



<https://coth.ui.ac.ir/?lang=en>

Journal of Comparative Theology

E-ISSN: 2322-3421

Document Type: Research Paper

Vol. 16, Issue 2, No.34, Autumn & Winter 2025-2026 pp.29-36

Receive: 26/07/2025

Accepted: 01/11/2025

Analogical Imagination in Scientific Modeling: A Critical Realist Approach with Reflections from Religious Thought

Ahmad Ebadi  *

Associate Professor, Department of Philosophy and Theology, Faculty of Theology and Ahl al-Bayt (AS) Studies, University of Isfahan, Isfahan, Iran
a.ebadi@theo.ui.ac.ir

Abstract

This study investigates the epistemological role of analogy (*tamthil*) and analogical reasoning as a shared cognitive strategy in science and religion, emphasizing its foundational function in the development of theories and conceptual models. Grounded in the framework of critical realism, the study challenges the notion that scientific knowledge and religious understanding arise solely from empirical observation or abstract theorization. Instead, it demonstrates that both domains rely on imaginative reasoning and analogical structures to interpret experience and generate meaning. In science, analogical models—such as Bohr's atomic model and wave-particle duality—serve as heuristic tools that extend theoretical domains and connect unobservable entities to empirical data. In religion, symbolic models derived from sacred narratives—such as analogical interpretations of divine attributes or jurisprudential *qiyas*—enrich spiritual experience and doctrinal formulation. Classical Islamic thought systematically employed analogy—in logic as *tamthil*, in jurisprudence as *qiyas*, and in theology and religious discourse—despite ongoing debates over its epistemic validity. The findings showed that analogy functions as a mediating structure between experience and conceptual insight in both scientific and religious contexts. It reveals that scientific observation is theory-laden, while religious understanding is belief-laden—yet both are shaped by imaginative analogical modeling. Through comparative analysis, the study reaffirms the centrality of analogical imagination in epistemology and argues that analogy is not merely rhetorical but a generative method for interdisciplinary knowledge production. Ultimately, the paper concludes that analogy remains a powerful and productive tool for explaining complex ideas and fostering dialogue between scientific and religious worldviews.

Keywords: Analogy, Critical Realism, Religious Epistemology, Theories and Models, Muslim logicians.

1. Introduction

Modern scientific knowledge is constructed through a dynamic interplay between observation, theory, and model-based reasoning. While ancient science, particularly in Aristotelian frameworks, emphasized deductive logic and final causality, it left little room for empirical observation and imaginative modeling. The rise of modern science introduced a methodological shift: theoretical innovation increasingly relied on creative imagination, where analogical reasoning and conceptual modeling play decisive roles in theory formation, interpretive clarity, and epistemic progress.

The term *analogy* refers to a cognitive process in which structural similarities between two domains are used to transfer understanding from a familiar source to a less familiar target. Unlike *metaphor*, which often emphasizes symbolic or

poetic resemblance, analogy seeks systematic correspondence. A *model*, in this context, is a structured representation that simplifies and explains complex phenomena. *Creative thinking* involves the imaginative generation of novel connections, often facilitated by analogical reasoning. *Imagination*, as a cognitive faculty, plays a central role in this process—it enables the mind to construct hypothetical scenarios, visualize abstract relationships, and explore conceptual possibilities beyond immediate experience. In both scientific theorization and religious reflection, imagination fuels the analogical leap from known patterns to new insights.

Analogies serve as heuristic bridges—linking familiar phenomena to unknown domains—and models help visualize and organize unobservable mechanisms. Scientific paradigms such as the kinetic theory of gases or quantum mechanics emerged from

*Corresponding author

Ebadi, A. (2025). Analogical Imagination in Scientific Modeling: A Critical Realist Approach with Reflections from Religious Thought . *Comparative Theology*, 16(2), 29-36.



imaginative constructs, often built through analogies to visible processes like the movement of billiard balls or wave-particle duality. These models not only facilitate theory development but also guide empirical testing, revealing how observation itself is theory-laden. In the critical realist perspective adopted here, theories and models are neither mere predictive instruments nor literal depictions of reality; rather, they are abstract symbolic systems that selectively and incompletely disclose aspects of the world, shaped by human cognition and embedded within historical paradigms.

The structure of religion exhibits comparable epistemological features. Religious inquiry is likewise rooted in experiential data—spiritual experiences, sacred narratives, and ritual practices—that are interpreted through preexisting theological frameworks and symbolic models. These models emerge within traditions and act as metaphorical tools that facilitate doctrinal development and conceptual coherence. As in science, religious observation is inseparable from belief: religious data is belief-laden, generated and shaped by the conceptual lenses through which it is experienced.

In classical Islamic intellectual traditions, *tamthil* (analogy) was institutionalized as a formal method of reasoning—used in jurisprudence, logic, and occasionally scientific discourse. Muslim logicians such as Ibn Sina, al-Farabi, Nasir al-Din Tusi, Suhrawardi, and Mulla Sadra systematically analyzed analogy's epistemic and structural functions. Unlike Western approaches that often regarded analogy as informal or rhetorical, these thinkers treated it as a valid, multi-functional method of cognitive extension. Their contributions laid the groundwork for a distinctly Islamic model of scientific reasoning in which analogy, imagination, and conceptual coherence function within an ontological and epistemological system.

