

<<统一坐标系下的计算流体力学方法>>

图书基本信息

书名：<<统一坐标系下的计算流体力学方法>>

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作者：许为厚(Wai How Hui) 著

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内容概要

本书是运用大规模数值计算来解决流体的运动问题。

众所周知，在流体计算中，一个给定流场的数值解是该流场的流动状态在为其设定的坐标中的体现。计算流体力学通常使用的两个坐标系，即欧拉坐标系和拉格朗日坐标系，既有优点又有不足。

欧拉方法相对简单，但是其不足在于：(a) 对接触间断的分辨率不足；(b) 在流体计算之前先要生成贴体坐标。

相反地，拉格朗日方法很好地分辨出接触间断（包括物质界面和自由面），但它的缺点在于：(a) 气体动力方程不能写成守恒型偏微分方程的形式，使得数值计算复杂和缺乏唯一性；(b) 由于网格扭曲导致计算中断。

因此，计算流体力学的基本问题除了深刻理解物理流动之外，同时也要寻找"最优的"坐标系。

统一坐标系方法是《统一坐标系下的计算流体力学方法》第一作者许为厚教授在前人坐标变换的基础上的进一步发展，并在与其同事多年的合作中建立起来的。

在计算流体力学的研究中寻找"最优的"坐标系肯定还会继续下去，目前为止，统一坐标系可较好地结合前两种坐标系的优点，避免它们的不足。

例如，统一坐标系可以通过计算自动生成网格，而且网格速度也可以考虑加入避免网格大变形的"扩散"速度。

《统一坐标系下的计算流体力学方法》首先回顾了一维和多维计算流体力学中的欧拉、拉格朗日以及ALE (Arbitrary-Lagrangian-Eulerian) 方法的优缺点以及各种移动网格方法，然后系统介绍了统一坐标法，用一些具体的算例阐明它和现有方法之间的关系。

书籍目录

Chapter 1 Introduction

1.1 CFD as Numerical Solution to Nonlinear Hyperbolic PDEs

1.2 Role of Coordinates in CFD

1.3 Outline of the Book

References

Chapter 2 Derivation of Conservation Law Equations

2.1 Fluid as a Continuum

2.2 Derivation of Conservation Law Equations in Fixed Coordinates

2.3 Conservation Law Equations in Moving Coordinates

2.4 Integral Equations versus Partial Differential Equations

2.5 The Entropy Condition for Inviscid Flow Computation

References

Chapter 3 Review of Eulerian Computation for 1-D Inviscid Flow

3.1 Flow Discontinuities and Rankine-Hugoniot Conditions

3.2 Classification of Flow Discontinuities

3.3 Riemann Problem and its Solution

3.4 Preliminary Considerations of Numerical Computation

3.5 Godunov Scheme

3.6 High Resolution Schemes and Limiters

3.7 Defects of Eulerian Computation

References

Chapter 4 1-D Flow Computation Using the Unified Coordinates

4.1 Gas Dynamics Equations Based on the Unified Coordinates

4.2 Shock-Adaptive Godunov Scheme

4.3 The Use of Entropy Conservation Law for Smooth Flow Computation

4.4 The Unified Computer Code

4.5 Cure of Defects of Eulerian and Lagrangian Computation by the UC Method

4.6 Conclusions

References

Chapter 5 Comments on Current Methods for Multi-Dimensional Flow Computation

5.1 Eulerian Computation

5.2 Lagrangian Computation

5.3 The ALE Computation

5.4 Moving Mesh Methods

5.5 Optimal Coordinates

References

Chapter 6 The Unified Coordinates Formulation of CFD

6.1 Hui Transformation

6.2 Geometric Conservation Laws

6.3 Derivation of Governing Equations in Conservation Form

References

Chapter 7 Properties of the Unified Coordinates

7.1 Relation to Eulerian Computation

7.2 Relation to Classical Lagrangian Coordinates

7.3 Relation to Arbitrary-Lagrangian-Eulerian Computation

7.4 Contact Resolution

7.5 Mesh Orthogonality

7.6 Unified Coordinates for Steady Flow

7.7 Effects of Mesh Movement on the Flow

7.8 Relation to Other Moving Mesh Methods

7.9 Relation to Mesh Generation and the Level-Set Function

Method

References

Chapter 8 Lagrangian Gas Dynamics

8.1 Lagrangian Gas Dynamics Equations

8.2 Weak Hyperbolicity

8.3 Non-Equivalency of Lagrangian and Eulerian Formulation

References

Chapter 9 Steady 2-D and 3-D Supersonic Flow

9.1 The Unified Coordinates for Steady Flow

9.2 Euler Equations in the Unified Coordinates

9.3 The Space-Marching Computation

9.4 Examples

.....

Chapter 10 Unsteady 2-D and 3-D Flow Computation

Chapter 11 Viscous Flow Computation Using Navier-Stokes

Equations

Chapter 12 Applications of the Unified Coordinates to Kinetic

Theory

Chapter 13 Summary

Appendix A Riemann Problem for 1-D Flow in the Unified

Coordinate

Appendix B Computer Code for 1-D Flow in the Unified Coordinate

章节摘录

插图：(2) Practical methods for computing solutions with shock discontinuities are developed: the artificial viscosity method of von Neumann and Richtmyer which smears shock discontinuities[4]; the Godunov method which reduces the general initial value problem to a sequence of Riemann problems with cell-averaging data[5]; the Glimm random choice method which also reduces the general initial value problem to a sequence of Riemann problems but with data of randomly chosen representative states[6, 7]; and the shock-fitting (front tracking) method[S]. The last two methods are not easily extended to the three-dimensional flow. (3) A very important discovery was made by Lax and Wendroff[9] that in order to numerically capture shock discontinuities correctly, the governing PDE should be written in conservation form to begin with. This is easily done in Eulerian coordinates (in any dimensions) and also for one-dimensional flow in Lagrangian coordinates. But for a long time, it was not known how to use Lagrangian coordinates to write the governing PDEs for multidimensional flows in conservation form. This problem was solved by Hui et al.

编辑推荐

《统一坐标系下的计算流体力学方法》编辑推荐：This book reviews the relative advantages and drawbacks of Eulerian and Lagrangian coordinates as well as the Arbitrary Lagrangian-Eulerian (ALE) and various moving mesh methods in Computational Fluid Dynamics (CFD) for one and multidimensional flows. It then systematically introduces the unified coordinate approach to CFD, illustrated with numerous examples and comparisons to clarify its relation with existing approaches. The book is intended for researchers and practitioners in the field of Computational Fluid Dynamics. Emeritus Professor Wai-How Hui and Professor Kun Xu both work at the Department of Mathematics of the Hong Kong University of Science & Technology, China.

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