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ARISTOTELIANISM AND THE LONGEVITY OF THE MEDIEVAL WORLD VIEW

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As the dominant intellectual system for the interpretation of the physical world, Aristotelianism endured for some 450 years, from the time of its reception in the Latin West at the end of the twelfth century, to its general abandonment between 1600 and 1650. Why and how did it survive for so long? What was there about medieval Aristotelian scholasticism that won it the allegiance of so many generations of students and scholars? At first glance, it would appear that historians of medieval science, and of medieval thought in general, would have placed the survival of Aristotelianism in the forefront of their speculations and analyses. In truth, the longevity of the Aristotelian world view is not exactly a medieval problem. Since it continued as the dominant conception of the cosmos well beyond the Middle Ages and its death occurred in the seventeenth century, it is hardly surprising that medievalists have ignored the questions posed above. And yet the problem of the longevity of medieval Aristotelianism ought to form part of the legitimate concerns of the historian of medieval science, not only because the basic character of Latin Aristotelianism was formed in the late Middle Ages, between 1250 and 1400, but even more so because the factors that would make for its longevity were inherent in the very process which shaped it.

Before any reasons for the longevity of Aristotelianism are suggested, it will be well to explain briefly the two basic concepts of vital concern in this paper, namely 'Aristotelianism' and 'medieval world view'. In the context of medieval natural philosophy, the fundamental core of Aristotelianism was composed of the physical, logical, and biological works of Aristotle, along with the late Greek and Arabic commentaries thereon. Taken as a whole, these works provided the framework and much of the detail of the medieval world view, especially its physics and cosmology. Aristotelianism in the narrow sense, then, comprised not only the core works mentioned above, but the innumerable commentaries and *quaestiones* on those works composed by medieval Latin scholastics. Scholastic Aristotelianism, however, was much broader than the works of Aristotle and the Greek, Arabic, and Latin commentaries they generated. Already in the thirteenth century, much Aristotelian natural philosophy and metaphysics had been imported into theology, especially in the commentaries on the *Sentences* of Peter Lombard, that monumental twelfth century theological treatise on which all bachelors in theology had to comment. Conversely, and almost inevitably, Aristotelian thought was, in turn, influenced by the demands and requirements of theology.

In this way, Aristotelianism extended much beyond the works of Aristotle and became the dominant, and, for some centuries, the sole intellectual system in western Europe. It was, as we all know, the basis of the curriculum of the medieval university, where it remained entrenched for centuries. From the time the works of Aristotle entered western Europe in the late twelfth century until perhaps 1600, or 1650, Aristotelianism provided not only the mechanisms of explanation for natural phenomena, but served as a gigantic filter through which the world was viewed and pictured.

As with all 'world views', the medieval version had two fundamental, but interrelated aspects. The first, often equated with the medieval world view to the exclusion of the second, concerns the overall structural framework of the world as it was popularly conceived in the late Middle Ages. Largely drawn from the physical works of Aristotle—i.e., from the Aristotelianism we have just described—but infiltrated at certain points with Christian ideas of the deity, angels, and soul, the structural frame of the world was, on the whole, remarkably simple. The cosmos was an enormous, finite, unique material sphere filled everywhere with matter. It was divided into two basic parts, celestial and terrestrial. Beginning with the lunar sphere and extending all the way to the sphere of the fixed stars, and even beyond to the empyrean sphere, the celestial region was conceived as filled with a perfect, incorruptible ether which moved with a perfect, uniform circular motion and from which the celestial spheres were formed. In contrast with the heavens, where the only activity was the uniform, circular motion of the spheres, the terrestrial region, lying below the concavity of the lunar sphere and descending to the geometric centre of the universe, was characterized by incessant change as the bodies within it came into being and passed away. These terrestrial bodies were compounded of four elements, earth, water, air, and fire, each of which had its own natural place and the innate capacity for natural motion toward that place. The dominant element in any body determined the direction of its natural motion, which was always toward the natural place of the dominant element. When unimpeded, earthy bodies always fell naturally toward the centre of the universe, and fiery bodies rose toward the lunar concavity. Watery bodies would rise in the natural place of earth and fall in the natural place of fire, while airy bodies rose in the natural places of earth and water and fell when located in the region of fire. Since the celestial region was judged more noble than the terrestrial, the former regularly influenced the behaviour of organic and inorganic bodies in the latter. Despite the contact of the convex surface of the sphere of fire, which was the outermost surface of the terrestrial region, with the concave surface of the lunar sphere, which was the innermost surface of the celestial region, the influences were all unidirectional, from the celestial to the terrestrial.

