

THE YOUNG EINSTEIN

The advent of relativity

Lewis Pyenson

THE YOUNG EINSTEIN

The advent of relativity

Lewis Pyenson

Adam Hilger Ltd, Bristol and Boston

© Adam Hilger Limited 1985

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the publisher.

British Library Cataloguing in Publication Data

Pyenson, Lewis

The young Einstein: the advent of relativity.

1. Einstein, Albert 2. Physics—Biography

I. Title

530'.092'4 QC16.E5

ISBN 0-85274-779-9

Consultant Editor: **Professor A J Meadows**
University of Leicester

Published by Adam Hilger Ltd
Techno House, Redcliffe Way, Bristol BS1 6NX, England
PO Box 230, Accord, MA 02018, USA

Typeset in Great Britain by Input Typesetting Ltd, London and printed
in Great Britain by Oxford University Press, Oxford.

Preface

The historian of science today enters the traditional realm of biography with some hesitation. Historical treatments using cliometrics, semiotics, structural anthropology, social psychology, demography, and prosopography are widespread, and studies of these kinds are united in rejecting explanations based on contingencies in one person's life. Discontent with the biographical genre, however, is not a recent phenomenon. Whether biographical narrative is a secure path to historical truth was questioned by the mature Sigmund Freud. In 1936 he wrote to Arnold Zweig: 'He who undertakes a biography commits himself to lies, dissimulation, hypocrisy, embellishment, even the concealment of his own lack of comprehension: for biographical truth is not to be had, and even if one did attain it, it would be of no value.' By these words Freud meant to warn against an overly simple approach when discussing individual motivation, one of the oldest problems in historical writing; during his career Freud did not avoid considering the immediate surroundings of Leonardo and Woodrow Wilson, to mention two case studies of his. Several years before Freud's pronouncement against biographical writings Einstein, too, expressed doubts concerning this genre. In providing a short foreword for the biography of himself written by his step-son-in-law, Rudolf Kayser, Einstein noted how the book 'perhaps . . . overlooked . . . the irrational, the inconsistent, the droll, even the insane, which nature, inexhaustibly operative, implants in an individual'. Such forces could only be explained, he believed, in the first person: 'These things are singled out only in the crucible of one's own mind.'

The reservations of Freud and Einstein notwithstanding, an appeal to biographical evidence lies at the base of a search for the environment that

encouraged, sustained, or inhibited the thought or actions of a historical figure. Although a chronicle of Einstein's youth and young manhood would need less justification than that of any other modern scientist, the present book does not have such a compilation as its goal. It focuses on the social circumstances of Einstein's formative years, as well as on the intellectual climate in Germany where, before 1919, Einstein's work on the theories of relativity received widest notice.

In the following pages, Einstein's early career is studied without much attention to the technical content of his publications. The reader will find no long discussions on the notions of simultaneity and covariance, on the true meaning of the Michelson-Morley experiments and eclipse photographs, or on the tensor calculus and the cosmological constant. These points are, and have been for many years, well-treated in the literature. I turn instead to consider the lesser known work of several of Einstein's contemporaries who were instrumental in elaborating his thought.

In view of the fact that little regarding Einstein's scientific papers is analysed in depth, it is natural to ask in what sense this book may provide information on Einstein's scientific *discourse*. My treatment assumes that a discourse extends beyond a text to encompass tacit understanding and shared beliefs. Distinguished critics, notably Timothy Reiss and (in some of his writings) Michel Foucault, have argued that a *text* carries in its language all that is necessary for properly understanding it. Though the text is surely important for writing history of science, many referents of a scientific text—many features of scientific life—remain *hors texte*, or in context. To understand a text it is often useful (if not perhaps always necessary) to reconstruct what at first glance may seem irrelevant discourses in areas such as pedagogy, banking, or eschatology. Over the past decade, indeed, the most interesting questions in the history of science have concerned the circumstances of scientific achievement and failure.

