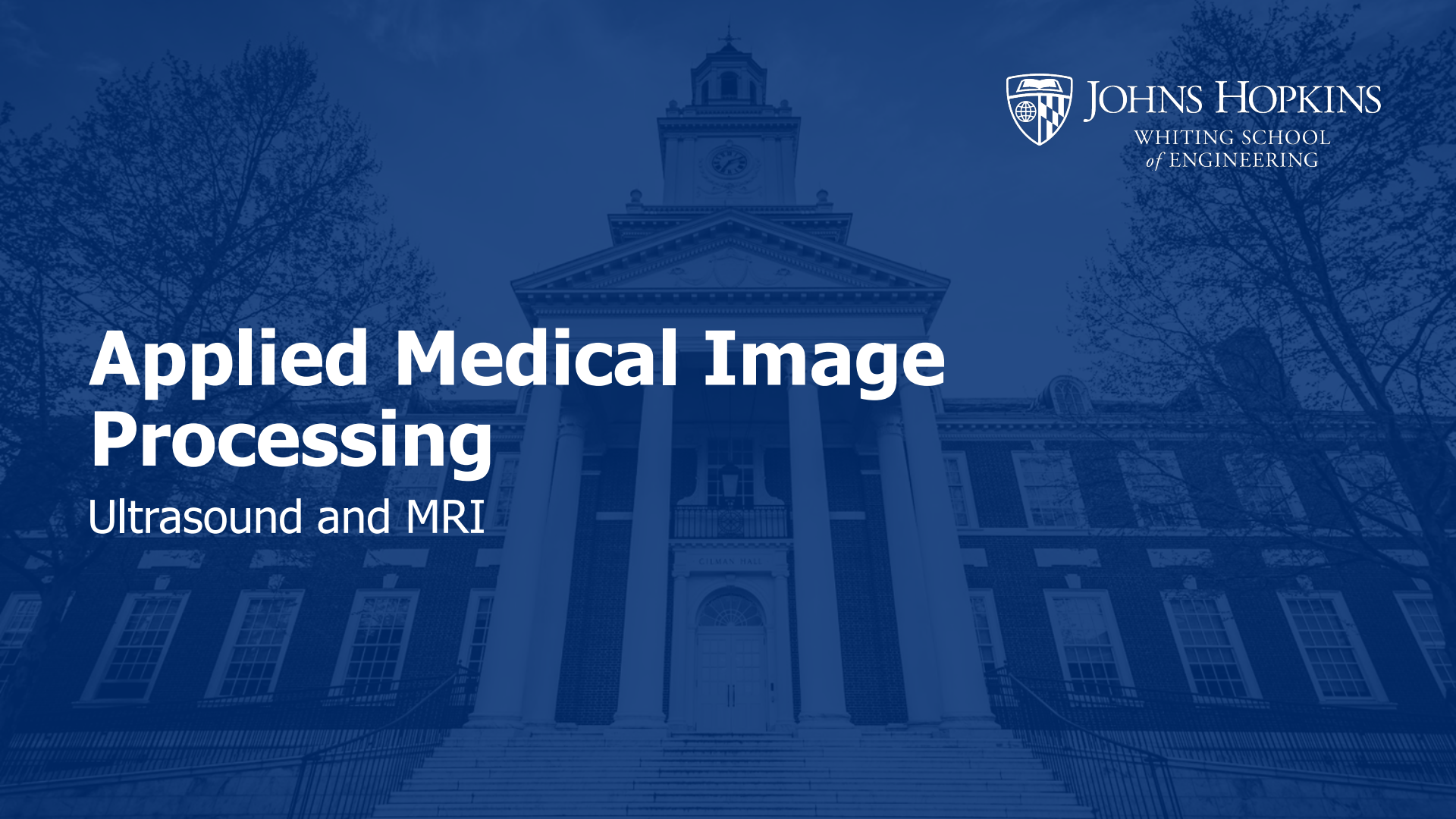

JOHNS HOPKINS
WHITING SCHOOL
of ENGINEERING
Applied Medical Image Processing
Ultrasound and MRI

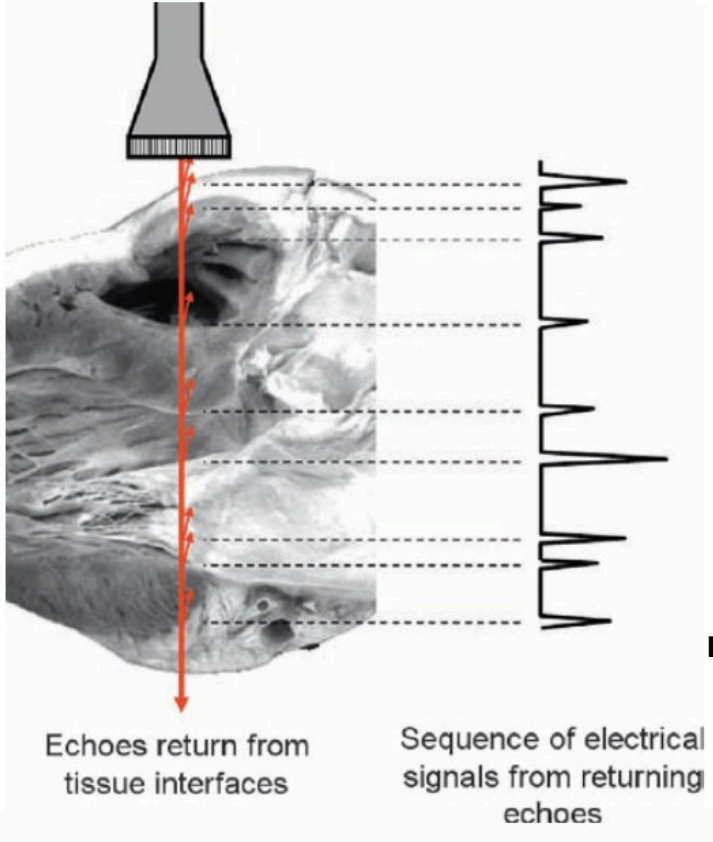
Outline

- Ultrasound
  - Doppler ultrasound blood velocity mathematical derivation (separate document)
- Magnetic Resonance Imaging (MRI) – part 1

Ultrasound

- Ultrasound (US) imaging is based on inverse Piezo effect.
  - Application of voltage to solids causes deformation of these solids inside the US transducer which in turn generates acoustic signals.
  - Acoustic signals penetrate tissue and reflected at the tissue boundaries.
  - Reflected pulses are picked up by the transducer and converted to electric signals.
- Simplest US provides one-dimensional information about location of surface boundaries and is called amplitude modulation or A- mode ultrasound imaging.
- A single transducer scans a line through the body with the echoes plotted on screen as a function of depth.

