Master's Thesis:
Magnetization Transfer Simulation in BART

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Overview

In magnetic resonance imaging (MRI) fast data acquisition requires excitation of the protons with many RF pulses in a short time interval. When using large excitation flip angles this leads to an excitation of macromolecules that then influence the measured signal, which confounds existing quantiative methods but also provides additional tissue-specific information. To describe the physics of this so-called magnetization transfer effect various two-pool models have been created. One important model is given by the Bloch-McConnell equation which is an ordinary differential equation.

The aim of this master thesis is to extend an existing Bloch simulation in the BART reconstruction toolbox to the Bloch-McConnell model, to implement methods for sensitivity analysis, and to further extend the framework to use efficient simulation methods based on state-transition matrices. BART is our toolbox for advanced computational MRI which is used by MRI groups world-wide and developed in collaboration with researchers at the University of California, Berkeley and th University of Texas, Austin.

Specific Tasks

- Literature review
- Learn the existing BART code (C language)
- Implementation of the Bloch-McConnell model
- Implement methods for sensitivity analysis
- Validation with existing simulation code (Matlab)
- Efficient implementation using state-transition matrices
- Documentation and illustration of the results

Recommended Knowledge

- Python, Matlab, C
- Interest in ordinary differential equations and their solutions
- Familiarity with the Linux operating system
- Basic git workflow

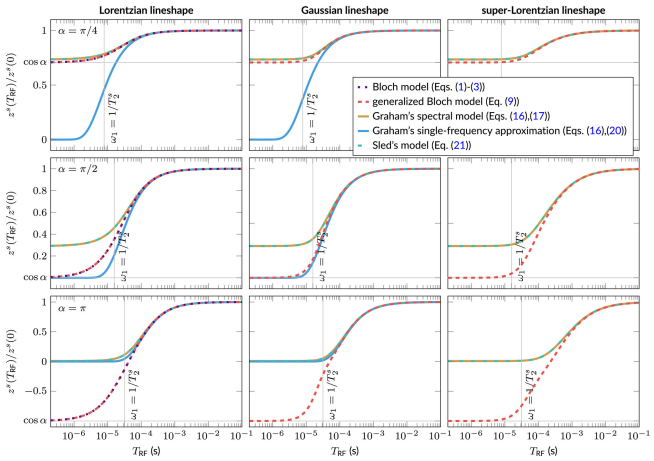

Figure 1: Figure: simulated z-magnetization of an isolated semi-solid spin pool at the end of a RF-pulse (Asslaender, MRM, 2021).

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