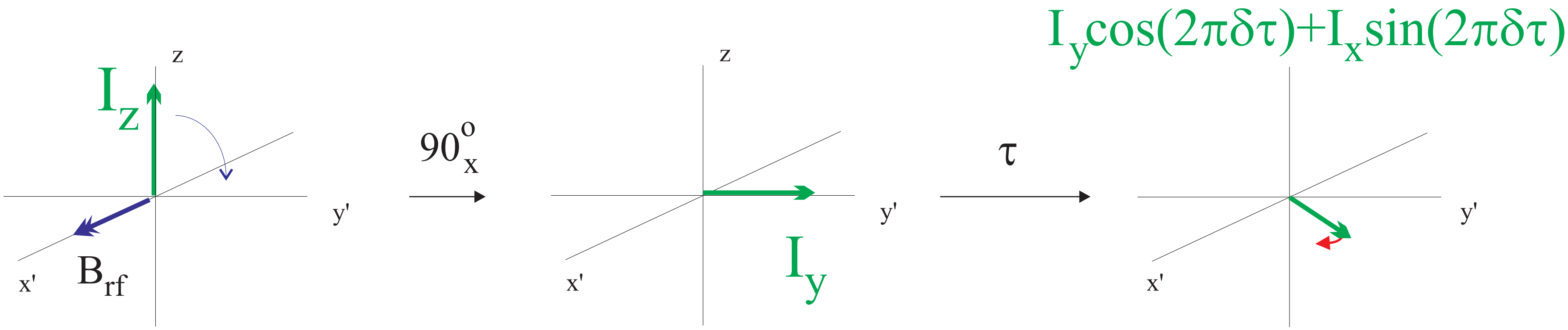
$^{13}CH_2$–CHRR'

Spin Echoes: δ

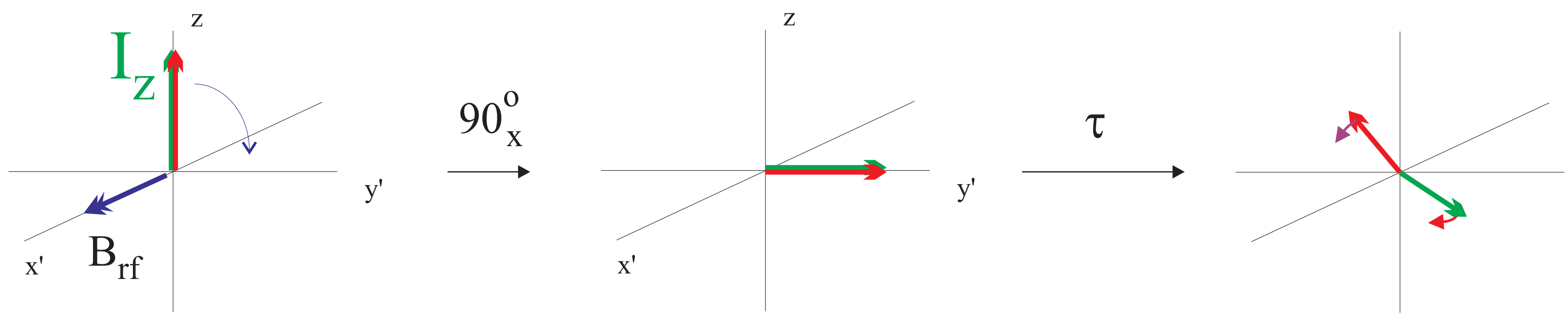


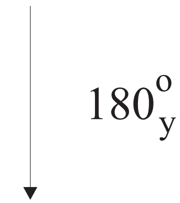
If τ = 100μs, δ = 2ppm @ 500 MHz = 1000 Hz

$\tau \times \delta$ = 0.1 so vector rotates $0.1\times360 = 36^o$

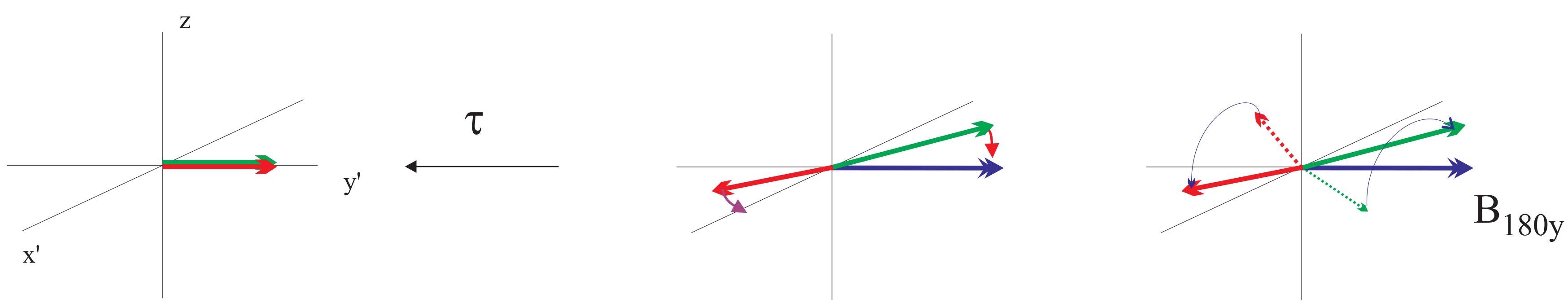
$^{13}CH_2$–CHRR’

