Magnetotactic Bacteria in Porous Media

A PhD offer on steered bioconvection in a microfluidic-based soil system

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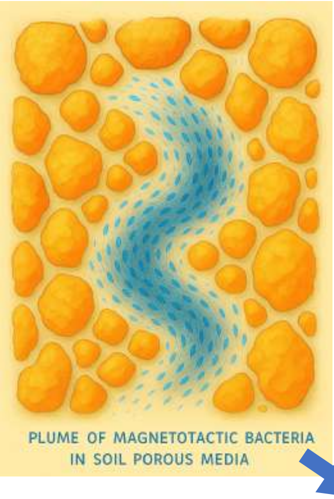
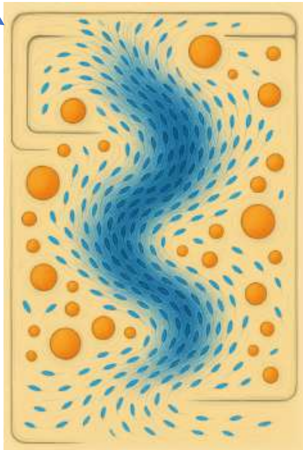
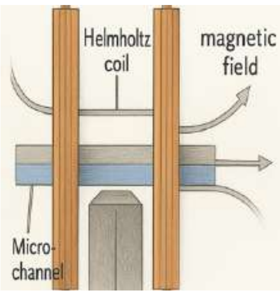


Magnetotactic bacteria dispersion in real-life environments is not well understood. These ubiquitous bacteria orient and navigate along the Earth's magnetic field lines, and shape sedimentary carbon dynamics in the ocean seabed (with potential impact for $C0_2$ capture), while being serious candidates for targeted drug delivery in medicine. Despite these interests, we lack well-controlled experimental systems to study the bacteria dispersion in porous environments, e.g. seabed soils and blood vascular network structure.



Magnetotactic bacteria spontaneously organize into coherent plumes Within microfluidic channels, magnetotactic bacteria move collectively as a self-propelled plume [1]. Yet magnetotatic bacteria mostly occupy the seabed, a densely confined porous media. Such porous are expected to lead to a chaotic mixing of plumes



Plume chaos Though at low-Reynold number, we expect the flows to exhibit turbulence features, whereby the impact of scattering obstacles driving

- **passive mixing**, eg. solely induced by pressure-difference watea flows,
- **active mixing,** mediated by the bacteria swimming

We have a 3-step plan of action Using our well-established microfluidic channel system [3], we will

Step 1 – characterize the **passive mixing** of plumes; starting with abiotic beads,

Step 2 – **active mixing**, the dispersion of such active magnetotactic plumes.

Step 3 - disantangle both mixing, collaborating with theoreticians,

Profile we seek The work combines experimental & image analysis; depending on the applicant's wish and profile, we can adapt the PhD work from pure experimental to a well-balanced mix of experimental work and theory (coarse-grained bioconvection + Active Brownian Particles simulations).

The PhD applicant will be integrated into the AMid*Ex TBTM consortium, with (**Lead) Nicolas Waisbord,** physicist, designing models & experiments of magnetotactic bacteria and porous media [4] and (cosupervisor) **Jean-François Rupprecht,** theoretician building active hydrodynamical models for living materials. NW & JFR collaborate since '16 [4].

PhD funding is secured, start date: 2025.

Location: Laboratoire de Chimie Bactérienne, Marseille, close to Luminy and the Calanques National Parc.

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[1] Waisbord, N., Lefèvre, C. T., Bocquet, L., Ybert, C., & CottinBizonne, C. *Destabilization of a flow focused suspension of magnetotactic bacteria*. PRF (2016).

[2] Meng, F., Matsunaga, D., Mahault, B., & Golestanian, R. (2021). Magnetic Microswimmers Exhibit Bose-Einstein-like Condensation, PRL (2021)

[3] Waisbord, N., Dehkharghani, A., & Guasto, J. S.. *Fluidic bacterial diodes rectify magnetotactic cell motility in porous environments*. *Nature Comm.* (2021)

[4] Rupprecht, J. F., Waisbord, N., et al. (2016). *Velocity Condensation for Magnetotactic Bacteria*. *PRL* (2016)