European Journal of Science and Theology, December 2007, Vol.3, No.4, 39-48

SCIENTIFIC KNOWLEDGE AND RELIGIOUS RELATION TO REALITY

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(Received 10 November 2007)

Abstract

The formal pole of knowledge is considered the guarantor of the objective character of the historically evolving scientific knowledge.
Is then religious knowledge objective and public? The religious dialogue supposes that the content of faith is public. Theologies from different religious traditions endeavour to rationally explain the religious propositions and experiences consistently with their religious tradition and with the current knowledge of Science. The difficulty lies in defining the semantics of the religious formalisms. Between the formal semantic models of Science and the formal metaphysical and theological semantic models, there is a basic difference: the domains of interpretation of the theological expressions cannot always be defined in the univocal sense in which the domains of interpretation of scientific formulations are defined.

Keywords: formal, empirical, models, semantics, religious formalism

1. Scientific knowledge and formal language

The characteristics proper to scientific knowledge are that it is objective and public and these have been the values which have mostly motivated scientist throughout the centuries of the modern era. The motivation of many scientists is rooted in the intention and wish to perceive reality objectively, as it is, rationally experiment it in the laboratory and on the work table, express it through scientific theories, personal reflection and scientific discussion, and communicate it through academia, publishing and cultural media. However, the development of Science over recent centuries, especially throughout the 20th century has achieved greater certainty as regards knowledge of many facts and, on occasions, has led to our doubting the real value of scientific knowledge and questioning the real value of scientific knowledge. *To what extent is scientific knowledge a knowledge of reality as it is? Is the image of the world offered by Science real?*

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These questions on the image of reality provided by scientific knowledge are meta-scientific questions. That is to say, they are questions about Science itself. It is possible to be a scientist and not care about answering these. Furthermore, some scientists who have taken an interest in these questions have given a variety of answers, depending on the historical epoch of science and the philosophical or meta-scientific viewpoint from where Science is perceived.

Science is a historical evolutionary phenomenon which has developed due to a great extent to the impulse received from the constant search for objective public knowledge. Knowledge is objective when it does not depend on the subject who knows, therefore, it is the same for all the subjects who know. Objective knowledge of reality does not depend on subjective opinions. It is public knowledge because it is the same for all. Objective knowledge can be expressed formally, in a language constructed clearly. Formal sciences, or sciences of formal languages attain the maximum level of objectivity when they are based on signs and symbols which are defined with precision and precise rules which make it possible to construct formulas with these signs and define relations between the formulas constructed in this way. Formal sciences have also evolved throughout history and continue to evolve at the present time. In a way, the historical evolution of Science questions the objectivity of scientific knowledge. If the scientific vision of the world evolves, will it not cease to be objective as it depends on different times in history? *Will the vision which Science gives us of the world not vary throughout history?*

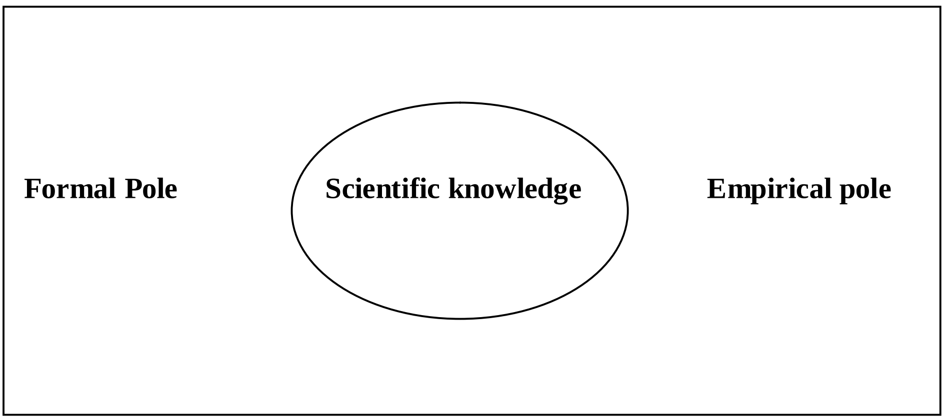

Figure 1. Two poles of scientific knowledge: formal and empirical.

I am going to respond to these questions with the special support of the formal pole of scientific knowledge. Scientific knowledge has two poles: formal and empirical. The formal pole is the one of scientific language. The empirical pole is the one of experiment and empirical observation. Scientific knowledge requires both o these poles (Figure 1). The formal pole is one of the two extremes of scientific knowledge and its importance can only be understood when we consider it in relation to the other extreme of scientific knowledge, which is the empirical pole. The empirical pole is that of observation, the methodical perception of reality. The formal pole is that of the theoretical drafting of what is perceived. Scientific observation cannot be separated from the formal theories from which this observation is understood, and it is not possible to separate the formal and abstract propositions of the institutions, which are often not rigorous and which precede these.

