Introduction to Project 1: Mapping relaxation times with MRI

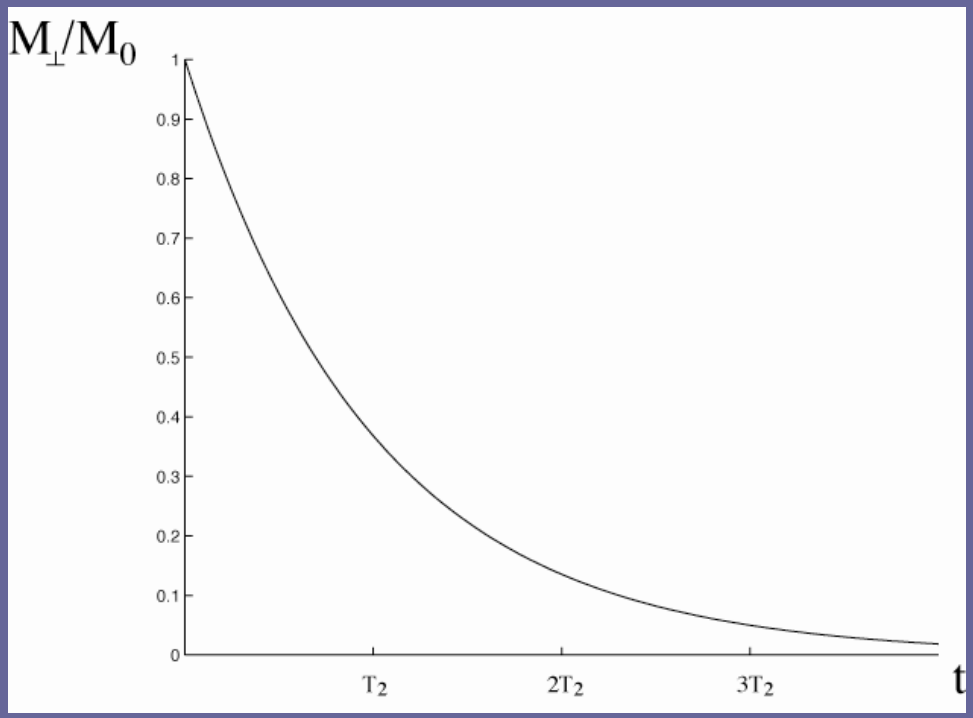
Quantitative and Functional Imaging
BME 4420/7450
Fall 2022

Measuring relaxation times with MRI

- Map relaxation times using
  - Multiple echo time measurements of $T_2=R_2^{-1}$
  - Inversion recovery measurements of $T_1=R_1^{-1}$

