CRITIQUES & CONTENTIONS

What Happened to Occult Qualities in the Scientific Revolution?

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IN THIS ESSAY I seek to re-evaluate current conceptions of the role of occult qualities in the Scientific Revolution. In Renaissance science "occult" qualities were commonly characterized as *insensible*, as opposed to "manifest" qualities, which were directly perceived. Christian Aristotelianism tended to deny the existence of occult qualities, and when it did allow that such a quality was real, it insisted that it was unintelligible, because *scientia* in the medieval tradition was restricted to entities within the range of the human senses. This attitude constituted a major epistemological impasse not surmounted until the seventeenth century. At that time occult qualities became fully and consciously accepted in natural philosophy, just as it became recognized that no qualities were ever directly perceived.

Existing secondary literature, however, tends almost universally to claim that the Scientific Revolution produced a scientific outlook that rejected these occult qualities. The misunderstanding seems to result principally from overlooking significant changes in the connotations of the word "occult" since the year 1600. For if their writings are closely examined, many leaders of the Scientific Revolution can be seen to be explicitly urging the acceptability of occult entities. When they *appear* to be recommending the abandonment of occult qualities, close examination reveals that they are instead objecting to the earlier thesis that the occult is unintelligible, to the use of substantial forms as causal explanations, or to the extremely idiosyncratic occult causes posited by some writers. With the acceptance of insensible agencies into the scope of natural philosophy, the word "occult" lost its connotation of "insensible" and henceforth referred solely to unintelligibility. The Scientific Revolution culminated in a good deal of dispute over occult causes because different philosophies differed in their estimation of the intelligibility of the world. But these disputes have little to do with the original application of the word "occult," and hence must not affect our judgment of what happened to those properties of bodies which were declared occult by the orthodox before the seventeenth century.

WHAT WAS AN "OCCULT" "QUALITY"?

I do not pretend to present here any definitive semantic history of "occult," but even my preliminary analysis will suffice to give us important insights not available if we insist on using the word only in its elusive modern sense. In fact, the

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current misunderstanding of the term "occult" is compounded by an important ambiguity in seventeenth-century usage of the term "quality." "Quality" was at that time indeed used in its modern sense, to refer to the properties, attributes, or features of an object, but it was also used in a technical Peripatetic sense to refer to the causes of those attributes: the forms or hypostatical *qualitates*, which had a real existence in the ontology of Christian Aristotelianism and related philosophies and served as the explanation of the attributes of bodies. This causal theory was widely rejected by seventeenth-century philosophers, and causal occult *qualitates* were banished *a fortiori*. But it was through their being real *qualitates* that they were thus banished, and not (I shall show) through their being occult: *qualitates* that were not occult were rejected in precisely the same manner. However, these philosphers often used occult qualities as examples when they wished to attack the theory of real causal *qualitates*, creating the impression that they were attacking the existence of the occult effects of those *qualitates*.[1]

At the beginning of the seventeenth century, furthermore, "occult" was part of the technical Peripatetic terminology used to distinguish qualities which were evident to the senses from those which were hidden. In this context it was the antonym of "manifest." Typical manifest qualities were tastes and colors, because they could be immediately apprehended by the senses. Typical occult qualities were planetary influences, the magnetic virtue (apparently unrelated to the perceptible qualities of a piece of rock), or the purported abilities of certain chemicals to effect specific medical cures. If a drug like aspirin, for example, manages to relieve a headache, it does so by virtue of qualities which are imperceptible, and its effect is no direct or indirect reflection of its being a silent, white powder of bitter taste and medium density. We can observe the effects of aspirin, but we cannot observe what it is in aspirin which achieves those effects. As Daniel Sennert put it early in the seventeenth century:

> Qualities are divided in respect of our knowledg into *Manifest* and *Occult*. The manifest are those, which easily evidently and immediately, are known to, and judged by the Senses. So light in the Stars, and Heaviness and Lightness. . . . But occult or hidden Qualities are those, which are not immediately known to the Sences, but their force is perceived mediately by the Effect, but their power of acting is unknown. So we see the Load-Stone draw the Iron, but that power of drawing is to us hidden and not perceived by the Sences. . . . So we perceive with our senses the evacuation caused by purgative medicaments; but we do not perceive that quality by which the purging medicaments do work that effect. After the same manner, we perceive with our Senses the symptoms which Poysons do stir up in our Bodies; but the qualities whereby they cause the said symptoms we perceive not by the sense. By our Senses . . . we perceive Heat in the Fire, by means whereof it heats: but it is not so in those operations which are performed by occult qualities. We perceive the Actions but not the qualities whereby they are affected.[2]

[1]This distinction is particularly clear in 16th-century disagreements over the nature of the sacraments. Both Luther and Calvin reject the idea that there is an occult *qualitas* in, e.g., baptismal water, which renders that water effective, but they do not deny the effect of the water. They simply attribute the effect to God rather than to an inherent virtue. See Martin Luther, *Luther's Works*, Vol. I, ed. J. Pelikan (St. Louis: Concordia, 1958), pp. 95–96, 227–228, and Jean Calvin, *Institutes of the Christian Religion*, ed. John T. McNeill, trans. Ford L. Battles, 2 vols. (London: S. C. M. Press, 1961), Vol. II, pp. 1289, 1292 (= 4.14.14, 17). For examples in a more "scientific" context, compare the section heading with the text of René Descartes, *Principia philosophiae*, Pt. IV, §187; *Oeuvres de Descartes*, ed. C. Adam & P. Tannery, 13 vols. (Paris, 1897–1913), Vol. VIII, pp. 314–315; and see Robert Boyle, *The Works of the Honourable Robert Boyle*, ed. T. Birch, 6 vols. (London, 1772), Vol. III, p. 44.

[2]Daniel Sennert, *Thirteen Books of Natural Philosophy*, apparently a translation by N. Culpepper & A. Cole of the 1632 *Epitome naturalis scientiae* (London, 1661), pp. 29, 431.

Today we accept such powers as a matter of course, as my superficially anachronistic aspirin example indicates, very simply and without the need for sophisticated argument, and we have accepted such powers continuously since the seventeenth century.

Substantial evidence that occult qualities were fully accepted by other seventeenth-century philosophers than Sennert will be presented later. More importantly, the same evidence indicates that these philosophers saw their acceptance of such occult qualities as one of the marks of the superiority of their new philosophy over then-orthodox systems of thought. They saw Aristotelianism as unable to handle occult qualities because it placed too much emphasis on the importance of sensation, and failed to solve the central epistemological paradox posed by occult qualities: How can a science based on sense perception handle agencies which by very definition are insensible? Montaigne for one had explicated this paradox late in the sixteenth century, when he attacked the Aristotelian thesis that our senses are complete:

> I make a question whether man be provided of all naturall senses, or no. I see divers creatures that live an entire and perfect life, some without sight, and some without hearing; who knoweth whether we also want either one, two, three, or many senses more: For, if we want any one, our discourse cannot discover the want or defect thereof. It is the senses priviledge to be the extreme bounds of our perceiving. There is nothing beyond them that may stead us to discover them: No one sense can discover another. . . . Who knowes whether . . . by this default the greater part of the visage of things be concealed from us? Who knowes whether the difficulties we find in sundry of Natures workes proceede thence? . . . The proprieties which in many things we call secret [*occultes*] . . . is it not likely there should be sensitive faculties in nature able to judge and perceive them, the want whereof breedeth in us the ignorance of the true essence of such things?[3]

Occult agencies are likely to exist then, says Montaigne, but if they do they will be unknowable. Later natural philosophers agreed that they exist, but found acceptable methods of knowing at least something about them. William Gilbert showed, for example, that even though one could not perceive the magnetic virtue (he believed that its cause was some kind of living soul), the effects of magnetism could be reliably studied by experiment.

OCCULT QUALITIES IN CHRISTIAN ARISTOTELIANISM

Many Aristotelians shared Montaigne's view that occult properties, even when real, were methodologically unstudyable.[4] Indeed, the intellect was seen, in Peri-

[3]Michel de Montaigne, *The Essayes of Michael Lord of Montaigne*, trans. J. Florio (1603), ed. H. Morley (London, 1886), p. 302.