This paper explores the integrative role of analogy, modeling, and critical realism in both scientific and religious domains. Section 2 investigates the epistemic legacy of analogy in Islamic thought and its role in scientific methodology. Section 3 analyzes the interaction between observation and theory, challenging the notion of data-driven science and emphasizing theory-laden observation. Section 4 examines the relationship between models and theories, highlighting their analogical structure and heuristic functions. Section 5 expands the analysis to religion, revealing parallel mechanisms of model-based reasoning and interpretive imagination. Through this comparative inquiry, the paper shows how both science and religion engage in imaginative epistemology—using analogy not merely as a rhetorical flourish but as a methodological engine of discovery, coherence, and conceptual expansion.

2. Literature Review

Analogy has long been recognized as a central cognitive mechanism in both scientific and religious reasoning. In the philosophy of science, Hesse (1966) emphasized the structural mapping between source and target domains in scientific models, arguing that analogies are not merely illustrative but epistemically generative. Dedre Gentner's structure-mapping theory further developed this view, highlighting the systematic correspondences that enable analogical transfer (Gentner, 1983). Cartwright (1983) explored how models function as mediators between theory and observation, often relying on analogical reasoning to simplify and explain complex phenomena.

In religious studies, analogy has played a pivotal role in interpretation and legal reasoning. Classical Islamic thought systematically employed analogy—in logic as *tamthil*, in jurisprudence as *qiyas*, and in theology and religious discourse—despite ongoing debates over its epistemic validity. Thinkers such as Al-Ghazali and Fakhr al-Din al-Razi defended the use of analogy in deriving legal rulings and interpreting divine attributes, while others questioned its reliability. Seyyed Hossein Nasr emphasized the symbolic and metaphysical dimensions of analogical thinking in Islamic cosmology and spirituality (Nasr, 2006).

Despite this rich background, few studies have examined analogy as a shared epistemological strategy across science and religion within a unified philosophical framework. This paper addresses that gap by applying critical realism to analyze how analogical imagination operates in both domains. The innovation of this study lies in its comparative approach, showing that analogy is not merely a rhetorical or pedagogical device but a generative method embedded in the cognitive architecture of scientific and religious thought.

3. Analogy and Scientific Imagination: Muslim Logicians and the Roots of Epistemology

Analogy plays a progressive epistemological role across scientific and religious disciplines by enabling structural and interpretive connections between observed phenomena and theoretical constructs. In the Islamic intellectual tradition, its epistemic legacy is deeply interwoven with philosophical logic, theology, jurisprudence, and metaphysics.

Muslim logicians inherited the Aristotelian framework, in which analogy was conceptually subordinated to demonstrative syllogism. Aristotle delineated analogy (*paradeigma*) as a form of reasoning that lacked independent epistemic force unless reducible to a valid syllogism (Aristotle, 1980, p. 69). This analytical model was transmitted through Arabic translations and integrated into foundational texts such as Ibn Sina's *Al-Shifa'* and *Daneshnameh 'Ala'i*.

Ibn Sina (Avicenna) acknowledged analogy's structural components but remained skeptical of its inferential strength. He maintained that analogy was epistemologically inferior to both syllogism and complete induction, and most appropriate in juridical or dialectical reasoning (Ibn Sina, 1994, pp. 868–869; Ibn Sina, 2015, pp. 80–92). Nevertheless, he analyzed its premises, explored its transformation into a valid syllogistic form, and detailed conditions for analogical transference. His definition emphasized the need for similarity and a common middle term, though he conceded that analogy could not yield demonstrative certainty.

Al-Farabi, dubbed the "Second Teacher," developed a nuanced classification of analogy in scientific and rhetorical contexts. He differentiated between analogy used for scientific understanding and that used for persuasive or public discourse. Farabi argued that analogy helps bridge experiential and conceptual gaps by transferring meaning between known and unknown entities (Farabi, 1987, pp. 142–143). His framing of analogy as both cognitive and communicative laid the foundation for later hermeneutic applications in philosophy and theology.

Khwaja Nasir al-Din Tusi, in his *Asas al-Iqtibas*, advanced a methodical typology of analogy. He identified four essential elements: origin (*asl*), target (*far'*), common attribute (*wajh al-shabah*), and judgment (*hukm*) (Tusi, 1982, pp. 333–334). Tusi demonstrated that analogy operates as a hybrid of syllogistic

and inductive reasoning, with its epistemic value contingent on the reliability of causal connections. His contributions marked a shift from rhetorical utility to analytical legitimacy.

Fakhr al-Din al-Razi examined the cognitive dimensions of analogy, particularly in relation to dialectical theology (*'ilm al-kalam*). While cautious about analogy's capacity to yield certainty, he nonetheless accepted its indispensability for theological and ethical inquiry (Razi, 2002, pp. 320–338). His engagement with analogy highlighted its role in conceptual mediation and argumentation, especially in contexts where demonstrative proof was unattainable.

