
Contents

| | |
|--|----|
| 1. Introduction | 1 |
| 1.1 General Remarks..... | 1 |
| 1.2 Elementary Considerations..... | 5 |
| a. Atomic States..... | 5 |
| b. Vibrational Motion..... | 9 |
| 1.3 Concept of the Exciton..... | 12 |
| a. The Tight-Binding Approximation..... | 12 |
| b. Effective Mass Approximation..... | 15 |
| 1.4 Summary..... | 23 |
| | |
| 2. Energy Transfer in Atomic Systems | 24 |
| | |
| 2.1 Introduction..... | 24 |
| 2.2 Optical Processes at Point Defects..... | 26 |
| 2.3 Resonance Transfer..... | 29 |
| 2.4 Other Mechanisms for Transfer..... | 37 |
| 2.5 Summary..... | 38 |
| | |
| 3. Formal Exciton Theory | 40 |
| | |
| 3.1 General Formalism..... | 40 |
| a. The Crystal Ground State..... | 40 |
| b. Excited States of the Crystal..... | 44 |
| 3.2 The Frenkel Model..... | 46 |
| a. General..... | 46 |
| b. Effects of the Transfer-Matrix Element..... | 48 |
| c. Davydov Splitting..... | 50 |
| 3.3 The Wannier Model..... | 51 |
| a. The Coupled Effective-Mass Electron and Hole..... | 52 |
| b. Wannier Exciton in Static Electric and Magnetic Fields..... | 54 |
| c. Corrections of the Simplified Model..... | 56 |
| 3.4 Intermediate Cases—Conclusions..... | 58 |
| Appendix..... | 60 |

| | |
|---|------------|
| 4. The Process of Optical Absorption | 63 |
| 4.1 The Lorentz Model..... | 64 |
| 4.2 Exciton Theory of Absorption..... | 71 |
| 4.3 Phonons and Polaritons..... | 79 |
| 4.4 Indirect Transitions..... | 85 |
| 4.5 Summary..... | 87 |
| 5. Energy Transport by Excitons | 89 |
| 5.1 Introduction..... | 89 |
| 5.2 Imperfections in Solids..... | 89 |
| 5.3 Scattering of Excitons..... | 93 |
| 5.4 Detection of Excitons..... | 96 |
| 6. Special Excitons | 106 |
| 6.1 Trapped Excitons..... | 106 |
| 6.2 High-Energy Excitons..... | 109 |
| 6.3 Excitons in Metals..... | 111 |
| 6.4 Excitons in Glasses and Liquids..... | 112 |
| 6.5 Longitudinal Excitons..... | 112 |
| 6.6 "Metastable" Excitons..... | 113 |
| 6.7 Generalized Excitons..... | 114 |
| 7. Current Topics | 116 |
| 7.1 Two-Photon Processes..... | 116 |
| 7.2 Two-Exciton Processes..... | 119 |
| 7.3 Exciton Statistics..... | 121 |
| 7.4 Urbach's Rule..... | 125 |
| 7.5 Spatial Dispersion..... | 130 |
| 7.6 Formal Theoretical Progress..... | 132 |
| 7.7 Summary of the Tract..... | 133 |
| Subject Index..... | 137 |