Cambridge University Press
978-1-107-12305-2 — Energy Deposition for High-Speed Flow Control
Doyle D. Knight
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Energy Deposition for High-Speed Flow Control

Written by a leading expert in the field, this book presents a novel method for controlling high-speed flows past aerodynamic shapes using energy deposition via direct current (DC), laser, or microwave discharge, and describes selected applications in supersonic and hypersonic flows. Emphasizing a deductive approach, the fundamental physical principles provided give an understanding of the simplified mathematical models derived therefrom.

These features, along with an extensive set of 55 simulations, make the book an invaluable reference that will be of interest to researchers and graduate students working in aerospace engineering and in plasma physics.

Doyle D. Knight is Distinguished Professor of Aerospace and Mechanical Engineering at Rutgers, the State University of New Jersey. His research interests include gas dynamics and design optimization. His research in gas dynamics includes shock wave–boundary layer interaction, incipient separation on pitching airfoils, turbulence model development, high-speed inlet unstart, and effects of unsteady energy deposition in supersonic flows. His research activity in design optimization focuses on the application of computational fluid dynamics to the automated optimal design of high-speed air vehicles. He is the author of *Elements of Numerical Methods for Compressible Flows* (Cambridge University Press, 2006).

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Energy Deposition for High-Speed Flow Control

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CAMBRIDGE
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University Printing House, Cambridge CB2 8BS, United Kingdom

One Liberty Plaza, 20th Floor, New York, NY 10006, USA

477 Williamstown Road, Port Melbourne, VIC 3207, Australia

314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre, New Delhi – 110025, India

79 Anson Road, #06–04/06, Singapore 079906

Cambridge University Press is part of the University of Cambridge.

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www.cambridge.org
Information on this title: www.cambridge.org/9781107123052
DOI: 10.1017/9781316389331

First published 2019

Printed in the United Kingdom by TJ International Ltd. Padstow Cornwall

A catalogue record for this publication is available from the British Library.

Library of Congress Cataloging-in-Publication Data
Names: Knight, Doyle, author.
Title: Energy deposition for high-speed flow control /
Doyle D. Knight (Rutgers, the State University of New Jersey).
Description: Cambridge ; New York, NY : Cambridge University Press, 2019. |
Series: Cambridge aerospace series ; 47 | Includes bibliographical references and indexes.
Identifiers: LCCN 2018043474 | ISBN 9781107123052 (hardback)
Subjects: LCSH: Aerodynamics. | Gas dynamics. | Air flow. | Fluid dynamics. |
Electric discharges. | Surface discharges (Electricity)
Classification: LCC QA930 .K5875 2019 | DDC 533/.62–dc23
LC record available at https://lccn.loc.gov/2018043474

ISBN 978-1-107-12305-2 Hardback

To Patrice

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Contents

Preface

The focus of this book is the emerging research area of energy deposition for flow control. The objective is to present the requisite material in an organized and understandable manner with a focus on analysis and understanding. The specific topics covered are energy deposition by DC, laser, and microwave discharge. The book omits any discussion of magnetohydrodynamics (MHD), magnetogasdynamics (MGD), and dielectric barrier discharge (DBD). The reader is referred to the extensive literature on these subjects.

I would like to express my appreciation to Prof. Wolfgang Schröder, Chair of Fluid Mechanics and Head of the Institute of Aerodynamics, RWTH Aachen University, for his kindness and hospitality during my sabbatical at the Institute of Aerodynamics in Fall 2013, where a significant part of this book was written. I also express my appreciation to my editors Peter Gordon and Steven Elliott, and Jade Taylor-Salazar, content manager (STM), at Cambridge University Press for their guidance and patience. A special thanks to Nadia Kianvashrad for her assistance with the figures, Dinesh Singh Negi at Cambridge TEX support, and to Mahnaz Shokrpour for her encouragement and support.

Following Druyvesteyn and Penning (1940), the term “molecules” is used throughout the book to indicate monatomic as well as polyatomic particles.

New Brunswick, NJ