DFG PRIORITY PROGRAMME “MICROSWIMMERS – FROM SINGLE PARTICLE MOTION TO COLLECTIVE BEHAVIOUR” (SPP 1726)

The German Research Foundation DFG is the major funding agency for basic sciences in Germany. The purpose of Priority Programs is to advance knowledge in an emerging field of research through collaborative-network support over several locations. Priority Programs are characterized by their

- enhanced quality of research through the use of new methods and forms of collaboration in emerging fields,
- added value through interdisciplinary cooperation, and
- networking.

The SPP 1726 “Microswimmers” focuses on the locomotion and transport of biological, artificial, and model microswimmers.

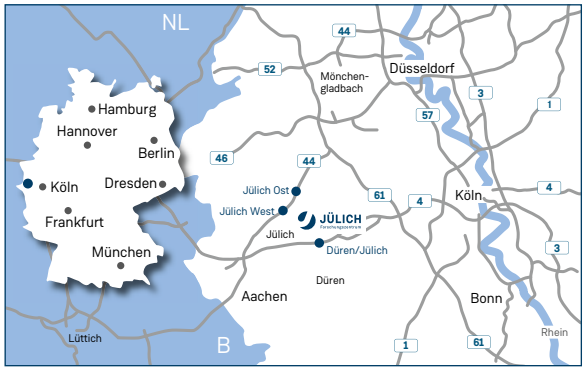
The locomotion of biological microorganisms facilitates the search for food, orientation toward light, the spreading of off-spring, and the formation of colonies, and, thus, is an essential aspect of life. Evolution has achieved necessary propulsion mechanisms that exploit the viscous drag of the surrounding medium on the microscale.

An understanding of these mechanisms opens an avenue for the control of biological systems or the design of artificial swimmers. For the latter, the development of swimming strategies that are even more efficient than those of biological microorganisms seems possible. Improved knowledge and control of microswimmers will have a major impact on various fields ranging from life and material science to environmental science.

The “Microswimmers” Priority Program connects physicists, chemists, biologists, and material scientists throughout German academic research laboratories. This combined expertise in experiment, theory, and simulation is used to investigate the behavior of microscopic swimmers. Overall, the three major objectives of the program are

- understanding biological microswimmers,
- designing and understanding artificial microswimmers, and
- elucidation of the cooperative behavior and “swarming” of microswimmer ensembles.

HOW TO FIND US:



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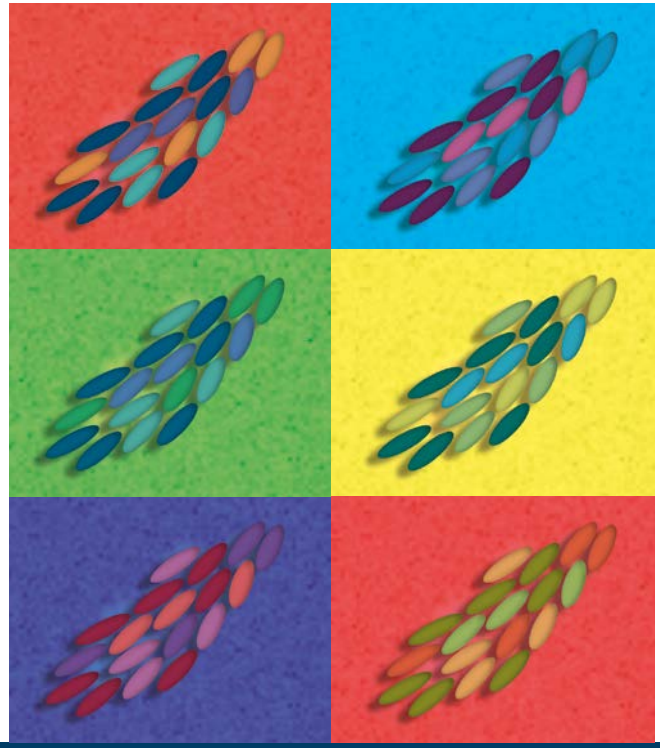

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Winter School

MOTILE ACTIVE MATTER:

NANOMACHINES, MICROSWIMMERS, AND SWARMS

February 25 – March 1, 2019 in Jülich, Germany

REGISTRATION AND FURTHER INFORMATION:

www.fz-juelich.de/ics/microswimmers

The lecture program, travel information, and workshop badge will be sent in due course to all registered participants.

Organized by the DFG Priority Programme 1726 Microswimmers – From Single Particle Motion to Collective Behaviour

MICRO-SWIMMERS

DFG

JÜLICH Forschungszentrum

PUBLICATION DETAILS

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OVERVIEW

Active matter is a novel class of nonequilibrium materials composed of a large number of agents, which consume energy and generate directed motion. The scale of agents ranges from nanomotors and microswimmers to cells and fish or birds. Unraveling, predicting, and controlling the behavior of active matter is a truly interdisciplinary endeavor, and involves scientists from biology, chemistry, ecology, engineering, mathematics, and physics. Recent progress in experimental and simulation methods, and theoretical advances, now allows for a detailed study of such systems, and to gain new insight into their behavior, which should ultimately lead to the design of novel synthetic active agents. This school will provide a broad overview of the field, covering state-of-the-art methodological aspects in experiment and simulation, and current research on natural and artificial active agents and their collective behavior.

