Physics 492 homework II, due Fri Jan 30

Reading: Chapters 1 and 2.1-2

Problems:

1. Williams, Problem 1.1

2. Williams, Problem 1.3

3. Williams, Problem 1.5. Skip the derivation, but illustrate your discussion with a sketch of the cross section, marking deviations.

4. (a) Prove that the energy E and momentum $\vec{p}$ of a particle with rest mass m are related by

$$E = \sqrt{(m\,c^2)^2 + (p\,c)^2}\,.$$

Start with the equations for E and $\vec{p}$ in terms of the particle's velocity $\vec{v}$.

(b) The Lorentz 4-momentum p^μ for a particle is the 4-component vector $(p^0, p^1, p^2, p^3) = (E/c, p^1, p^2, p^3)$. The Lorentz product of the 4-momenta p_1^μ and p_2^μ for two particles is defined by

$$p_1 \cdot p_2 = \frac{E_1\,E_2}{c^2} - \vec{p}_1 \cdot \vec{p}_2\,.$$

Use the Lorentz transformation equations for E and $\vec{p}$ to prove that $p_1 \cdot p_2$ is invariant under Lorentz transformations.

(c) Determine $p \cdot p$ for a particle of mass m.

5. Williams, Problem 2.1