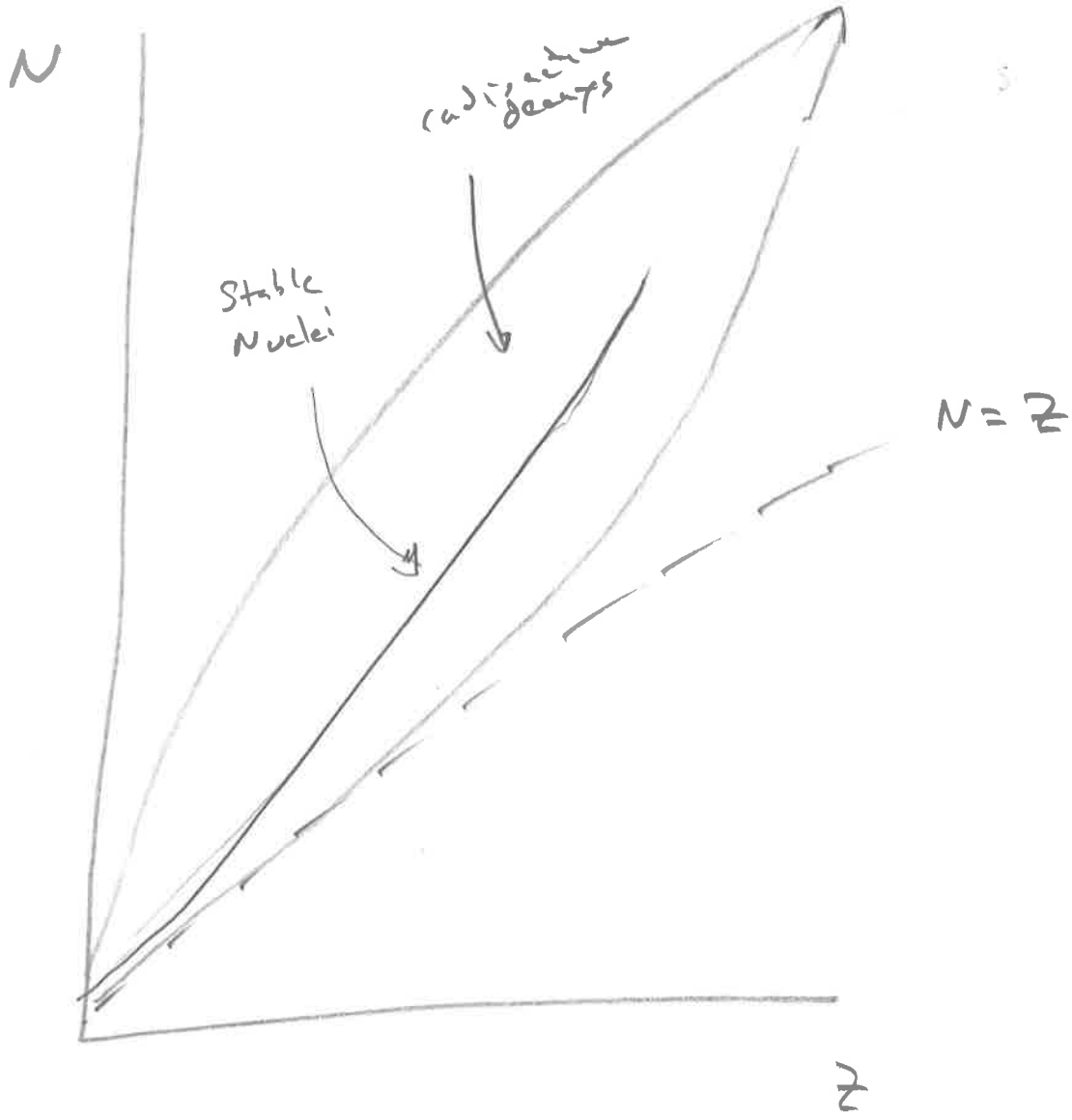
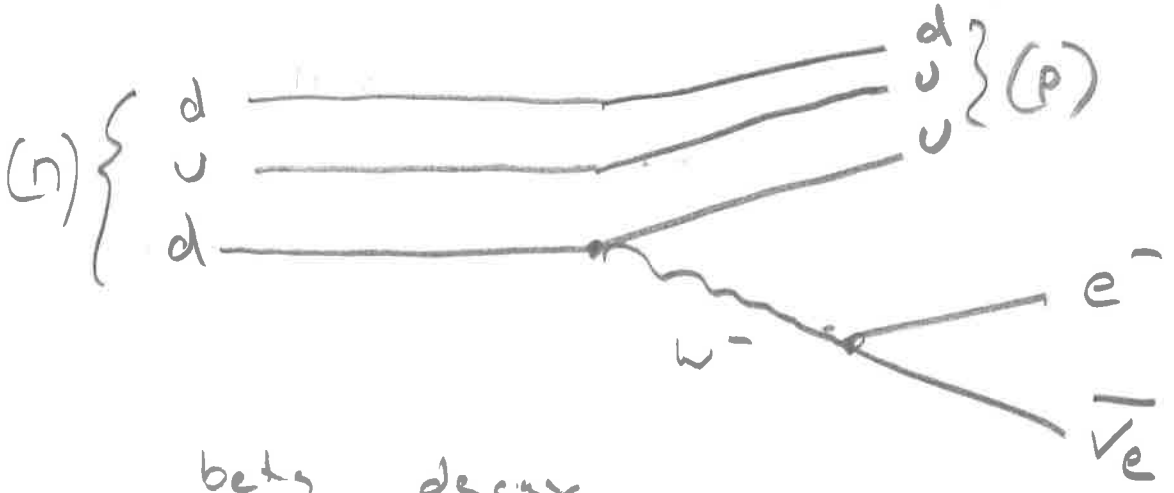
Radioactive Decay



