New results on collective chemotaxis in colonies

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I discuss two different problems in which a crude phenomenological description of chemotaxis leads to interesting new perspectives. The first question concerns the competition between chemotaxis and cell division, which might at first sight seem completely unrelated. We have developed a simple model to explore any possible interplay between the two processes, and studied it via dynamical Renormalization Groups methods [1]. We find that whereas details of the microscopic behavior of cells do not impact the collective behavior on a large scale, the interplay between the two general processes of growth and chemotaxis leads to a variety of collective phenomena, which includes a sharp transition from a phase that has moderate controlled growth and death, and regulated chemical interactions, to a phase with strong uncontrolled growth/death and no chemical interactions. Remarkably, for a range of parameters, the transition point shows nontrivial collective motion, which can even be described analytically. The second problem concerns the role of slowly diffusing chemical residues on the behavior of bacteria with twitching motility. We find evidence that a non-trivial perpendicular alignment mechanism tends to modulate the orientation of bacteria [2], and that this new coupling allows us to build a complete quantitative description of the observed collective behavior of such bacteria [3].

[1] A. Gelimson and R. Golestanian, Phys. Rev. Lett. 114, 028101 (2015)
[2] W.T. Kranz, A. Gelimson, and R. Golestanian, arXiv:1504.06814
[3] A. Gelimson, K. Zhao, C. Lee, W.T. Kranz, G.C.L. Wong, and R. Golestanian, unpublished (2016)