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Donald F. Scholz, Ph. L.,

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INTRODUCTION

We are all aware that the things about us move from place to place in some way. Local motion is the motion most evident to us. Yet it is not easy to say what place is. Aristotle was the first philosopher to consider the question in an orderly fashion.[1] But his definition of place has been rather neglected in modern times. If it is mentioned at all it is usually immediately dismissed for one reason or another. Thus Newton dismisses it in a few words, as we shall see. Nor has Aristotle's definition been rejected only in modern times. Thus, the Stoics rejected it, proposing in its place a kind of space.[2] Even Theophrastus is said to have held a somewhat different view.[3] It is entirely understandable that so many men have had so many difficulties with the definition both because Aristotle presented his analysis

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[1] Aristotle, III Physics, Ch. I, 208a35.
[2] Max Jammer, Concepts of Space, p. 22.
[3] Ibid., p. 21.

in such a concise fashion and because our imaginations usually lead us to think of place in quite different terms. It has been made even more difficult by the advance of modern science which appears to question some of the assumptions of Aristotle. Yet, as we hope to show, his definition can be defended if it is understood properly.

In studying this definition we are indeed fortunate in possessing St. Thomas' commentary on Aristotle's Physics. Without this commentary, there is no doubt that our task would be infinitely more difficult. But in reading this commentary we must be careful to use it only as a guide. Ultimately, if we are to possess natural science we must judge for ourselves whether what he says is correct.

As is the case with any treatment of a subject omitting an analysis of its presuppositions, our present work cannot be considered a complete examination of the subject. At most, it can only aim at showing the direction in which such a complete analysis must be directed. Yet, it is our hope that we will be able to arrive at a substantially correct understanding of the definition and to point out the weakness of many of the objections which may be raised against it. We hope, then, that this analysis will be of aid in making the final judgment of Aristotle's definition which we must make if we are to acquire natural science for ourselves.

We will begin by considering certain notions in

Aristotle's Categories which are related to physical place in some way. We will then consider the infinite, which is also presupposed to Aristotle's definition. Then we will analyse Aristotle's treatise on place. Next we will consider Newtonian space, comparing it with Aristotle's place. Finally, we will reconsider Aristotle's definition in the light of modern scientific knowledge.

THE CATEGORY OF WHERE

79. Any logical consideration of Aristotle's category of where (πού) is faced with the difficulty that he said so little about it. In our treatment of quantity, we found that Aristotle had been very concise. However, concerning quantity at least he made a few comments. But about where (ubi) all he does is give two examples, "in the market place" and "in the Lyceum".[1] The only other thing he says concerning it is that where, together with certain other categories, is so easily understood that he need say no more about it than give the above examples.[2] To say the least, this brevity leaves us in a state of confusion.

80. Though St. Thomas wrote no commentary on the Categories, he does make some remarks about the category where elsewhere. In the third book of the Physics, this is what he says.

> But certain measures are extrinsic and certain intrinsic...
> But the exterior measures are time and place.

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[1] Aristotle, Categories, Ch. IV, 2a and Ch. IX, 11b13.

[2] "as for the rest, when, where, in a position, since they are easily intelligible, I say no more about them than was said at the beginning..." Ibid., 11b10.

> Therefore, according as something is denominated by time, there is the category of **when**, but according as it is denominated by place there are the categories of **where** and **position**, which adds above **where** the order of parts in place.[1]

From these remarks this much is certain. St. Thomas regards the category **where** as a denomination of something by its place. This place is an exterior measure of the thing denominated from it. It is the thing within a place which is measured by that place, and which is denominated **somewhere** by a reference to that place. For example, Socrates is in the market place. The market place is the place of Socrates. But it is not the market place which is predicated of Socrates. We do not say that Socrates is the market place. Rather we say he is "in the market place". Yet, it is not "in the market place" which is Socrates' place, but the market place itself. It is by considering a certain relationship between Socrates and the market place that we obtain the category **where**. St. Albert tells us what this relationship is.

> But in order that it may be understood how that which is somewhere (ubi) is, and how it is said to be, according as it is somewhere (ubi), it must be understood that to be circumscribed is to be figured, because what is circumscribed is contained in the figure of the container, and conversely. And therefore there are three kinds of circumscription. For there is the circumscription of the containing body, and this is a certain action. And there is the circumscription of the circumscribed, and this is a certain passion. And there is the circumscription proceeding from and caused

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[1] St. Thomas, III Physicorum, Lect. V, n. 322(15).

> by both of these, and this is the commensuration of the placed to the place, according to which what is in place in itself is compared to a common place or this particular place. And this circumscription is where according as it is a special category, because it is one species of being which is predicated when it is designated under the voice, for in this way everything which is said to be somewhere is said it be where it is. And this so being compared to place is posited in none of the other categories.[1]

The author of the Summa Totius Logicae Aristotelis says something similar.

> Where is the circumscription of a body proceeding from the circumscription of its place. For an understanding of the preceding description, and what where is, it must be known that place is the immobile surface of the containing body.[2]

As the author of the Summa Logicae makes clear above, for a perfect understanding of what the category where is, we must know what is meant by place, for where a thing is, is determined by its place. From the above quotations it would seem that the place to which we refer when we say that "where" means "in a place", is the innermost surface of the containing body. We explain where a body is when we give the container within which it is. As St. Albert showed above, a thing is in a place, i. e., it can be denominated somewhere, when the exterior surface of the thing is together with the interior surface of the container. According to this notion, which seems to be a position held by St. Thomas, St. Albert, and the author of the

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[1] St. Albert, De Sex Principiis, Tract. V, Ch. I.
[2] Summa Logicae, Tract. VI, Ch. X.

Summa Logicae, while place belongs to the container (for the surface of a container certainly belongs to the container) the where which is related to it is not predicated of the container, but of the body contained.[1] We do not predicate a place of the placed but we do predicate in a place of it.

81. On the other hand, St. Albert sometimes speaks as if the place to which where is related is the place or space which we discussed in our analysis of quantity. Consider this passage of St. Albert:

> And thus anyone can perceive how the essential parts of the quantitative placed body are joined to the parts of place, for the points of the placed body are fitted to the points of the place, and the lines to the lines, and the surfaces to the surfaces, and the depths to the depths, and briefly, it may be said, the dimensions to the dimensions and the diameters to the diameters.[2]

We can see here that St. Albert holds that there are diameters of the place corresponding to the diameters of the body in place. Now, one would not be likely to talk of the diameters of the place and the placed thing being together if the place were only a surface external to the placed. What St. Albert means in the above quotation becomes more clear in another place.

