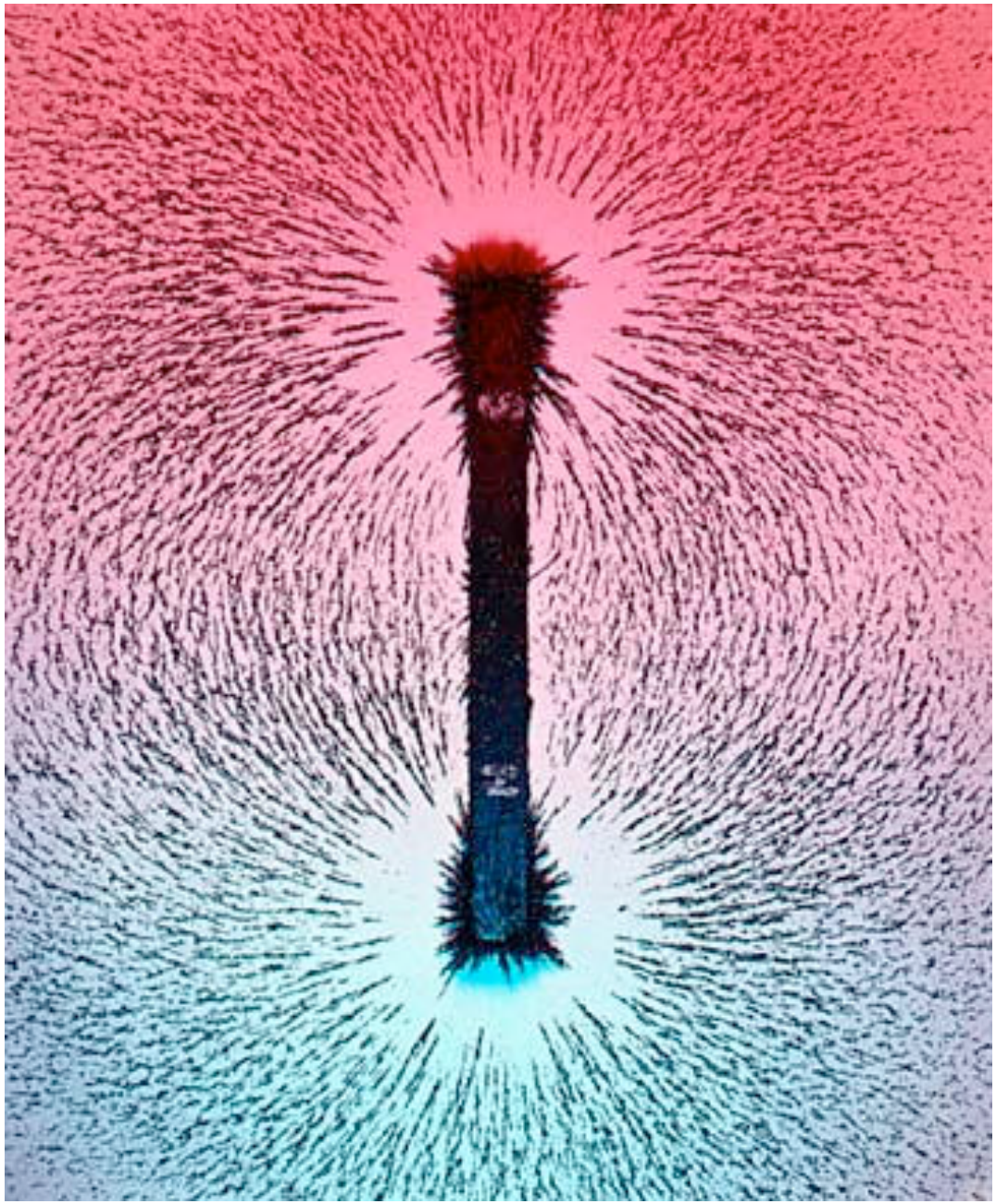
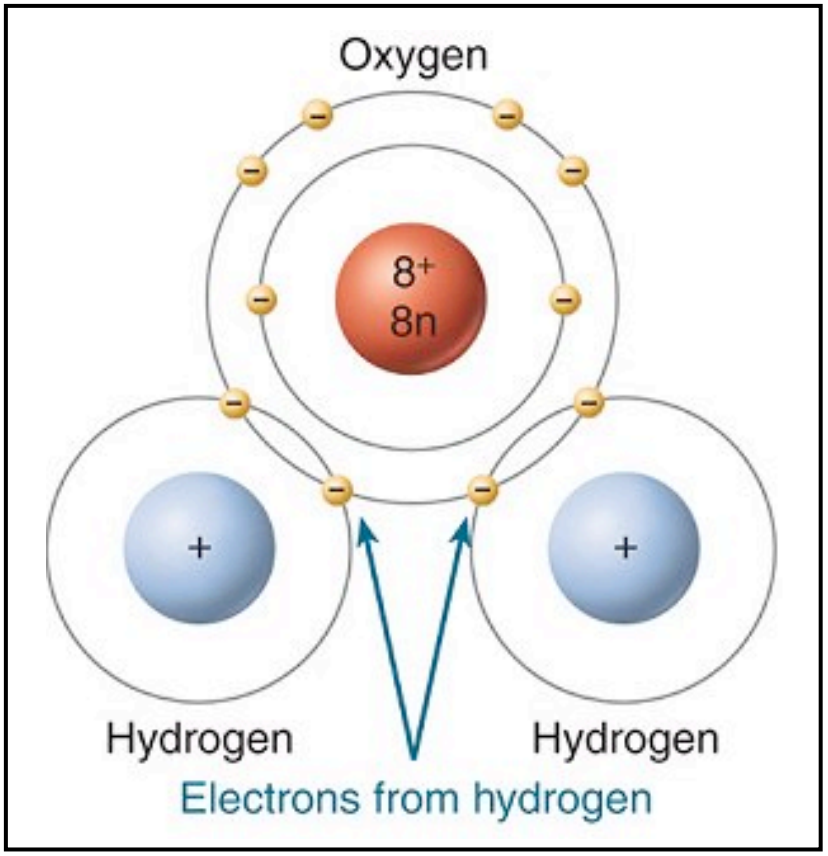
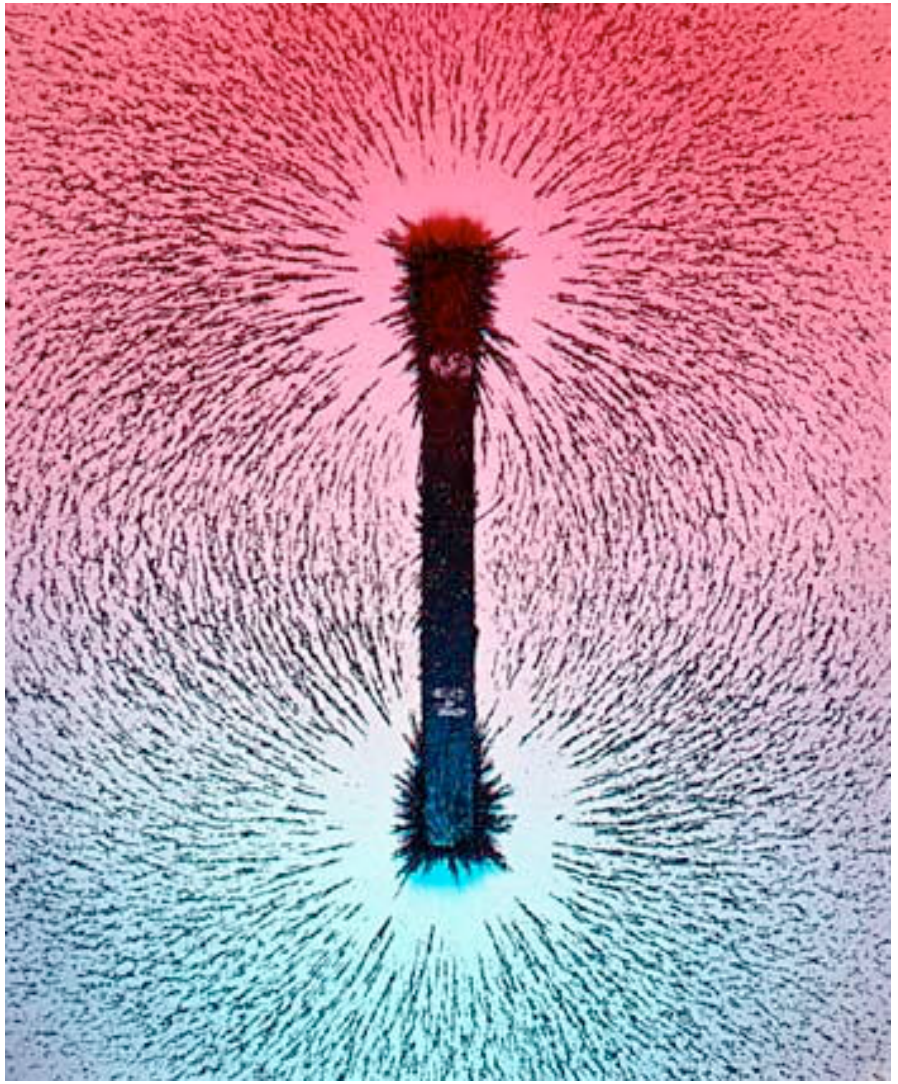
A Non-Physicist's Intro to MRI

