ACTA PHILOSOPHICA, vol. 11 (2002), fasc. 1- *PAGG*. 69-92

Science, Metaphysics, Philosophy: In search of a distinction

JUAN JOSÉ SANGUINETI*

Sommario: *1. Classical distinctions and their problems. 1.1. Philosophy as a search of wisdom within science. 1.2. Sciences as 'abstract'. 1.3. Mathematics as 'less philosophical'. 1.4. Sciences as 'hypothetical'. 1.5. Science weaker than philosophy? 2. Modern distinctions. 2.1. Sciences as empirical. 2.2. Sciences as 'empirical' in a positivist sense. New problems for realists. 2.3. Natural sciences as 'verifiable' or 'falsifiable'. 2.4. Science as 'constructive'. 2.5. Some conclusions.*

■

The distinction between philosophy and the empirical sciences is relatively recent in the history of human culture. It goes back to the development of experimental and descriptive sciences in the late seventeenth century. The birth of these sciences (geography, history, geology, paleontology, chemistry, biology) showed an unexpected distance between them and the old philosophical methods. Of course, sciences such as mathematics, astronomy or medicine were well-known in classical culture, but philosophy was not seen as something radically different from those studies. The distinction between science and philosophy was very fluid and not systematic before the seventeenth century. This problem is complex, since the configuration of the task of philosophers underwent many variations in ancient and modern times. 'Wisdom' (and philosophy is 'the love of wisdom') seemed to be in Antiquity more concerned with religious and ethical questions, but also with physical, mathematical or logical researches, or with political and social issues. The practical way of identifying philosophy, in Antiquity, was simply to point at Peripatetics, Academicians, Stoics and the like, who searched for wisdom in many different ways.

The *distinction* between science and philosophy (now including a strong *sep-*

* Pontificia Università della Santa Croce, Piazza di Sant'Apollinare 49, 00186 Roma. E-mail: sanguineti@usc.urbe.it

aration) was stressed in the early positivism (during the nineteenth century), when philosophical speculations were frequently identified with gnoseology and idealism. The existence of 'two cultures' in modern times (scientific and humanist culture) is another aspect of the same fact (this is more acute in Latin countries, where the division was imposed by the educational system).

Recently, the difference between science and philosophy is becoming more flexible, but it remains always controversial. There is a great deal of philosophical ideas among scientists, in literature, in the mass media, or in academic courses. And there is always a lack of unanimity among authors about the proper notion of philosophy and its specific methods. The increasing ramification of disciplines is due to specialization, but philosophy, leaving aside historical studies, is hardly identifiable as a specialized area. A non-trivial distinction between sciences and philosophy (or between science and metaphysics, which is similar), then, is a very serious speculative problem, linked with their mutual interaction and with the problem of the identity of philosophy.

Here there are several oppositions sketching the problem of the distinction between philosophy (the first member of the duality) and science (the second member):

– total/partial;
– universal/particular;
– ultimate causes/secondary causes- first principles/derivative principles;
– being/particular kind of beings;
– substantial issues, essence/details and accidents;
– qualitative/quantitative;
– problems of sense/technical problems;
– questioning every presupposition/assumed presuppositions or hypotheses;
– intellect/reason;
– ontological/empirical, experimental;
– intuition/demonstration;
– eidetic intuition/practical reasoning;
– deep explanation (*why*)/description (*how*);
– comprehension (*verstehen*)/law-like explanation (*erklären*);
– dialectical reason (*Vernunft*)/abstract intellect (*Verstand*);
– *separatio*/*abstractio*;
– ineffable/what can be said.

A number of these distinctions have a clear philosophical correspondence (e. g. the last one belongs to Wittgenstein). In these pages I will try to introduce a brief historical order in several of these dualities. Some of them concern the object, others the method, and a reduction to more fundamental pairs can be attempted. My approach in this paper is historical. It is not my intention here to settle the problem in a systematic way, but only to provoke some reflection in

order to prepare a more precise difference between the two areas. This will help to get a new insight in their mutual relations.

1. Classical distinctions and their problems

1.1. Philosophy as a search of wisdom within science

Among the ancient Greeks, philosophy was an attitude, an activity of men engaged in the search of wisdom, more than an objective discipline to be taught or learned. The so-called *disciplines* were the sciences, or the organized content of sciences such as mathematics or physics (*mathematics* etymologically means *discipline* or *teaching*: μάθημα).

According to Aristotle, empirical studies like biology or mineralogy were concerned with a low level of inquiry, deserving the name of *quia* sciences[1]. These sciences pointed to the *how* and not to the *why*. This preliminary research was meant to record the facts, in order to ascertain 'what there is' (it was concluded *quia est*: that *something is*). Descriptive or 'phenomenological' studies were not yet properly sciences for Aristotle, but just a first step (e. g. the *Historia animalium*: ἱστορία or *history* means precisely record or research). Ἐπιστήμη, instead, is the knowledge of the principles governing the phenomena. The deep science is the *propter quid* science, which tells us *why* something is in this way and not otherwise[2]. But Aristotle acknowledged the *quia* sciences, which awaited for a fuller understanding in the higher *propter quid* science. A descriptive science was to be 'explained' by an etiologic science.

Subordination, as an interdisciplinary relation between the sciences, involves in Aristotle and Aquinas that a higher etiologic level affords insight and deeper reasons of a phenomenological level of research[3]. The beautiful sounds of music are due to mathematical proportions, since order is more beautiful than disorder[4]. The thunder as a 'sound in the clouds' is scientifically understood as a 'sound caused by the extinction of fire in the clouds'[5]. Scientific demonstration operates the transition from the immediate *phenomena* to their initially unknown *causes*. Only at the last level do we properly 'understand' the thing or the events (*scire*): i. e. when we know why they are produced[6], though this *why* entails various meanings (material cause, formal cause, etc.).

---

[1] See my book *Scienza aristotelica e scienza moderna*, Armando, Roma 1992, pp. 35-73 and 101-138, concerning the Aristotelian conception of science and its real use in his scientific work.
[2] Cfr. ARISTOTLE, *Posterior Analytics*, 79 a 1-15.
[3] Cfr. THOMAS AQUINAS, *In I Anal. Post.*, lect. 15.
[4] Cfr. ARISTOTLE, *Posterior Analytics*, 90 a 24-31.
[5] Cfr. ARISTOTLE, *Posterior Analytics*, 93 b 8-14.
[6] Cfr. ARISTOTLE, *Posterior Analytics*, 71 b 10-13.

Aristotle was open to the Pythagorean vision of science. Like Plato, in the *Posterior Analytics* he placed mathematical reasoning in physical matters on the *propter quid* level, since mathematics was intended to explain what was first known in a merely descriptive physics[7]. The cause of the physical structure of the rainbow, for instance, is to be found in the laws of geometrical optics[8]. From this point of view, as Wallace has shown[9], the Aristotelian epistemological causal paradigm is not discordant with modern science, particularly with Galileo and Newton's science.

In this epistemological framework there is no place for a distinction between science and philosophy such as we understand it today. The relevant distinction here is rather between sciences concerned with different areas of being, like celestial bodies, earthly substances, mathematical entities, and the 'science we are seeking' (metaphysics), which would provide for Aristotle, as we know, the ultimate explanation of everything. In other words, the Aristotelian division concerns the subset of *particular sciences* dealing with particular explanations of the several parts of the universe, on the one hand, and the 'meta-science' of *first philosophy*, on the other hand. The latter faces the most universal and intelligible aspects of the world (entity as such) and therefore it can be directly referred to the ultimate explanation of everything: God as the first Cause, the pure self-understanding, separate *in esse*.

