Books

Basic Methods in Transfer Problems—Radiative Equilibrium and Neutron Diffusion. By V. Kourganoff with the collaboration of I. W. Busbridge. 281 pp. Oxford University Press, London and New York, 1952. $7.00.

This book deals with the mathematics and, to a somewhat lesser extent, the physical foundation of a restricted form of the Milne problem, i.e., the problem of the steady-state flow of radiation in a stellar atmosphere. The atmosphere is treated as infinitely deep, stratified in homogeneous, plane-parallel layers, devoid of energy sources, and in local thermodynamic equilibrium (or purely scattering). Scattering, if present, is assumed isotropic. Many of the results are applicable to the steady-state efflux of neutrons from a (nonabsorbing and nonmultiplying) scattering medium of large dimensions; and, in turn, some of the mathematical methods described were developed in neutron diffusion studies.

Chapter I discusses the physical foundations of radiative transfer, the definitions and interrelations of various quantities in the theory, the derivation of the equation of transfer and of the Milne integral equations, and their interpretation for neutron-transfer problems. Chapter II is concerned mainly with derivation of a large number of mathematical relations containing the integral operators of the Milne equations and the Laplace transformation.

The next four chapters, comprising the main part of the book, deal with the integrated radiation (i.e. integrated over frequencies) in the grey case. Here the absorption coefficient is assumed independent of the frequency of the radiation at each point; this is the case to which the Milne equations apply and to which the neutron problem is equivalent, for monoenergetic neutrons. All the principal methods (including approximate ones) that have been used for calculation of the Milne problem are collected together and discussed in detail. Chief among these are: the Milne-Eddington approximations, the spherical harmonic method, the method of discrete ordinates (Wick, Chandrasekhar), variational methods, and exact methods (primarily that of Wiener and Hopf), and the work of the Montreal group (Placzek, Seidel, Marshak, Mark and Lecaine) on neutron diffusion.

Chapter VII treats the general nongrey stellar atmosphere, still under the assumption of local thermodynamic equilibrium of the matter. The discussion is somewhat sketchy, presumably because of the great complexity of the subject, but there are numerous references to the literature.

To have so many different approaches to the problem presented in so much detail, and with such a wealth of formulae, has advantages and disadvantages. It is an advantage, for example, that the many quantities which various workers have used to characterize radiation fields are defined and given physical interpretations in the first chapter, and that the physical assumptions inherent in their use are set forth there. The encyclopedic coverage of the work that has been done is also an advantage. On the other hand, the casual reader may find that differences in motivation, generality, etc. among the different approaches are sometimes obscured by so much detail. For example, in Chapter VI, *Methods Giving Exact Solutions*, there is a lengthy discussion of work of the Russian astrophysicist Ambarzumian and its relation to the Wiener-Hopf method. The impression is given that Ambarzumian has found a competitor to the Wiener-Hopf method for obtaining the exact solution. It appears, however, that this is not so—that Ambarzumian has merely transformed Milne's first equation into another (and nonlinear) integral equation. This integral equation appears to be better suited to numerical calculation than most other forms of the theory; this fact is, of course, very good to know, but one has the feeling that it could have been stated more succinctly, and that it hardly belongs in a chapter on exact solutions.

For applications to neutron diffusion, a few omissions are regrettable. In the discussion of the spherical harmonic method, the restrictions to a flat atmosphere, isotropic scattering, absence of sources, absence of absorption or multiplication, are unfortunate, and not really necessary, from the neutronic point of view. Perhaps even more serious conceptually is the restriction of the Wiener-Hopf method to the case of nonabsorbing, nonmultiplying media.

Two appendices give formulae and tables (for the most part not previously published) relating to special functions occurring in the theory, such as the functions obtained by applying the Milne and Laplace operations to general exponential integrals, the functions

$$M_0(\tau), \ N_0(\tau) = \int_1^\infty e^{-\tau t} \ln{(t \pm 1)} \frac{dt}{t},$$

and the integrals

$$\int_0^\infty E_n(t) E_m(t) dt.$$

There is a six-page bibliography.

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Marx and Science. By J. D. Bernal. 48 pp. International Publishers, New York, 1952. $1.00.

According to the blurb, "J. D. Bernal, the world-renowned English Crystallographer, analyzes and pays tribute to Marx's contribution to mathematics, tech-