

Thomism, Nature, and Science

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(reduced draft; a full text is available in Italian)

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0. Introduction

When we place the work of Thomas Aquinas alongside contemporary scientific thought, two seemingly contrasting feelings spontaneously arise. On the one hand, Thomas continues to attract many men and women of science even today because of his trust in reason, his methodological precision, and the rigorous exposition of his arguments. On the other hand, the time that separates us from Aquinas' writings seems too long, and his view of nature too distant from our own, as to believe that his work can still illuminate our knowledge of the physical world. To ask whether Aquinas' thought is still relevant to our scientific culture is, therefore, not a trivial question.

At the epoch of Thomas Aquinas the term *scientia* had a very broad sense: it denoted knowledge as a whole, within which flowed what came from the observation of nature, as well as learning coming from other fields of knowledge. The term "scientist" did not exist yet, nor existed a method of knowledge of nature comparable to what we call today "scientific method." Moreover, at the time of Aquinas, a comparison between science and religion was not the subject of any specific study. Religion was a virtue belonging to the will, while knowledge of nature, as well as faith, concerned the intellect. Indeed, a comparison between faith and reason was feasible, since they were two intellectual sources of knowledge; the study of the relationship between science and theology was also possible, because they were two routes traced by reason, due respectively to the *lumen rationis naturalis* and to the *lumen fidei*.¹

How to assess, then, Aquinas' relevance to the sciences, when the sciences are understood according to their contemporary meaning? This relevance cannot be measured in terms of the insights or advice that Aquinas' thought may provide on the

level of a strictly scientific understanding of reality. It is clear that his contribution must be sought on other grounds.² I think there are three perspectives along which Aquinas' importance for science can be assessed.

a) The first perspective concerns the premises of scientific research. Since all scientific activity is based on philosophical, and to some extent on theological premises (if these point toward the *ultimate cause* of rationality and the existence of reality itself), it makes sense to ask whether a Thomistic-inspired philosophy (and theology) is capable of clarifying these premises and their rational bases, and whether Thomism does it better than other philosophical views.

b) The second perspective concerns the rational implications of the results of science. Since scientific results are often used to draw philosophical (and sometimes even theological) consequences, it makes sense to ask whether Aquinas' thought may help also today to judge the correctness of such inferences, unmasking inconsistencies and contradictions or, positively, confirming their validity.

c) The third perspective concerns the understanding of natural reality and the dialogue between different sources of knowledge. To penetrate reality more in depth and move toward a cognitive synthesis, the diverse sciences require a specific philosophical system; therefore, it makes sense to ask whether a philosophy inspired by Thomas Aquinas provides a deeper insight into natural reality, especially when the sciences point toward the search for unifying and global causes.

Unable to address the topic in its full extent, I will focus mainly on the natural sciences, without neglecting, when necessary, the life sciences and anthropology.

My study is organized into three parts. Part I is a bibliographical review of the major publications that have appeared in the time between now and the past International Thomistic Conferences. In this short talk I will only be able to mention the topics involved, not the individual papers. Part II examines the relevance of Thomas Aquinas to the dialogue with the natural sciences, briefly developing each of the three perspectives mentioned earlier, that is, his contribution to clarifying the philosophical premises of the sciences, judging the correctness of their implications, and deepening the intelligibility of their analysis of reality. Part III exposes the new questions that the sciences today pose to Thomistic philosophy, suggesting what syntheses between the sciences, philosophy and theology Aquinas' thought could still inspire. The present version of my talk, in English, is an abridged version. The Italian written version is more extensive and includes also the whole bibliographical review.

I. Thomistic thought and the natural sciences: a short look at studies and essays published in the recent decades

When considering the dialogue with the sciences, the topic that counts the largest number of articles published in the last 20 or 30 years is undoubtedly the Thomistic *doctrine on causality*, revisited from a variety of perspectives, always in close connection with its Aristotelian root. The works published in the last decades ascribe to Aquinas three main merits: a) to endorse a methodological naturalism which does not imply any ontological reductionism; b) to promote the understanding of the autonomy of creatures, which is neither apparent nor occasional, but really rooted in a self-ruled causality; and c) to convey a truly transcendent image of God the Creator, when investigating the relations between God and nature.

