



Bacteria, Biofilms and Fluid Dynamics: Elementary Flows and Unexpected Phenomena

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Bacterial biofilms have an enormous impact on medicine, industry and ecology. These microbial communities are generally considered to adhere to surfaces or interfaces. In most practical situations, the biofilms are exposed to flow. We investigate two features of such systems: (i) We examine the migration of bacteria along surfaces when exposed to a shear flow. In particular, we identify an unusual response where flow produces a directed motion of twitching bacteria in the upstream direction. (ii) We report the formation of biofilm streamers (threads of biofilm) suspended in the middle plane of curved microchannels under conditions of laminar flow. We use numerical simulations of the three-dimensional flow in curved channels to highlight the presence of a secondary vortical motion in the proximity of the corners, which suggests an underlying hydrodynamic mechanism responsible for the formation of the streamers. Thus, we bring together experiments, simulations, and models for the fluid-structure interaction to rationalize the spatial and temporal development of bacterial streamers.

Professor Howard A. Stone received a PhD in Chemical Engineering from Caltech in 1988. Following a postdoctoral year at the University of Cambridge, in 1989 he joined the faculty of Harvard University, where he eventually became the Vicky Joseph Professor of Engineering and Applied Mathematics. In 1994 he received both the Joseph R. Levenson Memorial Award and the Phi Beta Kappa teaching Prize, which are the only two teaching awards given to faculty in Harvard College. In 2000 he was named a Harvard College Professor for his contributions to undergraduate education. In July 2009 Howard moved to Princeton University where is Donald R. Dixon '69 and Elizabeth W. Dixon Professor in Mechanical and Aerospace Engineering. Professor Stone's research interests are in fluid dynamics, especially applications at the interface of engineering, chemistry and physics. He has received the NSF Presidential Young Investigator Award, is a Fellow of the American Physical Society (APS), and is past Chair of the Division of Fluid Dynamics of the APS. He is the first recipient of the G.K. Batchelor Prize in Fluid Dynamics, which was awarded in August 2008. In 2009 he was elected to the National Academy of Engineering. In 2011 he was elected to the American Academy of Arts and Sciences.

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