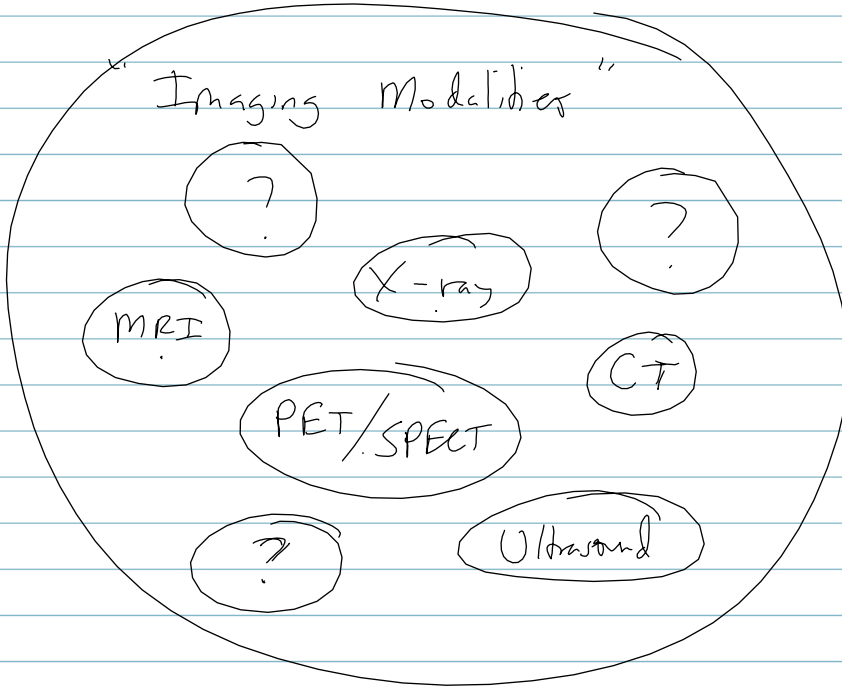
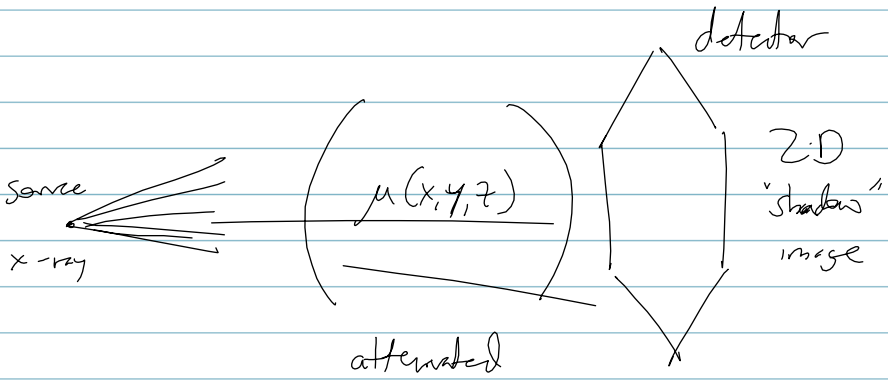


MRI = Magnetic Resonance Imaging



{ What is being measured?
how is it being measured?
practical factors?

* projection radiography (X-ray)



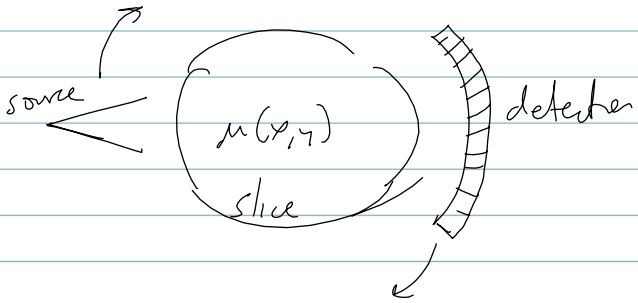
μ = X-ray attenuation coefficient

↳ f (atomic #, electron density; ...)

