

Lesson 8 (A): Pulse sequences (1)

Aims

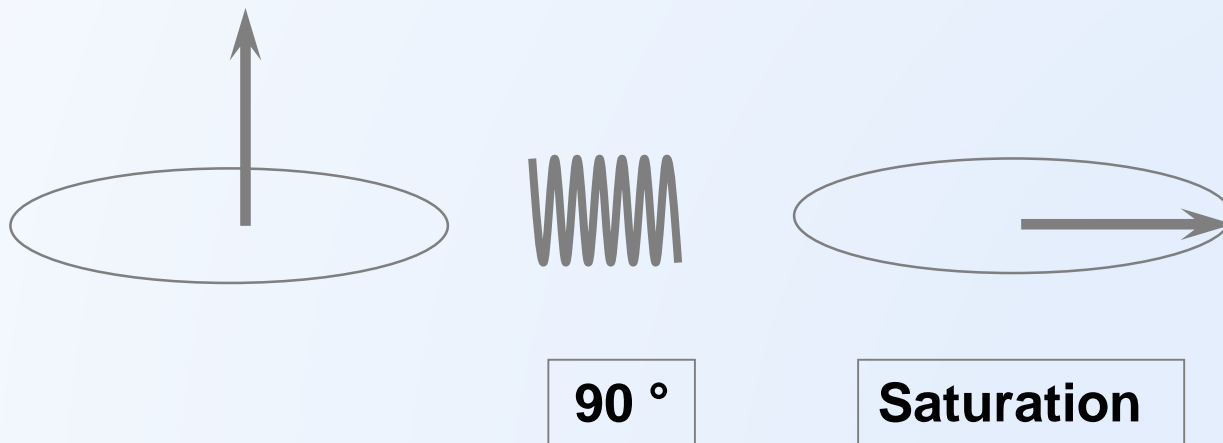
- Learning the following topics about pulse sequences:
- Definition
- Saturation recovery (SR)
- Partial saturation
- Spin echo (SE)

Pulse sequence

- A pulse sequence is a sequence of radio frequency (RF) pulses applied repeatedly during an MR study.

Saturation

- Immediately after the longitudinal magnetization has been flipped into the x-y plane by a 90° pulse, the system is said to be saturated. Application of a second 90° pulse at this moment will elicit no signal.

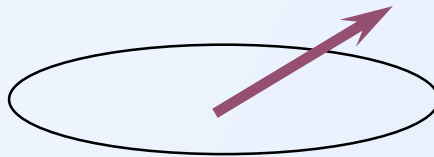


Partial Saturation

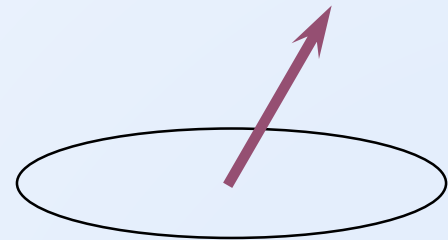
- A few moments later, after some T1 recovery, the system is partially saturated.



