Basics of MRI

Vinai Roopchansingh

Functional MRI Facility, National Institute of Mental Health, National Institutes of Health, DHHS

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Outline

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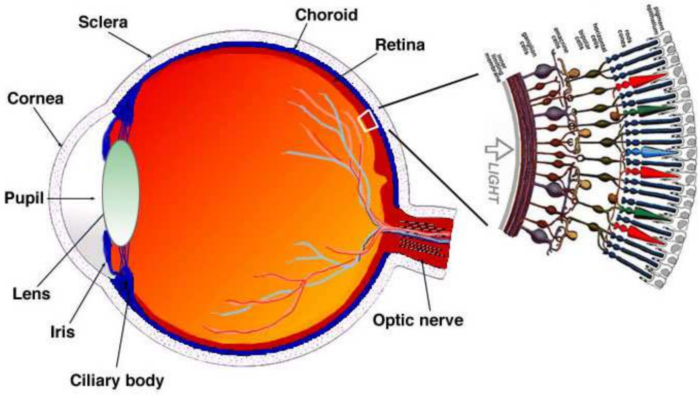

Fig. 1.1. A drawing of a section through the human eye with a schematic enlargement of the retina.

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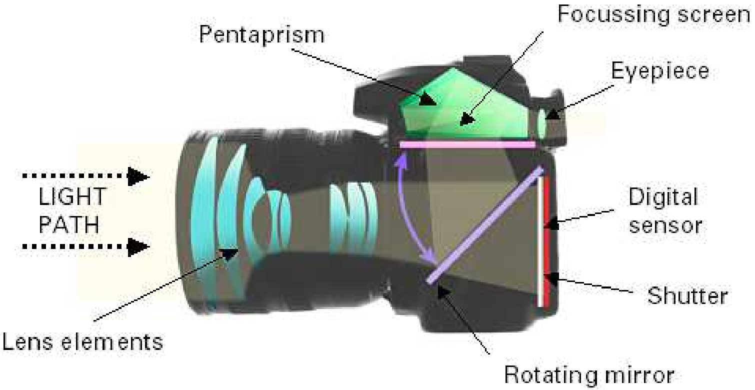

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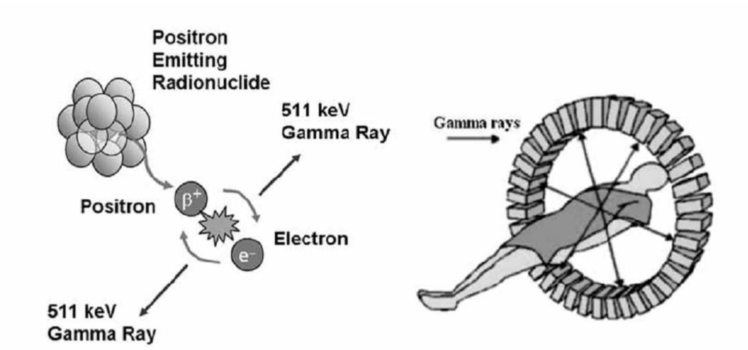
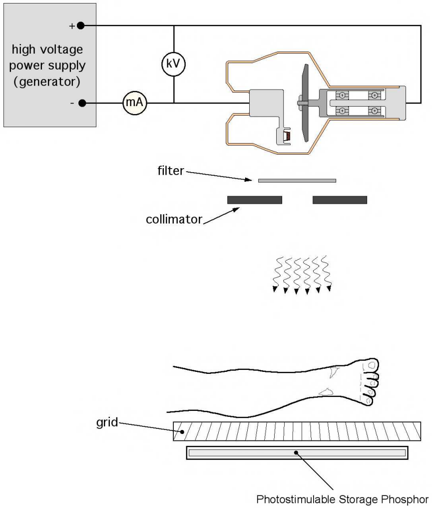
    - MRI: Emit radio waves ($\approx$ radar), then look at properties of "reflected" signals to produce images.