The book begins by examining three sides of Einstein's youth and young manhood to resolve apparent contradictions in his later career. Why did Einstein, who was an excellent mathematician, always view mathematics as something of a necessary evil in his pursuit of physical laws? How was it that the theoretician Einstein retained, throughout his life, a deep interest in experimental apparatus and mechanical objects? Why did Einstein always see himself as a stranger in all his many environments? I argue that Einstein's secondary-school and university teachers helped to mould his attitude towards the role of mathematics in physics; that the young theoretician always felt comfortable with instruments and mechanical objects because of his close contact with the family business in electro-technology; and that a number of features of Einstein's personal style may be understood from the perspective of the Jewish emancipation in southern Germany at the end of the nineteenth century.

Notwithstanding Einstein's strictures against formalism devoid of

physical content, the theoretician's work on the theories of relativity has been, from its first appearance, of great interest to mathematicians. The middle four chapters examine how and why mathematicians in Germany transformed Einstein's original interpretation of special relativity to satisfy their own vision of the world. There I examine the views of pure mathematicians at Göttingen and elsewhere, men who used a four-dimensional space-time formulation of relativity to advance a theory of absolute, unphysical, ether-filled space—all that Einstein had laboured to dispel. I consider the motivations behind their manifest desire to uncover new mathematical harmonies in the physical world.

In assimilating and modifying relativity, pure mathematicians did not confront the possibility that the cherished beliefs of their discipline would have to be changed. It was otherwise among physicists and astronomers. In the last chapters I address the reception of relativity in Germany from two points of view. I consider how the distinguished editor of the most prestigious physics periodical at the time, Max Planck of the *Annalen der Physik*, evaluated incoming manuscripts dealing with Einstein's theories. I also investigate how physicists and astronomers interacted with Einstein's early scientific collaborators: the latter, unlike Einstein, fell victim to the retribution of their jealous and powerful colleagues.

For their having sped my archival research, I thank Klaus Haenel of the Niedersächsischen Staats- und Universitätsbibliothek, Göttingen; Alwin Jaeggli and Beat Glaus of the Eidgenössischen Technischen Hochschule, Zurich; Joan Warnow and Spencer Weart of the American Institute of Physics, New York; Hans Troxler-Keller of the Kantonsschule, Aarau; Paul Forman of the Smithsonian Institution, Washington; the late Helen Dukas of the Institute for Advanced Study, Princeton; Murphy Smith, late of the American Philosophical Society, Philadelphia; and John Stachel of the Einstein Project, Princeton. For sharing their memories of Einstein with me I thank Ramón Enrique Gaviola, Ruth Laub Wendt, the late Robert Alexander Houston, and the late Derek de Solla Price. Books have never constituted an important part of the culture of Montreal, especially in French-language institutions. Without the friendly collaboration of Maria Murphy and Wendy Knechtel of the Interlibrary Loan Service at Vanier Library, Concordia University, my work could not have proceeded. Several colleagues generously found time for critical reading of one or another chapter: Pierre Boule, Paul Forman, John Heilbron, József Illy, Martin J Klein, Camille Limoges, Russell McCormmach, Horst Melcher, John David North, and Vladimir P Vizgin. To them I am especially grateful.

Portions of this book have appeared elsewhere in different form: chapter 1, *Isis* 71 (1980); chapter 2, *Historical Studies in the Physical Sciences* 12 (1982), reprinted here through the courtesy of the University of California Press; chapters 4, 5, and 6, *Archive for History of Exact Sciences* 17 (1977),

21 (1979) and 27 (1982), reprinted through the courtesy of Springer-Verlag; chapter 7, *Europa: A Journal of Interdisciplinary Studies* 2, no 2 (1979); chapter 8, *Proceedings of the Ninth International Conference on General Relativity and Gravitation*, edited by Ernst Schmutzer (Berlin-DDR 1983); chapter 9, *Historical Studies in the Physical Sciences, Seventh Annual Volume*, edited by Russell McCormach (Princeton 1976), reprinted by permission of Princeton University Press. Permission to cite from the published and unpublished writings of Albert Einstein is gratefully acknowledged from the Hebrew University, Jerusalem.

