CHAPTER FOUR

this chapter. But even if, as it turned out, everything in inanimate bodies were explicable in mechanistic terms, and even if we could be certain of that, then the elimination of forms and qualities would only be probable. For with bodies in general, as with animals, from the fact that behavior can be produced mechanically, it doesn’t follow that it is.

And so, in the end, Descartes fails to produce an argument for the elimination of forms that meets his standards of certainty. He can show (to his satisfaction) that we are certain that forms and qualities, if they exist, must be conceived of as mental substances of a sort, distinct from corporeal substance, and through various arguments he can convince us that it is improbable that they exist. But he cannot demonstrate to the scholastics that their view is false.

So far I have emphasized Descartes’ opposition to substantial forms, real qualities, and the hylomorphic conception of body common to the schools. Though his word may have been blunter than he might have thought (or wished), this is certainly not to deny his status as an opponent of the world as pictured in the schools. Although his arguments may not have met his own stringent (and ultimately unrealistic) standards of rigor, they made an important contribution to the ultimate demise of hylomorphism in the seventeenth century. Though Descartes neither invented them nor was he unique in pressing them, arguments like ones he used, arguments from parsimony, obscurity, and sterility, as well as more strictly Cartesian arguments from the nature of body, appear repeatedly in later thinkers, who, following his lead, pressed for the rejection of the Aristotelian framework. However, it is worth pointing out that in a deeper sense Descartes never managed entirely to extricate himself from the philosophy of the schools. He rejected the illicit projection of human nature, soul, and body onto the physical world in a sense, insofar as he rejected the explanation of the particular properties bodies have in terms of form and quality, tiny souls that move bodies about as our soul moves our body. But when explaining the general properties all bodies as such have, the conservation of motion, the tendencies bodies in motion have to preserve their motion in a rectilinear path, their behavior in collision, the scholastic model of animistic explanation returns. As we shall later see in chapters 7-9, Descartes rejects the tiny souls of the schools only to replace them with one great soul, God, an incorporeal substance who, to our limited understanding, manipulates the bodies of the inanimate world as we manipulate ours (AT V 347 [K 252]). In the end, as for the scholastics, as Descartes interprets them, the ultimate explanation of the characteristic behavior of bodies takes us back to ourselves, human nature projected not downward onto the material world, but upward to God.

DESCARTES AGAINST THE ATOMISTS: INDIVISIBILITY, SPACE, AND VOID

ARISTOTElian ideas about natural philosophy dominated the schools well into the seventeenth century, long after Descartes left La Flèche; it was the scholastic physics of matter and form that he would have taught at school, as was everyone else. But there had already been numerous challenges to the authority of Aristotle in physics and cosmology by the time Descartes began to formulate his own ideas and communicate them in a series of publications that were to play a significant role in eclipsing the reputation of the Aristotelian philosophy. There were, of course, many varieties of anti-Aristotelianism in the years before Descartes began his own system. But most important with respect to Descartes, indeed, of central importance to the history of the physical sciences in the seventeenth century and beyond, was the revival of the ancient atomistic doctrines of Democritus, Epicurus, and Lucretius. Like Descartes, these ancient atomists and their later followers attempted to explain the characteristic behavior of bodies in terms of the size, shape, and motion of the small particles that make them up, and like Descartes, they argued for eliminating sensory qualities like heat and cold, color and taste from the physical world. It is no wonder, then, that he was often associated by his contemporaries with these other mechanists. But at least as important to him as the similarities were the differences between his philosophy and that of the atomists; Descartes took great care to emphasize the points on which he differed from what was probably the dominant school of corpuscularianism at the time he began to write. After a brief discussion of the revival of atomism in the sixteenth and seventeenth centuries, this is what we shall turn to, Descartes’ rejection of the indivisible bodies of the atomists, and his rejection of their conception of space and void.

DESCARTES AND THE REVIVAL OF ATOMISM

The ancient atomists were by no means unknown to the medievals; at very least the views of Democritus and Leucippus could be gleaned
from the hostile accounts found in Aristotle. Though discussed to
some extent, by and large the position was not taken very seriously.
Interest in ancient atomism was no doubt spurred by the rediscovery in
1417 of a copy of Lucretius’ Epicurean poem, De rerum natura, published in 1473. The publication of Lucretius was followed shortly by the
publication of the first complete Latin translation of Diogenes Laertius’ Lives of the Philosophers, which contains the most extensive
collection of Epicurus’ own writings to survive, as well as brief accounts
of the atomistic philosophies of Leucippus and Democritus. Atomic
thought was widely discussed in the sixteenth century, and by the early
seventeenth century it had a number of visible adherents. In addition
to Lucretius and Diogenes Laertius the reader curious about atomism
in the early decades of the seventeenth century could turn to Nicholas
Hill’s Philosophia Epicurea, Democritana, Theophrastica (1601), to Sebasti-
ian Basso’s Philosophia Naturalis adversus Aristotelem (1621), and to symp-
pathetic accounts of atomism in the works of Bacon and Galileo. Descartes
may have become acquainted with the atomist tradition in any number of ways. But he must certainly have gotten a healthy dose
of atomistic thought from his early mentor Isaac Beeckman. Beeckman
seems to have been a dedicated atomist from at least 1616, and would
certainly have communicated his enthusiasm for the view to his young
disciple. By the 1630s and 1640s ancient atomism had been more or
less successfully resurrected; it could be found in the influential Daniel
Sennert’s Hypomnemata Physica (1636), in Jean Chrysostom Magnen’s
Democritus Renovatus (1646), and more importantly in Pierre
Gassendi’s enormous Animadversiones in Decimum Librum Diogenis Laertii
(1649), a massive study of Epicureanism that formed the basis for his
posthumous Syntagma Philosophicum (1658). By mid-century atomism
was established as an important school of thought not only in the librar-
ies, but also in the informal scientific circles where enthusiasts for the
new natural philosophies exchanged ideas.

It was against this background that many of Descartes’ early readers
approached his views, and quite naturally read his mechanist and anti-
Aristotelian philosophy as part of the revival of ancient atomism. And,
indeed, there are many important affinities between Descartes’
thought and that of the ancient atomists. Basic to the atomist tradition
is the idea that the sensible qualities of bodies are to be explained in
terms of smaller and insensible bodies with different sizes and shapes,
and that these bodies lack most of the sensible properties, like color,
taste, heat, and cold, that they are supposed to explain. Furthermore,
Descartes, like the ancient atomists, thought the universe to be without
limit in size, and that it contained an indefinitely large number of
worlds, suns, and planets roughly like ours; indeed Descartes held

as Lucretius and probably Epicurus before him did that all possible
configurations of matter arise at sometime or another. And finally,
Descartes agreed with the ancient atomists in seeing the present state
of the world, not only sun, earth, and planets, but also plants, animals,
and human bodies as having evolved out of an initial chaos in a purely
natural way. And so Descartes, like the atomists, rejected the consid-
eration of final causes from physics.

It is not surprising, then, that Descartes was often lumped together
with the revivalers of atomism by his contemporaries, and assumed to be
a Democritean or Epicurean. Fromondus was not atypical in reacting
to the Discourse and Essays with the unsympathetic comment that “he
unknowingly often falls into the physics of Epicurus, crude and over-
blown” (AT I 402). Even after the publication of the Principle in 1644,
where he explicitly distanced himself from the atomist tradition (Pr IV
202), Descartes still had to fend off such attributions. Responding to a
correspondent who had reported to him on the reaction to his recently
published Principles, probably in June 1645, Descartes commented
with some exasperation that “seeing that he says that...my principles in
physics are drawn from Democritus, I believe that he has not read [my
writings] very much” (AT IV 223; see also AT I 413 [K 36]; AT VII 381).

There can be no question but that Descartes was deeply influenced
by the atomist tradition, either directly or through one or another of
its later followers; the obvious correspondences between his program
and that of other mechanists, ancient and modern, can be no accident.
But, at the same time, we must be aware that Descartes himself did his
best to disassociate himself from that tradition. Part of his motivation
here is, no doubt, pride in his own discoveries. In general, Descartes
did not react well to challenges to his originality; it is not implausible
to suppose that he identified closely with the unnamed protagonist of
the Discourse, who cut himself off from the past and, by himself, aided
only by the method he had discovered, found a new world, a world that,
but for his labors, would be utterly unknown. It is this pride that I
suspect lies behind comments like the one he conveyed to Me-senne in
1640: “I wonder at those who say that I have written only a patchwork
of Democritus, and I would like them to tell me from what book I could
have taken those patches, and if anyone has ever seen any writings
where Democritus has explained salt, hexagonal snow, the rainbow,
etc., as I have” (AT III 166; see also AT II 51).

But leaving the question of pride aside, there are some real issues
that separate Descartes from the atomists; he quite understandably did
not want his readers to think that his agreement with some aspects of
the atomist program in any way entailed agreement on others. Some of
the differences involved aspects of the Epicurean doctrine that were
CHAPTER FIVE

apparently at odds with Christian doctrine or tradition. According to
the Epicurean doctrine, the soul is material, made up of atoms, and
dissipates when the body is destroyed.\(^{18}\) While some Christians, even
some among Descartes' contemporaries, had held such a view,\(^{19}\) this
sort of materialism certainly runs counter to his thought. The Epicure-
ans also believed that the gods are material and neither create nor
regulate the world, a view at odds both with Christian thought and with
the Cartesian system, a system in which an inmaterial God creates the
world and, as we shall see in later chapters, is the ground of order
insofar as his activity determines the laws bodies in motion and impact
obey.\(^{20}\) In addition there are important differences in physics. The
basic particles of the atomists are by their nature heavy, and tend by
their nature to move in one particular direction. For Descartes,
though, since bodies are only extended things, they have no innate
tendencies to motion of any sort; whatever tendencies we observe in
them derive from their own corporeal substructure and the way they
interact with the bodies in their vicinity.\(^{21}\) But where Descartes differs
most strikingly from the atomist tradition in physics is in his conception
of the basic constituents of the physical world. For the atomists what
there is, at root, is atoms and the void. The atoms are insensible bodies
that are, by their nature, indivisible into smaller bodies, and between
these indivisible bodies is void, space empty of body and anything
else.\(^{22}\) Descartes denies both of these doctrines. Descartes' conception
of body as extended substance entails that every body, however small,
is divisible into smaller parts, and that there can be no extension with-
out body, no region of space that is in any sense empty. In the remain-
der of this chapter we shall explore these two anti-atomist doctrines.

DESCARTES AGAINST INDIVISIBILITY

One of the most important properties of atoms in the atomist tradition
is their indivisibility, their indestructability. As Epicurus wrote:

> Of bodies some are composite, others the elements of which
these composite bodies are made. These elements are indivisible
and unchangeable, and necessarily so, if things are not all to be
destroyed and pass into nonexistence, but are to be strong
enough to endure when the composite bodies are broken up,
because they possess a solid nature and are incapable of being
anywhere or anyhow dissolved. It follows that the first beginnings
must be indivisible, corporeal entities.\(^{23}\)

Atoms are, thus, indivisible, unchangeable bodies, the ultimate parts

into which bodies can be divided and from which bodies can be con-
structed.

It is possible that in his early years Descartes was an atomist in this
sense. Beeckman most certainly was, and it is not implausible that
Descartes followed his mentor in this respect. There is no record in the
documents that survive of any disagreement on this point; indeed, the
lack of record of any discussion at all suggests that they agreed on this
basic point. Furthermore, in at least one passage from the surviving
documents, a short discussion of a problem in hydrostatics that
Descartes presented to Beeckman, he makes reference to "one atom of
water [una aquae atomus]" assumed to travel twice as fast as "two other
atoms" (JB IV 52 [AT X 68]).\(^{24}\) While Descartes may not be using the
term in its full technical sense here, it does, at least, suggest that he
have held the atomistic hypothesis in 1618.\(^{25}\) Evidence is similarly
scanty for the 1620s. The apparent identification of body and extension
in Rule 14, discussed earlier in chapter 3, suggests the position
Descartes later holds, that the indefinite divisibility of mathematical
extension entails the denial of indivisible bodies. But Rule 14's almost
certainly in the very last stage of composition of the Rules, and
Descartes' earlier concerns in the 1620s suggest a view that may be
more consistent with a belief in atomism. As I noted earlier in chapters
1 and 2, the law of refraction as given in Discourse II of the Dioptrics
probably dates from the mid-1620s. Now, Descartes' theory of light in
The World is closely connected with the existence of vortices in a continu-
ous, nonatomic plenum. But the model he uses in the Dioptrics to
derive the law of refraction, tennis balls colliding with different sorts of
surfaces, suggests that his original position may possibly have been an
atomic view of light as a stream of atomic particles, a view that was later
translated into the world of The World, where light is the pressure of tiny
balls, Descartes' second element, in a medium, with the clumsy and
highly problematical assumption that tendency obeys the same laws
that bodies in motion obey.\(^{26}\) Also weakly suggestive of an atomist posi-
tion in the 1620s is a curious passage from Rule 12. Talking about the
human mind and its relation to the brain he says, "this phantasia [phan-
tasia] is a true part of the body and it is of such a size that different
portions of it can embody many shapes distinct from one another" (AT
X 414). In an atomist view, in which there are bodies of minimum size,
the magnitude of the fantasy, the number of atoms it contains would set
an upper bound on the number of distinct impressions it could hold at
a given time. But if one were to reject indivisible atoms for indefinitely
divisible matter, then this wouldn't be an issue; any body, no matter
how small, could contain an indefinitely large number of distinct
shapes, providing that they were small enough.
CHAPTER FIVE

However, Descartes may have believed in the 1620s and before, though, by 1630 his mature view seems to have emerged. Writing to
Mersenne in April 1630 concerning some details of the treatise on
physics, later to be The World, that he was then working out, he noted:

These tiny bodies which enter when a thing is rarified and leave
when it condenses, and which pass through the hardest bodies are
of the same substance as those which one sees and touches.
But it is not necessary to imagine them to be like atoms nor as if
they had a certain hardness. Imagine them to be like an extremely
fluid and subtle substance, which fills the pores of other bodies.
(AT I 139–40 [K 9–10])

Matter, the matter that makes up not only this subtle and all-pervading
but all matter, Descartes implies, is not made up of indivisible and
unchangeable atoms. This is a position that he maintains throughout
his career; it is clearly put forward in The World of 1633 (AT XI 12), in the
Meteors of 1637 (AT VI 238–39 [Ols. 268]), in the Meditations and
Objections and Replies of 1641 (AT VII 85–86, 106, 163), in the Principles
of 1644 (Pr I 26; Pr II 20, 34; Pr III 51; Pr IV 202), and in a letter to More
from 1649 (AT V 273–74 [K 241–42]), not to mention other discussions
in numerous letters (AT I 422 [K 39]; AT III 191–92 [K 78–79]; AT III
213–14 [K 80]; AT III 477 [K 124]; AT IV 112–13 [K 147]). Rejecting
the indivisible unchangeable atoms others had insisted on seems to
have been a matter of some importance to him.

But it is important to understand the grounds on which Descartes
rejected the atomism. His most visible argument is an argument from
the nature of body. In the Second Replies Descartes asserts, "since . . .
divisibility is contained in the nature of body, that is, in the nature of
an extended thing (for we can conceive of no extended thing so small
that we cannot divide it, at least in thought), it is true to say that . . .
every body is divisible" (AT VII 163; see also AT III 213–14 [K 80]). And
so, Descartes tells Mersenne in October 1640, "as for an atom, it can
never distinctly be conceived, since the very meaning of the word
implies a contradiction, namely being a body and being indivisible" (AT
III 191 [K 79]; see also AT III 477 [K 124]; AT V 273 [K 241]). In more
detail, the argument goes as follows. As we discussed above in chapter
3, Descartes' bodies are extended substances in the sense that the only
properties they really have are geometrical extension and its modes,
size, shape, etc. Now, Descartes claims, one of the obvious properties
extension as such has is its divisibility; writing to Mersenne in March
1640 Descartes notes that "there is no quantity that is not divisible into
an infinity of parts" (AT III 36). And so body, being essentially ex-
tended, extension made real, must also be divisible into an infinity of

DESCARTES AGAINST THE ATOMISTS

parts, it would seem; every part of matter is divisible (Pr I 26; AT III 477
[K 124]), and since body is continuous (AT VII 69; AT I 422 [K 39]), it is
divisible in an infinite number of ways (AT VI 238–39 [Ols. 268]), a
division that goes to infinity and never comes to end, so far as we can
know (AT I 422 [K 39]; AT IV 112–13 [K 147]). And so bodies cannot
be made up of indivisible parts, as the atomists claim they are. If the
parts are extended, then they are not indivisible, and if they are non-
extended, then they are not bodies and cannot be genuine parts of
bodies (AT III 213–14 [K 80]).

This argument appears to take us from the infinite, or as Descartes
often prefers to put it, indefinite divisibility of geometrical extension
to the infinite or indefinite divisibility of extended substance, from the
fact that we cannot conceive of an extended thing that cannot be di-
vided in thought to the actual nonexistence of an extended indivisible
atom. But from the point of view of the atomists, this argument is
obviously inadequate.

Basic to atomists, both ancient and seventeenth century, was a dis-
tinction between two different sorts of atomism, mathematical (or con-
tceptual) and physical. There were, of course, disputes going back to
antiquity about whether or not the continuous magnitudes treated by
the geometres are made up of geometrical minima, whether lines are
made up of points, or surfaces are made up of lines, for example. But
this was a question quite carefully separated from that of the physical
indivisibility of atoms. As Gassendi put the matter, "that minimum or
indivisible that Epicurus admits is physical and of a far different nature
than the mathematical indivisible, that is, what they suppose to be a
point of some sort or another." And so, the fact that mathematical
extension is always divisible does not entail that every physical and
extended body is also divisible; even if the mathematical continuum is
divisible ad infinitum, it doesn't follow that there are no smallest ex-
tended bodies in nature that cannot be split by natural means.

It is quite possible that Aristotle and many later Aristotelians missed
this crucial distinction, and saw the arguments directed against math-
ematical minima as holding equally well against physical minima,
atomists. It is also possible that Descartes himself missed the point for
some years. But by the early 1640s, he saw the need to argue for a link
between the conceptual divisibility that pertains to every body by virtue
of being an extended thing, and the sort of real, physical divisibility
required to refute the atomistic hypothesis. The strategy he used to
establish the real divisibility of all bodies is similar to the one he used
to establish the real distinction between mind and body. As I noted in
chapter 3, Descartes appeals to God to link the conceptual separability
of the mind from the body with the real distinction between the two.
 CHAPTER FIVE

We can clearly and distinctly conceive of mind without body and body without mind. But what makes mind and body genuinely distinct things, capable of existing apart from one another, is God, who can bring about whatever I clearly and distinctly conceive. Thus, even though mind and body exist joined together in this life, our ability to conceive them apart from one another, together with God's omnipotence, entails that they can really exist separately. The case, Descartes thinks, is similar for the supposedly indivisible atoms that some philosophers have posited. The argument first surfaces in a letter to Mersenne in October 1640, where the appeal is not to God himself but to his angels. He writes, "If something has [extension], we can divide it, at least in our imagination, which is sufficient to be sure that it is not indivisible, since if we can divide it in this way, an angel can really divide it" (AT III 214 [K 80]). However, by 1642 it is to God's power that Descartes appeals with an explicit link to the argument for the distinction between mind and body (AT III 477 [K 124]), and it is this argument that appears in the Principles of 1644:

We also know that there can be no atoms, that is, parts of matter by their nature indivisible. For if there were such things, they would necessarily have to be extended, however small we imagine them to be, and hence we could in our thought divide each of them into two or more smaller ones, and thus we can know that they are divisible. For we cannot divide anything in thought without by this very fact knowing that it is divisible. And therefore, if we were to judge that it is indivisible, our judgment would be opposed to our thought. But even if we were to imagine that God wanted to have brought it about that some particles of matter not be divisible into smaller parts, even then they shouldn't properly be called indivisible. For indeed, even if he had made something that could not be divided by any creatures, he certainly could not have deprived himself of the ability to divide it, since he certainly could not diminish his own power. And therefore, that divisibility will remain, since it is divisible by its nature. (Pr II 20; see also AT V 273 [K 241])

But even though Descartes may be right in pointing out the divine divisibility of even the hardest body, this argument in an important way misses the mark. For the ancient atomists, like Epicurus and his school, the gods are themselves made up of atoms; while stronger than humans, they are not omnipotent and have no power to create the world or split the atoms it contains. Descartes' claim that God could divide any portion of matter, no matter how small, does, indeed, introduce a notion of divisibility that they would deny. But the Christian atomism of Descartes' contemporaries is quite another matter. Gassendi, for example, goes to considerable lengths to show that while he believes in the atoms of Epicurus, his God is the Christian God. In particular, Gassendi's God is omnipotent: "there is no thing that God cannot destroy, no thing he cannot produce." And so Gassendi would be quite willing to admit that God could split an atom if he chose to do so. But this is entirely consistent with God creating a thing which cannot be split by any natural means, a thing which cannot be split by any of his creatures, a thing which cannot be split by any but him. It is this that Descartes must establish if he is to refute atomism, that there are no naturally indivisible bodies; supernatural divisibility is, in a way, beside the point.

