FOREWORD

The topic with which I regularly conclude my six-term series of lectures in Munich is the partial differential equations of physics. We do not really deal with mathematical physics, but with *physical mathematics;* not with the mathematical formulation of physical facts, but with the physical motivation of mathematical methods. The oft-mentioned "prestabilized harmony" between what is mathematically interesting and what is physically important is met at each step and lends an esthetic — I should like to say metaphysical — attraction to our subject.

The problems to be treated belong mainly to the classical mathematical literature, as shown by their connection with the names of Laplace, Fourier, Green, Gauss, Riemann, and William Thomson. In order to show that these methods are adequate to deal with actual problems, we treat the *propagation of radio waves* in some detail in Chapter VI.

Chapter V deals with the general method of *eigenfunctions.* The most spectacular domain of application of that method is *wave mechanics*, as we show here with the help of some selected, particularly simple examples. The mathematically rigorous foundation of the existence and the properties of eigenfunctions with the help of theorems about integral equations cannot be given here; the latter are mentioned only occasionally as the counterpart of the corresponding theorems on differential equations.

Chapter IV on *Bessel functions* and *spherical harmonics* is comparatively lengthy despite a development that is as concise as possible. For the sake of brevity we have relegated some proofs to the exercises, as we have also done in other chapters. A special section is dedicated to the beautiful *method of reciprocal radii* and to the demonstration of the fact that it unfortunately cannot be applied to other than potential problems.

Chapter III deals exclusively with the classic problem of heat conduction. In addition to the Fourier method we develop in detail the intuitive method of *reflected images* for regions with plane boundaries. Chapter II deals with the different types of differential equations and boundary value problems; *Green's theorem* and *Green's function* are introduced in considerable generality.

Chapter I about Fourier series and integrals is based throughout on the *method of least squares.* If the latter is complemented by a requirement which we called "the condition of finality," then we can replace the more formal computations of the older developments in a complete and generalizable way, not only in the trigonometric case but also for spherical harmonics and general eigenfunctions.

As is seen from this survey, the arrangement of the material is determined not by systematic but by didactic points of view. Chapter I intends to put the reader in the midst of the methodology of the Fourier and the Fourier-like expansions. Only in Chapter II do we start to introduce the concepts from the theory of partial differential equations that are of the greatest importance for the mathematical physicist. From a systematic point of view Chapter III would be subordinated to the general methods of Chapter V but it precedes it for historic and didactic reasons. The lengthiness of Chapter IV may be justified by the fact that a large part of the material contained in the textbooks on Bessel functions and spherical harmonics is at least sketched there, and is put in readiness for application. The formal mathematical part is interrupted for didactic reasons for both classes of functions by typical examples of applications.

It is obvious that this material could not be presented completely in a short summer term. In fact several mathematically more complicated sections have been added in print, some of these in the form of appendixes. In this connection we wish to mention Appendix II to Chapter V, which was added only after the completion of the rest of the manuscript and which is likely to be of fundamental importance for problems dealing with the intermittent range between short waves and long waves, that is, for the passage from geometrical optics to wave optics.

In the preparation of the manuscript I was able to rely on the lecture notes of R. Schlatterer for 1935, as well as on earlier notes of Professor J. Meixner. My friend F. Sauter critically perused the entire manuscript and has also been most generous in giving me his own improved version on many points. I owe him more than I can point out in the text. My colleague, J. Lense, examined the manuscript from the mathematical point of view. Dr. F. Renner collaborated on the last chapter especially; H. Schmidt advised me on the arrangement of the material.

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[*Publisher's note:* This is a translation of Sommerfeld's "Lectures on Theoretical Physics," Volume VI. Translations of Volume I entitled, "Mechanics," and Volume II entitled, "Mechanics of Deformable Bodies," are in preparation. In this text they are referred to as v. I and v. II.]