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Reviewed work(s):

Source: *Isis*, Vol. 56, No. 1 (Spring, 1965), pp. 26-45

Published by: [The University of Chicago Press](#) on behalf of [The History of Science Society](#)

Stable URL: <http://www.jstor.org/stable/228456>

Accessed: 14/09/2012 03:37

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# The Principle *Omne quod movetur ab alio movetur* in Medieval Physics

By James A. Weisheipl, O. P.\*

THE PROBLEM WE wish to consider in this paper can be expressed very simply. The solution to the problem, however, is far from simple, both scientifically and historically. The problem is simply this: What is the meaning of the basic principle of medieval physics, *Omne quod movetur ab alio movetur*, literally, "Whatever is moved is moved by another"?<sup>1</sup>

The importance of this principle in medieval thought is most easily recalled in Aristotle's proof of a First Mover in the *Physics* and *Metaphysics*, and in St. Thomas' first proof for the existence of God in the *Summa theologiae*, *Summa contra gentiles*, and *Compendium theologiae*. Aquinas' first proof has been quoted, paraphrased, amplified and condensed, accepted and rejected, and even misunderstood so many times that we may sometimes feel uncertain as to what it really does mean. At the risk of quoting what is already well known, let us recall the argument from the *Summa theologiae*:

It is certain to the intellect and obvious to the senses that something is moved in this world. But whatever is moved is moved by another; for nothing is moved except insofar as it is capable of possessing the term to which it is moved, while a thing moves another inasmuch as it is actually effective. To move means to draw something from potentiality to actuality, and nothing can be drawn from potentiality to actuality except by something active; just as an actually hot body, like fire, makes wood, which is potentially hot, to be actually hot, thereby moving and changing it. It is not possible that a thing be both actual and potential possessor of the same term, but only of different terms; for what is actually hot cannot at the same time be potentially hot, although it can be potentially cold. Therefore it is impossible

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\* Dominican House of Studies, River Forest, Illinois. The substance of this paper was presented as an Institute Lecture at the Pontifical Institute of Mediaeval Studies, Toronto, on 25 October 1963.

<sup>1</sup> The meaning of this axiom was heatedly debated in the 1920's and 1930's in the context of its theological implications; see, for example, Johann Stuffer, S. J., "Der hl. Thomas und das Axiom: Omne, quod movetur ab alio movetur," *Zeitschrift für katholische Theologie*, 1923, 47: 369-390; Gallus M. Man-

ser, O. P., *Das Wesen des Thomismus*, 2nd ed. (Freiburg i. Schweiz, 1935), 312-322, 549-571. It is clear that modern Scholastics, while conceding the significance of the axiom, interpret it in a variety of ways, often diametrically opposed to one another. A diversity of medieval interpretations is now beginning to be appreciated; see Roy R. Effler, O. F. M., *John Duns Scotus and the Principle "Omne quod movetur ab alio movetur"* (St. Bonaventure, N. Y.: Franciscan Institute, 1962).

that anything be at the same time and in the same respect both mover and moved, or that it move itself. Thus whatever is moved is moved by something else. Consequently if that by which a thing is moved is itself moved, then it too must be moved by another, and that by another. But this cannot go on indefinitely, for then there would be no original mover, nor consequently any other mover, since dependent movers do not move except insofar as they have been moved by the original mover, even as a baton moves only because the hand moves it. Consequently one must arrive at some First Mover which in no way is moved; this all men understand to be God.<sup>2</sup>

In this presentation of the case a number of problems arise with regard to the principle *Omne quod movetur ab alio movetur*. The first problem is whether the principle is actually demonstrated or whether it is self-evident once the terms are understood, a principle *per se notum sapientibus* perhaps.<sup>3</sup>

In the passage quoted above, Aquinas shows the truth of the principle by explaining the terms *moveri* and *movere*. "To be moved" (*moveri*) is a passive capacity for someone else's action. "To move" (*movere*), on the other hand, is a transitive verb designating an agent's activity on a recipient. Thus the active voice *movere* signifies a movement, or change precisely as produced by an agent, while the passive voice *moveri* signifies that same movement, or change precisely as it is taking place in the recipient. As explained in Aristotle's *Physics*, III, 3, the one reality of motion belongs to both agent and patient, but in different ways. Motion belongs to the recipient as an actuality existing in it, perfecting it, for it is the recipient which undergoes change. But the same motion belongs to the agent as the actuality produced by the agent, caused by it, for it is the agent which is responsible for the change. Thus the process of constructing a building belongs both to the builders and to the building, but it is the builders who *build* and the building which *is built*. Once the terms *moveri* and *movere* are understood, then it is evident that "to be moved" cannot be the same as "to move," otherwise a thing would be moved and not moved at the same time under the same aspect. Thus if anything is to be moved at all, then it must be moved by something other than itself. That is, nothing can move itself. In other words, if "to be moved" is a passive capacity for someone else's action, then someone else must do the acting. This clarification of terms in St. Thomas' argument is essentially the same as Aristotle's procedure in *Physics*, VIII, 5. Although Aquinas says that the proposition

<sup>2</sup> *Summa theologiae*, I, q. 2, a. 3.

<sup>3</sup> In Aristotelian thought there are various kinds of principles. The basic distinction between principles of being (or things) and principles of thought was frequently employed by Aristotle himself. Principles of thought include not only definitions, but also true premises, some of which must be proved by prior principles, others are immediately evident, and still others are immediately evi-

dent and absolutely first. See *Posterior Analytics*, I, 2. The Schoolmen, following a suggestion of Boethius (*De hebdomadibus*, PL 64,1311), distinguished between principles immediately evident to everyone (*omnibus*) and those immediately evident to experts learned in a discipline (*sapientibus*, or *doctis*). See St. Thomas, *In Boethium De hebdomadibus*, lect. 1; *In I Post. Anal.*, lect. 5, n. 7.

must be proved (*probanda*),<sup>4</sup> it would seem that a clarification of terms such as this is not necessarily a demonstration in the strict sense of the term.

Aristotle, however, justifies the principle *Omne quod movetur ab alio movetur* with two additional arguments, which might be called "proofs" in the wide sense. In *Physics*, VIII, 4, he establishes it — to use the words of Aquinas and Albertus Magnus<sup>5</sup> — *per inductionem*. Aristotle shows that in all cases of violent motion, as when a discus is thrown or trees are blown down, the mover is obviously extrinsic; in all cases of natural motion, as coming-to-be, growing, ripening, and falling, the mover is also extrinsic, although this is less obvious; and in all animate motions, as walking, talking, and scratching, the mover is distinct from the part moved. Consequently everything that is moved is moved by another. We shall come back to this later. For the present it is sufficient to note that this induction is not strictly demonstration.

Finally in *Physics*, VII, 1, Aristotle shows that if anything is assumed to move itself, as Plato assumes, then it is not really moving itself *primo* and *per se* (*καθ' αὐτὸ καὶ πρῶτον*), but only by reason of parts, which is not self-movement *primo* and *per se*. Here Aristotle simply shows that it is impossible for anything to move itself *primo* and *per se* because "to move" is not the same as "to be moved."<sup>6</sup> As soon as it is shown that "to move" and "to be moved" are distinct actions requiring distinct parts, then it is clear that the mover does not move itself. Rather, the part that is moved is moved by a part distinct from itself, that is to say, by another.

Without attempting to give a definitive answer to our first problem, we perhaps can say that the principle *Omne quod movetur ab alio movetur* is not demonstrated strictly speaking. Rather it seems to be an axiom, or principle *per se notum sapientibus*, requiring sense experience and a careful analysis of the terms.<sup>7</sup> Once the terms are understood in their technical sense, the proposition seems to be immediately evident. In any case, since this point is not essential to our paper, it is true to say that in the late Middle Ages the principle was used axiomatically in philosophical argumentation,

<sup>4</sup> *Summa contra gentiles*, I, c. 13: "In hac autem probatione sunt duae propositiones probandae, scilicet quod omne motum movetur ab alio, et quod in moventibus et motis non sit procedere in infinitum." Aquinas goes on to say that Aristotle proves (*probat*) the first proposition in three ways, the ways described in the paper.

