

Contents

Preface	v
Introduction	xi
Chapter I. Electrostatic Accelerators	1
I.1 Scientific Motivation	1
I.2 Voltage Multiplying Columns	4
I.3 Silk Belts	5
I.4 Wisconsin Advances	6
I.5 Tandems	8
I.6 Commercial Production of Electrostatic Machines	9
I.7 Applications of Electrostatic Machines	9
Chapter II. Cyclotrons	11
II.1 The Anatomy of a Discovery	11
II.2 Lawrence and the Early Cyclotrons	14
II.3 Transverse Focusing	18
II.4 Relativistic Limitation	19
II.5 Calutrons	19
II.6 Cyclotrons for Peace Again	21
II.7 FFAG	22
II.8 Spiral Sector Cyclotrons	23
II.9 Modern Cyclotrons	26
II.10 Applications	26
Chapter III. Linear Accelerators	28
III.1 Science Motivation — An Idea in Search of a Technology	28
III.2 The Early Linear Accelerators at Berkeley	30
III.3 Proton Linacs	30
III.4 Electron Linacs	34
III.5 Heavy Ion Linacs — a Rich Field of Research	42
III.6 Induction Linacs	44
III.7 Applications of Induction Linacs	46

Chapter IV. Betatrons	49
IV.1 Early History	50
IV.2 The Kerst Betatron	51
IV.3 The Wideroe Betatron — Second Attempt	51
IV.4 The Years After World War II	53
Chapter V. Synchrotrons	55
V.1 Science Motivation	55
V.2 The Early History of the Synchrotron	55
V.3 First Synchrotron	56
V.4 Electron Synchrotrons	56
V.5 Early Proton Synchrotrons	56
V.6 Nimrod and Phasotron	60
V.7 Strong Focusing	60
V.8 Brookhaven's AGS and CERN's PS	64
V.9 Fermilab and SPS	67
V.10 Superconducting Magnets	75
Chapter VI. Colliders	78
VI.1 Science Motivation	78
VI.2 Principles	78
VI.3 Electron–Electron Colliders	81
VI.4 Electron–Positron Colliders	81
VI.5 Superconducting Cavities	90
VI.6 Proton–Proton Colliders	91
VI.7 Proton–Antiproton Colliders	94
VI.8 Asymmetric Collider Rings	97
VI.9 Large Hadron Collider (LHC)	103
VI.10 Heavy-Ion Colliders	107
Chapter VII. Detectors	110
VII.1 Early Primitive Detectors	110
VII.2 Scintillators, Photomultipliers and Cerenkov Counters	110
VII.3 Collisions in Three Dimensions	111
VII.4 A Modern Detector	115
VII.5 Digital X-ray Imaging	117
VII.6 Detection Techniques for Synchrotron Radiation Sources	119
Chapter VIII. Synchrotron Radiation Sources	121
VIII.1 Scientific Motivation	121
VIII.2 Principles and Early History	122
VIII.3 Synchrotron Radiation	123
VIII.4 First Generation Synchrotron Sources	123
VIII.5 Second Generation Synchrotron Sources	123
VIII.6 Third Generation Synchrotron Sources	124
VIII.7 Angstrom Wavelength Free Electron Laser Facilities	128
VIII.8 Future Fourth Generation Synchrotron Sources	132

Chapter IX. Cancer Therapy Accelerators	134
IX.1 Cyclotrons	134
IX.2 Linacs	135
IX.3 Synchrotrons	136
IX.4 Other Therapies	138
IX.5 Future Facilities	138
Chapter X. Past, Present and Future	140
X.1 Future Needs	140
X.2 Linear Colliders and Their Origins	141
X.3 The International Linear Collider (ILC)	144
X.4 The Compact Linear Collider (CLIC)	146
X.5 Spallation Neutron Sources	148
X.6 Rare Isotope Accelerators	151
X.7 Neutrino Super Beams, Neutrino Factories and Muon Colliders	153
X.8 Accelerators for Heavy Ion Fusion and for Creating High Energy Density Plasmas	157
X.9 Proton Drivers for Power Reactors	160
X.10 Lasers and Plasmas	161
Chapter XI. A Final Word	166
XI.1 Understanding the Universe	166
XI.2 Applications	166
XI.3 Bringing Nations Together	166
XI.4 A Word Especially for the Young	168
Appendices	
A. Bibliography and References	169
B. The Accelerator Community	174
C. Glossary	175
D. List of Illustrations with Acknowledgments	184
Index	189