
Preface

Historically, quasi-low-dimensional superconductors were considered as the main candidates to observe high-temperature superconductivity. For a discussion of the related exotic mechanisms of superconductivity, suggested by W.A. Little and V.L. Ginzburg, see a chapter by D. Jérôme in this volume. Unfortunately, high-temperature superconductivity has not been discovered yet in quasi-one-dimensional (Q1D) and quasi-two-dimensional (Q2D) organic materials. Nevertheless, very rich and, in many cases, unique physical properties of their metallic, superconducting, charge- and spin-density-wave phases allowed P.M. Chaikin to claim that the first organic superconductors, $(\text{TMTSF})_2\text{X}$, are probably the most interesting electronic materials ever discovered.

Our book welcomes a reader to a fascinating world of exotic condensed matter physics, low temperatures, and high and ultrahigh magnetic fields. It is written by leading experts in the area from USA, France, Japan, Russia, United Kingdom, Germany, Canada, South Korea, Croatia, Hungary, and Switzerland. The book consists of six parts, subdivided into 27 chapters, which contain both the experimental results and their theoretical explanations. The majority of the chapters contain pedagogical introductions and all necessary illustrations to be read separately. Although we concentrate on physical phenomena, in the most chapters related chemistry and structural aspects of Q1D and Q2D organic materials are also discussed.

The goal of our book is to cover a broad range of physical effects, experimentally observed in organic conductors and superconductors. In Part 1, “Historical Surveys,” the major experimental and theoretical discoveries, which have determined a development of the physics of organic compounds for more than two decades, are discussed from historical and pedagogical points of view. Among them are discoveries of the first organic superconductors, charge-density waves, charge ordering, field-induced spin-density waves, and three-dimensional quantum Hall effect (3D QHE). In Part 3, “Unusual Properties of a Metallic Phase,” some novel types of quantum macroscopic phenomena in a magnetic field, which appear when electrons move along open orbits in the extended Brillouin zone, are described. Among them are

very rich Fermi liquid and non-Fermi liquid angular magnetic oscillations and a novel type of the cyclotron resonance. Similar phenomena are discussed in Chaps. 5–9 of Part 2, “General Reviews.” In Part 4, “Field-Induced Spin(Charge)-Density-Wave Phases,” the corresponding phenomena and a related 3D QHE are described both from experimental and theoretical points of views. For these purposes, see also Chaps. 3 and 4 of Part 1 and Chaps. 5 and 7 of Part 2. In Part 5, “Unconventional Superconducting Properties,” unconventional singlet d-wave, reentrant and possible triplet superconducting phases both in Q1D and Q2D organic superconductors are discussed. They are described also in Chaps. 1 and 3 of Part 1 and Chaps. 5–7 and 9 of Part 2. Electron correlations in reduced dimensions are considered in Part 6, “Electron Correlations in Organic Conductors,” and Chap. 12 of Part 2. In Chaps. 10 and 11 of Part II, charge-density-wave like phases including charge ordering, solitons, and ferroelectric phases are considered.

Note that sometimes a historical term “organic conductor,” which reflects only a chemical aspect of a compound, is misleading. As one can see from the contents of the book, this is particularly true in our case. Indeed, organic conductors and superconductors, discussed in this book, have a little common with typical organic polymers. We use the above-mentioned term to describe extremely clean crystalline conductors and superconductors with highly anisotropic electron spectra, demonstrating fundamental and, in many cases, unique solid-state physics.

It is our pride and not very often case in a modern materials science physics that significantly more than a half of the experimentally observed properties in organic conductors and superconductors have been successfully explained. Moreover, some of them were theoretically predicted. Therefore, one can describe the existing relationships between the experiment and theory



Fig. 1. Friendship between theory and experiment (drawing of Natalia Lebed)

in this area of a condensed matter physics as a friendship (see Fig. 1). This friendship may be transformed into a true love if some of its dark places are clarified. Among them are triplet–singlet controversy of the superconducting properties in $(\text{TMTSF})_2\text{X}$ materials, the observations of the Giant Magic Angles Nernst effect, and some other still ill-understood phenomena. This work was partially supported by the NSF grant DMR-0705986.

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A.G. Lebed

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