

M. Cristina Marchetti
Active and Driven Soft Matter
Boulder 2009

Lecture 1: Introduction

- What are active systems?
- Hydrodynamics: symmetries, conservation laws and broken symmetries.
- Tutorial: phenomenological formulation of the hydrodynamics of an isotropic fluid.

Readings:

P. C. Martin, O. Parodi and P. S. Pershan, *Phys. Rev. A* **6**, 2401 (1972).

P. M. Chaikin and T. C. Lubensky, *Principles of Condensed Matter Physics*, pp. 440-452

Lecture 2: Hydrodynamics of “Living Liquid Crystals”

- Tutorial: hydrodynamics of nematic liquid crystals
- Active hydrodynamics: active stresses, nematic versus polar order
- Spontaneous flow in active films
- Asters, vortices and spirals

Readings:

P.G. De Gennes and J. Prost, *The Physics of Liquid Crystals*, section 5.1.

F. Jülicher, K. Kruse, J. Prost and J.-F. Joanny, *Physics Reports*, **449**, 3-28 (2007).

Lecture 3: From Microdynamics to Hydrodynamics - Self-Propelled Rods on a Substrate

- Tutorial: Langevin, Fokker-Planck and Smoluchowski dynamics
- Hydrodynamics of SP hard rods
- Instabilities, persistent diffusion, enhanced order

Readings:

R. Zwanzig, *Nonequilibrium Statistical Mechanics* (Oxford University Press, 2001), Chapter 1, Sections 1.1-1.3; Chapter 2, Section 2.2.

A. Baskaran and M. C. Marchetti, *Phys. Rev. E* **77**, 011920 (2008); *Phys. Rev. Lett.* **101**, 268101 (2008).

Lecture 4: Hydrodynamics of bacterial suspensions

- The simplest “swimmer”: pullers versus pushers
- Hydrodynamic interactions
- Instabilities and other results
- Outlook

Readings:

M. F. Copeland and D. B. Weibel, *Soft Matter* **6**, 1093 (2009)

General references:

- J. Toner, Y. Tu, and S. Ramaswamy, *Hydrodynamics and phases of flocks*, Annals of Physics **318**, 170–244 (2005).
- T. B. Liverpool and M.C. Marchetti, in *Cell Motility*, Peter Lenz, editor (Springer, 2008).
- T. Risler, *Cytoskeleton and Cell Motility*, in Encyclopedia of Complexity and Systems Science, Robert A. Meyers, editor (2009).