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[1] "Sicut autem in ante habito tractatu dictum est, non in eodem secundum substantiam et subjectum est locus et ubi: locus enim est in eo quod capit et continet et circumscribit. Ubi vero est in eo quod capitur et continetur et circumscribitur, et ab alio exteriori complectitur." St. Albert, De Sex Principiis, Tract. V, Ch. I.

[2] Ibid., Ch. II.

> For thus point is referred to point and line to line and surface to surface, and depth to depth, and diameter to diameter and so with the others. And indeed these are substantially the same according to the distance of the place and the placed, but being related to the container and contained they have the difference of the place and placed.[1]

This description sounds remarkably like our description of the relation between place or space in the category of quantity and the body which occupies it.[2] A place and the body which occupies it have all their dimensions together, but if place is merely the interior surface of the container, only the surface itself which is place can be together with the body placed in it. One cannot talk of the diameters of the two as being together. Hence it seems that if we are to accept those words of St. Albert, we must accept the place to which <u>where</u> is referred as being place in the category of quantity. But if we accept this notion, we must then explain what he means when he talks about the place to which <u>where</u> is referred as being the surface of the container. Further, St. Thomas' remarks seem difficult to understand in the context of this interpretation, for how is space an exterior measure of a body? On the other hand we must be very hesitant to accept a solution which contradicts the doctrine of a logician as great as St. Albert. Further, that there is more to the question than what we have considered is indicated by the fact that no matter

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[1] <u>Ibid</u>., Ch. III.
[2] Par. 22-26.

which alternative we take, St. Albert appears to have contradicted himself, in one place holding that the place we are talking about is the surface of the container, and only a few pages later holding it is the space between the surfaces of the container.

82. We will try to resolve this difficulty by first recalling our method of treating the category of quantity and then making our own attempt to discover the nature of the category where in the light of these previous analyses.

83. When examining the category of quantity we discovered it was so potential that when it was considered in its universality, without actually making reference to its species, there was little we could say about it. We cannot proceed in exactly the same way in our present treatment, by finding the immediate species of the category where and dividing these, because the species of where are far from evident. Yet, though Aristotle himself does not mention its species, he gives instances, which are in the mode of inferior or subjective parts. Thus, we can see that here too, Aristotle makes the genus known by its inferiors. However, this does not seem sufficient for us. In order to come to a more complete understanding of this extremely potential notion, i. e., to distinguish it more definitely from the other genera which we call the categories, St. Albert compares it to notions we have from other sciences,

particularly natural science, in this way giving it a certain additional intelligibility from the outside. He discusses whether a soul or a separated substance is in place, whether a point or the outer sphere of the heavens is in place. It is evident that these questions do not belong to logic, presupposing a great deal not only of natural science but also of metaphysics. Of course, such considerations are useful for a knowledge of the category where, but there is considerable danger that one will be led to a notion of place which is beyond the genus where as considered by logic. This is not a criticism of St. Albert's treatment of the category, which is certainly the best we have on the subject, but unless this analysis is read with considerable discernment it is likely to lead into error. Because of the need for this discernment, because of the need to separate the genus where as treated in logic from those things which can be brought in from the outside, we will begin again, reconsidering this category independently and adverting only to our common way of considering where, since the logical treatment of it proceeds from our common way of considering things, logic preceding as it does all the other sciences. Then we will compare what we have discovered with what St. Albert and St. Thomas have said.

84. When we say a man is in the next room or the milk is in the bottle, what do we mean? Obviously we are

predicating "in the next room" or "in the bottle" of the man or the milk. But what does "in the next room" or "in the bottle" mean? We are certain of what they mean, but we find it difficult to put into words. Knowing that the man is in the next room we are able to find him. We are tempted to say we can find him now because we know where the room is, but this merely pushes the problem back one step. In some way we make the man known by referring him to the room. In fact he becomes known because the room is known. Our knowledge of him participates in our knowledge of the room because he is contained by the room. We might say he is just outside the room, and in saying this we seem to be saying where he is, but in this case we seem to be indicating less exactly where he is. It seems that some reference to a container is essential to an exact or perfect statement of where he is. It seems that in order to know perfectly where he is, we must be able to give certain limits beyond which he does not extend. Yet, this is not sufficient for a perfect knowledge of where he is either. For, though certainly in the room, he may be behind the desk, or standing at the table.

35. With our other example, however, we do not have this problem. If the bottle is full of milk, by giving the bottle as the place of the milk we seem to have answered perfectly the question, "Where is it?" Thus, it seems that the very notion of where something is involves the notion

of its container. To tell perfectly where something is we must name a container which immediately encompasses the thing discussed. When we ask where something is, it does not seem that we commonly mean anything more definite than this.

86. Let us go back, now, and try to answer our original question. When we answer the question "Where?" to what notion of place do we refer: to the notion of a space between the sides of a container (the concept of place in the category of quantity) or to the container itself or the inside surfaces of the container (the concept of place in the fourth book of the Physics)? From what we have said above there can be no doubt that we refer to a container (and reductively to its internal surfaces), but this does not really exclude the possibility of there being a reference to the space between also. In any case, we cannot doubt that there is a reference to a container, for we know where a thing is by reference to the container. But the notion of space in the category of quantity always has a reference to the surface of a container also, as we saw previously. In fact, one space is distinguished from another precisely by the surfaces of the container at which it terminates. Thus, in fact, both the body about which we ask the question "Where is it?" and the logical place are denominated by the containing surface. Yet, when we commonly ask where something is, we do not necessarily advert to the fact that the

question primarily has reference to the container. Rather, we think of the "where" of a body as referring confusedly to both the container and the space. We know where a thing is by its container, but we also commonly consider the place in which it is to be coextensive with the thing also, to be spread out with the thing.

87. Now, when we consider the remarks of St. Albert,[1] there is no contradiction or difficulty. The logical notion of where refers confusedly to both the surface of the container (this primarily) and the space within the surfaces (this in a less clear way, though it is certainly present in our notion). In his exposition of "where", he refers primarily to the containing surface, because it is through the surface of the container that a body is denominated somewhere.[2] But several times he implicitly refers to the other notion of place, as space, which notion is really confused with the first in the logical notion (though we do not denominate a body by its space but both the space and the placed body are denominated by a container of both).

