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Review

Insolvability of the Problem of Demarcation

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The demarcation problem, a term coined by Karl Popper, refers to the problem of determining the nature of the criteria that should be implemented to establish the boundaries between science and non-science. Throughout this paper we will use this term in the more restrictive sense as the problem of determining the boundary between science and religion. The efforts to elucidate a solution to this problem usually place scholars into two incongruous extremes. The prevalent stance is not only that this boundary exists, but that it is definable, insurmountable, and impermeable. Some hold the exact opposite view and reject the idea that such a demarcation is, in fact, extant. A third alternative was offered by some philosophers of science of twentieth century such as Lakatos, Feyerabend and the epistemological anarchists that the problem of demarcation is, in fact, irresolvable. We do concur with their claim, and offer a logical proof that the existence or nonexistence of such a boundary is, ultimately, indeterminable. We start out by giving a brief history of the conflict between religion and science. We follow this by a condensed account of how the scientific process is delineated in various philosophies of science. We conclude by addressing the issue of demarcation and its insolvability.

Key words: Science, religion, epistemology, demarcation

INTRODUCTION

Science and Religion

Since the word “science” comes from Latin *scientia* meaning “knowledge,” and the word “religion” from Latin *religare* meaning “being bound,” by virtue of their etymological roots alone, the two disciplines seem to be set at the very start for unremitting discord. However, historically, there has been no permanence or constancy as to the relation between religion and science being utterly adversarial or absolutely supportive and accommodating of each other.

In the Medieval era, some leading philosophers such as Averroes, Maimonides, and Augustine of Hippo tried to establish a synthesis between religion, philosophy, and natural sciences, putting them, astoundingly, in almost equal status by maintaining that if religious teachings were found to contradict certain direct observations about the natural world, then the interpretations advocated by one or the other had to be reevaluated.

> Indeed, these attempts to establish a degree of concord between religion and science, was exemplified by the doctrine of *imago dei*, described by Thomas Aquinas in *Summa Theologiae* (Ia. q. 93, a. 4)
>
> Since human beings are said to be in the image of God in virtue of their having a nature that includes an intellect, such a nature is most in the image of God in virtue of being most able to imitate God.

This almost convivial relation between science and religion lasted a few more centuries. For example, the

founders and members of the Royal Society, including Isaac Newton - although declared an infidel by Bishop Berkley - were men of conventional religious faith (Harrison, 2008).

It was about the mid-nineteenth century, when science became more professionalized, that the construction of impregnable and insurmountable fortifications isolating the realms of religion and science from each other began in earnest (Turner, 1978). The Enlightenment scholars pointed out that in the early days of Christianity science was at best seen as a futile and even a superfluous extravagance. They referred to the examples of one of the early church fathers, Athanasius, who celebrated the fact that the first church leaders were "men of little intellect" (Athanasius, *On the Incarnation* 47), and to that of Theodosius II, who in 448, ordered all non-Christian books to be burned[1]. They concluded that, in general, all religious authorities advocated theological certainty and flawlessness at the expense of scientific skepticism and imperfection, thus rendering philosophical and scientific tenets less amenable to rectification and transformation and more subordinate to dogma. They blamed this intolerance and fanaticism for the naissance of the perspective that science and religion were in an irreconcilable discord and contended that the developments in natural sciences had usually been subjected to hostile confrontations and their architects to gratuitous penalties and even to outright violence by the religious establishment, using such egregious examples as the geocentric versus the heliocentric model argument; the case against Galileo Galilei; the burning at stake of his compatriot, the Copernican monk Giordano Bruno (1548-1600)[2]; and later, the vigorous attempts to discredit the theory of evolution espoused by Charles Darwin (1809-1882). Then there was, of course, the paramount refuge of quasi-intellectuals, the following statement of St. Augustine Quapropter bono christiano, sive mathematici, sive quilibet impie divinantium, maxime dicentes vera, cavendi sunt, ne consortio daemoniorum animam deceptam, pacto quodam societatis irretiant (Da Genesi ad Litteram, II, xvii, 37) which was translated as:

> The good Christian should beware of mathematicians and all those who make empty prophecies". The danger already exists that mathematicians have made a covenant with the devil to darken the spirit and confine man in the bonds of Hell.

And which, conspicuously and conveniently disregarded the fact that at the time the term "mathematici" was used to mean astrologers and soothsayers and not mathematicians.

Regardless, the scholars from both groups proceeded assiduously to distinguish between the methodologies used in establishing spiritual and scientific assertions. This constantly widening fissure between religion and science came to be known as the *conflict thesis.*

The conflict thesis gained increased momentum after the appearance of John William Draper's[3] *History of the Conflict between Religion and Science* (1875), where two mysterious entities called Religion and Science were in a battle for the domination of human mind. This was followed by Andrew Dickson White's[4] *History of the Warfare of Science with Theology* (1895), aimed at demonstrating that religious interference in scientific affairs end up harming both.

