

# PHILOSOPHY, ITS HISTORY AND HISTORIOGRAPHY

*Edited by*

A. J. HOLLAND

*Department of Philosophy,  
University of Lancaster*

D. REIDEL PUBLISHING COMPANY

A MEMBER OF THE KLUWER ACADEMIC PUBLISHERS GROUP

DORDRECHT / BOSTON / LANCASTER / TOKYO

1985

GARY HATFIELD

## FIRST PHILOSOPHY AND NATURAL PHILOSOPHY IN DESCARTES\*

Descartes was both metaphysician and natural philosopher. He used his metaphysics (among other things) to ground portions of his physics (or natural philosophy, or science of nature). However, as should be a commonplace but is not, he did not think he could spin all of his physics out of his metaphysics *a priori*, and in fact he both emphasized the need for appeals to experience in his methodological remarks on philosophizing about nature and constantly appealed to experience in describing his own philosophy of nature.<sup>1</sup> It remains unclear exactly what he took to be amenable to empirical support, and how his appeal to experience was squared with his notorious demand for absolute certainty in matters philosophical.

It is illuminating to consider Descartes' exploits in physics and metaphysics against the background of scholastic Aristotelianism. By focusing on what was novel in Descartes from this perspective, there emerges a different than usual picture of his work and its significance. For, while it may be that to the present-day philosophical mind the most troublesome and perplexing side of Descartes' dualistic ontology is the purported existence of a special mind-stuff, when Descartes first proposed his division of creation into mind and matter, the most troublesome claim for his scholastic audience would have been the conception of matter as a substance whose sole essence is extension. Descartes not only promoted the existence of such a substance, but he contended that all of nature is nothing but passive, inert, extended substance, thus denying in one fell swoop the scholastic Aristotelian conception of nature as populated with active principles and substantial forms. This radical rejection of the scholastic ontology not only embodied a substantively new conception of nature; it carried with it a new conception of the relationship among the three traditional branches of theoretical philosophy – physics, mathematics, and metaphysics – as well as a new ideal of 'scientific' reasoning about natural things.

In the Aristotelianism of the high scholastic tradition, as manifested in the commentaries of Thomas Aquinas and conveyed in Descartes' day by the Coimbra commentaries and the textbook of Eustace of Saint Paul,<sup>2</sup> it

was regarded as in principle impossible for a primary substance – a ‘such’ – to possess as its form or essence merely the property of mathematical extension. This is to say that in the scholastic ontology, mere extension could not play the role of form in the various form-matter combinations that constitute individual things in nature. Although the scholastics granted that all bodies do have extension, they denied that any given type of natural thing can be defined in terms of its geometrical properties alone. Rather, things are defined in terms of their nature or form, which is their principle of change or motion. As Aquinas said in his commentary on Aristotle’s *Physics*, “Natural philosophy is about natural things, and natural things are those whose principle is a nature. But a nature is a principle of motion and rest in that in which it is. Therefore the science of Nature deals with those things which have in them a principle of motion”.<sup>3</sup> This “principle of motion” is otherwise known as the substantial form of a thing. It determines the thing as whatever kind of thing it is – specifically determining its development and its characteristic modes of activity – whether the thing be a man, a rabbit, an oak tree, or a magnet.

The high scholastic tradition accepted a neat division among the branches of theoretical philosophy as regards their degree of abstraction from individual existing things. According to high scholastic doctrine, all human knowledge (apart from revealed knowledge) comes by way of abstraction from sensory particulars – even knowledge of God. Physics or natural philosophy is at the first level of abstraction; it abstracts from individual things, and considers bodies insofar as various of them exhibit the same form or nature. Hence natural philosophy studies the several kinds of things, as distinguished by their specific principles of change. Mathematics comes next, and abstracts from all sensible properties of bodies, and indeed from their principles of change, and considers bodies only insofar as they are extended. As it was commonly put, mathematics considers the ‘intelligible matter’ of objects – their pure extension. These geometrical properties were regarded as mere accidents in that they might be otherwise without changing the substantial form of the thing. Metaphysics is the most abstract, for it abstracts from all matter, sensible or intelligible, and considers ‘being as being’, which is to say that it considers the fundamental principles and predicates pertaining to things that exist. The law of contradiction, the law of the excluded middle, the distinctions between substance and accident, necessary and contingent, act and potency, the general predicates ‘one’, ‘true’, and ‘good’, and the investigation of such forms as may exist independently of matter (God and angels),

all are in the purview of metaphysics, or first philosophy.<sup>4</sup>

In this scheme of things, natural philosophy does not stand to derive much of its content from first philosophy. Although there was disagreement among various commentators and authors on this matter,<sup>5</sup> a minimal common position can be delineated. First philosophy can certify general principles that are used in natural philosophy, such as the distinctions between substance and accident, and between potency and act. It does not, however, provide knowledge of the particular forms that constitute the natures of things. That is the province of natural science. This knowledge is obtained by the cognitive separation of the universal from the particular, presumably as described in Book II, Chapter 19 of the *Posterior Analytics*.<sup>6</sup> Hence, one can discover the forms extant in nature only through experience with natural things. The number of such forms is indefinitely large, for it must be remembered that included here are not only the forms of the traditional four elements, but also, as Aquinas remarked, “every sort of animal, and their parts, such as flesh and blood, and also plants”.<sup>7</sup> There are as many active principles to be investigated as there are organized bodies in nature, including the organized parts of bodies.

