



Abstraction from Matter (I)
Notes on St. Thomas's Prologue to the *Physics*

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Abstraction from Matter

NOTES ON ST. THOMAS'S PROLOGUE TO THE *PHYSICS**

In the prologue¹ to his exposition of Aristotle's *Physics*, St. Thomas shows [i] what is the mode of definition that is proper to the science of nature, [ii] what the science is about, and, finally, [iii] what is the order of its parts. The first paragraph might be translated as follows :

Since the treatise called the *Physics*, which it is our purpose to explain, is also the one that comes first in the study of nature, we must show, at its very beginning, what natural science is about — viz. its matter and subject. To this end, we should point out, on the one hand, that inasmuch as every science is in the intellect, and since a thing becomes intelligible in act insofar as it is more or less abstracted from matter, things, according as they are diversely related to matter, are the concern of different sciences. Again, since science is obtained by demonstration, and the middle term of demonstration is the definition, it follows, of necessity, that the sciences will be distinguished according to a difference in their mode of definition.

In the very first sentence of the paragraph just quoted, several terms are used whose meanings differ widely from the current ones. Our present intention is confined to showing, as best we can, what they meant to the author of the *Physics* as well as to the commentator, and why they said what they did in using those words — whatever the truth of what they held in using them. There can of course be no question of taking up the problem of what scientific knowledge is, as if we were presenting an exposition of the *Posterior Analytics*. We intend to have recourse to that treatise only to the extent required for the clarification of the above text.

* These pages, which are based on a course of lectures (given at the University of Notre Dame, 1957), aim to provide a general introduction to a philosophy of nature ancient by more than two thousand years. It is hoped that even readers whose interest in the subject is only historical, or who seek to show where the Philosopher was wrong in his general conception of science and of the study of nature, will find these notes of value. Although the reader will not long remain in doubt as to the persuasion of the author himself, still it is the latter's purpose merely to set forth what Aristotle had in mind as St. Thomas understood it. A growing interest in the subject may now be seen, not so much among professional philosophers, who often prefer to soar off on wings by no means fully fledged, into the realms of metaphysics, but among scientists (especially in Germany) who are coming to see that their own knowledge, in its inception as well as in its further development, forms in fact part of the philosophy of nature, and that this truth is an important one for the progress of their understanding of what they achieve.

1. In the Leonine edition of *In Octo Libros Physicorum Aristotelis Expositio*, nn.1 to 4 inclusive, lectio 1. Notes on the second paragraph of this prologue, in which the sciences are distinguished according to their different modes of definition, and named, will appear in the next issue of this review.

I. WHAT IS GENERALLY MEANT BY THE NAME 'SCIENCE'
IN THE PRESENT CONTEXT

1. *Not every kind of knowledge is called science*

Because the word science is frequently used to signify widely different kinds of knowledge, and since St. Thomas, in this context, has in mind a definite kind, we must first point out what this is. The expression 'natural science,' as generally understood today, refers to a type of knowledge that differs, nearly beyond recognition, from the kind of knowledge intended by 'natural science' in this paragraph. When the same word is commonly used to mean different things, and the relation between them is not clear at first sight, it sometimes helps to point out something which pertains to the same genus, but is manifestly not an instance of any of its recognized meanings. Now science is a type of knowledge. Let us therefore consider a kind of knowledge that we do not commonly call science, e.g., the knowledge that Socrates is now standing at that corner of this street. This fact may be very certain to him or to someone else who sees him there, but we are not in the habit of calling this kind of awareness 'science.' The reason seems to be not that it is knowledge of a mere individual fact, but that this fact has not been established by some mediating term. When a historical fact — e.g. that Aristotle was not the author of the *Liber de causis* — has been ascertained as the result of an orderly approach, complying with definite rules, we are wont to call this knowledge 'scientific.' And we all know what is meant when one historian is called 'more scientific' than another who is willing to receive hearsay as fact. It is futile to quarrel over the use of the word 'science' in connection with such knowledge and far better to enquire why it came to be so used. Again, of the observed relationship between the tides and the phases of the moon or between the behaviour of people and the weather, we say that they are scientifically certain. When the makers of some product assure the consumer that their brand has been 'scientifically tested,' they refer to a process of examination performed according to accepted rules. "Any mode of investigation by which scientific or other impartial and systematic knowledge is acquired" is the description of Scientific Method found in an article under this heading in the *Encyclopaedia Britannica*. All this suggests that the term 'science' still has to do with knowledge obtained by some recognized means or process emphasized as impartial. It is implied that anyone who can grasp the means or understand the process ought to agree that what is so discovered or so proved deserves his assent.

Among the studies called sciences, mathematical physics is often presented as so ideal in method and standards that the other depart-

ments of the study of nature are called scientific only in the measure that they approach its exactness. Now, what we must notice is that, if mathematical physics is called the most exact, it is because it attains more closely to the precision of mathematics itself, which is undoubtedly more rigorous than any other science. For mathematics proceeds, more than any other science, "in the mode of discipline,"¹ where we give the reason for a proposition that is not self-evident. In fact, when Aristotle mentions the 'disciplines' without qualification, he means mathematics.² The reader must realize that we take the term 'mathematics' in the traditional sense, which is not quite what it means today.

To show what is meant by 'science' in our strict sense of this term, we will therefore consider in illustration some examples of scientific knowledge in mathematics.

2. *Illustration from Mathematics: demonstration of existence.*

The geometer accepts the meaning of the word 'triangle'; but he also proves that there *is* such a thing, as when, on the basis of the radius of a circle, he constructs an equilateral triangle. The expression 'a plane figure having its three sides equal' has meaning, but from this alone it does not follow that there can be such a thing.³ The name 'centaur' refers to 'half man and half horse,' but the fact that the term has meaning does not suppose that there is such a being, nor that there could be. 'The diagonal of a square, commensurate with the side,' has meaning, too; yet no such thing can be.⁴

To show, concerning the equilateral triangle, *that it is*, it is not sufficient to point to a figure on the blackboard, so carefully drawn that to our eyes its three sides are indistinguishable in length; for

1. Cf. ST. THOMAS, *In Boethium de Trinitate*, q.6, a.1.

2. It may be noted, however, that if we refused to consider as subjects of investigation those not amenable to the exactness of mathematics, we would have to renounce even mathematical physics, if only because of its dependence upon sense experience. Cf. ARISTOTLE, *Metaphysics*, II, chap.3, 995 a; ST. THOMAS, *ibid.*, lect.5, nn.334-337.

3. On the difference between the interpretation or the definition of the *meaning* of a word, and the definition of *what a thing is*, see *Post. Anal.*, II, chap.7; ST. THOMAS, *ibid.*, lect.5-6.

4. The question '*Can it be?*' is not the same as '*Can it be in nature?*' *Being* is understood here of what is true; not of what is or can be in reality. In the present context, "'to be' and 'is' mean that a thing is true, and 'not to be' that it is false. Similarly too in affirmation and negation, e.g. in 'Socrates is cultured,' 'is' means that this is true, or in 'Socrates is not-pale' that this is true; but in 'the diagonal [of the square] is not commensurate with the side' 'is not' means that it is false to say it is." (*Metaph.*, V, chap.7, 1017 a 30. Cf. ST. THOMAS, *ibid.*, lect.9, nn.895-896; *Quodl. IX*, a.3, c. and ad 4). If someone said that the word 'horse' stands for a certain kind of vegetable, his account would not be true. Nor can we know whether a proposition is true or false unless we first grasp its true meaning.

no amount of physical measurement could verify the exactness of 'equal sides.' To designate an actual horse would be enough to show that the name 'horse' stands for something that is ; this does not hold for the subjects of mathematics. While the geometer assumes the continuum as ' what is divisible without end, ' according to one or more dimensions, any subject of which he demonstrates some property, e.g. of ' triangle, ' must first be established by way of a construction to show that there *is* such a thing. Demonstrations by way of construction are called ' quasi operational. ' ¹ Every attempt at proof by experience that ' the equilateral triangle ' *is* (in the sense of ' true '), must prove hopeless. How, then, can we know of what we define as ' a plane figure having its three sides equal, ' that it also *is* — in the sense of true ? Euclid provides the following proof :

[i] *On a given finite straight line to construct an equilateral triangle.*

Let AB be the given finite straight line.

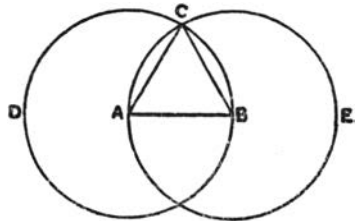
Thus it is required to construct an equilateral triangle on the straight line AB .

With centre A and distance AB let the circle BCD be described ;

[Post. 3]

again, with centre B and distance BA let the circle ACE be described ;

[Post. 3]



and from the point C , in which the circles cut one another, to the points A , B , let the straight lines CA , CB be joined. [Post. 1]

Now, since the point A is the centre of the circle CDB ,
 AC is equal to AB . [Def. 15]

Again, since the point B is the centre of the circle CAE ,
 BC is equal to BA . [Def. 15]

But CA was also proved equal to AB ;
therefore each of the straight lines CA , CB is equal to AB .

And things which are equal to the same thing are also equal to one another ; [C.N.I.]

Therefore CA is also equal to CB .

Therefore the three straight lines CA , AB , BC , are equal to one another.

Therefore the triangle ABC is equilateral ; and it has been constructed on the given finite straight line AB .

(Being) what it was required to do. ²

1. ST. THOMAS, *In I Post. Anal.*, lect.2, n.5. In this, the mathematical disciplines somewhat resemble the productive sciences. To construct a subject, e.g., a house, is the very purpose of the latter. They remain radically distinct, however, inasmuch as the construction of a subject is the very purpose of the latter, whereas in mathematics the construction is a means of discovery (*ibid.*, lect.41, n.7).

2. Book I, Proposition 1. *The Thirteen Books of Euclid's Elements*, translated by SIR THOMAS HEATH, Cambridge University Press, 1926, 3 vol., Vol. I, pp.241-242. Cf. ST. THOMAS, *In II Post. Anal.*, lect.6, n.4.

This demonstration by way of construction shows that there is 'a triangle whose three sides are equal,' and that this is indeed a definition of 'what it is to be such a triangle,' — not just an interpretation of the expression 'equilateral triangle,' nor even a definition by a property. This kind of proof makes us discover and establishes, by means of the construction, that there is such a subject, and it is by means of the definition of the latter that any of its properties will have to be demonstrated. So much for demonstration of existence in mathematics.

3. *Demonstration of a property.*

We must now turn to the kind of demonstration which establishes a commensurately universal property following with necessity from 'what its subject is.' Let us take in illustration another proposition from Euclid: *In any triangle, if one of the sides be produced, the exterior angle is equal to the two interior and opposite angles, and the three interior angles of the triangle are equal to two right angles.* This statement is not self-evident. That 'the sum of the angles of the triangle equals two right angles' is a proposition requiring proof: it follows from something other than itself, from a reason already known. How is this reason known, and how does it lead to such a proposition? Assuming certain demonstrations already provided, we quote the proof from Euclid:

[ii] Let ABC be a triangle, and let one side of it BC be produced to D ;

I say that the exterior angle ACD is equal to the two interior and opposite angles CAB, ABC , and the three interior angles of the triangle ABC, BCA, CAB are equal to two right angles.

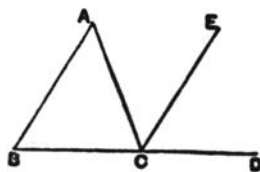
For let CE be drawn through the point C parallel to the straight line AB .

[I, 31]

Then, since AB is parallel to CE , and AC has fallen upon them, the alternate angles BAC, ACE are equal to one another.

[I, 29]

Again, since AB is parallel to CE ,



and the straight line BD has fallen upon them, the exterior angle ECD is equal to the interior and opposite angle ABC .

[I, 29]

But the angle ACE was also proved equal to the angle BAC ;

therefore the whole angle ACD is equal to the two interior and opposite angles BAC, ABC .

Let the angle ACB be added to each;

therefore the angles ACD, ACB are equal to the three angles ABC, BCA, CAB .

But the angles ACD , ACB are equal to two right angles ;
 [I, 13]
 therefore the angles ABC , BCA , CAB are also equal to two right
 angles.
 Therefore . . . etc.

Q.E.D.¹

What is the exact reason from which this property is inferred ? It is none other than the definition of the subject (triangle) to which, in the conclusion, we attribute the property 'to have the sum of its angles equal to two right angles.' Now the definition which, in this demonstration, is the middle term and contains the proper principles of the property is not just 'a figure enclosed by three straight lines,' but, as the first part of the proposition states, it is such a figure inasmuch as it has its "exterior angle equal to the two interior and opposite angles." It is in this exact respect, brought out, 'made actual,' by means of a construction ("if one of the sides be produced"),² that the triangle is both the subject and reason of the property 'to have its three interior angles equal to two right angles.'³

4. *A posteriori science*

Knowledge of a necessary, universal and commensurate property derived from the definition of its subject, is science in the fullest sense, because it follows from what is actually, on the part of the known, the proper principle of that property. In the case of mathematics, this principle or formal cause is also first known by us. (We would never say : 'This figure is a triangle because it has its angles equal to two right angles,' for this would be to put the cart before the horse.) Such knowledge, then, was called science in the most rigorous sense of the word.

But in actual usage the name 'science,' like the adjective 'scientific,' is not reserved to such knowledge alone. For although in science proper we cannot acquire knowledge of the unknown except through the mediation of something else already and better known, not everything that is first and better known to us is also prior in itself as in geometry. Hence it can happen that things better known in the

1. Book I, Proposition 32, HEATH, *ibid.*, pp.316-317.

2. ARISTOTLE, *Metaph.*, IX, chap.9, 1051 a 20 : "Geometrical constructions, too, are discovered by an actualization, because it is by dividing that we discover them. If the division were already done, they would be obvious ; but as it is, the division is only there potentially. Why is the sum of the interior angles of a triangle equal to two right angles ? Because the angles about one point [in a straight line] are equal to two right angles. If the line parallel to the side had been already drawn, the answer would have been obvious at sight." Cf. ST. THOMAS, *ibid.*, lect.10, n.1888ff.

3. Cf. ST. THOMAS, *In II Post. Anal.*, lect.1, n.9.

sense of more intelligible in themselves, which would be the proper means of a perfect demonstration, cannot at once be reached or used, because what we know first is not always what actually comes first on the part of the thing known, taken in itself.

Now, when the only knowledge accessible to us is not a proper means of proof, unlike the definitions of mathematics, which are such proper means, our only resource is to look backwards, doing our best to find our way from properties to definition, instead of from definition to properties. In the study of nature this is usually the only way in which we can make progress. For example, we know the alternation of day and night before we know the reason for it — a reason which it took some time to discover. To know that this phenomenon has always taken place, in all recorded experience, is one thing ; to know why it takes place, is another ; and the expression of the observed regularity, as a general proposition reached by induction, becomes the substitute for the definition required by science in the strict sense.

5. *Induction of self-evident principles from sense perception and imagination*

It has just been stated that very often in the study of nature, not having definitions to serve as a basis of reasoning as we have in mathematics, we must make do with propositions reached by provisional induction. This term induction is another which we must now consider if we are to understand the import of St. Thomas's preface. By induction, in general, is meant thinking our way from particulars to universals. The main thing to notice in the beginning is that there are two basically different types of induction : a distinction which is made, not with regard to the form of inductive reasoning, but on the basis of its matter. One of them passes unnoticed in ordinary life, because it goes on as unceasingly and unconsciously as breathing. It would be difficult to say just when we first suddenly understood that 'it is impossible to be and not be at the same time and in the same respect,' or that 'nothing can be a whole and a part in the same respect,' or that 'every whole number is either odd or even' (which we gather by mathematical induction.¹) But the fact is that knowledge

1. "Ipsa autem principia non eodem modo manifestantur. Sed quaedam considerantur *inductione*, quae est ex particularibus imaginariis, utputa quod omnis numerus est par aut impar. Quaedam vero accipiuntur *sensu*, sicut in naturalibus ; puta quod omne quod vivit indiget nutrimento. Quaedam vero *consuetudine*, sicut in moralibus, utpote quod concupiscentiae diminuuntur si eis non obediamus" (St. Thomas, *In I Ethicor.* lect. 11). The term induction in this passage is reserved to mathematics because here it is the most accomplished and least ambiguous. That every living thing stands in need of food is not that obvious. Even the principle of contradiction, the most certain of all, is difficult to express without confusion ; we must qualify what is meant by 'to be' and 'not to be,' 'at the same time' and 'in the same respect.' Further proof of this can be seen in the

of the most general principles, presupposed as it is to all reasoning,¹ is preceded by an induction, so natural that it passes unobserved.

The other kind of induction, which, now spontaneously, now deliberately, considers the particular cases within reach and concludes from them to a general proposition,² is familiar to us as the typical procedure of the arts and crafts as well as of experimental science in general. These propositions are made to serve as principles, but they are not the reason for the regularities which they enounce.

In comparing these two sorts of induction, it must be noted that they differ, not merely in the frequency or ease with which they are carried on, but more fundamentally in the role assigned to the enumeration of particular instances and in the certitude finally achieved. It may sound surprising, but an induction may lead to complete certitude without all instances having been covered, as in the case of first, self-evident principles ; and, on the other hand, may cover all instances without yielding a sufficient reason. The first and basic type of induction, whereby the mind moves from sense perception towards general, self-evident principles, is nothing like a complete enumeration, nor do we need one. Indeed, a principle like ' it is impossible to be and not to be ' etc., or ' any two things which, in the same respect, are like to a third, are in that respect like to one another, ' could hardly be the result of an examination of all the cases, since these are innumerable. In the primordial process of acquiring knowledge, propositions such as these are consequent upon sensation, memory and experience ; yet, once we grasp them, we see that they must hold good in all possible instances. In other words, it is characteristic of this first type of induction that no attempt is made to offer the survey of the particular cases as the proper reason for the truth of the universal proposition.³

fact that the primacy of this principle is forever in debate. As to the part-whole principle, it is extremely ambiguous, for there are wholes which are identical with each of their parts, namely the logical wholes with their subjective parts ; besides, any part of a line is not less divisible *ad infinitum* than the whole, and there are wholes that are not composed of the parts into which they can be divided, such as a circle.

