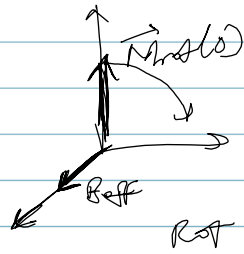
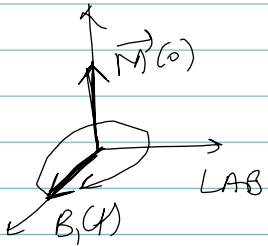


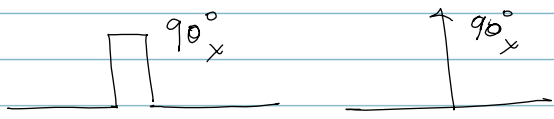
# Review



- $\frac{d\vec{M}_{rot}}{dt} = \vec{M}_{rot} \times \gamma \vec{B}_{eff}$

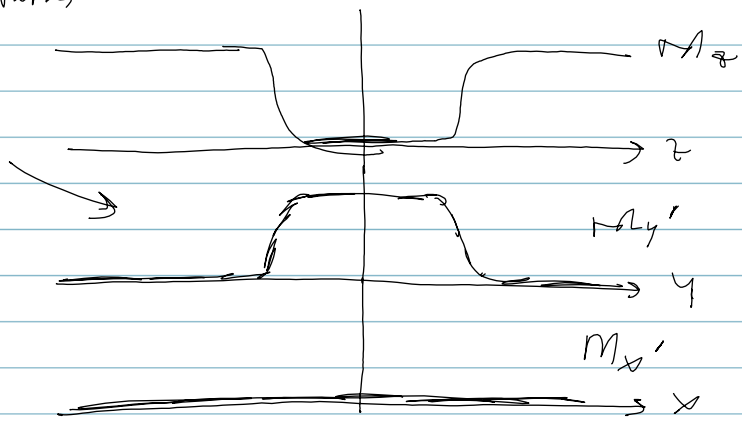
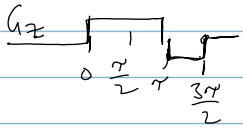
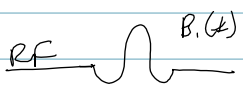
- rotation  $\Theta = \int_0^{\tau} \omega(t) dt = \int_0^{\tau} \gamma B(t) dt$

- specify  $\Theta$  (tip/flip angle) and axis



remember: left handed rotation!

## selective excitation



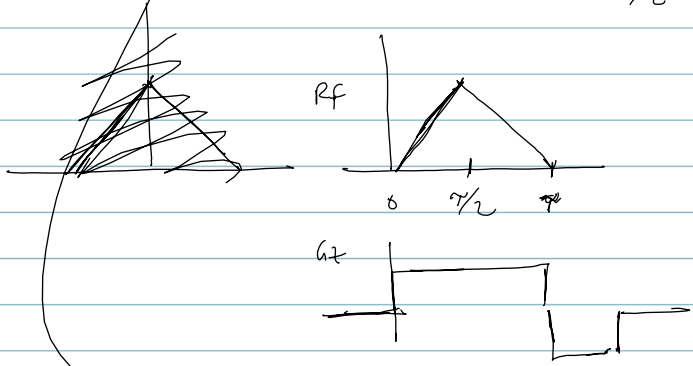
Small dip approximation,  $\theta$  small,  $M_z \approx M_0$

$$M_r\left(\frac{3\pi}{2}, z\right) = i M_0 \int \left\{ \underbrace{\omega_r(t + \frac{\tau}{2})}_{\text{curved } \gamma_B(t)} \right\} f = -\frac{\gamma}{2\pi} G_z z$$

↑  
equilibrium magnetization
↑  
curved  $\gamma_B(t)$

Mish 6.11

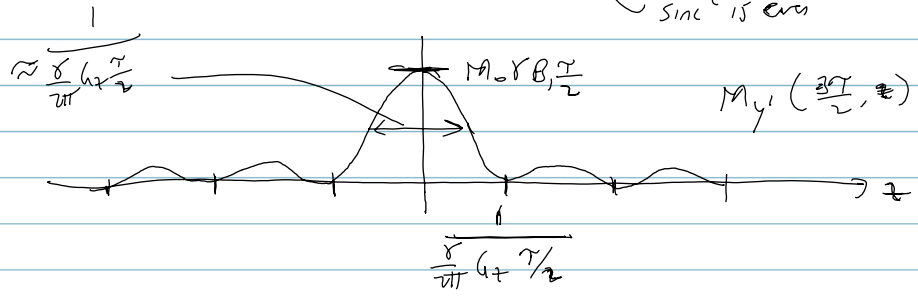
$$B_r(t) = B_1 \wedge \left( \frac{t - \frac{\tau}{2}}{\tau/2} \right)$$