PET

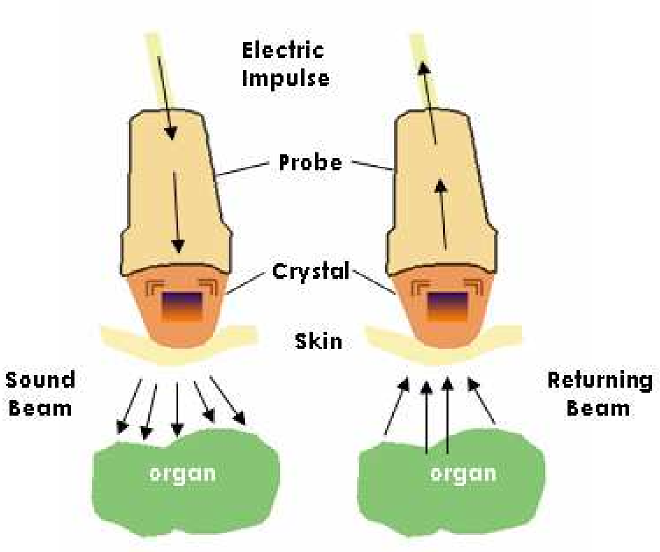

Positron
Emitting
Radionuclide
511 keV
Gamma Ray
Positron
β+
e-
Electron
511 keV
Gamma Ray
Gamma rays

X-Ray/CT



+
high voltage
power supply
(generator)
-
kV
mA
filter
collimator
grid
Photostimulable Storage Phosphor

Ultra-sound


Electric
Impulse
Probe
Crystal
Skin
Sound
Beam
Returning
Beam
organ
organ

MRI

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MRI

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- Measure characteristics of modified signal that comes back to derive images.
- Much richer and subtle encoding scheme: can enhance contrast between tissues (and even between oxygenated and deoxygenated hemoglobin - basis of BOLD MRI / FMRI).

MRI

MRI Scanners 33

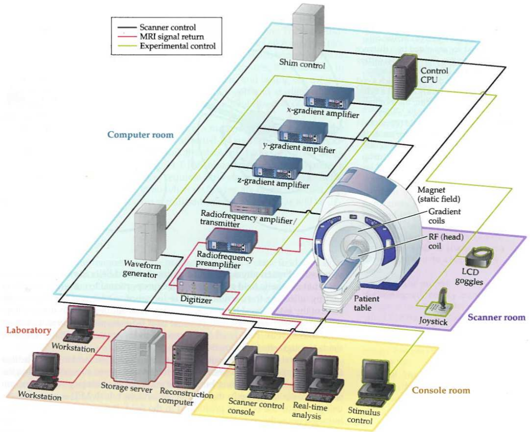
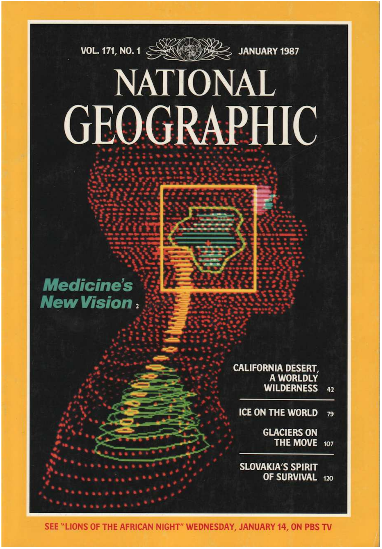


Figure 2.2 Schematic organization of the fMRI scanner and computer control systems. Two systems are important for fMRI studies. The first is the hardware used for image acquisition. In addition to the scanner itself, this hardware consists of a series of amplifiers and transmitters responsible for creating the gradients and pulse sequences (shown in black), and recorders of the MR signal from the head coil (shown in red). The second system is responsible for controlling the experiment in which the subject participates, and for recording behavioral and physiological data (shown in green).

MRI


VOL. 171, NO. 1
JANUARY 1987
NATIONAL GEOGRAPHIC
Medicine's New Vision 2
CALIFORNIA DESERT, A WORLDLY WILDERNESS 42
ICE ON THE WORLD 79
GLACIERS ON THE MOVE 107
SLOVAKIA'S SPIRIT OF SURVIVAL 120
SEE "LIONS OF THE AFRICAN NIGHT" WEDNESDAY, JANUARY 14, ON PBS TV

Outline

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- ^{1}H !