[4]I use the terms "Peripatetic" and "Aristotelian" rather loosely, attaching a philosopher to this tradition if he roughly adhered to a doctrine of immanent *qualitates*. In Lynn Thorndike's *History of Magic and Experimental Science*, 8 vols. (London: Macmillan, 1923; New York: Columbia Univ. Press, 1934–1958), there is no sustained discussion of epistemological issues, but my proposals are supported through numerous scattered instances: see Vol. I, pp. 377–379, 431, 644, 646, 778; Vol. II, pp. 8, 29–31, 131, 135, 144, 160–161, 166, 220, 281, 299, 336, 363, 387, 408, 508ff., 535, 545, 555, 573, 603–604, 632, 652–653, 701, 733–734, 769, 789, 829, 837, 886, 891, 893; Vol. III, pp. 157–158, 408, 577, 582; Vol. IV, pp. 118, 170–171, 208, 225, 229, 313; Vol. V, pp. 109, 117–118; Vol. VI, pp. 391, 432. See also David Knowles, *The Evolution of Medieval Thought* (London: Longmans, 1962), pp. 101–102; Armand A. Maurer, *Medieval Philosophy* (New York: Random House, 1964), pp. 183–184, 198, 221, 237–238, 282; John Herman Randall, *The Career of Philosophy*, Vol. I (New York: Columbia Univ. Press, 1962), pp. 31, 33–34, 104, 263, 305; William A. Wallace, *Galileo's Early Notebooks: The Physical Questions* (Notre Dame, Ind.: Notre Dame Univ. Press, 1977), p. 297.

patetic psychology, as operating by means of abstracted sense images, and since only the effects of occult virtues could be sensed, the causes of these effects were outside the range of man's intellect. Occult qualities could thus be detected experimentally, but could not be studied scientifically, since *scientia* in the Aristotelian tradition was, above all, a knowledge of causes. Built upon foundations laid by Plato and Augustine, mainstream medieval thought incorporated a large measure of skepticism and denied that man's reason was capable of achieving extensive knowledge, except when granted divine aid. With the accommodation of Aristotelian realism in the thirteenth century, the demarcation between reason and revelation was established around the level of sense perception: if an entity could not be sensed, then it was unlikely that God wished ordinary men to understand that entity. Occult agencies furthermore were widely regarded as unreliable in operation. Spurious experiential reporting and failure to isolate the precise preconditions of the operation of these agencies commonly led to the cause and effect relations involved being perceived as irregular. This perceived irregularity strengthened the refusal of Aristotelians to classify knowledge of the occult as a branch of science, since *scientia* was seen as dealing only with universal necessary causes. Accordingly, supernatural revelation was widely regarded as the path to a knowledge of occult virtues, and the occult was closely associated with mysticism and demonism. Being outside the province of *natural* philosophy, and dependent on a *supernatural* epistemology, occult powers were excluded from official science, just as their namesakes are today, now that the originals have been fully accepted.

To pretend that these extremely general remarks apply to the whole of that vast and heterogeneous field, medieval and Renaissance philosophy, would be to claim somewhat too much. But the philosophy of this era exhibited a very strong tendency to dismiss the occult, and furthermore, (as we shall see below), the innovators of the seventeenth century perceived this inability to handle the occult as an important fault in the philosophy they were supplanting. No doubt their view of this philosophy was somewhat warped, but the presumptive evidence provided by these opponents can fortunately be supported by strong, though scattered, direct evidence from the Aristotelians themselves. Numerous examples exist of medieval philosophers either failing to recognize that insensible entities can be corporeal, or declaring that what is insensible can only be known imperfectly.

Insensibility a Token of Incorporeality. Perhaps the most telling illustration of the failure to recognize the possibility of insensible matter is Aquinas's declaration that no animals can exist below the threshhold of our senses. "It is not possible," he writes in his commentary on the *Physics*, "that there should be certain parts of flesh and bone which are non-sensible because of smallness."[5] This stance had theological significance, because to accept the existence of animals that man could not sense would seem to lead to a clash with Genesis 2:19–20, where Adam is said to have given names to all the animals in a parade.[6] Genesis suggests further that the whole of creation functions to serve man: the stars are described as "adorn-

[5]Thomas Aquinas, *Commentary on Aristotle's Physics*, trans. R. J. Blackwell *et al.* (London: Routledge & Kegan Paul, 1963), p. 34. See also *Aristotle's De anima in the Version of William of Moerbeke and the Commentary of St. Thomas Aquinas*, trans. K. Foster and S. Humphries (London: Routledge & Kegan Paul, 1951), p. 490, and Galileo's discussion in Wallace, *Early Notebooks*, pp. 208–209, 224–225.

[6]See Aquinas, *Summa theologiae*, 1a. 94. 3.

ment," and man is said to have command over all creatures. This view, widely held until the seventeenth century, runs counter to the more modern idea that God has filled his universe with objects that make no impact on the human senses. Elsewhere Aquinas suggests in passing that the sense faculties of fallen men are inferior to those of the original creation: this would allow a fuller corporeal nature to have been accessible to Adam when he gave the animals their names. Augustine certainly includes epistemic impairment as part of God's punishment after the fall.[7]

Yet another symptom of the reluctance of medieval philosophers to accept the possibility of material entities that cannot be seen is their common tendency to use, if only in passing, terms such as "invisible" to refer to spiritual entities. Aquinas, indeed, lumps invisible material things together with darkness, and hence argues that such things are in fact perceived by sight: "Sight perceives both the visible and the invisible, the invisible being darkness, which is apprehended by sight." Aquinas does, however, classify the sun as invisible, because it is so bright that it overpowers the eye. Accordingly the owl was characterized as the animal with the *weakest* eyesight, since it could not even bear normal levels of illumination. Though it was recognized that some animals could see in the dark, such vision was often not explained through increased sensitivity to light but rather seen as evidence for the theory of extramission.[8] As these examples indicate, medieval philosophy had great difficulty in accommodating the existence of anything too "small" to be sensed.

Aquinas does in fact accept that there are some insensible actions in the corporeal world, like magnetic attraction, but he cites such attraction as an "occult virtue which man is not capable of explaining." Further, he insists that many actions which seem to be natural, like magnetism, are in fact supernatural. He rejects, for example, the claim that saintly relics have an occult curative virtue, and insists that since the cures performed by such relics are only performed selectively and do not succeed with every patient, they must be performed by angelic intervention.[9]

Aquinas's relegation of some insensible operations to the realms of the supernatural accords with a standard medieval and Renaissance view of magic, that it was not the magician who performed wonders but rather demons, who were summoned, implicitly or explicitly, by the magician. Such a theory of magic implies either that the magician's paraphenalia does not have occult powers, or that if it does, it is the demon rather than the magician who can deploy the powers. In Augustine's view, demons were aided in tapping such powers by the fact that they had keener senses than men, and Aquinas endorsed this idea, albeit ambiguously. Late in the Renaissance this view met an important competitor when the idea of a natural magic, which proceeded without supernatural intervention, was promulgated, but such a magic continued to be viewed with suspicion by the

[7]See Peter Brown, *Augustine of Hippo* (London: Faber, 1967), pp. 261–262; Aquinas, *Summa theologiae* 1a.99.1, 1a.101. See also Henry Power, *Experimental Philosophy* (1664; New York: Johnson, 1966), preface; George Atwell, *An Apologie, or Defence of the Divine Art of Natural Astrologie* (London, 1660), p. 59; Alexander Ross, *The Philosophical Touch-stone* (London, 1645), pp. 2, 56–57; *Luther's Works*, Vol. I, p. 62.

[8]See, e.g., Augustine, *Soliloquia* 1.3; Aquinas, *Summa theologiae* 1a.64.1, 2a.2ae.171.3; Aquinas, *Commentary on the Metaphysics of Aristotle*, trans. J. P. Rowan, 2 vols. (Chicago: Regnery, 1961), Vol, I, p. 118; Aquinas, *Commentary on De anima*, pp. 301, 305, 317; David C. Lindberg, *Theories of Vision from Al-Kindi to Kepler* (Chicago: Univ. Chicago Press, 1976), pp. 53, 88, 160.

