A SPECTRAL-FINITE ELEMENT METHOD FOR FLUID FLOW WITH LOW MACH NUMBER

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ABSTRACT

A combined Fourier Spectral and finite element method for sloving two-dimensional, semi-periodic problem for fluid flow with low Mach number. Fourier Spectral method and finite element method are employed in the periodic and non-periodic directions respectively. A class of fully discrete scheme are constructed and strict error estimation are proved.

1. INTRODUCTION

The incompressible flow with low Mach number is governed by the following differential equations [1]:

$$\frac{\partial U}{\partial t} + (U\cdot\nabla)U + \nabla P - \nu\nabla^2 U = f, \qquad \text{in } \Omega\times(0,T],$$

$$\nabla\cdot U = 0, \qquad \text{in } \Omega\times(0,T],$$

$$U(x,0) = U_0(x), \qquad P(x,0) = P_0(x) \tag{1.1}$$

$\tilde{I}$, and $I = \{x/\ |x|<1 \quad \tilde{I} = \{y/\ 0< |y|<\pi\}$, and $U = (U^1, U^2)$, $\nu > 0$ be the velocity, the ratio of pressure over density, the body force, and the Kinetic viscosity respectively. The functions U, P and f have period 2π for the variables and that

$$U(0,y,t) = U(1,y,t), \qquad \forall\ y,t \in \tilde{I}\times(0,T].$$

In addition, P satisfies the following normalizing condition:

$$\iint_{\Omega} P(x,y,t)\,dxdy = 0. \qquad t \in (0,T]. \tag{1.2}$$