Descartes has no arguments intended directly to show that all bodies are naturally divisible. But he does think that in certain circumstances, at least, bodies are actually divided ad infinitum, or, as he might put it, ad infinitum. To understand the grounds for this claim we must consider a circumstance he discusses in Pr II 33. There he begins with the assumption, argued earlier in Pr II 6, that "all places are filled with body and the same parts of matter always fill places of the same size." From this he claims that if it follows that all motion is very roughly circular, one body displacing another, the other body displacing yet another, until the place left by the original body is occupied, at the very moment it leaves; such a circular motion seems necessary, Descartes thinks, in order either to prevent a vacuum or to prevent a single bit of matter from occupying different volumes at different times. Such motion is relatively unproblematic if we imagine the ring of moving bodies to be uniform in width, as in ring ABCD of fig. 5.1.

But Descartes thinks that there is no real problem here even if the
ring is of nonuniform width, as in ring EFGH of fig. 5.2, if the particles making up the ring move with different speeds in different parts of the ring, say faster at E where the space is narrow and slower at G where it is wider, then the matter can move in this nonuniform ring without creating a vacuum or without a given body having to expand or contract. But in the case of the ring of nonuniform width that Descartes imagines, the matter going in such a path must actually be divided into indefinitely small parts, he reasons:

For it could not happen that the matter that now fills space G successively fills all of the spaces smaller by innumerable degrees that there are between G and E unless each of its parts accommodates its shape to the innumerable volumes of those spaces. For this to happen it is necessary that all of its imaginable particles (which are really innumerable) move the tiniest bit with respect to one another. And such motion, however small, is a true division. (Pr II 34)

The actual division of matter into indefinitely small parts, then, is required so that in moving, the incompressible and inextensible material substance not produce a vacuum, a place void of body. This view, that matter must be indefinitely divisible and sometimes indefinitely divided in order to prevent a vacuum, goes back to Descartes’ World and to the correspondence that precedes it.86

This argument is probably Descartes’ best answer to the atomist, his best reason for rejecting the hard, unchangeable, and indivisible atoms from which they tried to construct their world. But the argument depends crucially on a premise that the atomist tradition explicitly re-

---

**Space and Void**

As important to the ancient atomists as the tiny indivisible and unchangeable atoms they posited was the space they occupied and the space, empty space, vacuum, or void that surrounded them, the emptiness (inane), as Lucretius puts it, “in which they are situated and through which they are moved in different ways.”87 This emptiness can be found within the grosser bodies of everyday experience, tiny empty spaces that separate atoms from one another; this emptiness out to infinity, perhaps even beyond the region occupied by bodies.88

But speculation about empty space was not confined to the atomist school. Aristotle, of course, would have none of this nothingness, and quite firmly rejected the notion of space or place as independent of body, and along with it, the notion of a void, a space or place that exists without containing a body.89 But such a view seemed to set problematic limits on God’s power. For it seems, if Aristotle is taken at his word, then not even God could create an empty space. These considerations were among those that apparently disturbed Étienne Tempier, Bishop of Paris, who in 1277 issued a sweeping condemnation of the then-fashionable Aristotelianism.90 While the condemnation held only for Paris, strictly speaking, it affected the subsequent development of scholastic Aristotelianism in important ways. As a consequence, philosophers working within an Aristotelian framework were forced to think in very non-Aristotelian ways about place, space, and the possibility of a void, both within and without the world.91 Among the positions Tempier condemned was the claim that “God could not move the heavens [that is, the world] with rectilinear motion, and the reason is that a vacuum would remain.”92 In response to this, a number of figures consider the possibility, in some sense, of an empty space beyond the world, what came to be called “imaginary space,” space that would allow God to move the finite world as a whole.93

The full history of ideas of place, space, and vacuum in the later middle ages is extraordinarily complex.94 But the later medieval speculations about spatial concepts, together with the rediscovery and revival of ancient atomism, among other currents, lead to a wide variety of views on space, place, and void in the sixteenth and early seventeenth centuries. Writing to Mersenne in 1651, Descartes suggests that, unlike him, virtually everyone believes in empty space (AT I 228). This is certainly an exaggeration. But at the time Descartes was formulating his own ideas it was by no means uncommon to hold that space is in
some sense independent of the bodies that occupy it, and that there can be or actually are portions of this space unoccupied by body. For a wide variety of figures, space is something in some sense distinct from body, “a certain continuous three dimensional physical quantity in which the magnitude of bodies is received,” to quote Bruno. For some who adopted this view, like Bruno, Telesio, and Campanella, the container space, while independent of body, is always occupied by body. But for others it is not, and there are vacua both within and beyond our world. This position is strikingly held by Francesco Patrizi in the late sixteenth century, who was perhaps the first to step outside of the Aristotelian metaphysical framework and argue that space is neither substance nor accident, but *sui generis*, the container of all, God’s first creation in which he placed all else, filling some places but leaving others empty. In this he was followed by a number of seventeenth-century figures, most notably Descartes’ contemporary and sometimes antagonist Pierre Gassendi, who easily integrated Patrizi’s account of spatial concepts into his own revived Epicurean atomism. Such views were even represented in some sixteenth- and seventeenth-century scholastic thinkers. Dealing with the so-called imaginary spaces that exist beyond the bounds of our finite world, an issue to which we shall later return, Pedro Fonesca, Bartholomeus Amicus, and the Coimbran Fathers all allowed that such spaces really exist in some sense, and Suarez went so far as to characterize imaginary space as a vacuum. And even though Suarez argues that the place of a body “is a certain real mode, intrinsic to a thing,” he grants that God could destroy the sublunar world and leave an empty space behind.

It is not entirely clear just how much of this background Descartes himself knew. At La Fleche, Father Noel, later himself to become involved with Pascal on just this issue, certainly took the young Descartes through this material from a scholastic point of view, though it is not clear how much detail Descartes would have remembered some years later when formulating his own ideas about the physical world. He certainly remembered the scholastic term “imaginary spaces”; it is in these so-called imaginary spaces that Descartes imagines God to construct his new world of *The World*. But he by no means intends us to take the scholastic conception of imaginary space at face value. He notes that “the philosophers tell us that these spaces are infinite, and they should be believed since they themselves made them” (AT XI 31–32; see also AT VI 42). And though he remembers the notion well enough to poke fun at it, it is unlikely that he remembers the complex details of the debates and positions he learned at school. Descartes’ later knowledge of many of the antischolastic innovators is similarly uncertain. In 1630, writing to Isaac Beeckman, Descartes mentions the names of Telesio, Campanella, and Bruno in passing (AT I 158 [K 16]). But his point here is only to note that he can learn nothing from them, and to imply (very unfairly) that he learned nothing worth knowing from Beeckman either.

Despite Descartes’ rather ungracious remarks, it probably was Beeckman who introduced him to the modern anti-Aristotelian thought on space and vacuum in 1618. Beeckman certainly believed that there are genuinely empty spaces in nature, a view he advanced in his doctoral theses in medicine, defended on 6 September 1618, just a few months before he met Descartes. No doubt this was one of the subjects that he discussed with the young Descartes, whose head was at that time still filled with what he had learned from the Jesuits, as Beeckman reports (JB I 244 [AT X 52]). And while even those who believed in a plenum debated the question of motion in a vacuum, as Descartes himself was later to do, it may possibly be significant that one of the problems he and Beeckman discussed most extensively in 1618, and one of the extended pieces he wrote for Beeckman at that time, was a discussion of the motion of a falling body in a vacuum.

Whatever Descartes may have believed in 1618, by the end of the next decade he seems to have opposed the void. The situation in the *Rules*, which, granted, deals with method more than substance, is suggestive of the position he will later take, though not unambiguously. In Rule 12, for example, he claims that we are mistaken “if from the fact that in this space full of air we perceive nothing by vision, by touch, or by any other sense, we conclude that it is empty, improperly joining the nature of vacuum with that of space” (AT X 424). This might be taken to suggest that Descartes opposed vacua in general. But the passage seems to imply that the notion of an empty space is intelligible, in contrast to what he will later argue, and even if we are mistaken in thinking that a jar without wine, water, or peanut butter is empty, there is nothing in this passage that rules out the possibility that there may well be empty spaces elsewhere in nature. There is also a passage in Rule 14 that is suggestive of his later views on body and vacuum. There he seems to identify body and extension and argues, “even if someone could persuade himself, for example, that if whatever is extended in nature were reduced to nothing, and that meanwhile that extension per se could exist alone, he would not use a corporeal idea, but the intellect alone, badly judging” (AT X 442–43). This, again, is suggestive of his later position, and the argument we shall later examine, that extension without body is inconceivable, strictly speaking. But this passage is not without its complexities. It has a role to play in the rather complex argument of Rule 14, and it is not absolutely clear that Descartes intends this to support any general point about the nature of the world.
By 1631, though, Descartes has declared himself unambiguously against the void. Writing to Mersenne in October or November of that year concerning an earlier discussion they had about motion in the void, he remarks that "one cannot assume a vacuum without error" (AT I 229).

This is the view he takes in The World, of course, where God creates Descartes' hypothetical world without any empty space (AT XI 33, 49), a view that is repeated often in the letters and writings that immediately follow (AT I 301, 417; AT II 382–83; AT VI 86; AT XI 629; etc.).

When Descartes first declares himself against the void it is not absolutely clear just why he opposes what many of his contemporaries accepted. There is a chapter in The World entitled "On the vacuum, and why our senses do not perceive certain bodies" (AT XI 16). But, unfortunately, that chapter contains no proper argument against the void. Instead Descartes offers therapeutic considerations to "free us from an error with which all of us have been preoccupied from our youth" (AT XI 17). While it is not easy to follow the argument in this section, the main aim seems to be to show that contrary to our prejudices, air is not empty space, and, indeed, is less likely to contain empty spaces than are hard bodies. Descartes, for example, notes that hard bodies will bend and shatter rather than allowing a vacuum, from which he concludes that air, a fluid, will all the more deform itself to prevent an empty space. Furthermore, he notes that even if, as he thinks, the invisible bodies around us filled all available space, then this would not prevent larger bodies from moving, but only require that bodies moving in such a plasma set up circular streams of moving matter (AT XI 18–20). But nothing in that chapter establishes in any rigorous way the claims he is trying to make if not plausible then at least not implausible, that there are no empty places within bodies, solid or liquid, and the chapter does not even address the question of whether beyond this world there are extracosmic empty spaces. This is something Descartes fully realizes. In the course of his discussion he notes:

I don't want to establish in this way that there is no void in nature; I feared that my discourse would be too long if I tried to explain the whole matter, and the observations of which I spoke are not sufficient to prove it [i.e., that there is no vacuum], although they are good enough to persuade us that the spaces where we sense nothing are filled with the same matter and contain at least as much of it as the spaces which are occupied by the bodies we sense. (AT XI 20–21)

The discussion in chapter 4 of The World gives us reason for thinking that the world may be full, but it gives us no grounds for claiming that it is impossible that it isn't. However, in admitting this, Descartes suggests that he has stronger arguments at hand, and that it is only a matter of practical considerations that prevented him from treating the issue at greater length and giving those arguments. It is not implausible to conjecture that those stronger arguments are grounded in his conception of body. In The World, as in Rule 14, he claims that body and extension are intimately linked. He writes:

If I am not mistaken, all of the difficulty they [i.e. the scholastics] have with respect to theirs [i.e., their conception of matter] comes only from the fact that they want to distinguish [matter] from its quantity and its external extension, that is to say, from the property it has for occupying space. . . . They shouldn't find it strange if I assume that the quality that pertains to the matter I describe does not differ from its substance any more than number does from things numbered and that I conceive of its extension or the property it has to occupy space not at all as an accident but as its true form and essence. (AT XI 35–36)

It body and extension are linked in this way, then it is reasonable to suppose that there can be no region of extension that is without body, and that an argument something like this is what Descartes may have had in mind in the passage quoted earlier. If this is, indeed, what Descartes had in mind, then his reasons for not making it explicit may go beyond mere expository convenience: Descartes may not have been much of a scholar of scholastic philosophy in the early 1630s, but he surely would have remembered from his school days the theological problems connected with the view that a vacuum is impossible in any strong sense. And the argument suggested by the view of body in The World, that vacuum is impossible because space is identical with body, would seem to raise such problems, and make it impossible for even God to create a space empty of body.

But if caution it was, then by the end of the decade caution is thrown to the wind. Writing to Mersenne on 15 November 1638, Descartes announced that "it is no less impossible that there be a space that is empty than that there be a mountain without a valley" (AT II 440). This view—that empty space of any sort, inside or outside the word, is impossible—is a view that he repeats often in the following years, both in his letters and in his published writings.

The argument Descartes gives comes in a number of variants. He often expresses his view by saying quite simply that the idea we have of space or extension is the same as the idea we have of body. And so, to Roberval who attempted to argue him into distinguishing body from space in a discussion they had in summer of 1648, Descartes is reported
to have replied, "I clearly and distinctly see and know that body and space, which you think to be two distinct things because of some unknown blindness of intellect, are completely one and the same thing" (AT XI 689). While Descartes offers Roberval no argument, his reply is an apparent allusion to an argument given four years earlier in his Principles. There he considers as his example a stone, and shows how we can eliminate all of its properties except that of being extended without thereby eliminating its nature as a body [corpus natural]. Descartes then goes on to say that this extension "is the same thing contained in the idea of space, not only [space] full of body, but even that space which is called empty [vacuum]" (Pr II 11).

The argument is, of course, not entirely satisfactory. Leaving aside the problems with the way in which Descartes chose to establish the nature of body in this context discussed earlier in chapter 3, the argument is open to the obvious objection that while the extension of body may be the same as the extension of space, that is, while body and space may both be extended, it doesn't follow that they are the same. There were any number of opponents who were quite willing to distinguish between extension with body and the same extension without. But when developing the argument more carefully, Descartes intimates that the argument rests on an important metaphysical premise, that nothing has no properties. Writing, again in the Principles, he remarks:

It is obvious that there cannot be a vacuum in the philosophical sense, that is, in which there is no substance at all from the fact that the extension of space does not differ at all from the extension of body. For since we correctly conclude that a body is a substance from the sole fact that it is extended in length, width, and depth, because it is entirely contradictory that extension pertain to nothing, we must also conclude the same concerning space assumed to be empty, namely, that since there is extension in it, there must also necessarily be substance. (Pr II 16)

Here he makes clearer the possible grounds for his identification of body and space. Since it is the nature of body to be an extended substance, whenever we have an extended something, we have a body; as Descartes told Roberval, "whatever is extended in and of itself, that I call body" (AT XI 688). And so, insofar as the idea of extension without substance is incoherent, and the idea of extension with substance is just body, our idea of space, properly, that is, coherently considered, must be the same as our idea of body, extended something, extended substance. Thus, he concludes, there can be no vacuum, no space void of body.58

Descartes sometimes offers a graphic illustration of his argument.

The illustration, first formulated in January 1639 in apparent response to a question Mersenne raised, received an elegant statement in the Principles of 1644:

It is no less contradictory for us to conceive a mountain without a valley than it is for us to think of . . . this extension without a substance that is extended, since, as has often been said, no extension can belong to nothing. And thus, if anyone were to ask what would happen if God were to remove all body contained in a vessel and to permit nothing else to enter in the place of the body removed, we must respond that the sides of the vessel would, by virtue of this, be mutually contiguous. For, when there is nothing between two bodies, they must necessarily touch. And it is obviously contradictory that they be distant, that is, that there be a distance between them but that that distance be a nothing, since all distance is a mode of extension, and thus cannot exist without an extended substance. (Pr II 188)59

If the two sides of the vessel are separated, there must be some distance between them, and if there is distance, then there must be body. On the other hand, if there is no body, there can be no distance, and if there is no distance, then the two sides must touch.59

The argument we have been examining suggests that Descartes' denial of the vacuum, while obviously connected with his account of body as extended substance, is independent to the extent that it appears to require an additional premise, that no properties pertain to nothing. While it is true that he appeals to this premise, and, indeed, must appeal to some such principle for his strategy to work, there is another way of looking at the argument against empty space that ties it more closely still to his account of body. Writing probably to the Marquis of Newcastle in October 1645, commenting explicitly on the vessel argument we have just examined, he remarks:

I think that it implies a contradiction for there to be a vacuum, since we have the same idea of matter and of space, and since this idea represents to us a real thing, we would contradict ourselves and assert the contrary of what we think if we said that this space is empty, that is to say, that that which we conceive of as a real thing is not at all real. (AT IV 329 [K 184])

This, of course, takes us back to what I called the complete concept argument for the nature of body in chapter 3. The idea we have of body is the idea that terminates and grounds the incomplete ideas of modes of extension: it is the idea of a thing that is extended, and all notions of shape, size, and even distance depend upon that idea for their intelli-
CHAPTER FIVE

The possibility. It is because we have such an idea that grounds all of our ideas of the modes of extension and none of our ideas of the modes of thought that we know that bodies, material substances, are distinct from minds, mental or thinking substances. And it is because we have such an idea, and because such an idea grounds our ideas of modes of extension that we know that there cannot be a mode of extension that does not pertain to an extended thing, a body. Regarded in this way, the metaphysical principle that extension requires an extended substance is not a metaphysical principle extraneous to his conception of body. In fact, the metaphysical principle is, in a way, built into Descartes' account of body, and is absolutely essential to the argument by which he establishes the nature of body as extended substance. It is still, perhaps, too strong to say that the denial of the vacuum follows directly from his account of body. But it is fair to say that both the doctrine on the nature of body and the denial of the vacuum flow from the same underlying position, the view that all of our ideas of modes of extension depend for their intelligibility on an idea we have of an extended thing. In a sense, then, the way he chose to eliminate sensory qualities from bodies and geometrize the material world, the view of conceptual dependency that leads him to view bodies as extended things that exclude all mentality also leads him to deny the very possibility of empty space.

Even though Descartes identifies space with body, he concedes that there is a way in which it makes sense to talk about space or place independently of the bodies that actually occupy them, at least by the time of the Principles. Basic to the discussion there is the distinction between internal and external place.61

Internal place Descartes equates with the space (i.e., volume) occupied by a given body. Though in reality it does not differ from body itself, we can, nevertheless, make the following sort of distinction:

Space or internal place does not in reality differ from the corporeal substance contained in it except in the way in which we usually conceive it. For the extension in length, breadth, and depth which constitute space is plainly the same as that which constitutes body. But there is this difference. In body we consider it as an individual, and we think that it always changes whenever the body changes, but in space we attribute only a generic unity so that when the body that fills the space changes, the extension of the space is not thought to change, but is thought to remain one and the same as long as it retains the same size and shape, and keeps the same situation among certain external bodies through which we determine that space. (Pr II 10L)

Body, then, is concrete extension, the extension regarded as an individual. In this sense, when body moves, its extension moves with it. But we can also regard extension "generically," or, as he puts it in a later section, we can also "consider extension in general [extensio in general]." Considered in this way, abstracted from the extended thing, we can imagine the same space occupied by a stone, "wood, water, air, or other bodies, or even a vacuum, if there is such a thing" (Pr II 12).

Descartes' account of external place is not quite so clear. "External place," he says, "can be taken as the surface that most closely surrounds the thing located" (Pr II 15). This, of course, is the standard Aristotelian definition of place. Understood in this way, the place is a mode of a body, not a part, indeed a mode that a given body shares with the body or bodies that surround it (see Pr II 15; AT VII 433-34; AT III 387). But there is another slightly different way of understanding external place, a way that Descartes seems to prefer. In this sense the external place is understood to be the common surface, which is no more part of one body than of another, but is thought to remain the same when it retains the same size and shape. For even if every surrounding body changes, together with its surface, the thing is not thought to change its place on that account if it preserves the same situation among those external bodies which are regarded as immobile. (Pr II 15)

Regarded in this way, the external place is the surface taken abstractly, the surface regarded independently of what body or bodies may actually have that surface, the surface defined in terms of certain external bodies which are regarded as being at rest. Regarded in this way, the view of what is a given place, and what constitutes a change in place is strictly relative to the external bodies we happen to choose as our reference points, as he realizes: "In order to determine situation, we must look to certain other bodies which we regard as immobile, and as we look to different bodies we can say that the same thing at the same time both changes place and does not change place" (Pr II 13). When external place is understood in this way, the same thing can be regarded now in one place, now in another, and different things can be said to occupy the same place.

In this way Descartes is able to grant that the notions of space and place are, in a sense, independent from that of body. But his account should offer little comfort to those who posit a container space as something ontologically distinct from body, something in which bodies exist. As he summarizes his view, "the names 'place' and 'space' do not refer to anything distinct from the body which is said to be in a place, but only refer to its size, shape, and situation among other bodies" (Pr II 13). Space and place, thus, are not realities themselves, but merely...
abstractions from body, abstractions from that which is real. In thinking about internal place or space we abstract out size and shape, and in thinking about external place we abstract out position; indeed in dealing with external place on Descartes’ preferred conception, the very specification of the place depends upon the arbitrary choice of external bodies that serve as a frame of reference. Though in a sense independent of bodies, spaces and places could not exist if there were no bodies in the world. And so, when in 1646 Samuel Sorbière on behalf of Gassendi pressed Descartes to admit that, as commonly believed, there was space before God created the matter that occupies it, he is reported to have responded that “spaces were created together with body” (AT IV 109; see also AT II 138).

