SCIENTIFIC MODELS AND LITERARY FICTION

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1 Scientific Models and Literary Fiction

Scientific models play important roles in the scientific enterprise. Scientific theories are usually built on models. These models help in articulating the theory. However, despite the proliferation of the use of models in science, some questions persist. These semantical, ontological and epistemological questions are present in philosophy of science. My thesis is that models establish stable tendencies in the real world in much a similar way that models in literary fiction establish stable tendencies. I claim that viewing scientific models this way can illuminate our understanding of the scientific enterprise. I shall begin this essay by first considering the various understandings of scientific models in the philosophy of science. Thereafter, I will situate models in the debate between realists and anti-realists, and then make a case for the "stable tendency" argument for models. I will show how the "stable tendency" argument operates in literary fiction, and how it can illuminate the apprehension of models in science.

2 Different Understandings of Scientific Models

There has been increased debate in recent literature in philosophy of science on the place of models in scientific theories. Mary Hesse argues that the notion of models was present in Greek science. However, a serious consideration of models entered philosophy of science in the nineteenth century. This came with the increase of the positing of unobserved entities such as the atom, electrons, and electro-magnetic waves, in classical physics. The novel characteristic of these entities was that there was no directly observable evidence to corroborate their existence.[1] Models in classical physics were either material or formal. Material models describe physical entities and are semantic in structure. Examples of material models include a fluid medium and billiard balls. Formal models, on the other hand, are syntactic in structure and are expressions of the form or structure of physical entities. They do not contain any semantic content of the physical entities. An example is the wave equation in mathematical symbol which may represent the evolution of a quantum system, the laws of a simple pendulum, etc.[2] There are other types of models in addition to material and formal models. These include: analogue, explanatory, theoretical, mathematical, heuristic, developmental and computational models.

Roman Frigg and Stephan Hartmann observe that despite the proliferation and place of models in science, there are important questions that the use of models generate. These questions can be ontological, epistemological, semantical or in the general philosophy of science. What kind of things are models? (ontological). How do we learn with models? (epistemological). What is the representational function that models perform? (semantical). How do models relate to theory? What are the consequences of a model-based approach to science, especially in the debates in scientific realism, reductionism and explanations of the laws of nature?[3]

[1] Mary Hesse, "Models and Analogies" in *Blackwell Companion to the Philosophy of Science*, ed. W.H. Newton-Smith (Massachusetts: Blackwell Publishers Ltd, 2000), 299.
[2] Ibid.
[3] Stephan Hartmann and Roman Frigg, "Models in Science", *Stanford Encyclopedia of Philosophy* (February 27 2006).

My focus is on the last set of questions in the general philosophy of science. In answering these questions, it is important to consider, briefly, the debate between scientific realism and anti-realism and the place of models in this debate.

3 Models in the Realism Versus Anti-Realism Debate

In *The Dappled World: A Study of the Boundaries of Science*, Nancy Cartwright explains that philosophers of science have tended to be either realists or instrumentalists with regards to scientific laws. For the realists, scientific laws not only make claims about the world, but they do indeed make claims which are in most cases, true. Predictions derived from these laws do happen. Thus, realists do not postulate new properties in the world. The world is the way scientific theories describe it. On the other hand, the anti-realists or instrumentalists, argue that scientific theories are only tools for the construction of accurate and precise predictions. These theories or laws do not make claims about the world, but only serve as clues on how to manipulate the world.[4] Antirealists deny that truth is the goal of science.

Realists argue that a good scientific theory is one whose models represent the real world or the target, approximately. Instrumentalists view models as fictions, without direct relation to reality. They stress that models only serve as heuristic tools for the discovery and explanation of scientific phenomena.[5] The realist argument faces some problems. Scientists often use several incompatible models that point to the same target system. If these incompatible models ascribe different properties to the real world or the target system, they cannot all be true. This situation persists even if we invoke the clause that

[4] Nancy Cartwright, *The Dappled World: A Study of the Boundaries of Science* (Cambridge: Cambridge University Press, 1999), 35.
[5] Hesse, "Models and Analogies," 306.

these theories are only approximate. The shell model explains nuclear properties with regard to the properties of the composition of a nucleus—the protons and neutrons. On the other hand, the liquid drop model employs the analogy of the atomic nucleus and a charged fluid drop.[6] As a rebuttal, realists can argue for the predictive success of the incompatible models. However, what happens when the models are not good predictors?

The underdetermination of theory by evidence, is another problem for realism. A set of available evidence can support different, even conflicting, explanatory theories. The choice of which theory to accept is underdetermined by the evidence. This is because there is no empirical or evidential reason to believe one of the theories instead of the others. A realist's response to this may be focused on what constitutes data or evidence. What constitutes data, the realist may claim, is subject to change with the development of new techniques, instruments or knowledge. These changes can alter the assumptions needed for observation. Such a response changes the meaning of observation, which is in terms of human sensory capacities.[7]

Another objection to realism is in regard to theory change. If the realist model represents the world as it really is, what happens when there is a theory change? A look at the history of science reveals some "untrue" theories about the world. Scientific theories such as the view that the earth is flat are considered absurd today. It is conceivable that our best current theories will similarly be considered absurd in future.

