

**ARISTOTELIAN METHODOLOGY**

**A Commentary on the *Posterior Analytics* of Aristotle**

**By**

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**Pontifical Institute of Philosophy  
Dominican House of Studies-River Forest, Illinois.  
(1958)**

**Edited by  
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## INTRODUCTION

### I. Importance of Methodology

Since the time of Francis Bacon (1561-1626) and René Descartes (1596-1650) considerable attention has been given to “methodology” by both philosophers and physical scientists (since the 17<sup>th</sup> Century these have been distinct groups). All at least agree that methodology is concerned with *the correct procedure of discovering truth*, but not all agree as to what this “method” should be. For some the correct method is methodical doubt and justification by clear and distinct ideas (eg. R. Descartes); for others it is the experimental method (e.g., Robert Boyle, Robert Hooker); for others it is the exhaustive classification of individual observations (e.g., Francis Bacon, John Stuart Mill); for still others it is the mathematical method of the physical sciences (e.g., Galileo Galilei, Isaac Newton and most modern physicists).

Everyone wants to discover truth. Man has a natural desire to know the truth, not just the facts, but the reasons for their reality. All philosophical investigation begins in curiosity about the unknown. “When we see certain manifest effects, the causes of which are hidden from us, we are provoked to wonder; and for this reason wonder was responsible for the beginning of philosophy.” (St. Thomas, *In I Metaph.*, lect.3, n.55; cf. *Theaetetus* 155 D, Clement Alex. *strom.* VIII, chap. 11, n.60).

Illi, qui primo philosophati sunt, et qui nunc philosophantur, incipient philosophari propter admirationem alicuius causae; aliter tamen a principio et modo, quia a principii admirabantur dubitabilia pauciora, quae magis erant in promptu, ut eorum causae cognoscerentur, sed postea ex cognitionem manifestorum ad inquisitionem occultorum paulatim procedentes incoeperunt dubitare de maioribus et occultioribus. (*ibid.*, n.54; cf. St. Albert, *I De Praedicab.* tr.1, cap.1 (Borgnet 1, 2a-b); *In Post. Anal.* tr.11, cap. 1, 11 p. 22a-b; J. A. Weisheipl, O.P. “Philosophical Wellsprings,” *Reality* 1 (1950), 8-23)

The truth, therefore, which man desires to know is not merely factual truth, i.e., not just a collection of true data, but the *explanations* of reality. To know the explanation of a thing is to know its causes; this is *scientific knowledge*.

The “scientific method” is the correct procedure to be used by human beings in the discovery and knowledge of scientific truth. Clearly such a method is highly desirable as an *instrument* of philosophy; and the study of such a method, methodology is important for the acquisition of science and wisdom.

### II. The Difficulty of Methodology

The basic assumption found in modern methodological literature is the conviction that a method that has proved successful in one field of investigation is necessarily applicable to every other field. The mathematical method that has proved successful in mathematical physics is thought to be applicable and proper to the social sciences (moral philosophy); the historical method that is successful for the determination of historical facts is thought to be the method proper to philosophy and theology. This basic assumption cannot be admitted.

1. There is a method proper to each field of investigation, for the proper method of a science depends upon its formal subject and its proper principles.
2. There is a universal method of the speculative sciences in the sense that:

- (a) there is a general method the human mind must use of necessity to discover scientific truths, i.e., speculative explanations of reality; and that
- (b) this general method can be used analogically in the various speculative sciences, i.e., the use of this instrument of research depends upon the field of inquiry.

This universal method of the speculative science is logic that was perfectly organized (if not invented) by Aristotle in the 4<sup>th</sup> century B.C. The very name given to the logical works of Aristotle ἀναλυτικά indicates its instrumental role as a method of scientific investigation. For this reason Boethius says, “Non tam est scientia, quam scientiae instrumentum” (*Comm. super Porphyrium*, ed. sec., I, cap.3; cf. St. Thomas, *In Boeth. de Trin.*, q.5, a.1 ad 2; St. Albert, *Post. Anal.*, I, tr.I, cap.1, ed. cit., ll. 2b).

Although the proper function of logic is to be an instrument and an art, the discovery of the correct rules of logic and the construction of such a universal method is a science because in it we know the proper reasons for the rules. This science is also called *methodology*, the study of the method of science.

### 3. From what has been said it is clear:

- (a) The study of the different method of each science, i.e., the universal method as applied to the different sciences does not belong to logic. “Methodology” is sometimes spoken of as such a study. This kind of examination belongs to metaphysics.
- b) The study of logic is the study of the universal method of the speculative sciences, which when used in the real sciences (*scientiae reales*) is used analogically.

### III. The Order of study

If methodology is identical with logic in the sense explained, then we should study the whole of logic. For practical reasons, however, we will concentrate on the *Posterior Analytics*, which is the apex, the most perfect and only absolutely desirable study among the logical works (St. Albert, *I Post. Anal.* I. tr. I, ed. cit., I, 2b)

Posteriora autem analytica de demonstratione agunt et sunt propterea finis ultimus totius scientiae Logicae (*Praef.* ed. Leon., I, p.151)

**Explanation:** since all the philosophical investigation originates in wonder over a phenomenon, the explanation or cause of which is hidden from us, the fundamental principle of all method is that we must proceed from the known to the knowledge of the unknown. This, then, is the purpose of logic:

...docere principia per quae per id quod notum est devenire potest in cognitionem ignoti. (St. Alb. *De Praedicab.*, tr.I cap. 5 ed. cit., 18b).

The *Posterior Analytics* teaches the procedure in discovering necessary principles in order to have certain knowledge through causes, which is scientific demonstration. Hence the *Post. Anal.*, I. has been justifiably considered throughout the ages as a study of Aristotelian methodology.

### I. The Nature of Logic in General

- (a) Logic was commonly called *Ars artium* in the Middle Ages because it is the art by which all other arts and sciences are acquired. It does not consider real being, but “intentions” of

real being, i.e., those expressions, mental or verbal, which we use to acquire and express artificially our knowledge of reality. Precisely because logic does not consider reality itself, the Arabians taught logic together with mathematics as a propedeutic to philosophy and not as part of philosophy proper. (Cf. Gauthier, *Ibn Rochd*, Paris 1948, pp. 47-51; Averröes, *In Phys. prooem*, Venetiis 1574, IV, fol. r 4; *II Phys.*, comm.35).

(b) In its widest extent logic is concerned with all mental and verbal expressions, i.e., “intentions”, of reality. For this reason it is sometimes called “ars sermocinalis” (cf. *ibid.*, cap. 2, p. 7b; *Lib. de Praedicab.* tr. I, cap. 4, ed. cit., I, 8a; St. Thomas, *In Post. Anal.* Prooem., n. 6). In other words it is co-extensive with the *Trivium*.

(c) In the strict sense, logic is a method of inquiry, a method of searching for truth, rather than of expressing it, and hence is distinct from *Rhetoric*, *Poetics*, and *Grammar*. As a method it aims at investigating the processes of the mind in proceeding from known to unknown and at establishing certain norms of correct procedure in the attainment of knowledge. St. Thomas defines it:

ars directiva ipsius actus rationis, per quam scilicet homo in ipso actu rationis, ordinate, faciliter et sine errore procedat. (*In Post. Anal.*, prooem., n.1)

The subject of logic is the method of proceeding from known to unknown, i.e., *argumentation*.

Cum logica sit scientia docens qualiter et per quae devenitur per notum ad ignoti notitiam, oportet necessario quod logica sit de huiusmodi rationis instrumento, per quod acquiritur per notum ignoti scientia in omni eo quod de ignoti notum efficitur. Hoc autem est argumentatio. (St. Albert, *De Praedicab.*, tr. I, cap. 4, p. 6b)

“*Argumentatio igitur*,” says St. Albert following Avicenna and Alfarabi, “*logicae docenti proprium subjectum est.*” (*ibid.*) Argumentation must here be taken in its widest sense to include syllogism, enthymeme, induction and example. Of all these forms syllogistic reasoning is the most perfect. Induction does not give us *scire*, but *intellectus*. It is *scire* we desire in science. The enthymeme is merely an abbreviated syllogism; and example is an imperfect induction. Thus syllogistic reasoning is the *principal* subject of logic.

commune = argumentatio

subjectum logicae

principale = syllogismus

## 2. The Division of Logic in General

(a) The syllogism can be resolved into simpler elements or principles which can be called *formal* or *material* because of an analogy to the principles of sensible bodies.

(I) *Formal principles* are the modes and figures which compose the syllogism and which in a sense, make the syllogism to be what it is. Aristotle considers these formal principles of syllogistic reasoning in his *Analytica Priora*.

(II) The *matter* of the syllogism are the *real principles* which validate or vitiate the conclusion — “matter”, because they have yet to be determined by the form of the syllogism.

(a) If these principles are true, necessary and proper, such a reasoning process yields *scientific, demonstrative* and certain knowledge. Demonstration is the “pars indicativa logicae”.

(b) Probable principles yield *opinion* and *dialectical knowledge*. Dialectical principles are *common* principles and hence do not demonstrate (prove) the conclusion, but indicate that it is very likely demonstrable (provable) if proper principle are found. Dialectics is the “pars inventiva logicae”.

(c) False principles, of course, beget *sophistical*, or pseudo-knowledge. since the syllogistic form is common to all such reasoning, the analysis of formal principles is rightly studied first: the *Prior Analytics*. (cf. St. Albert, I *Post. Anal.*, tr.1 cap. I, p. 3b).

The traditional resolution of the syllogism into principles can be represented as follows (cf. St. Thomas, in *Post. Anal.*, prooem., n. 5-6; St. Albert, I *Post. Anal.*, tr. 1, cap. 1, p. 2a; *Priora Anal.*, I, tr.1, cap.1. *ed. cit.*, 1, 460a):

	(consequentiae = forma ... <i>Analytica Priora</i>
resolutio seu	
ANALYSIS	necessaria ... <i>Analytica Posterior</i>
In causas (consequentis	
	= principia probabilia ... <i>Topica</i>
	sophistica ... <i>De sophisticis Elenchis</i>

(b) From this it is clear that simple apprehension and judgment *are not* the principal concern of Logic, for they are not species of its principal subject. Logic discusses the products of the first and second acts of the mind for the sake of the syllogism or argumentation; hence St. Albert says that logic treats simple apprehension and the judgment “*per accidens et ratione argumentationis*.”

(I) The product of the first act of mind was discussed in antiquity in the following standard texts:

- (a) *Isagoge* (seu *De Praedicabilibus*) by Porphyry.
- (b) *Categoriae* (or *De Praedicamentis*) attributed to Aristotle.
- (c) *De sex Principiis* attributed to Gilbert de la Porrée.

(II) The product of the second act of the mind was discussed by Aristotle in his *Peri Hermeneias* (or *De Interpretatione*)

## *Aristotle's Posterior Analytics*

### 1. *The Text*

Few have ever doubted that the *Posterior Analytics* is a very difficult work to understand. Even Themistius, following the Greek text, found many obscurities:

Quomodo enim pleraque omnia Aristotelis scripta, quasi de composito, caligine quadam offusa oppletaque habentur, illud potissimum opere hoc (scil. *Post. Anal.*) intelligitur, cum ob ipsum genus elocutionis, quod, si alicubi, mixime pressum hic praecisumque est, tum ob capita, quae nullo ordine visunter disposita. (*Paraphras. in lib. Post., Praef.*)

Aristotle's *Posterior Analytics* was at least partially translated into Latin by Boethius (470-526). In any case only a partial and corrupt version survived to the 12<sup>th</sup> century:

Translatio Boetti apud nos integra non invenitur et id ipsum quod de ea reperitur vitio corruptionis obfuscatur (From the prologue to an anonymous translation of the *Post. Anal.*, cod. Toledo, Chapter Library 17.14, fol. 1r)

It was translated anew in the 12<sup>th</sup> century by James of Venice some time before 1159. James' version became the *versio vulgata* in the Middle Age; and was often erroneously ascribed to Boethius; it was published with the works of Boethius in PL 64, 711-762. (Cf. L. Minio-Palluelo, "Jacobus Venetus Grecus, Canonist and translator of Aristotle," *Traditio* VIII (1952), 265-304). By 1159 Aristotle's *Posterior Analytics* was known to the Masters in Paris, but according to John of Salisbury (d.1182) there was scarcely a Master willing to expound it because of its extreme subtlety and obscurity, *fere quot capita, tot obstacula habeat* (*Metalogicon* IV, cap. 6, ed. Webb 171); but John blames this on the bungling mistakes of scribes. John of Salisbury gives us the earliest known exposition of the *Post. Anal.* in the Latin West. In 1159 an anonymous translator made another version from the Greek without having seen James of Venice's version, which he condemns for its obscurities. This *Versio Toletana* (Cambridge, Mass, 1927, 223-241) published by Minio-Palluelo (*A. L.*, IV. 2) was little known in the Middle Ages. About the same time, a third translation was made by Gerard of Cremona (d.1187), this time from Arabic together with the commentary of Themistius. Gerard's version (*A. L.*, IV. 3) was widely used in the Middle Ages, and it was of great assistance to St. Albert, but it never supplanted the *versio vulgata* of James of Venice. When St. Thomas wrote his commentary on the *Post. Anal.* between 1269-1272, he used the version of William of Moerebeke from the Greek (cf. *De Rubeis*, Diss. XXIII, c. 1-2, ed. Leon. I, cclix-cclxii). Moerebeke's popular version was a revision of James of Venice's translation; it is to be found, though contaminated, in most editions of St. Thomas.

The medieval schoolmen relied heavily on the commentary of Averroës, translated some time between 1220-1240. The important and influential medieval Latin commentaries on Aristotle's *Post. Anal.*, are the following:

(a) Robert Grosseteste (between 1200-9) *Aristotelis Posteriorum Libri*, ed. Venetiis 1552, fol. 2r-43v. St. Albert the Great (by 1260) *In Posteriorum Analyticorum* ed. Borgnet, Paris 1890, t. 11, pp. 1-232.

(b) St. Thomas Aquinas (between 1269-72), *In Libros Posteriorum Analyticorum*, ed. Leonina, *Opera Omnia*, I, pp. 137-405. Walter Burley (between 1305-1319) *Expositio in lib. Post. Anal.*, not printed.

## II. The Contents

The *Post. Anal.* is concerned with the manner of acquiring science, i.e., demonstrated knowledge; hence it treats of the demonstrative syllogism and the medium of demonstration.

According to Galen (2<sup>nd</sup> cent.) the original title of the *Prior Analytics* was *περὶ συλλογισμὸν* and that of the *Posterior Analytics* *περὶ ἀποδείξεως*. But Alexander of Aphrodisias, a contemporary of Galen, gives their present names as original with Aristotle; and Aristotle himself refers to the *Posterior Analytics* under its present title in *Eth. Nic.* VI, c. 5, 1159b26. At present it is impossible to determine the exact title given to the work by Aristotle. At any rate, the *First Resolutions*, as the Arabs translated it, certainly treats the syllogism, and the *second Resolutions* are certainly concerned with demonstration. The word "analysis" or "resolution", as Themistius says, is a "redactio uniuscuiusque rei compositae in ea, ex quibus compositio facta est." It is the process of breaking a *compositio* into its principles, of going from effect to cause. The *Post. Anal.* show the method of resolving problems to first, immediate, proper and certain causes in order to obtain a scientific explanation, i.e., demonstrative knowledge.

## III. The Divisions of the Posterior Analytics

The divisions of Aristotle's work are not too difficult in broad outlines. The text is divided into two books and the Arabian commentators generally considered the first a treatment of *demonstration*, the second of *definition*. However, the precise place of definition in Book II is to be a principle of demonstration. Hence it is better to say with St. Thomas that Book I treats of the demonstrative syllogism, and Book II "de medio ex quo syllogismus demonstrativus procedit. (*In I Post. Anal.*, lect. 4, n.1)

The first chapter of Book I is a propaedeutic to the entire work; it poses the fundamental problem concerning the possibility of learning, i.e., of demonstrative knowledge: either we already know what we are seeking to learn, and thus do not learn, or we do not know what we are seeking, and hence cannot know when we have found it.

The last chapter, 19 of Book II indicates the source of all scientific knowledge, the basis of the possibility of demonstrative knowledge: the first principles of human reason, which are acquired from sense experience. The first and last chapters should be considered jointly to appreciate the unity of Aristotle's work and the force of Aristotle's answer to Plato's theory of anamnesis.

## General Outline of Aristotle's *Posterior Analytics*

- A. The Problem: Is demonstrative knowledge possible? Book I, ch. I
  - B. The solution:
    - I. The Nature of Demonstrative Knowledge.
    - II. 1. Considered in itself:
      - a. What is demonstrative knowledge? Book 1, ch. 2-3b.
      - b. The necessary conditions:
        - i. General conditions required for the principles, ch. 4-5
        - ii. Conditions required for *propter quid* demonstration. ch. 6-12
        - iii. Conditions sufficient for demonstration, ch. 13-15
      - c. Default of these conditions:
        - i. begets ignorance, ch. 16-18
        - ii. an infinite regress, which is impossible, ch. 19-21
    - 2. Considered in comparison:
      - a. Comparison of demonstrations one to the other, ch. 24-27 (text 41)
      - b. Comparison of demonstrative sciences, ch. 27-34 (text 42).
      - c. Comparison of science to other ways of knowing
  - II. The Medium of Demonstration. Book II
    - 1. What is the medium of demonstration? Book II, ch. 1-2
      - a. That there are only four scientific questions, ch. 1
      - b. That these are all concerned with the medium, *si est* or *quid est*. ch. 2
    - 2. How is the medium of demonstration to be found?
      - a. How *quod quid est* and *propter quid* are related to demonstration.
        - i. Relation of definitio (*quod quid est*) to the demonstration. ch. 3-10\*
        - ii. Relation of cause (*propter quid*) to the demonstration, ch. 11-12
      - b. How definitions and causes are to be found.
        - i. Discovery of definitions, ch. 15
        - ii. Discovery of proper causes, ch. 14-18
- C. The Ultimate Basis for the Possibility of Demonstration, ch. 19

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\* Chapters 9 to 19 follow the divisions of the Greek text (found in Ross and English translation), rather than the Renaissance division found in the editions of Saint Thomas.



## A BRIEF COMMENTARY ON ARISTOTLE'S *POSTERIOR ANALYTICS*

A. The Problem  
(or The Necessity of Demonstration)  
Book I, ch. 1, 71a1-71b7

### 1. The Problem of Learning

Aristotle's opening statement that "all learning and intellectual instruction proceed from pre-existent knowledge" was acceptable to everyone concerned—to Plato, to the Sophist, Nominalists, and to Aristotle himself. Throughout the treatise, however, Aristotle intends to give far more importance to the preposition *from* than could have been conceded by Plato or the Sophists. Only later in this chapter does Aristotle reveal the precise meaning he sees in this fundamental statement, and the entire treatise is an explanation of his own view. Hence this first chapter sets the theme of the *Posterior Analytics* by presenting the problem: Is scientific learning possible?

In the *Meno* (80 D-86D) Socrates attempts to inquire into the nature of virtue, a subject about which he admittedly does not have full knowledge. Meno intervenes and objects that all inquiry is impossible, for "a man cannot inquire either about that which he knows, or about that which he does not know; for he does not know the very subject about which he is to inquire." (*Meno* 80E) Plato through the voice of Socrates solves the dilemma by means of his doctrine of Recollection: "all inquiry and all learning is but recollection" (*ibid.* 81D). Inquiry consists in ordering the questions in such a way as to clear the obstacles to remembering the answer already possessed. In Plato's view the answer is actually known (*simpliciter*) and only *secundum quid* unknown because of imprisonment in this body. All knowledge was acquired in a previous life; present imprisonment impedes facile recalling. Plato admits clearly that all learning proceeds from pre-existent knowledge, but in the sense that all learning is already actually possessed.

