Biomedical Imaging FS 2021

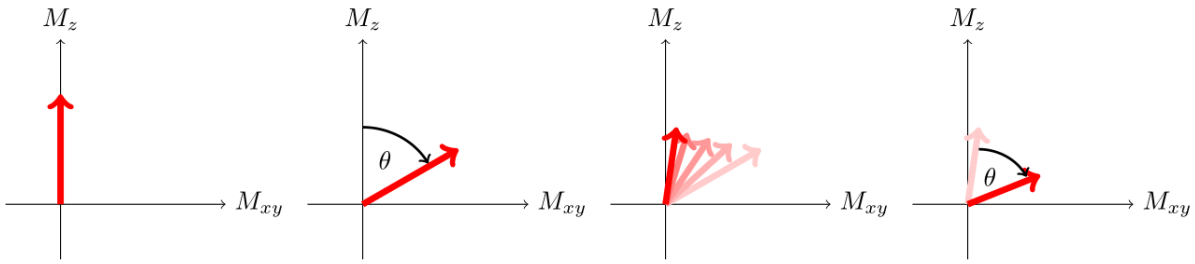
MRI 1

Exercises

1. Equilibrium Magnetization

- Calculate the relative difference $\frac{\Delta n}{n}$ in up- and down-state spin population for the common case of
  - Protons (^{1}H)
  - Body temperature (310 K)
  - 3T field strength

2. Magnetization Dynamics



- Write a Matlab program that simulates and visualizes repeated on-resonance excitation of nuclear magnetization at one point
  - perform equal excitations of given flip angle θ at a given repetition time T_R
  - assume excitation to be an instantaneous rotation by θ. Excitation is on-resonance, so all rotations are about the same axis.
  - consider the fact that relaxation between excitations is incomplete
  - vary T_1, T_2 and the flip angle. Study the magnetization behaviour. What happens in the course of long pulse series?

- Repeated excitation leads into periodic magnetization dynamics. Assuming complete transverse relaxation per interval, which flip angle yields maximum transverse magnetization in the periodic regime? Calculate analytically for given T_1 and T_R.

- Verify your solution with your simulation code

Questions?

Samuel Bianchi (bianchi@biomed.ee.ethz.ch)
Eric Michael (michael@biomed.ee.ethz.ch)
Thomas Ulrich (ulrich@biomed.ee.ethz.ch)