[9]Aquinas, *Summa theologiae* 2a.2ae.96.2; Aquinas, "On the Occult Works of Nature," in J. B. McAllister, *The Letter of Saint Thomas Aquinas De occultis operibus naturae* (Washington: Catholic Univ. Press, 1939), pp. 20, 22. See also Thorndike, *History*, Vol. IV, p. 208.

orthodox. Moreover, magic was not learned by the normal processes of human investigation, but from another magician who in turn learned from another magician and so on back to a magician who learned by demonic revelation.[10]

Insensibility a Token of Unintelligibility. As this conception of the epistemics of magic suggests, medieval thought also had great difficulty accepting the intelligibility of the insensible. Central to this difficulty was Aristotelian psychology, which required the distinction outlined by Sennert between occult and manifest qualities. When an object became known, according to this psychology, it became known through its sense image.[11] As it was sensed, its manifest qualities entered the imagination without the matter composing the object. The forms in the imagination were identical to the sensible forms in the object, and the *modus operandi* of the human intellect was the "sifting" of these forms to abstract the universal and essential forms from the accidental and singular. That process just could not occur in the absence of a sense image, and an occult quality was *a fortiori* outside the scope of the human intellect. As Aquinas comments, "all the objects of our understanding are included within the range of sensible things existing in space. . . . Whenever the intellect actually regards anything, there must at the same time be formed in us a phantasm [i.e., sense image]"; and elsewhere, "Man is not competent to judge of interior actions that are hidden [*qui latent*] but only of exterior motions that are manifest [*qui apparent*]."[12] Such a position could well be used to deny that God is knowable, since he is the prime example of an occult cause, and both Aquinas and Scotus consider the argument when examining the bounds of human reason. This view had the attraction of implying a major limitation on reason as opposed to faith and supporting the traditional skepticism of Christian theology, but both Aquinas and Scotus wish to establish that a measure of natural knowledge of God is possible. So Aquinas does allow some epistemic access to insensible causes, but he insists that such knowledge, acquired from sensed effects of the cause, is defective knowledge, nonquidditive in character.[13]

That Aquinas did not see these epistemic problems as restricted solely to the arena of theology appears from his opinion that magnetism was beyond human comprehension. This pessimism about understanding the nature of magnetism was very common, and persisted up to the end of the sixteenth century and beyond. In 1597, for example, William Barlow contrasted the marvelous-but-explicable behavior of gunpowder with the truly inexplicable behavior of the magnet.[14] Similarly, Augstine cited the *occultissimi* characteristics of quicklime, characteristics that cannot be directly sensed yet can be "experienced" (*sed compertus experimento*) in the sense that they have sensible effects, as a parallel in the material world to the miracles of Christian tradition. Hence he implied that the behavior of quicklime, which grows hot when mixed with the cold element water, yet remains cool when mixed with inflammable oil, is beyond man's understanding. Twelve hundred years later Augustine's example was still being used as a specimen of a

[10]Augustine, *Contra academicos* 1.7.20; Augustine, *De civitate dei* 9.22, 10.8–11, 21.6; Aquinas, *Summa theologiae* 1a.57.4, 1a.110.4, 1a.114.4; Aquinas, *Summa contra gentiles* 3. 101–107.

[11]See, e.g., Aquinas, *Summa theologiae* 1a.85.1; Randall, *Career of Philosophy*, Vol. I, pp. 31–36.

[12]Aquinas, *Commentary on De anima*, p. 456; *Summa theologiae* 1a.2ae.91.4.

[13]Duns Scotus, *Philosophical Writings*, ed. and trans. A. Walter (London: Nelson, 1963), pp. 14–33, Aquinas, *Summa theologiae* 1a.84.7; *Summa contra gentiles* 1.3. On God as an occult cause, see Aquinas, *Summa theologiae* 1a.64.1; Calvin, *Institutes*, Vol. I, pp. 52, 209 (=I.v.1, I.xvi.9).

[14]William Barlow, *The Navigators Supply* (London, 1597), page opp. p. B.

natural marvel "that man's understanding . . . may not apprehend," but could only be known through experience.[15] Cornelius Agrippa's discussion of occult virtues reflects this same general epistemic attitude:

> There are . . . vertues in things, which are not from any Element, as to expell poyson, to drive away the noxious vapours of Minerals, to attract Iron, or any thing else; and this vertue is a sequell of the species, and form of this or that thing; whence also it being litle in quantity, is of great efficacy; which is not granted to any Elementary quality. For these vertues having much form, and litle matter, can do very much; but an Elementary vertue, because it hath more materiality, requires much matter for its acting. And they are called occult qualities, because their Causes lie hid [from our senses], and mans intellect cannot in any way reach, and find them out. Wherefore Philosophers have attained to the greatest part of them by long experience [and conjecture], rather then by the search of reason.[16]

Agrippa makes the distinction, already met in Augustine, between *sensing* an entity and *experiencing* it, occult qualities being within the realm of experience, but outside the realm of sense. The fact that Aristotelianism emphasized the dependence of natural philosophy upon sense images is often regarded as evidence of the "empirical" nature of scholastic thought. But to insist on direct sensation as the foundation of one's epistemology is to devalue all other forms of experience. Thus in the seventeenth century Henry Power could castigate the Aristotelians for being "Sons of Sense" while himself recommending an experiential philosophy.[17] Scholastic *scientia* was reluctant to deal with entities which could *only* be experienced, and hence this philosophy must be regarded as having viewed experience as a poor basis for knowledge. Since experience normally indicates effects separated from their causes, it did not seem to supply the causes required by the Aristotelian conception of *epistêmê*.[18] Furthermore, even the effects themselves were commonly thought to be in doubt, for, as Hobbes put it, "to remember all the circumstances that may alter the success is impossible." This philosophical attitude, a remnant of Aristotelianism, explains why Kepler adopts a markedly defensive tone when he insists that experience is ultimately reliable, and that the old wives' tales polluting contemporary knowledge of occult actions can indeed be eliminated:

> Some lovers of nature . . . have found there are attributed to the stars effects that are certainly not fabricated, but that through protracted empirical experience are attested as regards some general consistency [*convenientia*]. Similarly, the physician first derives from experience that some herb, collected between two [festive] days . . . is supposed to be good for this or that specific ailment; now, since a very great number of such observations, certainly false, have nothing to do with the matter . . . such as the festive-days in themselves, such a herb is used effectively and curatively because of its own nature, or because of a quality that it has in common with many other herbs. . . . Therefore, in the case of materia medica, experience is not suspect, but diligent physicians know how to cultivate this empirical knowledge so that it is no longer mere empiricism or old wives' lore, but something true, reliable. In every way it is also like this with astrological experience. . . . Thus, just as there is little cause to exclude

[15]Augustine, *Civitate dei* 21.4–5; *The Book of Secrets of Albertus Magnus*, ed. M. R. Best and F. H. Brightman (ca. 1550; Oxford: Clarendon Press, 1973), pp. 82, 104.

[16]Heinrich Cornelius Agrippa of Nettesheim, *Three Books of Occult Philosophy*, trans. J. French (London, 1651), p. 24 (=1.10) (inserting material from p. 34).

[17]Power, *Experimental Philosophy*, preface. Cf. *Secrets of Albertus Magnus*, pp. 82–83.

[18]See, e.g., Aquinas, *Commentary on the Metaphysics*, Vol. I, p. 13; Thorndike, *History*, Vol. I, p. 585; Vol. II, pp. 71, 508–509, 769; Vol. VI, p. 358.

> medicine from the number of the arts by reason of false or defective experience, so there is as little cause to demand this of the entire and perfect astrology. . . . In its enquiry into the kinds and properties of herbs, medicine initially knew nothing of necessary and certain causes, but has finally learnt of these through diligence and rational conjecture, and it is to some extent still seeking. . . .[19]

Sensibility and the Four Elements. Another important idea introduced in the passage from Agrippa is the classification of a quality as occult if it cannot be accounted for in terms of the four elements of Aristotelian sublunar cosmology. This deficiency was commonly held to define an occult quality.[20] Since the four elements functioned as the basic principles of "perceptible body" in Aristotelian physics, the definition is effectively equivalent to that formulated in the quotation given from Sennert. Aristotle himself presented the four-element theory in the course of analyzing the sensible qualities of matter. Aquinas also relates the four-element theory to a theory of sensation, using it to argue that our senses are complete: qualities that might be sensed by any hypothetical additional sense, he seems to argue, would require that there be additional elements beyond the traditional four. He dismisses the idea abruptly.[21]

Idiosyncrasy of Insensible Actions. Apart from confirming that occult qualities could not be handled by human reason, consigning them outside the four-element system also supported the view that occult qualities were not universally distributed in nature. Since the Peripatetic ideal of *scientia* dealt only with causes which were universal (or near-universal), this was yet another ground for excluding occult qualities from the province of scientific knowledge. Indeed, an occult quality was often referred to as a *property* or *idiosyncrasy*, technical terms used to indicate that it was peculiar to a relatively narrow class of individuals, as opposed to the manifest qualities, which reflected universal characteristics of the four elements present in all terrestial bodies. Every individual body in the sublunary world was similar to every other body by virtue of its being composed of the elements, but it was also a unique body to the extent that it had an individual composition, shared to some extent with other bodies of its species and genus. The occult properties of the body were seen as attached to some entity representing this individuality, such as the substantial form of the body, or its "complexion," or "temperament," or the "whole substance," or the mathematical proportions of the elements.[22]

We have already seen that Aquinas explained the fact that saints' bones performed cures which were selective in nature by proposing that such cures were in fact performed supernaturally, but a naturalistic explanation could also be given by proposing that saints' bones have an occult curative virtue that applies only to particular individual patients. The most famous proponent of this approach to occult virtues is Paracelsus, who rejected the prevailing theory of disease as primarily a disorder of the whole body generated by an imbalance of the four

[19]Thomas Hobbes, *Leviathan* (London: Dent, 1973), p. 22; Johannes Kepler, *Gesammelte Werke*, Vol. IV (Munich: Beck, 1941), pp. 163–164 (my translation).

