

Harald H. Rose

SPRINGER SERIES IN OPTICAL SCIENCES 142

# Geometrical Charged-Particle Optics



Springer

# Geometrical Charged Particle Optics Springer Series In Optical Sciences

**Harald H. Rose**



## **Geometrical Charged Particle Optics Springer Series In Optical Sciences:**

Geometrical Charged-Particle Optics Harald Rose, 2013-02-02 This second edition is an extended version of the first edition of Geometrical Charged Particle Optics The updated reference monograph is intended as a guide for researchers and graduate students who are seeking a comprehensive treatment of the design of instruments and beam guiding systems of charged particles and their propagation in electromagnetic fields Wave aspects are included in this edition for explaining electron holography the Aharonov Bohm effect and the resolution of electron microscopes limited by diffraction Several methods for calculating the electromagnetic field are presented and procedures are outlined for calculating the properties of systems with arbitrarily curved axis Detailed methods are presented for designing and optimizing special components such as aberration correctors spectrometers energy filters monochromators ion traps electron mirrors and cathode lenses In particular the optics of rotationally symmetric lenses quadrupoles and systems composed of these elements are discussed extensively Beam properties such as emittance brightness transmissivity and the formation of caustics are outlined Relativistic motion and spin precession of the electron are treated in a covariant way by introducing the Lorentz invariant universal time and by extending Hamilton's principle from three to four spatial dimensions where the laboratory time is considered as the fourth pseudo spatial coordinate Using this procedure and introducing the self action of the electron its accompanying electromagnetic field and its radiation field are calculated for arbitrary motion In addition the Stern Gerlach effect is revisited for atomic and free electrons

**Geometrical Charged-Particle Optics** Harald H. Rose, 2009 This resource covering all theoretical aspects of modern geometrical charged particle optics is aimed at anyone involved in the design of electron optical instruments and beam guiding systems for charged particles

**Charged Particle Optics Theory** Timothy R. Groves, 2017-12-19 Charged Particle Optics Theory An Introduction identifies the most important concepts of charged particle optics theory and derives each mathematically from the first principles of physics Assuming an advanced undergraduate level understanding of calculus this book follows a logical progression with each concept building upon the preceding one Beginning with a non mathematical survey of the optical nature of a charged particle beam the text Discusses both geometrical and wave optics as well as the correspondence between them Describes the two body scattering problem which is essential to the interaction of a fast charged particle with matter Introduces electron emission as a practical consequence of quantum mechanics Addresses the Fourier transform and the linear second order differential equation Includes problems to amplify and fill in the theoretical details with solutions presented separately Charged Particle Optics Theory An Introduction makes an ideal textbook as well as a convenient reference on the theoretical origins of the optics of charged particle beams It is intended to prepare the reader to understand the large body of published research in this mature field with the end result translated immediately to practical application

**Advances in Optics of Charged Particle Analyzers: Part 2**, 2025-02-10 Advances in Optics of Charged Particle Analyzers Part Two Volume 233 merges two

