# A: Passive and active walkers

Weeks 5–9

How do molecules, beads and bacteria move in water? We start from random walks and diffusion, add viscous drag and the Langevin equation, find out why life at low Reynolds number is so different from ours, and end with active particles that propel themselves and flock.

## Reading

- Nelson, chapters 1–5
- Physics of active and passive motion in biology (lecture notes)
- Active matter (lecture notes)
- E. M. Purcell, Life at low Reynolds number (1977)
- T. Vicsek et al., Novel type of phase transition in a system of self-driven particles (1995)
- Background, not curriculum: Einstein 1905, Langevin 1908

## Lab and project

- Lab: Brownian motion, Tuesday 9 Feb 10–14
- P1: Measuring Boltzmann's constant with a microscope, report due Sunday 7 Mar, defense Tuesday 9 Mar

## Weekly exercises

| | Topic | Due |
|---|---|---|
| E1 | Orders of magnitude; Python warm-up | Wed 10 Feb |
| E2 | Random walks | Wed 17 Feb |
| E3 | Diffusion and tracking on synthetic data | Wed 24 Feb |
| E4 | Drag, Reynolds number, Langevin equation | Wed 3 Mar |
| E5 | Active Brownian particles, Vicsek model | Wed 10 Mar |

## Code

- `randomwalk_1d.py`, `randomwalk_exercise.py`: random-walk simulations
- `synthetic_brownian.py`: synthetic Brownian movies with known $D$, and a reference tracking pipeline
- `trackpy_anal.ipynb`: first steps with trackpy
- `vicsek/`: Vicsek model simulation