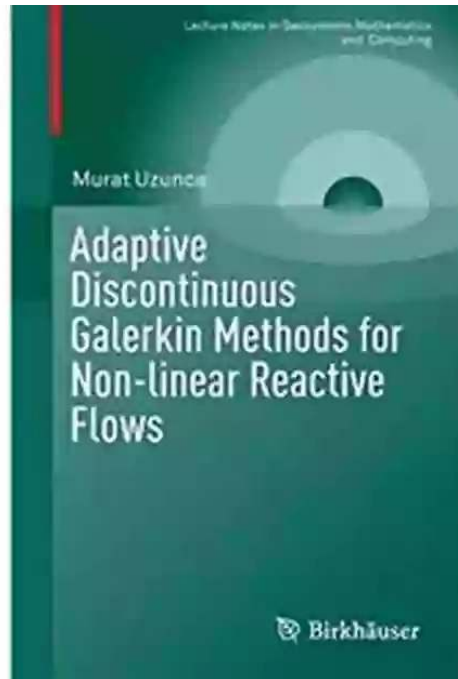


Unleashing the Power of Adaptive Discontinuous Galerkin Methods for Non-Linear Reactive Flows Lecture



In the realm of numerical methods for simulating fluid flow phenomena, the quest for accuracy, efficiency, and flexibility is ever-present. When it comes to non-linear reactive flows, the challenges magnify, requiring sophisticated techniques to capture the intricacies and dynamics involved. Enter the world of adaptive discontinuous Galerkin methods, a cutting-edge approach that unleashes an unparalleled power to model and simulate these complex systems.

What are Adaptive Discontinuous Galerkin Methods?

Adaptive discontinuous Galerkin methods (ADGM) are numerical techniques that combine the advantages of discontinuous Galerkin methods (DGM) with adaptive mesh refinement strategies. DGM is a numerical framework that discretizes the governing equations into smaller elements, allowing for discontinuities within the

solution. By incorporating adaptive mesh refinement, ADGM dynamically refines or coarsens the mesh based on error estimates, enhancing accuracy and computational efficiency.



Adaptive Discontinuous Galerkin Methods for Non-linear Reactive Flows (Lecture Notes in Geosystems Mathematics and Computing)

by John Everard(1st ed. 2016 Edition, Kindle Edition)

★★★★☆ 4.4 out of 5

Language : English

File size : 4107 KB

Screen Reader : Supported

Print length : 114 pages



Applications in Non-Linear Reactive Flows

The applications of ADGM in the field of non-linear reactive flows are vast and diverse. From combustion to chemical reactions, ADGM enables researchers to accurately simulate and analyze complex systems with intricate reactions occurring at various scales. By utilizing adaptive mesh refinement, numerical simulations can capture detailed phenomena, such as shock waves, flame fronts, and combustion instabilities.

One notable application of ADGM in non-linear reactive flows is the simulation of turbulent combustion. Turbulent combustion involves an intricate interplay of fluid dynamics, chemical kinetics, and heat transfer. ADGM allows researchers to account for these multidimensional effects, perform high-fidelity simulations, and gain insights into the behavior and efficiency of combustion systems.

Advantages and Challenges

ADGM offers several advantages over traditional numerical methods for non-linear reactive flows:

- **Accuracy:** ADGM leverages the flexibility of DGM to accurately capture discontinuities and complex phenomena within the flow.
- **Efficiency:** Adaptive mesh refinement optimizes the computational resources by adaptively allocating more computational power to areas of interest and reducing the computational effort where accuracy is already achieved.
- **Flexibility:** ADGM can handle a wide range of chemical reactions and combustion models, making it suitable for various applications.

However, ADGM also presents challenges:

- **Implementation Complexity:** The implementation of ADGM requires a solid understanding of numerical methods, adaptivity techniques, and fluid dynamics, making it a challenging task for beginners.
- **Computational Requirements:** ADGM simulations demand significant computational resources due to the fine-grained mesh and potentially high-dimensional systems.
- **Convergence Issues:** The non-linear nature of reactive flows can introduce convergence challenges, requiring careful consideration of time-stepping schemes and stabilization techniques.

Future Directions and Opportunities

The field of adaptive discontinuous Galerkin methods for non-linear reactive flows is continuously evolving. Ongoing research focuses on further enhancing

accuracy, reducing computational costs, and addressing convergence challenges.

Future developments aim to:

- **Improve Adaptivity:** Advanced adaptivity strategies that can dynamically adjust the mesh and handle complex flow features more efficiently.
- **Parallelization:** Utilize parallel computing techniques to exploit the power of modern high-performance computing architectures.
- **Multi-scale Modeling:** Integrate ADGM with multi-scale modeling techniques to capture the interaction between different length and time scales.

The lecture on adaptive discontinuous Galerkin methods for non-linear reactive flows has shed light on a powerful numerical approach that tackles the complexities of simulating and analyzing reactive flow phenomena. With its ability to capture intricate details and adaptively refine the computational mesh, ADGM opens up new possibilities for studying non-linear reactive flows in various applications.

As research continues in this field, the future holds promise for further advancements, enabling accurate simulations, reducing computational costs, and ultimately leading to better design and optimization of combustion, chemical, and reactive flow systems.

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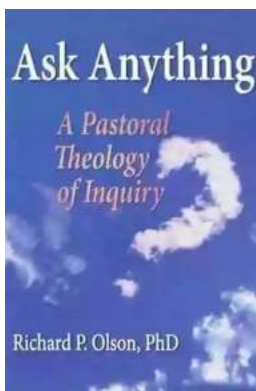
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The focus of this monograph is the development of space-time adaptive methods to solve the convection/reaction dominated non-stationary semi-linear advection diffusion reaction (ADR) equations with internal/boundary layers in an accurate and efficient way. After introducing the ADR equations and discontinuous Galerkin discretization, robust residual-based a posteriori error estimators in space and time are derived. The elliptic reconstruction technique is then utilized to derive the a posteriori error bounds for the fully discrete system and to obtain optimal orders of convergence. As coupled surface and subsurface flow over large space and time scales is described by (ADR) equation the methods described in this book are of high importance in many areas of Geosciences including oil and gas recovery, groundwater contamination and sustainable use of groundwater resources, storing greenhouse gases or radioactive waste in the subsurface.



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