Resonance

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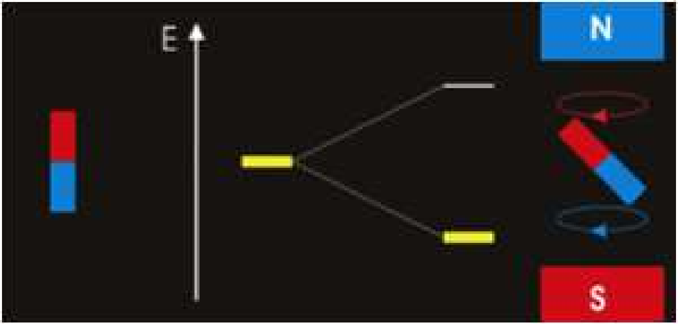
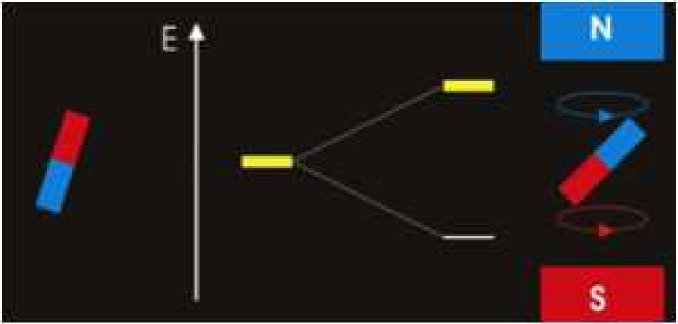
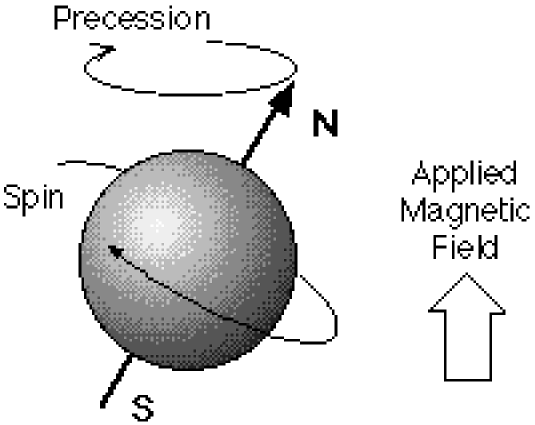


Resonance



Resonance



Planck and Larmor Equations

$$E = h\nu = hf_0$$

$$2\pi f_0 = \omega_0 = \gamma B_0$$

Resonance - resulting from precession

https://www.youtube.com/playlist?list=PLAE12114468910462

(Tyler Moore - Videos for MR Tutorial)

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- Precession

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(Tyler Moore - Videos for MR Tutorial)

- Precession
- Resonance and excitation

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Imaging Gradients

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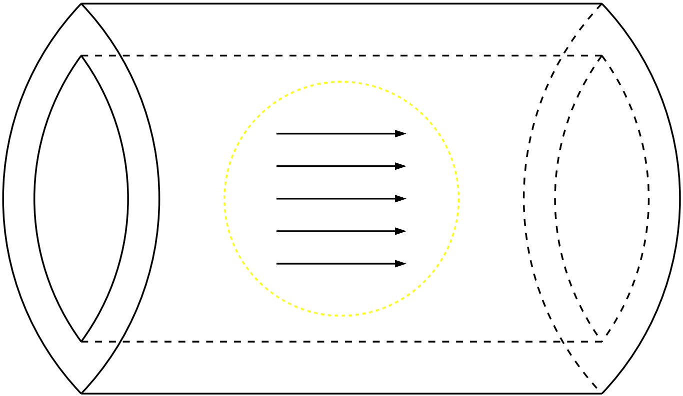

