A Reflection on How Scientific Theories Reflect the Empirical World—Do There Exist Scientific Theories that Precisely Explain How All Physical Objects Work?[1]

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Introduction

Laymen, including those having received some science education in high school, may perceive our world as being well described by scientific theories. Although some theories in biology still provoke controversies, like the problem of free will, or Darwin's theory of evolution; Newton's three laws of mechanics may receive nearly no doubt when describing the phenomena in our physical world.

In this paper, we would like to study scientific theories that are considered to be the most precise, like the three laws of mechanics; and

1 The original title was "Do all physical objects in the universe, such as planets, trees, fishes and humans as shown in the advertisement, work like machines? Does it mean that there are precise mechanisms to explain how all physical objects work?" I have always been wondering if I have misinterpreted the question, for the word machines makes me thought of reductionism. Here, I shall modify the title to what I actually mean in this paper.

to examine if they really are. We shall also focus on theories in a general manner, to study if we are ever possible to obtain theories that precisely explain how all physical objects work.

The Nature of Scientific Theories

To answer the question, "Do There Exist Scientific Theories That Precisely Explain How All Physical Objects Work?", we have to first understand the meaning and the nature of Scientific Theories and precision of which is respected to the explanation of how physical objects work.

We should beware of how our scientific laws and theories are obtained—they are obtained by observation, hypothesis, experiments and induction. We have seen that Newton's Laws of Motion are presented in an axiomatic structure (see more Newton 67–69). But are the laws self-evidently true premises? Newton did successfully propose laws that are seemingly accurate. With the help of abstract reasoning, imagination and repeated experiments he generalised the empirical knowledge to universal laws (Cohen 58). But they still originate from his observation and imagination of the physical world. Statements concerning our empirical world that is not self-contradictory are possible in *logical sense*, for they are contingent. A world that does not fulfil Newton's Law is possible in such sense.[2] We may have much evidence that Newton's Laws hold in our world. But we cannot claim that they are undeniable truth. And in fact, no scientist would claim their theories are absolute truth, in contrast with pseudo-science.

2 We have some interesting examples from Carnap's book: "'There is a man. He shrinks in size, becoming smaller and smaller. Suddenly he turns into a bird. Then the bird becomes a thousand birds. These birds fly into the sky, and the clouds converse with one another about what happened.' All this is a possible world. Fantastic, yes; contradictory, no." (11)

Here, we shall discuss the logical structure of scientific laws in a systematic manner.

A scientific law explains phenomena with a syllogism structure. It is a deductive process. We have a statement on how something *always* behaves. If an object qualifies to be that thing, then it would necessarily behave as stated. If we believe the premise to be true, then our conclusion can never be false. Scientific theories also have the nature of being transcendental that it is timeless and does not depend on geographical locations. So we can explain how things work at this moment, incidents that happened in the past, and predict how things work in the future.

So the crucial part we have to look at is the premises. How theories are obtained? We obtained empirical facts through our everyday experience. Scientists may perform experiments to obtain even more empirical facts. Then empirical facts are gathered to perform induction and empirical laws are obtained. We should notice that all the facts are happened in the past. So it is logically possible that our empirical laws would fail to describe the world in the next second.

Newton's Laws of Motion go even further. It is not at all an induction and a generalisation of empirical facts, although empirical facts do provide inspiration to the formation of law. It is a hypothesis.[3] As mentioned, imagination and abstract thinking are those vital in his formation of universal law. But still, counterevidence may falsify the law. And this is how scientists treat a hypothesis—they always make hypothesis and eliminate them if it is

3 "We observe stones and trees and flowers, noting various regularities and describing them by empirical laws. But no matter how long or how carefully we observe such things, we never reach a point at which we observe a molecule. The term 'molecule' never arises as a result of observations. For this reason, no amount of generalization from observations will ever produce a theory of molecular processes. Such a theory must arise in another way. It is stated not as a generalization of facts but as a hypothesis." (230)

falsified by experimental result. And hypothesis which "survives" under a large number of tests will acquire the name of *theory* or *law*[4].

Concrete Examples: The Current Scientific Theories

In this section, we shall see some concrete examples of scientific theories, and see how their nature is like.

In reality, most of the theories are not solely generalised from empirical facts by means of induction. Many start from observation, but the gist always lies on the hypothesis they made.

A notable example would be Gregor Mendel's discovery of *dominant* and *recessive* gene. The empirical fact he had is the 3:1 ratio of number of purple flowers to that of white flowers which are the offspring under crossbreeding ("Mendelian Inheritance"). And then he formulated a hypothesis that genetic information is transferred from parents to offspring; each parent owns a pair of information, but their offspring will only receive one from each parent. He also proposed that some information is dominant and some is recessive. Only be receiving two recessive genes will the characteristic the offspring carries be shown, in other cases, the dominant gene dominates (Watson 104–105).

So such thought is highly hypothetical and it was really a big jump from the empirical fact to the hypothesis, but after many times of testing it is confirmed to be a reliable theory. In fact, his hypothesis was not accepted by the scientific community until 50 years after his proposal. It was Walter Sutton who discovered the chromosome, which the scientists were studying

4 We should further note what kind of test we should perform: "If you are testing the law that all metals are good conductors of electricity, you should not confine your tests to specimens of copper. You should test as many metals as possible under various conditions—hot, cold, and so on." (21)

at that time, shared a lot of similarities with Mendel's paired factors. And later Thomas Hunt Morgan performed experiments with fruit flies, and the results confirmed Mendel's hypothesis (105–107).