Suhrawardi, founder of the Illuminationist (Ishraqi) tradition, reimagined analogy as a metaphysical device. In works like *Al-Mashari' wa al-Muṭarāḥat*, he defined analogy as a symbolic correspondence grounded in existential similarity (Suhrawardi, 2006, p. 808). For him, analogy was not merely logical but ontological—a tool for uncovering metaphysical truths that resist formalization.

Mulla Sadra, through his *Asfar al-Arba'a* and his synthesis of Avicennian, Illuminationist, and theological models, developed analogy within the framework of *structured scientific imagination* (*takhayyul sakhitmand*). Analogy served as a bridge between empirical particulars and metaphysical universals, aligned with his theory of gradational existence (*tashkik al-wujud*) (Mulla Sadra, 1984, pp. 573–879).

Ibn Taymiyyah, in contrast to the philosophical mainstream, defended analogy as a valid and practical form of reasoning. He critiqued formal logic for its abstraction and argued that analogy reflects natural human cognition, particularly in religious and ethical contexts (Ibn Taymiyyah, 2016, pp. 117–121). By grounding *qiyas* in experiential congruence and emphasizing its role in epistemic generalization, Ibn Taymiyyah restored analogy's functional legitimacy.¹

Across these diverse contributions, analogy emerges as more than rhetorical embellishment. It operates as a multidimensional reasoning method, connecting theoretical and practical knowledge, facilitating moral and legal inference, and mediating between empirical data and abstract theory. In religious epistemology, especially within Islamic theology and jurisprudence, analogy allows scholars to extrapolate principles from scriptural sources, derive legal rulings from precedents, and interpret metaphysical truths through familiar experiential models.

For example, in Islamic jurisprudence (*fiqh*), the method of *qiyas* (analogical reasoning) is used to derive legal rulings for new cases based on established precedents. For example, the prohibition of narcotic substances is analogically derived from the Qur'anic prohibition of wine, based on their shared intoxicating effect. This illustrates how analogy operates as a cognitive and epistemic tool within Islamic legal reasoning.

Thus, within the intellectual legacy of Muslim logicians, analogy (Analogy) remains a progressive epistemic instrument—one that not only reflects historical continuity but actively advances interpretive reasoning, theoretical innovation, and cross-domain conceptual development in both science and religion.

4. Interaction between Observations and Theories

Modern science has two main components: 1. Observation, 2. Theory. How are observations related to theory? According to the inductivist view, it can be said that (1) scientific practice begins with observation and (2) observations lead to the formation and development of theories. This point has been graphically shown in Figure 1.

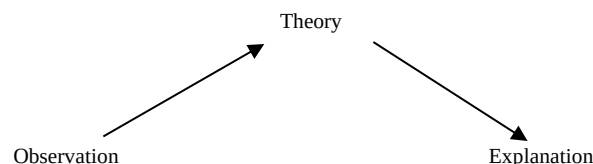


Figure 1. The Interaction between Observation and Theory (Chalmers, 1982, p.54)

However, both assumptions of the inductivists are incorrect. Firstly, observation is not the starting point of science because theories are always prior to observational statements. For example, when it is said that “the North pole of a magnet repels electrons,” we have several theories in this statement; that is, we have theories about what the North Pole, magnet and electrons are and how they function. Observational statements are expressed through a theoretical language and their accuracy is proportionate to the accuracy of their theoretical and conceptual frameworks. “Force”, for instance, as a concept that is used in physics is accurate, because it derives its meaning from the role that it plays in the accurate and relatively independent theory of Newtonian mechanics. The use of the same word in everyday language (i.e., the force of the wind, forces of nature, etc.) is inaccurate only because their related theories are themselves inaccurate. Theories that have been accurately formulated are a precondition of observational statements. In this sense, theory precedes observation (Chalmers, 1982, pp. 19-21).

Secondly, theories comprise underlying hypotheses and new concepts that cannot be found in observations. They often reveal and refer to relations and knowledge that are not directly observable.

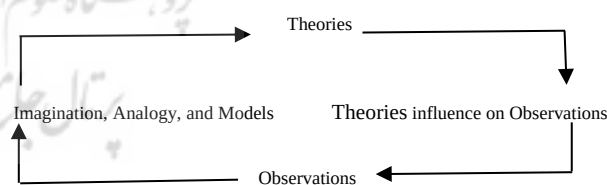


Figure 2. The connection between Observed Facts and Theory

Thus, as Figure 2 shows, there is no direct line connecting observed facts to theory. Instead, they are connected indirectly through the left side of the diagram, which is creative imagination for which no rules can be made. A relation or a new concept is often conceived by drawing an analogy to a familiar concept or relation. In many cases, analogy is systematically made of a conceptual model of a posited thing that is not directly observable. Such conceptual models result

¹. Ibn Taymiyyah refers to analogical logic as *qiyās*, which should not be confused with formal logical deduction.

in formulating a new theory. For example, in order to understand the behavior of gases, an analogy was drawn whereby billiard balls and their collision were compared to invisible gas particles and their collision with one another. With the help of this model, the kinetic theory of gases was developed.