Saturation



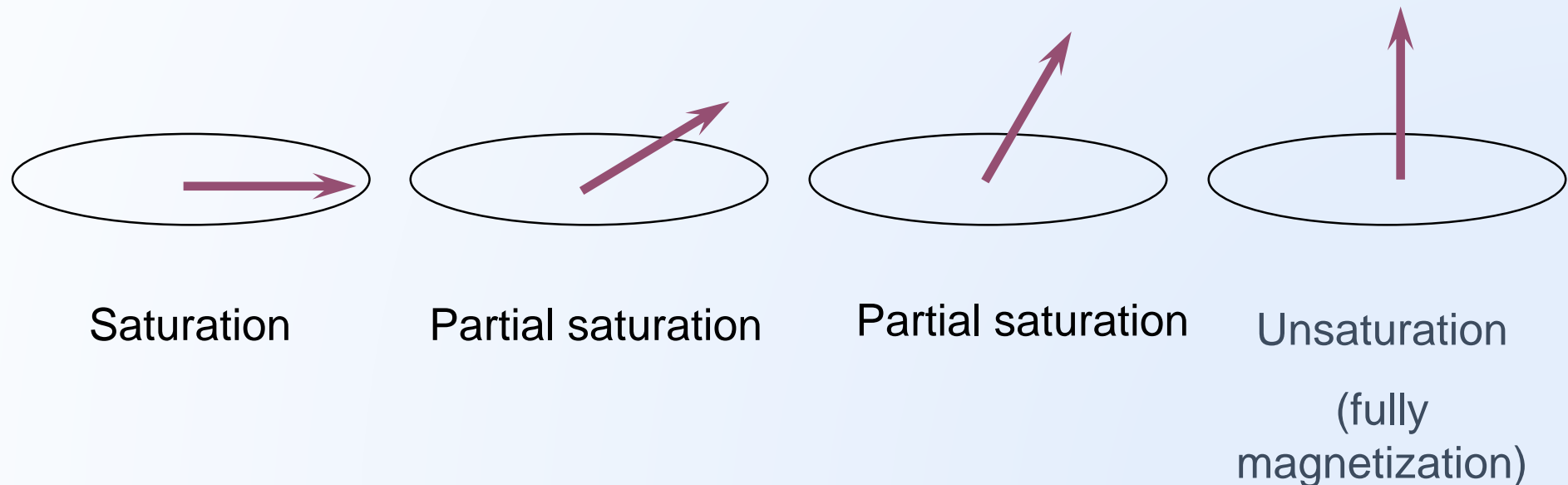
Partial Saturation



Partial Saturation

Unsaturatation

- With complete T1 recovery to the plateau value, the system is unsaturated or fully magnetized.



