Open PhD opportunities in Computational Neuroscience

We are looking for theoretically interested candidates with a bachelor or master's degree in physics, mathematics, or computer science who want to join us on the quest to understand how the brain works.

The department INM-6, Computational and Systems Neuroscience (www.csn.fz-juelich.de) at the Jülich Research Centre develops mathematical models of neuronal dynamics and function. Model-driven analyses of brain activity and structure as well as simulation and analytical investigation of biologically realistic models form the core of our work. To achieve our aims we work on the theoretical foundations of our field by importing and adapting methods of modern theoretical physics and develop analysis software and simulation technology for supercomputers. The institute is also part of the Institute for Advanced Simulation (IAS-6, Theoretical Neuroscience) and hosts the Coordination Site (BCOS) of the national Bernstein Network Computational Neuroscience. Among other projects, the INM-6/IAS-6 participates in the EU flagship "Human Brain Project" (HBP, www.humanbrainproject.eu). Together with its partners, the INM-6 develops the leading simulation code (NEST) for brain-scale networks at cellular resolution in an open-source approach (www.nest-initiative.org). NEST has been under continuous development for 20 years and serves a worldwide community. The second community code hosted by the department is the Elephant toolbox for the analysis of massively parallel electrophysiological data. We are also applying our knowledge to the creation of novel computing architectures specialized for the simulation of neural networks, a field called neuromorphic computing.

We offer participation in a young, dynamic, and internationally connected team, with a high percentage of female researchers at all levels, performing cutting-edge research. A structured program guides the doctoral researcher through the PhD work. Candidates receive advanced education in all competence fields required for computational neuroscience: neurobiology, theory of neuronal networks, data analytics, and simulation science. In addition introductions are provided into good scientific practice and key competences like scientific writing. Researchers have access to the best possible equipment for communication, computing, and making coffee. We expect a good command of English, openness to spending some time abroad in one of our partner laboratories, and an excellent background in mathematics or programming in C++ or Python.

We accept applications any time. The Jülich Research Centre is one of the largest research centers in Europe, with excellent scientific equipment, located on a green campus near the cultural centers Cologne, Düsseldorf, and Aachen.

Please send a motivation letter, CV, publication list, and copies of school and university certificates as a single PDF email attachment (max. 10 MB) to: Martina Reske, PhD (m.reske@fz-juelich.de) – scientific coordinator (www.csn.fz-juelich.de).

You may of course also approach us personally in one of our lecture courses at RWTH Aachen University.

Examples of presently open positions

1. We have an open PhD position in the framework of the HBP. The project focuses on the **development of a large-scale multi-area model of the cortex**, the outer shell of the brain. The model is formulated on the level of point neurons, mathematically equivalent to an impulse-coupled set of differential equations that phenomenologically describes the brain activity. The project integrates the latest connectivity data available from anatomical databases into a coherent model and analyzes the resulting dynamical properties. A major challenge of the project lies in the construction of a model that satisfies constraints not only on the structural level, but also on the level of neuronal activity. We therefore employ analysis methods known from statistical physics and many-particle systems, such as mean-field reductions, to understand and control the dynamical properties of the resulting, strongly interacting dynamical system.

2. A second open position is also related to the HBP and has the **focus on simulation technology for exascale supercomputers**. Here we are exploring advanced memory layouts and communication strategies. The candidate is embedded into a team experienced in simulation science and is expected to also join projects with a focus on understanding network dynamics. The results of the work will enter production code and will be published in peer-reviewed journal articles. Scientific stays at our partner laboratory in Norway are planned.

3. A position for a PhD student is available at the newly established interdisciplinary institute "Brain Structure-Function Relationships" (INM-10). The INM-10 is a virtual institute of the Jülich-Aachen Research Alliance (JARA) led by three directors: Prof. Frank Schneider (University Hospital Aachen), Prof. Ute Habel (School of Medicine, RWTH Aachen University), and Prof. Markus Diesmann (INM-6, Computational and Systems Neuroscience, Research Centre Jülich). The present project will mainly be embedded in the INM-6, but will involve a close collaboration with the group of Prof. Dirk Feldmeyer (Function of Cortical Microcircuits group, INM-2, Research Centre Jülich). The student will investigate **network effects of acetylcholine in neocortex using modeling and simulation approaches**. Acetylcholine is a neurotransmitter and neuromodulator involved in regulating attention, motivation, memory, and arousal. While the effects of acetylcholine on single neurons have been investigated in some detail, the mechanisms underlying its network-level effects are still poorly understood. The research will be performed in close collaboration with experimentalists in the same institute. The modeling work is expected to yield proposals for new experiments, leading to an interactive loop between modeling and experiments.