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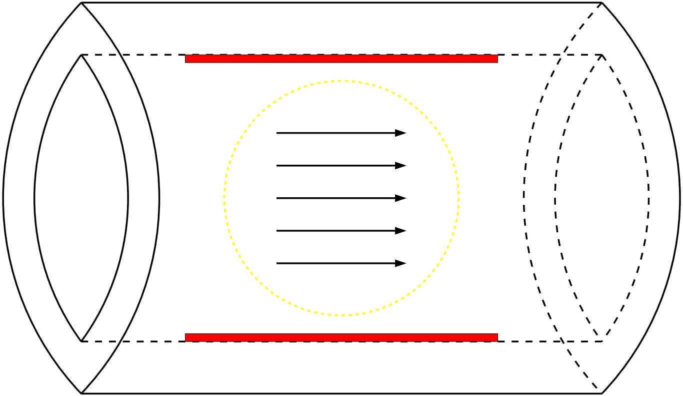

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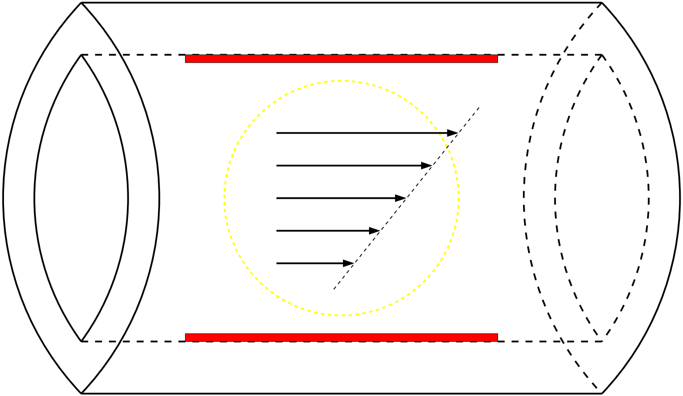
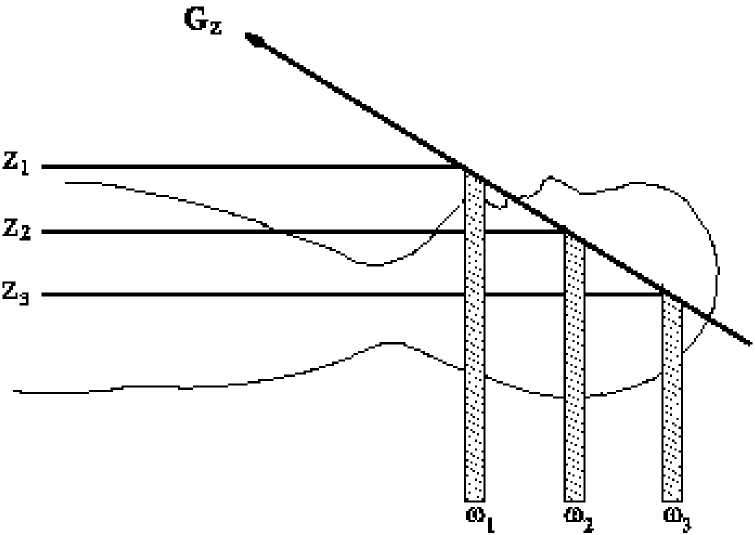


Slice Encoding/Selection



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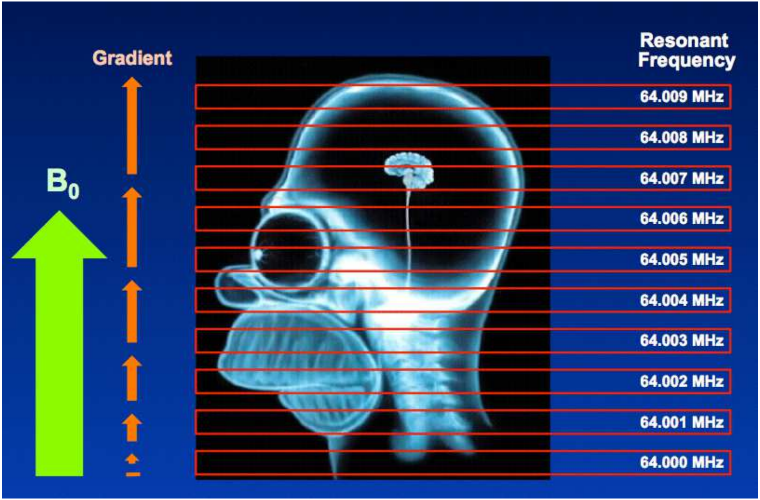