In Aquinas, theology brings metaphysics to a higher viewpoint, according to the self-revelation of God in the Son. Theology, the science of faith, maintains a continuity with the natural inquiry of human mind, especially with its aspiration to the vision of God. Both metaphysics and theology can be considered a *wisdom*, though metaphysics, in a Socratic fashion, could be rather viewed as a search for wisdom, which is precisely the philosophical enterprise. Metaphysics in this framework was the core of philosophy, but the other particular sciences remained likewise philosophical, inasmuch as they were not closed in themselves, but included the dynamic search for the ultimate truth and the first absolute principle of the universe.

---

[7] I do not assume that according to Aristotle mathematics provides the absolute *propter quid* of phenomena. But mathematics applied to physics produces a new scientific level of understanding, called *scientia media* by AQUINAS: see *In Boethium de Trinitate*, q. V, a. 3, ad 6. Aquinas was aware that the *scientiae mediae* were especially useful in technology: see *In I Anal. Post.*, lect. 17 and 25.

[8] Cfr. ARISTOTLE, *Meteorologicorum*, 375 b 16 - 377 a 28.

[9] Cfr. W. WALLACE, *Causality and Scientific Explanation*, The University of Michigan Press, Ann Arbor 1974; *From a Realist Point of View*, University Press of America, Boston 1983; *The Modelling of Nature*, The Catholic University of America Press, Washington 1996, pp. 322-376. «To the degree that it is able to demonstrate conclusions, modern science is just as philosophical as Greek, medieval, or Renaissance science» (*The Modelling of Nature*, p. 237).

1.2. Sciences as 'abstract'

The array of sciences is not monolithic in Aristotle. In the *Posterior Analytics* he highlights the autonomy of particular sciences, governed by *proper* principles concerning their own object, principles not to be deduced from the universal (or 'common') axioms. He opposes the presumed Platonic conception of a single universal science[10]. Whether or not the Academy historically dreamt of deducing the whole of knowledge from a little nucleus of principles, Aristotle in fact stressed the autonomy of sciences and consequently the impossibility of reducing one kind of science to another, though the concept of subordination to alien principles allowed him to combine heterogeneous sciences, such as physics and mathematics[11].

Scientific heterogeneity arises from the modalities of abstraction. The concept of abstraction opens Aristotle to a fruitful confrontation with modernity, inasmuch as it introduces a noetic perspective, correcting the Platonic hyper-realism which ignored the difference between the *modus essendi* and the *modus cognoscendi*[12]. Abstraction entails a special conceptual elaboration, maintaining very different relationships with experience and sensorial knowledge. Abstract thought captures its intelligible object separated from experience, but at the same time related to it, since the existential and singular entity is grasped by our mind only in the realm of experience.

The methodological differences between sciences such as mathematics, physics or metaphysics can be thought of within this general framework. The Platonic conception rather followed the pure concept, confusing the mental separation (abstraction) with a real separation *in esse*. Platonism equated scientific objects, grasped in the abstraction of an eidetic content, with transcendent immaterial beings. The few universal genera, to be discussed in Dialectics, are for Plato (see *The Sophist*) still more immaterial than the mathematical ideas. Belonging to the realm of separate thought, the Platonic 'idea' is sustained, as it were, by a *meta-mathematical* method.

Aristotle stressed instead the difference between *metaphysics* and the *particular sciences*. He tried to avoid the Platonic perspective, since he strived for a metaphysics drawn from nature and not from the essences as they appeared in the intentional thought. His theory of the modalities of abstraction (three, but not properly degrees: physical, mathematical and metaphysical immateriality), though inspired in Plato, should not be interpreted within a Platonic pattern. The three levels of thought are progressively immaterial, more formal, but not in the line of a homogeneous ascension. Metaphysics was for Aristotle more akin to

---

[10] Cfr. ARISTOTLE, *Posterior Analytics*, I, chapters 28, 29 and 32.

[11] Cfr. ARISTOTLE, *Posterior Analytics*, 75 a 25; 75 a 38 - 75 b 20; 78 b 35 - 79 a 15. See also THOMAS AQUINAS, *In I Anal. Post.*, lect. 17. Physics cannot be reduced to mathematics: ARISTOTLE, *On the Heavens*, 299 a 12-17; 299 b 23 - 300 a 19; 300 a 15-19.

[12] Cfr. THOMAS AQUINAS, *S. Th.*, I, q. 84, a. 1.

physics than to mathematics, rightly deserving the name received in the Peripatetic tradition.

According to Aquinas' commentary, *In Boethium de Trinitate*, the particular sciences should follow the method of *abstraction* in trying to circumscribe the *essence*. Metaphysics, dealing with *being* as such (*ens*), which is not a genus or a super-genus, should undertake the way of *separatio*[13]. Sciences stand to metaphysics as abstraction to 'separation' (or as particular senses stand to the whole perception). The meaning of *separatio* in Aquinas can be understood as an intellectual operation of 'separating' what really subsists, i. e. the substance as a unity, as a whole, as an individual and an existent (*ens per se*, *suppositum*). Metaphysics should not separate *in ratione*, but *in esse*. Its task is to turn to the total thing and its acts, operations and relations (e. g. the human person), being able precisely for this reason to attain the existent 'separate substances' or the realm of the existential transcendence over sensible matter (spiritual beings, persons, God), not in the line of essence as it appears in thought (objectivity), but in the line of act emerging over potency. A sound translation of *separatio* could be *existential transcendence*. Metaphysics strives for the most actual transcendence in terms of being: *Ipsum esse subsistens*. Without this transcendence, metaphysics would be reduced to a mere ontology of physics and biology, or to logic.

The path by which Aristotle overcame sensible matter and attained transcendence concerned the intellect *as an act* and not, as we have said, the immanent object of its operations (abstract thought). The intellect can subsist in itself because it is not immersed in matter. A teleological nature is intelligible (the universe) and therefore it is intrinsically related to the intellect. Upon this basis, Aristotle points to the Intellect as the governing principle of the universe, completed by Aquinas with the principle of the thinking and loving first Act (God). Therefore, the association between natural sciences, psychology and metaphysics in Aristotle and Aquinas was quite different from the binomial mathematics/dialectic in Plato. Accordingly, even if metaphysics is sharply distinguished from natural science (which is particular and abstract, in the context of the anti-reductionist trend of Aristotelian research), the latter nevertheless remains tied to metaphysics in a very natural way.

1.3. Mathematics as 'less philosophical'

Excessively forcing the distance between *separatio* and *abstractio* would be unfair to Aristotelianism. In Heidegger's view, modern science brought the forgetfulness of being, a criticism which he extended to Platonic essentialism as well as to the Aristotelian philosophy. This criticism is inconsistent with the deep

[13] Cfr. THOMAS AQUINAS, *In Boethium de Trinitate*, q. V, a. 3 and 4.

reasons underlying Aristotle's restless antiplatonism. It would be more justified if applied only to the Platonic inclination favorable to see in mathematical objects a first approach towards transcendence.

Aristotle's is basically a philosophy *of nature*. He does not reduce it to numbers or to the atoms of Democritus, rejecting both Platonism and materialistic naturalism. He was mistaken, of course, when he identified the heavens with a reign of quasi-geometrical material perfection. Nevertheless, his physical, biological and psychological researches were natural steps in the speculative pathway towards the science of being as an act. Natural sciences, if pursued as a philosophical endeavor, according to Aristotle, should naturally end up in metaphysics.

Strange as may appear, a similar structure can be found in Kant. There is a parallelism in Kant and Aristotle's distrust of the ontological weight of mathematics[14]. For the latter, mathematics, when applied to physics, must be severely controlled by experience, preventing it from building theoretical objects never to be found in the sensible world. In this respect, Aristotle seems an empiricist, and this explains why the Aristotelian approach to nature had no part in the birth of modern science. The concept of *impetus*, the notion of an ideal inertia, or the possibility of unobserved atoms were ruled out by Peripatetics, as being too theoretical. This rejection was philosophically prudent, though scientifically unproductive.