Partial saturation

- Two states:
- After some T1 recovery
- After flip angles less than 90°

Saturation Recovery Pulse Sequence

- TR is long and TE is minimal →
- PD weighting image

Partial saturation pulse sequence

- TR is short, TE is minimal →
- T1 weighting image

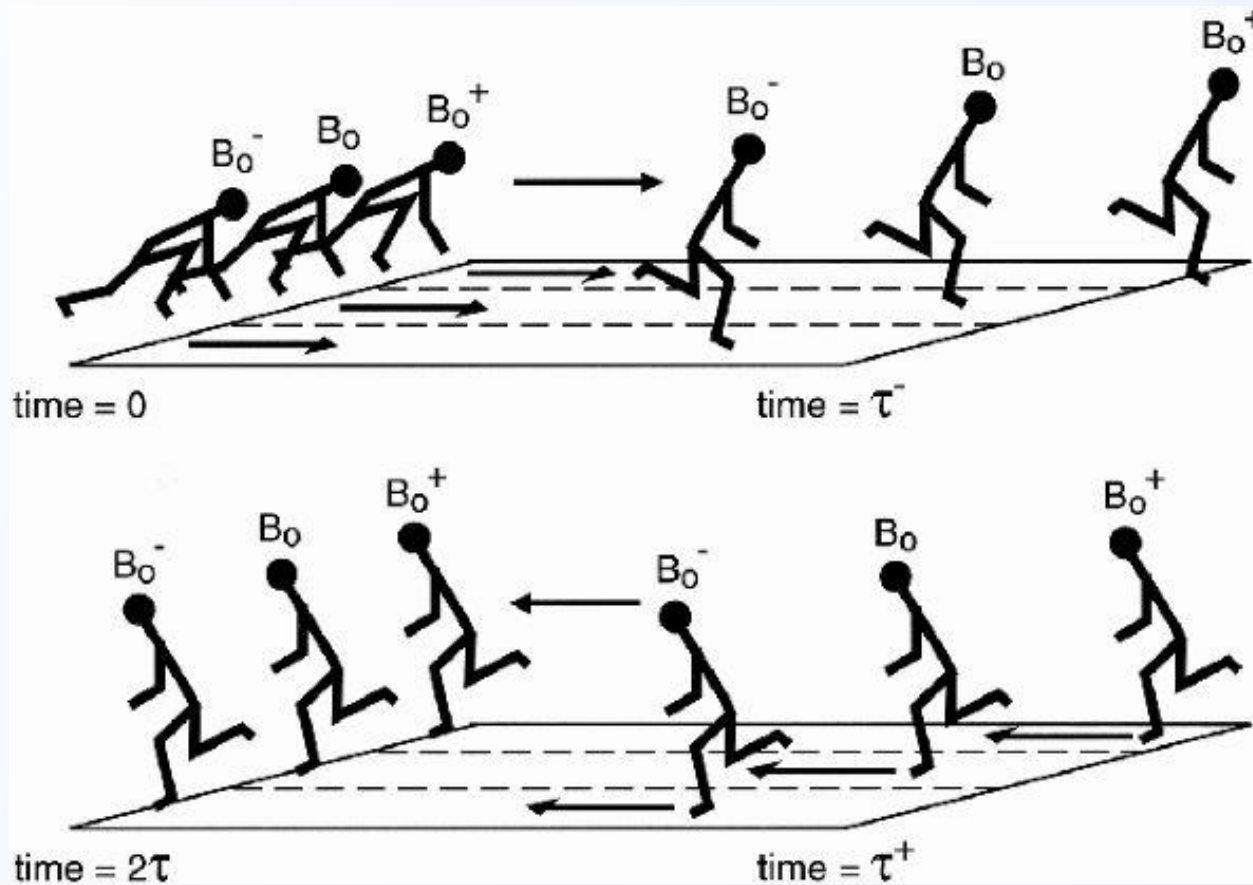
Spin echo pulse sequence

- Spin echo (SE)
- Conventional spin echo (CSE)

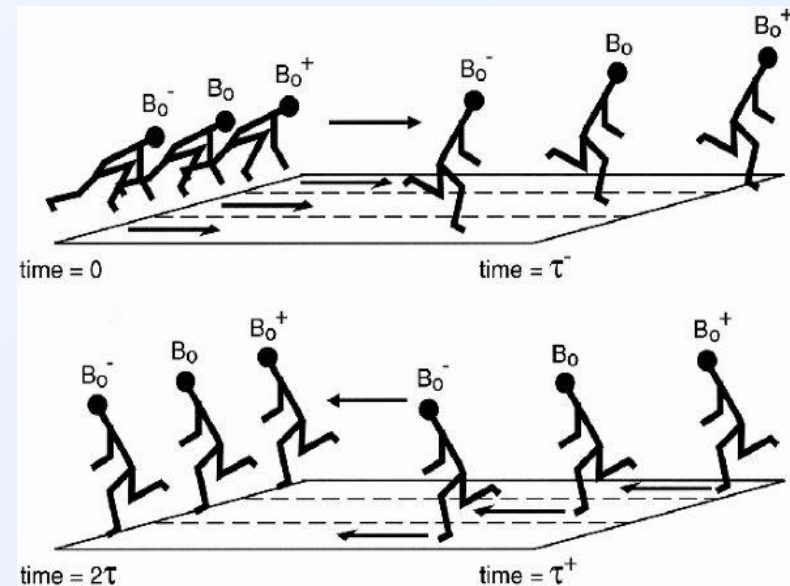
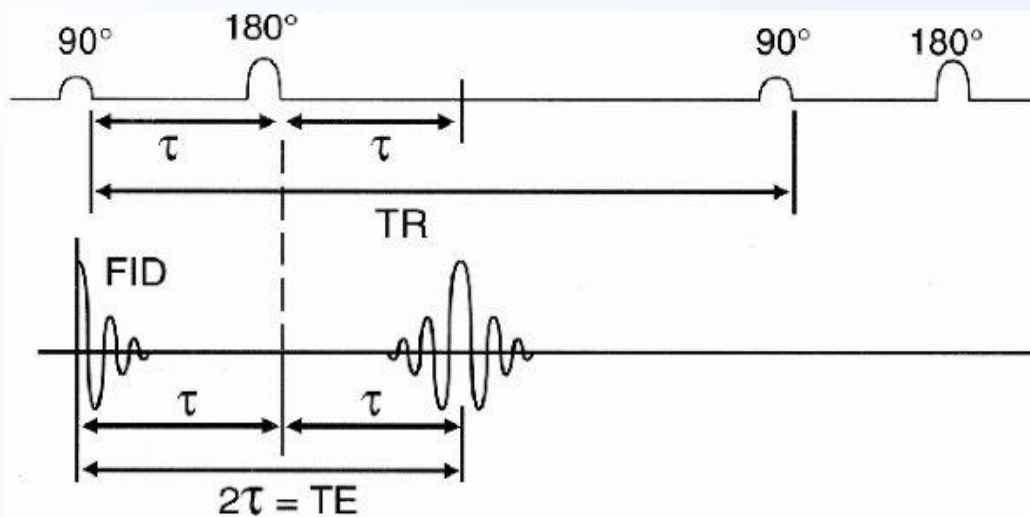
Spin echo