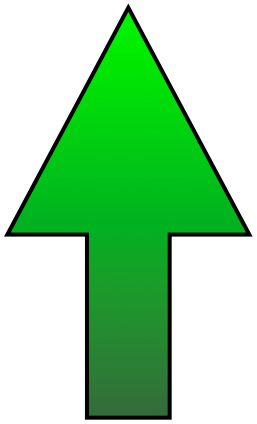
Dylan Tisdall
April 4, 2011



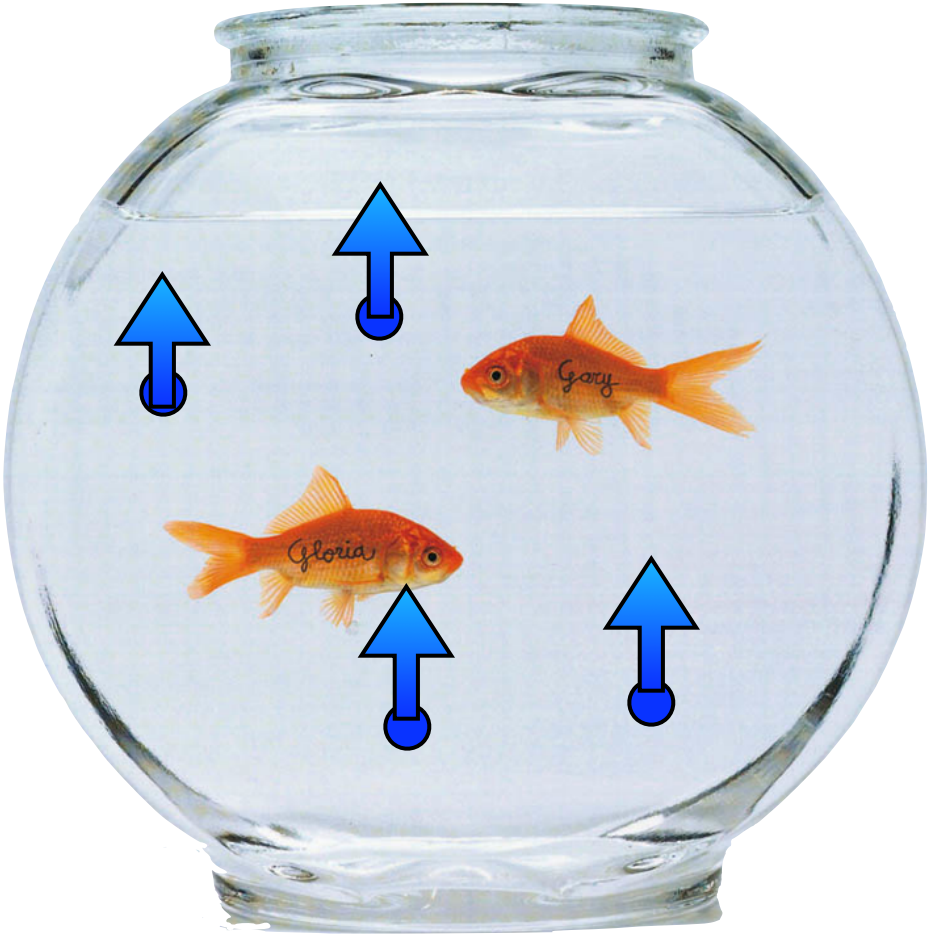
A human head

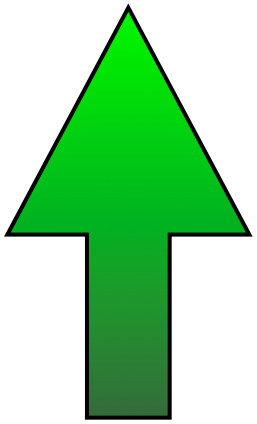

Oxygen
8+
8n
+
+
Hydrogen
Hydrogen
Electrons from hydrogen





main magnetic field





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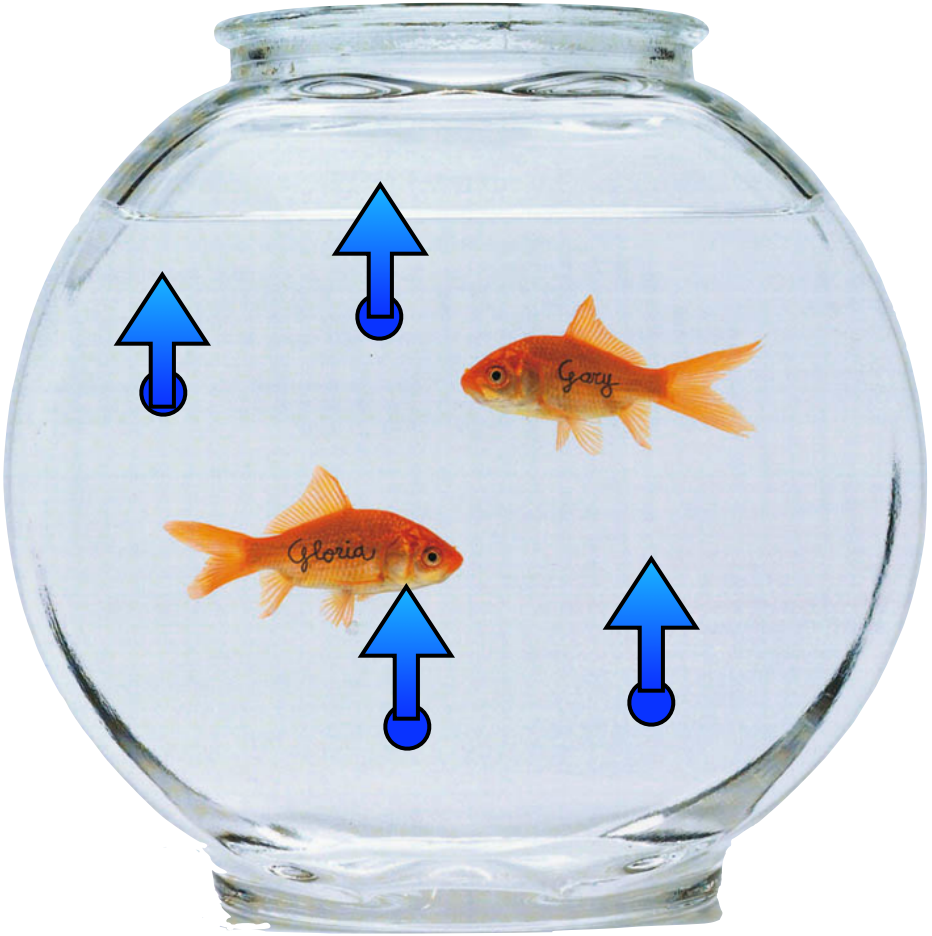

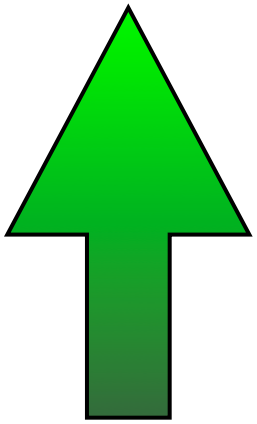

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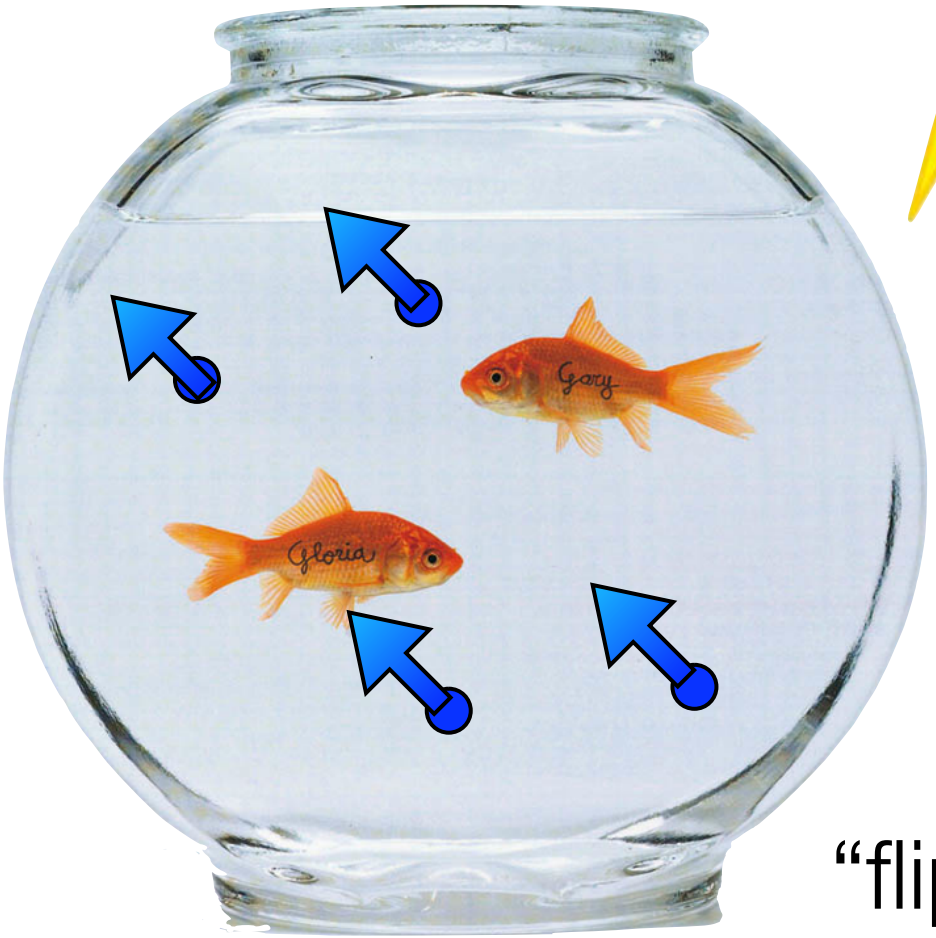
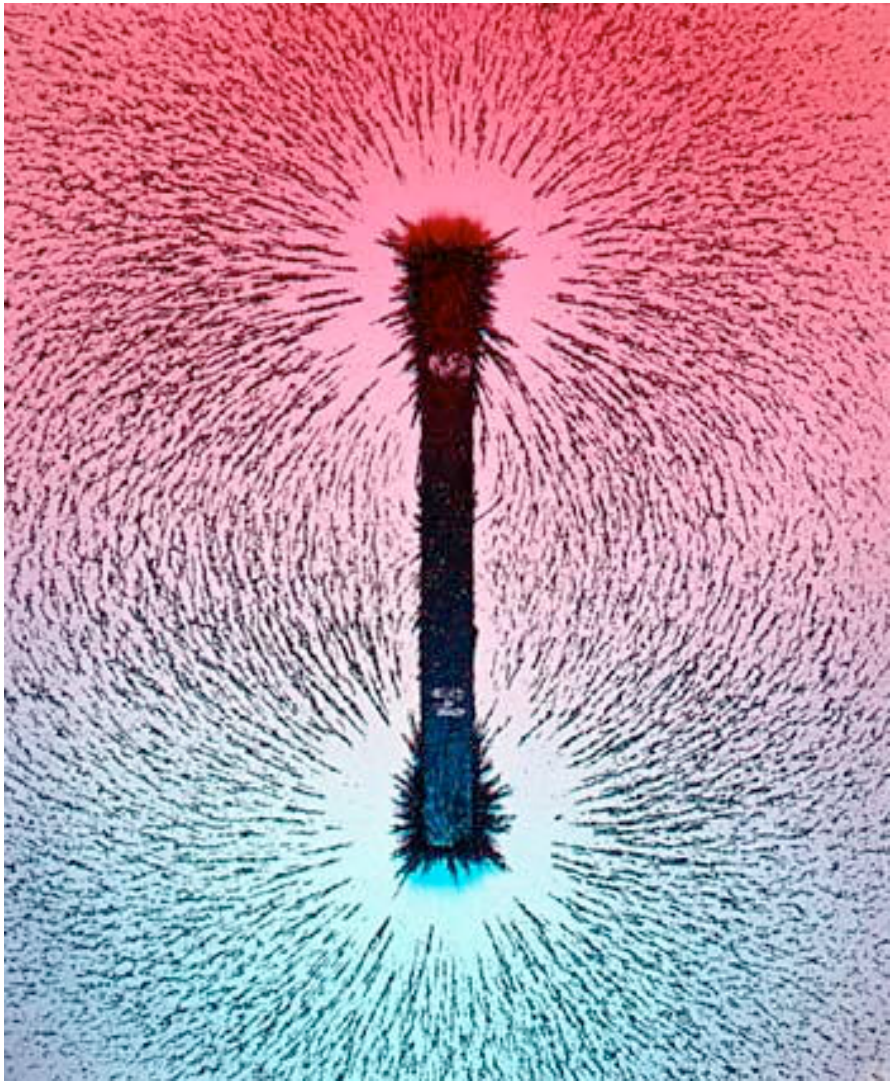
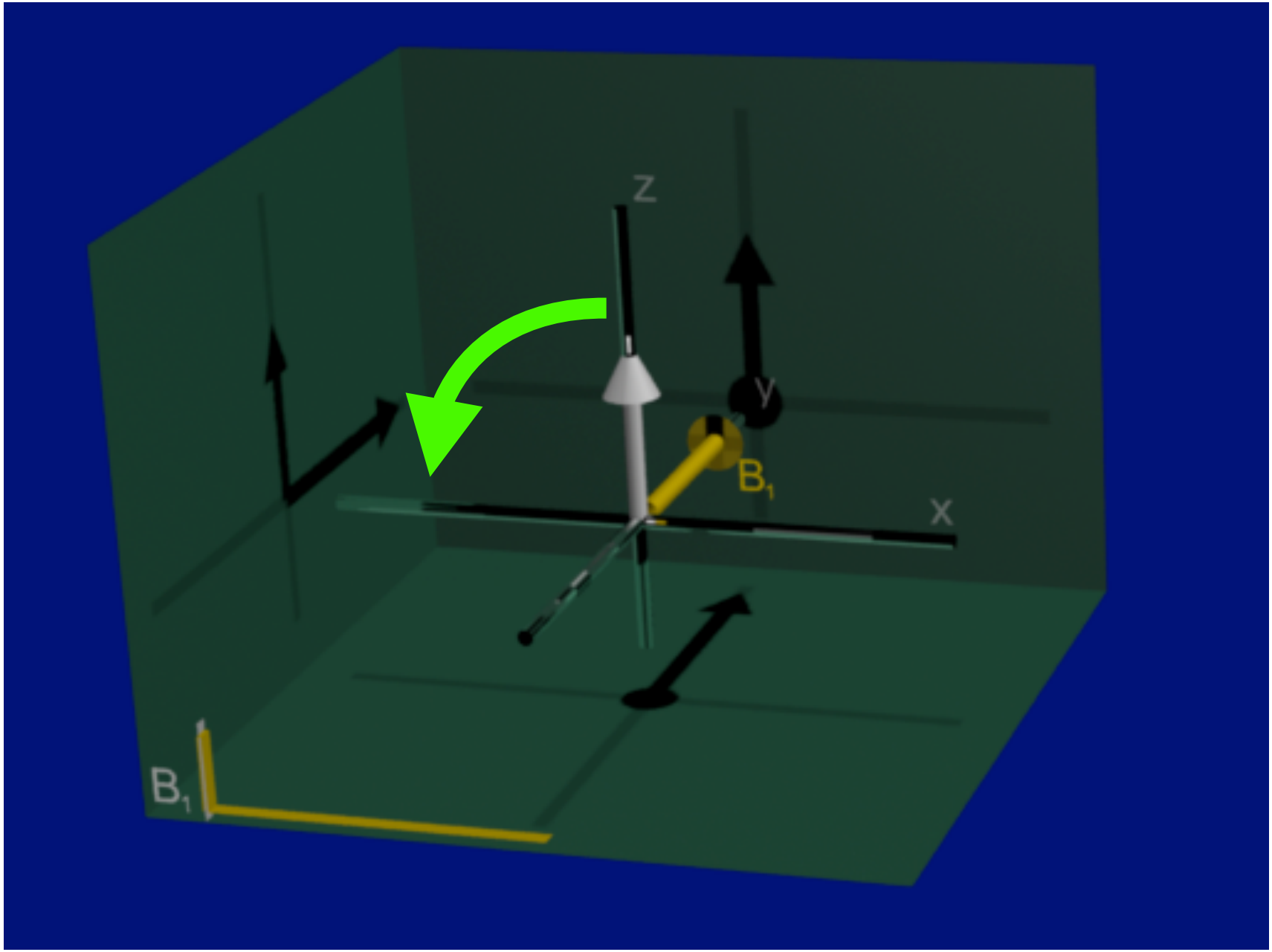