The Sophists of the Academy attempted to answer Plato's dilemma by a nominalist solution (cf. Arist., *Post. Anal.*, I, c. 1, 71a 34-b3), saying that all learning is simply an aggregation of individual observations. They know only what they have actually experienced, and in a so-called demonstration the minor term is already known to be in the extension of the major term. Learning is possible only in the sense of a completely new addition. This view is very much like John Stuart Mill's scientific method without the possibility of true demonstration.

The formal refutation of both Plato's idealism and the Sophist's nominalism belongs to metaphysics, as St. Albert observes, for it is a question of the reality of universals (I *Post. Anal.*, tr. I, cap.6, p.18a). Robert Grosseteste is correct when he says:

...cum in hoc libro non possit demonstrare quoniam scire sit, *quia nullius artificis est stabilire suum subjectum*, vel quod est ante suum subjectum, ne artem transgrederetur, vel dubium aut falsum penitus sine ratione supponeret, necesse habuit Arist. ut ante initium huius scientiae saltem modum ostenderet quo convenit scire esse, et aliquid addiscere, et solvere opiniones destruentes scire et addiscere. (Prooem., fol. 2ra)

Just as in the *Physics*, Aristotle establishes the subject of his inquiry by appealing to experience: we learn by proceeding from known to unknown, i.e., by argumentation.

The dilemma of Meno is similar to that of Parmenides concerning the possibility of motion (cf. *Phys.*, I, c. 8, 191a 29-32). And Aristotle's solution to both dilemmas is fundamentally the same. In a certain sense the object of inquiry is known, and in a certain sense it is not known. It is unknown *in actu*, but it is known *in potentia*. For Aristotle the end *simpliciter incognita*, otherwise there is no learning, but only remembering. However, that for which we search is already known in some way, *secundum quid*, otherwise we would not know what we are looking for and all investigation necessitates going from what we do know to what we do not *precisely in virtue of and in the light of what we know*, that is, we must proceed *from* known to unknown. But this is the process of demonstrative reasoning. Therefore all learning is by way of demonstration.

## 2. The Beginning of Learning: The Praecognita

All learning begins with a *question*, or a problem. Unless one raises a question, or has a problem there is no point in giving him the answer—it is not learning. A question is the expression of man's curiosity, his desire to know the unknown. Aristotle analyses this situation and sees that there are at least three things that are already known when a question is asked. It is in the light of these three that we pursue our inquiry, which is the process of learning.

a. *First*, we start out with the natural principles of human reason, such as, 'the whole is greater than any of its parts, and 'we can really affirm or deny one thing or another', such principles are natural to every man, and without them learning and demonstration are impossible (cf. *Post. Anal.*, II, c. 19, 99b 20-21). That these primary truths are acquired through sense experience is shown in chapter 19 of Book II. Even Plato admits that we have such principles; what he denies is that they are acquired through the senses. Thus we must know—and we do not know by nature—that such common first principles are *true*.

b. *Second*, the very question we ask implies some knowledge of the subject of inquiry, namely that it exists and something of its nature, i.e., *quia est* and *quid eSt*.

c. *Third*, before we can ask the question we necessarily know at least the nominal definition of the predicate, i.e., *quid nominis*.

It must be noted with Cajetan (*I Post. Anal.*, c.1, *His praesuppositis*, Venetiis 1506, fol. 43rd), that Aristotle is here speaking only of questions of fact, *quia*, not of *propter quid* questions. For example, if I want to know whether the soul is immortal, I obviously know that there exists such a thing as the soul and I know something of what it is. Likewise, I must have some idea of what 'immortality' is, or else I could not ask such a question. Cajetan points out that Aristotle is clearly speaking of *quia* knowledge when he says that we must know *quid nominis*, for "in ea questione quae terminat questionem propter quid medium est *diffinitio quid rei ipsius passionis*."

The common first principles, the subject and the predicate of the question are called *principles* of investigation and of demonstration because they all shed light upon the demonstration: common principles shed a remote light, the subject and predicate illumine by making up the syllogism by being incorporated into the reasoning process.

The most important principle of demonstration is obviously the medium of demonstration. But since this is what investigation expects to find, we cannot have pre-existent

knowledge of it—the medium of demonstration is *simpliciter* unknown. St. Albert expresses this clearly when he says:

quamvis medium sit necessarium in demonstratione, tamen non dicitur  
quod de ipso praecognoscere non oportet. (*I Post. Anal.*, tr. I, cap. 4, p.  
13b)

Schematically the knowledge implied in a question can be expressed as follows:

an est rei

si est

an est verum

Prima Principia Communia

Praecognita

quid rei

quid est

quid nominis P

NOTE: J. Gredt (I, 214) following John of St. Thomas (*Curs. Phil., Logica* II, q. 24, a. 1, ed. Reiser p. 663) maintains that the *an sit* of the subject means mere *possible* existence, for science abstracts from real existence. This is not satisfactory. We do not ask questions, as least not scientific questions about entities that may exist. As Gonzales de Apodoca points out, it is the prerogative of *divine* knowledge to know the *quid sit* of possible essences. Our knowledge requires that we know the real existence and real definition of the thing we tell about. (cf. Gonzales, I *Logica*, n.14-30, p. 239-243)

### 3. The Central Point of this Chapter

In this chapter Aristotle wishes to establish the subject of his inquiry, namely the reality of the learning process, which is the demonstrative syllogism. To establish this he appeals to experience; both Plato and the nominalists deny the fact of the learning process by failing to explain how it is that new knowledge is acquired *from* pre-existent knowledge. For Aristotle this experience can be explained only by a distinction of potentiality and actuality: what is actually unknown is potentially known in the first principles of human reason, and in the subject and predicate of the question.

B.  
The Solution:

I. The Nature of Demonstrative Knowledge  
Book I, ch. 2-34, 71b9-89b20

I. Considered in itself

a). What is demonstrative knowledge?

To understand the possibility of learning or demonstrative knowledge we must begin by considering what people who claim to have this knowledge think of their answer to a scientific question. Whether they have the true answer or not, they claim to have true knowledge because they know why it must be so, i.e., (1) they know the cause on which the stated fact (or reply) depends, (2) as the cause of that fact, and (3) that the statement could not be other than it is.

scire autem opinamur unumquodque simpliciter...cum causam  
arbitramur cognoscere propter quam res est, et quoniam illius causa est,  
et non est contingere hoc aliter se habere. (*Post. Anal.*, I, 2, 71b 9-12)

Not infrequently it happens that we have known the “cause” for some time before realizing that it is *the cause of this fact* e.g., we may have known for a long time that an opaque body in the light casts a shadow, but only when we know this to be the case of the earth coming between the sun and the moon do we understand a lunar eclipse; likewise we may have known that a spiritual substance cannot corrupt; but only when we know that the human soul is a spiritual substance do we understand that the human soul is immortal, and that the statement cannot be otherwise. The first two elements in the above definition according to St. Albert:

...respiciunt consequens quod scitur; tertia respicit consequentiam  
secundum quod ex syllogismo scitur” (*Lib. I, tr. II, cap. 1, p. 21 b*)

But it is better to understand all three elements as referring to the *consequens*:

Quia vero scientia est etiam certa cognitio rei; quod quidem contingit  
aliter se habere, non potest aliquis per certitudinem cognoscere; ideo  
ulterius oportet quod scitur non potest aliter se habere. (St. Thomas, lect.  
4, n. 5)

(1) Definition of demonstration “per finem” (*definitio formalis*):

Since the purpose of demonstration is to yield this scientific knowledge, it can be defined as “syllogismus faciens scire” (I, 2, 71b18). Not every syllogism yields scientific knowledge (scire, for some produce tentative knowledge (*dialectica*), and others produce fallacies (*sophismata*).

(2) Definition of demonstration “per materiam” (*definitio materialis*):

From what has been said it follows that the demonstrative syllogism must be made up of premises which are *true*, *primary* and *immediate*, which are *causes* of the conclusion and hence *prior* to and *better known* than the conclusion.

Necesse est et demonstrativam scientiam ex veris esse, et primis, et immediatis, et notioribus, et prioribus, et causis conclusionis" (I, 2, 71b20-22).

Schematically:

The premises or "principia immediata syllogismi" must be:

- (1) **true**, in order to obtain true knowledge in themselves
- (2) **primary or first**, in order to have a starting point
- (3) **immediate to the subject**, lest there be an infinite regress in demonstration.
- (4) **causes**, because scientific knowledge is through causes.
- (5) **in relation to prior**, because every cause is naturally prior conclusion to the effect better known, because every cause is more knowable *quoad naturam* than the effect, and it is the entire reason by which we know the truth of the effect: "Propter quod unumquodque tale et illud magis.

(a) What are these premises or "principia immediata syllogismi" which are true, primary and immediate? They are of two different types:

- (1) the first principles of human reason, *dignitates*, or *maximae propositiones*, which are *per se nota omnibus* once the terms of the proposition are clearly understood, such as 'affirmation and negation are not simultaneously true, or 'the whole is greater than any of its parts.' These are common to all the sciences and known to everyone.
- (2) proper principles which must be discovered in the science and which are called *positiones*. These are of two kinds:
  - (i) *suppositiones* or *axioms* of the science proper, which are either *per se nota sapientibus* or accepted as proved in another science.
  - (ii) *definitiones* of the subject and predicates, which are the proper medium of demonstration in that science.

(b) How are the principles the cause of scientific knowledge? The strongest and most perfect type of demonstration is *propter quid* in which we know the fact through the real causes involved in producing the fact, i.e., the four physical causes (if present) of the *existence* of the fact are the efficient cause of our *knowing* the fact.

Circa quod considerandum est quod *scire* aliquid est perfecte cognoscere ipsum, hoc autem est perfecte apprehendere veritatem ipsius: eadem enim sunt principia esse rei et veritatis ipsius, ut patet ex *II Metaphysicae*. Oportet igitur scientem, si est perfecte cognoscens, quod cognoscet causam rei scitae. (St. Thomas, lect. 4 n. 5).

But if there is no cause of the being, or if we cannot know it, then we must have at least some reason for asserting the fact, i.e., we must have at least some *causa cognoscendi*, otherwise our knowledge is not our own, or we have no reason for making the assertion. In all learning there must be some reason for the answer asserted; this reason is at least a *causa cognoscendi*.

(c) How are the principles better known than the conclusion? In general, since the conclusion is known because of the principles, the truth of the conclusion is derived from the truth of the principles. “Propter quod unumquodque tale et illud magis” (I, 2, 71b 28-29); therefore strictly speaking and according to the nature of the case the principles are more clearly true in themselves than are the conclusions, for the truth of the conclusions, for the truth of the conclusion *depends upon* that of the principles (cf. Plato, *Republic*, although better known *quoad naturam*, are not necessarily better known *quoad nos*).

Si enim aliunde conclusio esset nota, sicut per sensum, nihil prohiberet principia non esse magis nota conclusione in via illa. (St. Thomas, *I Post. Anal.*, lect. 6 n. 6)

But even when both the conclusion and the principle are a matter of direct sense experience, the principle is still better known *quoad naturam*, for it is the light by which the conclusion is understood.

iii. *Two errors of the ancients:*

(a) The first error, attributed to Heraclitus by St. Albert (tr.II, cap. 6, p. 33b), claims that demonstrative knowledge is impossible because if all knowledge were by demonstrated through prior principles and so an infinite regress would be involved. Therefore since the first principles cannot be demonstrated, nothing that follows from them is demonstrated.

Aristotle's reply is that not all truths are demonstrated (I, 3, 72b18-19). First principles, *both common and proper*, are not proved but are self-evident; they are not demonstrated, but intuitively understood. The natural habit by which these principles of science are known is called *intellectus*.

Nam ex cognitione principiorum derivatur cognitio conclusionum, quarum proprie est scientia; ipsa autem principia immediata non per aliquod medium extrinsecum cognoscuntur, sed per cognitionem propriorum terminorum. (St. Thomas, lect. 7, n.8).

This is expressed in the Aristotelian axiom, *scientia est conclusionum, et intellectus principiorum*. (Cf. Aristotle, *Magna Moralia*, I, c. 34, 1197a20-23)

(b) The second error, attributed to Empedocles by St. Albert (tr. II, cap. 6, p. 34a), claims that everything can be demonstrated, because all demonstration is really circular and reduces to “the mere statement that if a thing exists, then it does exist” (I, 3, 72b34). Aristotle's reply is that if we remember the distinction between induction and syllogistic reasoning, between what is better known *quoad nos* and *quoad naturam*, the “circular demonstration is impossible except in the case of attributes that imply one another, viz., peculiar properties”, i.e., where P implies Q and Q implies P. (I, 3, 73a6-7).

*Conclusion:*

Those who claim to have scientific knowledge (*scientia*) claim to know the “reasons why,” the “causes,” the “explanation” of the fact as well as the fact itself. That is to say, they *know* the statement, or *demonstrate* it through principles which are immediate, primary, and true; hence these first principles, common and proper: “*influentiam suae lucis intellectualis influunt super omnia sequentia*” (St. Albert, I. tr. II, cap. 6, 34a). Thus knowledge through *proper* principles alone is demonstrative and scientific; knowledge through any other is tentative (dialectical and probable) or untenable.

(b) *What are the necessary conditions for demonstrative knowledge?*

1. *General conditions required of the principles.* (Book I, chap.4-5).

Properly speaking only conclusions are knowable (*scibilia*) in a scientific way, viz., only statements which can be properly proved by some proper means.

Propria scibilia dicuntur conclusiones demonstrationis, in quibus  
passiones praedicantur de propriis subiectis. (St. Thomas, lect.10, 8)

Thus only *necessary* statements are the object of science. It has been shown above (p.11-12, n., a) that when we have certitude of the demonstrated truth we know that the statement cannot be otherwise than it is (I, 2, 71b12). That is to say, the predicate (P) belongs necessarily to the subject (S). But such necessary statements can be demonstrated only from necessary premises. Therefore for all demonstrations there are required *necessary* principles of demonstration.

By “necessary” Aristotle means that the predicate must be true of every instance of the subject (*dici de omni*), attributed essentially (*dici per se*), and universally commensurate with the subject (*dici ut universale*).

(a) *dici de omni* means that P is found in every instance of S and always

(b) *dici per se* means that P is attributed to S *ratione ipsius subiecti*:

First way of saying *per se* when P is the whole or part of the definition of S.

Second way of saying *per se* when P is a *proprio passio* of S, in which case S enters into the definition of P.

Third way of saying *per se* signifies autonomous existence.

Fourth way of saying *per se* when P is an effect produced by S formally in its aspect of proper cause.

Demonstratio est eorum quae per se insunt in secundo et quarto modo  
dicendi per se; sed definitio non est de huiusmodi. (St. Thomas, II *Post.*  
*Anal.*, lect. 2, n. 6).

c) *dici ut universale* means that P is commensurate with S and S is commensurate with P. Thus it is identical with the first and second ways of saying *per se primo*. For a more detailed explanation of these see Appendix I [I have not been able to track down the Appendices. Ed.]

ii. *Conditions required for ‘propter quid’ demonstration.* (Book I, chap.6-12)

Throughout this work Aristotle is primarily concerned with perfect demonstration, with *propter quid* knowledge (τὸ διότι), i.e., knowledge which explains the proper reason “why” of a necessary truth. Demonstrative knowledge which falls short of this can only express the truth of

the fact or *quia est* (ὅτι ἐστίν). That a demonstration be *propter quid* three conditions are required:

(a) That the conclusion proceed from *necessary* premises, (i) because the *proprio passio* (**P**) must proceed from the nature of the subject and this nature is expressed in its definition, which is necessary (I, 6, 74b6-10); and (ii) because the truth concluded cannot be “otherwise than it is.” (I, 6, 71b13-17) If the premises are not necessary we cannot know *propter quid* of a necessary statement.

The mere form of the syllogism should not deceive us. Even though the premises may be true, this does not mean that we have *propter quid* knowledge of the conclusion, but only if the middle term (**B**) is necessarily connected with the minor term (**A**), and the major term (**C**) is necessarily connected with the middle (**B**). (I, 6, 75a35-37).

(b) That the conclusions proceed from what is *per se*. science is about necessary properties, as has been explained, therefore the *passio proprio* must belong *per se* to the subject, i.e., it must be caused by the principles of the subject. subiectum est “proprium principium generationis eorum quae sunt in scientia.” (St. Albert, *I Post. Anal.* tr. II, cap.16, p.61a). This can be explained in two ways:

Uno modo quando ex principiis speciei accidens causatur; et tale accidens dicitur per se passio vel proprium. Alio modo, quando accidens dicitur causatur ex principiis individui; et hoc est accidens inseparabile. Omne autem accidens quod causatur ex principiis subiecti, si debeat definiri, oportet quod subiectum ponatur in sua definitione; nam unumquodque definitur ex propriis principiis; et sic oportet omne accidens, quod ex necessitate inest subiecto, esse accidens per se. Illa ergo quae non sunt per se, ex necessitate insunt. (St. Thomas, lect.14, n.2)

Thus in scientific conclusions **P** must belong to **S** *per se*; to show this demonstratively the means by which this is so must be the *medium* which are the principles of the subject. Hence the *medium* of demonstration must belong to both extremities *per se*. This is succinctly explained by Saint Thomas (lect.13, n.3) when he says:

Sciendum autem est quod cum in demonstratione probetur passio de subiecto per *medium*, quod est definitio, oportet quod prima propositio, cuius praedicatum est passio et subiectum est definitio, quae continet principia passionis, sit per se in quarto modo; secunda autem, cuius subiectum est ipsum subiectum et praedicatum ipsa definitio, in *primo modo*. Conclusio vero, in qua praedicatur passio de subiecto. est *per se* in *secundo modo*.

Schematically a scientific *demonstratio* can be represented as follows:

**M** (definitio continens - **P** principia passionis = 4<sup>th</sup> modo dicendi per se

**S** - **M** (ipsa definitio) = 1<sup>st</sup> modo dicendi per se

Subiectum - Passio = 2<sup>nd</sup> modo dicendi per se



(c) That the conclusion proceed from *proper principles*, and not from extraneous nor common principles, since proper principles alone can explain why (*propter quid*) the predicate is necessarily true of the subject.

There are three elements in demonstration:

- (1) what is proved, the conclusion (τὸ συμτέρασμα) –an attribute inhering essentially in a genus;
- (2) the axioms (τὰ ἀξιώματα) the axioms which are the premises of demonstration;
- (3) the subject-genus (τὸ γένος τὸ ὑποκείμενον) whose attributes, i.e., essential properties are revealed by the demonstration. (I, 7, 75a39-b2; cf. St. Thomas, lect.15, n.3).

The *axiomata*, or principles, must belong to the same category as the subject-genus, i.e., arithmetical principles properly belong to figure subjects, natural principles properly belong to natural subject. To use principles which belong to a category other than the *genus subiecti* about which we are inquiring would be to use extraneous principles, which cannot demonstrate anything *propter quid*. Hence in an inquiry concerning morals one could appeal to art to prove a point but this would not demonstrate anything *propter quid* in moral science; likewise in an inquiry concerning the freefall of bodies one could appeal to the measure or rate of acceleration, but this would not demonstrate *propter quid* in natural science. “It follows that we cannot in demonstrating pass from one genus to another.” (I, 7, 75a38).

In the mixed sciences (*scientiae mediae*) where the principles of a higher science, e.g. arithmetic, are the *media* of demonstrating truths of a more concrete subject, the subject of the lower science, e.g. music, and the subject of arithmetic “non sunt unum genus *simpliciter*”, but *secundum quid*.