$$M_r\left(\frac{3\pi}{2}, z\right) = i M_0 \int \left\{ \gamma B_1 \wedge \left( \frac{t - \frac{\tau}{2}}{\tau/2} \right) \right\} f = -\frac{\gamma}{2\pi} G_z z$$

$$= i M_0 \gamma B_1 \frac{\tau}{2} \text{sinc}^2 \left( \frac{\tau}{2} \left( + \frac{\gamma}{2\pi} G_z z \right) \right)$$

↑  
sinc<sup>2</sup> is even



Channel slices:

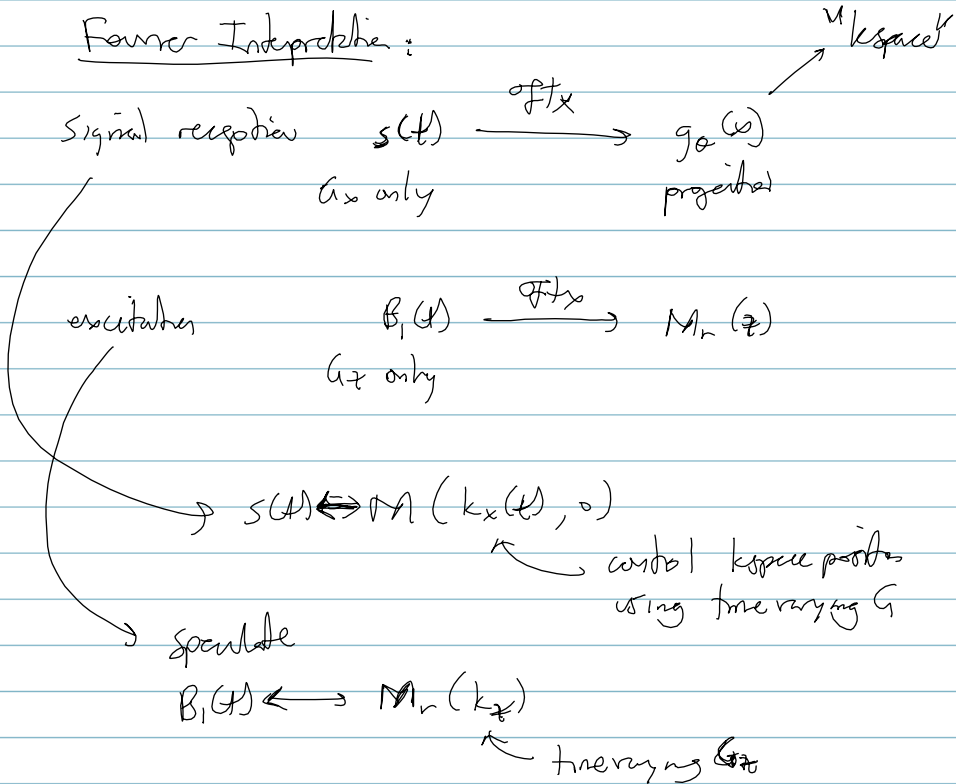
$\uparrow G_z \rightarrow$  OK, but amplitude limited  
 $\uparrow T \rightarrow$  reduce BW of  $B_z(t)$ ,  
 but off resource is an issue  
 $\searrow$  consider  $T_z$

$$G_z \approx 1 \text{ G/cm}$$

$$T \approx 1 \text{ ns}$$

$$\Delta z \approx 0.4 \text{ cm}$$

Fourier Independence:



## excitation k-space

return to small hp approx

$$M_r(\tau, z) = i m_0 \int_0^\tau \omega_r(s) e^{+i \omega_r(s)(s-t)} ds$$

$\omega_r$  constant  
 $\omega_r = \gamma G_z \tau$

consider  $B_r(t)$

&  $G_z(t)$  ← can be time varying

$$M_r(\tau, z) = i m_0 \int_0^\tau \omega_r(s) e^{-i \left( \gamma \int_s^\tau G_z(t') dt' \right) z} ds$$