"pulse"

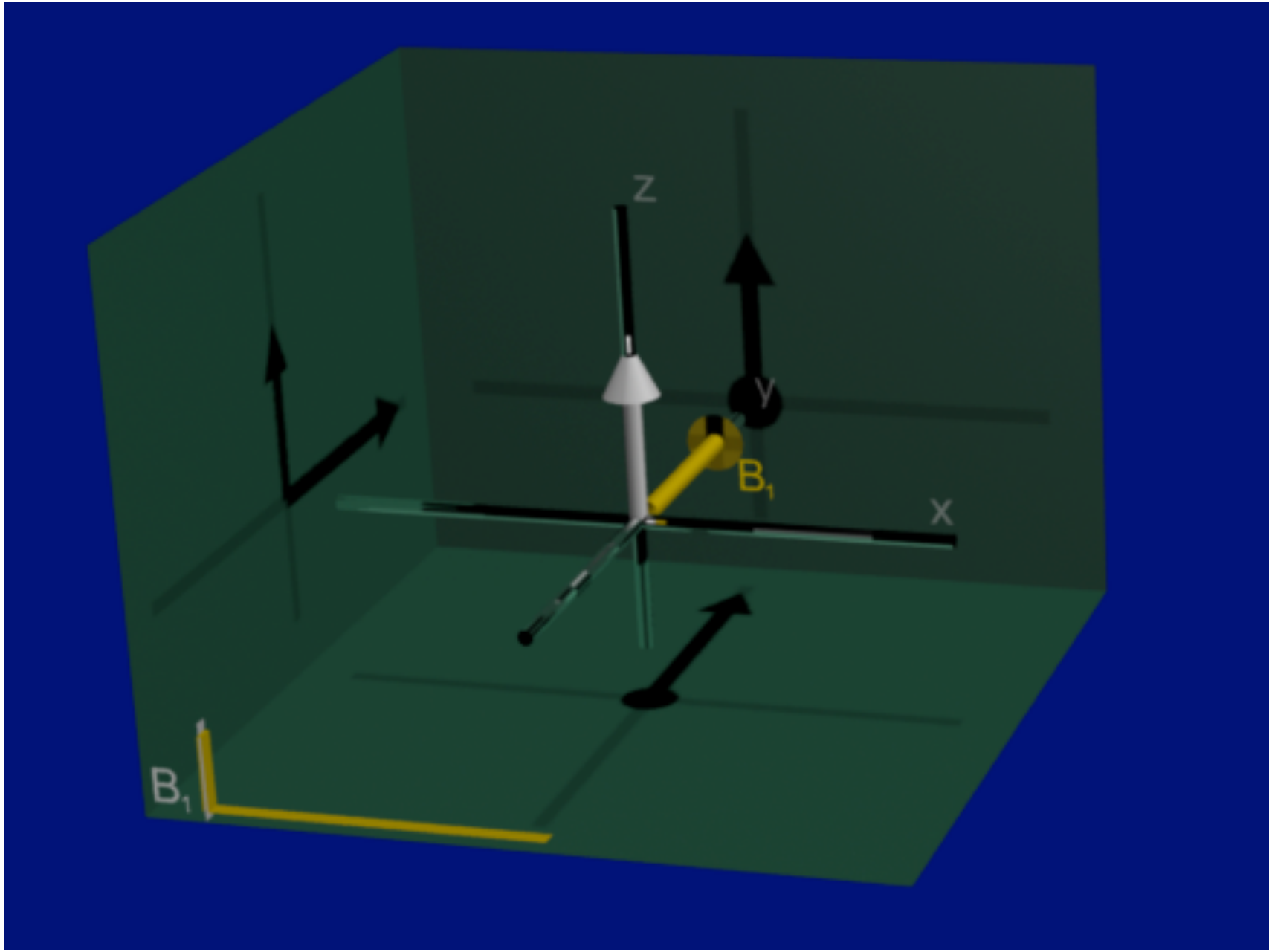
"flip angle"