88. Now that we have established with some degree of probability the logical notion <u>where</u>, we will distinguish

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[1] Par. 80-81.

[2] Also in the <u>Summa Logicae</u> we read, "Superficies autem corporis locantis potest dupliciter considerari. Uno modo ut est in corpore locante et denominat illud; et sic est quantitas. Alio modo ut denominat corpus locatum; et sic facit praedicatum ubi, quod nihil aliud est secundum rem, quam locus, ut denominat locatum denominatione extrinseca." Tract. VI, Ch. X.

those things of which we predicate "where" per se from those things of which we predicate it per accidens. We will then conclude our treatment of the category where with a discussion of its properties.

89. St. Albert explains which things are per se in place as follows.

> But from the things said it is clear that something is said to be in place properly and per se which is so referred to a place that the indivisible by which the place is united, as a point, is referred to the indivisible by which the placed is united, and the length of the place to the length of the placed, and the width of the place to the width of the placed, and the depth of the one to the depth of the other. And this circumscription is in the place actively, but it can be taken in the placed as in the formed. And so in the same way the placed is comparable to the place. And where, according as it is the category gives this comparison.[1]

Those things are properly and per se in place (according to the category where) which are circumscribed in such a way that the parts of the place and the parts of the placed correspond. The notion of place referred to here would seem to be that of surface, not space, because of the expression "this circumscription" by which he here describes the relationship of the place to the placed, though he might be said to be referring to place as space also. In any case, there is a reference to quantitative parts. Therefore, it is not surprising that we find St. Albert saying elsewhere:

> Similarly all those things which disagree or recede from the notion of body according to quantity (considering

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[1] St. Albert, De Sex Principiis, Tract. V, Ch. II.

> that a body is measured in three dimensions), but are defined as simple and indivisible according to quantity, are in nothing as in place, because they cannot be assigned a beginning, middle and end in place. This, therefore, is where according as it is a category or principle.[1]

Those things, then, are somewhere per accidens, or through another, which do not have quantity in themselves and which therefore cannot be circumscribed by virtue of their own quantity. Thus, a color is somewhere only per accidens, because it has quantity only by virtue of the surface which is colored. Likewise a point cannot properly be said to be somewhere.

> Also, to the statement of Aristotle it must be said that a point is not in place per se, and if it were in place per se, then it would follow that the same thing would be the point and the place of the point.[2]

The outer sphere of the universe (according to the ancient beliefs) and separated substances are not anywhere either, for they are not circumscribed. However, an analysis of these things belongs to natural science and metaphysics.

90. Now that we have considered what the category of where is, and which things are somewhere per se and which per accidens, we will consider the properties of the category.

91. Above, when we considered the category of quantity we said that two of its properties were 'not to have contraries and not to be said to a greater or lesser degree'.

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[1] Ibid., Ch. I.
[2] Ibid., Ch. III.

The category *where* has the same properties, and as properties they are related to it in the same way, that is, they belong to every inferior of the category and always, but not to these exclusively.[1]

92. Concerning the property of not having contraries, the same objection can be raised here as was raised previously concerning this property in the category of quantity. It seems that we do have contraries in *where*. For above and below seem to be contrary places, giving rise to contrariety in *where*.

93. However, this objection may be answered in the way a similar one was answered *a propos* of the category of quantity.[2] Above and below are relatives. This can be seen by the fact that the same thing can be above and below at the same time. The top of a tower is above those looking up at it, but below the heavens.[3] But this is true because it is related to different things. It is above what is below and below what is above. "Above" and "below" are correlative terms, then, and belong, in this respect, to the category of relation.[4]

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[1] "Hoc igitur modo ubi proprium est (quod convenit omni sed non soli) magis et minus non suscipere. Similiter autem proprium erit ubi non habere contrarium. Hoc proprium convenit omni et semper, sed non soli." Ibid., Ch. V.

[2] See par. 54.

[3] St. Albert, *Ibid*., Ch. V.

[4] See par. 43-48 for a similar consideration.

94. It might also be argued that the principle and term of every local motion is a where and that these are contraries,[1] or that the universe, being infinite, must have contrary places and hence contrariety in where. But since these contrarieties proceed from something outside our conception of where,[2] we may conclude with St. Albert that there is no contrariety in where.

95. Before we have completed our treatment of the category where, we must consider one small difficulty. When we treated the category of quantity we said that it had a property which was truly proper to it, for equality and inequality are found in quantity alone. But thus far we have given no such property of where. Is there such a property of this category? There does not seem to be any definite and certain answer to this question. One might propose as a property of where that something is said to be somewhere most perfectly in all cases, only, and always if it is equal to its place.[3] However, one might object to this answer that instead of giving a property of the

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[1] See the footnotes to par. 68 and 69.

[2] See par. 60-69, also see St. Thomas, V Physicorum, Lect. IV, n. 681(4).

[3] "Dici potest, sicut dictum est in tractatu de Quando, quod scilicet proprie proprium ubi intelligitur sitis ex praedictis, quod scilicet convenit ei aequale esse ad id in quo est, hoc est, ad corpus, quod est cause ubi per circumscriptionem, quod ubi est circumscriptum et convenit ei aequale esse ad id ex quo sicut ex causa procedit, et alia hujusmodi quae facile est assignare." St. Albert, De Sex Principiis, Tract. V, Ch. V.

category it expresses what it is to be somewhere.

96. Therefore, perhaps a better answer is the one which St. Albert finally gives.

> Nevertheless, it can be said concerning both those principles, namely when and where, that their substance is considered in comparison, and that they do not have much substance in reason, and less in natural being. And therefore there are not as many things rooted properly proper in their substance, as there are in those things which have absolute essences. Therefore, substance has such properties most, and quantity after substance, and after quantity quality; and relation has them according to speech. But the others do not have properties of this kind, and therefore they are not given. And therefore I think that this reason is the true reason why properties properly taken are not proposed here.[1]

97. We have now completed our consideration of quantity and where. In order to come to an understanding of place or space in the category of quantity, we have analyzed the entire category. We have seen that place (in this sense) is distinguished from the body with which it is co-extensive by a different notion of measure, the place being measured from the surfaces of the containing body and the body co-extensive with it being measured from the surface of the contained body. We have seen the properties of quantity and hence of place, i. e., not to have contraries, not to be said to a greater or lesser degree, and to have equality or inequality predicated of it. We have also considered the category where. We have seen what being "in a place" means, and we have seen that "place" in this expression refers primarily to the containing surface, but

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[1] Ibid.

in a confused way to place in the sense of a space. In considering where we discovered that it has some of the properties of quantity, but we have discovered no property proper to it alone.