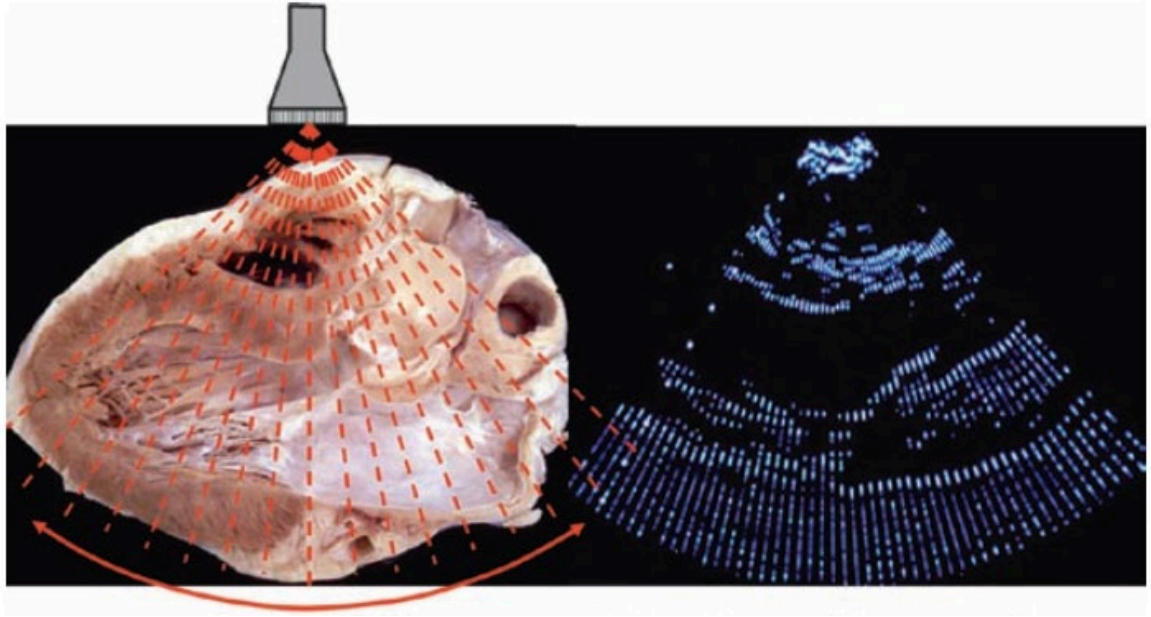
Ultrasound (A Mode)



Echocardiography 2nd ed. 2018 Edition

by Petros Nihoyannopoulos (Editor), Joseph Kisslo (Editor)

Ultrasound (B Mode) - 1



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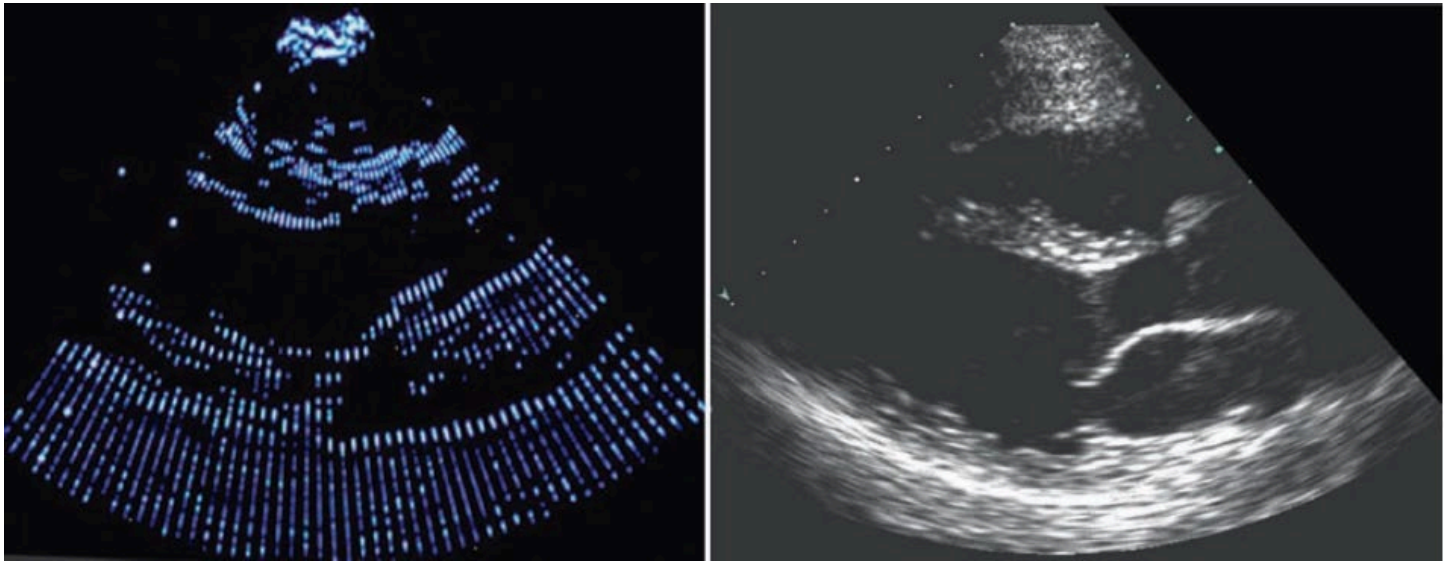
Ultrasound (B mode) - 2



