Physics 611, Fall 2014

Problem set #5 (due December 2)

1. Jackson 10.2 (no need to compare with 10.1)
2. **Double-scattering** A long-wavelength, left circularly-polarized, monochromatic plane wave scatters into the direction $\hat{k}_1$ from a uniform dielectric sphere with radius a and dielectric constant ε_r. The scattered wave travels a distance $r_1 >> a$ and scatters from an identical sphere into the direction $\hat{k}_2$. Find the twice-scattered electric field at a distance $r_2 >> a$ from the second sphere. Express your answer using polarization vectors which are (i) transverse to and (ii) parallel and perpendicular to the plane of the diagram.
3. **Preservation of polarization** A linearly polarized plane wave with polarization direction $\vec{\epsilon}_0$ is incident in a small, perfectly conducting sphere. Find the angle between the scattering wave vector $\vec{k}$ and the incident wave vector $\vec{k}_0$ where the radiated electric field points in the same direction as $\vec{\epsilon}_0$.
4. **Mie scattering from a large dielectric sphere** Find the Born approximation to the differential cross section from a uniform and lossless dielectric sphere with radius R and dielectric constant ε. Plot the cross-section for an unpolarized incident beam with $k_o R=15/2$.
5. **Radiation Pressure from Scattering** An object scatters an incident plane wave with $\vec{E}_{inc}(\vec{r},t) = \vec{\epsilon}_0 E_0 exp\left(i\vec{k}_0\vec{r} - i\omega t\right)$. Use the Maxwell stress tensor formalism to show that the time-averaged force on the object can be written in terms of the incident wave intensity I_{inc}, the total cross section σ_{tot} and the differential cross section for the scattering $d\sigma_{scat}/d\Omega$ as $\langle\vec{F}\rangle = \frac{I_{inc}}{c}\left(\sigma_{tot}\hat{k}_0 - \int d\Omega \vec{r}\frac{d\sigma_{scat}}{d\Omega}\right)$. The projection of this force on the direction $\hat{k}_0$ is often called the radiation pressure due to scattering. *Hint*: Integrate the stress tensor over the surface of the enormous sphere in the radiation zone.
6. Jackson 10.15