

Paper Title: Xavier Zubiri: Sentient Intelligence and the Relationship of Science and Philosophy

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This paper was prepared for “Science and Religion: Global Perspectives”, June 4-8, 2005, in Philadelphia, PA, USA, a program of the Metanexus Institute (www.metanexus.net).

Abstract:

Philosophy and science both seek truth about reality. Throughout its history, philosophy has been influenced by developments in other fields, particularly science and mathematics. But a solid working relationship between philosophy and science has proved elusive: either it was difficult to find room for science within the philosophical enterprise, because it covered the same ground, often with contradictory results, or particular scientific theories and results were wedded to philosophical doctrines, with disastrous consequences later. No satisfactory relationship can emerge until the nature of human intellection—in the broadest sense—is properly understood. Zubiri has argued that human intelligence unfolds in three stages: primordial apprehension of reality, logos, and reason. The latter two stages build on the first, and it is the first which puts us into direct contact with reality. In this view, reality is not a zone of things, but an aspect of the way we apprehend. In particular, reality is formality—the mode of delivery of our apprehension, and not the content thereof, as has been heretofore assumed. The scientific and the metaphysical are closely connected, because both are forms of knowledge emerging from reason or the third mode of human intellection. In a nutshell, the relationship is as follows: philosophy examines *all* of reality as delivered at *all* three levels, from *all* sources; science concentrates on measuring (explaining) what Zubiri terms *reality in depth*, or reality beyond our perceptions, at the third level only. Science utilizes functional explanations that ultimately allow us to perceive aspects of reality which would otherwise remain hidden; whereas philosophy tells us about the real *in toto* and how to interpret what science uncovers with respect to reality, what the functional explanations mean as descriptions of reality. For example, philosophy tells us how causality and functionality are related, and what that means with respect to the relationship of real thing. Indeed, the unfolding of reality through science is not fundamentally different from its unfolding through personal experience, poetry, music, or religious experience. All human knowing is of the real, because reality is the formality under which man apprehends anything. In man’s quest for understanding, the utilization of scientific concepts, amplified and interpreted, presupposes only that the sciences are an appropriate way of access to reality. Philosophy, in turn, reflects on the data offered by the sciences as “data of reality”. But philosophy is not looking to duplicate the efforts of science—that would be absurd; the two are complementary. Both philosophy and science examine the “world”, that to which the field of reality directs us. Science provides us with an invaluable window onto reality, but philosophy enables us to understand what we are seeing through that window as reality. There are other windows onto reality as well, provided by art, literature, music, and theology, for example.

Biography:

Thomas Fowler is president and founder of the Xavier Zubiri Foundation of North America. He works closely with the Fundación Xavier Zubiri in Madrid. He has taught physics, mathematics, engineering, logic, and philosophy at several colleges and universities in the United States and abroad. At present he is on the faculty of George Mason University in Fairfax, Virginia. He has authored numerous studies on Zubiri's thought, and translated two of Zubiri's works, *Nature, History, God* and *Sentient Intelligence*. He is editor and founder of *The Xavier Zubiri Review*, a journal devoted to Zubiri's philosophy, and will be traveling to El Salvador for an international Zubiri conference in June of 2005. He is doing research for a book on Zubiri and the problem of causality, a topic on which he has published several articles. He also works as a consultant to the U.S. Government in scientific and technical matters. In addition to his continuing work on Zubiri, he recently completed a book on the evolution controversy, a subject of life-long interest to him.

Paper Text:

I. Introduction

Philosophy and science both seek truth about reality. Throughout its history, philosophy has been influenced by developments in other fields, particularly science and mathematics. This is quite clear in the work of Aristotle, Descartes, and Kant. But a solid working relationship between philosophy and science has proved elusive: either it was difficult to find room for science within the philosophical enterprise, because it covered the same ground, often with contradictory results ("So much the worse for the facts", remarked Hegel), or particular scientific theories and results were wedded to philosophical doctrines, with disastrous consequences later (e.g., Kant). The optimal situation is for scientific knowledge and philosophy to be related in a complementary fashion, rather than vying to answer the same questions.

No satisfactory relationship can emerge until the nature of human intellection—in the broadest sense—is properly understood. Zubiri has argued that human intelligence unfolds in three stages: primordial apprehension of reality, logos, and reason. The scientific and the metaphysical are closely connected, because both are forms of knowledge emerging from reason or the third mode of human intellection. In a nutshell, philosophy examines reality as delivered at all three levels; science concentrates on measuring (explaining) what Zubiri terms *reality in depth*, or reality beyond our perceptions. The sciences allow us to perceive aspects of reality which would otherwise remain hidden. But this unfolding of reality is no different from its unfolding through personal experience, poetry, music, or religious experience. All human knowing is of the real, because reality is the formality under which man apprehends anything. In man's quest for understanding, the utilization of scientific concepts, amplified and interpreted, only supposes that the sciences are an appropriate way of access to reality. Philosophy, in turn, reflects on the data offered by the sciences as "data of reality". But philosophy is not looking to duplicate the efforts of science. Both philosophy and science examine the "world". Science is concerned with what Zubiri terms the "talitative" order, the "such-and-suchness" of the world, how such-and-such thing behaves; whereas philosophy is concerned with the respective unity of the real *qua* real, with its transcendental character,

what makes it *real*. But because the world discovered to us by science is quite different from our ordinary experience (electromagnetic waves and photons instead of colors, quarks and other strange particles instead of solid matter, and so forth), a critical problem arises which leads directly to Zubiri's radical rethinking of the notion of reality. When this is properly understood, the relationship between science and philosophy is notably clarified.

II. Overview of Zubiri's Philosophy of Sentient Intelligence

The history of philosophy is littered with corpses of failed systems. Many are the philosophers who, contemplating this situation, saw in it nothing but an inconvenient fact arising from some fault in the assumptions, reasoning, or scope of their predecessors' work. Each expected to put paid to this situation once and for all with his own new and improved philosophy, only to see it fall to the same fate.¹ Zubiri is determined to avoid such a fate, and to accomplish that goal, he needs to do three things:

- *Determine what went wrong with all past philosophies*, not individually but in common. To do this he must penetrate to a much deeper level than any of these philosophies, and determine the unspoken and unrecognized assumptions that lie there.
- *Develop a new way of doing philosophy* not subject to the vicissitudes of history and changes in the scientific worldview. This will require a totally new conception of reality as something *open* at multiple levels, rather than *closed*, *fixed*, and *exhaustible*, and a corresponding new theory of intelligence, knowledge, and truth.
- *Demonstrate that there is genuine progress in philosophy* by creating a new synthesis which is not a drop-in replacement for and rejection of all the old erroneous systems, but rather something which absorbs their key insights and refines and/or corrects them in a dynamic, rather than a static synthesis such as that of Kant. This synthesis must be equally capable of absorbing developments in science and mathematics.

To achieve his goal, Zubiri's rethinking of philosophy had to be extremely radical. Though in constant dialogue with the history of philosophy, and recognizing that this history must be the starting point for his (or any effort), Zubiri

- rejects the traditional view of reality as a *zone of things*, whether "out there" beyond perception, within the mind, in the realm of ideas, or anywhere else, replacing it with a more fundamental and general notion, that of formality, which refers to the nature of what is present to the intelligence;
- rejects the traditional four-part division of philosophy into metaphysics, epistemology, logic, and ethics as the *primary* basis for its organization, instead recognizing that no such strict division has ever been achieved or is even possible, and that a new approach to human intellection is necessary;
- rejects the traditional notion of God as a reality *object*, instead conceiving of Him as a reality *fundament* or *ground*;
- rejects the traditional idea of reality as "closed" and static, as implied in most conceptions of essence, in favor of a new view of reality and essence as "open";

- rejects the traditional notion of a person as another type of “thing,” arguing that personhood is a separate, distinct kind of reality.
- rejects the agreement of thought and things as the *fundamental* notion of truth; rather this *dual truth* is founded on a more fundamental truth, *real truth*, the impressive actuality of the real in sentient intellection.
- rejects the traditional notion of *sensible intelligence* founded on opposition between sensing and intelligence, replacing it with a fully integrated conception, *sentient intelligence*.

