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# Superconductor Applications: SQUIDs and Machines

Edited by
Brian B. Schwartz and Simon Foner
*Francis Bitter National Magnet Laboratory*
*M. I. T.*
*Cambridge, Massachusetts*

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# PREFACE

This book includes small and large scale applications of superconductivity. Part I, SQUIDs, comprises about 75% of this volume, and is devoted to small scale applications, mainly Superconducting QUantum Interference Devices (SQUIDs), and the remainder, Part II, Machines, presents an updated review of large scale applications of superconductivity. The present book combined with the previous book Superconducting Machines and Devices: Large Systems Applications edited by S. Foner and B.B. Schwartz, Plenum Press, New York (1974) represents a detailed and most up-to-date review of the applications of superconducting technology. The text of the current book is suitable for advanced undergraduates or graduate students in applied physics and engineering courses. The book should be valuable to scientists, engineers and technologists interested in the current status and future applications of superconductivity technology. The last 7 chapters in Part I review the major national efforts on small scale technology and should prove useful for industrial and government planners as well as scientists and engineers.

This book is based on a NATO Advanced Study Institute entitled "Small Scale Applications of Superconductivity" which was held from 1 September to 10 September 1976 in Gardone Riviera on Lake Garda in Northern Italy. This Study Institute complements a previous NATO Advanced Study Institute held in 1973 on Large Scale Superconducting Devices. As with the previous Institute, the focus of the lecturers and the present book involves both applications as well as the scientific principles. Part I, the major part of the present book, treats small-scale applications of superconductivity; and Part II contains an updated review of large scale applications. Part II, together with the previous NATO Institute book (Superconducting Machines and Devices: Large Systems Applications) gives a thorough coverage of large scale applications of superconductivity up to 1977.

Part I provides reviews of all the major principles and devices of small scale superconductivity. The opening chapter by Sir Brian Pippard gives a personal review of some of the historical highlights of superconductivity from the 1930's through the 1960's. Professor Pippard was Brian Josephson's thesis advisor at Cambridge and places Josephson's discovery within the context of the rapid theoretical and experimental developments in superconductivity in the late 1950's and early 1960's.

Chapters 2-6 discuss the basic principles of macroscopic quantum interference phenomena and weak links, superconducting quantum interference devices (SQUIDs), equivalent circuits and analogs, superconducting devices for metrology and standards, and high frequency applications of Josephson Junctions. Chapters 7 - 12 involve special topics including reviews of junction fabrication techniques, biomagnetism applications, status of commercial instruments in the United States, resistive superconducting devices, nonequilibrium properties of superconductors, and application of SQUIDs to computers. The last 7 chapters of Part I (13 - 17) in this book continue an innovation we introduced in the 1973 NATO Institute proceedings; reviews of national efforts. These reviews for Canada, France, Germany, Italy, The Netherlands, United Kingdom and the United States give an up-to-date summary of the current programs in the area of small scale devices. Part II, Chapter 20 presents a thorough review of Large Scale Applications of Superconductivity. (For convenience we have subdivided the subject index into two parts, Index Part I – SQUIDs, Index Part II – Machines.)

The 1976 NATO Institute which resulted in the present volume involved planning which dates back to the 1973 NATO Institute. We were fortunate in having a very effective advisory committee which helped us with the planning. Dr. Edelsack of the Naval Research Laboratory helped us throughout the planning of the Institute. We also profitted from many useful suggestions by S. Shapiro, University of Rochester, A. Baratoff, IBM Zurich, and A.D. Appleton, IRD, England, throughout the planning of the Institute. Members of our International Advisory Committee included R. Adde, G. Bogner, I. Giaever, B. Josephson, R.A. Kamper, C. Rizzuto, and K. Saermark.

We wish to thank Dr. T. Kester and Dr. M. Di Lullo, from the NATO Scientific Affairs Division for their continued interest and encouragement, and the NATO Science Council for their support of the Advanced Study Institute. We also wish to thank the National Science Foundation for Travel Grants to three students.

In addition to the lecturers, the NATO Institute had approximately 95 participants from 23 countries. Professor Carlo Rizzuto was the Local Chairman. He and his associates at the University of Genoa gave continuous help in all aspects of the planning and operation of the Institute. Professor Cerdonio of the University of Rome with Professor Rizzuto helped us to choose the site of the Institute. We would like to thank the Gardone Riviera region, the town of Salo, and the Lake region tourist agency for their hospitality.

We received excellent cooperation from all the lecturers, and we wish to thank them for their excellent talks and prompt completion of the manuscripts. Their cooperation in meeting our deadline dates has allowed us to adhere to a very tight publication schedule. We apologize to all the lecturers for the many demands we made, and wish to thank each of the lecturers for their dedication to the Institute. The success of the Institute required the continued cooperation of each lecturer before, during, and after the Institute. In addition to our personal thanks, we hope that the response of the students at the Institute and the present volume justifies their efforts. In return, we have attempted to set a record in rapidly publishing these contributions.

We would especially like to thank Dr. G. Bogner, Siemens for his review lectures on Large Scale Applications which comprise Part II of these Proceedings. His lectures and notes gave the participants a broad perspective of many additional areas of superconductor applications which are not normally encountered in Small Scale Applications.

We would like to thank R.B. Frankel for his help with the Institute. We would also like to thank Mary Filoso, Michael McDowell, Delphine Radcliffe and Nancy Brandon for helping with the typing and correcting of these manuscripts. We particularly wish to thank Mary Filoso who, as in 1973, was closely involved with the planning and execution of the Institute and Proceedings. Her experience and continued attention to the Institute arrangements and the present book were invaluable.

Cambridge, Massachusetts

October 1976

Brian B. Schwartz
Simon Foner

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