We live in an age that encourages economy of expression. The notes following each chapter accordingly employ, whenever possible, standard or readily understandable abbreviations for the titles of journals and sources. It is well, nevertheless, to signal several of these here:

Dict. Sci. Biog.: Dictionary of Scientific Biography ed Charles C Gillispie 16 vols (New York 1970-6);

Hist. Stud. Phys. Sci.: Historical Studies in the Physical Sciences annual vols 1-3 (1969-71) ed Russell McCormach (University of Pennsylvania Press); annual vols 4-7 (1974-6) ed Russell McCormach (Princeton University Press); annual vols 8-10 (1977-9) eds Russell McCormach, Lewis Pyenson, and R Steven Turner (The Johns Hopkins University Press); from vol 11 (1980) issued semi-annually and edited by John L Heilbron (University of California Press).

Unless otherwise noted, all dissertations are doctoral (PhD or Dr phil) ones; references indicate year of printing (in Germany) or submission (in North America) instead of year of defence.

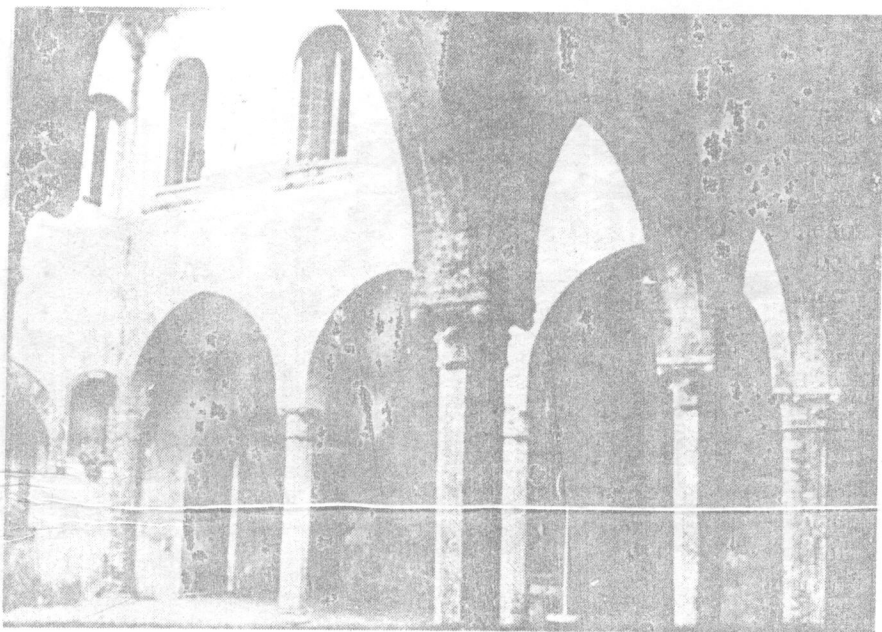
Credits and sources for the illustrations are given in the individual captions.

My research has been supported by the generosity of the Social Sciences and Humanities Research Council in Ottawa, the Deutschen Akademischen Austauschdienstes in Bonn, and the CAFIR fund of the University of Montreal.

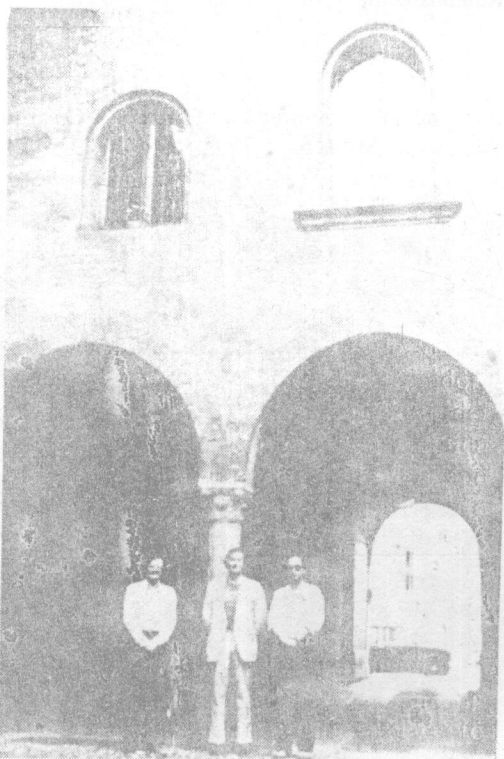
*Sie kann der Zufall gaukelnd nicht verwandeln.
Hab' ich des Menschen Kern erst untersucht
So weiss ich auch sein Wollen und sein Handeln.*

