M.8.2.6   Cosmic Muons

Videos: Muon Decay
               Muons and Einstein

Muons are elementary particles that can be created in the laboratory where they are nearly at rest. Their average lifetime under these circumstances (proper time) Δt_0 = 2.2 µs.

Muons are also created high (several kilometres) in the atmosphere by the action of cosmic rays and are then travelling with a typical velocity of v = 0.999 c.

Using classical Newtonian mechanics we would calculate the average distance that a muon could travel is **2.2 µs × 0.999 c = 650 m**.

This would suggest that only a few muons would ever reach the earth's surface. BUT muons from the upper atmosphere reach the earth's surface in abundance.

To resolve this inconsistency use **relativistic** (rather than Newtonian) mechanics

Using

$$t = \gamma \, t_0$$

$$t = \frac{2.2 \times 10^{-6}}{\sqrt{1 - \frac{(0.999 \, c)^2}{c^2}}}$$

$t = 49.2 \, \mu s$ as seen by the observer on Earth

In this time the muon could travel **49.2 µs × 0.999 c = 14745 m = 14.7 km**

Thus the muons are able to reach the Earth.

Text Questions: Page 219 Questions 8, 9, 10