After Hydrogen, need a mix of p/n to reach stable nuclei...

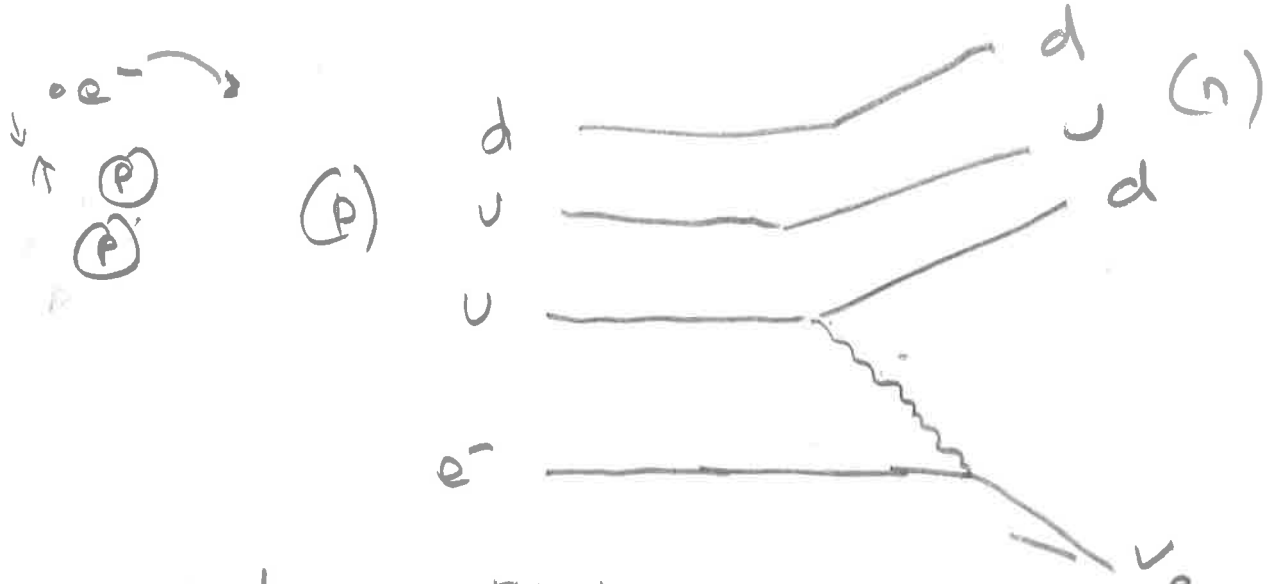
→ n are unstable (outside of nuclei)



beta decay...

