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Macroscopic model of reversing self-propelled bacteria

Periodic reversals in systems of self-propelled rod shaped bacteria enable them to effectively resolve traffic jams formed during swarming and maximize their swarming rate. A connection is shown between a microscopic one dimensional cell-based stochastic model of reversing non-overlapping bacteria and a macroscopic non-linear diffusion equation for the dynamics of cellular density. Boltzmann-Matano analysis is used to determine the nonlinear diffusion equation corresponding to the specific reversal frequency. A combination of microscopic and macroscopic models are used for studying swarming rates of populations of bacteria reversing at different frequencies. Cell populations with high reversal frequencies are able to spread out effectively at high densities. If the cells rarely reverse, then they are able to spread out at lower densities but are less efficient at spreading out at higher densities.