Pair-correlations in a bacterial suspension

Ganesh Subramanian¹ and Donald L. $Koch^2$

¹Engineering Mechanics Unit,

Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore 560064, India^{*} ²Department of Chemical and Bio-molecular Engineering,

Cornell University, Ithaca, USA

I will present a calculation of the pair-correlations induced by hydrodynamic interactions in an isotropic homogeneous suspension of swimming bacteria. The bacteria are assumed to execute a run-and-tumble motion, as is typical of many species including E.Coli; wherein periods of smooth swimming (runs) are punctuated by abrupt and large changes in swimming direction (tumbles). The calculation of the pair probability is for a suspension of random tumblers, the statistics of the tumbling process in this case being entirely specified by τ , the mean-free-time between successive tumbles. The results will be presented for two limiting regimes. The first pertains to the region where the pair-separation (r) is much smaller than the mean-free-path, $U\tau$ (U being the swimming speed) of the run-and-tumble motion, so the orientation de-correlation due to tumbles may be neglected during a pair-interaction. The second regime corresponds to distances much larger than $U\tau$, in which case the pair-interaction occurs along diffusive trajectories. One may then use a multiple-scales analysis to obtain an averaged equation, governing the pair-distribution function in physical space, in terms of an effective drift velocity and a diffusion coefficient. If time permits, I will discuss details of the solution procedure when the dimensionless parameter ($r/U\tau$) is comparable to unity.