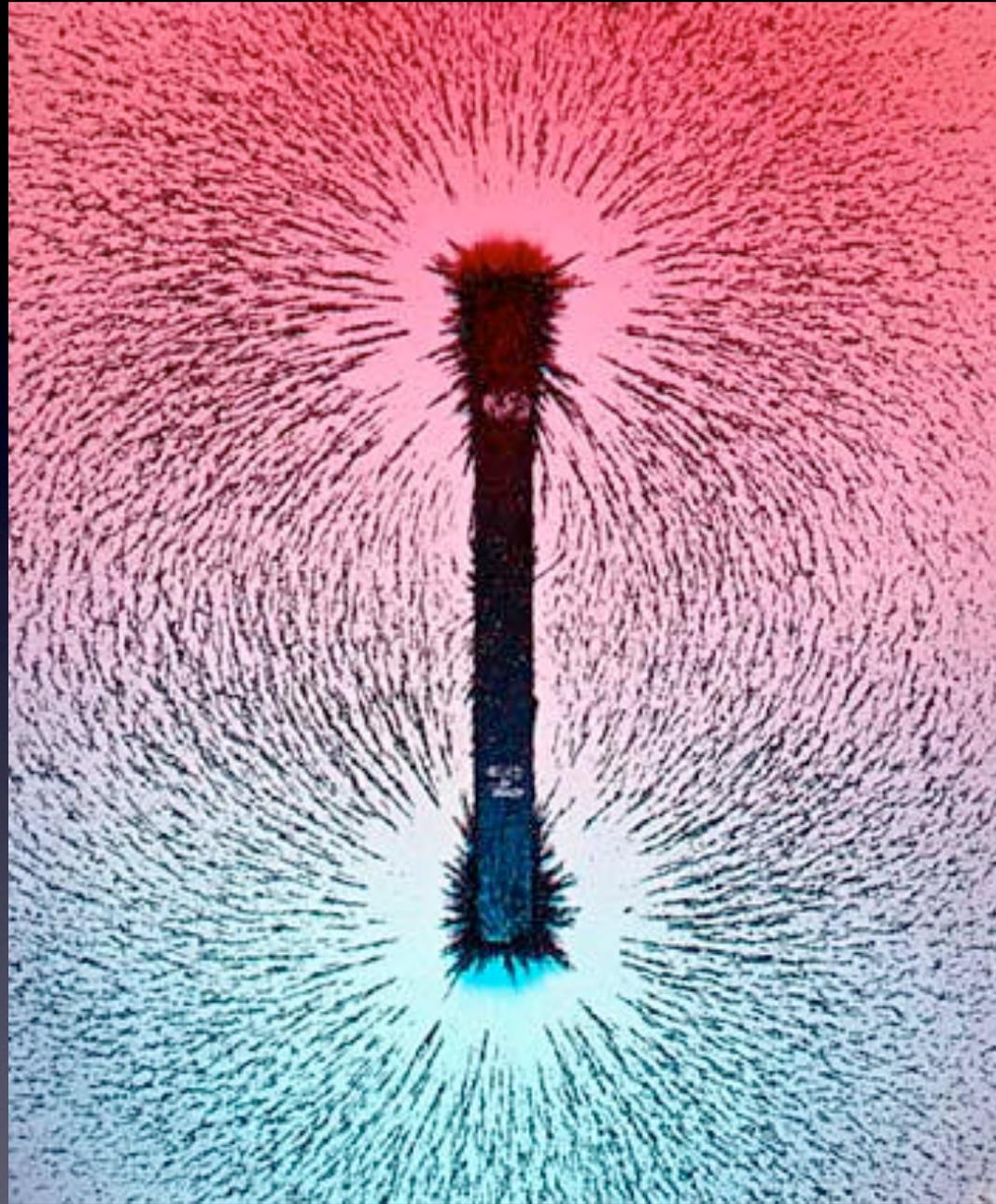


# **A Non-Physicist's Intro to MRI**

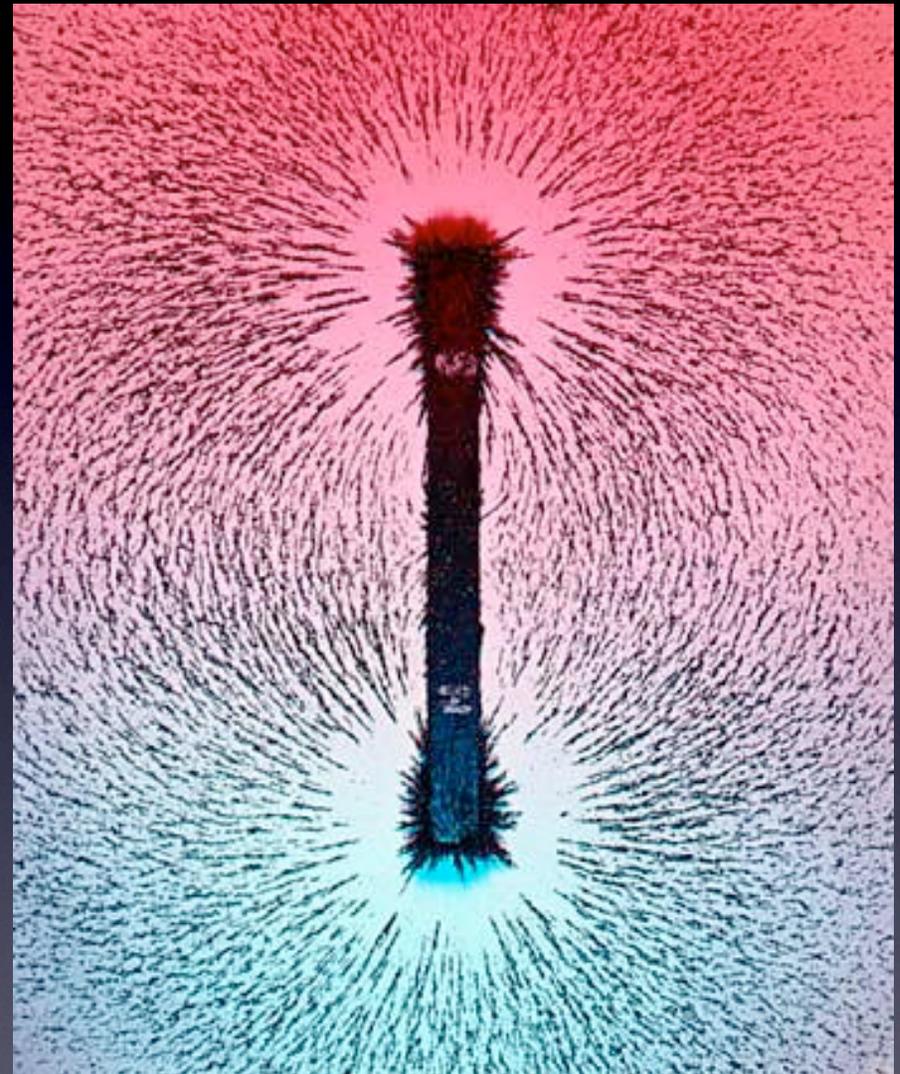
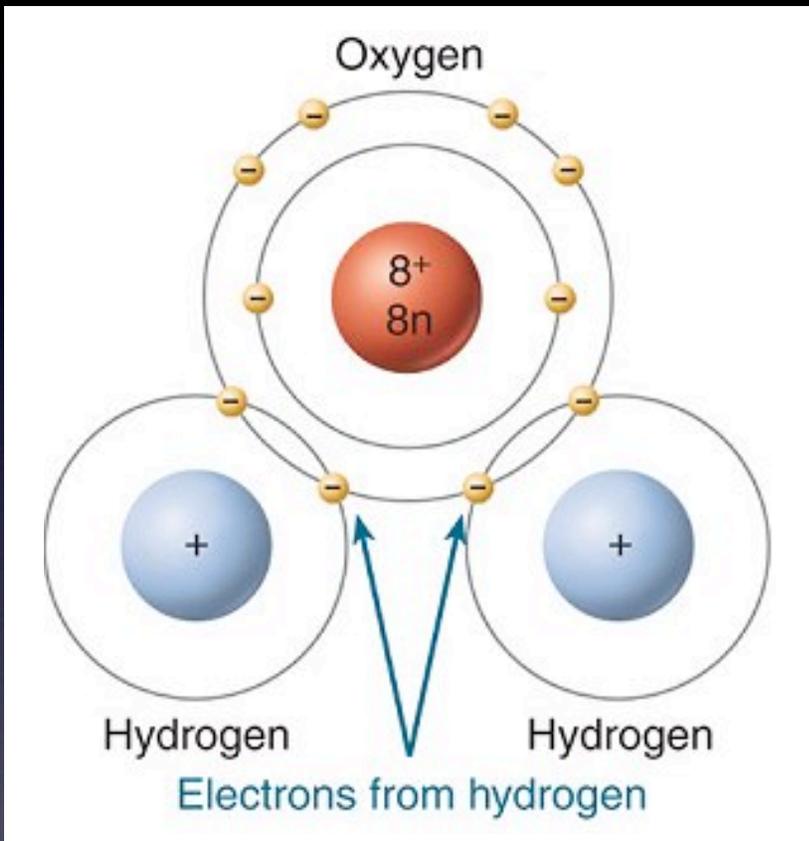
Dylan Tisdall

