heterostructures and comparisons of various semiconductor properties, he sets the pace and orientation of the book. Such effort is not often undertaken in most textbooks on devices.

Another area in which the book distinguishes itself is the very good treatment of photonic devices, particularly semiconductor lasers. An electrical engineering student should have a good basis for comprehending modern day photonic devices after reading this chapter. One often has to use specialized books on lasers to get this kind of understanding.

Inclusion of novel transistor structures is one of the strong suits of the book. This discussion presents a good overview of how device physicists are using new heterostructure concepts. The chapter, however, does not provide the reader with much basis for determining if these new ideas are worthwhile or not. (This is rather important to establish for reasons I mentioned above.) It is possible that Shur did not want to bias the reader as to the merits of these new developments, but I think a more useful approach is to discuss the needs of a technology and thus judge a particular device, as Robert Keyes does in his book *The Physics of VLSI Systems* (Addison–Wesley, Redwood City, Calif., 1987).

Most of the rest of the book is devoted to the physics of the standard solid-state devices, such as bipolar and heterojunction bipolar transistors, various field-effect transistors, transfer electron devices and so on. These discussions are quite good and give the reader a very good idea of the important issues in these devices. Shur's treatment of issues in submicron technology is quite useful because few electrical engineers will deal with long-channel devices. Discussions of amorphous semiconductor devices are also extremely good. In addition the book includes a software package that can be used by a reader to carry out several important numerical calculations: This is a most welcome addition because most people in the field know the importance of working with real numbers in device physics.

Areas that are becoming increasingly important and have not been addressed in the book are strained channel devices, which have become the fastest commercial devices, and Si–Ge heterojunction bipolar transistors, which are creating new excitement in silicon technology. However, this is not a serious drawback in the textbook because the book contains the basic concepts governing these advances. The exclusion of charge-coupled devices is somewhat disappointing because they have played such an important role in the video-camera industry.

I believe Michael Shur's book fills an important void in the availability of good textbooks on modern devices. It is a useful book for students as well as for practicing electrical engineers and physicists interested in device physics.

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Beyond the Atom: The Philosophical Thought of Wolfgang Pauli

K. V. Laurikainen
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A psychologist, a philosopher or any other representative of the humanities or the arts who expresses his views on transcendental philoso-

phy—the branch of thought that embraces such topics as the mind–body problem and the role of the unconscious in nature—will scarcely attract the attention of most physicists. Nevertheless such topics have historically been of great concern to the most influential thinkers in physics and mathematics. For example, Gottfried Wilhelm Leibniz introduced the idea of a pre-established harmony between physical and mental phenomena to explain their curious coordination. And Henri Poincaré was convinced that the unconscious played a part in the creative process of problem-solving.

For this reason we should not be so surprised to hear that one of the founders of modern quantum physics, Wolfgang Pauli, was also profoundly involved with questions beyond the traditional framework of empirical–rational science.

Pauli's first contacts with psychology began in the early 1930s when, during a personal crisis caused by the suicide of his mother and the failure of his first marriage, he was treated by the Swiss psychologist Carl Jung. Pauli underwent dream analysis, in which changes in the symbolic content of the patient's dreams are interpreted as manifestations of inner, unconscious transformations of the patient's mind. As we know today, Pauli's dreams, together with his own interpretations, were used by Jung in his well-known work *Psychology and Alchemy* (1944).

However, Pauli's interest in Jung's doctrines on the significance of the unconscious in a person's inner life did not stop there. Of special concern to Pauli was the resemblance of the concept of mutual interdependency of the conscious and the unconscious to the idea of complementarity in quantum mechanics. Pauli was convinced (as stated in a letter to Ralph Kronig, 10 March 1946) that "there seemingly must exist very deep relations between the soul and the matter and hence also between physics and psychology of the future, which are not yet expressed conceptually in the science of today." Over the course of history, Pauli believed, the irrational had been removed from our understanding of nature, by being driven into the unconscious. This had resulted in a distortion in our sense of the wholeness of reality, and had caused what Pauli perceived as a crisis in science and a related degradation of cultural values. To comprehend how the once integral scientific concepts of earlier times had been split into empirical–rationalistic and mystical–religious world views, according to the archetypical concept of Jungian psychology, Pauli undertook extensive historical studies on Johannes Kepler. According to Pauli, Kepler stood at the beginning of this split.

It is well known that Pauli exerted a great amount of his scientific influence through his correspondence. Thus we can follow very closely the emergence of his new ideas by studying his letters, now preserved in the Wissenschaftshistorische Sammlungen of the ETH in Zurich and in the Pauli letter collection at CERN in Geneva. Pauli's aforementioned psychological–physical concerns are discussed in great detail in the extensive correspondence (some 300 letters) with his former assistant Markus Fierz. These letters also form the principal source of inspiration for the present book on Pauli's philosophical thought, by the Finnish nuclear physicist and philosopher Kalervo Laurikainen.

To preserve the proper meaning of

Pauli's formulations, Laurikainen has chosen to supply large quotations, in German (supplemented by English translations in the appendix), from Pauli's letters. Nevertheless, in his own commentaries, Laurikainen sometimes introduces substantial deviations from Pauli's original wording. Particularly unsatisfactory is Laurikainen's own notion of statistical causality, here freely attributed to Pauli.

Pauli looked in vain for an appropriate "neutral language" by which he could relate physical and psychological aspects of phenomena in a symmetrical fashion. But what Pauli ventured as only first thoughts in his informal letters to a friend and colleague, Laurikainen presents as definite conclusions. Here more than elsewhere we must distinguish carefully between Pauli's formulations in his printed articles and the tentative and unaccomplished elaborations in Pauli's correspondence. The restriction to only a small amount of Pauli's correspondence on psychology, the lack of any comment on the content of Fierz's responses to Pauli's letters, and the absence of an explanation of the conceptual background of Jungian psychology will make it difficult for the reader unfamiliar with this psychology to obtain a clear idea of Pauli's views.

This book nonetheless represents an interesting start in making public the rich, and until now almost unknown, legacy of Pauli's philosophical musings. I hope that the publication of the complete Pauli correspondence now in progress will provide a stronger basis for understanding this new psychological–physical worldview.

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