Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

Size-Dependent Fluid Mechanics ALI HADJESFANDIARI, AREZOO HAJESFANDIARI, GARY DARGUSH, University at Buffalo, State University of New York — Classical fluid mechanics provides a reasonable basis for analyzing the behavior of fluid flow at the macro scale. However, experiments show that the behavior of fluid in small scales is different from their behavior at macro scales. An additional concern relates to the absence of a length scale in the governing Navier-Stokes equations, when the present description of turbulence seems to need the clear definition of a characteristic size. Consequently, there is need for a more complete fluid dynamics, which spans many scales and, of course, must reduce to classical fluid mechanics for flows with macro-scale size. Here we develop the consistent size-dependent fluid mechanics by discovering the skew-symmetric character of couple stress tensor. As a result, the skew-symmetric mean curvature rate vector as the consistent measure of deformation is introduced. It is demonstrated that this theory may provide a basis for fundamental studies of flows at the finest scales for which a continuum representation is valid and, perhaps, for gaining additional insight into the problem of turbulence.

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Date submitted: 02 Aug 2013 Electronic form version 1.4