The basic, skeletal frame described here was probably instrumental in the longevity of the Aristotelian world view. In the judgment of C. S. Lewis, "The human imagination has seldom had before it an object so sublimely ordered as the medieval cosmos".[1] By the magnificent simplicity of its fundamental structure, it satisfied the European mind, psychologically and intellectually, for some 450 years. It was this physical frame on which, and in which, the Christian God of the Middle Ages had exercised His wisdom and distributed angels and powers. Although additions to, and alterations of, the basic structure had occasionally been proposed and adopted in the course of the Middle Ages,[2] they posed no serious challenge to the world view we have described. And while many hypothetical suggestions had been made as to how God might have structured the world differently, and even made other worlds,[3] the passing centuries had seen the Aristotelian cosmos become ever more entrenched so that it seemed unthinkable, and even impious, to believe that He had actually made the basic frame of the world other than as it had been traditionally described. As Copernicus knew, and his followers would learn, Aristotelian cosmologists would not suffer rivals gladly.

But if western Europe was largely agreed on the fundamental structure of the world as just described, it was by no means agreed on the second significant aspect of a world view, namely the details of cosmic operations. Aristotelian scholastics, who were the principal architects of the medieval world view, had no commonly shared conception of the manner in which the interrelationships between the basic components of the world were effected, and little consensus on the causes of a host of specific operations and activities that were deemed essential to cosmic efficacy and harmony. The operational aspect of the medieval world view was thus characterized by diversity of opinion and lack of agreement. If the fundamental structure of the medieval cosmos was psychologically and emotionally satisfying and, therefore, instrumental in perpetuating the system for centuries, it will be the argument of this paper that the secondary aspect of a world view, namely the details of cosmic operations, also played a significant role in the long life of the Aristotelian cosmos. The diverse, and often conflicting, operational details of the medieval world view were not, however, the cause of its longevity, but are the *explicanda* for which a cause or causes must be assigned. With the cause, or causes, identified, we must then describe how it, or they, served to prolong the life of the

Aristotelian cosmos. Before all this, however, it is essential to convey a sense of the diversity of operational details, the causes of which will then be suggested.

For convenience, let us begin with the celestial region and proceed toward the earth at the centre of the universe.[4] We have seen that all were agreed that the celestial region, composed of a near-perfect fifth element, or ether, was conceived as a region of incorruptibility and the ultimate source of all physical influence on that part of the world lying below the moon. It was the locale of the planets and fixed stars moving around the earth as centre. But what was that celestial region really like? Was it, as St Bonaventure argued, a fluid mass, or was it subdivided into a series of solid, and perhaps hollow, spheres, as Themon Judaeus would have it? Those who decided on spheres had then to determine their number. Based on a variety of circumstances and requirements, estimates varied from eight to eleven, with some accepting an outermost Empyrean sphere, and others denying its existence. And what of the relationship between these orbs? Were they contiguous—that is, distinct and separate, as indicated by their diverse and contrary motions—as Michael Scot and Albert of Saxony believed; or did they form a continuous whole, sharing common surfaces by virtue of their identical, homogeneous composition, as Thomas Aquinas and others believed? What, or who, could be identified as the movers of celestial spheres? Angels, intelligences, souls, natural inclinations, and impressed forces were all suggested and partisans for each could be found. And what about relationships between celestial motions? Were they commensurable or incommensurable?[5] Although all were agreed that no material body existed beyond the last mobile sphere to serve as its physical container or place, the question of the place of the last sphere was a persistent one. In his discussion of the problem, Averroes included five separate solutions of which he was aware. Four of them found supporters in the Latin Middle Ages, to which one must add a fifth developed in the sixteenth century.