For a scientific theory to be useful, it has to be empirically tested. Each theory leads us to expect some observations rather than others. This is the hypothetico-deductive view of science, which is displayed by a downward arrow from theories to observations in Figure 2. The context of discovery [the left side of Figure 2] is different from the context of justification [the downward arrow of Figure 2]. If a theory or hypothesis is valid, certain patterns will be expected. Nevertheless, the reasoning process always consists of various assumptions, auxiliary hypotheses and rules of correspondence which link theory and observation to each other. In the case of the kinetic theory of gases, the change in momentum of hypothetical particles can be calculated while they collide with the walls of the container. If we assume the existence of ultrafine particles that are constantly colliding with each other, we will be able to derive Boyle's law, which describes the relationship between the pressure and the volume of any given gas sample. Confirmation of such deductions leads us, at least temporarily, to accept a theory (Hempel, 1966, pp. 160-163; Popper, 1956, pp. 73-76).

The hypothetico-deductive method was dominant in the philosophy of science in the 1950s and early 1960s. This method assumed that observations can be described independently of theories and that alternative theories should be tested in relation to such objective and verified data. Although agreement with observations does not prove a theory [because there might be other theories that are in agreement with the data], Karl Popper claimed that any disagreement with data falsifies a theory.

However, we can never test a theory in isolation. Rather, each theory is testable as a part of a network of theories. If there is agreement between a theory and data in everything but one aspect, we can adjust other components of the network in order to improve the consistency. Theories with terms far from the observational level are not decided solely by data (Quine, 1963, p. 43).

All observations are theory-laden. There is no observation that is theory-free. There are many ways that theories affect observations (as shown in the right side of Figure 2). Both the selection of phenomena that are going to be studied and the choice of variables that are crucial for measurement depend on theory. The questions that we ask and the answers that we receive are also determined by theory. Theories are reflected in the selection of instruments and the language that reports observations (Polanyi, 1958, p. 103-104; Hanson, 1958, p. 63).

5. Assessment of Theories from a Critical Realist Perspective

There are four criteria for assessing theories from a critical realist perspective:

Agreement with Data: This is the most important criterion, although it never proves a theory true. The reason why this criterion cannot verify a theory is that there might be other theories that fit the data equally or even better. Theories are never derived solely from data. Disagreement with data does not falsify a theory, either. However, agreement with data and fulfillment of predictions, especially novel predictions that

were not previously anticipated, is a strong confirmation of a theory.

Coherence: a theory should be consistent with other accepted theories and, if possible, it should have a reciprocal conceptual relation with them. Scientists also appreciate the "internal coherence" and simplicity of theories.

Scope: theories can be judged based on their comprehensiveness. A theory is valuable if it unifies previously separate fields and domains; if it is supported by a variety of evidence, or if it is applicable to a wide range of phenomena.

Fertility: a theory is judged not only by its past achievements but also by its present ability to provide a framework for ongoing research. Is the theory useful in advancing further theoretical explanations, in generating new theories, and also in proposing new experiments? What is important here is the continuous activity of the scientific community rather than the scientists' final results (Barbour, 1997, pp. 203-204).

There are three views of truth from an epistemological perspective, and each of the three views emphasizes one of the four criteria mentioned above (Pojman, 2000, pp. 20-25).

The Correspondence Theory of Truth: according to this view, a statement is true if it corresponds to reality. This view is the same as the common understanding of truth. This is also what classical realism claims. It seems more compatible with the empirical aspect of science; that is, theories should agree with data. But as it was said, there is no theory-free data against which a theory can be evaluated. Furthermore, many theories presuppose unobservable entities that have only indirect relations with observable data. We do not have unmediated and direct access to reality so that we can test it with our theories.

The Coherence Theory of Truth: a set of statements is true if it is comprehensive and has internal coherence. Rationalists and philosophical idealists adopted this position. This view seems to be compatible with the theoretical aspect of science. It was said that individual theories can never be assessed alone. Rather, they are assessable as part of the "network of theories". Therefore, the scope of a theory should be taken into account alongside the coherence of the theory. This view is also problematic because, in a particular domain, there might be more than one theory that possesses internal coherence. What's more, the nature of assessment of theories based on agreement with data is different from the nature of assessment of theories according to internal coherence, and these two views cannot be mixed. Furthermore, reality is less logical and more paradoxical than what rationalists believe.

Pragmatic Theory of Truth: In this view, a statement is true if it works in practice, and it should be judged by its consequences. Thomas Kuhn's opinion that considers scientific research as finding a solution in a particular historical context and in a "fixed paradigm" is an example of a pragmatic perspective (Kuhn, 1970, pp. 183-185). This aspect of science is reflected in the fourth criterion, which is fertility. Mere acceptance of this view is not enough, though. The fact that an idea should be useful and efficient remains unclear unless these concepts are clarified with the help of other criteria.

In conclusion, the meaning of truth is correspondence to reality, but because we do not have direct access to reality, the criteria of truth should embrace the four criteria mentioned above. If the aforementioned criteria are regarded collectively, they can involve authentic insights in all these views of truth.