1. Most modern writers on philosophy of science assume that by first, self-evident principles of a science, ARISTOTLE meant what he called ' common principles ', from which, he showed (*Post. Anal.*, I, chap.9 and 10), there can be no demonstration, although demonstration depends upon their truth.

2. This type of induction is analysed in *Priora Analytica*, II, chap.23, 68 b 5. See also ALBERTUS MAGNUS, *ibid.*, Tract.VII, chap.4. The text of this important exposition of the *Priora* has been transcribed from the Borgnet edition, long out of print, and made available in mimeograph by Michel Doyon, 1215-1223, chemin Sainte-Foy, Québec 6, Canada, 1951.

3. See *Post. Anal.*, II, chap.19, 99 b 15. Cf. ST. THOMAS, *ibid.*, lect.20. — (On the distinction between sense-perception, memory and experience, see also *Metaphysics*, I, chap.1, 980 b 20 – 981 a 30. ST. THOMAS, *ibid.*, lect.1). — Of this universality ARISTOTLE says that it is " at rest in the mind " inasmuch as it is eventually and suddenly perceived as independent of the particular, variable, instances ; although it could not be achieved without

Cases may be referred to by way of illustration, but the reason for the truth of the proposition is nothing else but what we intuit in any single instance — once the proposition has been achieved.

Since the kind of induction just described never offers the number of particular instances as the reason for accepting the strictly universal proposition, it is not knowledge acquired through prior principles and can be called science only in a loose sense. That it does nevertheless have some claim to the title is clear, since it enjoys great certitude and is a necessary preliminary to all science.¹

6. *Not even complete enumeration is the same as to provide the scientific reason*

We must now turn our attention to the second type of induction, where the multiplicity and similarity of the particular cases are actually given as the reason for a general statement offered as a conclusion. In this way of reasoning from particular to universal, the enumeration of the cases may be either complete or incomplete. By 'complete' is meant an enumeration which exhausts all possible cases, implying, of course, that they are clearly limited in number. Now, even when complete enumeration is possible, so that the property x is shown to be true of every possible instance, the inductive argument may still fail to provide a proper, universal reason for a general statement which is nevertheless certain.²

sensation of some instances, without memory and comparison of the instances retained, the results of which is experience. If we had no such knowledge, no word we use could have any meaning beyond that of vocal sounds as produced by beasts, i.e., signs of a state of passion, as the dog's bark or the lion's roar. For this type of induction, modern logicians still refer to ARISTOTLE, and call it "immediate" or "intuitive induction." (See, e.g., W. E. JOHNSON, *Logic*, Part II, chap.VIII, Cambridge, 1922, pp.188ff.; MORRIS COHEN and ERNEST NAGEL, *An Introduction to Logic and Scientific Method*, Harcourt, Brace and Company, New-York, chap.XIV, pp.273ff.). "Intuitive induction" is perhaps not a very happy expression for the reason that this induction and the intuition that follows it are not one thing. The "seeing" or intuition consequent upon the induction is not the proper effect of the induction itself.

1. Traditional philosophy accounts for this use of the word science. Cf. *Post. Anal.*, I, chap.31, 88 a 5. ST. THOMAS, *ibid.*, lect.42, n.9; and *In VI Ethicor.*, lect.3, n.1145.

2. "An error of this kind is similar to the error into which we fall concerning particulars: e.g. if A belongs to all B, and B to all C, A will belong to all C. If then a man knows that A belongs to everything to which B belongs, he knows that A belongs to C. But nothing prevents his being ignorant that C exists; e.g. let A stand for two right angles, B for triangle, C for a particular diagram of a triangle. A man might think that C did not exist, though he knew that every triangle contains two right angles; consequently he will know and not know the same thing at the same time. For the expression 'to know that every triangle has its angles equal to two right angles' is ambiguous, meaning to have the knowledge either of the universal or of the particulars. Thus then he knows that C contains two right angles with a knowledge of the universal, but not with a knowledge of the particulars; consequently his knowledge will not be contrary to his ignorance" (*Priora Anal.*, II, chap.20, 67 a 5-20).

An example using the materials of geometry will show what is meant by a complete enumeration failing to reach the proper reason for the proposition enounced by way of a conclusion. Suppose one established that 'the sum of the angles of any triangle is two right angles' by way of induction, that is, by verifying this property in each of the three kinds of triangle, "first in the equilateral, again in the isosceles, and afterwards in the scalene triangle."¹ Seeing that a rectilinear three-sided figure either has its three sides equal, only two of its sides equal, or its three sides unequal, and that there is no other possibility, the general statement will be quite certain: 'In every kind of triangle, the sum of the angles is two right angles.' Yet the verification of the general statement by enumeration of all the possible kinds of triangle does not provide the commensurately one and universal reason why it is true of each kind.

. . . Even if one prove of each kind of triangle that it has its angles together equal to two right angles, whether by means of the same or different proofs; still, as long as one treats separately equilateral, scalene, and isosceles, one does not yet know, except sophistically, that *triangle* has its angles equal to two right angles, nor does one yet know that triangle universally has this property, even if there is no other species of triangle but these. For one does not know that triangle as such has this property, nor even that every triangle has it, except in a numerical sense; nor does one know it according to the species [triangle] universally, though there be no kind [of triangle] in which one does not recognize this property.²

In the study of nature, too, an induction is judged complete when some general proposition is taken as true because it has been verified of each member of an adequate division; as when it is said that "irritability (the power of responding to a stimulus) is the general property of living beings" because it is true of both animals and plants.³

1. On whether or not ARISTOTLE's mention of such proofs (*Post. Anal.*, I, chap.5, 74 a15-35) refers to a historical development of the theorem, see HEATH, *op. cit.*, Vol.I, pp.317ff.

2. *Post. Anal.*, I, chap.5, 74 a 25-35. Cf. ST. THOMAS, *ibid.*, lect. 11-12. — Inasmuch as 'triangle' and other types of plane figure, such as circle, divide the genus 'plane figure,' triangle is a species which, with regard to the kinds of triangle that in turn divide triangle into species, has the nature of genus. Figure is called the 'remote genus,' triangle 'proximate genus.'

3. Even this so-called complete induction is only hypothetical, since it must assume that the terms of the division have been verified. Such tentative or dialectical use of the 'dici de omni' provides a universality that was formerly qualified as 'ut nunc, as of now,' i.e. valid in all the cases actually known. Cf. ST. THOMAS, *In I Post. Anal.*, lect.9, n.4. — Many philosophers of science nowadays are shy of, or even categorically reject, all so-called first, self-evident, necessary principles, both general and proper. To their mind, all principles must be stated in hypothetical form, qualified by 'if.' We may mention three points that appear to be in their favour: (a) The consequences of reasoning are at least materially the same. E.g., 'If the exterior angle of a triangle is equal to the two opposite interior angles, its three angles are equal to two right angles.' If you remove the

However, although this may be the reason why we believe the property to be common, it is not a commensurately universal reason, which must be one and adequate to all possible cases. The same judgment should be passed on an argument showing that all mobile beings are bodies because both animate and inanimate things — an adequate division of mobile beings — reveal three spatial dimensions. This is far from being the commensurate universal reason why anything that can be in movement must be a body. A genuine demonstration would have to show that 'to be *per se* in movement' belongs primarily to body as such.

More often, however, the induction used in the study of nature cannot be made complete. We say, for instance, that 'every man is mortal.' Yet, if this proposition is considered to be general merely because no man has been known to survive, its basis is an induction that is necessarily incomplete. For all practical purposes, the proposition is sound, though based on an incomplete induction and universal only *ut nunc*; but as such, it does not offer the reason why man is mortal. The observed fact 'no man has been known to survive' is not the natural reason why 'every man is mortal.' If the sun rises tomorrow, it is not because, in all human experience, it has always happened before.¹ So long as we cannot find the reason why they

"if" and make the statement categorical, the conclusion will be materially the same, but you will not know whether it is true or not. (b) Most universal terms and enunciations are no more than what we call universal *ut nunc*, that is, provisional, and must be taken as posits subject to change. There was a time when 'All swans are white' was valid. (c) It is possible to say that 'All statements are uncertain, including this one' an enunciation which is grammatically correct. This retreat from truth retains all the same a logical structure similar, in some respects, to that concerned with true knowledge acquired by induction and demonstration. A logical positivist such as Hans Reichenbach will be satisfied with knowledge, whether it be true or not, so long as it is an instrument of action, and we can readily produce examples where this is true. A speculative theory need not be true to ensure results that are in practice true. The ancient hypothesis that malaria was caused by the evening miasms of swamps produced results for those who followed the advice to stay away from them. The explosion of the Bomb did not depend upon the speculative truth of Einstein's theory. But it proved nonetheless that the theory is at least on the right track. In most departments of natural science, no matter how great our desire for ultimate truth, we never get beyond universality *ut nunc*.

1. ARISTOTLE's famous hypothesis of a radical difference between the phenomena on our planet and those on an astronomical scale is a case in point. He assumed that the latter were entirely uniform, unaging and unalterable, from which he concluded that they could not be subject to contrary states, such as hot and cold, so that the heavenly bodies, e.g. the sun, were actually incorruptible. "The mere evidence of the senses [he said] is enough to convince us of this, at least according to human belief. For in the whole range of time past, so far as our inherited records reach, no change appears to have taken place either in the whole scheme of the outermost heaven or in any of its proper parts" (*De Caelo*, I, chap.3, 270 b 10). "Nevertheless [St. THOMAS adds, in his commentary, lect.7, n.6] this is not necessary, but only probable. For the more a thing is lasting, the more time is required to observe its change; for instance, the change that over a period of two or three years takes place in a man is not as readily observed as that which affects a dog, or some

occur, the regularities observed in nature (such as the eventual death of every animate thing) will by themselves provide no strictly universal proposition. The proper, universal reason why man, as well as any other animate thing, is mortal must be found in what is inseparable from being an animate thing, and therefore from being a man.

7. *The 'universal' of demonstration is not the same as 'to be said of all' — or "dici de omni"*

The universal property, as understood in strict science or demonstration — of which an example is 'to have its three angles equal to two right angles' — must show the following characteristics : [a] it must be true of all instances that are under it (e.g., of each and every triangle) ; [b] its subject must belong to the very definition of the property (e.g., 'to have two angles equal to two right angles' implies triangle as having an exterior angle equal to the two opposite interior angles, viz. the *per se* subject of this property which follows from it with necessity) ; [c] it is primarily in that of which it is said (i.e. primarily in triangle as such, and not primarily in this and that of its species).¹

To assume that one has demonstrated that the triangle as such has the sum of its angles equal to two right angles by showing it to be true primarily of each one of its kinds, this is to be satisfied with the mere appearance of a reason. In fact the statement : 'In every kind of triangle the sum of the angles is two right angles,' when it is understood as the result of an induction by complete enumeration, is not a demonstrative conclusion at all, but a mere restatement of something already known, viz. [a] that any triangle is either *e*, *i*, or *s* ; [b] that *e*, *i*, and *s* each has its angles equal to two right angles.

What we are trying to show is that to establish something by induction as true of a class of things is not to prove anything about the nature of the thing in itself. Such inductions, however exhaustive, will always suffer from this limitation. The reason is that a class, as such, is never the same thing as a universal. A class, or collection, may be no more than an incidental whole, a grouping which supposes something held in common by many objects, but not necessarily something pertaining to what they are in themselves. If, instead of meaning 'a rectilinear figure contained by three sides,' which is one in notion, the term 'triangle' were used to stand primarily and immediately

other shorter-lived animal, during a time of equal length. Hence one could say that while the heaven is naturally corruptible, it is so long-lasting that the whole span of time which memory can record is not enough to observe its change." — Thus, according to both ARISTOTLE and ST. THOMAS their whole theory about celestial bodies was no more than a hypothesis.

1. *Post. Anal.*, I, chap.4 and 5, 73 a 20-74 b 5. ST. THOMAS, *ibid.*, lect.9-12.

for the *class* of each and all triangles, 'triangle' would lose its true universal meaning ; it could be said of no triangle whatsoever, neither of a kind nor of an instance of a kind. Where the term 'triangle' is intended to mean a class of things, to say triangle of equilateral, or of *this* particular one, would mean that 'equilateral' is the class of all triangles, whether equilateral or no. Likewise,¹ if we interpreted 'man' to mean primarily and immediately the class 'men' (that is, all of the subjective parts of the universal nature 'man,' viz. all beings of which 'man' can be predicated), then, to say 'man' of Socrates would mean that he is each and every man : Socrates and all men who are not Socrates, viz. all who have been, are, shall be, might have been, and even all possible men. Actually, a collection, as such, like an individual, can be predicated only of itself, viz. in a proposition of identity, 'A is A,' 'Socrates is Socrates,' or 'All Greeks are Greeks.'

If 'triangle' meant primarily and no more than the *class* of all triangles, the 'equilateral' could not even be called 'triangle' since this would imply that the class of all triangles is in the same respect both equal and unequal to only part of itself. It would be false to say : 'A surface enclosed by three straight lines is a figure,' or that 'it is a rectilinear figure,' or 'a rectilinear figure that has three sides.' For all these terms ('figure,' 'rectilinear figure,' etc.), when used to signify collections *qua* collections, are equivalent to symbols, viz. the kind of arbitrary signs that must be distinguished from names.

II. THE OBJECT AND SUBJECT OF A SCIENCE

St. Thomas said, in the passage quoted at the head of these pages, that "we must show, at its very beginning, what natural science is about, viz., its matter and subject." A well-known sentence from A. N. Whitehead's *Introduction to Mathematics* seems to advance the contrary opinion : "the last thing to be discovered in any science is what the science is really about."² Yet, towards the beginning of the same *Introduction* he had said that students should know "from the very beginning of their course . . . what the science is about."³ That there is no contradiction here can be made plain by first pointing out what is meant by 'the object of a science,' as distinguished from its subject, for the object includes the subject.

1. Cf. JOHN OF ST. THOMAS, *Cursus Philosophicus, Logica*, P. I, lib. II, chap.10-12 ; *Quaest. disput.*, q.6, (edit. Reiser, T.I, pp.29-35 ; pp.166-182).

2. P.223.

3. P.8. — We do not aim to show what WHITEHEAD actually means by 'science.' We have pointed out elsewhere (*Random Reflections on Science and Calculation*, dans *Laval théologique et philosophique*, 1956, Vol.XII, n.1) that what he calls 'mathematics' is what the ancients had named *logismos*, i.e. the art of calculation.

By the *object* of a science, in the strict sense of the term science, we mean knowledge acquired as the result of demonstration, e.g., that 'the plane triangle has its angles equal to two right angles.' The object of science is therefore nothing other than the conclusion, in which something (e.g., 'to have its angles equal to two right angles') is said about something (viz., 'triangle').¹ This object, then, is something complex : a composition of subject and predicate, which in perfect science follows from the definition of the subject (e.g., to be a triangle is 'to have an exterior angle equal to . . .'), or in other instances, from the substitute for a definition. By the *subject* of a science, we mean that *about which* we have knowledge by demonstration, viz., the very subject of the conclusion or 'that about which' (e.g., 'triangle') something is asserted by means of demonstration (e.g., the property 'to have the sum of its angles equal to . . .').

Now the subject about which we assert something in the object or conclusion of the demonstration does not of course make its first appearance in the conclusion. Something has already been predicated of that same subject in the principles or premises of the demonstration. For example, of the *triangle* we said that 'it has its exterior angle equal to the two interior and opposite angles,' and it is in virtue of this that the conclusion follows, viz., that 'the *triangle* has its three angles equal to . . .'. In other words, the subject of scientific knowledge is both [i] what is first known, viz., that about which we seek science,² and [ii] what is last known, viz., this same subject *qua* known to possess such or such a property. The subject, considered in the latter respect, is called the 'term' of the science.³ There is, then, no contradiction in saying, on the one hand, that students should know "from the very beginning of their course . . . what the science is about," and, on the other hand, that "the last thing to be discovered in any science is what the science is really about."

III. THE DISTINCTION AND RESPECTIVE UNITY OF THE SCIENCES, IN GENERAL

Although every demonstration produces scientific knowledge, a particular demonstration, obviously, does not constitute a science all by itself, since, if it did, there would be as many sciences as there are particular demonstrations. Rather, a single science, such as geometry, embraces many objects or conclusions, e.g., that 'the sum of the angles

1. *In I Post Anal.*, lect.10, n.8.

2. In geometry, that which is first known and about which we seek scientific knowledge is magnitude ; whereas the particular subjects are known, we say, by way of construction. These, in turn, are known before the demonstration of their properties. *In I Post. Anal.*, lect.2, n.5.

3. *In I Post. Anal.*, lect.41, n.7.

of a triangle is two right angles'; that 'the angle in a semi-circle is a right angle'; etc. And these form what is called the *material object* of a science. Now what is it that gathers such objects into a single science? Why do certain conclusions belong to mathematics and not to the science of nature? This will be what is called the *formal object* of the science.

We have noted that the means by which we acquire scientific knowledge are none other than the definitions, since the definition is the proper principle of the conclusion or object of science. What, we might ask, do the definitions of geometry have in common? To make this point briefly, we propose the question: how could we show that *in nature* there is such a thing as an equilateral triangle? By what method could we verify that this triangle cut in bronze has its three sides equal, or that its exterior angle is equal to the two opposite and interior angles? Or by what means could we demonstrate that the angles of the metal triangle are equal to two right angles? The only possibility is measurement by means of some standard or 'measure.' By a 'measure' we mean 'that by which the quantity of a thing is known primarily.' If the measurement is to be perfectly exact, the measure must be indivisible. Now, 'to be quite indivisible' is true only of the 'one' that is the principle of number, and not of magnitude; of the things, in nature, that are continuous, there can be no exact measure. The reason for this will become clearer if it is noted, that, as Aristotle said,

the measure is always homogeneous with the measured: the measure of magnitudes is a magnitude, and in particular that of length is a length, that of breadth, a breadth, that of articulate sound articulate sound, that of weight a weight, that of units a unit. (For we must state the matter so, and not say that the measure of numbers is a number; we ought indeed to say this if we were to use the corresponding form of words, but the claim does not really correspond — it is as if one claimed that the measure of units is units, and not a unit; number is a plurality of *units*.)¹

But at the same time, since the measure of a magnitude is itself a magnitude, and every magnitude *qua* continuous is divisible without end, the measure itself must be indefinitely divisible. Hence, to be entirely exact, the standard of length would have to be length without length, both divisible and indivisible. That is why, for practical purposes, some length, chosen by convention, like the yard or the metre, simply must be declared the correct standard.² The subdivisions

1. *Metaph.*, X, chap. 1, 1053 a 25.