<sup>5</sup> *Ibid.*, par. 8; Albertus Magnus, *Lib. VIII Phys.*, tr. I, c. 1, ed. A. Borgnet (Paris, 1890) III.484a.

<sup>6</sup> According to the text, Aristotle's argument rests on the impossibility of a "first part" in motion, since motion is infinitely divisible; therefore there cannot be a first moving part by which a body could move itself. This Aquinas considers to be a true demonstration *propter quid*, because it expresses the real reason why a thing cannot move itself: "sed

videtur dicendum quod non sit demonstratio quia, sed propter quid; continet enim causam quare impossibile est aliquid mobile movere seipsum." *In VII Phys.*, lect. 1, n. 6.

<sup>7</sup> In Aquinas' view such evident principles are "derived" from principles commonly known to all, but this is not to say that they are "demonstrated" merely because learned terms are reduced to simpler and better-known terms. The usual example of a principle *per se notum sapientibus* is rather striking. "Alia vero animi conceptio est communis solum doctis, quae derivatur a primis animi conceptionibus, quae sunt omnibus hominibus communes; et huiusmodi est 'incorporalia non esse in loco,' quae non approbatur a vulgo, sed solum a sapientibus." *In Boeth. De hebdomad.*, lect. 1.

even without proper clarification and justification. For this reason the principle has been and still is frequently misunderstood.

Incidentally — and here, I think, we come to the Gordian knot — we are not saying that “whatever moves or whatever is in motion is moved by another.” A proposition such as this is neither self-evident nor true. It is not true to say that whatever moves (*omne movens*) is also moved, for clearly the *primum movens* is not moved; that is the whole point of the argument. Nor can one say that everything that is now in motion (*omne in motu*) is being moved here and now by something else. In the first place, this is contrary to the grammar of the text. In the second place, this proposition is not at all evident to the senses or to reason. St. Thomas never said, *Omne movens ab alio movetur*; nor did Aristotle. The Greek verb κινούμενον in Aristotle’s text is middle and passive in form, and it means “is being moved,” a sense clearly expressed in the Latin passive *movetur*.<sup>8</sup> Certainly the active sense of *movens* is out of the question. Nor did St. Thomas — or Aristotle, for that matter — ever maintain that everything that is in motion must be here and now moved by something, as some imagine. This interpretation is grammatically impossible and philosophically absurd. It is precisely this bad grammar and bad philosophy which have given rise to misunderstanding concerning the principle *Omne quod movetur ab alio movetur*.

The second problem which arises out of St. Thomas’ first proof concerns the word *movetur*. What does St. Thomas intend to include in this term? According to Aristotle, motion (*κίνησις* or *motus*) strictly so-called is found only in three categories, namely “quantity” (growing and shrinking), “quality” (intension and remission), and “where” (various types of locomotion). If *movetur* means to be moved by these motions and not by any other kind of change, one will conclude either to an animated material substance causing motion or to a separated immaterial substance, which will not necessarily be God as St. Thomas understands him. In this case the existence of God is, strictly speaking, not demonstrated. Therefore, St. Thomas must have intended the verb *movetur* to be taken in the widest possible sense of any change whatever produced by another. Consequently *movetur* must include every coming into being, even of the whole substance whether it be physical or spiritual.

But then a third problem arises from the example of the hand moving the baton and from St. Thomas’ frequent reference to the whole universe as the instrument of the First Cause.<sup>9</sup> Does Aquinas mean that the whole universe is like a pencil or baton in the hand of God? This example of strict instrumental causality implies that not only the First Mover but also every intermediate mover is here and now moving the instrument to produce the desired effect, namely motion. In this case, it would seem that every physical motion would require “a particular mover bound to it and

<sup>8</sup> For the Greek text see fn. 19.

103, a. 5 ad 2; *Sum. cont. gent.*, II, cc. 22–23;

<sup>9</sup> *Sum. theol.*, I, q. 19, a. 4; q. 22, a. 2; q. III, cc. 64–70; etc.

generating it directly," to use the phrase of Anneliese Maier.<sup>10</sup> This interpretation, however, not only eliminates the concept of nature and the concept of secondary causality in physics, but it is contrary to the grammar of the axiom and contrary to St. Thomas' expressed view of the matter.

## I

In medieval physics there were three highly controversial problems which involved the principle *Omne quod movetur ab alio movetur*. These were the problem of the natural fall of heavy bodies, the problem of projectile motion, and the problem of celestial motion. I am not saying that these were the only problems of physics which involved the Aristotelian principle. By no means is this so. Since everything in nature is in some way *moved*, there is always the scientific problem of seeking its true physical causes. St. Thomas begins his treatise *De motu cordis* by saying, "Since everything which is moved must have a mover, there is the problem of what moves the heart and what type of motion does the heart have."<sup>11</sup> In fact, the principle *Omne quod movetur ab alio movetur* is so fundamental and universal in Aristotelian natural philosophy that it must be recognized as one of the first principles of the entire science of nature. In the eyes of modern historians of science this was the most basic and most erroneous principle in Aristotelian physics. Thus while recognizing the universality of this principle in ancient and medieval Aristotelianism, we wish to limit our discussion to three problems in medieval physics: the natural motion of heavy bodies downward, the unnatural motion of projectiles, and the perpetual motion of rotating spheres. Modern historians of science concentrate on these three problems in order to evaluate the Aristotelian principle by modern concepts of gravitational motion and the law of inertia.

Modern historians are surprisingly at one in their interpretation and evaluation of Aristotelian physics. Following an earlier tradition, historians like Pierre Duhem,<sup>12</sup> Sir David Ross,<sup>13</sup> Father Peter Hoenen,<sup>14</sup> Alistair C. Crombie,<sup>15</sup> Marshall Clagett,<sup>16</sup> Eduard J. Dijksterhuis,<sup>17</sup> and Anneliese Maier<sup>18</sup> interpret the Aristotelian principle to mean that everything that is

<sup>10</sup> Anneliese Maier, "Ergebnisse der spät-scholastischen Naturphilosophie," *Scholastik*, 1960, 35: 170.

<sup>11</sup> *De motu cordis ad mag. Philippum*, in *Opera Omnia* (ed. Parma, 1875), XVI.338a.

<sup>12</sup> Pierre Duhem, *Le Système du monde*, Vol. I (Paris: Hermann, 1913), pp. 174-175.

<sup>13</sup> W. D. Ross, *Aristotle's Physics* (Oxford: Clarendon Press, 1936), pp. 88-94; comm. on 266a10-11 (pp. 721-722), 266b27-267a20 (pp. 725-726).

<sup>14</sup> Peter Hoenen, *Cosmologia* (4th ed. Rome, 1949), pp. 497-502.

<sup>15</sup> Alistair C. Crombie, *Augustine to Galileo* (London: Falcon Press, 1952), p. 82; *Medieval and Early Modern Science* (2 vols. Garden City, N. Y.: Doubleday, 1959), Vol. 1, pp. 69-70,

76-78, 114-115; Vol. 2, pp. 47-48.

<sup>16</sup> Marshall Clagett, *The Science of Mechanics in the Middle Ages* (Madison: University of Wisconsin Press, 1959), pp. 424-426.

<sup>17</sup> E. J. Dijksterhuis, trans. C. Dikshoorn, *The Mechanization of the World Picture* (Oxford: Clarendon Press, 1961), pp. 24-31.

