k-Space Formalism in MRI

The k-space at a given time is related to the history of the gradients as follows:

$$k_x(t) = \gamma \cdot \int_0^t G_x(\tau) \cdot d\tau \qquad (1)$$

$$k_y(t) = \gamma \cdot \int_0^t G_y(\tau) \cdot d\tau \qquad (2)$$

$$k_z(t) = \gamma \cdot \int_0^t G_z(\tau) \cdot d\tau \qquad (3)$$

Consequently, the gradients for a given k-space trajectory are given by the derivative of that trajectory as follows:

$$G_x(t) = \frac{dk_x(t)}{dt} \qquad (4)$$

$$G_y(t) = \frac{dk_y(t)}{dt} \qquad (5)$$

$$G_z(t) = \frac{dk_z(t)}{dt} \qquad (6)$$

<u>Note:</u> Start from t=0 at the center of the RF pulse and compute the initial location of the k-space trajectory by integrating the x, y, and z gradients until the start of the readout period. Then, the trajectory is drawn based on the way the readout gradient is shaped.

Examples: Echoplanar imaging (EPI): zigzag (left) and blipped (right)