SCIENCE AND PHILOSOPHY

ACCORDING TO ST. ALBERT THE GREAT

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Because of the extensive and almost innumerable advances made in the experimental sciences, it seemed evident to almost all learned men that a division of these sciences from philosophy and a recognition of their autonomy was natural, just and necessary. But in this independence of theirs these experimental studies unjustly arrogated almost entirely to themselves the name of science. Thus arose the common division of human knowledge into philosophic and scientific, so that philosophy and science were generally considered as two distinct parts of human knowledge. A great number of philosophers and scientists applied themselves to this problem of the true distinction between philosophy and science, and the relations to be established between them. However, in recent years certain scientific theories, namely, electronic, relativistic, and quantitivistic, have been presented; and the consequences of these theories seem to touch philosophy and destroy its separation from science. Because of these theories this question was once more brought into prominence. At the present time this relation between philosophy and science is much discussed by philosophers and scientists, scholastics and non-scholastics, in books, periodicals, and congresses.

Besides the evident opportuneness of this question, its great import also appears immediately if one considers that the concepts of philosophy and science depend upon this division and that the clarity or confusion of these concepts is diffused throughout these fields. Certainly the fountain and origin of many errors and confusions in contemporary philosophy is found in the false or inexact notion of the relation between philosophy and science. Therefore in present-day higher ecclesiastical studies it is wisely and opportunely commanded, according to the norm of the Apostolic Constitution, Deus Scientiarum Dominus, that professors should lecture on - and in addition that students should learn - those more important questions from mathematics, physics, chemistry, biology and anthropology which have a significant connection with philosophy.

In conformity with the criterion enunciated by Pope Leo XIII as "the best rule for philosophizing" namely, "to seek out by contemplation new things, while at the same time retaining the established wisdom of the ancients," (1) we have considered the genuine and ancient principles of scholastic philosophy and the farthest advances of modern science; and our intention is to expound, in the interest of truth, what must be said about these relations.

Among the opinions of the early authors about this question, perhaps none is of such moment as the view of St. Albert the Great, "who - with the approbation

of the reigning pontiff - contemplated not only divine things and truths of philosophy, but also attained and illustrated all other human sciences." (2) Likewise, among the praises of others, Bartholomew of Lucca, Bishop of Torcellanus and a contemporary of St. Albert, affirmed that Albert had greatly excelled among the doctors of his time as far as the cultivation of all the sciences and a method of teaching is concerned. In this article we shall consider the opinion of St. Albert, noting well the fact that this proposed solution also conforms to the doctrine of the better known authors of Aristotelian-Scholastic philosophy. Most beautiful and opportune texts on the same subject are also found in St. Thomas, but the need for brevity prevents us from citing them here. For the same reason we touch only lightly certain questions which would require a greater explanation, in the hope that in the future we shall be able to present them more fully.

Since philosophy and science have many exceedingly diverse meanings, it must be understood that in this paper both are used in a restricted sense. Thus all human knowledge is divided into two parts: the one is called philosophy, the other science; and similarly, the cultivators of the former are called philosophers, and of the latter, scientists.

Great difficulty is experienced in trying to assign both a proper object, because much variety of opinion about this matter is found among the different authors. Abstracting from these manifold opinions, in this dissertation we shall indicate only the more common criteria, at least among scholastics, by which philosophy and science are distinguished. What the correct distinction is and what can be said of these various opinions will be evident from the solution given here to the question.

Among scholastics, perhaps the more common method of distinguishing philosophy and science is through the various kinds of causes which are assigned to each one. Philosophy, they say, seeks ultimate and remote causes, but science seeks proximate and immediate causes.

However, the ultimate causes of sensible things are substances, and the proximate causes are accidents; thus it is sometimes said that the object of philosophy is the substances of sensible things and any other higher knowledge, and that the object of science is the accidents of the same things, or rather, the relations between these accidents. It is not denied that philosophy also treats of accidents, but it is said that it considers them in relation to substance and not in so far as they are subject to sensible experience or measure, as happens in the positive sciences and mathematics.

Furthermore, all accidents of sensible things either are perceived by the senses immediately, and then for us their validity depends essentially upon sensible experience; or they are expressed by the numbers or the formulae of mathematics. On the other hand, substances cannot be perceived immediately by the senses nor can they be expressed by the numbers or formulae of mathematics. Therefore, one can state that the object of philosophy is reality which is attained by the intelligence alone, and the object of science is the reality of natural things which is immediately perceived by the senses or which is expressed by mathematical formulae. Briefly, the reality which is the object of philosophy, they say, is that which is intelligible only, but the reality of science is also sensible and imaginable.

The terms of Kantianism, 'noumena' and 'phenomena,' are sometimes applied to signify the same thing; nevertheless, their signification is not wholly consistent with the preceding material.

From these views they also infer that philosophy never properly and formally depends upon scientific experience or upon numbers as does science; and consequently the former is principally deductive while the latter is inductive.

Finally, some scholastics divide philosophy and science according to the two ways of demonstrating. Philosophy, they say, uses 'propter quid' causes (explaining the proper reason why); but science uses 'quia' demonstrations and seeks and exhibits only 'quia' causes (knowledge of the fact, but not of the proper reason why). Because of this philosophy is called perfect science, and experimental science is called imperfect science.

The first question that must be considered and solved is this: Do philosophy and science so defined differ essentially, or do they differ materially and accidentally only? In other words, is this division of human knowledge into philosophic and scientific a division into distinct species, or only a certain conventional division, more or less useful, not necessarily signifying a specific distinction? It is evident that the relations to be established in the one and the other case would be totally diverse.

Almost all modern scholastics, laying aside other opinions and speaking as if there were no doubt about this question, assert that philosophy and science, accepted in the modern sense, are specifically distinct. They admit, however, that this division is not found explicitly among the early Aristotelians and Scholastics who included all science of whatever kind in philosophy, and who certainly included all positive sciences in the philosophy of nature. But the reason for such inclusion or confusion, they say, was the state of positive science which was so imperfect that it was not deemed necessary to prepare a special tract. However, since these empirical sciences have been developed, they say, to fuller maturity in our times, through their marvelous advances, they are justly declared autonomous. Thus the philosopher is restricted to a proper object of his own, namely, the ultimate and highest causes of things. According to this interpretation, the earlier philosophers, at least the most eminent among them, such as Aristotle, St. Albert and St. Thomas, should have had in their own day essentially the same concept of philosophy as is now popular in the schools, and according to which the positive sciences must be distinguished specifically from philosophy. If, however, they didn't make this distinction explicitly, it must not be attributed to an ignorance or confusion of this distinction, but to the imperfection of the experimental sciences of that time. Thus to confuse them as the early authors did, according to these scholastics, is to continue to live in the middle ages as if there were no progress made in the following centuries, or to fall into that naive and now discarded 'conformism' of the scholastics which attempted to explain, in the 17th, 18th and 19th centuries, new scientific advances through ancient principles of philosophy.

A complete solution of the question would require that all parts of philosophy, namely logic, metaphysics, natural philosophy and ethics, be compared with the positive sciences and mathematics. So as not to make this treatise excessively long, we will devote only a few words to metaphysics, and then compare natural philosophy with the positive sciences, since the difficulty is principally between them.

First, it is necessary to note that almost all modern non-scholastic philosophers and scientists and many of the scholastics who hold the above mentioned opinion confuse philosophy or at least speculative and real philosophy with metaphysics itself. They consider cosmology and rational psychology as parts of metaphysics. Hence for them every speculation and real philosophic cognition is metaphysical and vice versa.

Therefore the names of philosophy and metaphysics are not precisely employed. Those who hold this opinion necessarily distinguish specifically natural philosophy, as they do metaphysics of which natural philosophy is part, from every other positive science and mathematics. Hence the relations established between philosophy and the sciences were the same as the relations between metaphysics and the sciences. This seems to be the reason why many hold as evident the specific distinction between philosophic and scientific knowledge.

