Physics 123 - May 1, 2013

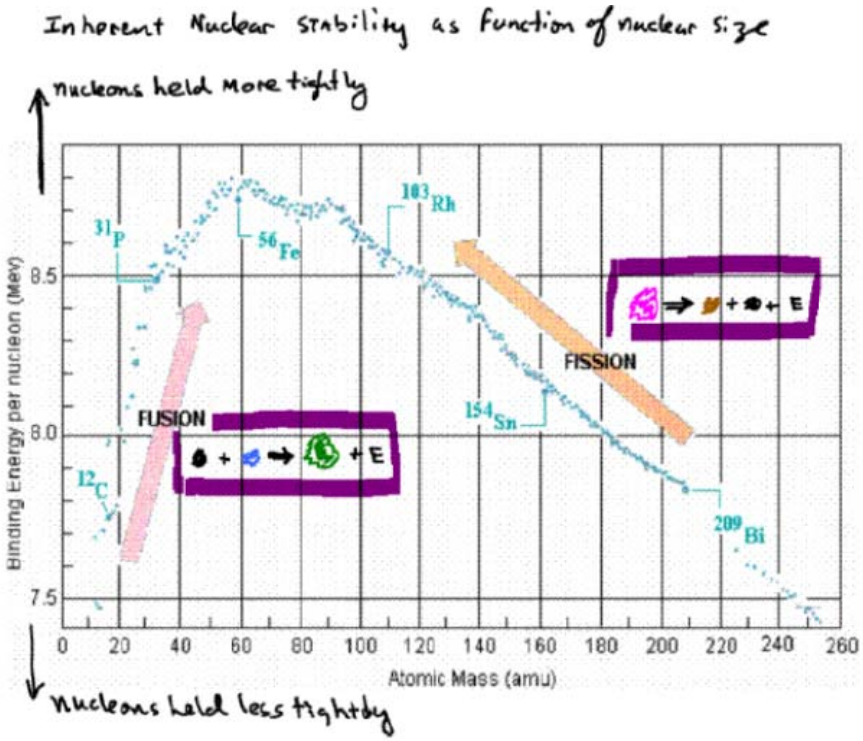
- Final Exam Tuesday - 0830 → Lower Strong
- Q+A session B+L 109 4-6 pm