[20]Aquinas, "Occult Works," p. 21. See also Thorndike, *History*, Vol. II, pp. 664, 667, 892–893; Vol. III, pp. 114, 130–139, 156, 240–245, 395, 408, 414, 440–441, 449, 483; Vol. IV, p. 34.

[21]Aristotle, *On Generation and Corruption*, 328b25–330a30; Aquinas, *Commentary on De anima*, pp. 352–353.

[22]Sennert, *Natural Philosophy*, pp. 432, 436, 439; Thorndike, *History*, Vol. I, p. 643; Vol. II, pp. 209–210, 535, 565–566, 854–855, 906, 910; Vol. III, pp. 245–246, 395, 415, 429, 440–441, 448, 499, 543; Vol. IV, pp. 190–191, 208, 532; Vol. IV, pp. 369, 371; *Secrets of Albertus Magnus*, pp. 75–76.

humors in favor of a conception of disease as a specific affliction of a specific section of the body. As such it was not to be attacked by universal remedies aimed at restoring bodily equilibrium through the manifest qualities of the four elements, but rather by specific chemical or natural agents with a special capacity to cure the particular affliction in question. These curative virtues were so specific that they were even subject to a variability both in time and between individual specimens, just as no two human bodies are identical:

> If the physician is to understand the correct meaning of health, he must know that there are more than a hundred, indeed more than a thousand kinds of stomach; consequently, if you gather a thousand persons, each of them will have a different kind of digestion, each unlike the others. One digests more, the other less, and yet each stomach is suitable to the man it belongs to. . . . It follows that no one drinks the same amount as another, that no one has the same thirst as another. . . .[23]

Precisely how he thought one could come to know such radically individual properties Paracelsus leaves unclear. He often recommends experience, yet reliance on experience presupposes some stability in the virtues being examined. The same applies also to his adoption of a doctrine of "signatures," according to which nature has so arranged things that the occult curative virtue of a plant or chemical will be indicated by some manifest external "sign," just as a man's internal character is revealed by his external physiognomy. Thus the "*Siegwurz* root is wrapped in an envelope like armour; and this is a magic sign showing that like armour it gives protection against weapons. And the *Syderica* bears the image and form of a snake on each of its leaves, and thus, according to magic, it gives protection against any kind of poisoning."[24] Perhaps the truly idiosyncratic virtues in nature could only be recognized by the suprarational intuitions of individual adepts. Only dependence on experience remained current as a solution of Montaigne's epistemological impasse at the end of the seventeenth century, but the survival of that solution required exiling occult virtues that were not universal in scope.

All Actions Ultimately Sensible in Kind. Some Aristotelians recognized the force of the argument from experience, and acknowledged that there were significant insensible actions in the material world. But to reconcile this acceptance with their theoretic commitment to sensibility, they resorted to what might be called a "manifestization" of occult qualities. Although, for example, Agrippa delineates occult virtues as those which exceed the elemental powers, a good deal of his discussion prior to the passage quoted gives elemental accounts of many properties of objects that others would typically have classified as occult. Agrippa claims, for example, that the strange behavior of quicklime noted by Augustine does in fact "follow the nature, and proportion of the mixtion of the . . . vertues" of the elements. Such manifestization of occult qualities was reasonably common.[25] It accepts that certain actions in nature may be insensible and does not interpret this insensibility as evidence that the actions are supernatural, but it insists that the insensibility is more or less incidental, and that the actions are really sensible in kind. The

[23]Paracelsus, *Selected Writings*, ed. Jolande Jacobi, trans. Norbert Guterman (London: Routledge & Kegan Paul, 1951), p. 161. See also pp. 102–103, 152–153, 170–171, 203.

[24]*Ibid.*, p. 197.

[25]Agrippa, *Occult Philosophy*, pp. 22–23; cf. *Secrets of Albertus Magnus*, pp. 78–79; Sennert, *Natural Philosophy*, pp. 433–438. See also Thorndike, *History*, Vol. II, pp. 564, 908; Vol. III, pp. 481–483, 531; Vol. IV, p. 228; Vol. VI, p. 358.

approach accepts occult qualities as effects to be accounted for, and attempts to account for these effects in terms of qualities which are preeminently intelligible. But other philosophers insisted that some qualities were genuinely occult. Sennert, for example, argued that if poisons really did act by cold, then ice would be a poison par excellence: and no combination of hot, cold, moist, and dry would ever produce magnetic attraction, just as no mixture of pigments would ever produce anything but a color, even when mixed by the most skilled painter. The philosopher had no right to expect that every effect he finds in nature would be readily intelligible, and he had to accept effects as he found them, whether explicable or not:

> . . . it is a ridiculous thing to deny that which is manifest by Experience, because we cannot tel the reason thereof. As if it were impossible any thing might happen in Nature of whose cause we are ignorant. We are ignorant of most things. And therefore they that would in Natural Philosophy find out the Truth, and not fal into wild and sophistical Opinions, they must begin with things known to the Sense, and so proceed to the Causes and having found them rejoyce in the Works of Nature; and not finding them, confess their own ignorance; but by no means deny things that are manifest. For it is less shameful having found out the effect to be ignorant of the Cause, which is frequently hid from the most expert Philosophers, than together with the cause to be ignorant of the effect.[26]

OCCULT QUALITIES IN THE NEW PHILOSOPHIES

The Aristotelians whom Sennert attacks are often "praised" in secondary literature for their "modernity" in denying the existence of occult agencies, but this is a very dubious judgment. Apart from the question whether there is much point in the historian's distributing such laurels, it is hardly a modern position to insist that the sole natural actions in the world are hot, cold, moist, and dry qualities. Despite their various differences, all adherents of the new science of the seventeenth century were at least agreed that actions beyond these four pervaded the universe, and that such "occult" actions were within the scope of the human intellect. Furthermore, such agreement was not merely implicit in their work, visible only to the retrospective gaze of the historian, but it was explicit and self-conscious. These innovators openly argued that the ability to accommodate occult qualities was one of the signs of the superiority of their new science.

Insensibility No Token of Incorporeality: Descartes. Just after his long discussion of the cause of magnetism in the *Principles*, Descartes announces his confidence that similar mechanical explanations will eventually be found for all other occult qualities: these have finally been brought within the scope of science: ". . . there are no qualities which are so occult, no effects of sympathy or antipathy so marvelous or so strange, nor any other thing so rare in nature (granted that it is produced by purely material causes destitute of thought and free will), that its reason cannot be given by [the principles of the mechanical philosophy.]"[27] Unlike the Aristotelians, Descartes does not have to posit an unknowable *qualitas* behind each occult quality. Instead he can give an explanation based on an insensible mechanism. Furthermore, he does exactly the same with manifest qualities. There are no *qualitates* behind them either, and the apparently sensible qualities of

[26]Sennert, *Natural Philosophy*, p. 435; cf. Boyle, *Works*, Vol. III, pp. 294, 297–301.
[27]Descartes, *Principia philosophiae*, Pt. IV, §187 (*Oeuvres*, Vol. IX, p. 309).

bodies are also generated by insensible mechanisms. There remains thus no strict distinction in Descartes's philosophy between the occult and the manifest. All qualities have become occult, for there are no properties of bodies that directly enter the intellect in the manner of the sensible forms of the Peripatetics. In Descartes's view, the function of our perceptions is not to give us a direct picture of reality, but simply to safeguard our bodies. It is then manifest qualities, not occult ones, that Descartes rejects.

This rejection of manifest qualities is in fact commonly recognized as an important feature of the Scientific Revolution, though the fact that it is usually referred to in Lockean terminology, as "the distinction between primary and secondary qualities," obscures its connection with the problem of occult causes. To insist, as adherents to this distinction did, that one's psychological perception of a sensible quality is of a different order of reality from the physical cause of that quality is tantamount to declaring that cause occult. So accepting Locke's distinction is equivalent to denying the existence of manifest qualities, and on this point all proponents of any form of the mechanical philosophy were agreed, though few expressed it this way. On the contrary, many retained the terminology of the Aristotelian distinction, but reinterpreted that terminology, perhaps not too consciously, to accord with their own philosophical outlook. But the persistence of the old terminology should not prevent us from recognizing that the new philosophy did not allow that bodies had attributes that were manifest in the Aristotelian sense. The only attributes that bodies have are those which satisfy the Aristotelian criterion for being occult.