Against this picture of nature teeming with many substances distinguished by their distinct natures, forms, or essences, Descartes promoted a program of ontological austerity. He reduced the number of forms or essences in the visible world to one. If one were to put his point in scholastic terminology, one would say that Descartes had drastically reduced the diversity of form-matter combinations in high scholasticism by decreeing that in all of nature matter has a single form or essence: extension. And in fact Descartes did cast his point in these terms. Thus in the *Principles of Philosophy* (Pt. I, art. 53) Descartes declared that “extension in length, breadth and depth constitutes the nature of corporeal substance”, and that with regard to matter extension is the “one principal property which constitutes its nature and essence”.<sup>8</sup> In direct contradiction with the scholastic doctrine that a body’s extension is a mere accident, Descartes makes extension the universal essence of natural things.

This equation of matter with extension – with the attendant stipulation that nature (including the entire universe, both celestial and terrestrial) is to be conceived as containing nothing but this matter – provided Descartes with the fundamental elements or ‘framework principles’ (so to speak) of his natural philosophy. He would allow into his explanations of natural phenomena reference to nothing but extended matter with its various ‘modes’ (modifications): size, shape, position, and motion. The task of the

natural philosopher would then be to discover or to posit various configurations of material particles (of a given size and shape) through which, together with the motions attributed to them, the diverse phenomena of nature can be derived or explained. The proposed explanations specifically cannot attribute to matter as fundamental properties such qualities as color, sound, odor, taste, heat, and cold. Descartes explicitly denies that these sensory qualities are real properties of matter, and maintains that they must be explained in terms of the dispositions of objects, by virtue of their size, shape, and motion, to cause a pattern of motion in the nervous system that gives rise to sensations such as color in the mind. Moreover, the motion of the parts of bodies, which must be invoked in any explanation of natural change, is to be explained by reference to a few simple laws or rules of motion.<sup>9</sup> These hold for *all* matter, as opposed to scholastic principles of motion or change that were specific to each kind of natural thing. Within the framework of Descartes' physics, the characteristic properties of natural bodies must be accounted for by the size, shape, and motion of their parts; not by a 'substantial form', *i.e.*, a scholastic nature or essence.

These fundamental properties – size, shape, and motion – all seem to derive directly from the introduction of geometrical modifications into pure extension. At first the inclusion of motion may seem problematical – it may not seem like a geometrical property. But it can be treated in a purely descriptive or kinematic way, without violating the dictum to attribute nothing to matter that cannot be conceived as a modification of pure extension. And indeed Descartes enjoins that this is the proper understanding of motion. In the *Principles* (Pt. II, art. 25) he defines motion as "the transference of one part of matter or of one body, from the vicinity of those bodies immediately contiguous to it and considered as at rest, into the vicinity of others", and goes on to draw attention to the fact that motion is defined as the "transference" of a body, rather than the "action" which transfers.

Regarding the various particular modifications of extension actually found in the world, one may ask how they arose. How did extension, which in its bare concept contains no blueprint for being carved up into the physical universe, come to be divided into just those parts that it did come to have? For the explanation of these facts, Descartes must go beyond the essence of matter, for in his world the essence of matter does not contain its own principle of motion or change. To explain the diversity of moving particles in the universe, Descartes introduced the 'fictional' hypothesis (as

opposed to the 'credal' reality of instantaneous creation of the world much as it is now) that God had introduced a chaotic pattern of motion into the universe at its creation, and that merely by the jostling of these particles the world had sorted itself into what we now see.<sup>10</sup>

It might seem that once having created this matter and put it in motion, God could retire. Descartes was sometimes read in this way during the seventeenth century, for example by Pascal who accused him of limiting God's role in governing the world to an initial flip of the finger, which set in motion the cosmic mechanism, never to run down. But consider again pure geometrical extension. From the fact that an extended portion of matter is at one instant in motion, does it follow that it will remain in motion over time? What about collisions? When two geometrically-conceived bodies collide, what can be determined merely from the fact that they each have a certain size, shape, and motion, except perhaps that they will not interpenetrate? I have said that Descartes' matter lacked a guiding principle of change within itself, an active principle or entelechy. Motion regarded kinematically may allow for descriptive laws of motion, but the laws themselves are not thereby explained, nor is there provided an understanding of the causal agency behind the kinematically described motion. This being so, the principles of motion and impact had to be sought elsewhere, and were found in God, acting at each instant in accordance with the three laws of motion as stated in *The World* and extended in the *Principles of Philosophy*.<sup>11</sup> Descartes thus reduced the scholastic menagerie of active principles in nature to one. Of course, Descartes is in accordance with scholastic doctrine in making God the ultimate cause of natural change. But his creative application of traditional doctrine makes for a conception of nature quite different from that of the scholastics. By banishing active principles from matter, he makes motion considered purely as natural a geometrically (kinematically) conceived property, and restricts actual force or causal agency to a being outside of nature, whose causal efficacy presumably is beyond doubt and requires no humanly intelligible explanation.