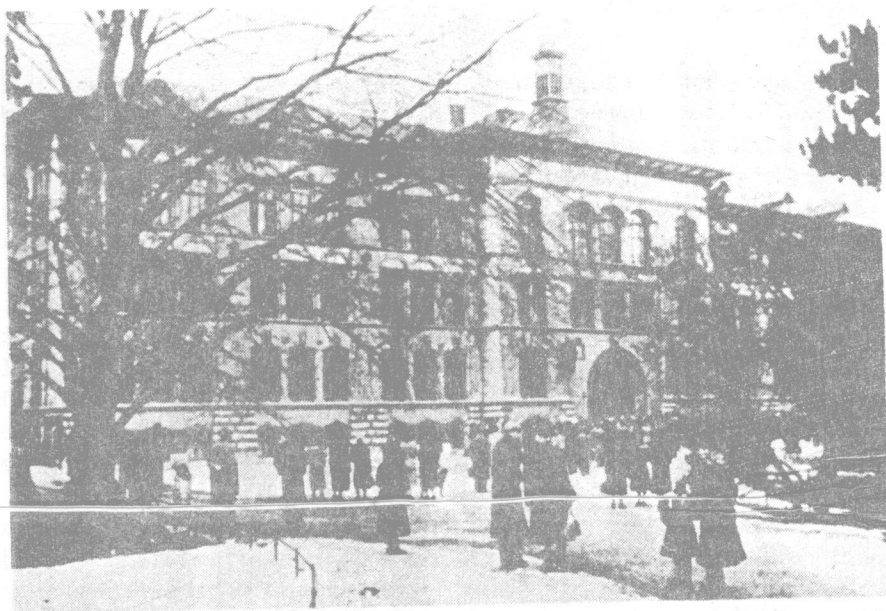
—Schiller, *Wallensteins Tod*.

Montreal West



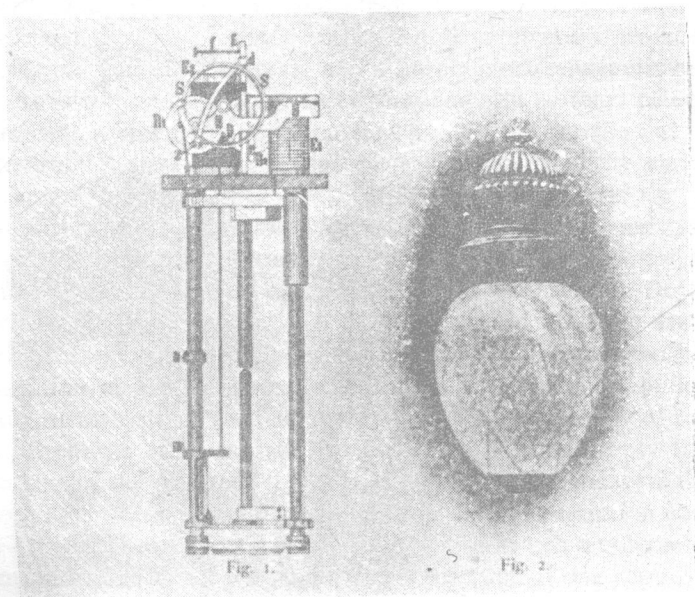
The Einsteins' family home in Pavia as it looks today. © Barbara Reeves.