December 12, 2011





A human head

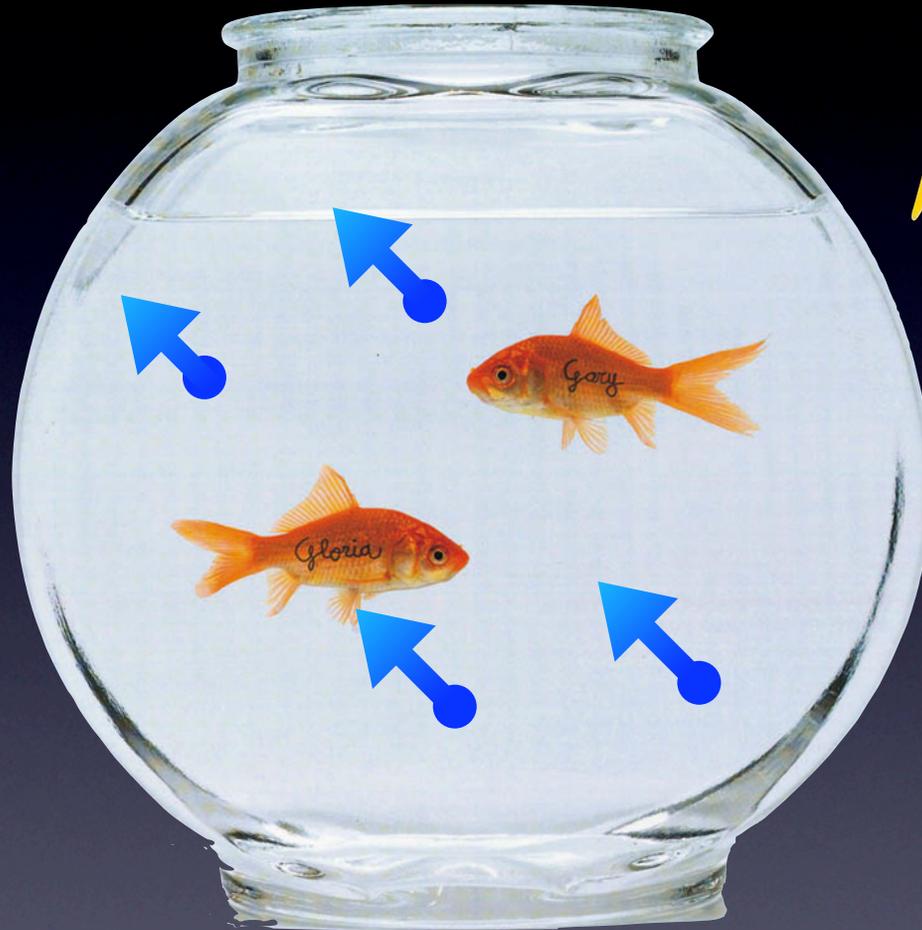




main  
magnetic  
field



main  
magnetic  
field



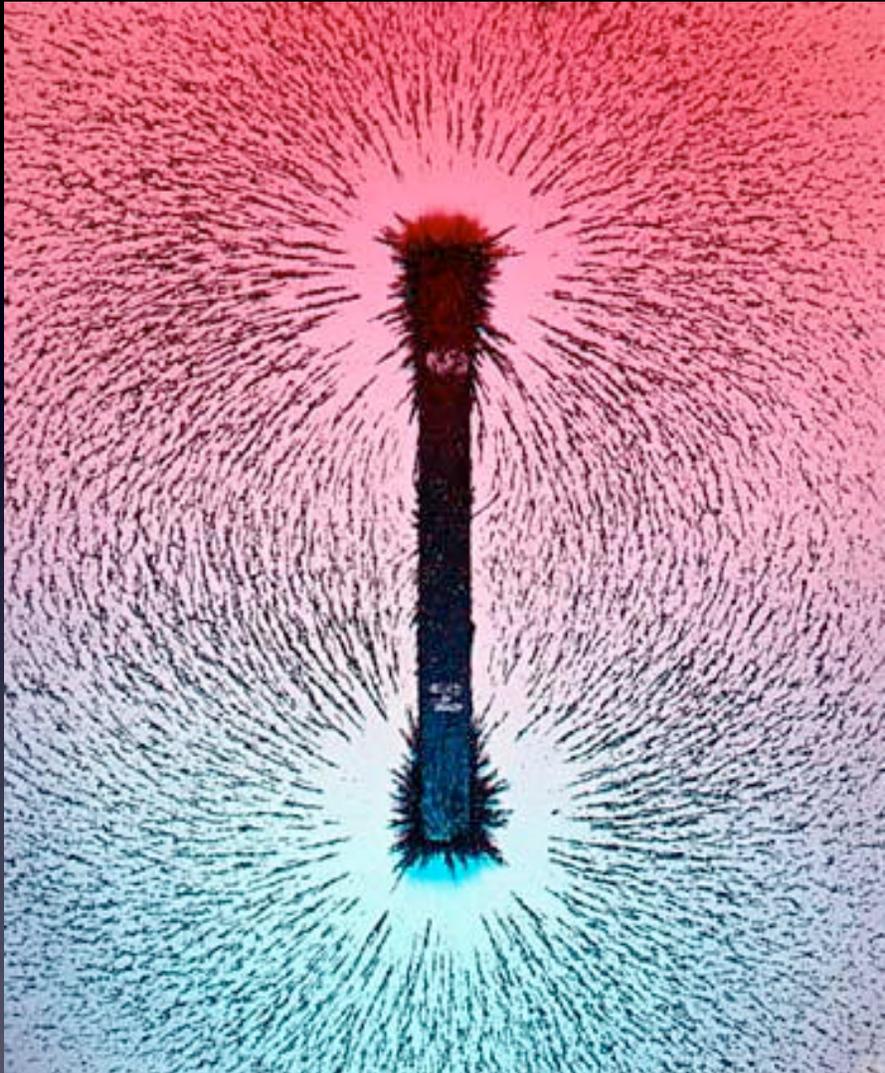
“pulse”

main  
magnetic  
field

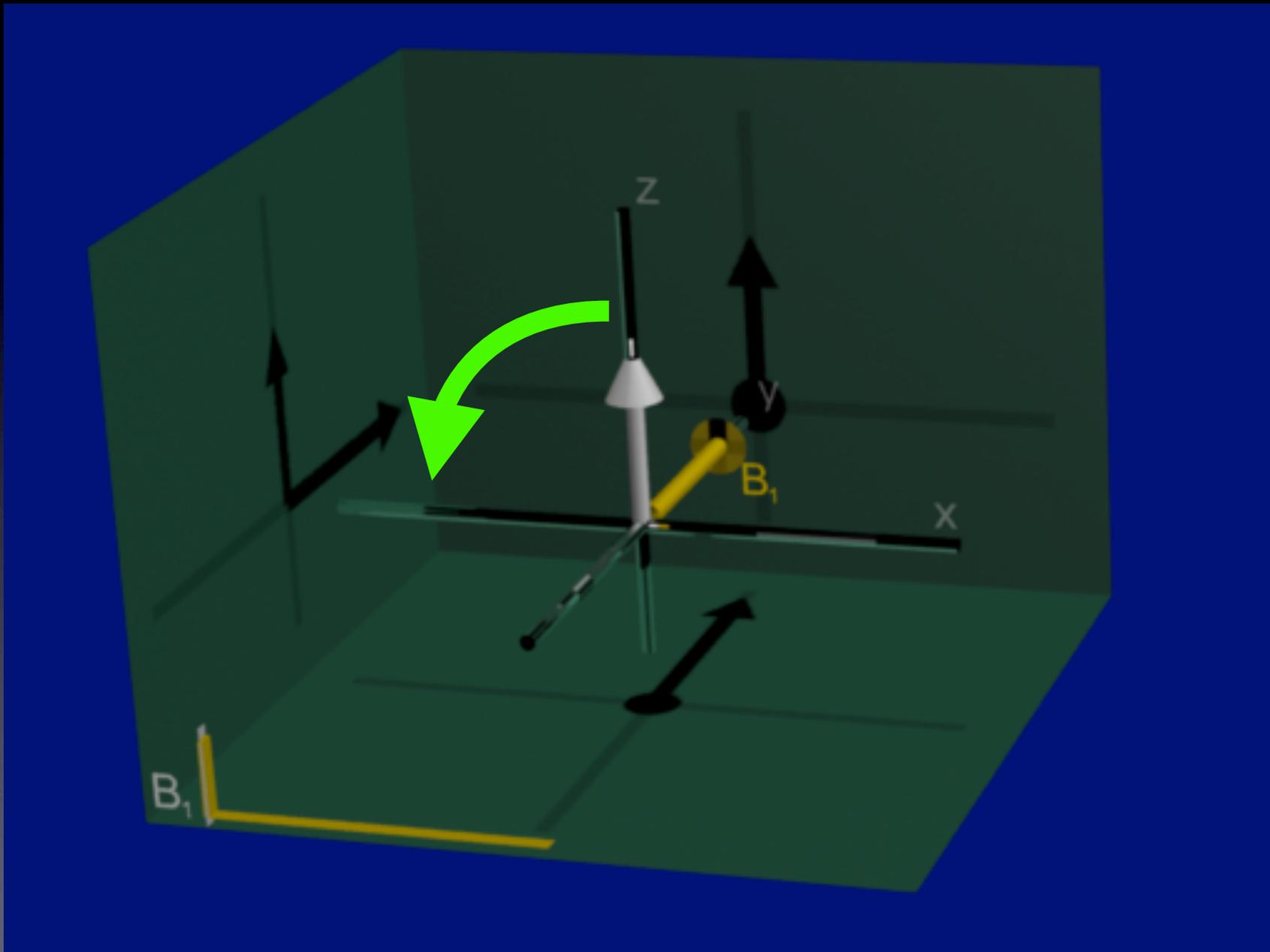


“pulse”

“flip angle”



