was then freed from pneumopolysaccharide by a precipitation or salting out method. The resulting free modified gamma globulin ("purified antibody") was found to precipitate type III pneumopolysaccharide *in vitro* but gave negative reactions with type I or type VIII polysaccharide. The modified gamma globulin would also agglutinate type III pneumococci *in vitro* but not types I or II. Mouse protection tests and swelling tests have not yet been carried out.

The earlier Russian attempts to synthesize specific antibodies were mainly undertaken for their theoretical interest, since substitution of relatively low titer artificial antibodies for high titer natural immune serums was of little clinical promise. With the wide use of human plasma banks at the present time, however, practical interest is aroused. If a conversion of normal human plasma globulins into immune globulins is feasible, artificial immune human plasma banks may become a subject of future clinical research. In this eventuality the California biochemists will have rendered a distinct service to clinical medicine by suggesting a definite chemical theory to replace the tentative metaphors of the earlier immunologic theorists.—*Journal of the American Medical Association.*

# SCIENTIFIC BOOKS

## THE FOURIER SERIES

*Fourier Series and Orthogonal Polynomials.* Number Six of the Carus Mathematical Monographs. By DUNHAM JACKSON. viii + 234 pages. Chicago: Open Court Publishing Company. 1941.

THE topics dealt with in the above monograph bulk large both in the literature of pure and of applied mathematics. The study of Fourier series and related developments in orthogonal functions, together with their application to problems of mathematical physics, dates back to the middle of the eighteenth century. Such study has had a continuous development since that time at the hands of many mathematicians of first rank, as well as lesser lights, and continues to be a live and important part of current mathematical research.

In preparing a book of moderate size on subject-matter of such scope which will be within the comprehension of readers having an adequate grasp of the calculus, the problem of selection of material is a difficult one. No two writers would be likely to make precisely the same selection, but the reviewer agrees in the main with the judgment of the author. The theory of Fourier series itself is dealt with in sufficient detail to enable the reader to appreciate the analytic difficulties that arise in justifying mathematically the formal solutions of the important boundary problems in mathematical physics. Other developments of greater complexity, such as the Legendre and Laplace series and the developments in Bessel functions are naturally treated with less detail but are dealt with in such a manner as to exhibit their analogy with trigonometric series.

In most cases the rigorous treatment of the properties of the development in question, needed to justify the formal solutions of the physical problems, are available in other literature cited by the author when not given in the book. An exception is found in the case of the developments in Bessel functions. One would naturally expect that reference to a work of such an encyclopedic character as Watson's "Theory of Bessel Functions" would cover this point, but this is not the case. For most of the standard boundary value problems, the uniform convergence (or the uniform summability by some regular method) of the development in the neighborhood of the origin is needed to justify the formal solutions. Such uniform convergence and uniform summability have been established in two papers by the reviewer.[1] They can not be inferred from the discussion of convergence and summability in Watson's treatise or from other standard discussions of these questions.

From the standpoint of readers of SCIENCE who are more interested in the application of the theory of orthogonal functions to the solution of boundary value problems of mathematical physics than in the mathematical refinements of the subject, a valuable feature of the book is found in the rapid but elegant approach to such application that is found in Chapters IV and V. It is quite feasible to begin with these chapters and take up later the more delicate questions of analysis that are involved. The references to preceding chapters that are contained in the chapters in question facilitate such a process.

It is natural to expect that in a book on orthogonal functions by one of the leading authorities on orthogonal polynomials a considerable percentage of space would be devoted to the theory of such polynomials, and this is the case. In addition to the discussion of Legendre polynomials, to which reference has been made, there is a chapter on the general theory of orthogonal polynomials, followed by separate chapters on Jacobi polynomials, Hermite polynomials and Laguerre polynomials, and a chapter on the convergence of developments in such functions. In the discussion of Hermite and Laguerre polynomials applications are given which connect up with Schrödinger's wave equation.

