A strange puzzle

Less than a year after Powell's discovery, further cloud chamber photographs revealed the existence of short-lived particles we now refer to as **K mesons** or kaons. Like π mesons, they are produced through the strong interaction, when protons moving at high speed crash into nuclei and they each travel far beyond the nucleus in which they originate before they decay – in other words, they decay through the weak interaction, even though they were created through the strong interaction. However, their decay products include π mesons. These and other properties of K mesons led to them being called **strange particles**. We will return to their strangeness in Topic 2.4.

All the new particles listed above can also be created using accelerators in which protons collide head-on with other protons at high speed. The kinetic energy of the protons is converted into mass in the creation of these new particles. So these new particles could be studied under controlled conditions using accelerators to create them.

The rest masses, charge (if they were charged) and lifetimes of the new particles were measured. Their antiparticles, including the **antimuon**, were detected. Their decay modes were worked out:

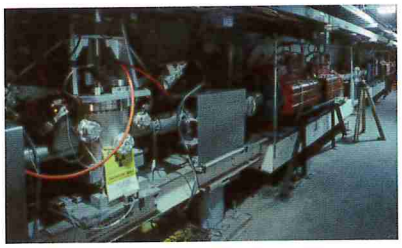
- K mesons decay into π mesons, muons and antineutrinos, and antimuons and neutrinos.
- Charged π mesons decay into muons and antineutrinos, or antimuons and neutrinos. The π^0 meson decays into high energy photons.
- Muons and antimuons decay into electrons and antineutrinos, or positrons and neutrinos.
- The decays always obey the conservation rules for energy (and momentum) and for charge. We will see in Topic 2.5 that there are some further rules that tell us which interactions and decays are allowed.

About accelerators

A TV tube is an accelerator because it accelerates electrons inside the tube through a potential difference of about 5000 V. The electrons form a beam that hits the inside of the TV screen. Magnetic fields produced by electromagnets deflect the beam so it scans the screen to create an image. LCD (liquid crystal display) TVs work on a different principle.

- The longest accelerator in the world is the Stanford linear accelerator in California. It accelerates electrons over a distance of 3 km through a potential difference of 50 000 million volts. The energy of an electron accelerated through this pd is 50 000 MeV (= 50 GeV). When the electrons collide with a target, they can create lots of particle–antiparticle pairs.
- The biggest accelerator in the world, the Large Hadron Collider at CERN near Geneva, is designed to accelerate charged particles to energies of more than 7000 GeV. Unlike a linear accelerator, this accelerator is a 27 km circumference ring constructed in a circular tunnel below the ground. It is used by physicists from many countries to find out more about the fundamental nature of matter and radiation. Protons, neutrons, π mesons and K mesons are all examples of particles that we call **hadrons** because they experience the strong interaction. We will learn more about hadrons in the next topic.

a *A TV tube*



b *The Stanford linear collider*

Figure 2 *Accelerators*

Summary questions

1 **a** List the following particles in order of increasing rest mass:

the electron, the K^0 meson, the muon, the neutron, the π^+ meson, the proton.

b Which of the above particles are uncharged?

2 State whether the strong or the weak interaction acts when

a a muon decays

b a K meson decays

c π mesons are produced.

3 **a** Which creates the longer trail in a cloud chamber, a muon or a π^+ meson?

b In terms of their properties, state one similarity and one difference between a muon and a π meson.

4 A high-energy collision between two protons creates π mesons and K mesons which then decay.

a What happens to **i** the K mesons? **ii** the π mesons?

b What particles are ultimately formed by the above decays?