Secundum quid autem est unum genus, quando assumitur circa subiectum aliqua differentia extranea a natura illius generis, sicut *visuale* est extraneum a genere linea, et *sonus* est extraneus a genere numeri.  
(St.Thomas, lect. 15, n.5)

But it is not clear whether Aristotle would assert that the subject of the mixed science are also *unum genus secundum quid*, as he insists that the mixed sciences such as optics, harmonics, and astronomy are “the more physical of the branches of mathematics.” (*Phys.* II, 2, 194a7) In any case the answer is clearer when it is a question of the principles involved (cf. below where the subordination of sciences is discussed).

#### (i) *The nature of proper principles*

Proper principles, as distinct from common principles, are all those sources of demonstration which belong to the subject *per se et secundum illud*, such as the existence of the (*quia est*), the real definition of the subject (*quid est*), and the real definition of the *passiones*, which must be discovered or borrowed from a higher science. “Tam enim subiecti quam passionis definitio in scientis pro principio habetur.” (St.Thomas, lect.18, n.7) The real definition of the *passio* (embodying the definition of the subject as its causal source) is the medium of demonstration in that science.

Cum enim definitio sit medium demonstrationis, et per consequens principium sciendi, oportet quod ad diversum modum definiendi,

*sequatur diversitas in scientiis speculativis*, (St. Thomas VI *Metaph.*, lect.1, n.1156; cf. I *Phys.* lect. 1, n.1)

Proper principles then are all those definitions which belong to the subject in the same grade of abstraction and intelligibility.

Sed in hoc differunt principia, et quae sunt ex principia, et quae sunt ex principiis, quia de principiis oportet accipere supponendo *quod sunt* de aliis autem, quae sunt ex principiis, oportet demonstrare *quia sunt*. sicut in mathematicis accipitur supponendo et *quid est unitas*; quae est principium, et quid est rectum, et quid est triangulus, quae non sunt principia, sed passiones sed quod unitas sit, aut quod magnitudo sit, accipit mathematicus quasi principia; alia vero demonstrat, scilicet quae sunt ex principiis. Demonstrat enim triangulum aequilaterum et angulum rectum, et etiam hanc lineam rectum esse. (St. Thomas, lect. 18, n. 4).

St.Thomas however does not mean to deny that the definition of properties are principles of the science, for in the same lectio, n.7, he says:

...exemplificat de utrisque, dicens quod propria principia sunt, ut lineam esse huiusmodi, vel rectum. Tam enim subiecti quam passionis definitio in scientiis pro principio habetur.

In the natural science the proper principles are first of all the definition of the subject; “scientia naturalis est ... circa *substantiam naturalem*, quae habet in se principium motus et quietas.” (VI *Metaph.*, lect. 1, n.1152).

Thus in describing the process of the second Book of the *Physics* St. Thomas says, “hic determinat (Aristoteles) *de principiis scientiae naturalis*” (II *Phys.* lect.1, n.1), namely nature as form and nature as matter. secondly the natural scientist accepts the existence of natural things and motion *as a principle* (I *Phys.* lect.2, n.4-7; St. Albert, *Phys.* I, tr.II, cap.1 p. 21a); for this reason Aristotle says it does not belong to the natural scientist to disprove the view of Parmenides and Melissus who denied plurality and motion. (*Phys.* I, 2,184b25-185a14) Finally the proper principles of natural science are the real definitions of the properties, such as motion, place, time, etc. and self-evident axioms concerning these. The purpose then of investigation in natural science is to discover the causal definitions of the properties, definitions which are apprehended with *sensible matter*.

Et ex hoc palam est quis est modus inquirendi quidditatem rerum naturalium, et definiendi in scientia naturali, quia scilicet cum materia sensibili. (VI *Metaph.* lect.1, n.1158)

Thus should the medium of demonstration be such that it does not include sensible matter, that principle would not be a proper principle.

(ii). *The nature of common principles*

Common principles are those *communes animi conceptiones* which are self-evident to all men immediately upon understanding the terms, and which cannot be denied, e.g. “a thing cannot both be and not be at the same time, in the same respect.”

Communis animi conceptio non est ad exterius rationem, quia non, potest probari per aliquam argumentationem, sed est ad eam quae est in anima, quia lumine naturalis rationis statim fit nota. (St. Thomas, lect. 19, n.3)

When these principles are said to be proved by a higher science, this means that first philosophy can demonstrate their truth “per demonstrationem ad impossibile”, as Aristotle does in Book IV of the *Metaphysics*; no science can demonstrate their truth directly, for they are self-evident and they have no possible *medium* of proof.

Each science adopts these common principles to its own subject matter; hence common principles are accepted in each particular demonstrative science “*secundum analogiam*, idest secundum quod sunt proportionata illi scientiae.” (St. Thomas, lect. 18, n.6) When natural science uses the principle, ‘a thing cannot both be and not be at the same time and in the same respect’ the term ‘be’ means physical, sensible existence—not the ‘being’ of metaphysics.

These principles are affirmed of the subject of a particular science *remotely*, and not *per se et secundum ipsum*. Hence in these sciences common principles are not the proper medium of demonstration. However they are “useful” (I,10, 76a34) in these particular sciences because they can serve as principles of tentative arguments and demonstrations *ad impossibilem*. (St. Albert, *I Post. Anal.* tr. III, cap.3. p.75b)

Communia autem dico principia, quae sunt talia principia quibus utuntur scientiae tanquam ex his demonstrantes, hoc est, per haec demonstrationes suas confirmantes; sed non communicant neque conveniunt in propriis quae sunt subjectum proprium et passiones propriae... De communibus autem scientiis sciendum quod dialectica quae communis est omnibus, utitur principiis communibus, et etiam alia si aliqua talis est in demonstrativis scientiis quae tenet universaliter, hoc est, per universalia monstrare prima aliarum scientiarum, sicut est prima philosophia, quae tamen medio modo inter logicam et demonstrativam procedit. (St. Albert, *I Post. Anal.*, tr. III, cap.4, p. 76a).

These common principles, which illuminate every particular science without becoming part of the proper demonstrations of these sciences, are in fact the proper principles of metaphysics, which has as its proper subject being as such.

Similiter *prima philosophia*, quae considerat omnia principia, habet pro subiecto *ens*, quod est commune ad omnia; et ideo considerat ea, quae sunt propria entis, quae sunt omnibus communia, tanquam propria sibi. (St. Thomas, *I Post. Anal.*, lect.17,n.4)

These principles precisely as common and not as proper predicates of being belong to the domain of dialectic, which is co-extensive with metaphysics. (cf. St. Thomas, *XI Metaph.*, lect.3, n. 2204.). The importance of these common principles should not be underestimated; for

while they do not enter into a *propter quid* demonstration of a “scientia particularis”, their truth makes scientific knowledge possible by *illuminating* and *confirming* every valid demonstration. (cf. Albert, I *Post. Anal.* tr.III, cap.2, p.71b-72a) It is these that Aristotle will establish as the ultimate basis for the possibility of learning in Book II, chapter 19.

(iii) *Conditions sufficient for 'quia' demonstration.* (Book I, chap. 13-15)

For Aristotle perfect scientific knowledge (*ἐπιστήμη*) is demonstration through proper and immediate causes, i.e., it is nothing less than knowledge *propter quid* (τὸ διότι). should the term ‘demonstration’ be used of knowledge other than through immediate and proper causes, the term is used in a different sense. That is to say, the term ‘demonstration’ is not univocal, but analogical, being predicated *per prius* (absolutely, primarily and perfectly) of demonstrations *propter quid*, and *per Posterius* (imperfectly, secondarily and inadequately) of scientific knowledge which proves only the fact of the statement being true (ὅτι ἐστίν).

(a) *How 'quia' and 'propter quid' differ within a particular science.* (Chap.13, 78a22-b34)

As we have seen, perfect demonstrative knowledge is “syllogismus faciens scire, scilicet *per causas immediatas*.” Thus scientific knowledge (*scire*) can be defective in two ways:

- (1) in that it does not know through causes, but through effects which are immediate;
- (2) in that it knows through causes, but not the proper and immediate ones.

Both of these will instead tell us *that* (ὅτι ἐστίν) the statement, or the fact is true, but neither will tell us the precise reason *why* (διότι ἐστίν) it is so. This kind of scientific knowledge is called *demonstratio quia*, because it merely proves the fact.

Circa nomen adnotandum est, primo demonstratio *quia* dicitur ex versione Boetii, nam potius appellanda esset demonstratio *quod hoc est hoc*, nam haec est differentia inter demonstrationem *quia* et *propter quid*, quod demonstratio *quia* demonstrat verum esse *quod hoc est hoc*, non redidendo causam illius, quam tamen reddit demonstratio *propter quid*. Et ideo illa *quia* non debet intelligi ut dicat causam, sed ut sit coniunctio, *scil.* demonstratio *quod hoc est hoc*, seu *quod hoc est verum*. Quo circa apud Argyropulum nunquam appellatur nisi demonstratio, qua ostenditur ipsum esse. (Dominici Soto, *Logica*, I *Poster.*, cap. 12, ed. Venetiis 1573, pag. 364, 366)

- (1) The “versio Boetii” mentioned by soto is the *vulgata* of James of Venice, cf. *PL* 64, 725 ff.
- (2) The anonymous *versio Toletana* translated the term as *quod est*, cf. A. L. IV. 2, p. 25ff.
- (3) Gerard of Cremona translates the term as *quod res est*, cf. A. L. IV. 3, p. 28ff. (4) Joannes Argyropulos mentioned by soto was a 15<sup>th</sup> century Florentine translator of Plato and Aristotle.

Demonstrations *quia* are of two kinds: *per effectum* and *per causam remota*.  
Demonstrative knowledge within a particular science can be schematized as follows:

(*propter quid* = ex causis immediatis et propriis rei convertibilem et immediatum (qui est prius et notius *quoad nos*)

*demonstratio* = syllogismus faciens scire per effectum (nonconvertibilem et mediatum  
*quia* per causam mediatam seu remotam)

(i) *Demonstrations 'quia per effectum'*

The existence of realities beyond physical nature cannot be known to us except through physical effects, and even within physical nature the effects are often, not usually better known to us than their causes; these effects are a means (*causae in cognoscendo*) of leading us at least to a knowledge of the existence of the cause. Every demonstration through effects, i.e., in which an effect is the medium of demonstration is called *demonstratio quia*. But these effects can either be commensurate (convertible) with the cause or not commensurate (not convertible).

(1) Cause and effect are 'convertible when P implies Q and Q implies P. such a demonstratio *quia per effectum* can be converted into a demonstration *propter quid*, "by reversing the major and middle of the proof" (I,13, 78a39-40). Aristotle gives the following example of such a *quia* demonstration (78a30-38)

Omne non-scintillans est prope (ex inductione)	All B is A
<u>Atqui planetae sunt non-scintillantes (ex sensu)</u>	<u>All C is B</u>
Ergo planetae sunt prope.	All C is A

The non-twinkling of the celestial body is the medium of demonstration (**B**). This is not a *propter quid* demonstration, because the middle term (**B**), non-twinkling, is not the cause of that celestial body being near, but the result. However, the major term (**A**) and the middle term (**B**) are convertible, i.e., all celestial bodies which are near do not twinkle, and all non-twinkling celestial bodies are near. Hence the above *quia* demonstration can be converted into a *propter quid* demonstration:

Omne quod est prope non scintillet.	All A is B
<u>Atqui omnes planetae sunt prope.</u>	<u>All C is A</u>
Ergo planetae non scintillant	All C is B

Notice that this conversion of a *quia* to a *propter quid* demonstration is accomplished by reversing the major and middle of the *quia* syllogism, i.e., instead of using the 'effect (**B**) as the medium of demonstration, it is used as the major term; and instead of using the 'cause (**A**) as the major term, it is used as the medium of demonstration. This happens very often in natural science, because sensible effects are better known to us than the immediate cause. Thus after determining the cause through proper and immediate effects, i.e., after demonstrating *that* it is so, we can then proceed to demonstrate *why* the effect is such through its cause.

(2) Demonstrations *quia per effectum non convertibilem* are syllogisms in which the middle term is an effect, which (a) is more universal than the minor extremity, or (b) less universal than the major extremity. For example:

All that breathes is animal.	All B is A
<u>But all dogs breathe.</u>	<u>All C is B</u>
Therefore all dogs are animals.	All C is A

The middle term (**B**), breathing, is not convertible with the major term (**A**), for not all animals breathe. In this example the effect demonstrates the *fact* of the remote *cause*, viz. animality. such

syllogisms cannot be converted into *a priori* demonstrations, for from the fact that C is an animal, it does not follow that it must be a breathing one; the proper cause of breathing is the possession of lungs. However, if the minor term (C) is *not joined* with the 'remote cause' used as the middle term, it does follow that even the non-convertible effect is *not joined*. Aristotle gives the example (78b15-20):

All that breathes is animal.	All B is A
<u>But no wall is animal</u>	<u>No C is A</u>
Therefore no wall breathes	No C is B

All such examples are demonstrations *quia per causam remotam*.

(2) *Demonstrations 'quia per causam remota*

Demonstrations *quia* through remote cause are those in which the medium of demonstration is not convertible with the major term, either (a) because it is of another genus, such as in negative syllogisms, or (b) because it is more universal than the major term. The previous example exemplifies this kind of demonstration. Whenever an *a posteriori* demonstration *quia* through a non-convertible effect is converted into an *a priori* demonstration, the result is *quia* demonstration through remote cause.

Notice that scientific demonstrations *propter quid* and *quia per effectum convertibilem* usually proceed in the first figure. Demonstrations *quia per effectum non convertibilem* and *per causam remotam* usually proceed in the second. (I, chap. 14-15)

*Summary.*

Every science uses both *propter quid* and *quia* demonstrations. These latter are of two kinds: through effect (convertible or non-convertible) or through remote cause. *Quia* demonstrations merely establish the truth of the fact, and do not indicate the proper reason for the existence of the fact. Demonstrations through effects are called *a posteriori*. They can be converted into demonstrations *a priori*, i.e., through causes: those through commensurate effects can be converted into *propter quid* demonstrations, and those through non-commensurate effects can be converted into *quia per causam remotam*.

(b) How 'quia' and 'propter quid' differ among the sciences. (chap. 13, 78b34-79a16)

When these terms 'quia' and 'propter quid' are used of sciences, as in chapter 13, 78b34-79a16, Aristotle uses these terms in quite another sense than that previously explained. In Aristotle's day the "astronomer" was said to know the facts (*quia est*) by observing the movements of the sun, moon, planets and stars, and the geometer, such as Plato, was said to know the reason why (*propter quid*) lines and circles are related in certain fixed ways. Eudoxus, a pupil of Plato, was the first—so it is said (Simplicius, *De Caelo*, ed. Heiberg, p. 488, 18-24) to apply the geometer's science to the facts of observation, and to create thereby the new science of mathematical astronomy. Thus in the present context *scientia quia* means the science which observes and collects the facts of experience, and *scientia propter quid* is an established superior science which proves its own conclusions. For this reason Aristotle says (79a3-4) that the mathematician oftentimes has demonstrations, e.g. geometrical systems and equations, without knowing the experimental facts or without knowing whether his mathematic will ever have a use in the study of nature. This is clear from the whole history of mathematics and applied mathematics. For Aristotle the new science is created by a more concrete determination of the subject of the superior science, as when a determination such as *visual* is added to the general subject of lines, or *sound* to number. (cf. I, 7, 75b10-20; I, 13, 78b37-79a16)

This new subject is *unum genus secundum quid*, which has been discussed above. Aristotle goes on to say (I, 13, 78b39) that some of these sciences have *almost synonymous names*, i.e., the new science of mathematical astronomy and observational astronomy, mathematical optics and observational optics. The observational sciences gather the facts (*quia*), but the superior science has *propter quid* knowledge of the conclusions which may be applied to those facts. When the conclusions of the higher sciences are used as principles of demonstration by the lower science, the lower science is said to be *subalternate* to the higher.

Aristotle does not give an adequate explanation of the nature of the *new science*, 'the *scientia media*', but such an explanation is implicit in what has already been said. The applied sciences, particularly mathematics applied to the study of nature, have developed tremendously since the time of Aristotle, and this is a convenient place to discuss the subalternation, or subordination of science.

Subalternation' of sciences can be understood in a *wide sense* and in a *narrow sense*:

(1) *In a wide sense*, any particular science can be said to be *subalternate* to a more general science, e.g. biology is subordinated to natural science, because *ens vivens* [a living being] is a species of *ens mobile* [moving being], and natural science is subordinated to metaphysics, because *ens mobile* is a particular kind of *ens* [being], although not a species of *ens ut ens* [being as being].

(2) *In the narrow sense*, a *subalternate* science is one which depends upon a higher (*subalternating*) science for its very principles, at least in part, i.e., the principles of demonstration (which constitute the *ratio formalis obiecti*) [the definition of the object] of the subalternate science are seen as evident and demonstrated in the subalternating science. This subalternation *ratione principiorum* [by reason of the principle] is a result of the subalternation *ratione subjecti*, i.e., the subject of the lower science adds an accidental and determining difference to the subject of the higher science.



(a) *ratione subiecti* : Aristotle discusses this subalternation in various places when he compares the subject of astronomy to the subject of geometry, the subject of optics to that of geometry, and the subject of harmonics to that of arithmetic. Geometry is concerned with the abstract dimensions of lines and figures, but astronomy is concerned with the more concrete dimensions of planetary figures, and optics is concerned with the more concrete visual lines and angles. Arithmetic is concerned with numerical proportions, but harmonics is concerned with the more concrete musical proportions. Modern mathematical physics is subalternated to both geometry and arithmetic, for it is concerned with all measurable quantities which can be expressed in equations or plotted continuously on a graph. The ‘accidental determining difference constituting the subject of the subalternate science is the more *formal* aspect of the subject compared to the aspect common to both the inferior and superior science. All practical sciences are thus subalternate to one or another of the speculative sciences, e.g. ethics is subalternate to psychology, medicine to biochemistry, mechanics and engineering to mathematics.

(b) *ratione principiorum*: among the human sciences which are subalternate by reason of subject are consequently those subalternate by reason of the principles used. since the subject of a science is the “*proprium principium generationis eorum quae sunt in scientia*” (St. Albert, I *Post.Anal.*, tr.II, cap.16 p.61a), it is clear that whenever there is subalternation of subjects, there must follow subalternation of principles to the same extent. Not all the truths of mathematics are used to explain planetary motions, but only those which are applicable; not all the truths of psychology are principles of ethics, but only those which affect morality. Since the principles of demonstration for any science constitute the *formal object* of that science (cf. *ST*, II-II, q.1, a.1), a science is most formally said to be “subalternate” when the principles of a science are assumed as established in a higher science; this is the case in such modern sciences as physics, dynamics, quantum and relativity mechanics, organic and inorganic chemistry, astrophysics, and the like.

