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Axial Green function method for the incompressible Navier-Stokes flows

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Since the advent of the Axial Green function method(AGM) in 2008, we have developed and improved it for various purposes. The first one is for the general elliptic problems with variable coefficients [1], which is a scalar equation. This AGM was extended to the problems with interface discontinuities and was equipped with adaptive refinements for the accurate numerical solution in complicated domains. For the refinement, we need a localization of discretization stuff, named axial lines. Through the convection-dominated diffusion equation[2], we have successfully done with this. Meanwhile, the Stokes flow, which is a system of partial differential equations, is considered[3]. Using this method as a stepping stone, we head towards the Navier-Stokes flows in complicated domains using a kind of projection method. For stability, we modified the traditional Crank-Nicolson scheme and time discretization through the axial Green functions in AGM. To demonstrate the ease of use and the solution accuracy as an AGM Navier-Stokes solver, we calculate the square cavity flow up to Re=3200, the backward-facing step flow up to Re=800, and the external flow passing through a circular cylinder up to Re=100. The previous two flows are both steady state and the last one is in general unsteady. Comparing our results to other reliable data, we conclude that our AGM Navier-Stokes solver is a promising approach to calculate incompressible viscous flows in complicated domains.

REFERENCES

[1] D.W. Kim, S.-K. Park, and S. Jun, Axial Green's function method for multidimensional elliptic boundary value problems. *Int. J. Numer. Methods Eng.*, Vol. **76**, no. 5, pp. 697–726, 2008.

[2] W. Lee, and D.W. Kim, Localized axial Green's function method for the convection–diffusion equations in arbitrary domains. *J. Comput. Phys.*, Vol. **275**, pp. 390–414, 2014.

[3] S. Jun and D.W. Kim, Axial Green's function method for steady Stokes flow in geometrically complex domains. *J. Comput. Phys.*, Vol. **230**, pp. 2095–2124, 2011.