This completes our basic account of Descartes on space and the void. But Descartes’ position is further clarified by examining his intellectual relations with two representatives of alternative points of view, Blaise Pascal and Henry More, and his relation to the scholastic tradition from which he derived and which he appears most closely to resemble in his opposition to atoms and the void. This is what we shall do in the remainder of this chapter.

**Descartes and Pascal: Experiments on the Void**

In October 1646 the Pascal family was visited in Rouen by Pierre Petit, a military engineer known to Étienne Pascal through scientific circles. Petit demonstrated to the family an experiment that had recently been performed in Italy under the direction of Evangelista Torricelli, a student of Galileo. Petit took a tube four feet in length, hermetically sealed at one end, and filled it with mercury. Placing his finger over the end, he lowered the open end of the tube into a bowl with mercury at the bottom and water covering the mercury. When the tube was near the bottom, he withdrew his finger, and the mercury dropped in the tube, leaving an apparently empty space at the top. The young Blaise Pascal objected that the space was not empty, but filled with air that had penetrated the tube through its pores. After some discussion of this possibility, in which Petit gave a number of arguments to show that no air could enter, Petit continued the experiment. He raised the tube little by little, and the apparently empty space grew, until lifting the open end of the tube above the level of the mercury and into the region of water, the mercury suddenly left the tube, which quickly filled with water, leaving no empty spaces. This, Petit argued, is definitive proof that the space at the top of the mercury was genuinely empty.

Though by no means uncritical, the young Blaise Pascal was intrigued. He undertook a complex series of experiments to explore the phenomena, and planned a major work, a treatise on the void that he never was to complete. But the direction his work took is evident from two publications, the *Expériences nouvelles touchant le vide* of October 1647, and the *Récit de la grande expérience de l'équilibre des liqueurs* of October 1648. In the first of these works Pascal reports on a series of variations he made on the original experiments Petit showed him. There, by varying the apparatus, using tubes of different widths, different configurations of tubes, different liquids, including water and wine, he attempted to exclude the hypotheses that the apparently empty space contained air of any sort, rarified mercury, water or wine, or “the more subtle air mixed with external air . . . [which is] separated and enters through the pores of the glass.” Pascal’s somewhat cautious conclusion is that “until someone shows me the existence of some matter which fills it, my view is that it is genuinely empty, and destitute of all matter.” In the *Expériences* he suggests that it is a limited horror of the vacuum that supports the column of mercury in the tube. “All bodies have a repugnance toward separating from one another,” but, Pascal wrote, “the force of this horror is limited,” and is equal to the force with which the column of liquid of a given height in the tube “tends to fall.” But by the time that the *Expériences* were published, he may have suspected that it isn’t a limited horror of the vacuum but the pressure of the air on the surface of the mercury that holds up the column. On 15 November 1647 he wrote to his brother-in-law Florin Périer, asking him to take the apparatus to the top of a mountain, the Puy-de-Dôme, to see if the lower air pressure there would affect the height of the column. The experiment was finally performed on 22 September 1648, and Pascal’s suspicion was borne out; the column of mercury was shorter at the top of the mountain than it was at the bottom. He hastily published the results in the *Récit de la grande expérience*, which appeared within weeks of the experiment. He ended his account of the details of the experiment with the following conclusion:

My dear reader. The universal agreement of people and the multitude of philosophers agree in establishing the principle that nature would allow its own destruction rather than allowing the least empty space. Certain more elevated spirits have taken a more moderate view; although they believe that nature has a horror of the vacuum, nevertheless they believe that this repugnance has limits, and that it can be overcome through violence. But until now one could find no one who took this third view, that nature
has no repugnance for the vacuum, that it makes no effort to avoid it, and that it admits vacuum without difficulty and without resistance. The experiments I have presented in my summary account [i.e., in the Expériences nouvelles] in my view destroy the first of these principles, and I don’t see how the second can resist those which I present you now. So, I no longer have any difficulty in taking the third, that nature has no repugnance for the vacuum, that it makes no effort to avoid it, and that all of the effects which people have attributed to this horror proceed from the weight and pressure of the air."72

Descartes had worried about similar experimental phenomena as early as 1631, and had proposed atmospheric pressure as the explanation of a number of phenomena often attributed to the horror of a vacuum (AT I 205–8; AT II 399, 465).73 It is possible that he may have heard about the Torricelli experiments that so moved Pascal as early as 1645, when Mersenne returned from Italy to Paris, and informed some of his circle of the new work.74 But there is no record of his knowledge of the new experimental proofs of the vacuum until 23 and 24 September 1647, when Descartes visited the young Blaise Pascal in Paris. At that time the Expériences nouvelles were not yet published (the official permission to print is dated 8 October), but the pamphlet was certainly complete, and issues connected with that writing were no doubt very much on Pascal’s mind.75

Descartes’ response to the new experiments appears, at first glance, to be rather curious. On the one hand he clearly rejected the view that the apparently empty space at the top of the tube of mercury is a vacuum. In the brief account Blaise’s sister Jacqueline gave of their meetings, an important but unfortunately none too detailed letter written on 25 September 1647 to her sister Gilberte, Madame Périer, Descartes is reported to have suggested that the space is filled with subtle matter, the fine and fast-moving tiny particles that make up his first element, which presumably enter through the pores of the glass.76 But yet he is happy to agree, somewhat to Pascal’s initial surprise, that it is atmospheric pressure, the weight of the surrounding air, that supports the column of mercury.77 Indeed, there is reason to believe that Descartes may have suggested to Pascal in their meetings of September 1647 that he perform an experiment like the one ultimately performed at the Puy-de-Dôme at Pascal’s direction in September 1648. In December 1647, before he knew of any directions Pascal might have given to Périer, Descartes told Mersenne that he had suggested this to Pascal, and later, in 1649, complained to Carcavy that he, Descartes, had originally suggested the experiment for which Pascal got full credit (AT V 99, 366, 391).78 Now, it is quite possible that Pascal may have had such an experiment in mind in September 1647 when Descartes may have suggested it. But what is interesting about these remarks is not their bearing on the question of priority, but the fact that Descartes took this experiment that Pascal thought established that nature has no horror of vacuum, this experiment that Pascal thought proved that there could be vacua in nature, to establish quite the contrary, that there could not be a vacuum in nature. Writing to Carcavy in August 1649, apparently without knowledge of the details of the Récit in which Pascal reported the results of the Puy-de-Dôme experiment, Descartes noted, “I had some interest in knowing [the outcome of the experiment] since it was I who asked him to do it two years ago [i.e., September 1647], and I was sure that it would succeed since it is entirely in accord with my principles. Without this he never would have thought of it, since he held a different opinion” (AT V 391).79

Descartes’ reaction to the Torricelli experiments and to Pascal’s extension of them raises two important questions, one narrow and one broad. The first and most straightforward question is why did Descartes and Pascal draw such different conclusions from the Puy-de-Dôme experiment? How could they have thought that the experimental confirmation of the view that the column of mercury is supported by the weight of the air confirmed both that there is a vacuum at the top of the tube and that there is no vacuum there? But the affair raises a more general question as well. Pascal, Torricelli, and many others saw the experiments as issue as an experimental demonstration that vacua are not impossible. Should Descartes have taken Pascal’s attack more seriously? Was he simply being dogmatic in refusing to concede Pascal’s argument?

The first issue is relatively easy to deal with. Pascal tells us in the passage from the Récit of October 1648 quoted above how he interprets the experiment of the Puy-de-Dôme. Consider a simple tube sealed at one end, filled with mercury, standing in a pool of mercury. Under these circumstances, the mercury remains in the tube, and does not descend completely into the bowl below. Pascal imagines three possible explanations: (a) nature abhors a vacuum altogether and the mercury column remains in the tube to prevent such a vacuum; (b) nature resists a vacuum, but does not prevent it altogether, and the mercury descends only as far as it can, while it leaves a vacuum above the column, a column which is supported by the resistance nature has to a larger vacuum; and (c) nature freely allows a vacuum, and the column of mercury is supported by an external force, the weight of the air. Now, Pascal claims, the simple experiments reported in the Expériences nouvelles eliminate the first possibility, (a), since if the tube is sufficiently
long, the mercury will drop to some extent, leaving what he takes to be a vacuum at the top. This leaves (b) and (c). The Puy-de-Dôme experiment shows that the length of the column in the tube lowers as the air pressure decreases, establishing that it is the weight of the air on the surface of the pool of mercury and not any resistance to the vacuum that supports the column; explanation (b) is thus eliminated, leaving explanation (c). And thus, "yielding to the force of truth, which constrains me," Pascal comes finally to the position that nature has no repugnance for the vacuum, a position he thinks is forced upon him by the results of the experiment at Puy-de-Dôme.80

It is somewhat more difficult to present the problem from Descartes' point of view; since he never wrote a systematic account of the experiments, we can only conjecture as to how exactly he saw the issue. But, I suspect, his view was something like this. Descartes, like Pascal, rejected the horror of the vacuum, indeed had done so a number of years earlier (see, e.g., AT II 399). And so he never considers Pascal's explanation (a) as a serious contender. On Descartes' view, I think, what the Pascal camp proposes is explanation (b), the view that the column is supported by a restricted horror of the vacuum in nature, that it is supported by a not altogether insuperable resistance nature has to allowing a vacuum. This is the view Pascal apparently takes in the *Experiences nouvelles* that Descartes received by December 1647;81 it is the view that Roberval likely pressed in the meeting of 23 September when he spoke for Pascal, then too ill to enter into the dispute, and was the view that Le Tenneur, another of Pascal's circle, expressed to Mersenne as late as January 1648, a view that likely made its way to Descartes.82 It is quite possible that the view (c) that Pascal eventually held after performing the Puy-de-Dôme experiment, the view that nature itself freely allows a vacuum, was never even considered by Descartes. While there is reason to think that Pascal may have considered it himself in September 1647, it is quite possible that it never came out in the discussion, dominated as it was by Roberval. Furthermore, that view is never as much as mentioned in Descartes' letters, and while it is prominent in Pascal's *Récit* of 1648, there is no reason to believe that he ever saw a copy of that work.83 So, as far as Descartes was concerned, those who posited a vacuum did so largely in order to explain why the column of mercury stood in the tube of the Torricelli apparatus. Against this he proposed what he took to be an altogether different explanation, that the space above the column was filled with subtle matter, and that the column of mercury was supported by the weight of the air. And so an experiment like the Puy-de-Dôme experiment, where the apparatus is carried to a higher altitude, seemed like the perfect crucial experiment, I suspect Descartes thought. If the column was shorter, he thought he would be vindicated; if not, then what he took to be Pascal's view would have been. It is, I think, because he was altogether unaware of Pascal's alternative (c) that Descartes suggested in August 1649 that Pascal would not have considered the Puy-de-Dôme experiment without his suggestion. It is, by the way, interesting to note that the view of Pascal's thinking I attribute to Descartes was probably shared by some members of Pascal's circle. When Mersenne wrote to Le Tenneur in January 1648, not knowing of Pascal's supposed request to Périer the previous November, and asked Le Tenneur to execute a similar experiment, Le Tenneur replied, "I tell you that I think, along with Roberval, that this would be entirely useless, and that the same thing found below would be found up high" (CM XVI 56).84

It is, I think, understandable how both Descartes and Pascal could have thought that the experiment performed at the Puy-de-Dôme could constitute a crucial experiment, and could support their own views. But however understandable it might be, both were wrong.85 The Puy-de-Dôme experiment suggests strongly that it is the weight of the air, greater at the bottom of the mountain and lesser at the top, that supports the column of mercury in the Torricelli apparatus. But while it may show us what supports the column, it doesn't tell us what lies above it in the tube; Descartes and Pascal can and did disagree on this question while being in perfect agreement on the other.86

The second question I raised earlier is somewhat less straightforward: was Descartes unreasonably dismissive of Pascal's arguments for the void? Should he have taken them more seriously as an attack on his own denial of the void? Descartes was without question deeply committed to his principles, and no doubt saw his identification of space and body and consequent denial of the vacuum as basic to his view, and would not give the position up lightly. And he certainly could appear dogmatic. In a public discussion held in the summer of 1648 in Paris, Roberval tried again to press Descartes with the same experiments and to argue again for the void. Baillet reports that Descartes "took no part but that of a spectator. That is why he spoke little and then only to note how these experiments are in agreement with his principles."87

But it was not merely the strength of his convictions that prevented Descartes from taking the attack of the Pascal camp more seriously. I think that it is fair to say that Descartes never saw in those experiments any serious challenge to his view, nor in Pascal any serious answer to his own interpretation. I think that it was simply obvious to him that the glass had pores that admitted the subtle matter pervading the universe to enter, even though they prevented the grosser particles of air to enter, a view that was explicitly pressed against Pascal by Étienne Noël, Descartes' physics teacher at La Flèche more than thirty years earlier,
a view that Pascal clearly identified as Descartes' as well. It is because of this view that Descartes never saw any inconsistency between his principles and the experiments Pascal and others presented him with. Pascal did answer Noël, of course, both in a letter directly to the Jesuit father and in a letter written in February 1648 to Le Pailleur. But there is no reason to think that Descartes ever saw these texts. All Descartes ever got from Pascal was the promise of a refutation of his preferred explanation. At the end of the *Experiences nouvelles*, a preliminary outline of a never completed treatise on the vacuum, Pascal promised to respond to the objection "that a matter imperceptible, extraordinary, and unknown to all of the senses fills the space [above the column]," a position formulated with Descartes in mind, no doubt. Descartes seems to have received the work in good humor. Writing to Huygens on 8 December, shortly after having received the *Experiences nouvelles*, he noted:

It appears to me that the young man who wrote this booklet has the vacuum a bit too much on his mind, and is somewhat hasty. I wish the volume he promises were already available, so that one could see his reasons, which are, if I am not mistaken, insufficiently solid for what he has undertaken to prove. (AT V 653)

A few days later, on 13 December, he wrote similarly to Mersenne:

It appears that he [Pascal] wants to oppose my subtle matter, and I am deeply grateful to him. But I beg him not to forget to give all of his best reasons on this subject, and not to take it badly if some time or place I explain everything I believe on this to defend myself. (AT V 98)

But almost two years later Descartes is still waiting for the objections. Writing to Carcavy in August 1649 Descartes says:

And since he had sent me earlier a small pamphlet [i.e., the *Experiences nouvelles*] where he described his first experiments on the vacuum and promised to refute my subtle matter, if you see him, I would be very pleased for him to know that I am still waiting for this refutation, and that I will receive it without offence, as I always receive objections made against me without calumny. (AT V 391–92)

Carcavy wrote to Pascal on Descartes' behalf, but no answer seems to have been received before Descartes' death the following February. Similarly, Baillet reports that Descartes asked Roberval to put his objections in writing, objections delivered with great passion in the public discussions of the summer of 1648, so that they could be given proper consideration, a request, Baillet reports, that Roberval denied. And so, from Descartes' point of view, there never seems to have been a serious experimental attack on his belief in the plenum for him to answer.

Indeed, the partisans of the Cartesian point of view had an interesting argument for their view that the space in the tube above the mercury was not empty; an argument not easy to dismiss. The argument is set out at greatest length by Father Noël in his two letters to Pascal on the void from autumn of 1647. The objection starts from the observation that light can pass through the supposedly empty space, and, indeed, is refracted when it enters it. Noël develops the argument in a number of different ways. Sometimes he suggests that the transmission of light requires an appropriate medium, sometimes that the phenomenon of refraction indicates that something in the interval is resisting the light while it passes through. But the most interesting objection Noël raises is the simplest one. The passage of light freely through the glass shows that the glass has pores, pores that could also admit subtle matter as well. A letter from Mersenne to Le Tenneur from January 1648 suggests that Mersenne had such an objection in mind as well, and the association of that discussion with Descartes' name suggests that Descartes may also have been aware of that consideration (CM XVI 59–61). Now, Pascal and Le Tenneur had answers to this kind of objection. Pascal, for example, pointed out that we don't really know what light is, and so we cannot say anything about what does or does not follow from the fact that light can pass through the apparently empty space above the mercury. Le Tenneur wrote Mersenne that he accepts the view common among his contemporaries that light is something corporeal. But since he believes that it is a limited horror of vacuum that holds up the column of mercury, he argues that if light or subtle matter could simply enter and fill the empty space, then the column in the tube would fall (CM XVI 60). Whether Descartes himself ever heard such answers we do not know; it is quite likely that they were discussed in his presence on a number of occasions. But it would have been no mere dogmatism to be skeptical of the supposed experimental refutations of the vacuum. It was, in fact, exactly on these grounds, the passage of light through the supposed vacuum, that Pierre Gassendi and following him, Walter Charleton, no foes of the vacuum and in Gassendi's case, among the very first supporters of Pascal's work, questioned the conclusions Pascal had drawn.

Descartes in the end may have been wrong in denying the vacuum, and Pascal may have largely been correct. But it is not unsurprising that nothing in his exchanges with Pascal and his circle should have led Descartes to see the error of his ways.
CHAPTER FIVE

DESCARTES AND MORE:
DIVINE EXTENSION AND IMPENETRABILITY

Pascal’s attack on Descartes’ view of space and body was experimental, or at least it was meant to be. But at roughly the same time Descartes was engaged in his discussions with the Pascal circle, there was another more metaphysical attack on Descartes’ position from another young philosopher, Henry More, of Christ’s College, Cambridge, a member of the group later to be known as the Cambridge Platonists. On 11 December 1648, More wrote Descartes a flattering letter that began an intense correspondence, cut short less than a year later by events surrounding Descartes’ departure for Sweden, where he died in February 1650. In the few letters they exchanged, More asked a series of probing questions on a variety of subjects, questions that elicited important clarifications of Descartes’ views. We have already seen some of the contents of their exchange in chapter 4 in connection with Descartes’ doctrine of the animal soul, and in later chapters we shall examine their exchanges about motion, force, and relativity. But in this chapter I would like to examine another issue More raises. In the letters with Descartes, More opposes to Descartes’ view of space and body an alternative point of view, an early hint of his view of space as a divine attribute that is later to prove so influential on English scientific thought.98

More’s first question in his first letter to Descartes in December 1648 concerns extension and the nature of body: “Firstly, you frame a definition of matter or body that is much broader than is appropriate. For God seems to be an extended thing, as is an angel, and indeed, anything subsisting in itself” (AT V 258).99 More goes on to give his reasons for thinking that God is an extended thing:

And, indeed, I judge that the fact that God is extended in his own way follows from the fact that he is omnipresent and intimately occupies the universal machine of the world and each of its parts. For how could he have impressed motion on matter, which he did once and which you think he does even now, unless he, as it were, immediately touches the matter of the universe, or at least, did so once? This never could have happened unless he were everywhere and occupied every single place. Therefore, God is extended in his own way and spread out; and so he is an extended thing. (AT V 238–39; see also 379)

God, insofar as he is everywhere, must be extended. And insofar as he is capable of causing motion, he must be present to cause the motion and so, again, must be extended. More, by the way, doesn’t seem to be worried about the problem that worried Elisabeth, that there is some

metaphysical problem about mental-physical causality, that if the mind is incorporeal and unextended, then it cannot be the sort of thing to cause motion in a body. The point is simply that if God causes motion at a given place, he must be there, and if he is there, and indeed everywhere (since he causes motion everywhere), then he must be extended.

But if God, angels, and, indeed, human souls can be extended, then what is to differentiate them from body? More suggests the following:

Although matter is not necessarily soft or hard, hot or cold, it is, however, most necessary that it be sensible, or, if you prefer, tangible. . . . But if it pleases you less to define body in terms of its relation to our senses, this tangibility can be taken more broadly and more widely to mean that mutual contact and power of touching between any bodies, be they animate or inanimate, and be it the immediate juxtaposition of the surfaces of two or of more bodies. And this points up another property of matter or body, which you can call impenetrability, namely, [the property of] not being able to penetrate other bodies or be penetrated by them. From this there is a quite obvious distinction between divine and corporeal nature, since divine nature can penetrate corporeal nature, but corporeal nature cannot penetrate itself. . . . These few considerations suffice to demonstrate that it would have been much safer to have defined matter as tangible substance, or as explicated above, as impenetrable substance, rather than as an extended thing. (AT V 239–40; see also 301, 378)

So, More suggests, what differentiates body from divine extension is the fact that body is impenetrable, while divine extension is not, insofar as divine extension contains bodies. And so, to define body as extended substance is to define it too broadly, and fail to distinguish that which pertains to body as such from that which seems, for More, to pertain to everything.100

One consequence of this position for More is that empty space, space devoid of body, is possible. More, unlike many who opposed Descartes’ theory of space, was in complete agreement with him that one cannot have extension without a substance for that extension to inhere in: “I concede . . . that there is some substance in every space.” But. More continues, that substance is “not necessarily corporeal substance, since divine extension or presence can be the subject of measurability” (AT V 302). And so, in response to the vessel example of Pr II 18, More claims that God could eliminate the matter in the vessel without the sides touching: “I contend that divine extension lies be-
tween [the sides of the empty vessel], and that here your assumption that only matter is extended is mistaken” (AT V 241).

