

Charles P. Enz and Karl von Meyenn (eds.), *Wolfgang Pauli. Writings on Physics and Philosophy*, Heidelberg, Springer-Verlag, 1994.

This collection of essays, all written by Wolfgang Pauli, has a rather remarkable history attached to it. Nearly all of the papers were written in German and the idea of publishing an English version was already suggested before 1957 by Paul Rosbaud, a close friend of Pauli and connected to Springer as scientific adviser. Rosbaud found an excellent translator, Dr. Robert Schlapp, but, unfortunately, Pauli died in 1958 and his widow opposed publication, apparently because one of the referees had written that "I felt that Pauli's unique personality does not quite come through" (p.10). The result is a book published in 1994, that should have been available 37 years earlier. Neither the author Pauli (d.1958), nor the translator Schlapp (d.1991), nor the adviser Rosbaud (d.1963), are still around to witness this long awaited moment.

If the reader is not familiar with the work of Wolfgang Pauli, then he or she should read this book. However, if the reader does have (some) familiarity with Pauli's scientific work, then he or she too should read this book. Twenty-one essays are brought together that cover: (a) the life and times of some of his colleagues, (b) ideas and thoughts on philosophy of physics, quantum mechanics and theory of relativity in particular, and (c) reflections on philosophy and history of science. This latter category includes Pauli's essay on Kepler (my classification, not the editor's, JPVB). As this reviewer is most interested in (b) and, above all, (c), I will only say a few words on class (a). However, before that, let me recall, in a nutshell, the life and work of Wolfgang Pauli.

Pauli was born on 25th April 1900, the godfather being Ernst Mach. In 1918, he went to München to study with Arnold Sommerfeld, in 1921-22, he was in Göttingen as assistant of Max Born. He met Niels Bohr and spent the next year in Copenhagen. There, in 1924, he formulated the famous *exclusion principle* that would earn him the Nobel Prize in 1945. After Copenhagen, he returned to Hamburg, and, finally, in 1928 he settled in Zürich at the Eidgenössische Technische Hochschule (ETH) until his death in 1958, interrupted by the second world war, during which Pauli stayed in the United States at the Institute for Advanced Study in Princeton. In the early Zürich period, Pauli came up with the idea of the *neutrino* (the name itself being coined by Enrico Fermi),

another major contribution to the developing theory of elementary particles. This very same period was a highly dramatic period in his personal life, leading to a psycho-analysis in the hands of Carl Gustav Jung and to a life-long influence on Pauli's philosophical ideas. At least two of the essays in this book are direct proof of this curious merging of the physical and the psychological.

Let me now turn to category (a), that consists of the followings essays (the numerals refer to the index of the book): *Niels Bohr on His 60th Birthday* (4), *Sommerfeld's Contribution to Quantum Theory* (5), *Arnold Sommerfeld* (6), *Rydberg and the Periodic System of the Elements* (7), *Paul Ehrenfest* (8), *Einstein's Contribution to Quantum Theory* (9), *The Theory of Relativity and Science* (11), *Impressions of Albert Einstein* (12), *Albert Einstein and the Development of Physics* (13). Obviously, some of these texts are tied to specific occasions that invite the speaker, Pauli in this case, to praise and to pay homage to the scientist concerned. Nevertheless, what makes these contributions interesting, is the fact that they have been written "from the inside". For a historian of science, it is not without interest to see how Pauli perceives and evaluates the scientific achievements of his colleagues.

For the philosophically inclined, category (b) is what they are looking for. It has to be mentioned that not all pieces are of equal weight. There is the two-page reply to F. Gonseth and P. Bernays - *Theory and Experiment* (14) - presented, however, without the original papers. Both *The Violation of Reflections Symmetries in the Laws of Atomic Physics* (19) and *On the Earlier and More Recent History of the Neutrino* (20) are technical papers that are difficult to read if one is not well at home with the state of the art in the first half of this century in fundamental physics. The same goes, although formula-free, for *Exclusion Principle and Quantum Mechanics* (18). A rather amazing fact, I have to confess, as this was Pauli's lecture upon receiving the Nobel Prize.