Aristotle allowed the use of mathematics in science, acknowledged the existence of a physico-mathematical level of abstraction, and conceived mathematical reasons as a *propter quid* level regarding the phenomenological research, as we have seen, but at the same time he refused to build mathematical models trying to adapt nature to them, as the Pythagoreans did (according to Aristotle's criticism[15]). He preferred a more inductive procedure wherein mathematics should limit itself to the role of an accidental measure of physical and sensible proportions. This insufficient approach is quite opposite to the spirit of modern science, which starts with the abandonment of the common sensible features of the world. Aristotle's option for these features was indeed methodologically misleading. He wanted thereby to preserve what he supposed to be the real content of physics, too close to the external appearances of things.

It is generally ignored that Kant as well considered mathematics as a pure instrument of physics, deprived of any philosophical importance, even if useful in the area of technical or practical rationality[16]. Mathematics is not a knowledge, according to Kant, but a pure method of calculating, though with its fictional clarity it perfectly provides the model of a deductive and very well-defined

---

[14] See my book *Scienza aristotelica e scienza moderna*, cit., pp. 38-44, 56-63, 149-163.
[15] Cfr. ARISTOTLE, *On the Heavens*, 293 a 25-27.
[16] See for example KANT, *Opus Postumum*, in *Gesammelte Schriften* (GS), vol. 22, pp. 544-546.

science[17]. The scientific status of physics in Kant is more problematic than usually acknowledged (problematic as well is the existence of synthetic *a priori* judgements *in physics*, not in mathematics, inside the Kantian system).

Long after the *Critique of Pure Reason*, being unsatisfied with Newtonian physics, which he considered too phenomenological, Kant tried (unsuccessfully) to elaborate a physics *based on metaphysics*, within the context of the transcendental turn. He tried, in other words, to accomplish the old project of Leibniz, i. e. to build a dynamic physics, after the epistemological introduction of the Critique (see his post-critical work *Metaphysical Principles of Natural Sciences*, 1786), not to speak of the restoration, in the *Critique of Judgement*, of the organic view, together with finalism and animism, which is more or less the traditional Aristotelian or Plotinian philosophy of nature. The *Opus Postumum* was further projected as a transition (*Übergang*) from the metaphysical principles to the specific contents of the physical sciences.

Therefore, there is a convergence between Kant and Aristotle in the project of building a science of nature with an ontological range, provided we control the use of mathematics in science. Mathematical objects sometimes could be purely imaginative (Kant in fact ruled out atomism since it entailed the fictional idea of a void[18]). Neither Kant nor Aristotle were willing to leave great space to imagination in science[19]. Both showed a sort of positivism regarding the use and interpretation of mathematics in science, though at the same time Kant (in physics) was far from the positivist mold usually attributed to him. Kant was rather a constructivist transcendental metaphysician, or a causal energetist, very concerned with the philosophy of mechanics·

The unity between metaphysics and physics, accordingly, is incontestable in Aristotle and Kant. But in the former the union is realist, while in the latter it is transcendental, preparing the soil for an idealist metaphysics. Moreover, the Kantian unity was an attempt to consecrate the contingent Newtonian structure of the physical world with a necessary *a priori*. This was a failure. The mechanical world should have been seen as the object of a particular science, not as a necessary structure of nature as read by our mind. Kant in this sense was absolutist, lacking an adequate distinction between philosophy and particular science.

Kant's projected metaphysics of nature was intended to be the last improvement of Newtonian physics, at the level of Intellect (*Verstand*). Of course, this is

---

[17] See KANT's works on Logic, as *Vorlesungen, Logik Busolt*, in GS, vol. 24, 2, p. 639; *Logik Pölitz*, in GS, vol. 24, 2, p. 560; *Kritik der reinen Vernunft*, in GS, vol. 3, B 754-760, 757-758, 760-761. Only mathematics enjoys the property of having perfect demonstrations: *ibid*., B 762-766.

[18] Cfr. KANT, *Metaphysical Principles of Natural Sciences*, in GS, vol. 4, p. 524. For a parallelism with ARISTOTLE, see note 12 (*On the Heavens*) and *On the Heavens* 299 b 23 - 300 a 19, against Plato's deduction of the physical constitution of natural bodies starting from their geometrical structure.

[19] Cfr. KANT, *Monadologia Physica*, in GS, vol. 1, p. 475.

quite different from the metaphysics of nature on the dialectical level of Reason (*Vernunft*), where there would be no theoretical objects to deal with, since there is no sensible basis for them. This is a real step towards positivism, or to functional neo-kantianism. In Aristotle's mind, the natural sciences make up a pathway to a transcendent metaphysics. In the Kantian scenario, on the contrary, this metaphysics is very weak, though in some way it is saved as a useful guide. But there remains in Kant a dogmatism, so to speak, regarding a transcendental metaphysics used to the philosophical comprehension of Newtonian mechanics. Of course, these are contradictory aspects in Kant's philosophy. This contradiction has to do with the problem of the distinction between science, philosophy, and metaphysics.

Looking to the development of contemporary science, the alleged small ontological range of the quantitative approach to nature should be revised. Measures are not merely conventional: they tell us something essential of material bodies and of their powers and relations with each other. The discovery of wonderful mathematical structures in matter is a bridge to a more accurate ontological comprehension of natural substances. It is time for philosophers to put an end to the quarantine of mathematics in the philosophical insight of nature. No reconciliation between philosophy and modern science can be expected without this step. Reductionism must be avoided, but quantity remains an important property of the material world, and it has to be seen integrated with qualities and natural essences. Substances, properties and relations, furtherly, should be considered in their mutual respect, not separated.

1.4. Sciences as 'hypothetical'

In several Aristotelian texts, mostly in the *Posterior Analytics*, we read that sciences like geometry begin from *hypotheses* or presuppositions. They are neither demonstrated nor justified inside those disciplines, whose task is merely to make deductions from the principles. These presuppositions are not so strongly self-evident as the so called *axioms*, against which it is impossible to think[20].

The context of this distinction is the axiomatic framework of deductive sciences (particularly in the line of geometry), not the inductive atmosphere of natural sciences. The Aristotelian axiomatism goes back to the Platonic distinction stated in *The Republic*[21] between *noetic* science (the science of the Ideas) and *dianoetic* science (mathematics). Platonic dialectic, Aristotelian metaphysics and the *scientia divina* of *De Trinitate* by Boethius[22] make use of an *intellectual* method, i. e. they employ primarily νους and only secondarily λόγος. They use,

[20] Cfr. ARISTOTLE, *Posterior Analytics*, 72 a 1-25; 76 b 23-34.
[21] Cfr. PLATO, *The Republic*, VI, 509 d - 511 e.
[22] Cfr. THOMAS AQUINAS, *In Boethium de Trinitate*, q. VI, a. 4.

in other words, an intellectual understanding or 'intuition' of the non-demonstrable principles, and only secondarily do they employ reasoning (διάνοια, *ratio*). But *ratio* is founded (not by mere deduction!) on the absolute non-hypothetical principles.

In this sense, as Aquinas suggests, particular sciences are more concerned with *demonstrations*, while philosophy deals with their ultimate principles, i. e. with the *insight* of immediate axioms[23]. Obviously, metaphysics employs demonstration as well, as in the proofs of the existence of God, but the philosopher, not being a logician, tries to illuminate the truth, and even in his rational arguments he attempts to introduce more *intellectus* within the logical procedures. Following Boethius, Aquinas conceives the intellect as a center of powerful light, as a starting point of the many rational movements and likewise as their final point of arrival[24].

