## **Contents**

| 1 |  | iation from Relativistic Particles                                 | 1   |  |  |
|---|--|--|-----|--|--|
|   | 1.1  | General Properties of Radiation from Relativistic Particles        | 1   |  |  |
|   | 1.2  | Radiation Formation Length   | 6   |  |  |
|   | 1.3  | Radiation from a Heavy Charged Particle Colliding With an Atom     | 9   |  |  |
|   | 1.4  | Transition Radiation and Diffraction Radiation                     | 13  |  |  |
|   | 1.5  | Wakefield in Linear Accelerators                                   | 19  |  |  |
|   | Refe   | rences   | 26  |  |  |
| 2 | General Properties of Diffraction Radiation                        |  |     |  |  |
|   | 2.1  | Diffraction Radiation as Radiation from Polarization Currents      | 29  |  |  |
|   | 2.2  | Formation Length of Diffraction Radiation                          | 32  |  |  |
|   | 2.3  | Radiation from Relativistic Particle Near a Screen                 | 35  |  |  |
|   | 2.4  | Diffraction Radiation from Ultrarelativistic Particles             | 38  |  |  |
|   | 2.5  | Effect of the Excitation of the Medium on Diffraction Radiation    | 43  |  |  |
|   | 2.6  | Diffraction Radiation from a Charged Particle Reflected from a     |     |  |  |
|   |  | Single Crystal   | 49  |  |  |
|   | Refe   | rences   | 53  |  |  |
| 3 | Diffraction Radiation at Optical and Lower Frequencies             |  |     |  |  |
|   | 3.1  | Diffraction Radiation from a Circular Hole in an Opaque Screen     | 55  |  |  |
|   | 3.2  | Diffraction Radiation from an Inclined, Perfectly Conducting Half- |     |  |  |
|   |  | Plane  | 64  |  |  |
|   | 3.3  | Radiation Generated by a Charge Passing Through a Slit             |     |  |  |
|   |  | in a Perfectly Conducting Screen                                   | 81  |  |  |
|   | 3.4  | Polarization Characteristics of Diffraction Radiation              | 92  |  |  |
|   | Refe   | rences   | 101 |  |  |
| 4 | Diffraction Radiation in the Ultraviolet and Soft X-Ray Regions 10 |  |     |  |  |
|   | 4.1  | Polarization Current and the Radiation Field                       |     |  |  |
|   | 4.2  | Forward Diffraction Radiation                                      |     |  |  |
|   | 4.3  | Backward Diffraction Radiation                                     |     |  |  |



|   | 4.4   | X-ray Diffraction Radiation Under Conditions                         |     |  |  |
|---|---|--|-----|--|--|
|   |   | of the Cherenkov Effect 11   |     |  |  |
|   | 4.5   | Diffraction Radiation from a Crystal Target                          | 23  |  |  |
|   | Refe  | prences 13   | 34  |  |  |
| 5 | Diff  | raction Radiation at the Resonant Frequency                          | 37  |  |  |
|   | 5.1   | Diffraction Radiation at the Resonant Frequency from a Nonplanar     |     |  |  |
|   |   | Surface 13   |     |  |  |
|   | 5.2   | Diffraction Radiation at the Resonant Frequency from a Wedge 14      |     |  |  |
|   | Refe  | erences  | 47  |  |  |
| 6 | Diffraction Radiation from Media with Periodic Surfaces           |  |     |  |  |
|   | 6.1   | Smith—Purcell Radiation 14   |     |  |  |
|   | 6.2   | Scalar Theory of the Diffraction of the Self Field of an Electron    |     |  |  |
|   |   | from a Plane Semitransparent Grating 12                              | 53  |  |  |
|   | 6.3   | Smith—Purcell Effect As Radiation Generated by Induced Surface       |     |  |  |
|   |   | •  | 56  |  |  |
|   | 6.4   | Smith—Purcell Effect As Resonant Diffraction Radiation               | 62  |  |  |
|   | 6.5   | Resonant Diffraction Radiation Generated by Electrons Moving         |     |  |  |
|   | 0.0   | Near a Tilted Planar Grating   | 77  |  |  |
|   | 6.6   | Smith—Purcell Radiation from a Thin Dielectric Layer                 |     |  |  |
|   | 0.0   | on a Conducting Substrate  | 86  |  |  |
|   | Refe  | prences  |     |  |  |
|   |   |  |     |  |  |
| 7 | Coh   | erent Radiation Generated by Bunches of Charged Particles 19         | 97  |  |  |
|   | 7.1   | Coherent Radiation Generated by Short Electron Bunches 1             |     |  |  |
|   | 7.2   | Coherent Synchrotron Radiation in the Millimeter                     |     |  |  |
|   |   | and Submillimeter Wavelength Ranges 24                               | 07  |  |  |
|   | 7.3   | Coherent Diffraction Radiation                                       |     |  |  |
|   | 7.4   | Coherent Smith—Purcell Radiation                                     |     |  |  |
|   |   | prences  |     |  |  |
|   |   |  | . / |  |  |
| 8 | Diff  | raction Radiation in the Pre-wave (Fresnel) Zone                     | 21  |  |  |
|   | 8.1   | Transition Radiation in the Pre-wave (Fresnel) Zone                  |     |  |  |
|   | 8.2   | Diffraction Radiation in the Pre-wave (Fresnel) Zone as a Tool for   |     |  |  |
|   |   | Beam Diagnostics   | 31  |  |  |
|   | Refe  | erences  |     |  |  |
|   |   |  |     |  |  |
| 9 | Experimental Investigations of Diffraction Radiation Generated by |  |     |  |  |
|   |   | ativistic Electrons  | 51  |  |  |
|   | 9.1   | Experimental Results on Diffraction Radiation and Comparison         |     |  |  |
|   | 0.0   | with Theoretical Calculations  | 51  |  |  |
|   | 9.2   | Optical Diffraction Radiation from a Slit Target and the Possibility |     |  |  |
|   |   | of the Measurement of the Transverse Size of an Electron Beam 2      | 60  |  |  |

| 9.3   | Experimental Investigations of the Generation of Smith—Purcell |     |
|-------|--|-----|
|       | Radiation by Ultrarelativistic Electron Beams                  | 265 |
| 9.4   | Some Prospects of Application of Diffraction Radiation         | 271 |
| Refer | ences  | 275 |