The only case known in which true *subalternation ratione principiorum* is not derived from a similar subalternation in subject matter is the case of supernatural faith and theology *in via* [in life’s journey] which is subalternate to the knowledge of God and the blessed *in patria* [in heaven]. (cf. *ST*, I, q.1, a.2; II-II, a.1, a.5; *De Verit.* q. 14, a.9)

Concerning the subalternate sciences known as the *scientiae mediae*, i.e., those which apply the principles of mathematics to natural phenomena, there are two important questions :

(1). *Are these sciences more mathematical or more physical?*

Sicut supra dictum est, quilibet cognoscitivus habitus formaliter quidem respicit medium per quod aliquid cognoscitur, materialiter autem id quod per medium cognoscitur. Et quia id quod est formale potius est, ideo illae scientiae quae ex principiis mathematicis concludunt circa materiam naturalem, magis cum mathematicis connumerantur, utpote eis



similiores. (St. Thomas *ST* II-II, q.9, a.2 ad 3; also I-II, q.35, a.8; *In II Phys.*, lect.3, nn.6-9)

Quaedam (scientiae) sunt mediae, quae principii mathematica ad res naturales applicant, ut musica, astrologia et huiusmodi, quae tamen magis sunt affines mathematicis, quia in earum considerations id quod est physicum, est quasi materiale, quod autem est mathematicum, est quasi formale. (St. Thomas, *In Boeth. de Trin.*, q.5, a.3ad 6)

However, although the entire intelligibility in a *scientia media* is formally mathematical and hence devoid of causal explanations, such knowledge is *for the sake of* the science of nature “tanquam propter finem”. (cf. St. Thomas, *In II Phys.*, lect. 3, n.8; *In II De Caelo*. lect.15, n.1; *In Boeth. de Trin.*, q.5, a.3 a6; St., II-II 9a.2 ad 3)

(2) *What kind of demonstrative knowledge do the “scientiae mediae” possess?*

Aristotle says, “Here it is the business of the empirical observers to know the fact (τὸ ὅτι), of the mathematicians to know the reasoned ‘fact’ (τὸ διότι), for the latter are in possession of the demonstrations giving the causes, and are often ignorant of the fact.” (*ST*. I., c.13, 79a2-4) At the very end of this chapter Aristotle says, “It is the physician’s business to know *that* (τὸ ὅτι) circular wounds heal more slowly, the geometer’s to know the *reason why* (τὸ διότι).” This seems to imply that mathematics can give the *propter quid* explanation of physical phenomena.

To clarify the misunderstanding arising out of the above passages, “we must repeat that here (τὸ ὅτι) and (τὸ διότι) do not mean *quia* and *propter quid* demonstrations. In the example given, the physician observes a fact of experience, viz, that a circular wound takes longer to heal; this is not a question of any explanation or demonstration at all. The geometer, on the other hand, is able to assign *some* explanation, although not the causal explanation, found in nature; hence he cannot give a *propter quid* explanation of the fact.

Saint Thomas indicates the answer to the problem when he says:

Sciendum autem est quod illa differentia quia et propter quid, quae est secundum diversas scientias, continetur subaltero, praedictorum modorum, scilicet quando fit demonstratio per causam remotam. (*In Post. Anal.*, lect.26, n.6)

In other word, here *quia* knowledge means an observed fact of experience; the explanation of the fact presented by the higher, or *propter quid* science is demonstrative knowledge *quia per causam remotam*.

The mathematical principles of nature do not yield *propter quid* explanations of natural phenomena, but simply *quia* explanations *through a remote formal cause, namely the quantitative proportions*. since Galileo and Newton physicists prefer to say that they are giving a “description of physical phenomena in determined mathematical laws”, rather than to say that they possess a causal explanation. They follow Newton’s sentiments:

To tell us that every species of things is endowed with an occult specific quality by which it acts and produces manifest effects, is to tell us nothing. But to derive two or three general (mathematical) principles of motion from phenomena, and afterwards to tell us how the properties and

actions of all corporeal things follow from those manifest principles, would be a very great step in philosophy, though the causes of those principles were not yet discovered. (*Optics*, Bk III, pt, i, Quest.31, 4<sup>th</sup> ed. London 1730, pp. 376-77)

Cajetan takes great pains to show that the mind of saint Thomas in the text quoted (*In I Post.Anal.*, lect.25 n,6) is that:

ipsum propter quid dicat causam remotam, et ipsum quia dicat nullam causam, sed tantum sensu vel experientia habetur ... , ita quod intendit, quod quando quia et propter quid pertinent ad diversas scientias, propter quid est causa remota ipsius quia. (*In I Post.Anal.*, cap.13, *Quomodo in diversis*, ed Venetiis 1599, fol, 131a-b)

**Summary.** The man who claims to have scientific knowledge claims to know the true, immediate and proper explanation for things as they are or can be. In order to have such scientific knowledge, the explanation or premises begetting it must be *necessary*, *per se*, and *proper*, i.e., in each premise the predicate must necessarily and properly belong to the subject *secundum quod ipsum*, namely with the same degree of intelligibility. These conditions are verified only when the medium of demonstration is the *immediate cause* (formal, final, efficient, material, or all four) of the connection between the major and minor terms. such a demonstration is called *propter quid*, because it explains *why* the fact is true. Demonstrations through causes which are remote or through effects do not explain, but merely prove that (*quia*) the statement is true. When the proven facts of a science such as mathematics are applied to elucidate physical problems, the higher science of mathematics can beget *quia* demonstrations of physical truths *per causam remotam*.

(c) *Default of these conditions* (Book I, chap. 16-21)

(1) *The default of these conditions begets errors, or "ignorance"*, (Chap. 16-21)

Unless the syllogism proceeds from true premises which are *necessary*, and *commensurate*, an erroneous conclusion may result rather than demonstrative knowledge. That is, error (or "ignorance") may result when the terms of the syllogism are "inappropriate". In such cases the inappropriate term must be distinguished in order to be verified in affirmative or negative propositions. since every syllogism requires three terms, error may result when the middle, major, or minor term requires a distinction to be true in the proposition.

(a) *Distinction of the middle term.* When the whole middle is not connected or disconnected with at least one of the terms then only one of the premises is true, while the other is false; hence there is no necessary connection between major and minor terms, and no conclusion follows. When the middle term is *distinguished* in the major premise, it is contradistinguished in the minor. That part of the distinction which is true in the major premise will be false in the minor; and that which is false in the major will be true in the minor. This indicates that there are really four terms in the syllogism, and consequently no conclusion follows.

(b) *Distinction of the major term.* When the *whole* predicate is not connected or disconnected with the subject by means of the middle, then the major term is not predicated *per se* in the major premise and in the conclusion. Hence the major term must be distinguished, and

that part which is not so connected or disconnected must be rejected; and in the conclusion the major term must be distinguished *in the same way*, so that the part which was not connected in the major premise is likewise not connected in the conclusion. Therefore the *consequentia* is denied.

(c) *Distinction of the minor term.* When the major term is not connected or disconnected with the *whole minor* term by means of the middle, then the predicate is *not commensurate* with the subject. Hence the minor term must be distinguished, and that part which is not so connected or disconnected must be rejected; and in the conclusion the minor term is distinguished *in the same way*, so that the part which was not connected in the minor premise is likewise not connected in the conclusion. Therefore the *consequentia* is likewise denied.

Thus when a real distinction, and not a mere verbal one is required in the middle, major, or minor term, that means that one of the necessary conditions for *propter quid* demonstration is missing, and this is a source of error.

(2) *Denial of these conditions implies that an infinite regress of proofs is possible, which is false.* (chap. 19-23)

Whoever denies that demonstration proceeds from necessary, *per se* and commensurate premises would have to hold that demonstrations proceed to infinity, i.e., that every statement can be demonstrated—or deny demonstration altogether. Assuming that some demonstration is possible, we must show that no demonstration can regress through an infinite number of middle terms, as some of the preSocratics thought (cf. above, pp. 13-14). For example, in the syllogism in which **C** is predicated of **A** by means of **B**, neither the proof of the major premise (through an ascending order of minor terms), nor the proof of the minor (through descending order of major terms) can be infinite, but both premises must rest in an essential predicate. Thus:

Syllogism: A - B	Prosyllogisms: B - D   D - E
<u>B - C</u>	(of major) <u>D - C</u> <u>E - C</u>
A - C	B - C   D - C

The proof of this major premise cannot regress to infinity, but must rest in an essential predication of **C** in its proper subject **X**.

Negative demonstration as well cannot regress to infinity in proofs, but must eventually rest in an essential affirmative truth i.e, a negative statement is ultimately proved by an essential affirmative statement.

(a) We are not here discussing accidental predication, e.g. “man is white”, or “this white thing is a man”, but only *per se* predicates of a subject. Every predicate is either substantial, or quantitative, or qualitative, relative, active, passive, locative, or temporal ( I, 22,83a21-23 ). Predications, however, can be either *per se* or accidental. All demonstrative syllogisms obtain their force from *per se* predications; dialectical syllogisms, on the other hand, can legitimately exploit accidental predications.

(b) “Demonstration proves the inherence of essential attributes in things. Now attributes may be essential for two reasons: either because they are elements in the essential nature of their subjects, or because their subjects are elements in their essential natures.” (I, 22, 84a11-14) That is:

(i) when **P** is a definition or part of a definition of **S**, then **P** is a substance in the secondary sense.

(ii) when **S** is part of the definition of **P**, then **P** is in one of the nine accidental categories

(c) Hence all demonstration ultimately begins from and rests in essential predications, which are known to be *true, necessary, per se* and commensurate without any medium of demonstration.

These are the principles, or basic truths, which cannot be demonstrated. Hence an infinite regress in demonstration is impossible. (*Post. Anal.*, 1, 22, 84a29-b2; cf. St. Thomas, *de Verit.*, q. 15, a. 1)

## 2. Comparison of demonstrative knowledge.

### (a) Comparison of demonstrations. (chap. 24-26)

There are many different types of demonstration. They can be divided into universal and singular, or affirmative and negative, or ostensive and *ducens ad impossibile*. (1, 24, 85a13-15) The question arises as to which is objectively the stronger in each one of these divisions.

(1) Universal demonstrations are stronger than singular, because (i) whoever knows the universal demonstrations, knows at least potentially and virtually the singulars under it, but not *vice versa* and (ii) universal demonstrations, being more disentangled from the conditions of matter, are more intelligible than singular demonstrations, which are obscured by the contingencies of material conditions. (I, 24, 86a22-30)

(2) Affirmative demonstrations are stronger than negative, because the former are more intelligible and explain the latter, just as being is more intelligible and explains non-being. (1, 25, 86b30-39)

(3) An ostensive demonstration, whether affirmative or negative, is stronger than one that is a *reductio ad impossibile*, because the former is direct, while the latter is indirect. A negative demonstration proceeds directly to a negative conclusion by means of a major premise, which is better known, and a negative minor. When, on the other hand, the impossibility of the conclusion is better known, we use the *reductio ad impossibile* to show the fallacy of one of the premises, and we conclude nothing directly. Since an affirmative argument is stronger than a negative one, and a negative argument stronger than a *reductio ad impossibile*, it follows that an affirmative argument is objectively stronger than a *reductio ad impossibile* (I, 26)

### (b) Comparison of demonstrative sciences. (chap. 27-32)

#### (1) As to certitude (chap. 27)

(a) A science which is knowledge of both the fact (*quia*) and the reasoned fact (*propter quid*) is more certain than one which is only of the fact, because the cause is prior and better known *in itself* than the effect (St. Thomas, lect. 41, n. 5). A sub-alternating science, (such as mathematics, is more certain than the subalternate science of mathematical physics. Even if by *scientia quia* one understands 'observed fact', e.g. a circular wound heals more slowly, (cf. above pp. 21-22) as St. Thomas seems to understand the term in this context (lect. 41, n. 2), it is still true that many observations of a fact are not as certain as a *reason why* it should be so, even when that reason is a remote formal cause.

(b) A science which is concerned with sensible matter is less certain than one which abstracts from such matter, for it leaves most of the difficulties out. Mathematics, for example, abstracts from sensible matter, and consequently from motion, efficient, and final causality, retaining only quantity and its subject, intelligible matter. Therefore mathematics is more certain than natural philosophy.

(c) A science that is concerned with a simple subject-genus in the Platonic sense of the term is more certain than one which is concerned with a complex subject-genus. since number is more simple than magnitude, arithmetic is more certain than geometry; and since abstract lines are more simple than visual lines, geometry is more certain than optics. Although this is a Platonic argument, as St. Thomas observes (lect.41, n.4), it can be generally conceded that the more complex is the subject matter, the less is the certitude, e.g., moral science offers less certitude than natural science, and astronomy offers less certitude than pure mathematics.

(ii) *As to Unity and Diversity* (chap. 28-32)

(a) First it must be noted that it is not within the competence of logic to discuss the division, objects and method of the sciences. It belongs to First Philosophy (Bk.VI) to consider the distinction and relation of the various sciences. since the domain of logic is second intentions of reason, it can only determine the *logical requirements* for unity and diversity among the sciences. What is about to be said follows necessarily from what has already been determined; it is the culmination of Aristotle's discussion of the nature of demonstrative knowledge.

(b) In this early work of Aristotle's the statement of his point is not very clearly expressed, either in Greek or in Latin.

Μία δ' ἐπιστήμη ἐστὶν ἡ ἐνὸς γένους, ὅσα ἐκ τῶν πρώτων σύγκειται καὶ μέρη ἐστὶν ἡ πάθη τούτων καθ'αυτὰ ἐπιστήμη ἐστὶν ἑτέρας, ὅσων αἱ ἀρχαὶ μήτ' ἐκ τῶν αὐτῶν μεθ' ἑτέρων ἐκ τῶν ἑτέρων (*Post. Anal.* I 28, 87a37-87b1)

Versio vulgata Jacobi.

Una autem scientia est, quae est generis, quaecumque ex primis componitur, et partes sunt aut passionibus horum, quae sunt per se. Altera autem scientia est ab altera, quarumcumque principia neque ex eisdem, neque ex alteris sunt.

(almost identical are the *Versio Toletana* and *Versio Guillelmi*) Versio Gerardi Cremonensis

Et scientia una est in qua est subiectum unum, et ostendit omnes res quae insunt si per mediationem rerum quae sunt sibi essentiales aut comitantur eam per se. scientie autem diverse sunt quarum principia sunt diversa et non sunt una et eadem, et subiectum in una earum est praeter subiectum in altera.

The English translation of G. R. G. Mure renders it as follows.

A single science is one whose domain is a single genus, viz., all the subjects constituted out of the primary entities of the genus, i.e., the parts of this total subject—and their essential properties. One science differs from another when their basic truths have neither a common source nor are derived those of the one science from those of the other.

The difficulty lies in the lack of a precise and fixed terminology. It is clear that the first requirement for a unified science is a single subject-genus (ἡ ἐνός γένος; cf. I, 7. 75a39-b2 : τὸ γένος ὑποκείμενον). What is not clear is the meaning of ἐκ τῶν πρώτων, *ex primis*, and whether this is identical with ἀρχαί, *principia* in the narrow sense of 'basic truths'.

The lengthy paraphrase of Averroës (lib.I, comm.179, ed.Venetiis 1574, t.I, p.II, fol.376v-378r) clearly identifies the terms:

Et posteaquam commemoravit, quod scientia una est cuius subiectum est unum, addidit conditionem secundam, et dixit. Et monstrantur omnia essentialia ipsi per media, quae sunt substantialia aut consequentia non per medium ipsorum; sensus est: et conditio scientiae unius cum hoc quod subiectum est unum est ut monstrantur omnia inexistencia huic subiecto uni per medium rerum quae accipiuntur in definitione istius subiecti aut specierum suarum aut rerum, in quarum definitionibus accipitur subiectum aut species ipsius. Et haec sunt accidentia consequentia; et species prima est quam voluit hic per substantialia. Atqui posuit hanc conditionem, quoniam in hac conditione est subiectum unum, et modus speculationis in ipso unus. (fol. 377r)

On this basis St. Albert lists four conditions required for the unity of a science:

Ad unitatem ergo scientiae exigitur unitas subiecti in genere, et (2) quod principia ipsius sint ad unitatem et proprietatem subiecti unificata; et tertio exigitur quod habeat partes unificatas subiecto, ita quod sint subiectae ei, vel integrantes vel essentielles ipsi; et quarto quod passionem quae probantur de ipso subiecto vel partibus eius sint per se subiecto et partibus eius inhaerentes. Ista quatuor requiruntur ad unitatem scientiae. (*In I Post.Anal.*, tr.V, cap.6, ed.cit., II, 140b)

St. Thomas simplifies and clarifies the conditions necessary for the unity of a science.

Ad hoc autem quod sit una scientia simpliciter utrumque requiritur et **unitas subiecti et unitas principiorum**. Et ideo de unitate subiecti supra fecit mentionem, cum dixit, '*quae est unius generis*'; de principiis autem, cum dixit, '*quaecunque ex primis*' etc. (*In I Post.Anal.*, lect.41, n.11)

(c) *The unity of a science depends upon the unity of the subject-genus and upon the unity of the principles*

(i) The **subject** of a science is the reality or class of realities *about which* the investigation is concerned, and about which truths are scientifically known.

Processus scientiae cuiuslibet est quasi quidam motus rationis. Cuiuslibet autem motus unitas ex termino principaliter consideratur, ut patet in *V Physica*, et ideo oportet quod unitas scientiae consideretur ex fine sive ex termino scientiae. (St.Thomas, *ibid.*, n.7)

The subject of the demonstrated conclusion is thus also the subject of the science. The Medieval schoolmen distinguished two aspects of the subject:

(1) the *genus subiecti*, or the *ratio formalis subiecti*, which is the *unifying formality* embracing the variety of things studied. In natural science it is the general category of mutable things; in geometry it is magnitude; in metaphysics it is *ens*, or *substance*; in architecture it is the constructible.

(2) the *subiectum materiale*, which designates the diverse realities constituting the integral parts of the subject-genus, e.g. in natural science this would be everything capable of change. No diversity of such material subjects can diversify sciences, no more than the diversity of colored objects diversify the visual power.

(i) science narrowly so-called is an intellectual *habitus* of demonstrated truths concerning some given subject.

Cuiuslibet cognoscitivi habitus obiectum duo habet, scilicet *id quod materialiter* cognoscitur, quod est sicut *materiale obiectum* et *id per quod cognoscitur* quod est *formalis ratio obiecti*. sicut in scientia geometriae materialiter scita sunt conclusiones; formalis vera ratio sciendi sunt media demonstrationis, per quae conclusiones cognoscuntur. (ST., II-II, q.1, a.1)

Ad huic ergo evidentiam sciendum est, quod materialis diversitas obiecti non diversificat habitum, sed solum formalis. Cum ergo scibile sit proprium obiectum scientiae, non diversificabuntur scientiae secundum diversitatem materialem scibilium, sed secundum diversitatem eorum formalem. Sicut autem formalis ratio visibilis sumitur ex lumine, per quod color videtur, ita formalis ratio scibilis accipitur secundum principia, ex quibus aliquid scitur. Et ideo quantumcunque sint aliqua diversa scibilia secundum suam naturam, dummodo per eadem principii sciantur, pertinent ad unam scientiam; quia non erunt iam diversa in quantum sunt scibilia. (St.Thomas, *In I Post.Anal.*, lect.41, n.11)

Thus the schoolmen distinguished two aspects of the *object* of a science:

(1) the *obiectum materiale*, which is any demonstrated conclusion; these of course are many and diverse.

(2) the *obiectum formale*, or the *ratio formalis obiecti*, which are the principles of the science, i.e., the media of demonstration. Considering the individual demonstrations, one may say that "*principia non multo minora sunt conclusionibus*". (1, 32, 88b4-5; cf. lect.43, n.7) However all the principles of a particular science manifest a twofold unity:

(a) *all the* principles of a particular science are included in the basic principles of that science, e.g. all the principles of natural science are included in the principles of motion, i.e., to nature as matter and as form.

(b) all the principles (definitions and dignitates) have the same degree of intelligibility, i.e., the same manner of defining.



Nec tamen intelligendum est quod sufficiat ad unitatem scientiae unitas principiorum primorum simpliciter, sed unitas principiorum primorum in aliquo *genere scibili*. Distinguuntur autem genera scibilium secundum diversum modum cognoscendi. sicut alio modo cognoscantur ea quae definiuntur cum materia, et ea quae definiuntur sine materia. Unde aliud genus scibilium est corpus naturale et corpus mathematicum. Unde sunt diversa prima principia utriusque generis, et per consequens diversae scientiae. (St. Thomas, *In I Post. Anal.*, lect 41, n.12; cf. *In VI Metaph.*, lect. n. 1147-1165)

This source of unity is commonly called the “degree of abstraction”, or the *obiectum formale quo* of the science.