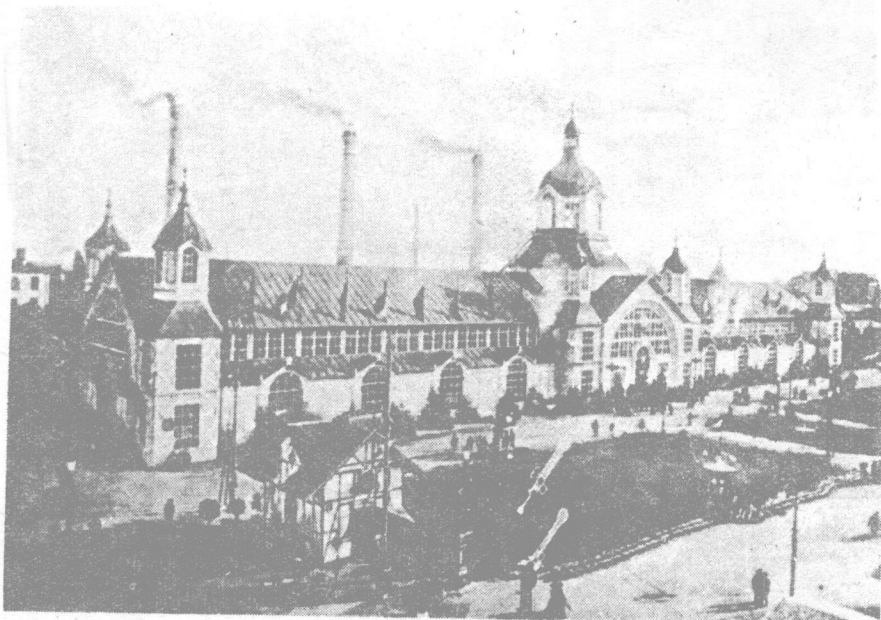




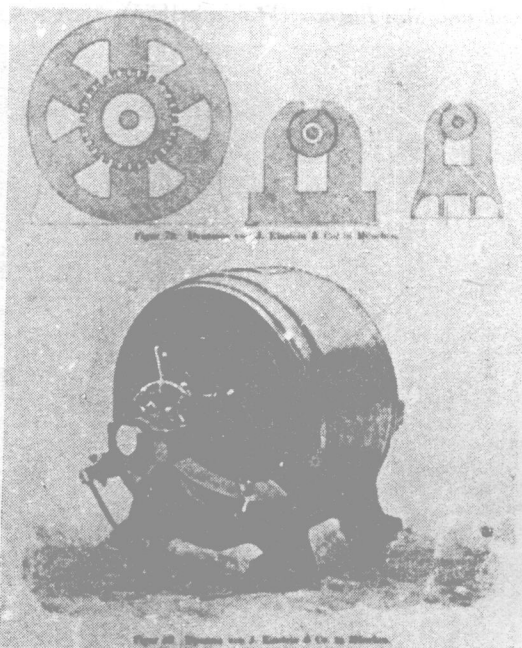
The cantonal school at Aarau, 1896. T Müller-Wolfer, *Die Aargauische Kantonsschule in den vergangenen 150 Jahren* (Aarau: H R Sauerländer 1952).

Arc lamp manufactured by J Einstein & Co around 1890. Deutsches Patentamt, Munich.

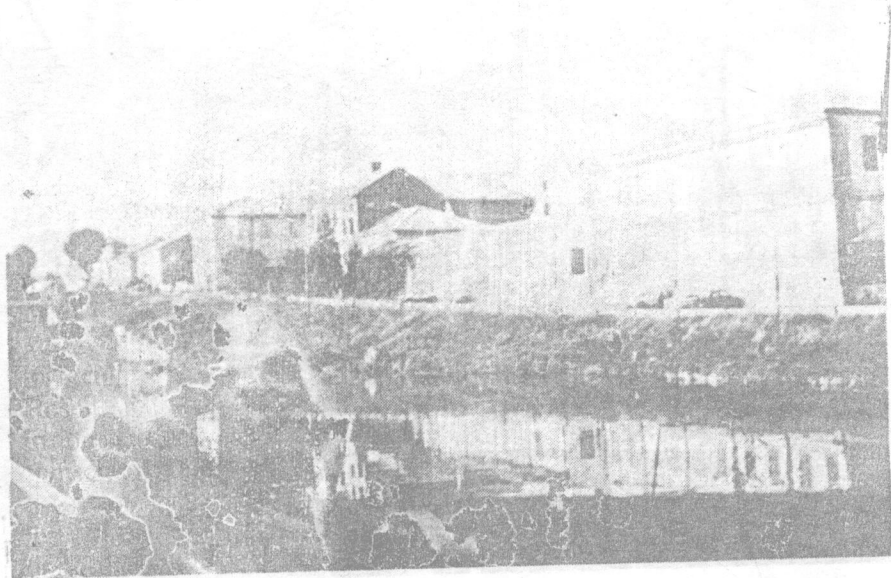




Main exhibition hall at the Frankfurt electrotechnical fair, 1891. *Offizieller Bericht über die Internationale Ausstellung in Frankfurt am Main 1891 1: Allgemeiner Bericht* (Frankfurt 1893).