This rejection of manifest qualities is implicit in most of Descartes's work. *Le Monde* begins with a direct attack on manifest qualities, and Descartes constantly reiterates his rejection of them in the *Meditations,* where he particularly wishes to deny that there is anything especially intelligible about the sensible, since the aim of the work is to reverse Peripatetic conceptions of the relative strengths of natural theology and natural philosophy. Descartes wishes to show that natural reasoning alone can lead to a knowledge of God superior to the knowledge it gives us of the sensible world.[28]

Not only does Descartes attack the prevailing belief in the especial intelligibility of the sensible, but he also consciously insists on the existence of insensible entities. He rejects the idea that lack of a sense image of these things prevents us from understanding them and uses his mechanical philosophy to explain how it is that such things do not register on our senses:

> . . . [M]any men are unable to believe that there is any substance unless it is imaginable and corporeal and even sensible. . . . [T]hey persuade themselves . . . that there is no body which is not sensible. . . . I consider that there are many particles in each body which cannot be perceived by our senses, and this will perhaps not be approved by those who take their senses as a measure of the things they can know. . . . [I]t should not be wondered at that we are unable to perceive very minute bodies, for the nerves which must be moved by objects in order to cause us to perceive, are not very minute . . . and thus cannot be moved by the minutest of bodies.[29]

[28]Descartes, *The Philosophical Works of Descartes*, trans. E. S. Haldane & G. R. T. Ross (Cambridge: Cambridge Univ. Press, 1931), Vol. I, pp. 133–134.

[29]*Ibid.*, pp. 209, 251, 297. Cf. Boyle, *Works*, Vol. I, p. 516; Charleton, *Physiologia Epicuro-Gassendo Charltoniana* (1654; New York: Johnson, 1966), pp. 113–116; Francis Bacon, *Works*, trans. and ed. J. Spedding, R. L. Ellis, and D. D. Heath, 14 vols. (London, 1858–1861), Vol. IV, p. 26.

Sensibility No Token of Intelligibility: Charleton. The most explicit discussion that I have come across of the idea that bodies do not have manifest attributes occurs in Walter Charleton's *Physiologia Epicuro-Gassendo-Charltoniana*. This book contains an illuminating chapter entitled "Occult Qualities Made Manifest," though "Manifest Qualities Made Occult" would perhaps be a more accurate description. In this chapter Charleton attempts, like Descartes, to give a "scientific" treatment of occult qualities by drafting mechanical explanations for them. Charleton begins by explicitly rejecting not the *existence* of occult qualities, but rather the Peripatetic distinction between the occult and the manifest. *All* qualities, redness just as much as magnetism, he argues, are occult, for the causes of what the Aristotelians see as a simple act of sense perception are really quite complex, and dependent upon the hidden mechanical structure of matter:

> . . . the Schools . . . too boldly praesuming, that all those Qualities . . . which belong to the jurisdiction of the senses, are dependent upon Known Causes, and deprehended by Known Faculties, have therefore termed them *Manifest*: and as incircumscriptly concluding, that all those Proprieties of Bodies, which fall not under the Cognizance of either of the Senses, are derived from obscure and undiscoverable Causes, and perceived by Unknown Faculties; have accordingly determined them to be *Immanifest* or *Occult*. Not that we dare be guilty of such unpardonable Vanity and Arrogance, as not most willingly to confess, that to *Ourselves all the Operations of Nature are meer Secrets*; that in all her ample catalogue of Qualities, we have not met with so much as one, which is not really Immanifest and Abstruse, when we convert our thoughts either upon its Genuine and Proxime Causes, or upon the Reason and Manner of its perception by that Sense, whose proper Object it is: and consequently, that as the *Sensibility* of a thing doth noe way praesuppose its *Intelligibility*, but that many things, which are most obvious and open to the Sense, as to their *Effects*, may yet be remote and in the dark to the Understanding, as to their *Causes*. . . .[30]

To say that Charleton and Descartes rejected the existence of manifest qualities but accepted occult ones is not, of course, to say that they accepted the existence of every agency put into this classification by one or another of their opponents. Accordingly, most of Charleton's chapter is an attack on the notions of sympathies and antipathies, "windy terms" (as Charleton calls them) referring, not to real actions at a distance, but to the mere visible effects of insensible mechanism:

> The means used in every common and Sensible Attraction . . . of one Bodie by another, every man observes to be Hooks, Lines, or some such intermediate Instrument continued from the Attrahent to the Attracted; and in every Repulsion . . . there is used some Pole, Lever, or other Organ. . . . Why therefore should we not conceive, that in every Curious and Insensible Attraction of one bodie by another, Nature makes use of certain slender Hooks, Lines, [and] Chains . . . and likewise . . . in every Secret Repulsion. . . . Because, albeit those Her Instruments be invisible and imperceptible; yet are we not therefore to conclude, that there are none such at all. . . . [F]or us to affirm, that nothing Material is emitted from the Loadstone to Iron . . . only because our sense doth deprehend nothing . . . is an Argument of equal weight with that of the Blind man, who denied the Being of Light and Colours, because He could perceive none.[31]

Similarly, if a viol tuned with some strings of sheep gut and some of wolf gut refuses to play in perfect consonance, the reason is *not* an occult *antipathy* be-

[30]Charleton, *Physiologia*, pp. 341–342.
[31]*Ibid.*, p. 344.

tween sheep and wolves but rather an occult *mechanism*, "the aer be[ing] unequally percussed and impelled by [the two strings, so that] the sounds created by one . . . confound and drown the sounds resulting from the other."[32]

The fact that Charleton, in common with many of his fellow mechanical philosophers, rejects sympathies and antipathies, is evidence that might be used to support the description of the seventeenth century as rejecting the occult. In the modern sense of the term, this description is probably quite accurate, but it misrepresents Charleton's real attitude. Another possible piece of evidence is a clear attack by Charleton on what he terms "that ill-contrived sanctuary of ignorance, called occult qualities." The Aristotelians who founded this sanctuary, he says,

> thought it a sufficient Salvo for their Ignorance, simply to affirme all such Properties to be *Occult*; and without due reflection upon the Invalidity of their Fundamentals they blushed not to charge Nature Herself with too much Closeness and Obscurity, in that point, as if she intended that all Qualities, that are *Insensible*, should also be *Inexplicable*. . . . [I]nstead of setting their Curiosity on work to investigate the Causes [of a difficult problem], they lay it in a deep sleep, with that infatuating opium of Ignote Qualities: and yet expect that men should believe them to know all that is to be known, and to have spoken like Oracles . . . though at the same instant, they do as much confess, that indeed they know nothing at all of its Nature and Causes. For, what difference is there, whether we say, that such a thing is Occult; or that we know nothing of it.[33]

In this passage Charleton might *seem* to be rejecting occult qualities, but close scrutiny reveals a subtly different attitude: what Charleton really objects to is a *doctrine* of occult qualities used as an intellectual refuge, as the termination rather than initiation of an enquiry. Insensible agencies certainly exist, in Charleton's view, and the natural philosopher has to do a lot more than simply designate them: he must investigate and explain them. Charleton is attacking not occult qualities but the Aristotelians. The same applies to many other apparent attacks on occult qualities in the seventeenth century. Hobbes, for example, makes almost the same point as Charleton:

> in many occasions [the Aristotelians] put for cause of Naturall events, their own Ignorance; but disguised in other words . . . as when they attribute many Effects to *occult qualities;* that is, qualities not known to them; and therefore also (as they thinke) to no Man else. And to *Sympathy, Antipathy, Antiperistasis Specificall Qualities,* and other like Termes, which signifie neither the Agent that produceth them, nor the Operation by which they are produced.[34]

Charleton's remarks also point to another major theme of the Scientific Revolution: the recognition that nature is permeated with *secrets* to which man has reasonable access. Like the closely related existence of occult properties, this is accepted as commonplace today. Because it has become a hackneyed metaphor, the intellectual advance it represents is often unappreciated, but the Scientific

[32]*Ibid.*, p. 357.

[33]*Ibid.*, pp. 342–343.

[34]Hobbes, *Leviathan*, pp. 371–372. Another well-known "attack" is that in Galileo, *Dialogue Concerning the Two Chief World Systems*, trans. Stillman Drake (Berkeley: Univ. California Press, 1953), pp. 445, 462, where Salviati says that he "cannot bring himself to give credence to such causes [of the tides] as lights, warm temperatures . . . , occult qualities, and similar idle imaginings." To argue from this that Galileo saw occult qualities as "idle imaginings" is no more valid than to argue that he also saw light and heat as "idle imaginings." Galileo is in fact rejecting *all* celestial influences, occult and manifest, on the tides.