Any of these criteria may gain a relatively higher significance at different stages of a scientific study. Since “correspondence” is taken as the definition of “reality,” it is a kind of realism which is called critical realism because a mixture of criteria is at work in it.

A classic example of scientific analogy is the Bohr model of the atom. While early atomic theories were based on empirical observations such as spectral lines, Bohr’s model introduced a conceptual structure that inferred deeper causal mechanisms—namely, quantized electron orbits and energy transitions (Bohr, 1913). This model did not merely describe what was observed; it proposed an underlying structure that explained atomic behavior. In terms of Bhaskar’s stratified ontology, the Bohr model operates across all three levels: the **empirical** (spectral data), the **actual** (electron transitions), and the **real** (the causal mechanisms governing atomic structure). Thus, it exemplifies how scientific models function as analogical tools that mediate between observable phenomena and deeper ontological commitments (Bhaskar, 2008).

6. Theories and Models in Science

Theoretical models have four general features:

Models are analogical: A scientist who is working in a new domain may postulate entities that share some features belonging to a familiar entity (positive analogy) while lacking other features (negative analogy). The Bohr model, in which electrons travel in circular orbits around the nucleus, bears resemblance to the structure of the solar system, but the main assumption of this model, whereby electrons can travel only in specific orbits [quantization], has no equivalent in classical physics (Bohr, 1913). The Bohr model contributed to the formation of mathematical equations in this theory. The equation for the energy level of the electron is an example of such a contribution. This model also shows how theoretical terms and identifiers of entities that are not directly observable may be related to observable entities. For instance, how an electron makes a transition between two orbits may be related to the frequency of the emitted light.

Models help the extension of theories: Some believe that models are tools that have provisional psychological utility and that they can be abandoned as soon as equations of the theory are formulated. Nevertheless, this claim ignores the fact that it is the model, rather than the theory, which suggests application to new phenomena and domains. It was the model of billiard balls that suggested how to use the kinetic theory of gases in diffusion, density and thermal conductivity of gases. What’s more, this model helped to amend the kinetic theory of gases. Deviation from Boyle’s law occurs when gases are under high pressure. This issue can be explained with a modified model [balls with finite volume and attractive forces], which is different from the simple model of billiard balls, but nobody thought of this model without paying attention to previous models, which were the model of billiard balls. The “suggestive” and “open-ended” characteristic of models is a permanent source for applications, extensions, and possible modifications of theories.

Received message. Here is a possible academic section based on the text: Section 4: Interaction between Theories and Models. As it was shown, there is no path that can be taken directly, with the help of logical reasoning, from data to theories in science. Theories are born mainly when creative imagination comes into play, and models normally play a role in creative imagination. What is meant by models in this paper

is conceptual or theoretical ones, rather than experimental and scale models that are developed in laboratories, or logical and mathematical models, which are abstract formal relationships. Theoretical models often take the form of imaginative mechanisms and processes. Such models are constructed by making analogies to known mechanisms and processes. At first, it seems that models and theories are the same thing and indistinguishable. For example, light phenomenon could be explained by means of light particles, as both the corpuscular model of light and the corpuscular theory of light. Similarly, the model of the DNA molecule could be considered in a way as the theory of the molecular structure of DNA (Hesse, 1966, p. 356). Theoretical models have three general features. 1. Models are analogical. A scientist who is working in a new domain may postulate entities that share some features belonging to a familiar entity (positive analogy) while lacking other features (negative analogy). The Bohr model, in which electrons travel in circular orbits around the nucleus, bears resemblance to the structure of the solar system, but the main assumption of this model, whereby electrons can travel only in specific orbits [quantization] has no equivalent in classical physics. The Bohr model contributed to the formation of mathematical equations in this theory. The equation for the energy level of the electron is an example of such a contribution. This model also shows how theoretical terms and identifiers of entities that are not directly observable may be related to observable entities. For instance, how an electron makes a transition between two orbits may be related to the frequency of the emitted light. 2. Models help the extension of theories. Some believe that models are tools that have provisional psychological utility and that they can be abandoned as soon as equations of the theory are formulated. Nevertheless, this claim ignores the fact that it is the model, rather than the theory, which suggests application to new phenomena and domains. It was the model of billiard balls that suggested how to use the kinetic theory of gases in diffusion, density and thermal conductivity of gases. What’s more, this model helped to amend the kinetic theory of gases. Deviation from Boyle’s law occurs when gases are under high pressure. This issue can be explained with a modified model [balls with finite volume and attractive forces].

Models are understandable as units: Models create mental pictures whose unity can be easily grasped. A model can be regarded as a “whole” which gives a clear summary of the complex relations, which is helpful in the extension and application of theories. The deductions produced from a theory to which a model leads should be tested carefully and the proposed model has to be repeatedly modified and even discarded if need be. Models are used in order to generate theories so that new theories can be assessed with the previously mentioned criteria. In quantum theory, which superseded Boyle’s model, mechanical models are put aside and there are serious constraints on the use of visualizable models. Nonetheless, the two models that built the foundation of quantum theory, that is, the wave model and the particle model, suggest ways that theory and experiment can be correlated. These two models cannot be fully unified because of the wave/particle paradox; although a unified set of equations can be incorporated in an abstract theory. This theory can only be used to predict the probability that an atomic or subatomic system will have a value, but the exact value of the measurement cannot be predicted. Models are more than temporary expedients because they play a

permanent role in the interpretation of mathematical formalism and the modification of theories or their extension to new domains.