Following Averröes (*I Post. Anal.*, test 43, comm.193, *ed. cit.*, fol. 394r), St. Albert says that there are three types of principles, only two of which are *proper* to a given science:

Principia enim sunt duplicia, hoc est, dupliciter dicta vel tripliciter, sicut principia *ex quibus* est demonstratio, et *quae* sunt in ipsa demonstratione, et *circa quae* est demonstratio. *Ex quibus* autem fit demonstratio, sunt dignitates non ingredientibus demonstrationes, sed extra stantes et confirmantes decursum syllogisticum demonstrationis; et haec sunt communis. *Quae* autem demonstrantur et sunt in ipsa demonstratione, sunt passionibus; et *circa quae* fit demonstratio, sunt subiecta et propositiones in quibus haec sunt praedicata et subiecta; et haec sunt propria et in diversis diversa. Patet ergo quod principia ex quibus, hoc est ex quorum virtute est demonstratio, communia sunt; quae autem et circa quae propria sunt, ut numerus in arithmetice et magnitudo in continuis, sicut in geometria. (*In Lib. I Post. Anal.*, tr. V, cap. 8, *ed. cit.* II, 148b-149a)

However, it must be noted that when the “common dignitates” are appropriated to a given science, the terms have the same degree of intelligibility as the proper principles of the science. It is because these *dignitates* are not restricted to that domain, that they are “common” and not proper. (cf. St. Thomas, *In I Post. Anal.*, lect. 43, n. 13)

Every science has its own proper principles, which belong *per se* to the subject genus of that science. Hence the subject of those principles is also the subject *circa quod* of the science. For the nature of proper and common principles, see above p. 16-18.

(d) *For the diversity of a science it is sufficient that there be a diversity of principles*

Sciences which differ in *formal subjects* clearly also differ in proper principles of demonstration, as for example, natural science, mathematics and metaphysics. But sometimes the same formal subject can be investigated according to two different types of principles. St. Thomas expresses the thought of Aristotle (1,28, 87a38-b1) by saying:

...ad diversificandum scientiae sufficit diversitas principiorum, quam comitatur diversitas generis scibilis. (*ibid.*, lect. 41, n. 11)

This is the case when mathematics investigates *ens mobile*, the subject of natural science,—but not according to the principles of motion. The mathematical-physicist investigates the world of changing reality according to the principles of mathematics, which are proportions of measure.



Sometimes the same conclusion can be demonstrated by two different types of middle terms (chap 27):

Sicut terram esse rotundam per aliud medium demonstrat astrologus, scilicet per eclipsim solis et lunae, et per aliud naturalis, scilicet per motum gravium ad centrum, ut dicitur in *II Physicorum* (St.Thomas, *ibid.*, lect. 41, n.16; cf. *In II Phys* lect.3)

But this difference in medium is sufficient to distinguish mathematical physics from natural physics. It has already been shown that although the same conclusion may be demonstrated by means of mathematical principles as well as by means of natural principles, the demonstration through a mathematical medium is a demonstration *quia per causam remotam* (cf. above pp. 23-25).

(e) *Characteristics of the subject and principles of a science* (chap. 30-32)

(1) *Concerning the subject*

(i) There can be no science of chance events, because in all such events there is no *necessary cause* responsible for the conjunction of the two or more factors. Each factor has its own *per se* causes, and science is concerned with each of these, but the chance conjunction itself has no more than a *causa per accidens* (cf. *Phys.*, II, chap. 4-5). since there is no necessary, *per se* cause of chance events, there can be no universal statement of their occurrence; hence these cannot be the subject of any science.

(2) There can be no science of individual sensible subjects as such, because those things which are determined to a particular time and to a particular place are not essentially necessary. Universal natures are indifferently and contingently related to time and place. Hence science properly concerns universal natures, which beget necessary and universal characteristics.

Manifestum est enim quod sensus cognoscit aliquid tale, et non hoc. Non enim obiectum per se sensus est substantia et quod quid est, sed aliqua sensibilis qualitas, puta calidum, frigidum, album, nigrum, et alia huiusmodi. Huiusmodi autem qualitates afficiunt singulares quasdam substantias in determinato loco et tempore existentes: unde necesse est quod id quod sentitur, sit hoc aliquid, scilicet singularis substantia, et sit alicubi et nunc, idest in determinato loco et tempore. Ex quo patet quod id quod est universale, non potest cadere sub sensu. Non enim quod est universale determinatur ad hic et nunc, quia iam non esset universale. Illud enim universale dicimus quod est semper et ubique. (St.Thomas, *In I Post.Anal.*, lect.42,n.5 )

However, universal natures cannot be known by us except through sense experience, and for some natures a considerable amount of experience, tabulation and experimentation is required. The perception of universal natures in the singulars of experience will be discussed in Book II. While there can be no “demonstration” concerning the individual sensible subject as such, for the reason given, this does not mean that nothing can be proved concerning an individual. First of all, whatever belongs necessarily to the nature can be demonstrated of the individual

possessing that nature. Further, everything which is experienced through the senses is also intelligible, even if there is only one such object e.g. the universe, the moon, etc.; concerning these we can have *propter quid* demonstration through a universal middle term and major. But it must be noted that concerning these subjects there can be no demonstration insofar as they are contingent, e.g. "Whether the universe was created in time." Finally, concerning an individual, sensible, contingent subject many contingent truths can be "proved" by arguments *per quaedam evidentia signa* (ST., III, q.55, a.5), as is done in a criminal investigation, in a court of law, and in historical investigation. History is not a "science" in Aristotle's sense of the term because its subject matter is individuals and contingent events as such. But to the extent that what is done is done and no longer contingent, the past possesses sufficient necessity for scientific investigation. And although the historian cannot "demonstrate" through universal and necessary causes, he can "prove" that a certain event took place and *why* through certain evident signs, or the testimony of evidence.

(2) *Concerning the principles*

It is impossible that all science have the same principles, for the principles of each demonstration must be appropriate, proper and *per se*. Hence the principles of a science are not much fewer than the number of real demonstrations (1, 32, 88b3—6). By "principles" (ἀρχαί) Aristotle here means the expression of a principle in the premises. The principles and the conclusion must belong to the same genus, since a demonstration of the conclusion from principles of another science is improper and yields, at most, *scientia quia per causam remotam* as has already been explained (above pp. 23-25). Therefore each science must have its own proper principles. The unity of these principles arises, as has been explained, from the fact that they all possess the same *modus definiendi* [way or method of defining] and that they all belong properly and commensurately to the subject of the science:

Unde necesse est quod diversarum scientiarum sint diversa principia, si oportet quod omnium scientiarum principia sint unius generis his, quae ex eis demonstrantur; sed oportebit quod ex istis principiis demonstrantur hae conclusiones, et ex illis illiae, ex diversis scilicet principiis demonstratione facta in diversis scientiis, quae sunt de diversis generibus. (St.Thomas, lect.43, b12 )

(c) *Comparison of science to other ways of knowing* (chaps. 33-34)

Scientific knowledge is by no means the only kind of knowledge; indeed it is not even the highest kind of knowledge. science itself would be impossible without immediate knowledge called *intellectus*, or νοῦς. In extent the most common form of knowing is *opinion*, which is vastly different from true scientific knowledge; human faith, which is the acceptance of a truth on the authority of another, is reducible to opinion.

(i) *science compared to opinion and dialectics*

(a) *The proper object of opinion*

We have seen that *scire*, or *scientia* is to know the necessary causes of a true statement, to know them as the proper and immediate causes, and to know that it cannot be otherwise. Thus the proper object of *scientia* is the *scibile*, i.e., a truth that can be known through a *medium*, thus *mediate knowledge*; and the manner of arriving at this kind of knowledge is called demonstration.

The proper object of *opinari*, or *opinio* (δόξης) is the opinabile (δοξάστον); and the manner of arriving at this kind of knowledge is called *dialectic* (διαλεκτική), or topical argumentation. In ordinary usage a man who claims to have an 'opinion' on some question not only realizes that he may be wrong but also that the question is open to discussion. The proper matter for such discussion is that which *in itself* is contingent, i.e., the very matter under discussion is contingent, e.g. should medicine be socialized? Is Russia sincere in her peace offers? and other questions of politics, current affairs, etc. The proper principles in such dialectical discussion are themselves contingent, i.e., the statement of the principle could be otherwise, but it is true *ut in pluribus* [in most cases], e.g. whether mothers love their children; therefore, is a contingent matter knowable through contingent, or probable principles:

...circa huiusmodi (contingentia) sit opinio, sive sint actu vera sive sint actu falsa, dummodo possint aliter se habere. (St. Thomas, *In I Post. Anal.*, lect. 44, n.4)

Opinatum autem de se non certum est, sed certum (probabiliter) efficitur sic apparentibus (hoc est, illis quibus ita videtur et apparet) et non est certum nisi inquantum talis opina immediatae propositionis cadit super ipsum; ... opinio enim de se inceptum quid est, et ipsum opinabile de natura sua (inquantum est opinabile huiusmodi) incertum sicut et opinio. (St. Albert, *I Post. Anal.*, tract.V, cap.9, *ed.cit.*, II, 150b-151a)

Thus properly speaking, the object of opinion is whatever is intrinsically contingent; and the immediate principles of a formed opinion are themselves not universal and necessary, but true *ut in pluribus*, or true in some other science or art.

(b) *The improper, or common object of opinion*

Sometimes it happens that one has only an opinion concerning an object that is in itself *scibile*, i.e., necessary and universal. In this case both opinion and science can have the same subject of inquiry, but the manner of arriving at the conclusion is essentially different, for an 'opinion' is formed on the basis of probable, dialectical, or contingent reasons, while scientific knowledge is formed on the basis of necessary, immediate, and proper reasons. Necessary matter, the proper object of *scientia*, is the improper, or common object or *opinio* that is, a scientifically knowable truth can be grasped through probable or common principles, as well as scientifically through immediate and proper principles. In this sense dialectics and science are said to be co-extensive, i.e., have the same referents. The normal procedure in every science is first to approach problems dialectically, as Aristotle does in all of his published works, before attempting to discover the proper causes that will solve the question demonstratively. These dialectical approaches to problems do not constitute an intellectual *habitus* [settled disposition] distinct from science, but belong as a preparation to science. There are many problems in every science which we have not yet solved, and opinion is the best we have so far.

Some, however, think that all knowledge is nothing but opinion, and that truth cannot be had. This is to deny that we can know anything through necessary truths. But it is evident that at least the first principles are absolutely necessary and grasped as such. Further, the demonstrations of mathematics are clearly necessary, at least hypothetically. Therefore there are at least some universal truths that are grasped immediately and there are some universal truths which are

grasped by demonstration. Therefore there is some object of human knowledge which is not a subject or matter of opinion.

(c) *The relation of science and opinion*

The proper subject/object of opinion, or dialectics is really distinct from any field of scientific investigation. The *opinabile* is matter for discussion and prudential action, not for scientific investigation. since matters of opinion are contingent and the principles of discussion are contingent, dialectics is not classified as an intellectual *habitus*, for the specifying object of a *habitus*, as distinct from a *dispositio*, must be objectively necessary, i.e., *difficile mobilis* (cf. Arist. *Cat.*, c.8, 8b28; St., I-II, q. 49a.2 ad 3). However dialectics can be called a 'disposition or an art; and there are some controvertialists who have developed this art to a high degree of perelection without having scientific knowledge of anything.

The dialectical part, however, of a science, i.e., the opinions and dialectical discussion concerning strictly scientific matter, *belongs* to the science which treats that matter scientifically. That is to say, science ultimately passes judgment on the dialectical discussions and needs dialectics to prepare for the scientific discovery of truth and to present the truth rhetorically.

(ii) *Science compared to 'intellectus'*

Both for Plato and for Aristotle the highest form of knowledge is the immediate or intuitive grasp of self-evident or immediately known truths, the first principles of human reason. This is the intellectual *habitus* called *νοῦς*, or *Intellectus* (Arist., *Post. Anal.* 1,33, 88b35-36; cf. St. Thomas, *De Verit.*, q. 15, a.1). The term '*intellectus*' here does not mean the 'intellect' which is a faculty of the soul. It means the natural *habitus* of first principles spontaneously generated when the intellect knows immediately evident truths:

Et accipimus hic intellectum non secundum quod intellectus dicitur quaedam potentia animae, sed secundum quod est principium scientiae; id est secundum quod est habitus quidam primorum principiorum, ex quibus procedit demonstratio ad causandam scientiam. (St. Thomas, *In I Post. Anal.*, lect. 44, n.3)

Thus the proper object of *intellectus* is the *intelligibile*, i.e., judgments in which the union of subject and predicate is immediately evident, and not through some medium or middle term of a demonstration. The object, therefore, of *intellectus* are the first principles of the human mind called *prima principia*, *prima dignitates*, or *principia communia*. (cf. above pp.18-19)

At vero nec intellectus est scientia, vel opinio. Dice enim hoc secundum istam intentionem qua hic loquendum est de intellectus habitu principiorum demonstrationis. Et ideo est principium scientiae sicut principia sunt causa conclusionis. Non tamen intellectus proprio principium opinionis; propter quod magis convenit cum scientia, quam cum opinione. Omnes autem isti tres habitus conveniunt in hoc, quod sunt circa verum quod est in complexis, non in incomplexis; sunt enim alicuius existentis in hoc, sicut praedicati in subiecto, vel (non) existentis in ipso. (St. Albert, *I Post. Anal.*, tr. V, cap. 9, *ed. cit.*, II, 150a)

(iii) *science compared to solertia'*

Intermediate between first principles of reason and a scientific truth is the *medium* of demonstrating that truth. The medium of demonstration, as we have said (above p. 29), is the *ratio formalis sciendi* hence the proper principles of a science belong to that science. However there is a special facility or ingenuity in jumping to the correct medium which Aristotle calls (ἀγχινοια), and which the Latins call *solertia*. It can be defined as “*quaedam subtilis et facilis coniecturatio medii, propter quod aliquid evenit, et hoc quando non habet magnum tempus ad perspicendum vel deliberandum.*” This facility to perceive quickly the true reason, or answer to a problem can be a natural gift varying with individual temperaments, or it can be the result of long familiarity with a certain field of inquiry.

Sicut si aliquis videns quod semper luna, quando convertitur opposita ad solem, splendorem habet per totum, statim intellexit propter quid sit, scilicet quia illustratur a sole. Et similiter in actibus humanis, si aliquis videat aliquem pauperem altercantem cum aliquo divite, cognoscit quod ille dives accommodavit ei aliquid, et altercantur de redditione; vel si aliquis videns aliquos, qui prius fuerant inimici, esse factos amicos, cognovit propter quid hoc sit, quia scilicet sunt inimici eiusdem.  
(St. Thomas, *I Post. Anal.*, lect. 44 n. 12)

*Solertia* is very well illustrated by the quick perception of Sherlock Holmes and Dr. Gideon Fell. Notice that the quick perception of truth is one thing, and the scientific proofs, or unraveling of the mystery is another. This is the difference between *solertia* and science. (cf. St. Thomas, *ibid.*)

## BOOK II

### II. *The Medium of Demonstration* (chap. 1-18)

#### 1. *What is the medium of demonstration?* (chap. 1-2)

##### (a) *That there only four scientific questions* (chap. 1)

Not all questions are scientific questions. Scientific questions are those which allow for a scientific answer, namely a demonstrative solution. Non-scientific questions are those which are answered merely by looking or counting. If I ask “How many causes are there?”, one would look and enumerate them. But if I asked, ‘Are there only four causes?’, then before one could answer, he would have to know of a *reason* for his affirmative or negative response. All scientific questions, therefore, are those which require a *reason* before the question can be answered.

Thus every scientific question is a quest for the reason, or medium of demonstration, “*non secundum formam quaestionis, sed secundum concomitantiam.*” (St. Thomas, *In II Post. Anal.*, lect. 1, n. 6)

(1) The original problem posed by Aristotle in the first chapter of Book I concerned the possibility of learning. Rejecting Plato’s solution of Recollection. Aristotle claims that learning is possible: the truth to be learned, which is actually unknown, is already known *potentially* and *virtually* in the statement of the question and in the first principles of human reason. In the statement of the question certain things are already actually known—normally, the existence and definition of the subject and the nominal definition of the predicate. The medium of demonstration is *simpliciter* unknown, but *secundum quid* known in the statement of the question. (cf. above pp. 10-11) Thus all science is a search for the medium of demonstration, for once it is known, the answer can be given scientifically, i.e., with a reason.

(2) There are only four types of scientific questions, since there are only four kinds of things we can know (II, c. 1, 89b23):

Aristoteles                      trans. Jacobi et Guillelmi                      trans. Gerardi Cremon.

(τὸ ὅτι)                      (quaestio) quia an hoc insit huic

(τὸ διότι)                      “                      propter quid quare istud insit huic

(εἰ ἔστι)                      “                      si est                      an hoc sit

(τί ἔστιν)                      “                      quid est                      quid est hoc

The first kind of question asks whether S is P, e.g. Is the [human soul] {immortal}; the second type of question asks for the proper reason for this truth; the third type of question seeks to know whether the S exists, e.g. Does God exist [Is God a being]; the fourth type seeks to know the nature of the S or the P, e.g. what is God, or what is Immutability. There are no other types of scientific questions; and for all of these the answer to the question requires some kind of *reason*, i.e., medium of demonstration

(3) Questions *si est* and *quid sit* are “*quaestiones simplices*”, i.e., they seek to discover answer concerning *incomplexa*; questions *quia* and *propter quid* are “*quaestiones quasi*

*compositae*", i.e., they seek to answer questions concerning *judgments*, or *complexa*, or "ponentes in numero" (II, c.1, 89b24-25). On the other hand, the questions *si est* and *quia* merely inquire into whether there is a reason for an affirmative or negative response, i.e., *an sit medium demonstrationis*, the questions *quid est* and *propter quid* inquire into the nature of the reason given, i.e., *quid sit medium*. Schematically these four scientific questions can be shown as follows:

	si esse	
questiones simplices	quid est = an sit medium	CAUSA
		seu medium
		demonstra-
		tionis
	= quid sit medium	
	quia est	
quasi compositae	propter quid	

"It is clear, then, that all questions are a search for a 'middle' . (II, c.3, 89b35) That is, every scientific question is implicitly a search for the middle term, which middle term is the cause, or the reason for the answer. To answer questions *quia est* it is generally sufficient to know a remote cause or a proper effect. But to answer questions *si est* and *propter quid* it is necessary to know the nature of things, i.e., the *quod quid est*, or the definition *quid est*.

If we begin with a question in which we know the existence and definition of the S and the nominal definition of the P, we must begin by searching for the real definition of P. This will necessarily involve the discovery of the nature of S as the *cause* of the inherence of P in S:

Videtur hic Aristoteles dicere quod definitio passionis sit medium in demonstratione. sed considerandum est quod definitio passionis perfici non potest sine definitione subiecti. Manifestum est enim quod principia, quae continet definitio subiecti, sunt principia passionis. Non ergo demonstratio resolvet in primam causam, nisi accipiat ut medium demonstratio subiecti. sic igitur oportet concludere passionem de subiecto per definitionem passionis, et ulterius definitionem passionis concludere de subiecto per definitionem subiecti. Unde et in principio dictum est quod oportet praecognoscere *quid est*, non solum de passione, sed etiam de subiecto; quod non oporteret nisi definitio passionis concluderetur de subiecto per definitionem subiecti. (St. Thomas, *II Post.Anal.*, lect.1, n.9)

Thus as we maintain, to know a *thing's* nature is to know the reason why it is; and this is equally true of things in so far as they are said without qualification to be. (II, c.2, 90a31-32 )

Aristotle means to say here that the ultimate reasons and causes are to be found in the natures of things. Therefore the whole of scientific method is a search for the true natures of things, which will explain why the thing is, why it is such and such, and why it does such and such. Therefore the answer to every scientific question lies in the discovery of the true natures or definitions of things.

