Wittgenstein’s Picture Theory of Language as a Key to Modern Physics

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The early Wittgenstein can help us to understand modern physics. This may be unexpected, although we know that *Tractatus* was inspired by Wittgenstein’s study of the philosopher-physicists Heinrich Hertz and Ludwig Boltzmann. Wittgenstein often referred to Hertz and planned to study under Boltzmann, but was prevented from doing so by Boltzmann’s sudden suicide. The problems facing those who want to understand modern physics are, however, more fundamental than those of the classical physics of Hertz and Boltzmann. In *Wittgenstein’s Vienna*, Janik and Toulmin (1973) outline a development where the Viennese intellectual’s critique of language in the Kantian spirit was combined with the approach to physics of Hertz and Boltzmann and the writings on logic by Frege and Russell into general philosophy of language, which found its expression in the terse statements of *Tractatus*. For our aim we need this elaborated philosophical synthesis. Wittgenstein’s early philosophy has been generally overlooked by both physicists and philosophers of physics. However, we will see that the philosophical insights found in *Tractatus* may be just the key we need for understanding the strange epistemological situation in which we are placed by new physics.

The first scientific revolution was caused by the discoveries of Copernicus, Kepler, Galileo, and Newton. The new world view became universally known and accepted, and has since become a part of both our cultural heritage and what we now consider to be common knowledge.

The next revolution in physics took place in the twentieth century and consisted of three main steps. The first and second steps were the special and general theories of relativity. The third (and even more revolutionary) step was quantum physics, starting with quantum mechanics in 1925. Except for a short period of newspaper headlines in 1919–20 making Einstein the most famous scientist ever, one can safely say that the man in the street never noticed that any change had taken place. The reason was not that these new developments were less revolutionary than the Copernican Revolution. The main reason is the fact that the new theories are inaccessible to people without a solid background in mathematics. Moreover, experts – including the creators of the theory – have been discussing throughout an entire century what it truly says, without reaching any conclusion upon which all parties can agree. Nonetheless, the theory’s mathematical structure has been established beyond discussion as being consistent, highly developed, and, according to physicists, beautiful.

Should philosophers care about these questions? Yes, for at least two good reasons. One compelling reason is that new physics challenges our most obvious assumptions about the material world. For instance, we take it as obvious that what is present in time exists, while neither the past nor the future exists. Likewise, it appears obvious that when a physical object moves in space, it maintains one position there, having as it does only one velocity. Theories that challenge these assumptions are certainly of philosophical interest. The second reason for philosophers to be interested in the new physics is the possibility that philosophical theory contains the key to the correct understanding of modern physics. There are good reasons to suspect that physicists trying to develop the correct interpretation have built-in philosophical assumptions of which they remain unaware and which may even prevent them from arriving at the right answers.

This paper focuses on quantum mechanics as a philosophical case, although a similar reasoning may be completed concerning the theories of relativity. My hope is that other philosophers than myself will find this to be an interesting and challenging case, allowing them in turn to catch a glimpse into a surprising, strange and beautiful part of the world into which, according to Heidegger, we are thrown.

The approach I recommend regarding the interpretation problem of quantum mechanics is similar to the more or less implicit view of one of the pioneers behind the theory, Paul A. M. Dirac. Dirac shared the Nobel Prize with Schrödinger and Heisenberg for creating the theory, but is much less known outside the physics community than the other two scientists. He has a reputation among physicists for refusing to comment on the interpretation of the theory. I think that his silence can be interpreted as exactly the type of silence recommended by Wittgenstein in *Tractatus* 7. Dirac was, unbeknownst to himself, essentially a *tractarian*. He also happened to be at Cambridge at the same time as Wittgenstein, although there is no indication of intellectual contact between them. Dirac wrote a textbook entitled, *The Principles of Quantum Mechanics* (Dirac, 1930) which Einstein praised as “the most logically perfect presentation of quantum mechanics” (Farmelo 2009, 179), and which is an important source of Dirac’s views. In the book’s third edition, he invented his own mathematical notation which John von Neumann calls “Eine Kürze und Eleganz kaum zu überbietende Darstellung der Quantenmechanik …” characterised by its “Durchsichtigkeit” (Neumann 1932). Brevity, elegance and transparency were Dirac’s trademark.

Quantum mechanics is perhaps the most consistent application of Galileo’s thesis which states that the book of nature is written in the language of mathematics. Quantum mechanics is exclusively written in mathematics, and is not translatable into any ordinary language. We therefore have a very clear-cut situation for examination.

In quantum mechanics, some of the properties of a physical object often have names which are known from classical mechanics. A quantum particle has properties like position, velocity and energy. However, in quantum mechanics, these properties do not always have specific numerical values; they may instead be associated with mathematical distributions, indicating that the quantity in a sense has many values simultaneously. Thus, a particle which is in several places at one time, or has many velocities simultaneously (even velocities pointing in opposite directions) is impossible to imagine, and the existence of such strange objects is not easy to accept. Nevertheless, this is essentially what quantum mechanics says, the details of which will be specified later.

One striking feature of what we may call Dirac's interpretation of quantum mechanics is that it is not an interpretation made "from the outside". In the spirit of *Tractatus*, Dirac always lets the theory express itself "from the inside", and in the clearest possible way, even developing his own mathematical notation that is notable for its "brevity, elegance, and transparency". In this way he let the logical structure of the theory be displayed, lets it "show itself" as clearly as possible, and then said nothing about it.

This has placed Dirac outside the discussion on the interpretation of quantum mechanics. The research activity growing out of this discussion, starting with early discussions between Bohr, Einstein and other pioneers, has always tried to interpret quantum mechanics from the outside in terms of the space-time-causality structure of classical mechanics, in terms of experiments, in terms of hidden variables, or in terms of existing language. Because Dirac did not participate in these discussions, he gave the impression that he did not have any view on the interpretation problem.