White tracked many (Christian) religion-based conflicts, and showed that they often take decades or even centuries to resolve, and noticed an eight-step pattern in these conflicts:

1. Some individual or group will propose a new belief system that is in conflict with established religious beliefs. The official religious institutions generally ignore this
2. A growing number of people will start to disagree with the teachings of the church
3. Churches issue statements which condemn the proposal, citing Biblical passages as justification for their stance
4. Support for the proposal continues to grow among the public
5. Churches issue statement pointing out that belief in the proposal negates the entire Christian message, or attacks a fundamental Christian principle
6. Public support continues to grow
7. Churches begin to ignore the proposal, and sometimes ignore the Biblical passages that they once quoted in opposition to the new idea
8. Many decades or centuries later, churches may incorporate the proposal into their beliefs[5]

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[1] There were, of course, precedents to this bonfire of ignorance. There was a massive book burning in 354. Later in 364, Emperor Jovian ordered the Library of Antioch to be burned.

[2] In 1584, Bruno suggested that stars were suns with other earths in orbit. He also posited that the Universe was infinite and sought to prove the existence of God through philosophy. These proved to be too much for the Catholic establishment that was already being challenged in many other ways.

[3] John William Draper (1811-1882) was an American scientist, philosopher, and historian. He was the first President of the American Chemical Society and the founder of the New York University School of Medicine.

[4] Andrew Dickson White (1832-1918) was a professor and co-founder of Cornell University.

[5] Of course, religious liberals have tended to readily accept scientific findings and incorporate them into their theology

Embedded in the conflict thesis are two major issues. First is the epistemological issue: can what is known about the universe through science be integrated with what is known about it through religion? Second is a methodological issue. Can science based on demonstrable facts and religion based on faith be anything less than polar opposites? The answer, for the adherents of the conflict thesis, is a resounding "No!" in both cases.

The conflict thesis, which has been the accepted norm for most historians of science for over a hundred years, has more recently, come under scrutiny, many authors expressing doubts as to whether this conflict truly existed. For example, Ronald L. Numbers claims "the war between science and theology in colonial America has existed primarily in the cliché-bound minds of historians" (Numbers, 2002: 58).

Indeed, in most instances the Church was much more lenient than it was regularly depicted to be

> Although popular images of controversy continue to exemplify the supposed hostility of Christianity to new scientific theories, studies have shown that Christianity has often nurtured and encouraged scientific endeavor, while at other times the two have co-existed without either tension or attempts at harmonization. If Galileo and the Scopes trial come to mind as examples of conflict, they were the exceptions rather than the rule (Ferngren 2002, ix).

The Church usually appealed to St. Augustine's *doctrine of accommodation*: *Holy Spirit accommodated itself on the pages of Scripture to the everyday language and terminology of appearances, it inspired the biblical writers to describe phenomena of nature in a way that was understandable and accessible to ordinary and unlearned people.* St. Augustine followed this principle in his interpretation of the six days of Genesis in his *De genesi ad litteram*. John Calvin, in his commentaries on Genesis and Psalms, was quite clear in stating that the writers of religious texts described nature simply as it appeared to their senses:

> The Holy Spirit had no intention to teach astronomy; and in proposing instruction meant to be common to the simplest and most uneducated person he made use by Moses and other prophets of the popular language (Hummel, 1986: 176).

Thus, as meaningful a model as the early monotheists had constructed to account for the phenomena they observed in the heavens and upon the Earth, there were no provisions of constancy in this model; it was only a time-bound conception of human knowledge and understanding that provided a context for the writers' revelations about God, and was not, as it was misinterpreted later on, intended to be timeless statements about the physical nature of the universe. The mechanical and scientific depiction of the universe and its value- and principle-laden religious view were to be regarded as distinct, and consequently, there could be no tenable reason for an epistemological conflict (Bray 1996). For instance, the proofs provided by the newly-emerging science of geology in 1800s would have forced the religious establishment to recant a literal view of the Genesis account concerning the age of the Earth or the story of the Flood, but not concerning their moral implications.

Probably nothing did more to kindle the conflict between science and religion than an 1859 book by a humble theist, Charles Darwin, *The Origin of Species*. The book, promulgating the theory of natural selection turned the concept of evolution into a scientific possibility, which after subsequent alterations became a widely-accepted theory. It also laid the foundation for anthropology to develop as an independent science; and conversely, the discovery of more primitive cultures around the world further helped to demonstrate that human development took place in successive stages.