Multiple solutions were also proposed for a wide range of problems concerned with the terrestrial region of perpetual generation and corruption. For example, scholastics could not agree on the cause by which an element moved to its natural place;[6] nor could they agree whether the cause of violent motion was external or internal,[7] or whether a resistant medium was required for finite, temporal motion.[8] They were in disagreement as to whether an element in a compound retained its elemental form.[9] Some were of the opinion that, as geologic changes caused the earth's centre of gravity to shift, the entire earth moved as its new centre of gravity sought to coincide with the geometric centre of the universe.[10]

In fact, many, if not most of the questions or problems that became part of the scholastic *questiones* literature on Aristotle's physical treatises had a few major solutions which formed the basis of dispute. While in some instances a strong consensus for a particular opinion emerged, in many other problems, as, for example, those mentioned earlier, two or more interpretations were in serious contention. No resolution of most of these problems was really possible. How, for example, could one determine, with reasonable conclusiveness, whether the celestial region was a fluid mass or a system of hard spheres? Or what really moved the spheres? Or how many spheres really existed?

To convey a sense of the enormous range of physical problems on which serious disagreements probably occurred, we need only realize that in the fourteenth century, Albert of Saxony included 107 questions in his *Questions on the eight books of Aristotle's Physics* and thirtyfive in his *Questions on the two books of On generation and corruption;* that John Buridan considered fiftynine questions in his *Questions on De caelo* and Themon Judaeus attended to sixtyfive in his *Questions on the four books of Aristotle's Meteorologica.* Excluding Aristotle's *Metaphysics,* which traditionally included a number of important physical questions, and the *Parva naturalia,* or the *Small physical treatises,* the authors of the four physical treatises just mentioned considered a total of 266 questions.[11] If even half of these problems produced at least two serious solutions—and half is not an unreasonable estimate, and may even prove conservative—it is evident that whatever the unanimity on the macrostructure of the Aristotelian cosmos, it did not extend to its operational details.

What produced such a proliferation of theories and opinions about the details of cosmic operation? At least three reasons seem relevant and significant. First there were Aristotle's own obscurities and ambiguities, which, in both large and small aspects of his thought, no amount of interpretation could resolve successfully with any large degree of unanimity. As with most cosmic system builders, there was often a maddening lack of detail in Aristotle's descriptions and arguments. In supplying those details, scholastic commentators, with varying degrees of subtlety, often altered Aristotle's arguments and apparent intent, thereby generating new opinions and interpretations. The multiplication of opinions was aided and abetted in no small measure by the Greek and Arabic commentators whose works accompanied the introduction of Aristotle into the West. Major commentators, such as Simplicius, Averroes, and Avicenna, frequently furnished a variety of interpretations for this or that concept, principle, or argument. Scholastics would opt for one or another of them, or fashion new ones to compete with the old.

Opinions and theories were also easily multiplied in Aristotelian natural philosophy because "Aristotle's was the most capacious of philosophies", because "in principle it explained everything".[12] Aristotelian physical principles, such as potentiality–actuality, the four causes, matter and form, the constitution of the four elements, the doctrine of natural place, and others, were so broad and comprehensive that they were easily applied to competing theories and arguments. Not only were these basic principles never seriously challenged, but they found a range of application that would have surprized, if not shocked, Aristotle himself.

But even more significant than these in the multiplication of opinions, though largely ignored until now, is a third major reason, which will be central in the discussion to follow. Let us recall that the most common mode of expression in medieval natural philosophy was by means of a commentary on a traditionally recognized authoritative text. These commentaries often took the form of a series of *questiones*, or specific problems, which followed the order of the commented text and developed from it; or they could take the form of a straightforward commentary in which the commented text was discussed systematically section by section. In the *questiones,* which furnished most of the interesting cosmological discussion, each *questio* was subjected to a reasonably thorough analysis by means of a series of pros and cons, followed by the commentator's solution. By its very nature, the *questio* form encouraged differences of opinion. It was a vehicle *par excellence* for dispute and argumentation. Scholastic ingenuity was displayed by introducing new subtle distinctions, which, upon further development, would yield new opinions on a given question. It is thus hardly surprising that centuries of disputation within the *questiones* format should have produced a variety of opinions on a very large number of questions ranging over the full scope of Aristotelian physics and cosmology.

