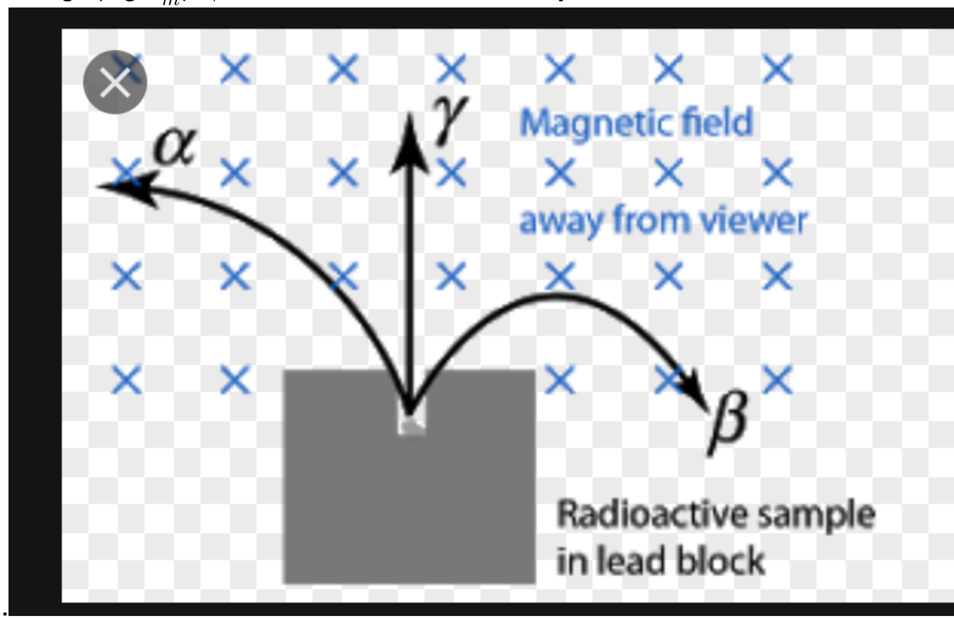
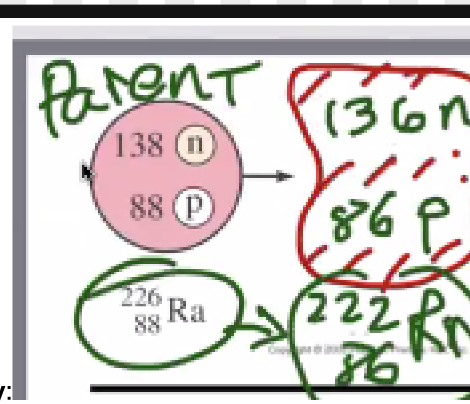
—title: Nuclear Physicssource: [[KBPhysicsMasterIndexcourse]]: PHYS201author: Houjun Liu—# Nuclear PhysicsFirst of all, recall [[KBhPHYS201ColoumbsLaw]]. Given the force between two particles is $\frac{kQ^2}{R^2}$, we could hand-wavily calculate the *work* between two particles if we know how much they travel near/far from each other. Through this, we could show that nuclear forces (through nuclear distance, proton=>electron) are much larger than that of the chemical forces (atom/atom, electron=>electron).#compilefromnoteRemember: $A_{nucl} = \frac{1}{10^{10}} A_{atom}$## RadioactivityRadiation is the emition of waves — lights, heat, etc. etc. We call something "radioactive" if it emits ionizing radiation: that it has enough energy to liberate an electron from an atom.### Geiger Counter#inserthowgeigercountersowrkBecause of the fact that Geiger counters require time to discharge, there is a certain rate called "dead time" during which Geiger counters simply sit and do nothing. As such, we have to account for this lossy "deadtime" of Geiger counters by relating the two values with the following equation$T = \frac{M}{1-(M/L)}$, where M is the measured rate of radiation and L is the "dead time" — the upper limit of the Geiger counter in question.### Radio Charge Types- α: positively charged + relatively massive (low $\frac{q}{m}$)- β: negatively charged + relatively high charge (high $\frac{q}{m}$)- γ: neutralThis could be seen by how these three types of charge curve into a magnetic field.



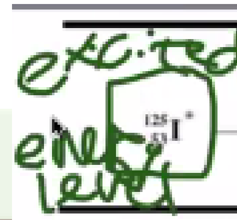
Apply right hand rule 1.5.### Creating a ray"Split a nucleus, somehow"**Alpha Decay**:



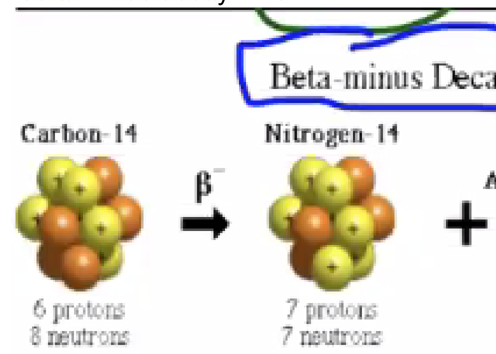
alpha decay, a massive nucleolus spits out a Helium-resulting part of itself to get rid of 2 protons and 2 neutrons. So, formally…

Gamma Decay Instead of splitting part of the nucleus, gamma decay spits an electrically excited (so… chemistry, charged, energy level, that stuff) atom *γ decay:*

$$ {}^{A}_{Z}\mathrm{N}^{*} \rightarrow {}^{A}_{Z}\mathrm{N} + \gamma $$



into a normal, non-excited atom and also emits a photon.
now, the most confusing one…**Beta Decay**There's two types of beta decay: "beta-minus" decay and "beta-plus" decay. When folks talk about just "beta-decay", they are talking about beta-minus decay.An el-



ement decays from the parent element into a different nucleus._Beta minus decay_
this case, the nucleus gained a proton and lost a neutron. What happened? A neutron in the nucleus turned into a positive proton and a negative electron. The newly-formed electron comes flying out as a "beta-minus" particle. Also, this process creates an "antineutrino", which is a tiny, charge-less element that will become important later._Beta plus decay_This is the opposite of beta-minus decay. The element

β decay:

$$ {}^{A}_{Z}\mathrm{N} \rightarrow {}^{A}_{Z+1}\mathrm{N}' + e^{-} + \bar{\nu} $$

$$ {}^{A}_{Z}\mathrm{N} \rightarrow {}^{A}_{Z-1}\mathrm{N}' + e^{+} + \nu $$

$$ {}^{A}_{Z}\mathrm{N} + \mathrm{e}^{-} \rightarrow {}^{A}_{Z-1}\mathrm{N}' + \nu\ [\mathrm{EC}]^{\dagger} $$

takes one of its protons