Frequency Encoding

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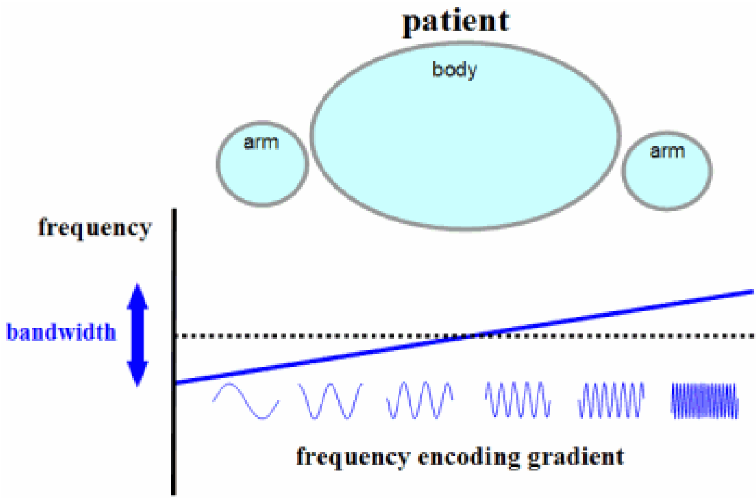
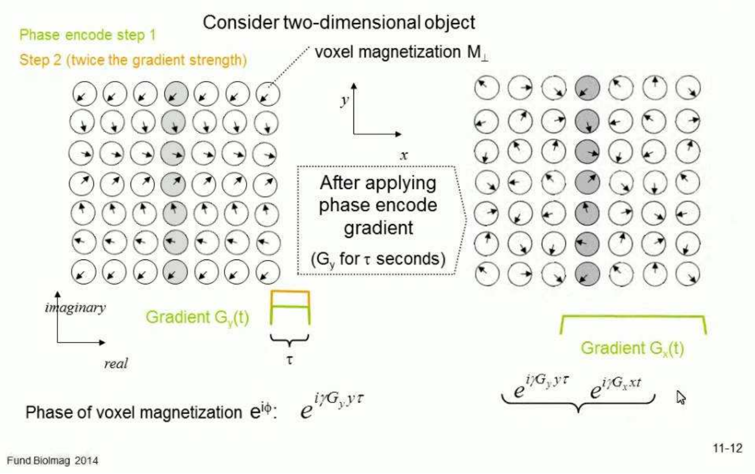


Phase Encoding

Phase Encoding



Creating image from signal

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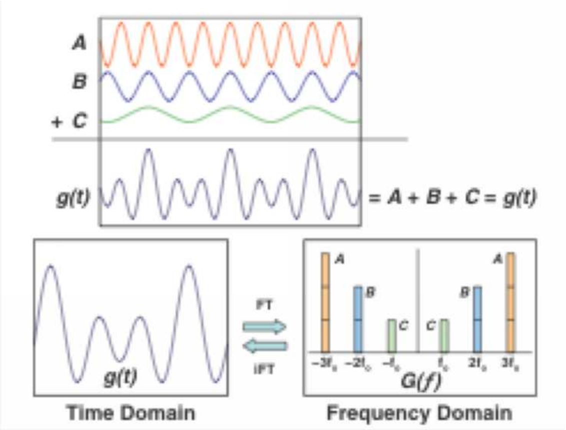

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- Nobel Prize in Physiology or Medicine in 2003 to Lauterbur and Mansfield.

