EDITED BY
C. DEWITT / B. DREYFUS / P.G. DE GENNES

low-temperature physics

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Conduction Electrons — Superconductivity
Helium — Magnetism — Mössbauer Effect
Defects and Irradiation

LECTURES DELIVERED AT LES HOUCHES
DURING THE 1961 SESSION OF THE
SUMMER SCHOOL OF THEORETICAL PHYSICS
UNIVERSITY OF GRENOBLE

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Cécile DeWitt

Directrice, Ecole d'été de Physique Théorique

Les Houches

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The Dynamics of Conduction Electrons

The course which follows is not a systematic course in the theory of metals; it is not even a systematic course on transport phenomena in metals. This would involve considerable discussion of mathematical methods and I should not dare to instruct would-be theoreticians in the technical mysteries of their craft. But I hope in the following pages to reveal the physical processes involved in electronic phenomena by the use of only elementary mathematics. Necessarily there are approximations and crudities, but these can be corrected by more sophisticated treatments when the necessity arises. For the most part I think my semi-classical methods are adequate as working tools, and sufficiently close to the experimenter's view of the problem to keep the discussion firmly tied to the brute facts whose elucidation is the ultimate aim. Some of the topics are essentially straightforward and have always been recognized as such. Others, such as spatially varying fields and acoustic attenuation, are not yet part of the standard curriculum. Yet others, particularly the de Haas—van Alphen effect and galvanomagnetic phenomena, have in the past been peculiarly the preserve of professional theorists and reputedly difficult to understand. But the development in recent years of a more geometrical approach to these problems (the approach which sees a surface of constant energy in k-space as a shape in its own right, and not simply the solution of an equation $\varepsilon(k) = \text{const.}$) has made it possible to strip the theory of many unnecessary pretensions and to disclose a basic structure which is not too incomprehensible. It is said that Plato wrote above the door of his Academy "Let none ignorant of geometry enter." This I too would choose as my motto. Not that I wish to return to the language of Newton's Principia or ask the student to recollect what he used to know of Projective Geometry; but I wish him to think of shapes and connections, and to picture the trajectories of electrons as lines in space and not as solutions of a differential equation, in short to be a geometer rather than an analyst. It may be that ultimately he will find that he must formulate his problems analytically in order to obtain a complete solution. I cannot help him here; but I hope I can help in the preliminary stages of his work to see what sort of solution he may look for.

I have found sufficient material for a long course of lectures in this special approach to the subject, and am very conscious of the lack of balance which has resulted. I have touched only lightly, and I fear imperfectly, on many topics of fundamental importance, such as the nature of the wave-functions of conduction electrons, and the difficulties of calculating them from first prin-