2. Cf. ARISTOTLE, *Metaph.*, X, chap. 1, 1052 a 15-1053 b 8. ST. THOMAS, *ibid.*, lect. 1 and 2 — SIR ARTHUR EDDINGTON, *Space, Time and Gravitation*, Prologue, pp. 1-16. Of the standard of length SIR ARTHUR says that "it has no length." This paradox may prove helpful to call attention to the difference between (a) length as 'what is extended according to one dimension' and (b) length as 'what is known by means of the measure of length.'

of such a standard make possible some improvement in precision,¹ but can never attain the exactness of mathematics, nor permit the demonstration of a theorem.

The reason why complete exactness is possible in geometry is that the definitions we use are formally independent of, and have no reference to, the order of sense experience, and the conclusions are established as following from such definitions with necessity. Yet by means of a construction² geometry can demonstrate that there is a triangle whose sides are equal, and that the angles of any triangle are equal to two right angles. Why cannot the same be done for a metal triangle? Why should the object of sense experience offer such hindrance to exactness? The answer to this difficulty, and the reason for the distinction between the 'matter' and the 'subject' of a science, lie in the quotation from St. Thomas, "a thing becomes intelligible in act insofar as it is more or less abstracted from matter."

Now the word 'matter' in 'abstraction from matter' and in 'the matter of a science' does not mean quite the same thing. Let us begin with 'abstraction from matter.' What is this 'matter' from which we must prescind as an essential condition of science?

IV. WHAT IS MEANT BY 'MATTER' IN 'ABSTRACTION FROM MATTER'?

In our scientific age the student of nature would, on the whole, show little concern for a doctrine such as that of 'abstraction from matter,' and apparently one can do well without it. Some might even suggest, since we know so little about 'matter,' except, for instance, that it is convertible with 'energy,' that the question of abstraction from matter' refers either to some outdated theory or to a knowledge not yet had. Fortunately, some recognized authors, especially in the field of mathematics and physics, still make very definite statements which show that a theory of abstraction is even now of no less consequence than it has been in the past. On the other hand, the reader may be willing to bear with us if we promise to show how the question

The measure itself must have length in the first sense; but it cannot have length in the second sense since, by definition, the standard of length cannot be measured (except *per accidens*, as when we express the ratio between the standard of one system of measurement, e.g., the meter, in terms of the standard of another system, e.g., the English or the U.S. 'yard,' where in either case, the measured ceases to be taken as a standard.

1. The meter, although of considerable magnitude, may be called the 'minimum of length,' provided we mean 'the material object whose variations owing, e.g., to changes in temperature, can be more precisely controlled; while the variations in a smaller object would be less noticeable.' This more readily controllable exactness is presupposed to the subdivisions of the standard.

2. Such proofs are called "quasi operational demonstrations." *In I Post. Anal.*, lect.2, n.5.

of abstraction from matter as a condition of the sciences and of their distinction arose in the mind of some ancient philosophers whose terminology is still in use. This may prove the best means to decide whether or not such a doctrine is still relevant. To this end, it will not be enough to point out what these philosophers intended when using such words as 'matter' and 'abstraction.' All this is bound to still another doctrine, a general, more basic one concerning the use of words and their various impositions.

Both the Greek word ὕλη and the Latin *materia* originally meant 'timber,' and then what we call 'lumber'; they were further extended to mean any 'building material,' including stone as well as lumber, bricks, cement, etc.; finally they were extended to mean 'that of which' anything is composed, even though this might be as various as the *vapor* of a cloud, the *sides* of a triangle, or the *terms* of a syllogism.¹

1. *Original meanings of words and new impositions*

Now a word may have some original meaning which it is well to know if its later impositions are to be understood.² That is, whenever the latter apply to things which cannot be known nor, therefore, named, without reference to something earlier and more known to us. For, since words are signs of our concepts, and concepts are the mental images of things, words can refer to things only through the medium of the mind's conception of them.³ The way in which words signify does not depend immediately on the way in which the things that they stand for are in themselves, but on the way they become known to us and are present in the mind. And hence it is that we can name a thing only as we know it, and that

in naming things we follow the progress of intellectual knowledge. Now our intellectual knowledge proceeds from the better known to the less known. Accordingly, we transfer names of things more known to signify things less

1. LIDDELL and SCOTT (*Greek-English Lexicon*) list the following meanings: I. *forest, woodland; forest-trees*. II. *wood cut down; firewood, fuel; brushwood; timber*. III. *the stuff of which a thing is made, material; generally, materials; in philosophy, matter, first in Aristotle, etc.*

2. The word *imposition* is here used in a scholastic sense, described by Webster as 'the application of a name to a thing.' Unlike mere vocal sounds, such as the growls and whimpers of animals, names do not have meanings by nature but by convention. It is man who deliberately confers or imposes their significance. Sometimes the term *application* may be used instead of *imposition*, but it should be borne in mind that not every application of a word constitutes an imposition of meaning, nor is every novel application a new imposition. Metaphors like "a heart of stone," "a huge ox of a man" do not change the original meaning of "stone" or "ox," but merely apply a word, in its first imposition, to an object which is in no proper sense what that first imposition designates. A new imposition would destroy the metaphorical force of the word.

3. ARISTOTLE, *Peri Hermeneias*, I, chap.1.

known to us. Hence it is that . . . the word *distance* has been transferred from things that are apart locally, to all contraries ; and in like manner words pertaining to local movement we use to signify the other kinds of movement [viz., according to quality or magnitude], because bodies, inasmuch as they are circumscribed by place, are better known to us.¹

That is why extended meanings of words indicate an order of progress in knowledge. St. Thomas illustrates this point in the following passage :

We can speak of a word in two ways : either according to its first imposition, or according to an extended use of it. This is shown in the word *sight*, which was originally imposed to mean the act of the sense of sight, and then, inasmuch as sight is the more excellent and trustworthy of our senses, according to common usage it extends to all knowledge obtained through the other senses. Thus we say : *see how it tastes, how it smells, or how warm it is*. Further [the word 'sight'] is extended to knowledge by the intellect, as in : *Blessed are the clean of heart, for they shall see God* [MATH., v, 8]. And thus it is with the word *light*. For it was first designed to mean that which makes manifest to the sense of sight. Afterwards it was extended to that which makes manifest according to knowledge of any kind.

And so we say things like : ' Let us look at this problem in the light of new evidence.' What, then, is the *proper* meaning of this word ? St. Thomas goes on to make the following important distinction : " If, then, the word [light] is taken according to its first imposition, it is used metaphorically of spiritual things. But if taken according as by common usage it is extended to any sort of clarifying or making plain, then it is properly said of spiritual things." ² If taken after this new imposition, which still refers to the original one as meaning what is better known to us, the word *light* is, in fact, used more properly of intellectual things — even though less known to us — since the light of science, for instance, has far more of the nature of ' what makes plain ' than candlelight has.³ To the man unaware of this change of imposition, the ' light of new evidence ' might seem no more than metaphor ; for him, nothing but the light which permits our eyes to see could be called light in any proper sense.⁴

2. *Original meaning and etymology*

Now concerning the word *matter*, the original meaning we have in mind should be distinguished from the word's origin or etymology,⁵ which is quite contingent.

1. *Ia IIae*, q.7, a.1, c.

2. *Ia Pars*, q.67, a.1, c.

3. *Q. D. de Potentia*, q.4, a.2, ad 3.

4. More specifically, unless the value of extended meaning is granted, most of the terms used in philosophy, and all metaphysical terms, will have to be taken as metaphors.

5. From the Greek *etymologia* : the real, true (*etymon*) or primitive meaning of a word.

The etymology of a word is one thing, its meaning is another. For its etymology shows that *from which* the word was taken for the purpose of signification [*id a quo imponitur nomen ad significandum*] : whereas the meaning of the word concerns *that upon which the word is imposed* for the purpose of signifying [*id ad quod significandum nomen imponitur*]. These things are not always the same : for the name *lapis* is taken from *laesio pedis*,¹ but this is not what it means ; else, iron, since it hurts the foot, would be a stone.²

Yet whatever the etymology of the word *lapis* — or of our own word *stone*, for that matter — the meaning we are concerned with here would be that of *lapis* as the name of this kind of object to which we can point a finger, and not with the name as drawn from the possibility of a stone affecting us in this way or that. A person may know the primary imposition of a word without knowing exactly how it came to get it in the etymological sense. For instance, the name *Metaphysics* came to mean what it does in a very casual way. Because of the place assigned to them — after the *Physics* — by an early compiler of Aristotle's works, certain treatises were called *Metaphysics* : *μετά τὰ φυσικά*. This provides us with the etymology of the name, i.e., 'that whence the name was taken' ; whereas the primary imposition of *metaphysica* as a single word refers to treatises which, in the proper order of learning, are to be studied after those on nature. Eventually, by a new imposition, going beyond yet embracing the previous one, *metaphysica*, as Boethius (*cir.* 480-524) employed this term, referred to the science which Aristotle himself had called *First Philosophy* and *Theology* — 'First' by reason of its principles, 'Theology' because of its principal term, viz., knowledge of what is divine.³

Of course, 'that from which the signification of the word is drawn' or 'that whence the name is imposed,' and 'that which the word signifies' are sometimes the same, viz. in the case of words conveying what is immediately known to our senses, such as *hot*, *cold*, *hard*, *white*, — words which are verified directly by reference to sense experience, and which are in no other way verifiable. The reason for this resides in the fact that even of the things which are present to our senses, and at any rate first and more known to us, we do not know directly what they are in themselves ; this we can approach only through something extrinsic to their nature, viz., some sensible effect or quality.⁴ What we first discern of a horse, for example, is

1. This etymology, reported by ST. ISIDOR OF SEVILLE (*cir.* 570-636), is in fact incorrect.

2. *I Ia IIae*, q.92, a.1, ad 2. ; *Q. D. de Potentia*, q.9, a.3, ad 1.

3. Outside the aristotelian tradition, for centuries now the name *metaphysics* (as the adjective *metaphysical*) has had almost as many different meanings as there have been authors to use it, its etymology being the only common aspect of the word to survive.

4. *Ia Pars*, q.13, a.6, c.

what appears to the senses and allows us to tell it from a cow, or pig, etc. These colours, textures, sounds, we can name at once, and, in such instances, 'that from which the signification is drawn' does not differ from 'what the name is intended to mean,' although that to which these qualities belong is still not truly known as to what it is in itself absolutely.¹

But it is perhaps well to point out that these qualities or operations which lead to a first attempt at naming a thing like a horse are not to be confused with the distinctive properties which truly set a horse apart from other things. Further knowledge may oblige us to change our minds about what constitute real differences. We may become acquainted with an animal like the zebra, let us say, possessing all the traits we had assigned as peculiar to the horse, and yet endowed with a few more of its own. What was thought to characterize a horse would now appear to be only something it has in common with certain other animals. In other words, if we assumed that we knew a given substance, e.g. a woodpecker, as to what sets it apart from all other things absolutely, just because we knew the word 'woodpecker' in its derivation from some other words previously formed to signify a substance and operations or effects of what we call a woodpecker, we would be like a man who, understanding that *bluefish* is derived from *blue* plus *fish*, insisted that every blue fish ought to be a bluefish, and all bluefish, blue. — Such examples may seem somewhat outlandish, yet the confusion they illustrate is widespread among philosophers and even among their critics.² To cling to first impositions as the only valid ones may be just as foolish as to lose oneself in vague, extended meanings without comprehending the basic imposition to which these may owe their force.

3. *Names that are not taken from other things*

It should be noted, however, that names signifying substances, such as *man*, *horse*, *tree*, *stone*, etc., can never have the immediate meanings of words like *noise*, *smell*, *sweet*, *pain*, *large*, *smooth*, *inside*, *feel*, *move*, etc. Terms like these are the most basic in any language. Whatever their philological origin, they are not named from other things: *that which* they mean is the same as *that from which* their signification is drawn. Now the fact that this identity holds only in

1. Obvious examples of substance-names taken from a perceptible quality or action already named would be *quicksilver* or *rattlesnake*; they do not signify the fluidity of mercury or the rattle of a certain type of snake. The word *snake* is another example, being kin to *sneak*, as well as to the Old German *snachan*, to creep.

2. The criticisms leveled against philosophical jargon by the 'logical positivists' are only too often well taken and should be turned to advantage.

the case of objects immediately known by our senses¹ should make us aware of how important it is to take into account what happens in the knower between his apprehension of a thing and his naming of it. Different words are intended to signify different things. But the differences indicated by variations in names are seldom the proper differences which set the things themselves apart from one another. If the knower, who imposes a meaning upon a word, does not actually attain the essential differences between the things named, he may in his naming of them, refer to some trait which, though admittedly not the essential difference, is used instead of it — as in the name *rattlesnake*. If we assumed that the warning sound referred to in this name, which is that whence it was imposed, was actually *what* the name meant, we would imply, gratuitously, that this sound was the essential difference of *that which* we name.² To sum up, if the essential differences between things were grasped at once, the differences of names would be taken from them: *that whence* they signify would be *that which* they signify — the specific differences of the things themselves. The whole relevance of the distinction between the specific difference of the thing itself and the trait from which the thing's name is taken derives from the fact that we do not know outright the essential differences of things, and that we can name things only as we know them.³

1. As we shall see in Part II, chap. 3, there is a notable difference between interpreting a word like *horse* by pointing to such an animal, and interpreting the word *white* by designating a white horse. What we call *white* is something sensible *per se*, whereas a white horse, as a substance, is sensible only *per accidens* — as we shall explain further on.

2. The word *rattlesnake* may, as a composite name, be used to confirm the distinction between etymology and signification. For, that which this name signifies, is not the two things called *rattle* and *snake*, these being only that 'from which' the name has been imposed. The components of this name can signify separately, but they cease to do so when taken together as one name. "The reason is that a single name is imposed to signify a simple concept; for, that whence the name is imposed to signify is not the same as that which the name signifies; as *lapis* from *laesio pedis*, which is not what the name signifies: for it was imposed to mean the concept of a thing. Hence it is that a part of the composite name imposed to signify a simple concept, does not signify part of the composite conception from which the name was imposed to signify. An expression [e.g., 'pale man'] signifies the composite conception itself: hence a part of the expression signifies a part of the composite conception" (ST. THOMAS, *In I Perih.*, lect. 4, n. 9).

3. "That a name is said to be imposed 'from something' can be taken [a] either on the part of the one who imposes it, or [b] on the part of the thing upon which it is imposed. In the latter case, a name is said to be imposed from that which completes the notion of the thing it signifies, viz., the specific difference of the thing [i.e. that which sets it apart from other things]. However, since the essential differences are unknown to us, we sometimes use accidents or effects in their stead . . . and name the things accordingly. And thus it is that, whatever is used to take the place of the essential difference is also that whence the name is imposed, considered on the part of the one who imposes the meaning: as when *lapis* is imposed from an effect, *laedere pedem*. And this need not be that which the word is intended to mean before all; the word means that instead of which we use the effect [viz., *laedere pedem*]" (ST. THOMAS, *Q. D. de Veritate*, q. 4, a. 1, ad 8).

However, though the relationship between meaning and etymology should not be confused with the dependence of a new and extended imposition upon a prior meaning, it must not be thought that knowledge of a word's origin is of importance only to the philologist. Etymology, providing as it does a kind of reason why a given word was formed and used to signify this or that, has the advantage of referring us to something known even before the first imposition of that word. For instance, the verb 'to manifest' — meaning 'to show plainly,' 'to make to appear distinctly,' 'to put beyond question or doubt' — comes from the Latin *manifestare* which was originally taken from *manus*, hand, and *fendere*, to seize; *fur manifestus* meant 'a thief caught in the act.' This word, then, referred originally to the most basic of our external senses: to touch, and to the palpable.

4. *The relevance of names signifying things first known to us*

Many of the so-called technical terms of philosophy look forbidding (if not pedantic) because they are borrowed from another language, like the word 'philosophy' itself. And they appear all the more remote because they are usually taken according to later, more abstract impositions which had become theirs in that language. Such is the case with the words 'syllogism' and 'abstraction,' for example. Even in Latin, the adverb *sylogistice* (used by Cicero), or the Low Latin noun *sylogismus*, refer immediately to an extended meaning of the Greek *συλλογισμός* used by Aristotle in logic. The word derives from *συν* (with, together) and *λογίζομαι* (to count, to calculate, and finally, to reason). So, in Latin, French, and English dictionaries, the very first meaning of 'syllogism' is 'a term of logic,' and reference is made to Aristotle. Actually, the word was once used by the man in the street who knew nothing about its extended meaning, and he would have been puzzled if told that the 'syllogism' was the invention, or discovery, of the founder of the Lyceum — as we are at times led to believe. Yet the passage from the meaning of the word in common use to its extended meaning can be followed as easily as the transition from 'light,' as in 'sunlight,' to 'enlighten,' as in 'enlighten me on this subject of geometry.' Both in French and in English, the disparaging remark 'What does reasoning have to do with syllogisms?' may well draw applause from the gallery. Such a reaction is only natural when the borrowed term is used outright to signify something which, without reference to something more known or more knowable to us, can be understood only with difficulty, or not at all. Such a reference must be provided either by an earlier imposition, or, if they are not the same, by the etymology which helps us to grasp that previous meaning. Failing this verification, such so-called technical terms take on an air of fraudulence which calls for exposure so long as one is presumed to know just what they mean.

The same holds for the word 'abstraction.' Both in French and in English it means, first and immediately, something far removed from what is more known to us : viz., a certain operation of the mind, or the status of something related to thought as distinguished from mere sensation. The original Latin (just like the Greek ἀφαίρεσις) conveyed 'the act of drawing or separating from,' a meaning very near to the etymology : *ab, abs* (from) and *trahere* (to draw, pull, take away). The sculptor, hewing away stone from stone, performs an abstraction in that primitive sense of the word. (This meaning was retained in the English adjective 'abstract,' but is now archaic.) Present-day discussions on the nature of abstraction show how bewildering are the consequences of using words intended to mean, from the first, something which can be properly known only by dependence upon something of which we are immediately aware.