The school is intended for students at the Master's and PhD level, and postdocs, from all fields related to active matter, and reflects its wide spectrum and interdisciplinary character. Selected topics from various fields will be covered. Hence, participants will gain insight into a variety of complementary aspects relevant for a comprehensive understanding of active matter.

The school is supported by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) and is organized within the framework of the DFG Priority Programme "Microswimmers – from Single Particle Motion to Collective Behaviour". It is open to everyone interested in state-of-the-art activities in this fascinating research area.

PROGRAM

The school provides about 25 hours of lectures. The lectures are grouped into four sections, covering aspects most relevant to active matter, their agents, and collective behavior. In particular, lectures will address synthetic nano- and micromachines, biological nano- and microswimmers, the cell dynamics and locomotion, as well as their collective swarming behavior. Experimental and simulation methods will be part of all lectures. Every section and/or lecture includes introductory aspects, which provide the basic knowledge for the understanding of more advanced, cutting-edge research subjects.

Biological Nano- and Microswimmers

Evolution has provided a large diversity of biological swimmers on the microscale, with propulsion mechanisms and navigation strategies tailored to their natural environment and function, ranging from soil to open seas. Microswimmers prototypically apply cilia or flagella for propulsion, which beat or rotate. Understanding of the underlying principles and communication strategies, e.g., chemotaxis and phototaxis, allows for their targeted manipulation and control in medicine, ecology, and multiple technical applications. Lectures will present an overview of propulsion principles and the migration behavior of different classes of natural swimmers, such as sperm cells, bacteria, and algae.

Synthetic Nano- and Micromachines

Various strategies for the design of autonomous synthetic nano- and micromachines have been proposed. This includes phoresis – inhomogeneous catalysis of chemical reactions, thermal gradients –, planktonic body deformations, and biology-inspired concepts. Such machines provide the basis for multifunctional and highly responsive (artificial) materials, which exhibit emergent behavior and the ability to perform specific tasks in response to signals from each other and the environment. The development of novel techniques facilitates control of the locomotion of individual nano- and micromachines as well as their interactions, and the design of intelligent active materials. The various propulsion and control concepts will be addressed.

Swarming

Active agents are able to spontaneously self-organize when present in large amount, resulting in an emerging coordinated and collective motion. Examples range from the cytoskeleton of cells, swarming bacteria and plankton, to flocks of birds and schools of fish. The mechanisms determining a swarm include the shape of the agents, sensing, fluctuations, and environmentally mediated interactions. Examples of appearing structures, the collective phenomena on various length scales, universal characteristics, and synchronized motion will be discussed.

Cell Dynamics and Locomotion

Fundamental biological processes, such as morphogenesis and tissue repair, require collective cell motions, where groups of cells exhibit collective behavior that emerges from motility and interactions between them. Diverse inter- and intracellular processes are involved in migration, ranging from cytoskeleton-generated forces to deform the cell body to intercellular and substrate adhesion. This gives rise to specific phenomena, for particular cell types, such as fingering-like instabilities and spreading, or glass-like arrest as the cellular adhesions mature. The diverse aspects of cell dynamics will be presented and explained.

GENERAL INFORMATION

Venue

The Spring School will take place in the Auditorium of Forschungszentrum Jülich from February 25 – March 1, 2019.

Participation

The background of participants is preferentially in natural sciences, material sciences, or engineering.

Registration Fee

Registration fee for the meeting is 150 Euros. This includes coffee breaks, the shuttle service to commute to the accommodation in Aachen, and participation at the Winter School dinner. The registration fee does not include any other meals. Members or affiliated members of the Microswimmer Priority Program (SPP 1726) are offered a reduced registration fee of 80 Euros.

Registration Deadline

All participants are asked to register online at www.fz-juelich.de/ics/microswimmers before November 30, 2018.

Accommodation

Low-cost accommodation will be arranged at a youth hostel in Aachen, if you select this option during the registration process. The accommodation fee between 160 and 190 Euros includes your overnight stay in a shared room from February 24 – March 1, along with breakfast and dinner. The number of available rooms in the hostel is limited and will be assigned on a first come, first served basis.

Daily Shuttle Service

A shuttle service will take participants to Forschungszentrum Jülich in the morning and back to the hostel in Aachen in the evening after the lectures have ended.

Payment and Cancellation Policy

On completing your registration for the "Active Matter" Winter School, you will receive confirmation by email. Cancellations must be received before January 15, 2019. Afterwards a cancellation fee will be charged for the registration and/or the hostel.