

Contents

Preface by D. de Wied, President of the Royal Netherlands Academy of Arts and Sciences	v
Preface by the Editors.	vii

INTRODUCTION

CHAPTER 1. FACTORS IN THE DEVELOPMENT OF MODERN PHYSICS <i>A. Sarlemijn, P.A. Kroes, F.W. Sluijter and M.J. Sparnaay</i>	1
1.1. Analysis of Factors versus Schematic Models.	1
1.2. Application of Mathematics and Developments of Modern Physics	5
1.2.1. Modern Physics is becoming More Formal	5
1.2.2. Required Contacts between Mathematics and Physics: The Göttingen School as an Example	10
1.3. Experimental Techniques as Development Factor of Modern Physics	15
1.4. Orientation on Engineering Methods as a Development Factor	19
1.5. Orientation on Practical Applications as a Development Factor	22
1.6. The “Culture” of Scientists and Engineers.	23

PART I: HISTORICAL EXAMPLES OF PHYSICS IN THE MAKING

CHAPTER 2. PHYSICS IN THE MAKING IN LEIDEN: PAUL EHRENFEST AS TEACHER <i>Martin J. Klein</i>	29
2.1. Ehrenfest’s Courses	30
2.2. Course on Statistical Mechanics in 1915–16	32
2.3. The Leiden Colloquium.	35
2.4. Confidence and Courage	37
2.5. “Uncle Socrates”	39
2.5.1. The Questioner	39
2.5.2. The Teacher	41

CHAPTER 3. PHYSICS IN THE MAKING IN BOHR'S COPENHAGEN. . .	45
<i>Abraham Pais</i>	
3.1. Physics in Denmark from a College of the Clergy to the Epoch of Ørsted	47
3.2. Bohr's Background	52
3.3. Bohr's Education, from Schoolboy to Ph.D.	57
3.4. In which Bohr Encounters J.J. Thomson and Rutherford	62
3.5. In which Bohr Emerges as "Director of Atomic Physics"	65
3.6. How Bohr Became Denmark's First Professor of Theoretical Physics	69
3.7. In which Bohr Acquires his Own Institute	73
3.8. Bohr As Fund Raiser	79
3.9. 1924–1929	83
3.10. Envoi	85
 CHAPTER 4. PHYSICS IN THE MAKING IN PAULI'S ZÜRICH.	 93
<i>Karl von Meyenn</i>	
4.1. Pauli and Trends in Physics after 1926	93
4.2. The Impact of the First Copenhagen Conference 1929: Quantum Theory Enters Nuclear Physics	97
4.3. The First International Congress on Nuclear Physics at Zürich in May 1931	107
4.4. A Brief Mathematical Digression: Continuous Groups and their Representations	109
4.5. November 1931: Pauli Receives his First Scientific Honors in Leiden	115
4.6. Pauli's New Assistant H.B.G. Casimir	117
4.7. Radiation Theory and the Search for New Procedures in Relativistic Quantum Field Theories	121
4.8. The End of a Fruitful Collaboration: Casimir's Return to Leiden in the Autumn of 1933	124
 <i>PART II: THEORETICAL AND EXPERIMENTAL PHYSICS: REPORTS ON RECENT DEVELOPMENTS</i>	
CHAPTER 5. THE PHYSICAL CONCEPT OF TIME IN THE 20TH CENTURY	131
<i>P.T. Landsberg</i>	
5.1. The Physical Concept of Time at About 1900	131
5.2. Key Theories of the Present Century	135