The ultimate consequence of this process must be viewed as of direct relevance to the longevity of the Aristotelian medieval world view. For what emerged was a series of distinct and often intensively considered problems that remained isolated from, and independent of, other related *questiones,* to which allusions and references were minimal. As the major form of scholastic literature in natural philosophy, the *questiones* produced an atomization of Aristotle's physical treatises into sequences of particular questions and problems which focused attention on the independent question and thus severed its connections and associations with other related issues treated in the same treatise or elsewhere in the Aristotelian corpus. Not only were related topics left unintegrated, but even single topics as, for example, the doctrine of place, were left in the form of a series of specific questions that were never organized into a larger, coherent whole, which might have drawn attention to glaring inconsistencies and weaknesses. It was the independent question that became the focal point of contention and with respect to which differing opinions were formulated.[13]

But how did all this contribute to the longevity of the medieval Aristotelian world view? Primacy of the independent question in medieval physical thought prevented any larger synthesis that might have forced a major overhaul or reconstitution of Aristotelian cosmology. It served to protect the satisfying macrostructure from any truly penetrating, critical inspection. The atomization of Aristotle's physical treatises resulted in an intellectual flotsam and jetsam of unrelated questions which actually concealed grave inconsistencies and discrepancies. Serious attempts to reconcile these might have encouraged efforts at a new synthesis, or perhaps riveted attention on the inadequate operational substructure which underlay the well-ordered and generally accepted macrostructure. Instead, the extreme atomization of physical thought in the *questiones* literature prevented medieval scholastics from producing, or even attempting to produce, any comprehensive and systematic treatises on the scope and scale of a Cartesian or Newtonian *Principia*. No genuine effort was made to formulate a coherent and reasonably consistent cosmology within which the disparate elements scattered throughout the *questiones* could be brought together, evaluated, and assessed as part of a larger whole.

The closest medieval scholasticism came to attempts at cosmological or physical syntheses was an occasional *Summa* in natural philosophy. During the first quarter of the fifteenth century, Paul of Venice (*ca* 1370–1429) composed a *Summa philosophie naturalis,* or *Summa naturalium.*[14] Here Paul subdivided natural philosophy into six parts corresponding to Aristotle's *Physics, De caelo, De generatione et corruptione, Meteorologica, De anima,* and *Metaphysics.* The order of the first four treatises was undoubtedly derived from Aristotle's opening remarks in the *Meteorologica,* where he explains that he had "already dealt with the first causes of nature and with all natural motion" (*Physics*); "with the ordered movements of the stars in the heavens" (*De caelo,* bks 1 and 2); and "with the number, kinds and mutual transformations of the four elements, and growth and decay in general" (*De caelo,* bks 3 and 4; *De generatione et corruptione*). It remains, then, to consider what is commonly called *Meteorology,* which is concerned with phenomena bordering "most nearly on the movement of the stars", that is, in the region immediately below the lunar sphere.[15] Faithful Aristotelian that he was, Paul of Venice not only followed the master's order of discussion, but considered the problems of each treatise in isolation. Under these circumstances, it is hardly surprising that Paul's *Summa* of natural philosophy is little more than a collection of six distinct Aristotelian treatises each with a set of its own *questiones.*[16] No more integration and synthesis was achieved than if the *questiones* on each treatise had been published separately.

By the fifteenth century, then, the Aristotelian *questiones* tradition had become so inflexible that not even a *Summa* could produce a higher synthesis or generate any significant rearrangement of problems. The individual treatise, with its rigidly compartmentalized, and largely unrelated, questions, reigned supreme. The *Summa* of natural philosophy thus represented little more than a convenient order in which to consider the different subject areas of that broad discipline. It was but an aspect of the medieval and renaissance penchant for displaying the organization of knowledge, a penchant nowhere better illustrated than in the *Margarita philosophica* of Gregor Reisch, first published near the close of the fifteenth century. Under Reisch's elaborate subdivision of philosophy,[17] natural philosophy, or physics, within which medicine is also included, is a theoretical, or speculative, discipline concerned with reality (as opposed to theoretical philosophy concerned with the purely rational subjects of the trivium, namely, grammar, rhetoric, and logic). The subjects of this division are drawn largely from pseudo- and genuine Aristotelian physical treatises, the first four of which are, not surprisingly, the *Physics*, *De caelo*, *De generatione et corruptione*, and *Meteorologica*, the order of treatment described in the last mentioned work. To these are added treatises on minerals, the elements, the soul (basically concerned with perception), animals and plants, the senses, memory, youth and old age, respiration, nourishment, health and sickness, the motion of the heart, life and death, and many others.