These problems constitute crucial challenges against the view that models establish facts or truths about what happens in the real world. So, to explain what scientific models do, I follow Nancy Cartwright's instrumentalism, to argue that models aim to establish

[6] Hartmann and Frigg, "Models in Science."
[7] Anjan Chakravartty, "Scientific Realism," *Stanford Encyclopedia of Philosophy* (June 12, 2017).

stable tendencies in the real world or target system and not the overall behaviour that occurs in the real world.[8]

4 The Stable Tendency Argument for Models

Both realists and instrumentalists acknowledge that models play a pivotal role in scientific activities. I, therefore, argue that in thinking about models, the concern should not be truth as in being literally true, but the establishment of stable tendencies. What this means is that, given the factors or conditions present, an object or system *tends* to behave in a certain way. This is different from structural realism where there is a structure in the world. The stable tendency argument focuses on objects in the world. In order for it to achieve this, a model must include a high degree of idealization.

In his famous experiments to ascertain the effect of the attraction of the earth on a falling body, Galileo Galilei eliminated all other causes of motion on the bodies involved in the experiments. He placed a ball on an inclined plane to decrease the acceleration, and thus, measured the elapsed time. When the ball was allowed to roll a given distance down the plane, the time taken for the ball to move the distance was measured. This experiment, with different bodies of varying masses, led Galileo to conclude that motion of a body on an inclined plane possessed constant acceleration. This constant acceleration is independent of the mass of the body, and dependent only on the angle of the plane. This conclusion was only arrived at by means of some degree of idealization—the blocking off of some conditions and/or holding some conditions constant.

[8] Nancy Cartwright, "The Vanity of Rigour in Economics: Theoretical Models and Galilean Experiments" in *Centre for Philosophy of Natural and Social Science.* London School of Economics, ed. Max Steuer, 4.

In real-world situations outside laboratory conditions, other causes of motion affect bodies. In idealizing the conditions within the experiment, Galileo aimed at establishing the contribution the pull of the earth will make, assuming that this contribution is stable across different situations that falling bodies may be involved. It is important to emphasize that the aim was neither to demonstrate how a particular body will fall nor to establish a type of regularity with regards to some kinds of bodies. The aim was to establish a stable tendency—the contribution of the pull of the earth. It is this stable tendency that makes it possible for the results of the model to be transferred into the real world, otherwise, there would be no ground for such a transference.[9]

A major critique of the stable tendency argument pertains to internal validity and external validity. Internal validity refers to the construction of genuine experimental conditions that can hold without being structurally, procedurally or logically incoherent. That the results of the experiment must hold in the real world or target system, is the experiment's external validity.[10] Opponents of the stable tendency argument hold that the conditions necessary for maintaining internal validity are anathema to those required for external validity. In idealizing the conditions within the experiment, the scientist or experimenter is in control, and can manipulate these conditions in order to achieve internal validity. With the idealized conditions, set in agreement to general principles (principles of physics in the case of Galileo), the results follow by deduction. There is no logical inconsistency. In the real world or target system, the artificiality or idealizations do not hold. Hence, how can the results of the experiment (which arose out of some degree of idealization) be taken to establish stable tendencies in the real world?

[9] Ibid., 10-11.
[10] Ibid., 6.

In order to respond to the above objection to the stable tendency argument, emphasis must be placed on the term, "tendency." What the argument claims is not a literal transfer of the results of the experiment. Thus, with the case of Galileo, the right conclusion will read thus: all other factors kept constant, the motion of a body on an inclined plane *tends to* possess constant acceleration. This acceleeration is independent of the mass of the body, and dependent only on the angle of the plane. This non-literal reading of the results of a model is what the stable tendency argument is about. It is idealized or abstract, but the abstractness or idealization is pivotal to its use in the concrete or real world. This abstract-concrete relation can also be found in literary fiction. Here, literary fiction can help illuminate the scientific enterprise.

5 Literary Fiction and Stable Tendencies

What constitutes literature has for a long time, been an object of debate among literary critics and philosophers of literature. One definition that has been proposed is that literature is creative and imaginative writing. This definition points to fiction; a term that stands in opposition to facts. Thus, fiction refers to that which is not literally true.[11] This definition does reveal an essential characteristic of literature; it being a creative and imaginative enterprise. When one reads the works of William Shakespeare, Sophocles, Chinua Achebe, Ngugi wa Thiong'o or Charles Mungoshi; it is hard not to notice the creative and imaginative investments that went into their works. Their creation of characters, use of language and plotting reveal the exercise of the imagination and creativity. However, this definition is inadequate. It is hard to think of any writing which does not involve the use of the imagination or of creativity. The dialogues of Plato, the works of Aristotle, Aquinas'

[11] Terry Eagleton, *Literary Theory: An Introduction* (Oxford: Blackwell Publishing, 1996), 1.

Summa Theologiae or Kant's *Critique of Pure Reason* are creative and imaginative writings. If these are creative and imaginative works, how is it possible that they do not bear the label of literature in the same way as Shakespeare's or Achebe's works? Thus, the definition of literature as creative and imaginative writing is inadequate.

