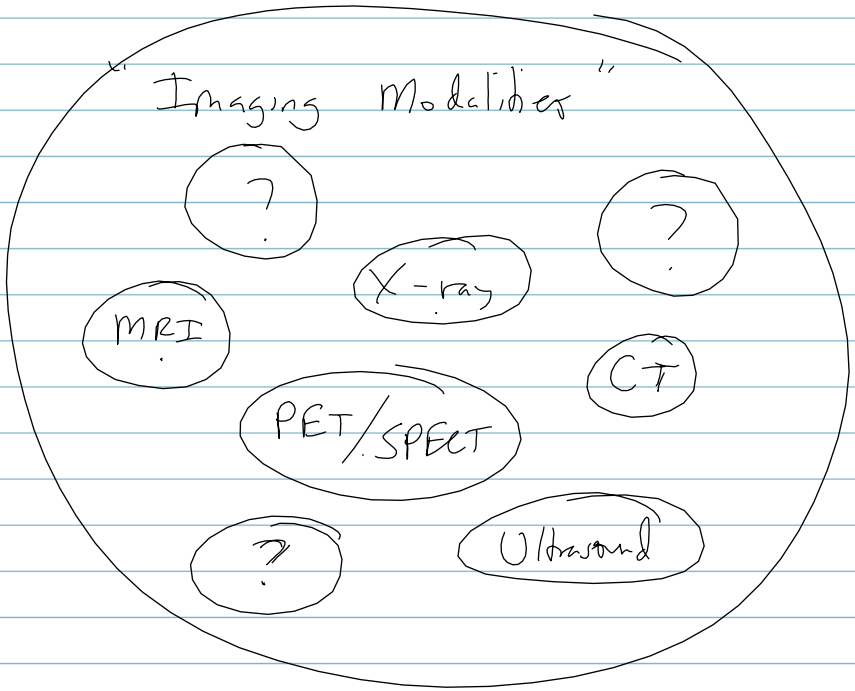
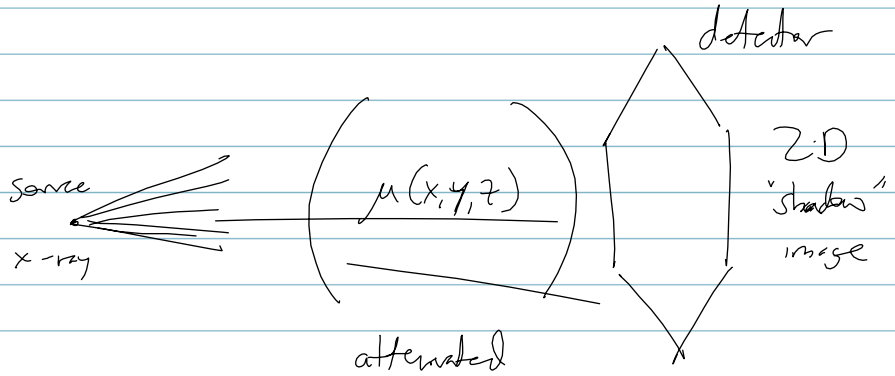
MRI = Magnetic Resonance Imaging



- what is being measured?
- how is it being measured?

practical factors?

⊛ projection radiography (X-ray)



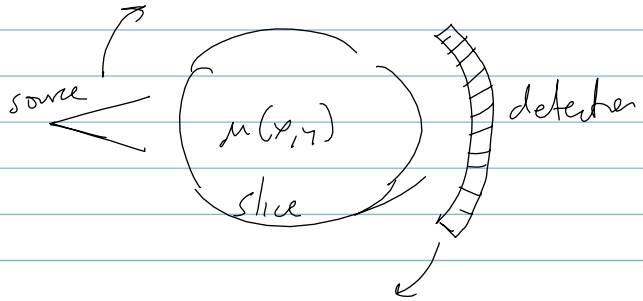
μ = X ray attenuation coefficient

↳ f (atomic #, electron density, ...)

