

# Preface

In the seven years since the first edition of this book, there have been critical advances in both x-ray-source technology and experimental methods, leading to previously unimagined vistas of scientific discovery. In particular, two developments in x-ray sources are revolutionizing x-ray science and techniques. First, the emergence of high-gain, hard x-ray free-electron lasers (XFELs) has resulted in, among other things, the birth of new fields in macromolecular crystallography and time-resolved surface and catalytic chemistry. Even more recently, advances in vacuum and computer-numerical-control machining technologies have facilitated the realization of novel magnetic storage-ring components that substantially improve the electron-beam quality, in so-called diffraction-limited storage rings (DLSRs). The greenfield facilities of MAX-IV at Lund, Sweden, and Sirius in Campinas, Brazil, are the first of these fourth-generation synchrotrons, closely followed by several upgrades of third-generation facilities to DLSRs. They promise an increase in brilliance of up to two orders of magnitude compared to the state-of-the-art synchrotrons available at the time of writing the first edition of this book.

This rapid evolutionary phase is reflected in a certain readjustment of the emphasis of some chapters in this second edition. In particular, Chapter 3 has been significantly expanded to include a more thorough description of DLSR science and technology, which in turn has an impact on beamline design (Chapter 5) and experimental techniques, not least in macromolecular crystallography (Section 6.11) and x-ray imaging (Chapter 8). XFELs now command a chapter of their own. All the figures in this second edition are available online at Wiley as PowerPoint slides.

In addition to up-to-date examples of applications of various x-ray techniques, each chapter in this new edition contains problem sets, plus comprehensive solutions in the Appendices. Some of the problems are a straightforward plugging-in of numbers to equations presented in the main text – they are not intended to constitute an intellectual challenge, but rather to provide the student with an opportunity to appreciate the magnitudes of things, and their potential impact on other considerations, both practical and fundamental. Other problems, however, require some thought and a deeper understanding of the background science. It is hoped that, as such, these problems will provide an adjunct to the main text and furnish additional insights into the fascinating, multidisciplinary, and ever-expanding field of x-ray science.

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