5.3. Reversible Quantum Processes	137
5.4. Quantum Measurement	139
5.5. Cosmological Evolution and Arrows of Time	141
5.6. The Time-Dependence of the “Constants” and the Cos- mological Coincidences	147
5.7. Black Holes	153
5.8. The Beginning and the End	157
Appendix A: Disorder and Entropy	160
Appendix B: The Search for an Energy Flux per Unit Solid Angle per Unit Frequency Range which Is of the Same Form for All Inertial Observers	161
 CHAPTER 6. STATISTICAL FOUNDATIONS OF ELECTRODYNAMIC THEORY	 167
<i>L.G. Suttorp</i>	
6.1. Introduction	167
6.2. Statistical Derivation of the Macroscopic Field Equations .	168
6.3. Composite Particles in Electromagnetic Fields	174
6.4. Macroscopic Forces on Polarizable Matter in Nonrelativistic and Semirelativistic Theory	177
6.5. Relativistic Energy-Momentum Laws	185
6.6. Conclusion	190
 CHAPTER 7. THE ROLE OF ONSAGER RELATIONS IN THE DEVELOP- MENT OF THERMODYNAMICS OF IRREVERSIBLE PROCESSES	 195
<i>P. Mazur</i>	
7.1. Symmetry Relations for Irreversible Processes Before 1930	195
7.2. 1931: The Principle of Microscopic Reversibility and On- sager’s Reciprocal Relations	202
7.3. 1945: A Second Look at the Principle of Microscopic Re- versibility; the Onsager–Casimir Relations	210
 CHAPTER 8. DYNAMIC SYMMETRIES AND SUPERSYMMETRIES IN NU- CLEAR AND PARTICLE PHYSICS	 217
<i>F. Iachello</i>	
8.1. Introduction	217
8.2. Casimir Operators and Dynamic Symmetries	218
8.3. Dynamic Symmetries in Quantum Mechanics	220

8.4. Dynamic Symmetries in Particle Physics	222
8.5. Dynamic Symmetries in Nuclear Physics	224
8.6. Casimir Operators and Dynamic Supersymmetries	227
8.7. Dynamic Supersymmetries in Nuclear Physics	229
8.8. Dynamic Supersymmetries in Particle Physics	330
8.9. Conclusions	231

CHAPTER 9. THE CASIMIR EFFECT

9A. THE HISTORICAL BACKGROUND OF THE CASIMIR EFFECT	235
<i>M.J. Sparnaay</i>	
9A.1. History	235
9A.2. Experiments	242
9B. THE CASIMIR EFFECT IN FIELD THEORY	247
<i>Bryce DeWitt</i>	
9B.1. Introduction	247
9B.2. The Quantum Ether	248
9B.3. Calculation of A	251
9B.4. Vacuum Stresses for Other Fields. The Role of Topology	252
9B.5. Curved Boundaries	254
9B.6. Accelerated Boundaries	255
9B.7. Formal Description of the Quantum Ether	257
9B.8. Hawking Radiation	258
9B.9. Back Reaction	261
9B.10. Heat-Kernel Methods	263
9B.11. Frontier Problems. The Vilkovisky Effective Action	269

PART III: PHYSICS IN INDUSTRIAL LABORATORIES

CHAPTER 10. THE DEVELOPMENT OF FLUORESCENT LAMPS AT PHILIPS UP TO 1940	273
<i>J.J. Hutter</i>	
10.1. Origin of Atomic Physics	274
10.2. Development Gas Discharge Physics (after about 1900)	276
10.3. The Start of Fluorescent Lamp Design at Philips	279
10.3.1. Efficiency and Luminous Flux	279
10.3.2. The Colour of the Light	281

10.3.3. Lamp Life	282
10.3.4. Current, Voltage, Starting Method and Power Factor	285
10.3.5. Radio Interference	290
10.4. Conclusion	292
 CHAPTER 11. APPROACHES TO SCIENCE IN INDUSTRY.	 297
<i>K. Alex Müller</i>	
11.1. Introduction and some Reminiscences	297
11.2. Projects in Industry, especially IBM	298
11.3. Industrial, University, and Government Laboratories	300
 <i>PART IV: REFLEXIONS ON PHYSICS IN THE MAKING</i>	
 CHAPTER 12. FUNDAMENTAL LAWS AND PHYSICAL REALITY.	 303
<i>P.A. Kroes and A. Sarlemijn</i>	
12.1. The Search for an Appropriate Philosophy of Physics. . . .	304
12.2. Cartwright's Philosophy of Physics	306
12.2.1. A Liberal Form of Empiricism	306
12.2.2. A Defence of Phenomenological Laws and Causal Principles	309
12.2.3. An Attack on Fundamental Laws	311
12.3. The Distinction Between Phenomenological and Fundamental Laws	313
12.4. Van der Waals' Equation of State: Fundamental and Phenomenological Aspects.	319
12.5. Concluding Remarks	324
 CHAPTER 13. A PHILOSOPHY OF PHYSICS IN THE MAKING.	 329
<i>C.F. von Weizsäcker</i>	
 <i>APPENDIX</i>	
 H.B.G. CASIMIR'S TEACHINGS IN LEIDEN AND IN EINDHOVEN. . . .	 341
<i>C.M. Hargreaves</i>	