Having catalogued Descartes' clean sweep of the fundamental explanatory principles and entities of high scholasticism, one may ask how Descartes justified such radical housecleaning. He employed two strategies, the better known of which depended on his metaphysics. His metaphysical ground for rejecting substantial forms and real qualities was that they cannot be clearly and distinctly understood by the human intellect. As he wrote to Mersenne in 1643, "My principal reason for rejecting these real

qualities is that I do not see that the human mind has any notion, or particular idea, to conceive them by; so that when we talk about them and assert their existence we are asserting something we do not conceive, and doing something we do not understand".<sup>12</sup> The intellect can intuit the geometrical properties of extension, but it can form no direct conception of a real quality conceived as a principle of change. These forms can be known only by their manifest effects, by alterations or motions that are perceivable. Descartes' claim, then, is that kinematically conceived motion and geometrically describable shapes and sizes are intelligible, whereas specific patterns of growth and alteration – principles for altering the geometrical and other properties of natural objects – are not.

Of course, a scholastic sympathizer might well ask for the criterion of intelligibility at work here. Descartes' response would draw upon the basic elements of his metaphysics and epistemology. For Descartes' metaphysical justification of the assertion that extension is the essence of matter depended upon the epistemic criterion of clear and distinct perception, where this is ultimately interpreted as clear and distinct perception by the intellect alone, operating independently of the senses and therefore of sensory abstraction. The metaphysical justification of the fundamental principles of his physics depended upon a novel conception of metaphysical knowledge – one that bases such knowledge on pure rational intuition as opposed to abstraction from sensory particulars – as developed in his *Meditations on First Philosophy*.<sup>13</sup>

The second type of justification that Descartes gave for the framework principles of his physics was, perhaps surprisingly, based on an 'empirical' criterion of explanatory adequacy. Thus, in the letter to Mersenne quoted above, Descartes continued the explanation of his rejection of 'real qualities':

The second reason is that the philosophers invented these real qualities only because they did not think they could otherwise explain all the phenomena of nature; but I find on the contrary that these phenomena are better explained without them.<sup>14</sup>

Although this letter does not elaborate further the claim of having provided a superior explanation, that theme is expounded in numerous other places. Specifically, in the *Discourse*, the *Meteors*, letters from 1638, and in the *Principles*, Descartes argues that the first principles of his physics can in fact be given an *a posteriori* justification, based upon their explanatory success and their comparative unity and simplicity.<sup>15</sup>

This *a posteriori* mode of establishing his principles depended upon reasoning from 'effects to causes.' Descartes made bold claims for its efficacy. Thus, in a letter to Vatier from February of 1638, he contended that he could 'demonstrate' the principles introduced in the *Meteors* – basically, the use of only particles of various sizes and shapes colliding in a plenum in framing explanations – through their comparative success in explaining a range of known phenomena ('effects'):

I cannot demonstrate *a priori* that which I have supposed at the beginning of the *Meteors* without expounding my whole physical theory; but the phenomena [*experiences*] which I have deduced necessarily from them, and which cannot be deduced in the same way from other principles, seem to me to demonstrate them sufficiently *a posteriori*.<sup>16</sup>

One might object, as did another correspondent, Morin, that this mode of reasoning proves nothing, since "nothing is easier than to fit a cause to an effect". Descartes defended his practice in a letter to Morin of 1638: "It is true that there are many effects to which it is easy to fit many separate causes; but it is not always so easy to fit a single cause to many effects, unless it is the cause which truly produces them. There are often cases in which in order to prove what is the true cause of a number of effects, it is sufficient to give a single one from which they can all clearly be deduced".<sup>17</sup> We shall see below that this sort of reasoning might be used to justify the postulation of a particular causal mechanism in the explanation of, e.g., magnetism or the properties of water. Of interest here is that Descartes used it to justify the most general principles of his account of nature, insofar as they are implicated in his unified account of natural phenomena. In fact, Descartes invited one to "compare all their [the scholastics'] *real qualities*, their *substantial forms*, their *elements* and their other countless suppositions with my single supposition that all bodies are composed of parts".<sup>18</sup> The unity and simplicity of his explanatory principles and particular explanations he regarded as an *a posteriori* demonstration of their merit. One may remark that to the extent that the effects are not rigorously but only loosely 'derivable' from the supposed causes and principles – here, in the sense that these causes and principles provide the fundamental elements from which purportedly successful explanations have been constructed – this *a posteriori* 'demonstration' has the less force, a fact that was not lost on Descartes.