Although these developments strengthened materialistic philosophies and espoused a hostile attitude towards miracles, they did not lead to the demise of religion. Quite the contrary, by promoting a historical criticism of religious texts, and encouraging the religious institutions to reinterpret the more dogmatic aspects of their faiths, they led the way to the progression of religion as a moral guideline.

Most contemporary historians of science now reject the conflict thesis in its original form and envision it merely as a derisory backdrop in the analysis of the relationship between religion and science, arguing instead that this theory has been supplanted by subsequent research alluding to a different stance; in fact, today, much of the scholarship on which the conflict thesis was originally based is considered to be inaccurate. For instance, the claim that people of the Middle Ages widely believed that the Earth was flat was first propagated in the same period during which the conflict thesis was propagated (Russell, 1997), and still remains quite prevalent. In fact, according to Lindberg and Numbers, not only most of the Christian scholars of the Medieval Ages acknowledged the spherical shape of earth, but they also had a fairly good idea about its approximate circumference (Lindberg and Numbers, 1986).

The conflict thesis had flourished mostly because during the Enlightenment science was conceived as a collection of empirical and theoretical methods developed

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and morality. Thus White's eight step process mainly applies to conservative sects (Hexham and Poewe 1997, 96).

to establish ontological and universal truths, whereas theology merely as assertions of truth based on doctrine. However, progresses attained during the twentieth century provided some impetus for the two structures to actually draw closer to each other: the perspective of science as an establisher of universal and ontological truths waned along with the decline of logical empiricism, and theology softened many of its own ontological claims. Consequently, by mid twentieth century, the conflict thesis was superseded by several other theories (Stace 1952).

One such view, namely, Stephen Jay Gould's *non-overlapping magisteria*, claimed that science and religion dealt with fundamentally separate aspects of human experience and involved isolated and unconnected realms of erudition and that when each stayed within its own domain, they could dwell together in peaceful tranquility (Gould 1999). Moreover, each one was consistent and complete within its own sphere of influence.

This position is not dismissive of either entity - both are held as being equally utile and equally necessary within the human experience[6] - nor does it aim to trivialize them; it just assigns them distinct functions and tasks: neither science, which is descriptive, should have prescriptive aspirations, nor religion, which is prescriptive, should have among its objectives the yearning to describe natural phenomena. The Genesis can be the object of severe criticism as a book of science, but scientists look no less ridiculous when they try to use their subjects to create a belief system. Pythagorean view of "All is number" was as inaccurate as the age of the Earth given by Biblical writers.

For those interested in a more detailed outline the history of the relationship between science and religion and related issues, I recommend Draper (1875), White (1895), Carr and Rees (1979), Curtis (1986), Laudan (1988a)[7], Polkinghorne (1989), Brooke (1991), Feyerabend (1993), Mayr (1998), and Barr (2003).

What Is the Scientific Process?

Our perception of what constitutes science has mutated and transformed considerably over the centuries. It would be way beyond the spatial constraints of this paper to give a full, detailed history. As such, many names from George Berkeley (1685-1753), to Immanuel Kant (1724-1804), to Charles Sanders Pierce (1839-1914), to Edmund Husserl (1859-1938), to Karl Jaspers (1883-1969), to Werner Heisenberg (1901-1976) will be conspicuously absent from our discussion.

No matter how condensed, no such historic account can afford to omit Plato's (c.428 BCE-c.348 BCE) *Allegory of the Cave*. In *Republic*, at the beginning of Book VII (514a–520a), Plato imagines a group of people who live confined in a cave all of their lives, facing a wall. They watch shadows projected on this wall by things passing in front of a fire behind them, and begin to ascribe forms to these shadows, which are as close as they get to seeing reality. Thus Plato asserts that *forms*, and not the material world of change known to us through our sensations, possess the highest and most fundamental kind of reality, that is, only knowledge of the *forms* constitutes real knowledge (The Republic), i.e. one reaches truth by deductive reasoning, not by experimentation. This deductive approach and the yoke of Aristotelian (384 BCE- 322 BCE) logic dominated our scientific methodology for centuries. The unwritten *argumentum ad verecundiam* principle of

> Aristotle says p is true
> Aristotle is the authority
> Therefore, p is true
> was to be challenged only centuries later by the first modernists, namely, Francis Bacon (1561-1626) and René Descartes (1596-1650).