The first major work of his grand synthesis was *Sobre la esencia* (1963; English edition *On Essence*, 1980). It dealt primarily with the *object* of knowing. His second major work, *Sentient Intelligence*, deals primarily with the *process* of knowing, which is founded upon an analysis of intelligence. These two subjects—object and process of knowing—should not be identified with “metaphysics” and “epistemology”, respectively, for two reasons: (1) the latter two topics are theoretical and of more restricted scope than the problems Zubiri addresses; and (2) Zubiri explicitly rejects the modern notion that the problems of *object of knowing* and *process of knowing* can be or indeed ever have been rigorously separated, as the distinction between epistemology and metaphysics in post-Kantian thought generally suggests.² The two are completely intertwined, and any comprehensive philosophy must address and encompass both together in its vision. At the outset, this requires not an epistemology, but rather an analysis of intelligence—something which must logically precede *any* type of rigorous epistemology or Kantian critique.³ Only when this foundation has been laid can work on a comprehensive epistemology be completed and securely grounded. Zubiri frequently criticizes previous philosophers for confusing epistemology and the theory of intelligence, and consequently advocating erroneous and often absurd theories. He also believes that understanding this distinction is the key to unraveling some of the paradoxes and puzzles from the history of philosophy, many of which turn out to be pseudo-problems, such as Hume’s famous analysis of causality. Finally, this analysis of intelligence undergirds Zubiri’s analysis of truth and the stages of intellectual knowledge.

Poles of Zubiri’s Thought

Roughly speaking, the two poles of Zubiri’s thought are (1) that which is most radical in Aristotle, his conception of essence as the τὸ τί ἦν εἶναι, what makes a thing be what it is; and (2) the phenomenological concept of reality. His own radical innovation was to weave these two into a unified whole via the new concept of sentient intellection. But Zubiri radically rethinks both Aristotle’s and the phenomenologists’ legacies; so his concept of essence, his concept of reality, and his concept of intelligence differ in many respects from the originals.

(1) Zubiri points out that Aristotle begins by conceiving of essence as that which makes a thing what it is, in the most radical sense. Later, however, Aristotle links his metaphysics with his epistemology by claiming that essence is the physical correlate of the definition (of a thing). Knowledge is then of essences via definition in terms of genus and species; the most famous example is of course “man is a rational animal”. Zubiri comments:

When the essence is taken as the real correlate of the definition, the least that must be said is that it is a question of a very indirect way of arriving at things. For instead of

going directly to reality and asking what in it may be its essence, one takes the roundabout way of passing through the definition.⁴

For Zubiri, this is not merely a roundabout way, but something worse:

...it is a roundabout way which rests on an enormously problematic presupposition, namely, that the essential element of every thing is necessarily definable; and this is more than problematical.⁵

In fact, Zubiri believes, the essence in general cannot be defined in genus-species form, and may not be expressible in ordinary language at all. He believes that essences—in the radical sense of determining what a thing is, and thus how it will behave, what its characteristics are, and so forth—can be determined only with great difficulty; and much of science is dedicated to this task. Specifically, Zubiri believes that it is necessary to go back to Aristotle's original idea of essence as the fundamental determinant of a thing's nature, what makes it to be what it is, and expand on this concept in the light of modern science.

This critique indicates the deep realist strain to Zubiri's thought, a belief that we can, in some ultimate sense, grasp reality. The problem arises in connection with our belief that what we perceive is also real—a belief upon which we act in living out our lives. This compels Zubiri to make an extremely important distinction with respect to reality: between reality in apprehension (which he terms 'reity'), and reality of what things are beyond sensing (true reality, *realidad verdadera*). Zubiri believes that the failure of past philosophers to distinguish these, and consequently, their failure to recognize that they refer to different stages of intellection, is at the root of many grave errors and paradoxes. This leads directly to the second pole of Zubiri's thought: Phenomenology.

(2) Zubiri takes three critical ideas from phenomenology (Husserl, Ortega y Gasset, and Heidegger). First is a certain way or "idea" of philosophy. In particular, he accepts that phenomenology has opened a new path and deepened our understanding of things by recognizing that it is necessary to position philosophy at a new and more radical level than that of classical realism or of modern idealism (primarily Hegel).⁶

Secondly, he accepts that philosophy must start with its own territory, that of "mere immediate description of the act of thinking". But for him, the radical philosophical problem is not that proclaimed by the phenomenologists: not Husserl's "phenomenological consciousness", not Heidegger's "comprehension of being", not Ortega's "life", but rather the "apprehension of reality". He believes that philosophy must start from the fundamental fact of experience, that we are installed in reality, however modestly, and that our most basic experiences, what we perceive of the world (colors, sounds, people, etc.) are *real*. Without this basis—and despite the fact that knowledge built upon it can at times be in error—there would be no other knowledge either, including science. However, at the most fundamental level, that of direct apprehension of reality, there is no possibility of error; only knowledge built upon this foundation, involving as it does *logos* and reason, can be in error. Zubiri points out that it makes sense to speak of error only because we can—and do—achieve truth.⁷

The third idea—perhaps 'inspiration' is a better term—which Zubiri draws from phenomenology has to do with his radically changed concept of reality. For Zubiri, reality is a formality, not a zone of things, as in classical philosophy:

In the first place, the idea of reality does not formally designate a zone or class of things, but only a formality, reity or “thingness”. It is that formality by which what is sentiently apprehended is presented to me not as the effect of something beyond what is apprehended, but as being in itself something “in its own right”, something *de suyo*; for example, not only “warming” but “being” warm. This formality is the physical and real character of the otherness of what is sentiently apprehended in my sentient intellection.⁸

This conception of reality is, so to speak, a radical “paradigm shift”, because it means that there are multiple types of reality and that many of the old problems associated with reality are in fact pseudo-problems. Zubiri notes that

The reality of a material thing is not identical with the reality of a person, the reality of society, the reality of the moral, etc.; nor is the reality of my own inner life identical to that of other realities. But on the other hand, however different these modes of reality may be, they are always reity, i.e., formality *de suyo*.

Much of the work is devoted to analyzing the process of intelligence, and explaining how its three stages (primordial apprehension, *logos*, and reason) unfold and yield knowledge, including scientific knowledge.

Sentient Intellection not Sensible Intellection

For Zubiri, perception of reality begins with the sensing process, but he rejects the paradigm of classical philosophy, which starts from opposition between sensing and intelligence. According to this paradigm, the senses deliver confused content to the intelligence, which then figures out or reconstructs reality. The Scholastics said, *nihil est in intellectu quod prius non fuerit in sensu nisi ipse intellectus*. This is *sensible intellection*, and according to Zubiri, the entire paradigm is radically false.

