UE Active matter

Niveau d'étude
Bac +5

ECTS
3 crédits

Composante
UFR Physique, Ingénierie, Terre, Environnement, Mécanique (PhITEM)

Période de l'année
Automne (sept. à dec./janv.)

Diplômes intégrant cet élément

- Master Nanosciences et nanotechnologies

Langue(s) d'enseignement: Anglais

Ouvert aux étudiants en échange: Oui

Code d'export Apogée: PAX9NFAA

Présentation

Description

The active material is made up of a large number of active living or artificial agents, each of which consumes energy to move and exert forces on other agents. The most important example is the plankton which represents the largest biomass on earth. Such systems are inherently out of thermodynamic equilibrium. The examples of active ingredient are very numerous and cover a wide range of length scales. At the nanoscale, important examples are biopolymers and microtubules in biology as well as synthetic janus nanoparticles and microparticles. On a larger scale, active systems are micro-organisms (plankton, bacteria), schools of fish, crowds of pedestrians and swarms of birds. Active matter is a relatively new material classification of soft matter: the most studied model, the Vicsek model, dates from 1995.

Active matter research includes hydrodynamics, kinetic theory and non-equilibrium statistical physics.

This course will present current research with illustrations at all the length scales mentioned above, emphasizing main relevant theoretical models. Within this course, a Python based programming for numerical and experimental study of active matter is proposed to the students at the LIPhy lab.

Informations non contractuelles.
Dernière mise à jour le 30 juin 2026

Content:

I. Microscopic phenomena:

- Self-propelled particles
- Biological and synthetic active particles
- Brownian motion
- Persistence Random walk.
- Interaction with environment (fluid/ particles/ walls)
- Dry active matter. Social interaction models: Vicsek model, Helbing model

II. Hydrodynamics

- Stokes equation
- Dipoles of forces and hydrodynamic interaction
- Pullers/pushers
- Interaction with a wall (Black green function)
- The squirmer model
- Singular solution of Stokes eq.

III. Macroscopic phenomena:

- Kinetic theory
- Rheology
- Bio-convection

IV. Python based programming for numerical and experimental study of active matter

V. Journal club: Each student studies a published paper and presents it to the class.

Heures d'enseignement

CMTD	Cours magistral - Travaux dirigés	22,5h

Pré-requis recommandés

A first course in statistical physics, and in hydrodynamics.
This course can be followed in 1st year or 2nd year of Master.

Période : Semestre 9

Infos pratiques

Campus

Grenoble - Domaine universitaire

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