98. We must next consider Aristotle's analysis of the infinite which is presupposed to his examination of place in book four of the Physics.

THE INFINITE

99. Once Aristotle has completed his consideration of motion, he begins to consider the infinite. As St. Thomas points out,[1] the infinite belongs to motion since motion is continuous. But Aristotle proves that motion is continuous in the sixth book of the Physics, where he proves it to be infinitely divisible. It might be asked, therefore, why he considers the infinite here, before he has proved the continuity of motion. One might answer that in the fourth book Aristotle considers place and time. Since these are extrinsic measures of the mobile and of motion,[2] it seems that they ought to be considered only after the infinite, which follows motion intrinsically.[3] However, this cannot be the entire solution for then, by this same reasoning, it would follow that the continuity of motion should be proved in the third book. After this the infinite

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[1] "Sed motum consequitur infinitum intranee, quod sic patet. Motus enim est de numero continuorum, quod infra patebit in sexto: infinitum autem cadit in definitione continui." St. Thomas, III Physicorum, Lect. I, n. 277(3).

[2] St. Thomas, IV Physicorum, Lect. I, n. 406(1).

[3] III Physicorum, Lect. I, n. 277(3).

might be treated. For if the infinite must be treated before place and time because they are extrinsic whereas it is intrinsic, since continuity is something intrinsic to motion also, it too must be treated before place and time. But, in fact, Aristotle treats continuity afterwards. Since continuity, which is intrinsic, is treated afterwards, it seems that infinity, which belongs to continuity, might have been treated afterwards also. Therefore, we must seek another reason why infinity is treated where it is, at the end of book three.

100. Actually, we can easily see two reasons why the infinite should be treated here if we consider the effect the solution to this problem has upon what follows immediately. First, if the mobile or motion could be infinite in act, what kind of measure could either of them have, how could there be a place for a mobile which is infinite, or how could time measure an infinite motion? Second, as we will see below, Aristotle's argument, that place cannot be a space presupposes that there is no actual infinite in nature. A consideration of the infinite, thus, is presupposed to the analysis made in book four. It is for this reason we will now discuss the infinite.

101. In reflecting upon the discussion presented here, one might note that Aristotle is taking up the question of the infinity of the universe as a whole as well as that of the infinity found in motion. He is treating the physical

infinite generally.

102. Aristotle begins his analysis of the infinite by showing that it belongs to natural science to consider the infinite. First he shows it by a reason, then by a sign.[1] The following is his argument:

> The science of nature is concerned with spatial magnitudes and motion and time, and each of these at least is necessarily infinite or finite, even if some things dealt with by the science are not, e. g. a quality or a point - it is necessary perhaps that such things should be put under either head. Hence it is incumbant on the person who specializes in physics to discuss the infinite and to inquire whether there is such a thing or not, and if there is, what it is.[2]

Because at least some of the things which natural science considers must be either finite or infinite, namely magnitude, motion and time, it belongs to natural science to discuss the infinite (because not all things are infinite, a consideration of the infinite must not be reserved to Metaphysics[3]).

103. This is the sign he gives to show it.

> The appropriateness to the science of this problem is clearly indicated. All who have touched on this kind of science in a way worth considering have formulated views about the infinite.[4]

From the fact that all those who have considered natural philosophy well made mention of the infinite, it seems that

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[1] St. Thomas, III Physicorum, Lect. VI, n. 326(1).
[2] Aristotle, III Physics, Ch. IV, 202b30.
[3] St. Thomas, III Physicorum, Lect. VI, n. 327(2).
[4] Aristotle, III Physics, Ch. IV, 203a1.

the infinite must be discussed by natural science.

104. Having presented the opinions of others about the infinite (which we will omit due to lack of space), Aristotle gives reasons for and against the existence of the infinite. First, he gives five reasons why men tend to think that the infinite exists. The first of these reasons is that time seems to be infinite, for a beginning or end of time "appears" impossible.[1]

105. The second reason is taken from the division of magnitudes to infinity. Mathematicians divide magnitudes infinitely, which they would not do if magnitude could be so divided.[2] We might add that in relatively modern times this has been held to be a tenable opinion even concerning natural magnitude. Thus in 1927 P. W. Bridgman said:

> It appears then that present experimental evidence makes very probable structures beyond the electron and the quantum; we may go even further and say that there is no experimental evidence that the sequence of phenomena in nature as we go to ever smaller scales is a terminated sequence, or that a drop of water is not in itself essentially infinite.[3]

106. Aristotle's third argument is that since generation and corruption do not give out, that from which things come to be must be infinite.[4]

107. The fourth argument is taken from what appears

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[1] Ibid., 203b16.
[2] Ibid., 203b17.
[3] P. W. Bridgman, The Logic of Modern Science, p. 207.
[4] Aristotle, III Physics, Ch. IV, 203b18.

to be the nature of the finite. For it seems to belong to the nature of the finite to be limited by something else. If this thing is finite in turn, it must also be limited by another and so on to infinity or until we come to something infinite. Thus, it follows that the infinite exists, for if the finite exists, the infinite exists, and if the finite does not exist, then what exists must be infinite.[1] In this way Copernicus denied that there was nothing outside the spherical universe because it seemed "really strange that something could be enclosed by nothing."[2]

108. And this is the fifth argument Aristotle gives.

> Most of all, a reason which is peculiarly appropriate and presents the difficulty that is felt by everybody - not only number but also mathematical magnitudes and what is outside the heavens are supposed to be infinite because they never give out in our thought.
> The last fact (that what is outside is infinite) leads people to suppose that body also is infinite, and that there is an infinite number of worlds. Why should there be body in one part of the void rather than in another? Grant only that mass is anywhere and it follows that it must be everywhere. Also if void and place are infinite, there must be infinite body too, for in the case of eternal things what may be must be.[3]

We might note that in modern times the same argument has been used to prove that space is infinite. Thus Descartes wrote:

> It is repugnant to my mind, or what amounts to the same thing, it implies a contradiction, that the world be finite or limited, because I cannot but conceive a space outside the boundaries of the world wherever I

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[1] Aristotle, III Physics, Ch. IV, 203b20.

