Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Effects of confinement on a rotating sphere[1] QIANLONG LIU, ANDREA PROSPERETTI, Johns Hopkins University — The hydrodynamic force and couple acting on a rotating sphere in a quiescent fluid are modified by nearby boundaries with possible consequences on spin-up and spin-down times of particles uspended in a fluid, their wall deposition, entraiment and others. Up to now, the vast majority of papers dealing with these problems have considered the low-Reynolds-number regime. This paper focuses on the effect of inertia on the hydrodynamic interaction of a spinning sphere with nearby boundaries. Rotation axes parallel and perpendicular to a plane boundary as well as other situations are studied. Several steady and transient numerical results are presented and interptreted in terms of physical scaling arguments. The Navier-Stokes equations for an incompressible, constant-property Newtonian fluid are solved by the finite-difference PHYSALIS method. Among the noteworthy features of this method are the fact that the no-slip condition at the particle surface is satisfied exactly and that the force and torque on the sphere are obtained directly as a by-product of the computation. This feature avoids the need to integrate the stress over the particle surface, which with other methods is a step prone to numerical inaccuracies. A locally refined mesh surrounding the particle is used to enhance the resolution of boundary layers maintaining a manageable overall computational cost.

[1]This research is supported by NSF under grants CBET-0625138 and CBET-0754344.

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Date submitted: 04 Aug 2009 Electronic form version 1.4