Both sides 8.5 x 11 sheet formulas + Note

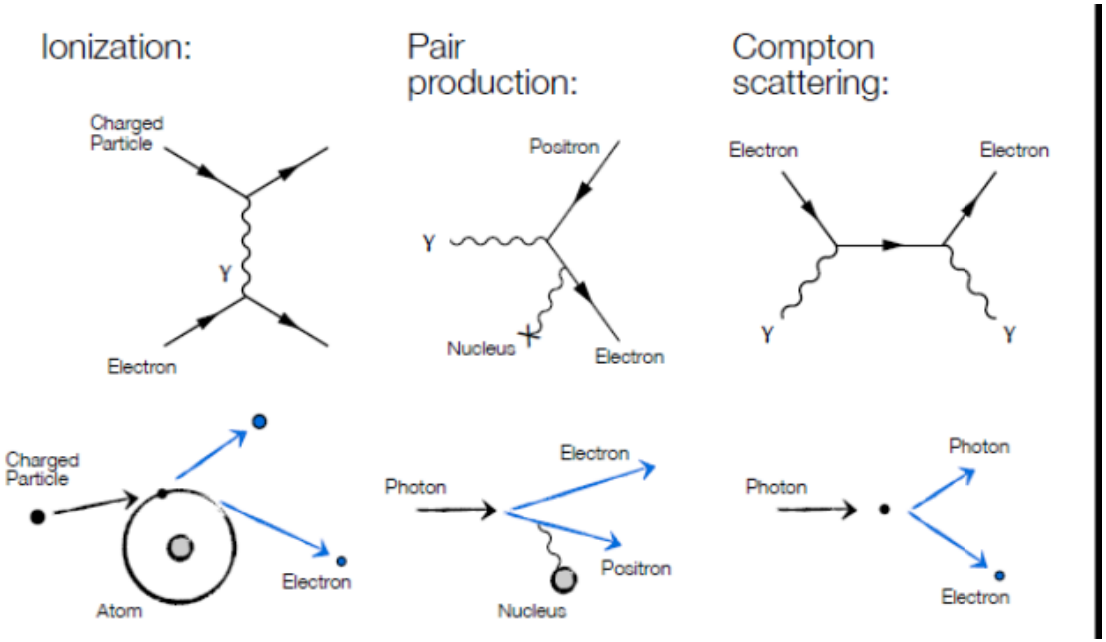
Calculator

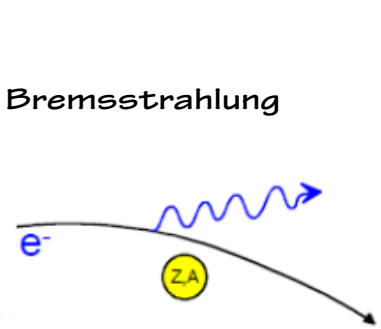
The driving relation
in nuclear physics ⇝

Power
Weapons
Stars
Element synthesis



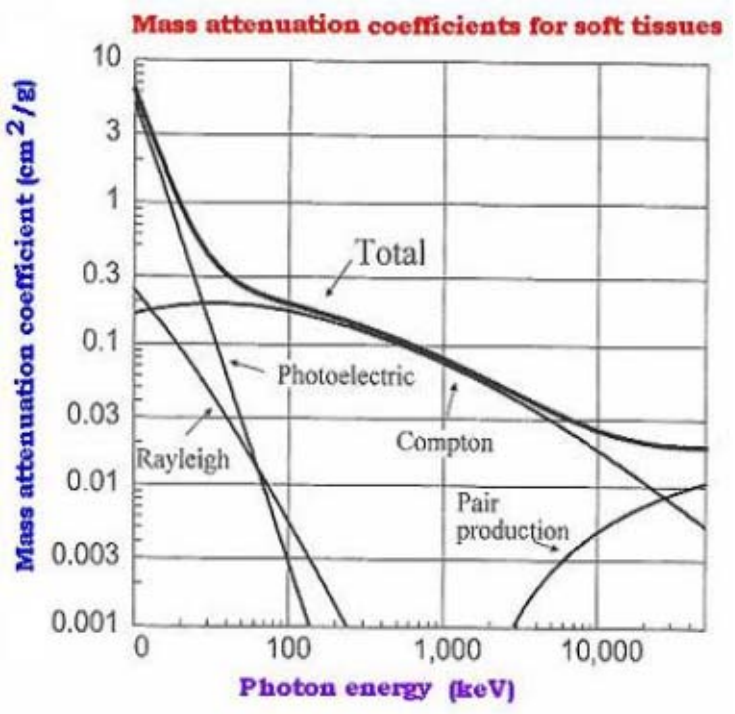
Interaction of radiation with matter





Nice figure from http://www.kip.uni-heidelberg.de/~coulon/Lectures/Detectors/Free_PDFs/Lecture2.pdf