<sup>18</sup> Maier, *art. cit.*, 161-187; *Studien zur Naturphilosophie der Spätscholastik*, Vol. I (Rome: Storia e Letteratura, 1949), pp. 54-72, 132-133; *Studien*, Vol. 2 (Rome: Storia e Letteratura, 1951), pp. 114-119; *Studien*, Vol. 3 (Essen: Essener Verlagsanstalt, 1943), pp. 143-157, 181-188, 220-223; *Studien*, Vol. 4 (Rome: Storia e Letteratura, 1955), pp. 227-230.

moving must be moved by something here and now conjoined to the moving body. In the Oxford translation of Aristotle's works, Hardie and Gaye always render the classical axiom as "Everything that is in motion must be moved by something."<sup>19</sup> According to Ross, Aristotle tacitly assumes

that one body can be in movement as a result of the influence of another only so long as the other body is continuing to act on it, and is in fact still in contact with it. He [Aristotle] has in fact no concept of the First Law of Motion, that if a body has once been set in motion it will continue to move till it is acted on by some fresh force.<sup>20</sup>

Since motion is by definition a continuous actualization of potentiality, Mr. Crombie conceives this to be a process which necessarily requires the continued operation of a cause in such a way that when the cause ceases to operate, so does motion.<sup>21</sup> Crombie goes on to explain, "All moving bodies which were not alive thus received their motion from a mover distinct from themselves and the mover necessarily accompanied the body it moved." Professor Clagett explains the mind of Aristotle in the same way:

The first point to recognize is that for Aristotle motion is a process arising from the continuous action of a source of motion or "motor" and a "thing moved." The source of motion or motor is a force — either internal as in natural motion or external as in unnatural motion — which during motion must be in contact with the thing moved.<sup>22</sup>

Professor Dijksterhuis gives the same explanation:

Aristotelian physics is based on the axiom that every motion (*motus*) presupposes a mover (*motor*): *omne quod movetur ab alio movetur*. This *motor* must either be present in the moving body or be in direct contact with it; action at a distance is excluded as inconceivable: a *motor* must always be a *motor conjunctus*.<sup>23</sup>

Modern historians, however, experience some difficulty in identifying the *motor conjunctus*, the *agens proximum* of freely falling bodies. They readily point out that for Aristotle the celestial spheres are moved by intelligent souls, and that projectiles are moved by the medium, both of which agents are clearly distinct from the body moved. But the accompanying mover of a freely falling body is less easy to discover in Aristotle. Dijksterhuis is of the opinion that "Aristotle does not make any unambiguous statement about this, and Scholasticism therefore had to study this problem anew."<sup>24</sup> According to Dijksterhuis the Scholastics finally decided that the *agens proximum* of natural motion downward or upward must be the substantial form.<sup>25</sup> Ross, Hoenen, Crombie, Clagett, and Maier do not hesitate to imagine the substantial form as the immediate, conjoined mover

<sup>19</sup> The Greek text reads: "Ἀπαν τὸ κινούμενον ὑπὸ τινος ἀνάγκη κινῆσθαι (*Phys.*, VII, 1.241b34; cf. alternative VII, I. 241b24).

<sup>20</sup> Ross, *op. cit.*, comm. on 266a10–11, *ed. cit.*, p. 722.

<sup>21</sup> Crombie, *Augustine to Galileo*, p. 82.

<sup>22</sup> Clagett, *op. cit.*, pp. 425–426.

<sup>23</sup> Dijksterhuis, *op. cit.*, p. 24.

<sup>24</sup> *Ibid.*, p. 26.

<sup>25</sup> *Ibid.*, also p. 177.

of natural bodies in Aristotelian physics. In this view the substantial form is the mover, and matter is that which is moved. Duhem, however, sensed the inappropriateness of this way of speaking; he insisted that "the Stagirite intended the form to be moved together with the matter."<sup>26</sup> Consequently Duhem preferred to explain Aristotle's doctrine exclusively in terms of natural place enticing bodies not yet in it, a kind of extrinsic form desired by bodies which must move toward it.<sup>27</sup> Giving in fact an explanation of the final cause of natural locomotion, Duhem did not identify the efficient mover supposedly responsible for the downward movement of heavy bodies and the upward movement of light. Contemporary authors, however, do not sense any inappropriateness in identifying substantial form as the *motor conjunctus*, the efficient cause of natural motion in Aristotelian physics. They are content to imagine substantial form and primary matter as two distinct and independent substances, one as mover, the other as moved. This view they attribute to Aristotle and to medieval Scholasticism! More important, they seem to be unaware of the insuperable difficulty presented when we come to explain the difference between living and nonliving things, for living things are precisely those things which are able to move themselves (*se moventes*), that is, to be an efficient cause of some of their motions. It will hardly do to say that Aristotle thought of inanimate bodies as "self-movers."

A similar awkwardness is noticed in the explanation of Aristotelian dynamics. Modern historians explain that the velocity of a moving body in Aristotle's physics is in direct proportion to the power of the accompanying mover and in inverse proportion to the resistance offered by the medium. Mr. Crombie explains the mind of Aristotle as follows:

With falling bodies the force or power causing the movement was the weight, and so it followed from the above principles that in any given medium the velocity of a falling body was proportional to its weight and further, that if a body were moving in a medium which offered no resistance its velocity would be infinite.<sup>28</sup>

Suddenly and without warning we are presented with a new factor, resistance from a medium, such as air. Matter, which "is moved" by the substantial form, drops from the picture completely without explanation. Apparently this matter offers no resistance to the *motor conjunctus*. But since it is assumed that Aristotle demanded resistance for the very possibility of motion, the medium is introduced to provide resistance and the possibility of motion. We are now not talking about motions as they actually occur in the universe, but about the very possibility of motion. Thus it is said

<sup>26</sup> Duhem, *op. cit.*, p. 208.

<sup>27</sup> *Ibid.*, p. 209: "Ce corps, étant en puissance de quelque chose, peut, à l'égard de ce quelque chose, être considéré comme une matière; ce dont il est en puissance, ce dont il est privé peut, à l'égard de ce corps, être regardé comme une forme; voilà pourquoi on

peut dire que lorsqu'il est porté vers son lieu naturel, il est porté vers sa forme." *Ibid.*, p. 209.

<sup>28</sup> Crombie, *Augustine to Galileo*, p. 83; *Medieval and Early Modern Science*, Vol. 2, pp. 47-49.



that the velocity of a freely falling body must be in direct proportion to the power of the accompanying mover and in inverse proportion to the resistance offered by the medium.<sup>29</sup>

Modern historians discussing the Aristotelian concept of motion inevitably argue the case in terms of acceleration, as though Aristotle had identified motion with acceleration or, what is worse, with velocity itself. For Aristotle speed is not motion, but a property of motion. While Aristotle had a great deal to say about "motion," "being moved," and the like, he had notoriously little to say about acceleration. He noted that in *natural* terrestrial motions a body "seems always to be moving with a quickening velocity, whereas what is *forced* against its nature is always losing velocity."<sup>30</sup> He further noted that only rotational motion can be uniform, for natural rectilinear motions "are never uniform as they pass from the beginning to the end, for in them the mobile moves more rapidly in proportion as it is further from the position of rest."<sup>31</sup> Aristotle was fully aware that in all natural local motion there was acceleration the closer the body got to its goal,<sup>32</sup> but he never conceived of this as a special problem needing a special solution in terms of new movers. For him it was sufficient that a body "be moved by another" in the first place and that, if the motion is natural, it will be accelerated by nature, by *φύσις*.<sup>33</sup> Aristotle's concern, at least in the *Physics*, was much wider than a concern over natural acceleration — which to him posed no problem. His concern was with the basic question of "being moved" in the first place, whether in natural generation, in unnatural (forced, or mechanical) motions, or in uniform celestial motions. Aristotle was clearly intent upon showing that in all three types of motion the body was or is moved by another; he does this in order to establish the activity of the First Mover. Modern historians, however, are anxious to evaluate all this in terms of the modern problem of acceleration and gravitational forces, thus restricting the wider Aristotelian concern.

In *Physics*, VII, 5, Aristotle did indeed discuss certain proportions of velocity which would follow from doubling the force exerted on a body and from decreasing its resistance by one-half. But modern historians see in this a universal law of Aristotelian dynamics so that in all motions, both mechanical and natural, velocity is thought to be inversely proportional to resistance, whether that resistance comes from a solid body being moved mechanically or from a natural medium such as air. Generally the universal law of Aristotelian dynamics is symbolized by

$$v = f \times \frac{F}{R} \quad \text{or} \quad v = f \times \frac{W}{R}$$

(in which  $F$  = moving force,  $R$  = resistance,  $v$  = velocity,  $f$  = constant of proportionality, and  $W$  = weight). In all such cases the moving force must

<sup>29</sup> *Ibid.*

<sup>30</sup> Aristotle, *Phys.*, V, 6. 230b24–25.