Before following up this last remark, let us pause to consider what may seem to be the strangeness of Descartes' procedure. It may seem that there

is something odd – even contradictory – about providing an empirical justification for fundamental principles that one believes have been or could be derived *a priori*. The ‘contradictoriness’ of this practice would be more apparent to a present-day philosopher than to Descartes, for we are likely to link ‘*a priori*’ with ‘analytic’ with ‘necessarily true’, and to sit pat with the notion that no justification that shows something to be ‘necessarily true’ can be improved upon. However, Descartes’ use of ‘*a priori*’ is less fixed than ours.<sup>19</sup> And in fact, while he believed that his metaphysical results provided the highest certainty possible to human reason – more certainty even than geometrical demonstration – for all that he claimed only that they were the best we could do, not that it would be impossible for some being (e.g., an angel) to do better.<sup>20</sup> If one has the best single ‘proof’ possible, but not the best proof possible *tout court*, it is not contradictory to reinforce it with evidence that is persuasive even if the reinforcement is not, by itself, as persuasive as the first bit of evidence.

But Descartes’ primary motivation in providing *a posteriori* arguments for his first principles was not simply to strengthen his position overall. He wanted to explore a different style of argumentation, one that he would use more fully in his reasoning about particular explanatory mechanisms. He explained this motivation in the same letter to Vatier as was quoted above: “I wanted to try whether the simple exposition of truth would be sufficient to carry conviction without any disputations or refutations of contrary opinions”.<sup>21</sup> Descartes was consciously testing an alternative to ‘*a priori*’ or ‘metaphysical’ modes of ‘proving’ his principles (to indicate his words).

This discussion of the motivation for an *a posteriori* justification invites fuller specification of the motivation for the metaphysical justification. In the letters from 1638 in which Descartes emphasizes the *a posteriori* proofs of his principles, he goes on quickly to add that nonetheless he could give an *a priori* demonstration of his first principles. What distinctive role could such a ‘demonstration’ play? The answer, I believe, was that he considered this *a priori* demonstration the only means of disposing of other explanatory principles, such as substantial forms, once and for all. The distinctive role of metaphysics, then, is to establish as certainly as possible what could be claimed as merely empirically plausible if left to its own, *a posteriori*, devices. This reading of the role of metaphysics is supported by the fact that in the *Meteors* and in a letter to Regius of 1642, Descartes was careful to say that the *a posteriori* fruitfulness of his own mode of explaining nature does not necessitate the rejection of substantial forms, but that it simply shows that they are unnecessary.<sup>22</sup>

If empirical modes of reasoning merely supplement metaphysical (here, *a priori* rational) modes of reasoning in establishing the fundamental principles of natural philosophy, they play a much stronger role in reasoning about the particular mechanisms that are invoked to explain specific natural phenomena (such as the properties of oil and water). Avowedly, Descartes proposed (or claimed he could provide) explanations for “all Natural Phenomena”.<sup>23</sup> Notoriously, the explanations he did propose were soon regarded as unfounded and doubtful. Of present interest is the fact that, as a number of commentators have remarked, in both the *Discourse* and the *Principles* Descartes insisted that *a priori* derivation of the whole of physics is impossible. Since many mechanisms – many combinations of shape, size, and motion – might account for the same phenomenon, just as there might be two clocks that appear the same on the outside and yet contain quite different works, one must seek to discern the actual mechanisms via experimentation.<sup>24</sup> This use of experiment is a species of the reasoning from effects to causes discussed above, as applied to the postulation of specific mechanisms to explain specific phenomena. The similarity between this type of reasoning and hypothetical-deductive reasoning, complete with ‘model-fitting’, has been explored with care and penetration by several authors.<sup>25</sup> Moreover, it has also been noted that in conformity with the hypothetical character of particular mechanistic explanations, Descartes was prepared to accept that the truth of his explanatory hypotheses can be ascertained only with less than metaphysical certainty. His technical term, adopted from scholastic terminology, was ‘moral certainty’: enough certainty to proceed in using one’s hypotheses as if they were true.<sup>26</sup>

What has perhaps not been sufficiently appreciated is the extent to which Descartes was himself grappling to alter the scholastic conception of science as demonstrative in order to accommodate the hypothetical character he ascribed to the knowledge of his particular explanatory mechanisms.

In order to clarify this point, it may be helpful to review and to extend my comparison of Descartes and high scholastic Aristotelianism. We have seen that the Aristotelians believed that metaphysics could provide only the basic framework within which scientific knowledge of nature must fit; explanations of specific natural things depend upon the physicist’s abstraction of principles of change peculiar to the specific thing. These principles then serve as the premises in providing an account of the phenomena associated with the type of thing under investigation. Descartes was

seeking to derive an alternative framework by establishing that the one universal form of all natural bodies is extension. He claims to have gotten more from his metaphysics than just his framework principles, for beyond arguing that any explanation in natural philosophy must be framed in terms of moving particles, he purports to have derived specific laws of motion *a priori* from God's immutability, and to have established the plenum (denying the vacuum) by reflecting on the fact that extension is the essence of matter (there is no place in Descartes' ontology for space distinct from extension). Yet just as the Aristotelian natural philosopher must investigate individual principles of change empirically, so too for Descartes one must discover the particular mechanisms that yield specific phenomena through empirical investigation. These mechanisms may then be used to explain the phenomena in question.