The importance which the formal has in order to understand the empirical is manifest by the fact that we can only say that the empirical observations which we express formally have attained the scientific intention to become public, objective knowledge, which can be discussed and accepted by persons from different cultural, racial and religious origins. The observations must be interpreted by formal theories. However, despite the importance this has, the formal pole of scientific knowledge requires an empirical pole so that scientific knowledge may become knowledge of reality. The formal pole is important because the empirical observations cease to be a disconnected set of data when they are explained by a theory. However, the empirical pole is also important because the theories only cease to be mere hypotheses when they are confirmed by empirical observations.

The empirical pole relates scientific knowledge to reality. According to the Popperian criteria of falsifiability [1], it must be possible to falsify all scientific formulations by an experiment or by observation. The experiments and the observations are an essential dimension of all scientific formulations because, through these, we perceive the reality which we formulate scientifically. Experiments and relationships are the windows which open Science to the knowledge of reality as it is.

However, the experiments and observations do not deny, but rather affirm and confirm the importance of the formal pole in Science, in order that an experiment or observation might falsify a scientific theory, the data obtained by observation must be expressed in the formal language of this theory. For example, we know that the observation of photons interpreted in the language of quantum theory contradicts the classical theory of physics which supposes that the emission of light is continuous. However, if the observation of light particles is to formally contradict classical physics, we must formulate this observation in quantum theory and express this observation in a proposition which is coherent with quantum theory and also contradicts classical physics.

The control which the formal pole exercises over knowledge is manifest by the fact that the same empirical data can be interpreted and understood from a variety of formal theories. One example is the measurement of time. In classical mechanics, time is an absolute magnitude which is the same for all observers. In relativist mechanics each observer perceives space-time in four dimensions according with their own state of movement, so the events perceived as simultaneous differ from one observer to another. The objective reality of observed time is different for different observers. Furthermore, according to the theory of relativity, clocks function more slowly when they are subjected to a strong gravitational field. Using the electronic vibrations produced in certain atoms as a clock, it has been observed that these vibrations are set back when they are influenced by the strong gravitational field of the Sun. This set back of the vibrations is an empirical confirmation of the conduct of clocks as forecast by the theory of relativity. The same empirical data of the movement of the planets will be interpreted with different equations if it is considered that it is a movement around the Earth, if it is interpreted as a movement around the Sun, or if it is interpreted within the theory of relativity.

The formal pole uses the clarity of mathematical language. Formal mathematical language has a high level of objectivity which makes it public and independent of the subject stating the proposition. The objectivity of the mathematical formulations makes them to have a public value, that is to say, to remain valid when they are used beyond the context in which they were produced. The same mathematical formulations are valid in different political, sociological and cultural contexts. Due to the public and objective nature of the mathematical formulations, scientific knowledge of reality endeavours to attain value beyond the subjective opinions and can be discussed, evaluated and accepted by persons with different cultural, racial and religious backgrounds.

One example of the inter-relation between the empirical and formal pole is the anomaly of the observations of the movement of the planet Mercury as regards the mechanical theory of Newton. It was observed that the point in which the orbit of Mercury is closest to Sun (perihelion) changes position in each successive orbit of the planet. The change of position of the perihelion of Mercury could not be explained by the mechanics of Newton and this led the French Mathematician Le Verrier (1811-1877) to predict the existence of a hypothetical planet called Vulcan. That is to say, certain mathematical calculations based on the mechanics of Newton led Le Verrier to predict the existence of a hypothetical planet which could not be empirically proved. Although some more or less professional astronomers said that they had seen the planet Vulcan, no one could empirically prove its existence. The anomalous conduct of Mercury in the perihelion was not justified until it was explained by the new general theory of relativity. Once this anomaly was explained through the theory of relativity, no one tried to find the planet Vulcan.

2. Human knowledge and natural language

The formal and empirical poles of scientific knowledge correspond to two essential poles of human knowledge. Until now we have referred to specifically scientific knowledge, however, all human knowledge involves the perception of experiences and the assimilation, expression and communication of these experiences by means of a rational language (Figure 2). All specifically human knowledge is experiential and rational. The capacity to express experiences through a rational language is a characteristic of human knowledge in general and this is previous to the existence of Science. The rational structuring through language and experiential perception are the active and passive poles of all human knowledge. These two poles of language and experience are referred to each other and cannot be completed separately. They are two extremes of knowledge. There is no pure language without experience and there is no human experience beyond language and communication. However, as occurs in the formalisms and observations in Science, language is what provides a rational category to experience.

