

**Exercise sheet 9****1. Energy losses.**

- a.) Find the time evolution of the energy,  $E(t)$ , of a particle suffering quadratic energy losses,  $-dE/dt = bE^2$ .
- b.) Compare the energy density of a magnetic field with  $B = 3\mu\text{G}$  and of the CMB. Determine  $b$ .
- c.) Make a  $E(t)$  plot for a 0.1, 1, 10, 100 TeV electron. Assuming a diffusion coefficient  $D(E) = D_0(E/E_0)^{1/3}$  with  $D_0 = 5 \times 10^{26} \text{cm}^2/\text{s}$  and  $E_0 = 10 \text{GeV}$ , what do you conclude if 10 TeV electrons are observed at Earth?

**2. Charged pion decay.**

Discuss the decay of a charged pion,  $\pi^+ \rightarrow \mu^+ + \nu_\mu$  analogous to the decay of a neutral pions.

**2. Muon decay.**

Consider the decay of the muon  $\mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu$  (at rest): find the condition that the electron energy is maximal.