Looking over the changes and noting the parallels, it may seem that Descartes has not gained much. For, it might be argued, it is difficult to see why God's immutability must lead to the particular conservation principles espoused by Descartes, and this difficulty calls into question the supposed 'derivation' of the laws of motion from metaphysics; moreover, in his investigation of particular (kinds of) natural things, Descartes has simply substituted many empirically-investigated mechanisms for many empirically-investigated forms, with no gain.

Such an assessment would miss the point in two ways. First, even if the 'derivation' of the laws of motion from metaphysics is questionable, and even if Descartes' actual laws needed to be revised, the metaphysical vision behind the idea that all of nature, celestial and terrestrial, might be constructed from a small set of properties of matter and a few laws of motion was historically efficacious, bearing fruit in Newton. Second, it misses the way in which Descartes altered the conception and ideal of scientific 'demonstration' or 'proof' maintained by scholastic Aristotelianism. According to the high scholastic tradition, the forms, natures, or essences discriminated as principles of change in natural things provide the basis for premises in demonstrative arguments. Physics is a science, and scientific knowledge is demonstrative knowledge of the reasoned fact — the facts being the phenomena of nature.<sup>27</sup> In altering this conception, Descartes didn't just ruefully admit that 'moral certainty' is the best one can get; he went to work on the idea of 'demonstration' itself.

Here the language that Descartes used is quite striking. Consider the following off-quoted passage from the *Discourse*:

If some of the matters of which I spoke in the beginning of the *Dioptrics* and *Meteors* should at first sight give offence [to readers] because I call them hypotheses and do not appear to care about their proof, let them have the patience to read these in entirety, and I hope that they will find themselves satisfied. For it appears to me that the reasonings are so mutually interwoven, that as the later ones are demonstrated by the earlier, which are their causes, the earlier are reciprocally demonstrated by the later which are their effects. And it must not be imagined that in this I commit the fallacy which logicians name arguing in a circle, for, since experience renders the greater part of these effects very certain, the causes from which I deduce them do not so much serve to prove their existence as to explain them; on the other hand, the causes are proved by the effects.<sup>28</sup>

Several things should be noted. First, Descartes wryly remarks on the form of Aristotelian demonstration of the reasoned fact, the conclusions of which are the phenomena to be explained. Certainly, he suggests, one doesn't want to prove that the phenomena exist, for they are the alleged starting point of all knowledge of nature (one recalls Aristotle's twinkling stars). Second, he uses the key Aristotelian term 'demonstration' with two implied senses: he glosses 'causes demonstrating effects' with causes *explaining* effects (as in effects being 'derived' from causes); he glosses 'effects demonstrating causes' with effects *proving* causes. But 'prove' (*prover*) had at that time not only the sense of 'logical proof', but also the sense of 'confirm', or even 'test'.

Support for this reading is provided by correspondence explicating this passage. In a letter of July 1638, Descartes responds to Morin's charge that there is "a vicious circle in proving effects from a cause, and then proving the cause by the same effects":

I agree: but I do not agree that it is circular to explain effects by a cause, and then prove the cause by the effects; because there is a big difference between proving and explaining. I should add that the word 'demonstrate' can be used to signify either, if it is used according to common usage and not in the technical signification given it by the Philosophers.<sup>29</sup>

The word 'demonstrate' is here stretched in two ways. First, in moving from causes to effects, it is used as above in the sense of 'to explain', rather than 'to prove' (or 'to demonstrate!'). Second, it is used in the sense of hypothetical reasoning from effect to cause, in which a postulated cause is 'proven' by the fact that it can serve as a unified explanation for a (wide) range of effects.

To this point, we have followed two shifts by Descartes away from scholastic Aristotelianism. The first pertains to Descartes' altered conception of nature. For, although he retained the Aristotelian terminology

of substance and essence, he broke the rules of Aristotelian ontology by attributing a passive essence, pure mathematical extension, to natural, corporeal things. He thereby maintained that geometrical descriptions fully capture the properties of all corporeal things, as opposed to the Aristotelian doctrine that geometrical properties are accidental. This may be called a substantive shift away from Aristotelianism, for it changed one's conception of what constitutes nature: conglomerations of whirling particles as opposed to bodies organized by principles of growth and change.

The second shift pertains to Descartes' conception of the method of investigating nature. Here, two movements away from Aristotelian doctrine occurred, in different directions, as it were. The first was the movement away from the doctrine that metaphysical knowledge is based upon abstraction to the notion that the essence of matter (as indeed of mind) can be known independently of abstraction from the senses, by means of direct intuition. The second was the movement from the idea that natural things are investigated by abstracting their natures from sensory particulars to the idea that natural things are investigated by positing (often sub-visible) mechanisms to explain a range of known phenomena (or effects). These together might be termed a methodological shift, for they change one's conception of how to go about investigating nature: via pure contemplation on the one hand, and via conjectural positing of hidden mechanisms on the other.

