Drag, lift and Nusselt coefficients for ellipsoidal particles using Particle-Resolved Direct Numerical Simulations.

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Particle-Resolved Direct Numerical Simulations has been performed using Implicit Tensorial Viscous penalty method [1] with ellipsoidal particles to extract the drag and lift force excreted by the fluid on the particles and the Nusselt number of the particles. The simulations results are compared to existing correlations for a single ellipsoid by changing the incident angle at different Reynolds number (figure 1 right). A new Lagrange extrapolation coupled to a Taylor interpolation of high order [3] is used to calculate the drag, lift forces and the heat flux. This work is an extension to the one for a spherical particle [3].

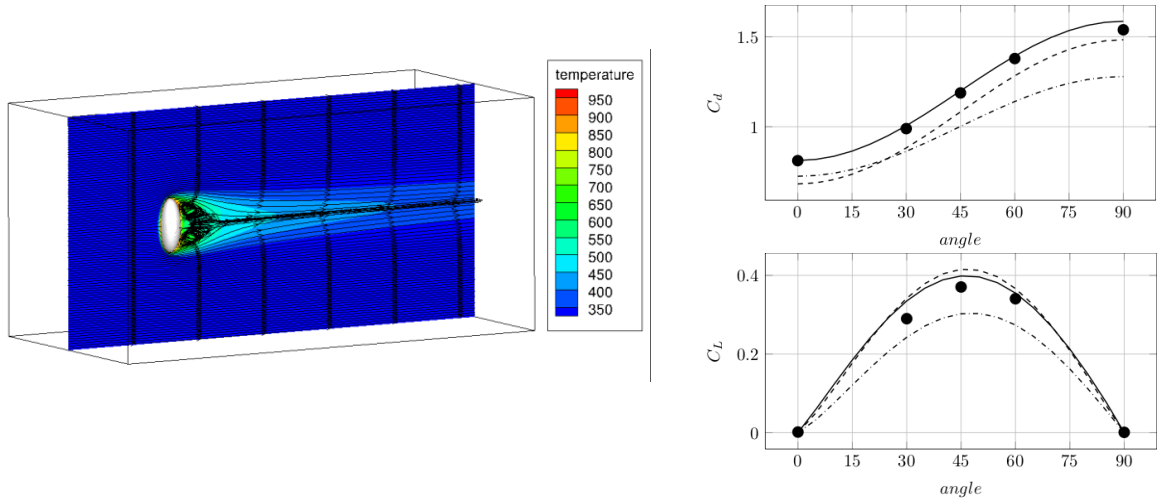

Figure1: left: Streamlines of a flow past a single ellipsoid with aspect ratio $r = 2.5$ at Re=100 - right: drag and lift coefficients for different orientation angles at Re=100: (—) Sanjeev [5],(– ·)Arcen [3], (---) Zastawny [4], (●) present work.

[1] S. Vincent, J.C. Brändle de Motta, A. Sarthou, J.-L. Estivalezes, O. Simonin, E. Climent, A Lagrangian VOF tensorial penalty method for the DNS of resolved particle laden flows, J. Comput. Phys., 256, pp. 582-614, 2014
[2] M.-A. Chadil, S. Vincent, J.-L. Estivalezes, Accurate estimate of forces on particles using particle-resolved direct numerical simulations, submitted to Acta Mechanica, 2018
[3] B. Arcen, R. Ouchene, M. Khalij, and A. Taniere. Prolate spheroidal particles behavior in a vertical wall-bounded turbulent flow. Physics of Fluids, 29(9):093301, 2017.
[4] M. Zastawny, G. Mallouppas, F. Zhao, and B. van Wachem. Derivation of drag and lift force and torque coefficients for non-spherical particles in flows. International Journal of Multiphase Flow, 39:227–239, 2012.
[5] S. K. P. Sanjeev, J. A. M. Kuipers, J. T. Padding. Drag, lift and torque correlations for non-spherical particles from Stokes limit to high Reynolds numbers. International Journal of Multiphase Flow, 2018.