special sciences themselves have been established. An indication that Newton thought similarly is to be seen in the fact that his chief published discussions of the metaphysics of nature, and of his views concerning God in relation to nature, occur *at the end* of his two great treatises: in the General Scholium to the *Mathematical Principles of Natural Philosophy*, and at the end of the long concluding Query 31 in Book 3 of the *Opticks.* In his discussion of theological matters in the General Scholium, Newton says of God: "We know him only by his most wise and excellent contrivances of things, and final causes"; and concludes that discussion with the words: "And thus much concerning God; to discourse of whom *from the appearances of things*, does certainly belong to Natural Philosophy" (emphasis added). In Query 31 of the *Opticks*, after a long review of the most diverse phenomena (chiefly of chemistry), he says: "*All these things being consider'd*, it seems *probable* to me, that God in the Beginning form'd Matter in solid, massy, hard, impenetrable, moveable Particles, [etc.]" (again, emphases added here). In both places the views put forward are thus expressed as, in point of knowledge, *a posteriori*; and in the latter place, the view is explicitly described as *probable* (this is a lower degree of confidence than Newton attaches to his principal results in physics).[17] Further, it is not only man's knowledge of God, among doctrines one would call metaphysical,

that Newton describes as deriving from experience rather than from pure reason. In the preface to the first edition of the *Principia*, and in the third of the "Rules of Philosophizing" at the beginning of Book 3 of that work,[18] Newton expresses the opinion that (a) *geometry* is founded in experience (in, as he says, "mechanical practice"), and (b) so is *everything* we know about *bodies* (in particular, their "extension, hardness, impenetrability, mobility, and *vis inertiae*"). This is a matter to which we shall return later; for the present, let it suffice to note that these statements leave little scope, in Newton's view of knowledge, whether in "first philosophy" or in natural philosophy, for the *a priori* or purely rational.[19]

Let us now turn to the content of Newton's metaphysical doctrine: what, according to him, is the basic constitution of the world – what are its constituents, and how are they interconnected?

The question does not have an entirely straightforward answer. In order to see why – and in order to arrive at as clear as possible a picture of his mature doctrine – it will be useful to pay some attention to the apparent development of Newton's view over time.

It is clear from Newton's early notebooks[20] that he moved rapidly, in his student years, towards adherence to the general views in natural philosophy represented by Galileo and – in part – Descartes, in opposition to the scholastic ("peripatetic") teachings; and also that he quickly became critical of some of the basic tenets of Descartes. For example, in a very early manuscript Newton discusses with evident skepticism various scholastic views about projectile motion;[21] argues against Aristotle's rejection of a vacuum;[22] and notes without comment Descartes's definition of motion in the strict sense of the term: "Cartes defines motion . . . to be the Transplantation of one part of matter or one body from the vicinity of those bodys which immediately touch it and seem to rest, to the vicinity of others."[23] Not long afterwards, in what is clearly an attempt (somewhat awkward) to sketch a systematic theory of motion, Newton states his own definition: "When a Quantity is translated/passeth from one parte of Extension to another it is saide to move"[24] – a definition not very remarkable, but which clearly deviates from the conception advocated by Descartes in his *Principles.* The result was a position that fell within the framework of the corpuscular philosophy. It is important to note, in particular, that in the manuscript last cited Newton offers a general characterization of

force, as follows: "Force is the pressure or crouding of one body upon another."[25]

We come now to a crucial document, and what the present commentator regards as a crucial turn in the character and depth of Newton's thought on fundamental issues. The document – first published in 1962, in the original Latin followed by an (unfortunately defective) English translation[26] – is of a curious kind. It is an incomplete and untitled draft of what was evidently intended to be a treatment of hydrostatics, and begins with the statement: "De Gravitatione et aequipondio fluidorum et solidorum in fluidis scientiam duplici methodo tradere convenit"; that is: "It is fitting to treat the science of the gravitation [i.e., the "weighing down"] and equilibrium of fluids and of solids in fluids by a twofold method."[27] The opening phrase, "De gravitatione et aequipondio fluidorum," is the title by which the piece has come to be known.

What makes the fragment both odd and extraordinarily interesting is the fact that, after a brief introduction and four definitions, there occurs a digression into questions of metaphysics, taking up about two-thirds of the entire length of the manuscript; then the technical presentation resumes, with another fifteen definitions followed by two propositions (with five corollaries) – and breaks off. Thus in spite of the title under which it is known, and its evident original intent, the entire interest of the piece is as an essay in metaphysics – of a kind that is unique among Newton's writings.

The first four definitions are introduced and stated as follows:

Definitions

The terms quantity, duration, and space are too well known to be susceptible of definition by other words.

Def: 1. A place is a part of space that a thing fills adequately.
Def: 2. A body is that which fills a place.
Def: 3. Rest is remaining in the same place.
Def: 4. Motion is change of place.

Newton explains that in saying that a body *fills* (Latin: *implet)* a space, he means to imply "so fully occupies it as utterly to exclude other things of the same kind (other bodies) as if it were an impenetrable thing." Why, one may ask, "as if"? Does not a body's exclusion of other bodies mean that it *is* an "impenetrable thing"? The answer to this emerges later: Newton believes that *minds*, as well as bodies,

have their definite places in space; and he believes that bodies and minds can occupy the same – or overlapping – places; so bodies are not absolutely impenetrable, but are so only to one another.

