Preface to the First Edition

Structural phase transitions constitute a fascinating subject in solid state physics, where the problem related to lattice stability is a difficult one, but challenging to statistical principles for equilibrium thermodynamics. Guided by the Landau theory and the soft mode concept, many experimental studies have been performed on a variety of crystalline systems, while theoretical concepts acquired mainly from isotropic systems are imposed on structural changes in crystals. However, since the mean-field approximation has been inadequate for critical regions, existing theories need to be modified to deal with local inhomogeneity and incommensurate aspects, and which are discussed with the renormalization group theory in recent works. In contrast, there are many experimental results that are left unexplained, some of which are even necessary to be evaluated for their relevance to intrinsic occurrence. Under these circumstances, I felt that the basic concepts introduced early on need to be reviewed for better understanding of structural problems in crystals.

Phase transitions in crystals should, in principle, be the interplay between order variables and phonons. While it has not been seriously discussed so far, I have found that an idea similar to charge-density-wave condensates is significant for ordering phenomena in solids. I was therefore motivated to write this monograph, where basic concepts for structural phase transitions are reviewed in light of the Peierls idea. I have written this book for readers with basic knowledge of solid state physics at the level of *Introduction to Solid State Physics* by C. A. Kittel. In this monograph, the basic physics of continuous phase transitions is discussed, referring to experimental evidence, without being biased by existing theoretical models. Since many excellent review articles are available, this book is not another comprehensive review of experimental results. While emphasizing basic concepts, the content is by no means theoretical, and this book can be used as a textbook or reference material for extended discussions in solid state physics.

The book is divided into two parts for convenience. In Part One, I discuss basic elements for continuous structural changes to introduce the model of pseudospin condensates, and in Part Two various methods of investigation are discussed, thereby revealing properties of condensates. In Chapter 10, work on representative systems is summarized to conclude the discussion, where the results can be interpreted in light of fluctuating condensates.

I am enormously indebted to many of my colleagues who helped me in writing this book. I owe a great deal to S. Jerzak, J. Grindley, G. Leibrandt, D. E. Sullivan, H. –G. Unruh, G. Schaack, J. Stankowski, W. Windsch, A. Janner and E. de Boer for many constructive criticisms and encouragements. Among them, Professor Windsch took time to read through an early version of the manuscript, and gave me valuable comments and advice; Professor Unruh kindly provided me with photographs of discommensuration patterns in K_2ZnCl_4 systems; and Dr. Jerzak helped me to obtain information regarding $(NH_4)_2SO_4$ and $RbH_3(SeO_3)_2$, and to whom I express my special gratitude. Finally I thank my wife Haruko for her continuous encouragement during my writing, without which this book could not have been completed.

"It was like a huge wall!" said a blind man.
"Oh, no! It was like a big tree." said another blind man.
"You are both wrong! It was like a large fan!" said another.
Listening to these blind people, the Lord said, "Alas! None of you have seen the elephant!"

From East-Indian Folklore.

A Remark on Bracket Notations

Somewhat unconventional bracket notations are used in this monograph. While the notations $\langle Q\rangle$ and $\langle Q\rangle_{\mathrm{s}}$ generally signify the spatial average of a distributed quantity Q over a crystal, the notation $\langle Q\rangle_{\mathrm{t}}$ indicates the temporal average over the timescale t_{o} of observation.

In Chapters 8 and 9, the *bra* and *ket* of a vector quantity v, i.e. $\langle v|$ and $|v\rangle$, respectively, are used to express the corresponding row and column matrices in three-dimensional space to fascilitate matrix calculations. Although confusing at a glance with conventional notations in quantum theory, I do not think such use of brackets is of any inconvenience for discussions in this book.

Guelph, Ontario M. Fujimoto
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Fujimoto, M.
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