Theory of Superconductivity is considered one of the best treatments of the field. This monograph, by Nobel Prizewinning physicist J. Robert Schrieffer, has been reprinted because of its enduring value as the introduction to the theory of superconductivity. Based on a series of lectures presented by the author at the University of Pennsylvania, the fundamentals of the microscopic theory of superconductivity are stressed as a means of providing the reader with a framework for the literature in which detailed applications of the microscopic theory are made to specific problems. It also serves as a foundation for the more recent developments in this active field.

The author has developed a number of the formal techniques found in the literature to describe pairing correlations basic to superconductivity. For the most part, only a standard graduate course in quantum theory is required to understand the techniques of quantum mechanics used.

J. Robert Schrieffer received his B.S. from MIT. He continued his studies at the University of Illinois, where along with Professors John Bardeen and Leon Cooper he developed the theory of superconductivity. He continued his work as a fellow at the University of Birmingham and the Niels Bohr Institute in Copenhagen. Following work at the Universities of Chicago and Illinois, Schrieffer won the Nobel Prize in 1972 for his work in superconductivity, sharing the honor with Bardeen and Cooper. He was a professor of physics at the University of California, Santa Barbara, and is currently Eminent Scholar Professor at Florida State University and Chief Scientist of the National High Magnetic Field Laboratory.

Cover design by Suzanne Heiser

ABOUT THE ADVANCED BOOK CLASSICS:

Read and cited by scientists and mathematicians worldwide, Advanced Book Classics are works that continue to inform today's groundbreaking research efforts. Redesigned and newly released in paperback, these graduate-level texts and monographs are now available to an even wider audience. Written by the most influential physicists of the twentieth century, these Advanced Book Classics promise to enrich and inspire a new generation of physicists.



Advanced Book Program

WESTVIEW PRESS

5500 Central Avenue • Boulder, Colorado 80301-2877
12 Hid's Copse Road • Cumnor Hill • Oxford OX2 9JJ
www.westviewpress.com

CONTENTS

Editor's Foreword	vii
Preface	xv
Preface to the Revised Printing	xvii
CHAPTER 1 INTRODUCTION	1
1-1 Simple Experimental Facts	4
1-2 Phenomenological Theories	9
rights from the second of the second	
CHAPTER 2 THE PAIRING THEORY OF SUPERCONDUCTIV	VITY 24
2-1 Physical Nature of the Superconducting State	24
2-2 The One-Pair Problem	28
2-3 Landau's Theory of a Fermi Liquid	34
2-4 The Pairing Approximation	36
2-5 Quasi-Particle Excitations	44
2-6 Linearized Equations of Motion	49
2-7 Concluding Remarks	57

x Contents

CHAP	TER 3 APPLICATIONS OF THE PAIRING THEORY	6			
3-1	Justification of the Pairing Hypothesis	6			
3-2 Acoustic Attenuation Rate 3-3 Nuclear-Spin Relaxation Rate					
3-5	The concrete Tactors	72			
3-6		78			
3-7	Other Applications of the Pairing Theory	87			
Снарт	TER 4 ELECTRON-ION SYSTEM	89			
4-1					
4-2	Bare Phonons	92			
4-3	Bare Electrons	95			
4-4	Bare Electron-Phonon Interaction	98			
4-5		102			
Снарт	MANY-BODY PROBLEM	103			
5-1	The Schrödinger, Heisenberg, and				
= 0	Interaction Pictures	103			
5-2 5-3	The Green's Function Approach	105			
	The Free Fermi Gas	108			
5-4 5-5	Spectral Representation of $G(\mathbf{p}, \tau)$	112			
5-6	Analytic Properties of G	115			
5-7	Physical Interpretation of $G(\mathbf{p}, p_0)$	116			
5-8	Interpretation of $A(\mathbf{p}, \omega)$	119			
5-9	The One-Phonon Green's Function	124			
9-9	Perturbation Series	126			
Снарт	ER 6 ELEMENTARY EXCITATIONS IN NORMAL METALS	137			
6-1	The Electron Gas with Coulomb Interactions	137			
6-2	The Coupled Electron-Phonon System	148			

	Contents	xi		
Снарт	ER 7 FIELD-THEORETIC METHODS APPLIED TO			
	SUPERCONDUCTIVITY	164		
7-1	Instability of the Normal Phase	164		
7-2	Nambu-Gor'kov Formalism	169		
7-3	Zero-Temperature Excitation Spectrum	180		
7-4	Extension to Finite Temperature	193		
Снарт	ER 8 ELECTROMAGNETIC PROPERTIES OF			
	SUPERCONDUCTORS	203		
8-1	London Rigidity	203		
8-2	Weak-Field Response	206		
8-3	The Meissner-Ochsenfeld Effect	212		
8-4	Electromagnetic Properties for Finite q and ω	220		
8-5	Gauge Invariance	224		
8-6	The Vertex Function and Collective Modes	233		
8-7	Flux Quantization	240		
8-8	The Knight Shift	244		
8-9	The Ginsburg-Landau-Gor'kov Theory	248		
Concl	USION	254		
APPEN	DIX SECOND QUANTIZATION FORMALISM	257		
A-1	Occupation-Number Representation	257		
A-2	Second Quantization for Bosons	259		
A-3	Second Quantization for Fermions	265		
APPEN	DIX NOBEL LECTURES, 1972	267		
Mac	roscopic Quantum Phenomena from Pairing uperconductors			
J.	J. R. Schrieffer			
	roscopic Quantum Interference Effects in the bry of Superconductivity			
Le	eon N. Cooper	279		
	tron-Phonon Interactions and Superconductivity	300		

xii Contents

Notes	AND	REFERENCES

Transfer of the Name of the Name

INDEX

329

317