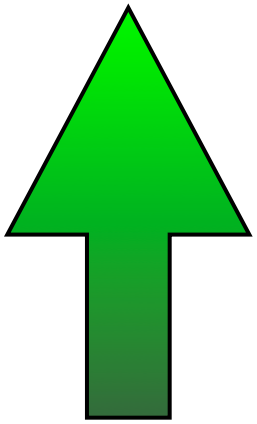
precession



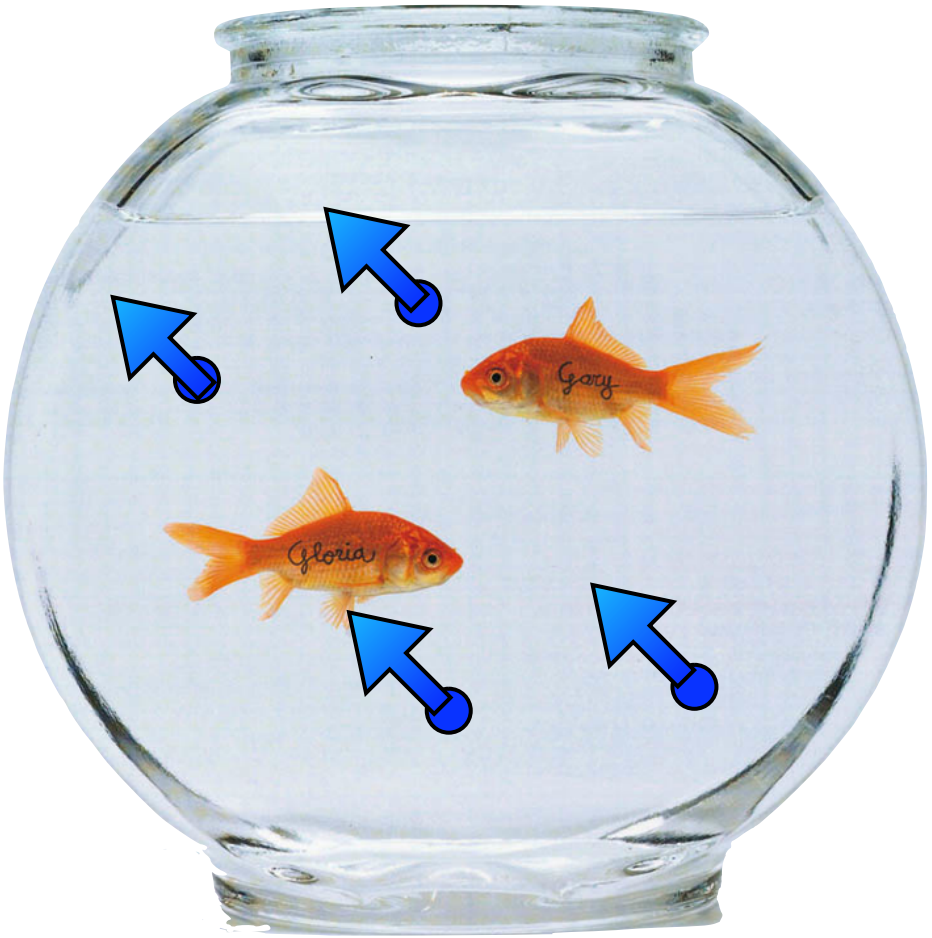
precession

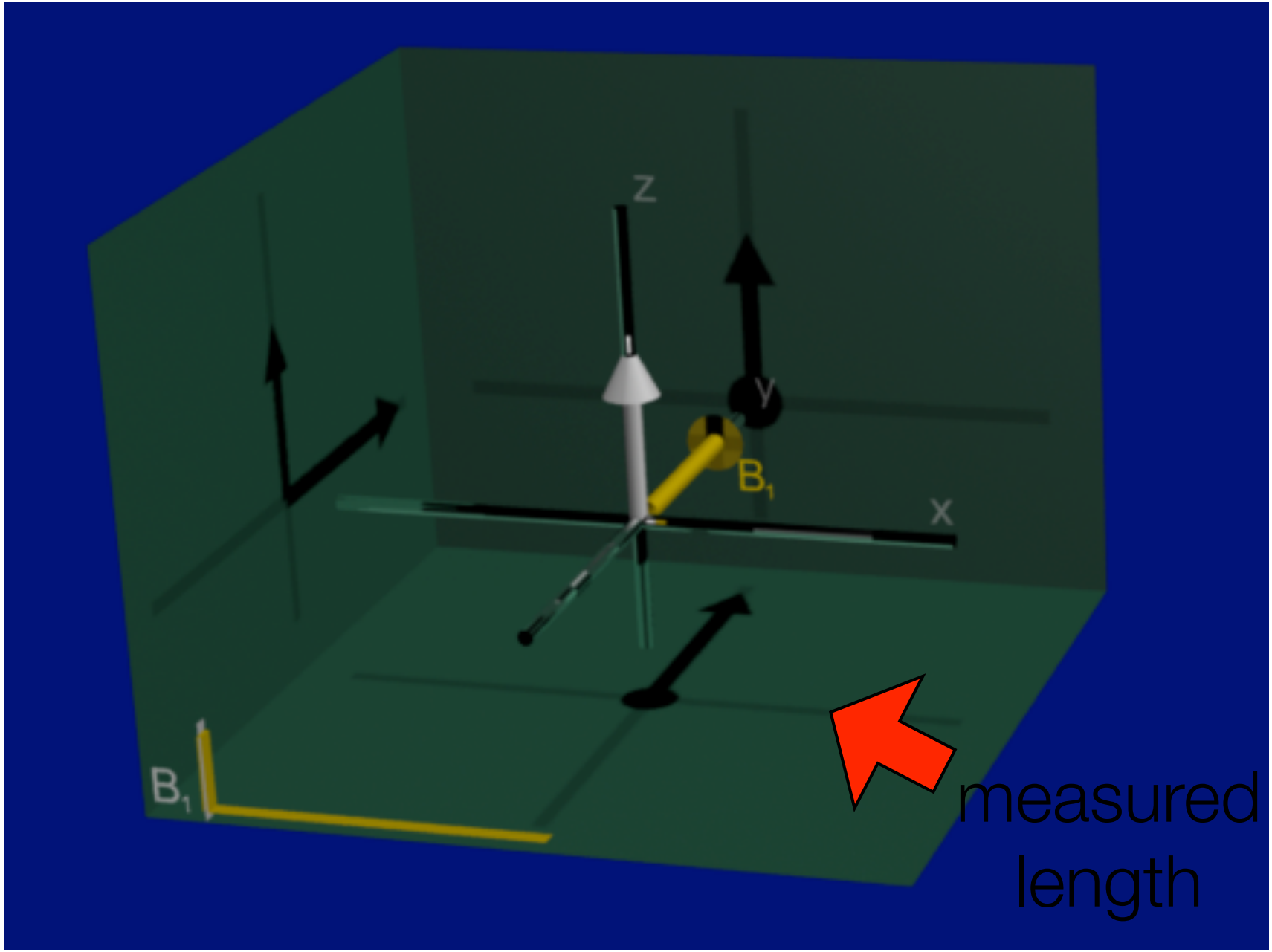


The **rate of precession** changes **linearly** with the strength of the **magnetic field**



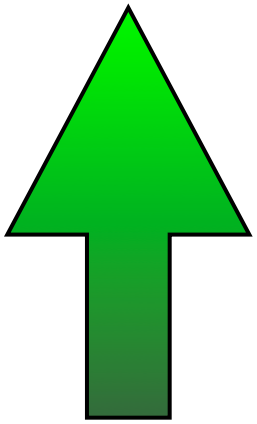
main magnetic field



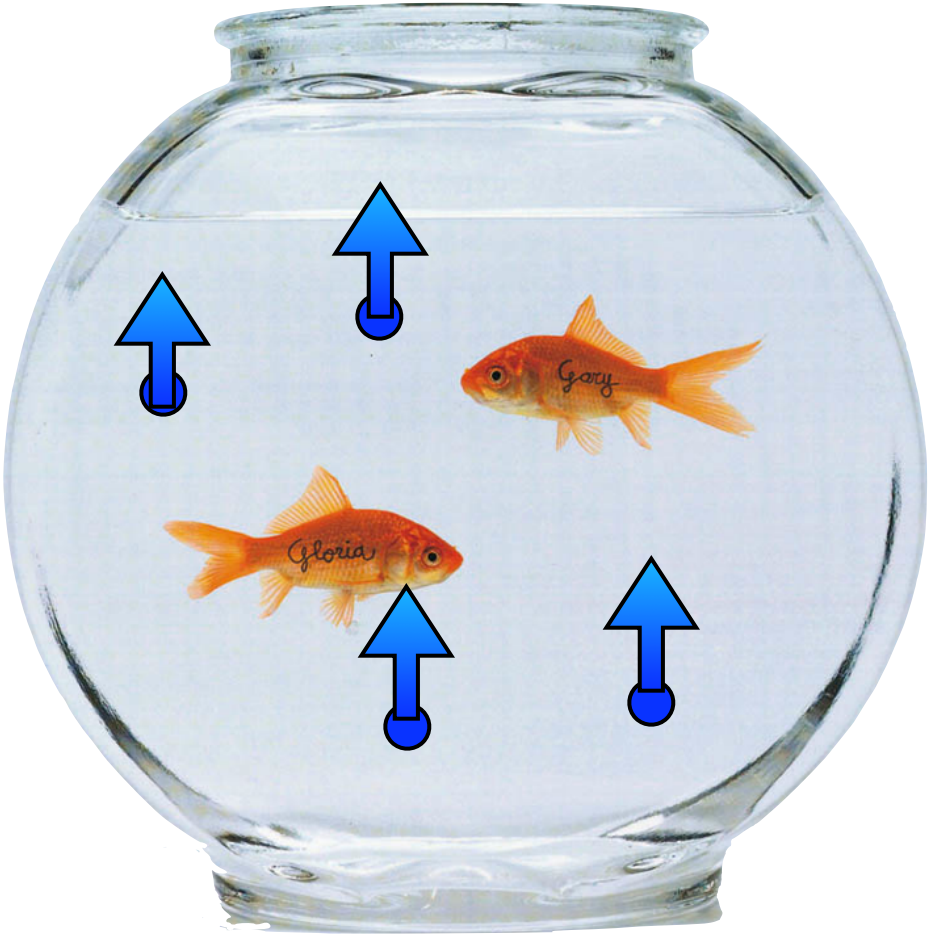

z
y
x
B_1
B_1
measured
length

“rotating frame of reference”