Terry Eagleton provides a different definition of literature. This definition does not make the split between facts and fiction. Here, what is essential to literature is its peculiar ways of using language.[12] Literary devices—narrative techniques, sounds, imagery, etc.—produce estranging effects on the reader or listener. In its use of language, the ordinary is made strange and unfamiliar, yet, this estrangement remains familiar and is crucial to the appreciation of literature.[13] By estranging the reader or listener from the ordinary, a literary work is able to comment on the existing social, economic and political situation of the time. This explains the charm present in literature. If this is true, it will mean that a literary work is only valuable at a given time and place. Why is it that Shakespeare's *Hamlet* (written in the 1599) and Achebe's *Things Fall Apart* (written in 1958) are still revelant today? In response, I argue that it is the stable tendencies that literary works exhibit which make them relevant outside the material reality that produced them.

When likened to an experiment in physics, models in literary fiction exhibits some similarities with scientific models. Here, model production in literary fiction can be seen as a type of thought experiment. In the construction of the character of Hamlet, Shakespeare shows how individuals tend to behave under certain conditions. When an individual discovers the murderer of a loved one, he or she tends to contemplate the possibility of revenge or forgiveness. This is characterized in the famous soliloquy—"to be, or not to be,

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[12] Ibid., 2.
[13] Ibid., 3-4.

that is the question."[14] The actions of Ophelia, Horatio and Polonius have effects on Hamlet. When these characters behave in a certain constant manner—an idealization—as shown by Shakespeare, Hamlet acts the way he does.

This kind of idealization makes *Hamlet* relevant today. The more plausible the hypothesis (or the stable tendency), the more gripping the story. Thus, literary fiction functions as a kind of model, where the idealization is indispensable to its external validity. All literary works are "re-written", sometimes unconsciously, in any given place and time.[15] This re-writing is only possible because of the stable tendencies present. Therefore, "science fictions" are not generally considered literary works because they do not reveal tendencies in humans.

6 Models and Fiction: What Makes a Good Model or a Good Fiction?

From the above discussion on models in literary fiction, there are at least three points of convergence that support my thesis that models and fiction both establish stable tendencies. The first point of convergence is on the aim or purpose of models and fiction. The Galilean model aims at explaining the behavior of bodies when they are pulled by the force of the earth. The works of Shakespeare point to human possibilities as they are realized in the real world. Thus, the aim of a model and literary fiction is to comment or explain some phenomenon or behavior in the real world. This does not rule out the possibility, for example, of reading fiction for fun. However, when *Hamlet* is read seriously, comparisons between the play and the real world are made. This enables the reader to learn something about the world through the play. For models, a similar attitude is

[14] William Shakespeare, *Hamlet* (New York: McGraw-Hill Book Company, 1984), 48.
[15] Eagleton, *Literary Theory*, 11.

applicable. In representing a situation in a model, one compares such representations with what is obtainable in the real world.

In claiming that models and fiction comment about the world, I do not mean that they do so about actual systems or particular persons. Any competent reader of fiction will realize that *Hamlet* is not a comment on a specific person in 16th century England. In the same vein, massless strings or frictionless planes, do not have counterparts in the real world.[16] This, however, does not suppose that they both do the same thing. It can be argued that physics is concerned with the physical, while literature engages the physical, metaphysical, emotional, political and social.

Models and fiction also make use of idealization. In the case of the model, the scientist "manipulates" the conditions by isolating a scenario. The novelist on the other hand, "manipulates" the various literary devices and sometimes, complicates a scenario. This is done via language towards achieving the aim—commenting or explaining some phenomenon or behavior in the real world. It can be argued that this is exactly what makes a model or fiction interesting. Both specify only essential properties, but one understands that there are other properties not mentioned in the description. As Roman Frigg argues, it will be uninteresting to study a model [or fiction] if all that there was to know is contained in the explicit description.[17]

Lastly, both ensures internal validity as well as external validity. This is part of what makes them "believable". Thus, a good model or a good fiction (with these features) is one which establishes stable tendencies about what happens in the real world. This is usually

[16] Roman Frigg, "Models and Fiction," *Synthese* 172 (2010): 257.
[17] Ibid., 258.

achieved through some rules of inference. Thus, finding out what is true about a model or fiction requires going beyond the explicitly stated.[18]

7 Conclusion

In this essay, I have demonstrated the important roles models play in the scientific enterprise. I began the essay by considering the various apprehensions of scientific models in the philosophy of science. The second part of the essay situated models in the realists versus anti-realists debate. Thereafter, I argued for the "stable tendency" apprehension of models and showed how this is present in literary fiction. In the final part of the essay, I highlighted the similarities between scientific models and literary fiction. This is in a bid to show how literary fiction, understood as models, can illuminate our understanding of the scientific enterprise. I am aware that the parallel drawn in this essay, between scientific models and fiction is not conclusive. However, I have tried to show that there is a nexus between these two seemingly divergent tools for understanding the world.

[18] Ibid., 258.

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