

Contents

Part I Two Rival Centers: Göttingen vs. Berlin

1	Introduction to Part I	3
2	On Gauss and Gaussian Legends: A Quiz	19
	Answers to the Gauss Quiz	21
3	Gauss, Dirichlet, and the Law of Biquadratic Reciprocity	29
4	Episodes in the Berlin-Göttingen Rivalry, 1870–1930	41
5	Deine Sonia: A Reading from a Burned Letter by Reinhard Bölling, Translated by D. E. Rowe	51
6	Who Linked Hegel's Philosophy with the History of Mathematics?	57
	Answers to the Hegel Quiz	60
	Kummer's Hegelian Orientation	61
	Steiner's Roman Surface	62
	Addendum: Plane Sections of a Steiner Surface (Computer Graphics by Oliver Labs)	64

Part II The Young Felix Klein

7	Introduction to Part II	69
8	Models as Research Tools: Plücker, Klein, and Kummer Surfaces	81
	Models as Artefacts for Discovery	83
	A Context for Discovery: Geometric Optics	85
	Kummer's Seven Models	86
	Models in Standardized Production	89
	Appendix	92
9	Debating Grassmann's Mathematics: Schlegel vs. Klein	95
	Grassmann's <i>Ausdehnungslehre</i>	95
	Mathematics at University and Gynmasium	96
	Professionalisation and Patterns of Reception	98
	Promoting Grassmannian Mathematics at the Gymnasium	99
	Klein's Critique	100
	Schlegel's Response	101

10	Three Letters from Sophus Lie to Felix Klein on Mathematics in Paris	105
11	Klein, Mittag-Leffler, and the Klein-Poincaré Correspondence of 1881–1882 . .	111
	Launching <i>Acta Mathematica</i>	111
	Klein's Projective Riemann Surfaces	113
	Klein's Influence on American Mathematics	115
	Klein's Leipzig Seminar	120
	Poincaré's Breakthrough	124
	"Name ist Schall und Rauch"	125
	On Cultivating Scientific Relations	127
	Delayed Publication of the Klein-Poincaré Correspondence	130
	Archival Sources	132

Part III David Hilbert Steps Onstage

12	Introduction to Part III	137
13	Hilbert's Early Career	151
	From Königsberg to Göttingen	151
	Hilbert in Königsberg	152
	Entering Klein's Circle	156
	Encounters with Allies and Rivals	158
	Returning from Paris	158
	A Second Encounter with Kronecker	161
	Tackling Gordan's Problem	162
	Mathematics as Theology	164
	A Final <i>Tour de Force</i>	166
	Killing Off a Mathematical Theory	167
14	Klein, Hurwitz, and the "Jewish Question" in German Academia	171
	Klein's Most Talented Student	172
	Hurwitz in Göttingen and Königsberg	175
	Playing the Game of "Mathematical Chairs"	176
	Paul Gordan to Felix Klein, 16 April, 1892	178
	The "Jewish Question" Reconsidered	180
	Appendix: Two Tributes to Adolf Hurwitz	182
	Max Born Recalling Hurwitz as a Teacher	182
	George Pólya on Hurwitz as a Colleague	182
15	On the Background to Hilbert's Paris Lecture "Mathematical Problems"	183
	From Königsberg to Göttingen	184
	Algebraic Number Fields	184
	Foundations of Geometry	186
	Munich, September 1899	188
	Minkowski's Sage Advice	189
	On Mathematical Knowledge	191

16 Poincaré Week in Göttingen, 22–28 April 1909	195
Program for Poincaré Week	197
Opening of Poincaré Week, April 22–29, 1909	197
For Klein on His 60th Birthday, April 25, 1909	198
Hilbert on Poincaré’s Conventionalism and Cantor’s Theory of Transfinite Numbers	200