Therefore, the Platonic distinction between noetic and dianoetic science marks a difference in the strength of the principles. Dianoetic or rational sciences, like geometry and astronomy, argue from hypotheses, whose truth is assumed but not regarded as an absolute necessity (Greek astronomy employed the method of 'saving the appearances', which corresponds to the modern hypothetico-deductive method). Geometricians, in this view, are not concerned with the ontology of principles. They simply assume them and draw the logical consequences for the sake of coherence. Dialectic, on the other hand, like Aristotle's metaphysics, deals with αρχή ἀνυπόθετος or with non-hypothetical principles, whose truth is *absolute*.

This feature does not correspond to the naturalistic character of the effective Aristotle's science (not to the idealized science, as it is in the *Posterior Analytics*). The indications concerning hypotheses in the *Posterior Analytics* remain laconic and perhaps they belong to aspects of the young Aristotelian thought, more related to the Academic approaches. Nevertheless, the point is very important for this paper, because in Aristotle the relationship between *hypotheses* and *axioms* is parallel to the relationship between *proper principles* and *common principles*, or between *particular sciences* and *metaphysics*[25]. In other words: *sciences are hypothetical, while metaphysics is axiomatic*.

---

[23] Cfr. THOMAS AQUINAS, *In Boethium de Trinitate*, q. VI: on dealing with metaphysics, we should operate *intellectualiter*, in physics *naturaliter*, in mathematics *disciplinabiliter*.

[24] Cfr. THOMAS AQUINAS, *In Boethium de Trinitate*, q. VI, a. 1, ad tertiam quaestionem: «intellectualis consideratio est principium rationalis (...) *intellectualis* consideratio est *terminus* rationalis».

[25] Proper principles, belonging to particular sciences, are hypothetical (cfr. ARISTOTLE, *Posterior Analytics*, 76 a 31-32; 76 b 23-30; 77 b 5), which does not mean *doubtful*. By the way, we disagree with those who stress the hypothetical character of scientific principles to simply discard them as meaningless for philosophy. *There are many degrees of hypotheses*. Some of them may be practically certain (for example, the existence of atoms), though they are always open to discussion and do not possess a metaphysical necessity. Conversely, other hypotheses may be mere conjectures with a very little empirical basis, and this corre-

I shall add three points to this section:

1. *About hypotheses*: I have not found an explicit reference in Aristotle's writings concerning the origin of the hypothetical principles, which are the typical principles of every particular science. The hypotheses according to Aristotle, it seems, could be just assumed in a mathematical way, or taken from empirical suggestions[26]. Thomas Aquinas recalls that a science can assume principles *borrowed* from another source of knowledge, so that the task of their justification would shift to a farther instance[27]. However, interdisciplinary subordination does not help us very much for the justification of physical or mathematical principles, whereas, according to an Aristotelian tenet already mentioned[28], mathematical principles are not reducible to physics (against Platonists and Pythagoreans). We might suspect that the science of being should be competent to clarify them. But precisely this point is excluded in Aristotle. The impossibility of demonstrating the proper principles from common metaphysical principles is tied to the autonomy of the different sciences. Otherwise they would be absorbed by a single super-science[29].

2. *About axioms*: according to the procedures of Aristotle, the metaphysical non-demonstrable principles (=axioms) can be discussed in a dialectical way (not properly scientific or demonstrative). This would be not a mere discussion, but a strategy in which some noetic understanding could be induced[30]. *Dialectic* can be the means of carrying on an *induction* so as to bring our mind to the *intuitive* grasp of a truth[31]. Dialectic reasoning, though generally weak, is stronger within metaphysics, since the first principles are fully noetic and they can be defended by indirect arguments, *per absurdum*, especially with the help of the principle of non-contradiction. In the field of sciences, instead, dialectic is weaker, inasmuch as the proper principles, as we have seen, are hypothetical and not axiomatic. In Aquinas' mind, hypotheses may be *per se nota sapientibus*, very well-known to the experts[32], whereas for Aristotle they are *endóxa*, i. e. well established or reasonable truths, held by many people or by authorized experts.

---

sponds to the popular view of hypothesis. The different meanings of epistemological notions among scientists and ordinary people (for instance, in popular writings or in journalistic declarations) should be noticed in order to avoid misunderstandings. Evolution, the Big Bang, superstrings, etc. are not hypothetical in the same degree. Today, the existence of atoms is as certain as the existence of elephants.

[26] Cfr. ARISTOTLE, *Metaphysics*, 1025 b 10-20, and AQUINAS' comments in *In VI Metaphysicorum*, lect. 1.

[27] Cfr. THOMAS AQUINAS, *In I Posteriorum Analyticorum*, lectiones 5, 19 and 21.

[28] See note 12.

[29] Cfr. ARISTOTLE, *Posterior Analytics*, 76 a 17-20.

[30] Cfr. W. WIELAND, *Die Aristotelische Physik*, Vandenhoeck und Ruprecht, Göttingen 1970; E. BERTI, *Le vie della ragione*, Il Mulino, Bologna 1987; *Le ragioni di Aristotele*, Laterza, Bari 1989.

[31] Cfr. V. KAL, *On intuition and discursive reasoning in Aristotle*, Brill, Leiden and New York 1988, pp. 59-60.

[32] Cfr. THOMAS AQUINAS, *In I Posteriorum Analyticorum*, lect. 1; *In Boethium de Hebdomadibus*, lect. 1.

3. The field of a philosophical discussion concerning scientific principles seems to be dialectic, which must be understood in a deep sense and not as a mere logical match. Dialectic, in this sense, can be conceived as a dialogue or a kind of controlled reasoning in the area of noetic principles. This should be the place for an encounter between metaphysics and the sciences, if we are to follow the Aristotelian suggestions[33].

But the autonomy of sciences should not be disregarded. The human mind cannot attain a total unification of sciences. We shouldn't aim for a philosophical justification of scientific principles, since they cannot obtain an axiomatic dignity. The sciences must run the risk of proposing their principles on their own. Although not explicit in Aristotle, I think this point corresponds well to his epistemology and to the few indications he gave in his works.

1.5. Science weaker than philosophy?

The distinction between hypotheses and axioms makes the particular sciences weaker than metaphysics, in contrast with the current view according to which philosophy plays the weaker part in human knowledge. However, philosophy for the ancients did not possess the *omnimoda certitudo* assigned to it by rationalist authors.

The 'strength' of a science, i. e. its degree of certainty, is correlated in Aristotelian philosophy to the object of study and to the dispositions of the knower. Contingent and variable entities do not provide the basis for a strong science. These entities characterize the object of social and political topics. But also in many physical questions there is uncertainty due to the contingence of matter, according to Aristotle (conversely, the absolute certainty of the old Newtonian physics was linked to its determinism).

The *tópos* of plain certitude in Aristotle and Aquinas is deduction, and this is why rigorous science (ἐπιστήμη) means *demonstrative science*, whose eminent paradigm is mathematics. It is not surprising to read Aquinas' statements that "mathematics refers to matters wherein we find an absolute certainty (*omnimoda certitudo*)"[34] and that "mathematical thought is easier and more certain than physical and theological thought"[35]. However, mathematical demonstrations start from hypotheses and Aristotle is reluctant to reduce all science to mathematical necessity. We could say that mathematics is pseudo-certain.

---

[33] Close to this distinction, R. SPAEMANN holds that the positive sciences assume models and objects with some decisionist elements (and abstraction has a degree of freedom), while philosophy discusses *every* presupposition and *every* kind of objectivity, critically investigating the relationship between scientific models and the whole of reality: see *Philosophische Essays*, Reclam, Stuttgart 1983, pp. 113-118.

