Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Dynamics of Arrays of Falling Cylinders and Modeling of Collisions Using the Lubrication Theory AÇMAE EL YACOUBI, Cornell University, SHENG XU, Southern Methodist University, Z. JANE WANG, Cornell University — Motivated by our interest in understanding collective behavior and self-organization resulting from hydrodynamic interactions, we investigate the dynamics of horizontal arrays of settling cylinders at intermediate Re. Here, we focus on pairwise interactions by quantifying the interaction force for a pair of cylinders and its dependence on the initial spacing d_0. We fiund that the pair initially experiences a repulsive force which varies as $1/d_0^{\alpha},\ \alpha > 0$. We then study the dynamics of a falling cylinder in presence of its left and right neighbors and compare them to those of an isolated cylinder and with results in Stokes flow. Our findings show that, unlike in Stokes flow, the middle cylinder experiences a higher drag force due to the presence of co-moving cylinders, resulting in a slower settling velocity. Additionally, the smaller d_0, the sooner wake asymmetries for the middle cylinder arise and the sooner it settles to steady-state. For small d_0 or for large collections of cylinders ($n > 5$), collisions occur. Instead of using an *ad hoc* collision model, we derive the interstitial pressure field using the lubrication theory. The lubrication pressure and shear force are then used to compute the repulsive force during the approach phase between two particles. Results using this theory will be compared to those using a simple dry collision model.

Acmae El Yacoubi
Cornell University

Date submitted: 03 Aug 2011 Electronic form version 1.4