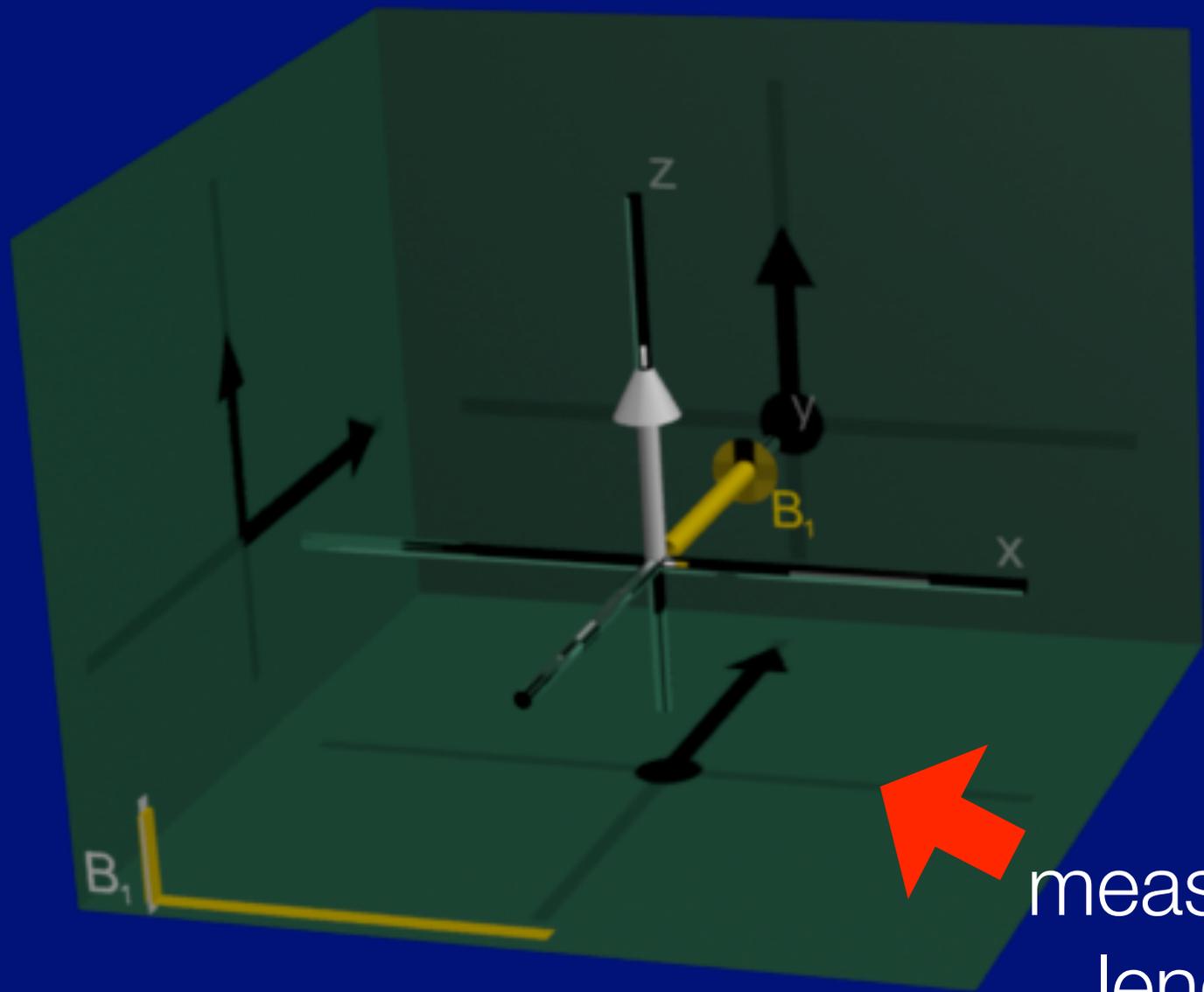
# precession



The **rate of precession**  
changes **linearly** with the  
strength of the **magnetic field**

main  
magnetic  
field





measured  
length

“rotating frame of reference”