The "scientific" methodology sanctioned by the religious establishment was codified by St. Thomas Aquinas (1225 – 1274), the famed and brilliant scholar and theologian who successfully merged the Aristotelian view of natural sciences with Christian theology in his monumental

[6] As Albert Einstein famously put it "Science without religion is lame; religion without science is blind." In fact, Einstein supported the compatibility of some interpretations of religion with science. In an article originally appearing in the New York Times Magazine in 1930, he wrote:

> Accordingly, a religious person is devout in the sense that he has no doubt of the significance and loftiness of those superpersonal objects and goals which neither require nor are capable of rational foundation. They exist with the same necessity and matter-of-factness as he himself. In this sense religion is the age-old endeavor of mankind to become clearly and completely conscious of these values and goals and constantly to strengthen and extend their effect. If one conceives of religion and science according to these definitions then a conflict between them appears impossible. For science can only ascertain what is, but not what should be, and outside of its domain value judgments of all kinds remain necessary. Religion, on the other hand, deals only with evaluations of human thought and action: it cannot justifiably speak of facts and relationships between facts. According to this interpretation the well-known conflicts between religion and science in the past must all be ascribed to a misapprehension of the situation which has been described (Einstein 1930, p. 1-4)

[7] Especially pages 337 – 350.

Summa Theologia (Aquinas, 1981), which for several centuries set the standard in European intellectual discourse. The two major tenets of Aristotelian natural philosophy, namely, that Earth was at the center of the universe and that the Earth and the heavens were composed of different materials, fitted perfectly with the Judeo-Christian view of a once perfect Earth created in the image of God (hence its central position and same pristine make as the heavens) soiled by the fall of humankind (now it is dirty and heavy), whereas everything else that was not sullied by the touch of humankind remained as perfect as God had made them.
St. Thomas Aquinas (1963, 136-137) declared two principles of his scientific methodology:

(i) Aristotle meant what he wrote
(ii) Whatever Aristotle wrote is worth the effort of understanding.

Cartesian rationalism replaced the method of *argumentum ad verecundiam* by intellect: one should accept nothing as true unless it is presented to the mind so clearly and distinctly that there can be no doubt about the statement's truth. This method based on systematic doubt, established reason and thought as the valid bases of knowledge. The intentions were honorable: rejection of *argumentum ad verecundiam* as a scientific method, but the proposed replacement "presented to the mind so clearly and distinctly that there can be no doubt about the statement's truth" was way too vague, in our opinion, to be of philosophical significance.

Francis Bacon on the other hand, mostly in *Novum Organum*, replaced the Greek deductivism and Cartesian rationalism by what is now called empiricisism: one starts with observations and then proceeds, inductively, to generalizations. The scientist then had to look for confirming or refuting instances of these generalizations. Thus, according to Bacon, negative instances of an experiment were just as important as its positive instances. Knowledge grew steadily from observations to axioms of increasing importance and generality, which by other experiments were verified or modified. We submit that the admittance of the significance of negative results was the greatest contribution of Bacon to the philosophy of science.

The problem with Bacon's empiricism was the way he answered "How can we eliminate errors from accumulating and affecting the knowledge obtained through this method?" His basic argument was based on several assumptions:

> Truth exists
> It is immutable
> Empiricism is the correct method of finding it
> Thus, if the final knowledge was erroneous the fault had to be with the scientist accruing the data.

Seventeenth and eighteenth centuries witnessed an intellectual and scientific eruption. Sir Isaac Newton's (1642 – 1727) calculus-based depiction of terrestrial and celestial mechanics (Cotes 1953) and Pierre-Simon Laplace's (1749 – 1827) account of cosmology (Laplace 1796) initiated a new era in sciences. By far the most serious attempt till then to establish a philosophy of science was initiated by the Scottish philosopher David Hume (1711-1776). In *A Treatise of Human Nature*[8] published in 1748, striving to remedy the frailties of Baconian empiricism, Hume established his ideas of cause and effect, which he used to ascertain a fallacy in Baconist empiricism, saving us to do so in this paper. Does induction based on facts observed in the past lead to generalizations about the future? For example, does the fact that we have observed sunrise every morning allow us to make the generalization that the sun will keep on rising every morning in the future? Certainly not! Thus, observing a few instances and generalizing to the whole is not a logically sound process. Hume avers as much in *An Enquiry Concerning Human Understanding.*

> As to past Experience, it can be allowed to give direct and certain information of those precise objects only, and that precise period of time, which fell under its cognizance: but why this experience should be extended to future times, and to other objects, which for aught we know may be on in appearance similar, this is the main question on which I insist (Hume, 2008: 23).