Descartes’ replies to More are interesting. Not unsurprisingly, he continues to defend the position articulated in the Principles, that there can be no space without body, that the idea of a vacuum hides a contradiction (AT V 271–73 [K 239–41]; AT V 403 [K 297]). And appealing to a distinction he first made six or so years earlier when answering Princess Elisabeth’s worries about the mind’s relation to the body (AT III 694 [K 142–43]), Descartes distinguishes the proper sense in which bodies are extended from the derivative sense in which God, angels, and human souls are extended:

In God, in angels, and in our mind I understand no extension of substance but at most the extension of power, so that an angel can exercise its power now in a greater, now in a lesser part of a corporeal substance. For if there were no body, I should think that there would also be no space with which an angel or God would be coextensive. (AT V 342 [K 249])

But most interesting is the discussion of the notion of impenetrability that More’s questions elicit. The discussion is not altogether new. Descartes does mention in passing in the Sixth Replies that “the true extension of body is such that all interpenetrability of parts is excluded” (AT VII 442). But the remark is just made in passing, and Descartes manages to pass through the entire Principles without even once confronting the issue of impenetrability directly.

As we saw earlier, More seems to conceive of impenetrability as being virtually equivalent to tangibility and sensibility: to say that body as distinct from empty space is impenetrable is to say that it is tangible, that it can be touched, discerned by the senses. Descartes, first of all, rejects this:

If you conceive of extension through the relation of parts with respect to one another, it seems that you cannot deny that each and every one of its parts touches all neighboring parts; and this tangibility is a true property, intrinsic to the thing, not something denominated by the sense of touch. (AT V 341–42 [K 248–49])

The notion of impenetrability, Descartes claims, is a real property of body, the property by virtue of which parts touch one another without penetrating, and is not the notion of tangibility defined in terms of the senses. The notion of impenetrability proper to bodies, Descartes goes on to say, is a direct consequence of the very notion of extension, or, more properly, a direct consequence of the notion of extended substance. The grounds of Descartes’ claim are clearly to be found in the discussion of body in the Principles. There Descartes denied that a given body can come to occupy a greater space without the addition of more substance, “since any addition of extension or quantity is unintelligible without the addition of substance which has quantity and is extended” (Pr II 7). And similarly, Descartes claims, “it cannot happen that the least bit of this quantity or extension be removed without exactly that amount of substance being eliminated” (Pr II 8). And so Descartes writes to More:

We cannot even understand one part of an extended thing penetrating another part equal to it without understanding by that very fact half of that extension eliminated or annihilated. But what is annihilated does not penetrate another thing. And thus, in my judgment, it is demonstrated that impenetrability pertains to the essence of extension. . . . Therefore, impenetrability must be admitted in every space. (AT V 342)

The argument is simple and ingenious. If body is an extended thing, in the sense in which Descartes understands it, then take away extension and you take away body. But if two bodies could penetrate one another, then total volume, and thus some amount of body itself, would be eliminated. But if one or another body is in part eliminated by this supposed interpenetration, then there is no real interpenetration, since what is annihilated does not penetrate anything. Consider two spheres, A and B, approaching one another and eventually appearing to interpenetrate. If they do interpenetrate, then the total volume of A and B is less than the total volume of the two spheres before interpenetration. And so, Descartes concludes, some amount of bodily substance must be eliminated in the process of this supposed interpenetration. Descartes’ claim seems to be that what happens in this case is that the area of apparent overlap belongs to one sphere alone, A, say, and that a corresponding amount of sphere B has been annihilated. And if this is the case, then in the case at hand, there is no interpenetration, only annihilation.

Descartes thought he had good grounds for holding that impenetrability followed from the notion of an extended substance. And, insofar as he thought that it was less basic than the notion of extension from which he took it to follow, he resisted More’s suggestion that he define body in terms of impenetrability rather than extension:

Let us see now whether [body] can more appropriately be called “impenetrable or tangible substance” in the sense in which you explicated it. But, on the other hand, that tangibility and impenetrability in body is only like risibility in people . . . . , not a true
and essential differentia, which, I claim, consists in extension. And because of this, just as 'man' is not defined as a risible animal but as a rational animal, so 'body' is not defined through impenetrability but through extension. (AT V 269 [K 288])

Indeed, Descartes goes on to say, unlike risibility, which is always defined in human beings, there are certain circumstances in which impenetrability is not found in corporeal substance, even though it is a direct consequence of a body being extended substance. Descartes continues the above quoted passage by noting that “tangibility and impenetrability are related to parts, and presuppose the concept of division and limitation.” And so, if we imagine the totality of corporeal substance without any divisions, without any parts, and, presumably, without anything outside of it, it will be extended, but the notion of impenetrability will not be applicable.

It was later to become a standard criticism of Descartes that he ignored the property of impenetrability, and because of this, conflated body and space. But this is not altogether fair, and shows the extent to which Descartes’ letters with More, published as early as 1657, were later ignored, and, more generally, the extent to which Descartes’ position was later misunderstood.

**Descartes and His Teachers: Void, Plenum, and Divine Omnipotence**

The enormous complexity and variety within late medieval accounts of space and vacuum, together with some uncertainty about what precisely Descartes may have been exposed to at La Flèche and later, and how much Descartes may have remembered about the numerous debates and disputes in the scholastic literature when he came to formulate his own views on the issues, make it virtually impossible to give any simple and straightforward answer to the question of his relation to the scholastic tradition on space and vacuum. In many ways it is fair to say, though, that Descartes’ position fits well within the mainstream of the scholastic tradition, and that Descartes must certainly have been deeply influenced on this question by his teachers.

As in Descartes, the orthodox scholastic view is that there are no empty spaces within the world. And like Descartes, many scholastics found the idea of extension without body to be unintelligible. It is interesting to note that even the thought experiment of Pr II 18 was not unlike medieval thought experiments to the same effect; instead of imagining just the water in a vessel to be annihilated, Descartes’ scholastic forebears would have God annihilate everything within the sphere of the moon. While some tried to figure out a way in which God would be able to preserve the extension without the body it had contained, many others were in agreement with Descartes that without body, the sides of the space evacuated must necessarily touch.

There appears to be a greater difference between Descartes and his teachers on the question of an extramundane vacuum. Aristotle’s cosmos had been finite in size, and nothing was thought to be outside of it. But as I noted earlier in this chapter, this is a doctrine that Christian physicists found in need of alteration, and concocted the idea that beyond the cosmos are the so-called imaginary spaces, apparently empty space that give God the freedom to move the cosmos. This, of course, appears quite foreign to Descartes’ thought. For Descartes, the world is not finite, but extends out indefinitely, not empty, but full all the way out (Pr II 21). But even here, Descartes’ views are not altogether unconnected to those of the schools. While there were some who held that the space beyond the cosmos is in some sense genuinely real, and others saw the infinite extracosmic space as filled with God, somewhat as More was later to do, for many the space without body is not space in the true sense. Though all had to admit something in some sense beyond the world, for many the so-called imaginary spaces are in no way real until occupied by body.

One can get a sense of the general orthodoxy of Descartes’ views on space and place by comparing his views with those of Francesco Toletus, the sixteenth-century Jesuit whose commentaries Descartes is known to have studied as a student at La Flèche, a late scholastic whose views on space and place are in many ways not unlike those the erstwhile student of the Jesuits came to adopt in the *Principles*. Toletus’ views on space and place are presented in his commentary on book IV of Aristotle’s *Physics*, following a series of seven *questiones* treating the orthodox Aristotelian position. Toletus finally turns to a moderately lengthy exposition of “a probable opinion” held by “certain more recent” authors “which . . . reconciles all opinions, and resolves all difficulties, and preserves . . . all properties of place.” Toletus first distinguishes place into intrinsic place or space, and extrinsic place (the sort of place “Aristotle spoke of”) and then divides place along a different dimension into true place and imaginary place, yielding four sorts of place, intrinsic and extrinsic true place, and intrinsic and extrinsic imaginary place. Intrinsic and extrinsic true place, a distinction Toletus did not himself invent, correspond closely to what Descartes calls internal and external place in the *Principles*. In the case of the external place, Toletus recognizes somewhat different
senses, ranging from the immediate boundary, to the situation of a body as determined by more remote bodies.\textsuperscript{119} Intrinsic true place, on the other hand, corresponds to Descartes’ internal place, “the space itself which the thing really occupies.”\textsuperscript{119} This space, Toletus tells us “is a certain property following from its quantity, namely the extension of its quantity.”\textsuperscript{120} But just as in Descartes, this true intrinsic place, this space cannot exist apart from body, but “inheres in things themselves as a proper accident of them.”\textsuperscript{121} As Descartes will later argue, this space is inseparable from body. “Moreover, it cannot be denied that this intrinsic space is in every body . . . since they [i.e., space and body] can be mutually inferred from one another. For if there is body, then there is space, and if there is true space, then there is body in it.”\textsuperscript{122}

Toletus’ account of imaginary place is also strongly suggestive of elements from Descartes. Imaginary place is “for example that imaginary space beyond the heavens which anyone can imagine to be there. And also vacuum here in the world, if it exists, would be imaginary place, indeed, imaginary space.”\textsuperscript{123} While Toletus is not very interested in the distinction between extrinsic and intrinsic imaginary place, there is another distinction here that interests him, the distinction between fictive and abstracted imaginary place. Fictive place, is “a thing altogether made and constructed, which does not exist.”\textsuperscript{124} Under this description Toletus includes, as Descartes no doubt would, space beyond the world (though for Descartes, unlike Toletus, the world extends indefinitely) and so-called empty space. Abstracted imaginary space is the true (intrinsic) space, considered apart from the particular bodies that happen to possess it: “since [space] seems to remain the same while bodies are always changing, one thinks that it [i.e. space] remains numerically the same, although it is only the same in species and in its equality.”\textsuperscript{125} And so we abstract the space from the bodies occupying it; it is in this sense for Toletus, as for Descartes some years later, that space can be conceived of as the immobile container that remains unchanged as the bodies it contains change.\textsuperscript{126} But though “this conception is not made but is true,”\textsuperscript{127} such a space is an abstraction from what is real, and could not exist were there no bodies.

My point in discussing Toletus’ views is not to suggest that Toletus is an important and original thinker; he presents his account only as a compendium of views from the “receptions.”\textsuperscript{128} And there is every reason to think that all of the views he expresses in the section we have been examining can be traced to earlier thinkers.\textsuperscript{129} I also do not intend to suggest that Toletus is in any sense the direct source of the ideas on space and place of Descartes to which I referred in my discussion. As I noted earlier, if he borrowed directly from any scholastic thinker it was probably from Eustachius’ rather more elementary and accessible ex-

position of the material as given in his Summa, a book he was known to have been reading in 1640 and 1641 while working out the relevant sections of the Principles. I am appealing to Toletus only as one example of what a scholastic position on the issues might look like, and my point is only that Descartes’ view on space, place, and vacuum is in many respects not so very different from what he or any other student might have learned in school.

But as similar as Descartes’ position may be to that of Toletus and other scholastic thinkers, there is an extremely important difference to note. For Toletus, as for Descartes, one can have real space or extension when and only when one has body. But for Toletus, despite this fact, extension is only what he calls a proper accident of body.\textsuperscript{190} A proper accident for Toletus, as for other schoolmen, is something like risibility in humans “that flows from the essential principles of the subject, since it cannot exist without the subject nor can the subject exist without it.”\textsuperscript{131} But though it flows from the essence, it is clearly distinct from the essence; risibility is in all and only human beings, but it is not part of their essence.\textsuperscript{132} And so, in his commentary on the Physics Toletus claims that whether or not quantity is really distinct from substance, “it is at least essentially distinct from substance.”\textsuperscript{133} Similarly, when distinguishing physics from mathematics, he argues that the quantity treated in mathematics is only one kind of accident bodies have, and not even the one of primary interest to the physicist.\textsuperscript{134} But, of course, matters are altogether different for Descartes. For Descartes there is nothing to body over and above its extension, which constitutes its very essence and nature. And Descartes fully realized his departure from scholastic orthodoxy. Responding to Regius in the Notes against a Program, he remarks that “I am the first . . . to have considered extension as the principle attribute of body” (AT VIIIB 348). It is, of course, from this position, the identification of extension and body, that Descartes’ position on space, place, and vacuum derives. However much it may resemble the positions he was taught in school, it flows from a somewhat different source.

But even though Descartes’ position is, in an important sense, radically non-Aristotelian, it raises for the Christian philosopher exactly the same sort of problem that Aristotle’s philosophy raised for the Latin West in 1277. Though the actual condemnation of that year had long been forgotten by the time Descartes was writing, the issues persisted;\textsuperscript{135} Antoine Arnauld and Henry More, both especially interested in the theological consequences of Descartes’ views, saw in his strong arguments against the possibility of a vacuum a potentially objectionable restriction on divine omnipotence. Arnauld wrote Descartes in July 1648:
On the vacuum, I confess that I cannot yet digest the fact that the connection between corporeal things is such that . . . God can reduce no body to nothing unless by virtue of that he is held immediately to create another [body] equal in size, or unless, without any new creation, the space which the body annihilated occupied is understood to be a true and real body. (AT V 215)

Similarly, in December 1648, a few months later, More objected:

When you intimate that not even by divine power can it happen that there exist a vacuum, properly speaking, and if all body were eliminated from a vessel, that the sides would necessarily meet, this seems . . . false . . . For if God imprinted motion on matter, as you have taught before, could he not impress a contrary motion, and prevent the sides of the vessel from meeting? . . . But the sides . . . will meet not by a logical necessity but by a natural necessity; only God could prevent them from meeting. (AT V 240–41).

The root problem is this. Descartes argues from the inseparability of the notions of body and extension in our mind to their inseparability in nature. But, one might ask, why should that be binding on God?

Descartes answers More as follows:

You readily admit that no vacuum arises naturally. But you are concerned about divine power, which you think could eliminate everything in some vessel and at the same time prevent the sides of the vessel from meeting. Since I know that my intellect is finite and God's power infinite, I never decide anything about this, but I only consider what I could or could not perceive, and I am careful not to let any judgment of mine disagree with what I perceived. Therefore I boldly affirm that God can do anything I perceive to be possible, but, on the other hand, I don't boldly deny that he can do what contradicts my conception: I say only that it implies a contradiction. Thus, since I see that it is in contradiction with my conception that all body be eliminated from a vessel, leaving the extension behind, extension which I conceive no differently from the body previously conceived contained in it, I say that it implies a contradiction for such extension to remain there after the body is eliminated, and therefore the sides of the vessel touch. (AT V 272 [K 240–41])

Descartes' answer to Arnauld a few months earlier is virtually identical (AT V 223–24 [K 236–37]). As with the answer to More, Descartes tells Arnauld that he sets no limits on God; indeed, he says that he "dare not say that God cannot make a mountain without a valley, or make one

plus two not equal three" (AT V 224 [K 236]). His only claim, he tells Arnauld, is that "God has given me such a mind" that I cannot conceive of extension without body. And so, he claims, we are forced to conclude that "wherever extension is, there is necessarily body as well" (AT V 224 [K 236–37]).

The response is a bit puzzling. Descartes says that space without body is a contradiction, so we must conclude that it cannot happen, and necessarily so. But, Descartes also says that he does not mean to deny that God could create space without body, something that seems to undermine the claim that there is no space without body. If God can do it, then it must be possible in a genuine sense, just as Descartes was prepared to admit the real distinction between mind and body on the grounds that God could create the two apart, or deny that there are atoms because at least God could split any particle of matter.

Matters are somewhat illuminated by an undated marginal note Descartes seems to have written in his copy of the Latin Principles, a note that, I suspect, may well have been penned in late 1648 or early 1649 in response to the questioning by Arnauld and More:

About these things that involve a contradiction, it can absolutely be said that they cannot happen. However, one shouldn't deny that they can be done by God, namely, if he were to change the laws of nature. But we should never suspect that he had done this unless he himself revealed this: as, for example, concerning the infinite world, the eternal [world], atoms, the vacuum, etc. (AT XI 654).

The view here seems to be close to the celebrated doctrine of the creation of eternal truths that Descartes elaborated first in letters to Mersenne in 1630, and came back to later from time to time. Descartes' position seems to be that since God fixed the laws of nature (eternal truths), he can change them, and allow for the possibility of body without extension. It is in this sense that God has the power to create a vacuum, if he so chooses. But having fixed the laws, having voluntarily constrained his power, as it were, vacua are impossible. And while we should always be aware that there is a sense in which God can create a vacuum, only divine revelation could show us that such a thing was really possible.

This is the position Descartes takes in the late 1640s. But my suspicion is that worries about divine omnipotence and the vacuum may well lie behind the original articulation of the doctrine of the creation of the eternal truths in 1630. Remember, first, that in Rule 14, written most likely in the late 1620s, Descartes comes close to articulating the position that will later lead him to deny the vacuum in the Principles of
1644, the identification of space and body. Though the vacuum does not come up in Rule 14, he was no doubt thinking seriously about it in 1629 and 1630, as he began to formulate *The World*, where the vacuum is explicitly rejected, and the considerations advanced in Rule 14 no doubt were prominent in his mind. But if Descartes remembered anything of his education at La Fleche, he must have remembered the theological problems and worries about divine omnipotence that come with an absolute denial of the vacuum, problems and worries still very much in evidence in scholastic literature almost 350 years after the Condemnation of 1277. My suspicion is that the doctrine of the creation of the eternal truths, first formulated in 1630 and called into service in the late 1640s, intended when first formulated in 1630 to take a prominent place in the treatise on physics then in progress, may originally have been formulated to reconcile divine omnipotence with the impossibility of a vacuum. The doctrine of the creation of the eternal truths does not, in the end, appear in *The World*, of course. But then, as we have seen, neither do the strong arguments against the vacuum that were to appear in 1644 and raise theological questions in the minds of Arnauld and More. My suspicion is that Descartes' caution about venturing into theological questions may have gotten the better of him, and rather than giving both the strong arguments against the vacuum and the theological view necessary to reconcile them with divine omnipotence, he chose to eliminate the arguments, in favor of weaker considerations suggesting the nonexistence of vacua rather than their absolute impossibility.

But though Descartes may have been plagued by many of the same worries about divine omnipotence and the vacuum that plagued his teachers, the solution he forged was rather interestingly different. There are, to be sure, precedents to Descartes' view on the creation of the eternal truths in scholastic thought, but to Descartes, no scholar of the past, it must have seemed that considerations relating to divine omnipotence had forced his teachers and their sources into recognizing that there was some sense in which empty space is genuinely possible, and in that way had forced them into conceptual incoherence, trying to make some sense of an utterly unintelligible idea. There is genuine excitement in the letters of 1630 where Descartes announces to Mersenne his view, a view he thought to be completely new and utterly unprecedented. For, if I am right, Descartes thought that he had discovered how he could exclude the vacuum altogether without compromising divine omnipotence; in Descartes' view, what he discovered in 1630, empty space is possible for God, but *only* in the sense that it is possible that $2 + 2 = 5$.

**Conclusion**

There were various attempts to bridge the gap between Descartes and the atomists in the seventeenth century. Gerauld de Cordemcy, for example, a member of one of the important Cartesian schools that formed after Descartes' death, attempted to frame arguments for atoms and the void using arguments in the style of the master. In Britain, Robert Boyle attempted to downplay the differences between Descartes and the atomists and forge a kind of nonsectarian mechanical philosophy. But the difference between his position and that of the atomists was extremely important to Descartes, and despite attempts at reconciliation, the denial of atoms and the void continued to characterize his followers throughout the century, and separate them from others, like Gassendi and his followers, who attempted to revive the doctrines of Democritus and Epicurus.
We have examined Descartes' account of body in general, the notion of corporeal substance as geometrical extension made substantial that grounds his mechanical world view. This extended substance can support a number of different modes; body can come in different sizes, different shapes; bits of this substance can be distant or near, contiguous or separated. But the most important mode matter has for Descartes is motion, local motion, and it is in terms of this mode that all properties bodies have are to be explained. Thus he writes in the Principles, beginning his extended account of motion, that "all variation in matter, that is, all the diversity of its forms depends on motion . . . and all the properties we clearly perceive in it reduce to this one thing, that it is divisible and mobile with respect to its parts, and thus is capable of all of those properties [affections] which we perceive can follow from the motion of its parts" (Pr II 23). In order to understand the foundations of Descartes' physics, we must thus understand his conception of motion and the laws it follows.