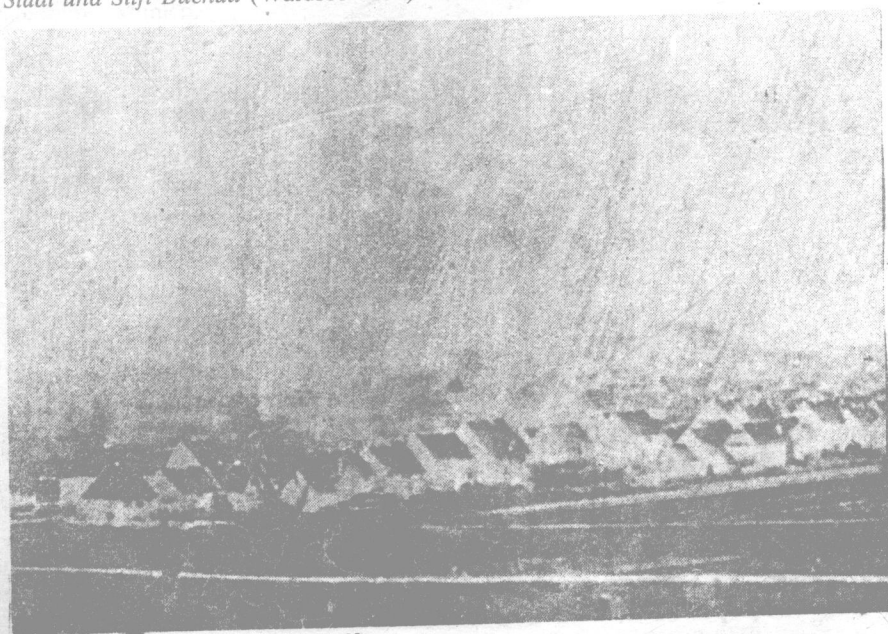


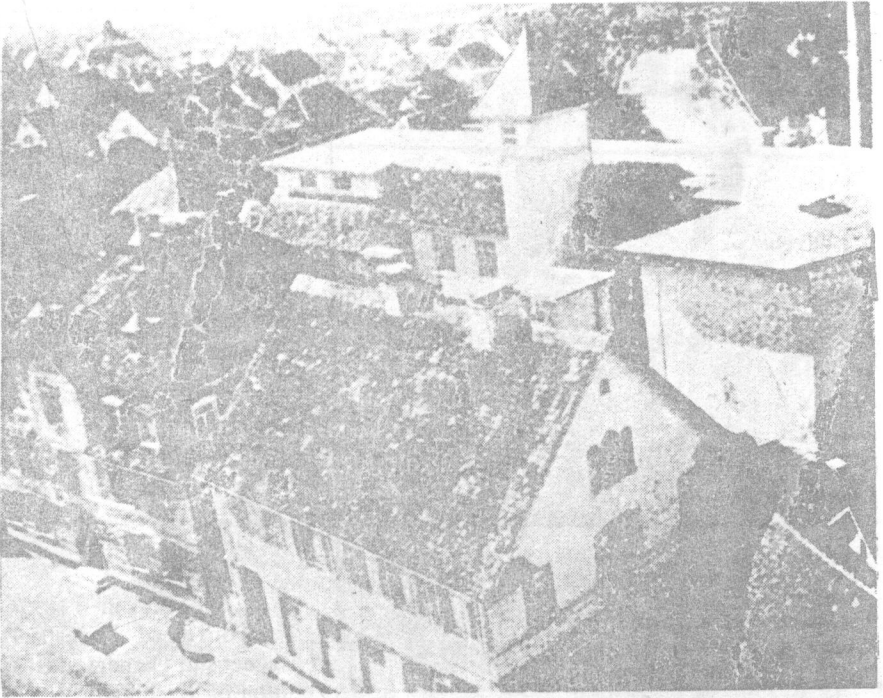
Various dynamos available from J Einstein & Co, around 1891. *Offizieller Bericht über die Internationale Ausstellung in Frankfurt am Main 1891 1: Allgemeiner Bericht* (Frankfurt 1893).