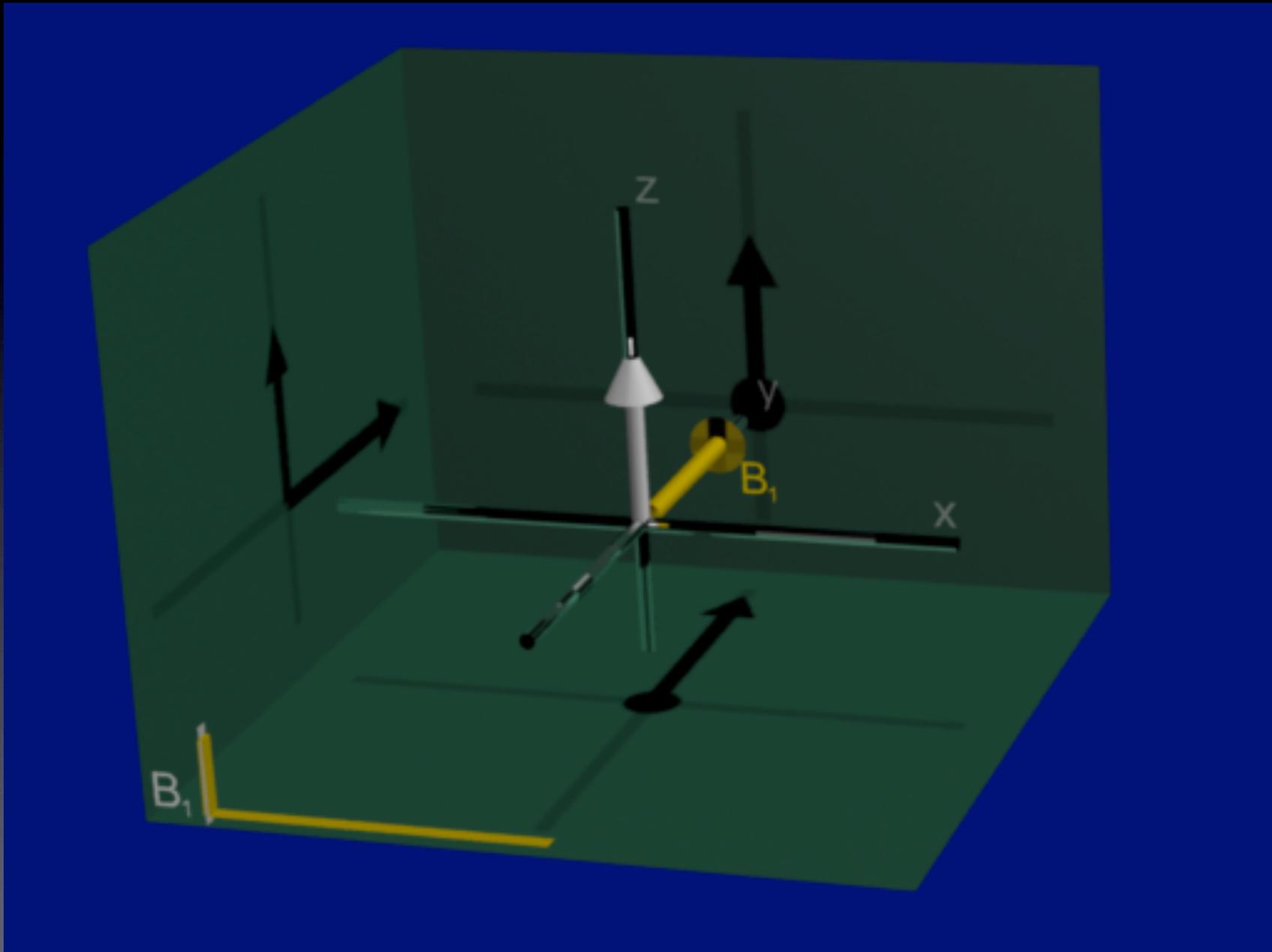
relaxation



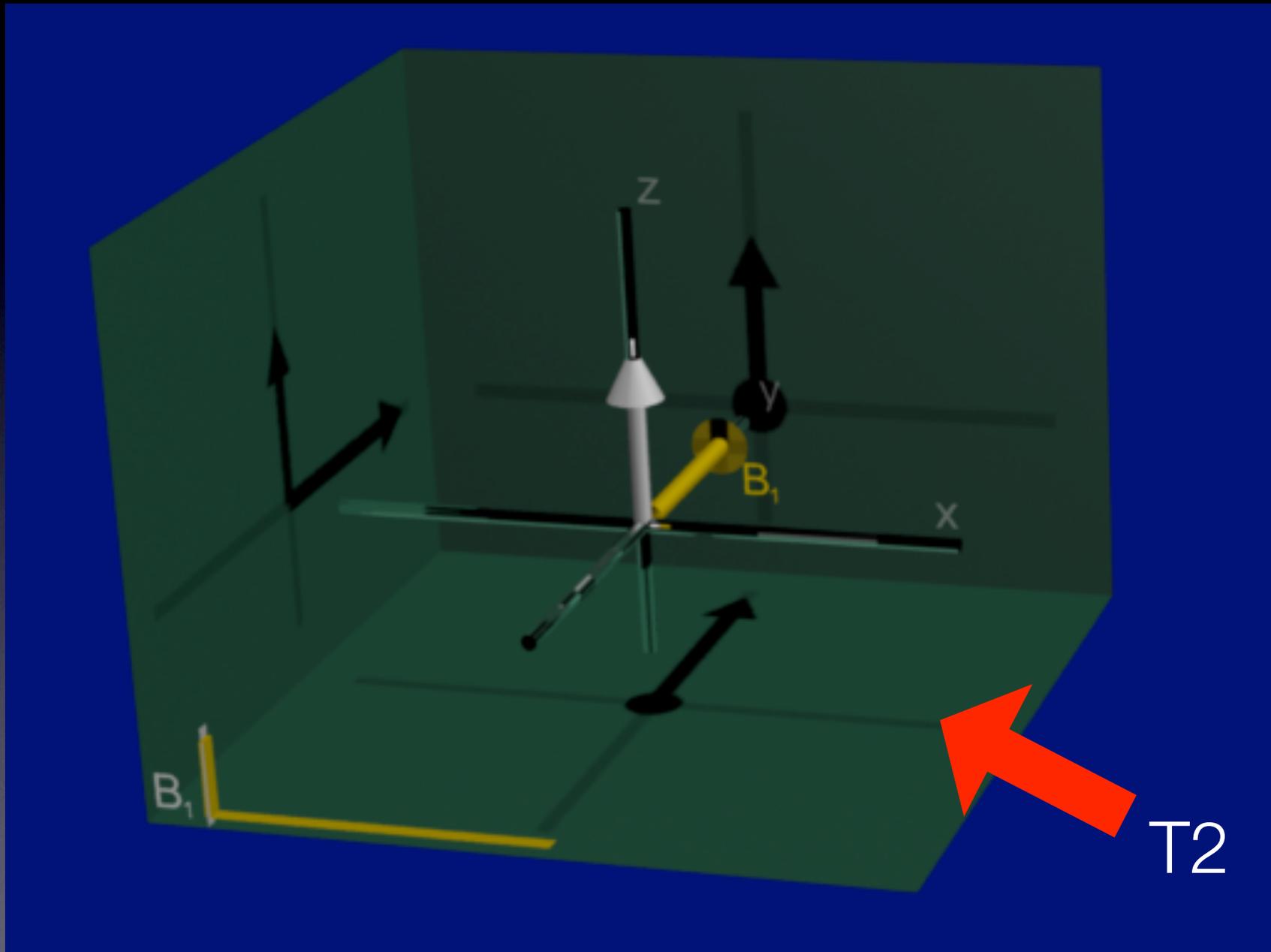
main  
magnetic  
field



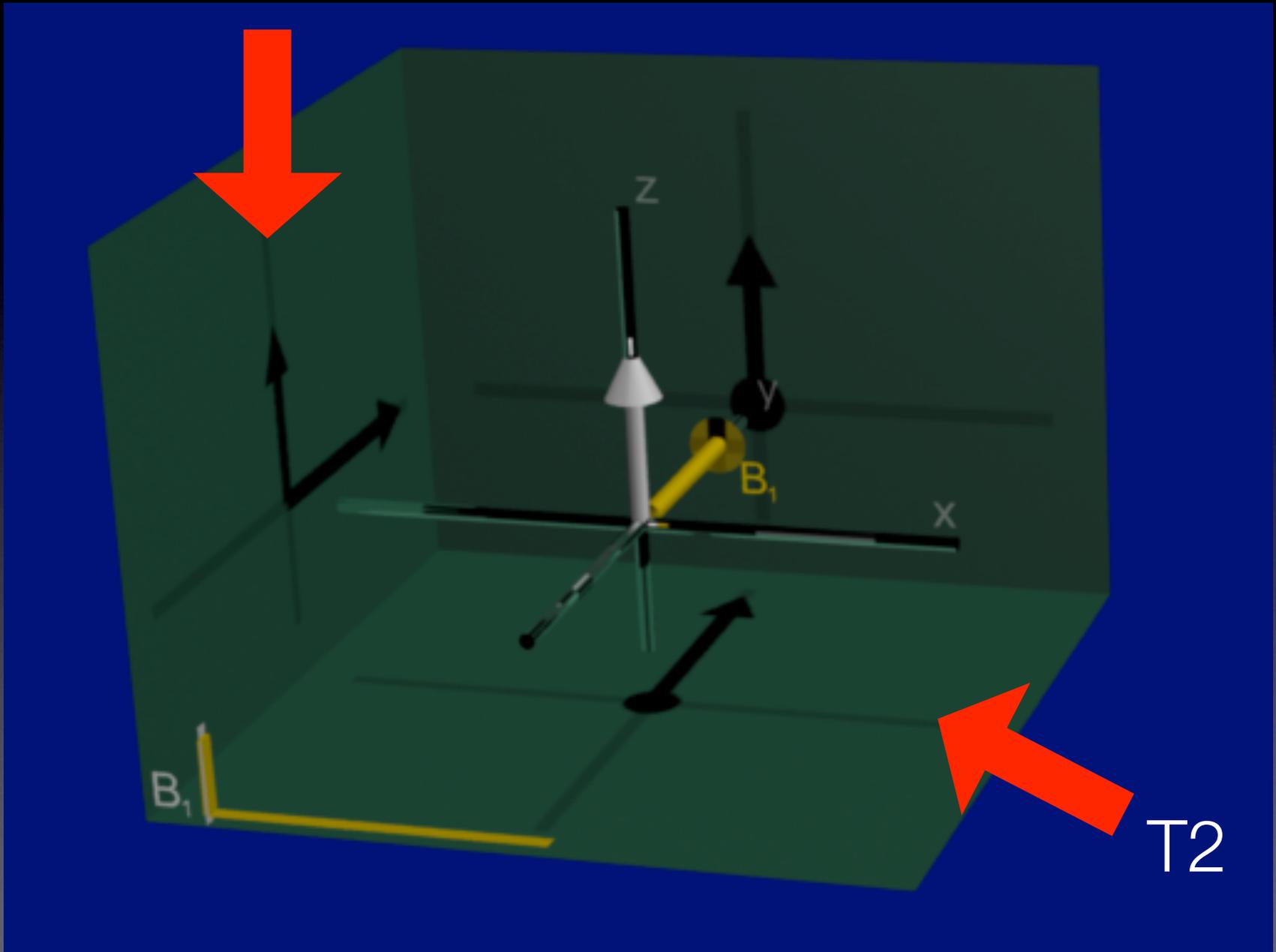
T2 is dephasing



dephasing looks like “less signal”



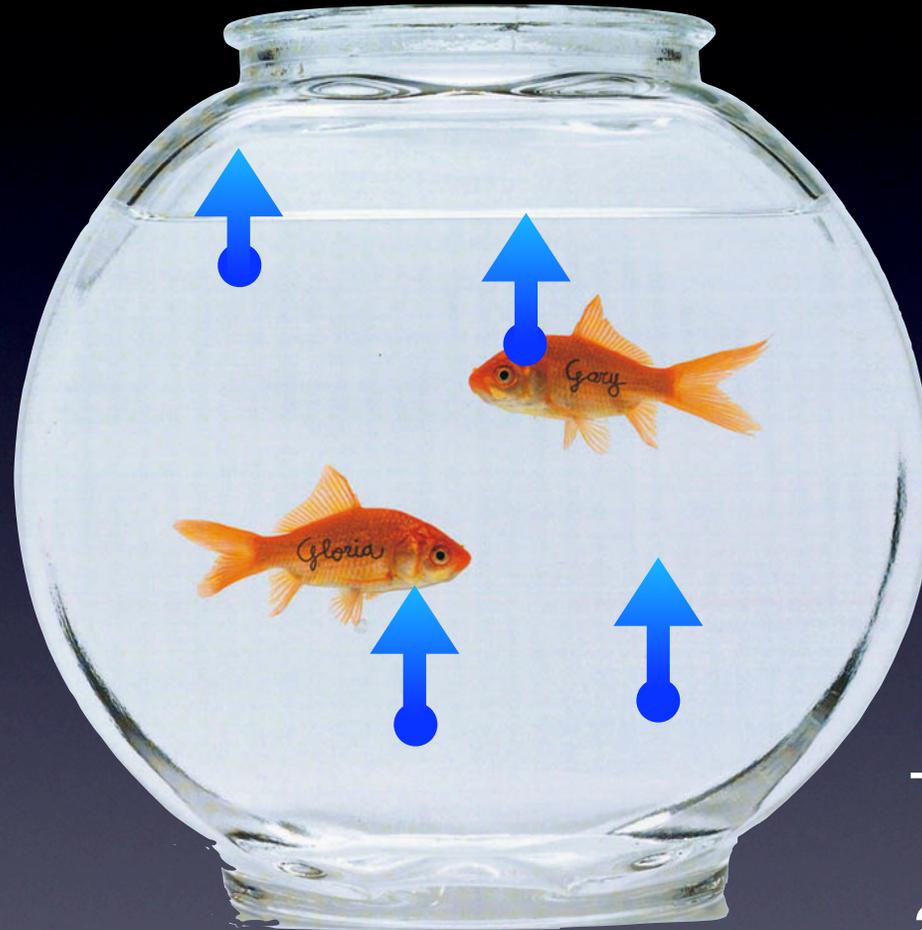
T1



T2

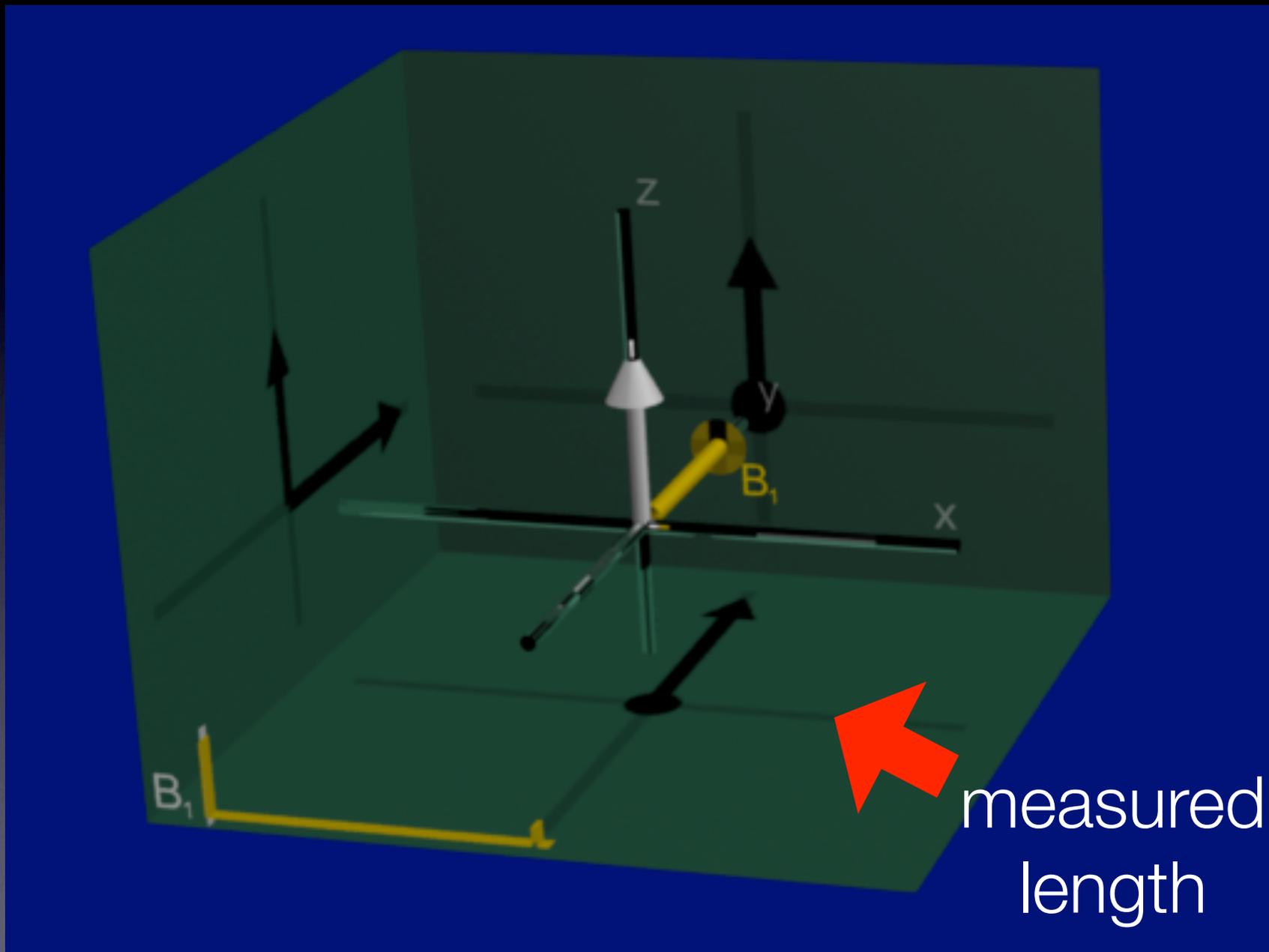


main  
magnetic  
field



The fish  
are what  
make it  
interesting....