<sup>31</sup> *Phys.*, VIII, 9. 265b12–14.

<sup>32</sup> *De caelo*, I, 8. 277a27–33.

<sup>33</sup> James A. Weisheipl, O.P., *Nature and Gravitation* (River Forest, Ill.: Albertus Magnus Lyceum, 1955).

be divided by resistance.<sup>34</sup> Thus resistance is thought to be an essential factor for all motion, and without resistance of some kind, velocity is said to be infinite, that is, instantaneous (*in instanti*). But all modern historians agree that for Aristotle *motus in instanti* is impossible. Therefore they conclude that in Aristotelian physics motion in a void is absolutely impossible.

These views of modern historians of Aristotelian physics are fully expressed by Anneliese Maier in her explanation of the principle under discussion. For Miss Maier the principle, which she phrases as *Omne quod movetur ab aliquo movetur*, means that "every movement requires a particular mover bound to it and generating it directly, and every normal, successive motion taking place requires a resistance which opposes the moving force and which is overcome by that force, since without resistance there would be no *motus*, but *mutatio*, i.e., an instantaneous change of place."<sup>35</sup> She goes on to explain that adherence to this erroneous principle prevented Aristotelian Scholastics from discovering the principle of inertia, which states that a body once set in motion will continue in rectilinear motion forever unless deterred by another body. Thus, according to Maier, the Scholastics not only failed to anticipate the principle of inertia, but they were prevented from doing so because they adhered to the erroneous principle *Omne quod movetur ab alio movetur*.<sup>36</sup>

From what has been said of natural movement downward and upward, it is not surprising that modern historians explain the impetus theory of the fourteenth century in terms of a *motor conjunctus*, an immediate efficient cause accompanying the moving body until it is overcome by the natural forces of the body. Impetus is thus conceived of as a mover, an efficient cause, the immediate agent of compulsory movement. Explaining the fourteenth-century theory of impetus, Dijksterhuis says, "It was assumed that the *projiciens* imparted this power to the *mobile*, for which it formed the *motor conjunctus*."<sup>37</sup> The difference between such an impetus and substantial form is that impetus will eventually be overcome and eliminated by the contrary tendencies of substantial form. But both are said to be movers accompanying the body in motion. Both are said to require resistance.

Jean Buridan had suggested in his questions on the *Physics*, q. 12, that God could have given such an impetus to the celestial spheres at the time of creation, thus eliminating the need for continual movement by Intelligences. Buridan went on to say that "these *impetus* which God impressed on celestial bodies have not been diminished or destroyed in the passage of time, because in celestial bodies there was no inclination to other motions, nor any resistance which could destroy or restrain these *impetus*."<sup>38</sup>

<sup>34</sup> *Op. cit.*, p. 30: On this Dijksterhuis says: "In the above formulation of the fundamental law of dynamics a peculiarity of Aristotelian thought, which later seriously impeded the growth of classical mechanics, is clearly revealed, namely the tendency to divide the moving force by anything that may be con-

sidered as resistance, and never to subtract the latter from the former."

<sup>35</sup> Maier, *art. cit.*, p. 170.

<sup>36</sup> *Ibid.*, pp. 169-170, 177-180.

<sup>37</sup> Dijksterhuis, *op. cit.*, p. 179.

<sup>38</sup> Jean Buridan, *QQ. in lib. Phys.*, q. 12, ed. Maier (*Studien*, Vol. 2, p. 212), lines 179-182.

Duhem, Crombie, and Dijksterhuis see in this statement a foreshadowing of Galileo's principle of inertia. But surely, if their interpretation of Aristotelian dynamics is correct, then there should be no motion at all, not even for Buridan, since celestial bodies in the traditional view never provided any resistance, whether moved by God immediately, or by Intelligences, or by impetus. Something is wrong somewhere!

From what has been said it would seem that we need to reconsider Aristotelian physics, particularly in the Middle Ages. What is needed is a reconsideration of the principle *Omne quod movetur ab alio movetur* along more historical and scientific lines.

## II

In the first place we must keep in mind that there were many interpretations of Aristotle in the Middle Ages. Not everyone who commented on the works of Aristotle, nor everyone who quoted him enthusiastically, should be classified as an Aristotelian. It is well known that many did not fully appreciate what has been called Aristotle's fundamental discovery in natural philosophy, namely the reality of pure potentiality as a passive principle of change, a principle called  $\pi\rho\tilde{\omega}\tau\eta \psi\lambda\eta$ , "first matter." Without this basic philosophical insight, the radical oneness of individuals is always in jeopardy. With this insight, however, there is no insolvable problem about the substantial unity of individuals, the unicity of substantial form, the possibility of fundamental change, and a host of related questions disputed in the Middle Ages. The failure to achieve this insight is plainly manifest in the conception of "form" as an accompanying mover and "matter" as a separate part moved. This conception is nowhere to be found in the works of Aristotle, as Duhem and Dijksterhuis have admitted. However, it did exist among some interpreters of Aristotle in the Middle Ages.

Avicenna's *Sufficientia*<sup>39</sup> explained natural motion to the Latins in terms of a natural inclination to a natural place. The rising of light bodies and the falling of heavy bodies comes about necessarily from the essence of the body. "However," Avicenna remarked, "it is absolutely impossible for an essence of a thing to cause its own motion unless it be a mover through its own form and a moved through its own subject (*nisi sit ipsamet movens per suam formam et mota per suum subiectum*)."<sup>40</sup> As Avicenna was never able to explain natural generation of forms from the potentiality of matter, but had to appeal to an external *Dator formarum*,<sup>41</sup> he could speak of forms as natural movers and subjects as matter moved. He saw no incongruity in speaking of inanimate bodies moving themselves through form, *elevando*

<sup>39</sup> Avicenna, *Opera philosophica* (ed. Venice, 1508), fol. 13r-36v.

<sup>40</sup> *Ibid.*, *Sufficientia*, lib. II, cap. 1, fol. 24ra. See Harry A. Wolfson, *Crescas' Critique of Aristotle* (Cambridge: Harvard University Press, 1929), pp. 673-675; also Bernard Carra de Vaux, *Avicenne* (Paris: F. Alcan, 1900),

pp. 184-185.

<sup>41</sup> On this see St. Thomas, *De pot.*, q. 3, a. 8; q. 6, a. 3; *Sum. theol.*, I, q. 45, a. 8; *In II Sent.*, d. 1, q. 1, a. 3 ad 5; a. 4 ad 4; *In VII Metaph.*, lect. 7, n. 14330-14331; lect. 8, n. 1438-1442.

*et movendo se*, as one Latin passage expressed it.<sup>42</sup> For Avicenna celestial motions are produced both by the natural inclination of the body and by the intelligent soul animating it.<sup>43</sup> Both of these views, of course, could also be read in Algazel's paraphrase, *Maqâcid el-falâcifa*.<sup>44</sup>

It was Averroës, however, who most influenced Latin interpretations of Aristotle's natural philosophy. Like Avicenna, Averroës conceived the form of heavy bodies, *gravitas*, to be the accompanying mover of downward natural movement and "matter" to be the body moved. However, his very detailed explanation rests on two assumed requirements for all motion: first, that some mover must accompany a body in motion, and second, that the mover must encounter resistance.

In his commentary on *De caelo*, III, comm. 28,<sup>45</sup> Averroës compares natural and violent motions. Violent, or unnatural, motion not only arises from an outside projector, but its entire production is foreign and alien to the body being imposed upon. The originator of this violent motion is the original *proiciens*, but the continuator of this alien motion — for both Aristotle and Averroës — is the medium, which has been given power to continue this motion. Similarly the original cause of natural gravitational motion is the generator of the heavy body, who in generating the form inevitably confers natural motion and all other natural accidents consequent upon that form. Thus the *generans* is the *motor extrinsecus* of natural movement by means of the form given. But Averroës goes on to assume that some intrinsic mover (*motor intrinsecus*) must continue to produce motion after the natural body has been separated from its extrinsic progenitor. Since this natural motion arises from the form, Averroës thinks that this intrinsic form is the immediate mover in natural motions. Consequently the natural movement of nonliving things is somewhat similar to self-movement in animals. But there is an essential difference: the animal soul is a self-mover *per se*, the natural form is a self-mover *per accidens*. True self-movement requires a real distinction between mover and part moved; this is the case in animals, which move their arms and legs *per se*. The natural form, however, is not distinct from matter in this way. Hence the natural form must move the medium, which in turn moves the entire body, much like a rower in a boat who is moved by his own rowing. Consequently Averroës concludes to the indispensability of the medium for natural motion.<sup>46</sup> Obviously without a resisting medium there is nothing for the rower to row against.

