Abstract Submitted
for the DFD08 Meeting of
The American Physical Society

The effect of Reynolds number on the dynamics of freely rising and falling spheres M. HOROWITZ, C.H.K. WILLIAMSON, Cornell University — In this study, we investigate the effect of Reynolds number on the dynamics and vorticity patterns of spheres rising or falling freely through a fluid. Initially, our experiments focused on two Reynolds numbers, $Re = 450$ and 10,000. At both Re, all falling spheres, with a mass ratio (or density relative to the fluid), $m* > 1$, are found to descend rectilinearly. For rising spheres, we observe that contrary to previous studies, rectilinear trajectories persist until some critical mass ratio, $m*_{crit}$, below which the spheres suddenly begin to vibrate vigorously in a vertical plane. At $Re \approx 10{,}000$, we find $m*_{crit} = 0.61$, while at $Re = 450$, the critical mass is distinctly lower, $m*_{crit} = 0.36$. To explore the dynamics of spheres over a wide range of Re, we controlled the fluid viscosity using glycerin-water mixtures, and considered over 130 cases of $m* =$ 0.08-1.5 and $Re =$ 100-15,000. For all Re studied, we find a wide range of spheres that rise rectilinearly, yielding $m*_{crit}$ significantly below 1. The only regimes observed in our study are rectilinear motion and periodic zigzag vibration. The vortex wakes for the rectilinear regime resemble those of a fixed sphere at similar Re, either a single-sided chain ($Re = 450$), or a double-sided chain ($Re \approx$ 10,000) of vortex rings. However, for the whole range of Re studied, we discover that the periodic zigzag regime is associated with a new vortex formation mode comprising *four vortex rings* per cycle of oscillation.

Charles Williamson
Cornell University

Date submitted: 31 Jul 2008 Electronic form version 1.4