Fundamentals and Visualization of the SWIFT Sequence

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Purpose

SWIFT (SWeep Imaging with Fourier Transform) is one of the newer sequence types [1]. In SWIFT, excitation and acquisition occur in rapid succession during a gapped frequency swept pulse. SWIFT is not typically covered in basic texts or courses in MRI. In addition, SWIFT embodies several concepts which individually and taken together challenge (and defy) the intuition formed from experience with more familiar MRI sequences. We introduce the concepts (outlined below), compare them to more familiar situations and place them in the context of the SWIFT.

Outline of Content

MRI excitation and spin response as a linear system (convolution)
- What is an impulse, hard pulse, amplitude shaped pulse? What is a spin isochromat?

Frequency swept pulses in the sub-adiabatic (linear) flip angle regime
- How is a frequency swept pulse different than an amplitude shaped pulse?
- What is phase dispersion?

Excitation profile of a periodically gapped pulse and resulting sidebands [2]
- What happens when you square wave modulate a pulse?

Gapped signal acquisition and sideband overlap [3]
- What happens when you square wave modulate the spin response?
- Sampling and oversampling SWIFT data [4].

Artifacts...[5]
- How fast is your T/R switch really? How many bits does your gradient and RF DAC use?
- Does your coil have a polymer background signal?

Excitation to signal reception “dead time” in SWIFT. What is the definition of “Echo Time?”
- What is the “Echo Time” of SWIFT? What can I image with SWIFT?

Summary

We outline important concepts for understanding the SWIFT sequence. We do this by comparison to more commonly known concepts of NMR/MRI and show departures needed for better understanding of SWIFT. When possible we use a combination of words, diagrams mathematical formulae and animations so that the reader can latch onto the representation (or representations) that works best to gain understanding.

References:
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