Hume did not reject experiments as tools of scientific research, but rather changed the interpretation of what is observed: combine the facts of experience into effects and from effects deduce their causes. Thus, in Baconian empiricism experiences are specific instances of causes, whereas in Hume they are effects. Of course, it is very hard (if not outright impossible) too see scientific theories as conjectures in flux that approximate the truth in Hume's argument.
Later the school of thought known as *logical positivists,* referred to as the *Vienna Circle,* under the influence of Ernst Mach (1838-1916) and (early) Ludwig Wittgenstein[9]

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[8] First published in 1739–1740 with the title *A Treatise of Human Nature: Being an Attempt to introduce the experimental Method of Reasoning into Moral Subjects* and later as *An Enquiry Concerning Human Understanding.*

[9] Wittgenstein's *Tractatus* was by held in high esteem by the members of the Vienna Circle. But the *Tractatus* already showed fundamental deviations from positivism, and these were only broadened further in the *Philosophical Investigations* (Shields 1993).

(1889-1951) came up with the algorithmic approach

State the problem → Formulate a hypothesis → Design an experiment → Collect and record data → Form conclusions

In our opinion, the only positive role of logical positivism within the realm of philosophy of science was its providing us with a viable school of thought exemplifying what philosophy of science should not be: First of all, we find the reduction of scientist to data collector and record keeper a bit offensive. We point out that in such a strict objective empiricism, the human experience is eliminated from the equation with some devastating results, not least of which would be the loss of creativity. Secondly, the logical positivist approach assumes that data are completely value-free and ignores the fact that the growth of science is a social phenomenon. The facts of science may be neutral but the activities of science are not neutral. As scientists are human beings, they are fallible, they are bound by the social, cultural, and linguistic modes of their times. Thirdly, not all theories can be proved or refuted on the basis of data. We would like to see how a logical positivist would design an experiment to prove or refute the quantum concept of many worlds. Thus, it is no surprise that positivism eventually self-destructed. Philosophers came to realize that positivism could not meet its own verificationist criterion of meaning: the verificationist criterion turned out to be neither empirically verifiable nor logically undeniable. Kurt Gödel (1906-1978), the Austrian mathematician and philosopher, who was in fact associated with the Vienna Circle as a young man, paved the way to the movement's demise. His two "Incompleteness Theorems ", proved in his 1931 paper, *Über formal unentscheidbare Sätze der Principia Mathematica und verwandter Systeme* that appeared in *Monatshefte für Mathematik und Physik* (*38*: 173-98), exposed the fundamental flaws in the foundations logical positivism. For more information see Torkel (2005) or Nagel, Newman, and Hofstadter (2002).

The modern period in philosophy of science has been dominated by Thomas Kuhn (1922-1996) Karl Popper (1902-1994), Paul Feyerabend (1924-1994), and Imre Lakatos (1922-1974). Kuhn in *The Structure of Scientific Revolutions* (Kuhn, 1970) established the concept of *paradigm shift* and claimed that scientific revolutions were paradigm shifts.
To this end, Kuhn defined a *paradigm* as:

> The entire constellation of beliefs, values, techniques, and so on, shared by members of a given community (Kuhn, 1962: 175)

> Science is made up of *normal periods* - periods where a paradigm is not in revolution, followed by revolutions. Normal periods are characterized by three types of inquiry: investigations of the revealing aspects of the paradigm, articulation of its various components, and verification of its theoretical predictions. Research is shaped by paradigm. Observations and experiments are paradigm dependent.

Scientific revolutions are major shifts of one paradigm to a new one. During the normal periods, there exist experiments that do not verify the paradigm. These anomalies are usually accommodated through *ad hoc* modifications of basic assumptions. As these anomalies increase, the old paradigm is rejected and replaced by the new one; a scientific revolution.

The problem with all of the above philosophies of science was that they were looking for *verification:* how can scientific theories be verified? The first philosopher to eradicate the tradition of verificationism in the philosophy of science was Karl Popper, who viewed science as being concerned primarily with refutation rather than confirmation.

Popper noted that one could not verify a theory by showing that its conclusions agreed with an experiment, because future experiments might conflict with the theory. Besides there might be other theories that explain the present evidence. Thus, the correct question to ask is:

> How can we hope to detect and eliminate error as we accumulate knowledge? (Popper, 1963: 25)

In other words, Popper was interested in not the source but in the growth of knowledge.

The crux of Popperian perspective is that although a negative result refutes a conjecture, repeated observations and experiments that are positive do not confirm it; they fail to reject it. Consequently, theories, though universal, are not absolute; they are tentative conjectures and are subject to logical and empirical criticism. The goal is not to produce theories but to eliminate false ones. Consequently, what distinguishes science from non-science is the fact that the former is falsifiable.

Modern epistemological perspectives assert that scientific knowledge is constructed by scientists and not discovered from the world. In other words, the concepts of science are mental constructs posited to elucidate our sensory encounters. Thus, although there is an external objective Reality, one cannot attain knowledge of it; the only reality one can attain is the one represented by human thought. Reality is independent of human thought, but knowledge is always a human construct.

