

A. Majda

Compressible Fluid Flow and Systems of Conservation Laws in Several Space Variables



Springer Science+Business Media, LLC

A. Majda
Department of Mathematics
University of California
Berkeley, CA 94720
U.S.A.

AMS Classification: 76NXX, 76L05, 73D05

ISBN 978-0-387-96037-1 ISBN 978-1-4612-1116-7 (eBook)
DOI 10.1007/978-1-4612-1116-7

Library of Congress Cataloging in Publication Data
Majda, Andrew

Compressible fluid flow and systems of con-
servation laws in several space variables.

(Applied mathematical sciences ; v. 53)

Bibliography: p.

Includes index.

1. Fluid dynamics. 2. Compressibility.
3. Conservation laws (Physics) 4. Variables
(Mathematics) I. Title. II. Series: Applied
mathematical sciences (Springer-Verlag New York
Inc.) ; v. 53.

QA1.A647 vol. 53 [QA911] 510 s [532'.05] 84-10601

© 1984 by Springer Science+Business Media New York
Originally published by Springer-Verlag New York, Inc in 1984
All rights reserved. No part of this book may be translated or reproduced in
any form without written permission from Springer Science+Business Media,
LLC.

9 8 7 6 5 4 3 2 1

Table of Contents

	Page
ACKNOWLEDGMENTS	v
CHAPTER 1. INTRODUCTION	1
1.1. Some Physical Examples of Systems of Conservation Laws	3
1.2. The Importance of Dissipative Mechanisms	7
1.3. The Common Structure of the Physical Systems of Conservation Laws and Friedrichs' Theory of Symmetric Systems	9
1.4. Linear and Nonlinear Wave Propagation and the Theory of Nonlinear Simple Waves	12
1.5. Weakly Nonlinear Asymptotics - Nonlinear Geometric Optics	16
1.6. A Rigorous Justification of Weakly Nonlinear Asymptotics in a Special Case	19
1.7. Some Additional Applications of Weakly Nonlinear Asymptotics in the Modeling of Complex Systems	22
Bibliography for Chapter 1	27
CHAPTER 2. SMOOTH SOLUTIONS AND THE EQUATIONS OF INCOMPRESSIBLE FLUID FLOW	30
2.1. The Local Existence of Smooth Solutions for Systems of Conservation Laws	34
2.2. A Continuation Principle for Smooth Solutions	46
2.3. Uniformly Local Sobolev Spaces	48
2.4. Compressible and Incompressible Fluid Flow	51
2.5. Equations for Low Mach Number Combustion	72
Bibliography for Chapter 2	79
CHAPTER 3. THE FORMATION OF SHOCK WAVES IN SMOOTH SOLUTIONS	81
3.1. Shock Formation for Scalar Laws in Several Space Variables	84
3.2. Shock Formation in Plane Wave Solutions of General $m \times m$ Systems	88
3.3. Detailed Results on Shock Formation for 2×2 Systems	94
3.4. Breakdown for a Quasi-Linear Wave Equation in 3-D	107
3.5. Some Open Problems Involving Shock Formation in Smooth Solutions	108
Bibliography for Chapter 3	109
CHAPTER 4. THE EXISTENCE AND STABILITY OF SHOCK FRONTS IN SEVERAL SPACE VARIABLES	111
4.1. Nonlinear Discontinuous Progressing Waves in Several Variables - Shock Front Initial Data	113
4.2. Some Theorems Guaranteeing the Existence of Shock Fronts	120

	Page
CHAPTER 4. (cont.)	
4.3. Linearization of Shock Fronts	133
4.4. An Introduction to Hyperbolic Mixed Problems	138
4.5. Quantitative Estimates for Linearized Shock Fronts	147
4.6. Some Open Problems in Multi-D Shock Wave Theory	153
Bibliography for Chapter 4	155
INDEX	157