The main fields of application of the Aristotelian-Thomistic understanding of causality are basically three. First, the relation between creation and physical cosmology, where the authors study the relationship between First Cause and second Causes, the problem of the origin of time, the question of the ontological foundation of reality, and the possible presence of teleology on a cosmic scale. Second, the doctrine of causality is applied to the study of divine action on nature, which includes the theme of miracles, the study of divine providence, and the demanding issue of physical evil. Third, a Thomistic doctrine of causality is used to tackle the relationship between creation and evolution, especially in the biological field, but sometimes also in the cosmological field. Finally, in the broad topic of causality, there is room, at various levels and with different applications, for reflection on the laws of nature, the relationship between chance and finality, and the different approach provided by Aquinas' teleology when compared to the advocates of *intelligent design*.

Immediately after his studies dealing with the doctrine of causality, the largest number of works which refers to Thomas' thought concern the field of epistemology. Aquinas is highly regarded for his ability to bring order among the different sciences, explaining their interrelation and preserving their autonomy. Authors put Aquinas' gnoseology in dialogue with the various approaches of contemporary philosophy of knowledge, often to emphasize epistemological realism and the search for truth as the two essential coordinates of all scientific work. Following a theological perspective, Aquinas' reflection on the uniqueness of truth and his view of the relation between faith and reason are put to the service of a better understanding of the act of faith. Also in the epistemological area, we find the presence of a Thomistic inspiration in those contemporary authors who try to re-assess the unity of knowledge and wish to underline the philosophical premises of scientific knowledge.

A third rapidly growing topic is that of neuroscience. Publications employing Aquinas' thought seem to offer two developments to this area of study. The first, which has now become mainstream, concerns the search for solutions to describe the relationship between soul and body when examined within the framework of the contemporary mind-body problem; the second concerns the understanding of feelings, affects and emotions in the light of a Thomistic-inspired anthropology, placed in dialogue with contemporary studies on the phenomenology of the neural system and brain activity. The holistic view of the soul as form of the body, provided by the Aristotelian-Thomistic approach, regains relevance today, because it is in tune with the scientific perspective of embodiment. This approach interprets the human operations of will, emotions and sense knowledge, as deeply rooted in corporeity, emphasizing the psycho-somatic and holistic dimension of human action, just like Aquinas did in his times.

Most of these publications are authored by philosophers, and only a minority of them by theologians. At a single glance, we should say that, in recent decades, Aquinas' thought inspired specific contributions in the areas of epistemology and metaphysics, philosophy of nature and anthropology, but also apologetics and fundamental theology, including in some cases applications in favor of moral theology (fundamental moral theology and bioethics) and dogmatic theology (theology of creation).

II. The contribution of a Thomistic-inspired philosophy to contemporary scientific thought and to interdisciplinary dialogue

There are well-founded reasons to state that a Thomistic inspiration is still working today in the dialogue between science, philosophy and theology. I will try to show this according to the three perspectives mentioned earlier, namely, the role of Thomism in: a) shedding light on the metaphysical presuppositions of scientific activity; b) correctly assessing the philosophical implications that some might infer from certain results of the sciences; and c) fostering a deeper understanding of natural reality.

a) The philosophical foundations of scientific activity

Aquinas' epistemology is rooted in a sound cognitive realism.³ He insisted on the primacy of sense knowledge, without confining it to the knowing of concrete particulars alone, but allowing knowledge to ascend, through abstraction, to the true understanding of general principles. Knowledge arises from the senses but goes

beyond them. A well-known Thomasian insight is that knowledge is an encounter between the rationality present in things and that present in our minds, not the mere projection of our mental categories onto the material world. Such a view is in good agreement with the well established scientific practice that experimental work is a dialogue between the researcher and nature, a dialogue always open to corrections and improvements whose ultimate source lies in reality itself.

