Problem 1 – 5-4 The lifetime of the ρ-meson is about 10^{-23} s in its own rest-frame. If the shortest distance that can be resolved in a photograph of a ρ-production process in a bubble chamber is about 10^{-4} cm, how fast must such a meson travel for us to see it? By the time it decays, how far would the ρ think the bubble chamber had moved?

Problem 2 – 5-8 As we shall see in later chapters, measurement of the energy of a particle gives us the quantity $\gamma \equiv 1/\sqrt{1 - v^2/c^2}$ where v is the speed of the particle. A cosmic-ray proton with a world record energy was (indirectly) detected in 1991, having $\gamma = 6 \times 10^{14}$. (a) Find the speed of this proton, expressed in the form $v/c = 1 - \epsilon$, where ϵ is a small quantity. That is, find the numerical value of ϵ, valid to one significant figure. (b) Suppose that instead of striking atomic nuclei (as it did) the proton had moved through 30 km of atmosphere all the way to the ground. How thick would the atmosphere have been to an observer in the proton's frame? Compare the distance with the radius of the hydrogen atom, about 0.5×10^{-10} m.