Models have heuristic functions in relation to theories:

N. R. Campbell was the first person to pinpoint the dependence of theory on model in his book *Physics, the Elements*. He criticized this claim put forward by positivists: models barely help the formulation of theories, and when a theory is ready, it can be independent of models and the models can be discarded. Campbell transformed the structure of a particular theory (that is, the elementary kinetic theory of gases) into a new structure, which came to be called “hypothetico-deductive” form. This form reveals three components of every theory: a formal deductive system (hypothesis) of axioms, theorems, and a dictionary for translation of the formal system into experimental language and laws. These laws can be either validated by experimental tests or derived from a set of hypotheses or a dictionary. In contrast to the opinion of those who demanded that all non-logical concepts in theory should be defined in empirical language, Campbell believed that the hypothetico-deductive form allows for “hypothetical ideas.” These hypothetical ideas are what were later called “theoretical concepts.” In Campbell’s opinion, the particle model is necessary for the structure of the theory of gases because with the aid of the model, the theory can be extended and amended so that it can make predictions for a wider domain of phenomena than it was designed for in the first place.

7. Interaction between Theories and Models from a Critical Realist Perspective

According to classical realism, models and theories are true descriptions of entities in the world. In contrast, instrumentalism claims that models and theories are calculating tools whose sole role is to make possible the correlation and prediction of observations. Instrumentalism regards models and theories as rational tools that are useful in organizing studies and controlling the world. Instrumentalists hold that theories and models do not describe or refer to real entities (Ryan, 1970, pp. 80-86).

Critical realism is opposed to these two views, though. According to this view, theories and models are abstract and symbolic systems that insufficiently and selectively reveal particular aspects of the world for particular purposes. This view satisfies the realistic intentions of scientists while it accepts that models and theories are imaginative creations of human beings. In this view, models are taken seriously. Models are neither real pictures nor useful legends. Rather, they are limited, incomplete ways of imagining unobservable entities. Models suggest tentative ontological claims based on the view that there are existing entities in the world that are somehow similar to entities postulated in models.

Opponents of realism argue that scientific theories are not convergent, cumulative or progressive. New theories, more often than not, cause a fundamental change in conceptual frameworks instead of preserving or adding to previous theories. It has been said that in the history of science, there were theories that were successful and fruitful in an era, but after some time, they became obsolete instead of being modified or adjusted. Ptolemaic astronomy, phlogiston chemistry and catastrophism, Lamarckian evolution, caloric theory of heat, and ether theory in physics are among theories that were totally rejected (Laudan, 1984, pp. 20-44).

But in recent decades, there was a revival of interest in realism. New theories show their continuity and discontinuity with the theories that they replace. Some concepts of old theories and the data obtained through those theories are frequently transferred to a new context. On occasion, laws of the old theories are included in new theories as “limiting cases.” Thus, laws of classical physics are deemed as limiting cases of “relativistic laws” at low speeds, although fundamental concepts are redefined. New theories provide empirical adequacy and extend to wider domains so that we can speak of the advancement of science based on the criteria that were previously mentioned in this paper.

We reach more certainty about a theoretical entity, such as electrons, if electrons are linked to a variety of phenomena investigated in different types of experiments. Scientists believe that not only can a new theory give a better structure to the correlation of observations, but it also helps them acquire a better understanding of the world. Theoretical concepts are tentative and modifiable but they are used to describe and refer to the world. If a theory is not partially true, how can we justify its success in predicting new phenomena with a variety of observations that are quite different from those that led to the theory? In brief, science is simultaneously a process of discovery and a serious act of human imagination.

The main assumption of realism is that existence precedes theory. Limitations of our theories originate in structures and relations that exist in nature. Scientific discoveries are often unexpected. Humility in the face of such discoveries is desirable. We learn from nature in order to impose limits on our imagination. Although the history of science does not represent a “simple convergence” or a “successive approximation,” it involves a collection of authentic theories and data, a large part of which is reliable. For instance, can anyone be doubtful of the fact that, in comparison with 500 years ago, we know more about the human body nowadays? Although there are many things to learn, some of our current ideas may be rendered obsolete in the future.

Ernan McMullin defends critical realism when it comes to models, especially those models that posit hidden structures. He believes that “a good model gives us insight into real structures, and that the long-term success of a theory, in most cases, gives reason to believe that something like the theoretical entities of that theory actually exist” (McMullin, 1984, p. 33). He says a good model is not a provisional and unnecessary solution, but an infinitely useful source of permanent ideas for possible generalizations and revisions (Ibid). Similar to a poetic metaphor, a model makes tentative suggestions for the study of a domain or field. A “structural model” may undergo change during research progress but it displays a fundamental continuity by extending the basic model. For instance, in geology, the incompatibility of the “model of continental drift” with recent geological data has been proven. However, this model led to the presentation of the “tectonic plate model”, which is a model confirmed by recent evidence from mid-ocean rifts and earthquake-prone areas.