Following the footsteps of Aristotle, Aquinas' way of thinking enables scientific analysis to truly understand itself as a *scire per causas*. The non-instrumental relationship between First Cause and Second Causes grounds the authenticity of true autonomous creaturely causality, thus laying the foundation for one being able to "do science."⁴ From this point of view St. Thomas makes a strategic unification of Plato's metaphysics of participation and Aristotle's metaphysics of substance. The former is more attentive to exemplary causality, the latter is more attentive to efficient causality; he does so by means of a metaphysics of *actus essendi* and thanks to the intensive concept of being. The Thomistic synthesis, which presents every creature as a composition of *essence* and *act of being*, placing the origin of both in transcendent divine causality, provides the philosophical premises for the scientific study of all material entities: in order for science to study its objects, it is necessary for things to be, and be according to a specific essence (that is, to a specific *nature*). The *being* and *nature* of all material entities, therefore, constitute an ontological substratum which is the philosophical premise of all scientific knowledge.⁵

Also relevant to science is Aquinas' view of the cosmos as an "ordered structure," according to the dual perspective of *ordo rerum ad invicem* (hierarchically ordered structure of created things) and that of *ordo rerum ad Deum* (divine providence). Such a view represents the necessary presupposition of all scientific research as a "search for order."⁶ The fruitfulness of this perspective is evident when science approaches nature according to mathematical criteria or when it sheds light on the lawful behavior of material entities. It is possible to show that this view remains fruitful even when science studies phenomena subject to computational indeterminism, or operates within the theoretical frameworks of quantum mechanics and complexity.⁷

It is, moreover, the Aristotelian-Thomistic doctrine of analogy that is of primary interest in scientific work.⁸ It makes it possible to link the empirical nature of entities (*ens* insofar as measurable) and the philosophical-metaphysical principles that allow entities to be such (*ens ut mobile* and *ens ut ens*), showing more easily the reasonableness of the philosophical foundations of science. The empirical knowledge of a material entity, and the metaphysical knowledge which explains the existence and the essence-nature of that same entity, are two irreducible ways of knowledge;

nevertheless, we can relate each other according to different levels of analogy and abstraction. Analogy, then, is employed by the sciences to describe on the logical level what reality is on the ontological level: in this way, the natural laws that are valid for a known case under study can be successfully applied to derive laws that operate in lesser known cases.

The doctrine of the analogy of being thus helps science avoid two perspectives that have been repeatedly acknowledged to be insufficient: the existentialist perspective, which attributes the truth of things to their mere emergence from the flow of existence; and the essentialist perspective, which believes that things and events can be fully understood by merely explaining their essence without any reference to the ultimate reason of their being. Both fail. The former, because science needs to generalize beyond single events; the latter because it runs up against the paradoxes of logical and ontological incompleteness. The essence of things cannot be derived from their existence; nor the existence of things can be justified by knowing their essence exhaustively.

b) *On the possible philosophical implications of scientific results*

A deep understanding of the transcendence of God the Creator and the employment of a correct epistemology provide us with intellectual tools to control the genuine implications of some scientific results over philosophy or theology. Even today, Thomistic thought can be successfully employed, both to do not ascribe to science what science could not say, and to avoid science's manipulation by ideologies or inaccurate philosophies.

In the debate between Christian faith and the natural sciences most of the problems arise because of erroneous or unsatisfactory views of the relationship between God and nature. By grounding divine causality in the participation of the act of being and in the conferring a specific essence-nature, St. Thomas proposes an image of God that does not interfere with the ordinary scientific description of empirical reality, nor with the search for secondary causes that govern its phenomena.