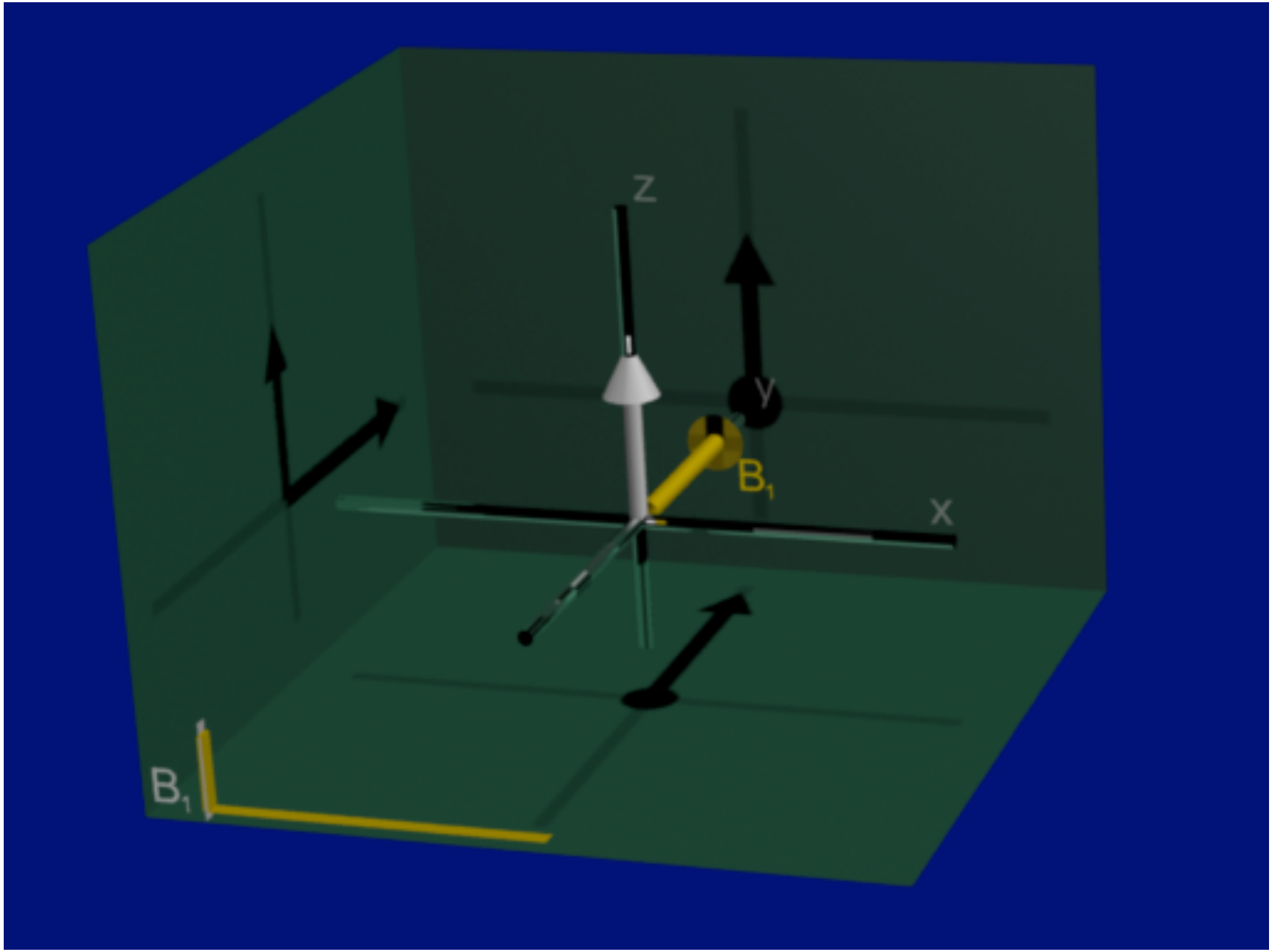
relaxation



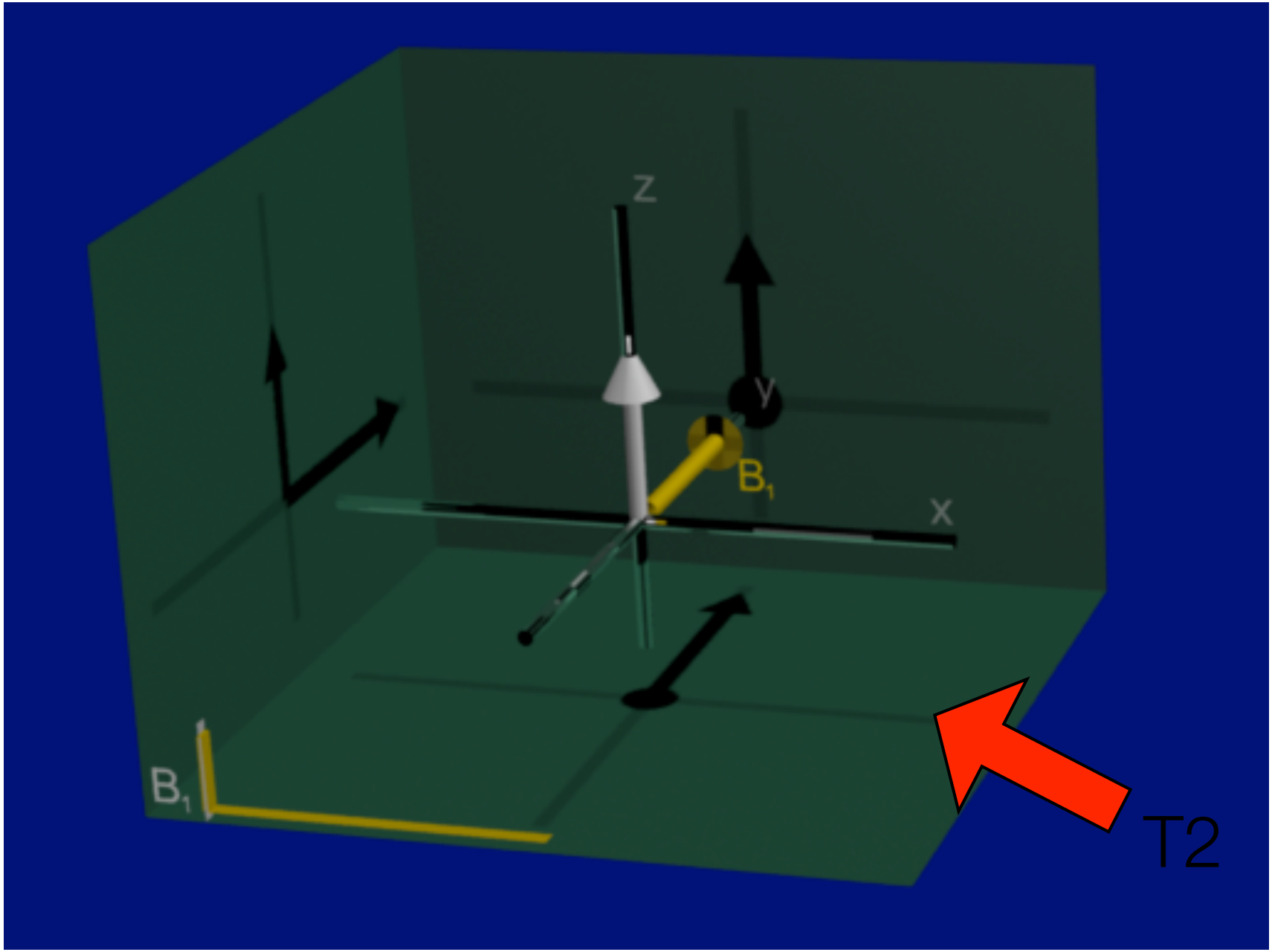
main magnetic field

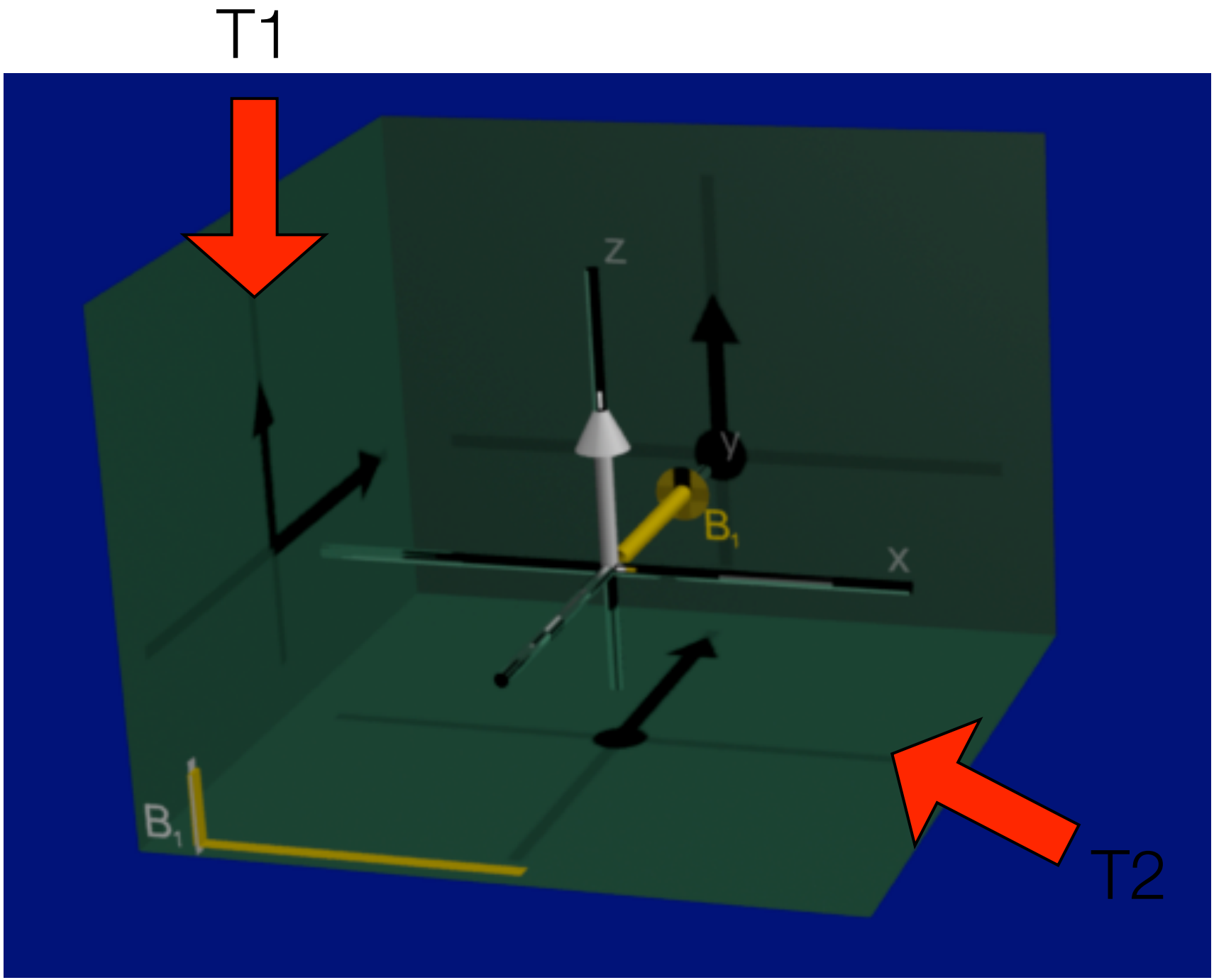


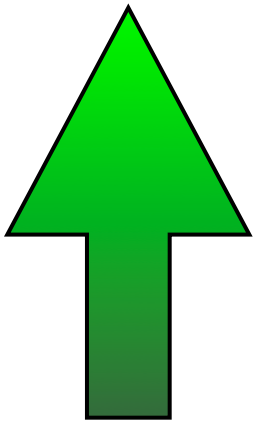
T2 is dephasing



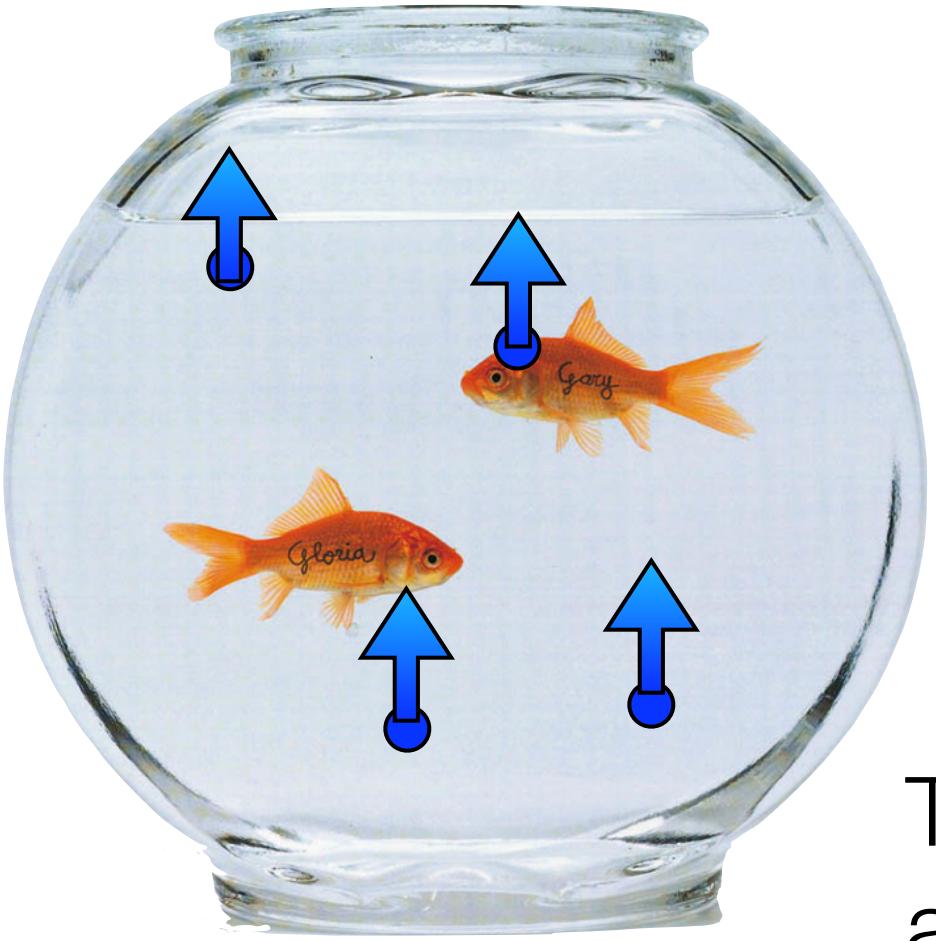
dephasing looks like “less signal”