It is in the same way how Newtonian mechanics are perceived to be true, especially by laymen. Physicists this time turn to predict when a comet will appear by using Newtonian physics. It was successful. And not to mention tons of examples which occur around us every day, from the motion of cars to structures of skyscrapers and even the launching of satellites. All these together increase the reliability of the theories.

Would Precise Scientific Theories Ever Exist?

We have mentioned that no scientist would claim their theories as absolute truth. However, would an absolute truth be discovered one day? After all, scientists are working with the aim of finding rules and explanations about the nature and the universe. Why would they be so devoted if it is impossible to find one?

I would interpret *precise* theories as the perfect theories that are always correct. Then we *could not know* if such theories exist in the physical world[5]. We know that the theories originate from induction or hypothesis but they do not provide any affirmation in a strict logical sense.

Let us put this aside and discuss if we can claim a theory is precise. Although it is now unknown if exists, if we can show that a theory is precise, then at least we would one day obtain a concrete precise theory and existence can be demonstrated.

5 We know that Plato proposed that, "[r]eality in its perfect fullness, Plato argued, is found only in the eternal forms, which are dependent on nothing else for their existence." (Lindberg 18–19) It is good to think about if our quandary coincide with Plato's thought.

If we obtain the scientific law by generalising empirical facts, then we could never verify if the theory is precise. It is due to the limitation of induction and human's experience. We attempt to generalise the empirical fact into universal laws. But our data is limited, in both duration and geographical sense. Scientists formulate their law with reference to empirical facts in the past, and we can never know if the law holds forever regardless of the time. The anticipated future will likely be in this way, but we are never sure.[6]

If we obtain the scientific law also by an abstract and axiomatic manner like Newton, still, we cannot claim the premise is true unconditionally, as it is not that self-evident like Euclidean's axioms (see more Euclid 275–290). Upon checking, every example showing that the theory holds only increases its trustworthiness, but never logically verifies that the theory is perfect.[7]

A Concrete Example: Newtonian Mechanics

Indeed, Newtonian mechanics was later discovered to be only the special case. We would not discover it is problematic in our everyday life. However in some extreme cases, like high speed tending to light speed, or micro scale down to the scale of elementary particles or even smaller, then relativity or quantum mechanics would be the new tool for explanation.

And light which was once thought to be particle by Newton, it was later found that light has wave properties—the interference pattern as observed by Young's double-slit experiments. But then Einstein's Photoelectric effect experiment demonstrates once again the particle

6 Original Text: 「我們只能說過往都是如此如此，從無反例，因此未來亦應如此。」（陶國璋 71）

7 "At no time is it possible to arrive at complete verification of a law. … How do we find confirmation of a law? If we have observed a great many positive instances and no negative instance, we say that the confirmation is strong." (Carnap 21)

property of light. And eventually, we nowadays say that light have wave-particle duality.

Therefore, sometimes theories are wrong because of ignorance—that we have not studiedthe nature well and deep enough. The moral here is that even today, the seemingly well-established theories which explain our physical world are not at all precise and are subjected to amendments.

And Sadly We May Not Even Refute a Hypothesis

We cannot claim that a scientific theory is perfectly precise, and it would be too naïve if we think that a theory can easily be refuted by counterevidence. It is not that easy to refute a scientific hypothesis even under the presence of counter examples. A scientific hypothesis always comes with some hidden auxiliary hypothesis, like the measurement should be accurate, or one should neglect air resistance. Errors we made in high school scientific experiments are examples of violation of auxiliary hypothesis. To save a hypothesis from being falsified under challenges, scientists would also propose auxiliary hypothesis.[8] Without fulfilling both the auxiliary hypothesis and the hypothesis, we may obtain counterevidence, but these cannot falsify the hypothesis.[9]

How We Should Respond to This Condition

It is important to be aware that we can never claim a theory to be perfectly precise, which can explainhow every physical object works. So every theory is probably faulty. But to make science this subject

8 For example, see R. A. Milikan's hypothesis that "electric charges have an atomistic structure and are all of them integral multiples of the charge of the atom of electricity, the electron" and Ehrenhaft's challenge. (Hempel 24–25)

9 You should read Hempel's *Philosophy of Natural Science* chapter three for a more detailed discussion.

meaningful, we shall not respond to this negatively and discard all the laws we obtain throughout the thousand years. Instead, we have an agreed open attitude that every scientific law can be refuted with counterexamples. Every positive confirmation is meaningful that it increases the trustworthiness. And every brand new theory that occurs due to previously faulty theory brings us closer to the perfect precision.

Sometimes, especially for theories in chemistry and biology, we rely largely on making hypothesis. And we might have various hypotheses, not only one, to explain a single phenomenon. We can never know which one is faulty until we arrive at a counterexample. But we shall classify some theories as being better than the others. This can prevent wild-guessing and promote the scientific development that we can have an agreed conclusion and succeeding theories can be built on top of it. Some criteria for good scientific explanation are: relevance, testability, compatibility with previously well-established hypotheses, predictive or explanatory power and simplicity. (陶國璋 59–60)

Laymen should also bear in mind that scientific evidence cannot serve for proving purpose. Nowadays, in most cosmetics commercials, we hear of claims that rely on experimental results. Of course the problems are always the misleading use of statistics. But why business would use science as the selling point, it then goes back to the attitude of laymen thinking that science is always correct. But science shall not tell the absolute truth, it can only bring us closer and closer to the truth.

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Teacher's comment:

The writer argues, in a convincing manner, that no scientific theory can be claimed to be absolute truth—not even when abundant evidence are present to support the theory in question. The arguments are backed by the writer's knowledge of the philosophy of science and illustrated with a number of solid examples. (Szeto Wai Man)