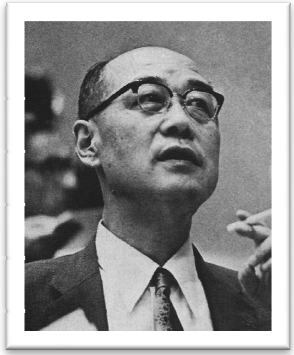
2.1 The Particle Zoo

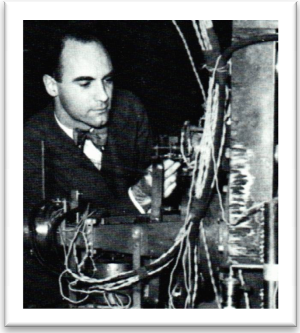
- In 1935, Hideki Yukawa, a Japanese theoretical physicist working in Kyoto, had developed a theory of the way the **strong nuclear force binds** nuclei together. He proposed that there should exist a particle (boson) responsible for carrying this force which would have a rest mass of more than 250 times that of an electron and a lifetime of about 10^{-8} s.

- A year later, Carl Anderson, a researcher at Caltech, presented his evidence for the existence of a new particle, discovered in cloud chamber tracks produced by cosmic rays. It had a mass between that of an electron and a proton. It was named the **mesotron** and later shortened to **meson**. Yukawa thought Anderson had found his force-carrying particle but he was wrong. The particle, now known as the **muon** is a lepton with a lifetime about 100 times longer than Yukawa's particle should have had. Its cloud chamber tracks were therefore much longer.

- The Yuawa particle was discovered 10 years later by British physicist Cecil Powell and is now known as the **π meson** or **pion**.



Hideki Yukawa



Carl Anderson

Particles revealed by cosmic rays

The new types of particle discovered in high-energy cosmic ray collisions included the muon (μ), the pions (π^+, π^- and π^0) and the kaons or kappa mesons (κ^+, κ^- and κ^0).

2.1 The Particle Zoo

The relative masses of the kaon, pion amd muon can be represented as:

$$m_p > m_\kappa > m_\pi > m_\mu > m_e$$

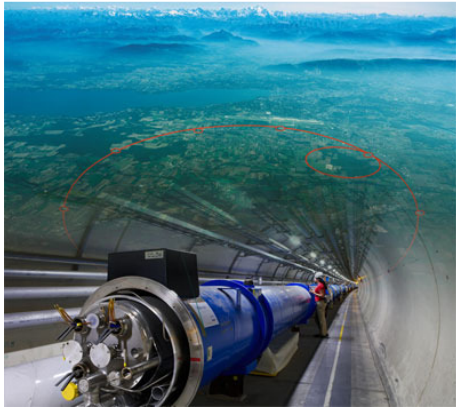
where m_p = proton mass and m_e = electron mass.

Particle Decays

κ mesons decay into muons + antineutrinos,antimuons + neutrinos, and π mesons.
Muons and antimuons decay into electrons + antineutrinos or positrons+ neutrinos.
Charged π mesons decay into muons + antineutrinos or antimuons + neutrinos.
Neutral π mesons decay into high energy photons.

Particle Accelerators

New particle discoveries have been made as accelerating machines have become more and more powerful, allowing them to smash existing particles together at higher and higher energies.
The biggest linear accelerator is at Stanford University in California. At 3 km long, it achieves energies of 50 GeV.
The largest circular accelerator is the newly-opened Large Hadron Collider at CERN in Geneva. It has a circumference of 27 km and accelerates particles to energies of more than 7000 GeV.



The Large Hadron Collider