My discussion of motion in Descartes will be structured around an important distinction that he draws in the Principles. There he carefully distinguishes between motion considered in itself as a mode of body, and the causes of motion, the "force or action which transfers [a body]," two distinct notions that "are usually not distinguished carefully enough" (Pr II 25). And so, in the Principles, he devotes a number of sections to the nature of motion considered as a mode of body before turning to his discussion of the causes of motion, both the general cause, God, and the laws of motion, what he calls "secondary and particular causes of different motions" (Pr II 37). While he himself may have been among those who confused motion with its causes in his earlier writings, as we shall see, the distinction is crucial to understanding Descartes' mature thought, and my discussion will respect that distinction.

Consequently we shall begin our discussion in this chapter with an account of the notion of motion as a mode of body. After an account of the notion of motion in Descartes' earlier writings, we shall turn to a discussion of his definition of motion in the Principles and later writings. The central question we shall have to take up is how Descartes thought motion to be a genuine mode of body. If all there really are in his physical world are extended bodies and their modes, then motion must be construed as a mode of body if it is to have the explanatory function it is intended to have in his physics. In order to show how he thought it to be a mode of body, we must discuss the so-called relativity of Descartes' account of motion, and its dependence on duration and time. I shall argue that contrary to the received wisdom, Descartes' definition of motion is carefully fashioned to allow for a nonarbitrary distinction between motion and rest, and that the duration on which the notion of motion depends is, itself, an attribute of body. The chapter will continue with a discussion of some other issues connected with the account of motion, the individuation of bodies, Copernicanism and the motion of the Earth, the notion of determination, and the rejection of scholastic conceptions of motion.

Motion and its laws concerned Descartes from his earliest years. The problem of the law governing the motion of a body in free-fall, a problem that brings into play many of the questions about motion that were later to concern him, is a problem he took up as early as 1618 during his brief period of apprenticeship with Beeckman. But, for all his interest in the phenomenon of motion, there is little interest in any attempt to formulate a precise definition of what motion is. In Rule 12 of the Rules, for example, Descartes writes:

Indeed, doesn't it seem that anyone . . . who says that motion, a thing well-known to all, is the actuality of a thing in potentiality insofar as it is in potentiality is putting forward magic words? For who understands these words? Who doesn't know what motion is? . . . Therefore, we must say that these things should never be explained by definitions of these sorts, lest we grasp complex things in place of a simple one. Rather, each and every one of us must intuit these things attentively, distinguished from all other things, by the light of his own intelligence [ingenium]. (AT X 426–27)

Descartes is taking the Aristotelian definition of motion to task here. And one of the main problems he sees in that definition is simply the fact that it is a definition at all. Motion, he seems to imply, cannot be defined strictly speaking; it is a simple nature, a concept that each and
CHAPTER SIX

Motion

Every one of us can grasp for ourselves in the privacy of our own minds, and we don't need a definition to tell us what it is.

Descartes displays a similar attitude toward motion in *The World* he began to work on shortly after setting the *Rules* aside. As in the *Rules*, he quotes the Aristotelian definition of motion to show its obscurity, quoting it in Latin: "[this definition] is so obscure to me that I am forced to leave it here in their language, since I cannot interpret it" (AT XI 39). But in *The World* he goes even farther than he went in the *Rules*; he argues that local motion is the only intelligible notion of motion and challenges the idea that there are some motions, recognized by the scholastics, that do not involve local motion, including motion with respect to form, motion with respect to heat, and motion with respect to quantity (AT XI 39). Later in this chapter we shall take these critiques up more carefully. But for the moment what I would like to call attention to is what Descartes substitutes for the Aristotelian definition of motion: nothing. Once again, he suggests that motion is a basic notion, indefinable and known through itself:

The nature of motion that I intend to speak of here is so easy to understand that the geometers themselves, who are the best of all people at conceiving very distinctly things which they have considered, have judged motion to be more simple and more intelligible than their surfaces and their lines; so it appears from the fact that they have explained the line from the motion of a point, and the surface from the motion of a line. (AT XI 39)

Lines and surfaces are certainly intelligible and unproblematic, Descartes implies. But, he says, motion is simpler even than they are, since geometers use the notion of motion in order to define lines and surfaces.4

But despite Descartes' studied avoidance of any careful discussion of the nature of motion, it is not difficult to discern his conception of motion in these early writings, the definition of motion he might have given had he been pressed to give one. Motion, it is fair to say, was just change of place. In *The World*, for example, motion is claimed to be "that by virtue of which bodies pass from one place to another and successively occupy all of the spaces in between" (AT XI 40).5 Similarly in *The World* he characterizes rest and its distinction from motion as follows: "For myself, I conceive that rest is also a quality which ought to be attributed to matter while it remains in one place, just as motion is a quality that is attributed to it while it changes place" (AT XI 40).

Much the same attitude toward motion persists through to the end of the 1630s. In a letter to Morin on 12 September 1638, for example, Descartes characterizes motion as "the action through which the parts of this matter change place" (AT II 364). Though the characterization of motion as an action is not without significance, as we shall see, it is also significant that as in *The World*, motion is characterized in terms of change of place. But as in *The World* and the *Rules*, it is not clear that an explicit definition is really needed. Writing to Mersenne about a year later, on 16 October 1639, Descartes notes, "Someone who walks in a room understands what motion is better than someone who says that it is the actuality of a thing in potentiality insofar as it is in potentiality, and so on" (AT II 597 [K 66]).

But when in the early 1640s Descartes turns to drafting his *Principles*, there is a significant change, both in his conception of what motion is and in his view on the necessity for a formal definition. It is not at all clear why he changed his attitude and adopted the new conception of motion he did; commentators, from his contemporaries down to our day, have tended to see Descartes' change in position motivated by his caution and his extreme reluctance to commit himself in print to a view on which the Earth can properly be said to move. Indeed, the claim has been made that the definition given in the *Principles* does not represent his real view. We shall examine this claim in some detail later in this chapter, where I shall argue that whatever fortuitous consequences Descartes' view of motion may have for Copernicanism, the definition of motion he offered in the *Principles* is firmly rooted in features internal to his program for grounding physics. But whatever his motivation may have been, it is clear that in the *Principles* Descartes explicitly attempts to define motion, and when he does so, the definition he offers is not simply given in terms of change of place.

Motion is, of course, one of the central concerns of part II of the *Principles*, where Descartes lays down the foundations of the natural philosophy that he will develop in the third and fourth parts. Descartes introduces his discussion of motion and its laws with two different definitions of motion. The first definition is intended to capture the notion of motion as it is ordinarily understood, *motus juxta vulgarem sensum*:

Motion... as commonly understood is nothing but the action by which some body passes [migrat] from one place into another. (Pr II 24)6

In contrast to this, Descartes proposes the following definition, which is intended to capture the true sense of motion, *motus propriè surnptus*, motion considered *ex rei veritate*:

But if we consider what we should understand by motion not so much as it is commonly used but, rather, in accordance with the truth of the matter, then in order to attribute some determinate
nature to it we can say that it is the transference [translatio] of one part of matter or of one body from the neighborhood [vicinit] of those bodies that immediately touch it and are regarded as being at rest, and into the neighborhood of others. (Pr II 25)

Before beginning to unpack these two definitions and to understand the differences Descartes saw between them, let me make two brief remarks about what they have in common. Both are, of course, intended to be definitions of local motion. In the Principles, as we saw earlier in The World, he claims that “no other [notion of motion] falls within the scope of my thought, nor [can] any other be imagined in nature” (Pr II 24; see also Pr I 69). Later in this chapter we shall investigate why he held this, and why he rejected other varieties of motion his Aristotelian contemporaries accepted. And second, both of these definitions appear to presuppose that we understand what it is that makes a region of extended substance one body, how it is that bodies are individuated. Immediately after giving the proper definition of motion, Descartes explains that “by one body or one part of matter I understand everything that is transferred at the same time” (Pr II 25). Bodies, thus, seem to be individuated by their motion. Just how he thought this works and the problems the account of individuation raises for the account of the nature of motion will also be discussed later in this chapter. But for the moment I would like to assume that we have a grasp of what it is that constitutes an individual body, and, given that understanding, explore the differences between the two definitions of motion that Descartes considers.

The first important difference between the two definitions concerns the notion of activity. According to the vulgar definition, motion is defined as an action, an actio, as Descartes himself had characterized motion only a few years earlier, in 1638. But in the proper definition, he calls motion a transference a translatio. There are, I think, two reasons for this change. For one, if we think of motion as an action, then we are immediately led to think of rest as the lack of action, as he notes in connection with the vulgar definition: “Insofar as we commonly think that there is action in every motion, we think that in rest there is a cessation of action” (Pr II 24). This, he thinks, is a mistake, one of the many prejudices we acquire in our youth (Pr II 26). On the contrary, he thinks, “no more action is required for motion than for rest” (Pr II 26). And so, he argues, the action necessary to put a body at rest into motion is no greater than the activity necessary to stop it; rest requires as much of an active cause as motion does (Pr II 26; AT V 345–46).

This observation of Descartes’ will be important in later in chapters where we discuss the laws of motion. There we shall see that motion and rest, while distinct states, are, in a sense, on a par with one another insofar as both motion and rest will persist unless impeded by an external cause, and both motion and rest have associated forces, as he will call them, that oppose change. But these observations do not properly speaking belong to a characterization of the bare notion of motion. And this is the second reason why he chooses to characterize motion in terms of transference rather than action: what properly pertains to the body as a moving thing is not the action or force associated with the motion, but simply the fact that the moving body passes from one region and into another. And so he remarks immediately following his definition of motion propri sumptus:

And I say that [motion] is transference, not the force or action that transfers in order to show that it is always in the mobile thing, and not in what is moving it, since these two things are not usually distinguished carefully enough, and to show that [motion] is a mode of a thing, and not some subsisting thing, in just the same way as shape is a mode of a thing with shape, and rest is a mode of a thing at rest. (Pr II 25)

There are a number of features of this passage to which we will have to return later, in particular, the characterization of motion as a mode of body and the comparison Descartes draws between motion and shape. But one thing he wants to distinguish here is what it is that is in a body by virtue of being in motion, what belongs to motion itself, and what belongs to the cause of motion in the body, which, he implies, is something distinct from the body in motion. This is made a bit clearer in a response he made to Henry More. In More’s last letter to Descartes, 23 July 1649, he tells Descartes that in his view, “motion is that force or action by which bodies said to be moved mutually separate” (AT V 380), a view close to the vulgar definition that Descartes had rejected a few years earlier. Descartes answers:

That transference that I call motion is a thing of no less entity than shape is, namely, it is a mode in body. However the force [vis] moving a [body] can be that of God . . . or also that of a created substance, like our mind, or something else to which [God] gave the power [vis] of moving a body. (AT V 403–4 [K 257])

In calling motion a transference rather than an action, Descartes means to distinguish the effect, motion, from its cause, the mover. We cannot, of course, know the cause: as I noted earlier, Descartes will give careful attention to the causes of motion, and will derive the laws of motion ultimately from its “universal and primary cause,” God. But Descartes
Chapter Six

thinks it is important to distinguish the nature of motion from its cause, and treat the cause only after we understand the nature of the effect.

So far we have examined one important difference between the vulgar definition Descartes rejects and the proper definition he means to substitute, the move from motion as action to motion as simple transference. But there is another difference just as important, though considerably more difficult to understand. The vulgar definition is given in terms of the notion of place, locus; motion, for the vulgar, and, indeed, for Descartes himself in his earlier writings, involves passing from one place to another place. In the proper definition, though, motion is defined not in terms of place, but in terms of neighborhoods of contiguous bodies; motion, as he came to understand it, is the passing from one neighborhood of contiguous bodies and into another.

This is a puzzling change, one that has driven numerous commentators to look for an external cause; as we shall later discuss, it has been common to attribute this change to Descartes' desire to hide his Copernicanism. Somehow, it has been claimed, by rejecting the definition of motion in terms of place and adopting this rather queer alternative, Descartes thinks he can hold that the Earth is, properly speaking, at rest. Later in this chapter we shall investigate these claims in some detail. But for now I would like to investigate the explanation Descartes himself gives of this change and the new account of the nature of motion he offers.

An important feature of the vulgar definition that Descartes chooses to emphasize is the fact that whether or not a given body is in motion depends on the apparently arbitrary decision to consider one or another place as being unmoved. And so he comments on the vulgar definition, referring to his earlier discussion of external place in Pr II 13:

As we showed above, the same thing can at a given time be said both to change its place and not to change its place, and so the same thing can be said to be moved and not to be moved. For example, someone sitting in a boat while it is casting off from port thinks that he is moving if he looks back at the shore and considers it as motionless, but not if he looks at the boat itself, among whose parts he always retains the same situation. (Pr II 24; see also Pr III 28)

It is this kind of arbitrariness that the proper definition of motion is intended to undermine. In explaining the proper definition of motion in terms of neighborhoods rather than places, Descartes notes:

Furthermore, I added that the transference take place from the neighborhood of those bodies that immediately touch it into the neighborhood of others, and not from one place into another since . . . what is taken as a given place varies [loci acceptio varia est] and depends upon our thought. But when we understand by motion that transference which there is from the neighborhood of contiguous bodies, since only one group of bodies can be contiguous to the mobile body at a given moment of time, we cannot attribute many motions to a given mobile body at a given time, but only one. (Pr II 28)

The move from defining motion (improperly) in terms of place, as Descartes once seems to have held, to a definition in terms of neighboring bodies is supposed to eliminate the claim that whether or not a body is in motion, and if it is in motion, what that motion is, is simply a matter of arbitrary choice, a distinction that depends on our thought. But, one might ask, why did Descartes want to eliminate the relativity that had accompanied the notion of local motion since its earliest discussions and how did he think that the rather strange definition he gave in the Principles accomplished that aim?

It is not difficult to see why Descartes might want to eliminate the kind of arbitrariness implicit in the vulgar definition. Motion is to be a basic explanatory notion in Descartes' physics: "all variation in matter, that is, all the diversity of its forms depends on motion" (Pr II 23). Now, if all the properties bodies have are ultimately to be explained in terms of motion, then motion must really be in body, as a mode. It is not entirely clear just what this means. But certainly one thing that it means is that there is a real fact of the matter about whether or not a given body is in motion or at rest; whether or not a body is in motion should in no way depend upon how we happen to think about it, upon an arbitrary decision we make to consider this or that body as being at rest. But if this is the case, then motion cannot be as it is commonly conceived, as change of place, since, as Descartes noted, on that conception of motion the distinction between being in motion and being at rest is arbitrary and depends on our thought; such a conception of motion is hardly up to the task Descartes intends for it to play in his system.

It is not clear just when Descartes came to see the importance of a nonarbitrary distinction between motion and rest. Descartes' position in his earlier writings is somewhat difficult to discern. In those writings, he does appear to conceive of motion as change of place. But it is important to note that he does not offer this as a formal definition, and that he nowhere draws any of the relativistic consequences of defining motion in that way that he will draw later in the Principles. Furthermore there are other remarks in those writings that suggest, if only weakly, a
genuine distinction between motion and rest. In the *Rules*, for example, 'rest' is listed as a simple nature, and distinguished from the simple nature of motion (AT X 420). In *The World* Descartes claims that rest is a "quality [qualité] which ought to be attributed to matter while it remains in one place," as much of a quality as motion is (AT XI 40). And referring to the scholastic view that things in motion tend per se to come to rest, a view that, as we shall later see, he rejects, Descartes notes that the motion of the scholastics tends toward rest and thus, "against all laws of nature, it tries to destroy itself" (AT XI 40), suggesting that motion and rest are distinct and opposing qualities of body.

Though all of these passages suggest a genuine distinction between motion and rest, they might be reconciled with a relativistic view of the distinction, perhaps, and may be made consistent with the view that the distinction between rest and motion is simply a matter of our way of thinking of them. But in the *Principles* Descartes is much more explicit. Motion and rest are genuine modes of body there, and genuinely distinct: "It is obvious that this transference cannot exist outside of a moving body, and that this body has one mode when it is transferred, and another when it is not transferred, that is, when it is at rest. And so, motion and rest are nothing in it but two different modes" (Pr II 27).

Indeed, he suggests that motion and rest are states, opposite states, that persist unless interfered with (Pr II 37, 44). And, as we shall later see, when he formulates his laws of impact, the difference between the states of motion and rest are manifested in a set of laws that clearly differentiate between the two states; the outcome of a collision may turn out to be entirely different depending on which of the bodies involved is designated as being at rest, and which is designated as being in motion.

It is important for Descartes to distinguish between motion and rest, to reject the view that whether or not a body is in motion depends upon our point of view, and make motion a genuine mode of body. But, one might well ask, how does he think it can be done? Does his preferred definition of motion allow for unambiguous attributions of motion or rest any better than the vulgar definition he rejects on those grounds?

Defining motion in terms of neighborhood is, in a clear sense, defining it in terms of place, Aristotelian place, what he himself called its external place earlier in *Principles*, part II, "the [inner] surface of the surrounding body" (Pr II 15). But by defining motion in terms of a neighborhood rather than an arbitrarily designated place, Descartes seems to think that he is entitled to say that insofar as there is only one neighborhood of surrounding bodies, there can only be one proper motion for a given body. He, of course, recognizes that there is a sense in which a body can be said to participate in many motions:

For example, if someone walking on a boat carries a watch in his pocket, the wheels of his watch will move with only one motion proper to them, but they will also participate in another, insofar as they are joined to the walking man and together with him compose one part of matter. They will also participate in another insofar as they are joined to the vessel on the undulating sea, and in another insofar as they are joined to the sea itself, and, finally, to another insofar as they are joined to the Earth itself, if, indeed, the Earth as a whole moves. And all of these motions will really be in these wheels. (Pr II 31)

And Descartes also recognizes that the single proper motion of a body can be decomposed into other motions that jointly can be thought of as making up the proper motion of the body:

And furthermore, that single motion of a body which is proper to it can be considered as if it were many motions. For example, in carriage wheels we can distinguish two different [motions], namely, a circular [motion] around their axle, and another straight [motion] along the length of the road on which it is traveling... We can imagine any line, even a straight line, the simplest line of all, to have arisen from an infinite number of different motions. For example, if line AB [see fig. 6.1] is carried toward line CD, and at the same time point A is carried toward B, then the straight line AD which point A marks out depends no less on the two straight motions, the motion from A to B, and from AB
to CD, than the curved line marked out by any point on the wheel depends on the straight and the circular motion. (Pr II 32)

But, Descartes emphasizes, the decomposition of the proper motion into other motions, is, in a sense, a fiction. Though the carriage wheel can be thought of as if it has two distinct motions,

the fact that these motions are not really distinct follows from the fact that every point of a body that moves marks out only one particular line. . . . Although it is often useful to divide a motion into several parts in this way in order to perceive it more easily, strictly speaking, though, we must count only one motion in any body. (Pr II 32)

And similarly, in the case of the wheels in the watch, even though a body may participate in a number of different motions, “every body has only one motion proper to it, since it is understood to recede from only one [group of] contiguous and resting bodies” (Pr II 31). And so, by defining motion not in terms of place, a notion notoriously relative to an arbitrarily chosen reference point, but in terms of a neighborhood of contiguous bodies, Descartes seems to think that he can undermine the relativity implicit in the vulgar definition of motion, at least to the extent that he can identify at most one motion that can be said to belong to a given body, strictly speaking; though the wheel in the watch participates in many motions, it has only one proper motion, and though the motion of a point on a carriage wheel can be thought of as the composition of a straight and a circular motion, it really has only one motion, properly speaking.

But this cannot be the whole story. There are, of course, obvious difficulties in defining precisely what the neighborhood of a given body is, particularly when we are dealing with bodies surrounded with fluid, as Descartes takes the Earth to be. But even this problem aside, it seems obvious (and has seemed obvious to most of his commentators) that however much the definition restricts the attribution of motion to a body, however many possible motions Descartes’ curious definition might eliminate, at root, his definition still fails to ground a genuine distinction between motion and rest. It appears. Motion, he says, is transference. But Descartes also tells us in the Principles that transference is reciprocal:

Finally, I added that the transference take place from the neighborhood of those regarded as being at rest. For that transference is reciprocal, and we cannot understand body AB transferred from

the neighborhood of body CD unless at the same time body CD is also transferred from the neighborhood of body AB. . . . Everything that is real and positive in moving bodies, that on account of which they are said to move is also found in the other bodies contiguous to them, which, however, are only regarded as being at rest. (Pr II 29, 31)

Now, if motion is transference, and transference is reciprocal in this sense, then it seems obvious that motion must be reciprocal in this sense. And so, given that there may be only one motion proper to a given body, it still seems to be an arbitrary decision whether to say that a body is moving and its neighborhood at rest, or to say that the body is at rest and its neighborhood in motion.

The reciprocity of transference that Descartes clearly acknowledges has convinced many commentators that his conception of motion does not allow for a genuinely objective distinction between motion and rest. But I think that this is a misunderstanding. Although transference is reciprocal, he still thinks that there is a genuine distinction between motion and rest. But it is not immediately obvious how he means to draw the distinction.

