Accepted Manuscript

A stable weak Galerkin finite element method for Stokes problem

Tie Zhang, Tao Lin

PII: S0377-0427(17)30551-4
DOI: https://doi.org/10.1016/j.cam.2017.10.042
Reference: CAM 11372

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

Received date : 28 December 2016
Revised date : 25 July 2017

Please cite this article as: T. Zhang, T. Lin, A stable weak Galerkin finite element method for Stokes problem, *Journal of Computational and Applied Mathematics* (2017), https://doi.org/10.1016/j.cam.2017.10.042

A Stable Weak Galerkin Finite Element Method for Stokes Problem

Tie Zhang*, Tao Lin†

*Department of Mathematics, Northeastern University, Shenyang 110004, China
†Department of Mathematics, Virginia Tech University, Virginia, USA

Abstract

We study the weak Galerkin finite element method for Stokes problem. A new weak Galerkin finite element velocity-pressure space pair is presented which satisfies the discrete inf-sup condition. Based on this space pair, we establish a stable weak Galerkin approximation scheme without adding any stability term or penalty term. Then, we further derive the optimal error estimates for velocity and pressure approximations, respectively. Numerical experiments are provided to illustrate the theoretical analysis.

Keywords: Weak Galerkin method; Stokes problem; Stability; Optimal error estimate

2000 MSC: 65N15, 65N30, 65M60

1. Introduction

Recently, the weak Galerkin finite element method has attracted much attention in the field of numerical partial differential equations [7, 9, 10, 11, 13, 15, 16, 17, 18, 19, 20]. This method was introduced and analyzed originally in [15] for second order elliptic problems in multi-dimensional domain. In general, a weak Galerkin finite element method can be considered as an extension of the standard finite element method where classical derivatives are replaced in the variational equation by the weakly defined derivatives on discontinuous weak functions. The main feature of this method is: (1) the weak derivatives are introduced as distributions for weak functions; (2) the weak Galerkin finite element function $u_h = \{u_h^0, u_h^b\}$ is used in which u_h^0 is totally discontinuous on the partition and the value u_h^b of u_h on element edge may be independent with its value u_h^0 in the interior of element. The readers are referred to articles [9, 11, 16] for more detailed

*Corresponding author at: Department of Mathematics, Northeastern University, Shenyang 110004, China. *E-mail address* : zhangt@mail.neu.edu.cn(T. Zhang). Tel & Fax: +86-024-83680949.