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Elements of Aerospace Engineering

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MACH WAVE AND ACOUSTICAL WAVE STRUCTURE IN NONEQUILIBRIUM GAS- PARTICLE FLOWS

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Cambridge University Press
978-1-108-96488-3 — Mach Wave and Acoustical Wave Structure in Nonequilibrium Gas-Particle
Flows
Joseph T. C. Liu
Frontmatter
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CAMBRIDGE
UNIVERSITY PRESS

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
103 Penang Road, #05–06/07, Visioncrest Commercial, Singapore 238467

Cambridge University Press is part of the University of Cambridge.

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education, learning, and research at the highest international levels of excellence.

www.cambridge.org
Information on this title: www.cambridge.org/9781108964883
DOI: 10.1017/9781108990585

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First published 2021

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

ISBN 978-1-108-96488-3 Paperback
ISSN 2631-7850 (online)
ISSN 2631-7842 (print)

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DOI: 10.1017/9781108990585
First published online: September 2021

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Abstract: In this Element, the gas-particle flow problem is formulated with momentum and thermal slip that introduces two relaxation times. Starting from acoustical propagation in a medium in equilibrium, the relaxation-wave equation in airfoil coordinates is derived through a Galilean transformation for uniform flow. Steady planar small perturbation supersonic flow is studied in detail according to Whitham's higher-order waves. The signals owing to wall boundary conditions are damped along the frozen-Mach wave, and are both damped and diffusive along an effective-intermediate Mach wave and diffusive along the equilibrium Mach wave where the bulk of the disturbance propagates. The surface pressure coefficient is obtained exactly for small-disturbance theory, but it is considerably simplified for the small particle-to-gas mass loading approximation, equivalent to a simple-wave approximation. Other relaxation-wave problems are discussed. Martian dust-storm properties in terms of gas-particle flow parameters are estimated.

Keywords: Mach waves, gas-particle flow, wall pressure coefficient, analytical methods, acoustic waves

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ISBNs: 9781108964883 (PB), 9781108990585 (OC)
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To
Shôn E. Ffowcs Williams
Sau-Hai (Harvey) Lam
Lester Lees
M. James Lighthill
Frank E. Marble
Ronald F. Probstein
J. Trevor Stuart
with respect and gratitude

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