Decay diagrams Activity

- Colored quark == 
- Anti-colored antiquark == 
- **Color-neutral objects**
  - Baryons: Red-Green-Blue quarks combined (or Antibaryons: antiRed-antiGreen-antiBlue)
  - Mesons: Any 'color + anti-color'
- Using the tables of baryons and mesons*+, identify
  - One baryon that decays weakly and one that decays strongly
  - One meson that decay weakly and one that decays strongly
- On the next slide fill in your four decays

* Particles that decay via the strong interaction have lifetime ~ 10^{-23} sec, whereas those that decay weakly (typically) have lifetime > 10^{-14} sec. Skip particles that decay to photons (those are electromagnetic decays)

+List of conventional baryons & quark content
https://en.wikipedia.org/wiki/List_of_baryons

+List of conventional mesons & quark content
https://en.wikipedia.org/wiki/List_of_mesons
(see "Meson properties")

Quark	charge
d	-1/3
u	+2/3
s	-1/3
c	+2/3
b	-1/3
t	+2/3

Fill in the table

First row is provided as an example

Parent particle	Quark content	Mass (MeV/c^2)	Lifetime (sec)	Strong or Weak decay?	Decay Products (up to 3) #1 (quarks)	#2 (quarks)	#3 (quarks)
Δ^{++}	uuu	1232	5.63×10^{-24}	Strong	p(uud)	$\pi^+(u\bar{d})$	

Now, using the rules of weak & strong decays, make decay diagrams

Strong decays:

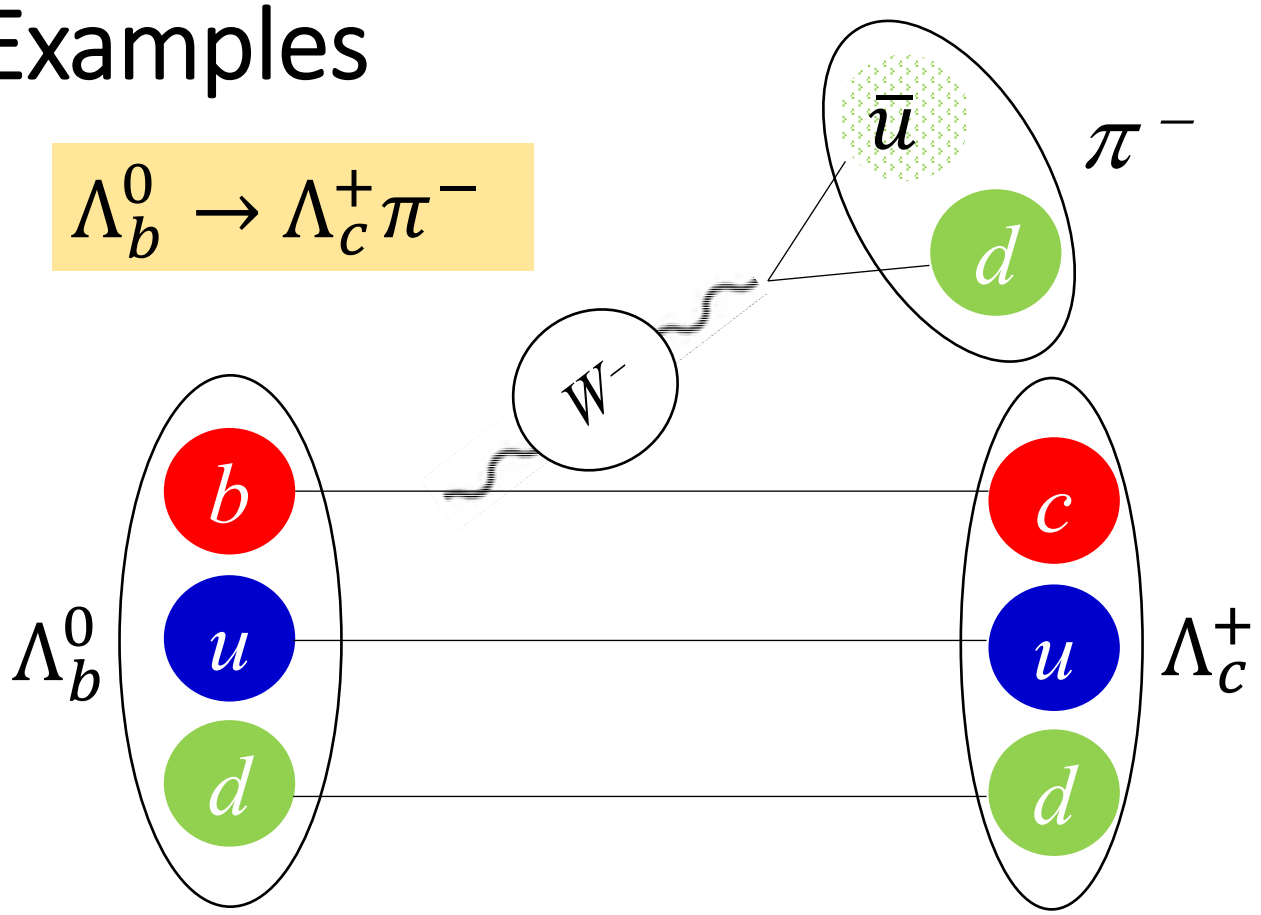
- ❑ **Always** involve gluons
- ❑ Gluons can be "radiated" off of any quark, and produce a quark-antiquark pair **of the same quark type.** (e.g. $u\bar{u}$)
- ❑ The quarks produced can have any combination of color-anticolor, but final state hadrons must be color neutral.