Site of Einstein, Garrone & Co (on the right) in Pavia, as it looks today. © Barbara Reeves.

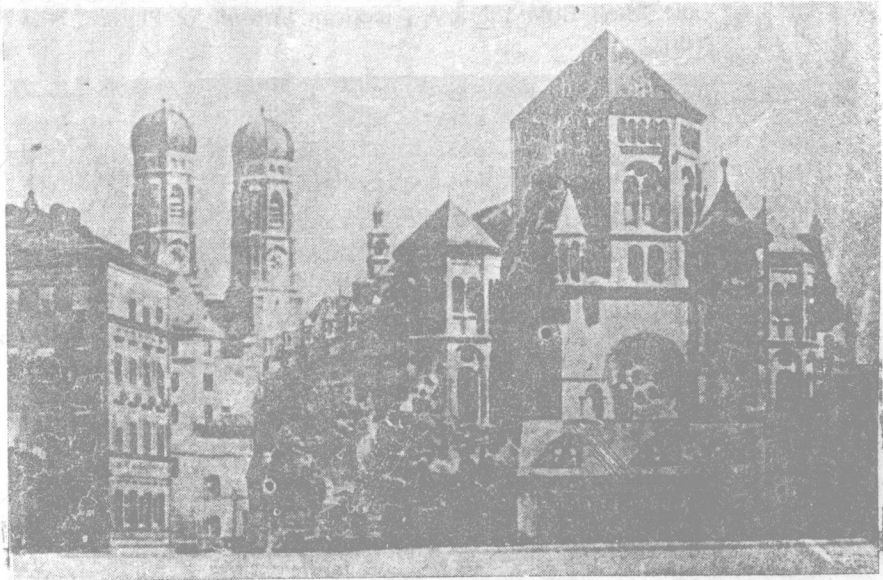
Buchau am Federsee, around 1860. Johann Evangelist Schöttle, *Geschichte von Stadt und Stift Buchau* (Waldsee 1884).





Buchau synagogue (with tower), around 1925. Walter Staudacher, *Führer durch Buchau und das Federseeried* (Buchau [1925]).

Main synagogue in Munich, 1887. Munich, Israelitische Kultusgemeinde, *Festgabe: 50 Jahre Hauptsynagoge München 1887–1937* (Munich 1937).