[2] Alexandre Koyré, From the Closed World to the Infinite Universe, pp. 31-32.

[3] Aristotle, III Physics, Ch. IV, 203b22.

suppose them.[1]

109. When Aristotle has given these five arguments to show that the infinite exists, he shows many difficulties which arise if one proposes the existence of the infinite. By means of these difficulties he attemps to show that the infinite does not exist. The natural arguments he gives are of two kinds. First, he shows that there is no infinite sensible body if it be supposed that the elements are finite in multitude.[2] Second, he shows it without making this supposition.[3] In considering Aristotle's arguments against the existence of the infinite one must carefully reflect upon certain remarks St. Thomas makes concerning them.

> About these it must be considered that because Aristotle has not yet proved that the celestial body is of another essence than the four elements, but the common opinion of his time was that there were four elements in nature, he proceeds in these reasons as if there were no other sensible body outside the four elements, according to his custom, because always before he proves what pertains to his opinion, he proceeds from the supposition of the common opinion of the others. Hence, after he has proved the heavens to be of another nature from the elements in the first book of the De Caelo et Mundo he repeats the consideration of the infinite, showing universally that no sensible body is infinite.[4]

We must understand what Aristotle is trying to do in the arguments he gives here to show that there is no sensible

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[1] Second letter of Descartes to Henry Moore, 15, IV, 1949, p. 345 of the text of the Adam-Tannery edition of the works of Descartes, (cited by Alexandre Koyré, Ibid., p. 123).

[2] St. Thomas, III Physicorum, Lect. VIII, n. 353(5).

[3] Ibid., Lect. IX, n. 358(1).

[4] Ibid., Lect. VIII, n. 353(5). St. Thomas makes similar remarks in I De Caelo et Mundo, Lect. IX, b. 95(2).

infinite body. According to St. Thomas he is not making a final determination of the question. As St. Thomas points out, it was Aristotle's opinion that the heavens were made of a fifth element. Yet, he proceeds in his arguments here as if there were no fifth element. This can be seen by an examination of his arguments. Since these arguments proceed from a supposition held to be false by Aristotle, he can hardly have intended them to settle the question.[1]

110. Furthermore, aside from this supposition which Aristotle himself held to be false, there are other suppositions which are no longer held to be likely, but which Aristotle himself may have thought to be true. To show what we mean, we will examine one of Aristotle's arguments. He argues:

> Further, every sensible body is in place, and the kinds or differences of place are up-down, before-behind, right-left; and these distinctions hold not only in relation to us and by arbitrary agreement, but also in the whole itself. But in the infinite body they cannot be.[2]

This argument can be understood by proceeding from our own bodies to the universe as a whole. It is plain that there is an up, down, front, back, right, and left with reference to our own bodies. These directions can be found by considering the organs of the body, which are not entirely

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[1] See also St. Thomas, I De Anima, Lect. X, n. 147.
[2] Aristotle, III Physics, Ch. V, 205b32.

homogeneous in any direction. The feet are at the lowest part of the body, the head at the top, and there is a like distinction between front and back. Even between left and right there is a distinction, for instance the left side of the brain is dominant in a right-handed person and the arrangement of the viscera is not an identical one on the left and the right side.

111. According to the argument, a like distinction is present in the universe as a whole, or at least that part of it which is visible. This distinction does not appear to be merely like the distinction between the left and right side of a column, i. e. only relative to us. Rather, it appears to be a distinction within the universe itself. All heavy bodies tend to fall to the same place, the earth, all light bodies tend to rise, the spheres rotate about their poles, and the sun rises in the east and sets in the west. Thus, the universe seems to have a definite form as a whole with parts distinct in some way and proportionate to the whole. Since it is impossible for an infinite to have parts of this kind,[1] and since the universe appears to have them, the universe cannot be infinite.

112. Obviously, this no longer appears to us to be a probable view of the universe. We no longer believe that all the heavy bodies in the universe tend to fall toward

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[1] In some way proportionate to the whole.

the earth. To us, it seems likely that only those heavy bodies which are near the earth tend to fall to the earth. Indeed, probably some bodies fall in the opposite direction (for instance toward Jupiter). Thus we no longer consider the direction downward (as determined by the direction of a falling body) to be a uniform direction throughout the universe. In the same way, we no longer consider that east and west (as determined by the apparent motion of the sun, for instance) are distinct directions determined for the whole universe. In general, we no longer hold we can perceive uniform differences according to direction for the universe as a whole. Rather, we are sure we can perceive these differences for relatively short distances, for instance the distance a body can be from the earth and yet fall to it rather rapidly, but we are unable to detect such differences over greater distances. Thus Max Jammer writes:

> The general validity of the principle that the universe presents the same aspect from every point (and according to a modern school of cosmologists also at every time), except for local irregularities, is accepted in modern science as a necessary condition for the respectability of experiments, since space and time are the only parameters which, at least in principle, are beyond the control of the experimenter and cannot be reproduced at his will.[1]

And in the Encyclopedia Britannica we find this remark:

> Most cosmological considerations are based on the so-called cosmological principle, which states that on a large scale all positions in space are equivalent; irregularities are only local. Thus on a large scale

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[1] Max Jammer, Concepts of Space, p. 82.

the universe is homogeneous.[1]

Modern cosmology can proceed on this assumption because there is no evidence to the contrary; the differences we can detect do not belong to the universe as a whole. Thus by themselves they do not prove the universe to be finite.

113. It is rather interesting to note that Johannes Kepler used an argument very similar to Aristotle's in trying to prove that the universe is finite. Kepler argued (several years before Galileo's astronomical discoveries by means of the telescope) that the distribution of the stars is such that the universe (insofar as it is perceptible) has a definite structure. Assuming that the apparent diameters of the stars correspond to their real diameters, and that stars equally bright are an equal distance away, he argued that since the universe would appear differently to one not situated on the earth (the stars would appear much bigger), one must admit that the place of the earth "is a certain particular place and the main cavity of the world." Therefore, since the universe is not homogeneous, it cannot be infinite.[2] However, later observations by means of the telescope (even by Galileo) did not confirm Kepler's assumptions.