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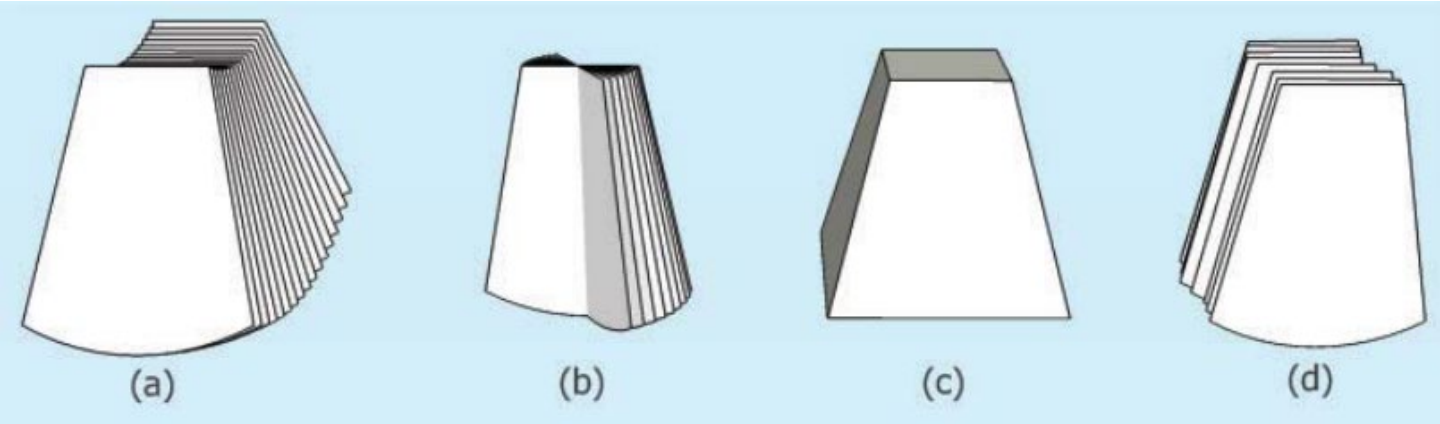
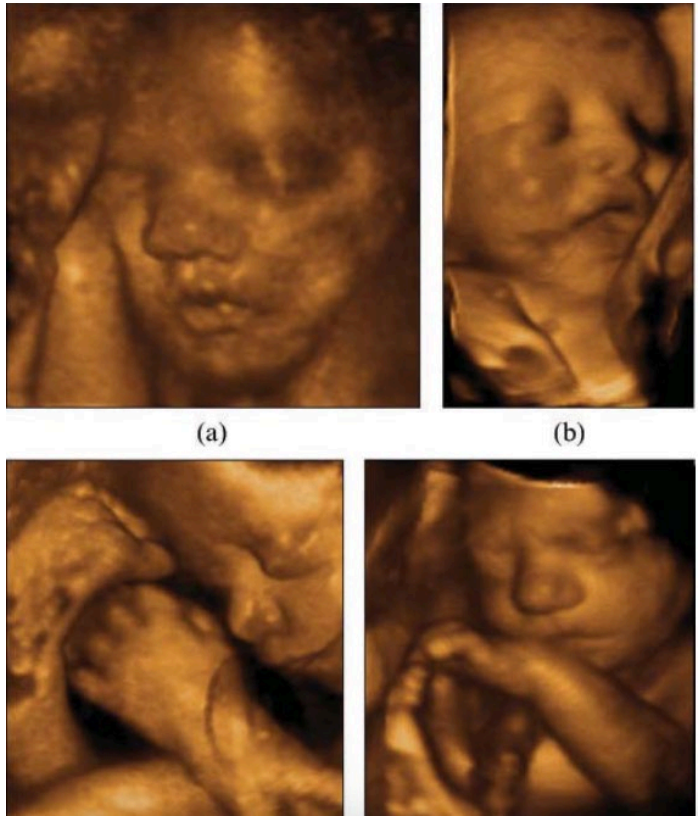
3D Ultrasound Probes



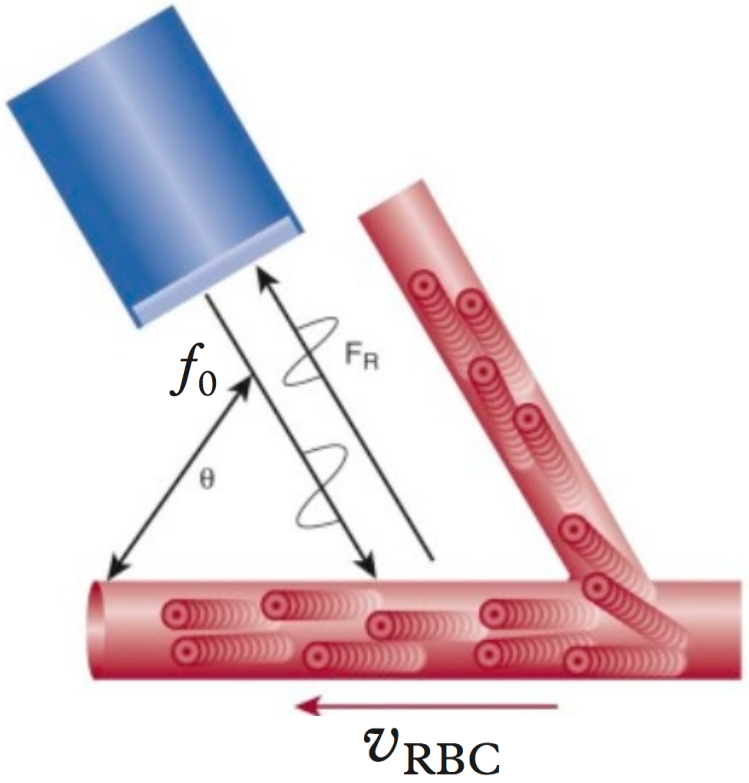
Proc Inst Mech Eng H. 2010;224(2):193-223