[34] THOMAS AQUINAS, *In I Ethicorum*, lect. 3.

[35] THOMAS AQUINAS, *In Boethium de Trinitate*, q. VI, a. 1, *ad secundam quaestionem*.

Another field of absolute certainty in Aristotle and Aquinas is the limited but very strong region of the first principles, such as the axiom of non-contradiction. The intellectual light of νους here is powerful: contradiction is unthinkable. But apart from non-contradiction and some other few mathematical principles, Aristotle did not applied explicitly the property of *unthinkable* to any other principle. Contradiction is irrational and belongs to pure non-being, of course, but our mind sometimes needs a hard reflection to single out an authentic contradiction (and this is not a matter of formal logic) in philosophical matters.

Necessary matters outside mathematics, with all the restrictions stated above, are metaphysical matters (for example, about God). In the Aristotelian view, they have *quoad se* (in themselves) a proper right to induce a necessary knowledge, concerning what is unconditionally and cannot be otherwise. But Aristotle and Aquinas' emphasis goes to man's intelligence which, like the eyes of the owl regarding the brightness of normal light, is initially blind to those high subjects[36]. They are *quoad nos* (for us) at the end of the research, not at the beginning. The strength of the first noetic principles does not allow a quick and easy metaphysics.

The question as to whether science is weaker than philosophy cannot be answered with a neat yes or no. Deduction is clear (λόγος is easy), and so the problem goes back to the intellectual comprehension of principles: to νους. The problem is to be related, furtherly, to human dispositions and habits. Aristotle acknowledged that some persons find more persuasive mathematical arguments, or perhaps rhetoric reasoning, or poetic presentations and the like. People today are more educated to deal with ease more in scientific matters than in philosophical insights.

Non-immediate metaphysical matters, like the knowledge of God, according to Saint Thomas are subtle and deep[37]. Philosophers, following the path of reason in these matters, were victim of various and awkward mistakes (*errores multiplices et turpissimos*), up to the point that hardly two or three did agree in a common opinion[38]. Though not legitimating fideism, this point manifests the weakness of human reason alone, lessening the strength of rationalism in philosophy and in science as well.

---

[36] Cfr. THOMAS AQUINAS, *In liber de Causis*, proemium.

[37] Cfr. THOMAS AQUINAS, *In Boethium de Trinitate*, q. III, a. 1. The context here are the many difficulties to know God, stated by Rabbi Moses, which Aquinas invariably brings forward when dealing with the moral necessity to receive Christian faith in order to know God without error.

[38] *Ibidem*, ad 3.

2. Modern distinctions

2.1. Sciences as empirical

As we have seen, the distinction between metaphysics and the other theoretical sciences (conceived altogether as 'philosophical': physics and mathematics) was current among ancient and medieval authors, although some disciplines were more empirical and others more mathematical (physico-mathematical). This division remained unchanged until the seventeenth century (see e. g. the title of Newton's work, *Philosophiae naturalis principia mathematica*: 'Mathematical principles of natural philosophy'). However, Newtonian physics had replaced the traditional philosophy of nature and, more specifically in classical rationalism, metaphysics and mechanics were interpreted together under the *a priori* of pure reason. The old name of *Rational mechanics,* still in use in some places (another denomination was *Analytic mechanics*), alludes to a science of motion dealing with pure rational principles, to be discovered at the level of analytic reason and not empirically.

Though rationalism is not univocal in the different authors, its common feature is to work out metaphysics and any rigorous science within the mathematical approach of conceptual analysis. Human thought (now preferentially called *reason*, as opposed to the *senses*) was supposed to be able to attain a clear necessary truth in the analysis of a purified concept. This should be the method of a *propter quid* science, in mechanics as well as in rational theology. A weaker use of our reason would be simply to receive truth (but not yet its deep reason) from outside, on the basis of factual experience. This was intended to be the field of 'empirical sciences' (the old *quia* sciences)[39]. In Kant's conservative view (inspired in Wolff's philosophy), the hypothetical sciences still remained on an empirical level, deprived of the *a priori* that would transform them into a necessary and serious science[40]. His tenacious search for an *a priori* physics indicates the identification between the latter and philosophy.

[39] WOLFF is an illustrative example in this respect, though not too rationalist as usually represented, since he was aware of the importance of the experimental studies. His two great volumes of *Psychologia empirica* and *Psychologia rationalis* (the former is conceived as a preparation for the latter) announces somewhat the incoming separation between experimental sciences and pure philosophy. He tried a balanced approach, which he called a *connubium rationis et experientiae* (*Gesammelte Werke*, *Psychologia Empirica*, Olms, Hildesheim 1968, § 497). In rational psychology, all the properties of the human being observed *a posteriori* are to be deduced *a priori* from the concept of the soul: «in psychologia rationalis ex unico animae humanae conceptu derivamus a priori omnia, quae eidem competere a posteriori observantur et ex quibusdam observatis deducuntur, quemadmodum decet philosophum» (*Gesammelte Werke*, *Philosophia Rationalis sive Logica*, Pars I, Olms, Hildesheim 1983, § 112). Philosophy strives to get a perfect certainty: «in philosophia studendum est omnimodae certitudini» (*ibidem*, § 33), the very qualification used by Aquinas only regarding mathematics (see note 35).

[40] Cfr. KANT, *Metaphysical Principles of Natural Sciences*, in GS, vol. 4, pp. 467-469.

At the same time, as I mentioned at the beginning of my exposition, the empirical sciences had been developing with extreme rapidity. The 'experimental' sciences created a definitive gap between philosophers and scientists. *The distinction between philosophy and the positive sciences (or simply 'sciences') became clear after the Enlightenment*, for the first time in history. That distinction, as we know, was not favorable for the former. Hard positivism meant the introduction of empiricism in the interpretation of the new positive sciences. In the positivist philosophy of science, the search for inner necessity was declared vane, and all the sciences concerning reality were located on the level of *quia*, so to say, while their rationality, devoid from ontological principles, became purely logical or syntactical.

At the beginning of the twentieth century, the scientific revolutions in mathematics and physics, i. e. in the headquarters of old rationalism, broke down more effectively, at least in many people, the idea of science as referred to the inner vision of analytic truth, with the predicate flowing out from the subject of the proposition. In the empiricist framework, essential or analytic predications (*per se*) were considered as implicit definitions or tautologies. This point belongs to the conventionalist or neopositivist view of science, which became widespread in the early years of the twentieth century.

The natural empirical sciences, covering now solely the whole enterprise of scientific knowledge, were considered the paradigm of the use of reason: rationality was equated with *empirical rationality*. Mathematics lost its flavor of eternal truth in the formalist conception (Hilbert). To be empirical was no longer a contemptuous qualification, but a label of truthfulness in science, both within inductive and deductive procedures. Accordingly, in the following historical considerations I shall restrict myself preferentially to the area of natural sciences.

2.2. Sciences as 'empirical' in a positivist sense. New problems for realists

The turn of physical sciences towards experience might have seemed reasonable from an Aristotelian perspective. But positivism envisage modern science as non-ontological, i. e. experimental sciences are supposed to tell us nothing about the essential and causal structure of the world. They would be made up of a net of functional relations worked out to calculate, to predict and to control phenomena for practical purposes. These pragmatic relations were thought of as excluding an essential insight in nature. The methodological predominance of a mathematical scrutiny of nature was the occasion (and the excuse as well) for this formalist view which is the nucleus of positivist epistemology.

Accepting this new version of science had new consequences for the distinction between science and philosophy. Obviously this was not a problem for neopositivism. The distinction proposed in logical positivism was simply destructive for philosophy. As it is well known, only natural science was sup-

posed to have a sense, according to the Vienna Circle. Metaphysics should be *senseless* and philosophy was transformed in a logical reflection on our linguistic procedures, becoming a satellite of science.