Zubiri’s point of departure for his rethinking of this problem is the immediacy and sense of direct contact with reality that we experience in our perception of the world; the things we perceive: colors, sounds, sights, are *real* in some extremely fundamental sense that cannot be overridden by subsequent reasoning or analysis. That is, there is associated with perception an overwhelming impression of its veracity, a type of “guarantee” which accompanies it, that says to us, “What you apprehend is reality, not a cinema, not a dream.” Implied here are two separate aspects of perception: first, what the apprehension is of, e.g. a tree or a piece of green paper, and second, its self-guaranteeing characteristic of reality. This link to reality must be the cornerstone of any theory of the intelligence:

By virtue of its formal nature, intellection is apprehension of reality in and by itself. This intellection...is in a radical sense an apprehension of the real which has its own characteristics....Intellection is formally *direct* apprehension of the real—not via representations nor images. It is an *immediate* apprehension of the real, not founded in inferences, reasoning processes, or anything of that nature. It is a *unitary* apprehension. The unity of these three moments is what makes what is apprehended to be apprehended in and by itself.⁹

Thus what we have is a fully integrated process with no distinction between sensing and apprehension which Zubiri terms *sensible apprehension of reality*. The fundamental nature of human intellection can be stated quite simply: “actualization of the real in sentient intellection”.¹⁰ There are three moments of this actualization:

- *Affection* of the sentient being by what is sensed (the *noetic*).
- *Otherness* which is presentation of something *other*, a “note”, *nota* (from Latin *nosco*, related to Greek *gignosco*, “to know”, and *noein*, “to think”; hence the *noematic*)
- *Force of imposition* of the note upon the sentient being (the *noergic*).

Otherness consists of two moments, only the first of which has received any attention heretofore: *content* (what the apprehension is of) and *formality* (how it is delivered to us). Formality may be either formality of stimulation, in the case of animals, or formality of reality, in the case of man.

The union of content and formality of reality gives rise to the process of knowing which unfolds logically if not chronologically in three modes or phases:

- Primordial apprehension of reality (or basic, direct installation in reality, giving us pure and simple reality)
- Logos (explanation of what something is *vis à vis* other things, or what the real of primordial apprehension is in reality)
- Reason (or *ratio*, methodological explanation of what things are and why they are, as in done in science, for example)

This process is shown schematically in Figure 1. Roughly speaking, primordial apprehension installs us in reality and delivers things to us in their individual and field moments; logos deals with things in the field, how they relate to each other; and reason tells us what they are in the sense of methodological explanation. A simple example may serve to illustrate the basic ideas. A piece of green paper is perceived. It is apprehended as something real in primordial apprehension; both the paper *and* the greenness are apprehended as real, in accordance with our normal beliefs about what we apprehend. (This point about the reality of the color green is extremely important, because Zubiri believes that the implicit denial of the reality of, say, colors, and the systematic ignoring of them by modern science is a great scandal.)

As yet, however, we may not know how to name the color, for example, or what the material is, or what to call its shape. That task is the function of the logos, which relates what has been apprehended to other things known and named from previous experience; for example, other colors or shades of colors associated with greenness. Likewise, with respect to the material in which the green inheres, we would associate it with paper, wood, or other things known from previous experience. In turn, reason via science explains the green as electromagnetic energy of a certain wavelength, or photons of a certain energy in accordance with Einstein’s relation. That is, the color green *is the photons as sensed*; there are not two realities. The characteristics of the three phases may be explained as follows:

- Primordial apprehension of reality is the basic, direct installation in reality, giving us pure and simple reality. This is what one gets first, and is the basis on which all subsequent understanding is based. Perhaps it can most be easily understood if one thinks of a baby, which has *only* this apprehension: the baby perceives the real world around it, but as a congeries of sounds, colors, etc., which are *real*, but as yet undifferentiated into chairs, walls, spoken words, etc. It is richest with respect to the real, poorest with respect to specific determination (ulterior modes augment

determination, but diminish richness). In it, reality is not exhausted with respect to its content, but given in an unspecific ambient transcending the content. This transcendence is strictly sensed, not inferred, even for the baby. Primordial apprehension is the basis for the ulterior or logically subsequent modes.

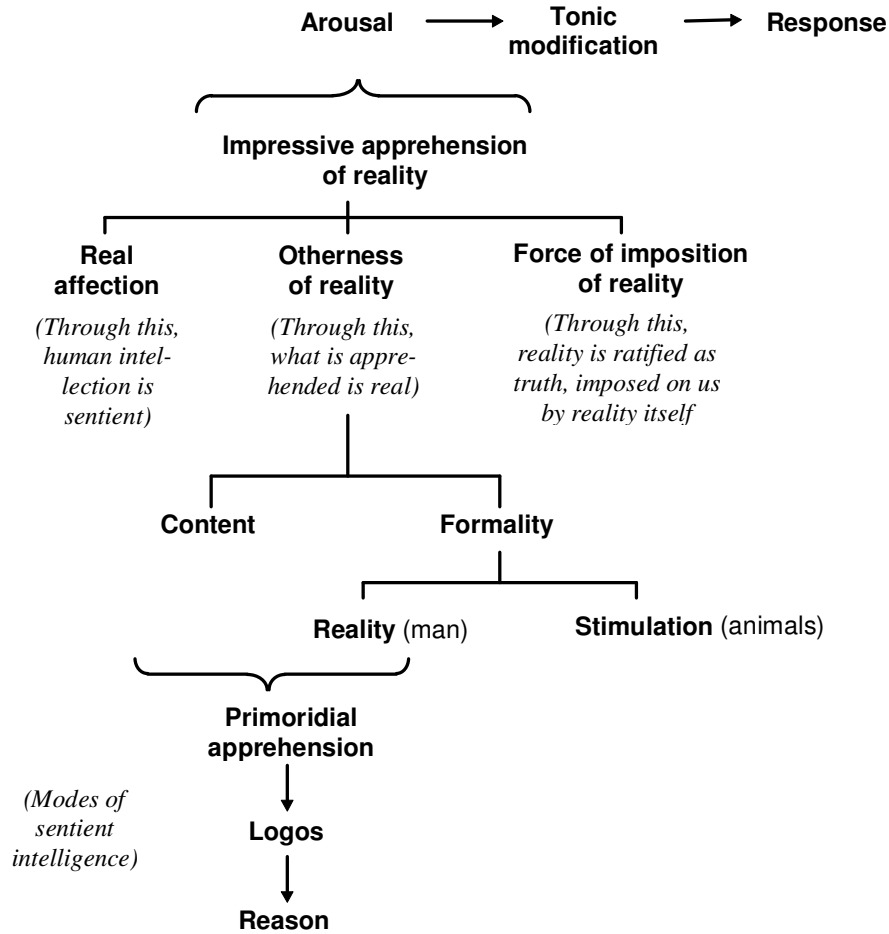


Figure 1
Sentient Intelligence in Zubiri's Philosophy

- Logos (explanation of what something is *vis à vis* other things, or as Zubiri expresses it, what the real of primordial apprehension is *in reality*). This is the second step: differentiate things, give them names, and understand them in relation to each other. As a baby gets older, this is what he does: he learns to make out things in his environment, and he learns what their names are, eventually learning to speak and communicate with others verbally. This stage involves a “stepping back” from direct contact with reality in primordial apprehension in order to organize it. The logos is what enables us to know what a thing, apprehended as real in sentient intellection, is *in reality* (a technical term, meaning what something is in relation to one's other knowledge). It utilizes the notion of the “field of reality”. The reality field is a concept loosely based on field concept of physics: a body exists “by itself”

but by virtue of its existence, creates field around itself through which it interacts with other bodies.