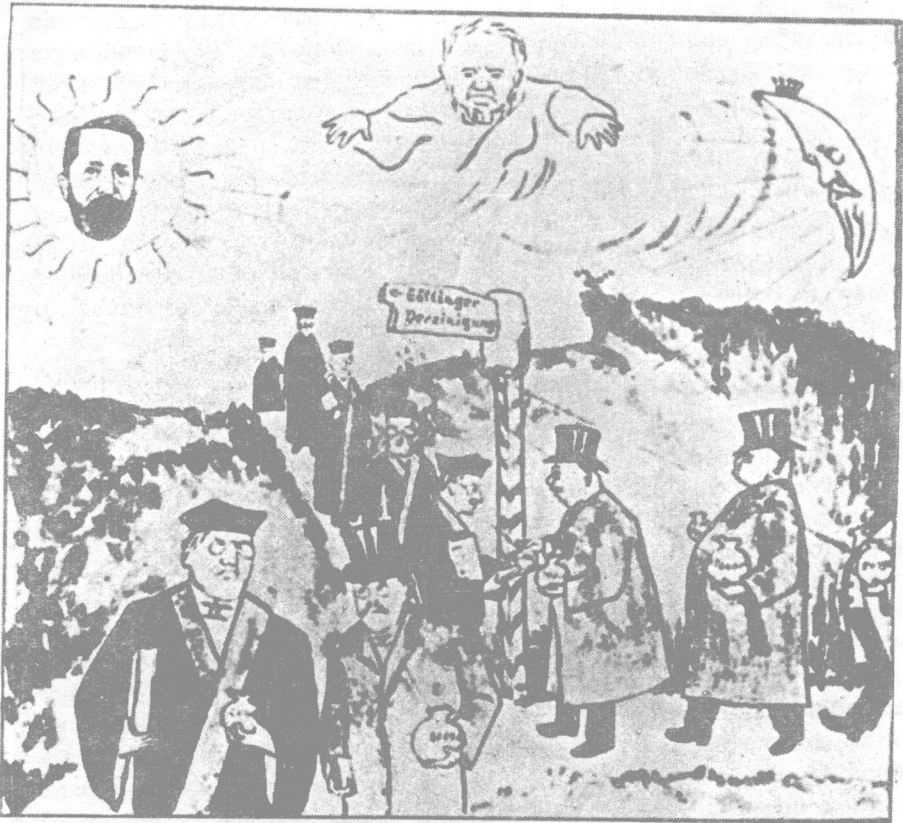




Max Planck in 1895.
Department of Terrestrial
Magnetism, Carnegie Insti-
tution of Washington.

Göttingen mathematicians at ease around 1905; Hermann Minkowski with moustache and David Hilbert reclining, with cane. Niels Bohr Library, American Institute of Physics, New York.





Cartoon illustrating the tenth anniversary meeting of the Göttingen Association for Applied Mathematics and Physics. A line of university professors, each bearing a large book and a small one, meets a line of industrialists carrying a large and a small purse. The small objects are exchanged, after which professors and industrialists continue on side by side. The transaction is overseen by Felix Klein, cast as the Sun; the Moon is probably Henry Theodore Böttinger, the leading industrialist behind the Association. Also present is the spirit of Friedrich Althoff, the Prussian educational authority who encouraged the Association. Niels Bohr Library, American Institute of Physics, New York.



Einstein in his Princeton study. © Lotte Jacobi.

Contents

Preface	xi
1 Einstein's education: mathematics and the laws of nature	1
The misperceived legacy of the Luitpold Gymnasium	1
The impact of the cantonal school at Aarau	9
Einstein's final examinations at Aarau	17
Uncongenial mathematics at Zurich	20
Conclusion	26
Notes and references	28
2 Audacious enterprise: the Einsteins and electrotechnology in late nineteenth-century Munich	35
Electrotechnology in late nineteenth-century Germany	35
The Einstein business	39
The Einsteins exhibit at Frankfurt	42
Financing a problematic expansion	46
The impact of the enterprise	50
Notes and references	53
3 <i>Einspänner</i>: the social roots of Einstein's world view	58
Adjusting to the circumstances of failure	58
The Jewish heritage and ethical predisposition	64
External forms and deep structure	69
Notes and references	76
4 Hermann Minkowski and Einstein's special theory of relativity	80
Introduction	80
Minkowski's interpretation of special relativity	81
Extending special relativity: Minkowski's theory of gravitation	88
Extending special relativity: Nordström's defence of Minkowski	91
Conclusion	94
Notes and references	96

5 Physics in the shadow of mathematics: the Göttingen electron-theory seminar of 1905	101
Introduction	101
The seminar syllabus	102
The seminar's leaders	105
Deriving the basic equations	110
Studying Abraham's electron dynamics	113
Rotating and accelerating electrons: Schwarzschild and Hertz	117
Sommerfeld: the outsider as insider	120
Electrons moving faster than light	123
Working in the shadow of mathematics	129
Notes and references	131
6 Relativity in late Wilhelmian Germany: the appeal to a pre-established harmony between mathematics and physics	137
Introduction	137
A classical vision	140
Pre-established harmony reconsidered	142
Pre-established harmony and Minkowskian relativity	145
Philosophical niceties	147
The triumph of pre-established harmony	151
Notes and references	154
7 Mathematics, education, and the Göttingen approach to physical reality, 1890–1914	158
The climate of education	159
The world picture of classical physics	162
The neohumanist imperative	166
Pure mathematics and the schools	168
The end of neohumanism	174
The new schoolteacher	176
The Göttingen offensive	178
Relativity misunderstood	183
Notes and references	188
8 Physical sense in relativity: Max Planck edits the <i>Annalen der Physik</i>, 1906–1918	194
Introduction	194
The <i>Annalen</i>	195
Planck and Wien take charge	199
The gatekeepers	203
Planck the editor	208
Notes and references	210