Consequently, science is not an autonomous form of reasoning, but is, in fact, a culture-based human activity inseparable from the larger body of human thought and inquiry.

In fact, some scholars have argued that the idea that science should function in accordance with universal, permanent, and predetermined imperatives is improbable, pernicious and detrimental to science itself (Feyerabend 1993) - the viewpoint called *epistemological anarchism* and espoused by Paul Karl Feyerabend (1924-1994), an Austrian/American philosopher of science, who disseminated this concept in his books *Against Method*, *Science in Free Society,* and *Farewell to Reason*. The term anarchism is intended to suggest the prevailing *methodological pluralism* (or *epistemological pluralism*), that is, the viewpoint that a variety of different epistemological methodologies are required to attain a full delineation of the world (Feyerabend 1993).

The Demarcation Problem and Proposed Solutions

In this paper we want to show that the problem of demarcation[10], a topic which is usually perceived as one of the more arcane and the more incommodious topics in the philosophy of science, is, in fact, unsolvable, in the sense that any attempt to give a solution leads, inevitably, to infinite regress.

The pursuit for the resolution of the demarcation problem is much more than an abstract intellectual exercise, for this problem has substantial and concrete implications and repercussions in our daily lives. For example, are theories concerning the link between race and intelligence scientific or can we simply dismiss them as pseudo-science? Even in the more restricted manner we have been using the term, namely, as the problem of determining how and where to draw the boundaries between science and religion, there are numerous vital questions and predicaments. Should creationism be allowed in the science classroom because it is a scientific theory? Are all languages related because they all began at The Tower of Babel? Thus, it should come as no surprise that the demarcation problem has been one of the most central, most significant, and most resilient conundrums in the philosophy of science (Shermer, 2001).

The first attempt to distinguish science from non-science was made by Aristotle who used the degree of certainty as a criterion: science produces definite true knowledge (*episteme*), whereas other types of inquiry, such as philosophy or theology, produce opinion (*doxa*). Yet, one can see the inherent deficiency of this simplistic approach. Suppose we make a statement *p* about an object or an occurrence, *Q*. Is *p* an *episteme* or *doxa*? In order to assert that it is an *episteme*, we must be able to assert that *p* provides "definite true knowledge" about *Q*, which necessarily implies that one must already know what definite true knowledge about *Q* should entail – a logical contradiction.

It might seem reasonable to assume that emphasizing the differences between the epistemological aspects of science and religion would provide us with such a criterion: scientists can know the external world through rational and empirical investigation, whereas man cannot know God from the observable evidence of the creation and needs faith.

Among the philosophers that promoted this view was Soren Kierkegaard (1813-1855). Kierkegaard accepted a fundamental epistemological distinction between science and religion. Since science deals with material objects and their interrelationships, objective knowledge is possible, that is, scientific knowledge can be categorized as impersonal and objective. Religion, however, involves a personal relationship with God, and therefore, is personal and radically subjective.

Logical positivists of the Vienna Circle also accentuated this dichotomy and claimed that only empirically verifiable (or logically undeniable) statements about observable entities can be meaningful. Metaphysical principles and convictions refer to unobservable beings (God) or principles (morality, love, etc.) and hence are meaningless. Thus for logical positivists *verificationism w*as the line of demarcation: a theory is scientific if and only if it is verifiable.

We reject this epistemological argument as a possible resolution of the demarcation problem on two accounts. First, use of verificationism as a method of demarcation leads to logical problems, for a theory being verified by contemporary methods does not necessarily make it true, as it may be shown to be false by future methods. Moreover, as we discussed earlier, there are theories that can neither be verified nor falsified.

Secondly, the fundamental hypothesis, the claim that scientists can know the external world through rational and empirical investigation is in fact false. The main tenet of modern epistemology is that the concepts of science are mental constructs proposed in order to explain our sensory experience. In other words, scientific knowledge is constructed by scientists and not discovered from the world. Consequently, the only reality we can know is the one which is represented by the human mind. This is not to deny that there is an external Reality independent of human thought, but to affirm that meaning or knowledge is always a human construction (Crotty 1998). Indeed, ontological Reality is utterly incoherent as a concept, since any claim that one has finally reached this Reality presupposes that we know what that particular Reality should entail.

An alternative approach to the demarcation problem was the *realm perspective*. According to this perspective,

[10] This term is used, from this point on, to mean "the problem of the selection of the criteria that can be utilized to distinguish scientific theories or truth claims from religious or metaphysical truth claims."

science and religion entail dissimilar endeavors, have different objectives, and different purposes. Religion focuses on God's self-revelation and science investigates the natural world. Consequently, science and religion occupy two different compartments. According to Kierkegaard and the positivists, these compartments are mutually exclusive. Science and religion inevitably offer different types of descriptions of different types of realities. Of course, from the point of view of logic, these mutually exclusive compartments need not be unrelated, in fact, they can be complementary. However, unrelated or complementary, these are assumed to be distinct domains of discourse. Science and religion always describe reality in categorically different (and sometimes complementary ways). Consequently, there can be neither conflict nor agreement between science and religion.