These substantive and methodological shifts complete Descartes' revolution of the sciences, by altering the relationships among physics, metaphysics, and mathematics. Descartes' first revolutionary step (which may now have a regressive ring) was to claim that metaphysics may determine the first principles of physics. A second step pronounced that the properties of corporeal things are to be accounted for using mathematical properties alone. But a third step decreed that although the properties of bodies are geometrical, and therefore that particular geometrical configurations may be understood with geometrical consequence, one cannot expect geometrical certainty about which constellations of properties actually do occur in nature. The *intelligibility* of specific kinds of natural things – such as the magnet or the action of light – depended upon what they had in common, their constitution as various modes of extension. Apprehension of what is peculiar to magnets or light depended upon attributing to the magnets or light a constellation of geometrical properties such that the known phenomena could be ex-

plained. It might be no easy job to make a satisfactory conjecture (and just as hard to decide what is 'satisfactory', although Descartes was optimistic), and one could always go wrong (as further experience might show).

These two shifts fit hand in glove. For in conceiving extension as the essence of corporeal substance, Descartes attributed to natural bodies a property that had been the age-long model of the object of rational comprehension; whence its apparent suitability for an a priorist conception of how it is known. Moreover, in replacing the many forms of the Aristotelian catalogue of nature with many mechanisms, he specified as that-which-is-to-be-known in specific bodies something other than an essence, form, or nature. In shifting away from the scholastics' conception of demonstrative science, Descartes may have been guided by the consideration that their ideal of scientific knowledge requires apprehending a 'form', or 'essence', which is an eternal principle. The ideal of demonstrative physical science sets up a standard of certainty that Descartes himself demanded in the domain of metaphysics, but which he doubted could be attained with respect to the particular constitution of nature. Hence, the shift from 'essences' to 'postulated mechanisms'. Essences serve in demonstrations. Mechanisms serve in hypothetical explanations, and in Descartes' 'demonstrations'. In consequence, the notorious 'Cartesian quest for certainty' does not extend to the particular mechanisms posited in Descartes' mechanistic physics.

*Johns Hopkins University*

#### NOTES

\* An earlier version of this paper was presented before a joint session at the meetings of the History of Science Society and Philosophy of Science Association in Philadelphia, October, 1982. The current version has been revised as the result of further work, still in progress. I wish to thank Owen Hannaway for helpful discussion of the earlier version of this paper, and Wilda Anderson for detailed comments and criticism of recent drafts.

<sup>1</sup> A long line of articles and books have provided forceful arguments for and characterizations of Descartes' explicit avowal of the need for experience and experiment in natural philosophy. Gerd Buchdahl, in his *Metaphysics and the Philosophy of Science* (Oxford: Blackwell, 1969), Chapter 3, provides a penetrating philosophical discussion of these issues. Desmond Clarke's *Descartes' Philosophy of Science* (University Park: The Pennsylvania State University Press, 1982) provides the most extensive discussion to date, and includes references to several of the earlier studies (on p. 16, n. 15).

<sup>2</sup> I have chosen Eustace of Saint Paul's *Summa Philosophiae* (Coloniae, 1620) and the University of Coimbra's *Commentariorum ... in octo libris Physicorum Aristotelis Stagiritae*

(Coloniae, 1599) as representative of scholasticism in Descartes' day; Descartes described the first of these as the best book of its kind "ever made", and remembered the second from his school days (*Oeuvres de Descartes*, edited by C. Adam and P. Tannery [hereafter AT], new edition, Paris, 1964-1974, Volume III, pp. 232, 185; the passages cited are among those in A. Kenny's [hereafter K] translation of Descartes' *Philosophical Letters*, Oxford: Clarendon, 1970, pp. 82, 78). In characterizing a generalized high scholastic position, I will often use quotations from Thomas Aquinas, who was frequently cited (often with favor) by Coimbra, and who also was cited by Eustace (who, however, maintained in the preface to his work that his chief aim was to interpret Aristotle's philosophy, as opposed to Thomas' or Occam's, and who was not averse to disagreeing with Thomas). In addition, I will sometimes give references to passages in Aristotle's works that could be read as supporting the scholastic position. Of course, I do not intend to suggest that the scholastic reading is philosophically or historically the best interpretation of Aristotle.

<sup>3</sup> Thomas Aquinas, *Opera Omnia* (Parma, 1865; reprint: New York, 1949), p. 227a, translated by Richard J. Blackwell, Richard J. Spath, and W. Edmund Thirkel as *Commentary on Aristotle's "Physics"* (New Haven: Yale University Press, 1963), p. 4. Eustace characterized the subject matter of physics as "Corpus naturale ut naturale", rather than "ens mobile" (Pt. 3, *Physica*, p. 4); on the definition of nature he quotes Aristotle from the *Physics*, II.1: "Principium & causa ut id moveatur & quiescat, in quo primo, per se, & non ex accidenti inest" (*ibid.*, p. 26). Coimbra accorded with Aquinas on both counts, cols. 33 and 249-252.

