Quantum field theory
Exercises 4.
2005-11-21

- **Exercise 4.1.**

  Consider a massive particle moving with velocity $v = \tanh \eta$.

  - Show that, if E is the energy of the particle and p its momentum along the propogation direction, then
  $$\eta = \frac{1}{2} \log \frac{E+p}{E-p} \,.$$
  - Verify that under a boost in the direction of motion of the particle with velocity v' (and corresponding rapidity $\eta' = \operatorname{arctanh} v'$) η transforms additively
  $$\eta \to \eta + \eta' \,.$$

- **Exercise 4.2.**

  Prove that, if ψ_R and ξ_R are right-handed Weyl spinors, $\xi_R^\dagger \sigma^\mu \psi_R$ is a four-vector, and similarly for $\xi_L^\dagger \bar{\sigma}^\mu \psi_L$, where ξ_L, ψ_L are left-handed Weyl spinors.

- **Exercise 4.3.**

  Find the explicit form of the variation of an antisymmetric tensor $F^{\mu\nu}$ under an infinitesimal Lorentz transformation. Writing $F^{0i} = -E^i$ and $F^{ij} = -\varepsilon^{ijk} B^k$, find the infinitesimal transformation of E^i and B^i.