Weak decays:

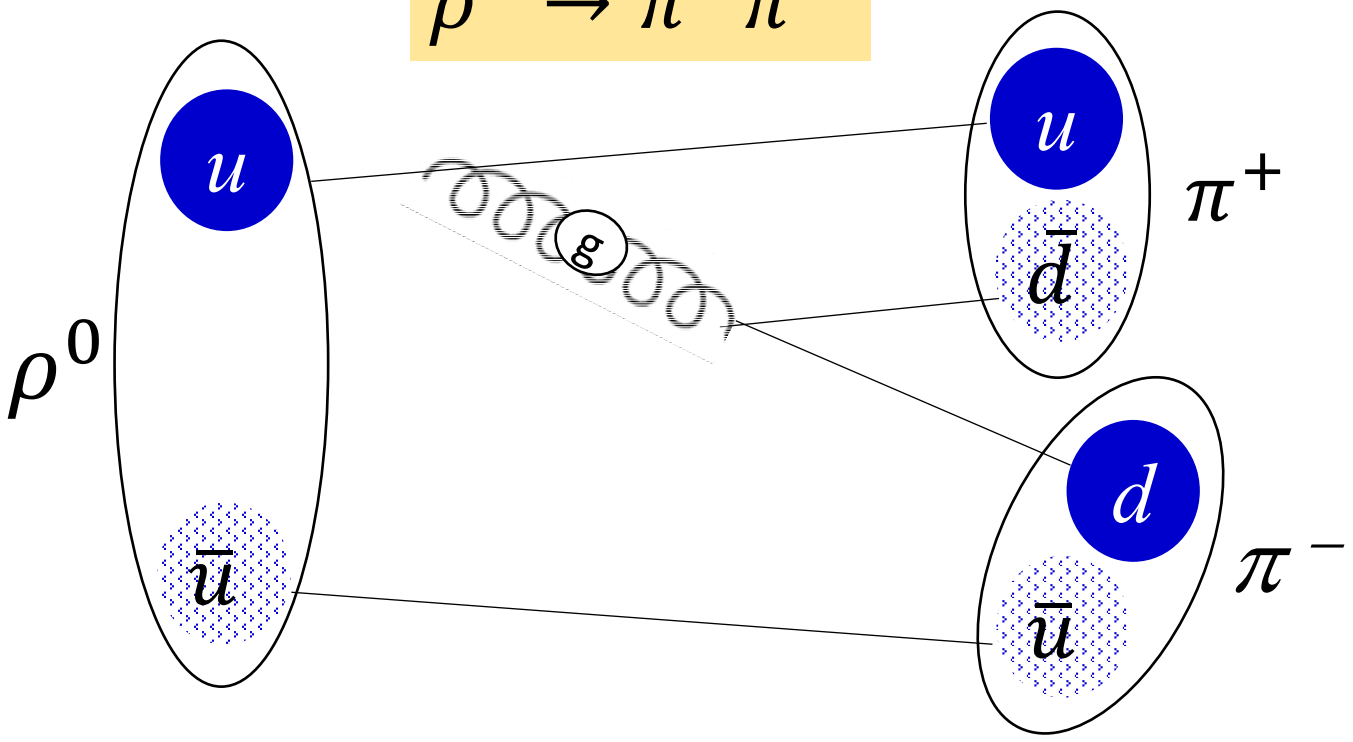
- ❑ Always involve W^+ or W^- bosons.
- ❑ Allow heavy quarks to decay to lighter ones, **but** the charge must change by 1 unit (and charge must be conserved in the process), e.g. $b \rightarrow c W^-$ (Also allows heavier μ^- and τ^- leptons to decay.)
- ❑ W^- bosons decay to either quarks: $W^- \longrightarrow \bar{u}d, \bar{c}s, \bar{u}s, \bar{c}d,$ or *pairs of leptons:* $e^-\bar{\nu}_e, \mu^-\bar{\nu}_\mu, \tau^-\bar{\nu}_\tau,$ (for W^+, replace all particles with their antiparticles)

Examples

$\Lambda_b^0 \to \Lambda_c^+ \pi^-$



$\rho^0 \to \pi^+ \pi^-$



Additional decays you can use

Some weak decays
$D^0(c\bar{u}) \rightarrow K^-\pi^+$
$D^0(c\bar{u}) \rightarrow K^-\mu^+\bar{\nu}_\mu$
$D^+(c\bar{u}) \rightarrow \bar{K}^0 e^+\bar{\nu}_e$
$D_s^+ \rightarrow \phi\,\pi^+$
$B^-(b\bar{u}) \rightarrow D^0(c\bar{u})\,\pi^-$
$B^-(b\bar{u}) \rightarrow D^0(c\bar{u})\,K^-$
$B^-(b\bar{u}) \rightarrow D^0(c\bar{u})D_s^-(\bar{c}s)$
$B_s^0 \rightarrow D_s^+\pi^-$
$\Lambda_c^+ \rightarrow \Lambda K^+$
$\Lambda_b^0 \rightarrow \Lambda_c^+\pi^-$
$\Lambda_b^0 \rightarrow J/\psi\,\Lambda$
$\Xi_b^- \rightarrow J/\psi\,\Xi^-$
$\Omega_b^- \rightarrow J/\psi\,\Omega^-$

Some strong decays
$K^{*-} \rightarrow K^-\pi^0$
$D^{*+}(c\bar{d}) \rightarrow D^0\pi^+$
$D^{*+}(c\bar{d}) \rightarrow D^+\pi^0$
$D_s^{*+} \rightarrow D_s^+\pi^0$
$\Upsilon(b\bar{b}) \rightarrow B^+B^-$

- If the quark content not listed above, you should be able to find it in the Wikipedia tables (or ask one of us)
- Note: On the Wiki page, the quark content is shown for the particle. For the antiparticle, you have to replace all quarks with antiquarks, and vice versa.