The need to lead extended meanings back to those that can be verified of things more known and unquestioned would not arise if, with Descartes, we could assume that what is most knowable in itself can be equated with what is most knowable to us — which is indeed the case in mathematics. To him, the words 'God' and 'soul' meant something first and most clearly known to us by intuition.¹ He believed that he was using the word 'soul' according to the sense in which Aristotle uses the word ψυχή (originally 'breath of life') in Book III of *De Anima*, i. e., intellective soul. We do not mean that Descartes had nothing in mind when he used this word, but only that he nowhere provided a means of verification. Nor would he need to do so if we enjoyed the kind of intuitions with which he credits us.² Actually, many later impositions of words depend upon a process of reasoning based, in the last resort, upon sense experience. For we can name things only insofar as we know them. Hence the very words we use to signify things that we can never know except by discourse, could not otherwise obtain such a particular meaning for us. Any statement containing, for instance, the word 'soul,' taken in a sense far removed from experience, yet with the assumption that this could, or should be its first imposition — like that of words for things immediately known, such as *hot, white, breath* — is going to be like any other enunciation made in terms not sufficiently grasped by its author. The neglect of primitive meanings opens the way to a philosophical jargon that all can repeat but no one understands.

5. *Philosophical terminology*

It has been observed that the original meanings of words have to do with things of rudimentary sense experience and practical life.

1. *Discours de la méthode*, part. IV ; also *Méditation II*.

2. Note that we are not speaking of propositions, but simply of the meaning of the words.

For instance, the Greek for 'soul' (*ψυχή*, whence our *psyche*, *psychic*, *psychology*, *psychiatry*, etc.) first meant the *breath of life*; while the Latin *anima* was used for *air*, *a current of air*, *a breeze*; and we saw that the adjective 'manifest' meant *seized by the hand*. For this reason, many believe that to recognize the simplest words of common speech (although the whole of Aristotle's vocabulary, however awesome it may have come to look in modern languages, was derived from them) as relevant to philosophy, is to condemn the latter as a science and abandon it to anthropomorphism. This is a denial of the progress of knowledge from more to less known. Rather than surrender to words in common use, some suggest that the philosopher should create his own vocabulary, out of nothing, so to speak, and employ only 'technical' terms divorced from usual meanings; much as the mathematical physicist, who must have recourse to symbols from the very start.

If this position were correct, it would imply that philosophy is a body of knowledge unrelated to what is actually more known to us; that it is based, perhaps, on some intuitions that are the privilege of a few; the only ones to have the right of calling themselves philosophers; or that the science is based on intuitions proper to some particular school. In effect, the reason why one does not understand the technical terms would be the lack of the proper intuitions. This position, which is rather widely held, implies that progress from the more commonly known to the less known, as well as the new impositions of words that attend it, cannot be achieved. Thus a word whose more original meaning referred to something practical, like 'manifest', *to seize with the hand*, could never be used to signify, in a proper sense, anything but that; or even 'symbol,' which meant the sign of a convention or contract, such as a wedding-ring, could not be reasonably extended to mean the sign of a collection that cannot be named.¹ So that once a word has been used to refer to something in the order of sensation or in that of action or of making, it should never be employed to mean anything else in any proper sense. If such were the case, we admit that philosophy could not name anything. And the reason is that there would be nothing known to require a name.

V. A NEW IMPOSITION OF THE NAME 'MATTER'

What is meant by 'matter' in the statement that a thing is intelligible in act only insofar as it is abstracted from matter? (We will pay no attention for the moment to what 'intelligible in act' may mean). It is also said that a thing is knowable only by reason of its 'form.' In treatises of philosophy these terms are often used with-

1. ST. THOMAS, *IIa IIae*, q.1, a.9.

out apology in a sense far removed from the meaning we know best. Let us here try to identify their meaning by taking an example from something well known, which leads us to a primitive meaning of 'matter,' viz., timber, the stuff that is used to make houses, tables, broomsticks, etc. 'Form,' on the other hand, originally meant the contour, shape or figure of a thing, e.g., the form of a bowling-pin.¹

1. 'Matter' as a connotative term

'Timber' happens to be a good example of a connotative term, since it does not mean just wood, but wood with reference to something to be made of it. Now, none of the class of things that are made of wood will be sufficiently described by 'made of wood' or 'wooden,' since a table, an oar, a toothpick or a house may all be equally wooden. They are distinguished by their shape or the arrangement of their parts, i.e., by their form. With respect to all these kinds of wooden objects, timber is a material still to be formed; and it is only when the timber is 'that of which this kind of thing is made,' or when the timber has taken on such a shape, that we have 'that for the sake of which' timber is. If this should be a table, it will not be primarily because it is made of wood — for it might still be a table even if made of metal or plastic — but primarily by reason of its shape or the disposition of its parts. In short, it is by reason of its form that this object is identified as a table and distinguishable from a bowling-pin.

2. Shape or form and matter are both principles of differences

At first sight, it might appear that, since a bowling-pin differs from a broomstick by its shape, we may, in defining or describing it, ignore the matter and give our attention only to the form. It is clearly the form of the bowling-pins which explains how they can be put up and knocked down in such a fashion as to make sport for the players. Yet, it should also be clear that we cannot afford to neglect the matter. The material must be wood or something like it.

Of wooden objects, the form is the principle of difference. Yet, when we want to distinguish wooden from non-wooden objects, we see that the matter too is a differentiating principle, though not at all in the same respect. That which a thing is made of is essential to it as the subject of the form; since the thing could not be what it is

1. The emphasis which we are placing upon the original meaning of a word is not intended to suggest that this same meaning is to be identified with its subsequent uses; but rather that to neglect original meanings entirely could lead to confusion with respect to later meanings. Etymology, in the historical and philological sense, can be the key to more abstract meanings of the same word. The principle involved is that even today, a word must be made to refer first of all to something more known to us, before we apply it to something less known. We always have to know what we are talking about.

without some kind of subject. Plainly, then, from the definition of bowling-pin matter may not be excluded. The matter that is thus part of the definition is called 'part of the species,' i.e., part of the kind of thing we are speaking of.

Notice, however, that the matter we put into the definition is not the matter of *this* bowling-pin, but only the *kind* of matter that the whole set of pins is made of, viz., wood. 'Wood' is never '*this* wood.' If it were, the wood of *this* bowling-pin would be all the wood there is, and there could be no other wood nor any more bowling-pins. 'To be a bowling-pin' is not the same as 'to be *this* bowling-pin.' Bowling-pin can be said of any one, while *this* bowling-pin can be said of only one. Hence, when we say *what* an individual thing is, the *what* compares to the individual thing as form to matter. For example, when we call a certain tool a saw, 'saw' is to this single tool as form to matter. It should therefore be clear that even the matter which enters into the definition (as steel in the definition of saw) has the nature of form if related to a single specimen of the thing defined (as steel in general has the nature of form as regards this particular saw). Thus we have a new imposition of the words 'matter' and 'form.' To return to our bowling-pin, 'matter' now will be individual bowling-pins as instances of 'bowling-pin.' It is in this sense that 'rational' and 'irrational' are called the subjective parts or matter of the predicable universal 'animal.'

3. When 'matter' refers to a principle of sheer numerical difference

'Matter' is used in still another sense, this time as a principle of difference. The bowling-pins of our set all have the same shape and are made of the same material. The same definition applies to each one of them. Yet they differ numerically: *this* one *here*, is not *that* one *there*. How can we account for this purely numerical difference? Of course we might argue that *this* particular pin differs from the others because it has been placed at the apex of the triangular grouping. But this position does not alter its shape nor the stuff of which it is made, and any other pin might just as easily have been set in its place. In short, the fact that it is a bowling-pin does not require that it be *this* one, *here* and *now* at the apex of the triangle; in other words, no amount of description of *this* bowling-pin considered by itself can account for its distinction from the others. When we identify it as the one closest to the player, we say nothing of what it is in itself. The shape and material that enter into the definition of bowling-pin do not account for *this* particular one qua *this*. 'That which' we define (the *definitum*), as well as the definition itself, can be said or predicated of any particular bowling-pin, and any and every pin is a *this*; yet both *definitum* and definition 'abstract' from each and every individual bowling-pin as a *this*.

4. '*Matter*' as a principle of sheer numerical difference
must imply '*amount*' of matter

Although apparently not differentiated in shape, size, and type of matter, our bowling-pins are actually not so much the same. Actual measurement would show them not exactly the same in form and size, and careful analysis would be sure to find structural differences in the grain of the wood, and even between its individual cells. But none of this expert information is needed to realize that *this* pin is not *that* one. And even if we did take into account the hidden differences in these pieces of wood, cut from the same tree, we would never hold such differences to be the reason why *this* pin is not *that* one. We are never going to maintain that, if the pins were actually as similar as circles of the same radius, they would lapse into a single pin ; or that, if all electrons were quite equal in charge — a basic supposition of the physicist — there could be only a single one. And even though we did grant of real objects, that any single thing in the real universe, or any single part of such a thing, must differ from every other single thing or part of such a thing by reason of the ' what it is ' expressed in its definition, we would still be left with those individual circles of equal radius that are used in Geometry. They give rise to much the same problem.

Perhaps we can narrow down the problem by asking why it is that we can have a whole set, and even many sets of wooden bowling-pins, apparently all the same so far as the maker and user of them are concerned. The answer might simply be ' because we have enough of the right kind of wood — and we could have as many as you please, so long as there is the wood to make them.' This seems to place the burden of sheer multiplication of individuals upon the stuff that our bowling-pins are made of, upon their matter. Yet not on the wood alone, but upon the *amount* of it ; or, to put it otherwise : upon how much wood there is available. Whatever that *amount* is, it must be an amount of *wood*. The same amount of water would not do. Nor can the amount or quantity be indeterminate when we realize that the size of each of our pins is the same. The same problem arises concerning the many, when these are the same size : how can they be many while similar in every other respect ?¹ Size will distinguish one pin

1. At this point some reader may begin to wonder what it can matter, since we know that there are such individual things ; and so to conclude that the whole problem had better be thrown out. But this will be like arguing : who cares what horses are, so long as we know that they exist ? and, if they truly exist, why question their possibility ? It has been maintained that the principle of individuation is precisely that incommunicable existence realized only in the individual. Now, we do not question the fact that only singulars exist in reality. Our problem concerns a special type of real individuals, those all of one kind. To assert that they are individuals because of their existence is like saying that they are apart because they are not together. What we want to know is simply this :

from the next no more effectively than shape, colour, or quality of wood. Or to put it in another way, the quantity or size of the pins calls for individuation no less than the wood of which it is the size. It is not 'fifteen inches high' that makes it *this* pin, or even *this* height, for all the others are the same in this regard. It is not quantity as size that plays the essential role in individuation. A thing may have its own quantity for so long as it exists, and that same quantity may vary in size at different times. The dimensions of Socrates were his own throughout his life no matter how much they varied in size. This is what is meant by the distinction between quantity as *dividing*, and quantity as *informing, ordering* the parts of the whole and terminating it. It is the former that has to do with individuation.

5. *Things differing no more than by number are indefinable*

It is not our purpose to define here what the principle of individuation is. Our aim, for the moment, is merely to point out that things which are many, yet indistinguishable in kind, cannot be accounted for in their numerical distinction by defining or describing *what* they are. The reason for their distinction must be something other than what is expressed in a definition or a description. Whatever it may be, it has something to do with *this* matter of *this* quantity, something that can be designated in sensation, a something here and now. In other words, if an individual of a particular type can be neither defined nor described as an individual, the reason must be something extrinsic, foreign to what we can know of it by the definition or description; and it must be something irrational, since it allows a thing to be *this* without any discernible differentiation from *that*. In the definition of a bowling-pin, by itself, there is nothing to limit the number of individual pins; such a limit will be determined by the available wood and the powers of *these* craftsmen. Similarly, that the individuating principle is something irrational is clear because none of these individual things can be known to us except in the act of sensation. It can be true to say "this is a bowling-pin," and truth is in the intellect; but

how can they be distinct in existence when, in every other respect, they are the same? The answer: 'Because they exist distinct from one another,' is something we already know. Some have also held that the principle of individuation is precisely the 'thisness' of the thing that is 'this.' But such a reply merely indicates what the question is about, leaving us still with the task of discovering what gives rise to it. To say that a thing is 'this' because of its thisness is pretty much the same as saying that a horse is a horse because of its 'horseness,' and does not help much if our aim is to learn something about horses. We have still got to find out what 'horseness' is, and no amount of mere designation can shed any light on the matter. This kind of verbalism became popular and was made fun of by MOLIERE, when he had the doctors pronounce that opium causes sleep "because there is in it a sleep-inducing power whose nature it is to lull the senses — *opium facit dormire quia est in eo virtus dormitiva cujus est natura sensus assoupire.*"

intellect does not hold this truth, except with reference to the thing actually sensed.

The act of reason alone, apart from sensation, does not attain to *this* thing here. Of course we know this kind of truth by our intellect — e.g., that this object is a man — but only with dependence on a particular sensation here and now. However, this truth is not attained by the kind of knowledge which proceeds by way of definition and demonstration : it is not reached by science, if the term science is taken strictly. While whatever is true of man can always be said of *this* man, the truth of ' this man is mortal ' depends upon an act of sensation. Such a proposition of course adds nothing to science, even though science can exist only in individual men, and they alone can contribute to it.

6. *In what sense science cannot be concerned with the individual*

The doctrine that science cannot be concerned with the individual is frequently misunderstood and interpreted as haughty indifference to reality. Small wonder if the reader's indignation is aroused when he learns that he is of no interest to science unless, for example, he displays some exceptional endowment, or even disease ; and that even this distinction is merely incidental to him, since anybody else with the same peculiarity would do just as well. But the point is that speculative science does not pretend to replace every kind of knowledge. It is only one kind — that which is pursued for the sake of knowing, insofar as ' to know ' can be sought for its own sake. And it remains true not only that the individual of sensation lies at the source of all knowledge, even of the most abstract, but also that science can never be indifferent to the qualitative varieties between individuals. Unless we know that human nature can assume widely different types, we know it very imperfectly indeed. When it is asserted that the individual is of no concern to science, the meaning is merely that the same thing over and over is of no concern to science ; while this individual, this duplicate of his fellow, remains of the first importance in the domain of action.¹

1. The doctrine applies with equal truth to emperor and clown. For as soon as we realize that the emperor could have been another man, indistinguishable in character, ability and motives, so that the substitution of one for the other would leave the course of history unaltered, we see that the actual historical personage is unique only as a matter of bare fact. His case is comparable to that of a given equilateral triangle, let us say, compared to another exactly like it. To argue that the perfection of speculative science is to be sought in such knowledge of the individual would be like holding that the aim of geometry is to contemplate, one after the other, all possible equilateral triangles of one size. There could be no end to this sort of thing. Wherever it began, and in whatever direction it proceeded, science could meet with nothing but frustration. To put the same idea in different words, the mere individual can never be pinned down except by designation through an act of the senses — *this, here and now*. No amount of description ever touches

Such is the 'individual matter' that science abstracts from, and which cannot be its subject, though the subject can be said of any individual of its kind. Of course, individuals are *used* in the study of nature, and the more one wishes to learn about man, the more one must turn to individuals. Yet while learning from them, they themselves are not 'what' is learned from them. Because of the real existence of *this* or *that* individual, we know that 'man' exists in the sense of being true; but from true propositions about man — e.g., that man is mortal — we cannot infer the existence of an individual, like Socrates, who can be known only through an actual sensation, or through the report of such an awareness. — It is in a somewhat similar way that we imagine and use a particular straight line, designated by 'AB,' to demonstrate by way of a construction that there actually is a kind of triangle whose sides are equal. Yet, from the existence of that kind of triangle — 'existence' being taken here in the sense of truth — we cannot infer that such a triangle exists in the way that Socrates does.

VI. 'A THING BECOMES INTELLIGIBLE IN ACT INsofar AS IT IS SOMEHOW ABSTRACTED FROM MATTER'

1. *An illustration of what it is to make something intelligible in act*

What do we mean by 'intelligible in act'? It is by making them actual that geometrical constructions are discovered, e.g., by actually dividing or protracting a line which was only potentially divided or protracted.

If the figures had been already divided, the constructions would have been obvious; but as it is they are present only potentially. Why are the angles of the triangle equal to two right angles? Because the angles about one point are equal to two right angles. If, then, the line parallel to the side had been already drawn upwards, the reason would have been evident to any one as soon as he saw the figure.¹

In other words, it is by making actual that which was only potential, that we come to know it. And the reason is that thinking is an actuality. We would never know this property of the triangle if its base were not actually protracted.

the individual. To assume that it can is to assume that there could never possibly be another like this one. As we describe Alexander the Great in all that made him different from every other figure of history, we might still be talking about somebody else. And this is what is meant by the statement that the individual is ineffable: all that can be done is to point him out.

1. ARISTOTLE, *Metaph.*, IX, chap.9, 1051 a 23.

The instance of a geometrical construction was chosen because it is more obviously a case of making something actually knowable than will be any example of the kind of actualisation which we perform when we make the things of sensation intelligible in act.

2. *The sheer individual cannot be rendered intelligible
in act qua individual*

If by 'intellect' we mean the power of our mind to define and to demonstrate, and by 'intelligible,' that about which there can be such an activity, then, as we have already pointed out, the individuals of sensation cannot be attained by the intellect directly, but only with reference to sensation of a *this, here and now*.¹ But how do we get hold of that which the intellect properly attains, and about which there is demonstration? It is enough to realize, here, that we do form propositions like 'Socrates is a man,' 'Plato is a man,' and that, while the subjects of these propositions stand for different individuals, their predicate is common, signifying one and the same kind of thing attributed to both subjects in the same way. Neither this individual, Socrates, nor that one, Plato, can be said of anything else, whereas 'man' can be said of every individual man. Now we can define man and describe him in such a way as to set him apart from any other kind of thing. But, as we saw, we could not do as much for the individual thing attainable only by the designation *this, here and now*. We can say *what* this individual is, namely, 'a man,' or 'the kind of animal that makes automobiles, constructs theories about the universe,' and so forth; but it remains clear that 'what it is to be a man' is not the same as 'to be *this* man.' To put the thing a little differently, when speaking of this individual thing, we have got to distinguish between '*what kind*,' meaning of what it is an instance, and 'which one,' meaning which instance of it this is. Only the *kind* of thing it is is definable, and demonstration can concern only the *kind* of thing it is. That is what we mean by saying that 'man' is 'intelligible in act,' whereas Socrates is not. There is no science about 'what it is to be this individual who is Socrates.'

