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Learning effective viscosity for moderate Reynolds number Navier-Stokes equations XIAOJUE ZHU, MICHAEL BRENNER, Harvard University — We propose that with an appropriately chosen effective viscosity $\nu(Re)$, a linearization of the Navier-Stokes equations perfectly captures the drag-determining features of flows around unsteady translating bodies, in the Reynolds number of order hundreds. Two ways are implemented to find the effective viscosity. First, $\nu(Re)$ is determined so that the time-averaged shapes of separatrix, a fluid surface that delimits the compact region of fluid that is entrained by the moving point force, match as closely as possible between the linearization equation and the Navier-Stokes equation. Second, $\nu(Re)$ is learned from a data-driven method, i.e. a deep neural network, by minimizing the mean squared error loss. We compare the results for the two methods, and we find that the data-driven method dramatically outperforms the former traditional method. We apply the linearization to the classical problem of predicting vortex shedding around a cylinder.

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