But if natural philosophy, using the modern conotation of these words, differs specifically from metaphysics, then it cannot be asserted that it also differs specifically from the positive sciences from the fact that metaphysics is already distinguished in this way. Hence if metaphysics and natural philosophy differ specifically, the relations of both with the positive sciences will not be the same. Therefore the solution of the question is totally and necessarily different in each of these cases.

In order to present what we consider to be a true solution which conforms to the genuine principles of Aristotle and St. Albert, we must begin with the following question: Is speculative and real philosophy, which is understood by the moderns as knowledge of ultimate causes, one only or many? Or to state it in another way: Is natural philosophy, namely cosmology and psychology, understood in the modern sense, part of metaphysics or a science specifically distinguished from it?

The correct explanation is found in the venerable and profound Aristotelian-Scholastic doctrine concerning the division of the sciences. This doctrine must be briefly reviewed and applied to this case, since it is fundamental for a proper understanding of the solution, and especially since this same doctrine is seldom correctly presented and explained.

It is a fact, verified experientially, that man cannot know anything naturally in this life, except in relation to sensible objects. Scholastic philosophy is founded on this fact: that the proper object of the human intellect is sensible things. However, these things become knowable to men only insofar as they are abstracted from matter.

Objective and formal abstraction, which would be better rendered 'abstractability,' is the unique and necessary formality by which natural things are made knowable by human reason. Thus this 'abstractability' must evidently be said to be the most formal constitutive and specificative cause of any human speculative science. Accordingly the diversity of the grades of abstraction alone is the formal cause of specific distinction of such sciences.

Furthermore, all admit that there are three obviously distinct grades of abstraction from matter, namely: abstraction from individual matter, or from matter insofar as it is the root of individuation; abstraction from sensible matter, or matter insofar as it is the foundation of sensible qualities; and abstraction from all matter, or more properly, abstraction from all that which is proper to matter. Three specifically distinct sciences, namely, natural philosophy, mathematics, and metaphysics, correspond to these three grades of abstraction.

Natural philosophy, as understood by the moderns, has as its object the ultimate causes of natural things or substances. These substances, if they are to be the object of natural science, can be abstracted from individual matter only. Thus natural philosophy, so understood, is specifically distinct from metaphysics, because it is in a different grade of abstraction. Since natural philosophy is in the first degree

of abstraction and metaphysics is in the last, they differ from each other by the greatest possible difference. Now if all specifically distinguish metaphysics from mathematics, then a-fortiori they must assert the same distinction regarding natural philosophy. To affirm a specific distinction between metaphysics and mathematics and to deny one between metaphysics and natural philosophy would be the same as to teach that man is specifically distinct from brute animals yet not distinct from plants or minerals because he has many qualities in common with these bodies. It is more absurd to name the knowledge which is acquired in natural philosophy metaphysical, than it is to impose the name metaphysical on mathematical knowledge; just as it is more absurd to attribute reason to plants rather than to brutes.

Aristotle argues in a similar way and he shows the falsity and inconsistency of Plato's identifying physics with mathematics. For if the sciences midway between them, such as music, etc., differ from mathematics because these sciences already include sensible matter, a-fortiori this distinction and this dependence upon matter must be affirmed of the natural sciences. (3)

Indeed, the moderns propose many questions in natural philosophy which are really metaphysical or theological questions, such as creation, the possibility of miracles, the refutation of pantheism, the objective existence of the sensible world, the causes per se, eternity, etc. But this error must be completely rejected, for the knowability of these things which are in the last grade of abstraction is altogether distinct from the knowability of such things as the ultimate constituent of bodies, the natures of motion, of space, of time, of life, of the human soul, etc., which are in the first grade of abstraction. These two genera of questions pertaining to philosophy taken in the modern sense cannot without error be treated in the same science. But if natural philosophy sometimes must treat of the former (i.e., the problem of creation, the possibility of miracles, the refutation of pantheism, etc.) because of extrinsic reasons, this should, in order to avoid confusion, be explicitly stated, as is done by Aristotle and St. Thomas.

Thus it follows that in order to properly explain the relations between sciences and speculative philosophy, natural philosophy and metaphysics must be compared separately with the positive sciences.

Beginning, however, with metaphysics, it would appear from what has been said that it is specifically distinct from the positive sciences and mathematics, and consequently formally independent of sensible experience and numbers. For metaphysical truth, although it has its origin in the senses, as does all other human cognition, is never formally resolved in them. Thus all of metaphysics ought to be and can be treated without any formal dependence upon the mathematical or positive sciences. These sciences, nevertheless, can be most useful and indeed even necessary to metaphysics for various reasons; first, they enable metaphysical questions to be more fully understood and explained because man is not able to know anything except through sensible things; second, the special nature of certain problems, such as the classification of the sciences, the defence of their objects, the demonstration of the existence of God, the causes, etc., requires a sufficient knowledge of the experimental sciences to be perfectly elucidated; third, those sciences aid in understanding and evaluating philosophic systems which thrive outside scholasticism today and which rest upon the positive and mathematical sciences and are expressed in their terms and concepts; fourth, scholastic philosophy cannot be rendered intelligible to learned moderns except by clothing it in scientific garb and pointing out its conformity with scientific reality.

Common experience does not suffice to fulfill all these needs in metaphysics. It is also necessary to consider scientific experience and mathematical progress. If metaphysicians were to know the positive sciences and mathematics more thoroughly, they would be able to instill much more beauty into it because by means of this knowledge the traditional theses would be illumined and perfected.

Nevertheless, we repeat again that this dependence of metaphysics upon the other sciences is not intrinsic and formal, but material or ministerial. Metaphysics, as a sort of queen, can by its own right make judgments about all things and can ask or rather demand that all the other sciences furnish her with everything necessary to fulfill her own goals. When metaphysics must use those things which are taught by the other sciences, it does not serve them as a handmaid but commands them as a queen. There must be caution, however, lest it be thought that metaphysics cannot attain all its objectives without the necessity of consulting the other sciences.

Many other things might be added about the utility of the sciences to metaphysics but we do not wish to dwell on them any longer because the question principally concerns the relationship between natural philosophy and the empirical sciences; and so we proceed immediately to it: Is natural philosophy, as the moderns understand it, namely insofar as it is restricted to the ultimate causes of sensible things, a science specifically distinct from the positive sciences; or does it differ only accidentally from them as a part of one and the same science?

From what has been said it is evident that the common opinion among modern scholastics is that natural philosophy and the positive sciences differ specifically. For the former is in the philosophical order and the latter is in the scientific; and these orders of knowledge must be specifically distinguished. Furthermore, they say that natural philosophy seeks ultimate or 'propter quid' causes or substances of sensible things, or noumena or reality per se intelligible only; that it uses 'propter quid' demonstrations; that it is principally deductive; that in its essence it does not need scientific experience; and that it is 'perfect science.'

On the other hand, they say that the positive sciences seek only proximate or 'quia' causes, or accidents, or phenomena, or immediate sensible reality; use 'quia' demonstrations; are principally inductive, need absolute experience perfected by instruments, and are and are called 'imperfect' sciences.

If, therefore, natural philosophy and science have altogether distinct objects and methods, they necessarily must be distinct. For they are two absolutely diverse interpretations and considerations of sensible nature.

However, the solution which we think is genuine and which conforms to the Aristotelian-Albertine philosophy, is extremely complex. Its root is found in the twofold manner of considering and knowing motion and other sensible qualities of natural things. This twofold procedure in knowing things was already known by the earlier writers in their wisdom.

These qualities can be considered under either a purely qualitative or a quantitative aspect. In the first case they are considered formally insofar as they are qualities which in themselves affect bodies in various ways, and insofar as they are perceived immediately by the senses and through them can be known by the intelligence by abstraction from the individual alone or without the aid of the formal light of mathematics. No one can deny that in this way much is known about these accidents. There are certain things which are known only under this qualitative aspect, such as the essence of any accident and its relations with a corporeal substance. We say

without the formal aid of mathematics, because the knowability of these accidents is not changed if in some case the light of mathematics is materially and secondarily employed.

