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Computation of Viscous Vortices with Fully Meshless Method

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Computing the interaction of viscous vortices using traditional CFD methods is severely hindered by numerical diffusion. In general, the vortices diffuse too rapidly to properly capture the details of their interaction with each other or with structures. To deal with this problem, a fully mesh-less method has been developed, which is characterized by non-diffusive truncation errors. It is a new formulation of the vortex particle method, using the core spreading scheme for viscous effects, and a mesh-less spatial adaption technique based on radial basis function (RBF) interpolation. Numerical experiments have demonstrated increased accuracy in comparison with the standard approach of remeshing with high-order kernels. Validation has been performed using a quadrupole-perturbed Gaussian monopole, which exhibits a quasi-steady tripole state that decays in the viscous time scale. The method has been implemented in parallel using the PETSc library, and a new application is being developed to study the viscous interaction of co-rotating vortices.

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