Although the organization of knowledge described here may perhaps reflect some deeper cosmic view, it is more likely that medieval and renaissance divisions of knowledge were little more than traditional representations of the classification of the sciences formulated by Aristotle himself and elaborated subsequently by Augustine, Boethius, Cassiodorus, Hugh of St Victor, Domingo Gundisalvo, and others.[18] While such trees of knowledge were useful pedagogical devices, they were also a false facade. For then and now, they led many to believe that the ideas and explanations in the treatises sequenced and ordered in the various schema of knowledge were as tidy and harmonious as the outlines in which they were located.

In the absence of any genuine rival system, the Aristotelian world view, with its well-ordered macrostructure and its richly diverse, but bewildering, inconsistent, and largely unexamined operational substructure, reigned unchallenged. By the time rival interpretations of any consequence appeared, as happened in the sixteenth century, Aristotelianism, despite its numerous inconsistencies and multiplicity of opinions on almost every major issue, had acquired a degree of acceptance approaching that of Euclidean geometry before Bolyai, Lobachewsky, and Riemann.

Despite its sheltered and protected status in the conservative university environment, Aristotelianism was eventually faced with rival systems and modes of thought. The humanism that had generated a new interest in Greek antiquity and the influx, beginning in the fifteenth century, of Byzantine Greeks into the Latin West touched off a new wave of translation, now directly from Greek manuscripts. Old works were retranslated and new ones not previously known to the Latins were made available. It was in this new wave of translation, the likes of which had not been seen in Europe since the twelfth and early thirteenth centuries, that new ways of looking at the world became familiar in the west. With translations of the works of Plato, Proclus, Hero of Alexandria, and the Hermetic corpus, Atomism, Stoicism, Platonism, Neoplatonism, and Hermeticism emerged as flesh and blood doctrines. Lucretius's *De rerum natura*, the most complete account of atomism known, reappeared after centuries of obscurity to compete as a major cosmic system. The hostile view of atomism which Aristotle had presented could now be countered in detail.

But if by the sixteenth century, Aristotelianism had not lost its intellectual dominance and appeal, it seemed to have lost its vitality. By the end of the fifteenth century, it had become uncreative and ossified. The responses and arguments formulated in the disputes of the thirteenth and fourteenth centuries were repeated in the fifteenth. As new universities were founded in eastern Europe in the late fourteenth and fifteenth centuries, and as the predominant Parisian and Oxford interpretations came to dominate there and in the established Italian universities, the commentators in those places made selections from among already formulated interpretations. The opinions they presented were a mere repetition, with occasional deviations, of well-established arguments and positions.

At the dawn of the sixteenth century, entrenched though it was, Aristotelianism had declined in vigour. At that point, one might well have pondered whether it could survive for long the influx of new ideas and philosophies that had already begun to enter Europe in the fifteenth century.

The new non-Aristotelian intellectual options available to scholars of the sixteenth century caused some to abandon Aristotelianism and to attack it. One need only mention Petrus Ramus, Francesco Patrizzi, and Giordano Bruno, to realize that times had changed. Aristotelianism was under attack in a way that it had never been in the Middle Ages. Medieval disagreements with Aristotle, numerous though they were, were never regarded as a means of destroying the system, as was the case in the sixteenth century.

