Lecture Notes in Physics 603

# Ruthenate and Rutheno-Cuprate Materials

Unconventional Superconductivity, Magnetism and Quantum Phase Transitions

Bearbeitet von
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# Preface

This volume is based on the lecture notes of the International Conference "Ruthenate and Rutheno-cuprate Materials: Theory and Experiments" held in Vietri sul Mare (Salerno)–Italy from 25th to 27th October 2001.

One of the most important developments associated with the discovery of high-temperature superconductivity in the cuprates has been a rapid growth in our understanding of related oxides. Oxides display all the ground states of strongly correlated electron physics, from many-body insulators to metals on the border of applicability of the well-known Fermi liquid theory. The various forms of magnetism which also occur are linked to a host of interesting properties such as colossal magnetoresistance and unconventional superconductivity. Recently, the class of ruthenate materials has been the focus of considerable work because of their interesting magnetic and superconducting properties.

Detailed studies of perovskite-like ruthenates belonging to the Ruddlesden-Popper series $Sr_{n+1}Ru_nO_{3n+1}$ have revealed an unexpectedly rich physics including itinerant $4d$ magnetism in $SrRuO_3$, triplet superconductivity in $Sr_2RuO_4$, and quantum critical phenomena in the bilayer compound $Sr_3Ru_2O_7$. Although much has been learned about these materials from a theoretical and experimental point of view, there is a lot of interesting physics beyond this level.

The enthusiasm in the physics and phenomenology of the ruthenate oxides has grown by the remarkable observation in hybrid rutheno-cuprate materials of superconductivity arising up to at least $T_c$=35K in $GdSr_2RuCu_2O_y$, despite its being ferromagnetic (FM) already at $T_m$=132K. In this respect, $GdSr_2RuCu_2O_y$ appears to be unique as a ferromagnet that becomes superconducting well within the FM phase. This compound can be derived from the YBCO high-$T_c$ superconductors by replacing the CuO chains by $RuO_2$ layers and are characterized by a sequence of $CuO_2$ double layers carrying the superconductivity and $RuO_2$ layers responsible of the magnetism. Nevertheless, the coexistence of superconductivity and long range magnetic order is intriguing and, in spite of extensive investigation, a consistent picture of the magnetic structure is still lacking.

The volume includes articles on various topics in this field and are grouped in three main parts devoted to $Sr_2RuO_4$, to rutheno-cuprate materials, and to $SrRuO_3$ and $Sr_3Ru_2O_7$, respectively. However, the ordering of the papers is largely arbitrary, since the problems addressed overlap to a considerable extent. The authors are specialists in their respective fields and are actively engaged in the study of the problems touched upon by them. For this reason we are

confident that this book will attract the attention of the readers and will prove to be useful for researchers involved in Solid State Physics.

We would like to express our gratitude towards the eminent scientists who have promptly and kindly accepted our invitation to give their lectures, and to all the participants who helped to create a warm and stimulating atmosphere, with their presence and interesting discussions.

This Conference has certainly summarized many of the recent theoretical and experimental issues on ruthenate and rutheno-cuprate materials. A number of factors, however, made it special: the non minor benefit coming from the wonderful and warm venue of Vietri sul Mare; the large number of young and enthusiastic people and the feeling of forming a community.

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