3D Ultrasound Images



Proc Inst Mech Eng H. 2010;224(2):193-223

Doppler Ultrasound



$$\frac{2 \cdot f_0 \cdot v_r}{c}$$

$$\frac{2 \cdot f_0 \cdot v_{RBC} \cdot \cos \theta}{c}$$

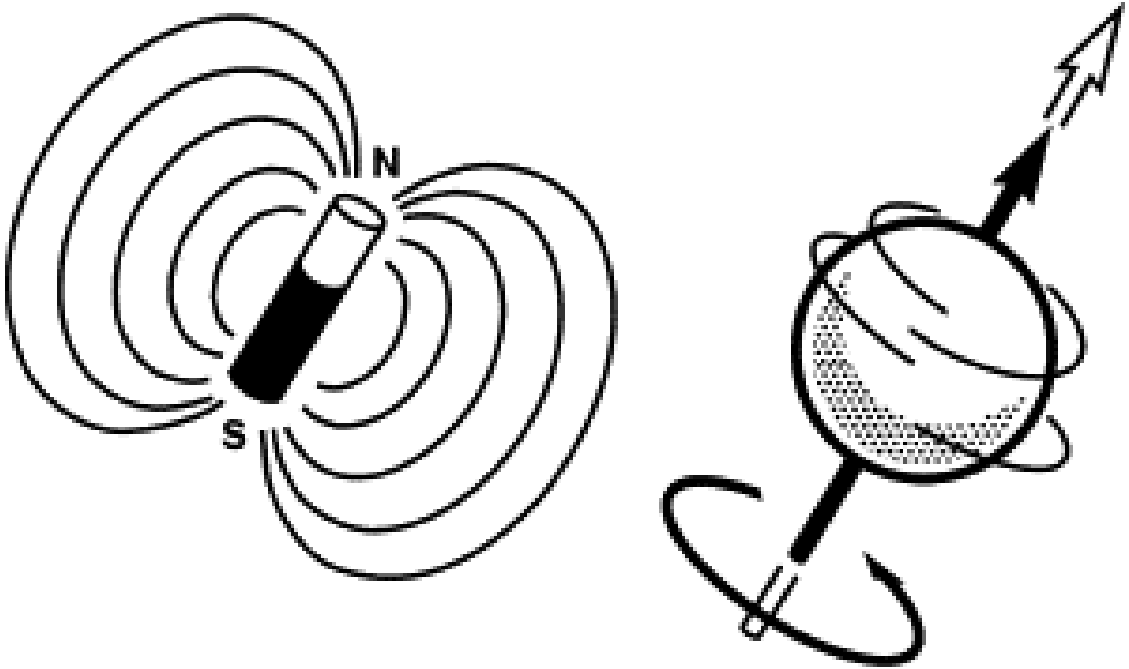
Diagnostic Ultrasound, 2-Volume Set 5th Edition

by Carol M. Rumack MD FACR , Deborah Levine MD

Magnetic Resonance Imaging

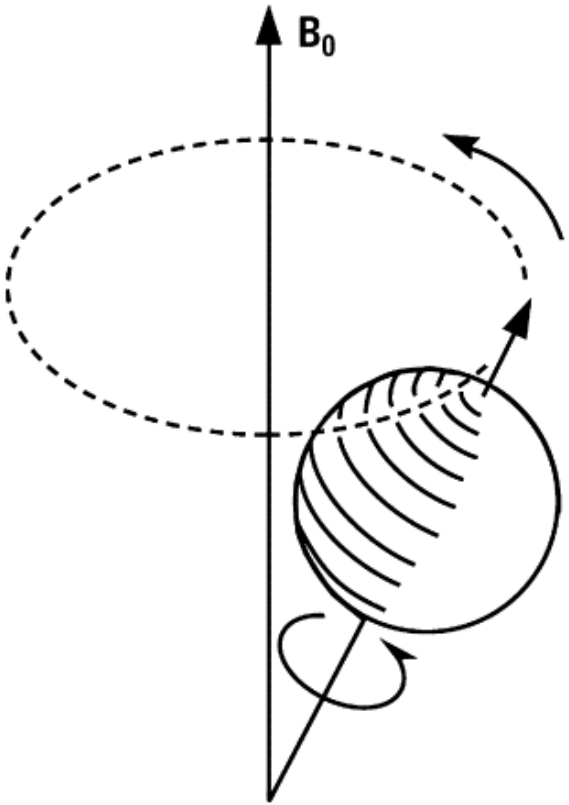
- Nuclear spin and net magnetization
- Radio-frequency pulse
- Relaxation times

Spins



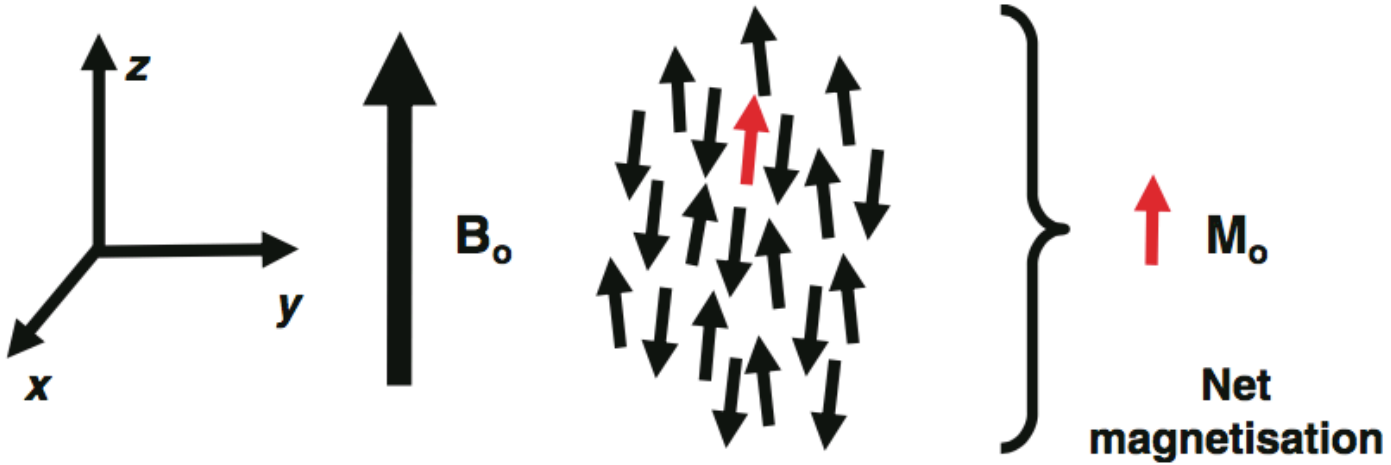
Magnetic Resonance Imaging Clinics of North America, Volume 19, Issue 1, 2011, 1–22

B0 Magnetic Field



Magnetic Resonance Imaging Clinics of North America, Volume 19, Issue 1, 2011, 1–22

Net Magnetization



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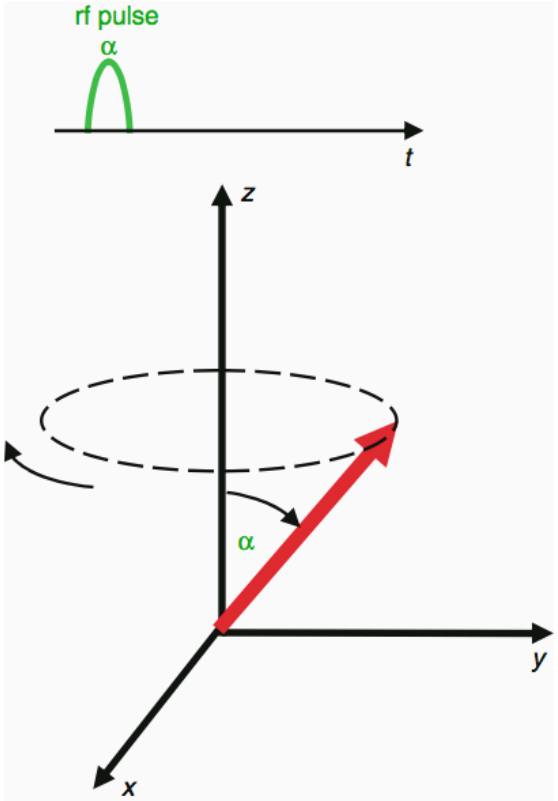
Radio-Frequency (RF) Pulse