We affirm that this scientific knowledge of accidents is of the same species as the knowledge of the substances that they affect. Consequently in this case, natural philosophy, understood in the modern sense, whose object is these substances, and the positive sciences, insofar as they consider accidents under a qualitative aspect, are not specifically but only accidentally distinguished, as different chapters or tracts of one and the same science.

The reason is evident. Sciences, as all concede, are constituted through objects formally considered. But in speculative sciences the formality of the object, according as it is knowable, is constituted through a determined grade of abstraction and which is known in the thing first and 'per se'. But in scholastic terminology, these two things are called respectively the formal object 'quo' and 'quod'.

However, these objects, namely, the grade of abstraction and the formality first known, are the same in natural philoosphy and in the positive sciences considered qualitatively; they are motion and abstraction from singular matter. Not only singular substances but also their qualities are known under the aspect of motion and by abstraction from singular matter. This is evident from the following examples: Beginning from the objects of experimental science, we see that sound is conceived as the vibration of bodies; heat as the disordered agitation of molecules; light, electricity, and other radiant energies as periodic variations of ether undulation or of the electro-magnetic field; powers or energies as the causes of all change; mass or inertia as a certain resistance to motion; the three principle states of bodies, namely solid, liquid, and gaseous, are distinguished according to the diverse relation these bodies have to motion; specific differences among bodies are determined through their diverse operations or motions produced or suffered; nutrition, assimilation, generation, sensation, affections, cognitions, and other biological phenomena are conceived and explained as motions; and finally all laws which are the principle object of science, are understood in relation to motion; such are the laws of gravitation, chemical combination, crystallization, biology, etc. All those laws, either physical, physiological, or psychical, which are attained by human reason from qualitatively considered objects are attained through motion and abstraction from singular matter alone.

The same holds true for the proper objects of matural philosophy. The notion of nature, the foundation of the whole of this philosophy, is defined and explained through sensible motion abstracted from singular matter only. Consequently the pecularity of any sensible thing must be determined and distinguished through its particular mode of relation in respect to this motion. The hylomorphic composition of bodies is known to us through generation and corruption. The concepts of the infinite, place, time, space, life, energy, etc., are arrived at through a similar consideration of motion. The very nature of the hu man soul and its faculties and its relations with the body become evident through operations which are always connected with a certain sensible change. Thus in these sciences to wish to know something in another way is to wish the impossible.

Therefore the formal object of knowledge is the same in natural philosophy and the positive sciences considered qualitatively, and thus they cannot be considered as specifically distinct, Cosmology, rational psychology, physics, chemistry, crystallography, botany, physiology, experimental psychology and the other positive sciences, insofar as they consider their object only under a qualitative aspect, are nothing else than different tracts or integral parts of one and the same specific science which cannot be divided into other inferior sciences.

No one should wonder how such divergent objects can pertain to the same science. Those who do, forget that sciences are not constituted nor specified by objects considered materially, but by objects considered formally. This great diversity among the objects of these sciences is material, insofar as these objects are things, not formal, i.e., insofar as they are knowable. Considered in this formal manner, there is no essential difference among them. Therefore, there should be no surprise if they are placed in the same science. If it were permissible to confirm physics through theological principles, we would reply that there also exists a great remoteness between the mystery of the Most Holy Trinity and the motion of Tobias' dog's tail. And yet, not withsta nding this distance, we place both of these in the same science of theology, since both are known by the same light of divine revelation.

It should be well noted that abstraction from singular matter is the minimum essential of any science, and within this grade of abstraction there cannot be other formally diverse grades. A body and a living thing, a living thing an d a man, a man an d a dog, a substance and an accident, are not abstracted from matter in the same way. This diversity occurs either from total abstraction, from which genera and species arise, or from a distinction of form in respect to the same qualities of the matter; but not, however, from formal abstraction from which alone the specific diversity of sciences is taken. All t ese things as the object of science depend upon the same characteristics of the matter, namely sensible qualities and quantity; and all abstract from the same characteristic of it, namely from individuation. Furthermore, insofar as they are knowable they are identical, and necessarily constitute one and the same object of science.

Therefore the earlier philosophers proceded in the best possible manner when they considered the ultimate and proximate causes of natural things in one science only. The fact that these men defended the specific unity of these causes must not be attributed to ignorance or imperfect knowledge of these things, but to their intrinsic nature which they saw had the same knowability. The truth and the exactitude of this doctrine is expecially manifest if we are cognizant of the fact that the earlier writers considered sensible accidents almost exclusively in a qualitative sense as two early principal physical theories, namely the theory of four elements and the theory of four qualities, sufficiently demonstrate.

Later progress does not indicate that this concept must be abandoned,for, as we have already seen, the formal knowability in all these things is the same today as it was in former times. Therefore, this doctrine still stands, and must firmly adheredto.

That this is the true traditional philosophy is substantiated explicitly in several texts of the earlier doctors, expecially in the texts of the most brilliant St. Albert the Great, who perhaps was the first to develop perfectly and profoundly this doctrine of Aristotle. Explaining the essence of natural science and its intended end in his commentary on the physics of Aristotle, he speaks thus:

> But physical things, to which we turn our attention here, are conceived entirely materially in regard to existence and definition. For if anyone defines the air or an element, or something made from the elements, such as a heart or bronze, he cannot difine it without matter. Indeed, it is the nature of a rounded heavenly body to be moved circularly; similarly, an element is the subject of motion and of change and is so defined; likewise those things which are composed of elements are defined materially. It is because of this that all natural things have natural definitions; for they are defined through their sensible matter and subject, since the essential

notes of a natural thing which must be placed in the definition are such that they are subordinated to motion and sensible qualities. (4)

And commenting on the Aristotelian text in which the differences between mathematics and physics are treated, he says:

Another who is a physicist considers the being of quantified things constituted from sensible composites whose being is mobile; and he rightly concludes to concepts which include both motion and matter, for such are the natural forms of water and of man; and of their qualities, which are hot and cold, and white and black. (5)

And a little after, he says:

Flesh, however, and bones which are physical subjects, and likewise, n hot and cold, rare and dense, which qualities predicated of these subjects are defined through those things which are the principles of their motion an and through those things which are the principles of the combination of their matter from sensible qualities. They are not defined abstractly as a curve is, but rather they include sensible matter, such as snub-nose includes the nose in tis definition; for the snub is the curve of the nose just as the lameness is a curvature of the shin bone. (5)

It must be noted how St. Albert explicitly puts air and other elements and things composed of these such as the mouth, heart, flesh, water, and man; and their qualities, such as hot, cold, white, black, rare, and dense, in the same science, that is, in natural philosophy. Yet these things are objects which according to present day classification pertain to physics, chemistry, the science of heat, and psychology. The reason whyythese things must be considered in natural philosophy is that they have the same knowability or dependence upon matter. For he most diligently explains and proves how all these things abstract from individual matter and must be conceived with sensible matter and therefore are defined and understood in the same manner.

St. Albert speaks with equal clarity when treating the formal subject of natural philosophy:

A natural body as a universal is the subject of natural philosophy, and this or that physical body (namely, mobile as regards formoor place), or a simple or composed body falls underthe consideration of some part of natural science. (6)

And a little further:

In order that we might know the endtowards which we tend in natural science and when we have all its parts and when we do not have them, and which of them are lacking and which are not, we wish to show from the definition of the subject, which we have introduced, all the divisions of natural science. We say, therefore, that since "mobile body" is the subject, it has to be considered in natural science according to all its differences and divisions. Its first division is that it can be considered in itself, both absolutely or simply and universally, or restricted by matter. Considered absolutely in itself, both simply and uviversally, it is treated in the book which is called "de auditu physico".

