

Lecture 11

1

Strangeness was postulated to be a conserved quantum number in strong interactions.

Weak decays violated strangeness conservation but these particles lived long enough to be seen directly before they decayed.

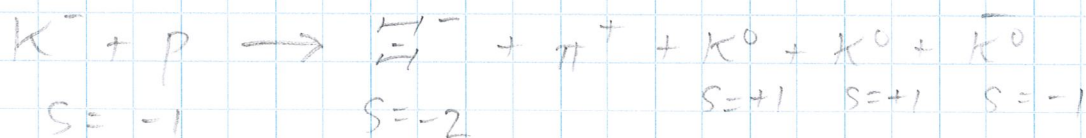


Initial strangeness is 0.

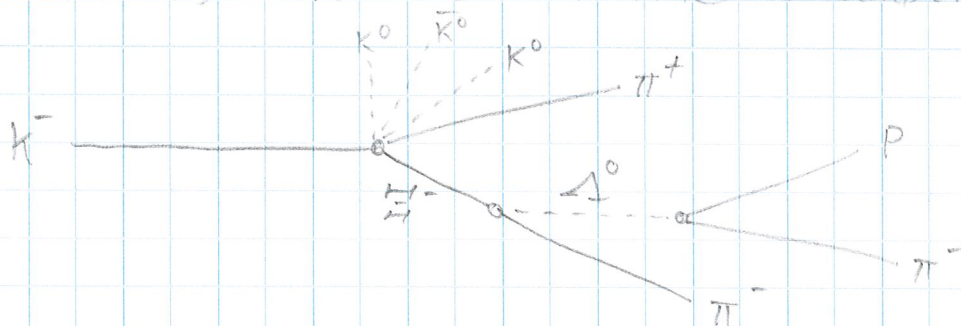
Σ^+ has strangeness +1

K^- has strangeness -1.

Strangeness is assigned to for example, the K^+ by convention to be +1. This establishes the strangeness for all other particles.



The Ξ^- decays to $\Lambda\pi^-$, creating a "cascade" of tracks in a bubble chamber:



Pseudoscalar mesons (spin 0)

$S = +1$	K^0	K^+	$m \sim 500 \text{ MeV}$	
$S = 0$	π^-	π^0	π^+	$m \sim 140 \text{ MeV}$
$S = -1$	K^-	$\bar{K}^0$	$m \sim 500 \text{ MeV}$	

Spin $1/2$ baryons

$S = 0$	n	p	$m \sim 940 \text{ MeV}$	
$S = -1$	Σ^-	Σ^0/Λ^0	Σ^+	$m \sim 1190 \text{ MeV}$
$S = -2$	Ξ^-	Ξ^0	$m \sim 1315 \text{ MeV}$	

Note that the K^+ and K^- are anti-particles but the Σ^- and Σ^+ are not.

Σ^- and Σ^+ are both baryons.

Their anti-baryon counterparts are indicated by $\bar{\Sigma}^-$ and $\bar{\Sigma}^+$.

Likewise $\bar{\Xi}^+$ and $\bar{\Xi}^0$ are anti-baryons.

The proton and neutron have almost identical mass.

Treat them as two states of the same type of particle (the nucleon).

Assign them "isospin" quantum numbers

$$|p\rangle = |\frac{1}{2} \ +\frac{1}{2}\rangle_I$$

$$|n\rangle = |\frac{1}{2} \ -\frac{1}{2}\rangle_I$$

The pions form a triplet

$$|\pi^+\rangle = |1 \ +1\rangle_I$$

$$|\pi^0\rangle = |1 \ 0\rangle_I$$

$$|\pi^-\rangle = |1 \ -1\rangle_I$$

The $S=+1$ kaons form a doublet

$$|K^+\rangle = |\frac{1}{2} \ +\frac{1}{2}\rangle_I$$

$$|K^0\rangle = |\frac{1}{2} \ -\frac{1}{2}\rangle_I$$

So do the $S=-1$ kaons

$$|K^-\rangle = |\frac{1}{2} \ -\frac{1}{2}\rangle_I$$

$$|\bar{K}^0\rangle = |\frac{1}{2} \ \frac{1}{2}\rangle_I$$

Vector mesons have spin 1 :

$S = +1$	K^{*0}	K^{*+}	$m \sim 892 \text{ MeV}$
$S = 0$	ρ^-	ρ^0	$m \sim 776 \text{ MeV}$
$S = -1$	K^{*-}	$\bar{K}^{*0}$	$m \sim 892 \text{ MeV}$

Similarly, a collection of spin $3/2$ baryons was observed

$S = 0$	Δ^-	Δ^0	Δ^+	Δ^{++}	$m \sim 1230 \text{ MeV}$
$S = -1$		Σ^{*-}	Σ^{*0}	Σ^{*+}	$m \sim 1385 \text{ MeV}$
$S = -2$		Ξ^{*-}	Ξ^{*0}		$m \sim 1530 \text{ MeV}$
$S = -3$			Ω^-		$m \sim 1670 \text{ MeV}$