The Dawning of
Gauge Theory

LOCHLAINN O’RAIFEARTAIGH

Princeton Series in Physics
Contents

PREFACE vii

ACKNOWLEDGMENTS xi

INTRODUCTION 3

PART I. Gravitation and Electromagnetism

1. Gauge Transformations in Classical Electromagnetism 13
   Gravitation and Electricity by H. Weyl (1918) 24

2. Aftermath of Einstein's Gravitational Theory 38

3. Generalizations of Einstein's Theory 44
   On the Unification Problem of Physics by Th. Kaluza (1921) 53
   Quantum Theory and Five-Dimensional Relativity by O. Klein (1926) 59
   On the Invariant Form of the Wave and Motion Equations for a Charged Point-Mass by V. Fock (1927) 70

4. The Renaissance of Weyl's Idea: EM Gauge Theory 77
   On a Remarkable Property of the Quantum-Orbits of a Single Electron by E. Schrödinger (1922) 87
   Quantization as an Eigenvalue Problem by E. Schrödinger (1926) 91
   Quantum-Mechanical Interpretation of Weyl's Theory by F. London (1927) 94

5. Weyl's Classic, 1929 107
   Electron and Gravitation by H. Weyl (1929) 121
PART II. The Nuclear Interactions

6. Klein's Serendipity, 1938
   On the Theory of Charged Fields by O. Klein (1939) 147

7. Pauli's Dimensional Reduction, 1953
   Meson-Nucleon Interaction and Differential Geometry
   by W. Pauli (1953) 166

8. The Yang-Mills Theory, 1953–54
   Isotopic Spin Conservation and a Generalized Gauge
   Invariance by C. N. Yang and R. Mills (1954) 182
   Conservation of Isotopic Spin and Isotopic Gauge
   Invariance by C. N. Yang and R. L. Mills (1954) 185

   Invariance under General Isotopic Spin
   Transformations by R. Shaw (1955) 197

    Invariant Theoretical Interpretation of Interaction
    by R. Utiyama (1956) 208

CONCLUSION 240
REFERENCES 243
INDEX 247