> But a mobile body restricted by matter is first divided according to the difference of matter; for this is a simple body or a mixed body composed from simple things. (7)

Afterwards he accurately enumerates all the proper subjects of the experimental sciences as truly parts of natural philosophy.

The question therefore cannot be expressed or solved with greater clarity. He says expressly that he intends to enumerate all the parts of natural science, in order that it might be known when this science is possessed fully, and which things treated may truly be its parts, and w ich are not part of it. And among these parts which necessarily pertain to natural philosophy and without which the science cannot be had perfectly, he lists all those things which are considered today as proper objects of the experimental sciences. And he saysexplicitly that the reason for this assertion is that all these things have the same formal subject, namely a mobile body abstracted from singular matter alone, under which they are regarded as parts or integral divisions. Therefore, since he declares so manifestly the cause of this specific identification, no one can interpret it in any other way stating that St. Albert had so conceived it because of the imperfect state of the sciences. Furthermore, if the earlier authors had included the empirical sciences in natural philosophy, not becauseof their intrinsic nature, but because of their imperfection; it would truly be something to wonder at; indeed itiwould be inexplicable that whenever they wished to illustrate the formal subject of natural philosophy, they always with a certain predilection took examples from the positive sciences.

Perhaps someone may wish to object that when the earlier authors united in the same science natural philosophy taken in the modern sense and the other positive sciences they referred to generic unity not to a specific unity indivisible into other inferior sciences. These sciences might, therefore, agree in a certain common knowability, for which reason they could be said to pertain to the same science generically taken; and this science would be the natural philosophy of the ancients, which was afterwards divided into other particular sciences according to knowabilities specifically diverse among themselves and contained under that general heading. These sciences, namely, cosmology, rational psychology, physics, chemistry, biology, etc., all agree in the same genus of knowability but not in the same ultimate species which is called the 'atoma' species. Whence a certain outstanding modern author lately urged that abstraction in physical things be more profoundly investigated, because perhaps the more perfect knowledge we have of these things today allows and compels us to distinguish diverse abstractions and consequently diverse knowabilities in these same sciences, which the earlier authors because of the imperfect knowledge they had of these things were not capable of knowing. And in this manner the question would be solved, preserving the honor of the earlier authors and placating the moderns.

There is no lack among the earlier writers of outstanding men who defended such an opinion openly. Among them must be numbered: Capreolus, Cajetan, and Soncinas; for they divided natural philosophy into as many sciences as there are diverse tracts written by Aristotle.

Certain words of St. Albert, by which he distinguishes the manifold ways of depending upon matter in t ose physical things, seem to favor this interpretation. He says:

> Physical things are conceived inirelation to matter in these different ways; for certain of these things designate a determined subject and mat-

> ter in their definition, as snub and lameness, and a man and an ass. Certain of these are more elevated more and designate a subject in a determined genus and not in a species, such as flesh, and mouth, and marrow, and things of this sort. Certain of these, still more general, directly seek a subject or a composite which is distinguishable by contrariety, as white and black, hot and cold, rare and dense, and things of this sort. All these, nevertheless, are less abstract than mathematical things; because nothing treated in mathematics designates in its definition a subject distinguished by a sensible quality, but so designates the subject in its definition that the subject becomes a mathematical property. This subject becomes the imaginable or intelligible only. (8)

In these words he openly teaches that there occur in physical things diverse grades of dependence upon matter, whence, according to the Holy Doctor, diverse knowabilities and sciences can be distinguished inithese things.

In answer to these opinions it must be said that it is already sufficiently evident from our treatment that such an interpretation should in no way be admitted. But in order that it might appear more clear, it should be remembered again that the abstraction that makes things knowable and the sciences distinguishable specifically is objective formal abstraction. The diversity in this abstraction is taken from the diverse dependence upon the proper conditions of matter, as is evident in those previously indicated three grades by which metaphysics, mathematics and natural philosophy are distinguished. Moreover, today as inearlier times, from one point of view, abstraction from matter insofar as it is the root of individuation is the fundamental abstraction absolutely indispensable for anything to be rendered knowable; from another point of view, any sensible thing insofar as it is sensible, whether substance or accident, or a remote or proximate cause, it attainable only by this abstraction from individual matter, and it cannot be known as sensible if a greater abstraction is made. Therefore within this grade of abstraction other grades specifically distinct cannot occur and thus things which are made knowable by this grade of abstraction could not in earlier times and cannot today constitute diverse specific sciences.

The opinion, therefore, of Capreolus, Cajetan, and Socinas, even though they are great authorities, must without a doubt be rejected. Furthermore, it is necessary that we turn our attention to the fact that their opinion completely differs from the opinion of the moderns; for they at no time divided the proximate and ultimate causes of sensible things, or substances and accidents into diverse sciences, but in every special science they considered all the causes and both substances and accidents which they had assigned to this science as an object. Whence it follows that these authors cannot be selected to justify the modern division in philosophy and the sciences. And it is with this division that we are principally concerned.

Neither do the words quoted from St. Albert prove otherwise. The threefold conception of natural things with matter signifies a diverse total abstraction, but not a formal abstraction. Whence these words more profoundly and more accurately considered seem rather to exclude the possibility of diverse abstractions in physical things which would cause diverse knowability and science. For although this triple dependence upon matter is proposed, in the same text it is mentioned that physical things insofar as they are intelligible all have equal dependence, because all are equally defined and understood. Thus, the definition of manis not by knowability formally distinct from the definition of flesh or white.

Furthermore, these very natures of things in which the Holy Doctor places that threefold mode of depending upon matter demonstrate that he is not speaking of the abstraction which specifies science. For it is evident that the consideration of man, flesh, and white, cannot constitute three specifically distinct sciences; which, nevertheless, would have to be affirmed if these words were understood in the sense of the proposed objection. Whence, neither here nor in any other place does St. Albert give the slightest indication about the possibility of the division of natural philosophy into other inferior sciences. It would be truly astonishing if he were to have thought such a division possible; for he diligently inquires and explains in many places how natural science may be diversified from metaphysics, mathematics, ethics, the intermediate sciences, and medicine, but he never mentions this present day division.

It is true that motion and the other sensible qualities an be considered and known by another method, namely under the quantative aspect. Quantity is the first accident of sensible substances and through its disposition the other accidents can exist in a substance. Therefore, motion and sensible qualities, with respect to many things, participate in the nature and conditions of quantity. Whence, it is not surprising that many of these sensible qualities can be known by the application of the mathematical method.

The knowledge of natural things acquired by the mathematical method constitutes what the earlier philosophers called the intermediate sciences and the moderns the physico-mathematical sciences. The former considered them as subalternate to mathematics; but the latter, although they may not know their name, do not consider them to be otherwise essentially, since they affirm that their scientific form is obtained through mathematical concepts.

Now Aristotle lists three especially unique or almost unique sciences, namely music, perspective and astrology, which later interpreters and scholatic philosophers mention.[9] But St. Albert, always surpassing the others in the natural sciences, in the commentary on these texts of Aristotle adds three others, namely, the science of weights, the scince 'de ingeniis,' and the science of 'sphera mota,' and indicates that there are yet others of the same nature. Thus he says in the Physics:

> Those sciences which according to the consideration of their subject more approach physics than mathematics demonstrate this distinction of natural philosophy from mathematics, and its dependence upon sensible matter. Such are the sciences of perspective, harmony, astrology, the science of weights, the science 'de ingeniis,' the science 'de mota sphera,' and others of the same kind; for perspective, according to the subjects of its inquiries, is about the light ray, which is a visual and physical line. Harmony, which is music, is about numbered times and tones in sounds which are also physical. Astrology is about a body perfected by a natural form and terminated by a natural field which is the sky. The science of weights, however, is about weight determined according to the proportion between motion and weight. And the science 'de ingeniis' concerns the proportion between velocity and the thrust which arises from a determined weight: so if the weight of one 'marcha' only moves it (something) an hour, the weight of two 'marcha' will move it in half an hour. But the science of 'mota sphera' considers the proportion of position and the distance of mobiles of such and such a velocity, which is compared to a body of lesser or greater speed. All these sciences according to their consideration of