<sup>42</sup> Avicenna, *op. cit.*, *Metaphysica*, tr. 6, cap. 3, fol. 93ra.

<sup>43</sup> See Harry A. Wolfson, "The Problem of the Souls of the Spheres from the Byzantine Commentaries on Aristotle through the Arabs and St. Thomas to Kepler," paper read at Dumbarton Oaks in May 1961, offprint, pp. 82–83.

<sup>44</sup> *Algazel's Metaphysics*, ed. J. T. Muckle (Toronto: St. Michael's College, 1933), pp. 30–31, 99–102.

<sup>45</sup> Averroës, *Opera* (ed. Venice 1574), t. V, fol. 197rb–199ra.

<sup>46</sup> *Ibid.*, fol. 199ra: "Et cum ita sit, lapis igitur non movet essentialiter nisi aerem in quo est, et movet se, quia hoc quod movet se sequitur motum aeris, sicut de homine cum navi. Et cum ita sit, aer igitur et aqua sunt necessaria in motu lapidis, et hoc est illud quod promisimus declarare hic in expositione Physicorum, sed iste locus est convenientior."

In his commentary on the *Physics*, IV, comm. 71,<sup>47</sup> Averroës discusses the possibility of movement in a vacuum. He insists that for all movement the moving force must meet some resistance in order to have a determined velocity. Since no resistance can arise from the matter of a natural body moved by its form, there must be resistance from some medium such as air or water. Since resistance is necessary for motion, there can be no motion in a void. Then Averroës raises an objection presented by Avempace, that the proportion of velocity does not depend on resistance, but on time. Avempace does not think that absence of resistance would produce instantaneous change, since celestial motions are devoid of resistance, yet they require time for their different velocities. Averroës dismisses Avempace's position as mathematically erroneous, since Avempace talks about velocity in terms of adding or subtracting amounts of motion, whereas Averroës conceives of velocity as inversely proportional to resistance, that is, as a divisor. Thus if resistance is zero, then velocity would be infinite, that is, instantaneous, which for Averroës is impossible.

Averroës recognized three possible sources of resistance: an independent obstacle as in displacement of bodies, natural resistance of a body to compulsory motion, and the medium through which a body moves. The sum of these resistances divides the moving force and renders motion possible. Thus in a vacuum there could be no natural successive motion; since there is no medium, there is no resistance against which to act.

Averroës dismisses Avempace's point about the lack of resistance in celestial bodies by pointing to the real distinction between the celestial body and the soul, and the proportion between them. Hence for Averroës there is a kind of resistance in celestial bodies to their proportionate movers. In elementary bodies, where matter is not a *res in actu* but only *in potentia*, the form needs a medium upon which to act.<sup>48</sup>

The position of Averroës can be summed up as follows: every movement taking place in the universe, whether natural or violent or celestial, requires an accompanying mover, intrinsic in the case of natural and celestial motion, extrinsic in the case of projectiles. Thus everything moved (*omne motum*) requires an immediate mover. Thus *omne motum* is equivalent to *omne in motu*. Moreover every motion presupposes resistance either from the body itself or from some medium. Thus velocity is directly proportional to the moving force or weight, and inversely proportional to resistance; where there is no resistance, there can be no successive motion.

Clearly the position attributed by modern historians to Aristotle is, in fact, the position of Averroës. Our concern here is not to evaluate Averroës' interpretation of Aristotle. Rather it is to compare medieval views of *Omne*

<sup>47</sup> Averroës, *Opera* (ed. Venice 1562), t. IV, fol. 158v-162ra.

<sup>48</sup> *Phys.*, IV, comm. 71, *ed. cit.*, fol. 161vb: "Manifestum est quod ista resistentia invenitur inter motorem et rem motam quando res mota fuerit distincta per se, sicut est dispositio in corporibus caelestibus. In elementis

vero res mota est in potentia et motor in actu, cum sit composita ex prima materia et formis simplicibus, et motor est forma et res mota est materia; et quia haec corpora non distinguuntur in rem motam et motorem in actu, impossibile est ea moveri sine medio."

*quod movetur ab alio movetur.* It cannot be denied that many Schoolmen accepted the interpretation of Averroës. In particular it was accepted by Peter of Auvergne, Godfrey of Fontaines, Peter Olivi, Duns Scotus, and by the bulk of beginners' manuals popular in the fourteenth and fifteenth centuries.<sup>49</sup> However, Averroës' interpretation was explicitly rejected on all essential points by St. Thomas Aquinas and to a lesser degree by Albertus Magnus<sup>50</sup> and even by Siger of Brabant, the eminent founder of Latin Averroism.<sup>51</sup>

The cornerstone of St. Thomas' explanation of the axiom is the concept of nature. Aristotle had defined nature (*φύσις*) as "the principle, *ἀρχή*, of movement and rest in those things to which it belongs *per se* and not as something concomitant."<sup>52</sup> Moreover Aristotle had shown that not only is the traditional notion of form *φύσις*, but also the potentiality for this form is *φύσις*.<sup>53</sup> That is, both matter and form are natures, form as the active principle of motion, matter as the passive principle for receiving motion and form. Medieval Scholastics in general, and St. Thomas in particular, developed to a great extent this twofold meaning of nature: "form" as an active and formal principle, "matter" as a passive and potential principle.<sup>54</sup> Nature as matter or *natura secundum materiam*, came to signify not only the pure potentiality of first matter, but all passivities of bodies which require a natural agent<sup>55</sup> to actualize them. Nature as form,

<sup>49</sup> For example, the anonymous beginners' manual published by Marshall Clagett (*op. cit.*, pp. 445-462) states: "the intrinsic form of a moving body is called the intrinsic motor of the moving body; from this it is evident that natural motion by form and by intrinsic motor are identical, since the intrinsic form and the intrinsic motor by which a moving body is moved are the same thing" (p. 445).

<sup>50</sup> Albert strongly insists that the "mover" in natural motions is the generator of the form and nothing else. "Et ideo dicendum videtur quod id quod movetur ad locum, et non movetur per se, movetur a generante aut removente prohibens, sicut dictum est in 8<sup>o</sup> Physicorum. Sed quando movetur a generante, non movetur aliter ab ipso nisi quia dat ei suam formam, et quia formam, dat ei consequentia omnia formam illam, sicut saepe diximus," *Lib. III, De caelo*, tr. I, cap. 7, ed. Borgnet, IV.255a. However, he clung to the instrumentality of the medium simply on the authority of Aristotle: "Sed in istam opinionem ego nulla ratione consentio, eo quod Aristoteles egregius Philosophus expresse dicit, quod aer deservit ad motum localem per modum instrumenti," *ibid.*, p. 254b.

<sup>51</sup> See fragments edited by Albert Zimmermann, *Die Quaestiones des Siger von Brabant zur Physik des Aristoteles* (Cologne, 1956), p. 31. For example, in the Borghese fragment (MS. Vat. Borgh. 114) of Book II, q. 2, Siger explicitly rejects the Averroist doctrine of self-

movement *per accidens* through a resisting medium: ". . . sed grave movet se per accidens ita, sicut movet se nauta per accidens eo quod movet navem per se. Ita dicit COMMENTATOR. Et modum dat dicens quod grave medium movet per se, et medio impulso ab ipso movetur per accidens ipsum grave. *Hoc autem non videtur esse verum.* Unde habet grave quod moveat medium? Nam medium movere non est nisi ex moveri ipsius gravis. Sic enim movent motores corporei, quod eorum impulsionem naturaliter et tempore praecedat moveri ipsorum. *Propter hoc dicendum est aliter.* Debetur intelligere, quod quando admotum est impedimentum gravis detinens ipsum superius, adhuc non est grave deorsum distantia media impediens. Est ergo deorsum in potentia. Sed potentia est accidentalitatis" (p. 31). Italics mine.