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

↖ line integral

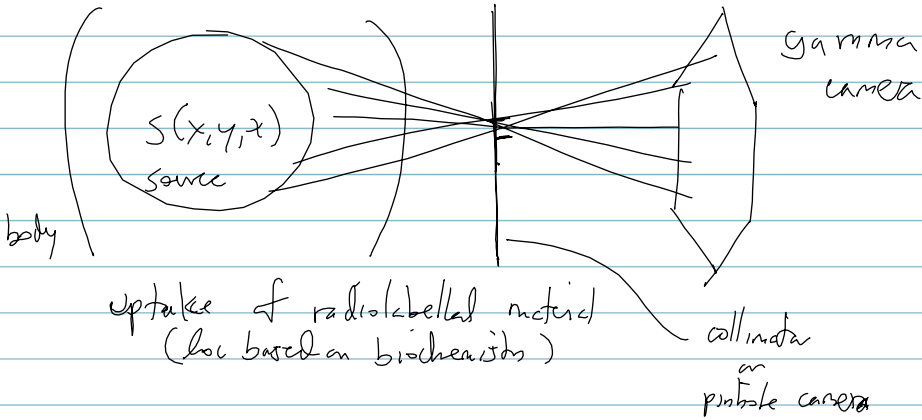
* Computed tomography (CT)



collect 1D projections at all angles
can they reconstruct $\mu(x, y)$

Central Slicing
Theorem
Back projection

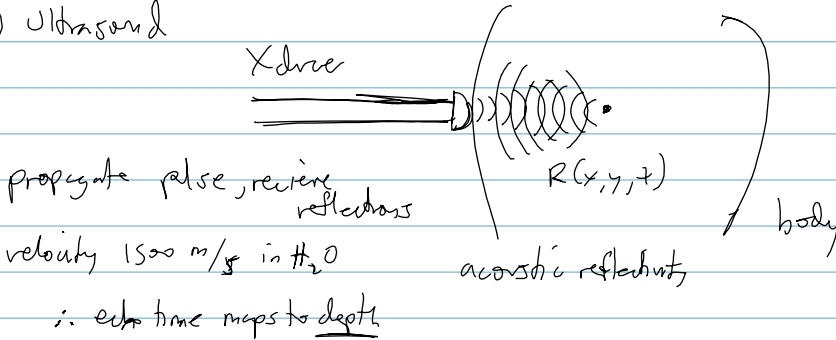
* Nuclear Medicine (SPECT/PET)



images of function not anatomy

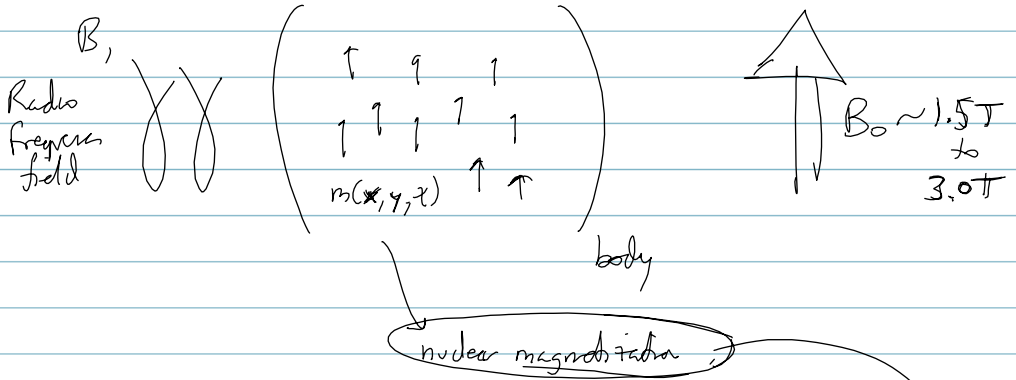
First three involve ionizing radiation

* Ultrasound



↑ frequencies \Rightarrow ↑ resolution
 \Rightarrow ↑ attenuation $\sim (1 \text{ db/cm}) / \text{MHz}$

* Magnetic Resonance (MR)



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

B_1 : "excite" sample
 \rightarrow 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

- B₀ metal, potential projectile, venting
- \vec{A} time varying fields — induce currents
 - $\frac{\partial B}{\partial t} > 10 T/s$ — light flickering
 - even higher — peripheral nerve stimulation
 - even higher — cardiac stimulation
- B₁ 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 total attenuation

(U) refraction, variations in c → affects depth estimate
diffraction $\lambda = \text{resolution}$ → lateral distortion

(M) RF penetration effects → intensity reaching
non-linearities in \vec{A} fields → geometric distortions

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

\vdots to be continued
 \vdots