114. Aristotle's other arguments contain other suppositions which are no longer held to be true or at least

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[1] Encyclopedia Britannica, the article on "space-Time" (1960, vol. 21, p. 106) by Nandor Laszlo Balazs.

[2] De stella nove in pede Serpentarii, Ch. XXI, p. 689-691 (Opera omnia, ed. Frisch, vol. II, Frankofurti et Erlangae, 1859), cited by Koyré, From the Finite World to the Infinite Universe, pp. 62-73.

evident. For instance, he supposes that if one element were infinite and another finite, the infinite element would destroy the finite one by virtue of its excessive power.[1] Such an opinion is reasonable if one supposes that the elements are differentiated by contrary qualities, such as hot and cold, wet and dry. Certainly, if what is hot is infinite it will destroy what is cold according to its nature if they are in contact. But we do not distinguish the "elements" in this way today. It does not seem that even an infinite excess of nitrogen would destroy a small amount of helium, nor an infinite excess of neutrons a small number of electrons, if we can call even these, elements. At any rate it is not clear how Aristotle's argument should be applied today. Of course, even for him it could have been only probable, since his fifth element was not supposed to have any contraries.

115. But if we can no longer accept Aristotle's arguments against the infinite, how are we to take Aristotle's entire treatment of the infinite? In the first place, as was plain from the words of St. Thomas above, Aristotle did not consider these arguments as demonstrative. They are to be taken as only probable, and probable only when viewed from the common opinion preceding his own. In fact, as we shall see below, Aristotle's treatment of the infinite does

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[1] Aristotle, III Physics, Ch. V, 205a23; St. Thomas, III Physicorum, Lect. IX, n. 362(5).

not stand or fall with these arguments. In the second place we can give a probable argument which will take the place of Aristotle's arguments for us. Since the most probable way in which an infinite universe might be considered to exist today would be for there to be an infinite multitude of finite bodies, to lead this notion into a paradox might be considered a probable argument against the existence of the infinite. Therefore, suppose an infinite multitude of finite bodies to exist. If one of these finite bodies should be divided, the infinite multitude would be increased. Yet to add something to the infinite seems to be impossible.[1]

116. Of course, it is true that not all men consider it impossible to add something to the infinite. For example, take the following remarks of George Gamow, a well known scientist and Professor of Physics at the University of Colorado. Speaking of the universe before its expansion he says:

> "...In such a highly compressed state all the matter which is now within the reach of the 200— inch telescope must have occupied a sphere only thirty times as large as the sun. But since the universe is, and always was, infinite, the space outside of that sphere was also occupied by matter, the matter which now lies beyond the reach of the 200—inch telescope.
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> The fact that material occupying an infinite space can be squeezed or expanded and still occupy the same infinite space is one of the so-called "paradoxes of infinity." It is best illustrated by an example given by a famous German mathematician, David Hilbert, in one of his lectures.

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[1]This argument is given, in its essence, by Vincent Smith in his The General Science of Nature, pp. 280-281.

> "Imagine," said Hilbert, "a hotel with a finite number of rooms, all rooms being occupied. When a new client arrives, the room clerk must turn him down with regrets. But let us imagine a hotel with an infinite number of rooms. Even if all these rooms are occupied, the room clerk will be glad to accomodate a new customer. All he has to do is to move the occupant of the first room into the second, the occupant of the second into the third, the occupant of the third into the fourth, und so weiter... Thus the new customer can get into the first room. Imagine now a hotel with an infinite number of rooms, all occupied," continued Hilbert, "and an infinite number of new customers. The room clerk will be glad to oblige. He will move the occupant of the first room into the second, the occupant of the second into the fourth, the occupant of the third into the sixth, und so weiter... Thus every second room (all odd numbers) will now be free to accommodate the infinity of new customers.
>
> In exactly the same way that an infinite hotel can accommodate an infinite number of customers without being overcrowded, an infinite space can hold any amount of matter and, whether this matter is packed far tighter than herrings in a barrel or spread as thin as butter on a wartime sandwich, there will always be enough space for it.[1]

From these remarks it is clear that Dr. Gamow sees no difficulty in the addition of something to what is already infinite. But if such an addition should take place, would the resultant infinite (say an infinite multitude or an infinite space) be greater than it was before? If it would be greater, it would seem not to have been infinite before. If, on the other hand, the resultant infinite would not be greater after the addition than before it, it would seem that what was supposed to be added, instead of being truly added to the infinite, merely disappeared. Therefore, it must be admitted that in spite of the argument of Gamow,

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[1] George Gamow, The Creation of the Universe, pp. 35-36.

it appears probable that nothing can be added to what is infinite and therefore that the universe cannot be infinite.

117. Under various other more concrete hypotheses, one may find other difficulties which arise. For instance, Hermann Weyl says:

> The infinite Euclidean space leads to absurdities if we assume that the masses are on the whole uniformly distributed throughout the universe and that Newton's law of attraction is valid. Even though the gravitational force of a constant mass decreases with the inverse square of the distance, the far-off masses would then be so predominant in the entire gravitational effect that the total force exerted upon any one star would remain completely indeterminate.[1]

118. Having substituted arguments perhaps more suitable today for those of Aristotle against the existence of the infinite,[2] let us continue with Aristotle's treatment of the infinite. Because there are arguments which seem to prove the infinite cannot exist, and others which seem to prove it must exist, Aristotle concludes that a distinction must be made. It must be that the infinite does exist in one way and does not exist in another.[3] Therefore, Aristotle proposes that the infinite does not exist in act, but exists in potency only.

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[1] Hermann Weyl, Philosophy of Mathematics and Natural Science, p. 108.

[2] It would be impractical to consider here Aristotle's more concrete treatment of the infinite in the De Caelo et Mundo because of the lack of space and because of the many problems involved in the presuppositions to this analysis and the opposition of the present views of modern science to many of these suppositions.

[3] Aristotle, III Physics, Ch. VI, 206a11.