Creating image from signal

Paper on Fourier Transform in MR: DOI:10.2214/AJR.07.2874

American Journal of Roentgenology, 2008, Vol 5, 1396-1405

Relaxation times

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- Longitudinal (a.k.a T_1) relaxation
- Transverse (a.k.a T_2) relaxation

Basic tissue contrast

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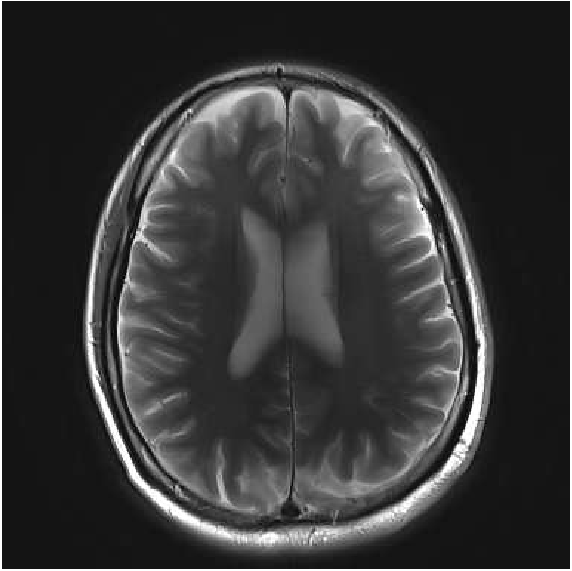

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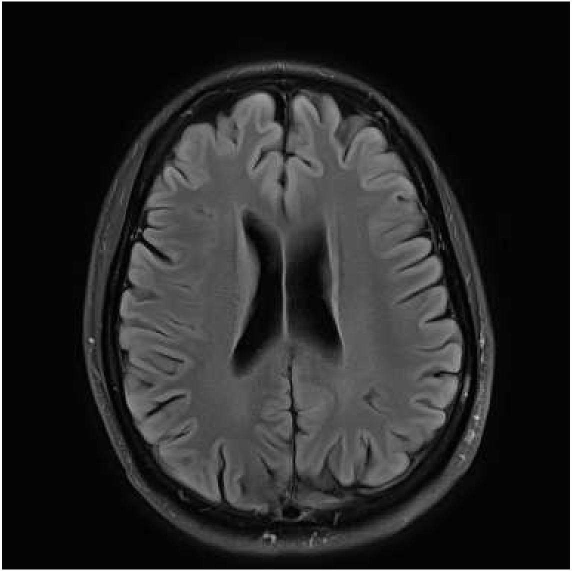

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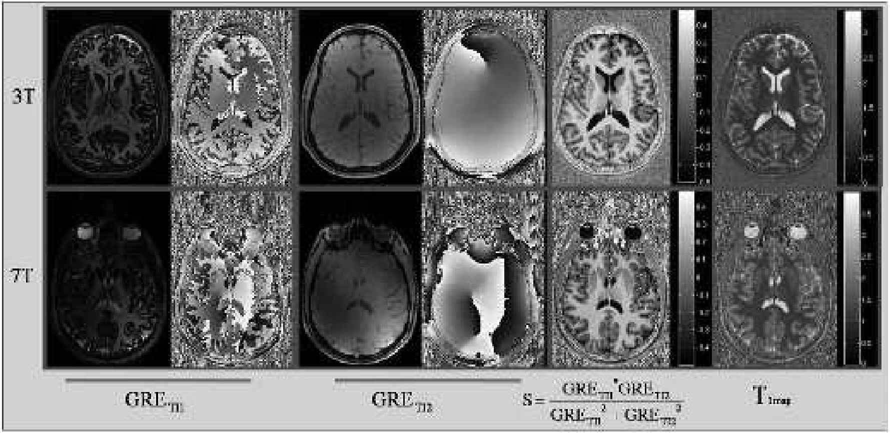
MP2-RAGE: NeuroImage:49 (2010), 1271 - 1281