> their objects are related to geometry in a contrary fashion. Geometry has as its subject a line which is physical in being, yet does not consider it as a physical being, but abstracts in the way which we have mentioned above. Perspective, however, considers a line which is mathematical. Yet it does not abstract it as a mathematician does, but considers it as it occurs in physical things, as in light or sight, and seeks mathematical properties of it.[10]

Among the earlier authors all these sciences were most imperfect, as was also the medium or mathematical instrument used to investigate and build them up. Therefore, it is not surprising that they knew little about physical things in this way. However, when the mathematical sciences received a new light and a greater perfection, both through analytical geometry created by Descartes and through infinitesimal calculus begun by Leibnitz and Newton and wonderfully perfected and amplified by later mathematicians, the physico-mathematical sciences also made new and unheard advances. Modern scientists, led and illuminated by that most powerful light which the most refulgent sun of modern day mathematics shines down upon physical things, have developed these sciences to such an increment and perfection, that there is no part of physics which is not subjected to and illuminated by this method; and thus certain of these sciences seem to lose somewhat of their physical and experimental nature and seem to approximate mathematics in perfection. The motions of bodies generically and specifically, the most intricate motions of the stars, sound, light, heat, electricity, magnetism, gravity, elasticity, affinity, spectral lines, and other physical and chemical qualities, through the application of the mathematical method, show forth with a new light and exhibit to us very many qualities which by other methods could only be known either obscurely or not at all. The most fertile, the most beautiful, the most magnificent fruits of this investigation are: mechanics with all its parts (kinematics, statics, dynamics, mechanics of solids, hydrostatics and hydrodynamics, aerostatics and aerodynamics), celestial mechanics, acoustics, thermology, optics, electrodynamics, many expositions of chemical theories, tracts on elasticity according to the method of Poincare, and other similar things. The intermediate sciences of the earlier writers compared with these appear as the most imperfect roots. The music, perspective, and astrology of Aristotle are very deficient treatments of acoustics , optics, and celestial mechanics. And the science of weights, 'de ingeniis,' and 'de mota sphera,' named by St. Albert, contemplating this imperfection and anticipating the new sciences said, "All the demonstrative sciences have not yet been discovered, but many still remain to be found."[11]

But although knowlddge of this kind or the state of the sciences was very undeveloped among the earlier authors, they knew and expounded their nature perfectly. For they already taught openly that these natural sciences, considered as illuminated by mathematical principles, were specifically diverse from natural philosophy. Modern advances confirm this concept more fully and clearly. It remains only to extend that which the earlier writers taught about these most imperfect sciences to the immense field of modern physico-mathematical sciences. These sciences must without a doubt be specifically distinguished from natural philosophy understood in the modern sense and from the positive sciences considered qualitatively. For in these physico-mathematical sciences the knowability or formal object is not motion as it is manifested solely by abstraction from singular matter, as in natural philosophy, but sensible motion illuminated by mathematical abstraction. The object of these sciences is still motion and sensible qualitiesnot, however, considered only insofar as they are sensible but rather according as they, partaking of the characteristics of quantity, are made

measurable and consequently attainable by the principles of mathematics. Therefore, although the objects of both materially considered are the same, formlly considered they are diverse.

This conclusion, already certain in regard to the older intermediat sciences, is still more evident and certain when applied to the modern physico-mathematical sciences. Dynamics infers all the relations among forces and the motions produced by these forces by a strictly mathematical consideration, using the principles of inertia, acceleration and relativity, expressed in mathematical formulae. Similarly, celsetial mechanics deduces all the laws of heavenly bodies from the law of gravitation; thermology shows all the properties of heat from the principles of equivalence and entropy alone; optics explains very may phenomena of light through the principles of Fermat and Huygens; electromagnetics demonstrates the properties of elecrticity and magnetism from the principles contained in the four equations of Maxwell; and from the principle for mulated in the fundamental equation of the aeriform state all other laws of the same state are extracted. These and the remaining parts of physics and chemistry are principally considered by means of this method in may modern tracts. Amont others the following are seen to develop this theme:

> NEWTON, Philosophiae naturalsis principia mathematica; - Optica; LAPLACE, Mecanique celsete; POINCARE, HENRI, Thermodynamique; -Electricite et Optique; -Lecons sur le theorie de l'elasticite; -Theorie analytiquede la propagation de la calour; -Lecons sur la theorie mathmatique de la lumiere; BECQUEREL, Cours de physique; -Les principe de la relativite at la theorie de la gravitation; LEVI-VIVITA, Lezone de meccanica razionale; - Fondamenti di meccanica relativistica; NERNST, Traite de Chimie generale; CHWOLSON, Traite de Physique; CABRERA BIAS, Principio de relatividad; -El atomo y sus propriedades electromagneticas; ECHEGARAY, Conferencias de Fisica matematica; JAGER, Fisca teorica; JEANS, Dynamical theorie of Cases; WEYD, Raum, Zeit, Materie; SOMMERFELD, Atombauund Spektrallinien; BOLTZMANN, Verlesungen uper die Gastheorie; BLOCH, La theorie cinetique dez gaz; LLRENTZ, The theory of Electrons; BLOCHE, Precis d'electricite theorique; MAXWELL, Traite d'electricite et du magnetisme; GIANGRANCESCHI, La Fisca dei corpuscoli; DRUDE, Optica; EINSTIEN, Ueber die speciellе und die allgemeine Relativistatstheorie; VON LAUE Die Relativitatstheorie; CASTELFRANCHI, Fisica Moderna.

In these and similar cases there is no doubt that the positive sciences are specifically distinct from natural philosophy whether the latter is restricted to ultimat causes of sensible things or is extended to all causes. However, the truly formal cause of this specific distinction is not the diversity between ultimate and proximate causes, substances and accidents, 'quia' and 'propter quid' demonstrations, inductive and deductive method, common and scientific experience, not that between a greater or lesser perfection; but is the distinction alone among the diverse grades of abstraction from matter, in regard to the manner of considering physical things. From this principle alone the specification of knowledge in speculative matters must always ultimately be taken. We have often said that natural philosophy is powerful soley by abstraction from singular matter, but that the physico-mathematical sciences participate, in a certain way, in mathematical abstraction by whose illumination diffused into natural things, everything which is treated by these sciences is known and explained in detail. If the earlier authors specifically distinguished these most imperfect intermediate sciences from natural philosophy for this reason, then, it is more reasonable and just to affirm the same distinction today

about the physico-mathematical sciences, since they partake of the nature of mathematics more perfectly. Therefore, even though their object is still natural and sensible mobile being, they are not purely natural sciences. The earlier authors classified them with mathematics.

Nevertheless, they are not to be confounded with mathematics specifically; since their object remains essentially natural and sensible; and thus they are never able to attain a perfect mathematical nature even though Plato, Descartes, and many moderns have thought otherwise. That great hope, conceived because of the extraordinary results obtained in recent years, now begins to fail and most certainly will never be fulfilled. For in these sciences quantitative relations are never absolutely sought, as in arithmetic and geometry, but only insofar as they occur in this or that sensible matter. This matter, namely sound, light, electricity, is governed by certain laws in a certain way and cannot be known 'a priori' by mathematical abstraction alone. For these laws depend upon the special nature of the sensible matter in question which we cannot know without some formal intervention of scientific experience. Therefore, the first task is to consult sensible experience so that we might know what principles and laws of mathematics must be applied and how they must be applied in some determined matter. This formal intervening of experience appears in the very first principles of these sciences, indeed, these principles never would have been found or at least never would have been acknowledged without experimental confirmation, as history and their analysis demonstrate.

Whence these sciences do not perfectly possess the clarity and certitude of mathematics. For it is not evident nor certain with the clarity and certitude of mathematics that these mathematical principles exactly express the quantitative reality contained in the sensible matter to which they are referred, as do the principles of arithmetic and geometry in regard to absolute mathematical reality. Wherefore, these things must often be corrected and formulated in a new manner according to later and more perfect experience in order that they might more easily and truly conform to sensible reality.