As repeatedly highlighted by various authors, by privileging the understanding of creation as a *relation*, as a continuous act that transcends time, Aquinas' thought allows us to clarify, even today, many "boundary questions" between physical cosmology and theology of creation, overcoming the false dialectic of those who want to establish whether the action of a Creator is something necessary or superfluous. The causation by which the pure Act of Being gives reason for the existence of the world does not concern any motion or change, and thus surpasses the "problem of the first move." Understanding the creation of the cosmos as a relationship between the creature and God becomes particularly fruitful when clarifying the difference between

a radical causal *origin* and the *beginning* of time.⁹ In philosophical terms, this contributes to freeing those cosmological models which predict a gravitational space-time singularity from the burden of having to confirm a theology of creation. Analogously, it points out the fallacy of inferring that a Creator would no longer be necessary when dealing with models which do not predict such a singularity. Moreover, the Thomistic view of God's causality in creation, together with the distinction between essence and act of being, can easily show the necessity of a Creator for those cosmological models that interpret the beginning of the physical universe as the appearance of a quantum object, or place its origin in a plurality of mutually independent space-time regions. In both cases we are dealing with measurable entities, with specific natures, essences and natural laws, which precede and govern all empirical phenomenology, whose existence on the ontological level cannot be deduced from its measurability on the logical or empirical level.

It is still Aquinas' doctrine of causality that allows us to correctly set up the relations between creation in theology and evolution in cosmology or in biology, avoiding fallacious deductions which try to deny the role of a Creator as *dator formarum*. Even if we were to limit evolutionary mechanisms to a neo-Darwinian framework, the randomness of genetic mutations on the plane of phenomena does not imply the absence of ends on the ontological plane, where the relationship between Creator and creatures ultimately resides. Aquinas readily admits the action of chance in nature, without thereby inferring the impotence or the non-existence of God.¹⁰ In a more general way, the "government" of the natural world is carried out by God through the *nature* of each entity, which has the reason of a *formal causality*. The action of a formal causality, even in what governs the interaction with other entities, expresses the tendency toward a final causality. Thus, in order to affirm the existence of a teleology in nature, it is not necessary to admit an extrinsic action of God, on the level of efficient causality, but only to recognize that God is the final cause that governs everything, because it is He who wants every formal cause, along with its *quidditas*, He who wants everything just as it is and not otherwise.¹¹

St. Thomas' philosophical-theological approach reconciles not only the relationship between creation and evolution, but also the apparent conflict between a universe of entities and forms, and a universe of events and processes. Within a more philosophical approach, it must be said that the First Cause, to which the "design" of the world belongs, transcends the empirical order, while a theological approach specifies that this transcendence concerns the level of a *personal intentionality*. A merely quantitative knowledge, proper to the empirical level, cannot have any access the ultimate reason of a personal, intentional project. To affirm or to deny the

existence of a Creator is only the object of a metaphysics (and materialism is a metaphysics too), not the object of a natural science, as physics or biology are.

Regarding the subject of miracle, a topic traditionally associated with the relationship between faith and reason, St. Thomas affirms that miracles have God as their author and concern causes that remain unknown to us on the empirical level: therefore, strictly speaking, it is not up to science to affirm or deny what a miracle is. Aquinas offers two important clarifications that are still useful today in dialogue between theology and the sciences. First, the miracle always possesses an ontological dimension and cannot be reduced to its anthropological or semiological dimensions: miracles are works that can be made only by the Creator of the natural world, He on Whom nature itself depends as a whole. Second, St. Thomas makes it clear that miracles operates outside the order of nature, not against nature, thus protecting theology from fallacious implications of those who, starting from the empirical order, want to show the conflicting or even irrational character of all miraculous events. The miracle is not a “correction” of creation, but a manifestation of the creative power of God, almost a perpetuation of it within history.