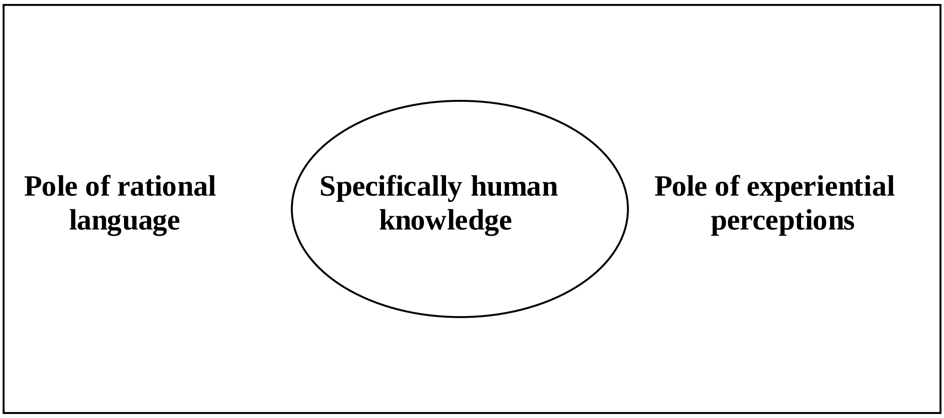

Figure 2. Two poles of human knowledge: experiential and rational.

Formal language and natural language. Formal language is constructed from natural language. Natural language is the language used by humans in communication. Natural and formal language both have a syntactical structure. The syntax of formal language is constructed through fixed rules based on defined symbols. The semantics of formal languages depends only on their form, it is univocally determined as a mathematical function. The basic syntactic schemes from which the formal languages are constructed are present in the natural languages. Natural language has a deep grammar which does not vary, therefore, it can be formalised. Formal languages are constructed from deep structures present in natural languages. However, natural languages have other more surface dimensions where their grammar varies, is imprecise and depends on the context.

Formal language as regards natural language is characterised by producing a consistent structuring of experimented reality, which makes it possible to predict its future behaviour. The active role of language becomes clearer and methodical in formal language. The same empirical observations are characterised as actively methodical. In the formal pole, the formal theories clearly and consistently explain what has been observed and render the empirical observations coherent and congruent. This is such that whenever data from new observations appear, normally the new data is explained by the previous formal theories. This is usually expressed by saying that the formal scientific are capable of predicting future observations. If the new observations are not as predicted by formal theories, then, the new observations are not properly done or the previous formal theories must be modified.

Does the vision that Science gives us of the world vary throughout history? In fact, the vision which Science gives of the world changes and evolves throughout history. However, the formal structures remain as fixed and constant visions of reality. Their historical value depends on their applicability to explain the empirical observations.

To what extent is scientific knowledge, knowledge of reality as it is? Science finds formal structures in observed reality which are objective and public. The formal structures which science finds in reality responds to a (provisional) knowledge though which (provisionally) we obtain a technological control of reality.

Is the image which Science offers of the world real? Due to their objective and public nature, the scientific structures of reality enable all men and women, regardless of their religion, race or culture, to have a common vision of reality.

3. Representative models and formal semantic models

The scientific models lie between the formal and the empirical poles of scientific knowledge. A scientific model is a structured representation of reality and its conduct. Among the multiplicity of different types of scientific models, I will distinguish two basic types: the *representative models* and the *formal semantic models* (Figure 3).

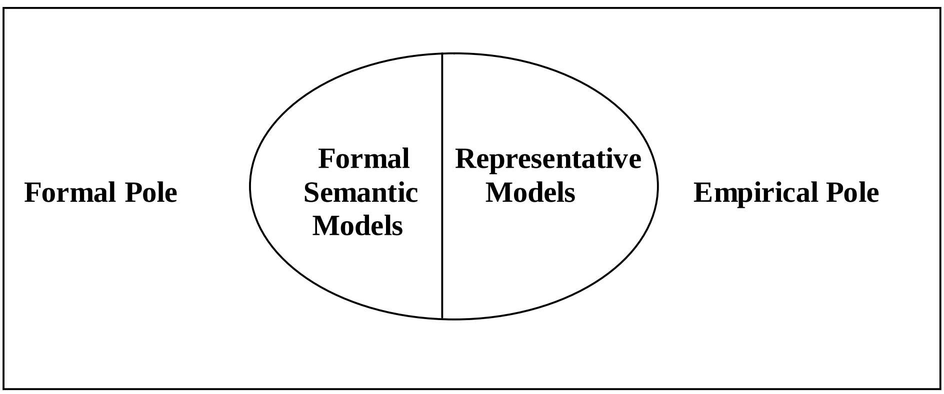

Figure 3. Two basic types of models: the representative and the formal semantic.

