Homework Problems I

1. Up to now, we have done the electrodynamics in the beam frame. In most of the literature the calculation is done in the lab frame. Reproduce Eqns. 2.17, working entirely in the lab frame, starting from the standard formula from Jackson's *Classical Electrodynamics:*

$$\frac{d^2E}{d\omega d\Omega} = \frac{e^2\omega^2}{8\pi^2 c}\left|\int_{-\infty}^{\infty} \vec{n}\times\left(\vec{n}\times\vec{\beta}(t)\right)e^{i\omega\left(t-\vec{n}\cdot\vec{r}(t)/c\right)}dt\right|^2$$

   Show that the final results have the proper symmetry with respect to the sign of the angular frequency ω. An early reference to calculations of this type is Alferov, D. F., Bashmakov, Yu. A., and Bessonov, E. G., *Sov. Phys. Tech. Phys.,* **18**, 1336, (1974).

2. Write the interference condition for a wavefront emitted by an electron in an undulator and derive formulae for the radiation wavelength of the *n*th harmonic number and bandwidth at a fixed angle (i.e., $1/nN$).

3. Lorentz transform the undulator field ($K<<1$) into the electron frame. Notice that the field in that frame is similar to that of an electromagnetic plane wave. These "virtual" photons can be back-scattered from the electron. Lorentz transform the Thomson back-scattered photons to the lab frame and show that the radiation frequency is identical to the result obtained the lectures.