Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Swimming of bacteria in polymer solutions ALEXANDER MOROZOV, VINCENT MARTINEZ, JANA SCHWARZ-LINEK, MATHIAS REUFER, School of Physics & Astronomy, University of Edinburgh, LAURENCE WILSON, Department of Physics, University of York, UK, WILSON POON, School of Physics & Astronomy, University of Edinburgh — The "standard model" of bacteria swimming in polymer solutions consists of experimental observations that the swimming speed first increases and then decreases as the function of the polymer concentration. This non-monotonic behaviour is usually explained by either swimming in pores in the polymer solutions or by its viscoelasticity. Using new, high-throughput methods for characterising motility, we have measured the swimming speed and the angular frequency of cell-body rotation of motile Escherichia coli as a function of polymer concentration in polyvinylpyrrolidone (PVP) and Ficoll solutions of different molecular weights. We find that non-monotonic speed-concentration curves are typically due to low-molecular weight impurities and, when cleaned, most molecular weight solutions exhibit Newtonian behaviour. For the highest molecular weight of PVP we observe non-newtonian effects. We present a simple theory that consists of the fast-rotating flagella "seeing" a lower viscosity than the cell body but otherwise Newtonian in nature. We show that our theory successfully describes the experimental observations and suggest that flagella can be seen as nano-rheometers for probing the non-newtonian behaviour of high polymer solutions on a molecular scale.

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Date submitted: 01 Aug 2014 Electronic form version 1.4