The representative models represent empirical reality. The Bohr atom and the representation of ADN of Watson y Crick are two examples of representative models. *The formal semantic models* are abstract mathematical structures. Among the formal semantic models, those formed by sets of components and relations defined regarding these sets are especially important. One example of a model formed by sets of components is the model **N** formed by the set of natural numbers, the zero constant and the addition and product functions of natural numbers.

There is a multiplicity of types of representative models. Empirical knowledge is expressed through a substantial variety of representative models, which describe different types of observed structures. There is a wide variety of models, just as there is a wide variety of sciences. Physics uses physical models, Biology uses biological models, Neuroscience, Economics, etc. use several types of models to explain their perception of the aspects of reality they wish to explain.

The formal semantic models are frequently described as sets. The description of a model is formal when all its parts are formally defined. A model described in the theory of models as a set has two basic parts: the domain of interpretation of the model formed by the set of all the components that constitute the model, and the different types of relationships between the components of the domain of the model. Formally a model is described as an ordered succession of sets $\langle D, (c^M),(f^M),(p^M)\rangle$, where the set D is the domain of the model, and the sets $(c^M),(f^M),(p^M)$ are the interpretations of the symbols of the constant, function and relationship of a language. The importance which formal languages have in Science corresponds to the importance which the semantic models have in order to explain the representative models. Science intends to explain the realities it studies through representative models by using formal semantic models. For example, the general theory of relativity represents the time-space observations through a formal mathematical model, which is four dimensional, non-Euclidian.

The formal languages are interpreted in formal semantic models. The formal languages, as a set of signs and applied rules, lack meaning in themselves. Semantics, which gives meaning to formal languages, is made up of formal models. The relationship between formal languages and the formal models which interpret their meaning has been studied especially by the Polish mathematician Tarski [2]. Semantics attributes a meaning to the formulas interpreting their truthfulness value – true or false – in formal structures.

The domain of interpretation of the formal semantic models is a defined set. The domain of interpretation may be, for example, the set of natural numbers or the set of graphs with a finite number of vertices. As regards these domains, we can define different types of functions and relations, but, in any case, we will only have defined a model if we have defined a domain and certain functions and relations concerning this domain.

The relation between the formal semantic models and the representative models of the observations connects the formal pole with the empirical pole of scientific knowledge: The representative models evolve throughout history. The semantic models are fixed instruments that serve to explain different representative models. The representative models represent and structure the data observed. However, the representative models need to be explained with formal precision through formal semantic structures (geometrical, arithmetical, logical, algorithmic…).

The representative models acquire an objective and public nature when formal semantic models explain them. The formal semantic models are characterised by their objectivity and the formal clarity by which they are defined. Due to their objective and public nature, the formal semantic models allow all men and women us to have a common vision of reality, regardless of their religions, race or culture.

4. The religious relationship with reality

Is religious knowledge objective and public? Are religious experiences subjective and particular or are they public and communicable to any person, regardless of culture, race or gender?

The religious dialogue supposes that the content of faith is public and that it is possible to speak of this among believers of different religions and non-believers. Many religions, and Christianity in particular, intend that the religious faith is not merely subjective. Inter-religious dialogue is based on the objective value that the religious propositions may have, regardless of the individual feelings and perceptions of the speaker.

We have seen that the characteristic of being objective and public, which characterises scientific knowledge, is based on the capacity to formally express the content of Science. We have also seen that only through the empirical observations which we formally express can we say that we have completely achieved the scientific intention to obtain public and objective knowledge, which can be discussed and accepted by persons with different cultures, races and religions. Can religious language be formalised? Can we use a formal language in order to communicate religious experiences?

Theologies from different religious traditions endeavour to rationally explain the religious propositions and experiences consistently with their religious tradition and with the current knowledge of Science. The diversity of theologies is due to the diversity of religious interpretations of the world and the diversity of religious visions of the meaning of life. As religions have developed in contact with different cultures, they have assimilated different visions of reality. Theologies ask about how formal coherence can be established between religious language and formal scientific objectivity.

