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An analytic approximation of the drag coefficient for the viscous flow past a sphere. (English)

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Summary: We give an analytic solution at the 10th order of approximation for the steady-state laminar viscous flows past a sphere in a uniform stream governed by the exact, fully nonlinear Navier-Stokes equations. A new kind of analytic technique, namely the homotopy analysis method, is applied, by means of which Whitehead's paradox can be easily avoided and reasonably explained. Different from all previous perturbation approximations, our analytic approximations are valid in the whole field of flow, because we use the same approximations to express the flows near and far from the sphere. Our drag coefficient formula at the 10th order of approximation agrees better with experimental data in a region of Reynolds number $R_d R_d$

MSC:

76D05	Navier-Stokes equations for incompressible viscous fluids
35Q30	Navier-Stokes equations
76M25	Other numerical methods (fluid mechanics) (MSC2010)

Keywords:

Laminar viscous flow; Sphere; Drag formula; Analytic approximations; Navier-Stokes equations; Homotopy analysis method

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