- Signal equation $s(t)$

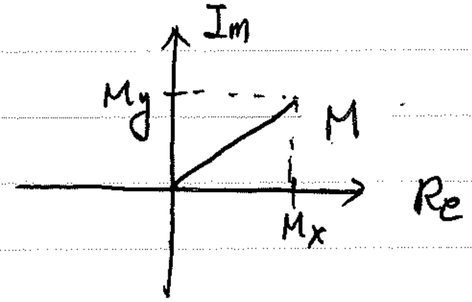
→ M_z does not provide any signal in MRI

→ The only thing we can detect in MRI is time-vary magnetization in the transverse plane (M_x & M_y)

Transverse M_{xy} $\Rightarrow$ FID $S_r(t)$

in a simplified notation,

$$M = M_x + i M_y \quad ; \text{ a complex rep. of } M_{xy}$$



length $|M|$

phase $\angle M$

$$\frac{dM}{dt} = \frac{dM_x}{dt} + i\frac{dM_y}{dt} \qquad \text{(see Eq. 5.6)}$$

$$= \gamma B_0 M_y - i\gamma B_0 M_x - \frac{1}{T_2}(M_x + iM_y)$$

$$= -\left(i\gamma B_0 + \frac{1}{T_2}\right)M_x - \left(-i\gamma B_0 + \frac{1}{T_2}\right)(iM_y)$$

$$= -(\underbrace{i\gamma B_0}_{\text{rotation on the complex plane}} + \underbrace{\tfrac{1}{T_2}}_{\text{decay}})\, M$$

EX $\Delta\omega$

soln $m(\bar{r}, t)$

$$\Delta\omega(\bar{r}, t) = \gamma \Delta B(\bar{r}, t)$$

1) linear gradient along X

$$\Delta\omega = \gamma G_x x$$

$$\Rightarrow m_a(\bar{r}, t)\, e^{-i\gamma G_x x t}$$

$$= m_a\, e^{-i 2\pi \underbrace{\left(\frac{\gamma}{2\pi} G_x x\right)}_{\text{think as freq.}} t}$$

2) linear gradient

$$\gamma \bar{G} \cdot \bar{r}$$

$$= \gamma (G_x x + G_y y + G_z \cdot z)$$

$$\Rightarrow m_a \cdot e^{-i 2\pi \left(\frac{\gamma}{2\pi} \bar{G} \cdot \bar{r}\right) t}$$

3) time varying

$$\Delta\omega = \gamma \bar{G}(t) \cdot \bar{r}$$

$$\Rightarrow m_a \cdot \underbrace{e^{-i 2\pi \left[\frac{\gamma}{2\pi} \int_0^t \bar{G}(\tau) \cdot \bar{r}\, d\tau\right]}}_{e^{-i\phi(r, t)}}$$

spatial varying phase due to $\bar{G}(\bar{r}, t)$