There remains of course a sense in which the individual is a remote principle of science, viz., in the enumeration of particular instances leading by induction to a universal. But note, again, that even here any one of these individuals might have been replaced by another. There is also the sense in which individuals of the same kind may be severally a term of the science, viz., when we apply what is scientifically

1. The question of the distinction between intellect and sense: whether they are distinct faculties, or constitute one and the same power of knowledge, does not concern us here. It is enough, for the moment, to recognize that to know what a thing is, even if only confusedly, to define it or to prove something about it, are not the same kind of activity as to feel warm or cold, to see red, to hear a noise, and so on.

known to *this* that we designate in sensation (the universality of the demonstration implies that such an application must be valid).¹ But what can never be is a science having Socrates as its proper subject ; for, if such a science could exist, ' what it is to be this *kind* of individual ' and ' to be *this* man Socrates ' would have to be utterly identical, so that nothing else could be an individual of his kind. Further, ' what the science is about ' would be in every respect as variable, as contingent, as what we know in actual sensation ; in other words, ' what it is to be a man of this kind ' could have existence, in the sense of truth, only so long as Socrates himself existed, and only for so long as we had actual sensation of him — whether he really continued to be or not.

3. *Knowledge of the individual could not be the aim of speculative science*

Again, if ' to know ' is that for the sake of which this kind of science is pursued — as distinguished from knowledge sought for the purpose of learning how to make something, or how to behave — and if, at the same time, the essential function of the science were to apply what is known to this individual and that, of the same kind, then the aim of such science could be achieved only through a process of designating successively and unceasingly, not merely distinct individuals of the same kind, but even the very same individual, over and over again ; for, this individual thing is knowable qua *this*, *here* and *now*, only for so long as it exists, and could be known in this manner only for so long as we would be in the act of designating it — a process which must be constantly renewed, subject as it is to the passage of time. In short, ' this thing here and now,' owing its individuation to the kind of principle pointed out above, can never possess the intelligibility and necessity essential to the subject and principles of science in the strict sense of the word.

The individual is to the true subject of science as the potential to the actual ; and even when it is spoken of as ' made intelligible in act ' the meaning is not that the individual can be rendered intelligible in act qua individual. It is not *this* thing qua *this* that our mind makes to be intelligible ; it is only ' what it is an instance of ' — that which it has in common with things the same as itself — that can be actualised and understood. It is the ' what ' of *this*, and not the *this*, *here* and *now*, that is called actually intelligible.

4. *The contingency of the individual is another reason why there can be no science of it*

Still another aspect of the potentiality that keeps the individual beyond the immediate grasp of science is revealed when we consider

1. ST. THOMAS, *In Boethium de Trinitate*, q.5, a.2.

that Socrates may now stand, then be seated, or even cease to be at all, without affecting the ' what it is to be a man ' which is the concern of science. Change affecting individuals does not oblige the notion of change to change. Even when science is about what is variable or what ceases to be altogether, ' what it is to be variable ' or ' what variation is,' remains invariable. Thus, ' what movement is ' is not in movement, and ' what it is to be contingent ' is not contingent : the right definitions of movement and contingency are changeless and necessary — unless we hold that all attempts at definition are equally good, or that things are as anyone chooses to have them. It may be objected that, in the pursuit of science about nature, most definitions are provisional and subject to revision ; but this is only because they belong to an order of research in which we ourselves are subject to change and contingency. It goes without saying that to be on the way towards a goal is not the same as to have already reached that goal ; but, if there were no goal, the pursuit of it would be meaningless. Nor are the things that we try to know in a scientific way other than they are when we do not know them ; nor do they cease to be what they are when we do not actually consider them. The one who possesses scientific knowledge may be subject to change, he may forget, or die, but the mutability of the scientist does not destroy the subject of the science and its properties.

5. *The ultimate aim of the science of nature cannot be to know
this universe qua " this," but to know
what it is in kind*

In conclusion, the science of nature cannot be science about this universe of ours qua *this*. The physicist assumes that the laws governing the universe, which he seeks to know by gradual approximation, progressing by hypotheses and provisional theory, would apply in every universe of the same kind as ours. So far as science is concerned, there might be another universe, governed by the same laws, quite indistinguishable from the present one in every respect. The only difference would be one of number. The numerical difference we can bring home to ourselves by reflecting that *this* universe is the one that we are alive in ; we feel ourselves alive in it when we touch, taste, smell, hear or see, conscious of this awareness, *here* and *now*. For no one else can be myself, no matter how like me in every respect. Similarly, although another universe can be wholly like the present one, none can be *this* one, since our incommunicable selves are part of it qua *this* universe (even though we, as *these* individuals, are not part of it as to its kind). *This* universe of ours is a matter of history, not of the kind of science we are invited to study here.

... In all formations and products whether of nature or of art we can distinguish the shape in itself and the shape in combination with matter.

For instance the form of the sphere is one thing and the gold or bronze sphere another ; the shape of the circle again is one thing, the bronze or wooden circle another. For when, of sphere or circle, we state ' what it is ' we do not include in the definition gold or bronze, because they do not belong to what those things are, but if we are speaking of the copper or gold sphere we do include them. We still make the distinction even if we cannot conceive or apprehend any other example beside the particular thing. This may, of course, sometimes be the case : it might be, for instance, that only one circle could be found ; yet nonetheless the difference will remain between the being of circle and of this particular circle, the one being form, the other form in matter, i.e. a singular. Now since the universe is perceptible it must be regarded as a singular ; for everything that is perceptible subsists, as we know, in matter. But if it is a singular, there will be a distinction between the being of ' this universe ' and of ' universe ' unqualified. There is a difference, then, between ' this universe ' and simply, ' universe ' ; . . ."¹

6. *A new imposition of the name matter,
to signify a part of the definition of natural things,
viz., " sensible matter "*

To return to our old example, the name ' bowling-pin ' can be accounted for by pointing out this particular bowling-pin. But if we are asked ' what a bowling-pin is,' it will not be enough merely to state its purpose and describe its form ; we shall also have to show ' what it is made of.' A bowling-pin, of course, is only an artifact, but the things that surround us in nature are like it in this respect : the matter or ' what they are made of ' should enter into their definition. No man is a man without bone, muscle and nerve of some special quality, arranged in some manner peculiar to man. ' What it is to be a man ' is not indifferent to the kind of matter that belongs to what he is.

So bone, muscle and nerve, the matter of man, must be considered by any genuine science of man. It should be clear, however, that this does not mean the bone, muscle and nerve of Socrates the individual, although our scientific findings are going to apply to his matter truly enough. What science does, then, is to abstract from individual sensible matter, but not from common sensible matter. But now a question arises : if science abstracts from the individual sensible matter attained in sensation, why, in speaking of the bones and flesh that are essential to man as such considered apart from this or that particular man, do we still use the qualification ' sensible ' ? The matter that enters into the definition cannot possibly fall under the senses as does that of Socrates ; bones and flesh, when they are those of ' man ' as defined by science, produce no alteration in the

1. ARISTOTLE, *De Coelo*, I, chap.8, 277 b 30. (ST. THOMAS, *ibid.*, lect.19).

senses. Why, then, retain the adjective *sensible* to describe an abstract matter which cannot be actually sensed?

Philosophies of experimental science are so distrustful of our senses in the study of nature that they are quick to make objections to the argument that sensible matter must be included in scientific definitions. Some of these objections must be faced now, even though this will oblige us to anticipate a few points of doctrine to be made later, *ex professo*, in that part of natural science which is studied in the treatise *On the Soul*. The need to explain what is meant by the archaic phrase 'common sensible matter' might perhaps be made to seem less acute by substituting for it the more conveniently vague and non-committal 'reference to sense-experience.' But this would merely be to evade a problem basic to an understanding of what natural science is about in each and everyone of its parts. Moreover, in our day, we have an obvious reason for continuing to use the old, candid and exact expression, a reason better than any the ancient philosophers could have dreamt of. The present knowledge of anatomy, physiology and, more especially, of the chemistry and physics these involve, have made us realize that the very organs of our senses can never be described adequately in terms of what we know first in sensation. Knowledge of the ultimate constituents of these organs, whatever they may be, would presumably lead us far away from anything that can be rendered in terms of sensible qualities like hard and soft, wet and dry, warm and cold, or in terms of taste, smell, sound and colour. So it is more important than it ever was to bear in mind that these sensible qualities are what we know first and best and that, no matter how far investigation may lead us away from this familiar realm, it continues to be the indispensable starting-point of all our knowledge about nature, and one to which we must always return. Unless anchored in sense experience, the study of nature can never keep to the right track, nor lead towards the truth.

If such a beginning and end in sensation are necessary, and if it is the 'sensible individual' matter that this science must abstract from while not abstracting from the 'sensible matter' that enters into the definition of natural things, we will first have to look more closely into what is meant by 'sensible' in this context.

7. '*To be sensed*' is not a property of sensible things

It is sometimes assumed, quite wrongly, that to call an object sensible is to assert its 'sensibility in act' as a property really inherent in it. But 'to be sensed' or 'to be sensible in act,' when applied to the things of nature, is manifestly a mere extrinsic denomination borrowed from the sense faculty of the animal. Things that we sense do not depend upon sensation to be what they are; even if there were no faculty to sense them, they would hold themselves unchanged. 'To

be actually sensed' cannot alter the state of the thing that produces the sensation, except incidentally, as when the temperature of my hand affects the temperature of the thing I touch. This sort of alteration is not sensation, and a piece of inorganic matter, if brought into contact with the object, could produce the same result.

The act of that which is sensible in act, as such, can only be in the sense. If 'to be actually sensed' were something of the object sensed, no object could be what it is unless actually sensed; so that if there were no animal to sense it, a thing could not exist nor be what it is in itself. Further, since the actuality of being sensed is essentially in the knower, 'to be sensible in act in itself' would imply that the thing must be in the act of sensing itself. To put it still another way: to be sensed, the thing that we sense must have an actuality of its own, but this actuality that it has apart from the knower and because of which it acts upon the sense, can hardly be the actuality of being sensed. The actuality of what is sensible in act arises in the knower and can in no way be said of the external agent that produces it; nor is this actuality one in nature with the actuality that produces it.

... The view that [if there were no faculty of sense] neither the sensible qualities nor the sensations would exist is doubtless true (for they are affections of the perceiver), but that the substrata which cause the sensation should not exist even apart from sensation is impossible. For sensation is surely not sensation of itself, but there is something beyond the sensation; for that which moves is prior in nature to that which is moved, and if they are correlative terms, this is no less the case.¹

When 'sensible' and 'sense' are said to be correlatives, the true reason for referring the one to the other is to be found on the part of the sense-faculty: the thing is called sensible because the sense refers to it.²

Hence the matter in our definitions of natural things is called sensible inasmuch as it may cause sensation, not because it is sensed. This shows, too, that the sensible matter of definitions is not confined to those things of which we can have an actual sensation, like a tree. Anything that is one in genus with what we can actually sense will be defined as made of sensible matter. When we call bones and flesh sensible matter, we make this denomination with reference to the sense faculty that is its foundation. And while it is true to say that things external to the percipient are sensible in potency, this potency is not to be understood as one that can be brought to an actuality inherent in what is sensible in potency. The actuality of the potentially sensible is still what it is even if, *per impossibile*, there could be no sensation.³

1. ARISTOTLE, *Metaph.* IV, chap.5, 1010 b 30. ST. THOMAS, lect.14, nn.706-707. Cf. *De Anima*, III, chap.2. (ST. THOMAS, lect. 2, nn. 596-597.)

2. ARISTOTLE, *Metaph.*, V, chap.15, 1021 b. (ST. THOMAS, lect.17, nn. 1026-1029.)

3. ST. THOMAS, *In IV Physic.*, lect. 23, n.5.

But there is more to it than this. If by 'sensible matter' we meant something that can be a *per se* object of sense, like warmth, colour, shape or size, then sensible matter, for example, bone and flesh, would not be sensible at all and, if it were, it would not be 'matter'. To show how this is true, we will have to distinguish the various realities which may be called sensible.

VII. THE DIVISION OF WHAT IS CALLED 'SENSIBLE'

Aristotle, in the *De Anima*, presents the following division :

In dealing with each of the senses we shall have first to speak of the objects which are perceptible by each. The term 'object of sense' covers three kinds of objects, two kinds of which are, in our language, directly perceptible, while the remaining one is only incidentally perceptible. Of the first two kinds one [a] consists of what is perceptible by a single sense, the other [b] of what is perceptible by any and all of the senses. I call by the name of proper object of this or that sense that which cannot be perceived by any other sense than one and in respect of which no error is possible ; in this sense colour is the proper object of sight, sound of hearing, flavour of taste. Touch, indeed, discriminates more than one set of different qualities. Each sense has one kind of object which it discerns, and never errs in reporting that which is before it is colour or sound (though it may err as to what it is that is coloured or where that is, or what it is that is sounding or where that is). Such objects are what we propose to call the proper objects of this or that sense.

'Common sensibles' are movement, rest, number, figure, magnitude ; these are not peculiar to any one sense, but are common to all. There are at any rate certain kinds of movement which are perceptible both by touch and by sight.

We speak of an incidental object of sense where, e.g., the white object which we see is the son of Diaries ; here, because 'being the son of Diaries' is incidental to the directly visible white patch, we speak of the son of Diaries as being (incidentally) perceived or seen by us. Because this is only incidentally an object of sense, it in no way as such affects the senses. Of the two former kinds, both of which are in their own nature perceptible by sense, the first kind — that of proper objects of the several senses — constitute *the* objects of sense in the strictest sense of the term and it is to them that in the nature of things the structure of each several sense is adapted.¹

1. *Special or Proper Sensibles*

We must observe that, when asked what is meant by 'warm,' we can only convey our meaning by inviting the questioner to share our experience of warmth. Actually we can do no more than interpret the word by designating an instance of a special object or proper

1. Bk.II, chap.6.

sensible ; in so doing, we refer to a particular kind of experience which the other must be able to share if he is to know what the word stands for. To a man born blind, it will never be possible to convey what is meant by the proper sensible 'colour.'

*2. Common sensibles do not have the ineffable immediacy
of the proper sensible, and are communicable*

'Common' does not mean that they can be perceived by each and every sense, but that they are not the exclusive object of one sense as colour is — though actually they appeal mainly to sight. Note that they are either quantity (like number and magnitude), modalities of quantity (figure, movement, rest), or reducible to quantity or to a modality of it (as time is to movement, and *situs*, i.e. position or order of parts in place, to external figure). The mind can collate and express them in terms of measure, without particular reference to a single kind of sensation. Even the person born blind can know what is meant by 'three marbles,' viz., their shape, size and number. Though blind and deaf, he might be led to an understanding of a phrase like 'the clatter of three, green, cold marbles,' without reference even to the feeling of cold. For, if by 'clatter' is meant the measurable intensity of a certain kind of vibration ; by 'green' a colour defined, not with reference to sight, but to the angle of refraction in a prism ; and by cold that which is expressed on a thermometer ; all these — clatter, green, cold — could be conveyed to him by mere resistance to his touch. It is upon such a basis that mathematical physics proceeds.

Later philosophers called the proper sensibles 'secondary qualities,' and the common sensibles 'primary qualities.' Part of the reason may be that quantity is more basic than quality, inasmuch as a certain division or extension are presupposed to anything that is a proper sensible, as number to octave, or surface to colour. But while this may explain why the common sensibles came to be judged primary, it does not explain how they can be called qualities. Figure is, indeed, a quality of a quantity ; but number and magnitude are quantities pure and simple. That is why we prefer the old division in terms of 'sensible,' allowing as it does for both quality and quantity. But there can be no objection to qualifying the proper sensibles as secondary qualities, provided it be remembered that they are primary in the order of perception, since we cannot perceive a common sensible independently of some proper sensible. By this I mean that, when seeing the size of something, I perceive it through seeing something coloured ; or when feeling the size, I perceive it because of some resistance to the touch. This dependence in perception of the common sensibles upon the proper is perhaps being acknowledged when the former are called, not merely primary, but primary qualities.

3. Sensible "*per accidens*"

There are two basically different ways in which anything can be sensed *per accidens*.

(i) The *per se* object of one sense may be a *per accidens* sensible with respect to another sense, as when sweetness is called visible inasmuch as a white thing may in fact be sweet, the sweetness being *per se* perceptible to taste ; or when the cube, whose shape is a common sensible, is called sweet. An object, incidentally sensible in this manner, remains within the domain of what is sensible *per se*.

(ii) 'To be a sense object *per accidens*' can also mean something quite different. It may be observed, for instance, that Socrates is a *per accidens* sense object, whereas his whiteness or his figure are *per se* sensible. It is *per accidens* that the white thing, sensed *per se* as white, should be a man. For white man does not act upon the sense *qua* man, but *qua* white. 'Incidentally' or *per accidens* qualifies the connection between what is *per se* sensible and what is not so to the sense itself. So far as the sense faculties are concerned, any other white thing, though not a man, would act upon the same sense in the same way. Socrates does not act upon or modify the sense of sight by being a man, but by being of such a colour. Yet, if Socrates is to be called sensible *per accidens*, he himself must be perceived somehow by the one who is sensing. If he were connected with the object that is *per se* sensible without himself being perceived, he could not be said to be sensed *per accidens*.

So, when someone says 'I met Socrates this morning, and he talked to me,' he means that he actually met the man named Socrates and heard *him* talk ; not merely that he perceived a colour pattern and heard a series of sounds, nor that what he met was only incidentally Socrates. And this implies that, while not perceived *per se* by any of the senses, Socrates is known *per se* nevertheless by the one who senses ; though not sensed *per se*, Socrates is yet somehow apprehended *per se* by the one who senses him *per accidens*.

