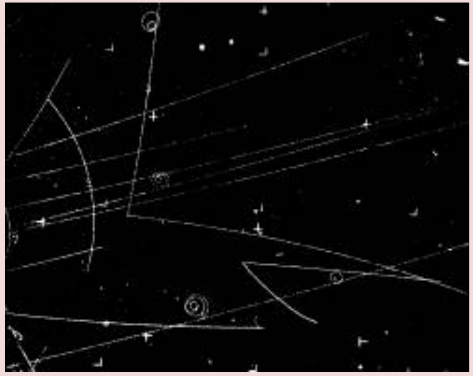
2.4 Quarks and Antiquarks

Strangeness

- When the kaons were discovered in 1946, they were referred to as **strange particles** because their lifetimes were about 10^{-8} s, about a million billion times longer than particle physicists expected. Four kaons were found: the charged κ^+ and κ^- and two neutral particles, κ^0 and $\overline{\kappa_0}$.
- Kaons are produced, like pions, from the strong interaction when hadrons collide, (e.g. when pions collide with protons or when protons collide with nuclei).
- They have longer lifetimes than pions because they decay via the weak interaction, whereas pions decay via the strong interaction.
- In all interactions involving kaons, charge, lepton number and baryon number are conserved, yet some interactions which would obey these conservation rules were never observed. This is because kaons have another property which must also be conserved. It was given the name **strangeness** (S). Kaons have the following strangeness numbers:



Originally, kaons were named V-particles because of the characteristic V-shaped tracks they left in cloud chambers. The angle between the tracks was too large for them to be caused by electron-positron pairs.

Particle	κ^+	κ^-	κ^0	$\overline{\kappa_0}$
Strangeness (S)	+1	-1	+1	-1

Strangeness *(continued)*

- Strangeness is **always** conserved in a strong interaction but not in a weak interaction.
- Other strange particles exist, such as the sigma particles (Σ^+, Σ^-, Σ^0), but these have rest masses greater than protons and decay either directly or in a sequence of decays into protons and pions.
- The discovery of the kaons was followed quickly by the discovery of many more mesons and baryons. As accelerator energies increased, so increasingly massive hadrons revealed themselves, such as the lambda (Λ) particles.

Examples of interactions involving strange particles

$$\pi^- + p \longrightarrow \kappa^+ + \Sigma^-$$

This interaction is observed, (charge, baryon number lepton number and strangeness are all conserved.

$$\pi^- + n \longrightarrow \kappa^- + \Sigma^0$$

This interaction is **not** observed, (charge, baryon number and lepton number are conserved but strangeness is not.