Basic tissue contrast



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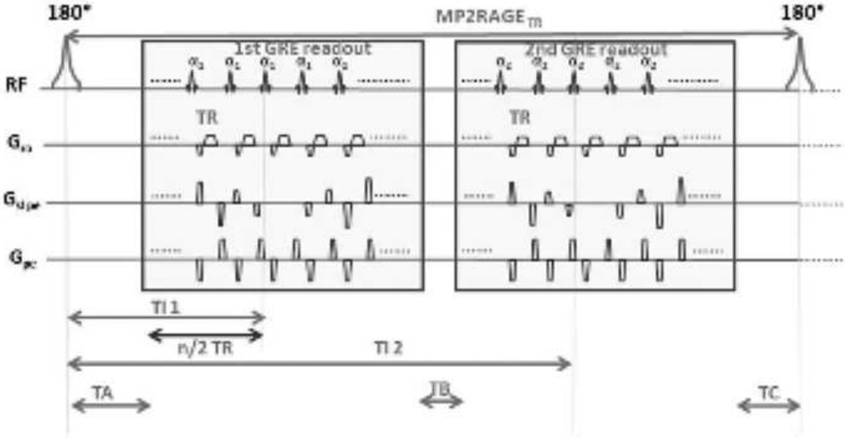

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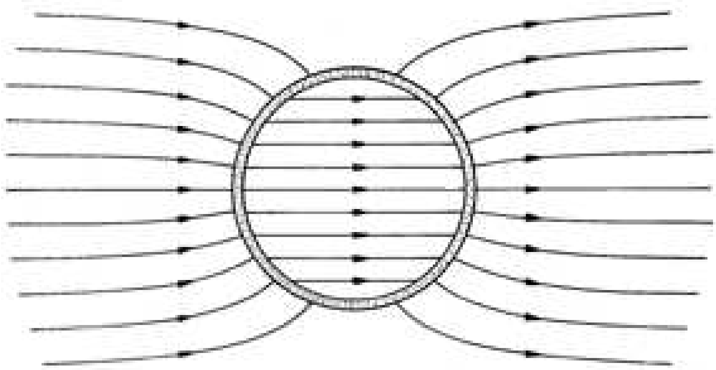

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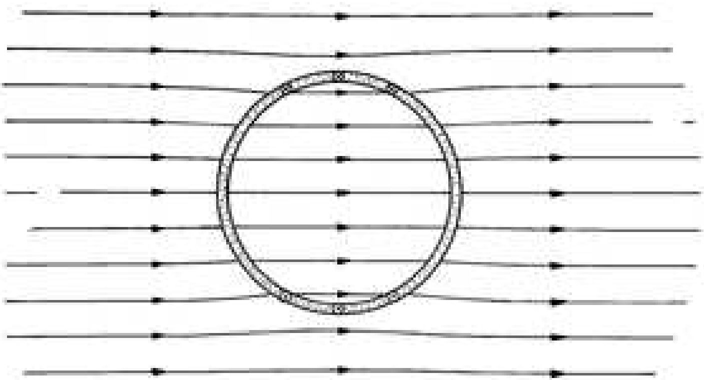

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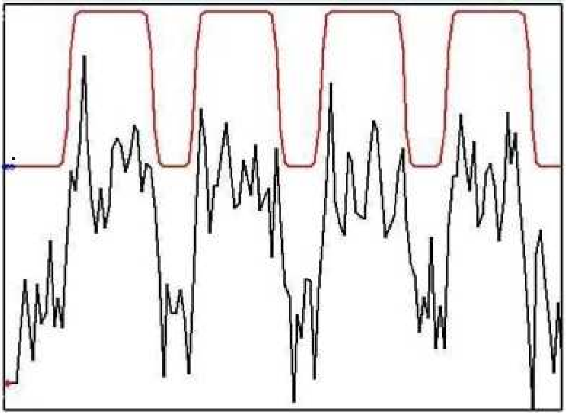

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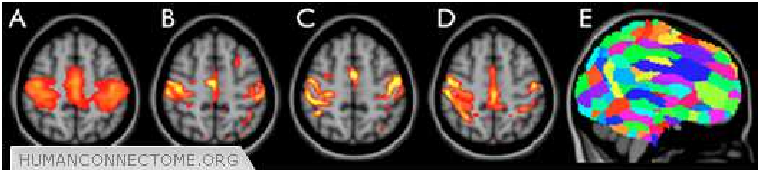