It does not follow, however, that anything thus knowable *per se* should be called incidentally sensible, but only that which is at once apprehended so soon as a *per se* sense experience occurs. Thus, as soon as I see anyone talking or moving himself, my mind perceives him as living, and I can say that I see him live. This shows us that 'to know' or 'to apprehend' does not always mean the same as to have an external sensation. That some faculty other than the external senses is coming into play here ought not to surprise us, realizing as we do that to understand his speech is not quite the same as to hear the sounds that convey what Socrates is talking about. But just what it is to know in this fashion, or what is the power or faculty of the mind by which we have such knowledge is not our immediate concern.

Knowledge of an incidentally sensible object of this kind must accompany every sensation, since all *per se* sensibles are at once perceived as belonging to something that is not *per se* sensed ; and this something, unlike the things we sense *per se*, is never attributable to anything else. When we see that Socrates is white, or hear him talking, we are aware that whiteness is in him, and talking one of his activities, but Socrates himself we do not attribute to anything else.

Notice also that, when it is asserted that Socrates is *per se* known to the mind and only *per accidens* to the senses, this should not be interpreted to mean that *per se* sensibles are only *per accidens* attained by mind. The mind extends *per se* both to what is *per se* sensible to the senses and to what is sensed by them *per accidens*, grasping both one and the other as connected *per se*, for it is not *per accidens* that Socrates has shape and colour. In a similar way the mind apprehends speech both as a series of sounds and as possessed of meaning.

4. *New imposition of the name 'subject' used with regard to what is sensible "per accidens"*

Observe that, in using the word 'subject' with reference to the thing incidentally sensed while apprehending what is *per se* sensible of the man Socrates, we imply a meaning that goes beyond the original and more known one exemplified by 'the floor beneath, and subject to, the table.' The new imposition would also apply to the wood that the bowling-pin is made of, as subject of its figure or form. In this second example, the word 'subject' is obviously not intended to suggest that the matter, viz. wood, is beneath or subjected to colour and figure in the same way in which the floor is beneath the table. The subject of the figure, colour, hardness of the bowling-pin is what we called its sensible matter, viz., the wood. Now, just as the wood, compared to all that is *per se* sensible in the bowling-pin, is the sensible matter of this object, so bones and flesh, compared to all that is *per se* sensible of Socrates, are his sensible matter, viz., the matter of the man as *per se* subject of whatever is known of him by sensation of quality, quantity and modes of quantity. It follows that what we call the sensible matter of Socrates, is sensible only in the manner that Socrates himself is, that is, *per accidens*. When we term his matter sensible, we do not imply that it is convertible with the subject in every respect, as if Socrates were no more than his sensible matter ; we mean Socrates precisely as the subject of what is *per se* sensible in him, and this subject will be that which, in him, is sensible *per accidens*.

Someone may suggest at this point that what we are calling sensible matter seems very like 'substance.' The term substance, however, has so many meanings, most of which are irrelevant to what is intended here, that we may avoid using it until we meet a problem requiring its explanation. For the present let it suffice that 'sensible matter'

refers to that which a thing is made of, like the wood of the bowling-pin, or the bones and flesh of man.

5. *Not every subject of "per se" sensible objects is to be called sensible "per accidens"*

Note further that not everything having the nature of subject with regard to the *per se* sensible is therefore merely sensible *per accidens*. With respect to its colour, for example, the surface of the bowling-pin is a subject, and yet it is sensible *per se*. Sensible matter, on the other hand, is perceived as subject of each and all *per se* sensible objects. But this raises an obvious difficulty. If sensible matter is what a thing is made of, like wood, and if, in its turn, the wood which we designate by means of its qualities and structure is made of something else not called wood — the cells that the fibers are made of and the molecules making up the cells — which do we intend by 'sensible matter?' Here is a problem which would be quite insoluble if the reason for the qualification 'sensible' were forgotten.

The point is that, when we call wood 'sensible matter,' all that we do is to refer to a subject as apprehended in the act of sensing these qualities and structure which are our only means of identifying wood. We have no sense perception of the nature of wood, nor is there any question of an insight into 'what wood is' absolutely. To grant that we can be aware of sensible matter is not to grant more than this : first, that, in perceiving sensible objects, if we can distinguish one from another, in number or in kind, it can only be to the extent that differences in the *per se* sensible objects (like number or figure) may be signs of different subjects (as one man is distinct from another, or from a horse) ; secondly, that we never sense any object without being made aware of some background, incidentally sensible, about which we know only that it has shape, colour, resistance or absence of resistance, and so on. This is the only way in which the incidentally sensible is known while the act of sensation is going on. Even though we may call the matter wood, rather than glass, let us say, the name chosen does not — at least in the beginning — refer to what the nature of the matter is in itself. And when we learn that the wood is made of cells, the cells of molecules, and the molecules of electrical charges, we may qualify these as sensible matter, inasmuch as they are held to be constituents of what is primarily apprehended as sensible matter. For it is surely what we apprehend as wood, and so name, that is made up of those things.

6. *Sensible matter is only "per accidens" sensible*

This shows how important it is to find the reason why that which is known to us in sensation as matter must be termed sensible. Al-

though it must be maintained that sensible matter is known *per se* to the mind, and to the senses only incidentally, this should not be interpreted to mean that the mind thereby knows 'what the matter is' absolutely. When the physicist points to the atom as an instance of matter, and then proceeds to show that it is convertible into energy, hinting, finally, that perhaps there is no matter there at all, he does not use the word as we intend it in the phrase 'sensible matter.' Whether sensible matter turns out to be a swarm of electrical charges or not does not affect what we mean when naming it; bone and flesh are not less bone and flesh for having an inner structure far more intricate and hidden than was dreamed of when man first knew and named them. And to make reference to what is thus called sensible matter is absolutely necessary for, if this reference be withheld or denied, there will be no way of knowing whether what science is elaborating upon has anything at all to do with the reality first attained by us in sense experience.¹

VIII. THE TERMS OF THIS DIVISION IN POINT OF CERTITUDE

In one way or another, all our knowledge depends on the senses. It should also be clear that all the definitions of natural science — whether they are definitions in the strict sense or not — must be in terms of sensible matter. Nevertheless, the physicist in particular feels obliged, from the start, to exclude sense-impressions as leading to confusion. It seems our duty, therefore, to examine what our sense-impressions actually bring us, and in what measure they are to be trusted.

1. *Errors with regard to proper sensibles*

In the text quoted on page 169, Aristotle observed that the proper object of each sense is one about which there is no mistake, as sight is not mistaken about colour; hearing, about sound; taste, about flavour; whereas, concerning the common sensibles, error is normal, as when the size of the sun appears to be about that of a dinner-plate, or when touch reports two objects when we cross our fingers over a single marble. But in that department of natural science called mathematical physics, where only the measurable aspect of things is considered, and in which there is plainly more exactness, the proper sensibles seem to have lost their favoured position. For instance, this water may seem warm to my right hand but cold to my left. What *is* the water,

1. A further subject of investigation would be the relations between real things, and how these are known to us. We would find that, although their foundations may be sensible *per se*, the relations themselves are only sensible *per accidens*. But this is a question too involved for full discussion at this juncture.

then, warm or cold? The trouble is, of course, that my two hands were at very different temperatures when I plunged them into the water. But no such problem arises when a thermometer is used to measure the temperature. Even sight, a more detached sense, does not entirely escape such relativity: I have the impression that this surface is red, while another may see it as a shade of grey; and the surface which, to the naked eye, appears white becomes a shade of green when I wear green glasses. The first difference is explained, to some extent, when it is learned that the man who sees only a shade of grey is colour-blind; but the second example shows that any colour we spontaneously attribute to a thing may also have something to do with the structure of the normal organ of sight in such a way that we always misjudge when in an absolute way we attribute the colour as we see it, to the thing to which our sight refers us. This relativity of sensation is something from which there is no escape.

After remarking that "each particular sense can discern these proper objects without deception; thus sight errs not as to colour, nor hearing as to sound," Aristotle qualifies this statement by adding: "though it might err about *what* is coloured, or *where* it is, or what it is that is sounding or where it is." What is meant by this qualification St. Thomas explains when he distinguishes¹ between the sense as a *thing* reporting to the mind how it is *itself* affected, and that same sense as one thing indicating *another* thing; as 'I have a bitter taste in my mouth while eating this apple', as opposed to 'the apple has a bitter taste.' As a thing reporting on itself, the sense does not err; but when indicating something else it may be responsible for a mistaken judgment. One might object that the apple is actually sweet, but tastes bitter when the tongue is coated by illness. However, even when this difference in taste is accounted for by the unusual disposition of the organ — which gave rise to an incidental error concerning what the apple *normally* tastes like — we still deceive ourselves if we attribute the quality perceived as belonging to the other thing (the apple) in the way in which the sense reports it, even when normally disposed. Spontaneously we do believe that the taste of an apple is wholly in the apple; yet in believing this we go beyond what the sense reports as its own affection. In other words, if my judgment goes like this: 'I sense things *as if* the quality which I perceive were present in the thing itself as my sense refers to it,' then my judgment is unassailably true. And there is surely some quite determinate reason why the sense reports the other thing in that way. How the apple and my sense of taste contrive to produce this kind of sensation is not revealed in sensation. The knowledge which allows me to verify the word 'taste' throws no light on this.

1. *Q. D. de Veritate*, q.1, a.11.

No matter what the conditions of sensation may be, I cannot doubt, when I see a surface as green, that I truly see green, nor doubt that I see it as being in that surface. But whether it *is* there in the way in which my sight reports it is another matter. In fact, the more we learn about sensation the better we realize that qualities are not simply *there* as we sense them. But this does not change the really relevant fact that we do perceive qualities, that the perception of them is real, and that the term 'reality' refers first of all to the kind of being attained in actual and external sensation.

Hence it would be idle to suppose that the senses could be detached from things sensed to the point where they would be as faithful in reporting on these things as they are in reporting their own affections. To put such a demand upon them would destroy their very nature as senses inasmuch as some kind of physical union of the organ with the object, occurring in a way which sensation does not convey, is a prerequisite of sense knowledge. What and how the things which sense refers to are out there simply cannot be known by the senses themselves when, by their very nature, they are organic faculties, operating by, and inseparable from, instruments entitatively part of material reality.¹ Even the organ of our most detached external sense, sight, is being physically affected when we see. Not that the mere physical affection is the act of knowing, but the sensation cannot take place without it.

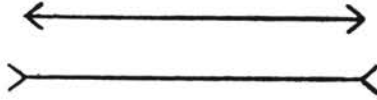
To put it briefly, error with regard to proper sensibles is incidental to them in two ways : (a) the typical examples are the colour-blind who believe that the way they see colours is the way in which all or most people see them ; or the sick, who attribute the bad taste to the food. Such errors consist in deciding what is normal by means of sense equipment that is abnormal, so that a difference which is only incidental is ascribed to the things the sense refers to. (b) When *any* quality is judged to belong to the thing indicated by the sense, as an absolute property of that thing in exactly the way the sense is affected by it.

Must we conclude from this that there is nothing in things themselves which could rightly be called sensible quality, or even, mere quality, to the point where the external cause of sensation would be of a different nature altogether, like quantity? We will come back to this question after discussing sensation with respect to certitude.

1. 'Organon' means tool or instrument. 'Organized body,' which the definition of the soul refers to, means a body equipped with tools, namely, physical instruments of the kind of operations which are characteristic of living beings in nature. ARISTOTLE, *De Anima*, II, chap.1, 412 b. Cf. CHARLES DE KONINCK, *Introduction à l'étude de l'âme*, dans *Laval théologique et philosophique*, 1947, Vol.III, n.1, pp.9 et sq.

2. *Error with regard to common sensibles*

Mistakes in judgment about the common sensibles are normal. The illusion illustrated here is a familiar example :



When two horizontal lines of equal length are made to terminate, one in arrow heads, the other in feather heads, the second will appear longer than the first. Of course, there is error only so long as we judge the things to be as they appear in sensation, and this example has exactly the value of that used by Aristotle, of the sun appearing to be only the size of a dinner-plate.

In our estimates of common sensibles we inevitably commit ourselves far more as to the status of the things 'out there,' although on the other hand, our mistaken judgment can be corrected by measurement. It is partly because of this possibility of verification by measure, that the common sensibles are accorded a more objective status than the proper ones. But it should be noted that the process of measuring involves a certain operation, namely, the collation and comparison of measure and measured, as in counting or in determining a length ; and that this operation is performed by the mind, though on the basis of, and together with, external sensation.

There is another way in which common sensibles lead to error in judgment. A process of mathematical abstraction is going on unceasingly as we receive perceptions of quantity and of quantitative modes. A line can be drawn so thin that it yields no distinct perception of width, and its parts in length are made to appear so fused that they give an impression of uninterrupted continuity. The result is that we assimilate the sensible line to the one generated in imagination by a point in motion. Both to touch and to sight the bowling-ball has the appearance of a true sphere. Actually, any visible or tangible line or sphere can offer no more than the appearance of true continuity and regularity. For it is only when we consider a line apart from any sensible example that we can be sure that it is a line ; and only when we consider a sphere apart from a sensible one can we know that it is a finite solid having every point on its surface equidistant from a point within called the center. When we project this exactness into the objects of sensation, we commit an error. It is only by prescinding from *per se* sensible objects that we achieve such rigour. To proceed as if ideal and real object were the same, as when a star is taken as a point, is an example of the kind of fiction needed by mathematical physics.

It is again a mistake to believe that proper sensibles can be expressed in terms of quantity or of quantitative modes, for example,

that the definition of a colour by its angle of refraction is a definition of colour as a proper sensible. If it were, we could know exactly what it is to perceive colour without possessing the power of vision at all.

3. *Errors with regard to the incidentally sensible*

Whenever sensation occurs, we also attain a *per accidens* sensible subject. Our natural inclination is to believe that this subject is just what it appears to be to the senses. An example, based on experience of certain qualities, would be the judgment that a certain liquid is honey, because it looks like honey, whereas actually it is bile. In this instance the error could be corrected by perception of some other sensible quality, like odour, or taste. Again, we distinguish the various kinds of animals, and of plants too, mainly by their difference in figure. Then we take the further step of thinking that difference in figure is identical with the difference that makes this thing to be the kind of thing it is, whereas figure is only an external sign (in plants and in animals a fairly proximate one, to be sure) of difference in kind.

As regards quantity, errors concerning the subject are also very frequent. It is easy to fall into the habit of thinking that a fluid, like water, is a continuous homogeneous mass, comparable to the three-dimensional continuum of geometry, so that no matter how long we might keep on halving it, we would always have water. The sun appears to revolve around the earth. The propagation of light seems instantaneous. Misjudgments like these concerning the subject of the common sensibles are so natural that scientific correction of them is of recent date, and the means of correction remain very remote from direct sense-perception.

But the thing to notice is that the difference in subject is always grasped at indirectly, through differences in what is *per se* sensible. Our judgment in all such cases would be quite correct if it confined itself to what appears to be. It is true that to sight this fluid appears to be honey. It is true that the body of water appears to be a continuous mass. In short, it all comes to this, that "regarding the nature of truth, we must maintain that not everything which appears is true; firstly, because even if sensation — at least of the object that is proper to a given sense — is not false, still imagination is not the same as sensation."¹

Those who are disturbed by so frank an acknowledgment of our propensity to err in these things, or who are made uncomfortable by the contrast between the stern requirements of truth and an easy adaptation to appearances, should be reminded that "error is a state more natural to the animals than the truth, and in which the mind spends the

1. ARISTOTLE, *Metaph.*, IV, chap.5, 1010 b; ST. THOMAS, lect. 14. Cf. *De Anima*, III, chap.3, 427 b 15; ST. THOMAS, lect.4.

greater part of its time.”¹ The thing we can never afford to forget is the vast difference between the kind of certitude about nature required for making, and the far higher certitude demanded by that knowledge of nature which is purely for the sake of knowing: between knowing what stone is for the purpose of building, or what wheat is for the purpose of baking, and knowledge of what stone and wheat are for the sake of knowing just what they are in themselves quite apart from what they may be used for. Lack of mineralogy and botany did not prevent the Greeks from erecting fine buildings, or making a nourishing bread. Certitude is achieved in practical life when we know a thing as suitable to the end we have in view, whereas in speculative science, our aim is to make the mind conform to what things are absolutely.

IX. DIVISION OF ‘ DEMONSTRATION TO SENSE,’ TO CORRESPOND
WITH THAT OF SENSIBLE OBJECTS

We have frequently been using the demonstrative pronoun ‘ this ’ to express designation of something individual. Such designation to sense is also called *demonstratio ad sensum*, where ‘ demonstration ’ is taken in the original sense of that showing of a thing, that setting it apart from other things by pointing it out, which occurs first of all in the order of sense experience. Now that the general division of sensible objects has been established, there is a parallel division of demonstration to sense to be explained. That various modes of demonstration to sense must be distinguished is clear from the fact that ‘ this ’ in ‘ this sensation of warmth,’ ‘ this figure,’ ‘ this stone ’ or ‘ this man,’ is not of one kind. The failure to observe the distinction, and the common enough insistence that the only valid designation is one in the mode of the common sensibles, are the consequence of a tacit assumption that only common sensibles are real.

1. ‘ *Demonstration to sense* ’ in the order of proper sensibles

When asked to convey what ‘ warmth ’ stands for, as the name of a proper sense-object, we define the word by referring to an experience that another must be able to share, e.g., by approaching the fire, or by putting his hand in this water that feels warm to me — provided his hand has approximately the temperature of my own. In doing this we are not ‘ pointing out ’ the warmth as we would a

1. ARISTOTLE, *De Anima*, III, chap.3, 427 b. ST. THOMAS’S exposition reads as follows: “ For error seems to be more natural to animals, as they actually are, than knowledge. For experience proves that people easily deceive and delude themselves, whilst to come to true knowledge they need to be taught by others. Again, the mind is involved in error for a longer time than it spends in knowing truth, for we barely attain to knowledge of truth even after a long course of study ” (*Ibid.*, lect.4, n.624).

number or a figure. The warmth I point out is not 'there' in exactly the way the figure of the billiard-ball is 'there.' It is because tangible qualities and tastes cannot be pointed out as common sensibles are pointed out, that they are sometimes held to be at least less real. Yet it is not possible to doubt the reality of this sensation of warmth, not only as a sensation, but precisely as a sensation of warmth; for the sensation is not received as the sensation of a sensation, but as the sensation of a warmth as real as anything else that I am aware of; nor can I doubt that this water that I now feel to be warm really has something to do with this sensation of mine. However, this does not imply that I believe the warmth to be in the water in the way I feel it: the sensible warmth in act is the sense in act, and not the water, which is never more than sensible in potency. Taste is another case in point. I have no doubt about the reality of the taste of this apple as I eat it. However, to assert that the taste of this apple is real does not mean that the apple tastes good when no one is tasting it. Nor may I doubt that the apple has something to do with the real taste I have, although this real taste is not, nor could be, in the apple in the way it really is in me as I sense it.