<sup>52</sup> *Phys.*, II, 1. 192b21-23. This definition is repeated more or less complete in various works of Aristotle: *Phys.*, III, 1. 200b12-13; VIII, 3. 253b5-6; VIII, 4. 254b16-17; *De caelo*, I, 2. 268b16; III, 2. 301b17-18; *De anima*, II, 1. 412b15-17; *De gen. animal.*, II, 1. 735a3-4; *Metaph.*, VI, 1. 1025b20-21; IX, 8. 1049b8-10; XII, 3. 1070a7-8; *Ethic. Nic.*, VI, 4. 1140a5-6; *Rhet.*, I, 10. 1369a35-b1.

<sup>53</sup> *Phys.*, II, 1. 193a9-b21; II, 2. 194a12-25.

<sup>54</sup> Weisheipl, "Concept of Nature," *op. cit.*, pp. 1-32.

<sup>55</sup> Natural and artificial products were distinguished on the basis of the natural and

or *secundum principium formale*, signified the active and spontaneous source of all characteristic properties and behavior; ultimately this active principle was considered to be the substantial form which functions through active qualities.<sup>56</sup> Thus in Scholastic terminology nature as "matter" is equivalent to *principium passivum, receptivum, and materiale*; while nature as "form" is equivalent to *principium activum et formale, and activa inclinatio formalis principii*. This identification of form with *principium activum* is consistent throughout the works of Aquinas.<sup>57</sup> Nevertheless, Aquinas does not identify *principium activum* with a *movens* or a *motor conjunctus*. The word *principium*, St. Thomas insists,<sup>58</sup> must be taken strictly; it is not a cause or a mover. A formal principle (*principium, ἀρχή*) is simply a spontaneous source of all that comes from it naturally, that is, all characteristic attributes and activities. Once it is brought into being, it immediately (*statim*) and spontaneously manifests characteristic behavior, unless accidentally impeded from doing what comes naturally. Thus, *qui dat formam, dat consequentia ad formam*.<sup>59</sup> For this reason Aquinas, following Aristotle, always says that the only *per se* cause of those motions is the generator of the body; the *per accidens* cause is whatever removes an impediment to natural, spontaneous motions.<sup>60</sup>

Speaking of the natural, spontaneous motion of heavy and light bodies, Aquinas consistently and repeatedly says:

In heavy and light bodies there is a formal principle of their motion, because just as other accidents flow from substantial form, so too place, and consequently movement toward place; not however that the natural form is a *motor*, rather the *motor* is the *generans*, which gave such a form from which motion follows.<sup>61</sup>

artistic (human) agencies required to actualize the passivity. This difference in agency indicated a difference in the "matter" of natural and artificial things, inasmuch as the matter of artificial things does not have a "natural aptitude" for an artificial form. A clear explanation is given by St. Thomas, *In VII Metaph.*, lect. 8, n. 1442z; *In II Phys.*, lect. 1, n. 4.

<sup>56</sup> St. Thomas, *In VII Metaph.*, lect. 8, n. 1448; *In II Sent.*, dist. 14, q. 1, a. 5 ad 2.

<sup>57</sup> For example, Thomas, *De pot.*, q. 5, a. 5: "Habet enim huiusmodi [elementaris corporis] motus in mobili principium, non solum materiale et receptivum, sed etiam formale et activum. Formam enim ipsius elementaris corporis sequitur talis motus, sicut et aliae naturales proprietates ex essentialibus principii consequuntur; unde in eis generans dicitur esse movens in quantum dat formam quam consequitur motus." Also ad 12; *Sum. cont. gent.*, III, c. 23; *In II Sent.*, d. 14, q. 1, a. 1 ad 1; d. 18, q. 1, a. 2; *In III Sent.*, d. 3, q. 2, a. 1 ad 6; d. 22, q. 3, a. 2, sol. 1; *In I De caelo*, lect. 16, n. 13; *In III De caelo*, lect. 7, nn. 5-9; *In VII Metaph.*, lect. 8, n. 1442z.

<sup>58</sup> *In II Phys.*, lect. 1, n. 5: "Ponitur autem in definitione naturae *principium*, quasi genus et non aliquid absolutum, quia nomen naturae importat habitudinem principii."

<sup>59</sup> *In III De caelo*, lect. 7, n. 8. This principle is found throughout St. Thomas' writings on the subject.

<sup>60</sup> *In VII Phys.*, lect. 8, n. 8: "Quaedam enim sunt quae moventur secundum naturam, non tamen a seipsis, sicut gravia et levia, et haec etiam ab aliquo moventur, ut ostensum est, quia aut moventur per se a generante, quod facit ea esse gravia et levia, aut moventur per accidens ab eo quod 'solvit,' idest removet ea quae impediunt vel remouent naturalem motum." See *Sum. theol.*, I, q. 18, a. 1 ad 2, and q. 105, a. 2.

<sup>61</sup> *In II Phys.*, lect. 1, n. 4: "In corporibus vero gravibus et levibus est principium formale sui motus, quia sicut alia accidentia consequuntur formam substantialem, ita et locus, et per consequens moveri ad locum; non tamen ita quod forma naturalis sit motor, sed motor est generans, quod dat talem formam, ad quam talis motus consequitur." (On the textual difficulty of this passage in the Leonine edition,

St. Thomas emphatically denies that the form is an accompanying mover or the efficient cause of natural motion. The reason for this is twofold: Aristotle clearly demonstrated that nothing can move itself *primo* and *per se*; second, there is an obvious difference between living and nonliving things. Living things can indeed move themselves to certain activities, but not to all. An animal can move itself from place to place, but it cannot move its heart to beat, any more than it can move itself to have a heart, arms, and legs. Thus it is the nature of a living form which spontaneously and necessarily provides a heart and motion of the heart, if there is no impediment. This nature, then, is not the efficient cause or mover of the heart's motion.<sup>62</sup>

In plain English we can say that for St. Thomas the form simply *moves*; it is not a *mover*. But since that form had to be generated in the first place, that is, "moved to be," the "mover" in all natural motions is the progenitor. Thus what is "being moved" is nature in the passive sense of matter, not the body already in existence. When nature in the passive sense "was moved" in the generation of a new substance, it was moved by something else: *Omne quod movetur ab alio movetur*. Once the new substance is generated, however, its formal principle no longer needs to be moved (*moveri*); it already has everything it needs to do whatever comes naturally, according to St. Thomas, even falling downward or rising upward. A natural body is, as it were, an instrument of its progenitor, even after a particular progenitor has ceased to exist, for everything a natural body does naturally, it does in virtue of what it received in the first place.<sup>63</sup>

see my *Nature and Gravitation*, pp. 25–26, fn. 78, and here below, fn. 58.) See also *In II Phys.*, lect. 5, n. 5; *In IV*, lect. 12, n. 9; *In VIII*, lect. 8, nn. 5–7; *In I De caelo*, lect. 18, n. 1; *In II*, lect. 2, n. 6; *In III*, lect. 7, nn. 5–9; *Sum. cont. gent.*, III, c. 23; *De pot.*, q. 5, a. 5; *De verit.*, q. 24, a. 1; *De motu cordis*; and additional references above in fn. 57. St. Thomas' view is expressed with particular clarity in *De verit.*, q. 22, a. 3: "In rebus corporalibus . . . formae earum non possunt esse moventes, quamvis possint esse motus principium, ut quo aliquid movetur; sicut in motu terrae gravitas est principium quo movetur, non tamen est motor." Of course, St. Thomas does not intend by this position to dispense with the universal causality of God in all natural actions, no more than does this universal causality dispense with nature as an active principle. Thus Aquinas says, *De pot.*, q. 3, a. 7: "Non ergo sic est intelligendum quod Deus in omni re naturali operetur quasi res naturalis nihil operetur, sed quia in ipsa natura vel voluntate operante Deus operatur; . . . sicut dicitur in IV Phys., quod generans movet grave et leve inquantum dat virtutem per quam consequitur talis motus. Et hoc modo Deus agit omnes actiones naturae, quia dedit rebus naturalibus virtutes per quas agere possunt, non solum sicut generans virtutem tribuit gravi et levi,

et eam ulterius non conservat, sed sicut continue tenens virtutem in esse, quia est causa virtutis collatae, non solum quantum ad fieri sicut generans, sed etiam quantum ad esse, ut sic possit dici Deus causa actionis inquantum causat et conservat virtutem naturalem in esse." (Italics mine.)