Diffusion contrast

Nature Reviews Neuroscience 4, 469-480 (June 2003) —
DOI:10.1038/nrn1119

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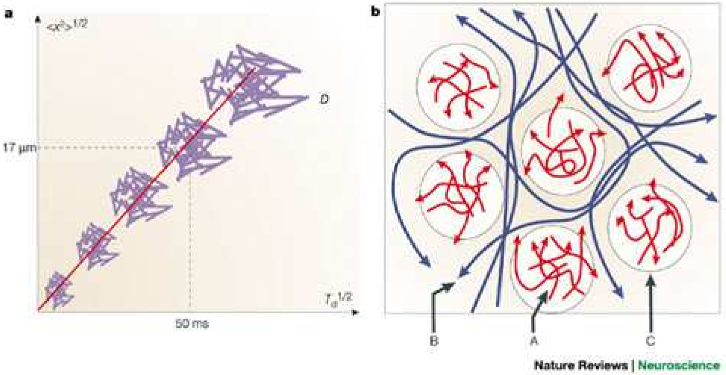

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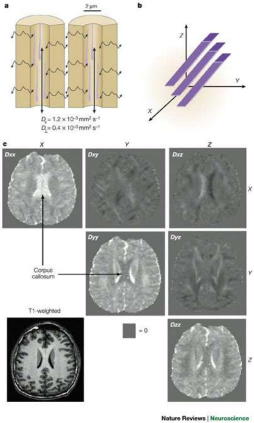

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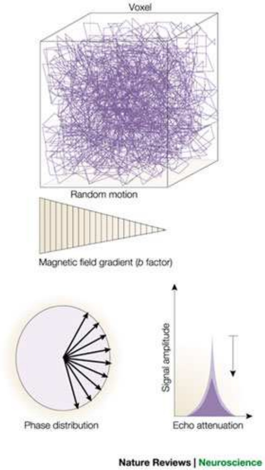

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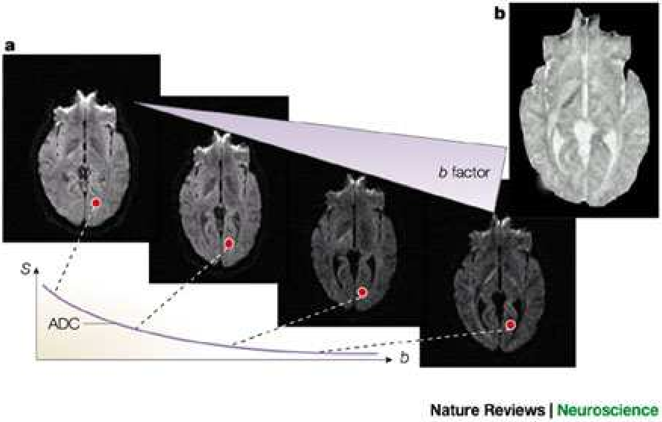

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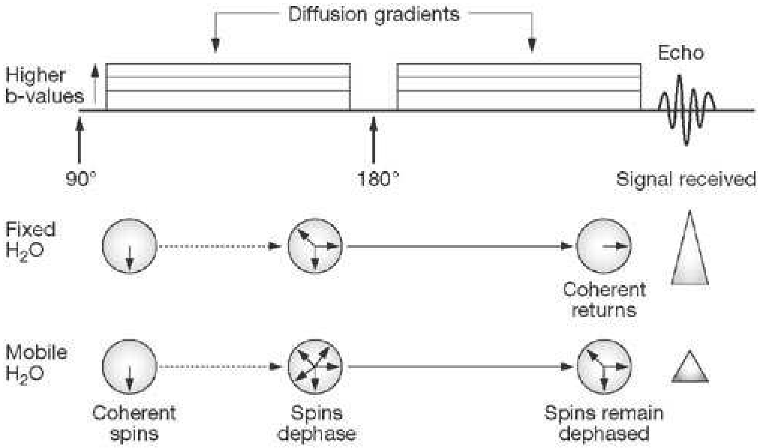

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- NMR Center Safety class:
  http://intranet.nmrf.nih.gov/safety_training.htm