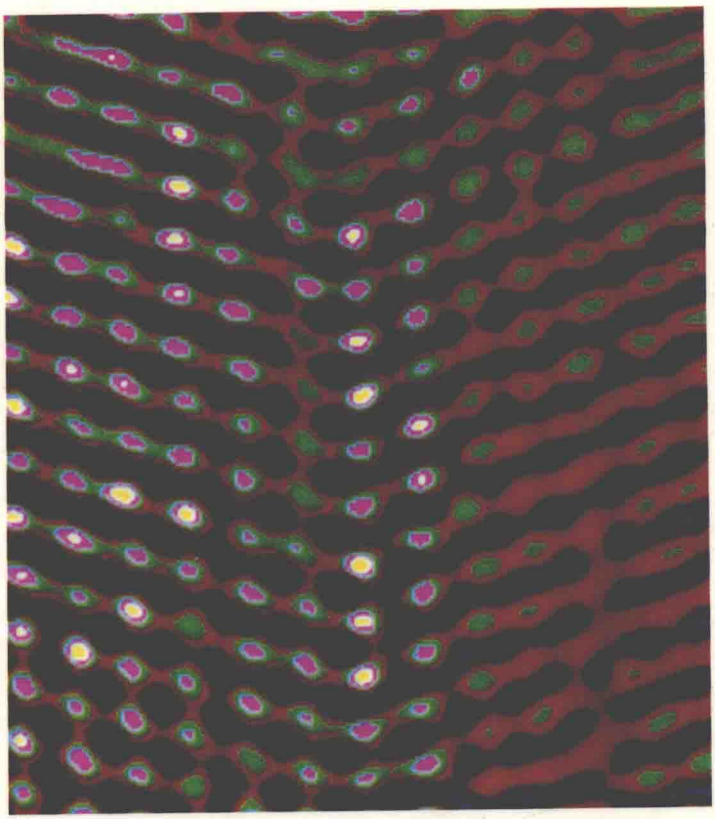
PHYSICS THROUGH THE 1990s



Condensed-Matter Physics

PHYSICS THROUGH THE 1990s

Condensed-Matter Physics

Panel on Condensed-Matter Physics
Physics Survey Committee
Board on Physics and Astronomy
Commission on Physical Sciences, Mathematics, and Resources
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Preface

In this survey of condensed-matter physics we describe the current status of the field, present some of the significant discoveries and developments in it since the early 1970s, and indicate some areas in which we expect that important discoveries will be made in the next decade. We also describe the resources that will be required to produce these discoveries.

Condensed-matter physics is divided roughly into two broad subareas devoted, respectively, to solids and to liquids. In this volume the subarea of solids is subdivided into several subfields, including the electronic properties of solids, their structures and vibrational excitations, critical phenomena and phase transitions, magnetic properties of solids, semiconductors, defects and diffusion, and surfaces and interfaces. The subarea of liquids is divided into the subfields of classical liquids, liquid crystals, polymers and nonlinear dynamics instabilities, and chaos. The subareas of solids and liquids are roughly linked by the subfield of low-temperature physics, which is concerned with phenomena occurring in both of them. This subdivision of condensed-matter physics reflects the manner in which the community organizes itself, through its conferences, workshops, and seminars.

Each of the subfields was reviewed by a member of the community working in that subfield, chosen both for technical expertise and scientific breadth who, in general, had the assistance of many other members of that community. These reviews of the subfields of con-

densed-matter physics were supplemented by reviews of the new materials that are exciting interest because of the unusual physical properties that they display and the opportunities for technological applications that they may afford, of new experimental techniques whose use has led to remarkable discoveries, and of the National Facilities that have provided researchers in condensed-matter physics with capabilities beyond those available in their own institutions. These reviews were also prepared by experts in the corresponding subject areas.

This volume is organized as follows. Part I is devoted to a discussion of the importance of condensed-matter physics; to brief descriptions of several of the most significant discoveries and advances in condensed-matter physics made in the 1970s and early 1980s, and of areas that appear to provide particularly exciting research opportunities in the next decade; and to a presentation of the support needs of condensed-matter physicists in the next decade and of recommendations aimed at their provision. In Part II, the subfields of condensed-matter physics are reviewed in detail. The volume concludes with several appendixes in which new materials, new experimental techniques, and the National Facilities are reviewed.

As one reads through this volume, one cannot help being struck with the conclusion that condensed-matter physics is an intellectually exciting field of physics in which discoveries have had, and are continuing to have, significant impacts on other fields of physics, as well as on chemistry, mathematics, and the biological sciences. At the same time, it is the field of physics that has the greatest impact on our daily lives through the technological developments to which it gives rise. It has witnessed a decade in which remarkable discoveries and advances in our understanding of the condensed states of matter have been made. It is currently experiencing a period of intensive activity in existing subfields and growth of new subfields, and it offers the promise of significant new discoveries and advances in the decade to come. However, research in condensed-matter physics at a world-class level today is becoming increasingly sophisticated in both theoretical and experimental techniques. With this increasing sophistication is associated a rapidly increasing cost of doing research, in dollars and in manpower, which must somehow be met if the opportunities facing this field are to be achieved. This is a challenge that together with the opportunities will be facing condensed-matter physics in the United States in the next decade.

Finally, I am grateful for the technical contributions of the members of the Panel on Condensed-Matter Physics and for their assistance in

drafting the recommendations made in this report. In addition, I want to thank the many members of the U.S. condensed-matter physics community who contributed to every part of this survey, either by writing parts of it or by reading it and making suggestions for its improvement. They are listed at the end of this volume. Their valuable contributions are greatly appreciated.

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