The Mechanism of Self-Phoresis

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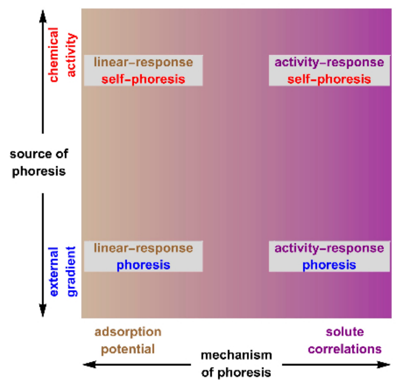
A frequent experimental realization of a microswimmer relies on self-chemophoresis. Chemophoresis (also called diffusiophoresis) denotes the motion of a particle in a fluid solution driven by a composition gradient. And self-chemophoresis pertains to the case that the gradient is generated by the particle itself through catalytic activity on its surface.
Conceptually one can write "phoretic velocity = *phoretic coefficient* x chemical gradient". In the "classic picture" of chemophoresis, the *phoretic coefficient* follows from linear response theory and is controlled by the interaction potential between the phoretic particle and the solute ("adsorption potential"). This picture lies at the basis of the usually invoked paradigm that "self-phoresis is just normal phoresis, but in a self-generated gradient". It has been argued [1-3], however, that this paradigm may break down because the activity of the particle can also affect the response significantly, leading to a contribution to the *phoretic coefficient* dominated by the solute-solute correlations [3-7].
We will discuss these two mechanisms of chemophoretic self-propulsion and their relative importance. We will also touch briefly on the recently found [8] unexpected connection with the self-propulsion of an intruder immersed in a shaken granular bath.

Keywords:
Chemophoresis, diffusiophoresis, active particle, theory



The phoretic diagram [4,7] for addressing the relative importance of different sources of chemophoresis (externally imposed vs. self-generated composition gradient) and of different mechanisms (linear vs. activity-induced response).

References:

[1] J. Moran, J. Posner, *J. Fluid Mech* . **680** , 31 (2011).
[2] M. De Corato, X. Arqué, T. Patiño, M. Arroyo, S. Sánchez, I. Pagonabarraga, *Phys. Rev. Lett.* **124** , 108001 (2020).
[3] A. Domínguez, M. Popescu, C. Rohwer, S. Dietrich, *Phys. Rev. Lett.* **125** , 268002 (2020).
[4] A. Domínguez, M. Popescu, *Curr. Opinion Coll. & Interface Sci.* **61** , 101610 (2022).
[5] A. Domínguez, M. Popescu, *Mol. Phys.* **122** , e2396545 (2024).
[6] A. Domínguez, M. Popescu, *EPL* **152** :67001 (2025).
[7] A. Domínguez, M. Popescu, *J. Electrostatics* **140** :104240 (2026).
[8] A. Domínguez, N. Khalil, *arXiv:2510.18436* (2025).

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