The same thing must evidently be asserted about the conclusions deduced from such principles by mathematical reasoning; for even if this reasoning cannot be questioned, the conclusions cannot exceed the certitude and clearness of the principles. Therefore, they also ought to be confirmed by experience. With good reason the wiser physicists always precede in this manner.

Therefore, along with the earlier writers we should consider these sciences as <u>intermediate</u> between pure mathematics and natural science. Because these intermediate sciences are acquired under the light of mathematics, they are superior in regard to clarity, certitude, and deduction to the purely natural sciences, including cosmology and psychology. Nevertheless, since this mathematical light in them is not pure but is restricted to special sensible matter and is diminished and obscured by it, they do not exactly attain the clarity, certitude, and perfection of mathematics.

On the basis of thes suppositions, it will be easy to see how many assertions which are commonly held in modern scholastic philosophy and taught as true doctrine and as altogether tenable and conformable to genuine traditional philosophy, but which rather are wholly foreign to this philosophy and often contrary to it, must be corrected or totally rejected. And because many opposite opinions rest upon these assertions, we are forced to say a few words about them.

First, the most common way od distinguishing philosophy and science according to ultimate and proximate causes, or substance and accidents, is entirely deficient for specific distinction. For what reason, or in what sense, should the ultimate and proximate causes be considered as formally distinct objects of knowledge? Rather, a more accurate analysis of their relations undoubtedly demonstrates the contrary. The proximate cause is the means to knowledge of the remote cause, and this knowledge of the remote cause is the perfection and complement of the knowledge of the proximate cause. In a similar way, substance and sensible accidents are related among themselves; substances cannot be known except through accidents, and knowledge of accidents is not perfected without knowledge of the substance. This mutual help and this intrinsic mutual ldpeendence in knowledge manifest that it is absurd to separate science and philosophy into necessarily distinct sciences. This is more fully confirmed if we consider that in these proximate and ultimate causes, in substance and accidents, noumena and phenomena, there is the same abstraction from matter. All these fall under the same formal ratio of knowledge and all constitute one and the same science.

For the fact that something takes on the ratio of substance or accident of of proximate or remote cause is purely material in respect to the formal specification of science. Two things which have the same formal and objective abstraction must always be placed in the same science, although one may be a proximate cause and the other a remote cause. On the other hand, if these two things have a distinct formal objective abstraction, although both may be proximate or remote causes, they must be considered in different sciences. Furthermore, if the difference between the proximate and remote cause would suffice to generate diverse sciences, then 'a fortiori' the difference between the four principle causes, which is a greater distinction, would suffice to generate distinct sciences. But this would be to fall into the error, already refuted by Aristotle, made by certain ancient thinkers who divided natural philosophy into two species, of which one treated of matter, and the other of form. The matter and form of natural things, says St. Albert, "are for the consideration of one particular science, which considers the mobile body insofar as it is mobile; this, however, is physics; therefore it is the business of physics to consider matter and form in this way."[12]

Precisely the same thing must be asserted about ultimate and proximate causes.

All these authors in this argument and in subsequent ones, labor under a very serious equivocation; they do not distinguish well the formal and material object. All explicitly acknowledge that sciences must be distinguished by the for-object, but in practice, because they do not know or because they forget in what the formality of an object, insofar as it is knowable, properly consists, they often distinguish sciences by objects considered materially. Whence they deny in deeds what they affirm in words.

Many other confusions lie hidden in these notions, but that which we have mentioned suffices to demonstrate that a specific division cannot be inferred from them.

In the second method of distinguisheing, by 'propter quid' and 'quia' demonstrations, there are found errors neither small nor few in number. First, it is necessary to note that even if these two demonstrations differ specifically, they nevertheless do not generate two specifically distinct sciences, as all

scholastics acknowledge; although later on, the moderns forget this when they treat of this question. Likewise these two demonstrations, when they are applied to physical things, are found in the same grade of abstraction; whence the science caused by them is necessarily one specifically.

Furthermore, in natural philosophy itself, understood in the modern sense, 'quia' demonstrations must often be employed. For we cannot arrive at knowledge of the essences of sensible things except 'a posteriori,' through their effects or operations. The hylomorphic composition of bodies, the nature of motion, of place, of life and the soul, are found by experimental induction. Also, all the principles of natural philosophy depend originally and formally upon experience and are at length formally verified or resolved into experience. Wherefore it is necessary for such demonstrations to occur frequently in natural philosophy. And if from the object of natural philosophy many properties are deduced, it must be noted that this is accomplished in the other experimental sciences, and sometimes more perfectly.

Likewise it is altogether false that in the positive sciences, only the 'quia' demonstration is employed, as modern scholastics commonly seem to think and to teach, as if 'propter quid' demonstration and 'propter quid' causes of natural things were found only in natural philosophy, and only 'quia' causes were found in the positive sciences.

If, however, the 'propter quid' cause is the proper and immediate cause of the thing or of the phenomenon which is examined, as the earlier and the modern scholastics teach, most certainly very many of these causes are sought and demonstrated in the positive sciences, and not in natural philosophy. Thus, the 'propter quid' cause of the eclipses of the sun is the interposition of the moon between the sun and the earth; and the 'propter quid' cause of the expansion of bodies by means of heat is the increase of internal repulsive energy between molecules; the 'propter quid' cause of the floating or sinking of bodies in fluids is Archimedes' principle; the 'propter quid' cause of the ascension and flight of an airplane in the atmosphere is the resistance of the air and the increase of this resistance according to velocity; the 'propter quid' cause of the falling of a stone is gravity; the 'propter quid' cause of the variation in a barometric column is the atmospheric pressure and its variation; the 'propter quid' cause of the combustion of wood is the affinity and combination between oxygen and cargon; the 'propter quid' cause of the succession of day and night and of the seasons is the rotation of the earth on its axis and its motion in an orbit around the sun; the 'propter quid' cause why trees render the atmosphere healthy is the power of chlorophyll to separate, in conjunction with the light of the sun, carbon from anhydrous carbonic oxygen by absorbing the carbon and liberating free oxygen; the 'propter quid' cause of the harmful action of sulphuric acit on organic textures, rendering them black, is its great affinity with water, by which it takes oxygen and hydorgen from the organic material and leaves only carbon; the 'propter quid' cause of consumption is the Koch baccilus; the 'propter quid' cause why allotropic salts cure or heal certain infirmities of the eyes is the property which they have of dilating the pupil, etc. And where are these 'propter quid' causes considered and shown, but in the positive sciences, namely in physics, chemistry, astronomy, botany, psychology, etc?

And what is the purpose of almost all theories and hypotheses, but to expose the true and intimate explanation of phenomena? The atomic theory shows the 'propter quid' cause of chemical combinations; the kinetic theory applied to

the gaseous state explains all the laws of this state; the theory of gravitation gives the reason for the motions of celestial bodies; the wave theory of light manifests the profound nature of diffraction, interference, and polarization; the Bohr atom proposes to explain specific spectal lines os simple bodies; and so on. Indeed this is denied by many philosophers and modern scientists according to whom the end off science is not to show the causes why things are, but to show how things succeed each other in space and time. Neverhtelss, those who so speak, either deny the principle of causality or have a false concept of it. However with such men we do not dispute at this time.

But for those, who admit with Aristotle that the end and essence of science is the investigation and knowledge of causes, the above examples more than sufficiently demonstrate that the positive sciences really and truly use the 'propter quid' demonstration and seek and manifest 'propter quid' causes.