If we turn our attention to neuroscience, the placing of the main functions traditionally associated with the “spiritual” life of human beings —such as memory, emotions, imagination, feelings, etc.— in specific brain areas, has led many to call into debate the existence of an non-material principle which could play the role usually assigned to the human soul. Again, the Thomistic perspective can help us to clarify matters. St. Thomas has no difficulty in locating sensory, cognitive and even behavioral dysfunctions in the physiological dimension of the human being as an animal, arguing that the bodily and material dimensions of the brain can truly affect psychic activity. Thanks to understanding the relationship between soul and body as hylemorphic, the fact that higher, so-called spiritual functions, are “rooted” in a material and bodily dimension does not make the non-material form of the human being superfluous. Indeed, the latter is aimed at making human, that is, unified by the same conscious self, the diverse operations of the subject, as if they arose from a single vital principle. Identity and intentionality are not replaced by the neural dimension of the brain. This latter belongs to a *personal subject*, the human being, which transcends that physiological dimension.¹²

c) The intelligibility of natural reality and the dialogue between different sources of knowledge

A third group of reflections concerns, finally, the contribution of Thomism to a better understanding of the material reality, that is, the very object of science.

If we credit Aristotelian-Thomist philosophy with the formal and rigorous development of the use of analogy, it would not be an exaggeration to say that St. Thomas' first contribution to the sciences was that he made possible the use of models, as an established scientific strategy for studying natural phenomena and predicting their future behavior. Indeed, it is on analogy that the employment and application of models are based, whether in physics, chemistry, biology or many other fields; and it is on abstraction, still a key element of Thomistic gnoseology, that the ability to mathematize models is founded, transforming them into powerful tools of knowledge.¹³

A second contribution of similar import, that has perhaps not been accorded the appropriate weight, is Aquinas' unified view of truth, a view capable of relating the different sources of knowledge to one another. Reality is the effect of a unique God and not a collection of fragments that science composes; the world is a unified project that emerged from the mind of the Creator Logos, an ordered cosmos that God leads toward its fulfillment. The uniqueness of truth, on which Thomas places a very special emphasis, unifies the knowledge of reality and makes the approaches of different disciplines contribute positively to one another, including that of both philosophy and theology.¹⁴ All access to truth, from whichever side or from whomever author it comes, is the fruit of the Holy Spirit.¹⁵

Thomistic thought, therefore, is capable of inspiring a coherent unity of knowledge, where the various disciplines are organized into hierarchical levels of intelligibility, according to their different formal object. The proper boundaries of each discipline are no longer read as limits that divide and fragment, instead as connections that unite. If the natural sciences need a philosophy of nature, it is not because they find a limit or an obstacle beyond which they can no longer proceed: it is because they find a foundation, namely the very existence of those philosophical assumptions that make scientific analysis possible. Within such an epistemic framework, the problems of incompleteness emerging from the logic of axiomatic systems, or those emerging in physical cosmology from the impossibility to conceptualize the universe as a whole, just to give two examples, are not paradoxes for which to seek a solution, but rather the perception of the logical and ontological foundations of scientific knowledge.

For a better understanding of physical and biological reality, the Aristotelian-Thomistic notion of "nature," here understood as the operative principle of the entity, also proves to be particularly fruitful. This notion fosters the comprehension of the stable properties of the material entity, the universality of its formal specificities, its lawful behavior, and the universality of the laws of nature. The metaphysical notion of nature also enables a proper distinction between *natural laws* and *scientific laws*,

making it clear to us that we can handle only the latter, but not the former. Phenomena that present themselves with the characters of indeterminism, unpredictability and complexity, do not violate the formal specificity of natures, but only indicate that they cannot be formalized or quantified in an exhaustive and finite way, by means of scientific laws.¹⁶

Aquinas' thought confers a proper intelligibility to the notion of *form*, today reevaluated in various areas of scientific research, especially those approaches that highlight the role of *information* in the mathematical, physical, chemical, and biological sciences. Information, just like form, represents something non-material capable of being transmitted, informing material supports, being preserved and reproduced beyond the matter it informs. Ignoring the notion of form, we would no longer understand the phenomenology of living things, their behavior and the relational logic found in their organism. Information, like form, is primarily intelligible and recognizable in an intentional context, and remains open to relate to a personal intelligence. Form, information, and logos are concepts that call on each other. Contemporary sciences glimpse this connection and its mysterious link to a source of meaning.