- Reason (or *ratio*, methodological explanation of what things are and why they are, as is done in science, for example). This is the highest level of understanding; it encompasses *all* of our ways of understanding our environment. One naturally thinks of science, of course; but long before science as we know it existed, people sought explanations of things. And they found them in myths, legends, plays, poetry, art, and music—which are indeed examples of reason in the most general sense: they all seek to tell us something about reality. Later, of course, came philosophy and science; but no single way of access to reality, in this sense, is exhaustive: all have a role. Reason, for Zubiri, does not consist in going to reality, but in going from field reality toward worldly reality, toward field reality in depth. If one likes, the field is the system of the sensed real, and the world, the object of reason, is the system of the real as a form of reality.

Reality

Given Zubiri's radically new approach to philosophy, and his analysis of intelligence as sentient, it is not surprising that his concept of reality is quite different from that of previous philosophy as well. As mentioned above, he rejects the idea of reality as a "zone of things", usually conceived as "out there" beyond the mind, and replaces it with a more general notion, that of formality. "Reality is formality", he says over and over, and by this he means that reality is the *de suyo*, the "in its own right"; it is *not* the content of some impression—a fundamental mistake of almost all previous philosophy. Anything which is "in its own right" is real. This *de suyo*, the formality of reality, is *how* the content is delivered to us. Our brains—Zubiri refers to them as organs of formalization—are wired to perceive reality, to perceive directly the "in its own right" character. It does *not* emerge as the result of some reasoning process working on the *content*; it is delivered *together with the content* in primordial apprehension.

This includes reality in apprehension, as well as reality beyond apprehension. But always, the character of reality is the same: *de suyo*. It is therefore something *physical* as opposed to something *conceptual*. And this is true whether one is speaking of things perceived at the level of primordial apprehension, such as colors, or things perceived in ulterior modes of apprehension such as reason, where examples might be historical realities such as the Ottoman Empire, or mathematical objects such as circles and lines: both are *real* in the same sense, though they differ in other respects (mathematical objects are real by postulation, whereas historical entities are not). Moreover, reality is independent of the subject, not a subjective projection, but something *imposed* upon the subject, something which is *here-and-now* before the subject. Logos and reason do not have to go to reality or create it; they are born in it and remain in it.

When a thing is known sentiently, at the same time it is known to be a reality. The impression of reality puts us in contact with reality, but not with *all* reality. Rather, it leaves us open to all reality. This is *openness* to the world. All things have a unity with respect to each other which is what constitutes the *world*. Zubiri believes that reality is fundamentally open, and therefore not fully capturable in any human formula. This openness is intimately related to transcendentalism:

...reality as reality is constitutively open, is transcendently open. By virtue of this openness, reality is a formality in accordance with which nothing is real except as open to other realities and even to the reality of itself. That is, every reality is constitutively respective *qua* reality.¹¹

Reality must not be considered as some transcendental *concept*, or even as a concept which is somehow realized in all real things:

...rather, it is a *real and physical moment*, i.e., transcendental is just the openness of the real *qua* real....The world is open not only because we do not know what things there are or can be in it; it is open above all because no thing, however precise and detailed its constitution, is reality itself as such.¹²

Sentient intellection is transcendental impression, in which the *trans* does not draw us out of what is apprehended, toward some other reality (as Plato thought), but submerges us in reality itself. The impression of reality transcends all its content. This is the object of philosophy, whereas the world as such-and-such is the object of science—all of which is delivered in the *content* of impressions.

Now of course, not everything which we perceive in impression has reality beyond impression; but the fact that something is real only in impression does not mean that it isn't real. It is, because it is *de suyo*. And what is real in impression forms the basis for all subsequent knowing, including science. Still, we are quite interested in what is real beyond impression, which may be something else, or the same thing understood in a deeper manner. For example, electromagnetic theory tells us that colors are the result of photons of a particular energy affecting us. But, according to Zubiri—and this is extremely important—there are not two realities (the photons and the colors): *the colors are the photons as perceived*. Reason is the effort to know what things are “in reality” which are known in primordial apprehension.

Truth

Truth, like reality, is much different in Zubiri's approach. The traditional view has always been that truth is some sort of agreement of thought and things. Zubiri rejects this view because it is incomplete and not sufficiently radical for two reasons: (a) “things” as understood in this definition are the product of ulterior modes of intellection, and (b) “thought” is not univocal, being different in the three modes. The notion of truth as agreement of two things, *dual truth*, is a derivative notion, which must be grounded upon something more fundamental. For Zubiri, the priority of reality is always paramount, and hence the primary meaning of truth, *real truth*, is impressive actuality of the real in sentient intellection. It is a quality of actualization, not agreement of two disparate things, which as the ground of truth would pose insuperable verification problems—and of course does in empiricist philosophies. All other truth is ultimately based on this real truth, this actualization. As such, *real truth* is imposed on us, not conquered; *dual truth*, a derivative form of truth, we conquer through our own efforts. Real truth must be sought in primordial apprehension:

...the real is “in” the intellection, and this “in” is ratification. In sentient intellection truth is found in that primary form which is the impression of reality. The truth of this impressive actuality of the real in and by itself is precisely real truth....Classical philosophy has gone astray on this matter and always thought that truth is constituted in the reference to a real thing with respect to what is conceived or asserted about that thing.¹³

Knowledge and Understanding

Zubiri believes that one of the principal errors of past philosophers was their excessively static view of knowledge—a conquer it “once and for all” approach. Typical of this mentality are the repeated attempts to devise a definitive list of “categories”, such as those of Aristotle and Kant, and Kant’s integration of Newtonian physics and Euclidean geometry into the fabric of his philosophy. Rather, knowledge as a human enterprise is both dynamic and limited. It is limited because the canon of reality, like reality itself, can never be completely fathomed. It is limited because as human beings we are limited and must constantly search for knowledge. The phrase “exhaustive knowledge” is an oxymoron:

The limitation of knowledge is certainly real, but this limitation is something derived from the intrinsic and formal nature of rational intellection, from knowing as such, since it is inquiring intellection. Only because rational intellection is formally inquiring, only because of this must one always seek more and, finding what was sought, have it become the principle of the next search. Knowledge is limited by being knowledge. *An exhaustive knowledge of the real would not be knowledge; it would be intellection of the real without necessity of knowledge.* Knowledge is only intellection in search. Not having recognized the intrinsic and formal character of rational intellection as inquiry is what led to...subsuming all truth under the truth of affirmation.¹⁴ [Italics added]

Understanding is also a richer and more complex process than heretofore assumed. Indeed, oversimplification of the process of understanding has led to major philosophical errors in the past. Understanding requires *both* apprehension of something as real, *and* knowing what that thing is with respect to other things (logos stage) and what it is in reality itself (reason stage). Traditionally only the latter is considered. Zubiri comments:

Understanding is, then, the intellectual knowing which understands what something, already apprehended as real, really is; i.e., what a thing is in reality (logos) and in reality itself (reason), the real thing understood in both the field manner and considered in the worldly sense.¹⁵

Understanding, then, requires sentient intellection and cannot exist, even for subjects such as mathematics, without it. This insight reveals clearly Zubiri’s radical departure from all previous thought.

III. Zubiri and Science

Articulating the relationship between science and philosophy has been a difficult problem for at least three centuries of Western philosophy, aggravated by the persistent failure to distinguish content and formality. Equally important is that many people ask of science what it cannot give, namely, to be a surrogate religion. Given Zubiri’s radical rethinking of philosophy, and his corresponding idea of reality, it is not surprising that his approach to science and the relationship of science and philosophy is also quite different. For him, the scientific and the metaphysical are closely connected, because both are forms of knowledge emerging from the reason or third mode of human intellection. The key difference between science and philosophy is that philosophy concerns itself with the real—what it is, how we know it, at all three levels of sentient intelligence—while

science is occupied with the search for the real beyond perception, which is exclusively at the third level (but not identifiable with it). Zubiri believes that many of the developments within science and mathematics during the past century point in the direction of a resolution along his lines, especially because they point to limitations of science (which actually stem from deeper limitations to human knowledge in general).