Spin Echoes: δ

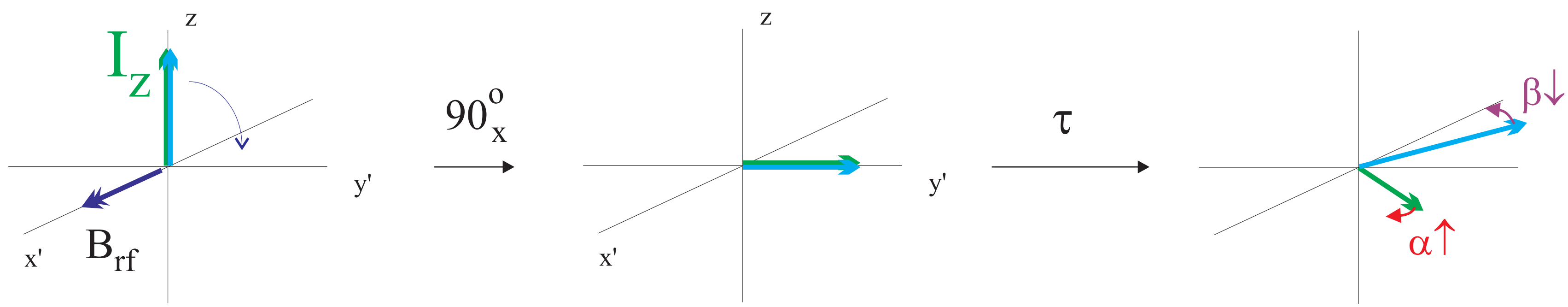




180° pulses refocus chemical shift!



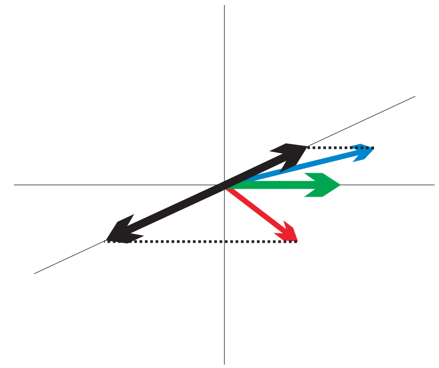
Spin Echoes: J-coupling



Remember that J-coupling involves 2 sets of molecules:
one where the coupled spin is α↑
the other with the coupled spin being β↓

$t_1 \sim 1/4J$

$$I_y \rightarrow I_y \cos(\pi J t_1) + I_x S_z \sin(\pi J t_1)$$

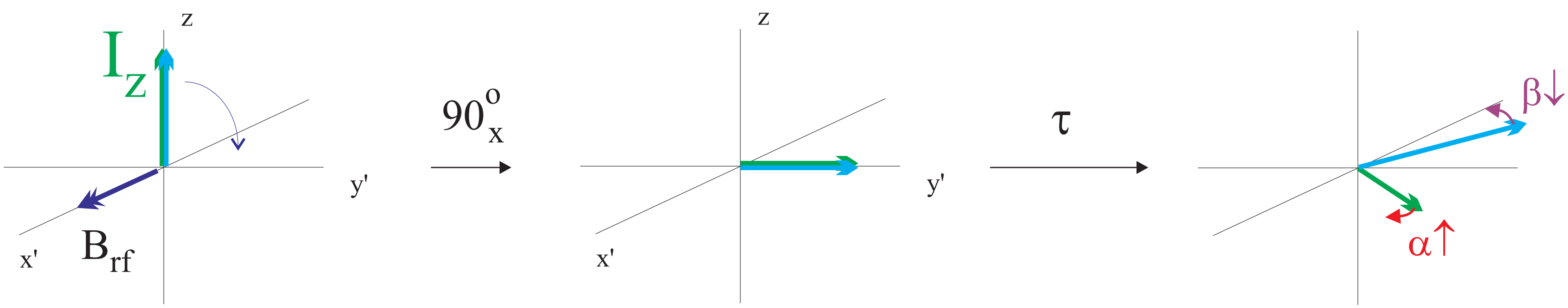


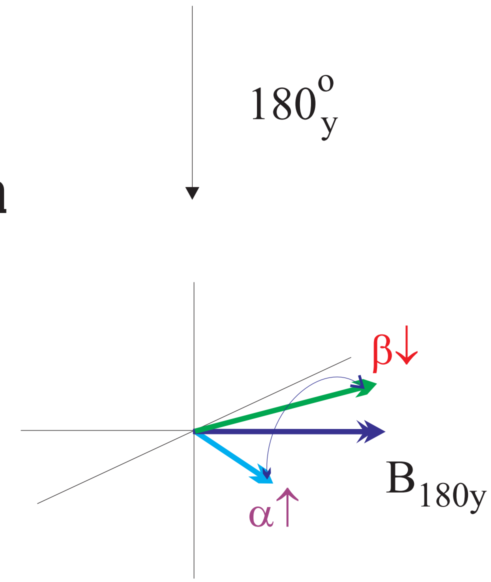
The product operator $\mathbf{I_x S_z}$ is called antiphase magnetization. The bilinear operator is a form of mixed magnetization that is not directly observable. It evolves, however, as:

$$I_x S_z \rightarrow I_x S_z \cos(\pi J t_1) + I_y \sin(\pi J t_1)$$

$^{13}CH_2$-CHRR'

