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Hydrodynamic forces acting on a rigid fixed sphere in early transitional regimes. (English)

Zbl 1093.76014

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Summary: A spectral element code is used to investigate the hydrodynamic forces acting on a fixed sphere placed in a uniform flow in the Reynolds number interval 10–320 covering the early stages of transition, i.e. the steady axisymmetric regime with detached flow, and the steady non-axisymmetric and unsteady periodic regimes of sphere wake. The mentioned changes of regimes, shown by several authors to be related to regular Hopf bifurcations in the wake, result in significant changes of hydrodynamic action of the flow on the sphere. We show that the loss of axisymmetry is accompanied not only by an onset of lift, but also of a torque, and we give accurate values of drag, lift and torque in the whole interval of investigated Reynolds numbers. Among other results we show, moreover, that each bifurcation is accompanied also by a change of the trend of the drag versus Reynolds number, the overall qualitative effect of instabilities being an increase in drag.

MSC:

76D05 Navier-Stokes equations for incompressible viscous fluids

76M22 Spectral methods applied to problems in fluid mechanics

Cited in 18 Documents

Keywords:

spectral element code; bifurcations; lift; torque; drag

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