Revolution, with its emphasis on thoroughness and active experimentation in place of uncritical passive observation, depended on such a recognition. Virtually all seventeenth-century scientists draw attention to this issue. Thus Galileo, discussing the unexpected results he has discovered in his study of the strengths of materials and the strange effects of scale, observes "how conclusions that are true may seem improbable at a first glance, and yet when only some small thing is pointed out, they cast off their concealing cloaks [*le vesti che le occultavano*] and, thus naked and simple, gladly show off their secrets." Bacon similarly writes of the need "to penetrate into the inner and further recesses of nature," and criticizes existing "speculation" for ceasing "where sight ceases. . . . Hence all the workings of the spirits enclosed in tangible bodies lies hid and unobserved . . . unless these . . . things . . . be searched out and brought to light, nothing great can be achieved in nature. . . ." To get at the truth Nature must be interrogated under torture and *forced* to reveal her secrets. Hooke urged a study of the "many excellent Experiments and Secrets" of the mechanical arts, and in the *Opticks* Newton also writes of the search for "the more secret and noble works of nature." It is, I suggest, important not to discount these passages as mere rhetoric. They are symptoms of a new approach to nature, new at least among men whom we classify as natural philosophers rather than magicians. Though there were numerous "books of secrets" circulating before the seventeenth century, these generally had a poor reputation, and were not part of official science. One of the most widely known of such works, the *Book of Secrets of Albertus Magnus*, for example, explicitly connects itself with the "science of magic" and declares that it deals with marvels "in which we know no reason."[35]

Sensibility No Token of Effectiveness: Boyle. Like Descartes and Charleton, Robert Boyle took a philosophical stance that assumes no ultimate distinction between the occult and seemingly manifest. But Boyle often avoided emphasizing this consequence of his adopting the mechanical philosophy; he frequently used the old terminology of occult and manifest qualities without constantly reminding his reader that he did not believe manifest qualities were really manifest, just as he did not constantly remind his reader that he did not believe in *qualitates*. He was, he said, interested in things, not words, and he was frequently content to use an old form of words, so long as the conceptions to be attached to these words were not the old misconceptions. Yet on occasion he did confront the issue as to what his terminology should be taken to mean, and he then endorsed the ideas we have already met above. In the *Origin of Forms and Qualities*, he explicitly denied the existence of manifest qualities—"there is no distinct quality in [a] pin answerable to what I am apt to fancy pain"—while the whole of the *Sceptical Chymist* can be interpreted as an elaborate argument against the existence of these qualities. In this work Boyle rejected the four-element theory by showing how impossible it was to use that theory to account for observed effects: even colors, paradigmatic manifest qualities, could not be accommodated. So Boyle showed that all qualities exceed the powers of the elements and thus, like Descartes and Charleton, effectively demolished the Aristotelian distinction between the occult and the manifest by arguing that all qualities are occult.[36]

[35]Galileo, *Two New Sciences*, trans. Stillman Drake (Madison: Univ. Wisconsin Press, 1974), p. 14; Bacon, *Novum organum*, I.18, 50, 98; Robert Hooke, *Posthumous Works*, ed. R. Waller (1705; New York: Johnson, 1969), pp. 27, 36, 43; Isaac Newton, *Opticks* (1730; New York: Johnson, 1952), p. 262; *Secrets of Albertus Magnus*, pp. xi, 3, 82.

[36]Boyle, *Works*, Vol. II, pp. 83–96, Vol. III, pp. 23–26, 41, 292–293, Vol. IV, p. 340.

Such arguments, explicit and implicit, against the existence of manifest qualities Boyle supplemented with overt support for occult qualities. Perhaps his fullest discussion of these qualities takes place in a medical context, in a review of the controversial Paracelsan theory of specific cures. Boyle does not reject Paracelsus's idea of occult curative virtues but specifically commends the mechanical philosophy as being able to accommodate such ideas. "Among the several kinds of occult qualities," he writes, "[those] afforded by the specific virtues of medicines . . . appear to be of much greater importance, than . . . commonly thought . . . because divers learned physicians do . . . disfavour the corpuscular philosophy [because] they think it cannot be reconciled to the virtues of specific remedies. . . ." Indeed not only does Boyle see occult properties as reconcilable with the mechanical philosophy, but he explicitly attacks the Aristotelians for refusing to recognize such virtues. He ascribes their refusal to an outworn theoretical commitment to the view that manifest effects can only be produced by manifest agencies:

> [The reason] physicians are wont to reject, if not deride, the use of such specificks, as seem to work after a secret and unknown manner, and not by visibly evacuating peccant humours (or by other supposedly manifest qualities) [is] generally this; that they see not, how the promised effects can well be produced by bodies, that must work after so peculiar and undiscerned a manner. . . . [T]he naturalists may do much towards the removal of this impediment by shewing . . . as strange operations, as are ascribed to these specificks, are not without example in nature; and consequently ought not to be rejected, barely as being impossible. And indeed the physiology . . . [of] the schools, has done . . . no small disservice, by accustoming [physicians] to gross apprehensions of nature's ways of working. Whence it comes to pass, that not a few even learned doctors will never expect, that any great matter should be performed in diseases, by such remedies, as are neither obvious to the sense, nor evacuate any gross, or at least sensible matter. Whereas, very great alterations may be wrought in a body, especially if liquid, as is the blood and peccant humour, without the ingress or egress of any visible matter, by the intestine commotion of the parts of the same body acting upon another. . . . How much an unperceived recess of a few subtile parts of a liquor may alter the nature of it, may be guessed at, by the obvious change of wine into vinegar; wherein upon the avolation (or perhaps but the misplacing) of so little of the spirituous and sulphureous part, that its presence, absence, or new combination with the other parts is not discernible to the eye, the scarce decreased liquor becomes of a quite differing nature from what it was. . . . That . . . invisible corpuscles may pass from amulets, or other external remedies, into the blood and humours, and there produce great changes, will scarce seem improbable to him, that considers, how perspirable . . . a living body is. . . .

And to demonstrate that the mechanical philosophy can accommodate such actions, Boyle argues that even in *ordinary* machines, it is quite common for manifest effects to have hidden, or at least tiny, causes:

> The faint motion of a man's little finger upon a small piece of iron, that were no part of an engine, would produce no considerable effect; but when a musket is ready to be shot off, then such a motion being applied to the trigger by virtue of the contrivance of the engine . . . throws out the ponderous leaden-bullet, with violence enough to kill a man at seven or eight hundred foot distance.

And the same is true of the human body,

> . . . that scarce sensible quantities of matter, having once obtained access to the mass of blood . . . may . . . give such a new and unnatural impediment or determination to the motion of the blood, as to discompose . . . its texture . . . (as a spark of fire reduceth a whole barrel of gunpowder . . .) need be manifested by nothing, but the

> operations of such poisons, as work not by any of those (which physicians are pleased to call) *Manifest Qualities*. For though I much fear, that most of those, that have written concerning poisons, supposing that men would rather believe than try what they relate, have allowed themselves to deliver many things more strange than true; yet the known effects of a very small quantity of opium, or of arsenick, of the scarce discernable hurt made by a viper's tooth, and especially of the biting of a mad dog, (which sometimes, by less of his spittle than would weigh half a grain, subdues a whole great ox into the like madness, and produceth truly wonderful symptoms both in mens bodies and beasts) are sufficient to evince what we proposed.[37]

In this discussion of Boyle's we can observe a repetition of the idea that we encountered in Agrippa, that occult agencies produce disproportionately large effects. Francis Bacon took such "inequality" between cause and effect as one of the defining characteristics of magic. It is then the poor handling of such *instantiae magicae* by Aristotelianism that Boyle is comparing unfavorably with the ease of their accommodation by the mechanical philosophy.[38]

No Tokens of Intelligibility At All: Constructive Skepticism. Boyle, like Charleton, was a figure active in achieving a reconciliation between the new natural philosophy and the skepticism of the late sixteenth century. This skepticism was a continuation of the medieval debates over the roles of revelation and reason, and the problem of delineating the domain of competence of the human mind. Late sixteenth-century skeptics had maintained that the human mind was totally incompetent, leaving revelation as the only source of knowledge. In response to this paralyzing stance, the doctrine of "mitigated" or "constructive" skepticism was developed by Mersenne, Gassendi, and their English followers, while the Cartesians retreated to a new dogmatism. Accepting that the Peripatetic ideal of *epistêmê* was unattainable, the mitigated skeptics settled for an "inferior" science of appearances and effects, in which the search for definitive knowledge about ultimate reality was abandoned. Sensations were accepted (apparently on the theological grounds that God is no deceiver) as being generally reliable, and capable of effective self-correction in cases of illusion, but attempts to glimpse the *Ding an sich* behind these perceptions were seen as futile. For things other than internal sensations, a doctrine of "degrees of certainty" was adopted, and assent was only to be granted partially, in proportion to the evidence available.[39]

Superficially, it might seem that this constructive skepticism would have been hostile to the occult. It denied that we would ever know the ultimate secrets of nature, and in denying further that anything but the immediate sensation is certain, it seemed to support the Peripatetic contention that the insensible is unintelligible. But the skeptics argued that everything else was equally unintelligible, and hence again put the manifest into the same basket as the occult: the cause of redness was just as unintelligible as the cause of magnetism, and the effects of magnetism were just as sensible as the effects of redness.[40] As soon as the negative side of skepticism was sidestepped, the occult became acceptable through the process we have

[37]*Ibid.*, Vol. II, pp. 170–171, 175, 183; Vol. V, p. 77.