Too many neutrons, beta decay (B^-)

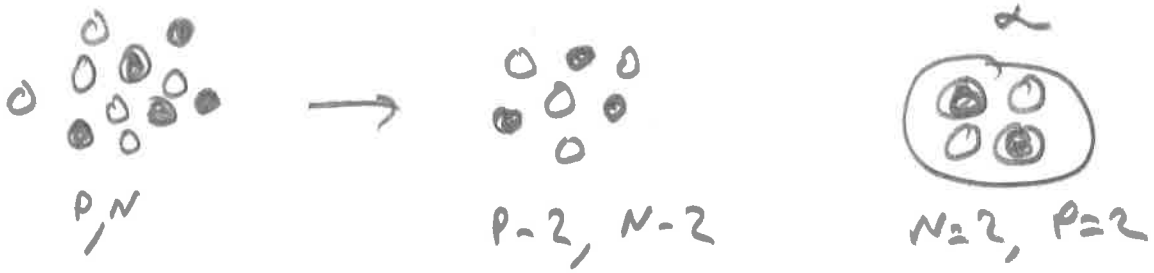
→ p are stable out side nuclei, but too many, Coulomb forces dominates



Too many protons, Electron capture

(B^+)

Too many protons or neutrons:



which is really just special case instance of nuclear fission:

Other (rarer) decay processes:

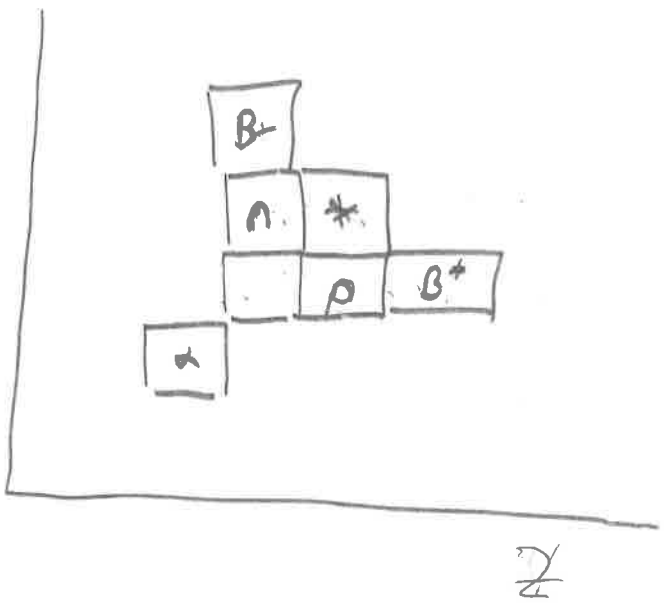
→ proton emission

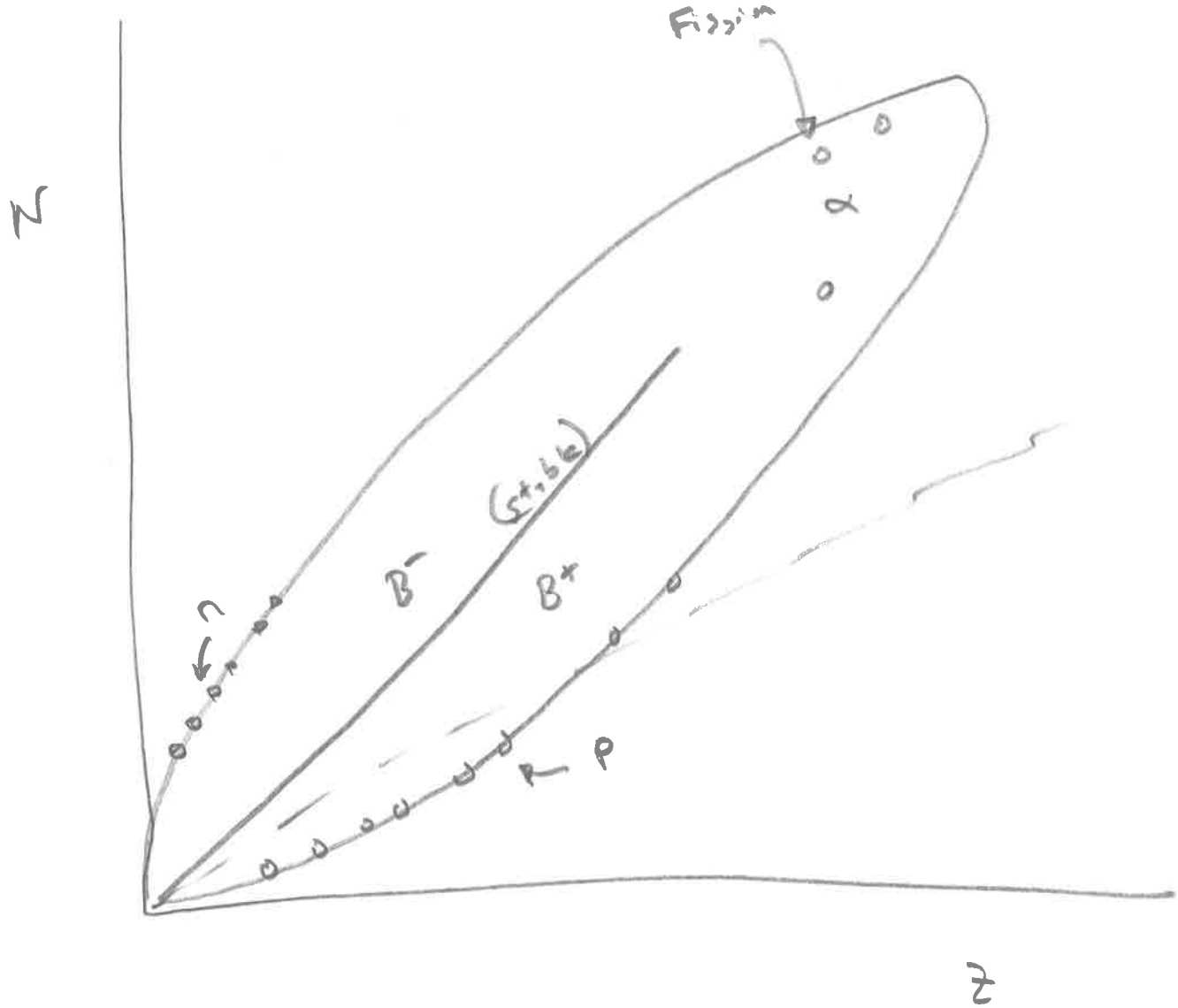
→ neutron emission

Excess p or n simply ejected.

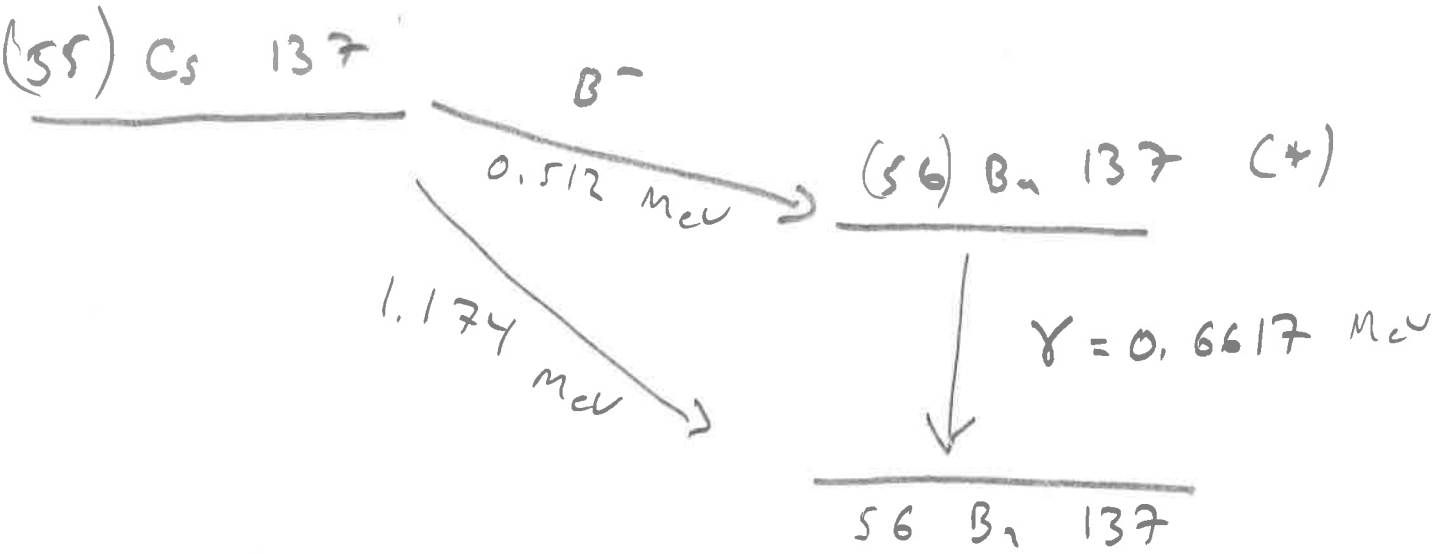
→ neutron emission is common as result of fission (extra neutrons!)