Here, the basic idea is categorization based on sphere of influence. We claim this is not a proper criterion either. To start with, the compartments cannot be mutually exclusive. Science and religion often make assertions about the same subject such as the origin and nature of the cosmos, the origin of life, and the origin of man, the nature of human beings, to name a few: Is Earth less than 10,000 years of age as indicated in Genesis or is it about 4.5 billion years old? Did all languages evolve at the Tower of Babel?

Now that we have shown science and religion do not live in disjoint domains, the question becomes whenever they intersect are they necessarily complementary? Not necessarily. Take the age of the Earth. There is an intersection and the proposed answers are not complementary; they are simply contradictory. Similarly, on any given topic in the intersection either science or religion (or both or neither) may be right or wrong about these subjects.

While this model is adequately agreeable and depicts some aspects of the relationship between science and religion accurately, for reasons given above, it cannot encapsulate this complex relationship in its entirety, and hence cannot provide a solution to the demarcation problem.

Karl Popper shared the positivists' conviction that there was a well-defined boundary between science and non-science. However, at the foundation of Popper's approach was the need to distinguish scientific from metaphysical statements, not meaningful from meaningless statements. For, unlike the positivists, Popper did not maintain that metaphysical statements had to be meaningless. In fact, a statement that at one time was unfalsifiable (and hence metaphysical) could in future be developed into falsifiable theories and thus become scientific.

In his collection *Conjectures and Refutations: The Growth of Scientific Knowledge* (1963), Popper writes,

Science must begin with myths, and with the criticism of myths; neither with the collection of observations, nor with the invention of experiments, but with the critical discussion of myths, and of magical techniques and practices. The scientific tradition is distinguished from the pre-scientific tradition in having two layers. Like the latter, it passes on its theories; but it also passes on a critical attitude towards them. The theories are passed on, not as dogmas, but rather with the challenge to discuss them and improve upon them.

Consequently, science cannot be distinguished from non-science on the basis its methodology; in fact, there is no distinctive methodology exclusive to science alone. Science, like virtually every other human activity, consists principally of problem-solving.

Thus, Popper's sole criterion for demarcation was *falsifiability*: a theory is scientific only if it is refutable by a conceivable event. Every legitimate test of a scientific theory is an attempt to disprove or to falsify it. But let us consider this example: geocentric theory. This theory has by now been overwhelmingly falsified. Consequently, it was falsifiable and, therefore, scientific. Thus, the question is now this: Is the geocentric theory more scientific than the heliocentric theory (which has not yet been falsified)? In other words, is a demonstrably false theory more scientific than one that has wide explanatory power and may well be true?

As another example, let us take the ideas, if this is the proper word for them, of Immanuel Velikovsky as proposed in his 1950 book *Worlds in Collision*. Velikovsky claimed that around the 15th century BCE, Venus was ejected from Jupiter as a comet-like object and passed near Earth, thus changing Earth's orbit and axis. This in turn instigated a disproportionate number of catastrophes as referenced in early mythologies and religions. Of course, this theory was immediately falsified. Applying Popper's falsificationism criterion, we would categorize Velikovsky's claims as scientific.

Moreover, if Popper's falsificationism criterion is truly scientific, then the principle of falsifiability should be falsifiable, that is, there should exist scientific theories that cannot be falsifiable.

CONCLUSION

The Insolvability of the Demarcation Problem

Let us now summarize what we did in the previous section. We have shown that the demarcation problem was a *bona fide* dilemma, for science and religion usually offered different answers to questions at the intersection of their areas of influence. Naturally, we then asked whether it was possible to find an immutable, rigid, and universal boundary that would separate the two. In other words, given a domain called science (*S*), we tried to find a method by which we could answer the following query:

Given an assertion p_0, does p_0 belong to S?
Here we make one fundamental assumption.

The Fundamental Assumption

To be consistent, our answer to the question "Given an assertion p_0, does p_0 belong to S?" must be a statement itself belonging to S. In other words, if there is a method of distinguishing science from non-science, this method must be "scientific."