Brief historical sketch

As the 20th century opened, a reductionist-deterministic paradigm reigned supreme. The goal of reductionism, as Zubiri¹⁶ and others have pointed out, is to reduce biology to chemistry, chemistry to physics. In conjunction with strict determinism, knowledge of the ultimate particles and the most fundamental laws, together with the necessary initial conditions, would permit us to rebuild all of science and, by implication, of reality. A commonly drawn corollary of this philosophy is a radical realism: the world *really* is made up of the ultimate particles and the laws governing them; even God perceives the world this way. Hence, for theologians, reductionism tended to mean that the laws of physics were the “mind” of God, who thus was turned into the super physicist – ironically, the ultimate realization of Laplace's Demon.¹⁷

Development of quantum mechanics in the early years of the 20th century was a devastating blow. In place of the familiar absolutes of position and momentum, Schrödinger's equation yielded as its solution a wave function which gave only probability distributions for these quantities. Worse, Heisenberg's Uncertainty Principle revealed a complementarity between position and momentum, and between time and energy, such that the product of uncertainties in them had a lower bound ($\Delta p \cdot \Delta x \geq \hbar$). The new edifice of physics built upon this foundation, including such paradoxes as the interference of single particles, tunneling, the concept of virtual particles, and quantum activity of the vacuum, has been verified to an extremely high degree by experiment and has permitted physicists to construct vast theories describing the creation and evolution of the universe, going back to the limit of Planck time, 10^{-43} second after the Big Bang. There is in fact a double blow to classical ideas of science: first, *deterministic* laws are replaced by *statistical* laws; and second, *exact* boundary conditions are in most cases replaced by boundary conditions with a lower bound of *uncertainty*. This latter is particularly important because it means that *even with deterministic laws* strict reductionism is impossible, and therefore implies that complexity in the world must be irreducibly hierarchical.

Early on, Zubiri understood the profound change which had occurred, and moreover, realized that it was not a degradation of science, but a giant purification step which freed science from its unnecessary (and probably false) metaphysical baggage:

So, not only is it untrue that the idea of cause gave rise to modern science, but in fact modern science had its origin in the exquisite care with which it restricted this idea. That renunciation was, for the representatives of the old physics, the great scandal of the epoch. How is it possible for physics to renounce explanation of the origin of *all* movement? This heroic renunciation, nonetheless, engendered modern physics. Hence it is not permissible to whisper of scandals in the face of Heisenberg's principle; it rather necessary to faithfully examine the situation and see if it does not give to physics its ultimate stroke of purity.¹⁸

Of course, the advocates of determinism in science did not take kindly to this radical reinterpretation of nature. They refused to believe that (their) “God plays dice with the universe”¹⁹ and therefore postulated the incompleteness of quantum mechanics and the necessity for “hidden parameters” to restore determinism.²⁰ With Einstein himself at their head, they leveled attack after attack, only to be beaten back by Heisenberg and others. Their criticism culminated with the Einstein-Podolsky-Rosen (EPR) paradox, postulating a certain experiment the outcome of which would differ depending on the determinism or indeterminism of reality. Thirty years later this led to Bell’s inequalities and thence to the famous experiment by Aspect and his group at the University of Paris in 1982.²¹ The pivotal nature of this experiment for both science and philosophy can scarcely be overestimated: in it, 2500 years of thought about the nature of reality came together. The outcome was quite clear: the universe is indeterministic and non-local, at least as far as measurement is concerned. The profound impression left by the Aspect experiment is of the inadequacy, the ultimate limitations of the human mind in perceiving the ultimate truth about reality, and of the complete futility of assuming that the laws of physics can in any sense represent God’s way of knowing the universe. Nearly 50 years earlier, Zubiri had already perceived it: “For God, not only is there no physics, there is no *Nature* in this sense either”.²²

But the ultimate disaster for classical physics (and the 19th century world view based upon it) may turn out to be the rediscovery in the 1960s, 70s, and 80s of what is now termed “chaos theory”: the existence of simple, deterministic physical systems, *obeying* Newton’s laws, which nonetheless exhibit behavior so irregular that it is, for all practical and experimental purposes, stochastic and unpredictable.^{23,24} Chaotic behavior was originally discovered by Poincaré and Bruns around 1880 in their investigations of celestial mechanics and the three-body problem, but was ignored at the time because it did not fit the then-current paradigm of science, viz. that simple systems evolving in accordance with Newtonian physics had to exhibit regular, predictable behavior. What is the sense of a science which cannot make exact, testable predictions? Or worse, for nature to behave chaotically in some fundamental sense? Irregular behavior, if observed, was regarded as the result of random noise or other interference. If physical laws were the mind of God, how could they yield anything other than order?

Though Zubiri was apparently unaware of the emergence of chaos theory, he had already foreseen its implications:

Indetermination seems to be what is most opposed to the character of all scientific thinking ... to renounce determinism would be to renounce causality, and with it, everything that has constituted the meaning of science from Galileo up to the present day.²⁵

But in fact, as Zubiri perceived, science understood in such terms was in reality a mixture of pure science and spurious metaphysical notions,²⁶ and that causality is a much broader concept than determinism: “Causality is not synonymous with determinism; rather, determinism is a type of causality.”²⁷ Forty years later he made an observation that is particularly relevant to chaotic system behavior:

...above all, the fact that an effect may have reality in virtue of a cause does not mean that either the effect or the cause are repeatable. That is, Determinism is ultimately a schema for a type of causality, but not causality itself.²⁸

Even without the Aspect experiment, chaos theory would have spelled the ultimate demise of classical notions of science because it strikes so much at their heart.

Scientifically, a precise set of initial conditions for the higher layers is impossible to measure *or even to specify* in the majority of cases. Therefore the higher layers must operate *in light of this ineluctable uncertainty*. It does not matter whether a conscious intelligence is at work, or blind forces of evolution. There are quantities which are quite real at one level, but which cannot be meaningfully defined or measured at lower levels; for example, blood pressure by the molecular components blood, or the operation of a computer program by study of solid state physics of the transistors, or thought and the firing of neurons.²⁹ In other words, higher levels exhibit organization and behavior quite different from lower layers. This does not imply that causality has broken down; only that causality as a concept is not identifiable with strict determinism. (Of course, if strict determinism *were* true, Laplace's demon would rule and everything up to the highest level behavior (evolution of the universe as a whole) could be predicted from knowledge of the fundamental particles.)