The question of the distinction between motion and rest, and its relation to the doctrine of the reciprocity of transference is broached directly in the notes on the Principles that Descartes seems to have written sometime after the publication of the Latin Principles in 1644. The relevant portion of the text reads as follows:

Nothing is absolute in motion except the mutual separation of two moving bodies. Moreover, that one of the bodies is said to move, and the other to be at rest is relative, and depends on our conception, as is the case with regard to the motion called local. Thus when I walk on the Earth, whatever is absolute or real and positive in that motion consists in the separation of the surface of my foot from the surface of the Earth, which is no less in the Earth than in me. It was in this sense that I said that there is nothing real and positive in motion which is not in rest [see Pr II 29-30]. When, however, I said that motion and rest are contrary, I understood this with respect to a single body, which is in contrary modes when its surface is separated from another body and when it is not. . . . Motion and rest differ truly and modally [modaliter] if by motion is understood the mutual separation of two bodies and by rest the lack[negatio] of this separation. However, when one of two bodies which are separating mutually is said to move, and the other to be at rest, in this sense motion and rest differ only in reason [ratione]. (AT XI 656–57)
Descartes is reasonably straightforward about motion and rest in this passage. There is, indeed, a sense in which the distinction between motion and rest is a distinction of reason, depending on our conception. In this sense, when I lift my foot it is correct to say that my foot is in motion and the Earth at rest, and equally correct to say that the Earth is in motion and my foot is at rest. In this sense, the distinction between motion and rest is only a distinction of reason, a distinction that depends on our conception, the way we think about things. But, he emphasizes in this passage, it is not the only way of thinking about motion and rest. One can also think of motion as the mutual separation of a body and its contiguous neighborhood. Understood in this sense, there is a genuine distinction between motion and rest that goes beyond our manner of conception. For, if a body is in transference with respect to its contiguous neighborhood, no mere act of thought can correctly construe it otherwise, and if it is not in transference, no mere act of thought can correctly construe it as if it were. Because of the doctrine of the reciprocity of transference, whenever a body is in motion, we must say that its neighborhood is as well, properly speaking; a body A cannot separate from its neighborhood B without, at the same time, B separating from A. And so he notes in the Principles:

If we want to attribute to motion its altogether proper and non-relative nature [omnia propriam, & non ad alium relatam, naturam] we should say that when two contiguous bodies are transferred, one in one direction, and the other in another direction, and thus mutually separate, there is as much motion in the one as there is in the other. (Pr II 29)

This, indeed, is the main thrust of the doctrine of the reciprocity of transference, not to introduce relativity and undermine the distinction between motion and rest, but to emphasize that a motion properly speaking belongs equally to a body and its contiguous neighborhood. But this in no way undermines the kind of distinction between motion and rest that Descartes wants to draw. If motion is understood as the mutual separation of a body and its neighborhood, then it is impossible for a body to be both in motion and at rest at the same time insofar as it is impossible for that body both to be in transference and not in transference with respect to the same contiguous neighborhood. Understood in this way, motion and rest are different and distinct modes of body, and the distinction between motion and rest not merely a distinction of reason, but a modal distinction in Descartes' technical terminology, a distinction between two different modes of the same substance (Pr I 61).

As clear as the text I quoted earlier is, one must admit that it is not always easy to see the reading of the distinction between motion and rest in the passages discussing motion in the Principles itself. One of the difficulties is clearly due to Descartes. Though his ostensible purpose is to distinguish the proper notion of motion from the vulgar conception, he finds it difficult to set aside the common conceptions of motion and rest, and there is at least a hint of vulgarity in his own use of the terms, even after introducing the proper notion of motion. It is with this in mind that we should approach the curious phrase he uses in his proper definition of motion, where he comments that the contiguous neighborhood must be "regarded as being at rest" (Pr II 25). A few sections later, when explaining this phrase, he asserts that, properly speaking, motion pertains as much to the neighborhood as it does to the body, in question; though considered at rest in one sense, the neighborhood is really in motion. This suggests that 'rest' must, in this context, be understood as resting in the sense of not changing place, that is, rest in the vulgar sense. What Descartes is doing, in essence, is using aspects of the vulgar and improper (though not unintelligible) sense of motion and rest, what we might call v-motion and v-rest, to define the proper sense of motion and rest, what we might call p-motion and p-rest, making use of notions we understand to define a new and less familiar notion. If we think of his enterprise in this way, as I think we must, then his definition of motion in the proper sense, p-motion, can be reconstructed as follows:

A is in p-motion if whenever the neighborhood of contiguous bodies B is considered at v-rest, then A will be in v-motion.

Of course, any body, like B, that we choose to regard as being at (v)-rest can also be regarded as being in (v)-motion. But this does not undermine the distinction between motion and rest considered in the proper sense as the mutual separation of a body and its neighborhood. Even though it is arbitrary whether or not B is at v-rest, once we consider B at v-rest, it is not a matter of arbitrary choice whether or not to consider A as being in (v)-motion; if A is really in motion in his proper sense of the term, if it is really separating from its neighborhood B, then no mere change of perspective will allow us to set A at rest in the proper sense. As confusing as it might be to make use of vulgar notions in explaining the proper sense of motion, the arbitrariness that attaches to the vulgar notion does not undermine the distinction between motion and rest properly understood.

Part of the difficulty of understanding Descartes derives from the apparent carelessness of the text, and the confusing mixture of the two different conceptions of motion and rest. But some of the blame must rest with us, and the inevitable tendency to impose later ideas of absolute and relative motion and rest back onto his text. When we consider
the question of a genuine distinction between motion and rest, it is quite natural for us to think of the issue as Newton posed it later in the seventeenth century. In his celebrated scholium to the definitions of book I of the *Principia*, Newton distinguishes absolute from relative time, space, and motion. Newton writes:

Absolute space, in its own nature, without relation to anything external, remains always similar and immovable. Relative space is a measure or some movable dimension of this absolute space. Our senses define [relative space] by its position with respect to bodies. . . . Absolute motion is the transference [translation] of a body from one absolute place into another; and relative motion, the transference from one relative place into another.  

As commonly interpreted, Newton seems to be claiming that there is one uniquely privileged point of view with respect to which places are to be picked out, and it is this point of view that defines absolute motion and absolute rest. On Newton's view, it seems, there is a real distinction between motion and rest, considered absolutely; no mere change in point of view can transform a body at rest with respect to the privileged frame of reference into a body in motion with respect to that frame.

Descartes' way of breaking the arbitrariness found in the common conception of local motion is altogether different from Newton's, and for that reason, I think, may have been altogether missed by his post-Newtonian commentators. Newton tried to make sense of a nonarbitrary notion of motion by positing a nonarbitrary reference point for the determination of place and change of place, a global rest frame in relation to which real motion and real rest can be defined; he tried to make sense of motion conceived of as change of place in a way that will allow a nonarbitrary distinction between motion and rest. But this is not Descartes' strategy, and if we read his text with Newtonian glasses, looking for a Newtonian rest frame, we will certainly be disappointed. Descartes breaks the arbitrariness implicit in the vulgar definition of motion as change of place, but he does so by changing the subject, as it were, replacing the notion of motion as change of place with a radically different conception of what motion is; rather than trying to make sense of motion as change of place, he focuses on the separation or nonseparation of a body with respect to its contiguous neighborhood, and calls that motion.

By doing this Descartes does get a distinction between motion and rest that is not simply dependent upon our conception. But the distinction comes at some cost. Had he given the proper definition of motion the careful attention that he should have given so basic a building block of his system, he would have discovered, I think, that even if his new definition made it easier to distinguish between motion and rest, motion so conceived is not altogether appropriate for the physics that he is attempting to build upon it. On the vulgar definition of motion as change of place, notions like speed and direction are well-defined, given the choice of a rest frame; once we specify such a rest frame, either by (arbitrarily) designating some bodies to be at rest or by abstractly designating points to be at rest, the speed and direction of motion of a body at any given time are reasonably straightforward to understand. For Descartes, there is, in a sense, a privileged frame for determining the motion and rest of a given body, just as there is for Newton; it is its contiguous neighborhood. But as a body moves in the plenum, its contiguous neighborhood will change from moment to moment. And without a common frame of reference from one moment to the next, it is very difficult to see what sense can be made of the speed or direction of a given body. But even if the speed and direction of an individual body could be determined on Descartes' conception, there would still be problems. While each individual body may have a natural rest frame with respect to which its motion is to be determined, the rest frames are local; each body has its own rest frame, and there is no reason to think that these different rest frames are at rest with respect to one another. But without a common framework in which to conceive of the relative motions of more than one body, it is difficult to see how we could give an adequate account of the phenomenon of impact, say. Consider two bodies, A and B, colliding at some angle with one another, and then going off in different directions. The outcome would seem to be determined not by the relation each body has to its own contiguous neighborhood, but by the relation that A and B have to one another; however A and B may be related to their neighborhoods, if those neighborhoods are in (v-)motion with respect to one another, one would rightly expect an altogether different outcome than if they were at (v-)rest.

How, then, are we to regard the definition of motion in the *Principles*? My suggestion is this. Descartes for many years before the drafting of the *Principles* held that there is a genuine distinction between motion and rest, while at the same time tacitly holding to a very traditional conception of local motion as change of place. Come the early 1640s and the project of writing a full and orderly account of his philosophy for presentation to the world, he finally faced up to the problem of squaring his definition of motion with the distinction between motion and rest that had become so central to his thought. The result is the definition of motion that he frames in Pr II 25. Imperfect as it is, it does allow for the distinction he feels he needs. But, I think, Descartes never
got around to working out the problematic consequences of such a definition of motion as the one he was proposing; indeed, I think that one can find clear indications that he is still thinking of motion in terms of change of place, even elsewhere in the Principles, most notably in the treatment of impact, where he assumes that the speed and direction of a pair of colliding bodies is measured with respect to the same frame of reference (Pr II 46–52). But even though it is not altogether successful, and not carefully worked out, the new definition of motion seems clearly to be an attempt to respond to serious problems from within his natural philosophy.

**Motion as Mode of Body**

In the earlier part of this chapter I argued that since motion is to be a primary explanatory concept in Descartes’ physics, motion must be a mode of body, something that really pertains to body. It is because of this, I suggested, that he must reject the relativism implicit in the vulgar definition of motion, and replace it with a conception of motion on which there is a genuine distinction between motion and rest. We have seen how the conception of motion Descartes is trying to capture in his definition of motion admits such a distinction, how he can say on the proper definition of motion that it is not merely a matter of our conception that determines whether a given body is in motion or not. But there are other features of the notion of motion that make it somewhat odd to consider motion to be a mode of body, features that differentiate motion from other modes of body like, say, shape. Unlike shape, motion seems to be inherently relational: though there may be a genuine distinction between motion and rest, motion seems to be a property that pertains not to an individual, but, in a strange way, to both an individual body and its surrounding neighborhood. And second, unlike shape, motion involves a physical magnitude that would seem to lie outside of body, properly speaking, insofar as it involves time. These, it seems, would undermine any claim that motion is a genuine mode of body.

Descartes often compares motion to other modes like shape in arguing that it is a mode of body. When introducing the proper definition of motion, he notes that “is a mode of a thing, and not some subsisting thing, just as shape is a mode of a thing with shape” (Pr II 25). Similarly, when writing to More, he emphasizes that “that transference that I call motion is a thing of no less entity than shape is, namely, it is a mode in body” (AT V 403 [K 257]). Other passages also suggest that he wants the reader to think of motion as a simple mode of an individual moving thing. For example, in the Principles, when attempting to get clear on the “altogether proper and nonrelative nature” we ought to attribute to motion, he notes that where two bodies are mutually separating, “we should say that . . . there is as much motion in the one as there is in the other” (Pr II 29, emphasis added; see also AT XI 656). But I think that we should not read Descartes too literally here, and demand that motion be construed as a mode in the narrowest sense, an intrinsic and strictly nonrelational property of an individual body. His point in comparing motion to shape in these passages is to differentiate motion, the effect, from its cause, the force that either puts a body in motion or sustains it in motion, as we discussed earlier in this chapter, and as we will discuss in the chapters to come. The point is that while the *cause* of motion may be “some subsisting thing,” *motion itself* is not; it is in this sense that motion is taken to be like shape. And his point in emphasizing that there is as much motion in the contiguous neighborhood as there is in the body usually taken to be moving is simply to emphasize that motion (at least as he wants to construe it) is the *mutual* separation of a body and its neighborhood. Indeed, the doctrine of the reciprocity of transference would seem to lead quite directly to the view that if motion is to be construed as a mode, a real property of anything, it must be construed as a mode not of the individual moving body but of the system composed of the body taken together with its contiguous neighborhood. Nor is there any real problem with this for Descartes’ program. What is important for him is that motion and rest be real features of the physical world, not arbitrary, not dependent upon the way in which we think of things. And conceived of in this way, as a mode of the system composed of a body together with its contiguous neighborhood, motion would seem to have that status.

Motion as mode differs from shape, then, insofar as it involves at least two bodies. But it also differs insofar as it seems to involve time, a feature of the physical world that would seem to lie outside of extended substance taken narrowly; though motion, like shape, presupposes extension, it seems to presuppose something more. One way of dealing with the apparent anomaly is to try to take the time out of motion by taking seriously what Descartes wrote in *The World* about his notion of motion. There he claims that his notion of motion is just the motion of the geometers, the motion by which “they have explained the line through the motion of a point, and the surface through the motion of a line” (AT XI 39; see also p. 40). Considered in this way, as an abstract geometrical operation, motion does not require time strictly speaking; its presence is manifested not so much by the change observed in time as by the geometrical objects it results in. This is the view that Alexandre Koyré takes of motion in Descartes, at least as it is treated in *The World*. Koyré writes:
Cartesian motion, on Descartes' own account of it, has only an indirect relation with time. . . . The 'motion' of a point which makes a line, the 'motion' of a line which makes a plane, 'motions' such as these have no speed. Having no speed they do not take place in time. Now it is on the model of these non-temporal 'motions' that Descartes fashions his idea of motion. . . . Thus what is left of motion when its temporal character has been suppressed is precisely whatever in it is immobile: position, direction, trajectory, functional relations. The thorough-going geometrization Descartes yields to undoes the work of time.¹¹

But as suggestive as this reading is, it isn't Descartes. Descartes' appeal to the motion of the geometers is, indeed, quite deliberate: it is meant at very least to differentiate his own conception of motion, local motion, the clear notion in terms of which everything is to be explained, from the complex Aristotelian notion of motion against which he argues in these passages of The World. But whatever the significance of the appeal to the geometrical conception of motion in The World, it is unlikely that he meant to separate motion from time. Already in Rule 12 Descartes noted that there is a necessary connection between motion and duration, just as there is between shape and extension, "since one cannot conceive of a shape that lacks all extension, or a motion that lacks all duration" (AT X 421). And in Meditation V, when discussing the modes that pertain to his idea of body he notes that "I assign certain durations to the motions" that belong to bodies (AT VII 63). Motion and duration are similarly linked in the Principles, where, Descartes says, we use "the durations of the motions of the greatest and most regular things" as a standard by which to measure the duration of other events (Pr I 57). As we shall see in later chapters, reasoning about the instantaneous states of bodies in motion is crucial to his strategy for deriving the laws of motion. But, Descartes is quite explicit in holding, from The World to the Principles, that "no motion takes place in an instant" (Pr II 39; see also AT XI 45; Pr II 215).

Motion is, thus, inextricably linked with duration in Descartes' mind. But this in no way undermines the claim that motion is a mode, a genuine property of body, something that belongs to body as such. To understand how, though, we must recall our earlier discussion of the notion of duration. As noted in chapter 3, Descartes holds that duration, along with other notions like existence and unity, pertain to substances, both mental and material, even though they are not comprehended through the principal attributes of the two substances. In particular, he claims, "since any substance that ceases to endure ceases to be, there is only a distinction of reason between it [i.e., a substance] and duration" (Pr I 62). And so, I argued, Descartes' claim that all accidents of body must be "referred to" the principal attribute, extension, are, in the strictest sense, false. The Cartesian world is a world of geometrical objects made real. But as he construes them, the objects of geometry, even as they exist objectively in the mind, are taken to be enduring things and thus are at least capable of objective motion in objective time. And so, the world of bodies, the objects of geometry existing formally outside of our conception, can have real duration and motion as well. Though not strictly a mode of extension, motion as Descartes construes it would thus seem to be a proper mode of extended substance, a real, thought-independent feature of the world of bodies.

Motion and Individuation

Everything in Descartes' world must be explained in terms of bodies in motion. But motion itself is defined in terms of individual bodies; motion is the transference "of one part of matter or of one body" with respect to its contiguous neighborhood (Pr II 25). And so, it appears, the explanatory adequacy of Descartes' physics depends upon making sense of the notion of an individual body.

Before discussing Descartes' notion of an individual body, it is important to distinguish the notion of individuality from a closely related question, that of the substantiality of finite bits of material substance. Descartes is usually quite happy to treat the individual bodies of common sense as separate substances. In various contexts he refers to a stone, clothing, and a hand or an arm as separate substances.²⁰ But finite material substances are not limited to what we (or he) would call individual bodies. Writing about body in the context of an exposition of the real distinction, he notes:

From the mere fact that we already have an idea of extended substance or body (though we don't yet know for certain that any such substance really exists) we are, however, certain that it can exist. And if it exists, we are certain that every part of it marked out by us in thought is really distinct from the other parts of that substance. (Pr I 60)

And so, he implies, every imaginable portion of material substance is really distinct from every other, that is, it is distinct in the way "two or more substances" are distinct from one another (Pr I 60). Later in the Principles he refers to each portion of a hard body as a distinct substance (Pr II 55). Similarly, in a letter to Gibieuf on 19 January 1642, he notes that we consider "the two halves of a portion of matter, however small it may be, as two complete substances," concluding from that that God
can separate them, in opposition to the atomist thesis that some small bodies cannot be split (AT III 477 [K 124–25]).

Now, Descartes’ apparent adherence to this view of each and every imaginable portion of matter as a separate substance is not unproblematic, either as a position to adopt or as an interpretation of Descartes’ own considered view. As we noted earlier in chapter 5, he holds that a body cannot simply be annihilated, leaving an empty space in its place. And so, he argued, if God were to annihilate all body within a vessel, the sides must necessarily touch. But if this is the case, then it would appear that the portions of matter are not really independent, as later commentators observed. Furthermore, some commentators have found reason to believe that his real view was that only body as a whole, infinite or indefinite extension, constitutes a genuine substance, and not its individual parts.

But whatever complexities may surround the doctrine of a multiplicity of finite extended substances and its attribution to Descartes, they are beside the point for our purposes, insofar as we are concerned with the definition of motion. Material substances, should they exist, are not the same as individual bodies. While individual bodies may count as substances, any imaginable portion of material substance may count as a substance, be it an individual body or just a portion of one, delimited by thought alone; being a substance (if individual bodies are indeed substances) doesn’t differentiate actual bodies from bodies that are only individuals in thought. And, Descartes is clear, it is only actual bodies that are relevant to physics. Writing in the Principles, again, Descartes notes that “a partition that exists only in thought changes nothing” (Pr II 23). For something to be a substance is for it to be capable of independent existence. But what is relevant to physics is not independence of this sort but individuality. And what is relevant for individuality is motion. Descartes writes in the Principles: “By one body or one part of matter I understand every thing that is transferred at the same time, even if the thing in question can be made up of many parts which, in themselves, have other motions” (Pr II 25; see also AT XI 15). The idea is, on its surface, a fairly simple and plausible idea; the thought is that from the point of view of physics, an individual is a portion of matter that moves together.

Before unpacking this account of individuality, it is important to note, first of all, that this definition should be understood as limited to a special kind of individuality, that which pertains to body as such, what we might call physical individuality, to distinguish it from a broader notion of individuality. As Descartes fully recognizes, a complex body can alter its constituents without thereby becoming a different body: “We can say that the Loire is the same river it was ten years ago, even though it no longer has the same water, and even though perhaps not a single part of the same earth that surrounds that water remains” (AT IV 165 [K 156]). He continues by giving a number of biological examples, animals and humans who change the constituent parts of their bodies as they absorb nutrition and grow, while at the same time maintaining their identity as the same individual bodies (AT IV 165–68 [K 156–58]). It is obvious on the face of it that the definition he gives of an individual in the Principles cannot accommodate this conception of an individual. The notion of an individual body he is concerned to define there is concerned with the notion of a physical individual, the sort of thing that can enter into the basic laws of nature. From other perspectives (morality, property law, medicine, animal husbandry, agriculture, etc.) we may be interested in individuals that persist as their constituent parts alter significantly. But, one might argue, from the point of view of physics, an alteration of constituent parts is a change from one individual to another; the snake that swallows a lamb may be, in one sense, the same snake, but it may well behave differently in collision with other bodies than it did before. And so, we should distinguish between the strict, physical sense of individuality that Descartes is trying to capture in connection with the definition of motion in the Principles, and other notions of individuality relevant to other concerns.