> We must keep in mind that the word 'is' means either what potentially is or what fully is.
>
> Further, a thing is infinite either by addition or by division.
>
> Now, as we have seen, magnitude is not actually infinite. But by division it is infinite. (There is no difficulty in refuting the theory of indivisible lines.) The alternative then remains that the infinite has potential existence.
>
> But the phrase 'potential existence' is ambiguous. When we speak of the potential existence of a statue we mean that there will be an actual statue. It is not so with the infinite. There will not be an actual infinite. The word 'is' has many senses, and we say that the infinite 'is' in the sense in which we say 'it is a day' or 'it is the games', because one thing after another is always coming into existence. For of these things too the distinction between potential and actual existence holds. We say that there are Olympic games, both in the sense that they may occur and that they are actually occurring.[1]

When we say something "is", we may mean it is in potency or it is in act. When we say the infinite exists in potency we do not mean that it may exist later as a whole in act. Rather, we mean it exists in potency as a day exists, partly in act (the now) and partly in potency. The infinite can never exist wholly in act (in material things). Only one part of it after another exists in act, the part which is Not in act always being infinite.[2] In this way there may be an infinite through division, as in magnitude, or through addition as in both magnitude and number. Of course, the finite which we actually take in magnitude by adding or

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[1] Ibid., 206a14.

[2] In a sense, one might say that no part of the infinite ever exists in act, just as the now, which is the only "part" of time which ever exists, is really not a part of time. St. Thomas, VI Physicorum, Lect. XI, n. 861(2).

dividing is permanent, whereas this is not true of time, since today exists today, but will no longer be in act tomorrow.[1]

119. Further, if magnitude is added to magnitude infinitely, the magnitudes cannot be of the same size, for then there would be an infinite in act, a magnitude surpassing every determined magnitude. Each magnitude added must be smaller than the previous, but it may have the same ratio to some term. Thus the first magnitude may be half of some given distance, the second, half of the remaining distance, and the third, half of what remains after the second magnitude has been added to the first. In this way addition is possible infinitely without there being any magnitude infinite in act,[2] for by such additions one merely approaches a definite (finite) quantity as a limit.

120. Next Aristotle defines the infinite. And he says that the infinite turns out to be the contrary of what it has been said to be, for "It is not what has nothing outside it that is infinite, but what always has something outside it."[3] Then he gives a sign that this is the case.[4] Circles are said to be infinite, for one part can always be taken after another. But although a circle is similar

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[1] St. Thomas, III Physicorum, Lect. X, n. 376(7).
[2] Ibid., nn. 387(9) - 380(11).
[3] Aristotle, III Physics, Ch. VI, 207a1.
[4] St. Thomas, III Physicorum, Lect. XI, n. 384(3).

to the infinite, it is not infinite properly speaking, for in the infinite one must be able to take part after part without ever taking again any part previously taken. Obviously this is not the case with a circle, in which one eventually comes back to that from which he began.[1] Thus the circle is not infinite, and the infinite is not that outside of which there is nothing. The fact that a circle is not infinite because one cannot always take another part not taken before is a sign that the infinite can be defined as that which always has something outside it.

121. In a more general way, "that outside of which there is nothing" is a definition more appropriate to the perfect.[2] For if there is something which a thing lacks, we tend to call that thing imperfect. In contrast, then, we can see that Aristotle's definition of the infinite is suitable, because the infinite, as such, is imperfect, in potency. Now, the infinite differs from the perfect precisely insofar as there is something lacking in the infinite, something outside what has been taken, and it differs from what can become perfect precisely insofar as there is <u>always</u> something more which can be taken. Thus the infinite is that which always has something outside it, that is, outside that part which has been taken or is in act.

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[1] <u>Ibid</u>.

[2] St. Thomas, III <u>Physicorum</u>, Lect. XI, n. 385(4).

122. Aristotle concludes his treatment of the infinite by refuting the five arguments given above to show that the infinite exists, insofar as they may be understood to refer to the infinite in act. First he considers the third argument, which was that generation and corruption do not fail. Now we can see that in order to meet this condition it is not necessary that generation and corruption exist infinitely in act, but only infinitely in potency, generations (and also corruptions) taking place in succession. Therefore, in fact, this is no argument for the existence of the infinite in act, but only in potency, which Aristotle admits to exist.[1]

123. Second he considers the fourth argument, which was that it seems to belong to the concept of finite that it be limited by something. Thus, each finite thing must be limited by another either to infinity, or until something infinite is reached. He answers this argument by distinguishing between touching and coming to an end. For whatever touches, touches something. But whatever comes to an end, needs not do so with respect to something else. It comes to an end, as it were, in itself. Thus there need not be something outside of what comes to an end which terminates it or touches it. Nor is it necessary that what is touched by one thing touches another. Thus, this argument

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[1]Aristotle, III Physics, Ch. VIII, 208a11.

is not valid.[1]

124. Third, he answers the fifth argument, which is taken from the fact that the imagination and intellect do not give out in considering either number or magnitude. From this it seems that the infinite exists. He answers this objection by saying that it is absurd to suppose that because we can think of something in some way that therefore it _is_ in that way. For we can consider someone bigger than he is, as much bigger as you wish, but he remains the size he is. Therefore, the argument proves nothing.[2]

125. Fourth, he considers the first argument, which was that time is infinite, for it always was and always will be. Here he points out that this argument is actually an argument showing that time is potentially infinite. For the whole of time does not exist in act, but only the now exists in act. Thus, time is infinite only potentially.[3]

126. Fifth, he considers the second argument, which was that magnitude is divisible infinitely. The answer he gives to this argument is similar to the preceding one, that there can be an infinite addition or division of magnitude in potency only, and this is all that the argument proves.[4]

127. It remains, now, to consider the validity of

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[1] Aristotle, III _Physics_, Ch. VIII, 208a11.
[2] _Ibid._, 208a15.
[3] _Ibid._, 208a20.
[4] _Ibid._, 208a22.

Aristotle's treatment of the infinite. What Aristotle wished to prove was that only the infinite in potency exists. His argument seems to depend upon his having shown that it is impossible for the infinite to be in act. But we admitted above he has not strictly proved this. For his arguments we have substituted some which might appear more convincing to us today, but which still do not prove the point. But, as we pointed out above,[1] Aristotle himself was well aware that these arguments did not strictly prove his point. Indeed, if one properly appreciates Aristotle's analysis of the infinite, he can see that the weakness of these arguments does not entirely undermine his general argument. For in considering his general argument we can see that, according to his custom, he uses opposed dialectical arguments (that the infinite does and that it does not exist) to show that a distinction must be made (between act and potency). Having made this distinction and defined the infinite, he then proceeds to destroy the arguments showing that the infinite in act must exist. As with these arguments, those against the existence of the infinite are used to lead into the distinction between the infinite in act and the infinite in potency.