Multiple echo time measurements of T_2

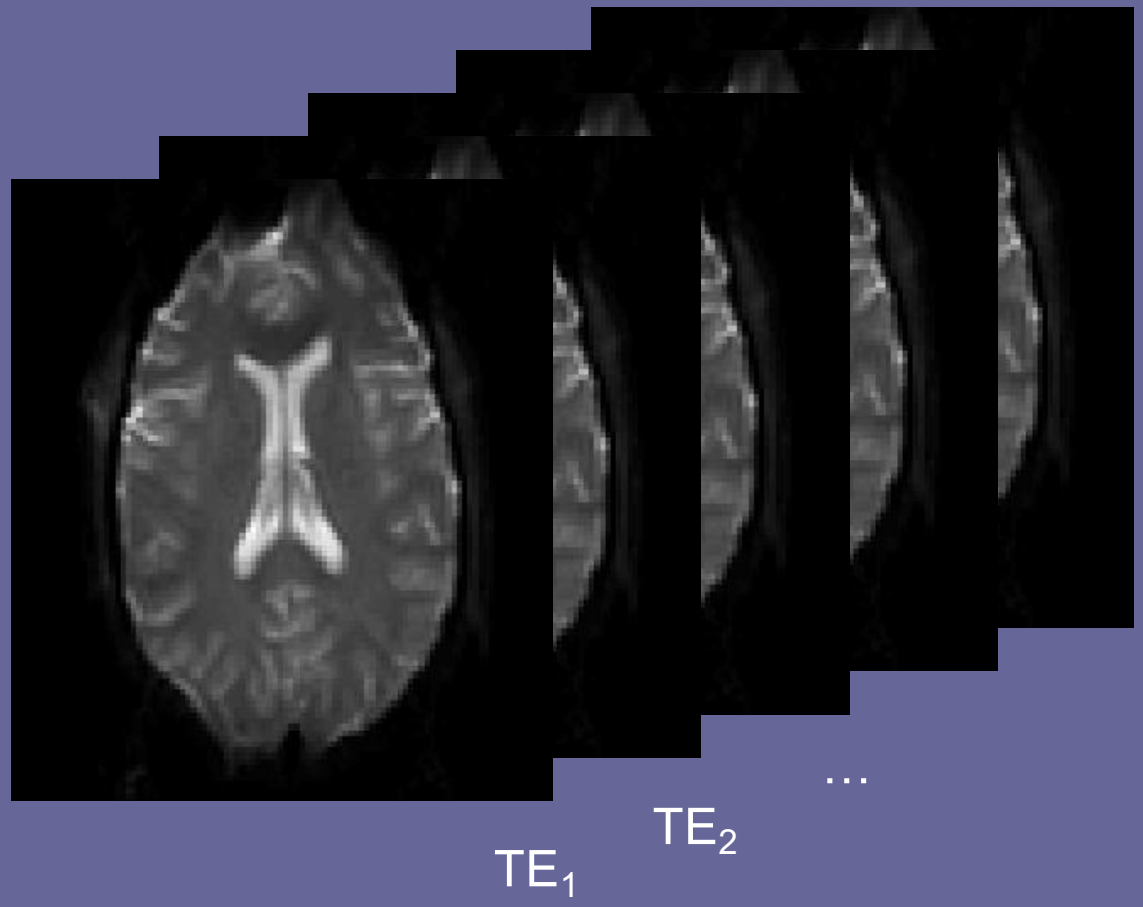
- Acquire a series of images, each at a different time after the tipping B_1 pulse
- Signal intensity decays exponentially with time constant T_2.



Multiple echo time measurements of T_2

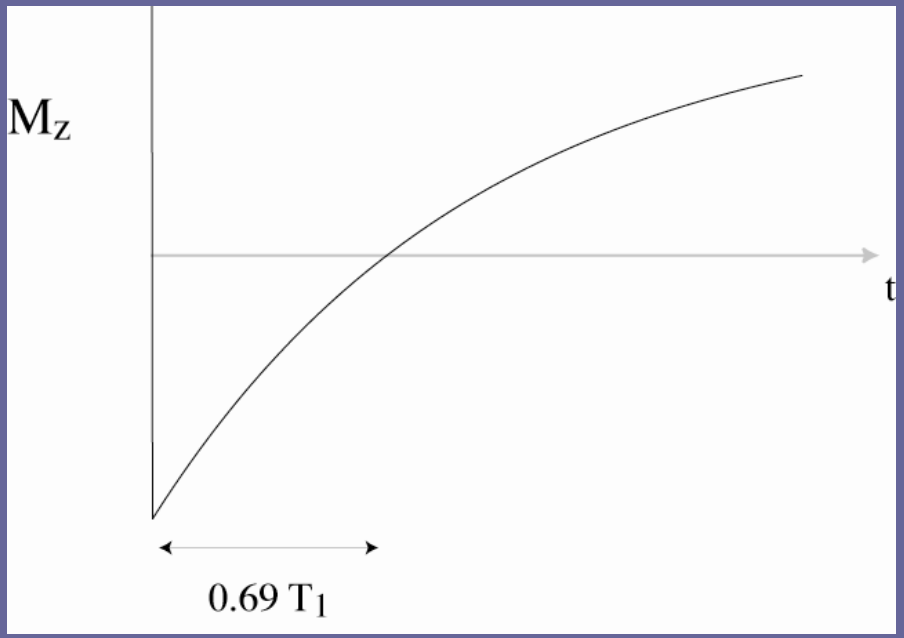
- Fit signal decay in each pixel to an exponential

