2019–12–20

- I simulated diffusion MR giving the ems the diffusion properties of free water to test my DWI-associated routines.

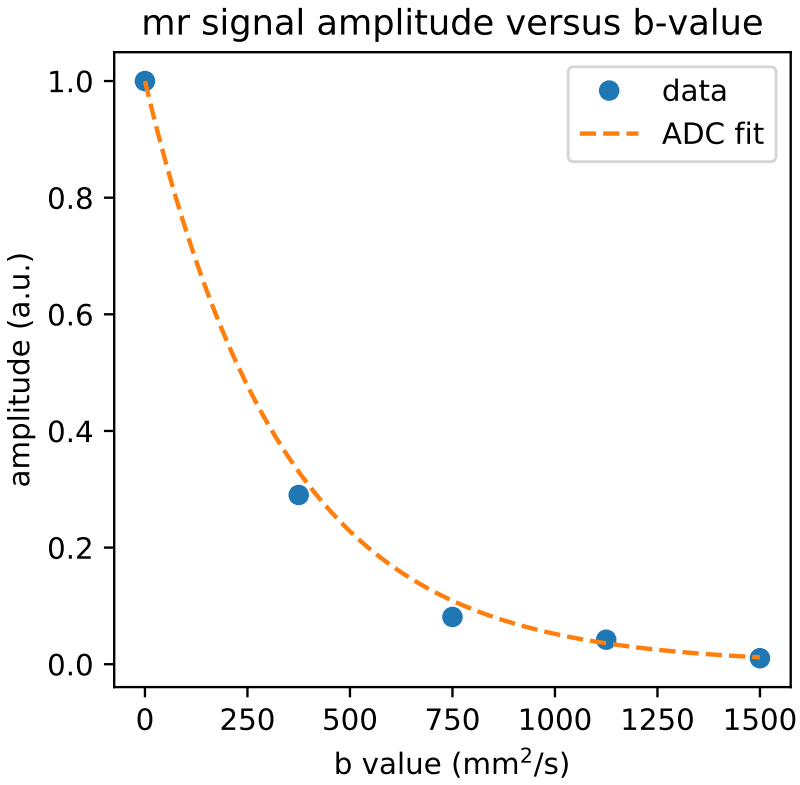
Diffusion MR test

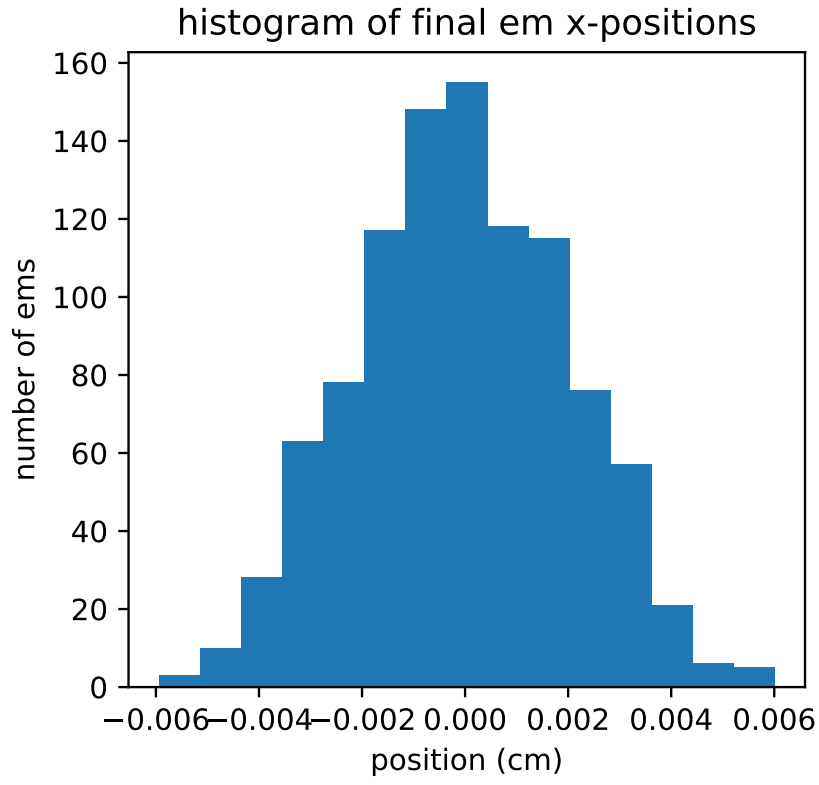
Summary

- I defined a pulse sequence with a single 90 degree tipping pulse and a diffusion-weighting gradient in the x direction. The magnitude of the diffusion-weighting gradient determines the "b value."
- I ran a simulation with 1000 ems, $D = 3 \times 10^{-9}\ \mathrm{m}^2/\mathrm{s}$ (diffusion coefficient of free water) in the x direction. No diffusion in the y or z directions.
- I repeated this simulation for b values in `linspace`(0,1500,5) and recorded the MR signal magnitude $S(b)$.
- In theory, the relation between $S(b)$ and b is

$$S(b) = S(0)\exp(-b \cdot ADC)\,,$$

where ADC is the "apparent diffusion coefficient." In this case, ADC should be equal to D.





$$D = 3 \times 10^{-9}\ \mathrm{m}^2/\mathrm{s}$$

$$ADC = 2.956 \times 10^{-9}\ \mathrm{m}^2/\mathrm{s}$$

Comments

- The fitted ADC agrees with D, the actual diffusion coefficient.
- The final em positions look Gaussian. According to the diffusion relation $\sigma = \sqrt{2DT}$, where T is the total diffusion time, the standard deviation of this Gaussian should be 0.0009 cm, which appears to be an underestimate of the standard deviation of the em distribution, not sure why.
- The results look reasonable overall.