Limitations to scientific knowledge

Quantum mechanics was regarded as a great scandal at the time of its introduction because of the limitations it placed on scientific knowledge.³⁰ In fact, however, the view displaced is the one which should be regarded as scandalous, because of its many speculative and unverifiable assumptions about human knowledge.³¹ What the new developments in science tell us is that while unaided reason has hard limits in respect to how far it can penetrate the secrets of the world (in contrast to what classical philosophy and the Continental Rationalists thought), the new language of mathematics used by modern science, though capable of penetrating much farther, also has fundamental limits. The main problem is that while we do directly perceive reality (e.g., the color green is photons as perceived; there are not two realities),³² we do not do so in the absolute, detached sense envisioned by classical science. Zubiri has analyzed this in his theory of sentient intelligence, where he begins by pointing out that the traditional approach to the problems of knowing and reality, an approach at least partly responsible for the shattered views of the 19th century, is radically wrong:

The fact is that an intrinsic priority of knowing over reality or reality over knowing is impossible. Knowing and reality are in their same root strictly and rigorously congeneric. There is no priority of one over the other. And this is true not simply because of *de facto* conditions of our investigations, but because of an intrinsic and formal condition of the very idea of reality and of knowing. Reality is the formal character–formality–according to which what is apprehended is something in “itself”, something *de suyo*.³³

Moreover, modern thought is itself guilty of a great scandal by attempting to relegate fundamental human experiences, such as the perception of color, to the periphery of science and explain it by reduction to other things which are logically dependent upon it:

How can someone ask if the real is deformed through perception if he has no other way of access to reality? On the other hand, to affirm that color is not a reality, one must have previously clarified what type of reality he is talking about, since the problem of reality can be posed at many different levels: that of primary perception and that of what a thing is when it is not perceived.³⁴

The root of the problem is that reality is more complicated than the human mind can understand; and even at the level of reason, it must rely upon multiple explanatory paradigms (science, theology, philosophy, poetry, and so forth) to grasp even a small part of reality. Even with this, reality must be broken down into pieces. There are four related aspects to the problem: (a) not everything has a rational explanation; (b) rational knowledge, including science, is a search not a *factum*, and therefore always radically incomplete; (c) reality is fundamentally open and not fully capturable by any human formula, and (d) rational knowledge is not the supreme form of intellection.

(a) For the purposes of human knowledge, it is not necessary that everything real have a rational explanation:

We are not dealing with the case that *all* of the real *qua* real is necessarily of rational structure; it suffices that *something* real, to wit, the field real, has this structure. To think that all the real necessarily has its “explanation” not only is an hypothesis, but moreover a falsehood.... God is absolute reality; but even in the worldly sense, it is not certain that every reality has a rational explanation. A free act does not³⁵

Other types of rational intellection of the world than science exist, and can tell us other things; indeed, we commonly speak of truth in connection with art and literature, as in Picasso’s famous remark, “Art is a lie that reveals the truth”.

(b) Moreover, all rational knowledge, including science, is a quest, not an accomplished fact. This is irremediable because it owes to the nature of rational intellection:

The limitation of knowledge is certainly real, but this limitation is something derived from the intrinsic and formal nature of rational intellection, from knowing as such, viz. being inquiring intellection. Only because rational knowledge is formally inquiring ... must one always seek more and find what was sought as the principle of the next search. Knowledge is limited by being knowledge. An exhaustive knowledge of the real would not be knowledge; it would be intellection of the real without necessity of knowledge. Knowledge is only intellection in search.³⁶

The incompleteness of rational knowledge (and by implication the impossibility of reductionism) is radical, not just an historical inconvenience:

... the complex of natural laws would never be able to explain everything present in the thing, because there always exists a margin of individuality and contingency which those laws would never succeed in exhausting.³⁷

(c) Reality is fundamentally open, and therefore not fully capturable in any human formula. This openness is intimately related to transcendentality:

...reality as reality is constitutively open....Reality is not a transcendental concept, nor is it a concept realized transcendently in each real thing; rather, it is a real and physical moment, i.e., transcendentality is just the openness of the real *qua* real....The world is open not only because we do not know what things there are or can be in it; it is open above all because no thing, however precise and detailed its constitution, is “the” reality as such.³⁸

The fundamental or constitutive openness of reality means that the search for it is a never-ending quest. Zubiri believes that the development of quantum mechanics in the

20th century has been an example of how our concept of reality has been broadened. The same is true with respect to the concept of person:

An intellection much more difficult than that of quantum physics was needed in order to understand that the real can be real and still not be a thing. Such, for example, is the case of person. Then not only was the field of real things broadened, but that which we might term ‘the modes of reality’ were also broadened. Being a thing is only one of those modes; being a person is another. Thus not only has the catalog of real things been changed, i.e., not only has a reality beyond the field reality been discovered, but the character of reality itself as a measure has changed, because a person is something different from a stone or a tree not just by virtue of his properties, but by his mode of reality...³⁹

Elsewhere, Zubiri points out that life, society, and history are also realities which are not objects in the sense of science either.⁴⁰

(d) Indeed, for Zubiri, the very position of rational knowledge in the “hierarchy” of human knowledge is different. Because of grounding in primordial apprehension, rational knowledge is essentially inferior to it:

Whence it follows that far from being the supreme form of intellection, knowledge is (by being rational actuality of the real, of a logico-historical nature), an intellection which is inferior to the mere intellection of primordial apprehension ... Knowledge is, I repeat, the successor to primordial apprehension⁴¹

This remains a stumbling block for those who have what amount to theological designs for science, and for whom renunciation of the ubiquity and universality of scientific explanation would be tantamount to an unconditional surrender, for whom a “Final Theory” of everything is the Holy Grail.^{42,43}

The limitations to scientific and mathematical knowledge, *uncovered in the course of science’s own development*, thus reflect a deeper reality: the underlying structure of the human mind and its ability to know reality through sensible apprehension. It has become clear that our perception of reality is not absolute in the 19th century sense, nor is it the way God perceives the world.⁴⁴ Science will always have limitations because of the fundamental openness of reality:

This openness is absolute, because however much we find, the search will never exhaust the openness of the world. And this is essential. In contrast to what Leibniz and Kant thought, reason is not totalizing or a totality, but something constitutively open. And this is not due to internal limitations of reason itself, but to the very nature of the real as impressively sensed.⁴⁵

Causality and scientific laws

Zubiri is keenly aware of the pivotal position of science and scientific laws in any discussion of reality. As discussed earlier, gone is the “classical view” wherein scientific laws were causal laws, and causality was understood as determinism. For him, causality is functionality rather than determinism,⁴⁶ but functionality remains the broader concept.⁴⁷ This means that a scientific law expresses a *functional* relation between quantities of interest, and the nature of that function can vary greatly. Determinism is one type of functionality, as in Newton’s second law, $F = m\ddot{x}$, where the value of x is completely determined once F and m are known; probability is another type of

functionality, as in Schrödinger's equation, $ih \frac{d\psi}{dt} = H\psi$, where ψ is a probability distribution function. However causality, in its usual acceptance, plays at most a background role; Zubiri's own example is the Universal Gas Law, $PV = nRT$: no causality is evident in the relationship among pressure, volume, and temperature.⁴⁸ In the case of biological systems, the functionality can become quite complicated indeed; an example which immediately springs to mind is that of a DNA molecule and its corresponding organism. Other types of functional relations exist, e.g., symmetry as used in subatomic physics; and new ones may be discovered in the future. Moreover, functionality is part of our normal perception of the world:

In classical philosophy a cause is that from which something proceeds by means of a real influence upon the being of the effect. Now, causality is not something given. We never perceive the productive influence of a real thing upon another... Our perception never perceives causality, but always does perceive the functionality; in the field of reality we sense reality in its functional moment as a field-nature moment of the impression of reality. We perceive that a thing is real as a function of others, a functionality which can be and is quite varied. Causality is only a type of functionality, and moreover very problematic...⁴⁹

To use Zubiri's example, if a pull the cord for a bell, the bell rings? Is this the cause? Suppose the bell were moved to the moon. Then a pull on the cord would produce no sound. Causality as perceived by a sentient intelligence is functionality, which may occur in many forms; it is not complete enumeration of causes.

