

1

INTRODUCTION

A. PREPARATION AND TEXTS

The subject of these lecture notes is "Concepts in the Theory of Solids"—in point of fact I should have said "in the *Quantum* Theory of Solids," because there is very little of our understanding of the properties of matter which does not depend to some extent on the quantum theory. Some acquaintance with the quantum theory will be necessary: a certain understanding of the matrix formalism and transformation theory as well as of elementary wave mechanics. For instance, time-dependent perturbation theory and operator equations of motion will be used without much further explanation but not techniques of modern field theory; these will be, if necessary, derived from scratch.

What preparation in the solid-state area is necessary is determined by the intent of this course, which is not to survey the phenomenology of the properties of solids but to go somewhat more deeply into what is behind these properties. In many cases, this means that we shall try to understand *why* solids behave as they do, but in many others of course—perhaps more—we shall simply be coming to the questions at which our real understanding fails. It will then, clearly, be a great help to have a reasonably wide knowledge of what the properties of solids are. Kittel's "Introduction to Solid State Physics" (1) is an excellent text which surveys the field on a level preparatory to what will be said. In other words, some familiarity with such concepts as Debye T^3 specific heat, Brillouin zones, free-electron specific heat or spin paramagnetism, electron or nuclear paramagnetic resonance, and others of the more or less standard theoretical ideas and experimental techniques will be assumed. No texts have even attempted to cover solid-state theory as a whole at any basic level since Seitz in 1940 completed "Modern Theory of Solids" (2); and that is in fact by far the best text still. This may indicate that we have not made much progress since 1940 in basic understanding, only in investigating much wider classes of phenomena, which is to some extent true. In any case, the only answer so far found to the problem of modernizing the "Modern Theory" has been to issue a series of books containing review articles, the so-called