Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Numerical investigation of the water entry of cylinders with and without spin ARETI KIARA, RUBEN PAREDES, DICK K.P. YUE, Massachusetts Institute of Technology — We perform laminar, weakly compressible, numerical simulations of water impacting cylinders with radius R, entry velocity V, and spin ω about their axis. We consider two Froude numbers $Fr=V/\sqrt{g2R}$=0.5, 1.5 and moderate spin ratios $\Omega=\omega R/V \leq 3$. Our numerical predictions are in agreement with experiments and identify the effects of Fr and Ω on the separation points, flow dynamics, and body trajectory. We find that the separation points depend primarily on Fr and observe two distinct regimes: for Fr=0.5 quasi-static cavities are obtained, while for Fr=1.5 the separation points approach a limiting angle of 70^o-80^o with respect to the negative vertical axis. For times tV/R >0.1 the total pressure force on the cylinder decreases with Fr, obtaining significantly larger values for Fr=0.5. The corresponding drag reduces with Ω, while lift is towards the windward side and increases with both Ω and time. As a consequence, free-falling spinning cylinders drop slightly faster, while at a given depth their lateral displacement increases with Ω.

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Date submitted: 01 Aug 2015 Electronic form version 1.4