of worthwhile illustrative problems in a careful exposition of the principles. Another quarter they devote to kinetics and nonequilibrium thermodynamics, which turns out to contain an extensive discussion of the Boltzmann equation, its extension to dense gases by Nikolai Bogoliubov and the solution of the equations for dilute gases and plasmas. They mention only briefly the time-correlation function approach ("Kubo method") to dynamical problems. For the student, this unfortunate emphasis gives an incorrect picture of currently important problems and techniques in nonequilibrium statistical physics.

The most serious defect in this textbook, however, is to be found in the section on the fundamentals of statistical mechanics, where the development is based on a classical phase-space approach that has been replaced during the last 25 years by quantum statistical mechanics in most pedagogical treatments. The reasons for the switch from classical to quantum mechanics are by now obvious: elimination of problems concerning the size of the volume element in phase space and statistical counting factors; and the desirability of the use of quantum mechanics to describe matter at the molecular level. Furthermore, one can obtain the classical results as a limiting case by introducing the elegant and powerful Wigner–Kirkwood argument. Unfortunately, the Wigner–Kirkwood theory is not even mentioned by Rumer and Ryvkin; rather they "establish" the quantum-classical correspondence by comparing a few of the cases (such as the ideal monatomic gas), that can be solved in closed form both by classical and, in the limit, by quantum statistical mechanics. On the other hand, the number and variety of specific applications they touch on in a statistical mechanical section is impressive. It includes Landau theory of phase transitions, BCS theory of superconductivity, Bogoliubov theory of superfluidity and degenerate gases. To sum up, this text can be useful as a supplement and as a quick reference for courses in thermodynamics and statistical mechanics. At the amazing price of $12.00, it is highly recommended for that purpose. Yao's book on irreversible thermodynamics is too long and too detailed to be really useful as a textbook, but could find occasional utility as a reference.

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Theories of Light from Descartes to Newton

A. I. Sabra

365 pp. Cambridge U. P., New York, 1982. $39.50 cloth, $12.95 paper

Samuel Johnson once said, "We all *know* what light is, but it is not easy to *tell* what it is." *Theories of Light* describes and analyzes an important period in the history of optics: when renewed interest in the physical world and the freedom of inquiry nurtured by the Renaissance were directed toward the nature of light; when early scientists, such as Rene Descartes, Francis Bacon, Pierre de Fermat, Ole Roemer, Christiaan Huygens, Robert Hooke and Isaac Newton, grappled with the nature of the speed of light, of reflection, of refraction, of dispersion, of interference, and even of scientific inquiry.

Like all artists and scientists, these men of science had distinctive philosophical styles and approaches toward their investigations. Near one end of a conceptual spectrum was Descartes, for whom explanation usually took the form of deduction: Starting from a few fundamental principles or propositions, he deduced laws of optics, often by analogy with mechanics—he almost completely neglected induction as a method of forming general principles from experiments. For example, he deduced Snell's law of refraction through an analogy with the motion of particles striking a racket, rather than from careful experiments on light itself. One shortcoming of such an approach is that any error in the fundamental postulates infects the entire theoretical framework. Descartes realized this when he wrote of his doctrine of light's instantaneous transmission, "light moves in an instant, ... it reaches our eyes from the luminous object in an instant; and I even added that for me this was so certain, that if it could be proved false, I should be ready to confess that I know absolutely nothing in philosophy."

Fermat was less extreme, though he too stressed deduction. Motivated by a metaphysical idea of the economy of nature, he formulated his principle of least time, with which he deduced Snell's law. Later, Huygens proposed his principle, that the propagation of a wave can be considered the result of an infinite number of wavelets produced along the wavefront, and then used it to derive Fermat's principle. Optics was advancing through the reinterpretation and rederivation of laws, rather than from the discovery of new phenomena.

At the other end of the conceptual spectrum was Newton, who favored experiments, careful observation and induction. Hypotheses were for him far more tentative than they were for Descartes, Fermat and Huygens. He used principles to suggest further experiments, and these, in turn, suggested new principles or revisions of old ones. A. I. Sabra points out that Newton's first observations in his famous prism experiment concerned the *shape* of the spot on the wall, not the spectrum of colors. Through the methods illustrated in his *Opticks*, Newton advanced the field by expanding the scope of the phenomena for study.