# inversion recovery



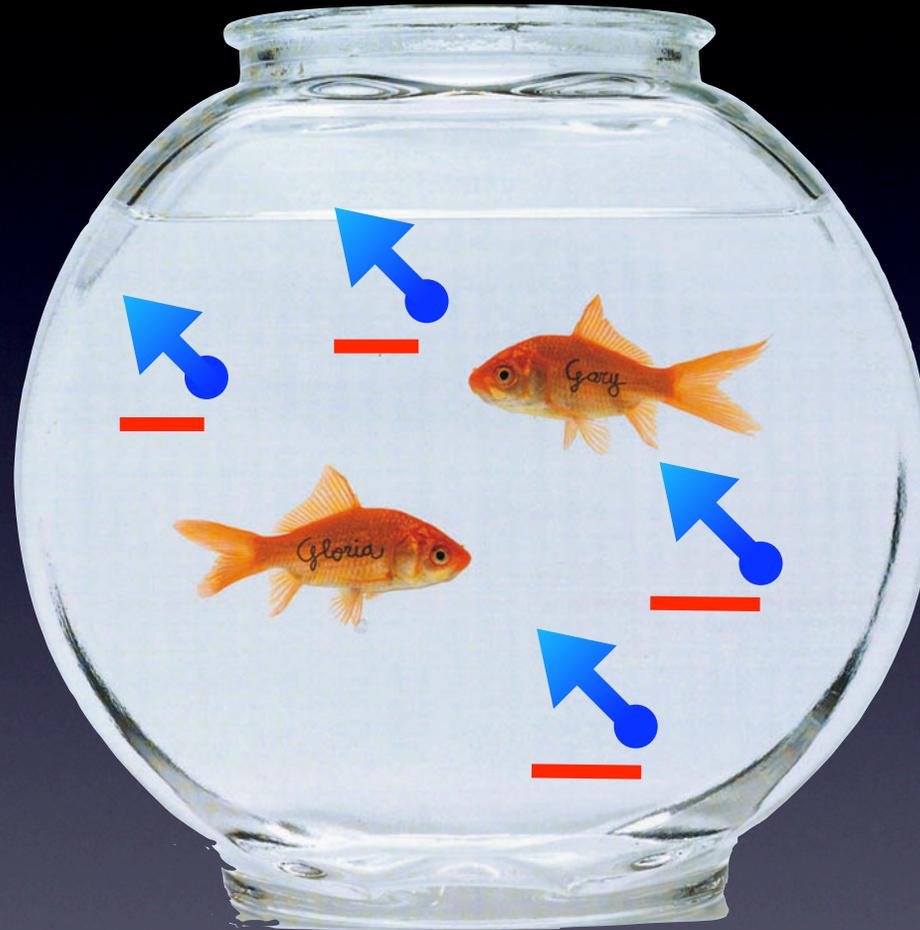
Using **inversion recovery** we  
can **weight** our measurements  
for tissues with **specific T1**

How do we get  
**spatial information?**

what do we measure?

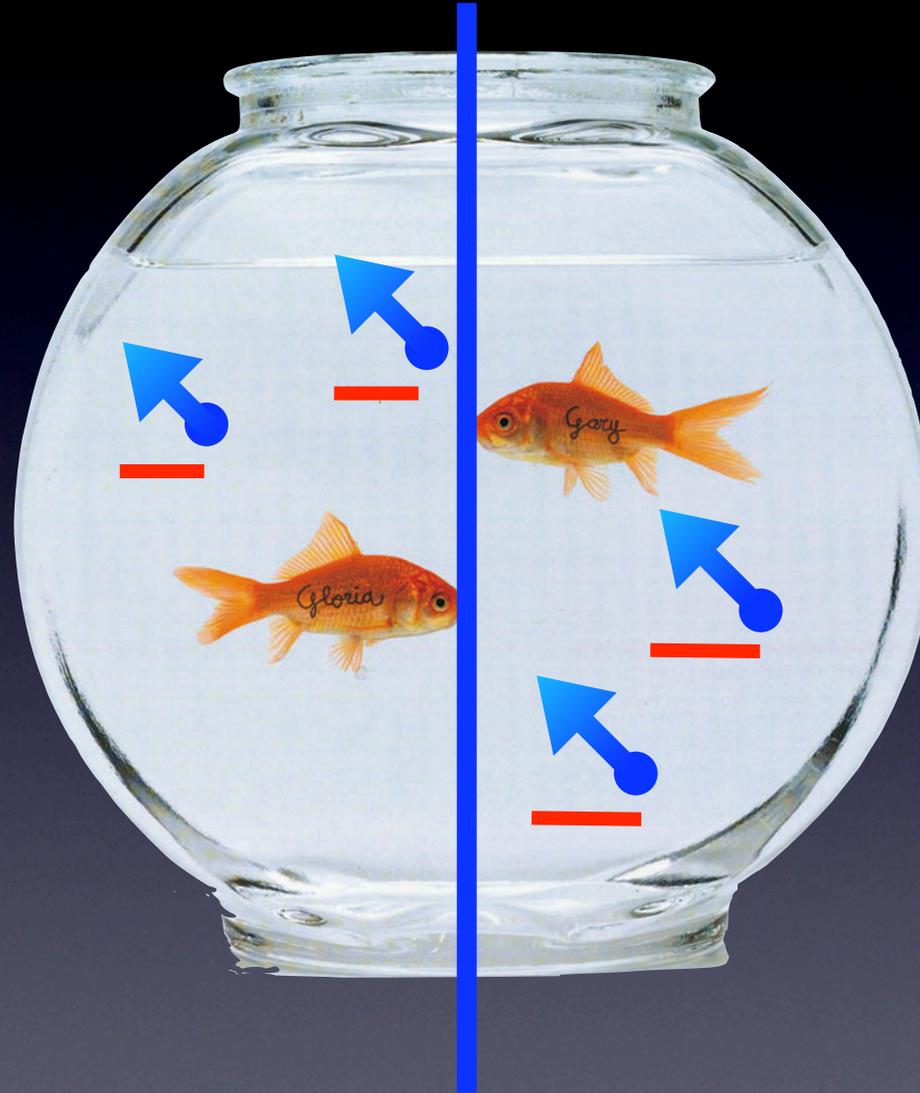


main  
magnetic  
field



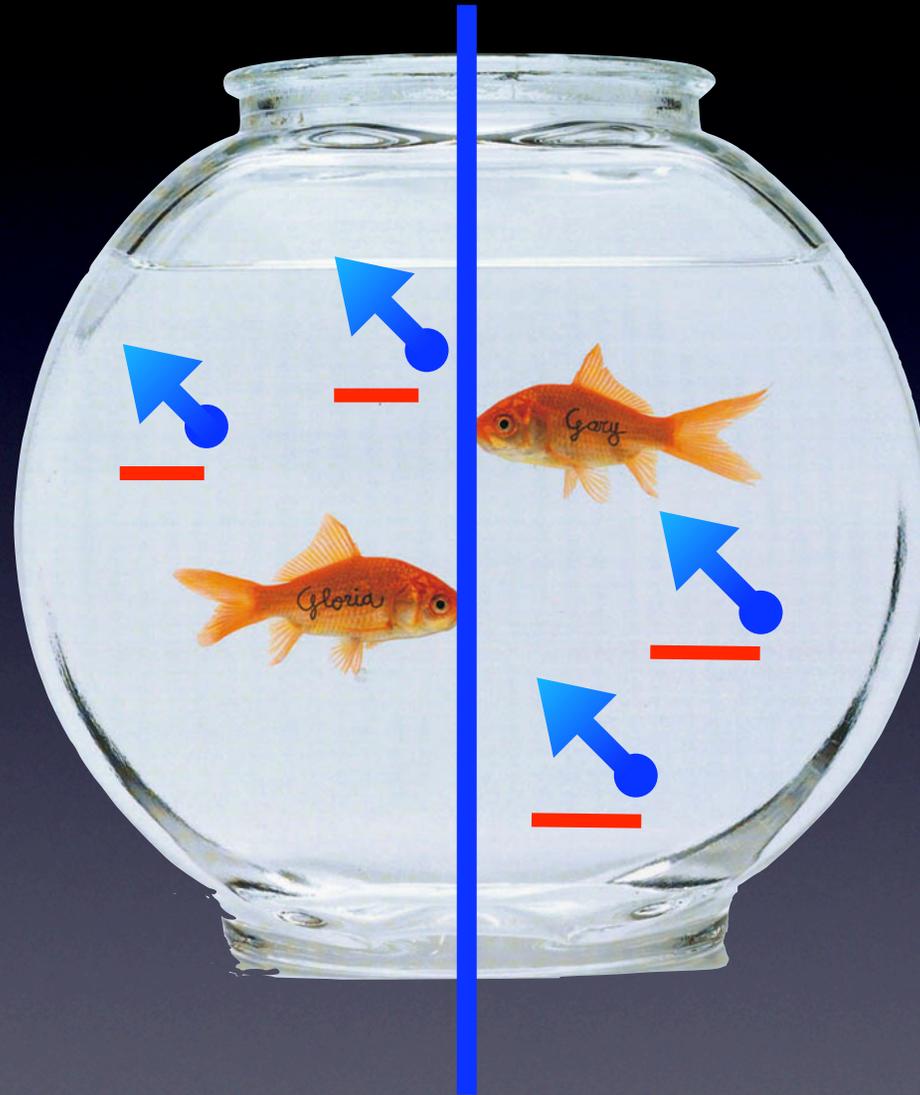
add up the red lines

two voxels (left and right)

