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Directions in active matter

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The living state operates far from thermal equilibrium, converting a free-energy supply from on-board or ambient sources into systematic movement and the creation of structures. The constituent particles of living matter, i.e., cells, are themselves driven systems. On still smaller scales, cells are loaded with energy-converting components such as motor proteins. Scaling up, large groups of organisms are usefully seen as a kind of nonequilibrium material, with the individual animals as the constituent driven particles. Inspired by this view of living systems, physicists have defined Active Matter: materials whose individual constituents are powered. The motivation, of course, is to bring cells, tissue, and animal groups into the embrace of condensed matter and statistical physics. On the one hand, this makes it possible to employ the powerful techniques and language of those venerable fields to construct a predictive theoretical description of order, fluctuations, changes in organisation, dynamics in living matter. On the other, it provides a framework within which to highlight the contrast between living and lifeless matter.

Active Matter has grown into an area of extraordinary excitement at the physics biology interface and at the frontiers of nonequilibrium statistical mechanics. My talk will introduce the subject, convey its excitement to a broad audience, and summarise work with my students and colleagues, on order, fluctuations, flow, and dynamics of active systems. For an idea of progress, current issues, and likely future directions in this field, I direct readers to a recent Perspective [1].

References

[1] Symmetry, Thermodynamics and Topology in Active Matter, M J Bowick, N Fakhri, M C Marchetti, S Ramaswamy, Phys. Rev. X **12**, 010501 (2022)