I now turn to the *Tractatus*. Since this work have been interpreted in so many different ways, I will make some commitments. One of my main secondary sources of interpretation is Allan Janik's and Stephen Toulmin's classic *Wittgenstein in Vienna* (Janik & Toulmin 1973). A recent study which has influenced my own thinking is *Wittgenstein's Tractatus* by Alfred Nordmann (Nordmann 2005). Nordmann has shown that today *Tractatus* can be considered as still valid. preferences should indicate my attitude towards *Tractatus*.

Following Janik and Toulmin, I see *Tractatus* as an attempt to solve the general problem of language by generalising the physics of Hertz and Boltzmann into language in general. It is then reasonable to ask if, by applying this philosophy to quantum mechanics, one is not just taking one step backwards from general linguistic philosophy to the specific case of model physics, which inspired it. This is, however, not the case. Quantum mechanics has placed physicists and philosophers in a completely new situation compared to the classical physics of Hertz and Boltzmann.

Inspired by Hertz' model for the presentation of physics, Wittgenstein considered the sentences of language to be models or pictures of *state-of-affairs*. Hertz' concept of a mathematical model is already an abstract notion, and a means to perceive the logical structure of the theory by observing the logical structure of the model. Wittgenstein made a new step in abstraction when he generalised this notion to language in general. The sentence is a kind of picture, but this picture cannot be directly compared with the *state-of-affairs* of which it is the picture by looking at each of them and then making the comparison. Only through the picture we are able to grasp and to express the *state-of-affairs*. To get a clear understanding of some fact, it is necessary to have a clear picture, a clear expression in language.

Wittgenstein tried to specify the limits of language "from within" by specifying what can be *said*, and only by implication, what cannot be said. He was therefore able to perform a critique of language yet save it for use whenever appropriate. It is appropriate when we deal with facts; therefore language is adequate for "science", when we take "science" in the widest possible sense to mean any field of knowledge which is concerned with facts. Wittgenstein thereby operates with such a wide concept of science that it includes many subjects of study which other philosophers than Wittgenstein would call philosophy.

In classical mechanics, the mathematics is assumed to be translatable, not only into ordinary language, but into a system of images, where we imagine stones that falls, planets orbiting the sun, water flowing in a pipe. This is an extraordinary situation, different from general language, and also different from quantum mechanics. Therefore quantum mechanics needed the general language problem to be solved before it could be understood. It needed the *tractarian* notion of a picture which is the only means to grasp some fact and its logical structure. The fact itself is said, and the logical structure displayed by the sentence.

Dirac (1930) interprets quantum mechanics in a similar manner by giving clear expression of what can be *said* within his theory, and the clearest possible display of its logical structure. Thus he exhibits its logical structure, which cannot be said, only shown, and even what can be said is exclusively expressed in mathematical language. Consequently, the mathematical symbols should be treated as analogies to ordinary word-signs, and the mathematical equations to sentences. In the same way that a sentence is a picture (in Wittgenstein's notion) of a state-of-affairs, so is the mathematical equation. Furthermore, in the same way that we are left with the linguistic picture to grasp the content or meaning of a state-of-affairs, we are also left with the mathematical symbols and equations of quantum mechanics.

Wittgenstein also rids the physicist of the apparently unanswerable question of meaning of each single symbol. Applied to quantum mechanics: instead of asking the meaning of "position" in a theory where one no longer can imagine a particle as something confined to a single place, we must accept that

> Only propositions have sense; only in the nexus of a proposition does a name have meaning.
> (Tractatus 3).

In quantum mechanics the nexus have changed. The new meaning of the old word in quantum mechanics is the meaning it acquires through its logical relationship to other symbols (names) in the logical (mathematical) structure of the theory itself.

Nonetheless, quantum mechanics is not only a propositional structure, but is supposed to be true about the world, even empirically verifiable. Does this coupling to the external world prevent us from thinking from the "inside"? It is true that traditional experimental equipment has, historically speaking, often been described by classical mechanics to such an extent that Niels Bohr thought that this was a necessity. However, it is not. The simplest and perhaps most widespread kind of quantum measurement is spectroscopy. This has traditionally been thought of as an interaction between a quantum object (such as an atom) and a classical electromagnetic field. However, although inconvenient, the electromagnetic field can be described within an extended quantum theory, and the interaction as well as the outcome can be described within the quantum language. Such a measurement serves as an empirical confirmation of both quantum mechanics and quantum electrodynamics, representing the end points of Wittgenstein's measurement gauge:

> Only the end points of the graduating lines actually touch the object that is to be measured
> (*Tractatus* 2.15121).

Today, there is great activity in developing models for experimental measurement within the theory. Models are even being developed for understanding why classical mechanics appears from within quantum theory (the socalled "decoherence phenomenon"). This how we see it today: quantum theory is universal in nature, while classical mechanics is a specific case found within this theory.

Finally, what about people – such as philosophers – who do not have a sufficient mathematical education to understand quantum physics from within? In order to deal with this problem, we need to put Wittgenstein's notion of "nonsense" into use. Outside the proper mathematical language, we are left to talk nonsense; however, nonsense is, in the philosophy of Wittgenstein, far from meaningless. E.g. "the particle is in many places simultaneously" or "have many velocities simultaneously" are useful and informative nonsensical statements. I find Wittgenstein's notion of nonsense very illuminating in cases like this. Such statements are both correct and slightly incorrect at the same time, and are used with a slight uneasiness by physicists. Nevertheless, they remain the best way of expressing the strangeness of the quantum world. Informed nonsense brings linguistically inaccessible truths about nature back to "the man in the street", including the philosophers.

Literature

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