128. What should be our conclusion from this? We find the basis for our solution in a remark which Aristotle made with reference to Anaxagoras in book one of the Physics.[2]

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[1] See par. 110.

[2] Aristotle, I Physics, Ch. IV, 188a17.

Aristotle says "...and it is better to assume a smaller and finite number of principles, as Empedocles does." St. Thomas explains this remark as follows:

> ...He disproves the position of Anaxagoras through a comparison to the opinion of Empedocles. And he says that it is better to make the principles fewer and finite, which Empedocles does, than many and infinite, which Anaxagoras does.[1]

The same principle holds here. By his treatment of the infinite Aristotle has shown that it is not necessary to propose the existence of the infinite in act. Since it is superfluous to propose more than is necessary to explain the facts, by his treatment of the infinite Aristotle has shown that at least on this general level of concretion, one must not propose the existence of the infinite in act.

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[1] St. Thomas, I Physicorum, Lect. IX, n. 74(17).

PLACE ACCORDING TO ARISTOTLE

129. When Aristotle has finished his examination of the infinite, he begins to consider place. First, he gives two reasons from the nature of place itself why the natural scientist must study place. Second, he shows from our indeterminate knowledge of it that we must study it.[1] This is the way Aristotle gives the first two reasons.

> The physicist must have a knowledge of Place, too, as well as of the infinite - namely, whether there is such a thing or not, and the manner of its existence and what it is - both because all suppose that things which exist are somewhere (the non-existent is nowhere - where is the goat-stag or the sphinx), and because 'motion' in its most general and primary sense is change of place, which we call 'locomotion'.[2]

The first argument which Aristotle expresses here[3] is that because none of the things which do not exist are in place (such as the goat-stag, which does not exist and is not in place), whatever does exist is in place. Therefore, since it belongs to natural science to consider those things which are common to natural things, and place is common

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[1] St. Thomas, IV Physicorum, Lect. I, n. 406(1), 409(4).
[2] Aristotle, IV Physics, Ch. I, 208a28.
[3] Actually beginning at "...both because all..."

to all natural things, it follows that it belongs to natural science to consider place.

130. Two observations may be made concerning this argument. First, the argument to show that all existing things are in place is sophistical. Understood as St. Thomas understands it,[1] the argument proceeds in two steps. From the fact that if something does not exist, it is not in place, it is assumed that if something is not in place, it does not exist. From this it is concluded that if something exists, it is in place. The first step is invalid. From the fact that what does not exist is not in place, it does not follow that what is not in place does not exist.

131. However, Aristotle's argument itself is not sophistical. Rather, certain men argued from one thing to another sophistically. Aristotle's argument merely consists in arguing from a position so reached (sophistically) by others to the conclusion he desires by principles which they would accept, or which were commonly accepted. Thus, Aristotle's argument is a dialectical one. Apparently, St. Thomas took the argument in this way, for he says that

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[1] "Et ad hoc probandum utuntur sophistico argumento a positione consequentis. Argumentantur enim sic. Quod non est, nusquam est, idest in nullo loco est: non enim est dare ubi sit tragelaphus aut sphinx, quae sunt quaedam fictitia sicut chimaera. Argumentatur ergo quod si id quod in nullo loco est, non sit; ergo omne quod est, est in loco." St. Thomas, Ibid., Lect. I, n. 407(2).

they used a sophistical argument,[1] whereas he would have said that he used one if he thought the sophistical part were actually Aristotle's own argument.

132. In the second place, even if it were granted that everything which is, is in place, it would not follow from the argument that the study of place belongs to natural science. Rather, it would then belong to metaphysics to study it.[2] For metaphysics treats what is common to all being, natural science considering what is common to natural things alone. Concerning this difficulty, St. Thomas says:

> And it must be said that here he argues from the opinion of those positing all being to be sensible, because they are not able to transcend the imagination of bodies, and according to these, natural science is first philosophy, common to all being, as is said in the fourth book of the Metaphysics.[3]

Since the ancients tended to think that all existing things were sensible, it would follow from their opinion that if all things were in place, place must be studied by natural science. In this respect it is plain that Aristotle is merely arguing from an opinion common in his day.

133. Furthermore, as we pointed out above,[4] it is Aristotle's custom to proceed from the common opinion until he has proved it false. Thus, he argued above that the

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[1] "Et ad hoc probandum utuntur sophistico argumento..." St. Thomas, Ibid., Lect. I, n. 407(2).

[2] "Sed si esse in loco convenit omnibus entibus, videtur quod locus magis pertineat ad considerationem metaphysici quam physici." Ibid.

[3] Ibid.

[4] See par. 109.

infinite could not exist by an argument supposing the existence of only four elements, even though later he will argue that there is a fifth element.

134. Aristotle's second argument is that since it belongs to natural science to study motion, and since motion cannot be known unless place is known, natural science must discuss place also. Motion cannot be known unless place is known because local motion is the most general motion and because it is motion in the "primary sense". It is most general motion, according to Aristotle, because there are some things which have only local motion (the celestial bodies). Hence, if local motion and therefore place were not studied by natural science, certain considerations about some natural things would have to be omitted from natural science. Local motion is the primary motion because it is the motion which is primarily continuous[1] and for other reasons which we cannot discuss here.[2]

135. When Aristotle has given these two arguments, he gives yet another one. This is what he says.

> The question, what is place? presents many difficulties. An examination of all the relevant facts seems to lead to divergent conclusions. Moreover, we have inherited nothing from previous thinkers, whether in the way of a statement of difficulties or of a solution.[3]

It would seem that this passage may be interpreted in two

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[1] See St. Thomas, VI Physicorum, Lect. V, n. 802(16).

[2] These are discussed by Aristotle in VIII Physics, Ch. VII and by St. Thomas in VIII Physicorum, Lect. XIV.

[3] Aristotle, IV Physics, Ch. I, 208a33.