T1
z
y
x
B_1
B_1
T2

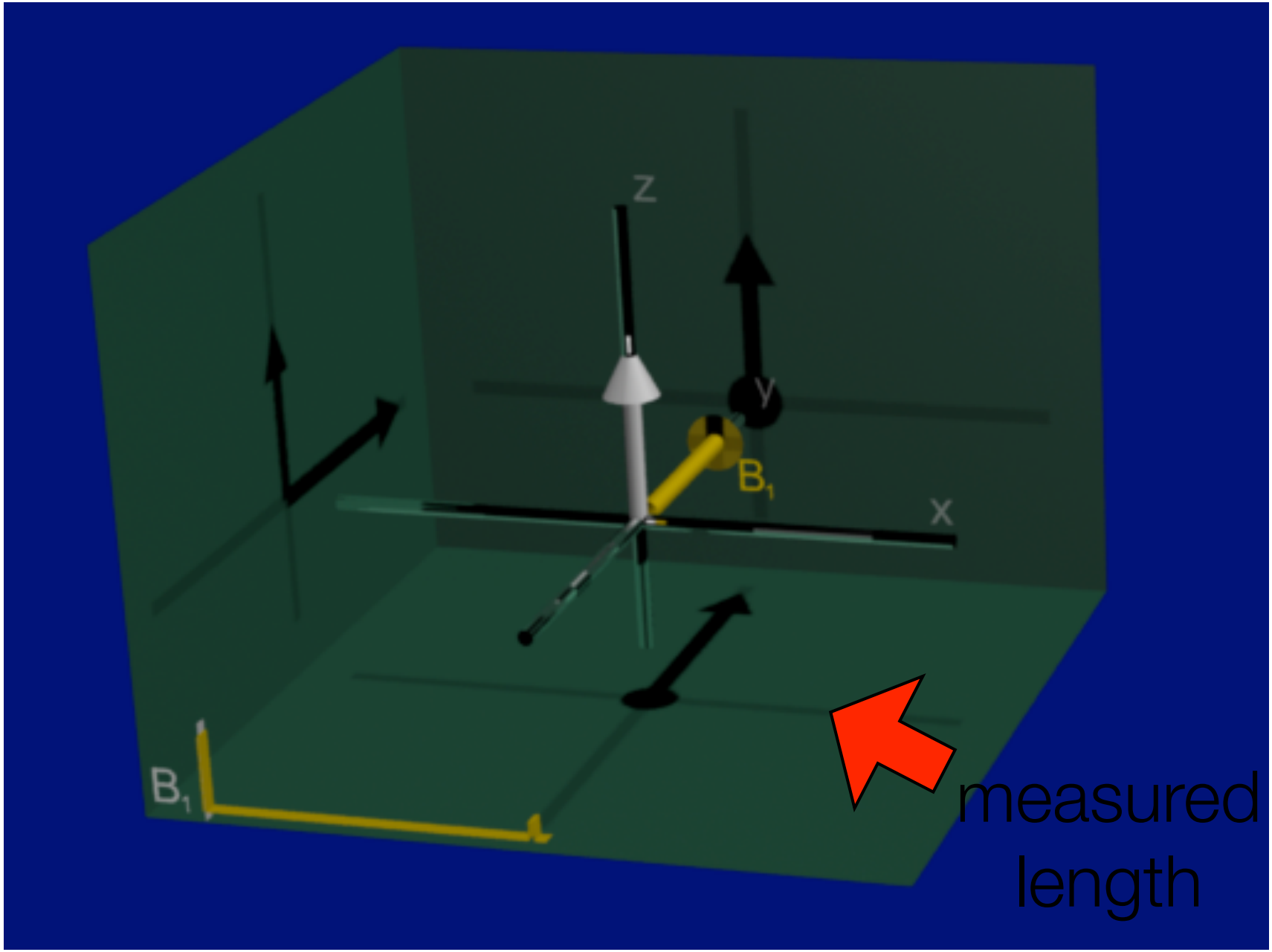


main magnetic field



The fish are what make it interesting....

inversion recovery

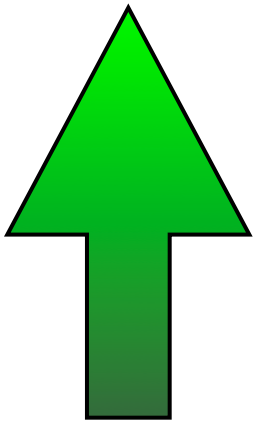


Using **inversion recovery** we can **weight** our measurements for tissues with **specific T1**

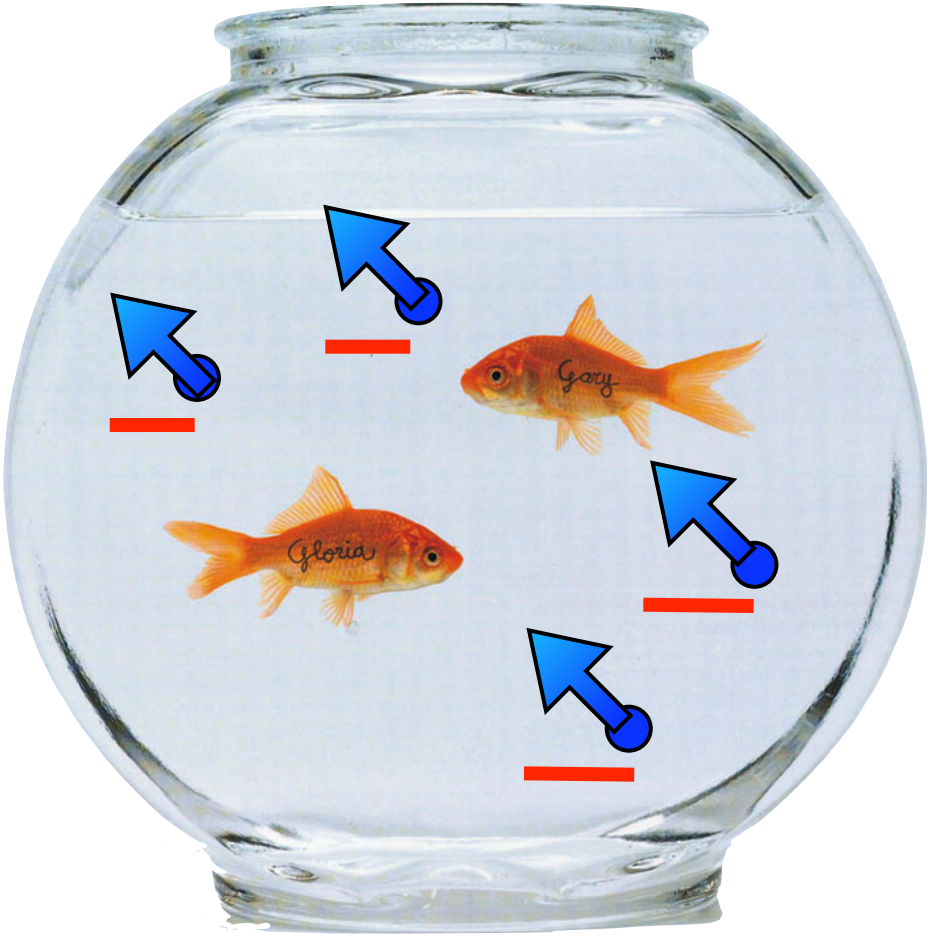
How do we get

spatial information?

what do we measure?

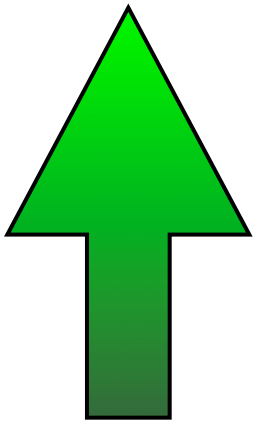


main magnetic field

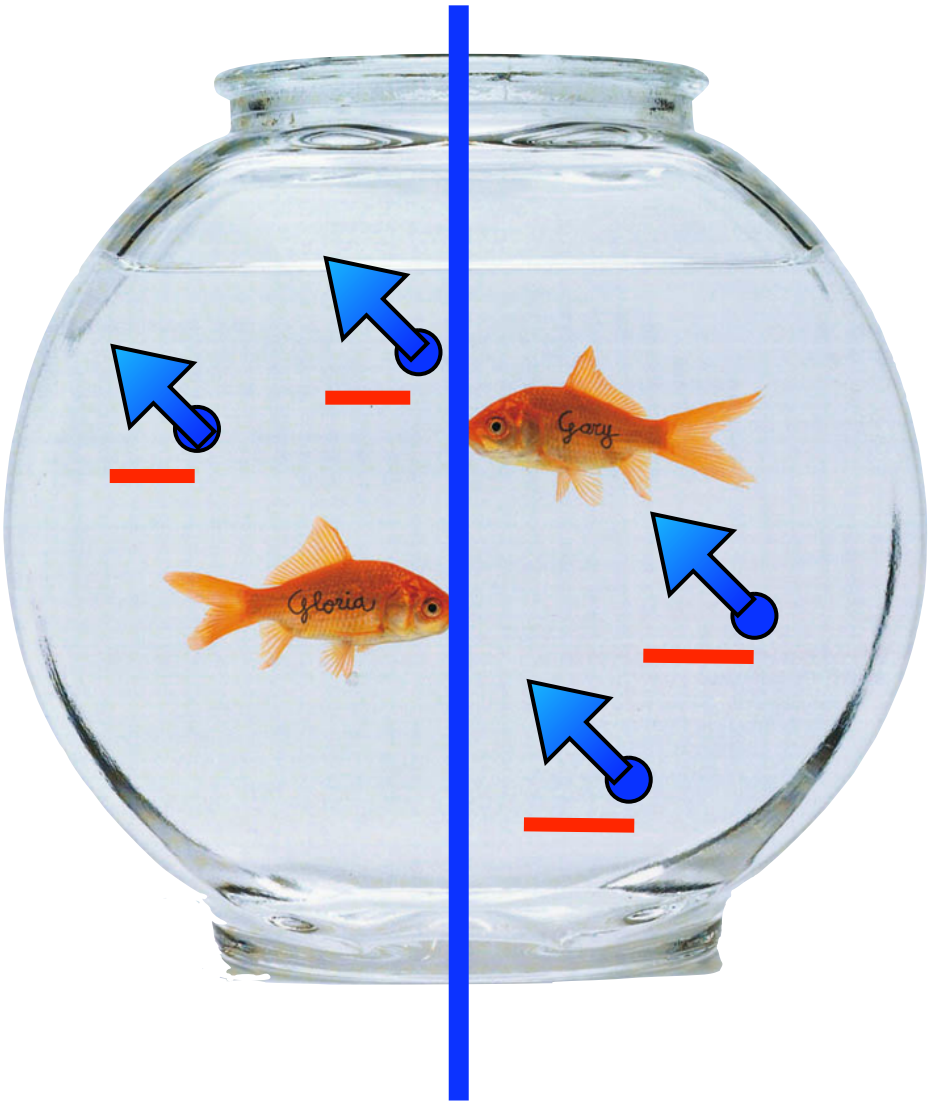


add up the red lines

two voxels (left and right)

