Physics 323. Problem set V. Tuesday, May 13, 2003

DUE TUESDAY, MAY 20, 2003

1. The generic expression for the energy radiated per unit time and unit of solid angle by a particle of charge q is given by

$$\frac{dP}{d\Omega} = \frac{q^2}{4\pi c}\left[\frac{\dot{\vec{\beta}}^2}{\left(1-\vec{\beta}\,\vec{n}\right)^3} + \frac{2(\vec{\beta}\dot{\vec{\beta}})\left(\vec{n}\,\dot{\vec{\beta}}\right)}{\left(1-\vec{\beta}\,\vec{n}\right)^4} - \frac{\left(\vec{n}\,\dot{\vec{\beta}}\right)^2}{\gamma^2(1-\vec{\beta}\,\vec{n})^5}\right] \tag{1}$$

a. Use the above expression to determine the angular distribution of radiation in the case in which the velocity is perpendicular to the acceleration at the time of emission.

b. Describe the angular distribution of radiation. Assuming that the velocity is along the z-axis direction, and the acceleration is in the direction of the x-axis, and calling θ the angle between the radius vector and the z-axis, and ϕ the angle between the projection of the radius vector on the x-y plane and the x-axis, make the partial integration over the angle θ. Describe the energy radiated per unit time in a small angular interval $\Delta\phi$ as a function of the angle ϕ.

c. Integrate the resulting expression over the angular variables and demonstrate that

$$P = \frac{2\,q^2\,|\dot{\vec{u}}|^2\,\gamma^4}{3c^3} \tag{2}$$

2. Jackson, Problem 14.4

3. Jackson, Problem 14.9

4. Jackson, Problem 14.11