[38]Bacon, *Novum organum*, II.51. Cf. Thorndike, *History*, Vol. III, p. 441.

[39]See Richard H. Popkin, *The History of Scepticism from Erasmus to Spinoza* (Berkeley: Univ. California Press, 1979), esp. pp. 129–150; Henry G. Van Leeuwen, *The Problem of Certainty in English Thought 1630–1690* (The Hague: Nijhoff, 1963).

[40]See Joseph Glanvill, *Scepsis scientifica* (London, 1885), pp. 145–148; Sennert, *Natural Philosophy*, p. 431.

witnessed: the destruction of the Aristotelian distinction between the occult and the manifest, and the abandonment of the idea that bodies have genuinely manifest qualities. The range of human intellect is thus paradoxically extended by an intellectual movement stressing its impotence, through a reduction in the standards of what constitutes rational thinking. The inconclusiveness of the hypothetico-deductive method, for example, ceased to be a barrier against its use in science, and the method was self-consciously adopted as a means of exploring the insensible realm of nature. Furthermore, the skeptical arguments were used to refute Peripatetic objections to such occult phenomena as actions at a distance: it is beyond the power of man's reason to know that these are impossible, the skeptics say, so they may well exist. Thus Glanvill, one of the leading constructive skeptics in the Royal Society, writes:

> . . . to shew how rashly we use to conclude things *impossible*; I'le instance in some reputed *Impossibilities*, which are only strange and difficult performances. . . . That Men should confer at very distant removes by an *extemporary* intercourse, is . . . a reputed *impossibility*; but yet there are some hints in Natural operations, that give us probability that it is feasible, and may be compast without unwarrantable correspondence with the people of the Air. That a couple of *Needles* equally touched by the same *magnet*, being set in two Dyals exactly proportion'd to each other, and circumscribed by the Letters of the *Alphabet*, may effect this *Magnale*, hath considerable authorities to avouch it. . . . Now though this pretty contrivance possibly may not yet answer the expectation of inquisitive *experiment*; yet 'tis no despicable item, that by some other such way of *magnetick efficiency*, it may hereafter with success be attempted, when *Magical* History shall be enlarged by riper inspections. . . .[41]

Even Descartes enlisted skepticism as an ally in the fight to achieve acceptance of occult entities in natural philosophy. When we investigate the remoter regions of nature, he says, we do not need to insist on rigorous demonstration. The certainty to be required of such explanations as that he has given for magnetism is only moral certainty, comparable in kind to that of the man who manages to decipher a code by trial and error. Other explanations may well exist in both cases, but the philosopher has done his duty when he has found a possible explanation.[42]

The view proposed above of the leaders of the mechanical philosophy, Boyle, Charleton, and Descartes, that they accepted the importance of occult qualities in natural philosophy and criticized the Aristotelians for failure to give a wide enough recognition to occult agencies, does not accord with prevailing descriptions of the seventeenth-century scientific movement. Even recent studies of the "hermetic" component of the Scientific Revolution have not confronted this view, for they have emphasized the survival and influence of seemingly irrational attachments to pre-seventeenth-century belief in occult qualities, and this emphasis has tended to obscure the essential soundness of the occult qualities themselves. Yet it was a consequence of the accommodation of occult qualities by official science that these "irrational" trappings could be dispensed with, for rational techniques to deal with the insensible had finally become available. Many historians have pointed out the affinities between natural magic and post-seventeenth-century science, but the prevailing misunderstanding of the role of occult virtues in the Scientific Revolution has led to the erroneous view that belief in these virtues on the part of the natural magician marks an irreconcilable difference between the two

[41]Glanvill, *Scepsis scientifica*, pp. 171–176: cf. Van Leeuwen, *Problem of Certainty*, p. 88.
[42]Descartes, *Principia philosophiae*, IV.204–205; *Philosophical Works*, Vol. I, pp. 300–301.

systems of thought. But in fact the two systems have in common a willingness to deal with occult qualities and a refusal to accept that insensibility implies spirituality: it is within natural magic that we can find precedents for the confidence with which seventeenth-century philosophy insisted that the insensible realms of nature could be profitably entered by human thought. Only in the case of Newton has there been significant recognition that something like occult agencies eventually achieved acceptance in the course of the Scientific Revolution. But even here the Newtonian position is strongly contrasted with the earlier mechanical philosophy, and many historians do not in any case accept the description of gravity as occult. If, however, my evidence is accepted, then all these descriptions clearly require modification.

Unintelligibility No Token of Noneffectiveness: The Dispute over Gravity. The one important obstacle to recognizing that the Scientific Revolution accommodated occult qualities is the dispute between the Newtonians and the Cartesians over gravity, in which the Cartesians claimed that gravity is occult. If the mechanical philosophy could openly accept occult agencies, why did this accusation apparently have force? To resolve this dilemma, we must recall the drift in meaning that the word "occult" has suffered since the late sixteenth century, the drift I have already labeled as responsible for much of existing misunderstanding of the role of occult qualities in the Scientific Revolution. For the disputes over gravity reveal that a significant part of this drift actually took place within the seventeenth century, so that when a Cartesian in 1700 refused to accept universal gravitation on the grounds that it was occult, he almost certainly did not mean the same thing by this accusation as might have been meant some half century earlier. When the seventeenth century opened, "occult" had the double connotation of "insensible" and "unintelligible," the two ideas being bound together by the belief that natural reason could not accommodate the insensible. Over the course of the Scientific Revolution, the intelligibility of many insensibles was recognized, and the distinction between the sensible and the insensible lost most of its earlier force, so the connotation "insensible" became somewhat vacuous. Accordingly, the bond between the two ideas was broken, and "occult" lost the connotation of "insensible," to retain only that of unintelligibility.

The most evident symptom of this drift is the fact that the dispute over gravity was clearly about intelligibility, not about sensibility: everyone agreed that gravitation acted insensibly. But the Cartesians were willing to introduce occult qualities in the old sense of the word into their science only on condition that they were not occult in the new sense, that is, that mechanical explanations could be framed for them. To the Newtonians, on the other hand, intelligibility was not essential, and they were happy to deal with occult entities they could not understand, so long as those occult entities satisfied other criteria, notably that they had been reliably detected, and that they were free of the idiosyncrasy so commonly attached to occult qualities in the Aristotelian era.

Thus the Newtonians did *not* maintain that they had banished occult entities, in either the old or the new sense of the word, but only that they had banished objectionable features of earlier approaches to such entities. Echoing Sennert and Charleton, Newton's spokesman Samuel Clarke insists that observed effects must be accepted even if their causes are unknown. He replies to Leibniz's charge that gravity is a "chimerical thing, a scholastic occult quality," with a rhetorical

question that *allows* the possibility that gravity may have an occult cause: "[Is] a manifest quality to be called . . . *occult* because the immediate efficient cause of it (perhaps) is occult?" Newton himself describes gravity and other "active Principles" as "manifest Qualities [whose] Causes only are occult." John Keill sees the successful Newtonian philosophy as an eclectic one, based on borrowings from the other main philosophers: what it has borrowed from Aristotelianism is the idea of a quality. "If the true causes be hid from us," he asks, "why may we not call them occult Qualities?"[43]

Although it is somewhat uncertain what Newton and Clarke meant by a manifest quality here, it is quite evident that neither of them had any objection to Newtonian gravitation's having a cause that might be called occult. But they did insist on an epistemic separation between a discussion of effects and a discussion of causes, and they maintained that one can detect effects reliably, whether or not one understands causes. This methodological point was by no means original with Newton (indeed we have already seen Sennert and Kepler argue to the same effect in earlier defenses of occult causes), but Newton showed more than anyone else how powerful the new method could be. As the attitudes of the opponents of Newton, Kepler, and Sennert indicate, this was a real intellectual advance.

