

Research Positions for Doctoral and Postdoctoral Researchers (m/f/d) - Research Training Group 2950 SyMoCADS

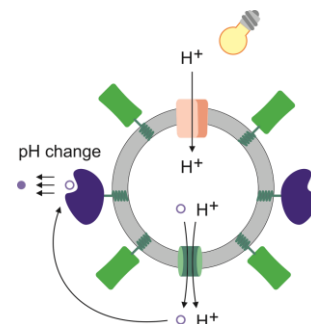
Research Training Group (RTG) 2950 - **Synthetic Molecular Communications Across Different Scales: From Theory to Experiments (SyMoCADS)** is a **research training program** funded by the **German Research Foundation (DFG)** with the aim to educate **scientists and engineers in this emerging interdisciplinary field** of research. The RTG comprises of ten principal advisors (PAs) from the Faculty of Engineering, Faculty of Science, the Medical Faculty, and the University Hospital. Research takes place in an excellent scientific environment at FAU, with top-notch instrumentation in the laboratories of the participating principal advisors (PAs).

The research program, consisting of **9 doctoral research projects** organized in **3 clusters (C1-C3)** and a **cross-cluster postdoctoral project**, and the structured qualification program aim to equip the participating researchers with the knowledge and skill set needed to significantly advance the field of molecular communication (MC) and to bring it to the realm of practical applications.

Cluster C1 focuses on the use of MC for the **design, monitoring, and control of bioprocesses on a microliter scale** and includes the following three projects:

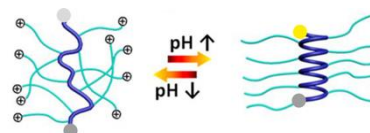
Project P1: Nanodevices for MC-Based Sensing and Control in Microliter-scale Bioreactors

- **PA:** Prof. Kathrin Castiglione (Institute of Bioprocess Engineering)
- **Project aim:** A light-driven nanodevice for monitoring and controlling pH in microliter-scale bioreactors is to be developed. Key components of the device are membrane transport proteins acting as high-precision pumps. These proteins are inserted into nanoscale polymer vesicles, so-called polymersomes, which serve as a structural chassis.
- **Qualification profile:** Master degree in Biotechnology, Life Science Engineering or a related field



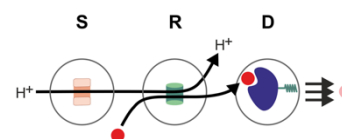
Project P2: Design and Characterization of Protein Modules for MC-Based Sensing and Control in Microliter-scale Bioreactors

- **PA:** Prof. Heinrich Sticht (Institute of Biochemistry)
- **Project aim:** Tailored protein components for the nanodevices generated in P1 will be developed to enable reliable pH-detection in different pH ranges. These components will contain polycationic or polyanionic peptides as core structures undergoing pH-dependent helix-coil-transitions.
- **Qualification profile:** Master degree in Biochemistry or a related field



Project P3: MC-based Modelling, Monitoring, and Control of Microliter-scale Bioreactors

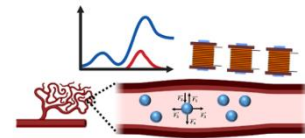
- **PA:** Prof. Robert Schober (Institute for Digital Communication)
- **Project aim:** Suitable models, signalling schemes, and algorithms for the optimal operation of the nanodevices developed in P1 will be investigated. To this end, taking into account the involved chemical reactions and the geometry of the environment, the MC framework will be exploited to develop (i) analytical, numerical, and simulation models for the individual components of the nanodevices, (ii) communication-theoretical models for all involved communication and sensing processes, and (iii) the required control signal designs and algorithms.
- **Qualification profile:** Master degree in Electrical Engineering with specialization in Communications or a related field



Cluster C2 focuses on the MC-based modelling, analysis, and design of magnetic steering systems for superparamagnetic iron oxide nanoparticles (**SPIONs**) and includes the following three projects:

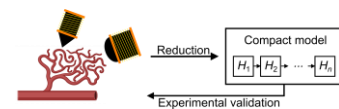
Project P4: Forces, Limitations, and Concepts for SPION Steering