What is striking about the other articles, is that Wolfgang Pauli fully embraced the philosophical consequences of quantum theory in stark distinction to Albert Einstein, to quote the most famous opponent. In *Matter* (1), he writes that in the end all matter and substance reduces to energy (p.31). This is written in 1954, long before Paul Davies and John Gribbin wrote their *The Matter Myth* (Simon & Schuster, New York, 1992). The idea that probabilities are fundamental aspects of nature in quantum mechanics, the idea that the observer cannot be a detached part

of nature, the idea that complementarity is the solution to the quantum puzzle, and the idea that the classical picture is quite inadequate to deal with these new views, are put forward and defended in, resp., *Probability and Physics* (3), *Phenomenon and Physical Reality* (15), *The Philosophical Significance of the Idea of Complementarity* (2), and *Space, Time and Causality in Modern Physics* (10). A typical quote is this: "Indeed I myself even conjecture that the observer in present-day physics is still too completely detached, and that physics will depart still further from the classical example" (p.132).

Two details for the philosophically inclined, are worth mentioning. First, I was quite astonished to read this: "It may also, as comprehending the rational (i.e., the possible events described by the quantum equations, JPVB) and irrational (i.e., the actual event, or, in modern terms, the collapse of the wave function, JPVB) aspects of an essentially paradoxical reality, be designated as *a theory of becoming*." (p.48). Names such as Alfred North Whitehead and Ilya Prigogine come immediately to mind, although I did not find any direct or indirect connection. Secondly, what about this? "Theories come into being through an understanding inspired by empirical material, an *understanding* (italics WP) which we may best regard, following *Plato* (italics WP), as a coming into congruence (zur Deckung kommen) of internal images with external objects and their behaviour" (p.129). Yes, this is still Wolfgang Pauli, defending, what seems to be, a straightforward world-thought isomorphism that would have pleased Einstein. Unless we invoke Pauli's interests in alchemy and interpret the isomorphism as a higher-order connection between micro- and macrocosmos. But this leads directly to the last category of papers in this book.

Category (c) consists of three papers: *Science and Western Thought* (16), *Ideas of the Unconscious from the Standpoint of Natural Science and Epistemology* (17), and, most important of all, *The Influence of Archetypal Ideas on the Scientific Theories of Kepler* (21).

Three elements form the cornerstones of this material. First, there is the idea that once, in the past, our knowledge of the world was integrated. However, in the west, this integration dissolved and since then we struggle to restore the unity. In his own words: "I believe that it is the destiny of the occident continually to keep bringing into connection with each other these two fundamental attitudes, on the one hand the rational-critical, which seeks to understand, and on the other hand the

mystic-irrational, which looks for the redeeming experience of oneness“ (p.139). Especially, the comparison between Johannes Kepler, astronomer and idiosyncratic astrologer, and Robert Fludd, alchemist, shows clearly the dissolution taking place in the 17th century.

The second element is the importance of the work of Carl Gustav Jung. Apart from Jung's role in Pauli's personal life, it is obvious that intellectually as well, Jung was a major source of inspiration for Pauli. Above all, the idea that the distinction between the physical and the psychic can be overcome, is essential to Pauli. For he sees the same thing happening in physics, and this leads me to the third element.

The third element is that, in present-day science, quantum mechanics in particular, we see signs that lost unity can be restored. E.g., he writes that: “Since the discovery of the quantum of action, physics has gradually been forced to relinquish its proud claim to be able to understand, in principle, the *whole* (italics WP) world. This very circumstance, however, as a correction of earlier one-sidedness, could contain the germ of progress toward a unified conception of the entire cosmos (Gesamtweltbild) of which the natural sciences are only a part“ (p.259). This last quote brings us back to the papers in categories (a) and (b), thereby closing the circle.

It is rather difficult to come to an overall conclusion. On the one hand, the book seems rather heterogeneous: texts for particular occasions (birthdays, Nobel Prize lecture), technical papers, philosophical articles and a detailed study in the history of science. On the other hand, it is clear that one general thought runs through this collection. Once again, I will let Pauli himself express this thought as a conclusion: “To us, unlike *Kepler* and *Fludd*, the only acceptable point of view appears to be the one that recognizes *both* (italics WP) sides of reality - the quantitative and the qualitative, the physical and the psychical - as compatible with each other, and can embrace them simultaneously“ (p.259). Do I see here the new mind of the emperor or the shadows of that emperor's mind?

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