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Frank Pobell

Matter and Methods at Low Temperatures

Second Edition

With 197 Figures, 28 Tables
and 77 Problems



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Preface

It has been a great pleasure for me to see this book – very often several copies – in almost every low-temperature laboratory I have visited during the past three years.

Low- and ultralow-temperature physics continue to be lively and progressing fields of research. New results have emerged over the four years since publication of the first edition of my monograph. The second edition contains relevant results particularly on thermometry and materials properties, as well as many additional references. Of course, typographical errors I had overlooked are now corrected. I am grateful to J. Friebel for checking and solving the problems I have included in this new edition. And, as for the case of the first edition, I again thank H. Lotsch for the very careful editing.

I hope that this lower-priced paperback edition will continue to be a valuable source for the research and study of many of my colleagues and their students.

Bayreuth
November 1995

F. Pobell

Preface to the First Edition

The aim of this book is to provide information about performing experiments at low temperatures, as well as basic facts concerning the low-temperature properties of liquid and solid matter. To orient the reader, I begin with chapters on these low-temperature properties. The major part of the book is then devoted to refrigeration techniques and to the physics on which they are based. Of equal importance, of course, are the definition and measurement of temperature; hence low-temperature thermometry is extensively discussed in subsequent chapters. Finally, I describe a variety of design and construction techniques which have turned out to be useful over the years.

The content of the book is based on the three-hour-per-week lecture course which I have given several times at the University of Bayreuth between 1983 and 1991. It should be particularly suited for advanced students whose intended masters (diploma) or Ph.D. subject is experimental condensed matter physics at low temperatures. However, I believe that the book will also be of value to experienced scientists, since it describes several very recent advances in experimental low-temperature physics and technology, for example, new developments in nuclear refrigeration and thermometry.

My knowledge and appreciation of low-temperature physics have been strongly influenced and enhanced over the years by many colleagues. In particular, I wish to express my thanks to my colleagues and coworkers at the Institut für Festkörperforschung, Forschungszentrum Jülich and at the Physikalisches Institut, Universität Bayreuth. Their enthusiasm for low-temperature physics has been essential for the work in our groups, and for many achievements described in this book. Among them I wish to mention especially R.M. Mueller, Ch. Buchal, and M. Kubota from the time at Jülich (1975-1983), K. Gloos, R. König, B. Schröder-Smeibidl, P. Smeibidl, P. Sekowski, and E. Syskakis in Bayreuth (since 1983).

Above all, I am deeply indebted to my colleague and friend Girgl Eska, who shares with me all the joys and sorrows of our low-temperature work in Bayreuth. He and Bob Mueller read the entire manuscript and made many important comments on it. I am also very grateful to Dierk Rainer for so often sharing with me his deep insight into the physics of many low-temperature phenomena.

It is a pleasure for me to thank Mrs. G. Pinzer for her perfect typing of the manuscript and Ms. D. Hollis for her careful copy-editing. Likewise, I

gratefully acknowledge the very thorough and time-consuming checking of the whole manuscript by Dr. H. Lotsch.

Finally, I thank the Institute for Physical Problems, USSR Academy of Sciences, where part of the manuscript was written, for the hospitality extended to me, and the "Volkswagen Stiftung" for a stipend which I held for some time while writing this book.

Bayreuth
September 1991

F. Pobell

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