The names of tangible qualities, of tastes and of smells are ambiguous, as can be seen from the expressions: 'the water feels warm,' 'the apple tastes good,' 'the milk smells sour,' — as if the feeling, the tasting, and the smelling were in the things themselves; as if the sensation were in them. But common usage is merely bringing out the fact that the share of our physical organs in sensation cannot be divorced from the share of the thing that acts upon them. Both are involved. It would be just as naive to put the whole responsibility for *what* is sensed on the one who senses, as to put it all in the thing our sense refers to. The temperature of the water can be raised until the sense finds it unbearable; and apple-growers can improve the taste of apples. These changes take place in the water and in the apples.

'The taste of an apple,' can mean two things, then, the particular kind of sensation of quality that I have when eating an apple, or that, in the apple, which produces (or co-produces with my sense organ) such a sensation. I can designate neither of these meanings to sense in the way that I can point out a billiard ball. And it should be noted particularly that there is more than the 'taste in the apple,' i.e., the share of the apple in causing sensation, that is 'outside the mind'; even my tasting is outside the mind as the taste I have is here and now as this individual sense experience, a thing which I cannot help while eating. But to designate this individual experience in the way I designate the shape of the apple is not in my power.

... The sense objects which actuate sensitive activities — the visible, the audible, etc. — exist outside the mind; the reason being that actual sensation attains to the individual things, which are outside the mind; whereas

science is of universals which exist somehow within the mind. Whence it is clear that the man who already has scientific knowledge does not need to seek the objects outside himself ; he already possesses them inwardly, and is able, unless prevented for some incidental reason, to reflect on them whenever he pleases. But a man cannot sense whenever he pleases ; for he does not possess the sense objects in himself, but they must be present to him externally. And as with the operation of the senses, so with the sciences of sensible things ; for the sensible things themselves are among those which are singulars, and which exist outside the mind. Therefore a man cannot consider scientifically whatever sensible things he pleases, but only those which he perceives by the senses.¹

2. *Demonstration to sense of the common sensibles*

To point out common sensibles, like numbers or shapes, is apparently something far more simple than to point out proper sense-objects. We verify the meaning of a sensible 'two' when we point out two billiard-balls, and the meaning of 'spherical' by indicating their shape, and of 'where' by showing where one is with respect to the other. Again the word 'warmth' no longer signifies the proper sensible, when used with reference to the measure-number obtained by using a thermometer. The result is conveyed without reference to the sensation of warmth, and the word no longer means specifically the tangible quality nor, in any clear way, even the real quality in the thing which causes the feeling of warmth upon contact with the organ of touch. As regards the thermometer, then, the term warmth stands indirectly for no more than the measurable aspect of the quality. Between degrees of temperature defined by means of a thermometer and what we sense as warmth there exists no doubt a relation, but the relation is hardly clear. Of course we observe that to a rise of the measurable temperature of the water, there corresponds a more intense sensation of warmth ; and from the fact that this rise can be carried to a point which entails destruction of the organ it is plain that there is indeed a connection between what is expressed by the measure-number and what we feel as warmth. But, when the temperature of the water is eventually defined as the kinetic energy of its molecules, we are given no reason why temperature should produce in us a sensation of that kind.

It should now be apparent that temperature, defined in terms of a common sensible, can be demonstrated to sense as 'out there,' in a way that is impossible for proper sensible objects. In connection with common sensibles, 'out there' takes on a special meaning, and so does the expression 'outside the knower.' What is said to be 'out there' can be verified by a process of measurement ; while 'outside the

1. ST. THOMAS, *In II de Anima*, lect.12, nn.375-6.

knower ' now conveys a spatial meaning, that is, the known is outside the knower as this billiard-ball lies outside that one. It is often assumed that ' outside the knower ' must always convey this kind of outsideness ; but the assumption is unwarranted, for the independent reality of what is known in sensation of proper objects is not diminished by the fact that I cannot point it out as I can the figure of the billiard-ball. Nor is the reality of the known lessened in any way in the case where it is something of the knower in his own physical nature ; as when I feel warmth in my brow, that warmth is not less external to the mind than the warmth I feel when putting my hand in that water out there. No matter where the irritation takes place in the man who feels pain in an amputated leg, it is still an awareness of reality. Were I the only being making up a world, feeling and comparing only parts of myself, that world would be no less objective, outside myself as knower, and real, than a world made up of many individuals and of other knowing selves.

In fact, the ' real ' status of common sensibles, or of whatever is defined in terms of them, is genuine only to the degree that we attain real sensation of proper sensibles. If there is no value in the designation of the proper sensibles, then there is assuredly none in the designation of the common sensibles. If the so-called secondary qualities be no more than " mind-spinning," the real status of the primary ones will be carried off with them. Sir Arthur Eddington recalls that " When Dr. Johnson felt himself getting tied up in argument over ' Bishop Berkeley's ingenious sophistry to prove the non-existence of matter, and that everything in the universe is merely ideal,' " he answered, " striking his foot with mighty force against a large stone, till he rebounded from it,—' I refute it *thus*.' " Eddington adds : " Just what that action assured him of is not very obvious ; but apparently he found it comforting." ¹ But what Dr. Johnson's understanding of Berkeley's idealism was is less important here than what he claimed to be sure of in that action. And Sir Arthur himself makes it obvious enough in another of his books :

But although we try to make a clean start, rejecting instinctive or traditional interpretations of experience and accepting only the kind of knowledge which can be inferred by strictly scientific methods, we cannot cut ourselves loose altogether from the familiar story teller. We lay down the principle that he is always to be mistrusted ; but we cannot do without him in science. What I mean is this : we rig up some delicate physical experiment with galvanometers, micrometers, etc., specially designed to eliminate the fallibility of human perceptions ; but in the end we must trust to our perceptions to tell us the result of the experiment. Even if the apparatus is self-recording we employ our senses to read the records.²

1. *The Nature of the Physical World*, chap.XV, p.326.

2. *New Pathways in Science*, chap.I, p.2.

Here is a frank admission that sensation cannot be dispensed with, and must be trusted somewhere, if we are to have any trust in the physical basis of mathematical physics. The proper sensibles may not appear in the definitions with which this branch of natural science begins — as we have seen, some time is spent in getting rid of them¹ — nor need they be defined or explained when the inevitable return is made to them. Thermodynamics does not give the proper reason why a certain amount of disorderly movement of molecules should be accompanied in us by a sensation of warmth, nor does optics tell us why light of a given wave-length should make us see red. There is no way of getting behind this kind of sensation, whereas we can proceed to do something about the common sensibles, for example, the operation of measuring them. Yet even here, as we choose a standard of length and then apply it, we remain bound to a proper sensible of one kind or another, which cannot be rendered in terms of number or magnitude. Although our definitions may appear detached from the proper sensible to a considerable degree, they can never be wrested wholly free of it. Definitions bearing no relation to proper sensibles would have lost all contact with that reality which our senses seize, with no clear awareness of its nature perhaps, but with utter sureness. We may grant that physics, in order to make headway, must ignore our feeling of weight ; but at the same time we ourselves must surely be subject to the gravity that it talks about.

3. *Demonstration to sense of what is sensible "per accidens"*

To point out 'this man Socrates' is still another kind of demonstration to sense as widely different from the two preceding types as the incidentally sensible is from *per se* sensible objects. In pointing out Socrates we demonstrate something to sense which is attained *per se* by the mind and *per accidens* by the senses.

It is noteworthy that, in choosing an instance of what is meant by an individual demonstrable to sense, we fix upon a man, or upon some familiar animal, like a horse, but not so readily upon a point on the blackboard, nor even a stone. The reason is that we have internal

1. MAX PLANCK, *Theoretical Physics* : " While originally, . . . the fundamental ideas of physics were taken from the specific sense perceptions of man, the latter are today in large number excluded from physical acoustics, optics, and the theory of heat. The physical definitions of tone, color, and of temperature are today in no wise derived from perception through the corresponding senses . . ." — " The result is nothing more than the attainment of unity and compactness in our system of theoretical physics, and, in fact, the unity of the system, not only in relation to all of its details, but also in relation to physicists of all places, all times, all peoples, all cultures . . . To sum up, we may say that the characteristic feature of the actual development of the system of theoretical physics is an ever extending emancipation from the anthropomorphic elements, which has for its object the most complete separation possible of the system of physics and the individual personality of the physicist. One may call this the objectiveness of the system of physics " (pp.4-7).

experience of numerical unity, exhibited in our sensations, in our conscious activities of thinking, doing and making, as belonging to one and the same self. Of the visible point on the blackboard we know that it is just particles of chalk ; and of the stone, that while it may have the tangible and visible appearance of an individual like an individual man, it might still be many individuals. That a stone is an instance of individuality in some fashion is beyond doubt — there is nothing universal about this particular stone — but the individuality could be like that of a single crowd, or of the individual sun. We do not think this of a horse.

Though in sensing we are always referred to something that is *per accidens* sensible, we can rarely be sure that this something is a single individual in the way that a man is. For a man is unmistakably an integral whole, notwithstanding the many respects in which he is a composite, an assemblage. There is, to be sure, a way of referring to him as a collection. To the mathematical physicist, Socrates is a swarm of electric charges, sparsely scattered in an emptiness so out of proportion with what remains in him of bulk that the latter amounts to less than one billionth of the total of Socrates himself. To the anatomist, he may be an assemblage of head, arms, legs, liver, etc. ; and to the physiologist, a compact of various kinds of fibers each made up of certain types of cells, etc. The psychologist reveals in him another set of parts, like intellect, will, and various kinds of internal and external senses. And yet, when we point out Socrates, we are confident that he nevertheless makes one single individual ; nor could we possibly treat him like a crowd or a mere bundle of events. But the physicist, to whom he may be no more than a bundle of events, could not possibly point him out in any other way ; his roundabout way of demonstrating to sense can never terminate anywhere but in the domain to which he had to confine himself from the start : the domain of common sensibles.

What would happen to Socrates if only the second type of demonstration to sense were recognized as valid ? if he were singled out only by means of his common sensibles ? Although substance as such is not our present concern, yet it may be helpful to watch what Socrates (or Mr. Smith) becomes when Bertrand Russell attempts to reject substance, both in notion and reality, by assuming that there is no other way of denoting than that permissible to the physicist :

“ Substance,” in fact, is merely a convenient way of collecting events into bundles. What can we know about Mr. Smith ? When we look at him, we see a pattern of colours ; when we listen to him talking, we hear a series of sounds. We believe that, like us, he has thoughts and feelings. But what is Mr. Smith apart from all these occurrences ? A mere imaginary hook, from which the occurrences are supposed to hang. They have in fact no need of a hook, any more than the earth needs an elephant to rest upon. Any one can see, in the analogous case of a geographical region,

that such a word as "France" (say) is only a linguistic convenience, and that there is not a *thing* called "France" over and above its various parts. The same holds of "Mr. Smith"; it is a collective name for a number of occurrences. If we take it as anything more, it denotes something completely unknowable, and therefore not needed for the expression of what we know.¹

It is surely very odd, though, that even as we are dismissing him as a mere collection of events, we do not seem able to avoid denoting this incidentally sensible *him*, Mr. Smith. If we can rest satisfied with this sort of verbal twist, it is because we accept the supposition that there is only one adequate way of denoting to sense. Yet, as the example proves, we are also assuming the third mode and actually using it to establish the second: that which we call a mere series of sounds and pattern of colour is the man we see and hear, Mr. Smith. In fact, even the first mode is involved here (and hence all three): for we cannot see him without seeing colour, nor hear him without hearing sound. Observe, too, that, in the example as it is stated, the second mode, to which the other two are intended to yield, is actually least in evidence. For it is not made clear that the colour pattern and the series of sounds are meant to be understood as the physicist defines them, not as we see and hear them. The implied reduction to measure-numbers would have been somewhat more awkward had the figure of Mr. Smith or the arrangement of his members been selected as samples of the experiences he occasions in us.

Required as we are to disregard the third mode of designation, we shall also logically be compelled to overlook *what* Mr. Smith is saying here and now, for what he intends to convey by his series of sounds is not present in them as spherical shape is in the billiard-ball, and hence must escape the scientific filter through which Russell is passing him. And if we choose to call Mr. Smith a man, and to explain 'man' by 'rational animal,' we will certainly be forced to abandon 'rational' as not susceptible of designation to sense. In fact, even 'animal' must escape us, if by 'animal' is meant 'a body apt to have sensation,' since we cannot point out a sensation as we can a common sensible.

In short, when we declare Mr. Smith to be no more than a collection of events, we imply that he is only something that the physicist can express in terms of measure-numbers. But, in mathematical physics, when names are used — and they seem to be needed at times — they stand for one or more measure-numbers and theoretical constructions properly expressed by symbols that are not names. By rigid scientific standards, then, once we really know Mr. Smith we should not name him at all; for he is not the kind of individual

1. *A History of Western Philosophy*, pp.201-202.

he seems to be, and to give him a collective name would only oblige us to face a collection of quasi-hims, things and aspects of things like those which 'France' is intended to convey.

X. THE ATTEMPT TO DIVORCE OURSELVES FROM DEPENDENCE
UPON SENSE OBJECTS

We have already said that to attribute to ourselves or, more exactly, to our sensations alone, the qualities we sense, would be just as naive as to put the burden of *what* we sense upon something designatable in the fashion of a common sensible. The clear impossibility of doing so has inclined many to reject 'secondary' qualities as unreal, as mere projections of the imagination. Now, what explains this attempt to shake off what is actually first in knowledge and without which nothing else can be known? For, just as we could not know what a sensation is without having a real one, so we could not know anything real without having a sensation.

What seems to instigate the typical objections to the validity of proper sensibles is the half-conscious hope of finding out how things would appear, and what essential properties they would have, if they could be reached by some avenue other than that avenue of proper sensation which is our first and last means of approach to them. "When an external object raps on the door at the extremity of a nerve, you cannot put your head outside to see what is rapping,"¹ but you cannot help wishing that you could. What should be observed is that the things our senses refer us to act upon us physically even before awareness is aroused — 'before' meaning at least by priority of nature. When I feel warmth, something happens to the temperature of my hand, thanks to a difference in temperature between the organ and that which is affecting it. The sensation of course does not consist simply in this physical change, for then stones ought to feel warmth when heated. But the point is that there is no sense-knowledge without some physical alteration, and it is this which makes all the difference between reason and sense, however much the former may depend upon the latter. A relatively high or low temperature is sufficient to destroy the sense of touch; while rational knowledge of a temperature, no matter how extreme, does not destroy reason. When we ourselves are so entitatively and obscurely involved in the very act of sensation, it follows that we can hardly hope for a detachment like that of reason in mathematics. There is detachment in sensation itself to the extent that there is knowledge, but it remains knowledge essentially bound to a physical organ involved in the act of knowing. And since sensation continues in one way or another to

1. EDDINGTON, *New Pathways in Science*, p.6.

be a condition of every kind of knowledge we can acquire, we have simply got to learn how to live with it, while keeping it in its place.

It is noteworthy that difficulties concerning the status of proper sensibles have been raised chiefly with regard to tangible qualities, and that these have been, in one breath, called fictitious and, in the next, invoked as the chief basis for our confidence in reality. It is indeed a paradox that touch may be considered the least objective of our senses, while at the same time it is in feeling resistance to touch that we are first and most vividly aware of what is 'outside the mind.' This is quite understandable when we realize that touch, as compared to sight, is, on the one hand, so coarse, so poor in representation, since its organ is so inextricably entangled with whatever is touched; while, on the other hand, it is in the feel of being buffeted by reality in resistance to our touch¹ that we have the most vivid experience of existence. It is the sense, the touchstone, upon which the most elaborate theories of mathematical physics must continue to rely. Without it we could not reach even existence in the sense of truth that is essential to every science. Yet if there were not this unmistakable entitative involvement² between touch and touched, if the organ itself were divested of the contraries of hard and soft, warm and cold, wet and dry, it could not bring us that assurance, admittedly gross, which it is normal to expect from it — the assurance sought by the doubting Thomas in all of us. The eye never conveys that assurance so strikingly, except when in pain from excessive light, and even this must be attributed to touch lying at its base.

XI. THE MEANING OF SENSIBLE MATTER

WITH REGARD TO THE DEFINITIONS OF MATHEMATICAL PHYSICS

In order to understand the precise relationship of sensible matter to the definitions of mathematical physics, it will be necessary to

1. It is a universal experience that, whenever man wants certainty about the real existence of a sense object, he will try to verify it by touch. It is for this reason especially that touch is called the sense of certitude, while sight is the sense of distinction, of clarity, and of representation. Where the brute fact of physical existence is concerned, sight, notwithstanding its accuracy of discernment and its certitude of distinction, yields less assurance than touch. The words "phantom" or "ghost" usually stand for things visual, yet unreal and intangible; we compare them to the kind of representations we have in our dreams. Even when not doubting the things we see but cannot touch, we somehow feel more at home when they are brought within our reach, as is proved by the large numbers of people in this century ready to face any risk in order to set foot on the moon.

2. Let it be repeated that sensation cannot, of course, consist in this mere entitative involvement. The material change by itself is no more than a prerequisite, during which the sense power is still only in potency to true sensation. Sensation as knowledge is a change of a radically different kind. This is a subject for rational psychology, taken up by ARISTOTLE in the *De Anima*, Book II, chap.5 and 12 (St. THOMAS's Commentary, lect.11, 12 and 24); Book III, chap.7 (lect.12).

determine three things : first, what the common sensibles have to do with these definitions — a question easily enough answered ; secondly, to what extent the measure-numbers of this science are independent of proper sensibles ; thirdly, in what sense the incidentally sensible subject called ‘sensible matter’ enters into the statements of the physicist.