<sup>62</sup> *De motu cordis*, ed. Parma, XVI, 359a; "Motus sursum est naturali igni, eo quod consequitur formam eius; unde et generans quod dat formam est per se movens secundum locum. Sicut autem formam elementi consequitur aliquis motus naturalis, sic nihil prohibet alias formas sequi alios motus naturales; videmus enim quod ferrum naturaliter movetur ad magnetem, qui tamen motus non est ei naturalis secundum rationem gravis et levis, sed secundum quod habet talem formam. Sic igitur et animal inquantum habet talem formam quae est anima, nihil prohibet habere aliquem motum naturalem; et movens hunc motum est quod dat formam. . . . Sic igitur motus cordis est naturalis quasi consequens animam, inquantum est forma talis corporis, et principaliter cordis. . . . sicut Philosophus dicit VIII Phys., motum gravium et levium esse a generante, inquantum dat formam, quae est motus principium." (Italics mine.)

<sup>63</sup> Because of this original *movetur* and continued activity in virtue of what was received,



Commenting on Averroës' reasons for considering the natural form a mover, St. Thomas remarks in his commentary on *De caelo*:

Both arguments stem from the same error. [Averroës] thought that the form of heavy and light bodies is an active principle of motion after the manner of a mover needing some resistance contrary to the tendency of form, and that motion is not immediately due to the agent who conferred the form. But this is absolutely false. The form of heavy and light bodies is not a principle of motion as a generator of motion, but as a means by which the mover moves, just as color, a principle of sight, is a means by which something is seen. . . . Thus movement of heavy and light bodies does not come from the generator by the intervention of another moving power (*mediante alio principio movente*). Nor even is there any need to look for resistance here other than that which exists between generator and generated. Thus it follows that air is not required for natural motion of necessity (*ex necessitate*), as in the case of violent motion, since that which moves naturally has a force (*virtutem*) imparted to it which is a source of motion. Consequently there is no need for a body to be moved by any other force impelling it, as though it were a case of violent motion, having no implanted force from which motion springs.<sup>64</sup>

In this passage St. Thomas explicitly denies three points: (1) that the natural form is a *motor conjunctus*, (2) that there need be any continual mover to explain natural motions, and (3) that there need be any resisting medium for natural motions.

The question of a resisting medium was discussed thoroughly by St. Thomas in his commentary on the *Physics*,<sup>65</sup> as Dr. Moody has already noted.<sup>66</sup> After noting the objections of Avempace and Averroës' attempt to refute them, St. Thomas calls Averroës' refutation frivolous (*frivola*). Even if there were no medium, there is still the quantitative distance to be covered by a moving body. Because of this distance to be covered, time

it is most proper to speak of all nature in the passive voice as opposed to true self-movers (souls) and movers of other things (*potentiae activae*). Compare the use of passive voice in text from *De veritate* and *De potentia* in fn. 61 above, and in fn. 62. For this reason Aquinas can say, "Potentia igitur secundum quod est principium motus in eo in quo est, non comprehenditur sub potentia activa, sed magis sub passiva," *In V Metaph.*, lect. 14, n. 955. In other words, in Aquinas' terminology *potentia activa* is not the same as *principium activum et formale*. See my explanation in *Nature and Gravitation*, pp. 25–26, fn. 78.

<sup>64</sup> *In III De caelo*, lect. 7, n. 9: "Utrumque autem ex eadem radice erroris procedit. Existimavit [Averroës] enim quod forma corporis gravis et levis sit principium activum motus per modum moventis, ut sic oporteat esse aliquam resistantiam ad inclinationem formae, et quod motus non procedat immediate a generante qui dat formam. Sed hoc est

omnino falsum. Nam forma gravis et levis non est principium motus sicut agens motum, sed sicut quo movens movet; sicut color est principium visionis, quo aliquid videtur. . . . Sic igitur motus gravium et levium non procedit a generante mediante alio principio movente; neque etiam oportet aliam resistantiam quaerere in hoc motu, quam illam quae est inter generans et genitum. Et sic relinquatur quod aer non requiratur ad motum naturalem ex necessitate, sicut in motu violento. Quia id quod naturaliter movetur habet sibi inditam virtutem, quae est principium motus; unde non oportet quod ab alio impellente moveatur, sicut id quod per violentiam movetur, quia nullam virtutem inditam habet, ad quam sequatur talis motus." (Italics mine.)

<sup>65</sup> *In IV Phys.*, lect. 12, nn. 8–14.

<sup>66</sup> Ernest A. Moody, "Galileo and Avempace," *Journal of the History of Ideas*, 1951, 12: 163–193, 375–422.

is required; therefore this motion has a determined velocity. Consequently for St. Thomas the velocity of a moving body is determined not by resistance, but by the time required to cover a given distance. Thus even if there were no resisting medium, as in a void, a body would fall at a determined rate because of the time required to cover that particular distance. On this point St. Thomas agrees with Avempace against Averroës. For Averroës, as we have seen, there could be no motion at all in a void because there would be nothing against which the moving form could row its boat.

While we are on the question of the vacuum, let us consider it for a moment. The point under discussion in Aristotle's *Physics*, IV, 6–9, is not whether a vacuum is possible, but whether the void posited by Leucippus and Democritus to explain motion is the real reason why natural bodies move as they do. Leucippus and Democritus had posited the reality of nonbeing, the empty, to allow for the movement of solid atoms.<sup>67</sup> Accordingly, the void is a cause of motion by allowing room for movement. St. Thomas believes that "Aristotle argues against them as though the whole cause of velocity depended on the medium; . . . we are thus given to understand that they attributed the entire cause of motion to the medium and not to the nature of bodies."<sup>68</sup> This accounts for the facetiousness of some of the arguments in these chapters.

Some of the commentators, including Averroës, made too much of Aristotle's arguments against a void, failing to see the point of this discussion in Book IV. The point is that the void posited by Leucippus and Democritus cannot account for the motions we witness in the universe. Averroës and many after him took the opposite position from that of Leucippus and Democritus. The Atomists said there could be no motion without a void; Averroës said there could be no motion in a void simply because there would be no resistance. Resistance, therefore, becomes the essential element in Averroist dynamics. This, as we have seen, is entirely rejected by St. Thomas.

Celestial motion, on the other hand, presents a special problem to St. Thomas.<sup>69</sup> Since nature as an active principle is always determined to a specific goal, "it is impossible that any nature intend motion for the sake of motion."<sup>70</sup> Therefore "celestial motion cannot arise spontaneously from the form of celestial bodies as from an active principle" similar to natural forms of terrestrial bodies, which act in order to possess a goal attained.<sup>71</sup> But if there can be no active principle of perpetual motion,

<sup>67</sup> For the pertinent texts, translation, and comment, see G. S. Kirk and J. E. Raven, *The Presocratic Philosophers* (Cambridge, Eng.: Cambridge University Press, 1962), pp. 404–409.

<sup>68</sup> *In IV Phys.*, lect. 12, n. 10. "Et ideo contra eos Aristoteles argumentatur, ac si tota causa velocitatis et tarditatis esset ex parte medii; . . . per hoc dat intelligere quod totam causam motus ponebant ex parte medii, et non ex natura mobilis."

<sup>69</sup> Weisheipl, "Celestial Movers in Medieval

*Physics*," *The Dignity of Science*, ed. Weisheipl (Washington: Thomist Press, 1961), pp. 150–190.

<sup>70</sup> "Impossibile est igitur quod natura intendat motum propter seipsum," *Sum. cont. gent.*, III, c. 23, par. 6. "Impossibile est quod aliqua natura inclinet ad motum secundum seipsum," *De pot.*, q. 5, a. 5.