<sup>4</sup> A helpful source on the division of the sciences and the doctrine of abstraction is *The Division and Methods of the Sciences*, A. Maurer's translation of Questions V and VI of Aquinas' commentary on the *De Trinitate* of Boethius. The division of the sciences is made with reference to the doctrine of abstraction by Eustace, Pt. 1, *Dialecticae*, pp. 155-157; Pt. 3, *Physica*, pp. 1-4; Pt. 4, *Metaphysica*, pp. 1-3; and by Coimbra, col. 6.

<sup>5</sup> Edith D. Sylla, in 'The *A Posteriori* Foundations of Natural Science', *Synthese* 40 (1979): 147-187, discusses a variety of medieval commentaries that address, among others, the question of whether metaphysics can prove the first principles of physics.

<sup>6</sup> Aquinas' commentary on Book II, Chapter 19 of the *Posterior Analytics* occurs in his *Opera*, Volume 18, pp. 222-225. Eustace touches upon the process of abstraction in his discussion of universals, Pt. 1, *Dialectica*, pp. 24-31.

<sup>7</sup> Aquinas, *Physics*, p. 69.

<sup>8</sup> AT VII, 25; the translation is from V. R. Miller and R. P. Miller, *Principles of Philosophy* (Dordrecht: Reidel, 1983), which I generally will follow. Descartes' language in making a similar point in *Le Monde* is of interest since he specifically contrasts his proposed 'nature of matter with scholastic active principles as well as with the scholastic notion of 'prime matter' (which was typically defined as 'pure potentiality'): it is worth quoting several sentences, which occur as Descartes is introducing matter into his 'imaginary' world, constructed at the center of an 'imaginary space': "Now, since we are taking the liberty of imagining this matter to our fancy, let us attribute to it, if you will, a nature in which there is absolutely nothing that anyone cannot know as perfectly as possible. To that end, let us expressly assume that it does not have the form of earth, nor of fire, nor of air, nor any more particular form (such as of wood, or stone, or metal); nor does it have the qualities of being hot or cold, dry or moist, light or heavy, or of having some taste, or smell, or sound, or color, or light, or suchlike, in the nature of which one could say that there is something that is not clearly known by everyone. Let us not think, on the other hand, that our matter is that prime matter of the Philosophers that has been so well stripped of all its forms and qualities that

nothing more remains that can be clearly understood" (AT X, 33; translated by M. Mahoney, *Le Monde*, New York: Abaris, 1979, pp. 51-53).

<sup>9</sup> On the project of explaining all natural phenomena in terms of only the modes of extension, see *Principles*, II, 64; III, 46-47; IV, 199-200. On the exclusion of sensory qualities from among the real properties of matter, see the passage quoted in n. 8, as well as *Principles*, I, 66-74; on the treatment of these qualities as 'dispositions' of the geometrical properties, see *ibid.*, IV, 196-199. On the laws of motion, see *ibid.*, II, 37-42; *Le Monde*, Chapter 7.

<sup>10</sup> The 'hypothesis' of a chaotic beginning for the universe is introduced in the *Principles*, III, 45-46, and the text continues under its aegis until Pt. IV, 188, where Descartes cuts off his account of things on the earth with an apology for not including projected fifth and sixth parts, on animals and plants, and on man. The hypothetical chaos is introduced in Chapter 6 of *Le Monde*.

<sup>11</sup> I have discussed Descartes' kinematic conception of motion, and his role for God in explaining the 'force' of moving bodies, in 'Force (God) in Descartes' Physics', *Studies in History and Philosophy of Science* 10 (1979): 113-140. Clarke, in Chapter 4 of *Descartes' Philosophy of Science*, presents an alternative point of view.

<sup>12</sup> AT III, 649 and K 135. The above claim that the geometrical properties of pure extension are known clearly and distinctly whereas active principles are intellectually obscure constitutes, I believe, the metaphysical foundations for his physics that Descartes claimed to Mersemne to have provided in his *Meditations* (AT III, 233, 297-298, and K 82, 94). Moreover, it is the type of justification provided for restricting his account of nature in *Le Monde* to modes of extension, thereby excluding real qualities and substantial forms. There he invokes repeatedly the idea that he is introducing into his world "nothing that anyone cannot know as perfectly as possible" (Chapter 6). Perhaps this conception, that extension can be clearly understood while active principles and real qualities cannot, constituted the metaphysical insight into the foundations of physics that Descartes wrote to Mersemne he had achieved in 1629, when at work on what is thought to have been an early version of the *Meditations* (15 April 1630, AT I, 144, and K 11).