How, therefore, can there be such a common error in something so evident? Many reasons can certainly be assigned. The first of which seems to be the identification of the 'propter quid' cause with the absolutely ultimate cause in a determined order, in this case, with the substantial essences of mobile things. But this is without doubt false in Aristotelian philosophy. These essences are most certainly the ultimate 'propter quid' causes of all things which emerge in the sensible world, but in noway are they the only and true 'propter quid' causes of all phenomena, because they are not the proper and immediate causes of all things. For the proper and immediate causes of many things are found in the accidents themselves as they are considered by the positive sciences and mathematics. Whence, in respect to these phenomena, substances either are 'quia' causes, or at lo ast, are not 'propter quid' causes in the proper sense. If only substances were 'propter quid' causes, it would also have to be denied that 'propter quid' demonstrations could occur in mathematics, and this is evidently false, for all these sciences consider mathematics as the exemplar of 'propter quid' science.

It can be demonstrated by innumerable examples that this is the genuine doctrine of the earlier authors, that not only substances or ultimate causes of sensible things are 'propter quid' causes, but also those mentioned above and others similar to them. Thus the nearness ofplanets is called by Aristotle and his followers the 'propter quid' cause why they do not shine as the fixed stars most remote from us; the roundness of the moon is the 'propter quid' cause why, as the light of the sun increases, the moon waxes spherically; the lack of angles and a greater distance between the sides of a circular figure is the 'propter quid' cause why circular wounds heal slower and with more difficulty; the repercusion of the motion produced gy sound in the air is the 'propter quid' cause of the echo; the reflection of rays of light in the raindrops or in a mirrior is the 'propter quid' cause of the rainbow or of the apparent image in a mirror; the 'propter quid' cause of the Nile's rising when the end of the month approaches is the humidity near the end of the month; and the 'propter quid' cause of this greater hujidity is given as the decreasing moon; the interposition of the earth between the sun and the moon is called the'propeter quid' cause of the eclipse of the moon; a good physical constitutuionis the'propter quid' cause of a long life; a little yellow bile in four legged beasts and a great lack of such humors in birds is the'propter quid' cause of the good constitution of these animals; the gravity of the earth is the 'propter q uid' cause of its rotundity; the motion of the heart is the 'propter quid' cause of the throbbing of blood vessels; walking is the efficient 'propter quid' cause of health; health is the final 'propter quid' cause of walking; and the efficient 'propter quid' cause of the war of the

Medes is the previous war by the Medes upon the people of Sardes and upon their allies and friends the Atheians, etc.

It is evident that if these are 'propter quid' causes, we can construct demonstrations of the same name with them. The following, drawn from Aristotle and related in this way by Soto, are such:

Stars which are near us do not shine; planets are near us; therefore planets do not shine; which indeed is 'propter quid' for to be near is the cause of not shining... Every round thing, as it is being illumined, waxes spherically; the moon is round: as the moon grows through the reception of light, it waxes spherically. (13)

And it should be especially noted that the examples cited above are not found accidentally or in some text foreign to this question, but almost all are found in the places where Aristotle explains the natures of the 'propter quid' cause and demonstration. (14)

Perhaps another cause of the error we have mentioned is the opinion that 'quia' sciences ought to use only 'quia' demonstrations and ought never to show the 'propter quid' cause, as if this function were reserved to other superior sciences. This also must be rejected in Aristotelian philosophy. For Aristotle calls certain sciences 'quia', not because they use only 'quia' demonstrations, but because they must take principles from other sciences in order to be able to demonstrate 'propter quid.' Certain sciences which are subalternate sciences of mathematics borrow these principles in all cases, e.g., music and perspective; certain other sciences use them only in some cases, e.g., surgery needs geometry to explain the more difficult healing of a circular wound; and likewise, to explain the rotundity of the earth, astronomy must have recourse to natural philosophy (according to ancient opinion). (15)

John of St. Thomas explains these statements in this way:

> The Philosopher does not say unqualifiedly that a subalternated science knows 'quia' as if he meant that every subalternated science knows 'quia', or what is worse, does he say that the subalternating science attains subalternated conclusions in its proper and determined matter, as some understood, but that the subalternated science attains its conclusions from effects and from quia demonstrations. However, the Philosopher does say that these sensible sciences, that is, those which descend down to sensible matter, properly know 'quia', that it pertains to mathematics to know propter quid, and that those sciences subalternated to mathematics which extend down to sensible things know 'quia', for they attain sensible things through induction and descend down to experience. If, however, those same sciences which know through experience wish to know propter quid, they must necessarily use principles taken from mathematics, i.e., from the subalternating science. Thus a surgeon says that circular wounds heal more slowly, first from daily experience; but if he wishes to give the proper reason for this, he must have recourse to geometry, which explains that a circular wound heals more difficultly because a circular figure lasks angles. However this proposition of Aristotle does not necessarily hold for every subalternated science, but only in that science which descends to sensible things. For nothing prevents such sciences from attaining sensible things in individuals, nor from using induction, which is to know with quia science. In order, however, to attain 'propter quid' knowledge, we must borrow principles from a higher science and apply them to the sensible matter of the science being treated. One should not understand that a subalternated science is said to know 'quia' the

> principles which it uses of the subalternating science; but one should understand that this science - not insofar as it is subalternated, but insofar as it is sensible and descends to sensible effects - also attains by experience itself and through 'quia' science the same conclusions which it is able to know from the principles of the subordinating science which are applied to its own matter. (16)

A science which would only demonstrate 'quia' would be so imperfect that it would scarcely merit the name of science.

In addition the phrase 'quia cause' must be completely rejected, for it seems to imply that the 'quia' demonstration always shows some cause of a things, and this is altogether false. Usually this method of demonstrating does not manifest a cause, but only the fact of existence, as when one proceeds from effects of a sign. Therefore the word 'quia' must not be understood causally as if it indicated the cause by which a thing is or exists, but must be understood only conjunctively as indicating the fact of existence (or that a thing exists) or the fact of the connection of a property with a subject, while, indeed, the proper cause of this existence or relationship with the subject still remains unknown. Hence if, because of what has been mentioned, "quia demonstration" must not be praised, a fortiori, the phrase "quia cause", in which the equivocation is explicitly allowed, must entirely be rejected. Dominic Soto, foreseeing this equivocation, again and again cautions that the word 'quia' must not be understood causally but conjunctively, and hence it would be better if "quia demonstration" were called "quod demonstration." For he says:

> About this name it should be noted, first that 'quia' demonstration received its name from the translation of Boethius, but should rather be called demonstration 'that this is so,' for the difference between demonstration 'quia' and 'propter quid' is that demonstration 'quia' shows that a things is, 'that this is so,' and does not render the cause of the fact, whereas demonstration 'propter quid' gives the cause of the fact. Therefore 'quia' should not be understood as expressing a cause, but as being a conjunction, sc., a demonstration 'that this is so,' or that this is true. Therefore by the Argyopile it is never called anything except a demonstration by which the existence itself is shown. (17)

And elsewhere:

> He (Aristotle) reduces those things which are sought to four, namely whether this is that particular thing, why this is that particular thing, whether this is in general, and what this is in general. Boethius changed these to 'propter quid' and 'quia,' etc., but that word 'quia' as we have often warned, occasions an equivocation and obscurity; Therefore it should not here be taken causally, or as a question about an effect, but it ought to be taken as a conjunction; for the question 'quia' does not ask anything except the truth of the proposition concerning "est, tertio adjacente," as whether a man is risible, which is evident from the words of Aristotle. (18)

From these things it is also openly inferred that natural philosophy and positive science cannot correctly be distinguished according to induction and deduction; for if both use 'propter quid' and 'quia' demonstrations, and both depend equally upon experience, as we shall immediately demonstrate, it follows that both are inductive and deductive, so that there is no difference or at least only a small difference between them in this respect. Are not all the principles or definitions of nat-

ural philosophy obtained through experimental induction just as in natural science? And conversely, do not the natural sciences demonstrate from their subjects and deduce many properties, as does natural philosophy? Moreover, against those things which are taught by the moderns, it must be said that when the natural sciences are expounded by a mathematical method, they are more deductive than cosmology and rational psychology. Thus in mechanics, optics and thermology, considered in this way, more deduction prevails than in natural philosophy. Only those who do not know or do not sufficiently consider the evolution and perfection of these sciences in conformity with mathematical perfection, can teach otherwise.

