Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Spin-down of a rotating air hockey disk PATRICK WEIDMAN, KEITH JULIEN, University of Colorado — We extend the work of Weidman (APS, DFD 2008) on the steady float height of a rotating disk to formulate and solve for the unsteady behavior of spin-down to rest. A similarity reduction of the Navier-Stokes equations reduces the problem to a coupled pair of partial differential equations in space and time. For a disk of fixed radius and density, the PDE's must be solved taking into account constraints imposed by the aerodynamic torque and aerodynamic lift. Thus the full solution for the unsteady azimuthal and axial dynamics of the disk can be obtained for given initial values of disk Reynolds number $R = W\,h/\nu$ and dimensionless disk rotation speed $S = \sqrt{2}\Omega h/W$, where h is the float height, W is the fluid levitation velocity, Ω is the disk rotation rate, and ν is the kinematic viscosity of the fluid. Integrations reveal interesting families of solutions when plotted over steady solution curves in R-S parameter space and vindicate the quasi-steady spin-down theory reported in earlier work, valid only in a restricted region of parameter space.

Patrick Weidman
University of Colorado

Date submitted: 29 Jul 2013 Electronic form version 1.4