Most scientists are inevitably realists, but their confidence in models and theoretical entities varies in different scientific domains and different eras. Models that are linked to larger scales and more familiar structures are readily seen realistically. It is not expected of a geologist to doubt the existence of “tectonic plates” and “prehistoric dinosaurs,” although neither of them is observable. In 1866, Mendel

posited “units of hereditary transmission”, which later came to be called genes in chromosomes and finally came to be named DNA in the recent era.

As we move beyond familiar things, tools increase our ability for direct and indirect observation. When we get to the marvelous “subatomic” world, common sense stops short of understanding, and we cannot imagine what’s happening. Quarks behave dissimilarly to anything we know and their quantum numbers (which are called strangeness, charm, top, bottom, and color) specify abstract principles for their combination and interaction. But even in a case like this, theories are attempts to represent reality, although micro-reality is unlike the ordinary world, and everyday language cannot adequately describe it.

8. The Structure of Religion

The structure of religion across diverse traditions shares key similarities with the structure of scientific inquiry. Religious scholars and practitioners engage in interpretive and epistemic processes that mirror the progression from observation to conceptual modeling found in the natural sciences. Religious experience, sacred narratives, and ritual practices collectively function as the experiential data of religion. These elements, much like scientific observations, are shaped by underlying conceptual frameworks and paradigms that guide interpretation and meaning.

Religious experiences and rituals are not neutral or autonomous phenomena; they are interpreted through theological doctrines and symbolic models. Just as scientific data is understood within theory-laden contexts, religious experiences are mediated by pre-existing beliefs and worldviews. Beliefs in this sense play a formative role—not only in how religious phenomena are interpreted, but in how they are constructed and experienced. Consequently, the conceptual load of religious interpretation often exceeds that found in science. This is due to the fact that religious beliefs help generate and shape experiences themselves, rather than merely offering a lens for their evaluation (Barbour, 2013, pp. 252–275).

No religious experience, narrative, or ritual is encountered in a purely unmediated state. Interpretation is intrinsic, relying on the believer’s existing framework of meaning. Even deeply personal mystical experiences occur within communal religious contexts that structure both their reception and articulation. This social embeddedness applies even to spiritual traditions that emphasize solitary meditation or internal purification—such practices still unfold within shared cultural and theological paradigms (Barbour, 2013, p. 252; Barbour, 1976).

Religious interpretation arises not through logical deduction from empirical data, but via creative imagination. In this process, models and analogies serve as cognitive tools for making sense of religious life. These models often derive from central stories within religious traditions, capturing patterns that recur dynamically across texts and practices. The modeling process thus enables theological abstraction and doctrinal formulation.

Empirically evaluating religious beliefs presents inherent challenges, yet criteria for reflective assessment do exist. The absence of unmediated experience in religion parallels the scientific recognition that no observation is theory-independent. However, the influence of religious beliefs on experience often surpasses the impact of theory on scientific data (Mahdavi & Bayat, 2022).

Creative imagination plays a foundational role in constructing religious belief systems. It manifests predominantly through metaphorical reasoning, with models serving as dominant forms of religious metaphor. These models arise within interpretive paradigms and act as bridges that connect religious experience, ritual, and narrative. Just as scientific modeling helps link empirical phenomena to explanatory theories, religious modeling enables coherence and insight across dimensions of spiritual life (Barbour, 2013, p. 284).

One example of a religious model is the *cosmological hierarchy* in Islamic metaphysics, which analogically maps the structure of the universe onto spiritual realities. For instance, the concept of the ‘*Arsh*’ (Divine Throne) is often interpreted as a symbolic model representing divine authority and order. This model functions analogically by linking physical imagery with metaphysical principles, allowing believers to conceptualize divine transcendence through spatial metaphors.

Model-building in theology is an imaginative act that allows theologians to mediate between symbolic representations and conceptual understanding. These models both inform and reflect doctrinal structures, shaping the interpretation of religious data and facilitating a cyclical relationship between belief and experience. Though not literal depictions of metaphysical realities, religious models remain epistemically significant. They should be taken seriously—not for their descriptive precision, but for their heuristic and symbolic utility. Much as scientific models provide access to unobservable phenomena, theological models aid in articulating aspects of the divine that lie beyond sensory representation. Religious traditions often discourage visual or literal portrayals of the divine—not because such representations are meaningless, but because symbolic modeling offers a deeper pathway to understanding transcendent realities (Mahdavi & Bayat, 2022).

Table 1: Structure of Science and Religion

Scientific Structure	Religious Structure
imagination, analogy, and models	creative imagination, metaphors, and models
theories	doctrines and theological concepts
observations	religious experiences, rituals, narratives
observations refine models	experiences reshape models and beliefs

This comparative schema demonstrates that both scientific and religious domains are underpinned by processes of imaginative modeling, which serve as interpretive mechanisms for structuring experiential phenomena. Within the scientific paradigm, theoretical models function as heuristic frameworks that generate explanatory constructs and synthesize empirical observations. Analogously, religious traditions employ symbolic models and metaphorical structures to formulate theological doctrines and facilitate the interpretation of spiritual experiences and ritual practices. In both spheres, the epistemic process is inherently cyclical and interpretive, with iterative feedback loops that continuously recalibrate and refine the underlying conceptual architecture.

