About the 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 Programmes is to advance knowledge in an emerging field of research through collaborative networked support over several locations. Priority Programmes 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.

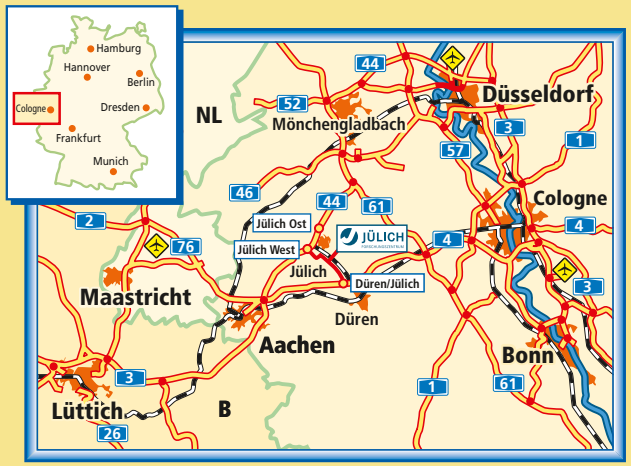
The SPP 1726 “Microswimmers” focuses on the locomotion and transport of biological, artificial, and model microswimmers. The locomotion of microorganisms facilitates the search for food, orientation towards light, the dissemination of off-spring, and the formation of colonies, and is in this way an essential aspect of life. Evolution has achieved propulsion mechanisms that overcome or even exploit the viscous drag of the surrounding medium, which is dominating the hydrodynamics because of the microscopic length scales.

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 Programme 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 behaviour of microscopic swimmers. Overall, the three major objectives of the programme are

- understanding biological swimmers,
- designing and understanding artificial microswimmers, and
- understanding cooperative behaviour and “swarming” of ensembles of microswimmers.

How to find us:



Scientific Organization

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Registration and Further Information
www.fz-juelich.de/ics/microswimmers

The lecture programme, travel information, and registration card will be sent in due course to all registered participants.

Member of the Helmholtz Association

Summer School: Microswimmers –

From Single Particle Motion to Collective Behaviour

21 – 25 September 2015 in Jülich, Germany

DFG MICRO-SWIMMERS JÜLICH FORSCHUNGSZENTRUM

Overview

The study of the mechanisms and dynamics of autonomous microswimmers is a fascinating field at the cutting edge of science. It combines the biophysics of self-propulsion via motor proteins, artificial propulsion mechanisms, swimming strategies at low Reynolds numbers, the hydrodynamic interaction of swimmers, and the collective motion of large numbers of agents. The recent progress in experimental and simulation methods, as well as theoretical advances nowadays allow detailed studies of these systems and new insights into their behaviour, which can then be used to design novel microswimmers. This summer school gives a broad overview of the field, covering on the one hand state-of-the-art methodological areas in experiment and simulation, and on the other hand current research on natural and artificial swimmers, and their collective behaviour.

The "Microswimmers" Summer School is aimed at students at the PhD level, but also at Master's students and postdocs, from all fields related to microswimmers, in particular in physics, biology, chemistry, material sciences, and engineering. It will not only teach selected topics from various fields related to microswimmers, but also introduce participants to subjects that are typically outside the scope of each individual research discipline. In this way, we aim to widen horizons to encompass the truly interdisciplinary field of microswimmers and self-propelled particles. For example, physicists will gain insights into biological aspects of self-propulsion, and biologists will be introduced to experimental physical methods.

The school is supported by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) and organized within the framework of the DFG Priority Programme "Microswimmers – from Single Particle Motion to Collective Behaviour", but it is open to all students interested in learning more about this area of research.

Programme

The school provides about 25 hours of lectures including discussions. All lectures will be given in English. Participants will receive a book of lecture notes, which contains all the material presented during the school. The lectures are grouped together in five sections that aim to cover the fields most relevant to microswimmers and self-propelled particles. These fields cover experimental and simulation methods, biological swimmers, artificial swimmers, the collective behaviour of self-propelled objects, as well as related topics concerning active, non-equilibrium systems. Each section will include both introductory material and later, building on this core knowledge, more advanced material.

Methods

Unravelling the complex processes of autonomous swimming at the microscale level requires input from experiment, theory, and simulation. This block contains lectures in which important methods from all these fields are presented. This will cover low Reynolds number hydrodynamics, mesoscale simulation techniques, non-equilibrium thermodynamics, models to describe collective motion, and various experimental methods.

Biological Microswimmers

Evolution has generated a large diversity of biological microswimmers, each using propulsion mechanisms and navigation strategies tailored to their natural environment and function. Understanding how and why biological swimmers work the way they do enables scientists to manipulate their behaviour and so use these swimmers directly in technical applications. Moreover, propulsion and synchronization mechanisms from natural swimmers can be transferred and even optimized in the design of artificial swimmers. Lectures will give an overview of the behaviour of different classes of natural swimmers: sperm cells, bacteria, algae such as *chlamydomonas*, and trypanosomes.

Artificial Microswimmers

Self-propulsion requires the conversion from chemical potential to kinetic energy. The first technical realizations of self-propelled objects have been developed both for various driving potentials as well as different conversion strategies. Lectures will provide insights into the fundamentals of driving potentials, for example, gradients in concentration, temperature, or chemical potential, and conversion mechanisms. Subjects such as diffusiophoresis, thermophoresis, and nanomachines will be covered.

Collective Behaviour

Microswimmers cannot accomplish their tasks without their ability to spontaneously organize coordinated and collective motion when present in large groups. Lectures will cover the collective behaviour of various model and biological systems. In particular, the collective behaviour of spheres and rods, surface effects, and synchronization will be discussed. Also, the behaviour of microswimmers in external gravitational or flow fields will be studied.

Miscellaneous

The governing physics of microswimmers is tightly connected to various other fields. Lectures will cover topics whose understanding is beneficial for a deeper insight into the behaviour of microswimmers. Topics will be motility assays, shaken granular media, and actuated hydrogels.

General Information

Venue
The Summer School will take place in the Auditorium of Forschungszentrum Jülich on **21 – 25 September 2015**.

Participation
Participants are expected to have a background in natural sciences, material sciences, or engineering.

Registration Fee
Registration fee for the meeting is 150 Euro. This includes the daily shuttle transfer to the meeting venue, a book with the lecture material, coffee breaks, and participation at the Summer School Dinner. The registration fee does not include any other meals. Members or affiliated members of the Microswimmer Priority Programme (SPP 1726) are offered a reduced registration fee of 75 Euro.

Accommodation
Low-cost accommodation can be arranged at a youth hostel in Aachen, if you select this option during the registration process. The accommodation fee of 150 Euro includes your overnight stay in a shared room from 20 – 25 September 2015, 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.

Participants who choose not to stay at the hostel are encouraged to stay in a hotel in Aachen located such that they can use the organized shuttle service.

Registration Deadline
All participants are asked to register before **24 July 2015** online at www.fz-juelich.de/ics/microswimmers.

Meals
No breakfast or dinner (except the conference dinner) is included in the registration fee. Lunch will be provided at Forschungszentrum Jülich at your own cost.

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. The daily transfer is free of charge for all registered participants.

Payment and Cancellation Policy
On completing your registration for the Microswimmers Summer School, you will receive confirmation by email. Cancellations must be received before 7 August 2015, otherwise a workshop cancellation fee of 50 Euro is required for all registered participants, plus an additional cancellation fee of 50 Euro for participants who chose to stay at the hostel.