How photons interact with matter depends on E_γ



Range and energy loss of charged particles in matter as a function of momentum

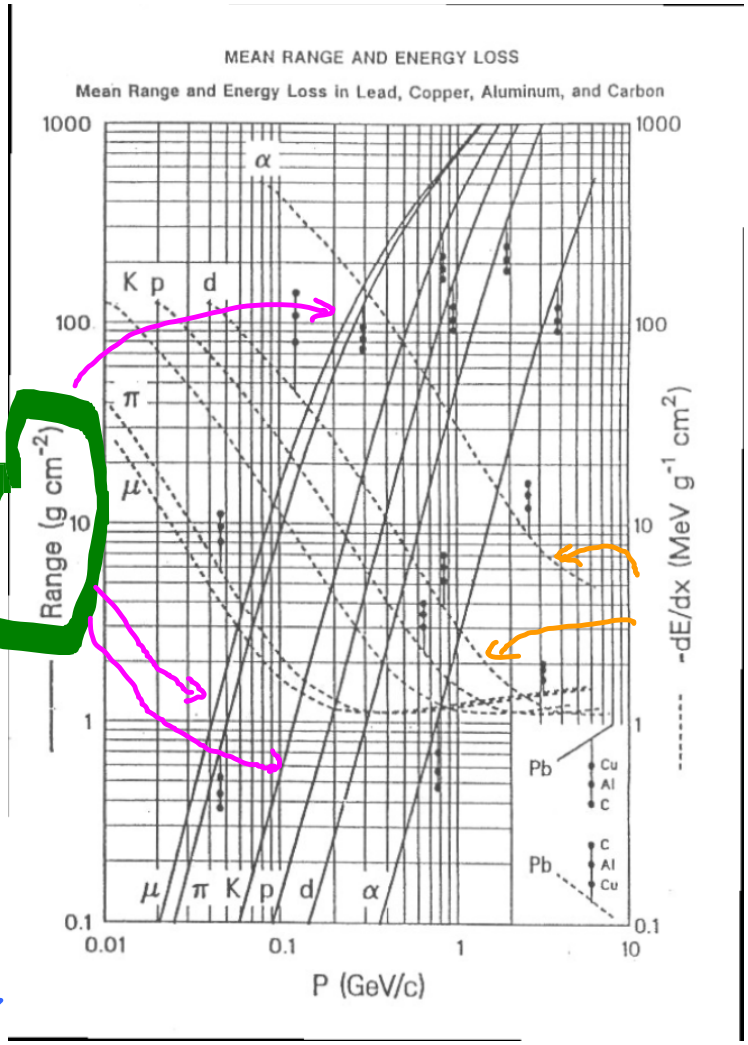
$\frac{dE}{dx}$ (ionization Energy loss)

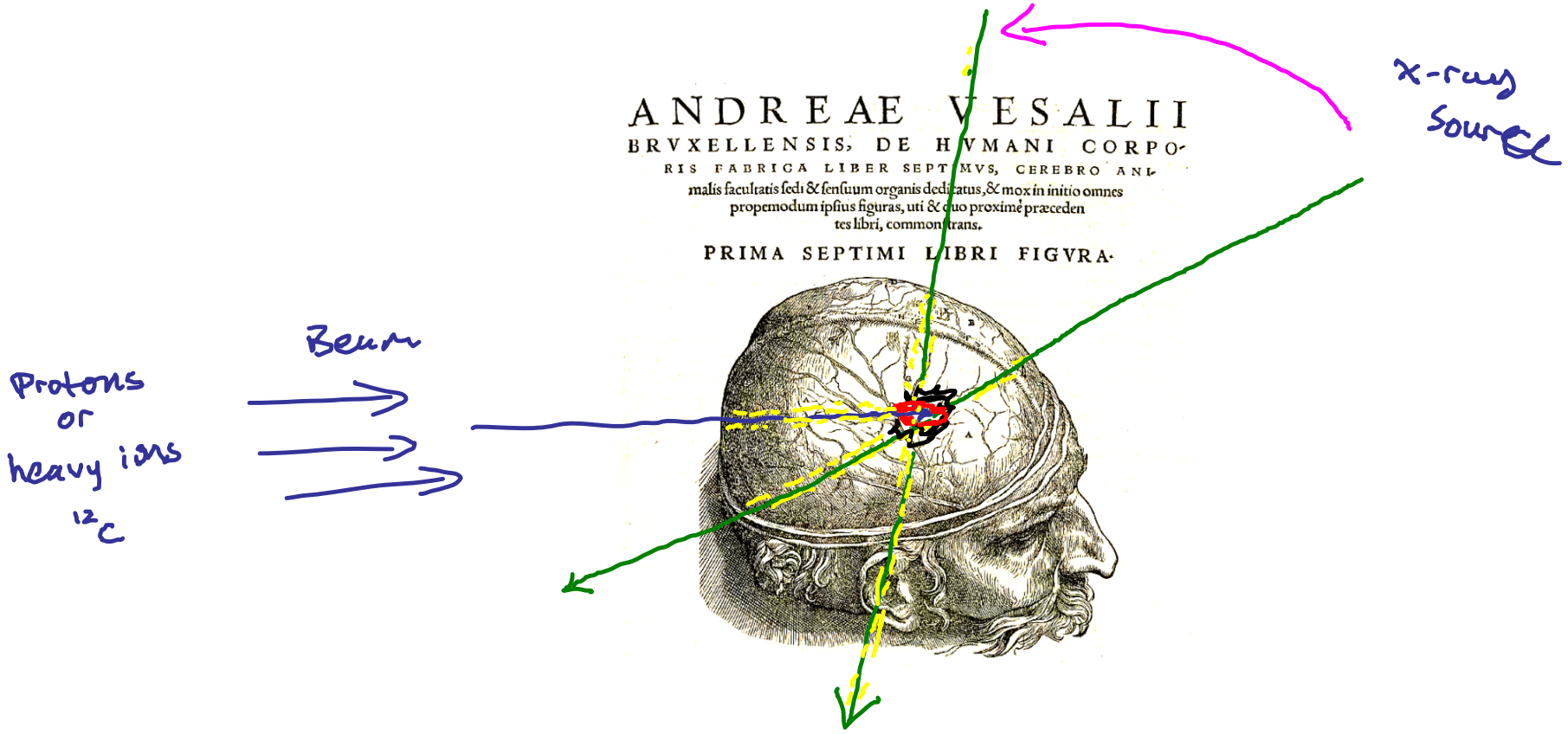
"dE-dx"