But even when we restrict our attention to the notion of a physical individual, one does not have to think too hard to realize that the surface simplicity of the definition hides a tangle of complexities. One set of complexities arises from the fact that individual bodies may be made up of smaller parts, parts which have their own motions. Descartes is fully aware that not everything within the surface of a complex body, one made up of smaller parts, necessarily belongs to that body. Characteristically between the parts that belong to a given body are pores. Because there are no empty spaces in his world, these pores cannot be empty, strictly speaking, but must be “filled with other bodies,” the subtle matter or ether that pervades the entire universe (Pr II 6). And so, he makes the following claim about the Host, a claim that should hold for any body made up of parts: “Since the bread remains always the same, even if air or other matter contained in its pores changes, it follows that these things do not belong to its substance” (AT VII 250). However, it is not clear that his definition of a single body can make sense of such bodies as individuals.

Descartes holds that a collection of parts in motion can constitute a single body as long as all of the moving parts are “transferred at the same time.” But what can this possibly mean? It is, first of all, very difficult to define what it might mean for Descartes for a system of particles to have a common motion, to be “transferred at the same
time." A natural suggestion is that what Descartes has in mind by common motion is the motion of a center of gravity of the particles that make up the body in question. Even if we could specify the relevant parts that make up a body, the center of gravity for a system of bodies in motion may well lie outside of any of the constituent parts that make up the body. But if so, then it is difficult to see what sense could be made of the notion of a system of bodies being in motion, on Descartes' proper definition. For motion, Descartes says, is the transference of one body with respect to contiguous bodies, and if no body corresponds to the center of gravity of a system of bodies, then, it would seem, a system of bodies can have no motion of its own, properly speaking. And even if we could make sense of the common motion of the particles that make up a body, any arbitrary collection of particles can be constituted into a system, with its own center of gravity and its own common motion. As a consequence, every arbitrary collection of particles would seem to be a Cartesian body.

So far I have emphasized considerations that derive from Descartes' definition of an individual as it applies to complex bodies, bodies made up of smaller parts in motion with respect to one another. But the problems are, if anything, more serious if we consider what might be called simple bodies, bodies that while divisible are not actually divided into smaller parts.

The most obvious problem derives from the evident circularity of the definition of body. Body is defined in terms of motion; an individual body is, by definition, something that is transferred, that is, a quantity of material substance that moves all together. But the definition of motion presupposes the notion of an individual insofar as motion is defined as the transference of one body from one neighborhood into another (Pr II 25). Not all circles of this sort are objectionable, of course. But the particular way in which the definitions of motion and body are related gives rise to a rather unwelcome consequence. Since bodies are individuated through motion, where there is no motion, there can be no distinct individuals. That is, two bodies that we are inclined to say are at rest with respect to one another must, for Descartes, really be two parts of a single body. And so, it would seem, Descartes is committed to the rather paradoxical view that all individual bodies must be in motion. This difficulty was well known to later seventeenth-century thinkers. Gerald de Cordemoy notes in his Six Discours, a Cartesian tract on physics and metaphysics first published in 1666:

Another difficulty that I note in the opinion of those who say that matter itself is an extended substance is that they cannot conceive a body as separate without assuming a motion. So that, in accor-

dance with their doctrine, one cannot conceive a body at rest with respect to other bodies, since assuming that it touches them, this doctrine teaches that together with them it makes up only one body. However, it appears to me that we have a sufficiently clear and natural idea of a body completely at rest with respect to other bodies, none of which is in motion.

For this reason (among others), Cordemoy was led to adopt a kind of atomism, and despite many other Cartesian commitments, posit as the basic building blocks of the physical world bodies that cannot be divided, and cannot change their shapes. In short, Cordemoy argues that we must appeal to something outside of motion to individuate bodies. This is similar to a view Martial Gueroult takes. When responding to a problem similar to the one that worried Cordemoy, Gueroult suggests that in order to individuate bodies, Descartes must step outside of motion, considered purely as a mode of body, and appeal to cohesion, a force that arises from God's activity on body.

This consequence, that a single body can never properly be said to be at rest, would seem to cause some difficulty for Descartes' strategy for deriving the laws of motion. As we shall see in later chapters, Descartes considers the distinction between bodies in motion and bodies at rest crucial for deriving the laws of impact. But if there are no bodies at rest, then this distinction can play no role in his derivation of the laws of impact. However, among the crucial cases Descartes discusses in connection with his law of impact are those in which a moving body collides with a body at rest. It is especially curious, then, that the one place where Descartes appears to acknowledge this consequence we have been discussing is in the context of a long letter on his laws of impact, and it is especially curious that he finds the consequence unproblematic. Writing to Clerseliers on 17 February 1645 in an important letter to which we will later return, Descartes notes:

In these rules [i.e., the rules governing specific cases of bodies in impact] by a body which is without motion I understand a body which is not at all in the act of separating its surface from those of the other bodies which surround it, and which, as a consequence, makes up a part of another larger hard body. (AT IV 186-87)

But there is another apparent problem with his account of the individuation of simple and uncompounded bodies, a problem that Descartes never seems to have been aware of, a problem that, I think, is far more damaging than any that we have considered up until now. The last problem we considered concerned the difficulties distinguish-
ing two contiguous bodies at rest. But, one can argue, given Descartes’ conception of body and motion, even bodies in motion are not really individuated. The argument is due to Leibniz, one of the sharpest critics of Descartes’ physics, and appeared first in 1698 in his essay, “De Ipsa Natura.” Now, on the Cartesian view, all body is extension and extension alone, and there are no empty spaces. So, Leibniz notes, whatever distinctions may possibly arise through motion, at any given instant, there can be no distinction between one body and another, one portion of matter and another: “in the present moment (and, furthermore, in any moment whatsoever) a body A in motion would differ not at all from a resting body B.” At any instant, it would seem, the Cartesian world would have to be a homogeneous, undifferentiated extension; while we would be able to distinguish one region of space from another three feet away, there would not be any intrinsic difference between the one and the other, if we only have extension and motion at our disposal to make the distinction. But if there are no intrinsic differences between portions of the extended world at any instant, then, Leibniz argues, there can be no differences over time:

If no portion of matter whatsoever were to differ from equal and congruent portions of matter . . . and, furthermore, if one momentary state were to differ from another in virtue of the transposition of equal and interchangeable portions of matter alone, portions of matter in every way identical, then on account of this perpetual substitution of indistinguishables, it obviously follows that in the corporeal world there can be no way of distinguishing different momentary states from one another.

And so, if there are no intrinsic differences between bodies at any given moment, motion cannot be called upon to provide any. Leibniz is clearly correct in holding that any given moment of the world will be indistinguishable from any other, as far as we are concerned; all will equally well be undifferentiated and homogeneous extension. But his point goes deeper than that: “Since everything substituted for something prior would be perfectly equivalent, no observer, not even an omniscient one, would detect even the slightest indication of change.” Leibniz’s worry seems to concern the reidentification of bits of Cartesian matter at different times; when comparing a present state with a future one, “under the assumption of perfect uniformity in matter itself, one cannot in any way distinguish one place from another, or one bit of matter from another bit of matter in the same place.” Since at any given time there are no intrinsic properties to differentiate one portion of the homogeneous whole from any other, there are no possible grounds for saying that this hunk of extension is in one place with respect to that hunk, and at a later time this same hunk is in a different place; if all we have to work with is extension, there seems to be no sense to the claim that the same bit of matter changes position with respect to others. And so, it would seem, motion can be used to individuate bodies only if there is some way of reidentifying bits of material substance across time, and this can only happen, Leibniz argues, if there is something in body over and above extension. Indeed, without such properties, without some means by which the same bit of matter can be reidentified, the very notion of motion appears to be incoherent. And so, if the world is as Descartes says it is, a plenum of bodies whose only property is extension, one cannot appeal to motion to individuate bodies.

I shall continue to talk as if Descartes is dealing with a world of individual bodies, colliding with one another, at motion and at rest with respect to one another. But, in the end, I suspect that this is something that he is not entitled to, and this is something that, if true, would seriously undermine his whole program.

**Motion and Copernicanism**

In the Preface General to his *Collection of Several Philosophical Writings*, published in 1662, Henry More, one of Descartes’ acutest correspondents and one of his most careful readers made the following remark:

*I cannot but observe the inconvenience this external force and fear does to the commonwealth of Learning, and how many innocent and well-deserving young Wits have been put upon the Rack, as well as Galilaeo in prison. For his Imprisonment frighted Des-Cartes into such a distorted description of Motion, that no mans Reason could make good sense of it, nor Modesty permit him to phansy any thing Non-sense in so excellent an Author.*

The charge stuck. It is now a commonplace of Cartesian scholarship that the definition of motion Descartes offered in the *Principles* was not a true representation of his position, but rather a device for enabling him to avoid Church condemnation by allowing him to say that there is a genuine sense in which the Earth is at rest; the claim is that the definition we have been carefully examining in the earlier part of this chapter is merely prudential, and that his real view of motion is quite different than the way he represents it. Now, there is no question but that Descartes was deeply affected by the condemnation of Galileo in 1633. He withdrew his own *World*, deeply Copernican, from the press, and delayed the publication of his system of physics for more than ten years. And there is also no question but that in his earlier writings
ing two contiguous bodies at rest. But, one can argue, given Descartes’ conception of body and motion, even bodies in motion are not really individuated. The argument is due to Leibniz, one of the sharpest critics of Descartes’ physics, and appeared first in 1698 in his essay, “De Ipsa Natura.” Now, on the Cartesian view, all body is extension and extension alone, and there are no empty spaces. So, Leibniz notes, whatever distinctions may possibly arise through motion, at any given instant, there can be no distinction between one body and another, one portion of matter and another: “in the present moment (and, furthermore, in any moment whatsoever) a body A in motion would differ not at all from a resting body B.” At any instant, it would seem, the Cartesian world would have to be a homogeneous, undifferentiated extension; while we would be able to distinguish one region of space from another three feet away, there would not be any intrinsic difference between the one and the other, if we only have extension and motion at our disposal to make the distinction. But if there are no intrinsic differences between portions of the extended world at any instant, then, Leibniz argues, there can be no differences over time:

If no portion of matter whatsoever were to differ from equal and congruent portions of matter . . . and, furthermore, if one momentary state were to differ from another in virtue of the transposition of equal and interchangeable portions of matter alone, portions of matter in every way identical, then on account of this perpetual substitution of indistinguishables, it obviously follows that in the corporeal world there can be no way of distinguishing different momentary states from one another. And so, if there are no intrinsic differences between bodies at any given moment, motion cannot be called upon to provide any. Leibniz is clearly correct in holding that any given moment of the world will be indistinguishable from any other, as far as we are concerned; all will equally well be undifferentiated and homogeneous extension. But his point goes deeper than that: “Since everything substituted for something prior would be perfectly equivalent, no observer, not even an omniscient one, would detect even the slightest indication of change.” Leibniz’s worry seems to concern the reidentification of bits of Cartesian matter at different times; when comparing a present state with a future one, “under the assumption of perfect uniformity in matter itself, one cannot in any way distinguish one place from another, or one bit of matter from another bit of matter in the same place.” Since at any given time there are no intrinsic properties to differentiate one portion of the homogeneous whole from any other, there are no possible grounds for saying that this hunk of extension is now in one place with respect to that hunk, and at a later time this same hunk is in a different place; if all we have to work with is extension, there seems to be no sense to the claim that the same bit of matter changes position with respect to others. And so, it would seem, motion can be used to individuate bodies only if there is some way of reidentifying bits of material substance across time, and this can only happen, Leibniz argues, if there is something in body and above extension. Indeed, without such properties, without some means by which the same bit of matter can be reidentified, the very notion of motion appears to be incoherent. And so, if the world is as Descartes says it is, a plenum of bodies whose only property is extension, one cannot appeal to motion to individuate bodies.

I shall continue to talk as if Descartes is dealing with a world of individual bodies, colliding with one another, at motion and at rest with respect to one another. But, in the end, I suspect that this is something that he is not entitled to, and this is something that, if true, would seriously undermine his whole program.

**Motion and Copernicanism**

In the Preface General to his *Collection of Several Philosophical Writings*, published in 1662, Henry More, one of Descartes’ acutest correspondents and one of his most careful readers made the following remark:

*I cannot but observe the inconvenience this external force and fear does to the commonwealth of Learning, and how many innocent and well-deserving young Wits have been put upon the Rack, as well as Galileo in prison. For his Imprisonment frighted Des-Cartes into such a distorted description of Motion, that no mans Reason could make good sense of it, nor Modesty permit him to phansy any thing Non-sense in so excellent an Author.*

The charge stuck. It is now a commonplace of Cartesian scholarship that the definition of motion Descartes offered in the *Principles* was not a true representation of his position, but rather a device for enabling him to avoid Church condemnation by allowing him to say that there is a genuine sense in which the Earth is at rest; the claim is that the definition we have been carefully examining in the earlier part of this chapter is merely prudential, and that his real view of motion is quite different than the way he represents it. Now, there is no question but that Descartes was deeply affected by the condemnation of Galileo in 1633. He withdrew his own *World*, deeply Copernican, from the press, and delayed the publication of his system of physics for more than ten years. And there is also no question but that in his earlier writings
Descartes came out unambiguously in favor of the claim that the Earth *moves*: “if [the motion of the Earth] is false, all of the foundations of my physics are also,” Descartes wrote to Mersenne in 1633 (AT 1:271; see also AT 1:285 [K 25–26]; AT III:258). But to what extent did his worries about Copernicanism motivate him to frame the new definition of motion in the *Principles* the way in which he did?29

Let us begin examining this question by reviewing Descartes’ discussion in the *Principles* of the main competing cosmologies, the Ptolemaic system, the Copernican system, and the Tychonic system. These discourses constitute a kind of preface to part III of the *Principles*, where, starting in §46, Descartes begins a careful exposition of his own view. He begins by quickly dismissing the Ptolemaic system, the system in which all planets and the sun travel around a motionless Earth:

The first [such system] is that of Ptolemy. Since this is in conflict with many phenomena (to take the most important example, it conflicts with) the waxing and waning of the light observed in Venus, just as in the Moon, it is now commonly rejected by all philosophers, and therefore I shall set it aside here. (Pr III:16)29

The serious alternatives, then, are to be Copernicus and Tycho, as well as Descartes’ own cosmological theory, which he understands as a variant of Copernicus’ system.30 As pure hypotheses, that is, considering only the relative motions they attribute to the sun, stars, and planets, Copernicus and Tycho both “satisfy the phenomena in the same way, and do not differ greatly from one another, except for the fact that Copernicus’ hypothesis is somewhat simpler and clearer” (Pr III:17). Indeed, the same can be said for Descartes’ own system: all three can be represented in terms of the planets and Earth moving in roughly circular paths around a central sun.32 Where the three differ is on the question of what is really said to move:

Tycho had no reason [ocasio] to alter [Copernicus], except for the fact that he was trying to explain things not only hypothetically but also in accordance with the very truth of the matter . . . Although Copernicus had not hesitated to attribute motion to the Earth, Tycho, finding this completely absurd as [a claim] in physics, and far from people’s common sense, wanted to alter this. (Pr III:17–18)

And so Tycho rejected Copernicus’ moving Earth, and instead claimed that all planets move around the sun except for the Earth, which remains immobile as the sun turns around it, with both a diurnal motion producing the cycle of night and day, and an annual motion, producing the cycle of the seasons. It is on this point, the question of what is really moving and what is really at rest, that Descartes will differ with both Copernicus and Tycho:

Since he had not sufficiently considered the nature of motion, [Tycho] asserted that the Earth is at rest merely in words, but in reality [*ipsa*] he yielded more motion to it than the other [i.e., Copernicus] did . . . Therefore, differing from both of them only insofar as I shall remove all motion from the Earth more truly than Tycho and more carefully than Copernicus, I shall propose here this hypothesis which seems to be the simplest of all, and the one most suitable both for understanding the phenomenon and discovering their natural causes. (Pr III:18–19; see also AT V:550)

Descartes doesn’t discuss Copernicus’ own version of his theory any further; Copernicus holds quite explicitly that the Earth has a number of motions, and there is nothing more to be said, as far as he is concerned. But he does confront the Tychonic system, and argue that contrary to what its inventor claimed, in that system the Earth must be said to move. First he discusses the diurnal motion. On Tycho’s view the sun and planets revolve daily around a resting Earth, resulting in day and night. Descartes first notes that “since this transference is reciprocal as noted above [e.g., Pr II:29] and plainly the same force or action is required for it in the Earth and in the heavens, there is no reason why that motion should be attributed to the heavens rather than to the Earth” (Pr III:38). But there is, indeed, some reason why it may be preferable to attribute the motion to the Earth rather than to the heavens on Tycho’s view. Appealing to what Gueroult called the criterion of displacement as a whole. Descartes argues since the transference occurs “on the whole surface [of the Earth], and not in the same way on the whole surface of the heavens, but only on a concave part contiguous to the Earth, which is tiny in comparison with the convex [surface],” the motion ought to be attributed to the Earth rather than to the heavens, if we are going to attribute it to the one rather than to the other. He treats the annual revolution in the Tychonic system similarly. In the Tychonic view, all of the planets revolve around the sun, while the sun revolves around a supposedly stationary Earth. But in revolving around the Earth, the sun must carry the fluid filling the spaces between the planets with it. And so, as with the case of the diurnal motion, the criterion of displacement as a whole would lead us to attribute the annual motion to the Earth rather than to the sun or the heavens, if one or the other must be said to be moved (Pr III:39).

When discussing the Tychonic system, the claim is that if we take Tycho’s view seriously, motion should be attributed not to the heavens, or to the sun, as Tycho actually does, but to the Earth. The claim,
though, is a weak one. As Descartes realizes explicitly in the context of his discussion of diurnal motion, strictly speaking, it is as correct to attribute motion in the Earth as it is to the heavens, on Tycho's view; when he claims that Tycho's Earth must move, he is appealing not to the strict conception of motion but to the sorts of rules of thumb that he introduced earlier in Pr II 30 to explain why we are inclined to overlook the reciprocity of transference, and assert that when we walk on the surface of the Earth is it us and not the Earth that moves.

But on Descartes' own version of the Copernican cosmological hypothesis, he asserts that in the strictest sense, the Earth is at rest. Descartes' view is that the heavens are fluid, filled with ether, and swirling around the sun in a great vortex; they carry the planets with them. This explains the annual revolution of the Earth around the sun (Pr III 24–27). But on this view, he claims, in its annual revolution, the Earth is really at rest, in the proper sense of the term. After reminding his readers of the proper definition of motion in Pr II 25, and the distinction between motion properly understood and the common conception of motion, Descartes goes on to remark:

Whence it follows that no motion, properly speaking, is found in the Earth or even in the other planets, since they are not transferred from the vicinity of the parts of the heavens which are immediately contingent to them, insofar as those parts of the heavens are regarded as being without motion. (Pr III 28).

Since the Earth and other planets are at rest in the heavens and carried along by them, they are not in motion, according to his proper definition (Pr III 26–27; see also AT V 550 and Pr II 62). Furthermore, he goes on to say, "even if motion is improperly understood in accordance with common usage, no motion is to be attributed to the Earth." Now in the Cartesian version of the Copernican cosmology, as in the strict Copernican cosmology, the Earth does move with respect to the stars. But, he claims, "the common people determine the places of the stars with respect to the parts of the Earth, regarded as being at rest, and regard them as moving to the extent that they recede from places determined in this way." And so, the common sort will regard the Earth as being at rest and the stars as moving, a view corresponding to the "philosophical sense" of the notion of place, in accordance with which place is determined by what is nearby (Pr III 29). Descartes ends the French version of this argument by saying:

If nevertheless in order to accommodate ourselves to common usage, we later appear to attribute some motion to the Earth, it must be realized that we are speaking improperly and in the same sense as one can sometimes say of those who sleep and lie in a boat, that nevertheless they pass from Calais to Dover because the boat carries them there. (Pr III 29–30)

The final conclusion of the argument is nicely summarized in a marginal comment on the Principles Descartes left:

The Earth does not move according to Copernicus but rather according to Tycho. And thus are the [Holy] Scriptures exonerated: for it is said that they spoke in accordance with common usage, then there is nothing in opposition to Copernicus, or if it is said that they spoke from knowledge of the truth then unknown by the common people, then they stand in favor of Copernicus. (AT XI 657)

The argument with respect to the diurnal motion would be similar. In addition to the great vortex that carries the Earth and the other planets around the sun, each planet (at least each planet with a moon) has its own vortex, of which it is the center. So, the Earth is at the center of a vortex that at the center turns once every twenty-four hours, while at the distance of the moon turns roughly once per month (Pr III 33). Presumably the Earth can be considered as being at rest in the center of that vortex in just the way that the Earth (or, perhaps, the Earth-moon system) can be considered at rest in the great vortex that carries it around the sun along with all of the other planets.