Sabra also analyzes the development of ideas through single scientists, for example, Huygens. The son of a seafarer, Huygens had ample opportunity in his youth to observe and ponder elementary wave phenomena. Later, he explicitly formulated the germinal problems he tackled, such as the speed of light. If, as Descartes believed, light was a tendency toward motion—a secondary property of an ether—Huygens saw a paradox: How could light pass simultaneously in opposite directions through a given point? Huygens argued that the passage of light was analogous to the motion of a billiard ball striking one end of a long chain of balls; as a ball strikes the left end of the chain, a different ball reacts and leaves the right end. Moreover, if two balls strike opposite ends simultaneously, they bounce off, just as if the "light beams" had passed through each other.

For this to happen, though, a central ball must have been compressed and then expanded. Because this takes time, light must propagate at a finite velocity, and Descartes was wrong to believe its velocity was infinite. Further, the concept of chain reaction led Huygens to his famous principle, and ultimately to the derivation of Snell's law in most optics texts today.

Sabra comments upon the works of other philosophers and historians of science who have dealt with this period. When he disagrees with them, he presents clear, persuasive arguments why. The bibliography in this reissue is expanded from that of the original (1967) and could serve as a starting point for anyone addressing the philosophical and historical aspects of the origin of modern optics.

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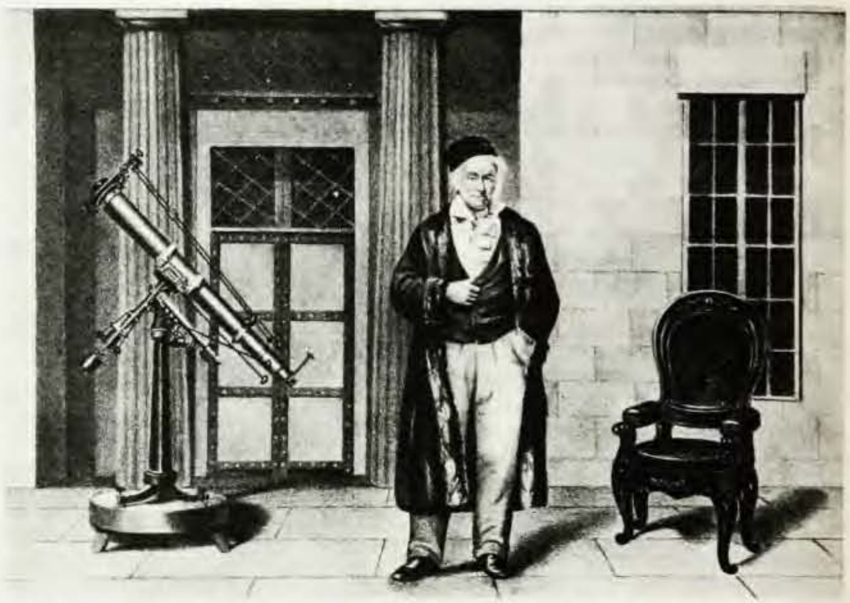

Gauss, astronomer and physicist as well as mathematician, on the terrace of the Göttingen Observatory, from *The Discovery of Nature* by Albert Bettex. (AIP Niels Bohr Library.)

Gauss: A Biographical Study

W. K. Bühler

208 pp. Springer, New York, 1981. $16.80

What is the value of publishing a comprehensive scholarly edition of the writings of a great scientist, such as Albert Einstein? We may get some idea of the answer to this question, which, applied to Einstein, is currently under discussion at the National Science Foundation and elsewhere, by examining a recent biography of Carl Friedrich Gauss (1777–1855). Gauss's place in the history of mathematics is comparable to that of Einstein in the history of physics—he is usually ranked with Archimedes and Isaac Newton as one of the three greatest mathematicians of all time. His collected works, including unpublished manuscripts and selected correspondence, were published in twelve volumes between 1863 and 1929; several additional volumes of correspondence with various scientists are also available. With many scholars having collected, transcribed and synthesized everything that Gauss wrote on mathematics and science, someone who wishes to interpret Gauss's achievements for readers with some technical knowledge will have extensive resources. The publication of Gauss's writings makes possible not merely a single "definitive" biography but rather a variety of studies, such as those Aristotle, Shakespeare, Bach and other giants continue to inspire.

W. K. Bühler states that his book "is addressed to the contemporary mathematician and scientist, not to the historian of science or the psychologist collecting the scalps of great men." He admits that he has included little not already known to the specialist. We must evaluate it on this basis: as an interpretation of Gauss's life and work for those who already have some idea of its significance, but neither as a popularization nor as a contribution to scholarship.

Buhler does succeed in giving a fascinating account of Gauss's personal and professional life. He makes effective use of quotations from letters to illuminate Gauss's personality and his