The reevaluation in biology of notions of form and information, as well as that of relational and systemic approaches, seem to endorse again the wish *to understand life from the living*, as Aristotle and Thomas already did. By studying its own form, we overcome those attempts to understand life as a composition of elements extrinsic to each other, typical of biological reductionism and biomolecular mechanism. Life is not just an emergent property of matter, but really a new strategy of immanence.¹⁷

III. A look toward the future: challenges and opportunities brought about by contemporary scientific thinking

So far the analysis of the present. What are the challenges that a thought inspired by Thomas Aquinas will encounter in the future, when engaging in a dialogue with the sciences? I personally believe that the most important challenge does not come from one or another highly specialized field of research. The real challenge is the formation of new young scholars, experts in St. Thomas' thought. This is the true challenge, I guess. There is a need to continue the work that Thomas didn't carry out, simply because his age was not our age; there is a need to work as he would have done, had he lived in our day. However, looking toward the future, a number of strategic fields of research require more attention. Let me mention a few of them.

Today the subject-matter of *causality* has become more complex. Until the beginning of the last century, philosophy and theology used to dialogue with a rather mechanistic view of causality, basically inherited from Newtonian mechanics. To put things in order on the epistemological or ontological level, it was enough for philosophy and theology to insist in their arguments on the relation between First Cause and Second Causes, emphasizing the transcendence of the First Cause. In our days, the causal description of physical and biological phenomena encounters unprecedented problems and it is enriched by new categories. Today we deal with emergence and complexity, while systemic theories and holistic approaches explore forms of causation from the whole to the parts. In quantum mechanics, the common sense of causal relationship is often challenged, as occurs in quantum non-locality. There is a need for expert philosophical mediation, familiar with contemporary scientific issues and with the philosophical premises underlying them. Such mediation should translate from classical Thomistic concepts into concepts more friendly to the world of science today. This will be especially important when understanding and explaining *the relationship between form and information*, in order to enhance and address the sensibility of contemporary sciences to formal causality.

A more extensive application of Thomistic philosophy to the life sciences is also needed today. Studies employing Aquinas' thought in the biological sciences are considerably fewer in number than studies regarding the physical sciences. This is probably due both to the greater role physics has historically played and to the absence of Aquinas' Commentaries on Aristotle's biological and zoological works. It is time for philosophy of biology to move beyond the debate between creation and evolution and aim for a better understanding of *life as a form of the living*, a perspective on which Aristotelian-Thomistic thought would still have much to tell us today.¹⁸

A further area of future work for a Thomism in dialogue with the sciences is the study of *divine action in nature*.¹⁹ In this field of research, Thomistic-based reflection, while containing great potentialities, is unfortunately in minority, just like the presence of Catholic scholars. Two classical fields flow into the issue of divine action in nature: namely, the theology of the miracle (quite underdeveloped today) and the theology of divine providence, both related to the severe problem of physical evil. All these were issues that Aquinas tackled with courage and innovation; they must be tackled also today, in the light of contemporary science, taking into account the enlarged knowledge we have today of nature, its dynamisms and its global history.

Also the ecological issue brings along some important challenges. Usually developed from a Franciscan-Bonaventurian perspective, it makes sense to ask whether there is a specific Thomistic perspective on Ecology, on the care and

safeguarding of our common home. Some attempts have been recently developed in the US under the name *Green Thomism*.²⁰ While a Franciscan framework privileges the line of exemplarity, a Thomist view is expected to emphasize relationality, hierarchical ordering among creatures, and finalism.²¹ As we have seen, contemporary scientific thought willingly endorses a relational structure of nature, in physics, quantum mechanics and biology. An interesting dialogue between Thomism and scientific thought is possible also here, according to an interdisciplinary perspective that has to include also theology. It is theology, in fact, which reveals that the root sustaining the relational logic present in the whole of creation, and then in all ecological systems, is ultimately Trinitarian. On this approach Bonaventure and Thomas would certainly agree.