(2) *How is the medium of demonstration to be found?* (chap. 3-18)

Of the four scientific questions only two, in the last analysis, are the proper concern of the scientist, the questions *quid est* and *propter quid est*. (Questions *quia* are sufficiently answered by *quia* demonstrations, and questions *si est* are properly answered when we know *quid sit*.) Therefore the main concern of the scientist—and our main concern here—is how to discover the answer to questions *quid est* and *propter quid est* in order to have perfect scientific knowledge, i.e., demonstration *propter quid*. But first we must determine how the answer to these questions are related to scientific demonstrations.

(a) *How quod quid est and propter quid are related to demonstration*

It is already clear from Book I how the answer to the question *propter quid* is related to demonstration:, namely by being the medium of demonstration; this, however, will be considered again in Chapters 11 and 12. What is not so clear is how the answer to the question *quid sit* is related to demonstration, and how the answer is to be discovered.

Let us now state how essential nature is revealed, and in what way it can be reduced to demonstration; what definition is, and what things can be defined. (II, c.3, 90a36-38)

But first we must clarify the precise relation between a definition expressing the *quod quid est* of a thing and scientific demonstration narrowly so-called. Are definition and demonstration identical, or are they mutually exclusive?

(1) *What is the relation of a definition (quod quid est) to a demonstration?* (chap. 3-10)

The problem is to determine (i) whether definition and demonstration are identical in whole or in part, (ii) whether the nature defined can be demonstrated to inhere in a subject, (iii) whether there is any way by which the *quod quid est* can be known, if not by demonstration.

(a) *Tentative and dialectical procedure* (chap. 3-7)

It would seem that definition and demonstration are mutually exclusive ways of knowing, for the former is immediately perceived without a medium, while the latter is a scientific procedure through a medium. (chap. 3, 91a7-11)

(b) It would seem that an essential nature (*quod quid est*) defined cannot be demonstrated to inhere in any subject, for the process of defining by division may be a valid procedure, but it is not a proof through a causal medium. (chap. 5)

Not even “hypothetically” can the *quod quid est* be demonstrated to inhere in a subject, for every such proof would be a begging of the question. (chap. 6)

(c) since essential natures cannot be demonstrated, nor perceived by induction (for induction terminates in a judgment of fact), nor pointed at with the finger, it would seem that there is no means by which we can know the essential natures. (chap.7)

(2) *Declarative and scientific procedure* (chap. 8-10)

The conclusions and arguments presented in the above dialectical discussion are only true in part. We must begin afresh to determine the relation between a definition of an essential nature and a demonstration.

First of all, there are many different kinds of definition. Even apart from accidental definitions, there are various ways of defining the essential nature of a thing, whether this 'thing' be a substance, a property, an accident, or an event. *A definition is a rational manifestation of the cause of the thing*. Material and formal causes are *intrinsic* to the thing; therefore definitions



through the material or formal cause are simply definitions manifesting the *quid est*. “Proponit [Aristoteles] alium modum definitionis significantis quid est.” (lect.8, n. 5) Final and efficient causes are *extrinsic* to the thing; therefore definitions through the final or efficient cause are explanatory definitions manifesting the *propter quid*. “Secundo, proponit [Aristoteles] alium modum definitionis significantis *propter quid*,” (lect. 8, n. 5)

Second, natural things and events are brought about by all four causes. since there is an order among causes, a definition through one cause will be the *reason for* a definition through a dependent cause. Hence one definition is in a certain sense the cause of the other definitions, but always in a determined order:

Quia enim materia est propter formam et non e converso, ut probatur in *II Physic.*, definitio quae sumitur ex causa formali, est causa definitionis, quae sumitur ex causa materiali eiusdem rei. Et quia generatum consequitur formam per actionem generantis, consequens est quod agens sit quodammodo causa formae et definitio *definitionis*. Ulterius autem omne agens agit propter finem; unde et definitio quae a fine sumitur, est quodammodo causa definitionis quae sumitur a causa agente. Ulterius autem non est procedere in generibus causarum; unde dicitur quod finis est causa causarum. (St.Thomas, *II Post. Anal.*, lect. 8, n.3 )

In other words, once we have discovered that the soul is *primum principium vivendi*, we can in a certain sense “demonstrate” that it is *actus primus corporis physici organici*. (cf. St.Thomas, *In III Phys.*, lect 4, n. 1-3) In these two cases the first definition is said to be a formal definition and a principle of demonstration, the second “se habet ad praemisam ut materialis ad formalem, et conclusio ad principium.” (*ibid.*, lect.4, n. 1) Likewise once we know that the purpose of a saw is to cut wood, we can “prove that it must be made of hard metal and possess sharp teeth. (St.Thomas, *In II Phys.* lect., 15, n.6) And by knowing the purpose of a house, we can show that it must be a solid structure with four walls and a roof<sup>1</sup> (St. Thomas, *In II Post.Anal.*, lect.7, n. 3)

In all these cases the definition that is “proven” is called a *definitio materialis seu secundum materiam* by Alfarabi, Averröes, Grosseteste, Albert and all the Schoolmen generally, while the definition used as a principle of such a proof is called a *definitio formalis seu secundum speciem*. These terms, however, have many different meanings, as will be shown below.

The relation of definition to demonstration can be summarized as follows (II, 10, 94a11-14):

(1) *Some definitions are an indemonstrable statement of essential nature:*

“Ἔστιν ἄρα ὁρισμὸς εἰς μὲν λόγος τοῦ τί ἐστὶν ἀναπόδεικτος (94a11-12)

Quaedam enim est definitio, quae est indemonstrabilis ratio eius quod quid est; et haec est illa, quam dixerat esse immediatum. (St.Thomas, lect. 8, n. 10)

All *formal definitions* are of this kind, whether it is a formal definition of the subject with respect to its material definition, or whether it is the medium of demonstration (*definitio significans quid*). For example, the formal definition of the soul as “the first principle of living things” cannot be demonstrated. Aristotle arrives at this definition by comparing all living things (*de Anima* II, 2, 413a11-b13), Nor can the medium of demonstration, or cause of the property be

demonstrated, e.g. that an opaque body interposed between the source of light and a reflecting surface casts a shadow; this is discovered by experience. In natural phenomena and in practical affairs the end, or *final* cause is of this kind; it cannot be demonstrated, but must be accepted as the starting point of demonstration.

In other words, there are some definitions which cannot be demonstrated in any way. They must be known in some other way below (chap. 13). It shall be explained how such definitions can be arrived at by the process of comparison and by the process of differentiation.

(2) *some definitions are implicit demonstrations, differing from a formal demonstration only in position:* εἷς δὲ συλλογισμὸς τοῦ τί ἐστὶ, πτώσει διαφέρων τῆς ἀποδείξεως (94a12-13)

Alia vero est definitio, quae est quasi quidem syllogismus demonstrativus eius quod quid est; et non differt a demonstratione nisi *casu*, idest secundum diversam acceptionem et positionem dictionum; ut cum dicitur, *tonitruum est sonus extincti ignis in nubibus*. (St. Thomas, lect.8, n. 10)

Properties and physical phenomena can be defined in two ways by a simple expression of *quid est*, and by an expression of both *quid* and *propter quid est*. (cf. above p. 39) St. Albert, who says that the definition of *passio* is twofold, explains this:

...scilicet ea quae dicit quid tantum, et non datur nisi per essentialia passionis prout ipsa est essentia formaliter constituta in materia ... Est autem alia passionis diffinitio, quae dicit et *quid* et *propter quid*, quae eum formalibus et essentialibus passionis concernit subiectum quod causa est passionis; et haec dicit *propter quid*, quia subiectum est principium et causa passionis. (Lib. II *Post. Anal.*, tr.II, c.10, cd. Borgnet II, 189)

*Propter quid* definitions of properties are identical with what Aristotle here calls *demonstratio positione different a demonstratione*. (cf. St. Albert quoted in Appendix II, pp. 3\*- 5\*[This appendix is not available. Ed.]

In other words, Aristotle is not here talking about the definition of the subject through its four causes (important as this may be), but about the *property* through its extrinsic productive cause, e.g. "a lunar eclipse is the periodic over-shadowing of the moon by the interposition of the earth between the sun and the moon" or "thunder is the rumbling sound of fire being quenched in the clouds." (II, 8, 93a30-b14) Or again, "immortality is the continued existence of a spiritual substance" or "motion is the actuality of what exists potentially, in so far as it is in potentiality." All definitions of properties or physical events which express not only the simple *quid sit* of the property, but also its extrinsic or quasi-extrinsic cause, e.g. active *nature* producing it, efficient cause, or final cause, are definitions signifying *propter quid*, differing from demonstration only in the position of the terms.

All *propter quid* definitions of properties are implicit demonstrations, because they contain the three terms necessary for the syllogistic presentation. One such a causal definition of a property or phenomenon is discovered, it can easily be unfolded into syllogistic form. Thus the definition "immortality is the continued existence of a spiritual substance," can easily be unfolded into syllogistic form:

In a wide sense such definitions could include every *definitio materialis* discussed above (pp.38-39). But specifically Aristotle here means only the “*definitio materialis passionis quae non dicit nisi quid*” (St. Albert *ibid.*) That is to say, definitions *quid est* of the property, e.g. eclipse, motion, continuous, etc. are the *predicate* of the conclusion; hence they are demonstrated, and therefore called *materialis* (cf. St. Albert in Appendix II) All three types of definition are exemplified briefly by St. Thomas:

Contingit autem quandoque in scientiis demonstratives triplicem esse definitionem. Quarum una est demonstrationis principium, ut haec: *tonitruum est extinctio ignis in rube*. Quaedam vero demonstrationis conclusio, ut haec *tonitruum est continuus sonus in nubibus*. Quaedam vero complectitur utrumque, ut haec: *tonitruum est continuus sonus in nubibus propter extinctionem ignis in nube* et haec comprehendit in se totam demonstrationem absque demonstrationis ordine. Unde in *I Poster.* dicitur quod definitio est demonstratione positione differens. (*In II Phys.*, lect. 15, n.6)

See also the detailed explanation of St. Albert given in Appendix II, pp. 3\*- 5\* [Not extant.Ed.]

*Summary:*

(a) Nominal definitions demonstrate what is signified by the name “Diffinitio igitur nominis demonstrat quid significat id quod dicitur,” (St. Albert, *Lib. II Post.Anal.*, tr.II, c. 12, *ed.cit.*, p. 195b)

(b) Essential definitions of the subject do not demonstrate, nor are they demonstrated; such definitions are presupposed to demonstration, and are apprehended directly. “Diffinitio autem subiecti dicens quid subiectum, neque ingreditur, neque concluditur.” (*ibid.*)

(c) Definitions of the predicate:

(1) Essential definitions (*dicens quid*) of the predicate are demonstrated of the subject; they are not the medium of demonstration. “Diffinitio autem passionis dicere quid est sicut id quod concluditur.” (*ibid.*)

(2) Essential and causal definitions (*dicens quid et propter quid*) of the predicate are implicit demonstrations. “Altera est passionis dicens quid et propter quid, sicut syllogismus demonstrativus casu differens a demonstratione in hoc quod una pars cadit in diversum cum alia ... Diffinitio passionis dicens quid et propter quid, principium est demonstrationis ingrediens in substantiam suis.” (*ibid.*)

(d) Therefore the medium of demonstration in *propter quid* demonstrations is the definition of the predicate *dicens quid et propter quid* precisely as causal:

Et tunc oportet cognoscere in medio quod passio sit ex illis; et sic oportet quod diffinitio passionis sit medium. Et ideo oportet quod diffinitio et dicat quid passionis et propter quid, et concernat subiectum quod est causa. Et talis diffinitio est verum medium demonstrationis. (*ibid.*, p.192a)

(2) *What is the relation of cause (propter quid) to demonstration?* (chap. 11-12)

We have seen that answers to the question *quid est*, once found can be diversely related to demonstrative knowledge: some definitions are presupposed to demonstration, such as those signifying *quod quid est* of the subject and predicate; other definitions are, in a sense, demonstrated; still others are really implicit demonstrations and media of demonstrations, such as definitions signifying *propter quid* of the predicate. Just how definitions are to be discovered will be discussed below in chapter 13.

Now we must discuss how answers to the question *propter quid*, once found, are related to demonstration. Definitions are media of demonstrations only because they are the *cause* of the demonstrated truth. The question here does not concern the discovery of causes, but the exact

relation of known cause to demonstrative truth. It is already clear that perfect scientific knowledge is not possessed until we know the answer to the question *propter quid*, i.e., “Why is the fact so?” or “What is the cause, or reason for its being so?” (cf. above, p.11-12). But the whole strength of the scientific knowledge (or answer) lies in the *necessary* connection between the cause and the fact, i.e., between the answer *propter quid* and scientific knowledge of the fact. The question here concerns the relation of *causal necessity* to true demonstrations, and the diverse kinds of causal necessity found in scientific demonstration.

(a) *In general* (chap. 11)

One claims to have scientific knowledge when he thinks he knows the cause “*propter quam res est, et quoniam illius causa est, et non est contingere hoc aliter se habere.*” (1,2, 71b9-12) But we know that there are four different kinds of causes responsible for physical reality:

- (1) Quarum una est quod quid erat esse, idest *causa formalis*, quae est completiva essentiae rei.
- (2) Alia autem est causa, qua posita necesse est causatum poni; et haec est *causa materialis*, quia ea quae sequuntur ex necessitate materiae, sunt necessaria absolute, ut habetur in *II Physic.* cap. 9.
- (3) Tertia autem causa est, quae est principium motus, idest *causa efficiens*.
- (4) Quarta autem causa est, cuius gratia fit aliquid, scilicet *causa finalis*. (St. Thomas, *In II Post.Anal.*, lect.9, n.2)

Hence one can claim to have scientific knowledge of a fact when he thinks he knows one or all of the causes why the fact is, as the cause of that fact, and that the fact cannot be otherwise than it is.

(3) *Relation of material cause to demonstration.*

It must be particularly noted that we are here talking about *effects* following necessarily from *matter* in the wide sense of the term. Aristotle here defines the material cause as: τὸ τίνων ὄντων ἀνάγκη τοῦτ' εἶναι that is, as an antecedent which necessitates the consequent effect (II, 11, 94 a21-22); he is not speaking about the premises as the material cause of the syllogism. The necessity by which an effect follows from the material cause is an *absolute necessity*. (cf. *In II Phys.*, lect. 15; *In V Metaph.*, lect. 6, n. 833-35, 838-40; *Contra Gentiles*, II, c. 29)

(a) *sensible matter*:

Certain effects follow necessarily from sensible matter hence anything composed of such matter will necessarily have those effects. For example:

Omne compositum ex contrariis est corruptibile; sed lapis est huiusmodi:  
ergo lapis est corruptibile (*In II Post.Anal.*, lect. 9, n. 4)

Ex hoc quod aliqua corpora ex elementis fuerunt composita, necessarium fuit ea calida aut frigida esse; sed omnia naturalia sunt huiusmodi; ergo, etc. (*Cont. Gent.*, II, c. 29)

In natural science many truths are demonstrated as necessary because the effects follow from the conditions of sensible matter. However in natural phenomena this *absolute* necessity of certain effects itself depends upon the conditional necessity arising from the final cause of nature.

Sic igitur manifestum est quod in rebus naturalibus dicitur esse necessarium, quod se habet per modum materiae vel materialis motus; et ratio huius necessitatis est ex fine, propter finem enim necessarium est esse materiam talem. (*In II Phys.* lect. 15, n. 5)

Since in natural things the necessary effects of matter are produced through formed matter, some effects may be impeded, for example by miracle; natural forms produce determined effects *ut in pluribus* [for the most part], since their necessity is conditioned by the natural end to be attained.

In *Post. Anal.*, II, c.11, Aristotle gives no example of necessary causality arising from sensible matter; St. Thomas, however, does so, and it is very important for an understanding of many demonstrations in natural science.

(b) *Intelligible matter*

Although mathematics abstracts from sensible matter, it cannot abstract from intelligible matter, which is the inevitable subject of imagined quantity (cf. *In VI Metaph.*, lect.1; *In VII Metaph.*, lect. 10, n.1496; lect. 11, n.1507-9; *In Boeth. de Trin.*, q. 5, a.3; St., I, q. 85, a. 1 ad 2; III, q. 77, a.2 ad 4.) The necessity involved in all mathematical demonstration is derived from intelligible matter, particularly as parts related to a whole, such as the parts of a summed series:

...quae quidem materia intelligibili consideratur secundum quod aliquid divisibile accipitur vel in numeris vel in continuis. Et ideo quandocunque in mathematicis liquid demonstratur de toto per partes, videtur esse demonstratio per causam materialem: partes enim se habent ad totum secundum rationem materiae, ut habetur in *II Phys.* [cf.lect. 5, n.8-9]. . Et quia materia magis proprio dicitur in sensibilibus, propter hoc noluit eam nominare causam materialem, sed causam necessitatis. (*In II Post.Anal.*, lect. 9, n, 5)

The only example Aristotle gives in chap.11 of demonstration through the 'material cause is a proof of the proposition that 'an angle incirbed in a semicircle is a right angle; later Euclid was to form this proposition universally and to give a correct proof of it (cf. *Elements*, III, prop. 31, ed. T. L. Heath, II, pp. 61-65; see also T. L. Heath, *Mathematics in Aristotle* (Oxford, 1949), pp. 71-74) . Aristotle's proof is valid only for a particular case of an inscribed angle, nevertheless the principle to be illustrated is identical with the proof given by Euclid.

Let **ABC** be a semicircle, and let the diameter be divided at point **D**, which is the center of the circle.

Let a perpendicular line be drawn from point **D** to the circumference at point **B**, and let **AB** and **BC** be joined by straight lines.

Let the angles be called **a**, **b**, **c**, **d**, **e**, **f**, as shown in the diagram

Question: Is the angle **ABC** a right angle?

Proposition: The angle **ABC** inscribed in the semicircle is a right angle.

Thus 'angle **ABC** is the subject of demonstration; 'right angle' is the predicate to be demonstrated; and the problem is to find the medium of demonstration.

Proof (Aristotle s):

**b, d, f**, are three angles equal to two right angles, i.e., equal to 180 degrees; but **d** is a right angle, since **BD** is perpendicular to **AC**; therefore **b** plus **f** are equal to one right angle, i.e., to 90 degrees.

By a similar process **a** is equal to half a right angle, i.e., equal to 45 degrees

Therefore **a** plus **b** are equal to 90 degrees; therefore the angle **ABC** inscribed in the semicircle is a right angle.

The medium of demonstration for Aristotle is the fact that **a** plus **b** are a right angle, i.e., "half of two right angles" for if this can be shown, then it necessarily follows that the whole angle **ABC** is a right angle. In Aristotle's example this medium follows from the fact that **b** plus **f** are equal to **d**, which is a right angle by supposition. In the universal proof of the proposition given by Euclid the medium of demonstration lies in the fact that **a** plus **b** are equal to the external angle formed by protracting the line **AB** to **F**. In both proofs the medium of demonstration is the *summation of parts* equaling 90 degrees; thus the cause of the necessity lies in the given *parts* of the whole. Thus the cause of the necessity is 'to be found in the "matter" '.