In Catholic Theology, there is a well known book with the title, Enchiridium symbolorum definitionum et declarationum de rebus fidei et morum, whose first author was the theologian Heinrich Joseph Dominicus Denzinger (1819 - 1883) [3]. It is a book which contains the formal declarations of the Catholic faith. Is it possible to translate this book to a formal language? Evidently it is possible to translate it to a formal language. The problem lies in defining the semantics of the formalism that we would obtain.

God Creator and transcendent is not a scientific concept. It refers to all things and, at the same time, it is different from all things. Between the formal semantic models of Science and the formal metaphysical and theological semantic models, there is a basic difference: the domains of interpretation of the metaphysical and theological expressions cannot always be defined in the univocal sense in which the domains of interpretation of scientific formulations are defined. The theological propositions of monotheist religions refer to God and to all things in reality created by Him. In all religions there are propositions which refer to all things.

The direct reference to the set of all sets is not necessary in the theory of sets and leads to paradoxes, such as the paradox of Russell. The semantic models described as sets have had to avoid paradoxes in order to be able to refer to the group of all the sets. For example, using the concept of class in order to refer to the group of all the sets. The *Type Theory* avoids Russell's paradox by creating a hierarchy of types [4]. In the case of the concept of God Creator, it is necessary to refer to the group of all the sets, moreover, it is necessary to predicate of God that He is the creator of all things. The domain of interpretation of the metaphysical and theological expressions cannot always be defined as a set because it refers to the ultimate causes of all things. God as the transcendent creator would have a different treatment from any other set.

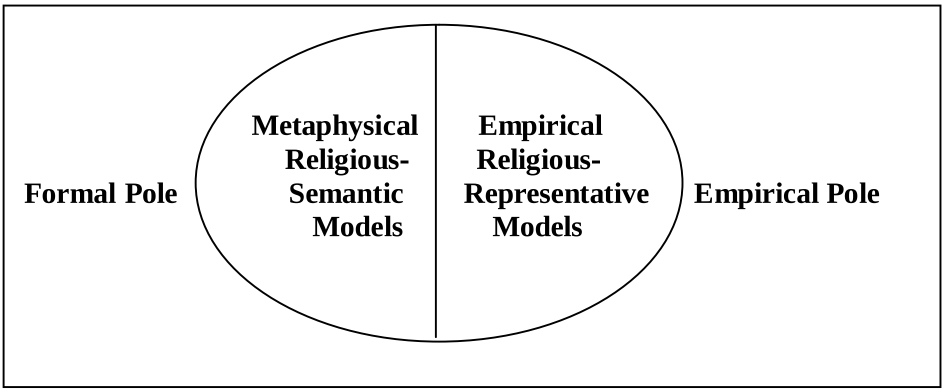

Figure 4. Two basic types of metaphysical-religious models: the representative and the semantic.

The religions have created different empirical-religious representative models (Figure 4). For example, the rule of Saint Benedict or of Saint Francis of Assisi. As in Science, in religion there are different types of representative models. The rules of discernment of the Spiritual Exercises of Saint Ignatius are another type of representative model. These representative models on occasions endeavour that any person from any culture and condition can understand them. If an empirical-religious representative model is to be really public and can be discussed by any person regardless of his culture and his religion, it must be explained through a formal language, which must be interpreted in metaphysical-religious semantic models.

The difference between a scientific semantic model and a metaphysical-religious semantic model establishes the difference between Science and Theology, between Science and Metaphysics. The domain of interpretation of the metaphysical-religious semantic models includes both the class of all the sets and the transcendent Creator to whom all sets are related. However, the formal explanations through formal metaphysical semantic models also have an objective value as they enable public dialogue on the metaphysical and religious dimensions of reality, with no cultural frontiers.

References

[1] K. Popper, *The Logic of Scientific Discovery*, TJ International Ltd, Padstow, Cornwall, 1999.

[2] A. Tarski, *Logic, Semantics, Metamathematics: Papers from 1923 to 1938*, translated in English by J.H. Woodger, Clarendon Press, Oxford, 1956.

[3] H.–S. Adolfus Denzinger, *Enchiridium Symbolorum Definitionum et Declarationum de rebus fidei et morum*, editio XXXVI, Herder, Barcelona/Friburgo/Roma, 1976.

[4] A.N. Whitehead and B. Russell, *Principia Mathematica*, 2nd edn. 1927, Cambridge University Press, Cambridge, reprinted in 1999.