Finally, Thomistic thought will always be useful to show the fallacy of those rational arguments which are intended to contradict some truths of faith transmitted by Revelation. It happens also today, when some statements which do not belong to science, are presented as if they were scientific conclusions.²² There is and will be no shortage of opportunities. Even in the future, St. Thomas will help us to bring order, to clarify matters, to understand what science says and what it could never say.

In conclusion, I believe there are good grounds for thinking that the reasons that determined Aquinas' successful establishment of the relations between philosophy, theology, and the sciences of his time, still hold their value, despite the fast progress of scientific knowledge. Thomism, after all and first of all, is a *method*. A method that can continue to inspire the interdisciplinary work which 21st century philosophy and theology are called to carry out.

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¹ It is not surprising that a query on the web made in various languages with the key-words "Thomas Aquinas" and "natural sciences," offers at the top of the list epistemological articles and comments on the unity of the sciences and on theology as a science.

² Perhaps emphatic in its form, but true in its substance is the judgment made years ago by Galli, also shared by Wallace: «We must recognize that St. Thomas, by inserting Aristotle into Western culture, did not contribute immediately and directly to the increase of scientific knowledge. Yet he did much more. He contributed more than any other of his century to reviving in Western man a love for the study of the natural sciences. For this, and for this alone, we can consider that in the history of scientific thought he deserves a most honorable place, probably not inferior to that occupied by Galileo and Newton.» G. Galli, *Cosmologia aristotelica e cosmologie moderne*, in "Tommaso d'Aquino nel suo VII centenario", 221; cf. also W. Wallace, *Thomas Aquinas*, in C.G. Gillispie (ed.), *Dictionary of Scientific Biographies*.

³ Thomas insists that science is possible only if we access the reality of things as they exist outside our souls, not merely reasoning about the species within it: cf. *Summa Theologiae*, I, q. 85, a. 2; *De veritate*, q. 2, a. 3, ad 19um.

⁴ Cf. *Summa theologiae*, I, q. 105, a. 5; *Contra gentiles*, Lib. III, c. 69. «Aquinas also thought that almost all substantial changes can be accounted for by causes in nature, and that there was no need to appeal, as Avicenna did, to a supernatural "giver of forms" to account for the appearance of new substances», W.E. Carroll, *Aquinas, Thomas*, in T.F. Glick, S. Livesey, F. Wallis (edd.), *Medieval Science, Technology and Medicine*, 36.

⁵ Cf. *In II Physicorum*, lec. 1, nn. 145-146; lec. 14, n. 267.

⁶ Cf. *Contra gentiles*, Lib. I, c. 78; Lib. II, c. 24

⁷ Sul tema, cf. J.-M. Maldamé, *San Tommaso e i fondamenti della scienza*, «*Annales theologici*» 15 (2001) 283-306.

⁸ Cf. *De principiis naturae*, c. 6, nn. 366-367. For an application to contemporary sciences, see F. Bertelè, A. Salucci, A. Olmi, A. Strumia, *Scienza, analogia, astrazione. Tommaso d'Aquino e le scienze della complessità*, Il Poligrafo, Padova 1999.

⁹ Cf. *Summa theologiae*, I, q. 45, a. 3; q. 46, a. 3.

¹⁰ Cf. L. Congiunti, *Ordine naturale e caso secondo Tommaso d'Aquino*, «*Espíritu*» 66 (2017) 303-323.

¹¹ Cf. *In II liber Physicorum*, lectio 13, n. 257; lectio 14, n. 268.

