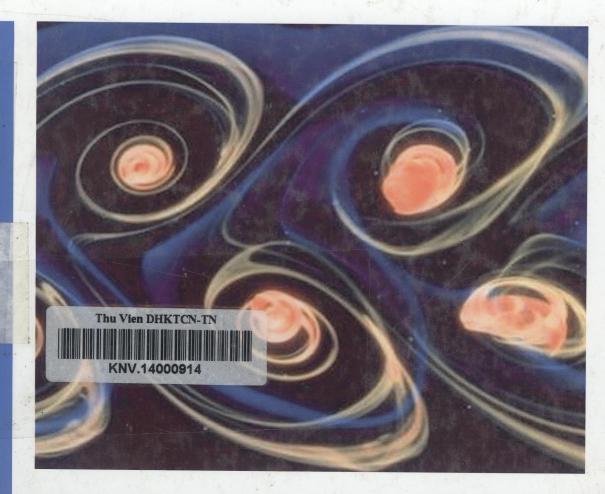
The Dawn of Fluid Dynamics

A Discipline between Science and Technology



Michael Eckert

The Dawn of Fluid Dynamics

A Discipline between Science and Technology



Michael Eckert

The Dawn of Fluid Dynamics

A Discipline between Science
and Technology

Related Titles

R. Ansorge

Mathematical Models of Fluiddynamics Modelling, Theory, Basic Numerical Facts - An Introduction

187 pages with 30 figures 2003 Hardcover ISBN 3-527-40397-3

J. Renn (ed.)

Albert Einstein - Chief Engineer of the Universe 100 Authors for Einstein. Essays

approx. 480 pages 2005 Hardcover ISBN 3-527-40574-7

D. Brian

Einstein - A Life

526 pages 1996 Softcover ISBN 0-471-19362-3

Michael Eckert

The Dawn of Fluid Dynamics

A Discipline between Science and Technology



The author of this book

Dr. Michael Eckert

Deutsches Museum München email: M.Eckert@deutsches-museum.de

Cover illustration

"Wake downstream of a thin plate soaked in a water flow" by Henri Werlé, with kind permission from ONERA, http://www.onera.fr

All books published by Wiley-VCH are carefully produced. Nevertheless, authors, editors, and publisher do not warrant the information contained in these books, including this book, to be free of errors. Readers are advised to keep in mind that statements, data, illustrations, procedural details or other items may inadvertently be inaccurate.

Library of Congress Card No.: applied for British Library Cataloging-in-Publication Data: A catalogue record for this book is available from the British Library. Bibliographic information published by Die Deutsche Bibliothek

Die Deutsche Bibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data is available in the Internet at http://dnb.ddb.de.

© 2006 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim

All rights reserved (including those of translation into other languages). No part of this book may be reproduced in any form – by photoprinting, microfilm, or any other means – nor transmitted or translated into a machine language without written permission from the publishers. Registered names, trademarks, etc. used in this book, even when not specifically marked as such, are not to be considered unprotected by law.

Typesetting Uwe Krieg, Berlin

Printing betz-druck GmbH, Darmstadt

Binding Litges & Dopf Buchbinderei GmbH,
Heppenheim

Printed in the Federal Republic of Germany Printed on acid-free paper

ISBN-13: 978-3-527-40513-8 **ISBN-10:** 3-527-40513-5

Contents

Preface /X

1	Diverging Trends before the Twentieth Century 1
1.1	Galileo's Abstraction 1
1.2	Hogs' Bladders in St. Paul's Cathedral 6
1.3	Ballistics 9
1.4	D'Alembert's Paradox 13
1.5	New Attempts to Account for Fluid Friction 15
1.6	Revival of Ideal Fluid Theory 18
1.7	Reynolds's Investigations of "Direct or Sinuous" Flow 22
1.8	Hydraulics and Aerodynamics: A Turn Towards Empiricism 24
1.9	Fluid Mechanics ca. 1900 28
2	The Beginnings of Fluid Dynamics in Göttingen, 1904–1914 31
2.1	Prandtl's Route to Boundary Layer Theory 32
2.2	"Per Experimentum et Inductionem Omnia" 38
2.3	The First Doctoral Dissertations on Boundary Layers 42
2.4	Airship Research 45
2.5	The Discovery of the Turbulent Boundary Layer 49
2.6	The Beginnings of Airfoil Theory 52
3	Aviation and the Rise of Aerodynamics in the First World War 57
3.1	A Symbiotic Relationship 59
3.2	War Contracts 63
3.3	Göttingen Profiles 67
3.4	Max Munk and the Foundation of Airfoil Theory 73
3.5	Theory and Practice in Airplane Design 76

VI Contents

4	The Internationalization of Fluid Mechanics in the 1920s 83
4.1	American Emissaries at Prandtl's Institute 84
4.2	Standardization 91
4.3	International Conferences 96
4.4	Applied Mathematics and Mechanics: A New International Discipline 100
4.5	Internationality in Practice: Max Munk at the NACA 102
5	A "Working Program" for Research on Turbulence 107
5.1	Turbulent Pipe Flow 108
5.2	Prandtl's Research Program on Turbulence 111
5.3	The Mixing Length Concept for the Fully Developed
	Turbulence 116
5.4	A Kind of Olympic Games 118
5.5	Wind Tunnel Turbulence 124
6	Aerodynamics Comes of Age 129
6.1	How Aerodynamics Became Institutionalized at Technical
	Universities 129
6.2	Glider Flight 134
6.3	Kármán and Junkers: The Beginnings of Industrial Consulting in
<i>c</i> 1	Aeronautics 138
6.4	Profile Measurements 142
6.5	Airfoil Theory 148
7	New Applications 153
7.1	Gas Dynamics 154
7.2	Cavitation 162
7.3	Meteorological and Geophysical Fluid Dynamics 167
7.4	The Scope of Fluid Dynamics by the Early 1930s 174
8	Prandtl, Fluid Dynamics and National Socialism 177
8.1	Preparing for War: Increased Funding for Prandtl's Institute 179
8.2	Aeronautical Science as an Instrument of Nazi Propaganda 187
8.3	Goodwill Ambassador 190
9	New Centers 195
9.1	Aachen 196
9.2	Pasadena 201
9.3	Zurich 207

10 10.1 10.2	Fluid Dynamics on the Eve of the Second World War Airfoil Theory 213 Turbulence 220	213
10.3 11	Gas Dynamics 228 Epilogue 233	

Appendix

Abbreviations 243

References 245

Author Index 271

Name Index 275

Subject Index 279