

Accepted Manuscript

Iterative finite element variational multiscale method for the incompressible Navier–Stokes equations

Yamiao Zhang, Jiazhong Zhang, Lianning Zhu

PII: S0377-0427(18)30103-1
DOI: <https://doi.org/10.1016/j.cam.2018.02.024>
Reference: CAM 11530

To appear in: *Journal of Computational and Applied Mathematics*

Received date: 10 May 2016
Revised date: 26 October 2017

Please cite this article as: Y. Zhang, J. Zhang, L. Zhu, Iterative finite element variational multiscale method for the incompressible Navier–Stokes equations, *Journal of Computational and Applied Mathematics* (2018), <https://doi.org/10.1016/j.cam.2018.02.024>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



Iterative finite element variational multiscale method for the incompressible Navier-Stokes equations[☆]

Yamiao Zhang^a, Jiazhong Zhang^{a,*}, Lianning Zhu^a

^a*School of Energy and Power Engineering, Xi'an Jiaotong University, Xi'an 710049, China*

Abstract

Three iterative finite element variational multiscale methods are proposed and applied to the numerical simulation of the Navier-Stokes equations. The main idea of these methods is to combine the finite element variational multiscale method based on two local Gauss integrations with three different iterative schemes. The existence and uniqueness of approximate solutions of these iterative finite element variational multiscale methods are proved firstly, and then the convergence and error estimates of them are deduced. Finally, some numerical examples are given to support the theoretical analysis. The numerical results show that the iterative finite element variational multiscale method has a wider range of Reynolds numbers than standard Galerkin iterative finite element method, and the Oseen iterative scheme is much more efficient than the other two under high Reynolds numbers.

Keywords: iterative scheme, variational multiscale method, high Reynolds number, Navier-Stokes equations

2010 MSC: 65N55, 76D05, 76M10

1. Introduction

The incompressible Navier-Stokes equations are the fundamental partial differential equations that describe the flow of the viscous Newtonian fluids, and the finite element method is one of the major tools used in numerical simulations of them [1, 2]. However, when solve the Navier-Stokes equations using the standard Galerkin finite element method at high Reynolds numbers, spurious numerical oscillations may occur in numerical results due to the domination of convection term. So it is challenging for constructing some stabilized finite element methods which are robust and efficient at a wide range of Reynolds numbers, especially at high Reynolds numbers.

There are numerous works on the stabilized finite element methods to overcome this defect, such as the defect-correction methods [3-6], the two-level and multi-level methods [7-11], the subgrid stabilized methods [12-16], and the techniques based on the variational multiscale method [17-19]. Among them,

[☆]This work was supported by 973 Program (No.2012CB026002), the NSF of China (No.51305355) and the National Key Technology R&D Program of China (No. 2013BAF01B02).

*Corresponding author: Tel: +86 029 82664177; Fax: +86 029 82668723.

Email addresses: yamiao_zhang@163.com (Yamiao Zhang), jzzhang@mail.xjtu.edu.cn (Jiazhong Zhang), zln.0423@stu.xjtu.edu.cn (Lianning Zhu)

Download English Version:

<https://daneshyari.com/en/article/8901970>

Download Persian Version:

<https://daneshyari.com/article/8901970>

[Daneshyari.com](https://daneshyari.com)