- **PA:** Prof. Georg Fischer (Institute for Electronics Engineering)
- **Project aim:** The relevant forces and energy gradients impacting SPION steering, the size of SPION agglomerates, and the formation of unwanted SPION accumulations in the MC channel will be unveiled. The obtained results will be exploited for the design of lumped-parameter models and steering algorithms (P5), and will be validated and refined in cooperation with P5 and P6.
- **Qualification profile:** Master degree in Electrical Engineering or a related field



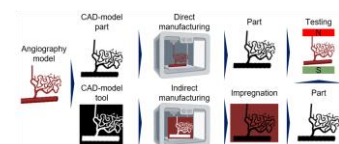
Project P5: Lumped-Parameter Models for and Optimization of SPION Steering in Highly Branched Vascular and Tissue Structures

- **PA:** Prof. Jens Kirchner (Institute for Electronics Engineering)
- **Project aim:** Methods are to be developed to derive a lumped-parameter model for the movement of SPIONs driven by the blood flow in a highly branched vascular structure and by an external magnetic field. The corresponding models will be numerically implemented and experimentally evaluated, including the development of corresponding hardware for particle sensing and magnetic steering.
- **Qualification profile:** Master degree in Electrical Engineering, Medical Engineering, Physics or a related field



Project P6: Development of Tumor Models for MC based on Additive Manufacturing Approaches

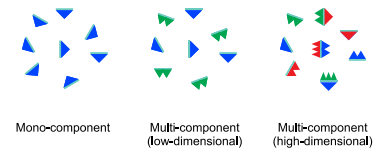
- **PA:** Prof. Dietmar Drummer (Institute of Polymer Technology)
- **Project aim:** A fluidic tumor model made of transparent and flexible materials, which allows the simplified modelling of complex fluidic processes outside and inside tumors will be developed. This includes the investigation of different additive manufacturing processes with regard to their usability for the production of tumor models with hierarchical complexity.
- **Qualification profile:** Master degree in Medical Engineering, Mechanical Engineering, Chemical Engineering or a related field; Experience with polymers



Cluster C3 focuses on the development of models, designs, and system architectures for airborne MC and includes the following three projects:

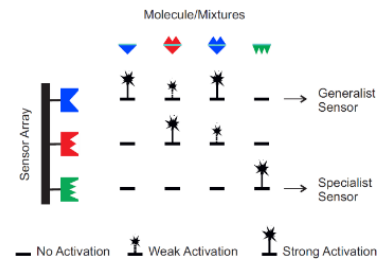
Project P7: Transmitter Systems for Releasing and Sending Airborne MC Signals as “Odor Objects”

- **PA:** Prof. Andrea Büttner (Chair of Aroma and Smell Research)
- **Project aim:** The fundamental principles of releasing and sending information as odor objects in airborne MC systems, considering molecular-structural aspects and using theoretical and experimental approaches will be investigated in collaboration with P8 and P9.
- **Qualification profile:** Master degree in Chemical Engineering, Electrical Engineering, Sensor Technology, Physics, Chemistry or a related field



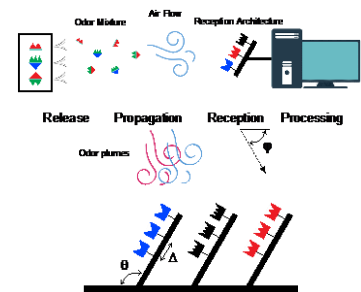
Project P8: Receiver Architectures for Information Recovery from Airborne MC Signals

- **PA:** Dr. Helene Loos (Chair of Aroma and Smell Research)
- **Project aim:** Investigation of sensing architectures using theoretical and experimental approaches for airborne molecular communication, particularly with respect to a robust detection of odor objects, will be performed.
- **Qualification profile:** Master degree in Physics, Chemistry, Engineering or a related field



Project P9: Theoretical Modelling, Design, and Analysis of Olfaction-inspired Molecule-Mixture Communications