Spin Echoes: J-coupling

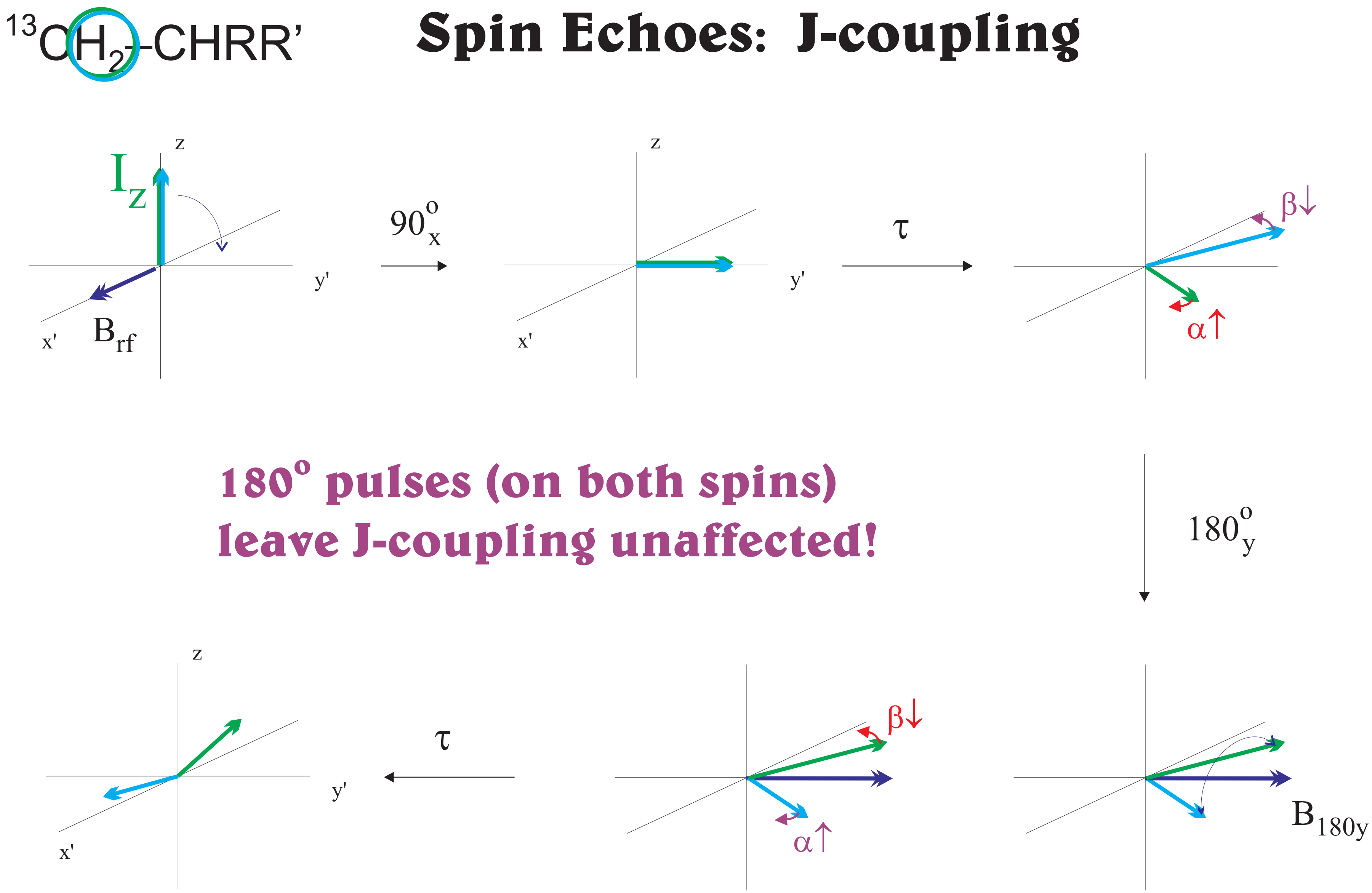




The 180° pulse rotates the isochromat as before. We might think α moves with the green, and β with cyan.

But the coupled spin is also inverted: $\alpha \rightarrow \beta$ **and** $\beta \rightarrow \alpha$

Spin Echoes: J-coupling



180° pulses (on both spins) leave J-coupling unaffected!