- By using the SE pulse sequence, we can eliminate dephasing caused by fixed external magnetic field inhomogeneities.

Spin echo

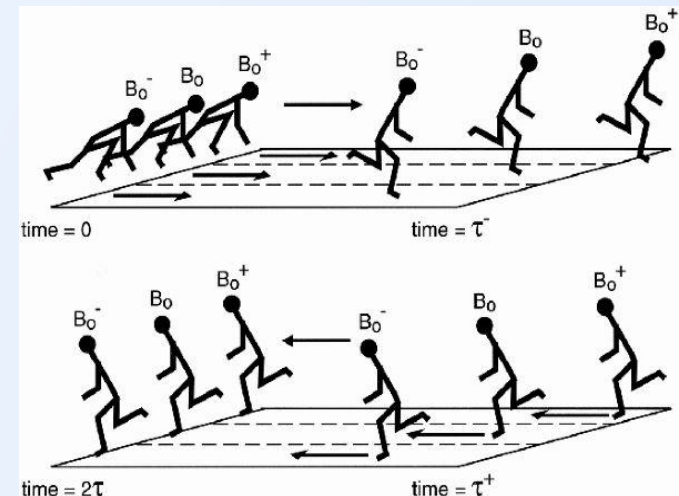
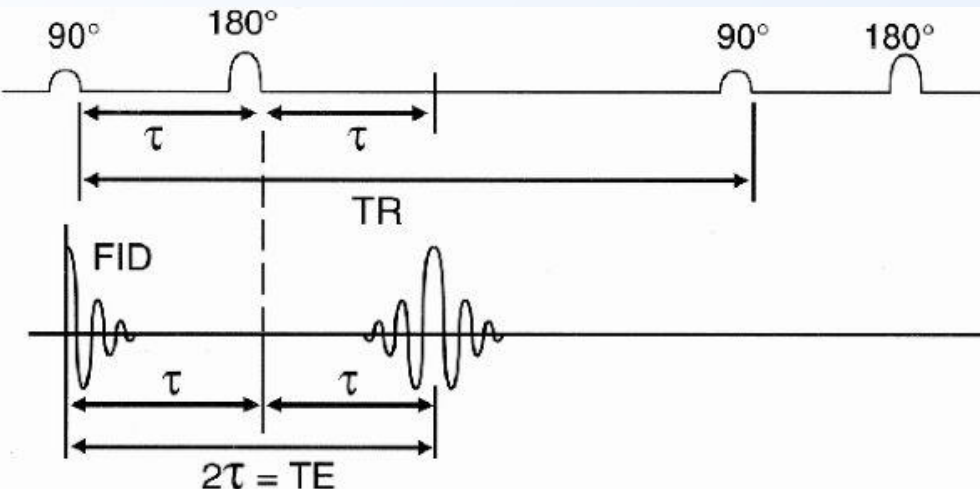


SE pulse diagram



SE pulse diagram

- The 180° pulse is called a refocusing or rephasing pulse.
- Echo: The point of maximum rephasing
- τ :
- The time from the 90° RF pulse to the 180° RF pulse
- Time τ is also the time from the 180° RF pulse to the echo.
- $2\tau = TE$



Summary

- Definition of pulse sequence
- Saturation recovery
- Image weight in saturation recovery
- Partial saturation
- Image weight in partial saturation
- Spin echo

Reference

- Hashemi, RH and Brandy, WG. MRI the Basics, Second Edition