<sup>13</sup> I have discussed Descartes' claims for clear and distinct perception by the intellect alone in ascertaining the framework principles of physics in 'The Senses and the Fleshless Eye: The *Meditations* as Cognitive Exercises', in *Essays on Descartes' Meditations*, edited by Amelie O. Rorty (Berkeley: University of California Press, forthcoming).

<sup>14</sup> *Op. cit.*, n. 12.

<sup>15</sup> *Discourse*, Pt. VI, AT VI, 76-77; *Meteors*, 1st Discourse; letters to Vatiier, 22 February 1638, and to Morin, 13 July 1638; *Principles*, IV, 205.

<sup>16</sup> AT I, 563, translation altered from K 48.

<sup>17</sup> AT II, 199, and K 58.

<sup>18</sup> AT II, 299, and K 59.

<sup>19</sup> Descartes often uses 'a priori' in the sense of 'known through its causes', but since he believed that such knowledge might be derived from pure intellectual contemplation of God, the soul, or the essence of matter, this 'a priori' knowledge might nonetheless be known independently of the senses. Gerd Buchdahl, in *Metaphysics*, Chapter 3, brings out the philosophical interest of the 'fluidity' of Descartes' use of such terms as 'a priori'.

<sup>20</sup> Clarke, *Descartes' Philosophy of Science*, p. 56, emphasizes the hypothetical character of Descartes' metaphysical remarks.

<sup>21</sup> To Vatiier, *op. cit.*, n. 16. One cannot help but remark Descartes' swipe at scholastic 'disputations'.

<sup>22</sup> *Meteors*, AT VI, 239; to Régis, AT III, 492, and K 127. Also, in Chapters 6 and 7 of *Le Monde*, Descartes leaves out substantial forms and real qualities for being unintelligible and of no use in framing explanations.

<sup>23</sup> *Principles*, II, 64; IV, 199.

<sup>24</sup> *Ibid.*, IV, 204; *Discourse*, AT VI, 64–65.

<sup>25</sup> For two such discussions with additional references, see Buchdahl, *Metaphysics*, Chapter 3, esp. pp. 118–126, and Clarke, *Descartes' Philosophy of Science*, Chapter 6.

<sup>26</sup> *Principles*, IV, 205–206; Descartes of course consistently maintained that 'the more general' aspects of his natural philosophy were more than morally certain. Clarke, *op. cit.*, Chapter 8, has emphasized the weakening of the demand for certainty on Descartes' part; cf. also Buchdahl, *op. cit.*

<sup>27</sup> The doctrine that physics is a demonstrative science – grasping eternal principles and natures of mutable things – was commonplace; see Eustace, Pt. 3, *Physica*, pp. 2–3, and Coimbra, col. 16–26. Clarke, *op. cit.*, pp. 65–66, discusses Descartes' weakening of the term 'demonstration'.

<sup>28</sup> AT VI, 76; translation slightly modified from E. Haldane and G. Ross, *The Philosophical Works of Descartes* (Cambridge: Cambridge University Press, 1931), Volume I, p. 129.

<sup>29</sup> AT II, 197–198, and K 57; cf. to Mersenne, AT II, 141, and K 55. "The Philosophers" is a reference to scholastic philosophy.

## CARTESIAN SCIENCE IN FRANCE, 1660–1700

In the years between the death of Descartes and the gradual introduction of Newtonian science into France, there was a distinctive French school of Cartesianism which propagated the central ideas of Descartes' philosophy and science, including his concept of scientific knowledge. Malebranche seems to have emerged from this period as the most interesting figure for philosophers today, possibly because of his obvious influence on Hume.<sup>1</sup> However, he was surely not so dominant in French science in the second part of the seventeenth century; both Jacques Rohault (1620–1672) and Pierre-Sylvain Régis (1632–1707) had a comparable influence on French science, and either Rohault or Antoine le Grand (1620–1699) were much better known in England at that time as exponents of Cartesian science. Given the number of different philosopher-scientists who deserve to be included among the influential Cartesians of this period, it seems preferable not to concentrate attention on one, such as Malebranche, and to attempt instead to characterise some features which were common to the French Cartesians as a group.

There are three features of the context in which this school developed which I shall mention at the outset:

(1) The most obvious one – the proliferation of scientific societies in France, for example those of Montmor and Thévenot, and their replacement, by Colbert, by the Royal Academy of Sciences (1666).<sup>2</sup> Huygens, Mariotte, Claude Perrault, Leibniz and many other scientists were invited to be members of the academy. None of the Cartesians was invited until after the reorganisation of 1699. None of the Cartesians was invited until, after the reorganisation of 1699, both Malebranche and Régis were made members in a subsidiary category. Thus, during the period under discussion, Cartesian science was not endorsed by the scientific establishment in France.

(2) The official philosophical teaching of the universities was a scholastic *mélange* usually attributed to Aristotle. Any attempt to introduce alternative philosophies was stubbornly resisted; the preferred strategy of the Sorbonne was to rely on a royal decree or on Church-enforced censorship. Cartesianism was one of the primary objects of this kind of censorship.<sup>3</sup>