Nor should it be said that the natural sciences, from the fact that they depend upon sensible experience and treat of sensible accidents, are imperfect sciences, as if natural philosophy enjoyed a greater perfection and as if in it the essence of science was had more properly. For the natural sciences are truly sciences 'properly' and 'simply,' and are equal to natural philosophy, because they are parts of the same species, having the same formal definition, if qualitatively considered. Hence just as metaphysics when it treats of accidents is not more imperfect in specific definition than metaphysics when it treats of substances, so a science about sensible accidents should not be called more imperfect than a science about sensible substances. For the specific definition is equally fulfilled in all integral parts.

However if the positive sciences are considered and expounded mathematically, then they must be said to be more perfect than natural philosophy. Probably the false concept which scientists and non-scholastic philosophers have about science, always denying that its end is to seek and to manifest causes, contributes in no small way to all these errors of modern scholasticism.

Perhaps the gravest error of modern scholastics is that they think that natural philosophy understood in the present day sense as restricted to the ultimate causes of natural things, does not absolutely need scientific experience aided by instruments. They say that common experience suffices for natural philosophy, and scientific experience is absolutely necessary only in the experimental sciences; it is useful, indeed, to natural philosophy, but not altogether necessary, because all its principal theses can be defended and presented using common experience alone. And they say that the earlier writers, as Aristotle, St. Albert and St. Thomas, used only this common experience and they philosophized correctly.

Nevertheless, according to the truth, the spirit and the letter, this opinion is wholly opposed to the true Aristotelian-Scholastic philosophy. For the human reason cannot know essences of natural things 'a priori' through innate ideas, as Plato taught, nor through mathematical principles alone as Descartes maintained, nor through pure theoretic deduction from some principle or idea as Hegel, Schelling and Fichte postulated, nor through immediate intuition as Bergson stated, but rather through the way of sensible experience which although a humble, long and difficult way, is the only one naturally possible to the human reason. For substances must necessarily be known from sensible accidents, and these accidents must be known by the senses, so that the knowledge of these accidents acquired through sensible experience is not merely a condition but rather a true formal cause of the knowledge of substances. Therefore the knowledge of substances cannot exceed the truth, certitude, exactitude and perfection of the knowledge of sensible accidents. If the knowledge possessed of the sensible qualities and of everything proper to substance is true, the knowledge of the substance itself can also be true; but if the former is imperfect, inexact, uncertain or false, the latter also will necessarily be imperfect, inexact, uncertain or false.

Now true, certain, exact and perfect knowledge about sensible accidents cannot be obtained by common experience alone. For by this aid alone we cannot distinguish

the true from the false, the certain from the uncertain, and the exact from the inexact. Scientific esperience, according as it is employed in present day natural sciences, is absolutely required for this knowledge. Daily experience and the history of science and philosophy abundantly demonstrate this absolute necessity for scientific experience. Therefore scientific experience must also be said to be necessary in the same way for the knowledge of substance.

Therefore natural philosophy taken in the modern sense, whose principal formal object is these sensible substances, depends intrinsically and formally upon the natural sciences, whose object is sensible accidents, or upon experiennes had in them. The conclusion is illustrated and supported by the consideration of the principal questions. Hylomorphism, the principal thesis of this philosophy, cannot be proved or explained without those things which biology and chemistry and physics teach about the constitution of living and non-living bodies. No one can establish the true definition of nature, the fundament of the whole of natural philosophy, by common experience alone, due to the fact that this experience does not suffice to discriminate true natural motions from non-natural motions. And how can immobility of place, its specific difference, and the unity of time, its essential property (upon which depends the meaning by which space, time, and motion must absolutely or relatively be assigned) be understood, since it cannot be determined or elucidated unless those things which modern astronomy, equipped with very perfect instruments, teaches about the motion and the dispositions of bodies in the whole universe are first heard. Finally how will the philosopher be able to judge, on account of his office, the very many theories and scientific axioms, such as the atomic, kinetic, undulatory, heliocentric, relativistic, quantivistic theories, and the principles of inertia, conservation, energy, entropy, indetermination, etc., which are all intimately connected with the primary philosophical theses, so that whenever great difficulties may arise against the basic theses from the positive sciences, then new arguments from these same sciences may rise to confirm them?

Against the assertion that Aristotle, St. Albert and St. Thomas philosophized perfectly on the basis of common experience alone, it must be answered that it is not true that they used only common experience in their philosophical investigations. Aristotle sedulously employed many experiments and observations about natural things already made by earlier wise men or by himself, and he depends upon these things in constructing philosophical doctrine about natural things. St. Albert and St. Thomas not only considered the experiments and observations already made by Aristotle, but also many other and more perfect ones made by later philosophers, among whom Ptolemy, Galen, Avicenna and Averroes should especially be noted. And because of these observations or because of others made by themselves, sometimes they deviated from the teaching of Aristotle and sometimes they completed it. (19)

Indeed these experiments do not enjoy modern perfection but nevertheless are greatly distant from common experience, and certain of the experiments made by Galen about the nervous system, (20) would not be suitable for the moderns. If, however, those experiments which are most imperfect when compared with modern experiments, were excluded from truly scientific experiments, the same would hold for the observations made by Galileo with his imperfect telescope, if they are compared with those observations which are now made with the most perfect of telescopes on Mount Wilson.

Finally, because the ancient were not able to establish exact and more perfect experiments, they did not, therefore, always philosophize correctly, and they sometimes fell away from the truth in the principal theses. For instance, the examples produced for the confirmation of hylomorphism are sometimes false; similarly, the opinion about the incorruptability of celestial bodies compelled the ancients to propose two kinds of prime matter, thus greatly endangering the pure potentiality of

prime matter, which is the foundation of the solution of the celebrated dilemma of Parmenides and of the whole system of hylomorphism. The definitions of place and time demand a new interpretation in conformity with the new doctrines of the science of astronomy. The generation of certain living things from matter through a universal power communicated by separated intelligences to celestial bodies and transmitted in an unknown way to earth is entirely without foundation.

These few examples perfectly demonstrate how the earlier authors, although possessed of highest genius, were not always able to attain complete truth about natural things because of deficient experience; and consequently that dependence of natural philosophy upon the positive sciences is not just purely conditional or accidental or material, as in metaphysics, but absolute, intrinsic and formal. We do not at all deny that if common experience is understood not as the experience of a great number of people, but as reflexive experience, according as it was exercised by the earlier writers, even though imperfectly, because they lacked instruments, much can be known about natural things and de facto was known by the earlier authors; but at the same time we affirm that in respect to many essentials and properties of this philosophy, the aid of natural science is absolutely required. In which case natural philosophy is not the queen who commands these sciences, as does metaphysics, but in a certain way is a handmaid receiving from them and subject to them. And to free it from this servitude is to kill it.

Therefore the method of investigation of the natural philosopher and the method of the scientist are not opposed ways which have only common experience as a beginning in common, but are two parts of the same method, of which the first should be pursued by the scientist and the other by the philosopher. For (in the order of induction) where a scientist stops, there a philosopher begins, whereas in the order of deduction, the opposite is the case.

The division of human knowledge into philosophic and scientific as into two species necessarily and always distinct by the very nature of the objects and the formal independence of one from the other is an assertion which can be made in Platonic, Cartesian, Hegelian and Bergsonian philosophy, but cannot be made in Aristotelian or Albertine philosophy, or according to truth.

We conclude, therefore, that also in natural philosophy understood in the modern sense, namely insofar as it is restricted to the ultimate causes of sensible things, the opinion of St. Albert the Great is perfectly fulfilled: "He who neglects in nature the definitions of motion and of sense, prepares to deceive himself and others, since the 'whole of nature' is about sensibles and mobiles." (21)

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