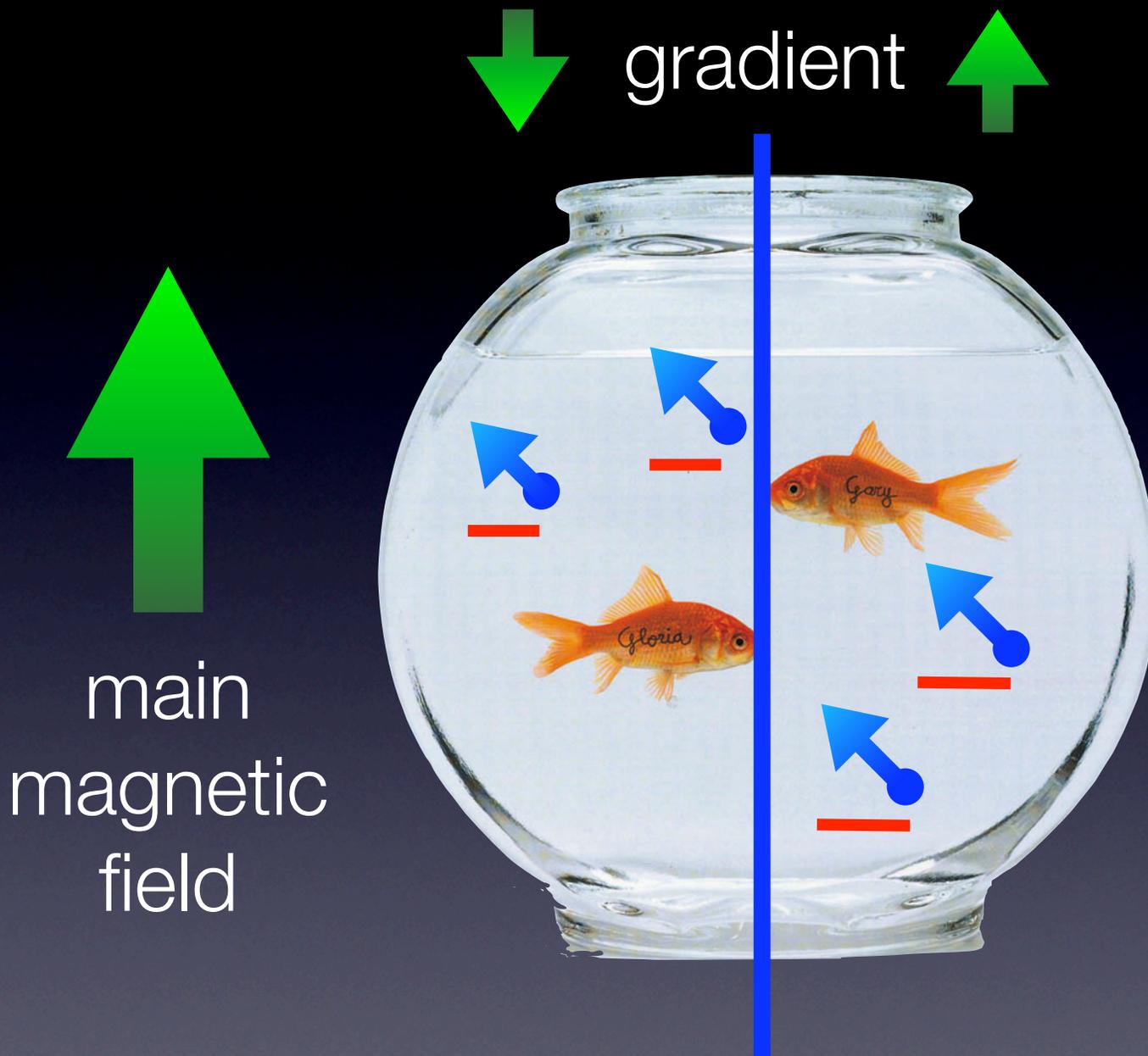


take one measurement (sum)

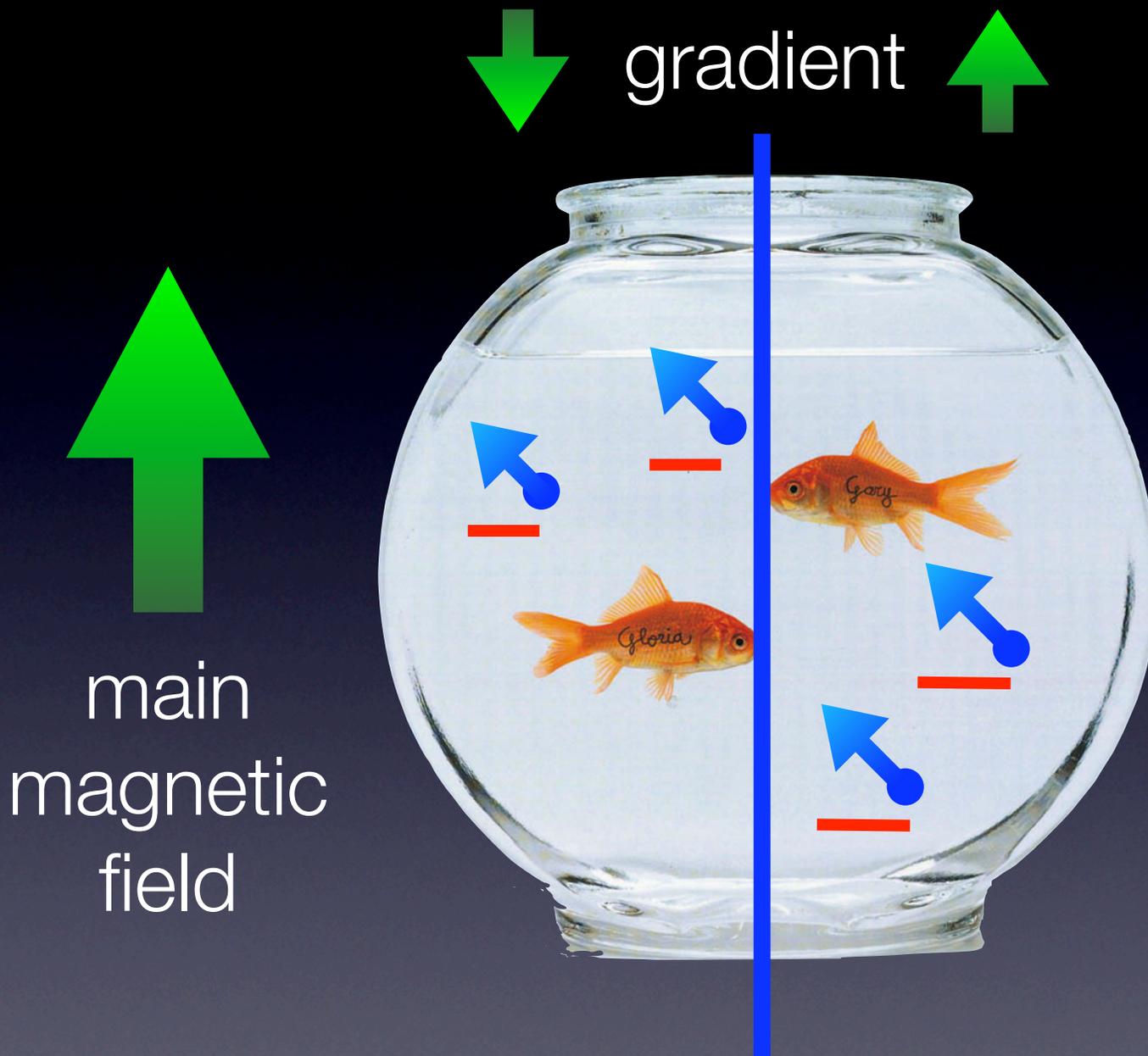
two voxels (left and right)



apply a different magnetic field to each half



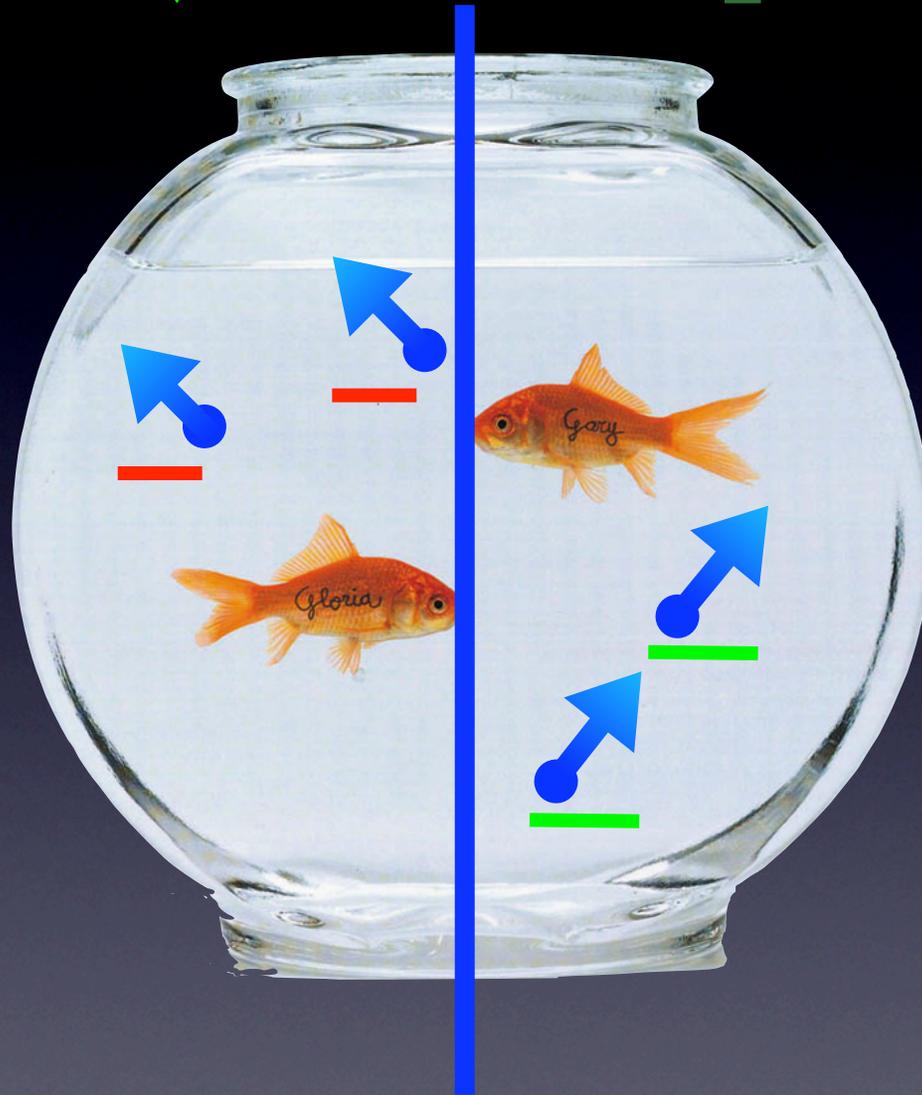
apply a different magnetic field to each half