Conclusion

This study demonstrates that analogy functions as a central cognitive strategy in both science and religion. Scientific theories rely on imaginative, analogical models to interpret

unobservable phenomena and guide inquiry, while religious epistemology employs symbolic constructs to articulate spiritual experiences and doctrinal understanding. From a critical realist view, models in both domains offer partial, provisional representations—tools that bridge experience and theory rather than depict reality directly. Classical Islamic thought formalized analogy as an epistemic method, integrating metaphysical, ethical, and empirical reasoning. Observations are shaped by conceptual frameworks and paradigms, making analogy a dynamic methodological link across disciplines. Reaffirming the role of analogical imagination affirms its epistemological significance and offers a foundation for interdisciplinary exploration.

References

- Aristotle. (1980). Prior analytics. In A. R. Badawi (Ed.), *Logic of Aristotle*. Dar al-Qalam.
- Barbour, I. (1976). *Myths, models and paradigms*. HarperCollins.
- Barbour, I. (1997). *Religion and science: Historical and contemporary issues* (Gifford Lectures Series). HarperOne.
- Barbour, I. G. (2013). *Religion and science: Historical and contemporary issues*. Shirazeh Publishing.
- Bhaskar, R. (2008). *A realist theory of science*. Routledge.
- Bohr, N. (1913). On the constitution of atoms and molecules. *Philosophical Magazine*, 26(151), 1–25.
<https://doi.org/10.1080/14786441308634955>
- Cartwright, N. (1983). *How the laws of physics lie*. Oxford University Press.
- Chalmers, A. F. (1982). *What is this thing called science?* (2nd ed.). The Open University Press.
- Farabi. (1987). *Al-Manṭiqiyyat [The logical works]*. Ayatollah Mar'ashi Library Press. [In Persian]
- Gentner, D. (1983). Structure-mapping: A theoretical framework for analogy. *Cognitive Science*, 7(2), 155–170. https://doi.org/10.1207/s15516709cog0702_3
- Hanson, N. R. (1958). *Patterns of discovery*. Cambridge University Press.
- Hempel, C. G. (1966). *Philosophy of natural science*. Prentice-Hall.
- Hesse, M. B. (1966). *Models and analogies in science*. University of Notre Dame Press.
- Ibn Sina. (1994). *Al-Shifa' [Book of demonstration]* (M. Qavam Šafari, Trans.). Fikr-e Ruz Publishing. [In Persian]
- Ibn Sina. (2015). *Daneshnameh-ye 'Ala'i [The Alai encyclopedia]*. Mowla Publications. [In Persian]
- Ibn Taymiyyah. (2016). *Al-Radd 'ala al-Manṭiqiyyin [Refutation of the logicians]*. Lahur Press. [In Persian]
- Kuhn, T. S. (1970). *The structure of scientific revolutions* (2nd ed.). University of Chicago Press.
- Laudan, L. (1984). A confutation of convergent realism. In J. Leplin (Ed.), *Scientific realism*. University of California Press.
- Mahdavi, S., & Bayat, M. (2022). A Study of Ian Barbour's View on The Role of Paradigms and Models in the Understanding of Religion. *Journal of Philosophy and Theology*, 29(1), 75–98.
<https://doi.org/10.22059/jitp.2022.345773.523364> [In Persian]
- McMullin, E. (1984). A case for scientific realism. In J. Leplin (Ed.), *Scientific realism*. University of California Press.
- Mulla Ṣadra, M. (1984). *Asfar al-arba'a [The four journeys]* (A. M. Meshkuh al-Dini, Trans.). Agah Publishing. [In Persian]
- Nasr, S. H. (2006). *Religion and the order of nature*. Oxford University Press.
- Pojman, L. (2000). *What can we know?*. Wadsworth.
- Polanyi, M. (1958). *Personal knowledge*. University of Chicago Press.
- Popper, K. R. (1956). *The logic of scientific discovery*. Hutchinson's University Library.
- Quine, W. V. O. (1963). Two dogmas of empiricism. In *From a logical point of view* (2nd ed.). Harper Torchbooks.
- Razi. (2002). *Al-Maṭalib al-'Aliya min al-'Ilm al-'Ilahi [The Elevated Questions on Divine Science]*. Dar al-Kutub al-'Ilmiyya.
- Ryan, A. (1970). *The philosophy of social sciences*. Pantheon Books.
- Suhrawardi. (2006). *Al-Mashari' wa al-Muṭaraḥat [The paths and discussions]* (M. Maḥmudi & A. 'Alipur, Eds.). Haqq-Yavaran Press. [In Persian]
- Tusi, N. (1982). *Asas al-iqtibas [The foundation of deduction]* (M. Rezvani, Ed.). University of Tehran Press. [In Persian]