Back-of-the-Envelope Physics

Winter Term 2022/23

Sheet 4

1. Show that the relativistic Larmor formula for the power radiated by an accelerating point charge e with 4-velocity u, can also be written in terms of the 3-velocity $\vec{\beta} = \vec{v}/c$

$$P = -\frac{2}{3}\frac{e^2}{c}\left(\frac{du}{d\tau}\right)^2 = \frac{2}{3}\frac{e^2}{c}\gamma^6\left(\dot{\vec{\beta}}^{\,2} - (\vec{\beta}\times\dot{\vec{\beta}})^2\right), \tag{1}$$

as given in the second expression of (1).

2. Evaluate the relativistic equation of motion

$$m\frac{d^2x^\mu}{d\tau^2} = qF^{\mu\nu}u_\nu$$

for $\mu = 0$ and give an interpretation of the result.

3. Find the Green function $G(r)$ with the property

$$(-\Delta + m^2)G(r) = 4\pi\delta(\vec{x})$$

4. Using natural units, compute the energy of the scattered photon in the Compton process

$$\gamma(k)e^-(p) \to \gamma(k')e^-(p')\,,$$

where the initial electron is at rest. k, p, k' and p' are the 4-momenta of the particles, as indicated.