rate of precession is different in each voxel

gradient

main  
magnetic  
field

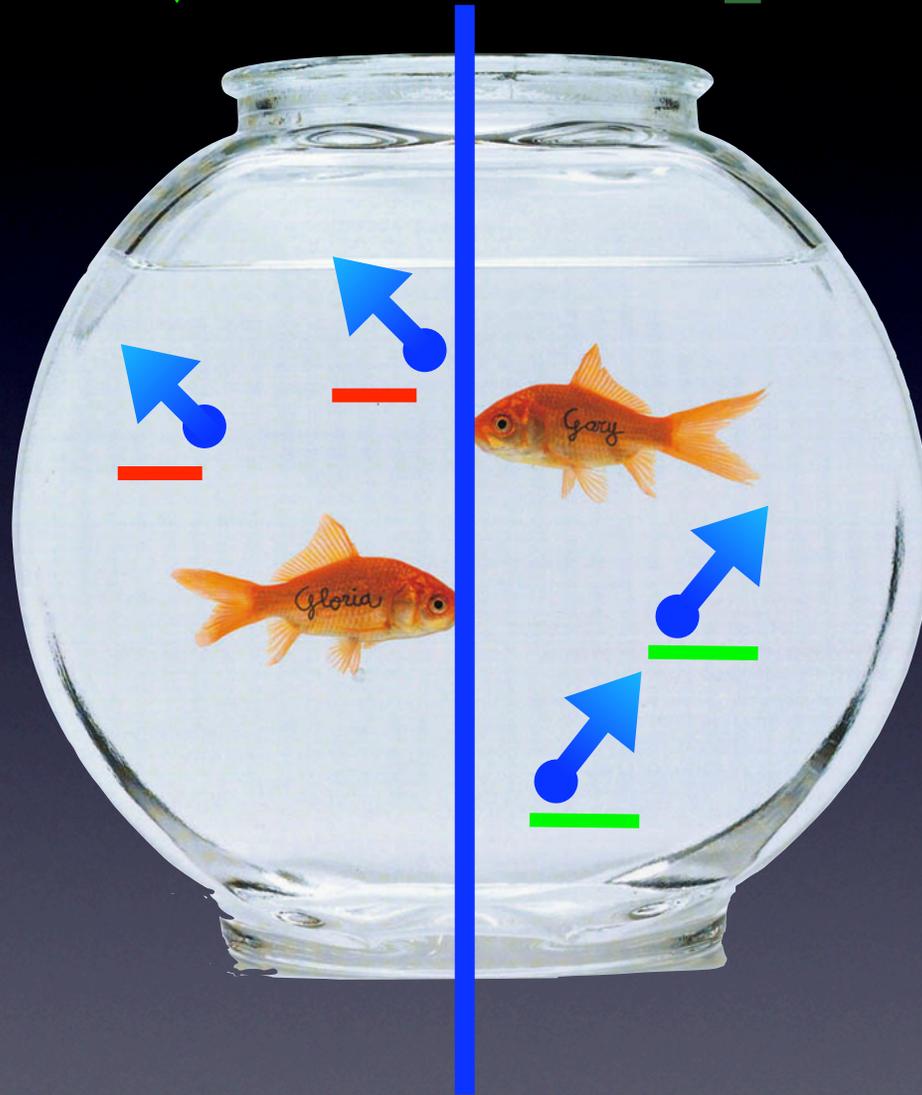


the voxels  
are out of  
phase

rate of precession is different in each voxel

gradient

main  
magnetic  
field



the voxels  
are out of  
phase

take second measurement (sum)

1st measurement: left + right

2nd measurement: left - right

---

add them: 2 x left

1st measurement: left + right

2nd measurement: left - right

---

subtract them: 2 x right

Real sequences sum together fractional amounts from all the voxels.

The fractions are changed using the x-, y-, or z-gradients.

The voxels are “unmixed” from all the measurements using an Inverse Fourier Transform.

# A Pulse Sequence

1. “Prepare” (invert, flip)

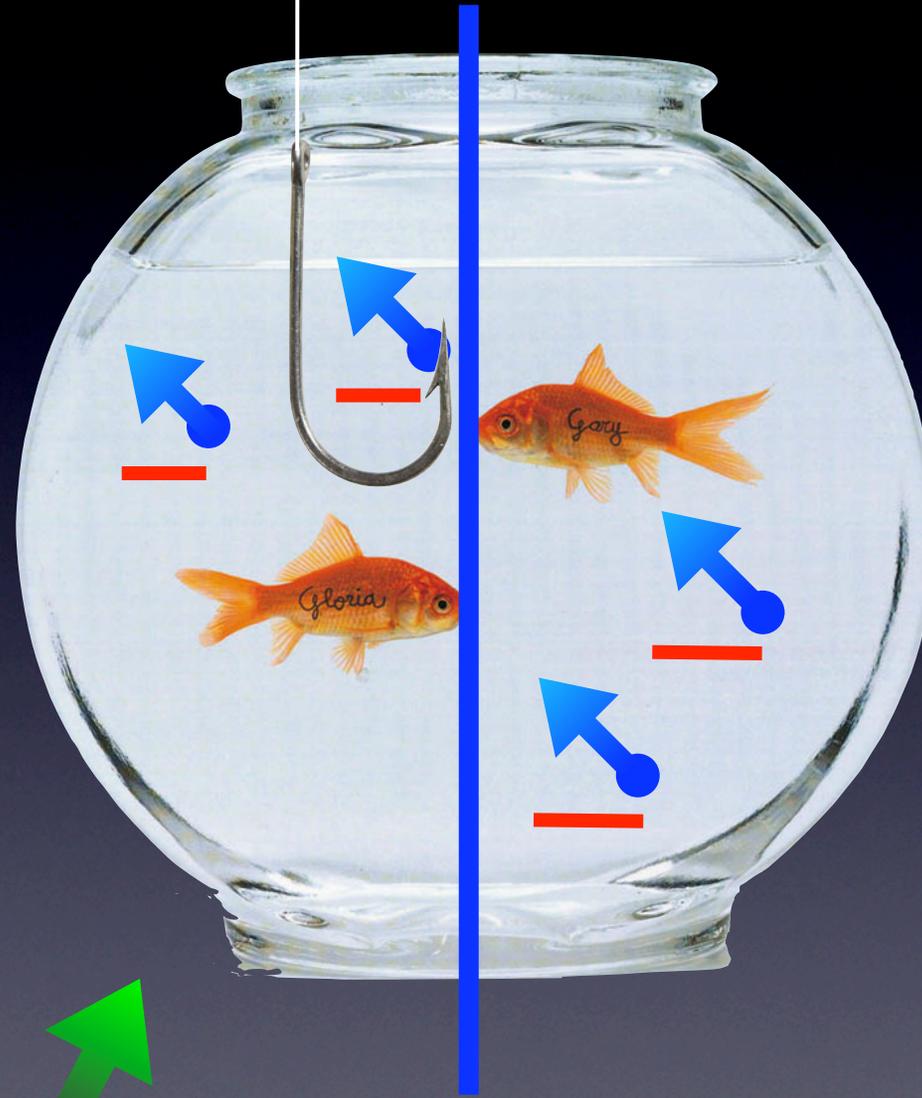
2. Localize (Gradients)

3. Measure repeat

4. Relax

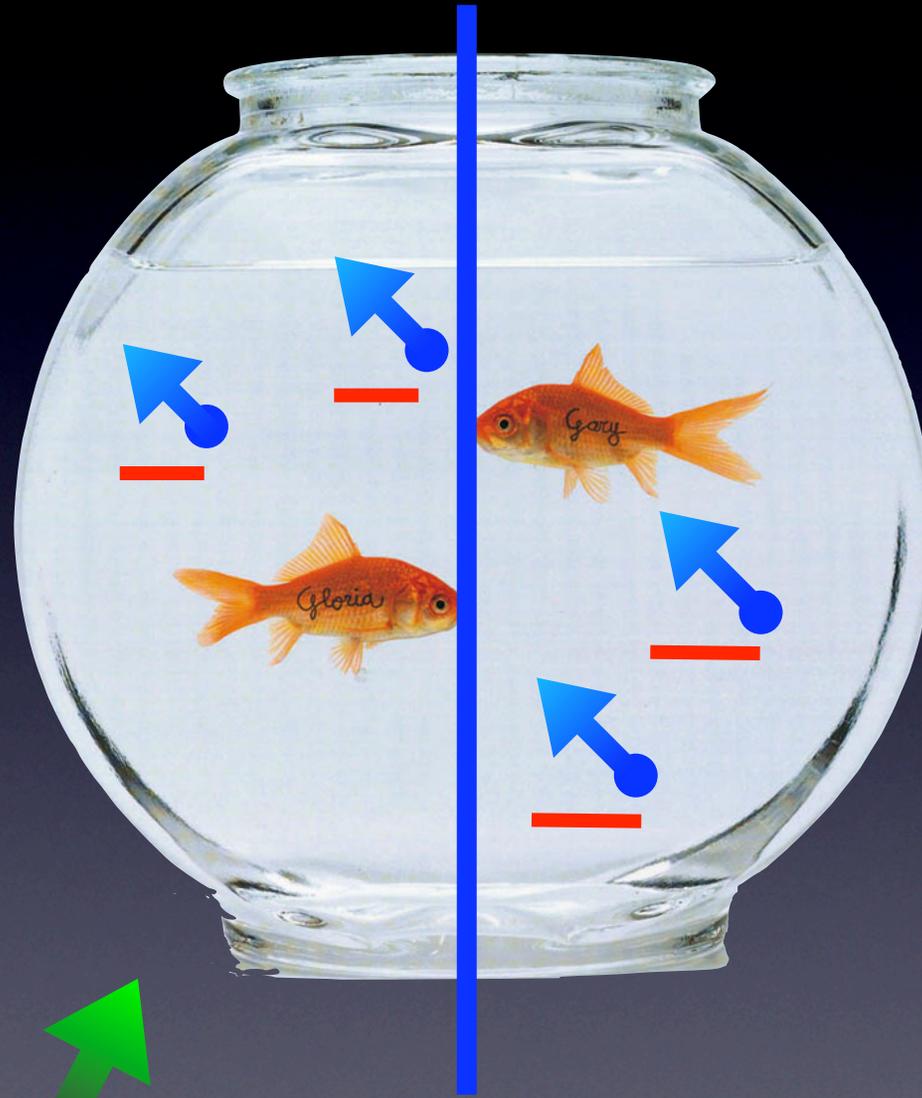
5. Go back to 1.