long running series Advances in Electronics and Electron Physics and Advances in Optical and Electron Microscopy The release in the series features articles on Electrostatic Energy Mass Analyzers With Combined Electrostatic and Magnetic Fields Mass Analyzers based on Fourier Transform Principles of Time of Flight Mass Analyzers Multi Pass Time of Flight Mass Analyzers and Radiofrequency Mass Analyzers Provides the authority and expertise of leading contributors from an international board of authors Presents the latest release in the Advances in Imaging and Electron Physics series Features articles on Electrostatic Energy Mass Analyzers With Combined Electrostatic and Magnetic Fields and more **Handbook of Charged Particle Optics** Jon Orloff, 2017-12-19 With the growing proliferation of nanotechnologies powerful imaging technologies are being developed to operate at the sub nanometer scale The newest edition of a bestseller the Handbook of Charged Particle Optics Second Edition provides essential background information for the design and operation of high resolution focused probe instruments The book's unique approach covers both the theoretical and practical knowledge of high resolution probe forming instruments The second edition features new chapters on aberration correction and applications of gas phase field ionization sources With the inclusion of additional references to past and present work in the field this second edition offers perfectly calibrated coverage of the field's cutting edge technologies with added insight into how they work Written by the leading research scientists the second edition of the Handbook of Charged Particle Optics is a complete guide to understanding designing and using high resolution probe instrumentation *Additive Manufacturing with Metals* Sanjay Joshi, Richard P. Martukanitz, Abdalla R. Nassar, Pan Michaleris, 2023-11-27 This textbook and reference provides a comprehensive treatment of additive manufacturing AM for metals including design and digital work flows process science and reliability metallic systems quality assurance and applications The book is rooted in the fundamental science necessary to develop and understand AM technologies as well as the application of engineering principles covering several disciplines to successfully exploit this important technology As additive manufacturing of metals is the fastest growing subset of this transformative technology with the potential to make the widest impact to industrial production Metals Additive Manufacturing Design Processes Materials Quality Assurance and Applications is ideal for students in a range of engineering disciplines and practitioners working in aerospace automotive medical device manufacturing industries **Structural Dynamics with X-ray and Electron Scattering** Kasra Amini, Arnaud Rouzée, Marc J J Vrakking, 2023-12-20 Since the early 20th century X ray and electron scattering has provided a powerful means by which the location of atoms can be identified in gas phase molecules and condensed matter with sub atomic spatial resolution Scattering techniques can also provide valuable observables of the fundamental properties of electrons in matter such as an electron's spin and its energy In recent years significant technological developments in both X ray and electron scattering have paved the way to time resolved analogues capable of capturing real time snapshots of transient structures undergoing a photochemical reaction Structural Dynamics with X ray and Electron Scattering is a two part book that firstly introduces the fundamental

background to scattering theory and photochemical phenomena of interest The second part discusses the latest advances and research results from the application of ultrafast scattering techniques to imaging the structure and dynamics of gas phase molecules and condensed matter This book aims to provide a unifying platform for X ray and electron scattering

**Advances in Imaging and Electron Physics** ,2018-06-15 Advances in Imaging and Electron Physics Volume 206 merges two long running serials Advances in Electronics and Electron Physics and Advances in Optical and Electron Microscopy The series features extended articles on the physics of electron devices especially semiconductor devices particle optics at high and low energies microlithography image science digital image processing electromagnetic wave propagation electron microscopy and the computing methods used in all these domains Contains contributions from leading authorities on the subject matter Informs and updates on all the latest developments in the field of imaging and electron physics Provides practitioners interested in microscopy optics image processing mathematical morphology electromagnetic fields electrons and ion emission with a valuable resource Features extended articles on the physics of electron devices especially semiconductor devices particle optics at high and low energies microlithography image science and digital image processing

**Aberration-corrected Imaging In Transmission Electron Microscopy: An Introduction (2nd Edition)** Rolf Erni,2015-03-23 Aberration Corrected Imaging in Transmission Electron Microscopy provides an introduction to aberration corrected atomic resolution electron microscopy imaging in materials and physical sciences It covers both the broad beam transmission mode TEM transmission electron microscopy and the scanning transmission mode STEM scanning transmission electron microscopy The book is structured in three parts The first part introduces the basics of conventional atomic resolution electron microscopy imaging in TEM and STEM modes This part also describes limits of conventional electron microscopes and possible artefacts which are caused by the intrinsic lens aberrations that are unavoidable in such instruments The second part introduces fundamental electron optical concepts and thus provides a brief introduction to electron optics Based on the first and second parts of the book the third part focuses on aberration correction it describes the various aberrations in electron microscopy and introduces the concepts of spherical aberration correctors and advanced aberration correctors including correctors for chromatic aberration This part also provides guidelines on how to optimize the imaging conditions for atomic resolution STEM and TEM imaging This second edition has been completely revised and updated in order to incorporate the very recent technological and scientific achievements that have been realized since the first edition appeared in 2010

