Nonconforming Finite Element Methods for Cavity Flows

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Abstract

The solution of the Navier–Stokes equation in an open cavity is singular at the two corners of open cavity boundary. Therefore, standard conforming finite element methods, without any special modification, are not suitable approaches to approximate the discontinuous behavior at the two corners. Instead, nonconforming finite element methods, which are discontinuous, may be better choices than the conforming ones.

In this talk, we introduce and analyze a “stable cheapest nonconforming finite element” pair on rectangular grids [KYS15], with modification on the corner elements adopting the nonconforming finite element method introduced by Cai–Douglas–Ye [CDY99, DSSY99]. Except at these two corner elements, for all other elements we use the simplest $P_1$ nonconforming quadrilateral element [PS03] for the approximation of each component of velocity fields plus a globally one-dimensional bubble space, while the pressure is approximated by the piecewise constant element.

Some numerical and mathematical comparisons ensure the simplicity and superiority in capturing the correct physical properties of cavity flow over other finite element methods. The numerical evidence with this element show simpler and cheaper elements can catch more precise physical characteristics.

This talk is mainly based on the paper [LS15], jointly written by Roktaek Lim.

References