# fMRI (BOLD)



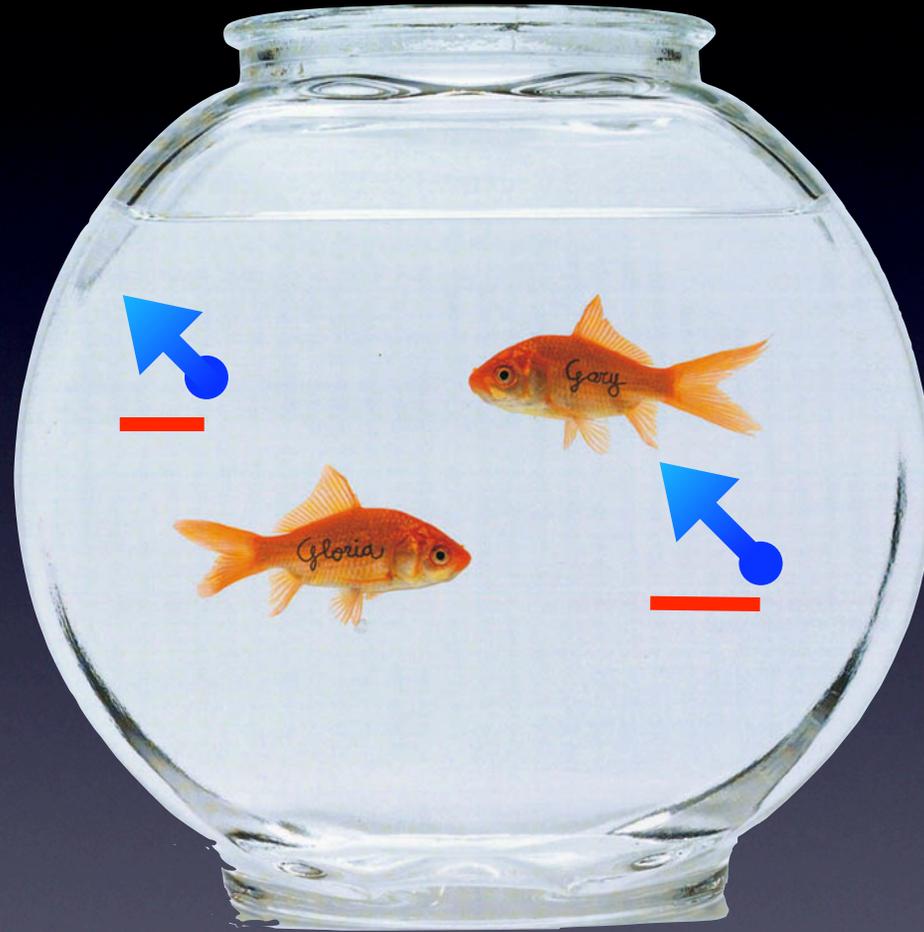
this side dephases faster = less signal

# fMRI (BOLD)



this side's T2 returns to normal

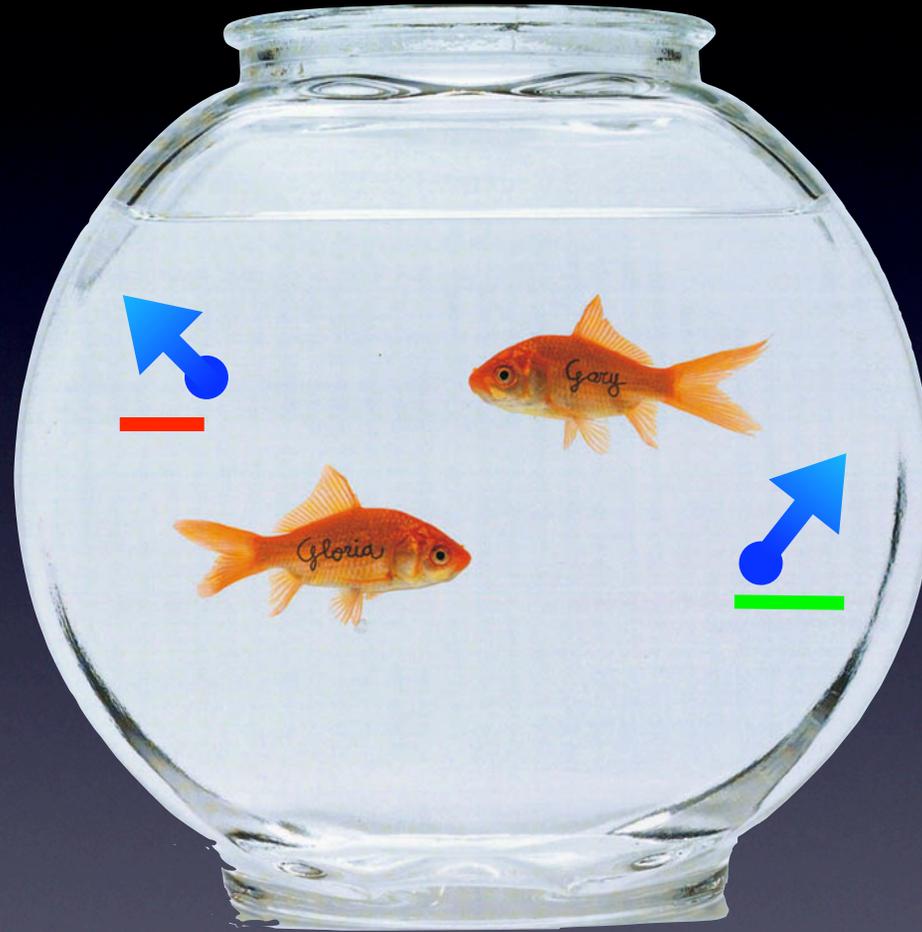
# Diffusion



gradient

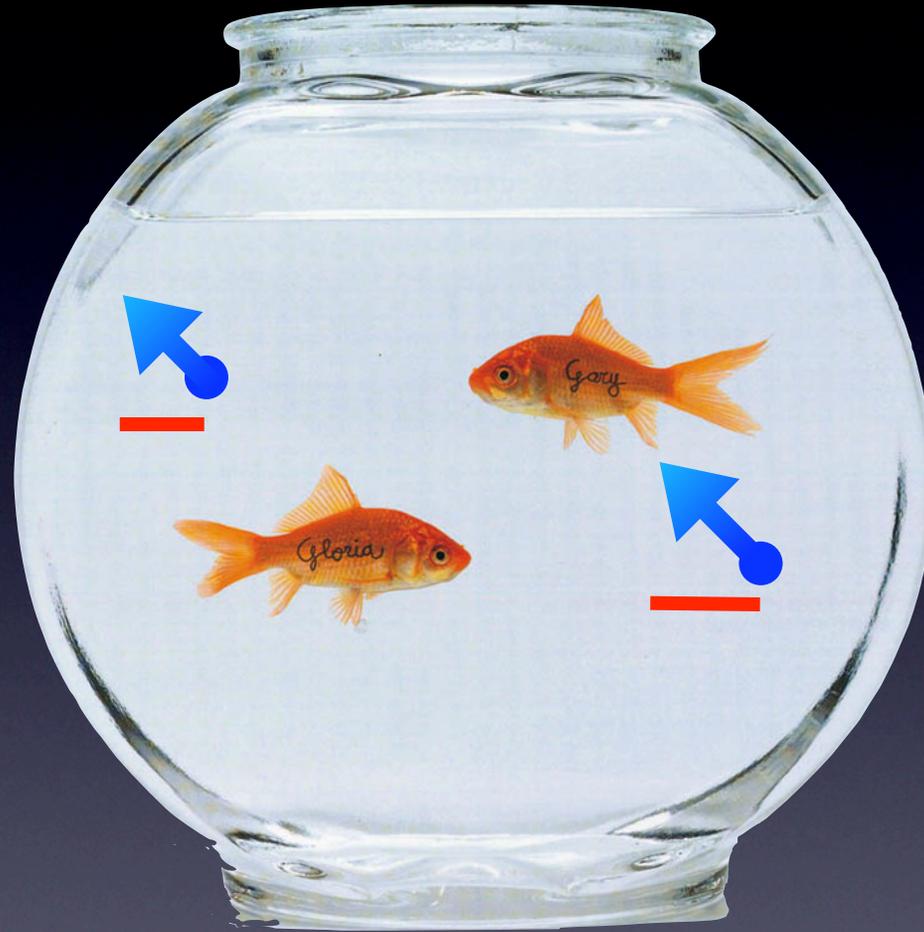


# Diffusion



gradient

# Diffusion



↑ gradient ↓

Diffusion imaging uses gradients to cancel out signal in water that moves in one direction.

Repeating the experiment, each time using gradient in a different direction, creates a map of how freely water diffuses in each voxel.

questions?