After a few further preliminary clarifications, Newton calls attention to the fact that in these definitions he has departed fundamentally from the doctrines of the Cartesians: both in *distinguishing* between space and bodies, and in that he has "determined motion with respect to the parts of that space, not with respect to the positions of the contiguous bodies." It is this remark that leads to the metaphysical digression, in which Newton is concerned, first, to refute the theory of space and motion of Descartes's *Principles of Philosophy*; then to present his own conception of the nature of space (and, with less elaboration, of time); finally – and with greatest originality – to present his conception of the nature of *body* – how it is related to, and how distinguished from, space.

The refutation of Descartes on place and motion has two main parts. In the first, Newton argues that Descartes himself, in the development of his physics in Parts 2 and 3 of his *Principles*, proceeds in a way that is inconsistent with his own theory of motion, and thus "seems to acknowledge" its inadequacy. Since we are not here primarily concerned with Descartes, one example may suffice – the one that is most directly connected with Newton's evidence for the view he himself favors. According to Descartes, the earth – and, indeed, each of the planets – is, "if we are speaking properly and according to the truth of the matter" (Newton paraphrases the second phrase as "according to the philosophical sense"), *not moved*, but rather *at rest*; since each of these bodies, according to Descartes's theory of the planetary system, is carried around the sun by a material vortex: each planet, then, is at rest *relative to the bodies that immediately surround it*, and is therefore at rest in the "proper" sense of the word.[28] This is the basis of Descartes's claim that his view in the *Principles* is immune to the charge of attributing motion to the earth. But, Newton points out, in his *dynamical theory* of the planetary system Descartes attributes to the planets *a tendency to recede from the Sun* on account of *their motion around it.* So in developing the principles *of his philosophy* Descartes makes use of a conception of motion that is *not* the one he puts forward as "proper and according to the truth of the matter"; or, again to use Newton's paraphrase, "according to the philosophical sense."[29]

In the second main part of his argument against the Cartesian theory of place and motion, Newton shows that the basic principles of the physics of motion generally agreed upon in his time cannot even be *formulated* within the conceptual framework provided by that Cartesian theory. (Thus we may say that whereas in the first part Newton had shown Descartes to be in contradiction with himself, in the second part he shows that the contradiction is not merely with some *special* features of *Cartesian* physics: rather, it is with the general principles – to which Descartes himself was a contributor – that underlie all of what for him is "modern" physics.) Again it will suffice here to consider one central point. Newton says it follows from Descartes's position "that a moving body has no determinate velocity and no definite line in which it moves. And," he adds, "what is much more, that the velocity of a body moving without resistance cannot be said to be uniform, nor the line straight in which its motion is accomplished." In other words, what is still called the "first law of motion" *does not make sense* in Cartesian terms. The reason is straightforward. In Descartes's terms, "according to the truth of the matter," a body's motion should be described in relation to bodies in immediate contact with it that "are regarded as at rest"; these define the body's "place" (at a given time). But over time, bodies that were once relatively at rest will in general no longer be so – they will disperse. Therefore, over time, these (former) "places" will no longer exist; so that it will be impossible to speak of the *distance a body has traveled* (the distance between its present and its former place) – and equally impossible to speak of the *path* it has followed (the ordered array of places through which it has passed).[30]

It is important to note that this argument of Newton's does not claim to rest on principles that are epistemologically *a priori.* When he claims that Descartes's concept of motion is *not the one needed for physics*, he is speaking of the *existing* physics of his time – and, indeed, of features of that physics that are *accepted* by the Cartesians as well as by himself. This physics had had some considerable success; therefore it was reasonable to make use of its principles, and to frame basic conceptions so as to be consistent with them. Objections should be considered out of order, unless (a) they are drawn from demonstrable inadequacies in the application of the accepted theory to phenomena, or (b) the objector has an alternative to offer that is

at least as good as that theory, and better in respect of the points he objects to.[31]

Newton summarizes his results so far in the following words:

> It follows indubitably that Cartesian motion is not motion, for it has no velocity, no direction, and hence there is no space or distance traversed by it. So it is necessary that the determination of places, and hence of local motion, be referred to some immobile being, such as extension alone, or space in so far as it is seen to be truly distinct from body. And this the Cartesian Philosopher may the more willingly acknowledge, if only he notices that Descartes himself had an idea of extension as distinct from bodies, which he wished to distinguish from corporeal extension by calling it "generic." Art. 10, 12, & 18, part 2 Princip. And that the whirlings of the vortices, from which he deduced the force of the aether in receding from the centers (and therefore his whole mechanical Philosophy), are tacitly referred to this generic extension.

He turns, then, to the question of what, in his own view, the nature is of the "immobile being" – *space* or *extension* itself, distinguished from body – to which places and motions are to be referred. He raises three possibilities, arising out of the philosophical tradition, as to how he might "now be expected" to define extension: either as itself a kind of *substance*; or as a kind of *accident* (note: this was the standard philosophical term for an *attribute*: anything that can be "predicated" of a substance); or, third, as "*simply nothing*." The third alternative looks odd, but is undoubtedly meant to refer to the anti-establishment ancient tradition of atomism, in which the fundamental ontological contrast of atoms and the void was also expressed as that of "being" and "non-being." Newton repudiates all three answers, and offers instead something rather new: he says that extension "has a certain mode of existence of its own, which agrees neither with substances nor accidents." It is not substance for two reasons: (1) "because it subsists, not absolutely of itself, but as, so to speak, an emanative effect of God, and a certain affection of every being"; (2) because it is not something that *acts*.[32] The first point we must presently examine more closely. The second is of capital importance for Newton's view: he says that although philosophers do not traditionally define substance as "a being that can *act* upon something," they in fact all tacitly hold such a definition – "as for instance is plain from this, that they would easily concede extension to be a substance like a body if only it could move and could

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