

Preface

Electronic and magnetic properties in condensed matters are dominated by the electronic structure as well as the crystal structure. Synchrotron X-ray diffraction is one of the most important methods to determine the crystal structure including the electron density distribution, while spectroscopic experiments using the synchrotron radiation have become indispensable to study the electronic structure. The resonant X-ray scattering (RXS), which has the combined characters of diffraction and spectroscopy, is a powerful tool to investigate the physical properties of solids and thin films. The RXS can provide valuable information on the valence electrons, especially a variety of ordered states for the electron degrees of freedom. In the *d*-electron systems, we call the electronic ordered states as charge, spin, and orbital orders, while in the *f*-electron systems, they are referred to as multipole orders. The RXS can give us the element- and site-specific information when the beam energy is tuned to the corresponding absorption energy. We can also elucidate the details of the ordered states using the polarization property of synchrotron X-rays. When we change sample environments such as temperature, pressure, magnetic field or electric field, we sometimes observe a phase transition accompanied by a drastic change of electronic states, which are directly detected by the RXS. Some examples of these in-situ observations are shown in this book. We also have learned over the last two decades that the resonant inelastic X-ray scattering (RIXS) can be effective to detect electronic excitations such as charge, spin and orbital waves in strongly correlated electron systems. In this way, the RXS and RIXS have played increasingly significant roles in many scientific fields as well as condensed matter physics.

This book is written with the intention of presenting systematic descriptions of the RXS and RIXS techniques and the applications. In Chapter 1, the RXS and RIXS are reviewed from theoretical point of view. The Chapters 2 and 3 contain RXS studies of *3d* and *4f* electron systems, respectively. Magnetism study using RXS is described in Chapter 4. The RXS using soft X-ray is introduced in Chapter 5. Chapter 6 is dedicated to the description of the RIXS technique for the study of electronic excitations. This book has been written by six authors who are experts at RXS and RIXS studies in condensed matter physics. The readers will find

the original points of view of these authors about physics in strongly correlated electron systems. We hope this book will be a useful textbook for researchers and students to study a variety of science using RXS and RIXS.

It is a pleasure to thank Prof. Atsushi Fujimori for his invaluable help in editing this book. The cooperation with Dr. Ute Heuser and Dr. Thorsten Schneider of Springer has been extremely helpful.

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Resonant X-Ray Scattering in Correlated Systems

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2017, VII, 241 p. 151 illus., 25 illus. in color., Hardcover

ISBN: 978-3-662-53225-6