Suppose the problem "Given an assertion p_0, does p_0 belong to S?" can be solved. The solution would be either "p_0 belongs to S" or "p_0 does not belong to S". Call the chosen assertion p_1. But based on our Fundamental Assumption, this assertion would make sense if p_1 belongs to S. Thus, now we have a new problem: "Does p_1 belong to S?" Again there are two possibilities: "p_1 belongs to S" or "p_1 does not belong to S." Suppose we answered this problem, and let us call its answer p_2. Now, we must answer the question: "Does p_2 belong to S?"

Hence, the placement of any assertion p_k in S, will entail a new problem: the placement of the assertion p_{k+1} into S or not S. Since this process contains countably infinite number of steps, it is impossible to determine, in a finite number of steps, whether p_0 belongs to S or not. Consequently, the problem of demarcation is irresolvable.

Accordingly, there is no justification for valuing scientific claims over any other category of claims: the purportedly scientific method does not have a monopoly on veracity or efficacy of results. To claim the preeminence of science is just as rigid, just as repressive, and just as unwarranted as any claim regarding the supremacy of any other ideology. Indeed, we should strive for a truly "free society [in which] all traditions have equal rights and equal access to the centres of power" (Feyereband 1978, 9). A tyranny of science is no more beneficial to society than any other type of tyranny, and our intellectual goal should be to replace the canon of scientific method by the heterodoxy of human ingenuity, resourcefulness, and imagination.

REFERENCES

Aquinas T (1981). *Summa Theologiae*. (Translated by Fathers of the English Dominican Province). Westminster, MD: Christian Classics (originally published 1267–1273).

Barr SM (2003). *Modern Physics and Ancient Faith*. Notre Dame: Notre Dame University Press.

Bray G (1996). *Biblical Interpretation, Past & Present*. Downers Grove: Downers InterVarsity Press.

Brooke JH (1991). *Science and Religion: Some Historical Perspectives*. Cambridge: Cambridge University Press.

Carr BJ, Rees MJ (1979). The Anthropic Principle and the Structure of the Physical World. In *Nature* 278, (April 12) 605–612.

Cotes R (1953). *Newton's Philosophy of Nature; Selections from his writings*. New York: Hafner Library of Classics.

Curtis R (1986). Are Methodologies Theories of Scientific Rationality? In *The British Journal for the Philosophy of Science*. 37(1):135–161.

Draper JW (1875). *History of the Conflict between Religion and Science*. New York: D. Appleton and Co., 5th ed.

Ferngren G (editor) (2002). *Science & Religion: A Historical Introduction*. Baltimore: Johns Hopkins University Press.

Feyerabend P (1978). *Science in a Free Society*. New York: Schocken.

Feyerabend P (1987). *Farewell to Reason.* London: Verso.

Feyerabend P (1993). *Against Method* (3rd ed.). London: Verso.

Gould SJ (1999). *Rocks of Ages: Science and Religion in the fullness of life*. New York: Ballantine Books.

Harrison P (2008). Religion, the Royal Society, and the Rise of Science. In *Theology and Science*, 6 (2008), 255-71.

Hume D (2008). (New Ed.) An Enquiry Concerning Human Mind. Oxford: Oxford University Press.

Hummel C (1986). *The Galileo Connection: Resolving Conflicts between Science & the Bible*. Downers Grove: InterVarsity Press.

Kuhn T (1962). Structure of Scientific Revolutions. Chicago: Chicago University Press.

Laplace PS (1796). Exposition du système du monde. (Translated from the French by J. Pond. London: printed for R. Phillips, 1809.)

Lindberg DC, Numbers RL (1986). Beyond War and Peace: A Reappraisal of the Encounter between Christianity and Science. In *Church History: Studies in Christianity and Culture* (1986), 55:338-354 Cambridge University Press.

Mayr E (1998). Toward a New Philosophy of Biology; Observations of an Evolutionist. Cambridge: Harvard University Press.

Nagel E, Newman JR, Hofstadter D (2002) . *Gödel's Proof.* New York: New York University Press.

Numbers RL (2002). Science and Religion: A Historical Introduction. Baltimore: Johns Hopkins University Press.

Polkinghorne J (1989). *Science and Creation: the Search for Understanding*. Boston: New Science

Library; New York: Random House.
Popper K (1963). Conjectures and Refutations: The Growth of Scientific Knowledge. London: Routledge Press.

Russell J (1997). *Inventing the Flat Earth: Columbus and* Modern Historians. Praeger Paperback; New Ed. Shermer M (2001). The borderlands of science: where sense meets nonsense. Oxford: Oxford University Press.

Torkel F (2005). Gödel's Theorem: An Incomplete Guide to its Use and Abuse. London: A.K. Peters.

Turner F (1978). The Victorian Conflict between Science and Religion: A Professional Dimension. In Isis, 49 (1978) 356-76.

White AD (1895). History of the Warfare of Science with Theology. New York: D. Appleton and Company.