To sum up the book as a whole, it can be regarded

[1] Transactions of the American Mathematical Society, Vol. XII (1911) and Vol. XXI (1920).

as an admirable solution of the difficult problem faced by the author: namely, to present an introduction to a vast theory with deep roots in both pure and applied mathematics, that would be intelligible to readers without great mathematical sophistication. A proper balance between formal applications and rigorous analysis has been maintained, and the approach in general has the clarity and elegance that one has come to expect from this particular author. For those who wish to begin the study of the field in question or for those who wish to prepare an introductory course on the subject, the book is equally useful. And we may add that the more sophisticated readers interested in the field will also find many items worthy of their attention, and many important unifications.

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## HYDROLOGY

*Hydrology*. Edited by OSCAR E. MEINZER. xi + 712 pp. New York: McGraw-Hill Book Company.

THIS book, which is the latest addition to a series of monographs sponsored by the National Research Council, eight of which have been previously issued, each treating of a particular phase of the physics of the earth, treats of water as it comes from the atmosphere to the surface of the earth in the form of rain and snow, passes over and through the crust of the earth as surface water and ground water and returns again by evaporation and transpiration to the atmosphere in a never-ending cycle, now commonly known as the hydrologic cycle. On the enormous and continuous exchange of water and water vapor between the land and water surfaces of the earth and its atmosphere, which constitutes that cycle and which is comparable in average magnitude with the combined flood discharges of 200 rivers of the size of the Mississippi, man is absolutely dependent for vital supplies of fresh water. Although he is interested in that portion of the cycle related to the ocean which is invaluable to him for purposes of transportation, which furnishes much of the water of evaporation that is later precipitated on the land and which affects in other ways the climates of the land surfaces and, therefore, his comfort and happiness, his greatest interest in the water of the hydrologic cycle relates to that portion of it which falls on the land and is used by vegetation or is possibly available for many human uses as it flows over and through the crust of the earth in the form of surface water and ground water. That portion, which is replenished by precipitation and depleted by evaporation, is complicated by diversities in topography and vegetation of the earth's surface, by variations in porosity of soils and rocks and by the activities and works of man. It is to that complicated portion of the cycle that the major part of the book is devoted, and properly so, since man's interest in the hydrologic cycle and the science of hydrology will continue to be excited, as it has been in the past, by their relation to the practical problems associated with the use of water rather than by the theories related to an abstract science.

In the introductory chapter, Dr. Meinzer defines the science of hydrology, outlines the phases of the hydrologic cycle and its relation to the problems of human life and traces the history of that science from its birth in the false concepts of the ancients, through the gradual development of the present rational and practical science, as a progressive growth resulting from the work of many students of the last 300 years. With his characteristic modesty, Dr. Meinzer has failed to mention, except casually, his own important contributions to those phases of the science that relate especially to the measurement, recharge and recovery of the water that is stored in or flows through the ground—a phase of the hydrologic cycle that is of relatively minor magnitude but is of major value to man.

Each subsequent chapter has been prepared by an expert in the phase that he discusses. Precipitation is presented by Merrill Bernard; the reverse processes of evaporation and transpiration are presented by Sidney T. Harding and Charles H. Lee. The courses and progress of flow of water over and through the crust of the earth are presented under several topics: snow, ice and glaciers are discussed by James E. Church and François E. Matthes; characteristics of surface runoff, by Adolph F. Meyer, Charles H. Pierce, LeRoy K. Sherman, William G. Hoyt, Royal W. Davenport, Clarence S. Jarvis and Walter B. Langbein; storage and control of water, by William G. Hoyt; prediction of runoff, by Royal W. Davenport; ground water and its movement, by Oscar E. Meinzer and Leland K. Wenzel; infiltration, by LeRoy K. Sherman and George W. Musgrave; soil moisture, by Karl v. Terzaghi and Leonard D. Baver; physical changes produced in and by water, by William H. Twenhofel, Harry R. Leach, Lorenz G. Straub, Charles S. Howard and Margaret D. Foster; and special conditions produced in limestone, by Allyn C. Swinnerton, and in lava rock, by Harold T. Stearns.

The volume as a whole constitutes an authoritative presentation of the present knowledge of the science of hydrology and of the hydrologic cycle whose continuity and reasonable uniformity in action at any place are of major importance. Man has been dependent, at all stages of his development, on the availability of supplies of water, first, for domestic use and later, for transportation, irrigation, generation of power, industrial-process uses and, finally, for air conditioning. What future new uses for water may arise, no one can predict in detail. If, however, a reliable