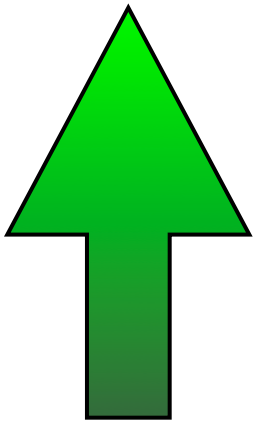


main magnetic field

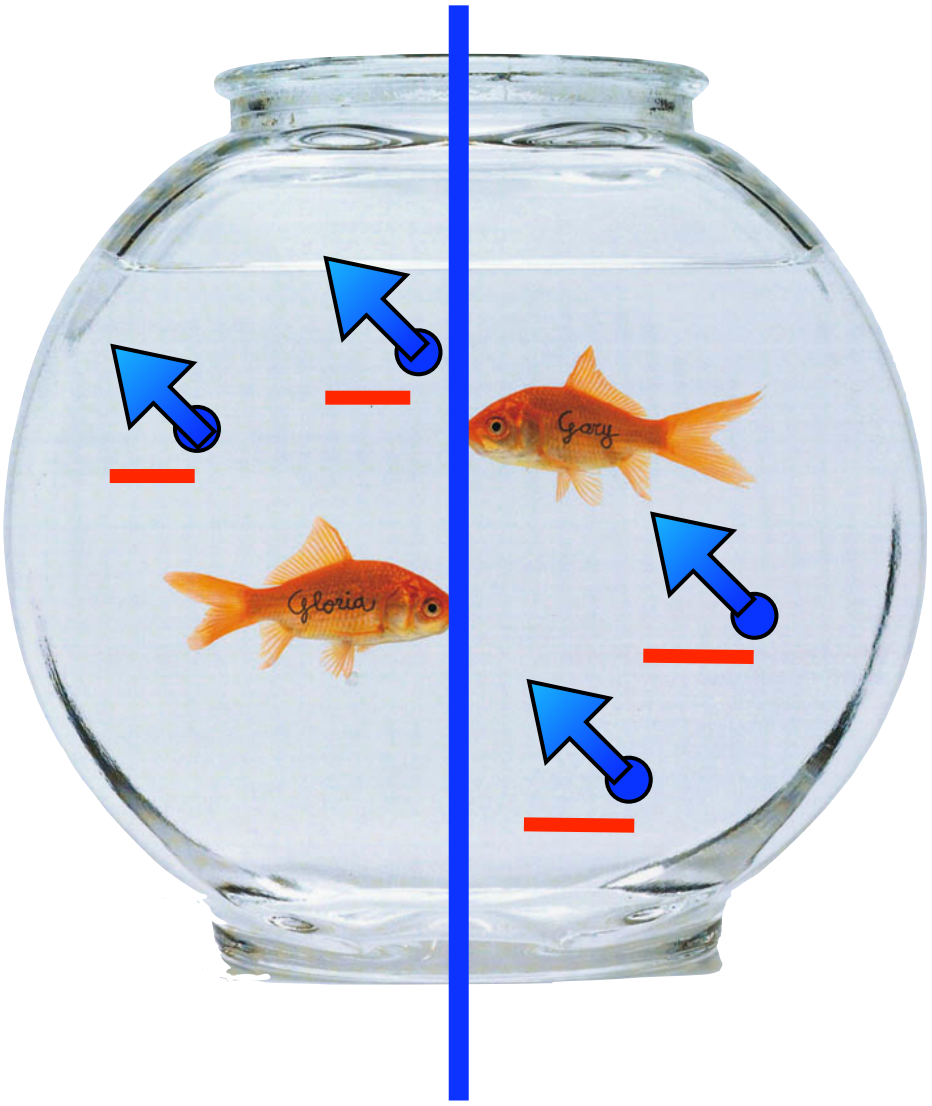


take one measurement (sum)

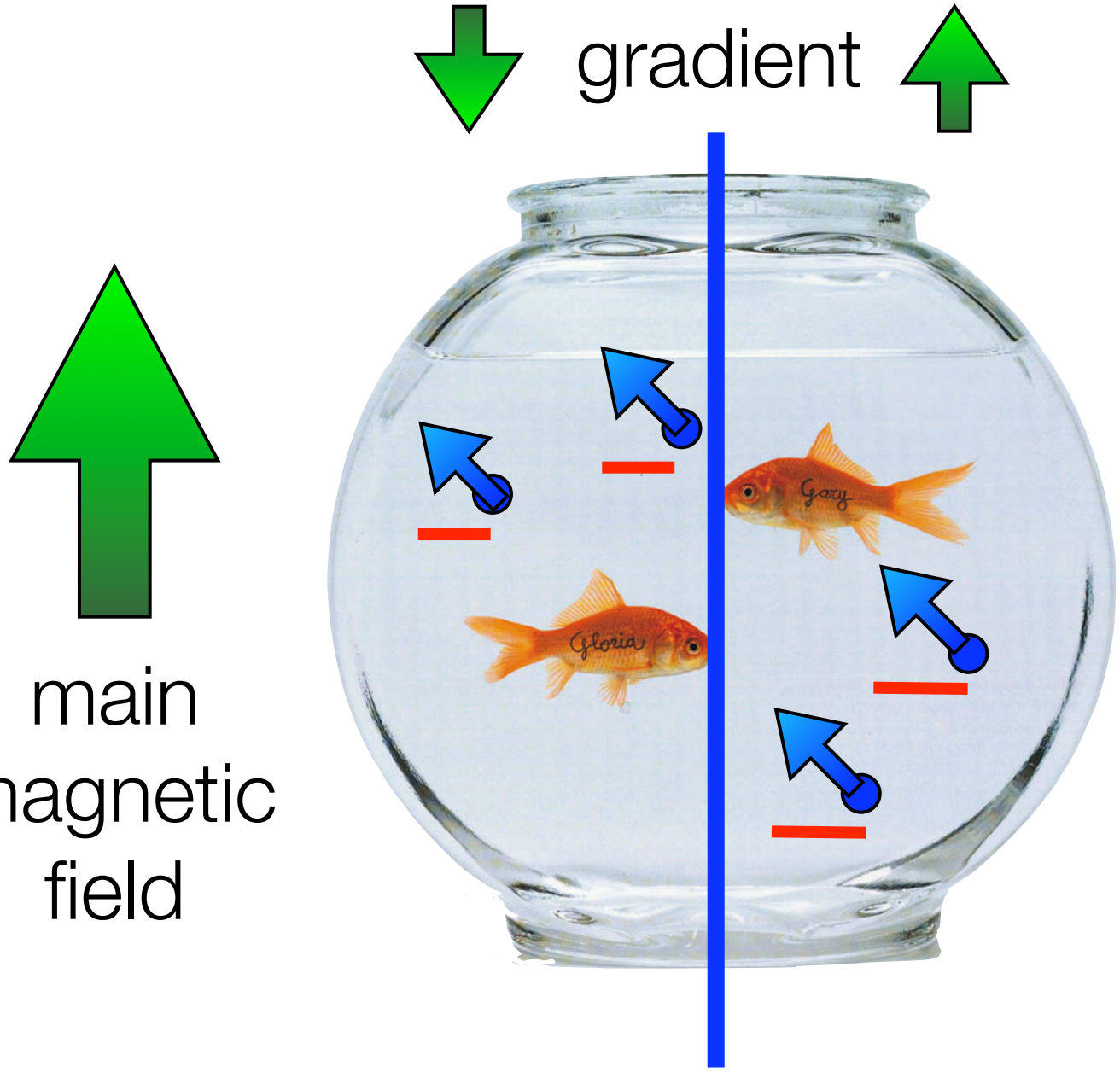
two voxels (left and right)