→ proton emission rare, but interesting experimentally (quantum tunelling)


N
Z
B-
n
*
p
B+
α


N
Z
Fission
α
B-
(stable)
B+
n
p
R

Often, nuclear decays result in a nucleus that is not in its ground state. It reaches ground state by γ emission



55 Cs 137 : 136.90709 amu

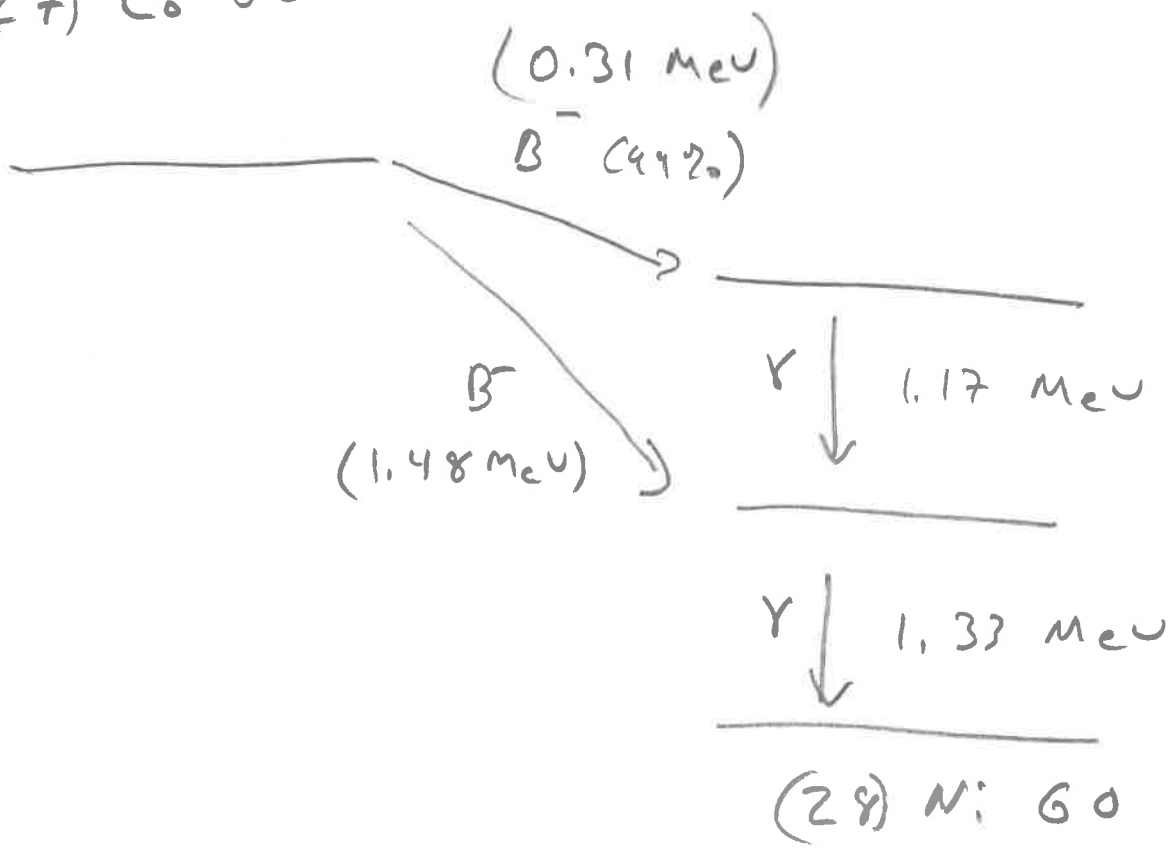
56 Ba 137 : 136.90582 amu

Δm = 0.00127 amu

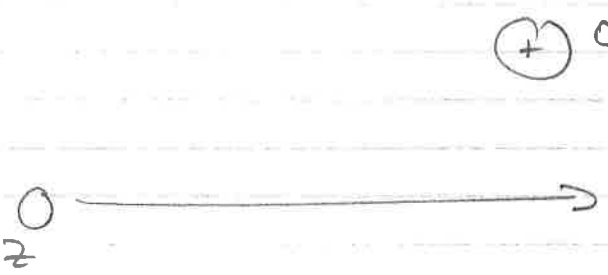
(1 amu) c^2 = 931×10^6 eV

$\Delta m c^2 \sim$ 1.18 MeV

(27) Co 60


(0.31 MeV)
β^- (99.8%)
β^-
(1.48 MeV)
γ
1.17 MeV
γ
1.33 MeV
(28) Ni 60

Passage of charged particles:



As charged particles move through medium, loose energy in a number of ways.

