Introduction
to
Magnetic Resonance Imaging
- NMR Spectroscopy -

Time Domain NMR Signal
Pulse Sequences

A set of RF pulses applied to a sample to produce a specific form of NMR signal.

Examples: spin-echo
gradient echo
inversion recovery
Timing Diagram

A multiple axis plot of various aspects of a pulse sequence versus time.

\[ S = k \rho \left( 1 - e^{-\frac{TR}{T_1}} \right) \]

\begin{align*}
S & = \text{Signal after Fourier Transform} \\
K & = \text{proportionality constant} \\
\rho & = \text{spin density}
\end{align*}
**Spin-Echo**

\[ S = k \rho \left( 1 - e^{-\frac{TR}{T_2}} \right) e^{-\frac{TE}{T_1}} \]

- \( S \) = Signal after Fourier Transform
- \( k \) = proportionality constant
- \( \rho \) = spin density

**Inversion Recovery**

\[ S = k \rho \left( 1 - 2e^{-\frac{TR}{T_1}} \right) \]

- \( S \) = Signal after Fourier Transform
- \( k \) = proportionality constant
- \( \rho \) = spin density
Chemical Shift ($\delta$)

Electron cloud around nucleus shields nucleus from some $B_o$.

Therefore, each nucleus absorbs a different frequency.

A measure of this shielding is called the chemical shift ($\delta$).

$$\delta = \frac{\nu - \nu_{ref}}{\nu_{ref}} \times 10^6$$

NMR Spectrum

A plot of the absorbed energy as a function of frequency or chemical shift.

Spectra indicate chemical structure.