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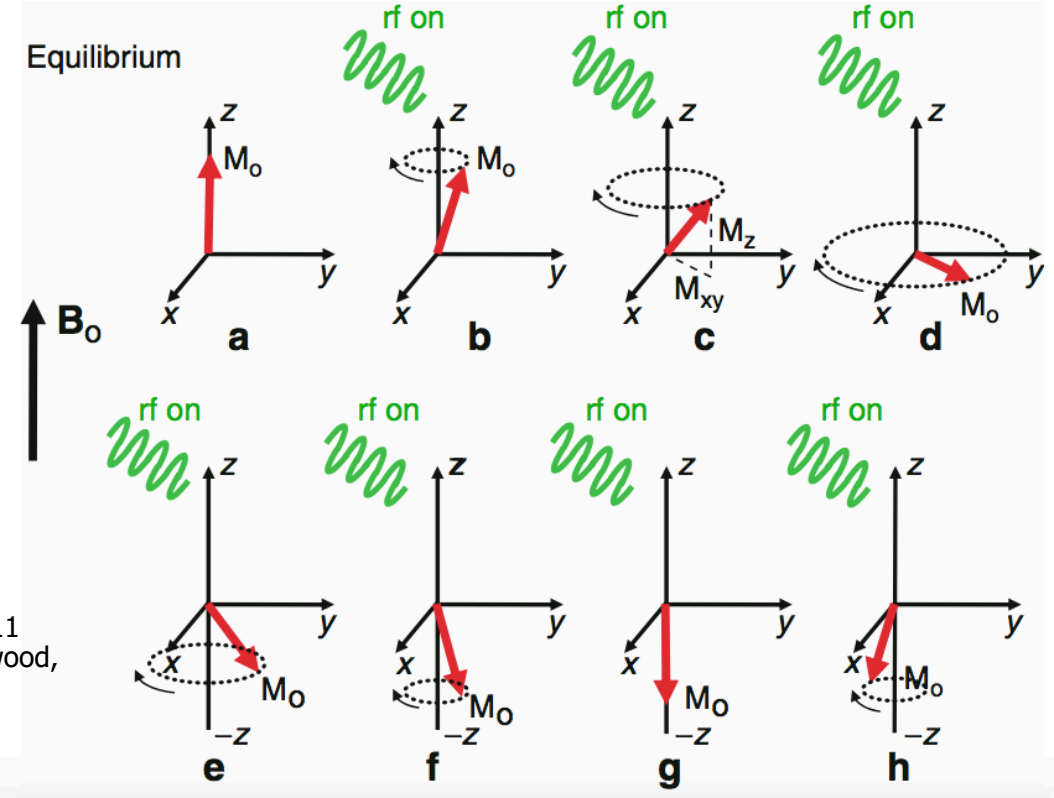
MRI



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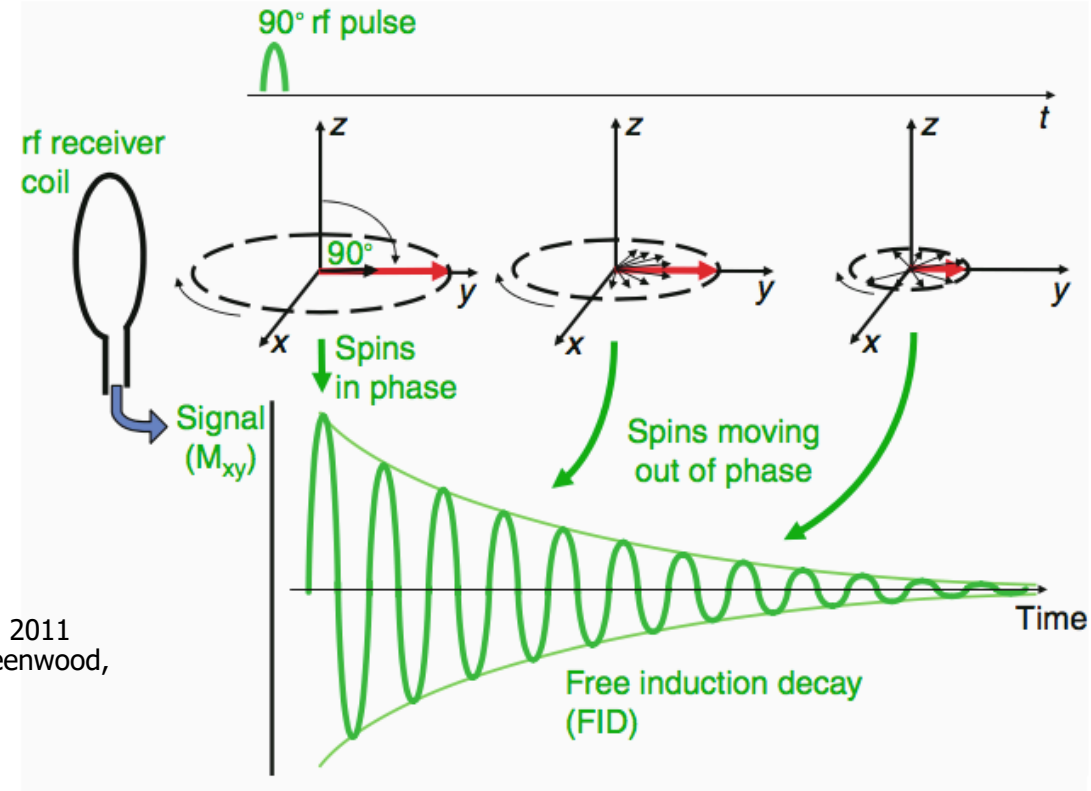
Free Induction Decay