But the system was not destroyed. Paradoxically, the very influx of Greek texts and new translations that threatened the existence of Aristotelianism, also served to impart new strength to it. The Aristotelian corpus was not only re-translated from the Greek, but the Greek texts were made available in printed editions. From the fifteenth century onward, the humanistic revival had encouraged the teaching of Greek, a trend which gained strength through the sixteenth century. And, as if to accentuate the new interest in Aristotle, the Greek texts and Latin translations of Aristotle's Greek commentators, such as Alexander, Philoponus, Simplicius, and Themistius, which accompanied the new Aristotle, were read with as much interest as was Aristotle himself. Their interpretations, especially of the *Physics,* contained some new arguments and insights that were of fundamental importance. Thus a whole new dimension was added to Aristotelianism, which served to revive and refresh it. Sixteenth century natural philosophers were now face to face with the real Aristotle and the more pristine interpretations of his thought. No longer were they dependent on translations from the Arabic. If it pleased them, they could now even abandon their old Arab guide, Averroes, for the Greek commentators. And, finally, they could also ignore the medieval Aristotelian tradition that was built primarily on translations from the Arabic and overreliance on Averroes and Avicenna. In the end, however, they followed many paths. Charles Schmitt[19] has aptly explained this Renaissance phase of Aristotelianism :

> Rather than a singly close knit group of philosophers, scholastic Aristotelianism turns out to be a series of many different sects agreeing only on the most fundamental issues. Some thinkers attempted to go back to the Greek text of Aristotle to obtain the truth, others followed Alexander, Themistius, Philoponus, or another ancient commentator, still others found the truth in Averroes or in Latin 'Averroists' such as John of Jandun or Siger of Brabant, and yet others tended to see philosophy through the eyes of Thomas, Albert, Ockham, or Scotus. All things considered, there was quite a range of interpretation and differences more pronounced than one might think. Moreover, each of the individual thinkers underwent influences from sources other than that of his principal allegiance. For example, we know that Nifo was strongly influenced by Plato and Plotinus through Ficino; Pomponazzi by Stoicism; and the Italian Aristotelian writers on logic by the medieval tradition stemming principally from Galen. What is perhaps more unusual is that at least some Aristotelians were influenced in one way or another by atomism through Lucretius and by popular traditions of craftmanship and technology. We know that even the most anti-Aristotelian thinkers of the period were significantly influenced by the Peripatetic tradition *malgré eux.*

If the new Greek texts and Latin translations had merely generated an interest in comprehending and establishing the meanings of the pristine Aristotle purged of medieval accretion and distortion, the new Aristotelianism would have qualified as the beginnings of the history of Aristotelian scholarship, but would have been an intellectual dead-end. The reinvigoration of Aristotelianism after the bleak period of the fifteenth century derived not from a narrow philological approach in quest of the real Aristotle, but rather from its continued capacity to absorb the 'new' into the old, where 'new' is understood in terms of the recently introduced Greek authors and commentators whose works and ideas had not been part of medieval Aristotelianism. The disparities and disharmonies of the Middle Ages, which we emphasized earlier, were thus merely expanded and multiplied, as the new opinions, from whatever source, were assigned appropriate places in the traditional division of Aristotelian problems. The revitalized Aristotelianism was now so truly capacious that there was something for everybody and it managed to sustain itself as long as efforts to synthesize it into a coherent whole were avoided. From this standpoint, Aristotelianism acquired new strength and was able to perpetuate itself as much, if not more, on the basis of intellectual vigor than from its entrenched and traditionally privileged position.