¹² Among the main Thomistic places, see, for instance: *Summa Theologiae*, I, q. 77, a. 4; q. 85, a. 7; q. 91, a. 3, ad 1; q. 84, a. 7; q. 101, a. 2; I-II, q. 63, a. 1; II-II, q. 155, a. 4, ad 2; q. 156, a. 1; *De anima*, q. un., a. 8; *De spiritualibus creaturis*, q. un., a. 2, ad 7.

¹³ For an introduction to the topic, which calls in all the major players in the scientific method, see, for example, the contributions collected in the volume by Bertelè et al., *Scienza, analogia e astrazione. Tommaso d'Aquino e le scienze della complessità*.

¹⁴ « Without doubt, Thomas possessed supremely the courage of the truth, a freedom of spirit in confronting new problems, the intellectual honesty of those who allow Christianity to be contaminated neither by secular philosophy nor by a prejudiced rejection of it. He passed therefore into the history of Christian thought as a pioneer of the new path of philosophy and universal culture. The key point and almost the kernel of the solution which, with all the brilliance of his prophetic intuition, he gave to the new encounter of faith and reason was a reconciliation between the secularity of the world and the radicality of the Gospel, thus avoiding the unnatural tendency to negate the world and its values while at the same time keeping faith with the supreme and inexorable demands of the supernatural ordine inflessibili esigenze dell'ordine soprannaturale», Paul VI, *Lumen Ecclesiae* (1974), cit. by *Fides et ratio*, n. 43.

¹⁵ Cf. *Summa theologiae*, I, q. 109, a. 1, ad 1um. On the unity of truth in Thomas Aquinas, cf. John Paul II, *Fides*

et ratio (1998): « Profoundly convinced that *whatever its source, truth is of the Holy Spirit* (omne verum a quocumque dicatur a Spiritu Sancto est) Saint Thomas was impartial in his love of truth. He sought truth wherever it might be found and gave consummate demonstration of its universality. In him, the Church's Magisterium has seen and recognized the passion for truth; and, precisely because it stays consistently within the horizon of universal, objective and transcendent truth, his thought scales "heights unthinkable to human intelligence". Rightly, then, he may be called an "apostle of the truth". Looking unreservedly to truth, the realism of Thomas could recognize the objectivity of truth and produce not merely a philosophy of "what seems to be" but a philosophy of "what is"» (n. 44).

¹⁶ Cf. G. Tanzella-Nitti, *The Aristotelian-Thomistic Concept of Nature and the Contemporary Scientific Debate on the Meaning of Natural Laws*, in «Acta Philosophica», 6 (1997) 237-264.

¹⁷ Cf. J.E. Carreño, *From self movement to esse. The notion of life and living being in Thomas Aquinas*, «Angelicum» 92 (2015) 347-376.

¹⁸ A deeper study of the use of Aristotelianism made, on these matters, by Albertus Magnus, should also be included in this development.

¹⁹ The topic was the subject of a project sponsored by the Center for Theology and The Natural Sciences (Berkeley) and the Vatican Observatory through a series of Conferences held from 1993 to 2001 and collected in 6 ponderous volumes. The results are presented in R.J. Russell, N. Murphy, W.R. Stoeger (edd.), *Scientific Perspectives on Divine Action. Twenty Years of Challenge and Progress*, Vatican Observatory Publications - The Center for Theology and the Natural Sciences, Città del Vaticano 2008.

²⁰ Cf. C. Thompson, "Perennial Wisdom. Notes toward a Green Thomism," *Nova et Vetera* (2012) 10, 67-80; Idem, *The Joyful Mystery. Field Notes toward a Green Thomism*, Emmaus Road, Stebenville (OH) 2017.

²¹ Cf. J. Sanguineti, *La filosofia del cosmo in Tommaso d'Aquino*, Ares, Milano 1996.

²² Cf. *Contra gentiles*, Lib. I, c. 9.