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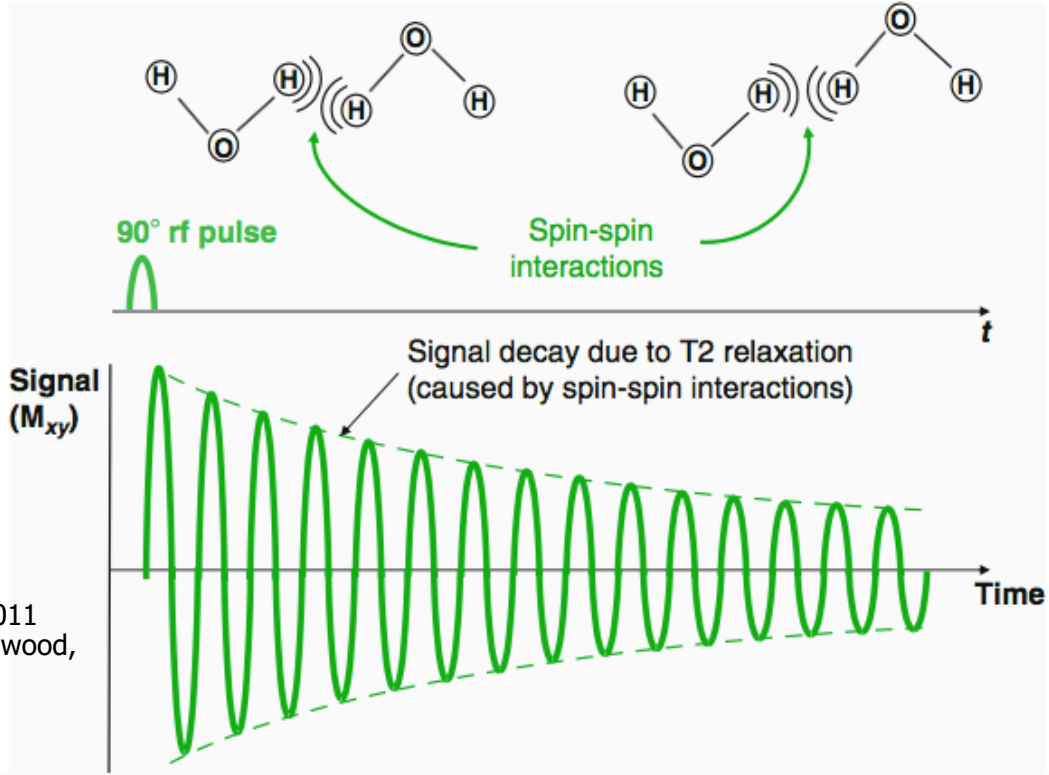
T2 Relaxation



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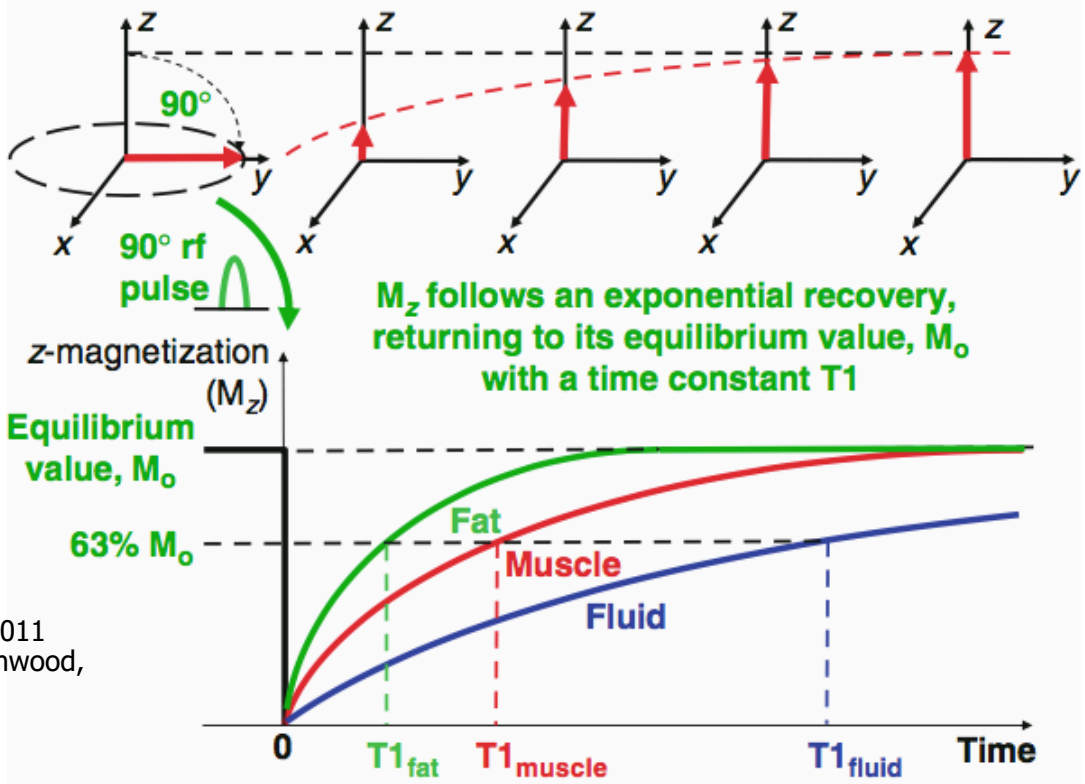
T1 Relaxation



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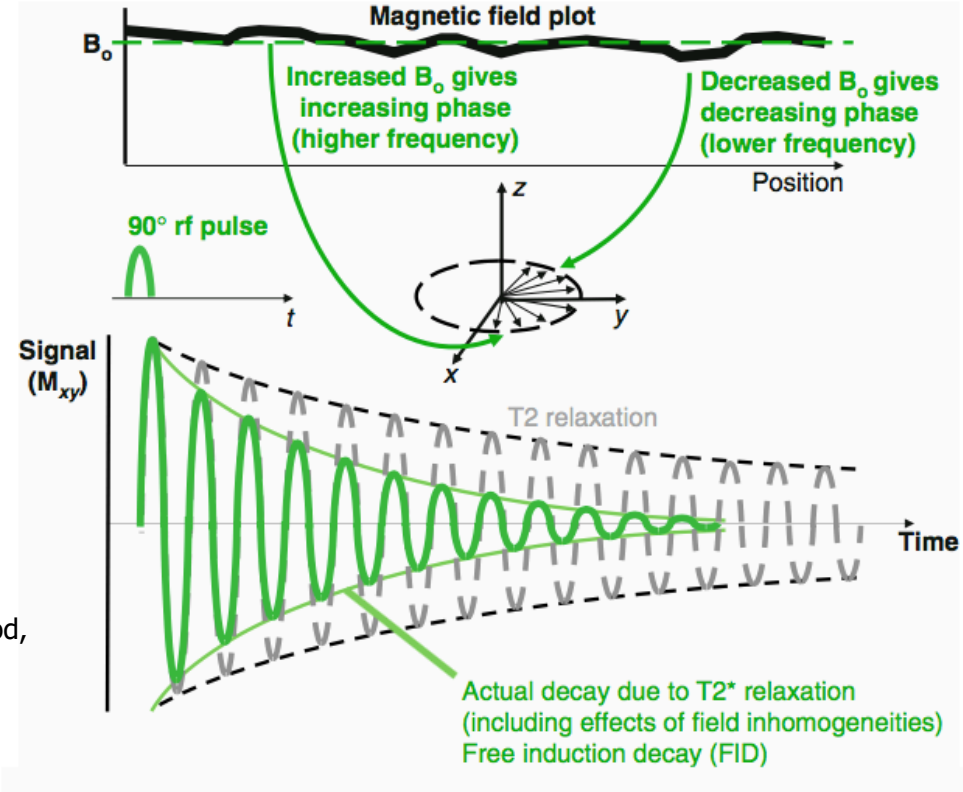
T2* Relaxation