1. *The case of common sensibles*

Even the common sensibles, while dependent upon some proper sensible for our perception of them, are *per se* sensible, since they too produce a modification in our senses. By this is meant that they produce a physical change, as well as the change involved in knowing ; as the shape of a coin is imprinted on the hand that squeezes it ; or as the contour of the desk is successively registered on the fingers run along its edge, along with the sensation of movement ; and as a change takes place in the organ of sight while watching this shape and this movement. Even though a common sensible, like the actual size of the sun, for example, may lie beyond the scope of sensation, its physical reality remains beyond question ; nor is physics obliged to limit its investigations to those which can be established by the senses working through the tape-measure.

But when the physicist puts down the diameter of the sun, he cannot mean diameter quite as in geometry, where diameters are as intangible as points or lines. There is indeed even a connection with proper sensibles involved here insofar as the size of the sun is inseparable from its temperature. The fact is that, when he determines real size, no matter how far beyond the range of actually sensible magnitude, he still defines size in terms of how we measure it within the narrow scope of actual sensation, by means of a standard agreed upon — like the meter. He can claim knowledge of that which lies beyond the immediate reach of our senses — in remote stellar space, or deep in our very organs of sensation — only on this basic assumption : that the realities far beyond the scope of sensation to which he is applying numbers, magnitudes and quantitative modes are yet one in nature with those we can actually sense.

2. *Reference to proper sensibles*

Now let us turn to the *proper sensibles*. Apparently they are never expressed in an equation ; yet no equation can be called physical without reference to one or another of them. Until recently, scientists failed to realize the extent to which measure-numbers are inseparable from the basic standard of length, from scales, clocks, thermometers, and so on, as well as from the operations performed in using them. Measure-numbers are not gathered freely like the numbers and magni-

tudes of mathematics. 'What is extended in one dimension' gives us length, but nothing like a standard of length; the latter cannot be made known by this type of definition at all. We can tell what we mean by 'the meter.' We call it a measure (in Latin *mensura*, in Greek *μέτρον*) which we define as 'that by which the quantity of a thing is first known'; but this definition does not tell us what the meter is, to which the merchant or the physicist actually refers. The meter happens to be an individual thing, kept in a certain place and even in its designation, bound to a particular time: "The meter as now defined is the distance between two lines on a certain platinum-iridium bar kept at the International Bureau of Weights and Measures in Paris, when this bar is at 0°C. or 32°F. Copies of this bar are kept elsewhere" (Webster's). How much this ties us to the ineffable singular is plain from the fact that the graduated scale of the very instrument used to measure the temperature of the meter is divided by lines which are measured by the meter.

All will concede that to look at this bar is to see a colour, thanks to which there can be perceived lines and a certain distance between them. All will concede that the bar is hard and cold to touch; that the lines could also be detected by the finger-tips, and the intervening distances by moving the finger-tips from one to the next. But, it will be argued, what we are really interested in is the bar as our standard of length, not the qualities which allow us to perceive it. But this is not the whole truth. If we abstracted from every sensible quality by means of which the thing becomes known to us as a physical thing decreed to be the standard of measure, what would meter mean? What the physical property of length would be to an intellect which needs neither sensation nor any practical operation to know it would be something fascinating for us to guess at; but our concern is with ourselves; how do we know a physical length? Aristotle faces this problem with the well-known example of the snub-nose. If our definition conveys the curve alone, prescind from bone and flesh, will our definition of such an object still be a physical one? If we call it physical, we are assuming that there are curves in nature apart from curved subjects like a nose, or a moon, or the orbit of a moon. The curve defined without sensible matter, the mathematically abstract curve, has a simplicity nowhere matched in experience, and can no more be identified with the shape of a nose or a planet than a mathematical point can be identified with a star. Now, when we divorce our common sensibles from all sensible qualities, we are making them into such mathematical entities, which are not even sensible; we are then faced with a curvature, for example, so absolutely exact that it can no longer be verified with exactness in experience.

It should now be clear that the incidentally sensed subject, which we called sensible matter, does appear in the definitions of the physicist. To abstract from that subject always means to be left

with something which is not the business of the physicist as such. Besides, if definitions are of universals, the definition of the meter to which the mathematical physicist refers, is not a definition in that sense ; it is a nominal definition or interpretation of a name.

X. IN WHAT MANNER THE DEFINITIONS OF MATHEMATICAL
PHYSICS CONTAIN SENSIBLE MATTER

It is one thing to establish that the physicist must define with sensible matter, and another to show just how he takes account of it. The common impression that his statements disregard sensible matter entirely is not without justification, to say the least ; for he certainly appears to confine himself to the order of common sensibles, that is, to sensible numbers, magnitudes and modes of quantity, and soon arrives at entities and structures beyond the reach of actual sensation. It is therefore our duty to explain exactly how, even in the mathematical science of nature, the law governing all natural science applies, namely, that contact with, and dependence upon, the material reality upon which we lay our fingers is the ultimate test of validity.

1. *Whether what lies beyond the threshold of sensation can still be called sensible*

Let us begin with the following observation. The limens or thresholds of sensation are very narrow. The range between extreme cold and extreme warmth, perceptible to human touch, is but a minute fraction in the scale of measurable temperature. The heat at which the sense organ itself would be destroyed is very near the bottom of a scale that runs to millions of degrees. In terms of the proper sensibles, then, what can be meant by the heat inside the sun ? If sensible matter is so called because of its sensible qualities, it seems a likely conclusion that sensible matter is nowhere to be found beyond the narrow thresholds of sense awareness, — not for the physicist, at any rate, since he seems not even to mention matter, nor to be inconvenienced by the absence of it. But, if we stop to think, we must realize that what he can never forsake or ignore is ‘ that of which we have sense experience.’ Our question therefore is always the old one : what is it that we do have sense-experience of ?

In his famous illustration of how the physicist treats the elephant sliding down a grassy hillside, Eddington makes plain that he is concerned only with pointer readings — like weight, bulk, friction, etc. — obtained by measurement applied to the elephant. Now the weighing-machine is of course quite indifferent to what it is that is being weighed : enough coal would provide the same measure-number of two tons. As the student puts down the elements needed to solve

the problem of how long it will take the elephant to reach the bottom of the hill, the elephant himself fades out of the picture ; i.e., what it is that slid down the hill has left the scene and that which the student retains can only be described as a bundle of pointer readings. To the mathematical physicist, the only man to handle such problems, it is precisely the "connectivity of pointer readings, expressed by physical laws, which supplies the continuous background that any realistic problem [in physics] demands."¹ And so "we have dismissed all preconception as to the background of our pointer readings, and for the most part we can discover nothing as to its nature."²

This kind of information does not of course pretend to teach us what it is to be an elephant. But it does tell us that, when something (whatever it may be) of a given bulk and weight slides down a slope of such a degree, it takes so much time to reach the bottom. Yet the point is that no matter how indifferent is the specific nature of the thing thus described, however irrelevant, once the pointer readings are obtained, something remains that is not a pointer reading. When the physicist considers a curve, it may be quite indifferent to the problem at hand whether it is the curve of a snub-nose or the curvature of the moon. But it must be the curvature of something or other, something demonstrable as 'this,' and which is not the curvature itself. Otherwise, what would be the difference between the form of a wave of liquid and its vaguely corresponding geometrical form? The reply need not grant so much as that the first is the form of a 'material mass,' but it must admit that it is the form of something conveyed to us through the senses even though in itself it could never actually be sensed *per se*. This much is certain, anyhow, the wave is not a wave of matter in the sense which the physicist intends when he distinguishes between 'matter' and 'energy.' The latter words are used by him as linguistic devices in lieu of the symbols that are the true means of expressing what he has in mind.

2. *Sensible matter and Eddington's 'knowability of matter'*

The sensible matter that we are talking about is not to be identified with what Eddington calls "the background of the pointer readings," but rather with what he calls matter as "knowable to mind," to mind as distinguished from mere sensation. What we term 'sensible matter,' i.e., sensible *per accidens* and intelligible *per se*, is indeed a kind of background, too. But we are not requested to picture this 'background' as we do an elephant or an ocean wave ; it is not to be thought of as standing behind a measure-number as a tree might stand behind Mr. Smith. The background which makes

1. *The Nature of the Physical World*, p.255.

2. *Ibid.*, p.259.

the curve a physical one does not hold it up as Lord Russell's elephant might support the earth. In what relation to the pointer readings does it stand? Eddington moves a step or two nearer to the character of this 'background' when he observes that "physics treats of what is knowable to mind," and the fact that matter is knowable must be set down as one of the fundamental attributes of matter.

[... And this] potentiality of the whole physical world for awakening impressions in consciousness is an attribute not to be ignored when we compare the actual world with worlds which, we fancy, *might* have been created... We recognize the actuality of a particular world because it is that world alone with which consciousness interacts. However much the theoretical physicist may dislike a reference to consciousness, the experimental physicist uses freely this touchstone of actuality. He would perhaps prefer to believe that his instruments and observations are certified as actual by his material sense-organs... Each of us is armed with this touchstone of actuality; by applying it we decide that this sorry world of ours is actual and Utopia is a dream...

From a broader point of view than that of elaborating the physical scheme of law we cannot treat the connection with mind as merely an incident in a self-existent inorganic world. In saying that the differentiation of the actual from the non-actual is only expressible by reference to mind I do not mean to imply that a universe without conscious mind would have no more status than Utopia. But its property of actuality would be indefinable since the one approach to a definition is cut off. The actuality of Nature is like the beauty of Nature. We can scarcely describe the beauty of a landscape as non-existent when there is no conscious being to witness it; but it is through consciousness that we can attribute a meaning to it. And so it is with the actuality of the world. If actuality means "known to mind" then it is a purely subjective character of the world; to make it objective we must substitute "knowable to mind." The less stress we lay on the accident of parts of the world being known at the present era to particular minds, the more stress we must lay on the *potentiality* of being known to mind as a fundamental objective property of matter, giving it the status of actuality whether individual consciousness is taking note of it or not.¹

"Knowable to mind" we interpret as 'sensible matter.' For it is acknowledged that there is reference to the actuality in question by the material sense organs, while Eddington goes on to explain (in a passage omitted above) that the "final guarantor is the mind that comes to know the indications of the material organs." These statements account well enough for what we call "sensible matter," insofar as it is *per se* knowable to the mind while only incidentally sensed; — a kind of actuality and knowability that we demonstrate to sense according to the third mode.

1. *Op. cit.*, pp.264-267.

Hence, the particular domain of mathematical physics shows "a definitely selective action of the mind ; and since physics treats of what is knowable to mind its subject matter has undergone, and indeed retains evidences of, this process of selection. [...] The sphere of the differential equations of physics is the metrical cyclic scheme extracted out of the broader reality. However much the ramifications of the cycles may be extended by further scientific discovery, they cannot from their very nature trench on the background in which they have their being — their actuality."¹ The whole point is, however, that while the sensible matter to which the pointer readings refer the mind, is not brought to the fore, the actuality of the metrical world of physics is guaranteed only by the actuality of that background as perceived by the mind thanks to sensation. Eddington pointedly says "knowable to mind" ; and he distinguishes "the actuality of being known" from "the potentiality of being known," just as we distinguished 'to be sensed in act,' which is on the part of the knower, from 'sensible in potency,' which is the actuality of what there is sensation of.

3. *Mathematical physics implies all three modes of demonstration to sense*

From this it is plain that mathematical physics actually depends upon all three modes of demonstration to sense, and that Eddington's philosophy of science implies this. (i) It confines itself to the metrical aspect of nature, first revealed as common sensibles (or primary qualities), and to which we must always return. (ii) The common sensibles are not perceived independently of some proper sensible or other. (iii) The mind cannot help but refer the metrical structure to a background which we call sensible matter.

This matter is not *per se* sensible ; nor is it something merely intelligible. It is an object which the mind attains to as the proper subject of what is *per se* sensed. It can be known *per se* neither by external sense nor by imagination. In fact, it is our unwarranted attempt to imagine that subject which creates the need of an elephant for the earth to rest upon.

XIII. IN WHAT SENSE THE OPERATIONAL DEFINITIONS OF PHYSICS ARE DEFINITIONS

By showing that the mathematical physicist, as well as any other student of nature, defines with sensible matter we have actually done more than that : we have found on the one hand that measure-numbers are symbols interpreted by describing certain contrivances and the

1. *Op. cit.*, p.264, 282.

operations by which these contrivances are put to use in order to reach a certain quantity ; we have seen how, in every instance, the standard of length is basic to all the other measurements, as is clear from the graduated scales of clocks, weighing machines, thermometers, and so on ; and that this basic standard is a certain platinum-iridium bar kept in Paris at a certain temperature. In other words, it is not enough to refer to 'some' individual thing : it must be the individual thing now in Paris.

1. *These definitions are interpretations of symbols*

Now this is not at all like the reply to "What is meant by the word 'man'?" which may consist in pointing out any man who happens along ; or like the answer to "What is intended by an 'equilateral triangle'?" which consists in making a particular construction. In physics it is as if the interpretation of the word man always implied reference to the particular individual called Socrates now living at such an address ; so that if any other man were pointed out, the reference would be valid only inasmuch as the other man were, not just another instance of man, but a reasonably faithful copy of the one named Socrates. It is as if, in the case of the 'equilateral triangle,' we had to refer to a construction made in the mind of Socrates, on the first of July, at such an address, with the help of a piece of chalk and the kitchen floor. An instance of the meter is never to be understood like an instance of 'man' or an instance of 'equilateral triangle.' An instance of a meter is a copy of 'the meter,' a particular object at a particular place, time, and temperature. The definitions of mathematical physics are therefore a very special type of interpretation : one which ultimately amounts to the designation of an individual something that will be the unique standard until a new convention is made. If we made the historical 'Socrates' equivalent to 'philosopher,' meaning that no one is a philosopher except in the degree that he is a duplicate of Socrates, we would be following a parallel usage.

Such definitions, then, cannot be definitions in the sense of expressing what a thing is ; they are simply interpretations of what the names or the symbols stand for. The definitions of mathematical physics are not even 'nominal' definitions and should not be confused with them. The physicist does not use descriptions, like "two-legged featherless animal" as interpreting the name 'man.' For the physicist as such does not use names, but operational symbols as distinguished from names. When he uses words like 'matter,' 'body,' 'movement,' or 'time,' he employs them merely as convenient linguistic substitutes for what should actually be expressed by measure-numbers. If he used them in any other way, he would be making them stand for something which, as a mathematical physi-

cist he cannot know, and hence cannot express. Further, unlike the symbols of mathematics, the symbols of physics can be interpreted only by referring to the kind of real individual described above.

2. *Although its interpretations must continue to refer to the individual sensible matter of the standard of measure, the aim of the science remains universal*

This last point seems to imply that the mathematical physicist is not concerned with the kind of universality that we saw as essential to science in the strict sense of this term. Yet, we have already insisted that even the physicist is not concerned with this universe *qua this*. And this view is still adhered to by men who are held to be authorities. Thus Whitehead declares that "to see what is general in what is particular and what is permanent in what is transitory is the aim of scientific thought."¹ Lord Russell agrees, for he speaks of "that essence of individuality which always eludes words and baffles description, but which, for that very reason, is irrelevant to science."² Henri Poincaré held, on the other hand, that "every generalisation is an hypothesis."³ The implication of this last remark is that, while the physicist does not pretend to have achieved any definitive generalisation, nevertheless, he seeks for his hypothesis the kind of confirmation by experiment that will assure him of being at least on the road towards strict generality. To attain this limit is out of the question, of course. No science can hope to formulate laws that apply everywhere and always when, by the very nature of the method which it employs, it is held bound to that standard of measure which alone gives meaning to its symbols.

If the day should dawn when the mathematical physicist could abstract from this particular standard to know the general laws of nature, he would find himself contemplating the universe from outside it, free from the limitations imposed on us by our dependence upon sensation. Individual sensible matter would no longer be a principle, neither *qua* individual nor *qua* sensible. In the meantime, he can only go on proposing tentative generalisations, on the general assumption of a similarity in structure between, on the one hand, the measure-numbers he obtains and the generalisations he makes from them, and, on the other hand, the absolute condition of the world, that is, the world as it is apart from how we get to know about it. Eddington put it this way :

But the physicist is not generally content to believe that the quantity he arrives at is something whose nature is inseparable from the kind of opera-

1. *Introduction to Mathematics*, p.11.

2. *Introduction to Mathematical Philosophy*, p.61.

3. *La Science et l'hypothèse*, p.178.

tions which led to it ; he has an idea that if he could become a god contemplating the external world, he would see his manufactured physical quantity forming a distinct feature of the picture. By finding that he can lay x unit measuring-rods in a line between two points he has manufactured the quantity x which he calls the distance between the points ; but he believes that that distance x is something already existing in the picture of the world — a gulf which would be apprehended by a superior intelligence as existing in itself without reference to the notion of operations with measuring-rods.

.....
 The study of physical quantities, although they are the results of our own operations (actual or potential), gives us some kind of knowledge of the world conditions, since the same operations will give different results in different world conditions. It seems that this indirect knowledge is all that we can ever attain, and that it is only through its influences on such operations that we can represent to ourselves a 'condition of the world.' Any attempt to describe a condition of the world otherwise is either mathematical symbolism or meaningless jargon.¹

It would be entirely facetious to insist that this most exact of the sciences of nature cannot really claim to be a science at all in the strict sense of the term 'science.' Mathematical physics is the only means we have to extract a certain kind of knowledge about nature, and to grasp its aim and how near it can approach to truth is not less important than to expose its limitations.

We must never forget that our nature is that of the animal, to whom error is more natural than truth. And the most unfailing error of this animal is perhaps the premature confidence that he has the truth, that universal terms and propositions are as readily plucked from nature as cherries from a tree. Even when it is granted a background of centuries, the human mind "is involved in error for a longer time than it spends in knowing the truth."² This was plainly the case of Descartes, and of his followers into the XIXth Century, believing as they did that, from what turns out to be no more than imaginary 'matter and movement,' man could construct the universe in all that it is.

Charles DE KONINCK.

(To be continued)

1. *The Mathematical Theory of Relativity*, pp.1, 3.

2. Cf. ST. THOMAS, *In Boethium de Trinitate*, q.3, a.1, ad 4: "... Etsi demonstratione nunquam falsum concludatur, tamen frequenter in hoc homo fallitur, quod putat esse demonstrationem quod non est."