**Springer Handbook of Microscopy** Peter W. Hawkes,John C.H. Spence,2019-11-02 This book features reviews by leading experts on the methods and applications of modern forms of microscopy The recent awards of Nobel Prizes awarded for super resolution optical microscopy and cryo electron microscopy have demonstrated the rich scientific opportunities for research in novel microscopies Earlier Nobel Prizes for electron microscopy the instrument itself and applications to biology scanning probe microscopy and holography are a reminder of the central role of microscopy in

modern science from the study of nanostructures in materials science physics and chemistry to structural biology Separate chapters are devoted to confocal fluorescent and related novel optical microscopies coherent diffractive imaging scanning probe microscopy transmission electron microscopy in all its modes from aberration corrected and analytical to in situ and time resolved low energy electron microscopy photoelectron microscopy cryo electron microscopy in biology and also ion microscopy In addition to serving as an essential reference for researchers and teachers in the fields such as materials science condensed matter physics solid state chemistry structural biology and the molecular sciences generally the Springer Handbook of Microscopy is a unified coherent and pedagogically attractive text for advanced students who need an authoritative yet accessible guide to the science and practice of microscopy

**Advanced Smart Information and Communication Technology and Systems** Mykhailo Ilchenko, Leonid Uryvsky, Larysa Globa, 2025-07-28 This book highlights the most important research areas in Information and Communication Technologies and their impact on digital society and environment sustainable development namely the research in fields of Information and Communication Technologies artificial intelligence in ICT lunar missions maintenance security of data and services smart robotic systems implementation in the digital environment and mathematical modeling for practical and research tasks in communication and data processing fields provided by various groups of researchers from Germany and Ukraine in cooperation with scientists from different countries The presented studies contain a discussion on the use of multi cloud integration approaches in particular based on methods of deep learning practical implementation of the Internet of Things IoT the modern study of V2V Communication and research in fields of mathematical modeling in applied problems The book focuses on the basics of information and analytical activities in the digital global space to providing broadband Internet access without decreasing the quality of experience QoE level improving services provision and system architecture with improving security The study of modern communication and information technologies contains original works dealing with many aspects of their improvement and use for research that shows some effective technological solutions that can be used for the implementation of novel cloud infrastructure and radio electronics systems These results can be used in the implementation of novel systems and to promote the exchange of information in e societies Given its scope the book offers a valuable resource for scientists lecturers specialists working at enterprises and graduate and undergraduate students who engage with problems in Information and Communication Technologies as well as aspects of society and environment sustainable development

**Principles of Electron Optics, Volume 1** Peter W. Hawkes, Erwin Kasper, 2017-10-29 Volume one of Principles of Electron Optics Basic Geometrical Optics Second Edition explores the geometrical optics needed to analyze an extremely wide range of instruments cathode ray tubes the family of electron microscopes including the fixed beam and scanning transmission instruments the scanning electron microscope and the emission microscope electron spectrometers and mass spectrograph image converters electron interferometers and diffraction devices electron welding machines and electron beam lithography

devices The book provides a self contained detailed modern account of electron optics for anyone involved with particle beams of modest current density in the energy range up to a few mega electronvolts You will find all the basic equations with their derivations recent ideas concerning aberration studies extensive discussion of the numerical methods needed to calculate the properties of specific systems and guidance to the literature of all the topics covered A continuation of these topics can be found in volume two Principles of Electron Optics Applied Geometrical Optics The book is intended for postgraduate students and teachers in physics and electron optics as well as researchers and scientists in academia and industry working in the field of electron optics electron and ion microscopy and nanolithography Offers a fully revised and expanded new edition based on the latest research developments in electron optics Written by the top experts in the field Covers every significant advance in electron optics since the subject originated Contains exceptionally complete and carefully selected references and notes Serves both as a reference and text

**Coherent Electron Microscopy: Designing Faster and Brighter Electron Sources** Peter W. Hawkes, Martin Hÿtch, 2023-08-17 Coherent Electron Microscopy Designing Faster and Brighter Electron Sources Volume 227 in the Advances in Imaging and Electron Physics series merges two long running serials Advances in Electronics and Electron Physics and Advances in Optical and Electron Microscopy Chapters in this new release cover Characterization of nanomaterials properties using FE TEM Cold field emission electron sources From higher brightness to ultrafast beams Every electron counts Towards the development of aberration optimized and aberration corrected electron sources and more The series features articles on the physics of electron devices especially semiconductor devices particle optics at high and low energies microlithography image science digital image processing electromagnetic wave propagation electron microscopy and the computing methods used in all these domains Provides the authority and expertise of leading contributors from an international board of authors Presents the latest release in the Advances in Imaging and Electron Physics series *Einmal auf der Welt. Und dann so* Arnold Stadler, 2009 *Optical Measurement Techniques* Kai-Erik Peiponen, Risto Myllylä, Alexander V. Priezzhev, 2009-03-15 Devoted to novel optical measurement techniques that are applied both in industry and life sciences this book contributes a fresh perspective on the development of modern optical sensors These sensors are often essential in detecting and controlling parameters that are important for both industrial and biomedical applications The book provides easy access for beginners wishing to gain familiarity with the innovations of modern optics **Jena Review**, 1985 **Electron Energy Loss Spectroscopy** Nicholas J. Heller, Audrey J. Washington, Scott K. Cushing, 2025-06-12 This primer is geared toward undergraduate and graduate students who possess a basic understanding of chemistry and physics and are looking for a route to enter the world of electron energy loss spectroscopy EELS It may also be a convenient reference for established researchers interested in adopting a new analytical method or simply for anyone eager to learn more about electron matter interactions This primer is divided into five chapters to guide your reading Chapter 1 introduces the concept of electron based spectroscopy and defines what qualifies as an

