The beginning of 1986 marked the inauguration of the cuprate superconductor epoch in the search for high-temperature superconductivity. The discovery by Karl Alex Müller and Johan Georg Bednorz of the occurrence of superconductivity in the lanthanum and barium copper oxides at temperatures up to 35 K caused an unprecedented wave of scientific activity in the study of superconductivity. In early 1987, the replacement of La by Y in the “Zürich” compounds raised the superconductivity onset to 90 K. Within the next few years, new copper oxide compounds containing bismuth, thallium, or mercury were discovered such that the maximum transition temperature at ambient pressure was raised to 136 K. K.A. Müller and J.G. Bednorz, at that time research associates at the IBM Research Division, Zürich Research Laboratory, were awarded the Nobel Prize in Physics in 1987. During the elapsed two decades, their discovery has also opened new doors in solid state physics, in particular in the physics of strongly correlated systems. The recent discovery of superconductivity in the ferropnictide compounds at temperatures up to 55 K points to the existence of alternate high-temperature candidates and revives the hope of finding even room-temperature superconductors in the future.

As a result of an enormous research effort of a large number of physicists, chemists, and material scientists, high-quality samples of cuprate superconductors have been manufactured and their generic physical properties have been studied with high precision by applying various experimental methods. It has emerged that these compounds possess a number of unusual normal state and superconducting properties due to a complicated interplay of electronic, spin, and lattice degrees of freedom. In view of the complicated character of the interplay, any theory of cuprate superconductors encounters a number of difficulties. Despite the powerful modern methods of statistical physics, the study of various microscopic models has not so far resulted in a commonly accepted interpretation of all the physical phenomena and the mechanism for formation of the superconducting state.

Presently, more than a hundred of thousands of papers are published on the problem of high-temperature superconductivity in cuprates in the form of
journal articles and reports at numerous conferences. A number of excellent reviews and monographs have been already published in which the results of studies obtained in separate fields or on the basis of particular experimental methods are discussed. At the same time, there are only a few publications, where the essential properties of high-temperature cuprate superconductors are reviewed on the background of their theoretical interpretation. The purpose of the present book is to achieve this aim in a form accessible to a wide circle of researchers in the field of cuprate superconductivity, both beginners and experts interested in a general overview.

As it follows from the contents of the book, the main physical properties of the cuprate superconductors are discussed in a concise form in Chap. 2–6, and the essential theoretical models are considered in Chap. 7. Several examples of successful technical applications are discussed only briefly in Chap. 8, since this field constitutes a separate large branch of high-temperature cuprate superconductor studies. In the Appendix, the superconductivity theory is formulated within the equation of motion method for the Green functions. The discussions are given at the text-book level.


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