Minimum ionizing particle "Min-I"

Range in $\frac{g}{cm^2} \times \frac{1}{g/cm^3} = cm$

- note rise in dE/dx as $p \rightarrow$ small
- note mass and charge dependence
- note given particle + $p \rightarrow$ ~fixed range




ANDREAE VESALII
BRVXELLENSIS, DE HVMANI CORPO-
RIS FABRICA LIBER SEPTIMVS, CEREBRO ANI-
malis facultatis sedi & sensuum organis dedicatus, & mox in initio omnes
propemodum ipsius figuras, uti & quo proximè præceden
tes libri, commonstrans.
PRIMA SEPTIMI LIBRI FIGVRA.
Beam
Protons
or
heavy ions
^{12}C
x-ray
source

Just How dangerous is that source of radioactivity ??

- Activity (dose)
- Distance + Proximity to vital organs
- Chemical activity
- Type of source

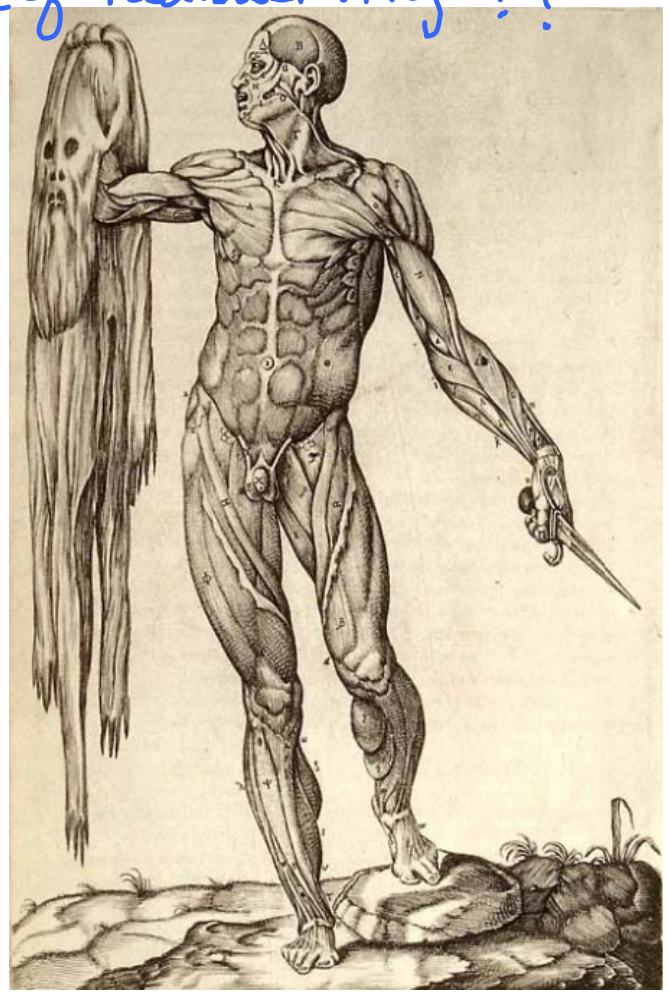
For equal activities

outside body

$\gamma >> e > \alpha$

inside body

$\gamma < e < \alpha$



DISTANCE

Time (reduce activity t/or exposure

Shielding

Plan

Activity — 1 Curie 3.7×10^{10} decays/sec

Absorbed Dose — 1 rad – Amt of radiation that deposits energy/mass of 1×10^{-2} J/kg in Material