The positivist version of modern science was partially shared by some philosophers in the first half of the twentieth century, even by those authors who regarded it as an inferior level of knowledge, while accepting the value of philosophy. I shall mention the opinions of some Thomists in this field, since they were very sensitive to the epistemological problem created by modern natural science.

Maritain, for example, shared in part Duhem's idea that modern physics was not *directly* ontological. Within the traditional physical degree of abstraction, Maritain proposed a kind of sub-degree corresponding to the special cognitive approach of modern empirical inquiry. Now physics would be concerned with measured phenomena, and everything not included in this formal object should be excluded from its reach[41]. Maritain's interpretation of modern physics as non-ontological is based upon two principles: 1) some highly theoretical physical abstractions do not attain reality, or at least it is problematic whether they do; 2) human knowledge of specific essences is very imperfect.

Maritain's treatment of the degrees of abstraction was useful. Personally I think that there are many ways of abstraction, not only three or four (classical mechanical abstraction, quantum mechanical abstraction, etc.). They should be conceived as dynamic, flexible and somewhat optional, and they are also historical habits, related to some scientific traditions. Scientific abstractions are in movement in researchers. They are always connected with their personal metaphysical insight, and also with ideas taken from the cultural environment. This connection between scientific concepts and personal philosophical views is the basis of a silent, personal and habitual interpretation of the *metaphysical sense* of positive sciences or some of their parts, an interpretation that may be correct or misleading (e. g. to see some aspects of science as indicators of theism, atheism, materialism, etc.)[42].

According to other authors, as *Simard*, theoretical concepts in physics would be *entia rationis*, useful creations of the human mind, not real physical entities[43]. I can agree, but there are many kinds of *entia rationis*, more or less founded on reality. Some of them may be altogether fictitious (like ether, or the epicycles of the old astronomy), while others may have some correspondence with reality, allowing true of false propositions. Some physico-mathematical concepts and laws involve a partial idealization of physical entities (e. g. the notion of a per-

[41] Cfr. J. MARITAIN, *La philosophie de la nature*, in *Oeuvres complètes*, vol. V, Ed. Universitaires, Paris 1982, pp. 819-968 (published originally in 1935); *Les degrés du savoir*, in *Oeuvres complètes*, vol. IV, 1983, cit. (orig. 1932), pp. 309-390, 509-626.

[42] Cfr. my paper *Ideas metafísicas y verificabilidad en las ciencias*, VI Simposio Internacional de Teología, Universidad de Navarra, Pamplona 1984, pp. 85-102.

[43] Cfr. E. SIMARD, *La nature et la portée de la méthode scientifique*, Les Presses de l'Université Laval, Québec, 1958, pp. 361-372 (in particular p. 366).

fect gas), but through them we do attain a partial and imperfect insight of reality, and this can be said in some way of every concept, including those used in ordinary life.

On the opposite side, *Hoenen* tried to read chemical and physical discoveries in the light of Aristotelian philosophical notions[44], and *Selvaggi* held that modern physics, even if not concerned with a thematic metaphysical interpretation of nature, nevertheless included some ontological grasping of substances, properties and causes[45]. Selvaggi's thesis was that phenomena manifest an aspect of reality, against the Kantian dualism between phenomena and substances. But philosophy of nature goes deeper than the experimental sciences, studying natural beings as beings, i. e. approaching metaphysics (philosophy of nature becomes a metaphysics of nature). In the same ontological line, *Wallace* sustained that modern science fits well the Aristotelian paradigm of *cognitio per causas*. Physics, chemistry and biology do produce a real knowledge of essences[46].

In a more middle position, *Agazzi* defended the idea of natural sciences as dealing with severely defined *objects* (objectivity should be determined in relation to instruments of observation and measurement), while philosophy would be *trans-objectual*, trying to know the foundations of the whole reality[47]. In a parallel way, *Artigas* referred positive sciences to a partial and contextual truth or, in other words, to a partial conceptualization of the physical world, fairly compatible with a realist view of scientific knowledge[48].

The difference between these realist epistemological views perhaps is more in emphasis than in substance. Pierre *Duhem*, for example, normally seen as a conventionalist in philosophy of science, had acknowledged that physics presupposed some metaphysical notions, taken from our ordinary knowledge[49]. He thought that scientific theories aimed to be a natural classification of experimental laws, and that their inherent logical order reflected an ontological order[50].

---

[44] Cfr. P. HOENEN, *Cosmologia*, Pontificia Università Gregoriana, Roma 1956. See Maritain's polemic with Hoenen, in MARITAIN, *La philosophie de la nature*, *Oeuvres complètes*, vol. V, cit., pp. 346-348.

[45] Cfr. F. SELVAGGI, *Filosofia del mondo fisico*, Pontificia Università Gregoriana, Roma 1985, pp. 159-163, 203-209. The triumph of atomism against phenomenalistic energetism, in the early twentieth century, opened the road to a more realist philosophy of science (cfr. *ibidem*, p. 168): atoms become real entities, not mere symbols of hidden entities. Scientific phenomenalism was sometimes a disappointed reaction motivated by the breakdown of classical determinism (cfr. *ibidem*, p. 162).

[46] Cfr. W. WALLACE, *The Modelling of Nature*, cit.

[47] Cfr. E. AGAZZI, *Temi e problemi della filosofia della fisica*, Abete, Roma 1974, pp. 364-378; *Philosophie. Science. Métaphysique*, Ed. Universitaires Fribourg Suisse, Fribourg (Switzerland) 1987.

[48] Cfr. M. ARTIGAS, *Filosofía de la ciencia experimental*, Eunsa, Pamplona 1989, pp. 269-275, 284-294; 383-393.

[49] Cfr. P. DUHEM, *Physique et métaphysique*, «Revue des questions scientifiques», 34 (1893), pp. 55-83.

[50] Cfr. P. DUHEM, *La théorie physique, son object et sa structure*, Chevalier et Rivière, Paris

Maritain, again, was always attentive to the relations between science and philosophy of nature. He conceived both fields as complementary[51]. Scientists and philosophers should dialogue and work together[52].

The birth of modern natural sciences, no doubt, created a new field of research, not systematically known in the classical tradition, though foreseen in some way under the concept of *scientiae mediae*. Mathematics must be distinguished from philosophy of mathematics, physics from philosophy of nature, biology from philosophy of life, and so on. The effort of the mentioned authors in this direction is understandable.

Now, the rationalist opposition between philosophy conceived as purely *rational*, namely as a task to be performed with the power of thought alone, and natural sciences as having to do with *experience*, is completely untenable. In post-rationalist philosophies, experience does play an essential role in the philosophical research (there is an inductive metaphysics), and science includes a rational interpretation as well. Experience is never bare: rather it is an intellectual reading ('insight') of sensible data. The proper distinction should be here between two different kinds of experience: more essential in philosophy, and more particular in the sciences.

The distinction we are discussing here has to do with the problem of the *ontological value* of scientific objects and propositions, such as atoms, elementary particles, energetic principles and the like: must they be taken seriously as real objects, described or referred to by science? Do scientific laws refer to something *essential* in nature?

a) If the answer is *no*, and *we continue to be realists* for the other fields of knowledge, it follows that science is irrelevant for philosophy. Accordingly, science will be seen as a mere practice, accomplished for technological purposes. Troublesome problems concerning the relation between philosophy and the sciences will be too easily dismissed. Perhaps the knowledge of the material world will be left to scientists (without philosophy), while philosophy will be confined to anthropology and ethics. I observe this attitude in people inclined to think that cosmological theories, evolutionary biology, the standard model of elementary particles and the like are mere symbols, images, myths, or to see modern science as purely practical, technological, but not at all speculative. The temptation, then, is to consider science as a wrong attitude towards the world, more or less contaminated by Nietzschean will of power (this is Heidegger's appraisal of occidental science).

b) If the answer is *no*, another possibility is to embrace a purely idealist or

---

1906. See also F.J. López Ruiz, *Fin de la teoría según Pierre Duhem. Naturaleza y alcance de la física*, Pontificia Università della Santa Croce, Roma 1998.

