6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 15 June 2018, Glasgow, UK

A NEW IMPLEMENTATION OF THE VORTEX METHOD

Robert Krasny[1*], Peter A. Bosler[2] and Ling Xu[3]

[1] University of Michigan, Department of Mathematics, 530 Church Street, Ann Arbor, Michigan, 48109 USA, krasny@umich.edu, www.math.lsa.umich.edu/∼krasny
[2] Center for Computing Research, Sandia National Laboratories, Albuquerque, New Mexico, 87123 USA, pabosle@sandia.gov, https://cfwebprod.sandia.gov/cfdocs/CompResearch/templates/insert/profile.cfm?pabosle
[3] University of Michigan, Department of Mathematics, 530 Church Street, Ann Arbor, Michigan, 48109 USA, lingxu@umich.edu, www.lingxu-human.com

Key words: *Incompressible Fluid Flow, Vortex Method, Lagrangian Particles, Remeshing, Adaptive Refinement, Treecode, Elliptic Vortex*

We discuss a new implementation of the vortex method for the incompressible Euler equations. This work focuses on general vorticity distributions as opposed to vortex sheets. As usual in a vortex method the vorticity is carried by Lagrangian particles and the velocity is recovered by the Biot-Savart integral. The new implementation uses remeshing and adaptive refinement to maintain accuracy and resolve small-scale features in the flow [1, 2], and a treecode algorithm is used to reduce the CPU time from $O(N^2)$ to $O(N \log N)$, where N is the number of particles representing the vorticity [3]. The method is demonstrated for problems involving vortex dynamics on a rotating sphere and in two-dimensional free space including axisymmetrization of an elliptic vortex [4]. This work was supported by a John von Neumann Postdoctoral Fellowship at Sandia National Laboratories, Office of Naval Research grants N00014-12-1-0509 and N00014-14-1-0075, and grants from the Mcubed program and the Michigan Institute for Computational Discovery and Engineering at the University of Michigan.

REFERENCES

[1] Bosler, P., Kent, J., Krasny, R. and Jablonowski, C. A Lagrangian particle method with remeshing for tracer transport on the sphere, J. Comput. Phys. (2017) **340**, pp. 639-654.

[2] Bosler, P., Wang, L., Jablonowski, C. and Krasny, R. A Lagrangian particle/panel method for the barotropic vorticity equations on a rotating sphere, Fluid Dyn. Res. (2014) **46**, 031406.

[3] Lindsay, K. and Krasny, R. A particle method and adaptive treecode for vortex sheet motion in three-dimensional flow, J. Comput. Phys. (2001) **172**, pp. 879-907.

[4] Koumoutsakos, P. Inviscid axisymmetrization of an elliptical vortex. J. Comput. Phys. (1997) **138**, pp. 821-857.