$I_d = I_0 e^{-\int \mu \, dl}$

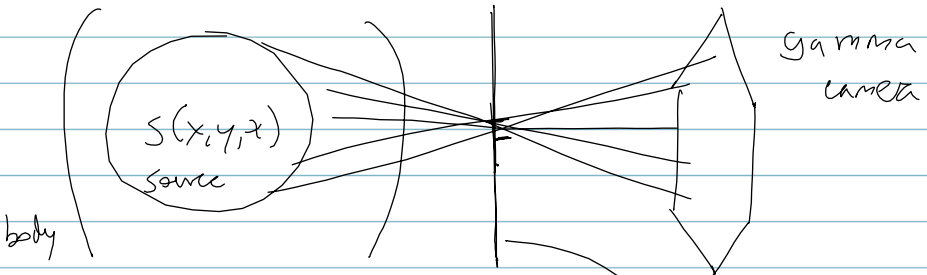
↖ line integral

⊛ computed tomography (CT)



collect 1D projections at all angles
can then reconstruct $\mu(x,y)$ → Central Section Theorem
→ Backprojection

⊛ Nuclear Medicine (SPECT/PET)



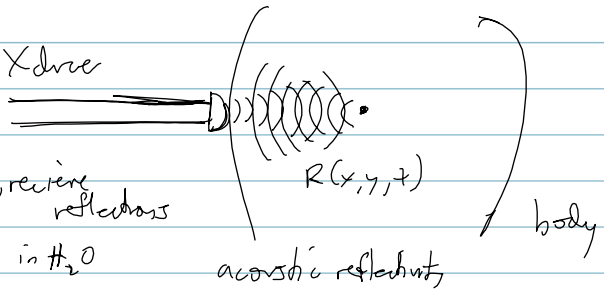
uptake of radiolabelled material (loc based on biochemistry)

collimator or pinhole camera

images of function not anatomy

First three involve ionizing radiation

⊛ Ultrasound



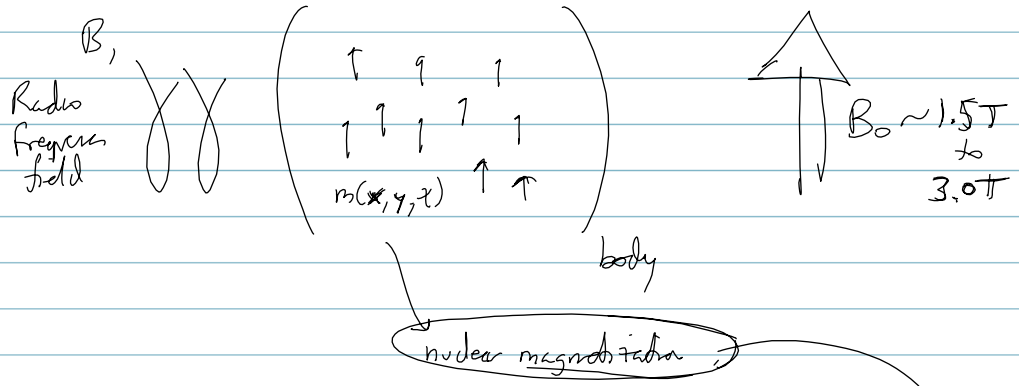
propagate pulse, receive reflections

velocity 1500 m/s in H_2O

∴ echo time maps to depth

↑ frequencies ⟹ ↑ resolution
⟹ ↑ attenuation ~ (1 db/cm)/MHz

⊛ Magnetic Resonance (MR)



nuclear magnetization

B_0 : polarizes the sample, creates a resonance condition
^1H = Hydrogen → tiny magnetic dipole

B_1 : "excite" sample
↳ nuclei produce RF time signal

$\vec{G}$: spatial localization, encode signals

- density of ^1H
- several tissue properties that influence behavior
- flow
- etc...

Comparisons

TOXICITY

(C)(X) ionizing radiation (U) appears safe

(M) appears safe — B_0 metal, potential projectile, vertigo
— $\vec{G}$ time varying fields — induce currents
$\frac{dB}{dT} > 10T/s$ - light flickering
even higher - peripheral nerve stim
even higher - cardiac stim
— B_1 RF heating

APPLICABILITY

(X)(C) everywhere (no physical constraints)

(U) soft tissue / fluid path

(M) everywhere ~~best~~ in stationary regions b/c long scan time
not great for solids

DISTORTION

(X)(C) no significant distortion, CT diff near bone/air interfaces

(U) refraction, variation in c → affects depth estimate
diffraction λ = resolution → lateral distortion

(M) RF penetration effects → intensity variations
nonlinearities in $\vec{G}$ fields → geometric distortion

Physical Parameter

(X)(C) μ – linear x-ray attenuation coefficient

(U) R – acoustic reflectivity

(M) ρ – density of ^1H

T_1, T_2 – tissue parameters

⋮ to be continued