[51] Cfr. J. Maritain, *La philosophie de la nature*, in *Oeuvres complètes*, vol. V, cit., pp. 910-915.

[52] Cfr. J. Maritain, *Le Paysan de la Garonne*, in *Oeuvres complètes*, vol. XII, 1992, cit., pp. 853-855.

pragmatist philosophy, according to which knowledge is a creative enterprise in the world, and science would be simply a highly sophisticated knowledge, more successful than ordinary or popular knowledge.

c) If the answer is *yes*, then it will be possible to look for a fruitful *dialogue* between philosophy and the sciences, since they will have something in common, though the problem subsists of distinguishing between the philosophical approach to nature and the conceptual and linguistic framework of science.

For this third possibility, which I obviously prefer, I think it is very important to abandon *philosophical rationalism*. Indeed, rationalism (even in Thomism) posed a serious obstacle for the relationship between science and philosophy. This means that *natural essences* are not to be thought of as something to be captured in an essential definition. If we follow this wrong opinion, then we will not be able to understand how can the sciences know a nature. In this sense, some distinctions proposed in other times between 'philosophical essences' and 'empirical essences', or between 'ontological causes' and 'empirical causes' are misleading and useless. Natural essences are partially caught in ordinary knowledge, as well as in scientific descriptions. Normally, a quantitative account of nature helps to discover unknown ontological structures, provided we accept that *an imperfect, open and revisable knowledge of natural kinds is a real knowledge of the essence* (this last assumption, obviously, is incompatible with a rationalist epistemology, which was the target, by the way, of Popper's criticism to Platonic essentialism). The ontological condition of material entities must not be conceived with conceptual rigidity.

Another important point in the same line is to abandon the classical (rationalist) opposition between *phenomena* or the things for us and the *things 'in themselves'*. We know real things as far as they present themselves to our personal sources of knowledge. This means that we know things imperfectly, from some sides, through our operations, sometimes building an image that is able to be referred to them, with the possibility of making true (or false) statements. There is a continuity, in this sense, between our perception of sensible things (relative, with some elaboration, subject to corrections), and scientific knowledge. And this *is* the *human* knowledge of the essential aspects of the world. Human action on things is not necessarily separated from contemplation. Practical operations on things can provide a better knowledge of what they really are.

2.3. Natural sciences as verifiable or falsifiable

Neopositivists, as it is well-known, viewed natural sciences as empirically *verifiable*, and metaphysics as unverifiable and therefore senseless. The language of *truth* in this account (to *verify* is to ascertain whether a proposition is true or false) introduces a difficult notion in logical positivism. Truth is a metaphysical concept. The first Wittgenstein, under the influence of modern logic (Frege,

Russell), could not avoid the latent contradiction in the positivist thesis: only physical propositions can be true or false, whereas their semantical truth *manifests* itself[53]. A positivist account of truth is unstable: its natural outlet should be pragmatism (or instrumentalism), i. e. the elimination of speculative truth (truth as *adaequatio intellectus ad rem*, an accordance between mind and being).

Popper rejected the Vienna Circle's thesis claiming, as we know, that the problem was not of sense but of *demarcation*, which should be properly located in falsification. In the debates concerning verification and falsification, the empirical traits were always seen as the distinctive character of the natural sciences. Popper's focusing on falsification was a sign of the ambiguity of sensible experience assumed as an absolute means of parting the territories of metaphysics and science. But falsification may be problematic as well, especially when isolated. Even admitting falsification as more powerful than verification, the asymmetry between them is less absolute than Popper thought[54].

Now, how can we decide the degree of a supposed verification or falsification? We cannot *verify* that some hypothesis is actually being verified to a greater or lesser extent. We have to be previously in agreement with the potential verifying role of certain events in relation to given propositions. And by no means do there exist any algorithmic procedures, separated from a framework of interpretation, capable of performing an experimental control which would determine the truth or falseness of a scientific statement.

Since no automatic empirical evidence is available, ultimately we should rely on some global estimation of many convergent proofs, at different levels, and in this sense we approach the weak Duhem-Quine thesis and Polanyi's epistemology[55]. But here we have a qualitative estimation, sustained by personal insights normally shared by most researchers of 'good sense'. This is, indeed, the way of science, and it works very well. But if human reason has always to judge when and to what extent some physical experience is a good test of truth, then it is not sufficient to place in experiments the borderline between physics and metaphysics, or physics and philosophy.

Dealing with a specific scientific area creates a field of concepts and ways of seeing things, reflected in language, but also in the unexpressed agreement to interpret what is said or is written in a certain way. Modern science is able to fill in the gaps of subjective interpretation by means of a tight univocal language, not

---

[53] Cfr. L. WITTGENSTEIN, *Tractatus logico-philosophicus*, 4.461.

[54] A more mature POPPER acknowledged that both philosophy and natural sciences are searching for speculative truth. According to him, metaphysics tries to join the different true aspects of the world (which are not only scientific) in a unifying image of reality, an image which in the long future should be an even wider and more truthful image: cfr. *Postscript to the Logic of Discovery*, vol. III: *Quantum Theory and the Schism in Physics*, W.W. BARTLEY III (ed.), Hutchinson, London 1982, pp. 199-200, 211.

[55] Cfr. M. POLANYI, *Personal Knowledge*, Routledge and Kegan, London 1983; *The Tacit Dimension*, Smith, Gloucester 1983.

open to ambiguities, and this is another reason which led Wittgenstein to assign natural science to the domain of *what can be said* (in the scientific language), and metaphysics to what is *ineffable*. The problem reappears whenever we admit that even in science 'what is said' is generally permeated by some *tacit intelligence*.

I am not underestimating the importance of empirical verifications and falsifications in the natural sciences. For Aquinas, physical abstraction entails that the *starting* and the *final* level of physical propositions should be placed on sensible matter[56]. In physics we must rely on propositions concerning sensible objects, in order to know the physical truth. *Without verifications there could be no ascertained truth in natural sciences*, but only mathematical imagination or mere hypothesis.

Nevertheless, verifications are not sufficient to solve our problem. First, because the distinction as such (verifiable, unverifiable) does not help to know what is properly philosophy or metaphysics (different from pseudo-philosophy, myth, etc.). Secondly, because there are *a posteriori* ways in philosophy to know the truth, in a realist conception of intelligence. Thirdly, because, as we have seen, experimental confirmations are always included in a theoretical context. Therefore, the members of a scientific community are prepared to accept some kinds of evidences and counter-evidences in their own area of research, and even so, confirmations are never automatic (the knowledge of a non-trivial truth is not automatic). So the problem of distinguishing between philosophy and science remains.

2.4. Science as 'constructive'

From what we have seen so far, it is clear that most empirical sciences include intelligible elements (theoretical, not properly observable), much more when science enlarges itself and tries to give a global account of a wide spectrum of phenomena, as is expected from it. Any attempt to reduce the empirical ground of science to sensations ends up with the elimination of the meaning of its propositions. Even a single factual proposition presupposes a meaning, which is not equivalent to a network of sensations. No science is sheer description, furthermore, since description has to be organized in sequences of propositions, tied to each other by different kinds of relationships, wherein causal links are especially relevant.