The Aristotelian system was never reformed from within. It was destroyed from without on the basis of ideas developed by Copernicus, who attacked the macrostructure, and by Galileo, who not only upheld Copernicus, but also destroyed fundamental operational principles in the Aristotelian substructure. In challenging Aristotle and his followers, Galileo left an almost indelible historical impression that his Aristotelian opponents were inflexible, slavish partisans incapable of adopting, or even considering, new ideas. By 'new', Galileo, of course, understood the Copernican heliocentric system and such of his own ideas as involved the abandonment of the concept of absolute heaviness and lightness. From this standpoint, he is undoubtedly correct, since these concepts were totally incompatible with the Aristotelian world view. But if we count as 'new' ideas and concepts developed in medieval scholasticism as well as those introduced by the Greek authors and commentators mentioned above by Schmitt and made available in the late fifteenth and sixteenth centuries, then the problem of Aristotelianism is not inflexibility, but rather too much flexibility, too great a readiness to accept ideas and concepts that did not fit well, if at all, into Aristotle's natural philosophy. In the process of multiplying and absorbing new ideas from whatever sources, Aristotelians failed to notice the growing incoherence of the substructure. The capacity of Aristotelianism to absorb so much that was incompatible was possible only because of an absence of critical integration of the many disparate, conflicting, and unreconciled explanations, which formed its complicated operational substructure. Produced primarily by the atomization of Aristotelian scholastic literature, that fragmented and confused operational substructure served inadvertently to protect the well-ordered macrostructure from critical scrutiny and enabled the medieval cosmos to retain its firm hold on the European mind. Thus did Aristotelianism live on until it fell under the onslaught that began with Copernicus and Galileo, who together provided not only the beginnings of a new cosmic macrostructure, but also laid the solid foundation of a new operational substructure on which the whole could appropriately rest.

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REFERENCES

1. *The discarded image, an introduction to medieval and renaissance literature* (Cambridge, 1964), 121.
2. As illustrations, we might mention that a few scholastics in the fourteenth century (Thomas Bradwardine, Nicole Oresme, and perhaps Jean de Ripa) assumed the actual existence of an infinite, extracosmic void (see my article, "Place and space in medieval physical thought", in *Motion and time, space and matter, interrelations in the history of philosophy and science,* ed. Peter K. Machamer and Robert G. Turnbull (Columbus, Ohio, 1976), 137-67; that there were those who insisted that the matter of the celestial and terrestrial regions was identical (for example, William Ockham, *Commentary on the Sentences,* bk 2, Question 22 in *Guilelmus de Occam, O.F.M., Opera plurima* (Lyon, 1494-96; reprinted by The Gregg Press, London, 1962), vol. iv: *Super 4 libros Sententiarum,* bk 2, Question 22 ("Utrum in celo sit materia eiusdem rationis cum materia istorum inferiorum"), sig. Hiii, recto-Hiiii, verso (no foliation)); and that at least one scholastic, Nicole Oresme, proposed a doctrine of place that clashed with Aristotle's (see *Nicole Oresme: Le livre du ciel et du monde,* ed. Albert D. Menut and Alexander J. Denomy; translated with an introduction by Albert D. Menut (Madison, Wis., 1968), bk 1, ch. 24, p. 173). Although other changes could be cited, these suffice to convey something of the nature of the alterations that were suggested.
3. Many of these suggestions followed as a consequence of the Condemnation of 1277, issued by Etienne Tempier, the bishop of Paris, and the general interpretation of God's absolute power in the fourteenth century. On the impact of the Condemnation of 1277, see Pierre Duhem, *Le système*

du monde. Histoire des doctrines cosmologiques de Platon à Copernic (10 vols, Paris, 1913-59), Quatrième Partie, "Le Reflux de l'Aristotélisme: Les condemnations de 1277", vol. vi, and Edward Grant, *Physical science in the Middle Ages* (New York, 1971), 24-36. In altering situations within and without our world, God was frequently imagined to annihilate or create bodies. The possible consequences of such actions were then discussed. On the possibility of a plurality of worlds, see Duhem, *Le système du monde*, vol. ix, ch. 20, 363-430, and his *Etudes sur Léonard de Vinci, ceux qu'il a lus et ceux qui l'ont lu* (3 vols, Paris, 1906-13; reprinted 1955), vol. ii, 57-96, 408-23; for a recent summary of medieval views, see Steven J. Dick, "Plurality of worlds and natural philosophy: An historical study of the origins of belief in other worlds and extraterrestrial life" (Indiana University, Ph.D. dissertation, 1977), 71-108.