→ Ionize atoms by liberating electrons

→ Multiple Scattering, from nuclei

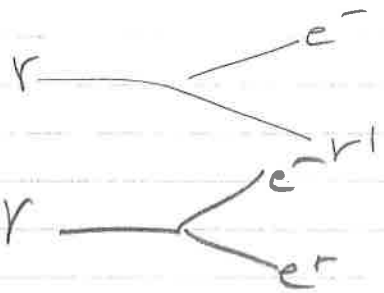
→ For light particles acceleration causes radiation (bremsstrahlung)

Photons

(a) Photo-electric effect

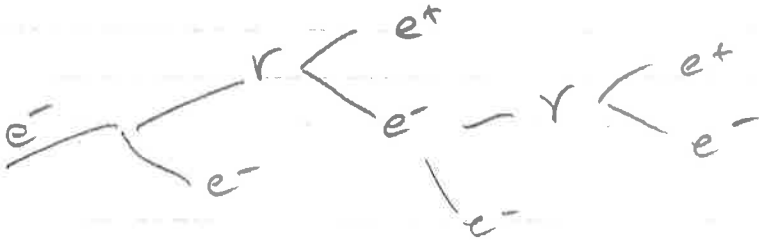
(b) Compton Scattering

(c) Pair production

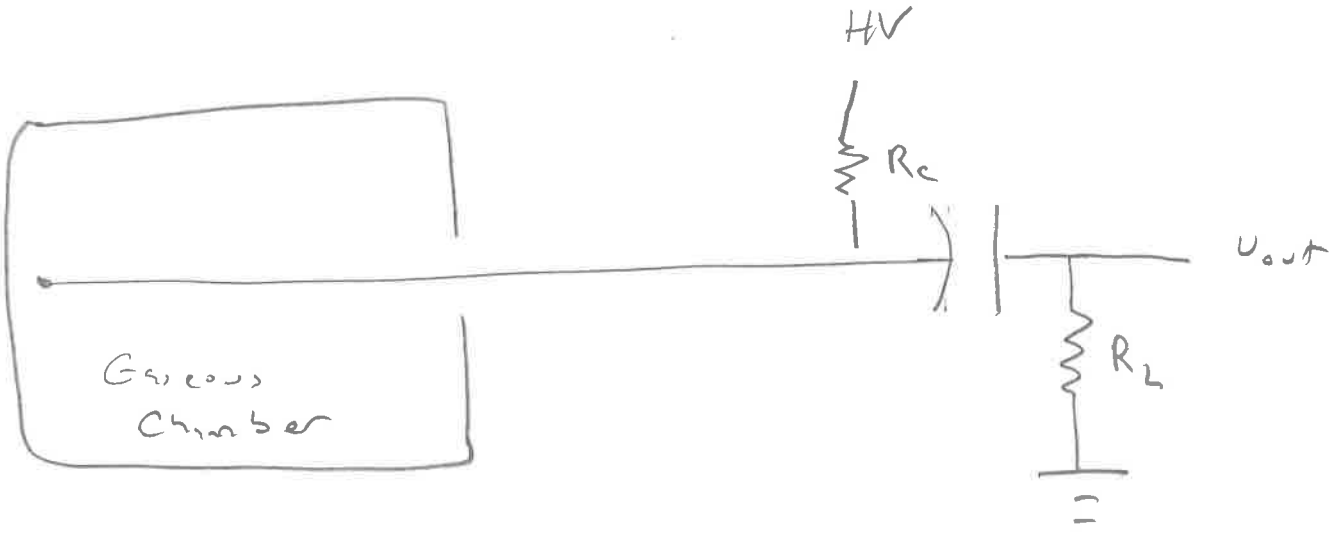


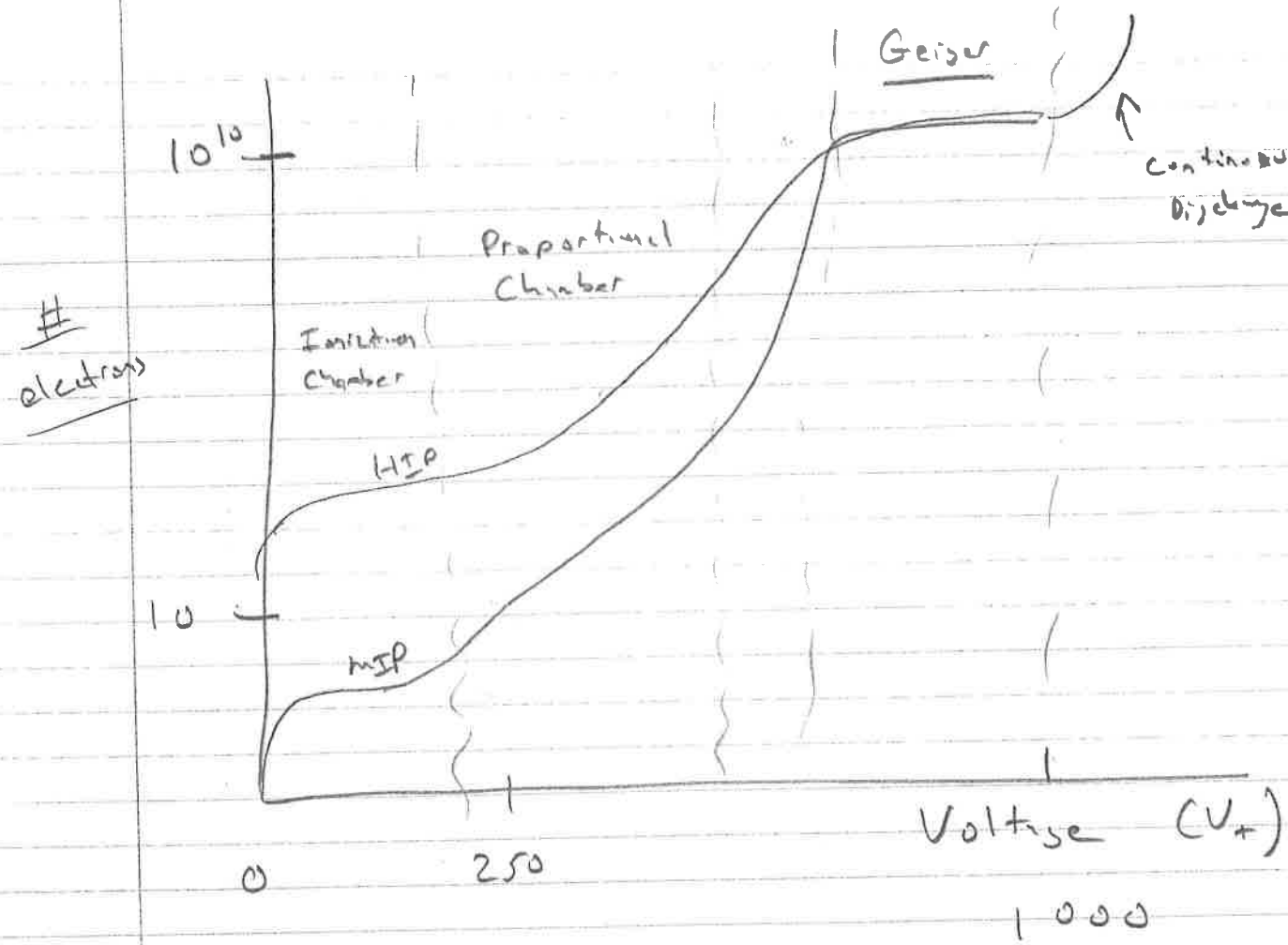
Energy ↓

Cascades:



Geiger Counter





As voltage increased:

(1) Collect ionized charge

(2) Voltage accelerates electrons to high energy energy to cause additional collisions, liberating additional electrons

(3) Saturation

From plot

$$V = \frac{Q}{C} = \frac{1.6 \times 10^{-19} C \times 10^{10}}{10^{-9} F} = \boxed{1.6\ V}$$

$\Rightarrow$ Proportion Chambers require tiny electronics.