main magnetic field

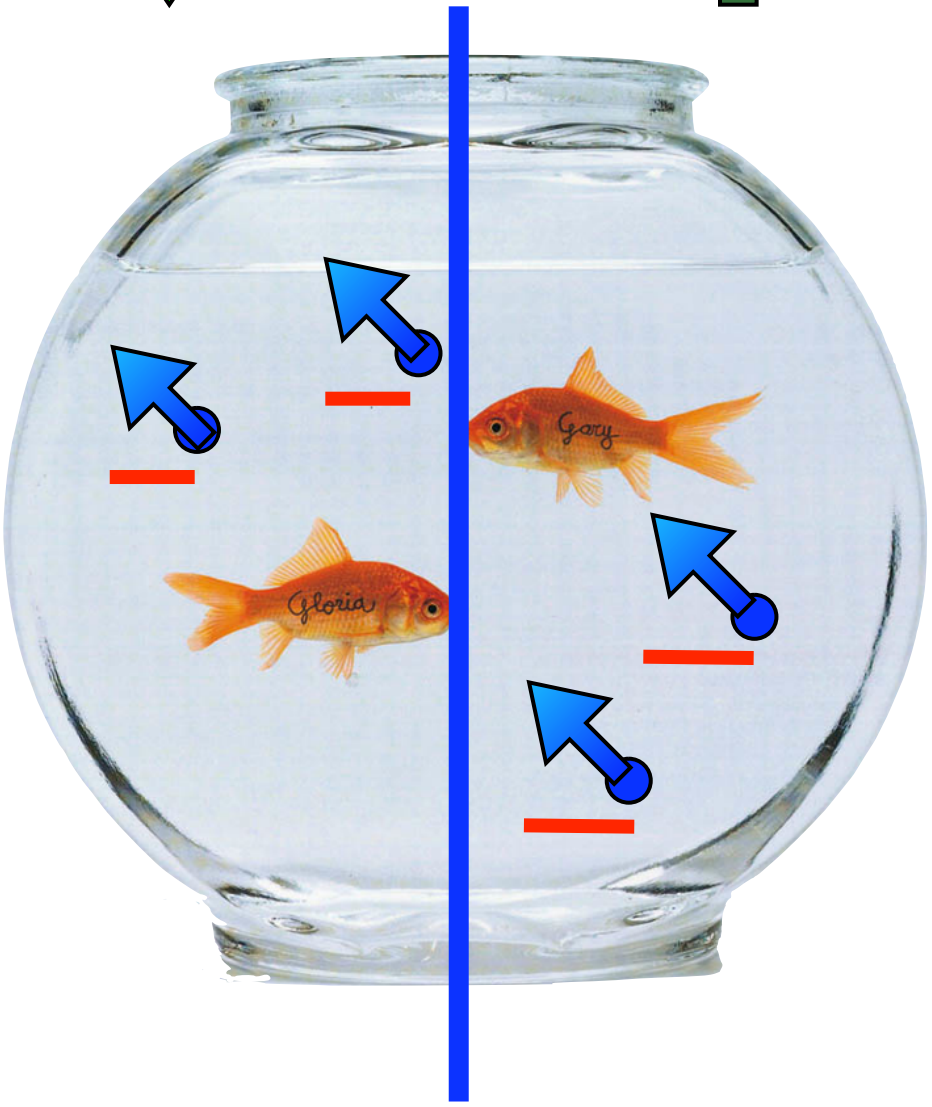


apply a different magnetic field to each half



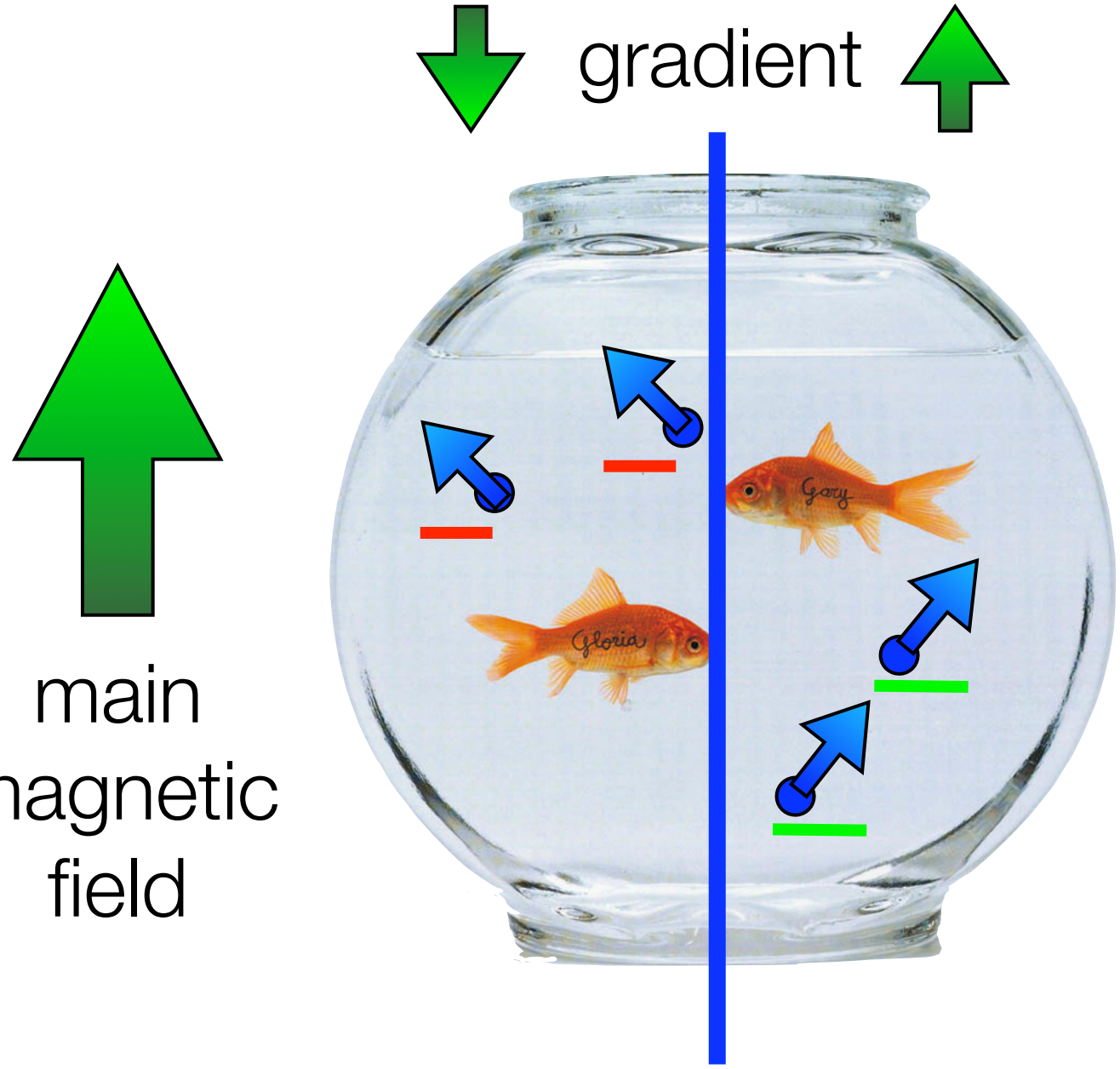
apply a different magnetic field to each half

gradient



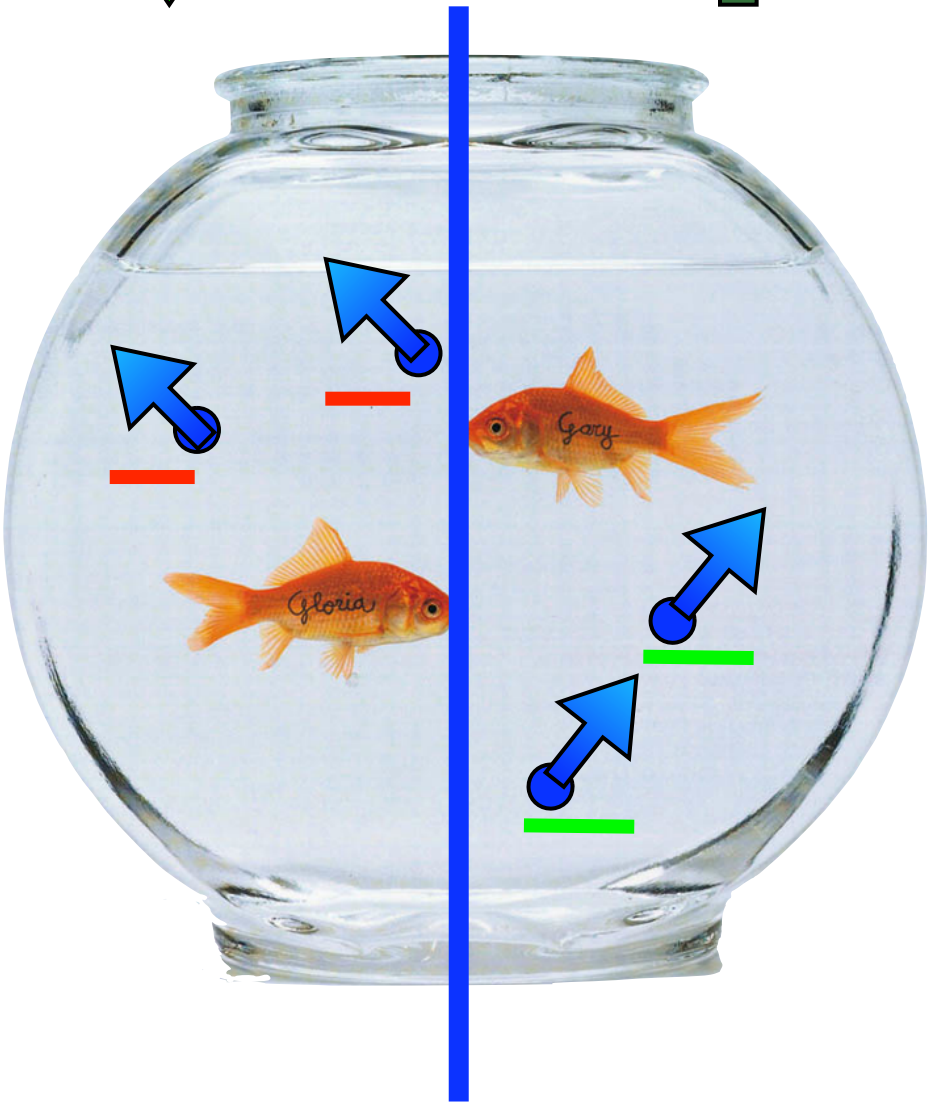
main magnetic field

rate of precession is different in each voxel



rate of precession is different in each voxel

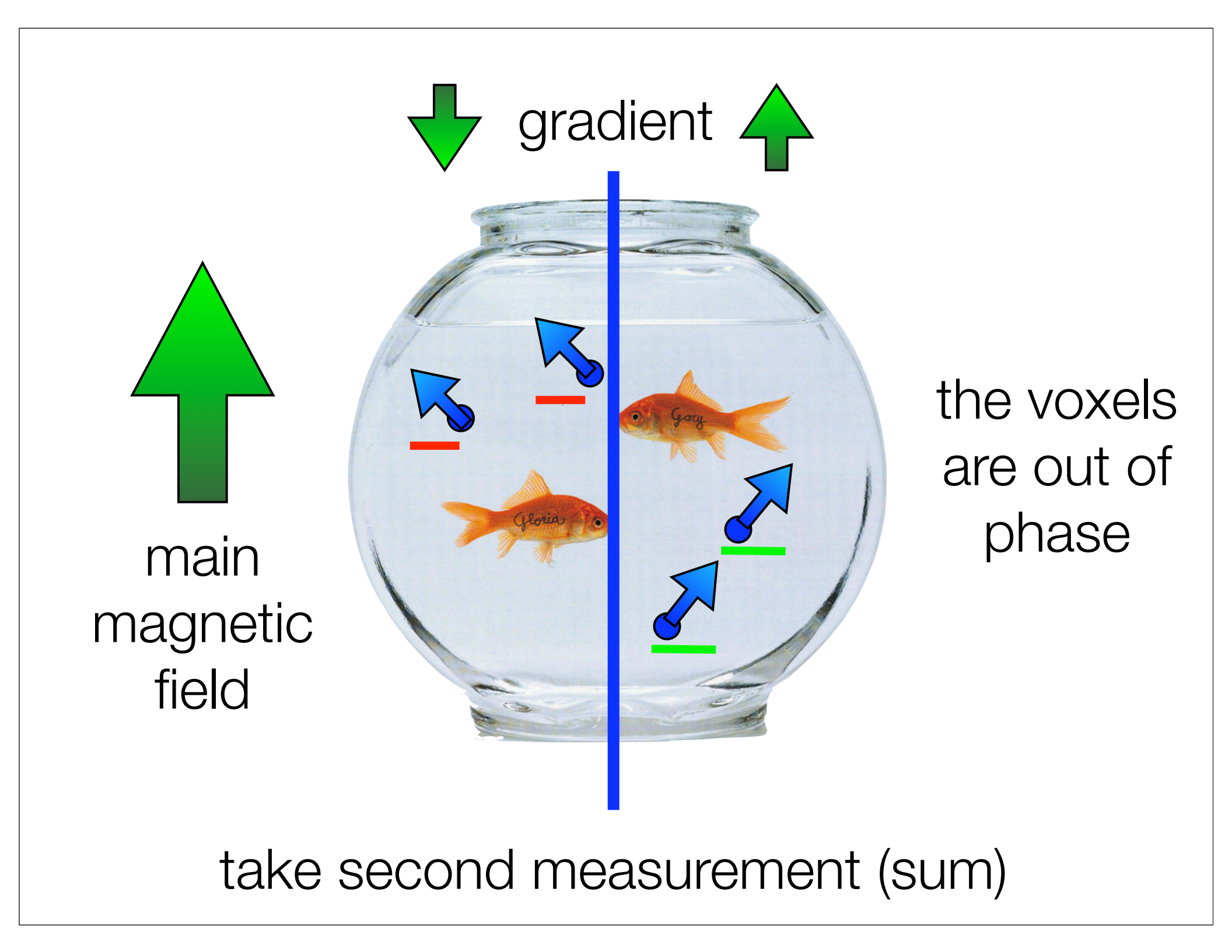
gradient



main magnetic field

the voxels are out of phase

rate of precession is different in each voxel


gradient
main magnetic field
Gary
Gloria
the voxels are out of phase
take second measurement (sum)

1st measurement: left + right

2nd measurement: left - right

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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.

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

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. Flip
2. Localize (Gradients)
3. Measure
4. Relax
5. Go back to 1.

A Pulse Sequence

1. Flip
2. Localize (Gradients)
3. Measure

repeat

4. Relax
5. Go back to 1.