To see how this view of causality and scientific laws meshes with modern science, it is necessary to ask a critical question: What is related by these functions? That which can be measured. For Zubiri, the concept of "measure" goes far beyond measurement in the quantitative sense understood by science; it is rather an essential part of reason as the highest form of human knowledge. For Zubiri, reason is not an organ of absolute evidence (Kant), nor basis of dialectic (Hegel), nor explanation of intellections, nor organization of experience.⁵⁰ It is what "gives us to think" about things and thus to go beyond what is present at levels of simple reality and logos:

Only as explanation of color is there intellection of electromagnetic waves or photons. The color which gives us to think is what leads us to the electromagnetic wave or to the photon. If it were not for this giving us to think, there would be no intellection of a beyond whatsoever; there would be at most a succession of intellections "on this side"...⁵¹

But it should not be assumed that only science, through theoretical constructs, can achieve this intellection:

... the beyond is not just a theoretical concept, as are the wave and the photon, for example. The beyond can also be what forges a novel; we would not create the novel if the real did not give us to think. The same could be said of poetry: the poet poetizes because things give him to think. And that which he thinks of them is his poetry. That what is intellectually known in this manner is a reality which is theoretically conceptualized, or a reality in fiction, or a poetic reality, does not change the essence of intellection as reason. A metaphor is one type of reasoning about things, among others. What is intellectually known of the beyond is purely and simply the intellection of what the things "on this side", upon being intellectually known, give us

to think. Therefore intellection of the beyond is reason or explanation, is intellection of the real in depth.⁵²

The notion of measure in connection with reason can now be understood. Every thinking intellection, for Zubiri, is based upon a principle of intellection. This principle he terms a 'ground-reality'.⁵³ It is in accordance with the ground-reality that a thinking intellection gauges the reality of what is present to it, or as Zubiri says, *measures* it. He takes as an example the conceptual shift required by quantum mechanics: in our most elementary field experience, we term material things 'bodies'. It was always assumed that things "beyond" the field were also bodies. Quantum mechanics disclosed that the real beyond the field is not always a body; elementary particles are not corpuscles in the classical sense.⁵⁴ Our *canon* of reality, in this sense, was thus enlarged. This canon, however inadequate, is nonetheless essential because it imparts a direction to our searching; in the case cited, it was only by seeking bodies that we encountered something new. Reason, indeed, is *intellectus quaerens*, a quest or search. Reason therefore has a certain character of provisionality:

The scientific method is "a" way of access to in-depth reality, but not every way of access is a scientific method....there is no implication that we will in fact actually reach this true encounter [with reality]; it may perhaps not always be possible. Science is not, as Kant thought, a *Faktum*, but an effort, not just with respect to its content, but also and above all with respect to the very possibilities of its existence—something completely different than the conditions of possibility of a science already achieved, such as the science about which Kant spoke. Science, in accordance with the three constitutive moments of rational intellection, is essentially a problematic knowledge, viz. a knowledge which seeks to take on the form of experimental facts, of a precise method of experimentation, or of grounding of verifiable truths.⁵⁵

Thus measurement, as understood in science, is a subclass of the more general type of measurement which constitutes part of reason as thinking intellection. In fact, measurement in science goes on at several levels: at the lowest, it is comparison of something with a fixed standard, e.g., a meter stick, which forms part of the *canon of measurable quantities and standards* (length, time, voltage, etc.). At an intermediate level, measurement is comparison of what is observed with the *canon of what is already known to exist*, e.g. species of plants or animals, or subatomic particles. But at the highest level—a level virtually unrecognized prior to the 20th century—it is exploration of in-depth reality based on the *canon of types or classes of reality known at the time*, e.g. material bodies. A change in the canon at this level generally entails a paradigm shift in Kuhn's sense:

Reason is always subject to possible canonic "renovations" or "repairs", which by virtue of being so are rational renovations. This renovation clearly concerns the content of what is presented in the canon ... [It] not only remakes the content of what is presented as real, but also the very direction of all subsequent search, of all subsequent reason; whence it is that the direction of reason is always provisional. Provisional does not mean that it is false ... Rather, it means that even if true, it is a truth which by its very nature will not necessarily be derogated, but superseded.⁵⁶

Scientific theories and laws are thus a way of measuring reality, but not the only way or a comprehensive way.

Hierarchical nature of reality

Science has disclosed to us the essentially hierarchical nature of the real, as well as its dynamical character at all levels. This implies mutual relationships among what we term 'things' at each level, things which tend to be defined through their dynamic relationships with other things at the same hierarchical level, as well as their contribution to higher levels. Science, slowly and painfully, attempts to determine the nature of these relationships; but the richness and depth of nature and its interrelationships will likely always far exceed the capabilities of the human mind. The causal nexus is too complicated to fathom; therefore we understand things through functional relationships, usually expressed mathematically. Moreover, as we now know from chaos theory, many systems have behavior so complex that no mathematical model will ever be able to predict them; they are, in this sense, their own fastest computer.⁵⁷ Such, for example, is likely the case with economic systems, and biological systems with respect to evolution:

... and this dynamic unity is the dynamic unity of the layers or degrees of reality. I say 'dynamic unity' because it does not seem to me that reality is a question of gradations (i.e., that there are realities more real than others), but that it is a true dynamic unity in which each higher reality, in the order of reality, is mounted upon the *substratum* of a reality of lower order... Each of the moments of reality which I have described metaphysically and dynamically subtends reality in its successor moment.⁵⁸

Reality, as disclosed to us by science, is essentially hierarchical. There is no ability to understand everything about it from one level; multiple hierarchical levels are required.⁵⁹ No thing exists or is understood by itself, but in relation to others, dynamically. In a remarkable passage, Zubiri points out the connection between respectivity and the essentially hierarchical nature of reality:

Here one starts from an initial and radical respectivity, in virtue of which each substantivity is *in re* essentially and constitutively respective. Here we are not dealing with an order of cause but with something different: a *grounding of causality*... and I say that the various dynamisms ... are *grounded* some upon others. The most elemental are therefore the basic dynamisms. [Though] the others are in no way reducible to the basic ones... they cannot be what they are unless founded upon the elemental and basic dynamisms. This is readily apparent in the problem of a particular type of dynamism, variation and change...⁶⁰

Finally, science does not look for some reality beyond the systems it examines; they are the reality at each level. For example, a society is a complex system with certain characteristics, some of which can be modeled mathematically. There is no "real" society lurking behind the system and giving rise to the observed properties. On the philosophical side, Zubiri has said the same:

... this substantivity is nothing hidden, or still less, something situated "behind" the system of constitutional notes or "beneath" it; rather, it is the system itself as such. Neither, for this same reason, is essence something which is found beneath the substantivity; it is, rather, an internal and formal moment of the system itself as such.⁶¹

Science searches for the ultimate structural principles of things, and through its method,⁶² tells us about the world, about these structural principles and their dynamics, these systems, which knowledge is grounded in logos and ultimately in primordial apprehension. The task of the philosopher is not to try an end run around science, and

short-circuit the investigation of reality by propounding “true” essences obtained unaided through sheer intuition; rather, it is to understand how all of the diverse forms of knowledge fit together in an integrated whole, based in reality. There is no problem of two types of knowledge of reality, one through philosophical essence and another through scientific “essence”, disconnected from it and based on entirely different principles, possibly leading to some new “dual truth” crisis such as arose in the Middle Ages.