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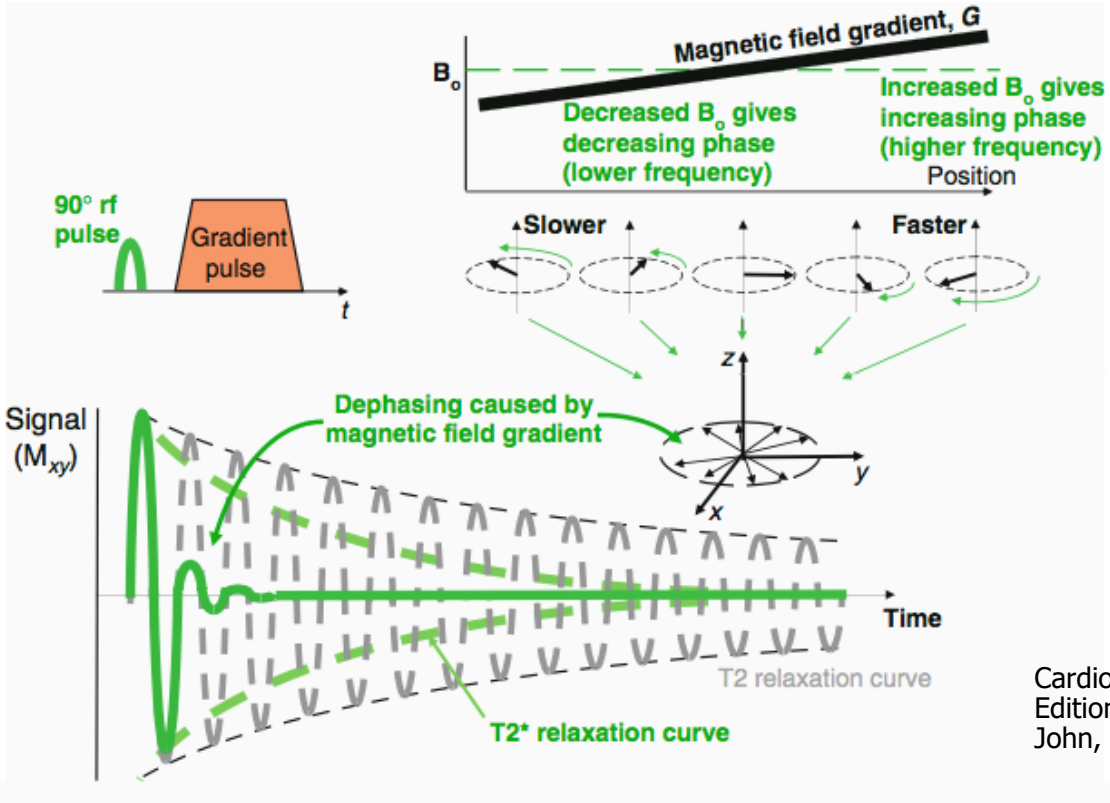
Gradients 1



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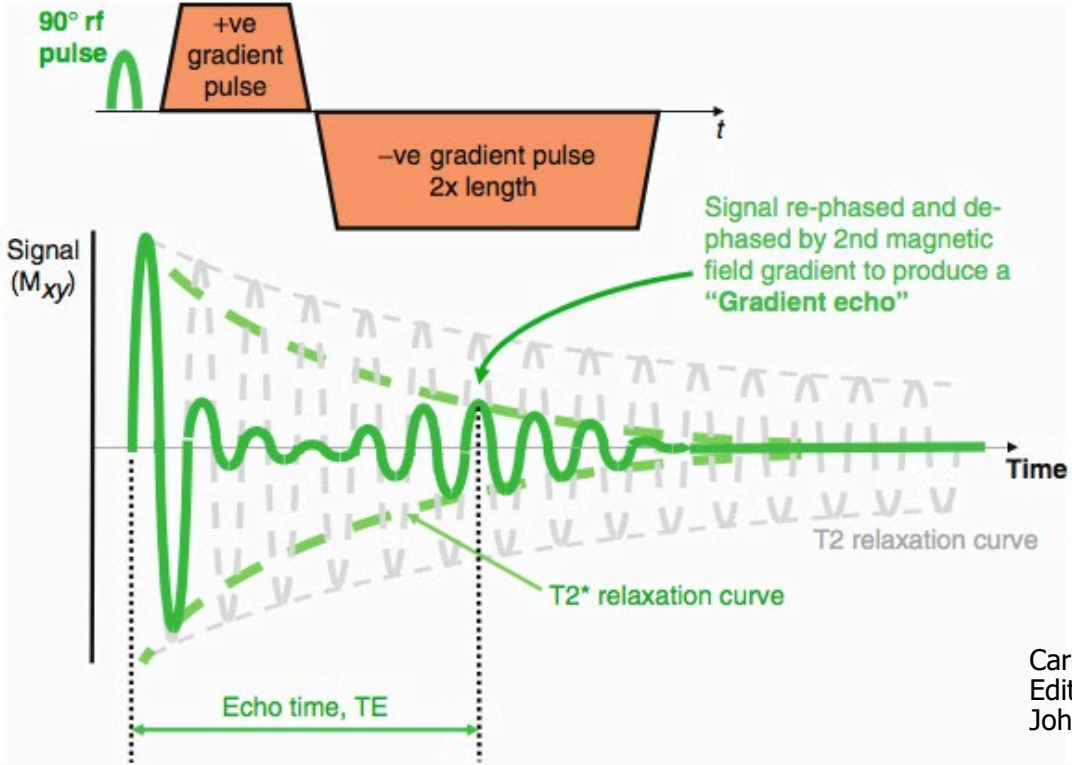
Gradients 2



