Doctoral Candidate 12 - Probing brain microstructure with multi-parametric, multi-component qMRI, AI at 3T and 7T

Host Institution	Forschungszentrum Jülich, Germany
PhD enrolment	RWTH Aachen, Germany
Primary Supervisor	Dr. Ana-Maria Oros-Peusquens, Institute for Neuroscience and Medicine
Subject area	High-field imaging, quantitative imaging, accelerated acquisition, multiparametric imaging, neurofluids

About this doctoral project and your tasks

The various aspects of the project fall are united by the concept of **highly-dimensional quantitative imaging**. We aim at combining various quantitative parameters to facilitate a deeper insight into tissue (micro)structure. This can reasonably be expected to allow for an earlier and more sensitive detection of various diseases affecting the brain.

Multicompartment relaxometry at high resolution suffers from low SNR, making the ill-posed inverse problem (e.g., NNLS) unstable, even when advanced, less noise-sensitive methods are employed. You will implement AI algorithms to replace the computationally challenging and noise sensitive inversion problem. Starting with extensive information about the multicomponent distribution of relaxation times and/or diffusion in single or few-slices acquisitions, you will investigate the feasibility of inferring accurate distributions using AI methods from fewer contrasts acquired with whole brain coverage.
Magnetisation transfer preparation is necessary for the measurement of qMRI parameters sensitive to e.g. aging or neurodegeneration but becomes increasingly difficult at 7T due to SAR constraints. Methods for **accelerating both the acquisition and the reconstruction and reducing the SAR** of the multiparametric qMRI protocol at 7T will be explored. Based on ~150 multiparametric qMRI data sets acquired on an elderly cohort at 3T with a heavily redundant acquisition, model-based reconstruction and AI methods will be implemented using retrospectively undersampled data. The best undersampling/reconstruction scheme on 3T data will be identified and used as a starting point for the implementation and optimisation of the multiparametric protocol at 7T with a further aim of deriving quantitative information directly from the k-space. The sensitivity of this approach will be used to predict brain age and correlate deviations from actual age with lifestyle influences. In addition to gray matter and white matter changes, quantitative properties of neurofluids will be explored in the context of aging.

Your tasks will include:

- Getting an in-depth knowledge of existing relevant literature with constant update
- Learning to operate MR scanners, assisting and conducting experiments
- Coding in Matlab, Python, possibly IDEA Siemens environment
- Data processing
- Writing monthly reports describing your research, writing conference abstracts and eventually papers
- Attending seminars, group and team meetings
- A very large amount of creative thinking and problem solving

Funded by the European Union

IQ-BRAIN is an MSCA-Doctoral Network funded by the European Union, starting in December 2024 (GA No. 101169519).

Foreseen secondments

For this project, we foresee secondments to:

- Dr. Dirk Poot (2 months) at **Erasmus MC** (The Netherlands)
- Prof. dr. Aleksandra Pizurica (3 months) at **University of Ghent** (Belgium)
- Prof. dr. Matthan Caan (2 months) at **Amsterdam UMC** (The Netherlands)

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