Summary

Reality is formality, the *de suyo*; it is not a zone of things. Hence traditional views of science as a mode of access to reality, regarded as a zone of things beyond our confused perception, are doomed to failure. Reality is delivered to us in primordial apprehension. Only on that basis can the next stage of knowledge occur, logos, and then the final stage, reason, on which science is based—not the other way around. Reason, which seeks reality in depth, is always a quest, never a *factum*. It has limitations with respect to reality itself, for example, the fundamental uncertainties uncovered by science during the course of its maturing; and also the essentially hierarchical nature of reality, which requires understanding on multiple levels. Both scientific and philosophical knowledge are essential in the quest for in-depth reality,⁶³ with philosophy concerned primarily with the overall nature of reality, as gleaned in all three levels of sentient intellection, and with both formality and content of our apprehensions. Science is more narrowly focused on their content and on the talitative order, the such-and-such of the world. Science is exploration of in-depth reality based on the *canon of types or classes of reality known at any given time*. This canon, of course, is subject to ongoing revision. Philosophy does not try to tell science what the canon should be, but tells us how the process works and also utilizes those canons to help us understand reality better. In its quest, science utilizes functional explanations that ultimately allow us to perceive aspects of reality which would otherwise remain hidden; whereas philosophy tells us about the real *in toto* and how to interpret what science uncovers with respect to reality, what the functional explanations mean as descriptions of reality. Science provides us with an invaluable window onto reality, but philosophy enables us to understand what we are seeing through that window as reality. Science is but one of several openings onto reality; others include music, art, literature, and theology.

¹ A. Pintor Ramos, *Zubiri*, Madrid: Ediciones del Orto, 1996, p. 18.

² See Author’s Preface, p. 3.

³ Xavier Zubiri, *On Essence*, translated by A. R. Caponigri, Washington, DC: Catholic University of America Press, 1980, p. 1. [hereafter OE]

⁴ *Sobre la esencia*, Madrid: Alianza Editorial/Sociedad de Estudios y Publicaciones, 1985, p. 89-90 [English translation by A. R. Caponigri cited above, p. 113.]

⁵ *Ibid.*

⁶ Diego Gracia, *Voluntad de Verdad*, Barcelona: Labor Universitaria, 1986, p. 89.

⁷ Xavier Zubiri, *Sentient Intelligence*, tr. by Thomas B. Fowler, Washington: Xavier Zubiri Foundation of North America, 1999, Part I, chapter VII, p. 83ff. [hereafter, referenced as SI].

⁸ *Ibid.*, p. 63.

⁹ *Ibid.*, p. 94.

¹⁰ *Ibid.*, p. 4, 84, 100, 243.

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- ¹¹ *Ibid.*, p. 248.
- ¹² *Ibid.*.
- ¹³ *Ibid.*, p. 84.
- ¹⁴ *Ibid.*, pp. 261-262.
- ¹⁵ *Ibid.*, p. 363.
- ¹⁶ *Nature, History, God*, tr. by Thomas B. Fowler, Washington, DC: University Press of America, 1981, p. 51. [hereafter, referenced as NHD].
- ¹⁷ In retrospect, it is clear that even under the suppositions of Newtonian physics, the reductionist goal was hopelessly unrealizable from any practical standpoint and therefore unverifiable. Brillouin (*Scientific Uncertainty and Information*, New York: Academic Press, 1964, p. 24) has pointed out that a motion of 1 gram of matter by 1 cm on a nearby star (e.g., Sirius) would change the gravitational field on the earth by about 10^{-100} -- small but enough to make it impossible to compute the motions of particles in an ideal gas for more than 10^{-6} second.
- ¹⁸ NHD, p. 253-254.
- ¹⁹ NHD, p. 266.
- ²⁰ J. S. Bell, *Speakable and Unspeakable in Quantum Mechanics*, Cambridge: Cambridge University Press, 1987, p. 1-40.
- ²¹ P. C. Davies, J. Gribben, *The Matter Myth*, New York: Simon and Schuster, 1992, p. 224.
- ²² NHD, p. 265.
- ²³ Gleick, *Chaos*, New York: Viking, 1987.
- ²⁴ T. Fowler, "Application of Stochastic Control Techniques to Chaotic Nonlinear Systems", *IEEE Trans. Automatic Control*, 34:201-205 (February, 1989).
- ²⁵ NHD, p. 252.
- ²⁶ NHD, p. 253.
- ²⁷ NHD, p. 256.
- ²⁸ Xavier Zubiri, *Estructura dinámica de la realidad*, Madrid: Editorial, Sociedad de Estudios y Publicaciones, Madrid: 1989, p. 99 [hereafter, ED].
- ²⁹ D. Hofstadter, *Gödel, Escher, Bach*, New York: Random House, 1980.
- ³⁰ NHD, p. 253.
- ³¹ John Templeton, *Who's Who in Theology and Science*, 1992 edition, Introduction, p. vii, Framingham: Winthrop Publishing Company, 1992.
- ³² SI, p. 125 (English ed.); *Inteligencia sentiente*, Editorial, Sociedad de Estudios y Publicaciones, Madrid: 1980, p. 186 (Spanish edition).
- ³³ SI, p. 1 (English ed.); *Inteligencia sentiente*, p. 10 (Spanish edition)
- ³⁴ Lopez Quintas, *op. cit.*, p. 254.
- ³⁵ SI, p. 642, Eng. ed.; *Inteligencia y razón*, Alianza Editorial, Sociedad de Estudios y Publicaciones, Madrid: 1983, p. 284.
- ³⁶ SI, p. 626, Eng. ed.; *Inteligencia y razón*, p. 262-262
- ³⁷ OE, p. 130 English edition, p. 106 Spanish edition.
- ³⁸ SI, p. 488-489 Eng. ed.; *Inteligencia y razón*, p. 20-21.
- ³⁹ SI, p. 514, Eng. ed.; *Inteligencia y razón*, p. 56-57.
- ⁴⁰ SI, p. 568, Eng. ed.; *Inteligencia y razón*, p. 178.
- ⁴¹ SI, p. 664, Eng. ed.; *Inteligencia y razón*, p. 316.
- ⁴² Steven Weinberg, *Dreams of a Final Theory*, New York: Pantheon, 1992.
- ⁴³ J. D. Barrow, *Theories of Everything: The Quest for Ultimate Explanation*, Oxford: Oxford University Press, 1991.
- ⁴⁴ NHD page. 302 (Spanish. ed.)
- ⁴⁵ *Inteligencia y razón*, p. 103.
- ⁴⁶ Technically, *functionality* means the formal unity of two moments of the formality of the real: the individual moment and the field moment. (SI, p. 604, Eng. ed.)
- ⁴⁷ SI, p. 609, Eng. ed.; *Inteligencia y razón*, p. 237.
- ⁴⁸ SI, p. 609, Eng. ed.; *Inteligencia y razón*, p. 237.
- ⁴⁹ SI, p. 223, Eng. ed.; *Inteligencia y logos*, Alianza Editorial, Sociedad de Estudios y Publicaciones, Madrid: 1982, p. 40.

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- ⁵⁰SI, p. 526, Eng. ed.; *Inteligencia y razón*, p. 68-69.
- ⁵¹SI, p. 508, Eng. ed.; *Inteligencia y razón*, p. 43.
- ⁵²SI, p. 508-509, Eng. ed.; *Inteligencia y razón*, p. 43-44.
- ⁵³SI, p. 511-514, Eng. ed.; *Inteligencia y razón*, p. 47-50.
- ⁵⁴SI, p. 517, Eng. ed.; *Inteligencia y razón*, p. 56.
- ⁵⁵SI, p. 564, Eng. ed.; *Inteligencia y razón*, p. 172-173.
- ⁵⁶SI, p. 522, Eng. ed.; *Inteligencia y razón*, p. 62-63.
- ⁵⁷R. Jensen, "Classical Chaos", *American Scientist* 75:168-181 (March-April, 1987).
- ⁵⁸ED, p. 326.
- ⁵⁹ED, 96
- ⁶⁰ED, 103.
- ⁶¹OE, 200 English edition., 191 Spanish edition.
- ⁶²SI, p. 613-614, Eng. ed.; *Inteligencia y razón*, p. 242-243.
- ⁶³Diego Gracia, *op. cit.*, p. 166.