**PHENIX SEMINAR**

# Self-organisation through nonequilibrium catalytic activity

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Particles that are both catalytically-active and chemotactic can interact through the chemical concentration fields upon which they act. Examples of such particles include micron-scale chemotactic microorganisms and phoretic colloids, as well as nano-scale enzymes. Through a combination of theory and simulations, we have unraveled the range of spatio-temporal self-organization phenomena that can emerge in mixtures of catalytic particles. Due to their nonequilibrium origin, the effective interactions among catalytic particles can display exotic features such as nonreciprocity, which enables the formation of dynamic clusters that actively self-propel [1]. Importantly, the complexity of the metabolic network in which such catalytic particles participate translates into a rich structure in the network of effective interactions that emerges among them and has a strong effect in the resulting self-organization, which can display new features such as periodic oscillations [2] or aggregation in spite of self-repulsion [3]. Lastly, far from being an ad-hoc effect, the emergence of effective interactions among catalysts is an unavoidable consequence in any thermodynamically-consistent theory of a catalytically-active mixture [4].

[1] J. Agudo-Canalejo and R. Golestanian, Phys. Rev. Lett. 123, 018101 (2019)
[2] V. Ouazan-Reboul, J. Agudo-Canalejo, and R. Golestanian, Nat. Commun. 14, 4496 (2023)
[3] V. Ouazan-Reboul, R. Golestanian, and J. Agudo-Canalejo, Phys. Rev. Lett. 131, 128301 (2023)
[4] M. W. Cotton, R. Golestanian, and J. Agudo-Canalejo, Phys. Rev. Lett. 129, 158101 (2022)