This, then, is Descartes' account of the motion of the Earth on the various planetary systems. There is no question but that Descartes makes explicit use of his formal definition of motion and the discussions that surround it in order to argue that on his system the Earth is at rest and that on the other competing systems, it isn't. Furthermore, it is highly unlikely that Descartes would have worried about such an issue had it not been for the condemnation of Galileo, and it is quite possible that Descartes would have continued to assert that the Earth moves. But the central question is this: was the definition of motion in the Principles formulated specifically for the purpose of allowing Descartes to deny that the Earth moves? Is it fair to say that the concept of motion he defines there is not his own, but one he adopted merely out of prudence?

There are several arguments found in Descartes' commentators. The first more widespread but more obviously unsatisfactory argument goes as follows. As we shall see in more detail in later chapters, Descartes' laws of motion in the Principles clearly presuppose a genuine distinction between motion and rest. For example if body A were one pound and body B three, then, it turns out on Descartes' laws of im-
CHAPTER SIX

motion, we would get incompatible outcomes if we set B at rest and imagine A to collide with it with speed v, as opposed to if we set A at rest and supposed B to collide with it at speed v; in the first case, A would rebound from B, while in the second, the two bodies would travel off together at the same speed, after the collision (Pr II 49–50). So, as far as the laws of motion are concerned, we are not free simply to decide to set one or the other body at rest; there must be a physical fact of the matter. But, the claim is made, Descartes’ preferred definition of motion in the Principles is relativistic, and does not admit a genuine distinction between motion and rest. And so, it is claimed, while Descartes himself recognized a genuine distinction between motion and rest, as manifested in the laws of impact, the relativistic definition of motion in the Principles is set out only for political reasons. Alexandre Koyré wrote in his Galileo Studies:

The Copernicanism which had been so openly on display in The World had disappeared from the Principles, or rather had been hidden behind an odd and peculiar theory of motion... The ultra-relativism of his idea of motion was not original with Descartes. It is our opinion that he only adopted it so as to be able to reconcile Copernican astronomy, or more simply the mobility of the earth, which was manifestly implied by his physics, with the official doctrine of the Church. It was an initiative which succeeded only in making Cartesian mechanics self-contradictory and obscure.37

Similarly Richard J. Blackwell has claimed:

If we are to give Descartes all the benefit of the doubt here, we must conclude that the relativity of motion does not play a systematic role in Cartesian physics. Rather, his appeal to the relativity of motion seems to have a polemical purpose enabling him to reconcile his heliocentric theory of astronomy with the prevailing attacks against Copernicanism.38

Blackwell goes on to suggest that the doctrine of relativity functions in the answer to the Church by allowing Descartes to hold both that the Earth is at rest in its vortex, and that it is moving around the sun, claims both true depending upon which frame of reference one chooses to work with.39

It should be clear that this reading is simply and evidently false; if Descartes fashioned the definition of motion in the Principles in order to allow himself to say that the Earth is at rest, it cannot be in this way. First of all, as I argued in detail earlier in this chapter, Descartes did not think that the preferred definition of motion he gave in the Principles was relativistic in the sense these commentators suppose it is; indeed, it was carefully crafted to admit a genuine distinction between motion and rest, and on this score, explicitly contrasted with the common definition that he rejected.40 And so, I think, there is no inconsistency between the definition of motion and its laws to be explained away by any appeal to politics or prudence; the distinction between motion and rest Descartes appeals to in framing his laws is just a reflection of the distinction he built into the definition, a distinction important for the grounding of motion as a real mode of body. And secondly, the relativity of motion and rest plays little role in Descartes’ discussions of the motion of the Earth. As we saw, he does appeal to the doctrine of the reciprocity of transference in order to argue that at very least Tycho must hold that there is as much motion in the Earth as there is in the heavens that, on his view, turn around it. But when discussing the motion of the Earth on his own view, the main point is that on his strict definition of motion, the Earth must be regarded as being at rest, and that one has no choice in the matter. When we say that the Earth moves around the sun, as we will from time to time, Descartes urges us to remember that at best, we are only speaking with the vulgar, and that in the proper sense, the Earth is at rest.

This eliminates one set of reasons for suspecting Descartes of dissimulation with respect to his definition of motion. But even when his definition of motion is properly understood and his discussion of the motion of the Earth more carefully considered, there is room for some worry on the issue. One might argue, for example, that the dissimulation goes the other way, that Descartes was really a relativist in motion, and that the apparent distinction between motion and rest that his proper definition allows him is not genuinely in accord with his own views, that it is there only to allow him to deny a moving Earth.41 This in a way accords better with the texts, and does better justice both to his definition of motion and to the use to which he puts it in the discussion of Copernicanism. But it does have one odd feature. On that view, though Descartes appears to be consistent insofar as the definition of motion allows a kind of distinction between motion and rest, as needed for the laws of impact, in reality he is inconsistent; if beneath the mask of the proper definition he is really a radical relativist, then his preferred account of the nature of motion is inconsistent with the account he gives of the laws of nature. The earlier reading we discussed and rejected makes Descartes coherent at the cost of making him dishonest; this one would have him come out both dishonest and dumb. Any principle of charity in historical interpretation should make us suspicious of that.

This, of course, does not altogether eliminate the possibility that
both the definition of motion in the *Principles* and the distinction between rest and motion embodied in the laws of motion are part of a carefully contrived strategy to enable Descartes to deny the motion of the Earth. It is indeed possible that the entire theory of motion and its laws is an elaborate mask. But such a claim is hardly plausible. For one, it is not clear what it is supposed to explain. The first argument we considered purports to explain the supposed inconsistency between Descartes' supposedly relativistic definition of motion and his nonrelativistic laws of impact, and the second is supposed to explain the contradiction between the apparently nonrelativistic definition of motion and Descartes' supposed commitment to relativism. At best, this last argument might be taken to explain why Descartes built into his physics, both the definition of motion and its laws, a genuine distinction between motion and rest. But there is another, better explanation for that, I think, the one I emphasized earlier in this chapter. If motion is to be a genuine *mode* of body, and is to be the basic explanatory principle in Descartes' physics, then there must be a genuine difference between being in motion and being at rest. And secondly, if the account of motion and its laws is supposed to be a mask, then Descartes has given us little hint of the face supposedly lurking underneath; if there is another Cartesian position the crafty and world-wise reader is supposed to see in the *Principles*, Descartes has hidden it so well that it may as well not be there at all. If mask it be, then it is an interesting mask, historically more important and more worthy of careful study than the face that supposedly lies beneath.

Descartes was no doubt pleased that he could argue that on his definition of motion, the Earth is at rest within his cosmological system, and, no doubt, he was looking over his shoulder at the Church when making this argument. But, I suspect, he would have tried to make this case no matter what definition of motion he adopted. The denial of motion to the Earth may well be political and prudential, without thereby undermining our faith in the sincerity of the account of motion on which it is based.

**Determination**

So far we have been talking about Descartes' notion of motion. Before leaving the subject, we must examine one of the most important (and difficult) notions that is connected with Descartes' conception of motion, that of determination. The notion of determination, together with that of speed, will prove to be crucial to understanding Descartes' laws of motion, as we shall attempt to do in the following chapters.

The notion of determination, the Latin noun *determinatio* and the corresponding verb *determinare* have a long and complex history in scholastic texts; surely Descartes was well aware that he was not the first to use these terms, and knew something of their usage in scholastic parlance, even if he may not have been a careful scholar in the years after he left La Flèche.\(^{35}\) But the difficulties various of his contemporaries had with Descartes' terminology here, the many times Descartes finds he has to explain himself to them, suggest that there is something idiosyncratic about the way Descartes understands that notion. And so we should begin by turning directly to Descartes' characterization of determination.

The notion of determination is intimately linked with the directionality of a body in motion, and is most often presented in contrast with other related notions that don't involve directionality. For example, in the *Dioptrics*, published in 1637 and, perhaps, the chronologically earliest use of the notion, Descartes writes, "The motion [of a body] differs entirely from its determination to move in one direction rather than another" (AT VI 97 [Ols. 77–78]; see also AT IX 9; Pr II 41; AT III 75, 289; AT IV 185). Elsewhere Descartes emphasizes the "difference between the determination to move this way and that, and the speed" (AT II 17).\(^{41}\) Elsewhere still the contrast is between determination and force, and, at one point, between "the determination and the speed or force" a moving body has (AT II 18).\(^{45}\) The determination to move in a particular direction is, for Descartes, a mode of a mode. Descartes writes to Clerel on 17 February 1645 that "we must consider two different modes in motion [movement]: the one is motion [motion] alone or speed, and the other is the determination of this motion [motion] in a certain direction" (AT IV 185).\(^{46}\) Similarly, writing to Mersenne on 26 April 1643 he noted that in motion, a mode, "there are only two differentia [varietes] to consider in it, the one, that it can be more or less fast, and the other that it can be determined in different directions" (AT III 650).\(^{47}\) Determination is thus linked to motion, just as shape is linked to quantity or extension linked to body; without motion there can be no determination.\(^{48}\)

Determination is closely linked with direction. But it is wrong simply to identify determination with direction, as many readers have done.\(^{49}\) Descartes himself warned against the misunderstanding. In a letter to Mersenne from June or July 1648 Descartes comments on something Mersenne had sent him, an essay by Roberval that dealt with Descartes' account of the composition of motion. One of the first things he takes Roberval to task for is borrowing his ideas but altering the terminology: "When he calls 'impression' what I call speed and 'direction' what I call the determination to move in a particular direction, this serves only to confuse himself" (AT V 203).\(^{50}\)
Descartes’ notion of determination can further be clarified by examining the way in which he uses this notion in the derivation of the law of refraction in the *Dioptrics*, perhaps the original motivation for the distinction. In deriving his law of refraction, Descartes considers three different analogies. A tennis ball is hit obliquely to a horizontal surface CBE, from A to B (see Fig. 6.2).

In the first case the surface CBE is imagined to be a cloth that hinders the motion of the ball while allowing it to pass through; in the second, it is the surface of a body of water; and in the third, it is a racket that adds motion to the ball by striking downward (AT VI 96–100 [Ols. 77–80]). The precise application of these analogies to the refraction of light is complex, as is the derivation of a sine law of refraction from them.

Since it lost nothing at all of the determination it had to go to the right, in twice the time that it took to pass from the line AC to HB, it ought to go twice the distance in the same direction, and consequently arrive at some point on the straight line FE at the same instant that it also arrives at the circumference of circle AFD. (AT VI 97 [Ols. 78])

And so, he continues:

These arguments, which turn on the distinction between speed (motion, force) and determination, reveal a great deal about Descartes’ conception of this key notion. For one, it is clear that a body does not have just one determination at a given time; the tennis ball under discussion in the *Dioptrics* has both a determination to move from left to right, and a determination to move downwards. This Descartes em-

---

**Figure 6.2** From René Descartes, *Discours de la méthode... plus la dioptrique, les météores et la géométrie...* (Leyden, 1637), *Dioptrique*, p. 17.
CHAPTER SIX

Motion

Motion is central to Descartes' physics, he tells us; it is the basic explanatory notion, that in terms of which all of the different properties bodies have are to be accounted for. But, he also tells us, the motion he has in mind in connection with this claim is not what his contemporaries might think it is. We have already examined one contrast he intends to draw, the contrast between the proper, philosophical definition of motion and the vulgar conception of motion, a contrast he comes to see as central in the early 1640s while drafting the Principles. But there is another contrast important to Descartes, a contrast he emphasized from his earliest writings. In The World, discussing the philosophers of

struggling with particular problems in optics, like the analysis of reflection and refraction; and though it has some role to play in the laws of nature presented both in The World and in the later Principles, only in the face of specific criticisms of the arguments in his Dioptrics did Descartes attempt to clarify it, and then in a relatively ad hoc and unsystematic fashion. Unlike the notions of body or space or the laws of motion, Descartes never seems to have turned his full attention toward making clear just what exactly the notion of determination means for him. In attempting to give an account of the notion, we should thus be sensitive to the fact that we are almost certainly dealing not with a clear and distinct conception but with a notion in the process of emerging. But for all the complexities, it is fair to see in Descartes' notion of determination a serious attempt to deal in a quantitative way with the directionality of motion, and something akin to the modern notion of velocity (the vector quantity corresponding to the scalar speed) or momentum. Gabbey calls it "the directional mode of motive force," and Sabra claims that the distinction between the determination of a moving body and its speed correspond to "the distinction between vector and scalar quantities." These interpretations are both illuminating, and correlate reasonably well with the closest thing to a definition Descartes himself gave. Writing to Mersenne on 3 December 1640, in connection with Father Bourdin's objections to the Dioptrics, he noted that "in speaking of determination to the right, I understand the entire part of the motion which is determined to the right" (AT III 251).

However problematic the notion of determination has proved to be for Descartes and his readers, his conceptions of directionality, determination, and their relations to the notions of speed, motion, and force will turn out to be crucial to the derivation of the laws of motion in the chapters to come.

Descartes against His Teachers: Motion and Change

Descartes himself gave. Writing to Mersenne on 3 December 1640, in connection with Father Bourdin's objections to the Dioptrics, he noted that "in speaking of determination to the right, I understand the entire part of the motion which is determined to the right" (AT III 251).

However problematic the notion of determination has proved to be for Descartes and his readers, his conceptions of directionality, determination, and their relations to the notions of speed, motion, and force will turn out to be crucial to the derivation of the laws of motion in the chapters to come.

Descartes against His Teachers: Motion and Change

Motion is central to Descartes' physics, he tells us; it is the basic explanatory notion, that in terms of which all of the different properties bodies have are to be accounted for. But, he also tells us, the motion he has in mind in connection with this claim is not what his contemporaries might think it is. We have already examined one contrast he intends to draw, the contrast between the proper, philosophical definition of motion and the vulgar conception of motion, a contrast he comes to see as central in the early 1640s while drafting the Principles. But there is another contrast important to Descartes, a contrast he emphasized from his earliest writings. In The World, discussing the philosophers of

struggling with particular problems in optics, like the analysis of reflection and refraction; and though it has some role to play in the laws of nature presented both in The World and in the later Principles, only in the face of specific criticisms of the arguments in his Dioptrics did Descartes attempt to clarify it, and then in a relatively ad hoc and unsystematic fashion. Unlike the notions of body or space or the laws of motion, Descartes never seems to have turned his full attention toward making clear just what exactly the notion of determination means for him. In attempting to give an account of the notion, we should thus be sensitive to the fact that we are almost certainly dealing not with a clear and distinct conception but with a notion in the process of emerging. But for all the complexities, it is fair to see in Descartes' notion of determination a serious attempt to deal in a quantitative way with the directionality of motion, and something akin to the modern notion of velocity (the vector quantity corresponding to the scalar speed) or momentum. Gabbey calls it "the directional mode of motive force," and Sabra claims that the distinction between the determination of a moving body and its speed correspond to "the distinction between vector and scalar quantities." These interpretations are both illuminating, and correlate reasonably well with the closest thing to a definition Descartes himself gave. Writing to Mersenne on 3 December 1640, in connection with Father Bourdin's objections to the Dioptrics, he noted that "in speaking of determination to the right, I understand the entire part of the motion which is determined to the right" (AT III 251).

However problematic the notion of determination has proved to be for Descartes and his readers, his conceptions of directionality, determination, and their relations to the notions of speed, motion, and force will turn out to be crucial to the derivation of the laws of motion in the chapters to come.

Descartes against His Teachers: Motion and Change

Motion is central to Descartes' physics, he tells us; it is the basic explanatory notion, that in terms of which all of the different properties bodies have are to be accounted for. But, he also tells us, the motion he has in mind in connection with this claim is not what his contemporaries might think it is. We have already examined one contrast he intends to draw, the contrast between the proper, philosophical definition of motion and the vulgar conception of motion, a contrast he comes to see as central in the early 1640s while drafting the Principles. But there is another contrast important to Descartes, a contrast he emphasized from his earliest writings. In The World, discussing the philosophers of
the schools, he remarked that "the motion that they discuss is so very different from the motion I conceive that it can easily happen that what is true of the one is not true of the other" (AT XI 38–39). In this section we shall explore this important difference.

As with the other questions in late scholastic thought that we have touched upon, the doctrine of motion in the schools was a matter of great complexity.58 Briefly, though, motion for the scholastics meant something significantly broader than it does for us, and, indeed, something significantly broader than it did for Descartes. Motion for the schools signified change in the broadest sense, the passage from one attribute, accident, or form (the terminus a qua) to another (the terminus ad quem). And so, for example, Eustachius characterizes motion as follows: "Motion, properly speaking is in its essence [formaliter] the very acquisition of a form, or the flow, path, or tendency [fluxus, via, seu tendential] toward a form."59 This is the sense of the common Aristotelian definition of motion Descartes often dismissively quotes: motus est actus entis in potentia prout in potentia est, motion is the actuality of a thing in potentiality insofar as it is in potentiality (AT XI 39).60 A body in passage from form X to form Y is in potentiality insofar as it is no longer X but not yet Y, and the condition of being in motion is precisely this condition of being in the process of becoming Y. Since there are any number of ways a body can change, there are any number of kinds of motion. But, according to the schools, all motion falls into three, possibly four categories, depending on the categories of that which is changing: there is motion with respect to quantity, quality, place, and, on some accounts, motion with respect to substance. Motion with respect to quantity is intended to include increase and decrease in size. Motion with respect to quality contains a variety of changes, from hot to cold, from black to white, etc. Motion with respect to place, local motion, is change of place. And finally, motion with respect to substance, should it be considered a genuine variety of motion, is generation or corruption, the departure of one substantial form, that which makes a body the sort of thing it is, and the acquisition of a new substantial form, resulting in a new sort of substance.61 All of these changes (with the possible exception of change of substance) are properly called motions for the schoolmen.

Descartes’ objections often center on the general definition of motion commonly given in the textbooks. Writing in The World, Descartes gives his most common complaint:

They themselves admit that the nature of their [motion of motion] is very poorly understood, and to render it in some way intelligible, they cannot explain it any more clearly than in these terms: Motus est actus entis in potentia, prout in potentia est, which is so obscure for me that I am forced to leave it here in their language, since I cannot interpret it. (And, in fact, their words [in translation] are no more clear for being in French). (AT XI 39; see also AT X 426, AT II 597 [K 66])

In addition to this general complaint about the unintelligibility of the Aristotelian definition, in a letter probably from the mid-1640s Descartes expresses a rather more specific criticism:

As for the definition of motion, is is obvious that a thing said to be in potentiality cannot be understood to be in actuality, so that when anyone says that "motion is the actuality of a thing in potentiality insofar as it is in potentiality," motion is understood to be the actuality of a thing which is not in actuality, insofar as it is not in actuality. This includes either an apparent contradiction, or, at least, it includes a great deal of obscurity. (AT IV 697–98)

But Descartes’ objections to the Aristotelian conception of motion in the schools goes deeper than that. In a way, Descartes objects to the very conception of motion that gives rise to the general Aristotelian definition of motion, the idea that motion is a notion that embraces all sorts of change, of which local motion is but one. For Descartes, of course, all change is explicable in terms of local motion alone; the change from small to large, from hot to cold, from black to white, from wheat to bread is explained in terms of the local motion of the small corpuscles that make up the visible world. And so, Descartes often emphasizes that by motion he means only local motion, "for no other sort falls within my understanding, nor, therefore, do I think that we should imagine any other sort in the natural world" (Pr II 24; see also Pr I 69; AT X 39–40, etc.). The rejection of all varieties of motion but local motion is one of Descartes’ basic commitments; it is, indeed, closely linked to his entire mechanist program for physics.

But even with respect to local motion, Descartes thinks the schoolmen have gotten it wrong. Now, motion is the passage from one terminus to another; indeed, without termini, the notion of motion is unintelligible, as far as the schoolmen were concerned.62 And so, a portion of elemental earth in free fall is in passage from its initial position toward the center of the universe, and elemental fire from its initial position to the sphere of the moon. For Descartes, as we shall see when discussing his laws of motion, a body in motion will have a definite direction toward which it tends at any given instant. But a body in motion has no determinate goal toward which it tends, no terminus ad quem. Motion is thus not the passage from one determinate state to
another, but is itself a state of body, a mode of body, “a thing of no less reality than shape” (AT V 403 [K 257]). This will lead Descartes to the radical view that a body in motion remains in motion unless an appropriate cause alters that state, a view we shall examine in detail in later chapters, where we shall see further ways in which Descartes came to differ from the conception of motion he learned in school.

The characteristic behavior of body, the laws governing bodies in motion were of concern to Descartes at least since his discussions with Beeckman in autumn of 1618. In his earliest attempts to give a mathematical account of a body in free fall, Beeckman reports that Descartes “proceeded in accordance with my basic principles, that is, that in a vacuum, something once moved always moves” (JB I 263 [AT X 60]). No doubt, this principle, known to Beeckman as early as 1613 (JB I 24), was a subject of their discussions; as we shall see, it will later become one of the cornerstones of Descartes’ own theory of motion. Other likely topics of conversation include the conservation of motion, and the tendency of a body in circular motion to proceed in a straight path, a question that appears in the Cogitaciones Privatae, and was probably a question Beeckman suggested to Descartes in December 1618. But even though the laws governing motion were important to Descartes’ earliest efforts in the new physics, it will be more than ten