Kinetic equations for bacterial movements

Benoît Perthame
https://www.ljll.math.upmc.fr/perthame/

Self-organisation of cell colonies is of paramount importance in medecine and biology (biofilms, bacterial invasions, tissue growth). For simple organisms as bacteria, a large variety of chemical processes and biophysical laws can be involved in the movement of a single cell and communication between cells. Progresses in experimental observations have raised many mathematical questions in terms of modeling, asymptotic analysis and wave propagation.

At the individual scale, bacteria as *E. coli* or *B. subtilis* perform so-called run-and-tumble movements. This means that they alternate a run phase (or jump) followed by fast re-organization phase (tumble) in which they decide of a new direction for run. For this reason, the population is described by a nonlinear kinetic-Botlzmann equation of scattering type.

However, on-going experimental devices exhibit new behaviours and lead to new modeling questions. One can incorporate that the tumbling frequency is modulated by the intra-cellular state (receptor methylation level) and the extra-cellular environment (chemoattractant for instance). In the fast-adaptation and stiff response limit, we recover pathwise dependant tumbling frequencies. In the large scale limit (space, time) we can recover the Keller-Segel model.

These new mathematical models however can shed a new light on the subject. They explain propagating pulses, observed since the 60's, thanks to the so-called Flux Limited Keller-Segel system.

They can also explain the recent measurements showing that, in some circumstance, *E. coli* cells perform Lévy flights.

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