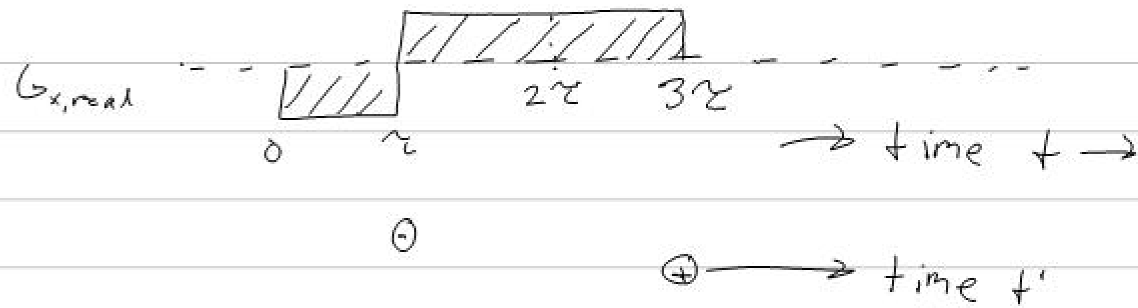
Review: Constant Velocity / Motion



otal Phase Accumulated $\varphi(t) = \varphi_s(t) + \varphi_{v_x}(t)$

$_s(t') = -2\pi k_x \cdot x$ at $t'=0$, $k_x = 0$, $\varphi_s(t'=0) = 0$

$_{v_x}(t') = -\frac{1}{2} \gamma G v_x (4\tau t' + 2\tau^2 + t'^2)$

→ three terms to $\varphi_{v_x}(t')$

$_{v_x}(t')$ term #1: $-\gamma G v_x \tau^2$ constant

$_{v_x}(t')$ term #1: $-\gamma G \; 2\tau t' \equiv -2\pi k_x v_x 2\tau$

just displacement, $2\tau - t' = 0$ due to v_x

at $t'=0$, $k_x = 0$, term #1 = 0

$v_x(t')$ #3: $-\frac{1}{2}\gamma G v_x t'^2$ → act like a fliter
blurring of the image

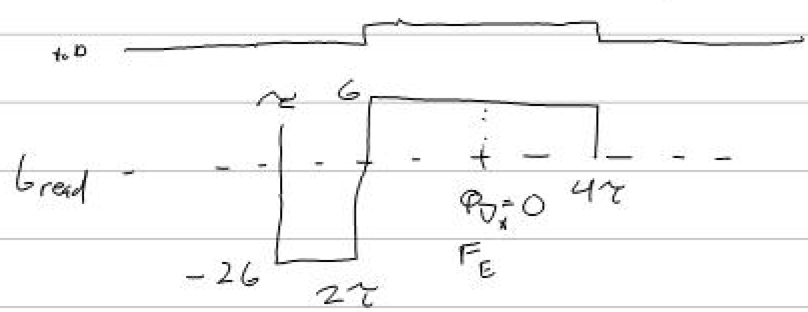
Solution: Design a multilobe eadout equence that compensates for constant elocity motion

equires,

$$M_0(F_E) = \int_0^{F_E} G(t)\,dt = 0$$

$$I_1(F_E) \int_0^{F_E} t \cdot G(t)\,dt = 0$$

$\varphi_{v_x}(F_E) \equiv 0$ for all v_x.



Three lobe readout sequence

-or constant acceleration you will nt the next moment to be zero as well, &c.

eneral Strategies: Consider the imaging experiment as consisting of two parts

art 1: Encode chemical or physical, or mechanical r functional property in the MR-signal → rt 2: patial Encoding — Create the Image

Mammalian Systems: Many tissues have quite different T_2's.

T_2W images give ood/excellent contrast nd nvolve pin echo ⇒ excellent resolution.

$$\Rightarrow M_{xy} = \underbrace{M_{xy}(t=0)}_{\approx M_0} \cdot e^{-t/T_2}$$

oxels with a long T_2: lots of signal: bright
vice versa

2 map: image where intensity of each voxel is T_2. linear elationship)

ould get by taking data at 2 times

1 ✓

not much contrast

· T_1 tends to be long

2 "inversion" recovery

$$M_z(TI) = A + Be^{-TE/T_1}$$

Going Fast

① Get minimum number (3) of TI values do EPI)

◯ Water protons give lots of S/N. Use a small flip angle in(θ)∝θ collect many points "Look Locker"

-t steady state, -ollowing a series of θ flip angle pulses.

$$\frac{S}{N} \text{ per unit time} = \frac{M_0 \left(1 - \quad ^{-TR/T_1}\right) \sin(\theta)}{\sqrt{TR}\left(1 - e^{-TR/T_1} \cdot \cos(\theta)\right)}$$

$$\text{os}(\theta_{optimal}) = e^{-TR/T_1}$$

-or a 90° pulse, $TR_{opt} = 1.27\, T_1$

$= f(TR, T_1, \theta)$.

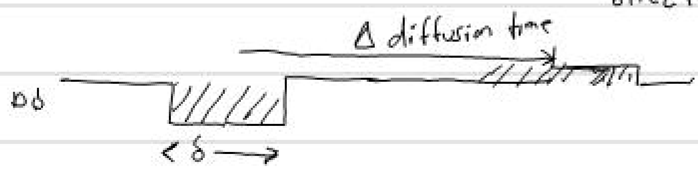
Vary θ to get T_1.

—

DWI iffusion Weighted —maging

→ pulsed field radients
ncoding of incoherent
isplacement otion

ollect the echo – trong echo if little diffusion



diffusion coefficient

$\text{=cho strength} \propto S_0 e^{-b \cdot D}$

$b = \gamma^2 G^2 \,{}^2 (\Delta - \frac{\delta}{3})$

Functional MRI ⇒ ~~FMRT~~ -MRI
an we image he brain at ork?

rain work increases ↑

Blood Flow to the relevant region goes up (lot)

$\frac{\text{xyhemoglobin}}{\text{deoxyhemoglobin}}$ ↑

. Fe, low spin

> Fe, high spin

↳ his causes ΔB_0 ↓ change in susceptibility → Do a gradient echo experiment signal will last longer now that field is more homogeneous)

image gets brighter where the brain is working