Not only did Newton disapprove of the Cartesian reluctance to endorse the manifest effects of causes which are occult, but he disapproved of the way the Cartesians dealt with the occult causes themselves. Although Descartes rejected the Aristotelian thesis that the insensible was outside philosophy, his attempts to reduce all occult qualities to the effects of peculiar combinations of extension and motion had ended in patent fabrication, and it was impossible to feel confidence in the reality of the speculative mechanisms his imagination had devised. In Newton's view part of the reason for this failure was that Descartes's explanations had been devised individually, with a new mechanical cause postulated for each new effect:

> Could all the phaenomena of nature be deduced from only thre or four general suppositions there might be great reason to allow those suppositions to be true: but if for explaining every new Phaenomenon you make a new Hypothesis if you suppose y^t y^e particles of Air are of such a figure size and frame, those of water of such another, those of Vinegre of such another, those of sea salt of such another, those of nitre of such another. . . . If you suppose that light consists in such a motion pression or force & that its various colours are made of such & such variations of the motion & so of other things: your Philosophy will be nothing else than a system of Hypotheses. And what certainty can there be in Philosophy w^{ch} consists in as many Hypotheses as there are Phaenomena to be explained.

Precisely the same objection could be raised against the idiosyncratic virtues of the Aristotelian era:

> To tell us that every Species of Things is endow'd with an occult specifick Quality by which it acts and produces manifest Effects, is to tell us nothing.[44]

Here is a sense in which it might be said that Newton banished occult qualities, but

[43] *The Leibniz-Clarke Correspondence*, ed. H. G. Alexander (Manchester: Univ. Press, 1956), pp. 94, 118; Newton, *Opticks*, p. 401; John Keill, *An Introduction to Natural Philosophy* (London, 1745), p. 4.

[44] Isaac Newton, Cambridge University Library MS. Add. 3970.3, fol. 479, quoted from Richard S. Westfall, *Force in Newton's Physics* (London: MacDonald, 1971), p. 386; Newton, *Opticks*, p. 401.

it is not their occultness that he objects to. Rather, it is the earlier practice of positing individual qualities—or even mechanisms—to explain individual effects. To the Peripatetics this was reasonable because the *qualitates* were seen as "real" and separate from the effects they produced, and to attribute the effect of a drug, for example, to a "soporific virtue" served the far from trivial task of locating the cause of drowsiness in the drug itself rather than in some supernatural agency summoned by the drug. To the moderns, by contrast, the seating of the cause of drowsiness *within* the drug was not the only alternative to supernatural causation. The action of the drug, to them, represented some special relationship between the mechanical properties of the drug and the frame of the human body, so that to locate it in the drug itself was mere nominalism, an acceptable way of speaking, but no causal explanation. Furthermore, even if it were true that the action of the drug was supernatural in origin, as Newton at times thought gravity might be, such nominalism allowed one to continue to speak of the action as attached to the drug, and one could study its effects exactly as one would study the effects of nonsupernatural actions, so long as they were regular. So the automatic positing of a *qualitas* behind each observed power was pointless, because such descriptions could only be generally true in a nominalistic sense. And given that each *qualitas* was an isolated individual, no explanatory reduction to general laws was even effected. Occult qualities were certainly banished in this sense, but only because they were real and individual. Their being occult was quite irrelevant here: it was just as unacceptable to Newton to explain individual colors through manifest qualities.[45]

As an alternative, Newton sought "two or three" *universal* occult causes, as exemplified in the gravitational force he discovered and in the chemical and optical forces he continually searched for. Not only do such causes have real explanatory powers, even if interpreted nominalistically, but their existence can be soundly confirmed by the accumulation of evidence. Though the seventeenth century saw removed any objection of principle to occult virtues, the same century also saw abandoned many occult virtues previously believed in, because sound evidence for these particular virtues could not be accumulated. The skepticism pervading the seventeenth century imposed new standards of evidence upon claimants to the title of established fact. Science became intolerant of events which could not be widely observed, and following Bacon's lead, rejected the idea of "unlevel wits," men whose subjective experiences were more valid than others. Experiments were expected to be repeatable, or else the evidence provided by them would be too weak to command significant assent.[46] Totally idiosyncratic occult virtues in the Paracelsan mold could not be accepted into science, because it was impossible to accumulate evidence for them. Universal occult actions such as Newton's gravity, by contrast, could be repeatedly detected by anyone, and evidence for them could be substantial. The less specific a virtue is, the more assent it can command, and the more it can explain. Occult virtues are acceptable to the constructive skeptic, but only after they have been shaved by Ockham's razor.

[45]A. I. Sabra, *Theories of Light from Descartes to Newton* (London: Oldbourne, 1967), pp. 290, 294.

[46]Joseph Glanvill, *Essays on Several Important Subjects* (1676; New York: Johnson, 1970), pp. xv, 49; John Locke, *An Essay Concerning Human Understanding* (London, 1690) 4.15–16; Bacon, *Works*, Vol. IV, p. 26; Jacques Rohault, *A System of Natural Philosophy*, trans. Samuel Clarke, 2 vols. (1723; London: Johnson, 1969), Vol. I, pp. 13–14. See Paolo Rossi, *Francis Bacon: From Magic to Science*, trans. S. Rabinovitch (London: Routledge & Kegan Paul, 1968), pp. 27–35.

Although the success of the Newtonian program partially eclipsed constructive skepticism, with Newton himself giving much support to this new dogmatism, there remains a large measure of skepticism in Newton's attitudes, even his conscious ones. Like his skeptical predecessors, Newton insisted that fundamental truth is beyond our reach, since God has the freedom and power to produce the sensible appearance of the world through any of a variety of unknowable means.[47] Newton adopted the notion of different levels of verification, and he accepted effects without understanding their causes. It is unclear whether he regarded gravity as beyond understanding or simply as not yet understood. His voluntarism would have allowed him to accept gravity's incomprehensibility, while his attempting to devise mechanisms for it suggests he thought it within the grasp of reason. But for a skeptically inclined mind the issue is not urgent: it is the effect rather than the cause that takes priority. The Cartesians interpreted the Newtonians' willingness to describe the cause of gravity as occult as a declaration that gravity *could not* be understood, that it was some sort of primary quality imposed directly by divine participation. It was this type of occultness that Leibniz objected to, not occultness in general:

> . . . the ancients and moderns who avow that gravity is an *occult quality*, are right if they mean thereby that there is a certain mechanism unknown to them, by which bodies are impelled toward the center of the earth. But if their notion is that this transpires without any mechanism, by a simple *primitive property*, or by a law of God which brings about this effect without using any intelligible means, then it is a senseless occult quality. . . .[48]

It was thus Newton's voluntarism, and the attached skepticism, or perhaps caricatures of these attitudes, that the Cartesians attacked under the banner of occult qualities. Unlike Newton, the Cartesians refused to base their philosophy upon any entities that were less than perfectly intelligible, and for them, or others who shared their insistence on intelligibility, the word "occult" could be applied in its new sense as a term of abuse. Some who shared this insistence did not agree that the Cartesian or Leibnizian ideas were as perfectly intelligible as their proponents made out. To them, the Leibnizian inherent activity of matter, or the basic mechanism of the Cartesian system, the impact interaction, could be just as occult as Newtonian forces were to a Cartesian.[49] Considerable dispute thus emerged from the seventeenth century as to what was to be counted as intelligible, that is, as to what constituted the reference of the word "occult." But there was widespread agreement over its sense of "beyond understanding." More importantly, there was universal agreement that the Aristotelian criterion for intelligibility—sensibility—was inadequate. The abandonment of this criterion and the exploitation of the epistemological ideas that lay behind this abandonment were undoubtedly major components of the Scientific Revolution.

[47]See, e.g., Isaac Newton, *Mathematical Principles of Natural Philosophy*, trans. A. Motte (1729), rev. F. Cajori, 2 vols. (Berkeley: Univ. California Press, 1966), Vol. II, p. 546; and Newton, *Unpublished Scientific Papers*, ed. and trans. A. R. and M. B. Hall (Cambridge: Cambridge Univ. Press, 1962), pp. 138–145.

[48]As quoted by Cajori in Newton, *Mathematical Principles*, Vol. II, pp. 668–669.

[49]See, e.g., Leonhard Euler, *Opera omnia*, Series II, Vol. III, ed. C. Blanc (Leipzig: Teubner; Zürich: Füssli, 1948), p. 50; Berkeley and Maupertuis, as cited and discussed on pp. 159–160 of Thomas Hankins, *Jean d'Alembert* (Oxford: Clarendon Press, 1970); *Leibniz-Clarke Correspondence*, p. 116; and Peter van Musschenbroek, *The Elements of Natural Philosophy*, 2 vols., trans. J. Colson (London, 1744), Vol. I, preface.