4. The illustrations below are drawn largely from my article "Medieval cosmology", which will appear in a forthcoming volume by David C. Lindberg (ed.), *Science in the Middle Ages* (University of Chicago Press).
5. On the problem of celestial commensurability or incommensurability, see *Nicole Oresme and the kinematics of circular motion: Tractatus de commensurabilitate vel incommensurabilitate motuum celi*, edited with an introduction, English translation, and commentary by Edward Grant (Madison, Wis., 1971). Oresme argues that each of these alternatives determines a radically different world order. For the consequences of each, and Oresme's position, see 67-77.
6. See Edward Grant, *A source book in Medieval science* (Cambridge, Mass., 1974), 263-4.
7. *Ibid.*, 275-80.
8. *Ibid.*, 253-62.
9. *Ibid.*, 603-14.
10. *Ibid.*, 621-4.
11. For the enunciations of all 266 questions, see *ibid.*, 199-210.
12. Charles Coulston Gillispie, *The edge of objectivity, An essay in the history of scientific ideas* (Princeton, N.J., 1969), 11.
13. A significant aspect of the *questiones* format, and the commentary form generally, is that it tended to discourage the introduction of topics and ideas which had no counterpart in the Aristotelian texts. Thus while a host of specific Aristotelian topics and themes were subjected to minute analysis, with a consequent multiplication of interpretations and opinions, subjects that were not considered at all by Aristotle could not be readily fitted into the traditional framework of questions. Thus it was *the independent question based on a problem specifically raised by Aristotle* which constituted the basis of medieval scholastic literature. Despite this seemingly severe restriction, however, new ideas and concepts could be introduced as extensions, or implications, of traditional problems.
14. *Summa philosophie naturalis Magistri Pauli Veneti noviter recognita et a vitiis purgata ac pristine integritati restituta* (Venice, 1503). In the first edition published at Venice in 1476, the title given in the colophon is *Summa naturalium*.
15. *Meteorologica* 1.1.338a.20-338b.22, as translated by H. D. P. Lee in the Loeb Classical Library (London, 1962; Cambridge, Mass., 1962). Although Aristotle's remarks might have served as a point of departure for cosmic

Thomas Aquinas offers a brief commentary on Aristotle's introductory passage (see Aquinas, *In Aristotelis libros De caelo et mundo; De generatione et corruptione; Meteorologicorum expositio* (Turin/Rome, 1952), p. 392, col. 1), others, such as Themon Judaeus, Nicole Oresme, and the Coimbra Jesuit commentators of the late sixteenth century, chose to ignore it in the commentaries and *questiones* on the *Meteorologica*.

16. Even the order of discussion is puzzling, since Paul places the *Metaphysics* last, rather than first, which seems *a priori* more logical. John Dumbleton's fourteenth century *Summa logicae et philosophiae naturalis* exhibits a similar tendency. "Parts II-X [Part I is on logic] of Dumbleton's *Summa*, the only one produced by the early Mertonians on natural philosophy, is really a collection of certain *dubia* 'magnorum naturalium quinque'" (James A. Weisheipl, O.P., "Ockham and some Mertonians", *Mediaeval studies*, XXX (1968), 200-1 (the bracketed phrase is mine)). The "five great natural books" from which the *dubia* were drawn are Aristotle's *Physics, De caelo, Meteorologica, De generatione et corruptione,* and *De anima.* During the 1550s Petrus Fonseca conceived the idea of a course on Aristotelian philosophy for Jesuit schools (see Charles H. Lohr, "Renaissance Latin Aristotle commentaries: Authors C", *Renaissance quarterly,* XXVIII (1975), 717). To achieve this, he simply ordered commentaries on the separate works of Aristotle. Construction of an integrated world view based on Aristotle, but not slavishly harnessed to the separate works of the corpus, probably never occurred to him.

17. Gregor Reisch, *Margarita philosophica*; mit einem Vorwort, einer Einleitung und einem neuen Inhaltsverzeichnis von Lutz Geldsetzer. *Instrumenta philosophica, Series thesauri,* I (Düsseldorf, 1973; reprint of the 4th ed., Basel, 1517), p.v., where Reisch furnishes a *partitio philosophie.*

18. See my introduction to the "Classification of the sciences", in E. Grant (ed.), *A source book in Medieval science* (ref. 6), 53-54.

19. Charles Schmitt, *A critical survey and bibliography of studies on Renaissance Aristotelianism, 1958-1969. Saggi e testi,* XI (Padua, 1971), 17-18.