electron based technique The authors outline the principal interactions at play and present a range of methods that correspond to different types of signals The chapter concludes with a concise historical narrative tracing the development of EELS Chapter 2 details the background required to build a deeper understanding of EELS and spectroscopy The authors connect photon based and electron based approaches highlighting where they overlap and where they diverge Chapter 3 focuses on the fundamental instrumentation used in electron spectroscopy discusses optimization strategies and introduces key instrument parameters The authors compare different electron sources optical geometries and lens configurations Chapter 4 explores scattering mechanisms and electron matter interactions offering theoretical underpinnings and guidance on interpreting EELS spectra Key concepts such as elastic and inelastic scattering core level transitions plasmons and analysis methods are reviewed Chapter 5 concludes with real world applications such as the use of EELS in biology nanomaterials polymers and solid state systems The authors also briefly survey emerging directions including in situ and ultrafast EELS underscoring the method s evolving landscape

*Microstructural Characterisation Techniques* Gunturi Venkata Sitarama Sastry, 2022-09-15 This textbook is aimed at graduate and upper undergraduate students studying materials science and metallurgy It comprehensively covers the topic of microstructural characterization and includes an emphasis on Fourier analysis and Fourier transformation electron diffraction electromagnetic waves and electron waves lens parameters transmission electron microscopy optical microscopy and scanning electron microscopy The author has included pedagogical features such as end of chapter exercises and worked examples with varying degrees of difficulty to augment learning and self testing This book will be a useful guide for upper undergraduate and graduate students along with researchers and professionals working in the field of microstructural characterization

**Surface Microscopy with Low Energy Electrons** Ernst Bauer, 2014-07-10 This book written by a pioneer in surface physics and thin film research and the inventor of Low Energy Electron Microscopy LEEM Spin Polarized Low Energy Electron Microscopy SPLEEM and Spectroscopic Photo Emission and Low Energy Electron Microscopy SPELEEM covers these and other techniques for the imaging of surfaces with low energy slow electrons These techniques also include Photoemission Electron Microscopy PEEM X ray Photoemission Electron Microscopy XPEEM and their combination with microdiffraction and microspectroscopy all of which use cathode lenses and slow electrons Of particular interest are the fundamentals and applications of LEEM PEEM and XPEEM because of their widespread use Numerous illustrations illuminate the fundamental aspects of the electron optics the experimental setup and particularly the application results with these instruments Surface Microscopy with Low Energy Electrons will give the reader a unified picture of the imaging diffraction and spectroscopy methods that are possible using low energy electron microscopes

*The Physics of Microfabrication* Ivor Brodie, Julius J. Muray, 2013-11-11 The Physical Electronics Department of SRI International formerly Stanford Research Institute has been pioneering the development of devices fabricated to submicron tolerances for well over 20 years In 1961 a landmark paper on electron beam lithography



and its associated technologies was published by K R Shoulderst then at SRI which set the stage for our subsequent efforts in this field He had the foresight to believe that the building of such small devices was actually within the range of human capabilities As a result of this initial momentum our experience in the technologies associated with microfabrication has become remarkably comprehensive despite the relatively small size of our research activity We have frequently been asked to deliver seminars or provide reviews on various aspects of micro fabrication These activities made us aware of the need for a comprehensive overview of the physics of microfabrication We hope that this book will fill that need

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