## (2) The formal cause as medium of demonstration

In this chapter Aristotle offers no separate example of demonstration through the formal cause. He merely says that this has already been shown (94a35-6) in the example from geometry, because the middle term, "half of two right angles", is the definition of the subject, inscribed angle". (94a34-5) On this basis St. Albert presents the argument as follows:

Omne cuius ratio rectitudinis habetur, rectum est; anguli in semicirculo constituti ratio est rectitudinis; ergo est rectus (*Lib. II Post.Anal.*, tr. III. c.2, p.199a)

It is commonly said that mathematics demonstrates only through the formal cause, and not through the material, efficient or final cause. (*In Boeth. de Trin.*, q.5, a.4 ad 7; *In III Metaph.* lect.4, n. 375; *In I Phys.*, lect.1, n. 5) If one is to designate the mathematical medium as a "cause", then it is more accurate to say that mathematics demonstrates through *formal cause*, meaning by this a functional dependency or equality of proportion or proportionality between two wholes, which dependency reduces to *extrinsic formal causality*. However, the radical source of this equality or dependency is the *materia intelligibilis* of the parts making up the quantitative whole. Thus from the view point of the "whole" which is related to another, the causality can be called *formal*; but from the view point of the "parts" making up the whole and necessitating the relation, the causality can be called *material*. (cf. St. Thomas, *In II Phys.*, lect.5, n. 8-9) St. Thomas, however, carefully explains, "quia materia magis proprio dicitur in sensibilibus, propter hoc noluit [Aristoteles] eam nominare causam materialem, sed causam necessitatis." (*In II Post.Anal.*, lect. 9, n. 5)

Even in non-mathematical demonstrations through the "formal cause" the cause of the necessity of the predicate lies in the parts of the definition, e.g. the corruptibility of man is due to the body, the risibility of man is due to his rationality. since parts are related to the whole as



matter to form, the cause of this necessary sequence can be said to come from the “matter.” (cf. *In II Phys.*, lect.5, n. 9)

(3) *The efficient cause as medium of demonstration.*

An efficient cause is the agent responsible for the occurrence of the effect but here are various kinds of agents: singular, specific, generic, universal, as well as efficient cause of *esse* or *fieri* of the effect, In matters of history the efficient cause is always a singular person or incident, as in the example given by Aristotle concerning the Athenians and the Athenians and the Persian wars (94a36-94b8; cf. Herodotus, *Persian Wars*, Bk. V, chap. 100ff.). The question is how did the Athenians become involved in it, i.e., why did the Persians wage war against the Athenians? From Herodotus it is clear that the Athenians together with the Eretrians first raided Sardis, which belonged to the Persians, This unjust aggression rendered retaliation unavoidable (Herodotus, *ibid.* chap. 103 ). Thus the efficient cause of the Athenians (S) becoming involved in war (P) was the unprovoked raid on Sardis (M). In syllogistic form this could be expressed as follows:

{Participants in an unprovoked raid} become (involved in war):  
but [the Athenians] {participated in an unprovoked raid on Sardis}:  
 therefore [the Athenians] became (involved in war)

(4) *The final cause as medium of demonstration*

Since every agent acts for an end, demonstrations through final cause and through efficient cause are correlative, i.e., by means of the efficient cause one can demonstrate the end, and by means of the end. one can demonstrate the efficient cause.

Quarumcumque autem efficientius causarum est propter aliquod (hoc est, propter effectum vel finem) in his et finis concluditur per efficientem, et e converso efficiens per finem. (St. Albert, *Lib. II Post. Anal.*, tr, III, c.3, p.199b-200a)

In such questions as, why does a house exist, or why does a man take a walk after dinner, the cause sought is *cuius gratia*; the response to those questions expresses the final cause, namely, the protection of one's belongings in the case of the house, and health in the case of walking after dinner. But to demonstrate that such is the final cause, *oportet ut causa efficiens sit medium* (St. Albert, *ibid.*, p. 200a )

For example, in the Hippocratic maxim concerning walking, the final cause of walking is health, which is the predicate (P), and the means proving that a walk is productive of health is 'aiding digestion (M). The demonstration can be formulated thus:



{Whatever aids digestion} is [healthful]  
but (a walk after dinner) {aids digestion}  
 therefore (a walk after dinner) is [healthful]

In this demonstration by way of “final cause” it must be noted that ‘health’, which is the final cause of the walking, is the end *intended*, but the *last thing* produced, for “primum in intentione est ultimum in executione” [that which is first in intention is last in accomplishment]. Hence in the demonstration it is the predicate; the medium of demonstration is the efficient cause productive of health, namely good digestion.

Hoc autem ultimum (quod est sanativum) est sicut ratio (hoc est, causa finalis) ad illud quod est deambulare : finis enim est ratio motus efficientis; P enim (quod est sanari) sic demonstrabitur et concludetur per causam dicentem propter quid, quia si M est in s, quoniam haec littera quae est P est sanari vel sanativum esse. (*St. Albert, Lib. II Post. Anal.*, tr. III, c. 3, p. 200a-b.)

All demonstrations using an efficient cause as a medium can be converted into demonstrations using a final cause as medium by interchanging the middle and major terms, because every agent acts for an end. But such a conversion is not necessarily useful or instructive. The above, example can be converted as follows:

{Whatever is healthful} [aids digestion];  
but (a walk after dinner) {is healthful};  
 therefore (a walk after dinner) [aids digestion].

Strictly speaking, proper demonstrations in natural science *are not through the final cause, but through the efficient, formal and material causes*. Nature always acts for an end, and it is the end which the natural scientist seeks in his investigations in order to understand the activities of nature. But since the end realized by nature is the *last produced*, this “finis effectus” is *demonstrated* by the productive agencies bringing it about. This is why St. Albert says:

Attendendum quod licet finalis sit causa rei et sit primaintentione quamvis sit ultima in executione, tamen in naturalibus passionibus non fit demonstratio per causam finalem. Ad esse enim rei sufficit materialis et efficiens et formalis, quia efficiens facit, forma dat esse, et materia perficitur ipso et tenet esse. Et ideo finis in talibus est Posterior; ex Posterioribus autem secundum esse non fit demonstratio; finis autem secundum esse [est] Posterior. Et si movet efficientem, hoc est metaphorice dictum; actum enim et opus moventis non facit nisi efficiens. Et ideo ad demonstrandum esse passionis non portet congregare nisi efficientem et formam et materiam. Quamvis tamen non fiat demonstratio per ipsam, tamen consideratur a naturali in quantum natura non facit frustra, sed semper propter finem ipsum. Est tamen finis non tantum ipsius fieri, sed etiam ipsius esse. sed quia Posterior est ipso esse, et ex Posterioribus non fit demonstratio, ideo non oportet quod in demonstratione potissima finis ponatur cum aliis tribus terminis. (*Lib. II Post. Anal.*, tr. II, c. 11, p. 192a)

The natural sciences demonstrate through all four causes, and complete knowledge of a natural phenomenon is not had until all of the natural causes are discovered (cf. Arist., *Phys.* II, c.7). Natural properties and functions (*finis effectus*) are demonstrated *propter quid* through the *nature*, which is their *principle* in the fourth manner of saying *per se*.

Oportet cognoscere in medio [demonstrationis] quod passio sit ex illis, et sic oportet quod diffinitio passionis sit medium. Et ideo oportet quod diffinitio et dicat *quid* passionis et *propter quod*, et concernat subiectum quod est causam; et talis diffinitio est verum medium demonstrationis. (St. Albert, *ibid.* p.192a) see below pp. 00-00.

The necessity derived from the end is called hypothetical, and this necessity is both *ad esse* and *ad bene esse*. (cf. *In V Metaph.*, lect. 6, n. 832-835) The necessity found in nature is of various kinds, depending upon the kind of causality involved. The necessity of nature acting for an end is conditioned. upon the determined end; the necessity of an efficient cause is either violent or natural; the necessity of matter is absolute:

Natura enim quaedam facit propter finem, quaedam vero facit ex necessitate priorum causarum. Quae quidem est duplex una secundum naturam, quae est secundum conditionem materiae; *alia* secundum causam moventem sicut lapis movetur quidem ex necessitate quandoque sursum, quandoque deorsum, sed non propter idem genus, necessitatis; sed dorsum movetur propter necessitatem naturae, sursum autem propter necessitatem moventis, idest proicientis. (*In II Post.Anal.*, lect.9, n.12; cf. *In II Phys.*, lect.5, n. 8-9; *In V Metaph.* lect.6, n.832-5)

In demonstrations the truth demonstrated derives its necessity from the necessity of the medium of demonstration. Here we are not considering the *necessitas consequentiae*, but the *necessitas consequentis*.

(b) *In particular considerations* (chap. 12)

(1) *When cause and effect are simultaneous.* (lect.10, n. 1-4.

When any cause is formally acting as cause, then some effect is *necessarily* produced, for actual causality means the production of some effect. "Simul enim dum movens movet mobile movetur, eo quod motus nihil est aliud quam actus mobilis a movente, secundum quem movens dicitur movere et mobile moveri." (St.Thomas, *In II Post.Anal.*, lect. 10, n. 2) This is true of every type of cause. Clearly there must be due temporal proportion between the *esse* of the cause and *esse* of the effect, the *fieri* of the cause and the *fieri* of the effect. the *factum esse* of the cause and the *factum esse* of the effect, the *futurum esse* of the cause and the *futurum esse* of the effect. (cf. *ibid.*, n.3)

(3) *When cause and effect are consecutive* (chap. 12)

(a) *In irreversible arguments.* (lect. 10, n. 5-10; lect. 11)

When an effect is temporally Posterior to its cause, then demonstrations are necessary only in one direction, i.e., from effect to cause, and not *vice versa*. From the cause one cannot demonstrate that the effect will take place at any definite time, or even at any indefinite time. The reason for this is that every *factum esse* terminates a *fieri*, but no *fieri* terminates a *factum esse*. "Sic ergo dicit quod *fieri* non potest esse consequenter se habens et contiguum cum hoc quod est *factum esse*. (*ibid.*, lect. 11, n. 2)

(b) *In circular arguments* (lect. 12, n. 1-3)

Since natural processes are “circular”, one can in a certain sense argue from cause to effect and from effect to cause. For example, water naturally becomes vapor and vapor naturally becomes water; hence one can argue from the present existence of one to the future existence of the other. This order of causality, however, is accidental, it not *per se*, since there is no return to a former identity in number, but only in species. Hence such “circular” arguments are possible only among accidental causes.

Iste tamen causarum circuitus inveniri non potest secundum ordinem qui invenitur in causis *per se*; sic enim necesse est pervenire ad unum primum in quolibet genere causarum... Procedendo ergo in causis *per se* non erit circulatio. (lect 12, n. 4-6)

(3) *When the effect is always or frequently produced* (lect 12, 4-6)

There must always be a proportion between effect and cause. Thus if the effect is produced *semper* the cause must be present *semper*; if the effect is produced *ut in pluribus*, the cause must be present *ut in pluribus*. In the former case one can necessarily conclude the existence of the effect from the existence of the cause, e.g. from intellectual nature one can necessarily conclude immortality. In the latter case one cannot necessarily conclude the existence of the effect from the existence of the cause, but only *sicut frequenter*. For example, from the fact that men should have beards (final cause), one cannot conclude that this man will have a beard (effect); but the conclusion follows *for the most part*, i.e., *ut in pluribus*. “Unde huiusmodi scientiae deficiunt a scientiis, quae sunt de necessariis *absolute*, quantum ad certitudinem demonstrationis.” (lect. 12, n. 5) Not all demonstrations in natural science are through final cause (cf. above p. 48-49).

(a) *How definitions and causes are to be found* (chap. 13-18) (cf. above p.37-38)

We have seen how definitions (*quod quid est*) and causes (*propter quid*) are related to demonstration (p. 37-48). Now we must determine the more important question of how to discover definitions and causes in order to have the true medium of scientific demonstration. From what already has been said it is clear that the proper medium of scientific demonstrations is a causal definition of the predicate (*passio*), i.e., *definitio passionis dicens et quid et propter quid, et concernens subiectum quod est causa*. Before we can determine how such causal definitions are to be found, we must discuss how simple definitions are to be found.

(1) *Discovery of simple definitions* (chap. 13)

(a) *In General:*

By a simple definition is meant a definition expressing *quid est tantum* (as opposed to one expressing both *quid* and *propter quid*) Every definition whether of a substance or property, is composed of *genus* and *difference*; the proper definition of anything (*quod quid est*) is expressed by the immediate genus and ultimate difference comprising the species. The meaning of ‘genus’ and ‘difference’ is only analogously similar in the case of substantial natures and accidental natures. The Porphyrean tree of genera and difference is a logical schema of substantial natures; the real problem comes in determining the physical species of natural things. All accidental natures, e.g. gravity, energy, pride, etc. have this in common, that they all have a certain kind of *inesse subiecto* but that is not sufficient to express the definition of those pro-

perties; one must determine 'the immediate genus and specific difference in order to define them properly.

The essential natures of physical substances are not *per se notae* to us, but must be perceived through sense experience. The immediate genus is perceived through the common attributes. The determination of the specific difference is more difficult, and it is perceived in the differences among such accidents as size, weight, shape, number of parts, etc. This is not to say that the aggregate of such accidents found in one type constitute the specific difference of the essential nature (as John Locke thought); rather, the unique aggregate of such accidents is significative of the specific difference.

Quia formae essentiales non sunt nobis per se notae, oportet quod manifestentur per aliqua accidentia, quae sunt *signa* illis formae, ut patet in *VIII Metaph.*(lect. 2) Non autem oportet accipere accidentia propria illius speciei, quia talia oportet per definitionem speciei demonstrari; sed oportet notificari formam speciei per aliqua accidentia communiora; et secundum hoc differentiae assumptae dicuntur quidem substantiales, inquantum inducuntur ad declarandum formam essentiabem; sunt autem communiores specie, in quantum assumuntur ex aliquibus signis, quae consequuntur superiora genera. (St. Thomas, *In II Post. Anal.*, lect.13, n. 7)

For further explanation of this text of St. Thomas, see the note of Card. T. M. Zigliara, O.P., quoted in Appendix III, pp. 6\*-7\* [This Appendix has not been found. Ed.]

#### (b) *In Particular*

Knowledge of the etymology of the term, or *id a quo nomen sumitur* (cf. St., II-II, q.92, a.1ad 2), is very useful in helping toward an understanding of at least the analogy of the term. But the etymology of the term should not be confused with its signification, or *id ad quod nomen imponitur*, which is the reality intended by the term. From antiquity there have been two methods of discovering the real definition: the method of division and the method of composition.

#### (1) *Venatio definitionis per divisionem generis* (96b15-97b6)

The best way of approaching a real definition of substances and properties is by division of the genus. It is an ancient method used by Plato in the *Sophist* (218D-231C) and in the *statesman* (258C-267C). It consists in starting first with the obvious common genus of the thing to be defined, e.g. substance, quality, artifact, activity, etc. and in dividing that whole into species, re-dividing until some proximate genus is determined. Then it consists in determining the specific difference through the common accidents, which are proper to the reality under discussion:

Postquam acciperimus per divisionem generis in species quid sit genus, puta utrum sit in genere qualitatis vel quantitatis, oportet ad investigandum differentias considerare proprias passiones, quae, sicut dictum est, sunt signa manifestantia formas proprias specierum. Et hoc oportet primum facere per aliqua communis. (*In II Post. Anal.*, lect.14, n.3)

This method of discovering or “hunting” the definitions of things is not a demonstration, nor does it involve demonstration. At first sight this method of defining may appear useless, since one does not seem to have more at the end of the process than was had at the beginning (97b29-30). In reality this process is most useful for two reasons (1) it immediately manifests the proper genus and specific difference in the correct order of subalternate genera; and (2) “division is the only possible method of avoiding the omission of any element of the essential nature” (96b35-36). “In establishing a definition by division one should keep three objects in view: (1) the admission only of elements in the definable form, (2) the arrangement of these in the right order, (3) the omission of no such elements.” (97a23-26)

For the five classical rules of defining correctly and the ways of violating them, see St. Albert, *Lib. De Praedicabilibus*, tr. I, cap. 6, *ed. cit.*, I, 11b-13b.

The disciples of Heraclitus (cf. St. Albert, *II Post. Anal.*, tr. IV, cap. 3, p. 213b-214b) claimed that to know the definition of anything one had to know all the existing differences of everything. This view, however, is a fallacy, since not every differentiation is essential, e.g. the shape of human noses, or the color of human skin, and to define a natural species it is not necessary or permissible to include accidental varieties. It belongs to the real sciences, and not to logic to determine what is essential and what is accidental. Furthermore the definition of a species may not include those differences excluded by it, e.g. the definition of man as a *rational* animal may not include any of those differences belonging to *irrational* therefore there is no need to know everything about those excluded differences. (97a12-14)

## (2) *Venatio definitionis per similia et dissimilia* (97b6-39)

St. Albert considers this method as belonging to the definition of properties (*passiones*), and the former method as belonging to the definition of the subject. (*Lib. II Post. Anal.*, tr., IV, c. 5, p. 215b-217b) St. Thomas, however, clearly does not consider this to be the case since his examples for both methods of defining are taken from the category of substance and accidents (cf. quotation above, p. 50). Actually this method of *comparing* similarities and dissimilarities is useful for both subjects and predicates. It is another method of approach and can be used in conjunction with the first method, particularly in determining the specific difference.

As a special method of defining it was used by Plato in the *Meno* (72B ff.; see also Aristotle, *Metaph.*, XIII, c.4, 1078b23-30). Compared to the method of division, this one is *inductive* and *synthetic*, beginning with all known cases of the reality to be defined, and arriving at the essential elements by eliminating everything accidental to it. Essential similarities reveal the genus, while essential dissimilarities reveal the difference; accidentals, of course, must be eliminated from the definition. For example, if one wants to define the nature of pride, one could begin by comparing such cases of pride as Achilles, Alcibiades and Ajax to see what they have in common, e.g. intolerance of insult; then one could compare this common element to other reactions to insult e.g. the case of Lysander, Socrates, etc.

[Note: The Medieval Latin translations unanimously rendered μεγαλοψυχία (97b16 ff.) by *magnanimitas*. But it would seem that here Aristotle intends to give it the pejorative sense of “arrogance”, or “pride” Cf. Ross ed. note p. 661 cites *E.N.* 1123a34-1125a35 as the *locus classicus*.]

The method of discovering definitions by comparison of similarities and dissimilarities is very practical and highly suited to the natural sciences, since these sciences concern sensible material realities. It is easier to discover the immediate genus by comparing many particular cases, than to descend methodically from a very remote genus. By noting dissimilarities it is easy to arrive at a specific difference after the accidental variations have been eliminated. This method of determining the true natures of things is taken for granted by physicians, biologists, pharmacologists, chemists and the like, since this is their normal method of procedure in classifying and describing.

The method of defining by comparison does not mean that metaphorical language may be used. Metaphorical definitions, such as 'man is an inverted tree' are useless in scientific demonstrations. (98b37-39) "Quia metaphora accipitur secundum aliquid simile, non autem oportet ut ut id quod est simile secundum unum, sit simile quantum ad omnia." (Lect. 16, n. 8)

### Summary

It has been shown that before any scientific question is raised certain things must already be known (*praecognita*). Normally one already knows that the subject of inquiry exists, its definition, and at least the nominal definition of the predicate. (Cf. above pp. 8-10) If the definition of the subject is not yet known it must be discovered by one of the above methods, or at least clarified so that the *quod quid est* of the subject is manifest. Before one can arrive at the answer to the question, the real definition of the predicate must be determined. This can be determined either by the method of division or by the method of comparison. These definitions of the subject and predicate of the question are *definitiones dicentes quid tantum*. The scientific question cannot be answered until we have discovered the *definitio passionis dicens quid et propter quid*, i.e., until we have discovered the *propter quid* cause of the affirmation or negation.

### (2) Discovery of proper causes (chap. 14-18)

The goal of all the real sciences is to know why certain properties (P) belong to specific realities (S). That is to say, the term of all scientific inquiry is to know the proper cause of the judgment affirming P of S, even though the affirmative fact (*quia*) may be known by experience. Logic itself cannot discover or indicate the true causes; it can only explain and classify the method to be used in their discovery.