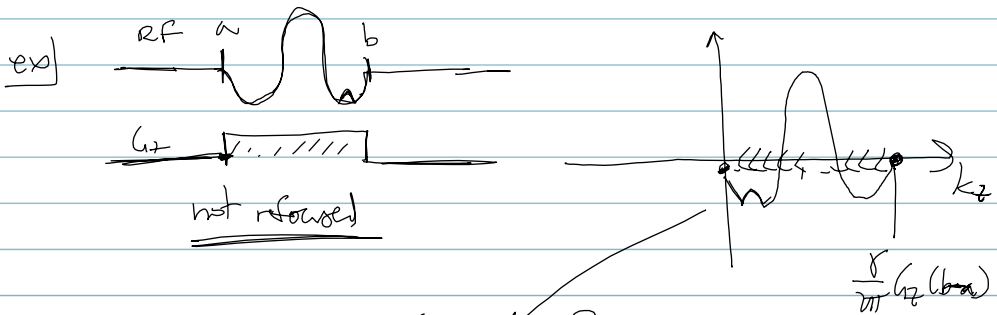
Define  $k_z(s) = \frac{\gamma}{2\pi} \int_s^\tau G_z(t') dt'$

$$= i m_0 \int_0^\tau \omega_r(s) e^{-i 2\pi k_z(s) z} ds$$

⊛  $\omega_r(s)$  "depositing" weight in excitation k-space  $[\gamma B_r(s)]$

⊛ trajectory in excitation k-space is controlled by gradients  
Note: always end at ~~the~~ origin

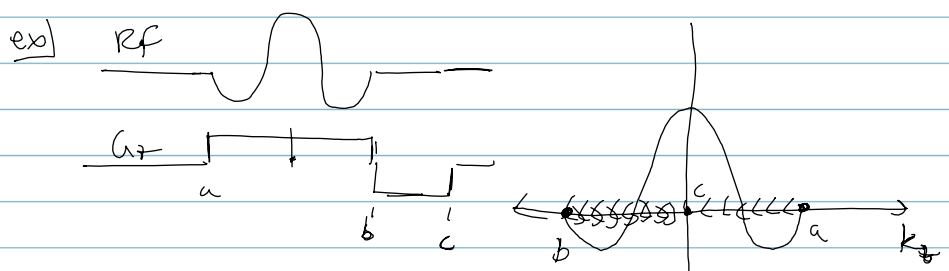
⊛  $M_r(z)$  is the same transform of the weighting



$$M_n(z) = \mathcal{F}\{T_x\} \left\{ \begin{array}{l} \text{ } \\ \text{ } \end{array} \right\}$$

$$= \text{rect} \cdot \text{phase factor}$$

$$= e^{-i \omega(z) T_x / 2}$$

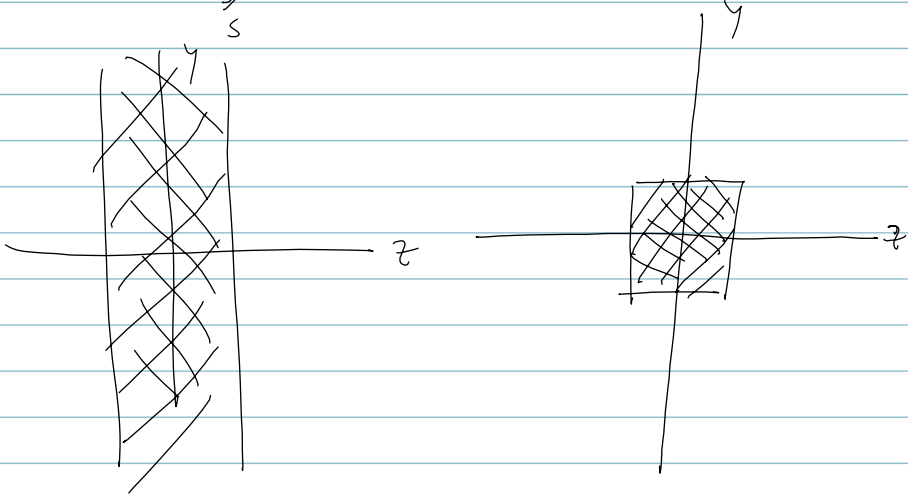


centered sinc  
no phase in the slice profile!



framework applies to 2D & 3D selective erasure

$$\vec{r}(s) = \int_s^{\gamma} \vec{c}(t') dt'$$



see Past Projects  
for examples