REM
(Rad Equivalent Man)

$$\text{dose in REM} = \text{dose (in Rad)} \times \text{quality factor}$$

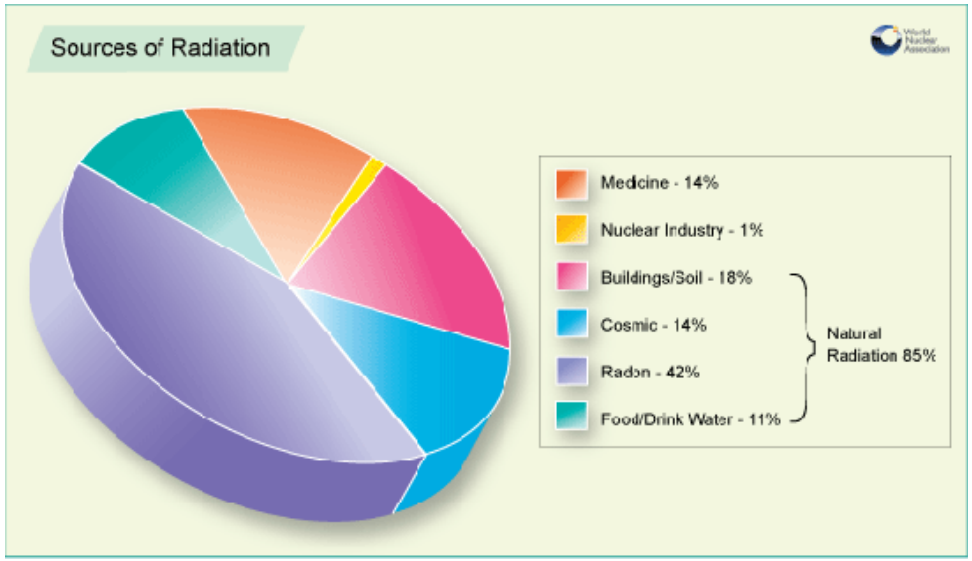
1 for γ
~20 for α

Steady + small over time — Blast

Chronic versus Acute dose important too!

$$\text{dose in Sievert (Sv)} = \text{dose in Gy} \times \text{qual. factor}$$

100 rad



Chest X-ray	0.1 mSv
Average background exposure in one year	3 mSv
Abdominal X-ray	4 mSv
Living on the Colorado Plateau for one year	4.5 mSv
Typical yearly dose for a uranium miner	5-10 mSv
Full-body CT scan	10 mSv
Lowest dose for any statistical risk of cancer	50 mSv
Mild radiation sickness (headache, risk of infection)	0.5-1 Sv
Light radiation poisoning (mild to moderate nausea, fatigue, 10% risk of death after 30 days)	1-2 Sv
Severe radiation poisoning (vomiting, hair loss, permanent sterility, 35% risk of death after 30 days)	2-3 Sv
Severe radiation poisoning (bleeding in mouth and under skin, 50% risk of death after 30 days)	3-4 Sv
Acute radiation poisoning (60% fatality risk after 30 days)	4-6 Sv
Acute radiation poisoning (bone marrow destroyed, nearly 100% fatality after 14 days)	6-10 Sv
Acute radiation poisoning (symptoms appear within 30 minutes, massive diarrhea, internal bleeding, delirium, coma)	10-50 Sv
Coma in seconds or minutes, death within hours	50-80 Sv
Instant death*	>80 Sv

Ave Background Exposure

130 mR/yr Ave

.13 R ~ mSv

End of Material for final exam