All true properties are somehow caused by the subject in which they really inhere, rising from the material or formal principles of the subject, "Subiectum est causa propriae passionis." (lect. 17, n. 2) Even properties in the wide sense of the term, e.g. eclipses, echoes, rainbows, etc. are caused by the nature or activity of the subject, e.g. the circular movement of the moon around the earth is the cause of lunar eclipses. Hence the cause of P belonging to S is something in S itself. The problem is to find this something in order to understand the cause of the connection, i.e., in order to express the medium of demonstration. We have already seen that this medium of demonstration is the *cause* (which is the whole or the part of the subject) of the predicate, or the *propter quid* definition of the predicate. The problem, then, is to discover that precise element in the subject, which is responsible for the universal and necessary property. The actual searching for that causal element belongs to the particular sciences. But there are certain points, which can be noted by the logician.



(a) *In general* (chap.14-15)

Since the causal element lies somehow within the subject of inquiry, the best approach is through the property itself, i.e., by trying to find the universal convertible cause of the major term. For example, if we were asked 'why does a robin fly', we would answer 'because it is a bird, since being a bird is the proper cause of flying, whether it be a robin, a canary or an eagle. Likewise in seeking why the moon at times does not give light, we should first ask why any reflecting body at times ceases to give light. In other words, to discover which element in the subject is responsible for the property in question, we must first try to determine the common cause of all such properties; that common cause is in reality the *proper* cause of the major term, universal and convertible with it, so that wherever the cause is found the property in question will necessarily also be found. Thus in searching for the proper causes of the property the first step is to find the common cause of the major term; once that cause is discovered, we will be in a position to discover how that cause is present in the subject, for it will be in the subject as a remote or proximate genus, as a specific difference, as an efficient cause, or even as a material cause. The precise function of the cause in question, viz., of the cause of the major term, can be determined by the definition of the subject and by comparison with other subjects and other properties.

When the common and universal cause of the major term is a univocal genus (remote or proximate) or a species, the discovery and declaration of that cause is relatively easy. For *human* scientific knowledge univocal middle terms are the most perfect and easily understood, "But we must not confine ourselves to considering these" (Aristotle, *PA*, II, c.14, 98a14), for scientific knowledge is also acquired through *analogical* middle terms, as in metaphysics, certain parts of natural science and moral science, We must distinguish three types of middle terms which can serve as common causes of the major term

(1) *commune univocum nominatum* (98a10-12), as in the ordinary examples given above. Common causes that are relatively simple and better known to us are usually univocal and well named. Most of the examples of demonstration used by Aristotle in the *Posterior Analytics* are of this kind.

(2) *commune univocum innominatum* (98a13-19), for example, 'horned animal', since there are four different kinds of horned animals and there is no named class to which only horned animals belong. This is a deficiency not only of language, but also of detailed knowledge of the real natures involved.

(3) *commune analogicum* (93a20-23), for example, a squid's sepia, a fish's spine, and hard animal bone can all be called bone, but in this case the term is being used analogically. since analogous terms are *simpliciter diversa* with respect to the various analogues we must realize fully that the unity of the term designating the 'common cause' is only proportional (*secundum proportionem*). "Ad hoc autem commune analogum quaedam consequuntur propter unitatem proportionis, sicut si communicarent in una natura generis vel speciei, sicut esse co-opertum carnibus." (St. Thomas, *In II Post. Anal.*, lect 17, n. 4) The *commune analogicum* is not really prior to the effect, since the analogical concept actually contains all its analogues; but as a middle term of demonstration and as a medium of understanding the proportional unity is prior.

The cause we seek, therefore, may function as a kind of *formal cause* of the subject in the sense explained in chapter 11, being a proximate or remote genus (named or unnamed), a specific difference or the whole species; it may even be an analogically unified cause. Further

the cause we seek may function as an *efficient* cause or as a *material* cause. But in all these cases the cause of the major term will be located in the *minor term*, i.e., in the complex subject of inquiry. scientific demonstration is possible only because the minor term in some manner contains the explicative cause of the major term. Once this cause is discovered it is a simple matter to express the demonstration in syllogistic form. It must be repeated, however, that the syllogistic form is not a method of discovery; rather it presupposes discovery, it is a method of presentation or learning.

From what has been said we can perhaps understand more clearly the solution offered by Aristotle in chapter 1 of Book I to the problem of learning. The 'cause' or 'middle term' we seek in scientific inquiry is really (*simpliciter*) unknown, i.e., unknown in *actu* but it is *potentially*, or *virtually* known already in the subject and predicate of the scientific question, which is the starting point of learning. Thus the discovery of proper causes begins with an analysis of the subject and predicate of the question, an analysis of the *praecognita* of scientific knowledge. This analysis, as we have seen, can never be conducted on an *a priori* basis, for this kind of analysis requires continual observation, comparison, elimination and precise ordering of existential factors in order to discover real causal definitions.

(b) *In Particular* (chap. 16-18)

Two particular questions arise concerning the scientific cause. The first concerns the simultaneity of cause and effect; the second concerns the identity of the cause.

(1) *When the effect is present is the cause also necessarily present, and vice versa?* (chap. 16)

First of all, the question here does not involve temporal simultaneity, but only simultaneity of sequence (*quantum ad simultatem consecutionis, utpote si positio uno consequatur aliud vel simul tempore, vel prius et post* St. Thomas, lect. 18, n. 2) The question is whether in knowing the existence of the cause we can necessarily prove the existence of the effect and vice versa.

We have already seen that a cause is not a cause unless an effect necessarily follows from it some time or other, at least *ut in pluribus*; and if there is an effect, then necessarily there must be a cause to produce it, for a cause is "that from which something proceeds with dependence in *esse*." However, Aristotle observes (98b16-21), while it is true that we can demonstrate the effect from the cause and cause from the effect, we should not think that each is the cause of the other, or that the terms are used indifferently, or that the demonstrations are equivalent. Only one is the 'cause' and only demonstration through that medium is demonstration *propter quid* "That the eclipse is not the cause of the interposition, but the interposition is an element in the definition of eclipse, which shows that the eclipse is known through the interposition and not vice versa." (98b21-24)

(2) *Is it possible that a certain kind of effect be produced by different kinds of causes, or for each effect must there be only one specific cause?* (chap. 17-18)

First it must be noted that the term 'cause' can be taken in three senses a cause *per se*, an indicative sign, and an *accidental* cause.

If by cause we mean a true medium of demonstration, viz., a *per se* cause of being and demonstrative knowledge, then clearly there can be only one specific cause for each effect:

Si ergo accipiatur pro causa id quod per se est medium demonstrationis, non potest esse nisi una causa unius effectus in omnibus. Et hoc probat quia medium per se in demonstrationibus est *ratio ultimi*, id est definitio



maioris extremitatis. Quae tamen si demonstrari indigeat de subiecto, demonstra-bitur per definitionem subiecti, ut supra habitum est (lect. 1, n. 9). Manifestum est autem quod unius una est definitio. Unde oportet quod unius effectus non accipiat nisi una causa, quae est medium demonstrationis. (St. Thomas, *In II Post. Anal.*, lect.19, n.2)

Since the medium of demonstration is the "definition of the major" (II, 17, 99a21-22), cause and effect must be reciprocal, i.e., there can be only one total *per se* cause of the inherence of the property.

If however by 'cause' we mean an *accidental cause* or an *indicative sign*, then the same cause may have diverse effects, i.e., the same medium may 'prove different statements. This is why when we use indicative signs to prove a case, we need many signs to prove the single conclusion: we need to have a *proportion* between cause and effect, between the medium and the major term in order to have certainty of 'demonstration'.

Likewise in *analogical* demonstrations there must be proportion, or reciprocity between the middle term and the major term.

Take the question why proportionals alternate? The cause when they are lines, and when they are numbers, is both different and identical; different in so far as lines are lines and not numbers, identical as involving a given determinate increment. In all proportionals this is so. ... Connections requiring proof which are identical by analogy have middles also analogous. (*PA* 99a8-16)

From what has been said it follows that there must be a proportion or reciprocity between the effect and the cause and the subject containing the cause. It is precisely this proportion between effect, cause and subject which is expressed in the *definitio passionis dicens propter quid*, which, as we have seen (above pp. 39-42), is itself a *demonstratio positione different*. "We conclude, then, that the same effect may have more than one cause, but not in identical subjects" (99b3-5) The ultimate reason for this is that definitions are like numbers: any addition or subtraction changes the species. (cf. Arist., *Metaph.*, VIII, 3, 1043b35-1044a14)

## Conclusion

"As regards syllogism [cf. *Anal. Prior.*, I, c. 1] and demonstration, the definition of, and the conditions required to produce each of them, are now clear, and with that also the definition of, and the conditions required to produce, demonstrative knowledge, since it is the same as demonstration." (11,19, 99b15-17) Here Aristotle refers not only to the end of the *Prior Analytics*, but also to the termination of the *solution* of the problem presented in the first chapter of the *Posterior Analytics*.

The *problem* concerned the possibility of learning, i.e., the possibility of acquiring scientific knowledge, knowledge that explains *why* events are what they are. On the one hand, it would seem that explanations are not really *new*, for we seem always to have possessed the answer even before we pose the question; it would seem that the so-called process of learning is really a remembering of the answer we always had. This was the position of Plato. On the other hand it would seem that learning is nothing more than the acquisition of new facts; any pretense of explanation involves a vicious circle, for the 'explanation' is nothing more than a collection of already known facts. This was the position of the sophists

The *solution* rests on a distinction between what is already *actually* known and what is only *potentially*, or *virtually* known. Everyone who believes he knows the answer to a scientific question, or who knows the explanation of a problem (whether rightly or wrongly) claims to give the cause or *reason* for the statement he holds to be true. The statement is objectively true when the cause or reason for it is (1) invariably true, (2) a *per se* causal explanation, (3) convertible, or proportionate to the statement. The explanation we seek is *simpliciter unknown* at the beginning of scientific inquiry, but it is *virtually or potentially* known in the scientific problem posed for discussion. In the very statement of the question we must know what it is that we are asking (the real subject) and we must know what it is that we are asking (the definition of the predicate). An explanation is found when we have discovered the cause of the predicate's existence to be a determined element inherent in the subject. The search for this element is *through the predicate* it is a search for the common convertible cause of all such predicates. Thus the whole of scientific inquiry is a search for *definitiones passionis dicentes propter quid*. The causal element of the property can be found nowhere except in the subject. Once this causal element is isolated, irrespective of whether it is a material, efficient, or formal cause, we have found a true explanation and this can be expressed in the form of a demonstrative syllogism in which the major premise is a *per se* statement in the fourth way or mode of saying *per se*, the minor in the first way of saying *per se*, and the conclusion in the second way.

Attendendum autem quod quamvis in syllogismo secundum ordinem naturalem maior extremitas primum, et medium sit positione medium et secundum, et minus extremum ordine naturali sit ultimum, tamen in demonstratione potissima secundum ordinem naturalem e converso est ordo, quia subiectum quod est, minor extremitas secundum ordinem naturalem est primum, quia hoc est in definitione quae dicit propter quid ut principium ipsius, et definitio dicens propter quid quod medium est secundum primum subiectum, et definitio dicens quid est passio, et passio quae est maior extremitas secundum ordinem naturae est ultimum. Propter quod non oportet tradere artem venandi *propter quid*, quia definitio dicens propter quid semper continet subiectum in seipsa, et scitur quod per subiectum vel aliquod subiecti principium habetur. Nec oportet logicum descendere ad docendum qualiter in diversis scientiis diversimodi per propter quid demonstratur vel per causas; hoc enim et metaphysici est et illi relinquendum. (St. Albert, Lib. II *Post.Anal.*, tr. IV, cap. 9, *ed.cit.*, II, 227b)

The solution to the problem, therefore, lies in the *reduction of potentiality to actuality*, in making actually intelligible that which was only virtually intelligible in the known facts. But nothing is reduced from potentiality to actuality except by something that is already in act. This active agency of scientific investigation is the *light of first principles of human reason*. Therefore the foundation of all reasoning and scientific investigation is the *habitus* [or settled disposition] of first principles.

*The Ultimate Basis of Learning*  
(or *The Knowledge of First Principles*)  
*Posterior Analytics* Book II, ch. 19

*I Relation of this chapter to Book I, chapter 1*

In solving Meno's dilemma Aristotle acknowledges that all learning is from pre-existent knowledge. (73a1-2). But Aristotle *denies*:

(1) that this preexistent knowledge is *actual*, for if this were the case then all learning would be a mere remembering. For Aristotle the truth is contained potentially in what is already known, and not actually. This solution is basically identical with Aristotle's solution to the dilemma of Parmenides concerning change.

(2) that this preexistent knowledge is *identical* for all learning, for if this were the case then not even the first knowledge would be *acquired*, but all would be remembering. For Aristotle there is an essential difference between the way in which scientific knowledge is acquired and the way in which immediate knowledge is acquired. That is to say, the acquisition of the medium of demonstration (scientific knowledge) takes place in virtue of the *subject* and *predicate* known; the acquisition of immediate knowledge (first principles and definitions) takes place in virtue of being *derived from sensed knowledge*. This solution is basically identical with Aristotle's distinction between substantial change and accidental potentiality (second matter)

*II. The acquisition of first principles*

The problem is whether first principles of human reason are also acquired in virtue of preexistent knowledge. On the one hand, it would seem that these principles cannot be acquired from preexistent knowledge, for these principles are known with absolute certainty, and if they were acquired from what is more certain, there would be an infinite regress of demonstrations. On the other hand, if these principles are not acquired, then we would have possessed from birth principles more certain than scientific demonstration without even knowing it; this is contrary to the experience of every man. Therefore there must be a sense in which first principles are acquired, and a sense in which they are not acquired. First principles are not acquired in the sense that there are prior intellectual principles for this would result in an infinite regress without any solution to the problem. But first principles are acquired in the sense that potentiality is reduced to actuality. First principles of human reason are potentially in the "congenital discriminative faculty which is called sense perception (δύναμιν σύμφυτον κριτικὴν ἣν καλοῦσιν αἰσθησιν, II 19,99b35)

This discriminative sense faculty is commonly called *vis aestimativa* in irrational animals and *vis cogitativa* in man. The term 'estimative' aptly designates the discriminating sense judgments concerning what is pleasurable and distasteful to the animal. In rational animals this faculty is called *vis cogitativa* or *ratio particularis*, because besides judging discriminatively between what is pleasurable and distasteful, this faculty judges concrete situations from the recollection of similar situations; this judgment is called *experience* (ἐμπειρία), "for a number of memories constitute a single experience" (100a-6). "Experimentum enim est universalis cognitio ex similitudine sensibili accepta per potentiam judicativam" (Albert, *Lib. II Post.Anal.*, tr.V, cap.I, p.230a). These experiential judgments are themselves *potentially universal*. They are reduced to actuality by the "mind produces all things or agent intellect. Therefore universal first

principles are indeed acquired from preexistent knowledge, but from knowledge of a very different kind from what has been discussed above for scientific demonstration.

Manifestum est enim quod singulare sentitur *proprie et per se*, sed tamen sensus est quodammodo etiam ipsius universalis. Cognoscit enim Calliam non solum in quantum est Callias, sed etiam in quantum est *hic homo*. Et exinde est quod tali acceptione sensus praeexistente, anima intellectiva potest considerare hominem in utroque. *si autem ita esset quod census apprehenderet solum id quod est particularitatis, et nullo modo cum hoc apprehenderet universalem naturam in particulari, non esset possibile quod ex apprehensione sensus causaretur in nobis cognitio universalis*. Et hoc idem manifestat consequenter in processu qui est a speciebus ad genus. Unde subdit quod iterum in hic, scilicet in homine et equo, anima stat per considerationem quousque perveniat ad aliquid impartibile in eis, quod est universale. Ut puta consideramus tale animal et tale, puta hominem et equum quousque perveniamus ad commune animal, quod est genus; et in hoc similiter facimus quousque perveniamus ad aliquod genus superius. Quia igitur universalium cognitionem accipimus ex singularibus, concludit manifestum esse quod necesse est prima universalia principia cognoscere per inductionem. sic enim, scilicet per viam inductionis, sensus facit universale intus in anima, in quantum considerantur omnia singularia. (St. Thomas, *In II Post. Anal.*, lect. 20, n. 14; cf. *de Verit.*, q. 12, a. 1 ad 9; *St. I.*, q. 84, a6; Cajetan, *In Sum. Theo.*, I, q. 45, a. 3)

Thus Aristotle calls experience or *experimentum* “principium artis et scientiae” (100a8)

*Artis* quidem in quantum est unitivum praeceptorum ad unum operationis finem: quia ars operationis est directivum cum ratione habitus. *scientiae* autem in quantum est unitivum principiorum ad finem speculativae veritatis: quia scientia est veritatis contemplativae demonstrativus habitus (Albert, *Lib. II Post. Anal.*, tr. V, cap. I, p. 230b) see also *Metaph.*, I, c. 1 and St. Thomas, *In I Metaph.*, lect. 1, n. 5-35.

### III. The habitus of first principles

The habitual knowledge of indemonstrable first principles is called *intellectus*, or νοῦς (*Post. Anal.*, II, 19, 100b12-17; *Ethic. Nicom.*, VI, 1-3)

All teaching starts from what is already known, as we maintain in the *Analytics* also; for it proceeds sometimes through induction and sometimes by syllogism. Now induction is the starting point which knowledge of even the universal presupposes, while syllogism proceeds from universals. There are therefore starting points from which syllogisms proceed, which are not reached by syllogism; it is therefore by induction that they are acquired (*Ethic. Nicom.*, VI, 3, 1139b26-30).

*Intellectus*, as the habitus of first principles of human reason, is the starting point of all demonstration, for it is in the light of absolutely immovable first principles that all learning and scientific investigation proceed. For this reason Aristotle insisted in Bk. I, ch. 1, that the truth of first principles is presupposed to learning scientifically (cf. above pp. 8-10). The certainty and

necessity of scientific demonstrations are derived from these first principles; therefore the first principles are more certain and more necessary in themselves than scientific truths. “Hic intellectus, qui est principium scientiae, est cognoscitivus principii, ex quo procedit scientia” (St. Thomas, *In II Post. Anal.*, lect. 20, n. 15).

Intellectus, or νοῦς is called a habitus in the sense that its object is objectively immovable, viz., necessary, self-evident, eternal truths. Subjectively this habitus is acquired, but not in the manner other habitus are acquired, for the human intellect is by nature disposed to accepting these truths with certainty as soon as the agent intellect illumines the potentially universal judgments or the *vis cogitativa*. When the sense images and judgments of experience are rendered actually intelligible by the agent intellect, the human mind immediately accepts such truths as “a thing cannot be and not be at the same time”, “the whole is greater than its parts”, etc. Therefore the habit of first principles is *quasi naturalis*.

Motus omnis ab immobili procedit, ut dicit Augustinus, VIII *super Genesi ad litteram*; motus etiam finis est quies, ut. in V *Physica* dicitur. Et sicut motus comparatur ad quietem et ut ad principium et ut ad terminum, ita et *ratio*--e.g., scientia—comparatur ad intellectum ut motus ad quietem, et ut generatio ad esse. (St. Thomas, *de Veritate*, q.15, a.1)

Thus *intellectus* is the unmoved mover and the term of all human learning. it is a participation of the Eternal νοῦς [nous] which is the beginning and the end of all learning.

Sic igitur finis sit *Posterior Analyticorum*. si autem in hoc non subtiliter processimus transponendo sententiam in syllogismis, neo miretur; his enim pauperibus in religione positus studemus, quibus simul ordinationem litterae Aristotelis et ipsam scientiam tradere studemus, ut in eo labore et scientiam habeant et etiam notitiam litterae Aristotelis. Nec difficile putamus quamlibet sententiam in syllogismum ponere; hoc enim modicam vel nullam habet difficultatem (St. Albert, Lib. II *Post. Anal.*, tr. V, cap. 2, *ed. cit.* p.232b)