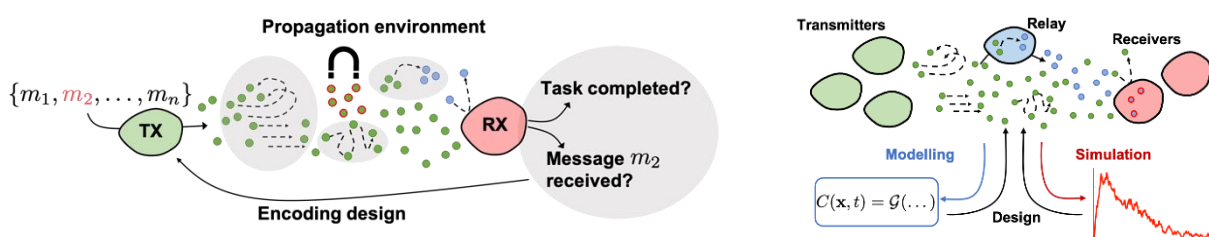
- **PA:** Prof. Vahid Jamali (Institute for Digital Communication)
- **Project aim:** Communication-theoretical models, modulation, and detection schemes for the olfactory-inspired MC systems studied in P7 and P8 will be developed. Optimization of the studied MC systems for efficient operation, e.g., the optimal odor mixture code or 3D arrangement of release and reception sites, will be performed. The developed theory will be verified and refined using measurement data collected in P7 and P8.
- **Qualification profile:** Master degree in Electrical Engineering with specialization in Communications or a related field



The **cross-cluster postdoctoral project** investigates the implications of specific properties of MC systems (e.g., length scale, transport mechanism, propagation environment, communication task, and constraints imposed on transmitter and receiver), particularly those considered in the doctoral projects of SyMoCADS, for **performance metrics, encoding of information, mathematical analysis, and efficient simulation**. The postdoctoral project cuts across all three clusters of SyMoCADS, connecting them and unveiling conceptual synergies and differences.

Moreover, the researcher working in the **postdoctoral project** will be supported by a mentoring team to establish her/himself as an independent researcher with the national and international visibility needed to qualify for an academic career.

Crossed-Cluster Postdoctoral Project (P10): Task-oriented and Environment-dependent Modelling, Analysis, and Design of MC Systems



- **PA:** Prof. Robert Schober (Institute for Digital Communications)
- **Project aim:** Studying the impact of the dominant molecule transport mechanisms, the release and reception mechanisms, the propagation environment, and the purpose of the communication on appropriate performance metrics and the effective representation of information in task-oriented single-user MC systems with the objective of developing design guidelines. The main objectives include (i) the definition of different categories of MC systems based on environmental conditions and the communication tasks where inspiration is drawn from natural MC systems and the synthetic MC systems considered in SyMoCADS, (ii) analysis of the MC systems using information-, communication-, and estimation theoretical performance metrics, considering different possible objectives of the communication, (iii) the development of practical guidelines for the design of task-oriented synthetic MC systems, and (iv) the development of a multi-scale toolbox for efficient simulation-based modelling of the considered MC systems operating in different environments and catering to different MC tasks.
- **Qualification profile:** Doctoral degree (Ph.D.) in Electrical Engineering with specialization in Communications or a related field.

We offer

- TV-L E13 position (doctoral researchers, according to the DFG discipline specific guidelines) / TV-L E14 position (postdoctoral researcher) for up to four years starting on **1. June 2024**
- High quality interdisciplinary research in an emerging and fascinating field of research
- A structured supervision and qualification program

Applicants for doctoral researcher positions are expected to have achieved outstanding grades in their Bachelor and Master programs. Prior publications are an asset but not required.

Prior high-quality research in the field of MC, documented through journal publications and awards, is expected from applicants for a **postdoctoral position**.

Application via e-mail

Please submit a **single pdf file**, including a **motivation letter** (max. 1 page, specifying which project you would like to work on and why you feel you are well qualified for the project), **curriculum vitae** (max. 2 pages), and **copies of graduation certificates** and **transcript of records** to symocads-coordination@fau.de by January 15, 2024. Later applications might also be considered but some positions may not be available anymore.

In its pursuit of academic excellence, FAU is committed to equality of opportunity and to a proactive and inclusive approach, which supports and encourages all under-represented groups, promotes an inclusive culture and values diversity. FAU promotes professional equality for women. Female applicants are therefore particularly encouraged to apply.

For further information contact PD Dr. Anna Maria Becker (symocads-coordination@fau.de).