Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Hydrodynamic forces on a wall-bound leukocyte due to interactions with flowing red cells AMIR H. G. ISFAHANI, JONATHAN B. FREUND, University of Illinois at Urbana-Champaign — As part of both healthy and pathologically physiological mechanisms sphere-like white blood cells (leukocytes) adhere to the walls of small blood vessels. We use quantitative numerical simulations to compare the forces from flowing red blood cells on a wall-adhered leukocyte to a homogenized model of blood at the same flow conditions. We model the highly flexible red blood cells using a fast $O(N \log N)$ boundary integral formulation. These elastic membranes deform substantially but strongly resist surface dilatation. They enclose a higher than plasma viscosity hemoglobin solution. The no-slip condition is enforced on the stationary leukocyte as well as the vessel walls. Vessel diameters of 10 to 20 microns are studied. Different hematocrits, leukocyte shapes, and flow conditions are examined. In vessels comparable to the size of the cells, we show that the particulate character of blood significantly affects the magnitude of the forces that the leukocyte experiences, transiently increasing it well above the homogenized-blood prediction: for example, for a tube hematocrit of 25% and a spherical protrusion with a diameter 0.75 that of the tube, the average forces are increased by about 40% and the local forces by more than 100% relative to those expected for a blood model homogenized by its effective viscosity.

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Date submitted: 01 Aug 2011 Electronic form version 1.4