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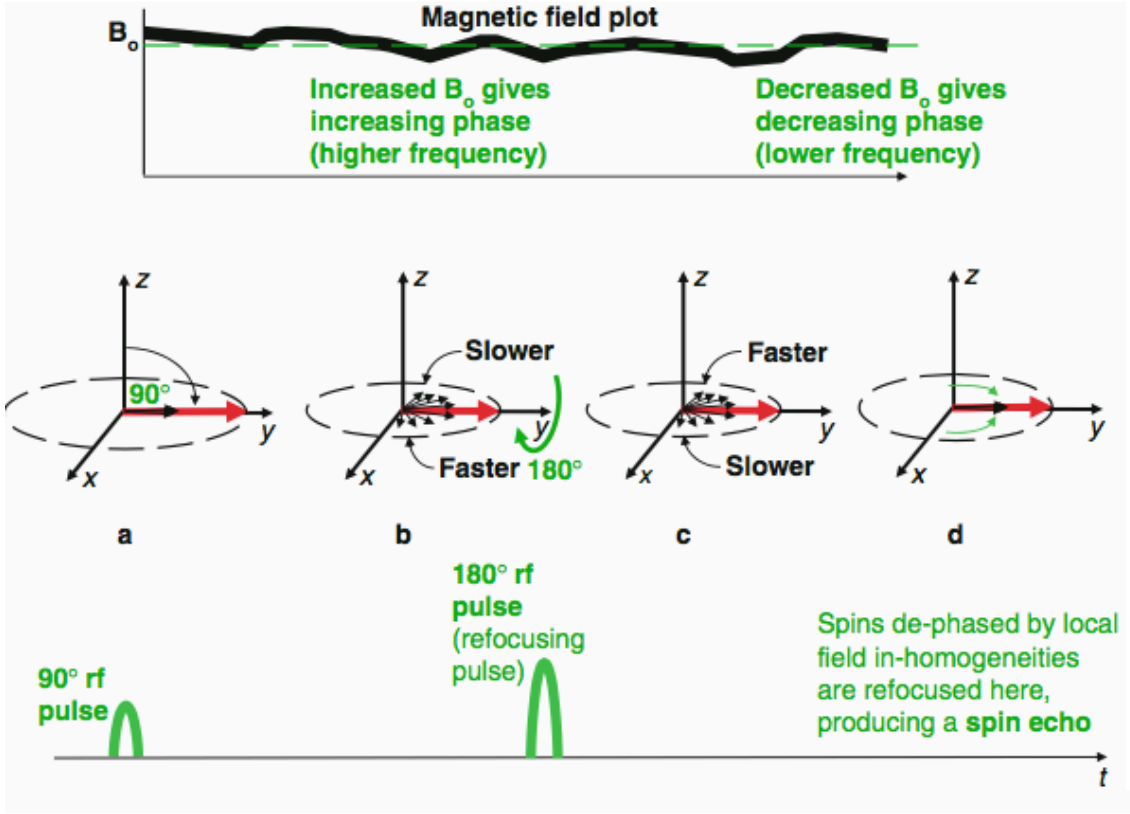
Spin Echo



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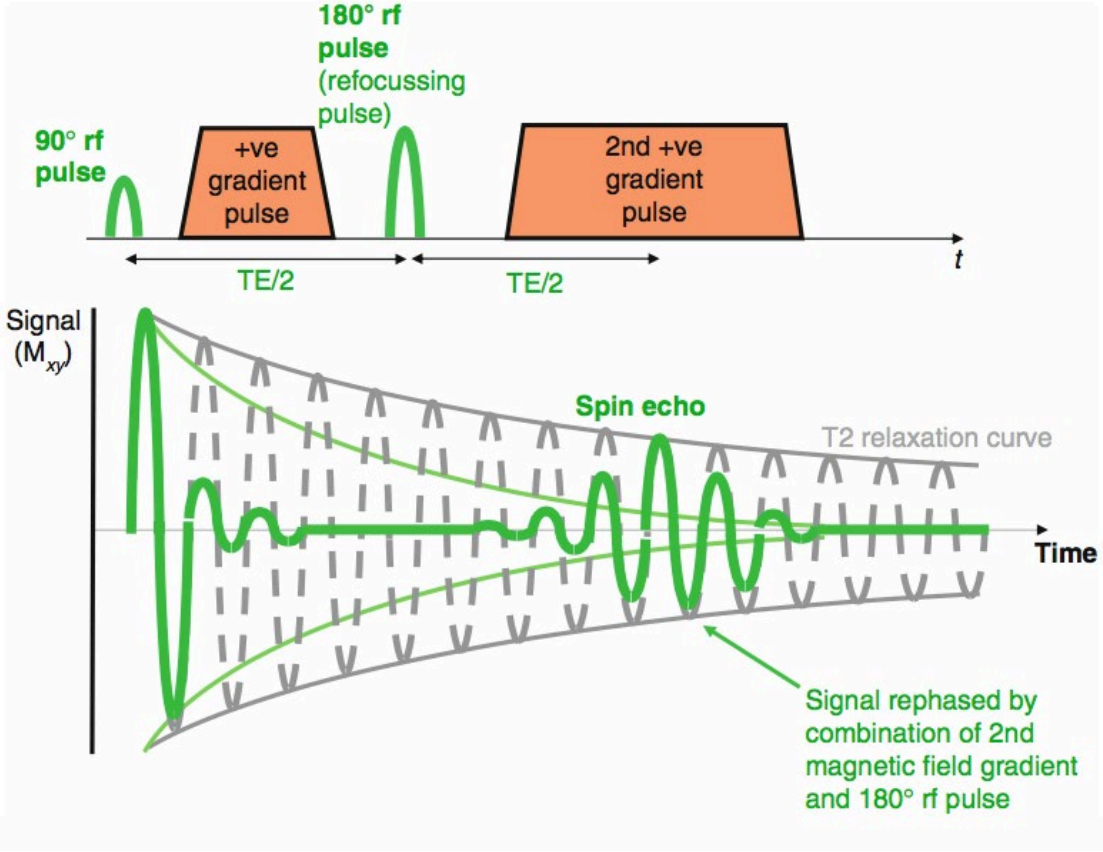
Spin Echo 2



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