<sup>71</sup> *Sum. cont. gent.*, III, c. 23; *De pot.*, q. 5, a. 5; *In II De caelo*, lect. 18, n. 1; *Resp. ad XLII art.*, a. 5.

then celestial bodies can have only a passivity to be moved by something else. In this matter, St. Thomas notes, it makes no difference whether we conceive of the celestial bodies to be moved by intelligent souls conjoined to them, as Aristotle thought, or by intellectual substances entirely distinct, like angels. In either case the only "nature" celestial bodies can have is a passive, receptive, material one, *ratione principii passivi, quod est materia*, needing to be moved by another. St. Thomas sees no other way of explaining perpetual motion.<sup>72</sup> "Hence, unless the celestial bodies are moved by God, they must either be animated and moved by their proper souls or be moved by angels, *quod melius dicitur.*"<sup>73</sup>

In this paper I am not trying to evaluate St. Thomas' arguments for angelic movers of the heavens. I am merely trying to explain *movetur* in St. Thomas' view. It should be clear that for St. Thomas *movetur* refers exclusively to nature as a passive and material principle of motion and rest. It does not refer to nature as an active and formal principle of motion and rest, except in the sense that it too had "to be moved," generated, produced in the first place. In order to prove the existence of God one would have to go beyond the physical order of terrestrial and celestial movements to determine whether separated substances are in any sense *moventur*, that is, brought into being or moved intellectually. This is not our concern here. My only point is that *movetur* always means passivity for someone else's action, and not the fact that something is here and now in motion.

Until the early fourteenth century all violent motions, being *a principio extrinseco nil conferente vim passo*, were generally explained in terms of an extrinsic mover continuing to exert force.<sup>74</sup> In the case of projectiles, which are no longer in contact with the original mover, an explanation was sought in the surrounding medium, such as air. Plato had explained continued movement of projectiles by mutual replacement (*ἀντιπρόστασις*), that is, the air pushed in front of the projectile gathers in behind it and so pushes it on.<sup>75</sup> Aristotle objected that in Plato's explanation only motion is conferred on the air and not the power to move as well. In Aristotle's explanation both movement and power to move are given to the medium. Aristotle could not conceive this power being given to the projectile because the power "to move" must be distinct from the body "moved."

However, around 1320 a Franciscan, Francesco Rossi (de Marchia), proposed a new theory while lecturing on the Fourth Book of *Sentences* at Paris. While discussing sacramental causality, he raised the question of impetus in order to show that both the sacraments and the projectile have

<sup>72</sup> "Non autem esset via solvendi, si moverentur per solum naturae impetum, sicut corpora gravia et levia," *In II De caelo*, lect. 18, n. 1.

<sup>73</sup> *Resp. ad XLII art.*, a. 5.

<sup>74</sup> Despite various attempts to prove the contrary, it must be admitted that Aquinas did not teach a doctrine of impetus like that proposed by de Marchia and Buridan. Rather he followed the view of Aristotle on projectile

motion. This is rather surprising, since his doctrine of sacramental causality contained all the essential principles for the analogy with projectile motion, as de Marchia was later to see. In other words, the new doctrine of impetus was seen to be consistent with the principles of Aquinas by such Thomists as Capreolus, Dominic de Soto, and others.

<sup>75</sup> Plato, *Timaeus*, 80 C; see also 59 A, 79 B, C, E.

a certain residing force within by which something is produced. After a long and careful discussion of the Aristotelian theory, he concluded that projectile motion cannot be explained by the air, but must be explained by a *virtus derelicta in lapide a motore*.<sup>76</sup> In order to indicate the unnatural and alien character of this force, de Marchia called it "an accidental and extrinsic force," "a certain extrinsic form." De Marchia did not conceive this *virtus derelicta* in projectiles and in the sacraments as *motores conjuncti*, but simply as instrumental powers separated from the true cause which conferred the *virtus*.

Buridan developed the theory of impetus in his commentaries on Aristotle. Like de Marchia he insisted that the impetus given to a projectile is violent, unnatural, extrinsic in its nature, and destined to be diminished and extinguished by the natural forces of the body. Similarly, Buridan did not conceive impetus as a *motor conjunctus*, but simply as a vehicle by which the mover achieves his goal. Later Scholastics, such as Capreolus and Dominic de Soto, saw even more clearly that impetus cannot be considered an accompanying mover, an efficient cause of projectile motion, for this would be to conceive the body as a self-mover. Rather it is the instrument of the agent who is the only true mover. De Soto points out the analogy between impetus and nature as a formal principle, for just as the "mover" or "cause" of natural motion is the progenitor and not nature, so too the "mover" or "cause" of violent motion is the agent and not impetus.<sup>77</sup>

Considering, however, the widely accepted notion of form as an accompanying mover, it is not surprising that many Scholastics in the late Middle Ages came to consider impetus as a "mover accompanying the projectile." This, as we have seen, is the interpretation given to it by modern historians of medieval science. The fundamental error, we suggest, lies in the failure to distinguish a "principle" from a "cause." We can agree that the projectile "is moved." Indeed, the ball "is thrown." But, we suggest, the ball is thrown by the boy, not by the force impressed.

Some years ago Sir Edmund Whittaker published a critique of Aquinas' arguments for the existence of God in the light of modern scientific theory. For him,

the first proof, or the proof from motion, is open to the objection, first brought against it by Duns Scotus and William of Ockham, that the principle *omne quod movetur ab alio movetur*, on which the whole argument depends, is irreconcilable with sound dynamical science, and is therefore false.<sup>78</sup>

However, Sir Edmund interprets this axiom to mean whatever is in motion must be kept in motion by another,<sup>79</sup> which we have seen is not the meaning of the principle. He does, however, point out the absurdity of speaking

<sup>76</sup> Text edited by Maier, *Studien*, Vol. 2, pp. 166-180.

<sup>77</sup> Dominic de Soto, *Super libros Physicorum Quaestiones*, lib. VII, q. 3 (Salamanca, 1551), fol. 104v-105

<sup>78</sup> Edmund Whittaker, *Space and Spirit: Theories of the Universe and the Arguments for the Existence of God* (Hinsdale, Ill.: Regnery, 1948), pp. 45-46.

<sup>79</sup> *Ibid.*, p. 51.

of position *B* as a "perfection" not yet possessed by a star in position *A*.<sup>80</sup> And he does point out the impossibility of calling an impulse given the star in the beginning a "mover" and an *aliud*.<sup>81</sup> He has in fact criticized the Averroist and late Averroist view on sound Thomistic grounds. What Sir Edmund failed to see was that even in the principle of inertia we admit that bodies "are moved" and indeed "by another"; that is the point of the phrases "put into motion" and "unless acted upon by another body." More important, Sir Edmund failed to see that a body in natural motion does not need other forces to move it, since it already has everything it needs to move *in virtute primae agentis*; it already has, for Aristotle and many Schoolmen, everything it needs even to accelerate naturally. As far as the actual motion is concerned, neither the principles of inertia nor the Aristotelian principle demands that there be movers to account for motion. The only basic difference is that the principle of inertia demands additional force to account for acceleration. Aristotle and his medieval followers on this point saw no need for additional movers to account for acceleration; the original mover and the nature (*φύσις*) of the body were thought to be enough.

This is not to suggest that Aristotelian physics is in any way similar to modern dynamics. Not at all. The "natural way" and the "mathematical way," to use Newton's felicitous expressions, are two radically different approaches to the world of nature. What I am suggesting is that the principle *Omne quod movetur ab alio movetur*, understood as Aquinas understood it, is still philosophically correct today. Its philosophical validity in no way undermines modern laws of dynamics; on the other hand, its validity in no way validates those laws. But the Averroist interpretation, presented by modern historians of science as the "Aristotelian view," did not have to wait until the seventeenth century to be discredited; it was already discredited in the thirteenth on strictly Aristotelian grounds.

<sup>80</sup> *Ibid.*, pp. 133–135.

<sup>81</sup> *Ibid.*, pp. 136–137.