Part IV Mathematics and the Relativity Revolution

17 Introduction to Part IV	205
18 Hermann Minkowski’s Cologne Lecture, “Raum und Zeit”	219
Minkowski’s Partnership with Hilbert	223
Plans for Hilbert’s Paris Lecture	225
Boltzmann and the Energetics Debates	226
Minkowskian Physics	228
On Canonizing a Classic	229
19 Max von Laue’s Role in the Relativity Revolution	233
Einstein’s Obsolete Account of SR	234
New Math for Physicists	236
Laue’s Influence on Einstein	237
Laue’s Slow Acceptance of General Relativity	238
20 Euclidean Geometry and Physical Space	243
Gauss and the Advent of Non-Euclidean Geometry	249
21 The Mathematicians’ Happy Hunting Ground: Einstein’s General Theory of Relativity	253
Einstein in Berlin and Göttingen	253
The Schwarzschild Solution	254
Relativity and Differential Geometry	256
Einstein’s Enemies: The Anti-relativists	258
Appendix: Text of an Article by Hilbert and Born in the <i>Frankfurter Zeitung</i>	260
Soldner und Einstein	260
22 Einstein’s Gravitational Field Equations and the Bianchi Identities	263
Introduction	263
Einstein’s Field Equations	266
General Relativity in Göttingen	267
On Rediscovering the Bianchi Identities	268
23 Puzzles and Paradoxes and Their (Sometimes) Profounder Implications	273
Implications for Foundations of Geometry	273
Doodlings of a Physicist	275
On Machian Thought Experiments	277

24 Debating Relativistic Cosmology, 1917–1924	279
Introduction	279
Cosmological Combatants	281
De Sitter's Non-Machian Universe	284
Geometric Motifs: Felix Klein	286
Einstein on the Counterattack	288
Confronting Space–Time Singularities	290
On Losing Track of Time in de Sitter Space	293
Einstein's Ether as Carrier of Inertia	295
On the Persistence of Static Cosmologies	297
25 Remembering an Era: Roger Penrose's Paper on "Gravitational Collapse: The Role of General Relativity"	301

Part V Göttingen in the Era of Hilbert and Courant

26 Introduction to Part V	315
27 Hermann Weyl, The Reluctant Revolutionary	331
On the Roots of Weyl's Ensuing Conflict with Hilbert	333
Weyl's Emotional Attachment to Intuitionism	338
28 Transforming Tradition: Richard Courant in Göttingen	343
Biography and Oral History	345
Counterfactual Courant Stories	346
Courant as Innovator	351
29 Otto Neugebauer and the Göttingen Approach to History of the Exact Sciences	357
Neugebauer's Cornell Lectures	358
Neugebauer and Courant in Göttingen	359
Neugebauer's Revisionist Approach to Greek Mathematics	360
Greek Mathematics Reconsidered	364
30 On the Myriad Mathematical Traditions of Ancient Greece	369
31 The Old Guard Under a New Order: K. O. Friedrichs Meets Felix Klein	375
32 An Enchanted Era Remembered: Interview with Dirk Jan Struik	379

Part VI People and Legacies

33 Introduction to Part VI	395
34 Is (Was) Mathematics an Art or a Science?	407
35 Coxeter on People and Polytopes	413
Coxeter's Heroes	414
Coxeter on the Intuitive Approach to the Fourth Dimension	416
Coxeter as Promoter of Geometrical Art	418
36 Mathematics in Wartime: Private Reflections of Clifford Truesdell	421
Building Applied Mathematics at Brown	423
Truesdell's Private Reflections	427
A Participant's Perspective	429
Truesdell Looks Back	431

37 Hilbert's Legacy: Projecting the Future and Assessing the Past at the 1946 Princeton Bicentennial Conference	435
Hilbert's Inspirations	436
Princeton Agendas	436
Nativism Versus Internationalism in American Mathematics	438
A Rivalry Lives on	439
Taking Stock	442
38 Personal Reflections on Dirk Jan Struik By Joseph W. Dauben	445
Introduction: Dirk Struik and the History of Mathematics	445
Personal Reflections on Dirk Jan Struik By Joseph W. Dauben	447
Name Index	453