

Direct and inverse models for Diffusion MRI

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Diffusion Magnetic Resonance Imaging is a promising tool to obtain useful information on the microscopic structure and has been extensively applied to biological tissues. We establish a new macroscopic model from homogenization theory for the complex transverse water proton magnetization in a voxel due to diffusion-encoding magnetic field gradient pulses in the case of intermediate water exchange across biological cellular membranes. Based on a particular scaling of the permeability condition modeling cellular membranes, this macroscopic model reproduces the memory effects often observed in experiments. Explicit formulae given by homogenization for the coefficients of this model emphasize their link to the relevant physiological quantities. In addition, we explicitly solve the macroscopic model to obtain an ODE model for the dMRI signal. This ODE model is numerically easy to invert, and the inverse problem of retrieving model coefficients from synthetic dMRI signal data is considered. This work is in collaboration with Jing Rebecca Li and Julien Coatlen.