analyzed in the supplementary notes.

This book achieves a very broad coverage of subject matter in a limited space by confining formal developments to the main points, without presenting detailed proofs. In concluding his review of the original edition, Einstein recommended Pauli's treatment to "everyone working creatively in the field of relativity as well as to everyone who wants an authoritative orientation in fundamental questions."

Another of Pauli's legacies to modern physics is his equally highly esteemed article on "The general principles of wave mechanics," in the *Handbuch der Physik* [(Springer, Berlin, 1958), vol. 5, part 1]. It would be of at least equal value to the large community of monolingual American physicists if this, too, were to find its way into English.

SIDNEY D. DRELL
Department of Physics,
Stanford University

Aircraft and Missile Propulsion. vol. 1, *Thermodynamics of Fluid Flow and Applications to Propulsion Engines.* 538 pp. Illus. $11.50. vol. 2, *The Gas Turbine Power Plant, Turboprop, Turbojet, Ramjet, and Rocket Engines.* 636 pp. Illus. $13. M. J. Zucrow. Wiley, New York; Chapman and Hall, London, 1958.

These two volumes represent a considerable step forward from the author's earlier book, *The Principles of Jet Propulsion and Gas Turbines* (Wiley, New York, 1948). Zucrow, a noted expert in jet propulsion and a teacher of many years' standing, has recognized that the practices of jet propulsion have moved forward in the past decade and require a more comprehensive treatment. This he has provided.

He has included rocket propulsion in these volumes, correctly categorizing it as a branch of jet propulsion. That rocket propulsion belongs in this category has not always been well understood by other authors, some of whom have tended to separate air-breathing and rocket jet propulsion.

Volume 1 consists of five chapters, of which the first is a review of fundamental principles. This is one of the more valuable chapters, since it allows the reader to go back and "brush up" on fundamental principles without referring to other volumes. Indeed, laudable as the inclusion of this chapter is, one wishes the author had made it even longer, to include, perhaps, more definitions—in particular of words such as *entropy*—and more background on compression and expansion processes in gases.

One of the very important problems facing the jet engine (and rocket engine) designer is that of heat transfer. Again, a separate chapter on the principles and practices of heat transfer would have been desirable. Indeed, since so much has been written on ballistic equations for space flight, and since other good treatises are available on solid-propellant rocket design, one wishes that the two chapters on ballistics and space flight in volume 2 could have been replaced by one very good chapter on the advanced principles of fluid mechanics and heat transfer.

Nevertheless, the author has vigorously and thoroughly covered (volume 1, chapters 2–5) the general characteristics of propulsion systems, the thermodynamics of compressible fluid flow (inclusion in this chapter of some of the theory and principles of shock tube phenomena would have been interesting), gas flow through nozzles, and flow through diffusers. In these later chapters, a more thorough treatment of rocket and jet-engine nozzle design would have been helpful. Some controversy and some empiricism are manifest in the rocket industry today in connection with the design of the exhaust nozzle. Some designers favor straight cones and other so-called "Prandtl" nozzles. It is true that Zucrow had no thought of catering to the designer (and this is proper), but at least a discussion of the gas flow phenomena in curved nozzles and of the related theory would have been helpful.

In volume 1 Zucrow has included many tables which contribute greatly to an understanding of the theory that he presents. I found his charts of isentropic compressible flow and his tables of conversion factors for dynamic viscosity most helpful.

There is, of necessity, some duplication of material in volumes 1 and 2, but the latter concentrates more on the practical problems of jet engines, covering gas turbine power plant cycles and analysis of ideal cycles (chapter 6); analysis of gas turbine power plants and the turbopropeller engine (chapter 7); and the turbojet engine (chapter 8). These three chapters are easily the most useful I have found in the literature, and section 9 (of chapter 9), on the turbojet engine, which deals with flight performance at the design point, is remarkable for its conciseness and thoroughness.

In chapter 9 the author devotes about 60 pages to the ramjet. This important power plant, somewhat neglected in the literature, warrants all the description and analysis possible. Indeed, the chapter might have been rounded out a bit with a review of actual problems met in the last few years and discussion of the application of ramjets in the field of missile propulsion. There are some interesting variants of the ramjet and turbojet engines called turborockets and ramrockets. It is true that the author concentrates on fundamental principles as much as possible, but a description, at least, of these power plants would have been desirable. Perhaps this will be included in volume 3.

Perhaps the largest single instance of increase in text material over the earlier book on jet propulsion occurs in chapter 10, "Rocket jet propulsion." Some of the nomenclature and standard expressions—for example, "specific impulse"—reflect the author's earlier work and show that standardization of symbols and terms in the field of rocket propulsion has not yet been achieved. I had to refer continuously to the principal notation at the beginning of the chapter (this notation covers more than two pages and is somewhat labored) in order to understand the equations or at least the terms the author has used in this chapter. The last section of the chapter, on questions of space travel and the multistage rocket, covers only eight pages and might as well have been left out, since, as was stated before, there are more voluminous books available on these subjects. Similarly, the author, in trying to cover as wide a field as possible, has included (section 8, chapter 10) a review of interior ballistics of solid-propellant rocket motors. While this material is useful, it might have been better used for, say, a thoroughly theoretical treatment of rocket combustion, particularly in one of the author's pet fields, combustion instability.

Six tables on enthalpies, rocket propellant properties, and equilibrium constants complete this volume.

In general, despite the minor shortcomings I have noted, these two volumes are a most useful addition to the library of the engineer and designer who wants to get a good understanding of jet propulsion principles without having to refer to a vast number of treatises on the subject.

KURT R. STEHLING
Naval Research Laboratory,
Washington, D.C.

Hydrogéologie. Introduction à l'étude des eaus destinées à l'alimentation humaine et à l'industrie. P. Fourmarier. Masson, Paris; Vaillant-Carmanne, Liége, Belgium, ed. 2, 1958. 294 pp. Illus. Paper, F. 3000.

This book is the second edition of a well-known textbook of hydrogeology (or ground-water geology) which was published originally in 1939. Although the present edition contains only ten pages more than the previous edition, an expansion of about 20 percent has been accommodated by use of smaller