$$S(T_E) = S_0 \cdot e^{-T_E/T_2}$$



Inversion recovery measurements of T_1

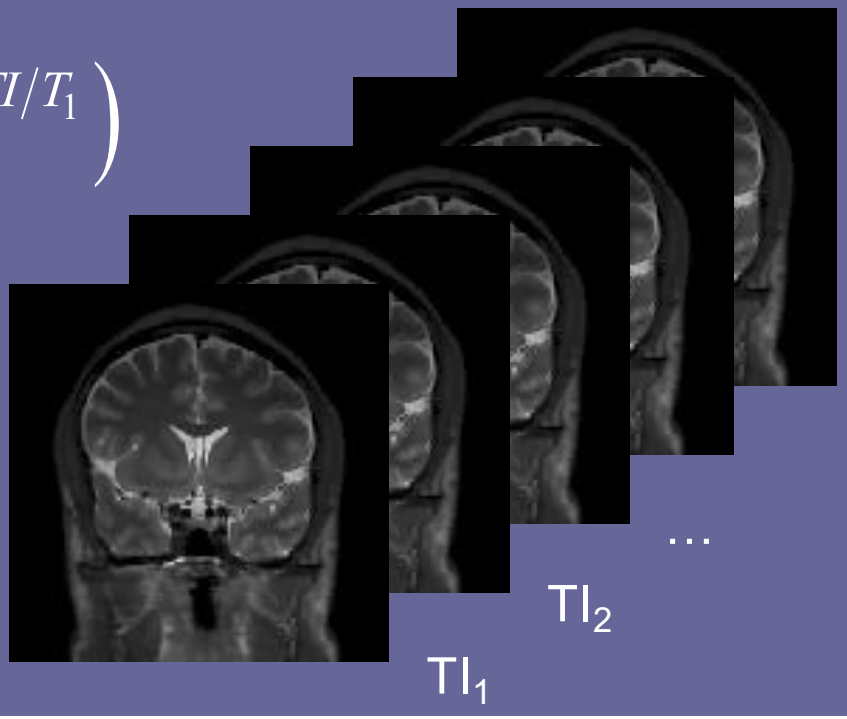
- Apply an 'inversion' B_1 pulse to orient M along –Z
- Wait some delay (inversion) time, TI, during which M_z recovers toward M_0
- Tip spins into the transverse plane and measure magnetization immediately (indirect measure of M_z)



Inversion recovery measurements of T_1

- Acquire a series of images each with a different inversion time
- For each pixel location, fit signal recovery to estimate T_1

$$M_z(TI) = M_0 \cdot \left(1 - 2e^{-TI/T_1}\right)$$



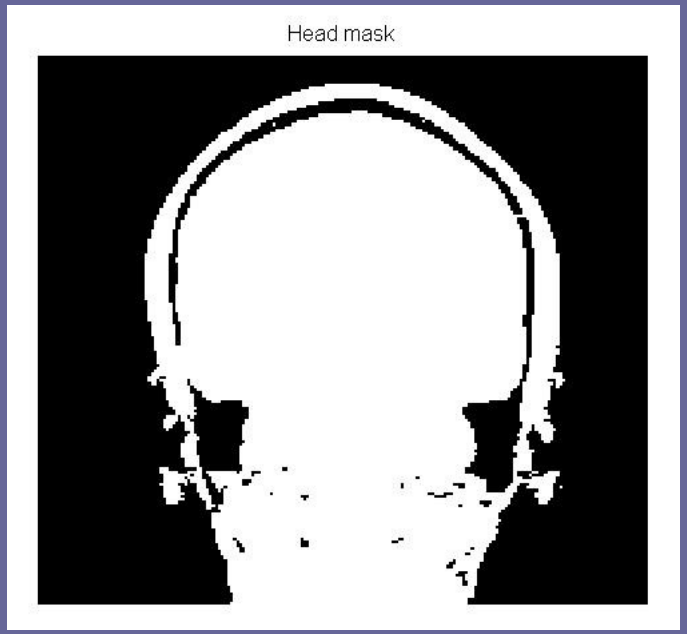
Goals of project

- Calculate and interpret T_2 and T_1 maps
- Compare T_1 and T_2 for tissue classification
- Practice basic MATLAB skills for image analysis

Making a head mask

- Identify pixels in background of image
- Compare pixel intensities to a threshold at 10% of maximum:

```
mask_m = (image_m > 0.1*max(image_m(:)));
figure
imagesc(mask_m)
colormap(gray)
axis image
axis off
title('Head mask')
```



- mask_m has 1's in head