Flow properties of active matter

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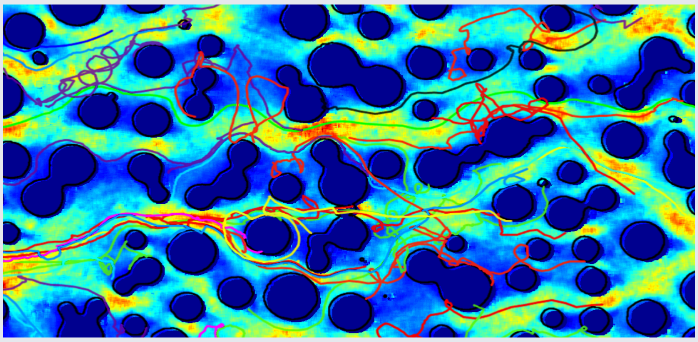
Active matter concerned material which are not in equilibrium like crowds of human people, flocks of insects or molecular motors... Their common characteristic is that each element or unit absorb and consume energy locally, and use the resource to divide, grow or move. The development of active matter is mainly lifted by theoretical and numerical studies and experimental measurements are sparse. Our goal is to explore experimentally the flow properties of active matter.

Bacterial suspensions are good examples of active fluids; the swimming activity of each bacteria modifies the flow field in its vicinity creating hydrodynamic interaction leading – when a sufficiently high number of bacteria is suspended in the fluid - to collective motions. As a first step, we have characterized the resistance to the flow of the suspensions under various shear rate and for different concentration of bacteria using a rheometer allowing to measure very small stresses (Lopez 2015). The experiment demonstrates that the bacteria coordinate creating a counter flow that reduces drastically the viscosity. The data have proven to be crucial to benchmark the numerical models currently developed.

Thanks to the Labex Palm, we developed a visualization platform to study active matter under flow. Beside an improved knowledge of the flow characteristics of active matter, our study has strong implication on applied domain like filtration of bacteria (ANR BacFlow 2016-2020), straining of soil bacteria in the proximity of roots or bacterial carbonatogenesis (contrat industriel SolEtanche-Bachy).



Superposition of wild type Escherichia coli bacteria trajectories (colored lines) transported in a porous media with the local flow velocity (colors). The average diameter of the grains (dark blue) is 35µ m. The porous medium is obtained by soft lithography. The bacteria are transported by a flow going from right to left with a mean velocity of 30µm.s^{-1}. We observed that the swimming activity has a strong effect on the trapping in small pores and on the time spend in the vicinity of the grains

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