At this point, a more or less neo-kantian move could be introduced, by claiming that science superimposes among sensations a network of functional relationships, intelligible but *not ontological*. Theoretical constructions here would

[56] Thomas Aquinas, *In Boethium de Trinitate*, q. VI, a. 2: «in scientia naturalis terminari debet cognitio ad sensum, ut scilicet hoc modo iudicemus de rebus naturalibus, secundum quod sensus ea demonstrat, ut patet in III *Caeli et Mundi*, et qui sensum negligit in naturalibus, incidit in errorem». It could not have been expressed in a simpler way this empiricist criterion, so to speak, typical of the Aristotelian science, which is fully compatible with a realist view of nature.

amount to rational links between thoughts, as created independently and not under constraint from the object. Then, science would be a rational construction addressed to practical success: *ratio* without *intellectus*.

Modern science is practical or technical, since it is oriented to modify the material world. But hard pragmatism views science as reduced to pure *practice*. Theory becomes a function of technology. Knowledge as such (*to know what it is*) fades away, and becomes undistinguished from a practical fitness in the environment, or from physical operations. To know, then, is not an *immanent* activity, but purely *transitive*. At most, knowledge might be preserved as a pure self-awareness of practice. In a coherent radical pragmatism (functionalism, instrumentalism), even the notion of self is problematic, and we shall not be able to distinguish man from a perfect ideal 'intelligent' robot (every action of a robot is material, efficient, external, since it has no internal actions, such as feeling, thinking, knowing or loving).

Radical constructionism is self-refuting, because we can *understand* constructionism. To *understand* the constructionist account of knowledge is a refutation of constructionism. The awareness of accomplishing even a rational construction, like building a proposition, is not a construction. *To know is not to build*. In consciousness, something is grasped: not built, but given, and this *is* knowing. Even a constructivist account of science must go back to philosophy as a non-constructivist way of knowing.

Now, from this viewpoint it is possible to explain the difference between philosophy and science in terms of opposition between *contemplation* and *action*. This kind of distinction was proposed by authors like Bergson, or by phenomenology and existentialism. At the beginning of the twentieth century, when pragmatism was strongly widespread in epistemology and philosophy of science (e. g. Mach), many philosophers tried to defend a non-pragmatist kind of knowledge, while accepting the pragmatist conception of science. This knowledge is intuition (e. g. Bergson). Animals perceive objects of their environment only in relation to their instincts, to what is meaningful for their vital needs and actions. The same pragmatist account of nature is accomplished by modern science, according to Scheler (science is *will of work and potency over nature*: this view influenced Heidegger's negative and pragmatist conception of science). For example, physics selects in nature only the mechanical forces: experimental sciences represent a practical project of dominating nature. They start from a practical mechanic *a priori*. But human spirit (and philosophy) is able to participate intimately in the essence of things[57].

So in the twentieth century, post-rationalist philosophers, belonging to non-scientific areas, tried to overcome the dominating scientific view by the

[57] Cfr. M. SCHELER, *Erkenntnis und Arbeit*, in *Gesammelte Werke*, vol. 8, Franck, Bern 1980, third ed., pp. 191-378. See also F. BOSIO, *Filosofia e scienza della natura nel pensiero di Max Scheler*, Il Poligrafo, Padova 2000.

acknowledgment of a superior way of thinking, more penetrating, comprehensive and sympathetic to the heart of reality. Existentialists, personalists and vitalists criticized modern science as instrumental, technological, dealing with constructed objects, which concealed real being and produced, according to Heidegger, its oblivion. Philosophy *understands*, it might be said, and science, like a blind man, just *operates*.

This drastic opposition leads to an overly pessimistic view of science, which becomes easily condemned for its interventionism in nature. There is more than construction, arbitrary model-making and pure technological interest in modern science. Its constructive elements can be assumed as a property of abstraction, but through abstraction, and even through action and practical interests, we may know many intelligible and true aspects of reality. Action and contemplation are not to be separated. Contemplation without action can be fruitless, and action without contemplation is blind. The recent *realist* trend in philosophies of science and nature testifies to the inadequacy of conventionalist and instrumentalist versions of science.

Another possibility, of course, is to propose a constructivist philosophy, like idealism and radical pragmatism (e. g. Kant, Quine), which would be in the line of scientific instrumentalism. Then, the difference between philosophy and science would be less drastic. Philosophy could be just a theory of action. But, as I have said above, radical constructionism in epistemology is self-refuting. Essentially, *to know is to contemplate*, and action or creation is a consequence (God is creator, because He contemplates and loves Himself).

2.5. Some conclusions

Insofar as particular sciences are concerned with a real account of nature, though limited and partial, they approach philosophical realism. Insofar as this account is, furthermore, global and unified, they are much closer to philosophy. These variables warrant a fruitful communication between philosophical and scientific knowledge.

The distinction between philosophy and science is flexible and changes with time, because they are both dynamic and in mutual interaction. In general terms, philosophy tries to grasp the essential of everything, while science investigates particular areas, with autonomy. The *a priori* versus *a posteriori* opposition generated the most deviant distinction between philosophy and science. The recourse to the feature of the empirical knowledge, which involved verification and falsification, was restricted to the natural sciences (for example, it is useless to distinguish mathematics from philosophy of mathematics), and could not avoid some of the ambiguities born in the positivist matrix. Both philosophy and the particular sciences are theoretical and empirical, according to their own object and method.

It seems likewise inadequate to make too drastic an opposition between a

constructivist science and an 'eidetic' philosophy. Although science works in the area of *ratio*, operating with different kinds of abstractions ('building an object') and often starting from hypothetical premises, while philosophy is more concerned with a comprehensive understanding (*intellectus*), the binomial converges towards a fuller knowledge of reality.

Two conditions warrant a more fruitful agreement between science and philosophy:

1) The mathematical knowledge of nature may be also qualitative, and in principle it can be a guide to grasp something about the ontological layers of reality. Hard positivism decides to stop our natural understanding, separating it from data and numbers. But this is a non-necessary, voluntary decision. Of course, some mathematical constructions can be fictitious, and mathematical devices (e. g. spaces) are not simply natural facts. A scientific image of reality is not reality *tout court*: it is very partial, and in some way it is an intellectual construction, in different degrees.

2) An imperfect account of natural essences is a real knowledge of essence. Therefore, a scientific description of a part of the world normally is indispensable for the corresponding philosophy of that area, and consequently it is relevant for metaphysics.

A non-rationalist unity between science and philosophy is highly desirable. A unique science with merely provincial departments is inconceivable. It is possible to establish a *relational and analogical unification* between positive science and philosophy. They can constitute a *unitas ordinis* (unity of order), not an organism. This unification (not integration) is to be reconstructed again and again, through constant relationships, especially on the level of principles. It is more a problem of openness of mind, of human habits, of dialogue, than a purely objective affair. I think that the sciences today are moving in this direction.

* * *

Abstract: *L'articolo esamina la problematica distinzione tra la filosofia (o la metafisica) e le scienze particolari in una prospettiva storica, cercando di avviare ad una riflessione che possa aiutare a chiarire il problema, fondamentale per la comprensione dei rapporti dinamici tra le due aree di pensiero. Una prima parte studia le diverse distinzioni proposte dalla tradizione platonica, aristotelica e tomistica, quando ancora non si conosceva propriamente una distinzione tra filosofia e scienza, ma solo tra metafisica e altre scienze, più particolari. La seconda parte del lavoro affronta le distinzioni proposte nella filosofia moderna, quando le scienze naturali si distinguono nettamente dal pensiero filosofico. Alcune distinzioni (per esempio sulla base della verificabilità, razionalità costruttiva, ecc.) sono considerate insufficienti. Nelle conclusioni, si cerca di favorire la continuità tra pensiero filosofico e scientifico, grazie a una versione realistica della conoscenza scientifica.*